Chapter 4 AFFECTED ENVIRONMENT

1. What is the environmental setting of this project?

Figure Eight Island is located on the northwest end of New Hanover County, in southeastern North Carolina, approximately eight miles north of Wilmington. It is a private, gated residential barrier island with 463 homes and 93 undeveloped lots. The island is bordered to the south by Mason Inlet and Wrightsville Beach and to the north by Rich Inlet and Hutaff Island, an undeveloped, privately owned island. Figure Eight Island covers approximately 526.1 hectares (1300 acres) and is approximately 8.0 km (5.0 mi) long and approximately 0.6 km (0.4 mi) wide. The Permit Area encompasses 4,282 acres and includes a wide diversity of estuarine and nearshore habitat types supporting diverse ecosystems typically associated with a developed and undeveloped barrier island system in southeastern North Carolina. The proposed project is located on the northeast end of the island and within the channel and shoals in Nixon Channel and Rich Inlet.

The Permit Area, as shown in Figure 4.1, is defined as the boundary of where direct and indirect effects of the project will, or may likely occur. The Permit Area was identified and delineated based on the modeling results depicting potential sedimentation distribution in the inlet as a result of the realigned inlet channel proposed for Alternative 3 and the point of intercept calculated along the oceanfront shoreline from proposed nourishment activities. Since developing the Permit Area, Alternative 5D has become the applicant's preferred alternative. Because the extent of the beach fill and the anticipated sedimentation distribution within the inlet are similar to Alternative 3, the scope of the Permit Area will remain unchanged. It should also be noted that all borrow sources for Alternative 5D are within the Permit Area.

The Permit Area also includes portions of Hutaff Island, which is located to the northeast of Rich Inlet. Hutaff Island is one of the few remaining undeveloped and vehicle-free barrier islands on the North Carolina coast. It is the 2nd largest near-pristine barrier island and salt marsh system in the region. Natural communities that are found in the area include: dune grass, upland forest, scrub-shrub, salt marsh, and beaches and foredunes. The natural area supports a gull-tern-skimmer colony, and the upper beach provides habitat for seabeach amaranth (*Amaranthus pumilus*). Threatened and endangered animals supported by the area include the loggerhead sea turtle (*Caretta caretta*), (*Charadrius melodus*), Carolina diamondback terrapin (*Malaclemys terrapin centrata*), black skimmer (*Rhychops niger*), least tern (*Sterna atillarum*), and eastern painted bunting (*Passerina ciris ciris*). The North Carolina Natural Heritage Program (NCNHP) has identified Hutaff Island as a Significant Natural Heritage Area (SNHA) of statewide significance (NCNHP, 2006). This site is partly owned by the NC

What is the North Carolina Natural Heritage Program?

As part of the Office of Natural Resource Planning and Conservation within the NC Department of Environment and Natural Resources, the program serves to inventory, catalogue, and support conservation of the rarest and the most outstanding elements of the natural diversity within North Carolina. These elements of natural diversity include those plants and animals which are so rare or the natural communities which are so significant that they merit special consideration as land-use decisions are made.

Division of Parks and Recreation; the remaining area is privately owned (NCNHP, 2006a). In 2001, the United States Fish and Wildlife Service (USFWS) designated Hutaff Island as Piping Plover Critical Habitat. This area provides foraging and nesting grounds for the endangered piping plover (*Charadrius melodus*). The Piping Plover Critical Habitat Area extends beyond Hutaff Island through Rich Inlet and onto approximately the northern 305 m (1,000 ft) of Figure Eight Island (Figure 4.1). In addition, the USFWS and NMFS has designated portions of North Carolina beaches as critical habitat for the Northwest Atlantic (NWA) population of loggerhead sea turtles. A portion of the Permit Area is located within Critical Habitat Unit LOGG-T-NC-04 (Figure 4.1). As described in the Federal Register Notice, this unit includes Onslow Beach, Topsail Island, and Hutaff Island. The unit contains nearshore reproductive habitat only. Specifically, the unit consists of a nearshore area from Browns Inlet to Rich Inlet (crossing New River Inlet and New Topsail Inlet) from the MHW line seaward 1.6 km.

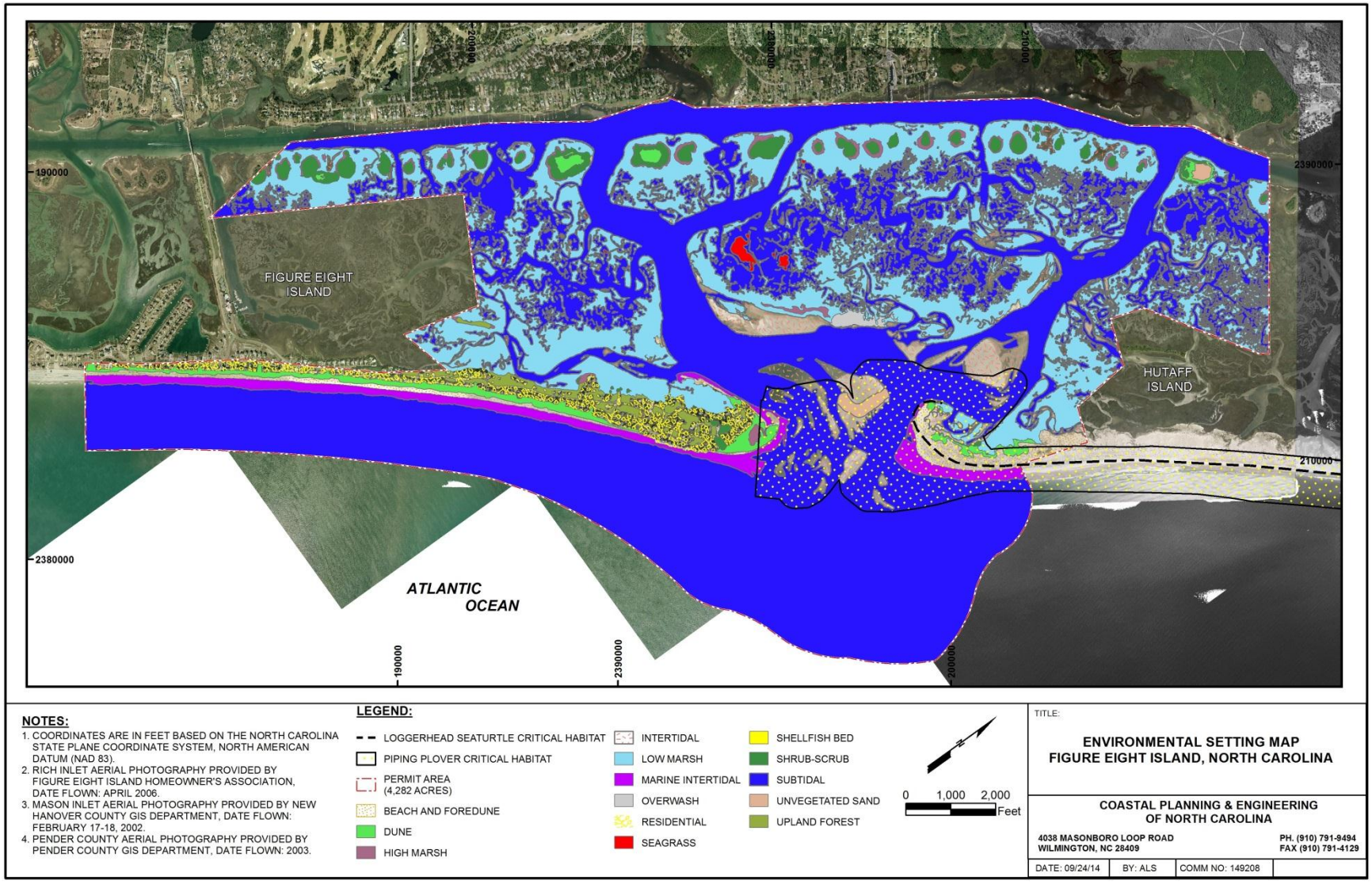


Figure 4.1. Figure Eight Island Environmental Setting Map within the Permit Area

The North Carolina Division of Marine Fisheries (NCCDMF) has designated about 595 km^2 (230 mi^2) of fishery nursery areas throughout North Carolina, dividing the habitats into three categories of nursery areas: Primary, Secondary and Special Secondary Nursery Areas (NCDMF, 2007). Primary Nursery Areas (PNAs) are usually shallow with soft muddy bottoms and surrounded by marshes and wetlands. PNAs are located within the Permit Area, specifically within the salt marsh habitat between the Atlantic Intracoastal Waterway (AIWW) and the back side of Figure Eight Island and Hutaff Island. To protect juveniles, many commercial fishing activities are prohibited in these waters including the use of trawl nets, seine nets, dredges or any mechanical methods used for taking clams or oysters.

The geomorphology of the Permit Area is characterized by beaches, dunes, and marshes typical of a barrier island complex. The Atlantic Coastal Plain and Onslow Bay are both underlain by relatively flat-lying sedimentary units which gently dip and thicken as they move to the southeast.

Barrier islands, such as Figure Eight Island, are composed of unconsolidated fine- to medium-sized quartz and shell material that is in a constant state of flux due to wind, waves, currents and storms. The oceanfront beach and the backing dunes are deposits of sand that are constantly changing their shape, and hence position, with time as they respond to coastal processes.

Areas of Environmental Concern

Lands adjacent to coastal inlets that are vulnerable to natural processes including erosion and flooding are known as inlet hazard areas. These inlet hazard areas, as designated by the North Carolina Coastal Area Management Act (CAMA), as important Areas of Environmental Concern (AEC). Generally, the Inlet Hazard Areas AEC are natural-hazard areas especially vulnerable to adverse effects of sand, wind, and water, because of their proximity to dynamic ocean inlets (NCAC T15A 7H.0304(3)). The Inlet Hazard Area AEC boundaries were originally approved by the Coastal Resources Commission (CRC) in 1979. Although the inlet hazard AEC boundaries are more than 30 years old, they are still in force at this time. It is not certain if or when new boundaries will be officially adopted.

What are Areas of Environmental Concern?

The Coastal Resources Commission designates areas as AECs to protect them from uncontrolled development, which may cause irreversible damage to property, public health or the environment, thereby diminishing their value to the entire state. The CRC has set up four categories of AECs:

A. The Estuarine and Ocean System
B. The Ocean Hazard System
C. Public Water Supplies
D. Natural and Cultural Resource Areas

Many AECs have also been designated as SNHA by the NCNHP. The NCNHP has identified more than 2,000 SNHAs in North Carolina, which are defined as an area of land or water important for conservation of biodiversity. SNHA's contain one or more natural heritage elements such as high-quality or rare natural communities, rare species, and/or special animal habitats.

2. What are the characteristics of the various habitats found within the project area?

Barrier islands within North Carolina are dominated by wave and tidal processes, often with large flood and ebb tidal deltas. Like other inlets in southeastern North Carolina, Rich Inlet serves as the primary pathway of sediment transportation into its sound via Green Channel and Nixon Channel. These inlets historically migrated along the Outer Banks and were typically created by storm breaching. Many are now maintained by the USACE for navigation purposes. Historically, Rich Inlet has shown little tendency to migrate, however, the cyclical reorientation of the ebb channel can produce very rapid erosion on adjacent shorelines (Cleary and Pilkey, 1986). The Permit Area contains various habitat types such as salt marsh, upland hammocks, intertidal flats, shoals, dunes, and beaches (Figure 4.2).

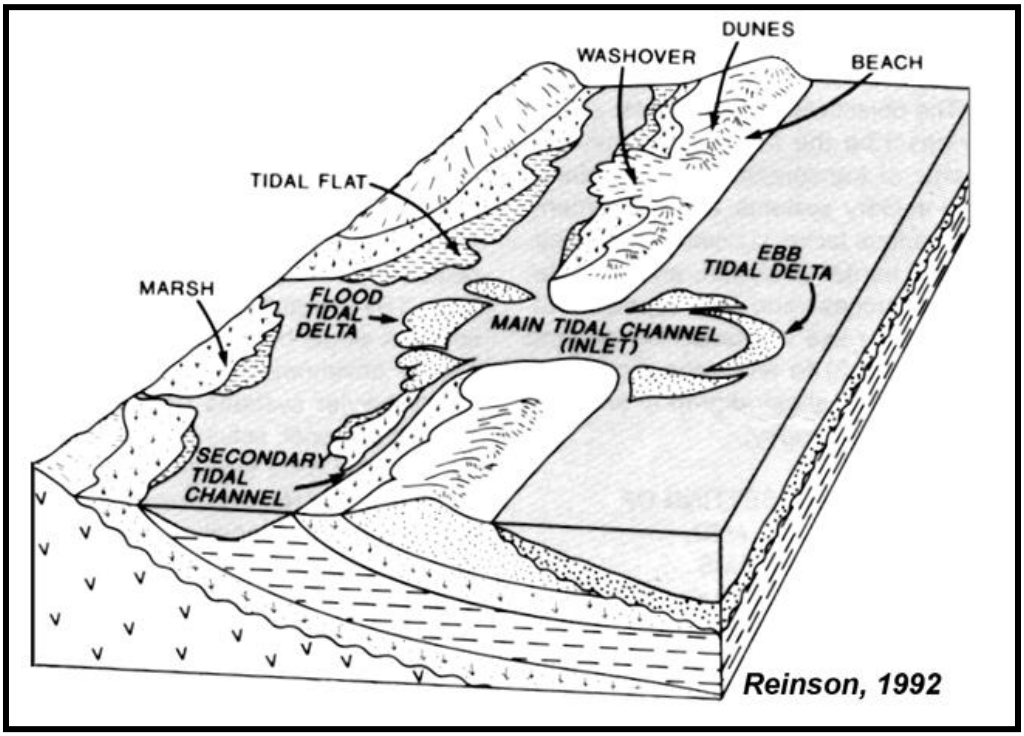


Figure 4.2. Schematic depicting various habitats associated with a barrier island

A. Estuarine Habitats

While estuaries are also often known as bays, lagoons, harbors, inlets, or sounds, the defining feature of an estuary is the mixing of fresh and saline water (32 to 36 parts per thousand [ppt]). Flush with nutrients and inhabited by resilient organisms, estuaries are among the most productive ecosystems on earth. They provide rich feeding grounds for coastal fish and migratory birds, and spawning areas for fish and shellfish (NPS, 2007). This section will characterize the following estuarine communities that are found, or have potential to be found, within the Permit Area including salt marshes, submerged aquatic vegetation (SAV), and shellfish areas.

1. Salt Marsh Communities

These community types are found in relatively flat and poorly drained topographic areas found along the North Carolina coastline and are subject to regular and irregular tidal flooding. These systems are extremely important for water filtration and water storage during flood events, as well as supplying food and providing habitat for a wide-array of flora and fauna. Coastal wetlands within the project vicinity include tidal salt marshes, and occur along the shoreline and island fringes along the backside of Figure Eight and Hutaff Island.

Salt Marsh Communities

In eastern North Carolina, salt marsh communities can be found along 4,500 miles of coastal shoreline, which encompasses 2.1 million acres of estuarine habitat (NCCF, 2007).

Estuarine systems, such as those characterized within the Figure Eight Island Permit Area, have been designated as AEC by the CRC. These areas have been identified as "sensitive and productive coastal lands and waters where uncontrolled development might cause irreversible loss of property, public health and the natural environment" (NCDCM, 2006b). Section 15A NCAC 07H .0205 of the North Carolina Administrative Code defines coastal wetlands as any salt marsh or other marsh subject to regular or occasional flooding by tides, including wind tides (whether or not the tide waters reach the marshland areas through natural or artificial watercourses), provided this shall not include hurricane or tropical storm tides (NCDCM, 2008a). There are four kinds of coastal marsh habitats found in North Carolina; low marsh, high marsh, brackish marsh, and freshwater marshes. Of these kinds, the Permit Area contains low and high marsh.

Low salt marsh environments are regularly flooded with the tides and are characterized by organic mats with smooth cordgrass (*Spartina alterniflora*) as the dominant vegetative species. *S. alterniflora* marshes occur within the intertidal zone along the sounds and tidal creeks, and provide valuable nursery habitat for commercially valuable species of marine and estuarine organisms. The zonation of vegetation in salt/brackish marsh is largely determined by variations of salinity and drainage of sediment porewater. Some species are restricted in the low marsh because of high porewater salinity, frequent inundation, and high-sulfide porewaters associated with frequent inundation (Deaton et al., 2010). Smooth cordgrass can tolerate a wide range of environmental conditions, including pH levels from 5.4 to 7, salinities from 3% to 5%, and a water table four inches above ground level (ANHP, 2004). The majority of the salt marsh habitat within the Permit Area is located between the AIWW and the back sides of Figure Eight and Hutaff Islands. There have been 1,007 acres of low marsh delineated within the Permit Area, as determined through interpretation of high resolution aerial photography.

Cowardin (1979) classifies high marsh as an estuarine intertidal emergent wetland or palustrine, emergent wetland. High salt marsh environments are irregularly flooded lands where plant species such as saltmeadow cordgrass (*S. patens*), glasswort (*Salicornia* Spp.), salt (or spike) grass (*Distichlis spicata*), and sea lavender (*Limonium carolinianum*) may be found. Saltmeadow cordgrass grows at the seaward edge of the high marsh, just above the high water line, providing habitat for a variety of waterfowl and songbirds, as well as other types of wildlife indigenous to the area. This environment is important in stabilizing the shifting sands of the barrier islands. Eventually, over time, the high marsh habitat can transform as it becomes

vegetated with dominant shrub species such as marsh elder (*Iva frutescens*), wax myrtle (*Myrica cerifera*), and yaupon holly (*Ilex vomitoria*). Thirty acres of high marsh have been delineated within the Permit Area, as determined through interpretation of high resolution aerial photography. This includes an area of high marsh that is located along the northern tip of Figure Eight Island situated between the sand spit and the residential development.

For both low and high salt marsh, the benthic communities consist of many faunal species. A 2007 wildlife utilization study conducted in the low salt marshes within the Bogue Inlet complex revealed high numbers of macroinvertebrates including fiddler crabs (*Uca puglator*), periwinkle snails (*Littorina irrorata*), oysters (*Crassostrea virginica*), and unidentified species of mud crabs, clams, and mussels (Rosov and York, 2007). Other common macroinvertebrates in the salt marsh include blue crabs (*Callinectes sapidus*) and grass shrimp (*Palaemonetes* species) (Meyer, 1991).

Benefits of Salt Marsh Habitats to Shorebirds, Colonial Waterbirds, and other Waterbirds

Due to their biological productivity, estuaries provide ideal areas for migratory birds to rest and forage during their long migratory journeys. Various species of shorebirds utilize marsh habitats for wintering, as well as feed on fish, shrimp and fiddler crabs found in the salt marsh. Along with a number of shorebirds and waterbirds, various waterfowl including dabbling ducks, diving ducks, geese, swans and coots utilize the salt marsh (Cowardin 1979).

Colonial waterbirds that utilize marsh habitat include black skimmers, gull-billed terns, common terns, least terns, egrets (*Egretta* spp.), and green herons (*Butorides virescens*). Most of these species prefer sandy beaches and shoaling habitats for nesting. The green heron is a habitat generalist, frequenting most coastal freshwater bodies as well as some saltwater bodies. The green heron nests in coastal shrub thickets, upland and swamp forests, and salt marshes, as well as in suburbs where habitat is deemed suitable. This species is less colonial than other wading birds, and although it often nests in mixed colonies with other herons and ibis (*Plegadis falcinellus* and *Eudocimus albus*), the green heron will frequently nest singly or in colonies of a few pairs. Nests are typically elevated in trees or shrubs between five and 30 ft off the ground (Alsop, 2002).

Willets (*Catoptrophorus semipalmatus*), American oystercatchers *(Haematopus palliatus)*, piping plovers, Wilson's plovers, and killdeers (*Charadrius vociferous*) usually nest above the high tide line on coastal beaches, on sand flats at the ends of sand spits, in blowout areas behind dunes and in overwash areas. However these various shorebirds also utilize various estuarine habitats including intertidal-emergent and submerged vegetated areas, intertidal-unvegetated, managed wetlands, as well as inland habitats for feeding (Hunter *et al*., 2001; Brown *et al*., 2001).

A variety of other waterbird species that are not classified as shorebirds or colonial waterbirds can also be found utilizing different estuarine habitats. For example, species such as red-breasted mergansers (*Mergus serrator*), clapper rails (*Rallus longirostris*) and ospreys (*Pandion haliaetus*) can be found in and surrounding inlet habitats such as Rich Inlet. Many waterbirds are piscivorous and forage by surface diving, some are aquatic gleaners, while others are herbivores that feed on submerged aquatic vegetation. These waterbirds can be found in

estuaries, marshes, and in the vicinity of Rich Inlet year-round or part of the year. However, they are mainly present during spring and fall migrations, as well as during the winter.

Benefits of Salt Marsh Habitat to Terrapins

The Carolina diamondback terrapin is the only North American turtle found in brackish waters, and are common in salt marsh environments. Juveniles use matted *Spartina* and other marsh grasses as cover. The marshes behind Figure Eight and Hutaff Islands provide suitable habitat for diamondback terrapins (LeGrand, pers. comm., 2008).

Benefits of Salt Marsh Habitats to Fishery Resources

Finfish and shellfish using salt/brackish marsh habitats fall into several categories based on location and timing of use (Deaton et al., 2010). Essential Fish Habitat (EFH) species that are expected to occur in estuarine emergent wetlands of North Carolina include the penaeid shrimp, summer flounder, and others. Year-round residents of the marsh include small forage species such as killifish (*Fundulus confluentus, F. luciae, F. majalis, Lucania parva, Fundulus heteroclitus*), sheepshead minnows (*Cyprinodon variegates*), grass shrimp (*Palaemonetes pugi*), bay anchovies (*Anchoa mitchilli*), and silversides (*Membras martinica, Menidia* spp.). Transient species include those spawning near the marsh, and those spawned in deeper waters using marsh habitat as nursery or foraging areas. Among transient species, some prefer the edge of salt/brackish marsh (i.e. flounder) while others are found near the marsh edge on non-vegetated bottom (i.e., spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*)). Some species are not found in the marsh, but derive substantial food resources from marsh plants as detritus (i.e., menhaden (*Brevoortia* spp.)) or from microalgae produced on the marsh surface. Of the fishery species in North Carolina, penaeid shrimp and red drum are considered critically linked to marsh edge habitat (SAFMC, 1998).

Red drum spawning occurs in the fall (August through October) in estuaries and around coastal inlets with optimal temperatures being between 22^0 C and 30^0 C (72^0 to 86^0 F) (NCDMF 2005). In North Carolina, spawning adults were reported to be common in salinities above 25 ppt in Bogue Sound and the Cape Fear River. Spawning adults were present, but not frequently encountered in Pamlico Sound and the New River (ASMFC, 2002).

Penaeid shrimp are reported to spawn offshore, moving into estuaries during post-larval stage during the early spring. As the shrimp grow larger in size, they migrate to higher salinity environments. In late summer and fall, they return to the ocean to spawn (NCDMF, 2005). It is during the July through October period that approximately 77% of the North Carolina shrimp harvest (for all waters) is landed, 66% of which is taken from ocean sub-areas <3 mi offshore and south of Cape Hatteras (NCDMF, 2005). In a NCDMF juvenile brown, white and pink shrimp sampling program (1999 – 2003) the majority of shrimp were “collected in close proximity to shallow wetland systems, such as salt marsh.

- Brown Shrimp

Brown shrimp spawn in the deep ocean during February and March. Larval immigration to estuaries peaks from mid-March through mid-April. Brown shrimp prefer peat and muddy bottoms as habitat (NCDMF, 2005).

- Pink Shrimp

Pink shrimp spawn in ocean waters from April to July. Post larvae immigrate to estuaries from May to November. Juvenile pink shrimp are reported to over-winter in North Carolina estuaries. Pink shrimp prefer foraging in shallow waters among marine plants. They are nocturnal feeders but may feed during the day in turbid water (NCDMF, 2005).

- White Shrimp

White shrimp spawn at depths greater than 30 feet in the ocean from March to November. Post larvae immigrate to estuaries two to three weeks after hatching when they become benthic. Juvenile white shrimp prefer muddy bottoms in low to moderate salinity estuarine waters and brackish waters. White shrimp migrate south from estuaries during fall and early winter. "Some of the slower-growing individuals overwinter in the estuaries, but usually do not survive in North Carolina" (NCDMF, 2005).

2. Submerged Aquatic Vegetation (SAV)

SAV habitat occurs along the entire east coast of the United States, with the exception of South Carolina and Georgia, where high freshwater input, high turbidity, and large tidal amplitude (vertical tide range) inhibit their occurrence. Along the Atlantic coast, North Carolina supports more SAV than any other state, except for Florida (Funderburk et al. 1991; Sargent et al. 1995). The 2005 CHPP reported that, based on interpretation and field verification by NOAA of remotely-sensed imagery taken during 1985-1990, the total area of visible SAV in North Carolina was approximately 134,000 acres (Ferguson and Wood 1994). Since 2005, some additional mapping efforts have added over 20,000 acres of mapped vegetated areas, suggesting SAV habitat covers over 150,000 acres in coastal North Carolina (Deaton, et al., 2010).

Submerged Aquatic Vegetation

North Carolina is in a "transitional area which represents the southernmost extension for some cold-adapted species and the northernmost extension of warm-adapted species.

Rosov, 2008

In North Carolina, Submerged Aquatic Vegetation (SAV) is defined as "estuarine waters vegetated with one or more species of submerged vegetation such as eelgrass (*Zostera marina*), shoalgrass (*Halodule wrightii*) and widgeon grass (*Ruppia maritime*). These vegetation beds occur in both subtidal and intertidal zones and may occur in isolated patches or cover extensive areas (Deaton et al., 2010). In North Carolina the dominant seagrass is *Z. marina*. *H. wrightii* is also observed in North Carolina; however it is not as abundant. Seagrass meadows are now much reduced, probably due to elevated nitrogen and increased sedimentation (Mallin *et al.*, 2000).

Dr. Don Field of the Applied Ecology and Restoration Research Laboratory at the National Oceanic and Atmospheric Administration (NOAA) Center for Coastal Fisheries and Habitat Research identified potential occurrences of SAV within the Permit Area via interpretation from April 2006 aerial photography. Similarly, limited presence/absence data collected by Dr. Wilson Freshwater of UNCW in 2003 and 2004 from areas within the Rich Inlet complex was obtained. Each of the 47 potential SAV beds identified by Dr. Field and Dr. Freshwater were groundtruthed on September 15, 17, and 22, 2008 (Figure 4.3). Of these, three were confirmed to contain SAV resources. Two contained sparse patches of *Z. marina* (eelgrass) while one site contained a dense to sparse bed of *Z. marina* and *R. maritima* (widgeon grass). The remaining sites were identified as dark sandy bottom, shellfish shells, macroalgae, or other substrate types devoid of seagrass. Utilizing the three SAV beds identified through groundtruthing efforts as confirmed SAV resources, an additional 17 sites with similar color signatures were extrapolated from the 2008 high resolution aerial photographs (Figures 4.3, 4.4a and 4.4b). In total, seven (7) acres of SAV habitat have been identified within the Permit Area.

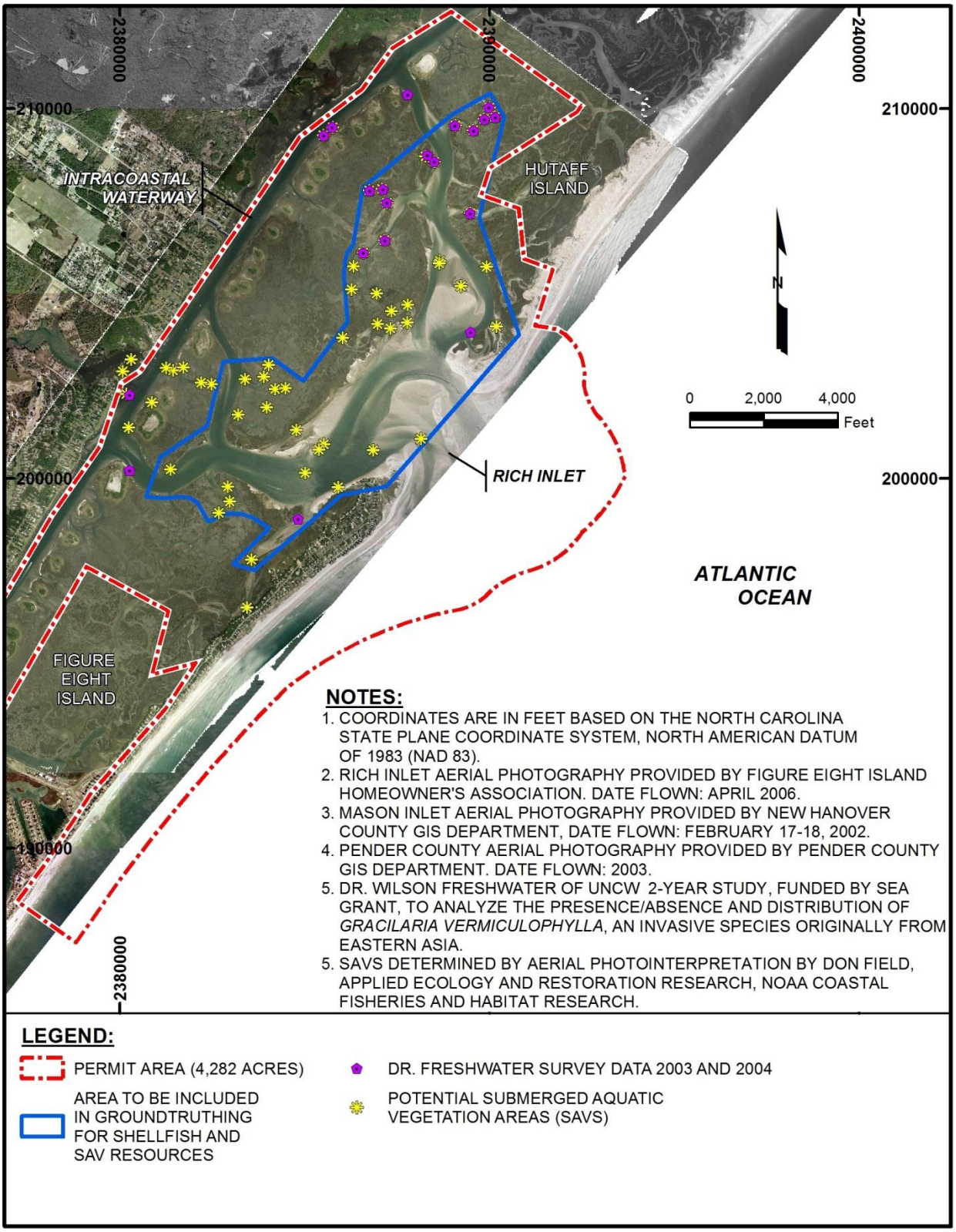


Figure 4.3. Potential Submerged Aquatic Vegetation (SAV) Locations

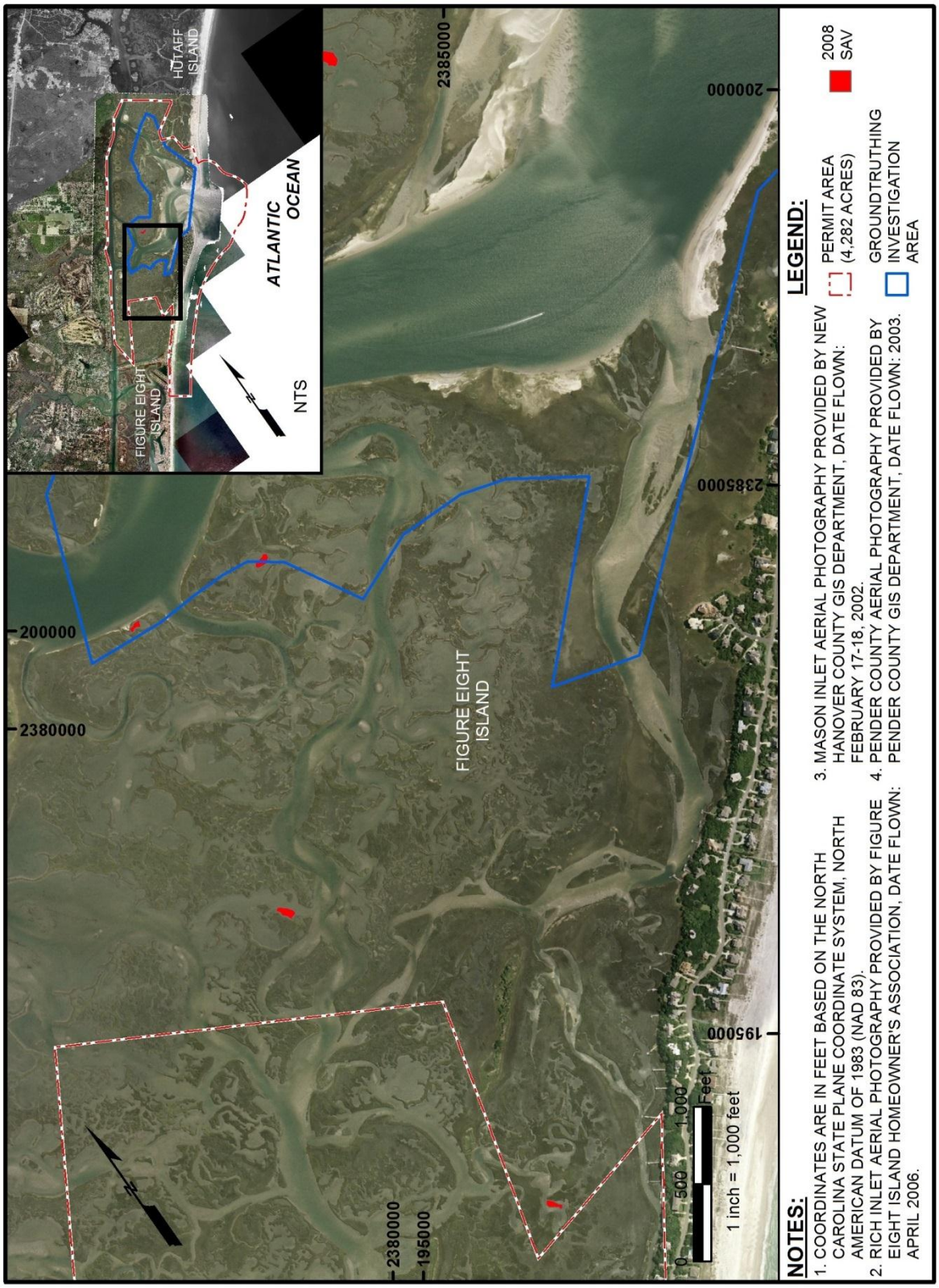


Figure 4.4a. Identified SAV Resources within the Permit Area

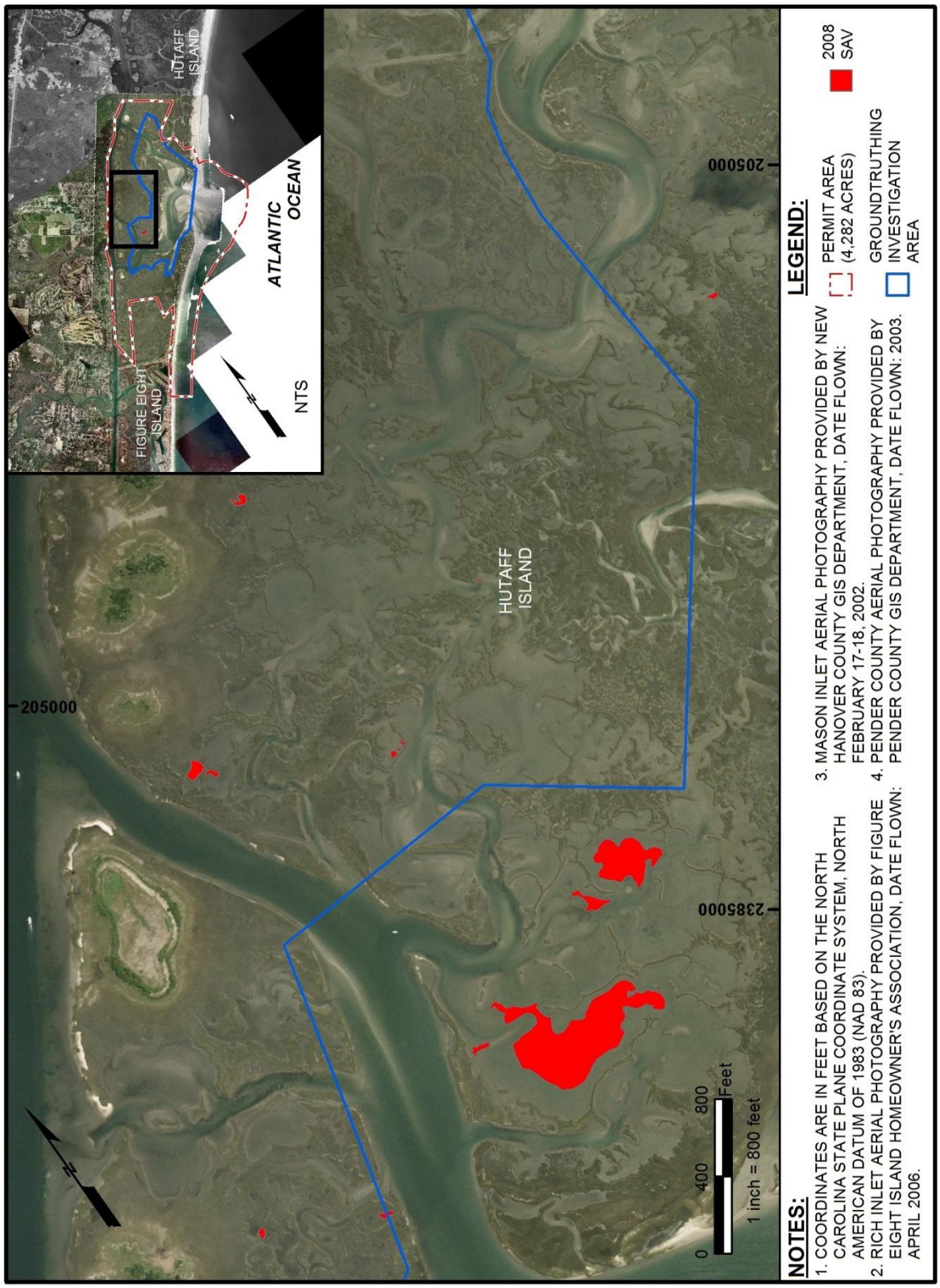


Figure 4.4b. Identified SAV Resources within the Permit Area

Benefits of SAV Areas to Fishery Resources

Submerged aquatic vegetation provides important structural fish habitat and other important ecosystem functions in estuarine and riverine systems in coastal North Carolina. Submerged aquatic vegetation is recognized as an essential fish habitat because of five interrelated features – primary production, structural complexity, modification of energy regimes, sediment and shoreline stabilization, and nutrient cycling. Water quality enhancement and fish utilization are especially important ecosystem functions of SAV relevant to the enhancement of coastal fisheries.

SAV are utilized by larval and juvenile fishes for foraging and escape from predation. Commercial and sport fishes in their larval and juvenile stages, such as; gag grouper (*Mycteroperca microlepsis*), gray snapper (*Lutjanus griseus*), bluefish (*Pomatomus saltatrix*), flounder species (*Paralichthys* sp.), fish of the Clupeidae family and others, are found in seagrass beds in the early spring and summer. Bay scallops (*Argopecten irradians concentricus*) are also typically found in SAV habitat. Because of its use for foraging, spawning and shelter, SAV is designated as Habitat Areas of Particular Concern (HAPC). The red drum (*Sciaenops ocellatus*) is one species for which SAV serves as a HAPC.

3. Shellfish

The shellfish industry is a large economic industry for North Carolina coastal areas. Three species of shellfish found in coastal waters include eastern oysters (*Crassostrea virginicus*), hard clams (*Mercenaria mercenaria*), and bay scallops (*Argopecten irradians concentricus*).

Shellfish

Common terms used to describe shell bottom habitats in North Carolina are “oyster beds,” “oyster rocks,” “oyster reefs,” “oyster bars,” and “shell hash.”

Shellfish are also an important resource in the estuarine environment within the permit area. The structures that shellfish create, such as beds and reefs, are used by many species of fish and invertebrates (Burrel, 1986). The SAFMC defines this habitat as “the natural structures found between (intertidal) and beneath (subtidal) tide lines, that are composed of oyster shell, live oysters and other organisms that are discrete, contiguous and clearly distinguishable from scattered oysters in marshes and mudflats, and from wave-formed shell windrows” (SAFMC, 1998). The SAFMC has designated oyster reefs as EFH for red drum (NMFS, 1999). NCDMF has designated two Oyster Management Areas (OMA) within the Permit Area and one adjacent to the southwestern boundary (Figure 4.5).

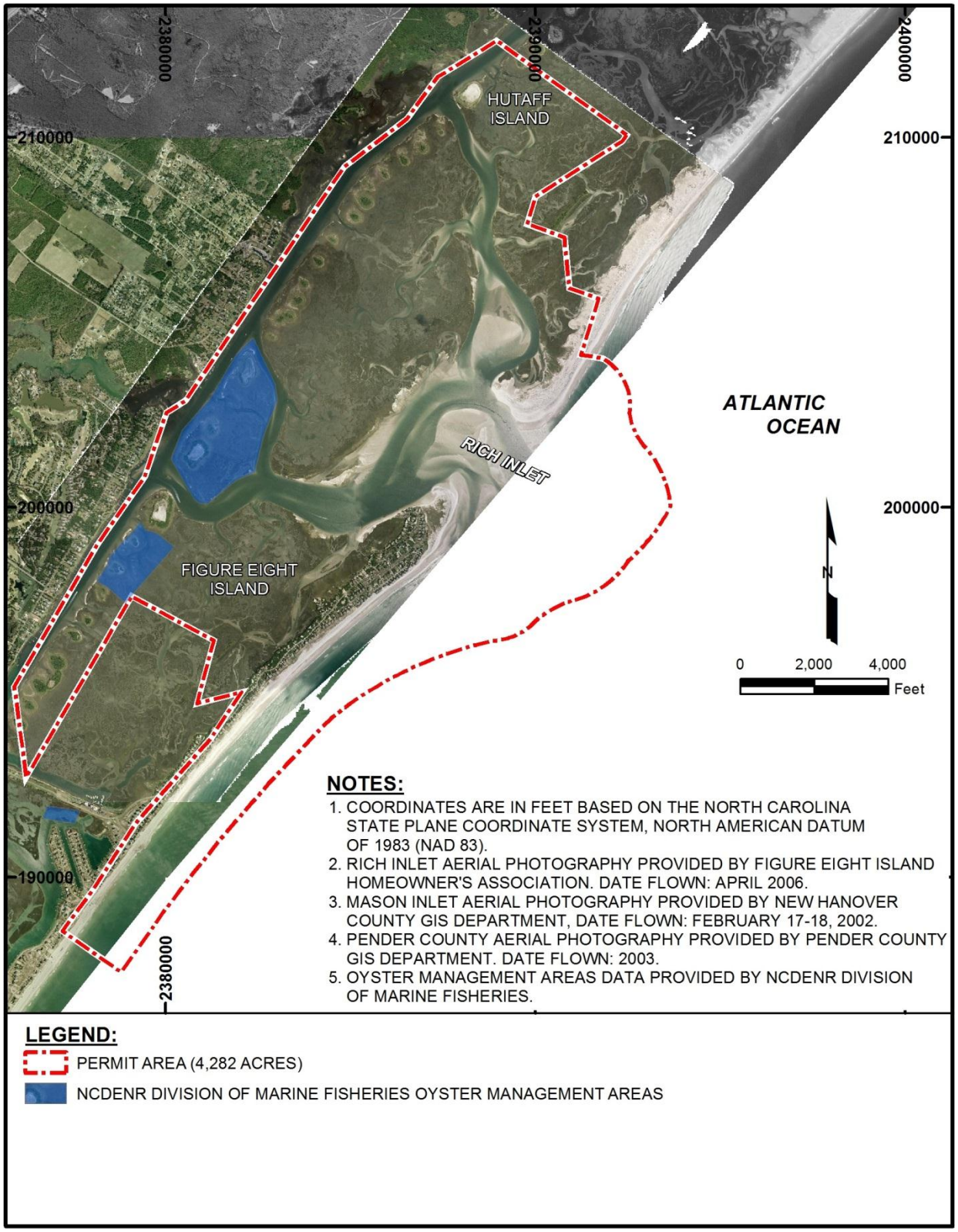


Figure 4.5. Oyster Management Areas within and in proximity to the Permit Area

Table 4.1 below summarizes the spawning seasons for the three shellfish species typically found within the Permit Area.

Table 4.1. Spawning Seasons for Shellfish

SPECIES	SPAWNING SEASONS
Hard Clam *(Mercenaria mercenaria*)	May through November
Eastern Oyster (*Crassostrea virginica*)	May through September
Bay Scallops (*Argopecten irradians*)	August through December

The NCDMF Shellfish Mapping Program was developed using a stratified random sampling design that delineates all bottom habitats (or strata) and samples the density of oysters, clams, and bay scallops in these areas (Deaton *et al*., 2010). Benthic habitat surveys in Rich Inlet and the estuarine habitats behind Figure Eight Island and Hutaff Island were conducted by the NCDMF in 1991 (Conrad, pers. comm.). Shellfish were found within strata R (intertidal firm, vegetated without shell), strata S (intertidal firm, non-vegetated with shell), strata T (intertidal firm, non-vegetated without shell), and strata W (intertidal hard, non-vegetated with shell) (Conrad, pers. comm.). Figures 4.6 and 4.7, created by the NCDMF Shellfish Mapping Program, illustrates the distribution of the various habitats within proximity of the Permit Area. The number and density of clams (*M. mercenaria*), oysters (*C. virginica*), and scallops (*A. irradians*) present within these strata are listed in Tables 4.2 and 4.3. Stratum W is the habitat containing the highest densities of shellfish in this area. No scallops were observed in these sampling surveys.

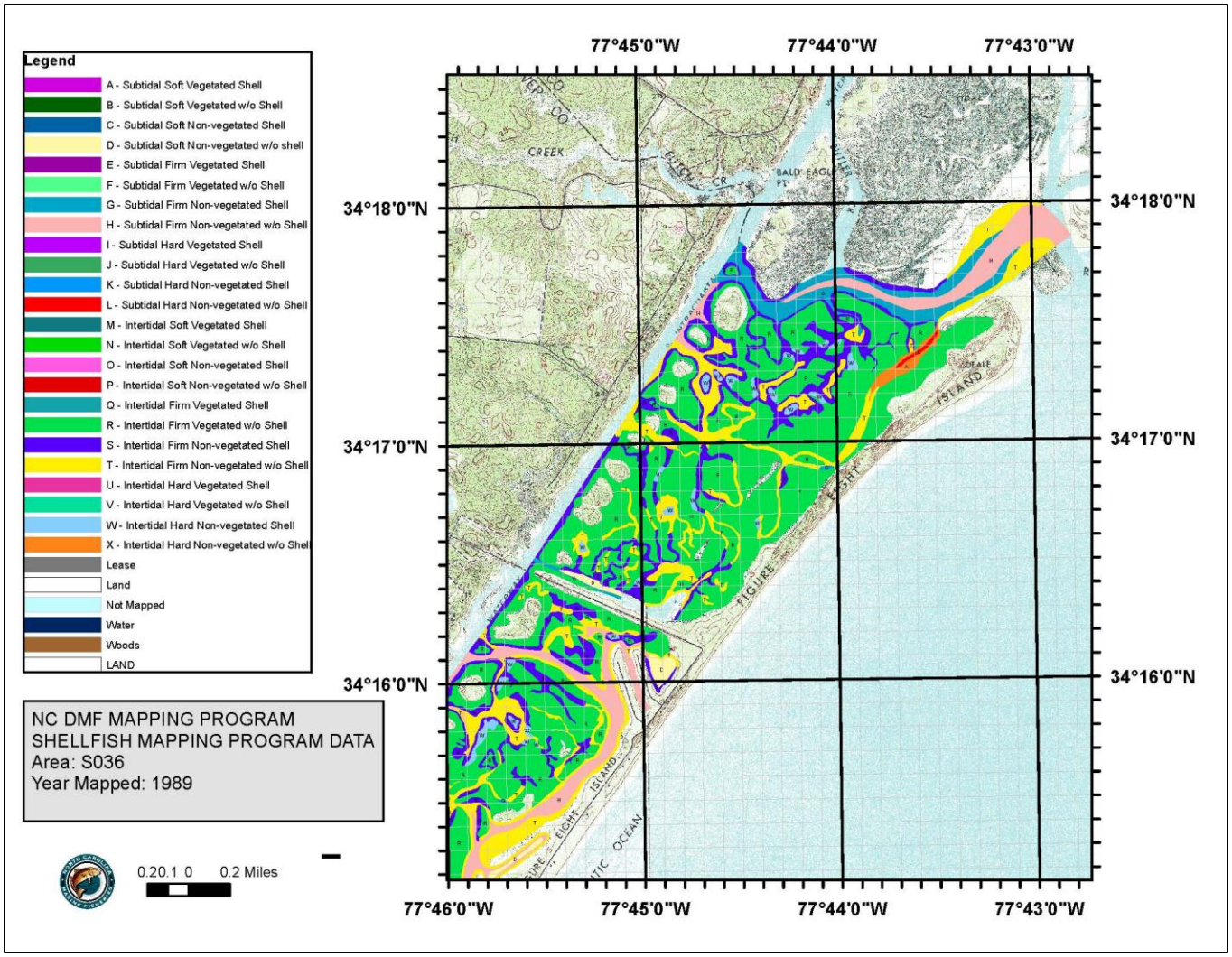


Figure 4.6. NCDMF Shellfish Mapping Program – Area SO36

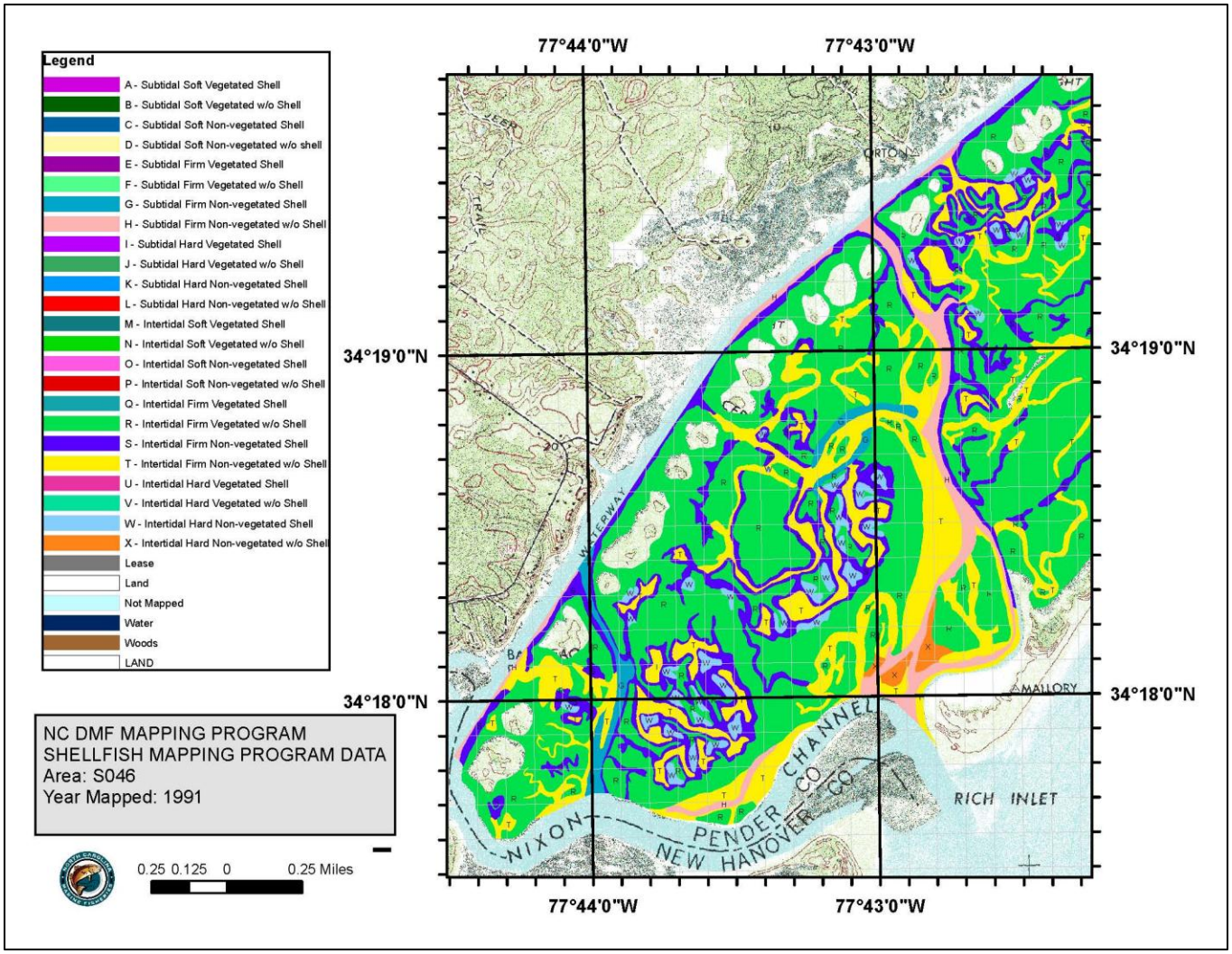


Figure 4.7. NCDMF Shellfish Mapping Program – Area SO46

Table 4.2. Shellfish Density Data for Area SO36. Surveys conducted by NCDMF between 1989 and 1991

Strata	Number of Samples	Area Sampled (Square meters)	Collection Number	Density (Shellfish per square meter)
S036				
		CLAM		
D	15	13.50	0.00	0.00
G	19	17.10	0.00	0.00
H	25	22.50	0.00	0.00
L	15	13.50	0.00	0.00
R	105	105.00	2.00	0.02
S	56	55.20	75.00	1.36
T	44	43.60	13.00	0.30
W	21	20.40	69.00	3.38
X	15	14.50	0.00	0.00
		OYSTER		
D	15	13.50	0.00	0.00
G	19	17.10	0.00	0.00
H	25	22.50	0.00	0.00
L	15	13.50	0.00	0.00
R	105	105.00	1,176.00	11.20
S	56	55.20	4,469.00	80.96
T	44	43.60	1.00	0.02
W	21	20.40	5,354.00	262.45
X	15	14.50	0.00	0.00
		SCALLOP		
D	15	13.50	0.00	0.00
G	19	17.10	0.00	0.00
H	25	22.50	0.00	0.00
L	15	13.50	0.00	0.00
R	105	105.00	0.00	0.00
S	56	55.20	0.00	0.00
T	44	43.60	0.00	0.00
W	21	20.40	0.00	0.00
X	15	14.50	0.00	0.00

Table 4.3. Shellfish Density Data for Area SO46. Surveys conducted by NCDMF between 1989 and 1991

Strata	Number of Samples	Area Sampled (Square meters)	Collection Number	Density (Shellfish per square meter)
S046				
		CLAM		
G	15	13.50	0.00	0.00
H	15	13.50	0.00	0.00
R	15	15.00	0.00	0.00
S	39	39.00	114.00	2.92
T	15	15.00	3.00	0.20
W	15	15.00	45.00	3.00
X	15	15.00	0.00	0.00
		OYSTER		
G	15	13.50	0.00	0.00
H	15	13.50	0.00	0.00
R	15	15.00	79.00	5.27
S	39	39.00	6,506.00	166.82
T	15	15.00	0.00	0.00
W	15	15.00	6,413.00	427.53
X	15	15.00	0.00	0.00
		SCALLOP		
G	15	13.50	0.00	0.00
H	15	13.50	0.00	0.00
R	15	15.00	0.00	0.00
S	39	39.00	0.00	0.00
T	15	15.00	0.00	0.00
W	15	15.00	0.00	0.00
X	15	15.00	0.00	0.00

The NCDMF shellfish habitat maps contain 23 individual polygons representing the W stratum within the limited area within the Permit Area. Field investigations were conducted on 15, 17, and 22 September 2008 by CPE-NC staff biologists to visually groundtruth these potential shellfish areas within the Permit Area that may receive impacts due to project related activities. Coordinates of the center point of these polygons were obtained and GPS was utilized to navigate to each location. Water clarity was generally poor with visibility less than 2 ft; therefore snorkelers utilized both visual cues and tactile cues to assess the presence or absence of shellfish resources. The spatial extents of discrete shellfish beds were determined by following the boundary while periodically recording GPS coordinates. These coordinates were then converted to a Geographic Information System (GIS) shapefile using ArcView 9.3 software and overlaid upon high resolution aerial photography. The boundaries of the mapped shellfish beds were then refined through visual interpretation of the aerial photos. Additional shellfish resources within

the entire Permit Area were then identified via extrapolation of areas with similar color signature in the 2008 high resolution (<2 feet) geo-referenced aerial photography. These areas were groundtruthed to determine the size and extent of shellfish beds within this area. Of the 23 potential shellfish sites groundtruthed, nine were confirmed to contain live shellfish. Each of these confirmed areas contained scattered patches of live shellfish (primarily *C. virginica*) fringing along the edge of a salt marsh and were not considered to be a discrete shellfish bed. Therefore it was not possible to determine distinct boundaries utilizing GPS. The remaining sites were identified as muddy substrate or scattered shellfish shells.

CPE-NC located and delineated one additional discrete shellfish bed that had not been identified by the NCDMF. Utilizing this site as a confirmed shellfish bed, an additional three sites with similar color signatures were extrapolated from the 2008 high resolution aerial photographs (Figures 4.8 and 4.9). In total, 0.1 acres of shellfish bed habitat have been identified within the Permit Area.

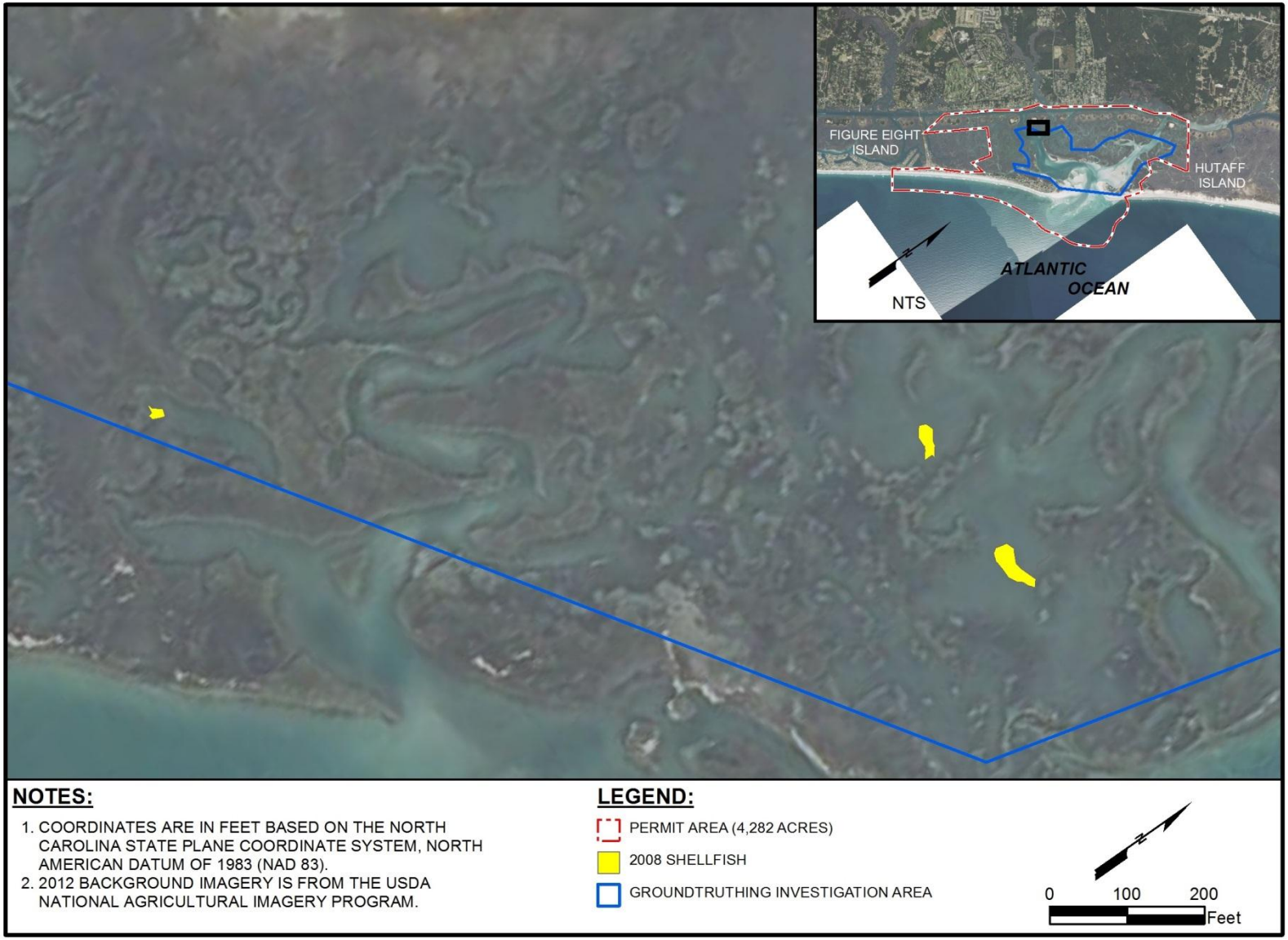


Figure 4.8. Identified Shellfish Resources within the Permit Area

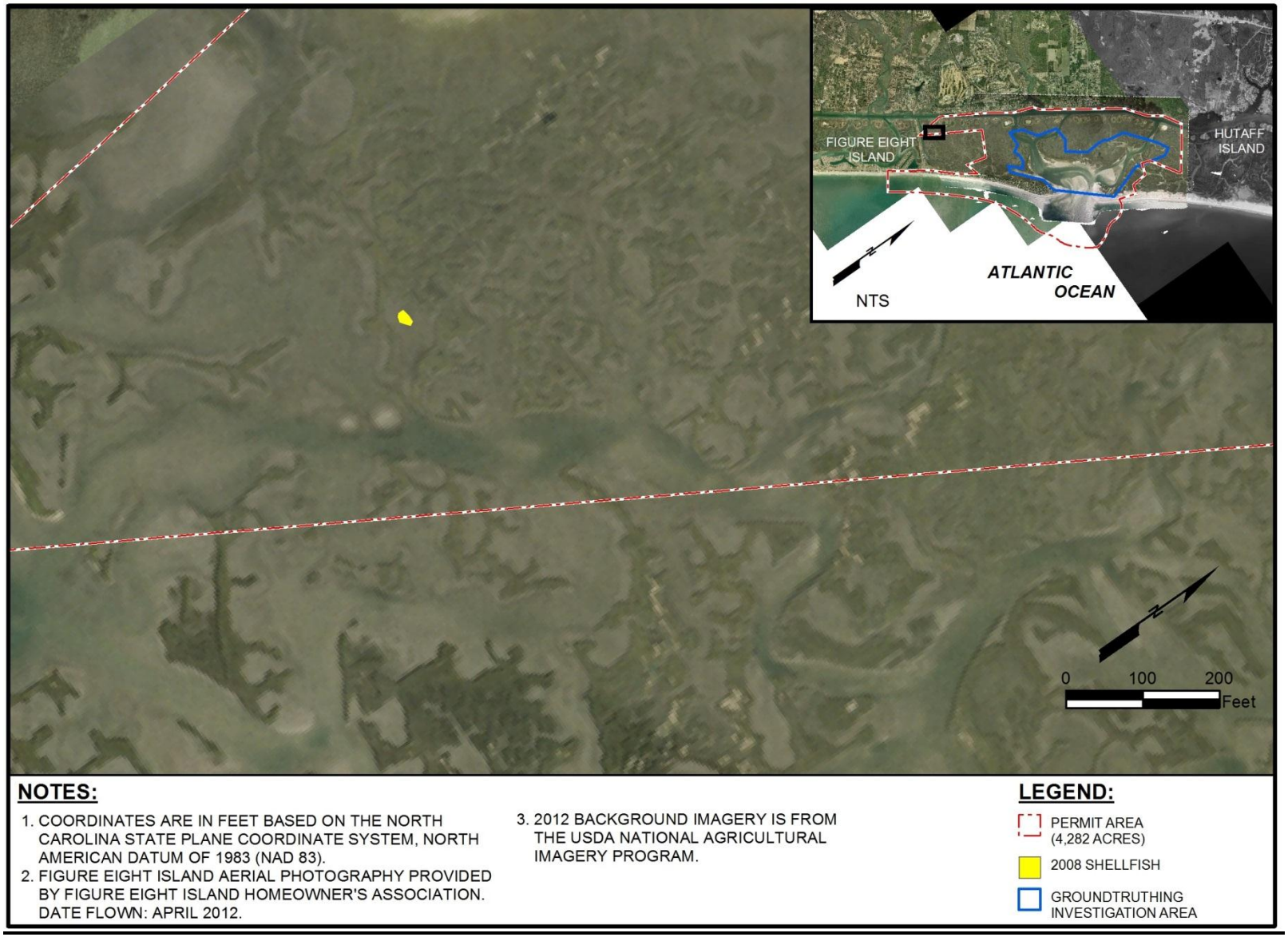


Figure 4.9. Identified Shellfish Resources within the Permit Area

- Hard Clams

According to the NCDMF, the stock status of hard clams (*Mercenaria mercenaria*) is unknown because there is no data available to assess the population size (NCDMF, 2001). Hard clams are an estuarine-dependent mollusk found primarily in sandy and vegetated bottoms. Increased fishing, poor water quality, and habitat loss have impacted this fishery (NCDMF, 2003a). The EFH for the hard clam, as designated by the SAFMC, includes subtidal and intertidal flats, oyster reefs and shell banks, and SAV (NCDMF, 2001). A State Fishery Management Plan was updated in 2008.

Hard clams are suspension feeders that subsist primarily on phytoplankton. Growth of hard clam larvae is quickest at temperatures found between 22.5 and 36.5ºC (72.5 and 97.9°F) with salinities of 21.5 to 30.0 ppt (Eversole, 1987). They spawn from May through November, when water temperatures reach 20ºC (68°F). Salinities above 25 ppt significantly affect normal embryonic development while temperatures too low will not allow maturation and spawning (Eversole, 1987). Hard clams can be found in nearly all of the sheltered marine waters of North Carolina. Based on research examining clam landings per trip, the NCDMF found that the harvest of clams appeared to be particularly stable (NCDMF, 2001). Results from the 1991 surveys conducted by NCDMF indicated that clams were present in the permit area.

- Eastern Oysters

Eastern oysters (*Crassostrea virginica*) are long-lived (approximately 40 years) and are capable of forming large reefs. According to the NCDMF, the eastern oyster has a stock status designation of concern due to a long-term decline most likely caused by over harvesting, habitat disturbances, and pollution. Oysters require a relatively clean, firm substrate to attach to and can be found in intertidal or subtidal estuarine environments. Spawning in North Carolina occurs from May through September. Vast intertidal reefs formed by oysters are significant biological and physical formations in the estuaries of North Carolina. Fish, crabs, and shrimp utilize oyster beds as refuge and as a source of food. The intertidal oyster beds also provide habitat for various infaunal and epifaunal species.

The eastern oyster is a very successful estuarine bivalve and can tolerate a wide variety of salinities, temperatures, currents, and turbidities. The preferred habitat for eastern oysters is from just below MLW to 1 m (3.28 ft) above MLW (Burrel, 1986). The eastern oyster is a prolific bivalve, whose stocks have been depleted, which identified a need for a State Fishery Management Plan (updated in 2008) in parallel with the Hard Clam Fishery Management Plan.

Results from the 1991 surveys conducted by NCDMF indicated that eastern oysters were present in the permit area.

- Bay Scallop

Bay Scallop

The NCDMF lists the bay scallop (*Argopecten irradians*) as a species of concern based on poor recruitment and low abundances. NCDMF has developed a fisheries management plan for the bay scallop in 2007. *A. irradians* is an estuarine-dependent bivalve found in seagrass (mainly eelgrass) beds. Bay scallops are rarely found attached, although they do have the ability to attach by byssal threads, mainly as juveniles, but as they mature, scallops sink to the bottom and continue to grow (Fay *et al*., 1983). Adult scallops prefer calm waters, secluded from high winds, storms, with tides and depths of 0.3 to 10 m (0.98 to 32.8 ft). Environmental factors, such as temperature and rainfall, play a critical role in scallop abundance (NCDMF, 2003b). They spawn between August and December when water temperatures are approximately 15.5°C (60ºF). No scallops were present during the 1991 surveys conducted by the NCDMF. However, habitat with the potential to support scallops was identified within the Permit Area.

Benefits of Shellfish Habitat Areas to Fishery Resources

Shell bottom provides critical fisheries habitat not only for oysters, but also for recreationally and commercially important finfish, other mollusks, and crustaceans. The SAFMC has designated oyster reefs as EFH for red drum (*Sciaenops ocellatus*). The ecological functions of oyster reefs related to oyster production are well known and accepted. These functions include aggregation of spawning stock, chemical cues for successful spat settlement, and refuge from predators and siltation. Oysters have also been described as "ecosystem engineers" that create reef habitat important to estuarine biodiversity and fishery production. Several studies have found higher biological abundance and diversity on shell bottom than adjacent softbottom, particularly pinfish (*Lagodon rhomboides*), blue crabs (*Callinectes sapidus*), and grass shrimp (*Palaemonetes pugio*) (Deaton et al., 2010).

B. Upland Hammock Habitat

Upland hammock

These forested systems are typically dominated by live oak (*Quercus virginiana*), loblolly pine (*Pinus taeda*), and red cedar (*Juniperus virginiana*) trees with an understory of shrub thicket which can support such species as swamp bay (*Persea palustris*) and sweetbay (*Magnolia virginiana*).

Maritime hammocks, also known as maritime forests, tropical hammocks or coastal hammocks, are characterized as narrow bands of forest that develop almost exclusively on stabilized backdunes of barrier islands, inland of primary dunes and scrub. This habitat type is typically dominated by species of broad-leaved evergreen trees and shrubs, maritime hammocks are climax communities influenced heavily by salt spray. Figure 4.1 depicts the upland hammock habitat and designates the area as "scrub-shrub" and "upland forest". The dominant wind direction and influence of salt spray is usually evidenced by the

sculpted vegetation (Texas Cooperative Research Unit, 2002). Twenty-seven (27) acres of upland hammock as well as 67 acres of scrub-shrub habitat have been delineated within the Permit Area, as determined through interpretation of high resolution aerial photography.

Benefits of Upland Hammocks to Colonial Waterbirds

Colonial waterbirds utilize a variety of habitats for foraging, roosting, and nesting, which includes estuaries, oceanfronts, open dunes, inland areas, and intertidal shoal habitats. These birds also use a variety of habitats for nesting. Some colonial waterbirds such as green herons and yellow-crowned night herons utilize vegetated, upland environments. These three colonial waterbird groups prefer trees, shrubs, and grass lands for nesting and, as a result, may utilize the upland hammocks identified within the Permit Area.

C. Inlet Dunes and Dry Beach Habitats

This section identifies and discusses the dune and beach communities within the Rich Inlet complex. These habitats are present around the periphery of the inlet. Inlet dunes and inlet beaches are similar to coastal dunes and coastal beaches, however, as a result of episodic overwash, these habitats are typically not as established as coastal beaches and often lack the vegetation common on the coastal beach and dune systems. Inlet dunes are defined as any hill, mound, or ridge of sand along the inlet coastline created by natural or artificial forces. The inlet dry beach habitat is defined as the portion of the ocean beach in proximity to the inlet that is between mean high water and the toe of the dune. These inlet dunes and beaches are also susceptible to forecasted sea level rise.

Benefits of Inlet Dunes and Dry Beaches to Shorebirds, Colonial Waterbirds, and Other Waterbirds

Most shorebirds are long distance migrants, who migrate through and winter in North Carolina en route to find suitable breeding sites in the Arctic. To complete these flights, shorebirds must obtain a large food reserve. The inlet dunes and beaches in proximity to Rich Inlet provides migration stop-over areas used by shorebirds to replenish food reserves and accumulate fat needed for the long flights. There are few places that have the necessary combination of resources. In some areas, between 50% and 80% of the entire population of a species may visit a single site (MCCS, 2003). Migratory arctic-bound shorebird species that may be found during the non-breeding season within inlets of North Carolina include the red knot (*Calidris canutus rufa*), dunlin (*Calidris alpine)*, western sandpiper (*Calidris mauri)*, and sanderlings (*Calidris alba*). Many arctic breeding species are experiencing declines, including the red knot, which was recently listed as a candidate for protection under the Endangered Species Act. Surveys conducted during 2007 by Audubon North Carolina revealed a total of 878 red knot individuals observed along Mason Inlet, Rich Inlet, Lea Island, and Hutaff Island. The maximum count at each location on an individual survey was 188, 258, 6, and 20, respectively at each location (Mangiameli, pers. comm., 2008).

Shorebirds utilize these inlet dunes and beaches for breeding, wintering and migrating. Many species rely on a few, key stopover sites to complete their annual migratory cycle. The Outer Banks of North Carolina constitute a prime example of a potentially important area for which only limited information on migratory birds is available (Dinsmore, *et al*., 1998).

Some species of waterbirds, such as terns and black skimmers, nest on bare sand and shell with little or no vegetation. These species will change nesting areas in response to changing environmental conditions, such as increased vegetation or storm events. In selecting nesting habitat, waterbirds recognize the area and past success, but mainly adhere to group dynamics. This type of grouping creates nesting, resting, and foraging areas with large colonies that can include multiple species of waterbirds.

1. Overwash Habitats

One type of dry inlet beach habitat that is an important feature is overwash areas. Natural processes, such as storms, create overwash features behind primary sand dune areas. A total of 7 acres of overwash habitat has been delineated within the Permit Area. Overwash areas are usually created during strong storm events when tides wash over portions of the beach and move sand back towards the sound, creating new habitat. Overwash areas are characterized by the low sand flats left where storm waves have washed across a barrier island. This includes loose sand, perhaps piled into dunelets and/or divided by sluiceways, and usually scattered weedy shrubs and herbs. After the site has gone for an extended period without storm scouring, the vegetation may develop into a dense mat of vines and grasses. Island overwash is an important natural process in maintaining coastal barrier islands. Large man-made dunes may limit the occurrence of overwash features. When overwash occurs, the net volume of sand is often maintained and the island migrates landward (Donnelly *et al.*, 2006). Barrier islands naturally migrate landward as a result of sea level rise. This is accomplished through overwash events where sediments are pushed to the sound side, which contributes to building marsh on the sound side.

Benefits of Overwash Habitats to Shorebirds, Colonial Waterbirds, and other Waterbirds

Overwash features are not unique to inlets; however, the dynamic and productive microhabitats formed as a result of inlet migration are very important to both breeding and non-breeding waterbirds. Overwash habitats include ephemeral pools and bayside mudflats which are important feeding areas to piping plovers at the start of the nesting season and throughout the year (Fraser, 2005; USFWS, 1996). Overwash habitat is utilized by wildlife, particularly shorebirds, colonial waterbirds and other waterbirds as they provide suitable foraging and nesting habitat for these birds. Overwash events usually occur during storm events or in low areas during spring high tide conditions when seawater flows through the primary dune line, spreading out sand from the beach and dunes. Recently created overwash fans are generally unvegetated and function similar to the dry beach community. Willets, American oystercatchers, piping plovers, Wilson's plovers, and killdeers usually nest on open areas such as above the high tide line on coastal beaches, on sand flats at the ends of sand spits, and along blowout areas behind dunes and in overwash areas. These open habitats are utilized by breeding and non-breeding colonial waterbirds. In particular, the Wilson's plover and the federally threatened piping plover are both dependent on hurricanes and storms to provide the overwash needed for nesting habitat (Deaton et al., 2010).

D. Intertidal Flats and Shoals

Intertidal flats and shoals

These habitats areas are considered to be important feeding areas to shorebirds at the start of the nesting season and throughout the year. This includes the federally protected piping plover (Fraser, 2005; USFWS, 1996).

Intertidal flats and shoals are defined as non-vegetated, soft sediment habitats, found between mean high-water and mean low-water spring tide datum (Dyer et al. 2000) and are generally located in estuaries and other low energy marine environments. Mean high water is defined as the average elevation of all high waters recorded at a particular point or station over a considerable period of time. Mean low water is defined as the average elevation of all low water at a particular location also over a considerable period of time. Intertidal flats and shoals are distributed widely along coastlines world-wide, accumulating fine-grain sediments on gently sloping beds, forming the basic structure upon which coastal wetlands build. The tidal flats and shoals of North Carolina are habitat to a variety of migratory shorebirds, colonial waterbirds, marine mammals, reptiles, fish and macro-infauna. For this reason, these habitats are considered to be a valuable natural resource. These habitats have developed into a dynamic inlet system and, therefore tend to be ephemeral in nature, especially with regard to dynamic island formation within the inlet. A total of 206 acres of intertidal flats and shoals are located within the Permit Area, mainly within the inlet complex.

Benefits of Tidal Flats and Shoals to Shorebirds, Colonial Birds and Other Waterbirds

During all months of the year, Rich Inlet provides important foraging, roosting and nesting habitats for shorebirds, colonial birds, and other waterbirds. The intertidal shoals and sand flats provide sheltered and isolated habitat for roosting and foraging. Prey resources for shorebirds include mainly invertebrates and small fish. Most shorebirds are aquatic and terrestrial probers/gleaners that can wade in the surf of intertidal areas. Breeding and non-breeding federally endangered species and species of special concern also utilize intertidal flats and shoals. Therefore, Rich Inlet's habitats and the shorebirds that utilize them are a very important natural resource to the coast of North Carolina. Intertidal flats and shoals, particularly low-energy wet sand flats and shoals, are essential to many species of migrating and wintering shorebirds (Colwell 2010).

Benefits of Tidal Flats and Shoals to Benthic Macroinfaunal Community

These tidal flats and shoals in the inlet complex provide habitat for the macroinfaunal community due to their softbottom consistency. Softbottom habitats are comprised of unconsolidated sediment and defined as "unvegetated", lacking visible structural habitat. However, this "soft" substrate supports an abundance of macroalgae and numerous burrowing organisms (macroinfauna) living below the surface (Deaton et al., 2010).

Macroinfaunal species are resident to the upper 1 m (3.28 ft) of the substrate due to the available oxygen content and aeration properties; although some larger species may live deeper in the seabed (USFWS, 2002). Dominant macroinfaunal species typical of the bays and sounds of North Carolina include bivalves, decapods, polychaetes, and amphipods.

Macroinfaunal species are a primary food source for several migratory and resident shorebirds, waterbirds, as well as for many commercially and recreationally important fish. Bird species can

be found utilizing the Inlet and surrounding estuarine environments as a stop-over feeding station while traveling to their wintering and nesting grounds. Migratory fish species utilizing the inlet depend upon the macroinfaunal community as a food reserve, en route to upstream seagrass beds and estuarine habitats.

Benefits of Tidal Flats and Shoals to Fishery Resources

As stated above, these habitat areas host an abundance of macro species which are food sources for many fishery resources. The tidal flats and shoals of North Carolina are habitat to a variety of, anadromous, estuarine, and marine fish species (USFWS, 2002), such as cobia (*Rachycentron canadum*), lane snapper (*Lutjanus synagris*), red drum (*Sciaenops ocellatus*), red grouper (*Epinephelus morio*), spadefish (*Chaetodipterus faber*), gag (*Mycteroperca microlepis*), king mackerel (*Scomberomorous cavalla*), white shrimp (*Penaeus setiferus*), brown shrimp (*Penaeus aztecus*), pink shrimp (*Penaeus duorarum*), Atlantic sharpnose shark (*Rhizoprionodon terraenovae*), southern flounder (*Paralichthys lethostigma*), and summer flounder (*Paralichthys dentatus*). These species benefit from tidal flats and shoals as the habitat is used for refuge, corridor, nursery, and spawning purposes (Deaton, 2010).

E. Oceanfront Dry Beach and Dune Habitats

1. Oceanfront Dune Communities

The primary dune extends landward to the lowest elevation in the depression behind that same mound of sand (commonly referred to as the dune trough). Frontal dunes are defined as the first mound of sand located landward of the ocean beach having sufficient vegetation, height, continuity and configuration to offer protective value (NC DCM, 2008b).

Oceanfront beach and dune habitats

Section 15A NCAC 7H .0305(c) of the North Carolina Administrative Code defines primary dunes as the first mounds of sand located landward of the ocean beaches having an elevation equal to the mean flood level (in a storm having a one percent chance of being equaled or exceeded in any given year) for the area plus six feet.

Dunes and their associated plant species are important in providing shorefront protection against coastal storms and supplying sand to the beach system during periods of erosion. A total of 60 acres of dune communities are located within the Permit Area primarily the oceanfront shoreline along Figure Eight Island and Hutaff Island behind the dry beach habitat. This habitat is also found within the back side of the inlet system.

Benefits of Oceanfront Dune Communities to Plant Species

High temperatures, strong winds, and varying wet and dry conditions typical of a dune environment provide unique conditions for plant species with specific adaptations. These specific adaptations include plant species that grow extensive root systems, allowing for prolific growth in unconsolidated beach sand. Perennial grasses are the primary stabilizers of frontal dune systems along beaches and dunes. North Carolina is located in a vegetation transition zone, between American beach grass (*Ammophila breviligulata*) to the north, and sea oats (*Uniola paniculata*) to the south.

2. Oceanfront Dry Beach Communities

Eroded material from the dune system contributes to the dry beach located between the toe of dune or scarp and mean high water (MHW) line. The dry beach area is susceptible to wind and storm surge, which supports less vegetation than the dune community. However, this habitat type provides recreational areas for humans and nesting grounds for sea turtles and shorebirds. A total of 75 acres of dry beach communities are located along the ocean shoreline on Figure Eight Island and Hutaff Island within the Permit Area.

Benefits of Oceanfront Dry Beach Habitats to Sea Turtles

Five species of sea turtles nest on North Carolina beaches: the green sea turtle, loggerhead sea turtle, leatherback sea turtle, hawksbill sea turtle and Kemp's Ridley sea turtle. Sea turtles prefer to nest on wide sloping beaches or near the base of the dunes. Dry beaches must allow for the following in order for nesting to be successful: beach areas above the mean high water line must be wide enough to allow nesting to occur; access to the dry beach must be devoid of obstructions (i.e. fencing, seawalls); the sand compaction must allow for digging, and; the nesting area to be located away from areas of inundation throughout the nesting season. The composition, color, and grain size can affect the incubation time, gender, and hatching success of turtle hatchlings (Deaton et al., 2010).

Benefits of Oceanfront Dry Beach Habitats to Shorebirds, Colonial Waterbirds, and other Waterbirds

Beach-nesting birds that utilize dry beach habitats for nesting include terns, black skimmers, Wilson's plovers, piping plovers and American oystercatchers. Terns and black skimmers nest on bare sand and shell with little or no vegetation. These species will change nesting areas in response to changing environmental conditions, such as increased vegetation. Waterbirds use group dynamics to select suitable nesting areas. This grouping creates nesting, resting, and foraging areas with large colonies that can include multiple species of waterbirds (Cameron, pers. comm., 2007). This is one reason why it is important that these birds have a number of suitable nesting, foraging, and roosting sites along the coast. For colonial waterbirds such as black skimmers and gulls, they utilize estuarine habitats, oceanfront shorelines, open dunes, inland areas, and dry beach habitats for foraging, roosting, and nesting.

The undeveloped beaches along Hutaff Island have been identified by the NCWRC as one of the most important migratory stop over sites and wintering sites for the federally threatened piping plover. Portions of the Permit Areas are regulated under a Critical Habitat listing as identified in the Endangered Species Act.

Wet beach with scarp formed on Figure Eight Island (March 18, 2008)

(Jarrett, 2008)

F. Wet Beach Communities

The intertidal zone of oceanfront barrier island beaches or wet beach communities are areas that are periodically exposed and submerged by waves, varying with frequency and with lunar tidal cycles. Like intertidal shoals, these areas are comprised mainly of sandy bottoms and shell hash and are influenced by tidal changes and are susceptible to storms.

This high energy area is habitat to many benthic organisms and foraging grounds for birds and finfish. A total of 96 acres of wet beach habitat are found primarily along the oceanfront shoreline of Figure Eight Island and Hutaff Island within the Permit Area.

1. Benthic Infaunal Community

On oceanfront beaches, most benthic organisms in the intertidal zone consist of infaunal burrowing forms, particularly polychaete worms (Phylum Annelida), coquina clams (*Donax variabilis and D. paruvula*) and mole crabs (*Emerita talpoida*) (USFWS, 2002). Many benthic organisms are filter feeders, which pump large amounts of water through their bodies. As they pump water, they remove sediments and organic matter, thus filtering the water. Some of the organic matter filtered from the water is not used and instead deposited in the sediment. These nutrients can later be recycled by benthic organisms and dispersed back into the water column, making them available to other organisms. Thus, benthic organisms are critical in maintaining the high production rates of estuaries.

While several species of amphipods and polychaetes populate the intertidal and shallow subtidal beaches of North Carolina, their contribution to the total biomass of benthic infauna is low due to their small body size. Due to their short life spans and frequent reproduction events and despite their relatively low biomass, these species are important to the benthic infaunal community in regard to their contribution to primary and secondary productivity. Therefore, mole crabs and coquina clams dominate the benthic infaunal community due to their biomass (Peterson *et al.*, 2000).

- Mole Crab

Mole crabs (*Emerita talpoida)* live at depths above 5 cm under sand in shallow water in the swash zone or marine intertidal areas (Bowman and Dolan, 1985). *E. talpoida* is a very mobile species and is highly adaptable to the harsh and dynamic swash zone environment. Mole crabs have the color of rippled sand at the water's edge and live mostly buried in the sand, with their antennae reaching into the water forming a "V" shaped obstacle in the water as the wave recedes. These antennae filter plankton and organic debris from the water. Mole crabs also eat the tentacles of Portuguese man o' war (*Physalia physalis*), which are collected by winding the tentacle around the mole crab's leg. Camouflage protects the mole crab from predators, primarily fish and birds. Males are smaller than females, only reaching 20 mm, making the sexes easy to tell apart when fully grown. Females grow to 35 mm in length and carry their bright orange colored eggs under their telson until they are ready to hatch. Recruitment can occur year round, but large numbers of recruits are found in early summer and in early fall. Diaz (1980) found that most recruitment occurred in September as a result of summer spawning. Amend and Shanks (1999) also found that the reproductive season ended in late September.

Female mole crabs do not rely on tidal cues to time larval release; instead, larvae are released at sunset regardless of the time of the tide. Since larval release occurs within the intertidal zone, the physical wave motions and currents are most likely strong enough to transport larvae away from the shoreline to coastal areas for development (Ziegler and Forward, 2005). Amend and Shanks (1999) reported that larval release is also influenced by wave height during rough seas where larvae are rapidly transported offshore away from adult habitat and predation.

As the swash zone changes with the tide, so does the location of the mole crabs. The mole crabs move up and down the beach with the tides. In the winter, storms carry them offshore possibly into sandbars; however, when the sand is transported back onshore in the spring, the mole crabs travel with it. Bowman and Dolan (1985) found that the overwintering populations migrate onshore in April during a period of rapidly increasing water temperatures. These population fluctuations are an important consideration when using *E. talpoida* as an indicator species for assessing environmental impacts.

- Coquina Clam

Coquina clams (*Donax variabilis)* are small, generally less than 2.5 cm in length, and possess wedge-shaped shells (Ruppert and Fox, 1988). Like most bivalves, coquinas are filter feeders, ingesting phytoplankton, bacteria, and other small suspended particles in the surf zone. The wet beach environment is extremely dynamic, eroding and accreting several times in a period of months. Although many organisms feed in the surf zone, this clam has unique adaptations to this habitat type, making the coquina clam a key habitat indicator species.

Donax variabilis migrates shoreward with the incoming tide and seaward with the outgoing tide (Ellers, 1995). While these clams spend most of their time buried in the sand, they emerge several times per tidal cycle to ride waves. Ellers (1995) named this method of movement "swash-riding" where each clam emerges from the sand and the flow from waves drags it to a new position to maintain optimum position at the sea's edge. Coquina clams actively migrate up and down the beach during spring and summer; however these tide-related migrations cease in winter as *D. variabilis* eventually moves into the subtidal zone in late fall. The fluctuation of the location of populations in relation to the changing tides is an important consideration when assessing this species and one should expect variation if sampling at different tidal levels.

Both males and females are required for reproduction. Spawning occurs subtidally in winter and juveniles recolonize the intertidal beach in late winter (Ruppert and Fox, 1988). The typical lifespan of coquina clams is two years.

The temporal pattern of presence and recruitment of macroinvertebrates of the South Atlantic Bight are depicted in Table 4.4 below.

Table 4.4. Temporal presence and major recruitment periods of surf zone invertebrates of the South Atlantic Bight (Hackney, et al., 1996).

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Coquina Clams (Donax variablis)	P	P	P	P	H	H, R	H,R	H	H	H	P	P
Ghost Crabs (Ocypode quadrata)	P	P	P	P	P	P, R	P, R	P, R	P, R	P	P	P
Beach Hoppers (Orchestiodea)	?	?	P	P	P	P	P	P	P	P	P	P
Sand Hoppers (Talorchestia)	?	?	P	P	P	P	P	P	P	P	P	P
Worms (Polychaetes)	P	P	P, R	H, R	H, R	H, R	H, R	H, R	H, R	H	P	P
Mole Crabs (Emerita taploidea)	P	P	P	P	H	H	H	H, R	H, R	H	P, R	P, R

P = present, H = periods of peak abundance, R = periods of recruitment

Benefits of Wet Beach Habitats to Fishery Resources

Many infaunal species are important food sources for demersal predatory fishes and mobile crustaceans. Some of the species that forage on benthic invertebrates in the swash zone include inshore lizardfish (*Synodus foetens*), Florida pompano (*Trachinotus carolinus*), pigfish (*Orthopristis chrysoptera*), pinfish *Lagodon rhomboides*, spot (*Leiostomus xanthurus)*, kingfish (*Menticirrhus littoralis, M. americanus*), red drum (*Sciaenops ocellatus*), Atlantic croaker (*Micropogonias undulates*), northern sea robin (*Prionotus carolinus*), summer flounder (*Paralichthys dentatus*), weakfish (*Cynoscion regalis*) and penaeid shrimp (Deaton et al., 2010). Many of these species use the high energy environment as protection from other predatory species, as well as for feeding grounds.

Benefits of Wet Beach Habitats to Shorebirds, Colonial Waterbirds, and Other Waterbirds

Many infaunal species are important food sources for a variety of bird species, especially the beach-nesting birds. Colonial waterbirds, such as black skimmers that utilize estuarine habitats, oceanfront shoreline, open dunes, and inland areas also utilize wet beach habitats for foraging, roosting, and nesting. These colonial waterbirds can alter their location in response to changes in environmental conditions.

G. Marine Habitats

Cowardin (1979) classifies marine habitats as open ocean waters overlying the continental shelf and its associated high energy coastline where salinities exceed 30 ppt. With this broad classification, many habitats or community types fall within the definition and have previously been, or will be, discussed in other sections of this EIS. This section, however, will focus on soft and hardbottom communities that are considered marine habitats. Marine nearshore softbottom communities are found in the intertidal zone as well as the subtidal zone. Marine intertidal and subtidal zones along the shoreline are highly affected by tides and bottom friction. North Carolina's tidal amplitude along ocean shoreline is greatest where the continental shelf is widest in the southern coastal area; average tidal height is approximately 2 ft (0.6 m) near Cape Hatteras and 4.3 ft (1.3 m) near Cape Fear (Deaton et al., 2010).

1. Softbottom (Unconsolidated) Communities

Softbottom habitat is the unvegetated bottom sediment in all coastal systems, and includes features such as inlets, shoals, channel bottoms, intertidal ocean beaches, and cape shoals. Softbottom plays a key role in primary productivity in shallow estuarine and marine systems. This habitat strongly influences the water column through dynamic cycling processes, storing and releasing nutrients and chemicals over time. Other ecosystem functions of softbottom include the reduction of physically destructive storm effects on oceanfront beaches, and providing sand sources for barrier island and inlet migration.

Softbottoms consist of both mud and sand substrates. Mudflats are sedimentary intertidal habitats created by deposition in low energy coastal environments, particularly estuaries and other sheltered areas and therefore are not pervasive in marine habitats. The sediments generally consist of silts and clays with a high organic content" (NMFS, 2006 - Mudflats). Sand bottoms consist of materials with grain sizes more coarse than silt (>0.0625 mm) (Anderson, 2006).

Periodic storms can affect benthic communities along the Atlantic coast to depths of approximately 35 m (115 ft). As a result, softbottom communities tend to be dominated by opportunistic taxa which have adapted to relatively quick recovery from disturbance (Deaton et al., 2010). Seasonal climatic changes can also influence the diversity and abundance of macroinfaunal species in these areas. Species abundance during the late winter and early spring is typically higher with densities of over 3,500 per 100cm^2 commonly observed (Mallin *et al*., 2000), although individual species vary considerably in their abundance throughout the year.

Generally, inadequate data are available to clearly indicate the current condition of softbottom habitat. Fortunately this habitat is relatively resistant to a changing environment. This is the most abundant submerged coastal fish habitat. This "soft" substrate supports an abundance of macroalgae and numerous burrowing organisms (macroinfauna) living below the surface (Deaton et al., 2010). Intertidal shoal, marine intertidal (wet beach) and subtidal areas in the Permit Area provide a total of 2,580 acres of possible habitat for softbottom communities.

Benefits of Softbottom Communities to Fishery Resources

Muddy bottoms are not pervasive in the marine environment and, rather, are located primarily in the estuarine habitats behind Figure Eight Island and Hutaff Island. Sandy substrates dominate the marine softbottom communities located off the ocean shoreline.

Softbottom habitat is used to some extent by almost all native coastal fish species in North Carolina. Certain species are better adapted to this shallow non-vegetated bottom. Flatfish, rays and skates are well suited for utilization of softbottom. Juvenile and adult fish species that forage on the rich abundance of macroalgae, detritus and small invertebrates are highly dependent on the softbottom. Softbottom habitat is particularly important as a foraging area for all size ranges of bottom feeding fish and invertebrates, such as blue crabs, shrimp, flounders, striped mullet, spot, croaker, and kingfish. Burrowing mollusks (e.g., hard clams, coquina clams), flatfishes (e.g., southern flounder, hogchoker) and baitfish (e.g., striped mullet) are highly associated with shallow softbottom, while larger benthic feeding predators (e.g., weakfish, coastal sharks, sturgeons) typically utilize deeper softbottom areas. Valued fishery species that depend on healthy softbottom habitat include hard clams, shrimp, blue crabs, southern flounder,

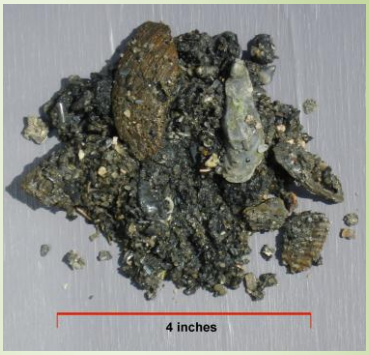
Atlantic croaker, striped mullet, kingfish, and spot. Of these, the NCDMF stock status of Atlantic and shortnose sturgeons, southern flounder, and coastal sharks was overfished. Striped mullet and Atlantic croaker were listed as Concern. The Atlantic sturgeon, which is classified as Overfished, has been under a fishing moratorium since 1991 but has not shown signs of recovery.

Offshore sand bottom communities along the North Carolina coast are relatively diverse habitats containing over a hundred polychaete taxa (Posey and Ambrose, 1994). Tube dwellers and permanent burrow dwellers are important benthic prey for fish and epibenthic invertebrates.

2. Hardbottom (Consolidated sediment) Communities

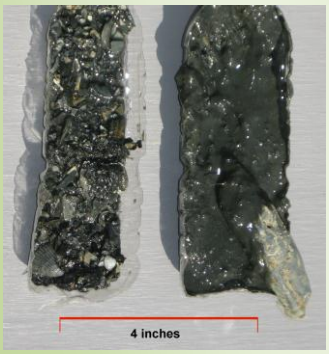
The term "hardbottom" refers to areas of rock or consolidated sediments in temperate, subtropical, and tropical regions, generally located in the ocean rather than in the estuarine system. Hardbottom habitats are also called "livebottom" due to the variety and abundance of invertebrates and plants that attach to or bore into these hard substrates. The topography of these habitats can vary from a relatively flat, smooth surface to a scarped ledge with stepped relief. Hardbottom habitats include shallow kelp-covered areas in rocky headlands, rock outcrops, submarine canyon walls, and the deep-water plateau. Along the south Atlantic states, hardbottom ranges from the shoreline and nearshore (within the state's 3-mi jurisdictional limit) to beyond the continental shelf edge (>200 m deep). It typically occurs in clusters across the shelf in specific areas. Estimates of the percent cover of hardbottom vary greatly along the south Atlantic coast between Cape Canaveral and Cape Hatteras (NOAA, 2007; Deaton et al., 2010).

Samples of material acquired during hardbottom investigations



Course Material

Fine Material



Fluidized Mud

Benthic water temperatures at hardbottom habitats in the ocean off North Carolina range from approximately 52.8° to 80.6° F (11° to 27° C). Salinity is typically around 35 ppt with little fluctuation. The composition of invertebrate, algal, and fish communities varies with temperature, depth and season.

Dr. William Cleary identified two areas of potential hardbottom resources located offshore Figure Eight Island and Hutaff Island (Cleary, 2000) (Figure 4.10). In order to verify the presence of hardbottom communities within the project area, a sidescan sonar survey was conducted off Figure Eight Island on 24 April 2009 (Figure 4.10). Following analysis and interpretation of the sidescan sonar data, a groundtruthing investigation of eleven (11) sites was

conducted on 30 June 2009 (See Appendix D). A number of sorted bedform features were identified through sidescan interpretation and verified through groundtruthing. Several areas generically interpreted as "bottom morphology of interest" were found to be sandy areas with abundant sand dollars. Other areas interpreted as "bottom morphology of interest" were found to be areas where fluidized mud had covered the existing bottom substrate. No rock outcrops or hardbottom communities were observed at any of the eleven (11) locations either exposed or buried; therefore, no hardbottoms are likely to be present within the Permit Area.

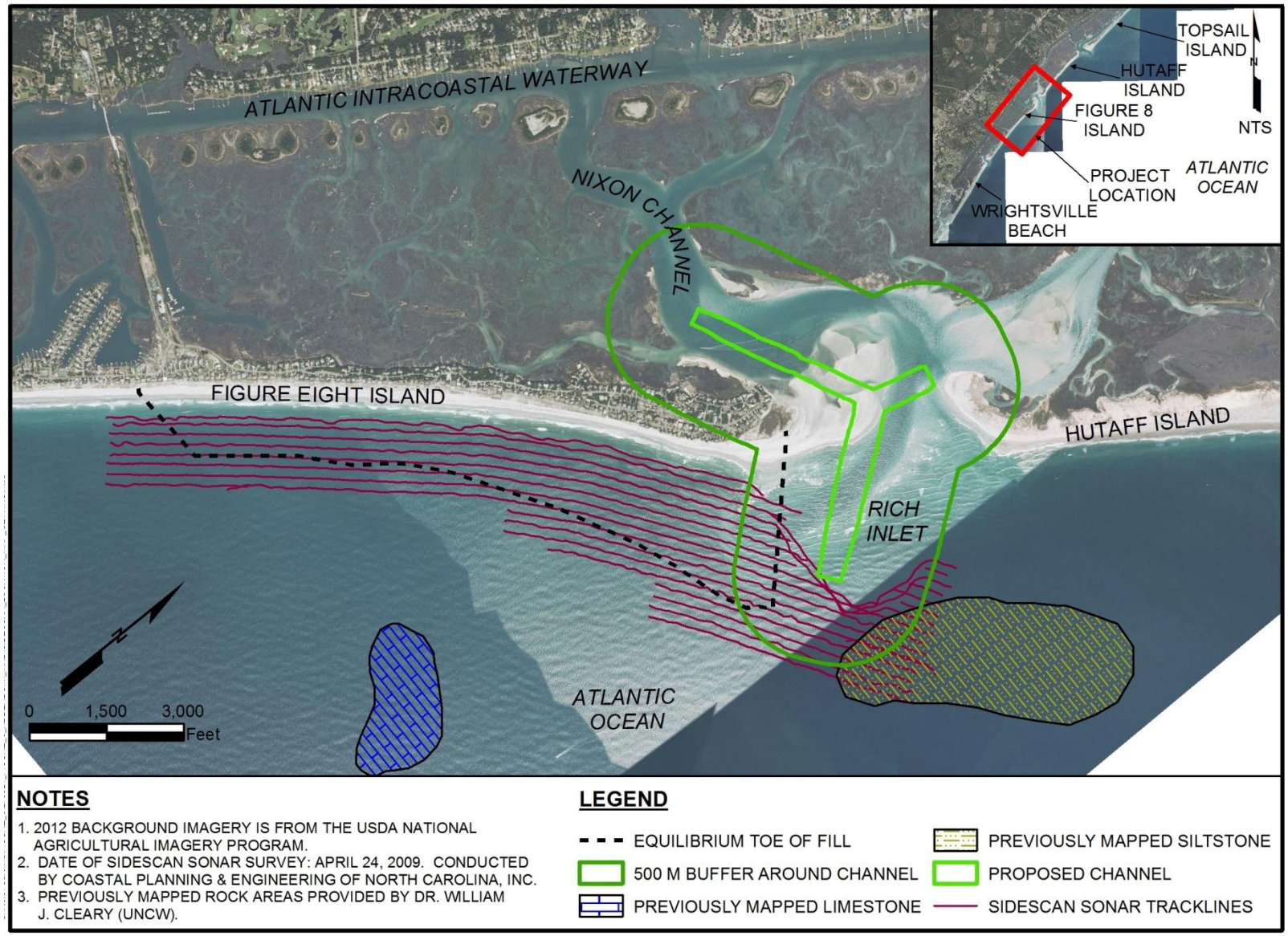


Figure 4.10. Map depicting sidescan sonar survey area. Note the tracklines cover the area within 500 meters of the proposed channel and the shoreface out beyond the point of equilibrium toe of fill.

H. Water Column

Water column is a conceptual column of water from its surface to bottom sediments. The concept of water column is important, since many aquatic processes are explained by the vertical mixing of chemical, physical or biological parameters. The depth of water column varies greatly throughout the Permit Areas. Within the waterbodies of Nixon and Green Channels, the depth ranges from less than 1 foot to approximately 18 feet; and the water column depth from the inlet gorge to the outer bar channel of Rich Inlet ranges from approximately 5 feet to nearly 30 feet. Along the ocean shoreline, the water column ranges from approximately 2 feet deep within the surf zone to approximately 25 feet deep. Conditions that influence the water column are hydrodynamic flow processes and salinity levels. The water column encompasses approximately 2,580 surface acres within the Permit Area.

Water column

Water column habitat is defined in North Carolina's Coastal Habitat Protection Plan (CHPP) as "the water covering a submerged surface and its physical, chemical, and biological characteristics" (Street *et al.,* 2005). It connects all other aquatic habitats, and is the "medium of transport for nutrients and migrating organisms between river systems and the open ocean" (SAFMC, 1998).

1. Hydrodynamics and Salinity

Hydrodynamic flows in nearshore, shallow environments, including the surf zone, are different from coastal and deep-ocean flows mainly because of the shoreline barrier, shallow depths, bathymetric features associated with the continental shelf, and nearshore inputs of freshwater. Moreover, flows in nearshore waters tend to be more complex than in the deep and coastal ocean because many processes operate there, including surface gravity waves, buoyancy driven flows, wind-forcing, surface and internal tides, large-amplitude internal waves and bores, and boundary-layer effects (Pineda et al, 2007). These differences between nearshore and coastal/open ocean hydrodynamics are important for larval transport.

Ocean tides on Figure Eight Island are semi-diurnal (occurring approximately every 12 hours), with a spring-neap variation of 28 days. Tidal ranges inside the AIWW range from 3.2 to 3.6 ft. The tidal range in the throat of the inlet is approximately 3.7 ft. The tidal prism through the throat of Rich Inlet is approximately 560,000 cubic feet.

In the throat of the inlet and Green Channel, the tidally influenced currents are flood-dominated, which means that water flows are greater as the water flows from the ocean through the inlet. In Nixon Channel, the currents appear to be ebb-dominated, meaning that the water flows are greater as the water flows from the inlet toward the ocean. In the throat of the inlet, the peak currents were 3.2 feet/second during flood and 2.7 feet/second during ebb, with a principal axis of 319º/139º. In Green Channel, the peak currents were 3.0 ft/sec during flood and 2.0 ft/sec during ebb, with a principal axis of 341º/161º. In Nixon Channel, the peak currents were 1.7 ft/sec during flood and 1.8 ft/sec during ebb, with a principal axis of 280º/100º. For more information regarding the tides and tidal flow within the Permit Area, refer to the Engineering Analysis (Appendix B).

The principal direction of waves along the beaches of Figure Eight Island and Hutaff Island are from the east-southeast and the southeast. The highest waves occur in February during the northeaster season and in August and September during hurricane season. During the summer, waves tend to approach from the south-southeast, driving the sediment transport towards the northeast. During the winter, waves tend to approach from the east-southeast, driving the sediment transport towards the southwest. For more information regarding the wave climate within the Permit Area, refer to the Engineering Analysis (Appendix B).

Rich Inlet is a sediment sink that gains 100,000 to 200,000 cy of sand material each year. The source of this material alternates between the adjacent beaches on Figure Eight Island and the adjacent beaches on Hutaff Island depending on the orientation of Rich Inlet. The present source is Hutaff Island.

Near the northern end of Figure Eight Island, there is a nodal point, at which eroding sediments spread towards both the northeast and the southwest. This nodal point has shifted towards the northeast since 1999, but currently lies near Inlet Hook Road. Along the middle of Figure Eight Island, sediment transport can occur in either direction. The present sediment transport direction is towards the southwest. On the southern end of Figure Eight Island, the predominant sediment transport is towards the southwest. Sediment transport rates at the south end of Beach Road vary from 50,000 to 250,000 cy per year. Given the present and past erosion patterns within a mile of Rich Inlet, the northeasterly sediment transport on Topsail Island (USACE, 2006), and the southwesterly transport near Mason Inlet, Rich Inlet probably functions as a regional nodal point.

A primary factor affecting the distribution of estuarine-dependent fish and shellfish is salinity. Marine waters of the Permit Area vary on a daily basis in current and salinity conditions due to fresh water inflow, tides, and wind.

The North Carolina Recreational Water Quality Program (RWQ) also tests coastal waters. Their mission is to protect the public health by monitoring the quality of N.C.'s coastal recreational waters and notifying the public when bacteriological standards for safe bodily contact are exceeded. The coastal waters monitored include the ocean beaches, sounds, bays and estuarine rivers. RWQ tests for *Enterococci* bacteria, an indicator organism found in the intestines of warm-blooded animals. While *Enterococci* will not cause illness itself, its presence is correlated with that of organisms that can cause illness. The program tests 241 ocean and sound-side areas, most of them on a weekly basis. Lower-use beaches are tested twice a month.

Three RWQ sampling stations are located within the Permit Area. These stations include Station 50 (located in the AIWW between Mason’s Creek and Pages Creek), 50A (located in Middle Sound at the south end of Figure Eight Island), and 50B (located in Nixon’s Channel). Information taken at the stations includes salinity readings. In 2007, measurements obtained by RQW within stations 50, 50A, and 50B averaged 35.7 ppt, 36.0 ppt, and 35.9 ppt, respectively. These salinity levels support a wide range of fishery resources that are typical in inlet and estuarine complexes similar to Rich Inlet and associated water bodies.

Benefits of Water Column to Fishery Resources

Estuarine and marine water column environments in the Permit Area include the beach areas and surf zones of Figure Eight Island, Hutaff Island, Rich Inlet, Nixon Channel, Green Channel, and Middle Sound. Fish that utilize the water column of North Carolina include: anadromous fish, which can be found in coastal waters but migrate into rivers to spawn in freshwater (e.g. striped bass, Atlantic and shortnose sturgeon, herring); estuarine-dependent species (e.g. flounder, blue crab, panaeid shrimp, red drum); permanent resident species (e.g. black sea bass, Atlantic bumper, lizardfish); and seasonal migrant species (e.g. bluefish, Spanish and king mackerel, cobia, spiny dogfish). The transport of larval fish from the offshore water column to the estuarine nursery areas through inlets plays a vital role in the life cycle of many fish species.

2. Larval Transport

Larval transport is defined as the horizontal translocation of a larva of any species between points (Pineda, et al, 2007). In the southeastern USA, many species of estuarine-dependent fishes spawn offshore and their larvae are transported into estuaries. The dispersal and subsequent retention of larvae back into the estuary is regulated by a number of factors including astronomical and meteorological tides. Some larvae have the capability to actively migrate horizontally and vertically in the water column to utilize the stratification, tidal currents, flows, and other physical properties of the aquatic environment to help regulate their transport from spawning grounds to settlement areas.

Larvae utilize inlets as the conduit between the open ocean and the estuarine environment. Rich Inlet, a relatively large inlet separating Hutaff Island from Figure Eight Island to the southwest, drains an expansive marsh-filled lagoon where two large, relatively deep tidal creeks, Nixon and Green Channels, connect the inlet to the AIWW. The tidal prism for Rich Inlet has been estimated at approximately 560,000 cubic feet (Appendix B). This mass of flowing water acts as a conduit for larvae found within the water column in proximity to the inlet. Settle *et al.* (2005) estimated that the larval fish concentrations in close proximity to Bogue Inlet ranged throughout the water column between 0.5 and 5.0 larvae per cubic meter. Assuming that there is similar larval concentration in proximity to Rich Inlet, Rich Inlet would serve as an important pathway for numerous species of zooplankton into the estuary.

3. What are the characteristics of the federally threatened, endangered, and State listed species found within the project area?

Federal and State Listed Species

The following section describes the Federal and State listed species that occur, or have the potential to occur in the Permit Area, as listed in Table 4.5.

Table 4.5. Federal and State Listed Species Found or Have the Potential to be Found within the Permit Area

Common Name	Scientific Name	Federal Status	State Status
Reptiles			
Green Sea Turtle	*Chelonia mydas*	Threatened	Threatened
Hawksbill Turtle	*Eretmochelys imbricate*	Endangered	Endangered
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Endangered	Endangered
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	Endangered
Loggerhead Sea Turtle	*Caretta caretta*	Threatened	Threatened
Carolina Diamondback Terrapin	*Malaclemys terrapin centrata*	None	Species of Special Concern
Mammals			
West Indian Manatee	*Trichechus manatus*	Endangered	Endangered
North Atlantic Right whale	*Eubaleana glacialis*	Endangered	Endangered
Sei whale	*Balaenoptera borealis*	Endangered	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered	Endangered
Finback whale	*Balaenoptera physalus*	Endangered	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered	Endangered
Blue Whale	*Balaenoptera musculus*	Endangered	Endangered
Fish			
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered	Endangered
Atlantic sturgeon	*Acipenser oxyrinchus*	Endangered	Species of Special Concern
Vascular Plants			
Seabeach amaranth	*Amaranthus pumilus*	Threatened	Threatened
Birds			
Piping Plover	*Charadrius melodus*	Threatened	Threatened
Wilson's Plover	*Charadrius wilsonia*	None	Species of Special Concern
American Oystercatcher	*Haematopus palliatus*	None	Species of Special Concern
Common Tern	*Sterna hirundo*	None	Species of Special Concern
Gull-billed Tern	*Sterna nilotica*	None	Threatened
Black Skimmer	*Rynchops niger*	None	Species of Special Concern
Eastern Painted Bunting	*Passerina ciris ciris*	None	Species of Special Concern
Red Knot	*Calidris canutus*	Threatened	None

Key: Status — Definition

Endangered - A taxon "in danger of extinction throughout all or a significant portion of its range."

Threatened - A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

Species of Special Concern- Any species of wild animal native or once native to North Carolina that is determined by the Wildlife Resources Commission to require monitoring but that may be taken under regulations adopted under the provisions of Article 25

A. Reptiles

1. Sea Turtles

Sea turtles are large marine reptiles that spend most of their lives in marine or estuarine habitats. Sea turtles can be found in subtropical and temperate oceans as well as in sub-arctic seas around the world (Musick and Limpus, 1997). Several studies have shown that the beaches adjacent to inshore and offshore waters along the Atlantic Coast of the United States are important foraging

and developmental habitats for many threatened and endangered species of sea turtles (Shoop and Kenney, 1992; Ehrhart, 1983; Keinath *et al*., 1987).

Although sea turtles spend most of their lives in the ocean, female turtles must return to land to nest (Miller, 1997). Therefore, oceanfront beaches, such as those found along Figure Eight Island and Hutaff Island, provide an important habitat for sea turtle survival. Female sea turtles show nest site fidelity by returning to the nesting beach where they hatched (Limpus *et. al*., 1984; Limpus, 1985). Nesting females prefer beaches with limited lighting and open-water access, while other factors such as elevation from water inundation, dune vegetation, beach slope and the moisture and compaction of the sand may also influence site selection (Hendrickson, 1982; Mortimer, 1982). Female sea turtles typically emerge from the water at night, select a nest site, and excavate a chamber to deposit her eggs. Females cover the nest and return to sea allowing the eggs to develop for 6 to 13 weeks depending upon the species of sea turtle and the temperature of the nest (Miller, 1985). Hatchlings will emerge at night and migrate from the nest to the ocean where they begin their offshore migration into the open ocean.

Five species of sea turtles utilize the waters of North Carolina for breeding, feeding, and development. These species include: the loggerhead sea turtle (*Caretta caretta*); green sea turtle (*Chelonia mydas*); hawksbill sea turtle (*Eretmochelys imbricata*); Kemp's Ridley sea turtle (*Lepidochelys kempii*); and the leatherback sea turtle (*Dermochelys coriacea*) (Epperly *et al*., 1990; USFWS, 2003a). Sea turtles can be found in offshore as well as inshore waters at all times of the year, although they are more common inshore during the spring, summer and fall months (Epperly *et al*., 1995a). Immigration of sea turtles into North Carolina's sounds and estuaries occurred most frequently in the spring with dispersal throughout the sounds as the waters warmed. Emigration out of inshore occurred during the latter part of fall when the waters began to cool. Although the exact numbers and frequencies of species inhabiting the inshore and offshore waters of North Carolina are not available, it is known that these habitats are used at various times throughout the year by all five sea turtle species discussed (Epperly *et al*., 1990). Species composition of turtles captured by fisherman in the inshore waters of North Carolina consisted of loggerheads (71%), greens (17%), and Kemp's ridley (12%) (Epperly *et al*., 1995b). Public sightings reported all five species in inshore waters with leatherbacks and hawksbills being observed infrequently (Epperly *et al*., 1995a).

- *Green Sea Turtle*

Green sea turtle

Breeding populations of green sea turtles (*Chelonia mydas*) along Florida and the Pacific coast of Mexico have been federally listed as endangered, while all other populations have been listed as threatened under the Endangered Species Act since July 28, 1978. Additionally, a green sea turtle Critical Habitat was designated for the coastal waters surrounding Culebra Island, Puerto Rico (NMFS, 2006). Green sea turtles are mid- to large-sized sea turtles that reach an average weight of 136.2 kg (303 lbs) (Pritchard, 1997). Feeding habitats for adults are specific to seagrasses and marine algae, while hatchlings may be found feeding on various plants and animals. Green sea turtles are generally found near seagrass habitats in shallow aquatic environments, such as

nearshore reefs, bays and inlets. Coral reefs and rocky patches may also be utilized for shelter and feeding when seagrass is not available (Hirth, 1997).

The green sea turtle is globally distributed with an estimated population of 600,000 adults (USFWS, 2003e). While green sea turtle populations generally range throughout warm tropical and temperate waters of more than 140 countries, their nesting and feeding grounds are predominantly located along coastal areas between 30° North and 30° South. The green sea turtle nesting season of southern U.S. populations generally occurs between June and September, but varies depending upon its locality. Hatchling incubation time and sex determination are both temperature dependent (Mrosovsky, 1995). Green sea turtle hatchlings emerge at night and migrate offshore spending several years feeding and growing in oceanic current systems (USFWS, 2003e).

Along the U.S. beaches of the Atlantic, green turtles primarily nest in Florida. Less significant nesting populations have been identified in the U.S. Virgin Islands, Puerto Rico, Georgia, South Carolina, and North Carolina (USFWS, 2003e). NCDENR reports that the green sea turtle has been observed in Brunswick, Carteret, Dare, Hyde, New Hanover, Onslow, and Pender Counties. While green sea turtles have been sighted, primarily from spring through fall, along the entire North Carolina coastline, nesting activities have only been observed in Onslow, Brunswick, and Hyde Counties. According to data supplied by Dr. Webster of UNCW and Mr. Golder of Audubon North Carolina, no green sea turtle nests have been observed in the study area on either Figure Eight Island or Hutaff Island (Webster, pers. comm., 2011; Golder, pers. comm., 2008).

- *Hawksbill Sea Turtle*

The Hawksbill sea turtle (*Eretmochelys imbricata*) was listed as endangered in 1970. The hawksbill is also internationally protected under Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (NMFS, 2007). A Critical Habitat designation has also been identified for the waters surrounding Mona and Monito Islands of Puerto Rico. These islands provide primary foraging habitat for several life stages for this species (NMFS, 2007; USFWS, 2003c).

Hawksbill sea turtle

Hawksbill turtles are usually found in tropical and subtropical waters of the Atlantic, Pacific and Indian Oceans occurring from 30°N to 30°S latitude (NMFS, 2007). These turtles are widely distributed in the Caribbean and the western Atlantic Ocean. Hawksbill turtles prefer the clear shallow waters of coral reefs, creeks, estuaries and lagoons in tropical areas. Their diet primarily consists of sponges but also includes algae, fish, mollusks, and other benthic species found in the nearshore zone. Adults may reach up to 0.9 m (3 ft) in length and weigh on average about 136 kg (300 pounds) (USFWS, 2003c).

Hawksbill neonate behavior is similar to other sea turtles; they remain pelagic for several years before returning to coral reef habitats. Juveniles move from pelagic to coastal habitats at a much smaller size than other turtles (20 to 25 cm [to 10 in] carapace length) (Lutcavage and Musick,

1985). Juveniles are not often seen in waters deeper than 19.8 m (65 f) (Witzell, 1983), however they are frequently associated with floating *Sargassum* in the open ocean (Musick and Limpus, 1997).

Within the U.S., hawksbill turtles are most common in the waters surrounding Puerto Rico, U.S. Virgin Islands and Florida (NMFS, 2007). Hawksbills are recorded in the continental U.S. from all the Gulf states and from the eastern seaboard as far north as Massachusetts, but sightings north of Florida are rare (NMFS, 2007). The U.S. Fish and Wildlife Service North Carolina Office reports that the presence of hawksbill sea turtles along the North Carolina coast is rare (USFWS, 2007c); therefore, none are expected to be present in the study area.

The hawksbill has experienced major population decline with only five regional nesting populations remaining in the Seychelles, Mexico, Indonesia, and two in Australia (USFWS, 2003c). Nesting females lay on average 3-5 nests per season which contain 130 eggs per nest (NMFS, 2007). Nesting season varies with locality, but most nesting occurs sometime between April and November (USFWS, 2003c). There are no reported nesting activities of hawksbill sea turtles on the beaches within the study area (Godfrey, pers. comm.).

- *Kemp's Ridley Sea Turtle*

The Kemp's ridley sea turtle (*Lepidochelys kempii*) has been listed as endangered under the Endangered Species Act since December 2, 1970 (USFWS, 2003d). The range of Kemp's ridley includes the Gulf coast of Mexico, the Atlantic coast of North America as far north as Newfoundland and Nova Scotia, and the Gulf coast of the U.S., especially Padre Island, Texas (USFWS, 2003d). Kemp's ridley is the smallest of the eight species of sea turtles, averaging 35-45 kg (78-100 lbs) with an average length between 56 and 76 cm (22 and 30 in) (Marquez, 1994; USFWS, 2003d). As juveniles, Kemp's ridley turtles feed primarily on crabs, clams, mussels, and shrimp and are most commonly found in productive coastal and estuarine areas. Recruitment from pelagic habitats occurs at a carapace size between 20 and 25 cm (7.9 and 9.8 in) (Lutcavage and Musick, 1985).

Hatchlings are dispersed within the Gulf and Atlantic by oceanic surface currents. According to the U.S. Fish and Wildlife Service, rare nesting events have been recorded in Florida, South Carolina and North Carolina (USFWS, 2003d). Most sea turtle species are widely distributed; however, the Kemp's ridley is mostly restricted to the Gulf of Mexico (Miller, 1997). They have also been sighted in shallow coastal waters along the east coast of the United States.

As reported by the USACE (2006):

> *..Kemp's ridley sea turtle is commonly observed migrating within North Carolina inshore waters during the spring and fall, but has been documented to nest only once in North Carolina, on Oak Island in 1992* (Godfrey, pers. comm.).

Kemp's ridley turtles are also occasionally found stranded on the beaches of North Carolina (Mihnovets, 2003). These strandings may be attributed to the juvenile sea turtles getting caught in the southern Gulf of Mexico loop current that eventually moves these turtles east and north up the eastern Atlantic coast (Musick and Limpus, 1997). Conservation measures initiated in the late 1970's are thought to be contributing to the Kemp's ridley population recovery; however, the Kemp's ridley sea turtle still remains the rarest sea turtle in the world (Pritchard, 1997). Four Kemp's ridley sea turtles were taken by a hopper dredge working off of Bogue Banks in December 2001, but there were no turtles taken during the relocation of Mason's Inlet in 2000 (Sugg, pers. comm.). Since monitoring began, only one (1) Kemp's ridley nest has been observed within in the project area. This nest was observed during the 2010 nesting season on Figure Eight Island (Godfrey, pers. comm.).

- *Leatherback Sea Turtle*

The leatherback sea turtle (*Dermochelys coriacea*) was listed as an endangered species on June 02, 1970 (under a law that preceded the Endangered Species Act of 1973), and then listed as endangered throughout its range in the United States under the Endangered Species Act of 1973 (NMFS, 2007). A Critical Habitat designation is listed for Sandy Point, St. Croix, U.S Virgin Islands and surrounding waters (NMFS, 2007; USFWS, 2003b).

Nesting leatherback sea turtle

The U.S. range of the leatherback extends from Nova Scotia south to Puerto Rico and the U.S. Virgin Islands. Small nesting populations occur in Florida, St. Croix, and Puerto Rico (USFWS, 2003b). Although nesting in the State of North Carolina is rare, Rabon *et al*. (2003) confirmed seven leatherback turtle nests between Cape Lookout and Cape Hatteras. The nesting frequency included two nests in 1998, four nests in 2000, and one nest in 2002. Leatherback sea turtles nest an average of five to seven times within a nesting season, with an observed maximum of 11 nests. The average inter-nesting interval is about 9-10 days (USFWS, 2003b). While infrequently found in inshore waters, Epperly *et al*. (1995) reported that, on average, 15 leatherback sea turtles per year were sighted in inshore waters (within three miles of shore) of North Carolina between 1989 and 1992. According to Epperly *et al*. (1995) these inshore sightings coincided with the appearance of jellyfish and leatherback sightings diminished by late June. The NCWRC (Everhart, 2007) reported a leatherback false crawl in North Carolina in 2007. No leatherback sea turtle nests have been reported within the project area within recent years (Godfrey, pers. comm.).

Loggerhead sea turtle

- *Loggerhead Sea Turtle*

The loggerhead sea turtle (*Caretta caretta*) has been listed in the Federal Register as threatened throughout its range since July 28, 1978 (USFWS, 2003f). Loggerheads are large reddish-brown turtles weighing between 91-159 kilograms (200-350 lbs) (Pritchard, 1997). Adult loggerheads nest at night along sandy beaches and may nest from one to seven times within a nesting season (USFWS, 2003f). The average

nest depth for loggerhead sea turtles is 61 cm (24 inches). Loggerhead sea turtles are the only marine sea turtles that have been reported to nest predominantly outside of the tropics (Bolten and Witherington, 2003).

Hatchling loggerheads migrate offshore into circular oceanic current systems (gyres) and are often found in drifting masses of *Sargassum* macroalgae until they have grown to be much larger juveniles (Carr, 1967; Fletmeyer, 1978). Loggerhead sea turtles will remain within the gyre for several years before leaving their pelagic habitats to return to their coastal foraging and nesting habitats (Klinger and Musick, 1995; Bolten *et al*., 1993). Recruitment into coastal habitats occurs when their carapace length is between 25 and 70 cm (9.8 and 27.5 in) (Lutcavage and Musick, 1985; Bolten *et al*., 1993).

Five nesting subpopulations in the western North Atlantic have been identified through genetic DNA analysis and include: 1) the Northern subpopulation from North Carolina to Northeast Florida; 2) the South Florida subpopulation north of Cape Canaveral, following the eastern coastline south and around to Sarasota on Florida's west coast; 3) the Dry Tortugas, Florida, subpopulation; 4) the Northwest Florida subpopulation, found along the panhandle of Florida's northwest coast; and 5) the Yucatán subpopulation, which includes the eastern Yucatán Peninsula, Mexico (USFWS, 2003f).

Eighty percent of all loggerhead nesting that occurs in the southeastern U.S. takes place in Florida. Loggerhead sea turtle nesting occurs to a lesser extent on suitable beaches on islands off the Gulf states and along the entire North Carolina coastline, including New Hanover and Pender Counties where the study area is located (USFWS, 2003f). The Fish and Wildlife Service reported that although declines in nesting since the 1970's have been documented, no long-term trend data is available for the Northern subpopulation (USFWS, 2003f). Bolten and Witherington (2003) reported that studies on the Northern subpopulation from 1989 to 1998 illustrated a stable or declining population trend.

The USFWS and NMFS has designated portions of North Carolina beaches as critical habitat for the Northwest Atlantic (NWA) population of loggerhead sea turtles. A portion of the Permit Area is located within Critical Habitat Unit LOGG-T-NC-04 (Figure 4.11). As described in the Federal Register Notice, this unit includes Onslow Beach, Topsail Island, and Hutaff Island. The unit contains nearshore reproductive habitat only. Specifically, the unit consists of nearshore area from Browns Inlet to Rich Inlet (crossing New River Inlet and New Topsail Inlet) from the MHW line seaward 1.6 km. This unit contains areas of high density nearshore reproductive habitat (Topsail Island) as well as areas adjacent to high density nearshore reproductive habitat (Onslow Beach and Hutaff Island).

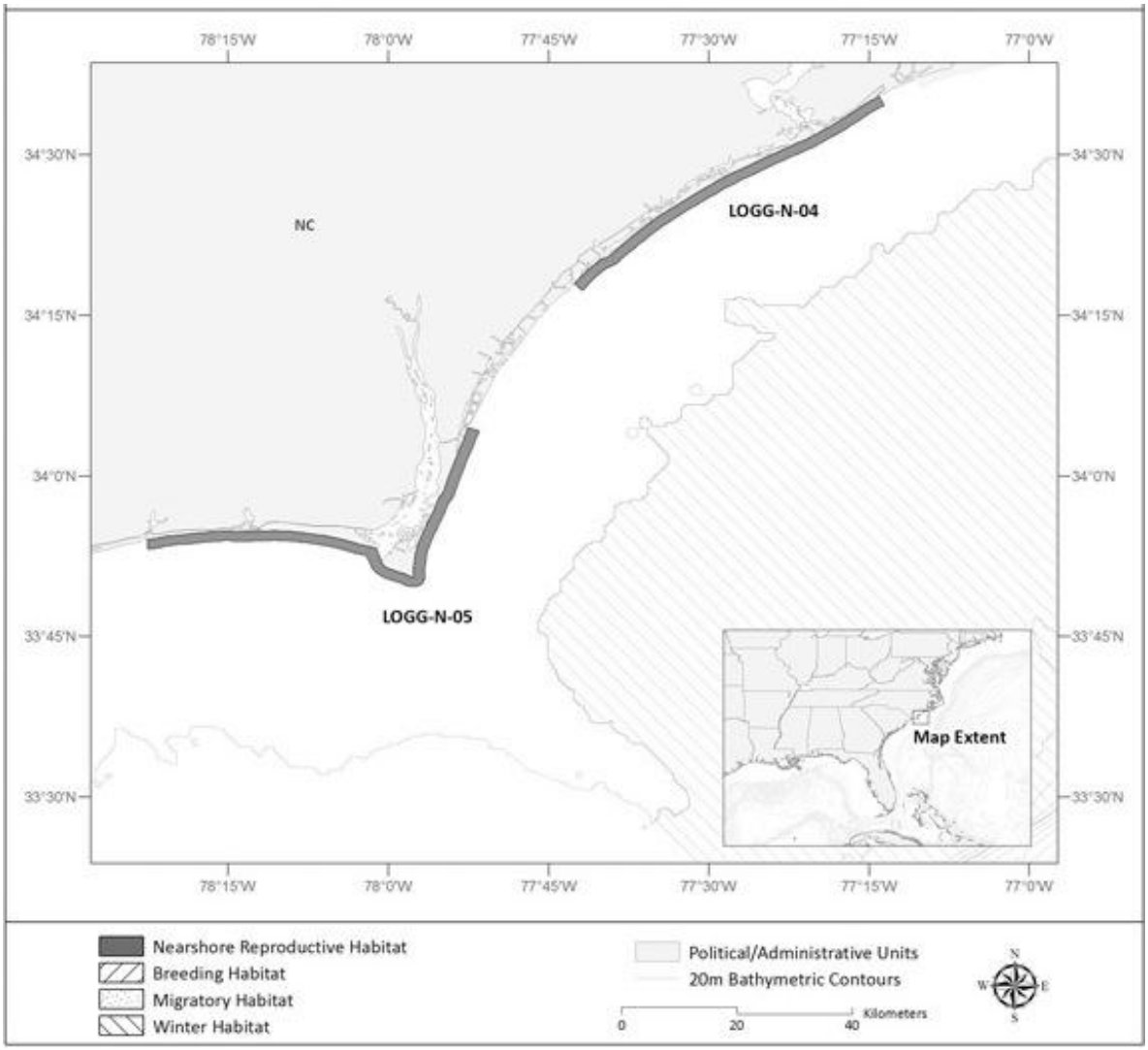


Figure 4.11. Designated Loggerhead Sea Turtle Critical Habitat: LOGG-N--04

Loggerhead nesting data for the study area on Figure Eight Island, North Carolina has been recorded since 2001 with an average of 11.7 nests per year. Table 4.6 includes the number of loggerhead sea turtle nests that were documented between 2001 and 2010 for the study area located on Figure Eight Island and Hutaff Island, North Carolina (Webster, pers. comm., 2011; Godfrey, pers. comm., 2011; Golder, pers. comm., 2008). Figures 4.12 - 4.21 depict the distribution of these nests along the beaches within and in proximity of the Permit Area. Godfrey (pers. comm.) expressed the difficulties in reporting sea turtle population and nesting trends since the availability of observers and consistency in data collection can contribute to the unreliability of the data.

Table 4.6. Number of Loggerhead Sea Turtle Nests Documented in defined Permit Area, Figure Eight Island, NC, 2001 to 2007 (Godfrey, pers. comm., 2011; Webster, pers. comm., 2011) and Hutaff Island, NC, 2005 to 2007 (Golder, 2008)

Loggerhead Sea Turtle (*Caretta caretta*)		
Year	Figure Eight Island	Hutaff Island
2001	5	5
2002	9	NA
2003	31	NA
2004	9	NA
2005	11	4
2006	6	12
2007	5	0
2008	22	9
2009	5	2
2010	13	11

NA – Historic data for the period of 2002 to 2004, for Hutaff Island is unavailable.

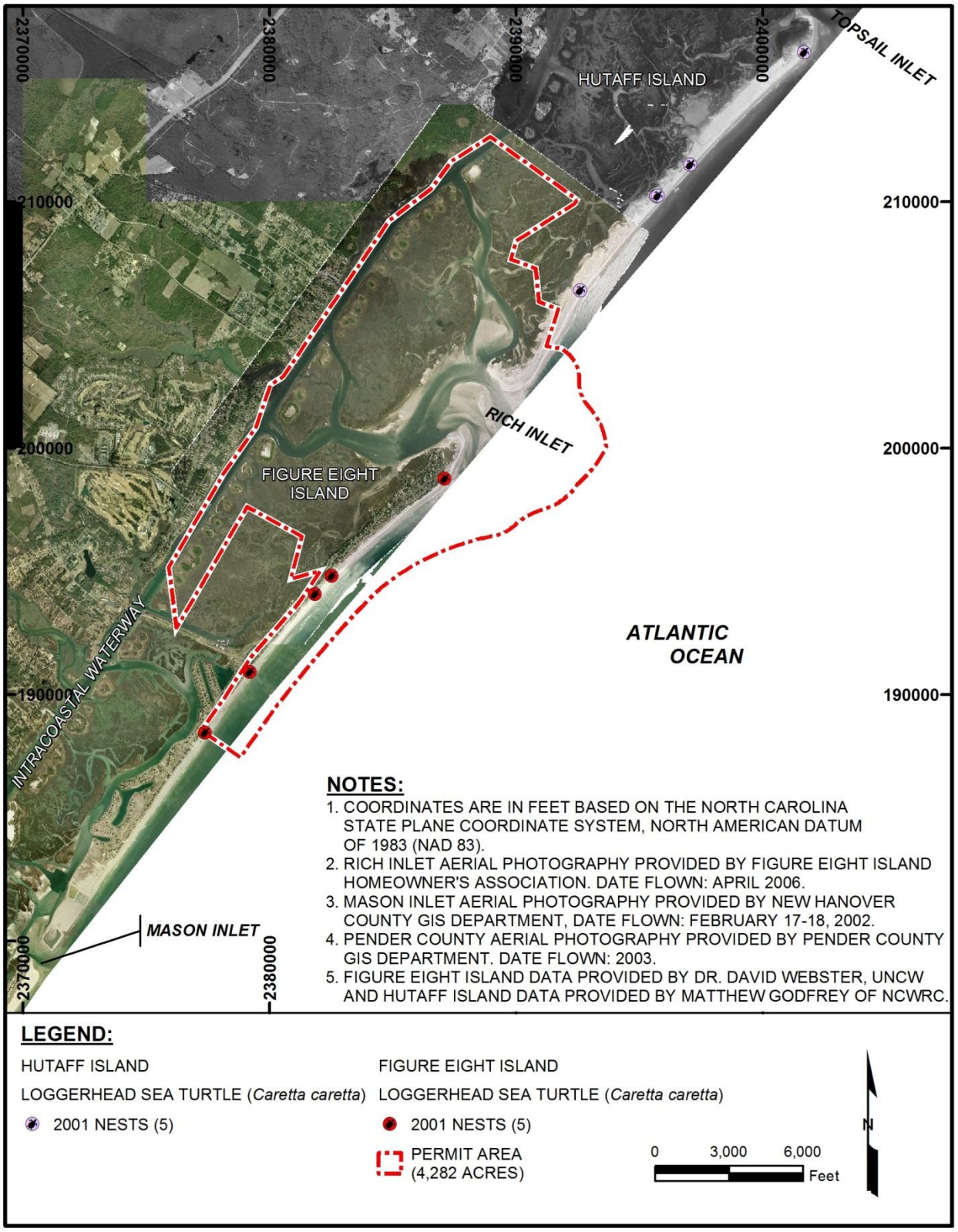


Figure 4.12. 2001 Loggerhead sea turtle nests within the Permit Area

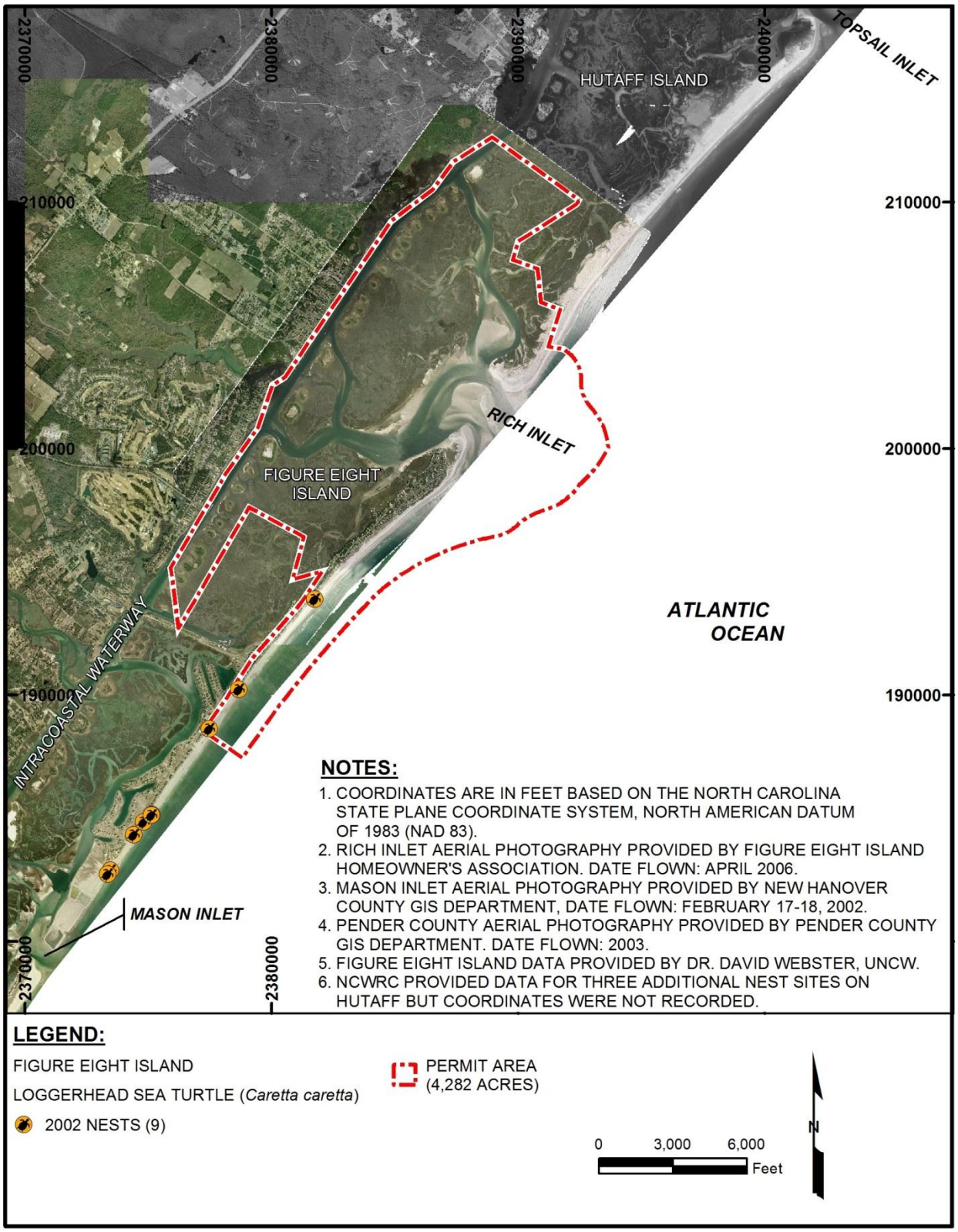


Figure 4.13. 2002 Loggerhead Sea Turtle Nests within the Permit Area. Note that additional nests were observed on Hutaff, however coordinates were not accurately recorded.

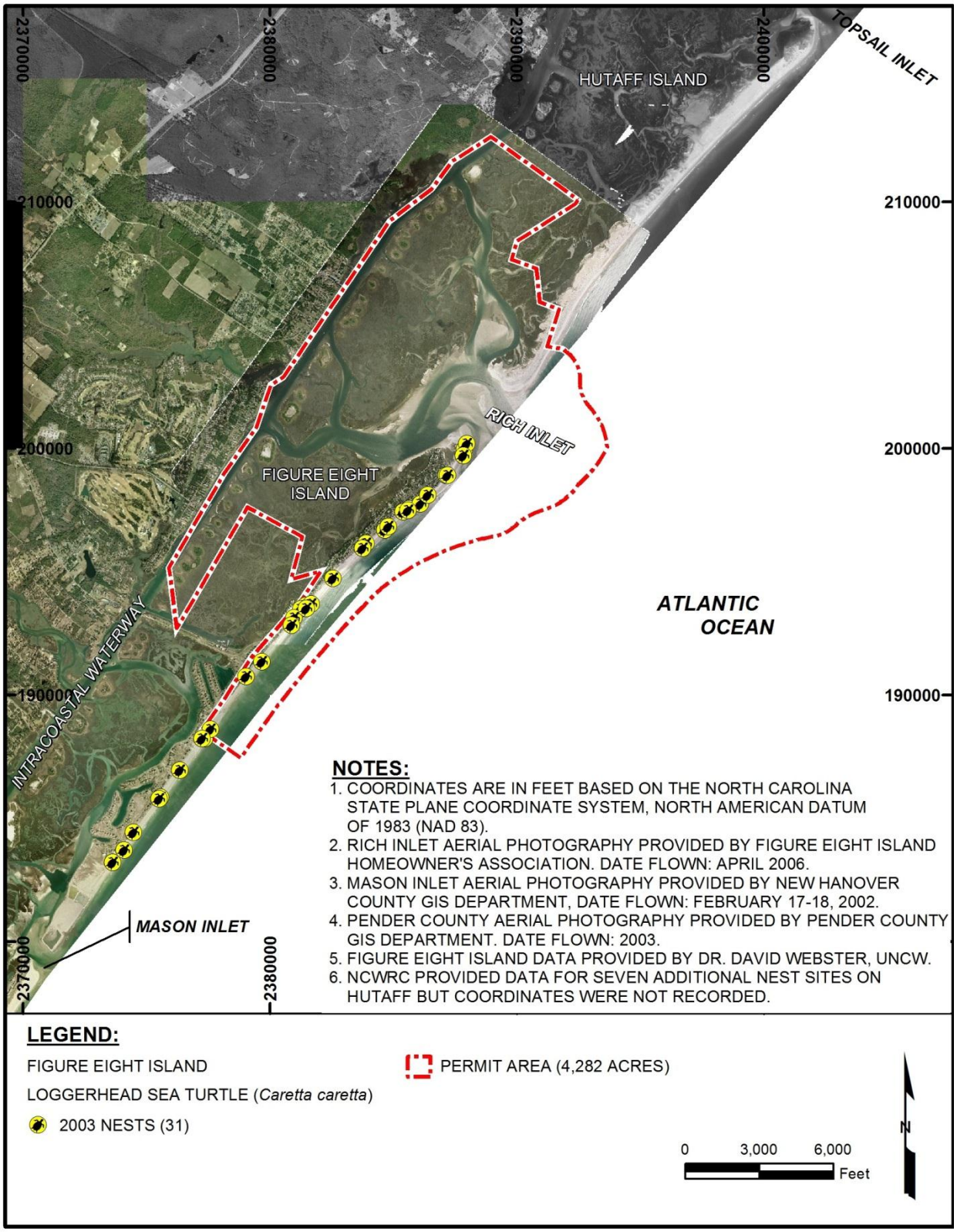


Figure 4.14. 2003 Loggerhead Sea Turtle Nests within the Permit Area. Note that additional nests were observed on Hutaff, however coordinates were not accurately recorded.

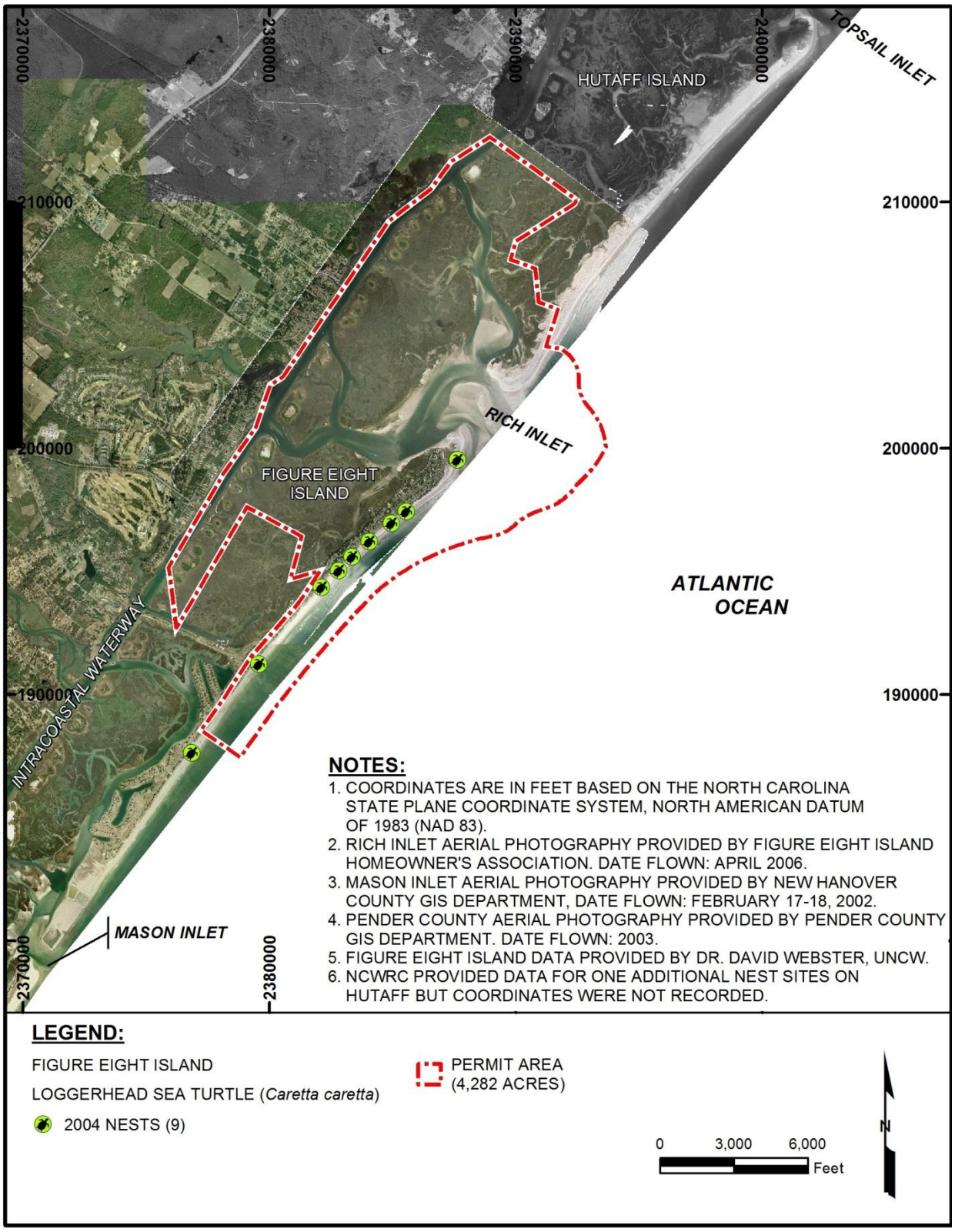


Figure 4.15. 2004 Loggerhead Sea Turtle Nests within the Permit Area. Note that additional nests were observed on Hutaff, however coordinates were not accurately recorded.

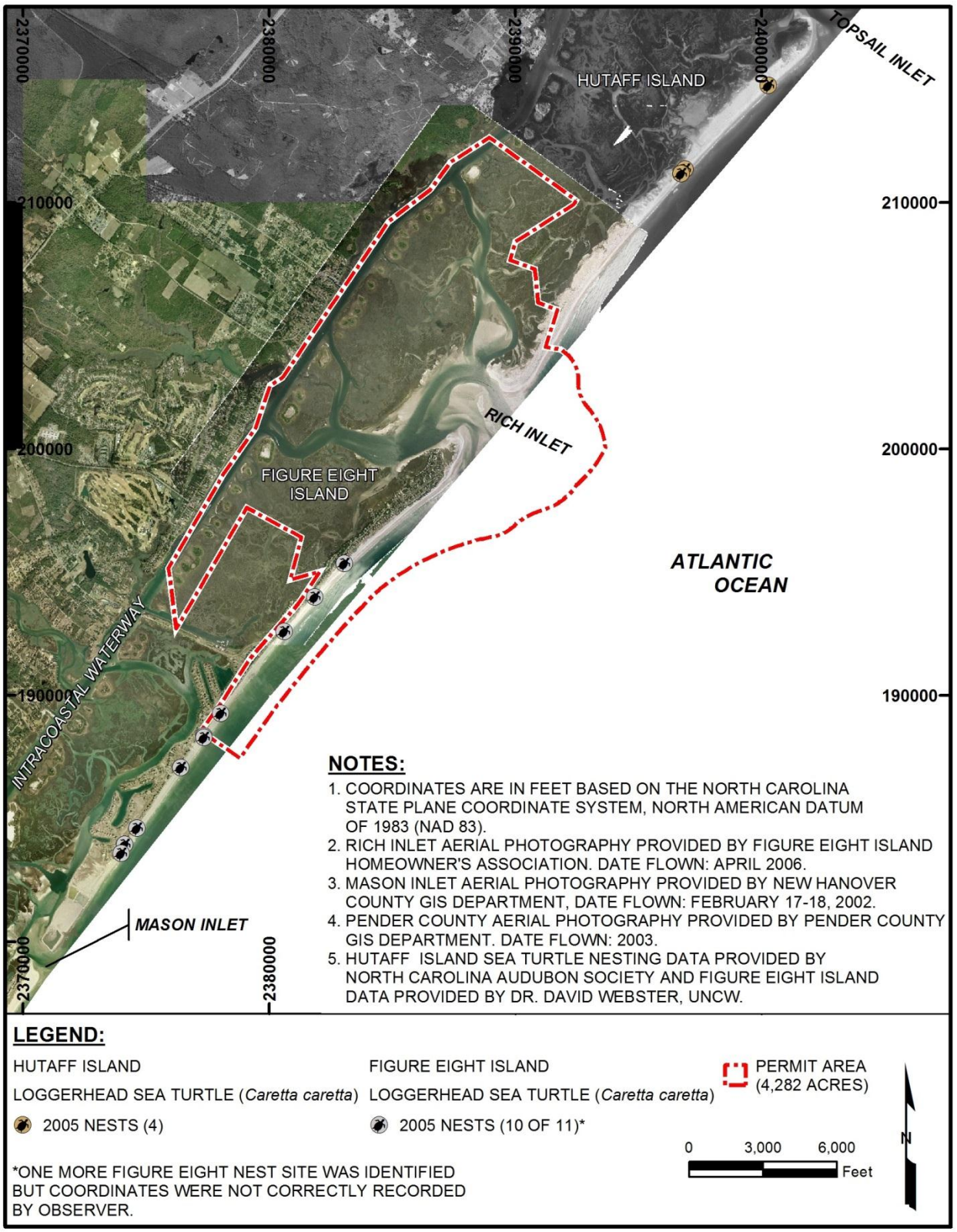


Figure 4.16. 2005 Loggerhead Sea Turtle Nests within the Permit Area

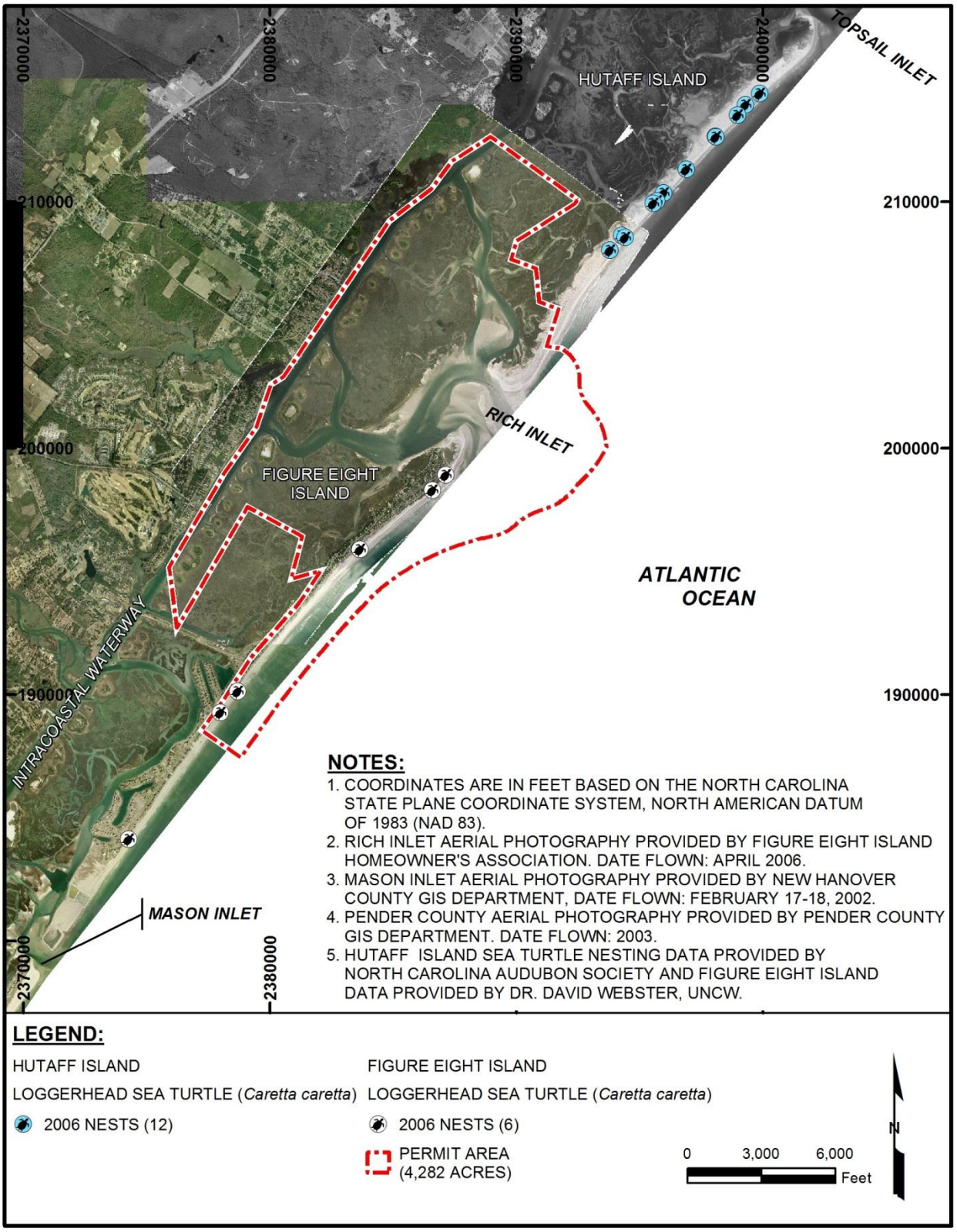


Figure 4.17. 2006 Loggerhead Sea Turtle Nests within the Permit Area

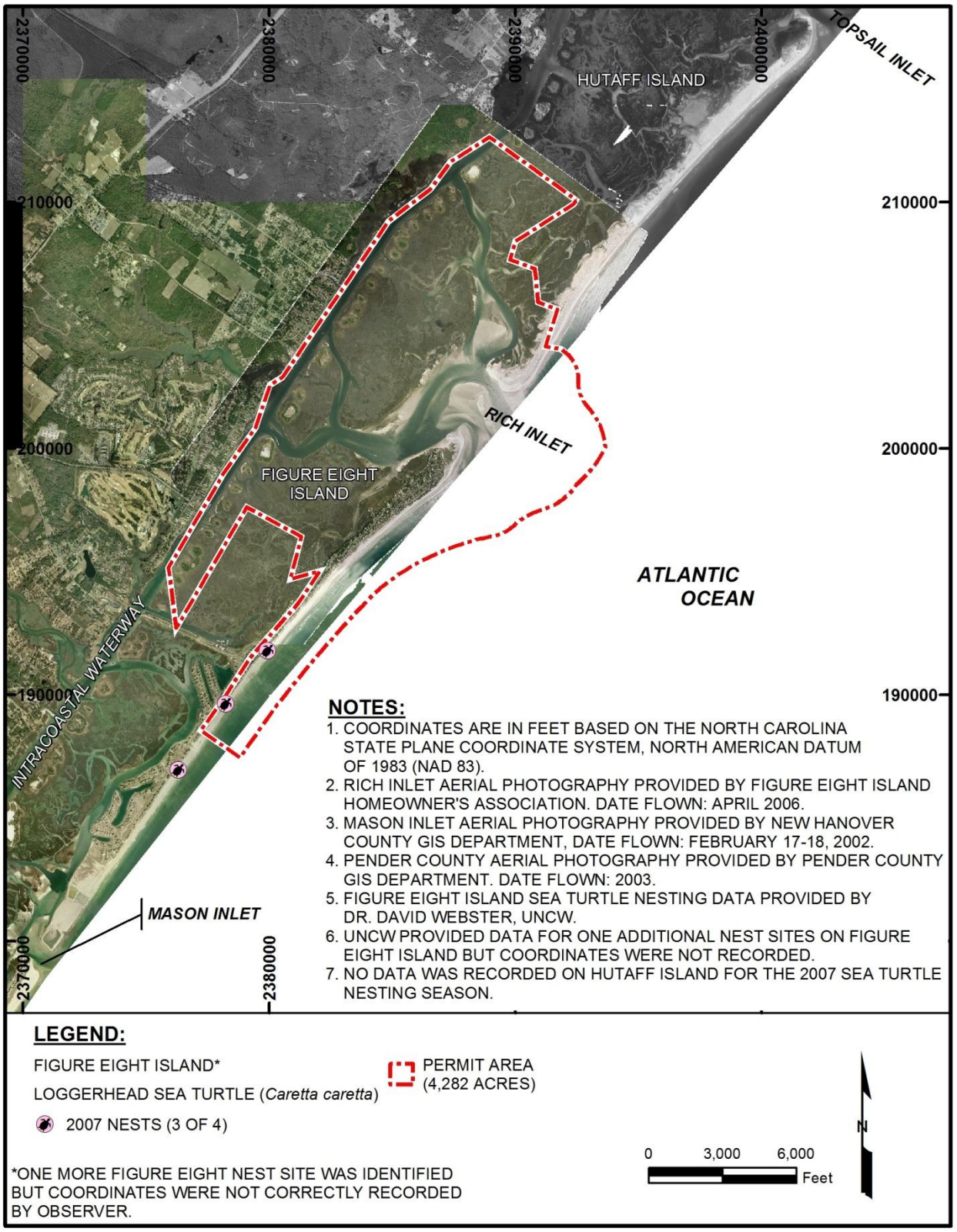


Figure 4.18. 2007 Loggerhead Sea Turtle Nests within the Permit Area. Note that additional nests were observed on Hutaff, however coordinates were not accurately recorded.

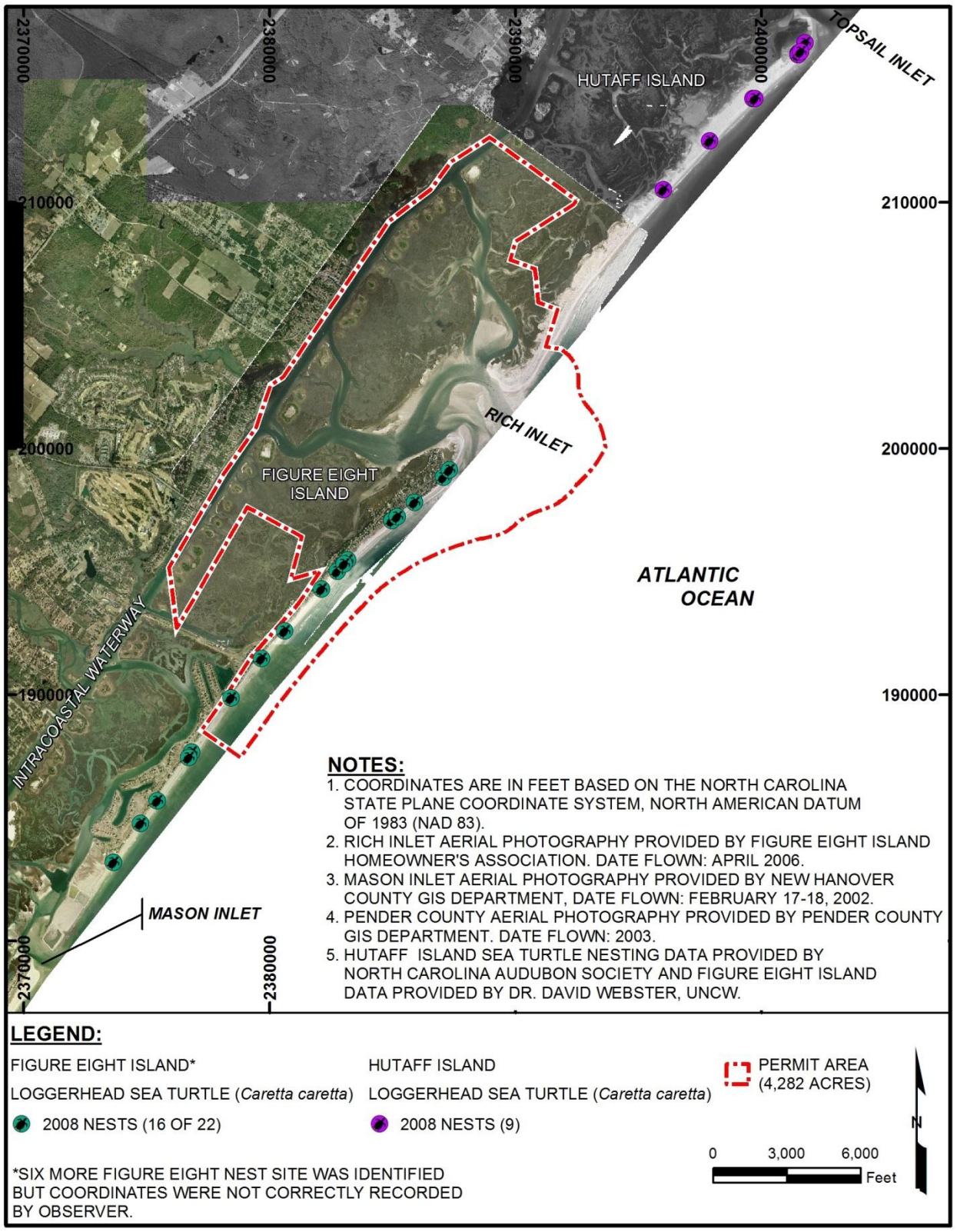


Figure 4.19. 2008 Loggerhead Sea Turtle Nests within the Permit Area

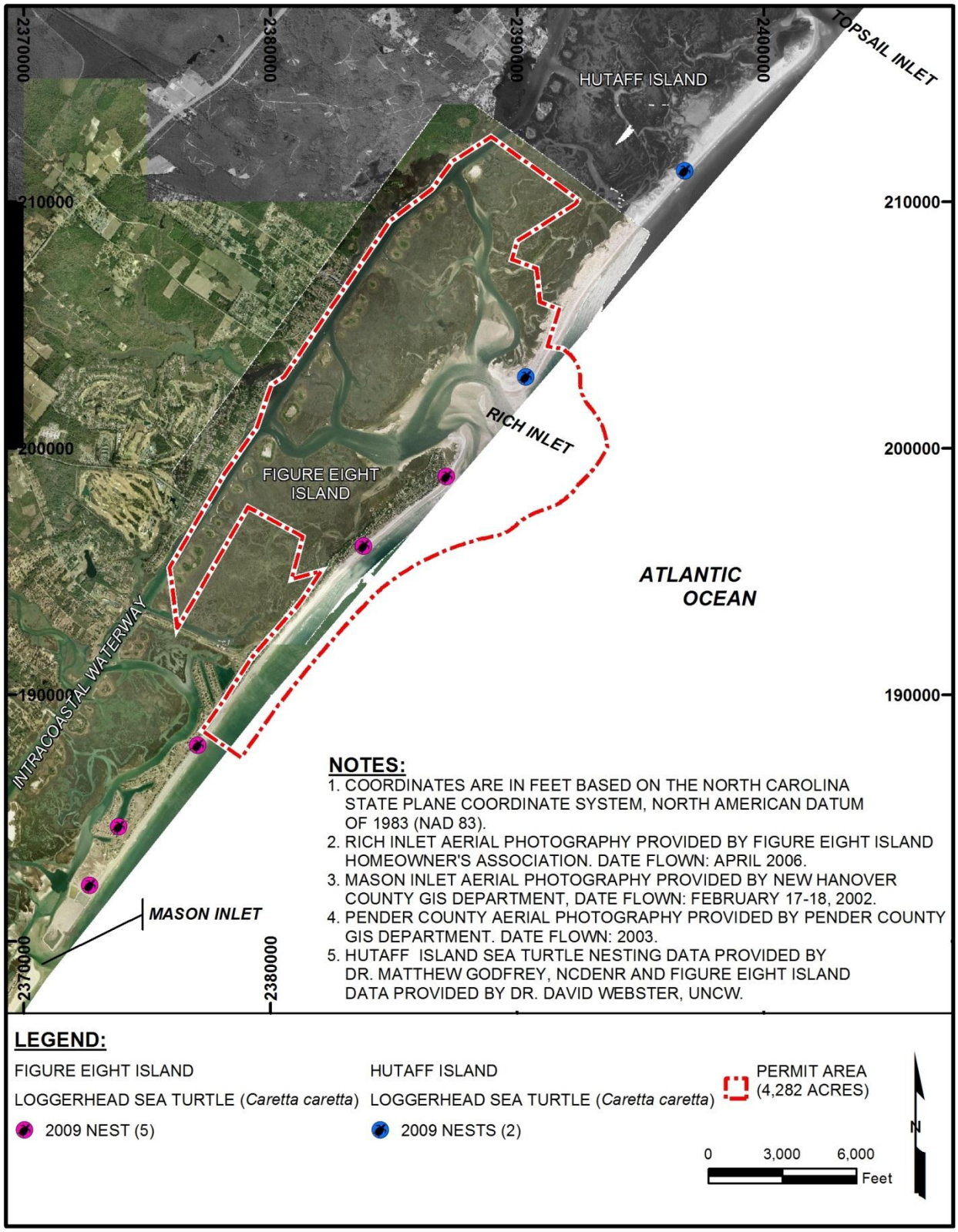


Figure 4.20. 2009 Loggerhead Sea Turtle Nests within the Permit Area

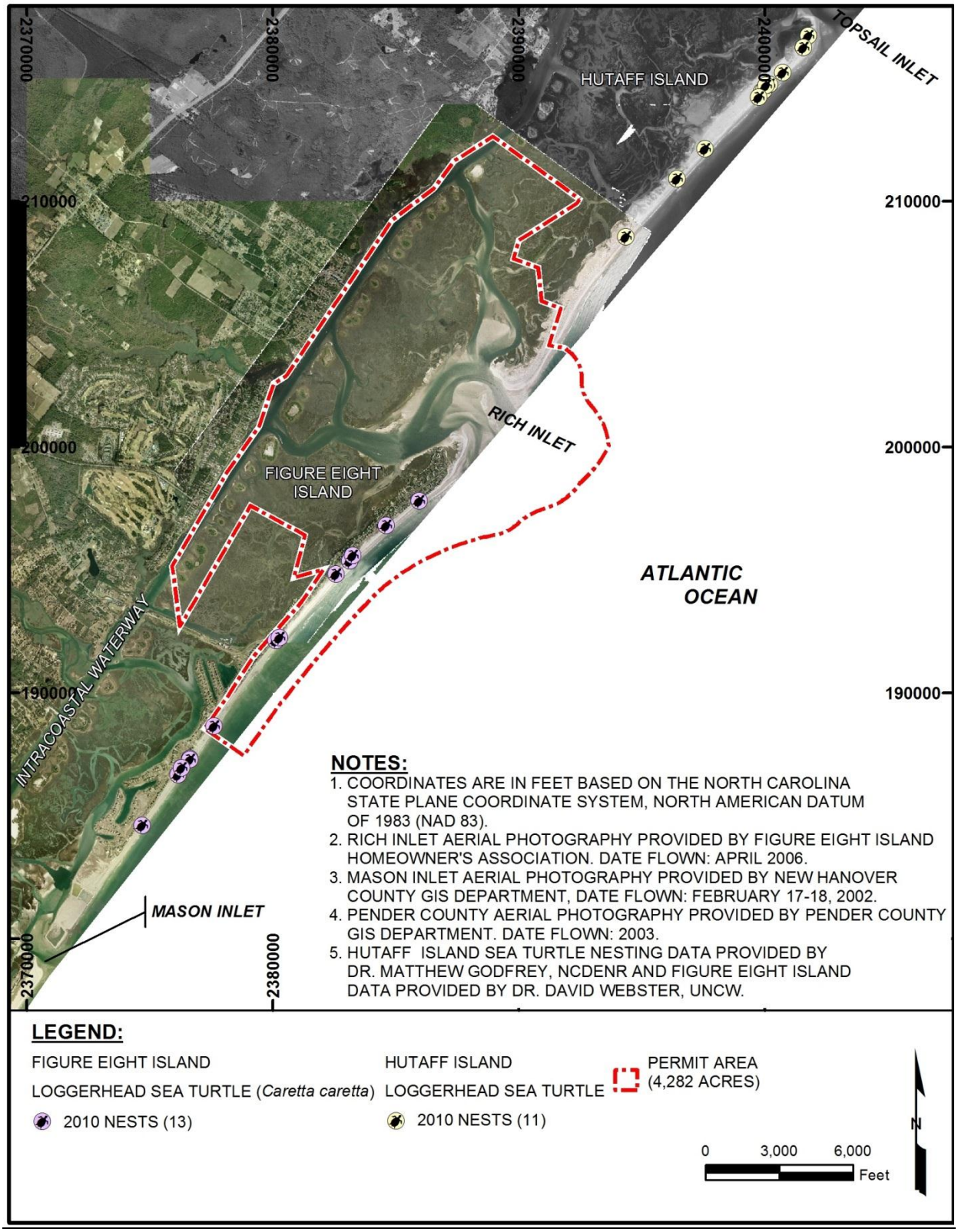


Figure 4.21. 2010 Loggerhead Sea Turtle Nests within the Permit Area

2. Terrapins

The Carolina diamondback terrapin (*Malaclemys terrapin centrata*) is State and federally listed as a Species of Special Concern. They are commonly found within the inshore waters of North Carolina. This subspecies ranges from Cape Hatteras to northeastern Florida and tolerates a wide range of salinities (Robinson and Dunson, 1975). They are the only North American turtle species native to brackish waters and are commonly found in salt marshes, impoundments, tidal creeks, lagoons and mud flats. These areas serve as central feeding grounds for this species throughout most of the year. Carolina diamondbacks are primarily carnivorous, feeding upon crabs, snails and nereid worms.

Carolina diamondback terrapin

During the winter months, Carolina diamondback terrapins hibernate in the muddy burrows along the embankments of tidal creeks. Nesting typically occurs after the mating season in May. Females build nests in sandy substrates above the high tide mark during the months of May and June and eggs are left to incubate for 60 to 120 days depending upon temperature conditions within the nest (Martof *et al*., 1980). Unlike sea turtles, emergence takes place during the day and hatching diamondback terrapins move to the surrounding vegetation rather than out to sea. It has been reported that juvenile terrapins (2.5 to 7 mm [1 to 3 in]) spend their time out of water living beneath surface debris and matted *Spartina grasses*, rarely entering open water. Adult terrapins spend their summer months in full marine conditions and other times of the year are spent in submerged mud and brackish water (Davenport, 1992).

The NC WRC has compiled numerous sightings of the Carolina diamondback terrapin in coastal New Hanover County, particularly in the area of Wrightsville Beach southward. There has been one recorded sighting on Hutaff Island in July of 1981 (LeGrand, pers. comm.). Despite the paucity of data from this area, the marshes on the sound side of Figure Eight Island and Hutaff Island provide habitat for the Carolina diamondback terrapin.

B. Mammals

1. West Indian Manatees

The West Indian manatee (*Trichechus manatus*) is listed as a federally protected species under the Endangered Species Act of 1973 and the Marine Mammal Protection Act of 1972. The average size of an adult manatee is 10 feet, weighing approximately 2,200 lbs and typically referred to as the "sea cow".

West Indian manatee

West Indian Manatees are rare visitors to the Figure Eight Island area, however, recent manatee sightings have been reported in the AIWW approximately 50-60 miles north of Figure Eight Island including observations north of State Highway 101, July 2000; Beaufort waterfront and near Calico Creek, August 1999; Hammocks

Beach State Park, June 1998; Sportsman Pier in Atlantic Beach, August 1994; US Coast Guard Station at Fort Macon, August 1994; Barden Inlet, November 1992; Peletier Creek, October 1990; and the west end of Shackleford Banks, August 1983. All of these observations occurred in Carteret County. Though none of these sightings occurred within the project vicinity, it is likely that manatees transit through the region since sightings occurred north and south of Figure Eight Island. Due to a lack of existing literature on the number of manatees utilizing the coastal waters of North Carolina, it is difficult to determine the number of manatees utilizing the nearshore waters of the Cape Fear region and the study area.

2. Whales

Blue, finback, humpback, North Atlantic right, sei, and sperm whales all occur infrequently in the ocean off the coast of North Carolina. Of these, only the North Atlantic Right (NARW) and the humpback whale may come close enough inshore within the Permit Area, therefore the following discussion will only consider these two species in greater detail.

- *Humpback Whales*

Though other whale species sometimes occur off the coast of North Carolina, only the humpback whale and the right whale regularly come close enough inshore to encounter the study area. Both species are federally listed as endangered.

Humpback whales (*Megaptera novaeangliae*) were listed as federally endangered throughout their range on June 2, 1970 under the Endangered Species Act and are considered "depleted" under the Marine Mammal Protection Act. The North Atlantic population of the humpback whale is estimated at 10,600 individuals (Waring et al., 1999), however the minimum population estimates for the Gulf of Maine stock is 647 individuals (NMFS, 1991a).

Humpbacks are found in protected waters over shallow bars and shelf waters, which are used for breeding and feeding. They migrate towards the poles in the summer and toward the tropics in the winter to breeding and birthing grounds. Humpbacks visit the North Carolina coast during the migratory season, especially between the months of December and April (Conant, 1993). Migrating humpbacks can be found nearshore, but probably migrate well offshore of the study area to their principal wintering range (NMFS, 1991a). On December 6, 2011, a 30 foot humpback whale was sited inshore in proximity to Masonboro Inlet, approximately 7 miles south of the Permit Area.

- *Right Whales*

Right whale and calf

The right whale (*Baleana glacialis*) is considered the world's most endangered large whale, with a total population of only around 300 individuals, and recent models predict this population will be extinct in less than 200 years (NMFS, 2006). The North Atlantic right whale utilizes six (6) major habitats or congregation areas including the coastal waters of the southeastern United States, the Great South Channel, Georges Bank/Gulf of Maine, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Scotian Shelf. The southeastern United States (Charleston, SC to the east coast of Florida) is considered Critical Habitat for the right whale because of these calving grounds (NMFS, 1991b). A Critical Habitat designation recognizes specific areas "that are essential to the conservation of a listed species, and that may require species management considerations or protection". During late winter and early spring, right whales begin moving north past the North Carolina coast (this includes cow/calf pairs and others wintering south of Cape Hatteras). Southerly migration to wintering areas south of Cape Hatteras begins as early as October (NMFS, 1991b). Right whales have been documented along the North Carolina coast between December and April with the majority of sightings reported between mid to late March. It is unclear as to the frequency with which right whales occur in offshore waters in the southeastern United States (NMFS, 1991b). The Right Whale Program of the New England Aquarium reported that 93% of all North Carolina sightings between 1976 and 1992 occurred between mid-October and mid-April (Slay, 1993). Typically, when spotted, right whales are observed very close to the shoreline only a few hundred meters offshore (Schmidly, 1981).

C. Fish

1. Shortnose Sturgeon

Shortnose Sturgeon

The shortnose sturgeon, *Acipenser brevirostrum*, was listed as endangered on March 11, 1967 under the Endangered Species Preservation Act of 1966 (a predecessor to the Endangered Species Act of 1973). NMFS later assumed jurisdiction for shortnose sturgeon under a 1974 government reorganization plan (38 FR 41370) (NOAA, 2007). Shortnose sturgeon is the smallest of the three sturgeon species that are found in eastern North America, rarely exceeding a length of 1.1 m (3.5 ft) and a weight of 6.4 kg (14 lbs) (NYSDEC, 2007). Shortnose sturgeon are bottom feeders, typically feeding on crustaceans, insect larvae, worms, mollusks, and some plants (NMFS, 1998). They appear to feed in either freshwater riverine habitats or near the freshwater/saltwater interface. This species is anadromous, primarily utilizing riverine and estuarine habitats, migrating between freshwater and mesohaline river reaches. Spawning occurs in upper, freshwater areas, typically in January and February, while feeding and

overwintering activities may occur in both fresh and saline habitats. Aside from seasonal migrations to estuarine waters, this species rarely occurs in the marine environment (NMFS, 1998; NCWRC, 2007; USFWS, 2007e).

The shortnose sturgeon inhabits lower sections of rivers and coastal waters along the Atlantic coast from the St. John River in New Brunswick, Canada to the St. Johns River, Florida (NOAA, 2007). The NMFS federal recovery plan (1998) for the endangered shortnose sturgeon identifies 19 distinct population segments, each defined as a river/estuarine system in which these fish have been captured within the generation time of the species (30 years). This species is significantly more common in northern portions of its range than it is in the south. Shortnose sturgeon are found in rivers, estuaries, and the sea, but populations are most often confined to natal rivers and estuaries (NMFS, 1998). Those shortnose sturgeon captured in the ocean are usually taken close to shore, in high salinity environments; there are no records of shortnose sturgeon in the NMFS database for the northeast offshore bottom trawl survey (NMFS, 1998).

There are few confirmed historical reports of shortnose sturgeon captures. Because fishermen and scientists often confuse shortnose sturgeon with Atlantic sturgeon, there are no reliable estimates of historical population sizes (NMFS, 1998). There are several reports of shortnose sturgeon taken in North Carolina in the early 1800s, but the distribution and status of this species has not been fully documented in North Carolina. No shortnose sturgeon were reported in North Carolina waters between 1881 and 1987. Since then, several shortnose sturgeon have been caught in the Brunswick and Cape Fear rivers by commercial fishermen, a single fish was caught in the Pee Dee River, and it is now believed that a shortnose sturgeon population may also exist in western Albermarle Sound (NCWRC, 2007). With this discovery, the species is once again considered to be a part of the state's fauna; however, because of the lack of suitable freshwater spawning areas in the proposed project area and the requirement of low salinity waters by juveniles, any shortnose sturgeons present would most likely be non-spawning adults (NMFS, 1998).

2. Atlantic Sturgeon

In 2009, the Natural Resources Defense Council (NRDC) petitioned NMFS to list the Atlantic sturgeon (*Acipenser oxyrinchus*) under the Endangered Species Act of 1973 (ESA). As a result of the petition, the Carolina Distinct Population Segment (DSP) for Atlantic sturgeon has been designated as endangered under the ESA. Atlantic sturgeon are similar in appearance to shortnose sturgeon (*Acipenser brevirostrum*), but can be distinguished by their larger size, smaller mouth, different snout shape, and scutes (NMFS, 2011). The Atlantic sturgeon is a long-lived, estuarine dependent, anadromous fish. They are benthic feeders and typically forage on invertebrates including crustaceans, worms, and mollusks. Atlantic sturgeon can grow to approximately 14 feet (4.3 m) long and can weigh up to 800 lbs (370 kg) (NMFS, 2011). They are bluish-black or olive brown dorsally (on their back) with paler sides and a white belly. Spawning adults migrate upriver in spring, beginning in February-March in the south, April-May in the mid-Atlantic, and May-June in Canadian waters. In some areas, a small spawning migration may also occur in the fall. Spawning occurs in flowing water between the

salt front and fall line of large rivers (NMFS, 2011). Atlantic sturgeon spawning intervals range from 1 to 5 years for males and 2 to 5 years for females (NMFS, 2011).

Adults range from Hamilton Inlet, Labrador (Scott and Scott, 1988) south to the St. Johns River in Florida (Vladykov and Greeley 1963). Following spawning, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks. Juveniles move downstream and inhabit brackish waters for a few months and when they reach a size of about 30 to 36 inches (76-92 cm) they move into nearshore coastal waters (Smith, 1985).

Tagging data indicates that these immature Atlantic sturgeon travel widely once they emigrate from their natal (birth) rivers. Although Atlantic sturgeon are regularly caught in North Carolina, details of their distribution patterns and habitat preferences are unknown (Ross et al., 1988). Atlantic sturgeon have been reported in the Atlantic Ocean off South Carolina in months of low water temperatures (November–April) from nearshore to well offshore in depths up to 40 m (Collins and Smith, 1997). Moser et al. (1998) obtained sturgeon records from federal, private, and state surveys and documented use of nearshore Atlantic Ocean habitats from the North/South Carolina state line to off the mouth of Chesapeake Bay. Stein et al. (2004) found peak Atlantic sturgeon captures along the coast in 10–50 m depths. A study conducted between 1988 and 2006 examined the offshore distribution of Atlantic sturgeon based on incidental captures in winter tagging cruises conducted off the coasts of Virginia and North Carolina, including in and near extensive sand shoals adjacent to Oregon Inlet and Cape Hatteras. A total of 146 juvenile Atlantic sturgeon were captured during this investigation by bottom trawling in depths from 9.1 to 21.3m (Laney et al, 2007). Many of the fish were captured over sandy substrate which coincides with results observed in several other studies (Laney, 2007). In a tagging study conducted my Moser and Ross (1995), 100 juvenile Atlantic sturgeon were captured within the Cape Fear River. Of these, four fish were observed moving from the river into the ocean and were caught in gill nets set from shore at Carolina Beach, Kure Beach, and Ft. Fisher (Moser and Ross, 1995). Therefore, these fish are known to frequent nearshore waters in proximity to the Cape Fear River.

D. Plants

1. Seabeach Amaranth

Seabeach amaranth (*Amaranthus pumilus*) is federally and State-listed as threatened. It grows in low clumps comprised of sprawling, fleshy, reddish branches with dark leaves. The plant is profusely branched and generally grows to 1 m (39 in) in diameter. Historically, this species was found from Massachusetts to South Carolina, but according to USACE surveys between 1992 and 2004 (unpublished data), its distribution is now limited to North and South Carolina with some populations on Long Island, New York (USACE, 2006).

Seabeach amaranth

Seabeach amaranth is an effective sand binder, building dunes where it grows. A single large plant may be capable of creating a dune up to 60 cm high, containing 2 to 3 cu m of sand,

although most are smaller (Weakley and Bucher, 1992). The plant is typically found at elevations from 0.2 m to 1.5 m (0.6 ft to 4.9 ft) above mean high tide (Weakly and Bucher, 1992). Seabeach amaranth appears to function in a relatively natural and dynamic manner, allowing it to occupy suitable habitat as it becomes available (USFWS, 1993).

Figure Eight Island has been surveyed by UNCW for seabeach amaranth from 2002 to 2010 (Webster, pers. comm., 2011) while Hutaff Island has been monitored by field representatives of Audubon North Carolina between 2005 and 2010 (Mangiameli pers. comm., 2008; Suiter, pers. comm.). A total of 1,505 plants (ranging from 0 to 768 each year) have been recorded on Figure Eight Island (Table 4.7 and Figure 4.22 – 4.30) (Webster, pers. comm., 2011; Suiter, 2011). A total of 1,130 plants were found on Hutaff Island, with observations ranging between 14 and 1,011 between years. Seabeach amaranth data does not exist for Hutaff Island prior to 2005 (Golder, 2007).

Seabeach amaranth experiences a great deal of natural population variability from one year to the next, as is evident by Dr. Webster's and Audubon North Carolina survey results (Table 4.7). These natural fluctuations can be attributed to a number of factors, such as erosion, storms and seed dispersal.

Table 4.7. Figure Eight Island (Webster, pers. comm., 2011) and Audubon North Carolina annual Seabeach amaranth data (2005 to 2007) on Hutaff Island, North Carolina (Mangiameli, 2008; Suiter pers. comm., 2011).

Year	Seabeach amaranth (*Amaranthus pumilus*)	
	Figure Eight Island	**Hutaff Island**
2002	72	No Data
2003	3	No Data
2004	656	No Data
2005	768	1011
2006	No Data	47
2007	2	21
2008	0	14
2009	0	19
2010	4	18
Totals	**1505**	**1130**

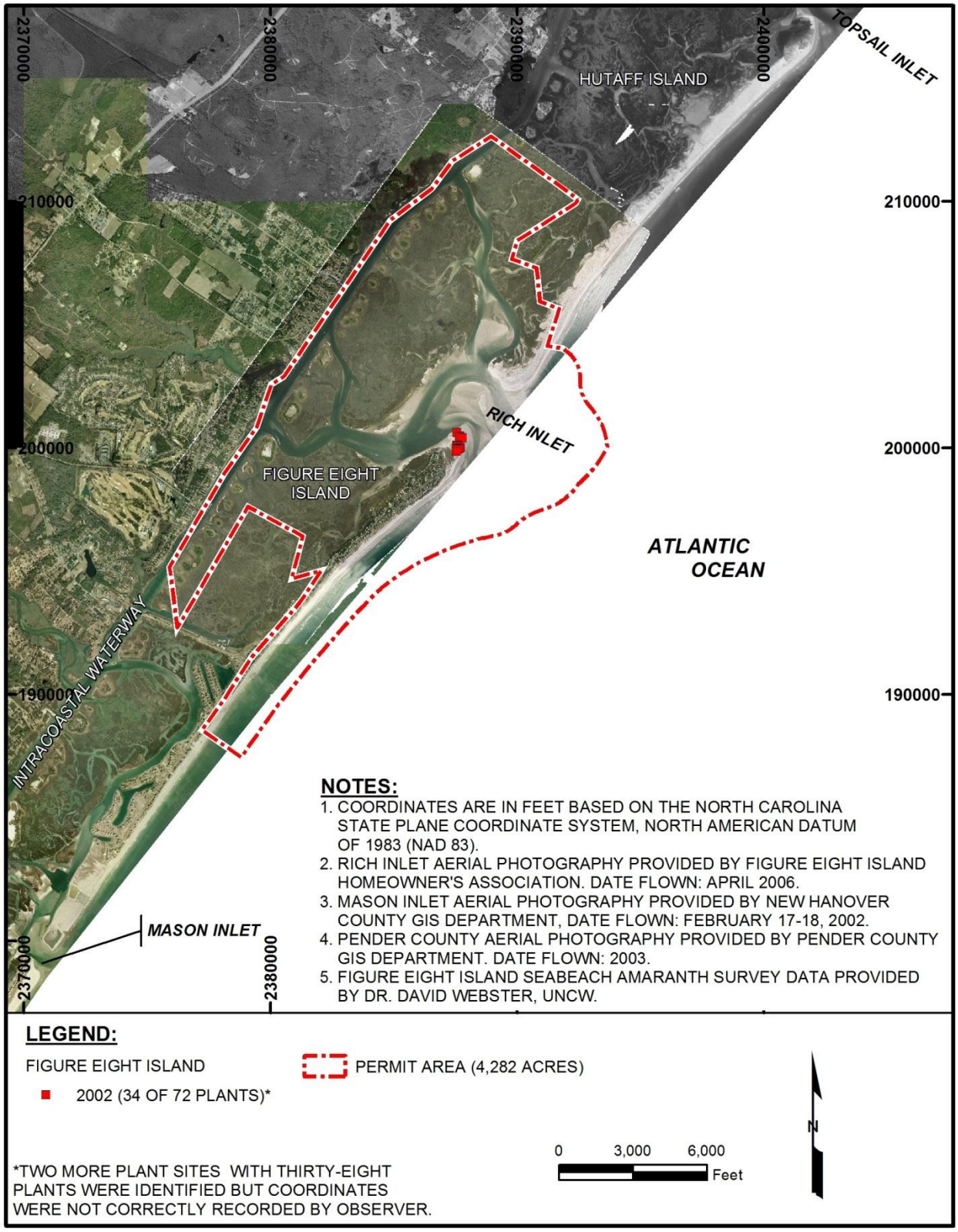


Figure 4.22. 2002 Seabeach amaranth distribution within the Permit Area

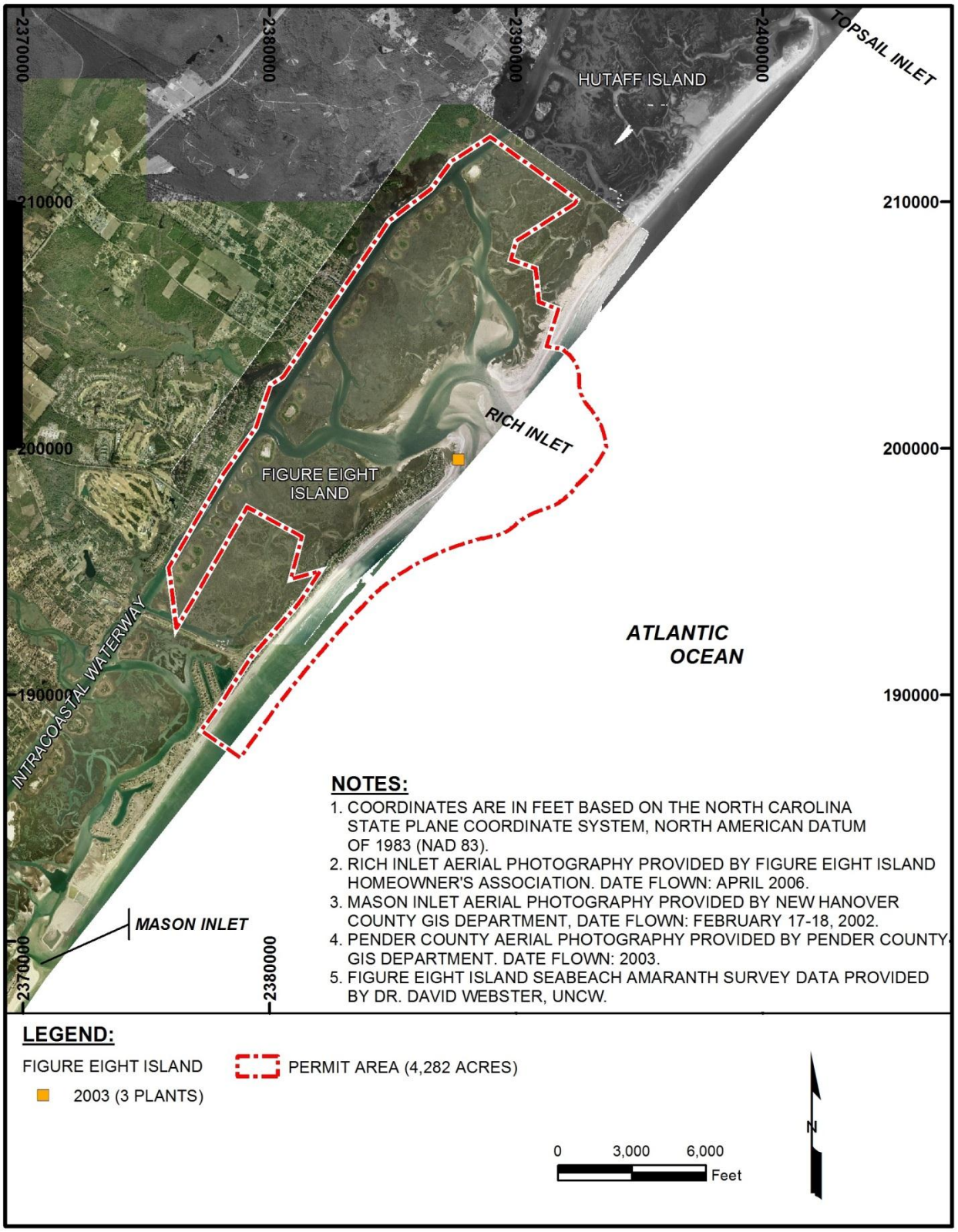


Figure 4.23. 2003 Seabeach amaranth distribution within the Permit Area

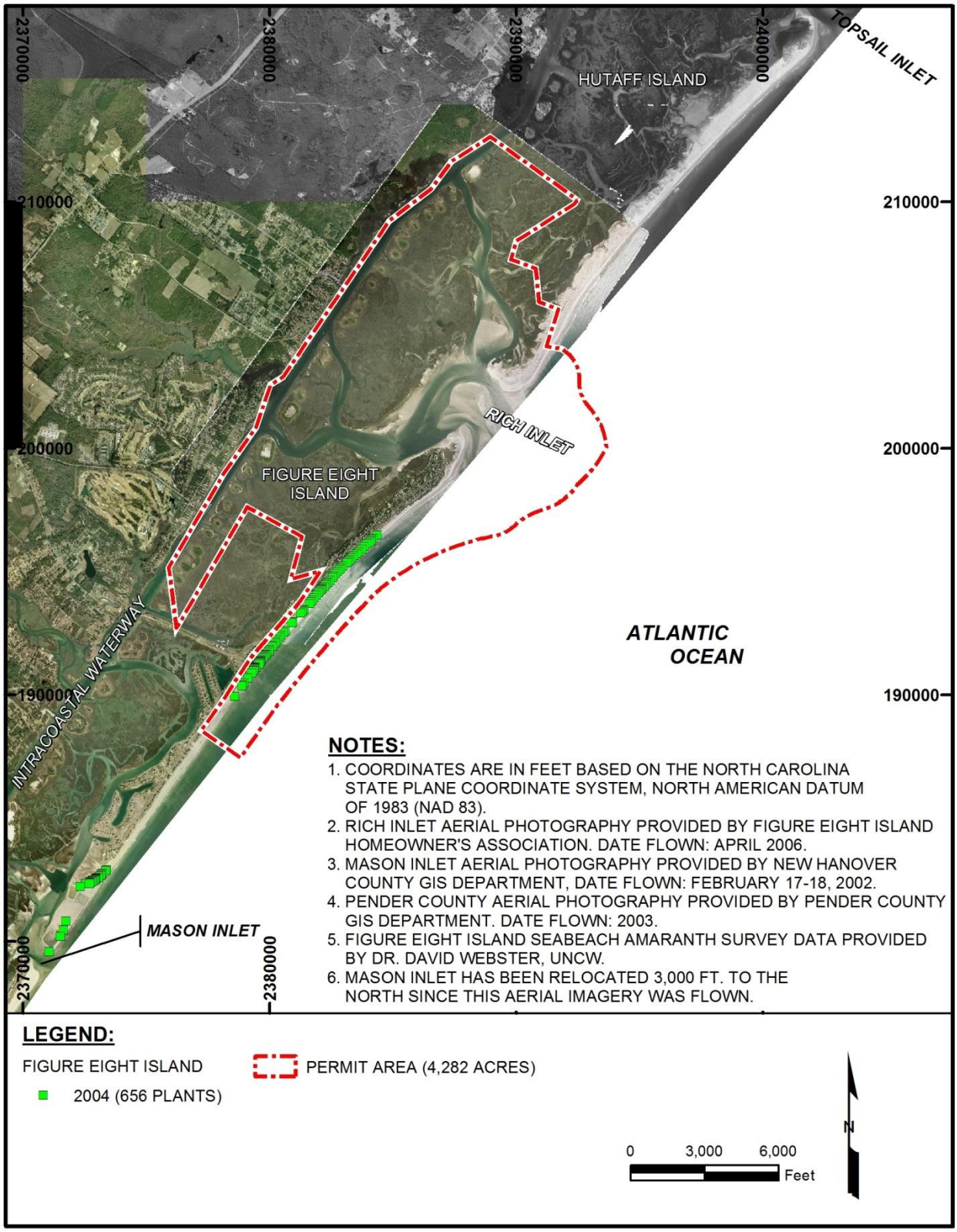


Figure 4.24. 2004 Seabeach amaranth distribution within the Permit Area

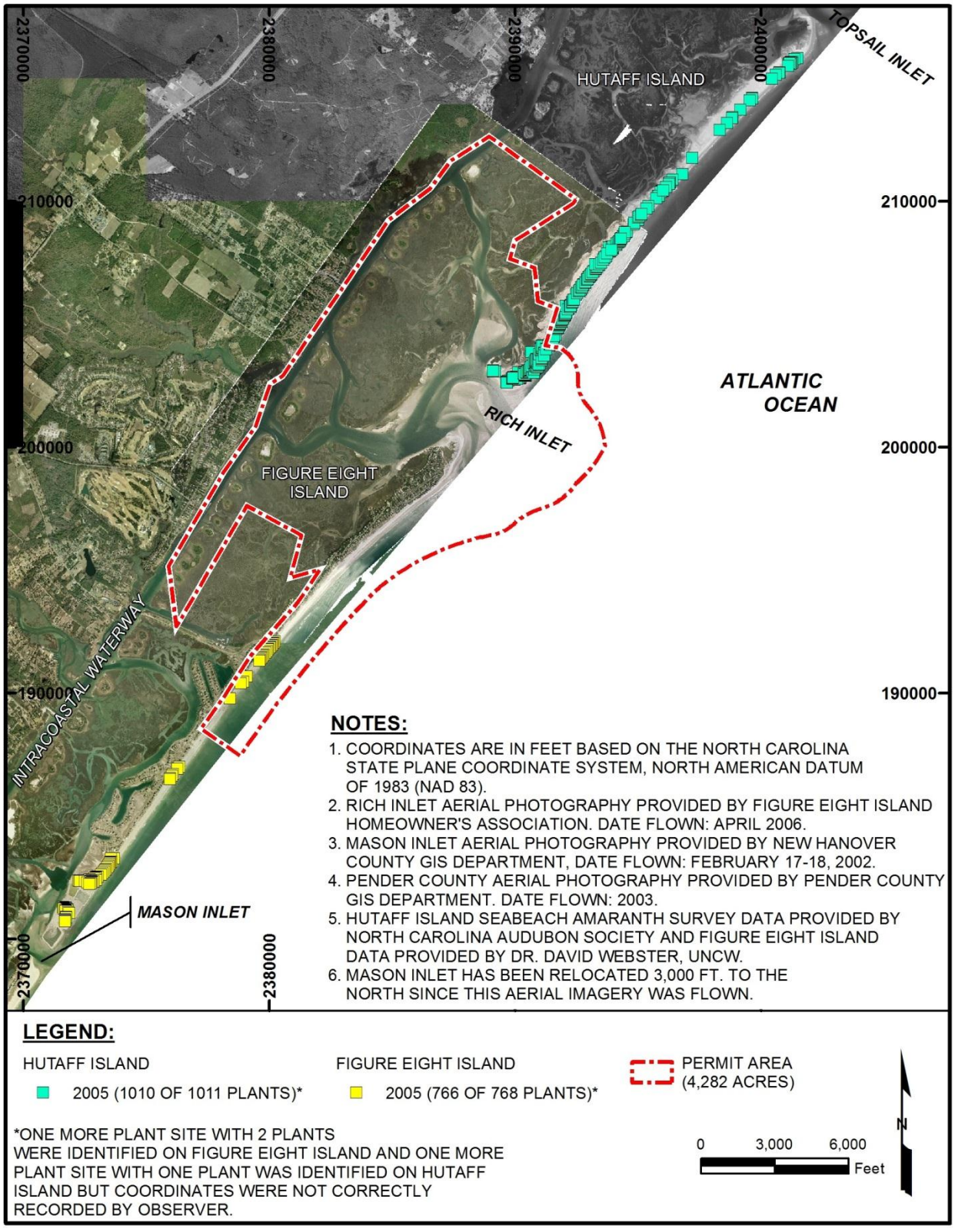


Figure 4.25. 2005 Seabeach amaranth distribution within the Permit Area

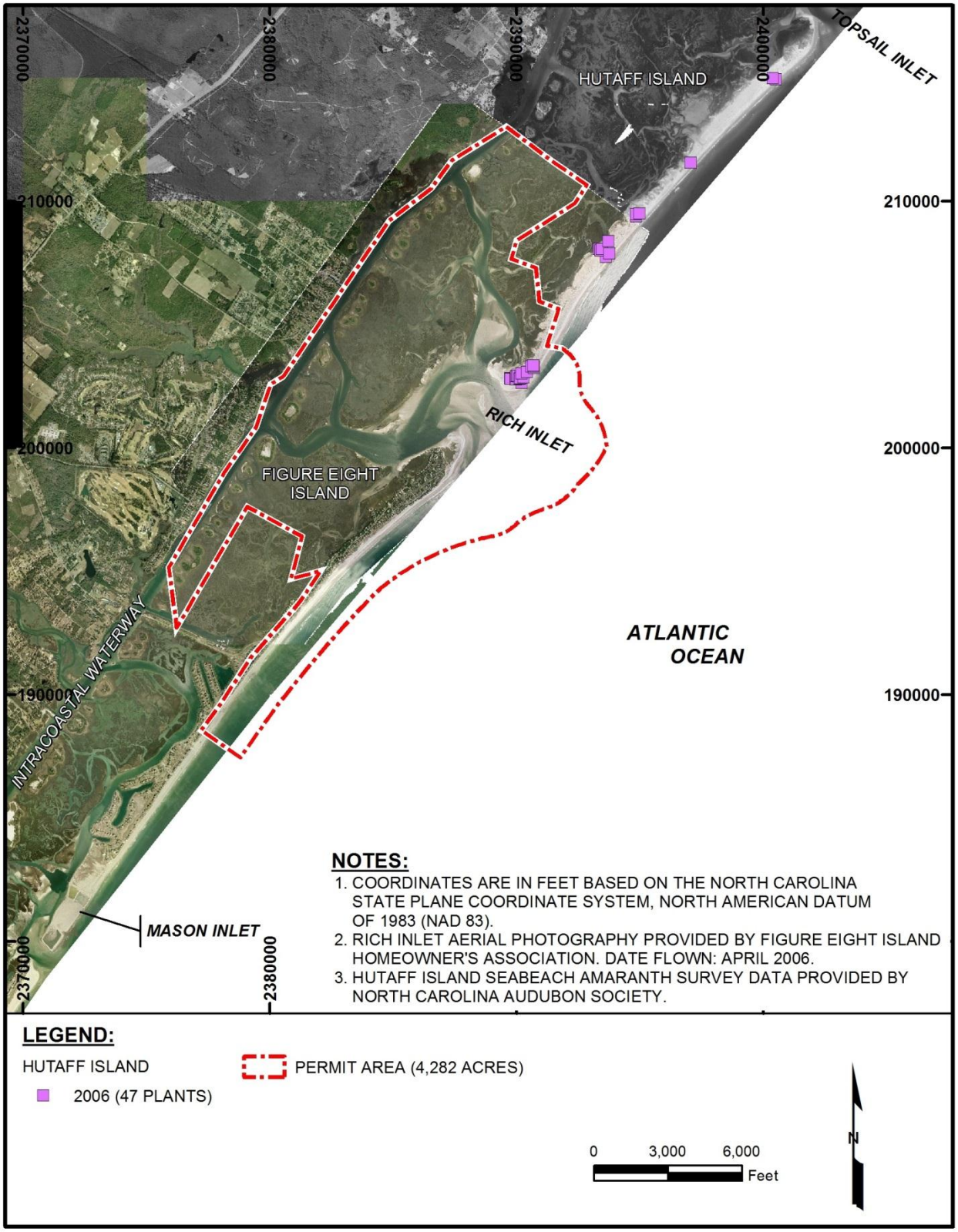


Figure 4.26. 2006 Seabeach amaranth distribution within the Permit Area

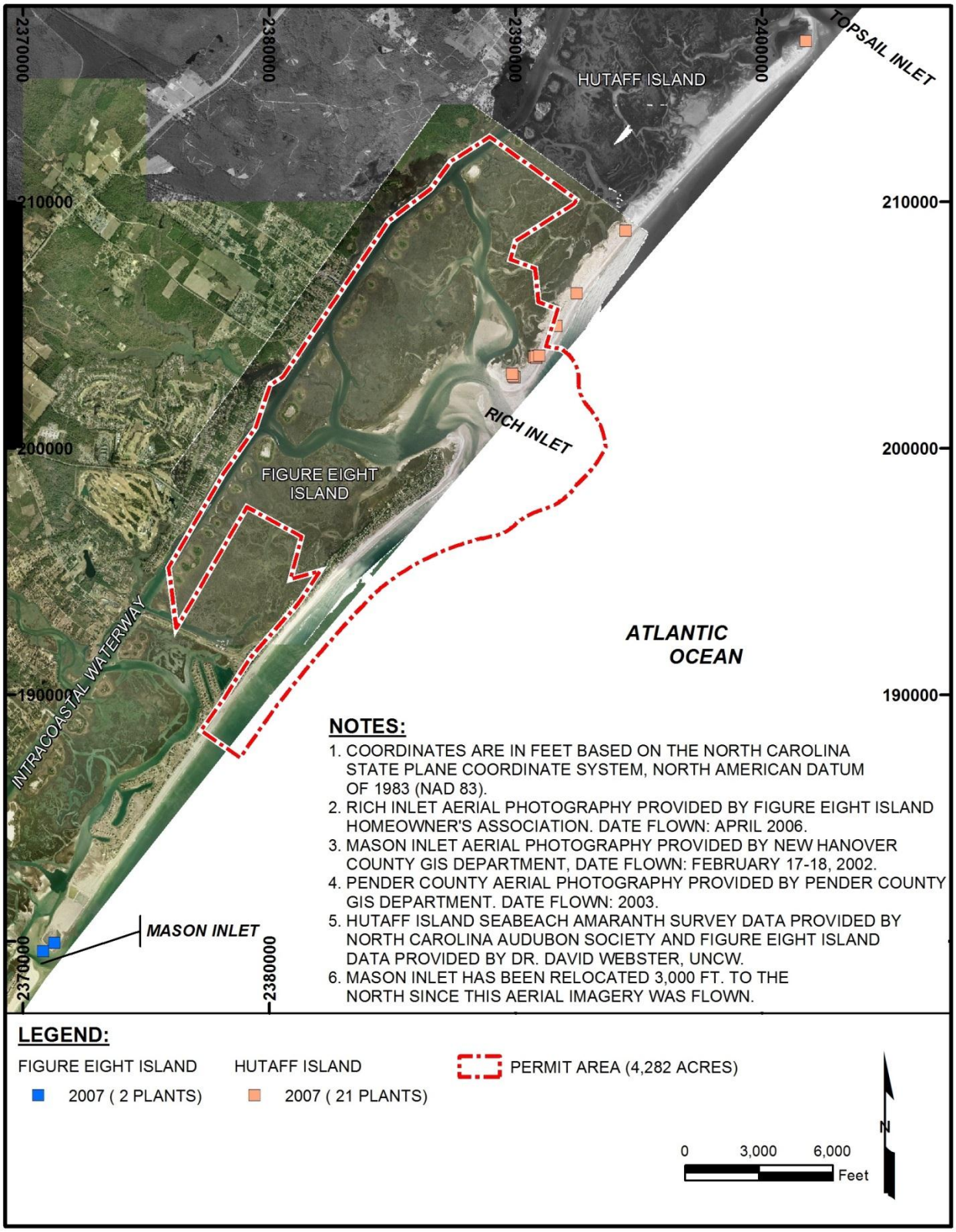


Figure 4.27. 2007 Seabeach amaranth distribution within the Permit Area

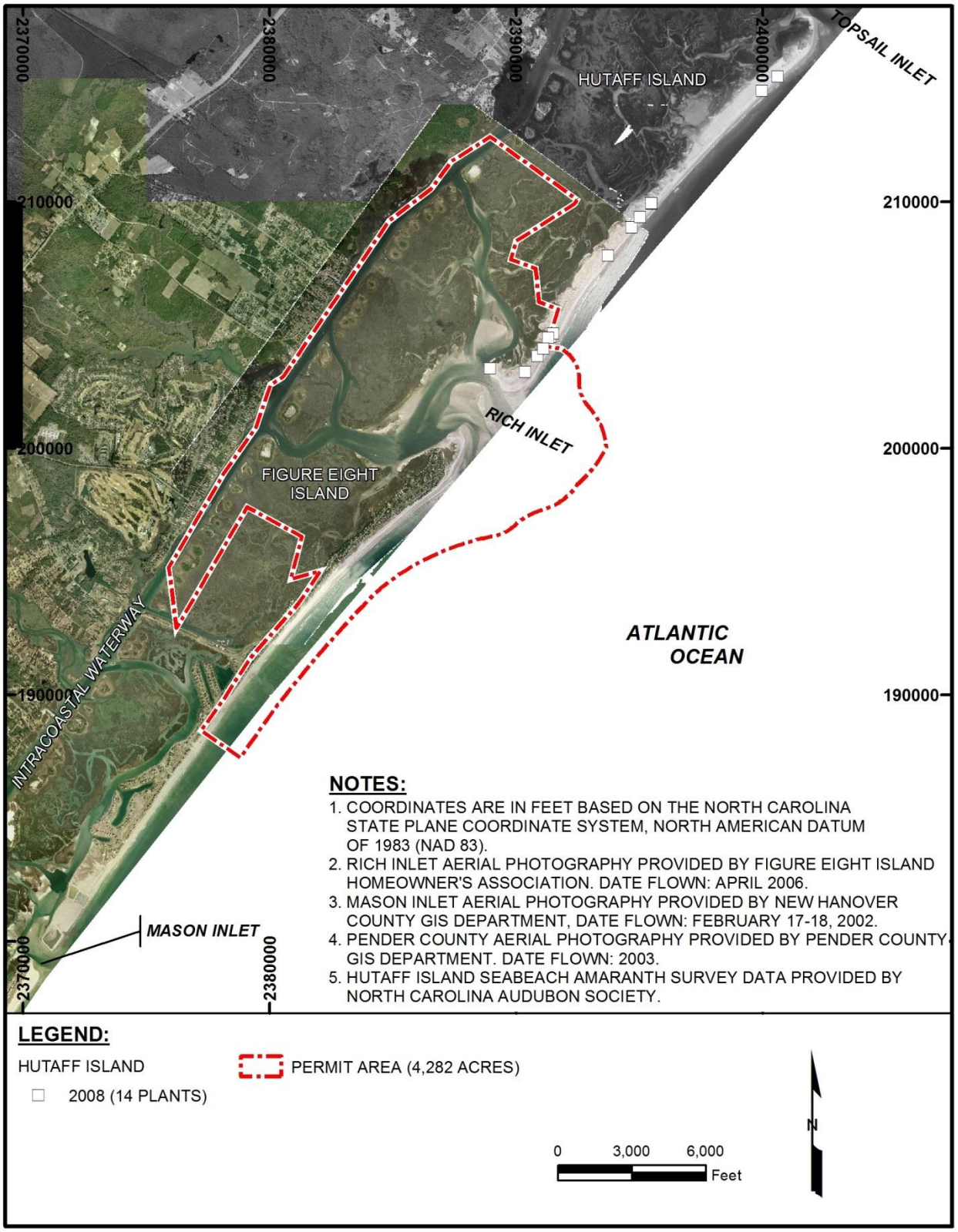


Figure 4.28. 2008 Seabeach amaranth distribution within the Permit Area

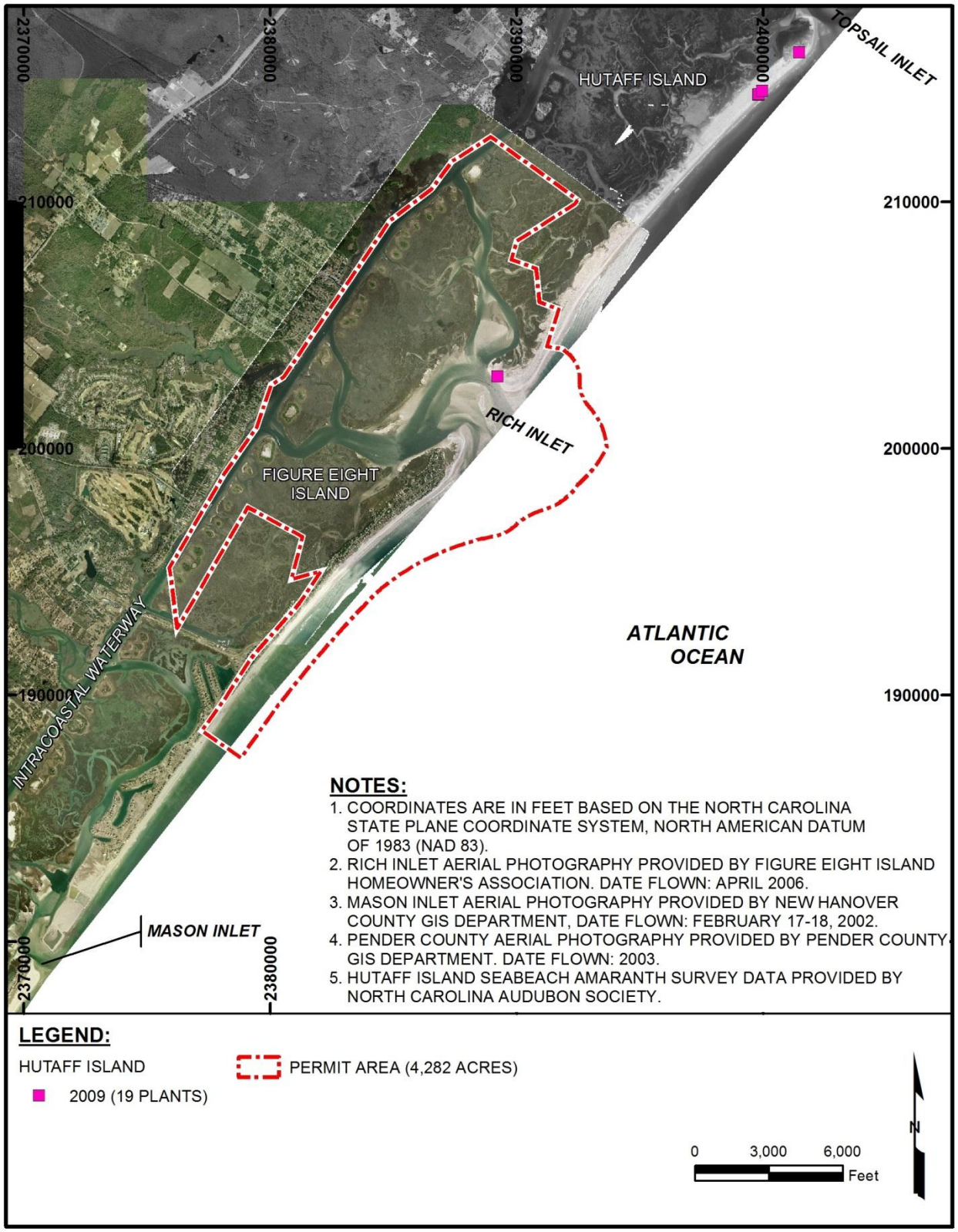


Figure 4.29. 2009 Seabeach amaranth distribution within the Permit Area. Note that more than one plant was observed at several sites.

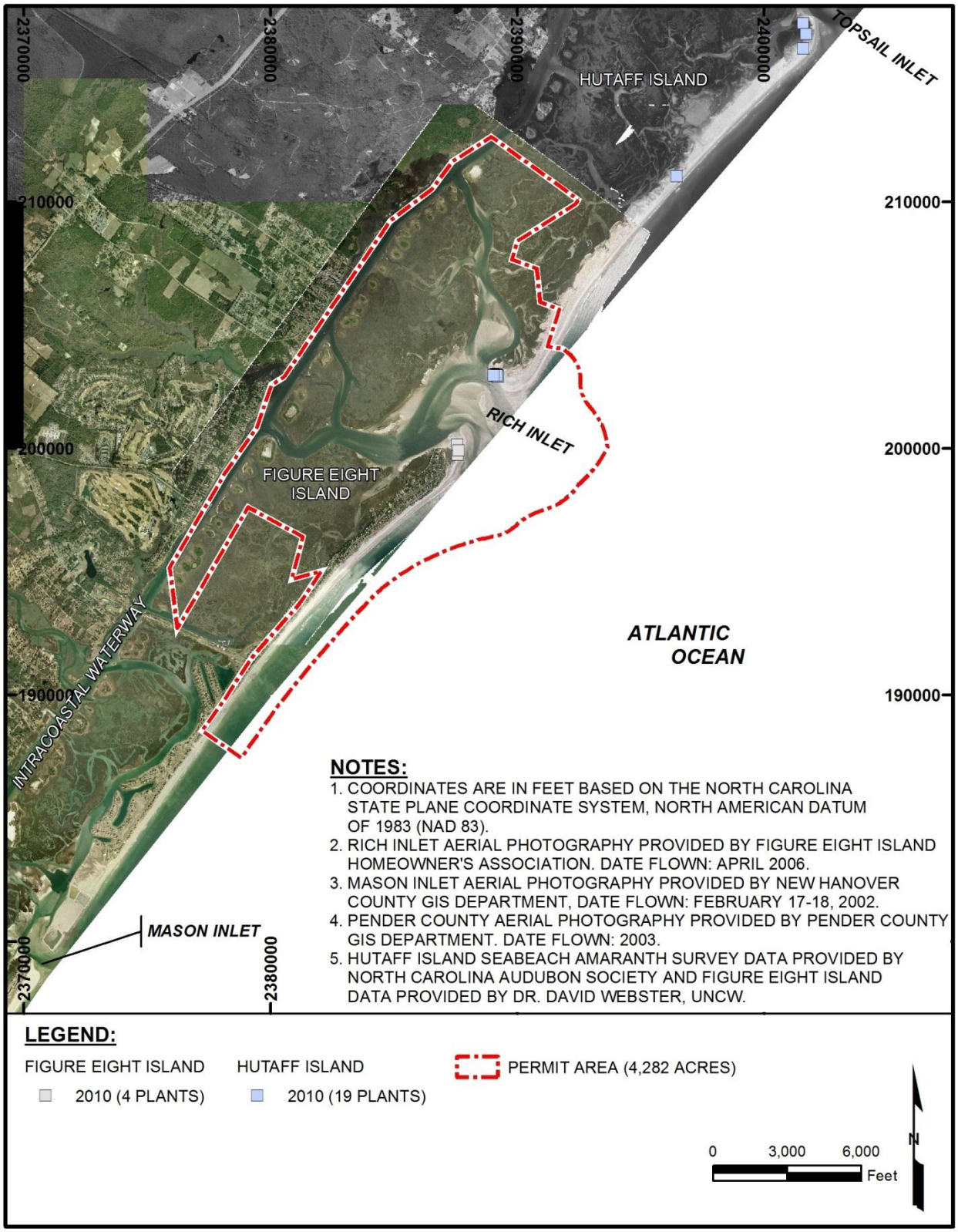


Figure 4.30. 2010 Seabeach amaranth distribution within the Permit Area.

E. Birds

The following section reviews and describes threatened and endangered bird species, both breeding and non-breeding, that have been documented within the Permit Area and/or within the vicinity of the project site. Bird species of special concern and of high conservation priority in North Carolina are also listed and discussed.

The North Carolina Wildlife Resource Commission and Audubon North Carolina have performed breeding surveys for colonial nesting waterbirds within proximity of the Permit Area on a regular basis since 1977. Specifically, surveys have been conducted within the north side of Mason's Inlet and the Southside of Rich Inlet, flanking Figure Eight Island. Surveys have also been conducted on Hutaff Island as well as the Southside of New Topsail Inlet, the northside of Rich Inlet, and Old Topsail Inlet. Surveys for breeding piping plovers have been conducted since 1989 at the same locations. Surveys for non-breeding piping plovers have been conducted in more recent years. These surveys include data from breeding and non-breeding seasons for several listed bird species as well as other shorebirds and waterbirds.

In 2011, researchers with UNCW conducted daily bird surveys on Figure Eight Island in between April 1 and April 14. These surveys occurred along the northern portion of the island between Nixon Channel and Inlet Hook Court, which are within the Permit Area. Surveys were performed at various times of the day and at various tidal stages. A total of 54 bird species were observed during the fifteen (15) surveys, including at least thirty (30) species per survey (Webster, pers. com.). The most commonly observed species were, in order, the Ring-billed gull, Double crested cormorant, Laughing gull, Herring gull, Least tern, and Brown pelican (Webster, pers. com).

Audubon North Carolina performed bird surveys within the greater Rich Inlet area on a monthly basis on a monthly basis beginning in the winter of 2007 and transitioned to a weekly schedule in March 2008. Thereafter, surveys were conducted on a weekly basis during shorebird migration (March-May and July-November) and bi-weekly during winter (December-February). Surveys were suspended in June, at the height of the nesting season when use by migrants is minimal. The domain of the survey area encompassed approximately 2.9km2 and included the south end of Hutaff Island, the north end of Figure 8 Island, and Rich Inlet proper (which encompasses the marsh and dredge island shoreline in Nixon and Green Channels, the large intertidal shoal in Green Channel (Green Shoal), the large intertidal shoal in the middle of the main inlet channel (Rich Shoal), and any other emergent shoals or sandbars in the inlet system. Between January 2010 and September 2014, a total of 228,823 birds, representing 90 species were observed within this area. Individuals of 26 species represented 96% of all birds observed at Rich Inlet (Addison and McIver, 2014). Of the 90 species observed at Rich Inlet, 27 species (30%) are of conservation concern, either as federally listed species, state-listed species or identified as declining or otherwise vulnerable.

1. Piping Plover

The piping plover (*Charadrius melodus*) was federally listed in 1986 under the Endangered Species Act of 1973, as amended with three separate breeding populations in North America: 1) the Atlantic Coast population (threatened), 2) the Northern Great Plains population (threatened),

and 3) the Great Lakes population (endangered). Piping plovers are also listed as threatened throughout their wintering range (USFWS, 1996). All three populations migrate to the coastal shorelines of the South Atlantic, Gulf of Mexico and the beaches of the Caribbean Islands to winter (USFWS, 2007c).

Piping plover

The habitat for wintering piping plover is protected under a Critical Habitat listing as identified by the ESA. On July 10, 2002, 137 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas were designated as Critical Habitat for wintering piping plover. Critical Habitat designation for North Carolina wintering piping plover includes Rich Inlet in Unit NC-11, which is described by the USFWS as follows (USFWS, 2001):

> *The entire area is privately owned. This unit extends southwest from 1.0 km (0.65 mi) northeast of MLLW of New Topsail Inlet on Topsail Island to 0.53 km (0.33 mi) southwest of MLLW of Rich Inlet on Figure Eight Island. It includes both Rich Inlet and New Topsail Inlet and the former Old Topsail Inlet. All land, including emergent sandbars, from MLLW on Atlantic Ocean and sound side to where densely vegetated habitat, not used by the piping plover, begins and where the constituent elements no longer occur. In Topsail Sound, the unit stops as the entrance to tidal creeks become narrow and channelized.*

While overwintering piping plovers have Critical Habitat within the Permit Area, this species also nests in the region. Piping plovers nest in dry sand habitats above the high tide line along coastal beaches, spits, flats, barrier islands and other sparsely vegetated dune and beach environments, although they may utilize other shoreline habitats if these are not available. Their nests are comprised of sand and shell material making them well camouflaged, with an average clutch size of three to four eggs (USFWS, 1996).

In 1990 the USFWS (2008) counted fewer than 1,000 piping plover nests in the Atlantic Coast population (including Canada). By 1996, 1,348 breeding pairs were documented. The number of breeding pairs has continued to steadily increase, reaching 1,438 pairs in 2000 and 1,690 pairs in 2002 (USFWS, 2008). The number of piping plover breeding pairs in North Carolina decreased from 55 pairs in 1989 to 24 pairs in 2003. However, estimates indicate a slight increase occurred in breeding pairs to 37 in 2005 and 46 in 2006 (USFWS, 2008).

The North Carolina coastline is important to piping plovers since it provides habitat for wintering, breeding, and migration. Piping plovers have been documented arriving on their breeding grounds in North Carolina beginning as early as mid-March. By mid-July, adults and young may begin to depart for their wintering areas. The piping plover is present year round in North Carolina and utilizes the coastal habitats for foraging, roosting, nesting, wintering and migrating (Cameron pers. comm., 2007).

The UNCW, NCWRC, Audubon North Carolina and partners have conducted piping plover surveys of the project area during various seasons since 1987. There are three areas that have

been monitored, Figure Eight Island, Rich Inlet and Hutaff Island. Only one (1) breeding pair, observed in 1996, has been located on Figure Eight Island. Hutaff Island, however, appears to be an important breeding area based upon the annual observations of breeding pairs. Since 1989, the peak number of breeding pairs observed on Hutaff was five (5) (Cameron pers. comm., 2007).

Data collected within the Rich Inlet area includes observations of piping plovers along the ebb bar in Rich Inlet near the northern end of Figure Eight, bars in Nixon and Green Channels, and the southern tip of Hutaff Island. Although the exact location of individuals within this complex was not noted in the data set; it is presumed that some of the individuals could have been or were foraging on the ebb bars during low tide. The greatest number of individuals noted in this area at one time was twenty-one (21) during the fall migration in 2006 (Cameron pers. comm., 2007).

Despite the lack of regular monitoring during the non-breeding season, data suggests that the area around Rich Inlet is valuable for migrating and wintering piping plovers. Surveys conducted by North Carolina Wildlife Resources Commission (NCWRC) and their partners observed approximately 192 piping plovers which included 31 breeding pairs between 2000 and 2007 surveys (Table 4.8) (Cameron pers. comm., 2007). It is important to mention that although 192 piping plovers and 31 breeding pairs were observed over the course of these surveys, it is possible that some individual birds were observed during multiple surveys and therefore summating these numbers may not be indicative of the actual number of distinct piping plovers found within the permit area.

In 2011, UNCW observed numerous piping plovers along the northern end of Figure Eight Island during a two week survey. Daily observations ranged from one (1) to nine (9) piping plovers (Webster, pers. comm., 2011) with an average of over five (5) per survey. No breeding pairs of piping plovers were observed on Figure Eight Island during the breeding season, however two nesting pairs were observed on Hutaff Island during breeding season (Schweitzer, pers. comm., 2011).

Between 2010 and 2014, Audubon North Carolina reported a total of 1,514 observations of piping plovers were made within Rich Inlet (Addison and McIver, 2014). While sightings were made in every month of the year, the greatest numbers were observed during fall migration (July-November). In some years piping plovers nested on Hutaff Island (2 pairs 2008, 1 pair 2009, 2 pairs 2010) or Figure Eight Island (1 pair 2014) (Addison and McIver, 2014). Piping plovers were observed throughout the Rich Inlet system using all areas of the inlet: the shoals in the main channel and Green Channel, beaches and spits on the northern and southern sides of the inlet mouth, and, much less frequently, beach or sandbar areas at the back of the inlet. Of the 1,514 piping plover sightings at Rich Inlet, 909 (60.0%) were of foraging birds, 515 (34.0%) were of roosting birds, and 90 (6.0%) were of birds performing another activity such as preening or agonistic behavior. Of the 909 sightings of foraging Piping Plovers at Rich Inlet, 458 (50.4%) were on shoals or sandbars in Rich Inlet; 201 (22.1%) were on Hutaff Island, typically in the swash zone at mid or low tide, and 250 (27.6%) were on North Figure 8 Island, typically on the low-energy sound side (Addison and McIver, 2014).

Table 4.8. Piping Plover Survey Data (1987-2007) for Figure Eight Island (Webster, pers. comm., 2011) & Hutaff Island (Mangiameli, 2007).

Year	Season	Number of birds	Number of breeding pairs
1987	Winter	0	
	Spring Migration	No Data	
	Breeding	No Data	No Data
	Fall Migration	No Data	
1988	Winter	No Data	
	Spring Migration	No Data	
	Breeding	No Data	No Data
	Fall Migration	No Data	
1989	Winter	8	
	Spring Migration	No Data	
	Breeding	0	0
	Fall Migration	1	
1990	Winter	9*	
	Spring Migration	0	
	Breeding	No Data	No Data
	Fall Migration	No Data	
1991	Winter	14*	
	Spring Migration	No Data	
	Breeding	0	0
	Fall Migration	No Data	
1992	Winter	No Data	
	Spring Migration	No Data	
	Breeding	No Data	No Data
	Fall Migration	No Data	
1993	Winter	No Data	
	Spring Migration	No Data	
	Breeding	No Data	No Data
	Fall Migration	No Data	
1994	Winter	No Data	
	Spring Migration	No Data	
	Breeding	0	0
	Fall Migration	No Data	
1995	Winter	No Data	
	Spring Migration	No Data	
	Breeding	No Data	No Data
	Fall Migration	No Data	
1996	Winter	16	
	Spring Migration	No Data	
	Breeding	10	5
	Fall Migration	No Data	
1997	Winter	19*	
	Spring Migration	No Data	
	Breeding	4	2
	Fall Migration	No Data	

Year	Season	Number of birds	Number of breeding pairs
1998	Winter	0	
	Spring Migration	No Data	
	Breeding	7	3
	Fall Migration	No Data	
1999	Winter	No Data	
	Spring Migration	No Data	
	Breeding	11	4
	Fall Migration	6	
2000	Winter	No Data	
	Spring Migration	No Data	
	Breeding	8	3
	Fall Migration	11*	
2001	Winter	18*	
	Spring Migration	9*	
	Breeding	10	4
	Fall Migration	19*	
2002	Winter	5*	
	Spring Migration	6*	
	Breeding	4	2
	Fall Migration	2*	
2003	Winter	4*	
	Spring Migration	3*	
	Breeding	20	10
	Fall Migration	2*	
2004	Winter	No Data	
	Spring Migration	No Data	
	Breeding	6	3
	Fall Migration	4*	
2005	Winter	No Data	
	Spring Migration	2*	
	Breeding	8	4
	Fall Migration	13*	
2006	Winter	2*	
	Spring Migration	8*	
	Breeding	0	0
	Fall Migration	21*	
2007	Winter	No Data	
	Spring Migration	No Data	
	Breeding	0	0
	Fall Migration	No Data	

*** These values represent the greatest number of individuals observed during a single sampling event. This designation has been utilized for those years where sampling events were conducted often and multiple counts of the same individuals in a single season are likely. This method of data reporting may lead to an underestimation of individuals found in these areas in a season. Given the frequency of data collection, it was determined that adding all of the observations in a single season for this data set would result in a gross overestimation of actual individuals would not be an appropriate way to present the data.**

2. Wilson's Plover

Wilson's plover

The Wilson's plover (*Charadrius wilsonia*) is designated by the State of North Carolina as a Species of Special Concern. There is no Federal status for this species, and it is considered globally secure (G5 rank) (NCNHP, 2006). However, Wilson's plovers are listed as species of high conservation concern in the US Shorebird Conservation Plan (Brown et al., 2001). This species breeds in North Carolina and has a current breeding range extending into northern Virginia in the Delmarva Peninsula; its historic range reached New Jersey (Corbat and Bergstrom 2000). Complete surveys were conducted in 2004 and 2007 along Hutaff Island and the inlet areas flanking Figure Eight Island. Additional surveys were conducted from 1989 and 2001 (Table 4.9). The number of Wilson's plovers recorded during this period ranged from 10 to 54 individuals and 5 to 27 breeding pairs (Cameron, pers. comm. 2007). In 2007, Audubon North Carolina observed 27 breeding pairs of Wilson's plovers on Hutaff Island (Mangiameli, pers. comm., 2008). An average of nearly two (2) Wilson's plovers were observed during each of the daily surveys conducted along the northern portion of Figure Eight Island in April, 2011 (Webster, pers. comm., 2011). In 2012, there were 25 defended territories, indicating 25 nesting pairs and 46 defended territories in 2011 (Audubon unpublished data).

Table 4.9. Wilson's Plover Survey Data Observed 2000-2007 (NCWRC Shorebird Database, 2007)

Location	Year	Season	Number of Birds	Number of Breeding Pairs
Figure Eight Island	1989*	Breeding	48	24
Hutaff Island	1989*	Breeding	51	23
Figure Eight Island	2001*	Breeding	28	14
Hutaff Island	2001*	Breeding	22	11
Figure Eight Island	2004	Breeding	10	5
Hutaff Island	2004	Breeding	52	26
Figure Eight Island	2007	Breeding	2	1
Hutaff Island	2007	Breeding	54	27

*Incomplete survey

3. American Oystercatcher

American oystercatcher

American oystercatchers *(Haematopus palliatus)* are State listed as a Species of Special Concern. However, the American oystercatcher is considered stable globally (G5), and is not federally listed under the ESA. Along the western Atlantic coast, the eastern race of the American oystercatcher breeds from Massachusetts to Florida, with the highest concentrations from Virginia to Georgia (Humphrey, 1990). As indicated in Table 4.10, this species has been observed in or near the Permit Area during the April to June breeding period (Cameron, pers. comm., 2007). In addition, the species is known to utilize Rich Inlet

during migration, particularly in the spring when numbers increase as breeding and local birds' numbers are augmented by migrants (Audubon, 2012). An average of two (2) American oystercatchers were observed during each of the daily surveys conducted along the northern portion of Figure Eight Island in April 2011 (Webster, pers. comm., 2011).

Table 4.10. American Oystercatcher Survey Data Observed 2000-2007 (NCWRC Shorebird Database, 2007)

Location	Year	Season	Number of Birds	Number of Breeding Pairs
Figure Eight Island	2001	Breeding	8	4
Hutaff Island	2001*	Breeding	10	5
Figure Eight Island	2004	Breeding	10	5
Hutaff Island	2004	Breeding	26	13
Figure Eight Island	2007	Breeding	4	2
Hutaff Island	2007	Breeding	24	12

***Incomplete survey**

4. Common Tern

The common tern (*Sterna hirundo*) is designated by the State of North Carolina as Species of Special Concern (species which are determined by the NCWRC to require monitoring). There is no Federal status for this species, although the common tern is considered globally secure (G5 rank). Common terns seem to be undergoing a decline in the southeast and are therefore listed as a species of regional concern (Hunter et al., 2001).

Complete surveys were conducted along Hutaff Island and the inlet areas flanking Figure Eight Island by the NCWRC and Audubon North Carolina in 1977, 1983, 1988, 1993, 1995, 1997, 1999, 2001, 2004, and 2007. A total of 495 nests were observed through this period (Table 4.11). Common terns have experienced dramatic population declines in North Carolina and are currently down from their long-term average by 66% (Cameron et al. 2004). Common terns move frequently in response to changes in their highly ephemeral nesting habitat. The area along Hutaff Island and Figure Eight Island provides potentially important nesting habitat for common terns.

An average of nearly twenty (20) common terns were observed during daily surveys conducted along the northern portion of Figure Eight Island in April 2011 (Webster, pers. comm., 2011). In the spring of 2012, as many as 463 common terns were counted on shorebird surveys, and in the fall as many as 670 were counted (Audubon 2012a). These flocks are often observed on the shoals in the mouth of Rich Inlet.

Table 4.11. Number of Common Tern Nests Observed 1977-2007 (NCWRC Shorebird Database, 2007)

Site Name	Survey Date	Number of Nests
Figure Eight Island	1977	7
Hutaff Island	1977	9
Figure Eight Island	1983	0

Hutaff Island	1983	96
Figure Eight Island	1988	11
Hutaff Island	1988	34
Figure Eight Island	1989	13*
Hutaff Island	1989	35*
Figure Eight Island	1990	51*
Figure Eight Island	1993	16
Hutaff Island	1993	0
Figure Eight Island	1995	5
Hutaff Island	1995	25
Figure Eight Island	1997	1
Hutaff Island	1997	52
Figure Eight Island	1999	0
Hutaff Island	1999	67
Figure Eight Island	2001	20
Hutaff Island	2001	38
Figure Eight Island	2004	0
Hutaff Island	2004	15
Figure Eight Island	2007	0
Hutaff Island	2007	0

***Incomplete survey**

5. Gull-Billed Tern

The gull-billed tern (*Sterna nilotica*) is designated by the State of North Carolina as threatened. There is no Federal status for this species, and it is considered globally secure (G5 rank). However, these terns are listed as species of high conservation concern (Kushlan et al., 2002). Surveys were conducted along Hutaff Island and the inlet areas flanking Figure Eight Island by the NCWRC and Audubon North Carolina in 1977, 1983, 1988, 1993, 1995, 1997, 1999, 2001, 2004, and 2007. Although only nine (9) nests were observed in proximity to Figure Eight Island and two (2) along Hutaff following 10 years of complete surveys spanning 30 years, Sue Cameron of the NCWRC noted that the habitat type within the Permit Area makes these areas potentially important nesting sites (Table 4.12). No gull-billed terns were observed during each of the daily surveys conducted along the northern portion of Figure Eight Island in April 2011 (Webster, pers. comm., 2011).

Table 4.12. Number of Gull-Billed Tern Nests Observed 1977-2007 (NCWRC Shorebird Database, 2007)

Site Name	Survey Date	Number of Nests
Figure Eight Island	1977	0
Hutaff Island	1977	0
Figure Eight Island	1983	0
Hutaff Island	1983	0
Figure Eight Island	1988	0
Hutaff Island	1988	0
Hutaff Island	1989	1*
Figure Eight Island	1990	9*
Figure Eight Island	1993	0
Hutaff Island	1993	0

Figure Eight Island	1995	0
Hutaff Island	1995	0
Figure Eight Island	1997	0
Hutaff Island	1997	0
Figure Eight Island	1999	0
Hutaff Island	1999	1
Figure Eight Island	2001	0
Hutaff Island	2001	0
Figure Eight Island	2004	0
Hutaff Island	2004	0
Figure Eight Island	2007	0
Hutaff Island	2007	0

***Incomplete survey**

6. Black Skimmer

The black skimmer (*Rynchops niger*) is designated by the State of North Carolina as a Species of Special Concern (species which are determined by the NCWRC to require monitoring). There is no Federal status for these species, although the black skimmer is considered globally secure (G5 rank) (Kushlan et al., 2002).

Complete surveys were conducted along Hutaff Island and the inlet areas flanking Figure Eight Island by the NCWRC and Audubon North Carolina in 1977, 1983, 1988, 1993, 1995, 1997, 1999, 2001, 2004, and 2007. A total of 562 nests were observed during this time (Table 4.13).

Of the fifteen (15) daily surveys conducted by UNCW along the northern portion of Figure Eight Island in April 2011, black skimmers were observed on only two dates. These included observations of fifty (50) and twelve (12) individuals (Webster, pers. comm., 2011). In the fall, black skimmers use Rich Inlet for staging. Audubon reports that in 2012 the peak spring count was 132 and the peak fall count was 1,500 (Audubon 2012a). Also like the common terns, black skimmers use the emergent shoal in the mouth of Rich Inlet, as well as the islands' spits to roost in these large groups.

Table 4.13. Number of Black Skimmer Nests Observed 1977-2007 (NCWRC Shorebird Database, 2007)

Site Name	Survey Date	Number of Nests
Figure Eight Island	1977	0
Hutaff Island	1977	52
Figure Eight Island	1983	0
Hutaff Island	1983	38
Figure Eight Island	1988	20
Hutaff Island	1988	16
Figure Eight Island	1989	1*
Hutaff Island	1989	41*
Figure Eight Island	1990	48*
Hutaff Island	1991	25*
Figure Eight Island	1993	14
Hutaff Island	1993	0
Figure Eight Island	1995	0

Hutaff Island	1995	42
Figure Eight Island	1997	0
Hutaff Island	1997	24
Figure Eight Island	1999	0
Hutaff Island	1999	27
Figure Eight Island	2000	20
Figure Eight Island	2001	40
Hutaff Island	2001	67
Figure Eight Island	2004	0
Hutaff Island	2004	87
Figure Eight Island	2007	0
Hutaff Island	2007	0

***Incomplete survey**

7. Eastern Painted Bunting

The Eastern painted bunting (*Passerina ciris ciris)* is State-listed as a Species of Special Concern. The eastern population of painted bunting breeds in a restricted range within the Atlantic Coastal Plain, from North and South Carolina to Georgia and Florida. In North Carolina, eastern painted bunting breeding habitats are found in a narrow range along marine coasts and waterways (Audubon North Carolina, 2007b). NCWRC Biologist Dave Allen described their habitat as "…early succession habitat such as shrubby areas with occasional shrubs, edge habitat and even marsh edges or marsh interior if some shrubs or trees are nearby. This includes some residential area" (Allen, pers. comm., 2007).

Eastern painted bunting

A volunteer monitoring program has been established for the painted bunting in partnership between UNCW, SCNDR, USFWS, and the North Carolina Museum of Natural Sciences. This goal of this program, called the Painted Bunting Observation Team (PBOT), is to observe, record, and catalogue sightings of painted buntings. PBOT has reported twelve (12) sightings from four (4) locations on Figure Eight Island in 2011. Several hundred additional observations were made along the landward area of New Hanover and Pender County in proximity to the AIWW, (Painted Bunting Observer Team, 2011).

8. Red Knot

The red knot was designated by the USFWS as threatened in 2014. At nine to ten inches long, the red knot is a large, bulky sandpiper with a short, straight, black bill. Large numbers of red knots rely on Atlantic stopover habitats during the spring and fall migration periods. Red knots winter at the southern tip of South America and breed above the Arctic Circle. These small shorebirds fly more than 9,300 miles from south to north every spring and reverse the trip every autumn, making the red knot one of the longest-distance migrating animals. Migrating red knots break their spring migration into non-stop segments of 1,500 miles or more, converging on just a few critical stopover areas along the way. Large

Red Knot

flocks of red knots arrive at stopover areas along the Atlantic coast each spring, with many of the birds having flown directly from northern Brazil. Red knots are faithful to these specific sites, stopping at the same locations year after year. Mole crabs (*Emerita talpoida*) and coquina clams (*Donax sp.*) are an important food source for migrating knots in North Carolina. Birds arrive at stopover areas with depleted energy reserves and must quickly rebuild their body fat to complete their migration to Arctic breeding areas. During their brief 10 to 14-day stay in the mid-Atlantic, red knots typically double their body weight.

Red knots do utilize habitat within and around the Permit Area during their migration. Surveys conducted during 2007 by Audubon North Carolina revealed a total of 878 red knot individuals observed along Mason Inlet, Rich Inlet, Lea Island, and Hutaff Island. The maximum count at each location on an individual survey was 188, 258, 6, and 20, respectively at each location. (Mangiameli, pers. comm., 2008). Surveys conducted by Audubon North Carolina between 2008 and 2014 revealed that banded red knots were observed on 55 occasions, representing at least 26 individuals. Since not all knots' bands codes could be read completely, and since not all red knots have unique bands, the number of individuals is likely underrepresented by this count (Addison and McIver, 2014). The majority of red knots observed during this study roosted on the sound side of Figure Eight Island, with additional roosts on Hutaff Island and Green Shoal. Foraging red knots used the ocean beaches of Figure Eight Island and Hutaff Island, as well as Green Shoal.

4. What are the public interest factors within the project area?

Public Safety

A total of 215 boating accidents were recorded in North Carolina by the NCWRC in 2005 (including personal watercraft), 14 of them fatal. The U.S. Coast Guard (USCG) Boating Statistics for 2005 ranked the waters of North Carolina as number 11 out of the 56 bodies of water owned by the U.S., for the total number of boats operating in North Carolina waters. In 2005 a total of 362,784 boats were registered in North Carolina. This number increased to 370,291 in 2006 (USGC, 2006). Between 2002 and 2006, the number for boating accidents has steadily risen from 138 to 175. Within the same time period, there was an increase of boat accident related mortalities; from 11 in 2002 to 24 in 2006. In 2005, NCWRC reported 10 boating accidents in New Hanover County resulting in eight injuries and two fatalities. Ten accidents were also reported in Pender County with nine injuries and one fatality. In 2007, a boating accident injured three occupants of a vessel which crashed into the Figure Eight Island bridge as it traveled in the AIWW. On May 26, 2008 a small recreational vessel capsized in proximity to Rich Inlet leading to one drowning fatality. The waters in North Carolina, including those found within the Permit Area are policed by the North Carolina Marine Patrol administered through the Officers of the Wildlife Resources Commission. Their jurisdiction includes all coastal waters, extends to 3 miles offshore, and ranges to 200 miles offshore for some federally regulated species. Officers monitor 2.5 million acres of water and over 4,000 miles of coastline. Currently, the Marine Patrol has 59 officers that work in three law enforcement districts along the North Carolina coast. In addition to checking commercial and recreational fishermen, officers patrol waterways, piers, and beaches in coastal areas. Officers use a variety of different size boats, aircraft, helicopters, and patrol vehicles to accomplish these tasks.

Figure Eight Island is a privately owned island and access from the mainland by way of Bridge Road is restricted to residents and their guests limiting public entrance. Public access to Hutaff Island, which has no mainland access, is by boat only. Therefore public access to beaches in the Permit Area is somewhat restricted limiting potential compromises to public safety on the islands' beaches. Public safety is expected to be more focused toward boat use, particularly during peak summer months.

Aesthetic Resources

Figure Eight Island covers approximately 526.1 ha (1300 ac) and is approximately 8.0 km (5.0 mi) long and approximately 0.6 km (0.4 mi) wide. Figure Eight Island is a private, gated residential barrier island situated amongst the Atlantic Ocean, the AIWW, and vast expanses of salt marsh and wetlands. The island is bordered to the south by Mason Inlet and Wrightsville Beach and to the north by Rich Inlet and Hutaff Island, an undeveloped, privately-owned island. The Permit Area includes a wide diversity of estuarine and nearshore habitat types supporting diverse ecosystems typically associated with a developed and undeveloped barrier island system in southeastern North Carolina, and provides uninterrupted to slightly interrupted natural vistas to both residents and non-residents. Because of its private nature, Figure Eight Island is a suitable place for wildlife conservation.

Recreational Resources

The terrestrial and aquatic environment within the Permit Area offers a number of recreational opportunities. Bird watching, surfing, fishing, sunbathing, boating, and swimming are offered to both tourists and local residents. Due to the restricted access to both Figure Eight Island and Hutaff Island, many of these recreational opportunities are limited to residents of Figure Eight Island and boaters. However, during peak summer periods, Nixon Channel, Green Channel, Rich Inlet, along with the adjacent shoreline beaches are routinely utilized by boaters for watersports and sunbathing.

Table 4.14 depicts the recreational boat usage of four specific areas in proximity to Rich Inlet: The northern spit of Figure Eight Island, defined as the sand accreted north of development on the island and also along the back side of the island above the mean high water line, the intertidal shoals within the flood tide delta of Rich inlet that is exposed during low tide, the Hutaff Island area along the shoreline in proximity to Rich Inlet, and all open waters within Rich Inlet, Nixon Channel, and Green Channel.

Eighteen (18) historical aerial photographs were analyzed within the Rich Inlet complex (including Nixon Channel and Green Channel) for recreational boat usage dating back to November 2004. Aerial photos were obtained from the USACE Wilmington District Office, New Hanover County GIS Department, and Google Earth. Photos represent a one-time snapshot at a particular time of the day. The photos provided by the USACE were all taken between 9:30 and 11:00am and represented both high and low tides. Each photo was viewed and boats were counted. Although this is not a statistically defendable analysis, the simple observation of boat usage during different times of the year and during high and low tides is intended to provide a

reasonable assessment of boater usage including high usage times. As shown in Table 4.14, the predominant usage areas were along Hutaff Island and the open waters within the vicinity of Rich Inlet with a total of 88 and 77 boats observed, respectively. A total of 44 boats, or half the number of boats observed at Hutaff Island, were located along the northern spit on Figure Eight Island. In total, seasonal usage was highest in the fall and summer time periods.

Table 4.14. Recreational boat usage in proximity to Rich Inlet as observed via select aerial photographs.

Date	Figure Eight Northern Spit	Intertidal Shoal	Hutaff Island	Open Water
Sunday, November 14, 2004	0	1	2	1
Monday, October 17, 2005	1	0	3	1
Monday, June 13, 2005	4	0	2	2
Tuesday, April 19, 2005	0	0	0	0
Thursday, April 06, 2006	0	0	0	3
Friday, June 30, 2006*	14	1	16	10
Friday, September 01, 2006	24	0	24	8
Monday, December 18, 2006	0	0	0	1
Sunday, September 30, 2007	0	0	0	7
Thursday, April 24, 2008	0	0	1	3
Wednesday, June 25, 2008	0	1	1	4
Thursday, April 16, 2009	0	0	0	0
Saturday, May 30, 2009	2	1	12	1
Saturday, October 09, 2010	2	2	13	15
Friday, October 22, 2010	0	0	5	13
Jan-10	1	4	8	8
Thursday, July 28, 2011	0	0	1	0
Total # of Boats	**48**	**10**	**88**	**77**

Seasonality Usage	Dec-Feb	March-May	June-August	Sept-Nov
# of Images Evaluated	1	5	5	6
Total # of Boats	**1**	**23**	**77**	**122**

***- Holiday (Labor Day) weekend**

Navigation

Rich Inlet serves as the access point for numerous recreational and fishing vessels year round. During the year, especially during peak tourist season, the Inlet can experience intense recreation navigation usage. Despite this frequent usage, Rich Inlet and surrounding waters are not maintained by federally authorized dredging activities. Masonboro Inlet is the closest

maintained inlet which is located approximately 9.5 miles to the south. Although smaller recreational vessels can typically navigate through Rich Inlet into the ocean, larger vessels will generally access the ocean through Masonboro Inlet. Nixon Channel serves as the primary connecting waterway between the inlet and the AIWW. Outside the area that is periodically dredged, the inlet channel depth ranges from approximately 5 to 10 feet. Green Channel experiences high rates of shoaling and infilling and therefore is not utilized as frequently as Nixon Channel. The depth of Green Channel ranges from approximately 4 to 6 feet NAVD making it difficult to navigate larger vessels.

Socio-Economic Resources

New Hanover County has a diverse economic base relying on tourism, trade, pharmaceuticals/healthcare, manufacturing, and government. As the population continues to grow, the area becomes more attractive to national retailers and companies. Figure Eight Island, located in New Hanover County, is primarily a residential community with limited commercial and retail facilities. Figure Eight Island contains 463 homes with 93 undeveloped lots. In 2004, the market value of these homes ranged from nearly $1,000,000 to over $7,500,000. Between March 2003 and March 2004, 14 homes sold on the island ranging in price between $825,000 and $2,000,000 with an average listing price of $1,418,266. The average selling price of these homes was $1,244,583. Since this time, the housing market has decreased within the region; however the average selling price of homes on Figure Eight Island has increased. During 2011, 13 homes were sold on the island for an average price of $1,757,514. Commercial activity on the island consists of home construction contractors and associated sub-contractors, landscapers, home cleaning services, and general residential and commercial services.

Land Use

The Coastal Area Management Act (CAMA) requires Counties, Cities and Towns within the 20 coastal counties to periodically prepare Land Use Plans to protect and manage the health of the coastal environment and economy. The North Carolina Division of Coastal Management requires that these counties keep the Land Use plans up to date. The most recent plan for Wilmington and New Hanover County was updated in 2006. The primary focus of the plan has been protection and appropriate development of coastal areas of environmental concern on a countywide perspective.

Figure Eight Island is located on the northeast end New Hanover County, in southeastern North Carolina, approximately eight miles north of Wilmington. It is a private, gated residential barrier island with 463 homes and 93 undeveloped lots. The island is bordered to the south by Mason Inlet and Wrightsville Beach; and to the north by Rich Inlet and Hutaff Island, an undeveloped, privately-owned island.

As a small residential community, the Figure Eight Island has limited land use compatibility problems when compared with larger urban municipal areas. The amount of commercial activity in community is extremely limited. There are no large manufacturing, industrial or mining type operations in community.

Infrastructure

World War II had a tremendous impact on the migration of immigrants to the United States in the mid to late 1900's. North Carolina began to notice the effects of this migration as evidenced by the steady increase in infrastructure and development in the 1970's (NCDCM, 2006b). This increase in population and development was most noticeable along the North Carolina coastline. The New Hanover County 2006 Land Use Plan found a high rate of increase in population growth within the county between 1940 and 2000 (NCDCM, 2006b). Figure Eight Island contains 463 homes providing primary and vacation residences for its owners.

A swing bridge, installed in 1980, provides access to the island via Bridge Road. Beach Road spans the entire length of the island providing access to homes, along with several side roads, to the north and the south. Residential homes utilize individual septic tanks to manage waste water; however there is a Type V onsite wastewater system that serves the yacht club, offices, pool and restaurant facility. This system is maintained and operated by a private management entity and is inspected by the New Hanover County Health Department on an annual basis (Timpy, 2011).

Storm water management on Figure Eight Island falls under the New Hanover County stormwater ordinance and the Sediment and Erosion Control Local Program. However, the majority of the impervious on the island predates the County ordinance that went into effect in September 2000. Therefore, the permitting for stormwater management is currently managed through NCDENR only.

Solid Waste

New Hanover County has no solid waste collection system, requiring County residents and businesses, including those on Figure Eight Island, to contract directly with private vendors for waste collection. The New Hanover County Department of Environmental Management oversees an integrated solid waste disposal system. Through waste-to-energy, recycling and lined landfilling techniques, the resulting system minimizes the use of land resources for burying waste, and minimizes the potential risks for contaminating the area's groundwater. The County's present solid waste management system is a direct result of long-term planning put in motion in 1981. The resulting system accomplishes the primary goals set in 1981, which were to minimize our reliance on landfilling as a means of managing solid wastes, and to minimize the potential impacts of managing solid wastes on the area's coastal environment. With proactive planning and maintenance, the community has a solid waste system that can provide environmentally sound disposal well into the future.

Since 1990, the use of recycling has increased as a solid waste management tool. In 1990, the City of Wilmington instituted a curbside recycling program, with the Town of Wrightsville Beach, Town of Carolina Beach and the County starting drop-off collection programs. The Town of Carolina Beach began collecting recyclables at the curb in 1992, with the Town of Kure Beach beginning its drop-off program the same year. The Town of Kure Beach began curbside recycling in 1997. A cardboard recovery operation was put in place in 1997 that nearly doubled the amount of material recycled through the County's operations. In 2004, the County's landfill received 207,000 tons of waste. In the same time period over 10,000 tons of materials came to the facility to be recycled. Figure Eight Island residences utilize drop-off collection facilities to manage recyclable goods.

Drinking Water

The New Hanover County Water and Sewer District operates a public water system in the Unincorporated County. All of the County systems depend on groundwater for potable water and are withdrawn from the Pee Dee aquifer, the Castle Hayne aquifer and the surficial aquifer. The existing County well system consists of 27 small, developer built systems that have been acquired by the County over the last decade. Three of the 27 wells have been abandoned, while 24 wells are active. In 2004, the County had an average day water demand of 2.35 mgd. This average day demand does not include Porters Neck and Figure Eight Island.

Drinking water on Figure Eight Island is provided from public water supply wells administered by Figure Eight Utilities. This supply is also maintained and operated by a third party who submits sample results to the Public Water Supply Section of the Division of Water Resources (Timpy, 2011).

Select North Carolina Primary Surface Water Classifications

HQW: Rated excellent based on biological and physical/chemical characteristics.

SA: Tidal salt waters that are used for commercial shellfishing or marketing purposes and are also protected for all Class SC and Class SB uses.

SB: Tidal salt waters protected for all SC uses in addition to primary recreation such as swimming.

SC: All tidal salt waters protected for secondary recreation such as fishing, boating, and other activities involving minimal skin contact.

Noise Pollution

Since Figure Eight Island is a private primarily residential area, ambient levels of human-induced noise in the area are relatively low. Natural noise levels, such as wind and pounding surf, does vary and is sporadic. During storm events, decibel levels can increase.

Water Quality

Many of the waterways within and in proximity to the Permit Area are designated as either High Quality Waters (HQW) or Outstanding Resource Waters (ORW) by the North Carolina Division of Water Quality (NCDWQ). NCDWQ defines HQW as:

> *waters which are rated excellent based on biological and physical/chemical characteristics through Division monitoring or special studies, primary nursery areas designated by the Marine Fisheries*

> *Commission, and other functional nursery areas designated by the Marine Fisheries Commission*

ORW waterways are described by the NCDWQ as:

> *a subset of High Quality Waters. This supplemental classification is intended to protect unique and special waters having excellent water quality and being of exceptional state or national ecological or recreational significance. To qualify, waters must be rated Excellent by DWQ and have one of the following outstanding resource values:*
>
> - *Outstanding fish habitat and fisheries,*
> - *Unusually high level of waterbased recreation or potential for such kind of recreation,*
> - *Some special designation such as North Carolina Natural and Scenic River or National Wildlife Refuge,*
> - *Important component of state or national park or forest, or*
> - *Special ecological or scientific significance (rare or endangered species habitat, research or educational areas).*

Middle Sound, located north of the Hutaff Island complex, is designated as ORW along with Green Channel, Nixon Channel, Cedar Snag Creek, and Butler Creek. Portions of the AIWW (between the eastern mouth of Old Topsail Creek to the western mouth of Howe Creek) are designated as ORW as well. Futch Creek, located to the west of the Permit Area, is designated as HQW.

The North Carolina Department of Environmental and Natural Resources, Division of Marine Fisheries, Shellfish Sanitation Section is responsible for monitoring and classifying coastal waters as to their suitability for shellfish harvesting for human consumption. Recommendations are made to the Division of Marine Fisheries to close those waters that have the potential for causing illness and opening those that are assured of having clean, healthy shellfish. All shellfish growing areas are surveyed every three years to document all existing or potential pollution sources to assess the bacteriological quality of the water and to determine the hydrographic and meteorological factors that could affect water quality. Water samples are collected at least six times a year from each growing area and tested for fecal coliform bacteria, which are an indicator that human or animal wastes are present in the water. A number of waterways in close proximity to Figure Eight Island have been closed for shellfishing due to poor water quality. These include the waters surrounding Figure Eight Harbor, Figure Eight Island Marina, Mason's Landing Yacht Club, Scott's Hill Marina, and portions of Futch Creek (NCDENR Shellfish Sanitation, 2008) (Figures 4.31 and 4.32).

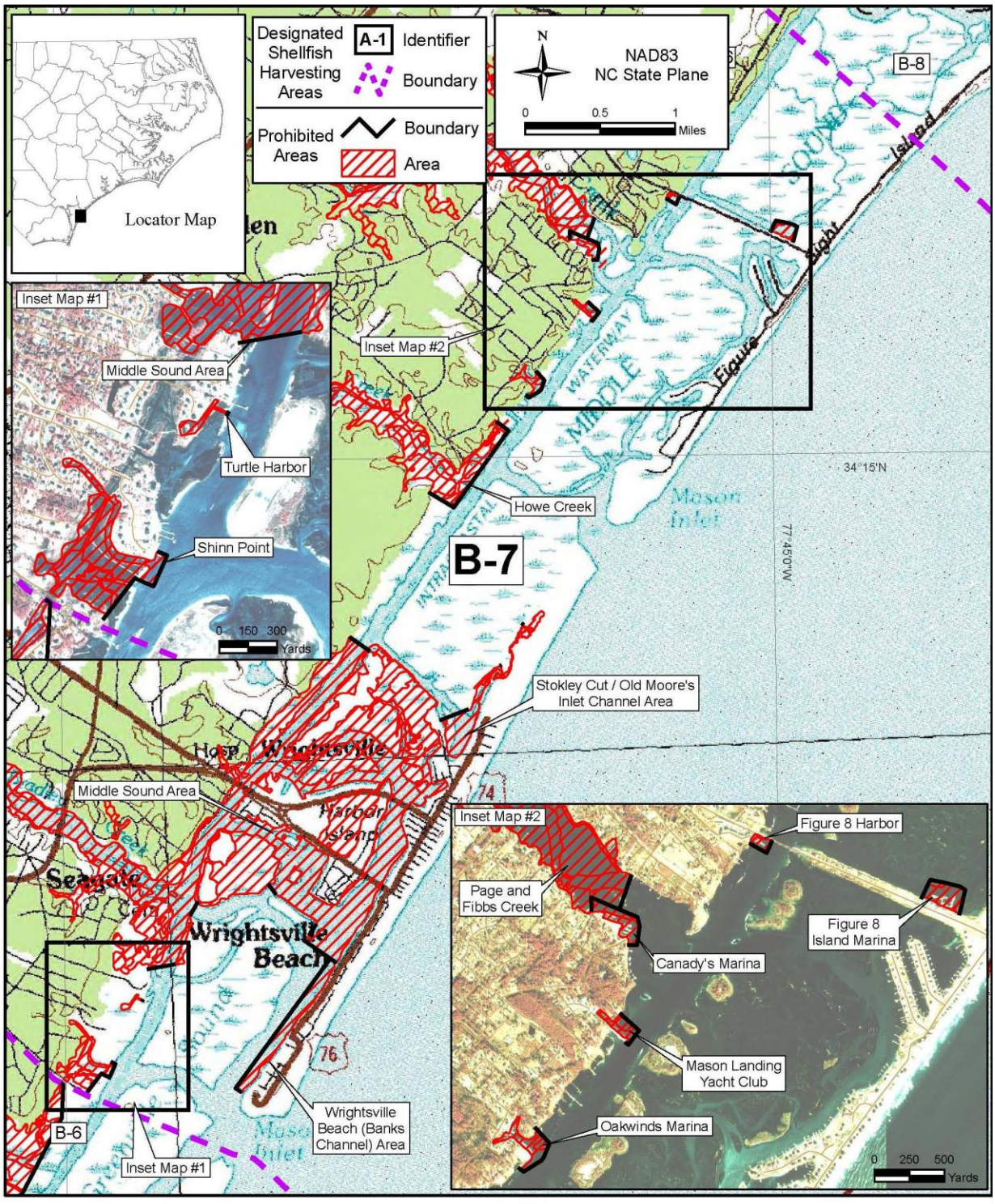


Figure 4.31 - NCDENR Shellfish Sanitation Map of Shellfish Closures in Proximity the Figure Eight Island Permit Area

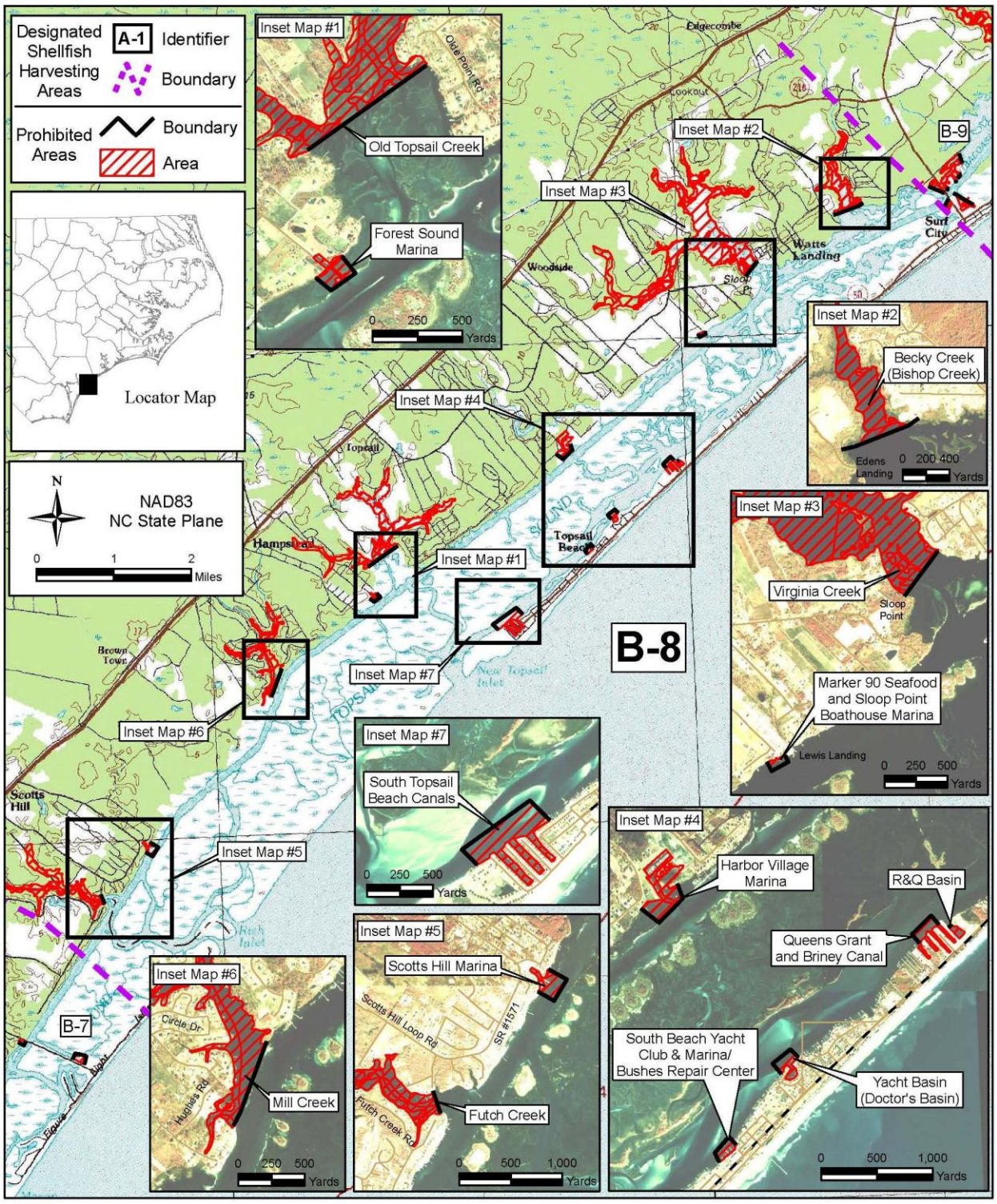


Figure 4.32 - NCDENR Shellfish Sanitation Map of Shellfish Closures in Proximity the Figure Eight Island Permit Area

CPE-NC performed preliminary water quality monitoring at 13 sites within the Permit Area on March 30 and 31 of 2007 (Figure 4.33). Physical parameters collected included depth, temperature, specific conductivity, dissolved oxygen, pH, and turbidity. All dissolved oxygen observations were above the State Standard of 5.0 mg/l with an average value of 8.2 mg/l.

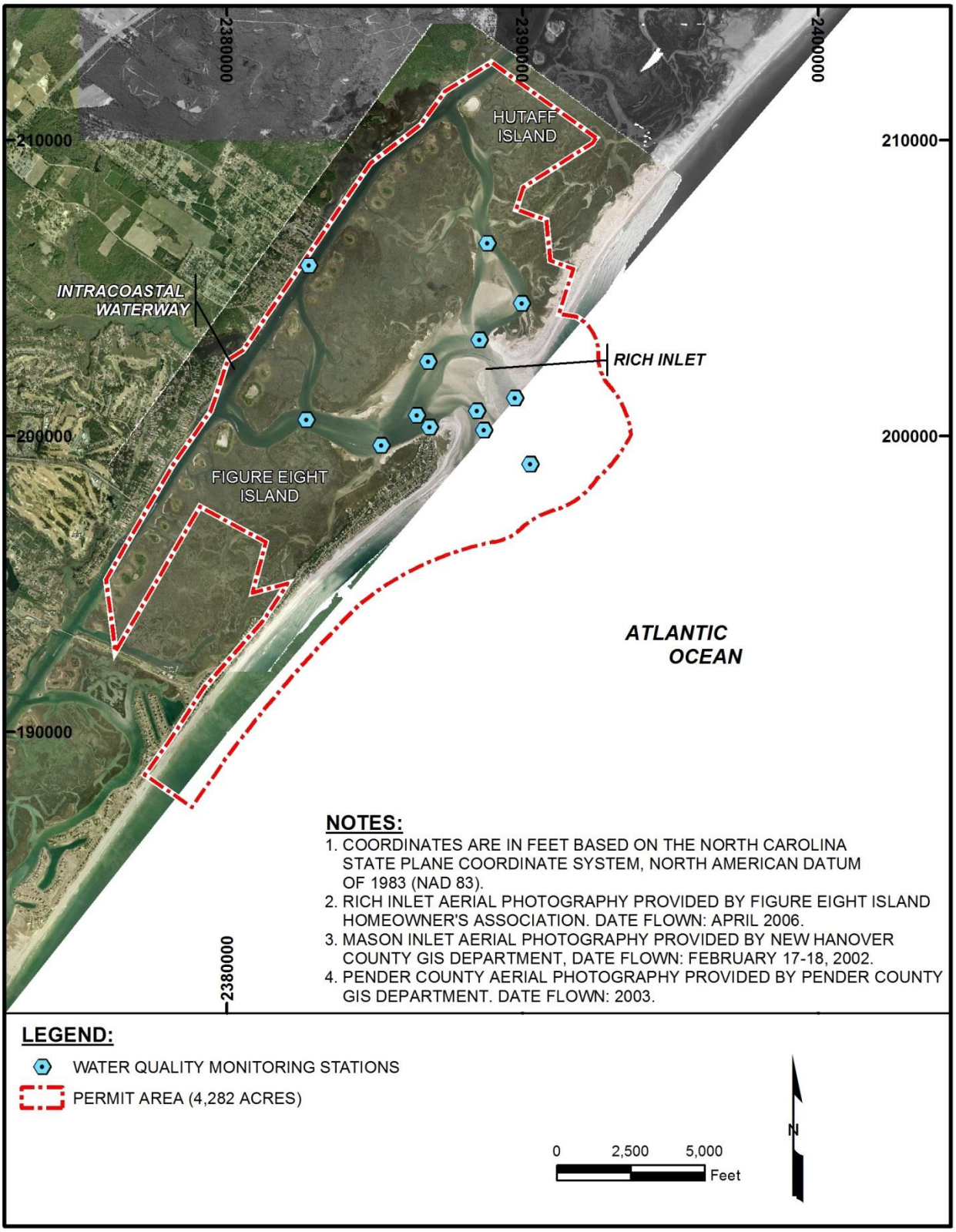


Figure 4.33. CPE-NC Water Quality Monitoring Sites

Until 2007, three RWQ sampling stations were located within the Permit Area. These stations included Station 50 (located in the AIWW between Mason's Creek and Pages Creek), 50A (located in Middle Sound at the south end of Figure Eight Island), and 50B (located in Nixon's Channel). These stations, designated as Tier 2, used for recreational purposes, were sampled on average three times per week. Tier 2-single sample maximum for *Enterococci* bacteria is 276 Colony Forming Units (CFU) per 100 ml water or a running monthly average (geometric mean) of 35 CFU per 100 ml water. In 2007, zero (0) samples from these stations contained *Enterococci* levels beyond the Federal standard. Currently, there are no active RQW sampling stations within the Permit Area.

Water quality monitoring has been conducted monthly within Futch Creek and Pages Creek by the University of North Carolina at Wilmington (UNCW) (between 1996 and 2006) and CPE-NC (in 2007 to present). Results have determined that these waterways often contain levels of *Enterococci* and fecal coliform bacteria above the State standards, particularly following a significant rain event. Subsequently, Futch Creek and Pages Creek have been listed on the 303(d) list for impaired waters. These tidal creeks flush into the AIWW in proximity to the Permit Area.

1. Turbidity and Total Suspended Solids (TSS)

Turbidity, expressed in Nephelometric Turbidity Units (NTU), quantitatively measures the light scattering properties of the water. However, the properties of the material suspended in the water column that create turbid conditions are not reflected when measuring turbidity. The two reported major sources of turbidity in coastal areas are very fine organic particulate matter, and sand sized sediments that are re-suspended around the seabed by local waves and currents (Dompe and Haynes, 1993). In Class SA waters, North Carolina State guidelines limit turbidity to values under 25 NTU above ambient levels outside turbidity mixing zones (NCDWQ, 2003).

Total Suspended Solids (TSS) are basically solids that are present anywhere in the water column. TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. Currently, there are no standards associated with TSS in North Carolina. Turbidity measurements were recorded by CPE-NC during preliminary water quality monitoring from 13 sites within the Permit Area in March of 2007. The average turbidity was 0.6 NTU, well below the State standard of 25 NTU.

2. Nutrients

Nutrients in the waters within the Permit Area are influenced from the inland tidal creeks, AIWW, and the marsh environment. Non-point source pollution including stormwater runoff provides a conduit for nutrients entering these waterbodies which can influence their levels. Nutrient data in the form of nitrate/nitrite and orthophosphate has been collected within Futch Creek and Pages Creek on a monthly basis since November 2007 by CPE-NC. Although a standard has not been developed for nutrients in North Carolina, the levels observed following eight months of sampling have been within typical ranges observed at other tidal creeks in New Hanover County which is approximately 0.01-0.03 mg/l for nitrate/nitrite and orthophosphate. Therefore these waters are not considered to be eutrophic.

Non-Relevant Resources

1. Hazardous, Toxic, and Radioactive Waste

There are no known hazardous, toxic, or radioactive wastes in the Permit Area that would be affected by a proposed project.

2. Energy Requirements and Energy Conservation

A proposed project within the Permit Area would not be expected to utilize an unusual amount of energy beyond typical construction needs.

3. Air Pollution

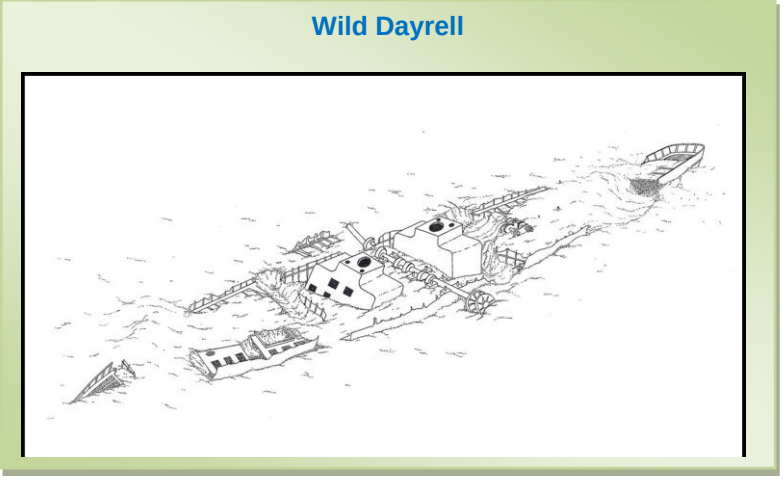
It is not expected that any activities associated with the proposed project alternatives would significantly contribute to air pollution within the Permit Area.

5. How would cultural resources be affected by the project?

Historical Properties and Cultural Resources

1. Rich Inlet Cultural Resources

CPE contracted Tidewater Atlantic Research, Inc. (TAR), of Washington, North Carolina to carry out a remote sensing survey to determine the exact position of the Civil War blockade-runner *Wild Dayrell* located in proximity to Rich Inlet. The remote sensing survey conducted by TAR was successful in identifying the remains of the *Wild Dayrell* and generating an accurate geographical position for the wreck site.



Refer to Appendix C- Submerged Cultural Resources Remote Sensing Survey for more information regarding the wreck of the *Wild Dayrell*.

An additional cultural resources survey in proximity to the proposed terminal groin will be conducted under a methodology approved by NCDCR as stated in an email dated 15 September 2009. This survey has not been conducted at this time, however, it has been suggested that a magnetometer survey of the upland and submerged area in proximity to Rich Inlet. This survey is expected to be conducted prior to the construction of this proposed project.