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

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BIOLOGICAL ASSESSMENT

CAPE HATTERAS NATIONAL SEASHORE

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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.

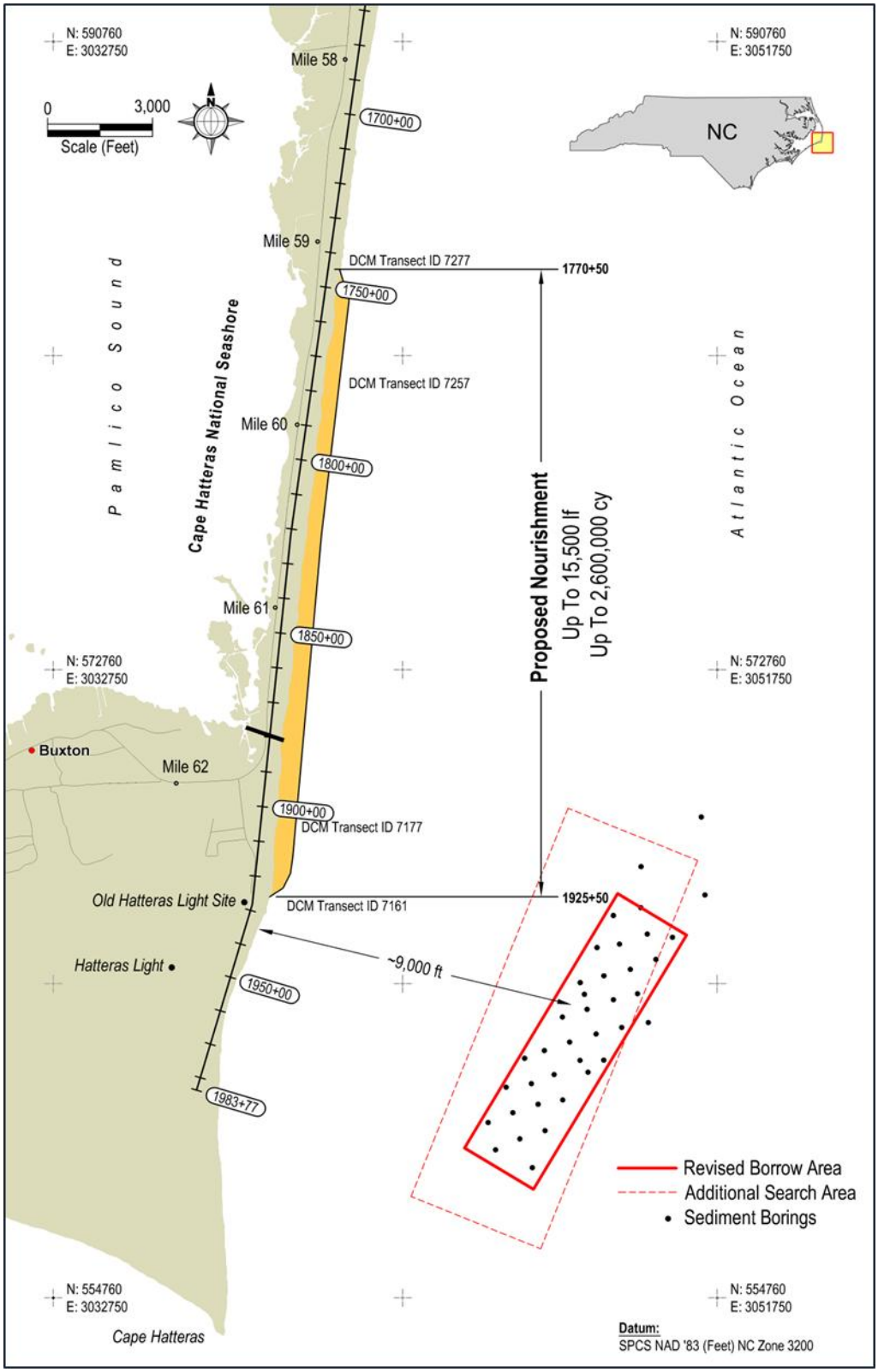

FIGURE 1.1. The project area for beach restoration to protect NC Highway 12 at Buxton, Dare County (NC), showing maximum limit of beach nourishment and proposed offshore borrow area within state waters near Cape Hatteras. A 2013 feasibility study for the project referred to portionsof the offshore sand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

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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.

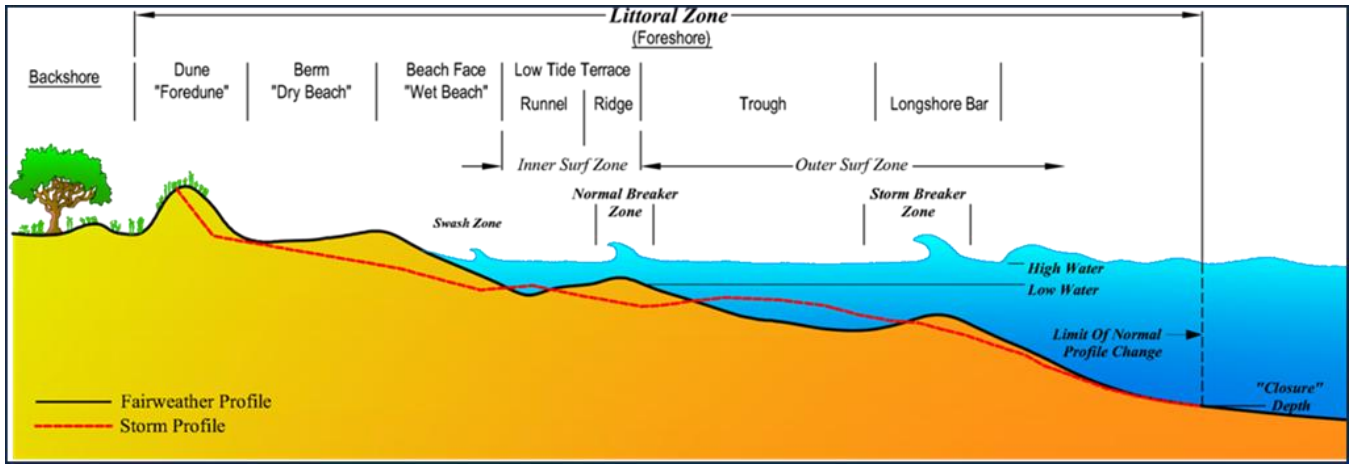


FIGURE 3.1. Representative profile of the littoral zone illustrating the principal features between the dune and offshore. Areas identified include the foredune, dry beach, wet beach, low tide terrace, trough, and longshore bar. The profile varies with changes in wave energy, the passage of storms, and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

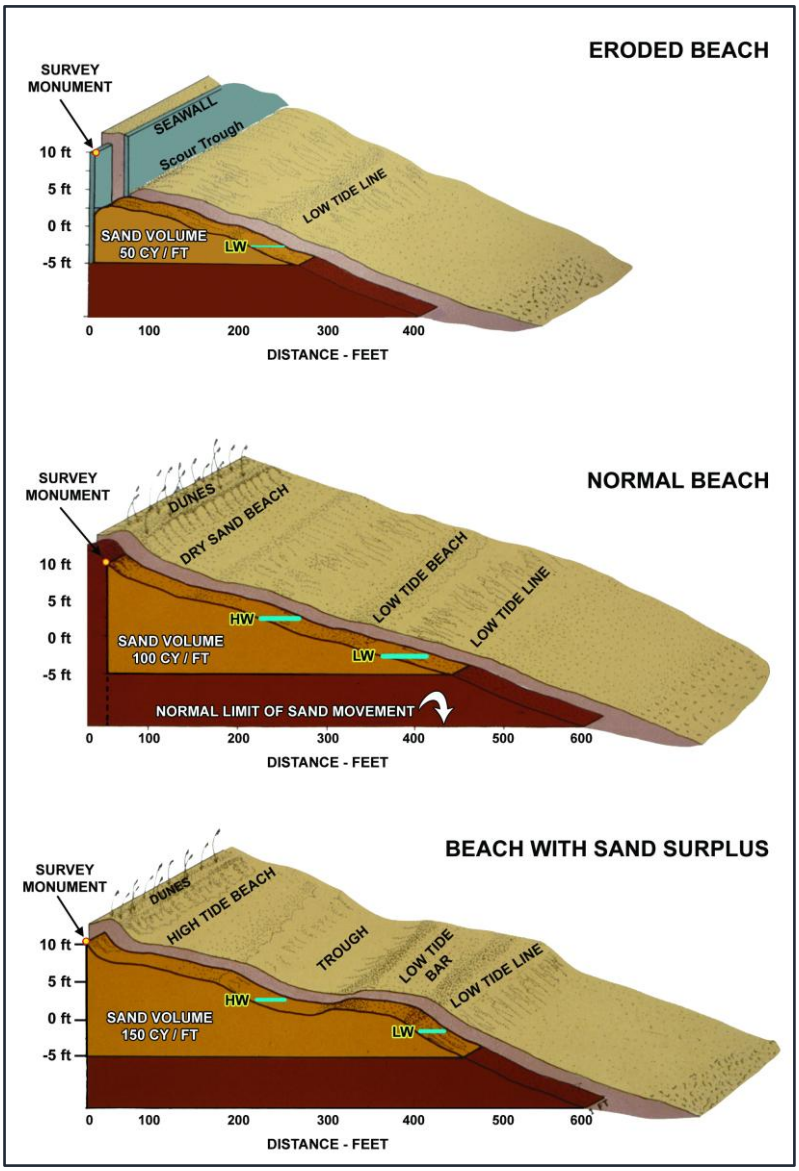


FIGURE 3.2

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.

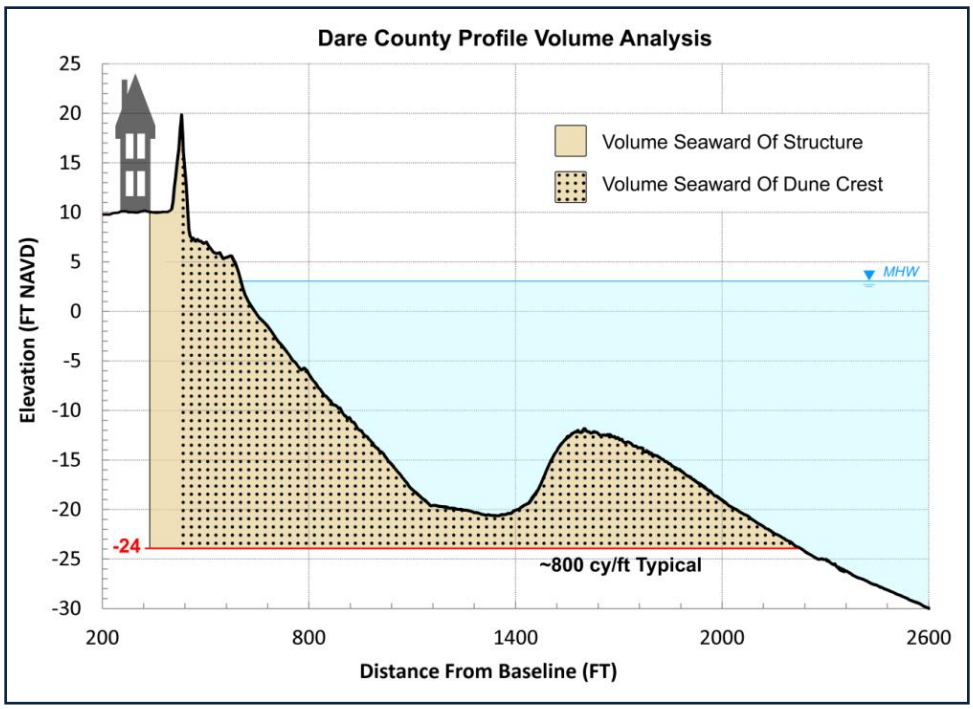


FIGURE 3.3. Illustration of the two lenses used in the profile volume analysis for Buxton. The first volume quantifies sand contained between the approximate foredune crest and –24-ft NAVD. The second calculates the volume between the seaward most structure (buildings or road) in the vicinity of the 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).

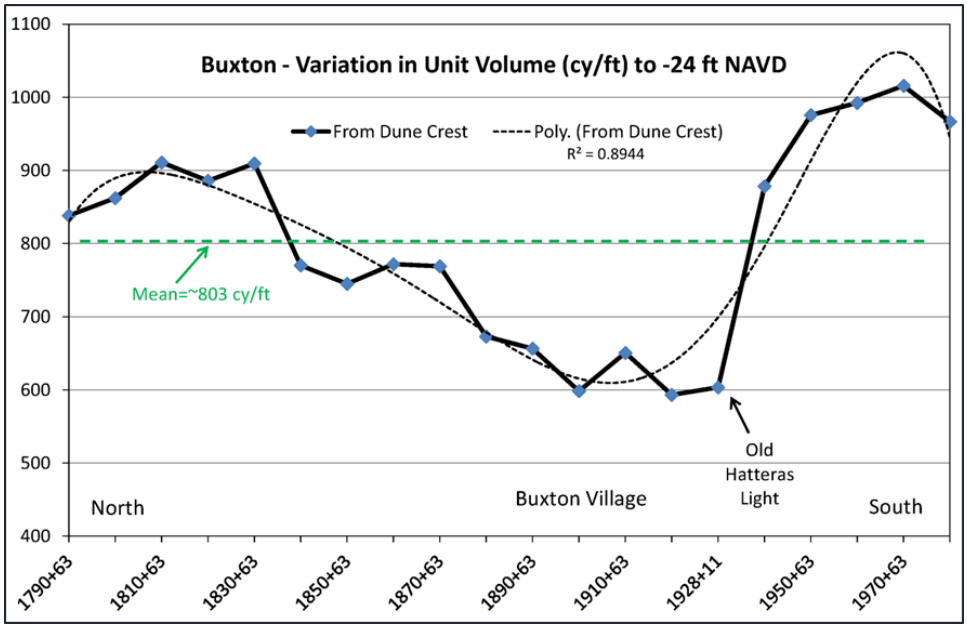


FIGURE 3.4. Profile volumes by station in the **Buxton** area in August 2013 computed to –24 ft NAVD relative to the foredune crest (from CSE 2013).

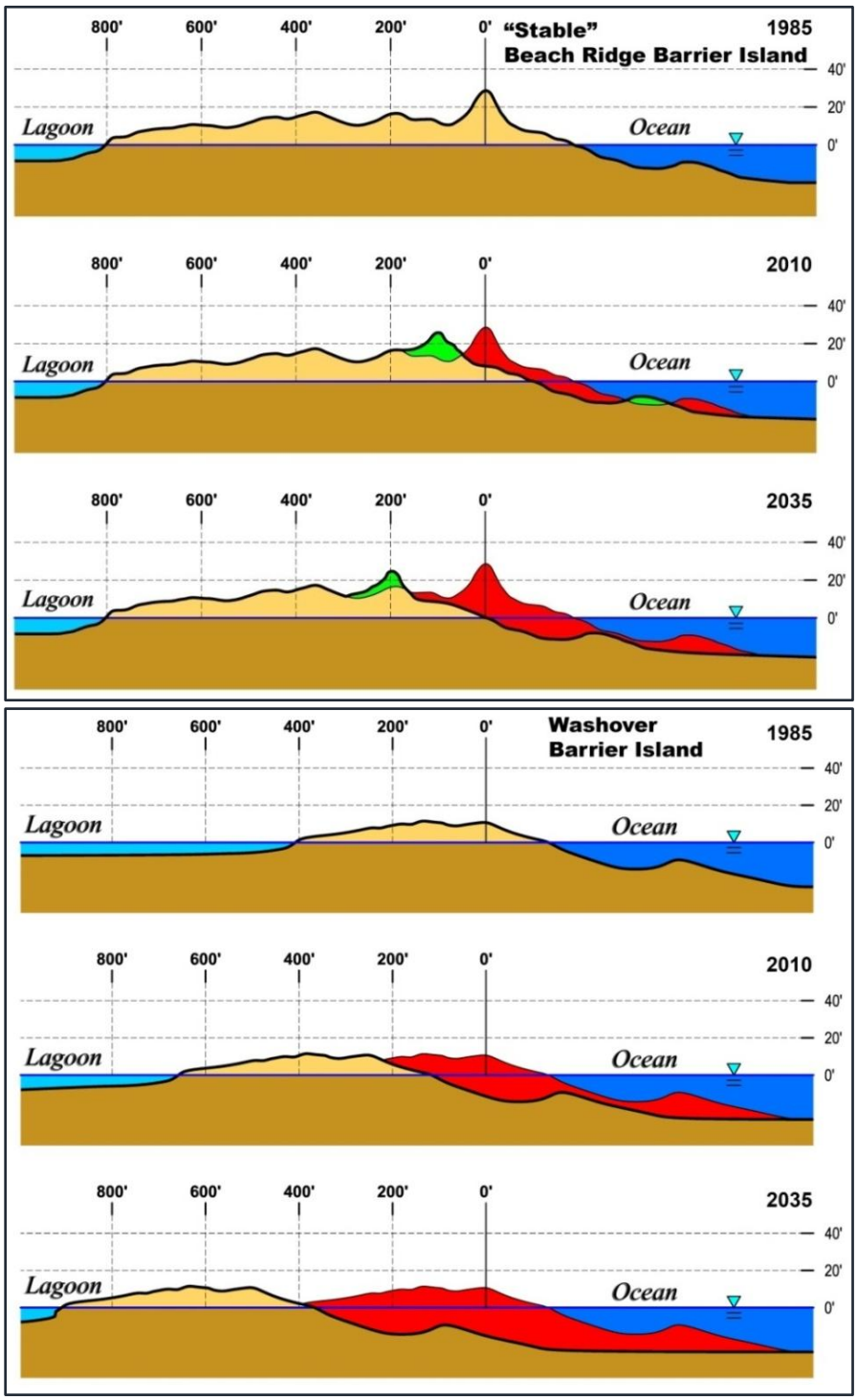


FIGURE 3.5. Illustration of two types of barrier-island cross-sections. A "stable" beach ridge barrier island (Hayes 1994) is likely to retain sand in the littoral zone with little volume lost to washovers (shown in red). Net erosion rates tend to be lower. The other barrier beach (lower panel) lacks 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.

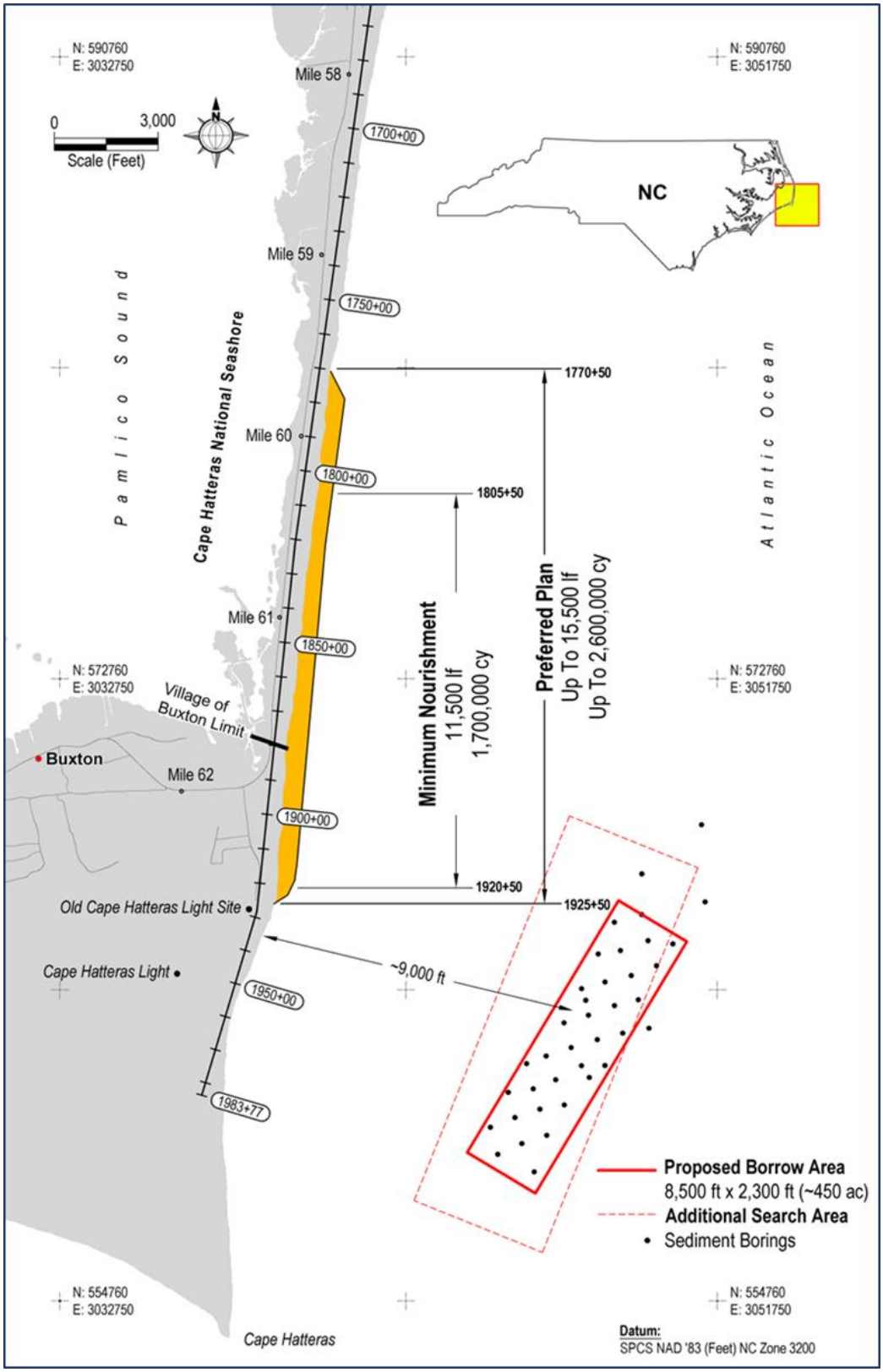


FIGURE 3.6. The project area showing the range of nourishment volumes considered viable for the project under the applicant-proposed action (Alternative 3–Summer Construction) and offshore borrow area.

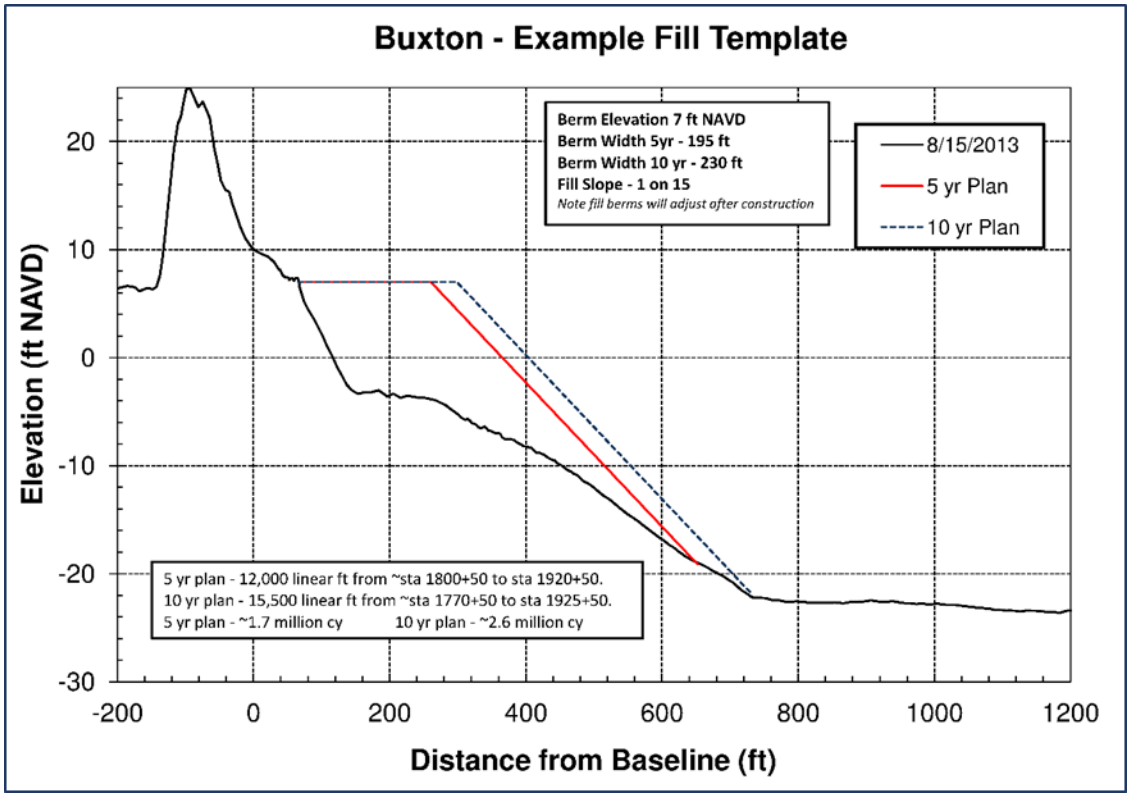


FIGURE 3.7. Representative beach nourishment fill template superimposed on a representative profile before profile adjustment. Highway NC 12 is positioned immediately adjacent to the foredune which was pushed up after the dunes breached in some areas during Hurricane *Irene* (27 August 2011) and Hurricane *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**

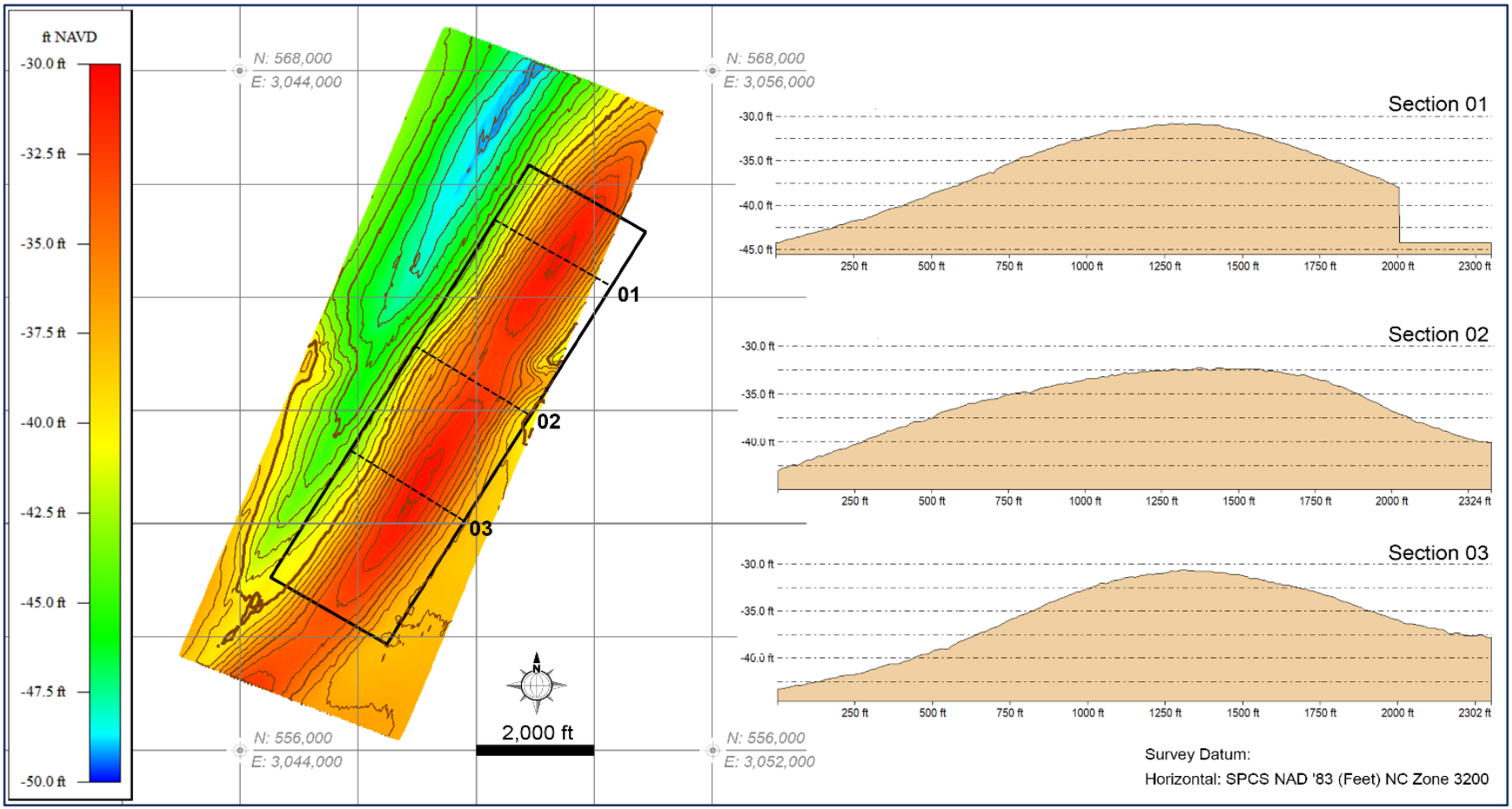


FIGURE 3.8. Bathymetry and cross sections (September 2014) through the proposed borrow area (black outline) offshore of Buxton based on field data collection by CS in August 2013 and October 2014. (See Fig. 1.1 for location of sand search area.)

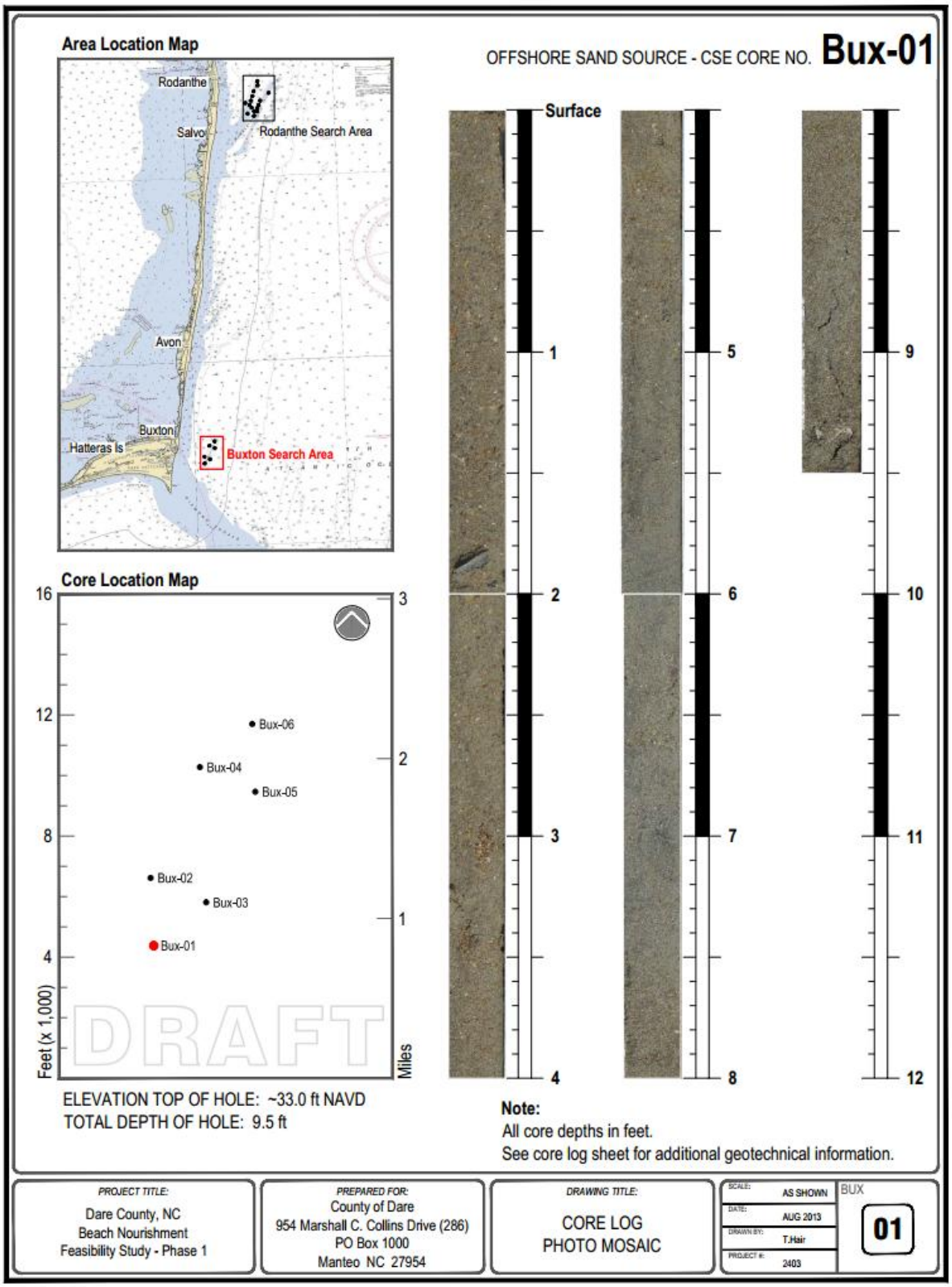
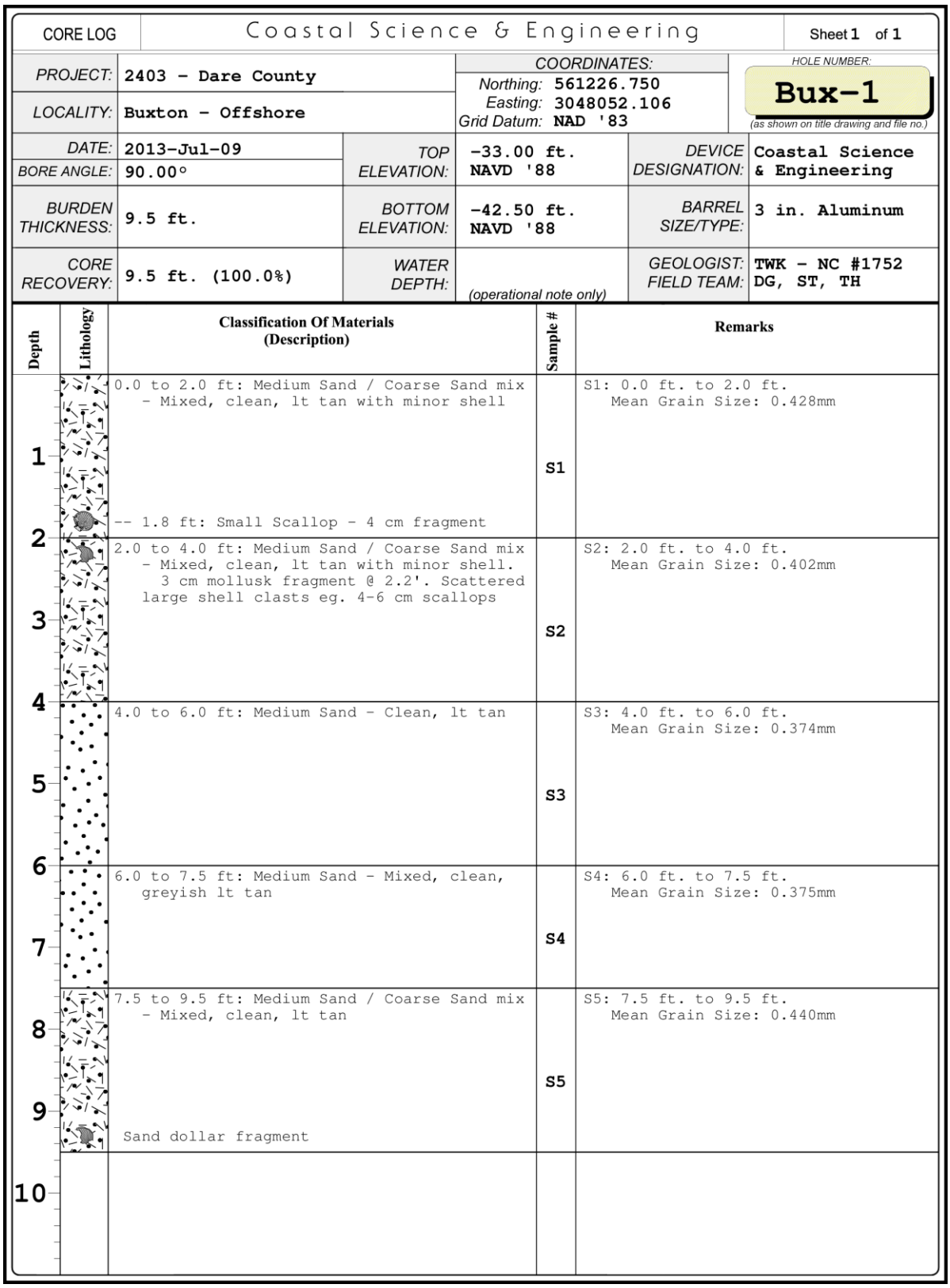


FIGURE 3.9a. Representative core photo log from Boring Bux-01 in the center east edge of the proposed borrow area.



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	Lithology	Classification Of Materials (Description)	Sample #	Remarks
1–2		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		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
8–9		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.

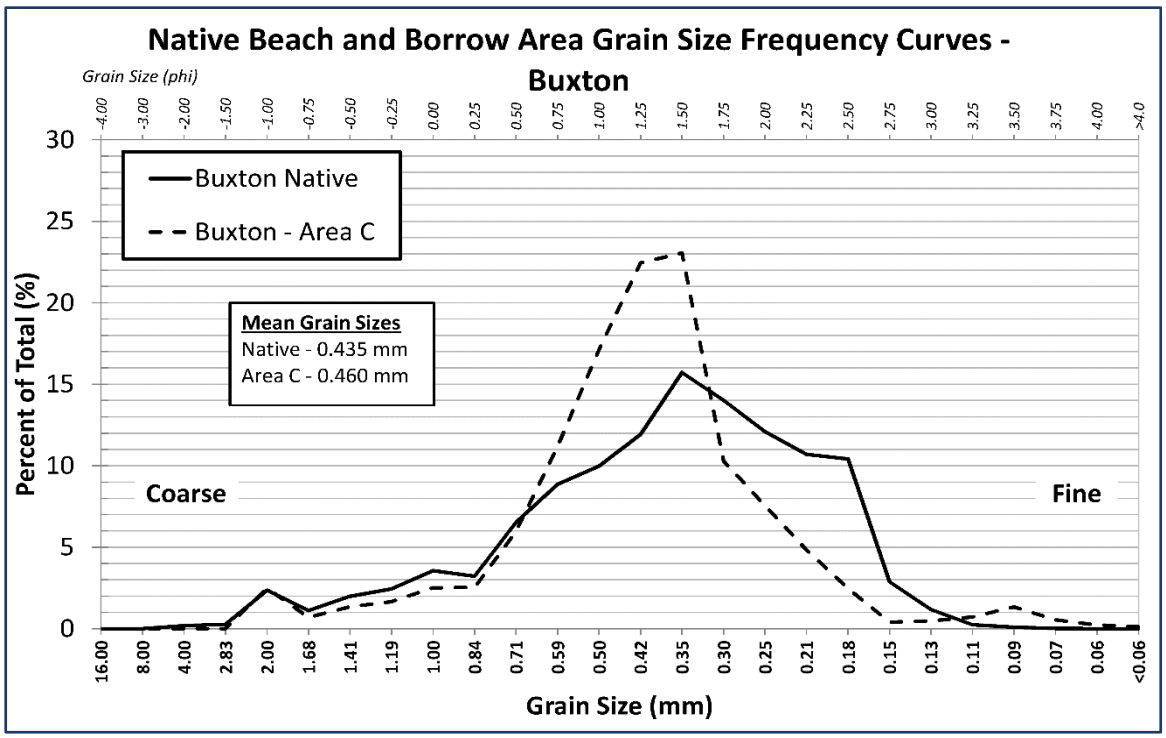


FIGURE 3.10. Preliminary comparison of mean grain-size distributions for Buxton native beach sand and the proposed borrow area. Results composited from Phase 1 samples (CSE 2013). (Detailed results in CSE 2015 Geotechnical Report.)

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.]

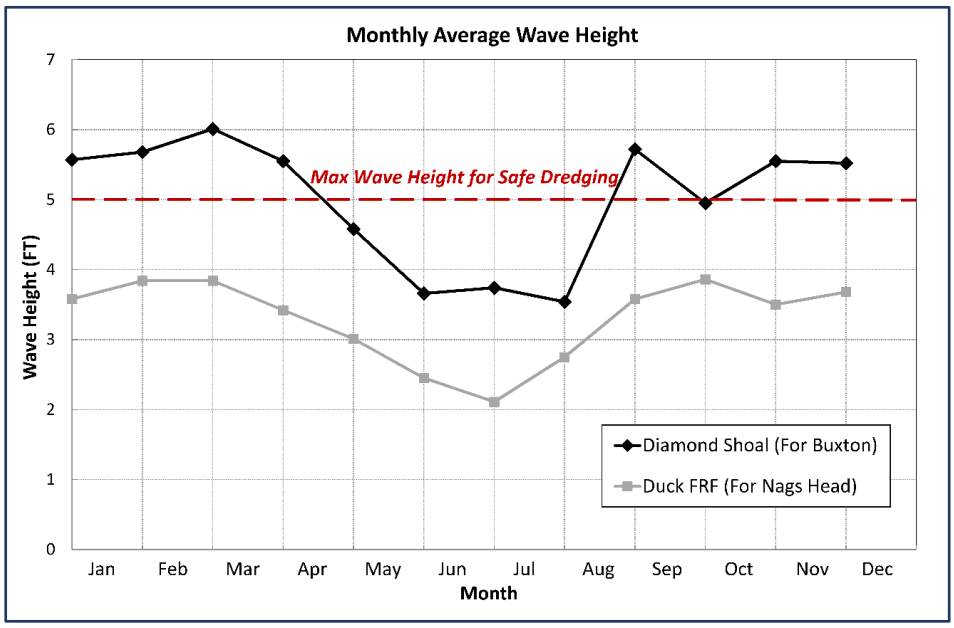


FIGURE 3.12. Monthly average wave climate 2003 through 2013 at NDBC wave buoy Station 4 1025 at Diamond Shoals (NC) compared to wave climate at the USACE FRF at Duck (NC). Safe dredging criteria apply to hopper dredge operations with ocean certified equipment per informal guidance by dredging companies. 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.]

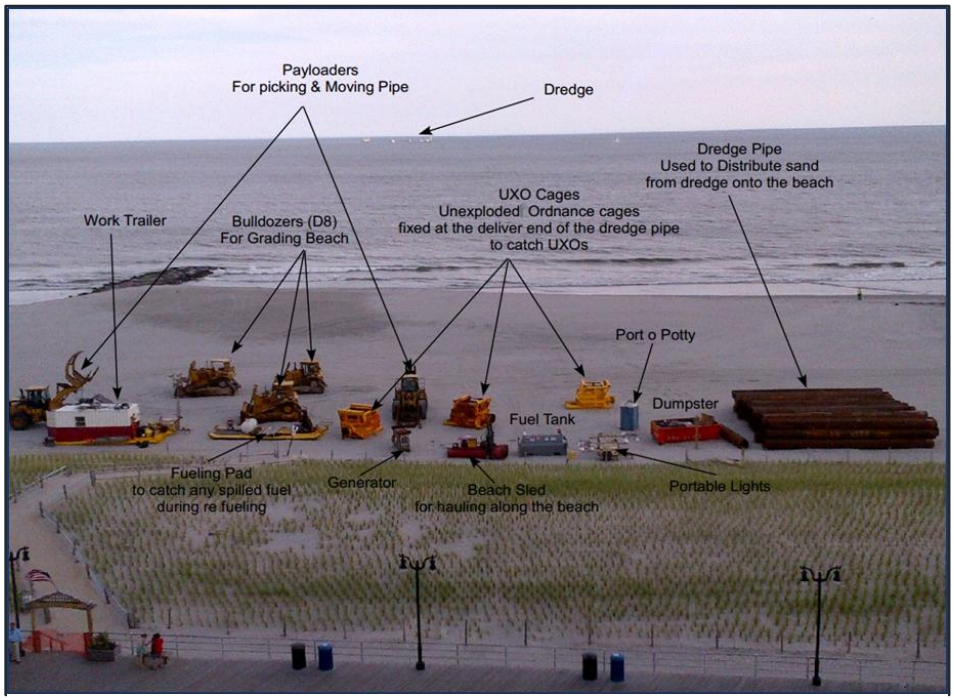


FIGURE 3.13. Types of land-based support equipment generally required for beach nourishment construction. [Photo annotations courtesy of J Lignelli and First Coastal Corp of New York.}

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).

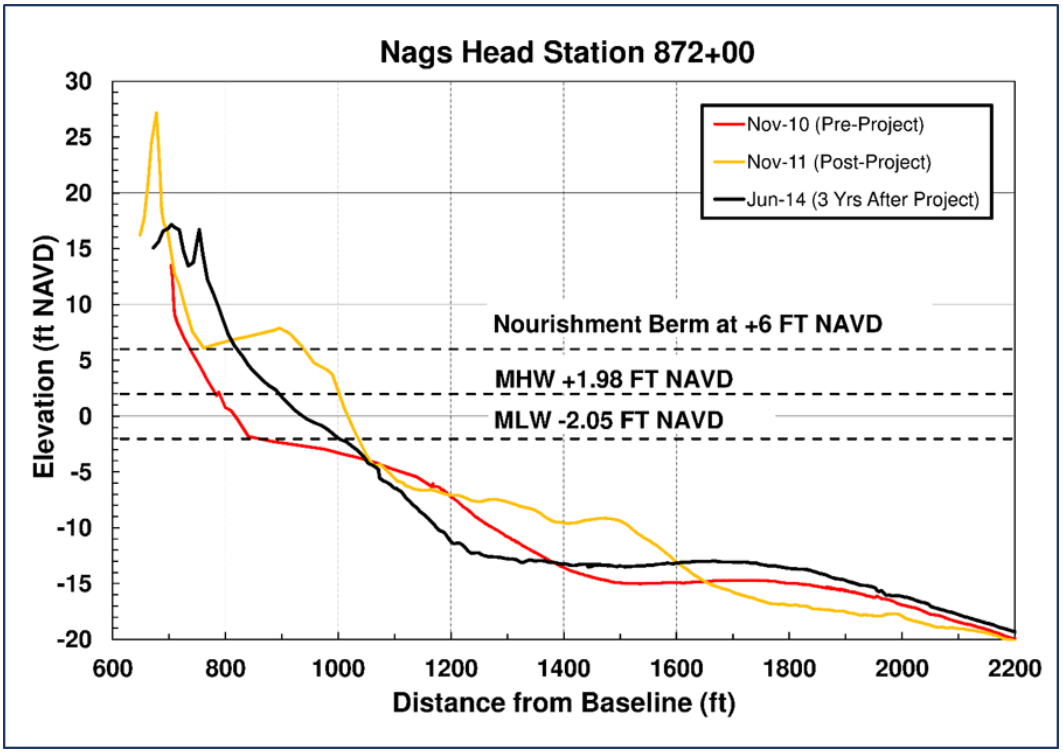


FIGURE 3.14. Pre- and post-nourishment profiles from a station in south Nags Head ~900 ft south of Jennette's Pier (Whalebone Junction) showing fill adjustment after three years. Note ~20:1 vertical exaggeration. No sand was placed above the +7-ft NAVD contour. Natural profile adjustment by Year 3 included 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).

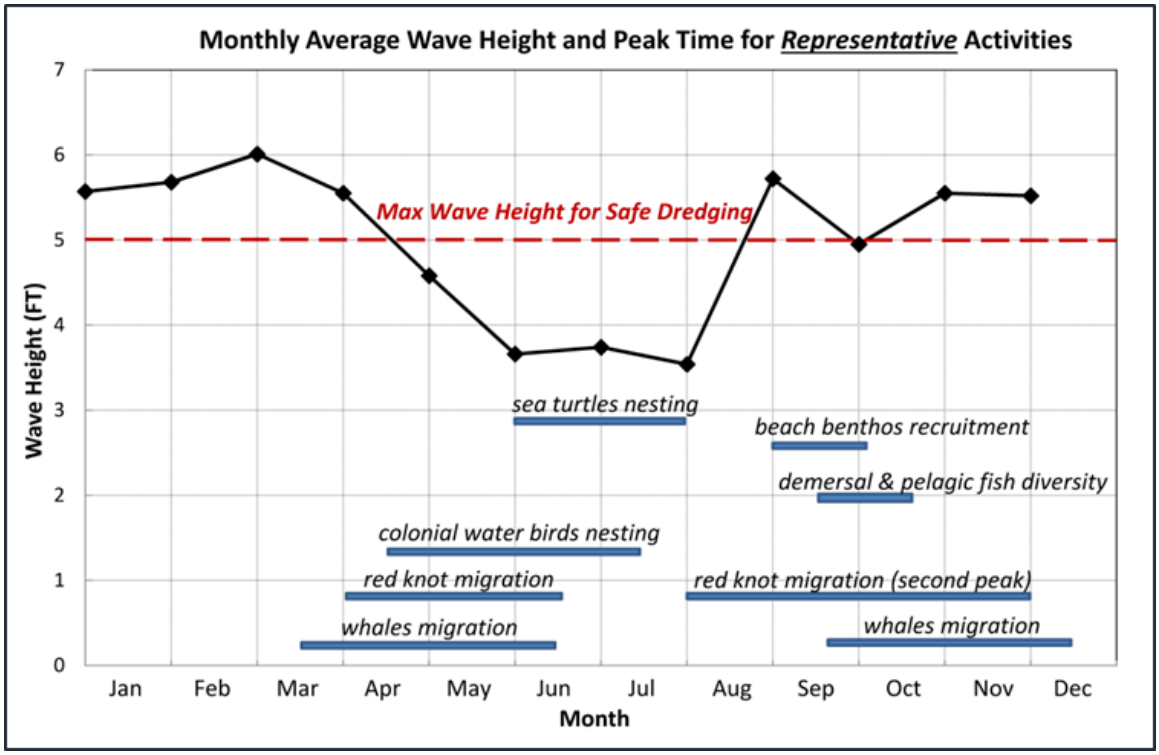


FIGURE 3.16. Graph showing the monthly average wave climate from 2003–2013 at NDBC Wave Buoy Station 41025 at Diamond Shoals (NC) near Buxton compared with the wave climate at the USACE Field Research Facility at Duck (NC). The criteria for safe dredging apply to hopper-dredge operations using ocean-certified 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).

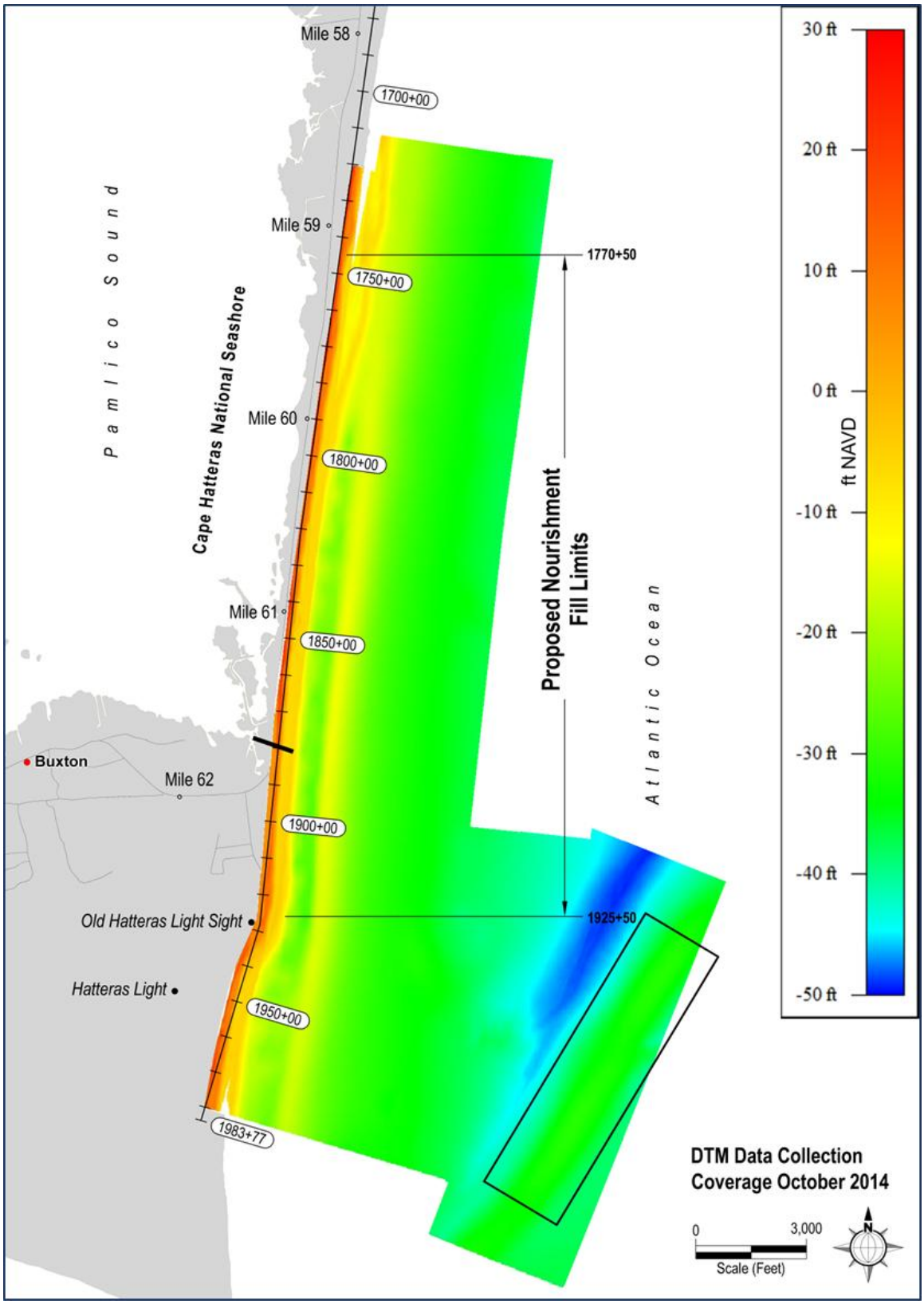


FIGURE 4.1. Digital terrain model (DTM) showing topography and bathymetry in the project area in October 2014.

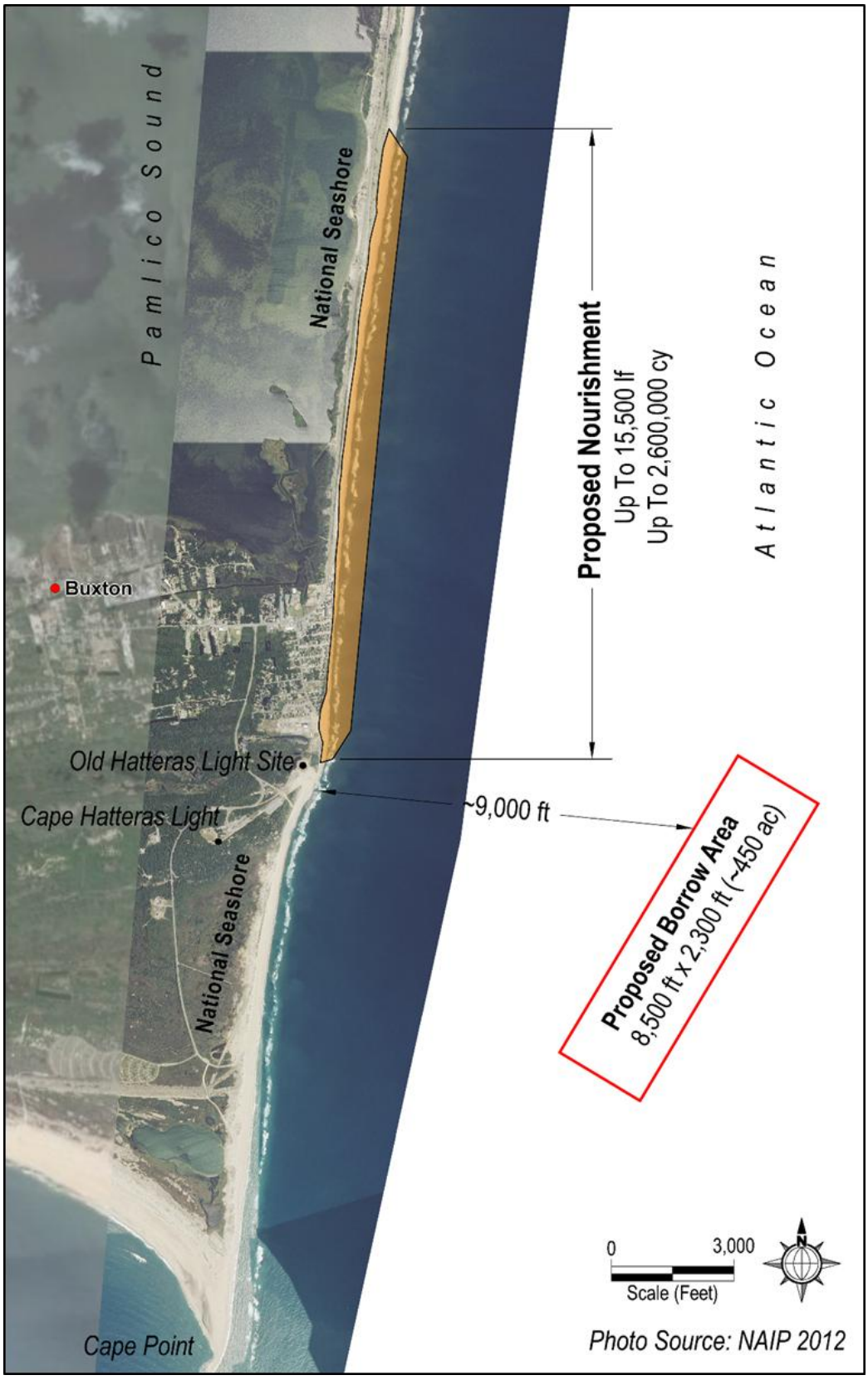
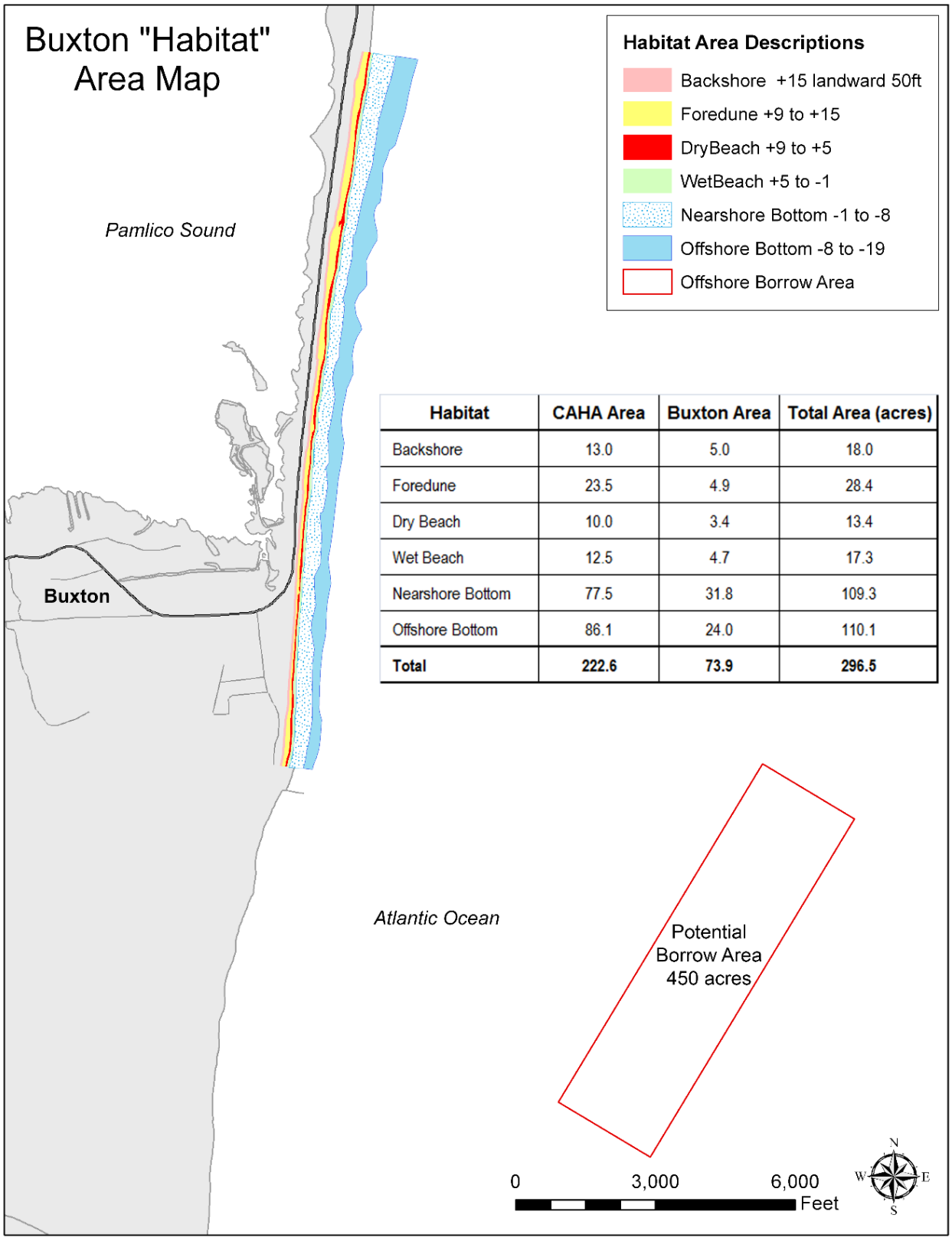
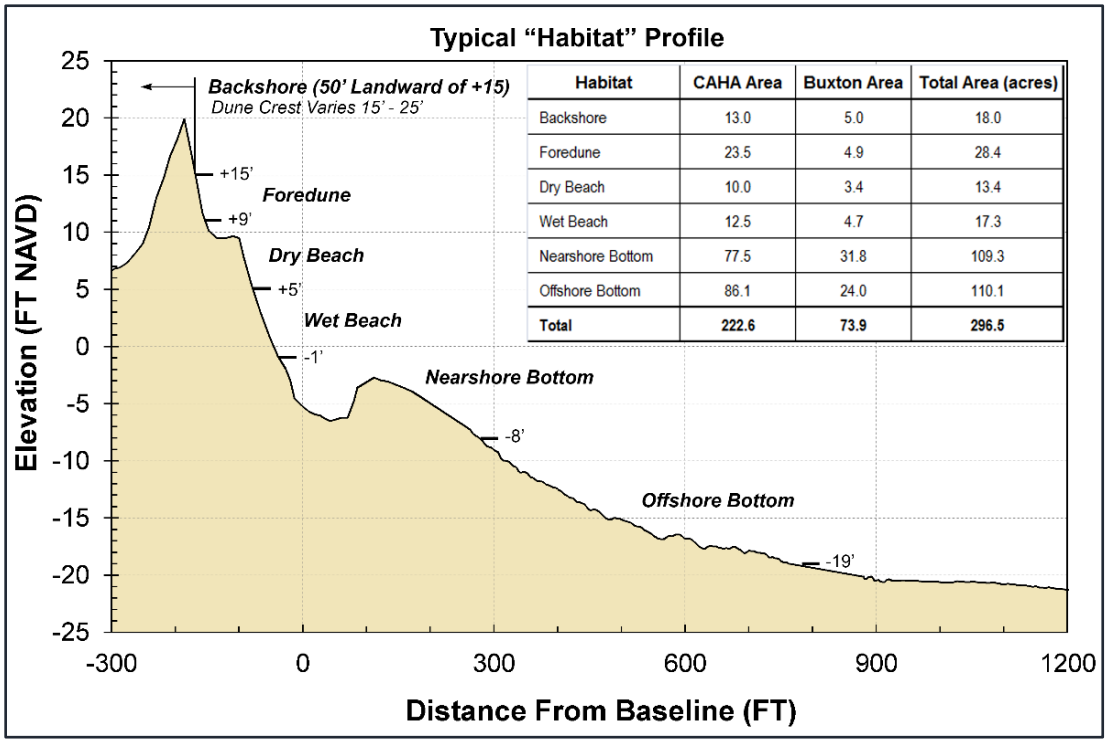


FIGURE 4.2. Aerial photo of the project area (2013).



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.



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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 4.4. 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.

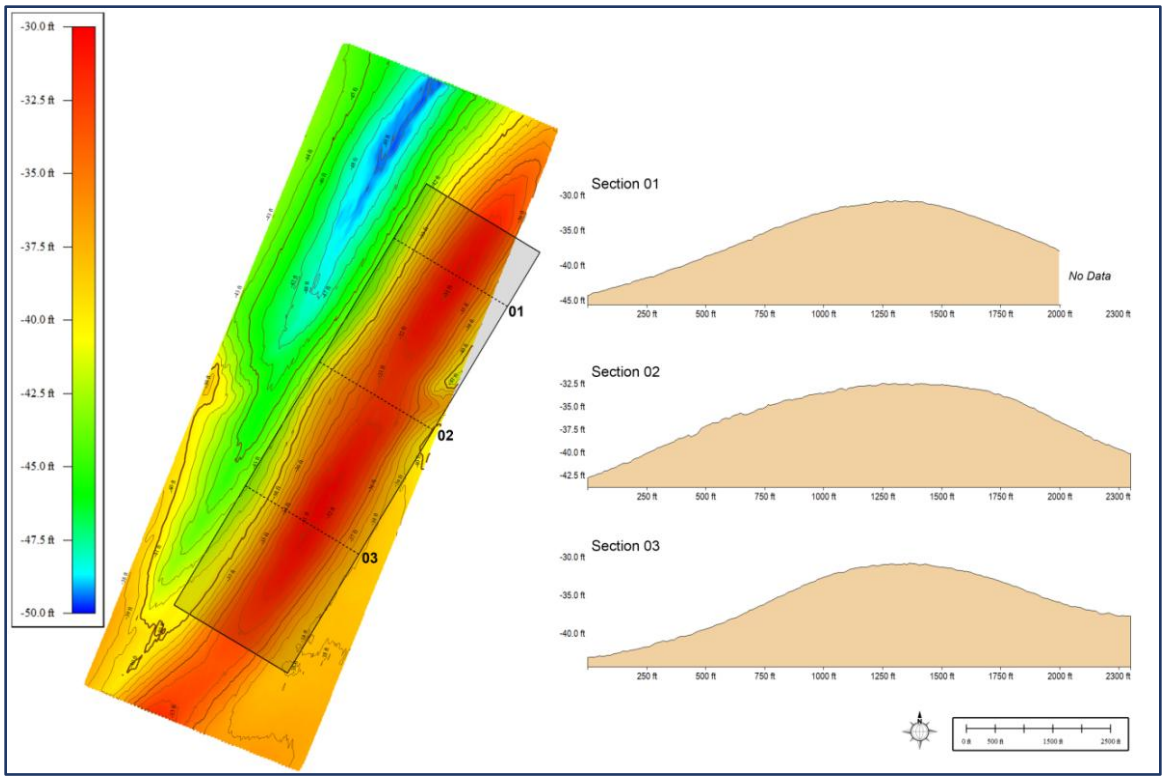

FIGURE 4.5. Detailed borrow area bathymetry and representative sections based on condition surveys in October 2014. Depths are in feet NAVD'88.

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**	

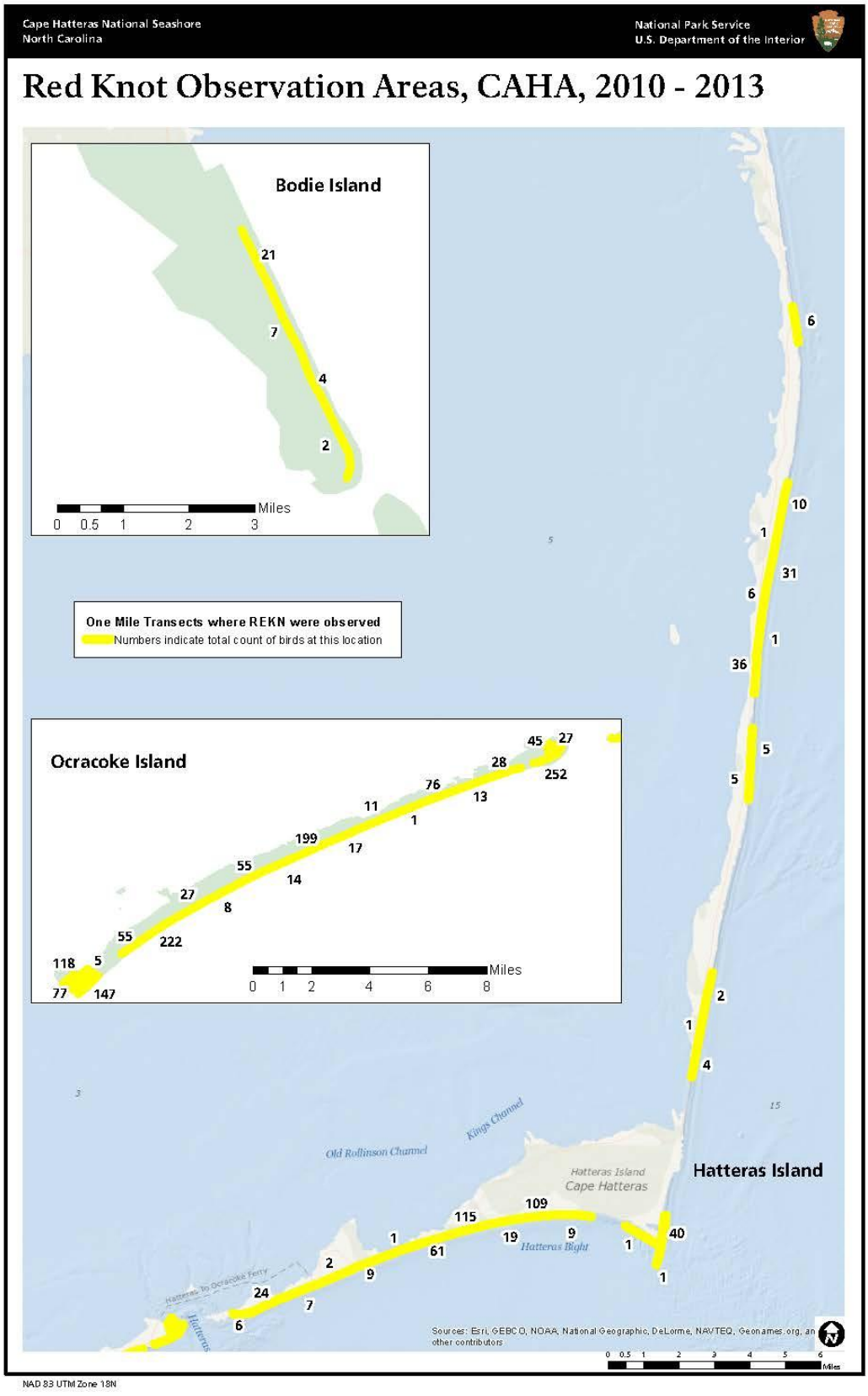

FIGURE 7.1. Summary of red knot observations in Cape Hatteras National Seashore 2010–2013.

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