APPENDIX B – BIOLOGICAL ASSESSMENT

US ARMY CORPS OF ENGINEERS

US DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE

CAPE HATTERAS NATIONAL SEASHORE
NORTH CAROLINA

ENVIRONMENTAL ASSESSMENT

BEACH RESTORATION TO PROTECT NC HIGHWAY 12
CLEAN WATER ACT 404 AND NPS SPECIAL USE PERMITS
AT BUXTON, DARE COUNTY, NORTH CAROLINA

SEPTEMBER 2015

BEACH RESTORATION TO PROTECT NC HIGHWAY 12 AT BUXTON, DARE COUNTY, NORTH CAROLINA

BIOLOGICAL ASSESSMENT

CAPE HATTERAS NATIONAL SEASHORE

SEPTEMBER 2015

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BEACH RESTORATION TO PROTECT NC HIGHWAY 12
AT BUXTON, DARE COUNTY, NORTH CAROLINA

BIOLOGICAL ASSESSMENT

INTRODUCTION

The Endangered Species Act of 1973 (16 U.S.C 153 *et seq.*), as amended (ESA or Act) requires lands under federal jurisdiction to conserve and recover listed species and use their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of endangered and threatened species (50 CFR § 402). The Act directs all federal agencies to consult (referred to as section 7 consultation) with the US Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service (NMFS) when their activities "may affect" a listed species or designated critical habitat. The Act also mandates that federal agencies contribute to the conservation of federally listed species by using their authorities to conserve (recover) federally listed species so that listing is no longer mandatory. Additionally, National Park Service (NPS) Management Policy (2006) states parks must also "inventory, monitor, and manage state and locally listed species in a manner similar to its treatment of federally listed species to the greatest extent possible".

Dare County has proposed a project at Buxton, North Carolina, to protect NC Highway 12 (NC 12) via beach nourishment using sand from an offshore borrow area (Fig 1.1). The project encompasses up to 15,500 linear feet (lf) of ocean beach (~2.9 miles), including up to ~11,500 lf along Cape Hatteras National Seashore (National Seashore) and up to ~4,000 lf along the Village of Buxton, beginning near Mile Post 59 in the National Seashore and extending south to the approximate former location of the Cape Hatteras Lighthouse at Buxton Village.

The primary purpose of the project is to protect NC 12, which is the only north-south highway along Hatteras Island, serving Buxton and Hatteras villages and the community of Frisco, as well as the National Park Service (NPS) facilities at the National Seashore. Secondly, the project purpose is to protect infrastructure and development in the village of Buxton and a portion of the shoreline in the Seashore. The historic Cape Hatteras Lighthouse, situated just south of Buxton, draws thousands of visitors each year. Dare County is the project applicant with US Army Corps of Engineers (USACE) as lead federal agency.

Through the National Environmental Protection Act (NEPA) process which includes preparation of an Environmental Assessment (EA), an Essential Fish Habitat (EFH) assessment, and this Biological Assessment (BA), the National Park Service will determine whether, where, and under what conditions it may issue a Special Use Permit to Dare County for the proposed action, and the USACE will determine whether or not to issue required federal permits under their authority (e.g., Section 404 of the Clean Water Act (CWA).

The site of the project is a narrow isthmus north of Buxton Village, which is vulnerable to dune breaching, washovers into NC 12, and formation of breach inlets. Each of these types of erosion events have occurred at various frequencies during the past 60 years since NC 12 was completed (NPS 1980, Birkemeier et al. 1984). The most frequent events are dune breaches and washovers into the roadway.

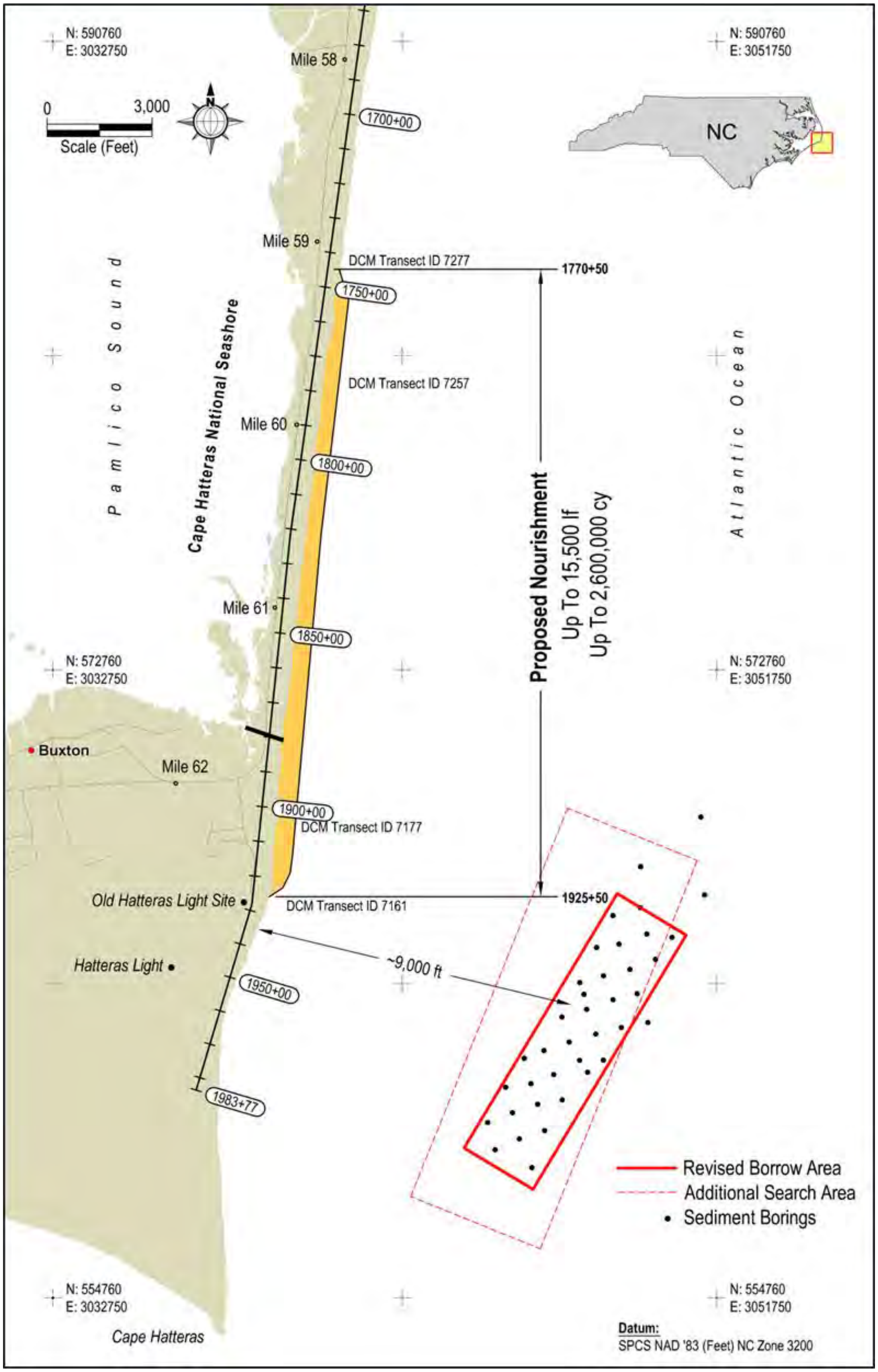

FIGURE 1.1. The project area for beach restoration to protect NC Highway 12 at Buxton, Dare County (NC), showing maximum limit of beach nourishment and proposed offshore borrow area within state waters near Cape Hatteras. A 2013 feasibility study for the project referred to portionsof the offshore sand search area as "Borrow Area C" (CSE 2013).

After each event, the most recent of which occurred during Hurricane *Irene* (27 August 2011) and Hurricane *Sandy* (27–28 October 2012), NCDOT typically scrapes sand off the road and pushes up a protective dune in the action area (NCDOT, J Jennings, Division Engineer, pers. comm., August 2014). Thus, the foredune along the project area has been manipulated frequently in recent years. Dune construction and other coastal stabilization activities have been documented in the National Seashore, including the Buxton area, since the 1930s (Dallas et al. 2013).

A breach inlet formed between Avon and Buxton during the March 1962 "Ash Wednesday" storm. A series of storms in the early 1970s, including the "Lincoln's Birthday" storm in 1973, produced considerable erosion and overwash into Pamlico Sound immediately north of Buxton (NPS 1980). Repairs included breach closure, road realignment, groin construction, and dune repair, as well as beach nourishment using an onshore sand source from Cape Point (Machemehl 1973, 1979; NPS 1980). Given the narrow width of Hatteras Island along the project site and the presence of tidal estuarine wetlands adjacent to the highway, NC 12 is positioned as far westward as practicable (NCDOT, J Jennings, Division Engineer, pers. comm., August 2014). Neither Dare County nor the National Park Service has authority for maintenance or alignment of NC 12.

Dare County proposes to add sand to the natural beach system and restore a deficit that has made the project area more vulnerable to erosion. With a major infusion of sand, the beach would be wider and better able to attenuate storm tides and waves before they can damage the dunes, NC 12, or the power and communication infrastructure, which are the lifeline to the historic communities on Hatteras Island. Dare County has determined that beach nourishment, using an offshore borrow source, is the most viable and environmentally compatible alternative for addressing erosion over a time scale of 5–10 years. Other alternatives considered include: Alternative 1-No-Action, likely to force frequent, costly repairs of NC 12 and abandonment of property, or Other Borrow Sources, likely to involve using inland deposits or Pamlico Sound deposits. See *Environmental Assessment (EA), Beach Restoration to Protect NC 12 at Buxton, Dare County, North Carolina* (September 2015), for which this BA is an Appendix.

A critical project requirement is the dredging schedule. A summer construction window is necessary for work offshore in this case because of safety and operations concerns. Prior to a beach nourishment project at Nags Head (2011), dredging industry officials indicated it is not possible to safely or efficiently dredge offshore in winter along the northern Outer Banks of North Carolina (Dredging Contractors of America, B Holliday, Executive Director, pers. comm., 2009). Average waves in the project vicinity are higher than any site along the US East Coast (Leffler et al. 1996). The nearest safe harbor for oceangoing dredges is Little Creek, Virginia, at the entrance to Chesapeake Bay over 100 miles north of the project site. It is also likely the preferred equipment for dredging operations would be a self-propelled, trailing arm, hopper dredge. Such dredges can motor to a safe harbor on the approach of a storm, whereas a traditional cutterhead pipeline dredge is a barge that must be towed by tug at slow speeds to a safe harbor.

Because the proposed action may be conducted during summer months, additional measures are anticipated for purposes of monitoring and safeguarding threatened and endangered species, such as sea turtles or Atlantic sturgeon, which may be present at the time of construction. Regular NPS management activities and species monitoring surveys will occur on their scheduled basis which helps to minimize effects of the project on protected species (summarized page 8). While the NEPA process and permit conditions may identify specific monitoring, the applicant has anticipated the necessity to follow species protection measures during dredge operations as summarized in the recent project to protect NC 12 at Rodanthe (USACE 2013). These dredge measures are shown in Table 1.1 and have been updated with comments pertinent to Buxton where possible.

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TABLE 1.1. Anticipated species protection recommendations for dredge operations (after USACE 2013) in addition to regular NPS monitoring surveys. Other additional monitoring may be required as a result of NEPA process and/or specific conditions attached to permits. The comment column has been modified to reflect the Buxton project and these modifications are shown in bold text. Sea turtles and Atlantic sturgeon are primary species of concern.

Source	Recommendation	Considered in Borrow Area Design and Dredging			Comments Updated for Buxton Where Possible/Applicable (in bold)
		Yes	*Partial*	*No*	
Dibajnia and Nairn (2011)	Avoid shoals in waters deeper than 30 meter (m) which show a decrease in height with increasing depth representing a possible Shoal Height Decrease Zone beyond 30 m depth	X			**The shallowest portion of Borrow Area C proposed to be dredged (i.e., top of ridge) ranges between 30–35 ft deep and the deepest areas along the gently sloping sides of the ridge ranges between 40–45 ft deep.**
	Consider ridge and shoal dredging scenarios which minimize impacts to overall shoal integrity and protect habitat for benthos and fish	X			**Borrow Area C** use plans **would** be developed in accordance with dredging guidelines to the maximum extent practicable to minimize morphologic shoal response provided by Dibajnia and Nairn (2011). Cutting **would** be targeted such that portions of the habitat structure unique to the feature and important to resource use **would** be maintained; thus, no adverse effects to overall shoal integrity are expected. **Geotechnical data (CSE 2015) confirm there is uniformity of sediment size and type within the full section of the proposed dredge cut, with similar quality surficial sediments expected to be left in place after excavations of overlying material.**
CSA International Inc et al. (2009)	Priority locations for shoal dredging to minimize physical impacts is the leading edge due to net long-term deposition and faster infilling rates, followed by the crest and the trailing edge		X		**Use of the topographic high within Borrow Area C, overall shallow excavation depth of the hopper dredge, and the borrow site's location in an area of high sand movement are important factors that would maximize biological recovery rates.** However once the proposed borrow area surveys have been completed, coordination with appropriate State and Federal Agencies **would** occur to avoid impacts to existing high valued biological resources associated with specific shoal features.
	Innovative dredging methodologies utilizing "striped" dredging pattern appear to support a more timely and uniform recovery	X			Hopper dredges are the proposed primary dredging method. Hopper dredging operations typically dredge in a "striped" pattern to maximize production over long expansive portions of the borrow area leaving portions of the borrow area unimpacted.
	Shallow dredging over large areas rather than excavating small but deep pits may be preferred	X			The current borrow area design and borrow area use plan supports this recommendation. Hopper dredges operate most efficiently dredging shallow cuts over a large surface area rather than excavating small deep pits. The usable dredge depths **would** be determined once the surveys have been completed.
	Dredging in a striped pattern to leave sediment sources adjacent to and interspersed throughout target areas, leading to a more uniformly distributed infilling process	X			Hopper dredging operations typically dredge in a "striped" pattern to maximize production over long expansive portions of the borrow area leaving portions of the borrow area unimpacted to support infilling processes
Discussions with NMFS and NCDMF	Borrow area design should consider a wider and shallower cuts rather than deep dredge holes	X			**Geotechnical data (CSE 2015) within the proposed borrow area confirm the sediments are beach compatible and exceed North Carolina state standards for similarity with the native beach. A high density of 33 borings (~1 per 11 acres) demonstrates general uniformity of sediments in the upper 8 ft of substrate. The potential beach quality sand reserves total >5 million cubic yards within an ~440 acre area if dredged to 8 ft. Shallower cuts over a smaller area are therefore feasible. The final borrow area layout and dredge plan would be prepared in consultation with resource agencies pending results of cultural resource studies. If a suction cutterhead dredge is used, the minimum and maximum excavation depth would be in the range 6–8 ft due to operational considerations for large ocean-certified dredges. If a hopper dredge is used, the cut depths would vary between ~2 ft and 8 ft according to the number of passes over a given area.**

Table 1.1 (cont'd)

Source	Recommendation	Considered in Borrow Area Design and Dredging			Comments
		Yes	*Partial*	*No*	
Discussions with NMFS and NCDMF (cont'd)	Review published literature and integrate significant information or lessons learned from dredging of other shoal features throughout the region into borrow area use planning for this project	X			Relevant literature pertaining to the physical and biological activities associated with sand ridge features as well as potential dredging related impacts have been integrated into this impact evaluation
	Consider leaving a segment of un-dredged sediment to allow for recovery and recolonization into impacted areas.	X			Hopper dredges **would** likely be the primary dredging methodology for this project. As a result of the operating characteristics of the hopper dredging, it is likely that un-dredged ridges **would** be left behind allowing for recolonization from un-impacted areas. Additionally, it is anticipated that the dynamic nature of the borrow area **would** result in infilling of the impacted areas with adjacent sediments
Diaz et al. (2004) and Slacum et al. (2010)	Shoals should be only partially dredged to facilitate post dredging re-colonization from un-impacted refuge areas	X			The proposed borrow areas and associated quantity of sediment to be dredged is small relative to the areas of **shoals off Hatteras Island, including Platt, Wimble, Kinnakeet, and Diamond Shoals**.
	Limiting the distance between the remaining patches of shoal habitat would reduce the distance and time a shoal-associating species would have to travel between patches	X			**The Borrow Area C shoal is ~ 2 miles north of the large expansive area of Diamond Shoals and is a rather small component within the overall complex of available habitat.** Considering the nearness of similar adjacent habitat types no adverse impacts to shoal associated species are anticipated.
	Shoals with less relief should be targeted for mining instead of steeper shoals when the option is available	X			**The** borrow area use plan **would** be developed that maximizes opportunity to dredge along the relatively flat and gradual sloped transition towards the shoal crest in order to minimize shoal impacts to higher relief shoal features.
	Dredging should be avoided when demersal finfish are using the inner continental shelf as a nursery ground			X	**Dredging for the proposed beach nourishment to protect NC 12 at Buxton is proposed to occur in summer 2016 and is anticipated to be completed in two months (anticipated to begin between May and July).**
	Sand could be mined at night, when some species migrate vertically into the water column to reduce the direct injury to fish that can result from mining activities			X	Dredging activities **would** not be confined to nighttime activities due to efficiency constraints
	Shoals should be mined in rotation to allow shoal-associated assemblages to recover between mining events; this should be done in consideration of the rate at which sand accumulates at the particular shoal where sand is being harvested		X		The proposed action to protect **NC 12 at Buxton** is a one-time only event, **which would provide needed site-specific data on the performance of nourishment for purposes of evaluating long-term strategies for protecting and maintaining a transportation corridor along this section of Hatteras Island. Benthic communities of the borrow area are expected** to quickly recover.

Additional measures to minimize impacts during sand placement activities on the beach are discussed in more detail in the section on summer construction (pages 20-24). Monitoring anticipated in addition to NPS policies and procedures would be typical of other North Carolina beach nourishment projects (e.g., marine mammal and turtle spotters on the dredges at all times, trawling for turtles ahead of hopper dredges during operations, nightly turtle patrols on the beach, and maintenance of sand ramps and pipeline along the beach).

Purpose of this Biological Assessment

This BA analyzes the potential effects of the applicant-proposed action, *Beach Restoration to Protect NC 12 at Buxton, Dare County, North Carolina,* on the Cape Hatteras National Seashore on federally listed threatened, endangered, candidate animal (wildlife, invertebrates, and fish) or plant species, and designated or proposed critical habitats, pursuant to Section 7 of the Endangered Species Act of 1973 (16 U.S.C 1531-1544), as amended. Two alternatives to the proposed action are also evaluated. Federally listed threatened or endangered animal or plant species and designated or proposed critical habitat meeting the following criteria are addressed in this assessment:

1) known to occur in the Seashore based on confirmed sightings;
2) may occur in the Seashore based on unconfirmed sightings;
3) potential habitat exists for the species in the Seashore; or
4) potential effects may occur to these species.

As part of the ESA Section 7 Consultation process, an effects determination would be made only for the species protected pursuant to the ESA. The document may also serve to outline the steps taken to reduce and minimize potential effects to the species which may be affected by the proposed action. On the federal level, the species, or their designated critical habitat, (wildlife, fish, reptiles, and plants) listed as threatened, endangered, or candidate by the US Fish and Wildlife Service and/or the NOAA Fisheries Service—National Marine Fisheries Service benefit from legal protection. This Biological Assessment is prepared in accordance with legal requirements set forth under Section 7 of the Endangered Species Act (ESA) (16 USC. 1535 (c)) and policy requirements of the Biological Assessment Guidebook (NPS 2014).

Current Management Direction

Current management direction for federally listed and proposed threatened and endangered species can be found in the following documents, filed at the National Seashore office:

- Endangered Species Act of 1973, as amended (ESA or Act)
- 1916 NPS Organic Act
- NPS General Authorities Act of 1978
- NPS Management Policies 2006
- Migratory Bird Treaty Act (MBTA)
- National Environmental Policy Act (NEPA)
- Species-specific recovery plans which establish population goals for recovery
- Species management plans, guides, or conservation strategies
- Cape Hatteras National Seashore Off-Road Vehicle (ORV) Management Plan (2010)
- EA-Review and Adjustment of Wildlife Buffers, Cape Hatteras National Seashore (2015)

As stated in the NPS Management Policies 2006 (NPS 2006), natural resources of each park will be managed to preserve fundamental biological and physical processes as well as individual species, features, and plant and animal communities. These 2006 policies also recognize that natural change is an integral part of the evolution and function of all natural systems and that each park must be managed within the context of its larger ecosystems. However, the park is not to intervene in natural biological or physical processes except in four situations, one of which is "when a park plan has identified the intervention as necessary to protect park resources, human health and safety or facilities."

The enabling 1937 legislation by Congress established Cape Hatteras National Seashore for the enjoyment and benefit of the people and to permanently reserve the area and its resources as primitive wilderness for future generations. Management decisions are made in response to increased understanding of the significance of the National Seashore, whenever new species are provided federal or state protection (or become delisted), or when other unique circumstances require new management directive(s).

One recent unique circumstance reflected the slow cultural shift in the amount of, the frequency of, and the purpose of vehicle use of the beaches since establishment of the Seashore and the subsequent necessity to manage continued beach access for these vehicles (as well as pedestrians) and to protect natural resources of the National Seashore. The 2010 final Cape Hatteras National Seashore Off-Road Vehicle (ORV) Management Plan / Environmental Impact Statement (plan/EIS), the December 2010 Record of Decision (ROD) on that plan/EIS, and the 2015 EA-Review and Adjustment of Wildlife Protection Buffers (NPS 2015a) resulted in very specific regulations regarding permits, time of and kind of vehicle use, vehicle and pedestrian routes, closures, and resource protection measures, including resource monitoring.

Of pertinence to this BA, the various species management strategies identified in the plan/EIS/ROD afford "protection for threatened, endangered, and other protected species (e.g. state listed species) and their habitats, and minimize impacts related to ORV and other uses as required by laws and policies, such as the *Endangered Species Act*, the *Migratory Bird Treaty Act*, and NPS laws and management policies." Management actions and directives currently in place which affect this proposed action include:

- establishment of pre-nest closures for shorebirds and colonial waterbirds in March,
- frequent surveys March to July/August and establishment of 248–660-ft (75–200-meter) buffers dependent on certain behaviors observed during surveys (e.g. courtship, breeding, nesting, hatching);
- daily patrols to identify sea turtle crawls and nests from May 1 to September 15 (or later depending on last nest or crawl) and periodic patrols until 15 November; and
- erection of 33 by 33-ft (10 by 10-meter) symbolic fencing and signage around each turtle nest which expand to the surf line after 50–55 day incubation.

CONSULTATION HISTORY

On behalf of Dare County and the National Park Service, CZR Incorporated (CZR) contacted the USFWS via their ECOS IPaC website on 19 September 2014 and requested an official species list and final or proposed designated critical habitat that may occur within the project boundary and/or may be affected by the proposed action; an updated version was requested on 5 February and 29 June 2015 (Consultation Tracking Number 04EN2000-2014-SLI-0473). Additionally, the National Oceanic and Atmospheric Administration—National Marine Fisheries Service Southeast Region (NMFS/SERO) website was accessed for a list of those species under their purview when in the water and personnel were also contacted via email on 1 October 2014 for site specific information. Formal consultation with USFWS will be initiated by the USACE upon receipt of the permit application from Dare County.

PROPOSED MANAGEMENT ACTIONS AND ALTERNATIVES CONSIDERED

The foredune along the narrow isthmus of the National Seashore immediately north of Buxton Village has breached in the past under storms like Hurricane *Irene* (27 August 2011) and Hurricane *Sandy* (28 October 2012). Dune breaches cause washovers across NC 12, damage to pavement, and force emergency closure of the highway until repairs can be performed. The National Park Service and Dare County have worked together on a method to reduce chronic highway damage along this portion of Hatteras Island, maintain federal and state infrastructure in the vicinity, and allow continued public access to the natural and cultural resources managed by the National Park Service within the Seashore.

Representatives of NCDOT attended several meetings to discuss the project purpose as the action area is within a 4.7-mile zone identified in their long range study of NC 12 as the Buxton-Canadian Hole "hotspot" (NCDOT TIP No. R 4070 B—one of the three transportation improvement projects south of Rodanthe discussed in their study). The NCDOT has undertaken feasibility studies for these three projects which will include an analysis of potential short-term and long-term options for each action area; this analysis will examine the potential environmental impacts of the projects as well as preliminary project costs. The feasibility studies will assist NCDOT in appropriating funds and scheduling the projects in future State Transportation Improvement Plans (STIP). Once the projects are scheduled in the STIP, NCDOT will begin the full project development process. The feasibility studies for all three projects are expected to be complete in the summer of 2015. In the meantime, Dare County and National Park Service have gone forward with this proposed action out of a pragmatic, proactive concern that NCDOT may not be able to act on this hotspot in a timely fashion except in an emergency mode, a situation which Dare County and National Park Service would prefer to avoid if possible.

Plan Formulation

Dare County commissioned a feasibility study of the Rodanthe and Buxton beaches to quantify differences in beach condition relative to healthy beaches along the National Seashore and to outline alternative strategies for beach restoration in hotspot areas (CSE 2013). The County study used detailed surveys of the littoral profile to compute unit volumes in the active beach zone. It is well established that beaches develop a profile which adjusts to changes in wave energy (Fig 3.1) (Komar 1998). The condition of the profile can be measured as a function of sediment grain size, average wave heights and periods, tidal range, and foreshore slope (Dean 1991). It can also be measured in terms of the unit volume of sand contained between reference contours (Verhagen 1992). Figure 3.2 illustrates the concept of unit-width profile volumes for a normal healthy beach (one with sufficient volume to withstand normal seasonal adjustments of the profile without damage to the foredune) or beaches with more or less volume than normal.

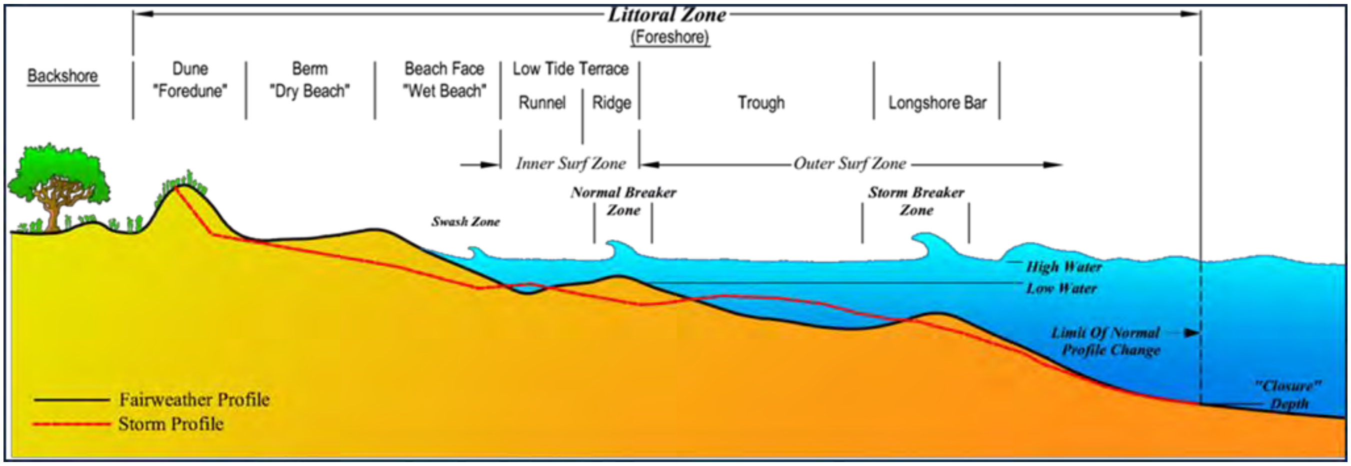


FIGURE 3.1. Representative profile of the littoral zone illustrating the principal features between the dune and offshore. Areas identified include the foredune, dry beach, wet beach, low tide terrace, trough, and longshore bar. The profile varies with changes in wave energy, the passage of storms, and differences in sediment quality. [Based on Komar 1998]

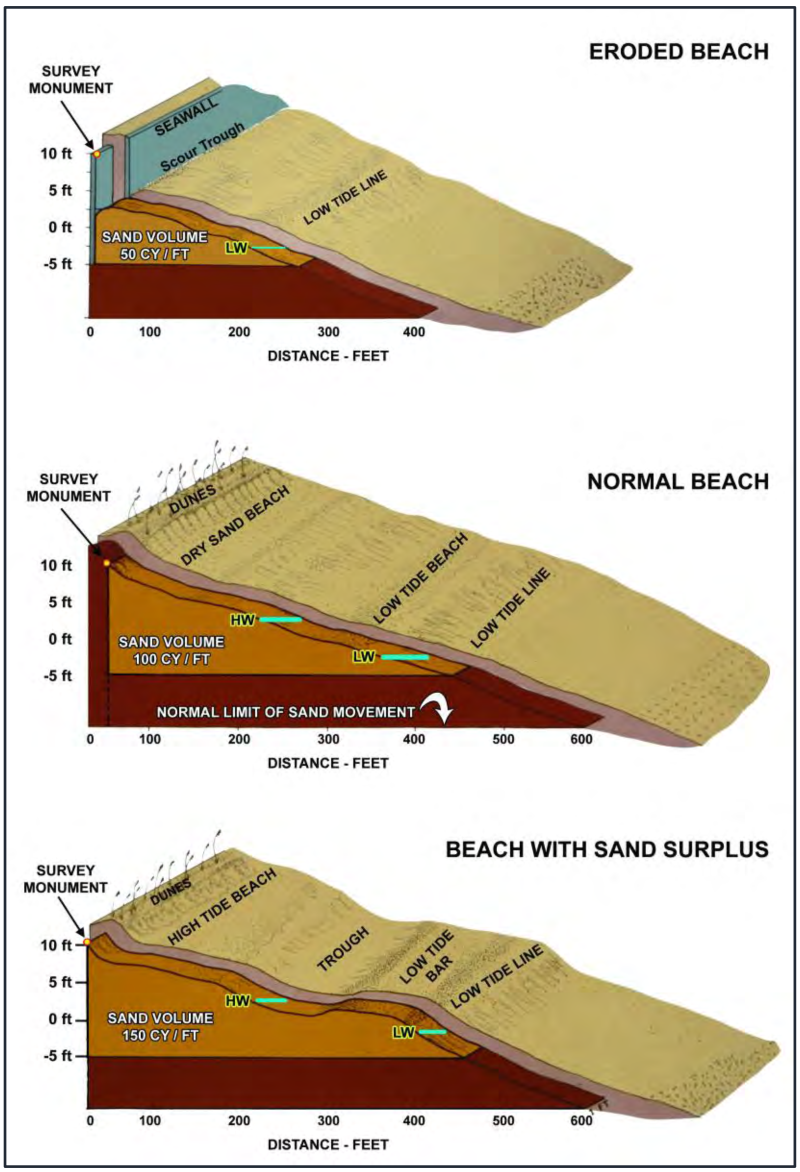


FIGURE 3.2

The concept of unit-width profile volumes for a series of beach profiles showing an eroded beach with a deficit, a normal beach, and a beach with a volume surplus.

Profile volumes integrate small-scale perturbations in profile shape and provide a simple objective measure of beach condition based on three conditions (eroded, normal, and sand surplus).

Indicated quantities are realistic for many east coast beaches within the elevation limits shown. {After Kana 1990]

Dare County determined that the Buxton area has significantly less sand in the profile than nearby stable* beaches (CSE 2013) as illustrated in Figures 3.3 and 3.4. Figure 3.3 shows the calculation boundaries applicable for Buxton between the foredune crest (or structure of interest) and a depth contour of −24 ft NAVD**. Nearly all measurable change in bottom elevation at yearly to decadal scales occurs landward of this contour along the northern Outer Banks (Birkemeier et al. 1984).

*[*A stable beach is herein defined as*

***NAVD'88 — North American Vertical Datum of 1988 which is roughly 0.5 ft above present mean sea level along the North Carolina coast.]*

As Figure 3.3 illustrates, a healthy profile in this setting typically contains ~800 cubic yards per linear foot of beach. [This is calculated by taking the cross-sectional area in square feet within the hatched part of the diagram and applying it over a 1-ft length of shoreline. This yields a measure in cubic feet which is then converted to equivalent cubic yards, the standard units for earthworks.]

Figure 3.4 shows the systematic variation in profile volumes along Buxton (see Fig 1.1 for station locations). The project shoreline includes a central section along the National Seashore and Buxton Village where there is a significant volume deficit relative to adjacent healthy sections of beach. A primary goal of the proposed action is to restore the profile to a quantity of sand necessary for normal wave processes to act without frequent breaches in the dunes. The project has also been formulated to add volume in anticipation of normal yearly losses.

The Dare County study found that total nourishment volumes in the range ~1.7–2.6 million cubic yards would be required to provide restoration and protective benefits of a normal beach in this setting for 5–10 years (respectively) (CSE 2013). The addition of sand to the littoral system from a non-beach source would replenish the sand-sharing system along a part of the coast.

Figure 3.5 illustrates in concept the impact of nourishment to maintain a particular shoreline position. Along developed ocean coasts where fixed infrastructure precludes relocation at normal planning time frames (i.e. – decades), the basic character, morphology, and position of the beach system may be preserved via infusions of sand. The amount of sand needed depends on the underlying erosion rate. In the proposed project area, 50-year erosion losses have averaged ~150,000–200,000 cubic yards per year (cy/yr) (CSE 2013) based on extrapolation of volumes from linear shoreline change rates determined by North Carolina Department of Environment and Natural Resources (NCDENR 2012).

The proposed plan is an attempt to restore the sand deficit by nourishment and place additional sand to accommodate future erosion for some number of years. Beach nourishment is a nature-based feature (NBF) as defined by USACE (Bridges et al. 2015) and the "*only engineered shore protection alternative that directly addresses the problem of a sand budget deficit….*" "*The result is a wider beach that improves natural protection while also providing additional recreational area. Beach nourishment serves as a sacrificial rather than fixed barrier.*" (NRC 1995, pgs 1–2) The resulting wider beach adds habitat area, particularly in the important dry-beach zone where certain critical species nest.

The length of the project is dependent on funding availability and favorable bids for construction. The minimum level of effort considered necessary for a viable project is ~1.7 million cubic yards, which is projected to provide up to five years of erosion relief (Figure 3.6). For purposes of this BA, the full scope of up to 2.6 million cubic yards is assumed.

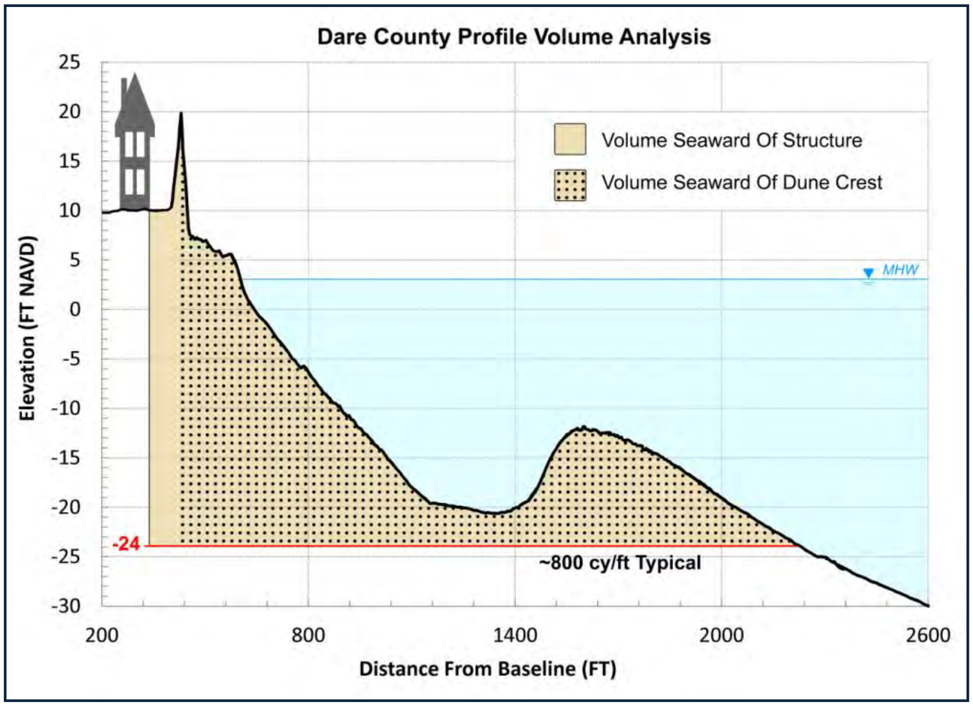


FIGURE 3.3. Illustration of the two lenses used in the profile volume analysis for Buxton. The first volume quantifies sand contained between the approximate foredune crest and –24-ft NAVD. The second calculates the volume between the seaward most structure (buildings or road) in the vicinity of the profile and –24-ft NAVD. Based on typical dimensions in the project area, the hatched cross-section shown here has a 2-D area of ~21,600 square feet. This is equivalent to a "unit volume" of 800 cu yd/ft (i.e. – 800 cu yd are contained in a 1-ft length of beach – see Fig 3.2).

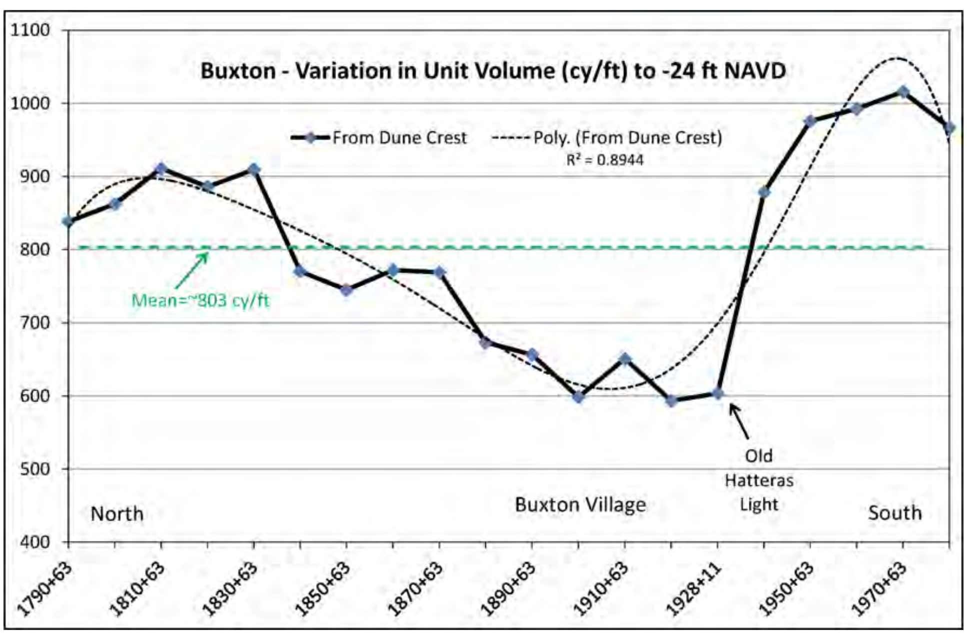


FIGURE 3.4. Profile volumes by station in the **Buxton** area in August 2013 computed to –24 ft NAVD relative to the foredune crest (from CSE 2013).

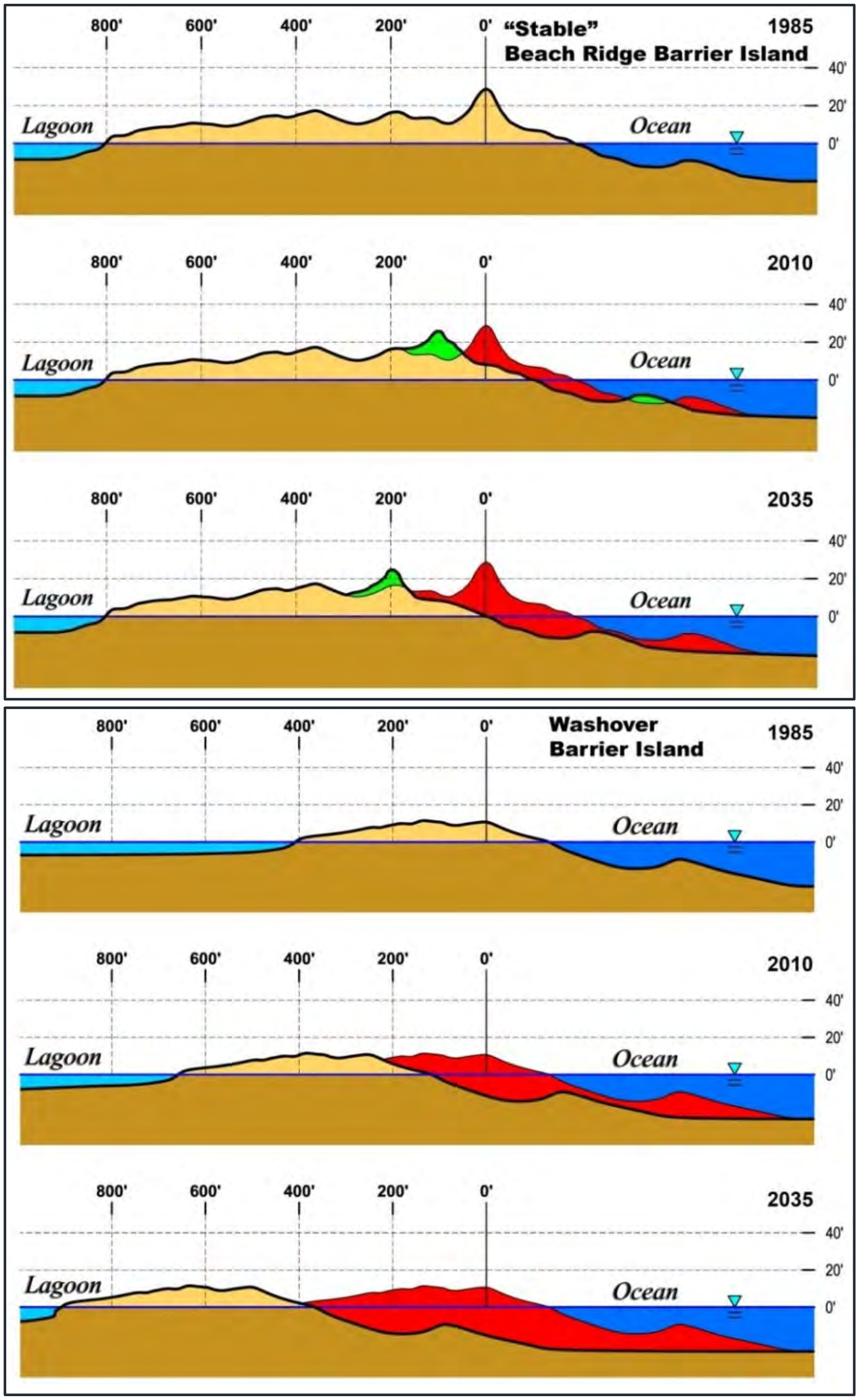


FIGURE 3.5. Illustration of two types of barrier-island cross-sections. A "stable" beach ridge barrier island (Hayes 1994) is likely to retain sand in the littoral zone with little volume lost to washovers (shown in red). Net erosion rates tend to be lower. The other barrier beach (lower panel) lacks elevation and frequently washes over, withdrawing littoral volume and increasing the net erosion rate. The upper type of cross-section is characteristic of most Dare County beaches at decadal scales (cf – Everts et al 1983). The washover barrier is common along <20 percent of the North Carolina coast. (North Carolina Sea Grant, S Rogers, Coastal Construction & Erosion Specialist, pers. comm., August 2013) [Diagram by T Hair, CSE]

The proposed action, *Beach Restoration to Protect NC Highway 12 at Buxton, Dare County NC*, is planned to begin by June 2016 with project completion by September 2016. It would consist of placement of up to 2.6 million cubic yards of beach-compatible sediment (≥90% sand) along up to 2.94 miles of oceanfront beach beginning near Mile Post 59 in the National Seashore and extending south to the approximate former location of the Cape Hatteras Lighthouse at Buxton Village (Fig 3.6).

The length of the project may be reduced if funding availability precludes implementation of the applicant proposed action. The beach nourishment project design specifies the majority of the sand placement within a ~11,000-ft zone within the National Seashore and the balance within the Village of Buxton. The design beach width throughout the planned nourishment area would average up to ~150 ft wide after normal profile adjustment. The north and south ends of the project would taper gradually back to the existing shoreline over a minimum distance of 500 ft. Sand would be placed in a normal conFiguration which closely matches the grades and slopes of the native dry sand beach between the toe of the foredune and mean high water line. The maximum design berm elevation would be ~7 ft NAVD. The healthy, native dry-beach elevation for the area is typically ~9 ft NAVD at the toe of the foredune sloping gently to+5 ft at the berm crest.

Natural profiles vary seasonally around a range of berm elevations. Figure 3.7 shows a typical beach fill template prior to natural fill adjustment. No sediment would be placed directly on the existing foredune or toe of dune such that a minimum buffer of ~50 ft or more remains between the active construction area and the edge of vegetation. No sediment would be placed over existing structures, emergency sand bags, or existing ingress and egress points along the project area. Also, all construction activities would adhere to no-work buffers or environmental closure zones established by NPS and resource agencies.

Sediment Quality — Sediment quality is a key variable in beach nourishment design (Dean 2002). Dare County initiated a search for beach-quality sand that may be used for the project. All sediment placed on the Buxton project beach adjacent to NC Highway 12 would be compatible with the native beach. Table 3.1 lists typical mean grain sizes for the subaerial beach in the project area (August 2013 conditions). The beach fill sand would be dredged from the proposed Borrow Area C located about 1.7 miles offshore of Buxton from within an unnamed sand ridge (Fig 3.8).

Geotechnical investigations were conducted in August 2013 and October and December 2014 within the proposed borrow area to identify sufficient quantities of beach compatible material (≥90% sand) and determine presence of cultural resources or hard grounds. Figure 3.9 shows an example core photo log and core log from the center of the proposed borrow area. Figure 3.10 shows a preliminary comparison of the grain-size distribution along the subaerial beach and borrow area (composited samples in the upper 7 ft of core). The proposed borrow area is a shoal exposed to high wave energy in water depths between 30 to 40 ft with negligible, fine-grained material present (e.g., mud or organics) (CSE 2013). Geotechnical data within the proposed borrow area confirm the sediments are beach compatible and exceed North Carolina state standards for similarity with the native beach (CSE 2015). A high density of 33 borings (~1 per 11 acres) demonstrates general uniformity of sediments in the upper 8 ft of substrate. Cultural resource data have been collected and will be provided in the project EA as they become available.

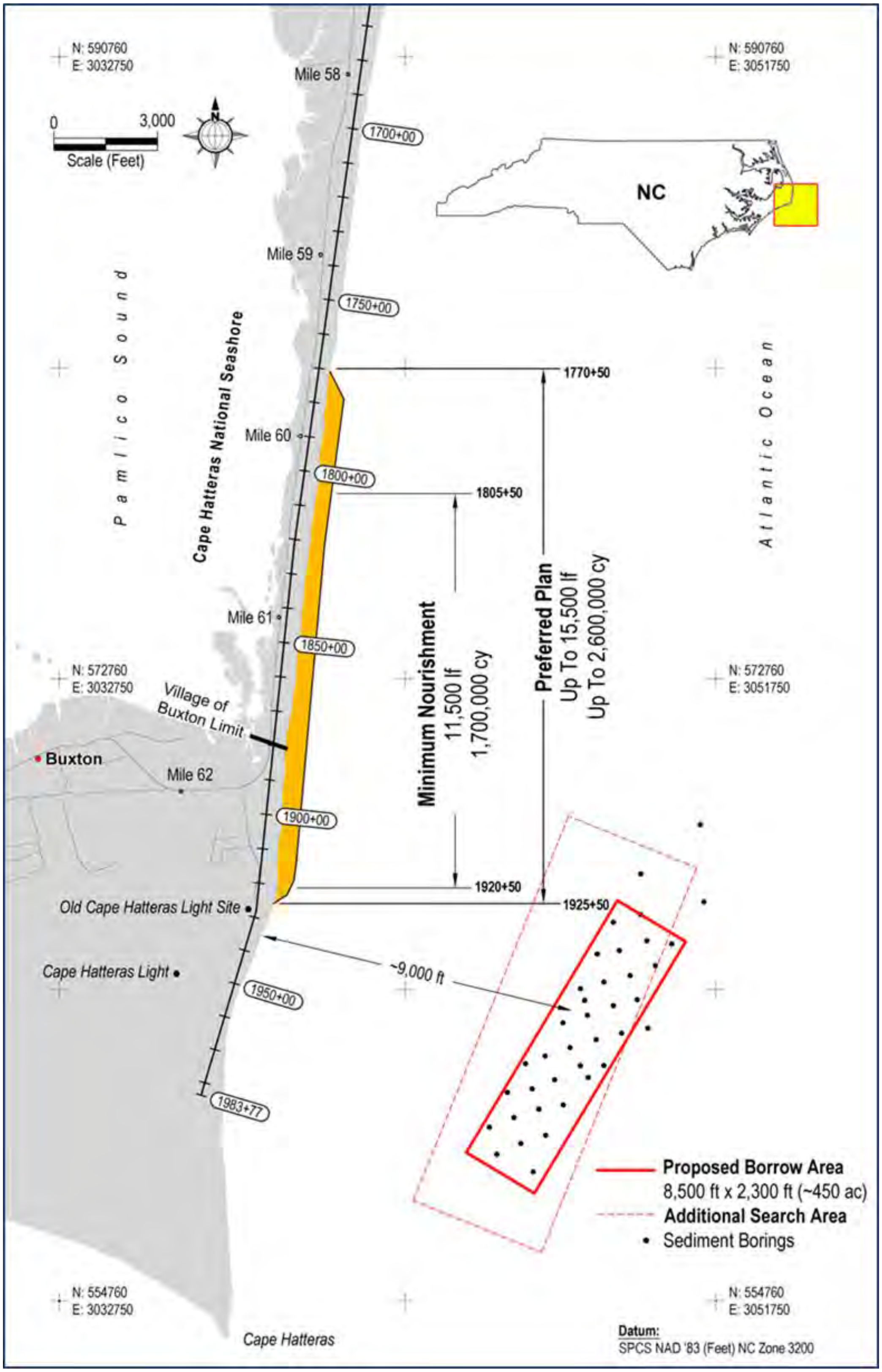


FIGURE 3.6. The project area showing the range of nourishment volumes considered viable for the project under the applicant-proposed action (Alternative 3–Summer Construction) and offshore borrow area.

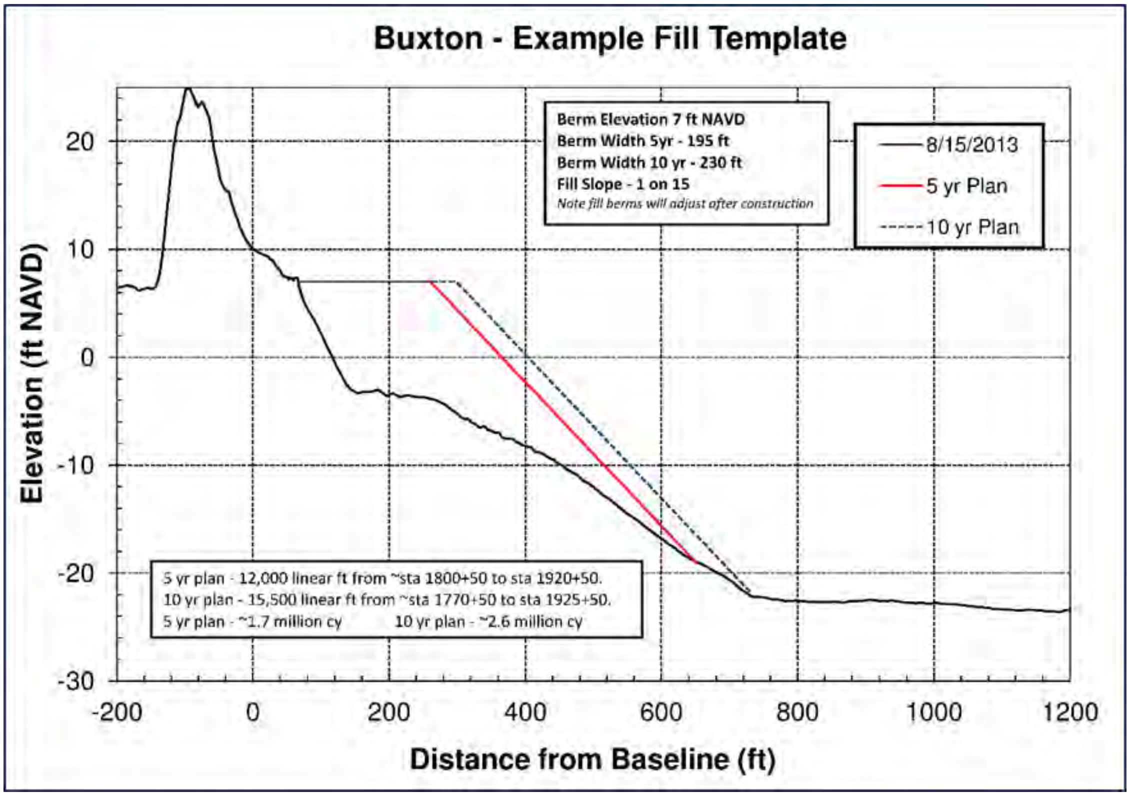


FIGURE 3.7. Representative beach nourishment fill template superimposed on a representative profile before profile adjustment. Highway NC 12 is positioned immediately adjacent to the foredune which was pushed up after the dunes breached in some areas during Hurricane *Irene* (27 August 2011) and Hurricane *Sandy* (27 October 2013). The average dry beach width after adjustment will be ~80 to 140 ft, depending on the section and final volume placed (constrained by fixed budget). No sand would be placed above +7-ft NAVD, on the upper beach foredune, or on any sandbags in place at the time of construction.

TABLE 3.1. Native beach sediment sample mean grain-size by station and position across the subaerial beach (sampling in August 2013) (after CSE 2013).

BUXTON – Cape Hatteras National Seashore							
	Mean Grain-Size Distribution (mm)						
Station	**Dune Toe**	**Berm Middle**	**Beach Face**	**Low-Tide Terrace**	**Averages All**	**% Shell (Average)**	**% Gravel (Average)**
1790+63	0.469	0.469	0.373	0.461	**0.443**	5.2	1.9
1840+63	0.397	0.345	0.459	0.222	**0.356**	3.4	0.3
1890+63	0.613	0.352	0.464	0.540	**0.492**	11.8	4.4
1900+63	0.666	0.425	0.352	0.643	**0.522**	16.9	5.5
1940+63	0.368	0.442	0.277	0.347	**0.359**	14.0	0.9
1980+63	0.469	0.508	0.278	0.491	**0.437**	9.3	1.1
Averages	**0.497**	**0.424**	**0.367**	**0.451**	**0.435**	**10.1**	**2.4**

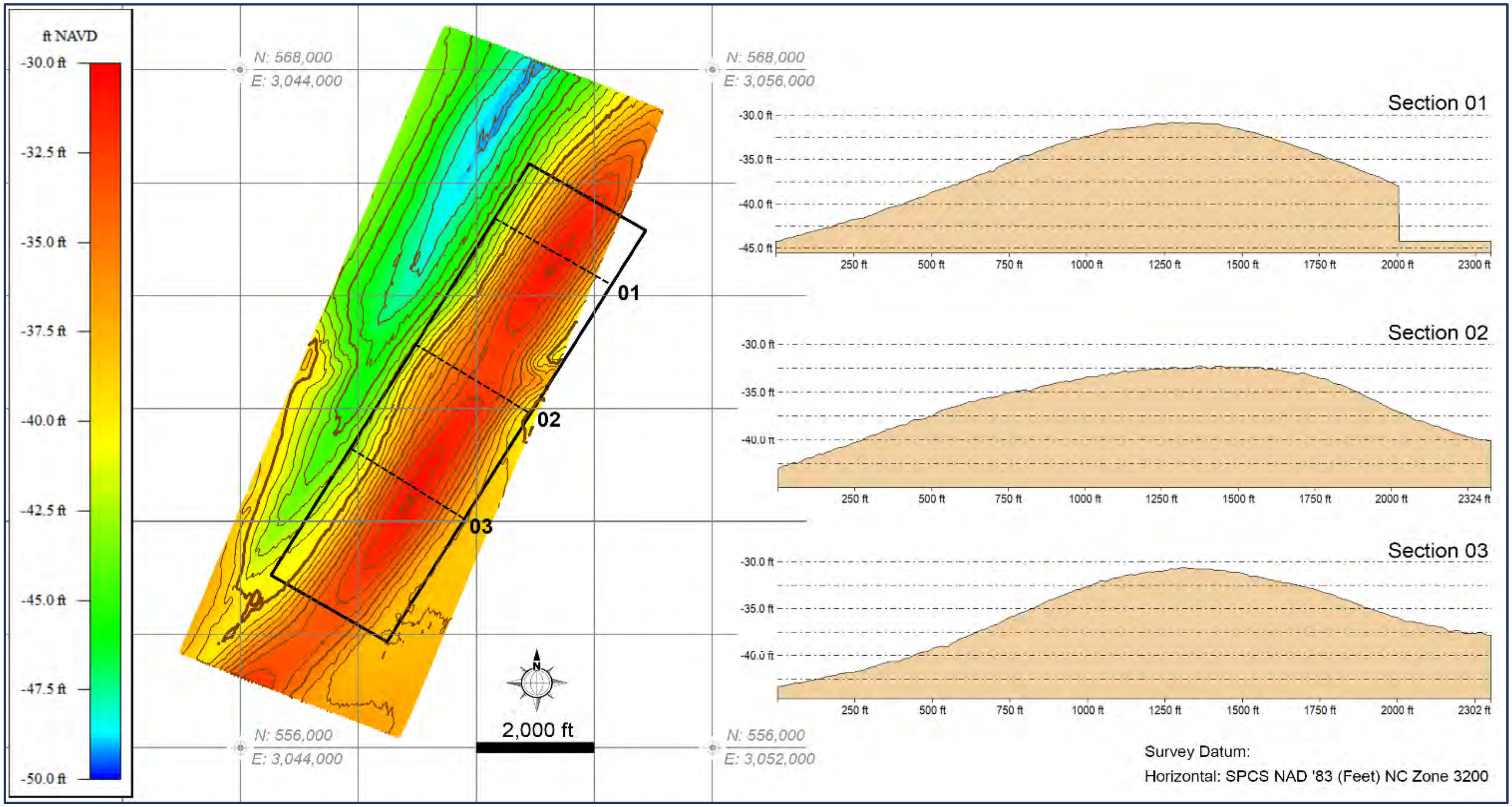


FIGURE 3.8. Bathymetry and cross sections (September 2014) through the proposed borrow area (black outline) offshore of Buxton based on field data collection by C! in August 2013 and October 2014. (See Fig. 1.1 for location of sand search area.)

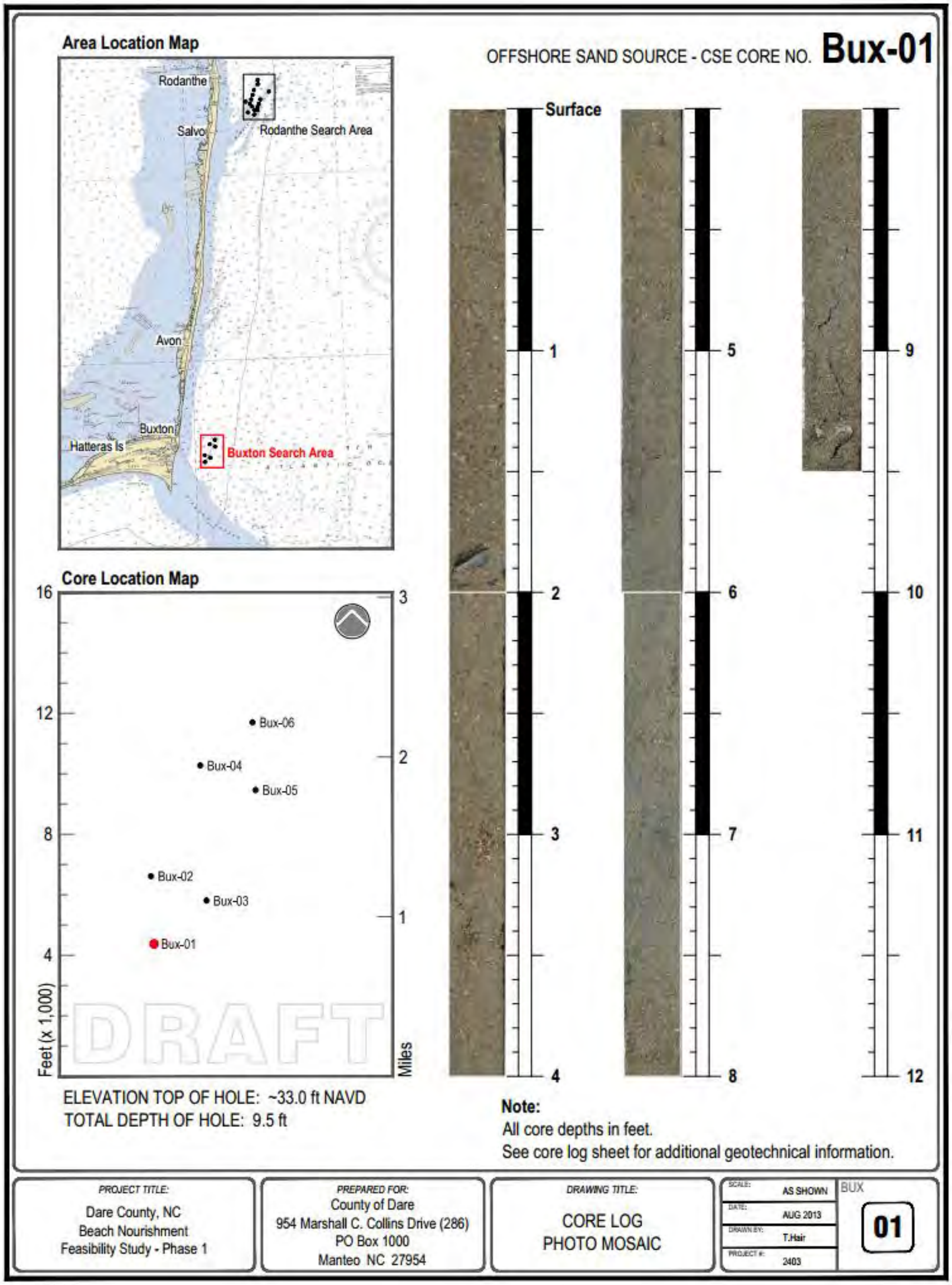
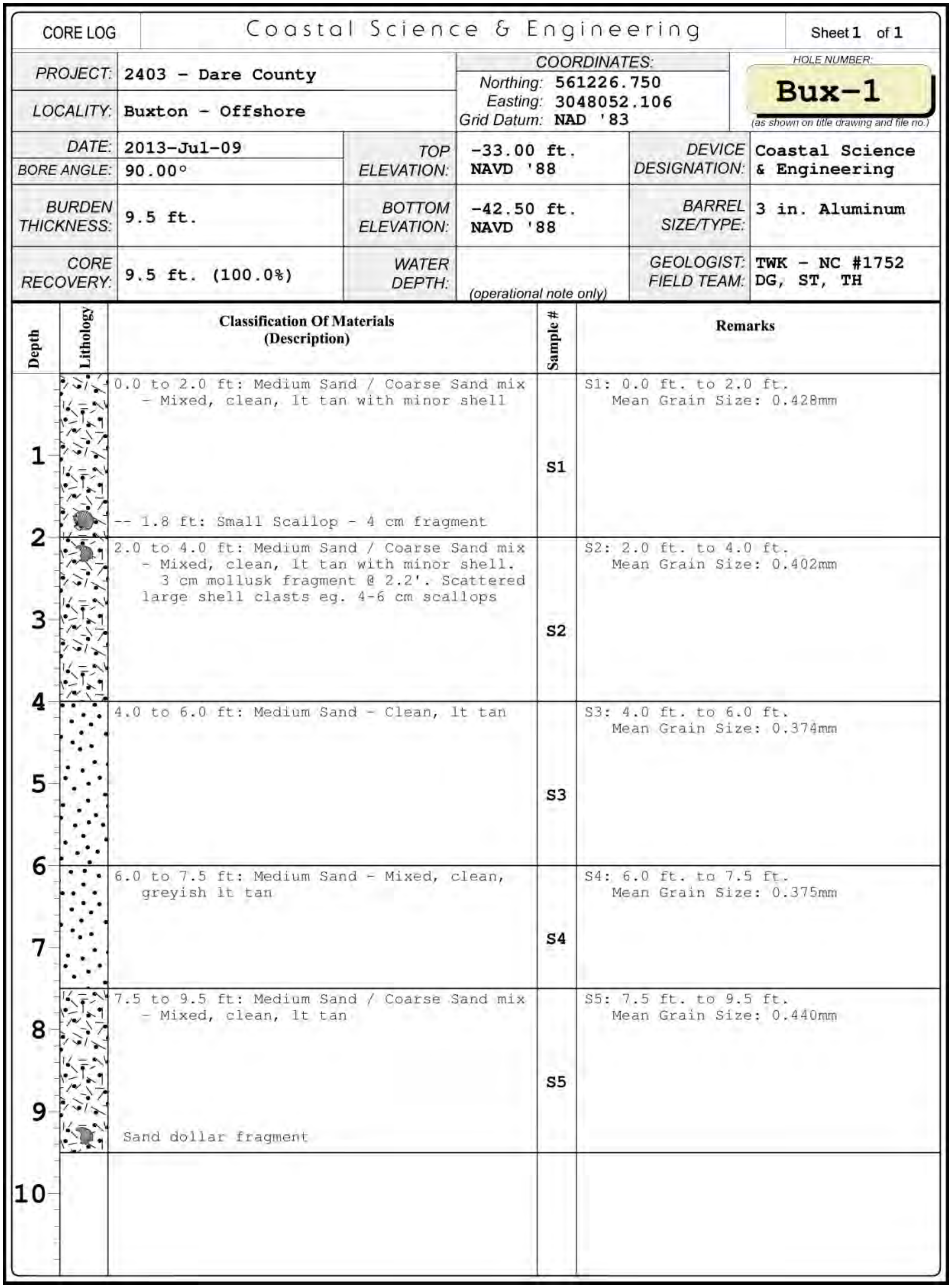


FIGURE 3.9a. Representative core photo log from Boring Bux-01 in the center east edge of the proposed borrow area.



CORE LOG — Coastal Science & Engineering — Sheet 1 of 1

PROJECT:	2403 - Dare County	COORDINATES: Northing: 561226.750 Easting: 3048052.106 Grid Datum: NAD '83	HOLE NUMBER: Bux-1 (as shown on title drawing and file no.)
LOCALITY:	Buxton - Offshore		

DATE:	2013-Jul-09	TOP ELEVATION:	-33.00 ft. NAVD '88	DEVICE DESIGNATION:	Coastal Science & Engineering
BORE ANGLE:	90.00°				
BURDEN THICKNESS:	9.5 ft.	BOTTOM ELEVATION:	-42.50 ft. NAVD '88	BARREL SIZE/TYPE:	3 in. Aluminum
CORE RECOVERY:	9.5 ft. (100.0%)	WATER DEPTH:	(operational note only)	GEOLOGIST: FIELD TEAM:	TWK - NC #1752 DG, ST, TH

Depth	Classification Of Materials (Description)	Sample #	Remarks
0–2	0.0 to 2.0 ft: Medium Sand / Coarse Sand mix - Mixed, clean, lt tan with minor shell -- 1.8 ft: Small Scallop - 4 cm fragment	S1	S1: 0.0 ft. to 2.0 ft. Mean Grain Size: 0.428mm
2–4	2.0 to 4.0 ft: Medium Sand / Coarse Sand mix - Mixed, clean, lt tan with minor shell. 3 cm mollusk fragment @ 2.2'. Scattered large shell clasts eg. 4-6 cm scallops	S2	S2: 2.0 ft. to 4.0 ft. Mean Grain Size: 0.402mm
4–6	4.0 to 6.0 ft: Medium Sand - Clean, lt tan	S3	S3: 4.0 ft. to 6.0 ft. Mean Grain Size: 0.374mm
6–7.5	6.0 to 7.5 ft: Medium Sand - Mixed, clean, greyish lt tan	S4	S4: 6.0 ft. to 7.5 ft. Mean Grain Size: 0.375mm
7.5–9.5	7.5 to 9.5 ft: Medium Sand / Coarse Sand mix - Mixed, clean, lt tan Sand dollar fragment	S5	S5: 7.5 ft. to 9.5 ft. Mean Grain Size: 0.440mm
10			

FIGURE 3.9b. Representative core log from Bux-1 showing lithology and mean grain size by core section illustrated in Figure 3.9a.

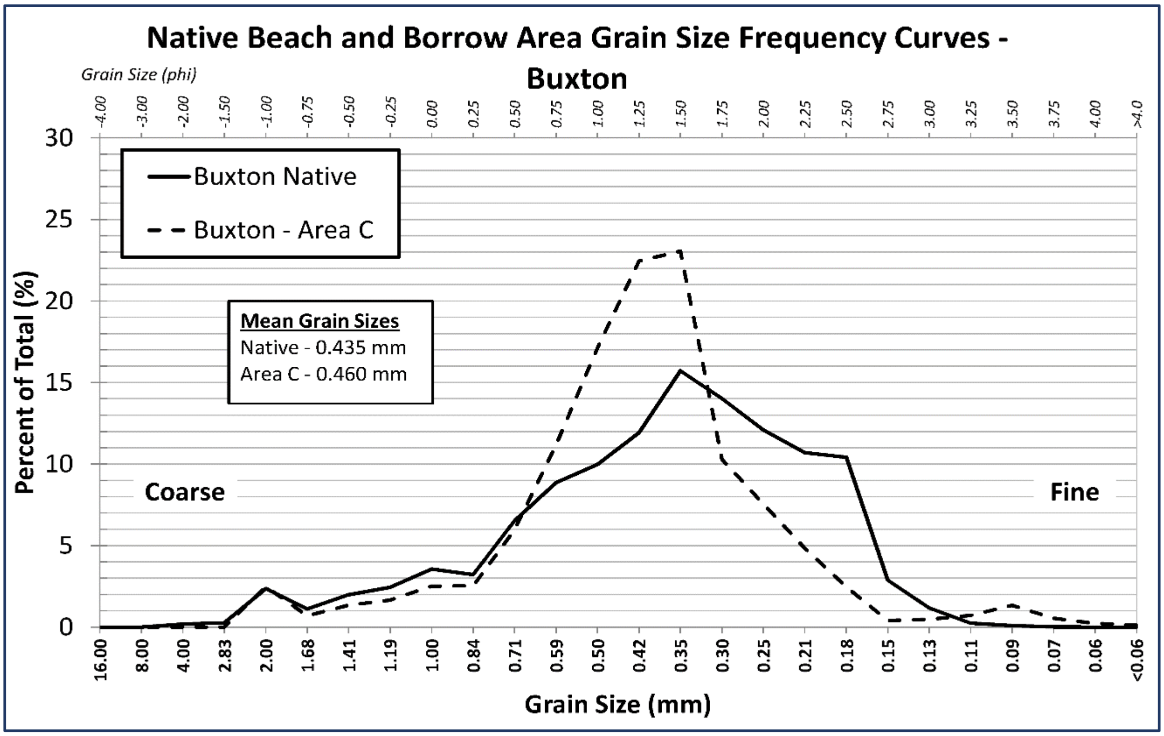


FIGURE 3.10. Preliminary comparison of mean grain-size distributions for Buxton native beach sand and the proposed borrow area. Results composited from Phase 1 samples (CSE 2013). (Detailed results in CSE 2015 Geotechnical Report.)

Description of Applicant Proposed Action (Alternative 3-Summer Construction)

The applicant-proposed action, *Beach Restoration to Protect NC Highway 12 at Buxton, Dare County NC*, is planned to begin by June 2016 with project completion by September 2016. The applicant proposed action (see Fig 1.1) includes the following items:

1) Placement of up to 2.6 million cubic yards of beach compatible sediment (≥90% sand) along up to 2.94 miles of ocean front beach beginning near Mile Post 59 in the Seashore and extending south to the approximate former location of the Cape Hatteras Lighthouse at Buxton Village. The beach nourishment project design specifies the majority of the sand placement within a ~13,000-foot zone within the Seashore and the balance within the Village of Buxton. The design beach width throughout the planned nourishment area would average up to ~150 ft wide after normal adjustment. The north and south ends of the project would taper gradually back to the existing shoreline over a minimum distance of 500 ft. Sand would be placed in a normal conFiguration which closely matches the grades and slopes of the native dry sand beach between the toe of the foredune and mean high water line. The maximum design berm elevation would be ~7 ft NAVD. The native dry beach elevation for the area is typically ~9 ft NAVD at the toe of the foredune sloping gently to ~+5 ft at the berm crest. Natural profiles vary seasonally around a range of berm elevations. Figure 3.7 shows a typical beach fill template prior to natural fill adjustment. No sediment would be placed directly on the existing foredune or toe of dune such that a minimum buffer of ~50 ft remains between the active construction area and the edge of vegetation. No sediment would be placed over existing structures, emergency sand bags, or existing ingress and egress points along the project area.

2) All sediment placed on the Buxton project beach adjacent to NC Highway 12 would be compatible with the native beach. Table 3.1 lists typical mean grain sizes for the subaerial beach in the project area (August 2013 conditions). The beach fill sand would be dredged from the proposed Borrow Area C located about 1.7 miles offshore of Buxton from within an unnamed sand ridge (Fig 3.8). Geotechnical investigations were conducted in August 2013 and October and December 2014 within the proposed borrow area to identify sufficient quantities of beach compatible material (≥90% sand) and determine presence of cultural resources or hard grounds. Figures 3.9a and 3.9b show an example core photo log and core log from the center of the proposed borrow area. Figure 3.10 shows a preliminary comparison of the grain-size distribution along the subaerial beach and borrow area (composited samples in the upper 7 ft of section). The proposed borrow area is a shoal exposed to high wave energy in water depths between 30 to 40 ft with negligible fine grained material present (e.g., mud or organics) (CSE 2013).

3) The proposed work would use either an ocean certified hopper dredge (with pump-ashore capabilities) and/or a hydraulic pipeline cutterhead dredge (Fig 3.11) to excavate and pump the material from the proposed offshore Borrow Area C to the sand placement area. The most feasible and safe method for excavation is anticipated to be via hopper dredge during summer months when wave energy at the borrow site is within threshold criteria for safest and most optimal operations (Fig 3.12). The project area is exposed to the highest waves along the East Coast (Leffler et al. 1996) and is situated approximately 105 miles from the nearest safe harbor at Little Creek Virginia. Ocean-going dredges, which can legally operate offshore generally have drafts which exceed the navigation channel depth or actual depth at Oregon Inlet (~45 miles away) or Hatteras Inlet (~20 miles away, not counting the extra steaming required around Diamond Shoals for safe passage).

4) Once sand has been pumped to the site, heavy equipment typically used in beach fill placement operations (i.e., bulldozers, front end loaders, excavators) would be used to build the design beach profile in addition to other support vehicles (i.e., ATVs, trucks) (Fig 3.13). Operations at the active beach construction site would be around the clock seven days a week until completion, the active beach discharge point would be fenced to protect public safety, and land based personnel would work within the beach construction zone to ensure compliance with conditions and restrictions of the applicable state and federal permits. Staging areas would be used to store additional shore pipe, fuel, mobile on-site office, and other necessary equipment. Locations of any staging areas and two anticipated access points for support vehicles and heavier equipment would be coordinated with the National Park Service and the Village of Buxton, as necessary.

5) The duration of construction is expected to be ~2 months assuming operations are permitted during summer months. Production for a 4.6 million cubic yards project at Nags Head, North Carolina (~50–60 miles north of the Buxton project site) was ~3.8 million cubic yards in three months between 27 May and 27 August 2011 using one large hopper dredge (~6,000 cy capacity) and one suction cutterhead dredge (for ~1.5 months), and ~0.8 million cubic yards in two months between 27 August and 27 October using two smaller hopper dredges (~3,000 cy capacity each) (CSE 2012). Low production rates for the latter 20 percent of the Nags Head project reflect a high frequency of no-work days associated with high wave events in September and October. Hurricane Irene impacted the Nags Head project on 27 August 2011.

FIGURE 3.11. Three hopper dredges and one suction cutterhead dredge (inset photos) were used to construct the Nags Head (NC) beach nourishment project (24 May to 27 October 2011). Image shows nourishment construction in progress working south to north toward Outer Banks Pier in south Nags Head. [Photos by CSE and Great Lakes Dredge & Dock Co.]

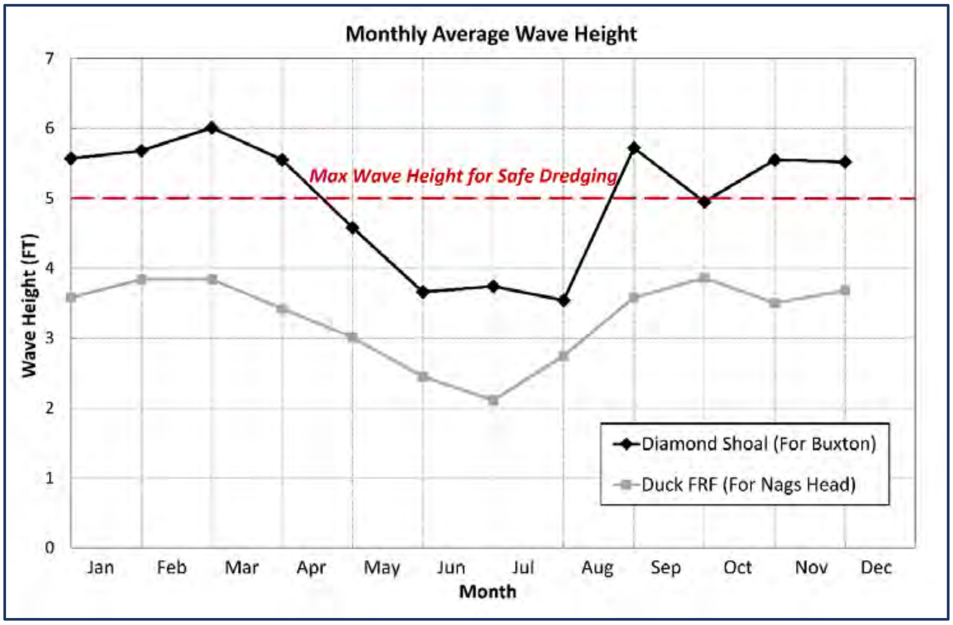


FIGURE 3.12. Monthly average wave climate 2003 through 2013 at NDBC wave buoy Station 4 1025 at Diamond Shoals (NC) compared to wave climate at the USACE FRF at Duck (NC). Safe dredging criteria apply to hopper dredge operations with ocean certified equipment per informal guidance by dredging companies. Operations decisions include numerous additional factors: wave period, sea state, pumping distance, size of dredge, and sediment characteris-tics. Suction cutterhead dredges generally cannot operate safely in waves >3 ft (USACE 2010). [Source: NDBC; After CSE 2013.]

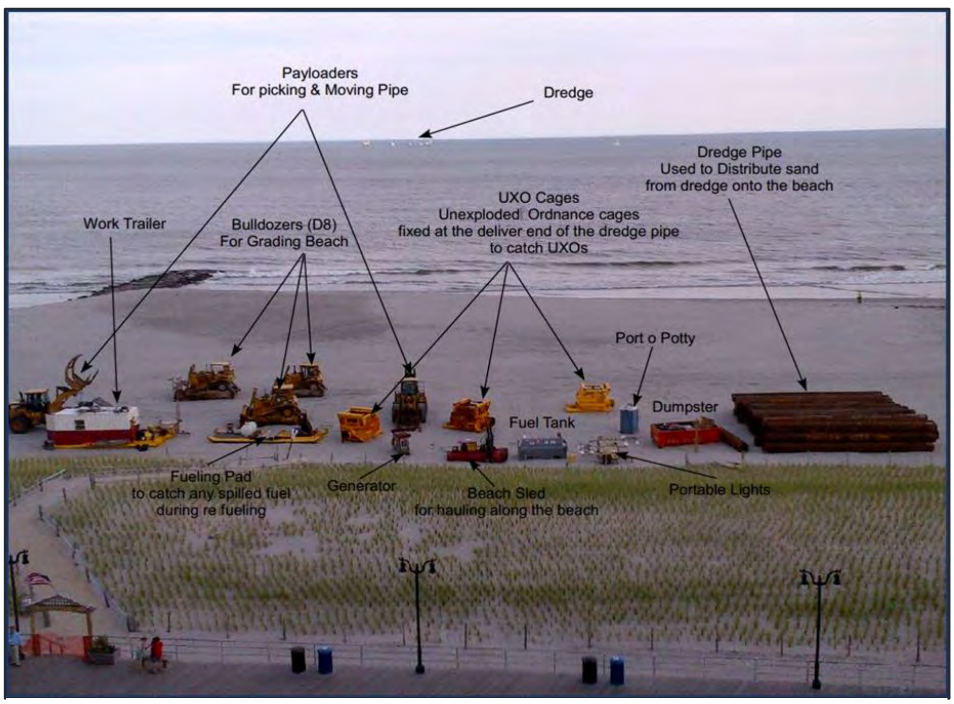


FIGURE 3.13. Types of land-based support equipment generally required for beach nourishment construction. [Photo annotations courtesy of J Lignelli and First Coastal Corp of New York.}

6) On a given day, the typical impact area along the beach in the project area would average ~1,000 linear feet. Project areas outside the active work area would remain open to the public, subject to NPS natural resource protection, management, and policy. As sections of the project are completed, the nourished area would be reopened immediately to the public as appropriate. Sections of shore pipeline extending up to ~4,000 linear feet along the beach would be left in place along the completed berm. Sand ramps would be placed over the pipeline for vehicle and pedestrian access to and from the beach every 100–200 feet (ft). The pipeline would be monitored nightly while in place to detect any turtle activity in the project area and to insure no turtles are stranded landward of the pipeline. Upon completion of a section of the project, the shore pipeline would be removed and relocated to a new pump-out point and shore pipe extended along the beach as the subsequent sections are completed. Thus, the shore length over which pipe extends during construction would vary from <100 ft to ~4,000 ft. Resource closure areas designated by NPS biologists before or during construction would be bypassed or avoided by shifting construction as far seaward as practicable to minimize impacts and maintain acceptable no work buffers near closure areas. Close coordination between NPS personnel and contractors would be maintained throughout the construction of the project.

7) Loaders would remove and relocate the pipeline and bulldozers would shape the nourishment berm into its final grades and slopes above mean high water. The seaward slope cannot be controlled accurately, but the likely intertidal beach slope for the nourished beach at the time of construction would be ~1 on 15 based on experience in similar settings. The constructed berm is expected to adjust rapidly to slopes and morphology typical of the surf zone, including low-tide bars and troughs formed within weeks in response to varying wave action. During fall months, the project area is subject to frequent high energy wave events associated with minor extra-tropical storms ("northeasters"). The berm elevation of the nourished beach is expected to be lower than the typical wave uprush limit during northeasters and be overtopped periodically within months of project completion. Washover deposits would shift sand landward to higher elevations near the foredune and shift sand into shallow water. Figure 3.14 illustrates a sequence of profile changes at one station along the Nags Head project area during and shortly after construction (from CSE 2012). Figure 3.15 shows natural buildup of the foredune over sand fencing placed at the toe of the foredune one year and three years after construction of the Nags Head project. No dune planting or sand fencing are included in project plans.

8) The offshore borrow area would be excavated to a maximum depth of ~7 ft below existing grade. If hopper dredges are used, excavations would leave undisturbed areas in close proximity to dredged corridors. High wave energy is expected to rapidly eliminate irregularities in the borrow area topography and promote mixing of exposed sands which underlie the removed sediments. The anticipated borrow area contains potential sand resources totaling >5 million cubic yards. The maximum project volume to be removed would be less than 50 percent of the sand resources in the designated area. Upon adjustment, the average depth over the designated borrow area is expected to increase by ~3 ft to an average depth in the range ~35–45 ft below mean sea level. The excavations over a natural ridge are not expected to leave deep holes. An adjacent trough within 1,000 ft west of the proposed borrow area contains natural water depths >50 ft (see fig 1.3).

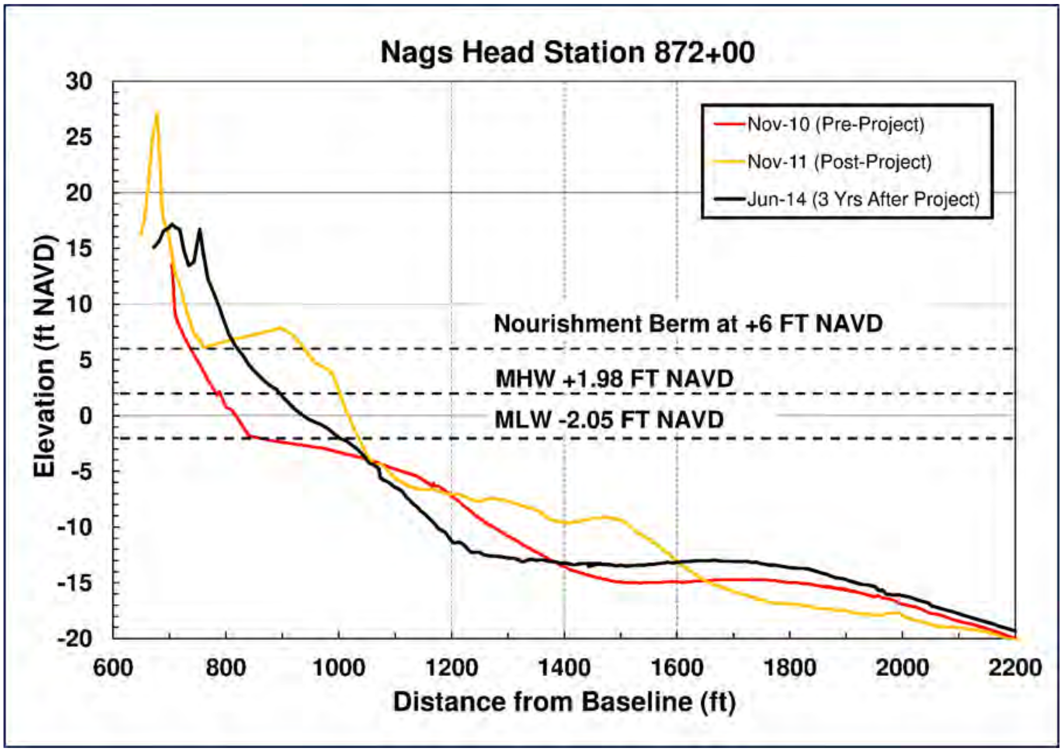


FIGURE 3.14. Pre- and post-nourishment profiles from a station in south Nags Head ~900 ft south of Jennette's Pier (Whalebone Junction) showing fill adjustment after three years. Note ~20:1 vertical exaggeration. No sand was placed above the +7-ft NAVD contour. Natural profile adjustment by Year 3 included a large shift of sand from the nourishment berm to the foredune as well as a buildup of sand offshore. The buildup of the foredune since nourishment is due to natural processes (from CSE 2014). The profile changes include impacts from Hurricane *Irene* (2011) and Hurricane *Sandy* (2012).

FIGURE 3.15. Natural dune growth along south Nags Head (NH Station 855+00) after the 2011 nourishment project. **[UPPER]** 11 June 2012, locality in Nags Head (NC) seven months after nourishment. **[LOWER]** 5 June 2014, same locality two years and seven months after nourishment. [From CSE 2014]

Alternatives Considered

Alternatives eliminated included Sound Borrow Source, Onshore Borrow Source, and Hard Structure Stabilization. Under consideration are Alternative 1-No-Action, Alternative 2-Winter Construction, and Alternative 3-Summer Construction (applicant proposed action). Each alternative is described below. Alternative 2-Winter Construction and Alternative 2-Summer Construction have the potential for most impacts to natural resources and are examined in more depth in this BA. Details for each alternative are also provided in the EA (in preparation).

Alternative 1-No-Action

Alternative 1-No-Action would maintain the status quo. Recent data suggests that the erosion rate within the project area is approximately two times the average rate at Nags Head with losses of the order 10 cubic yards per foot per year (cy/ft/yr); equivalent to dune recession averaging 8–10 ft/yr. Erosion would continue and result in continued periodic interrupted public access along NC 12 as sand from storm overwash events is deposited across the highway or an actual breach occurs. At some level of interrupted access or highway damage, and of course when a breach occurs, NCDOT would recommend to the governor to declare an emergency which would provide some level of temporary relief (e.g. – removal of sand from highway, breach closure, and/or bridge across breach). Presently, if the pavement edge of NC 12 is less than 230 ft from the active shoreline, NCDOT considers the highway vulnerable to short-term storm impacts. The longer-term NCDOT solution for the Buxton-Canadian Hole “hotspot” would remain in the future dependent on funding.

Alternative 2-Winter Construction

Alternative 2-Winter Construction would meet the project purpose and need by construction of a wider beach which would afford a buffer against chronic erosion issues common to the existing narrow beach configuration. However, winter dredging would severely lower the volume of sand that can be dredged under a fixed budget of Dare County funds. While winter dredging is generally preferred from an environmental standpoint, the Buxton setting precludes safe operations during high wave months (Fig 3.16). Operations involving suction cutterhead (i.e., traditional pipeline) dredges are typically suspended when wave heights in the borrow area exceed ~3 ft. Hopper dredge operations are typically suspended when seas exceed 5 ft (Weeks Marine Inc, R. Smith, former project manager, pers. comm., May 2008).

Buxton lacks a safe harbor in close proximity to the project site. At the approach of a storm, ocean-going dredges have to be towed or motored over 100 miles to the Chesapeake Bay entrance to take shelter in a safe harbor until the storm passes. Such delays reduce production time, extend the duration of construction, and add significant costs. Dare County is funding the project with no state or federal matching funds. Under a fixed budget, the volume of work accomplished during winter months would likely be less than half the volume of operations during the calmer summer months. The difference is considered to be extreme in the case of Buxton, because of its exposure to the highest waves along the US East Coast (Leffler et al. 1996).

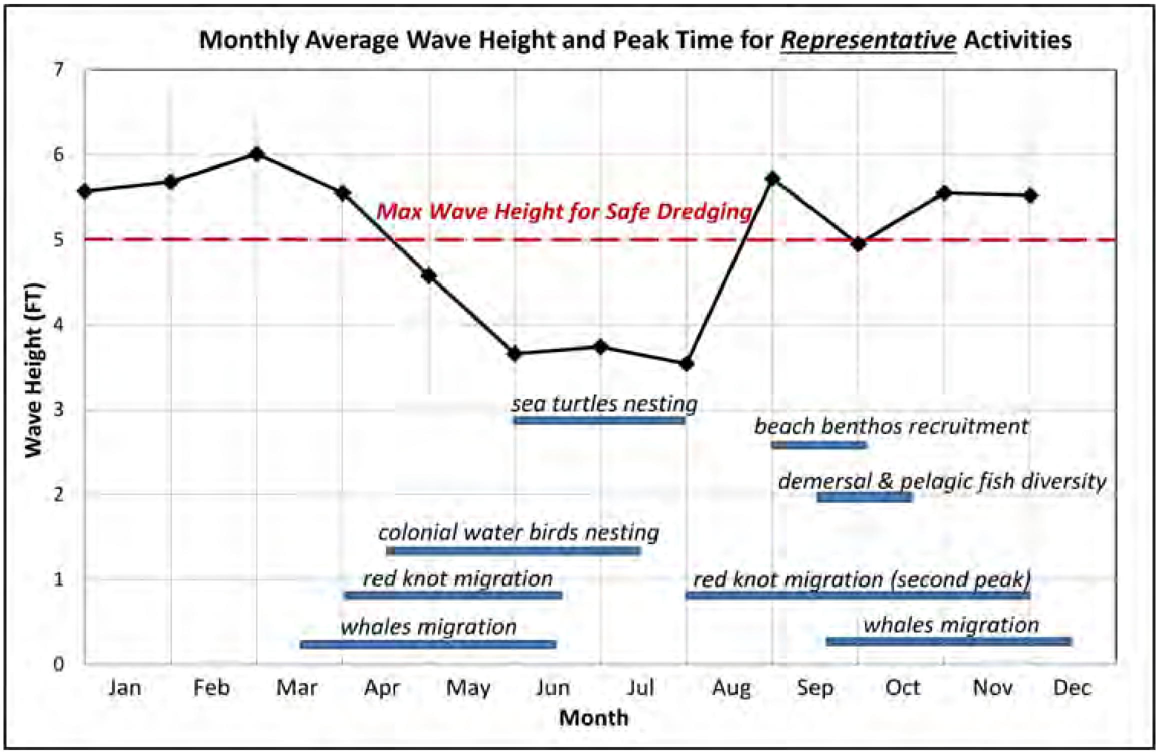


FIGURE 3.16. Graph showing the monthly average wave climate from 2003–2013 at NDBC Wave Buoy Station 41025 at Diamond Shoals (NC) near Buxton compared with the wave climate at the USACE Field Research Facility at Duck (NC). The criteria for safe dredging apply to hopper-dredge operations using ocean-certified equipment per informal guidance by dredging contractors. Suction-cutterhead dredges generally cannot operate safely in waves >3 feet (USACE 2010). The graph shows that average monthly wave height exceeds 5 feet from September to April in the Proposed Action Area. Calmest conditions occur in June and July when average wave heights are ~3.7 feet. The bars at the bottom of the graph show approximate range of dates when certain protected species may be present in or near the Action Area. (Source: NDBC)

The 2011 Nags Head Nourishment Project (4.6 million cubic yards) was 85 percent complete in three months between 24 May and 27 August using one ocean going hopper dredge (~6,000 cy capacity) for three months and one hydraulic cutterhead dredge for ~1.5 months. Operations were suspended for about one week when Hurricane *Irene* impacted the area on 27 August 2011. The remaining 15 percent of the project required two months to complete, utilizing two hopper dredges (~3,000 cy capacity each). During September and October 2011, a time of year when fall northeasters are frequent along the northern Outer Banks, dredging operations at Nags Head were suspended due to weather conditions over 50 percent of the time.

A recent nourishment project along eastern Long Island, New York, which is less exposed to high waves than Buxton, required over four months to dredge 2.5 million cubic yards between mid-October and late February 2014 using one cutterhead dredge. The borrow area was 1 mile offshore, offering efficient pumping distances and production over 60,000 cy/day on fair-weather days. Nevertheless, operations were suspended for over 50 days (ie ~40 percent standby time) due to weather (CSE 2014). In that project, the dredge was towed to the nearest safe harbor 10 miles away approximately a dozen times. Unit costs for the Long Island project were ~50 percent higher than the Nags Head project, largely because of the fall-winter season of construction. The cost differential between winter and summer dredging at Buxton is likely to be upwards of 100 percent (i.e., twice as much as summer operations).

Dare County officials have been alerted to the serious safety concerns within the dredging industry regarding work offshore of Nags Head and the Northern Outer Banks (B. Holliday, Dredging Contractors of America (DCA), 1 February 2007). Some excerpts of a letter from DCA to the Town of Nags Head follows:

> *… intense "Hatteras Lows" form off of Oregon Inlet, without warning and of such magnitude that no dredging work would be possible, and one such storm resulted in an industry hopper dredge being driven through the Oregon Inlet Bridge even though it was anchored and all engines were at full throttle. Forecasting these intense local low pressure systems is not very effective, and often the intensities are not properly captured by measurement equipment some distance from the full fury of these storms. This area is called the "Grave Yard of the Atlantic" because of the vulnerability of these storms and the extremely high energy environment of the region….*
>
> *Attempting to dredge in the winter months would result in numerous interruptions in operations due to shutdowns forced by each storm passage or even the potential for a storm to develop. The dredges would have to seek shelter all the way up to Hampton Roads….Severe winter storms would most likely damage equipment and pipelines on the beach, and substantial contingencies would be required to address this risk….*
>
> *My opinion is that it would be extremely dangerous and expensive to place a dredge and support equipment needed to accomplish a beach nourishment project in the offshore waters (around) Oregon Inlet during winter months. This would be extremely unsafe and warrant very high prices to address the risk and extra equipment and vessels needed to attempt to operate in this high energy environment.*
>
> *Barry W. Holliday, Technical Director, Dredging Contractors of America, 1 February 2007.*

Notwithstanding concerns regarding winter dredging, this alternative is retained for analysis under the present BA because such a schedule is recommended under the existing SARBO (South Atlantic Regional Biological Opinion 5 September 1997 — concerning the use of hopper dredges in channels and borrow areas along the southeastern U.S. Atlantic Coast)

Alternative 3-Summer Construction (Applicant's Proposed Action)

Alternative 3-Summer Construction would provide a wider oceanfront beach and would meet the project purpose and need, but is predicted to afford protection for twice as long as Alternative 2-Winter Construction. The applicant proposed action would include placement of up to 2.6 million cubic yards of compatible sands (also dredged from Borrow Area C) along up to 15,500 ft (2.94 miles). Up to 75 percent of this length is within National Seashore property on its eastern oceanfront north of Buxton Village (c.f. fig 3.6, page 15). The proposed dredging offshore and sand placement on the beach is projected to occur over a <3-month period between June and August 2016.

Recognizing the serious concern for endangered and threatened species protection during summer dredging periods along the ocean coast of the South Atlantic Region, certain monitoring and mitigation measures are anticipated and would be implemented by the project owner (Dare County) and dredging contractor in close coordination with resource agencies and the National Park Service.

National Seashore biologists closely monitor shore bird and turtle nesting activities along the National Seashore and establish closure areas when certain species are present and actively nesting. Following informal interagency consultation with USFWS, NCWRC, and NPS, Dare County proposes to minimize or mitigate impacts to nesting shorebirds and sea turtles by the following measures:

- Time construction activities to avoid active nesting areas to the extent practicable.
- Configure the fill sections to avoid placement on the dry sand beach in the vicinity of any designated bird closure areas; placement would occur seaward of mean low water for limited sections of the project.
- Monitor both sides of the shore pipe each night during construction for signs of turtle activity.
- Daily sea turtle nesting surveys initiated by 1 May through end of project.
- USFWS- and/or NCWRC-authorized personnel will relocate all sea turtle nests that may be affected by construction or sand placement ahead of construction to minimize impacts to sea turtles. All relocated nests must be moved before 0900 the morning following deposition to a secure setting meeting criteria to optimize hatch. Nest relocations will cease as project segments are completed unless other factors threaten successful hatch. All nests will be marked and avoided.
- Use special lights for turtles as recommended by USFWS, subject to conformance with OSHA minimums for work safety.
- Maintain a minimum back beach buffer of the order 50-ft (no work area) between the foredune and active nourishment area to avoid disturbance of incipient vegetation or potential nesting areas.
- Maintain certified and NMFS/PRD-approved onboard endangered species observers with authority to stop work as deemed necessary by current ESA protocols and/or standard conditions of the Biological Opinion. Optional measures suggested to mitigate adverse effects will be fully considered.
- Trawl ahead of hopper dredges (non-capture trawling) to mobilize any sea turtles or Atlantic sturgeon that may be resting in the surficial sediments of the borrow area.

A goal of summer dredging is to accomplish the work at the largest volume possible in the shortest time, so as to provide the greatest project longevity. A project of ~2.6 million cubic yards can be constructed in two to three months in the summer, based on recent experience. Typically, projects at the scale of Buxton require two or more landing points for the submerged pipeline. The sand slurry is pumped via the submerged pipeline to shore, then runs parallel to the beach by way of "shore pipe". Work proceeds north or south for a distance of 3,000-4,000 ft (typical) until that section of the project is complete. Then the shore pipe is removed and used to build the next section in the opposite direction until complete. Buxton would likely be completed in four discrete sections, working around the clock due to the high cost and number of personnel required for the operation of ocean certified dredges. It is not practical or cost-effective to suspend operations for several weeks and restart the project. Suspension of work for several weeks would result in remobilization costs or high standby costs per day (order of $150,000-200,000) with concomitant reduction in the volume that can be dredged under a fixed budget.

Fill sections can be modified to avoid placement landward of the low tide line for limited distances so as to place active construction as far as possible from nest closure areas. Such a conFiguration would leave a swale between the nourishment berm and the native beach. After construction is finished and all equipment removed, autumn storms would be expected to overtop the nourishment berm and drive sand into the swale. This procedure was used at Nags Head to avoid placing sand under condemned houses that were positioned in the active swash zone (CSE 2012). It is not practical or advisable to leave gaps in the project, given the anticipated cross-shore dimensions. Bulges in the fill adjacent to gaps potentially produce accelerated erosion of unnourished sections. For similar reasons, the ends of the project would incorporate long taper sections (order of 1,000–1,500 ft).

As sections are being completed, a 1,000-4,000 ft length of shore pipe remains in place for a 1–2 week period. The connection points every 40 ft must remain exposed for inspection for leaks by the dredgers, but numerous sand ramps will be placed over the pipe for vehicles and beach goers. The duration of time that the shore pipe would be strung out the maximum distance alongshore (~4,000 ft) would be a few days. As soon as the section volume is in place, the shore pipe would be removed and the nourishment berm graded to final contours with nearly all construction activity ceasing in that section. To minimize ingress of heavy equipment along the beach at night, unused pipe sections would be pre-positioned by loaders during daylight hours near the active work area for adding as needed during the night shift. This would also confine lighting to the ~300 ft active work area each night.

Dare County proposes these monitoring and mitigation measures based on consultation with USFWS, NMFS, and NPS officials and the limited experience with Northern Outer Banks nourishment projects.

PROPOSED PROJECT AREA DESCRIPTION

Cape Hatteras National Seashore occupies over 30,000 acres (ac) from the ocean to the sound and includes 64 miles of shoreline across three North Carolina islands, Bodie, Hatteras, and Ocracoke. The Proposed Action Area is in Dare County, North Carolina and portions of the project footprint are included in the jurisdiction and management of the National Park Service. In the nearshore and beach portion of the 296.5 ac project approximately 73.9 ac are within jurisdiction of the Village of Buxton. The sand placement will widen the beach in front of the very narrow portion of the island along NC 12 located just north of the village of Buxton, an area which is subject to repeated flooding and overwash during storms. Depending on the selected alternative (five- or ten-year predicted project life), the sand placement will extend to the north and south of this narrow area and taper into the existing beach profile.

As shown on the topographic/bathymetric map (Fig 4.1) and aerial photograph (Fig 4.2), the majority of the 296.5-ac project area considered terrestrial is unvegetated. Figure 4.3 shows the terrestrial footprint ranges in elevation (NAVD) from mean sea level to 15 ft and includes the backshore (15 ft elevation and landward 50 ft = 18 ac), foredune (9 ft to 15 ft elevation = 28.4 ac), and dry beach (5 ft to 9 ft elevation = 13.4 ac). The aquatic or marine footprint ranges in elevation from −19 ft to 5 ft and is comprised of wet beach (5 ft to −1 ft elevation = 17.3 ac), nearshore bottom (−1 ft to −8 ft elevation = 109.3 ac), and the offshore bottom (−8 ft to −19 ft elevation = 110.1 ac). No nourishment would be placed directly on the backshore, foredune, or upper dry beach above the +7-ft elevation contour. However, post-construction adjustment of the profile would likely include natural aeolian transport of sand from the nourishment berm to the upper beach and foredune. Therefore, habitat areas above the +7-ft contour are referenced herein as part of the project area habitat.

Borrow Area C includes an additional 450 ac of offshore bottom from approximately −30 ft to −45 ft elevation. Nearshore and offshore bottom includes the trough and longshore bars of the surf zone as well as the more persistent shoals in deeper waters. Figures 4.4 and 4.5 show typical profiles of the topography of the beach and Borrow Area C. East of NC 12, construction access points for equipment staging and manipulation will occur at two points along the project length chosen by the selected contractor (in coordination with NPS personnel) and may include other somewhat vegetated terrestrial habitats not affected by the actual sand placement.

The analysis/action area includes both the marine and terrestrial portions of the activities. All direct effects would be those which may occur during the project itself including the dredging within Borrow Area C, pipeline transport of dredged sediments to the placement areas, and/or the sand placement and shaping activities on the beach and nearshore. Indirect effects would include those which may occur after the project but as a secondary response to the project.

The proposed action would occur between June and September 2016 and would include use of the following equipment and activities:

- an ocean certified dredge (hopper dredge and possibly a suction cutterhead dredge) to dredge suitably sized sand from a borrow area ~1.7 miles offshore;
- these sands would be piped to shore and placed seaward of the toe of the dune (+7-ft contour); and

- bulldozers would shape the piped sand to closely match the contours and elevations of the natural beach.

The nourishment berm may be varied as necessary to avoid or provide additional separation around nest closure areas.

The project would likely increase the area of beach suitable for turtle, shorebird, and colonial waterbird nests and increase suitable areas for shorebird and colonial waterbird foraging and resting. Therefore, both the size and location of pre-nest closures may increase, as well as the time required for NPS personnel to establish the closures and perform their required surveys. Although unlikely, it is also possible that species not currently managed (or found within the National Seashore) become established in or use portions of the increased habitats subsequent to the project which may then require additional NPS management (e.g. seabeach amaranth).

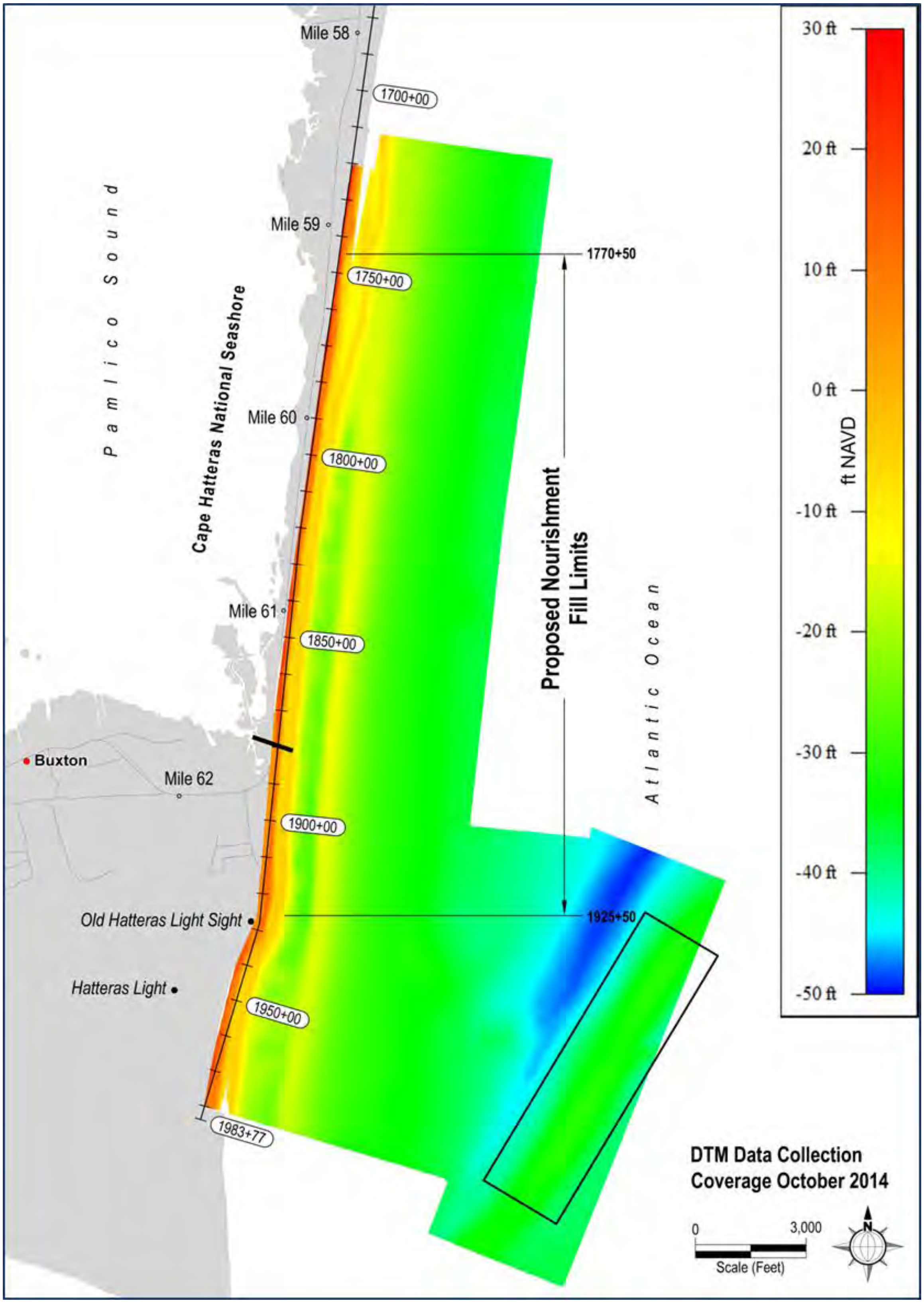


FIGURE 4.1. Digital terrain model (DTM) showing topography and bathymetry in the project area in October 2014.

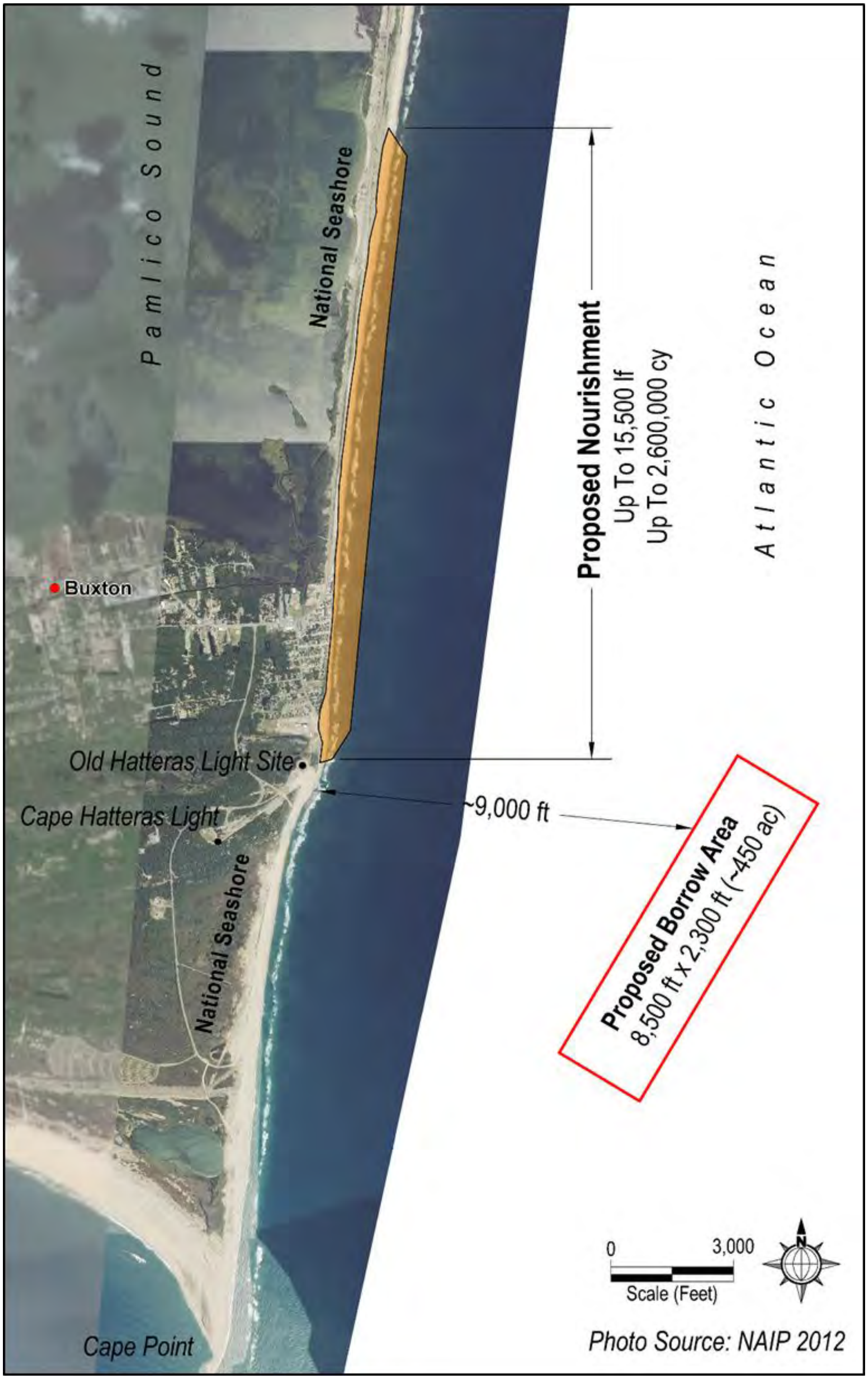
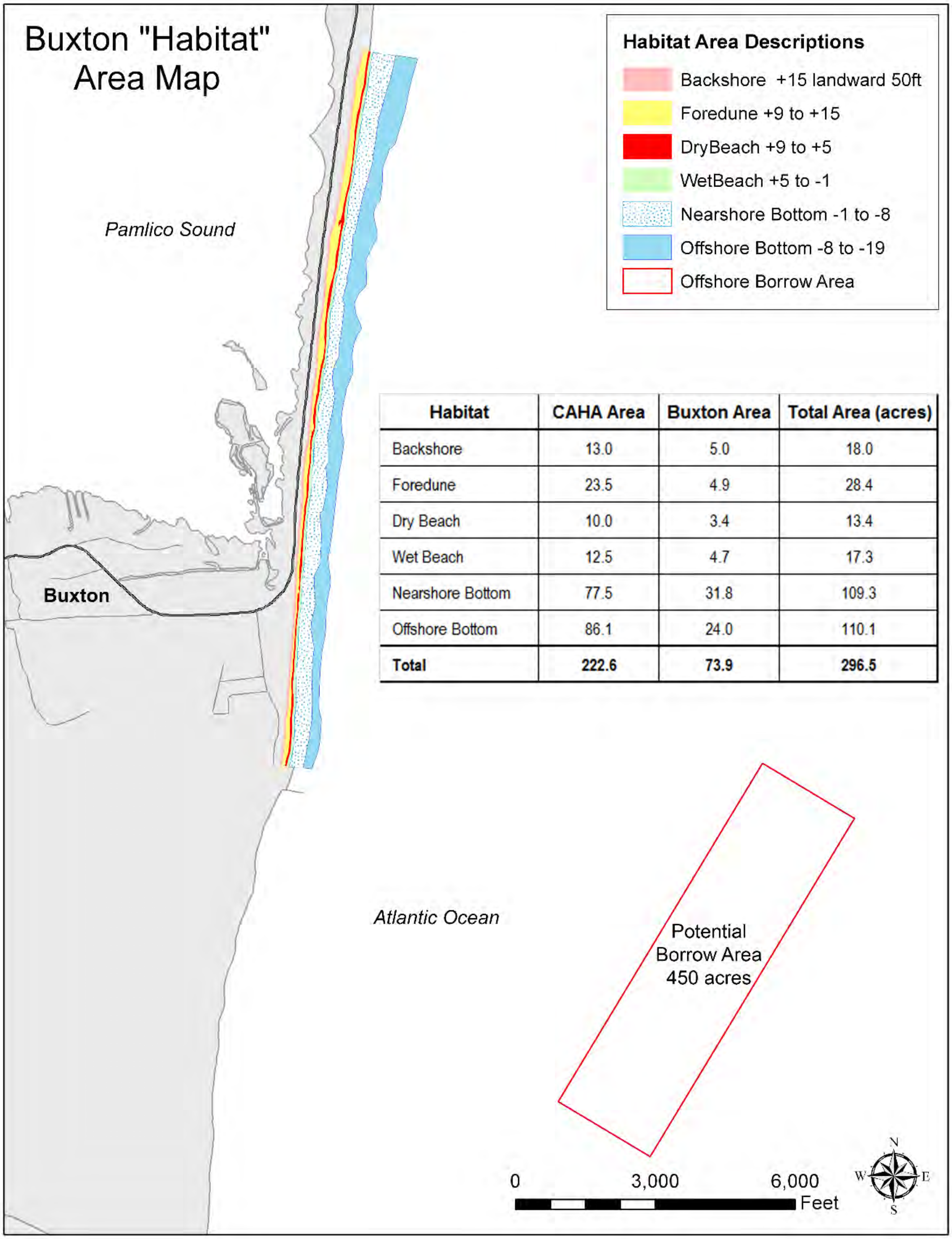
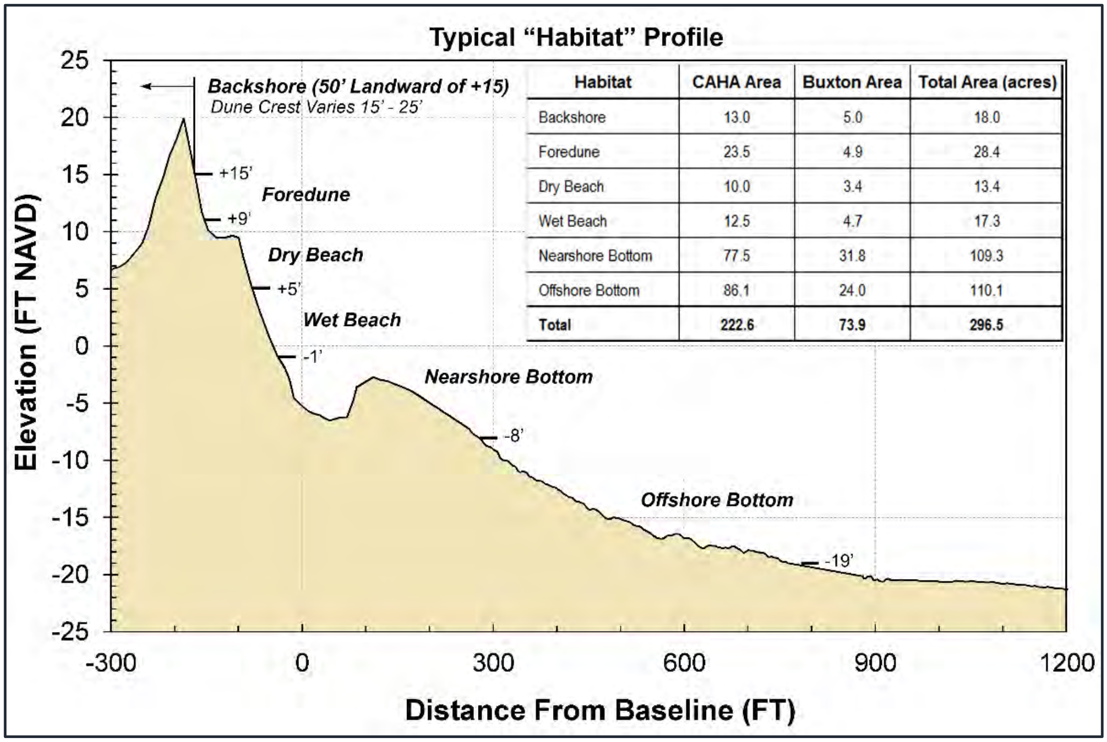


FIGURE 4.2. Aerial photo of the project area (2013).



Habitat	CAHA Area	Buxton Area	Total Area (acres)
Backshore	13.0	5.0	18.0
Foredune	23.5	4.9	28.4
Dry Beach	10.0	3.4	13.4
Wet Beach	12.5	4.7	17.3
Nearshore Bottom	77.5	31.8	109.3
Offshore Bottom	86.1	24.0	110.1
Total	**222.6**	**73.9**	**296.5**

FIGURE 4.3. Habitat area map of the project area showing acreage of various dune, beach, and inshore habitats out to the −19 ft NAVD depth contour.



Habitat	CAHA Area	Buxton Area	Total Area (acres)
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Nearshore Bottom	77.5	31.8	109.3
Offshore Bottom	86.1	24.0	110.1
Total	**222.6**	**73.9**	**296.5**

FIGURE 4.4. Representative habitat profile in the Buxton project area showing elevation limits for various habitat types and corresponding areas along ~15,500 linear feet based on conditions in October 2014.

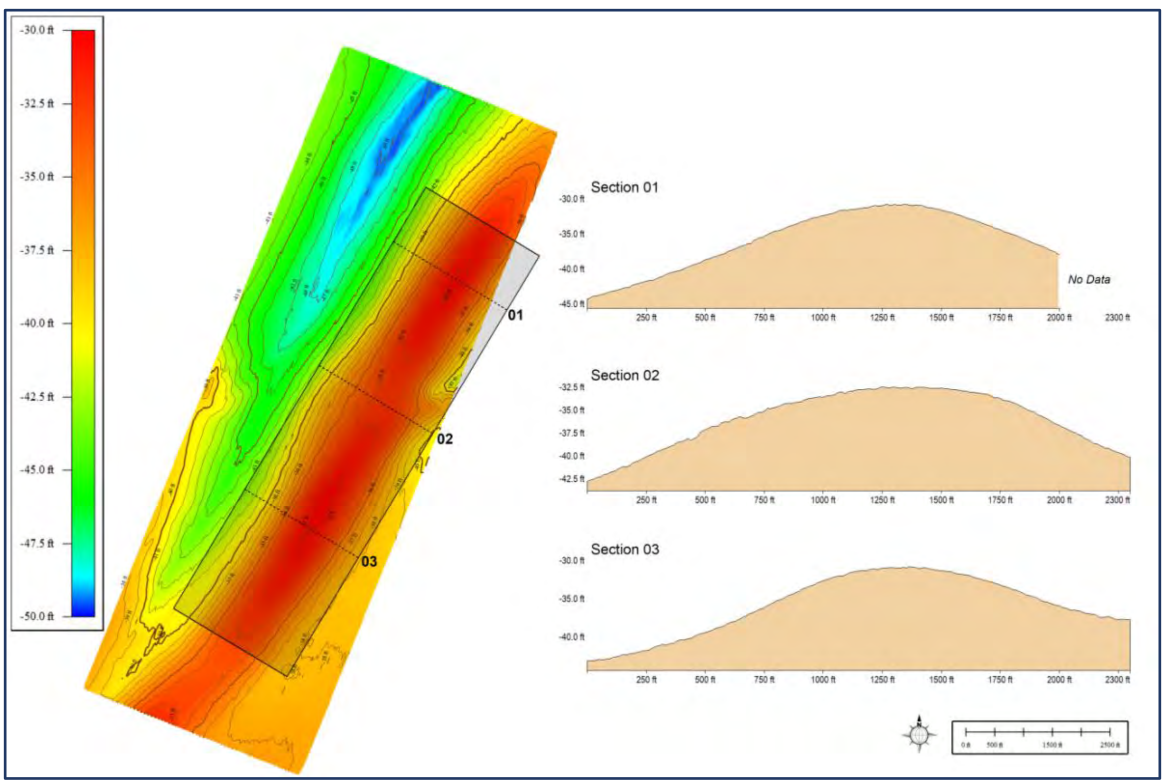

FIGURE 4.5. Detailed borrow area bathymetry and representative sections based on condition surveys in October 2014. Depths are in feet NAVD'88.

PRE-FIELD REVIEW

A list of all species considered as endangered, threatened, candidate, or proposed by federal agencies was generated. Those agencies included USFWS and NMFS. With these lists, it was determined which species had a potential to occur within the analysis area (as shown in Table 6.1). Species not known to occur or with no potential to occur in the analysis area are documented with rationale in Table 6.1 and will not be discussed further in this document. Excluded species have been dropped from further analysis under one or more of the following conditions:

1) Species does not occur nor is expected in the action area during the time period activities would occur;
2) Occurs in habitats that are not present; and/or
3) Is outside of the geographical or elevational range of the species.

In addition, Table 6.1 also gives a very brief summary of the species, designated critical habitat, species' habitat requirements, and known occurrence information of species that are known or may occur in the analysis area.

For all federally listed species in Table 6.1, there is no proposed critical habitat within the analysis area; however, designated critical migratory habitat for the loggerhead sea turtle does exist within the analysis area. There is no other designated or proposed critical habitat for any species within the analysis area.

SPECIES CONSIDERED AND EVALUATED

Species listed as threatened or endangered by USFWS or NMFS are afforded federal protection under the Endangered Species Act of 1973 as amended. The following table indicates whether the species from the USFWS official species list (dated 29 June 2015) and the NMFS southeast region list are (1) known or expected to occur within the analysis/action area and/or within 1 mile, (2) suitable habitat is present, or (3) if not, why they are excluded from further analysis. Additionally, for the marine mammals, North Carolina stranding data collected from 1997–2008 were consulted to help determine whether or not to evaluate a species in more detail (Byrd et al. 2014).

As indicated in Table 6.1, of the 21 federally protected species (including four birds, two fishes, one plant, nine mammals, and five reptiles), there are 13 species with the potential to occur (i.e. – habitat is present). Therefore, only those species will be addressed in this assessment (evaluated species). The remaining eight species shown in Table 6.1 will not be analyzed further based on the rationale of no habitat in analysis area or species not expected to occur during project window and no effect is anticipated for these eight species.

TABLE 6.1. Threatened, endangered, and candidate/proposed species with the potential to occur within the action/analysis area as determined by federal agencies with jurisdictional authority. The species lists were obtained from appropriate agencies (USFWS, NMFS) and reviewed; species without the potential to occur were excluded from further review with a no-effect determination based on the rationale codes as shown below. No freshwater species included.

[1] **Status Codes**: **E**= federally listed endangered; **T**=federally listed threatened; **Exp**=experimental population, non-essential: **CH**-critical habitat

[2] **Exclusion Rationale Codes**: **HAB**=no habitat present in analysis area; and **SEA**=species not expected to occur during the season of use/impact

SPECIES COMMON AND SCIENTIFIC NAME	STATUS[1]	POTENTIAL TO OCCUR	RATIONALE FOR EXCLUSION[2]	HABITAT DESCRIPTION AND RANGE
BIRDS				
Piping plover (*Charadrius melodus*)	T	Yes		Coastal beaches, sandflats at the end of sand spits and barrier islands, gently sloped foredunes, sparsely vegetated dunes, and washovers
Red-cockaded woodpecker (*Picoides borealis*)	E	No	HAB	Mature pine forests with an open understory
Roseate tern (*Sterna dougallii dougallii*)	E	Yes		Nest on ends of or breaks in small barrier islands other than North Carolina; NEUS population may use North Carolina beaches as stopover during seasonal migrations
Red knot (*Calidris canuta rufa*)	T	Yes		Coastal and inland areas for resting and feeding during spring and fall migration
FISHES[1]				
Atlantic sturgeon (*Acipenser oxyrinchus*)	E	Yes		Western Atlantic waters- fresh water rivers to spawn, estuarine waters as juveniles, marine waters as subadults and adults (10-50m depths)
Shortnose sturgeon (*Acipenser brevirostrum*)	E	Yes		Rivers and estuaries of the east coast of US
FLOWERING PLANTS				
Seabeach amaranth (*Amaranthus pumilus*)	T	Yes		Overwash flats, dunes, and accretion areas on barrier islands of the Atlantic Ocean
MAMMALS				
Blue whale (*Balaenoptera musculus*)	E	Yes	HAB;SEA	Worldwide oceans; occasionally in coastal waters but thought to occur generally more offshore than other whales; poleward migration in spring; 0 North Carolina strandings 1997-2008.
Finback whale (*Balaenoptera physalus*)	E	Yes		Deep offshore waters of all major temperate to polar oceans; may be in North Carolina waters during winter migration from north to south; 3 North Carolina strandings 1997-2008, 1 in proposed construction window (May)
Humpback whale (*Megaptera novaeangliae*)	E	Yes		Worldwide oceans equator to subpolar; winter migration to tropical and subtropical waters; 23 North Carolina strandings 1997-2008, 1 in proposed construction window (Sept). 14 strandings on Seashore beaches 2008-2014

Table 6.1 (continued)

SPECIES COMMON AND SCIENTIFIC NAME	STATUS[1]	POTENTIAL TO OCCUR	RATIONALE FOR EXCLUSION[2]	HABITAT DESCRIPTION AND RANGE
North Atlantic right whale (*Eubalaena glacialis*)	E	Yes		Worldwide temperate to subpolar oceans; nursery grounds in shallow coastal waters; movements strongly tied to prey food distribution; in lower latitudes and coastal waters in winter, more inshore during spring migration; 5 North Carolina strandings 1997-2008, 1 during proposed construction window (Sept). 1 stranded on Seashore beach in 2008.
Sei whale (*Balaenoptera borealis*)	E	No	HAB;SEA	Subtropical to subpolar waters on continental edge and slope; usually observed in deeper oceans far from coastline; move to northern latitudes in summer; 1 North Carolina stranding 1997-2008 and not in proposed construction window
Sperm whale (*Physeter macrocephalus*)	E	Yes	HAB	Worldwide oceans; uncommon in waters <300m; 8 North Carolina strandings 1997-2008, 2 in proposed construction window (June). 1 stranded on Seashore beach in 2008
West Indian manatee (*Trichetus manatus*)	E	Yes	HAB	Florida coast and Caribbean; rare visitor to North Carolina ocean waters and further north; 5 North Carolina strandings 1997-2008 all inshore, 2 in proposed construction window (July, Aug)
Red wolf (*Canis rufus*)	Exp	No	HAB	North Carolina's Albemarle peninsula, species found from agricultural lands to pocosins in areas of low human density, a wetland soil type, and distance from roads
Northern long eared bat (*Myotis septentrionalis*)	T	No	HAB	North Carolina represents southern coastal extent of range; needs forests (live and snags) for summer roosts. No confirmed record in Dare County
***REPTILES*[1]**				
Green sea turtle (*Chelonia mydas*)	T	Yes		Global distribution in tropical and subtropical waters along continents and islands; inshore and nearshore waters of North Carolina; nests on ocean beaches
Hawksbill sea turtle (*Eretmochelys imbricata)*	E	Yes		Circumtropical; usually in waters <20m; rare in North Carolina waters but has stranded on North Carolina and CAHA beaches; nests on ocean beaches elsewhere
Kemp's ridley sea turtle (*Lepidochelys kempii*)	E	Yes		Neritic habitats including Gulf of Mexico and US Atlantic seaboard; nests on ocean beaches
Loggerhead sea turtle (*Caretta caretta*)	T	Yes		Circumglobal in temperate and tropical oceans; nest on ocean beaches; **CH** (migratory corridor) designated in North Carolina offshore waters within project area

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EVALUATED SPECIES INFORMATION

Field Reconnaissance

National Seashore biologists provided the following information about recent surveys or documentation of listed species within the park by the Park Service:

- **Piping plover** *(Charadrius melodus)* — The species nests within the park on a yearly basis, primarily on Cape Point which has the premier habitat. Within the past five years, a total of seven piping plover nests have been documented within the Proposed Action Area.

- **Red-cockaded woodpecker** *(Picoides borealis)* — Habitat does not exist for this species within the defined action area; no documentation of species.

- **Roseate tern** *(Sterna dougallii)* — The species may be observed along the National Seashore while migrating along the east coast. The majority of nesting habitat is located at the Northeast/New England states. The species has not been documented to nest in the park within the past five years.

- **Rufa red knot** *(Calidris canutus rufa)* — The species is primarily observed foraging on mudflats near the points and spits. In 2014, there were five instances where red knot were observed within the action area, totaling 54 individual birds.

- **Atlantic sturgeon** *(Acipenser oxyrinchus oxyrinchus)* — No documented instances of this species within the action area. Typically observed within low-salinity habitat characteristic of bays and inlets; the closest inlet (Hatteras Inlet) is located ~12 miles southwest of the Proposed Action Area.

- **Shortnose sturgeon** *(Acipenser brevirostrum)* — No documented instances of this species within the action area. Typically observed within low-salinity habitat characteristic of bays and inlets; the closest inlet (Hatteras Inlet) is located ~12 miles southwest of Proposed Action Area.

- **Seabeach amaranth** (*Amaranthus pumilus*) —Although habitat for this particular species is sufficient, yearly surveys within the park have yielded zero documentations of the plant since 2005. There are no historic records of this plant from within the action area (Cape Hatteras National Seashore, Randy Swilling, Natural Resource Program Manager, pers. comm.,15 April 2015).

- **Red wolf** *(Canis rufus)* — Habitat does not exist for this species within the defined action area; no documentation of species.

- **West Indian manatee** *(Trichechus manatus)* — Habitat does not exist for this species within the defined action area, which is highly turbid and has little to no vegetation. There have been few documented instances of manatees north of the action area near inlets where the manatee is likely to traverse into brackish water for vegetation consumption and to drink.

- **Green sea turtle** *(Chelonia mydas)* — The species nests on National Seashore beaches on a yearly basis but makes up a fraction of the overall nesting turtle numbers. Only three nests have been documented within the action area for the past five years.

- **Hawksbill sea turtle** *(Eretmochelys imbricata)* — The majority distribution for this species is limited to the equatorial tropics and well out of range of the proposed nourishment area. To date, the species has not been documented alive within the park, but strandings have occurred in the Seashore.

- **Kemp's ridley sea turtle** *(Lepidochelys kempii)* — Primarily nesting in the Gulf of Mexico, this species is a very rare nester at the National Seashore; only two nests have been documented for the past five years, neither of which was in the proposed nourishment area. The closest nest was laid on 16 June 2011 and was located ~3 miles southwest of the proposed area (west of Cape Point). The second nest was on Ocracoke Island.

- **Leatherback sea turtle** *(Dermochelys coriacea)* — Regularly observed off the coast of the National Seashore during peak summer months, very seldom does this species nest in the park (majority nesting occurs in tropics). Only one nest has been documented within the past five years; ~30 miles southwest of action area (Ocracoke Island).

- **Loggerhead sea turtle** *(Caretta caretta)* — The most commonly observed nester on National Seashore beaches. Over the past five years, a total of 172 loggerhead nests have been documented within the proposed nourishment area.

Wildlife Species Status and Biology (Species with ESA Protection)

Birds

Piping Plover (*Charadrius melodus*)

Both federally and state protected, there is designated critical habitat for the wintering population of the piping plover at four locations on the Outer Banks, the closest of which is Unit NC-2 Cape Hatteras Point. The northern boundary of Unit NC-2 is 468 ft south of the southern tip of the project footprint. This Unit extends south ~2.8 miles from the old ocean groin at the old Cape Hatteras Lighthouse location to the point of Cape Hatteras and then continues west for ~4.7 miles along Hatteras Cove shoreline (Shore Beach) to the edge of Ramp 49 near the campground at Frisco. Beaches, pools, and intertidal areas, especially in the vicinity of inlets, are the primary habitats used by piping plovers; the area of analysis which may affect this species is composed of beach face and intertidal zones.

The piping plover is a small shorebird about 6.7 inches in length with a 15-inch wingspan (USFWS 2003). The species is named for its melodic call. Overall plumage is light colored, allowing it to often blend into sandy habitats. During the breeding season the species has a single black band across the upper breast, a smaller band across the forehead, and bright orange legs and bill with a black tip. (Photo courtesy of USFWS Digital Library.) Females are often duller in coloration and lack a complete breast band. In the winter, the bill is black, legs are pale, and dark markings (breast and forehead bands) are absent.

Piping plovers breed in North America in three geographic regions: beaches of the Atlantic Coast from Newfoundland to South Carolina; shorelines of the Great Lakes; and along lakes, rivers, and wetlands of the Northern Great Plains. The Great Lakes population is designated as endangered and the Atlantic Coast and Northern Great Plains populations are designated as threatened. Piping plovers on migration and in wintering areas are considered threatened under the ESA of 1973, as amended.

Piping plovers occur year-round along the Outer Banks; North Carolina represents the normal southern edge of the breeding range and the northern edge of the wintering range, and is the only Atlantic coast state to have piping plovers during all phases of its annual cycle . The species is migratory, and birds from coastal and interior nesting populations both winter in North Carolina. For nesting, piping plovers typically select open, sparsely vegetated, sandy habitats near inlets and overwash areas. The nesting season lasts from April through August. Nests consist of shallow depressions or scrapes in sand often lined with shell fragments or pebbles. Both adults defend territories and share nest incubation duties. Typically a clutch consists of three to four eggs which are incubated for 25 to 31 days. Re-nesting will often be attempted if nests are destroyed. Young are precocial, feeding themselves after hatching, but still depend on adults for protection until flight (about 28 to 35 days after hatching). Chick survival has been linked to access to quality foraging habitats (Loegering and Fraser 1995).

Foraging occurs on a variety of substrates including: intertidal beaches, sand/mud flats, wrack lines, shorelines, and tidal and ephemeral pools. Use of areas for foraging is largely dependent upon availability of habitat, food abundance, stage of breeding cycle, and disturbance from humans (Burger 1991; Loegering and Fraser 1995; Zonick et al. 1998). Wintering birds spend much of their time foraging on insects, marine worms, crustaceans, and mollusks (Haig 1992).

Primary threats to eggs and young include avian and mammalian predators, including red foxes (*Vulpes vulpes*), feral cats (*Felis catus*), raccoon (*Procyo lotor*), gulls (*Larus* spp.), fish crows (*Corvus ossifragus*), grackles (*Quiscalus* sp.), and ghost crabs (*Oncypoda* sp.) (USFWS 1996a, 2003). Lack of suitable and undisturbed habitat creates additional pressures on nesting and foraging birds. Human-related disturbances of threat to the species are those associated with recreational activities and pets (USFWS 2003).

There were 14 piping plover nests documented within the National Seashore in 2014, seven at Cape Point and the other seven further to the south; five fledglings were documented from the seven Cape Point nests and none from the other nests. Individual piping plovers counted during the annual census (1-9 June 2014) along the North Carolina coast showed three individuals (presumed to be single non-nesting adults), 14 pair, and five young fledged within the entire Cape Hatteras National Seashore (Cape Hatteras National Seashore, Randy Swilling, Natural Resource Program Manager, pers. comm., 4 June 2015). Comparatively, during the same census, 47 pair, five individuals, and nine young fledged in Cape Lookout National Seashore. The closest documented piping plover nest is ~660 ft north of Ramp 43, or 1.5 miles away from the project area. While it is likely that the project area may be used by this bird during migration or foraging, the Cape Hatteras National Seashore field data has not documented this use; no breeding activity has ever been recorded in the project area (Cape Hatteras National Seashore, Randy Swilling, Natural Resource Program Manager, pers. comm., 4 June 2015). Table 7.1 shows numbers of piping plover breeding pairs documented in Cape Hatteras National Seashore from 1987–2014 (modified from NPS 2010).

TABLE 7.1. Number of piping plover breeding pairs by site at Cape Hatteras National Seashore (1987–2014) [expanded from Table 15 in NPS 2010]. [a]After Hurricane Irene, erosion of this spit had removed all suitable breeding habitat. [b]Total numbers of pairs was 202 through 2011, but locations were not available in 1989, so percentages from the specific sites are based on the 187 nests recorded at one of the six specific nesting areas.

Year	Bodie Island Spit	Cape Point	South Beach	Hatteras Inlet Spit[a]	North Ocracoke Spit	South Point	Total Pairs
1987	0	4	0	4	1	1	10
1989	–	–	–	–	–	–	15
1990	0	8	0	4	2	0	14
1991	0	5	0	3	5	0	13
1992	0	4	0	4	4	0	12
1993	0	5	1	3	3	0	12
1994	0	5	1	3	2	0	11
1995	0	6	1	4	2	1	14
1996	1	5	1	5	1	1	14
1997	1	4	1	3	0	2	11
1998	0	4	1	3	0	1	9
1999	0	3	1	1	0	1	6
2000	0	2	0	2	0	0	4
2001	1	1	0	1	0	0	3
2002	1	0	0	1	0	0	2
2003	0	0	0	1	0	1	2
2004	1	0	0	1	0	1	3
2005	0	0	1	1	0	1	3
2006	1	2	1	1	0	1	6
2007	1	4	0	0	0	1	6
2008	1	5	1	0	0	4	11
2009	0	5	0	0	0	4	9
2010	0	6	1	0	1	4	12
2011[b]	2	5	2	0	1	5	15
2012	1	8	1	-	1	4	15
2013	0	7	0	-	0	2	9
2014	0	7	0	-	1	4	12
Total	11	105	14	45	24	39	253
Percent of Total Pairs[b]	**4.3**	**41.5**	**5.5**	**17.8**	**9.5**	**15.4**	

Roseate Tern (*Sterna dougallii dougalli*)

The roseate tern a federally endangered migratory coastal seabird about 14–16 inches in length, with light-gray wings and back. Its first three or four primaries are black and so is its cap. The rest of the graceful and slender body is white, with a rosy tinge on the chest and belly during the breeding season. The tail is deeply forked, and the outermost streamers extend beyond the folded wings when perched. During the breeding season the basal three-fourths of the otherwise entirely black bill and legs turn orange-red. It feeds by plunge diving, often completely submerging, but also may feed in the shallows and even steal food from common terns. It can be found singly, in small loose groups, or in mixed flocks with hundreds of other birds (Urban et al. 1986, Snow and Perrins 1998, Ramos 2000). (Photo courtesy of USFWS Digital Library.)

It is divided into four subspecies, based largely on small differences in size and bill color. The North American subspecies is divided into two separate breeding populations, one in the northeastern US and Nova Scotia and one in the southeastern US and Caribbean. It nests in widely but sparsely distributed colonies and among the northeastern US populations, usually among colonies of common tern.

Threats to the species include habitat loss to barrier island development, nest or even entire colony abandonment due to disturbance from humans, vehicles, or predators, and competition from expanding numbers of larger gulls (e.g., great backed gull and herring gull in the northeastern US population) (USFWS 2011).

In North Carolina, the roseate tern is exceedingly rare and most likely only to be seen on a Dare County barrier island as it passes through the area to and from northern breeding grounds May through September. There are July records of the bird in the Seashore (eBird 2015 "Bird Observations North Carolina" and "Dare County").

Rufa Red Knot (Calidris canuta rufa)

On September 27, 2013, the US Fish and Wildlife Service released a proposal to list the rufa red knot (*Calidris canutus rufa*) as a threatened species under the Endangered Species Act and the final rule was published in the Federal Register on 11 December (Volume 79, No. 238) effective date 10 January 2015. During more than 130 days of public comment periods and three public hearings since September 2013, the Service received more than 17,400 comments on the threatened listing proposal, many of which were supportive form letters, while others raised issues with the adequacy of horseshoe crab management, the impacts of wind turbines, the inclusion of interior states in the range, and other topics. The agency requested additional time to complete the final decision in order to thoroughly analyze complex information available after the proposal, such as national and global climate assessments and carefully consider and address extensive public comments. On 9 December 2014, USFWS designated the bird as threatened. Critical habitat for this species is likely to be proposed for public review and comment in 2015.

A handsome robin-sized shorebird with a wingspan of 20 inches, this species annually migrates from the Canadian Arctic to southern Argentina, making these birds among the longest migrants in the animal kingdom. Adult plumage in spring: above finely mottled with grays, black and light ochre, running into stripes on crown; throat, breast and sides of head cinnamon-brown; dark gray line through eye; abdomen and undertail coverts white; uppertail coverts white, barred with black; in winter: pale ashy gray above, from crown to rump, with feathers on back narrowly edged with white; underparts white, the breast lightly streaked and speckled, and the flanks narrowly barred with gray; and in autumn: underparts of some individuals show traces of the "red" of spring. (Photo courtesy of Greg Breese, USFWS.)

The red knot, whose range includes 25 countries and 40 US states, uses spring and fall stopover areas along the Atlantic and Gulf coasts arriving in large flocks containing hundreds of birds. Estimates for the mid-Atlantic population based on marked bird data and mathematical models are 44,680 for birds stopping in Delaware Bay (2012) and 12,611 to 14,688 stopping annually in Virginia (2007-2011) (USFWS Red Knot QAs 092713). These estimates do not include birds migrating overland directly to Canada from Texas or the Southeast.

Changing climate conditions are already affecting the bird's food supply, the timing of its migration, and its breeding habitat in the Arctic. Mismatches in migration timing often put the bird out of synchrony with peak periods of food availability. The shorebird also is losing areas along its range due to sea level rise, shoreline projects, and coastal development (USFWS 9 December 2014 Press Release). Just over half of the beaches from North Carolina south to Texas is developed and one third of the available knot habitat in the US is available for development (USFWS Red Knot QAs 092713). A primary factor in the recent decline of the species was reduced food supplies in Delaware Bay due to commercial harvest of horseshoe crabs. In 2012, the Atlantic States Marine Fisheries Commission adopted a management framework that explicitly ties horseshoe crab harvest levels along the Atlantic Coast to red knot recovery targets. The Service's analysis shows that although the horseshoe crab population has not yet fully rebounded, the framework should ensure no further threat to the red knot from the crab harvest.

The peak spring migration for the red knot in North Carolina is May to early June and the peak fall migration occurs from late July to early November (ebird.org). The red knot does not nest in North Carolina but has been documented foraging on mudflat habitats in the points/spits within the National Seashore by NPS personnel. Table7.2 contains summary data of red knot observations within the Seashore from 2008-2013 and demonstrates that while the project area is used by the species in most years, the North Hatteras segment is among the segments with the least numbers of observations. Figure 7.1 shows red knot observations from 2010-2013 with a gap in much of the project area. The foraging habitat for this species is very marginal in the project area due to the high energy conditions and eroding beach face.

TABLE 7.2. Historical red knot observations in Cape Hatteras National Seashore survey segments from 2008–2013. The project area is contained within segment PM19-PM44 and PM indicates Park Mile along the ocean side.

	2008	2009	2010	2011	2012	2013	Total by Segment
Bodie Island (PM 0 - PM 3)	0	0	6	5	17	4	**32**
Bodie Island Spit (PM 4 - PM 5)	1	0	2	0	105	8	**116**
North Hatteras (PM 19 - PM 44)	0	0	10	22	24	16	**72**
Cape Point (PM 45 - PM 46)	0	0	2	37	13	0	**52**
South Hatteras (PM 47 - PM 57)	0	0	21	32	1292	1606	**2,951**
Hatteras Inlet (PM 58)	0	0	0	0	13	0	**13**
North Ocracoke (PM 59 - PM 60)	0	184	91	291	400	474	**1,440**
Ocracoke Island (PM 61 - PM 73)	0	0	158	378	2292	9640	**12,468**
South Point (PM 74)	439	671	116	88	683	494	**2,491**
Total by Year	**440**	**855**	**406**	**853**	**4,839**	**12,242**	

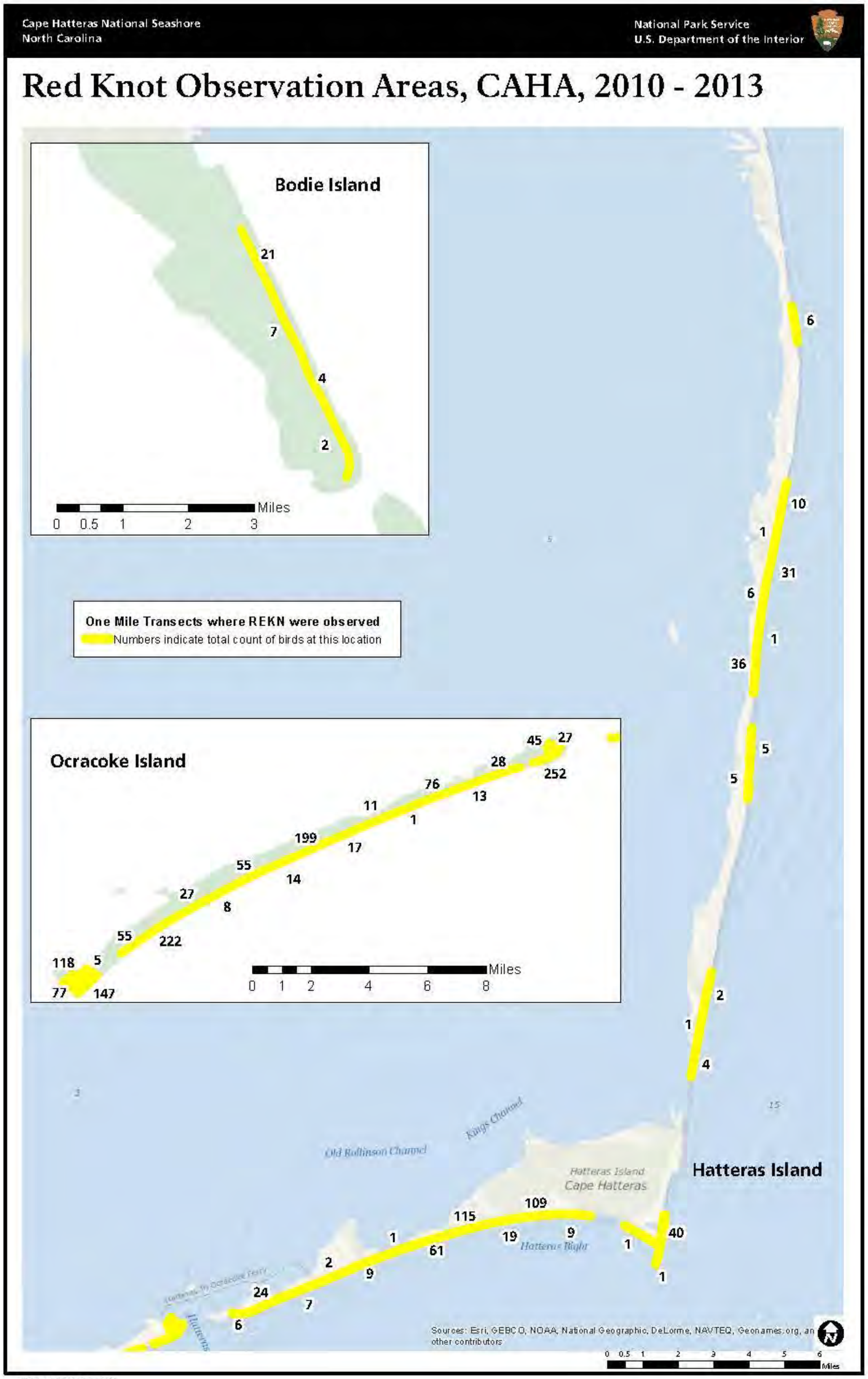

FIGURE 7.1. Summary of red knot observations in Cape Hatteras National Seashore 2010–2013.

Reptiles

Green Sea Turtle (*Chelonia mydas*)

The largest of the hard-shelled sea turtles, the green sea turtle is both federally and state threatened in North Carolina. In 2004, the Marine Turtle Specialist Group of the IUCN classified this turtle as endangered globally. On 20 March 2015, NOAA reclassified 11 distinct population segments as threatened due to successful conservation efforts while three segments remain classified as endangered. The North Atlantic population (also included Florida and the Gulf coast of Mexico) is one of the 11 distinct population segments. The two largest nesting populations are found at Tortuguero, on the Caribbean coast of Costa Rica, where 22,500 females nest per season on average and Raine Island, on Australia's Great Barrier Reef where 18,000 females nest per season on average (www.nmfs.noaa.gov/pr/species/turtles/green.htm). In the US, green turtles nest primarily along the central and southeast coast of Florida where an estimated 200-1,100 females nest annually. All marine sea turtles spend up to 90 percent of their lives in the open oceans; such inaccessibility complicates population monitoring regardless of species and is the reason why nesting data are used to extrapolate population health.

The green sea turtle grows to a maximum of about 4 ft and 440 pounds. Variably colored, it has a heart-shaped shell, small head, and single-clawed flippers. Hatchlings generally have a black carapace, white plastron, and white margins on the shell and limbs, while the adult carapace is smooth, keelless, and light to dark brown with dark mottling and a white to light yellow plastron. Heads of adult green sea turtles are light brown with yellow markings. Identifying characteristics include four costal plates which do not border the nuchal shield, no jagged marginals, and one pair of prefontals between the eyes (photo courtesy of Doug Shea).

When not migrating, green sea turtles are generally found in relatively shallow waters where marine grass and algae can flourish, such as those found inside lagoons, reefs, bays, and inlets. Green sea turtles require open, sloping beach platforms and minimal disturbance for nesting. Strong nesting site fidelity (tendency to return to birth beach areas) is characteristic of the species and long distances often exist between feeding grounds and nesting beaches. Sargassum clumps are often used as refugia and food resource areas. Carnivorous as hatchlings and juveniles, they begin feeding on algae and marine grasses when they are approximately 8 to10 inches in size and, as adults, they are the only plant-eating sea turtle. This trait is thought to render a greenish color to their fat from which they are named.

For the southeastern United States, nesting season is usually June through September and occurs nocturnally at 2-, 3-, or 4-year intervals. One turtle may lay as a many as seven clutches in a season at 9- to 13-day intervals with 75 to 200 eggs in a clutch requiring incubation for 48 to 70 days, depending on nest temperatures. Although hatching generally occurs at night, mortality is extremely high. Age at maturity is thought to be between 20 and 50 years.

A major factor contributing to the green sea turtle's decline worldwide is commercial harvest for eggs and meat. Mortality of green sea turtles has been documented in Florida, Hawaii, and other parts of the world from fibropapillomatosis, a disease of sea turtles characterized by the development of multiple tumors on the skin and internal organs. These tumors interfere with swimming, eating, breathing, vision, and reproduction, and heavy tumor burdens can lead to severe debilitation and death. Evidence is mounting that this disease may not be the death knell for green sea turtles as was originally thought in the early 1990s. Like other sea turtles, other threats to this species include loss and/or degradation of nesting habitat from human activities such as armoring and development projects; disorientation of hatchlings by beachfront lighting; excessive nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and incidental take from channel dredging and commercial fishing operations.

Green sea turtles have nested every year in the National Seashore since 2006 but on average represent ~4 percent of the total sea turtle nests; at 23 nests, 2013 was the year with the highest number of nests followed by 2011 at nine and 2007 at seven while the other six years each had five or fewer (www.seaturtle.org) (Fig 7.2). Figure 7.3 shows green sea turtle nests documented from 2010 to 2014 within the nourishment fill area. Over this period, four green sea turtles nests have been documented within the nourishment fill area, two nests within 1 mile north of the nourishment fill area and 0 nests within 1 mile to the south. Since 2012, only two green sea turtle nests have been documented within the Proposed Action Area and neither were relocated (Outer Banks Group, Leslie Frattaroli, Acting GIS Specialist, pers. comm., 29 December 2014). It is important to note that turtles do not clump their nests in any particular location at the Seashore and that nests have been relatively evenly distributed in the project area over the years (Cape Hatteras National Seashore, Randy Swilling, Natural Resource Program Manager, pers. comm., 4 June 2015).

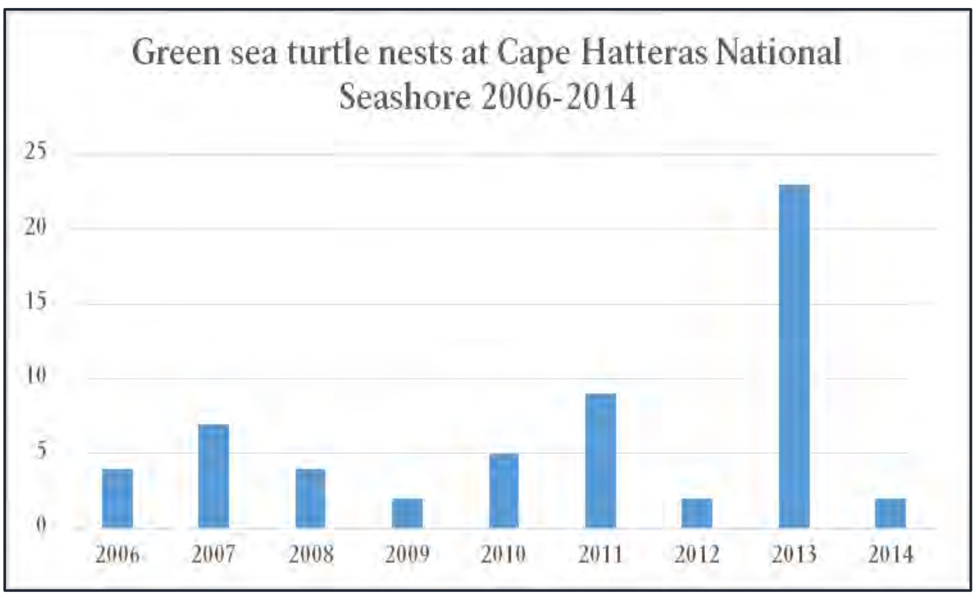

FIGURE 7.2. Green sea turtle nests at Cape Hatteras National Seashore from 2006 to 2014. (from www.seaturtle.org)

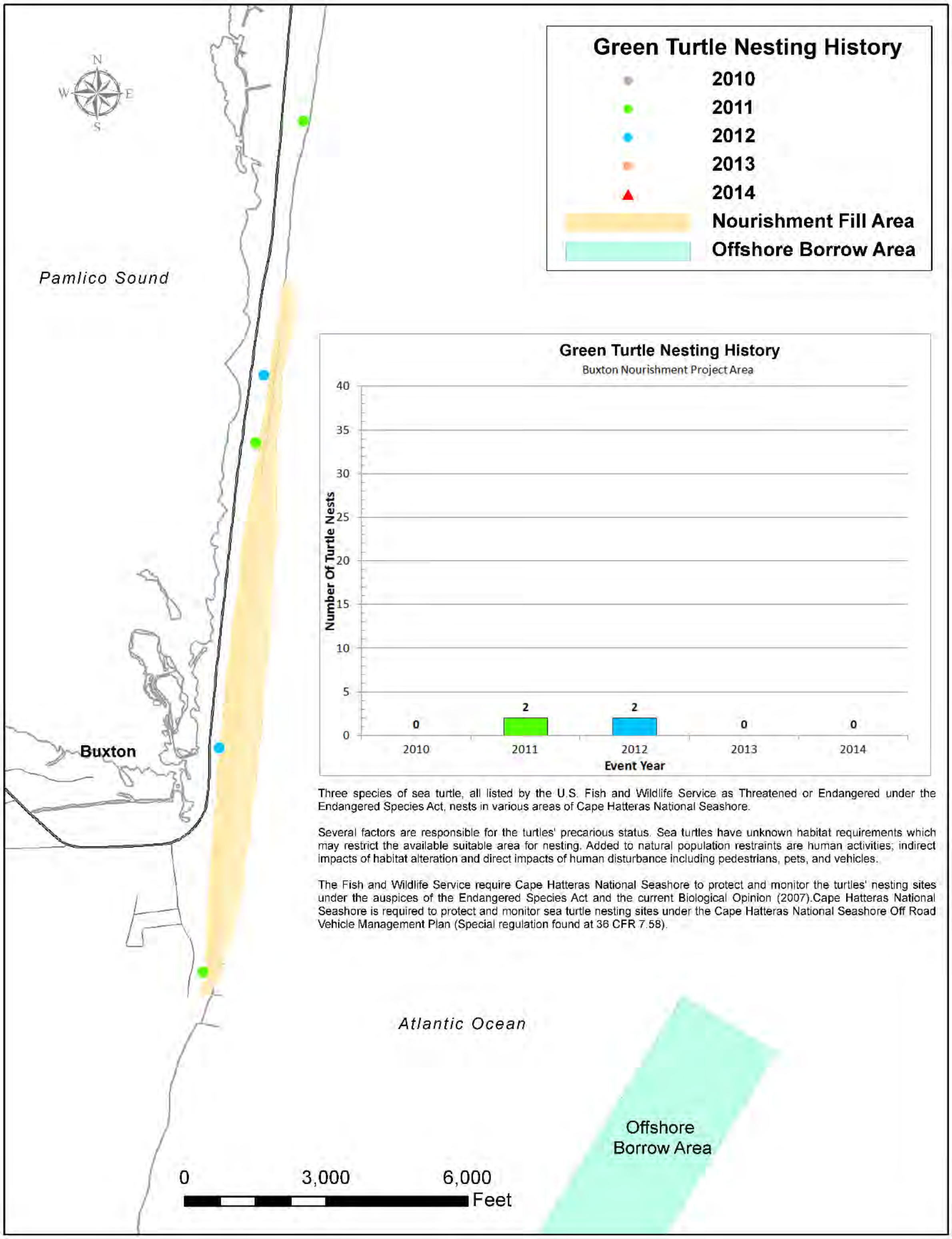

FIGURE 7.3. Green sea turtle nests recorded in the proposed Buxton nourishment area between 2010 and 2014. [Source: NPS unpublished data]

Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)

This species is the most endangered of the sea turtles and was given endangered status throughout its range in 1970. The Kemp's ridley was historically abundant in the Gulf of Mexico. Approximately 60 percent of Kemp's ridley sea turtles nest within a 25-mile length of beach at Rancho Nuevo in Tamaulipas, Mexico. Scattered nests also exist to the north and south of this primary nesting ground. During one nesting season in the 1940s, an estimated 40,000 turtle nests were recorded at Rancho Neuvo. However, the Kemp's ridley declined substantially from the 1940s to the 1980s, primarily because of the harvest of eggs and mortality from commercial fish and shrimp trawling and gill net operations, but also from pollution, dredging, and commercial exploitation of adults for food. It was given endangered status throughout its range in 1970. . By 1985, only 740 nests were recorded in Rancho Nuevo. Since species management and recovery plans were implemented, populations have rebounded. Nesting increased steadily from the early 1990s to the present. In 2006, 7,866 nests were recorded in Rancho Nuevo.

Kemp's ridley is one of the smallest of all extant sea turtles. Adults grow to about 2 ft in carapace length and 120 pounds in weight. The Kemp's ridley has a light grey-olive carapace and a cream-white or yellowish plastron (photo courtesy of USFWS). Males display distinct morphological features not found on females including a longer tail, a more distal vent, recurved claws, and, during breeding, a softened, mid-plastron. Hatchling sea turtles likely spend 1.5–4 years associated with floating Sargassum near the ocean surface. Subsequently, at about 8 inches in length, they enter a benthic-feeding immature stage until reaching sexual maturity 7–9 years later. During this juvenile period they enter shallow coastal waters and forage along the bottom. As adults, Kemp's ridley sea turtles continue to forage in the sediments of shallow estuaries, consuming crabs and other invertebrates. Females reach sexual maturity at ~2 ft in length. Females nest multiple times during the nesting season (April to June in tropical areas) producing clutches of about 100 eggs. A unique feature of the Kemp's ridley is that they tend to nest in large aggregations. Most females nest once every two years. As with other sea turtles, hatchling sex is temperature dependent. A 1:1 ratio of males to females is produced at 30.2° C. Above this temperature an egg will likely develop into a female, while more or all males will be produced at 28°–29° C. In most natural nests, 64 percent of hatchlings are female.

Sea turtle data have been collected prior to 2010 statewide and in the National Seashore, and while those data are available in NPS online annual reports and on the NCWRC website (www.seaturtle.org), data prior to 2010 are under review and revision and not included here. While the Kemp's ridley is rarely found in North Carolina, numbers of this species sighted in North Carolina appear to be on the increase; possibly a phenological response to environmental changes associated with sea temperature variations (Solow et al. 2002; Mazaris et al. 2013). Pound nets set in Core and Pamlico Sound from 2007 to 2009 showed an increase in Kemp's ridley and recent gill net captures in Cape Lookout Bight in May 2014 yielded seven Kemp's ridley, while in previous years only loggerheads were netted there (NMFS, Joanne B. McNeill, Fishery Biologist, pers. comm., 14 October 2014). The North Carolina Natural Heritage program has documented this species in Beaufort, Brunswick, Carteret, Dare, Hyde, and Pamlico, Currituck, New Hanover, Pender, and Onslow counties (North Carolina Natural Heritage Program 2014).

The Kemp's ridley is one of the more common species found in strandings on the National Seashore; generally 10 or more individuals have been found most every year between 1996 and 2006 (National Park Service 2006). Only one nesting occurrence of Kemp's ridley sea turtles has been documented in the National Seashore in the last five years, the first ever occurred in 2011. In 2013, one loggerhead nest was incorrectly identified as a Kemp's ridley (Outer Banks Group, Leslie Frattaroli, Acting GIS Specialist, pers. comm., 29 December 2014). The one nest in 2011 was not in the area of analysis.

Leatherback Sea Turtle (*Dermochelys coriacea*)

The leatherback sea turtle was listed as endangered under the ESA throughout its global range on 2 June 1970, and is listed as endangered by the State of North Carolina. The leatherback nests all over the world, but most commonly nests in the tropics. Nesting in the continental United States occurs mainly in Florida, but has also occurred in Georgia, South Carolina, and North Carolina. The leatherback is a common visitor in waters along the North Carolina coast during certain times of the year.

The Recovery Plan for Leatherback Sea Turtles (NMFS and USFWS 1992) includes an estimate of 115,000 existing adult female Leatherback sea turtles. The International Sea Turtle Society estimates that there are 17,000 nesting females from the Atlantic Ocean (International Sea Turtle Society, press release, April 2, 2007). In a 2003 interview, Larry Crowder of Duke University indicated that leatherbacks in the Pacific have declined more than 90 percent in the last 20 years (Black 2003).

Largest of all turtles, the leatherback is easily distinguished by its ridged leathery skin rather than the more common hard shell of marine turtles. The back, head, and neck are dark brown or black with a few white or yellow mottles or blotches. The lower shell is whitish and ridged. The flippers are paddle-like without claws and proportionally longer than in other sea turtles (photo courtesy of USFWS). The average adult can weigh 640 to 1,300 pounds and its carapace length measures 61 inches. The hatchlings are mostly black on their backs and covered with tiny bead-like scales (NMFS and USFWS 1992).

While this species is killed for its meat, the greatest threats are fishing gear, ingestion of marine debris, and egg collection. Threats to nesting areas stem predominantly from increased human presence and include beach erosion and beach nourishment, beach armoring, artificial lighting, and vehicular compaction of the beach.

Although common in North Carolina waters during certain times of the year, the leatherback is a rare nester in North Carolina. North Carolina beaches are the northern most extent of confirmed Atlantic nesting of this species (Rabon et.al.2003). The first documented leatherback nest was in 1998 in the National Seashore and since 2010, there have been 10 documented nests in North Carolina, one of which occurred in the park (www.seaturtle.org). Data have been collected prior to 2010 statewide and in the National Seashore; those data are available in online annual NPS reports and on the NCWRC website, but those data are under review and revision and not included here. In 2012, one leatherback nest was relocated approximately 28 beach miles from the project area (Outer Banks Group, Leslie Frattaroli, Acting GIS Specialist, pers. comm., 29 December 2014).

Loggerhead Sea Turtle (*Caretta carretta*)

The loggerhead sea turtle has received federal protection as a threatened species under the ESA since 28 July 1978 and the State of North Carolina also considers this marine turtle threatened. This species of sea turtle is widely distributed within its range of the temperate and tropical regions of the Atlantic, Pacific, and Indian oceans. According to the Recovery Plan, finalized in 2008, for the North Atlantic population of loggerhead sea turtles, only two loggerhead nesting beaches have greater than 10,000 females nesting per year: South Florida and Masirah, Oman. Beaches with 1,000 to 9,999 females nesting each year are north Florida through North Carolina, Cape Verde Islands, and Western Australia. Smaller nesting aggregations with 100 to 999 annual nesting females are found in northwest Florida, Cay Sal Bank (Bahamas), Quintana Roo and Yucatán (Mexico), Sergipe and Northern Bahia (Brazil), Southern Bahia to Rio de Janeiro (Brazil), Tongaland (South Africa), Mozambique, Arabian Sea Coast (Oman), Halaniyat Islands (Oman), Cyprus, Peloponnesus (Greece), Island of Zakynthos (Greece), Turkey, and Queensland (Australia).

Adult females from United States beaches are found in waters off the eastern United States and throughout the Gulf of Mexico, Bahamas, Greater Antilles, and Yucatán in years when they are not nesting. The Northern Recovery Unit, extending from northeast Florida through North Carolina, represents approximately 1,287 nesting females per year with annual total nests ranging from 3,629 to 6,642 between 1989 and 1998. With the addition of the females estimated to occupy the other three Recovery Units, the total estimate of females nesting in the United States is 19,993 (NMFS and USFWS, unpublished data).

The Sea Turtle Conservancy estimated in 2004 that there were 44,560 nesting female loggerhead sea turtles. The USFWS says the number of nests in the United States has fluctuated between 47,000 and 90,000 a year for the past two decades. Nesting of this species on all Florida beaches was in decline for the decade after 1998, but according to recently completed trend analysis of data from 1988–2014, the trend has been upward since 2009 with 2014 nest totals being slightly higher than the previous high in 1998 (Florida Fish and Wildlife Conservation Commission website, 10 December 2014).

The loggerhead has a large head with blunt jaws with a reddish-brown carapace and flippers and yellow plastron. Identifying characteristics include five pairs of costal scutes on the carapace, with the first touching the nuchal scute and three large inframarginal scutes on each of the bridges between the plastron and carapace (photo courtesy of NOAA website; shows loggerhead escaping fishing net via TED). Adults grow to an average weight of about 200 pounds and they feed on mollusks, crustaceans, fish, and other marine animals (NMFS and USFWS 1991).

Loggerheads are found at sea hundreds of miles from the coast, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Common feeding areas are coral reefs, rocky places, and ship wrecks. Loggerheads nest on ocean beaches typically between the high tide line and the dune front, but occasionally will nest on estuarine shorelines with suitable sand. It is thought that most United States-hatched loggerheads lead a pelagic existence in the North Atlantic gyre for an extended period of time while young, perhaps as long as 10 to 12 years. They are most documented from the eastern North Atlantic near the Azores and Madeira. Post-hatchlings have been found floating at sea in association with Sargassum rafts taking advantage of the food and refuge offered in these rafts. Juvenile loggerheads begin moving to coastal areas in the western Atlantic, feeding on the benthos of lagoons, estuaries, bays, river mouths, and shallow coastal waters. These feeding grounds may be utilized for a decade or more before their first reproduction when females will return to their natal beach to lay their eggs.

The continental United States nesting season extends from about May through August with nesting occurring primarily at night. A single loggerhead may build from one to seven nests within a season (mean is about 4.1 nests per season) at intervals of approximately 14 days. Mean clutch size varies from about 100 to 126 along the southeastern United States coast, with incubation time ranging from about 45 to 95 days, depending on incubation temperatures. Hatchlings typically emerge at night. Remigration intervals (intervals between successive nesting years) of 2 to 3 years are most common in nesting loggerheads, but this has been known to vary from 1 to 7 years. Like all sea turtles, loggerheads are slow to mature with age at sexual maturity estimated to be about 20 to 30 years. Adult loggerheads will make long distance migratory journeys between foraging areas and nesting beaches.

The majority of loggerhead nesting occurs in the western rims of the Atlantic and Indian Oceans where high energy, generally narrow, moderate to steeply sloped, coarse grained beaches backed by high dunes are preferred. In the US, loggerheads will nest from Texas to Virginia, but over 80 percent of nesting occurs in six counties in Florida (Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward). In the SEUS, mating occurs in late March to early June, and females lay eggs between late April and early September. In a single nesting season, females may lay three to five nests and sometimes more. Incubation requires about two months but is very dependent on temperature; hatching occurs between late June and mid-November. Both egg-laying and hatching usually occur at night.

Researchers at the University of Georgia have been genetically fingerprinting nesting loggerhead mothers since 2008 in the Northern Recovery Unit and in October 2013 the researchers were awarded additional NOAA funds to continue the fingerprinting in Georgia, South Carolina, and North Carolina. Through the NCWRC, NPS personnel have participated in this Georgia-based research since 2010. While flipper tags are the most common method used to track turtle numbers, it is estimated that flipper tagging typically misses up to 20 percent of all nesting females on a beach each season. Previous studies had also shown that nesting females may use more than one beach which can lead to incorrect estimates about the population. One unexpected result of the Georgia research findings shows that sister turtles often do not nest on the same island, contrary to the common belief of strong natal beach fidelity (philopatry). At least for the turtle population in the study, philopatry was relaxed; one suspected reason was the abundance of good nesting habitat (The Red & Black, October 2013).

Other investigations of loggerhead nesting preferences indicate that among four environmental factors evaluated (temperature, moisture, slope, and salinity) for nest site location, slope appeared to have the greatest influence (Wood and Bjorndal 2000). Some investigators attribute large inter-annual variations in nesting numbers of sea turtles to be driven by individual variation in re-migration patterns which are often triggered by sea surface temperature variables which then affect feeding conditions at sea where turtles spend 90 percent of their lives (Solow et al. 2002). In 2012, approximately 8,000 loggerhead nests were documented in the Northern Recovery Unit (The Red & Black, October 2013).

Loggerhead sea turtles have nested every year in the National Seashore since 2000 with generally increasing numbers (Fig 7.4). Between the years 2000 and 2007, less than 100 nests were recorded each year. Since 2008, there have been over 150 nests per year on average. Figure 7.5 shows that 79 loggerhead sea turtles nested in the nourishment fill area from 2010 to 2014. NPS data also indicate that over the same period, only 9 loggerheads nested within 1 mile north of the nourishment fill area compared to 34 nests within 1 mile south. Within the Proposed Action Area in 2012, 36 nests were documented and 5 were relocated; in 2013, 22 nests were documented and 3 were relocated; and in 2014, four nests were documented and none were relocated (National Seashore GIS, Leslie Frattaroli, Acting GIS Specialist, pers. comm., 29 December 2014). It is important to note that turtles do not clump their nests in any particular location at the Seashore and that nests have been relatively evenly distributed in the project area over the years (Cape Hatteras National Seashore, Randy Swilling, Natural Resource Program Manager, pers. comm., 4 June 2015).

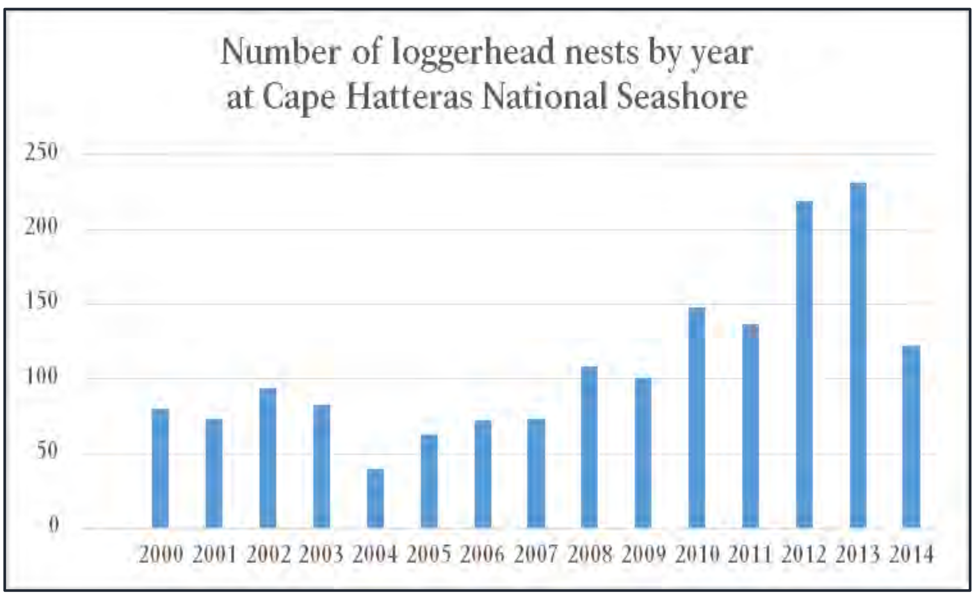

FIGURE 7.4. Number of loggerhead nests by year (2000–2014) at the Seashore (revised from Figure 13 of NPS 2010 with additional data per www.seaturtle.org).

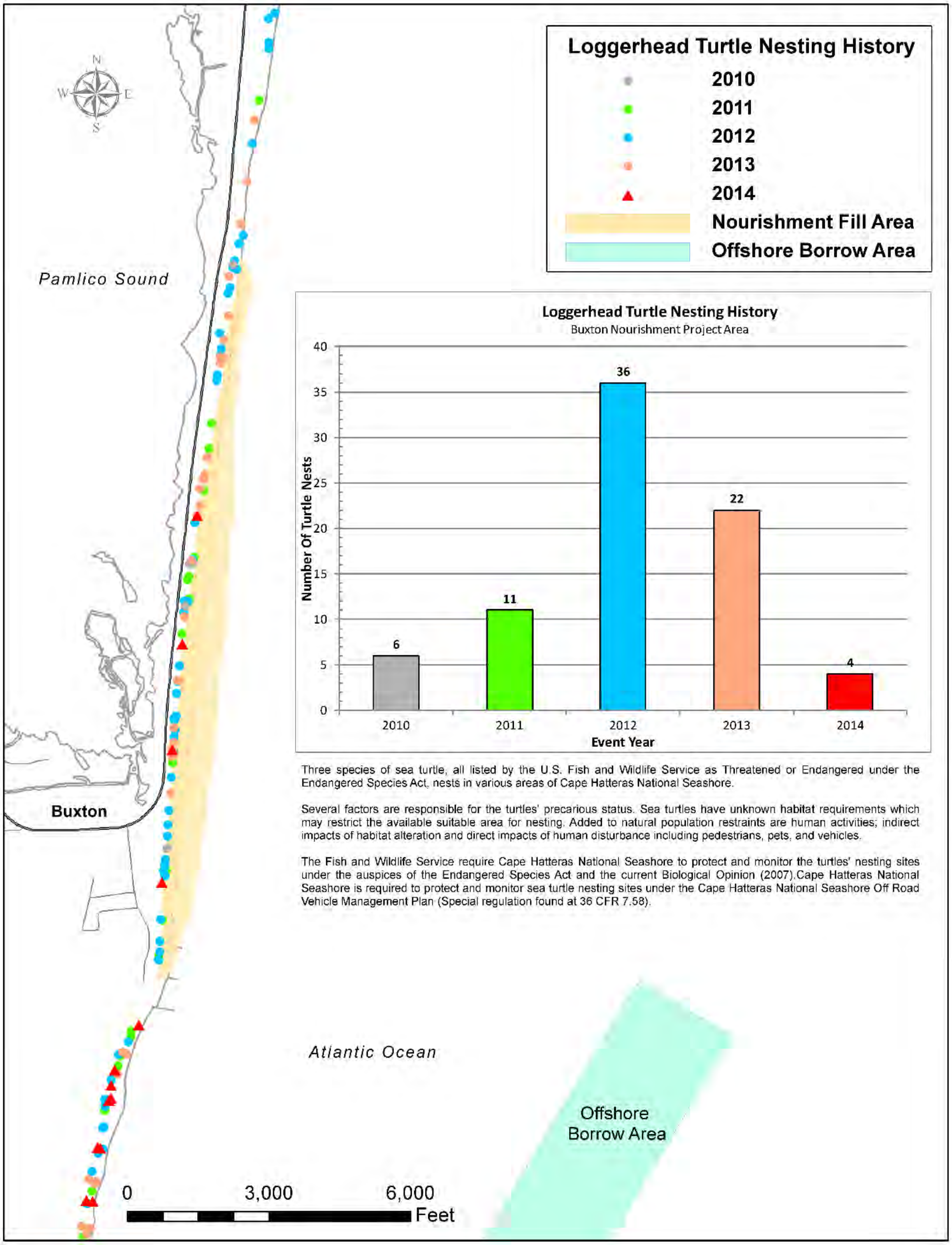

FIGURE 7.5. Loggerhead sea turtle nests recorded along the Buxton Action area from 2010 to 2014. [Source: NPS unpublished data. Courtesy of Randy Swilling, Natural Resource Program Manager.]

Hawksbill Sea Turtle (*Eretmochelys imbricata*)

The hawksbill sea turtle was listed as a federally endangered species in June 1970. Currently, the hawksbill sea turtle lacks any protective status from North Carolina, most likely due to its rarity of occurrence in the state. The hawksbill sea turtle derives its name from its distinctive hawk-like beak. The shell of the hawksbill is brown with yellow, orange, and reddish-brown markings. The underside of the hawksbill is yellowish with black spots. The hawksbill may reach up to 3 ft in length and 300 pounds in weight, but is more commonly 2.5 ft in length and 95–160 pounds in weight. (Photo courtesy Caroline S. Rogers, USGS.)

This sea turtle is found worldwide in tropical and sub-tropical marine waters although it has been documented as far north as Massachusetts. It prefers rocky bottoms, coral reefs, and coastal bays and lagoons, in water depths <65 ft. In the US, hawksbill turtles nest only in Florida on rare occasions. Like other sea turtles, hawksbills occupy a variety of habitats over their life cycle.

For the first few years of their lives, hawksbill turtles are associated with floating algal mats in deep oceanic waters. At ~8 to 10 inches, hawksbills migrate to nearshore marine waters and begin consuming sponges, which will be their primary dietary constituent throughout their life. Hawksbill sea turtles reach sexual maturity (27 inches for males and 31 inches for females) at 20–30 years of age. Nesting occurs on tropical and subtropical sandy beaches from April to November, depending on location. Females show high fidelity to natal beaches (beaches where they hatched) and nest three to five times per season, laying about 130 eggs per nest. Adult females generally reproduce every two years. Sex ratio of hatchlings is temperature dependent with warmer temperatures producing more females.

The historical decline in hawksbill turtle populations was primarily due to commercial exploitation of adults for their shell. Other causes of mortality include habitat degradation, marine pollution, and incidental take by commercial trawling and gill netting activities. In general, Caribbean populations have increased somewhat in recent years, coinciding with the decline in the shell trade. However, hawksbills nest in isolated locations, and it is often difficult to gather accurate records of the number of reproductively active individuals. Today, worldwide numbers are likely decreasing, although certain populations in the Caribbean and Pacific are increasing because of better management.

The North Carolina Natural Heritage program has a record of this species in Dare County (North Carolina Natural Heritage Program, 2006), and four strandings of hawksbills have been recorded between 1996 and 2006 (National Park Service, 2007). Hawksbills have occurred in the Pea Island National Wildlife Refuge during the last 20 years (USFWS, 2006); however, this species does not nest in North Carolina and has not been documented in the National Seashore itself.

Mammals

Finback Whale (*Balaenoptera physalus*)

Endangered throughout its range under the precursor to the ESA since June (USFWS) and December 1970 (NMFS), this slender streamlined whale is the second largest of all whale species. It is also listed as depleted throughout its range under the U.S. Marine Mammal Protection Act of 1972 (MMPA).

For management purposes, finback whales in US waters are divided into four stocks, one of which includes the western North Atlantic Ocean. The minimum population estimate for this stock is 1,678 and insufficient data prevents determination of any trends. No critical habitat rules have been published for the finback whale.

The finback whale is a fast swimmer found in deep, offshore waters of all major oceans primarily in temperate to polar latitudes and less commonly in the tropics. In the northern hemisphere, these whales reach a maximum length of about 75 ft with the females usually 5–10 percent larger than the males. The whale has a V-shaped head, a tall curved dorsal fin located about two-thirds of the way back on the body, and a distinctive coloration pattern: the back and sides of the body are black or dark brownish grey, and the ventral surface is white (photo courtesy of Lori Mazzuca, NOAA). The unique, asymmetrical head color is dark on the left side of the lower jaw, and white on the right side. Many individuals have several light-gray, V-shaped "chevrons" behind their head, and the underside of the tail flukes is white with a gray border. Lifespan is 80–90 years.

Usually associated with small social groups of two to seven individuals, they often are also part of larger feeding aggregations of marine mammals (humpback and minke whales and other species) in the north Atlantic. Commercial hunting was a major threat to the species but this practice ended in 1987 for the north Atlantic population. Vessel collisions are a primary threat to this species and this species is the large whale most often reported in vehicle collisions (Jensen and Silber 2004). Other threats include fishing gear entanglement, reduced prey abundance due to overfishing (krill, herring, capelin, sand lance, and squid), habitat degradation, and disturbance from low-frequency noise.

Although the deeper ocean habitat where this species is most commonly found does not exist within the project vicinity, the finback whale is included in analysis because the species may be in the deeper offshore waters during its winter migrations through the area from the north and three strandings have occurred on North Carolina beaches between 1997 and 2008, one of which occurred during the proposed construction window (May). There is no record of the finback stranding on Seashore beaches from 2008-2014 (NPS 2012, 2013a, and 2014b).

Humpback Whale (*Megaptera novaeangliae*)

Protected from commercial whaling since 1966, the humpback whale was listed as endangered under the precursor to the ESA in June 1970. It is also protected by the MMPA. This whale lives in all major oceans form the equator to sub-polar latitudes and are increasing in abundance in much of their range. On 20 April 2015, NOAA proposed delisting most populations of this whale (10 of the 14 distinct populations would be removed including the West Indies population that migrates through the western Atlantic to its northern Atlantic feeding grounds). For the north Atlantic, the best available estimate is about 11,500 individuals.

The Latin name means "big-winged New Englander" as the New England population was best known to Europeans and refers to their long pectoral fins. This species is the favorite of whale watchers as they perform acrobatic displays with their fins, heads, and bodies. Similar to all baleen whales, females are larger than males and can reach up to 60 ft in length. Their body coloration is primarily dark grey, but individuals have a variable amount of white on their pectoral fins and belly. This variation is so distinctive that the pigmentation pattern on the undersides of their "flukes" is used to identify individual whales, similar to a human fingerprint (photo courtesy USFWS digital library).

Humpback whales migrate the farthest of all mammals during their travel from summer high latitude feeding grounds to winter calving grounds in subtropical or tropical waters. During migration, they stay near the ocean surface and during feeding and calving, they prefer shallow waters. Their summer feeding builds up the blubber on which they will live off of during the winter as the warm water calving grounds are less productive. They utilize multiple feeding strategies and methods to corral, herd, or disorient the small fish upon which they prey, one of which is called "bubble netting". This technique unique to humpbacks involves a coordinated effort among groups, with defined roles for individual whales, to concentrate the prey and force it to the surface for easy feeding. For the western Atlantic population, feeding occurs during spring, summer, and fall with a range that encompasses the eastern US coast and into western Greenland. The wintering grounds are used for calving and mating and are where their famous, but poorly understood, singing takes place.

Threats to the species include fish gear entanglement, ship strikes, harassment by whale watcher, habitat impacts, and legal harvest (Japan has issued scientific permits in the Antarctic and western north Pacific in recent years). Numerous conservation efforts have been undertaken by NOAA and various partners to reduce these threats including education, take reduction measures, and monitoring.

This species is more likely to be in the offshore waters of North Carolina than the finback whale, as evident by the 23 strandings which have occurred on North Carolina beaches between 1997 and 2008, one of which occurred during the proposed construction window (September). Humpbacks have also stranded on Seashore beaches in five out the last seven years (none in 2012 or 2014); four each year in 2011 and 2013, three in 2010, one in 2009, and two in 2008 NPS (NPS 2012, 2013a, and 2014b).

North Atlantic Right Whale (*Eubalanae glacialis*)

Originally listed endangered throughout its range under the precursor to the ESA in June 1970 as the northern right whale and under the ESA since 1973, it is also considered depleted throughout its range by the MMPA. In 2008, NMFS listed the northern right whale as two separate endangered species, the North Pacific right whale (*E. japonica*) and the North Atlantic right whale (*E. glacialis*). There are two other species of right whale, one found in the north Pacific and the other found in oceans of the southern hemisphere. Primarily found in coastal or shelf waters in all the oceans of the world, right whales can sometimes be found moving over deeper waters. They migrate to higher latitudes in spring and summer. Current population estimates for this critically endangered whale suggest 400-455 individuals and a recent slightly increasing trend (NatureServe comprehensive report April 2014). Once heavily exploited by whalers off southern Europe and northwest Africa, the species is suspected to no longer frequent these areas and in fact the eastern North Atlantic right whales are nearly extinct.

This large whale grows to about 50 ft in length with a stocky black body, large head, no dorsal fin, deeply notched tail, and raised patches of rough skin (callosities) on the head region (photo courtesy of GA Dept. Natural Resources). Like other baleens, the females are larger than the males and while few data exist on longevity of right whales, their lifespan is estimated to be about 50 years. They feed on zooplankton and are skimmers, removing prey from the water with their mouth open. They were deemed the "right" whale to hunt because of their tendency to float when dead due to their thick blubber.

The North Atlantic right whale has two critical habitat areas designated by NMFS, the Northeast US and the Southeast US, neither of which are within the project vicinity. The northern limit of the Southeast US critical habitat includes the waters offshore of the southern half of the Georgia coast. On 13 February 2015, NOAA proposed to expand designated critical habitat in the northwest Atlantic to include areas that will support calving and nursing (calving from southern North Carolina into northern Florida and nursing/feeding in Gulf of Maine and Georges Bank). This whale feeds from spring to fall although in some areas they may also feed in winter; however, their distribution is strongly tied to prey distribution. The whereabouts of the winter population remains unknown. Most known right whale nursery areas are in shallow coastal waters and nursing mothers will often aggregate in other areas; breeding areas are not know for any population.

The most common human threats include ship collisions and fish gear entanglements with additional threats of habitat degradation, contaminants, climate change, disturbances from whale watchers, and noise from industrial activities. They are also prey of large sharks and killer whales. Numerous conservation efforts have been undertaken by NOAA and various partners to reduce these threats including measures to reduce ship collision and fish gear entanglement, take reduction measures, and monitoring.

Of the three whale species evaluated in this BA, the North Atlantic right whale is the species most likely to occur in the shallower coastal ocean within the action area. The species is found more inshore during spring migration and there have been five North Carolina strandings between 1997 and 2008, one of which occurred during the proposed construction window (September). Since 2008, there is only one record of the species stranding on the Seashore beaches with one individual in 2008 (NPS 2012, 2013a, and 2014b).

Fish

Atlantic Sturgeon (*Acipenser oxyrinchus*)

The Atlantic sturgeon, specifically the Carolina and South Atlantic distinct population segments (DPSs), was designated as "endangered" in February 2012 (effective April 2012) and granted protection by NMFS (Federal Register, 2012). Atlantic sturgeon is listed as a special concern species in the state of North Carolina. Sturgeon, including the Atlantic sturgeon, are among the most primitive of the bony fishes. All are characterized by bony plates (scutes) that run the length of the body, sensory organs called barbels, and a mouth positioned on the underside of their snout. Atlantic sturgeon can reach 14 ft in length and weigh up to 800 pounds. They have olive-brown or bluish-black backs with paler sides and have a white belly (NOAA Fisheries 2014). Sturgeon species, including the Atlantic, are long-lived and may reach over 60 years old. Atlantic sturgeon mature at approximately seven years and the young may remain in freshwaters for up to five years before migrating to the ocean (Rohde et al. 1994). (Photo courtesy of NOAA.)

The Atlantic sturgeon is an anadromous species that inhabits the lower downstream sections of larger rivers and coastal waters of the Atlantic coast, moving into freshwater only to spawn in the spring. Five DPS's of Atlantic sturgeon have been identified: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic. The Carolina DPS includes all Atlantic sturgeon that spawn, or are spawned, in the watersheds from Albemarle Sound southward along the southern Virginia, North Carolina, and South Carolina coastal areas to Charleston Harbor, South Carolina. The marine range of Atlantic sturgeon from the Carolina DPS extends from Labrador, Canada south to Cape Canaveral, Florida. A bottom dweller and benthic feeder, it prefers areas with soft substrate and vegetated bottom for most of the year. At spawning, the fish requires fast current and rough bottoms. Suitable Atlantic sturgeon habitat exists in the project vicinity and action area and this species has been documented in the project vicinity. The suitable habitats include open water marine and estuarine environments, including inlets. As bottom feeding animals, sturgeon primarily consume organisms associated with sediment such as worms, bivalves, crustaceans, insect larvae, and small fish. They also consume live and detrital plant material.

Historically, Atlantic sturgeon have been abundant in most North Carolina coastal rivers and estuaries, with the largest fisheries located in the Roanoke River/Albemarle Sound system and the Cape Fear River (Kahnle et al. 1998). Landing records from the late 1800s indicate that Atlantic sturgeon were very abundant in the Albemarle Sound, and North Carolina as a whole supported an estimated 7,200 to 10,500 adult females (Armstrong and Hightower, 2002; and Secor, 2002). In 2007, it was estimated that fewer than 300 spawning adults reside within the Carolina DPS (Atlantic Sturgeon Status Review Team [ASSRT] 2007). There also are many records of Atlantic sturgeon from the Neuse River, Tar River, and Pamlico Sound.

Between April 2004 and December 2005, the NCDENR-DMF Observer Program documented the capture of 12 Atlantic sturgeon in the Pamlico Sound (ASSRT, 2007). Laney et al. (2007) documented mostly juvenile Atlantic sturgeon in North Carolina nearshore water depths of <60 ft from cooperative winter tagging conducted from 1998 to 2006. Other captures in North Carolina waters were primarily associated with inlets and nearby bays (Stein et al. 2004). Recent acoustic data collected from the vicinity (Atlantic Cooperative Telemetry Network data referenced in CBI 2015) indicate that Atlantic sturgeon are present in nearshore North Carolina in higher numbers in November and March. Threats to current populations of Atlantic sturgeon include incidental by-catch, human activity such as dredging, dams, and water withdrawals that result in habitat loss, and ship strikes (NOAA Fisheries 2014).

Shortnose Sturgeon (*Acipenser brevirostrum*)

In March 1967, the shortnose sturgeon was listed as endangered under the precursor to the ESA. The NMFS later assumed jurisdiction for shortnose sturgeon under a 1974 government reorganization plan (38 FR 41370). The shortnose sturgeon is managed by the Atlantic States Marine Fisheries Commission (ASMFC) of which North Carolina is a member. In 1990, the ASMFC devised a Fishery Management Plan (FMP) to aid in the recovery of Atlantic and shortnose sturgeon. In response to continued declines, in 1998, the FMP was amended to include a moratorium on sturgeon fishing in participating states. Although the shortnose sturgeon was not targeted by the commercial fishing industry, it was a common incidental catch in the Atlantic sturgeon fishery. Therefore, by banning all sturgeon fishing, the ASMFC reduced the fishing related mortality to the shortnose sturgeon. In addition, possession of the shortnose sturgeon is illegal because of its federally protected status. The shortnose sturgeon is also listed as endangered by the state of North Carolina.

The shortnose sturgeon is the smallest North American sturgeon, reaching 3–4.5 ft in length and 61 pounds in weight. The shortnose sturgeon has a blackish head and back, a yellowish-brown body and a pale underside and can be distinguished from Atlantic sturgeon by its shorter snout, wider mouth, and the lack of scutes between the anal fin base and the lateral row of plates (NMFS 1998). Like other sturgeon, this species is long lived and may live 60 years. (Photo courtesy of Gary Shepard, NOAA; shortnose shown on top, Atlantic beneath).

Shortnose sturgeon occur from the St. John River in New Brunswick Canada south to the St. Johns River in north Florida. They spawn in several major river systems along the east coast, including the Albemarle Sound drainages and the Cape Fear River. In general, the Atlantic sturgeon is more saline oriented, whereas the shortnose sturgeon spends more time in freshwaters and migrates upstream earlier in the year (Gilbert, 1989). Shortnose sturgeon begin their freshwater migration in late winter and early spring and spawn from April to June. Developing sturgeon may occupy the upper reaches of the natal river for up to five years, at which time they move to the ocean. However, unlike other anadromous species, the shortnose sturgeon does not seem to make long distance offshore migrations after spawning, but rather occupies the estuarine and nearshore marine environments.

In the mid-Atlantic region, both male and female shortnose sturgeons reach sexual maturity at three to five years, spawning every three years thereafter in the case of females and often yearly in males. As bottom feeding animals, shortnose sturgeon primarily consume organisms associated with sediment such as worms, bivalves, crustaceans, insect larvae and small fish. They also consume live and detrital plant material. Suitable habitat exists within Dare County, and historic records document the species within the area. It is believed that the shortnose sturgeon declined along with the Atlantic sturgeon beginning in the early 1900s. Population declines were a result of dam construction, commercial fishing, pollution, and habitat loss.

Today, these human activities continue to threaten the survival of the shortnose sturgeon. Historically the species probably occurred in major rivers throughout North Carolina; however, the current distribution is not well known. There is no historical information on the shortnose sturgeon population size, but today, the shortnose sturgeon populations varies by river system. Few if any shortnose sturgeon are collected in scientific trawl surveys, so population assessments are difficult to make. The shortnose population in the St. John River is among the largest in North America and the Hudson and Delaware Rivers also support substantial numbers. Oakley (2003) adds evidence to the opinion that the species has been extirpated from the Neuse River of North Carolina.

In North Carolina the shortnose sturgeon seems to be most abundant in the Cape Fear River system. The USFWS cites 2003 NCNHP data indicating records from 11 counties in North Carolina, not including Dare County. There is, however, a record from 2006 in Pamlico Sound in Dare County (USFWS, David Rabon,Biologist, November 30 2006). Further information from NMFS indicates that this record probably occurred in summer of 2005 during the North Carolina Independent Fisheries Assessment. Personnel participating in this assessment were trained to identify species, but the sturgeon referred to in this instance was not verified nor were any photographs taken.

Plants

Seabeach Amaranth (*Amaranthus pumilus)*

Seabeach amaranth is a federally threatened annual plant native to the Atlantic coast barrier island beaches where it prefers the lowest topographic position that can support vascular plants. It has a low, sprawling habit and small, fleshy spinach-like leaves on red stems. (Photo courtesy of USFWS Digital Library.) A fugitive species, it is able to spread quickly and colonize habitat as it becomes available in space and time. This species occurs where there is low competition from other vegetation and it can serve to trap and stabilize sand. A single large plant is capable of building a mini-dune up to 1.9 ft in height that contains up to 105.9 cubic feet of sand (USFWS 1993, 1996b).

Its preferred habitat is barrier-island beaches and nearby environments which are sparsely vegetated with annual herbs (forbs) and, less commonly, perennial herbs (mostly grasses) and scattered shrubs. Primary habitat consists of overwash flats at accreting ends of islands, lower foredunes, and upper strands of non-eroding beaches (landward of the wrack line). In rare situations, this annual is found on sand spits 160 ft or more from the base of the nearest foredune. It occasionally establishes small temporary populations in other habitats, including sound-side beaches, blowouts in foredunes, interdunal areas, and on sand and shell material deposited for beach replenishment or as dredge spoil.

Seabeach amaranth germinates from April to July, from a small sprig which branches from the center to form a clump which may contain over 100 stems. The diameter of a large clump can be over 3 ft, although size is more typically 8–16 inches. Flowering begins in June and lasts through late fall, with seed production beginning in July. The yellow flowers are inconspicuous and wind pollinated. The species is a prolific seed producer, and the waxy seed are thought viable for extended periods. Wind, water, and possibly birds disperse seed, and whole plants and seed are temporarily buoyant. Plants are usually detectable from April through December (frost dependent).

As stated in the 2014 Cape Hatteras National Seashore annual report on this species, some notable research in the past several decades has assessed the life history and habitat requirements of seabeach amaranth (Bucher and Weakley 1990, Johnson 2004, Jolls et al. 2004, Sellars and Jolls 2004, Strand

2002). Compilation and review of these studies, many of which address the crucial habitat characteristics that determine likelihood of amaranth occurrence (i.e., elevation, overwash disturbance potential, and competition), have provided a baseline for the selection of survey locations and methods at the Seashore. Locations of historic amaranth occurrences in the Seashore are also taken into consideration. Specific habitats surveyed include high beach (between the wrack line and foredune), sand flats on accreting ends of the islands, and large dune blowouts. All surveys are conducted in accordance with the Cape Hatteras National Seashore Seabeach Amaranth Monitoring Protocol created in 2013 and amended in 2014.

Seabeach amaranth has historically been documented in the National Seashore and suitable habitat exists within the area of analysis, but it has not been documented in any annual surveys in the park since 2005. As shown in Table 7.3, seabeach amaranth populations have fluctuated greatly since surveys began in the park in 1985. The area on Bodie Island spit where amaranth had been located in 2004 and 2005 has been continuously protected through summer and winter resource management closures. At Cape Point, a portion of the area where amaranth was historically found has also been continuously protected through summer and winter resource closures. However, no plants were found within any of these protected areas in the 2014 survey. At Hatteras Inlet, large portions of the historic range are simply no longer present due to continued erosion. While it is thought that the plant may possibly be extirpated from the Seashore, it should be noted that since plants are not evident every year, but may survive in the seed bank, populations of seabeach amaranth may still be present even though plants are not visible for several years (USFWS 2007).

TABLE 7.3. Population estimates* of seabeach amaranth in Cape Hatteras National Seashore. [*Population estimates by North Carolina Natural Heritage Program, East Carolina University and NPS. Table from NPS (2014) annual report on seabeach amaranth.]

Year	Bodie Island Spit	Cape Pt. / South Beach	Hatteras Island Spit	Ocracoke Island	Totals
1981				15	15
1984				1	1
1985	0	300-500	300-500	100	700-1100
1986	0	>200	>300	>100	>600
1987	0	5,200	274	1,409	6883
1988	0	800	1,718	13,310	15,828
1990	0	2,830	252	250	3332
1994			0	0	0
1996	0	6	82	10	98
1997	0	59	16	6	81
1998	0	55	210	0	265
1999	0	3	5	0	8
2000	0	1	1	0	2
2001	0	27	16	8	51
2002	0	11	75	7	93
2003	0	16	3	11	30
2004	1	0	0	0	1
2005	1	0	0	1	2
2006	0	0	0	0	0
2007	0	0	0	0	0
2008	0	0	0	0	0
2009	0	0	0	0	0
2010	0	0	0	0	0
2011	0	0	0	0	0
2012	0	0	0	0	0
2013	0	0	0	0	0
2014	0	0	0	0	0

ENVIRONMENTAL BASELINE

The environmental baseline is defined as the past and present impacts of all federal, state, or private actions and other human activities in an action area. This baseline also includes the anticipated impacts of all proposed federal projects in an area that have already undergone formal or early ESA Section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process (USDOI-USFWS & NMFS 1998). The environmental baseline for this BA refers to conditions based on the assumption that the proposed action would not occur. As the action area is a dynamic barrier island system subject to rapid and ongoing responses to short-term (storms) and long-term (sea level rise and or climate change) wind, wave, and ocean current conditions, many changes occurred before the establishment of the Seashore in 1937; those responses continue today. The flora and fauna found in a variety of habitats at the park include migratory birds and several threatened and endangered species. The islands are rich with maritime history of humankind's attempt to survive at the edge of the sea, and with accounts of dangerous storms, shipwrecks, and valiant rescue efforts. Today, the Seashore provides unparalleled opportunities for millions to enjoy recreational pursuits in a unique natural seashore setting and to learn of the nation's unique maritime heritage.

Additionally, as a very popular park within the national park system, other changes have occurred based on human uses of the Seashore ecosystems as well continued growth of the towns and villages of the islands shared by the Seashore. For the period 1967– 2014, each year has documented more than 1 million visits/year to the Seashore, with a high of 2.9 million visits in 2002 (NPS 2015b). For the past two decades (1995-2014), the average number of visits/year is 2.38 million (NPS 2015b).

While vehicle use on the beach occurred prior to 1937, it was primarily done for transportation and it was not until NC12 was paved, the Bonner Bridge was completed in 1967, and the Ocracoke ferry was added to the North Carolina ferry system, that access to the Seashore was significantly facilitated (NPS 2010). The increased access and subsequent popularity of sport utility vehicles in recent years have changed the vehicle use from primarily transportation to primarily recreation (NPS 2010). Off-road vehicle (ORV) use on the beaches of the National Seashore continues to increase with as many as 2,200 vehicles/day counted by rangers during summer months concentrated near the three spits associated with inlets through the National Seashore (Bodie, Hatteras, and Ocracoke Islands) and Cape Point (NPS 2005).

Land within the action area is comprised of ocean beach and portions of dunes either within the National Seashore, Buxton Village, or in private ownership. See Figure 4.3 for approximate project acreage with ~74 percent National Seashore and the balance in Buxton Village or in private ownership.

Previous Consultation with USFWS within the Analysis Area

The National Park Service submitted a BA in support of the Final ORV Management Plan (EIS) on 27 February 2010 and received the Biological Opinion (BO) with concurrence 15 November 2010. The USFWS also amended the ORV plan BO in early 2015 for the modified wildlife protection buffers (NPS 2015a). The National Park Service also conducted an informal consult for the Proposal to Facilitate Additional Beach Access (EA); concurrence was received on 24 September 2013.

Past and Current Activities within the Analysis Area

Previous shore-protection measures along the Buxton Action Area include dune reconstruction, emergency breach closures, and shoreline armoring, groin construction, and beach nourishment to protect Cape Hatteras Lighthouse. Recent measures include installation of large sand bags to protect existing buildings at the south end of the project area.

Dune Reconstruction and Management

In 1935, during the height of the Great Depression, the federal government funded a major dune reconstruction effort to build up a protective dune line and reduce the threat of breaching along barrier islands. This Works Progress Administration (WPA) project "*. . . saved 120 miles of the barrier islands on the state's northeastern coast*" (Stratton 1957, pg 4). Over 1,500 workers were brought to the Outer Banks "*. . . to eliminate the flow of ocean water over the Banks*" (Stratton 1943, pg 26). Brush panels were installed over a denuded landscape to trap sand and establish a dune line.

AC Stratton was the field supervisor with the National Park Service during the dune restoration efforts. His reports (Stratton 1943, 1957) describe the degraded condition of the Outer Banks in the 1930s compared with conditions in the late 1800s. "*What at one time was a thriving, prosperous, and productive part of the country became only a fast eroding barrier reef . . .. It almost ceased to be a productive asset and it became questionable as to the length of time it would continue to protect the mainland*" (Stratton 1943, pg 25). Stratton (1943) reported that in earlier times, "*. . . villages scattered along the beach were dotted with woods, grape vines, and vegetation of great variety extending from the sounds toward the ocean and in some cases to the beach itself*" (pg 25). He attributed the denudation in the early part of the 20th century to overgrazing, particularly by hogs, and timber removal by commercial interests. He also discussed the adverse impacts of blowing sand on the elevation of the Outer Banks and the "*. . . salt water that flowed over into the Currituck Sound. . .*" (pg 25). As erosion took its toll in "*several places along the coast for a distance of three miles or more, ordinary high tides were running over the Banks*" (pg 26).

Stratton (1957) reported that much of the efforts from the 1930s project remained in place 20 years later. The work was credited with reducing erosion and saving the Cape Hatteras Lighthouse which had been abandoned in 1936 (www.ncsu.edu/coast/chl/timeline.html, accessed 31 October 2013). Stratton (1957) described a planned rehabilitation program by the National Park Service (Mission 66) to repair damaged dunes over a ten-year period and restore them to their condition following the 1930s project.

Everts et al. (1983) prepared a detailed analysis of shoreline change for the Outer Banks. This cooperative study by the Coastal Engineering Research Center (CERC) and National Ocean Service (NOS) within the US Army Corps of Engineers (USACE) and the National Oceanic and Atmospheric Administration (NOAA) (respectively) measured ocean and sound shoreline changes between the 1850s and 1980. Everts et al. found that the Outer Banks, on average, were narrowing by ~3 ft/yr (~0.9 m) with the majority of the recession occurring along the oceanfront ~2.6 ft/yr (~0.8 m/yr average).

The CERC–NOS study found that the sound shoreline was not prograding significantly by overwash at decadal to century time scales. It further suggested that the principal losses of sand along the Outer Banks were associated with inlets, particularly the deposits of sand in the flood shoals in the sounds. After breach channels or ephemeral inlets closed, the deposits in the sound stabilized with marsh vegetation and left a characteristic bulge into the sound which is readily observable in aerial photographs (Everts et al. 1983).

While Everts et al. (1983) documented a narrowing of the Outer Banks, they emphasized that this trend was established well before the dune reconstruction efforts of the 1930s. They concluded "*. . . overwash has not been an important mechanism in sound shoreline progradation for the last several hundred years. Today, the islands are probably too wide in most places for overwash penetration across the entire island*" (pg 95). Everts et al. concluded that "*. . . if island migration occurred . . . between 1585* *and 1850, it was probably the result of inlet processes,"* which is the primary mechanism for major withdrawal of sand from the littoral zone in settings like the Outer Banks.

One implication of prior dune reconstruction efforts along Hatteras Island is the apparent positive effect in reducing sand losses while restoring the general character of the island to its condition prior to overgrazing and timber harvesting. A number of references suggest the northern Outer Banks is relatively sand-rich compared with the southern coast of North Carolina (Byrnes et al. 2003) or with barrier islands that have been in stable position for at least several centuries (Everts et al. 1983). Average erosion rates along Hatteras Island are low relative to the average width of the island and have likely benefitted by the presence of high natural dunes which tend to reduce the frequency of washovers and breach inlets (CSE 2013).

Beach Nourishment

Beach nourishment projects in Cape Hatteras National Seashore have emplaced over 10.2 million cubic yards of sediment on Seashore beaches between 1962 and 2011; this quantity does not include dredged sediment (Dallas et al. 2013). Dredging at three inlets and two marinas has also removed an unquantified, but likely significant, volume of material. Not counting side cast dredging, 12 million cubic yards have been taken out of the inlet system between 1960 and 2012 and over 5.7 million cubic yards of this material was placed offshore; the remaining 6.3 million cubic yards were placed on northern Pea Island beaches and the nearshore from 1997 to 2010 (Dallas et al. 2013).

Reports show there have been several nourishment projects in the Buxton area. In 1966, 312,000 cy were pumped from Pamlico Sound onto the beach along the Buxton Motel area and a US Navy Facility (since abandoned) immediately north of the lighthouse (NPS 1980, USACE 1996). Historical aerial photographs show borrow pits in Pamlico Sound that may have been relicts of the sand source for the 1966 project (Fig 8.1). This National Park Service-sanctioned project was intended to restore sand losses and protect the lighthouse after the March 1962 ("Ash Wednesday") northeaster of record breached Hatteras Island just north of Buxton. The National Park Service (1980) reported that the *"borrow material . . . was too fine and did not remain on the subaerial beach"* (pg 48).

A destructive northeaster on 24 October 1970 caused severe erosion near the Hatteras Court Motel (adjacent to the National Seashore at the north edge of the Village of Buxton). A total of ~2,300 cy were placed in an emergency berm using sand from an inland stockpile. Severe erosion in 1970 led to plans for another nourishment in 1971 (NPS 1980). The 1971 project reportedly involved pumping ~200,000 cy* from an inland pit on Cape Point to the critically eroding area of the Village of Buxton and the lighthouse. The National Park Service (1980) states the "*. . . sand . . . remained for a longer period of time than 1966. However, the quantity of borrow material proved insufficient to have any significant impact on the beach or on the inshore bar system*" (pg 48).

> *[*Machemehl (1973) reported the volume as 300,000 cy obtained from a man-made lake at Cape Point and pumped via 14-inch cutterhead dredge owned by JA LaPort Dredging Company with the aid of a booster station a total distance of ~3.5 miles. The sand slurry was discharged near Hatteras Court Motel and allowed to move south from there via normal littoral currents.]*

Continued erosion after the 1971 project resulted in a decision to implement the third nourishment in 1973. That project reportedly involved 1,300,000 cy** obtained from an interior borrow area within the Cape Point accreted lands (NPS 1980, pg 48). [***USACE (1996) reported the volume as 1,250,000 cy.*]

FIGURE 8.1. Aerial image of the project area in January 2014 showing relict borrow areas in Pamlico Sound likely used in a 1966 beach nourishment project (source: Google Earth). An inland pit within the Cape Point area of Seashore was excavated and used for borrow material during the 1971 and 1973 nourishment projects.

The basin for the borrow area is visible on aerial images as a zone of altered vegetation which has propagated over the area (see Fig 8.1). A 16-inch dredge with three booster pumps discharged the sand slurry 4 miles north in the vicinity of Hatteras Court Motel. Over a 5,000-ft reach, the beach was widened by ~500 ft and the "horizontal berm" (i.e. – dry-sand beach) was widened by 70 ft (NPS 1980).

Fisher et al. (1975) tracked the project using subaerial profiles, which terminate near mean low water, before and after pumping. They confirmed a net gain of ~608,480 cy above mean sea level. They reported a net loss of 771,003 cy between September 1972 and February 1973 (presumed period of construction) and projected that ~25 percent of the fill would be retained at the end of four years under favorable conditions (NPS 1980, pg 49). Fisher et al. (1975) monitoring reported *"large losses of material in the fill area and north end and large gains on the point and Diamond shoals."* No pre- or post-project data are available for the underwater portion of the 1973 project areas. Therefore, it is not possible to confirm the fate of the 1973 nourishment material. The Fisher et al. (1975) quantities for the visible beach and timing of their surveys suggest that their measurements reflect initial profile adjustment rather than net erosion across the entire profile.

Commonly, nourishment is placed in the upper part of the foreshore, mostly above low-tide wading depth so the sections and volumes can be controlled. Waves then shift a portion of the fill toward deeper water as the profiles equilibrate (Dean 2002). If nourishment sediments are coarser than the native beach sediments, there is a natural tendency for the beach slope to become steeper and for more sand to be retained along the visible beach. By comparison, if the nourishment sediments are significantly finer than the native beach, the resulting slope will be gentler with a high proportion of the added sand shifting to the underwater zone (Fig 8.2). Thus, to achieve a particular dry-beach width upon equilibration, more fine sand would be required than coarse sand as demonstrated by Dean (1991, 2002). The sand losses detected by Fisher et al. (1975) following the 1973 nourishment project provide indirect evidence that the borrow material may have been finer than the native sand on the beach and the loss was more accurately a shift of sand into the active surf zone.

Further north along the Outer Banks, a recent 10-mile beach nourishment project for the Town of Nags Head (North Carolina) in the summer of 2011 provides a good example of the fate of nourishment sediments during profile adjustment. At Nags Head, about 1 million cubic yards (out of 4.6 million cubic yards) shifted from the visible beach at placement to the inshore zone between mean low water and −12 ft depths within the first month or so after nourishment (Kana & Kaczkowski 2012). Such profile adjustment is normal and necessary for the equilibration of nourishment projects (NRC 1995, Dean 2002). While no other monitoring reports were found for the Buxton projects, some local observers believe the 1973 project yielded benefits for many years because of the lack of emergency protection measures needed along existing hotels and houses until recently (Lighthouse View Motel, J Hooper, former Dare County commissioner, pers. comm., April 2013).

The most recent beach nourishment to occur within the Seashore was an emergency project to widen the beach in front of where Hurricane Sandy severed NC 12 in October 2012. The worst damage occurred in the NCDOT-identified "hot spot" known as the S-Curves just north of Mirlo Beach. The damaged area was subject to ocean overwash and direct surf zone energy and the emergency response to NC 12 damage from Hurricane Sandy was ongoing for months after the storm. This emergency nourishment project was designed to provide short-term protection against ocean overwash and future NC 12 damage (estimated three-year project life) by the application of 1.7 million cubic yards of sand to this vulnerable section of Hatteras Island.

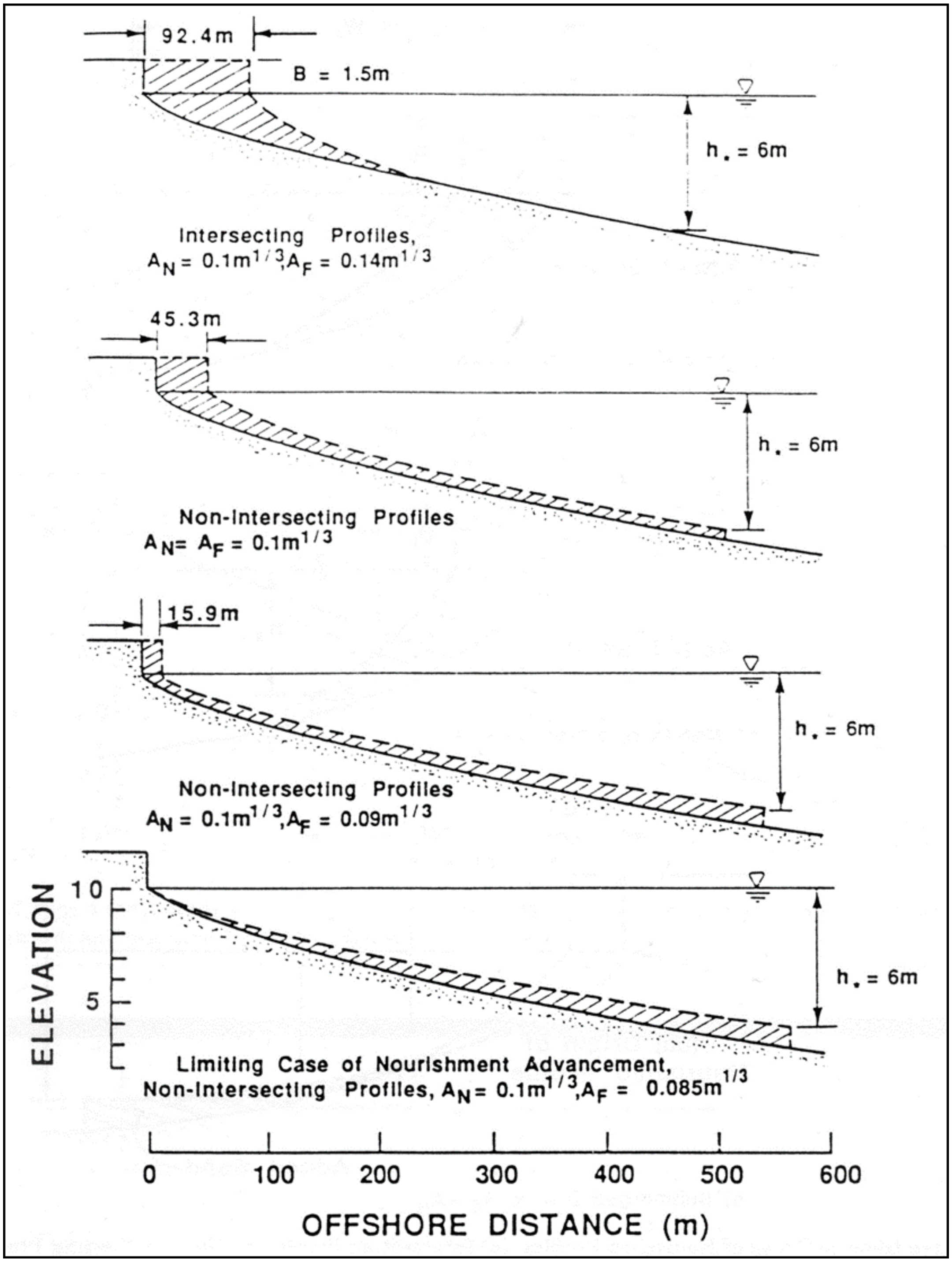

FIGURE 8.2. Effect of borrow material grain size (nourishment scale parameter, A_F) on the width of the dry beach for a fixed volume of nourishment sand added per unit beach length (from Dean 1991, Fig 25). In simple terms, coarser sand relative to the native sediment produces a wider visible beach than finer sand. [Note: 1 m ≈ 3.28 ft]

Groins

Persistent erosion in the vicinity of Cape Hatteras Lighthouse and the adjacent US Naval Facility has led to various shore-protection measures in the past 50 years. Following the first nourishment in 1966, the US Navy installed sand bags along 1,100 ft of shoreline in 1967. These geotextile bags deteriorated rapidly (NPS 1980) and proved short-lived. As shown in Figure 8.3, the Navy then installed a field of three groins to stabilize the beach along their facilities with design assistance by the USACE–Wilmington District (USACE, JT Jarrett, pers. comm., November 2013). Three concrete and steel sheet-pile groins were constructed in 1970. The southernmost (#3) groin was installed first, positioned ~100 ft south of the old lighthouse position (Machemehl 1979, USACE 1996). Groin spacing was ~650 ft. Machemehl (1979) reported the design lengths of groins #1 and #2 (fronting the US Naval Facility) were ~530 ft (161.5 m) and the southernmost structure was ~610 ft (185.9 m). Each groin incorporated a "berm" section at ~7.9 ft (+2.4 m) above mean low water (MLW), a 90-ft-long sloping section, and a planned 210-ft-long outer section with crest at ~3.6 ft (+1.1 m) above MLW.

During construction, the seaward ends were being installed in "*. . . very deep scour pockets and had only 1.0 or 1.2 m (3.0 or 4.0 ft) of penetration when the* (16 April 1970) *storm hit*" (US Naval Facilities Engineering Command, pers. comm., as quoted by Machemehl 1979, pg 322). The storm caused southerly deflection of each structure near the heads. As a result of scour and damage at the seaward ends during construction, the design was changed to eliminate the outer 100 ft of each groin (Machemehl 1979).

Additional damages occurred on 11 August and 24 October 1970 when sections of groins #1 and #3 were severely damaged. Repairs were made several times, including 1975, when steel sheet piles were installed along groin #1 after additional damage (offset from the original concrete sheet-pile alignment) (USACE 1996). In 1980 and 1982, landward extensions (totaling ~150 linear feet each) were needed to control flanking along the southernmost groin adjacent to the lighthouse (USACE 1996).

The groins slowed the erosion rate and for a time there was accretion along the US Naval Facility. This was likely aided by the 1973 nourishment along the Village of Buxton. Dolan et al. (1974) reported the positive impact of the 1973 nourishment extending to the Cape Hatteras Lighthouse. USACE (1996), in their analysis, suggested "*. . . the impact of the fill is believed to be minor compared to that of the groins, which have been influencing the shoreline for more than 25 years*" (pg 3-10). The downcoast area of Cape Point continued to erode with the resulting shoreline forming a "salient" (bulge) in the vicinity of the lighthouse (USACE 1996) (Fig 8.4). During the 1980s, erosion around groin #3 (fronting the lighthouse) was threatening to flank the groin although a sheet-pile wall (groin extension) had been installed around the lighthouse to check the erosion (USACE 1996). The present conditions of the Hatteras groins are illustrated in Figure 8.5.

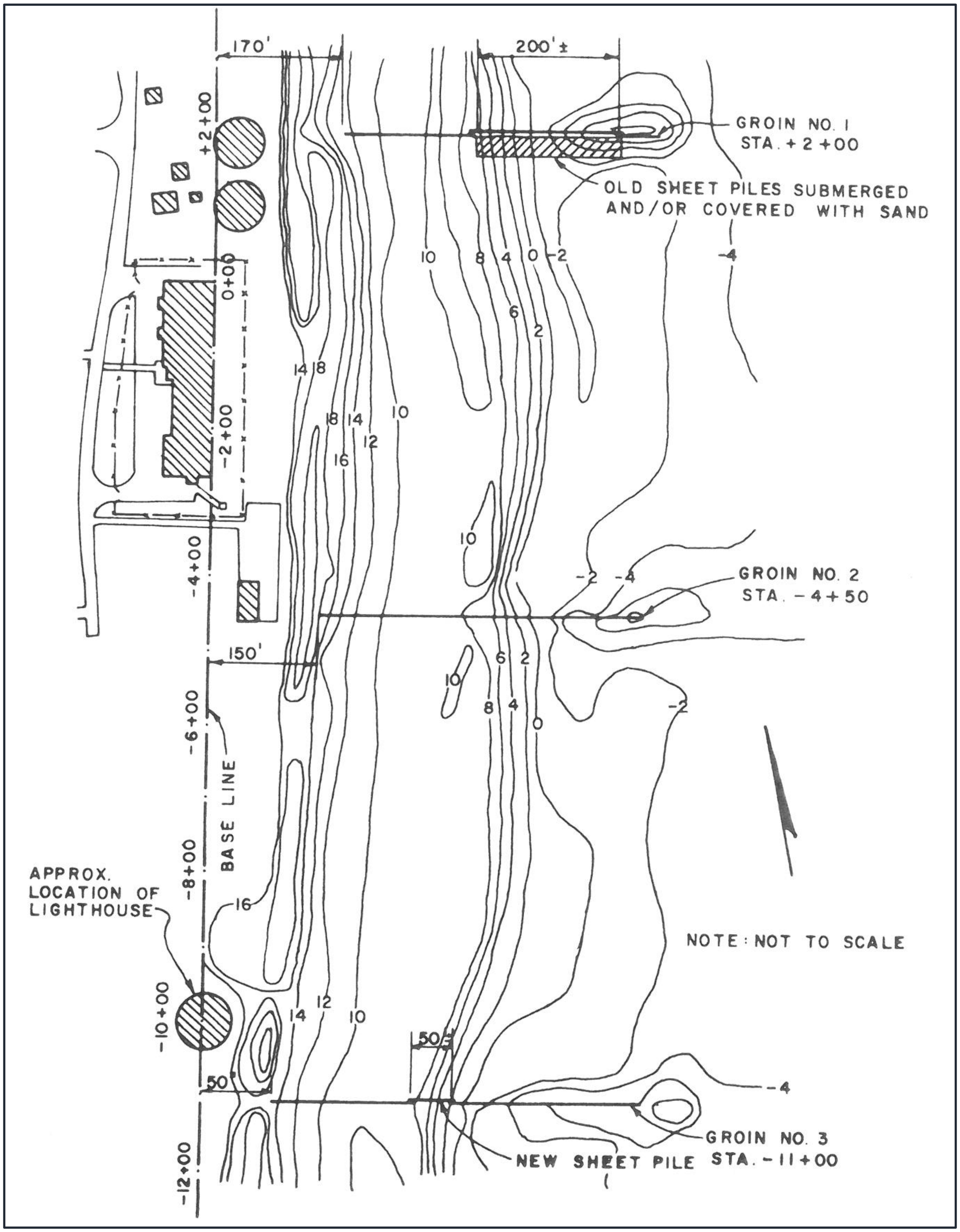

FIGURE 8.3. U.S. Navy plan for three groins fronting the Naval Facility and old Cape Hatteras Lighthouse location (from Machemehl 1979, Fig 6). The USACE–Wilmington District provided the design for implementation by contractors to the Navy (JT Jarrett, pers. comm., November 2013).

FIGURE 8.4. Oblique aerial photograph looking north of the shoreline "salient" (bulge) produced by three groins fronting the former US Naval Facility and old Cape Hatteras Lighthouse location. [Image courtesy of USACE–Wilmington District taken on 9 September 2000]

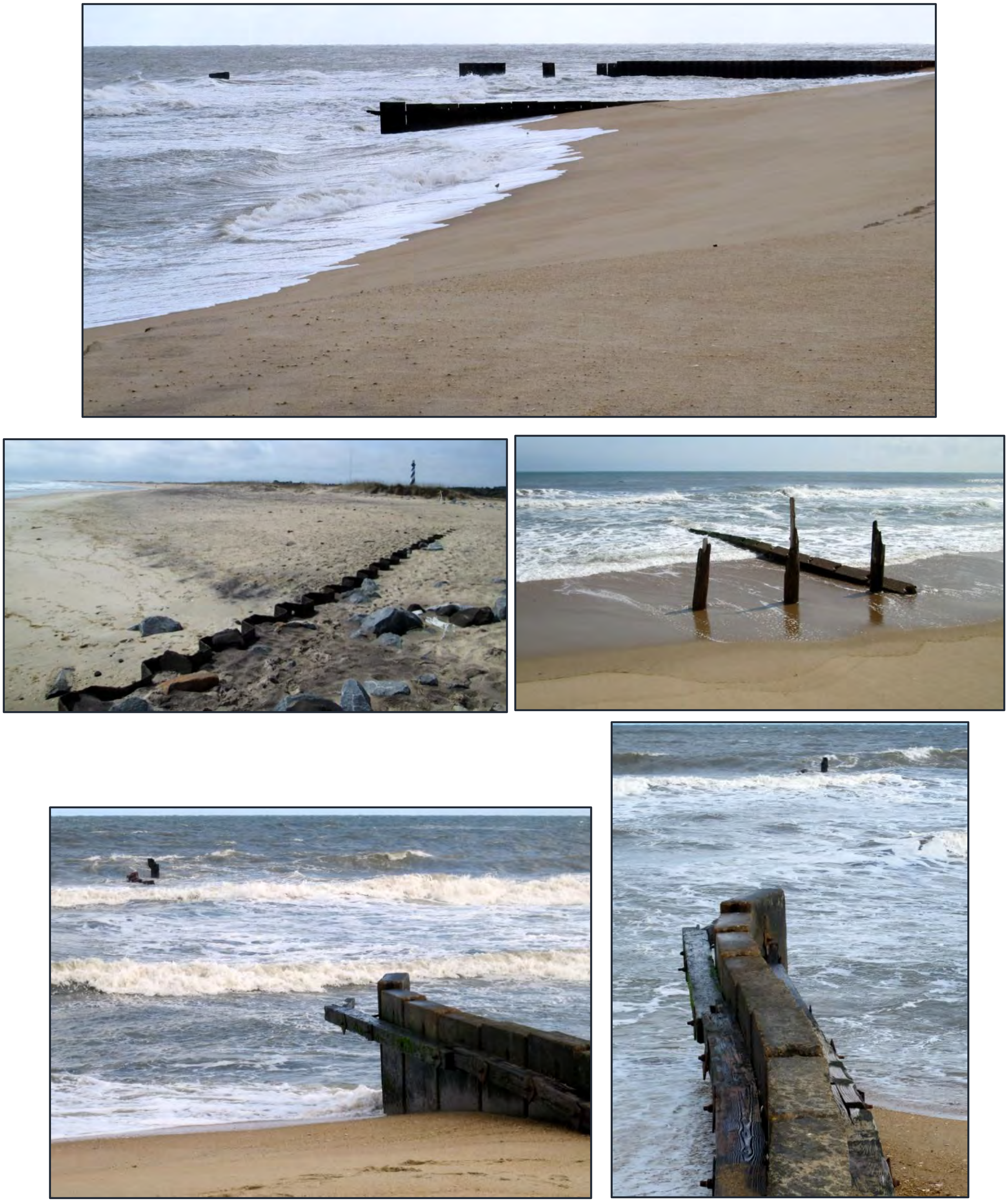

FIGURE 8.5. Cape Hatteras Groins. **[UPPER]** Groins 2 and 3 on 4 November 2013. **[MIDDLE LEFT]** Groin 3 – wing wall with Hatteras Lighthouse in the distance on 19 March 2013. **[MIDDLE RIGHT]** Groin 1 – visible remnant section in the surf zone on 19 March 2013. **[LOWER]** Groin 2 – missing sheet piles, damage and deflection at seaward end on 4 November 2013. [CSE 2013]

Lighthouse Protection and Relocation

The original Cape Hatteras Lighthouse, completed in 1802 and positioned ~1 mile inland, was deemed inadequate because of its limited height and setback from the ocean (NPS 1980, NRC 1988). A new lighthouse, the tallest in the United States, was completed in 1870 at which time it was positioned ~1,500 ft from the ocean. According to NPS records, the ocean was within 300 ft of the structure in 1919. By 1936, the US Coast Guard abandoned the lighthouse due to erosion, and ownership was transferred to the National Park Service. The National Park Service reports the ocean had advanced to within 100 ft of the lighthouse by 1935. This anecdotal information implies that, between 1870 and 1919, the shoreline eroded ~1,200 ft (~25 ft/yr) but erosion slowed between 1919 and 1935 to a rate of ~12.5 ft/yr.

Erosion apparently lessened or reversed between 1936 and 1950 when the US Coast Guard reactivated the lighthouse (NPS 1980). Shore-protection measures to protect the lighthouse resumed in the 1960s as previously described herein. In addition to nourishment, groins, and large sand bags, experimental shore protection in the form of a breakwater of "artificial seaweed" was tried in 1981 and 1986. Rogers (1986) monitored the installation and concluded that any benefits of artificial seaweed were short-lived and insufficient for the problem, although at the time, there was evidence of accretion along extended segments of Hatteras Island well removed from the area of the artificial seaweed.

During the 1980s, the Corps of Engineers evaluated a number of protection alternatives for the lighthouse, but at the urging of a private group (Move the Lighthouse Committee–Fischetti et al. 1987), the National Park Service contracted with the National Academy of Sciences for an independent review of all protection alternatives (NRC 1988). The Academy committee recommended moving the lighthouse.

During the 1990s, additional emergency repairs to the groins and sandbag revetment were completed, particularly following erosion and dune breaching during Hurricane *Gordon* in 1994. The south groin was repaired in 1995 by installing 184 ft of steel sheet piling along damaged sections. The Corps of Engineers (USACE 1996) completed a review of prior shore-protection measures and evaluated alternative designs for a fourth groin south of the lighthouse. The Wilmington District report was requested by the National Park Service because of uncertainties in funding for lighthouse relocation. However, funds were finally acquired, and the lighthouse was moved ~2,900 ft southwest in 1999 (completion on 14 September 1999). The American Society of Engineers recognized the project as one of the Annual Outstanding Civil Engineering Achievements of 1999 with some referring to the project as "The Move of the Millennium." At 200 ft, the Cape Hatteras Lighthouse is the tallest masonry structure ever moved (Booher and Ezell 2001).

With the lighthouse now situated ~1,600 ft landward of the beach (see Fig 8.5, left center image), shore-protection measures for the structure are not needed. However, it is apparent from the image of Figure 8.4 that the groins continue to hold a major section of the Village of Buxton shoreline in place. Their influence appears to extend to the Highway NC 12 "S-curve" immediately north of the village (Fig 8.6).

FIGURE 8.6. Project area on 11 September 2014 looking south. The "salient" (bulge) in the shoreline is situated at the south end of Buxton Village at the former site of Cape Hatteras Lighthouse and three groins which were constructed in 1970 by the US Navy. [Image by CSE]

Highway NC 12

Prior to the 1950s, Highway NC 12 was an intermittent paved road and unpaved trail between Oregon Inlet and Buxton. In 1952, the two-lane highway (fully paved) was completed. Shortly thereafter (1953), the National Park Service officially established Cape Hatteras National Seashore. Certain sections of Highway NC 12 along Hatteras Island have been subject to erosion, washovers, and inlet breaching from the beginning (Riggs et al. 2009).

Three hurricanes in 1955, (*Connie* on 12 August, *Diane* on 17 August, *Ione* on 19 September) resulted in severe erosion and damages to Highway NC 12 between Buxton and Oregon Inlet (USACE 1996). The "Ash Wednesday" northeaster of record (March 1962) in the Middle Atlantic states breached the barrier island between Buxton and Avon (CHWA 1977), causing emergency repairs to close the channel and rebuild the highway. In 1973, the "Lincoln's Birthday Storm" (NPS 1980) produced considerable erosion including severe overwash into Pamlico Sound immediately north of Buxton. *"Oceanfront motels at Buxton and beach cottages north of the lighthouse were significantly damaged"* (NPS 1980, pg 32). The storms of the early 1970s forced officials to relocate a section of Highway NC 12 in the Buxton area, but the narrow width of Hatteras Island in some places and concern for fringing wetlands along the back barrier preclude further shifts. Other factors restricting the NCDOT from relocating the highway are existing easements and rights-of-way through the National Seashore (NCDOT, J Jennings, Division Engineer, pers. comm., August 2014).

In recent years, including 2011 after Hurricane *Irene* and 2012 after Hurricane *Sandy*, portions of the foredune in the Buxton Action Area breached. Sand washed over NC 12 and forced temporary road closures (NCDOT 2015, in preparation). NCDOT scraped sand off the road and pushed it back into the protective dune to restore vehicle access as soon as possible. In other areas of Hatteras Island where the barrier island and foredune are narrow, breach inlets formed during Hurricane *Irene* (see Fig 1.5). These inlets resulted in over two months of road closure and lack of normal access to all communities on the island. Prior to *Irene*, the separation distance between high water and NC 12 was <150 ft in the S-Curves Mirlo Beach (Rodanthe) "hot-spot" area, where one of the inlets formed. Riggs and Ames (2011) estimated that NCDOT has spent a minimum of $100 million from 1983-2009 to maintain NC 12.

Oregon Inlet Dredging

Oregon Inlet is an outlet/inlet across the barrier island that opened in 1846 and separates Bodie Island from Pea Island. In response to dynamic conditions, the inlet steadily migrated south from its original position and then in 1962-63 a 2.4-mile-long bridge (the Herbert C Bonner Bridge), with a fixed navigational span, was constructed across the inlet. To maintain the main channel under the bridge, dredging occurred with offshore, deep water disposal of the dredged sand. The southern migration of the inlet was halted by a terminal groin and rock revetment built in 1989–1991. However, the northern Oregon Inlet shoreline (Bodie Island spit) continued to migrate southward into the inlet channel driven by the dominant energy of nor'easter storms which required a further increase in frequency and volume of dredging to "hold the channel" under the fixed navigation span (Riggs and Ames 2011a). After the terminal groin and revetment were built, dredged sand from the inlet was more frequently put on Pea Island beaches between 1 and 3 miles south of the inlet. Riggs and Ames (2011b) compiled data from various sources to summarize Oregon Inlet dredging and Pea Island nourishment which had occurred from 1992-2009; the conservative estimate is 12.7 million cubic yards.

Major dredging of Oregon Inlet is estimated to occur every four or five years with maintenance dredging as needed on a more frequent basis. However, a new memorandum of agreement is under negotiation between the USACE, the state, and Dare County which would provide dredging on a more regular basis. A recent tactic by the USACE during the spring 2015 Oregon Inlet dredging was to cut the Bodie Island spit in two with the hopes that the encroaching south end would be swept away by the current (The Outer Banks Voice 26 April 2015).

Emergency Sand Bags

There have been 15 General Permits issued by the NCDCM for placement of emergency sand bags to protect private oceanfront property threatened by beach erosion in the most northern portion of Buxton Village; 14 of these permits were issued in 2013 and one was issued in 1992. These permits were issued for the first 15 parcels within Buxton Village from its northern limit. Under terms of the NCDCM permit, the sand bags must be removed by a certain date or when sand is placed along the eroding section of beach under a permitted nourishment project (NCDENR, D Huggett, Manager, pers. comm., 8 January 2015).

EFFECTS TO EVALUATED FEDERAL SPECIES, CRITICAL HABITAT, AND DETERMINATIONS

The following ESA definitions apply to federally listed species and designated critical habitats and are used in the evaluation of effects of the proposed action:

- No effect – the proposed action or project and its interrelated and interdependent actions would not directly or indirectly affect listed species or destroy or adversely affect designated critical habitat. Formal Section 7 consultation with NMFS and USFWS is not required when the no effect conclusion is reached.
- May affect, not likely to adversely affect – the proposed action or project and its interrelated and interdependent actions may occur in suitable habitat, or may result in indirect impacts on the species but the impact is likely to be insignificant (small, immeasurable), or discountable (unlikely to occur), or even beneficial (contemporaneous positive effects with no adverse effects). Based on best judgement, the impacts could not be meaningfully measured, detected, or evaluated, are not expected to occur, and never reach the scale where a take could occur.
- May affect, likely to adversely affect – the proposed action or project and its interrelated or interdependent actions have at least one adverse effect that does not meet the above definitions. There may be a combination of beneficial and adverse effects which result in neutral or positive effects. Incidental take may or may not be anticipated and this definition requires formal Section 7 consultation with NMFS and USFWS who must prepare a Biological Opinion (BO).

Direct effects are caused by the proposed action and occur simultaneously and in the action area and indirect effects are those reasonably certain to occur as a result of the proposed action but at a later time and/or place. Interrelated activities and their effects are part of the proposed action that depends on the proposed action for their justification and interdependent actions have no independent utility apart from the action.

Cumulative effects are defined somewhat differently under ESA than in NEPA. Under ESA, cumulative effects include the environmental baseline plus the additive effect of reasonable foreseeable future state, private, and tribal activities; however, the effect of future federal actions are not considered by the NPS. Under NEPA, the cumulative effects are almost identical to those described for ESA, the only difference being that cumulative effects under NEPA also include the effect from reasonably foreseeable future federal actions as well. Below is a summary of future federal and non-federal (private, state, or tribal) activities that are reasonably likely to occur within the action area that directly and indirectly affect species addressed in this assessment. These are added to the environmental baseline (discussed above). In many instances, these past activities and their effects remain to this day and are currently ongoing as well.

The following future activities are likely to occur within the action area or adjacent to it within the next several decades:

- Maintenance and repair of NC 12 after major storms which breach the foredune and deposit sand over the roadbed or into Pamlico Sound (removal of overwashed sand into bulldozed artificial dunes to protect the roadway contributes to sand deficit which steepens and narrows the beach and degrades nesting, resting, and foraging habitat for birds and nesting habitat for sea turtles).

- Installation of emergency sand bags along private property within the Village of Buxton (steepens the beach face and removes potential foraging and nesting habitat for birds and nesting habitat for sea turtles).
- Three other beach nourishment projects in Dare County are in planning and permitting phases. These encompass portions of Duck (~1.7 miles), Kitty Hawk (~3 miles), and Kill Devil Hills (~2 miles). Combined with the proposed action at Buxton of about 3 miles, a total of ~20 miles (~30%) of the Dare County shoreline north of Cape Hatteras is likely to receive nourishment over the 10-yr period 2010-2020. The majority of shoreline that has or may be nourished is developed. (similar potential adverse and beneficial impacts for resting, foraging, and nesting habitats for birds and sea turtles; similar potential adverse effects for Atlantic sturgeon and swimming turtles)
- Beach renourishment at Buxton at five-year to 10-year intervals based on documented performance of the proposed project; funding is anticipated by Dare County and/or NCDOT (construction of a wider beach in more developed coastal regions of North Carolina may cause an increase in summer rentals with a concomitant increase in night lighting which may affect nesting and hatching sea turtles; also likely to increase the use of the beach by both beach-goers and their pets which may contribute to increased disturbance to birds in the area).
- Beach nourishment along other erosional "hotspots" along Hatteras Island based on documented surveys for purposes of restoration of the measured sand deficit (see other beach nourishment bullets above).
- Identification and use of other offshore borrow areas along Hatteras Island (may affect Atlantic sturgeon and swimming sea turtles).
- Installation of sand fencing and vegetation along the foredune to intercept nourishment sand and help promote dune growth without encroachment onto NC 12 or adjacent developed properties (may provide benefit to species which use the dry beach for nesting and foraging).

While this BA addresses only those species with federal protection under the ESA, there are additional species which also have federal protection. Other birds that may occur in the project area/vicinity are federally protected under the Migratory Bird Protection Act (MBTA); e.g., colonial waterbirds, other shorebirds, and birds of prey. For MBTA-protected species, there is no provision for incidental take related to dredging or filling or crushing by equipment. The U.S. Marine Mammal Protection Act of 1972 as amended (MMPA) protects all marine mammals including cetaceans (whales, dolphins, and porpoises), pinnipeds (seals and sea lions), sirenians (manatees and dugongs), sea otters, and polar bears within the waters of the U.S. The MMPA prohibits marine mammal take and enacts a moratorium on the import, export, and sale of any marine mammals, along with any marine mammal part or product within the U.S. The MMPA defines "take" as the "act of hunting, killing, capturing, and/or harassment of any marine mammal; or, the attempt at such". The MBTA-protected species and the MMPA-protected species without ESA protection are addressed in the Environmental Assessment in preparation for the Buxton project. The USACE as lead federal agency for the proposed Buxton project will initiate Section 7 consultation with federal resource agencies. Under Section 7 consultation, USFWS or NMFS may authorize incidental take through a Biological Opinion for ESA-protected species that are likely to be adversely affected by the project activities.

Piping Plover

As part of standard annual management practices, NPS personnel patrol the Seashore and evaluate all potential breeding habitat for this species by 1 March and recommend pre-nesting closures based on that evaluation. Surveys continue three times/week and closures are adjusted accordingly throughout the nesting season until 31 July when unused pre-nesting closures are removed if no breeding activity is seen in the area; or 2 weeks after all chicks have fledged whichever comes later. All NPS surveys are conducted seven days a week once nesting has begun. Non-breeding habitat protection areas are implemented prior to removal of pre-nesting closures and are designated vehicle free areas (VFA) but are open to pedestrians. Under the revised buffers for piping plovers implemented by NPS (2015a), the mandated breeding behavior/nest buffer is 165 ft (50 meters) for both ORVs and pedestrians and the buffer from unfledged chicks is 1,650 feet (500 meters) for ORVs and 330 feet (100 meters) for pedestrians. Shorter than those identified in the 2010 plan and ROD, the revised buffer distances are contingent upon the ability of NPS biologists to conduct intensive monitoring of plover chicks for the duration of the day that the beach is open for ORV driving (0700–2100 hr).

Direct and Indirect Effects

While the closest, documented piping plover nest was 1.5 miles away from the project area, one non-breeding plover was observed immediately north of the northern project boundary. One of the NPS migratory bird transects, Park Mile 38 (PM38), overlaps the northern project boundary but no additional transects are within project boundaries (Cape Hatteras National Seashore, Randy Swilling, Natural Resource Program Manager, pers. comm., 4 September 2015). While it is reasonable that protected birds may use the area during migration, no piping plovers have been documented in the project area since the July-May weekly migratory bird surveys began in 2010. No direct effects are expected as a result of the offshore dredging activity, but individuals could be temporarily affected by sand placement activities. The sand placement activities on the beach will occur outside of NPS-established buffers designed to minimize disturbance effects for breeding, nesting, foraging, and roosting behaviors.

Additionally, this species is not as likely as other species to occur in the area of sand placement and is very unlikely to nest in the project area. However, should the bird occur outside of established closures, direct effects for foraging, roosting, or nesting adults would include disruptions and disturbance from the pipeline application of slurry sands, movements of support vehicles, and scraping the new beach. Even so, for non-nesting adults, the effects in a given area would be temporary as the project is predicted to cover ~800–1,000 feet per day (ft/day) within the larger context of miles and miles of shoreline available for foraging and roosting; these mobile adults can move to more favorable habitat. However, should there be any chicks in the project area, which is unlikely, direct effects would include disturbance and interruptions in foraging activities since the chicks are unable to fly elsewhere to forage. Infaunal prey species in the surf zone would suffer direct effects as existing organisms would be buried in the slurry deposit and the beach scraping would reduce available food in the vicinity of the active impact. Therefore, direct effects which may occur are considered short-term, temporary, and insignificant or discountable.

Potential indirect effects could stem from the wider post-project beach. Wider beaches lead to more rapid dune growth (Bagnold 1941) as demonstrated by the 2011 Nags Head nourishment project (CSE 2014). Along accreting beaches or where sustained nourishment is implemented, the dune field can become stabilized to the detriment of species which prefer unvegetated washover deposits. Indirect effects are considered insignificant with the abundance of preferred habitats nearby.

While burial of many benthic surf zone prey of the piping plover will occur during the sand placement, an indirect effect on the prey population could include potential reduction on subsequent visits the following season or year which could affect the ability of the piping plover to refuel with enough reserves to complete their annual life-cycle in optimum condition, or at least in the condition they might have been without the proposed action. This effect would also be difficult to meaningfully quantify or evaluate in regards to this project. However, as shore protection project studies in different locations and settings have demonstrated, compatible sediments placed on the target beach in a configuration appropriate to the geomorphology result in a short-term impact to the infauna of the surf zone and viable communities are present within the first year; recolonization begins to occur rapidly depending on species.

Studies have shown that depending on species, recolonization of beach benthos can begin as soon as two to 6.5 months if borrow sediments are similar in grain size to the target beach as is the case for the proposed Buxton project (Burlas et al. 2001). The benthic organisms which thrive in the harsh dynamics of the surf zone are well adapted to perturbation and wide fluctuations of wave energy, suspended sediments, transported sediments, and other disruptions from coastal storms which can sometimes last over several days- conditions not dissimilar to sand placement activities of the proposed action (Deaton et al. 2010). Infauna in these disturbed environments are well adapted by being small bodied, short lived, with a maximum rate of fecundity, efficient dispersal mechanisms, dense settlement, and rapid growth rates. However, it is recognized that tube dwellers and permanent burrow dwellers are most susceptible to these types of disturbances compared to more mobile organisms.

Daily NPS surveys within the project area and vicinity will help minimize disturbance to the piping plover; if individual birds are observed within the project activities NPS personnel will alert the contractor and appropriate management measures will ensue to reduce potential effect. One positive direct effect for this species would include a wider beach with the potential for increased habitat suitable for roosting and for foraging after a recovery period for the benthic organisms.

Cumulative Effects

Climate change would likely bring changes in temperature and precipitation which can significantly affect habitats in both the short-term and the long-term, especially if the seasonality of precipitation deviates from the norm. These type of changes are difficult to predict with accuracy and therefore it is hard to state how such changes might affect piping plover habitats. However, most scientists think that climate change is likely to bring more intense storms and potentially more frequent storms but in a somewhat unpredictable manner. Storms and other weather events during the piping plover breeding season (March-August) can result in temporary displacement and disturbance to nesting birds or even wash away nests, eggs, chicks, and breeding adults, depending on timing and severity of the event. More powerful storms can surge and overwash large areas of piping plover habitat even up to the toe of the foredune and beyond. Conversely, storms outside of breeding season may provide benefit to piping plover with new overwash areas and new nesting and foraging habitats but may also adversely affect existing suitable habitat by associated erosion.

Hurricanes can also affect the piping plover because of their impact on staff resources. Storm recovery that pulls staff from resource management duties (including species monitoring or law enforcement) during piping plover breeding season would have adverse impacts. A hurricane after

August would have no direct effect on piping plover and for the reasons stated in first paragraph could benefit or enhance habitat.

Coastal development is likely to continue throughout Dare County on both state and private lands. This would bring added pressures of more vehicles on NC 12 and more people to the action area beach and beyond, either as residents or tourist rentals. The need to maintain NC 12 for vehicles reduces the chance of natural washover formation, creating new nesting habitat in back barrier areas. Even without more development, recreation on the beach within the action area and throughout Dare County is expected to continue to increase with a concomitant rise of tourists and vehicles on the beach especially in the summer. While recreational vehicle and pedestrian use is highly managed by the Seashore's efforts to protect natural resources of the Park, the summer season coincides with high productivity life cycles for piping plover (mating, nesting, incubating, and fledging).

Visitor use of the beach, notably surf fishers, will likely increase not only in summer, but also in fall and spring. Such use is not likely to adversely affect piping plover prey in the surf or intertidal area. Commercial fishing will continue in nearshore and offshore waters which may affect the abundance of the prey on which both the fish (target and bycatch) and piping plover prefer.

Interrelated and Interdependent Actions — There are no interrelated and interdependent actions associated with this project; therefore there are no anticipated adverse effects to the piping plover from such actions.

Determination — Effects are considered insignificant or discountable, therefore, the proposed action may affect but is not likely to adversely affect the piping plover.

Roseate Tern

Direct and Indirect Effects

Due to rarity of appearance in the action area, no direct or indirect effects to this species are expected. However, since it is a rare visitor to North Carolina, visitor(s) could occur during construction. Normal beach surveys performed by NPS biologists will note any roseate terns in the action area or vicinity; although unlikely to occur, if individuals are noted by NPS staff during construction their presence will be communicated to contractor and appropriate actions will be taken to minimize disturbance. Project-related activity will not affect their ability to feed because preferred locations for foraging (shallow bays, tidal inlets and channels, sandbars) are widespread, thereby providing the rare visitor with other options for these activities. Nonetheless, potential visitor(s) could attempt to rest in the project area and be temporarily disturbed by sand placement activities, although preferred habitat for resting (sheltered estuaries, inshore waters, and creeks) are not found within the sand placement area. No nests have been documented in North Carolina.

Cumulative Effects — *Please refer to Cumulative Effects section on piping plover above. The roseate tern is a rare visitor to North Carolina and does not nest in the state, so the activities discussed above would have even less likelihood to adversely affect the roseate tern than the piping plover*.

Interrelated and Interdependent Actions — There are no interrelated and interdependent actions associated with this project; therefore there are no anticipated adverse effects to the roseate tern from such actions.

Determination — Effects to the roseate tern are considered insignificant or discountable therefore, the proposed action may affect but is not likely to adversely affect the roseate tern.

Rufa Red Knot

There are no standard management practices currently in place specifically for the rufa red knot within the National Seashore's current ORV management plan but its presence and use of the beach will be included in data collected by NPS biologists during their other beach bird surveys (e.g., non-breeding survey from July through May). As it will not nest in North Carolina, no pre-nesting surveys or closures are expected. When compared with seven other US east coast locations, the Outer Banks ranked last in regional importance for red knots (Dinsmore et al. 1998). In addition, North Carolina observations of red knot are generally more numerous in the southern half of the coast and outside the action area (Carolina Bird Club 2014).

Direct and Indirect Effects

No direct effects are expected to this species as a result of the offshore dredging activity but individuals could be temporarily affected by sand placement activities. The sand placement activities on the beach will occur outside of NPS-established buffers which are designed to minimize disturbance effects for foraging and roosting behaviors for the red knot. As the rufa red knot forages in the surf zone and roosts on the beach, activities on the target beach associated with sand placement, particularly from April through June, would temporarily disrupt migrating adults from foraging or roosting in the area, will therefore cause expenditure of energy to seek quieter locations, and will temporarily reduce surf zone prey preferred by the species (coquina clams, mole crabs, marine worms, and horseshoe crab eggs). Stress and the bioenergetics impact on shorebirds from such project disturbance are very difficult to measure, although this species already suffers from asynchronies in migration timing and food supply. These direct effects may negatively affect their ability to gain enough weight to arrive at the next stop over in an optimal condition, which may affect their ability to successfully nest, breed, and rear young, or complete their migration. However, these effects are difficult to measure, meaningfully quantify, or evaluate.

Current NPS management practices will help minimize the likelihood of prolonged disturbance to the rufa red knot and there are abundant higher quality roosting and foraging habitats north and south of the project area. In addition, compared to species which nest on North Carolina beaches, individual migrating birds do not remain very long in the vicinity and will either move to adjacent areas undisturbed by nourishment activities, or continue their migration. Also, the foraging habitat for this species is very marginal in the project area due to the high energy conditions and eroding beach face. One beneficial direct long-term effect for this species would include a wider beach with the potential for increased habitat suitable for roosting and for foraging after a recovery period for the benthic organisms.

While burial of many benthic surf zone prey of the rufa red knot will occur during the sand placement, an indirect effect on the prey population could include potential reduction on subsequent visits the following season or year which could affect the ability of the red knot to refuel with enough reserves to complete their annual life-cycle in optimum condition, or at least in the condition they might have been without the proposed action. This effect would also be difficult to meaningfully quantify or evaluate in regards to this project. However, as shore protection project studies in different locations and settings have demonstrated, compatible sediments placed on the target beach in a conFiguration appropriate to the geomorphology result in a short-term impact to the infauna of the surf zone and viable communities are present within the first year; recolonization begins to occur rapidly depending on species.

Studies have shown that depending on species, recolonization of beach benthos can begin as soon as two to 6.5 months if borrow sediments are similar in grain size to the target beach as is the case for the proposed Buxton project (Burlas et al. 2001). The benthic organisms which thrive in the harsh dynamics of the surf zone are well adapted to perturbation and wide fluctuations of wave energy, suspended sediments, transported sediments, and other disruptions from coastal storms which can sometimes last over several days- conditions not dissimilar to sand placement activities of the proposed action (Deaton et al. 2010). Infauna in these disturbed environments are well adapted by being small bodied, short lived, with a maximum rate of fecundity, efficient dispersal mechanisms, dense settlement, and rapid growth rates. However, it is recognized that tube dwellers and permanent burrow dwellers are most susceptible to these types of disturbances compared to more mobile organisms.

Cumulative Effects

Please refer to Cumulative Effects Section for the piping plover as the same activities have the potential to affect resting or foraging rufa red knots that may be migrating through the action area and beyond during the spring and early fall.

Most of the precipitous decline of the rufa red knot is tied to (1) climate change which is likely to continue to affect asynchrony with food supplies as the birds migrate south too soon from the Arctic and (2) the commercial horseshoe crab harvest in Delaware Bay which has severely depleted a preferred food source during their migration. While horseshoe crab harvests have been managed since 2012 with conservation of the rufa red knot in mind, the horseshoe crab populations in Delaware Bay have not yet rebounded.

Cumulative impacts from persistent stress can be inferred when a population declines. More specifically, when combined with other stressors such as repeated flushing while foraging or from sheltered areas during inclement weather, such impacts can have a cumulative negative impact on fecundity and overwinter survival (Byrne et al. 2009).

Interrelated and Interdependent Actions — There are no interrelated and interdependent actions associated with this project; therefore there are no anticipated adverse effects to the rufa red knot from such actions.

Determination — Effects are considered insignificant or discountable; therefore, the proposed action may affect but is not likely to adversely affect the rufa red knot.

Sea Turtles

For sea turtles occurring in the Atlantic Ocean, Atlantic sturgeon, and the shortnose sturgeon, the applicant presumes to operate under the 1997 SARBO and associated incidental take allocation for the potential risk of a lethal take of green, loggerhead, hawksbill, and/or Kemp's ridley sea turtles during dredge operations for this project. [The 1997 SARBO indicates that while leatherback sea turtles may be in the area of hopper dredge operations in inlets or along the coast, the species is not likely to be adversely affected by those operations.] Consultation for in-water impacts to these marine species will occur between the lead federal agency (USACE) and NMFS upon publication of the permit application and supporting documents. The applicant acknowledges the needs for compliance with all current recommendations and conditions of the 1997 SARBO as well as future revisions to the SARBO should they occur during the timeframe of the project.

Direct and Indirect Effects Common to Sea Turtles

Non-breeding sea turtles of all five species with potential to be affected can be found in the nearshore waters in the action area during much of the year and may be disturbed by increased turbidity or disrupted while swimming during dredging activities (NPS 2013b). During sand placement activities, the primary direct effects on sea turtles which may nest on the beach include disturbance during nesting and the potential for escarpments and compaction of beach sand. Large escarpments can impede access to nesting areas, increase the number of false crawls, or cause a turtle to lay eggs in a location subject to overwash (Byrd 2004). Sand compaction can affect digging behavior and result in false crawls, can affect incubation temperature which in turn affects sex ratios, and can affect gas exchange parameters within incubating nests (Mann 1977, Ackerman 1980, Mortimer 1982b, Raymond 1984). Other effects from construction activities would be noise, construction lighting, and the potential for a nest to be crushed if missed by the NPS regular patrols.

Noise criteria for sea turtles as well as other species have been somewhat formalized between NMFS and the US Navy. To replace regulatory uncertainty with scientific facts, NOAA convened a panel in 2004 to develop noise exposure criteria for fishes and sea turtles. When NOAA's support ended in 2006, a Working Group was established to determine broadly applicable sound exposure guidelines for fishes and sea turtles under the support of ANSI-Accredited Standards Committee S3/SC 1, Animal Bioacoustics, which is supported by the Acoustical Society of America. Few data are available on the hearing abilities of sea turtles, their uses of sounds, or their vulnerabilities (Popper et al. 2014), although Level A (205 dB re 1μPa^2·sec) and Level B (182 dB re 1μPa^2·sec) criteria for sea turtle harassment have been considered by NMFS and the US Navy for explosions associated with certain ordnance disposal training operations, and interim criteria have been developed by NMFS for pile driving. While some researchers have suggested that marine mammals should be used as the analog for sea turtle responses to noise, the view of the Working Group is that fishes are more appropriate due to dissimilar functions of the marine mammal cochlea and the basilar papilla in the ear of sea turtles (Popper et al. 2014). Broadband sound with many frequencies is generated from dredge activities.

For turtle activities on shore, much research links decreased sea turtle nesting in areas with human activity, disruptions to hatchling ability to orient, and increased hatchling predation caused by high light levels compared to natural beaches (Witherington 1992, Kikukawa et al. 1999, and Martin 2000) Although nest relocations in the project area already occur somewhat regularly due to the narrow eroding beach, relocations as a result of the project construction would be another direct effect. Dredging itself, the noise associated with dredging and piping, and the concomitant increased turbidity in the waters of Borrow Area C, could also present adverse effects to sea turtles. While monitoring requirements and procedures prior to and during dredging make it unlikely, potential entrainment of a turtle by the dredge operation could also be a direct effect.

As part of the standard management practices, NPS personnel conduct daily patrols from 1 May to 15 September in most years but the end date can extend through September when conditions favor late nesting. Ordinarily, they are charged to relocate only those nests directly threatened with loss from erosion, nests laid below the high tide line and subject to frequent inundation, and nests with broken eggs from predation or ORV contact. In the action area, the percent of turtle nest relocations varies from 13.2 and 13.6 percent in 2012 and 2013 (respectively) to 0 percent in 2014. For these three years the total nest count also decreased from 38 to 22 to 4 in the Proposed Action Area. Over the same period within all of Hatteras District (Ramp 30 to Hatteras Spit), the relocation rate is slightly higher in Hatteras South-from Cape Point to Hatteras Inlet (24.9% average) than from Hatteras North-from Cape Point to Ramp 30 (16.8%). But it is impossible to predict how many nests would be moved in any given year in the future if the project were not to occur.

However, per project specific informal guidance from USFWS/NCWRC on 29 July 2015, any turtle nest found within the project area will be relocated as soon as possible after discovery by USFWS and NCWRC-approved personnel. The relocations would follow all USFWS/NPS/NCWRC guidelines and protocols. Within the entire Seashore for the past three years (2012-2014), the average percent of relocated nests is 25.7. Over that same period, for each year, mean hatch success, mean emergence success, and overall nest success has been higher in the relocated nests than in the in situ nests (Table 9.1).

From 2009 to 2014, the number of sea turtle nests laid within the project area ranged from 4 in 2014 to ~32 in 2012. For the same time period, the percentage of total nest laid within the Seashore that were located within the project area ranged from 2.6 percent (2014) to 14 percent(2012) (Cape Hatteras National Seashore, Randy Swilling, Natural Resource Program Manager, pers. comm., 4 June 2015). As described elsewhere, lack of safe harbors in the action area results in preference for a summer dredging window. Therefore, this project poses a higher threat to sea turtles because the sand placement is proposed to occur during two months of the nesting season which runs from May through September. Existing NPS management activities will continue to occur in addition to daily turtle patrols during construction to limit and minimize adverse effects to these species.

The project also may have indirect effects on sea turtle nesting habitat which could include changes in beach morphology or sediment characteristics. Changes in beach morphology could result in less preferred nest sites and changes in sand characteristics (higher mineral content or color change) can cause a temperature change in the nest which is known to affect the sex ratios of hatchlings.

TABLE 9.1. Sea turtle nest relocation compared to in situ success in the Seashore 2011-2014 compiled from Cape Hatteras National Seashore annual sea turtle monitoring reports available online.

Year	Percent relocated nests	Nest Type	Mean hatch success	Mean emergence success	Nest success
2014	26.6	In situ	48	44	57
		Relocated	58.9	47	60.6
2013	26	In situ	63.7	55	72
		Relocated	68.3	59.6	89.2
2012	24.3	In situ	78	73.1	88.6
		Relocated	80.96	74.46	98.1
2011*	25.9	In situ	-	-	-
		Relocated	-	-	-
Average	25.7	In situ	63.2	57.4	72.5
		Relocated	69.4	60.4	82.6

*the 2011 report did not contain summary data in this format

Suitable sand size and color and measures to avoid disturbance of sea turtles during dredging and sand placement will help minimize effects. One beneficial direct effect for this species would include the potential for increased habitat suitable for nesting due to the wider beach.

Although ORV access and authorized ORV calendar use of ORV areas are strictly managed by NPS practices and regulations, known turtle nests are protected with buffers, and incubating nests and hatchlings are monitored and protected, a wider beach may also promote increased use of the beach by ORVs, as well as pedestrians. Under this scenario, the potential that a turtle is disrupted from nesting or that a nest or hatchling is disturbed also increase.

The project action may temporarily adversely affect turtles during the short term of construction although it is likely to have a longer term beneficial effect post-construction as potential turtle nesting habitat is likely to expand from a wider beach. Addition of appropriate sand from Borrow Area C similar in color and grain size is expected. The addition of sand in the nearshore environment replaces sand lost as a result of natural processes in this eroding beach, which will reduce this beach's susceptibility to a breach in the near future, enhance its resilience, and help sustain its biological integrity. While construction of a wider beach in more developed coastal regions of North Carolina may cause an increase in summer rentals with a concomitant increase in night lighting, the majority of this project occurs in the National Seashore where further development and increased lighting will not occur. The portion of the project area adjacent to existing sandbagged structures in Buxton Village (where the beach is currently so narrow that a turtle is unlikely to select it for a nest and if one was laid it would have to be relocated) will also be wider; a wider beach front may spur an increase in rental use of these particular structures and therefore an increase in nighttime lights and nighttime pedestrians.

Differences in Direct and Indirect Effects among Sea Turtles

The difference between the potential effects on these five sea turtle species is based on the extent to which the species is likely to be present during the proposed activity. Species presence and potential effects are closely related to nesting, with the leatherback, Kemp's ridley and green sea turtles being infrequent nesters, while the hawksbill never nests in North Carolina. Of the five sea turtles, the loggerhead is the species most likely to be affected by the proposed action.

Kemp's Ridley Sea Turtle — Of the sea turtles that commonly or occasionally nest in North Carolina, the Kemp's ridley is the rarest and is unlikely to nest on eroding or steep beaches, characteristics of the proposed beach at Buxton. Kemp's ridley is primarily a tropical to subtropical nesting species; however, there have been seven documented nests in North Carolina since 2010 and the National Seashore documented its first Kemp's ridley nest in 2011 (this nest was not in the action area (Cape Hatteras National Seashore, Randy Swilling, Natural Resource Program Manager, pers. comm., 10 April 2015). As the use of North Carolina beaches by this species seems to be on the increase, the potential exists for it to come ashore in the Proposed Action Area or to be in the waters in the vicinity of the dredge and pipeline.

Leatherback Sea Turtle — The leatherback is also a rare nester in North Carolina and especially rare in the northern part of North Carolina. Although loggerhead, green, and Kemp's ridley sea turtles are commonly found in beach strandings in the National Seashore, leatherbacks strand more rarely and only one was documented from 2010-2014 in the entire park. Seven nests have been documented in North Carolina since 2010, one of which was in the Seashore in 2012, but no nests were documented in the past two years. No leatherback nests have been documented in the action area (Cape Hatteras National Seashore, Randy Swilling, Natural Resource Program Manager, pers. comm., 10 April 2015). This species is less likely to be impacted by either dredge or sand placement activities than loggerheads or green sea turtles. Per project specific USFWS/NCWRC guidance, nest surveys for leatherback may be required to begin 15 April since this species may nest earlier than May.

Green Sea Turtle — The green sea turtle is essentially a tropical species and does not generally breed in temperate zones, but it does occasionally nest on North Carolina beaches, and occurs in North Carolina waters during the warmer months where it feeds on sea grass in the sounds. From 2010 to 2014, 114 green sea turtles have been documented in North Carolina, 41 of which were in the National Seashore, and two of those 41 were in the action area. In 2013, 23 nests were documented in the Seashore while there were only two in 2014. As a somewhat regular nester in the Seashore, individual green sea turtles may be impacted in the water during dredging or on the beach during sand placement activity.

Loggerhead Sea Turtle — The loggerhead sea turtle is well adapted to the highly dynamic environment of the Outer Banks and is the most common marine turtle nesting in North Carolina; the average number of nests per year is around 750 (Godfrey 2013). Since 2010, 4,694 loggerhead nests have been documented in North Carolina with 857 of them in the National Seashore in that period (www.seaturtle.org). Within the action area from 2010-2014, mostly loggerhead nests have been documented (Outer Banks Group, Leslie Frattaroli, Acting GIS Specialist, pers. comm., 27–28 October and 29 December 2014). While tagging data has been used most extensively to predict population numbers for marine sea turtles, satellite telemetry of a southwest Florida loggerhead rookery improved measurements of site fidelity (philopatry) and revealed a need to recalculate fecundity estimates (Tucker 2009). If clutch frequency numbers are representative of the Western Atlantic population of this species, then confidence bounds on the estimated breeding stock could be underestimated by as much as 32 percent (Tucker 2009). As the most common nester in North Carolina, the proposed action is most likely to impact the loggerhead sea turtle with either dredge or sand placement activity.

Hawksbill Sea Turtle — From 2008 to 2013, there is no record of a stranding of a hawksbill (NPS 2013b) and no nest has been documented in North Carolina. While it is possible one could occur in North Carolina waters, due to its rarity of occurrence in North Carolina, the project is expected to have no effect on nesting females and among sea turtle species with the potential to occur, hawksbill individuals are the least likely to be encountered.

Cumulative Effects Common to Sea Turtles

Climate change directly affects the reproduction of sea turtles in three ways: (1) sea level rise may affect significant nesting beach areas on low-level sand beaches, (2) higher temperatures increase the chance that sand temperature will exceed the upper limit for egg incubation which is 34°C, and (3) higher temperatures bias the sex ratio toward females because incubation temperature determines the sex of the egg. Loggerhead turtle nests in Florida are already producing 90 percent females owing to high temperatures, and if warming raises temperatures by an additional 1°C or more, no males will be produced there.

Adult feeding patterns are also affected by climate change. Sea grass beds are in decline, water temperature is higher on intertidal sea grass flats, and coral reefs, typically feeding grounds for green turtles, are affected by bleaching. Sea turtles have existed for more than 100 million years and have survived ice ages, sea level fluctuations of more than 100 meters and major changes to the continents and the seas. As a result, they may be able to respond to unfavorable nesting temperatures or inundation of beaches as they have in the past, by seeking out new nesting sites or modifying the seasonality of nesting. It may however take decades or centuries for sea turtles to re-establish and stabilize their habitats, and steadily encroaching human development of coastal areas makes the availability of new habitat for them very limited.

Coastal development will continue to increase which would increase the number of buildings and roads which are lighted at night which may adversely affect nesting and hatching sea turtles. With more development come more residents and tourists which increase recreational use of the beach in the action area and beyond. Increased use of the beach by both beach-goers and their pets may contribute to increased disturbance of nesting sea turtles and turtle hatchlings in the area.

Interrelated and Interdependent Actions — There are no interrelated and interdependent actions associated with this project; therefore there are no anticipated adverse effects to sea turtles from such actions.

Determination — Minimization measures followed by the National Park Service (all nests will be relocated prior to construction) and by the dredging contractor during the project would minimize the likelihood of lethal take on the beach and in nearshore waters; however, there is a likelihood that an incidental take could occur (especially for the loggerhead). Therefore, the proposed action may affect and is likely to adversely affect nesting female sea turtles on the beach or other sea turtles in the nearshore waters. The USACE would initiate formal Section 7 consultation with USFWS for nesting sea turtles and with NMFS for swimming sea turtles. The 1997 SARBO from NMFS is expected to be utilized for any take which may occur and should the 2008 SARBA in review be finalized during the construction, the project would be subject to the terms of the latest SARBO. The National Park Service would issue a Special Use Permit subject to issuance of a USACE permit for the project.

Whales

Direct and Indirect Effects Common among Whales

Noise generated as part of the dredge and pipeline operations would be one direct effect experienced among any whale in the vicinity of the operation within range of its hearing. Short impulsive sounds and nearby high frequency sounds have been documented to be disruptive to many species of marine life including whales, other aquatic mammals, and fishes. However, aside from the occasional normal activity which may create a punctuation noise event at higher or louder frequency such as transit maneuvers or cavitation, most of the noise generated during the dredge and pipeline activity would be continuous and low range. A trailing suction hopper dredge operation is purported to emit sound levels at frequencies below 500 Hz, a level generally parallel to that of a cargo ship traveling at moderate speed [Robinson et al. 2011 (per CEDA Position Paper 7 November 2011) Reine et al. 2014].

As stated by Reine et al. (2014), using the current NMFS threshold, peak source levels did not exceed Level A Criterion (180dB re 1μPa rms) for injury/mortality to marine mammals during any aspect of the dredging operations in the study. However, in this Reine study, noise levels exceeded 120dB, Level B Criterion for harassment, and were measured at this level out to 1.3 miles from the source. While it is acknowledged that smaller support vessels and the pipeline emit higher frequency noise than the dredge and that pipeline noise also increases with size of the aggregate in the pipe, the sand size in Borrow Area C will not be large; in addition higher frequency sound attenuates faster than low frequency. For the dredges in the Reine et al. (2014) study, attenuation distances for noise levels associated with eight different dredge operations among three different dredges ranged from <0.7 mile to 1.7 miles.

Nevertheless, while research has increased in the last decade on the biological effects of marine noise, not enough is known to be able to confidently state a degree of injury with a particular degree of noise for a particular species, especially not on an individual basis. Therefore, an individual whale in close proximity to the dredge operation could experience a temporary hearing loss if exposed for long enough, but this is not thought likely as the whale could move away from the noise source; this noise avoidance could be considered harassment if the noise level exceeded 120 dB. Noise avoidance could affect foraging behavior which could lead to reduced productivity if there were prey in the vicinity of the noise that did not also avoid the noise source. Noises could interfere with communication between whales in the vicinity. There would be an increased risk of collision with a project-associated vessel. Nourishment and renourishment projects targeted for segments of the North Carolina coast that include offshore dredging may pose the potential for indirect effects.

On board marine mammal observers are expected to be a permit requirement which will greatly reduce the potential for collision or other direct interaction with any whales in the area. In addition, if disturbed by the noise associated with the dredge operation, any whale is likely to avoid the project vicinity.

Differences in Direct and Indirect Effects among Whales

As the whale most often recorded in ship strikes and collisions, the finback whale is more susceptible to activities which result in an increase in ocean vessel traffic, addition of a new commercially targeted fishery, or changes in methods or popularity of an existing fishery. None of these effects are expected as a result of the proposed action.

As the most popular whale species targeted for human observation, humpback whales are more susceptible to potential harassment from whale watchers in both their winter and summer congregation areas. Humpbacks generally are further offshore and migrate through in the fall and spring so the whale-watching industry is not as popular or as sophisticated in North Carolina as it is in places like the Gulf of Maine or Baja California. Potential harassment of humpback whales is not likely to increase as a result of the proposed action.

As the whale most likely to utilize the shallower waters within the action area, especially during spring migration, the Northern right whale is the species with the highest likelihood of being in the vicinity of the dredge activity. Although one of the rarest and most critically endangered whales, the species is also a somewhat regular fall and winter visitor to North Carolina waters.

Cumulative Effects Common among Whales

In response to a rise in sea surface temperatures from climate change, recent research has shown that over a 27-year period, finback and humpback whales have adapted their arrival to feeding grounds in the Gulf of St. Lawrence by one day later each year. During the period of the study researchers were surprised to find that, despite following separate migration routes, the two species synchronized their arrival times each year to avoid competing with each other for food (Ramp et al. 2015). As whales have adapted to many other changes in climate in the historic record, this study gives hope that these animals will continue to adapt to the current challenges of climate change, but their response would be affected by the rate of change and how adaptable their food source is to the same challenges. Climate change effects on the North Atlantic right whales is tied to a tiny crustacean, *Calanus finmarchicus*, a key food source. Without dense patches of this zooplankton, female whales are unable to bulk up to prepare for calving, carry a pregnancy to term or produce enough milk. When the concentration of zooplankton is too low, right whales do not feed; such highly concentrated patches often occur where currents converge or at the boundary of water of different densities. Changes of seawater temperature, winds and water currents can affect patch formation of zooplankton (New England Aquarium website www.neaq.org).

Cumulative effects to the finback, humpback, and northern right whales would include the continuation of current threats such as ensnarement in commercial fishing gear, overfishing of prey species for human or animal food sources, and habitat degradation. Noise generated as a result of LaMont-Doherty Earth Observatory's month-long 2014 air gun survey off North Carolina to study the earth's crust may have been disruptive to whales moving through the area. When added to the noise generated by upcoming larger scale seismic testing/surveys in ocean waters from Delaware to Florida (in 2015) as part of oil/gas exploration activities and by pile-driving associated with construction of offshore wind turbine clusters on the western Atlantic continental shelf, noise may be cumulatively detrimental even if it does not cause measureable injury. Once constructed, offshore oil/gas platforms and wind turbines will require vessels to supply operation and/or maintenance personnel and equipment which will increase noise from vessel traffic, facility operations, and will increase potential for ship collisions.

Interrelated and Interdependent Actions — There are no interrelated and interdependent actions associated with this project; therefore there are no anticipated adverse effects to whales from such actions.

Determination — Effects are considered to be insignificant or discountable; therefore, the proposed action may affect, but is not likely to adversely affect any protected whale species with the potential to occur in the project vicinity.

Atlantic Sturgeon

Direct and Indirect Effects

Atlantic sturgeon have been documented in the nearshore marine waters in the vicinity of the action area so the potential exists that one could be foraging or migrating in the waters during the dredge and pipeline activity or during the placement of sediments on the target beach. Their presence is possible throughout the year, so a summer dredge window does not necessarily increase the potential for effect; in fact, results from a recent acoustic study conducted by the Atlantic Cooperative Telemetry Network from February 2012 – May 2014 off of Cape Hatteras indicated numbers are highest in November and March (referenced in CBI 2015). Direct effects could include noise, turbidity, temporary interruption of access to food sources, accidental collision with hopper dredge or support vessels, and potential loss of foraging habitat due to potential changes in prey species habitat as a result of the dredge activity. However, the average incidental take of Atlantic sturgeon during all USACE-authorized dredging projects on the southeast Atlantic coast since 1995 is 0.7/year, and most of those incidental takes associated with dredging occur in inlets or harbors, not offshore (David Bauman, Regional Environmental Specialist, USACE Southeast Division HQ, pers. comm., 4 September 2015). In US Gulf and Atlantic sandy borrow areas studied within BOEM jurisdiction, general faunal recovery (total abundance and biomass) has been shown to vary from 3 months to 2.5 years; however, paucity of long term studies suggest that diversity and dominants composition may take 3.5 years (Michel et al. 2013). No infilling fines in the borrow area and accurate placement of properly sized sediment at Nags Head Beach in 2011 allowed a full suite of species similar to the native beach and offshore zone to recolonize the impact areas within one season and by the second year taxa richness and abundances were similar to controls (CZR 2014).

Indirect effects to Atlantic sturgeon as a result of the project may include changes in the marine nearshore bottom habitats as a result of changes in bathymetry in the Borrow Area C shoal. If those changes in bathymetry occur, the suite of potential prey species might also be altered. However, these effects are not likely due to construction procedures designed to minimize such changes.

Cumulative Effects

Like other species, climate change has the potential to affect the Atlantic sturgeon with changes in temperature of the rivers and oceans or seasonality of these changes. The variations in conditions may affect prey species or timing of sturgeon movements from the ocean into freshwaters. Dams in place in spawning rivers will continue to block the migration of Atlantic sturgeon into their native rivers; although there are efforts to remove some dams or improve the migration pathway by construction of rock ramps at some dams. These rock ramps are considered beneficial. Cumulative effects would also include continued commercial fisheries that use bottom disturbing fishing gear in particular and accidental by catch of all types of commercial fisheries.

Interrelated and Interdependent Actions — There are no interrelated and interdependent actions associated with this project; therefore there are no anticipated adverse effects to the Atlantic sturgeon from such actions.

Determination — Research has shown that the Atlantic sturgeon may be in the action area in higher concentrations during November and March and primarily in proximity to inlets. Although the nearest inlet is ~12 miles from the project area, the dredge activities may result in an incidental take since there is much uncertainty about the habits of the species. Therefore, the proposed action is likely to adversely affect the Atlantic sturgeon. The USACE would initiate formal Section 7 consultation with NMFS for the Atlantic sturgeon. The 2008 SARBO includes the Atlantic sturgeon, but it is unknown whether the 1997 SARBO would be amended or modified to include the Atlantic sturgeon prior to implementation of the proposed project should it be permitted. The National Park Service would issue a Special Use Permit subject to issuance of a USACE permit for the project.

Shortnose Sturgeon

Direct and Indirect Effects — As this species is rarely documented within the aquatic marine habitats of the action area there are no direct effects expected. They are sometimes documented in nearshore marine areas close to inlets but the closest inlet is 12 miles away. There is a remote chance that a shortnose sturgeon on its way between inlets and its estuarine and riverine habitats would be in the area and potentially disturbed by dredging activities but this effect is unlikely. An indirect effect would include a short-term decline in the amount and quality of benthic foraging habitat in the borrow area but this effect is considered insignificant in light of the scale of available nearby similar foraging habitat.

Cumulative Effects — *Refer to cumulative effects for Atlantic sturgeon which would also be considered similar for shortnose sturgeon.* However, climate change effects may affect the shortnose in different ways since more of its life is spent in the shallower waters of rivers, river mouths, and estuaries. These bodies of water may respond to changes in precipitation or temperature more quickly, or with more frequent variation, than the ocean with uncertain effects to the species which use those habitats, including the shortnose sturgeon.

Interrelated and Interdependent Actions —There are no interrelated and interdependent actions associated with this project; therefore there are no anticipated adverse effects to shortnose sturgeon from such actions.

Determination — Effects are considered discountable; therefore, the proposed action may affect, but is not likely to adversely affect the shortnose sturgeon.

Seabeach Amaranth

Direct and Indirect Effects — As this species has not been documented within action area and NPS personnel perform annual surveys, no direct effects are expected to any existing populations. The deteriorated condition of the beach and absence of backshore area free of vegetation with a stable dry beach to sustain the species continues to make the project area unsuitable for seabeach amaranth. The project may increase suitable habitat, but no harmful indirect effects are expected.

Cumulative Effects — Increased storm intensity or frequency could have both adverse and beneficial effects on seabeach amaranth. Often colonizing species on somewhat ephemeral habitats like overwash fans, the seabeach amaranth could benefit from increased events of this type provided there was seed available from a nearby population or dormant seeds exposed by the erosion/deposit. Conversely, larger more frequent storms could wash away or bury established populations. Coastal development and encroachment on habitat by increased human recreational use of the dry beach will continue to have adverse effects on sea beach amaranth.

Interrelated and Interdependent Actions — There are no interrelated and interdependent actions associated with this project; therefore there are no anticipated adverse effects to seabeach amaranth from such actions.

Determination — Effects are considered discountable; therefore, the proposed action will have no effect on this species.

Critical Habitat

The only species with designated critical habitat in the project area is the loggerhead sea turtle. Recent telemetric tracking of juvenile loggerheads indicate that the life history of sea turtles is likely more complex than previously understood (Mansfield et al. 2009, McClellan & Read 2007). Largely as a result of such tracking, Constricted Migratory Corridor Critical Habitat for the northwest Atlantic Ocean loggerhead turtle Designated Population Segment (DPS) was designated by final rule in July 2014 (Fig 9.1). This habitat is designated primarily because of its high use and constricted narrow width (land to west and Gulf Stream to east). The corridor is used by juvenile and adults loggerheads migrating between nesting, breeding, and foraging areas, and because of such high use and narrowness, is more subject to perturbation.

Dredging and sand placement activities could present obstructions to loggerhead turtles in transit through either the surf zone or the offshore borrow area. But as stated in the final rule (CFR # 15725 on 7.10.2014, Comments on Constricted Migratory Corridors, response to comment 73), "…many of the possible impacts associated with dredging and or disposal activities are not expected to occur, or to occur at a level that would affect or modify the essential features of the critical habitat." Additional conservation measures to avoid impacts to this designated corridor are not likely beyond those measures that are typical for projects of this type and which would be in place to protect the species itself.

Interrelated and Interdependent Actions — There are no interrelated and interdependent actions associated with this project; therefore there are no anticipated adverse effects to critical habitat from such actions.

Determination — Effects are considered insignificant; therefore, no critical habitat for any species will be adversely affected by the proposed action.

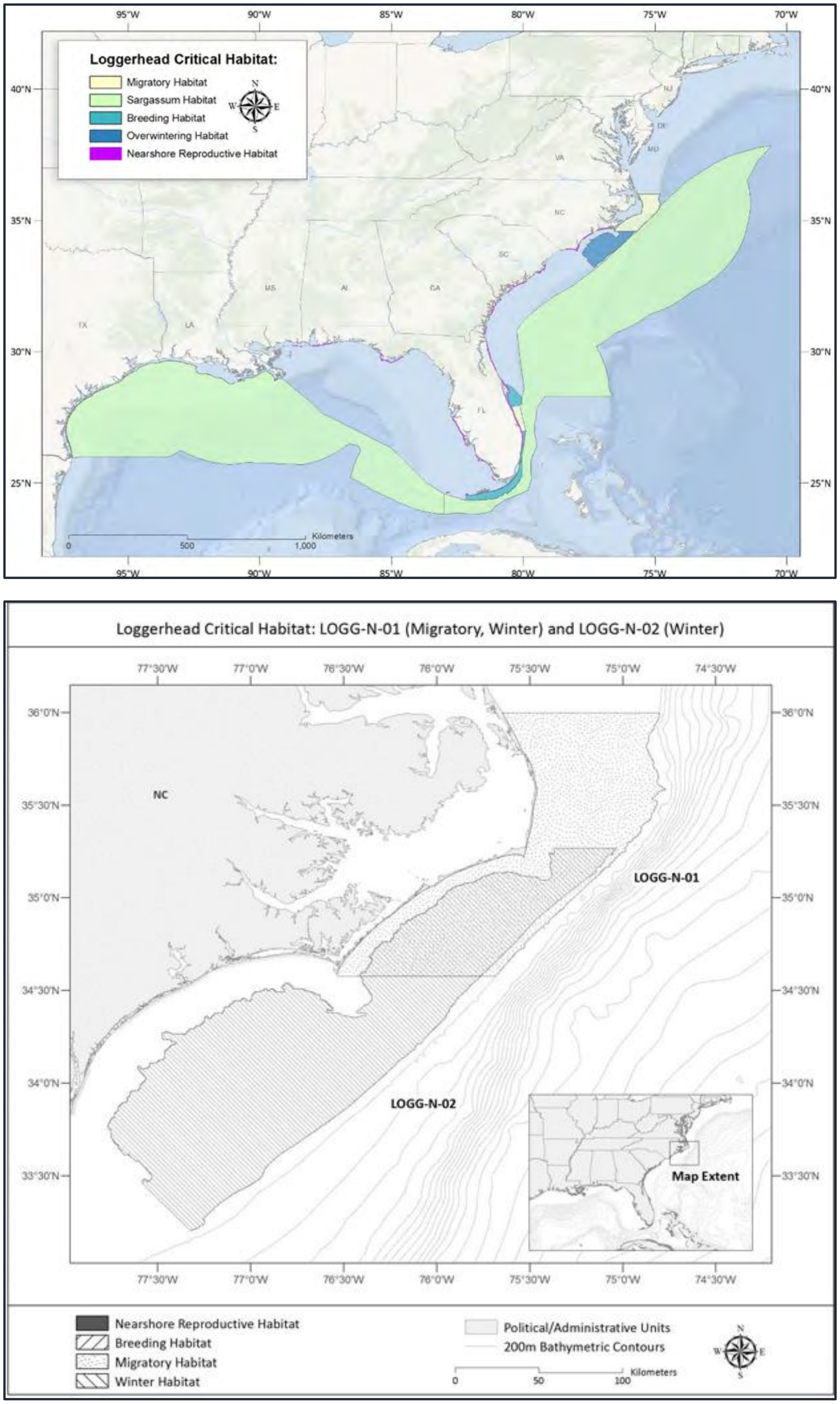

FIGURE 9.1. **[UPPER]** Critical migratory habitat for the loggerhead sea turtle in light yellow. **[LOWER]** Critical migratory habitat designated units for loggerhead sea turtle.

EFFECTS DETERMINATION SUMMARY FOR ESA PROTECTED SPECIES

Of the 14 federally listed species with the potential to occur in the action area or vicinity shown in Table 6.1 (see page 39), evaluation of the effects of the proposed action resulted in a No Effect conclusion for seabeach amaranth, a May Effect, not Likely to Adversely Affect conclusion for eight species (piping plover, roseate tern, rufa red knot, finback whale, humpback whale, north Atlantic right whale, and shortnose sturgeon), and a May Effect, Likely to Adversely Affect conclusion for five sea turtles (Kemp's ridley, green, leatherback, loggerhead, and hawksbill) and Atlantic sturgeon. As mentioned previously, the 1997 SARBO from NMFS is expected to be utilized for the sea turtles. Section 7 consultation will be initiated and USFWS and NMFS will respond with their Biological Opinion and Incidental Take Statement(s) as applicable (USFWS- species on land; NMFS-species in water). Table 10.1 is a summary of the effects determination for those 14 species.

TABLE 10.1. Summary effects determination of proposed action by species with potential to occur in project area or vicinity.

SPECIES COMMON AND SCIENTIFIC NAME	FEDERAL STATUS	DETERMINATION
BIRDS		
Piping plover (*Charadrius melodus*)	T	MAY AFFECT, NOT LIKELY TO ADVERSELY AFFECT
Roseate tern (*Sterna dougallii dougallii*)	E	MAY AFFECT, NOT LIKELY TO ADVERSELY AFFECT
Red knot (*Calidris canuta rufa*)	T	MAY AFFECT, NOT LIKELY TO ADVERSELY AFFECT
FISHES		
Atlantic sturgeon (*Acipenser oxyrinchus*)	E	MAY AFFECT, LIKELY TO ADVERSELY AFFECT
Shortnose sturgeon (*Acipenser brevirostrum*)	E	MAY AFFECT, NOT LIKELY TO ADVERSELY AFFECT
FLOWERING PLANTS		
Seabeach amaranth (*Amaranthus pumilus*)	T	NO EFFECT
MAMMALS		
Finback whale (*Balaenoptera physalus*)	E	MAY AFFECT, NOT LIKELY TO ADVERSELY AFFECT
Humpback whale (*Megaptera novaeangliae*)	E	MAY AFFECT, NOT LIKELY TO ADVERSELY AFFECT
North Atlantic right whale (*Eubalaena glacialis*)	E	MAY AFFECT, NOT LIKELY TO ADVERSELY AFFECT
REPTILES		
Green sea turtle (*Chelonia mydas*)	T	MAY AFFECT, LIKELY TO ADVERSELY AFFECT
Hawksbill sea turtle (*Eretmochelys imbricata)*	E	MAY AFFECT, LIKELY TO ADVERSELY AFFECT
Kemp's ridley sea turtle (*Lepidochelys kempii*)	E	MAY AFFECT, LIKELY TO ADVERSELY AFFECT
Leatherback sea turtle (*Dermochelys coriacea*)	E	MAY AFFECT, LIKELY TO ADVERSELY AFFECT
Loggerhead sea turtle (*Caretta caretta*)	T	MAY AFFECT, LIKELY TO ADVERSELY AFFECT

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