beds are found is described by NCDMF as primarily consisting of unconsolidated sand bottom, with variable shell content.

The closest SAV is located 0 feet from the Permit Area perimeter found east of the Coast Guard Channel.

4.4 THREATENED AND ENDANGERED SPECIES

This following section describes in detail, the Federal Threatened and Endangered species found in the Permit Area.

4.4.1 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-artic seas around the world. Several studies have shown that the beaches, inshore, and offshore waters along the Atlantic Coast of the United States are important foraging and developmental habitats for many of the threatened and endangered species of sea turtles (Shoop et al., 1992; Ehrhart, 1983; Keinath et al., 1987).

The warm, shallow waters of North Carolina serve as an important breeding, feeding, and developmental areas for five species of sea turtles; 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). Sea turtles can be found in offshore as well as inshore waters at all times of the year, although they are more common in the spring, summer and fall months (Epperly et al. 1995). Species compositions of turtles captured by fisherman in inshore waters consisted of loggerheads (71%), greens (17%), and Kemp's Ridley (12%) (Epperly et al., 1995). Public sightings reported all five species in inshore waters with leatherbacks and hawksbills being observed infrequently (Epperly et al., 1995). 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 waters occurred during the later part of fall when the waters began to cool. Although the exact numbers and frequencies of species inhabiting the inshore and off shore 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.

Although sea turtles spend most of their lives in the ocean, female turtles must return to land to nest. Therefore, beaches provide an important habitat in sea turtle reproduction and survival. Female sea turtles show nest site fidelity by returning to the nesting beach where they hatched. Females

prefer dark beaches with open-water access. Other factors such as elevation from water inundation, dune vegetation, beach slope and the moisture and compaction of the sand may influence site selection (Ripple, 1996). 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.

North Carolina is towards the northern limit for loggerhead sea turtle nesting along the east coast of the United States and the beaches of North Carolina are common nesting sites. In addition to loggerheads, green sea turtles and leatherbacks regularly reproduce on North Carolina beaches, although in much smaller numbers. More infrequently, Kemp's Ridley sea turtles nest along North Carolina's beaches (NCWRC, 1998). For loggerhead sea turtles, the nesting season in North Carolina occurs between the months of May and August. Green sea turtle nesting season occurs from June through September. Although it is infrequent, leatherbacks sea turtles have been known to nest on North Carolina's beaches as early as February or March.

Volunteer participants in the N.C. Wildlife Resource Commission (NCWRC) Sea Turtle Project have been monitoring sea turtle reproductive activity in Bogue Banks for more than 15 years. Because of an extensive multiyear nourishment project scheduled for Bogue Banks beginning in 2002, a formal research project was set up by the NCWRC, starting in May 2002. This project is designed to assess the potential impacts of nourishment activities on sea turtle reproductive success along the beaches of Bogue Banks in Carteret County. The monitoring includes eighteen miles of beach between the Fort Macon/Atlantic Beach town boundary to Bogue Inlet. Sea turtle monitoring includes the recording of nesting and non-nesting emergences using GPS coordinates, the marking and protection of nests, observations regarding nesting success and nest fate, recording of nest incubation temperatures and general sand temperatures and occurrences of live-stranded or dead hatchling sea turtles along the beach, as well as, the presence of escarpments and sand compaction along nourished and unnourished sections of beach. Monitoring will continue, on a seasonal basis between May first and November fifteenth, for six years after the initial sediment disposal during the winter of years 2001 and 2002. Sand temperature and compaction is measured year round, also strandings are monitored year round.

Loggerhead Sea Turtles

Loggerhead sea turtles (*Caretta caretta*) are large reddish-brown turtles weighing between 91-159 kilograms (200-350 lbs.) (Pritchard, 1997). Loggerhead sea turtles are widely distributed throughout their oceanic habitats. In the North Atlantic, hatchling loggerheads migrate offshore into circular oceanic current systems or gyres and are often associated with drifting masses of sargassum macroalgae until they have grown to be much larger juveniles (Carr, 1967; Fletemeyer, 1978). Loggerhead sea turtles will remain within the gyre for several years before leaving their pelagic habitats to return to their coastal feeding and nesting habitats (Klinger et al., 1995; Bolten et al., 1998). Recruitment into coastal habitats occurs when their carapace length (upper portion of the shell) is between 25 and 70 cm (9.8 and 27.5 inches) (Lutcavage et al., 1985; Bolten et al., 1993). Loggerheads primarily feed on crustaceans, mollusks, horseshoe crabs and fish found in coral reefs and other rocky nearshore environments during their juvenile stage.

Loggerhead sea turtle nest numbers collected for Bogue Banks from 1990 to 2001 (Godfrey, pers. comm.) are presented in Table 4 - Loggerhead Sea Turtle Nesting History on Bogue Banks. Nest numbers from 1990 to 2001 for Hammocks Beach State Park are presented in Table 5 - Loggerhead Sea Turtle Nesting History on Hammocks Beach State Park. During the 2000 monitoring year event, two green sea turtles were reported nesting on Bogue Banks. A total of thirty-two loggerhead sea turtles were reported nesting on both Bogue Banks and Hammocks Beach that same year (Godfrey, pers. comm., Jan. 14, 2003). The locations of both loggerhead and green sea turtle nests recorded on Bogue Banks and Hammocks Beach State Park in 2000 are presented in Appendix C – Emerald Isle, North Carolina 2000 Sea Turtle Nesting map. Twelve (12) locations of loggerhead nests were excluded from the map since their GPS coordinates placed them offshore, too far inshore or outside the project area.

Table 4
Loggerhead Sea Turtle Nesting History on Bogue Banks (1990-2001)

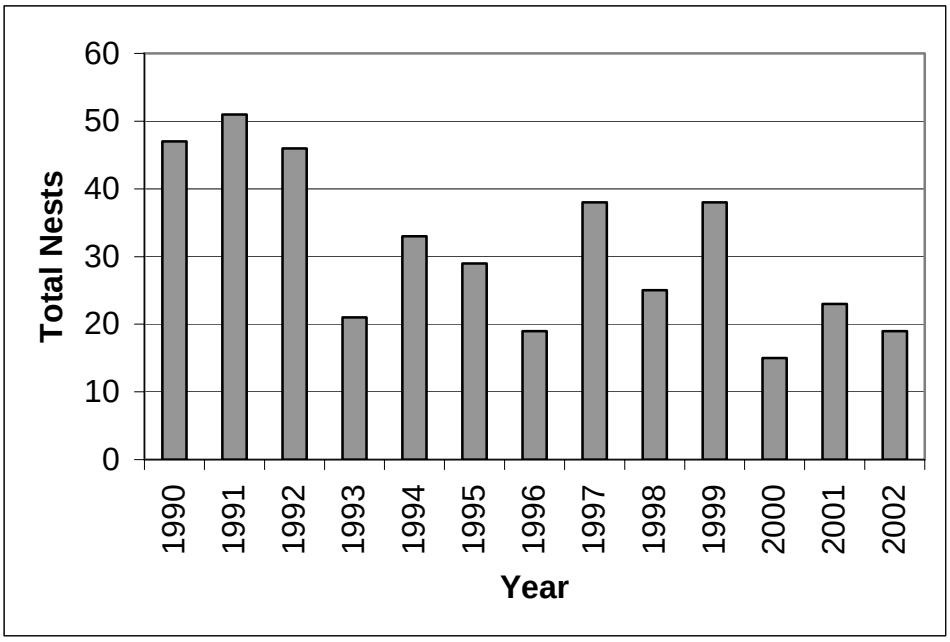
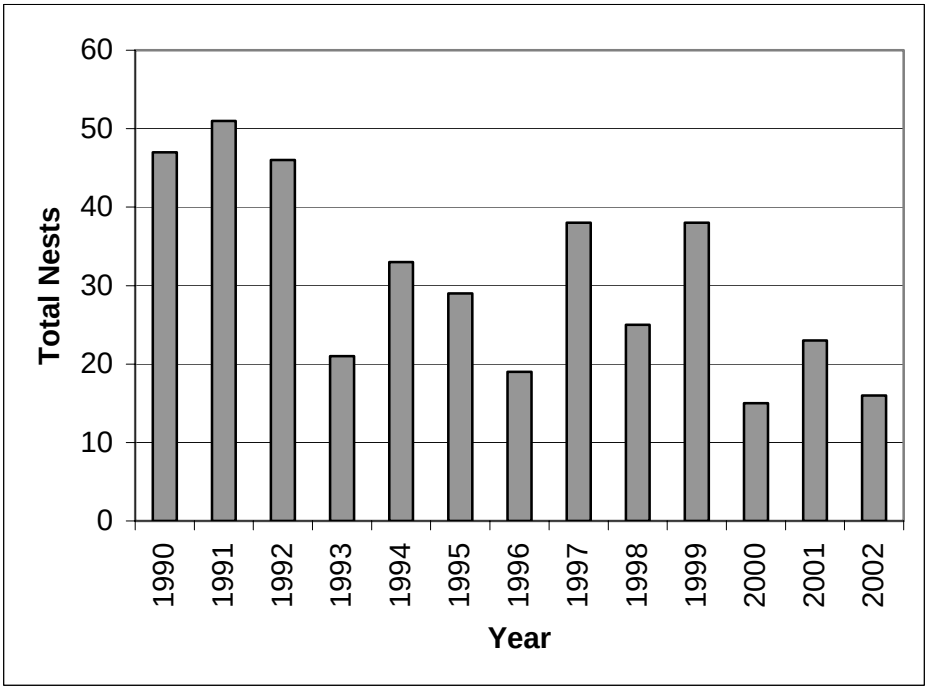


Table 5
Loggerhead Sea Turtle Nesting History on Hammocks Beach State Park (1990-2001)



During the sea turtle nesting season in 2001 a total of thirty (30) loggerhead sea turtles were reported nesting on both Bogue Banks and Hammocks Beach State Park. No green sea turtles nests were recorded nesting in either location that year (Godfrey, pers. comm., Jan. 14, 2003). The locations of the loggerhead nests along Bogue Banks and Hammocks Beach State Park in 2001 are presented in Appendix C – Emerald Isle, North Carolina 2001 Sea Turtle Nesting. Eleven (11) loggerhead nests were excluded from the map due to placement of coordinates. Seven (7) of the nests could not be plotted based on the information provided. The other four loggerhead nests were removed because their GPS coordinates placed them offshore, too far inland or outside of the project area.

During the 2002 nesting season, thirty-five (35) nests were identified by the NCWRC along Bogue Banks and Hammocks Beach State Park. Loggerhead sea turtles laid five nests in Pine Knoll Shores, one in Indian Beach, and thirteen in Emerald Isle (Godfrey, pers. Comm., April 28, 2003). No green sea turtle nests were recorded in 2002. Emerald Isle, North Carolina 2002 Sea Turtle Nesting map in Appendix C shows the location of loggerhead nests along Bogue Banks and Hammocks Beach State Park in 2002. Two loggerhead nests were excluded from the map since their coordinates placed them outside of the project area.

Strandings of dead sea turtles also provide information about which species inhabit or frequent the waters in and around an area. During 2002, twenty-five sea turtle strandings were recorded on Bogue Banks: twelve dead and two live loggerheads; two dead and one live green sea turtle; one dead and one live Kemp's Ridley; three dead leatherbacks; and three unknown species (NCWRC, 2003).

Green Sea Turtles

Green sea turtles (*Chelonia mydas*) are midsize to large size turtles that reach an average size of 136.2 kilograms (303 lbs) (Pritchard, 1997). They are found in warm tropical and temperate waters. Green turtles, like most other sea turtles, migrate offshore as hatchlings and spend several years feeding and growing in oceanic current systems. During this time, they feed primarily on mollusks, crustaceans, sponges, and jellyfish. In the North Atlantic, green sea turtles leave their pelagic habitats and enter coastal feeding grounds when they have reached a carapace length of 30 to 40 cm (11.8 to 15.8 inches) (Lutcavage et al, 1985). Once green sea turtles enter their neritic developmental habitats they prefer shallow waters near reefs, sounds, bays, and inlets where they feed on algae and seagrasses. Coral reefs and rocky patches may also be used for shelter and feeding when seagrass is not available (Hirth, 1997).

Hawksbill Sea Turtles

The Hawksbill (*Eretmochelys imbricata*) is relatively small sea turtle, weighing 40-60 kilograms (89-133 lbs) (Pritchard, 1997). They are found along the eastern Atlantic coastline but are not common in North or South Carolina. 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 inches] carapace length) (Lutcavage et al., 1985) and prefer the clear shallow waters of coral reefs, creeks, estuaries and lagoons in tropical areas. The hawksbill feeds close to shore on sponges, algae, fish, mollusks, and other bottom dwellers. Juveniles are not often seen in waters deeper than 19.8 meters (65 feet) (Witzell, 1983).

Kemp's Ridley Sea Turtles

Kemp's Ridley (*Lepidochelys kempii*) are small turtles averaging 35-45 kilograms (78-100 lbs) (Marquez, 1994). They are common in the Gulf of Mexico; however, they have been sighted in shallow coastal waters along the east coast of the United States and infrequently nest on the beaches of North Carolina. Recruitment from pelagic habitats occurs at a carapace size between 20 and 25 cm (Lutcavage et al., 1985). 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.

Leatherback Sea Turtles

The leatherback (*Dermochelys coriacea*) is the largest of the sea turtles, the adults weigh on average nearly 450 kilograms (1000 lbs) (Pritchard, 1997). Hatchlings migrate offshore and remain pelagic throughout their lives. Leatherbacks are commonly seen migrating through coastal waters of North Carolina in the spring months, particularly May and June (Grant et al., 1996). They occasionally enter shallow bays and estuaries in North Carolina (Epperly et al. 1995). Leatherbacks have been found to prey upon jellyfish, squid, shrimp, and other types of fish.

4.4.2 Mammals

The northern right whale is considered the world's most endangered large whale, with a total population of only around 325 individuals. Right whales may be found in ocean waters near Bogue Inlet during the winter months as they have calving grounds in waters along the coast of Georgia. The southeastern United States (Charleston, SC to east coast of Florida) is considered critical habitat for the right whale because of these calving grounds (NMFS, 1991). The calving grounds are typically populated by adult females before, during and after calving from September through April, with an observed peak in January (NMFS, 1991b). 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). Migrations south to wintering areas of other northern right whales occur as well and may include areas south of Cape Hatteras and begin as early as October (NMFS, 1991).

The following section reviews and describes the threatened and endangered whales and manatee found within the vicinity of the Permit Area.

Humpback and Right Whales

Humpback whales (*Megaptera novaeangliae*) are found in protected waters over shallow bars and shelf waters 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 are known to visit the North Carolina coast during the season migration, especially between the months of December and April (Conant, 1993). Migrating humpbacks can be found nearshore (North Carolina Aquariums, 1997) but probably migrate will offshore of the project area to their principal winter range (NMFS, 1991).

The northern right whale is considered the world's most endangered large whale, with a total population of only around 325 individuals. Right whales may be found in ocean waters near Bogue Inlet during the winter months as they have calving grounds in waters along the coast of Georgia. 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, 1991). 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). Migrations south to wintering areas of other northern right whales occur as well and many include areas south of Cape Hatteras and begin as early as October (NMFS, 1991).

West Indian Manatee

The West Indian manatee (*Trichechus manatus*) may be found from Bogue Inlet to the upstream estuarine, brackish, and freshwater environments of the White Oak River. The West Indian manatee a federally-endangered species, may be found from the saltwater inlet to upstream estuarine and freshwater environments of the White Oak River from June to October (Schwartz, 1995). They can be found in waters as shallow as 5 feet to as deep as 20 feet (USFWS, 2002). The warmer water temperature during summer months permits the migration of manatees north into the inshore waters of North Carolina. Manatees are seasonal inhabitants of North Carolina and have been sighted in the Atlantic Intracoastal Waterway north of State Highway 101 in July 2000, along the Beaufort waterfront and near

Calico Creek in August 1999, near Hammocks Beach State Park in June 1998, near Sportsman Pier in Atlantic Beach in August 1994, near the US Coast Guard Station at Fort Macon in August 1994, in Barden Inlet in November 1992, in Peletier Creek in October 1990 and near the western end of Shackleford Banks in August 1983 (USFWS, 2002).

Manatees have been recorded in North Carolina waters nine months of the year, but are most likely to occur from June through October (Schwartz, 1995). Manatees prefer warm water (temperatures above 23.9ºC [75ºF]), have not been observed, and are not expected to be found in North Carolina waters during the winter months. Manatees can be found in waters as shallow as five feet to as deep as 20 feet (USFWS, 2003).

4.4.3 Birds

Piping Plover

The piping plover is listed as threatened (*Charadrius melodus*) under the Federal Endangered Species Act. The piping plover is known to be present year round for nesting, overwintering and migrating along the coast of North Carolina. The region is extremely important to piping plovers for wintering and very important for breeding and migration. Furthermore, piping plover habitat is listed as critical and requires protection under Federal regulations.

Plovers have been documented arriving at their breeding grounds from late March to April. By early September, both adults and young may depart for other wintering areas. These birds prefer coastal environments during the winter, especially areas with expansive sand or mudflats (for feeding) close to a sandy beach (for roosting).

Preliminary review of the baseline bird monitoring data collected to date (April 2003 to September 2003) indicates piping plover to be present in the Permit Area during the months of April, May, and August. A more detailed assessment of the baseline bird monitoring data will be made available in the Draft EIS submittal.

Critical Habitat for Wintering Piping Plover

According to the Endangered Species Act of 1973, piping plover are considered a threatened species when on their wintering grounds. In addition, the primary constituent elements within piping plover wintering grounds, that include components that support foraging, sheltering, roosting, or have the capacity to develop those components, are considered critical habitat. As a result, the USFWS, under a Federal Register (50 CFR Part 17), designated the wintering grounds of piping plovers as Critical Habitat for the species. On July 10, 2002, 137 areas along the coasts of North Carolina,

South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas were designated at critical habitat for wintering piping plover. Critical habitat designations recognize specific areas "that are essential to the conservation of a listed species, and that may require species management considerations or protection" (USFWS, 2001).

The areas that contain the primary constituent elements are found in geologically dynamic coastal areas such as migrating inlet that can support or have the potential to support intertidal beaches, mud flats, sand flats above the annual high tide line, and associated dune systems. The essential components of intertidal flats, sand, and/or mud flats utilized for feeding with no or very sparse emergent vegetation located near a sandy beach that can be used for roosting, have been identified as preferred wintering areas (USFWS, 2003).

Intertidal sand and/or mud flats are naturally characteristic of Bogue Inlet. The designated areas of Critical Habitat for Wintering Piping Plover incorporates these intertidal flats in Conservation Unit NC-10 of the Federal Register (50 CFR Part 17). The unit is described as the "contiguous land south, west, and north of Bogue Court to the MLLW line of Bogue Inlet on the western end of Bogue Banks. It includes the sandy shoals north and adjacent to Bogue Banks and the land on Atlantic Ocean side to MLLW. This unit also extends 1.3 km (0.8 mi) west from MLLW of Bogue Inlet on the eastern portion of Bear Island." The MLLW designation refers to the mean low lower water line. The areas of Bogue Inlet designated as Critical Habitat for Wintering Piping Plover, total 356 acres and thus, provide habitat components utilized by piping plovers for primary biological needs.

Roseate Tern

The roseate tern (*Sterna dougallii)* is listed as an endangered species under the Endangered Species Act (USFWS, 2003). Roseate terns have been observed along the coast of Carteret County for more than 20 years. They have been found to breed primarily on small offshore islands, rocks, cays, and islets. Nesting generally occurs near vegetation or jagged rock, on open sandy beaches, close to the waterline on narrow ledges of emerging rocks, or among coral rubble (USFWS, 2003). This species has been found south of Cape Hatteras, particularly at Cape Point within the Cape Hatteras National Seashore, during the months of July and August. The roseate tern has not been documented in the vicinity of Bogue Inlet.

4.4.4 Seabeach Amaranth

Seabeach amaranth (*Amaranthus pumilus*) is an annual herb that can be found on barrier island beaches, lower foredunes and overwash flats. Seabeach amaranth is most typically found along sparsely vegetated sand

beaches and is tolerable of salt spray, poor soil and low freshwater input. Small populations can occasionally develop along sound-side beaches, blowouts in foredunes, as well as renourished beaches containing sand and shell material or dredge spoil (USFWS, 1993). The plant is typically found at elevations from 0.2 to 1.5 m (0.6 to 4.9 ft) above mean high tide (Weakly and Bucher, 1992).

Seabeach amaranth (*Amaranthus pumulis*) grows annually in low clumps comprised of sprawling, fleshy, reddish branches with dark leaves, resembling spinach leaves. The seabeach amaranth plant is profusely branching and generally grows to 1 meter (39 inches) in diameter. Flowering begins when plants have reached the appropriate size, and can begin as early as June, but more typically commences in July. The flowering period usually ends in late fall and seed production begins in July or August, reaching its peak in September and continuing until the plant dies back in the winter (USFWS, 2003). Flowers and fruits are inconspicuous, and develop in clusters along the stems.

Seabeach amaranth is listed as threatened by both the USFWS and the North Carolina Department of Agriculture and Consumer Services. The historic range of seabeach amaranth included 31 counties in nine different coastal states from Massachusetts to South Carolina. The latest reports indicate that seabeach amaranth can be found in only one-third of its historic range. (USFWS, 1993) There are 55 known plant populations, of which 34 are in North Carolina and the remaining plant populations outside of North Carolina are small. North Carolina is considered to be the only state to have large populations of seabeach amaranth and although the North Carolina populations reached historic lows in 2000 (Jolls, et al., 2003), the Endangered Species Bulletin (Randall, 2002) reported that the numbers of *A. pumilus* are increasing.

The 2002 survey of seabeach amaranth on Bear Island (from Bogue Inlet to Bear Inlet), conducted by Hammocks Beach State Park personnel (McElhone, 2002), found 50 plants grouped on the eastern end of Bear Island. Most of the plants were of medium size, with only two showing signs of grazing from resident animals. The 2002 survey stated that the island is showing signs of "significant dune accumulation" (since hurricane activity from 1996 through 1999), which is providing additional habitat for seabeach amaranth.

Annual field surveys of seabeach amaranth were conducted by Coastal Science & Engineering, PLLC along Emerald Isle beach from 2000 to 2003. These surveys, conducted under the permitted Bogue Banks Beach Nourishment Project, includes both baseline and post-construction data for the dry beach and include the towns of Atlantic Beach, Pine Knoll Shores,

Indian Beach, Salter Path, and Emerald Isle. Overall, the number of plants specific to Emerald Isle have shown a significant increase in plant population from the 2000 survey (four plants), 2002 survey (175 plants), to 2003 survey (530 plants).

4.5 MARINE RESOURCES

4.5.1 Inlet Resources

This section identifies the resources of the Bogue Inlet complex and the species that utilize this habitat. For the purpose of this assessment, the inlet complex is bounded on the north by the southern extent of Dudley Island; to the east by Bogue Banks; and to the west by Bear Island.

Benthic Infaunal Community

Macroinvertebrates and infaunal species of the benthic community are primary food sources for several migratory and resident shorebird and waterbird species, as well as for many commercially and recreationally important fish. The sub-, inter-, and supra-tidal habitats of Bogue Inlet and other coastal regions of North Carolina are a major source of food for several migratory bird species. 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 utilize the benthic community of the inlets as a food reserve, en route to upstream seagrass beds and estuarine habitats. Benthic macroinvertebrates are sensitive to changes in water quality and, therefore, are useful indicators of a wide range of environmental disturbances.

Macroinvertebrates indicative of a healthy benthic community can depend on variable particle sizes and available interstitial pore space in the substrate. The type of benthic taxa found dominating the bays and sounds of North Carolina include bivalves, polychaetes, and amphipods. The wet beaches of Bogue Banks are mostly dominated by polychaetes worms, coquina clams (*Donax variables*) and mole crabs (*Emerita talpoida*) (USFWS, 2002).

Seasonal climatic changes can influence the diversity and abundance of macroinvertebrate and infaunal species in these areas. Species abundance during the late winter and early spring is typically higher with densities of over 3,500 per 100 cm^2 (15.5 $inches^2$) commonly observed (Mallin et al., 2000). During the mid-to-late summer, species abundance has been found to decline, especially in deeper waters. The decline in species during the mid-to-late summer may be attributed to an increase in predatory fish and birds during this season.

Macroinvertebrates are commonly used for biomonitoring of aquatic habitats because of their limited mobility that makes them a good indicator of localized environmental conditions. Typically, a number of species in a benthic community can provide insight into the types of environmental stressors affecting an area.

Most benthic species are found in the upper 1 meter (3.28 feet) of the seabed due to the available oxygen content and aeration properties, although some larger species may live deeper in the seabed (USFWS, 2002). The macroinvertebrate and infaunal sampling plan developed for the project includes the collection and analysis of species in intertidal habitats of the Permit Area.

Baseline monitoring of macroinvertebrate and infaunal species in the intertidal and salt marsh locations began April 2003. Macroinvertebrate and infaunal sampling in the intertidal areas of the inlet and salt marsh system are being conducted on a seasonal basis during the months of April, July, October, and January. Benthic community sampling will be conducted on a seasonal basis during the months of April, July, October, and January during the pre-construction period. Monitoring of macroinvertebrate and infaunal species in the existing and proposed channels and salt marsh locations began in April 2003 and will continue through January 2004, and for a period of three years after project construction.

The baseline monitoring program includes seasonal sampling of benthic taxa at ten sampling stations in the Permit Area. Six sampling stations are located along the existing channel (Stations 1-3) and adjacent to the new channel alignment (Stations 4-6) to provide a representation of the species common to the project area. One sampling site (Station 7) is located in the intertidal habitat on the south side of Island No. 2, to be used as a reference site for the infaunal communities located along the existing and proposed channel alignment. Three additional infaunal stations are located in the salt marshes of Dudley Island, Hammocks Beach State Park and Bogue Sound. Refer to the Macroinvertebrate/Infaunal Monitoring Plan (Appendix 1 of the Final Draft Biological Assessment Figure [Appendix G]).

The station locations were chosen to reflect a representative sample of infaunal and macroinvertebrate species on the seaward side, bayside and center of the existing channel. Sampling parameters include coquina clams (*Donax variabilis*), mole crabs (*Emerita talpoida*), penaeid shrimp (*Penaeus* sp.) and amphipod and polychaete indicator species. Quantitative sampling stations for macroinvertebrate and infaunal species are collected between mean high water and mean low water elevations. Infaunal sampling at the three salt marsh stations will assist in characterizing shoal versus marsh

species. Sampling locations along the proposed channel are from the inner to the outer intertidal shoal areas. Due to the variable nature of the Bogue Inlet system, the horizontal position of the sampling stations may change slightly in response to erosion and accretion, however, the vertical location of each sample will remain the same (between 2.29 and –1.59 National Geodetic Vertical Datum) at each site.

The first sampling event, conducted in April 2003, showed a low species diversity in the samples collected along the east side of the main channel (Stations 1-3) and species diversity increased in the samples collected along the proposed inlet (Stations 4-6). The benthic community identified in the salt marsh locations show variations in species diversity. Table 6 below provides a list of the dominant infaunal species collected at each monitoring station.

Table 6
April 2003 Monitoring Event
Dominant Taxa

Station Location	Dominant Taxon	Number of Species	Percent of Total Sample
No. 1 Bogue NW	Amphipod (*Haustorius Canadensis*)	2	67%
No. 2 Bogue Central	Coquina clam (*Donax variabilis*)	4	50%
No. 3 Bogue SE	Polychaete (*Scolelepis squamata*)	2	89%
No. 4 Inlet NE	Amphipod (*Bathyporeia Parkeri*)	8	40%
No. 5 Inlet Central West	Amphipod (*Acanthohaustorius millsi*)	5	63%
No. 6 Inlet SW	Amphipod (*Parahaustorius longimerus*)	8	25%
No. 7 Island #2 (Reference Site)	Amphipod (*Acanthohaustorius millsi*)	8	25%
No. 8 Marsh (Bogue)	Polychaete (*Neanthes succinea*)	19	19%
No. 9 Marsh (Dudley)	Polychaete (*Neanthes succinea*)	3	63%
No. 10 Marsh (Bear)	Polychaete (*Capitella capitata*)	7	50%

Results from the July 2003 monitoring event also indicate a low species diversity along the existing channel while increasing in the number of taxa at the reference site and at Station no. 4. Dominant taxa collected during the July sampling event are listed in Table 7. See Appendix I for details.

Table 7
July 2003 Monitoring Event
Dominant Taxa

Station Location	Dominant Taxon	Number of Species	Percent of Total Sample
No. 1 Bogue NW	Decapoda (*Emerita talpoida*)/Amphipoda (*Neohaustorius schmitzi*)	29/29	46%/46%
No. 2 Bogue Central	Decapoda (*Emerita talpoida*)	54	78%
No. 3 Bogue SE	Decapoda (*Emerita talpoida*)	61	51%
No. 4 Inlet NE	Polychaeta (*Leitoscoloplos fragilis*)	11	58%
No. 5 Inlet Central West	Amphipod (*Scolelepis squamata*)	6	46%
No. 6 Inlet SW	Amphipod (*Parahaustorius longimeris*)	4	57%
No. 7 Island #2 (Reference Site)	Polychaete (*Magelona papillicornis*)	2	25%
No. 8 Marsh (Bogue)	Uca sp.	10	43%
No. 9 Marsh (Dudley)	No species found	0	N/A
No. 10 Marsh (Bear)	Uca sp./*Capitalla capitata*	1/1	50%/50%

See Appendix I for benthic community results from both April and July 2003 monitoring events. Samples have been collected for the October 2003 monitoring event, however these results are not yet available.

Shellfish

Shellfish are an important resource in Bogue Inlet. The structure that shellfish create, such as beds and reefs, is used by many species of fish and invertebrates. Oyster reefs and shellfish beds are designated as Essential Fish Habitat (EFH) by the South Atlantic Fishery Management Council (SAFMC). Shellfish also are food for various bird and invertebrate species, such as whelks (*Busycon* spp.) and blue crabs (*Callinectes sapidus*). The shellfish industry is a large economic industry for North Carolina coastal areas, as well. Three species of shellfish found in Bogue Inlet waters include eastern oysters (*Crassostrea virginicus*), hard clams (*Mercenaria mercenaria*), and bay scallops (*Argopecten irradians concentricus*). The NCDMF identifies two types of strata, strata W (intertidal hard, non-vegetated, with shell) and strata V (intertidal hard, vegetated without shell) in and around Bogue Inlet where the three species of shellfish can be found.

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 (NCDENR, 2001). It is known that hard clams are an estuarine dependent mollusk found primarily in sandy and vegetated bottoms and increased fishing, poor water quality, and habitat loss has impacted this fishery (NCDMF, 2003). The Essential Fish Habitat for the hard clam, as designated by the South Atlantic Fisheries Management Council (SAFMC), is subtidal and intertidal flats, oyster reefs and shell banks, and Submerged Aquatic Vegetation (SAV) (NCDENR, 2001). A state Fishery Management Plan was approved for the hard clam in August 2001.

Hard clams are suspension feeders that feed primarily on phytoplankton. They spawn from May through November, when water temperatures reach 20ºC (68°F). When hard clam larvae settle to the bottom, it uses its foot to dig into the substrate, and secretes a calcium carbonate shell. 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). The NCDMF Shellfish Mapping Program identified only 279 m^2 (3,003 ft^2) of Strata W in Bogue Inlet that may contain clams. Samples collected between December 1990 and November 1991 found 324 clams in Strata W of Bogue Inlet, which equaled a density of approximately 1.16 shellfish per square meter.

Oysters are long-lived (40 years) and are capable of forming large reefs. According to the North Carolina Division of Marine Fisheries (NCDMF), the eastern oyster (*Crassostrea virginica*) 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 the 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. In fact, *C. virginica* thrives in the most rigorous of habitats (Burrel, 1986). The preferred habitat for eastern oysters is from just below the mean low water level to about 1 m (3.28 ft) above mean low water (Burrel, 1986). The eastern oyster is a prolific bivalve, whose stocks have been depleted. A state Fishery Management Plan was adopted in August of 2001, in parallel with the Hard Clam Fishery Management Plan.

The NCDMF Shellfish Mapping Program has delineated two habitats where oysters may be found in Bogue Inlet. These two sites include the areas around and behind Dudley Island (Strata V) and areas in the upper reaches of Bogue Inlet (Strata W). From December 1990 through November 1991, samples were taken from a 50 m^2 (538 ft^2) study area of Strata V habitat and a 279 m^2 (3,003 ft^2) study area of Strata W in Bogue Inlet. Oysters collected from the 50 m^2 (538 ft^2) study area of Strata V totaled 1,203 individuals, or 24.06 shellfish per square meter. Oysters from the Strata W habitat totaled 21,106 individuals, or 75.65 oysters per square meter.

The NCDMF lists the Bay Scallop (*Argopecten irradians*) as a species of concern based on poor recruitment and low abundances. However, the NCDMF has not yet developed a fisheries management plan for the Bay Scallop. *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 the mature, scallops sink to the bottom and continue to grow (Fay et al., 1983). Adult scallops prefer calm waters, secluded from high winds, storms, and tides and depths of 0.3 to 10 m (98 to 32.8 ft). Environmental factors, such as temperature and rainfall, play a critical part in scallop abundance (NCDMF, 2003). They spawn between August and December when water temperatures are approximately 15.5°C (60°F). Bay scallops are filter feeders that feed on diatoms. In coarse sand substrates, shallow burrowing may be used during feeding. Soft mud and silt substrates are harmful to juvenile survival, only if the juveniles are not first attached directly to seagrass for a short period of growth before dropping to the bottom (Fay et al., 1983). Bay scallops are short-lived, living generally less than 26 months.

In the western areas of Bogue Sound, near Bogue Inlet, two areas were sampled from various years between 1984-2002 for bay scallops (NCDMF, 2003). In one area, near Dudley Island, scallop densities averaged 27.5 individuals per square meter from 1984-1989. Official monitoring of scallops in this area was not continued because of the severe effects of the 1987 red tide event and budget constraints within the NCDMF. The other study area in western Bogue Sound found 48.22 scallops per square meter, on average, from 1987 to 1990 and 1998 to 2002. According to NCDMF's Shellfish Mapping Program, only three scallops were found in 279 square meters of habitat of strata W (Intertidal hard non-vegetated shell strata) within the Bogue Inlet study area from 1990-1991 (NCDMF, 2003).

The 1987-1988 red tide that affected North Carolina closed 98 percent of the shellfish harvesting waters in North Carolina. Recruitment two years

after the red tide event was deemed a "virtual failure" (Summerson and Peterson, 1990), as only 2 percent of the pre-red tide event populations were documented.

Table 8 below summarizes the spawning events for the three shellfish species indicative of the project area.

Table 8
Spawning Events for Shellfish

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

Shellfish require optimal temperature, salinity, and water current to ensure proper development and survival. The eastern oyster is a more resistant shellfish than hard clams or bay scallops. Oysters can tolerate a wide variety of temperature, currents and salinities. As a general rule, eastern oysters require temperatures above 19.5ºC (66.2ºF) for egg development, above 20ºC (68ºF) for larval development, and 10 to 30ºC (50 to 86ºF) or higher for adult growth. Optimal salinities for egg development of *Crassostrea virginicus* are from 10 to 22 ppt; for larvae development, 5 to 39 ppt; and for growth, 25 to 29 ppt. Optimal environmental conditions for the bay scallop are temperatures that range from 26 to 28ºC (78.8 to 82.4ºF) for egg survival, and 20 or 25ºC (68 or 77ºF) for normal development, paired with salinities of 25 ppt (Fay et al., 1983). Growth of hard clam larvae is quickest at temperatures found between 22.5 and 36.5ºC (72.5 and 97.9ºF) with salinities of 21.5 to 30.0 ppt (Eversole, 1987). Research on growth of adult hard clams found that growth of adults was fastest at 20ºC (68ºF) and stopped below 9ºC (48.2ºF) and above 31ºC (87.8ºF). Salinities above 25 ppt significantly affect normal embryonic development while temperatures too low will not allow maturation and spawning (Eversole, 1987)

Baseline shellfish mapping of the W and V Stratum (Appendix C – Shellfish Areas) was conducted on September 11, 2003. Results of the field investigations conducted by CZR, Inc. with the assistance of NCDMF identified two W strata areas via GPS around Bogue Inlet. Current field verification of V stratum from the 2003 aerial photos is undergoing and will be provide in the next EIS submission. The northern and north western