

**Bogue Inlet Channel Erosion Response Project**  
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perimeter of the permit area is 0 feet away from the closest shellfish habitat Strata V.

Finfish

This section reviews several managed fish species found within the vicinity of Bogue Inlet. The following species were removed from the Essential Fish Habitat Assessment since these species are managed by other entities besides the National Marine Fisheries Service.

The following information describes North Carolina state-listed fish species found in the vicinity of the project.

Hickory shad (*Alosa mediocris*) is listed by the NCDMF with an unknown stock status. *A. mediocris* are anadromous fish that spend most of their life in oceanic waters, but return to fresh waters in the spring to spawn. (NCDMF, 2003)

Striped bass (*Morone saxatilis*) are listed as overfished by the NCDMF in the central and southern regions of North Carolina. A revised fisheries management plan (N.C. Estuarine Striped Bass Management Plan) is currently being developed for the *M. saxatilis* by the NCDMF. Striped bass are anadromous fish that spend a majority of their lifetime in estuarine waters, but migrate to freshwaters in the spring to spawn. (NCDMF, 2003)

Three species of Kingfish or sea mullet are found in North Carolina southern kingfish (*Menticirrhus americanus*), northern kingfish (*Menticirrhus saxatilis*), and (*Menticirrhus littoralis*) are listed with an unknown stock status by the NCDMF. The southern kingfish is listed as the most abundant of the three species, however all three species are somewhat short-lived. Kingfish are affected by seasonal fluctuations in the water temperatures, estuarine and nearshore waters in the warmer months moving to offshore deeper waters in the colder months. (NCDMF, 2003)

The southern flounder (*Paralichthys lethostigma*) is a species of concern to the state of North Carolina due to overfishing. Currently, a Fishery Management Plan for the southern flounder is being developed by the NCDMF and is scheduled for completion in July 2004. The southern flounder can be found over sand bottoms, mud bottoms in estuaries, and coastal waters to about 40 m (131 feet) in depth. Southern flounder are estuarine dependent flounder found in the same family as the summer flounder.

Southern flounder can tolerate wide variations in environmental conditions, such as salinity levels. *P. lethostigma* are frequently found in brackish bays

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and estuaries, marine waters, and occasionally freshwater. This species of flounder moves to offshore, deeper waters in the winter and early springs and inshore and north during late spring, summer, and fall. Spawning for the southern flounder is close to shore, over the continental shelf, from November through March. Unlike summer flounder, many adult southern flounder return to the estuaries of North Carolina after spawning. (NCDMF, 2002)

Striped mullet (*Mugil cephalus*) is listed as a species of concern in the 2003 NCDMF fish stock status report. The concern for the stock is primarily due to the economical value and year-round fishing. Spawning migration of the fish occurs during the fall season when the fish move from freshwater and/or estuarine environment to marine waters. Striped mullet have also been identified as a critical link between the lower and upper food chain, by feeding on microorganisms and microalgae while in turn fed on by birds, other fish, sharks, and porpoises. (NCDMF, 2003)

The following section describes fish species managed by the North Carolina Division of Marine Fisheries protected under the authority of the Atlantic States Marine Fisheries Commission (ASMFC).

The American shad (*Alosa sapidissima*) is listed as a species of concern by the NCDMF based on the fish's importance in commercial and recreational fisheries along the Atlantic coast. Since 1985, the American shad has been managed under the authority of the ASMFC. American shad are highly migratory, anadromous fish that spend the majority of their life in marine waters and return to fresh water to spawn. Juveniles utilize estuarine waters as nursery areas for their first growing season until a decrease in water temperatures triggers an emigration to the ocean. Juveniles remain in ocean waters until maturity then return to fresh water to spawn once they reach sexual maturity. Juveniles may also be found in brackish waters. Most shad returning to North Carolina waters are short-lived and usually die shortly after they have spawned.

The Atlantic croaker (*Micropogonias undulates*) is managed solely by the ASMFC and inhabits mainly mud and sand bottom areas, feeding on crustaceans, worms, mollusks, detritus, and small fishes. Mud and sand bottom habitats in estuaries are considered nursery and feeding grounds for the croaker. Atlantic croakers are the most abundant inshore bottom dwelling fish from Chesapeake south through the Gulf of Mexico (New Jersey Scuba Diver, 2003).

The Atlantic menhaden (*Brevoortia tyrannus*) are managed solely by the ASMFC and are listed as viable under the NCDMF stock status report.

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Atlantic menhaden are estuarine-dependent fish that serve as prey for many fish, sea birds, and marine mammals. Adults are found in near surface waters, usually in shallow areas overlying the continental shelf, but are in greatest abundance immediately adjacent to major estuaries (Fishbase, 2003). Adults and juveniles migrate in and out of bays and inlets. The menhaden fishery is one of the most important and productive fisheries on the Atlantic coast (ASMFC, 2003).

Atlantic menhaden migrate in the fall and early winter to North Carolina, around Cape Hatteras, to spawn. The majority of spawning occurs primarily offshore 32-48 km (20-30 miles) during the winter. However, migration patterns are related to spawning habits, and some spawning occurs every month of the year. Larvae are carried into inlet and estuarine nursery areas by ocean currents. Menhaden also migrate to the northern parts of their range, outside of the project area, in the spring and others even migrate to Florida waters in the winter.

The Atlantic sturgeon (*Acipenser oxyrinchus*) can be found in the intertidal flats and subtidal areas of Bogue Inlet. This species is managed by the ASMFC who considers this species as depleted along the Atlantic coast. The NCDMF listed *A. oxyrinchus* as an overfished species in their 2002 Stock Status assessment. The sturgeon is known to inhabit the northwest and central-west Atlantic Ocean, as well as Labrador, Newfoundland, Canada to northeastern Florida. This fish can be found in the intertidal flats and subtidal areas of Bogue Inlet, as well as the estuarine emergent wetlands in the project area.

Adult Atlantic sturgeon are typically found along the shallow waters of the continental shelf. This fish is also anadromous and requires the freshwater of an estuarine system to spawn. The timing of spawning is dependant on the water temperature. Spawning usually occurs when the water temperature ranges between 15° and 23°C (59° and 73°F) (Caron, 2001). Juveniles will remain in the estuaries and brackish waters until 3-5 years of age or up to 76-91.5 cm (30-36 in) in length (FishBase, 2003)

Spot (*Leiostomus xanthurus*) are managed under authority of the ASMFC and listed as viable in the 2002 NCDMF Stock Status assessment. Spot are estuarine dependant, but can also be found over sandy bottoms to 60 m (197 ft) along the western Atlantic coastline. *L. xanthurus* spawn in nursery and feeding grounds of estuaries in the summer and fall. Juvenile spot fish can remain in the estuaries throughout the entire year. (FishBase, 2003)

Spotted sea trout (*Cynoscion nebulosus*) utilize Habitat Areas of Particular Concern, and are listed as viable in the 2002 NCDMF Stock Status

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assessment. Its stock status is found to be heavily dependant on environmental conditions. The spotted sea trout can be found along the western Atlantic from New York to south Florida and in the Gulf of Mexico. *C. nebulosus* is estuarine dependant, but can also be found in the nearshore waters, subtidal areas, and seagrass beds of the project area. Juvenile spotted sea trout are typically found in seagrass beds, while adult species inhabit rivers, salt marshes, and coastal areas.

The NCDMF has managed the tautog (*Tautoga onitis*) under the authority of the ASMFC since 1996 and classified the North Carolina statewide population as overfished. Tautog prefer submerged hard-structure habitat, such as offshore and inshore wrecks, artificial reefs, rocky reefs, and pier areas. Juvenile tautogs rely primarily on shallow, estuarine, macroalgal areas and eelgrass beds as nursery habitat. During the spring, when water temperatures are close to 9°C (48°F), tautog migrate inshore to spawn in estuaries and nearshore marine waters. Tautogs remain inshore throughout the summer and move to offshore wintering areas in the fall when temperatures are below 11°C (52°F). Some adults will remain offshore throughout the year.

Weakfish (*Cynoscion regalis*) are solely managed within the state waters of the Atlantic by the NCDMF under the authority of the ASMFC. NCDMF listed this species as 'viable' in the 2002 Stock Status assessment since both spawning counts and age structure have increased and mortality rates are decreasing.

This fish can be found along the intertidal flats, creeks and river systems, shallow sand and mud bottoms, and in the salt marshes of the project area. *C. regalis* utilize the upper reaches of the estuaries (fish nursery areas) to feed and spawn during the summer months. Adult weakfish inhabit the shallow coastal waters of the western Atlantic from Nova Scotia to northern Florida.

Species managed under federal jurisdiction (i.e. NMFS, SAFMC, MAFMC) are discussed in detail in Appendix E - Final Draft Essential Fish Habitat Assessment.

Table 9 (end of Section 4) lists species identified by both Coastal Planning & Engineering and the National Marine Fisheries Service Table 9 includes the affiliated management council and/or commission; NCDMF Stock Status; expected life stage in the Bogue Inlet area; fish habitat associated with the species; and associated habitat that may be found in the Bogue Inlet area.

### Marine Mammals - Dolphins

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Little data is available to assess baseline conditions of marine mammals in Bogue Inlet. A study was conducted in July 2000 of Atlantic bottlenose dolphins (*Tursiops truncatus*) in the bays, sounds, and estuaries of North Carolina that documented bottlenose dolphins in higher numbers near the Intracoastal Waterway (Read et al., 2003). Read (2003) also estimated that there were approximately 1,033 bottlenose dolphins in the inshore waters of North Carolina during the July 2000 study period. It is not known if the dolphins documented during the study are residents or migrants through the area. Studies of dolphin populations during the winter months in inshore waters of North Carolina have not been conducted.

### Intertidal Flats and Shoals

The intertidal flats and shoals of North Carolina are habitat to a variety of migratory shorebirds, colonial waterbirds, marine mammals, and reptiles, anadromous, estuarine, and marine fish (USFWS, 2002). Refer to Table 9 for a list of fish species specific to this habitat. For this reason, these habitats are considered to be a valuable resource. The intertidal flats and shoals of Bogue Inlet area primarily composed of sand sized particles. These habitats have developed in a dynamic inlet system and therefore tend to be ephemeral in nature. The unstable nature of these habitats creates a dynamic relationship for the species that utilize these habitats.

Current baseline investigations include ground-truthing and aerial mapping of the Permit Area, which indicates that 970.66 acres of intertidal habitat and shoals are available.

### **4.5.2 Beach Resources**

This section identifies the communities found from the nearshore environments to the along the oceanfront shoreline found in the Permit Area.

### Supratidal Beach and Dune Communities

The CAMA handbook defines the primary dune as "the first mound of sand (measured from the ocean) that is six feet taller than the mean flood level for the area". Frontal dunes are defined by CAMA as "the first mounds of sand that have enough vegetation, height and continuity to offer protection". (NCDCM, 2003) Bogue Banks barrier island creates one of the highest dune ridges in North Carolina. The dune system can extend up to 4 to 5 m (13-16.4 ft) in elevation in western Emerald Isle. (USFWS, 2002). Dunes and the species that dunes comprise of are very important to North Carolina by providing stabilizing protection against coastal storms by absorbing the energy from storm waves and providing sand to the beach during periods of erosion.

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Perennial grasses are the primary stabilizers of frontal dune systems along the beach and dune communities of the Atlantic coasts, including the islands that surround Bogue Inlet. 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. These grasses inhabit the front of most dune systems along the Atlantic and can be seen along the dunes of Bogue Banks, Bear Island, and Dudley Island.

Based on the pre-construction mapping, conducted by CZR, Inc., of terrestrial fringing communities around Bogue Inlet, dune grass communities were found to occur primarily on well drained dune systems inland of the beach at Emerald Isle, and on older dune systems along Bear Island where vegetation cover ranges from sparse to fairly dense. Dune grass communities were mapped along Dudley Island with dominant species including sea oats (*Uniola paniculata*), saltmeadow cordgrass (*Spartina patens*), and other grasses. Soils of this community were mapped as Bohicket silty clay loam; identified as a very poorly drained soil. However, conditions indicate that the primary dunes of Dudley Island are an excessively drained soil. Dunes and the supratidal beach also provide shelter and food for a variety of animals and shorebirds as well as areas of recreation for people along the coast.

### Intertidal Beach

Intertidal flats are characterized of the Bogue Inlet environment. The main intertidal zones of Bogue Inlet can be found at the swash platform at the mouth of the inlet, the south side of Dudley Island, and on the western end of Bogue Sound. These areas are comprised mainly of sandy bottoms and are influenced by tidal changes. The intertidal zone is widely used by many benthic organisms, birds, and finfish as foraging grounds.

### Nearshore Soft Bottom Communities

The unvegetated, soft bottom nearshore intertidal and subtidal areas serve as important habitats for benthic organisms that live on or within the sediment. Soft bottom communities can support high species diversity. Bogue Inlet nearshore soft bottom communities are dominated by worms, mollusks, and crustaceans. These organisms provide food for wading birds and shorebirds. Nearshore soft bottom habitats are also serve as areas where migratory fish can travel into and out of the sounds.

The nearshore soft bottom habitats include the oceanfront shorelines of Emerald Isle and Bear Island.

### Offshore Soft Bottom (Consolidated sediment) Communities

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The Bogue Banks Final Environmental Assessment describes the sediment of the offshore community as "fine sand with low to moderate relief scattered among hard bottom". (USACE, 2001) However, based on the offshore surveys reported in the Environmental Assessment, no hardbottom communities were found within the area identified as the Project Impact Zone/Survey Area for the Bogue Inlet Channel Erosion Response Project.

Biological characteristics of these offshore communities included a low biomass, high diversity, with high seasonal variations. Samples collected from the offshore community in fall of 1999 by Coastal Science Associates, Inc. (CSA) identified polychaetes as the dominant phyla (>50% of total macrofauna) and mollusks, crustaceans, and echinoderms as common phylum. (USACE, 2001)

Offshore soft bottom communities are very important habitats for benthic organisms, which serve as an important source of food for fish and other animals.

### Benthic Infaunal Community

The wet beaches of Bogue Banks are mostly dominated by polychaete worms, coquina clams (*Donax variabilis*) and mole crabs (*Emerita talpoida*) (USFWS, Draft CA Report, 2002).

The type of benthic taxa found dominating the beaches of North Carolina include bivalves, polychaetes, and amphipods. The wet beaches of Bogue Banks are mostly dominated by polychaete worms, coquina clams (*Donax variabilis*) and mole crabs (*Emerita talpoida*) (USFWS, 2002).

Benthic species are an important link in the food chain. The sub-, inter-, and supra-tidal habitats of Bogue Inlet and other coastal regions of Bogue Inlet are a major source of food for several migratory and resident shorebird and waterbird species, as well as for many commercially and recreationally important fish. Migratory fish species utilize the benthic community of the inlets as a food reserve, en route to upstream seagrass beds and estuarine habitats. Impacts to macroinvertebrates and infaunal species and their habitat can have a detrimental affect on the food web.

Many benthic organisms are filter feeders, which pump large amount of water through their bodies. As they pump water through their bodies, they remove sediments and organic matter, thus, cleaning 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 remineralized by benthic organisms and dispersed back into the water column, making them available to other organisms. Thus, benthic organisms are critical in maintaining the

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high primary production rates of estuaries. Many benthic macroinvertebrates are sensitive to changes in water quality and, therefore, are also useful as indicators of a wide range of environmental disturbances.

### Finfish

A total of 89 fish species were from offshore coastal waters (including nearshore, surf zone and beach habitat); intertidal and shallow water environments; subtidal habitats (i.e., White Oak River); shellfish and seagrass habitats; bays and lagoon environments (including Bogue Sound); inshore sandy and/or muddy bottom habitats; and estuarine and salt marsh environments. Finfish are an important food source for local residents. Commercial fishing contributes to the economy of North Carolina and thus, is an important economical resource. Fish are also an important part of the diet of many other animals such as shore and water birds, turtles, whales, etc. In addition to a food resource, finfish are also a recreational resource.

## **4.6 TURTLE RESOURCES**

### **4.6.1 Diamondback Terrapin**

The Carolina diamondback terrapin (*Malaclemys terrapin centrata*) is commonly found within the inshore waters of North Carolina. The diamondback terrapin is a medium sized turtle measuring 120 to 160 mm (4.7 to 6.3 inches) in carapace length. This subspecies ranges from Cape Hatteras to northeastern Florida and has a wide tolerance for salt water (Robinson et al., 1975). They are the only North American turtles 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 throughout most of the year. Carolina diamondbacks are primarily carnivorous, feeding upon crabs, snails and nereid worms. During the winter months, Carolina diamondback terrapins hibernate in the muddy burrows along the embankments of tidal creeks. They remain buried until mid to late February when they emerge to mate (K. Hart, pers. comm.).

Carolina diamondback terrapins spend most of their lives in brackish water, however they too must return to land to nest. Diamondback terrapins hibernate in submerged mud throughout the winter and emerge from the mud in February and mate immediately (Davenport, 1992). 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 other 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 inches]) spend their

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time out of water living beneath surface debris and matted spartina, rarely entering open water. Adult terrapins spend their summer months in fully marine conditions and other times of the year are spent in submerged mud and brackish water (Davenport, 1992).

### **4.6.2 Sea Turtle Nesting Habitat**

During the summer months, the inshore waters of North Carolina comprise an important habitat for growth and development of the northern United States population of loggerhead (*Caretta caretta*) sea turtles (Epperly et al. 1995). An increase in the number of juveniles is commonly noted in late May when water temperatures increase. Turtles leave the inshore sounds as the water temperature decreases in the autumn months (Epperly et al. 1995).

The Sounds of North Carolina also serve as important developmental habitats for Kemp's Ridley (*Lepidochelys kempii*) sea turtles. Juvenile Kemp's Ridley's sea turtles show similar seasonal migration patterns as loggerheads (*Caretta caretta*), with immigration into the North Carolina sounds in May and emigration in September (Epperly et al., 1995).

Leatherbacks (*Dermochelys coriacea*) occasionally enter shallow bays and estuaries in North Carolina. Epperly (1995) found large numbers of leatherbacks moving north off the coast of North Carolina in early May. However, leatherbacks were spotted infrequently in North Carolina's inshore waters by aerial surveys (Epperly et al., 1995) and public sightings (Epperly et al., 1990).

### **4.6.3 Offshore Turtle Habitat**

Surveys and tracking studies show that as fall approaches and the turtles leave inshore waters and bays in North Carolina and Virginia, they migrate close to the coast moving south of the Cape Hatteras area (Keinath et al., 1996). Inland water temperatures in North Carolina often fall below the lethal lower limit of loggerhead sea turtles (5 to 6.5° C [41 to 43.7°F]) (Musick et al., 1997) and account for the movement of juveniles from the sounds of North Carolina to coastal waters (Epperly et al., 1995). Those juveniles that remain in North Carolina waters winter off the coast near the western edge of the Gulf Stream (Epperly, 1995).

Aerial surveys (Epperly et al., 1995) and public sightings (Epperly et al., 1990) demonstrate that the occurrence of hawksbill sea turtles (*Eretmochelys imbricata*) in inshore and offshore waters of North Carolina is rare.

## **4.7 RESIDENT AND MIGRATORY BIRD RESOURCES**

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The Bogue Inlet area is currently being monitored for bird species. The monitoring plan has been designed to provide information on resident and migratory bird species found nesting, roosting, and foraging in the vicinity of the Bogue Inlet area. Survey areas include the inlet complex, the mid-tidal shoal, and the tidal habitats of Bogue Inlet.

The one-year pre-project bird monitoring plan was developed and implemented to assess the number and activities of the various species of shorebirds and waterbirds within the Bogue Inlet permit area. Transects were established and are monitored at the following locations: 1) the west end of Emerald Isle (69.5 acres); 2) Island No. 2 and the mid-inlet shoal (184.8 acres); 3) the south side of Dudley Island (12.7 acres); and 4) 500 meters along the ocean shoreline of Bear Island. The bird monitoring program includes the use of a spotting scope to identify nesting, roosting, and foraging activities, as well as territory establishment, courtship, and copulation. The transect areas are typically surveyed during low tide events to account for all birds in the area. Baseline monitoring began in April 2003 and will continue for one year (April 2004). Field efforts for bird monitoring were conducted by CZR, Inc. for Coastal Planning and Engineering, Inc. in support of the EIS for the Bogue Inlet Channel Erosion Response Project. Data collected from April 2003 to date under the baseline monitoring efforts has been included in Appendix I. The baseline bird monitoring data discussed in the forthcoming sections includes observations from April through September 2003. Future baseline bird monitoring data will be included in upcoming submissions of the EIS.

### **4.7.1 Inlet and Beach Resources**

In 1998, the Bogue Inlet shoal system was classified as the eighth largest inlet shoal system available to avifauna encompassing 250 acres of habitat for birds (USFWS, 2002). During migration, large numbers of many species of birds utilize the shoal systems and intertidal habitats of Bogue Inlet for foraging and resting while en route to their final destination. The barrier island shorelines of Bogue Banks and Bear Island, as well as the beaches of Dudley Island, have also been found to consistently provide nesting, foraging, and roosting habitat for a variety of waterbird and shorebird species.

#### Shorebirds

The term 'shorebird' refers to a group of migratory birds that can mostly be found along shorelines but also inland, upland, on arctic tundra or at sea. Sandpipers and plovers are commonly referred to as shorebirds, but this group of birds also includes oystercatchers, avocets, and stilts (S. Cameron, pers. comm.).

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Various species of shorebirds utilize the project area and its microhabitats for a variety of behaviors including nesting, migrating, wintering, feeding, and roosting. Species of shorebirds that do use Bogue Inlet for nesting grounds (i.e. Wilson's plovers, willets, American oystercatchers) usually nest above the high tide line on coastal beaches, sand flats at the ends of sand spits, blowout areas behind dunes and washover areas. Other habitats such as intertidal-emergent and submergent vegetated areas, intertidal-unvegetated, and managed wetlands, plus inland habitats are often used by shorebirds (Hunter et al., 2001; Brown et al., 2001).

One important shorebird that nests around Bogue Inlet is the Wilson's plover (*Charadrius wilsonia*). Wilson's plover is a shorebird that is significantly rare according to the North Carolina Natural Heritage Program (LeGrand and Hall, 1999), of high priority according to the Partner's in Flight Bird Conservation Plan for the South Atlantic Coastal Plain (Hunter et al., 2001), and of high concern according to the U.S. Shorebird Conservation Plan (Brown et al., 2000). Bogue Inlet is important to the species for breeding, as Wilson's plovers are known to "nest on sand beaches and tidal mud flats" (letter from USFWS [Garland Pardue] to USACE [Colonel Alexander], November 22, 2002). Wilson's plovers can be found in Bogue Inlet during the spring, summer and fall (NOAA, 2000). Preliminary review of the bird monitoring data revealed Wilson's plovers nesting in May, June, and July of 2003. In May, nests were observed on Dudley Island and along the beaches of Bogue Banks as up to three nests were seen with up to three eggs in a nest. In June and July, nests were only observed along Dudley Island and one nest was seen along the marsh of the island.

Bogue Inlet is also heavily used by migratory wintering shorebirds. Most shorebirds are long distance travelers who fly thousands of miles to areas across the world to find suitable nesting grounds. To complete these flights shorebirds must obtain a large fuel reserve. Bogue Inlet is one of many North American, food-rich, migration stop-over areas used by shorebirds to replenish fuel reserves and accumulate fat needed for the long flights. There are few places that have the right combination of resources, in some areas between 50 and 80% of the entire population of a species may visit a single site (Manomet Center for Conservation Sciences-International Shorebird Survey, 2003). Migrating species include but are not limited to semipalmated sandpipers (*Calidris pusilla*), sanderlings (*Calidris alba*), and whimbrels (*Numenius phaeopus*). According to the U.S. Shorebird Conservation Plan (Brown et al., 2001), the Southeastern Coastal Plain, in which the coasts of North Carolina are a part of, is extremely important for migrating semipalmated sandpipers, sanderlings, and whimbrels.

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Semipalmated sandpipers (*Calidris pusilla*) have been recorded migrating and utilizing the intertidal and surf zones for migratory stop-over feeding in the spring, summer, and fall as indicated in the baseline bird monitoring reports from April 2003 to date. In fact, on May 16, 2003, 146 semipalmated sandpipers were observed feeding on the intertidal shoals of the inlet. NOAA's (2000) Seasonal Table for Living Resources corresponds with these results stating semipalmated sandpipers are present from April through October in the area.

Sanderlings (*Calidris alba*) can be found year round in the area (NOAA, 2000) and bird monitoring results from the baseline monitoring reports correlates as sanderlings were recording migrating in April, May, July, August, and September. During the current study period, from April to date, sanderlings were also seen feeding and roosting. During the month of September, 131 sanderlings were observed resting on intertidal flats/shoals adjacent to Bogue Banks (Transect No. 1).

Whimbrels (*Numenius phaeopus*) have been recorded migrating, feeding, and roosting in the area in the months of April and May as well as from July through October according to research conducted by NOAA (2000). Review of the baseline bird monitoring results recorded whimbrels migrating in August (over the surf regions of Bogue Banks) and in May (over Dudley Island beach), as well as feeding and/or roosting in the permit area during the months of April and May. The numbers of whimbrels seen either migrating or feeding were fairly low as only a maximum of two birds were observed at one time. However, whimbrels were observed utilizing the surf, intertidal and beach habitats of Bogue Banks and Dudley Island.

Several species, including the threatened piping plover (*Charadrius melodus*), utilize the inlet for wintering. Wintering species other than the piping plover (Section 4.4.3.1) include but are not limited to American oystercatchers (*Haematopus palliatus*), dunlins (*Calidris alpina*), and black-bellied plovers (*Pluvialis squatarola*). According to the U.S. Shorebird Conservation Plan (Brown et al., 2001), the Southeastern Coastal Plain is extremely important for wintering American oystercatchers, dunlins, and black-bellied plovers as well as other species of shorebirds. Numbers up to 25 American oystercatchers were recorded on May 16, 2003 at the inlet's intertidal area (Transect No. 2). Also on May 16, 2003, 46 dunlins were observed feeding along the intertidal areas of Bogue Inlet. On September 12, 2003, 120 black-bellied plovers were seen feeding, resting or migrating along the beach and intertidal habitats of Bogue Banks (Transect No. 1).

During all months of the year, Bogue Inlet provides important foraging and roosting habitats. The intertidal shoals and sand flats provide protected and

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isolated habitat for roosting, as well as 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. Therefore, Bogue Inlet's habitats and the shorebirds that utilize them are a very important resource. With decreasing habitat world-wide compounded by increased threats from various sources, remaining habitat available to shorebirds for wintering, migrating, and nesting are becoming more critical.

### Colonial Waterbirds

Colonial waterbirds are specific waterbirds that nest in large groups called colonies and include terns (*Sterna* spp.), black skimmers (*Rynchops niger*), herons, egrets (Family Ardeidae), gulls (*Larus* spp.), ibis (Family Threskiornithidae), and pelicans (*Pelecanus occidentalis*) (Sue Cameron, pers.comm.). Colonial waterbirds can further be divided into subcategories of waterbirds largely determined by where they forage. The subcategories include: 1) seabirds, 2) coastal waterbirds, and 3) wading birds. Seabirds primarily feed in the open ocean, and some only reach land to nest and breed. Seabirds include such birds as storm-petrels (Family Hydrobatidae) and gannets (*Morus bassanus*). Coastal waterbirds consist of gulls, pelicans, terns, as well as cormorants (*Phalacrocorax* spp.), and these waterbirds primarily utilize the interface between land and both salt and fresh water. Wading birds include herons, egrets, and ibis as they mainly feed by wading in shallow waters. Therefore, colonial waterbirds can be found in estuaries, ocean fronts, open dunes, and inland areas, in addition to intertidal shoal habitats as all these habitats are often used for foraging, roosting, and nesting. These birds use a variety of habitats for nesting. For example, some colonial waterbirds utilize vegetated, upland environments such as brown pelicans (*Pelecanus occidentalis*), herons, and egrets (Family Ardeidae). These three colonial waterbird groups prefer trees, shrubs, and grass for nesting.

Waterbirds, especially colonial species, can rapidly populate and alter ranges in response to changes in environmental conditions. For example, some species of waterbirds such as terns (*Sterna* spp.) and black skimmers (*Rynchops niger*) 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. This is one reason why it's important that these birds have a number of suitable nesting, foraging, and roosting sites along the coast. 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.

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Research on the trends of waterbirds in North Carolina shows that the overall numbers are declining, although with fluctuation, along the North Carolina coast since a peak of 28,356 tern and skimmer nests in 1977 (S. Cameron, pers.comm.). The most recent coast-wide census of nesting colonial waterbirds was conducted by NCWRC in 2001 when a total of 17,089 tern and skimmer nests were recorded. The National Park Service (2000) reported that royal and sandwich terns do not breed on ocean beaches, but on more isolated islands (such as dredge spoil islands) in the sounds of North Carolina. Royal and sandwich terns have shown more population stability in North Carolina but have not been recorded nesting around Bogue Inlet (S. Cameron, pers. comm.). Black skimmers, common terns (*Sterna hirundo*), and gull-billed terns (*Sterna nilotica*) have shown some of the steepest declines in North Carolina (S. Cameron, pers. comm.). Nests of these three species have not only declined, but so have the number of nesting sites. In 1977, 96 black skimmer, common tern, and gull-billed tern nesting sites were found along the North Carolina coast, while in 2001, the number of nesting sites recorded only totaled 44 sites (S. Cameron, pers. comm.).

Colonial waterbirds known to nest around Bogue Inlet include black skimmers (*Rynchops niger*), least terns (*Sterna antillarum*), and common terns (*Sterna hirundo*). Black skimmers arrive in North Carolina in May and nesting activities extend from May through August, usually in mixed-species colonies with common, least, and gull-billed terns. Black skimmers prefer open, bare sand habitat for nesting and the majority of black skimmer nests and colonies are found on natural beaches and dredged spoil islands. Records of black skimmers from bird monitoring (April through September, 2003) documented possible nesting in only one month (May 2003) on the eastern beaches of Bear Island.

Historic records of least tern (*Sterna antillarum*) nesting have been documented in areas of Bogue Inlet and Bogue Sound (Parnel et al., 1994). Least terns nest on barrier beaches, natural islands, or dredged-material islands with a substrate of mixed sand and shell hash and little or no vegetation. Least terns arrive in North Carolina in April, with nesting and egg-laying occurring from early May through early July (Parnel et al., 1994). Preliminary review of the bird monitoring by CZR, Inc. collected from April through September 2003 revealed nesting least terns in May, June and July on the beaches of Bear Island, the intertidal areas adjacent to Dudley Island beaches, and along Island No. 2 where there were 15-30 nests reported on June 30, 2003.

Common terns are known to nest on "barrier island beaches, natural islands and shoals, marsh islands, and dredged-material islands" (Parnel et al.,

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1994). Nesting at colony sites begins in late April and early May in North Carolina (Parnel et al., 1994). Preliminary review of bird monitoring data (April through September 2003) recorded possible nesting of common terns in May 2003 on the beaches of Bear Island.

Similar to shorebirds, many waterbirds have large ranges that cross national and continental borders, or span oceans, where individuals may cover enormous distances in their lifetimes over periods of years or even weeks (Kushlan and Steinkamp, 2002). However, most colonial waterbird species are present in the Bogue Inlet area year round, and some species, such as the terns, are present most of the year, in the spring, summer, and fall 

Many waterbirds are tactile hunters, which forage by skimming the water. Others are plunge divers and some are surprise predators that stalk and strike their prey. Prey resources of colonial waterbirds include various aquatic and terrestrial fauna comprised of fish, squid, and invertebrates.

### Other Waterbirds

Other species of waterbirds that are not classified as shorebirds or colonial waterbirds can also be found along the North Carolina coast. Other waterbirds can include various species. For example, species such as common loons (*Gavia immer*), red-breasted mergansers (*Mergus serrator*), clapper rails (*Rallus longirostris*) and ospreys (*Pandion haliaetus*) utilize the different habitats in and surrounding Bogue Inlet.

Many waterbirds, not included as shorebirds or colonial waterbirds are piscivorous that 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 inlet areas year-round or part of the year, but are present in the area mainly during spring and fall migrations, as well as during the winter.

The baseline bird monitoring data available to date (April through September 2003) revealed the described species of loons, mergansers, rails, and ospreys in the months of April, May, June, and September foraging on intertidal areas of Dudley Island and Bogue Banks, the beaches of Bogue Banks and Bear Island, and along the surf zones of Bear Island. Other waterbirds were also recorded during April through September migrating in the areas of the inlet, Bogue Banks, Dudley Island and Bear Island.

## **4.8 WATER QUALITY**

Historically, infrequent water sampling has been conducted in the vicinity of Bogue Inlet. The North Carolina Department of Environment and Natural

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Resources (NCDENR) Basinwide Assessment Report (2000) states turbidity levels taken adjacent to Swansboro from 1994 through 1999 ranged from 1.0 to 13.0 NTUs, with an average measurement of approximately 5.2 NTU. Additionally, data collected by Searcy (2003) off the Highway 24 Bridge in Swansboro, from November 2002 through January 2003, reported a range of salinities from 24.0 to 28.6 ppt, with an average of 26.7 ppt in the area. During the same period, water temperatures ranged from 4.0°C (39.2°F) to 17.1°C (62.8°F), with an average of 9.8°C (49.6°F). No additional information regarding water quality data in the Permit Area is available as confirmed with the NC Division of Water Quality (Lutheran, pers. comm.).

Bogue Inlet is a dynamic system that forms the mouth of the White Oak River, providing an outlet to the Atlantic Ocean. The River is unique as it begins and ends in the southern coastal plain, while other river systems in North Carolina begin in the piedmont range. The White Oak River stretches from its freshwater source, the Hoffman State Forest, to the ocean. Hoffman State Forest is classified as a Pocosin, which is a raised bog or swamp containing black organic 'muck' (NCCF, 2001). Along its route, the White Oak River contains five distinct natural communities, including tidal red cedar forest, brackish marsh, coastal plain bottomland hardwood forest, tidal cypress marsh and tidal freshwater marsh. The tidal red cedar forest associated with the White Oak River is considered extremely rare in North Carolina. The river widens near the Stella Bridge and the formation of saltwater marshes results.

Due to the nearly pristine nature of Bogue Inlet, the water quality is considered an important resource for the area. The White Oak River, which feeds into Bogue Inlet and ultimately the Atlantic Ocean, contains various natural and unspoiled waters. Until the waters reach the Intracoastal Waterway, there is little industrial, residential, or commercial development. According to the North Carolina Department of Environment and Natural Resources (NCDENR, 2001) Bogue Inlet "contains some of the highest quality environments remaining along the coastal edge of North Carolina, with excellent examples of maritime forests, dune communities, and extensive areas of unditched marshes and tidal creeks." There are only nine permitted dischargers into the entire White Oak River sub-basin and the flows are all less than 0.5 million gallons/day (MGD) of minor wastewater discharge (NCDENR, 2001). Furthermore, the area has good tidal flushing and as a result, has high water quality. Because of this, special protection measures apply to waters with outstanding water quality.

Water quality is important to the health and survival of estuarine flora and fauna. Marine animals such as anadromous fish and shellfish can only survive in a certain range of salinities, temperatures, and turbidity levels. If

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water quality is degraded, these animals can die. Flora, such as seagrass beds, relies on clear waters for photosynthesis and thus, for survival. If waters are highly turbid, seagrass cannot obtain adequate sunlight for survival and the loss of seagrass communities can result. However, due to the variation in water quality in an estuarine system, flora and fauna are accustomed to the dynamic system and can adapt to minimal and temporary change.

Bogue Inlet is classified as a Class SA by the North Carolina Department Environment Natural Resources. Class SA waters are suitable for commercial shell fishing and all other tidal saltwater uses (NCDENR DWQ, 2000). Waters to the west and east of Bogue Inlet are also classified as Outstanding Resource Waters (ORW), which are unique and special surface waters that are considered to be unimpacted by pollution and have some outstanding resource value (NCDENR DWQ, 2000). Special protection apply to the ORWs of North Carolina according to 15A NCAC 2B .0225 (see Section 1.7).

### **4.8.1 Turbidity**

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 SA class waters, North Carolina state guidelines limit turbidity to values under 25 NTU above ambient levels outside turbidity mixing zones (NCDENR DWQ, 2000).

A summary of water quality parameters from Table 15 of the NCDENR Basinwide Assessment Report (NCDENR, 2000) shows turbidity samples taken at Swansboro (1994 – 1999) range from 1.0 – 13.0 NTU, with an average around 5.2 NTU. These reading are all well below the state standard.

### **4.8.2 Salinity**

A primary factor affecting the distribution of estuarine – dependent fish and shellfish is salinity (Environmental Sensitivity Index: North Carolina Vol. 1). The area of Bogue Inlet has three different periods during the year of high, transitional, and low salinity. The high salinity time period is June through August; transitional is April through May and September through December; and low is January through March. Salinity levels in the upper reaches of the river systems are moderately stratified and experience variability during the low salinity period. Salinities become more stable and less stratified

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during the high – salinity (Environmental Sensitivity Index: North Carolina Vol. 1).

Data obtained from Steven Searcy at the Highway 24 Bridge in Swansboro (Searcy, 2003) during the months of November to January, gave a range of salinities from 24.0 to 28.9 ppt, with an average of 26.7 ppt. This range in salinity levels is tolerated by many species of fish and invertebrates. Anadromous fish such as the shortnose sturgeon (*Acipenser brevirostrum*), can spend all or part of its life in the low salinity levels of the estuarine areas of Bogue Inlet, however it can also be found in maximum salinity levels of 30 – 31 ppt and the open ocean (35 ppt). (Gilbert 1989)

### **4.9 AIR QUALITY**

According to the EPA, air qualities of the closest monitoring stations (Wilmington and Jacksonville) have air quality indices well below the State and National Ambient Air Quality Standards (USEPA Air Quality Index Summary Report, 2001). Ambient air quality standards monitored include TSP, PM-2.5, PM-10, CO, O<sub>3</sub>, SO<sub>2</sub>, NO<sub>2</sub>, and Pb. All facilities in the Bogue Inlet area are within air quality pollution compliance, according to 15A NC Administrative Code 2Q.0500, as well.

The North Carolina Department of Environment and Natural Resources, Division of Air Quality has jurisdiction over air quality in Carteret and Onslow Counties, and ambient air quality is in compliance with the National Ambient Air Quality Standards (CSE, 2001).

### **4.10 PUBLIC SAFETY**

Public safety issues primarily refer to navigational practices in Bogue Inlet.

The U.S. Coast Guard (USCG) Boating Statistics for 2001 ranked the waters of North Carolina as number 12 out of the 56 bodies of water owned by the U.S., for the total number of boats operating in North Carolina waters. An average of 351,595 boats was calculated for the total number of boats in North Carolina waters for years 2000 and 2001. The total number of accidents in North Carolina that occurred in 2000 and 2001 averaged 175.5 accidents. County totals were also identified in the USCG 2001 report that listed the total number of accidents per county out of the total number of registered boats. Carteret County had a total of 10,037 boats registered with 16 total accidents in 2001, out of which three were fatal. Onslow County had a total of 7,270 boats registered with three total accidents in 2001, no fatalities. (USCG, 2001)

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The 2001 report from the North Carolina Insurance News Service (NCINS, 2002) listed one boating accident that occurred in Bogue Inlet out of 70 bodies of water in North Carolina. The NCWRC - Division of Enforcement 2002 Report of Boating Accidents and Fatalities listed a total of two boating accidents in Bogue Inlet (one fatal, one non-fatal). The 2002 report include accidents that involve medical treatment, loss of life, total damage greater than \$500, and/or missing person from scene of accident.

Local residents have expressed a general concern for recreational boat operators who utilize Bogue Inlet. The narrowing main ebb channel, coupled with the migration of inlet and increased velocities have raised local residents concerned about boating safety of recreational boaters, especially tourists unfamiliar with Bogue Inlet.

### **4.11 AESTHETIC RESOURCES**

There are several bird islands around Bogue Inlet, which include extensive areas within and around Bogue Sound, Hawkins Island to the northwest and Jones Island and Cedar Point Marshes in the White Oak River at the north of the inlet. The beaches along the western end of Emerald Isle and the east end of Bear Island also provide nesting, migratory, and overwintering habitat for several migratory birds, including the piping plover (USFWS CA Report 2002). A state park, Hammocks Beach State Park, on Bear Island, creates a wilderness environment due to the shrub thickets and maritime forests, while other parts of the park create a desert – like environment from the large dunes and sand ridges that line the beaches. The uninhabited, natural environment brings many people to the park.

Bogue Banks is known for its miles of sandy beaches, which are cumulatively called the Crystal Coast due to the green color of the water on calm days. The Crystal Coast consists of narrow islands and favorite beach – vacation spots of Fort Macon, Atlantic Beach, Pine Knoll Shores, Indian Beach, Salter Path, and Emerald Isle. In addition, nearby cities, such as Swansboro, Beaufort and Morehead City contain several significant natural, cultural, and historic areas.

There is a natural aesthetic beauty to Bogue Inlet and the surrounding areas that provide uninterrupted natural vistas from river salt marsh to barrier island ocean views. Overall, there are many photographic opportunities for scenic and wildlife pictures in and around Bogue Inlet.

### **4.12 RECREATIONAL RESOURCES**

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Bogue Inlet contains sections of wildlife areas, maritime forest, shrub thickets, estuarine creeks, salt marshes. Significant Natural Heritage Areas do exist within the area. These include Huggins and Dudley Island, West End Beach on Emerald Isle, and Bear Island to the west of the Inlet. Extensive areas within Bogue Inlet and Bogue Sound are designated as bird islands (NCWRC), as well as, Hawkins Island to the Northwest and Jones Island and Cedar Point Marshes in White Oak River, north of the inlet. Habitat Bear Island is part of the Hammocks Beach State Park system that also includes all of Huggins Island and 35 acres on the mainland in the city of Swansboro. The State Park is bordered by the Atlantic to the South, salt marshes, estuarine areas, and Intracoastal Waterway to the North, as well as the Western Channel and Bogue Inlet to the east. Bear Island has limited accessibility, with access only available through public ferry service, marine taxi, private boat, canoe, or kayak. Approximately 35,000 visitors per year attend the park at Bear Island utilizing the provided ferries (S. Bland and S. Regier, pers. comm.). Common activities on the island include camping, fishing, picnicking, canoeing, bird watching, sun bathing, educational tours, and swimming. There are also bird watching groups that frequent Bear Island to observe the diverse bird species that utilize the island. Fishing is a major recreational activity in the area along Bogue Banks and along the sand shoals of Bogue Inlet. Puppy drum, flounder, trout, and blue fish are frequent catches from the park.

Bogue Inlet includes many scenic and recreationally important estuarine creeks. Visitors and locals alike come to the area to view pristine natural features. The estuary is a known nursery and safe haven for many game and recreational fish. Along The Pointe shoreline, surf fishing has been in existence for decades. This area has long been used as a fishing spot and used by vacationers as well as locals.

The image shown below was taken in August 2003 in Bogue Inlet and demonstrates a good example of boat usage in the Inlet.