

SECTION 6. FUTURE FISH AND WILDLIFE RESOURCES WITHOUT PROJECT

The Service has previously summarized the anticipated impacts of previously authorized artificial beach and dune construction projects in USFWS (1999), USFWS (2000a), USFWS (2000b), USFWS (2001) and USFWS (2002a). These reports are incorporated by reference.

Resource category determinations, with supporting technical information, for each of the habitat complexes described in Section 5 are presented below. These determinations serve as one way to evaluate the existing fish and wildlife resource values in the project area. Alterations to those determinations, if any, will be discussed in light of reasonably foreseeable, future coastal projects in the Bogue Banks Shore Protection Project study area. Appendix D summarizes the relative importance of the Bogue and Beaufort Inlet areas to migratory birds in North Carolina, and Appendix F ranks the level of past and present disturbance at tidal inlets between Cape Henry, Virginia and Cape Romain, South Carolina.

Resource Category Determinations

The Bogue Banks Shore Protection Project study area can be divided into eight distinct areas of similar ecology (as outlined in Section 5): (1) Bogue Banks interior; (2) Bogue Banks oceanfront shoreline; (3) Bogue Banks estuarine shoreline; (4) Bogue Sound; (5) Bogue Inlet; (6) Beaufort Inlet; (7) nearshore marine; and (8) offshore marine. Each of these regions supports a different assemblage of fish and wildlife resources, varying degrees of human disturbance, and clear geographic boundaries. The relative value of each of these regions to fish and wildlife resources can be ranked, as outlined in Section 4. The Service assessed the value of each of the eight geographic areas to fish and wildlife resources in coordination with the NC WRC, NC DMF, NMFS and the Wilmington District of the Corps. The resource categories discussed in this section represent a consensus amongst these agencies.

Sixty-four evaluation species were selected for these regions (Tables 2 to 5). Each species was selected based upon its known occurrence in the project area, utilization of the regions by different life history stages, seasonal abundance, and ecological niche. Tables 2 to 5 list each species, its ecological niche, population status and management status (if known). The areas where each species occurs within the project area are listed in Table 1.

Twenty different species of aquatic resources were selected to reflect the freshwater, estuarine and marine habitats found in the project area. These species represent benthic and pelagic species, various positions in the food web, and several life history stages. The fishes include representative anadromous and catadromous species. Some of the fish are bottom feeders while others are pelagic predators. The bottlenose dolphin was selected as the representative marine mammal since the majority of marine mammals found in the project area are Federally-listed threatened and endangered species, which cannot be evaluation species. Horseshoe crabs are important bioturbators, nest on estuarine beaches and provide an important source of nourishment for avifauna via their eggs (Jackson 2001; Smith et al. 2002).

The twenty-four species of avifauna selected as evaluation species represent diving, wading,

swimming, and terrestrial birds. Some species feed upon intertidal invertebrates, while others feed on fish, crustaceans, insect larvae or seeds and berries. Several of the evaluation species utilize the project area for nesting, while others for migratory staging or overwintering. Birds that are only occasional or accidental species to the project area were not considered sufficient for further evaluation, as they do not depend on the project area for sustenance or reproduction. The piping plover is not included, nor is its critical habitat, due to its protection status under the federal Endangered Species Act. Species that may be state-listed or Federal Species of Concern were included, however, because they do not have the same level of federal protection.

The avian species range from those with no significant concern (or are common) to those with extremely high management concern for the nation and regionally. American oystercatchers and red knots, for instance, are two of the four top priority species for the region. North Carolina provides valuable nesting habitat for American oystercatchers and Wilson's plovers, for which there are an estimated 1000 and 1500 nesting pairs respectively on the entire Atlantic and Gulf coasts combined (Hunter 2001). The state also provides migratory and overwintering habitat for the oystercatcher, increasing its importance to the species. Based upon their high priority status and known use of the project area, these species were included as evaluation species.

Sanderlings are considered an evaluation species due to their high concentrations in North Carolina during winter periods, and their tendency to forage on oceanfront beaches the majority of the time (Hunter 2001, Root 1988). Willets are a shorebird found year-round in North Carolina, and dunlin represent a migratory shorebird that feeds in a wider variety of habitats than sanderlings. Eastern painted buntings, boat-tailed grackles and marsh wrens were included to represent terrestrial and marsh habitats. Similarly, northern gannet, red phalarope and Cory's shearwater were chosen to represent seabirds present in the nearshore and offshore project area. Several species of colonial waterbirds are included as evaluation species to represent bare ground, scrub-shrub and forest nesting areas, as well as different seasons of high use and varying foraging techniques and sources. Finally, black rails, common loons, red-breasted mergansers and canvasbacks were included to represent waterfowl that are found in the project area.

The remaining evaluation species are vegetation and invertebrate species. The vegetation represents key habitat types – the eelgrass and widgeon grass representing SAV and *Spartina* spp. the estuarine marsh, for instance. Live oak was selected to represent the maritime forest habitat, red bay to represent scrub-shrub wetlands and Atlantic white cedar to represent swamp forest. Sea oats were selected as the representative vegetation for the oceanfront dunes. *Sargassum* is the evaluation species for macroalgae found growing attached to hardbottom areas or areas with limited sediment cover; this marine plant provides additional habitat value, especially for marine birds and fish, when free-floating.

The invertebrates included as evaluation species represent the benthic ecological niche of the intertidal beach (coquina clams, mole crabs), estuarine benthos (Eastern oyster, hard clam, bay scallop), nearshore or offshore seafloor (sand dollar, moon snail). Mole crabs, coquina clams and ghost crabs represent the macroinvertebrates commonly found on the beach and intertidal oceanfront shoreline. Each of these three species has been used as indicator species in previous monitoring projects in the project area (e.g., Lindquist and Manning 2001, Peterson et al. 2000,

Reilly and Bellis 1978).

The sand dollar was chosen as a representative of the phylum Echinodermata and because it was used as an indicator species in the large scale monitoring project in New Jersey (Ray 2001, Wilber 2001). The bay scallop was chosen as the representative mollusk for SAV areas. The polychaete worm *Scolelepsis squamata* represents the burrowing segmented worms that are an important food source for birds and fish in the intertidal, nearshore and offshore areas. The encrusting star coral and boring bivalve *Jouanettia quillingi* were chosen to represent the epifauna found in marine hardbottom areas.

Gastropods are represented by the moon snail for the nearshore and offshore areas and by the marsh periwinkle for the estuarine area. Eastern oyster was selected for its importance as a filter feeder, a keystone species for estuarine reef-like structures, and commercial value. Hard clams were chosen for their economic significance and occurrence in sandy and vegetated estuarine substrates. Bay scallops are commonly found in eelgrass beds, and are more mobile and shorter lived than hard clams and oysters.

The resource category determination for each of the eight ecological regions within the project area are presented in Table 13, and the discussion for each determination follows.

Table 13. Resource category determinations, or the value of the existing habitats to fish and wildlife, were calculated for eight distinct regions within the project area.

Area	Resource Category	Value to Fish and Wildlife
Bogue Banks Interior	2	High value, relatively scarce
Bogue Banks Oceanfront Shoreline	4	Medium to low value
Bogue Banks Estuarine Shoreline	2	High value, relatively scarce
Bogue Sound	2	High value, relatively scarce
Bogue Inlet	2	High value, relatively scarce
Beaufort Inlet	3	High to medium value, relatively abundant
Nearshore (0 to 30 ft water depth)	2	High value, relatively scarce
Offshore (greater than 30 ft water)	2	High value, relatively scarce

I. *Bogue Banks Interior*

The terrestrial habitats on Bogue Banks represent some of the last remaining tracts of maritime forest and freshwater wetlands on barrier islands in coastal North Carolina. The unusual height and width of the island, along with its geographic orientation, further creates a comparably unique ecological setting. At least 1,015 acres of maritime forest are estimated to be in conservation status on the island, with significant tracts at Fort Macon State Park, the Theodore Roosevelt State Natural Area and the Hoop Pole Creek preserve owned by the NCCF. Approximately 2,000 acres of freshwater and brackish wetlands are estimated on the island. Most of these wetlands are scrub-shrub and emergent marsh, but roughly 166 acres are forested wetlands.

Evaluation species for this area include live oak, red bay, Atlantic white cedar, Eastern painted bunting, and boat-tailed grackles. The island's interior provides shelter and foraging opportunities for numerous migratory birds, mammals, reptiles and other wildlife. With the exception of a few areas near Nags Head and Buxton on the Outer Banks, Bogue Banks contains more maritime forest and freshwater wetland habitat than any other barrier island in North Carolina. As coastal development continues to increase, these habitats remain threatened with fragmentation and elimination. Therefore Bogue Banks' interior is a resource category 2 area, of high value to the evaluation species. This high value may decrease in the future with continued development that clears and further fragments the freshwater wetland and maritime forest ecosystems.

II. *Bogue Banks Oceanfront Shoreline*

The oceanfacing shoreline of Bogue Banks has been increasingly manipulated in recent years. Individual property owners and local government entities have used beach scraping (bulldozing), sand fencing, sandbag revetments and dredge and fill projects to stabilize the shoreline. Beach driving and lighting pose potential hazards to nesting wildlife. Existing federal dredge disposal projects with beach placement include Fort Macon, Atlantic Beach, Pine Knoll Shores and Emerald Isle. The towns of Pine Knoll Shores, Indian Beach and Emerald Isle currently have federal and state permits to construct a large dredge and fill project along 17 miles of oceanfront beach. The first phase of this project was constructed along ~6 miles of beachfront during the winter of 2001-02.

Evaluation species for the Bogue Banks' oceanfront shoreline include coquina clams, mole crabs, ghost crabs, a polychaete worm, horseshoe crabs, least terns, common terns, black skimmers, dunlins, sanderlings, short-billed dowitchers, willets, Wilson's plovers, red knots, American oystercatchers, Gulf kingfish and Florida pompano. Most of the avian evaluation species are declining and have been designated as high or moderate priority species for management. Studies following beach scraping and fill activities (e.g., Lindquist and Manning 2001, Peterson et al. 2000, Reilly and Bellis 1978) have documented the decline of coquina clams and mole crabs with each event. No waterbird or shorebird nesting has been observed on the oceanfront beaches in many years.

Due to the high management priority for the majority of the evaluation species and the degraded habitat quality of the oceanfront beaches, this habitat has a resource category of 4, or of medium to low value for the evaluation species.

III. *Bogue Banks Estuarine Shoreline*

The estuarine shoreline of Bogue Banks, on the north side of the island, consists of fringing marsh (~51%), sandy beach (~7%), artificially stabilized (~22%) and a mix of stabilized and natural shorelines (~20%). In some areas scrub-shrub estuarine wetlands border the Bogue Sound shoreline. One area, at Archer Creek, has been designated a primary nursery area. Other areas such as Hoop Pole Creek and the Theodore Roosevelt State Nature Preserve contain segments of estuarine shoreline that have been placed in conservation status. The Roosevelt tract has also been designated an Otherwise Protected Area (OPA) under the Coastal Barrier Resources Act (CBRA). The only significant manipulation to the natural configuration of the Bogue Banks estuarine shoreline is a large dredged material island at the east end, Brandt Island.

Evaluation species for this area include little blue heron, snowy egret, marsh wren, common loon, black rail, canvasback, red-breasted merganser, *Spartina* spp., horseshoe crab, marsh periwinkle, Eastern oyster, hard clam, shrimp, blue crab, diamondback terrapin, Atlantic croaker, striped mullet, menhaden, hogchoker, American eel, American shad, spot, red drum, and southern flounder. Many of the aquatic evaluation species utilize the estuarine shoreline areas during juvenile development as nursery habitat. The adult stages of several are commercially and recreationally valuable fisheries. The avifauna use the estuarine shoreline habitats for foraging, nesting and shelter during stormy weather. Nationally and regionally, undisturbed estuarine shoreline habitats are declining.

Due to its high ecological use and declining abundance, the Service determined that the estuarine shoreline of Bogue Banks is a resource category 2 (high value). If current trends of estuarine wetland loss continue, this value may decline in the future as the estuarine shoreline becomes dominantly stabilized and natural marsh and sandy beach shorelines are increasingly fragmented.

IV. *Bogue Sound*

Bogue Sound has been designated a Habitat Area of Particular Concern (HAPC) by the South Atlantic Fishery Management Council, a geographic designation reflecting its high value to aquatic resources. The distribution of seagrasses within the sound is estimated at over 6100 acres, consisting of a mix of widgeongrass, eelgrass and shoalgrass (*Halodule wrightii*). The western portion of the sound is designated as an ORW, the highest in the state's ranking system for water quality. The east-west orientation of the sound and its intermediate width (i.e., narrower than Pamlico Sound, wider than Middle Sound) render it one of a only two-of-a-kind in North Carolina (Back Sound being the other with the same geographic features).

Brackish marsh (over 800 acres), intertidal shoals and disposal islands provide habitat to

migratory shorebirds and colonial waterbirds that is declining in North Carolina as more dredge and fill projects are constructed. The commercial fishery harvest in Bogue Sound includes 26 species for an average annual value of \$ 672,512. Tributaries to the sound contain four designated primary nursery areas for fishery resources (Archer Creek, Goose Creek, Broad Creek and Gales Creek). The variety of salinity concentrations in Bogue Sound create the microhabitats needed by larval and juvenile aquatic resources, fostering their development through various life history stages.

The east-west orientation of the sound creates a comparably unique setting where migratory birds find Bogue Banks and its estuarine system as the first or last estuary and land during long north-south migrations. Diving ducks, waterbirds and shorebirds utilize the sound as a migratory stopover site, with several remaining to overwinter in Bogue Sound and its associated habitats. In addition, Bogue Sound has provided nesting habitat for 14 species of colonial waterbirds, several of which are evaluation species (little blue heron, snowy egret, black skimmer, common tern, least tern, gull-billed tern). Many of the islands used by these birds for nesting have been designated a Significant Natural Heritage Area by the North Carolina Natural Heritage Program. The majority of these species have been designated as high or moderate priority management species due to recent population declines.

Therefore Bogue Sound has a high to medium habitat value, is a limited resource nationally, and has been designated as a geographically important fishery area on a regional basis. The sound also contains several habitat types that should receive special consideration. These areas include mud and sand flats, SAV, wetlands, special aquatic sites and floodplains. Thus its resource category is a 2, a high value. The high value of Bogue Sound is not likely to decline in the future unless the water body is targeted as a sand source for beach fill projects.

V. *Bogue Inlet*

Bogue Inlet has one of the largest tidal shoal systems in North Carolina, providing foraging and loafing habitat for dozens of species of shorebirds and waterbirds. The NC WRC manages some of the emergent shoals as nesting waterbird sites. The barrier island shoulders of the inlet also provide nesting, migratory and overwintering habitat for migratory birds. The shoals provide habitat for spawning red drum and blue crab, both of which are evaluation species for this area. Tidal inlets have been designated a HAPC for red drum, shrimp and the snapper-grouper complex of fish. The North Carolina Natural Heritage Program has designated several areas within or near the Bogue Inlet complex as Significant Natural Heritage Areas for the state. Hammocks Beach State Park on the western shoulder of the inlet is an OPA under CBRA. Some of the small islands within the inlet complex also have cultural resources of historical significance. Altogether, the inlet complex contains sandy shoals, marsh, SAV, and open water habitats.

The White Oak River that drains through Bogue Inlet supports valuable aquatic habitat for spawning anadromous fish like American shad and the catadromous American eel. Bogue Inlet serves as an essential linkage between marine, estuarine and freshwater spawning and nursery

habitats for these migratory fisheries. The White Oak River-Bogue Inlet system supports commercial fishery landings for up to 39 species, averaging \$390,900 a year in annual revenue for local fishermen.

Bogue Inlet is minimally disturbed at present, with a federal navigational channel maintained within the natural deep channel in the inlet. Some property owners on Emerald Isle have constructed sandbag revetments along the eastern shoreline of the inlet. A proposal to dredge a large channel through the center of the inlet to protect these properties is currently under development, however. Bogue Inlet's current status as one of the least disturbed in the state increases its value to fish and wildlife resources, combined with its various state management designations, generate a high value resource category determination of 2. If the Town of Emerald Isle implements an ebb channel relocation project, the high ecological value of the inlet may be degraded as the inlet becomes more disturbed and this resource category determination will need to be re-evaluated.

VI. *Beaufort Inlet*

Beaufort Inlet is one of the most managed inlets within North Carolina, with hard stabilization on both shoulders (albeit landlocked on the eastern shoulder) and a deep navigational channel to the state port in Morehead City. The barrier island shorelines on both the east (Shackleford Banks) and west (Fort Macon) have been designated as OPAs under the CBRA; the former is part of the Cape Lookout National Seashore and the latter a state park. The Rachel Carson National Estuarine Research Reserve (NERR) is northeast of the inlet, within its tidal influence; this reserve is another OPA and a Significant Natural Heritage Area for the state of North Carolina. The Newport River supports anadromous fish spawning areas and primary nursery areas upriver from Morehead City and Beaufort, again creating an essential linkage between freshwater, estuarine and marine aquatic habitats at Beaufort Inlet.

Over two dozen species of birds have been observed in the Beaufort Inlet area, with greater numbers and diversity at the Rachel Carson NERR. Intertidal shoals and flats within the NERR provide valuable foraging habitat for the migratory shorebirds, waterbirds and waterfowl on the evaluations species list. Over 100 different species of larval fish have been documented within Beaufort Inlet and its surrounding waters.

Beaufort Inlet itself is artificially maintained with a dredged channel exceeding 45 feet of water depth. Maintenance dredging of this channel often deposits dredged material on the Fort Macon shoreline adjacent to the inlet. The inlet and its associated river (the Newport) are more intensively harvested for fishery resources than Bogue Inlet, earning almost triple the amount of annual revenues. Ballast water releases and intakes within the deep navigation channels of the inlet complex have the potential to degrade aquatic habitats by introducing non-native species, contaminants and pathogens.

The highly manipulated state of the Beaufort Inlet complex reduces its ecological value as compared to similar, undisturbed systems. The presence of hard stabilization, dredge disposal on adjacent shorelines and a deepwater navigational channel would suggest a low value to fish and

wildlife resources. But one of the jetties is landlocked and non-functional at present, and three valuable conservation tracts (Rachel Carson NERR, Cape Lookout National Seashore, and Fort Macon State Park) surround the inlet. Since Fort Macon State Park frequently receives dredge disposal material, the western shoulder of Beaufort Inlet has less value than the eastern shoulder on Cape Lookout National Seashore to fish and wildlife resources. So the presence of the conservation tracts prevents Beaufort Inlet from having a low habitat value, but the presence of hard stabilization, dredge disposal and a deep navigational channel prevent the inlet from having a high habitat value. Thus Beaufort Inlet's overall value is a resource category of 3, or medium value.

VII. *Nearshore (0 to 30 ft water depth)*

The nearshore region of the project area is defined for this analysis as marine waters from 0 to 30 feet water depth, from Cape Lookout in the east to the military exclusion areas of Camp Lejeune to the west. Evaluation species for this area include Gulf kingfish, Florida pompano, king mackerel, Spanish mackerel, bluefish, gag, southern flounder, spot, red drum, menhaden, American shad, striped mullet, shrimp, bottlenose dolphin, coquina clam, mole crab, sand dollar, a polychaete worm, moon snail, star coral, Quilling piddock, *Sargassum*, brown pelican, least tern, common tern, red phalarope, northern gannet and Cory's shearwater.

The fishery resources utilizing this zone are commercially and recreationally valuable species, supporting sport fishing tournaments, pier fishing, surf casting and beach seining. At least two evaluation species of fish utilize the surf zone area, where waves break in shallow water, as a nursery area for juveniles (Florida pompano and Gulf kingfish). Other fish rely upon the currents and waves within the nearshore area to disperse larvae between life history stages (e.g., Atlantic croaker). Peterson and Wells (2000) found this area to be dominated by polychaete worms, bivalves, nemerteans, small crustaceans, echinoderms and gastropods (in decreasing order of abundance); altogether 16 separate phyla of benthic fauna were documented. The same surveys found 51 species of demersal fishes in the nearshore Bogue Banks area, with the most abundant species being Atlantic croaker, weakfish (*Cynoscion regalis*), pigfish (*Orthopristis chrysoptera*), pinfish (*Lagodon rhomboides*), kingfish (sea mullet, *Menticirrhus* sp.), silver perch (*Bairdiella chrysoura*), American silverside (*Menidia menidia*) and spot (Peterson and Wells 2000).

There is an offshore dredge disposal site seaward of Beaufort Inlet utilized as a demonstration project for nearshore disposal of dredge material. The shoals near this area contain a shipwreck thought to be the *Queen Anne's Revenge*; this site and potentially a few others are archaeological resources of high value. The extensive shoals at Cape Lookout have been designated a HAPC for their high value to fishery resources. At the western portion of the project area livebottom (or hardbottom) habitats are present on the seafloor; the precise extent of these productive areas in the nearshore is not known.

The recent dredge and fill project at Pine Knoll Shores and Indian Beach utilized part of this area as a dredge site for fill material, removing the top few feet of substrate. The diversity of fishery resources and benthic fauna found prior to this dredging indicate the nearshore area's value to

marine fish and wildlife resources, however. The increasing number of offshore dredge sites for beach fill projects and offshore disposal sites, plus commercial trawling disturbances, indicate an increase in the spatial area of disturbed benthic marine habitats (or a decline in undisturbed areas). For instance, the Dare County (Bodie Island Portion) Beaches dredge and fill project will disturb 7 square miles of benthic marine habitat over the life of the project, generating a decline of 7 square miles of undisturbed benthic habitat (USACE 2000). The new ODMDS near Cape Fear will further disturb an anticipated 9.4 square nautical miles of marine benthos (EPA 2001).

The diverse array of fish and wildlife resources found in the nearshore project area and increasing disturbances to similar areas support a resource category determination of 2, or high value, for the nearshore area of the Bogue Banks Shore Protection Project study area.

VIII. *Offshore (> 30 ft water depth)*

The offshore marine section of the project area extends from 30 to approximately 60 feet water depth, or a distance roughly equivalent to 1 to 5 miles offshore Shackleford and Bogue Banks. This area contains artificial reefs, numerous shipwrecks and areas of both soft and hard bottom habitats. The proximity of the Gulf Stream to Cape Lookout generates a mix of tropical and temperate species. Evaluation species for this area include King mackerel, Spanish mackerel, bluefish, gag, southern flounder, spot, red drum, menhaden, striped mullet, bottlenose dolphin, sand dollar, moon snail, star coral, the boring bivalve Quilling piddock, *Sargassum*, Cory's shearwater, and northern gannet.

Ecotourism, commercial and recreational fishery industries utilize this area for its diversity of fishery resources, diving sites and spotting seabirds and marine mammals. The shoals at Cape Lookout have been designated a HAPC and border this area to the east. Hardbottom or livebottom areas have also been designated as essential fish habitat in recognition of their high value to fishery resources. Hard and soft coral, sponges, tunicates, algae and a variety of encrusting and boring mollusks rely upon hard bottom or rocky substrates as their benthic habitat. These areas are limited in their extent and vulnerable to burial by soft sediments. The macroalgae *Sargassum*, an evaluation species, requires less than 6 centimeters of sediment cover, for instance (Riggs et al. 1998). While relatively abundant within Onslow Bay, these hardbottom areas are limited nationally. The mixing of tropical, temperate and arctic oceanographic currents creates a unique assemblage of pelagic species for the project area. As a result of these factors, the offshore project area has a resource category of 2 to reflect its high value to evaluation species.

Future Conditions Without Project

This report assumes that the several ongoing and proposed projects in the Bogue Banks project area will occur without this shore protection project. Maintenance dredging of the Morehead City state port and associated navigational channels will continue. Periodic maintenance dredging of the AIWW through Bogue Sound will also continue. A new dredged material island

is likely to be constructed in Bogue Sound near Peletier Creek, and the island's design will include several environmental enhancement features. The Beaufort Inlet navigational channel will continue to be maintained at an approximate depth of 45 feet. The federal navigational channel through Bogue Inlet will be periodically dredged, with dredged material placement on western Emerald Isle beaches. The nearshore and offshore disposal sites will be filled to capacity and new marine disposal sites sought.

We also assume that the Section 933 project under study for Pine Knoll Shores and Indian Beach will be feasible, expanding dredged material placement from Brandt Island to those communities as well as Atlantic Beach. Atlantic Beach and Fort Macon will continue to receive dredged material from maintenance dredging of Morehead City and Beaufort navigational channels. The Town of Emerald Isle is developing a permit application to dredge a new, larger channel through Bogue Inlet to redirect tidal currents away from vulnerable structures at The Pointe. Sediment dredged during this project is assumed to be placed on the beaches of western Emerald Isle.

The locally funded beach fill project has completed the first phase of three, covering 6.75 miles of oceanfront beach with 1,733,580 cubic yards (cy) of fill material. Phase II is proposed for construction from November 16, 2002 through April 15, 2003 along 7.5 miles of oceanfront beach in Indian Beach and eastern Emerald Isle, and the without project condition assumes this phase will be constructed using up to 2,050,000 cy of fill material dredged from the seabed immediately offshore Bogue Banks.

The Phase II sediments for this locally funded project contain an average of 42% carbonate material, which Carteret County's sample data indicate consists of clam shells, *Donax* spp. shells and other crushed shells of various grain sizes. Thus the material being placed on the beach will increase the carbonate content of the natural beach sediments, which average 20% or less (CSE and Stroud 2000; Appendix G). Without the federal project that is the subject of this report, the local beach fill project will continue to be the without project condition.

Other assumptions are also included in the without project condition. The high number of federal, state and academic research institutions in Morehead City and Beaufort will continue to generate scientific data on the physical and biological environment in and around Bogue Banks (e.g., Reed and Wells 2000, Roessler and Wells 2001). The shipwreck thought to be the *Queen Anne's Revenge* will continue to be excavated and Beaufort Inlet will continue to be studied because of this archaeological value. The estuarine and marine waters in Carteret County will continue to support a large fishing industry, several fishing tournaments and increasing ecotourism.

Finally, sea level is assumed to be rising at an accelerating rate and coastal development will continue. The rate of sea level rise is assumed to be that summarized by Riggs (2002), increasing from 1.01 - 1.06 feet per century at present to 2.8 - 3.2 feet/century by 2100. The present loss rates of estuarine fringe habitats are 1,166 acres per year along 1,593 miles of shoreline in the Albemarle-Pamlico estuarine system, with the highest erosion rates along marsh shorelines (as compared to sediment banks, bluffs and swamp forests; Murphy 2002). In a 50 year period without the project, these rates would result in the loss of at least 91 square miles of estuarine

fringe habitat in northeastern North Carolina (the total length of estuarine shoreline in NC is close to 4,000 miles, and this loss is calculated for 1,593 miles of that total). In 1976, approximately 19 miles, or 8.5%, of estuarine shoreline in Core and Bogue Sounds was artificially stabilized (Riggs 2002). This trend has likely increased since then and is assumed to continue in the without project condition. The Bogue Banks shore protection project is aimed towards protecting oceanfront areas, however, and would not affect these estuarine loss rates.

Development, and associated shoreline protection measures, has been increasing along American coastlines (Nordstrom 1994). Indeed, the “dominant agent of landform change is earth-moving machinery” (Nordstrom 1994, p. 479). An analysis of shoreline evolution in New Jersey found a shift over time from “extensive use of groynes, through a period of extensive construction of shore-parallel structures (bulkheads, seawalls, revetments), to the present emphasis on beach nourishment” (Nordstrom 1994, p. 491). “Federal funding increases the likelihood of human alterations and their scale. ... The sequence of human alterations on the New Jersey coast [for example] indicates that the occupation of the coastal fringe is widespread, inevitable, and incontrovertible under present management practice” (Nordstrom 1990 as cited in Nordstrom 1994, p. 502). Peterson and Manning (2001) also note the increasing trend in coastal development and shoreline stabilization projects in North Carolina. Nordstrom (1994) concludes that “the precedent established on the barriers in New Jersey and many other developed barriers in the USA indicate that there may be fewer” locations that are naturally functioning systems in the future (p. 504).

In New Jersey, for instance, the barrier island coastline was originally low-lying, narrow and backed by fringing marshes prior to development. Overwash occurred, covering backbarrier marshes and creating upland habitat in places. The natural dune geomorphology consisted of isolated hummocks of dunes, with 28.3% of the islands having no dunes at all (Nordstrom 1994). “The coastal barriers appeared to be highly mobile prior to human development” (Nordstrom 1994, p. 486). As development occurred along the barriers, the dunes were flattened, “natural vegetation was destroyed,” marshes were filled, channels were dredged through the marshes, and the bays were filled to allow construction of causeways and new buildings (Nordstrom 1994, p. 486). “Native plant species are prevented from recolonizing on most of the barriers because of the human preference for using lawn grass and exotic shrubs and trees for landscaping. ... Natural vegetation other than foredune communities only remains in a few natural zones that are maintained as preserves” (Nordstrom 1994, p. 487).

Considering an increase in the rate of sea level rise, Nordstrom (1994, p. 501) describes two potential future conditions for New Jersey (“without regard to human action”) that were proposed by Psuty (1986): (1) drowning in place, or (2) island migration through inlet sedimentation, overwash and wind transport of sand across the island. A separate postulation put forth by Titus (1990) includes four future scenarios: “(1) no protection, leading to eventual abandonment (although development compatible with a dynamic barrier is still possible); (2) engineered retreat that mimics natural retreat by artificially filling the bay sides of barriers while the oceanside erodes; (3) raising the barrier in place by placing sand on the beach and concomitantly raising buildings and support infrastructure; and (4) constructing seawalls and flood protection structures around the barrier, creating a ring-levée enclave” (Nordstrom 1994, p. 501).

Nordstrom (1994) describes a closed system of coastal evolution over time, trending towards hard stabilization where beaches and dunes are replaced by bulkheads and seawalls. The assumptions used by Nordstrom (1994) in a without project condition include that “shoreline mobility will be reduced in areas protected by structures; [and] ... inlets that are now dredged will continue to be dredged, and existing channels will be maintained in place” (p. 500). Beach nourishment options have the potential for more natural processes than hard stabilization options, though (Nordstrom 1994). In order to restore more naturally functioning systems, beach nourishment projects need to incorporate habitat improvement features and nature based tourism in addition to flood control and storm protection features. Compromises must be sought, resulting in semi-natural systems that balance the needs of all stakeholders (Nordstrom 2001).

The trends observed by these researchers are incorporated in the Service’s without project condition for Bogue Banks. That is, development will continue, shoreline stabilization will continue or increase, and rising sea level will require compromises to balance development with geomorphic responses to higher sea levels. Natural ecological communities will be altered or lost over time as current disturbance and loss rates continue.

SECTION 7. ALTERNATIVES CONSIDERED

As provided by the Corps to the Service on June 17, 2002, the preliminary alternatives under consideration are described as the following:

“A no action plan, non-structural alternatives, and various configurations of beach fills will be evaluated as described below for the Bogue Banks Shore Protection study. All alternatives will have to be consistent with the Coastal Area Management Act.

1.0 Without Conditions (No Action).

“Under a no-action alternative, there would be no federal participation in hurricane and storm damage reduction for the project area. However, a “no action” plan would not preclude temporary or emergency measures, such as beach scraping, sandbagging, and non-Federal beach nourishment. Non-Federal beach nourishment may not be adequate for the long-term, but could take place as a short-term measure.

2.0 Nonstructural Alternatives.

“Potential non-structural measures that will be considered include (1) retrofitting existing buildings, (2) stricter zoning and setback requirements and building codes for new buildings (3) relocation, and (4) evacuation. Retrofitting existing buildings may allow some structures to withstand some levels of storm and erosion forces. Stricter zoning requirements and setbacks, as well as stronger building codes could minimize storm and erosion damages to structures that have not yet been built.

“Relocation is the movement of a structure to another parcel of property. Evacuation would involve a buy-out program. As long-term erosion approaches a structure, it may undergo relocation to safer ground if sufficient time, funding, and an acceptable alternate site are available, or, alternatively, the structure could be purchased with public funds, demolished, and subsequently removed.

3.0 Structural Alternatives.

“Structural alternatives may include:

“A. The construction of seawalls and/or revetments, groin fields, breakwaters and/or submerged rubble mound reefs, and tee head groins.

“B. The placement of beach quality sand on Bogue Banks.

“Two types of alternative beach-fill sections may be evaluated: 1) a beach berm, and 2) a dune and berm. These proposed beach-fill sections are described below.

“ 1. Beach Berm Plans. The berm is a fill extending seaward from the existing profile, with an elevation of about 7 feet NGVD. Berm width is measured seaward along the top of the berm from the point where the top of berm intersects the natural profile. Seaward of the designed berm width, the with-project profile parallels the existing profile out to the closure depth of -22 feet NGVD. The widths evaluated may include 50, 100, and 150 feet.

“ 2. Dune and Berm Plans. Existing dunes were assumed to remain in place, with the designed dunes tying into them where appropriate. Designed dune templates were tied to a construction line, which is based on both the existing shoreline and the existing development. The landward slope of the dune template is 5 feet horizontal to 1 foot vertical, the top of the dune is 25 feet wide, and the 5 feet horizontal to 1 foot vertical seaward slope. The berm elevation is about 7 feet NGVD, with berm width measured from the toe of the constructed dune. Seaward of the designed berm width, the with-project profile parallels the existing profile out to a closure depth of -22 feet NGVD. Top of dune elevations of 13 and 15 feet NGVD may be evaluated with a 50-foot berm at elevation 7 feet NGVD. A 13-foot high dune with a 25-foot berm at 7 feet NGVD may also be evaluated.

4.0 Alternative Borrow Sources.

“Central to the consideration of any beach fill alternative is the availability of environmentally acceptable borrow sites with material of sufficient quality and quantity to construct and maintain the project for its authorized life. Investigations for borrow material may be made at Bogue and Beaufort Inlets, Brandt Island, offshore of Cape Lookout to Shackleford Banks, within the estuary, the area offshore of the area where the project is proposed, Morehead City navigation channels (i.e., Range A, the Cutoff, etc.), the United States Environmental Protection Agency (USEPA) designated Morehead City Ocean Dredged Material Disposal Site (ODMDS), and the nearshore area.”