US Army Corps
of Engineers ®
Wilmington District

General Re-evaluation Report and Environmental Assessment
Surf City, Onslow and Pender Counties, North Carolina
Coastal Storm Risk Management Project

Appendix K: US Fish and Wildlife Service

Section 7 (a)(2) of the Endangered Species Act

and Coordination Act

Final

April 2025

US Army Corps of Engineers ®
Wilmington District

BOEM
Bureau of Ocean Energy Management

BIOLOGICAL ASSESSMENT

for

Surf City

Coastal Storm Risk Management Project

Pender and Onslow Counties, North Carolina

2024

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1.0 Project Area/Background

Topsail Island is a 22-mile-long barrier island located in Pender and Onslow counties, North Carolina. From south to north, the three communities on the island are the Towns of Topsail Beach, Surf City, and North Topsail Beach (**Figure 1**). In accordance with Congressional study authorizations, Coastal Storm Risk Management (CSRM) opportunities were evaluated for the entire island. An *Integrated Feasibility Report and Environmental Impact Statement, Coastal Storm Damage Reduction, Surf City and North Topsail Beach, North Carolina, December 2010* (2010 EIS) was prepared to evaluate coastal storm risk management along Surf City and North Topsail Beach (SCNTB). In addition, a supplemental *Environmental Assessment for West Onslow Beach and New River Inlet (Topsail Beach) and Surf City and North Topsail Beach Coastal Storm Damage Reduction Projects, July 2013* (2013 EA) was prepared to address changes that were implemented after the Environmental Impact Statements (EISs) for both projects were completed. The subject of this Biological Assessment is the 2024 Surf City CSRM General Re-evaluation Report and Environmental Assessment (GRR/EA), which was authorized by the Water Resources Development Act of 2014 and recently funded by Public Law 116-20, the Additional Supplemental Appropriations Disaster Relief Act, 2019.

The proposed action, which is the elimination of the environmental window for initial construction and expansion of the window for periodic nourishments will increase flexibility and efficiencies for initial construction and periodic nourishments for the 50-year project . This approach will also comply with the 2020 National Marine Fisheries Service's South Atlantic Regional Biological Opinion (SARBO) by reducing risks to the most vulnerable species within the project area. The authorized plan for Surf City consists of a dune (14 feet above National American Vertical Datum NAVD 88) and berm (50 feet wide at 6 feet above NAVD 88) extending along approximately 9.9 miles of shoreline. The total required sediment volume for initial construction is approximately 8.0 Million Cubic Yard (MCY). The proposed plan is the elimination of environmental window for the duration of initial construction, which is expected to take about 16 months. Due to the high number of sea turtle nests annually on Topsail Island, nourishment events (every 6 years), will be done between November 16 and April 30 to the maximum extent practicable to avoid sea turtle nesting season. For the Surf City CSRM project, increasing the timeframes when work may occur, significantly lowers risks associated with limited dredge availability. These construction activities will be abiding by all environmental conditions outlined in the 2010 EIS, including benthic and turbidity monitoring of borrow sites.

For the following resource categories there is no anticipated change in effects associated with three alternatives from those analyzed in the 2010 EIS and therefore they are not addressed in this EA: wetlands and floodplains, inlets, flats and sounds, maritime scrub thicket, beach and dune, wave conditions, shoreline and sand transport, hydrology, groundwater, air and water pollution, man-made and natural resources, community cohesion and the availability of public facilities and services, and hazardous, toxic and radioactive wastes. The focus of analysis in this section is on geology and sediments, water quality, surf zone and nearshore ocean fishes, nekton, larval entrainment, benthic resources, Essential Fish Habitat (EFH) and hard bottoms, birds, cultural resources, noise, threatened and endangered species, recreation, aesthetic and fishing resources. It should be noted that although changes in the time of year for work do not result in changes to cultural resources, cultural resources will be addressed in this section since additional survey work is required prior to construction to ensure that pipeline routes between the offshore borrow sites and the beach avoid cultural resources.

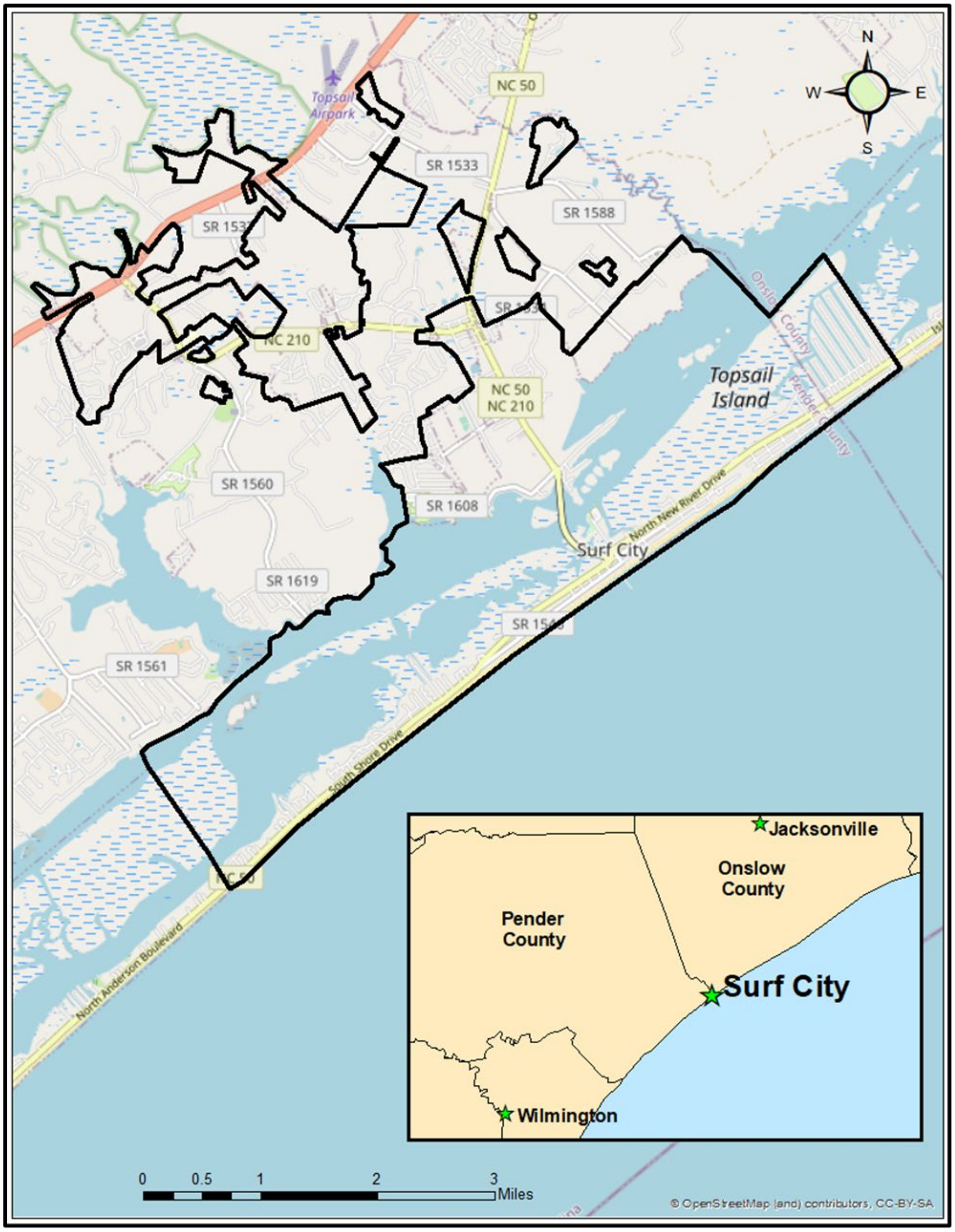


Figure 1. Project Location and Vicinity Map.

Subsurface investigations using a combination of boring data and geophysical surveys were used to identify and define borrow areas for the Surf City project. Based on these initial study phase investigations, 20 borrow areas were identified (Borrows A-T) located between 1-5 miles offshore of Topsail Island. Further investigations determined that 13 of these borrows (A, B, C, D, E, F, G, H, J, L, N, O, and P) contained sufficient beach quality sand to the meet the 50-yr volume requirements (**Figure 2**).

In 2010 and 2011, the Pre-construction Engineering and Design (PED) phase of work was completed for the Surf City CSRM project. The PED phase included additional analysis of the previously identified borrow areas and confirmed the presence of adequate volumes of beach quality sand for the Surf City 50-year project. Specific information regarding the PED phase and outcomes can be found in the July 2013 EA/FONSI. Otherwise, confirmatory bathymetric surveying of borrow areas was performed during March of 2020. Respective data are still being assessed, which may result in adjustments to volumetric estimates of suitable sand.

As part of the borrow area use plan, the contractor will recover the maximum amount of beach nourishment material within one portion of a borrow area before relocating to another portion of the same borrow area or to a separate borrow area. Maximum recovery of material shall be determined by dredging equipment efficiencies, entrainment of unsuitable nourishment material, or the maximum dredging depth determined by the government, whichever depth is less.

If non-beach quality material from the borrow areas is placed on the beaches, a screen will be installed on the inflow and outflow pipes to prevent further placement of large shells, clay balls, or rocks. These screens, which shall be onsite during construction, will have a 3/4 inch to 1-inch screen to prevent larger material from being placed on the beach. If non-beach quality material is placed on the beach, dredging will cease until this material is removed.

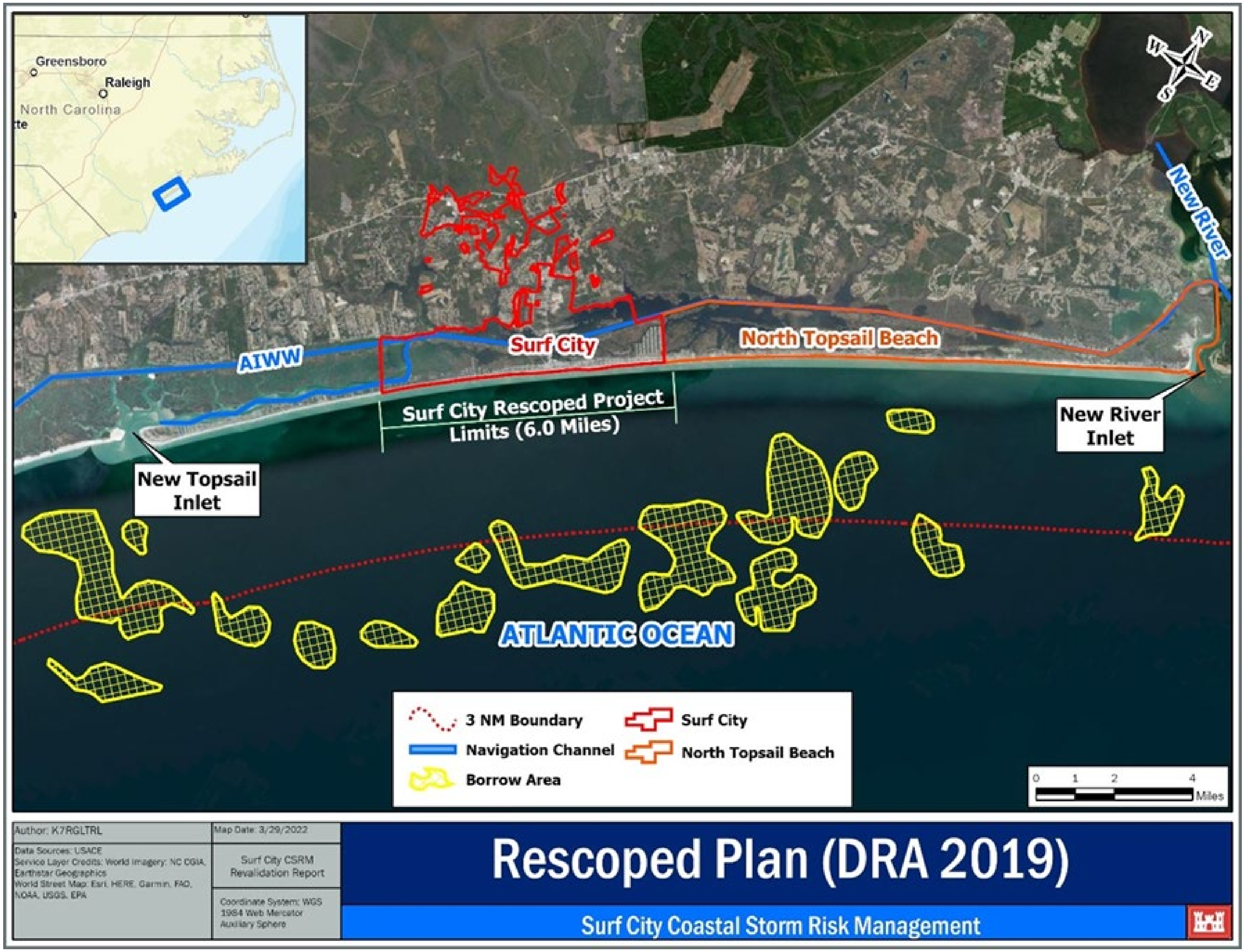


Figure 2. The Proposed Project and Borrow Area Locations.

2.0 Placement of Beach Quality Sand

The total required sediment volume for initial construction and nourishment events over the 50-year project is approximately 21.8 Million Cubic Yard (MCY). It's anticipated that initial construction will require approximately 8.0 MCY of sand. This assessment addresses the onshore components of beach quality sand delivery via a hopper dredge or hydraulic cutterhead pipeline systems. Although it's anticipated that a hopper dredge will be used for the Surf City (SC) CSRM project due to the location of the offshore borrow areas, any type of dredge plant may be used for construction or periodic nourishments.

Placement of beach quality sand is accomplished by pumping a mixture of beach quality sand and water (slurry) through a pipeline leading to the recipient beach. The placement operations typically employ a spreader that is attached to the discharge end of the pipeline. Spreaders are designed to slow the velocity of the discharge to prevent erosion and to facilitate sediment settling. Temporary shore-parallel containment dikes are constructed in front of the onshore beach discharge points to facilitate sediment settling and to reduce turbidity in the nearshore environment. As placement activities progress, the onshore pipeline is extended along the beach by adding new sections of pipe. Pipeline placement is typically on the upper beach, but seaward of the dunes and any upper beach vegetation. Booster pumps may be required along the pipelines as they are extended along the beach. The location where the pipeline emerges onto the subaerial beach may also shift incrementally as construction progresses along the beach. Throughout the construction process, front-end loaders or other heavy equipment are used to transport and position the onshore pipeline sections.

2.1 Sand Placement Redistribution and Grading

Bulldozers and other heavy equipment, such as backhoes, front-end loaders, and tractors are used to redistribute and grade the discharged sediment as it falls out of suspension. A variety of supporting vehicles, such as pick-up trucks and all-terrain vehicles, are typically used to transport equipment and personnel along the beach throughout the construction process. Grade stakes are placed throughout the beach fill template to facilitate the construction of berms and dunes to design specifications. To maintain separation between the public and potentially hazardous operations, the active construction area, consisting of a ~500-ft zone on either side of the beach fill discharge point, is typically fenced. Sand placement operations are generally conducted around-the-clock, thus requiring appropriate nighttime lighting in accordance with USACE and Occupational Safety and Health Administration safety regulations. The USACE Safety and Health Requirements Manual (EM 385-1-1) specifies a minimum luminance of three lumens per square foot for outdoor construction zones.

Regulations also require front and back lighting on all transport vehicles and heavy equipment during nighttime operations. Post-construction tilling and/or escarpment leveling may be conducted as needed based on North Carolina Wildlife Resources Commission (NCWRC) recommendations. Tilling and leveling are accomplished by heavy equipment like that employed in redistribution and grading operations.

Compacted beach fill areas between the toe of the dune and the mean high water (MHW) line are typically tilled to a depth of 24 inches using a series of overlapping passes to ensure thorough decompaction. Chain-linked fencing or a similar apparatus may be dragged over the tilled areas as necessary to eliminate any ruts and furrows created by the tilling process. Escarpments are regraded according to the original berm design specifications.

2.2 Staging Areas and Beach Access

Staging areas for equipment and pipes are generally located off the beach to the extent practicable. When necessary, staging areas on the beach are generally positioned as far landward as possible without impacting established vegetation on the upper beach or the frontal dune system. Beach access for construction equipment is typically provided by existing public beach access points. Pedestrian and emergency vehicle access is generally maintained during the construction process. Sand ramps or walkovers are constructed over pipeline sections at the access points to provide access for pedestrians and construction equipment.

2.3 Construction Lighting

According to the 2014 US Army Corps of Engineers Safety and Health Requirements Manual (EM 385-1-1), a minimum of 3 lm/ft2 is required for general outdoor work or construction areas. To meet these safety standards, appropriate lighting must be provided at night during specific components of the project site (i.e. disposal site, dredge, staging area, etc.). While project construction typically occurs around-the-clock to make efficient use of equipment, most of the equipment staging, mobilization, and demobilization of pipeline are performed during daylight hours. However, nighttime work does occur if there is a small construction window, and the work schedule is tight. For projects where lighting is a concern for sensitive organisms, ample lighting can be obtained without impacting a large area by using light shields and appropriate angling of lights. In addition to lighting in the construction area, the vehicles used for transport, as well as the bulldozers moving sediment will have lights on the front and back of the equipment. Features within the active placement area, including the “dump shack,” equipment storage, etc. may also have lighting associated with them. Working around heavy equipment is dangerous any time. Injuries and fatalities have occurred in both the water and on the beach. Ample lighting of work areas at night is a major human safety consideration.

3.0 Status of Species and Critical Habitats

3.1 Affected Environment

Descriptions of affected environment for the Surf City CSRM project are provided in the following reports:

- U.S. Army Corps of Engineers. 2010. Final Integrated Feasibility Report and Environmental Impact Statement, Coastal Storm Damage Reduction, Surf City and North Topsail Beach, North Carolina. December 2010.

- Environmental Assessment for West Onslow Beach and New River Inlet (Topsail Beach) Surf City and North Topsail Beach Coastal Storm Damage Reduction Projects, July 2013.

- Draft General Re-evaluation Report and Environmental Assessment for Surf City Coastal Storm Risk Management Project, August 2024.

3.2 Piping Plover

Range-Wide Status

The piping plover was listed as endangered and threatened under the ESA on 10 January 1986 [50 Federal Register (FR) 50726 – 50734]. The final listing rule recognized three demographically independent populations that breed in three separate regions: the Atlantic Coast from North Carolina to Canada, the Great Lakes watershed, and the Northern Great Plains region. Birds that breed along the Atlantic Coast are recognized as the subspecies *C. m. melodus*, while birds belonging to the interior Great Lakes and Northern Great Plains breeding populations are recognized as the subspecies *C. m. circumcinctus* (Miller et al. 2010). The piping plover is classified as endangered within the Great Lakes watershed and as threatened throughout the remainder of its breeding, migratory, and wintering range. The shared migratory and wintering range of the three breeding populations encompasses the Atlantic and Gulf Coasts from North Carolina to northern Mexico, as well as the Bahamas and the West Indies. Outside of their breeding range, birds belonging to the endangered Great Lakes breeding population are indistinguishable from those belonging to the threatened Great Plains and Atlantic coast populations; and consequently, all piping plovers are classified as threatened within their shared migratory and wintering range (USFWS 2009). Critical habitat has been designated for the Great Lakes (66 FR 22938 22969) and Northern Great Plains (67 FR 57638 57717) breeding populations. Critical habitat has not been designated for the Atlantic Coast breeding population; however, critical habitat units for the United States (US) wintering population have been designated along the Atlantic and Gulf coasts from North Carolina to Texas (66 FR 36038 - 36143).

Although there is no exclusive partitioning of the wintering range based on breeding origin, band sightings indicate that Atlantic Coast breeding birds from Eastern Canada and most of the Great Lakes population winter along the southeast coast from North Carolina to Southwest Florida (Gratto-Trevor et al. 2012). Banded Eastern Canada plovers are more heavily concentrated in North Carolina, whereas a larger proportion of banded birds from the Great Lakes are found in South Carolina, Georgia, and Florida. Banded piping plovers from the Northern Great Plains population are concentrated farther west and south along the Gulf Coast, although a few banded individuals from Prairie Canada occur along the Atlantic Coast from North Carolina to Florida. Banding efforts on the Atlantic Coast breeding grounds have been less extensive; and consequently, the distribution of these birds during winter remains poorly understood. However, of 57 piping plovers banded in the Bahamas in 2010, 79% have been reported breeding on the Atlantic Coast (USFWS 2012).

The US Fish and Wildlife Service (USFWS) has approved separate recovery plans for the Atlantic Coast (USFWS 1996a) and Great Lakes (USFWS 2003) breeding populations. The Northern Great Plains breeding population is currently covered under the 1988 Recovery Plan for the Great Lakes and Northern Plains populations (USFWS 1988); however, on 16 March 2015, the USFWS released a draft revised Recovery Plan specific to the Northern Great Plains population (USFWS 2015a). The 1996 revised Recovery Plan for the Atlantic Coast breeding population established a recovery goal of 2,000 breeding pairs maintained for five years and distributed among four recovery units [Eastern Canada, New England, New York-New Jersey, and Southern (**Table 1**)]. The Southern Recovery Unit, encompassing North Carolina, Virginia, Delaware, and Maryland; was assigned a subpopulation goal of 400 breeding pairs. Additional recovery criteria include a five-year average annual productivity rate of 1.5 fledged chicks per pair in each of the four recovery units, and the long-term maintenance of wintering habitat sufficient to maintain a breeding population of 2,000 breeding pairs. Annual Atlantic Coast population abundance estimates are reported as numbers of breeding pairs [i.e. adult pairs that exhibit sustained (>2 weeks) territorial or courtship behavior or are observed with nests or unfledged chicks] (USFWS 1996a). Annual Atlantic Coast breeding pair estimates are based on multiple surveys of most suitable breeding habitat, including currently unoccupied sites. Sites that cannot be monitored repeatedly in May and June are surveyed at least once during a standard nine-day period (Hecht and Melvin 2009).

Table 1. Atlantic Coast Breeding Pair Recovery Criteria.

Recovery Unit	**States/Provinces**	**Breeding Pairs**
Eastern Canada	New Brunswick, Newfoundland, Nova Scotia, Prince Edward Island, Quebec	400
New England	Minnesota, New Hampshire, Maine, Rhode Island, Connecticut	625
New York – New Jersey	New York, New Jersey	575
Southern	Delaware, Maryland, Virginia, North Carolina	400
Atlantic Coast Total		**2,000**

Since its listing, the Atlantic Coast population has increased by 137% from approximately 790 pairs in 1986 to an estimated 1,870 pairs in 2015 (**Table 2**). Most of the Atlantic Coast population growth between 1986 and 2015 occurred in the New England Recovery Unit, where the breeding population increased by 399% (net gain of 734 pairs). The estimated number of breeding pairs in the Southern Recovery Unit increased by 129%, and the New York-New Jersey Unit experienced an increase of 98%. The Eastern Canada Recovery Unit experienced a net loss of 61 pairs, resulting in a 25% decrease. New England surpassed the recovery criterion of 625 pairs from 2001 through 2004 and again from 2006 through 2015. New York-New Jersey surpassed the recovery criterion of 575 pairs in 2007, but subsequently declined to 411 pairs in 2015. The Southern Recovery Unit reached a high of 377 pairs in 2012 but has yet to meet the recovery criterion of 400 pairs. The highest annual estimate of 274 pairs for Eastern Canada in 2002 was well below the recovery target of 400 pairs.

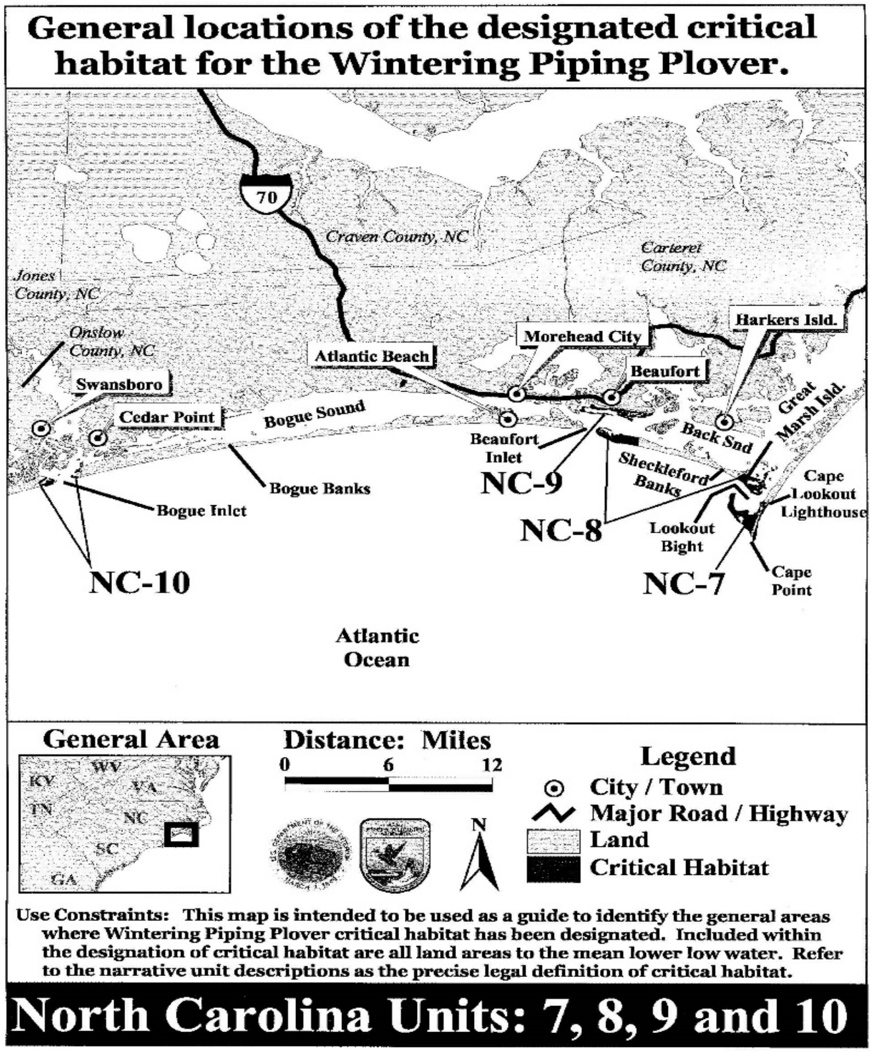
Table 2. Net change in estimated Atlantic Coast breeding pairs 1986 to 2015

Recovery Unit	Net Change Number Breeding Pairs	Percent Increase/Decrease
Eastern Canada	-61	-25%
New England	+734	+399%
New York – New Jersey	+203	+98%
Southern	+204	+129%
Overall Atlantic Coast Net Change	**+1,080**	**+137%**

Status in the Action Area

According to the Portal Access to Wildlife Systems database and ebirds.org, there were no reported piping plover breeding pairs on Surf City from 2010-2020. Likewise, Surf City is not considered part of a wintering critical habitat unit, therefore there is no data listed under the piping plover winter census (**Figure 3**). According to the ebird.org, since 2015, there have been 24 piping plovers observed on Surf City.

(https://ncpaws.org/PAWS/Wildlife/Shorebird/Shorebird.aspx).


General locations of the designated critical habitat for the Wintering Piping Plover.
70
Craven County, NC
Carteret County, NC
Jones County, NC
Onslow County, NC
Swansboro
Cedar Point
Bogue Sound
Atlantic Beach
Morehead City
Beaufort
Harkers Isld.
Great Marsh Isld.
Back Snd
Beaufort Inlet
Shackleford Banks
Cape Lookout Lighthouse
Lookout Bight
Cape Point
Bogue Banks
Bogue Inlet
NC-7
NC-8
NC-9
NC-10
Atlantic Ocean
General Area
WV
KY
VA
TN
NC
SC
GA
Distance: Miles
0
6
12
N
Legend
City / Town
Major Road / Highway
Land
Critical Habitat
Use Constraints: This map is intended to be used as a guide to identify the general areas where Wintering Piping Plover critical habitat has been designated. Included within the designation of critical habitat are all land areas to the mean lower low water. Refer to the narrative unit descriptions as the precise legal definition of critical habitat.
North Carolina Units: 7, 8, 9 and 10

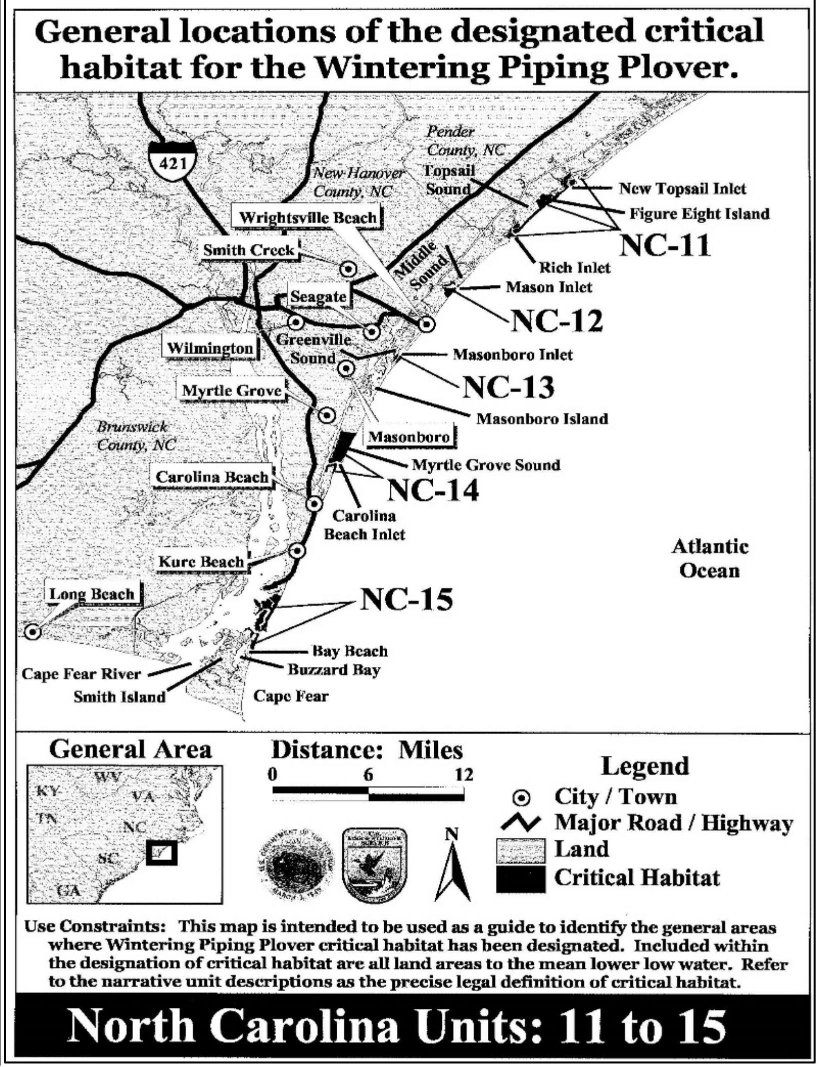

General locations of the designated critical habitat for the Wintering Piping Plover.
421
Pender County, NC
New Hanover County, NC
Topsail Sound
New Topsail Inlet
Figure Eight Island
NC-11
Rich Inlet
Mason Inlet
NC-12
Wrightsville Beach
Smith Creek
Middle Sound
Seagate
Wilmington
Greenville Sound
Masonboro Inlet
NC-13
Myrtle Grove
Masonboro Island
Brunswick County, NC
Masonboro
Myrtle Grove Sound
Carolina Beach
NC-14
Carolina Beach Inlet
Kure Beach
Long Beach
NC-15
Bay Beach
Buzzard Bay
Cape Fear River
Smith Island
Cape Fear
Atlantic Ocean
General Area
WV
KY
VA
TN
NC
SC
GA
Distance: Miles
0
6
12
N
Legend
City / Town
Major Road / Highway
Land
Critical Habitat
Use Constraints: This map is intended to be used as a guide to identify the general areas where Wintering Piping Plover critical habitat has been designated. Included within the designation of critical habitat are all land areas to the mean lower low water. Refer to the narrative unit descriptions as the precise legal definition of critical habitat.
North Carolina Units: 11 to 15

Figure 3. North Carolina Wintering Critical Habitat Units for the Piping Plover (Southern Coast).

Effects of the Proposed Action on Piping Plover

Direct Effects

The proposed plan to accomplish initial construction any time of year may have adverse impacts on piping plover nesting and brood-rearing, as the active beach construction process (heavy equipment operations, generator use, pipeline placement, night-time lighting, and related construction activities) may affect piping plovers through disturbance and behavioral modification (i.e. nest abandonment). Construction activities may impact piping plovers directly through the mechanical destruction of nests and eggs or through an increased risk of egg predation if adults are flushed from their nests.

As is typical for most beach nourishment projects, sand placement may eliminate important microhabitat elements such as wrack lines, tidal pools, and isolated clumps of vegetation; thereby reducing the quality or availability of breeding, foraging, and/or roosting habitats. The initial effects of sand placement would include the loss of most intertidal benthic invertebrates within the placement areas. Reductions in the availability of invertebrate prey may negatively affect the energy budgets of breeding and non-breeding plovers; potentially resulting in reduced survivability and productivity.

Since initial project construction could take approximately 16 months, the work is likely to occur during peak benthic invertebrate recruitment periods; however, as beach sections are completed and heavy equipment vacates completed areas, benthic recovery may begin on the completed sections. Most benthic recovery studies have reported relatively rapid recovery (≤1 year) when peak larval recruitment periods were avoided. However, it is undetermined what effect the activity will have on larval communities if work is done during the summer months. Beach construction during this time could ultimately affect food sources for foraging birds in the fall/winter months. After the initial construction, nourishment events will occur approximately every six years, giving benthic invertebrates time to recover between nourishments.

Indirect Effects

Piping plovers are largely restricted to the unstable portions of barrier islands where over wash and/or inlet processes create and maintain optimal habitats. Constructed berms and dunes may impede over wash and inlet processes; thereby limiting new habitat formation and/or reducing the quality of existing habitats through stabilization and succession. Based on the recurring nature of sand placement projects, the effects of stabilization may be long-term and cumulative.

The establishment of wider and higher dry beach habitats with little to no emergent vegetation may increase the quantity and quality of supratidal nesting and roosting habitats and enhance the ability of plovers to detect and avoid predators. The placement of beach-quality sand derived from sources outside of the inlet-dominated littoral system (e.g., offshore borrow sites) may increase inlet sediment budgets, potentially contributing to the formation of high value inlet complex habitats for piping plovers.

Cumulative Effects
Cumulative effects are those caused by the proposed federal action in combination with future non-federal actions that are reasonably certain to occur within the action area. Pursuant to the ESA, non-federal actions include anticipated state, local, and private activities that would not be subject to Section 7 consultation. Anticipated non-federal actions within the action area would include temporary sandbag placement and beach scraping activities above the MHW line. These activities would have the potential for impacts on piping plovers that are comparable to those associated with sand placement. Depending on the timing and location of specific projects, the combined impacts of the proposed action and non-federal actions could have cumulative effects on piping plovers and their habitats. Cumulative effects may occur if the combined actions increase the frequency of habitat disturbance along a specific beach or if the combined actions result in simultaneous habitat impacts along separate beaches.

Determination of Effect
Sand placement after 30 April would employ conservation measures to minimize the duration of direct effects on benthic invertebrate communities and potential nesting piping plovers; including the use of beach-quality sand and the delineation and avoidance of shorebird nesting areas. Physical habitat changes within the placement areas may temporarily reduce the quality or availability of foraging and roosting habitats; and impacts on intertidal benthic invertebrates may temporarily reduce the prey base for piping plover. The construction of stabilizing berms and dunes may have long-term indirect negative effects on the quality or availability of foraging and roosting habitats. Wider beaches may induce additional recreational activities that impact piping plover through disturbance and/or habitat modification. However, beach placement and subsequent nourishments would mean more viable future habitat for these birds. Since there have been no reports of piping plover pairs breeding or nesting within the project area, and as of 2024, no foraging individuals were observed in the project area, it is determined that the proposed action may affect but is not likely to adversely affect the piping plover.

3.3 Red Knot
<u>Range-Wide Status</u>
The rufa red knot (hereinafter referred to as “red knot”) was listed as threatened under the ESA on 12 January 2015 (79 FR 73705 73748). The USFWS has not approved a recovery. Red knots migrate between breeding grounds in the central Canadian High Arctic and wintering areas that are widely distributed from the southeastern US coast to the southern tip of South America. Migration occurs primarily along the Atlantic coast, where red knots use key stopover and staging areas for feeding and resting. Departure from the Arctic breeding grounds occurs from mid-July through August, and the first southbound birds arrive at stopover sites along the US Atlantic coast in July. Numbers of southbound birds peak along the US Atlantic coast in mid-August; and by late September most birds have departed for their wintering grounds. Major fall stopover sites along the US Atlantic coast include the coasts of Massachusetts and New Jersey and the mouth of the Altamaha River in

Georgia. Principal wintering areas include the southeastern US Atlantic Coast from North Carolina to Florida, the Gulf Coast from Florida to northern Mexico, the northern Atlantic coast of Brazil, and the island of Tierra del Fuego along the southern tip of South America. Smaller numbers of red knots also winter along the central and northeastern US Atlantic coast and in the. The core southeastern US Atlantic wintering area is thought to shift from year to year between Florida, Georgia, and South Carolina (USFWS 2014a).

On July 15, 2021, and revised on April 13, 2023, the USFWS proposed to designate a total of approximately 683,405 acres (276,564 hectares) as critical habitat for the rufa red knot across 127 units (18 of which are further subdivided into 46 subunits) in Massachusetts, New York, New Jersey, Delaware, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas. Unit NC–5: New Topsail Inlet–Topsail Beach, North Carolina (**Figure 4**) consists of approximately 1,612 ac (652 ha) of occupied habitat in Onslow and Pender Counties consisting of shoreline habitat that stretches about 23 mi (37 km) from the west side of the New River Inlet channel west to the east side of the New Topsail Inlet channel. This unit includes from MLLW to the toe of the dunes or where densely vegetated habitat, not used by the rufa red knot, begins and where the physical or biological features no longer occur. This unit also includes the emergent sand shoals within the flood-tidal and ebb- tidal deltas associated with the west side of the New River Inlet channel, as well as the emergent sand shoals within the flood-tidal and ebb-tidal deltas on the east side of the New Topsail Inlet channel.

Red knots typically arrive at southeastern US and Caribbean wintering sites in November but may arrive as early as September. Birds wintering along the US Atlantic coast and in the Caribbean typically remain on their wintering grounds through March, and in some cases as late as May. Northbound birds from both North and South American wintering areas use stopover sites along the US mid-Atlantic coast from late April through late May/early June (USFWS 2014a). Important spring stopover sites in the US include Delaware Bay and the Atlantic Coast from Georgia to Virginia; however, small to large groups of northbound red knots may occur in suitable habitats along all the Atlantic and Gulf Coast states. Unknown numbers of non-breeding red knots, many consisting of one-year-old subadult birds, remain south of the breeding grounds throughout the year (USFWS 2014a).

The distribution of red knots on the breeding grounds is diffuse across large areas of the remote High Arctic; and consequently, abundance and productivity estimates have not been developed for the breeding range (USFWS 2014a). In lieu of comprehensive breeding range estimates, the status of the red knot has been monitored through extensive survey efforts in key areas throughout the migratory and wintering range. Long-term monitoring efforts in two key areas, Delaware Bay and Tierra del Fuego, have shown sustained declines in red knot numbers on the order of 75% since the 1980s.

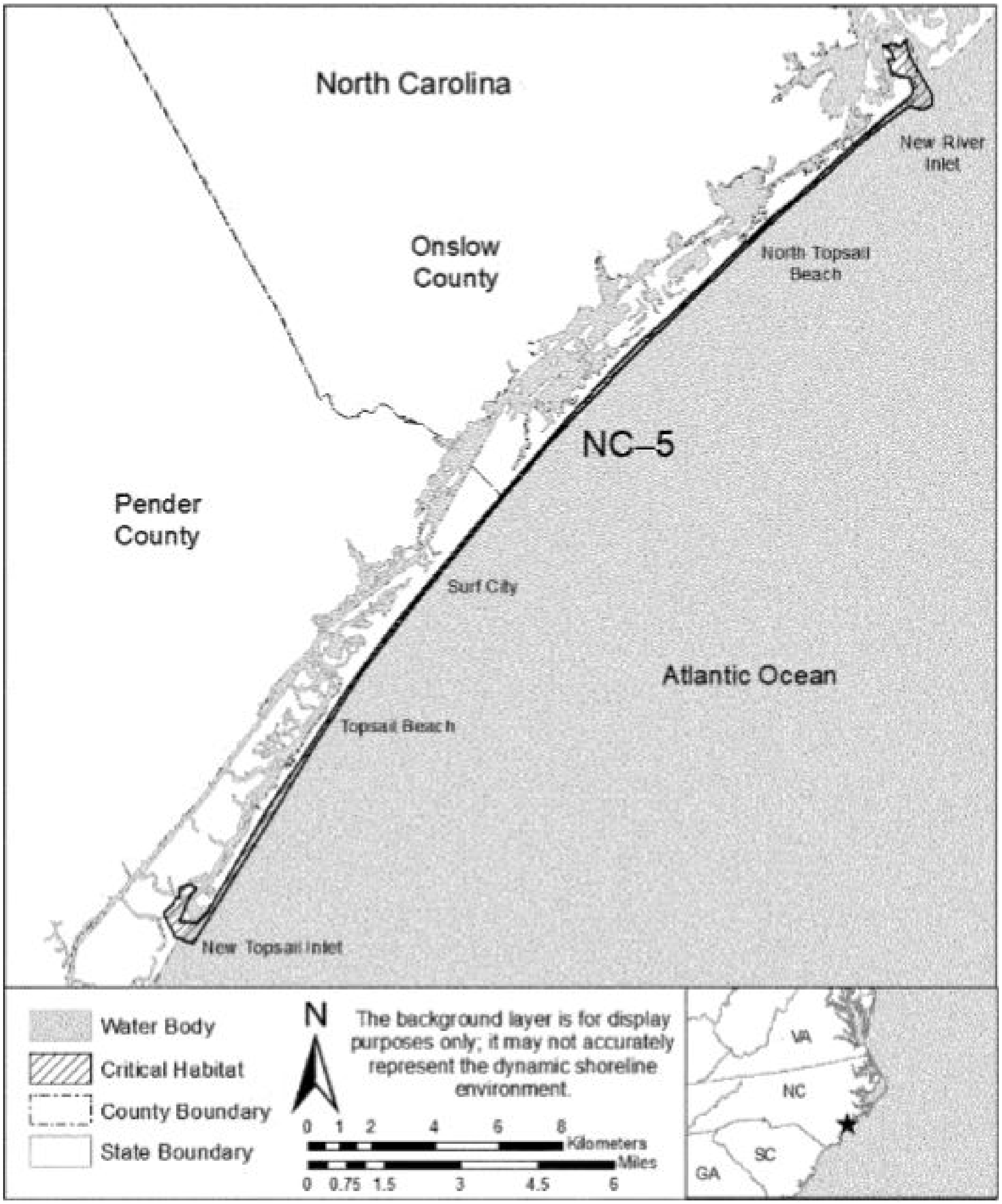


Figure 4. Proposed Critical Habitat for the Rufa Red Knot NC-5 New Topsail Inlet to Topsail Beach; Onslow and Pender Counties, North Carolina

Population estimates for the southeastern US Atlantic Coast wintering population were approximately the same during the 1980s and 2000s (USFWS 2014a), and recent evidence suggests that the southeast wintering population may number as high as 20,000 birds (USFWS 2014a). Consistent aerial surveys of the entire Virginia barrier island coast since 1995 have produced stable counts of red knots during peak migration periods, and more recent ground surveys in Virginia suggest an upward trend since 2007.

Since 2006, annual coordinated aerial surveys covering the Atlantic Coast from Florida to Delaware Bay have been conducted during the peak spring migration period (20-24 May). All changes in counts from 2006-2010 were attributed to varying geographic survey coverage (Dey et al. 2011). More recent aerial surveys show an apparent increase between 2010 and 2012; however, analyses of additional annual data sets are needed before this trend can be confirmed. Available data for the remainder of the stopover and wintering areas are generally insufficient for trend analysis (USFWS 2014a).

Ecological Requirements

Migrating and wintering red knots use similar habitats, generally expansive intertidal sand and mud flats for foraging and sparsely vegetated supratidal sand flats and beaches for roosting. The red knot is a specialized molluscivore, feeding on hard-shelled mollusks that are swallowed whole and crushed in the gizzard. The diet is sometimes supplemented with softer invertebrate prey such as shrimp- and crab-like organisms, marine worms, and horseshoe crab eggs. Both high-energy oceanfront intertidal beaches and sheltered estuarine intertidal flats are used for foraging. Preferred habitats include sand spits and emergent shoals associated with tidal inlets, and habitats associated with the mouths of bays and estuarine rivers. Access to quality high-tide roosting habitat near foraging areas is an important constituent of high-quality stopover and wintering sites (USFWS 2014a).

Status in the Action Area

Migratory bird surveys are conducted in the southeastern U.S. tri-monthly during the spring (15 March-5 June) and fall (15 July-15 October) migration periods. In 2010, comprehensive non-breeding season surveys for red knots and other focal shorebird species were initiated using the Southeast Coast Network shorebird monitoring protocol (Byrne and Muiznieks 2013). Numbers of northbound birds generally peak during the first two weeks of May, although annual peak counts have been recorded from mid-April to late May. Numbers decline rapidly after the end of August; and by the end of September most red knots have departed for their wintering grounds. According to the ebird.org, since 2015, there have been 428 red knots observed on Surf City.

Effects of the Proposed Action on Red Knot

Direct Effects

Sand placement activities would occur within foraging and roosting habitats for red knots. During the active beach construction process; heavy equipment operations, generator use, pipeline placement, night-time lighting, and related construction activities may affect red knots through disturbance and behavioral modification. Disturbance may cause migrating and wintering red knots to spend less time foraging and conserving energy; thereby potentially affecting survivability and productivity. Disturbance may prevent red knots from using otherwise suitable foraging and roosting sites; requiring birds to expend additional energy seeking out alternative habitats. The sand placement activities may occur during the peak May migration period in North Carolina .

As is typical for most beach placement projects, sand placement may eliminate important microhabitat elements such as wrack lines, tidal pools, and isolated clumps of vegetation; thereby reducing the quality or availability of foraging and/or roosting habitats. The initial effects of sand placement would include the loss of most intertidal benthic invertebrates within the placement areas. Reductions in the availability of invertebrate prey may negatively affect the energy budgets of red knots; potentially resulting in reduced survivability and productivity.

Under normal conditions, sand placement activities are expected to affect an average of 37 miles of potential red knot foraging and roosting beaches in North Carolina per year. The proposed project would add about six miles over a 16-month period with nourishments at Surf City occurring every 6 years. As a result of direct impacts on habitats and benthic communities, red knots may experience reduced foraging and roosting opportunities along the affected beaches for at least the first year following beach placement. In some cases, direct effects on habitats and benthic communities may persist into the second post-placement year. Consequently, the extent of habitat in recovery on an annual basis may be greater than the projected annual impact average of 37 miles.

Indirect Effects

Red knots exhibit a preference for the unstable portions of barrier islands where over wash and/or inlet processes create and maintain optimal habitats. Constructed berms and dunes may impede over wash and inlet processes; thereby limiting new habitat formation and/or reducing the quality of existing habitats through stabilization and succession. Based on the recurring nature of sand placement projects, the effects of stabilization may be long-term and cumulative. The construction and maintenance of wider beaches may facilitate and increase recreational activities within red knot habitats.

Beneficial Effects

The establishment of wider and higher dry beach habitats with little to no emergent vegetation may increase the quantity and quality of supratidal roosting habitats and enhance the ability of red knots to detect and avoid predators. The placement of beach-quality sand derived from sources outside of the inlet-dominated littoral system (e.g., offshore borrow sites) may increase inlet sediment budgets, potentially contributing to the formation of high-value inlet complex habitats for red knots.

Cumulative Effects

Cumulative effects are those caused by the proposed federal action in combination with future non- federal actions that are reasonably certain to occur within the action area. Pursuant to the ESA, non-federal actions include anticipated state, local, and private activities that would not be subject to Section 7 consultation. Anticipated non-federal actions within the action area would include temporary sandbag placement and beach scraping activities above the MHW line. These activities would have the potential for impacts on red knots and their habitats that are comparable to those associated with sand placement. Depending on the timing and location of specific projects, the combined impacts of the proposed and non-federal actions could have cumulative effects on red knots and their habitats. Cumulative effects could occur if the combined actions increase the frequency of habitat disturbance along a specific beach or if the combined actions result in simultaneous habitat impacts along separate beaches.

Determination of Effect
Sand placement activities may disturb migrating and wintering red knots; causing individuals to spend less time foraging and conserving energy. Sand placement after 30 April would employ conservation measures to minimize the duration of direct effects on benthic invertebrate communities and foraging, sheltering, and roosting habitat; including the use of beach-quality sand. Physical habitat changes within the placement areas may temporarily reduce the quality or availability of foraging and roosting habitats; and impacts on intertidal benthic invertebrates may temporarily reduce the prey base for red knots. The construction of stabilizing berms and dunes may have long-term indirect negative effects on the quality or availability of foraging and roosting habitats. Wider beaches may induce additional recreational activities that impact red knots through disturbance and/or habitat modification. However, beach placement and subsequent nourishments would mean more viable future habitat for these birds. The long-term effects of the project may restore lost foraging, sheltering, and roosting habitat through the addition of beach fill. Therefore, it has been determined that the project may affect but is not likely to adversely affect the red knot.

3.4 Sea Turtles
<u>Range-Wide Status</u>

Loggerhead Sea Turtle
The loggerhead sea turtle (*Caretta caretta*) was initially listed under the ESA as threatened throughout its range on 28 July 1978 (43 FR 32800). On 22 September 2011, the loggerhead's ESA status was revised to threatened and endangered based on the recognition of nine distinct population segments (DPS). DPSs encompassing populations in the Northwest Atlantic Ocean, South Atlantic Ocean, Southwest Indian Ocean, and Southeast Indo-Pacific Ocean were reclassified as threatened; while the remaining five populations in the Northeast Atlantic Ocean, Mediterranean Sea, North Pacific Ocean, South Pacific Ocean, and North Indian Ocean were reclassified as endangered. Loggerhead sea turtles occur throughout temperate and tropical waters of the Atlantic, Pacific, and Indian Oceans; however, nesting occurs predominantly along the western rims of the Atlantic and Indian Oceans. Nesting in the Northwest Atlantic occurs along the coasts of North America, Central America, northern South America, the Bahamas, the Antilles, and Bermuda; however, nesting is concentrated on beaches of the southeastern US and the Yucatán Peninsula in Mexico. Nesting in the US occurs along the Atlantic and Gulf coasts from southern Virginia to Texas, but most of the nesting occurs from North Carolina through Alabama (NMFS and USFWS 2008).

The revised 2008 Recovery Plan for the Northwest Atlantic DPS designated five recovery units: the southeastern US coast from southern Virginia to the Florida-

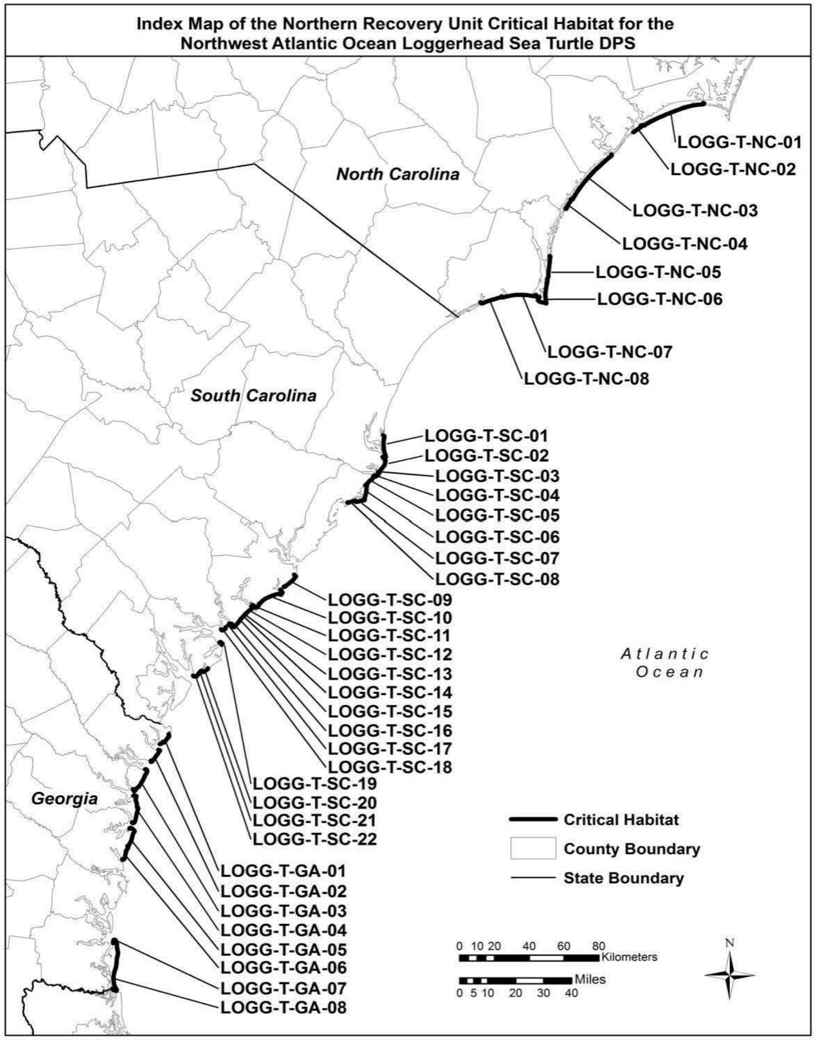
Georgia border (Northern Recovery Unit), peninsular Florida, the Dry Tortugas, the northern Gulf Coast, and the Greater Caribbean (**Figure 5**). A total of 88 terrestrial critical habitat units encompassing ~685 miles of nesting beaches have been designated for the Northwest Atlantic Ocean DPS along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi (79 FR 39756). A total of 38 units encompassing ~245 miles of nesting beaches have been designated within the Northern Recovery Unit; including eight units (~96 miles) in North Carolina, 22 units (~79 miles) in South Carolina, and eight units (~69 miles) in Georgia. Nesting in these 38 units comprises approximately 86% of all loggerhead nesting within the Northern Recovery Unit.

In addition, a 2019 Loggerhead Recovery Plan Progress Assessment was completed to review the progress since the 2008 Recovery Plan. The Northern Recovery Unit (NRU) is the second largest nesting assemblage and has an annual rate of increase in number of nests of 1.3% ($p = 0.04$) based on a log-linear regression model for 37 years of nesting data (1983-2019) (**Figure 6**). This annual rate of increase is below the 2% criterion for achieving recovery. According to the 2019 Loggerhead Recovery Plan, although there has been an observed increase in the number of nests for the past decade (total nests exceeded 14,000 for the first time in 2019), the Recovery Plan cautions that looking at short-term trends in nesting abundance can be misleading and needs to be considered in the context of one generation (= 50 years for loggerhead sea turtles) as specified in the Demographic Recovery Criteria. However, based on genetic analyses of all nests laid in the NRU, the number of annual nests since 2010 significantly correlates to the number of annual nesting females. Therefore, this Demographic Recovery Criterion for the NRU is being accomplished.

Green Sea Turtle

The green sea turtle (*Chelonia mydas)* was listed under the ESA on 28 July 1978 (43 FR 32800). Breeding populations in Florida and along the Mexican Pacific Coast were listed as endangered, while all other populations throughout the species' range were listed as threatened. In March 2015, the National Marine Fisheries Service (NMFS) and USFWS published a proposed rule to list eight threatened and three endangered green sea turtle DPSs. The proposed rule would list all North Atlantic green sea turtles as threatened under a single North Atlantic Ocean DPS. Green sea turtles are distributed circumglobally in tropical, subtropical, and to a lesser extent, temperate waters; with nesting occurring in more than 80 countries worldwide. Nesting in the US is primarily limited to Florida, although nesting occurs in small numbers along the coasts of North Carolina, South Carolina, Georgia, and Texas. Nesting turtles in Florida appear to prefer high wave energy barrier island beaches with coarse sands, steep slopes, and prominent foredunes (Witherington et al. 2006).

The highest nesting densities occur on sparsely developed beaches that have minimal levels of artificial lighting. The revised 1991 Recovery Plan for the US Atlantic population established recovery criteria of 5,000 nests per year for at least six years in Florida and the protection of at least 25% of the Florida nesting beaches



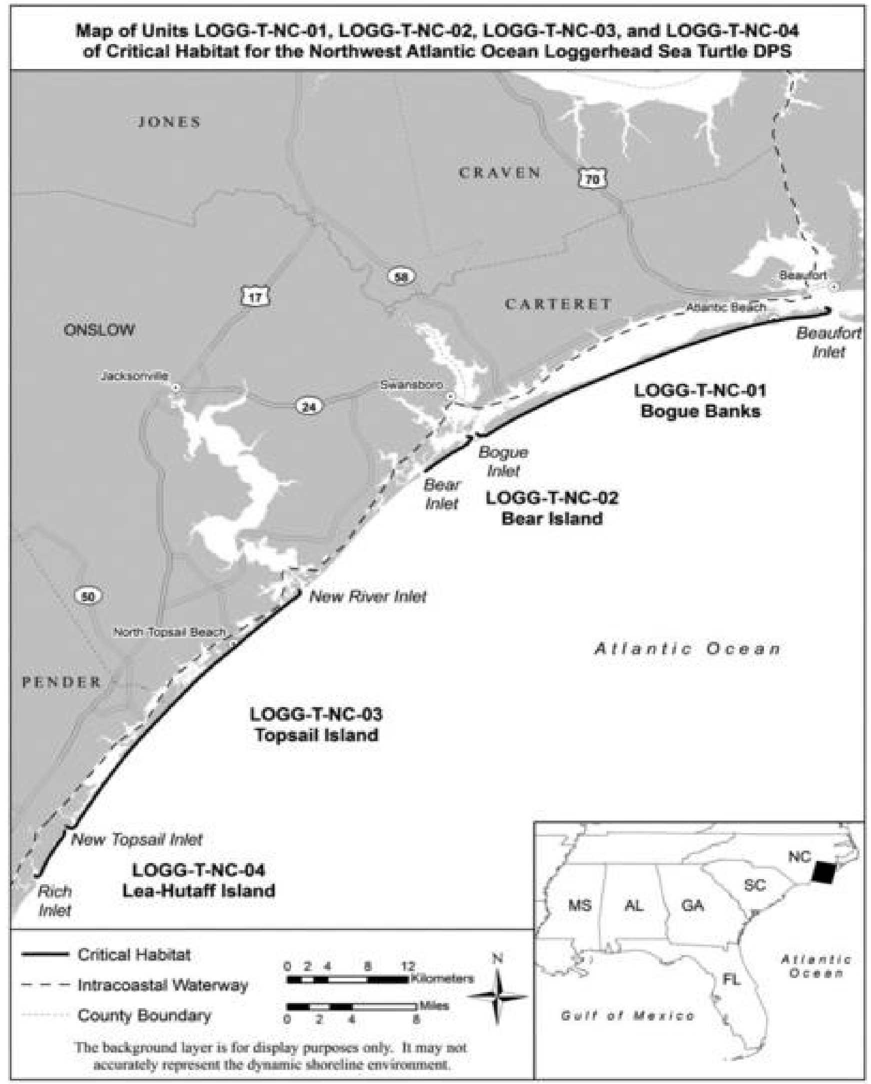


Figure 5. North Carolina Loggerhead Sea Turtle Terrestrial Critical Habitat Units

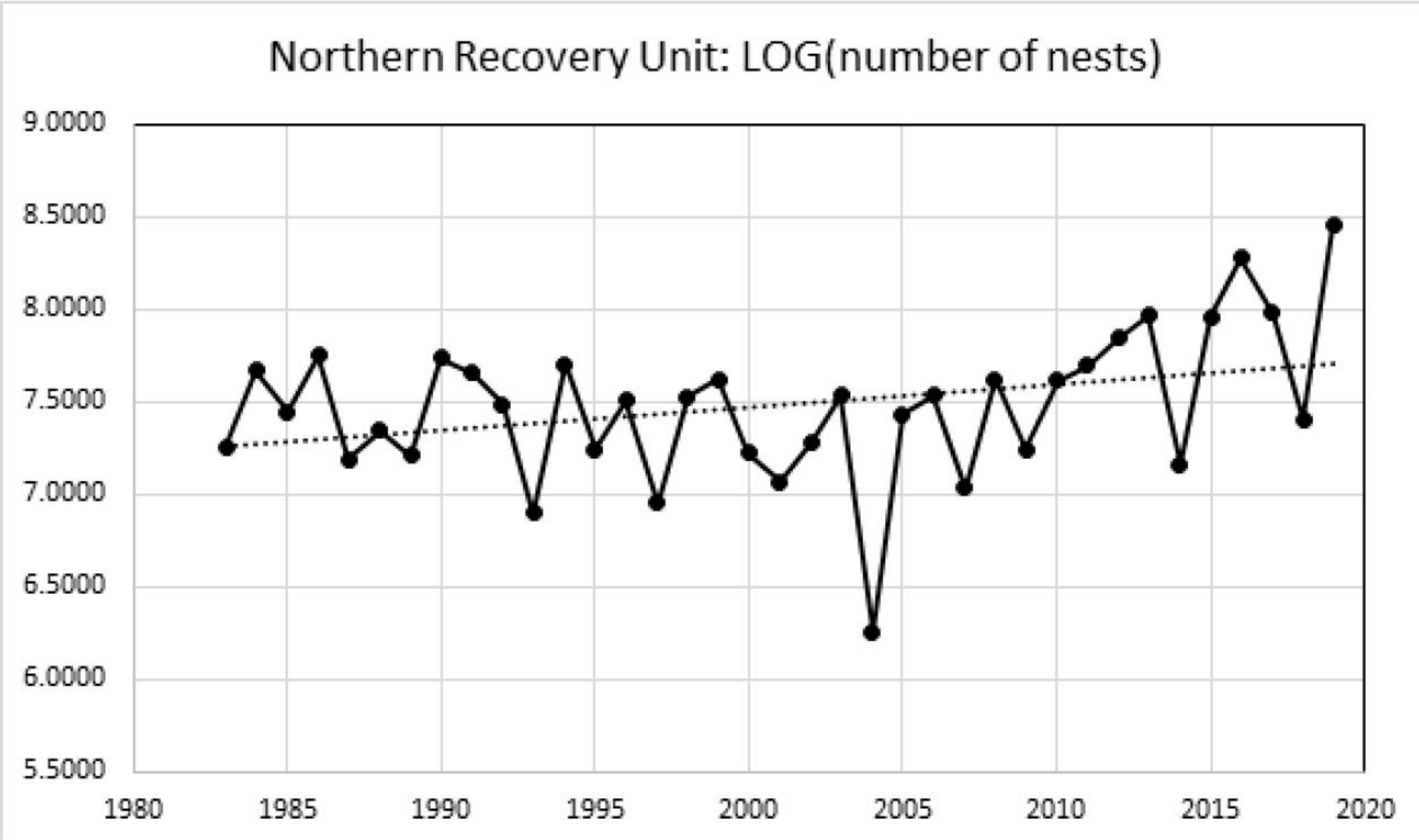


Figure 6. Log of annual loggerhead nest counts from the Northern Recovery Unit beaches, 1983-2019.

encompassing at least 50% of all nesting activity in the state. Nesting in Florida has increased exponentially over the last 20 years, with record highs of 36,195 and 37,341 nests recorded in 2013 and 2015, respectively [Florida Fish and Wildlife Conservation Commission (FWC)/Fish and Wildlife Research Institute (FWRI) 2014]. No critical habitat has been designated in the continental US.

Leatherback Sea Turtle
The leatherback sea turtle (*Dermochelys coriacea*) was listed as endangered throughout its range on 2 June 1970 (35 FR 8491). Leatherback nesting occurs on beaches throughout the tropical and subtropical regions of the Atlantic, Pacific, and Indian Oceans. Nesting in the US is primarily restricted to Florida, Puerto Rico, and the US Virgin Islands; although nesting occurs in small numbers along the coasts of North Carolina, South Carolina, Georgia, and Texas. Marine and terrestrial critical habitat have been designated for the leatherback sea turtle at Sandy Point on the western end of the island of St. Croix, US Virgin Islands [50 Code of Federal Register (CFR) 17.95]. The 1992 Recovery Plan for the US Caribbean, Atlantic, and Gulf of Mexico populations established recovery criteria for the assemblage of nesting populations in Florida, Puerto Rico, and the US Virgin Islands; including an increasing adult female population over 25 years (based on a statistically significant increasing trend in nest numbers) and the protection of nesting beaches encompassing at least 75% of all nesting activity (NMFS and USFWS 1992). Nesting in Florida has decreased by 2.1 percent annually from 2008 to 2017 with a highest nest count of 1,747 in 2009 and the lowest in 2017 with 663 nests (NMFS and USFWS 2020).

Kemp's Ridley Sea Turtle
The Kemp's ridley sea turtle (*Lepidochelys kempii*) was listed as endangered throughout its range on 2 December 1970 (35 FR 18320). Nesting is primarily restricted to coastal beaches along the Mexican states of Tamaulipas and Veracruz, although a small number of turtles nest consistently along the Texas coast [Turtle Expert Working Group (TEWG) 1998]. Rare nesting events have also occurred along the coasts of North Carolina, South Carolina, Georgia, Florida, and Alabama. A total of 80 Kemp's ridley nests were documented in Florida from 1979 to 2013 (FWC/FWRI 2014). No critical habitat has been designated for the Kemp's ridley sea turtle.

Hawksbill Sea Turtle
The hawksbill sea turtle (*Eretmochelys imbricata*) was listed as endangered throughout its range on 2 June 1970 (35 FR 8491). Nesting occurs on sandy beaches throughout the tropical and subtropical regions of the Atlantic, Pacific, and Indian Oceans. Nesting in the US is primarily limited to Florida and the US Caribbean on beaches throughout Puerto Rico and the US Virgin Islands (NMFS and USFWS 1993). Marine and nesting critical habitat for the hawksbill sea turtle have been designated in Puerto Rico along the islands of Mona, Monito, Culebrita, and Culebra (63 FR 46693). Rare nesting events in the continental US are essentially restricted to the southeastern coast of Florida and the Florida Keys (Meylan 1992; Meylan et al. 1995), although two hawksbill nests were recently confirmed in North Carolina (NPS 2015d). A total of 46 hawksbill nests were

documented in Florida from 1979-2013 (FWC/FWRI 2014). Although documented nesting in the continental US is extremely rare, hawksbill tracks are difficult to differentiate from those of the loggerhead and may not be recognized by surveyors. Therefore, surveys in Florida likely underestimate actual hawksbill nesting numbers (Meylan et al. 1995).

Status in the Action Area

Loggerhead Sea Turtle
Loggerhead nesting occurs along the entire North Carolina coast; however, nesting is concentrated along three sections of the coast: the Cape Fear region (Holden Beach, Oak Island, Caswell Beach, Bald Head Island, and Fort Fisher), Topsail Island and Onslow Beach, and Shackleford Banks north to Bodie Island.

Nesting is typically restricted to the period of 1 May to 15 September. Of the approximately 1807 loggerhead nests (average 90 nests per year) that were reported in North Carolina from 2000-2019, only 17 occurred outside of the 1 May to 15 September nesting window. However, annual surveys that are typically limited to the 1 May to 15 September window may underestimate the extent of nesting before and after this period. Relatively few nests are recorded during the first three weeks of May. Nesting increases rapidly from late May onward, peaking from mid-June through the end of July. Nesting declines abruptly after the end of July, and few nests are recorded after the third week of August.

The Sea Turtle Nest Monitoring System (seaturtle.org) reported a total of 108 nests laid on Topsail Island in 2023. Of these nests, 104 were loggerheads and 4 were green sea turtles. From 2000 to 2019, 1827 total sea turtle nests were observed on the island: 1807 loggerhead, 19 green, and 1 Kemp's Ridley.

Loggerhead Sea Turtle Critical Habitat
A total of eight terrestrial critical habitat units encompassing approximately 96 miles of nesting beaches have been designated in North Carolina (79 FR 39756). All the units are located south of Cape Lookout along the coasts of Brunswick, Carteret, New Hanover, Onslow, and Pender Counties. The designated units encompass the dry ocean beach from the MHW line landward to the toe of the secondary dune or the first developed structure. The units represent beaches that can support a high density of nests or those that are potential expansion areas for beaches with high nest densities. Critical nesting habitats include: 1) unimpeded ocean-to-beach access for adult females and unimpeded nest-to-ocean access for hatchlings, 2) substrates that are suitable for nest construction and embryonic development, 3) a sufficiently dark nighttime environment to ensure that adult females are not deterred from nesting and that hatchlings are not prevented from reaching the ocean, and 4) natural coastal processes that maintain suitable nesting habitat or artificially maintained habitats that mimic those associated with natural processes.

Topsail Island contains 26 miles of Loggerhead terrestrial critical habitat (Unit LOGG-T-NC-07), which encompasses the entire length of the island (see Figure 9). It is the longest area of designated terrestrial critical habitat (out of eight units) in

North Carolina. Approximately 10 miles of critical habitat on Topsail Island are contained within the project area.

Green Sea Turtle
Green sea turtles nest in relatively small numbers along the North Carolina coast, with reported nesting from 2000 through 2019 averaging 20 nests per year. Annual nest totals from 2000 through 2019 was 406 nests. The overall statewide trend from 2000 through 2016 is very similar to that of the loggerhead turtle in North Carolina. Green sea turtle nesting records span the entire North Carolina coast but are concentrated along the barrier islands of Cape Lookout and Cape Hatteras.

From 2000 – 2019, only 19 green turtle nests were laid along Topsail Island, only 5% of the statewide total (Seaturtle.org 2019).

Based on 2019 data from the Northern Recovery Unit (GA, SC and NC) Green Turtle DNA Project, 88 nests laid in 2019 were greens. According to this data, a single green turtle lays an average of 2.6 nests per season, but often nests on the same beach (seaturtle.org Sea Turtle Nest Monitoring System).

Leatherback Sea Turtle
Leatherback nesting is rare in North Carolina, with just 37 nests reported from 2000 - 2019 for the entire state. Nesting from 2000-2019 averaged four nests per year; however, 11 of the 19 years during this period had no reported nesting events. Of the years when nesting was reported, statewide annual totals ranged from one to eight nests. Nesting records span the entire North Carolina coast but are heavily concentrated along the barrier islands of Cape Hatteras and Cape Lookout National Seashores. The last recorded nesting of a leatherback in North Carolina was 2018 when 2 nests were laid on Fort Fisher State Recreational Area and Cape Lookout National Seashore.

No reports of leatherback nests were reported on Topsail Island from 2000 – 2019. Based on 2019 data from the Northern Recovery Unit (GA, SC and NC) Leatherback Turtle DNA Project no Leatherback nests were reported in 2019 (seaturtle.org Sea Turtle Nest Monitoring System).

Kemp’s Ridley Sea Turtle
Kemp’s ridley nesting is also rare in North Carolina, with just 29 nests reported from 2000 - 2019 for the entire state. Of the 29 nests, 2018 had the highest nesting rate by far, with 12 nests. Based on the 2019 data from the Northern Recovery Unit (GA, SC and NC) Kemp’s Ridley Turtle DNA Project, 3 nests laid in 2019 were Kemps. According to the seaturtle.org data, Kemps only lay 2.6 nests per season on average (seaturtle.org Sea Turtle Nest Monitoring System).

<u>Effects of the Proposed Action on Sea Turtles</u>
Sand placement on Surf City between 1 May and 15 November has the potential to adversely affect nesting females, nests, and hatchlings within the project area. Potential effects include destruction/burial of nests deposited within the boundaries of the project, harassment in the form of disturbing or interfering with females nesting

because of beach placement activities, and disorientation of hatchling turtles from project lighting on beaches.

(1) Pipe Placement
A general discussion of the construction activities associated with the placement of sediment on the beach, including pipeline routes, is included in this report. When construction operations extend into the sea turtle nesting season, pipeline routes and pipe staging areas may act as an impediment to nesting females approaching available nesting habitat or to hatchlings orienting to the water's edge. If the pipeline route or staging areas extend along the beach face, including the frontal dune, beach berm, mean high water line, etc., some portion of the available nesting habitat will be blocked. Nesting females may encounter the pipe and false crawl (return to the water) or nest in front of the pipeline in an area that is subject to heavy equipment operation, erosion, and wash over. If nests are laid prior to placement of pipe and end up landward of the pipeline once it is placed, hatchlings may be blocked or become misoriented (oriented away from the most direct path to the ocean) during their approach to the water.

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

Adult female turtles survey a nesting beach from the water before emerging to nest (Carr and Ogren, 1960; Hendrickson, 1982). Parameters considered important to beach selection include the geomorphology and dimensions of the beach (Mortimer, 1982; Johannes and Rimmer, 1984) and bathymetric features of the offshore approach (Hughes, 1974; Mortimer, 1982). Beach profile changes and subsequent escarpment formations may act as an impediment to a nesting female resulting in a false crawl, or nesting females may choose marginal or unsuitable nesting areas either within the escarpment face or in front of the escarpment. Often these nests are vulnerable to tidal inundation or collapse of the receding escarpment. If a female is capable of nesting landward of the escarpment prior to its formation, as the material continues to slough off and the beach profile approaches a more natural profile, there is a potential for an incubating nest to collapse or fallout during the equilibration process. Loggerheads preferentially nest on the part of the beach where the equilibration process takes place (Brock, 2005; Ecological Associates, Inc., 1999) and are more vulnerable to fallout during equilibration.

A study conducted by Ernest and Martin (1999) documented increased abundance of nests located farther from the toe of the dune on nourished vs. control beaches. Thus, post-nourishment nests may be laid in high-risk areas where vulnerability to sloughing and equilibration are greatest. Though nest relocation is not encouraged, nest relocation may be used to move nests that are laid in locations along the beach that are vulnerable to sloughing of escarpments and fallout (i.e. near the MHW line). As a nourished beach is re-worked by natural processes and the construction profile approaches a more natural profile, the frequency of escarpment formation declines and the risk of nest loss due to sloughing of escarpments is reduced.

(3) Compaction

Sediment placed on the beach can often affect sediment density (compaction), shear resistance (hardness), sediment moisture content, beach slope, sediment color, sediment grain size, sediment grain shape, and sediment grain mineral content. Changes in particle size can have a direct influence on the shear resistance of the sediment and therefore make the beach relatively harder after placement of sand. Harder or more compact beaches result primarily from angular, finer grained sediment dredged from stable offshore borrow sites, whereas less compacted beaches result from smoother, coarse sediment dredged from high energy locations such as inlets. Hard sediment can prevent a female from digging a nest or result in a poorly constructed nest cavity. Females may respond to harder physical properties of the beach by spending more time on the beach nesting, which may result in physiological stress and increased exposure to disturbances and predation; thus, in some cases leading to a false dig (Nelson and Dickerson, 1989).

Studies suggest that tilling compacted sand after project completion can be performed to reduce compaction to levels comparable to unnourished beaches. Under current USFWS guidelines, the decision to till a beach after sediment placement is based upon measurements of sediment compaction using a soil auger. The NCWRC has routinely visited a beach nourishment site directly after placement activity is completed to determine the necessity for beach tilling to mitigate compaction impacts.

(4) Lighting

The presence of artificial lighting on or within the vicinity of nesting beaches is detrimental to critical behavioral aspects of the nesting process including nesting female emergence, nest site selection, and the nocturnal sea-finding behavior of both hatchlings and nesting females. Artificial lighting on beaches tends to deter sea turtles from emerging from the sea to nest; thus, evidence of lighting impacts on nesting females is not likely to be revealed by nest to false crawl ratios considering that no emergence may occur (Mattison et al., 1993; Witherington, 1992; Raymond, 1984a.). Though nesting females prefer darker beaches, considering the increased development and associated lighting on most beaches, many do nest on lighted shorelines. Although the effects of lighting may prevent female emergence, if emergence, nest site selection, and oviposition does occur, lighting does not affect nesting behavior (Witherington and Martin, 2003). However, sea turtles rely on vision to find the sea upon completion of the nesting process and use a balance of light intensity within their eyes to orient towards the brightest direction (Ehrenfeld, 1968);

thus, misdirection by lighting may occur, resulting in more time being spent to find the ocean. Furthermore, successful nesting episodes on lighted shorelines will directly affect the orientation and sea-finding process of hatchlings during the nest emergence and frenzy process to reach the ocean. Hatchlings rely almost exclusively on vision to orient to the ocean and brightness is a significant cue used during this immediate orientation process after hatching out (Mrosovsky and Kingsmill, 1985; Verheijen and Wilschut, 1973; Mrosovsky and Shettleworth, 1974; Mrosovsky et al., 1979).

Hatchlings that are misoriented (oriented away from the most direct path to the ocean) or disoriented (lacking directed orientation or frequently changing direction or circling) from the sea by artificial lighting may die from exhaustion, dehydration, predation, and other causes. Though hatchlings use directional brightness of a natural light field (celestial sources) to orient to the sea, light from artificial sources interferes with the natural light cues resulting in misdirection (Witherington and Martin, 2003).

3.5 Seabeach Amaranth

Range-Wide Status and Distribution

Seabeach amaranth (*Amaranthus pumilus*) was listed as threatened throughout its range on 7 April 1993 (58 FR 18035 18042). No critical habitat has been designated for this species. Although historically distributed along barrier island beaches from Massachusetts to South Carolina, by the 1980s extant populations were known only from North and South Carolina. In 1990, seabeach amaranth was rediscovered in New York after an absence of 40 years. Between 1998 and 2000, additional populations were rediscovered in Virginia, Maryland, Delaware, and New Jersey after periods of absence ranging from 30 to 125 years (USFWS 2005). The range-wide trend over the last 25 years has been dominated by dramatic fluctuations in the New York population. After the initial rediscovery of 341 plants in 1990, the New York population increased exponentially to an estimated 244,608 plants in 2000. The corresponding 2000 range-wide estimate of 249,261 plants was highest on record; however, the New York population accounted for 98% of the plants. The overall population trend since 2000 is characterized by equally dramatic declines in the New York and range-wide populations to just 729 and 1,308 plants in 2013, respectively. Changes in other state-specific populations, although occurring on a much smaller scale, have generally mirrored those of the overall range-wide population. All the state-specific populations increased substantially at some point between 2000 and 2005, only to decline to record or near record low numbers by 2013.

Seabeach amaranth is an annual flowering plant that overwinters entirely in the form of small seeds. Seed germination begins in April or May and continues through July. Flowering begins as early as June, and seed production is initiated in July or August. Flowering and seed production continue until the death of the plant in late fall or early winter. Under favorable climatic conditions, some plants may survive and continue to produce seed into January (USFWS 1996b). Seabeach amaranth is a pioneering colonizer of newly formed and recently disturbed barrier island habitats; including supratidal over wash flats on the accreting ends of barrier islands, the upper dry ocean beach, and the lower exposed faces of foredunes. The species is intolerant of competition and requires habitats that are largely devoid of other plant species. Suitable habitats are eventually lost to dynamic erosional processes or succession to more stable dune grass communities. Consequently, seabeach amaranth is dependent on continual new habitat formation through dynamic barrier island and inlet processes. The species is well-adapted to this ephemeral habitat niche, producing vast numbers of tiny seeds that are widely dispersed throughout the coastal barrier system, thereby providing for the rapid colonization of new suitable habitats as they are formed.

Status of the Species in the Action Area

The Corps conducts annual seabeach amaranth surveys every summer on beaches affected by federal projects. According to the Corps' Annual Seabeach Amaranth Survey Reports, Topsail Island was surveyed from 1992 to 20120 however, this section will only focus on the last 6 years. Topsail Island reported the following number of plants from 2014-2019:

2018 – 23

2019 – 0

2020 – 0

2021 – 0

2022 – 0

2023 – 0

Effects of the Proposed Action on the Species

The principal factors affecting seabeach amaranth within the action area include habitat loss and degradation attributable to beach nourishment. Sand placement may affect seabeach amaranth by altering the dynamic coastal processes that create and maintain suitable habitat. Sand placement projects typically include the construction of berms and continuous artificial dunes that may impede natural ocean-to-sound over wash. Barrier islands respond to sea level rise by migrating landward, a process driven primarily by sediment deposition along the back-barrier estuarine shoreline via over wash events and inlet processes. In the absence of sufficient back-barrier sediment deposition, the long-term consequence of rising sea level is simultaneous ocean and back-barrier shoreline erosion, resulting in island narrowing (Riggs et al. 2009). Shoreline erosion and island narrowing may reduce the availability of suitable habitat for seabeach amaranth.

Based on seabeach amaranth annual surveys, numbers have greatly fluctuated since 2013. In 2020, seabeach amaranth surveys for the entire state of North Carolina resulted in no plants. The placement of sand from the proposed action will occur during the growing season; therefore, if plants are present, the proposed action may affect seabeach amaranth directly through the burial and mortality of plants. For this reason, the proposed action may affect but is not likely to adversely affect the species.

3.6 West Indian Manatee

Range-Wide Status and Distribution

The manatee is an occasional summer resident off the North Carolina coast with presumably low population numbers (Clark 1987). The species can be found in shallow (5 ft to usually <20 ft), slow-moving rivers, estuaries, saltwater bays, canals, and coastal areas (USFWS 1991). The West Indian manatee is herbivorous and eats aquatic plants such as hydrilla, eelgrass, and water lettuce (USFWS, 2018). Manatees are thermally stressed at water temperatures below 18ºC (64.4ºF) (Garrot et al. 1995); therefore, during winter months, when ambient water temperatures approach 20ºC (68ºF), the U.S. manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia. During the summer months, sightings drop off rapidly north of Georgia (Lefebvre et al, 2001) and are rare north of Cape Hatteras (Rathbun et al, 1982; Schwartz 1995). However, they are sighted infrequently in southeastern North Carolina with most records occurring in July, August, and September, as they migrate up and down the coast (Clark 1993). The Species is considered a seasonal inhabitant of North Carolina with most occurrences reported from June through October (USFWS 2001). According to Schwartz (1995), manatees have been reported in the state during nine months, with most sightings in the August-September period. Manatee population trends are poorly understood, but deaths have increased steadily. A large percent of mortality is due to collisions with watercrafts, especially of calves. Another closely related factor in their decline has been the loss of suitable habitat through incompatible coastal development, particularly destruction of sea grass beds by boating facilities (USFWS 2001).

Status of the Species in the Action Area

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

Effects of the Proposed Action on the Species

The principal factors affecting West Indian Manatee within the action area include potential habitat loss and degradation attributable to dredging within the Cape Fear River and inlet area. With the current state of knowledge on the habitat requirements for the manatee in North Carolina, it is difficult to determine the magnitude of such impacts. Studies currently underway by the USFWS using animals fitted with satellite transmitters may provide data on the nature of these seasonal movements and habitat requirements during migrational periods. Foods that are used by the manatee in North Carolina are unknown. In Florida, their diet consists primarily of vascular plants. The proposed action will impact the beach of Surf City with no known impacts to vascular plants; overall nearshore productivity should remain high throughout the project area. Therefore, potential food sources for the manatee should not be affected.

4.0 Consultations

The Corps held a virtual scoping meeting on June 15, 2020 with resource agencies to discuss the Corps' proposed window plan and to solicit input regarding associated resource impacts and impact minimization measures. Agencies represented on the call included the National Marine Fisheries Service Habitat Conservation Division, North Carolina Division of Coastal Management, the US Fish and Wildlife Service, North Carolina Audubon Society, and the North Carolina Department of Environmental Quality. As discussed in this meeting, every effort will be taken by the Corps to minimize takes of threatened and endangered species, to include coordinating pipeline placement and equipment traffic routes with the resource agencies, lighting minimization on the beach at night, 24-hour monitoring for sea turtle nesting activities along the entire pipeline, and relocation of turtle nests from the project area. At least two sea turtle monitors shall be present on a continuous basis from dusk to dawn to monitor sea turtle activity until all equipment is off the beach. In addition to this, monitoring for piping plover activity will occur and any waterbird nests and bird nesting habitat will be delineated and avoided to the maximum extent practicable. Strict adherence to the USFWS Manatee Guidelines will also apply.

On May 26, 2020, the Corps sent a scoping letter to all agencies soliciting comments with a response deadline of June 16, 2020. This resulted in a request from the USFWS to enact formal consultation by means of submitting a Biological Assessment, and a request from the North Carolina Division of Coastal Management to provide a Coastal Zone Management Act consistency determination. Both parties have agreed to provide responses (Biological Opinion/CZMA Consistency decision).

5.0 Conservation Measures

All beach activities during the nesting season will require monitoring for sea turtle nesting activity throughout the construction area, including the discharge area and pipeline routes. Monitoring for nest activity 24 hours/day starting 1 May will be required so that nests laid in a potential construction zone can be relocated outside of the construction zone prior to project commencement to avoid potential losses.

The following direct impacts may occur due to working within the turtle nesting season. Each item is followed with proposed measures to avoid or minimize impacts:

(1) Both stockpiled pipe on the beach and the pipeline route running parallel to the shoreline may impede nesting sea turtles from accessing more suitable nesting sites.

Though pipeline alignments and staging areas may pose impacts to nesting females and hatchlings during the nesting season, several measures can be implemented to minimize these impacts. Because construction activities likely will occur throughout the nesting season, 24 hour/day monitoring will be required starting 1 May to document all nests laid within the project area, as well as false crawls and false nesting. A Sea Turtle Monitoring and Nest Relocation Plan will be developed and implemented to clearly direct monitors regarding actions to take when a turtle or nest is encountered. All nests within the project area will be relocated outside of the construction area within 24 hours of nesting. This will ensure the highest success rate of hatching.

Throughout the period of sea turtle nesting and hatching, construction pipe that is placed on the beach parallel to the shoreline will be placed as far landward as possible so that a significant portion of available nesting habitat can be utilized, and nest placement is not subject to inundation or wash out. Furthermore, temporary storage of pipes and equipment will be located off the beach to the maximum extent practicable. If placement on the beach is necessary, it will be done in a manner that impacts the least amount of nesting habitat by placing pipes perpendicular to shore and as far landward as possible without compromising the integrity of the existing or constructed dune system.

(2) The operation of heavy equipment on the beach may impact incubating nests. The goal of the Sea Turtle Monitoring Nest Relocation Plan will be to identify and remove any turtle nests from dangers of the project area as quickly as possible. This will include the entire length of the pipeline route to the farthest extent of the beachfill limits.

(3) During nighttime operations, the nourishment construction process, including heavy equipment use and associated lighting, may deter nesting females from coming ashore and disorient emerging hatchlings down the beach.

Use of heavy equipment along the pipeline route at night will be limited to the maximum extent practicable. A minimum of two nighttime monitors will traverse the length of the pipeline to identify any turtles coming ashore to nest. False crawls, false nests and successful nests will be documented. If proper monitoring and relocation are carried out, all turtle nests should avoid being buried or crushed and thus hatchlings will be safeguarded while emerging.

All lighting associated with nighttime project construction including lighting aboard dredges and associated vessels, barges, etc. operating near sea turtle nesting beaches, will be minimized to the maximum extent practicable while maintaining compliance with EM 385-1-1 and all other Corps, U.S. Coast Guard, and OSHA safety requirements. Direct lighting of the beach and nearshore waters will be limited to the immediate construction area(s). To reduce illumination of the adjacent beach and nearshore waters, to the extent practicable, lighting on offshore or onshore equipment will be minimized through reduced wattage, shielding, lowering, and/or use of low-pressure sodium lights.

Shielded low-pressure sodium vapor lights have been identified by the FWCC as the best available technology for balancing human safety and security, roadway illumination, and endangered species protection. They provide the most energy efficient, monochromatic, long-wavelength, dark sky friendly, environmentally sensitive light of the commercially available streetlights and will be highly recommended for all lights on the beach or on offshore equipment.

(4) Escarpment formations and resulting impediment to nesting females.
Management techniques will be implemented to reduce the impact of escarpment formations. For completed sections of beach during sand placement operations, and for subsequent years following, as the beach profile approaches a more natural profile, visual surveys for escarpments will be performed. Escarpments that are identified that interfere with sea turtle nesting (exceed 18 inches in height for 100 ft.) will be leveled to the natural beach for a given area. If it is determined that escarpment leveling is required during the nesting or hatching season, leveling actions should be directed by the USFWS or NCWRC.

(5) Reduced nest success because of relocation efforts.
In some instances where the nesting season cannot be avoided, nest relocation is used as a management tool to relocate nests laid in the impact area to areas that are not susceptible to disturbance. For any given project, if the earliest documented nest attempt precludes the project commencement or completion date, nest relocation may be used as a last resort mitigation effort. If relocation is implemented, the proper protocol established by the USFWS will be adhered to avoid the potential adverse impacts outlined above. Considering the increased risk of finding and relocating nests, additional relocation requirements will be implemented (i.e. nighttime monitoring and relocation) to assure that nests are not missed.

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

6.0 Conclusions

6.1 Piping Plover Effect Determination

The proposed plan to accomplish initial construction any time of year may affect piping plovers through disturbance and behavioral modification. Construction activities may impact piping plovers directly through the mechanical destruction of nests and eggs or through an increased risk of egg predation if adults are flushed from their nests. The initial effects of sand placement would include the loss of most intertidal benthic invertebrates within the placement areas. Reductions in the availability of invertebrate prey may negatively affect the energy budgets of breeding and non-breeding plovers. Most benthic recovery studies have reported relatively rapid recovery (≤1 year) when peak larval recruitment periods were avoided. However, it is undetermined what effect the activity will have on larval communities during the summer months. Beach construction during this time could ultimately affect food sources for foraging birds in the fall/winter months.

After the initial construction, nourishment events will occur approximately every six years, giving benthic invertebrates time to recover between nourishment events. The establishment of wider and higher dry beach habitats with little to no emergent vegetation may increase the quantity and quality of supratidal nesting and roosting habitats and enhance the ability of plovers to detect and avoid predators.

The placement of beach quality sand on the beach and the associated construction activities may temporarily impact foraging, sheltering, and roosting habitat and may impact the constituent elements for piping plover wintering habitat. However, considering the potential impacts of these actions, it has been determined that the placement of sand may affect, but is not likely to adversely affect the piping plover.

6.2 Red Knot Effect Determination

Sand placement activities would occur within foraging and roosting habitats for red knots. During the active beach construction process, construction activities may affect red knots through disturbance and behavioral modification. Disturbance may cause migrating and wintering red knots to spend less time foraging and conserving energy; thereby potentially affecting survivability and productivity. Disturbance may prevent red knots from using otherwise suitable foraging, sheltering, and roosting sites; requiring birds to expend additional energy seeking out alternative habitats. The initial effects of sand placement would include the loss of most intertidal benthic invertebrates within the placement areas. Reductions in the availability of invertebrate prey may negatively affect the energy budgets of red knots; potentially resulting in reduced survivability and productivity.

Considering that beach placement activities likely will occur during peak red knot migration (May-June), the placement of sand on the beach may affect but is not likely to adversely affect the species. Any beach construction action that occurs during the month of May and into June will have negative impacts on the quality and/or availability of foraging and roosting habitats. July-August numbers decline as final populations depart for their winter habitat.

6.3 Red Knot Critical Habitat Effect Determination

The entire length of Topsail Island is considered critical habitat for the red knot. Placement of 8.0 MCYs of beach quality sand over the 16-month initial construction period on about six miles of Surf City will have long-term benefits to red knot critical habitat. It has been determined that the proposed action is not likely to adversely modify the red knot critical habitat area.

6.3 Sea Turtle Effect Determination

The proposed project could potentially affect sea turtles both directly and indirectly in the following ways: (1) The pipeline route running parallel to the shoreline may impede nesting sea turtles from accessing suitable nesting sites, (2) The operation of heavy equipment on the beach may impact nesting females and incubating nests, (3) Associated lighting impacts from the nighttime operations and the increased beach profile elevation may deter nesting females from coming ashore and may disorient emerging hatchlings, (4) Burial of existing nests may occur if missed by monitoring efforts, (5) Escarpment formations could result in impediments to nesting females as well as potential losses to the beach equilibration process, (6) Relocation efforts could reduce nest success rates, and (7) Sediment density (compaction), shear resistance (hardness), sediment moisture content, beach slope, sediment color, sediment grain size, sediment grain shape, and sediment grain mineral content may be altered, potentially affecting the nesting and incubating environment.

The USACE plans to alleviate impacts to nesting sea turtles in the project area by implementing steps including, but not limited to, (1) risk assessments, (2) 24-hour monitoring for nesting activity, and (3) relocating turtle nests for the duration of the project. A Sea Turtle Monitoring and Nest Relocation Plan will be developed and implemented by the contractor to minimize impacts for the duration of the project (until all equipment is removed from the beach).

Despite implementing the conservation measures to the maximum extent practicable, the chance of impacting nesting loggerhead turtles and their incubating environment still exists. Therefore, it has been determined that the proposed action may affect and is likely to adversely affect the loggerhead sea turtle.

As for Kemp's ridley, hawksbill, and leatherback sea turtles, these species are less likely to nest on Topsail Island; therefore, it has been determined that the proposed action may affect but is not likely to adversely affect these sea turtle species.

6.4 Loggerhead Critical Habitat Effect Determination

The entire length of Topsail Island is considered critical habitat for the loggerhead sea turtle (see Figure 9). Placement of 8.0 MCYs of beach quality sand over the 16-month initial construction period on about six miles of Surf City will have long-term benefits to sea turtle nesting habitat. It has been determined that the proposed action is not likely to adversely modify the loggerhead critical habitat area.

6.5 Seabeach Amaranth Effect Determination

Sand placement may affect seabeach amaranth by altering the dynamic coastal processes that create and maintain suitable habitat; however, shoreline erosion and island narrowing may reduce the availability of suitable habitat for seabeach amaranth. Considering that beach placement activities may occur during seed germination (May – July) and seed production (July or August), the placement of sand on the beach in the summertime may be likely to adversely affect the species. However, since 2019 seabeach amaranth surveys only showed 19 plants in populations state-wide, it can be assumed that the proposed action may affect but is not likely to adversely affect the species.

6.6 West Indian Manatee Effect Determination

Since the manatee is an infrequent summer resident of the North Carolina coast, the proposed action should have little effect on the manatee since its habitat and food supply will not be significantly impacted. Regarding vessel collisions, direct impacts from collision could take place, and precautionary measures for avoiding impacts to manatees, as established by USFWS, will be implemented for transiting vessels associated with the project; therefore, the proposed action may affect, but is not likely to adversely affect the manatee.

7.0 Literature Cited

Ackerman, R.A. 1996. The nest environment and embryonic development of sea turtles. In: Lutz, P.L. and J.A. Musick (eds.). The Biology of Sea Turtles. CRC Press.

Ackerman, R.A., T. Rimkus, and R. Horton. 1991. The Hydric Structure and Climate of Natural and Renourished Sea Turtle Nesting Beaches along the Atlantic Coast of Florida. Unpublished report prepared by Iowa State University for Florida Department of Natural Resources, Tallahassee.

Addison, L. and T. McIver. 2015. Use of inlets by shorebirds and terns in southeastern North Carolina. Presentation, NC Partners in Flight 2015 Waterbird Meeting. Audubon North Carolina.

Allen, D. 2002. The 2001 International Piping Plover Winter Census in North Carolina. In: Ferland, C.L. and S.M. Haig. 2002. 2001 International Piping Plover Census. U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Corvallis, Oregon. 293 pp.

Brock, K.A., J.S. Reece, and L.M. Ehrhart. 2009. The effects of artificial beach nourishment on marine turtles: differences between loggerhead and green turtles. Restoration Ecology 17(2): 297–307.

Byrd, J.I. 2004. The effect of beach nourishment on loggerhead sea turtle (*Caretta caretta*) nesting in South Carolina. Master's Thesis, College of Charleston, Charleston, SC.

Byrne, M.W. and B.D. Muiznieks. 2013. Sampling schedule for migratory and wintering shorebird monitoring at Cape Hatteras National Seashore. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP-1.4.29. National Park Service, Athens, Georgia.

Cameron, S.E. 2006. The 2006 International Piping Plover Winter Census in North Carolina. In: Elliott- Smith, E., S. M. Haig, and B. M. Powers (eds.) Data from the 2006 International Piping Plover Census, U.S. Geological Survey Data Series 426.

Cameron, S., D.H. Allen, M.M. Lyons, J.R. Cordes, and S.B. Maddock. 2006. Compilation and Assessment of Piping Plover Wintering and Migratory Staging Area Data in North Carolina. In: Rabon, D.R. (compiler). Proceedings of the Symposium on the Wintering Ecology and Conservation of Piping Plovers. U.S. Fish and Wildlife Service, Raleigh, NC.

Carr, A. and L. Ogren. 1960. The ecology and migrations of sea turtles. Bulletin of American Museum of Natural History, 121: 1-48.

Carthy, R.R., A.M. Foley, and Y. Matsuzawa. 2003. Incubation environment of loggerhead turtle nests: effects on hatching success and hatchling characteristics. In: Bolten, A.B. and B.E. Witherington (eds.) Ecology and Conservation of Loggerhead Sea Turtles. University Press of Florida, Gainsville, Florida, pp.145-153.

Christens, E. 1990. Nest emergence lag in loggerhead sea turtles. Journal of Herpetology 24:400-402.

Clark, M.K. 1993. Curator of Mammals, North Carolina State Museum of Natural Sciences. Personal communication regarding seasonal distribution of manatees in the Cape Fear region; p.6, In: Biological Assessment: Channel Realignment Masonboro Inlet, New Hanover County, NC. August 1995. USACE.

Clark, M. K. 1987. West Indian Manatee. Pages 18-21 in: Endangered, threatened and rare fauna of North Carolina Part I. A re-evaluation of the mammals (M. K. Clark, editor). Occasional Papers of the North Carolina Biological Survey 1987-3.

Cleary, W.J. 1996. Inlet induced shoreline changes: Cape Lookout - Cape Fear. In: Cleary, W.J. (ed.), Environmental Coastal Geology: Cape Lookout to Cape Fear, NC. Carolina Geological Society Fieldtrip Guidebook, pp. 49-60.

Crain, D.A., A.B. Bolten, and K.A. Bjorndal. 1995. Effects of beach nourishment on sea turtles: Review and research initiatives. Restoration Ecology 3(2): 95-104.

Daniel, R.S. and K.U. Smith. 1947. The sea-approach behavior of the neonate loggerhead turtle (*Caretta caretta*). Journal of Comparative and Physiological Psychology 40(6):413-420.

Davis, R.A., M.V. Fitzgerald, and J. Terry. 1999. Turtle nesting on adjacent nourished beaches with different construction styles: Pinellas County, Florida. Journal of Coastal Research 15(1), 111-120.

Dey, A., L. Niles, H. Sitters, K. Kalasz, and R.I.G. Morrison. 2011. Update to the status of the red knot, *Calidris canutus* in the Western Hemisphere, April 2011, with revisions to July 14, 2011. Unpublished report to New Jersey Department of Environmental Protection, Division of Fish and Wildlife, Endangered and Nongame Species Program.

Ehrhart, L.M. 1995. The relationship between marine turtle nesting and reproductive success and the beach nourishment project at Sebastian Inlet, Florida, in 1994. Melbourne, Florida, University of Central Florida, Technical Report to the Florida Institute of Technology.

Ernest, R.G. 2001. The Effects of Beach Nourishment on Sea Turtle Nesting and Reproductive Success, a Case Study on Hutchinson Island, Florida Proceedings of the Coastal Ecosystems and Federal Activities Technical Training Symposium August 20-22, 2001.

Ernest, R.G. and R.E. Martin. 1999. Martin County beach nourishment project: sea turtle monitoring and studies, 1997 annual report and final assessment. Unpublished report prepared for the Florida Department of Environmental Protection.

Ernest, R.G. and R.E. Martin. 1993. Sea turtle protection program performed in support of velocity cap repairs, Florida Power & Light Company St. Lucie Plant. Applied Biology, Inc., Jensen Beach, Florida. 51 pages.

Garrott, R.A., B.B. Ackerman, J.R. Cary, D.M. Heisey, J.E. Reynolds, III, and J.R. Wilcox. 1995. Assessment of trends in sizes of manatee populations at several Florida aggregation sites. Pages 34-35 in T.J. O'Shea, B.B. Ackerman, and H.F. Percival (eds.). Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington, D.C.

Godfrey, M.H. and N. Mrosovsky. 1997. Estimating the time between hatching of sea turtles and their emergence from the nest. Chelonian Conservation and Biology 2(4): 581-585.

Gorzelany, J.F. and W.G. Nelson. 1987. The effects of beach replenishment on the benthos of a sub- tropical Florida beach. Marine Environmental Research 21(2): 75-94.

Gratto-Trevor, C, D. Amirault-Langlais, D. Catlin, F. Cuthbert, J. Fraser, S. Maddock, E. Roche, and F. Shaffer. 2012. *Connectivity in piping plovers: Do breeding populations have distinct winter distributions? Journal of Wildlife Management*, 76(2): 348-355.

Haig, S.M. 1992. The Piping Plover (*Charadrius melodus*). In: Birds of North America. No. 2. A. Poole and F. Gill, eds. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists Union, Washington D.C.

Hayden, B. and R. Dolan. 1974. Impact of beach nourishment on distribution of *Emerita talpoida*, the common mole crab. Journal of the American Waterways, Harbors, and Coastal Engineering Division; ASCE 100: WW2. pp. 123-132.

Hays, G.C., J.S. Ashworth, M.J. Barnsley, A.C. Broderick, D.R. Emery, B.J. Godley, and E.L. Jones. 2001. The importance of sand albedo for the thermal conditions on sea turtle nesting beaches. Oikos 93: 87-94.

Hecht, A., and S.M. Melvin. 2009. Population trends of Atlantic Coast piping plovers, 1986-2006.

Hendrickson, J.R. 1982. Nesting behavior of sea turtles with emphasis on physical and behavioral determinants of nesting success or failure. In: K.A. Bjorndal (ed.), Biology and Conservation of Sea Turtles. Washington, D.C.: Smithsonian Institution Press, pp. 53-57.

Heron, S.D., T.F. Moslow, W.M. Berelson, J.R. Herber, G.A. Steele, and K.R. Susman. 1984. Holocene Sedimentation of a Wave-dominated Barrier Shoreline: Cape Lookout, North Carolina. Marine Geology, 60, pg. 413.

Herren, R.M. 1999. The effect of beach nourishment on loggerhead (*Caretta caretta*) nesting and reproductive success at Sebastian Inlet, Florida. Orlando, Florida: University of Central Florida, Master's Thesis.

Houghton, J.D.R. and G.C. Hays. 2001. Asynchronous emergence by loggerhead turtle (*Caretta caretta*) hatchlings. Naturwissenschaften 88:133-136.

Knutson, T.R., J.L. McBride, J. Chan, K. Emanuel, G. Holland, C. Landsea, I. Held, J.P. Kossin, A.K. Srivastava, and M. Sugi. 2010. Tropical Cyclones and Climate Change. **Nature Geoscience** 3: 157-163.

Lefebvre, L.W., M. Marmontel, J.P. Reid, G.B. Rathbun, and D.P. Domning. 2001. Status and biogeography of the West Indian manatee. Pp. 425-474 in C.A. Woods and F.E. Sergile, eds. Biogeography of the West Indies: Patterns and Perspectives. CRC Press, Boca Raton, FL. 582pp.

Limpus, C.J., P. Reed, and J.D. Miller. 1983. Islands and turtles: the influence of choice of nesting beach on sex ratio. pp. 397-402 in Baker, J.T., R.M. Carter, P.W. Sammarco, and K.P. Stark (editors). Proceedings of the Inaugural Great Barrier Reef Conference, James Cook University Press, Townsville, Queensland, Australia.

Limpus, C.J. 1971. Sea turtle ocean finding behavior. Search 2(10): 385-387.

Marcovaldi, M.A., M.H. Godfrey, and N. Mrosovsky. 1997. Estimating sex ratios of loggerhead turtles in Brazil from pivotal incubation durations. Canadian Journal of Zoology 75:755-770.

Matsuzawa, Y., K. Sato, W. Sakamoto, and K.A. Bjorndal. 2002. Seasonal fluctuations in sand temperature: effects on the incubation period and mortality of loggerhead sea turtle (*Caretta caretta*) pre- emergent hatchlings in Minabe, Japan. Marine Biology 140: 639-646.

Miller, M.P., S.M. Haig, C.L. Gratto-Trevor, and T.D. Mullins. 2010. Subspecies Status and Population Genetic Structure in Piping Plover (*Charadrius melodus*). The Auk 127(1): 57-71.

Miller, J.D., C.J. Limpus, and M.H. Godfrey. 2003. Nest site selection, oviposition, eggs, development, hatching, and emergence of loggerhead turtles. Pages 125-143 in Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Miller, J.D. 1997. Reproduction in sea turtles. Pages 51-81 in Lutz, P.L. and J.A. Musick (editors). The Biology of Sea Turtles. CRC Press. Boca Raton, Florida.

Mortimer, J.A. 1990. The influence of beach sand characteristics on the nesting behavior and clutch survival of green turtles (*Chelonia mydas*). Copeia 1990: 802-817.

Mrosovsky, N. 1988. Pivotal temperatures for loggerhead turtles from northern and southern nesting beaches. Canadian Journal of Zoology 66:661-669.

Mrosovsky, N. 1995. Temperature and sex ratio. In: Bjorndal, K. (ed.) Biology and Conservation of Sea Turtles, revised edition. Smithsonian Institution Press, Washington, DC, pp. 597–598.

Mrosovsky, N. and Yntema, C.L. 1980. Temperature dependence of sexual differentiation in sea turtles: Implications for conservation practices. Biological Conservation, 18, 271-280.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 2020. Endangered Species Act status review of the leatherback turtle (Dermochelys coriacea). Report to the National Marine Fisheries Service Office of Protected Resources and U.S. Fish and Wildlife Service

National Marine Fisheries Service and United States Fish and Wildlife Service. 2008. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*), Second Revision. National Marine Fisheries Service, Silver Spring, MD and U.S. Fish and Wildlife Service. Atlanta, GA.

NMFS and USFWS. 2007a. Loggerhead Sea Turtle (*Caretta caretta*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD and U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, FL.

NMFS and USFWS. 2007b. Green Sea Turtle (*Chelonia mydas*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD and U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, FL.

NMFS and USFWS. 2007c. Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD and U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, NM.

NMFS and USFWS. 2007d. Hawksbill Sea Turtle (*Eretmochelys imbricata*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD and U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, FL.

NMFS and USFWS. 2007e. Leatherback Sea Turtle (*Dermochelys coriacea*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD and U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, FL.

NMFS and USFWS. 1993. Recovery Plan for Hawksbill Turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. National Marine Fisheries Service, St. Petersburg, FL.

NMFS and USFWS. 1992. Recovery plan for leatherback turtles (*Dermochelys coriacea*) in the U.S. Caribbean, Atlantic, and Gulf of Mexico. National Marine Fisheries Service, Washington, D.C.

North Carolina Division of Coastal Management (NCDCM). 2015. NC Oceanfront construction setback and erosion rates. Oceanfront interactive map viewer. http://ncdenr.maps.arcgis.com/apps/webappviewer/index.html. (Accessed November 10, 2015).

North Carolina Department of Environment and Natural Resources (NCDENR). 2011. North Carolina Beach and Inlet Management Plan. Final Report. April 2011.

North Carolina Science Panel. 2015. Draft North Carolina Sea Level Rise Assessment Report. Update to the 2010 report and 2012 addendum. 31 March 2015. NC Coastal Resources Commission's Science Panel.

North Carolina Wildlife Resources Commission (NCWRC). 2015a. NCWRC shorebird database, piping plover and red knot statewide data 2000-2014. Unpublished data provided by S. Schweitzer, NCWRC, Wildlife Diversity Program, Waterbird Investigations and Management Project, New Bern, NC.

North Carolina Wildlife Resources Commission (NCWRC). 2015b. North Carolina sea turtle nest data 2000- 2014. Unpublished data provided by M. Godfrey, NCWRC Sea Turtle Project, Beaufort, NC.

Pilkey, O.H. and T.W. Davis. 1987. An Analysis of Coastal Recession Models: North Carolina Coast. In Nummedal, D., O.H. Pilkey, and J.D. Howard, eds., Sea-level Fluctuation and Coastal Evolution. Society of Economic Paleontologists and Mineralogists, Tulsa, OK, pp. 59–68.

Rathbun, G.B., R.K. Bonde, and D. Clay. 1982. The status of the West Indian manatee on the Atlantic coast north of Florida. Pages 152-165. in R.R. Odum and J.W. Guthrie (eds.). Proceedings of the Symposium for Nongame and Endangered Wildlife. Technical Bulletin WL 5. Georgia Department of Natural Resources. Social Circle, Georgia.

Rice, T.M. 2012b. Inventory of habitat modifications to tidal inlets in the continental U.S. coastal migration and wintering range of the piping plover (*Charadrius melodus*). Appendix 1b in Comprehensive Conservation Strategy for the Piping Plover (*Charadrius melodus*) in its Coastal Migration and Wintering Range in the Continental United States, U.S. Fish and Wildlife Service, East Lansing, Michigan. 30 p.

Rice, E. and S. Cameron. 2009. Bogue Inlet Waterbird Monitoring and Management 2003-2008 Final Report. North Carolina Wildlife Resource Commission. Prepared for the Town of Emerald Isle. NC.

Riggs, S.R., W.J. Cleary, and S.W. Snyder. 1995. Influence of inherited geologic framework on barrier shoreface morphology and dynamics: Marine Geology, v. 126, p. 213–234.

Rumbold, D.G., P.W. Davis, and C. Perretta. 2001. Estimating the effect of beach nourishment on (*Caretta caretta*) loggerhead sea turtle nesting. Restoration Ecology, 9(3): 304-310.

Salmon, M., J. Wyneken, E. Fritz, and M. Lucas. 1992. Sea finding by hatchling sea turtles: role of brightness, silhouette and beach slope as orientation cues. Behaviour 122(1-2): 56-77.

Salomon, C.H. and S.P. Naughton. 1984. Beach restoration with offshore dredged sand: effects on nearshore macroinfauna. NOAA Technical Memorandum, NMFS-SEFC (133). US Department of Commerce. NOAA, National Marine Fisheries Service, Southeast Fisheries Center: Panama City. 20 pp.

Seaturtle.org. 2016. Sea Turtle Nest Monitoring System. NCWRC Sea Turtle Project 2016 Nesting Data. Schweitzer, S. 2015. The 2011 International Piping Plover Winter Census in North Carolina.

Smith, E., Bidwell, M., Holland, A.E., and Haig, S.M. 2015. Data from the 2011 International Piping Plover Census: U.S. Geological Survey Data Series 922, 296 pp.

Steinitz, M.J., M. Salmon, and J. Wyneken. 1998. Beach renourishment and loggerhead turtle reproduction: A seven-year study at Jupiter Island, Florida. Journal of Coastal Research 14: 1000- 1013.

Schwartz, F.J. 1995. Florida Manatees, Trichechus manatus (Sirenia: Trichechidae), in North Carolina 1919-1994. Brimleyana No. 22:53 60. June 1995.

Turtle Expert Working Group (TEWG). 1998. An Assessment of the Kemp's; Ridley (*Lepidochelys kempii*) and Loggerhead (Caretta caretta) Sea Turtle Populations in the Western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-409. 96 pp.

USACE. 2014. 2014 seabeach amaranth (*Amaranthus pumilus*) survey. USACE, Wilmington District. September 2014.

U.S. Army Corps of Engineers, Wilmington District. Final Environmental Impact Statement CFEIS), Maintenance of Wilmington Harbor, North Carolina, dated April 1977.

U.S. Army Corps of Engineers, Wilmington District. FEIS, Long-term Maintenance of Wilmington Harbor, North Carolina, dated October 1989.

U.S. Army Corps of Engineers, Wilmington District. Environmental Assessment, Preconstruction Modifications of Authorized Improvements, Wilmington Harbor, North Carolina, dated February 2000.

U.S. Army Corps of Engineers, Wilmington District. Finding of No Significant Impact, Preconstruction Modifications of Authorized Improvements, Wilmington Harbor, North Carolina dated August 2000.

U.S. Army Corps of Engineers, Wilmington District Sand Management Plan Wilmington Harbor 96 Act, North Carolina 2000.

U.S. Army Corps of Engineers, Wilmington District Reevaluation Sand Management Plan Wilmington Harbor 96 Act, North Carolina 2011.

United States Fish and Wildlife Service (USFWS). 2018. West Indian manatees in North Carolina. https://www.fws.gov/nc-es/mammal/manatee.html.

USFWS. 2016. Estimated abundance of Atlantic Coast piping plovers 1986 - 2014 and preliminary 2015 estimates. USFWS, Sudbury, Massachusetts.

USFWS. 2015a. Recovery Plan for the Northern Great Plains piping plover (*Charadrius melodus*). Volume I: Draft breeding recovery plan for the Northern Great Plains piping plover (*Charadrius melodus*) 132 pp. and Volume II: Draft revised recovery plan for the wintering range of the Northern Great Plains piping plover (*Charadrius melodus*) and Comprehensive conservation strategy for the piping plover (*Charadrius melodus*) in its coastal migration and wintering range in the continental US 166 pp. Denver, CO.

USFWS. 2015b. Statewide Programmatic Biological Opinion (Revised) for the U.S. Army Corps of Engineers (Corps) planning and regulatory shore protection activities in Florida. 27 February 2015. South Florida Ecological Services Field Office, Vero Beach, FL.

USFWS. 2015c. North Carolina seabeach amaranth survey data 1987-2014. Compiled by Dale Suiter, USFWS, Raleigh Ecological Services Field Office, Raleigh, NC.

USFWS. 2014a. Rufa red knot background information and threats assessment. Supplement to endangered and threatened wildlife and plants; final threatened status for the rufa red knot (*Calidris canutus rufa*). Docket No. FWS-R5-ES-2013-0097; RIN AY17. New Jersey Field Office; Pleasantville, New Jersey.

USFWS. 2014b. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Northwest Atlantic Ocean Distinct Population Segment of the Loggerhead Sea Turtle. Final Rule. Federal Register 79:39755-39854

USFWS. 2012. Comprehensive conservation strategy for the piping plover (*Charadrius melodus*) in its coastal migration and wintering range in the continental United States. U.S. Fish and Wildlife Service; East Lansing, Minnesota.

USFWS. 2009. Piping plover (*Charadrius melodus*) 5-year review: summary and evaluation. U.S. Fish and Wildlife Service, Hadley, Massachusetts.

USFWS. 2008. Revised designation of critical habitat for the wintering population of the piping plover (*Charadrius melodus*) in North Carolina. Federal Register 73: 62816-62841.

USFWS. 2005. Seabeach Amaranth (*Amaranthus pumilus*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Raleigh Ecological Services Field Office, Raleigh, NC.

USFWS. 2003. Recovery Plan for the Great Lakes Piping Plover *(Charadrius melodu*s). Fort Snelling, Minnesota.

USFWS. 2001. Endangered and threatened wildlife and plants; Final determinations of critical habitat for wintering piping plovers; Final rule. Federal Register 66(132):36037-36086.

USFWS. 1996a. Piping Plover (*Charadrius melodus*), Atlantic Coast Population, Revised Recovery Plan. U.S. Fish and Wildlife Service, Hadley, MA.

USFWS. 1996b. Recovery Plan for Seabeach Amaranth (*Amaranthus pumilus*), Southeast Region, Atlanta, Georgia.

USFWS. 1991. Endangered and Threatened Species of the Southeast United States.

USFWS. 1988. Great Lakes and Northern Great Plains piping plover recovery plan. U.S.Fish and Wildlife Service, Twin Cities, Minnesota. 160 pp.

Van Dolah, R.F., P.H. Wendt, R.M. Martore, M.V. Levisen, W.A. Roumillat. 1992. A physical and biological monitoring study of the Hilton Head beach nourishment project. Marine Resources Research Institute, South Carolina Marine Resources Division, Charleston, S.C. 159 pp.

Wibbels, T. 2003. Critical approaches to sex determination in sea turtles. In: Biology of Sea Turtles, Vol. II (Eds. Lutz, P.L., J.A. Musick, and J. Wyneken) pp. 103-134. Boca Raton: CRC Press.

Witherington, B.E. 1992. Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48(1):31-39.

Witherington, B.E. 1986. Human and natural causes of marine turtle clutch and hatchling mortality and their relationship to hatchling production on an important Florida nesting beach. Unpublished Master of Science thesis. University of Central Florida, Orlando, Florida. 141 pages.

Witherington, B., S. Hirama, and A. Mosier. 2006. Changes to armoring and other barriers to sea turtle nesting following severe hurricanes striking Florida beaches. Final Project Report to the U.S. Fish and Wildlife Service. 11 pages.

Witherington, B.E. and R.E. Martin. 2003. Understanding, Assessing, and Resolving Light-Pollution Problems on Sea Turtle Nesting Beaches. Third edition revised 2003. Florida Marine Research Institute Technical Report. Technical Report TR-2.

Wood, D.W. and K.A. Bjorndal. 2000. Relation of temperature, moisture, salinity, and slope to nest site selection in loggerhead sea turtles. Copeia 2000(1):119-128.

Yntema, C.L. and N. Mrosovsky. 1982. Critical periods and pivotal temperatures for sexual differentiation in loggerhead sea turtles. Canadian Journal of Zoology, 60, 1012-1016.

Appendix A: Project Plans

Project plans will be placed here when complete.