8.0 CEA STEP 5 – RESOURCES RESPONSE TO CHANGE AND CAPACITY TO WITHSTAND STRESS

This section identifies the resource and how it responds to stresses. The goal of characterizing the stresses is to determine whether the resources of concern are approaching conditions where additional stresses could have an important cumulative effect.

8.1 Effects of Stress on Birds

Coastal development, human activities, and overall habitat loss can create stresses to migratory and resident birds. Many areas used by birds in Bogue Inlet are highly ephemeral, such as intertidal sand shoals. It is difficult to determine a bird's response to change and its capacity to withstand stress. However, it may be assumed that changes to habitat, or loss of habitat can decrease population numbers if the birds cannot obtain adequate prey resources needed for migration, nesting, and breeding.

8.1.1 Effects of Stress on Shorebirds

Shorebirds rely on wetlands, shoreline areas, and adjacent habitats in the Bogue Inlet area (i.e. intertidal shoals, beach areas, etc). Historically, these communities throughout the southeastern Atlantic Coast have been disturbed and are generally decreasing in size. According to the United States Shorebird Conservation Plan (Brown et al., 2001), the loss of bird migration habitats in the coastal zone has been extensive. Coastal development and human activities have reduced intertidal habitats used for foraging and roosting.

Determining the decline in shorebird habitat areas and how it affects shorebird populations can be difficult. Habitat loss poses a threat and, despite conservation efforts, many shorebird populations are declining. Thus, it can be assumed that a decrease in essential shorebird habitat used for breeding, migration stop-overs, wintering grounds, and foraging may cause declines in shorebird numbers.

Further evidence comes from the fact that wetlands and their associated habitats have high densities of food available at critical times during migration stop-overs. Shorebirds use these food resources to obtain fuel reserves for their migrations. If the prey resources are not present, and shorebirds are unsuccessful in gaining necessary fat reserves, low survival rates may occur. In addition, shorebirds have low rates of reproduction, with clutch sizes of most species consisting of four or fewer eggs; and very few species re-nest after a successful first nesting attempt.

Specific habitats are utilized by many species of shorebirds in the Bogue Inlet environment. Shorebirds have been surveyed on the south side of Dudley Island, the West beach area of Emerald Isle, Island No. 2, and the intertidal shoals in the inlet. These habitats are dynamic systems, characteristic of a migrating inlet. Intertidal shoals, Island No. 1 and Island No. 2 are particularly ephemeral areas that are used by many species of shorebirds for feeding and resting. It can be assumed that shorebirds may have an ability to adapt to changes in the intertidal habitats of Bogue Inlet due to their continued use of the area.

The west end of Emerald Isle is heavily influenced by the migration of the inlet. The erosion rate in this area is very high with roosting and foraging areas being altered by morphologic changes in the inlet complex. Of the four areas surveyed, the west end of Emerald Isle is the only area adjacent to a human community. Tourists and residents often use this area recreationally, and the shorebirds are apparently accustomed to the presence of the people in these areas.

The beach habitat along the south side of Dudley Island is frequently used by nesting, foraging, resting, and migrating shorebirds. Dudley Island is minimally affected by boaters and sun-bathers. Shorebirds that utilize this area must adapt to the changing environment along the south side of the island. Thus, it can be assumed that shorebirds have the ability to adapt to physical changes in Dudley Island.

Bird surveys, conducted by CZR, Inc. for the Bogue Inlet Channel Relocation Project, report feeding, resting, and migrating shorebirds on Bear Island's intertidal and beach areas. Similar to Dudley Island, Bear Island is an undeveloped coastal environment. There is limited human activity on Bear Island due to its designation as a State Park protected by the North Carolina Division of Parks and Recreation (NCDPR). Bear Island's intertidal and beach areas are dynamic and are changing in response to natural forces to which shorebirds adapt.

It can be difficult to determine how the declines in any of the habitat areas in Bogue Inlet have affected the shorebirds that utilize the area. Although limited historic data exists, North Carolina Wildlife Resource Commission (NCWRC) surveys from previous years of Bogue Inlet's shorebird habitats have shown no significant declines in populations. Due to the natural dynamics of the wetlands and intertidal environments of Bogue Inlet, it can be assumed that shorebirds are well adapted to the dynamic environment, responding well to changing conditions.

8.1.2 Effects of Stress on Waterbirds

Animal and human disturbances, depending upon duration and proximity of perceived threat, may result in adults leaving eggs or chicks exposed to predators or inclement weather and may result in disruption of nesting, foraging, and loafing behaviors. Adult mortality has been identified as the key determinant in population trends, while decreases in nestling/juvenile mortality may not have as strong of an effect on populations. Although human disturbances may result in acclimation by birds to disturbances in some cases, abandonment of critical habitats often results.

Waterbirds are long-lived, have low annual reproductive output, high juvenile mortality, with high adult survivorship. As a result, reproductive success in any one year may not be as critical to population success as adult mortality because waterbirds are long-lived with delayed maturity.

The formation of colonies at feeding, nesting, and loafing sites results in an increased susceptibility of waterbirds to environmental disasters. Hydraulic changes in freshwater wetlands, degradation of coastal and marine habitats, and depletion of food resources can also adversely affect waterbirds and cause population declines. For this reason, the Cumulative Effects Assessment is performed as a tool to determine if habitats essential for foraging, resting, and nesting will be impacted by this and future actions. Inlet and shoreline stabilization projects have been identified as affecting sand and mud flat usage by birds (Federal Register Part II, 2001). These projects can limit the overwash processes that form the various dynamic shoals characteristic of inlets. Waterbirds, especially colonial species, can rapidly populate and alter ranges in response to changes in environmental conditions. Due to the waterbirds' ability to acclimate to a changing environment, the Bogue Inlet Channel Erosion Response Project is expected to have minimal effects on waterbirds in the area. The project is not expected to cause the deaths of any adult waterbirds or nesting disturbances due to the winter timing of the project.

These disturbances may cause birds to temporarily relocate, but adverse effects to nesting are not expected.

8.2 Effects of Stress on Shellfish

The eastern oyster (*Crassostrea virginicus*) is a very successful estuarine animal that can tolerate a wide variety of environmental conditions. Oysters can survive in waters with varying salinities, temperatures, currents, and turbidities. In fact, "intertidal oysters thrive in the most rigorous of habitats" (Lunz, 1960). Oysters do have certain requirements that, when available, account for higher concentrations in particular areas. The presence of suitable substrates, food, current velocities, acceptable levels of turbidity, and/or exclusion of some disease-causing organisms represents an optimal environment for oysters. Extreme changes in one or more of these factors may affect oysters.

Two of the most important requirements for successful oyster populations are suitable habitat and food availability. If oysters inhabit an area that does not receive adequate food sources via water currents, the oyster cannot survive, even if the habitat is optimal. Although preferred, firm substrate is not necessary for oyster reefs to become established. Oysters have the ability to build large reefs in soft mud habitats, beginning with a few oysters attaching to a bit of shell or wood in a mud flat. Other oysters then attach to them and push them into the mud which smothers the original oysters, however, it provides habitat for subsequent spat. This process continues until the first set of oysters sink deep enough into the mud to provide a sufficient basement that prevents further subsidence. Recent evidence shows that disturbances (marine fishing, shellfishing) can alter the physical structure of oyster reefs and negatively affect populations (Lenihan and Peterson, 1998). Research by Lenihan and Peterson (1998) indicate that reef habitat degradation by disturbance (fisheries) caused oyster mortality on natural reefs when paired with bottom-water hypoxic/anoxic conditions. Furthermore, Lenihan and Micheli (2000) showed that both oyster and clam harvesting using tongs and rakes affected oyster populations by disturbing and/or possibly killing oysters due to cracking/puncturing of shells or smothering individuals beneath sediments.

Even though oysters are highly tolerant of a variety of conditions, extreme stress can cause damage. The Bogue Inlet Channel Erosion Response Project is not expected to directly affect or cause significant stress to oysters. Construction machinery that could potentially damage oyster reefs will be located outside of areas where oysters are found in Bogue Inlet (See Appendix A - NCDMF C004 Shellfish Map). Turbidity, salinity, dissolved oxygen, current velocity, and food availability effects, if any, should be minimal and temporary.

8.2.1 Effects of Stress on Hard Clams

Hard clams (*Mercenaria mercenaria*) occur extensively in estuarine systems throughout North Carolina, and because of their wide distribution, may be exposed to various environmental impacts throughout their life cycle. The planktonic stage of hard clams is particularly sensitive to environmental changes while adult hard clams are less susceptible to changes. However, adults have been found to be particularly vulnerable to the effects of pollution and coastal development. Similar to oysters, hard clams rely on water currents to provide food and remove bio-deposits.

Hard clams are osmoconformers that are capable of altering their water balance as environmental conditions change; an adaptation that allows them to withstand extreme stresses. For example, clams have been found to withstand salinities from 4 ppt to over 35 ppt (Eversole, 1987).

Furthermore, hard clams have the ability to close their shells tightly during periods of stress, and respire anaerobically. Clams also have the ability to move from their habitat or correct for displacement caused by disturbances (Eversole, 1987). Horizontal movement of adult clams is limited and distance traveled corresponds with the size of the clam (the smaller the clam, the farther it can travel). Adult clams can also avoid unfavorable conditions by rapidly burrowing into sediments.

Densities of hard clams have been positively correlated with seagrass cover in Bogue Sound. Research reveals that the presence of seagrass insulates hard clams from higher mortality rates (Peterson, 1982) by adding protection against decreases in water quality related to turbidity or variations in current speeds.

Mortality of hard clams in the absence of predation appears low and the larger the clam (>50 mm), the lower the natural mortality rate. Mortality is extremely high in juvenile stages until the clams reach a critical size greater than 50 mm when mortality drastically decreases (Eversole, 1987). Research conducted by Peterson (2002) reveals that hard clam numbers decreased from 1980-1997 within the fishing grounds of central North Carolina. Peterson contributes the declines in numbers to a decrease in hard clam recruitment which is, in part, due to overfishing. "The overfishing has lead to low recruitment in subsequent years and not even an initiation of recovery of historic abundance" (Peterson, 2002).

This project should not impact hard clams because these bivalves have not been documented in significant numbers in the area and have various adaptive methods to protect and shield themselves from changing environmental conditions. Clams can osmoconform to their environment, move to another habitat, close their shells, or bury into the sediment to avoid environmental stress. The project is not expected to cause significant disturbance to areas utilized by clams (seagrass beds, sand flats with shell, or Strata V and W) or affect future clam recruitment to the area.

8.2.2 Effects of Stress on Bay Scallops

Bay scallops (*Argopecten irradians*) are much more susceptible to environmental conditions than oysters and hard clams. From the autumn of 1987 to early winter of 1988, a red tide epidemic decreased the populations of bay scallops found in western Bogue Sound. Recruitment to the area by scallops in the subsequent years after the red tide event was significantly lower.

Bay scallops live up to 26 months and rely on the presence of seagrass for survival and growth. In the early stages of life, bay scallops attach to the blades of seagrass with a byssal thread. As the scallops mature, they fall to the bottom of the seagrass bed where they continue to grow. It has been hypothesized that feeding may be more efficient in seagrass beds due to slower currents (Eckman et al., 1989). Additionally, it has been shown that bay scallop densities decline with declining seagrass biomass (Peterson et al., 1982). Past research also reveals that fishing methods, such as clam kicking or dredging, destroys seagrass habitat and thus, could possibly lower the number of bay scallops in those areas (Peterson, 2002).

Adult bay scallops are efficient swimmers and can utilize voluntary movements, as well as shallow burrowing to escape from unfavorable environmental conditions (Fay et al., 1983). The movement of adult scallops results in a motion that appears zig-zag but is not directional. Directionality may result if movement is influenced by tidal flow (Fay et al., 1983; Moore and Marshall, 1967).

The project is not expected to disturb or affect seagrass habitat and any disturbances will be temporary and minimal. Scallops located in seagrass beds close to the permit area should gain protection from the seagrass if any decreases in water quality should occur.

8.3 Effects of Stress on the Benthic Community

A reduction in the population, abundance and diversity of infaunal species in the construction area are expected during and immediately after construction activities. The Coordination Act Report developed for Bogue Banks (USFWS, 2002) states that recovery rates of infaunal species and their ecosystem is dependent on the size of the sediment grains. Fine-grained (mud, silts and clays) were found to have similar levels of biodiversity in a dredge site within one year after construction. However, ecosystems associated with medium-grained size sands took one to three years to recover and coarse-grained deposits (>2 mm) required a five year recovery time. The recovery of an infaunal community was further defined as "a successional community of opportunistic species providing evidence of progression towards a community equivalent to that previously present, or at non-impacted reference sites" (USFWS, 2002). Therefore, if the abundance of the benthic community decreases, fish, birds, other aquatic organisms and terrestrial animals utilizing the fauna as a primary food source will be affected if adequate replacement opportunities are not present close to the disturbed site.

Studies have shown recovery in beach nourishment areas as well as at dredged areas and offshore borrow sites. Due to the medium sized grains of the inlet, recovery time for benthic infauna is expected to be 1 to 3 years. In addition, the frequency of large storms such as hurricanes and heavy wave actions suggests that benthic infauna are adapted and accustomed to change. Furthermore, populations are seasonally and thus, lower populations may be found during the winter.

8.4 Effects of Stress on Nesting Sea Turtles

Loss of nesting habitat is a significant stress for both sea turtles and the Carolina diamondback terrapin (Lutcavage et al., 1997; Reshetiloff, 2001). While all six species discussed are aquatic turtles they must return to land to nest. Female sea turtles construct their nests on coastal beaches and the Carolina diamondback terrapin builds their nests on embankments found along salt marshes, impoundments, tidal creeks, lagoons and mud flats (Reshetiloff, 2001). The loss of these habitats affects the ability of females to nest and reproduce.

Sand grain size, composition, and sorting of fill material are critical elements of nourishment activities that affect sea turtle nesting ability. Many beach nourishment projects obtain sand from offshore borrow sites where sediment properties of the material may not be comparable to the nourishment area. Projects that utilize fill material that is similar in grain size and composition to the nourishment area may prevent some of the adverse effects associated with some nourishment efforts (Crain et al., 1995).

The Bogue Inlet Channel Erosion Response Project is not expected to negatively affect the nesting habitat of sea turtles. Nourishment activities along Emerald Isle are expected to positively affect sea turtles by increasing the amount of available nesting habitat. Obtaining fill material from areas adjacent to the eroded beach may provide sediments that are similar to the sediments naturally occurring on the beach. Using sediment from Bogue Inlet, adjacent to the beach, will decrease the likelihood of adverse effects associated with non-compatible fill material.

Sea turtles are a group of highly migratory species (Lohmann et al., 1997). The activities associated with the Bogue Inlet plan will not affect juvenile or adult sea turtles because of the timing of the project. During the winter months the turtles migrate out of inland waters and into nearshore coastal waters; or they migrate further south into warmer coastal waters, until the spring time (Keinath et al., 1987; Epperly et al., 1995; Epperly et al., 1994).

8.5 Effects of Stress on Seabeach Amaranth

The stability of the frontal dune communities is important for the survival of the seabeach amaranth (*Amaranthus pumilus*). Seabeach amaranth, along with other dune plants act as dune stabilizers, securing the dune system with their roots and capturing wind-blown sand. However, these dune communities are frequently exposed to significant wind and wave actions and are susceptible to the erosive properties of these elements. The loss of these habitats can be detrimental to the survival of seabeach amaranth.

Nash (2002) reported that observations of the seabeach amaranth in Brunswick County and along Bogue Banks showed significant signs of recovery in 2002. Nash suggested two reasons for the recovery of the plant species: (1) beach renourishment activities have provided habitat for the plant; and (2) the North Carolina coastline has not suffered the effects of hurricanes since 1999, which can relocate seedlings during washover events. Nash also indicated that seabeach amaranth is a prolific seed producer, which may be one of the measures the plant has adopted to ensure its survival in the active frontal dune community.

The proposed beach nourishment activities are expected to have a positive indirect and cumulative effect on the seabeach amaranth population of North Carolina. The proposed beach nourishment activities will provide suitably sorted, beach-compatible material to the frontal dune system and high beach environment between mean high water and toe of dune. The supply of this material will provide the habitat needed for seabeach amaranth colonization. Natural recruitment from aeolian and wave actions to the nourished beach and dune area will assist in further recovery of the plant population.

8.6 Effects of Stress on Submerged Aquatic Vegetation

Three main contributing factors affect the sustainability of Submerged Aquatic Vegetation (SAV) habitat, these include: water quality, qualitative and quantitative light effects, and sedimentation (Livingston et al., 1998). Drastic influences to submerged aquatic vegetation can occur from the co-occurrence of changes in sediment and water quality characteristics and light restrictions (Stevenson, 1988; Livingston et al., 1998; Mallin et al., 2000).

Water quality factors that can affect SAV include: color levels, salinity, nutrient levels, turbidity, temperature, and pollution. Based on field data collected by Livingston et al. (1998), water quality factors were one of the best predictors of SAV distribution. For example, the quality and quantity of SAV habitats have been shown to increase with improvements in water quality and nutrient reductions (Carter and Rybicki, 1990).

Light is a major factor influencing the growth and distribution of seagrass (Stevenson, 1988; Grice et al., 1996; Mallin et al., 2000). Significant changes in the light regime of seagrass habitats have caused large scale losses of seagrass in the natural environment (Dennison et al, 1993 and Grice et al., 1996). Sufficient amounts of high-intensity sunlight can create more productive SAV species compared to species under low-intensity lights (Dennison et al, 1993 and Grice et al., 1996). In addition, reductions in SAV cover have been linked to reductions in “photosynthetically active radiation” (PAR) reaching the bottom of coastal waters (Onuf, 1994). Dennison et al. (1993) describes the minimum light requirement of SAV as 4-29% of incident light measured just below the water surface.

Extensive loss in seagrass cover in Laguna Madre, Texas from 1965 and 1974 was attributed to turbidity caused by maintenance dredging which then reduced the amount of light surrounding the seagrass habitat. A study by Onuf (1994) verified this hypothesis by assessing the influence of dredging on light and seagrass cover in Laguna Madre, Texas and found reduced light levels attributable from dredging in several areas of the study. Reduced light levels were evident in the seagrass meadow up to 10 months after dredging. Onuf (1994) did not attribute dredging as the sole contributor to increases in turbidity, reductions in light, and therefore, losses in seagrass cover. The dredging paired with “resuspension and dispersion events caused by wind-generated waves” were in part responsible for the long suspension time and large areal coverage of the dredge-related turbidity.

Sediment quality can also affect seagrass distribution (Livingston et al., 1998). Research conducted by Livingston et al. (1998) suggests that sediment characteristics are one of the best predictors of SAV distribution (along with water quality, photic depth and wavelength distribution). This study stated that sediment can contain nutrients which can then affect seagrass growth, morphology and abundance. One discussed effect of nutrient enrichment on eelgrass (*Zostera marina*) beds included increased growth.

Water quality, light, and sediments influence seagrass abundance and quality, which then influences predation where an increase in plant density yields an increase in predation (Irlandi, 1998). The theory for this stems from the increase in the amount of edge associated with small patches and fragmented habitats. The “greater amount of edge associated with small patches and fragmented habitats increases the accessibility of prey residing in patches to predators that forage from patch to patch” (Irlandi, 1998). The size of seagrass assemblages, density, composition, and fragmentation of these habitats can be critical to the diversity, abundance, composition, and biological interactions of faunal species that depend on these communities. The size of a seagrass patch is considered to be an important factor in supporting nursery habitat for commercially important fish species (Irlandi, 1998). Ultimately, the shape and areal coverage of these habitats are influenced by both abiotic and biotic factors.

Recovery time for an SAV habitat has additionally been found to vary based on the length, width and depth. The larger the size of the SAV patches, the quicker the recovery (SAV/DOT Advisory Panel Meeting December 2002).

8.7 Effects of Stress on Salt Marsh Ecosystems

Wetlands are often located on the receiving end for wastes from human and natural sources. The location of these habitats forces them to function as a sink to filter nutrients, phosphorous, metals, organic compounds and sediments prior to outletting into the ocean. The effects of these pollutants to the salt marsh system can be significant, although there are no studies to support this finding, the potential for detrimental effects to this system are evident. Pollutant loading to an estuarine system may interrupt the food web in the salt marsh by killing off some species and prompting other, potentially invasive species, to greatly increase in numbers (SCDNR, 20003).

Sea level rise may lead to flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges which have potential adverse effects to human and natural systems. In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding (EPA, 2000). Wetlands located in flood zones can restrict development and provide water storage areas to protect adjacent property from potential flood damage.

The inclusion of ditches for mosquito and can alter water flow and cause water loaded with vital nutrients to bypass the marsh. Many bird species rely on low, wet marsh systems, which could diminish along with the supply of nutrients and food sources once available in these fragile ecosystems. Canals designed for flood control can increase the surface water and stress and ultimately kill the grass species. (SCDNR, 2003)

It is estimated that three-quarters of the Nation's marine harvestable species are, at some point in their life cycle, dependent on estuarine habitats for food and shelter or as migratory routes and spawning grounds (NOAA, 2001). The loss of these habitats could be detrimental to many components of the food web.

8.8 Effects of Stress on Water Quality

Water quality is susceptible to impacts from point and non-point source pollution, tides, currents, dredging, boat traffic and recreational activities that may contribute to fluctuations in the water quality of an estuarine environment. Tides and currents constantly exchange water in Bogue Inlet by accepting freshwater from the White Oak River, and oceanic water from the Atlantic. Freshwater from the White Oak River can contain agricultural runoff that may impair water quality. Saltwater from the ocean, which is less likely to contain pollutants, enters the inlet during flood tides which flush the estuarine system. During ebb tide, estuarine water is flushed out of the sound and into the ocean.

An important aspect of water quality for floral and faunal species in the estuarine ecosystem is dissolved oxygen level in the water. Tidal exchange within the Inlet can minimize or limit the effects of hypoxic conditions in the system. The chemical and physical parameters of water quality (temperature, salinity, dissolved oxygen, pH, and turbidity) are expected to change slightly, if at all, resulting in minimal and temporary direct and indirect effects to water quality in Bogue Inlet. No cumulative effects are expected to result from project implementation.

9.0 CEA STEP 6 - STRESSES IN RELATION TO REGULATORY THRESHOLDS

CEA Step 6 discusses the regulations, criteria and plans associated with each the resource.

9.1 Regulatory Thresholds of Birds

The waterbird and shorebird species that frequent Bogue Inlet are protected under the Migratory Bird Treaty Act of 1918 and are included in the following conservation plans: U.S. Shorebird Conservation Plan, Caribbean Regional Shorebird Plan, and the North American Waterbird Conservation Plan. These plans assign the various bird species with a high, moderate, low, or not at risk designation as a guide to further protect the resource. Higher designation suggests that an effect may have more influence on a species that is of higher concern. Piping plovers (*Charadrius melodus*), for example, are listed as Federally endangered species and a species of extremely high priority (Hunter, 2001). Effects on piping plovers, and other species of high concern, must be minimal due to the regulatory thresholds that govern the species conservation.

9.1.1 Regulatory Thresholds of Shorebirds

Specific shorebird species of concern range from species not at risk to species of extremely high priority. Species of extremely high priority are designated by the Southeastern Coastal Plan – Caribbean Regional Shorebird Plan (Hunter, 2001) and include the American oystercatcher (*Haematopus palliates*), the piping plover (*Charadrius melodus),* and the red knot (*Calidris canutus*). Species of high priority include Wilson's plover (*Charadrius wildonia)* and the short-billed dowitcher (*Limnodromus griseus*). Species of moderate priority include the sanderling (*Calidris alba*), willet (*Catoptrophorus semipalmatus*), and dunlin (*Calidris alpine*). The red phalarope (*Phalaropus fulicarius*) is a species of high concentration and its populations are thought to be in decline. The U.S. Shorebird Conservation Plan (Brown et al., 2000) lists the red phalarope as a species of moderate concern because of its perceived population decline. According to the North American Waterbird Conservation Plan, the population status of Cory's shearwater (*Puffinus diomedea*) is apparently stable and the species is designated as moderate to low concern (Kushlan and Steinkamp, 2002). The North American Waterbird Conservation Plan also lists the northern gannet (*Morus bassanus*) as a species not at risk because biologically significant population increases have been documented.

Species in highest need of conservation, based on the above cited plans, include American oystercatchers, piping plovers, and red knots. The American oystercatcher is designated as a species of extremely high concern because existing information suggests that their populations are significantly declining and significant threats exist to the current populations. In addition, the Southeast region is extremely important for breeding and wintering for the species. The piping plover is listed as endangered under the Federal Endangered Species Act and the North Carolina Natural Heritage Program (LeGrand and Hall, 1999). The region is extremely important to piping plovers for wintering and very important for breeding and migration. Furthermore, piping plover habitat is listed as critical and requires protection under Federal regulations.

Red knots migrate to the Bogue Inlet area during their spring and fall migrations and may be sporadically found in the region during the winter. Wilson's Plover, a species of high priority is also listed as significantly rare under the North Carolina Heritage Program (LeGrand and Hall, 1999) and the Bogue Inlet region is important to this species for breeding.

All shorebirds are protected under the Migratory Bird Treaty Act of 1918, which prohibits, pursuing, hunting, shooting, wounding, killing, trapping, capturing, collecting, or attempting such conduct without appropriate permits. As a Federally listed species, the piping plover is protected under the Endangered Species Act of 1973 (ESA). Federal actions are all subject to consultation so as not to jeopardize the continued survival and recovery of a species listed under the ESA. The ESA prohibits taking, and harming and harassing piping plovers, or significantly modifying or degrading critical habitat that may impair essential behavioral patterns including breeding, feeding, or sheltering (Federal Register Part II, 2001). The major goal for piping plover management is to protect wintering grounds where the plovers forage, roost, and shelter. Important regulatory thresholds are based on sustained wintering habitat constituents essential for the primary biological needs of foraging, sheltering, and roosting.

The stressors from the project will include noise, relocation of habitat, and a temporary increase in human activity in Bogue Inlet. These stressors should not be of sufficient duration or intensity to effect drastic changes to foraging, roosting, sheltering, or nesting shorebirds. No long-term habitat loss or human disturbance to critical habitat is expected to occur. Activities will be timed as to minimize the effects on piping plovers and other shorebirds in the area.

There are no identified stress thresholds regarding shorebirds in general, however, the areas of Bogue Inlet have been defined as Critical Habitat for Piping Plovers. The potential impact areas are limited for this project and significant similar habitat is available on a local and statewide basis. Furthermore, It is unlikely that the cumulative impacts from the Inlet Channel Erosion Response Project and other known projects will cause population impacts to shorebird species due to the timing of the project outside the critical nesting period.

9.1.2 Regulatory Thresholds of Waterbirds

Waterbirds are also protected under the Migratory Bird Treaty Act of 1918 and harm or harassment of waterbirds is strictly forbidden without the appropriate Federal permits. This project is not expected to harm or harass any waterbirds.

Waterbird conservation and protection is addressed in the North American Waterbirds Conservation Plan (Kushlan and Steinkamp, 2002). This plan provides the framework for the conservation and management of 210 species of waterbirds, including seabirds, coastal waterbirds, wading birds, and marsh birds utilizing aquatic habitats throughout North America. Many of these waterbirds, seabirds, and wading birds may be found along North Carolina coasts, estuaries, and pelagic waters.

Waterbird species found in and around Bogue Inlet may be listed under the Conservation Plan as high, moderate, or low levels of concern. Species of high concern are those where threats to breeding are occurring and can be documented, and may have apparent population declines (Kushlan and Steinkamp, 2002). Moderate species of concern are waterbirds that may have declining populations with moderate threats or distributions; or may be stable with known or potential threats and moderate to restricted distributions; or may be represented by relatively small populations with relatively restricted distributions. Low species of concern have populations that may be stable with moderate threats and increasing distributions; or of moderate population size with known or potential threats and moderate to restricted distributions.

Species of high concern in the Bogue Inlet include snowy egret (*Egretta thula*), tricolored heron (*Egretta tricolor*), little blue heron (*Egretta caerulea*), gull-billed tern (*Sterna nilotica*), black skimmer (*Rynchops niger*, and least tern (*Sterna antillarum*). These species have known threats to breeding that are occurring and can be documented, and they may have apparent population declines (Kushlan and Steinkamp, 2002). Moderate waterbird species of concern observed in the Bogue Inlet ecosystem include white ibis (*Eudocimus albus*), bonaparte's gull (*Larus philadelphia*), lesser black-billed gull (*Larus fuscus*), royal tern (*Sterna maxima*), black tern (*Chilidonias niger*), Forster's tern (*Sterna forsteri*) and brown pelican (*Pelecanus occidentalis*). Low species of concern include glossy ibis (*Plegadis falcinellus*), herring gull (*Larus argentatus*), caspian tern (*Sterna caspia*), and common tern (*Sterna hirundo*).

The gull-billed tern (*Sterna nilotica*) is listed by the State of North Carolina as threatened. The Natural Heritage Program (Le Grand and Hall, 1995) also lists various species as significantly rare and species of concern. The common tern (*Sterna hirundo*), least tern (*Sterna antilllarum*), and the black rail (*Laterallus jamaicensis*) are all listed as significantly rare under the North Carolina Natural Heritage Program. Also of importance to the State of North Carolina is the brown pelican (*Pelecanus occidentalis*), which was removed from the Federal listing in 1985.

9.2 Regulatory Thresholds of Shellfish

The North Carolina Marine Fisheries Commission (NCMFC) was created to "manage, restore, develop, cultivate, conserve, protect, and regulate the marine and estuarine resources of the State of North Carolina" (NCDMF, 2001a; NCDMF, 2001b). The NCMFC issues proclamations (public notices) to implement rules governing fishery practices in the State. In addition, shellfish are regulated under the Fisheries Reform Act (FRA) of 1997 that establishes a process for development of coastal fisheries management plans in North Carolina. The FRA states that "the goal of the plans shall be to ensure the long term viability of the State's commercially and recreationally significant species or fisheries". During the 1994 Session of the North Carolina General Assembly, a Blue Ribbon Advisory Council was appointed to study and make recommendations concerning policies and management of the State's oyster resources.

Laws and regulations exist to protect shellfish and to ensure a proper balance between fishermen, swimmers, boaters, and developers, along with providing adequate protection for the environment. These goals and management issues for shellfish include maintaining water quality, preventing increases in sedimentation, protecting habitat (SAV, primary nursery areas, oyster rock) that are necessary for shellfish growth and survival, and to prevent further habitat destruction, especially to wetlands, which can contribute significantly to the degradation of shellfish. The North Carolina Shellfish Sanitation and Recreational Water Quality Section of the Division of Environmental Health is responsible for monitoring and classifying coastal waters as to their suitability for shellfish harvesting for human consumption and inspection and certification of shellfish processing plants.

Both the oyster (*Crassostrea virginicus*) and the hard clam (*Mercenaria mercenaria*) fisheries are regulated under a Fishery Management Plan (FMP) for the state of North Carolina. The bay scallop (*Argopecten irradians*) is not covered by a FMP because the status of the fishery in North Carolina is healthy. However, the depletion of grass beds in North Carolina's estuaries may create the need for a FMP for the bay scallop in the future. The Bogue Inlet Channel Erosion Response Project is expected to result in minimal and/or temporary effects to the seagrass beds in Bogue Inlet's estuaries with minimal effects on shellfish.

In 1998, the South Atlantic Fishery Management Council designated intertidal and subtidal shell bottom as Essential Fish Habitat. The hard structure that a shellfish species creates (i.e. oyster reefs) can be used by other species, as well as finfish and invertebrates. It has been documented that topography, morphology, and structural heterogeneity often control recruitment, persistence, and diversity in coral reefs, seagrass communities, and salt marshes. This finding has led to the development of measures to protect these areas from direct anthropogenic disturbances. Shellfish communities serve as fishery nursery habitats and provide natural water filtration that has beneficial effects on the surrounding marine environment. Shell bottom habitat also provides structure for attachment, cover from predators and food opportunities to the estuarine community (NCDMF, 2001). Studies have shown that the most critical areas for oyster populations are oyster beds or rocks, which the oysters themselves formed by accumulation of shells over time and the removal and degradation of oyster habitat has contributed to a decline in oyster landings (NCDMF, 2001). More importantly, shellfish are sensitive to changes in water quality and can be used as environmental indicators. Therefore, there have been many management activities and regulations implemented to assess impacts to shellfish populations from various anthropogenic activities and ensure survival of shellfish communities.

9.3 Regulatory Thresholds of the Benthic Community

There are no federal, state or local regulatory thresholds or guidelines associated with infaunal species in North Carolina. However the survival of these species and their habitat is crucial for the sustainability fish, birds and marine mammals that feed on these species. Therefore, maintaining the biological integrity of this resource is crucial regardless of the lack of regulatory thresholds assigned resident infaunal species.

9.4 Regulatory Thresholds of Sea Turtles

The Endangered Species Act of 1973 protects sea turtles in the United States (Pritchard, 1997) and lists declining species as either endangered (in danger of becoming extinct) or threatened (may soon face extinction unless measures are taken to protect it). Under the ESA, the loggerhead sea turtle is designated as threatened throughout its entire range. Green sea turtles are also designated as threatened throughout its entire range, except for the State of Florida and Pacific coast of Mexico where it is listed as endangered. The hawksbill (*Eretmochelys mbricate*), Kemp's Ridley (*Lepidochelys kempi*) and leatherback (*Dermochelys coriacea*) sea turtles are all designated as endangered throughout their entire range (Ripple, 1996). The ESA makes it illegal to import, sell or transport turtles or products derived from turtles for domestic or international commerce. Because sea turtles are found on beaches as well as in the surrounding water of the United States two Federal agencies have jurisdiction over sea turtles. The NMFS has jurisdiction over sea turtles in the water and the USFWS oversees activities that may affect them while on land.

The North Carolina Wildlife Resources Commission (NCWRC), through an agreement with the USFWS, established the State's Sea Turtle Protection Program under Section 6 of the Endangered Species Act (NCWRC, 1998). The Sea Turtle Protection Program monitors, manages, and protects sea turtle nests on North Carolina's beaches where over 20 sea turtle nest-monitoring programs currently exist. Individual program scopes vary in involvement from counting nests, emergences, and false crawls to full-scale management of nests and their success. The program also maintains records of sea turtle mortality, and strandings that occur in the State.

To protect turtles within the state waters the State of North Carolina, in cooperation with the NMFS, enforces the use of Turtle Excluder Devices (TEDs) on fishing vessels year-round. TEDs allow sea turtles to escape trawling nets through an escape hatch at the cod end of the net. Before implementation of requirements to use TEDs, a study conducted by the National Academy of Sciences reported that incidental capture of sea turtles by shrimp trawlers accounted for more sea turtle deaths than all other human activities combined (National Research Council, 1990). Crowder (1995) found that the use of TEDs has reduced the bycatch of loggerhead sea turtles in South Carolina by 44%.

The Carolina diamondback terrapin is listed by North Carolina state law (NCDMF, 2003) as a species of special concern.

9.5 Regulatory Thresholds of Seabeach Amaranth

In 1993, the USFWS listed the seabeach amaranth (*Amaranthus pumilus*) as a threatened species throughout its range which includes the shorelines of Delaware, Maryland, North Carolina, New Jersey, New York, South Carolina, Virginia.

North Carolina established a seabeach amaranth conservation program in conjunction with the State's enactment of the Plant Protection and Conservation Act in 1979. The Plant Conservation Program mandates that the North Carolina Department of Agriculture and Consumer Services (NCDACS) list and protect threatened and endangered plant species. Management responsibilities of the Conservation Program include: 1) maintaining the list of endangered, threatened and special concern plant species, 2) enforcing regulations and issuing permits for activities that may affect listed plants, 3) monitoring and managing of plant populations, 4) educating the public, and 5) monitoring the trade of American ginseng (*Panax quinquefolius*).

The NCDACS defines a threatened species as any resident plant species that is “likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, or one that is designated as threatened by the USFWS” (NCDACS, 2003). A permit is not anticipated for the project since the proposed activities will occur during the winter months when the plant will have died back and construction activities will occur outside the area where the plant is found.

9.6 Regulatory Thresholds of Submerged Aquatic Vegetation

Submerged aquatic vegetation is managed by the National Marine Fisheries Service as an Essential Fish Habitat and Habitat Area of Particular Concern under the 1996 amendment to the Magnuson-Stevens Fishery Conservation and Management Act (NMFS, 2000). In response to NMFS regulation, every state that is located in the coastal zone and has seagrass communities is required to preserve, protect, and restore submerged aquatic vegetation.

The North Carolina Division of Marine Fisheries is in the process of developing Coastal Habitat Protection Plans (CHPPs) for the long-term enhancement of coastal fisheries through protection and heightened consideration of fish habitat in resource management decisions. Plan development is part of a cooperative effort among scientists from state agencies with jurisdiction over marine fisheries, water quality and coastal area management (NCDMF, 2003).

The first CHPP will be developed to apply to the entire coastal area. The overall CHPP will be based on the six basic habitats that support all of North Carolina's coastal fisheries resources: the water column, shell bottom, submerged aquatic vegetation, wetlands, soft bottoms, and ocean hard bottom. (NCDMF, 2003)

9.7 Regulatory Thresholds of Salt Marsh Ecosystems

The Federal and State regulations have been implemented throughout North Carolina to protect and prevent a net loss of wetlands within the coastal zone. Coastal and freshwater wetlands of North Carolina are protected and managed under Federal regulations pursuant to Section

404(f)(1) of the Clean Water Act and North Carolina Division of Water Quality Section 401 Water Quality Certification Program. In addition to these regulations, the North Carolina Coastal Area Management Act of 1974 (CAMA) has specific management rules which designate saltwater wetlands. (NCDWQ, 2000).

Protection of coastal wetlands in North Carolina is in effect for the twenty coastal counties of North Carolina and two state laws governing coastal wetland protection in North Carolina are:

(1) North Carolina Dredge and Fill Act (1969) which requires permits for excavation or filling in any estuarine waters, tidelands, marshlands, or state-owned lake. This law is currently administered with CAMA (1974)".

(2) North Carolina CAMA (1974) attempts to control development pressures through coordinated management in order to preserve North Carolina's coastal features that make it economically, aesthetically and ecologically rich. The Coastal Resources Commission, a 15-member board appointed by the Governor, that oversees CAMA implementations (NCDWQ, 2000).

The Coastal Resources Commission, a State commission created under the Coastal Area Management Act of 1974, has identified four Areas of Environmental Concern (AEC), (estuarine system, ocean system, public fresh water supplies, and natural and cultural resource areas) within the twenty coastal counties of North Carolina. The estuarine system includes a broad network of brackish sounds, marshes, and surrounding shorelines. Except for an activity that is considered exempt, any development that occurs within an AEC must obtain a CAMA permit (Cox et al., 1994).

9.8 Regulatory Thresholds of Water Quality

Bogue Inlet is listed as Class SA Outstanding Resource Waters (ORW) by the North Carolina Department Environment Natural Resources (NCDENR). Class SA waters are suitable for shellfishing for market purposes and important to aquatic life propagation, survival, fishing, as well as primary and secondary recreation (NCDENR, 2000). ORW are classified as pristine surface waters that are considered to be exceptional by the State, and have a national recreational or ecological significance that requires special protection to maintain existing uses (NCDENR 2000). The special protection measures that apply to North Carolina ORW's are set forth in 15A NCAC 2B .02225 (NCDENR, 2001).

Table 9.1
North Carolina Water Quality Standards
(NCDWQ, 2003)

Water Quality Physical Parameters	North Carolina Surface Water Standards
Dissolved Oxygen	5.0 mg/L
pH	6.8 – 8.5
Salinity	Changes should not result in removal of the functions of a Primary Nursery Area (PNA)
Temperature	Changes should not increase 2.2ºC (3.96ºF) during all months except June – August; in no case should temperature increase above 32ºC (89.6ºF) due to discharge of heated liquids
Turbidity	25 NTU

The North Carolina Administrative Code does not provide specific standards for Class SA ORW, however, SA waters are incorporated into the rules that apply to fishing and secondary recreational waters as provided in Table 9.1.

Turbidity is measured in Nephelometric Turbidity Units (NTU) that defines the light-scattering properties of the water. The state guideline for turbidity in North Carolina SA waters are not allowed to increase in turbidity levels above ambient conditions. Turbidity levels within the immediate vicinity of the construction activities (i.e., existing and proposed channel locations, sand dike and nearshore beach nourishment zone). Due to the low percentage of silt in the material to be excavated, the increase in NTU is expected to be minimal. Vibracores taken at Bogue Inlet in 2002 show that, on average, silt comprised only 1.25% of the material. Additionally, turbidity samples taken at Swansboro from 1994 to 1999 showed an average background turbidity level of approximately 5.2 NTUs (NCDENR, 2000). Thus, it is not expected that the project will cause large increases in turbidity values above the State standards. Turbidity levels will be monitored during construction activities and measured levels that exceed State standards will require modification of construction techniques or cessation of dredging activity until acceptable levels are reached.

Salinity is another important water quality parameter for estuarine environments. During the year, Bogue Inlet has natural fluctuations and periods of high, transitional and low salinities. No changes in salinity above natural fluctuations are expected to occur during project implementation.

10.0 CEA STEP 7 – BASELINE CONDITIONS

The following EIS sections describe the baseline conditions for the resources and ecosystems pertinent to this assessment.

11.0 CEA STEP 8 - CAUSE AND EFFECT RELATIONSHIPS

This section of the CEA provides a conceptual model of the cause and effect relationships between resources and a changing environment. Two models were developed for each identified resource within the project area to show (1) the pathway of the resource response from non-project specific cumulative effects and (2) the pathway of the resource response from project specific effects. A project related flowchart for some of the resources was not created because the project was not expected to have high direct, indirect, or cumulative effects on that resource. Attachment B provides the general and project specific flow charts developed for the project.

12.0 CEA STEP 9 - MAGNITUDE AND SIGNIFICANCE OF CUMULATIVE EFFECTS

Step nine of the CEA assesses the effects of other projects that have occurred within the last 50 years, are presently occurring, or are going to occur in the coastal environments of North Carolina. Table 12.1 lists 53 other significant projects (M. Sugg, pers. comm., 2003), their associated occurrence, magnitude and significance of cumulative effects on the environment.

Table 7.1 (Section 7.0) was used to assist in determining the magnitude and significance of other projects on the resources identified in the geographic scope of the project. The magnitude column indicates positive cumulative effects versus negative cumulative effects associated with each project based on the findings provided in Table 7.1. The significance column is based on the total number of cumulative effects (positive and negative) and assigns a degree of effect to that project (Very Low = 1, Low = 2-4, High = 5-7, and Very High = 8-9).

The following is a description of how similar project activities within close proximity to the Bogue Inlet Project Area may affect resources in terms of space and time.

12.1 Beach Nourishment

Existing beach nourishment activities occur, on average, along three miles of beach per year for USACE projects only, or along one percent of North Carolina beaches. However, the minimum of activities that have occurred in any given year is zero. The current maximum affected beach incorporates 13 miles or about 4 percent of North Carolina ocean beaches. Proposed beach nourishment activities will average 17 miles or up to 5 percent of all North Carolina ocean beaches per year. In any given year, a minimum of zero to a maximum of 42 miles (13 percent) of North Carolina ocean beaches could be nourished.

Beach quality sand is a valuable resource that is highly sought by beach communities to provide wide beaches for recreation and tourism, as well as to provide hurricane and wave protection for public and private property in these communities. When beach quality sand is dredged from navigation projects, it has become common practice of the USACE to make this resource available to beach communities, to the maximum extent practicable. Placement of this sand on beaches merely represents return of material, which eroded from these beaches, and is, therefore, replenishment with native material. The design of beach placement sites is very simple; generally it extends the elevation of the natural berm seaward. Widths of beach placement zones generally reflect the wishes of the local government relative to the choice between a long, narrow beach or a shorter, wider beach. The Bogue Inlet project will utilize well-sorted inlet material to nourish the west end of Emerald Isle. The use of this highly compatible material will assist in re-establishing the natural beach community for the resources that utilize this habitat.

12.2 Inlet Relocation

Existing inlet relocation activities include 2 out of 21 (Tubbs and Mason Inlets) or about 10 percent of all inlet complexes south of Cape Lookout, North Carolina have been relocated. Proposed inlet/channel relocation projects projected to occur in the near future include Bogue Inlet (1 out of 21 or ~5 percent). Relocation projects, such as Mason and Bogue Inlets provide beach habitat for birds, nesting sea turtles, and seabeach amaranth. This additional habitat can be assumed to be cumulatively positive for the respective resources.

Maintenance activities for these inlet relocation projects typically occur every one to three years, however the maintenance schedule is highly dependent on storm events, littoral drift, tidal prism/channel cross-section, and rainfall events. Maintenance dredge for Mason Inlet is expected to occur in the year 2005; 2006 for Bogue Inlet; and sometime in the near future for Tubbs Inlet. The cumulative effects of these maintenance activities to the resources in the Bogue Inlet Project Area could be significant since these activities will occur within the same approximate timeframe.

Further analysis of the effects of these activities in relation to cumulative negative or cumulative positive effects to the resources of Bogue Inlet will be determined and included in a future EIS submission.

TABLE 12.1

BOGUE INLET
PROJECTS FROM PAST 50 YEARS
PAST, PRESENT, RFFA

PROJECTS	PAST	PRESENT	RFFA[3]	MAGNITUDE	SIGNIFICANCE
Inlet Projects					
Inlet Openings					
Drum Inlet Opening & Dredging	X			1+/6-	High
Carolina Beach Inlet Opening	X			5+/4-	Very High
Inlet Closures					
Moore Inlet Closure	X			3+/6-	Very High
Inlet Navigation Projects					
Oregon Inlet Dredging & Disposal	X	X	X	3+/0-	Low
Hatteras Inlet Dredging	X	X		0+/0-	Minimal
Beaufort Inlet Dredging	X	X	X	0+/1-	Very Low
Bogue Inlet Dredging	X	X	X	0+/3-	Low
New River Inlet Dredging	X	X	X	2+/3-	High
New Topsail Inlet Dredging	X	X	X	0+/1-	Very Low
Rich Inlet Dredging	X	X	X	3+/1-	Low
Carolina Beach Inlet Dredging	X	X	X	0+/0-	Minimal
Tubbs Inlet Dredging			X	3+/0-	Low
Shallotte Inlet Dredging	X	X	X	3+/0-	Low
Lockwood's Folly Inlet Dredging			X	0+/0-	Minimal
Inlet Relocations					
Bogue Inlet Relocation		X	X	3+/0-	Low
Mason Inlet Relocation		X	X	6+/1-	High
Tubbs Inlet Relocation	X			0+/0-	Minimal
Beach Nourishment Projects					
Carteret Co. Bogue Banks Beach Restoration Project		X	X	3+/0-	Low
Dare County Beaches North Beach Nourishment			X	3+/0-	Low
Bogue Banks Beach Nourishment		X	X	3+/0-	Low
Camp Lejune Beach Nourishment			X	3+/0-	Low
Topsail Island Beach Nourishment			X	3+/0-	Low
Topsail Beach/West Onslow Beach Nourishment & Terminal Groin			X	3+/0-	Low
Figure 8 Island Beach Nourishment	X	X	X	3+/0-	Low
Wrightsville Beach Beach Nourishment	X	X	X	3+/0-	Low
Carolina Beach Beach Nourishment	X	X	X	3+/0-	Low
Kure Beach Beach Nourishment	X	X	X	3+/0-	Low
Fort Fisher Revetment	X	X		3+/0-	Low
Bald Head Island Beach Nourishment	X			3+/0-	Low
Oak Island Beach Nourishment			X	3+/0-	Low
Holden Beach Beach Nourishment		X	X	3+/0-	Low
Ocean Isle Beach Nourishment		X	X	3+/0-	Low
Maintenance Dredging					
Nags Head/Kitty Hawk Dredge Disposal		X		3+/0-	Low
Beaufort Inlet Nearshore & Offshore Disposal Sites	X	X	X	0+/0-	Minimal
Emerald Isle Dredge Disposal	X	X	X	3+/0-	Low
Onslow Bay Dredge Disposal Islands	X	X	X	1+/0-	Very Low
Cape Fear River (Wilmington Harbor) Dredging	X	X	X	4+/3-	High
Soft Structure Projects					
Topsail Island Sandbags	X	X	X	0+/0-	Minimal
Figure 8 Island Sandbags	X	X	X	0+/0-	Minimal
Mason Inlet Sandbag Revetment	X	X		0+/0-	Minimal
Holden Beach Sandbags	X	X		0+/0-	Minimal
Ocean Isle Sanbags	X	X		0+/0-	Minimal
Dredge Disposal Projects					
Atlantic Beach Dredge Disposal	X	X	X	1+/0-	Very Low
Pine Knoll Shores Dredge Disposal	X	X	X	1+/0-	Very Low
Hard Structure Projects					
Oregon Inlet Jetties			X	0+/4-	Low
Oregon Inlet Terminal Groin	X	X		3+/0-	Low
Cape Lookout Jetty				3+/0-	Low
Shackleford Banks Jetty				2+/0-	Low
Fort Macon Jetty & Groins	X	X		3+/0-	Low
Masonboro Inlet Jetties & Dredging	X	X		3+/1-	Low
Habitat Restoration					
NC 12 Dune Maintenance - Hatteras Island	X	X	X	0+/0-	Minimal
Bogue Banks Beach Scraping	X	X		2+/0-	Low

NOTES:

(1) The numbers assigned to the magnitude column correspond with **Table 8.1** and the positive and negative cumulative effects designated to each project and the listed resource.

(2) A very low to very high designation was assigned to each project in the significance column based on the number of positive or negative cumulative effects (Very Low = 1, Low = 2-4, High = 5-7, Very High 8-9) listed in the magnitude column.

(3) RFFA = Reasonably Foreseeable Future: Projects that have been formally proposed, environmental documents have been prepared or are being prepared, or the relevant authorization and/or permits have been obtained but construction has not started

13.0 CEA STEP 10 – MODIFY OR ADD ALTERNATIVES TO AVOID, MINIMIZE OR MITIGATE SIGNIFICANT CUMULATIVE EFFECTS

Significant cumulative effects are not expected to occur from the proposed Bogue Inlet Channel Erosion Response Project. Several monitoring and potential mitigation measures may be implemented to minimize and avoid adverse impacts to both Federal and State protected species and their habitat during and after project construction. These measures or expected benefits from project implementation include:

1. Establishing access restrictions around piping plover nesting areas along the west end of Emerald Isle during breeding season;
2. Implementation of a habitat management plan that limits public access and usage to nesting piping plover habitat especially during nesting season;
3. Creation a sand dike along the existing main ebb channel to assist in the closure and infilling of the abandoned waterway. This mitigation measure will immediately replace a portion of the habitat lost during channel relocation and quicken the reestablishment of sufficient intertidal habitat for infaunal recruitment and beach and dune communities for turtles and bird species;
4. Installation of the sand dike will assist in the rapid growth and development of a sand spit along the western shoulder of Bogue Banks and shoaling along the ocean side of the existing channel, providing habitat for listed species and their critical habitats;
5. Shoreline accretion along 7500 feet of oceanfront shoreline of Bear Island resulting in the preservation of beach and dune systems for seabeach amaranth and sea turtle nesting;
6. Anticipated development of the complex spit that currently extends into the eastern channel. This area may be considered as conservation land and mitigation for potential temporary shorebird and salt marsh habitat losses resulting from project construction;
7. Sand placement and dredge operations outside of primary invertebrate production and recruitment periods (spring and fall) thereby limiting impacts to amphipods, polychaetes, crabs and clams. Natural recruitment and repopulation of disturbed areas are expected to result in minimal impacts from the sand relocation efforts;
8. Use of a qualified biologist during construction activities to monitor the construction zone for piping plover, shorebirds, colonial waterbirds, and marine mammals to avoid or minimize disruption;
9. An ocean certified cutter suction hydraulic dredge will be used to minimize the potential for impacts to sea turtles and marine mammals resulting from mobile construction equipment;
10. Biological monitoring of infaunal species, birds and salt marsh will be conducted for one-year prior to construction and for three years after construction completion. This extensive monitoring plan will be used to evaluate project affects and develop mitigation requirements if necessary;
11. Digital aerial photography, surveying and habitat ground-truthing conducted during the summer of 2003 will provide updated habitat and physical information on the project study area.
12. Approximately 80% or more of the well-sorted sand material removed from the dredged channel will be used for beach renourishment along Emerald Isle. The proposed nourishment material is similar to the existing beach material in both color and grain size and is considered to be well suited for beach nourishment. This material will greatly

contribute to the re-establishment of sea turtle nesting habitat within the Phase 3 project area of the Bogue Banks Shore Protection Project;

13. Sand compaction may be monitored within the Bogue Banks Phase 3 project area. If required, the Phase 3 project area will be tilled prior to April 1st for up to three years following project construction to address compaction issues; and
14. Visual surveys of escarpments along the project area will be made immediately after completion of project construction and remedial measures will be implemented to eliminate or minimize escarpments.

14.0 CEA STEP 11 - MONITORING OF CUMULATIVE EFFECTS

Step 11 of the CEA lists the following components that should be considered as part of a monitoring program: (1) measurable indicators of the magnitude and direction of ecological and social change, (2) appropriate timeframe, (3) appropriate spatial scale, (4) means of assessing causality, (5) means of measuring mitigation efficacy, and (6) provisions for adaptive management.

Biological monitoring plans developed for the project were designed to provide information regarding the utilization and habitat significance for listed, protected, and managed fish and wildlife species within the proposed project area. Due to concerns over indirect effects to Huggins and Dudley Islands, West End Beach, Bear Island, Island Number 2, areas of Bogue Sound, Hawkins Island, Jones Island, and Cedar Point Marshes in the White Oak River; these areas were considered for inclusion. Approximately 14 square miles of land and water resources in and around Bogue Inlet are being extensively surveyed through the use of aerial photography, topographic/bathymetric surveying and habitat mapping to provide accurate pre-construction baseline data. Methods of avoidance and minimization of proposed project affects on shellfish, Submerged Aquatic Vegetation (SAV), fish populations, migratory shorebird nesting and foraging habitat, and sea turtle nesting habitat will be identified during the plan formulation analysis.

Three biological monitoring plans were developed for the project and designed to provide current baseline data upon which potential effects to sensitive resources within the project area can be evaluated. Pre-construction biological monitoring of the project area began in April 2003 and will continue until April 2004. A minimum of three-years post-construction monitoring is expected to be required by State and Federal resource protection agencies to evaluate project effects. Monitoring and sampling efforts within the study area include benthic macroinfauna sampling; piping plover, other shorebirds, and colonial waterbird monitoring; sea turtle nesting and hatching; and salt marsh community and sedimentation monitoring. Water quality sampling of turbidity will be conducted during construction to ensure that the project is in compliance with the requirements of the North Carolina Department of Environmental Water Quality.

The biological monitoring plans were submitted to the USACE on November 21, 2002 and distributed to members of the Project Delivery Team (PDT). The monitoring protocols, methods and schedules were reviewed and have been modified to address concerns presented by the USACE, North Carolina Wildlife Resource Commission, North Carolina Division of Water Quality, USFWS, NMFS, and other members of the PDT.

A summary of the biological monitoring efforts is provided below.

14.1 Bird Monitoring

Bird monitoring for the project is being conducted along four transect areas: Transect Area No. 1 west end of Bogue Banks; Transect No. 2 encompasses Island No. 2 and a portion of the eastern perimeter of the mid-inlet shoal; Transect Area No. 3 encompasses the south side of Dudley Island; and Transect No. 4 extends along the eastern side of Bear Island. Bird monitoring observations are conducted by an ornithologist equipped with a spotting scope to assist in identifying nesting, roosting, and foraging activities, as well as territory establishment, courtship, and copulating birds. Monitoring of bird species began on April 2, 2003 and will continue for one-year during the breeding, migratory and wintering periods to obtain baseline information. Section 4 of the Environmental Impact Statement (EIS) describes in detail the bird monitoring locations assigned to the Bogue Inlet Channel Relocation Project.

14.2 Macroinvertebrate and Infaunal Sampling

An indepth description of the details of macroinvertebrate and infaunal sampling is provided in Section 4 of the EIS identifies the benthic monitoring stations for Bogue Inlet. Infaunal data for the ten sampling stations will be reported as the number of individuals from each taxon, the number of species and the total number of organisms per square meter.

14.3 Salt Marsh Monitoring

Monitoring of salt marsh habitats in the project area was designed to assess and document the potential effects of project implementation, such as sedimentation accumulation, on adjacent salt marshes. Salt marsh monitoring transects are located at the following stations: 1) north of Bogue Inlet on the east side of the main channel, 2) on the east side of Dudley Island, and 3) north of Bear Island (Appendix A – Salt Marsh Monitoring Stations). A total of four monitoring events will be conducted to determine if impacts are directly or indirectly attributed to project activities. A more detailed assessment of salt marsh monitoring is described in Section 4 of the EIS

15.0 SUMMARY

During the past three decades, the morphology of Bogue Inlet has changed substantially. In the middle to late 1970's, inlet morphology was changing rapidly and adjusting to the ebb channel reorientation/repositioning that occurred in 1975. This channel reorientation resulted from the merging of two ebb channels into a single channel. The ebb channel then began migrating in a westward direction due to the formation of a single channel. This westward movement eroded as much as 155 meters (509 feet) from the Bogue Banks Inlet shoreline and created spit elongations on the adjacent Inlet shoulders.

Between 1981 and 1988, the single, well-defined ebb channel began migrating to the east at a rate of 36 meters/year (119 feet/year). The pattern of shoulder accretion from Bogue Banks was reversed by 1984 (due to the change in migrating directions) when erosion became the dominant force. In addition, Bear Island initially experienced a period of progradation beginning when the ebb channel started its easterly migration. The easterly migration also created a wide marginal flood channel on the Bear Island shoulder. The expansion of the flood channel allowed for the development, in the late 1980's, of the swash platform and the mid-inlet shoal system characteristic of the present-day inlet. The flood channel then caused a recession of the Bear Island shoulder. The recession of Bear Island and the erosion of Bogue Banks, paired together, have led to the widening of the inlet since 1984. From February 1984 to September 1984, the mid-point of the ebb channel has moved east at a steady rate of 28.4 meters/year (93.3 feet/year).

During this time, the only significant change in the morphology of the inlet was from the emergence of ephemeral islands (Islands Nos. 1 and 2) that developed on the linear margin bars and in the vicinity of the flood ramp.

The complex interaction of the expanding mid inlet shoal and the continued development of the Bogue Banks spit led to a shift in the ebb channel and erosion along the western edge of Emerald Isle, as well as, accretion along the Bogue Banks oceanfront. The majority of erosion losses from Bogue Banks inlet shoreline occurred between January 1994 and September 1996 during a time of increased storm activity. Further development of Islands Nos. 1 and 2 began in 1996 along the western margin of the ebb channel. Comparison of September 2001 and September 2002 aerial photographs showed that Island No. 2 has migrated to the west about 1,000 feet.

Marsh and sandy shoreline segments comprise the seaward portion of Dudley Island. These segments have experienced significant and rapid erosion due in part to the eastward movement of the ebb channel, the growth of the Bogue Banks spit, and the consequent migration of the eastern channel toward Dudley Island. The elongation of Bogue Banks spit has caused the thalweg of the Eastern Channel to shift west towards Dudley Island, resulting in erosion and overwashing of the landward bank.

Current conditions in Bogue Inlet include: erosion of the southern shore of Dudley Island; erosion along the western end of Bogue Banks; expansion of the spit on Bogue Banks; accretion of the Emerald Isle ocean shoreline; erosion and westerly migration of Island No. 2; accretion of Island No. 1; erosion of the Bear Island ocean shoreline; and an accelerated easterly migration of the inlet channel. It is evident that most of the Bogue Inlet habitat is eroding which leads to the current extensive shoal system and swash platform present in the inlet. The inlet is very dynamic as evident from analyses conducted over the last several decades.

Listed below are the major events and associated changes expected to occur within the project area from the westward repositioning of the ebb channel:

1. Migration of the middle ground shoal (located west of the existing channel) to form the ebb tidal delta of the new channel;

2. Accretion along the ocean shoreline of Bear Island;

3. West end of Bogue Banks;
   onshore movement of ebb tidal delta at the west end of Bogue Banks
   transport and deposition of sediment along the inlet shoreline of Bogue Banks
   development of sand spit from the west end towards Bogue Inlet
   infilling of abandoned (existing) channel west of The Pointe shoreline

4. Continued migration of Island 2 with or without project implementation and sand dike installation;

5. Easterly transport effects along Emerald Isle that will limit overall net sediment transport along the ocean shoreline of Emerald Isle;

6. Beach nourishment of 20,000 feet (3.8 miles) of Phase 3 of the Bogue Banks project area;

7. 39,000 cy of sediment deposition transport in the southern portion of the Western Channel; and

8. 158,000 cy of sediment deposition in the southern portion of the eastern channel area of Bogue Inlet.

Effects from the proposed channel relocation and associated activities (including beach nourishment and sand dike construction) are expected to equilibrate within three years after construction. Based on recommendations of the U.S. Fish and Wildlife Service, National Marine Fisheries Service and other members of the Project Delivery Team, the proposed monitoring efforts for the project were extended for three years post-construction to assess the positive and negative direct and indirect effects from the project.

The hydrodynamic modeling conducted for the project shows direct and indirect effects from the project due suspended sediments displaced in the water column along the East and West Channels and the south side of Dudley Island. Additional effects from the project will include the closure of the existing channel as the sand spit on the west end of Bogue Banks collapses and migrates into the abandoned channel. The effect of the sand spit migration from the placement of the sand dike may be considered a positive cumulative effect since it will immediately replace lost intertidal habitat.

Due to the migratory nature of Bogue Inlet, other direct or indirect effects associated with the actions of the project may be difficult to ascertain. However, digital aerial imagery collected in June 2003 (pre-construction) will be compared to post-construction aerial photography collected one and a half years after project construction to determine if additional project specific effects have occurred.