Draft
January 2015

ENVIRONMENTAL ASSESSMENT

For the Town of Kill Devil Hills Shore Protection Project

ENVIRONMENTAL ASSESSMENT
TOWN OF KILL DEVIL HILLS SHORE PROTECTION PROJECT

Prepared for:
The Town of Kill Devil Hills, North Carolina

and U.S. Army Corps of Engineers and the Bureau of Ocean Energy Management

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1 INTRODUCTION

1.1 Where is the Proposed Action Located?

The Kill Devil Hills Shoreline Protection Project is located in Kill Devil Hills, along the Atlantic coast of the Outer Banks within Dare County, North Carolina (Figure 1). Specifically, the project includes a 2.77-mile section of oceanfront shoreline spanning the northern portion of Kill Devil Hills and a small part of the southern portion of Kitty Hawk. Material will be obtained from two Outer Continental Shelf (OCS) borrow areas located in federal waters offshore of Dare County (Figure 1). Borrow area A is located between 5.0 and 6.5 miles offshore, while Borrow Area B is located 4.1 to 5.2 miles offshore.

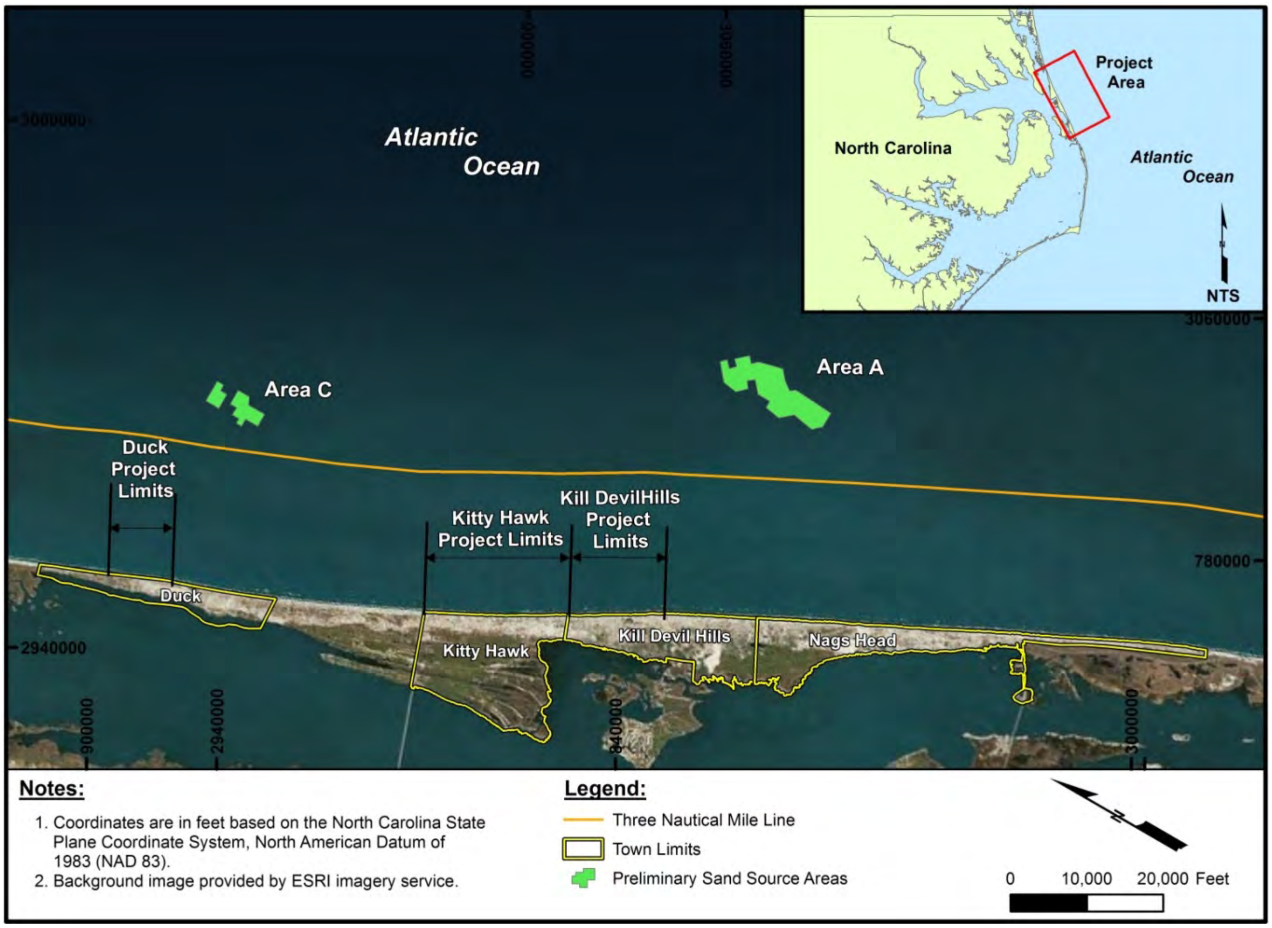

Figure 1. Map showing general site location (inset), and project locations, including project and town limits for each town and locations of preliminary sand source areas.

1.2 Scoping and Consultation History

The intent of the Kill Devils Hills Shore Protection Project is to construct a beach nourishment project similar in scope and design to the portion of the federally authorized project within the Town's jurisdiction. On September 14, 2011, the Town held an interagency meeting in

Washington, NC with representatives from various state and federal agencies including the US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). The purpose of the meeting was to present the scope of the proposed locally sponsored project and to develop an agreed upon permitting approach and scope of necessary environmental documentation. One outcome of the meeting was the decision for the Town to develop a “Project Information Document” that would provide the USACE with a summary of the relevant existing environmental documentation and biological data that pertains to the proposed Kill Devil Hills Shore Protection. The information provided within the document was used to assist the USACE in determining the necessary permitting requirements. Following the submittal of the document, the USACE responded that due to the likelihood of determining a Finding of No Significant Impacts (FONSI), an Environmental Assessment (EA) would be the recommended approach regarding the required environmental documentation. The meeting minutes from the September 14, 2011 interagency meeting are included in Appendix A. Appendix B contains the Project Information Document.

Soon after the 2011 interagency meeting, two other beach towns in Dare County, Duck and Kitty Hawk, expressed interest in pursuing their own beach nourishment projects in light of continued erosion on their respective shorelines. Another interagency meeting was held on June 19, 2013 with representatives from many of the same agencies to discuss proposed permitting and environmental documentation approaches for Kill Devil Hills, Duck and Kitty Hawk. Because the potential borrow areas under consideration for the three nourishment projects are located in federal waters, it was determined that the Bureau of Ocean Energy Management (BOEM) would act as a co-lead agency along with the USACE. Representatives from the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) agreed that while individual EAs could be drafted for each of the three proposed projects (resulting in three individual sets of permits), a single regional Essential Fish Habitat (EFH) assessment and a single batched Biological Assessment (BA) could be submitted for all three beach towns to satisfy consultation requirements with NMFS and USFWS. The meeting minutes from the interagency meetings are presented in Appendix A.

It is important to note that the proposed dredging of OCS borrow areas falls outside the jurisdiction of several existing biological opinions. The 1995/1997 South Atlantic Regional Biological Opinion (SARBO) does not apply because 1) the USACE does not have regulatory jurisdiction over OCS borrow areas, and 2) the project is not being funded or undertaken by the USACE. The USACE has re-initiated consultation with the USFWS and the NMFS to include new species, actions and geographic areas in the SARBO. The presently proposed dredging activities would be covered under this re-initiated SARBO, since both the USACE and BOEM would be party to it. However, it cannot be assumed that the SARBO will be completed in time to be applicable to the Duck project; therefore, BOEM will need its own “stand-alone’ biological opinion and Incidental Take Statement to authorize any potential protected species interactions occurring in federal waters.

1.3 What is the Proposed Action?

The project would involve construction of a portion of the federal Dare County Beaches project that falls within the Town limits of Kill Devil Hills including tapers on both the north and south end (Figure 2). The proposed action will include sand placement along a 13,597 ft. section of Kill Devil Hills and a 912 ft. section of Kitty Hawk oceanfront shorelines, for a total of 14,509 ft. of shoreline (Figure 2). Beach quality sand will be obtained via ocean certified hopper dredge, cutter suction dredge or a combination of the two from an offshore borrow area and transported to the recipient beach by a submerged or floating pipeline. The proposed borrow areas for the project are located in federal waters, and range from 4.1 to 6.5 miles offshore of the Dare County coastline. Details of the proposed action are discussed in section 2.2 under Alternative 2, the Applicant's Preferred Alternative.

1.4 What are the Purpose and Need of the Proposed Action?

The Town of Kill Devil Hills is focused on a long-term shoreline management program that will serve to sustain the beaches that support a significant portion of their local economy and maintains the tax base of the Town. Infrastructure protection, storm damage mitigation and rapid recovery from storm events are important considerations. In order to accomplish these stated goals, the Town is taking steps to maintain its oceanfront beach and dune to a configuration that 1) provides a reasonable level of storm damage reduction to public and private development, 2) mitigates long-term erosion that could threaten public and private development as well as recreational opportunities and biological resources, and 3) maintains a healthy beach habitat that supports valuable shorebird and sea turtle nesting habitat.

Based on long-term shoreline and volume change rates and storm vulnerability analyses, the southern 2.3 miles of oceanfront shoreline currently meets the Town's threshold to provide an adequate level of storm damage reduction and to mitigate long-term erosion. However, the northern 2.45 miles of shoreline currently do not meet this threshold. The proposed action for which the Town is seeking permits and approvals therefore includes the northern 2.45 miles of the oceanfront shoreline with a small taper section extending into Kitty Hawk. The Town is seeking the permits and approvals necessary to construct the proposed project. The project also includes advanced nourishment to maintain the integrity of the project design for a period of 5 years. The Town will regularly monitor and re-evaluate on 5-year intervals the level of storm damage reduction and erosion mitigation that the existing beach provides.

2 DESCRIPTION OF ALTERNATIVES

This section describes the various alternatives evaluated for responding to the erosion threat and the risk of storm damage to existing structures and infrastructure along the northern 2.57 mi (4.14 km) of the Town of Kill Devil Hills. The area of concern begins at the north town limits, located near baseline station 190+00, and extends south to Windsong Way located near baseline station 315+50. The alternatives include:

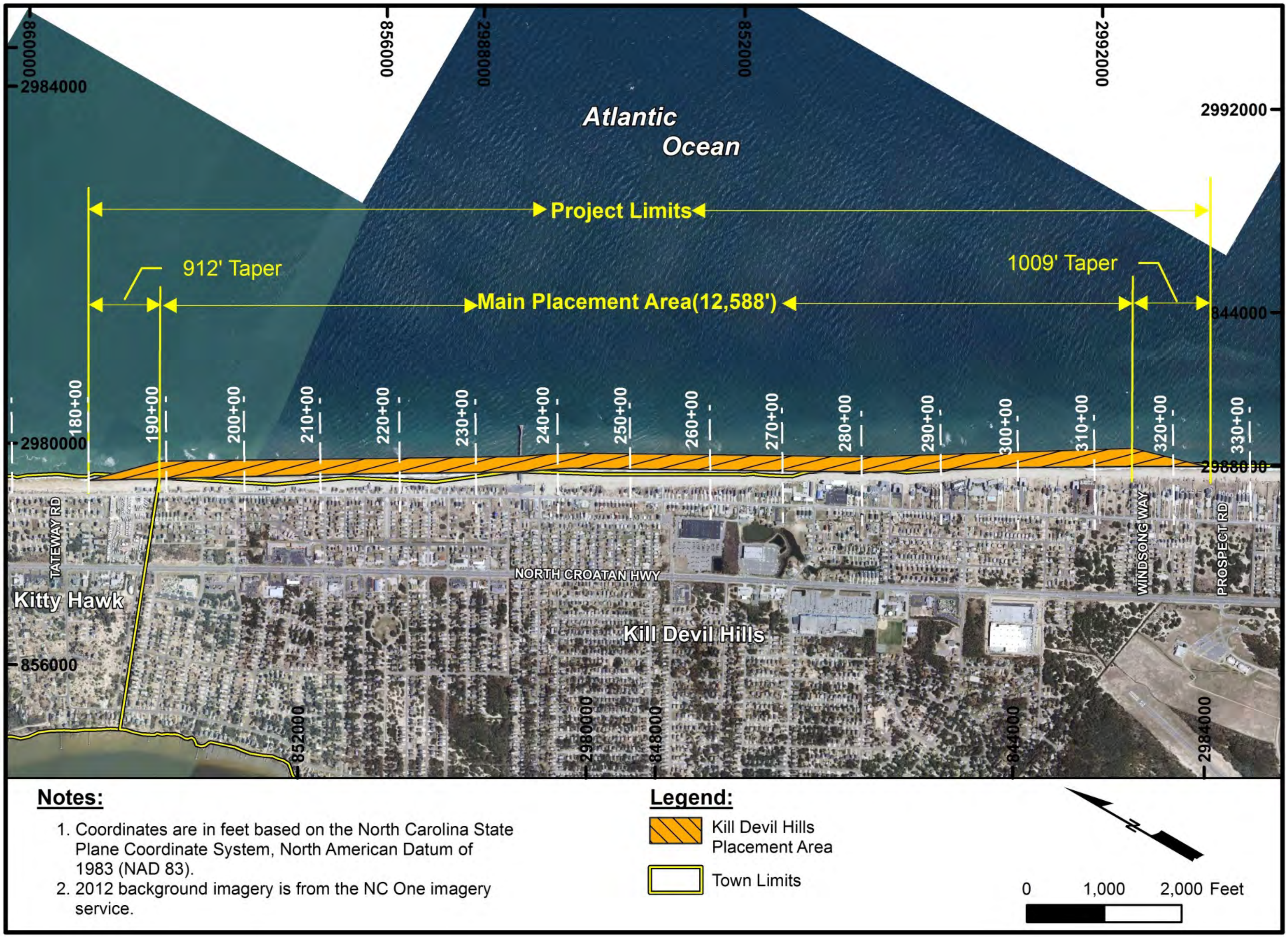

Figure 2. Proposed placement area for the Kill Devil Hills shore protection project.

- Alternative 1 – Abandon/Retreat
- Alternative 2 – Applicant's Preferred Alternative – Beach Nourishment with Offshore Borrow Areas within State and BOEM Waters
- Alternative 3 – No Action

The primary tools used to evaluate the effectiveness of the various alternatives in meeting the needs and objectives included:

- LiDAR surveys;
- NC Division of Coastal Management (DCM) 2011 Shoreline Change Update; and
- SBEACH model

LiDAR surveys

Shoreline changes along the Town of Kill Devil Hills were evaluated using LiDAR (Light Detection and Ranging) data collected by USACE JALBTCX (Joint Airborne LiDAR Bathymetry Technical Center of Expertise), USGS (U.S. Geological Survey), NASA (National Aeronautics and Space Administration), and NOAA (National Oceanographic and Atmospheric Administration). LiDAR is an optical remote sensing technology that measures the ground elevation or seafloor at relatively high spatial resolutions. LiDAR data are better suited for surveying subaerial platforms since light penetration may be restricted by water clarity. For this analysis, only elevations collected along the dry beach were evaluated. Twelve (12) sets of LiDAR data collected over a 16-year period between 1996 and 2012 were used for the shoreline study. Details of the shoreline change analysis are provided in Appendix C and summarized in Chapter 4.

NC Division of Coastal Management (DCM) 2011 Shoreline Change Update

The North Carolina DCM periodically updates shoreline change rates for the entire state for purposes of computing ocean hazard setback factors. DCM computes shoreline change rates using the "end point" method that essentially measures the difference in position of an "early shoreline" with the shoreline shown on a more recent set of aerial photographs. For the 2011 update, DCM actually used an early shoreline interpreted from a 1940 set of aerial photos and the more recent shoreline determined from 2009 aerial photos. Since the DCM data covered a larger timeframe, the DCM shoreline change rates along Kill Devil Hills had less variability than the rates computed from the LiDAR data. A full discussion of the DCM shoreline change rates and a comparison of those rates with the LiDAR data rates is provided in Appendix C and summarized in Chapter 4.

SBEACH model

Storm erosion modeling for Kill Devil Hills was conducted using the **S**torm- Induced **BEA**ch **CH**ange Model (SBEACH, Larson and Kraus, 1989). SBEACH simulates the beach profile changes due to storm generated waves and water levels over the duration of the storm. The SBEACH analysis for Kill Devil Hills used storm characteristics associated with Hurricane Isabel to 1) determine which structures would be vulnerable to storm damage under existing conditions and 2) evaluate the potential for erosion response alternatives to reduce storm damage vulnerability. Hurricane Isabel impacted the area in September 2003 and produced a maximum water level of +5.6 feet NAVD. The storm still water level was measured at the USACE Field

Research Facility (FRF) located in Duck, NC, which is about 9.5 miles (15.3 km) north of the northern town limits of Kill Devil Hills.

In general, a storm similar to Hurricane Isabel would have a 4% to 5% probability of occurring in any given year, i.e., a storm similar to Hurricane Isabel would be expected to impact the area an average of once every 20 to 25 years. Notwithstanding the storm frequency, there is a 70% to nearly 80% risk that a storm similar to Hurricane Isabel will impact Kill Devil Hills over the next 30 years.

The SBEACH model was applied to each of the approximate 500-foot baseline transects along Kill Devil Hills and the landward most point where the post-storm profile was one (1) foot below the pre-storm profile was used as an indication of the landward limit of the storm's "impact". The impact point at each transect was superimposed on 2012 aerial photographs and an impact line connecting the impact points was generated using GIS software. If the impact line reached the front of a structure, as defined by the Dare County GIS data, or bisected the structure, that structure was deemed impacted by the storm. No attempt was made to determine the extent of the potential damage only that the structure would be impacted to some degree.

Details of the SBEACH analysis along with figures showing the impact line for the Alternative 1 – Abandon/Retreat (which is also applicable to Alternative 3 – No Action) as well as the impact lines for various beach design options evaluated for Alternative 2 are provided in Appendix C.

The SBEACH analysis for the Abandon/Retreat Alternative (Alternative 1) provided an assessment of the number of structures at risk of storm damage should measures not be implemented to reduce the level of risk. The SBEACH analyses for the various beach design options provided a relative measure of the potential reduction in storm damage to existing development relative to Alternative 1. This provided a basis for selecting the most cost-effective beach design option.

In this EA, all three (3) alternative actions listed above were considered viable and were thus subjected to analysis of impacts to the human, physical and biological environments and threatened and endangered species.

2.1 Alternative #1: Abandon and Retreat

The existing shoreline management initiatives within the Town of Kill Devil Hills includes a town sponsored program to install sand fences along vulnerable sections of its shoreline in an attempt to rebuild dunes, and actions by individual property owners to rebuild storm damaged dunes through the use of beach scraping (bulldozing). In addition, a limited number of individual property owners have installed temporary sandbag revetments to protect imminently threatened structures. Under Alternative 1, these activities would cease and buildings threatened by erosion, or those that have a high probability of being damaged by storms, would be either moved landward to existing vacant lots or abandoned and demolished.

Shoreline erosion rates determined from the analysis of the LiDAR data sets spanning the 16-year period from October 1996 to November 2012 varied along the shoreline. Rates ranged from a maximum recession of 3.6 feet/year between baseline stations 290+00 (just north of 1st St.) and

340+00 (south of Raleigh Ave.) to 2.3 feet of accretion between stations 190+00 (south of E. Sibbern Dr.) and 215+00 (approximately E. Sothel St.). In general, the shoreline change rates determined from the LiDAR data alternated between recession and accretion every 2,000 feet to 5,000 feet beginning at the north end of town (Appendix C). Average shoreline change rates determined from the LiDAR data applicable to various shoreline segments are provided in Table 1.

Table 1. Average shoreline change rates from LiDAR data.

Shoreline Segment		Shoreline Distance (feet)	Average Rate Shoreline Change (ft/yr)
From Station	To Station		
170+00	190+00	2,000	-2.5
190+00	215+00	2,500	+2.3
215+00	240+00	2,500	-1.3
240+00	290+00	5,000	+1.1
290+00	340+00	5,000	-3.6

Updated shoreline change rates published by the NC Division of Coastal Management (DCM) in 2011, which were based on measured changes between 1940 and 2009, indicate a more consistent recession trend between baseline stations 170+00 and 290+00 with rates varying from -1.4 feet/year to -1.9 feet/year. The DCM rates indicated the 5,000-foot shoreline segment between stations 290+00 and 340+00 (south end of the area of concern) accreted at a rate of 0.6 feet/year. Note the long-term trend determined by DCM between 290+00 and 340+00 was completely different from the trend computed from the sixteen-year LiDAR data that indicated a recession rate of 3.6 feet/year.

The relatively moderate shoreline recession rates along the northern portion of Kill Devil Hills indicated by the LiDAR data, as well as the DCM data combined with the location of the ocean front structures relative to the shoreline suggests that very few ocean front structures would be impacted by long-term erosion over the next 30 years. In this regard, erosion of the shoreline was deemed to render the structures imminently threated once the +6-foot NAVD contour encroached within 20 feet of the front of the structure. The +6-foot NAVD contour represents the approximate elevation of the natural berm crest in the area and is representative of the average wave run-up elevation under normal conditions. The 20-foot criteria used to determine if a structure would be imminently threatened by long-term erosion is generally the same definition of imminently threated used by DCM.

Based on the relatively low rates of shoreline change along the north end of Kill Devil Hills, only 16 ocean front structures would be imminently threated over the next 30 years. The estimated number of ocean front structures that could be impacted by long-term erosion is summarized in 5-year increments in Table 2.

Table 2. Number of ocean front structures that would be imminently threatened by long-term erosion over the next 30 years.

Time Increment (years)/Structures Imminently Threatened					
0-5	5-10	10-15	15-20	20-25	25-30
0	1	0	1	8	6

Notwithstanding the apparent relatively minor threat of damage to the ocean front structures due to long-term shoreline erosion, the SBEACH analysis of potential impacts to ocean front structures during storms similar in magnitude to Hurricane Isabel identified 35 residential and 5 commercial structures that could be impacted by a storm similar to Hurricane Isabel. For this analysis, commercial structures included motels and condominium complexes. The majority (30) of the residential structures at risk of storm damage are located between the north town limits and the Avalon Pier (approximate baseline station 235+13). Commercial buildings that are vulnerable to storm damage are all located south of 4th St. and include the Mariner Motel and the Sea Ranch Resort and three large condominium complexes. More detailed information on the impacted structures is provided in Appendix C.

Of the 35 residential structures that are at risk of damage due to a hurricane similar to Hurricane Isabel, only 1 appeared to be on a lot that was large enough to allow the structure to be moved back on its existing lot. In that particular case, the structure would only have to be moved about 35 feet landward to put it in line with the adjacent structures and landward of the SBEACH impact line. The other 34 structures deemed to be at risk would have to be moved to another lot entirely or demolished. In order to implement the Abandon/Retreat alternative, it is recommended the Town of Kill Devil Hills proactively invest in at least 30 vacant lots north of the Avalon Pier in anticipation of relocating many of the at-risk structures.

The 5 commercial buildings at risk of damage due to a storm similar to Hurricane Isabel include portions of 2 motels (The Mariner and the Sea Ranch) and 3 large condominium complexes. Potential storm impacts to the Mariner include the swimming pool located on the seaward edge of the property and the building situated along the south boundary of the property. The main building fronting Virginia Dare Trail is not at risk. Based on the position of the impact line, the swimming pool would be cut in half while the building along the south boundary of the property could lose the seaward end. Given the size of the property, the swimming pool could be demolished and a new pool constructed elsewhere on the property while the seaward end of the building along the south boundary of the property would properly have to be demolished and the building reconfigured. The Sea Ranch complex, which includes the older main building on the oceanfront and a new newer building along the north property line, would both be subject to potential storm damage during a hurricane similar to Hurricane Isabel. Other buildings on the property could also suffer some damage. Given the size and type of construction of the Sea Ranch structures, moving is probably not an option. One possibility would be to demolish all or portions of the existing structures and rebuild a smaller facility on the existing property. This could be done at the expense of sacrificing portions of the existing parking lot.

The condominium complexes that could experience significant damage during a storm similar to Hurricane Isabel include the Sands, Golden Strand and Sea Oat Villas. Based on the size of the condominium properties, the existing structures could be demolished and rebuilt closer to Virginia Dare Trail. This type of response would normally have to be approved by some percentage of the property owners.

The threat of a storm comparable to Hurricane Isabel impacting the area over the next 5 to 15 years was evaluated in order to provide some guidance as to the most prudent timeframe structures should be moved or abandoned, since very few of the structures appear to be at risk from damage due to long-term erosion. In this regard, assuming Hurricane Isabel has a probability of 4% to 5% in any given year, the risk of a similar storm impacting Kill Devil Hills within the next 5 years would be between 18.5% and 22.6%. Over the next 15 years, the risk would increase to 45.8% to 53.7%. While there is not a definitive way to dictate when action should take place to move and/or abandon the at-risk structures, given the risk of a reoccurrence of a storm similar to Hurricane Isabel, most of the at-risk structures should be moved or abandoned within the next 15 years.

2.2 Alternative #2: Applicant's Preferred Alternative - Beach Nourishment with Offshore Borrow Areas within BOEM waters

A portion of the ocean shoreline of the Town of Kill Devil Hills is included in the federal storm damage reduction project for the Dare County Beaches, which was authorized by the Water Resources Development Act of 2000. The section of the Kill Devil Hills shoreline included in the main portion of the federal project begins at the north town limit (baseline station 189+00) and ends at baseline station 297+30, or approximately 500 feet south of E. First Street. The design template for the federal project included a 25-foot wide dune at elevation +12.0 feet NAVD fronted by a 50-foot wide berm at elevation +6.0 feet NAVD.

Due to federal budget priorities, Dare County has been unsuccessful in obtaining federal construction funds for the project and the prospects of obtaining federal funding for the project in the near future appear remote. Consequently, the Town of Kill Devil Hills has elected to pursue a locally funded beach protection project. The proposed local project maintains some elements of the federal design, but extends the limits of the main portion, while also considering additional borrow areas. Henceforth, the physical boundary of the nourished beach, including the main portion, tapers and the proposed borrow areas will collectively be referred to as the "Project Area".

The main portion of the proposed local project begins at the north town limit (baseline station 189+00) and extends south to Windsong Way located near baseline station 314+88. The length of the main portion of nourished shoreline, excluding the tapers, is 12,588 feet. If the Kill Devil Hills project is constructed as a stand-alone project, two taper sections would be included, one on the south end and the other on the north end of the main placement area (Figure 2). The south taper would end just north of the Prospect Ave. public access at station 324+97 (1,009 ft.), while the north taper would extend into the Town of Kitty Hawk, terminating just south of Tateway Road at station 179+88 (912 ft.). Thus, the Kill Devil Hills project would include 14,509 (2.75 mi.) of shoreline.

Currently, the Town of Kitty Hawk is also seeking permits to allow the construction of a beach protection project along its entire ocean shoreline. Consequently, there is a possibility both the Kill Devil Hills and Kitty Hawk projects could be constructed concurrently, which would eliminate the need for the north taper section of the Kill Devil Hills project. Likewise, a south taper for the Kitty Hawk project would not be needed if the two projects are constructed at the same time.

Formulation of the beach nourishment project focused on developing a design template that would provide a reasonable level of storm damage protection to ocean front development within the Project Area. While any beach nourishment project would also address issues associated with the damaging impacts of continued shoreline recession, if the shoreline change rates indicated by the analysis of the LiDAR data between 1996 and 2012 (Table 1) continued, very few ocean front structures would be impacted by long-term erosion over the next 30 years (Chapter 4 and Appendix C).

Consequently, the formulation of the design template was based primarily on the results of an SBEACH analysis, which evaluated the number of structures that could be impacted by a storm similar in magnitude to Hurricane Isabel that impacted the area in September 2003. This analysis is provided in detail in Appendix C. Design templates evaluated included ‘berm-only’ plans in which berms at elevation +6.0 feet NAVD were extended seaward of the existing dune by 40 and 50 feet. However, the 50-ft berm-only plan would afford only a moderate level (60%) of potential storm damage reduction to the 30 residential structures deemed at-risk from storm damage in Alternative 1. Specifically, of the 35 residential structures determined to be at-risk, 14 (40%) would still be impacted if a berm-only project were in place. Furthermore, two of the five large commercial buildings could also experience significant storm damage with a berm-only design.

Design templates that included enhancement of the existing dune combined with berms fronting the dune were also evaluated for their potential to decrease storm damage. The design chosen as the most optimal design included a 20-foot wide dune at elevation +15.0 feet NAVD fronted by a 40 ft. berm. Two other options that provided a relatively high level of potential storm damage reduction that were assessed earlier on in the analysis included a 25-foot wide dune at elevation +18.0 feet NAVD and one at elevation +20.0 feet NAVD, both of which were fronted by a 50-foot wide berm at elevation 6.0 feet NAVD. These options are designated as the15/40 Design, 18/50 Design and 20/50 Design, respectively. Other options evaluated, which are presented in Appendix C, included the same 18-foot NAVD and 20-foot NAVD dunes fronted by 75-foot and 100-foot berms; however, they did not afford any additional protection over the 50-foot berm. For the 15/40 Design, the SBEACH analysis indicated only one residential structures would be impacted by a storm comparable to Hurricane Isabel compared to 21 for the No Action Alternative. This represents a 95% reduction. With the 15/40 Design, none of the at-risk commercial structures were impacted. Preliminary estimates suggest 947,500 cy of sand would be required to be placed to construct the 15/40 Design including five (5) years of advanced nourishment. Given the fact that larger designs considered such as the 18/50 Design and 20/50 Design provided minimal additional potential storm damage reduction, the preferred design alternative is the 15/40 Design. A typical cross-section of the design template is provided in Figure 3**Error! Reference source not found.**, and the distribution of the sand between baseline stations given in Table 3.

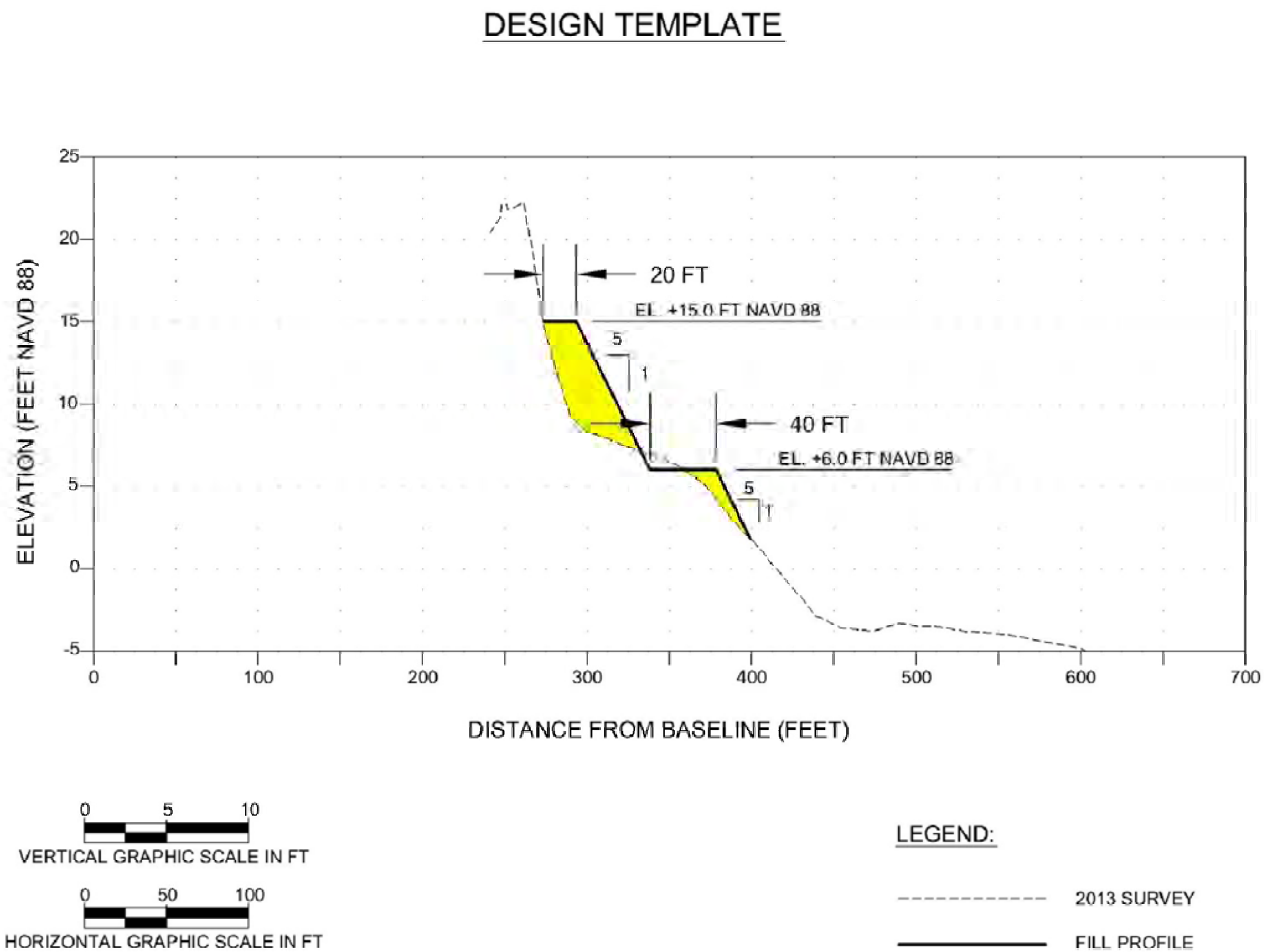

Figure 3. Typical beach design template for the Applicant's Preferred Alternative, depicting a 20-ft. wide dune at elevation +15.0 ft. NAVD 88 with a 40 ft. berm at +6.0 ft. NAVD 88

Table 3. Distribution of material for the Applicant's Preferred Alternative.

Station	To Station	Distance (ft)	Sand Density (cy/lf) including advanced fill		Volume (cy)
			from	to	
179+00	189+87	1000	0.0	71.9	36,000
189+87	194+90	503	71.9	66.0	35,000
194+90	199+93	503	66.0	70.3	34,000
199+93	204+84	491	70.3	74.0	35,000
204+84	209+74	491	74.0	72.7	36,000
209+74	214+87	513	72.7	73.5	37,000
214+87	220+00	513	73.5	89.2	42,000
220+00	224+92	492	89.2	74.1	40,000
224+92	229+83	492	74.1	67.2	35,000
229+83	235+13	529	67.2	70.3	36,000
235+13	240+42	529	70.3	69.3	37,000
240+42	245+12	470	65.5	65.2	31,000
245+12	249+82	470	65.2	68.3	31,000
249+82	254+99	518	68.3	63.5	34,000
254+998	260+17	518	63.5	64.7	33,000
260+17	264+83	466	64.7	64.5	30,000
264+83	269+49	466	64.5	65.0	30,000
269+49	274+65	516	71.0	83.3	40,000
274+65	279+81	516	83.3	70.7	40,000
279+81	284+90	510	70.7	70.4	36,000
284+90	289+99	510	70.4	69.0	36,000
289+99	294+96	497	69.0	74.2	36,000
294+96	299+92	497	74.2	70.9	36,000
299+92	304+82	489	70.9	71.3	35,000
304+82	309+71	489	64.2	63.9	31,000
309+71	314+88	517	63.9	64.4	33,000
314+88	324+88	1000	64.4	0.0	32,000
				Total	**947,000**

2.2.1 Borrow Source

Material to construct the project would be obtained from one or both of the borrow areas shown in Figure 1. Both borrow Area A and C are located entirely within federal waters, i.e., seaward of the Three Nautical Mile Line, placing them under the jurisdiction of the Department of the Interior Bureau of Ocean Energy Management (BOEM). Borrow Area A is the closest to the Kill Devil Hills shoreline; therefore, it would be the primary borrow source provided the material is found to be compatible with the native beach material, and that it meets engineering requirements for beach placement performance.

Initial coordination with BOEM has been completed with geotechnical investigations of the potential borrow areas currently in process. The geotechnical investigations include geophysical (sonar) surveys, vibracores, hydrographic surveys, cultural resources surveys and sand compatibility analysis. These efforts lead to the development of the borrow area designs. Preliminary designs are shown in Figure 4 and Figure 5 below. The compatibility analysis (discussed in section 3.1.2 and 3.1.3) determines if the offshore borrow material meets the engineering requirements for the Kill Devil Hills design template and the compatibility requirements established by the North Carolina Coastal Resources Commission (CRC).

To obtain material from the borrow areas, the Applicant proposes to use an ocean-certified, self-contained hopper dredge with direct pump-out, a cutterhead suction dredge or a combination of the two. The types utilized will depend on many factors, including competition in the bid process, pumping or haul distance, and depth and extent of dredging. The offshore borrow area locations are subjected to the most severe wave climate along the entire East Coast of the United States. Therefore, the potential for adverse sea conditions and construction schedule will be a major consideration in the selection of the dredging methods and equipment used. A hopper dredge is a self-propelled, maneuverable vessel that can independently load, transport and unload dredged material. The hopper dredge has a trailer suction pipe with a draghead that strips off layers of sediment and hydraulically suctions the material into the hopper. For the proposed project, material would be offloaded by direct pump-out through a submerged pipeline while the vessel is moored offshore. There are potential environmental impacts associated with using hopper dredges, such as entrainment of threatened and endangered species by the draghead, localized turbidity plumes at the draghead site and near the surface as the hoppers are filled. However, advances in design have included under hull release of overflow sediment and anti-turbidity valves, which help reduce sediment plumes (W.F. Baird and Associates, 2004). Efforts to mitigate the take of listed species include pre-dredge and relocation trawls and inclusion of turtle deflectors on dragheads.

A cutter suction dredge can be self-propelled, or require a barge for transport. During operation, the cutter suction dredge is anchored at one corner by a spud, and the cutter suction dredge moves in an arc over the dredge area rotating around the spud. During dredging, material is hydraulically pumped up the suction pipe and discharged at a disposal site (may be upland or in-water) or to a barge for transport to the disposal site. Cutter suction dredges are limited by sea-state condition and do not perform well in areas of elevated sea states. Environmental effects include suspension of sediment around the cutterhead, or turbidity plumes resulting from leaks or dredge overflow. Turbidity created by a cutter suction dredge is generally less than that of a trailing suction hopper dredge since sediment re-suspension is confined to near the substrate and around the cutterhead. Environmentally conscious developments have involved design improvements to the cutter suction dredge that increase accuracy and reduce mechanical disturbance of the seabed (McLelland and Hopman, 2000).

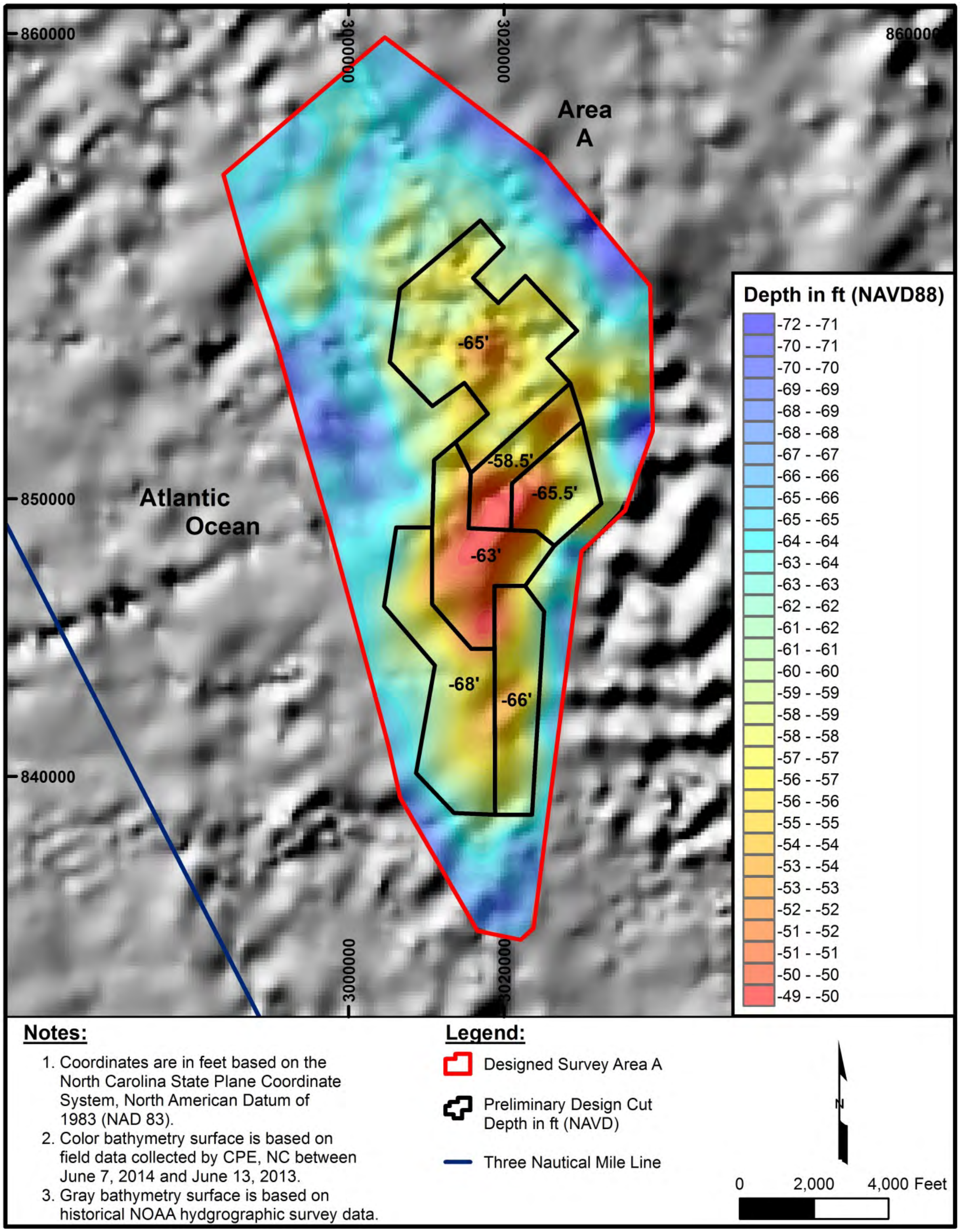

Figure 4. Borrow Area A with preliminary design cuts.

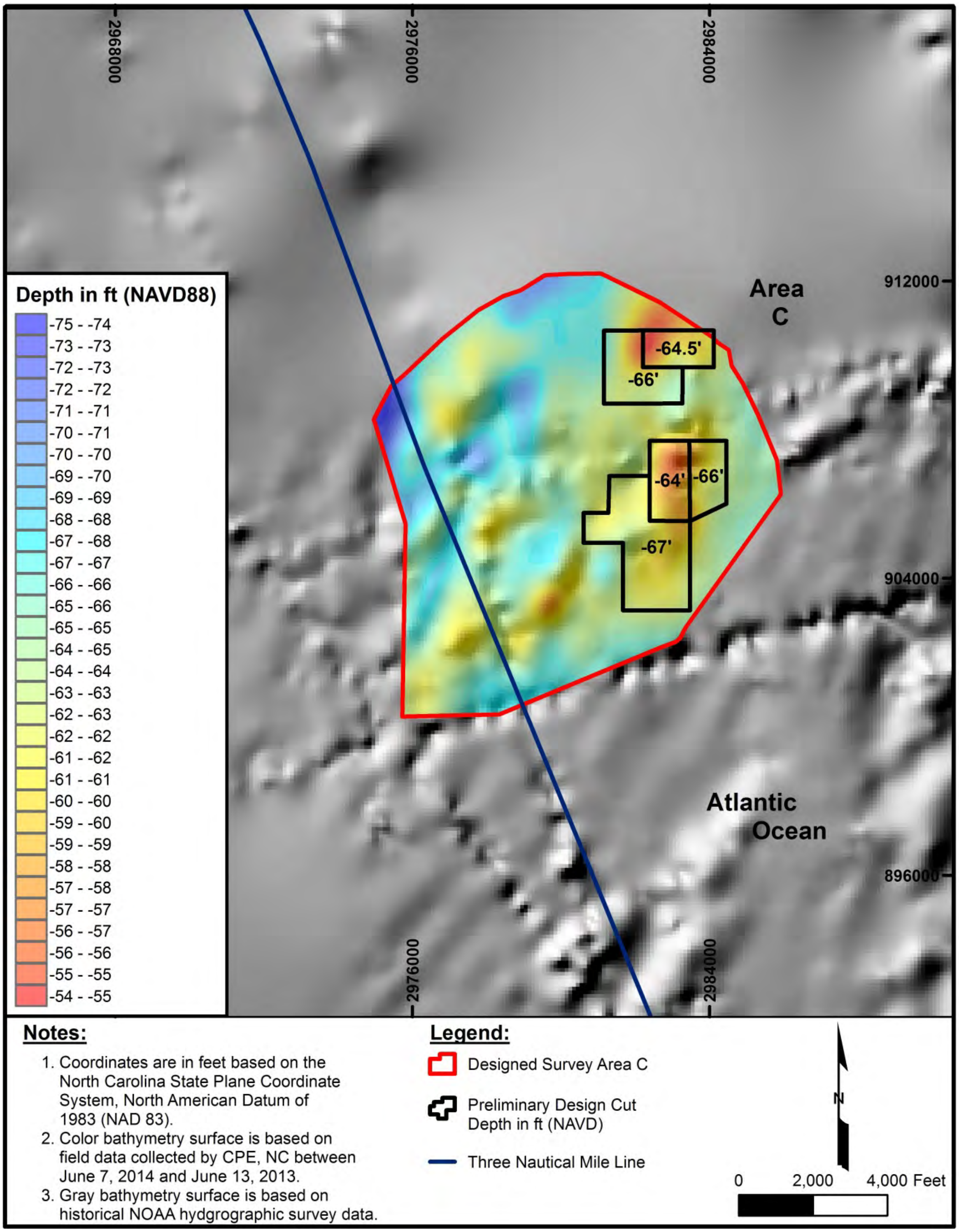

Figure 5. Borrow Area C with preliminary design cuts.

2.2.2 Construction Methods

To obtain material from the borrow areas, the Applicant proposes to use either an ocean-certified, self-contained hopper dredge with direct pump-out, a cutterhead suction dredge, or a combination of the two. The types utilized will depend on many factors, including competition in the bid process, pumping or haul distance, and depth and extent of dredging. The offshore borrow area locations are subjected to the most severe wave climate along the entire East Coast of the United States. Therefore, the potential for adverse sea conditions and construction schedule will be a major consideration in the selection of the dredging methods and equipment used.

Hopper Dredges. A hopper dredge is a self-propelled, maneuverable vessel that can independently load, transport and unload dredged material. The hopper dredge has a trailer suction pipe with a draghead that strips off layers of sediment and hydraulically suctions the material into the hopper. For the proposed project, material would be offloaded by direct pump-out through a submerged pipeline while the vessel is moored offshore. There are potential environmental impacts associated with using hopper dredges, such as entrainment of threatened and endangered species by the draghead, localized turbidity plumes at the draghead site and near the surface as the hoppers are filled. However, advances in design have included under hull release of overflow sediment and anti-turbidity valves, which help reduce sediment plumes (W.F. Baird and Associates, 2004). Efforts to mitigate the take of listed species include pre-dredge and relocation trawls and inclusion of turtle deflectors on dragheads.

Cutter Suction Dredge. A cutter suction dredge can be self-propelled, or require a barge for transport. During operation, the cutter suction dredge is anchored at one corner by a spud, and the cutter suction dredge moves in an arc over the dredge area rotating around the spud. During dredging, material is hydraulically pumped up the suction pipe and discharged at a disposal site (may be upland or in-water) or to a barge for transport to the disposal site. Cutter suction dredges are limited by sea-state condition and do not perform well in areas of elevated sea states. Environmental effects include suspension of sediment around the cutterhead, or turbidity plumes resulting from leaks or dredge overflow. Turbidity created by a cutter suction dredge is generally less than that of a trailing suction hopper dredge since sediment re-suspension is confined to near the substrate and around the cutterhead. Environmentally conscious developments have involved design improvements to the cutter suction dredge that increase accuracy and reduce mechanical disturbance of the seabed (McLellan and Hopman, 2000).

Management of Material on the Beach. Once the material is discharged from the pipe onto the beach, onshore construction crews will shape the material into the desired construction template. The material is typically managed in a way that reduces turbidity by constructing shore parallel berms along which the water from the slurry will run, allowing additional time for material to settle out of suspension before the seawater returns to the ocean. Equipment such as bulldozers and front-end-loaders are typically used to shape sand on the beach and move pipes as necessary. At the location where the submerged pipeline comes ashore, the slurry flow is typically diverted with a 90-degree elbow to direct the flow towards the project area. As portions of the project are constructed, the pipeline is extended to allow for the next section of beach to be constructed.

Relocation Trawling.
Should hopper dredges be utilized, the proposed projects will employ relocation trawling as a means to reduce the potential for entrainment of protected species, such as sea turtles and Atlantic sturgeon. Relocation trawling has been employed in select USACE dredging projects since the 1980's, and has proved to be a successful method for temporary displacement of sea turtles from a project area when hopper dredging was ongoing (Bargo *et al.*, 2009).

The protocols and techniques of relocation trawling were researched and developed by the USACE, and have become a standard practice for reducing lethal sea turtle takes during dredging projects. Two types of trawls are used during hopper dredging projects. Sea turtle abundance trawling is employed several days before commencement of dredging activity, and is used to determine the abundance of sea turtles in the area. A finding of high sea turtle abundance initiates the need for relocation trawling. Essentially, this method employs a capture-relocation technique, and is targeted at the active dredging site within the borrow area. The distance covered by each tow may vary as dictated by large vessel traffic in the area, or by the size and configuration of the borrow site. A separate vessel, usually a shrimp trawler, deploys a trawling net ahead of the approaching dredge to remove sea turtles from the dredge's path. Typically, trawlers tow two specially designed 60-ft trawl nets in the vicinity of the dredge on a 12 or 24 hour schedule. The position at the beginning of each tow is determined from GPS positioning equipment, and tow speed is recorded at the approximate midpoint of each tow. Water temperature measurements are also taken twice per day, and weather conditions (air temperature, wind velocity and direction, sea state, wave height, precipitation) are recorded by instrumentation and visual observations aboard the trawler. If relocation trawling is implemented, standard relocation trawling conditions will be observed as set forth by NMFS including specification for trawl time, handling, holding conditions, take and release, any tagging, etc.

Construction Schedule
The Town aims to complete the project in the shortest time practicable, during a safe operating period and with the least environmental impact possible. Weather and sea-state conditions play a crucial role in the safety and efficiency of offshore dredging projects, particularly during the winter. The wave climate in the northern Outer Banks is reportedly among the most inclement on the U.S. eastern coast (Leffler *et al.*, 1996). The Final Environmental Impact Statement (FEIS) written in association with the 2010 Nags Head Beach Nourishment project presents a detailed analysis of the local offshore wave climate. Data were obtained from the USACE Field Research Facility (FRF), located in Duck, NC, and are considered representative of conditions offshore of Kill Devil Hills. The USACE (2010a) analyzed a three-year record of wave heights between January 2003 and December 2005 collected by Waverider Buoy 630, located 2.4 miles offshore in 55 ft. of water. Waves were predominately from the east, with the highest-energy waves originating from the northeast. The USACE reported that during the three-year period analyzed, there was an annual average of 59 weather events producing wave heights in excess of 1.6 m, and an average of 5.3 storm events producing wave heights greater than 3.4 m. Two storm events, one of which was Hurricane *Isabel*, produced wave heights in excess of 7 m.

Historical data also show the wave climate in the northern Outer Banks varies seasonally. Using a 21-year record of wave data area maintained by the USACE-FRF station, the USACE described:

"…average significant wave heights are greatest from September through April (3.4 – 3.9 ft.) and decrease from May through August (2.1 – 3.0 ft). Average wave periods remain consistent (~8–9 sec), with highest wave period being in September, coinciding with the peak of Atlantic hurricane season. Wave direction during the fall and winter is from the east-northeast, averaging between 70E and 80E from north, coinciding with larger waves produced from northeaster storms. During the spring and summer months, waves approach more from the east, averaging between 84E and 96E."

The Nags Head EIS and feasibility study developed for the 2010-2011 Nags Head project suggest that, based on conditions encountered during two previous projects constructed in North Carolina, there is an inverse relationship between wave height and dredging efficiency (Figure 6 and Figure 7) (USACE, 2000; USACE 2010a). Larger, steeper waves are frequently generated by wintertime storms, and adversely impact dredging operations by decreasing safety, increasing downtime and total project cost. In the Nags Head FEIS, dredging efficiency for Dare County was calculated based on two other dredging projects completed in North Carolina, and was estimated to range from 81% in July to only 46% in February (USACE, 2000). A complete, detailed analysis is included in the Biological Assessment developed for the 2010 Nags Head Beach Nourishment project (USACE, 2010a, Appendix H – Attachment 8), and is incorporated here by reference.

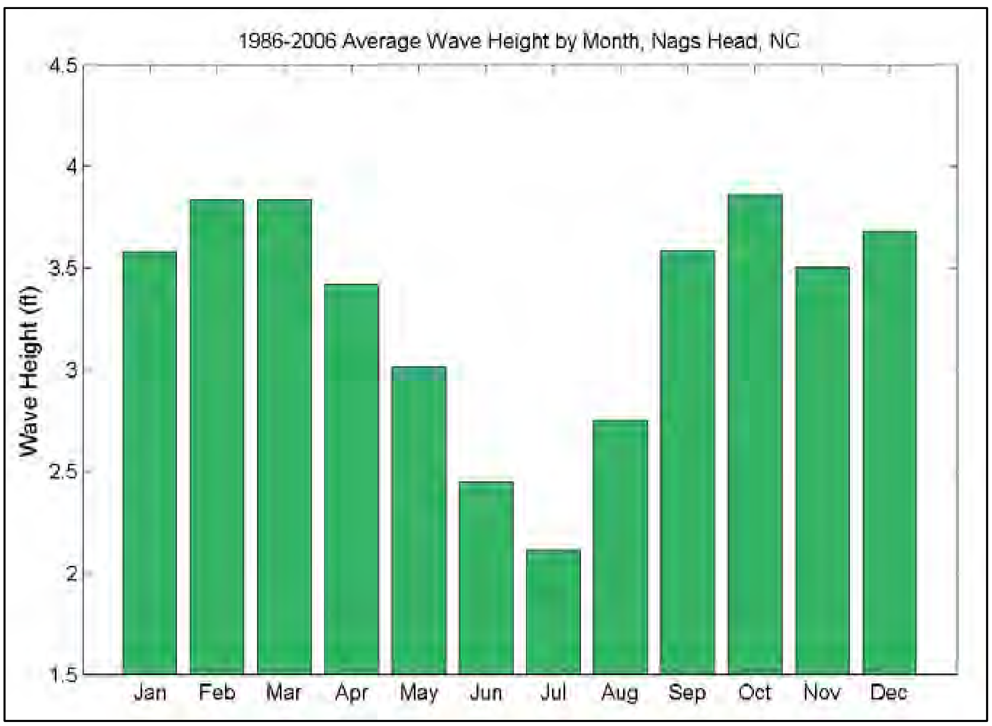

Figure 6. Monthly averaged wave heights near Nags Head, NC for the period 1986 – 2006 (graph from USACE, 2010a; source data courtesy USACE-FRF).

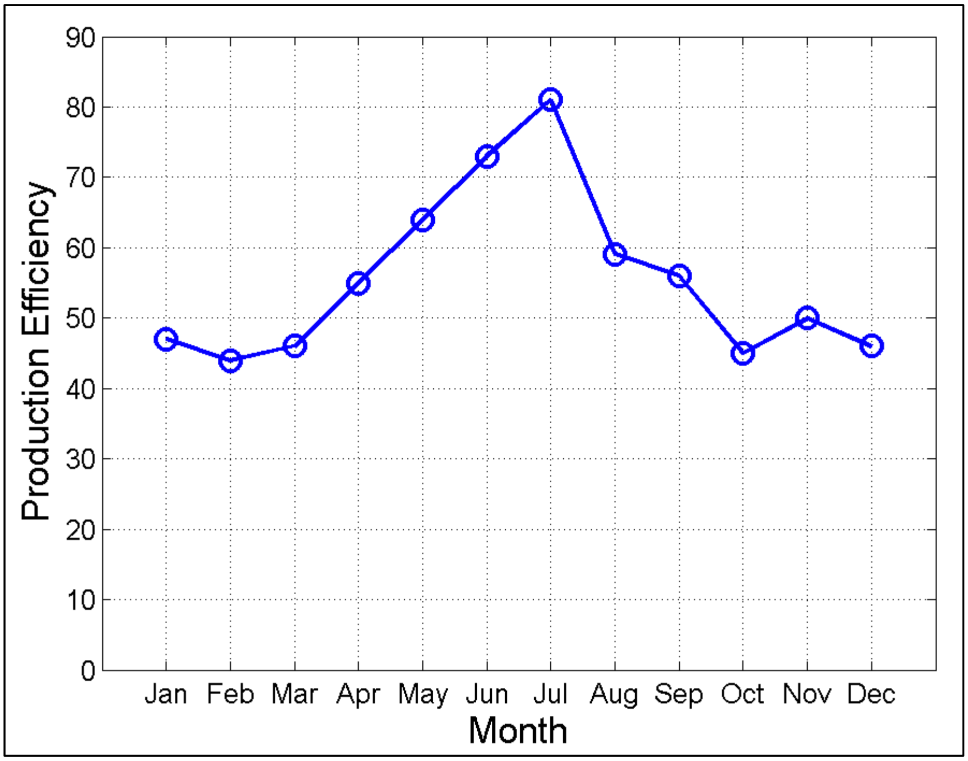

Figure 7. Estimated pipeline dredging efficiencies at Dare County, NC (graph from USACE, 2010a; source data from USACE, 2000)

Due to the aforementioned sea state conditions, dredging during the winter months (October to March) increases the risk to crews and equipment, and reduces dredging efficiency. This, in turn can result in a longer construction period, potentially prolonging environmental impacts. Risks translate directly into costs whether the risks are related to safety, weather, financial, environmental or other factors. The downtime associated with shutdown and redeployment represents the main factor contributing to inefficiency and the overall economics of the project. In a letter addressed to the Town of Nags Head, the Technical Director from the Dredging Contractors of America (DCA) stated "…it would be extremely dangerous and expensive" to conduct dredging operations during the winter months north of Oregon Inlet, due to the high risk of dangerous wave and storm events and the associated potential for frequent shut-downs of dredging operations (CSE, 2007 – Attachment 6). The warmer months between April and September are relatively calm compared to the fall and winter months. This period also corresponds with recommended "environmental windows" during which time sand placement and hopper dredging is typically discouraged to avoid construction during periods of high biological activity within coastal waters and beaches along the U.S. Atlantic coast. In North Carolina, it is generally recommended that sand placement and dredging projects occur from November 16 through April 30, to avoid peak sea turtle activity in nesting and marine areas, and from September 1 through March 31 to avoid the peak shorebird nesting seasons.

Year-round construction would provide the contractor the most flexibility and provide a safer and more economical work environment for offshore dredging activities in the Northern Outer Banks. Based on estimated production rates, the Duck project will likely require approximately 3 months, the Kitty Hawk project will require approximately 3.5 months and the Kill Devil Hills project will require approximately 2.5 months. Construction of the three projects could be independent or concurrent. The maximum time anticipated for completion of the three projects is 9 months; however, the contractor could utilize multiple pieces of equipment and construct the projects in parallel, leading to a minimum construction time of 3.5 months. These timeframes are based on the production rates for hopper dredges achieved during the 2010-2011 Nags Head project. The production rates have been adjusted to account for distances from the project areas to the identified borrow areas. All timeframes assume that material will be obtained from Area A; however, if Area C is used, the construction time for the Duck project may decrease.

2.2.3 Periodic Nourishment

The restored beach would be maintained through a program of periodic maintenance nourishment with the material also obtained from one of the borrow areas discussed above. The initial design volume for the beach fill provided in Table 3 includes five years of advanced nourishment totaling 170,130 cubic yards. This initial estimate of the 5-year nourishment requirement was based on the shoreline changes determined from the LiDAR data. The actual performance of the restored beach and the periodic nourishment needed to maintain the design template will be determined from beach profile monitoring surveys taken at designated transects at least once a year.

Typically, the costs associated with obtaining material from an offshore borrow area involves relatively high costs for mobilization and demobilization of the dredge, pipeline, and all of the ancillary equipment needed to support the operation in addition to the actual cost of pumping the material from the offshore site to the shoreline. If the volume of material for the operation is relatively small, the effective unit cost of a cubic yard of sand (which includes mobilization and demobilization costs plus the actual cost of pumping the material to the shoreline) would be relatively high. With mobilization and demobilization costs running in the millions, the volume of material to be dredged in any one operation should be as large as possible in order to keep the effective unit cost within reason.

In this regard, the Kill Devil Hills project is being developed in conjunction with similar projects for the towns of Duck and Kitty Hawk. By combining periodic nourishment of all three projects into one operation, the effective unit cost of the operation would be lowered to the benefit of all three towns. Based on preliminary periodic requirements for all three projects, the combined volume of material that will be needed every five years to nourish the three projects is around 650,000 cubic yards.

Estimates of the initial costs for constructing the Kill Devil Hills Shore Protection Project and the cost for periodic nourishment assuming it is combined with the other two projects are provided in Appendix C.

2.3 Alternative #3: No Action Alternative

The existing shoreline management program of the Town of Kill Devil Hills is limited to the installation of sand fencing along vulnerable portions of its shoreline. Individual property owners on occasion have used beach scraping or bulldozing to push-up or rebuild a dune that had been damaged by a storm. Also, a few property owners have installed sandbag revetments to provide temporary protection to homes deemed to be imminently threatened. Under Alternative 3, the status quo will be maintained and these activities will continue.

Even if the limited measures by the town and individual property owners listed above continue, the same 35 residential structures and 5 commercial buildings identified under Alternative 1 as being at risk of damage by a storm similar in character to Hurricane Isabel would still be at risk under Alternative 3. However, in the case of Alternative 3, the at-risk ocean front structures would remain in place and would eventually be damaged beyond repair and have to be demolished or abandoned. Based on the risk analysis for a storm similar to Hurricane Isabel, there is a better than 50% chance that all 35 of the at-risk residential structures would be damaged beyond repair within the next 15 years. This would remove the tax value of the structures from the town's tax base. The lots on which the at-risk structures are on would also decrease in tax value with the value essentially dropping to zero.

3 ENVIRONMENTAL SETTING

3.1 Physical Environment

The Town of Kill Devils Hills is located on the Outer Banks, a coastal barrier island system along the Atlantic coastline of northeastern North Carolina. Kill Devil Hills is located at approximately at 36.0256° N, 75.6700° W with a maximum elevation of 15 feet above sea level. The town is situated between Kitty Hawk (at its northern boundary) and Nags Head (at its southern boundary), and is bordered by the Albermarle sound to the west. The town encompasses 5.52 sq. miles and is oriented in a north-northwest/south-southeast direction. The natural habitats follow a profile typical of a coastal barrier island system, transitioning from open ocean to island shoreline, dune, over-wash (mud flat), salt marsh and finally, marine sound.

3.1.1 Geology and Geomorphology

The North Carolina coastal system consists of 325 miles of oceanfront shoreline, 23 inlets, over 5,000 miles of estuarine shoreline and over 3,000 square miles of brackish-water estuaries (Riggs *et al.*, 2008). The geomorphology of the North Carolina coastal environment can be geographically divided into northern and southern zones by the paleotopographic high referred to as the Cape Lookout High (Mallinson *et al.*, 2009). The region north of Cape Lookout, or the Northern Coastal Zone, consists of a 90 m thick Quaternary stratigraphic record (Mallinson *et al.*., 2009). This northern zone has been shaped by multiple cycles of deposition and erosion related to global sea-level cycles during the Pleistocene epoch. Sea level rise during the present geological epoch (Holocene) has resulted in non-uniform deposition of coastal sediments over the eroded embayments. The modern North Carolina barrier island system is therefore superimposed upon multiple geological layers and consists of sediments ranging from peat and mud to unconsolidated or semi-unconsolidated sands, gravel and shell beds.

The development of the slope and sandbars that characterize the beach and nearshore is highly influenced by this underlying geological framework (McNinch, 2004). The influence of this framework is even greater in areas with limited sand supply, such as North Carolina, where sediments for beach development are derived from the erosion and transport of sediments from adjacent beaches or the inner continental shelf (Thieler *et al*.., 2014). Some of the characterizing features of the coastal zone of North Carolina's Outer Banks include the development of shore-oblique sandbars adjacent to large gravel outcrops and identical redevelopment or sustained maintenance of large-scale sandbar morphology and position before and after very energetic conditions, and close spatial alignment between the location of outcrops/shore-oblique bars and shoreline erosional hotspots (McNinch, 2004).

The Northern Coastal Zone is characterized by a gentler land slope than the steeper Southern Coastal Zone, such that rising seas have produced longer barrier islands and the broad expanse of drowned river estuaries called the Albermarle-Pamlico estuarine system. These northern barrier islands project seaward to form Cape Hatteras and the Outer Banks, and are interspersed by five inlets. The coastal system can be further divided into four geomorphic compartments, known as embayments, which are defined by capes and associated cape shoals (Riggs *et al.,* 2008). The Hatteras compartment, bounded in the south by Cape Hatteras and the associated shore-perpendicular sand shoal called Diamond Shoals, is oriented northeast, and therefore takes the brunt of frequent nor'easters (Riggs *et al.,* 2008)

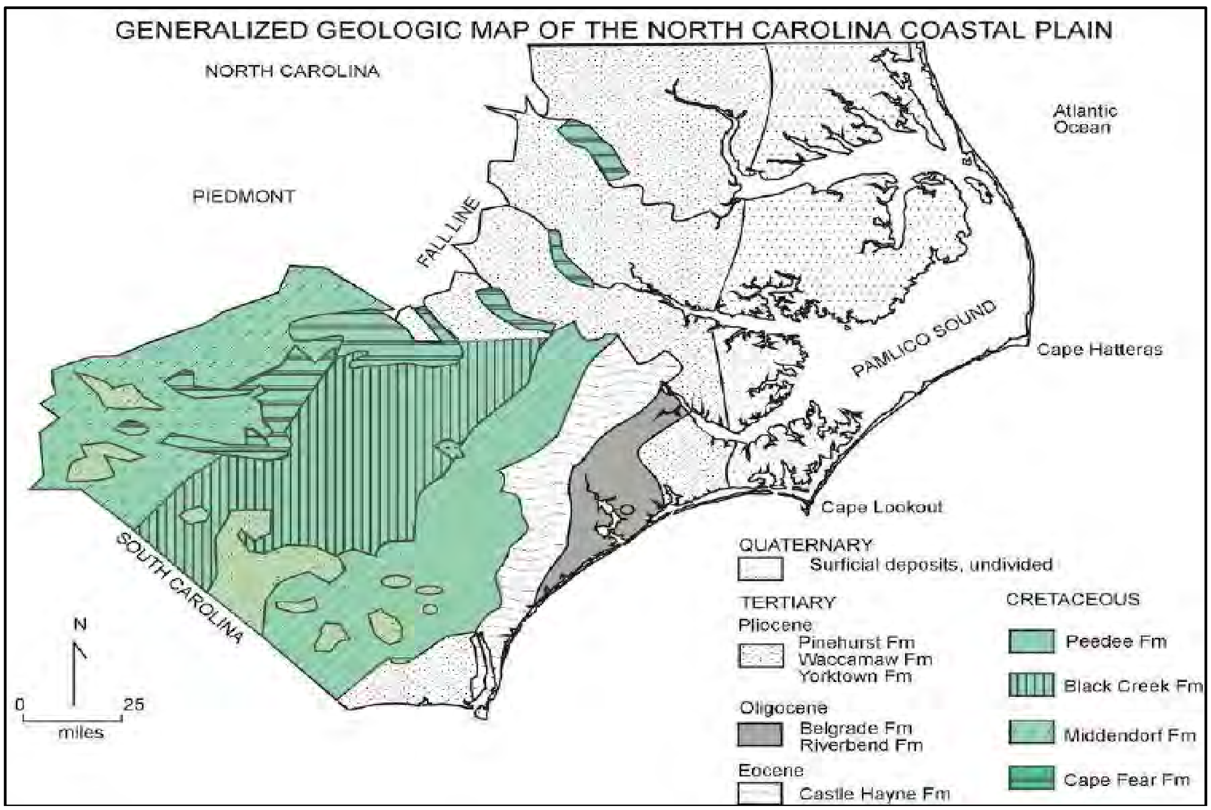

Figure 8. Generalized geologic map of the North Carolina Coastal Plain illustrating the regional outcrop/subcrop patterns of the various stratigraphic units (Mallinson *et al*.., 2009) .

3.1.2 Native Beach Sand Quality and Composition

The oceanfront beach and dunes are deposits of sand that are constantly changing their shape, and hence position, with time as they respond to coastal processes. Along with the many variables that can affect a coastline's morphology, regional sediment composition, sediment size and sediment shape can play a major role. The coastal zone of North Carolina’s Outer Banks is characterized by a vertical and horizontal heterogeneity of lithology and grain-size and a minimum volume of sand, ranging from 0 to 1.5 m thick (McNinch, 2004). Barrier islands in North Carolina, such as the Outer Banks and the beachfront of the Town of Kill Devil Hills, are primarily composed of unconsolidated fine- to medium-sized quartz and shell (calcium carbonate) material that is in a constant state of flux due to wind, waves, currents and storms.

Taking material from offshore and placing it onto the beach has the potential to alter the physical characteristics of the native beach. To minimize the risk of such alterations, projects are designed to use similar sediment with regards to sorting, mean grain size, median grain size, and sediment composition. The North Carolina State Sediment Criteria Rule (15A NCAC 07H .0312) sets state standards for borrow material aimed at preventing the disposal of incompatible material on the native beach. The rule limits the amount of material by weight in a borrow area with a diameter equal to or greater than 4.76 mm and less than 76 mm (gravel), between 4.76 mm and 2.0 mm (granular), and less than 0.0625 mm (fines) to no more than 5% above that which exists on the native beach. Additionally, the rule requires the proportion of calcium carbonate in borrowed material not to exceed 15% above that of the native beach (Table 4).

Based on the State Sediment Criteria, sampling of the native material are required from a minimum of five transects regardless of the total length of the project. At least 6 samples are to be taken landward of the mean low water line to the dune and 6 samples seaward of mean low water to the depth of closure. One sample is also required from the mean low water line for 13 samples per transect. The rule also sets forth guidelines to ensure the sediment characteristics of material placed on the recipient beach are compatible with the native sediment. Essentially, the rule states:

- The average percentage by weight of fine-grained sediment (less than 0.0625 mm) in each borrow site shall not exceed the average percentage by weight of fine-grained sediment of the recipient beach characterization plus five (5) percent.
- The percentage by weight of granular sediment (greater than or equal to 2 mm and less than 4.76 mm) in each borrow site shall not exceed the average percentage by weight of coarse-grained sediment of the recipient beach characterization plus five (5) percent.
- The percentage by weight of gravel (greater than or equal to 4.76 mm) in a borrow site shall not exceed the average percentage by weight of gravel-sized sediment for the recipient beach characterization plus five (5) percent.
- The average percentage by weight of calcium carbonate in a borrow site shall not exceed the average percentage by weight of calcium carbonate of the recipient beach characterization plus 15 percent.

In 1996, the USACE collected and analyzed samples of the native beach material from the Kill Devil Hills shoreline for the federal Dare County Beaches project. Four of the profiles sampled (stations 160+00, 210+00, 260+00 and 320+00) fell within the limits of the proposed Kill Devil Hills project. Since the State Sediment Criteria requires samples from a minimum of five transects, CPE-NC collected and analyzed samples from transect 240+00 in September 2013. In addition, the location of the samples collected by the USACE did not meet the sampling requirements of the State Sediment Criteria necessitating the collection and analysis of three additional samples from each of the four transects previously sampled by the USACE. Collection and analysis of the additional samples of the native beach material was accomplished in September 2013 by CPE-NC with a summary of the characteristics of the native material derived from the two sampling operations provided in Table 4.

Table 4. Characteristics of the Kill Devil Hills native beach material.

	Mean Grain Size (mm)	% Carbonate	% Granular	% Gravel	% Silt
State Standard Allowance		Native +15	Native + 5	Native +5	Native + 5
Kill Devil Hills Native Beach	0.39	3.0	6.76	1.92	1.13
State Standard Cutoff		18.0	11.76	5.92	6.13

3.1.3 Borrow Area Sand Quality and Composition

Four offshore borrow areas were investigated as potential sand sources for this project - one within state waters, two within federal waters, and one that straddles the state/federal border. The primary investigation areas included Area A, B, C and S1-4. Because the sediment in these offshore areas are not part of the active littoral system, the sediment may be differ from the beach in terms of size and composition. Using material for beach nourishment that differs significantly from the recipient beach can affect project performance and the natural and human environment. In order to identify and characterize sand source material, CPE-NC used a systematic approach to marine sand searches developed by Finkl, Khalil and Andrews (1997), Finkl, Andrews and Benedet (2003), Finkl, Benedet and Andrews (2005), and Finkl and Khalil (2005). CPE-NC divided the investigation into three (3) sequential phases. These included a comprehensive review of the recipient beach/project area and sediment resources offshore of the project area; a reconnaissance level geotechnical (washbores) and geophysical (sub-bottom profiler, sidescan sonar, bathymetry and magnetometer) survey; and design level geotechnical (vibracores) and geophysical (sub-bottom profiler, sidescan sonar, bathymetry, and magnetometer) investigations and borrow area design. These investigations were conducted to evaluate the four target areas and ultimately delineate the borrow areas presented in the following section.

3.1.3.1 Offshore Borrow Areas

There are potential areas of beach compatible sand located further offshore than borrow area S1-4, and closer to the proposed project location. These areas are located more than three miles offshore, and are therefore within federal waters managed by the Bureau of Ocean Energy Management (BOEM). These areas, referred to as area A, B, and C, were investigated by CPE-NC geologists in 2013 and 2014. A reconnaissance washbore survey was conducted in September 2013, which confirmed that the quality of the material within area A and B warranted further investigations. Based on the results of the washbore survey and the similar morpho-sedimentary characteristics of Area C, this third area was also targeted for further investigation. During the geophysical survey conducted in June 2014, additional geophysical (sub-bottom profile, sidescan, magnetometer and bathymetric) data were collected further suggesting that the material within these areas warranted vibracore investigations. During the preliminary geotechnical (vibracore) investigations conducted in July/August 2014, CPE-NC geologists determined that the material contained in Area B did not appear to be of as high a quality and in sufficient volume to warrant design level surveys. However, areas within Area A and C were identified and additional vibracores were collected to support borrow area design. A cultural resource/design survey is currently planned for October 2014, which will result in final delineation of borrow areas A and C. Preliminary designs are shown in Figure 4 and Figure 5. The sediment characteristics suggest that the material within borrow areas A and C meets or exceeds the State Sediment Criteria (Table 5).

Table 5. Sediment characteristics of the offshore borrow area within BOEM jurisdiction.

Parameter	Borrow Area A	Borrow Area C
Mean Grain Size (mm)	0.36	0.27
Sorting (Phi)	0.90	1.09
Silt (%) (<0.0625mm)	0.83	1.59
Granular (%) (2mm < and < 4.76mm)	1.48	2.05
Gravel (%) (>4.76mm)	0.52	1.07

3.2 Littoral Processes

Kill Devil Hills is subject to littoral processes typical of the barrier islands that line the North Carolina coast, referred to as the Outer Banks. The islands are subject to winds, rising sea levels and strong storms that gradually push sand from the ocean side of the islands to the land side. The Project Area includes the intertidal and subtidal unconsolidated bottoms, as well as the offshore sand shoals within the borrow areas. Coastal salinity is maintained at approximately 35 ppt year round and water temperatures range from 49ºF in January to 80ºF in August. This coastline experiences semi-diurnal tides with an average tidal range of approximately 3 ft. Net water movement is from north to the south via a longshore current that veers toward the southeast in the summer and toward the southwest in the winter (Inman and Dolan, 1989).

3.2.1 Waves

The predominant wave direction is from the south to southeast in the spring and summer and from the north to northeast in the fall and winter. Annually, the wave heights typically range from 1.6 to 4.9 ft., with a mean wave height of about 3.3 ft. (USACE, 2006). Highest waves are generally associated with tropical storms and may occur in phase with hurricane surges. According to the USACE (2006), this area can experience waves in excess of 15 ft. during tropical storms, although they occur sporadically. Figure 9 presents a wave rose from Wave Information System (WIS) station 63221 located offshore and in the vicinity of Duck in 17m depth. Examination of hindcast data shows the majority of waves higher than 0.5 m come from the northeast and the east northeast.

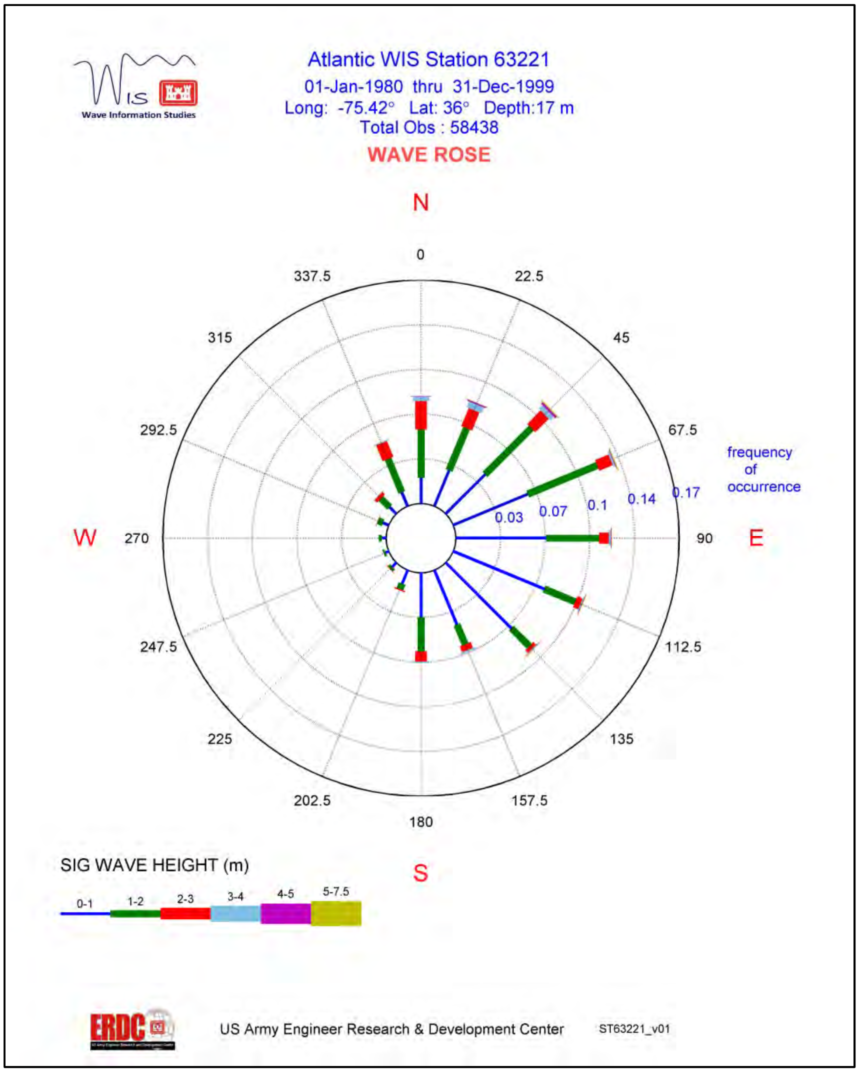

Figure 9. Wave rose from Wave Information System (WIS) 63221 (1980-1999) located offshore of the Project Area (USACE, 2010b)

3.2.2 Storms

Although not available for Kill Devil Hills, historical storm data for nearby Elizabeth City (approximately 37 miles northwest of Kill Devil Hills) show the area is brushed or hit by a tropical system every 2.37 years. This area is directly hit by a hurricane (experiences hurricane force winds for at least a few hours) once every 14.2 years, and is most likely to be hit in late August to early September. In the past 142 years, Elizabeth City was hit by a tropical system 60 times. Of these storms, 39 (65%) were tropical storms and 21 (35%) were hurricanes (hurricanecity.com, 2014). Nor'easters, or strong areas of low pressure that tend to form off the east coast, tend to influence the coastline of the Outer Banks more frequently than hurricanes and tropical storms. Nor'easters can cause severe coastal flooding, coastal erosion, hurricane force winds or blizzard conditions; these conditions are usually accompanied with very heavy rain or snow, depending on when the storm occurs.

3.2.3 Erosion

Coastal erosion as a whole is the wearing away of land or the removal of beach and dune sediments by wave action, tidal currents, wave currents or drainage. Waves and wind generated by storms, contribute to coastal erosion. Erosion may take the form of long-term losses of sediment and rocks or merely the temporary redistribution of coastal sediments whereby erosion in one location may result in accretion elsewhere, as the sand is veritably "moved" from one stretch of beach to another. Wave action can be either constructive or destructive. While constructive wave action aids in building up the beach by leaving deposits of sand, alternatively destructive wave action may remove more sand than is deposited. An imbalance of the latter results in an eroded beach and the aforementioned oceanographic and littoral variables contribute to this occurring.

3.2.4 Sea Level Rise

According to the International Panel on Climate Change (IPCC) (2013), the long-term global mean sea level trend estimate from 1901 to 2010 is 1.7 mm/year, for a total sea level rise of 0.19 m. The latest IPCC report states that global mean sea level will continue to rise during the 21st century, and climate models predict that rates of sea level rise will increase due to increased ocean warming and melting glaciers and ice sheets (IPCC, 2013). Therefore, the impacts of changing sea levels to coastal and estuarine zones must be considered in Civil Works programs.

On October 1, 2011, the USACE distributed an Engineering Circular (EC) setting parameters for the inclusion of the effects of projected sea level rise for all phases of USACE coastal projects. This consideration includes the planning, engineering, design, construction, operation and maintenance phases (EC 1165-2-212). Because projects are implemented at a local or regional scale, it is important to distinguish between global mean sea level (GMSL) and local mean sea level (MSL). According to the USACE (1996), global mean sea level (GMSL) change is defined as a global change of oceanic water level. Local mean sea level (MSL) changes result from the collective effects of GMSL and regional changes, such as local land elevation changes. Local mean sea level trends can be estimated using historical tidal gauge records. The National Oceanographic and Atmospheric Administration (NOAA) has maintained a tide observation station at Duck, North Carolina called Tide Station 8651370 since 1977 (NOAA, 2013b). This station presently is in working order and continues to collect tide data. This tide station is located approximately 12.6 miles to the north of Kill Devil Hills, North Carolina. The mean sea level trend for Duck is estimated at 4.59 mm/year, based on monthly mean tidal data recorded by Tide Station 8651370 from 1978 to 2011 (NOAA, 2013b).

4 AFFECTED ENVIRONMENT

4.1 Water Quality

The waters of the Atlantic Ocean contiguous to that portion of Pasquotank River Basin that extends from the North Carolina-Virginia State Line to the northeast tip of Ocracoke Island are classified as SB by the North Carolina Department of Environment and Natural Resources, Division of Water Resources. Class SB waters are tidal salt waters protected for all SC uses in addition to primary recreation. Primary recreational activities include swimming, skin diving, water skiing and similar uses involving human body contact with water where such activities take place in an organized manner or on a frequent basis. Class SC waters are all tidal salt waters protected for secondary recreation such as fishing, boating and other activities involving minimal skin contact; fish and noncommercial shellfish consumption; aquatic life propagation and survival; and wildlife.

The North Carolina Department of Natural Resources (NCDENR) Division of Marine Fisheries maintains water quality sampling sites throughout the state. Two stations near the project area within Kill Devil Hills indicate good water quality levels, with enterococci levels within the EPA standards for swimming (Figure 10).

Water quality can be measured by a number of different methods that quantify re-suspended sediments and the related effects of turbidity, light attenuation and water chemistry. Turbidity, expressed in Nephelometric Turbidity Units (NTU), quantitatively measures the clarity of water, taking into account the scattering and absorption of light by suspended particles. The two reported major sources of turbidity in coastal areas are very fine organic particulate matter and sand sized sediments that are re-suspended around the seabed by local waves and currents (Dompe, 1993). Total Suspended Solids (TSS) are solids that are present anywhere in the water column. TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes and sewage. Currently, there are no standards associated with TSS in North Carolina.

The inshore zone along Kill Devil Hills has free circulation of oceanic waters with little direct input of fine-grained material from inlets or estuaries. The surf zone is devoid of fines because of relatively high, wave-energy characteristics of the beach environment. The combination of low amounts of fine-grained sediments and frequent, high-wave energy off the Kill Devil Hills coast tends to inhibit the accumulation of silts and clays. Low concentrations of fine-grained material tend to minimize the potential for pollutants to adsorb on particles and become concentrated within the proposed project area.

Figure 10. Water quality sampling stations in proximity to the Permit Area in Kill Devil Hills. Green indicates no alert/advisory, meaning the enterococci levels are within the EPA standards for swimming.

4.2 Air Quality

Ambient air quality standards are based on six common pollutants: particulate matter less than 2.5 m (PM-2.5); particulate matter 2.5 to 10 m (PM-10); carbon monoxide (CO); ozone (O3); sulfur dioxide (SO2); nitrogen dioxide (NO2); and lead (Pb). According to the EPA, a geographic area that meets or is within the national ambient air quality standard is deemed an "attainment area"; an area that doesn't meet this standard is called a nonattainment area. Dare County as a whole is designated as an attainment area (USEPA, 2014).

4.3 Noise

Noise levels in the proposed project area are relatively low. No commercial or industrial activities exists within the proposed project area, the residential nature of the shoreline in Kill Devil Hills generally equates to low ambient noise. Increases of the ambient noise levels in Kill Devil Hills tend to originate from public use, such as recreational activity and traffic along Virginia Dare Trail. Natural noise levels, such as wind and pounding surf, vary and decibel levels can increase during storm events.

4.4 Natural Setting and Wildlife

Natural habitats and significant resources found within the Permit Area include the dry beach, dunes and foredunes. Other natural habitats, including marine intertidal and subtidal zones, and offshore sand shoals, are designated as Essential Fish Habitat and are discussed in Section 4.5 below.

4.4.1 Beach and Dune

Figure 11. Beach and dune community at Kill Devil Hills showing sea oats and beach grass (photo taken October 2009).

Dunes are vegetated mounds of unconsolidated sediments that lie landward of the active beach. Dune formation occurs when winds carrying beach sediments encounter resistance from vegetation, thereby causing the wind to deposit this material. Typically, dunes are comprised of finer sands, while those in the berm and beach face are coarser (Rogers and Nash, 2003). Dunes are dynamic geologic features that continually accrete and erode from factors such as seasonal fluctuations in wave height and storm activity (Rogers and Nash, 2003). Dune vegetation is essential to maintaining dune structure, and generally consists of hearty plants tolerant of extreme conditions such as sea oats, beach elder and beach grasses. Dune vegetation typical along the uppermost dry beach of Kill Devil Hills includes beach spurge (*Euphorbia polygonifolia*), sea rocket (*Cakile edentula*) and pennywort (*Hydrocotyle bonariensis*). The foredune includes American beach grass (*Ammophila breviligulata*), panic grass (*Panicum amarum*), sea oats (*Uniola paniculata*), broom straw (*Andropogon virginicus*) and salt meadow hay (*Spartina patens*) (USACE, 2000). The beach and dune community within the Permit Area is limited in extent due to development and a coastline that is receding due to storm events and beach erosion (Figure 7) (Leatherman *et al.*, 2000).

Beaches are formed from the deposition and accumulation of material by way of coastal currents and wave transport. Beaches are constantly evolving and often experience periods of erosion during winter by way of rough seas and strong winds. During the calmer spring and summer months, the beach often experiences accretion. The intertidal zone or wet beach is the area that is cyclically exposed due to tidal exchange. These habitats are comprised mainly of sandy bottoms that support many benthic and infaunal organisms, and provide foraging areas for birds and finfish. The dry beach begins at the berm and slopes gently upwards to the foot of the dune, and provides habitat for roosting birds and invertebrates such as the ghost crab (*Ocypode quadrata*). The exposed environment of North Carolina sandy beaches leads to low diversity, but high abundance of organisms that can survive in the high-energy environment.

4.5 Essential Fish Habitat

4.5.1 Fishery Management

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) of 1976, amended on October 1996 and also referred to as the Sustainable Fisheries Act, was enacted by the U.S. Congress to protect marine fish stocks and their habitat, prevent overfishing while achieving optimal yield and minimize bycatch to the extent practicable. Congress defined Essential Fish Habitat as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity". The MSFCMA requires that EFH be identified for all fish species federally managed by the Fishery Management Councils (FMC) and the National Marine Fisheries Service (NMFS).

Eight FMC were established under the MSFCMA to manage living marine resources within federal waters and are required to describe and identify EFH designations in their respective regions. Each of these councils is responsible for developing Fishery Management Plans (FMP) to achieve specified management goals for fisheries. The FMP includes data, guidelines for harvest, analyses and management measures for a fishery. Each FMP must describe the affected fishery, analyze the condition of the fishery, and describe and identify relevant EFH.

In close coordination, both the South Atlantic Fisheries Management Council (SAFMC) and the Mid-Atlantic Fisheries Management Council (MAFMC) manage marine fisheries in the federal waters off the North Carolina coast. Federal water limits off the North Carolina coast extend from 3 nautical miles to 200 nautical miles. In addition, the Atlantic States Marine Fisheries Commission (ASMFC) manages fisheries in the state waters of all 15 Atlantic coast states from Maine to Florida. The ASMFC manages fish stocks within the state waters of North Carolina from the coastline to three nautical miles offshore.

The SAFMC is responsible for the conservation and management of fish stocks within the federal 200-mile limit of the Atlantic off the coasts of North Carolina, South Carolina, Georgia and east Florida to Key West. The seven states that comprise the MAFMC are New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia and North Carolina (North Carolina is also on the South Atlantic Council). The MAFMC also works with the ASMFC to manage summer flounder, scup, black sea bass, bluefish and spiny dogfish. The SAFMC broadly defines EFH habitats for all of its managed fisheries in a generic management plan amendment that contains life stage based EFH information for each of the federally managed species. The SAFMC currently manages eight fisheries that include coastal migratory pelagics, coral and live bottom habitat, dolphin and wahoo, golden crab, shrimp, snapper grouper, spiny lobster and Sargassum.

Of these eight fisheries, only the snapper grouper complex contains species that are considered overfished. Both the recreational and commercial snapper grouper fisheries are highly regulated and progress continues to be made as more species are removed from the overfished list each year. The other fisheries are expected to continue into the future at productive sustainable levels (SAFMC, 2014). The areas designated as EFH by the SAFMC and MAFMC are listed in Table 6.

Table 6. Essential Fish Habitat identified in FMP Amendments of the South Atlantic and Mid-Atlantic FMC's (NMFS, 2010).

SAFMC	MAFMC
Estuarine Areas	**Estuarine Areas**
Estuarine Emergent Wetlands	Seagrass
Estuarine Scrub/Shrub Mangroves	Creeks
Oyster Reefs and Shell Banks	Mud Bottom
Intertidal Flats	Estuarine Water Column
Palustrine Emergent and Forested Wetlands	
Aquatic Beds	
Estuarine Water Column	
Marine Areas	**Marine Areas**
Live/Hard Bottoms	(None)
Coral and Coral Reefs	
Artificial/Manmade Reefs	
Sargassum	
Water Column	

The MAFMC is responsible for the conservation and management of fish stocks in the federal waters off the coasts of New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia and North Carolina. They have prepared multiple FMPs with amendments to identify EFH for each life stage (eggs, larvae, juvenile and adults) of its managed fisheries (Table 7). The MAFMC identifies several broad areas designated as EFH in estuarine and marine environments. The six FMPs developed by the council are the golden tilefish; summer flounder, scup, black sea bass; dogfish; surf clam and ocean quahog; Atlantic mackerel, squid, and butterfish; and bluefish (MAFMC, 2014).

NMFS has also prepared multiple FMPs with amendments to identify EFH within its authority. Four fisheries (billfish, swordfish, tuna and sharks) are managed under the FMPs of NMFS and are classified as Highly Migratory Species (HMS). NMFS geographically defines EFH for each HMS along the Atlantic coast. The defined EFH areas are species-specific and include shallow coastal waters, offshore waters inside the exclusive economic zone (EEZ), offshore waters outside the EEZ and inshore waters along the Atlantic coast (NMFS, 2010).

The North Carolina Marine Fisheries Commission (NCMFC) manages commercially and recreationally significant species of fisheries found in state marine or estuarine environments. The NCMFC designates Primary Nursery Areas (PNA) that are included as EFH by the SAFMC.

Table 7. EFH for managed species within coastal North Carolina. Not all species within a management unit have EFH designated; such species have 'none' within the life stages column.

Management Agency	Management Plan Species group	Common name	Scientific name	EFH life stages
SAFMC	Calico Scallop	Calico scallop	*Argopecten gibbus*	A
SAFMC	Coastal Migratory Pelagics	Cobia	*Rachycentron canadum*	E L P J A
SAFMC		Dolphin	*Coryphaena hippurus*	L P J A
SAFMC		King mackerel	*Scomberomorus cavalla*	J A
SAFMC		Spanish mackerel	*Scomberomorus maculatus*	L J A
SAFMC	Coral & Coral Reef	Corals	100s of species	Florida only
SAFMC	Golden Crab	Golden crab	*Chaceon fenneri*	A
SAFMC	Red Drum	Red drum	*Sciaenops ocellatus*	E L A
SAFMC	Shrimp	Brown shrimp	*Farfantepenaeus aztecus*	E L A
SAFMC		Pink shrimp	*Farfantepenaeus duorarum*	E L A
SAFMC		Rock shrimp	*Sicyonia brevirostris*	A
SAFMC		Royal red shrimp	*Pleoticus robustus*	A
SAFMC		White shrimp	*Lilopenaeus setiferus*	E L A
SAFMC	Snapper Grouper	Blackfin snapper	*Lutjanus buccanella*	J, A
SAFMC		Blueline tilefish	*Caulolatilus microps*	E, A
SAFMC		Golden tilefish	*Lopholatilus chamaeleonticeps*	A
SAFMC		Gray snapper	*Lutjanus griseus*	L, A
SAFMC		Greater amberjack	*Seriola dumerili*	J, A
SAFMC		Jewfish	*Epinephelus itajara*	Florida only
SAFMC		Mutton snapper	*Lutjanus analis*	Florida only
SAFMC		Red porgy	*Pagrus pagrus*	E L J A
SAFMC		Red snapper	*Lutjanus campechanus*	L, P, J, A
SAFMC		Scamp	*Mycteroperca phenax*	A
SAFMC		Silk snapper	*Lutjanus vivanus*	J, A
SAFMC		Snowy grouper	*Epinephelus niveatus*	E L A
SAFMC		Speckled hind	*Epinephelus drummondhayi*	A
SAFMC		Vermillion snapper	*Rhomboplites aurorubens*	J, A
SAFMC		Warsaw grouper	*Epinephelus nigritus*	E A
SAFMC		White grunt	*Haemulon plumieri*	E, L, A
SAFMC		Wreckfish	*Polyprion americanus*	A
SAFMC		Yellowedge grouper	*Epinephelus flavolimbatus*	E L A
SAFMC	Spiny Lobster	Spiny Lobster	*Panulirus argus*	L J A
MAFMC	Atlantic Mackerel, Squid, Butterfish	Atlantic butterfish	*Peprilus triacanthus*	None
MAFMC		Atlantic mackerel	*Scomber scombrus*	None
MAFMC		Long finned squid	*Loligo pealei*	None
MAFMC		Short finned squid	*Illex illecebrosus*	None
MAFMC	Atlantic Surfclam & Ocean Quahog	Ocean quahog	*Artica islandica*	None
MAFMC		Surfclam	*Spisula solidissima*	None
MAFMC	Bluefish	Bluefish	*Pomatomus saltatrix*	L J A
MAFMC	Spiny Dogfish	Spiny dogfish	*Squalus acanthias*	J A
MAFMC	Summer Flounder, Scup, Black Sea Bass	Black sea bass	*Centropristis striata*	E L J A
MAFMC		Scup	*Stenotomus chrysops*	E L J A
MAFMC		Summer flounder	*Paralichthys dentatus*	L J A

(Table 7 Continued)

Management Agency	Management Plan Species group	Common name	Scientific name	EFH life stages
NMFS	High Migratory Species	Blue marlin	*Makaira nigricans*	E L J A
NMFS		Longbill spearfish	*Tetrapturus pfluegeri*	J A
NMFS		Sailfish	*Istiophorus platypterus*	E L J A
NMFS		White marlin	*Tetrapturus albidus*	J A
NMFS		Atlantic angel shark	*Squatina dumerili*	None
NMFS		Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	J A
NMFS		Basking shark	*Cetorhinos maximus*	None
NMFS		Big nose shark	*Carcharhinus altimus*	J
NMFS		Bigeye sand tiger shark	*Odontaspis noronhai*	None
NMFS		Bigeye sixgill shark	*Hexanchus vitulus*	None
NMFS		Bigeye thresher shark	*Alopias superciliosus*	E L P J S A
NMFS		Blacknose shark	*Carcharhinus acronotus*	J A
NMFS		Blacktip shark	*Carcharhinus limbatus*	J A
NMFS		Blue shark	*Prionace glauca*	J S A
NMFS		Bonnethead	*Sphyrna tiburo*	J A
NMFS		Bull shark	*Carcharhinus leucas*	J
NMFS		Carribean reef shark	*Carcharhinus perezi*	Research Area
NMFS		Carribean sharpnose shark	*Rhizoprionodon porosus*	None
NMFS		Dusky shark	*Carcharhinus obscurus*	A
NMFS		Finetooth shark	*Carcharhinus isodon*	E L P J S A
NMFS		Galapagos shark	*Carcharhinus galapagensis*	None
NMFS		Great hammerhead	*Sphyrna mokarran*	J A
NMFS		Lemon shark	*Negaprion brevirostris*	J A
NMFS		Longfin mako shark	*Isurus paucus*	E L P J S A
NMFS		Narrowtooth shark	*Carcharhinus brachyurus*	None
NMFS		Night shark	*Carcharhinus signatus*	J A
NMFS		Nurse shark	*Ginglymostoma cirratum*	J A
NMFS		Oceanic whitetip shark	*Carcharhinus longimanus*	J S A
NMFS		Porbeagle shark	*Lamna nasus*	None
NMFS		Sand tiger shark	*Odontaspis taurus*	J A
NMFS		Sandbar shark	*Carcharhinus plumbeus*	J A
NMFS		Scalloped hammerhead	*Sphyrna lewini*	J A
NMFS		Sharpnose sevengill shark	*Heptranchias perlo*	None
NMFS		Shortfin mako shark	*Isurus oxyrinchus*	E L P J S A
NMFS		Silky shark	*Carcharhinus falciformis*	J
NMFS		Sixgill shark	*Hexanchus griseus*	None
NMFS		Smalltail shark	*Carcharhinus porosus*	None
NMFS		Smooth hamerhead	*Sphyrna zygaena*	None
NMFS		Spinner shark	*Carcharhinus brevipinna*	J A
NMFS		Thresher shark, common	*Alopias vulpinus*	None
NMFS		Tiger shark	*Galeocerdo cuvieri*	J S A
NMFS		Whale shark	*Rhincodon typus*	None
NMFS		White shark	*Carcharodon carcharias*	J
NMFS		Swordfish	*Xiphias gladius*	E L J S A
NMFS		Albacore	*Thunnus alalunga*	A
NMFS		Atlantic bigeye tuna	*Thunnus obesus*	J A
NMFS		Atlantic yellowfin tuna	*Thunnus albacares*	E L J S A
NMFS		Skipjack tuna	*Katsuwonus pelamis*	E L J S A
NMFS		Western Atlantic bluefin tuna	*Thunnus thynnus*	E L J S A

1.These Essential Fish Habitat species were compiled from **Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate forFederal Agencies**. February 1999 (Revised 10/2001) (Appendices 2, 3, 6, 7, and 8). Although 49 species are listed in Appendix 3 under National Marine Fisheries Service management, only 35 of these species have EFH listed in Appendix 8.

2. Life stages include: **E** = Eggs, **L** = Larvae, **P** = PostLarvae, **J** = Juveniles, **S** = SubAdults, **A** = Adults

3. Organizations responsible for Fishery Management Plans include: **SAFMC (**South Atlantic Fishery Management Council); **MAFMC** (Mid-Atlantic Fishery Management Council; **NMFS** = National Marine Fisheries Service)

4.5.2 Habitat Areas of Particular Concern

Habitat Areas of Particular Concern (HAPC) are subsets of designated EFH and are defined as rare, particularly susceptible to human-induced degradation, especially ecologically important or located in an environmentally stressed area. The SAFMC and the MAFMC have designated HAPC areas to focus conservation priorities on specific habitat areas that play a particularly important role in the life cycles of federally managed fish species. HAPC may include high value intertidal and estuarine habitats, offshore areas of high habitat value or vertical relief and habitats used for migration, spawning and rearing of fish and shellfish (NMFS, 2004).

Areas identified as HAPC by the NMFS and the FMCs in the South Atlantic and North Carolina are presented in Table 8 below (NMFS, 2010). There are no designated HAPC identified within the Project Area.

Table 8. Geographically defined HAPC identified in the FMP Amendments affecting the South Atlantic area (NMFS, 2010).

South Atlantic HAPC	Project Area Habitat
Council-Designated Artificial Reef Special Management Zones	Not Applicable
Hermatypic Coral Habitat and Reefs	Not Applicable
Hard bottoms	Not Present
Hoyt Hills	Not Applicable
Sargassum Habitat	Not Applicable
State-Designated Areas of Importance to Managed Species	Not Applicable
Submerged Aquatic Vegetation	Not Applicable
North Carolina HAPC	**Project Area Habitat**
Big Rock	Not Applicable
Bogue Sound	Not Applicable
Pamlico Sound at Hatteras/Ocracoke Inlets	Not Applicable
Capes Fear, Lookout & Hatteras (sandy shoals)	Not Applicable
New River	Not Applicable
The Ten Fathom Ledge	Not Applicable
The Point	Not Applicable

4.5.3 Nursery Areas

The North Carolina Division of Marine Fisheries (NCDMF) has designated three categories of nursery areas, Primary, Secondary and Special Secondary Nursery Areas. Primary Nursery Areas (PNAs) encompass approximately 80,000 acres throughout North Carolina. PNAs are typically shallow with soft muddy bottoms and surrounded by marshes and wetlands. They are found in the upper portions of bays and creeks, where the low salinity and abundance of food is ideal for young fish and shellfish. To protect juveniles, many commercial fishing activities are prohibited in these waters. Secondary Nursery Areas (SNAs) are located in the lower portion of bays and creeks. As juvenile fish and shellfish develop, primarily blue crabs and shrimp, they move into these waters. Trawling is prohibited in SNAs. Special SNAs are found adjacent to SNAs, but closer to the open waters of sounds and the ocean. These waters are closed for a majority of the year when juvenile species are abundant (Deaten *et al.*, 2010). There are no NCDMF designated PNAs in the proposed Project Area.

4.5.4 Significant Natural Heritage Areas

The North Carolina Natural Heritage Program (NCNHP) serves as an information clearinghouse in support of conservation of the rarest and most outstanding elements of natural diversity in the state. These elements of natural diversity include plants and animals that are so rare or natural communities that are so significant that they merit special consideration in land-use decisions. There are no anticipated direct or indirect impacts to significant natural heritage or managed areas associated with the proposed Project Area.

4.5.5 Essential Fish Habitat

There are no estuarine areas located within the Project Area. There are also no live/hard bottoms, coral and coral reefs, artificial/manmade reefs or Sargassum essential fish habitat marine areas located with the Project Area. In the absence of these habitats, discussions on these EFH resources have been omitted since there are no potential impacts to these EFH categories expected.

The marine water column will be temporarily affected by an increase in turbidity, and potentially by a decrease in dissolved oxygen (DO), as a result of dredging in the offshore borrow areas and by the placement of sand onto the beach. Transient indirect effects to the marine water column, offshore shoals and managed species are expected due to benthic resources being temporarily effected by the removal of sediment within the offshore borrow areas and through burial with sand placement along the oceanfront shoreline. Brief descriptions of the marine water column, offshore shoals and managed species present within the Project Area are continued below, followed by discussion of the potential effects to these resources.

4.5.6 Marine Water Column

The SAFMC and MAFMC designate the marine water column as an EFH. The marine water column is divided into oceanographic zones that are defined by physical parameters of the water column such as temperature, salinity, density and others. Three oceanographic zones are defined for the North Carolina area including outer shelf (131 to 230 ft.), mid-shelf (66 to 131 ft.) and inner shelf (0 to 66 ft.). These zones are influenced by the Gulf Stream, winds, tides and freshwater runoff (SAFMC, 1998).

Marine water column environments in proximity to the Project Area include the inner shelf waters associated with the proposed borrow areas and the surf zone waters associated with the placement of sand on the oceanfront shorelines of Kill Devil Hills. Managed fish species that utilize marine water column EFH in North Carolina waters are managed by the ASMFC, NCDMF, NMFS, SAFMC and MAFMC and are discussed in Section 4.5.1 above.

4.5.7 Offshore Shoals

Although not identified as Essential Fish Habitat in the FMP Amendments of the South Atlantic and Mid-Atlantic FMC’s (Table 8; NMFS, 2010), offshore shoal environments are utilized by many fish species and NMFS has identified shoal complexes as EFH for Coastal Migratory Pelagics and Highly Migratory Species (SAFMC, 1998; NMFS, 2009).

A shoal is a natural, underwater ridge, bank or bar consisting of sedimentary deposits, typically sand or gravel dominated, with bathymetric relief of three feet or greater and providing potentially important habitat. The term shoal complex refers to two or more shoals and adjacent morphologies, such as troughs, that are interconnected by past and or present sedimentary and hydrographic processes (Normandeau Associates Inc., 2014). In a 2014 study, Thieler *et al.* identified that large-scale bedforms are present over broad areas of the inner shelf from 500 m to approximately 11 km off the coast of the northern Outer Banks, including both the tops of the shoals and the intervening swales (Thieler *et al.*, 2014). Sorted bedforms are subtle, large-scale regions of coarse sand with gravel and shell hash that trend obliquely to the coast. They tend to be fairly low relief, generally with relief at or below 1 m (Normandeau Associates Inc., 2014). The seafloor in the region exhibits a series of shore-oblique ridges that seismic data indicate are composed largely of Holocene sand (Thieler *et al.*, 2014). Major shoal features in the area are located both north and south of the Project Area (Figure 12). More detailed bathymetry of the borrow areas and shoal features are shown in Figure 4 and Figure 5.

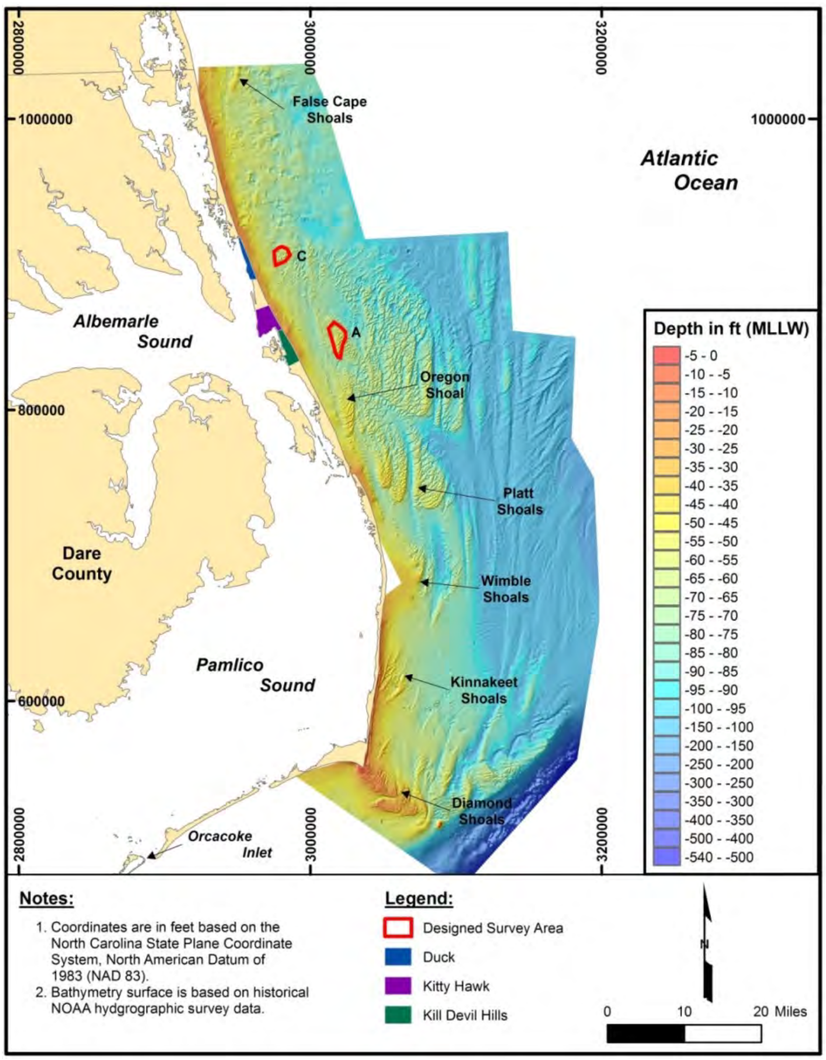

Figure 12. Regional Bathymetry with Potential Borrow Areas and Major Shoal Features.

4.5.8 Managed Species

Managed species that have the marine water column or shoals listed as an EFH and that may be present in the Project Area include coastal migratory pelagics, highly migratory species; snapper grouper complex; shrimp; summer flounder, scup and black seabass; red drum; bluefish and spiny dogfish. The following narratives briefly describe each of these groups or species.

4.5.8.1 Coastal Migratory Pelagics

Prior to the 1980's, king and Spanish mackerel catches were essentially unregulated. Introduction of airplane reconnaissance and large power-assisted gill net vessels in the commercial fishery took advantage of the schooling nature of the fish and greatly increased catches. Harvests by both recreational and commercial fishermen in the 1970's and early 1980's exceeded reproductive capacity and led to overfishing. Federal regulations were implemented in 1983 to control harvest and rebuild dwindling stocks of king and Spanish mackerel. Different migratory groups were later managed separately, and quotas, bag limits and trip limits established to rebuild the mackerel fisheries. Gear regulations included the elimination of drift gill nets in 1990. Since the implementation of management measures, stocks have been increasing (SAFMC, 2014).

The Coastal Migratory Pelagic (Mackerel) FMP for the Gulf of Mexico and South Atlantic regions is a joint management plan between the Gulf of Mexico Fishery Management Council and SAFMC. Beginning in January 2012, in addition to managing separate migratory groups of king mackerel and Spanish mackerel, the two fishery management councils have added separate migratory groups of cobia to the FMP.

Essential fish habitat for coastal migratory pelagic species includes sandy shoals of capes and offshore bars, high profile rocky bottom, barrier island ocean-side waters and waters from the surf to the shelf break zone, including *Sargassum.* In addition, all coastal inlets and all state-designated nursery habitats are of particular importance to coastal migratory pelagics.

Spanish Mackerel (*Scomberomorus maculates*)

Spanish mackerel make north and south migrations depending on water temperature, with 68° F being a preferred minimum. Spanish mackerel can be found from April to November in North Carolina’s waters, then they migrate south to the Florida coast in the late fall. They may be found as far inland as the sounds and coastal river mouths in the summer months. Spanish mackerel spawn from May to September (SAFMC, 1998).

King Mackerel (*Scomberomorus cavalla*)

Similar to Spanish mackerel, water temperature and prey availability trigger inshore and offshore migrations of king mackerel. In the winter and early spring, king mackerel congregate just inside the Gulf Stream along the edge of the continental shelf. During the summer and fall, they move inshore along the beaches and near the mouths of inlets and coastal rivers. King mackerel prefer water temperatures between 68° F and 78° F (SAFMC, 1998).

Cobia (*Rachycentron canadum*)

Cobia have a world-wide distribution preferring warm water temperatures from 68° to 86° F. Cobia are pelagic fish, and typically congregate off North Carolina to spawn in May and June. However, spawning has been observed in shallow bays and estuaries with the young heading offshore after hatching (FLMNH, 2010). Cobia typically migrate south in the fall to over-winter in warmer waters. EFH for cobia includes, but is not limited to high salinity bays, estuaries, seagrass habitat, sandy shoals and rocky bottom (SAFMC, 1998).

4.5.8.2 Highly Migratory Species

Atlantic Highly Migratory Species are managed under the dual authority of the MSFCMA and the Atlantic Tunas Convention Act (ATCA). Under the MSFCMA, the National Marine Fisheries Service (NMFS) must manage fisheries to maintain optimum yield by rebuilding overfished fisheries and preventing overfishing. Under ATCA, NMFS is authorized to promulgate regulations, as may be necessary and appropriate, to implement the recommendations from the International Commission for the Conservation of Atlantic Tunas (ICCAT). Before this action, tunas, swordfish and sharks were managed under the 1999 FMP for Atlantic Tunas, Swordfish and Sharks (and its 2003 amendment) and billfish were managed under the 1988 Atlantic Billfish FMP (and its 1999 amendment). The 2006 final HMS FMP combined the management of all Atlantic HMS into one FMP (NMFS, 2006).

In Amendment 1 to the consolidated HMS FMP released in 2009, NMFS updated identification and descriptions for EFH and revised existing EFH boundaries for Atlantic HMS (NMFS, 2009). Table 9 identifies the HMS and corresponding life stage for which the marine waters in vicinity of the project are designated as EFH.

Table 9. HMS and their life stage that have marine waters in vicinity of the Project designated as EFH.

Tuna	**Life Stage**[1]	**Sharks**	**Life Stage**
Bluefin (*Thunnus thynnus)*	J	Sandbar (*Carcharhinus plumbeus*)	YOY, J, A
Skipjack (*Katsuwonus pelamis*)	J, A	Silky (*Carcharhinus falciformis*)	YOY, J, A
Yellowfin (*Thunnus albacres*)	J	Spinner (*Carcharhinus brevipinna*)	J, A
Billfish	**Life Stage**	Tiger (*Galeocerdo cuvieri*)	YOY, J, A
Sailfish (*Istiophorus platypterus*)	J	Sand Tiger (*Carcharias taurus*)	YOY, J, A
Sharks	**Life Stage**	Angel (*Squatina dumerili*)	J, A
Scalloped Hammerhead (*Sphyrna lewini*)	J, A	Sharpnose (*Rhizoprionodon terraenovae*)	A
Dusky (*Carcharhinu obscurus*)	YOY, J, A	Thresher (*Alopias vulpinus*)	YOY, J, A

[1] Young of the Year (YOY), Juvenile (J), Adult (A)

4.5.8.3 Snapper Grouper Complex

Ten families of fishes containing 73 species are managed by the SAFMC under the snapper grouper FMP. Association with coral or hard bottom structure during at least part of their life cycle and their contribution to an interrelated reef fishery ecosystem is the primary criteria for inclusion within the snapper grouper plan. There is considerable variation in specific life history patterns and habitat use among species included in the snapper grouper complex (SAMFC, 1998).

Essential fish habitat for snapper grouper species includes coral reefs, live/hard bottom, submerged aquatic vegetation, artificial reefs and medium to high profile outcroppings on and around the shelf break zone from shore to at least 600 feet where the annual water temperature range is sufficiently warm to maintain adult populations. EFH includes the spawning area in the water column above the adult habitat and the additional pelagic environment, including *Sargassum*, required for larval survival and growth up to and including settlement. In addition, the Gulf Stream is an essential fish habitat because it provides a mechanism to disperse snapper grouper larvae. Essential fish habitat for specific life stages of estuarine dependent and nearshore snapper grouper species includes areas inshore of the 100-foot contour such as attached macroalgae; submerged rooted vascular plants; estuarine emergent vegetated wetlands; tidal creeks; estuarine scrub/shrub; oyster reefs and shell banks; unconsolidated bottom; artificial reefs; and coral reefs and live/hard bottom.

Given the lack of EFH present near the Project Area and space constraints in this document, thorough characterizations of this diverse multispecies complex is omitted but may be referenced in the SAFMC FMP (SAFMC, 1998).

4.5.8.4 Shrimp

Penaeid Shrimp (Brown Shrimp (*Penaeus aztecus*), Pink Shrimp (*Penaeus duorarum*), White Shrimp (*Penaeus setiferus*)

Penaeid shrimp are reported to spawn offshore, moving into estuaries during the post-larval stage during the early spring. As the shrimp grow larger, they migrate to higher salinity environments. In late summer and fall, they return to the ocean to spawn (NCDMF, 2006).

For penaeid shrimp, EFH includes inshore estuarine nursery areas, offshore marine habitats used for spawning and growth to maturity, and all interconnecting water bodies as described in the Habitat Plan. Inshore nursery areas include tidal freshwater (palustrine); estuarine and marine emergent wetlands; tidal palustrine forested areas; mangroves; tidal freshwater, estuarine and marine submerged aquatic vegetation and subtidal and intertidal non-vegetated flats. This applies from North Carolina through the Florida Keys.

4.5.8.5 Summer Flounder, Scup and Black Sea Bass

Summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*) and black sea bass (*Centropristus striata*) are managed by the MAFMC. The three species are considered part of an offshore-wintering guild of fish, a migratory group of warm temperate species that are intolerant of colder, inshore winter conditions (MAFMC, 2014).

Summer flounder (*Paralichthys dentatus*)

Adult summer flounder emigrate from North Carolina estuaries beginning in November as water temperatures decrease and spawning takes place in continental shelf waters (MAFMC, 2014). Larvae immigrate to the higher salinity areas of estuaries becoming common January through April. Juveniles are present year-round at salinities between 5 ppt to > 25 ppt (MAFMC, 2014).

Adult summer flounder are common in estuaries in November and December, but typically not present January through March as they will have migrated to warmer offshore waters to over-winter. Juveniles are abundant year-round in estuarine waters from 5 ppt to >25 ppt salinity. From January to April larval summer flounder are rare at lower salinities (5 ppt to 25 ppt), becoming common at salinities > 25 ppt (MAFMC, 2014). This stage (larval) of the life cycle is reported as most abundant in nearshore waters (12 – 50 miles offshore) at depths between 30 and 230 feet from November to May in the southern part of the Mid-Atlantic Bight (MAFMC, 2014). EFH for summer flounder has been identified as shelf waters and estuaries from Albemarle Sound, North Carolina through to St. Andrew/Simon Sounds, Georgia for the larval, juvenile and adults stages (MAFMC, 2014).

Scup (*Stenotomus chrysops*)

Scup are a schooling continental shelf species of the Northwest Atlantic that undertake extensive migrations between coastal waters and offshore waters. Spawning occurs from May through August, peaking in June. Scup spawn once annually over weedy or sand-covered areas. Juvenile and adult scup are demersal, using inshore waters in the spring and moving offshore in the winter. About 50% of age-2 scup are sexually mature (at about 17 cm total length, or 7 inches), while nearly all scup of age 3 and older are mature. Adult scup are benthic feeders and forage on a variety of prey, including small crustaceans (including zooplankton), polychaetes, mollusks, small squid, vegetable detritus, insect larvae, hydroids, sand dollars, and small fish. The Northeast Fisheries Science Center food habits database lists several shark species, skates, silver hake, bluefish, summer flounder, black sea bass, weakfish, lizardfish, king mackerel and goosefish as predators of scup (MAFMC, 2014). Essential Fish Habitat for scup includes demersal waters, sands, mud, mussel beds and seagrass beds, from the Gulf of Maine through Cape Hatteras, North Carolina.

Black Sea Bass (*Centropristus striata*)

The northern population of black sea bass spawns in the Middle Atlantic Bight over the continental shelf during the spring through fall, primarily between Virginia and Cape Cod, Massachusetts. Spawning begins in the spring off North Carolina and Virginia, and progresses north into southern New England waters in the summer and fall. Collections of ripe fish and egg distributions indicate that the species spawns primarily on the inner continental shelf between Chesapeake Bay and Montauk Pt., Long Island. Adult black sea bass are also very structure oriented, especially during their summer coastal residency. Unlike juveniles, they tend to enter only larger estuaries and are most abundant along the coast. A variety of coastal structures are known to be attractive to black sea bass, including shipwrecks, rocky and artificial reefs, mussel beds and any other object or source of shelter on the bottom. Essential Fish Habitat for black sea bass consists of pelagic waters, structured habitat, rough bottom shellfish, and sand and shell, from the Gulf of Maine through Cape Hatteras, North Carolina (MAFMC, 2014).

4.5.8.6 Red Drum

Red drum (*Sciaenops ocellatus*) are managed solely by the ASFMC through Amendment 2 to the Interstate FMP (ASFMC, 2014). Red drum populations along the Atlantic coast are managed through the Atlantic Coastal Fisheries Cooperative Management Act (Atlantic Coastal Act). Unlike the MSFCMA that addresses fishery management by federal agencies, the Atlantic Coastal Act does not require the ASFMC to identify habitats that warrant special protection because of their value to fishery species. Nonetheless, the ASFMC identifies habitats used by the various life stages of red drum for management and protection purposes (ASFMC, 2013).

Red drum occur in a variety of habitats distributed from Massachusetts to Key West, Florida on the Atlantic coast. Spawning occurs at night in the fall (August through October) along ocean beaches and near inlets and passes and in high salinity estuaries with optimal temperatures being between 72^{o} to 86^{o} F (SAFMC, 1998; ASMFC, 2013). In North Carolina, spawning adults were reported to be common in salinities above 25 ppt (ASMFC, 2013). Juveniles are reported to prefer shallow shorelines of bays and rivers and shallow grass flats in the sounds (SAFMC, 1998).

Adult red drum migrate seasonally along the Atlantic coast. Reports from fishermen and menhaden spotter pilots indicate that red drum typically arrive at Cape Hatteras, North Carolina between March and April, some entering Pamlico Sound and others proceeding up the coast. They are expected about a week later at Oregon Inlet and three weeks to a month later in Virginia. Red drum leave Virginia in most years by October and North Carolina by November (SAMFC, 1998).

The SAFMC recognizes several habitats as EFH for red drum from Virginia to Florida. In North Carolina, these natural communities include tidal freshwater, estuarine emergent vegetated wetlands, submerged rooted vascular plants, oyster reefs and shell banks, unconsolidated bottom, ocean high salinity surf zones, and artificial reefs. Of the designated EFH, HAPC have been recognized for red drum by the SAFMC. Areas that meet the criteria for HAPC in North Carolina include all coastal inlets, all state-designated nursery habitats of particular importance to red drum, documented sites of spawning aggregations, other spawning areas identified in the future, and areas supporting submerged aquatic vegetation (NCDMF, 2008b).

4.5.8.7 Bluefish

Bluefish (*Pomatomus saltatrix*) are managed by the NMFS as a single stock under a joint FMP collaboratively developed by the MAFMC and the ASMFC and implemented in 1990. Bluefish are considered warm water migrants, preferring waters above 57° to 61° F (Shepherd and Packer, 2006). Generally, juvenile bluefish occur in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from May through October, and South Atlantic estuaries March through December, within the "mixing" and "seawater" zones. Adult bluefish are found in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from April through October, and in South Atlantic estuaries from May through January in the "mixing" and "seawater" zones. Bluefish adults are highly migratory and distribution varies seasonally and according to the size of the individuals comprising the schools. Juveniles utilize estuaries as nursery areas and then emigrate to warmer offshore waters when temperatures approach 59° F (Shepherd and Packer, 2006). Bluefish can tolerate temperatures of 53.2° to 86.7° F, but exhibit signs of stress at both extremes. They can survive temporarily in waters of 45.5° F but juveniles cannot survive below 50° F (Lund and Maltezos, 1970).

Bluefish EFH has been designated for marine areas north of Cape Hatteras based on life stage. Based on the maps provided in Amendment 1 to the Bluefish FMP (MAFMC, 2014), EFH for all life stages of bluefish exists within or in proximity to the Project Area, with an emphasis on young of the year (YOY) and adult bluefish surveys showing the most dense coverage near the Project Area.

4.5.8.8 Spiny Dogfish

In North Carolina, the spiny dogfish (*Squalus acanthias*) is currently included in the Interjurisdictional FMP, which defers to ASMFC/MAFMC/NEFMC FMP compliance requirements. It is managed jointly under the MAFMC and the North East Fisheries Management Council (NEFMC) FMPs (NCDMF, 2008a).

The spiny dogfish is a long-lived species with an estimated life expectancy of 25 to 100 years and is reported to be one of most abundant sharks in the world. Spiny dogfish are found in oceans and coastal zones, are rarely found in the upper reaches of estuaries and do not occur in fresh water. Generally, spiny dogfish are found at depths of 33 to 1475 ft. in water temperatures ranging between 37^{o} and 82^{o} F. The preferred temperature range is 45° to 55° F. Spiny dogfish migrate seasonally, moving north in the spring and summer and south in fall and winter (MAFMC, 2014). They are most common in shelf waters in North Carolina from November through April, at which time they begin their northward migration toward Newfoundland and Labrador. Pregnant females and pups are present from February through June in North Carolina waters, with the preferred pupping area located around the Cape Hatteras shoals (MAFMC, 2014).

North of Cape Hatteras, EFH is the waters of the continental shelf from the Gulf of Maine through Cape Hatteras, North Carolina in areas that encompass the highest 90% of all ranked ten-minute squares for the area where adult dogfish were collected in the NEFSC trawl surveys. Based on figures within the Spiny Dogfish FMP (MAFMC, 2014), this includes marine water located within the Project Area.

4.6 Threatened and Endangered Species

The species under consideration within this biological assessment were identified from updated lists of threatened and endangered (T&E) species provided by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (UFWS) (NMFS, 2014e; USFWS, 2014). These lists were combined to develop the following composite list of T&E species that could be present in the project area based upon their geographic range. However, the actual occurrence of a species in the project area would depend upon the availability of suitable habitat, the seasonality of occurrence, migratory habits and other factors.

Table 10 provides a list of these T&E species that may be found in the various habitats within the Project Area. The Project Area is defined by the stretch of shoreline within Kill Devil Hills receiving beach nourishment, the borrow areas under consideration and the pipeline corridors to be used in association with cutterhead pipeline operations and hopper dredge pump out operations. Any potential impacts on federally listed T&E species would be limited to those species that occur in habitats encompassed by the Project Area. Therefore, the proposed work will not affect any listed species that generally reside in freshwater, forested habitats or savannas.

Table 10. Federally threatened, endangered or proposed listed species that may occur in the Project Area.

Common Name	Scientific Name	Federal Status
Mammals		
West Indian Manatee	*Trichechus manatus*	Endangered
North Atlantic Right Whale	*Eubalaena glacialis*	Endangered
Sei Whale	*Balaenoptera borealis*	Endangered
Sperm Whale	*Physeter macrocephalus*	Endangered
Finback Whale	*Balaenoptera physalus*	Endangered
Humpback Whale	*Megaptera novaeangliae*	Endangered
Blue Whale	*Balaenoptera musculus*	Endangered
Reptiles		
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Endangered
Loggerhead Sea Turtle	*Caretta caretta*	Threatened-NWA DPS[1]
Green Sea Turtle	*Chelonia mydas*	Endangered
Fish		
Shortnose Sturgeon	*Acipenser brevirostrum*	Endangered
Atlantic Sturgeon	*Acipenser oxyrinchus*	Endangered–Carolina DPS[3]
Vascular Plants		
Seabeach Amaranth	*Amaranthus pumilus*	Threatened
Birds		
Piping Plover	*Charadrius melodus*	Threatened
Roseate Tern	*Sterna dougallii dougallii*	Endangered
Red Knot	*Calidris canutus rufa*	Proposed Threatened
Critical Habitat		
Piping plover Unit NC-11		Designated
Loggerhead Unit		Designated
Loggerhead Unit		Designated

[1]There are nine distinct population segments of the loggerhead sea turtle listed as either threatened or endangered. The Northwest Atlantic Ocean (NWA) Distinct Population Segment (DPS) was listed as Threatened (76 FR 58868).
[2]Green sea turtles are listed as threatened, except for breeding populations of green turtles in Florida and on the Pacific Coast of Mexico, which are listed as endangered.
[3]NMFS listed two Atlantic sturgeon DPSs that spawn in the southeast (the Carolina and the South Atlantic) (77 FR 5919). There are an additional three Atlantic sturgeon DPSs in the northeast that spawn in the northeast (the Gulf of Maine, New York Bight, and Chesapeake) (77 FR 5880). Depending on the project area, a combination of DPSs may be present, particularly in marine waters. Please see Federal Register Notices for additional information.

4.6.1 Species Biology

4.6.1.1 West Indian Manatee

The West Indian manatee is listed as a federally protected species under the Endangered Species Act of 1973 (ESA) and the Marine Mammal Protection Act of 1972 (MMPA). An adult manatee is, on average, 10 ft (3 m) long, weighs approximately 2,200 lbs. and is typically referred to as the "sea cow." The coloring of the manatee is grayish brown, which contributes to the difficulty in detecting manatees in silt-laden waters. This mammal can be found in shallow waters (5-20 ft [1.5-6.1 m]) of varying salinity levels including coastal bays, lagoons, estuaries and inland river systems. Manatees primarily feed on aquatic vegetation, but can be found feeding on fish, consuming between four and nine percent of their body weight in a single day (Schwartz, 1995; USFWS, 2014f). Sheltered areas such as bays, sounds, coves and canals are important areas for resting, feeding and reproductive activities (Humphrey, 1992).

The West Indian manatee occupies the coastal, estuarine and some riverine habitats along the western Atlantic Ocean from Virginia to the Florida Keys, in the Gulf of Mexico, the Caribbean Islands, Mexico, Central America and northern South America (Garcia-Rodriguez *et al*., 1998; USFWS, 2014g). The West Indian manatee (*Trichechus manatus*) includes two subspecies, the Florida manatee (*T. m. latirostris*) and the Antillean manatee (*T. m. manatus*). Within U.S. waters, the Florida manatee can be found throughout the southeastern U.S., including North Carolina, while the Antillean manatee is found in Puerto Rico and the Virgin Islands (Lefebvre *et al.*, 2001). As the Antillean manatee does not occur within the southeastern U.S., this biological assessment will only evaluate the Florida manatee population.

No statistically robust estimate of population size is currently available for manatees (USFWS, 2014g). The current, best available information includes FWC's 2011 counts, and suggests a minimum population size of 4,834 individuals in the Florida stock (Laist *et al.*, 2013). Occurrence throughout the southeastern U.S. changes seasonally, as the manatees seek out warmer water temperatures. During the winter months (October through April), the entire U.S. population typically moves to the waters surrounding Florida (Humphrey, 1992).

The greatest threat and cause of mortality for manatees is boat collisions. Other dangers to the species include entanglement in fishing lines, entrapment and entanglement in locks, dams and culverts, loss of warm-water refuge areas, and exposure to cold. Long-term and cumulative impacts are associated with a loss of aquatic vegetated habitat and blocking of estuarine and riverine systems (Runge *et al.*, 2007).

Sightings and stranding data suggest the Florida manatee regularly occurs within inland and coastal waters of North Carolina, and they have been sighted most frequently from June through October when water temperatures are warmest (above 71.6ºF [22ºC]) (USFWS, 2003a; USFWS, 2014f). Manatees may also overwinter in North Carolina where the discharge from power plants supports the warm water temperatures (USFWS, 2008). The USFWS has reported manatee sightings in the last 20 years in the counties of Beaufort, Bertie, Brunswick, Camden, Carteret, Chowan, Craven, Currituck, Dare, Hyde, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Pitt, Tyrrell and Washington. Cummings *et al.* (2014) documented 99 manatee sightings in North Carolina from 1991 to 2012, with 30 manatee sightings occurring in 2012.

Manatees arrived in North Carolina in April, and sightings were most common from June to October, when water temperatures were above 20°C (68°F). Sightings declined with water temperature in November, and manatees appeared to absent from the region from December through February (Cummings *et al.*, 2014). Within northeastern North Carolina, sightings have increased since 2011, which may be due to greater awareness and improved survey efforts (Cummings *et al*., 2014). The greatest number of manatee sightings occurred within the Intracoastal Waterway, sounds and bays, and rivers and creeks. Manatees were least commonly sighted in the open ocean and around marinas. The number of manatees potentially occurring in the Project Area is not known, but is presumed to be low with the greatest likelihood of occurrence during the warmer months, in particular June through October.

4.6.1.2 Whales

All whales are protected under the MMPA and are under NMFS jurisdiction. There are six species of whales also listed as endangered under the ESA that are known to occur in the Western North Atlantic. These species include the blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), humpback whale (*Megaptera novaeangliae*), North Atlantic right whale (*Eubalaena glacialis*), sei whale *(B. borealis)* and sperm whale (*Physeter macrocephalus*). The blue, sei and sperm whales are considered oceanic whales and rarely venture into the shelf waters offshore North Carolina (Kenny and Winn, 1987; NMFS, 1998a). Therefore, these species are considered unlikely to occur within the Project Area and will not be evaluated further in this biological assessment.

The major threats to the whale species discussed below are largely the same and include entanglement in fishing gear and ship collisions. The commercial hunting of whales is illegal in U.S. waters, and therefore this threat has been vastly minimized. However, ship collisions remain a significant threat to these species. For the period 1993-1997, the total estimated human-caused mortality and serious injury to whales from fishery interactions and vessel collisions is estimated at 4.4 per year (NMFS, 2003). According to the large whale ship strike database, of the 292 records of confirmed or possible ship strikes to large whales, 44 records (15%) were of humpback whales, the second most often reported species next to fin whales (75 records or 26%) (Jensen and Silber, 2004). Of the five (5) documented ship strikes resulting in serious injury or mortality for North Atlantic humpback whales from January 1997-December 2001, three (3) were located in North Carolina and South Carolina waters. Collisions with vessels is consistently identified as one of the most severe threats affecting recovery of the North Atlantic right whale (Kraus *et al*. 2005; Waring *et al*. 2014). Though the total level of human-caused mortality and serious injury is unknown, current data indicate that it is significant,The annual rate of human-caused mortality and serious injury due to ship strikes for the period from 2007 to 2011 was 0.8 reportedly whales per year, which exceeds the rate of potential biological removal (Waring *et al.*, 2014)). Historical and continued commercial harvesting pose an additional threat to fin, humpback and North Atlantic right whales, as does overfishing of prey species, habitat degradation, climate and ecosystem change and disturbance from marine noise and whale watching activities.

Fin whale

Fin whales (*Balaenoptera physalus*) were listed as endangered throughout their range on December 2, 1970 under the ESA and are considered "depleted" under the MMPA. There are two subspecies of fin whales, one in the North Atlantic and one in the southern ocean. The present assessment will focus only on the North Atlantic subspecies *B.p. physalus.* Fin whales are the second largest whale species, reaching sizes of 75-85 ft. They have a sleek, streamlined body with a distinctive falcate dorsal fin positioned two-thirds of the way back on the body. Coloration is counter shaded, with the upper part of the body black or brownish grey, and a white underbelly.

The fin whale is extensively distributed throughout the North Atlantic, from the Gulf of Mexico and the Mediterranean north to the arctic pack ice. Although not well defined, migration patterns are thought to follow a "southward flow" in the fall from Newfoundland to the calving grounds in the West Indies (Clark, 1995). Fin whales fast in the winter during migrations and feed in the summer and fall on krill and small schooling fish. These whales can be found in social groups of a small number of fin whales or feeding in large groups that include other whales and dolphins (NMFS, 2014b). Feeding areas are generally thought to occur offshore and north of New England but fin whales have been seen feeding as far south as the coast of Virginia (Hain *et al.*, 1992). Off the eastern United States, sightings are common along the 200-m isobaths, but sightings have occurred within both shallower and deeper waters, including submarine canyons along the shelf break (Kenney and Winn, 1987; Hain *et al.*, 1992). Hain *et al*. (1992) analyzed fin whale distribution from Cape Hatteras, North Carolina to approximately Nova Scotia, Canada, within continental shelf waters from the shoreline to 5 nm seaward of the 1,000 fathom isobath. Results indicated frequent and wide-ranging distribution over shelf waters, with a predominance of sightings (65%) in the 21-100 m range. While sightings were reported in depths less than 21 m, the nearshore areas of North Carolina were among the few areas identified as "rarely or never occupied by fin whales". However, recent sightings data in OBIS-SEAMAP show several fin whale occurrences within North Carolina shelf waters (Halpin *et al*., 2009), a number of which were in the vicinity of Kitty Hawk and Kill Devil Hills, less than 5 miles from shore at approximately 20 m depth (McLellan, 2001; UNCW, 2006). These nearshore sightings occurred in February..

Humpback whale

Humpback whales (*Megaptera novaeangliae*) were listed as endangered throughout their range on December 2, 1970 under the ESA and are considered "depleted" under the MMPA. Humpbacks are circumglobal, and are often found in protected waters over shallow banks and shelf waters for breeding and feeding. The humpback is a medium-sized baleen whale, reaching as much as 51 feet and 34 metric tons at maturity. The body is short and rotund, and is accentuated by exceptionally long flippers. As a baleen whale, major prey species for humpbacks include small schooling fishes (herring, sand lance, capelin, mackerel, small pollock and haddock) and large zooplankton, mainly krill (up to 1.5 tons per day) (NMFS, 2014c). Distinguishing behaviors including breaching displays, slapping the water surface with flukes or flippers, bubble feeding. Humpacks are also known for their varied and rich vocabulary of sounds, or "songs". Both males and females reach sexual maturity around 9 years of age, and the females generally give birth approximately every two year (Johnson and Wolman, 1984). During spring, summer and fall, feeding grounds for the Gulf of Maine population of humpback whales (*Megaptera novaeangliae*) extend from the eastern coast of the U.S. to the Gulf of St. Lawrence, Newfoundland/Labrador and western Greenland. During the winter, this population migrates from the North Atlantic down to the West Indies to mate and calf (NMFS, 2014c), passing the North Carolina coastline while en-route. It is thought that most adult and newborn humpbacks migrate well offshore in deep waters (NMFS, 1991), and are on breeding grounds from January to April (Katona and Beard, 1990; Whitehead, 1992). However not all whales migrate to the West Indies during winter. Sighting and stranding reports suggest that sexually immature whales migrate to Mid-Atlantic States to feed during the winter, and they may utilize the nearshore waters as feeding grounds (Swingle *et al*., 1993; Wiley *et al*. 1995). Swingle *et al*. (1993) documented juvenile humpback whales feeding within 4 km of shore near Chesapeake Bay during the period of January through March 1991, and feeding behavior was observed in shallow water (2.5–6 m). Analysis of stranding data from 1985 – 1992 from New Jersey to southern Florida also suggests presence of juvenile whales during much of the year (Wiley *et al*., 1995). Strandings occurred with greatest frequency in April, and the highest number of strandings occurred within the area from the Chesapeake Bay to Cape Hatteras. Strandings occurred throughout the fall (October – December), winter (January – March) and spring (April – June) seasons, but few occurred during the summer (July – September). For all years, no strandings occurred within July and August (Wiley *et al*., 1995).

More recently, sightings and stranding data queried from OBIS-SEAMAP indicate a number of humpbacks have been recorded within the area from Corolla to Nags Head, North Carolina (Halpin et al., 2009). Specifically, during the University of North Carolina Wilmington Right Whale surveys flown November 2005 and February 2006 a total of ten sightings were noted in this area . These surveys were flown in parallel lines from the South Carolina/North Carolina border to the south end of Assateague Island, Virginia from October 2005 and April 2006. One of these humpback sightings occurred directly off Kitty Hawk, and a group of three humpbacks were sighted directly off Kill Devil Hills in February 2006 (UNCW, 2006). Additionally, one stranding occurred on December 21, 2007 (Virginia Aquarium Stranding Response Program, 2008).

North Atlantic right whale

North Atlantic right whales (*Eubalaena glacialis*) were listed as endangered throughout their range on December 2, 1970 under the ESA and are considered "depleted" under the MMPA. These large baleen whales have a stocky body, and can reach up to 70 tons in weight and 50 feet in length at maturity. North Atlantic right have black coloration, no dorsal fin, and a large head that is often covered with callosities. Two large plates of baleen hang from the upper jaw, and are used to strain zooplankton from the water. North Atlantic right whales may live up to 50 years in age, and females generally birth their first calf at 10 years of age (NMFS, 2013e). The North Atlantic right whale population ranges primarily from calving and nursing grounds in coastal waters off the southeastern United States to summer feeding and mating grounds that include New England waters, the Bay of Fundy, Scotian Shelf and Gulf of St. Lawrence. Wintering grounds include waters off the southeastern United States where females give birth from December to March (NMFS, 2013e), as well as Cape Cod Bay (Brown and Marx, 1998). However, not all reproductively active females return to calving grounds each year (Kraus *et al*., 1986), and the whereabouts of much of the population during winter remains unknown (NMFS, 2005). In the spring and summer, right whales migrate to the higher-latitude New England waters (Hamilton and Mayo, 1990) and Canadian waters during summer and fall (Winn *et al*., 1986). Although the mid-Atlantic waters south of Cape Cod and north of the Georgia/Florida wintering grounds are not considered "high use" areas, they do serve as migration corridors (NMFS, 2013e). Additionally, recent surveys suggest mother/calf pairs may use the area from Cape Fear, North Carolina to South Carolina as wintering/calving areas as well (NMFS, 2005). According to the Northeast Fisheries Science Center, there have been 19 right whale sightings off the coast of North Carolina from January 1, 2010 to May 2014. It should be noted that each of these sightings might not indicate a separate individual or group; it may be that the same whale had been spotted multiple times. Reported sightings occurred during the months of February, March, April and December (NEFSC, 2014). Additionally, an adult and calf were sighted from the relocation trawler during the Bogue Banks Phase II Nourishment project on March 30, 2004. The same pair was also seen the same day from the dredge operating during the Morehead City Project (USACE, 2013b).

4.6.1.3 Sea Turtles

There are five species of sea turtles that can be found nesting on the beaches of North Carolina, swimming in offshore waters, or both. These species include the leatherback sea turtle (*Dermochelys coriacea*), hawksbill sea turtle (*Eretmochelys imbricata*), Kemp's ridley sea turtle (*Lepidochelys kempii*), green sea turtle (*Chelonia mydas*), and the loggerhead sea turtle (*Carretta carretta*).

Sea Turtle Nesting Activity in North Carolina

Data provided by the North Carolina Wildlife Resources Commission (NCWRC) show the leatherback, Kemp's ridley, green and loggerhead sea turtles have been documented nesting along the Northern Outer Banks (Figure 13– Figure 17).

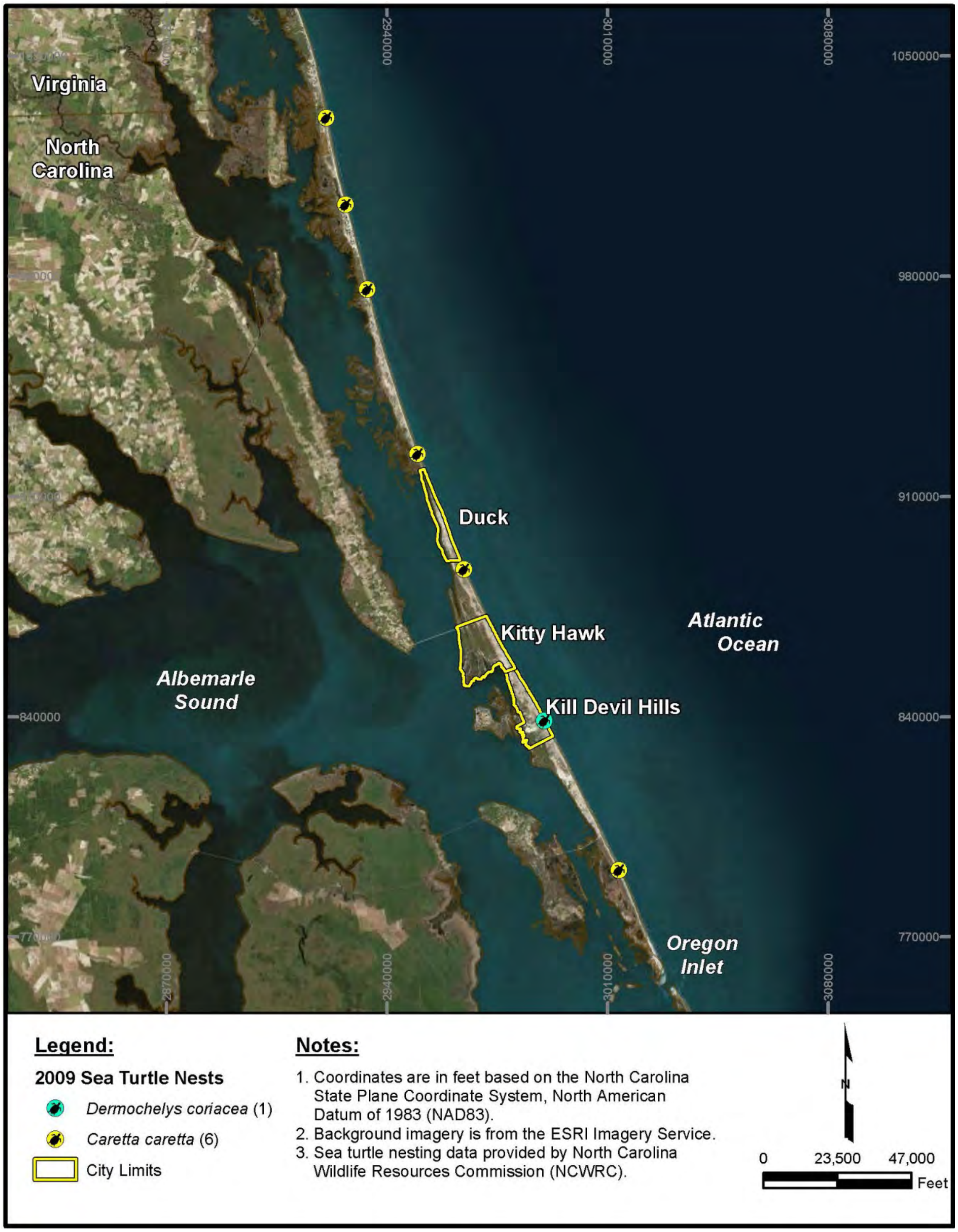

Figure 13. Number and species of sea turtle nests recorded from Oregon Inlet to the North Carolina/Virginia border in 2009. Data provided by the NCWRC (Matthew Godfrey, *pers. comm.*, May 22, 2014).

Figure 14. Number and species of sea turtle nests recorded from Oregon Inlet to the North Carolina/Virginia border in 2010. Data provided by the NCWRC (Matthew Godfrey, pers. comm., May 22, 2014).

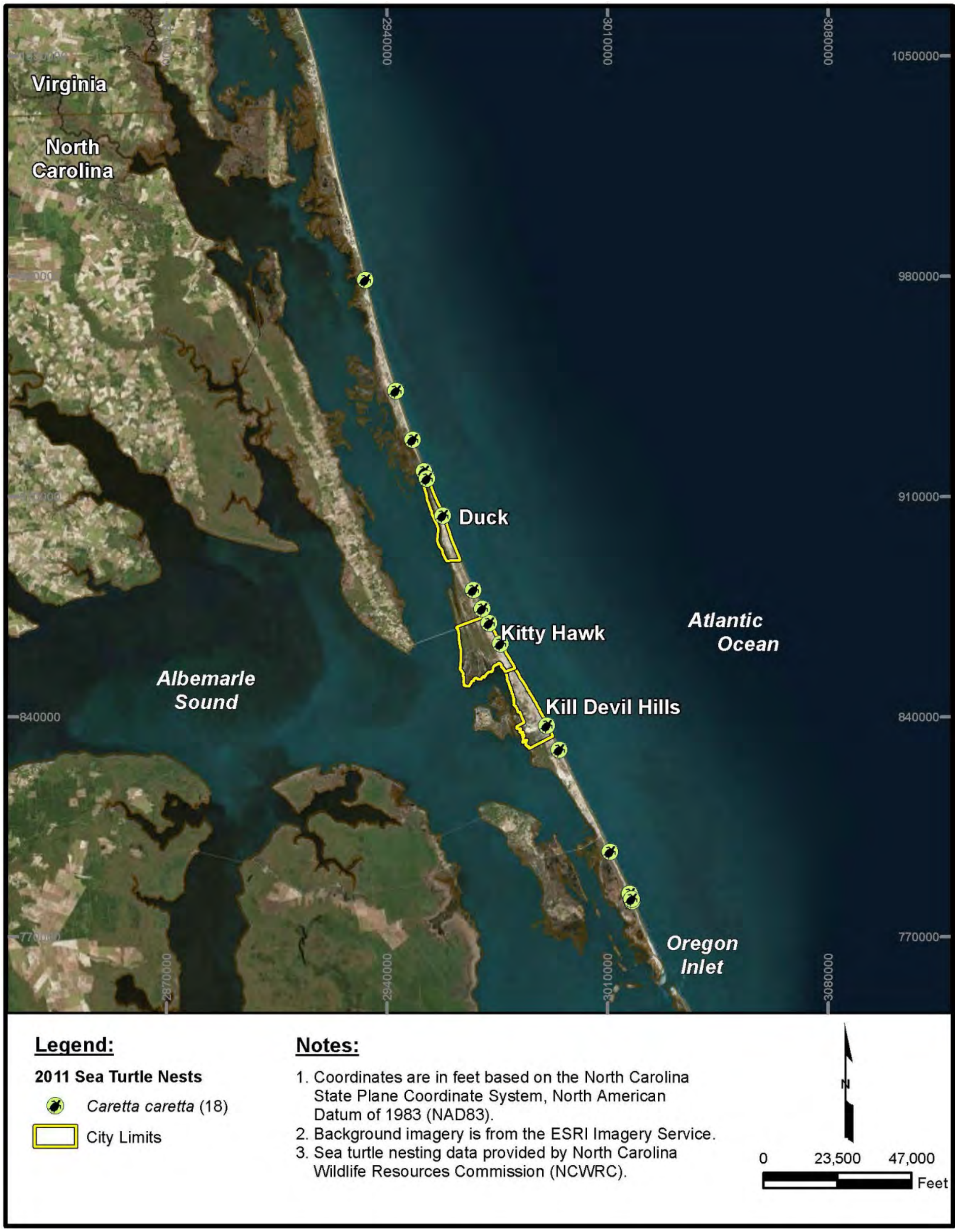

Figure 15. Number and species of sea turtle nests recorded from Oregon Inlet to the North Carolina/Virginia border in 2011. Data provided by the NCWRC (Matthew Godfrey, pers. comm., May 22, 2014).

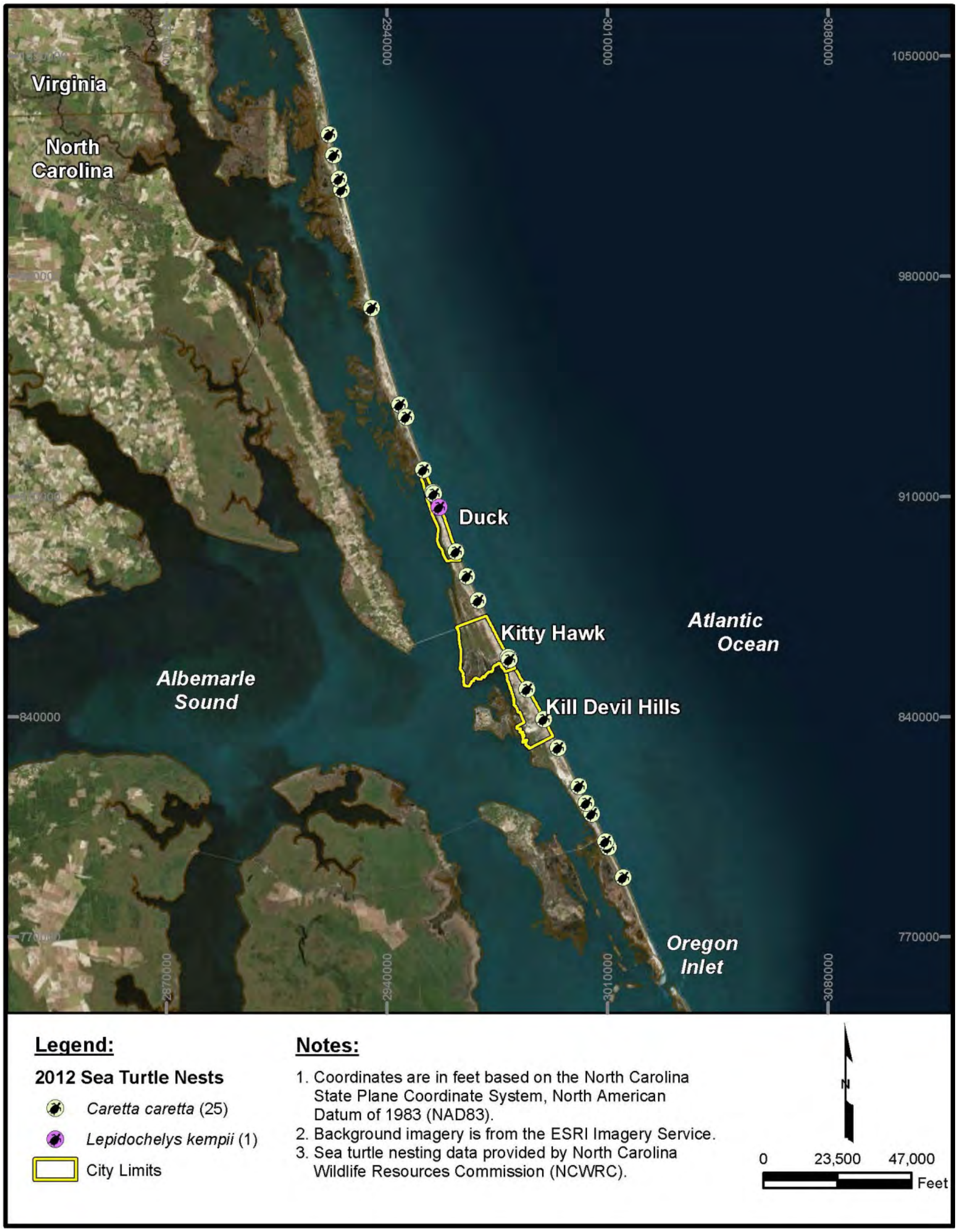

Figure 16. Number and species of sea turtle nests recorded from Oregon Inlet to the North Carolina/Virginia border in 2012. Data provided by the NCWRC (Matthew Godfrey, pers. comm., May 22, 2014).

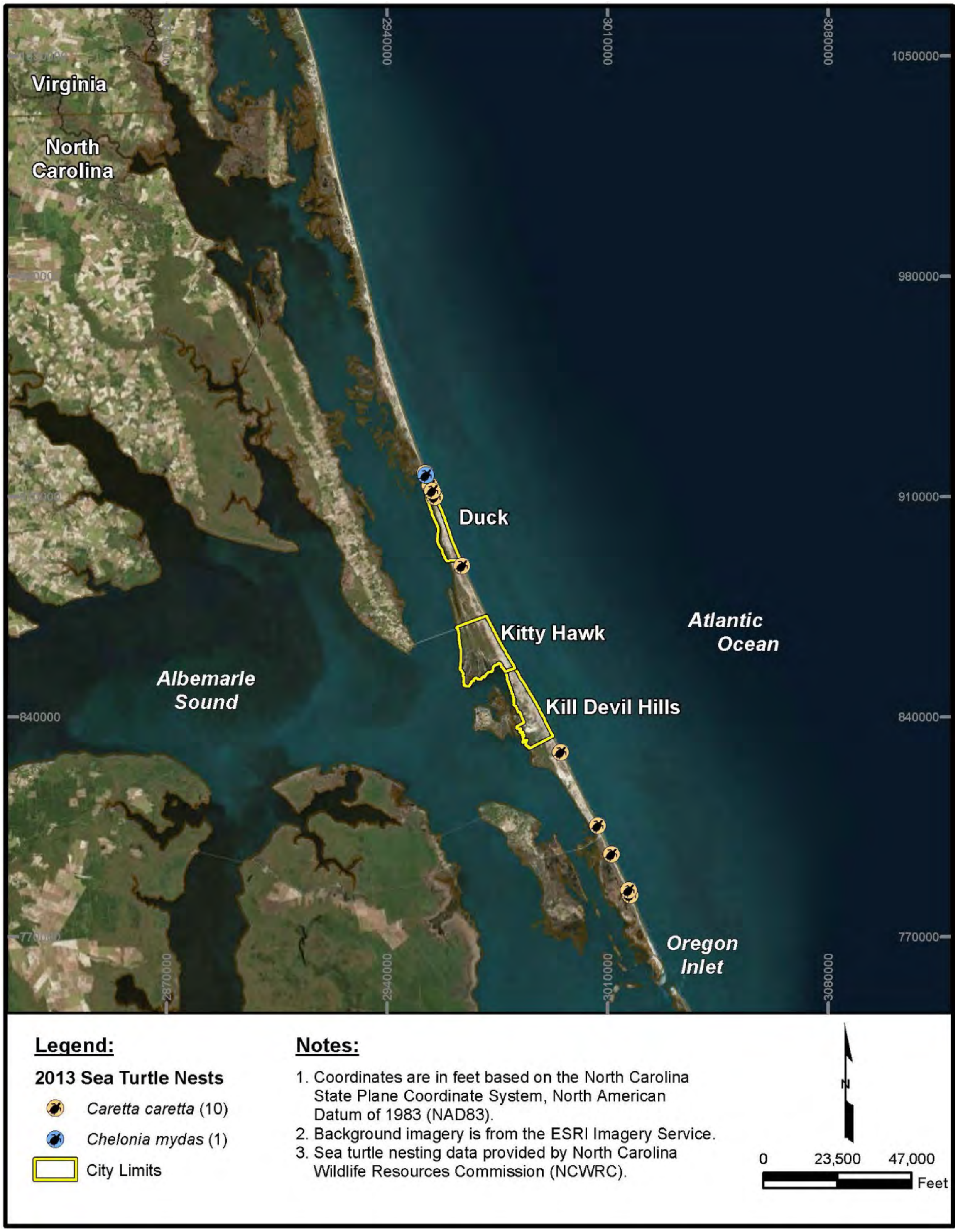

Figure 17. Number and species of sea turtle nests recorded from Oregon Inlet to the North Carolina/Virginia border in 2013. Data provided by the NCWRC (Matthew Godfrey, pers. comm., May 22, 2014).

In North Carolina, sea turtle nesting season starts May 1 and ends August 31, although turtles have been documented nesting outside of these dates in the past. Sea turtle nesting data, provided by the NCWRC (Matthew Godfrey, *pers. comm.*, 2014), were analyzed to quantify monthly nesting activity throughout North Carolina. Data were provided for eight locations including Ocean Isle, Oak Island, Wrightsville Beach, Topsail Island, Emerald Isle, Atlantic Beach, Cape Hatteras and Oregon Inlet to the NC/VA border from 2009 to 2013. The dates of nesting and hatchling emergences for all sea turtle species combined were examined to determine the most active periods of nesting activity. Figure 18 presents daily nesting and hatchling emergence activity observed throughout the five years of analysis (2009-2013). Over the five years, 2023 nests were laid. The earliest nesting occurred on May 11 and the earliest hatchling emergence occurred on July 11. The latest nesting occurred on October 7 and the latest hatchling emergence occurred on November 15.

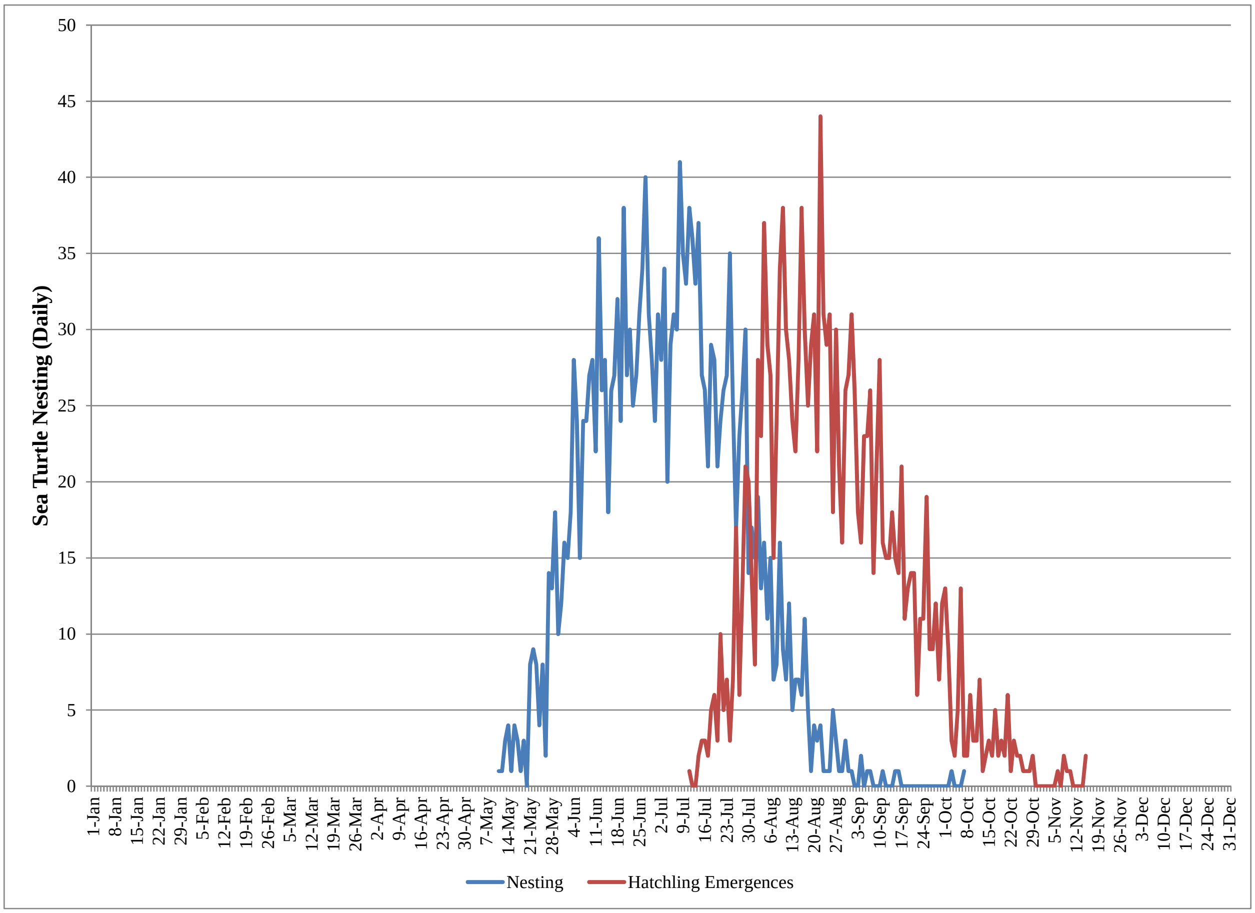

Figure 18. Daily nesting (blue line) and hatchling emergence (red line) observed for all sea turtle species throughout North Carolina between 2009 and 2013.

Nest Counts

To determine when, on average, the most nesting activity occurred throughout the season in North Carolina, statewide nesting counts over the five-year period were grouped into eleven, two-week increments. A two-week increment was used in order to maintain large enough sample sizes necessary for statistical analyses (not feasible at the daily scale), yet allowed for a finer level of comparison than monthly increments. When summed over the five year period, nest counts were generally highest during June and July, while the fewest number of nest counts occurred toward the end of the season (September through October) (Figure 19, Table 11). The number of nests counted during the month of May essentially made up 7% of total nesting, while the period between August 10 and October 7 constituted 5% of total nesting. It can therefore be said that the majority (82%) of nesting occurred between June 1 and August 9 (Table 11).

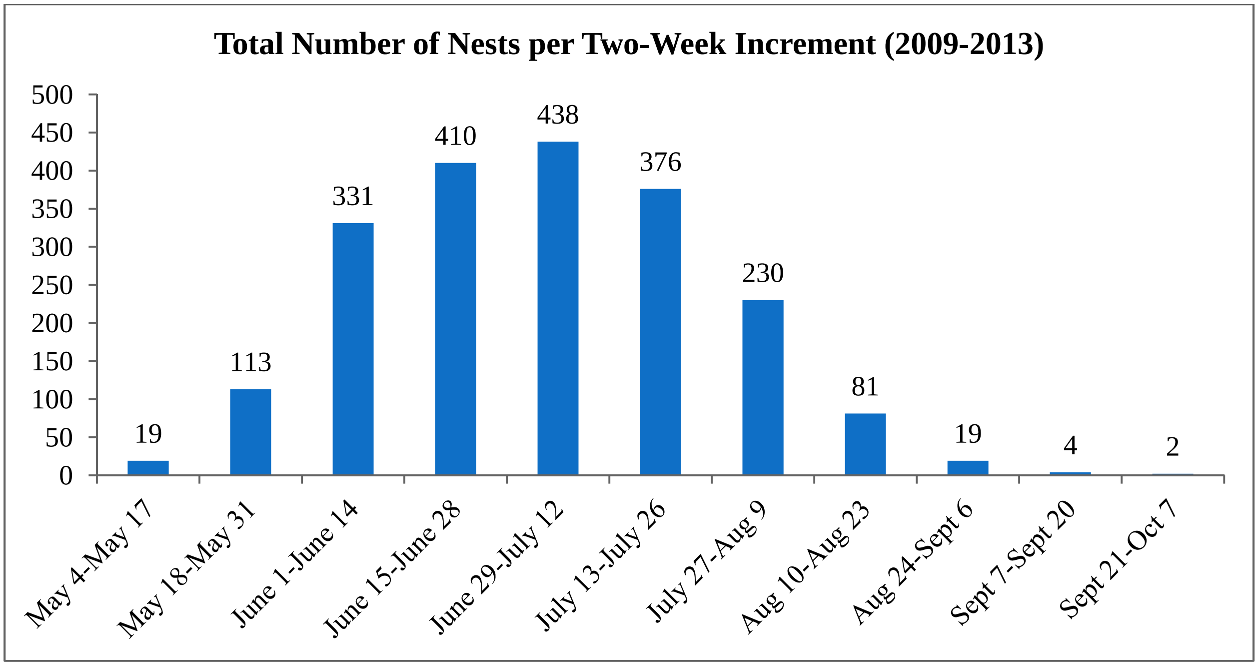

Figure 19. Total number of nests counted within two-week increments over the course of 2009 through 2013 throughout North Carolina.

Table 11. Total number of nests observed within each two-week increment used in the analyses. Nesting counts were combined over the five years of analysis (2009 to 2013).

Week Block	*n (number of days)*	Mean Nest Counts/Day (±SD)	Total Number of Nests	% of Total Nesting
May 4-May 17	70	0.27 (0.70)	19	1%
May 18-May 31	70	1.61 (1.86)	113	6%
June 1-June 14	70	4.73 (2.76)	331	16%
June 15-June 28	70	5.86 (2.81)	410	20%
June 29-July 12	70	6.26 (2.67)	438	22%
July 13-July 26	70	5.37 (3.01)	376	19%
July 27-Aug 9	70	3.29 (2.45)	230	11%
Aug 10-Aug 23	70	1.16 (1.30)	81	4%
Aug 24-Sept 6	70	0.27 (0.56)	19	1%
Sept 7-Sept 20	70	0.06 (0.23)	4	0.2%
Sept 21-Oct 7	85	0.02 (0.15)	2	0.1%
Total Nests			2023	100%

To determine where significant increases or decreases in nest counts occurred throughout the season, counts during the two-week increments were compared using non-parametric statistical analyses. Because the nesting data were non-normal, a Kruskal-Wallis ANOVA was run to compare the effect of time on nest counts when counts were grouped into two-week increments. The Kruskal-Wallis ANOVA does not require the data to be normally distributed and is essentially an analysis of variance performed on ranked data. Results of the Kruskal-Wallis ANOVA indicated there was a significant effect of time on nest counts at the $p<0.05$ level for the eleven two-week groupings [$H_{(10, 785)}=573.0429$, $p=0.000$]. Post-hoc comparisons of mean ranks between all groups revealed a number of significant differences between two-week blocks. The p-values associated with each of these comparisons are displayed in Table 12. It is important to note that the Kruskal-Wallis ANOVA is a non-parametric test based on ranks of the data, not the arithmetic means. The post-hoc test is therefore also a comparison of the mean ranks of all pairs of groups, and the mean rank (R) for each group is displayed in the table. Taken together, these results suggest nesting does vary with time throughout the nesting season. Nesting counts during May 4 through May 17 were significantly lower than the subsequent seven two-week blocks between May 18 and August 23. There was a period of eight weeks, from June 1 to July 26, in which nesting counts were significantly higher than any other two-week blocks. The four, two-week increments within this period were not statistically different from one another in terms of nesting counts (Table 12). The first significant decrease in nesting counts occurred between the two-week blocks of July 27 to August 9 and August 10 to August 23. It is also interesting to note that first two-week period in the nesting season is statistically similar to the last six weeks (Table 12), suggesting that nesting activity quickly increases in the beginning of the season, but continues in low numbers for a longer period toward the end of the season. It can be concluded that, based on data compiled from 2009 to 2013, the least amount of nesting occurred from May 4 to May 17 at the beginning of the season, and from August 24 to October 7 at the end of the season.

Table 12. Post-hoc multiple comparisons *p*-values (2-tailed) of mean ranks of nesting counts. Mean rank of each two-week group are also provided (R). Red values indicate a significant difference.

Week Block	May4 - May17	May18-May31	June1-June14	June15-June28	June29-July12	July13-July26	July27-Aug9	Aug10-Aug23	Aug24-Sept6	Sept7-Sept20	Sept21-Oct7
R	***202.14***	***356.69***	***574.34***	***624.81***	***645.49***	***597.88***	***496.36***	***330.25***	***208.38***	***171.3***	***164.36***
May4 - May17		0.00	0.00	0.00	0.00	0.00	0.00	0.05	1.00	1.00	1.00
May18-May31	0.00		0.00	0.00	0.00	0.00	0.01	1.00	0.01	0.00	0.00
June1-June14	0.00	0.00		1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00
June15-June28	0.00	0.00	1.00		1.00	1.00	0.04	0.00	0.00	0.00	0.00
June29-July12	0.00	0.00	1.00	1.00		1.00	0.01	0.00	0.00	0.00	0.00
July13-July26	0.00	0.00	1.00	1.00	1.00		0.44	0.00	0.00	0.00	0.00
July27-Aug9	0.00	0.01	1.00	0.04	0.01	0.44		0.00	0.00	0.00	0.00
Aug10-Aug23	0.05	1.00	0.00	0.00	0.00	0.00	0.00		0.08	0.00	0.00
Aug24-Sept6	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.08		1.00	1.00
Sept7-Sept20	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00		1.00
sept21-Oct7	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	

HatchlingEmergences

Similar to the nest count data, nest emergence counts over the five-year period were grouped into two-week increments, spanning July 11 to November 15. Because emergences were only recorded on five separate days during the final two-week increment (October 31 to November 15), the sample size (*n*) would have been 5 for this group. This *n* would have been substantially smaller than the *n's* of the remaining two-week groupings; therefore, these data were rolled into the previous grouping for the sake of statistical comparisons. As a result, there are eight groupings of hatchling data: seven two-week groupings and one spanning one month (Figure 20).

When emergences are summed for each two-week grouping over the five-year period, it becomes apparent that the greatest number occurred during mid-August, and the least have occurred from July 11 to July 24 and October 16 to November 15 (Figure 20, Figure 20). Emergences occurring during July 11 to July 24 (3%), and October 2 to November 15 (7%) accounted for approximately 10% of total emergences. It follows that the majority of emergences occurred from July 25 to September 4 (65%), with the peak number occurring during August 8 to August 21.

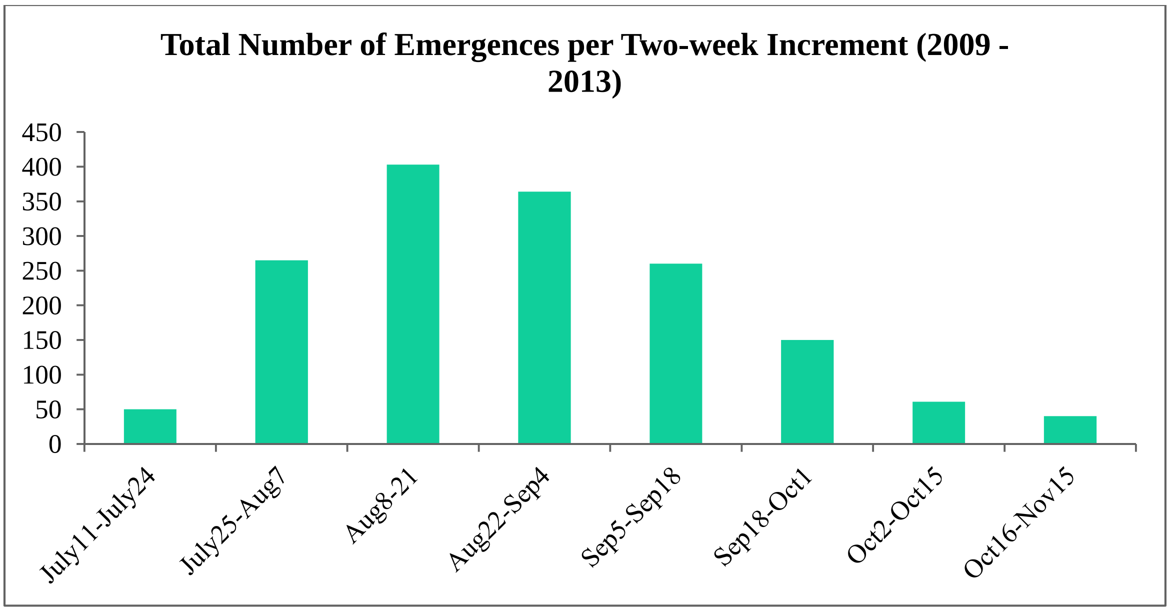

Figure 20. Total number of emergences counted within two-week increments over the course of 2009 to 2013.

To determine when significant increases or decreases in nest emergences occurred, counts during two-week increments were compared using a non-parametric Kruskal-Wallis ANOVA. Results of the Kruskal-Wallis indicated time has an effect on number of nest emergences at the $p<0.05$ level when data are grouped into two-week increments [$H_{(8,414)} = 140.3825$, $p=0.00$]. Post-hoc comparisons of mean ranks between all groups show a number of significant differences between the two-week increments. The p-values associated with each comparison are displayed in Table 14. The first significant increase occurred between the two-week increments of July 11 to July 24 and July 25 to August 7. There was essentially no significant difference in emergences between the July 25 to August 7, August 8 to August 21 and August 22 to September 4 two-week periods.

Table 13. Summary of hatchling emergence activity per two-week block observed throughout the five year period (2009 to 2013). The term *n* refers to the number of days for which emergences were observed.

Week Block	*n* *(number of days on which emergences occurred)*	Mean Eemrgences/ Day (±SD)	Sum of all Emergences	% of Total Emergences
July11-July24	29	1.7 (1.3)	50	3%
July25-Aug7	61	4.3 (2.7)	265	17%
Aug8-21	69	5.8 (3.14)	403	25%
Aug22-Sep4	67	5.4 (3.49)	364	23%
Sep5-Sep18	69	3.8 (2.38	260	16%
Sep18-Oct1	56	2.7 (1.96)	150	9%
Oct2-Oct15	33	1.8 (1.37)	61	4%
Oct16-Nov15	30	1.3 (0.66)	40	3%
Total			1593	100%

Table 14. Post-hoc multiple comparisons *p*-values (2-tailed) of mean ranks. Mean ranks (R) of each two-week group are also provided. Red values indicate a significant difference.

Week Block	July11-July24	July25-Aug7	Aug8-21	Aug22-Sep4	Sep5-Sep18	Sep18-Oct1	Oct2-Oct15	Oct16-Nov15
R	***104.12***	***240.66***	***288.6***	***266.64***	***217.93***	***165.54***	***112.79***	***79.917***
July11-July24		0.00	0.00	0.00	0.00	0.70	1.00	1.00
July25-Aug7	0.00		0.63	1.00	1.00	0.02	0.00	0.00
Aug8-21	0.00	0.63		1.00	0.01	0.00	0.00	0.00
Aug22-Sep4	0.00	1.00	1.00		0.49	0.00	0.00	0.00
Sep5-Sep18	0.00	1.00	0.01	0.49		0.42	0.00	0.00
Sep18-Oct1	0.70	0.02	0.00	0.00	0.42		1.00	0.04
Oct2-Oct15	1.00	0.00	0.00	0.00	0.00	1.00		1.00
Oct16-Nov15	1.00	0.00	0.00	0.00	0.00	0.04	1.00	

Sea Turtle Nesting Activity in the Outer Banks

A regional analysis was also completed to determine if the Outer Banks differed from the rest of North Carolina in terms of nesting activity (nest counts and emergences). To do so, all data were grouped into three regions: South (Long Bay), Central (Onslow Bay), and North (Outer Banks). As the length of surveyed beach differed between regions (South Region = 20 miles, Central Region = 43.5 miles, North Region = 109 miles) a comparison of an average nesting density (nests/mile surveyed) and per season (May through October) was made to determine if there were differences between regions. Hartley's F test was conducted to compare the nesting density per region and no statistically significant differences were found between variances ($F_{max} = 7.2 < F_{crit} = 10.8$). As this data was homoscedastic, a one way ANOVA for treatments was conducted and there were no statistically significant differences between mean nesting density per region (ANOVA [$F_{(2,15)} = 0.795$, $p = 0.470$]) (Figure 21). Likewise, a comparison of an average hatchling emergence density (emergences/mile surveyed) per season (July-November) was made to determine if there were differences between regions. A Hartley's F test determined there were no significant differences between variances of emergence density between regions ($F_{max}=11.2 < F_{crit} =15.5$. A one-way ANOVA for treatments also showed no significant differences between mean emergence density per region (ANOVA [$F_{(2,12)} = 1.19$, $p= 0.36$]).

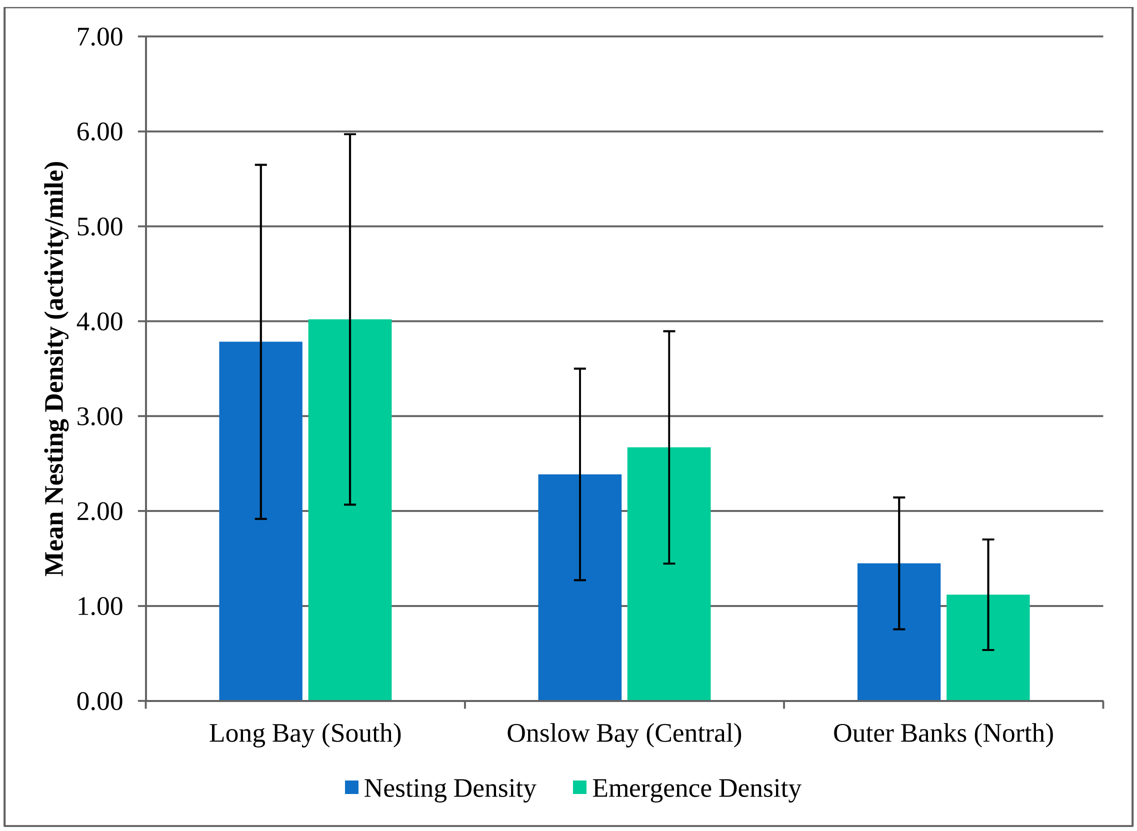

Figure 21. Mean nesting density (± standard error) and mean emergence density (± standard error) per region throughout the five years of analysis (2009-2013).

Nest Counts

Monthly activity was analyzed to show which months were most active for sea turtle nesting within each region. In each region, the majority of nesting occurred in June and July (Figure 22).

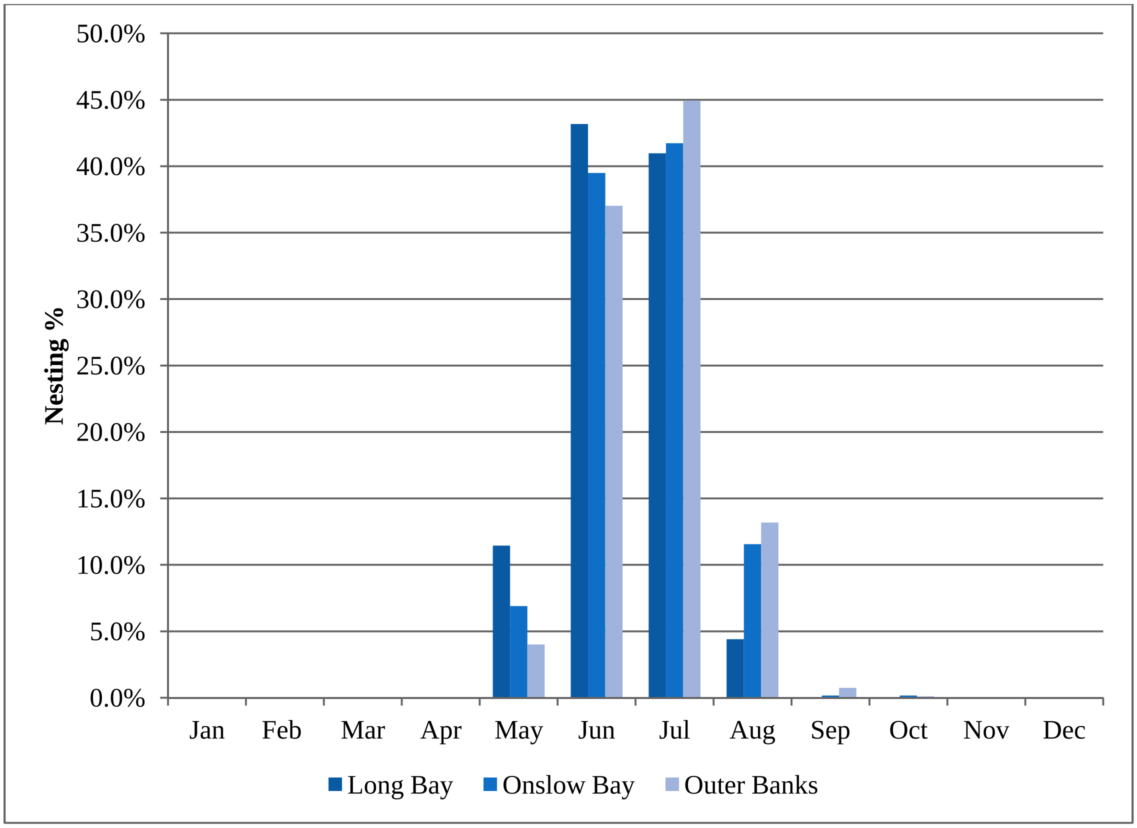

Figure 22. Monthly nesting observed within each region throughout the five years of analysis (2009-2013).

A comparison of monthly nesting within the Northern Region was made to determine if there were monthly differences in nest counts. Within the Outer Banks, Hartley's F test was conducted to compare the nests per month and statistically significant differences were found between variances ($F_{max} = 4968.5 < F_{crit} = 29.5$). As this data was heteroscedastic, the Games-Howell test was conducted to determine if there were significant differences in nest counts between months. Significant differences in monthly nesting were found between May and June, May and July, June and August, June and September, July and September, June and October, and July and October (Table 15).

Table 15. Multiple comparisons of nesting per month within the Outer Banks using the Games-Howell test.

Month 1	Month 2	lower 95% CI	upper 95% CI	mean difference	Games-Howell q statistic	df	Critical value of q (at p=0.05)
May	Jun	-103.97	-21.23	**-62.60**	8.64	5.77	5.71
May	Jul	-141.84	-13.36	**-77.60**	7.42	4.79	6.14
Jun	Jul	-79.15	49.15	-15.00	1.26	6.90	5.38
May	Aug	-43.57	8.77	-17.40	3.47	7.67	5.23
Jun	Aug	3.60	86.80	**45.20**	5.95	6.53	5.48
Jul	Aug	-3.38	123.78	60.20	5.63	5.19	5.94
May	Sep	-14.69	27.09	6.20	1.95	4.19	6.55
Jun	Sep	25.16	112.44	**68.80**	10.52	4.04	6.67
Jul	Sep	16.96	150.64	**83.80**	8.40	4.02	6.70
Aug	Sep	-2.29	49.49	23.60	6.02	4.12	6.60
May	Oct	-13.73	28.53	7.40	2.35	4.02	6.70
Jun	Oct	26.23	113.77	**70.00**	10.73	4.00	6.71
Jul	Oct	18.14	151.86	**85.00**	8.53	4.00	6.71
Aug	Oct	-1.28	50.88	24.80	6.37	4.01	6.70
Sep	Oct	-1.90	4.30	1.20	2.40	4.69	6.20

Hatchling Emergence

A regional analysis was competed between the South (Long Bay), Central (Onslow Bay), and North (Outer Banks) regions, to determine if there was a spatial preference to hatchling emergence. Monthly activity was analyzed to show which months were most active for sea turtle hatchling emergence. In each region, the majority of emergences occurred in August and September (Figure 23).

Within the Outer Banks, a Hartley's F test was conducted to compare the emergences per month and statistically significant differences were found between variances ($F_{max} = 3784.333 < F_{crit} = 25.2$). As this data was heteroscedastic, the Games-Howell test was conducted to determine if there were significant differences in emergences between months. Significant differences in monthly emergences were only found between August and November (Table 16).

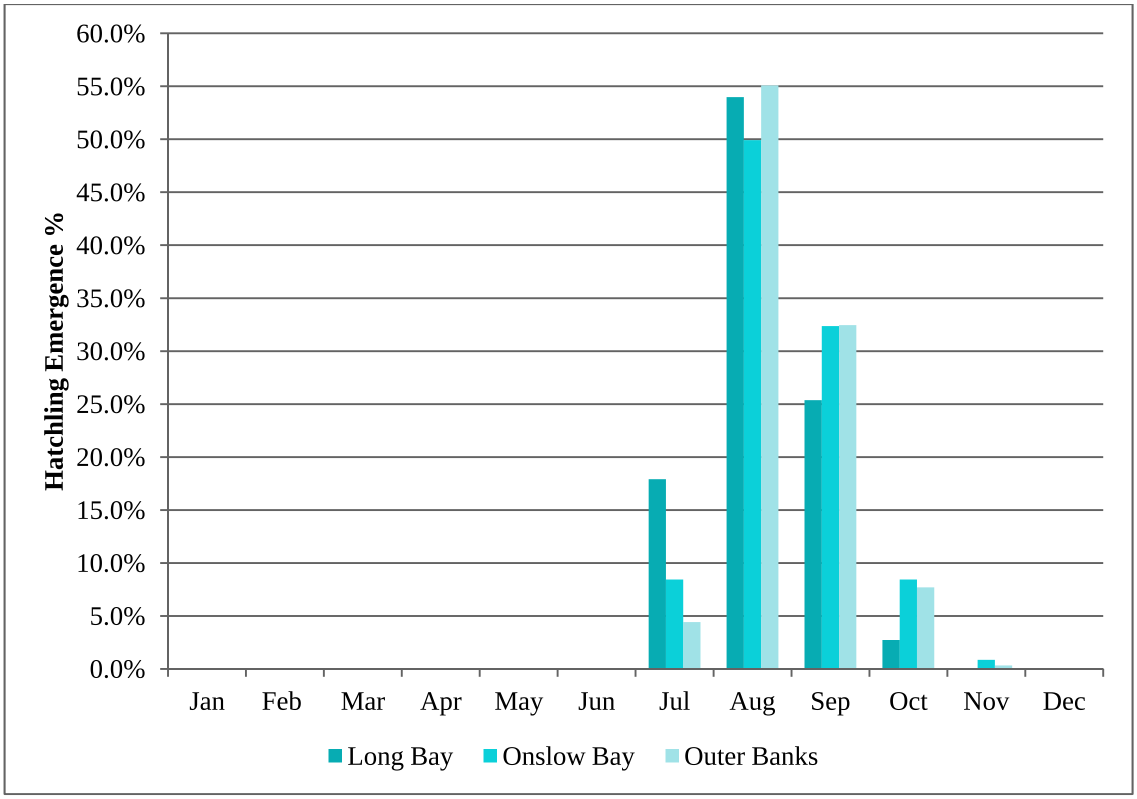

Figure 23. Monthly hatchling emergences observed at each region throughout the five years of analysis (2009-2013).

Table 16. Multiple comprisons of hatchling emergences per month within the Outer Banks using the Games-Howell test.

Month 1	Month 2	lower 95% CI	upper 95% CI	mean difference	Games-Howell q statistic	df	Critical value of q (at p=0.05)
Jul	Aug	-126.96	3.36	-61.80	5.77	4.28	6.08
Jul	Sep	-100.19	31.79	-34.20	3.16	4.27	6.09
Aug	Sep	-45.61	100.81	27.60	1.84	8.00	4.89
Jul	Oct	-16.24	8.24	-4.00	1.62	7.48	4.97
Aug	Oct	-7.74	123.34	57.80	5.43	4.16	6.16
Sep	Oct	-36.19	96.59	30.20	2.81	4.16	6.17
Jul	Nov	-7.26	17.26	5.00	2.54	4.06	6.24
Aug	Nov	0.59	133.01	66.80	6.34	4.00	6.29
Sep	Nov	-27.80	106.20	39.20	3.68	4.00	6.29
Oct	Nov	-0.33	18.33	9.00	5.99	4.11	6.21

Swimming Sea Turtles Offshore North Carolina

Numerous studies have shown that the Mid-Atlantic and South-Atlantic Bight, particularly the waters from North Carolina to New Jersey, provide important seasonal and migratory habitat for sea turtles, especially juvenile and adult loggerheads from the

Northern U.S population. The Mid-Atlantic Bight (MAB) includes oceanic waters from Cape Cod, Massachusetts to Cape Hatteras, NC; and the South Atlantic Bight (SAB) includes oceanic waters from Cape Hatteras, NC to Cape Canaveral, Florida. Loggerhead sightings data compiled for the Atlantic Marine Assessment Program for Protected Species show the presence of this species inside the 200-m isobaths is well-documented during the spring (NOAA, 2012) (Figure 24). The occurrence and distribution of sea turtles along the Atlantic coast is tied to sea surface temperature (SST) (Coles and Musick, 2000; Braun-McNeill *et al.*, 2008). In addition, Mansfield *et al.* (2009) shows that site fidelity of juvenile loggerheads can be due to environmental changes such as water temperature as well as prey availability. Throughout the region, water temperatures increase rapidly in March and April and decrease rapidly in October and November; these temperature changes are quicker in nearshore waters. An analysis of historical tracking and sightings data conducted by the Turtle Expert Working Group (TEWG) indicates that the shelf waters (out to the 200-meter isobaths) off North Carolina are seasonally "high-use areas" for certain life stages of loggerhead sea turtles (TEWG, 2009). During the winter months (January through March), very few loggerheads occurr coastally north of Cape Hatteras, North Carolina. During the spring (April through June), summer (July through September) and fall (October through December), the nearshore waters from the North Carolina/South Carolina border up to the Chesapeake Bay, Virginia serve as high-use areas for juvenile and adult nesting females. Similarly, male loggerheads frequent the nearshore waters of the mid-Atlantic Bight from the spring through the fall (essentially April through December), with a high-use area in the vicinity of Cape Hatteras. Braun-McNeill *et al.*(2008) show that loggerhead turtle presence off Cape Hatteras (based on sightings, strandings, and incidental capture records) occurred when 25% or more of the area exceeded SST of 11°C (51.8°F). Satellite tagging studies of juvenile loggerheads performed by Mansfield *et al.* (2009) also demonstrate that the waters of Virginia and North Carolina serve as important seasonal habitat for juvenile sea turtles from May through November, and the Cape Hatteras area creates a "migratory bottleneck" that warrants "special management consideration".

In a study spanning ten years (1998-2008) 68 female loggerhead sea turtles (Caretta caretta) were tagged following nesting on the beaches of North Carolina (NC), South Carolina (SC), and Georgia (GA) (Griffin *et al*., 2013). Using satellite tags, their movements were observed to document where the turtles spend their time at sea. Tagging data from the "Northern Recovery Unit (NRU) turtles" (those turtles nesting in this area of the United States) indicate that they migrate to areas offshore Cape Hatteras, NC to northern New Jersey (NJ) to forage and recover from the stresses of reproduction and nesting (Griffin *et al*., 2013). The majority of the NRU tagged turtles (42 of 68) used migration routes over the continental shelf off Cape Hatteras, NC moving south to the SAB in the winter (mid-September-November) and north to the MAB in the summer (April-June) (Griffin *et al.*, 2013) (Figure 25). The width of the migratory corridor used by the turtles was constricted off Cape Hatteras, NC and used over 7 months of the year (Griffin *et al*., 2013). This indicates that it is an important high-use area for female loggerheads and this should be considered when conducting activities there.

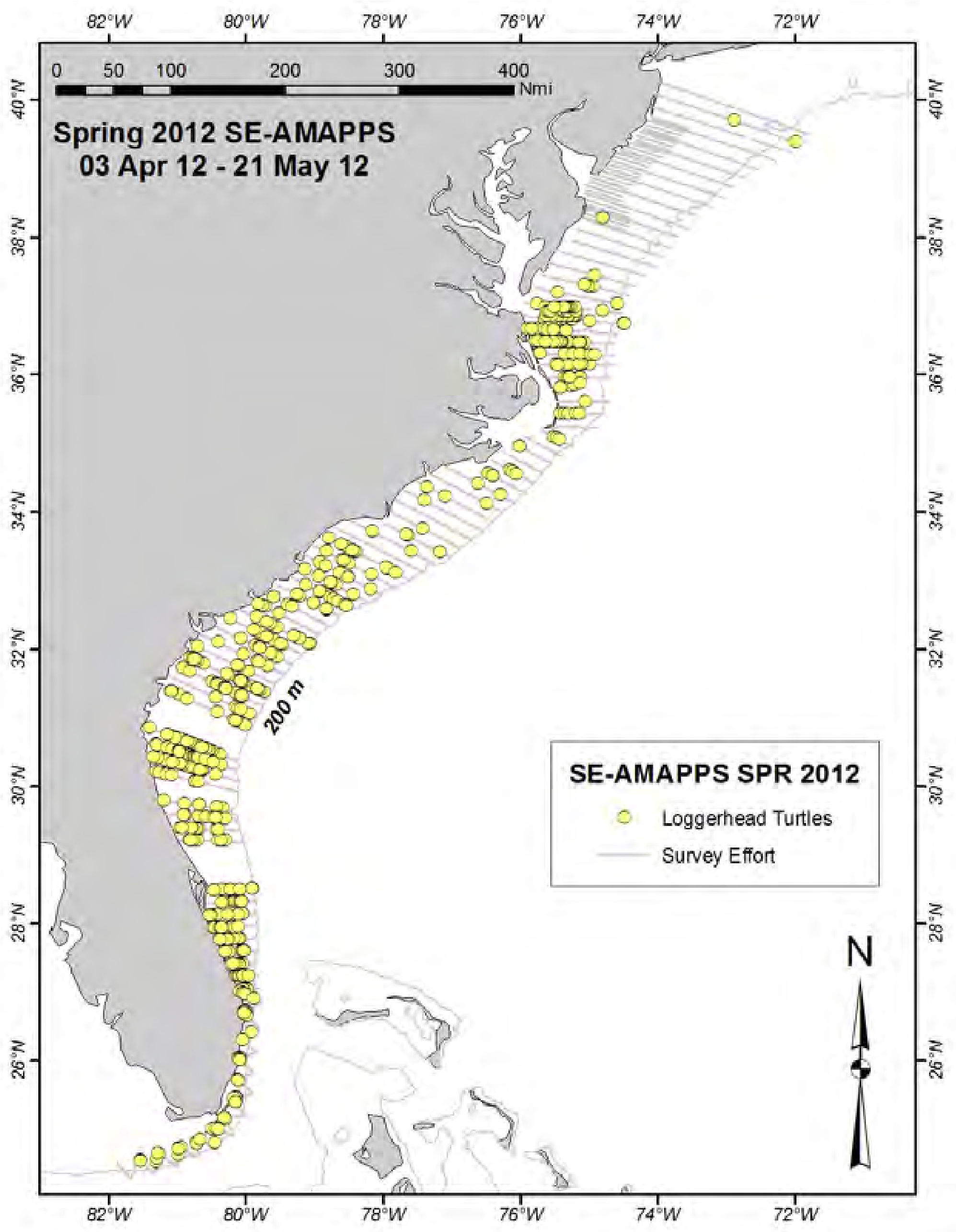

Figure 24. Loggerhead turtle sightings during the Southeast AMAPPS spring 2012 aerial survey. Image from NOAA, 2012.

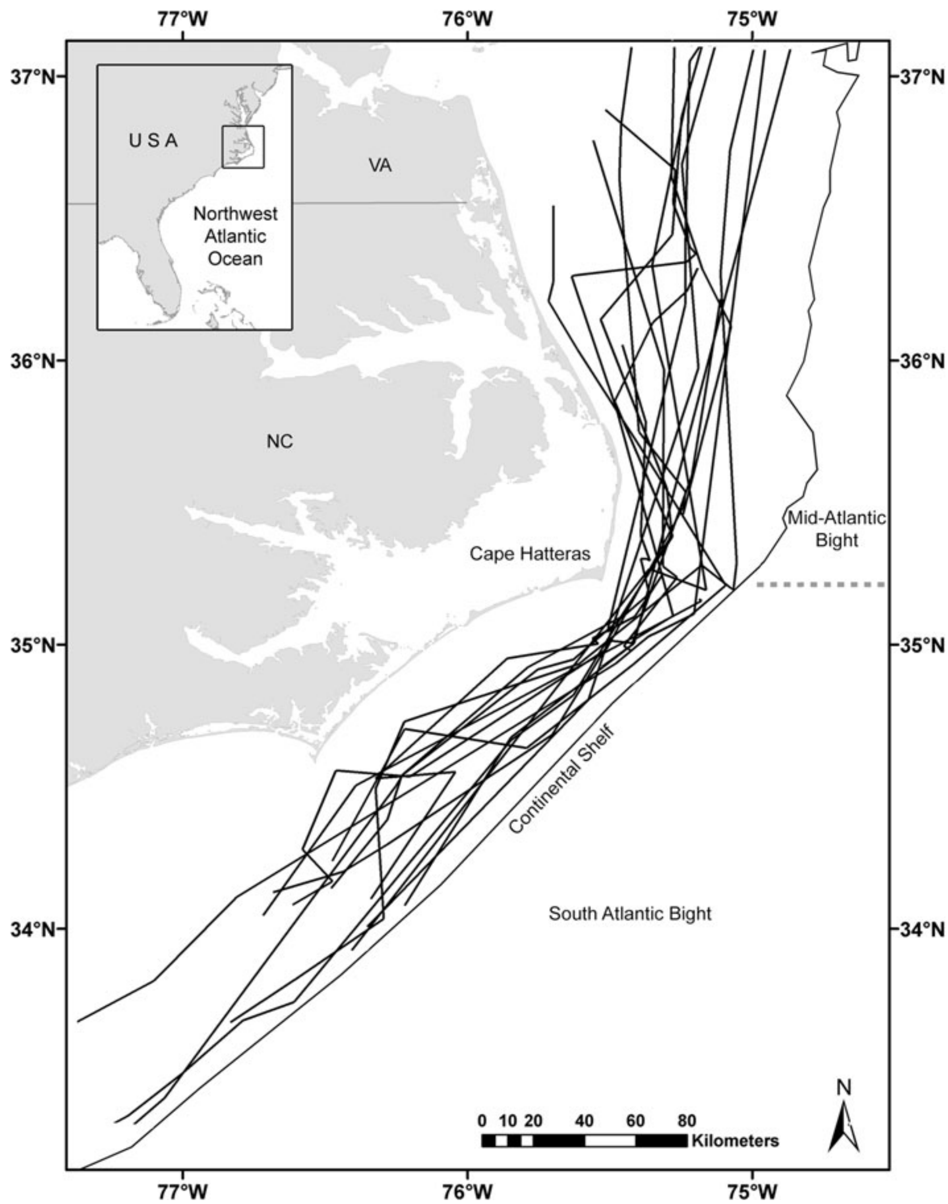

Figure 25. Migration routes (post-nesting and inter-foraging segments) of satellite-tracked loggerhead turtles (*N* = 15) represented by individual *black lines* in the Cape Hatteras, North Carolina (NC) region. The *horizontal dotted line* separates the Mid-Atlantic and South Atlantic Bights. Figure from Griffin *et al.*, 2013.

Although loggerheads are the most common turtle occurring offshore of North Carolina, the state's marine waters also provide important habitat for green and Kemp's ridley sea turtles. A review of sightings reports obtained from commercial and recreational fishermen and the public indicate that sea turtles are present offshore North Carolina year-round. There were two seasonal peaks: one in spring (April to June) off the entire North Carolina coast, and one in late fall (October through December) off the northern North Carolina coast (Epperly *et al.*, 1995). Sightings were generally greatest in offshore water (>5.6 km from shore), except during the period from May to June, when nearshore (<5.6 km) sightings were equal to offshore sightings. Leatherbacks were also documented nearshore in "large numbers" in early May, presumably with the appearance of prey. The sightings data also indicated the leatherbacks subsequently moved northward along the beach, and leatherback presence declined by late June (Epperly *et al.*, 1995).

Sea turtle stranding data from 2013 in North Carolina show that of 897 total recorded strandings, 553 (62%) occurred in the months of January through March and November through December. Of these 553, 13% (71) were loggerheads, 65% (362) were green turtles, and 21% (115) were Kemp's ridley turtles. The remaining 1% (5) were unidentified. The higher number of strandings for green and Kemp's ridley turtles may be due to their lower tolerance for cooler water temperatures; however, the strandings also indicated that these species are in fact present throughout the year in waters off of North Carolina (seaturtle.org, 2013)

Table 17. Total number of sea turtle strandings recorded in per month in North Carolina in 2013. Totals are reported for each species. Abbreviations in the table are interpreted as the following: CC, *Caretta caretta*; CM, *Chelonia mydas*; LK, *Lepidochelys kempii*; DC, *Dermochelys coriacea*; EI, *Eretmochelys imbricata*; HY, hybrid; UN, unidentified. (Table modified from seaturtle.org, 2013)

Species by Month								
Month	**CC**	**CM**	**LK**	**DC**	**EI**	**HY**	**UN**	**Total**
January	25	108	35	0	0	0	2	170
February	6	9	12	0	0	0	2	29
March	6	6	3	0	0	0	0	15
April	8	8	5	0	0	0	1	22
May	24	15	17	1	0	1	3	61
June	34	9	14	2	0	0	1	60
July	25	17	12	1	0	0	3	58
August	26	0	7	0	0	0	5	38
September	22	16	14	0	0	0	1	53
October	17	21	10	0	0	0	4	52
November	22	176	44	0	0	0	1	243
December	12	63	21	0	0	0	0	96
Total	227	448	194	4	0	1	23	897

While in foraging areas and migratory corridors, sea turtles can come into contact with fisheries, dredging activities, as well as other offshore activities. Therefore, bycatch records can be useful tools for determining sea turtle presence in nearshore and oceanic waters. The 2011 NMFS Bycatch Report includes estimates of bycatch over the years 2001-2006. Per this report, bycatch is defined as discarded catch of any living marine resource and as unobserved mortality due to a direct encounter with fishing gear (NMFS, 2011). Loggerheads are the most common species of sea turtle to be taken as bycatch in fisheries operations (Griffin *et al*., 2013). The highest values of sea turtles caught as bycatch occur in the Southeast Region by the reef fish, Atlantic pelagic longline, and southeastern Atlantic and Gulf of Mexico shrimp trawl fisheries (NMFS, 2011). The most common species taken as bycatch are loggerheads, followed by

Kemp's ridley, and leatherbacks (NMFS, 2011). Sea turtle bycatch estimates for the North Carolina southern flounder pound net fishery were 536 loggerheads, 107 green turtles, and 13.6 Kemp's ridley turtles; and estimates for the North Carolina inshore gillnet fishery were 37 green turtles, 19 leatherbacks, and 4 loggerhead turtles (NMFS, 2011). The fisheries with the highest level of sea turtle bycatch (based on 2001 data only) were the Gulf of Mexico and Southeastern Atlantic shrimp trawl fisheries with the majority of turtles caught being Kemp's ridley and loggerhead sea turtles (NMFS, 2011).

Leatherback Sea Turtles

The leatherback sea turtle (*Dermochelys coriacea*) was listed as an endangered species on June 02, 1970 (under a law that preceded the Endangered Species Act of 1973), and subsequently listed as endangered throughout its range in the United States under the ESA (35 FR 8491). Critical Habitat is designated for this species in Sandy Point, St. Croix, U.S. Virgin Islands and surrounding waters (44 FR 17710).

The leatherback is one of the largest sea turtles with an average sized adult weighing 450 kilograms (1,000 lbs) (Pritchard, 1997). It is barrel-shaped in appearance with a rigid leather-like carapace. The front flippers are paddle-like without claws and proportionally longer than those of any other sea turtle (USFWS, 2014c). The average leatherback nest depth is approximately 90 cm (35.4 inches) or less (Stefanie Oullette, *pers. comm.*, 2006). Considered to be the most pelagic of sea turtle species, leatherback hatchlings migrate offshore and remain pelagic through their adult lives. Leatherbacks feed throughout the water column from depths of 50 m (164 ft.) recorded in Australia, to surface waters and nearshore shallow environments of 4 m (13 ft). These turtles primarily prey upon jellyfish, squid, shrimp and other types of fish (Bjorndal, 1997).

While the leatherback has a worldwide distribution in temperate and tropical waters of the Atlantic, Pacific and Indian Oceans, it is not found in large numbers anywhere (USFWS, 2013c; USFWS, 2014c). Nesting populations of leatherback sea turtles were first discovered in the 1950's; however, most were not recorded until the 1960's and 1970's (Lutz and Musick, 1997). In 1995, an estimated 34,500 females nested worldwide, and global nesting populations are currently estimated between 34,000 and 94,000 adult leatherbacks (USFWS, 2013c). Major nesting grounds discovered in Mexico once contributed over 65% to the total known populations worldwide (Pritchard, 1997). However, according to the U.S. Fish and Wildlife Service, the Mexico leatherback nesting population has declined dramatically to less than one percent of its estimated size in 1980. The largest nesting populations are now found in Indonesia, West Papua, Columbia and French Guiana (USFWS, 2013c).

The U.S. range of the leatherback extends from Nova Scotia south to Puerto Rico and the U.S. Virgin Islands. Small nesting populations occur in Florida, St. Croix and Puerto Rico (USFWS, 2013c). Although nesting in the State of North Carolina is rare, Rabon *et al*. (2003) confirmed seven leatherback turtle nests between Cape Lookout and Cape Hatteras. The nesting frequency included two nests in 1998, four nests in 2000 and one nest in 2002. Leatherback sea turtles nest an average of five to seven times within a nesting season with an observed maximum of eleven nests. The average inter-nesting interval is about nine to ten days (USFWS, 2012). Therefore, Rabon *et al*. (2003) hypothesized that these nesting activities could be attributed to a single female. The North Carolina Wildlife Resources Commission (NCWRC) reported one leatherback false crawl in North Carolina in 2007 (S. Everhart, *pers. comm.*, 2007). More recently, data provided by the NCWRC shows three leatherback nests were documented between 2009 and 2013, one in the northern Outer banks (Figure 13) and two in the Cape Hatteras National Seashore (Table 18) (Matthew Godfrey, *pers. comm.*, 2014). Of these nests, one occurred in Kill Devil Hills on June 18, 2009.

Table 18. Leatherback sea turtle nests recorded in North Carolina between 2009 and 2013. Data provided by the North Carolina Wildlife Resources Commission (Matthew Godfrey, *pers. comm.*, 2014).

Location	Date
Northern Outer Banks (Kill Devil Hills)	06/18/2009
Cape Hatteras National Seashore	06/28/2009
Cape Hatteras National Seashore	07/09/2012

While infrequently found in inshore waters, Epperly *et al*. (1995) reported that on average, 15 leatherback sea turtles per year were sighted in inshore waters (within three miles of shore) of North Carolina between 1989 and 1992. According to Epperly *et al*. (1995), these inshore sightings coincided with the appearance of prey, and leatherback sightings diminished by late June. Sightings data from the AMAPPS surveys have also documented infrequent occurrence of leatherbacks in the shelf waters off North Carolina (Figure 26) (NOAA, 2012).

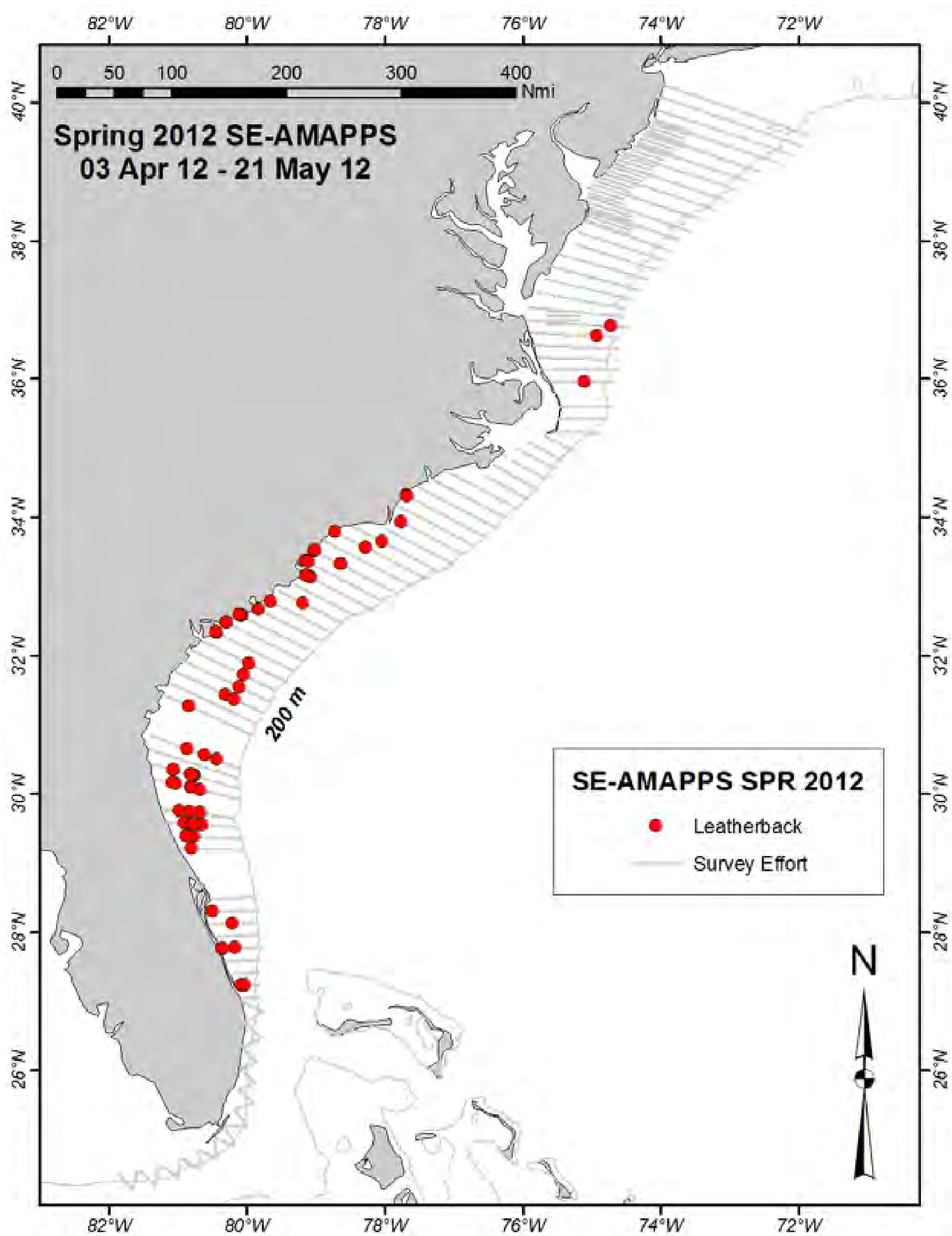

Figure 26. Sightings of leatherback sea turtles during the spring 2012 AMAPPS surveys. Image from NOAA, 2012.

Hawksbill Sea Turtles

The hawksbill sea turtle (*Eretmochelys imbricata*) was listed as endangered in 1970. A Critical Habitat designation has also been identified for the waters surrounding Mona and Monito Islands of Puerto Rico (63 FR 46693). These islands provide primary foraging habitat for several life stages for this species (NMFS, 2013b; USFWS, 2013a).

Hawksbill turtles are usually found in tropical and subtropical waters of the Atlantic, Pacific and Indian Oceans from 30°N to 30°S latitude (NMFS, 2013b). These turtles are widely distributed in the Caribbean and the western Atlantic Ocean. Hawksbill turtles prefer the clear shallow waters of coral reefs, creeks, estuaries and lagoons in tropical areas. Their diet primarily consists of sponges but also includes algae, fish, mollusks and other benthic species found in the nearshore zone. Adults may reach up to 3 feet in length and weigh on average about 300 pounds (USFWS, 2013a). The hawksbill has experienced major population declines, due primarily to human exploitation for the shell trade. Panama, once a major nesting location, now supports only a remnant nesting population. Mexico and Cuba now host the largest nesting sites within the Caribbean. Nesting numbers totaled 534 to 891 females during the period between 2001 and 2006 in Mexico's Yucatan Peninsula. An estimated 400 to 833 females nested in Cuba in 2002 (USFWS, 2013a).

Hawksbills nest in low numbers on scattered beaches. Females lay on average 3-5 nests per season that contain 130 eggs per nest (NMFS, 2013b; USFWS, 2013a). Nesting season varies with locality, but most nesting occurs sometime between April and November (USFWS, 2013a). There have been no reported nesting activities of hawksbill sea turtles on the beaches within the Project Area (Matthew Godfrey, *pers. comm*., 2010).

Hawksbill neonate behavior is similar to other sea turtles; they remain pelagic for several years before returning to coral reef habitats. Juveniles move from pelagic to coastal habitats at a much smaller size than other turtles (5 to 21 cm [1.9 to 8.2 in] straight carapace length) (Musick and Limpus, 1997). Juveniles are not often seen in waters deeper than 65 feet (Witzell, 1983); however, they are frequently associated with floating *Sargassum* in the open ocean (Musick and Limpus, 1997).

Within the U.S., hawksbill turtles are most common in the waters surrounding Puerto Rico, U.S. Virgin Islands and Florida (NMFS, 2013b). Hawksbills are recorded in the continental U.S. from all the Gulf States and from the eastern seaboard as far north as Massachusetts, but sightings north of Florida are rare (NMFS, 2013b). The U.S. Fish and Wildlife Service, North Carolina Office reports that the presence of hawksbill sea turtles along the North Carolina coast is rare (USFWS, 2014b) and no nests of this species have been documented by the NCWRC between 2009 – 2012 (Matthew Godfrey, *pers. comm.*, 2014). Therefore, it is considered unlikely this species will occur within the Project Area.

Kemp's Ridley Sea Turtles

The Kemp's ridley sea turtle (*Lepidochelys kempii*) was listed as federally endangered under the ESA on December 2, 1970 (35 FR 18319). The range of Kemp's ridley includes the Gulf coast of Mexico, the Atlantic coast of North America as far north as Newfoundland and Nova Scotia, and the Gulf coast of the U.S., especially Padre Island, Texas. A few records exist for the Azores, Morocco and the Mediterranean Sea (USFWS, 2006; NMFS, 2013c). Kemp's ridleys are the smallest of the eight species of turtles, averaging 35-45 kilograms (78-100 lbs) with an average length between 60 and 70 cm (24 and 28 inches) (Marquez 1994; NMFS 2013c). Juvenile Kemp's ridley turtles feed primarily on crabs, clams, mussels and shrimp and are most commonly found in productive coastal and estuarine areas. Recruitment from pelagic habitats occurs at a carapace size between 20 and 25 cm (7.9 and 9.8 inches) (Lutcavage and Musick, 1985).

Female Kemp's ridley turtles exhibit large-scale synchronized nesting, a phenomenon called "arribadas". During an arribada, females come to shore in large numbers to nest, usually during the daylight hours (NMFS, USFWS and SEMARNAT, 2011; NMFS, 2013c). Females generally nest from May to July, and lay two to three clutches in a season. Hatchling emergence occurs generally at night after 45-58 days of incubation. Nesting aggregations discovered at Rancho Nuevo, Tamaulipas, Mexico in 1947 were estimated at over 40,000 females. Within decades, however, the population was estimated to be around 300 nesting females. The species appears to be in the early stages of recovery and the number of nests counted annually at all monitored beaches suggest a female nesting population of 5,500 (NMFS, USFWS and SEMARNAT, 2011). Conservation measures initiated in the late 1970's are thought to be contributing to the Kemp's ridley population recovery; U.S. Fish and Wildlife Service reported 20,570 nests in Mexico and 199 nests in the U.S. in 2011. However, the International Union for the Conservation of Nature still lists the Kemp's ridley as Critically Endangered (NMFS, USFWS and SEMARNAT, 2011). .

Unlike most sea turtle species that are widely distributed, the Kemp's ridley is mostly restricted to the Gulf of Mexico (Miller, 1997). The largest nesting populations occur on the coastal beaches of the Mexican states of Tamaulipas and Veracruz (NMFS, USFWS and SEMARNAT, 2011). Smaller nesting events occur near Padre Island National Seashore, Texas. According to the U.S. Fish and Wildlife Service, rare nesting events have also been recorded in Florida, South Carolina and North Carolina (USFWS, 2013b). Data from the North Carolina Wildlife Resources Commission (NCWRC) show four Kemp's ridley sea turtle nests have been documented in North Carolina between 2009 and 2013, all of which occurred in the Outer Banks Table 19). Two of these nests were deposited along Cape Hatteras National Seashore in June and August (Table 19). The other two nestings occurred in Corolla (Figure 14) and Duck (Figure 16), both during June (Table 19).

Table 19. Kemp's ridley sea turtle nests documented in North Carolina from 2009 to 2013. Data provided by the NCWRC (Matthew Godfrey, *pers. comm.*, 2014).

Location	Date
Northern Outer Banks (Corolla)	07/09/2010
Cape Hatteras National Seashore	06/16/2011
Northern Outer Banks (Duck)	06/14/2012
Cape Hatteras National Seashore	08/14/2013

Hatchlings are dispersed within the Gulf and Atlantic by oceanic surface currents. They have also been sighted in shallow coastal waters along the east coast of the United States. Kemp's ridley sea turtles are commonly observed migrating within North

Carolina inshore waters during the spring and fall and occasionally found stranded on the beaches of North Carolina (Mihnovets, 2003). These strandings may be attributed to juveniles being caught in the southern Gulf of Mexico Loop Current that eventually moves these turtles east and north along the western Atlantic coast (Musick and Limpus, 1997).

Green Sea Turtles

Breeding populations of the green sea turtle (*Chelonia mydas*) in Florida and the Pacific coast of Mexico have been federally listed as endangered, while all other populations have been listed as threatened under the ESA since July 28, 1978. Additionally, Critical Habitat was designated for the coastal waters surrounding Culebra Island, Puerto Rico (NMFS, 2013a; USDC, 1998). Green sea turtles are mid- to large-sized sea turtles that reach an average weight of 136.2 kg (303 lbs) (Pritchard, 1997). In the North Atlantic, green sea turtles leave their pelagic habitats and enter coastal feeding grounds when they have reached a carapace length of 30 to 40 cm (11.8 to 15.8 inches) (Lutcavage and Musick, 1985). Their shell is heart-shaped, of variable color and becomes smooth during the adult phase. Feeding habitats for adults are specific to seagrasses and marine algae, while hatchlings may be found feeding on various plants and animals. Green sea turtles are generally found near seagrass habitats in shallow aquatic environments, such as nearshore reefs, bays and inlets (NMFS, 2013a). Coral reefs and rocky patches may also be utilized for shelter and feeding when seagrass is not available (Hirth, 1997).

The green sea turtle is globally distributed and generally ranges throughout warm tropical and temperate waters of more than 140 countries. Their nesting and feeding grounds are predominantly located along coastal areas between 30° N and 30° S. The green sea turtle nesting season of southern U.S. populations generally occurs between June and September, but varies depending upon its locality. Nest depth ranges between 60 and 90 cm (23.6 and 35.4 inches) (Stefanie Oullette, *pers. comm.*, 2006). The clutch size of a female turtle varies from 75 to 200 eggs with an incubation time from 45 to 75 days (USFWS, 2014e). Hatchling incubation time and sex determination are both temperature dependent (Hays *et al*., 2001). Green sea turtle hatchlings emerge at night and migrate offshore spending several years feeding and growing in oceanic current systems (USFWS, 2012a).

Along the U.S. beaches of the Atlantic, green turtles primarily nest in Florida. Less significant nesting populations have been identified in the U.S. Virgin Islands, Puerto Rico, Georgia, South Carolina and North Carolina (USFWS, 2012). The U.S. Fish and Wildlife Service (2014) reports that the green sea turtle has been observed in Beaufort, Brunswick, Carteret, Currituck, Dare, Hyde, New Hanover, Onslow, Pamlico and Pender Counties. While green sea turtles have been sighted, primarily from spring through fall, along the entire North Carolina coastline, nesting activities have only been observed in Onslow, Brunswick, Hyde, Dare and Currituck Counties (Matthew Godfrey, *pers. comm.*, 2014).

Nesting survey data provided by the NCWRC indicates 48 green sea turtle nests have been recorded within North Carolina from 2009 to 2013. The earliest nest was laid on June 7, 2011, along the Cape Hatteras National Seashore, and the latest nest was laid

October 3, 2013 on Topsail Island. Of the 48 nests documented, only one nest was laid north of Oregon Inlet; this nest was deposited in Duck on July 17, 2013 (Figure 17).

Loggerhead Sea Turtles

The loggerhead sea turtle (*Caretta caretta*) was listed under the ESA as threatened throughout its range on July 28, 1978 (43 FR 32800). On September 22, 2011, the listing was revised from a single threatened population to nine Distinct Population Segments (DPS) with four listed as threatened and the remaining five listed as endangered. Within the Northwest Atlantic Distinct Population Segment (DPS), five nesting recovery units in have been identified through genetic DNA analysis and include: 1) the Northern recovery unit from southern Virginia to the Georgia-Florida border; 2) Peninsular Florida recovery unit from the Florida-Georgia border, following the eastern coastline south and around to Pinellas County on Florida's west coast; 3) the Dry Tortugas, Florida recovery unit including loggerheads nesting on the islands west of Key West, Florida; 4) the Northern Gulf of Mexico recovery unit, from Franklin County along Florida's northwest coast through Texas; and 5) the Greater Caribbean recovery unit, which includes loggerheads originating from all other nesting assemblages within the Caribbean (Mexico through French Guinana, The Bahamas, Lesser Antilles, and Greater Antilles (USFWS, 2012b).

Loggerheads are large reddish-brown turtles weighing between 91-159 kilograms (200-350 lbs) (Pritchard, 1997). The average carapace length of an adult southeastern U.S. loggerhead is about 92 cm (3 ft) with an associated body mass weighing 133 kg (293 lbs). Adult loggerheads nest at night along sandy beaches and may nest from one to seven times within a nesting season (NMFS, 2013d; USFWS, 2012). The average nest depth for loggerhead sea turtles is 61 cm (24 inches) (Stefanie Oullette, *pers. comm.*, 2006). Loggerhead sea turtles are the only marine sea turtles that have been reported to nest predominantly outside of the tropics (Bolten and Witherington, 2003).

Hatchling loggerheads migrate offshore into the Gulf Stream where they move at a northeastward trajectory into the northwestern Atlantic. These neonate turtles have been shown to venture out of the Gulf Stream and into meso-scale eddies, continue into the North Atlantic Gyre or into the Sargasso Sea where they can be found in drifting masses of *Sargassum* macroalgae until they have grown into much larger juveniles (Fletmeyer, 1978; Mansfield *et al.*, 2014). Loggerhead sea turtles will remain within the open ocean for several years before leaving their pelagic habitats to return to their coastal foraging and nesting habitats (Klinger and Musick, 1995; Bolten *et al*., 1993). Recruitment into coastal habitats occurs when their carapace length is between 25 and 70 cm (9.8 and 27.5 in) (Lutcavage and Musick, 1985; Bolten *et al*., 1993).

The loggerhead is widely distributed, inhabiting different oceanic zones throughout the temperate and tropical regions of the Atlantic, Pacific and Indian Oceans (USFWS, 2012d). According to the U.S. Fish and Wildlife Service (2012), loggerhead sea turtles predominantly nest along the western coasts of the Atlantic and Indian Oceans. Major nesting aggregations include Masirah Island (Oman), Australia and south Florida.

Eighty percent of all loggerhead nesting that occurs in the southeastern U.S. takes place in Florida. The Archie Carr National Wildlife Refuge (ACNWR), a 20-mile stretch of coastline found along the east coast of Florida, is considered the most important nesting area for loggerhead turtles in the western hemisphere. Over 625 nests per kilometer have been recorded by researchers within the ACNWR (NMFS, 2013d). Loggerhead sea turtle nesting occurs to a lesser extent on suitable beaches on islands off the Gulf states, Georgia, South Carolina, and along the entire North Carolina coastline, including Dare County where the Project Area is located (NCDENR, 2001; USFWS, 2014a). The U.S. Fish and Wildlife Service reported that although declines in nesting since the 1970's have been documented, no long-term trend data is available for the Northern subpopulation (USFWS, 2012b). Bolten and Witherington (2003) reported that studies on the northern subpopulation from 1989 to 1998 illustrated a stable or declining population trend. The Florida Fish and Wildlife Conservation Commission analyzed trends in loggerhead nesting in Florida and found no demonstrable trend for the period between 1998 to 2013, indicating a reversal in the decline detected prior to 1998. Between 1989 and 2013, there was an almost 30% positive change in nest counts (FWC, 2014).

Nesting survey data provided by the NCWRC indicate 1,634 loggerhead sea turtle nests were recorded within North Carolina from 2009 to 2013. The earliest nest recorded was May 11, 2012, and the latest record of the season occurred on October 7, 2009. Of the total nests recorded in North Carolina, 67 (4.1%) occurred along the northern Outer Banks, north of Oregon Inlet. Nests in this region were recorded from May through September, with the majority being recorded during June and July (Figure 27).

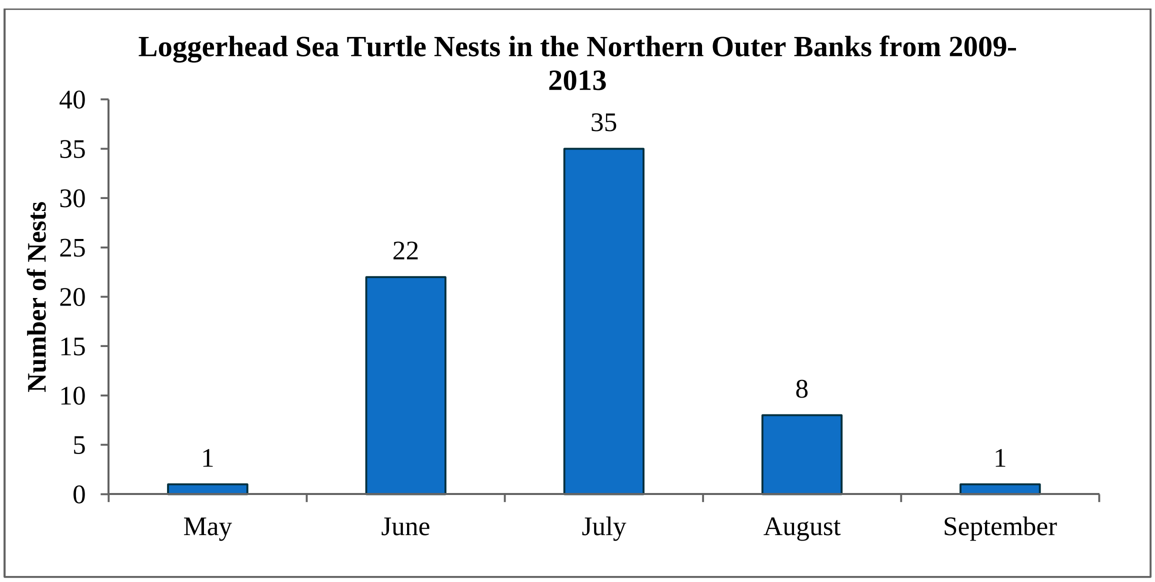

Figure 27. Number of loggerhead sea turtle nests recorded along the northern portion of the Outer Banks, north of Oregon Inlet, from 2009 to 2014. Data provided by the NCWRC (Matthew Godfrey, *pers. comm.*, 2014).

Designated Critical Habitat for Loggerhead Sea Turtles

Critical habitat is designated under the ESA for the loggerhead turtle Northwest

Atlantic DPS along the U.S. Atlantic coast, in the Gulf of Mexico, and in open water habitats. On July 10, 2014 the USFWS designated 1,102 km of the western Atlantic and Gulf of Mexico coastlines as terrestrial critical habitat for the Northwest Atlantic Ocean Distinct Population Segment (NWA DPS) of loggerhead sea turtles. Critical habitat is designated on sandy beaches capable of supporting a high density of nests in North Carolina (Brunswick, Carteret, New Hanover, Onslow and Pender counties), South Carolina (Beaufort, Charleston, Colleton, and Georgetown counties), Georgia (Camden, Chatham, Liberty, and McIntosh counties), and Florida (Bay, Brevard, Broward, Charlotte, Collier, Duval, Escambia, Flagler, Franklin, Gulf, Indian River, Lee, Manatee, Martin, Monroe, Palm Beach, Sarasota, St. Johns, St. Lucie, and Volusia counties). The designation also includes non-continuous sections of coastline from Alabama and Mississippi. Department of Defense lands are exempt from critical habitat designation. Maps of the specific terrestrial critical habitat locations may be found in the FWS Final Rule (79 FR 39756). In North Carolina, the northernmost segment of the proposed terrestrial Critical Habitat, referred to as LOGG-T-NC-01, is located on Bogue Banks, approximately 125 miles south of Dare County (Figure 28). There are no units proposed within Dare County.

Additionally, on July 10, 2014 the National Marine Fisheries Service (NMFS) proposed marine critical habitat for the loggerhead sea turtle NWA DPS within the Atlantic Ocean and the Gulf of Mexico. Open water critical habitat is designated for nearshore reproductive habitat, breeding habitat, migratory habitat, and winter habitat and is located along the U.S. Atlantic coast from North Carolina south to Florida and into the Gulf of Mexico. Critical habitat is designated offshore of the U.S. Atlantic coast coincident with the Gulf Stream to the edge of the U.S. Exclusive Economic Zone (EEZ) stretching from approximately 38° North latitude, 71° West longitude south to the Gulf of Mexico-Atlantic border. This includes the majority of the Mid- and South Atlantic and Straits of Florida Planning Areas. Detailed descriptions and maps may be found in the NMFS Final Rule for critical habitat designation (79 FR 39856).Unit LOGG-N-01 is the northernmost unit within North Carolina and the closest to Dare County. This unit is defined in the Federal Register as (79 FR 39856):

> *LOGG-N-1—North Carolina Constricted Migratory Corridor and Northern Portion of the North Carolina Winter Concentration Area:* This unit contains constricted migratory and winter habitat. The unit includes the North Carolina constricted migratory corridor and the overlapping northern half of the North Carolina winter concentration area. [NMFS] defined the constricted migratory corridor off North Carolina as the waters between 36° N. lat. and Cape Lookout (approximately 34.58° N) and from the shoreline (MHW) of the Outer Banks, North Carolina, barrier islands to the 200-m depth contour (continental shelf).
>
> The constricted migratory corridor overlaps with the northern portion of winter concentration area off North Carolina. The western and eastern boundaries of winter habitat are the 20-m and 100-m contours, respectively. The northern boundary of winter habitat starts at Cape Hatteras (35°16′ N) in a straight

latitudinal line between the 20- and 100-m depth contours and ends at Cape Lookout (approximately 34.58° N) (Figure 29).

According to the above description, there is no designated critical habitat that falls within the municipal boundaries of Duck or Kitty Hawk. However, the southernmost limit of the town of Kill Devil Hills is at 35.9949° N, therefore unit LOGG-N-1 barely extends into the waters off the southernmost portion of Kill Devil Hills. One of the proposed borrow areas - Borrow Area A - is located within unit LOGG-N-1 which includes constricted migratory habitat.

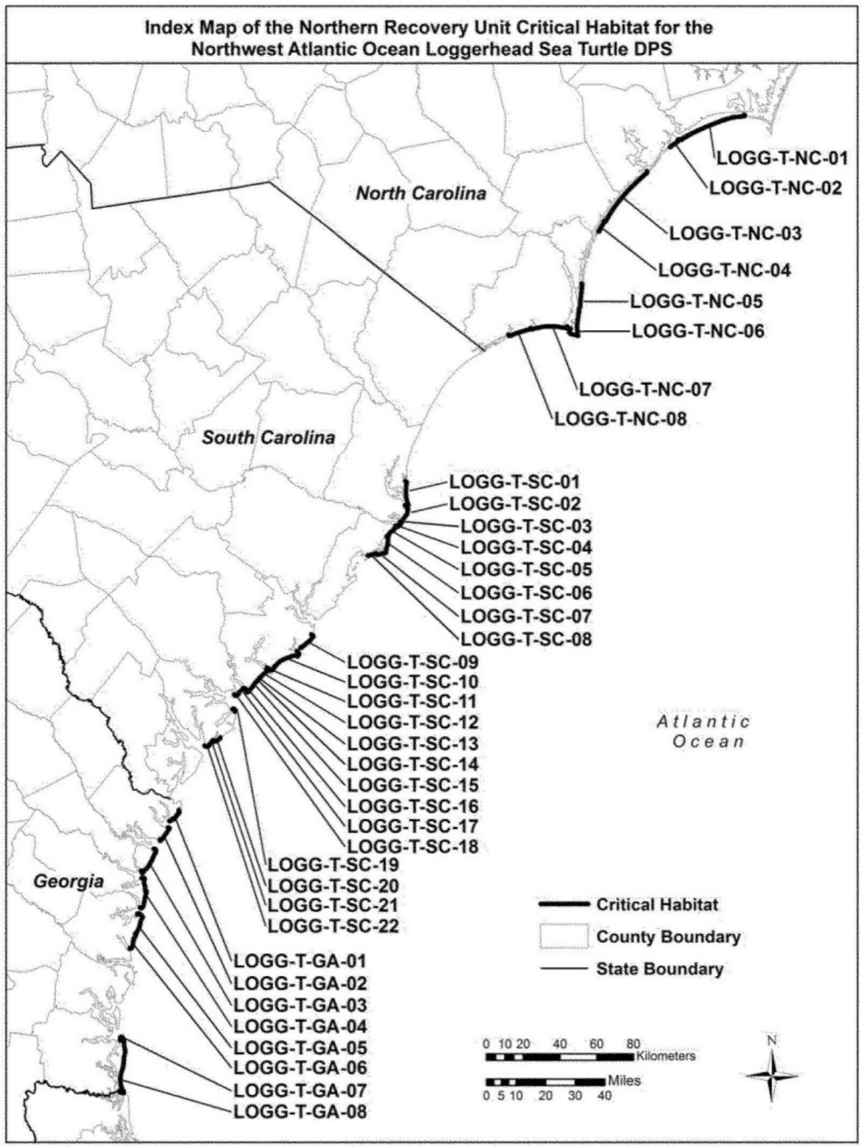

Figure 28. Terrestrial critical habitat proposed by the USFWS for the loggerhead sea turtle (Northwest Atlantic DPS). The northernmost unit is LOGG-T-NC01, located in Carteret County, NC and does not extend into the towns of Kill Devil Hills.

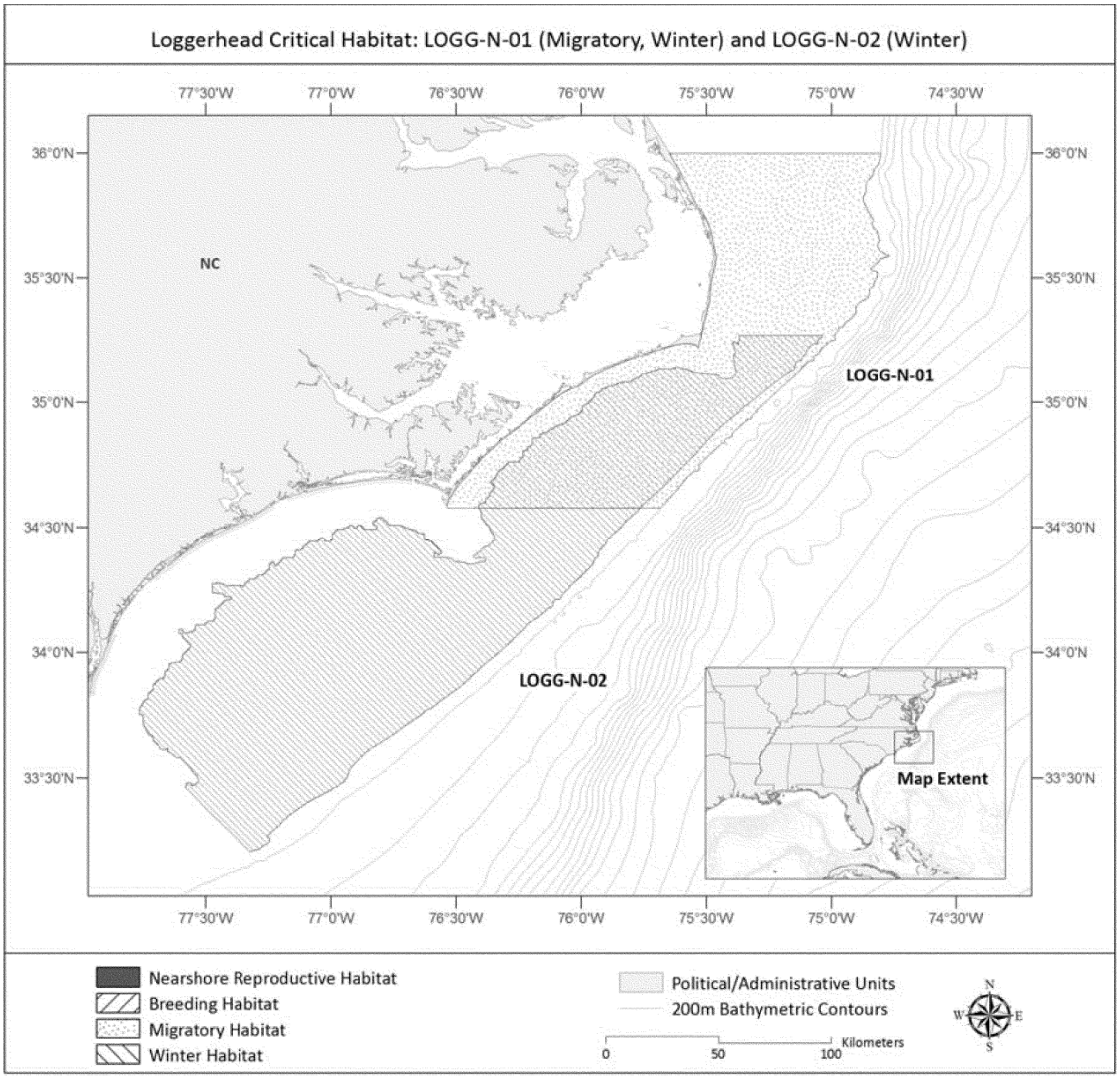

Figure 29. Location of the NMFS designated loggerhead sea turtle critical habitat in proximity to Kill Devil Hills.

4.6.1.4 Shortnose Sturgeon

The shortnose sturgeon (*Acipenser brevirostrum*) was listed as endangered on March 11, 1967 under the Endangered Species Preservation Act of 1966 (a predecessor to the Endangered Species Act of 1973). NMFS later assumed jurisdiction for shortnose sturgeon under a 1974 government reorganization plan (38 FR 41370). The shortnose sturgeon is the smallest of the three sturgeon species that are found in eastern North America, rarely exceeding a length of 1.4 meter (4.7 ft) and a weight of 23 kilograms (50.7 pounds) (NMFS, 2014d). Shortnose sturgeons are bottom feeders, typically feeding on crustaceans, insect larvae, worms, mollusks and some plants (NMFS, 1998b). They appear to feed either in freshwater riverine habitats or near the freshwater/saltwater interface. This species is anadromous, primarily utilizing riverine and estuarine habitats, migrating between freshwater and mesohaline river reaches. Spawning occurs in upper, freshwater areas, typically in January and February while feeding and overwintering activities may occur in both fresh and saline habitats. Aside from seasonal migrations to estuarine waters, this species rarely occurs in the marine environment (NMFS, 1998b; Keiffer and Kynard, 1993).

The shortnose sturgeon inhabits lower sections of rivers and coastal waters along the Atlantic coast from the Saint John River in New Brunswick, Canada to the St. Johns River, Florida (NMFS, 2014d). The NMFS federal recovery plan (1998) for the endangered shortnose sturgeon identifies 19 distinct population segments, each defined as a river/estuarine system in which these fish have been captured within the generation time of the species (30 years). This species is significantly more common in northern portions of its range than it is in the south. Shortnose sturgeons are found in rivers, estuaries, and the sea, but populations are confined mostly to natal rivers and estuaries (NMFS, 1998b). There are accounts of shortnose sturgeons occurring in the Atlantic Ocean offshore of NC (Holland and Yelverton, 1973; Dadswell *et al.*, 1984), however, these records are not well substantiated and there is speculation as to whether they were misidentified juvenile Atlantic sturgeon (Shortnose Sturgeon Status Review Team, 2010). Those shortnose sturgeon captured in the ocean are usually taken close to shore, in low salinity environments; there are no records of shortnose sturgeon in the NMFS database for the northeast offshore bottom trawl survey (NMFS, 1998b).

There are few confirmed historical reports of shortnose sturgeon captures, and because fishermen and scientists often confused shortnose sturgeon with Atlantic sturgeon, there are no reliable estimates of historical population sizes (NMFS, 1998b). There are several reports of shortnose sturgeon taken in North Carolina in the early 1800's, but the distribution and status of this species have never been well known in North Carolina. No shortnose sturgeons were reported in North Carolina waters between 1881 and 1987. Since then, several shortnose sturgeon have been caught in the Brunswick and Cape Fear rivers by commercial fishermen, a single fish was caught in the Pee Dee River. Based on anecdotal evidence from commercial fishermen, it is now believed that a shortnose sturgeon population may also exist in western Albemarle Sound (Moser *et al.*, 1998). With this discovery, the species is once again considered part of the state's fauna.

The inland waters along the sound side of Kill Devil Hills are part of a system of freshwater to brackish water creeks, rivers, estuaries and sounds that make up the Albemarle-Pamlico complex. The waters within the Albemarle Sound and the associated tributary sounds (Currituck, Roanoke and Croatan Sounds) are used by many anadromous fish and were historically an epicenter for commercial anadromous fisheries on the east coast. While most historical commercial sturgeon landings were from Albemarle Sound, the shortnose sturgeon was not differentiated from Atlantic sturgeon. Therefore, there are no historic commercial records of shortnose sturgeon landings from within the sound. Only two non-commercial records exist for shortnose sturgeon, one from 1881 and one from 1998. No records have been definitively documented in Albemarle Sound since 1998 (Shortnose Sturgeon Status Review Team, 2010).

Declines in shortnose sturgeon populations throughout the species' range can be attributed to several anthropogenic factors. During the period of industrial growth in the

1800s and early 1900s, construction of dams and pollution of many northeastern rivers may have reduced a great deal of suitable habitat for shortnose sturgeon (NMFS, 2014c). Dams have restricted and in many cases prevented sturgeon from reaching spawning grounds, fragmented populations and altered riverine flows and temperatures (The Shortnose Status Review Team, 2010). Hydropower plants also pose the threat of habitat alteration and physical injury or mortality (The Shortnose Status Review Team, 2010). In the late nineteenth and early twentieth century, shortnose sturgeons were frequently taken in the commercial fishery for the closely related, and commercially valuable, Atlantic sturgeon (*Acipenser oxyrinchus*). Shortnose sturgeons were often misidentified because, at smaller sizes, Atlantic sturgeons are easily confused with shortnose sturgeon. More than a century of extensive fishing for sturgeon contributed to the decline of both Atlantic and shortnose sturgeon populations along the east coast (NMFS, 1998b).

Habitat degradation or loss (for example, from dams, bridge construction, channel dredging, and pollutant discharges), and mortality (for example, from impingement on cooling water intake screens, dredging, and incidental taking in other fisheries) are the current primary threats to the species' survival (NMFS, 1998).

4.6.1.5 Atlantic Sturgeon

In 2009, the Natural Resources Defense Council (NRDC) petitioned NMFS to list the Atlantic sturgeon (*Acipenser oxyrinchus*) under the Endangered Species Act of 1973 (ESA). As a result of the petition, the Carolina Distinct Population Segment (DSP) for Atlantic sturgeon has been designated as endangered under the ESA. Atlantic sturgeon are similar in appearance to shortnose sturgeon (*Acipenser brevirostrum*) but can be distinguished by their larger size, smaller mouth, different snout shape and scutes (NMFS, 2014a). The Atlantic sturgeon is a long-lived, estuarine dependent, anadromous fish. They are benthic feeders and typically forage on invertebrates including crustaceans, worms and mollusks. Atlantic sturgeon can grow to approximately 14 feet long and can weigh up to 800 pounds (NMFS, 2014a). They are bluish-black or olive brown dorsally (on their back) with paler sides and a white belly.

Adults range from St. Croix, ME south to the St. Johns River in Florida (NMFS, 2014a). These fish undergo seasonal migrations to and from freshwater, but spend much of their adult life in the marine environment for growth (Stein *et al*., 2004; Atlantic Sturgeon Status Review Team, 2007). Atlantic sturgeons are found offshore primarily during the fall to spring months of approximately October to March. However, different life stages will utilize the marine environment during the summer as well. Although Atlantic sturgeons spawn repeatedly, they do not necessarily spawn every year (Smith and Clugston, 1997). During non-spawning years, adults may utilize marine waters year-round (Bain, 1997). Spawning adults migrate upriver in spring, beginning in February to March in the south, April to May in the mid-Atlantic, and May to June in Canadian waters. In some areas, a small spawning migration may also occur in the fall. Spawning occurs in flowing water between the salt front and fall line of large rivers. Atlantic sturgeon spawning intervals range from one to five years for males and two to five years for females (NMFS, 2014a). Following spawning, males may remain in the river or lower estuary until the fall while females typically exit the rivers within 4 to 6 weeks (NMFS, 2014a). Juveniles move downstream and inhabit brackish waters for a few months and when they reach a size of about 30 to 36 inches, they move into nearshore coastal waters (Smith, 1985). Tagging data indicates that these immature Atlantic sturgeons travel widely once they emigrate from their natal (birth) rivers.

Records from federal, private and state surveys also show that Atlantic sturgeon have been documented within nearshore Atlantic Ocean habitats from the North/South Carolina state line to off the mouth of Chesapeake Bay (Moser *et al*. 1998). Collins and Smith (1997) reported the occurrence of Atlantic sturgeons in the Atlantic Ocean off South Carolina in months of low water temperatures (November–April) from nearshore to well offshore in depths up to 40 meters. The rivers, estuaries and nearshore waters of coastal North Carolina serve as important habitat for Atlantic sturgeon. Coastal North Carolina is considered one of several concentration areas along the northeastern U.S. where sturgeon have been shown to aggregate, and Stein *et al*. (2004) found the fish were often associated with inlets of the Outer Banks. An acoustic array deployed offshore Cape Hatteras has collected data on acoustically-tagged Atlantic sturgeon (tagged by members of the Atlantic Cooperative Telemetry network) from February 2012 to May 2014. The array consists of 12 VR2W receivers placed 1.6 km apart, from nearshore to just shy of 20 km offshore. Data has been collected for 123 individual Atlantic sturgeon, and indicate the highest numbers of detections have occurred during the months of November and March (Charles Bangley, *pers. comm.*, September 15, 2014). In general, few acoustically tagged Atlantic sturgeon were recorded passing the array during the summer months. The array has picked up signals from sturgeon released from Connecticut through Georgia, and the data suggest the area may be a "hotbed for Atlantic sturgeon" (Rulifson, *pers. comm.*, September 11, 2014) (Figure 30).

A study conducted by Laney *et al.* (2007) provides some insight into spatial distribution of Atlantic sturgeon in the marine waters offshore Virginia and North Carolina, based on incidental captures in winter tagging cruises conducted between 1988 and 2006. The surveys included sampling in and near extensive sand shoals adjacent to Oregon Inlet and Cape Hatteras. During the months of January and February from 1998 through 2006, investigations by bottom trawling captured 146 juvenile Atlantic sturgeons in depths from 9.1 to 21.3 m. (29.9 to 69.9 ft.) (Laney *et al.*, 2007). Numbers of Atlantic sturgeon captured and tagged in a given year ranged from 0 (1993, 1995) to 29 (2006). Atlantic sturgeon were encountered in 4.2% of tows, with the percentage varying from 0 in 1993 and 1995 to 12.6% in 1988. Captures typically occurred near shore at depths less than 18 m. Capture patterns suggested that Atlantic sturgeon were likely aggregating to some degree. Many of the fish were captured over sandy substrates. Total lengths of captured Atlantic sturgeon ranged from 577 to 1,517 mm (mean of 967 mm), suggesting that most fish were juveniles. Limited tagged returns and genetic data suggest that fish wintering off North Carolina constitute a mixed stock.

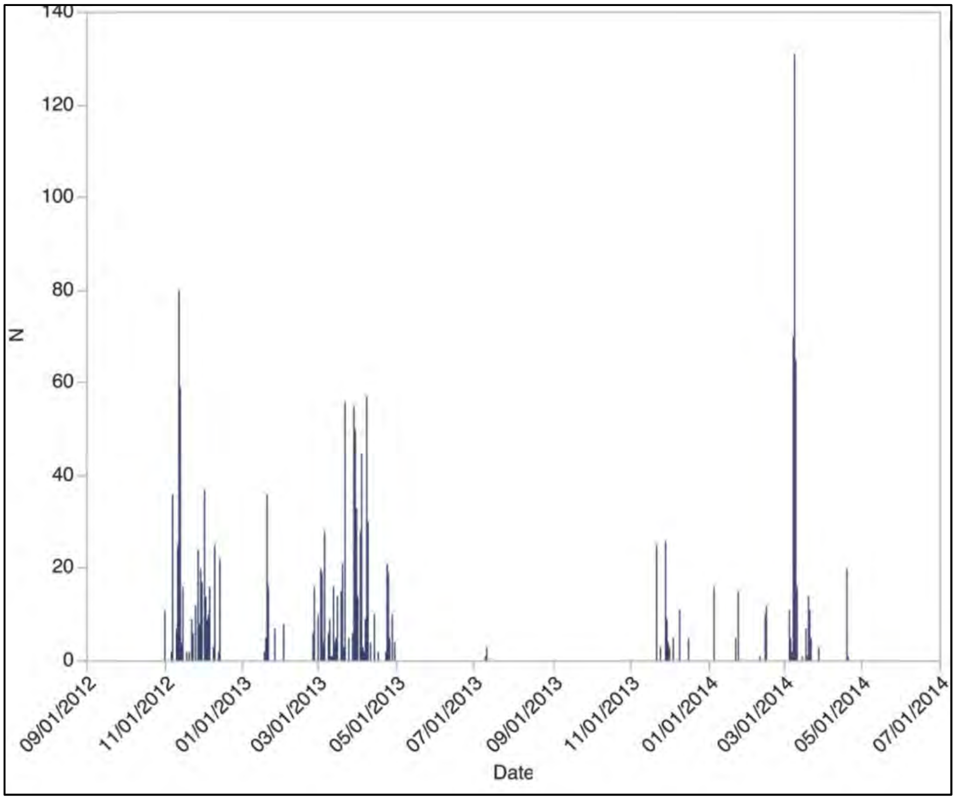

Figure 30. Atlantic sturgeon detections recorded by acoustic array located offshore Cape Hatteras, NC. Sturgeon were tagged by the Atlantic Cooperative Telemetry Network (Charles Bangley, *pers. comm.*, September 15, 2014)

Sturgeons are distributed within areas that provide foraging opportunity. The narrow depth ranges and substrate types preferred by sturgeon correspond with bottom features that likely support depth-specific concentrations of prey (Stein *et al.,* 2004; Kynard *et al*., 2000). Analysis of commercial fishery by-catch data suggests that, along the northeastern U.S., migratory sub-adults and adults show preference for shallow (10-50 m) coastal areas dominated by gravel and sand substrate (Stein *et al*., 2004). Within the mid-Atlantic Bight (including coastal North Carolina), sturgeon may prefer even shallower depths (25 m or less). Coastal features, such as inlets and mouths of bays, support high concentrations of Atlantic sturgeon presumably due to the physical and biological features produced by outflow plumes (Stein *et al.,* 2004). This species has also been shown to utilize sand shoals in the mid-Atlantic Bight. Atlantic sturgeon were collected during otter trawl surveys over the Beach Haven Ridge, a large shoal feature located about 11 km offshore New Jersey in water depths 2 - 19 m (Milstein and Thomas, 1977). CSA International *et al.* (2009) suggests pelagic and demersal species that affiliated with shoals are likely seeking food, shelter, orientation or a break from the currents.

4.6.1.6 Seabeach Amaranth

Seabeach amaranth (*Amaranthus pumilus*) is an annual plant that is native to Atlantic Ocean barrier island beaches. Historically, this species was found from Massachusetts to South Carolina, but is currently only found in New York, New Jersey, Delaware, Maryland, Virginia, North Carolina and South Carolina (USFWS, 2011b). A reduction in range, population sizes and number of seabeach amaranth populations prompted the USFWS to list the species as threatened on April 7, 1993 under the Endangered Species Act of 1973. Seabeach amaranth grows in low clumps comprised of sprawling, fleshy, reddish branches with dark leaves. The plant is profusely branched and generally grows to 1 meter (39 inches) in diameter. Flowering begins as soon as plants have reached sufficient size, sometimes as early as June, but more often beginning in July and continuing until the death of the plant in late fall. Seed production commences in July or August and peaks in September during most years, but continues until the death of the plant (USFWS, 1993; USFWS, 1996b; USFWS, 2011b).

The primary habitat of seabeach amaranth consists of overwash flats at accreting ends of islands and lower foredunes and upper strands of non-eroding beaches on barrier island beaches. It may form small temporary populations in other habitats, including sound-side beaches, blowouts in foredunes, and sand and shell material placed as beach nourishment or dredge spoil (USFWS, 1993; USFWS, 2011b). The plant is typically found at elevations from 0.2 m to 1.5 m (0.6 ft. to 4.9 ft.) above mean high tide (Weakly and Bucher 1992) and is an effective sand binder, building dunes where it grows. A single large plant may be capable of creating a dune up to 60 centimeters (23.6 inches) high, containing 2 to 3 cubic meters of sand, although most are smaller (Weakley and Bucher, 1992). Seabeach amaranth appears to function in a relatively natural and dynamic manner, allowing it to occupy suitable habitat as it becomes available (USFWS, 1993).

Annual seabeach amaranth surveys have been performed by the U.S. Army Corps of Engineers, Wilmington District (CESAW) throughout North Carolina's coastal counties. In accordance with conditions set forth in the 1993 Biological Opinion for various beach disposal projects occurring in North Carolina, these surveys are performed along beaches subject to USACE activity. Since 1991, the USACE has surveyed a number of locations within Dare, Carteret, Onslow, Pender, New Hanover and Brunswick counties, with the last survey completed in 2013. From 1992 to 2009, scattered surveys were performed at various locations throughout Dare County, including Bodie Island, Pea Island, Rodanthe, Avon, Buxton, Frisco to Hatteras, and Hatteras to the Hatteras Inlet. No seabeach amaranth has been identified in the USACE surveys. It should be noted that not all areas were surveyed every year, and no surveys were performed in 2006 (USACE, 2013a). Also, no surveys have been conducted within Dare County since 2009 as no USACE activity has occurred on the beaches (Theresa Bullard, *pers. comm.*, May 16, 2013). The National Park Service (NPS) has conducted annual surveys within the Cape Hatteras National Seashore (CHNS), but as of 1995, no plants had been found (USACE, 2000). The USFWS has no records of the species on the Pea Island National Wildlife Refuge (PINWR) but suitable habitat for this species does exist near Bonner Bridge. The nearest known population is at Cape Point, approximately 40 miles south of the inlet (USACE, 2000).

Among those threats presently affecting the range and habitat for seabeach amaranth, the USFWS listed shoreline stabilization as one of the primary threats (USFWS, 2007). In many ways, hard (groins, seawalls and jetties) and soft (sand placement) beach stabilization efforts are considered a leading contributor to the decrease in the population (USFWS, 1996b; 2002). By stabilizing beaches and overwash areas, these practices reduce or remove the dynamic coastal areas that serve as primary habitat for seabeach amaranth, and are considered a major cause of loss of suitable habitat for the species. However, hard and soft shoreline protection measures may also result in beneficial effects. For example, beach erosion is considered one of the primary causes of population decline for seabeach amaranth due to loss of suitable habitat. The plant is not found on beaches where the foredune is scarped by undermining water at high or storm tides; therefore, it is dependent on an upper beach habitat that is not flooded during the growing season from May into the fall (USFWS, 1996b). This type of habitat is rare on severely eroded barrier islands. Under natural conditions, storm-related beach erosion and dune movement disturb, alter or remove seabeach amaranth habitat, but do not pose a threat to the continued existence of the species (USFWS, 1993; USFWS, 2011b). However, coastal development and beach armoring (i.e. seawalls) has curtailed the ability of barrier beaches to respond naturally to these pressures, ultimately resulting in destruction of habitat for seabeach amaranth (USFWS, 1993; 2002). Estimates of sea level rise also threaten to undermine existing habitat further.

Accretion that occurs upstream of a groin may create or maintain a shoreline that would otherwise be completely lost to erosion. In this way, stabilization of beaches through successful implementation of nourishment or hard structures (such as groyns) can create or maintain habitat for seabeach amaranth (USFWS, 2002). However, it is important to note that this species depends on dynamic coastal processes to create primary habitat, such as overwash areas; therefore, any shoreline stabilization will likely make the habitat marginal and ultimately be detrimental to the range-wide persistence of the species (USFWS, 2002).

Previous beach nourishment projects have rebuilt habitat for seabeach amaranth and encouraged growth of some populations, as seen in Bogue Inlet (Dale Suiter, *pers.comm.,* 2007) and Wrightsville Beach (USFWS, 1996b). For example, historically, seabeach amaranth had been recorded on Wrightsville Beach, but after severe erosion and lack of nourishment during the 1970's no plants were recorded in surveys from 1987 – 1980. After two nourishment projects in 1980-81 and 1986, surveys in 1988 recorded nearly 3,000 plants. According to the USFWS (1996b), Wrightsville Beach had become one of the largest and least variable populations of seabeach amaranth known and had apparently reestablished itself (whether from a seedbank or from colonization is not known) on this renourished beach. However, surveys performed by the USACE have not recorded the species on Wrightsville Beach since 2011, when only two plants were observed. Prior to 2011, no plants had been recorded since 2008 (USACE, 2013a). This suggests the ephemeral nature of even well-established populations of seabeach amaranth. Another population displaying this ephemeral behavior is located in Bogue Banks, Carteret County, NC. Prior to 2001, the area surveyed between Fort Macon and Atlantic Beach supported substantial populations of seabeach amaranth, with plant counts numbering in the thousands some years. In 2001, the number of plants had fallen to 20. After nourishment, seabeach amaranth increased to over 5,000 plants in 2002, 2003 and 2004. In 2010, plant counts fell below 100 and by 2013, only one plant was found in the entire area surveyed within Carteret County (USACE, 2013a).

4.6.1.7 Piping Plover

The piping plover (*Charadrius melodus*) was federally listed in 1986 under the Endangered Species Act of 1973, as amended with three separate breeding populations in North America: 1) the Atlantic Coast population (threatened), 2) the Northern Great Plains population (threatened) and 3) the Great Lakes population (endangered). Piping plovers are also listed as threatened throughout their wintering range (USFWS, 1996a). The Atlantic Coast population breeds along the east coast of North America from the Canadian Maritime Provinces to North Carolina. The Northern Great Plains population can be found breeding from southern Alberta to Manitoba and south to Nebraska. The Great Lakes population breeds along the shorelines of the Great Lakes. All three populations migrate to the coastal shorelines of the South Atlantic, Gulf of Mexico and the beaches of the Caribbean Islands to winter (USFWS, 2012c).

Piping plover are small shorebirds weighing approximately 42.5 to 56.7 gm (1.5 to 2 oz), measuring 17.8 cm (7 in) in length, with an average wingspan of 38.1 cm (15 in). Piping plovers resemble a sandpiper with the upper body parts a pale brownish or grayish color and the underbody white (S. Everhart, *pers. comm.*, 2007). Distinguishing features are noticeable during the summer months, including a black band across the forehead, a second black band forming a ring around the neck and orange legs. During the winter months, the black bands fade and are not visible, and the legs fade to a pale yellow. Coloration and size of both the male and female adults are similar. Plovers primarily feed on invertebrates endemic to the wet sand environment between mean low and mean high water (USFWS, 1996a).

As of the 1986 listing, the USFWS (2011a) estimated that 790 piping plover breeding pairs existed in the Atlantic Coast population (including Canada). By 1996, 1,348 breeding pairs were documented. The number of breeding pairs has continued to steadily increase, reaching 1,438 pairs in 2000, 1,690 pairs in 2002 (USFWS, 2011a) and 1,782 pairs in 2010 (USFWS, 2011a). However, overall population growth has been tempered by abrupt declines within recovery units. For example, the number of piping plover breeding pairs in North Carolina decreased from 55 pairs in 1989 to 24 pairs in 2003. Nevertheless, estimates indicate a slight increase occurred in breeding pairs to 37 in 2005 and 46 in 2006 (USFWS, 2011a). Overall, the southern recovery unit of the Atlantic Coast population increased by 66% between 1989 and 2008 with the majority of this increase occurring between 2003 and 2005 (USFWS, 2009).

Coastal habitats along the U.S. Atlantic coast serve a variety of ecological functions for piping plovers. For nesting, piping plovers utilize dry sand habitats above the high tide line along coastal beaches, spits and flats at the ends of barrier islands, gently sloping foredunes, blowout areas within primary dunes and washover areas (USFWS, 2010a). Nests are usually found in sparsely vegetated dune and beach environments (USFWS, 2003b; Cohen *et al.*, 2008a), although they may nest under patches of beach vegetation

(USFWS, 1996a). Nests are shallow, scraped depressions made of fine sand, pebbles, shells or cobble (Patterson, 1991). In North Carolina, non-breeding piping plovers primarily use bayshore beaches and sound islands for foraging and ocean beaches for roosting and preening (Cohen *et al.*, 2008).

According to the USFWS, the piping plover may be found within all eight coastal counties of North Carolina (USFWS, 2014a). The spring migration of piping plovers occurs from March 1 through April 30 and piping plovers have been documented arriving on their breeding grounds in North Carolina beginning as early as mid-March. Eggs can be found along the nesting habitat from mid-April through late July (Sue Cameron, *pers. comm.*, 2007). At the age of 25 to 35 days, chicks are able to fly and leave the nest (USFWS, 1996). By mid-July, adults and young may begin to depart for their wintering areas. In North Carolina, fall migration for the new chicks and adult parents begins in mid-July and can extend through the end of November (S. Cameron, *pers. comm.*, 2007). Aside from breeding activities, the North Carolina coastline serves as habitat for migration activities of the Atlantic Coast population, as well as wintering grounds for all three breeding populations. Piping plovers are therefore present year-round in North Carolina and utilize the coastal habitats for foraging, roosting, nesting, wintering and migrating (Sarah Schweitzer, *pers. comm.*, April 18, 2014).

Since the 1980's, breeding pairs of piping plovers in North Carolina have been surveyed annually; the state also participates in a winter survey held every five years, the last of which was performed in 2011. Data on piping plovers during their migration are more scant because they are not part of a formal survey but are recorded opportunistically in a variety of surveys including the International Shorebird Surveys, which determine fall and spring migration counts. Other opportunistic piping plover data are gathered during monitoring performed by consultants as part of permit requirements, NGO and agency surveys for other purposes including research and by the public (Sarah Schweitzer, *pers. comm*., March 26, 2014). Additional data from winter surveys, or un-specified surveys, dating back to 1965 are also included in the database. It should be noted that it is likely that piping plovers are present outside these survey efforts but are not recorded in a systematic manner. Thus, lack of data at a location or during a period does not imply piping plover absence, it only implies no surveys were conducted (Sara Schweitzer, *pers. comm.,* April 18, 2014).

The data from the aforementioned surveys are maintained by the North Carolina Wildlife Resources Commission (NCWRC) and are summarized in Table 20. Statewide data were broken down into the following regions: southern (all sampling locations from Bird Island to Bald Head Island), central (all sampling locations from Fort Fisher to Fort Macon State Park) and northern (all sampling locations from Beaufort Inlet to Currituck). Habitats surveyed included oceanfront beaches of barrier islands, sand shoals, dredge spoil islands, natural marsh islands and mainland bayshores. Because the various surveys were not performed systematically or using the same methodology, data are not standardized across all surveys. Table 20 shows piping plovers have been observed within all three regions during all months of the year. The total number of piping plovers observed was highest in the summer months (July through September) for the Central and Northern regions, and in the spring for the southern beaches. The lowest number of observations was recorded from December to February for all three regions. Overall, total piping plover observations were highest in July and August and lowest during the winter months throughout the state (Table 20). These two months also correspond with the highest number of surveys performed; therefore, it is not clear whether the trends are seasonally driven or the result of survey effort. The northern region supported the greatest number of piping plover observations (n = 21,029) and also the greatest number of surveys performed; therefore, it cannot be determined if the results are driven by regional differences in piping plover occurrence or survey effort. Breeding pairs were observed in all three regions but only during the months of May, June and July (Table 21). The highest number of breeding pairs was observed during July in all three regions, as well as overall. The northern region supported the greatest number of breeding pairs.

Data were also summarized for Bodie Island, which is in the northern region and is the closest area surveyed to the Kill Devil Hills. The last piping plover surveys along Bodie Island occurred in 2008, during which 62 piping plovers were recorded: 29 in March, 2 in July and 31 in August. Surveys were not performed in any other months during 2008. Sightings data for individuals and breeding pairs are available from 1965 to 2008 and are summarized by month in Table 20. During this time, 2,247 piping plover individuals were observed along Bodie Island, which represents 11% of observations within the northern region and 8% of statewide observations. The total number observed was highest in August (508), followed closely by December (406). Breeding pairs were observed only in June and July, which makes up less than 1% of statewide observations.

Piping plovers have been found year-round during surveys on Bodie Island, (including the area from Oregon Inlet to approximately the northern town limit of Nags Head), and total counts for the area comprise a substantial portion of total statewide counts. When totaled from 1965 to 2013, counts on Bodie Island represent 8% and 12% of statewide counts during the months of July and August, respectively, and 29% of statewide counts during both April and May.

Table 20. Total number of individual piping plovers observed per month within the northern, central and southern regions of North Carolina as compared to the total number of individuals observed within Bodie Island, North Carolina from 1965 to 2013. The last two rows in the table display the Bodie Island observations as a percentage of both statewide and northern region observations. To display monthly trends, rows are color-coded such that the lowest values are shaded green and the highest values are shaded red.

Region	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	*Winter	Total
Statewide														
Northern Region	720	789	1311	1064	328	887	3883	4979	2618	1823	1000	1551	76	21029
Central Region	303	305	653	510	243	163	482	788	666	474	299	223	54	5163
Southern Region	16	5	77	30	23	16	53	17	19	34	7	5	32	334
Statewide Monthly Totals	1039	1099	2041	1604	594	1066	4418	5784	3303	2331	1306	1779	162	26526
Bodie Island														
Bodie Island Beaches	31	25	129	312	95	12	310	580	183	87	73	406	4	2247
% of North Region	***4%***	***3%***	***10%***	***29%***	***29%***	***1%***	***8%***	***12%***	***7%***	***5%***	***7%***	***26%***	***5%***	***11%***
% of Statewide	***3%***	***2%***	***6%***	***19%***	***16%***	***1%***	***7%***	***10%***	***6%***	***4%***	***6%***	***23%***	***2%***	***8%***

Table 21. Total number of piping plovers nesting pairs observed per month within the northern, central and southern regions of North Carolina as compared to the total number of nesting pairs observed within Bodie Island, North Carolina from 1965 – 2008. The last two rows in the table display the Bodie Island observations as a percentage of both statewide and northern region observations. To display monthly trends, rows are color-coded such that the lowest values are shaded green and the highest values are shaded red.

Location	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	*Winter	Total
Statewide														
Northern Region	0	0	0	0	4	448	797	0	0	0	0	0	0	1249
Central Region	0	0	0	0	11	50	70	0	0	0	0	0	0	131
Southern Region	0	0	0	0	4	6	19	0	0	0	0	0	0	29
Statewide Monthly Totals	0	0	0	0	19	504	886	0	0	0	0	0	0	1409
Bodie Island														
Bodie Island Beaches	0	0	0	0	0	3	8	0	0	0	0	0	0	11
% of North Region	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***
% of Statewide	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***

Critical Habitat

On July 10, 2002, the USFWS published a final rule to list 137 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana and Texas as Critical Habitat for wintering populations (66 FR 36038). A Critical Habitat designation recognizes specific areas "that are essential to the conservation of a listed species, and that may require species management considerations or protection." Eighteen critical habitat units for the wintering piping plover have been designated within seven of the eight coastal counties in North Carolina, with the exception of Currituck County (66 FR 36038; 73 FR 62816). The Critical Habitat closest to the Town is Unit NC-1, which the USFWS delineates to be the following (Figure 32).

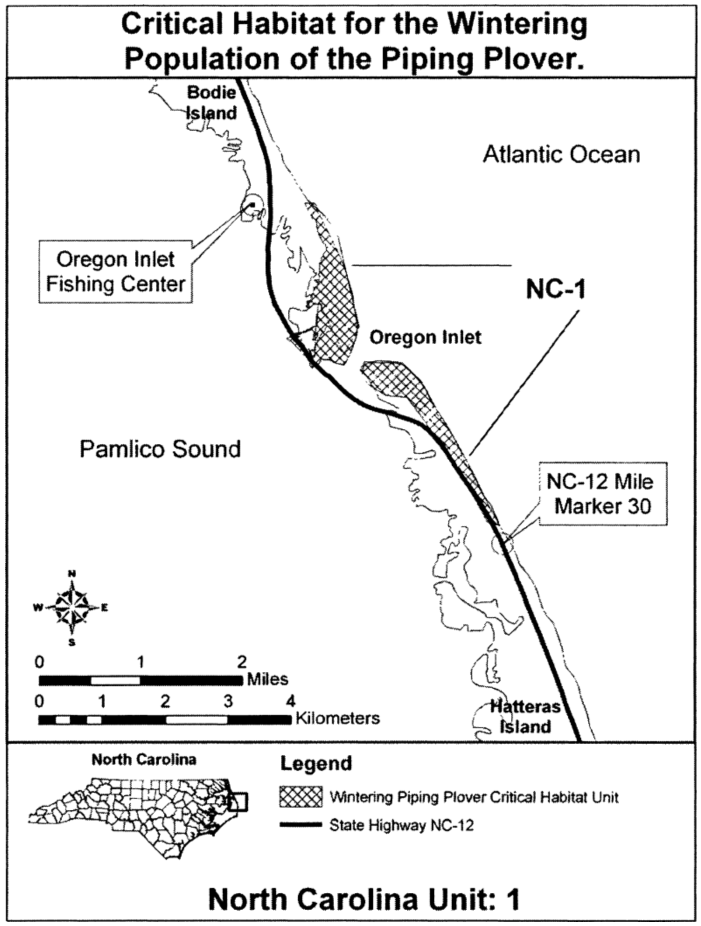

Figure 31. Wintering piping plover critical habitat unit NC-1. Image from 73 FR 62840.

"Unit NC-1 is approximately 8.0 km (5.0 mi) long, and consists of about 196 ha (485 ac) of sandy beach and inlet spit habitat on Bodie Island and Pea Island in Dare County, North Carolina. This is the northernmost critical habitat unit within the wintering range of the piping plover. Oregon Inlet is the northernmost inlet in North Carolina, approximately 19.0 km (12.0 mi) southeast of the Town of Manteo, the county seat of Dare County…The unit begins at Ramp 4 near the Oregon Inlet Fishing Center on Bodie Island and extends approximately 8.0 km (5.0 mi) south to the intersection of NC Highway 12 and Salt Flats Wildlife Trail…" (73 FR 62816).

The northern boundary of NC-1 is approximately 24 km (15 mi) south of Kill Devil Hills, the southernmost of the three towns considered in this assessment. There is no critical habitat unit within Kill Devil Hills.

4.6.1.8 Rufa Red Knot

The *rufa* red knot (*Calidris canutus rufa*) is one of the six subspecies red knots and one of the three that resides in the Western Hemisphere. Subspecies *rufa* winters in northern Brazil, the greater Caribbean and along the U.S. coast from Texas to North Carolina. Due in part to substantial population declines in the 1990's and 2000's, the USFWS released a proposed rule to list the rufa red knot as threatened on September 30, 2013 (78 FR 60023). Population estimates for subspecies rufa up to the early 1990s were 100,000-150,000, one of the smallest red knot populations worldwide. During the 1990s, this fell to around 80,000. By the early 2000s, the population may have dropped to 35,000-40,000. The population now numbers 18,000-33,000 (NatureServe, 2013). The rufa red knot population decline that occurred in the 2000s was caused primarily by reduced food availability from increased harvests of their key prey species, the horseshoe crab, and was exacerbated by small changes in the timing that knots arrived at the Delaware Bay. Decreased foraging success during migration has been linked to decreased breeding success and the probable increased mortality of adults. Wintering rufa red knots tend to concentrate at a few localities where habitat loss or reduced food availability can influence a sizable proportion of entire populations. Additionally, climate change may have long-term effects on coastal foraging areas, due to sea level rise, and its Arctic breeding grounds due to habitat change (USFWS, 2014d). The 2010 Spotlight Species Action Plan prepared by the USFWS attributes the destruction and modification of the rufa red knot's habitat, and particularly the decline of key food resources resulting from reductions in horseshoe crabs, as a significant threat. The shore of the Delaware Bay is the only significant breeding area for horseshoe crabs on the Atlantic coast of North America. The rufa red knots rely on the eggs of horseshoe crabs as a food source to fuel the migratory flight from the wintering grounds of Chile and Argentina, to the breeding grounds of the Arctic. Along the North Carolina coast, threats to migration stopover habitat include beach erosion, human disturbance and competition with other species for limited food sources.

Rufa red knots winter at the southern tip of South America and breed above the Arctic Circle, requiring the birds to fly over 9,300 miles from south to north every spring and reverse the trip every autumn (USFWS, 2014d). The spring migration is broken into non-stop segments of 1,500 miles or more with the birds converging at critical stopover areas along the entire Atlantic coast. Red knots are faithful to these specific sites, and will stop at the same locations year after year (USFWS, 2010b). Mole crabs (*Emerita talpoida*) and coquina clams (*Donax sp.*) are reportedly an important food source for migrating knots in North Carolina (Gilbert Grant, *pers. comm.*, March 20, 2014). Birds arrive at stopover areas with depleted energy reserves and must quickly rebuild their body fat to complete their migration to Arctic breeding areas. During their brief 10 to 14-day stay in the mid-Atlantic, rufa red knots typically double their body weight (USFWS, 2010b).

Although the Delaware Bay and coastal Virginia represent the largest stopover concentration of rufa red knots, coastal North Carolina does support the birds during their spring and fall migrations. Various surveys for rufa red knots have been performed throughout the state and data from these surveys is maintained by the North Carolina Wildlife Resources Commission (NCWRC). These surveys are performed at discrete times of year, as well as opportunistically to fulfill various permit requirements or research interests. Surveys are not performed systematically or monthly, therefore, it should be emphasized that lack of data in the NCWRC database does not imply absence of the species; rather, it implies only that no surveys were performed at that time (Sara Schweitzer, *pers. comm.*, March 26, 2014). Data from the various surveys within the NCWRC database were summarized to determine total counts per month of rufa red knots observed throughout the state from 1985 to 2013. Habitats surveyed include oceanfront beaches along barrier islands, dredge material islands and sand and inlet shoals. It should be noted that surveys for the rufa red knot in North Carolina are quite varied, inconsistent and were not conducted every month or in all years. Therefore, it cannot be determined if red knots were present at un-surveyed times or locations.

The data from the aforementioned surveys are summarized in Table 22. Statewide data were broken down into the following regions: southern (all sampling locations from the North Carolina-South Carolina state line to Bald Head Island), central (all sampling locations from Fort Fisher to Fort Macon State Park) and northern (all sampling locations from Beaufort Inlet to Currituck). Habitats surveyed included oceanfront beaches of barrier islands, sand shoals, dredge spoil islands, natural marsh islands and mainland bay shores. Table 22 shows rufa red knots have been observed throughout the state during all months of the year. The greatest number of observations occurred during May, followed by April. The northern region has supported a substantial number of red knot observations with 31,218 rufa red knots recorded from 1986 to 2013. Surveys occurred all months except November and birds have been observed during each month. The majority of surveys have been performed in May, which corresponds with the highest number of observations. May also corresponds with the greatest number of surveys.

Data were summarized for Dare County, including all barrier islands and inlet shoals extending from the Hatteras Inlet to the northern limit of Southern Shores. Table 22 shows that red knots have been observed during the months of January, April, May and June, with the greatest number of observations occurring in May. These were also the only months surveyed; therefore, it is not known if the birds occur in the area during other months. The greatest number of surveys also occurred in May; therefore, it may be the larger counts are driven by survey effort. Nevertheless, the data indicate red knots do occur within Dare County during the surveyed months.

Based on available data, it can be concluded that red knots have historically utilized numerous locations in the northern region of coastal North Carolina, including Dare County, and may occur outside the environmental dredge windows in substantial numbers. The birds also appear to occur in highest numbers from April to June; however, it is unclear whether these large numbers are true seasonal differences or the result of a larger survey effort.

Table 22. Total number of red knots observed per month within the northern, central and southern regions of North Carolina as compared to the total number observed within Dare County, North Carolina from 1986 to 2013. The last two rows in the table display the Dare County observations as a percentage of both statewide and northern region observations. To display monthly trends, rows are color-coded such that the lowest values are shaded green and the highest values are shaded red.

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Tot
Statewide													
North	868	168	52	2991	20163	1949	886	1793	923	889		536	**31218**
Central	135	135	14	64	2386	30	0	0	0	0	109	49	**2922**
South	50	18		1990	742	81							**2881**
Statewide Monthly Totals	1053	321	66	5045	23291	2060	886	1793	923	889	109	585	**37021**
Dare County													
Dare County Monthly Totals	35				1950								**1985**
% of Northern Region	***4%***												***8%***
% of Statewide	***3%***												***7%***

4.6.1.9 Roseate Tern

On November 2, 1987, the USFWS listed two populations of the Roseate tern (*Sterna dougallii dougallii*) as endangered and threatened. The population that nests in northeastern North America was determined to be endangered, while the Caribbean population (including nesting birds in the U.S. Virgin Islands, Puerto Rico and Florida) were listed as threatened. Roseate terns measure approximately 15 inches long with a wingspan about twice the length. They are distinguished by a black bill, pale coloration and rosy chests during summertime. In the winter, the black cap is replaced with a white forehead. Roseate terns breed primarily on small offshore islands, rocks, cays and islets. Rarely do they breed on large islands. They have been reported nesting near vegetation or jagged rock, on open sandy beaches, close to the waterline on narrow ledges of emerging rocks or among coral rubble (USFWS, 1998). The roseate tern is a rare occurrence in North Carolina and is not listed as one of the bird species prioritized for conservation in the North Carolina Wildlife Resources Commission's Wildlife Action Plan (Sara Schweitzer, *pers. comm.*, July 9, 2014). This species is primarily observed south of Cape Hatteras, particularly at Cape Point within Cape Hatteras National Seashore during the months of June through August. According to eBird, there have been opportunistic sightings of the roseate tern in Dare County; however, these occurrences have been rare. Sightings have occurred during the months of June, July and August (eBird, 2014). There are no records of the species nesting in the proposed Project Area (USFWS, 1999; eBird, 2014).

4.7 Cultural Resources

Cultural resources, such as archaeological or historic artifacts and structures, may exist in or near the project area. It is necessary to determine if any cultural resources exist within the Project Area and if they are eligible for listing on the National Register of Historic Places. The federal statutes associated with these actions include Section 106 of the National Historic Preservation Act of 1966, as amended (PL 89-665); the National Environmental Policy Act of 1969; the Archaeological

Resources Protection Act of 1987; the Advisory Council on Historic Preservation Procedures for the Protection of Historic and Cultural Properties (36 CFR Part 800); and the Abandoned Shipwreck Act of 1987.

Of the twenty-seven sites in Dare County that are listed in the National Register of Historic Places, only two are located in Kill Devil Hills: the Wright Brothers National Memorial and Sam's Diner. The site on which the Wright Brothers National Memorial is located is less than one mile south and approximately 0.6 miles west of the stretch of shoreline proposed for nourishment, and will not be influenced by project activities. Underwater sites include the shipwrecks *USS Monitor* and *USS Huron*. The *USS Monitor* is a 179 ft. iron-hulled steamship wreck located about 26 miles southeast of Cape Hatteras. In 1973, the wreck site was designated as the United States' first marine sanctuary, and remains one of only thirteen marine sanctuaries created to protect a cultural resource. The *USS Huron* is an iron sloop-rigged steam gunboat shipwreck located approximately 250 yards off of Nags Head beach. The *USS Huron* was designated as North Carolina's first "Historic Shipwreck Preserve" in 1991.

In 2009, offshore underwater archaeological surveys were performed in association with the Dare County federal project. The surveys targeted three offshore borrow areas located approximately 1.75 miles east of Nags Head. However, the Kill Devil Hills project does not propose to use the borrow areas previously surveyed for the federal project. Accordingly, additional surveys will be performed to identify whether any cultural resources exist in the vicinity of the newly proposed borrow areas, and clearance from the State Historic Preservation Office will be obtained prior to project commencement. Should the surveys identify potentially culturally sensitive material the appropriate avoidance measures, such as buffer zones, will be recommended and implemented.

4.8 Socioeconomic Resources

Kill Devil Hills is situated in the geographic middle of the northern Outer Banks, and is the largest municipality in Dare County. The town's year-round population was estimated to be 6,920 in 2013, which represents a 3.5% increase since April 2010. During the summer months, the population swells to nearly 40,000 (City of Kill Devil Hills, 2014). Tourism is the main economic driver in Kill Devil Hills, and in fact Dare County as a whole, as the area provides many recreational and scenic resources. In 2011, tourism alone brought $877 million into the local economies within Dare County (Outer Banks Visitors Bureau, 2012). For Kill Devil Hills, the most common three industries include accommodation and food services, finance/insurance and real estate, and construction. The commercial and residential construction industry in Kill Devil Hills provides new homes, commerce and increased revenue each year to the town. In 2012, Kill Devil Hills issued 40 Single-family new house construction building permits with the average cost being $273,900. Since 2008, Kill Devil Hills has seen a steady increase with this resource. According to the United States Census Bureau (USCB) the town contained 6,617 homes, 3,486 of which are for seasonal and recreational use and income. The average value of a home in this area is $269,300 (± $17,435) (USCB, 2008-2012 American Community Survey). The median sales price for homes from April 14 to July 14, 2014 was $236,000, which was an increase of 2.6% compared to the prior quarter, and an increase of 6.9% compared to the prior year. Although the housing market has fluctuated within the area over the past five years, the average selling price of homes within Kill Devil Hills has steadily increased in that time (www.trulia.com). Of the 6,617 housing units, 35 are within the Project Area.

4.9 Recreational and Scenic Resources

Dare County spans 110 miles of oceanfront shoreline that supports millions of residents and visitors each year. As a tourist destination, Kill Devil Hills has numerous recreational venues that include Aviation Park, Fresh Pond Park, Hayman Park, Meekins Field, the Centennial Pathways, NC 12 Bike Path, Ocean Bay Multi-Use Trail, Veteran's Drive Multi-Use Trail, Wright Brothers Multi-Use Trail, Dare County Family Recreation Park, Wright Brothers National Memorial and Avalon Fishing Pier. Kill Devil Hills also offers surf shops, kayak rental shops, bicycle rental shops, fishing rental shops, charter boat fishing, beach tours and bird watching. Other water related recreational services provided are kite surfing, jet ski rentals and dive charters in the area.. The Outer Banks are also known as a surfer's destination. Surfer enthusiasts visit from all over to surf the waves provided by expansive shoreline and there are six surf shops located within Kill Devil Hills. Recreational fishing is also a major draw for tourists and locals alike. In-shore anglers, pier fishing, surf fishing and boat fishing collectively draw in revenue through fishing enthusiasts' hotel accommodations, rentals, dining and permits. Avalon Fishing Pier is centrally located in Kill Devil Hills and is open 24 hours a day during the peak season. This recreational fishing brings in revenue year round. According to the Department of Marine Fisheries, 2010 figures show there were 975,831 recreational fishing trips, which include outings on a charter, private boats along with bank and pier fishing. These trips generated $30,477,340 in direct income for captains and guides but the economic impact of these trips was $77.64 million.

Kill Devil Hills includes many natural environments that contribute to the area's scenic draw. The town is surrounded by the Atlantic Ocean, the Albermarle Sound, various creeks and bays. An array of salt marshes, wetlands, sandy beaches, maritime forests and estuarine habitats can also be found in the area. The Project Area includes nearshore habitat types that support ecosystems typically associated with a developed barrier island system in southeastern North Carolina, including dunes, sandy beaches, surf zones and nearshore submarine softbottom ecosystems.

5 IMPACTS ASSOCIATED WITH EACH ALTERNATIVE

Beach nourishment affects the infrastructural and economic aspects of the human environment. Beach nourishment can have considerable positive and negative biological impacts to the several components of the beach ecosystem including terrestrial arthropods, marine zoobenthos, microphytobentos, shorebirds, vascular plants, nesting sea turtles and swimming marine fauna. Negative impacts dominate in short term, while long term impacts depend on the ecological recovery of the system, which is influenced by the project timing, project size and location, techniques employed, sand quality and quantity and conditions prior to nourishment (Speybroeck *et al.*., 2006). In general, positive impacts include protection of upland structures and infrastructure, restoration of eroded beach and dune habitat for wildlife nesting and roosting, as well as potential benefits to local economies due to increased use for recreation.

The Council on Environmental Quality (CEQ) regulations (40 CFR §§ 1508.7 and 1508.8) defines direct effects as those caused by the action and occur at the same time and place. Indirect effects are defined as those caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. A Cumulative impact is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time. The following sections describe the negative and positive impacts anticipated for the human environment as well as the abiotic and biotic components of the coastal system for each of the alternatives.

5.1 Water Quality

5.1.1 Associated Impact with Abandon and Retreat Alternative

Turbidity along the Outer Banks is generally lowest in the summer months and highest in the winter months, corresponding with winter storm events. The abandon and retreat alternative does not involve any activities affecting the marine environment, therefore turbidity events will continue to fluctuate naturally. The intertidal areas are subject to periodic increases in turbidity resulting from storms and wave activity. As a result, the biological communities found in the intertidal and nearshore zone are comprised of stress tolerant species. Turbidity levels near the beach fill sites will not be affected if the abandon and retreat alternative is taken.

5.1.2 Associated Impact with Preferred Action Alternative

One concern associated with nourishment projects is the effect to water quality, particularly concerning turbidity and sedimentation at the borrow site and in the surf zone adjacent to the nourished beach. When sediment re-suspension occurs, larger particles will likely settle out; however, the finer sediments will remain suspended for longer periods, or even indefinitely in turbulent water (Adriaanse and Coosen, 1991). Suspended particles may interfere with the biological functions of some organisms such as feeding, respiration, reproduction and potentially cause predator avoidance. High turbidity and silt loads can have detrimental impacts to filter feeding organisms associated with nearshore benthic communities including amphipods, isopods, decapods, polychaetes, mollusks and others. The conditions of diminished light penetration can detrimentally affect the photosynthetic activity of phytoplankton, the primary producers of energy production.

Depending on the type of dredge being used, temporary sediment plumes will arise from various sources during borrow area dredging. In the case of a hopper dredge, sediment re-suspension will result as the draghead moves over the seafloor, as well as during the discharge of overflow while filling the hopper. Sediment re-suspension that results from overflow as the hopper is being filled generally only occurs during a portion of the filling time. The time required to fill a hopper (fill cycle) can vary, but on average may take 45 minutes to one hour when dredging sandy substrates. The first 1/3 of the cycle involves filling the hopper with sand and water. For the remaining 2/3 of the fill cycle, sand replaces the water in the hopper, and the water sporadically overflows back into the ocean. Turbidity plumes can also be created sub-surface at the drag head site. These plumes are localized to the immediate vicinity of the drag head and do not reach the surface (LaSalle *et al.*, 1991). The sediment plume generated by hopper dredging has been shown to extend 1,640 to 4,000 feet from the dredge, and is generally reported to be short-term (Hitchcock *et al.*, 1999; Anchor Environmental 2003; Roman-Sierra *et al.*, 2011). The length and shape of the plume depends, in part, on the hydrodynamics within the water column as well as the sediment grain size. In sandy substrates typical of borrow sites, the grain size is larger and the extent of sediment suspension is therefore more restricted. However, in cases where there is a fine-grained sediment overburden that must be stripped to access the borrow sand, sediment suspension would be more extensive. The borrow areas presently proposed for the Duck project will be composed of high-quality sand, with low organics and biological oxygen demand. Therefore, re-suspended material is expected to have a quicker settling time, and have no appreciable effects on the dissolved oxygen, pH or temperature. Additionally, the hydrodynamics of the open-ocean environment at the borrow sites allows adequate mixing with oxygen rich surface waters. Accordingly, it is anticipated the proposed project would have only minor impacts to the marine water column at the borrow areas.

Cutter suction dredges generate comparatively lower amounts of suspended sediment and plumes are confined to within a few meters of the drilling cutterhead at the seafloor. A cutter suction dredge functions by drilling below the surface of the substrate; therefore, the sediment plumes created from the drilling cutterhead are generally highly localized (CSA *et al.*, 2009). Additionally, the material is hydraulically moved from the cutterhead /sediment interface directly into a pipeline, eliminating the hopper-filling stage and associated overflow. Although unlikely, a leaking submerged pipeline can also be a source of elevated turbidity (Michel *et al.* 2013). At the placement site, turbidity will increase within the surf zone due to pipeline discharge and can affect hundreds of meters of shoreline. Several studies of similar projects involving sand placement activities have shown elevated concentrations within the nearshore extend an alongshore distance of 1,310 to 1,640 feet from the discharge pipe in the swash zone, and dissipate on the order of hours (Shubel *et al.*, 1978; Burlas *et al.*, 2001; Wilber *et al.*, 2006). The beach quality material that will be placed along the shorelines for the proposed project will have a low percentage of fine-grained sediment, thus the turbidity plume generated is anticipated to be comparable to these studies, and temporary.

The borrow areas proposed for this Alternative consist of high-quality sand; therefore, dredging these areas is expected to result in sediment plumes that will be temporary and highly localized at the offshore borrow area. In the nearshore adjacent to the nourished beach, the discharged sediment will not elevate turbidity beyond levels naturally occurring in the turbulent surf zone. The preferred alternative is therefore not expected to result in long-term adverse impacts to water-quality in the nearshore or offshore marine environment.

5.1.3 Associated Impact with No Action Alternative

The no action alternative will impart no change on natural or anthropogenic activities already occurring in the Project Area. The status quo involves short-term solutions to storm protection taken by the property owners such as erecting sand fencing, occasional beach scraping and placement of sand bags. None of these activities will affect the turbidity levels in the marine environment and turbidity events will continue to fluctuate naturally. Turbidity levels will therefore not be affected if the no action alternative is taken.

5.2 Air Quality

5.2.1 Associated Impact with Abandon and Retreat Alternative

The abandon and retreat alternative will result in no adverse impacts to air quality.

5.2.2 Associated Impact with Preferred Action Alternative

A temporary reduction in air quality will occur as a result of emissions created by dredges and construction vehicles on the beach. These discharges will be localized and will not result in any significant or long-term impact to ambient air quality in Kill Devil Hills.

5.2.3 Associated Impact with No Action Alternative

The no action alternative will result in no adverse impacts to air quality.

5.3 Noise

5.3.1 Associated Impacts with Abandon and Retreat Alternative

Noise levels within the Project Area are relatively low. The abandonment of structures within the Project Area will not elevate ambient noise. The relocation of residential or commercial structures would require a degree of construction activity dependent on the size, number and type of buildings being relocated, and noise levels would be elevated due to operation of construction equipment. As it is not known at this time which structures in imminent danger would be abandoned versus relocated, it is not feasible to estimate the extent or period for which noise levels would be elevated.

5.3.2 Associated Impact with Preferred Action Alternative

During dredging activities, noise levels will increase above the ambient levels at the borrow areas and beach site due to the presence of construction equipment and personnel. Marine dredging produces broadband, continuous, low frequency sound that can be detected over considerable distances and may trigger avoidance reactions in marine mammals (Thomsen *et al.*, 2009) and other organisms. The sound produced is dependent on many factors including, but not limited to, substrate type, sediment type being dredged, type of equipment used and skill of the dredge operator. The variation in noise emitted by equipment type is related to how the machinery makes contact with and extracts material from the sea floor. Clarke *et al.* (2002) performed a study of underwater noise produced by various types of dredging equipment, including a hydraulic cutter suction dredge and a trailing suction hopper dredge. Recordings of a hydraulic cutter performing maintenance dredging in Mississippi Sound, Mississippi emitted noise as the cutterhead was turned at 1 – 10 rpm within the substrate. Sounds were continuous and fell within the 70 to 1,000 Hz range while sound pressure levels peaked between 100 to 110 dB re 1µPa rms. In the case of a hopper dredge, much of the sounds emitted during the active dredging process are produced by propeller and engine noise, pumps and generators. Similar to a cutter suction dredge, most of the sound energy produced fell within the 70 to 1,000 Hz range and was continuous in nature. However, Clarke *et al.* (2002) found that peak pressure levels for hopper dredges ranged from 120 to 140 dB re 1µPa rms, which were much higher than a cutter suction dredge.

Sound plays an important role in the marine environment; however, the function of sound in the ecology of many marine animals is not entirely understood. The extraction of sand from the marine environment produces sound that elevates levels above ambient, and may therefore disturb or cause injury to some marine fauna such as invertebrates, fishes, mammals and sea turtles. For example, in marine cephalopods, exposure to low-frequency sound was found to cause acoustic trauma to sensory structures responsible for the animals' sense of balance and position (Andre *et al.*, 2011). Sound can also prove detrimental to fishes, especially those considered "hearing specialists", which have specialized hearing structures, and those with swim bladders. The frequency and sound levels emitted by dredges overlap the range of hearing for some fish species, meaning dredging can cause adverse effects such as behavioral changes or physiological damage (Thomsen *et al.*, 2009). Impacts from dredging noise incurred by certain threatened and endangered species (e.g. manatees, whales and sea turtles) are discussed further in section 5.6.

At the placement site, noise levels will also be elevated during beach construction due to the presence of heavy machinery such as excavators and front-end loaders. Noise disturbance created by heavy machinery may drive birds and sea turtles from their foraging or nesting activities (Speybroek *et al*., 2006). Noise levels will only be elevated during active construction and will return to pre-construction levels upon project completion.

5.3.3 Associated Impact with No Action Alternative

The no action alternative will impart no change on natural or anthropogenic activities already occurring in the Project Area. Under the status quo, property owners within the Project Area have resorted to short-term solutions to storm protection such as erecting sand fencing, occasional beach scraping and placement of sand bags. Ambient noise levels will temporarily increase due to operation of equipment to complete these measures, such as bulldozers, but will return to ambient after project completion. No long-term impacts to noise levels will occur with the no action alternative.

5.4 Beach and Dune Habitat

5.4.1 Associated Impact with Abandon and Retreat Alternative

Analysis of historical shoreline trends using LiDAR data and DCM shoreline change rates show moderate recession rates tempered by some areas of accretion along the Kill Devil Hills shoreline (refer to section 2.1). Abandonment or relocation of threatened structures would not likely alter these trends and recession/accretion would continue at similar rates. Because the abandon and retreat alternative would not reduce or mitigate shoreline recession within the Project Area, loss of beach and dune habitat will continue to occur in some areas This translates into reduction or degradation of sea turtle nesting habitat in these receding areas.

The abandon and retreat alternative does not address the purpose and need item of providing storm damage reduction to imminently threatened structures over the next 5 years. As a result, storm damages may be incurred in the form of acute erosion or dune overwash, but these changes would likely be naturally restored after a period of accretion.

5.4.2 Associated Impact with Preferred Action Alternative

Much of the dune community along the Kill Devil Hills shoreline has been lost due to a combination of development and erosion. Sand placement and dune construction would contribute to development of a stable beach and dune habitat that may prove beneficial for many plant and animal species. During construction, impacts to extant dune vegetation will be minimal, as operations will avoid disturbing or placing sand directly on existing vegetation.

At the same time, construction would negatively impact the infaunal community that inhabits the intertidal and subtidal beach (e.g. polychaetes, amphipods, crustaceans, gastropods) as well as the biological community that depend on them such as, ghost crabs, fish and a variety of seabirds and shorebirds. However, numerous studied have demonstrated that nourishment does not prevent recolonization of the beach by infaunal organisms. An example of short-term recovery of beach infauna can be seen in the 2011 nourishment project at Nags Head Beach, North Carolina. The Town of Nags Head implemented a beach nourishment project and placed material along approximately 10 miles of oceanfront shoreline. Results from post-construction benthic monitoring have confirmed that the area impacted by sand placement on Nags Head beach has regained a viable assemblage of benthic organisms that is similar to non-impacted beaches both one year post-construction (CZR Incorporated and CSE, Inc., 2013) and two years post-construction (CZR Incorporated and CSE, Inc., 2014). The year-2 post-construction surveys showed no significant differences between the nourished beach in Nags Head from the control beaches in the study in terms of mean difference of taxa richness or sand grain size. On the nourished beach, wintertime abundance was actually significantly higher two years post nourishment than pre-nourishment (CZR Incorporated and CSE, Inc., 2014).

5.4.3 Associated Impact with No Action Alternative

A barrier island is a dynamic feature that naturally undergoes erosion of the beach and dune from the seaward side and accretion on the backside of the island. In this way, the island essentially “moves” with changing sea states. It is this ability to adapt that allows these features to persist. However, development along the Kill Devil Hills shoreline prevents this natural erosion/accretion cycle from occurring resulting in sand that will be progressively lost but not replenished naturally. This may result in progressive loss and possible elimination of the remaining beach and dune habitat and the ecological services these areas provide. Loss of beach would threaten sea turtle nesting habitat and result in a reduction in foraging and nesting grounds for shorebirds and seabirds that frequent the Kill Devil Hills shoreline.

Additionally, continued erosion along the Kill Devil Hills beaches would increase the risk of storm damages to the human and natural environments. As a result, armoring measures (i.e. sand fences, sand bags and beach scraping) potentially undertaken by property owners to reduce the threat of storm damage would further degrade the dune habitat and result in negative impacts to the biological communities. While installation of sand fencing and sandbags may encourage dune formation and increase storm protection, respectively, these efforts do little in the way of mitigating shoreline recession. Sandbags are considered Temporary Erosion Control Structures and are regulated under NCAC 7H .0308(a)(2), though they may persist for many years beyond their permitted use. If left un-maintained, the sandbags can begin to deteriorate or become damaged, littering nearby nearshore waters and beaches.

5.5 Essential Fish Habitat

5.5.1 Associated Impact with Abandon and Retreat Alternative

The abandon and retreat alternative is not expected to result in any adverse impacts to EFH.

5.5.2 Associated Impact with Preferred Action Alternative

There are no estuarine areas or associated EFH within the project area. There are also no live/hard bottoms, coral and coral reefs, artificial/manmade reefs or sargassum essential fish habitat marine areas located with the Project Area. As such, there are no potential impacts to these EFH categories.

There are two habitats, the marine water column and offshore shoals that are considered EFH within the Project Area and may be affected by the project. The marine water column within the Project Area includes the inner shelf waters around the borrow area and pump-out site and the surf zone adjacent to the section of shoreline proposed for nourishment.

5.5.2.1 Effects on Marine Water Column

Mid and Inner Shelf Waters

The Project's proposed borrow areas are located from 4.1 to 6.5 miles offshore (Figure 1). Potential effects from elevated turbidity levels may be expected to occur in the mid and inner shelf waters surrounding the proposed borrow area resulting from the dredging activities' sea floor disturbance and in the surf zone resulting from sand placement on the beach. Potential effects to the surf zone and benthic prey species are discussed in the next section.

The physical disturbance created by the use of a dredge in the offshore borrow areas can negatively affect the physiology and feeding behavior of visually orienting fish via increased turbidity (Wilber *et al*., 2003). Depending on the type of dredge being used, temporary sediment plumes will arise from various sources during borrow area dredging. In the case of a hopper, sediment re-suspension will result as the draghead moves over the seafloor and during the discharge of overflow while filling the hopper. Cutter suction dredges generate comparatively lower amounts of suspended sediment and plumes are confined to within a few meters of the drilling cutterhead at the seafloor. A cutter suction dredge functions by drilling below the surface of the substrate; therefore, the sediment plumes created from the drilling cutterhead are generally highly localized (CSA *et al.*, 2010). Additionally, the material is hydraulically moved from the cutterhead /sediment interface directly into a pipeline, eliminating the hopper-filling stage and associated overflow. Although unlikely, a leaking submerged pipeline can also be a source of elevated turbidity (Michel *et al.*, 2013).

Several typical estuarine projects have shown sediment settling rates ranging from centimeters/second to meters/second resulting in settlement primarily within the dredge site's immediate area (Bohlen, 2002). Larger grain sizes within the plume settle more rapidly. Coarse sand (>2 millimeters) and gravels settle almost immediately, often with a distance of less than 50 meters from the dredger (Challinor, 2000). As shown in Table 5 above and discussed in Section 2.2.1, the material within the borrow area is comprised of a large mean grain size and low silt content. Regardless of the dredge type used, the potential for EFH turbidity effects is therefore limited by the borrow source's sand percentage and rapid fallout during removal and placement. In addition, given the high-energy environment in conjunction with the borrow area characteristics, adverse effects from lowered DO are unlikely.

Surf Zone and Benthic Effects Determination

The beachfront surf zone, a subcategory of the marine water column EFH, is characterized as a high-energy shallow area located between the marine intertidal habitat and where waves form and break. This high-energy area is habitat to many benthic organisms and a foraging ground for finfish. The surf zone has been designated as EFH by the SAMFC because of the ecological functions provided to the aquatic resources.

The proposed Project's temporal and spatial effects on surf zone habitat and associated invertebrate prey species along the collective 15 miles of oceanfront shoreline of the Project Area could adversely affect other fishes of commercial, recreational or ecological importance such as Atlantic croaker (*Micropogonias undulates*), spot (*Leiostomus xanthurus*), striped mullet (*Mugil cephalus*) and Florida pompano (*Trachinotus carolinus*). These species serve as prey for king mackerel, Spanish mackerel, cobia and others that are managed by the SAFMC and for highly migratory species (e.g., billfishes and sharks) that are managed by NMFS. Effects to managed species are discussed below.

Placing sand directly along the surf zone will adversely affect this EFH through the burial of benthic organisms. Although the infaunal communities in both the surf zone and offshore borrow areas will be directly impacted during construction, it is expected that these communities will recover in a short period due to recolonization from adjacent communities as described and referenced below.

Benthic monitoring is a frequently required component of beach nourishment monitoring programs. A study on the northern New Jersey coastline by Wilber et al. (2003) concluded that a temporary reduction in benthos did not detrimentally affect prey consumption of fish that forage in the nourished area. As a result, the author suggested that continued mandatory benthic monitoring does not appear to be a prudent use of limited monitoring resources.

While the number of trophodynamic studies linking surf-zone fish and non-fish communities is limited, researchers have evaluated the dominant prey for many surf zone and nearshore fish species. Hackney et al. (1996) identified both the mole crab (*Emerita talpoida*) and the coquina clam (*Donax variabilis*) as dominant prey items in the trophic web for the majority of surf zone and nearshore fish of the South Atlantic Bight. Although the effects remain short-term, there is a difference in recovery rate attributable to the season in which a project is constructed. A literature review of the effects of beach nourishment on benthic habitat performed by Taylor Engineering (2009), prepared for the Florida Department of Environmental Protection, evaluated a wide variety of sites along the Atlantic and Gulf coasts and spanned the years of 1980 to 2007. The review concluded that benthic habitat within nourished areas typically recovered within 2 to 7 months. Variability was attributed to the season in which fill activities occurred and the compatibility of the fill material, with winter projects having less of an impact.

The Nags Head beach nourishment project, completed in 2011, was conducted during the peak period of benthic productivity spanning the months of May through October. The fill area included approximately 10 miles of oceanfront shoreline and utilized an offshore borrow source located within states waters. The Year 1 post-construction monitoring report for the project was released in

June of 2013. The report concluded that benthic populations in the nourished beach as well as the offshore borrow area are generally not significantly different from control stations and demonstrate viable populations of organisms during the earliest post project sample events (CZR, 2013). The Year 2 post-monitoring report confirmed the results of the Year 1 report. Both reports concluded benthic populations along the beach as well as the offshore borrow area were generally no different from control stations and demonstrated viable populations of organisms during the post-construction sampling events (CZR, 2014). These results support more than three decades of similar previous findings such as those described above.

In summary, although seasonality of project construction may affect the recovery time of benthic communities, affects to benthos within nourished and borrow areas continue to be shown as minimal and transient. With the expected relatively quick recovery of infaunal communities, non-impacted adjacent communities, use of compatible material, mobility and adaptability of fish species found within the surf zone EFH and offshore borrow area, the Project is not expected to result in significant or long-term impacts to this EFH or benthic prey resources.

5.5.2.2 Effects on Offshore Shoals

Dredging at offshore shoals may result in effects associated with shoal physiology, benthic abundance and elevated turbidity. The proposed maximum extents of the borrow areas encompass a cumulative total of 1600 acres or approximately 2.5 square miles. Relative to the extent of shoals in the region (Figure 12), the proposed project only has the potential to affect a comparably small area.

Potential long-term physical and biological impacts could occur if dredging significantly changes the physiography of the shoals. Sediment removal has the potential to alter seabed topography, particularly if sediment removal in the borrow area results in a deep hole. As shown in Figure 4 and Figure 5, the proposed Project's borrow area sediment removal does not exceed the surrounding depths. Therefore, the proposed Project does not include significantly deep excavations resulting in holes likely to alter seabed topography. It should also be noted that major shoal features (Figure 12) will not be affected by the proposed Project.

Benthic resources within offshore borrow areas will be affected during project construction by the removal of sediment. Benthic invertebrates that inhabit sand shoals provide structural fish habitat via the development of worm tubes, burrows and depressions. In addition, these invertebrates provide a foraging base for demersal feeders. Similar to the surf zone effects described above, recolonization by opportunistic species would be expected to begin soon after project construction ceases. Because of the opportunistic nature of the species, rapid recovery would be expected to occur from the migration of benthic organisms from adjacent areas and larval transport. Benthos found in sand bottoms of high-energy environments, such as those within the Project borrow areas, tend to recover more quickly than those occurring in lower-energy environments with a higher percentage of fine particles (Normandeau, 2014). Faster recovery in shallow high-energy environments may reflect the adaptation of communities that occur in these habitats to frequent disturbance from episodic storm events (Normandeau, 2014).

Benthic communities on the offshore shoals are known to vary seasonally. This seasonal variation becomes less apparent with distance offshore and increasing depth. Slacum et al. (2006) surveyed mobile benthic species on shoals and nearby habitats off Delaware and Maryland (16 to 25 km off the coast, in 5 to 22 m depth) and found significant seasonal variation in assemblages at both shoals and reference sites. Species richness and abundance were both highest in summer and fall, and lowest in winter (Normandeau, 2014). Regardless, monitoring studies of post-dredging effects and recovery rates of borrow areas indicate that most borrow areas usually show significant recovery by benthic organisms approximately 1 to 2 years after dredging and greater inter-annual variability than differences from the effects of dredging (USACE, 2013). Burlas et al. (2001) monitored borrow sites with bathymetric high points off northern New Jersey and found that essentially all infaunal assemblage patterns recovered within 1 year after dredging disturbance, except recovery of average sand dollar weight and biomass composition, which required 2.5 years. Similar to the effects determination for the surf zone, with the expected relatively quick recovery of infaunal communities, the Project is not expected to result in significant long-term impacts to benthic prey resources.

As described in the Mid and Inner Shelf Waters Effects Determination above, the potential for EFH turbidity effects are limited by the borrow source's sand percentage and rapid fallout during removal. Although turbidity plumes associated with dredging often are short-lived and affect relatively small areas (Cronin et al., 1970; Nichols et al., 1990), resuspension and redispersion of dredged sediments by subsequent currents and waves can propagate dredge-related turbidity for extended periods after dredging ends (Onuf, 1994). Biological responses to turbidity depend on all of these physical factors, coupled with the type of organism, geographic location, and the time of the year. In the case of sand dredging from offshore shoals for beach nourishment, turbidity plumes at the borrow site are virtually nonexistent due to rapid settling of sand-sized particles, resulting in minimal, if any, sedimentation impacts relative to background transport processes (Louis Berger Group, 1999). Additionally, in an analysis of potential biological and physical impacts of dredging on offshore ridge and shoal features, CSA et al. (2009) confirmed that turbidity plumes and their effects are expected to be less important in unprotected offshore areas. This is due to sand settling more rapidly than clay and silt and offshore shoals tend to be coarser than inshore deposits (CSA et. al., 2009).

5.5.2.3 Effects on Managed Species

The physical disturbance caused by dredging and the placement of sand onto the beach may affect fish distribution patterns. However, it is anticipated that changes in turbidity from dredging operations will be less significant than changes in background levels that will occur during the range of environmental conditions experienced in the Project Area (Lally and Ikalainen, 2001). Additionally, any managed species migrating through, or potentially near the Project Area are expected to avoid active construction areas. Effects to managed species in regards to turbidity are expected to be transient and minimal.

The precise nature of any obligate association of demersal or pelagic fishes with shoals is not known, but it appears that many fish species rely on shoal features as a part of a broader, cross-shelf habitat (CSA et al., 2010). Regardless, as discussed in in the prior Section and shown in Figure 4, Figure 5 and Figure 12, the proposed borrow area design and cuts will have a minimal effect on the individual shoal and a miniscule effect on the shoal complex in the area. Adverse effects to managed species from the relatively small affected area are not anticipated.

Additionally, as discussed and documented above, effects to benthic resources and consequentially to managed species or managed species prey sources are also expected to be transient. With the availability of adjacent undisturbed areas and fleeting effects within the Project Area, indirect effects to managed species in regards to prey loss and disturbance are expected to be short-lived and minimal.

5.5.3 Associated Impact with No Action Alternative

Continuation of the status quo is not expected to result in any adverse impacts to EFH.

5.6 Threatened and Endangered Species

Several threatened and endangered species may occur directly within or near the Project Area, and thus may be affected by the proposed project. Potential effects to threatened and endangered species are discussed in the following sections.

5.6.1 West Indian Manatee

5.6.1.1 Associated Impact with Abandon and Retreat Alternative

The abandon and retreat alternative will not involve any in-water work, or impacts to habitats utilized by manatees. This alternative will therefore have no effect on West Indian manatees.

5.6.1.2 Associated Impact with Preferred Action Alternative

One of the major threats to the West Indian manatee is collisions with watercraft, resulting in serious injury or mortality. Manatee and vessel interactions are possible while the dredge is underway to and from the fill site. However, open ocean habitat is not commonly used by manatees (Cummings *et al*., 2014); therefore, the likelihood of manatees occurring within the operational area of the dredge is quite low. Additionally, the project will not affect estuarine habitats and there is no submerged aquatic vegetation (primary food source for manatees) near the Project Area.

Marine mammals are highly vocal and dependent on sound for many aspects of life making them particularly susceptible to impacts from noise. For example, manatees have been shown to select grassbeds with lower ambient noise for frequencies below 1 kHz. Noise levels within the nearshore environment will likely be elevated due to construction activities associated with the placement of sand onto the receiving beaches. As stated above, however, manatees do not commonly utilize the nearshore environment off North Carolina; therefore, it is considered unlikely manatees will occur within the Project Area.

5.6.1.3 Associated Impact with No Action Alternative

The no action alternative will not impact any habitats utilized by West Indian manatees, and will therefore not affect this species.

5.6.2 Whales

5.6.2.1 Associated Impact with Abandon and Retreat Alternative

Activities under this alternative will not impact any habitats utilized by whales, and will therefore have no effect on any whale species.

5.6.2.2 *Associated Impact with Preferred Action Alternative*

Of the six species considered, only the humpback whale and the North Atlantic right whale would be expected to occur within the Project Area. Although fin whales may occur within the nearshore waters of North Carolina during the winter, it is likely these individuals would be migratory. Fin whales are not anticipated within coastal waters of North Carolina during the summer, as they would likely be on their feeding grounds in Northern waters. The proposed project is therefore not anticipated to result in additional impacts to fin whales.

The major concern for humpback or North Atlantic right whales occurring within the Project Area will be the possibility of collisions with the hopper dredge or other vessels. Due to their critical population status, slow speeds and tendency to linger at the surface, vessel collisions are the greatest threat for North Atlantic right whales (NMFS, 2012). Collisions with the dredge are most likely to occur while sailing to and from the offloading site. Vessel speed has been shown to affect the probability of lethality of a collision substantially, and is therefore considered a major concern for North Atlantic right whales. Speeds at which dredges typically operate are quite slow, less than 10 kts., which is below the speed recommended by the NMFS if North Atlantic right whales are spotted. Laist *et al.* (2013) reports that of 41 ship strike accounts for which vessel speed has been reported, no lethal or severe injuries occurred at speeds below 10 kts. and no collisions have been reported for speeds of less than 6 kts. The potential for an interaction between the dredge and a listed species increases with the level of dredging effort required for the project. Dredging effort includes parameters such as the total volume of material dredged, number and size of dredges used and total number of dredge days. Distance from the borrow area to the pump-out site and the number of trips made between them factor into dredging effort.

Table 23. Typical dredging operations based on information provided by potential dredge contractors.

Operation	Typical Values
Speed Dredging Underway (loaded) Underway (empty)	 1 – 3 kts 5 – 8 kts 10 – 11 kts
Hopper Fill Time Overflow	45 min – 75 min Sporadic, only during 2/3 of fill time

The noise produced by dredging activity while the dredge is stationary may also impact North Atlantic right whales and humpback whales if they are present near the Project Area. As discussed in the previous section, underwater noise of anthropogenic origin can potentially affect or alter normal migration patterns, communication, foraging and breeding habits. During dredging activities, noise levels will increase above the ambient levels at the borrow areas. While the above impacts are possible, North Atlantic right whales are not anticipated in the vicinity of the Project Area due to the proposed summertime construction schedule. During this time, the whales are generally found on, or migrating to, the northern feeding grounds.

5.6.2.3 Associated Impact with No Action Alternative

Activities under the no action alternative will not impact any habitats utilized by whales, and will therefore have no effect on any whale species.

5.6.3 Sea Turtles

5.6.3.1 Associated Impact with Abandon and Retreat Alternative

Under the abandon and retreat alternative, the line of development would slowly shift landward and the beach would be allowed to shift and change shape according to changing wind and wave conditions. In the absence of structures, the shoreline would be able to migrate inland, during times of seasonal and storm induced erosion, yet sand would be maintained within the system for natural recovery of the beach. Additionally, dune vegetation would likely begin to colonize the beach strand, helping to build a dune system. Essentially, beach habitat would be naturally maintained, ultimately benefiting sea turtles. Additionally, the abandon and retreat alternative may reduce the amount of human presence along the beach strand, which would reduce disturbance, e.g. lighting, recreational activity, to hatchling or nesting sea turtles.

5.6.3.2 Associated Impact with Preferred Action Alternative

Sea turtles utilize different habitats in different phases of their life cycle. While sea turtles spend the vast majority of their life within the marine environment, they also utilize the beach for nesting purposes. Beach nourishment activities, including dredging of marine substrate and placement of sand on oceanfront beaches, may lead to several effects on swimming and nesting sea turtles. Beach nourishment activities occurring outside the typical environmental windows recommended for sea turtles (November 16 through March 31 for hopper dredges; November 16 through April 30 for cutterhead dredges could exacerbate these impacts as construction would coincide with warmer water temperatures and periods of increased sea turtle activity within North Carolina waters and beaches. Therefore, impacts are addressed for sea turtles both within the water column and on the nesting beach.

Potential Water Column Impacts

The greatest risk of direct impacts to swimming sea turtles comes from interactions with the dredging vessels, where vessel strikes or entrainment by dredging equipment can result in injury or fatality. The risk of entrainment is largely associated with hopper dredges, which can directly kill turtles if crushed by, or caught in, the drag heads during dredging (NMFS, 1991).

Approaches to mitigating these threats include implementing environmental windows for dredging activities, trawling and relocation ahead of the dredge, and turtle deflectors for the drag head. The turtle deflector is a rigid shield installed over the draghead that pushes a sand wave ahead of the draghead and displaces turtles away from the immediate suction field. Even with these mitigation measures, turtle takes still occur on occasion. NMFS has hypothesized that the number of turtle interactions is positively associated with the volume of material dredged and time spent dredging, such that takes increase as the volume and duration of dredging increases (NMFS, 2012).

Although loggerhead sea turtles are the species most commonly documented within Dare County, takes of other turtle species have occurred during offshore dredging projects. According to the

USACE's Sea Turtle Warehouse database, among the six nourishment projects within the Wilmington District of the USACE SAD that utilized offshore borrow areas, two projects resulted in turtle takes (Table 24). A total of six turtle takes occurred, including two juvenile loggerheads, three juvenile Kemp's ridley turtles, and an additional loggerhead of unknown age. Although sizes were not recorded for most takes, one juvenile loggerhead was measured to be 71.12 cm straight carapace length (SCL). Of particular note is the relatively high number of takes that occurred during the Bogue Banks Nourishment Project - Phase I completed from November 26, 2001, to April 11, 2002. Although this project was characterized by a longer duration and larger amount of material dredged, the first four turtle takes occurred after twenty days of dredging. The project adhered to mitigation measures including drag head deflectors and construction well within the environmental windows recommended for the project (December 1 through March 31); however, relocation trawling had not yet started for the project, which may have contributed to the high number of takes. Other possible contributing factors include a higher temp (64.4° F) than was reported for those projects that did not result in takes. Additionally, notes within the database indicate that a diver was sent down to explore why takes were occurring, and suggested that an "…abundance of old tires in the area attracted sea life which the turtles were feeding on (i.e. crustaceans, octopus bycatch)." It was also reported that observers witnessed an "appearance of *Sargassum* during time of December takes." (USACE, 2013b). Relocation trawling was implemented during three of the four projects presented in Table 24, and did not cause turtle takes. However, one dolphin take did occur as a result of relocation trawling during the Bogue Banks Phase I Nourishment Project.

The data discussed above suggest juvenile sea turtles are present in nearshore waters during the month of December; this concurs with the spatial distributions of juvenile and adult loggerheads presented by the Turtle Expert Working Group (TEWG) (TWEG, 2009). Based on satellite telemetry tracks of 248 loggerhead sea turtles, the TEWG concluded that few to no juvenile turtles occur close to shore north of Cape Hatteras during the winter (January through March). High-use areas occurred from the North Carolina-South Carolina border to the Chesapeake Bay, Virginia from spring (April through June) through fall (October through December). The historic satellite tracking data analyzed by the TWEG showed during the colder months of fall and winter, juvenile turtles had a higher frequency of occurrence off the Carolinas south of Cape Hatteras.

Of the takes presented in Table 24, the one turtle measured upon take was a loggerhead with 71.12 cm SCL. The TWEG defines five life stages for loggerhead sea turtles by non-rigid size classes and habitat usage. Stage I (hatching to 15 cm SCL) and II juveniles (15 cm to 63 cm SCL) are entirely oceanic, while Stage III juveniles (41cm to 82 cm SCL) can be oceanic or neritic. Stage IV juveniles (63 cm to 100 cm SCL) and Stage V adults can also be oceanic or neritic. The 71.12 cm loggerhead turtle taken falls into the Stage III juvenile category.

Considering the TEWG studies and USACE take data, it seems that the takes reported for the Bogue Banks Phase I nourishment do not represent an anomaly in sea turtle abundance; but rather can be explained by the location (south of Cape Hatteras), habitat (neritic) and season (December) in which the takes occurred. Other species including the green, leatherback and Kemp's ridley sea turtles have also been documented within nearshore waters of North Carolina; however, only the Kemp's ridley turtles have reportedly been killed during offshore dredging projects within the SAD Wilmington District (Table 24). Nevertheless, there remains the potential for these species to occur in the Project Area, and may therefore incur adverse project related impacts.

Table 24. Dredging projects within the Wilmington District of the USACE South Atlantic Division using offshore borrow areas. Any records of turtle takes, conditions at time of take, and pertinent biological information are also included. A designation of 'n/a' indicates no data are available.

	Name	**Bogue Banks Beach Nourishment-Phase I**					**Bogue Banks Beach Nourishment-Phase II**	**Kure and Carolina Beach Shore Protection Project**	**Bogue Banks Beach Nourishment-Phase II**	**Nags Head Beach Nourishment Project**	**Emerald Isle Post-Irene Renourishment Project**
Project Info	Project Dates	11/26/01 - 4/11/02					2/5/03 - 3/27/03	3/11/04 - 3/22/04	3/23/2004 - 3/30/04	5/24/11 - 10/27/11	2/27/13 - 3/24/13
	Total Days Dredging	165					74	11	16	180	n/a
	Total Cubic Yards	1,869,390					989,895	324,453	n/a	4,615,126	630,000
	Sea Temperature	18° C/ 64.4° F	18° C/ 64.4° F	18° C/ 64.4° F	18° C/ 64.4° F	16° C/ 60.8° F	16° C/ 60.8° F	12° C ± 3/ 53.6° F	12.7±3°C / 54.86°F	23-24°C/73.4-75.2°F	11.8°C/53.2°C
	Borrow Source	Offshore Bogue Banks					Offshore Bogue Banks	Offshore Borrow Area	Offshore Bogue Banks	Offshore Nags Head	Offshore Dredged Material Disposal Site
Take Info	Species	Loggerhead	Loggerhead	Kemp's Ridley	Kemp's Ridley	Kemp's Ridley	Loggerhead	None	None	None	None
	Date of Take	12/15/2001	12/15/2001	12/15/2001	12/15/2001	4/11/2002	3/19/2003	None	None	None	None
	Condition	Dead	Dead	Dead	Alive, Died later	Injured; Released	Dead	None	None	None	None
	Age	Juvenile	Juvenile	Juvenile	Juvenile	Juvenile	Unkown	None	None	None	None
	SCL(cm)	71.12	n/a	n/a	n/a	n/a	n/a	None	None	None	None
Conservation Measures Implemented	Pre-dredge Trawling?	No					No	No	No	No	No
	Relocation Trawling?	Yes: 12/22/01-12/31/01 (after takes occurred)				Yes: 3/28/02-4/11/02	Yes: 3/13/03-3/27/03	No	Yes: 3/23/04-3/30/04	Yes(non-capture): 5/22/11 - 10/27/11	Yes: 2/27/2013 - 3/24/13
	Deflector Used?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes(non-capture): 5/22/11 - 10/27/11	Yes
	Within Windows?	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes

Should hopper dredges be utilized, the proposed projects will employ relocation trawling (as described in Section 2.2.2 of the present document) as a means to reduce the potential for entrainment of protected species, such as sea turtles and sturgeons. This method can successfully reduce the number of turtles taken by entrainment during dredging projects. For example, during the 2013 West Destin Beach Restoration project, in Okaloosa County, Florida, 23 green, loggerhead, Kemp's ridley and leatherback sea turtles were successfully relocated by trawling, and no lethal takes occurred during the project (USACE, 2013c). However, relocation trawling results in the non-lethal take of protected species, and there is also a documented history of lethal take of both protected and non-protected species. During the 2002 Bogue Banks Phase I Beach Nourishment Project, although four sea turtles were successfully relocated, one dolphin was lethally taken by the trawler. Additionally, five sea turtles were taken by the dredge during this project (USACE, 2013c).

In the Biological Opinion developed for the Shoreline Restoration Protection Project in Fort Story, Virginia Beach, the NMFS hypothesized that the number of sea turtle-dredge interactions is dependent upon factors such as time of year that dredging occurs, the terrain of the dredged area and the presence or absence of sea turtle habitat within the dredged area (NMFS, 2012). The proposed project may occur wholly or partially during the time period when loggerhead, green, Kemp's ridley and leatherback sea turtles are most abundant, which, coupled with the use of a hopper dredge, elevates the potential for entrainment. Additionally, a portion of the migratory critical habitat unit LOGG-N-1 for the loggerhead sea turtle slightly overlaps the southernmost portion of Kill Devil Hills. Furthermore, there is a history of green sea turtle takes during dredging of navigation channels in North Carolina. Although the risk of entrainment is reduced during offshore dredging projects, there remains the possibility that green sea turtles could be entrained during the proposed project. Finally, implementation of relocation trawling could result in the capture of loggerhead, green, leatherback and Kemp's ridley sea turtles. Considering the above listed factors and historical data, it is considered likely that sea turtles will be present in the vicinity of the borrow areas and the proposed project may adversely affect swimming loggerhead, green, leatherback and Kemp's ridley sea turtles.

Similar to the potential affects due to entrainment, potential affects resulting from vessel collisions are also elevated due to the proposed projects' construction outside of the typical environmental window. The risk of collision also depends upon the amount of time the animal remains near the surface of the water (NMFS, 2012). The greatest risk of collision would occur when the dredge is transiting between the offshore borrow area and the nearshore pump-out location. While vessel collisions are a significant source of mortality for swimming sea turtles, it is assumed that turtles are more likely to avoid slower moving vessels, such as dredges, due to a greater amount of time to maneuver out of harm's way. To date, there has been no hardbottom areas that would serve as sea turtle foraging habitat identified in or near the borrow areas. Therefore, it is most likely any sea turtles present will be swimming in the water column or on the surface to breathe rather than on the bottom foraging. This may increase the chance of a collision; while at the same time reduce the potential for entrainment

Potential Impacts to Nesting and Hatchling Sea Turtles

The loggerhead sea turtle is the species most commonly observed nesting in North Carolina. As previously discussed, loggerhead nesting along the northern Outer Banks (north of Oregon Inlet) constitutes 4.1% of total nesting activity that has occurred throughout North Carolina from 2009 through 2014. According to the Recovery Plan for the Northwest Atlantic Population of the loggerhead sea turtle, the loggerhead nesting season typically ranges from late April to early September, with hatchling emergence occurring between late June and early November (NMFS and USFWS, 2008). Green, leatherback and Kemp's ridley sea turtles have also been documented nesting along the northern Outer Banks, although to a much lesser extent than loggerhead sea turtles. Beach nourishment activities occurring during nesting season therefore have the potential to directly impact nesting females and hatchlings of these species. As discussed in section 4.6.1.3, in the past, there has been significantly more sea turtle nesting between June and July than the other months within the nesting season. Additionally, significantly more hatchling emergences were found to occur between July 25 and September 4. It is therefore considered likely that dredging activities occurring during these periods have the greatest chance for affecting nesting and hatchling sea turtles.

The effects of a nourishment project to nesting and hatchling sea turtles depend in part on the type of nourishment material used. An improperly re-nourished beach (i.e., one that does not adequately mimic the physical composition and profile) can negatively affect sea turtle nesting success, as well as hatchling emergence and survival. Nest site selection and digging behavior of the female can be strongly influenced by the compaction and compatibility of the nourished beach with a natural beach (Lutcavage *et al*., 1997). If the nourishment sand is dissimilar from the native sand, results can include changes in sand compaction, beach moisture content, sand color, sand grain size and shape, and sand grain mineral content, all of which may alter sea turtle nesting behavior (Crain *et al*., 1995). Nest site selection and digging behavior of the female can be altered, or deterred, if she finds the beach unsuitable. Additionally, escarpments may develop on nourished beaches and can prevent sea turtles from accessing the dry beach causing the female to return to the water without nesting. This is energetically wasteful to the female and may result in overall decreased reproductive success. If unable to reach preferable nesting sites, females may also choose to deposit nests in unfavorable areas seaward of the escarpment making them vulnerable to washout (Crain *et al*., 1995).

To provide the most suitable sediment for nesting sea turtles, the color of the nourishment material must resemble the natural beach sand in the area. A change in sediment color due to beach nourishment could alter the natural incubation temperatures of sea turtle nests (Morreale *et al*., 1982). Sex determination in hatchlings is dependent upon temperature, where higher temperatures tend to skew the hatching sex ratio in favor of female hatchlings (Broderick *et al.*, 2001; Mrosovsky and Provancha, 1992; Ackerman, 1997). The thermal tolerance range for development of sea turtle embryos falls within 25 to 27°C (77 to 80.6°F) and 33 to 35°C (91.4 to 95°F), and the threshold temperature at which sex determination occurs falls around 28 to 30°C (82.4 to 86°F) (Ackerman, 1997). The temperature that a nest incubates is determined, in part, on the color of sand. Lighter sand will result in a lower incubation temperature, while darker sand will cause higher incubation temperatures. Therefore, it is possible that a change in sediment color on a nourished beach could alter sex ratios of hatchlings in sea turtle nests.

Aside from compatibility of the nourishment material, the functionality of a newly nourished beach as sea turtle nesting habitat also depends upon the design profile, e.g. slope and elevation. In a report assessing how beach nourishment construction templates can affect sea turtle nesting, PBS&J (2007) lists the following among the principle documented impacts:

- Traditionally built nourished beaches tend to be wide and flat, whereas heavily nested natural beaches are often relatively narrow and steeply sloped. Alteration of beach profile (width, slope, and elevation) presents nesting turtles with different tactile and visual cues that may affect pre-emergent assessments of beach suitability (i.e., affect the number of emergences onto the beach), nesting success (percentage of emergences resulting in nests), and nest site selection. Reductions in nesting success and/or relative nest densities are typically observed on most traditionally nourished beaches.

- Changes in beach elevation and slope following nourishment may also alter incubation environments relative to natural beaches and can affect the prevalence of scarping.

- Patterns of nest placement are altered on nourished beaches relative to natural beaches. A disproportionate number of nests are placed along the seaward edge of the beach berm. These nests are more susceptible to erosion during periods of profile equilibration. As a nourished beach equilibrates, a substantial amount of sand can be lost along the seaward edge of the beach berm. Nests placed in this area of equilibration experience high rates of loss due to "washout".

Furthermore, the authors suggest creation of a wider beach may result in additional energy expenditures for females and hatchlings due to greater crawl distances between the nest site and the ocean (PBS&J, 2007).

In an attempt to address the above risks and improve the quality of habitat provided by beach nourishment, construction of beach nourishment projects has typically been restricted to occurring outside the sea turtle nesting season. Additionally, constructed beaches are designed to mimic the native beach in terms of elevation, slope and sediment composition, such that scarping is limited and the biological performance is improved.

The Dare County projects discussed herein are pursuing year-round construction, therefore it is possible construction and subsequent equilibration of the profile may occur during a portion of the nesting season. However, the proposed projects will incorporate a design that closely resembles the native beach, with an upper beach slope of 1:10. These pre-cautions will preclude dramatic changes to the beach during the equilibration process, improving the quality of sea turtle nesting provided by the new beach.

Importantly, the potential impacts addressed above may extend into multiple nesting seasons following the nourishment. Welch *et al*. [no date] found significant effects from nourishment such that loggerheads largely avoided nesting on a nourished beach and nests deposited on the nourished beach were placed in unfavorable locations. Rumbold *et al*. (2001) found that loggerhead sea turtle nesting density decreased, and false crawls increased, in the first two nesting seasons following nourishment, although these changes are lessoned during the second season following nourishment. Therefore, while nourishment may result in an increase in available nesting habitat for sea turtles, it is not certain to result in more nesting (Ecological Associates, Inc., 1999).

Projects that utilize fill material that is similar in grain size and composition to the nourishment area may prevent or reduce some of the adverse effects associated with nourishment efforts (Crain *et al*., 1995). The design of the beach involves the use of compatible beach material to widen the existing dry beach, thereby increasing the amount of available suitable nesting habitat for sea turtles. In April 2008, the North Carolina Coastal Resources Commission (CRC) adopted State Sediment Criteria Rule Language (15A NCAC 07H .0312) for borrow material aimed at preventing the disposal of incompatible material on the beach. The new rule limits the amount of material by weight in the borrow area with a diameter equal to or greater than 4.76 mm and less than 76 mm (gravel), between 4.76 mm and 2.0 mm (granular) and less than 0.0625 mm to no more than 5% above that which exists on the native beach. The material proposed for use in the project will meet these criteria (Table 4 and Table 5) and consequently reduces many of the potential impacts to nesting and hatchling sea turtles.

The proposed project may affect sea turtles in various other ways. Project construction during sea turtle nesting season poses the risk for direct mechanical destruction or burial of nests, and the potential for encounters with construction equipment on the beach during nesting activities. The presence of heavy machinery on the beach at night can create barriers to nesting females (if stationary). Tracks left by heavy machinery in the sand may affect hatchlings as they crawl toward the water. Studies have shown that hatchlings become diverted not because they are unable to maneuver out of the tracks (Hughes and Caine, 1994), but because the sides of the rut cast a shadow, causing the hatchling to lose sight of the horizon (Mann, 1977). Driving over un-marked nests may destroy them, or cause sand compaction that adversely affects nest site selection, digging behavior, clutch viability and hatchling emergence (Mann, 1977; Nelson and Dickerson, 1989). Artificial lighting associated with the project may also directly affect sea turtle nesting and hatchling behavior. Artificial lighting on beaches tends to deter sea turtles from emerging from the sea to nest (Witherington and Martin, 1996). Project lighting can also result in the hatchling disorientation. Hatchlings, which use visual cues to locate the sea once they emerge from the nest, can be misdirected by artificial lighting (Dickerson and Nelson, 1989; Lorne and Salmon, 2007). Following beach nourishment projects, the wider and flatter beach berm may expose turtles and their nests to artificial lighting that was less visible, or not visible at all, from nesting areas before the project, leading to greater hatchling disorientation and possible mortality (Trindell *et al.*, 2005).

Critical Habitat

The closest segment of terrestrial Critical Habitat for the loggerhead sea turtle, unit LOGG-T-NC01, is located 125 miles to the south of Dare County, and will therefore not be affected by the proposed project. A small portion of the offshore North Carolina Constricted Migratory Corridor Critical Habitat unit LOGG-N-01 does extend into the southern part of Kill Devil Hills. Two of the four proposed borrow areas (Borrow Area A and S1-4) fall within the boundaries of this unit. The portion of the unit the encompasses the borrow areas is considered constricted migratory critical habitat, which consists of 1) constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and 2) passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas. The constricted migratory corridor serves as a concentrated migratory pathway for loggerheads transiting to neritic foraging areas in the north and back to winter, foraging and/or nesting areas in the south. While the majority of loggerheads pass through this corridor from April to June and September to November, loggerheads are present in the area from April through November. Periods in which loggerheads are present in these areas vary with water temperatures and individual migration patterns.

In the final rule designating critical habitat for the loggerhead sea turtle, the NMFS highlights special management considerations for the physical or biological features (PBF) of constricted migratory habitat., and states that the "…primary impact to the functionality of the migratory routes…would be a loss of passage conditions that allow for free and efficient migration along the corridor." Of major concern are large-scale or multiple construction activities that alter the habitat to such a degree that large scale deviations of migration patterns result. The NMFS also highlights activities that may, but will not likely impact important characteristics of the habitat, including the "Dredging and disposal of sediments that results in altered habitat conditions needed for efficient passage" (79 FR 39856).

The proposed activities may result in elevated turbidity levels in the immediate vicinity of the dredge, and this impact will be greater for hopper dredges than cutterhead dredges. However, the turbidity plumes will be temporary and localized to the dredging site, and should not result in large-scale deviation from migration patterns. Additionally, the proposed borrow areas encompass a very small area (2.5 square miles or 1600 acres) relative to the much larger area encompassed by the entire LOGG-N-01 unit.

Impacts Summary

In summary, with the potential project construction occurring during periods of higher sea turtle abundance, the proposed project may affect sea turtles. Further, without the conservation measure discussed in Section 7 of the present document, the proposed project would likely adversely affect nesting, hatching and swimming loggerhead sea turtles. There are no impacts to critical habitat expected.

5.6.3.3 Associated Impact with No Action Alternative

Under the no action alternative, the Kill Devil Hills shoreline will experience the same long-term erosion rates and risk of storm damage as discussed under the abandon and retreat alternative, which will ultimately result in loss of nesting habitat for sea turtles over the next 20 to 25 years. Additionally, the nesting habitat may be further degraded by efforts of property owners within the Project Area to afford their properties storm protection temporarily, including beach scraping, sand fencing and sand bagging. Placing hard structures such as sand fences and sand bags along the beach creates obstacles to nesting females, and, in the case of sand bags, may exacerbate erosion seaward of the bag. These items may also obstruct hatchling sea turtles attempting to traverse the beach to get to the ocean.

5.6.4 Shortnose Sturgeon

5.6.4.1 Associated Impact with Abandon and Retreat Alternative

The abandon and retreat alternative will not involve any activity that affects the spawning, migratory, foraging or overwintering habitat of the shortnose sturgeon, and will therefore have no effect on this species.

5.6.4.2 Associated Impact with Preferred Action Alternative

Shortnose sturgeons primarily utilize riverine and estuarine habitats, neither of which is located in the proposed Project Area. Spawning occurs in upper, freshwater areas, typically in January and February while feeding and overwintering activities may occur in both fresh and saline habitats. Aside from seasonal migrations to estuarine waters, this species rarely occurs in the marine environment (NMFS, 1998b; Keiffer and Kynard, 1993). Shortnose sturgeons appear to feed either in freshwater riverine habitats or near the freshwater/saltwater interface (NMFS, 1998b). Although shortnose sturgeons are capable of entering open ocean water, it has been suggested that the species appears hesitant to enter open ocean water (Gilbert, 1989). This factor may limit extensive coastal migrations of this species. Dredging will not occur within the typical spawning or foraging grounds for the shortnose sturgeon

5.6.4.3 Associated Impact with No Action Alternative

The no action alternative will not involve any activity that affects the spawning, migratory, foraging or overwintering habitat of the shortnose sturgeon, and will therefore have no effect on this species.

5.6.5 Atlantic Sturgeon

5.6.5.1 Associated Impact with Abandon and Retreat Alternative

The abandon and retreat alternative will not involve any activity that affects the spawning, migratory, foraging or overwintering habitat of the Atlantic sturgeon and will therefore have no effect on this species.

5.6.5.2 Associated Impact with Preferred Action Alternative

Atlantic sturgeons are known to inhabit the nearshore waters in North Carolina (Moser and Ross, 1995; Laney et al., 2007). The project area does not include suitable spawning grounds for the Atlantic sturgeon, as the closest spawning grounds are located in the Roanoke River and Albemarle Sound. However, Atlantic sturgeon spend much of their life history in the marine environment and can be found there year-round; therefore, the possibility of transient individuals occurring near the Project Area during dredging operations on the offshore sand shoals cannot be ruled out.

Dredging offshore sand shoals will have various effects on the physical and biological environments of these features. Dredging these areas is expected to alter the benthic community by removing sediments and benthic invertebrates, thereby disrupting trophic energy flow from mined sites until re-establishment of the community occurs (CSA International *et al.*, 2009). Additionally, removal of sediment from the shoal will create a depression that may or may not refill after dredging. A simulation of morphologic changes associated with offshore sand mining using numerical modeling suggests that borrow area location will determine whether infilling will occur. If dredging is performed in an active shoal area, the dredged area will be filled; conversely, if the dredged area is in an un-active area, the depression will not be refilled (CSA International *et al.*, 2009). The depression left by a dredged area that does not refill, may affect the hydrodynamics and hydrology that affects recolonization and recovery of benthic invertebrates. The ability of fish populations to recolonize dredged areas is largely unknown, but is thought to depend on degree of association with the dredged feature and reestablishment of the trophic structure of the features (CSA International *et al.*, 2009).

The ocean environment may be affected by elevated turbidity levels resulting from placement of sand; however, any increase should be transient and restricted to the nearshore environment. Although Atlantic sturgeons are highly mobile, there is conflicting evidence on whether they will evade dredging activities. Moser and Ross (1995) noted that Atlantic sturgeon occupied both undisturbed areas as well as regularly dredged areas and were present during dredging operations in the Wilmington Harbor. Alternatively, in a study of Atlantic sturgeon presence at an open-water disposal site in an estuarine transition zone, Hatin *et al.* (2007) found a significant decrease in presence of Atlantic sturgeon after sand disposal occurred. The authors suggest habitat modification was likely the driving factor, rather than elevated turbidity or reduction of dissolved oxygen levels, which are more likely to occur when the material disposed is silt-clay, not sand. Furthermore, Atlantic sturgeon frequently use estuarine zones with high levels of suspended matter. Because only beach quality sand will be placed into the nearshore environment of the Project Area, turbidity levels are not expected to reach levels considered detrimental to Atlantic sturgeon.

Vessel strikes have been reported as a threat to Atlantic sturgeon but have only been reported to occur in river systems (NMFS, 2012). For the proposed projects, the greatest risk of collision would occur when the dredge is transiting between the offshore borrow area and the nearshore pump-out location. Similar to the sea turtles, it is assumed that Atlantic sturgeon are more likely to avoid slower moving vessels, such as dredges operating at approximately 5 to 11 kts while transiting, as they are considered highly mobile and able to maneuver away from an approaching dredge. Because sturgeon will not likely be at the surface and are highly mobile, the chance of a collision is considered unlikely.

The greatest threat for Atlantic sturgeon occurring in the Project Areas would be the potential for entrainment by the hopper dredge; this risk is not as much of a concern with cutterhead dredges. Entrainment data from projects within the USACE North Atlantic Division suggest that entrainment risk for Atlantic sturgeon is much higher in channel or river dredging projects than offshore or coastal project. The USACE reports 17 interactions with Atlantic sturgeon during 12 separate river and harbor dredging operations along the entire U.S. east coast from 1990 to 2011. Of these 17 interactions, 15 involved entrainment in hopper dredges (NMFS, 2012). While only seven were measured and confirmed to be juveniles, the NMFS deemed it likely that all entrained individuals were juveniles as the large size of adult sturgeon relative to the opening of the draghead would prevent their entrainment. By comparison, the USACE reported only three entrainments of Atlantic sturgeon among 31 coastal and offshore projects between 1998 and 2011. Pre-dredge trawling and relocation trawling was employed during 3 of the 31 offshore/coastal projects, and a total of 16 Atlantic sturgeon were successfully removed using these methods. No takes were documented during trawling or dredging activities during these projects, despite the fact that Atlantic sturgeon were obviously present in the vicinity of construction. The NMFS suggests the low level of interactions may have been due, in part, to the use of pre-dredge trawling and relocation trawling (NMFS, 2012).

In the Biological Opinion developed for a shoreline restoration project in Virginia Beach, Virginia, the NMFS put forth several factors that may contribute to the likelihood of entrainment for large mobile animals, such as sturgeon (NMFS, 2012). It was suggested that risk of entrainment is high where space is limited, as in rivers and channels, such that restricted movement inhibits the chance to escape an approaching dredge. Entrainment risk would also be elevated where there are higher numbers of individuals, as in aggregation areas. Additionally, sturgeons are benthic feeders and are commonly found foraging along the bottom. Because hopper dredge drag heads operate along the bottom, there would be a greater risk of entrainment if dredging of this type occurred within foraging areas.

These risk factors, along with knowledge of sturgeon behavior, can be used to assess the threat of entrainment at the offshore dredge sites that may be utilized by sturgeon during the summer months. Because an offshore borrow area is an open ocean environment, movements would not be restricted and sturgeon may therefore be able to avoid an approaching dredge (NMFS, 2012). There is evidence to suggest sturgeon may not behave in this manner, however. During a channel dredging project, Moser and Ross (1995) noted that shortnose sturgeon regularly moved through an area during dredging operations; however, one Atlantic sturgeon moved within 100 m of a hydraulic pipeline dredge on two separate occasions, showing no signs of behavioral changes. While this suggests sturgeon behavior may not be negatively impacted by dredging, it may also imply that, although mobile, sturgeon may not readily swim away from an approaching dredge. Risk of entrainment may also vary with location of the dredge site in offshore waters. An offshore borrow area may exist within sturgeon migration corridors. In this case, the fish may be highly mobile and positioned higher in the water column, which could lower entrainment risk (NMFS, 2012). However, as discussed in Section 4.6.1.5, sturgeon distribution was found to be concentrated within a narrow depth range offshore North Carolina, suggesting the fish are aggregating with bottom features that support prey. Therefore, it is possible that migrating sturgeon forage within coastal North Carolina waters. Because sturgeons are bottom feeders, they would be vulnerable to entrainment if a dredge is operating within these areas of higher distribution. Additionally, the proposed use of a hopper dredge elevates the risk of entrainment

In summary, Atlantic sturgeon may be present near the Project Area and susceptible to entrainment by hopper dredges. However, the proposed borrow areas are not located in river, harbor or channel areas and instead are located in the unconfined open ocean environment outside of any known congregating or spawning areas.

5.6.5.3 Associated Impact with No Action Alternative

The no action alternative will not involve any activity that affects the spawning, migratory, foraging or overwintering habitat of the Atlantic sturgeon, and will therefore have no effect on this species.

5.6.6 Seabeach Amaranth

5.6.6.1 Associated Impact with Abandon and Retreat Alternative

Under the abandon and retreat alternative, no action will be taken to provide storm damage reduction to the environmental resources in the Project Area. Storm vulnerability analyses indicate a high probability that a large hurricane similar in magnitude to Hurricane Isabel will impact the area within 20 to 25 years, in which case much of the dry beach and dune that may serve as habitat for seabeach amaranth will likely be lost. Consequently, the abandon and retreat alternative could adversely affect this species. However, as discussed in above, seabeach amaranth is likely not found along the Kill Devil Hills shoreline due to development and heavy recreational use of the beach; therefore, it is not likely to adversely affect seabeach amaranth.

5.6.6.2 Associated Impact with Preferred Action Alternative

As discussed in Section 4.6.1.6, beach stabilization efforts have the potential to affect seabeach amaranth negatively. The nourishment portion of the proposed project could result in adverse effects as seed burial may deter germination the following season, depending upon the depth of disposal material (USFWS, 1993). Additionally, seabeach amaranth grows in dynamic coastal environments such as overwash areas and dune blowouts; therefore, stabilization of these areas through nourishment actually degrades the primary habitat. Burial during sand placement presents another direct impact to the species. Although seabeach amaranth seeds are accustomed to becoming wholly or partially buried by winter sand movement (USFWS, 1996b), if seeds become deeply buried due to nourishment activity, populations could be negatively affected (USFWS, 2002; 2010). Studies have found that seedlings do not emerge from a depth of more than 1 or 2 cm (USFWS, 2010a). Burial of the seed bank may be particularly detrimental to isolated populations, as no nearby seed sources are available to re-colonize the nourished site and will contribute to fragmentation (USFWS, 2002). USFWS biologist Dale Suiter suggested it is likely that burial would delay germination of seeds, not prevent germination entirely (*pers. comm.*, 2007). The extent of the potential effects of burial relies on the nature of seabeach amaranth's seed bank and the importance of long distance and water dispersal of seeds; however, these topics need further study (USFWS, 1996b). In contrast, the restoration of the eroded shoreline may provide suitable habitat and encourage colonization post-nourishment, as has been observed following other nourishment projects. It should also be noted that while the above impacts may occur to seabeach amaranth, no recent (post 2009) surveys have been performed in the area; therefore, it is not known if any plants exist there currently.

5.6.6.3 Associated Impact with No Action Alternative

Under the no action alternative, the Kill Devil Hills shoreline will experience the same long-term erosion rates and storm vulnerability discussed under the abandon and retreat alternative, which will likely result in a loss of beach and dune habitat over the next 20 to 25 years. Additionally, this habitat may be further degraded by efforts of property owners within the project area to afford their properties storm protection temporarily, including beach scraping, sand fencing and sand bagging. There is conflicting evidence that sand fencing may adversely affect this species. On the one hand, sand fencing may stabilize dunes such that the plant communities undergo succession to species that outcompete seabeach amaranth, which prefers unstable, dynamic environments. Contrastingly, plants have been observed thriving in areas where sand fencing occurs, such as Bogue Banks, NC (USFWS, 2009) Placement of sand bags generally occurs in the narrow strip of sand where seabeach amaranth would occur. As previously stated, it is unlikely seabeach amaranth would occur within the project area due to the level of development and recreational use of the beach. Therefore, the No Action Alternative is not likely to affect seabeach amaranth adversely.

5.6.7 Piping Plovers

5.6.7.1 Associated Impact with Abandon and Retreat Alternative

With the abandon and retreat alternative, the line of development would slowly shift landward and the beach would be allowed to shift and change shape according to changing wind and wave conditions. In the absence of structures, the shoreline would be able to migrate inland, during times of seasonal and storm induced erosion, yet sand would be maintained within the system for natural recovery of the beach. Storms winds and waves would result in the creation of natural overwash areas, which serve as primary habitat for the piping plovers. Essentially, beach habitat would be naturally maintained, ultimately benefiting piping plovers. Additionally, the abandon and retreat alternative may reduce the amount of human presence along the beach strand, which would reduce disturbance to piping plovers while foraging, nesting and roosting..

5.6.7.2 Associated Impact with Preferred Action Alternative

Because piping plovers occur year-round in North Carolina, construction may overlap with the presence of wintering, breeding or migrating piping plovers. The data provided by the NCWRC indicates that piping plovers have been observed along Bodie Island and that breeding activity occurs there as well. If piping plovers are present within the Project Area, they will be temporarily disturbed by the staging, storage and transportation of equipment, materials, supplies and workers on the beach in support of the sand placement onto the beach. Noise associated with construction may stress the piping plovers during the projected construction period by causing them to spend more time being alert than foraging and resting (Burger, 1994). These disturbances will likely cause piping plovers to seek out and use alternative habitat areas outside of the influence of project activity. Responses to noise levels are difficult to predict and the frequency, duration and intensity of noise must be taken into account. Higher noise levels may result in a startle response such as flushing from nests when incubating eggs, or interruption of feeding or courtship (USFWS, 2010).

Infaunal prey density has been shown to affect habitat use in shorebirds (Peterson *et al.*, 2006). The direct placement of sand will result in the burial and nearly complete mortality of benthic infauna along the beach and shallow water surf zones at the project nourishment locations. This would indirectly affect any adult and flightless chicks attempting to forage in the ocean intertidal zone within the Project Area. While adults may seek out alternate foraging areas adjacent to the Project Area, chicks would be unable to and hence would be adversely impacted.

A wider and more stable beach following project construction may both positively and negatively affect piping plovers. While it may provide a more consistent buffer between important bird habitat areas and upland development and associated human activities, it may also encourage more development and recreational use of the beach, further degrading habitat. With increased development comes the potential for increases in populations of domesticated and feral animals that predate on piping plover nests. At the same time, beach nourishment may benefit plovers by creating new habitat in an area where erosion has degraded or reduced available habitat. The increase in beach width from beach nourishment activities should increase the amount of available roosting habitat, and eventually increase the amount of suitable foraging habitat after benthic invertebrates repopulate the nourished area.

Beaches near the Project Area (Bodie Island) have historically supported 12% of piping plover occurrences within the northern region and 10% of statewide occurrences. However, in the case of Kill Devil Hills, shoreline recession coupled with residential development has greatly reduced the amount of dry beach available for roosting and nesting, as well as wet beach for foraging. Additionally, the beaches in these areas are heavily utilized recreationally, with pedestrians, dogs and vehicular traffic that discourages use by shorebirds (Sara Schweitzer, *pers. comm.*, August 29, 2013). Therefore, it is not likely that piping plovers will occur within the Project Area.

1.1.1.1 Associated Impact with No Action Alternative

Under the no action alternative, the Kill Devil Hills shoreline will experience the same long-term erosion rates and risk of storm damage as discussed under the abandon and retreat alternative, which will ultimately result in loss of beach and dune habitat over the next 20 to 25 years. Additionally, this habitat may be further degraded by efforts of property owners within the project area to temporarily afford their properties storm protection, including beach scraping, sand fencing and sand bagging. These activities can temporarily disrupt benthic communities (beach scraping) and reduce amount of habitat available (sand bagging). Regardless, it is unlikely piping plovers would occur within the project area due to the level of development and recreational use of the beach.

5.6.8 Red Knot

5.6.8.1 Associated Impact with Abandon and Retreat Alternative

The retreat of development from the shoreline would allow the beach and dune system to respond naturally to the ever-changing environmental conditions. The shoreline would shift landward during times of increased wind and wave activity, and accrete seaward during more benign sea states. This would allow for the persistence of primary foraging habitat – the wet beach – and ultimately benefit red knots. Additionally, the abandon and retreat alternative may reduce the amount of human presence along the beach strand, which would reduce disturbance to red knots while foraging.

5.6.8.2 Associated Impact with Preferred Action Alternative

In North Carolina, shore protection projects occurring outside the environmental dredging windows, particularly during the months of April through June, may affect migrating red knots. Construction activities will likely cause the birds to seek out other areas for foraging or roosting, expending extra energy to do so. Because the birds arrive at stopover locations with depleted energy reserves, having to seek out alternate foraging areas could be detrimental to weight gain before departing to the next stopover. Departing for the next stopover with depleted energy reserves could result in cumulative weight problems that prove detrimental to survival and successful reproduction once the birds reach nesting grounds in the artic.

Shore protection projects involving sand placement may also indirectly affect the foraging success of red knots by reducing or eliminating the infaunal prey source. Key infaunal prey species for red knots include coquina clams, mole crabs and marine worms, all of which will be susceptible to burial and smothering in a beach nourishment project. Although the infaunal communities will likely be directly impacted during construction, it is expected that these communities would recover in a short period due to re-colonization of infaunal organisms from adjacent undisturbed habitat. In a literature review of the effects of beach nourishment on benthic habitats covering documentation of a wide variety of sites along the United States coasts of the Atlantic Ocean and Gulf of Mexico, Taylor Engineering, Inc. (2009) concluded that most studies have found impacts to benthic habitat to be short-term, as most benthos are adapted to a dynamic environment. Nelson (1985) also found organisms that reside in intertidal zones are more adaptable to fluctuations in their environment, including high sediment transport and turbidity levels. Therefore, long-term affects to the infaunal community are not expected to result from a project placing material onto the beach. An example of a project that constructed a beach fill project spanning a considerable length of shoreline was completed in Nags Head in 2011. The Town of Nags Head implemented a beach nourishment project and placed material along approximately 10 miles of oceanfront shoreline. Results from post-construction benthic monitoring have confirmed that the area impacted by sand placement on Nags Head beach has regained a viable assemblage of benthic organisms that is similar to non-impacted beaches both one year post-construction (CZR Incorporated and CSE, Inc., 2013) and two years post-construction (CZR Incorporated and CSE, Inc., 2014). The year-2 post-construction surveys showed no significant differences between the nourished beach in Nags Head from the control beaches in the study in terms of mean difference of taxa richness or sand grain size. On the nourished beach, wintertime abundance was actually significantly higher two-years post nourishment than pre-nourishment (CZR Incorporated and CSE, Inc., 2014).

In summary, although the Delaware Bay and coastal Virginia represent the largest stopover concentration of red knots, coastal North Carolina does support a relatively small number of red knots during their spring migration. Beach nourishment activities have the potential to affect red knots directly due to disturbance and indirectly due to impacts to benthic prey sources. A reduction in the infaunal prey base could adversely affect red knots by causing them to expend valuable and depleted energy reserves to locate prey in adjacent areas. However, the adaptability and rapid recovery of benthic communities, sufficient periods between maintenance events and proximity of adjacent non-effected and less disturbed habitats, all serve to reduce the level of impact to rufa red knots. In addition, one of the many planning initiatives identified in the 2010 USFWS Action Plan includes habitat enhancement and restoration, including sand nourishment and beach restoration; hence the proposed projects may serve to benefit the species (USFWS, 2010b).

5.6.8.3 Associated Impact with No Action Alternative

Impacts to red knots resulting from the no action alternative will be similar to those discussed for piping plovers. With no action, the current long-term erosion rates and risk of storm damage will continue as the status-quo, and may ultimately result in loss of beach and dune habitat over the next 20 to 25 years. Additionally, this habitat may be further degraded by efforts of property owners within the Project Area to afford their properties storm protection temporarily, including beach scraping, sand fencing and sand bagging. These activities can temporarily disrupt benthic communities (beach scraping) and reduce amount of habitat available (sand bagging). Regardless, it is unlikely red knots would occur within the Project Area due to the level of development and recreational use of the beach. Therefore, the No Action Alternative is not likely to affect red knots adversely.

5.6.1 Roseate Turn

5.6.1.1 Associated Impact with Abandon and Retreat Alternative

This species has rarely been observed within Dare County, and specific nesting locations within the state are largely unknown. The abandon and retreat alternative will likely have no effect on the roseate turn.

5.6.1.2 Associated Impact with Preferred Action Alternative

Construction of the proposed project will not affect habitats preferred by this species for nesting (densely vegetated areas of coastal islands, among rock rip-rap or coral rubble piles), or foraging (shallow bays, tidal inlets and channels, sandbars with rapidly moving water) nor will it significantly affect food resources on which it depends during migrations (most often small schooling fish). The proposed project should therefore have no effect on the roseate tern.

5.6.1.3 Associated Impact with No Action Alternative

With the absence of roseate turn habitat and lack of observations within the project area, the No Action Alternative is not likely to affect roseate terns adversely.

5.7 Cultural Resources

5.7.1 Associated Impact with Abandon and Retreat Alternative

There were no imminently threatened structures of historical or cultural importance along the shoreline where sand will be placed. As a result, abandonment or relocation of any structures along the shoreline within the Project Area will not impact any cultural resources.

5.7.2 Associated Impact with Preferred Action Alternative

Currently, there are no known cultural resources within the proposed offshore borrow areas. Should culturally significant materials be identified the appropriate avoidance measures will be taken to ensure the project activities do not impact these resources.

5.7.3 Associated Impact with No Action Alternative

No impacts are anticipated for cultural resources, offshore or on land, with the no action alternative.

5.8 Socioeconomic Resources

5.8.1 Associated Impact with Abandon and Retreat Alternative

While analysis of LiDAR data and historical shoreline change indicate only 16 structures will become imminently threatened by long-term erosion within the next 25-30 years, storm vulnerability (SBEACH) analysis suggests there are 40 (35 residential and 5 commercial) structures at risk of substantial storm damage within the next 20 to 25 years. The tax values of the 35 residential threatened structures range from $50,000 to just under $1.0 million. The low tax value of some of the structures is due to their proximity to the shoreline and the non-conforming status of their lots that would not, under existing CAMA (Coastal Area Management Act) development rules, allow the structures to be rebuilt if they are damaged by more than 50% of their value for any reason. The total tax value of the 35 structures is $5.64 million, or an average of $161,000 per structure.

At the present time, there are an estimated 40 vacant lots located between N. Virginia Dare Trail and NC 158 (Croatan Highway) south of the town limits to the vicinity of the Avalon Pier. This is the same general area where most of the vulnerable structures are located. The vacant lots have a tax value ranging from $32,000 to around $250,000 and average $124,000 per lot.

While there appears to be enough vacant lots to accommodate the at-risk ocean front structures in this section of Kill Devil Hills, many factors would be involved in determining which structures would or could be moved to new lots and which structures would be demolished. The primary factors include the desires of the property owners to either move or demolish the structure, the associated cost to move a structure versus demolition, and the willingness of the owners of the vacant lots to sell. Due to the many unknowns, no attempt was made to determine the total cost of relocating or demolishing the at-risk structures. However, based on previous analysis performed by Coastal Science & Engineering (CSE) for the Town of Nags Head (CSE, 2005), the cost of moving a structure could cost up to $150,000 per structure. This does not include the cost of the new lot.

In order to implement the Abandon/Retreat alternative in an orderly fashion, it is recommended the Town of Kill Devil Hills acquire at least 30 vacant lots north of the Avalon Pier in advance of the need to move threatened structures. This assumes that at least 5 of the at-risk structures would be demolished. Based on the average tax value of vacant lots along the northern portion of Kill Devil Hills, the cost of 30 lots would be around $3.75 million.

The five (5) commercial buildings at risk of damage due to a storm similar to Hurricane Isabel include portions of two (2) motels (The Mariner and the Sea Ranch) and three (3) large condominium complexes (the Sands, Golden Strand, and Sea Oat Villas). The assessed value of the five (5) structures is about $6.0 million or an average of $1.2 million per structure.

Under the Abandon/Retreat alternative, structures that are relocated to another lot within the Town of Kill Devil Hills should retain their value; however, the value of the abandoned lot would decrease to essentially zero. Structures that are demolished would be removed from the Kill Devil Hills tax base as would most of the value of the lot on which they were located.

5.8.2 Associated Impact with Preferred Action Alternative

Due to the proposed project schedule, construction activities will be performed during the peak of tourist season in Kill Devil Hills. During periods of active construction, sections of the beach will be closed to the public to ensure public safety. Likewise, the borrow areas and pump-out locations will be closed to boat traffic. These safety measures, coupled with increased noise and decreased aesthetics of construction equipment on the beach, may result in a temporary reduction in the number of beach visitors and associated revenue. Upon completion of the project there will be several benefits to the socioeconomics of the Town. A wider beach will create more space for recreational activities, while affording the residential and commercial properties there a greater level of storm damage reduction. This will sustain the beaches that support the local economy and maintain tax base, as well as prevent the Town from incurring the costs associated with demolition or relocation of the structures.

5.8.3 Associated Impact with No Action Alternative

Under the No Action alternative, no additional attempts would be made to reduce or mitigate shoreline recession or the threat of storm damages beyond the status quo. As such, property owners would be expected to continue to implement temporary protection measures such as sand fences, beach scraping or sand bagging. As a result, the same 35 residential and 5 commercial structures identified at risk under Alternative 1 would remain for Alternative 3. Based on the risk analysis for a storm similar to Hurricane Isabel, there is better than a 50% chance that all 35 of the at-risk residential structures would be damaged beyond repair within the next 15 years. This would remove the tax value of the structures from the town's tax base. The lots on which the at-risk structures are on would also decrease in tax value with the value essentially dropping to zero.

Of the 5 at-risk commercial building, only one would probably suffer enough damage to make it non-repairable in its present location. That structure could possibly be demolished and a new structure built further back on the same lot. Damage to the other 4 at-risk commercial properties would not necessarily destroy the entire complexes, as some of the structures located on the properties are situated landward of the storm impact line. However, assuming the structures remain at their present locations, the potential for repetitive storm damage would impact their habitability for significant periods of time post-storm and could lower their overall value.

The primary financial difference between Alternative 1 (Abandon/Retreat) and Alternative 3 (No Action) is that individual property owners would not incur the cost of moving structures to inland lots. Demolition and rebuild cost for the at-risk commercial structures would be essentially the same for both Alternative 1 and Alternative 3.

5.9 Recreational and Scenic Resources

5.9.1 Associated Impact with Abandon and Retreat Alternative

Scenic resources will deteriorate if any of the at-risk properties are abandoned and left to the elements. Damages incurred by the structures from coastal processes such as winds, waves, and erosion will eventually render the structures uninhabitable, and may make the beach area in the immediate vicinity unsafe for any recreational activities. The recreational value of the beach will also depreciate as storm induced erosion reduces the amount of beach available for activities such as beach driving, walking, surf fishing, etc.

5.9.2 Associated Impact with Applicant's Preferred Alternative

The proposed timeline for the project means construction may occur during peak recreation season in Kill Devil Hills. Beachgoers will temporarily be exposed to elevated noise levels due to construction activities on the beach, and sections of the beach and nearshore environment will be off-limits to the public for safety reasons.

5.9.3 Associated Impact with No Action Alternative

Under the no action alternative, impacts to the scenic and recreational resources will be similar in nature to the abandon and retreat alternative. As storm-induced erosion causes shoreline recession, the short-term protection measures potentially taken by some property owners can alter the recreational and aesthetic value of the beach. Activities such as beach scraping and sand bag placement effectively reduce the amount of recreational beach available, as well as reduce the aesthetic nature of the shoreline. In this way, no action can negatively impact recreational and scenic resources of the Kill Devil Hills shoreline.

5.10 Impacts Comparison of Alternatives

For comparative purposes, each of the major impacts discussed for the three alternatives are summarized in Table 25.

Table 25. Comparison of potential impacts for each resource resulting from the three alternatives.

Resource	Potential Impacts		
	Abandon/Retreat	**Proposed Action**	**No Action**
Water Quality	No impacts.	Temporary turbidity increase at borrow area; temporary increase at fill site	No impacts.
Air Quality	No impacts.	Temporary and localized reduction in air quality due to emissions from construction equipment and dredging vessels	No impacts.
Noise	Temporary increases due to construction associated with demolition or relocation efforts.	Temporary increase at beach fill site due to construction equipment and activites; temporary increase in marine sound at borrow areas from dredging; higher peak pressure levels produced by hopper dredges may be detrimental to marine life	Possible temporary and sporadic increase in noise levels due to use of construction equipment used for beach scraping or sand bag emplacement
Beach and Dune Habitat	Loss of beach/dune in some areas due to long-term erosion and storms until structures removed; Removal of coastal structures may allow shoreline to respond naturally to erosion, undergoing natural recession and accretion.	Increase in beach/dune habitat; temporary elimination of infaunal benthic community	Loss of beach/dune in receding areas due to long-term erosion and storms; potential further degradation of habitat from beach scraping or sand bag emplacement.
EFH – Marine Water Column	No impacts.	Temporary elevated turbidity levels at borrow site(mid-and inner-shelf) and fill site (surf zone); burial of benthics in surfzone	No impacts.
EFH – Offshore Shoals	No impacts.	Removal of benthic organisms due to sand excavation; alteration of seabed topography could reduce habitat value	No impacts.

Table 25 Continued.			
T&E Species	Loss of beach/dune habitat in some areas due to long-term erosion could adversely affect sea turtles, red knot and piping plovers; Removal of structures may indirectly create additional habitat and reduce human disturbance to sea turtles, red knots, piping plovers	Adverse impacts include: Entrainment of sea turtles; Noise harassment to sea turtles; Burial of beach/subtidal; Harassment/injury to nesting and hatchling sea turtles from construction lighting and activities; Alteration of sea turtle nesting habitat; Disruption of foraging and roosting activity for piping plovers and red knots during active construction Positive impacts include: Increased beach habitat for sea turtles (nesting), red knots (foraging, roosting), piping plovers (nesting, foraging, roosting), seabeach amaranth (germination, growth)	Loss of beach/dune habitat potentially utilized by sea turtles (nesting), red knots (foraging, roosting), piping plovers (nesting, foraging, roosting), seabeach amaranth (germination, growth); degradation of same habitats due to potential use of sand fencing, beach scraping, sand bags
Cultural Resources	No impact.	No impact.	No impact.
Socioeconomics	If at-risk structures are abandoned, the value of structures and lots will be removed from tax base; If relocated, structure will maintain value, original lot will decrease to $0; expenditure to purchase new lots for relocation (~$3.75 million); reduction in volume and cost of material needed to construct beach nourishment project.	Cost of project implementation and periodic nourishment, may be reduced if performed in conjunction with Duck and Kitty Hawk; temporary reduction in tourism and associated revenue due to construction activity and temporary closure of actively constructed beach sections; post-project increased tourism due to wider recreational beach; maintains the tax base of homes in the Project Area by reducing storm vulnerability	Loss of recreational beach from storms would decrease tourism revenue; Eventual removal of at-risk residential structures from tax base if damaged beyond repair; Reduction of lots to $0 if structures damaged; Temporary impact to habitability of at-risk commercial structure due to storm damages.
Recreational and Scenic	If structures are abandoned, storm-induced erosion may reduce amount of recreational opportunities afforded by the beach; Deterioration of abandoned property will temporarily reduce aesthetic value of beach, reduce safety and usage of beach until demolition occurred. Relocation of structure may allow establishment of natural communities, improving aesthetics, and allow natural cycles of accretion/recession to maintain recreational beach	Temporary reduction in tourism due to construction activity and temporary closure of actively constructed beach sections; Closure of areas in proximity to the offshore borrow areas to recreational boat traffic; Reduced aesthetics due to construction equipment and offshore dredges; Increased beach width supports more recreational activity and creates a more aesthetically pleasing beach	Loss of recreational beach from storm-induced erosion, Reduced aesthetics from beach scraping or sand bag projects

6 Cumulative Impacts

The Council of Environmental Quality defines cumulative impacts as:

> *"The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably forseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time."*(NEPA 40 CFR 1508.7)

Cumulative impacts may occur on a temporal (e.g. time crowding or time lagging) or spatial (e.g. space crowding, cross-boundary, or fragmentation). The likelihood that multiple projects will occur throughout coastal North Carolina contributes to time-crowded and space-crowded cumulative effects. Currently, there are several non-federal beach nourishment/construction projects within the state that have been proposed or are currently in the permitting process, some of which also propose to construct outside the environmental windows (Table 26).

Table 26. Proposed federal and non-federal beach nourishment projects within North Carolina and the projected start dates.

Project	Projected Start Date
Duck	February 2016
Kitty Hawk	February 2016
Kill Devil Hills	February 2016
Rodanthe	Summer 2016
Atlantic Beach/Ft. Macon	Winter 2019/2020
Pine Knoll Shores	Winter 2022/2023
Salter Path	Winter 20222023
Emerald Isle	Winter 2019/2020
North Topsail Beach	Winter 2014/2015
Topsail Beach	November 2014
Figure Eight Island	November 2015
Wrightsville Beach	Winter 2018/2019
Carolina Beach	Winter 2016/2017
Kure Beach	Winter 2016/2017
Bald Head Island	Winter 2015/2016
Caswell Beach	Winter 2017/2018
Ocean Isle Beach	November 2015

As can be seen in the table, various other projects are also slated to occur during 2016. Carolina and Kure beaches will be constructed during the winter, within the environmental windows typically recommended for nourishment projects. While they will not occur at the same time as Kill Devil Hills, there is the potential for any time lag effects to occur simultaneously with those resulting from Kill Devil Hills.

The towns of Kitty Hawk and Duck are pursuing nourishment projects similar in nature to the Kill Devil Hills project, and the projects will likely be coordinated between the three towns. The towns are all pursuing constructing their respective projects outside the environmental windows. The proximity of these beaches and timing of the projects leads to the potential of time-crowded and space-crowded impacts in Dare County.

It is also important to evaluate the amount of beach habitat that could be impacted by beach nourishment in the foreseeable future, relative to the entire North Carolina shoreline. Table 27 presents a summary of the miles of shoreline that are currently managed, under development for a beach management program, or could potentially be managed in the future. In the case of Kill Devil Hills, the proposed project will involve approximately 2.77 miles of nourished shoreline, representing less than 0.01% of the 326 miles of oceanfront shoreline in North Carolina. Going further, there are 124 miles of shoreline that are actively managed either in a beach nourishment program or under development for one. Additionally, when the municipalities that *could potentially* seek management in the future are considered, the total amount of managed shoreline could reach 163 miles. Considering an average nourishment interval of 4.4 years, up to 11.4% (37 miles) of shoreline could be nourished per year. This number assumes all projects will be constructed during the same year, and is therefore the maximum amount of shoreline that could be nourished in a given year. Actual mileage of nourished shoreline per year will likely vary from this number. Additionally, it is not likely that all projects will pursue summertime dredging, therefore the type and magnitude of direct and indirect impacts will vary.

Table 27. Summary of beach nourishment projects in North Carolina that are authorized, being pursued, or may be pursued in the foreseeable future.

Status of Beach Management	Miles of Shoreline	Average Nourishment Interval	% of NC Shoreline.
Currently Managed	86	4.4	6
Currently Managed and Under Development	124	4.4	8.7
Currently Managed, Under Development, and Potentially Managed	163	4.4	11.4

Bearing this information in mind, the following sections discuss the cumulative impacts for the resources identified in Chapter 4

6.1 Water Quality

The water quality along the beaches in Kill Devil Hills and the Outer Banks in general, is very high. Offshore borrow areas targeted for beach nourishment projects are generally comprised of "clean" sand with a low percentage of fine material. As a result, sediment plumes generated while dredging are generally short-lived, measurable on a scale of thousands of meters, and a not considered a source of concern (Michel *et al*., 2014). In the proposed project, the dredging and placement of high quality sand will limit the amount of turbidity created within both the offshore borrow area and nearshore surfzone. There are no long-term adverse impacts to water quality anticipated for the Kill Devil Hills nourishment project. Therefore, cumulative impacts are also not anticipated within the project area.

6.2 Air Quality

It can be assumed that insignificant additions of greenhouse gases will be emitted from dredge and construction equipment. There are no long-term adverse impacts to air quality anticipated for the proposed project. As a result, the project will not contribute to cumulative impacts to air quality within or in the vicinity of the project area.

6.3 Noise

There are many sources of sound in the marine environment, and sound produced in one location can perpetuate for long distances, reaching areas many miles from the source. Within the Project Area, the most likely sound sources include noise from commercial shipping activities, commercial and recreational fishing vessels, and dredging activities. Although the hearing thresholds for many marine organisms are unknown, it has been determined that hopper dredging noise overlaps the hearing spectrum for baleen whales and possibly sea turtles. Although increased noise levels from the proposed project will be temporary, and not likely to cause injury, the cumulative impact of many sources of marine noise may mask biologically important sounds for these and other marine animals.

Additional sources of marine noise that may occur within the project area in the forseeable future include geological and geophysical (G&G) activities, which have recently been approved by the Bureau of Ocean Energy Management (BOEM). The G&G activities will require the use of air guns to perform seismic surveys in search of oil and gas resources under the ocean floor, as well as to map sand deposits. One of the major concerns with these activities comes from the potential impacts to marine life that would result from the intense blasts of sound used during the surveys, which send acoustic waves into the sea floor. These blasts may be detrimental to marine mammals, fishes and other marine organisms in the area.

6.4 Natural Setting and Wildlife

Current factors affecting the beach and dune setting include increasing population along the coast, increasing recreational use of coastal habitats, and increased development. In some cases, the presence of hard structures (roads, homes, commercial buildings) prevents the shoreline from naturally responding to erosional forces, precluding natural accretion. Sea level rise and storm-induced erosion have also decreased the amount and quality of natural beach habitat. All of these elements cumulatively encroach upon natural beach and dune habitat that serves has storm protection for the human environment and habitat for wildlife.

It is reasonable to expect that the factors affecting the beach and dune habitat will continue, as will the demand for shoreline nourishment and increased storm protection. The major impacts to these habitats resulting from future nourishment projects will likely be similar to the proposed project. Firstly, burial of the infaunal community will be complete and instantaneous, removing an important food source for many animals. The period anticipated for infaunal recovery varies, but is generally reported to be less than one-year post disturbance. Secondly, the project will artificially create a new, larger beach and dune. As the sand is reshaped by natural forces (sun, wind, rain, waves), the beach can eventually provide habitat suitable for flora and fauna, such as nesting habitat for sea turtles. This is only true if the restored beach is sufficiently representative of the native beach in shape and composition. The restored beach is still subject to the above listed anthropogenic and natural forces that will continually result in loss of the beach. This creates the need for repeated nourishment projects. For example, the volume of material that will be placed along the project shoreline in Kill Devil Hills includes five years of advanced nourishment. Thereafter, the beach will be maintained through a program of periodic nourishment. The larger beach welcomes more human activity such as recreation and development and may make it unsuitable habitat for some species, such as piping plovers and seabeach amaranth.

Cumulative impacts to the beach and dune environment may be time crowded (as in maintenance nourishment occurring frequently on a single beach) and/or space crowded (multiple beaches within a region undergoing nourishment simultaneously). In essence, if numerous beach nourishment projects with relatively insignificant negative impacts are clustered spatially and temporally, the result could be a summation of impacts such that they become large scale and significant.

6.5 Threatened and Endangered Species

6.5.1 West Indian Manatee

The greatest threat to manatees is watercraft strikes, and it is reasonable to expect that these collisions will continue to take place in the future. However, the proposed projects will not occur within primary habitat (warm water sights or areas containing submerged aquatic vegetation), and manatees reportedly do not frequent open ocean areas where dredging will occur. There are no cumulative impacts to manatees within the Project Area and the proposed project is therefore not expected to contribute to cumulative effects for the West Indian Manatee.

6.5.2 Humpback and North Atlantic Right Whales

In addition to those threats previously discussed in section 4.6.1.2, it is reasonable to expect that federal and non-federal beach nourishment projects will continue to occur for many coastal towns of North Carolina in the foreseeable future. Although humpback and North Atlantic right whales may be present within coastal waters of North Carolina, they are most commonly observed in the fall, winter and spring; therefore, the proposed projects do not pose a significant risk for direct impacts to whales. The proposed project is therefore not expected to contribute to cumulative effects for either whale species.

6.5.3 Sea Turtles

Activities that cumulatively threaten the survival of all sea turtle species include mortality or injury from fisheries by-catch, vessel strikes, marine debris ingestion or entanglement, environmental contamination and disease. These factors may occur within the Project Area and are expected to continue in the future. Threats to nesting and hatchling success include disturbance from humans (unintentional or intentional harassment of nesting females or hatchlings), coastal development (increased lighting issues, reduced nesting habitat quality and quantity), predation and nest washout.

The proposed beach nourishment project may compound several of these threats and therefore may contribute to these negative cumulative impacts. The potential for the project construction 24 hours-per-day exposes nesting females and hatchlings to affects caused by artificial lighting used at night. These affects include false crawls, nest deposition in unfavorable areas and hatchling disorientation and mortality. As artificial lighting from coastal development already poses a great risk to sea turtles, the proposed project could potentially exacerbate these impacts. The construction activities and presence of machinery on the beach may also deter females from nesting, resulting in an increase in the number of false crawls. Other nighttime human activity reduces nesting success by preventing nesting females from emerging to nest, or causing them to abandon a nesting attempt. Additionally, beach furniture and recreational equipment left on the beach overnight can create barriers to females and hatchlings.

The proposed project aims to create a more stable, wider beach that may lead to a greater anthropogenic use such as increased recreational activities and more urban development to support growing tourism. An increase in development brings with it domesticated animals such as cats, dogs and other wildlife that are attracted to an urban setting such as raccoons and foxes. These animals may prey on eggs and hatchlings, exacerbating the natural predation pressure.

The likelihood that multiple nourishment projects will occur throughout coastal North Carolina also contributes to these cumulative impacts. At the present time, there are several non-federal beach nourishment/construction projects within the state that have been proposed or are currently in the permitting process, some of which also propose to construct outside the environmental windows (Table 26). In essence, numerous beach nourishment projects could lead to reduced nesting success, increased hatchling mortality and a larger draw for tourism, development and subsequent negative impacts across a large area. It is important to evaluate the amount of sea turtle nesting habitat in North Carolina that could be impacted by beach nourishment in the foreseeable future. Table 27 evaluates the current and potential beach nourishment activities affecting the North Carolina coastline, which spans 326 miles. In the case of Kill Devil Hills, Kitty Hawk and Duck, the proposed projects will involve a combined 8 miles of nourished shoreline, representing just over 2% of the oceanfront shoreline in North Carolina. Going further, there are 124 miles of shoreline that are actively managed either in a beach nourishment program or under development for one. Additionally, when the municipalities that *could potentially* seek management in the future are considered, the total amount of managed shoreline could reach 163 miles. With an average nourishment interval of 4.4 years, up to 11.4% (37 miles) of shoreline could be nourished per year. This number assumes all projects will be constructed during the same year, and is therefore the maximum amount of shoreline that could be nourished in a given year. Actual mileage of nourished shoreline per year will likely vary from this number. Additionally, it is not likely that all projects will pursue summertime dredging; therefore, the type and magnitude of direct and indirect impacts to sea turtles will vary.

Beach erosion is also considered a threat to sea turtles due to loss and degradation of nesting habitat. While erosion can be remedied through beach nourishment projects, if they are designed and constructed such that the new beach does not mimic the native beach in composition or profile, sea turtles can be negatively affected. It follows that if multiple projects produce improperly designed beaches with poor-quality sediment, the cumulative impacts to turtles could be negative and quite substantial. However, when designed and constructed properly, a renourished beach may benefit sea turtles by providing a stable nesting habitat. Therefore, if the culmination of beach nourishment projects within the region were able to construct turtle friendly beaches, the resulting cumulative effect would be a substantial increase in habitat available for nesting.

6.5.4 Atlantic and Shortnose Sturgeon

The proposed projects will not occur within habitats utilized by the shortnose sturgeon, as this species has rarely been sighted in the marine environment. There are no cumulative effects for this species within the Project Area. However, the Atlantic sturgeon may utilize the offshore marine environment throughout the year, therefore the Project Area may contain habitat used by migrating and foraging individuals. Cumulative effects for Atlantic sturgeon that occur within the Project Area include by-catch of sturgeon in fisheries targeting other species, and habitat degradation of foraging areas resulting from shoal dredging. Continued beach nourishment projects are likely to occur throughout the sturgeon's range. Many of these projects, like those for Kill Devil Hills, Kitty Hawk and Duck, will likely propose dredging of offshore sand shoals as a source of beach restoration material, which may also serve as foraging or aggregation areas for Atlantic sturgeon. Dredging of multiple offshore sand shoals may result in detrimental changes in physical and environmental characteristics of these features resulting in degradation of this habitat.

6.5.5 Seabeach Amaranth

Seabeach amaranth is threatened, in part, due to loss of suitable habitat caused by dune and beach erosion. Proposed beach nourishment projects will provide suitably sorted, beach-compatible material and will offer potential habitat for seabeach amaranth colonization. Previous beach nourishment projects have rebuilt habitat for seabeach amaranth and have had long-term benefits to populations, as seen in Bogue Inlet (Dale Suiter, *pers. comm.*, 2007) and Wrightsville Beach (USFWS 1996b). The cumulative impact that would result from multiple beach nourishment projects throughout this species range is therefore considered beneficial.

6.5.6 Piping Plover

Disturbance from humans, motorized vehicles and pets are cited as some of the major contributors to the decline of the Atlantic coast population of this species. The proposed project may result in an increase in anthropogenic influence (increased recreational use of the new beach), potentially intensifying the negative disturbances caused by humans and domestic animals.

Piping plovers can be found on many beaches throughout the North Carolina coastline, therefore; the various projects presented in Table 26 may cumulatively affect piping plovers. Of particular note are the Kitty Hawk and Duck nourishment projects that may occur simultaneously with Kill Devil Hills. As discussed in section 6.5.3, the three shorelines constitute a combined 8 miles, which is just over 2% of the total oceanfront shoreline within North Carolina. The cumulative effects of these projects can be complex; however, as beach nourishment can simultaneously benefit the birds by restoring important foraging habitat for the Atlantic Coast populations, yet also degrade foraging habitat by eliminating infaunal communities within the wet beach.

Nourishment projects may also adversely affect wintering and nesting habitat by stabilizing and eliminating dynamic overwash areas. The assumption that the Kill Devil Hills project and all other proposed projects will be constructed with quality, compatible sand that allows for recovery of the infaunal community permits the determination that the proposed project will not permanently affect foraging. Nourishment projects in North Carolina may affect a maximum of approximately 11% of the North Carolina coastline annually, which is considered a comparatively small amount of the shoreline available to piping plovers within the state.

6.5.7 Rufa Red Knot

The U.S Fish and Wildlife Service has proposed to list the *rufa* red knot due to several factors including habitat loss from sea level rise, shoreline stabilization, Artic warming, reduced food availability, increasing asynchronies in timing of the bird's migratory cycle and food availability and increases in predation at the Artic breeding grounds (78 FR 60023). Beach nourishment may contribute to these factors, mainly the reduction in food availability and asynchronies between stopovers and feeding opportunities.

Red knots need to encounter favorable food, habitat and weather conditions within narrow seasonal windows at stopover locations to successfully complete the migration and are therefore sensitive to changes in these parameters. This can be exemplified by the reduction in availability of horseshoe crab eggs at the Delaware Bay stopover, which caused a substantial decline in red knot numbers beginning in the 1980's (78 FR 60023). Therefore, the burial and subsequent reduction of the infaunal communities caused by beach nourishment activities, combined with already stressed food resources, may cumulatively affect food availability for the migrating birds.

A related and major factor threatening the *rufa* red knot is the asynchronies between arrival at stop overs with food availability caused by climate change. Timing of stopovers must be precise, as the birds must reach the Artic breeding grounds in time for the short breeding season there. The birds arrive at the stopovers nearly depleted of energy; therefore, the ability to accumulate small additional energy reserves at a stopover is crucial, should migration be delayed or feeding conditions be poor at the next location (78 FR 60023). Beach nourishment projects inevitably bury and smother the infaunal communities when fill is placed on the beach. While this impact is expected to be temporary, and the infaunal communities are anticipated to recover, the reduction in foraging success could potentially create long-term impacts such as reducing breeding success and increased adult mortality.

Aside from reduced food resources, human disturbance and beach erosion threaten the amount of quality habitat available, which is exacerbated by rising sea levels associated with climate change. Beach nourishment may serve to restore crucial habitat by replacing sand lost to storms and erosion. At the same time, the nourishment can indirectly increase human disturbance and development, create a steeper beach or reduce sediment quality, thereby impeding foraging and invertebrate recovery, all of which can negatively affect the *rufa* red knot.

As all of the risks are associated with any beach nourishment project, the combined effects of the projects presented in Table 26 could cumulatively affect the food availability, synchrony of *rufa* red knot presence with prey and habitat quality. Those projects occurring in the same year will produce a cumulative effect of disturbance and reduced infaunal prey available during the year following nourishment, while also creating a synergistic and positive effect on the amount of foraging habitat available (assuming recovery of infaunal communities). But, as discussed for piping plovers above, the assumption that the Kill Devil Hills project and all other proposed projects will be constructed with quality, compatible sand that allows for recovery of the infaunal community supports the determination that the proposed project will not permanently affect foraging. Nourishment projects in North Carolina may affect a maximum of approximately 11% of the North Carolina coastline annually, which is considered a comparatively small amount of the shoreline available to red knots within the state.

6.5.8 Roseate Tern

The Project Area does not include habitats or other resources utilized by the roseate tern. There are no cumulative effects for this species expected to occur within the Project Area.

7 CONSERVATION AND MONITORING MEASURES

The following describes actions and measures incorporated into the design of the Applicant's Preferred Alternative to avoid and/or minimize direct, indirect and cumulative effects to the resources found within the Permit Area and the species that utilize it.

7.1 Construction Practices

7.1.1 Borrow Area Design

The design and configuration of the borrow area can play a major role in dredging efficiency, as well as the level of risk of sea turtle entrainment. For example, hopper dredging within small and irregularly shaped borrow area with varying and step contours can lead to challenging hopper dredging conditions, resulting in a need for frequent turns, or difficulty keeping the draghead in contact with the bottom at all times during pumping. Both of these scenarios result in lifting the draghead from the bottom, which substantially increases the risk for sea turtles to be entrained in the suction field. Therefore, the size and shape of the borrow areas have been designed such that a minimum number of turns will be required by the hopper dredge, which increases dredge efficiency and reduces the potential for sea turtle entrainment.

7.1.2 Dredge Type

Construction of the project will be accomplished using cutterhead suction dredges, trailing suction hopper dredges or a combination of the two. To minimize impacts from hopper dredging, the project will follow all provisions set forth in the South Atlantic Division Corps of Engineers Hopper Dredging Protocol for Atlantic Coast. Specific measures implemented to reduce impacts to turtles are discussed in section 7.3.2.

7.1.3 Dredge Positioning

DREDGEPAK® or similar navigation and positioning software will be used by the contractor to accurately track the dredge location. The software will provide real-time dredge positioning and digging functions to allow color display of dredge shape, physical feature data as found in background Computer Aided Design (CAD) charts and color contour matrix files from hydrographic data collection software described above on a Cathode Ray Tube (CRT) display. The software shall also provide a display of theoretical volume quantities removed during actual dredging operations.

Dredge anchors shall not be placed any further than 200 feet from the edge of the areas to be dredged. The dredge contractor will be required to verify the location of the anchors with real time positioning each and every time the anchors are relocated.

7.1.4 Pipeline Positioning

On the beach, pipelines will transport the sediment to the designated placement area. The pipeline alignment will be designed to avoid potential piping plover habitat or sea turtle nests. The alignment will be coordinated with, and approved by, the USACE. As-built positions of the pipeline will be recorded using GPS technology and included in the final construction observation report.

7.2 Construction Observations

Several initiatives will be undertaken by the Town, the Engineer or his duly authorized representative to monitor construction practices. Construction observation and contract administration will be periodically performed seven days per week, approximately twelve hours per day during periods of active construction. Most observations will be during daylight hours; however, random nighttime observations may be conducted. The Town, the Engineer, or his duly authorized representative will provide onsite observation by an individual with training or experience in beach nourishment and construction observation and testing, and that is knowledgeable of the project design and permit conditions. The project manager, a coastal engineer, will coordinate with the field observer. Multiple daily observations of the pump-out location will be made for quality assessment and quality control (QA/QC) of the material being placed on the beach. The construction contractor will provide redundant observations 24 hours per day during construction.

7.2.1 Sediment Compatibility

The Sediment Criteria Rule, contained in the Technical Standards for Beach Fill Projects (15A NCAC 07H .0312), provides beneficial guidelines for both grain size and percent weigh of calcium carbonate. However, other important characteristics such as organic content, heavy mineral content and color are not addressed. These aspects of the beach material will be considered. Maintaining adherence to this sediment criteria rule for material placed on the beach will reduce adverse impacts to the beach invertebrate community and would also reduce effects to sea turtle nest construction and incubation of the eggs. Multiple daily observations of the active placement locations will be made by the Town, the engineer or his duly authorized representative for QA/QC of the material being placed on the beach. The individual will collect a representative sub-surface (6 in. below grade) grab sediment sample from each 100-ft long (along the shoreline) section of the constructed beach to visually assess grain size, wet Munsell color, granular, gravel, and silt content. Each sample will be archived with the date, time, and location of the sample. Samples will be collected during beach observations. The sample will be visually compared to the acceptable sand criteria. If determined necessary by the Engineer, or his duly authorized representative, quantitative assessments of the sand will be conducted for grain size, wet Munsell color, and content of gravel, granular and silt. A record of these sand evaluations will be provided within the Engineer's daily inspection reports and submitted to USACE and NC DCM for verification.

Following construction, compaction of placed fill material will be inspected by the Town, the Engineer or his duly authorized representative in coordination with the Division of Coastal Management and USACE. Compaction monitoring will begin after the material has been graded and dressed to the final slope and a period of time will be allowed for finer particles to be washed away and final settling of the material to occur prior to compaction monitoring. If the fill material appears to have a higher degree of compaction than that which is acceptable additional testing such as cone penetration testing will be considered. After subsequent testing, if it is determined that tilling is necessary to reduce compaction based on consultation with the appropriate agencies, the contractor will till the beach to a minimum depth of 36 inches throughout the constructed portion of the beach to loosen the compaction of the placed material. Beach tilling will only be performed as a result of an identified compaction problem based on agency consultation. Beach compaction monitoring and, if necessary, tilling would ensure that project impacts on sea turtle nesting are minimized.

7.2.2 Escarpments

Visual surveys of escarpments will be made along the beach fill area immediately after completion of construction. Escarpments in the newly placed beach fill that exceed 18 inches for greater than 100 ft. shall be graded to match adjacent grades on the beach. Removal of any escarpments during the sea turtle hatching season (May 1 through November 15) shall be coordinated with the North Carolina Wildlife Resources Commission (NCWRC), USFWS and the USACE. The likelihood of escarpment formation can be reduced by incorporating a beach design that closely resembles the native beach in terms of berm elevation, sediment size, and sediment sorting characteristics. The proposed project will be designed with a berm elevation of +6 ft. NAVD88, and sediment characteristics that fall within the ranges required by the North Carolina State Sediment Criteria.

7.2.3 Water Quality

The nearshore and offshore water columns are classified as SB waters under the North Carolina State water quality standards. North Carolina state standards require that work within the water column shall not cause turbidity levels to exceed 25 NTU or background (ambient) conditions that are above 25 NTU.

Construction operations are expected to temporarily elevate turbidity levels in the water column at the borrow area and beach placement sites. Higher turbidity levels are likely to be found in the discharge zone (nearshore swash zone) during periods of active construction. Turbidity monitoring during construction will be managed by the contractor. The contractor will be responsible for notifying the construction engineer in the event that turbidity levels exceed the state water quality standards. Measures that could be taken to subsequently reduce turbidity include moving the dredge to a different location, or asking the contractor to extend the berm, which would allow more time for fines to settle out before the water flows back into the ocean.

7.2.4 Pipeline Observations

In order to avoid adverse effects associated with the transport of placement material to the active shoreline reach, observation and assessment of the pipeline during construction will also be conducted. This will serve to avoid pressurized leaks from the pipeline couplings or other equipment that may result in sediment plumes, siltation and/or elevated turbidity levels. The Town, along with the associated engineer, will coordinate with the dredgers and have in place a mechanism to cease dredge and fill activities in the event that a substantial leak is detected In the event that a substantial leak is detected (leaks resulting in turbidity that exceed state water quality standards). The contractor will cease dredge and placement activities until an appropriate repair of the affected equipment has been completed.

7.3 Species Monitoring and Impact Minimization

7.3.1 West Indian Manatee, Humpback and North Atlantic Right Whales Monitoring

During construction or dredging activities, the contractor will adhere to the "Guidelines for Avoiding Impacts to the West Indian Manatee" created by the USFWS. Full-time NMFS-certified endangered species observers will be present on the hopper dredge(s) to alert dredge operators of any whales or manatees in the area. In the event a whale or manatee is spotted, the ship's captain will make proper maneuvers to avoid collisions or injury to the marine mammals. Vessel operators will abide by the 10 kt (18.5 km/h) speed restrictions in any Dynamic Management Areas (DMAs) that may be established while underway. Operators will abide by NMFS Southeast Region marine mammal viewing guidelines and maintain 50 yds. from sea turtles and dolphins and 100 yds. from whales. Vessel operators will also follow the restricted vessel approach of 500 yds. established for North Atlantic right whales. Participation in the Right Whale Early Warning System is required; therefore, dredging within right whale critical habitat from December through March will follow the protocol established within the Early Warning System (NMFS, 1995).

7.3.2 Sea Turtle Monitoring

Several measures will be taken to reduce impacts to swimming turtles during dredging activities. In the event hopper dredges are used, a turtle relocation trawling plan will be implemented to decrease risk of entrainment. The terms and protocols that will be implemented in association with relocation trawling are discussed in section 2.2.2. The applicant will electronically monitor the locations of trawlers and hopper dredges so that trawling is implemented to maximum effectiveness. Risk of entrainment can be further reduced by use of a sea turtle deflector, which is rigid device mounted on the draghead that effectively displaces the sea turtle outside the reach of the suction field. Every effort will be made to keep the dredge pumps disengaged when the hopper dredge dragheads are not firmly on the bottom. Also, the rotating cutterhead will not be lifted from the sediment surface during operations. Additionally, full-time NMFS-certified endangered species observers will be present on the hopper dredge to document any sea turtle activity and monitor turtle takes through screening of inflow and/or outflow. Dredging operations will abide by the terms and conditions deemed necessary to minimize hopper dredging impacts to sea turtles set forth in the 1995 and 1997 South Atlantic Regional Biological Opinion (SARBO).

On the beach, several steps will be taken to minimize construction impacts to nesting and hatchling sea turtles. Artificial lighting used during nighttime construction activities will be angled or shielded to reduce deterrence of sea turtle nesting and hatchling disorentation. A sea turtle nest monitoring and avoidance/relocation plan will be implemented through coordination with USFWS and NCWRC. Sea turtle nest monitoring is also considered an important part of sea turtle conservation. Dare County is included in surveys conducted by Network for Endangered Sea Turtles (N.E.S.T), the volunteer organization which performs systematic surveys of the northern Outer Banks from the Virginia border to the southern tip of Nags Head. Surveys are performed throughout the nesting season (May through August), and include daily morning patrols to mark and protect newly laid nests, as well as monitoring during incubation period and emergence. These surveys have been performed since 1981. Because the Dare County projects propose nourishment during the summer months (nesting season), monitoring will be needed to identify, and subsequently avoid burial or excavation of, existing nests during construction. This monitoring will be performed by trained individuals knowledgeable of the beach construction operations.

In addition to these monitoring surveys, efforts will be taken to reduce potential impacts to incubating sea turtle eggs. One manner of doing so is to relocate nests deemed in danger of being impacted by construction activities. Sea turtle nest relocation is a management tool with the potential to both aid, or impair, the recovery of sea turtle populations. The primary benefit associated with relocating sea turtle nests (clutches) is to abate threats that would otherwise compromise the hatching and emergence success rate. Where clutches would otherwise have been lost and where populations require intervention, clutch relocation may be an acceptable management practice for conservation of marine turtle populations. Some studies, including Hopkins & Murphy (1983) and Stancyk *et al.* (1980), have shown that the relocation of presumed "doomed" eggs increases nest productivity. In the case of beach nourishment activities, nests may be crushed, buried, or unearthed by construction equipment; therefore, moving a nest out of the activity area may be beneficial. Nevertheless, there are potential negative effects associated with relocating eggs. Nest relocating that is unnecessary or improperly executed can result in movement-induced mortality of embryos, or adverse changes to hatchling fitness or sex-ratios due to changes in the egg chamber environment. Studies evaluating hatch success reported higher hatch success rates in relocated than *in situ* nests, lower hatch success rates in relocated than *in situ* nests and no difference in hatch success between relocated and *in situ* nests (Bimbi 2009, Pintus *et al.* 2009, Tuttle 2007, Wyneken *et al.* 1988). However, implementing measures such as strict adherence to decision criteria for relocation and using only highly trained personnel can improve the effectiveness of this technique. For the proposed project in Duck, trained personnel will be used to monitor for sea turtle nests and relocate them out of the project area as necessary.

7.3.3 Bird Monitoring

Migrating, wintering and breeding piping plovers in North Carolina are monitored through various systematic and non-systematic surveys. North Carolina participates in an International

Piping Plover Winter Census that takes place every five years, and Bodie Island is included in these surveys. The last survey was performed in 2011 but surveys are likely to continue in the future. A Breeding Census for breeding pairs of piping plovers is conducted annually, although not all locations are surveyed every year and Bodie Island has not been surveyed since 2008. Migrating piping plovers are not part of a formal survey; however, they are picked up in International Shorebird Surveys that capture spring and fall migration counts. Additionally, piping plover data are picked up opportunistically in surveys conducted pursuant to permit requirements, research interests for non-governmental groups, consultants and federal agencies (Sarah Schweitzer, *pers.comm.*, 2014).

In the past, rufa red knot surveys have been performed annually during the month of May in Dare County (2010 – 2012), Bodie Island (2007 – 2009) and the Cape Hatteras National Seashore (2006 – 2010). The aerial surveys are coordinated out of the New Jersey state department and are dependent upon funding. The North Carolina coast has been flown by biologists with the North Carolina Wildlife Resources Commission, the North Carolina Audubon and/or the Center of Conservation Biology (Sara Schweitzer, *pers. comm.*, June 14, 2014).

All personnel involved in the construction process along the beach will be trained to recognize the presence of piping plovers and red knots prior to the initiation of beach construction. Personnel will be provided photos of each species, which will be required to be kept at the construction site for quick reference. A contractor representative authorized to stop or redirect work will conduct a shorebird survey prior to 9:00 am each day of sand placement activities. The survey will cover the work area and any locations where equipment is expected to travel. The contractor will note any observance of red knots or piping plovers and submit observations to the USACE Wilmington District Office the next calendar day.

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