4.0 AFFECTED ENVIRONMENT

The Affected Environment section describes the existing environmental resources of the areas that would be affected if any of the alternatives were implemented. This section describes only those environmental resources that were found to be relevant to the decisions being made. It does not describe the entire existing environment, but only those environmental resources that would affect or that would be affected by the alternatives if they were implemented. This section, in conjunction with the description of the "no-action" alternative, forms the baseline conditions for determining the environmental impacts of the proposed action and reasonable alternatives.

Two study areas were identified in order to delineate and differentiate between areas anticipated to receive primary and secondary effects and areas that are used to analyze cumulative effects within the Bogue Inlet complex. The study area for primary and secondary effects is the Permit Area/Project Impact Zone; and the boundary limits for analyzing cumulative effects is known as the Project/Survey Area. For this particular document we will be referring to these two areas as Permit Area and Project area. The basis for determining the Permit Area was identified from the hydrodynamic modeling results (Appendix B - Engineering Report [Appendix D - Hydrodynamic Model]), as well as from the sedimentation analysis conducted for Bogue Inlet (Appendix B - Engineering Report [Sections 5 and 6]). Based on these analyses, the area of effect was predicted to occur in the immediate vicinity of the Bogue Inlet complex and along the southern portions of the Western Channel and Main Ebb Channel. A buffer zone was added, which included known aquatic resources directly bordering the area of effect, to the predicted zone of influence by extending the Permit Area further up the reach of the Western and Main Ebb Channels, to the Atlantic Intracoastal Waterway. The Permit Area encompasses portions of Bear Island, approximately 3,000 feet offshore of Bogue Inlet, and approximately 4.5 miles of the Emerald isle shoreline (from the intersection of Sea Breeze Road and South Windjammer to the Land's End subdivision). The Project Area was developed for the purpose of evaluating each resource and how each resource relates to the proposed action, in terms of determining the significance of the cumulative impacts of the proposed actions on that particular resource. See Figures 6 and 7 for boundaries of each area.

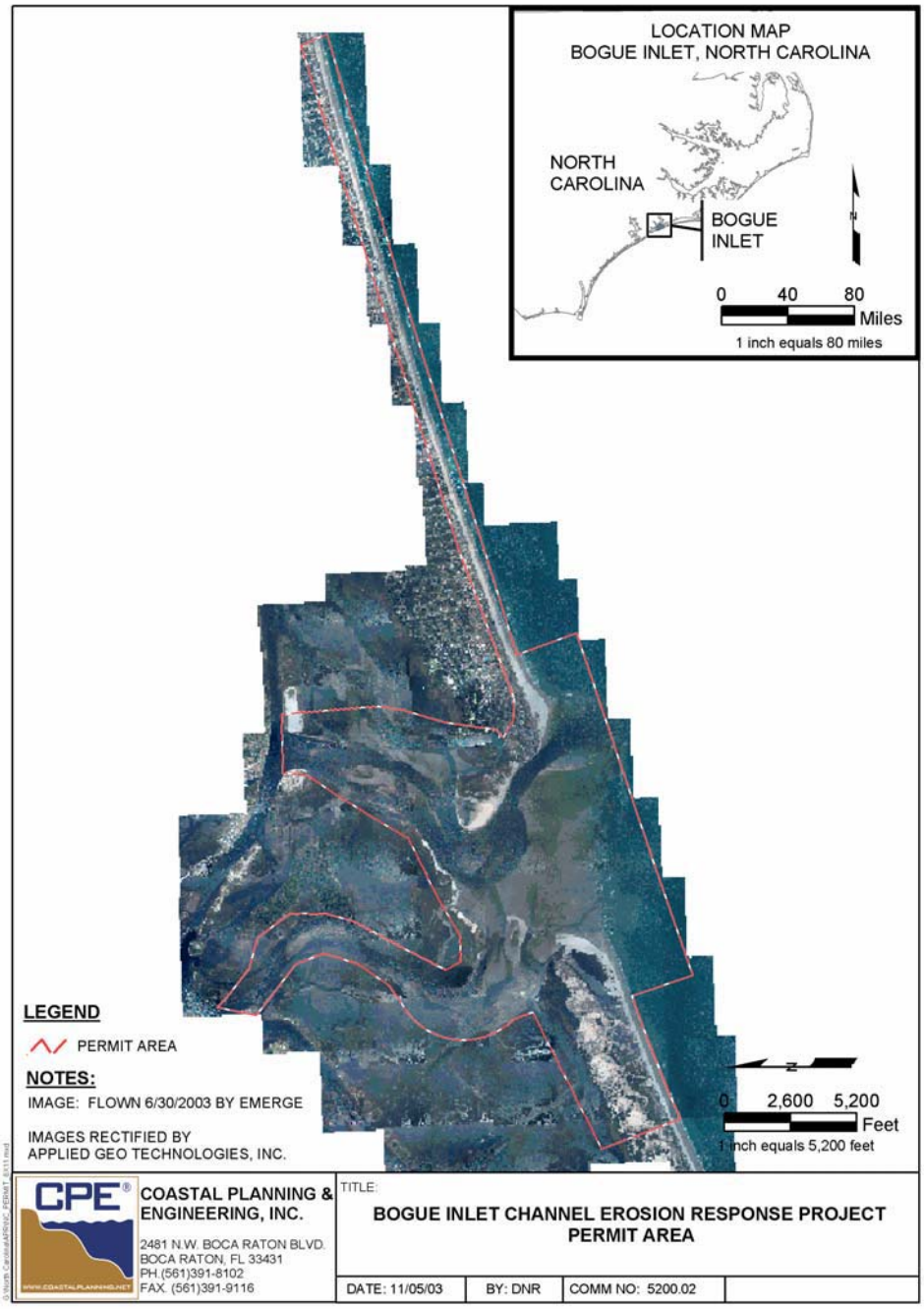


Figure 6
Permit Area Map

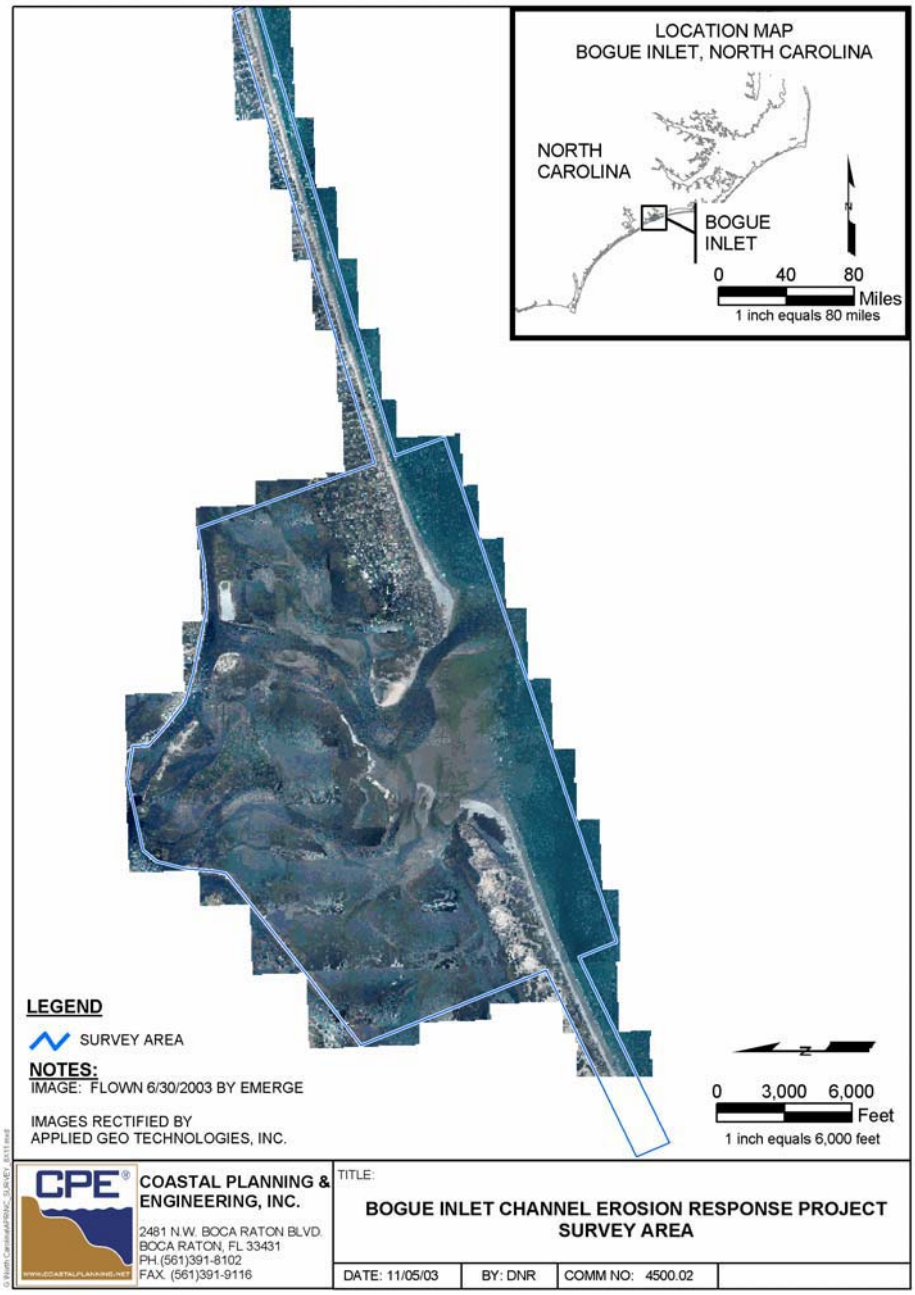


Figure 7
Project Area Map

Legal town and county boundary limits found within the project area are described below.

- Bogue Banks is the southern Outer Banks Island bordered by the Atlantic Ocean to the south and by Bogue Sound to the north. The town of Emerald Isle is located on the western end of Bogue Banks in Carteret County, North Carolina. The "boundaries of the Town of Emerald Isle Begin at a concrete marker at the high water mark of the Atlantic Ocean, this being the southwest corner of Wica Chemical Company property, located South 71 degrees 35 minutes West 7255.0 feet from the church spire at Salter Path Village, and run with the Wica Chemical Company West property line North 03 degrees 35 minutes West 452.80 feet to a concrete monument marked `A.H. (Alice Hoffman) Lane'; then continuing same course 203.7 feet to a concrete monument at the high water mark of Bogue Sound (Wica Chemical Company northwest corner); continuing North 03 degrees 35 minutes West 1,350 feet to a point in Bogue Sound; then in a westerly direction parallel to and 1,320 feet from the water line of Bogue Sound to a point in Bogue Sound formed by the intersection of this call and a line perpendicular thereto passing through the westernmost projection of Bogue Banks at the mean high water mark; then southerly along the line as extended to a point where said line meets the high water line of the Atlantic Ocean; then due South 2,640 feet to a point in the Atlantic Ocean; then in an easterly direction parallel to and 2,640 feet from the high water line of the Atlantic Ocean to a point which is 2,640 feet South 03 degrees 35 minutes East from the concrete monument which is heretofore described as the point of the beginning; thence continuing North 03 degrees 35 minutes West 2,640 feet to the point of beginning. All the above courses are based on true meridian". (Town of Emerald Isle, 2003)

- Carteret County is located in the southern end of Outer Banks, North Carolina. Carteret County is comprised of approximately 524 square miles (135,715 hectares) of land.

- Onslow County is located in southeastern region of North Carolina approximately 120 miles east of Raleigh, and 50 miles north of Wilmington, NC. The county covers a total of 1.95 square meters 756 square miles (195,803 hectares). The Onslow County line is located in the middle of Bogue Inlet.

- Bear Island is an undeveloped barrier island extending 3.5 miles from the west side of the Bogue Inlet complex, and to the east side of Bear Inlet complex. Bear Island is the largest section of Hammocks Beach State Park, containing approximately 892 acres. Seven hundred acres of Bear Island is a Registered Natural Heritage Area under the Natural Heritage Program.

4.1 GENERAL ENVIRONMENTAL SETTING

Bogue Inlet is located between two barrier islands, Bogue Banks to the east and Bear Island to the west. Bogue Inlet channel is unstable, similar to other channel systems, and has been migrating to the east and to the west between Bear Island and Bogue Banks (west end of Emerald Isle). The migratory nature of the inlet contributes to the formation of several shoals and bars in the inlet, as a result of the erosional effects occurring in other areas of the inlet.

There are many permanent and temporary (or ephemeral) islands surrounding the inlet with sand shoals and salt marsh systems (developed as a result of the tidal influence and aggradation of organic sediments). Dudley Island to the north of the inlet is a privately owned island comprised mainly of salt marsh habitat. This island is located on the outer bend of the main ebb channel and is experiencing erosion on the southeast side and accretion on the southwest side. Island No. 2 has accreted above the mean high tide level (elevation +2.4 NGVD) with minimal relief located on the west side of the inlet complex. This island appeared to stabilize, since emerging in 1996. However, aerial footage obtained since that time (1998 to present) has shown Island No. 2 to be steadily migrating to the west of the inlet complex. Island No. 1, also an ephemeral island that emerged in 1996, is located on the eastern margin of the ebb tide delta. This island has historically been intertidal; however, the island has recently developed to be exposed during high tide events.

4.1.1 Beach Environments

Oceanfront shoreline beaches can be found along approximately 25 miles of Bogue Banks and approximately 3.5 miles of Bear Island. Dudley Island has a narrow beach system along the south side of the island and north of the inlet complex. These beach systems can be divided into three main ecosystems: foredune, dry beach, and wet beach. Sand dunes and vegetation that comprise the foredune system are extremely important for the North Carolina coastline since they provide protection from storm surge. The foredune system, typically the southern most ridge, is characteristic of an erosional scarp on the beach side. The eroded material contributes to the dry beach located between the toe of dune or scarp and mean high water

(MHW) line. The wet beach is located between mean low water and mean high and is strongly influenced by tidal wave action.

4.1.2 Bear Island

Bear Island is located west of Bogue Inlet and north of Onslow Bay. Bear Island is a barrier island approximately 3.5 miles (5.63 kilometers) long and 1,968.5 feet (600 meters) wide. The undeveloped barrier island is located west of the mid-inlet shoal and is comprised of dune grass habitats, maritime wet grasslands, maritime shrublands, and maritime evergreen forest communities.

Bear Island is the largest part of the Hammocks Beach State Park system, totaling 892 acres. Hammocks Beach State Park also includes 35 acres on the mainland in the City of Swansboro, and 210 acres on Huggins Island. Bear Island is also designated as a National Natural Landmark by the U.S. Department of Interior (NPS, 2004), while the waters behind Bear Island are designated as Outstanding Resource Waters (NCDWQ, 2003b). 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.). Bear Island provides many educational opportunities for island visitors, including a new visitors center that focuses primarily on coastal ecology.

Refer to Appendix D – Biotic Community Maps for a graphical presentation of habitats identified from the June 2003 aerial and field verified in July to September 2003. Details of the habitats and their locations can be found in the Bogue Inlet GIS provided under separate cover.

4.1.3 Inlet Complex

Bogue Inlet is located in the southwestern boundary of Bogue Banks, approximately 35 miles west-southwest of Cape Lookout in the northeastern portion of Onslow Bay (Figure 1). The inlet is one of the larger inlets in southeastern North Carolina and separates Bogue Banks in Carteret County and Bear Island in Onslow County. Bogue Inlet drains an expansive marsh filled sound where two large, relatively deep tidal creeks connect the inlet to the Atlantic Intracoastal Waterway and the White Oak River Basin, which includes Bogue Sound. The inlet complex has been a relatively stable feature whose throat section remained in approximately the same location for the past 75 years (Cleary, 1996). The ultimate origin of the inlet is related to the ancestral channel of the White Oak River, which controlled the location

of the inlet as sea level rose during the past four thousand years. The inlet is currently controlled by ancestral drainage patterns.

Bogue Inlet has been classified as a wave-influenced transitional inlet with an exceptionally wide throat (~8,500 feet), a relatively narrow ebb channel (~700 feet), and a large mid inlet shoal that occupies most of the western portion of the floodway (Cleary and Marden, 1999; CSE, 2001). The ebb channel is unstable and has a history of migration related to spit growth on opposing shoulders. Breaching of the inlet shoals has also led to rapid repositioning of the ebb channel during several time periods since the late 19th century. The most dramatic realignment event occurred in the mid 1950's when the ebb channel was repositioned ~3,000 feet east of its 1938 position. The elevated water level associated with Hurricane Hazel (1954) was the likely trigger mechanism that led to the shoal-breaching event. The rapid realignment of the ebb channel promoted large-scale changes on the Bear Island shoulder as extensive portions of the offshore shoals migrated and welded onto the adjacent shoreline (Cleary and Marden, 1999; CSE, 2001). The direction and rate of channel migration has varied considerably since 1938. During the past three decades, the channel has steadily migrated in an easterly direction at an average rate of ~75 feet/year.

4.2 GEOLOGY AND GEOMORPHOLOGY OF STUDY AREA

Most shoreline features in North Carolina, are controlled by the pre-Holocene stratigraphic framework of the shore face and most of these beaches are perched on top of pre-existing Pleistocene, Tertiary, and Cretaceous consolidated sediments (Riggs et al., 1996). North of Cape Lookout the geological framework consists of a Quaternary sequence that fills a regional depositional basin called the Albemarle Embayment. The coastal zone south of Cape Lookout is dominated by Tertiary and Cretaceous units that outcrops across the coastal plain and continental shelf, with very thin Quaternary units only locally preserved.

Superimposed upon this regional stratigraphy is an ancient drainage system resulting in a series of fluvial valleys filled with younger coastal sediments separated by large interfluve areas of older stratigraphic units. This results in a coastal system in which the shore face is either nonheadland or headland dominated (Riggs et al., 1996).

Tertiary and Quaternary marine sediments in the North Carolina Coastal Plain are distributed on two crustal blocks, the Onslow block in the southern section, and the Albermarle block to the north section (Harris, 1996). The study area is situated on top of the Onslow block.

Regional geology and stratigraphy of this area was described by Mixon and Pilkey (1976). The Waccamaw / James City formations were used for description of early Pleistocene sediments of similar lithology that occur on the southern and northern parts of the Onslow block. Late Pleistocene units in this area are poorly described and are assigned to numerous lithostratigraphic names (Harris, 1996). Several Pleistocene to early Holocene scarps and terraces are recognized on the Onslow block between Cape Fear and Cape Lookout such as the Bogue-Suffolk scarp that delimits the modern mainland coast of the Onslow block.

A series of barrier islands spits and cuspate forelands form the 115 mile stretch of open coast of Onslow Bay. This mesotidal shoreline is composed of thirteen morphologically diverse barriers that were grouped into distinct classes by Riggs et al. (1996). The main morphological / stratigraphic division occurs between Browns Island and Onslow Beach, where a submarine headland composed of tertiary limestone and sandstone forms a preeminent protuberance along the coast (Cleary, 1996).

Onslow Beach is perched on top of the submarine headland and separates the wide, high beach ridge and modified ridge barriers to the northeast, including the Bogue Banks, from the transgressive barriers with low narrow profiles to the southwest. Overwashes and historic inlet breaches are more common southwest of Onslow Beach on the transgressive barrier systems. Regressive barriers, such as the Bogue Banks situated at the northeastern section of Onslow Bay, are composed of forested beach ridges and contain 15 to 25 times more sand per unit length of coast than do the transgressive, perched barriers at the southwestern section.

4.2.1 Sand Source Location

Alternatives for responding to the inlet shoreline erosion include the possible relocation of the main ebb channel through Bogue Inlet (ocean bar channel) to a more central location between Bogue Banks and Bear Island. Material removed to reposition the channel could be used to close the existing channel located immediately adjacent to the west end of Emerald Isle or be used as a source of beach nourishment material to complete Phase 3 of the Emerald Isle beach nourishment project that covers 23,831 feet of beach beginning at a point approximately 0.5 miles east of Bogue Inlet.

4.2.2 Sand Quality

In July 2002, Coastal Planning & Engineering, Inc. (CPE) collected 27 jet probes and 5 vibracores in Bogue Inlet. Most of the jet probes and vibracores were located within a corridor through which a centrally located

channel would pass. The locations of the CPE jet probes and vibracores are shown on Figure 4.1 in Appendix B – Engineering Report.

Jet probes consist of jetting a 20-foot long PVC pipe into the seafloor using a water pump. A CPE geologist/diver observes the depth of the probe and the associated material characteristics as the probe penetrates into the sediment. A small deposit mound is formed around the jet probe site as jetted water carries sediment to the surface. Sand samples are then collected by the geologist/diver from these mound deposits. Three samples are obtained 1) a seafloor surface sample, 2) a sample from the jet probe mound that penetrates the seafloor to 20 feet or when the probe hits refusal and 3) a sample collected from a second jet probe mound that penetrates the seafloor at half the depth of the first probe. One sediment sample was analyzed by a standard sieve analysis and the remaining two samples were visually analyzed.

The average mean grain size for all of the jet probe samples subjected to a sieve analysis was 0.27 mm. The silt content of the jet probe samples analyzed by standard sieves was generally below 2 percent; however, since most of the fine grained material is washed out of the sediment during the jet probe process, the silt content indicated by the jet probe samples may not necessarily be indicative of the in situ silt content.

The five vibracores were obtained in July 2002. Each core was measured and labeled onboard the vessel. At the end of each day, the cores were transported to shore where they were cut lengthwise, visually inspected, and sealed in plastic. One-half of each core was shipped to the University of North Carolina at Wilmington for archiving while the other half was transported to the CPE lab in Boca Raton, Florida for detailed analysis. The layering of the sediment was recorded and samples obtained for grain size analysis from each distinct sediment type in the core. The grain size data for all of the samples obtained from the five vibracores is presented in Table 2.

Table 2
Summary of Grain Size Analysis of Vibracore Samples

Number	Approx. Depth ft. NGVD	Mean (mm) M_{mm}	Mean (phi) M_{phi}	Sorting S_{phi}	Variance S^2_{phi}	% Silt < 230 Sieve	% > 2mm	% > 1 mm
BIVC-02-01								
BIVC-02-01 #1	-3.8	0.26	1.94	0.86	0.74	1.20	1.36	3.05
BIVC-02-01 #2	-4.8	0.21	2.24	0.51	0.26	1.59	0.03	0.00
BIVC-02-01 #3	-8.8	0.24	2.04	0.82	0.67	1.62	1.27	2.94
BIVC-02-01A #1	-11.1	0.64	0.63	2.32	5.38	0.91	18.96	26.33
BIVC-02-01B #1	-20.5	0.64	0.64	1.56	2.43	0.57	11.30	27.27
BIVC-02-02								
BIVC-02-02 #1	-5.0	0.28	1.83	0.88	0.77	1.19	1.38	3.97
BIVC-02-02 #2	-7.3	0.24	2.08	0.56	0.31	1.33	0.21	0.41
BIVC-02-02 #3	-9.0	0.37	1.43	1.22	1.49	1.21	4.33	8.72
BIVC-02-02 #4	-12.0	0.25	2.02	0.55	0.30	1.24	0.00	0.12
BIVC-02-03								
BIVC-02-03 #1	-5.3	0.34	1.56	0.88	0.77	1.03	1.18	3.81
BIVC-02-03 #2	-8.8	0.31	1.69	0.98	0.96	1.36	1.98	5.18
BIVC-02-03 #3	-10.8	1.34	-0.43	2.22	4.93	0.73	30.24	48.99
BIVC-02-03 #4	-12.3	0.45	1.16	0.93	0.86	0.80	3.18	7.32
BIVC-02-03A #1	-13.5	0.21	2.27	0.49	0.24	1.59	0.54	0.68
BIVC-02-04								
BIVC-02-04 #1	-14.3	0.26	1.94	0.84	0.71	1.21	0.48	1.73
BIVC-02-04 #2	-16.3	0.38	1.41	1.52	2.31	1.28	5.26	13.20
BIVC-02-04A #1	-17.5	0.27	1.91	0.90	0.81	1.11	0.00	1.09
BIVC-02-04A #2	-19.2	0.52	0.93	1.64	2.69	0.96	10.32	19.69
BIVC-02-04B #1	-20.7	0.87	0.19	2.12	4.49	0.93	21.97	33.59
BIVC-02-05								
BIVC-02-05 #1	-24.8	0.15	2.74	0.57	0.32	1.88	0.18	0.55
BIVC-02-05 #2	-28.1	0.65	0.61	1.55	2.40	1.20	10.11	19.38
Average all samples		0.42	1.47	1.27	1.61	1.19	5.92	10.86
Avg. of samples above -17.5		0.38	1.61	1.16	1.35	1.21	4.40	7.97

One of the alternatives under consideration would use a portion of the material removed from the inlet to reposition the channel midway between Bogue Banks and Bear Island to nourish the 23,831 feet of beach included in Phase 3 of the Emerald Isle beach nourishment project. Accordingly, an analysis was performed to determine the compatibility of the inlet material with the native beach material. When beach fill material is placed on the

upper portion of the beach, it undergoes a certain degree of sorting by wave action that tends to move discrete grains sizes to quasi-equilibrium positions on the active beach profile. In general, the coarser fraction of the borrow material will remain on the upper or higher energy portion of the profile while the finer grained material will be transported to deeper depths. Compatibility analyses between beach fill material and native beach material is carried out using composite characteristics that include samples of the native beach out to some depth of closure of the fill with the pre-project profile. Based on the wave climate in the Bogue Banks area and the configuration of the existing beach profile, the depth of closure appears to be approximately 20 feet below MLW (-21.5 feet NGVD). The USACE as part of an island wide Federal storm damage reduction feasibility study, collected samples of the native material for the entire length of the island from the base of the dune seaward to the 24-foot depth contour with samples being collected at 2-foot depth intervals across the profile. Four of the profiles sampled by the Corps of Engineers are located within Phase 3 of the Emerald Isle beach nourishment project. The samples collected from these four profiles out to a depth of -20 feet NGVD were used to compute the characteristics of the native beach material within the Phase 3 beach nourishment area. Table 3 provides a summary the characteristics of the samples collected at discrete points on the profile and the characteristics of the composite native material for these four profiles.

The compatibility of borrow material for use as beach fill is determined by a numerical method that compares the mean grain size and sorting characteristics of the borrow material to the mean and sorting characteristics of the native beach material. The results of that comparison yields a factor known as the overfill ratio (R_a) which is an indication of the number of cubic yards of borrow material needed to result in 1 cubic yard of sorted beach fill material. If the borrow material is completely compatible with the native material, R_a will be equal to 1.0 and the net volume of material needed will equal the gross or borrow area volume. R_a greater than 1.0 means that more material is needed from the borrow area to yield 1 cubic yard of sorted material on the beach. The overfill factor for the inlet material was determined to be 1.015. Adjusting the overfill factor for the amount of sand in the inlet material (98.75%) results in a total overfill factor of 1.03.

Table 3
Characteristics of the Native Beach Material
Phase 3 – Emerald Isle Beach Nourishment Project
(Corps of Engineers Profile Stations 962+84.91, 1033+59.23, 103+90.23, 1174+03.3)

Sample Location	Average Shell Content (% by weight)	Mean (mm)	Mean (phi units)	Standard Deviation (phi units)
Berm Crest	2.20	0.24	2.05	0.459
MHW	5.16	0.25	2.0	0.617
MSL	16.44	0.39	1.36	1.085
MLW	27.87	0.48	1.07	1.404
-3	4.87	0.22	2.19	0.611
-4	2.46	0.21	2.25	0.524
-6	1.50	0.18	2.49	0.277
-8	1.38	0.16	2.60	0.258
-10	1.63	0.15	2.70	0.332
-12	2.17	0.16	2.68	0.369
-14	1.61	0.17	2.52	0.442
-16	2.59	0.17	2.52	0.442
-18	2.59	0.16	2.60	0.563
-20	2.70	0.16	2.68	0.369
Composite	5.37	0.22	2.26	0.790

The overfill factors for the Bogue Inlet material is highly compatible with the native beach material with total sorting and winnowing losses expected to be five percent or less. This is not particularly surprising as the ebb tide delta is composed primarily of material derived from the adjacent beaches. Apart from the compatibility of the grain sizes, when material is removed from a borrow area and deposited on a beach, there are inherent differences in the volume of material removed from the borrow area compared to the volume that can be measured on the beach. Much of this difference is due to measurement error and a factor commonly referred to as shrinkage. Based on past experience, the difference between borrow area volume and the volume of sediment retained on the beach generally ranges from 10 to 20 percent. Since the material in Bogue Inlet is highly compatible with the native beach material, the total overfill factor would be around 1.15.

4.2.3 Depleted Natural Resources

According to the North Carolina Division of Coastal Management (NCDCM), Bogue Inlet is located within several NCDCM Areas of Environmental Concern. Under the NCDCM Coastal Area Management Act (CAMA), permits are necessary for development type projects proposing work in any

Areas of Environmental Concern (AEC) established by the Coastal Resources Commission. An AEC includes areas of natural importance such as 1) estuarine and ocean systems, 2) ocean hazard system, 3) public water supplies, 4) natural and cultural resource areas. Under CAMA, the proposed work cannot cause significant damage to one or more of the historic, cultural, scientific, environmental or scenic values or natural systems identified in any of the AECs listed. In addition, significant cumulative effects cannot result from a development project (NCDCM, 2003a).

The Natural Heritage Program has designated several Significant Natural Heritage Areas within the project area. Significant Natural Heritage Areas of Bogue Inlet are located on or around Huggins and Dudley Islands, West End Beach on Emerald Isle, and Hammocks Beach State Park. Significant Natural Heritage Areas include exemplary natural communities (elements of natural diversity) and various endangered plants and animals. Some examples of exemplary natural communities in the area include brackish marsh, maritime swamp forest, and salt marsh. There are several threatened and endangered animals in the area of Bogue Inlet, each of which are described in Section 4.

4.3 VEGETATION

The following sections identify the various types of vegetative habitats found within the Permit Area. These habitats were field verified by CZR, Inc. in September 2003 (see Appendix H, Biotic Mapping Report). Acreage amounts identified for each of these habitats found in both the Project and Permit Areas can be found in Table 12.

4.3.1 Maritime Hammocks

Forested maritime hammocks are typically isolated and flooded by storm surges. These forested systems are dominated by live oak (*Quercus virginiana*), loblolly pine (*Pinus taeda*), and red cedar trees with an understory of shrub thicket which can such species as include swamp bay (*Persea palustris*) and sweetbay (*Magnolia virginiana*). The dominant wind direct and influence of salt spray is usually evidenced by the sculpted vegetation. (USC, 2002; Texas Cooperative Research Unit, 2002)

Utilizing the digital aerial image collected on June 30, 2003, forested maritime hammocks were identified in the Permit Area mainly on the northeast end of Bear Island and on the south side of Dudley Island, totaling approximately 50.5 acres. See Appendix D – Biotic Community Map. Additional maritime communities found along Bear Island include maritime wet grasslands, maritime scrub, and maritime evergreen forests (S. Bland and S. Regier, pers. comm.).

The nearest upland hardwood forest is approximately 46 feet east outside the Permit Area on Emerald Isle just east of the Coast Guard Channel. The closest upland mixed forest is located inside of the Permit Area perimeter located at the northwest end of Emerald Isle just east of the Coast Guard Channel. The Permit Area perimeter is 0 feet away (inside of the Permit Area) from the nearest upland shrub area located on South Dudley Island.

The closest wetland hardwood region is 0 feet away (inside) from the permit area perimeter, just east of the Coast Guard channel. The nearest wetland mixed forest is 0 feet away from (inside) the permit area perimeter on the east side of the Western Channel. The perimeter of the permit region near south Dudley Island is located 0 feet (inside) from the closest wetland shrub area.

4.3.2 Beach and Dune Communities

High temperatures, strong winds, and varying wet and dry conditions typical of a dune environment provide unique conditions for plant species with specific adaptations. These specific adaptations include plant species that grow extensive root systems, allowing for prolific growth in unconsolidated beach sand; fleshy leaved plants that provide water storage, limiting the possibility of desiccation.

Beach and foredune environments found in the Permit Area are located on the oceanfront shorelines of both Emerald Isle and Bear Island, as well as the inlet side of Dudley Island. Bogue Banks spit contains an extensive beach and foredune system on the east side of the inlet, providing shelter to other ecosystems in the spit. Island No. 2 also contains a supratidal system of unconsolidated sands and cobbles. Sparse vegetation is found on this ephemeral island. Refer to Table 12 for acres of beach and dune habitats identified from the June 2003 aerial and September 2003 investigations.

The perimeter of the Permit Area is located 0 feet away from the nearest dune habitat, located inside and outside the permit area along the shoreline of Bear Island. The northeastern end of the Permit Area perimeter is 0 feet away (inside) from the closest unvegetated sand area. The unvegetated sand areas are located inside and outside the Permit Area on the east side of Dudley Island and the northwest side of Emerald Isle.

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., the terrestrial fringing communities (dune grass communities) were found to occur: 1) primarily on well-drained dune systems inland of the dry beach at Emerald Isle and 2) 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.

4.3.3 Salt Marsh Communities

Salt marsh communities can be found along 4,500 miles of oceanfront shoreline throughout the sounds, creeks and rivers of North Carolina (NCCF, 2003). The relatively low velocity and flat, poorly drained topographic areas found along the North Carolina coastline have provided for the extensive development of these wetlands. These systems are extremely important for filtering water, providing storage during flood events, supplying food and providing habitat for many species.

The North Carolina Coastal Resource Commission has characterized estuarine systems as an Area of Environmental Concern. These areas have been identified as "sensitive and productive coastal lands and waters where uncontrolled development might cause irreversible loss of property, public health and the natural environment" (NCDCM, 2003b).

The North Carolina Coastal Resource Commission defines coastal wetlands as "any marsh in the 20 coastal counties that regularly or irregularly floods by lunar or wind tides, and that includes one or more of the 10 plant species" identified by CAMA (NCDCM, 2003b). There are four kinds of coastal marsh habitats found in North Carolina: low marsh, high marsh, brackish marsh, and freshwater marshes. Low and high marsh environments were identified in the Permit Area and were found in the western end of Bogue Sound, Dudley Island, and the estuarine system north of Bear Island.

The boundaries of marsh vegetation communities were mapped digitally through visual interpretation of multispectral aerial photography for the Permit and Survey Areas. Marsh communities were classified as low marsh, dominated by smooth cordgrass (*Spartina alterniflora*) or high marsh, dominated by saltmeadow cordgrass (*Spartina patens*). Along with

identifying high and low marsh, fringing terrestrial communities were classified as wetland or non-wetland as well as by general vegetation type. Habitat mapping in the Permit Area was conducted by field investigations via boat access in the nearby channels. Verification of the wetland/non-wetland status of communities was determined during ground-truth investigations. Refer to Appendices B and H for the results of these surveys.

In Bogue Sound, most of the marsh systems are adjacent to disposal islands and appear to be more abundant along the east and west ends of the Sound than in the center of Bogue Sound. In addition to the 808 acres of salt and brackish marsh identified in Bogue Sound by the U.S. Fish and Wildlife Service, 339 acres of scrub-shrub wetlands were identified using aerial photography by the North Carolina Division of Coastal Management. (USFWS, 2002)

Low and high marsh environments of the Project Area are located in the western end of Bogue Sound, Dudley Island, and the estuarine system north of Bear Island. These marshes are regularly and irregularly flooded lands where plant species such as salt marsh cordgrasses (*Spartina alterniflora* and *S. patens*), glasswort (*Salicornia* spp.), salt grass (*Distichlis spicata*), and sea lavender (*Limonium carolinanum*) may be found.

The project effects on vegetative conditions will be most pronounced during active vegetative growth and development periods. Therefore, observations of these effects will be better identified at the end of the growing season in the months of September/October. Pre-construction monitoring to collect baseline conditions was conducted at the end of the growing season September 2003. Annual salt marsh monitoring will continue for three-years post-construction in September/October of each year. Results of the September 2003 monitoring are provided in Appendix H – Salt Marsh Monitoring Report.

High Salt Marsh

Cowardin (1979) classifies high marsh as an estuarine intertidal emergent wetland or palustrine, emergent wetland. High salt marsh environments are irregularly flooded lands where plant species such as saltmeadow cordgrass (*Spartina patens*), glasswort (*Salicornia* spp.), salt (or spike) grass (*Distichlis spicata*), and sea lavender (*Limonium spp.*) may be found. Saltmeadow cordgrass grows at the seaward edge of the high marsh, just above the high water line, providing habitat for a variety of waterfowl and songbirds, as well as other types of wildlife indigenous to the area.

Based on the habitat mapping and field verifications, high salt marsh areas were in irregularly flooded transitional zone. These areas were found mostly

between low marsh and shrub-scrub communities throughout the Project and Permit areas of Bogue Inlet. Isolated areas typical of this habitat were also found in several inter-dunal swales or low depressions throughout Bear Island. Vegetation of this community is characteristic of transitional intertidal areas and areas with a high water table in which saltmeadow cordgrass (*Spartina patens*) is the dominant vascular plant. However, sea-oxeye (*Borrichia frutescens*), salt grass (*Distichlis spicata*), rushes (*Fimbristylis* spp.), and shrub species such as marsh elder (*Iva frutescens*) and silverling (*Baccharis halimifolia*) coexist. Soils of this community are mapped as Carteret sand and Bohicket silty clay loam.

The nearest high marsh community is located to the north of the inlet complex, on the east side of the western channel, inside of the Permit Area.

Low Salt Marsh

Low salt marsh environments are regularly flooded with the tides and are characterized by organic mats with salt marsh (smooth) cordgrass (*Spartina alterniflora*) as the dominant vegetative species. Smooth cordgrass thrives in low marsh habitats where conditions in the soil are anoxic and where the average water table is 10.2 cm (4 inches) above ground level. This plant is found dominating the salt marsh system between mid- and high tide levels. The upper or inland boundary of this plant is limited by *Spartina patens* on the seaward side of the high marsh.

The ground-truthing and mapping efforts of marsh habitats and fringing terrestrial communities (scrub-shrub, pine forest, hardwood forest, mixed forest, dune grasses, and unvegetated sand) in September 2003 revealed that low marsh was the most extensive of all biotic communities mapped within the Survey and Permit Area. This community is restricted to the intertidal zone in which smooth cordgrass (*Spartina alterniflora*) is the predominant vascular plant. However, near mean high water, glasswort (*Salicornia* spp.) and sea lavender (*Limonium carolinianum*) become more common. Strong zonation also occurs in the higher parts, with zones of black needle rush (*Juncus roemerianus*) dominating. In the Project Area, smooth cordgrass was found to be less than three feet in height (see Appendix H –Saltmarsh Monitoring Report). Soils of this community are mapped as Carteret sand and Bohicket silty clay loam. Both soil types are defined as nearly level, frequently flooded, and very poorly drained. These soils are normally found in tidal marshes on the sound side of the barrier islands less than 3 feet above sea level.

The nearest low marsh is 0 feet away (inside) of the Permit Area on the east side of the Western Channel.

4.3.4 Submerged Aquatic Vegetation (SAV) Communities

Dominant, year-round seagrass species of North Carolina include both eelgrass (*Zostera marina*) and Cuban shoal grass (*Halodule wrightii*). Widgeon grass (*Ruppia maritime*) is otherwise commonly found growing in brackish water and low-saline pools of salt marshes. Seagrass species that dominate seasonally are *Z. marina* from winter to early summer, and *H. wrightii* from late summer through early fall. (Mallin et al., 2000)

Seagrass habitats are essential to sediment trapping and stabilization, nutrient uptake, and fishery habitats. These habitats also produce dissolved oxygen and assist in wave minimization, as well as supply detritus to the food chain. In addition to their photosynthetic properties, seagrass beds are also known to serve as a protective environment for the larval development of many marine species. Larval and juvenile stages of gag grouper (*Mycteroperca microlepis*), gray snapper (*Lutjanus griseus*), mullets *(Mugil* spp.), spot croaker (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonius undulates*), flounder (*Paralighthys* spp.), fish of the herring Family (Clupeidae) and others are frequently found in SAV (ASFMC, 1997). The bay scallop (*Argopecten irradians*) is an epibenthic, suspension feeding bivalve that is typically found inhabiting seagrass beds during both the juvenile and adult life stages. The blue crab (*Callinectes sapidus*) and the pink shrimp (*Penaeus duorarum*), are also closely associated with seagrass habitat.

Seagrass habitats are characterized as Submerged Aquatic Vegetated (SAV) habitats, and the distribution and composition of seagrass communities are influenced by several factors; among the most important are light, salinity, wave action, and nutrient levels. Cowardin (1979) classifies SAV as an estuarine subtidal aquatic bed system which are most often found in the sheltered environments of shallow estuarine waters. High energy sand shoals are typically formed in the coastal bays and sounds of North Carolina and can be found in Bogue Inlet. These types of sand shoals are usually colonized by patchy seagrass colonies (Irlandi, 1998). Historically, seagrass beds around Bogue Inlet have been observed in areas behind Bear Island, around Dudley Island and throughout western Bogue Sound. USFWS (2002) stated that "the distribution of seagrasses within Bogue Sound is estimated at over 6,100 acres, consisting of a mix of widgeon grass, eelgrass, and shoalgrass."

In 1992, NOAA surveyed over 6,100 acres of SAV habitat in Bogue Sound. However, due to the time that has passed since NOAA's 1992 survey, the National Marine Fisheries Service requested that the Town of Emerald Isle conduct a pre-construction survey for SAV within the project area. Comparisons between NOAA's 1992 photo-interpreted seagrass map and June 30, 2003 digital imagery, combined with ground-truthing efforts

conducted in September 2003 showed that SAV or seagrass beds were primarily found in the high salinity areas of Bogue Sound generally in waters less than six feet in depth. The dominant seagrass species occurring within the Permit and Survey Area are eel grass (*Zostera maritima*) and shoal grass (*Halodule wrightii*). Dense seagrass beds are also found on the east side of Eastern Channel and Banks Channel. Scattered seagrass beds were identified north of Dudley Island and adjacent to Western Channel. The substrate type where SAV or seagrass 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 away (inside) 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 (Musick and Limpus, 1997). 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 and Kenney, 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; USFWS, 2003c). 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. 1995a). Species compositions of turtles captured by fisherman in inshore waters consisted of loggerheads (71%), greens (17%), and Kemp's Ridley (12%) (Epperly et al., 1995b). Public sightings reported all five species in inshore waters with leatherbacks and hawksbills being observed infrequently (Epperly et al., 1995a). 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. (Epperly et al., 1990)

Although sea turtles spend most of their lives in the ocean, female turtles must return to land to nest (Miller, 1997). Therefore, beaches provide an important habitat for sea turtle survival. Female sea turtles show nest site fidelity by returning to the nesting beach where they hatched (Limpus et. al., 1984; Limpus, 1985). 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 (Hendrickson, 1982; Mortimer, 1982). Female sea turtles typically emerge from the water at night, select a nest site, and excavate a chamber to deposit her eggs. Females cover the nest and return to sea allowing the eggs to develop for 6 to 13 weeks depending upon the species of sea turtle and the temperature of the nest (Miller, 1985). Hatchlings will emerge at night and migrate from the nest to the ocean where they begin their offshore migration into the open ocean.

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. Loggerheads have also been found to regularly nest in Virginia (DeGroot and Shaw, 1993). In addition to loggerheads, green sea turtles and leatherbacks regularly reproduce on North Carolina beaches, although in much smaller numbers (Godfrey, pers. comm.). 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 (USFWS, 2003c).

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 1st and November 15th, 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 (Godfrey, pers. comm.).

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 and Musick, 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 2002 (Godfrey, pers. comm.) are presented in Table 4 - Loggerhead Sea Turtle Nesting History on Bogue Banks. Nest numbers from 1990 to 2002 for Bear Island are presented in Table 5 - Loggerhead Sea Turtle Nesting History on Bear Island. During the 2002 nesting season 38 emergences by loggerhead turtles were observed, nineteen of which were false crawls (NCWRC, 2002). 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 Bear Island that same year (Godfrey, pers. comm., Jan. 14, 2003). The locations of both loggerhead and green sea turtle nests recorded on Bogue Banks and Bear Island 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 (1990-2002)

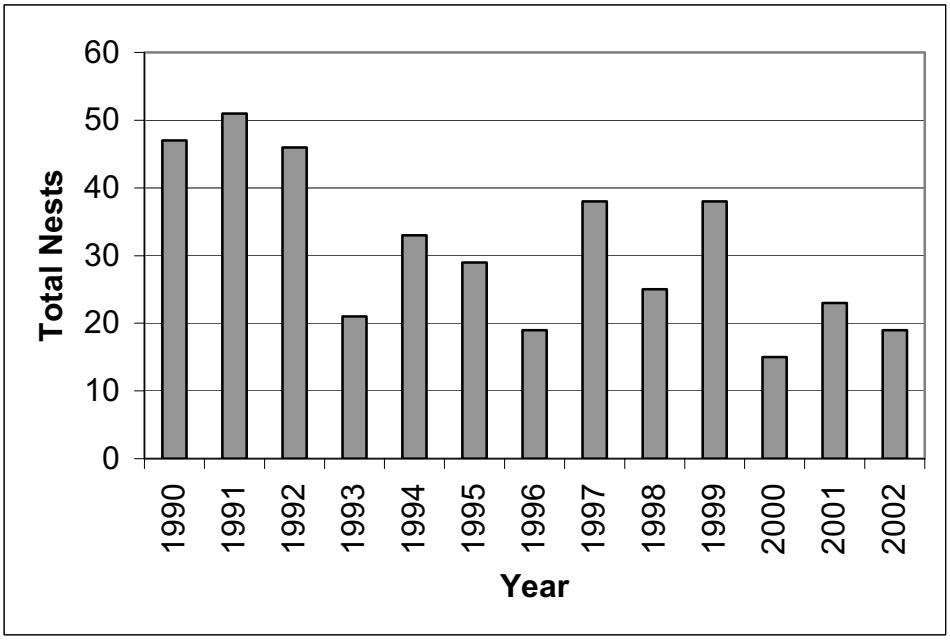
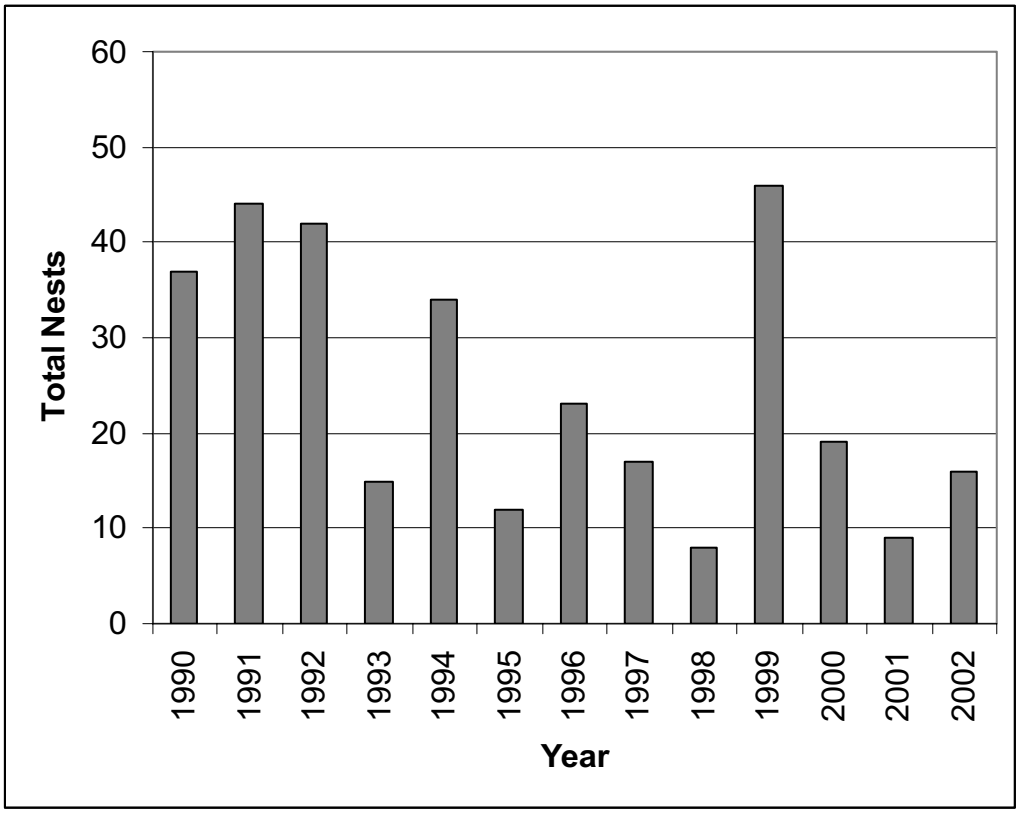


Table 5
Loggerhead Sea Turtle Nesting History on Bear Island (1990-2002)



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 since 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 (Mihnovets, 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 following section reviews and describes the threatened and endangered whales and manatee found within the vicinity of Bogue Inlet.

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, 1991a).

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, 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 many include areas south of Cape Hatteras and begin as early as October (NMFS, 1991b).

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.

4.4.3 Birds

Piping Plover

The piping plover (*Charadrius melodus*) is listed as threatened under the Federal Endangered Species Act. The piping plover is present year round in North Carolina and utilizes the coast for nesting, overwintering and migrating. The North Carolina coastline is important to piping plovers for wintering, breeding, and migration. Furthermore, the west end of Bogue Banks and the east end of Bear Island are listed as Critical Habitat for wintering piping plover and requires additional protection under Federal regulations (USFWS, 2003j).

Plovers have been documented arriving at their breeding grounds from late May. By mid-July, adults and young begin to depart for their 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) (Cameron, 2002).

No piping plovers were observed nesting in any of the four monitoring areas established for the project. Pre-construction monitoring has shown that piping plovers are mostly found foraging in the intertidal zones of Bogue Banks, Bear Island, and Island Nos. 1 and 2. Refer to Appendix H for pre-construction bird monitoring results. Banding combinations observed on the piping plovers during monitoring events were confirmed as birds from the Great Lakes (Stucker, 2004), Saskatchewan (Cameron, 2004), and Eastern Canada regions (McKnight, 2003).

Critical Habitat for Wintering Piping Plover

According to the Endangered Species Act of 1973, piping plovers are considered a threatened species when on their wintering grounds. The primary constituent elements within piping plover wintering grounds include components that are considered critical habitat to support foraging, sheltering, roosting, or have the capacity to develop those components. As a result, the USFWS under 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, 2001a).

The areas that contain the primary constituent elements are found in geologically dynamic coastal areas, such as migrating inlets, that can support or have the potential to support intertidal beaches, mud flats, sand flats and shoals above the annual high tide line, and associated dune systems. The

essential components of intertidal flats, sand, and/or mud flats with no or very sparse emergent vegetation located near a sandy beach utilized for feeding that can also be used for roosting, have been identified as preferred wintering areas (USFWS, 2002).

Intertidal sand and/or mud flats are 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 Federal 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, 2002). 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. To date, 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. The plant is tolerant 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 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, 2003o). 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 most up-to-date range-wide reports indicate that seabeach amaranth is found in only one-third of its historic range. (USFWS, 1993) There are 55 known plant populations, of which 34 are in North Carolina with the remaining smaller plant populations outside of North Carolina. 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 survey data for the dry beach and includes 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 (4 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 to 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 a primary food source 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 food source for these 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 depend on variable particle sizes and available interstitial pore space in the substrate. 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 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.

Research studies conducted along the eastern Atlantic shoreline have focused on the recovery rate of infaunal macroinvertabrate communities from beach nourishment activities (National Research Council, 1995). Results of the subaerial infaunal assemblages of the beach environments documented temporary alterations (few weeks to months) in the species abundance, diversity and composition. Findings from these studies indicate that the effects from nourishment activities in the dredged area will have an initial short-term negative effect on the species abundance, diversity and

composition; however these numbers return to pre-construction conditions within one year.

Nelson (1985) indicates that organisms that reside in intertidal zones are more adaptable to fluctuations in their environment, including high sediment transport and turbidity levels. This may support the reasoning for some organisms to withstand burial up to 10cm. Other studies reported by Maurer (National Research Council, 1995) supported the burial capabilities of nearshore species, which found that these species were capable of burrowing through sand up to 40 cm. These findings support a temporary decrease in population, followed by recovery.

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. The macroinvertebrate and infaunal sampling plan developed for the project includes the collection and analysis of species in intertidal habitats (between mean low water and mean high water) of the Permit Area (see Section 6.2).

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 systems are being conducted on a seasonal basis during the months of April, July, October, and January. Sampling for pre-construction monitoring was conducted on a seasonal basis during the months of April, July, October 2003, and January 2004.

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 Section 6.2 - Macroinvertebrate/Infaunal Monitoring Plan .

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 intertidal shoal versus marsh species. Sampling locations along the proposed channel are located 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 shows variation 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	Total Taxa	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.

Table 7
July 2003 Monitoring Event
Dominant Taxa

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

A summary of October 2003 monitoring results are presented in Table 7a. These results show a decrease in species diversity and abundance which may be representative of the effect of Hurricane Isabel (September 21, 2003).

Table 7a
October 2003 Monitoring Event
Dominant Taxa

Station Location	Dominant Taxon	Total Taxa	Percent of Total Sample
No. 1 Bogue NW	Amphipoda (*Hausterius Canadensis*)	1	100%
No. 2 Bogue Central	Decapoda (*Emerita talpoida*)	1	100%
No. 3 Bogue SE	Decapoda (*Emerita talpoida*) / Bivalva (*Donax variabilis*)	5	29/29%
No. 4 Inlet NE	Polychaeta (*Leitoscoloplos sp.*)	1	100%
No. 5 Inlet Central West	Amphipoda (*Acanthohaustorius sp. / Polychaeta (Lietoscoloplos sp.*)	2	50/50%
No. 6 Inlet SW	Amphipoda (*Neohaustorius schmitzi*) / Polychaeta (*Sclolelepis squamata*)	2	50/50%
No. 7 Island #2 (Reference Site)	No species found	0	0%
No. 8 Marsh (Bogue)	Bivalvia (*Geukensia demissa*)	4	57%
No. 9 Marsh (Dudley)	Isopoda (*Sphaeroma quadridentata*)	1	100%
No. 10 Marsh (Bear)	Polychaeta (*capitella capitata*)	3	71%

Table 7b represents dominant benthic species found during the January 2004 monitoring event. Species diversity is well represented at sample station No. 7 compared to the salt marsh and inlet sample stations.

Table 7b
January 2004 Monitoring Event
Dominant Taxa

Station Location	Dominant Taxon	Total Taxa	Percent of Total Sample
No. 1 Bogue NW	Amphipod (*Haustorius* sp. D)	2	75%
No. 2 Bogue Central	Decapoda (*Emerita talpoida*)	2	61%
No. 3 Bogue SE	Decapoda (*Emerita talpoida*)	1	100%
No. 4 Inlet NE	Isopoda (*Amkusanthura magnifica*)	4	69%
No. 5 Inlet Central West	Polychaeta (*Leitoscoloplos fragilis*) / Polychaeta (*Paraonis fulgens*)	2/2	40/40%
No. 6 Inlet SW	No species found	0	N/A
No. 7 Island #2 (Reference Site)	Gastropoda (*Olivella pusilla*)	9	33%
No. 8 Marsh (Bogue)	Decapoda (*Uca pugnax*)	2	75%
No. 9 Marsh (Dudley)	No species found	0	N/A
No. 10 Marsh (Bear)	Decapoda (*Uca pugnax*)	1	100%

See Appendix H for benthic community results from April, July, and October 2003, and January 2004 monitoring events.

Shellfish

Shellfish are an important resource in Bogue Inlet. The structures that shellfish create, such as beds and reefs, is used by many species of fish and invertebrates (Burrel, 1986). Oyster reefs and shellfish beds are designated as Essential Fish Habitat (EFH) by the South Atlantic Fishery Management Council (SAFMC). Shellfish are also 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 oysters and hard clams can be found (NCDMF, 2002). Bay scallops are typically found in submerged aquatic vegetated (SAV) habitat.

According to the NCDMF, the stock status of hard clams (*Mercenaria mercenaria*) is unknown because there is no data available to assess the population size (NCDMF, 2001a). 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, 2003c). 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) (NCDMF, 2001a). 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 (68ºF). 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, 2001a). In 1990 and 1991 the NCDMF Shellfish Mapping Program identified 15.03 acres of Strata W in and around Bogue Inlet. Samples collected between December 1990 and November 1991 found approximately 76.82 shellfish per square meter in Strata W of Bogue Inlet. This equates to approximately 1,025 bushels of shellfish (1,013 bushels oysters and 12 bushels clams) per acre.

Oysters are long-lived (40 years) and are capable of forming large reefs. According to the North Carolina Division of Marine Fisheries, 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. *C. virginica* can thrive in the most rigorous of habitats (Burrel, 1986). The preferred habitat for eastern oysters is from just below mean low water to 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 eastern oyster can be found in both shellfish habitats Strata V and W. The shellfish population in Strata V is composed of 100% oysters and Strata W is composed of 98% oysters and 2% clams. In NCDMF's 1990 and 1991 investigations, 24.06 shellfish were found per square meter in Strata V (approximately 320 bushels of oysters). September 2003 habitat mapping investigations conducted by CZR, Inc. found that the low marsh habitat was representative of Strata V habitat and was mapped as such (Appendix C - Shellfish Habitat Map 2003).

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, 2003e). 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, 2003a). 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, 2002).

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 (66.2°F) for egg development, above 20°C (68°F) for larval development, and 10 to 30ºC (50 to 86°F) 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 82.4°F) for egg survival, and 20 or 25ºC (68 or 77°F) 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 97.9°F) 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 (68°F) and stopped below 9ºC (48.2°F) and above 31ºC (87.8°F). 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 Map) 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 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, 2003b).

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, 2003b).

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, 2003b).

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 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, 2003b).

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, 2003b.)

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. 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 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 (48ºF), 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 (52ºF). 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 - Essential Fish Habitat Assessment.

Table 9 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.

TABLE 9
ESSENTIAL FISH HABITAT SPECIES OF THE ATLANTIC WATERS
BOGUE INLET, NORTH CAROLINA

SAFMC - South Atlantic Fisheries Mangement Council; **ASMFC** - Atlantic States Marine Fisheries Council; **MAFMC** - Mid-Atlantic Fisheries Management Council; **NCDMF** - North Carolina Division of Marine Fisheries; **NM** - Nautical Mile; / = not likely to occur in area

Taxa	Common Name	NMFS (Highly Migratory Species)	SAFMC (3-200NM)	MAFMC (3-200 NM)	Management Designation		Probable Life Stage in Project Area	Fish Habitat Ecology	Estuarine Emergent Wetlands	Submerged Aquatic SAV (SAV) and Seagrass Beds	Oyster Reefs and Shell Banks	Intertidal Flats	Estuarine, Marine Water Columns, and Creeks (Subtidal)	Shallow Sand and Muddy Bottoms	Feeding Habits
					ASMFC (0-3 NM)	NCDMF Stock Status (2002)									
Seriola rivoliana	Almaco jack		X			Concern	/	Pelagic; rarely near shoreline, 15 to 160 m (49 to 525 ft); Juv: around floating objects (*Sargassum*)							fish, invertebrates
Anguilla rostrata	American eel				X	Unknown	Juvenile/ Adult	Catadromous: ocean, estuaries, freshwater streams, rivers, brakishwater, Juv: estuaries, lakes, rivers, SAV, soft bottom	X	X		X	X	X	invertebrates and small fish
Alosa sapidissma	American shad				X	Concern	Juvenile/ Adult	Anadromous: ocean waters, move to rivers to spawn; Juv: rivers, sounds					X		plankton, mainly copepods and mysids, fish
Micropogonias undulatus	Atlantic croaker				X	Concern	Juvenile/ Adult	Inhabit mud and sand-bottom areas, coastal waters, estuaries; Juv: estuaries	X					X	crustaceans, worms, mollusks, detritus, fish
Brevoortia tyrannus	Atlantic menhaden				X	Viable	Juvenile/ Adult	Estuarine-dependent; along the coast; Juv: inlets and estuary	X			X	X		phytoplankton
Chaetodipterus faber	Atlantic spadefish		X			Concern	Juvenile/ Adult	Juv: estuarine, shallow water; Adult: sandy beaches, shallow coastal waters, artificial reefs; 3-35 m (10-115 ft)	X			X	X		invertebrates, plankton
Acipenser oxyrinchus	Atlantic sturgeon				X	Overfished	Juvenile/ Adult	Rivers, estuaries, shallow waters of continental shelf; Juv: brackish water, freshwater	X			X	X		molluscs, fish, worms, invertebrates, gastropods, shrimp
Seriola zonata	Banded rudderfish		X			Concern	Juvenile/ Adult	Coastal waters, inshore around structures, anywhere from surface to seafloor				X	X		fish, shrimps
Centropristis ocyurus	Bank sea bass		X			Concern	/	Hardbottom, shipwrecks to 55 m (180 ft), deep water							small fish, benthic invertebrates
Argopecien irradians	Bay Scallop					Concern	Juvenile/ Adult	Estuarine-dependent; SAV (eelgrass)	X	X	X				diatoms
Thunnus obesus	Bigeye tuna	X					/	Oceanic							fish, cephalopods, crustaceans
Myceteroperca bonaci	Black grouper		X			Concern	Juvenile	Adult: offshore, over 18 m (60 ft); Juv: may occur inshore in shallow water				X			fish, cephalopods, crustaceans
Anisotremus surinamensis	Black margate		X			Concern	Juvenile/ Adult	Over rocky bottoms, ledges, wrecks, nearshore reefs, surf areas, around groins					X		crustaceans, urchins, molluscs, fish
Centropristis striatus	Black sea bass		X	X	X	Concern	Juvenile	Adult: Offshore over wrecks, rubble, reefs, rocky bottoms; Juv: estuaries and offshore	X						fish, crustaceans, shellfish
Apsilus dentatus	Black snapper		X			Concern	Juvenile/ Adult	Rocky bottoms; Shallow waters around reefs and SAV		X					fish, cephalopods, tunicates
Lutjanus buccanella	Blackfin snapper		X			Concern	/	Deeper waters over rocky bottoms, near drop-offs and ledges							fish
Callinectes sapidus	Blue crab					Concern	Juvenile/ Adult	Highly migratory; ocean waters, freshwater, sounds, rivers					X		plankton, invertebrates, fish, plants, mollusks, crustaceans, organic debris
Makaira nigricans	Blue marlin	X					/	Oceanic							fish, cephalopods
Haemulon sciurus	Blue stripe grunt		X			Concern	Juvenile	Juv: *Thalassia* beds; Adults: migrate to offshore reefs		X					crustaceans, bivalves, small fish
Thunnus thynnus	Bluefin tuna	X					Juvenile/ Adult	Oceanic, seasonally comes close to shore					X		small schooling fish, squids, red crabs
Pomatomus saltatrix	Bluefish			X	X	Recovering	Juvenile/ Adult	Juv: estuaries, bays, coastal waters Adult: open ocean, large embayments, estuaries	X				X		fish, crustaceans, polychaetes
Caulolatilus microps	Blueline tilefish		X			Concern	Juvenile/ Adult	Surf beaches, estuaries, brackish water, shallow coastal waters	X				X		benthic invertebrates, fish
Ameiurus nebulosus	Brown bullhead					Unknown	Juvenile/ Adult	Rivers, impoundments, rarely enters brackish waters					X		mollusks, insects, leeches, crayfish, plankton
icialurus punctatus	Channel catfish					Unknown	Juvenile/ Adult	Rivers, streams, reservoirs					X		fish, crustaceans, clams, snails, insects, sm. Mammals
Ameiurus catus	White catfish					Unknown	Juvenile/ Adult	Mud-bottom pools, open channels, rivers, impoundments					X		aquatic insects, crustaceans, worms, and smaller fish
Ameiurus natalis	Yellow bullhead					Unknown	Juvenile/ Adult	Sluggish current over soft substrate in creeks, large rivers, impoundments					X		aquatic SAV, crayfish, larvae, crustaceans

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					ASMFC (0-3 NM)	NCDMF Stock Status (2002)									
Scomberomorus regalis	Cero		X				Juvenile/ Adult	Over wrecks, along ledges at depths 1-20 m (3.3 - 66 ft); over coral reefs							crabs, fish, squid
Rachycentron canadum	Cobia		X				Juvenile/ Adult	Over mud, sand, and gravel bottoms, inshore and offshore, estuaries	X			X	X	X	crabs, fish, squid
Epinephelus fulvus	Coney		X			Concern	/	Shallow and deep water, hides in caves or under ledges							small fish, crustaceans, shrimp
Lutjanus cyanopterus	Cubera snapper		X			Concern	Juvenile	Juv: inshore in SAV; adult: offshore or nearshore over wrecks, reefs, and ledges		X					fish, shrimps, crabs
Lutjanus jocu	Dog snapper		X			Concern	Juvenile	Juv: estuaries, rivers adult: offshore rocky reefs	X				X		fish, benthic invertebrates, gatropods, cephalopods
Coryphaena hippurus	Dolphin fish		X			Viable	Juvenile	Juvs: found near the coast, with floating *Sargassum* ; Pelagic, deep water, close to surface					X		fish, zooplankton, crustaceans, squid
Crassostrea virginica	Eastern oyster					Concern	Juvenile/ Adult	Intertidal, subtidal, estuarine	X		X	X	X		algae, plankton, and detritus
Haemulon flavolineatum	French grunt		X			Concern	Juvenile	Juv: nearshore SAV; Adults: rocky reefs, under ledges		X					small crustaceans
Myceteroperca microlepis	Gag grouper		X			Recovering	Juvenile/ Adult	Juv, larvae: estuaries and SAV; Adults: offshore on rocky bottom, inshore on rocky or SAV bottom	X	X					fish, crabs, shrimp, cephalopods
Chaceon fenneri	Golden crab		X				/	Deep ocean, waters over continental shelf, EFH areas							zooplankton
Lopholatilus chamaeleonticeps	Golden tilefish		X	X		Concern	/	Over mud, rock, sand bottom; continental shelf, 80-540 m (262-1772 ft), ledges							shrimp, crabs, fish, squid, bivalves, holothurians
Epinephelus itajara	Goliath grouper		X			Concern	/	Shallow, inshore areas, rock or mud bottoms, brackish estuaries; not commom north of Florida							crustaceans, turtels, fish, stingrays
Lutjanus griseus	Gray snapper		X			Concern	Juvenile/ Adult	Coastal and offshore waters; rocky areas, estuaries, rivers (juv)	X				X		fish, shrimp, crabs, gastropods, cephalopods, plankton
Balistes carolinensis	Gray triggerfish		X			Concern	Juvenile/ Adult	Bays, harbors, lagoons, reefs; Juv: among *Sargassum*					X		benthic invertebrates; mollusks, crustaceans
Epinephelus cruentatus	Graysby		X			Concern	Juvenile/ Adult	Inhabits SAV (*Thalassia)* beds, coral reefs, rocky reef ledges		X					shrimp, fish
Seriola dummerili	Greater amberjack		X			Concern	Juvenile/ Adult	Deep water, will enter coastal bays					X		fish, invertebrates
Menticirrhus littoralis	Gulf kingfish					Unknown	Juvenile/ Adult	Sandy bottoms of surf zone, seasonal movement from estuarine and nearshore waters to offshore waters	X				X		worms, crustaceans
Mercenaria mercenaria	Hard clam					Unknown	Juvenile/ Adult	Estuarine-dependent; sandy bottoms, SAV bottoms	X	X	X			X	diatoms
Alosa mediocris	Hickory shad				X	Unknown	Juvenile/ Adult	Anadromous: ocean waters, move to rivers to spawn; Juv: estuaries, ocean waters	X				X		fish, squid, crustaceans, fish eggs
Lachnolaimus maximus	Hogfish		X			Concern	Juvenile/ Adult	Over open bottoms or coral reef areas; lagoons					X		molluscs, crabs, sea urchins
Calamus bajonado	Jolthead porgy		X			Concern	Juvenile/ Adult	Coastal waters, vegetated sand bottoms		X			X		sea urchins, crabs, molluscs
Scomberomorus cavalla	King mackerel		X				Juvenile/ Adult	Along beaches and near mouths of inlets and coastal rivers				X	X		fish, penaid shrimp, squid
Calamus nodosus	Knobbed porgy		X			Concern	/	Over reefs, ledges, wrecks and other hard bottom areas							gastropods, crabs, sea urchins, bivalves, other invertebrates
Lutjanus synagris	Lane snapper		X			Concern	Juvenile/ Adult	Over all types of bottoms, but mainly coral reefs and SAV sandy areas		X				X	fish, crabs, shrimp, worms, gastropods, cephalopods
Seriola fasciata	Lesser amberjack		X			Concern	/	Coastal pelagic or demersal							squid, fish
Euthynnus alletteratus	Little tunny		X				Juvenile/ Adult	Neritic waters close inshore					X		crustaceans, fish, squid, heteropods, tunicates

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					ASMFC (0-3 NM)	NCDMF Stock Status (2002)									
Lutjanus mahogoni	Mahogany snapper		X			Concern	Juvenile/ Adult	Shallow waters over rocky bottoms, sandy or SAV areas		X		X		X	fish, shrimps, crabs, cephalopods
Haemulon album	Margate		X			Concern	Juvenile/ Adult	SAV, sand flats, wrecks		X		X		X	benthic and subsurface invertebrates
Epinephelus mystacinus	Misty grouper		X			Concern	/	Deep water, 100-400 m (328-1312 ft); juv: sometimes 30m (98 ft)							fish, crustaceans, squid
Lophius americanus	Monkfish			X		Overfished	Juvenile/ Adult	Inshore out to depths greater than 800 m (2625 ft); most common in depths 70 to 100 m (230-328 ft)					X		fish, sharks, sea birds
Lutjanus analis	Mutton snapper		X			Concern	Juvenile	Continental Shelf; Adults: among rocks; Juv: over sandy, SAV bottoms		X				X	fish, shrimp, crabs, cephalopods, gastropods
Epinephelus striatus	Nassau grouper		X			Concern	Juvenile/ Adult	From shoreline to at least 90 m (295 ft) depth, close to caves; Juv: SAV		X			X		fish, crabs, crustaceans, molluscs
Menticirrhus saxatilis	Northern kingfish					Unknown	Juvenile/ Adult	Mud or sand-mud bottom types: seasonal movement from estuarine and nearshore waters to offshore waters	X				X	X	worms, crustaceans
Canthidermis sufflamen	Ocean triggerfish		X			Concern	Juvenile/ Adult	Over rocky reefs, sand and SAV areas		X				X	benthic invertebrates
Penaeus setiferus	White shrimp		X			Viable	Juvenile/ Adult	Estuarine, palustrine, intertidal marshes and flats, subtidal flats, SAV	X	X		X	X		algae, worms, fish, crabs, other shrimp
Penaeus aztecus	Brown shrimp		X			Viable	Juvenile/ Adult	Estuarine, palustrine, intertidal marshes and flats, subtidal flats, SAV	X	X		X	X		algae, worms, fish, crabs, other shrimp
Penaeus duorarum	Pink shrimp		X			Viable	Juvenile/ Adult	Estuarine, palustrine, intertidal marshes and flats, subtidal flats, SAV	X	X		X	X		algae, worms, fish, crabs, other shrimp
Etelis oculatus	Queen snapper		X			Concern	/	Offshore over rocky bottoms of continental shelf to 137 m (450 ft)							small fish, squid
Balistes vetula	Queen triggerfish		X			Concern	Juvenile/ Adult	Rocky or coral areas, sand and SAV areas		X				X	benthic invertebrates
Sciaenops ocellatus	Red drum		X	X	X	Overfished	Juvenile/ Adult	Sand and sandy mud bottoms in coastal waters and estuaries; surf zone; oyster reefs and shell banks	X		X		X	X	crustaceans, molluscs, fish
Epinephelus morio	Red grouper		X			Concern	Juvenile/ Adult	Rocky and muddy bottoms; juv: shallow water						X	fish, invertebrates
Epinephelus guttatus	Red hind		X			Concern	/	Shallow reefs and rocky bottoms; wrecks and ledges; 18 to 110 m (59-361 ft); rare north of Florida							crustaceans, fish, and octopods
Pagrus pagrus	Red porgy		X			Concern	Juvenile/ Adult	Rock, rubble, or sand bottoms; Juv: SAV		X				X	crustaceans, fish, molluscs
Lutjanus campechanus	Red snapper		X			Concern	Juvenile	Rocky bottoms; Juv: shallow waters, over sand or muddy bottoms						X	fish, shrimp, crabs, worms, cephalopods, plankton
Epinephelus adscensionis	Rock hind		X			Concern	/	Rocky inshore areas or deep reef bottoms, to depths of 76.2 m (250 ft); wrecks, ledges; rare north of Florida							crabs, fish
Centropristis philadelphicus	Rock sea bass		X			Concern	/	Offshore sandy and muddy bottoms; hardbottom, rocks, jetties, and ledges							invertebrates, fish, squid, plankton, crustaceans
Sicyonia brevirostris	Rock shrimp		X				/	Sand bottom habitats; 18 -182 m (59-597 ft) in depth							algae, worms, fish, crabs, other shrimp
Istiophorus platypterus	Sailfish	X					Juvenile/ Adult	Oceanic epipelagic; waters close to coasts					X		fish, crustaceans, cephalopods
Calamus calamus	Saucereye porgy		X			Concern	Juvenile	Juv: SAV (*Thalassia)* sandy bottoms; Adults: coral areas		X				X	molluscs, benthic invertebrates, crustaceans
Mycteroperca phenax	Scamp		X			Concern	Juvenile	Adults: deeper waters; inshore and offshore reefs, ledges, *Oculina* coral reefs, depths of 30 to 100m (98-328 ft) in N. Carolina;	X				X		fish, squid, crustaceans
Lutjanus apodus	Schoolmaster		X			Concern	Juvenile	Shallow, clear water over coral reef, near corals / gorgonians; Juv: sand bottoms with or without SAV, muddy bottoms of lagoons,	X	X			X	X	crustaceans, fish, invertebrates
Stenotomus chrysops	Scup		X	X	X	Overfished	Juvenile/ Adult	Intertidal and subtidal habitats, over sand, silty-sand, shell, mud, mussel beds and eelgrss, wrecks, artificial reefs, on or near		X	X	X	X	X	crustaceans, benthic invertebrates, squid, zooplankton, fish

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					ASMFC (0-3 NM)	NCDMF Stock Status (2002)									
Carcharhinus obscurus	Dusky shark	X				Overfished	Juvenile/ Adult	Surf zone to well offshore; surface to 400 m (1312 ft) depths					X		bony fish, sharks
Carcharhinus brevipinna	Spinner shark	X				Overfished	Juvenile/ Adult	Nearshore to offshore, over continental shelf					X		fish, octopods, squids, cuttlefish, small sharks
Galeocerdo cuvier	Tiger shark	X				Overfished	Juvenile/ Adult	Near surface to depths of 140 m (459 ft), on or adjacent to continental shelves, river estuaries, lagoons	X				X		fish, sharks, rays, marine mammals, sea turtles, seabirds, more
Carcharius taurus	Sand tiger shark	X				Overfished	Juvenile/ Adult	Nearshore from the surf zone, shallow bays to at least 191 m (627 ft) on the outer continental shelves					X		fish, small sharks, rays, squids, crabs, and lobsters
Carcharhinus plumbeus	Sandbar Shark	X	X			Overfished	Juvenile/ Adult	Inshore and offshore, bays, river mouths, harbors					X		bony fish, sharks, cephalopods, shrimp
Rhizoprionodon terraenovae	Atlantic sharpnose	X				Overfished	Juvenile/ Adult	Continental shelves, from the intertidal to deeper waters, surf zone off sandy beaches, estuaries, bays, river mouths	X			X	X		fishes, shrimps, crabs, segmented worms and molluscs
Squalus acanthias	Spiny dogfish			X	In development	Overfished	Juvenile/ Adult	Inshore and offshore, enclosed bys and estuaries, can enter freshwater					X		fish, mollusks, crustaceans, other invertebrates
Archosargus probatocephalus	Sheepshead		X			Concern	Juvenile/ Adult	Bays and Estuaries, brackish water, freshwater, around pilings, jetties	X				X		molluscs, crustaceans
Lutjanus vivanus	Silk snapper		X			Concern	/	Near edge of continental shelf, deeper waters, below 200 m (656 ft), shallow water at night							fish, crustaceans, gastropods, cephalopods, urochordates
Epinephelus niveatus	Snowy grouper		X			Concern	Juvenile	Adults: well offshore on rocky bottoms, deep as 244 m (800 feet); Juv: can be found inshore							fish, gastropods, cephalopods, brachyuran crustaceans
Paralichthys lethostigma	Southern flounder					Overfished	Juvenile/ Adult	Estuarine dependent, nearshore waters; Juv: inlets, muddy bottoms, estuaries	X			X	X	X	fish, crabs, shrimp
Menticirrhus americanus	Southern kingfish					Unknown	Juvenile/ Adult	Mud or sand-mud bottom types; seasonal movement from estuarine and nearshore waters to offshore waters	X				X	X	fish, shrimp, invertebrates
Scomberomorus maculatus	Spanish mackerel		X		X		Juvenile/ Adult	Inshore, nearshore, and offshore, especially over SAV beds and reefs		X			X		fish, shrimp, cephalopods
Epinephelus drummondhayi	Speckled hind		X			Concern	/	Offshore rocky bottoms, common between 60 and 120 m (197 and 394 ft)							fish, crabs, shrimp, molluscs
Panulirus argus	Spiny lobster		X				Juvenile/ Adult	Oceanic, shallow subtidal, seagrass, unconsolidated bottom, *Laurencia* algal communities, coral live hardbottom		X			X	X	benthic scavengers
Leiostomus xanthurus	Spot				X	Viable	Juvenile/ Adult	Estuarine-dependent; estuarine and coastal waters; Juv: inlets, estuary	X			X	X		worms, crustaceans, organic detritus
Cynoscion nebulosus	Spotted sea trout				X	Viable	Juvenile/ Adult	Estuarine-dependent; Juv: SAV, Adult: river eatuaries, coastal marine water sand bottoms, SAV, salt marshes	X	X			X		crustaceans and fish
Morone saxatilis	Striped bass				In development	Concern	Juvenile/ Adult	Inhabits coastal waters, bays, rivers					X		crustaceans, worms, fish, other invertebrates
Mugil cephalus	Striped mullet					Concern	Juvenile/ Adult	Wide variety of habitats; freshwater, estuarine, marine; near inlets to offshore areas	X			X	X		microorganisms, microalgae, decaying plant matter
Paralichthys dentatus	Summer flounder			X	X	Recovering	Juvenile/ Adult	Estuarine dependent, coastal waters; Juv: inlets, sandy bottoms in higher-salinity areas of estuaries	X			X	X	X	fish and shrimp
Xiphias gladius	Swordfish	X					Juvenile/ Adult	Oceanic but sometimes found in coastal waters					X		fish, crustaceans, squid
Tautoga onitis	Tautog				X	Overfished	Juvenile/ Adult	Adult: offshore and inshore hard-structure, shellfish beds; Juv: shallow, estuarine, SAV	X	X	X				gastropods, other mullusks, crustaceans
Mycteroperca tigris	Tiger grouper		X			Concern	/	Coral reefs and rocky areas							fish, crustaceans
Haemulon aurolineatum	Tomtate		X			Concern	Juvenile/ Adult	SAV, sand flats, and patch reefs		X		X		X	crustaceans, molluscs and other invertebrates, plankton, algae
Rhomboplites aurorubens	Vermilion snapper		X			Concern	/	Moderately deep waters, over rock, gravel or sand bottoms near edge of cont. shelf; Juv: shallower depths below 25 m (82 ft)							fish, shrimp, crabs, benthic invert, cephalopods, plankton
Acanthocybium Solanderi	Wahoo		X			Viable	Juvenile/ Adult	Oceanic, epipelagic, coastal					X		fish, squid
Epinephelus nigritus	Warsaw grouper		X			Concern	/	Rocky bottoms; Juv: jetties, shallow reefs							crabs, shrimp, lobster, fish

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					ASMFC (0-3 NM)	NCDMF Stock Status (2002)									
Cynoscion regalis	Weakfish				X	Viable	Juvenile/ Adult	Shallow water over sand, sandy mud bottoms; in summer move to river estuaries	X			X	X	X	crustaceans, fish
Haemulon plumieri	White grunt		X			Concern	Juvenile/ Adult	Adults: patch reefs, coral heads, sandy bottoms; Juv: SAV (*Thalassia*)		X				X	crustaceans, fish, molluscs
Tetrapturus albidus	White marlin	X						Deep water, over 100 m (328 ft)							fish, squid
Morone americana	White perch					Concern	Juvenile/ Adult	Rivers, sounds					X		crabs, shrimp, and small fishes
Calamus leucosteus	Whitebone porgy		X			Concern		Fairly deep water, 10-100 m (33-328 ft), over rocks, reefs or patchy bottom							crustaceans, molluscs
Polyprion americanus	Wreckfish		X			Concern		Inhabit caves and shipwrecks; Juv: congregate below floating objects							crustaceans, cephalopods and benthic fishes
Persca flavescens	Yellow perch					Concern	Juvenile/ Adult	Rivers, estuaries	X				X		fish, insect larvae, plankton, and worms
Mycteroperca venenosa	Yellowfin grouper		X			Concern	Juvenile/ Adult	Juv: shallow SAV (*Thalassia*) beds; Adults: rocky and coral reefs, mud bottoms, 2 to 137 m (6.6-450 ft)		X					fish, squid
Thunnus albacares	Yellowfin tuna	X						Oceanic							fish, crustaceans, squid
Mycteroperca interstilitialis	Yellowmouth grouper		X			Concern	Juv/Sm Adult	Rocky or coral bottoms from shoreline to at least 55 m (509 ft) depth; smaller fish: lagoons					X		fish
Ocyrus chrysurus	Yellowtail snapper		X			Concern	Juvenile/ Adult	Coastal water, coral reefs; Juv: SAV		X			X		plankton, fish, crustaceans, worms, gastropods, cephalopods

Marine Mammals - Dolphins

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 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. Refer to Table 12 for intertidal habitat and shoals identified from the June 2003 aerials and September 2003 ground-truth investigations.

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 mount 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, 2003b). 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. 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.

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 (refer to Appendix H - Mapping Results).

Intertidal Beach

Intertidal flats are characteristic of the Bogue Inlet complex. The main intertidal zones of Bogue Inlet can be found along Dudley Island, on the western end of Bogue Sound, and along Bear Island. 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 wadding 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

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, 2001a). 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, 2001a).

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, 2002).

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 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

Approximately 89 fish species have been identified 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 (NCDMF, 2003; Appendix E - Essential Fish Habitat Assessment). 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 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 Nearshore Turtle 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. 1995a). 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. 1995b).

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., 1995a).

Leatherbacks (*Dermochelys coriacea*) occasionally enter shallow bays and estuaries in North Carolina. Epperly (1995a) found large numbers of leatherbacks moving north off the coast of North Carolina in early May. However, leatherbacks were spotted infrequently in North Carolinas inshore waters by aerial surveys (Epperly et al., 1995c) 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 6.5º C [41 to 43.7ºF]) (Musick et al., 1997) and account for the movement of juveniles from the sounds of North Carolina to coastal waters (Epperly et al., 1995b). Those juveniles that remain in North Carolina waters winter off the coast near the western edge of the Gulf Stream (Epperly, 1995a).

Aerial surveys (Epperly et al., 1995c) 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

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.

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 H.

4.7.1 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.).

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). 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, which the coasts of North Carolina are a part of, is extremely important for migrating semipalmated sandpipers, sanderlings, and whimbrels.

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. Refer to Section 6.2, Transect No. 1.

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

4.7.2 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.

Research on the trends of waterbirds in North Carolina shows that the numbers of several species 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. For example, common tern nesting sites have declined from forty-nine in 1977 to twenty-two in 2001. Fewer suitable nesting sites providing for the same number of birds nesting could make nesting populations vulnerable to catastrophic events.

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., 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.

4.7.3 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 though 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 Resources (NCDENR) Basinwide Assessment Report 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 (NCDWQ, 2000). 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 4.0ºC (39.2ºF) to 17.1ºC (62.8ºF), with an average of 9.8ºC (49.6ºF). No additional information regarding water quality data in the Permit Area is available as confirmed by 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 DWQ, 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 (NCDWQ, 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 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 Class SA waters by the North Carolina Department Environment Natural Resources. Class SA waters are suitable for commercial shell fishing and all other tidal saltwater uses (NCDWQ, 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 Class SA waters, North Carolina state guidelines limit turbidity to values under 25 NTU above ambient levels outside turbidity mixing zones (NCDWQ, 2000).

A summary of water quality parameters from Table 15 of the NCDENR Basinwide Assessment Report (NCDWQ, 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's 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 during the high – salinity (NOAA, 2003a).

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 been 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, 2001). Ambient air quality standards monitored include TSP, PM-2.5, PM-10, CO, O_3, SO_2, NO_2,

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 described below 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)

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 NC 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, 2002). 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 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

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. Extensive areas with in Bogue Inlet and Bogue Sound are designated as bird islands (S. Cameron, pers. comm.), 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.

Four marinas are located near Bogue Inlet and include, Dudley's Marina, Casper's Marina, and the Nancy Lee Fishing Center on NC Highway 24 near Swansboro, NC and the Island Harbor Marina located in Emerald Isle. All four have boat slips, and overnight dockage and all but Casper's Marina offer charters for deep sea fishing and sight seeing. Bogue Inlet Pier is a favorite fishing and beach resort destination for thousands of visitors each year.

Located on the west end of Emerald Isle, close to Bogue Inlet, the pier is used to catch many different species of sport and recreational fish such as, Black Drum, King Mackerel, Flounder, Spotted Sea Trout, and Spot fish. The beaches of Emerald Isle provide a variety of excellent scenic and recreational opportunities for the public. Popular activities include, but are not limited to, surf fishing, swimming, walking, shell hunting, sunbathing, bird watching, kayaking and boating. Scenic vistas of the ocean are many. Surfing is especially high in the area. Emerald Isle is known for its great wave activity. However, with erosion of the beach there have been significant losses of dry beach areas limiting many beach activities to occur during low tide periods.

4.13 NAVIGATION

Bogue Inlet serves as the access point for several recreational and fishing vessels year round. During the year, especially during peak tourist season, the Inlet can experience intense recreation navigation usage. Federally authorized and maintained channels in the vicinity of Bogue Inlet include: the Atlantic Intracoastal Waterway (AIWW) which has an authorized depth of 12 feet MLW and a bottom width of 90 feet; a 12-foot deep by 90-foot wide side channel leading from the AIWW through the lower portion of the White Oak River to the Town of Swansboro; a 6-foot by 90-foot wide channel from the AIWW to the gorge in Bogue Inlet; and an 8-foot by 150 wide channel from the gorge in Bogue Inlet to the Atlantic Ocean.

A few commercial vessels (45 to 50 feet in length) and many recreational boats (16 to 35 feet in length) utilize the inlet (Cone, pers. comm., 2003). Mr. Lee Manning, of the Nancy Lee Fishing Center has noted that there are few fishing boats that use the Inlet during the winter (Manning, pers. comm., 2003). Diving in the area is year round and includes trips to several shipwrecks offshore. Bogue Inlet's navigational usage also includes military exercises. The Marine Corps has used Bogue Inlet in the past for simulated attacks on Camp Lejeune, located in south Onslow County (Cone, pers. comm., 2003). Bogue Inlet is highly used for a variety of navigational uses, throughout the year.

4.14 HISTORIC PROPERTIES AND CULTURAL RESOURCES

Humans have inhabited the area surrounding Bogue Inlet for over 2,500 years. However, the area remained largely unsettled until the 1950's. The area was originally home to the Algonquin Indian tribe, a nomadic tribe of Native Americans, from 500 A.D. to about colonial times. The Europeans the Native Americans from the area after the Tuscarora War in 1711, in which the Algonquin and Tuscarora Indian tribes attacked New Bern and the surrounding countryside (Swansboro Historical Association, 1990).

Around 1730, the first permanent settlement was established on a former site of an Algonquin Indian Village, at the mouth of the White Oak River. They called this settlement Swansborough (Swansboro) after Samuel Swan, former Speaker of North Carolina's House of Commons. In 1771, Theophilus Weeks became the "founder of Swansboro" which remained the only permanent settlement on the coast between Wilmington and Beaufort for several years (Littleton, 1983). The early colonial economy of Onslow County was based primarily on small-scale agriculture, fishing and on forest products (Louis Berger Group, 2002). The lack of adequate roads in this

region led Bogue and Bear Inlet to become principal trading areas (Angley, 1984).

Throughout the 1700's, the area was well known as pirate territory. The famous pirate, Blackbeard supposedly used the inlets along the coasts and the shallow waterways behind the barrier island as safe havens. It was thought that Bear Island, west of Bogue Inlet, was used by Blackbeard as a getaway while he terrorized traders. Many of the shipwrecks off the coasts of North Carolina may be due to Blackbeard. One shipwreck located directly off the coast of Beaufort Inlet, could be Blackbeard's pirate ship, *Queen Anne's Revenge*, which sunk around 1718. The general Cape Lookout area, which includes ocean waters stretching from Drum Inlet around the cape to Bogue Inlet, contains at least 184 historically documented shipwrecks.

During times of war, the Inlet played various important roles. Throughout the Revolutionary War, a number of patriot privateers operated through the Inlet preying on English merchant ships. Salt works were created in the Swansboro area because the British blockade prevented imports. Following America's independence, Swansboro began its transformation into a coastal port. In 1786, Swansboro took over customs functions in the region (Watson, 1995). The major exports from Swansboro and Deer Island consisted of tar and turpentine. These resources were heavily exported from 1770 until the late 19th century.

The War of 1812 and the British Navy blockage of the American coast led to a slowdown in the trading industry and construction of ships. The construction of ships resumed when the war ended and agricultural products became increasingly important as a commodity of trade. Maritime trade reached its peak in Swansboro shortly before the onset of the Civil War.

Huggin's Island was the site of a fort built by the Confederates to guard Bogue Inlet and the major access channel to Swansboro during the Civil War. The fort was burned and Swansboro was captured twice between 1862 and 1864 by the Union forces. Salt works were established once again on Deer Island. However, they were destroyed in 1862 by a Union raid.

Trade and commerce in Swansboro had suffered great losses by the end of the war. The years after 1865 showed a slow recovery of the town's exports but the shipbuilding industry never fully recovered. Inlets, especially Bogue Inlet, tended to silt up during this time without dredging. Lumber and fishing became the center of Swansboro's economic base. Construction on the Intracoastal Waterway began in the 1920's. Its construction brought an increase to the number of commercial vessels in the area.

During World War II, the U.S. Coast Guard used Bear Island to secure the coast and monitor German U–boat activity. At this time trawl fishing and trawler construction became important in the area (TAR, 2003). After the war ended, the Marine Corps base was established in Jacksonville. The economic contributions moved to involve more civil service employment, tourism and retirement community development.

The National Historic Preservation Act of 1966 and the Archeological and Historic Act of 1979 established criteria for identification, documentation, and assessment of submerged cultural resources. Compliance with submerged cultural resource legislation is administered by the North Carolina Division of Archives and History and the US Department of the Interior. These archives and governmental agencies give no mention of any shipwrecks in or near Bogue Inlet.

In January and June 2003, Tidewater Atlantic Research, Inc., of Washington, N.C. (TAR), conducted a magnetometer survey of the central portion of the Bogue Inlet ebb tide delta and the existing channel to determine the presence of potentially significant submerged cultural resources. Three anomalies were found, two on the ebb tide delta and a third in the existing channel at a point approximately 1,600 feet north of Inlet Drive. The two anomalies found on the ebb tide delta were relatively small and appeared to be consistent with modern debris such as small diameter pipes, boat anchors, or crab traps and therefore were considered to be of no archeological significance. The anomaly found in the existing channel exhibited characteristics consistent with submerged cultural resources. Since alternatives that would include modifications of Bogue Inlet would only involve filling of the existing channel, TAR concluded that no further investigation were warranted.

4.15 SOCIO-ECONOMIC

The Crystal Coast includes the coastal shoreline of Atlantic Beach, Emerald Isle, Indian Beach, Salter Path and Pine Knoll Shores. These towns, specifically Emerald Isle, have shown exceptionally high population growth rates in the last decade. Based on the growth rate from 1990 to 1995, Emerald Isle was ranked 17th out of the 117 municipalities in the state, with population increases from 2,500 to 9,999. From 1990 to 2000, the population of Emerald Isle increased 43.3% from 2,434 to 3,488. The adjacent town of Swansboro also showed a significant population increase of 22.4% from 1,165 to 1,426 from 1990 to 2000 (North Carolina State Demographics, 2003).

Carteret County is a primary vacation destination for many domestic and international visitors. Carteret County relies on the tourism industry as its primary source of revenue. Restaurants, motel accommodations, recreational fishing, retail trade services, construction, real estate, and finance industries benefit directly from the impact of tourism. (NCDCM, 1996) Many visitors utilize the beaches of Emerald Isle, which accounts for a large portion of the revenue generated in the area (NCDCM, 1996). Surfing, waterskiing, jet skiing, and wind surfing are a few of the recreational activities available to visitors of Bogue Inlet. However, in many places, high erosion rates can limit beach use to low tide events. Beach renourishment is expected to attract more visitors and contribute favorably to the local economy, resulting in increased revenue.

The permanent population of Emerald Isle has grown steadily since 1991 increasing from slightly over 2,400 in 1991 to approximately 3,500 in 2002. During the summer tourist season, the population swells to over 50,000. Accordingly, the town must structure is services to support the inflated seasonal population.

The economy of Emerald Isle depends on tourism and support of a growing population of retirees. Businesses focus on providing the necessary services to support the seasonal visitors and year-round residents. There are numerous restaurants, retail stores, and motels all of which are located in a compact business district along the west end of Emerald Drive. There are also businesses that provide or support recreational opportunities such as fishing, surf boarding, boating, and other water oriented activities.

Since the late 1970's, Carteret County has been the number one ranking county in the state in terms of total licensed commercial fishing vessels, total seafood landings (pounds), and total dockside value of seafood landings (NCDCM, 1996). Shellfishing is an important economic resource for the White Oak River. The North Carolina Administrative Code (15A NCAC 02B) states that Class SA waters, which includes Bogue Inlet, identifies shellfishing for 'market purposes' as its best usage of waters (NCDWQ, 2002a). The outstanding quality of the water allows for abundant shellfishing in the area. The White Oak River shellfish resources are considered productive, but threats to the health of the shellfish do exist. Shellfish closures that occur in the area are typically due to an increase in sedimentation and stormwater runoff.

The 2001-2002 tax base for all of Emerald Isle was over $1.33 billion or almost double the value of the 1992 tax base. The tax rate is a modest $0.175 per $100 valuation and funds the majority of the Towns budget which was almost $5.4 million in 2001-2002.

4.16 LAND USE

The Coastal Area Management Act (CAMA) requires counties, cities and towns within the 20 coastal counties, to periodically prepare land use plans to protect and manage the health of the coastal environment and economy. CAMA Areas of Environmental Concern are classified as conservation and include all areas within both the Permit and Project Areas. Land use community decisions are based on the seasonal or peak population months. Land use plans developed by both Carteret and Onslow Counties are intended to be an integral and sensible part of North Carolina environmental law.

The North Carolina Division of Coastal Management requires that the 20 coastal counties keep the Land Use plans updated. The Onslow County Joint Land Use Study was recently updated in February 2003. The Carteret County Land Use Plan was last updated in 1996, but is currently being revised for anticipated release in May 2004. (M. Christenberry, pers. comm. 2003).

The Town of Emerald Isle occupies approximately 5.6 square miles on the west end of Bogue Banks with most of the land used for single family and multi-family housing. Very few buildings in the town are over three stories. Businesses are located in a compact area along the west end of Emerald Drive and include restaurants, motels, and traditional retail stores. Emerald Isle strives to maintain its small town family oriented atmosphere that supports both its year-round residents and seasonal visitors. Private property owners and developers alike make a conscious effort to preserve native vegetation and as a result, the landscape of Emerald Isle is dominated by native trees and shrubs.

Retirement and tourism are the focus of the local economy with the major employers associated with the retail and service sector. The town boasts a healthy beach system and is committed to its enhancement and maintenance. In this regard, the Town of Emerald Isle pass a bond referendum to fund a beach nourishment project that will eventually restore 9.7 miles of it's nearly 11 mile ocean beach. To date, the town has completed construction of 5.9 miles of the beach nourishment project with the completion of the remaining 3.8 miles scheduled for the fall of 2004.

Recreational opportunities abound in Emerald Isle with the focus being on water oriented activities including swimming, sunbathing, and fishing to mention a few. The Town has one fishing pier, the Bogue Inlet Pier, located in the heart of the business area.

Emerald Isle protects its coastal lifestyle by giving preservation of natural resources and protection of water quality the highest priority. The Town cooperates with state and federal agencies to protect coastal wetlands from harmful development. Important freshwater wetlands are intact and they continue to store, clean water, and provide a rich habitat for a rich diversity of plants and animals. The Town protects surface waters from degradation by storm water and polluting discharges and they remain clean.

4.17 HYDRODYNAMICS

4.17.1 Tides and Tidal Flow

The mean tide range in the Atlantic Ocean in the vicinity of Bogue Inlet is 3.7 feet while the average spring range is 4.3 feet. The primary tidal datum is the National Geodetic Vertical Datum-1929 (NGVD). The relationship between NGVD and other tidal datum are as follows:

Mean Higher High Water (MHHW)..... +2.53 feet NGVD
Mean High Water (MHW)..... +2.21 feet NGVD
Mean Tide Level (MTL)..... +0.35 feet NGVD
NGVD.....0.00 feet NGVD
Mean Low Water (MLW).....-1.50 feet NGVD
Mean Lower Low Water (MLLW).....-1.75 feet NGVD

The mean tide range for Bogue Inlet, which was determined at the US Coast Guard Station, is 2.2 feet with a mean spring range of 2.6 feet. On the average, the time of high tide and low tide at the Coast Guard Station lags the ocean tide by 28 minutes and 26 minutes respectively.

The tidal prism of Bogue Inlet, i.e., the total volume of water flowing through the inlet during an ebbing tide or flooding tide, was determined from flow measurements made by Coastal Science and Engineering, PLLC (CSE) on 16 October 2001 during a period of spring tides. Based on these flow measurements, the ebb tidal prism was 7.66×10^8 cubic feet while the flood tidal prism was 5.57×10^8 cubic feet.

O'Brien (1969) discovered a strong relationship between the cross-sectional area of an inlet (measured at mean sea level) and its spring tidal prism. This relationship comes about as a result of the natural balancing of tidal flow forces that tend to scour the inlet and littoral transport that deposits sediment in the inlet. Jarrett (1976) developed refinements in the functional relationship between an inlet's cross-sectional area and its tidal prism by considering inlets on the Atlantic, Gulf, and West Coast of the U.S. as well as whether the inlets were stabilized with one jetty, two jetties, or not stabilized by structures (refer to Appendix B - Engineering Report). For inlets on the Atlantic Coast of the U.S., this relationship is given by:

$$A = 5.37 \times 10^{-6} P^{1.07} \text{ (Jarrett 1976)}$$

Where: A = Minimum cross-sectional area in square feet
P = Spring tidal prism in cubic feet

The minimum cross-sectional area of Bogue Inlet obtained from the October 2001 survey by CSE was 13,600 square feet. The cross-sectional area predicted by the above equation for the average tidal prism of Bogue Inlet (i.e., the average of the flood and ebb tidal prisms) is 14,700 square feet. The agreement between the measured and predicted inlet cross-sectional areas is rather good considering inlets are know to undergo short-term fluctuations in their cross-sectional area of the order of ±10% due to high sediment loads during storms or as a result of changing lunar or meteorological tide conditions. The agreement between the measured and predicted minimum cross-sectional area indicates that Bogue Inlet maintains a balance between the hydraulic forces tending to keep it open (tidal flow) and sedimentary forces (littoral transport) that would tend to close it.

The hydrodynamics of Bogue Inlet were evaluated using the Advanced Three-Dimensional Circulation Model for Shelves, Coasts, and Estuaries (ADCIRC). The model was constructed from a detailed hydrographic and topographic survey of the inlet obtained by CSE in September and October 2001 with supplemental soundings from the Corps of Engineers and National Ocean Service navigation charts. The model was calibrated and verified with tide and current data also obtained by CSE in September and October 2001. Details of the numerical model investigation are provided in Appendix B - Engineering Report.

For the base or existing conditions in Bogue Inlet, the existing bar channel carries 71.6% of the inlet's ebb tidal prism while 22.7% flows across the middle portion of the ebb tide delta. The remaining 5.7% of the ebb tidal prism flows past the east end of Bear Island. During flood, the existing channel and the middle portion of the ebb tide delta carry equal portions of the flood tidal prism (46.5% each) with the balance flowing past the east end of Bear Island. Eastern Channel serves as the main channel connecting the inlet to the AIWW and Bogue Sound during both ebb and flood while the Western Channel only carries approximately 9% of the ebb and 20% of the flood tidal prism.

4.17.2 Waves

Wave information for the Bogue Inlet area was obtained from the Wave Information Study (WIS) conducted by the U.S. Army Corps of Engineers Engineering Research and Development Center, Coastal Hydraulics Laboratory located in Vicksburg, Mississippi. The WIS wave information is based on a 20-year hindcast (1976 to 1995 inclusive) of wave conditions based on synoptic wind patterns over the entire Atlantic Ocean basin and includes the effects of hurricanes and other tropical storms. The wave information is provided in 3-hour increments for the entire 20-year period. The WIS station used is designated as AU2045 and is located in 90 feet of

water off the west end of Emerald Isle (see Figure 5.13 in Appendix B (Engineering, Geology, and Geotechnical Investigations).

The general alignment of the shoreline in the vicinity of Bogue Inlet is North 70 degrees East; therefore, waves propagating from the north-northeast clockwise around to the west-southwest are moving onshore. Table 10 provides a summary of the energy distribution by wave angle.

Based on the percent of wave energy moving in the onshore direction, 60% of the wave energy would tend to move sediment in a westerly direction and 40% of the wave energy would move sediment in an easterly direction.

Table 10
Average Wave Heights by Direction and
Percent of Wave Energy from Each Direction
(WIS Station AU2045)

Wave Direction	Onshore or Offshore	Average Wave Height (feet)	Percent of Wave Energy
0.0 deg - N	Offshore	3.9	1.51%
22.5 deg - NNE	Offshore	4.7	2.44%
45.0 deg - NNE	Offshore	5.4	5.78%
67.5 deg - ENE	Offshore	5.0	4.36%
90.0 deg - E	Onshore	3.3	11.78%
112.5 deg - ESE	Onshore	3.2	15.42%
135.0 deg - SE	Onshore	3.4	11.93%
157.5 deg - SSE	Onshore	4.9	9.41%
180.0 deg - S	Onshore	5.1	12.45%
202.5 deg - SSW	Onshore	4.4	7.32%
225.5 deg - SW	Onshore	4.7	6.02%
247.5 deg - WSW	Onshore	4.7	3.45%
270.0 deg - W	Offshore	4.8	3.07%
292.5 deg - WNW	Offshore	4.4	1.63%
315.0 deg - NW	Offshore	4.5	1.89%
337.5 deg - NNW	Offshore	4.1	1.54%

4.17.3 Littoral Transport

The wave information provided for WIS Station AU2045 was used to compute the average longshore sediment transport potential in the vicinity of Bogue Inlet for each month. Details of the sediment transport estimates are provided in Appendix B with average monthly and yearly littoral transport rates for the shorelines near Bogue Inlet summarized in Table11.

Table 11
Average Monthly and Annual Transport Rates (cy/yr)
WIS Station AU2045
1976 to 1995

Month	East	West	Gross	Net[(a)]
Jan	-28,654	58,247	86,901	29,594
Feb	-31,986	46,850	78,836	14,863
Mar	-48,688	52,963	101,651	4,275
Apr	-37,666	38,160	75,826	495
May	-28,277	31,526	59,803	3,249
Jun	-24,784	21,707	46,491	-3,077
Jul	-23,877	17,003	40,880	-6,874
Aug	-11,327	38,973	50,299	27,646
Sep	-8,089	89,299	97,389	81,210
Oct	-6,632	55,439	62,071	48,807
Nov	-18,922	63,412	82,335	44,490
Dec	-26,406	54,008	80,414	27,602
Total	-295,308	567,587	862,895	272,280

[(a)] + = Net Transport to the West, - = Net Transport to the East.

The predominant direction of littoral transport in the vicinity of Bogue Inlet is to the west with the net transport averaging 272,300 cubic yards/year to the west. During the months of March to July, the average net sediment transport is nearly balanced with strong predominance to the west during the other months of the year. The gross rate of littoral transport is approximately 863,000 cubic yards/year. For the 20-year hindcast period, the gross rate of sediment transport ranged from a low of 667,000 cubic yards/year to a maximum of 1,138,000 cubic yards/year. Net transport was to the west for all 20 years; however, net westerly transport varied over a wide range from a minimum of 13,000 cubic yards/year (1994) to a maximum of 558,000 cubic yards/year (1980).

4.18 INFRASTRUCTURE

World War II had a tremendous impact on the migration of immigrants to the United States in the mid to late 1900's. North Carolina began to notice the effects of this migration as evidenced by the steady increase in infrastructure and development in the 1970's (Carteret County, 1999a). This increase in

population and development was most noticeable along the North Carolina coastline. The Carteret County 1996 Land Use Plan found the highest increase in population growth along seven coastal counties during the years of 1970 to 1994 (Carteret County, 1999).

Military facilities such as: the U.S. Marine Corps Air Station base at Cherry point in Havelock; U.S. Marine Camp Lejeune base at Jacksonville and port at Morehead City; and U.S. Air Force Base Seymour Johnson in Goldsboro; have contributed significantly to population increases along the North Carolina coastline. However, the U.S. Marine Corps Air Station base at Cherry Point in Havelock has been identified as having the greatest population and infrastructure impact on the Crystal Coast (Insiders Guide, 2003a). Industrial decentralization also contributed to the increase in population along the Crystal Coast. However, the most significant influence was found to be due to the increase in recreational and retirement facilities. The recreational and retirement facilities have provided a resource for tourists during the seasonal or peak population months (May through August) in Carteret County.

Over the past 25 years, the recreational and retirement centers have shifted the permanent population and economic structure along coastal communities in North Carolina. The high seasonal population has changed the economic structure of these communities to service and retail oriented industry (Carteret County, 1999).

The Pointe Subdivision is connected to other sections of Emerald Isle by Coast Guard Road. Other roads within The Pointe Subdivision, include Inlet Drive, Bogue Court, Inlet Court, and Channel Drive. Power lines, telephone service, storm sewers, and television cables generally follow the existing roads. There is no central sanitary sewer system as the individual homes are all served by septic tanks. There are over 100 lots located west of Coast Guard Road, most of which (95) are developed. The Swansboro Coast Guard Station is located on the sound side of the Pointe Subdivision and occupies approximately 4.5 acres.

4.19 WATER COLUMN

Estuarine waters, marine waters, and creeks characterize subtidal areas in and around Bogue Inlet. Subtidal areas are found in areas east of the inlet, west of the inlet, and behind Dudley Island. Soft-bottom, subtidal habitats consist of various percentages of sand, silt, and clay, occurring in sheltered bays and estuaries. These habitats are influenced to a great extent by tides and thus have a variety of different salinities and water temperatures.

Biological resources associated with subtidal environments include shrimp, crabs, clams, fish, and the pelagic and benthic communities that support them.

4.19.1 Marine

The nearshore environments and coastal waters in the Permit Area include the beach areas and surf zones of Bear Island and Emerald Isle. Species common in these habitats range from sharks and the snapper-grouper reef fish complex.

4.19.2 Estuarine

Estuarine waters in the State of North Carolina are defined by CAMA as "all the water of the Atlantic Ocean within the boundary of North Carolina and all the waters of the bays, sounds, rivers, and tributaries thereto seaward of the dividing line between coastal fishing waters and inland fishing waters, as set forth in the most recent official published agreement adopted by the Wildlife Resource Commission and the Department of Environment and Natural Resources" (NCDCM, 2003b).

Bogue Sound is a shallow body of water characterized as having sand and mud bottoms and an estuarine environment. The sound is highly influenced by tides at the western end near Bogue Inlet and as a result, has high salinity variation. The area closest to Bogue Inlet contains various areas of sand shoals and SAV habitats (see maps in Appendix C), in addition to mud bottom habitat.

Some of the most productive and valuable wetlands are estuarine environments. Estuarine systems in the project area are located in the western end of Bogue Sound, Dudley Island, and the estuarine system north of Bear Island. These marshes are regularly and irregularly flooded lands where plants species such as salt marsh cordgrasses (*Spartina alterniflora* and *S. patens*), glasswort (*Salicornia* spp.), salt grass (*Distichlis spicata*), and sea lavender (*Limonium carolinanum*) can be found. These habitats are important for fish spawning and juvenile development. Acquisition of digital aerial imagery, along with the field investigations of the low and high marsh (September 2003), will provide definitive boundaries of the marsh environments of Bogue Inlet.

4.20 URBAN QUALITY

The location of the project area assessment is within an inlet environment and will therefore does not involve urban quality issues.

4.21 SOLID WASTE

The Solid Waste Management Act of 1989 regulates the safe disposal and management of solid wastes, more specifically the reduction of wastes in North Carolina. A Solid Waste Management Plan was adopted in 1991, however the North Carolina Department of Natural Resources is in the process of updating the plan with surveyed data. There are currently 39 operating lined Municipal Solid Waste Landfills (MSWLF) in the state of North Carolina. However, the challenge continues for the state as the volume of material needing to be disposed of increases, while the amount of available landfill space decreases (NCDWM, 2000).

The Coastal Regional Solid Waste Management Authority (CRSWMA) was appointed by the Boards of County Commissioners from Carteret, Pamlico, and Craven Counties to operate and manage solid waste in the aforementioned counties. The CRSWMA operates and manages three solid waste facilities and one lined MSWLF site in the three counties.

The nearest MSWLF site available to the Town of Emerald Isle, in Carteret County, is located in Swansboro at the W.A. Page ACB Site on State Route 1114. A Construct and Demolition Landfill (CDLF) is also available for the disposal of landscaping and construction materials at the Styron facility located in Morehead City (NCSWS, 2003).

4.22 DRINKING WATER

Similar to other rural areas, the primary public water supply source for both Carteret and Onslow Counties is fed by a groundwater source (USEPA, 2002a). This groundwater source (aquifer) of the coastal plain region of North Carolina is available in the pore spaces of both consolidated and unconsolidated stratified materials such as clay, sand, gravel and shell. These aquifers are considered to be high yielding for the municipalities utilizing them (GWPC, 2003).

The watershed system, called the Bogue-Core Sound Watershed (USGS Cataloging Unit 03020106), supplies groundwater to the surrounding cities, towns, and islands around Bogue Inlet. Bogue Banks Water Corporation supplies the water to the Town of Emerald Isle, while the City of Swansboro operates and maintains the water supply and distribution for the entire city.

4.23 ECONOMICS

An economic assessment is described in detail under Section 5.23.

4.24 NON-RELEVANT RESOURCE ISSUES

The following section describes resources that are considered to be insignificant due to the scope of the project alternatives.

4.24.1 Hazardous, Toxic, and Radioactive Waste

No chemical analysis of the sediments within the proposed channel has been performed to date. It is unlikely that the project area sediments have accumulated hazardous, toxic, or radioactive substances regulated by CERCLA or RCRA. There are currently no hazardous, toxic, or radioactive waste producers adjacent to or known discharges of contaminants to Onslow Bay (CSE, 2001). The high energy nature of the project area with wave, tidal, and littoral currents make the retention or deposition of hazardous, toxic, and radioactive wastes within the project area unlikely. Studies have shown that contaminants usually do not adsorb to particles with grain size suitable for beach restoration (USACE, 1993) which is characteristic of the material found in Bogue Inlet.

There were no bulk storages of hazardous materials, no toxic waste dump sites, and no disposal of toxic wastes found in Onslow County based on a Camp Lejeune Environmental Assessment (EA) (Camp Lejeune, 2002). Carteret County opposes the dumping of toxic substances within the county (Carteret County, 1999). In addition, there are no known radioactive waste sites near Bogue Inlet. Beaufort, at the U.S. Department of Commerce, is the closest site for radioactive waste based on its use as an on-site storage for decay of low-level radioactive waste (USEPA and FCPM, 1995). A closer source of hazardous materials could be Camp Lejeune Marine Base. In North Carolina, there are concerns with contaminants at military bases. Some military-related contaminants of concern include VOCs, PCBs, PAHs, heavy metals, pesticides, and solvents. In 1989, the NOAA Coastal Resource Coordination Program conducted a coastal hazardous material site review for Camp Lejeune which was contaminated with pesticides and PCBs (NOAA-Office of Response and Restoration, 2003). Camp Lejeune also routinely conducts Shore Fire Control Party Training. This entails firing onto the camp in a practice attack. During the attacks, there is repetitive artillery fire. According to the Environmental Assessment (July, 2002), 99% of rounds fall within the Naval Gunfire Impact Area and the potential for rounds to fall short is less than 0.01%.

Direct concerns with contaminants in Bogue Inlet can come from local businesses. There are no large industries in the area, but small business, such as paint shops can put contaminants directly into the estuarine waters.

4.24.2 Noise

Levels of noise in the area are relatively low. However, "a noise impact on Emerald Isle's lifestyle is obvious," according to John Pike (Global Security). He states that there is a noise impact from the Marine Corps Auxiliary Bogue Landing Field (MCALF). MCALF serves as a training facility primarily for AV-8 Harriers from Cherry Point Marine Corps Air Station. In addition, MCALF Bogue is used for practice approaches by C-130 transports from Cherry Point, F-18 fighters from Beaufort, SC, and helicopters from New River MCAS. These aircrafts do have serious noise impacts on developed areas (NCDCM, 1996). Noise levels associated with dredging and construction are generally low and should not greatly affect the surrounding areas.

4.24.3 Energy Requirements and Energy Conservation

Energy requirements for this type of project assessment would be confined to fuel for operating machinery, labor transportation, and other construction type equipment.

The energy conservation potential assessment associated with the project would include such activities as the reuse of sand for beach nourishment and the relocation of existing structures.

No other energy requirements or conservation measures have been identified for this project assessment.