Bogue Banks Oceanfront Shoreline

Bogue Banks contains approximately 24 miles of southward-facing oceanfront beaches. The oceanic shoreline can be divided into several ecological niches: the dune; dry beach; wet beach; and shoreface. These communities have been described in USFWS (1999), USFWS (2000a), USFWS (2000b), USFWS (2001) and USFWS (2002a), which are incorporated here. The long-term erosion rates for the Bogue Banks oceanfront average less than 3 feet per year, with most of the island listed at the minimum of 2 feet per year (NC DCM 1992).

The comparatively high sediment volume composing the interior of the barrier island creates one of the highest dune ridges in North Carolina along the oceanic beach. The northern, or landward, side of the dune system is generally vegetated by dense maritime forest or scrub-shrub along Bogue Banks. In western and central Emerald Isle, eastern Indian Beach, Pine Knoll Shores and portions of Atlantic Beach, the dune system consists of multiple dune ridges reaching 4 to 5 m (~13 - 16.4 ft) in elevation. The southernmost dune ridge typically has an erosional scarp facing the beach. These dune scarps supply clean, quartz sand to the beach during storm events, naturally dissipating wave energy.

The dune face adjacent to the beach provides habitat for ghost crabs (*Ocypode quadrata*) and other invertebrate species. This ecological community has been disrupted by extensive beach scraping, or bulldozing, along the majority of the island's beaches. The scraping has degraded the biological community naturally found in the dune scarp and dune toe, suppressing the abundance and distribution of fauna such as ghost crabs (Conaway 2000; Peterson et al. 2000; Peterson and Manning 2001).

The dry beach is found between the dune toe or scarp and the mean high water (MHW) line. Along virtually the entire length of Bogue Banks the dry beach is narrow and occasionally nonexistent during spring high tides or minor storm events. This ecological niche provides habitat for several species of amphipods, nesting sea turtles, burrowing ghost crabs and loafing shorebirds and colonial waterbirds. Authorized federal dredge disposal projects in Atlantic Beach, Pine Knoll Shores and Emerald Isle have periodically disturbed the dry beach ecosystem, with varying degrees of impact (Lindquist and Manning 2001; Peterson et al. 2000; Reilly and Bellis 1978).

Most recently the Towns of Pine Knoll Shores, Indian Beach and Emerald Isle received a Regulatory permit from the Corps to dredge sediment offshore of the central part of the island and place the material along 17 miles of beach from the Pine Knoll Shores-Atlantic Beach town line to western Emerald Isle. The first phase of this project was constructed from November 2001 to April 2002 and covered between 6 and 7 miles of beach in Pine Knoll Shores, Indian Beach and Salter Path. Phase I was prematurely halted in April due to the taking of five sea turtles by the dredge equipment, shortening the length of beach impacted. The sediment used in this project is not ecologically compatible with the native beach sediments of Bogue Banks, and the sandy beach fauna have not recovered in the beach fill as of this time (Appendix G).

In 2000 there were 17 sea turtle nests and 6 false crawls recorded along Bogue Banks' beaches.

All but two of the nests were of loggerhead sea turtles (*Caretta caretta*); the other two were green sea turtle nests (*Chelonia mydas*). In 2001 there were 21 nests (all loggerhead sea turtles) in Emerald Isle and 19 false crawls. By comparison, Shackleford Banks recorded 19 loggerhead sea turtle nests and 8 false crawls in 2001 and 21 nests with 5 false crawls in 2000. Hammocks Beach to the west reported 9 loggerhead sea turtle nests and 15 false crawls in 2001 and 19 loggerhead nests with 24 false crawls in 2000. The 2002 sea turtle nesting season documented 13 loggerhead nests in Emerald Isle, 5 in Pine Knoll Shores and 1 in Indian Beach/Salter Path; there were 19 false crawls along Bogue Banks during the same period (12 in Emerald Isle and 7 in Pine Knoll Shores).

The oceanfront beaches of Bogue Banks have not recorded any colonial waterbird or shorebird nesting in recent memory. Birds may use the beach for loafing or foraging, however.

The native beach sands of Bogue Banks are light brown in color with periodic patches of black where heavy minerals (e.g., garnet, magnetite, ilmenite) have been deposited by storm or spring tide waves on the normally dry beach (Figure 4). The newly filled beaches in Pine Knoll Shores and Indian Beach are noticeably different in color than the native beaches, with a gray to black coloration (Figure 5). The native and newly artificial beaches differ mineralogically as well, with the native (dry) beaches dominated by quartz with minimal well-rounded marine shells and

Figure 4. Black heavy minerals (including garnet) occur in patches along the beaches of Bogue Banks, as on this stretch of Emerald Isle near Mile Marker 15 on May 30, 2002. Both the black and light brown (quartz) sands are native. Note the very narrow to nonexistent dry beach; this photograph was taken near high tide during fair weather.

Figure 5. The color contrast between the native sediments of Bogue Banks' beaches on the right and the artificial beach fill placed on the beach during the winter of 2001-02 on the left is pronounced. The native sands are light brown with low shell content while the new fill is gray with a high shell content. The view is towards the west from the state park in Indian Beach near Mile Marker 10 on May 29, 2002.

quartz disc-shaped pebbles (Figure 6) while the artificial fill is dominated by angular estuarine shells that have been stained black by iron in an anaerobic environment (Figure 7). Using the visual percentage method of Terry and Chilingar (1955), the native dry beaches of Bogue Banks tend to have 0 to 5 % shell content on the surface and the newly filled dry beaches range from 0 to 100%.

The repopulation of the new beach fill by ghost crabs allows for a unique comparison of the new sediments versus the native sediments. The local project did not construct artificial dunes and the construction only minimally disturbed the dune toe and face. Thus the fill ranges from a few inches to less than 24 inches thick at the landward portion of the dry beach. Ghost crab burrows can exceed 48 inches in depth and have several exits on the beach surface. Figure 8 shows how the ghost crabs have excavated burrows through the new fill along the landward most 10 m (33 feet) of the dry beach, depositing native sediments on top of the new fill. The color contrast between the two sediment types is striking and lends a colonial look to the ghost crab population.

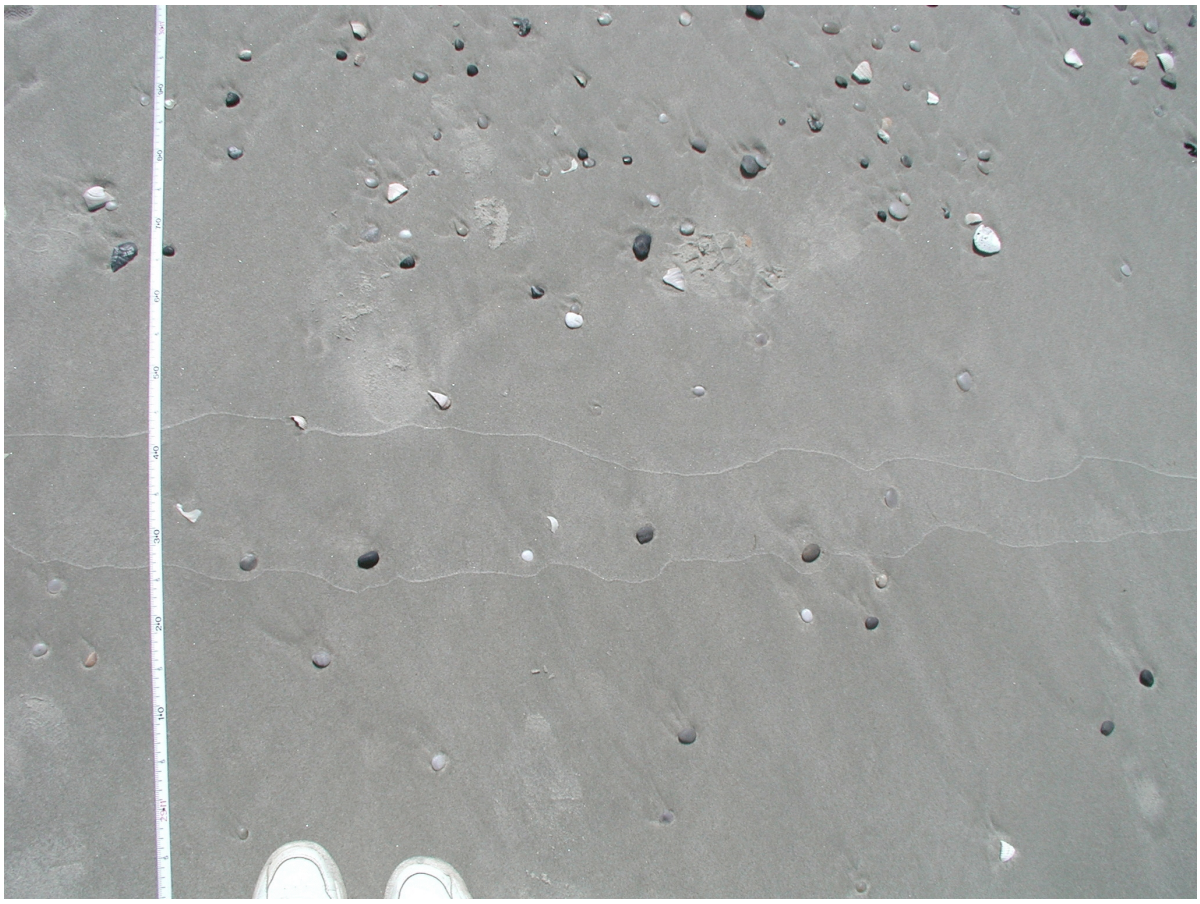

Figure 6. The natural beach at Mile Marker 4 in Atlantic Beach is dominated by light brown quartz sand with less than 5% disc-shaped, well-rounded quartz pebbles and shell fragments. This photograph was taken of the surface sediments in the intertidal zone, 31 meters from the dune toe, on March 14, 2002. The two wavy lines are swash marks left by the outgoing tide.

The noticeable differences between the natural and artificial beaches of the project area persist in the wet beach, or the area subject to daily tidal flux. This ecological niche is subject to wave action which creates alternating periods of subaqueous and subaerial conditions. The fauna adapted to this environment are concentrated in the top 5 to 10 centimeters (cm; ~2-4 inches) (Dr. C.H. Peterson and L. Manning, UNC-Institute of Marine Sciences, personal comm.) and are sensitive to the grain size, geomorphology and swash energy of the intertidal zone (Alexander et al. 1993; Donoghue 1999). Therefore the fauna are patchily distributed depending upon the specific physical and hydrologic characteristics at any given location along and across the beach (Bowman and Dolan 1985; Donoghue 1999; Lindquist and Manning 2001).

Along Bogue Banks, the wet beach infauna is dominated by polychaete worms, coquina clams (*Donax variabilis*) and mole crabs (*Emerita talpoida*) (Diaz 1980; Lindquist and Manning 2001; Peterson et al. 2000; Peterson and Manning 2001; Reilly and Bellis 1978). Predators foraging on the infauna include shorebirds such as sanderlings (*Calidris alba*) and willets (*Catoptrophorus semipalmatus*) and surf zone fish including Florida pompano (*Trachinotus carolinus*) and Gulf kingfish (*Menticirrhus littoralis*) (Lindquist and Manning 2001; Peterson et al. 2000; Peterson and Manning 2001).

The native wet beaches of the project area often have depressed infaunal populations due to beach scraping and beach fill activities relative to pre-project levels (Peterson et al. 2000; Peterson and Manning 2001; Reilly and Bellis 1978). The substrate providing the habitat for the infauna is naturally light brown quartz sand with patches of well-rounded, marine shell hash and black to purple heavy minerals. The new beach fill in Pine Knoll Shores and Indian Beach, on the other hand, consists of 0 to 100% angular, estuarine shell hash that tends to be black in color (Figure 7). Large oyster (*Crassostrea* sp.) and clam (*Mercenaria* sp.) shells are preferentially winnowed from the sand-sized quartz sediment by the waves, creating patches of pure shell or quartz on the wet beach. The oyster and clam shells range from 4.0 to 13.2 cm (~1.6-5.2 in) in size and 38 to 497 grams (g) in weight (Figure 9). Where quartz has been sorted by the waves, angular shell hash is commonly within 5 cm (~2 in) of the surface.

The upper part of the current wet beach in Pine Knoll Shores and Indian Beach is dominated by beach fill that has not yet been sorted by the waves. This substrate is a mixture of angular shells and quartz sand that is more resistant to sorting by the waves than the natural sediments; spring

Figure 7. The artificial beach fill placed along the oceanfront beaches of Pine Knoll Shores and Indian Beach during the winter of 2001-02 is dominated by large, angular shell fragments. Most of the shells seen here are clams (*Mercenaria* sp.) normally found in estuaries. The shells have been stained bright orange, gray and black by burial in marsh muds and replacement of portions of the calcium carbonate by iron. Photo taken March 2002 by USFWS.

tides and minor storm events have generated periodic scarps in the beach fill as a result (Figure 10). These scarps allow for a look at the internal structure of the new beach fill and the source of the sediments being sorted on the wet beach.

The portion of the beach that remains wet during all tidal stages is the shoreface. This ecological zone supports a diverse faunal community of infaunal invertebrates and surf zone fishery resources. Bogue Banks tends to have a single or double sand bar and trough bathymetry, generating several ecological niches. This area extends from 0 to approximately 9.1 m (30 ft) of water depth along Bogue Banks.

The local beach scraping and beach fill project have minimally disturbed the aqueous system because construction was limited to areas above the mean low water (MLW) line. Nevertheless, the shoreface's surface sediment within the Pine Knoll Shores-Indian Beach beach fill area appears to be shifting to a higher concentration of shells being winnowed out of the fill. Research is ongoing to monitor large-scale modifications to this habitat resulting from the local project.

Figure 8. Ghost crabs (*Ocypode quadrata*) have burrowed through the relatively thin layer of new beach fill, excavating native sediments (light brown) from burrows and depositing the sands on top of the darker artificial fill. The ruler is 15 cm long for scale and the photograph taken May 29, 2002, near Mile Marker 6 in Pine Knoll Shores. The dune is to the right, outside the frame.

Figure 9. Large, angular clam and oyster shells are being preferentially sorted by the waves from the sand-sized quartz grains in the new beach fill in Pine Knoll Shores and Indian Beach. The ruler is 15 cm for scale and the outgoing swash is visible in the upper left of the photograph. Photo taken May 30, 2002, by USFWS.

The aquatic resources present near the beach in the shoreface, or surf zone, area support a traditional commercial fishery in Salter Path. Although specific landings data are confidential, the fall months appear to be the period when beach seining and gill netting is used along this stretch of beach to harvest fish. Thus the fishery resources in the nearshore (or shoreface) zone are abundant enough to support commercial harvest.

Figure 10. The new beach fill in Pine Knoll Shores is more resistant to higher tides and minor storm waves, forming low scarps as seen here in Pine Knoll Shores near Mile Marker 5.5 on May 29, 2002. The ruler is 15 cm high for scale and Twin Pier is in the background.