4.0 AFFECTED ENVIRONMENT

4.1 What is the Environmental Setting of the Project?

The Permit Area, based on the area of potential secondary and cumulative effects, is comprised of 1,655 acres (ac) and includes portions of Holden Beach and Oak Island on the coast of southeastern NC in Brunswick County (Figure 4.1). The barrier islands of Holden Beach (eight miles long) and Oak Island (12 miles long) are located west of Cape Fear and have an east-west orientation, facing Long Bay and the open Atlantic Ocean to the south, and separated from mainland Brunswick County to the north by tidal marshes and the AIWW. Holden Beach and Oak Island are separated by the LFI. The west end of Holden Beach is separated from Ocean Isle Beach by Shallotte Inlet. The Town of Oak Island is bordered to the east by Caswell Beach and to the north in part by the town of St. James.

The relatively narrow subaerial ocean beach along the eastern end of Holden Beach is backed by a narrow line of low vegetated foredunes and wide interior parabolic dunes that protrude northward towards the AIWW (Figure 4.1). The majority of the interior dunes have been fully or partially developed for residential use. A few of the relatively undisturbed interior dunes on the extreme eastern end of the island continue to support patchy areas of maritime shrub and forest vegetation. The interior dunes are backed by a narrow fringe of tidal marsh that separates the island from the AIWW (Figure 4.1). Prior to construction of the AIWW in the 1930s, Holden Beach was accessible from the mainland at low tide via a continuous expanse of intertidal marsh (Cleary 2008). Construction of the 12-ft-deep by 90-ft-wide AIWW channel divided the marsh into a southern component regarded as part of the island of Holden Beach and a northern component associated with the mainland. The AIWW extends east across LFI and behind the west end of Oak Island where it crosses the Lower Lockwoods Folly River. The west end of Oak Island is backed by a narrow fringe of tidal marsh that separates the island from a waterway known as the Eastern Channel. A spoil island-marsh complex known as Sheep Island lies between the Eastern Channel and the AIWW to the north. The Lower Lockwoods Folly River estuary to the north of the AIWW contains an expansive estuarine complex of marsh islands, sandy shoals, shellfish beds, and tidal creeks (Figure 4.1) (Photos 4.1 and 4.2). Appendix I provides an historical overview of Lockwood Folly Inlet and associated habitats from the 1930s to the present.

The embayed section of the Atlantic Ocean overlying the continental shelf between Cape Fear, NC, and Cape Romain, SC, is known as Long Bay. The marine component of the Permit Area encompasses the subtidal ocean bottom (benthic) and ocean water column (pelagic) habitats and communities that occur seaward of the

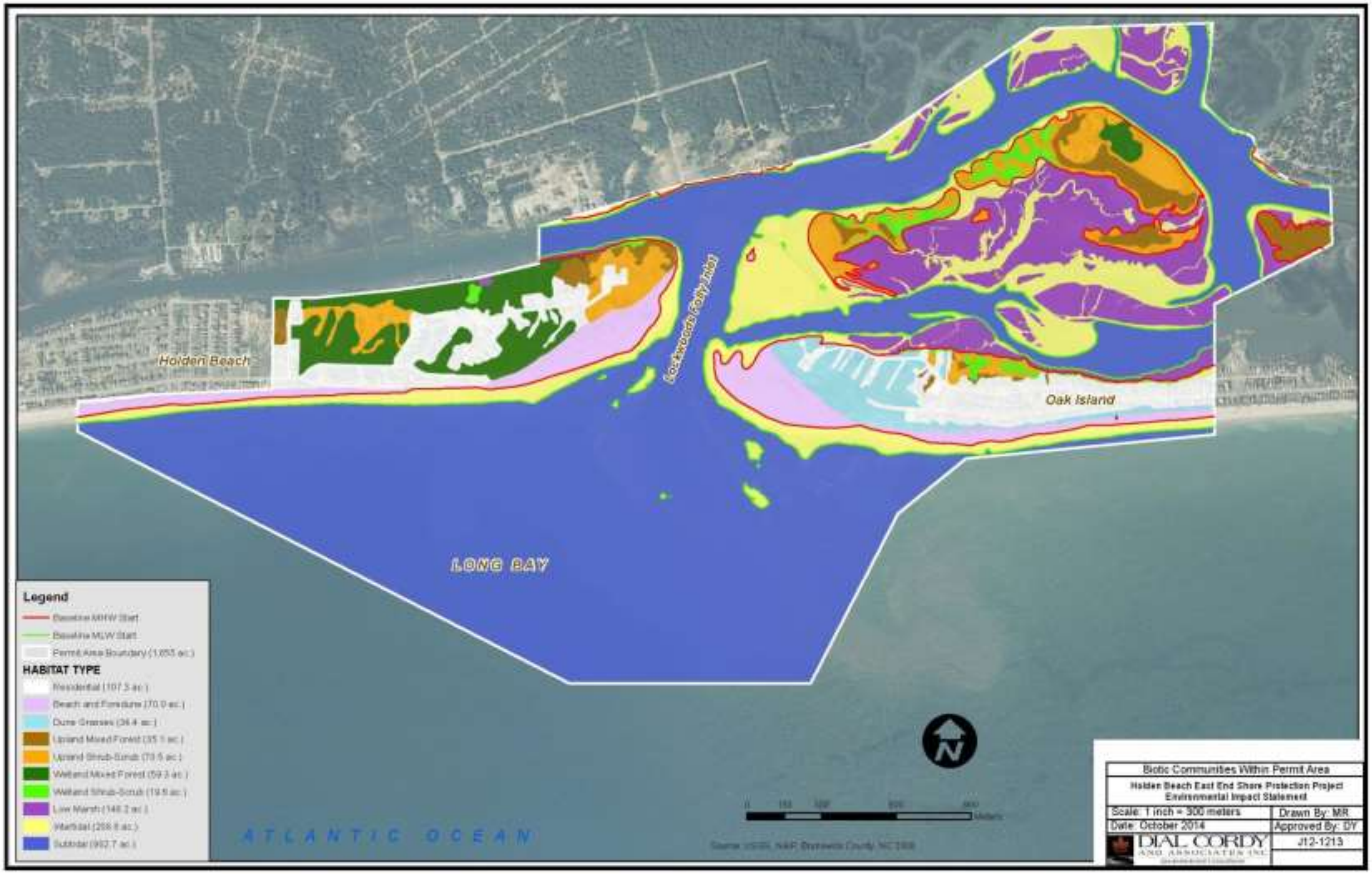


Figure 4.1. Biotic Communities within the Permit Area

Photo 4.1. View of tidal marsh along Eastern Channel, Oak Island, NC.

Photo 4.2. View to the north of Eastern Channel and LFI flood shoal system.

intertidal ocean beach to approximately the 40-ft isobath on the inner continental shelf of Long Bay (Figure 4.1). The subtidal seafloor extends below the low-tide line as a relatively steep, seaward-sloping surface known as the shoreface. Approaching onshore waves break as they interact with the shoreface forming the nearshore surf zone. The shoreface eventually flattens and matches the gentle slope of the inner continental shelf. The shoreface and inner shelf along Holden Beach contain underlying ancient hard strata (sandstones and limestones) that are covered by a thin and discontinuous veneer of modern sand. The hard strata are frequently exposed on the shoreface and inner shelf forming extensive benthic hardbottom habitats (Marden et al. 1999).

The Permit Area includes a variety of biotic community types and sizes. Visual interpretations of biotic community types were digitally mapped using ArcView 9.3 software over high-resolution georeferenced digital multispectral aerial photographs as part of the initial pre-construction assessment of biotic communities. The methods employed for interpretation of aerial photography included visual analysis of color variations in the photographs to delineate habitats (dark areas = submerged land; white areas = sediment exposed above high tide line). Resolution of this imagery (< 2 ft) allowed for adequate delineation of the habitats and features within the Permit Area. These habitat types are summarized in Table 4.1 and depicted in Figure 4.1. Additional details about the marine, beach and dune, and inlet and estuarine communities are included in Sections 4.2-4.4. Residential community acreages were calculated to take into account all possible community types within the Permit Area.

Table 4.1. Biotic communities in the Permit Area.

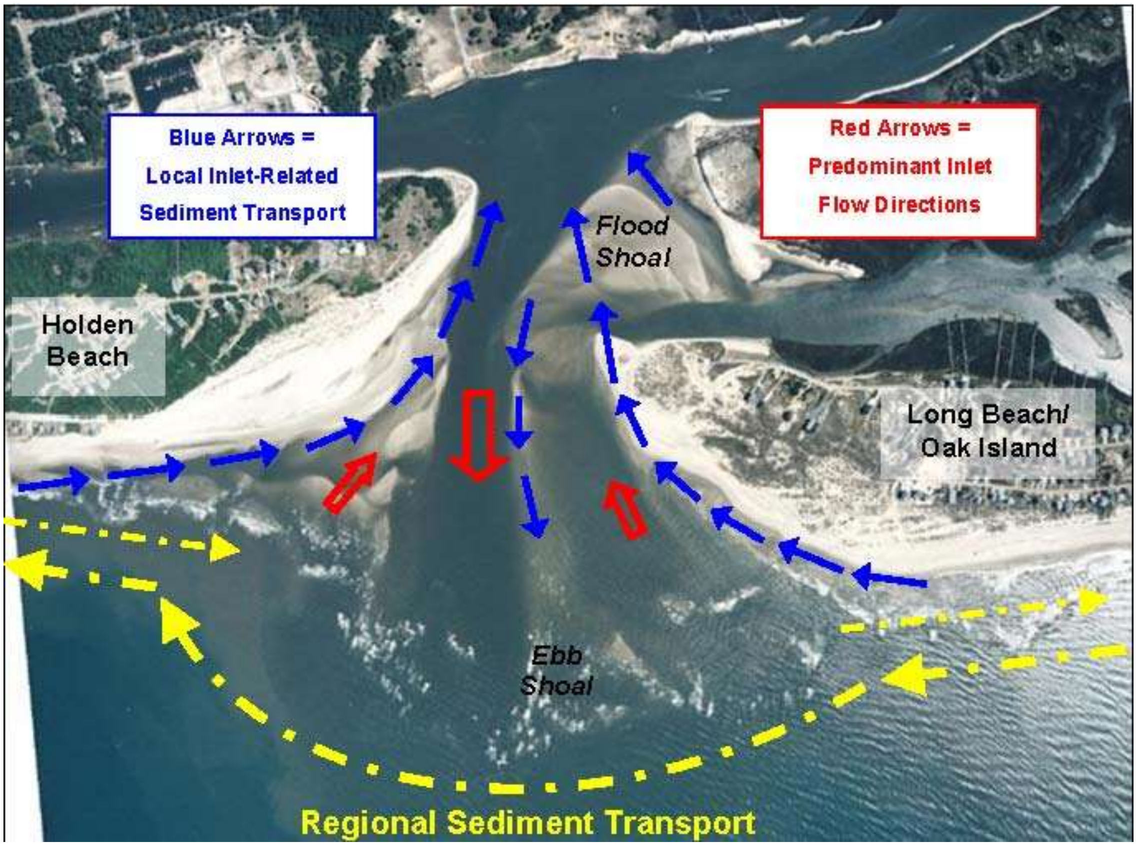
Habitat Type	Size (ac)
Residential	107.3
Beach and Foredune	70.0
Dune Grasses	34.4
Upland Mixed Forest	35.1
Upland Shrub-Scrub	70.5
Wetland Mixed Forest	59.3
Wetland Shrub-Scrub	19.6
Low Marsh	148.2
Intertidal	208.8
Subtidal	902.7

The majority of the oceanfront beach on Holden Beach has experienced long-term net erosion over the last 70 years. Erosion has been the most severe along the island's easternmost two-mile-long reach where average long-term erosion rates range from -3 to -8 ft/yr (NCDCM 2011). A chronic erosion trend exists along the East End of Holden Beach, up to 2 kilometers (km) (about 1.2 miles) from LFI. The approximate influence of LFI is 2 km in both the eastern (Oak Island) and western (Holden Beach) directions (Cleary, 1996; Cleary, 1998). Since 2001, numerous beach nourishment projects have been implemented along this eastern reach to mitigate erosion (ATM 2013).

4.2 Sediment Transport Processes

Along Holden Beach, the seaward extent of significant fair-weather sediment mobilization (i.e., depth of closure) occurs at a depth of approximately 30 ft (Cleary et al. 2001). Sediments mobilized on the shoreface by onshore waves are picked up by longshore currents and transported along the beach in a process known as longshore or littoral drift (Figure 4.2). Depending on incident wave conditions, longshore sediment transport along Holden Beach and the other Brunswick County beaches occurs in both westward and eastward directions. Westward longshore transport rates generally exceed eastward transport rates, resulting in a regional longshore transport pattern that is predominantly westward (Thompson et al., 1999; OCTI 2008). At LFI, transport modeling analyses predict westward longshore transport at a rate of 400,000 cy/yr and eastward longshore transport at a rate of 150,000 cy/yr, thus indicating a net westward transport rate of 250,000 cy/yr (OCTI 2008). West of the inlet along Holden Beach, predicted westward transport rates increase to a range of 400,000 – 600,000 cy/yr, whereas eastward transport rates increase to a range of 175,000 – 225,000 cy/yr. Although sediment transport is predominantly westward at a regional scale, local transport patterns exhibit considerable variability due to the influence of inlets, shoals, and local bathymetry (Thompson et al. 1999; OCTI 2008). As depicted in Figure 4.2, relatively large volumes of sediment move eastward along the east end of Holden Beach and are eventually transported into LFI where they are retained within the inlet flood shoal system and the federal navigation channels (ATM 2013). The resulting effect on the east end beach is a localized reversal of the regional net westward transport pattern within ~0.7 mile of LFI. Sediment retained in the inlet is permanently lost to the east end beach, thus accounting for much of the ongoing chronic erosion.

Sediments mobilized on the upper shoreface also move onshore and offshore in a process known as cross-shore transport. Offshore transport is primarily a storm driven response involving the formation of a nearshore sand bar, whereas onshore transport involving the movement of sandbars back onshore predominates during fair-weather wave conditions. A recent study of Long Bay beaches (North Myrtle Beach, Myrtle Beach, and Garden City) found the most active profile changes occurred in the surf-zone between the +2-meter (m) (+6.5-ft) NAVD contour (approximately the upper beach berm) and the -4-m (-13-ft) NAVD depth contour (Park et al. 2009). Seaward of the depth of closure (~30-ft contour) on the lower shoreface and inner shelf, significant sediment mobilization is strongly related to the passage of high-energy storms and associated increases in wave orbital velocities (Davis 2006). Although fine-grained [~0.125 millimeters (mm)] sediments are frequently suspended during the passage of routine cold/warm fronts and low pressure systems (Warner et al. 2012), full suspension conditions involving coarse sand particles are primarily associated with hurricanes and nor'easters (Davis 2006).



Source: ATM 2013

Figure 4.2. Conceptual regional and local net sediment transport schematic at LFI (2004 aerial).

4.3 Marine Habitats and Communities in the Permit Area

4.3.1 Marine Benthic Communities

Marine Soft Bottom

Marine soft bottom habitats encompass all areas of the subtidal seafloor that are covered by a surface layer of unconsolidated sediment. Sediment transport processes on the shoreface and inner shelf are driven primarily by waves and wave-generated currents. Under fair-weather conditions, significant sediment mobilization is largely confined to the upper shoreface where seafloor sediments are agitated by onshore waves.

Seaward of the shoreface on the inner shelf, significant sediment mobilization is strongly related to the passage of high-energy storms and associated increases in wave orbital velocities (Davis 2006). Although fine-grained (~0.125 mm) sediments are frequently suspended during the passage of routine cold/warm fronts and low pressure systems (Warner et al. 2012), full suspension conditions involving coarse sand particles are primarily associated with hurricanes and nor'easters (Davis 2006).

Marine soft bottom habitats support a diverse community of benthic invertebrate infauna (burrowing organisms that live within the sediment) and epifauna (organisms that live on the surface of the sediment). Nearshore soft bottom communities along the southeastern NC coast are dominated by deposit- and filter-feeding invertebrates, including polychaetes, bivalve mollusks, nematodes, amphipod crustaceans, echinoderms (sand dollars), and gastropods (snails) (Hague and Massa 2010, Posey and Alphin 2002, Peterson and Wells 2000, Peterson et al. 1999). Soft bottom sites also provide important habitat for large, mobile decapod crustaceans (e.g., crabs and shrimp). Based on annual trawl surveys conducted by Posey and Alphin (2002), the large decapod assemblage in nearshore Long Bay is dominated by white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), and the iridescent swimming crab (*Portunus gibbesii*). Soft bottom habitats and their associated benthic invertebrate communities provide important habitat and food resources for many species of demersal (bottom-dwelling) fishes. The Southeast Area Monitoring and Assessment Program-South Atlantic (SEAMAP-SA) has conducted annual nearshore (15- to 60-ft-deep) trawl surveys for demersal fishes in Long Bay since 1986. Catches have been consistently dominated by sciaenid fish which utilize estuaries during part of their life cycle (SEAMAP-SA 2000). Overall patterns of demersal fish abundance are strongly influenced by the high abundance of spot (*Leiostomus xanthurus*) and Atlantic croaker (*Micropogonias undulatus*). These two species have been consistently dominant, accounting for more than 36 percent of the total catch between 1990 and 1999. Other abundant demersal fishes in this region include the Atlantic bumper (*Chloroscombrus chrysurus*), scup (*Stenotomus* spp.), pinfish (*Lagodon rhomboides*), star drum (*Stellifer lanceolatus*), banded drum (*Larimus fasciatus*), gray trout (*Cynoscion regalis*), silver seatrout (*C. nothus*), southern kingfish (*Menticirrhus americanus*), and inshore lizardfish (*Synodus foetens*) (SEAMAP-SA 2000).

Many of the demersal fishes associated with marine soft bottom habitats are estuarine-dependent/ocean-spawning species that utilize estuarine waters for juvenile development before moving into the ocean as adults. During the fall and winter, large numbers of these estuarine-dependent species leave the estuaries and enter the nearshore ocean zone (Deaton et al. 2010). Peterson and Wells (2000) documented seasonal variations (November, February, and May) in demersal fish communities at inshore (~1 mile) and offshore (~5 miles) soft bottom sites off of North Carolina. In November, catches at the offshore sites were dominated by spot (>50 percent of total catch), pinfish, pigfish (*Orthopristis chrysoptera*), and croaker while the inshore sites were dominated by croaker, silver perch (*Bidyanus bidyanus*), Atlantic silversides (*Menidia menidia*), pinfish, and striped mullet (*Mugil cephalus*). In February, total catches at the offshore and inshore sites were reduced by 96 and 59 percent, respectively. Pinfish, Atlantic menhaden (*Brevoortia tyrannus*), and silversides collectively accounted for 96.4 percent of the total combined inshore/offshore catch in February. The combined inshore/offshore totals for spot and croaker were reduced by 98.9 and 99.8 percent, respectively, and catches of all other taxa decreased sharply, with the exception of silversides and pinfish at the inshore sites. During the May sampling period, large numbers of Atlantic silversides and Atlantic threadfin herring (*Opisthonema oglinum*) increased the total inshore catch. Peterson and Wells (2000) also analyzed the stomach contents of demersal fishes that were caught during the November sampling period and found that croakers and pinfish were primarily consuming polychaete worms, bivalves, grass shrimp (*Palaemonetes* spp.), and pinnotherid crabs. Silver perch, pigfish, and spot consumed polychaetes, grass shrimp, and other small bottom-dwelling crustaceans. Gray trout consumed grass shrimp, penaeid shrimp, and portunid crabs whereas kingfishes primarily consumed pinnotherid crabs, portunid crabs, and large polychaete worms.

Several other studies have investigated estuarine and nearshore larval and juvenile fish distribution and abundance near inlets along the SC and NC coast. An annotated bibliography (with emphasis on inlets in close proximity to the Cape Fear region) has been assembled and is included for reference (Appendix J).

Marine Hardbottom

The northern section of Long Bay between Cape Fear and Shallotte Inlet contains one of the highest concentrations of known hardbottom sites along the NC coast (Deaton et al. 2010). Offshore of Holden Beach and Oak Island, hardbottoms consisting of Cretaceous and Paleocene Age limestones and sandstones are frequently exposed on the shoreface and inner shelf (Marden et al. 1999). The extent and distribution of hardbottom areas within the Permit Area have not been fully determined; however, extensive hardbottom data for the region have been compiled from sand resource studies and regional bottom-mapping efforts (Figure 4.3). A myriad of remote sensing investigations and vibracore analyses related to the USACE's Brunswick County Beaches Storm Damage Reduction Project have identified numerous hardbottom areas offshore of Holden Beach and Oak Island. Local hardbottom data from other sources have been compiled by the SEAMAP-SA as part of a regional mapping effort within the South Atlantic Bight (SEAMAP-SA 2001). The SEAMAP-SA dataset has facilitated the identification of potential borrow sites that are consistent with state regulations prohibiting dredging within 500 m of hardbottom habitats (15A NCAC 07H.0208). The proposed borrow site and a peripheral 500-m buffer zone for the current project were subjected to a more intensive remote sensing investigation in conjunction with the Central Reach Project. Analyses of acoustic and bathymetric data did not identify any potential hardbottom areas within the borrow site or buffer zone (Tidewater Atlantic Research 2011).

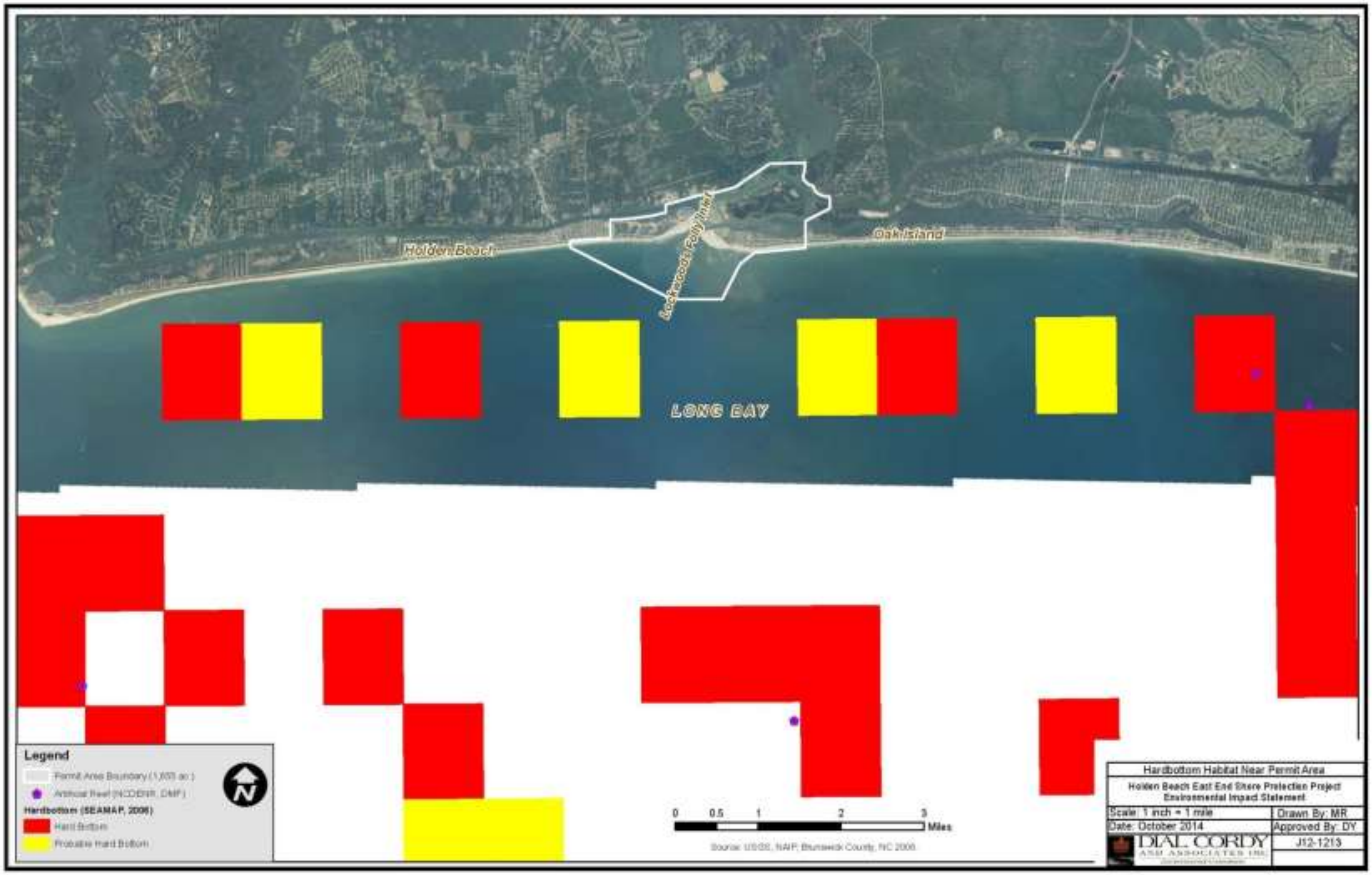


Figure 4.3. Hardbottom Habitat near Permit Area

Hardbottom habitats exhibit varying degrees of colonization by marine algae and sessile invertebrates (e.g., sponges, soft corals, and hard corals). Marine macroalgae are the dominant colonizing organisms on NC hardbottoms with attached, sessile invertebrates typically accounting for ten percent or less of the total coverage (Peckol and Searles 1984). Dominant large, attached invertebrates include the soft corals *Titandeum frauenfeldii* and *Telesto fructiculosa* and the hard coral *Oculina arbuscula*. The small macroinvertebrate community is dominated by mollusks, polychaetes, and amphipods (Kirby-Smith 1989), and the most common large mobile invertebrates are the purple-spined sea urchin (*Arbacia punctulata*) and the green sea urchin (*Lytechinus variegatus*). Hard and soft corals are less prevalent on nearshore hardbottoms in NC compared to offshore and more southerly hardbottoms. In the nearshore environment, cooler water temperatures limit the growth of tropical corals (Kirby-Smith 1989, Fraser and Sedberry 2008), and macroalgae outcompete the dominant hard coral (Miller and Hay 1996). Along the NC coast, tropical reef-building corals are restricted to deep offshore waters (>20 miles from shore) (MacIntyre and Pilkey 1969, MacIntyre 2003).

Hardbottoms along the NC coast provide important foraging habitat and protective cover for tropical, subtropical, and warm-temperate reef fishes. Inner-shelf hardbottoms support a higher proportion of temperate fishes, such as the black sea bass (*Centropristis striata*), spottail pinfish (*Diplodus holbrookii*), and estuarine-dependent migratory species (Huntsman and Manooch 1978, Grimes et al. 1982). Lindquist et al. (1989) reported 30 species representing 14 families at a nearshore hardbottom site in Onslow Bay. Common species included juvenile grunts, round scad (*Decapterus punctatus*), tomtate (*Haemulon aurolineatum*), spottail pinfish, black sea bass, slippery dick (*Halichoeres bivittatus*), scup, pigfish, cubbyu (*Equetus umbrosus*), belted sandfish (*Serranus subligarius*), and sand perch (*Diplectrum formosum*). Nearshore hardbottom sites support spawning of smaller and more temperate reef species, such as black sea bass and sand perch, and also provide larval settlement sites and juvenile nursery habitats for reef-associated fishes, including a number of taxa that are thought to spawn in deep offshore waters (Powell and Robins 1998).

4.3.2 Water Column

Physical oceanographic processes in Long Bay are controlled primarily by interactions among the Gulf Stream, tides, and local wind stress. On the inner shelf (depths <20 m), wind stress is the principal driver of alongshore currents, and tides are responsible for much of the cross-shelf current (Pietrafesa et al. 1985a, 1985b). Wind-driven currents are strongly correlated with synoptic scale (2 to 14 days) wind events that are driven by low/high pressure systems and associated cold/warm fronts (Pietrafesa et al. 1985b). The tidal regime is dominated by the lunar semidiurnal (two cycles/day) tidal constituent, which has a mean annual tidal range of approximately 4.72 ft and a spring tidal range of approximately 5.27 ft in the vicinity of Holden Beach. The salinity along Holden Beach varies considerably throughout the year and ranges from ~26 to 35 parts per thousand

(ppt) (mean = 34 ppt). Wide variations in salinity reflect the influence of low salinity discharge from the Cape Fear River. Salinities are relatively low (<34 ppt) during peak flows in the late winter/spring and relatively high (>34 ppt) during the summer and fall when the discharge is low [Carolinas Coastal Ocean Observing and Prediction System (Caro-COOPS):
http://nautilus.baruch.sc.edu/carocoops_website/buoy_detail.php?buoy=WLS3].

Discharge from the river also carries suspended sediments that lead to elevated turbidity levels in the immediate vicinity of the river mouth; however, turbidities west of the Cape Fear River along Oak Island are usually low (2 to 5 NTU) regardless of discharge conditions (Durako et al. 2010).

Results from wave hindcast studies indicate that the inner shelf wave climate along Holden Beach is dominated by small (mean = 3 ft), short period (mean = 5.2 seconds) wind waves out of the southeast sector (Jensen 2010). During the spring and summer, prevailing winds are out of the southwest, and the predominant direction of wave approach is from the south. As the prevailing winds shift to the northeast in the fall, the predominant direction of wave approach shifts to the southeast. During the winter, the prevailing winds are out of the north-northwest, and the predominant direction of wave approach is from the east. The wave climate along Holden Beach is influenced by the Cape Fear River and its associated shoal complex which shelters the area from the high-energy northeast winds and waves that dominate the region. The sheltering effect results in a relatively low-energy wave regime dominated by small, short-period, southerly waves. Although protected against northeast winds and storm waves, the area is highly exposed to tropical storms and hurricanes approaching from the south (Jensen 2010.

The ocean water column provides important habitat for pelagic fish species, such as alewife (*Alosa pseudoharengus*), shad (*A. sapidissima*), blueback herring (*A. aestivalis*), bay anchovy (*Anchoa mitchilli*), silversides, Atlantic menhaden, striped mullet, bluefish (*Pomatomus saltatrix*), cobia (*Rachycentron canadum)*, Spanish mackerel (*Scomberomorus maculates*) and king mackerel (*Scomberomorus cavalla*). Coastal pelagics, highly migratory species and anadromous fish species depend on the water column for adequate foraging habitat (Manooch and Hogarth 1983). The boundaries of water masses (coastal fronts) in the nearshore ocean are important foraging areas for mackerel and mahi mahi (*Coryphaena hippurus*) (SAFMC 1998). King and Spanish mackerel feed on baitfish that congregate seasonally over shoals, hardbottoms and artificial reefs. Anadromous species such as shad, river herring (Alosa sp.) and striped bass (*Morone saxatilis*), utilize cape shoals as a staging area for migration along the coast. Some pelagic species such as anchovies and king mackerel, rely on the nearshore boundaries of ocean water masses as nursery habitats (SAFMC 1998). Juveniles of other pelagic species such as Spanish mackerel and bluefish, use the surf zone and nearshore waters seasonally while migrating between estuarine and ocean waters [Godcharles and Murphy 1986, Hackney et al. 1996, North Carolina Division of Marine Fisheries (NCDMF) 2000].

Ichthyoplankton (fish larvae) are an important component of the zooplankton community in the ocean water column. Powell and Robbins (1994) collected ichthyoplankton taxa representing 66 families along an inshore-offshore transect in Onslow Bay. Abundance and diversity were lowest at inner shelf sampling stations and highest at mid-to-outer shelf stations. A follow-up study targeting the water column above hardbottom sites yielded taxa from 110 families (Powell and Robbins 1998). During late fall and winter, estuarine-dependent species such as Atlantic menhaden, spot and Atlantic croaker, were an important component of the zooplankton community. Ichthyoplankton from estuarine-dependent species that spawn in the sounds and inlets [e.g., pigfish, silver perch and weakfish (*C. regalis*)] were found in the ocean water column shortly after the spring/early summer spawning period. Reef fish larvae were most abundant during the spring, summer and early fall (Powell and Robbins 1998).

4.4 Beach and Dune Communities in the Permit Area

4.4.1 Intertidal Ocean Beach

The intertidal ocean beach is alternately inundated and exposed by twice-daily ocean tides and waves. The intertidal zone is a high-energy environment where sediments are continually reworked and sorted according to grain size. Sediments are generally coarse and highly sorted (sediment sizes are similar) with relatively little organic matter. Wave action in the intertidal zone generally precludes the growth of benthic algae; however, waves result in the continuous re-suspension of inorganic nutrients which support phytoplankton productivity. Phytoplankton production (primarily diatoms) supports benthic invertebrate filter feeders which are an important food resource for surf zone fishes and shorebirds. The dominant benthic macrofauna of NC intertidal beaches are mole crabs (*Emerita talpoida*), coquina clams (*Donax variablis* and *D. parvula*), several species of haustoriid amphipods and the spionid polychaete (*Scolelepis squamata*) (Deaton et al. 2010).

Leber (1982) described seasonal variations in the composition of intertidal macroinvertebrate communities along Bogue Banks. Mole crabs and coquina clams dominated the macroinvertebrate community for most of the year. Mole crab densities were highest from April through October, and densities of the coquina clam were highest from May through November. Densities of both species declined sharply in the late fall, and these species were completely absent between mid-January and mid-February. Recolonization by juveniles and adults of both species was evident by late February. Densities of the coquina clam were highest from May through August; this species disappeared from the intertidal zone in late August and remained absent until the following March. Haustoriid amphipods (*Haustorius* spp. and *Amphiporeia virginiana*) dominated the benthic community for a brief period during early winter, but were present in low numbers throughout the remainder of the year. Peterson et al. (2006) detected seasonal changes in polychaete abundance. Densities of intertidal polychaetes (*Scolelepis squamata*) increased after March, peaked during the warmer months, and declined in the fall.

At high tide, the inundated intertidal beach provides foraging habitat for surf zone fishes. The most common surf zone species along southeastern NC include Atlantic menhaden, striped anchovy (*A. hepsetus*), bay anchovy, rough silverside (*Membras martinica*), Atlantic silverside, Florida pompano (*Trachinotus carolinus*), spot, gulf kingfish (*M. littoralis*) and striped mullet (Ross and Lancaster 1996). The intertidal beach also provides important foraging habitat for shorebirds and waterbirds that probe or search the surface of wet intertidal sediments for benthic invertebrates. Shorebirds and waterbirds are present year-round, but are most abundant along the NC coast during spring and fall migration periods. Grippo et al. (2007) described shorebird and waterbird utilization of oceanfront beach habitats along Holden Beach and Oak Island between 2002 and 2003. The most abundant shorebirds were sanderlings (*Calidris alba*), willets (*Tringa semipalmata*), ruddy turnstones (*Arenaria interpres*), and semipalmated plovers (*Charadrius semipalmatus*). The most abundant waterbirds were laughing gulls (*Leucophaeus atricilla*), ring-billed gulls (*Larus delawarensis*), brown pelicans (*Pelecanus occidentalis*), and herring gulls (*L. argentatus*). Overall shorebird and waterbird abundance was highest during the fall.

4.4.2 Dry Ocean Beach and Dune

The dry upper beach is a highly dynamic environment that is continuously reworked by wind and water. Although located above the mean high tide line, the upper beach is subject to inundation by high spring tides (lunar tides) and storm tides. Vegetation of the upper beach is sparse and dominated by a few herbaceous species consisting primarily of annual succulents (Schafale and Weakley 1990). Dune grass communities occur on the frontal active dune system immediately landward of the ocean beach. This community type is dominated by grasses such as sea oats (*Uniola paniculata*), American beach grass (*Ammophila breviligulata*), seaside little bluestem (*Schizachyrium littorale*) and other herbaceous species that are adapted to this highly dynamic and stressful environment. Continuous salt spray, excessive drainage and shifting sands exclude most other plant species (Schafale and Weakley 1990).

NC is part of the breeding range of several beach-nesting shorebirds and waterbirds including the American oystercatcher (*Haematopus palliatus*), willet, piping plover (*Charadrius melodus*), Wilson's plover (*C. wilsonia*), black skimmer (*Rynchops niger*), least tern (*Sternula antillarum*), common tern (*Sterna hirundo*) and gull-billed tern (*Gelochelidon nilotica*) (Parnell et al. 1995). Although dry ocean beach and dune habitats on NC's undeveloped and unstabilized barrier islands provide nesting habitat for shorebirds and colonial waterbirds, nesting on developed islands is restricted to inlet habitats. During 2007 and 2011 coastwide nesting surveys, no waterbird nests were observed on the developed barrier islands in Brunswick County (Cameron 2007, Schweitzer 2011). Many of the same shorebirds and waterbirds that utilize the intertidal ocean beach for foraging are likely to also use the dry beach for foraging and/or loafing (Photo 4.3).

Photo 4.3. Colonial waterbirds resting on the Oak Island western spit.

Photo taken by DC&A April 20, 2015

4.4.3 Maritime Upland Forest Communities

Maritime upland forests occur on interior stabilized dune ridges that are protected from overwash and the most extreme salt spray. Dominant species in this habitat include evergreen shrubs and trees such as wax myrtle (*Myrica cerifera*), yaupon (*Ilex vomitoria*), red cedar (*Juniperus virginiana*), live oak (*Quercus virginiana*), sand laurel oak (*Q. hemisphaerica*) and loblolly pine (*Pinus taeda*) (Schafale and Weakley 1990). The stature of the vegetation is controlled by exposure to salt spray with dense salt-pruned shrub thickets characterizing sites near the ocean and a stunted canopy of larger trees characterizing sites along the backside of the island. Maritime shrub/forest communities on Holden Beach are naturally limited by the island's narrow width and low topography, and concentrated development on the island's larger dunes has eliminated most historical occurrences of this community type. Existing communities are patchily distributed across the large, relatively undisturbed parabolic dunes on the extreme eastern end of the island (Schafale and Weakley 1990).

4.5 Inlet and Estuarine Communities in the Permit Area

4.5.1 LFI Complex

LFI separates Holden Beach from Oak Island and links the Lockwoods Folly River/AIWW estuarine system with the Atlantic Ocean. The tidal regime in LFI is dominated by the lunar semidiurnal (2 cycles/day) tidal constituent with a mean tidal range of ~4.2 ft and a spring tidal range of ~4.8 ft (NOAA Water Level Station TEC2869). Salinities in the AIWW between LFI and Lockwoods Folly River range from ~29 to 36 ppt (NCDWQ 2007). Salinities inside the mouth of the Lockwoods Folly River (~2,600 ft north of the AIWW) range from ~8 to 39 ppt (Ambient Monitoring Station 19480000). Turbidity levels are well below the state water quality standard of 25 NTU with an observed range of ~1 to 18 NTU in the AIWW (Ambient Monitoring Stations 19530000 and 19510000) and a range of ~1 to 23 NTU inside the mouth of the Lockwoods Folly River (Stations 19480000 and 19500000). Concentrations of total suspended solids (TSS) in the AIWW range from ~7 to 51 milligrams/Liter (mg/L), whereas concentrations inside the mouth of the Lockwoods Folly River range from ~3 to 48 mg/L (NCDWQ 2002, 2007, 2012). The main deepwater (ebb) channel through the inlet is periodically dredged by the USACE under a federal navigation project. The federal project authorizes maintenance of a channel 8 ft deep and 150 ft wide between the ocean and the AIWW. LFI was dredged 62 times between 1980 and 2007 with an average of 68,415 cy of material removed per dredging event. Dredging has been performed primarily by sidecaster dredges (NCDENR 2011).

Although the inlet has a history of migration along the west end of Oak Island, its position has remained relatively stable since the late 1930s. The inlet ebb channel alignment for most of the past 75 years has been oriented to the southeast along the Oak Island shoulder, resulting in chronic erosion on the East End of Holden Beach and long-term accretion on the west end of Oak Island. Between 1974 and 1984, the ebb channel shifted to the southwest reversing the erosion/accretion pattern. In 2001, an ebb delta breaching event resulted in the realignment of the ebb channel to a shore-normal orientation. The new alignment led to a reconfiguration of the ebb tidal delta which, in turn, initiated a period of accretion along the East End of Holden Beach. Changes in the ebb channel alignment and flood channel complex alter the symmetry and breakwater effect of the ebb delta. The symmetry of the ebb delta also determines the zone of attachment of swash bars on the adjacent shoulders of Holden Beach and Oak Island. The inlet's influence on erosional and accretional processes extends ~2 km along the oceanfront shorelines of both islands (Cleary 2008, Cleary et al. 2001).

The inlet spit-shoal complex encompasses a diverse collection of shifting sand habitats. Accreting sand spits along the opposing inlet shorelines and detached shoals associated with the ebb and flood tidal deltas form a complex assemblage of subtidal, intertidal, and supratidal flats and shoals. The spit-shoal complex is part of a high-energy inlet system in which habitats are continually destroyed, recreated and redistributed by natural erosional and depositional processes. Ephemeral inlet flats and shoals provide important habitat for breeding, migrating and wintering shorebirds and waterbirds. As development and artificial beach stabilization have increased along NC's barrier islands, shorebirds and waterbirds have become increasingly dependent on inlet habitats. These habitats are especially important to migrating and wintering shorebirds and waterbirds, including dunlin (*C. alpina*), short-billed dowitcher (*Limnodromus griseus*), sanderling, semipalmated sandpiper (*C. pusilla*), black-bellied plover (*Pluvialis squatarola*), western sandpiper (*C. mauri*), laughing gull, royal tern (*Thalasseus maximus*), black skimmer, herring gull, and brown pelican (Rice and Cameron 2008).

Tidal inlets are a critical conduit for adult and larval ocean-spawning/estuarine-dependent fishes that spawn offshore on the continental shelf and use estuarine habitats for juvenile development. Larvae spawned offshore are transported shoreward by the prevailing currents and eventually pass through tidal inlets and settle in estuarine nursery habitats. Juveniles remain in the estuarine nursery areas one or more years before moving offshore and joining the adult spawning stock (Deaton et al. 2010). Successful larval recruitment to estuarine nursery areas is dependent on transport through a relatively small number of narrow tidal inlets. Larval ingress studies indicate that larvae accumulate in the nearshore ocean zone where they are picked up by along-shore currents and transported to the inlet (Churchill et al. 1999). The results of a long-term larval fish sampling program at Beaufort Inlet indicated that the most abundant larval taxa passing through the inlet are spot, pinfish, croaker, menhaden, speckled worm eel (*Myrophis punctatus*), flounders, pigfish, gobies (Gobiidae) and striped mullet (Taylor et al. 2009). Overall larval densities within the inlet were generally highest from late May to early June and lowest in November (Hettler and Chester 1990).

4.5.2 Estuarine Communities

The back-barrier estuary behind the East End of Holden Beach is occupied by the AIWW and relatively narrow fringing marshes. The Lower Lockwoods Folly River estuary to the north of the AIWW contains an expansive estuarine complex of marsh islands, sandy shoals, shellfish beds, and tidal creeks. The AIWW borders a spoil island-marsh complex known as Sheep Island which is separated from the estuarine shoreline of Oak Island by the Eastern Channel. The estuarine shoreline of Oak Island is occupied by a narrow band of tidal marsh.

Intertidal and Subtidal Flats and Shoals

Intertidal flats and shallow soft bottom habitats support a highly productive benthic microalgal community. Benthic microalgae, along with phytoplankton and detritus, support a diverse community of benthic infaunal and epifaunal invertebrates including nematodes, copepods, polychaetes, amphipods, decapods, bivalves, gastropods and echinoderms (SAFMC 1998, Peterson and Peterson 1979). Large mobile invertebrates that move between intertidal and subtidal habitats with the changing tides include blue crabs (*Callinectes sapidus*), horseshoe crabs (Limulidae) and penaeid shrimp. Mobile predatory gastropods (e.g., whelks and moon snails) occur along the lower margins of submerged tidal flats, and fiddler crabs (*Uca* spp.) are common on exposed flats during low tide (Peterson and Peterson 1979). Benthic invertebrates are an important food source for numerous predatory fishes that move between intertidal and subtidal habitats; these fishes include spot, Atlantic croaker, flounders (Paralichthys sp.), inshore lizardfish, pinfish, red drum (*Sciaenops ocellatus*) and southern kingfish. Planktivores [e.g., anchovies, killifish (*Fundulus* spp.) and menhaden] and detritivores [e.g., striped and white mullet (*M. curema*) and pinfish] also forage on tidal flats and shallow soft bottom areas. Intertidal flats function as an important nursery area for numerous benthic-oriented and estuarine-dependent species, especially Atlantic croaker, penaeid shrimp, flounder and spot (SAFMC 1998). A number of resident estuarine fishes and invertebrates, as well as seasonal migratory fish, spawn over estuarine soft bottom habitats. The majority of these estuarine-spawning species are resident forage finfishes that spawn in estuaries during the warmer months.

Submerged Aquatic Vegetation

Submerged Aquatic Vegetation (SAV) include several species of aquatic vascular plants such as common eelgrass (*Zostera marina*), shoalgrass (*Halodule wrightii*) and widgeongrass (*Ruppia maritima*), that occur in NC estuaries. SAV beds occur on subtidal and occasionally intertidal sediments in sheltered estuarine waters. Environmental requirements include unconsolidated sediments for root and rhizome development, adequate light reaching the sediments and moderate to negligible current velocities (Thayer et al. 1984, Ferguson and Wood 1994). In NC, eelgrass is more common in shallow, protected estuarine waters during the winter and spring. During the summer when water temperatures are above 25–30°C, shoalgrass is more abundant in these waters, and eelgrass dominates only in deeper waters and/or on tidal flats with continuous water flow and where water temperatures are lower (SAFMC 1998). Coast-wide mapping conducted by the SAV Cooperative Habitat Mapping Program indicates that SAV beds are uncommon along the Brunswick County coast. SAV in the Permit Area may occur in a few small patches in the Eastern Channel behind Oak Island and in the Lower Lockwoods Folly River (Figure 4.4). According to the NCDMF, no SAV occurs in the Eastern Channel (personal communication, NCDMF, Anne Deaton, 22 May 2014). The current absence of SAV in the Eastern Channel was confirmed via groundtruthing by DC&A in September 2014.

Figure 4.4. Potential Submerged Aquatic Vegetation in and near Permit Area

SAV beds provide important structural fish habitat and perform important ecological functions, including primary production, structural complexity, energy regime modification, sediment and shoreline stabilization, and nutrient cycling. SAV beds produce large quantities of detritus which is broken down by invertebrates, zooplankton and bacteria and transferred to higher trophic levels through the estuarine-detrital food web. Water quality enhancement and fish utilization are especially important functions of SAV that enhance coastal fisheries (Deaton et al. 2010). Fish and invertebrates use SAV as nursery, refuge, foraging and spawning habitat. Invertebrates occurring on SAV leaves include protozoans, nematodes, polychaetes, hydroids, bryozoans, sponges, mollusks, barnacles, shrimp and crabs. Sampling in NC's estuaries has documented over 150 species of fish and invertebrates in SAV beds; of these species, 34 fish and six invertebrates are important commercial species (NCDMF 1990).

Large predatory species such as Atlantic stingrays (*Dasyatis sabina*), bluefish, flounders, red drum, sharks, spotted seatrout (*C. nebulosus*), weakfish and blue crabs are attracted to SAV beds due to their high concentrations of prey (e.g., juvenile finfish and shellfish) (Thayer et al. 1984). Important commercial and recreational fish that utilize SAV as juveniles during the spring and early summer include Atlantic croaker, black sea bass, bluefish, flounders, gag grouper (*Mycteroperca microlepis*), herrings, mullets, red drum, snappers, spot, spotted seatrout, weakfish, and southern kingfish. Bay scallops, hard clams, penaeid shrimp, and blue crabs use SAV for attachment and protection. SAV is considered an EFH for red drum, penaeid shrimp, and species in the snapper-grouper complex (SAFMC 1998). SAV also provide an important food source for waterfowl, sea turtles, and sea urchins. Birds, such as egrets, herons, sandpipers, terns, gulls, swans, geese, ducks, and osprey feed in SAV beds (Ferguson and Wood 1994). Birds, fishes, echinoderms, turtles, and manatees feed directly on SAV (SAFMC 1998).

Shell Bottom

Shell bottom habitats include oyster reefs, aggregations of non-reef-building shellfish species [e.g., clams and scallops (*Argopecten irradians*, *A. gibbus*)] and surface concentrations of broken shells (i.e., shell hash). The eastern oyster (*Crassostrea virginica*) is the dominant and principal reef-building species of estuarine shell bottom habitats in NC. Non-reef-building shellfish species that occur at densities sufficient to provide structural habitat for other organisms include scallops, pen shells (*Atrina seratta* and *A. rigida*) and rangia clams (*Rangia cuneata*) (SAFMC 2009). Shell bottom habitats perform a number of important ecological functions such as water filtration, benthic-pelagic coupling, sediment stabilization and erosion reduction (Deaton et al. 2010, SAFMC 2009, and Coen et al. 2007). Oysters and other suspension-feeding bivalves reduce turbidity in the water column by filtering particulate matter, phytoplankton and microbes. The consumption of particulates also results in the transfer of material and energy from the water column to the benthic community (i.e., benthic-pelagic coupling). Shell bottom structural relief alters currents and traps and stabilizes suspended solids, thus further reducing turbidity. By moderating waves and currents, oyster reefs and other shell bottom habitats reduce shoreline erosion. Shell bottom habitat within the intertidal and subtidal strata in and near the Permit Area is depicted in Figure 4.5.

The hard surfaces provided by existing oyster reefs and shell hash function as important larval settlement and accumulation sites for recruiting oysters, hard clams and other shellfish (NCDMF 2008b). Studies summarized by Deaton et al. (2010) have documented the importance of shell bottom as foraging, spawning and nursery habitat for numerous species of invertebrates and fish. Shell bottom structure concentrates macroinvertebrates [e.g., grass shrimp and mud crabs (*Scylla* spp.)] and small forage fishes (pinfish and gobies) which, in turn, attract larger predatory fish such as Atlantic croaker, black drum (*Pogonias cromis*), pigfish, southern flounder (*Paralichthys lethostigma*), summer flounder (*P. dentatus*), and spotted seatrout. Shell bottom habitats are utilized as spawning areas by a number of finfish and decapod crustaceans, including anchovies, blennies (Blennidae), gobies, mummichog (*F. heteroclitus*), oyster toadfish (*Opsanus tau*), sheepshead minnow (*Cyprinodon variegatus*), grass shrimp and blue crabs. Numerous finfish and decapod crustaceans including anchovies, black sea bass, blennies, gobies, oyster toadfish, pinfish, red drum, sheepshead, spot, weakfish, penaeid shrimp, blue crabs, and stone crabs (*Menippe mercenaria*) also utilize shell bottom habitats as nursery areas (Deaton et al. 2010).

Tidal Marsh

Tidal salt and brackish marshes occur along the margins of tidal estuarine waters at salinities ranging from 0.5 to >35 ppt (Wiegert and Freeman 1990). The vegetative community is dominated by emergent, salt-tolerant, herbaceous species including smooth cordgrass (*Spartina alterniflora*), salt-meadow grass (*S. patens*), salt reed-grass (*S. cynosuroides*), black needlerush (*Juncus roemerianus*), glasswort (*Salicornia* spp.), salt grass (*Distichlis spicata*), sea lavender (*Limonium* spp.), bulrush (*Scirpus* spp.), sawgrass (*Cladium jamaicense*) and cattail (*Typha* spp.). The waterway behind the west end of Holden Beach is naturally constricted and the associated marshes are limited to a relatively narrow fringe (~50 to 100 ft wide) along both the island and mainland shorelines. The back-barrier environment between Oak Island and Sheep Island contains a more extensive complex of fringing marshes, detached marsh islands and tidal creeks. The estuarine environment north of the AIWW in the Lower Lockwoods Folly River contains an expansive marsh island complex with an intricate network of small tidal creeks (Wiegert and Freeman 1990).

Salt and brackish marshes exhibit high primary productivity in the form of detritus, microalgae and bacteria (Hackney et al. 2000). Tidal flooding connects the marsh with adjacent estuarine waters allowing utilization by fish and other aquatic organisms. Slow-moving or sessile species residing in salt/brackish marsh and contributing to secondary production include fiddler crabs, mud snails, amphipods, oysters, clams, and Atlantic ribbed mussels (Geukensia demissa) (Wiegert and Freeman 1990). Marshes provide

Figure 4.5. Intertidal and Subtidal Habitat in and Near the Permit Area

habitat for numerous species of decapods and fish. Resident marsh species such as grass shrimp, killifish, mummichogs, sheepshead minnows, gobies, bay anchovies, and silversides provide an important link between marsh primary production and transient predatory fish populations (Wiegert and Freeman 1990, SAFMC 1998). Tidal marshes are utilized as nursery and/or foraging areas by economically important species such as red drum, flounder, spotted seatrout, spot, Atlantic croaker, and blue crab. In NC, penaeid shrimp and red drum are considered critically linked to marsh edge habitat (SAFMC 1998). Other species (e.g., Atlantic menhaden) that are not directly associated with marsh habitats derive substantial food resources from the marsh in the form of exported detritus and microalgae. Along with the shallow soft bottom and shell bottom areas, the bordering salt and brackish marshes along the NC coast are an important nursery habitat for estuarine-dependent species. The majority of the Primary and Secondary Nursery Areas in NC are located in soft bottom areas surrounded by salt/brackish marsh (Deaton et al. 2010).

4.6 Endangered, Threatened, and Rare Species and Species of Concern

4.6.1 Federally Listed Species

This section includes background information on the federally listed species that may occur in the Permit Area. These species are designated as threatened or endangered under the ESA. A total of 14 species are currently listed and include three marine mammal species, three bird species, five sea turtle species, two fish species, and one plant species (Table 4.2).

4.6.1.1 Marine Mammals

Thirty-seven marine mammal species may occur off the southeastern NC coast based on sightings, strandings and bycatch data and known habitat associations and distributions [see Jefferson et al. 2008 and summaries in Department of Navy (DoN) 2008a and DoN 2008b). These species include 32 cetaceans (whales, dolphins, and porpoises), four pinnipeds (seals) and one sirenian (manatee). All marine mammal species are protected under the Marine Mammal Protection Act (MMPA). Of the 37 species with known or potential occurrence off southeastern NC, the following seven are listed as endangered under the ESA: the North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*), fin whale (*B. physalus*), blue whale (*B. musculus*), sperm whale (*Physeter macrocephalus*), and West Indian manatee (*Trichechus manatus*). Sei, blue, and sperm whales are most likely to occur in deeper waters offshore of the Permit Area (Hain et al. 1985, Wenzel et al. 1988, Waring et al. 1993, Prieto et al. 2011). Fin whales have been recorded in shallow waters close to shore along the US east coast [e.g., Geo-Marine Inc. (GMI) 2010, DoN 2008a and 2008b] but are more common in waters deeper than the

Table 4.2. Federally listed species.

Common Name	Scientific Name	Status
North Atlantic right whale	*Eubalaena glacialis*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
West Indian manatee	*Trichechus manatus*	Endangered
Piping plover	*Charadrius melodus*	Threatened[1]
Red knot	*Calidris canutus rufa*	Threatened
Wood stork	*Mycteria americana*	Threatened
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened[2]
Green sea turtle	*Chelonia mydas*	Threatened[3]
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered
Seabeach amaranth	*Amaranthus pumilus*	Threatened

[1]The Great Lakes breeding population is currently listed as endangered while the Northern Great Plains and Atlantic Coast breeding populations are currently listed as threatened. All piping plovers are considered threatened when on their wintering grounds.
[2]Four distinct population segments (DPSs) of the loggerhead turtle are designated as threatened while five DPSs are designated as endangered under the ESA. The Northwest Atlantic Ocean DPS, which occurs in NC, is designated as threatened.
[3]Although this species as a whole is listed as threatened, the Florida (FL) and Mexican Pacific nesting stocks of the green turtle are listed as endangered. The nesting area for green turtles encountered at sea cannot be determined; therefore, a conservative management approach is to assume that green turtles in the offshore environment may be from the endangered populations.

nearshore waters of the Permit Area. Therefore, the North Atlantic right whale, humpback whale and West Indian manatee are the ESA-listed marine mammal species most likely to occur in the Permit Area and are discussed below.

<u>North Atlantic Right Whale</u>

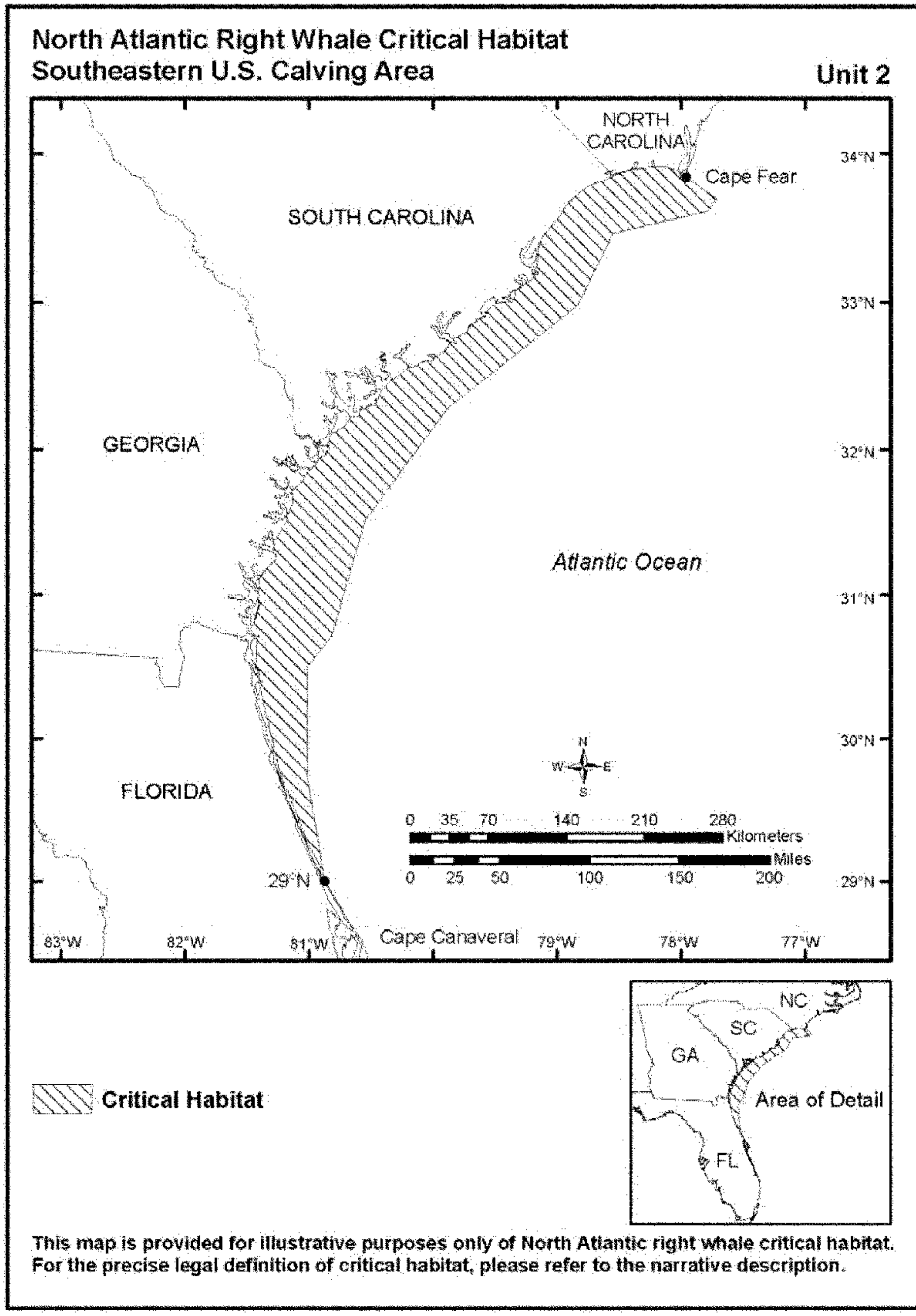
Status, Habitat, Distribution

The North Atlantic right whale is one of the world's most endangered large whale species [Clapham et al. 1999, Perry et al. 1999, International Whaling Commission (IWC) 2001] and is classified as endangered under the ESA. The most recent best estimate of cataloged right whales in the western North Atlantic is 510 individuals and is based on the number of photographed whales in the North Atlantic Right Whale Consortium database in 2012 (Pettis 2013). According to the most recent NMFS Stock Assessment Report, the minimum population size for the western North Atlantic stock is 455 individuals and is based on the number of recognized whales in the North Atlantic Right Whale Catalog that were known to be alive in 2010 (Waring et al. 2014).

The North Atlantic right whale ranges throughout the North Atlantic Basin but occurs primarily along the eastern coasts of the US and Canada (Brown 1986, Winn et al. 1986, Jacobsen et al. 2004, Jefferson et al. 2008, Hamilton et al. 2009, Silva et al. 2012). Most sightings of this species are recorded in well-known, frequently used habitat areas, including the coastal waters of Georgia (GA) and Florida (FL), within Cape Cod and Massachusetts Bays in the northeastern US, east of Cape Cod in the Great South Channel and in Canadian waters in the Bay of Fundy and over the Scotian Shelf (Winn et al. 1986, NMFS 2005).

North Atlantic right whale critical habitat is currently designated for feeding grounds in Cape Cod Bay and the Great South Channel and for calving grounds off GA and northern FL (59 FR 28793). However, as of February 2015, NOAA Fisheries has proposed to expand the designated critical habitat for endangered North Atlantic right whales to include calving grounds from southern North Carolina to northern Florida (Figure 4.6). The southeast right whale calving area consists of all marine waters from Cape Fear, NC, southward to 29° N latitude (approximately 43 miles north of Cape Canaveral, FL) within the area bounded on the west by the shoreline and the 72 COLREGS line. The proposed northern critical habitat areas include important physical and biological features that provide foraging areas where the whales' preferred prey, copepods (tiny planktonic crustaceans), are abundant. The proposed southern habitat area includes physical features that support calving and nursing with optimal physical oceanographic features including calm sea surface conditions, specific sea surface temperatures (45°F to 63°F), and water depths of 20 ft to 92 ft.

Right whale occurrence is concentrated in these areas in February through June and November through March, respectively (Winn et al. 1986, Hamilton and Mayo 1990, Kenney et al. 1995, Nichols et al. 2008). Many right whales undergo seasonal migrations between these feeding and calving grounds (Winn et al. 1986, Kenney 2001), and new regulations to expand critical habitat to include portions of the mid-Atlantic migratory corridor have been proposed (75 FR 61690). However, there is relatively little information on the geographic and temporal extent of the migratory corridor (Firestone et al. 2008, Schick et al. 2009). A review of sightings data collected in the mid-Atlantic found that 94 percent of all right whale sightings were within 56 km from shore (Knowlton et al. 2002). Not all individuals in the population complete this migration and the seasonal distribution of many whales is unknown. Right whales are often detected in these well-known habitat areas outside of the 'typical' time periods (Winn et al. 1986, Kenney 2001, Patrician et al. 2009). Right whales have been recorded in the mid-Atlantic year round (e.g., DoN 2008a and 2008b, Whitt et al. 2013). Some individuals have been sighted throughout the fall and winter on the northern feeding grounds, and a large portion of the population may spend the winter in several northern areas such as the Gulf of Maine and Cape Cod Bay (Cole et al. 2013, Clark et al. 2010, Mussoline et al. 2012).



Source: Office of Federal Register, 2015

Figure 4.6. Area Considered for Designation as North Atlantic Right Whale Southeastern Calving Critical Habitat

Occurrence in the Permit Area

The coastal waters of the Carolinas are part of the migratory corridor for the North Atlantic right whale (Winn et al. 1986, Knowlton et al. 2002). Right whales are expected to occur from the shoreline to the offshore boundary of the Permit Area but not in the inshore portions of the Permit Area. Right whales have been recorded off NC throughout the year [see DoN 2008a and 2008b); therefore, right whales may occur in the Permit Area during any time of the year. Sighting records suggest that there is some overwintering along the NC coast (Reeves and Mitchell 1988, Kraus et al. 1993). Between Cape Hatteras and GA, Knowlton et al. (2002) identified a pattern of sightings recorded between 1974 and 2002. Most sightings were recorded during March and April, few to no sightings were from May through October (survey effort was lower during summer and early fall) and some sightings were from November through February. Sightings near Wilmington, NC, occurred from October through April with a peak during February and March (Knowlton et al. 2002).

Humpback Whale

Status, Habitat, Distribution

The humpback whale is designated as endangered under the ESA. Humpback whales occurring in US North Atlantic waters belong primarily to the Gulf of Maine feeding stock although individuals from Canadian populations have also been sighted in US waters including the mid-Atlantic (Barco et al. 2002). The minimum population estimate for the Gulf of Maine stock is 823 individuals and is based on mark-recapture studies from 2008 (Waring et al. 2014).

Although humpback whales typically travel over deep oceanic waters during migration, their feeding and breeding habitats are mostly in shallow coastal waters over continental shelves (Clapham and Mead 1999). Females with calves occur in significantly shallower waters than other groups of humpback whales, and breeding adults use deeper, more offshore waters (Smultea 1994, Ersts and Rosenbaum 2003). No critical habitat has been designated for the humpback whale.

Humpback whales occur worldwide in all major oceans and most seas and are known to make long-distance, seasonal migrations (Jefferson et al. 2008). In the western North Atlantic, humpbacks are widely distributed and their occurrence is strongly seasonal. During spring and summer in US waters, the largest numbers of humpback whales are found off the northeast and mid-Atlantic coasts [Cetacean and Turtle Assessment Program (CETAP) 1982, Whitehead 1982, Kenney and Winn 1986, Weinrich et al. 1997, Hamazaki 2002, Stevick et al. 2008]. During the winter, many individuals migrate to calving grounds in the West Indies (Dawbin 1966, Whitehead and Moore 1982, Smith et al. 1999, Stevick et al. 2003); however, significant numbers of humpbacks have been found at mid- and high latitudes during this time suggesting that not all individuals in this stock undergo a seasonal migration (Dawbin 1966, Clapham et al. 1993, Swingle et al. 1993, Charif et al. 2001, Clapham 2009). Mid-Atlantic waters [New Jersey (NJ) to NC] may be a supplemental winter feeding ground for humpbacks (Barco et al. 2002). Humpbacks have been sighted in mid-Atlantic waters during all seasons (Barco et al. 2002).

Occurrence in the Permit Area

The humpback whale is one of the most common baleen whales to strand along the NC coast (Byrd et al. 2014). Strandings recorded between 1997 and 2008 were all of immature humpback whales. According to Wiley et al. (1995), juveniles may spend time feeding at mid-latitudes instead of migrating as far south as adults. Most NC humpback whale sightings are concentrated off Cape Hatteras during winter and spring. Few sightings and strandings have also been recorded during these seasons off southeastern NC (see summaries in DoN 2008a and 2008b). Because humpack whales are known to occur year-round in the mid-Atlantic, they may occur in the nearshore waters of the Permit Area during any season, but are most likely to be found farther north at the feeding grounds during the summer.

<u>West Indian Manatee</u>

Status, Habitat, Distribution

The West Indian manatee is designated as endangered under the ESA. The West Indian manatee population in FL is considered a distinct stock. The current minimum population estimate for this stock is 4,824 manatees based on a synoptic survey of warm-water refuges in January 2014 [Florida Fish and Wildlife Conservation Commission (FWCC) 2014].

West Indian manatees occur in shallow waters generally close to shore in estuarine and river mouth habitats (Rathbun et al. 1982). Preferred feeding habitats include shallow seagrass beds close to deep channels in coastal and riverine habitats (e.g., Lefebvre et al. 2000, USFWS 2001a). West Indian manatees are frequently located in secluded canals, creeks, embayments and lagoons near the mouths of coastal rivers and sloughs. These areas serve as suitable locations for feeding, resting, mating and calving (USFWS 2001a). Estuarine and brackish waters, including natural and artificial freshwater sources, are typical West Indian manatee habitat (USFWS 2001a). West Indian manatees rarely occur in offshore waters where abundant seagrass and vegetation are not available (Reynolds III and Odell 1991); however, sighting and tracking data indicate that some animals have ventured offshore (e.g., Reynolds III and Ferguson 1984, Lefebvre et al. 2001, Alvarez-Alemán et al. 2010). Critical habitat is designated for the West Indian manatee in FL (41 FR 41914).

The West Indian manatee occurs in warm, subtropical and tropical waters of the western North Atlantic from the southeastern US to Central America, northern South America and the West Indies (Lefebvre et al. 2001). During winter months, the FL population confines itself to inshore and inner shelf waters of the southern half of peninsular FL where they utilize warm-water springs, heated industrial effluents and other warm-water sites (Laist et al. 2013, Lefebvre et al. 2001). As water temperatures rise in spring, West Indian manatees disperse from winter aggregation areas. West Indian manatees are frequently reported in coastal rivers of GA and SC during warmer months (Lefebvre et al. 2001). They have been sighted as far north as Massachusetts (MA) (Beck 2006).

Occurrence in the Permit Area

West Indian manatees have been recorded in estuarine and coastal waters of NC during all seasons with summer and fall having the most reports (Cummings et al. 2014, Schwartz 1995). Schwartz (1995) suggested that West Indian manatees may be expanding their range into NC waters. Based on opportunistic data collected from July 1991 through September 2012, a total of 99 sightings and nine strandings of manatees have been recorded in NC (Cummings et al. 2014). Although almost all of the strandings were recorded in southeastern NC, sightings were reported throughout NC and were most common in the AIWW. However, manatees were also observed in sounds, bays, rivers, creeks, marinas and the open ocean. Sightings peaked during June through October when water temperatures were at least 20°C (Cummings et al. 2014). Based on their known habitat associations and the previous NC records, manatees may occur throughout the freshwater, estuarine and nearshore coastal waters in or near the Permit Area during any time of year.

4.6.1.2 Birds

Three species of federally protected birds are most likely to occur in the Permit Area: the piping plover, the red knot (*C. canutus rufa*) and the wood stork (*Mycteria americana*). Background information on these birds and their occurrence in the Permit Area are discussed in more detail below.

<u>Piping Plover</u>

Status, Habitat, Distribution

The population of piping plovers that breeds in the Great Lakes watershed is listed as endangered while all other piping plovers are designated as threatened under the ESA. All piping plovers are considered threatened when on their wintering grounds because the Great Lakes, Great Plains, and Atlantic piping plover populations cannot be separated here. The most recent abundance estimate of Atlantic Coast piping plovers is 1,849 breeding pairs based on data from 2009 (USFWS 2011). In NC, the breeding pairs increased from 30 to 54 between 1986 and 2009 (USFWS 2011).

Piping plovers breed in three discrete geographic areas: the Atlantic Coast from NC to Newfoundland, the Great Lakes region and the Northern Great Plains region. The three populations migrate between their respective breeding grounds and wintering sites that include coastal areas from NC to Texas (TX), Mexico, and the Caribbean (USFWS 2011). Members of the Atlantic Coast breeding population arrive on the breeding grounds and initiate courtship in late March and early April. In NC, the breeding season extends from April through August. Nests in NC may be found in mid- to late-April; piping plovers continue to nest during May and June [Personal communication, S. Schweitzer, North Carolina Wildlife Resource Commission (NCWRC), September 2014]. Chicks and fledglings may be present in May, June, July and August (Personal communication, S. Schweitzer, NCWRC, September 2014).

Southward fall migration to the wintering grounds occurs in NC during August, September and October (Personal communication, S. Schweitzer, NCWRC, September 2014). The migratory routes and wintering ranges of the three breeding populations overlap but are not fully understood (USFWS 2009). In NC, relatively large numbers of piping plovers have been sighted during migration at several sites including Oregon Inlet, Ocracoke Inlet/Portsmouth Flats and New Drum Inlet within the Cape Hatteras and Cape Lookout National Seashores (McConnaughey et al. 1990, USFWS 1996a). Critical habitat for the wintering population of piping plovers is designated along the coasts of NC, SC, GA, FL, Alabama (AL), Mississippi (MS), Louisiana (LA), and TX (66 FR 36038, 73 FR 62816, 74 FR 23476). Piping plovers overwinter in NC between November and early March. Northern spring migration from NC back to the breeding grounds occurs in March and April (Personal communication, S. Schweitzer, NCWRC, September 2014).

Piping plovers nest on coastal beaches, sandflats along the accreting ends of barrier islands, and washover and blowout areas between dunes. Nests consist of shallow scraped depressions in the sand, are often lined with shell fragments, and are typically located in areas with little or no vegetation (Cohen et al. 2008, USFWS 1996a). Wintering plovers on the Atlantic coast are found at accreting ends of barrier islands, along sandy peninsulas and near coastal inlets. Preferred foraging habitats include sandflats adjacent to inlets or passes, sandy mudflats along prograding spits and overwash areas. Roosting sites generally include inlet and adjacent ocean and estuarine shorelines and nearby exposed tidal flats (USFWS 1996a).

Occurrence in the Permit Area

Piping plovers occur along NC's coast year-round; they nest on beaches during the spring and summer, stop over during spring and fall migrations, and overwinter on beaches and around inlets. Therefore, they may occur in the Permit Area during any time of year. Sightings have been recorded throughout the LFI area (NCWRC data, Figure 4.7). See Appendix K for more details about these records. Breeding sites in NC are primarily confined to undeveloped and unstabilized barrier islands along the northern section of the coast, primarily within the Cape Lookout National Seashore, Cape

Figure 4.7. Shorebird Critical Habitat, Sightings, and Nests in and near the Permit Area

Hatteras National Seashore, Pea Island National Wildlife Refuge, and on Lea and Hutaff Islands (USFWS 2009, Dinsmore et al. 1998). A few pairs nest sporadically along the southern coast as far south as Brunswick County. Nesting was first confirmed on the west end of Holden Beach in July 1993 (Slack 1994), and a nest was recorded on Oak Island in May 1989 (NCWRC data, Figure 4.7). Breeding sites along developed barrier islands are restricted to the accreting ends of the islands along tidal inlets, and piping plovers in NC are very rarely seen on developed ocean facing beaches; these areas are not considered suitable habitat (Cameron 2009). Inlet habitats along many of NC's developed barrier islands, including the west end of Oak Island along LFI and the west end of Holden Beach along Shallotte Inlet, provide important habitat for migrating and wintering plovers from all three breeding populations (Cameron et al. 2006). Recent bird surveys conducted along the Holden Beach beachfront by a local bird expert found as many as 24 piping plovers in this area in March and April (Holden Beach Beachfront Shorebird Survey Report 2014). Additional sightings in the Permit Area were recorded by birders on Holden Beach's East End in July 2007 and in LFI during August 2010 and March 2014 (eBird 2014).

Two critical habitat units for the Atlantic coast wintering population are designated in and near the Permit Area (66 FR 36038). The LFI Unit (NC-16) covers 90 ac and extends from the west end of Oak Island (West Beach Drive) west to the mean lower low water (MLLW) line at LFI and includes emergent sandbars south and adjacent to the island (Figure 4.7). This unit includes land from MLLW on the Atlantic coast to the MLLW adjacent to the Eastern Channel and AIWW. The Shallotte Inlet Unit (NC-17) covers 296 ac and includes the west end of Holden Beach and the unnamed island emergent shoals to MLLW within the inlet (Figure 4.7).

<u>Red Knot</u>

Status, Habitat, Distribution

The *rufa* subspecies of the red knot was recently listed as threatened under the ESA due to loss of breeding and nonbreeding habitats, potential disruption of natural predator cycles on breeding grounds, reduced prey availability in the nonbreeding range and frequent and severe asynchronies in the timing of annual migration relative to favorable weather and food conditions (79 FR 73706). Population abundance estimates are not available for the breeding range of the rufa red knot (hereafter referred to as "red knot") because this subspecies is thinly distributed across large remote areas of the Arctic during the breeding season (USFWS 2013). Recent counts of red knots wintering in the southeast US totaled 3,814 to 3,939 in 2011 with 157 of those birds occurring in NC (USFWS 2013). Seasonal surveys conducted between 1992 and 1993 on the Outer Banks resulted in totals of 4,088 and 1,334 red knots during spring and fall, respectively, with a peak count in May (Dinsmore et al. 1998). The most recent peak count from the

National Park Service's long-term monitoring program was 854 red knots in the Outer Banks during May 2013 (National Park Service 2013a).

Red knots breed in the central Canadian Arctic and occur in three main wintering groups: short distance migrants that winter in the southeastern US, medium distance migrants that winter on the northern coast of Brazil and long distance migrants that winter in Tierra del Fuego (southern tip of South America) (Niles et al. 2012). In the southeastern US, red knots overwinter primarily in FL and GA (Niles et al. 2008). However, red knots are known to winter as far north as Virginia (VA) (Niles et al. 2012). Major stopover sites during the southbound migration include MA, Connecticut (CT) and Rhode Island (RI). During the northbound migration, stopover sites along the US Atlantic coast include the primary stopover in Delaware Bay, although some red knots stop farther south between VA and FL (Gillings et al. 2009, Niles et al. 2008). In NC, red knots use the Outer Banks as a stopover site during spring and fall migrations, and they also overwinter there (Niles et al. 2012, Dinsmore et al. 1998). Overwintering red knots may be hatch-year and/or subadult red knots (Personal communication, S. Schweitzer, NCWRC, September 2014). Red knots are most abundant in NC during the spring migration (April-June), particularly in May (Personal communication, S. Schweitzer, NCWRC, September 2014). Fall migrants arrive in July with a small peak in September (Dinsmore et al. 1998).

Preferred wintering and migration habitats include muddy or sandy coastal areas, particularly the mouths of bays and estuaries and unimproved tidal inlets and tidal flats. Wintering habitat in the southeastern US also includes peat banks, salt marshes, brackish lagoons and mangroves. In this region, red knots forage along sandy beaches, in tidal mudflats, along peat banks and along barrier islands (Niles et al. 2008). Preferred prey in nonbreeding habitats include horseshoe crab eggs, snails, clams and crustaceans (Cohen et al. 2010, Niles et al. 2008, Tsipoura and Burger 1999).

Occurrence in the Permit Area

Red knots have been observed in NC during all seasons (Dinsmore et al. 1998), therefore, they may occur in the Permit Area during any time of the year. They are most common in NC during the migration seasons (mid-April through May and July to mid-October) (Personal communication, K. Matthews, USFWS, September 2014) and appear to be most abundant in May during the spring migration (Personal communication, S. Schweitzer, NCWRC, September 2014). Known stopover sites for red knots in Brunswick County include Tubbs Inlet and Ocean Isle Beach during April (Niles et al. 2008) and Bald Head Island during May/June (USACE 2014a). Aerial surveys conducted by the Center for Conservation Biology (College of William and Mary), NC Audubon, and NCWRC during May 2009, 2011, and 2012 recorded groups of red knots ranging from 15 to 56 on Holden Beach and Oak Island (Long Beach) (Personal communication, S. Schweitzer, NCWRC, September 2014) (Figure 4.7) (See Appendix K for more details about these records). Additional sightings in the Permit

Area were recorded by birders on Holden Beach near the western boundary of the Permit Area in October 2012 and on the western tip of Oak Island during May 2011 (eBird 2014). During recent bird surveys conducted along the Holden Beach beachfront between mid-November 2013 and late April 2014, researchers observed scattered small groups of red knots along the beachfront in December and January and groups of 10-25 red knots in the marshes and mudflats on the northern side of Holden Beach in late November (Holden Beach Beachfront Shorebird Survey Report 2014). Note that the global positioning system (GPS) coordinates were not available for these sightings; therefore, they are not included in Figure 4.7.

<u>Wood Stork</u>

Status, Habitat, Distribution

In June 2014, the US breeding population of the wood stork was reclassified from endangered to threatened under the ESA (79 FR 37078). This breeding population in MS, AL, FL, GA, SC, and NC was also designated as a Distinct Population Segment (DPS). A distinct population segment is the smallest division of a taxonomic species permitted to be protected under the ESA.

The current breeding range includes peninsular FL, the coastal plain and large river systems in GA and SC, and southeastern NC. Nesting periods vary geographically. In southern FL, wood storks lay eggs as early as October and fledge in February or March. However, in northern and central FL, GA, and SC, storks lay eggs between March and late May with fledging occurring in July and August (79 FR 37078).

Wood storks are not true migrants, but they generally disperse following breeding. Beginning in late May, following breeding in FL; most fledglings, immatures, and adults disperse in peninsular FL and northward (Coulter et al. 1999).

The breeding population has been increasing; three-year population averages of total nesting pairs have been higher than 6,000 since 2003. Between 2011 and 2013, the average total nesting pairs for FL, GA, SC, and NC was 9,692 (79 FR 37078). This species has been increasing in the Carolinas over the past 20 years possibly due to a northward shift in the breeding populations (LeGrand 2013). The first colony in NC was recorded at Lays Lake, Columbus County in 2005 and consisted of 32 nesting pairs (USFWS 2007). Since then, the number of nesting pairs at this colony have been continuously increasing; the most recent pairs recorded here were 220 in 2010 based on the Wood Stork Colony Dataset (1970-2010) maintained by the University of Florida (http://www.wec.ufl.edu/faculty/frederickp/woodstork/). In 2013, three colonies and 205 nesting pairs were documented in NC (79 FR 37078). In addition to the Lays Lake colony, the new colonies were found just east of Tabor City (Columbus County) and along the Black River (Bladen/Pender Counties line) (LeGrand 2013).

Wood storks use a wide variety of freshwater and estuarine wetlands for nesting, feeding and roosting sites. Nesting colony sites are in freshwater and marine-estuarine forested habitats, primarily in cypress swamps. However, depending on the location, colony sites may consist of other plants such as dead oaks, mangroves, cactus, black gum, willow and buttonbush (Coulter et al. 1999). Storks tend to use the same colony site over many years as long as the site remains undisturbed and there is sufficient feeding habitat in the surrounding area (USFWS 1997). Feeding habitat consists of natural and artificial wetlands where prey species are available and water depths are appropriate [<50 centimeters (cm)] (Coulter et al. 1999). However, wood storks are also known to feed in shallow brackish and saltwater pools and channels (LeGrand 2013). Wood storks also use man-made wetlands for foraging and breeding. Some of these man-made wetlands include storm water treatment areas and ponds, golf course ponds, borrow pits, reservoirs, roadside ditches, agricultural ditches, drainages, flow-ways, mining and mine reclamation areas and dredge spoil sites (USFWS 2007). Roosting sites are generally in trees over water, but storks may also rest on the ground close to feeding sites (Coulter et al. 1999).

Occurrence in the Permit Area

Wood stork occurrence has been increasing in NC, particularly the southeastern portion of the state. Wood storks are considered summer residents and post-breeding visitors to several areas of coastal NC (LeGrand 2013). They are common at the primary breeding site at Lays Lake in Columbus County and the post-breeding site at Twin Lakes, the mainland portion of Sunset Beach in Brunswick County. They are rare but increasing in other portions of Columbus and Brunswick Counties, Robeson County, along the Black River and as far north as the Outer Banks. They may occur during any time of the year, but are primarily sighted from early June to November (LeGrand 2013). During the winter, most wood storks retreat to FL and southern GA after dispersing widely throughout the coastal plain of the southeast US after the breeding season (Coulter et al. 1999). Although they are very rare in NC during the winter, there are several records of this species during December, January, and February (LeGrand 2013). Wood storks return to their breeding sites by April (LeGrand 2013).

Wood storks have been sighted on Holden Beach, Oak Island and in the Lockwoods Folly River; most of these sightings have been recorded during the months of July, August and October in recent years (2012-2014) (eBird 2014). Between October 2012 and July 2014, nine sightings were documented on Holden Beach and ranged from Holden Island Point on the west end of the island to the eastern tip. This East End sighting of two wood storks is in the Permit Area and was recorded in July 2013 (eBird 2014). Other sightings on Holden Beach are also recorded along the beachfront and in the marsh areas. A total of four sightings of wood storks were recorded on Oak Island between October 1987 and July 2013 (eBird 2014). All except one of these sightings were inland of the beachfront. Wood storks were recently sighted in the Lockwoods

Folly River just north of the Permit Area boundary in October 2014. Additional sightings of wood storks were recorded in this same area in August 2013 (eBird 2014).

4.6.1.3 Sea Turtles

Five species of sea turtles are known to occur along the NC coast: the leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), and Kemp's ridley (*Lepidochelys kempii*). The Kemp's ridley sea turtle is the only one of these species that occurs sporadically in this region. The other four species are regular inhabitants.

NC waters provide important transitional habitats for juvenile and adult sea turtles. Juvenile sea turtles frequent these waters year-round and exhibit seasonal foraging movements (migrating north along the coast in the early spring to coastal developmental habitats and south in the fall as waters cool) (Morreale and Standora 2005). Adult sea turtles may be found foraging in shallow, coastal (Hawkes et al. 2007) or offshore waters (Hopkins-Murphy et al. 2003). Shelf waters also serve as habitat for adult sea turtles (Hopkins-Murphy et al. 2003). Adult loggerhead, leatherback and green sea turtles are known to nest on NC's ocean facing beaches in the summer (Schwartz 1989; Rabon et al. 2003).

<u>Leatherback Sea Turtle</u>

Status, Habitat, Distribution

Leatherback sea turtles are listed as endangered under the ESA (NMFS and USFWS 1992). Recent abundance estimates for adult leatherbacks range from 34,000 to 94,000 individuals in North Atlantic waters [NMFS and USFWS 2007a, Turtle Expert Working Group (TEWG) 2007]. Critical habitat for Atlantic leatherbacks is designated in the Caribbean at Sandy Point, St. Croix, US Virgin Islands (44 FR 17710).

Late juvenile and adult leatherback sea turtles are known to range from mid-ocean to continental shelf and nearshore waters (Schroeder and Thompson 1987, Shoop and Kenney 1992, Grant and Ferrell 1993, Dodge et al. 2014). Juvenile and adult foraging habitats include both coastal feeding areas in temperate waters and offshore feeding areas in tropical waters (Eckert and Abreu-Grobois 2001). Leatherback nesting beach habitat is generally associated with deep water, strong waves and oceanic currents, but shallow waters near mud banks are also utilized for nesting (TEWG 2007).

A regular, seasonal occurrence of leatherbacks is known along the northeast US Atlantic coast. Leatherbacks foraging in the western North Atlantic prefer waters from 16 to 18ºC (Thompson et al. 2001, James et al. 2006); their lower thermal limit is in sea surface temperatures (SSTs) between 10 to 12ºC (Witt et al. 2007). In the late winter and early spring, leatherbacks are distributed primarily in tropical latitudes (Stewart and Johnson 2006); survey data show that around this time of year, individuals begin to move north along the North American Atlantic coast. By February and March, the majority of leatherbacks found in US Atlantic waters are distributed off northeast FL. This movement continues through April and May when leatherbacks begin to occur in large numbers off the coasts of GA and the Carolinas (NMFS 1995 and 2000). Leatherbacks become more numerous off the mid-Atlantic and southern New England coasts in late spring and early summer, and by late summer and early fall leatherbacks may be found in the waters off eastern Canada (CETAP 1982, Shoop and Kenney 1992, Thompson et al. 2001, Dodge et al. 2014).

Leatherback nesting occurs on isolated mainland beaches in tropical and temperate oceans (NMFS and USFWS 1992) and to a lesser degree on some islands, such as the Greater and Lesser Antilles. In the US, the densest nesting is on the Atlantic coast of FL (Stewart and Johnson 2006). Sporadic nesting occurs in GA, SC, and NC (Rabon et al. 2003). Nesting activities in NC were reported in June/July 1998 and in April/June 2000 along Cape Hatteras National Seashore and in June 2000 at Cape Lookout National Seashore (Rabon et al. 2003). The most recent nesting activity for this species in NC was two sites in 2009 (one on Cape Hatteras and one on the northern Outer Banks), two sites in 2010 (one on Bald Head Island and one on Holden Beach), and five sites in 2012 (four at Cape Lookout and one at Cape Hatteras) (Seaturtle.org 2014).

Occurrence in the Permit Area

NC waters may be utilized by foraging leatherbacks or individuals in transit. The coastal area immediately adjacent to Cape Hatteras is recognized as a migratory pathway for leatherbacks (Lee and Palmer 1981). Leatherbacks are found year-round in NC waters (Schwartz 1989); therefore, they may occur in the Permit Area during any time of year. The majority of leatherback sightings and strandings off southeastern NC have been recorded during spring (DoN 2008a). The greatest concentrations of leatherbacks are expected to occur in NC from mid-April through mid-October (Keinath et al. 1996). Sporadic nesting activity has occurred in NC; one of these nest sites was on Holden Beach in 2010 near the Permit Area boundary (NCWRC data).

<u>Loggerhead Sea Turtle</u>

Status, Habitat, Distribution

The loggerhead sea turtle is composed of nine DPSs. The Northwest Atlantic Ocean DPS occurs in NC and is designated as threatened under the ESA (76 FR 58868). Five recovery units (nesting populations) are identified in the Northwest Atlantic: (1) Northern - FL/GA border to southern VA; (2) Peninsular FL – FL/GA border south through Pinellas County, FL (excluding Key West); (3) Dry Tortugas – islands west of Key West, FL; (4)

Northern Gulf of Mexico - Franklin County, FL, west through TX; and (5) Greater Caribbean – Mexico through French Guiana, The Bahamas, and Lesser/Greater Antilles (NMFS and USFWS 2008). The Peninsular FL population represents approximately 87 percent of all nesting effort in the Northwest Atlantic Ocean DPS (Ehrhart et al. 2003). Turtle nests in NC totaled 557 nests in 2013; the majority of these nests were loggerheads with a few green turtles and one Kemp's ridley (Seaturtle.org 2014).

Loggerheads occur worldwide in habitats ranging from coastal estuaries, bays and lagoons to pelagic waters (Dodd 1988). Early juvenile loggerheads are primarily oceanic, occurring in pelagic convergence zones where they are transported throughout the ocean by dominant currents, such as the North Atlantic Gyre (Caldwell 1968, Carr 1986, Bolten et al. 1994, Witherington 1994). Late juveniles and adult loggerheads most often occur on the continental shelf and along the shelf break of the US Atlantic and Gulf coasts as well as in coastal estuaries and bays (CETAP 1982, Shoop and Kenney 1992). Subadult and adult loggerhead turtles tend to inhabit deeper offshore feeding areas along the western Atlantic coast from mid-FL to NJ and most likely forage on benthic prey (Hopkins-Murphy et al. 2003, Roberts et al. 2005, Hawkes et al. 2007).

In the US North Atlantic, loggerheads commonly occur in shelf waters as far north as the New York Bight (CETAP 1982, Shoop and Kenney 1992). Loggerhead distribution along the US Atlantic coast is strongly seasonal and is dictated primarily by SSTs. Loggerheads prefer SSTs between 13 and 28°C (Mrosovsky 1980); they tend to become lethargic in SSTs below 15°C and may become incapacitated ("cold-stunned") at temperatures below 10°C (Schwartz 1978, Mrosovsky 1980). Loggerheads occur north of Cape Hatteras primarily in late spring through early fall (May and October) with a peak occurrence in June; however, sightings are recorded in mid-Atlantic and northeast waters year round (CETAP 1982, Lutcavage and Musick 1985, Shoop and Kenney 1992). During the summer, loggerheads may be found regularly in shelf waters from Delaware Bay to Hudson Canyon, including Long Island Sound and Cape Cod Bay (Burke et al. 1991, Shoop and Kenney 1992, Prescott 2000, UDSG 2000). As SSTs decrease in the winter, most individuals move south of Cape Hatteras to overwinter (Epperly et al. 1995a, Mitchell et al. 2002, Hawkes et al. 2011). From November to April, loggerheads are primarily found off the coast of southern NC in the South Atlantic Bight (Griffin et al. 2013). However, stranding and sighting data indicate that not all loggerheads leave mid-Atlantic and New England waters during the winter (Burke et al. 1991).

Critical habitat for the Northwest Atlantic Ocean DPS was recently designated for terrestrial and marine areas in the Atlantic and Gulf of Mexico (79 FR 39756, 79 FR 39856). The USFWS-designated terrestrial critical habitat areas include 88 nesting beaches in NC, SC, GA, FL, AL, and MS (79 FR 39756). These critical habitat areas include a total of 38 units encompassing 393.7 km of the Atlantic Ocean shoreline designated for the Northern Recovery Unit: eight units in NC, 22 in SC and eight in GA. These units comprise approximately 86 percent of the documented nesting within the recovery unit. Three of the eight units in NC are within Brunswick County and include portions of Bald Head Island (LOGG–T–NC–06), Oak Island (LOGG–T–NC–07) and Holden Beach (LOGG–T–NC–08) (79 FR 39756).

The NOAA-designated marine critical habitat for the Northwest Atlantic Ocean DPS includes some nearshore reproductive areas directly offshore of nesting beaches from NC through MS, winter habitat in NC, breeding habitat in FL, constricted migratory corridors in NC and FL and *Sargassum* habitat in the western Gulf of Mexico and in US waters within the Gulf Stream in the Atlantic Ocean (79 FR 39856). The nearshore reproductive areas are adjacent to high-density nesting beaches used by hatchlings egressing to the open-water environment and by nesting females transiting between the beach and open water during the nesting season and extend 1.6 km offshore. The winter habitat in NC includes warm-water habitats between Cape Hatteras and Cape Fear near the western edge of the Gulf Stream (between the 20- and 100-m isobaths) that are used by a high concentration of juveniles and adults during the winter months. The constricted migratory corridor off NC consists of waters between 36°N and Cape Lookout from the edge of the Outer Banks barrier islands to the 200-m isobath. This corridor overlaps with the northern portion of winter habitat off NC and serves as a migratory pathway for loggerheads transiting to neritic foraging areas in the north and back to winter, foraging and/or nesting areas in the south. The majority of loggerheads pass through this migratory corridor in the spring (April to June) and fall (September to November), but loggerheads are also present in this area from April through November (79 FR 39856).

Occurrence in the Permit Area

Seasonal water temperatures influence loggerhead occurrence offshore NC, but loggerheads are resident year round south of Cape Hatteras. Therefore, loggerheads may be found in the Permit Area during any time of year. Sea turtle nesting and hatching season in NC extends from May 1 through November 15 (Holloman and Godfrey 2008); 2005-2014 nesting activity along Oak Island and Holden Beach was typically recorded between May and August (NCWRC data). Based on all nesting data from 1998-2013, the nesting density (nests per 1 km) was relatively high for both Oak Island (4.12) and Holden Beach (3.37) (Hernandez 2014). Average nests per year on Oak Island and Holden Beach are approximately 64 and 35, respectively (Hernandez 2014). In 2013, 93 loggerhead nests were recorded on Oak Island and 71 were recorded along Holden Beach. The number of loggerhead nests recorded in 2014 was well below average at 31 on Oak Island and 19 on Holden Beach (NCWRC data). Nesting sites have been recorded in and near the Permit Area during each year between 2005 and 2014 (Figures 4.8 and 4.9). See Appendix L for more information about the location of nesting sites in the Permit Area during each of these years.

Two terrestrial critical habitat units for nesting loggerheads are designated within the Permit Area (79 FR 39756) (Figure 4.10). The Oak Island unit (LOGG–T–NC–07)

Figure 4.8. Loggerhead Turtle Nesting near Permit Area (2005 - 2014)

Figure 4.9. Loggerhead Turtle Nesting within Permit Area (2005 - 2014)

Figure 4.10. Loggerhead Turtle Critical Habitat in and near Permit Area

extends from the mouth of the Cape Fear River to LFI and includes lands from the MHW line to the toe of the secondary dune or developed structures. This unit protects the high-density nesting of loggerheads in this area. The adjacent Holden Beach unit (LOGG–T–NC–08) supports the potential expansion of nesting. This unit extends from LFI to Shallotte Inlet and includes lands from the MHW line to the toe of the secondary dune or developed structures. The marine critical habitat designated within the Permit Area includes a nearshore reproductive area within unit LOGG–N–5 which includes Pleasure Island, Bald Head Island, Oak Island and Holden Beach in New Hanover and Brunswick Counties, NC. This unit consists of nearshore habitat from Carolina Beach Inlet around Cape Fear to Shallotte Inlet (crossing the mouths of the Cape Fear River and LFI) from the MHW line to 1.6 km offshore (Figure 4.9).

<u>Green Sea Turtle</u>

Status, Habitat, Distribution

The green sea turtle is designated as threatened under the ESA with the FL and Mexican Pacific coast nesting populations listed as endangered (NMFS and USFWS 1991). The nesting area for green turtles encountered at sea cannot be determined; therefore, a conservative management approach is to assume that green turtles in the offshore environment may be from the endangered populations. Recent population estimates for green turtles in the western North Atlantic are not available (NMFS 2006a). Juvenile green turtles are the second most abundant sea turtle species in NC summer developmental habitats (Epperly et al. 1995b). The only designated critical habitat for this species is in Puerto Rico (63 FR 46694).

Post-hatchling and early-juvenile green turtles reside in convergence zones in the open ocean (Carr 1987, Witherington and Hirama 2006). Once green turtles reach a carapace length of 20 to 25 cm, they migrate to shallow nearshore areas (<50 m in depth) where they spend the majority of their lives as late juveniles and adults. The optimal developmental habitats for late juveniles and foraging adults are warm, shallow waters (3 to 5 m in depth) with an abundance of SAV, and also areas in close proximity to nearshore reefs or rocky areas (e.g., Holloway-Adkins and Provancha 2005, Witherington et al. 2006).

Green turtles found in US waters come from nesting beaches widely scattered throughout the Atlantic (Witherington et al. 2006). Along the US east coast, green turtles are found as far north as MA (NMFS and USFWS 1991). Juvenile green turtles utilize estuarine waters as far north as Long Island Sound, Chesapeake Bay and NC sounds as summer developmental habitat (Epperly et al. 1995b, Epperly et al. 1995c, Musick and Limpus 1997). NC waters, especially Pamlico and Core Sounds, serve as important neritic developmental habitat for benthic-stage green turtles (Epperly et al. 1995a, Epperly et al. 1995c). The highest proportions of green turtles in NC waters are observed in the fall (Epperly et al. 1995b) in conjunction with the southward migration of juvenile greens moving to warmer waters for the winter (Mendonça 1983).

Most nesting in North America occurs in southern FL and Mexico (Meylan et al. 1995) with scattered records in the FL Panhandle, AL, GA, and the Carolinas (NMFS and USFWS 1991, Peterson et al. 1985, Schwartz 1989). Green turtle nesting in NC has primarily been documented at Onslow Beach, Caswell Beach and Bald Head Island and near Cape Hatteras (Peterson et al. 1985, Schwartz 1989).

Occurrence in the Permit Area

During spring, summer and fall, green turtles occur in waters offshore of NC. South of Cape Hatteras, green turtles may occur year-round in waters between the shoreline and the 50-m isobath, where their preferred habitats of seagrass beds and worm-rock reefs are found. Green turtles have been recorded off southeastern NC year-round (see summaries in DoN 2008a). Therefore, this species may occur in the Permit Area during any time of year and may nest there. In 2013, a total of 40 green turtle nests were recorded in NC; over half of these nests were documented at Cape Hatteras National Seashore (National Park Service 2013b), and one of these nests was on Holden Beach (Seaturtle.org 2014).

<u>Hawksbill Sea Turtle</u>

Status, Habitat, Distribution

The hawksbill sea turtle is designated as endangered under the ESA. This species is second only to the Kemp's ridley sea turtle in terms of endangerment (NMFS and USFWS 1993, Bass 1994). The most recent estimate of hawksbill abundance in the Atlantic Ocean was 3,072 to 5,603 nesting females based on historical and recent estimates of nesting colonies from around the Atlantic Basin (NMFS and USFWS 2007b). Critical habitat for this species is designated in Puerto Rico (63 FR 46693).

As post-hatchlings and small juveniles, hawksbill turtles inhabit oceanic waters where they are sometimes associated with driftlines and floating patches of *Sargassum* (Parker 1995, Witherington and Hirama 2006). The developmental habitats for juvenile benthic-stage hawksbills are the same as the primary feeding grounds for adults; they include tropical, nearshore waters associated with coral reefs, hardbottoms or estuaries with mangroves (Musick and Limpus 1997). Coral reefs are optimal habitat for juveniles, subadults and adults (NMFS and USFWS 1993, Diez et al. 2003). Late juveniles generally reside on shallow reefs less than 18 m deep. However, as they mature into adults, hawksbills move to deeper habitats and may forage to depths greater than 90 m. Benthic-stage hawksbills are seldom found in waters beyond the continental or insular shelf unless they are transiting between distant foraging or nesting grounds (NMFS and USFWS 1993).

In the Atlantic Ocean, this species is found throughout the Gulf of Mexico, the Greater and Lesser Antilles and southern FL, as well as along the mainland of Central America south to Brazil (NMFS and USFWS 1993). The hawksbill is rare north of FL (Lee and Palmer 1981, Keinath et al. 1991, Parker 1995, Plotkin 1995, USFWS 2001b). Small hawksbills have stranded as far north as Cape Cod, MA (NMFS 2006a).

Occurrence in the Permit Area

Hawksbill sea turtles are not known to nest in NC. Sightings and strandings of this species have been recorded off NC throughout the year (see summaries in DoN 2008a and 2008b). Epperly et al. (1995b) reported the incidental capture of one hawksbill in Pamlico Sound. Few sightings have been recorded in nearshore waters off southeastern NC near the Permit Area during summer (see DoN 2008a). Occurrences of this species in the Permit Area are possible year round but would be rare.

<u>Kemp's Ridley Sea Turtle</u>

Status, Habitat, Distribution

The Kemp's ridley sea turtle is designated as endangered under the ESA (35 FR 18319); this is considered the world's most endangered sea turtle species (USFWS and NMFS 1992). The worldwide population declined from tens of thousands of nesting females in the late 1940s to approximately 300 nesting females in 1985 (TEWG 2000).

Kemp's ridley turtles occur in open-ocean and *Sargassum* habitats of the North Atlantic Ocean as post-hatchlings and small juveniles (e.g., Manzella et al. 1991, Witherington and Hirama 2006). Large juveniles and adults move to benthic, nearshore feeding grounds along the US Atlantic and Gulf coasts (Morreale and Standora 2005). Habitats frequently utilized include warm-temperate to subtropical sounds, bays, estuaries, tidal passes, shipping channels and beachfront waters where their preferred prey, including the blue crab, occurs (Lutcavage and Musick 1985, Landry and Costa 1999, Seney and Musick 2005). Their most suitable habitats are less than 10 m deep with SSTs between 22° and 32°C (Coyne et al. 2000). Seagrass beds, mud bottom and live bottom are important developmental habitats (Schmid and Barichivich 2006). Postnesting Kemp's ridleys travel along coastal corridors generally shallower than 50 m (Morreale et al. 2007).

Feeding grounds and developmental habitats are along the Atlantic and Gulf coasts of the US. Some Kemp's ridley juveniles migrate as far north as New York (NY) and New England as early as June (Morreale and Standora 2005). During the winter, they migrate south to warmer waters off FL (Marquez-M. 1994). They typically migrate within the nearshore waters along the mid-Atlantic coast (Morreale and Standora 2005, Morreale et al. 2007); juveniles and adults often travel inshore of the 18-m isobath (Renaud and Williams 2005).

Individuals are known to overwinter south of Cape Hatteras, although the majority of Kemp's ridley turtles stay in FL near Cape Canaveral during the winter (Henwood and Ogren 1987). Individuals that overwinter off southern NC may subsequently move into warmer waters (e.g., Gulf Stream or areas off SC) during the mid-winter (Renaud 1995, Morreale and Standora 2005). For example, an individual tagged in Beaufort in 1989 remained in Onslow Bay during the winter and moved into the Gulf Stream when temperatures cooled close to shore in January 1990 (Renaud 1995). Kemp's ridley turtles utilize habitats in NC from April through October (Morreale and Standora 2005).

Occurrence in the Permit Area

Sightings and strandings have been recorded off NC year round (see summaries in DoN 2008a and 2008b). Therefore, Kemp's ridley sea turtles may occur in the Permit Area during any time of year. Occasional Kemp's ridley nests have been recorded in NC over the past few years; the first known nest in Cape Hatteras was in 2011 (National Park Service 2013b). Recent nests include one at Cape Lookout in 2014 and two in 2012 (Cape Lookout and northern Outer Banks) (Seaturtle.org 2014). No nests have been recorded in the Permit Area. Strandings of Kemp's ridley turtles have been recorded on the southeastern NC coast in and near the Permit Area during all seasons (see summaries in DoN 2008a and 2008b).

4.6.1.4 Fishes

Two species of federally protected fish are most likely to occur in the Permit Area: the shortnose sturgeon (*Acipenser brevirostrum*) and the Atlantic sturgeon (*Acipenser oxyrinchus*). Background information on these sturgeons and their occurrence in the Permit Area are discussed in more detail below. The US DPS of smalltooth sawfish (*Pristis pectinata*) is listed as endangered under the ESA from FL to Cape Hatteras, NC (68 FR 15674, 70 FR 69464). Although there have been historical records of this species in NC (Core Sound, Bogue Sound, New River and Cape Lookout) (NMFS 2006b), this DPS occurs only off southern FL (NMFS 2003). Therefore, the smalltooth sawfish is not expected to occur in the Permit Area and is not discussed further.

<u>Shortnose Sturgeon</u>

Status, Habitat, Distribution

The shortnose sturgeon is designated as endangered under the ESA (32 FR 4001). NMFS recognizes 19 DPSs of shortnose sturgeon inhabiting 25 river systems from Saint

John River, New Brunswick, Canada to St. Johns River, FL. One of these includes a DPS in the Cape Fear River, NC (NMFS 1998). However, few surveys have been conducted in the rivers and bays along the NC coast, and it is unknown if a reproducing population(s) of shortnose sturgeon exists [Shortnose Sturgeon Status Review Team (SSSRT) 2010]. Based on tagging and re-capture data analyzed in 1995, the most recent population estimate of shortnose sturgeon in the Cape Fear River is less than 50 individuals (Cape Fear River Partnership 2013).

The shortnose sturgeon inhabits rivers and estuaries. Although this species may move to the mouths of estuaries and nearby coastal waters, populations are primarily confined to natal rivers and estuarine habitats. Adults spawn in freshwater, but regularly enter saltwater habitats (NMFS 1998). In estuarine systems, the shortnose sturgeon occurs in areas with little or no current over a bottom comprised primarily of mud and sand. Sturgeons prefer freshwater swamps or areas with fast flows and gravel cobble bottoms in the riverine areas (Gilbert 1992). Adults are found in deep waters (10 to 30 m) in winter and in shallow waters (2 to 10 m) in summer. Juveniles are nonmigratory, typically inhabiting deep channels of swiftly flowing river above the salt wedge (Burkhead and Jenkins 1991).

Migrational patterns of shortnose sturgeons vary with fish size and home river location. Pre-spawners generally move upstream to spawning grounds in spring and summer, and post-spawners move back downstream in fall and winter to wintering areas with movements usually restricted to the areas above the saltwater/freshwater interface. Shortnose sturgeons are not known to participate in coastal migrations (NMFS 1998). Spawning begins from late winter/early spring (southern rivers: January to March) to mid to late spring (northern rivers: April to May) when water temperatures increase to 8° to 9°C. Spawning usually ceases when water temperatures reach 12° to 15°C (O'Herron et al. 1993, Kynard 1997).

Shortnose sturgeons were thought to be extirpated from NC waters until an individual was captured in the Brunswick River in 1987 (Ross et al. 1988). Subsequent gill-net studies (1989-1993) resulted in the capture of five shortnose sturgeons which confirmed the presence of a small population in the lower Cape Fear River (Moser and Ross 1995). A capture was reported in 1998 in western Albemarle Sound (Armstrong and Hightower 1999). Surveys in the Neuse River during 2001 and 2002 failed to capture any shortnose sturgeons (Oakley and Hightower 2007). Additional surveys are currently underway in the Roanoke, Chowan, and Cape Fear River Basins (NMFS 2010a). The current distribution of shortnose sturgeons in NC is thought to include only the Cape Fear and Pee Dee Rivers (SSSRT 2010). The Cape Fear River Estuary likely serves as a migration or staging corridor for spawning (SSSRT 2010).

Occurrence in the Permit Area

The shortnose sturgeon has not been recorded in or near the Permit Area. However, genetic studies indicate that some individuals move between the various populations (Quattro et al. 2002, Wirgin et al. 2005). The lack of records near the Permit Area may be due to a lack of survey effort. There is no documentation of a reproducing population of shortnose sturgeon in the Lockwoods Folly River, but this species may use the inlet and nearshore waters of Oak Island and Holden Beach as a feeding/staging area during coastal migrations (Personal communication, J. Facendola, NCDMF, October 2014). They are not expected to occur in the Eastern Channel or other inshore portions of the Permit Area (Personal communication, F. Rohde, NMFS, October 2014).

Atlantic Sturgeon

Status, Habitat, Distribution

Five distinct Atlantic sturgeon (*Acipenser oxyrinchus*) population segments along the Atlantic Coast are listed under the ESA (77 FR 5914, 77 FR 5880). The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs are designated as endangered while the Gulf of Maine DPS is listed as threatened. The Carolina DPS includes Atlantic sturgeon originating from the Roanoke, Tar/Pamlico, Cape Fear, Waccamaw, Pee Dee, and Santee-Cooper Rivers (77 FR 5914). The existing spawning populations in each of these rivers are thought to have less than 300 adults spawning each year [Atlantic Sturgeon Status Review Team (ASSRT) 2007].

Atlantic sturgeon spawn in freshwater but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the spring/early summer (Smith and Clugston 1997). Spawning is believed to occur in flowing water between the salt front and fall line of large rivers. Post-larval juvenile sturgeon move downstream into brackish waters and eventually move to estuarine waters where they reside for a period of months or years (Moser and Ross 1995). Subadult and adult Atlantic sturgeons emigrate from rivers into coastal waters where they may undertake long range migrations. Migratory subadult and adult sturgeon are typically found in shallow (10 to 50 m) nearshore waters with gravel and sand substrates (Collins and Smith 1997, Stein et al. 2004). Although extensive mixing occurs in coastal waters, Atlantic sturgeons return to their natal rivers to spawn (ASSRT 2007).

In NC, spawning occurs in the Roanoke, Tar-Pamlico, and Cape Fear River systems and possibly in the Neuse River (ASSRT 2007). Based on tagging data collected between 1988 and 2006, shallow nearshore waters off NC represent a winter (January-February) aggregation site and an important area of Atlantic sturgeon winter habitat (Laney et al. 2007).

Occurrence in the Permit Area

The Atlantic sturgeon occurs in the Cape Fear River system just east of the Permit Area. Subadults and adults are known to migrate in nearshore waters. Although there is no documentation of a reproducing population of Atlantic sturgeon in the Lockwoods Folly River, this species may use the inlet and nearshore waters of Oak Island and Holden Beach as a feeding/staging area during coastal migrations (Personal communication, J. Facendola, NCDMF, September 2014). The NCDMF's independent gillnet survey program has caught several Atlantic sturgeon off Oak Island during the winter sampling period (Personal communication, J. Facendola, NCDMF, September 2014). Atlantic sturgeons are not expected to occur in the Eastern Channel and other inshore portions of the Permit Area (Personal communication, F. Rohde, NMFS, September 2015.

4.6.1.5 Plants

The only ESA-listed plant species occurring in the Permit Area is the seabeach amaranth (*Amaranthus pumilus*). This species and its occurrence in the Permit Area are discussed below.

<u>Seabeach Amaranth</u>

Status, Distribution, and Habitat

The seabeach amaranth is designated as threatened under the ESA (58 FR 18035). Extant populations currently range from NY to SC. In NC, populations occur in Core Banks, Shackleford Banks, Brunswick County, Cape Hatteras, Ocracoke Island, Hammocks Beach State Park, Camp Lejeune, Bogue Banks and Wrightsville. The number of plants across NC has decreased from 19,978 in 2005 to 165 in 2013 (personal communication, Kathy Matthews, USFWS 2014 data). No critical habitat is designated for this species.

The seabeach amaranth is an annual plant found only along the Atlantic coastal plain where it inhabits barrier island beaches (Beacham 1994). Its primary habitat includes overwash flats at the accreting ends of the islands, lower foredunes, and upper strands of noneroding beaches (at the wrackline). Seabeach amaranth is usually found on a nearly pure silica sand substrate that is sparsely vegetated with annual herbs (forbs) and, less commonly, perennial herbs (mostly grasses) and scattered shrubs (USFWS 1996b). This natural community or vegetation type is classified by Schafale and Weakley (1990) as Upper Beach although seabeach amaranth can be found on sand spits 50 m or more from the base of the nearest foredune (USFWS 1996b). Seeds germinate from April through July, flowering begins as early as June in NC, and seed production begins in July or August with a peak in September. The reproductive season may extend into January (USFWS 1996b).

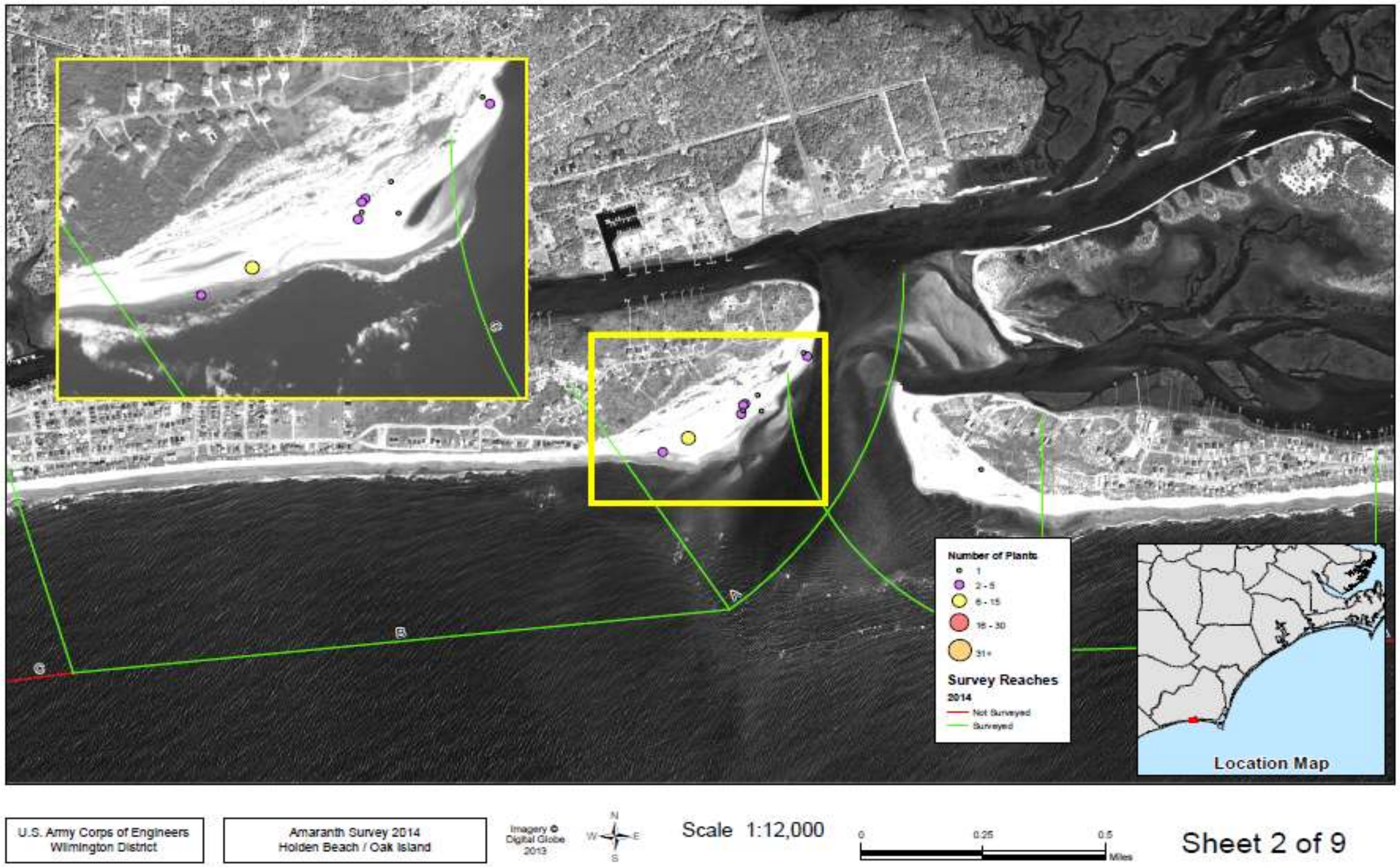
Occurrence in the Permit Area

The USACE has conducted comprehensive annual surveys for seabeach amaranth on NC beaches since 1999. Surveyed populations have generally declined since 2010 (USACE 2014b). On Holden Beach, seabeach amaranth has been found along the entire oceanfront beach and both inlet shorelines; however, since 1999, it has been consistently found along the western half of the island. The total number of plants observed between 2010 and 2013 ranged from 434 to 46 plants (USACE 2014b). A total of 349 plants were recorded on Holden Beach during the 2014 annual survey conducted in July and August; 26 of these plants are on the East End of Holden Beach in the Permit Area (USACE 2014b) (Figure 4.11).

Based on USACE survey data from 2009 through 2014, the majority of seabeach amaranth plants have been documented on the western tip of Oak Island (Personal communication, Dale Suiter, USFWS Raleigh office, 12 November 2014). Since 1992, there has been an extensive decrease in the presence of seabeach amaranth plants from a high of 5,826 plants surveyed on the western end of Oak Island to one plant surveyed in 2013 (USACE 2014b, USACE data). Decreased habitat availability on this portion of Oak Island has negatively affected the seabeach amaranth population there since 2010. The most recent survey conducted in July and August 2014 confirmed one plant on the western end of Oak Island in the Permit Area (USACE 2014b) (Figure 4.11).

4.6.2 State-Listed Species and Federal Species of Concern

Animal and plant species listed by the State of NC as threatened, endangered or of special concern are afforded protection under the NC ESA (G.S. 113-331 to 113-337) and the NC Plant Protection Act of 1979 (G.S. 196 106-202.12 to 106-202.19). State laws are primarily in place to protect listed species from poaching and illegal trafficking. In addition to state protected species, county rare species lists maintained by the North Carolina Natural Heritage Program (NCNHP) include "significantly rare" taxa that exist in the state in small numbers. Some state-listed species are also identified by the USFWS as federal species of concern (FSC). FSC is an informal designation that applies to former Category 2 (C2) candidate species that were removed from the official federal candidate list in 1996. Although former C2 species no longer have any official federal status, many of the USFWS regional offices continue to include FSC taxa on county species lists that are distributed for environmental project reviews. Although these species are not protected under the ESA and are not subject to Section 7 consultation, the USFWS advocates the consideration of these species during the NEPA process. The NCNHP rare species list for Brunswick County includes a number of state-listed and FSC species that may occur in marine, estuarine, and/or barrier island habitats (Table 4.3).



Map from USACE (2014b)

Figure 4.11. Seabeach Amaranth in the Permit Area in 2014. Inset is of seabeach amaranth located on East End of Holden Beach

Table 4.3. State-listed species.

Common Name	Scientific Name	State Status[2]	Federal Status[3]	Habitat
Wilson's plover	***Charadrius wilsonia***	**SC**		**Beaches, inlet flats, estuarine islands [breeding evidence only]**
Common ground dove	*Columbina passerina*	SR		Dunes, edges of maritime forest/shrub
Little blue heron	*Egretta caerulea*	SC		Maritime forest/shrub [breeding sites only]
Snowy egret	*Egretta thula*	SC		Maritime forest/shrub [breeding sites only]
Tricolored heron	*Egretta tricolor*	SC		Maritime forest/shrub [breeding sites only]
Gull-billed tern	*Gelochelidon nilotica*	T		Sand flats [breeding sites only]
American oystercatcher	***Haematopus palliatus***	**SC**		**Estuaries, oyster beds, mudflats [breeding evidence only]**
Bald eagle	*Haliaeetus leucocephalus*	T		Mature forests near large water bodies [nesting], lakes and sounds
Least bittern	*Ixobrychus exilis*	SC		Fresh/brackish marshes
Painted bunting (Eastern subspecies)	***Passerina ciris ciris***	**SC**	**FSC**	**Maritime forest/shrub**
Brown pelican	*Pelecanus occidentalis*	SR		Maritime islands [breeding sites only]
Glossy ibis	*Plegadis falcinellus*	SC		Maritime forest/shrub [breeding sites only]
Black skimmer	*Rynchops niger*	SC		Sand flats [breeding sites only]
Least tern	***Sternula antillarum***	**SC**		**Beaches, sand flats, dunes [breeding sites only]**
Loammi skipper	*Atrytonopsis loammi*	SR	FSC	Grassy areas near the coast
Giant swallowtail	***Papilio cresphontes***	**SR**		**Maritime forest/shrub**
Southern oak hairstreak	*Satyrium favonius favonius*	SR		Maritime forests
A liverwort	*Cheilolejeunea rigidula*	SR-P		Maritime forests
Diamondback terrapin	*Malaclemys terrapin*	SC	FSC	Salt/brackish marshes
Spreading sandwort	*Arenaria lanuginosa* var. *lanuginosa*	SR-P		Maritime grasslands and forests
Georgia sunrose	*Crocanthemum georgianum*	E		Maritime forests
Coral bean	***Erythrina herbacea***	**E**		**Maritime forests**
Southern seaside spurge	***Euphorbia bombensis***	**SR-T**		**Ocean beaches**
Beach morning-glory	***Ipomoea imperati***	**T**		**Ocean beaches and dunes**
Large-seed pellitory	*Parietaria praetermissa*	SC-V		Maritime forests
Seabeach knotweed	*Polygonum glaucum*	E		Ocean and sound beaches
Rhynchospora odorata	**Fragrant beaksedge**	**SC-V**		**Maritime wet grasslands**
Sesuvium maritimum	Slender seapurslane	SR-O		Ocean beaches, marshes
Sideroxylon tenax	Tough bumelia	T	FSC	Maritime forest and scrub
Solanum pseudogracile	Graceful nightshade	SR-T		Dunes
Solidago villosicarpa	**Coastal goldenrod**	**E**	**FSC**	**Edges and openings in maritime forests**
***Trichostema* spp.**	**Dune bluecurls**	**SR-L**	**FSC**	**Dunes, openings in maritime forest and scrub**
Yucca gloriosa	**Moundlily yucca**	**SR-P**		**Dunes**

[1]Bold = Species that have been observed in or near the Permit Area based on NCNHP Element Occurrence records (NCNHP 2014).
[2]E = Endangered, T = Threatened, SC = Special Concern, SC-V = Special Concern Vulnerable (all known populations are historical or extirpated), SR = Significantly Rare, SR-T = Significantly Rare Throughout (species is rare throughout its range), SR-L = Significantly Rare Limited (range of the species is limited to NC and adjacent states), SR-P = Significantly Rare Peripheral (species is at the periphery of its range in NC, generally more common elsewhere within its range), SR-O = Significantly Rare Other (species range is sporadic or does not correspond to any of the other SR categories)
[3]FSC = Federal Species of Concern

4.7 Cultural Resources in the Permit Area

As a consequence of nearly 400 years of sustained maritime activity, the waters off Brunswick County, including the mouth of the Cape Fear River, contain the remains of innumerable historical shipwrecks. Abandoned shipwrecks and other cultural resources that occur on submerged lands of the state are protected under the Federal Abandoned Shipwreck Act of 1987 and Chapter 121, Article 3 of the NC GSs (Salvage of Abandoned Shipwrecks and Other Underwater Archaeological Sites). Pursuant to Section 106 of the National Historic Preservation Act of 1966, projects affecting submerged lands of the state must be evaluated for potential effects on underwater cultural resources that are listed or may be eligible for listing in the National Register of Historic Places.

At least 22 historical shipwrecks dating from the early 1700s through World War II have been recorded near LFI (Hall 2011). The remains of four Civil War vessels at LFI are listed in the National Register of Historic Places under the Cape Fear Civil War Shipwreck District (Figure 4.12). The U.S.S. *Iron Age* and two sidewheel steamer blockade runners (*Elizabeth* and *Bendigo*) are located in a line across the mouth of the inlet, and a third sidewheel blockade runner (*Ranger*) is located ~1 mile west of the inlet (Photo 4.4). A remote sensing survey for potential cultural resources within the proposed borrow site was conducted by Tidewater Atlantic Research (Hall 2011). The survey identified a single magnetic anomaly and no acoustic targets. Data analyses indicated that the magnetic anomaly was a single, isolated object most likely consisting of modern debris.

4.8 Public Interest Resources in the Permit Area

The decision whether to issue a permit by the USACE is based on an evaluation of the probable impacts of the proposed activity and its intended use on the public interest. All factors which may be relevant to the proposal are considered in this document including economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, floodpain values, navigation, water quality, and in general, the needs and welfare of the people (33CFR320, Section 320.4).

4.8.1 Socioeconomic Resources

Population

Demographic statistics for Holden Beach and the west end of Oak Island (Census Tract 203.8) are presented in Table 4.4. The 2010 US Census reported a total of 575 permanent residents on Holden Beach and a total of 1,648 permanent residents on western Oak Island. The overwhelming majority of the permanent residents (97.6 percent) reported their race as “White” in 2010. All other single race groups combined

Figure 4.12. Shipwrecks Located in LFI

Photo 4.4. Exposed boilers of the Bendigo (left foreground) and the USACE dredge boat, Currituck, Site 0001LFI.

Source: Wilde-Ramsing and Angley 1985

Table 4.4. Demographic summary.

	Holden Beach	Oak Island Tract 203.8	Total
Total permanent resident population	575	1,648	2,223
White, percent	96.9	97.9	97.6
Black/African American, percent	0.9	0.4	0.5
American Indian/Alaska Native, percent	0.2	0.5	0.4
Native Hawaiian/Pacific Islander, percent	0.0	0.1	0.1
Asian, percent	0.0	0.1	0.1
Some Other Race, percent	1.4	0.1	0.4
Two or More Races, percent	0.7	0.9	0.9
Hispanic or Latino origin, percent	2.4	0.6	1.1
Population aged 65 years or older, percent	19.9	13.4	15.1
Median household income	$52,206	$52,319	-
Population below poverty level, percent	9.2	6.1	7.1
Housing units	2,335	2,126	4,461
Permanently Occupied	296	789	1,085
Seasonal use	1,732	1,145	2,877
Vacant	307	192	499

Source: US Census Bureau (2010a, 2010b)

accounted for 1.1 percent of the population, and the remaining residents (1.3 percent) were classified as either "Some Other Race" or "Two or More Races." In addition to race, 1.1 percent of the residents identified their ethnic origin as Hispanic or Latino. The resident population includes a substantial number of retirees with 15.1 percent of the population aged 65 or older and 34.4 percent of the households reporting retirement incomes. Median household incomes for Holden Beach and Oak Island are $52,206 and $52,319, respectively. In contrast to the relatively small permanent population on Holden Beach, the estimated peak seasonal population during the summer is approximately 13,000 and includes permanent residents, seasonal residents and persons renting private units on a monthly or weekly basis. The peak seasonal estimate does not account for day-trip visitation which may add as many as 1,000 additional people to the peak season population (Imperial et al. 2009). Oak Island has an estimated island-wide (Town of Oak Island and Caswell Beach) peak season population of around 32,000 and an island-wide permanent resident population of 6,531.

Housing

The 2010 US Census reported a total of 4,461 housing units on Holden Beach and western Oak Island; this total includes 1,085 permanently occupied units; 2,877 seasonal units; and 499 vacant units (Table 4.5). As indicated by the large number of seasonal units, over half of the housing units are secondary vacation homes that are occupied or rented out on a seasonal basis. Detached single family homes account for 91.3 percent of the units on Holden Beach and western Oak Island (Table 4.5). Buildings with two or more units account for 6.7 percent of the total followed by row houses (1.3 percent) and mobile homes (0.7 percent).

Table 4.5. Housing characteristics.

Units in Structure	**Holden Beach**	**Oak Island Tract 203.8**	**Total**	**Percent of Total**
1 unit, detached	2,111	2,035	4,146	**91.3**
1 unit, attached	36	25	61	**1.3**
2 or more units	210	94	304	**6.7**
Mobile home	30	0	30	**0.7**
Total housing units	2,387	2,154	4,541	**100**

Source: US Census Bureau 2010a

Economy

According to the North Carolina Department of Commerce, direct traveler expenditures in Brunswick County amounted to $418 million in 2011. Additional economic impacts attributable to travel spending included 4,670 jobs; a $75.8 million payroll; and $46.7 million in state and local tax revenues (US Travel Association 2011). In 2008, beach recreation on Holden Beach generated over $54 million in direct traveler expenditures (Table 4.6). The total estimated impact on sales and business activity due to direct beach recreation expenditures and economic multiplier effects was nearly $95 million. In 2005-2006, direct expenditures and multiplier effects attributable to beach recreation on Holden Beach supported an estimated 1,299 jobs. The economic impact of Holden Beach is also reflected in its contribution to the county tax base. According to the North Carolina Department of Revenue, the value of taxable real property on Holden Beach accounted for 16.7 percent ($1.2 billion) of the overall Brunswick County property tax base in 2011/2012 (Table 4.7). Substantial economic impacts are also attributed to the area's inlets and waterways. In 2008, the estimated total economic impact of recreational fishing charters and private boating trips through Brunswick County's inlets exceeded $70 million, and commercial fishery activity associated with Lockwoods Folly Inlet generated $900,157 in total economic impacts (NCDENR 2011).

Table 4.6. Economic impact of beach recreation.

Beach	2005-2006 Total Jobs Supported	2008 Direct Expenditures	2008 Total Impact Sales/Business Activity
Holden Beach	1,299	$54,097,121	$92,858,134
Oak Island/Caswell Beach	898	$37,424,734	$64,239,849
Total	**2,197**	**$91,521,855**	**$157,097,983**

Source: NCDENR 2011

Table 4.7. Value of taxable real property FY 2011/2012.

	Taxable Real Property[1]
Town of Holden Beach	$1,201,909,702
Town of Oak Island	$2,394,448,315
Total	**$3,596,358,017**
County	**$21,516,090,139**

[1]North Carolina Department of Revenue (www.dor.state.nc.us/publications/property.html)

Economic Costs and Benefits

Alternative actions for the Holden Beach East End Shore Protection Project each create a unique array of costs and benefits. These include market costs, such as construction and engineering costs associated with active mitigation, potential economic losses associated with upland damage, risk to coastal real estate and infrastructure, and non-market costs and benefits, such as those associated with effects on the natural environment, aesthetic appeal, habitats and species.

This section describes the potential scope of these values for each of the six alternative actions under consideration for the Holden Beach East End Shore Protection Project. Monetary measures are provided for values that are readily identifiable and measurable based on existing data, such as construction and maintenance costs for the alternatives that involve nourishment or a terminal groin, as well as assessed tax values for properties at-risk to loss from erosion. These values should not be considered definitive and should not be used as the sole basis for choice or ranking of alternatives.

This section should not be considered a formal cost-benefit analysis; it is not an attempt to monetize all aspects of the range of market and non-market costs and benefits that are associated with the alternative actions. Costs and benefits associated with changes in aesthetic appeal, opportunities for recreation, or services provided by the affected natural environment constitute real economic costs but are not monetized as part of this report. Based on results in the published and peer-reviewed literature as described in Appendix M, these values are known to be substantial. However, the precise magnitude, distribution, and timing of these values will remain unknown. As such, the select monetary values that are provided herein should be considered general approximations and not representations of the true economic worth associated with the alternatives. Given the inherent uncertainties regarding specific performance of alternatives over a 30-year project planning horizon, providing an estimate of total costs, total benefits, or net gains is not practical. As a result, ranking of the alternatives based on their relative economic values is not performed.

In many cases, the benefits associated with alternatives that mitigate the effects of erosion can be considered costs of alternatives that do not mitigate erosion. For example, the benefits of shoreline stabilization via nourishment or hardened structures include maintaining the integrity of the Holden Beach shoreline and the associated real estate. These economic values may be partially or wholly sacrificed in the absence of active mitigation. Hence, the costs of no action or retreat should account for declinations in the economic value of associated real estate due to lost shoreline integrity as well as losses associated with effects on use and non-use values associated with recreation and tourism on Holden Beach. It is important to note, however, that inaction or retreat may have the greatest adverse effect on environmental conditions. Therefore, strategies that do not protect the shoreline from continued erosion are not expected to maintain environmental conditions in the Permit Area.

Cost and benefit values described below include explicit and implicit values. Affected stakeholders include property owners, business owners, visitors, taxpayers of NC, and individuals who value coastal species and ecosystems and the character of Holden Beach. The incidence of costs and benefits across these stakeholder groups is expected to vary across the alternatives. As noted in Landry and Hindsley (2011), stakeholders can be expected to have different perceptions of the effectiveness of natural and man-made storm and erosion buffers and variable evaluations of beach characteristics in terms of aesthetics, recreation and leisure. Hence, the alternative actions can be expected to convey net economic gains to some user groups while conveying net economic losses to other groups.

Explicit costs associated with alternative actions include physical construction costs associated with shoreline nourishment activities, channel excavation costs, construction costs of a terminal groin and costs associated with destruction and/or removal of existing properties and infrastructure. Implicit costs include losses in economic value to coastal property and public infrastructure associated with degradation of the character of the shoreline and proximate coastal and marine ecosystems, as well as reductions in use and non-use values associated with recreation, aesthetics and changes in the quantity and quality of habitats and species.

Construction and maintenance costs detailed herein are those incurred by the Holden Beach Home Owners Association and are based on estimates provided by ATM as part of an engineering analysis of project alternatives (Appendix F).

These estimates were constructed using a 30-year time horizon beginning in year 2015. A four percent annual inflationary increase is assumed for construction costs. Discounting is applied to current dollar value expenditures in order to provide cost estimates in present value terms. Lower discount rates result in higher estimated present values for future expenditures and cause alternatives that involve higher future expenses to appear less favorable. Similarly, higher discount rates result in lower present values for future expenditures. The discount rate used in analyzing public projects should reflect the opportunity cost of public funds. Current long-term rates on US Treasury Bills are approximately 2.5 percent. Because the public is generally risk-averse with regard to spending on projects with uncertain outcomes, higher discount rates are more appropriate. For this analysis, the present value of future expenditures associated with the alternatives is examined using discount rates of 2.5 percent, 4.125 percent, and six percent. A 4.125 percent discount rate is standard practice for Civil Works projects by the USACE. Therefore, by using rates above and below 4.125 percent, we provide sensitivity analyses for this important and uncertain parameter.

Shoreline management alternatives that include the construction of a terminal groin involve large initial costs associated with construction but lower future costs associated with beach nourishment. This future cost saving is due to smaller quantities of sand that would be placed during each episode and/or decreased frequency of nourishment episodes. Because these alternatives involve larger up-front costs and lower future costs, they will appear more favorable when lower discount rates are employed. For the range of estimates provided for the present value of future expenditures associated with the project alternatives, higher estimates correspond to a two percent discount rate, and lower estimates correspond to a six percent discount rate.

To understand the relative scope of potential impacts on coastal property, the most recent (2012) assessed tax values for at-risk properties were used. Note that the current assessed tax values may not be reflective of current market values. To the extent that risk of future erosion is known or perceived by market participants, market values could be considerably lower than the assessed tax value. Given the dynamic nature of the Holden Beach shoreline in recent years, the loss of numerous homes and parcels to erosion, and the uncertainty regarding the potential for mitigating action, it seems logical that current market values for at-risk Holden Beach properties, especially those that are imminently threatened, will have capitalized a sense of future risk. Whether or not such risks are incorporated into value assessments is unknown.

Changes in the real estate market that have transpired since the most recent assessment may generally effect market values. These changes include general market trends as well as modifications to insurance rates specific to properties in the coastal zone. While the general real estate market trend since 2012 is upward, such enhancements are not homogenous across locations and may not be conferred upon properties at risk to erosion. Recent trends in insurance rates as part of the NC Beach Plan have been generally unfavorable for properties in the coastal zone. Expected or realized additional costs may decrease demand for coastal properties offsetting some of the general market improvements experienced in recent months. Moreover, it can be argued that the appropriate values to be used in understanding the possible effects of alternative shoreline management actions are the values that exist at the time of the associated environmental change. As noted above, and with the important exception of acute change due to damage from storms, anticipated changes in coastal environments are likely to be capitalized into the market value of real estate far in advance of actual change (Landry and Hindsley 2011, Landry 2011).

The assessed tax values of at-risk properties are used as a means of appreciating the relative magnitude of the management alternatives rather than the absolute value that is at risk. Even in terms of relative magnitudes, these values should be used with caution. As noted in Landry and Hindsley (2011), if active mitigation creates an expectation of improved conditions over time, value estimates should be interpreted as lower bounds on true value. In contrast, if conditions are expected to degrade, value estimates should be interpreted as upper bounds on true value.

Impending property loss due to erosion may result in some structures being demolished and some being moved farther inland. Monetizing the value of the transition losses associated with destruction or location of property or monetizing the gains in value that will be realized by currently unimproved parcels that are subsequently improved when structures are relocated was not attempted with this study. Although it is important to acknowledge that such effects are very likely to transpire in the case of some alternatives, forecasting the magnitude, timing and location of such transitions is not practical.

Stabilized shorelines may also convey additional use and non-use values associated with protecting coastal habitats and species. Such values may be conferred upon the public at large regardless of past or present experience with the Permit Area. Existence values, option values, and bequest values may also accrue to past and potential visitors to Holden Beach who derive benefits from the maintenance of favorable conditions at the site. Descriptions of these values are included in Appendix M. Actions that involve the construction of a terminal groin (i.e., Alternatives 5 and 6) may also create economic benefits in terms of enhanced recreational fishing opportunities on the East End of Holden Beach although these gains have the potential to be offset by diminished visual appeal and/or any potential detrimental environmental effects produced by physical alteration of the shoreline.

Alternatives 1 (no action) and 2 (abandon/retreat) may produce economic benefits to a set of individuals who place economic value on unimpeded ecosystem function and change. These values are probably best described as non-use values although some use value losses would also transpire and can be expected to accrue to some portion of the general public. A critical assumption with regard to these values is that baseline environmental conditions are naturally occurring which may not be the case for Holden Beach given the lengthy history of shoreline protection projects that have taken place in the area.

4.8.2 Land Use

The existing land use in the Town is summarized in Table 4.8. The jurisdictional limits of the town encompass a total area of 1,489 ac, including 809 ac of "usable" high ground and 680 ac of "unusable" conservation areas consisting of unvegetated beaches (26 ac) and a combination of back-barrier tidal marshes and dredged material management areas (654 ac) (Imperial et al. 2009). Collectively, lands designated as residential, vacant and conservation account for 96 percent of the total municipal land area. Approximately 83 percent of the usable land area is zoned for residential land use, including 477 ac of existing residential development and 195 ac of vacant land that are zoned for residential use. Commercial land use accounts for about 1.3 percent of the usable land area, and with the exception of a few small outlying parcels, commercial land is concentrated at the foot of the Holden Beach Bridge (Imperial et al. 2009).

The Town of Oak Island contains approximately 12,752 ac including portions of the island (5,204 ac) and the mainland (7,547 ac). The island portion of the town is predominately residential with some commercial and tourist-related development. The western end of Oak Island, extending from State Road (SR) 1105 (Middleton Ave.), contains predominantly single family residences. Areas under development include the Point at the extreme western end of the island and the areas along NC 133. Commercial land use is concentrated along NC 211, NC 133, Yaupon Drive, a small

Table 4.8. Land use summary.

Land Use	Town of Holden Beach[1]		Town of Oak Island[2]	
	Acres	Percent	Acres	Percent
Residential	477	32	3,134.27	24.58
Vacant Land	265	18	--	--
State Owned	29.25	2	--	--
Common Area/Recreation	22	1.5	81.84	0.64
Commercial	10.25	0.7	83.35	0.65
Civic Club/Lodge/Hall	3	0.2	--	--
Church	1.25	0.08	--	--
Municipal/Institutional	1	0.07	19.23	0.15
Utilities Commercial	0.25	0.02	25.78	0.20
Transportation	--	--	110.00	0.86
ROW	--	--	579.80	4.55
Agriculture	--	--	0.52	0.004
Marsh/Spoil/Wetland	654	44	785.82	6.16
Forest/Wooded	--	--	553.47	4.34
Eroded/Unvegetated Beach	26	1.7	--	--

Source: [1]Imperial et al. (2009); [2]Town of Oak Island (2009)

commercially zoned area surrounding the Oak Island fishing pier and along a portion of Oak Island Drive. The existing land use in the Town of Oak Island is summarized in Table 4.8 for specific land uses classified in Town of Oak Island (2009). Note that some land uses are not specified in this document.

4.8.3 Infrastructure

Water Supply and Wastewater Treatment

Holden Beach operates its own municipal water supply system. The town's water supply is purchased from Brunswick County, which obtains its water supply from the Cape Fear River (above Lock and Dam #1) and groundwater drawn from the Castle Hayne aquifer. Water from the Cape Fear River is treated at the county's Northwest Water Treatment Plant in Leland which is capable of treating 24 million gallons per day (MGPD). Groundwater drawn from 15 wells is treated at the county's 211 Water Treatment Plant near Southport which is capable of treating seven MGPD. Water is delivered to the island via two pipelines that cross the AIWW at Seagull Drive and the Holden Beach Bridge. The town's distribution system includes approximately 20 miles of water distribution lines and a 300,000 gallon storage tank. The county has developed a water system master plan that addresses future demands on the county water supply. The county anticipates that Holden Beach will require additional water at the rate sufficient to meet the demands of an additional 50 housing units per year. At this rate, Holden

Beach will require 0.145 MGPD on an average day in 2015. Additional wholesale users of the Brunswick County water supply system will require 8.714 MGPD on an average day in 2015. The Holden Beach system is more than capable of meeting the projected future demand. The town completed construction of a wastewater collection system in March 2006. Connection to the municipal sewer system is mandatory for all residents and businesses. Based on the anticipated rate of growth, the current sewer system capacity is expected to meet the increase in demand over the next 10 to 15 years.

Transportation

As described in the Town CAMA Land Use Plan (2009), the Holden Beach Bridge is the only means of ingress or egress to the Town from the Mainland. Accordingly, traffic at the bridge during summer months is common as is traffic congestion at major intersections on and adjacent to the Island. The Holden Beach Bridge is maintained by the North Carolina Department of Transportation (NCDOT). Based upon information provided by the NCDOT Bridge Maintenance Unit, the Holden Beach Bridge was constructed of pre-stressed concrete in 1985.

The Holden Beach Bridge was designed for seven percent of traffic to be trucks, and for 40 miles per hour speeds. The 1985 average annual daily traffic (AADT) for the Holden Beach Bridge was 2,000 vehicles. The design year AADT (which was set at 2005) was estimated in 1985 at 3,300 vehicles. Based upon the AADT that was measured just a few miles north of the bridge (at Portable Traffic Count Station 900031), the 2004 AADT was 10,000. It seems that the bridge designer had underestimated the amount of traffic that the Holden Beach Bridge would receive. Although the design year AADT is set at a point 20 years from the date when the bridge was constructed, the design life for the bridge project is typically 50 years or more, depending upon budget constraints.

The Island's transportation system and its one connection to the mainland are adequate to serve current and projected populations in the event that an evacuation is ordered. However, the CAMA Land Use Plan contains other policies and recommendations pertaining to its transportation system. The Town supports federal and state road and bridge improvement programs. The plan also recommends treating stormwater using infiltration and other structural and nonstructural best management practices to ensure that future road improvements reduce nonpoint source (NPS) pollution.

4.8.4 Scenic Resources

Scenic resources include the physical, biological and cultural landscape elements that contribute to perceptions of scenic beauty. NC's barrier islands are highly valued for their natural beauty. Important natural landscape elements of these islands include marine and estuarine water resources, sandy beaches, dunes, maritime forests, salt marshes and associated wildlife. Cultural elements, such as historic coastal structures, contribute to a sense of place and the perception of barrier islands as a unique scenic resource. The scenic beauty of NC's barrier islands is reflected in their popularity as a tourist destination. Surveys of beach visitors in NC indicate that tourists and residents consider natural beauty, wide sandy beaches, visible wildlife and historical structures to be important elements of a positive beach experience (Ellis and Vogelsong 2005). The dune/beach/ocean system is a highly visible public resource that is readily accessible to the general public via numerous access points along the entire island.

4.8.5 Light

Artificial nighttime lighting has aesthetic and ecological implications for NC's barrier islands. Existing sources of artificial nighttime light on Holden Beach include residential and commercial exterior lighting, street lights, lighted signs, outdoor recreational facilities, lighted docks and piers, telecommunication towers, vehicular headlights, recreational and commercial vessel traffic and lighting associated with federal navigation maintenance dredging. Although artificial lighting has many beneficial effects related to safety, work productivity and recreational opportunities, excessive or misdirected light may lead to degradation of visual quality, alteration of scenic vistas and visual annoyance. Misdirected or unshielded light sources that emit upward or horizontal light contribute to light pollution in the form of sky glow, light trespass and/or glare. Light source properties that influence the amount of light pollution include wattage, spectral properties, height, angle, and degree of shielding (Shi 2010).

Ongoing federal navigation dredging projects and shoreline protection projects are a direct source of artificial light within marine, estuarine and ocean beach habitats. To take advantage of limited environmental construction windows and maximize the efficient use of construction equipment, operations are usually conducted during day and night. Nighttime construction lighting requirements for human safety are dictated by the USACE, US Coast Guard (USCG) and Occupational Safety and Health Administration (OSHA) regulations. Safety lighting requirements apply to staging areas, dredges and disposal sites [USACE Engineering Manual (EM) 385-1-1]. The USACE employs multiple measures to minimize the adverse ecological effects of artificial lighting: 1) lighting only the immediate construction area; 2) using the minimum amount of light required by federal regulations; 3) controlling light distribution by shielding, redirecting and/or lowering light fixtures; and 4) using lights with spectral properties that minimize disruption to sea turtles (e.g., low-pressure sodium vapor lights) (USACE 2008).

4.8.6 Water Quality

All surface waters in NC are assigned a primary surface water classification by the NCDWQ. Each classification must meet a specific set of water quality standards. All ocean waters within the Permit Area are classified as SB waters. SB waters support primary recreation, including frequent and/or organized swimming, and must meet water quality standards for fecal coliform bacteria. All waters of the AIWW, LFI, and the Lower Lockwoods Folly River from the AIWW to SR 1200 have a primary classification of SA. SA waters support commercial shellfishing and are subject to fecal coliform bacteria standards, restrictions on domestic wastewater discharges and specific stormwater control measures. All SA waters are also classified as HQW, which have excellent water quality and/or important functions such as primary nursery areas. Waters of the Lower Lockwoods Folly River are also classified as Special Management Strategy Waters in accordance with 15A NCAC 2B .0227 (Water Quality Management Plans).

4.8.7 Air Quality

The North Carolina Division of Air Quality (NCDAQ) maintains an ambient air monitoring network for those criteria pollutants requiring monitoring by the EPA. Areas that exceed EPA national ambient air quality standards based on regional ambient air monitoring are designated as non-attainment areas. Brunswick County is included in the non-metropolitan statistical area of NC's southern coastal plain (NCDAQ 2010). The Wilmington Regional Office of the NCDENR has jurisdiction over the air quality in this location, and it has been determined that the ambient air quality for the area is in compliance with the National Ambient Air Quality Standards.

4.8.8 Floodplains

In 1968, Congress created the National Flood Insurance Program (NFIP) in response to increasing flood damage and the rising cost of disaster relief for flood victims. The NFIP is administered by the National Insurance and Mitigation Administration (NIMA), a component of the Federal Emergency Management Agency (FEMA). The NFIP develops flood hazard risk maps [i.e., Flood Insurance Rate Maps (FIRMs)], offers federally backed flood insurance to property owners, and oversees the development of floodplain management plans for participating communities. In order to participate in the NFIP, local communities must adopt floodplain management ordinances that meet or exceed the NFIP management requirements. Communities that reduce flood risk through a floodplain management plan are eligible for reduced insurance rates through the NIMA Community Rating System.

In 2000, NC signed a Cooperating Technical Program agreement with FEMA. This agreement led to the creation of the North Carolina Flood Mapping Program (NCFMP) which assumed responsibility for updating digital FIRMs for the entire state. The NCFMP completed the first set of updated FIRMs in 2008. FIRMs delineate floodplains with 100-year and 500-year return intervals. Areas that fall within the 100-year floodplain have a one percent chance of flooding in any given year, and areas that fall within the 500-year floodplain have a 0.2 percent chance of flooding in any given year. Major flood insurance rate zones include Unshaded Zone X (low risk), Shaded Zone X (moderate risk), Zone AE (high risk) and Zone VE (Coastal High Hazard Area).

Unshaded Zone X corresponds to low risk areas above the 500-year floodplain. Shaded Zone X corresponds to moderate risk areas within the 500-year floodplain. Zone AE corresponds to high risk areas within the 100-year floodplain, and Zone VE corresponds to high risk areas within the 100-year floodplain that have additional vulnerability associated with high velocity wave action. The purchase of flood insurance is required for Zone AE and VE homes that are financed through federally regulated lenders. FIRMs also provide Base Flood Elevations (BFEs), which are specific flood elevations associated with 100-year flood events. BFEs for Zone AE are based on Coastal Stillwater Elevations (no wave component); whereas, BFEs for Zone VE may include an additional wave height, wave run-up, or wave setup component. BFEs are used by local communities to establish minimum elevation requirements for new structures within the 100-year floodplain.

Permit Area Flood Zones

Figure 4.13 depicts the distribution of flood zones in the Permit Area. The majority of the ocean front properties fall within Zone VE; these coastal areas have a one percent or greater chance of flooding and an additional hazard associated with storm waves (velocity hazard). They also have a 26% chance of flooding over the life of a 30-year mortgage. Many of the water front properties along the AIWW fall within Zone AE. These areas have a one percent annual chance of flooding and a 26 percent chance of flooding over the life of a 30-year mortgage. Some of the interior portions of the East End of Holden Beach are within Zone X; these areas are outside the 500-year floodplain and have a less than 0.2 percent annual chance of flooding.

The dominant source of flooding on Holden Beach is wind-driven surge created in the Atlantic Ocean by tropical storms and hurricanes. The surge propagates into the inlets, sounds and estuaries. High winds can produce extremely high waves that create higher than normal surge. The wave action can be much more damaging than the high water level. Although Holden Beach may also experience coastal flooding in association with extratropical nor'easters, these relatively minor flooding events do not influence the determination of base flood elevations or flood zone boundaries (FEMA and State of North Carolina 2003).

State and Local Floodplain Regulations

The State of North Carolina Floodplain Regulation (§143-215.51, et. seq.) is designed to minimize losses of life and property by regulating development and other uses within floodplains. Specifically, this statute was developed to minimize the extent of floods by preventing obstructions that inhibit water flow and increase flood height and damage. This statute authorizes counties and municipalities to adopt flood hazard prevention ordinances and grant permits for activities in flood hazard areas (e.g., 100-year floodplain). The statute sets minimum standards for local ordinances, specifies prohibited uses within flood hazard areas, and establishes criteria for granting variances

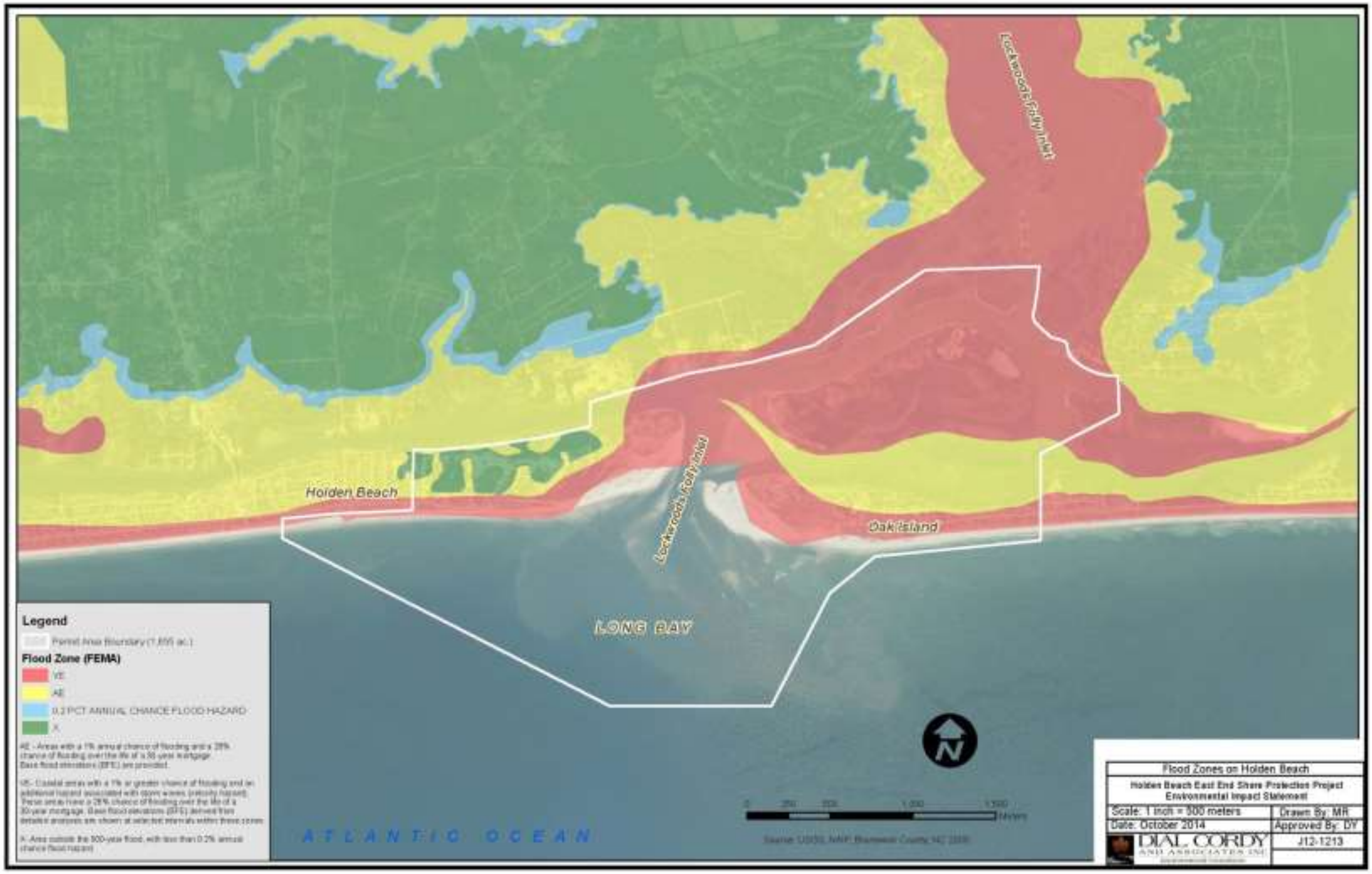


Figure 4.13. Flood Zones on Holden Beach

for prohibited uses. Local ordinances must meet the minimum requirements for NFIP participation. Strictly prohibited uses within the 100-year floodplain include new solid waste treatment facilities, hazardous waste management facilities, chemical storage facilities, and salvage yards. The Floodplain Regulation also prohibits all other structures and obstructions; however, such uses may be allowed under a variance granted by the local county or municipality. Variances can only be granted under the following conditions: 1) the use serves a critical community need, 2) there is no feasible location outside of the flood hazard area, and 3) all proposed structures will be elevated above the 100-year BFE. As participants in the NFIP, Holden Beach and Oak Island have adopted ordinances that meet the floodplain management requirements of the NFIP and the North Carolina Floodplain Regulation.

4.8.9 Navigation

The USACE is responsible for constructing and maintaining federal navigation projects specifically authorized by Congress. The USACE also has the authority, under Section 107 (Continuing Authorities Program) of the River and Harbor Act, to construct certain water resource improvement projects without specific Congressional authorization. Section 107 also authorizes the USACE to undertake hurricane protection and beach erosion projects which are frequently conducted in conjunction with the maintenance of federal navigation projects. The Wilmington District is responsible for several federal navigation projects in the vicinity of Holden Beach including the AIWW, LFI, and the Lower Lockwoods Folly River. These federal channels are maintained either by USACE dredges or private dredges under contract to the federal government. Dredged materials deemed suitable for beach disposal have been used in a number of USACE shore protection projects along Holden Beach. The LFI is utilized on a daily basis for both recreational and commercial navigation.

4.8.10 Noise

Numerous metrics are used to quantify the noise produced by various underwater activities, including a variety of alternative metrics for measuring both single-event noise and cumulative noise over an extended time period. Anthropogenic noise has the potential to cause behavioral disturbance and permanent injury to exposed marine mammals depending on the intensity level that individual animals experience (Southall et al. 2007). The NMFS currently uses the root-mean-square (RMS) sound pressure level (SPL) metric to evaluate potential impacts on marine mammals and federally listed species of fish. RMS SPL values represent the average sound pressure over the duration of the event and are expressed as decibels (dB) referenced to one micropascal (dB re: 1 μPa). The NMFS is in the process of developing a comprehensive acoustic policy that will provide guidelines for evaluating noise effects based on the sensitivity of individual marine mammal species to different noise frequency ranges and intensities. However, the NMFS currently uses generic noise exposure thresholds to define two levels of acoustic "take" under the MMPA. Actions that may expose marine mammals (mysticetes and odontocetes) to sequences of pulsed sounds with source levels of 180 dB re: 1 µPa constitute Level A harassment which has the potential to cause injury. The Level A harassment criterion for pinnipeds exposed to such sounds is 190 dB re: 1 µPa. Actions that may expose marine mammals to pulsed sounds with source levels of 160 dB re: 1 µPa constitute Level B harassment which may lead to behavioral disturbance and potential temporary threshold shifts in hearing.

Sources of anthropogenic underwater noise within the Permit Area include commercial shipping operations associated with the Port of Wilmington, recreational watercraft activity and periodic maintenance dredging of federally maintained navigation channels. Clarke et al. (2002) documented noise levels ranging from 120 to 140 dB re: 1µPa rms at a distance of 40 m during navigation dredging in Mobile Bay, AL. Peak spectral levels for individual commercial ships are in the frequency band of 10 to 50 Hertz (Hz) and range from 195 dB re: µPa 2/Hz @ 1 m for fast-moving (>20 knots) supertankers to 140 dB re: µPa 2/Hz @ 1 m for small fishing vessels [National Research Council (NRC) 2003]. Small boats with outboard or inboard engines produce sound that is generally highest in the mid-frequency [1 to 5 kilohertz (kHz)] range and at moderate (150 to 180 dB re: 1 µPa @ 1 m) source levels (Erbe 2002, Kipple and Gabriele 2003 and 2004). For instance, small craft with outboard motors [14 to 18 ft (4.3 to 5.5 m) in length with 25 to 40 horsepower, 19 to 30 kilowatt (kW) outboard motors and operated at a speed of from 10 to 20 knots] had maximum source levels (one-third octave band) at 160 dB re: 1 µPa @ 1 m with peak energy at 5 kHz (Kipple and Gabriele 2003). On average, noise levels were found to be higher for the larger vessels, and increased vessel speeds resulted in higher noise levels (Hildebrand 2009).

4.8.11 Water Safety

A total of 304,658 recreational vessels were registered in NC during 2013 and include 9,264 registered vessels in Brunswick County (NCWRC 2013). Recreational vessel operations in state and federal territorial waters are subject to concurrent federal/state safety regulations promulgated under Title 46 of the US Code and the North Carolina Boating Safety Act. NC has entered into a cooperative agreement with the USCG whereby the state (acting through the NCWRC) has assumed the major role in carrying out and enforcing federal and state recreational boating safety laws and regulations. NCWRC responsibilities include boater education, assistance, law enforcement, accident investigations and other related safety initiatives. The NCWRC Division of Enforcement is the primary agency responsible for enforcing federal and state recreational boating safety regulations on concurrent jurisdictional waters. The Division of Enforcement exercises jurisdiction over recreational vessels in state territorial waters and federal waters when navigated as part of a trip to or from the shores of NC. The USCG has exclusive responsibility for the enforcement of vessel inspection and related federal statutes applicable to non-recreational vessels.

An average of 160 recreational boating accidents and 21 fatalities were reported in NC each year between 2006 and 2013 (NCWRC 2013). Annual boating accidents declined steadily from a high of 217 during 2006 to a low of 143 during 2013. During 2013, a total of ten recreational boating accidents and one fatality were recorded in Brunswick County. The vast majority of accidents throughout NC occurred between April and October with a peak during June, July, and August. Collisions with vessels have been the number one type of non-fatal boating accident in NC since 1990. The top causes of non-fatal accidents were operator inattention, fault of machinery/equipment/hull, careless and reckless operation, operator inexperience and hazardous/congested waters. The largest number of fatalities resulted from persons falling or jumping overboard. Most boaters of the fatal and non-fatal accidents had no formal boating safety education. The state recently enacted mandatory boater safety education for persons under the age of 26. As a result, the number of persons participating in state boating safety courses increased from 3,706 in 2006 to 16,877 in 2013 (NCWRC 2013).