Chapter 3

CAHA #2024

Mike's comments - 11/29/09

CHAPTER 3: AFFECTED ENVIRONMENT

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CHAPTER 3: AFFECTED ENVIRONMENT

The "Affected Environment" describes existing conditions for those elements of the natural and cultural environments that would be affected by the implementation of the actions considered in this plan / environmental impact statement (plan/EIS). The natural environment components addressed include wetlands and floodplains; wildlife and wildlife habitats (with a focus on birds and invertebrate species that could be affected by ORV use or management); rare, unique, threatened, or endangered species; state listed and special status species; soundscapes; visitor use and experience (including night skies); socioeconomic resources; and Seashore management and operations. Impacts for each of these topics are analyzed in "Chapter 4: Environmental Consequences."

WETLANDS AND FLOODPLAINS

WETLANDS

Wetlands include areas inundated or saturated by surface or groundwater for a sufficient length of time during the growing season to develop and support characteristic soils and vegetation. NPS classifies wetlands based on the U.S. Fish and Wildlife Service (USFWS) Classification of Wetlands and Deepwater Habitats of the United States, or the Cowardin classification system. Based on this classification system, a wetland must have one or more of the following attributes:

- The habitat at least periodically supports predominately hydrophytic (wetland) vegetation.
- The substrate is predominately undrained hydric soil.
- The substrate is nonsoil and saturated with water, or is covered by shallow water at some time during the growing season (Cowardin et al. 1979, 3).

The majority of the undeveloped acreage within the Seashore can be classified as a wetland. The predominant wetland types at the Seashore are marine and estuarine. Marine wetlands occur along the beaches on the oceanside of the Seashore, and estuarine wetlands generally occur along the soundside, adjacent to the many tidal creeks that are prevalent along the islands.

Marine wetlands at the Seashore are located in the intertidal zone (from extreme high tide to extreme low tide) and in the subtidal zone, which includes areas permanently submerged below shallow coastal waters (Cowardin et al. 1979, 4). Marine wetlands are found along the entire length of the ocean shoreline and are typical of a sandy beach environment, subject to high wind and wave energy. Estuarine wetlands consist of deepwater and adjacent tidal wetland areas that are often partially enclosed by land but are influenced by marine waters and fresh water runoff from adjacent uplands (Cowardin et al. 1979, 4).

Estuarine wetlands at the Seashore typically fall into two classes: emergent or scrub–shrub. Emergent wetlands, also referred to as tidal marshes, are characterized by herbaceous perennial vegetation such as salt marsh cordgrass (*Spartina alterniflora*), black needlerush (*Juncus roemerianus*), bulrush (*Scirpus* spp.) and cattail (*Typha* spp.) (NCDENR 2008a, 1). Scrub–shrub wetlands are typically dominated by woody vegetation less than 20 feet tall. Typical vegetation species found in these wetlands include waxmyrtle (*Myrica cerifera*) and Eastern red cedar (*Juniperus virginiana*) (Sutter 1999, 20). Although most wetlands at the Seashore are tidal, there are also some areas of nontidal wetlands located primarily on Hatteras Island near the village of Buxton and Buxton Woods Coastal Reserve. These wetland areas include forested and emergent wetlands and are predominantly freshwater swamps and marshes that are not influenced by the tides.

Wetland areas provide substantial environmental and economic benefits to the Seashore and surrounding areas of coastal North Carolina. For example, wetlands trap sediment and pollutants from stormwater runoff and provide a natural filter before this runoff can enter local waterways. Wetlands also store large volumes of water and function as a "sponge" to reduce the likelihood of flooding during storm events. Wetlands also protect the shoreline from erosion and provide excellent habitat for fish and wildlife, many of which are threatened or endangered (NCDENR 2008b, 1). As required by Director's Order #77-1, NPS must avoid adverse impacts on wetlands to the extent practicable, must minimize any impacts that could not be avoided, and must compensate for any remaining unavoidable adverse impacts on wetlands (NPS 2008d, 2).

FLOODPLAINS

North Carolina's barrier islands have historically been and continue to be affected by coastal forces and flooding events. The barrier islands that comprise the Seashore lie adjacent to the wide and shallow Pamlico Sound and are flat and narrow. The widest part of the Seashore islands is near Cape Point, between Buxton and Frisco (Pendleton et al. 2005, 3). According to Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps, the entire Seashore is within the 100-year floodplain.

Generally, lands along the ocean beaches and adjacent to the sound (at wide points) are in flood zone "VE," which is the flood insurance rate that corresponds to 100-year coastal floodplains that have additional hazards associated with storm waves. Zone "VE" is also referred to as the "Coastal High Hazard Area." The remainder of the Seashore not directly adjacent to the ocean or sound lies within the "AE" zone, which is within the 100-year floodplain and subject to waves less than 3 feet high (NCDCCPS 2008, 25).

Because the Seashore is entirely within the 100-year floodplain and is subject to high water table conditions, many areas are conducive to drainage and flooding that often result from storm events. Areas near Buxton Woods and Cape Point Campground have been documented as historically flood-prone and are examples of popular Seashore destinations that experience flooding during times of above average precipitation events (NPS 2003a, 1). As required by Director's Order #77-2, the NPS must protect and preserve the natural resources and functions of floodplains, must avoid environmental effects associated with the occupancy and modification of floodplains, must avoid actions that could adversely affect wetland functions, and must restore floodplain values previously affected by activities in floodplains (NPS 2003b, 2).

WILDLIFE AND WILDLIFE HABITATS

In addition to the federally listed threatened and endangered species and other protected species detailed in subsequent sections of this chapter, other wildlife species depend on the habitats within the Seashore. This section describes those invertebrate species and other bird species that could be found in the study area and could be affected by ORV management alternatives. (photos to be added)

INVERTEBRATES

The Seashore beach ecosystem is home to a vast quantity of invertebrates, which form a valuable link in the coastal food chain. Invertebrates on sandy beaches can be classified into two groups: meiofauna, which are less than 1.0 mm (0.04 inches) in size; and macrofauna, which include polychaetes, crustaceans, and bivalves. Meiofauna live and feed among the sand grains and are an important part of the food chain. Meiofauna are either juveniles of larger macrofauna or exist as meiofauna for their entire life history. The vertical distribution of meiofauna is determined by the degree of drainage and oxygenation of the sediment. On high energy beaches of coarse sand, meiofauna can extend deep into the sediment. However, in low energy situations, such as sand flats with fine sand, oxygen is the major limiting factor, and meiofauna are concentrated in the surface layers of the sand (Stephenson 1999, 12). Common meiofauna include copepods, oligochaetes, and some polychaetes (sidebar: Meiofauna, crustaceans, bivalves, copepods, oligochaetes, polychaetes)

Macrofauna are invertebrates larger than 1.0 mm (0.04 inches) in size and are dominated by polychaetes, bivalves, and crustaceans (principally amphipods, decapods, and isopods). The distribution of macrofaunal invertebrates on individual beaches exhibits patchiness, zonation, and fluctuations related to tidal and other migrations (Stephenson 1999, 11). Patchiness results from passive sorting by waves and swash (part of the intertidal zone which is periodically covered by water in response to tide excursions

and wave run-up), from localized food availability, from variations in the penetrability of the sand, and from species actively aggregating (Stephenson 1999, 11). Zonation across a beach results from exposure, changing wave energy levels, and sand water content and stability (Stephenson 1999, 11). Exposed sandy beaches are typically dominated by crustaceans, while polychaetes become increasingly dominant with decreasing exposure, and dominate in very protected areas (Stephenson 1999, 10). (sidebar: Macrofauna; swash)

High energy, intertidal beaches in the southeastern United States may have as many as 30 invertebrate species. Within the boundaries of the Seashore, mole crabs (*Emerita talpoida*), ghost crabs (*Ocypode quadrata*), and coquina clams (*Donax variabilis*) are the most abundant (NPS 2006, 148–149). Ghost crabs are a top predator of the beach ecosystem and can be used as an indicator species to analyze the health of the beach ecosystem, due to their prominence and high susceptibility to anthropogenic disturbances (VIMS 2004, 11). The ghost crab creates burrows for shelter from heat and desiccation stress during summer daytime periods. Juveniles produce shallow J-shaped burrows with a mean depth of 160 mm (6.3 inches), while adults dig Y-shaped and spiral burrows with mean depths of 361 mm (14.2 inches) (Chan et al. 2006, 43). Air-breathing crustaceans such as crabs tend to be located above the drift line, in what is termed the supralittoral zone or "spray zone" and is the area above the spring high tide line that is regularly splashed but not submerged by ocean water (Stephenson 1999, 12). These animals emerge from their burrows at night to feed in the intertidal zone. The mole crab, also known as the "sand crab" or "sand flea", is found along the Atlantic coast from Massachusetts southward. In contrast to other species of crabs, they do not have pincers and move backwards rather than walking sideways. The mole crab diet includes organic matter and very small animals that it collects on the sand of the swash zone between periods when water inundates the beach. Between tides, they dig into the sand to hide from the shorebirds and larger crabs that feed on them. Females grow to about one inch, while males grow to about half an inch (Sastre 1991, 103).

Marine bivalves such as oysters (*Crassostrea virginica*), razor clams (*Siliqua costata*), coquina clams, and ribbed mussels (*Geukensia demissa*) also inhabit the Seashore, forming the diet for many birds. Clams characteristically lie buried from just beneath the surface to depths of up to 0.6 m (2 feet) (MDAR 2008, 1). Due to its importance in food webs, the coquina clam is considered an indicator species for the sandy beach ocean front habitat. It feeds on small particles such as unicellular algae and detritus and in turn, is consumed by fish and birds.

In the beach zones that are subject to ORV use, the areas of highest concentrations of invertebrates include the moist sand flats, island spits, and the intertidal zone, as well as the wrack line (drift line). The intertidal zone is defined as that part of the beach between the spring low water mark and the spring high

water mark. The upper limits of the intertidal zone are defined by the uppermost wrack line. A wrack line is a line of stranded debris along a beach face marking the point of maximum run-up during a previous high tide, and there may be several on a beach. The wrack line is composed of drying seaweed, tidal marsh plant debris, decaying marine animals, shells, and miscellaneous debris washed up and deposited on the beach. The wrack line provides a habitat suitable for many invertebrates such as amphipods, beetles, mites, flies, and spiders. The sand flats, intertidal zone, and wrack line are extremely dynamic and harsh environments, often changing over short periods of time. The various invertebrates that inhabit these areas have evolved a variety of adaptations for dealing with their ever-changing environment. Some burrow into the sand to escape the elements, and others migrate back and forth between the beach grass and the wrack; still others migrate back and forth with the swash. (sidebar: photos of beach zones, intertidal zone, wrack line)

The dynamics of the fauna on sandy beaches has never been completely investigated, and there is scant information on the biota in intertidal beaches (NPS 2006, 149). One source of information is a three year study on Cape Cod and Fire Island, New York (Steinback 1999, 1–252). The study found that amphipods, which are shrimp-like crustaceans ranging from 1 mm to 140 mm in length and are particularly vulnerable to drying out in immature stages, use the wrack line as cover. Several species of flies also use the site to lay their eggs, and wolf spiders (family *Lycosidae*) migrate back and forth from the beach grass to the wrack line to feed on these amphipods. The study observed a difference between the fauna in communities inhabiting beaches with high and low off-road vehicle (ORV) traffic, with higher vehicle traffic having the effect of dispersal and desiccation of the wrack line, thereby reducing the amount of available food and habitat for beach organisms. (sidebar: amphipods)

Other invertebrates within the Seashore beach ecosystem include clamworms (*Nereis succinea*), limpets (*Patella vulgata*), which can be found in the intertidal zone, and varieties of jellyfish (class *Scyphozoa*), sea urchins (class *Echinoidea*), and starfish (class *Asteroidea*) (NPS 2006, 148–149), all of which spend their entire lives in the water.

BIRDS

The Outer Banks of North Carolina provide a critical link in the migratory path of several shorebird species. The barrier island ecosystems at the Seashore provide habitat for large numbers of migratory and nesting bird species, and coastal marshes are critical to overwintering populations of many waterbirds. Nearly 400 species of birds have been sighted within the Seashore and its surrounding waters. Migration routes for many raptor species include southeastern barrier islands. Neotropical migrants use the islands

as a point of departure and arrival in their travels to and from their winter habitats in the tropics (NPS 2006d, 149–150).

Studies have recorded 21 species of shorebirds (table 1) on the Outer Banks of North Carolina, such as whimbrels (*Numenius phaeopus*), willets (*Catoptrophotus semipalmatus*), and sanderlings (*Calidris alba*). These shorebirds are most abundant in May and August. Least terns (*Sterna antillarum*), common terns (*Sterna hirundo*), gull-billed terns (*Sterna nilotica*), black skimmers (*Rynchops niger*), piping plovers (*Charadrius melodus*), Wilson's plovers (*Charadrius wilsonia*), willets, and American oystercatchers (*Haematopus palliatus*) can all be found nesting on North Carolina beaches (North Carolina Audubon 2008, 1). Several of these species are designated as state-listed and/or federally listed threatened or endangered species and are discussed in a later section of this chapter. However, nonlisted shorebirds such as willets have similar nesting and foraging habitats as state and federally listed species. The eastern willet, for instance, breeds in coastal salt marshes and nests on the ground, often in colonies, usually in well-hidden locations in short grass. These birds forage on mudflats or in shallow water, probing or picking up food by sight. Their diet consists of insects, crustaceans, and marine worms, as well as some plant material. Killdeer (*Charadrius vociferus*), whose breeding range also includes North Carolina, often nest in unlined gravel depressions. However, although killdeer are technically in the family of shorebirds, they are unusual in that they often nest and live far from water (Porter 1997, 1).

TABLE 1. SHOREBIRDS ON THE OUTER BANKS OF NORTH CAROLINA, 1992–1993

Species	Common Name
Pluvialis squatarola	Black-bellied Plover
Charadrius wilsonia	Wilson's Plover
Charadrius semipalmatus	Semipalmated Plover
Charadrius melodus	Piping Plover
Haematopus palliatus	American Oystercatcher
Catoptrophotus semipalmatus	Willet
Numenius phaeopus	Whimbrel
Limosa fedoa	Marbled Godwit
Arenaria interpres	Ruddy Turnstone
Calidris canutus	Red Knot
Calidris alba	Sanderling
Calidris pusilla	Semipalmated Sandpiper
Calidris mauri	Western Sandpiper
Calidris minutilla	Least Sandpiper
Calidris alpine	Dunlin

TABLE 1. SHOREBIRDS ON THE OUTER BANKS OF NORTH CAROLINA, 1992–1993

Species	Common Name
Limnodromus griseus	Short-billed Dowitcher
Charadrius vociferus	Killdeer
Tringa melanoleuca	Greater Yellowlegs
Tringa flavipes	Lesser Yellowlegs
Actitis macularia	Spotted Sandpiper
Calidris fuscicollis	White-rumped Sandpiper

Source: Dinsmore et al. 1998, 174

Migratory birds are often found throughout the year on the way to and from their destinations. During the winter months, the common loon (*Gavia immer*), pied-billed grebe (*Podilymbus podiceps*), northern gannet (*Morus bassanus*), tundra swan (*Cygnus columbianus*), as well as Canada geese (*Branta canadensis*), are common sights at the Seashore. During the summer migratory season, several varieties of herons (*Ardea herodias*), Audubon's shearwater (*Puffinus lherminieri*), and the barn swallow (*Hirundo rustica*) populate the Cape Hatteras shores. While less frequently sighted, grebes (*Podiceps auritus*), mallard ducks (*Anas platyrhynchos*), hawks (genus *Accipiter*), bald eagles (*Haliaeetus leucocephalus*), peregrine falcons (*Falco peregrinus*), and various species of sandpipers also inhabit the island at one point or another throughout the year. Rarely, birds like the tropical masked booby (*Sula dactylatra*) and the magnificent frigate bird (*Fregata magnificens*) have been seen (NPS 2006d, 149–150). Common crows (*Corvus brachyrhynchos*) and gulls (*Larus canus*) are also present within the Seashore.

RARE, UNIQUE, THREATENED, OR ENDANGERED SPECIES

This section addresses species present at the Seashore that are listed by USFWS as either endangered or threatened. In some cases, the species may also be listed by the state of North Carolina. These species include the federally listed piping plover, federally and state-listed loggerhead, green, and leatherback turtles, and federally and state-listed seabeach amaranth (*Amaranthus pumilus*).

Species listed only by the state, and which are not federally listed as threatened and endangered, are discussed in the State Listed and Special Status Species section.

PIPING PLOVER

The piping plover is a small (6 to 7 inches long, weighing 1.5 to 2.2 ounces), highly camouflaged, sand-colored shorebird endemic to North America (Haig 1992, 2). Two genetic races (Haig 1992, 2) and three geographic subpopulations are recognized: (1) the Atlantic Coast (from the Maritime Provinces of Canada

to the Outer Banks of North Carolina), (2) the Great Lakes (along Lake Superior and Lake Michigan), and (3) the Great Plains (from southern, prairie Canada to Iowa). Wintering populations are found on the Atlantic Coast, from North Carolina to Florida, and on the Gulf Coast, from Florida to Mexico, and in the Caribbean, with the greatest number of wintering birds found in Texas (Haig 1992, 1).

A 2001 census estimated 5,938 breeding plover pairs present across Alberta, Canada, to the Atlantic coast (USFWS 2006b, 32). The Atlantic Coast population was federally listed in 1986 as threatened (Federal Register 1985). At the time of listing, there were approximately 790 Atlantic Coast pairs, and the species was in decline. Therefore, a recovery target of 2,000 pairs was established in the Revised Recovery Plan for the Atlantic Coast population (USFWS 1996a, *iii*).

Habitat loss, caused by human development and recreation, and low reproductive rates, caused by human disturbance and predation, are considered to be the primary causes of the decline (Haig 1992, 13). Disturbance and predation were intensively managed after the listing, and the Atlantic Coast population rose to 1,887 pairs by 2007 (USFWS 2007, 1), but was still short of the recovery goal of 2,000 pairs (USFWS 1996a, *iii*; A. Hecht, Endangered Species Biologist, USFWS, pers. comm. 2008).

The plover breeding population south of New Jersey is less densely populated than the north and was estimated at 333 pairs in 2007, short of the regional goal for the southern Atlantic Coast of 400 pairs (table 2). North Carolina experienced more than a 50% decline in breeding pairs from 1989 (55 pairs) to 2003 (24 pairs) (table 2; USFWS 2004b, 4) for reasons discussed in the "Risk Factors" section later in this document; however, the number of breeding pairs has since rebounded to 64 pairs in 2008 (NCWRC 2008, 2).

TABLE 2. SOUTHERN REGION (INCLUDING NORTH CAROLINA) PIPING PLOVER POPULATION TRENDS, NUMBER OF BREEDING PAIRS

	Delaware	Maryland	Virginia	North Carolina	South Carolina	Southern Region
1986	8	17	100	30 [b]	3	158
1987	7	23	100	30 [b]	—	160
1988	3	25	103	40 [b]	—	171
1989	3	20	121	55	—	199
1990	6	14	125	55	—	201
1991	5	17	131	40	—	194
1992	2	24	97	49	—	172
1993	2	19	106	53	—	181
1994	4	32	96	54	—	186
1995	5	44	118	50	—	217
1996	6	61	87	35	—	189
1997	4	60	88	52	—	204

TABLE 2. SOUTHERN REGION (INCLUDING NORTH CAROLINA) PIPING PLOVER POPULATION TRENDS, NUMBER OF BREEDING PAIRS

	Delaware	Maryland	Virginia	North Carolina	South Carolina	Southern Region
1998	6	56	95	46	—	203
1999	4	58	89	31	—	182
2000	3	60	96	24	—	183
2001	6	60	119	23	—	208
2002	6	60	120	23	—	209
2003	6	59	114	24	—	203
2004[a]	7	66	152	20	—	245
2005[c]	8	63	193	37	—	300
2006[d]	9	64	202	46	—	321
2007[e]	9	64	199	61[f]	—	333
GOAL						400

[a]Source: USFWS 2004, figures are preliminary estimates

[b]The recovery team believes that the apparent 1986–1989 increase in the North Carolina population is because of an intensified survey effort.

[c]USFWS 2005. Preliminary 2005 Atlantic Coast Piping Plover Abundance and Productivity Estimates

[d]USFWS 2006a. 2006 Atlantic Coast Piping Plover Abundance and Productivity Estimates

[e]USFWS 2007. 2007 Atlantic Coast Piping Plover Abundance and Productivity Estimates

[f] For 2008, the end-of-season best estimate is 64 pairs. This represents a 5% increase from the 2007 best estimate of 61 pairs and is the highest number recorded along NC in the years that complete surveys have been conducted (1989–2008).

Source of 1986–2001 data is USFWS 2002

Source of 2002–2003 data is USFWS 2004b

— = No data available.

Piping Plover in North Carolina

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SEA TURTLES

Sea turtles are large marine reptiles found in subtropical, tropical, and temperate oceans, as well as subarctic areas. They spend the majority of their time in ocean waters, with females coming ashore only to nest on sandy beaches. Five of the seven sea turtle species existing in the world today occur in the coastal waters of North Carolina and the Seashore, and all are listed as either federally threatened or endangered. The species are: the loggerhead sea turtle, the green sea turtle, the Kemp's ridley sea turtle, the leatherback sea turtle, and the hawksbill sea turtle. Of the five species, only three are known to nest at the Seashore: the loggerhead, green, and leatherback sea turtles. The other two species, Kemp's ridley and

hawksbill, are known to occur only on the beaches of the Seashore through the occasional stranding, usually either due to prior death or incapacitation due to hypothermia, and are therefore not discussed further.

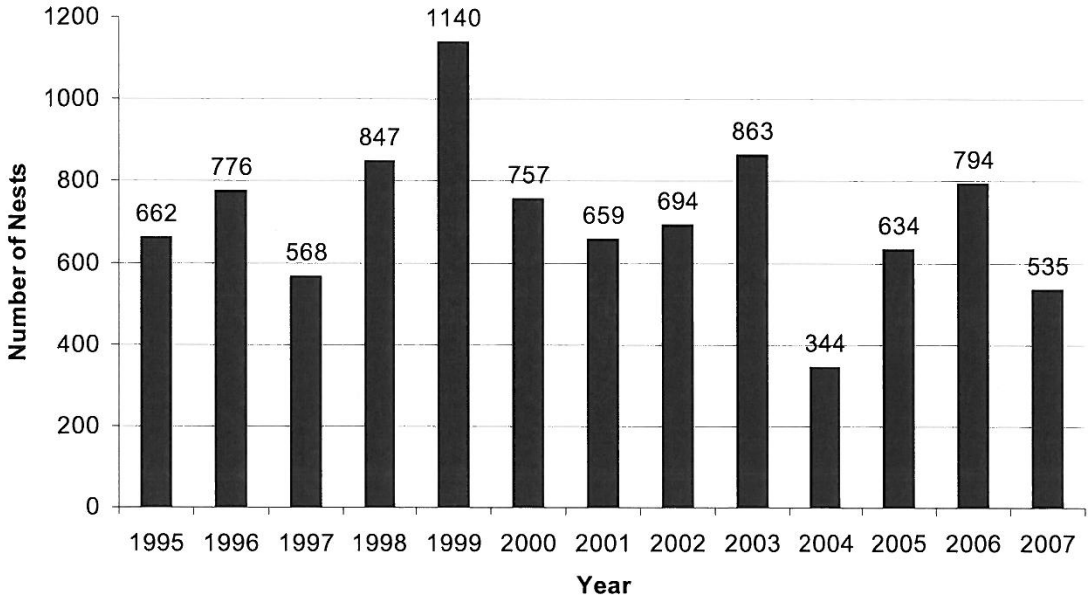
In 1978, the loggerhead turtle was federally listed as threatened (NMFS and USFWS 1991a, 2). Also in 1978, the green turtle was federally listed as threatened, except for the breeding populations in Florida and on the Pacific Coast of Mexico, which were listed as endangered (NMFS and USFWS 1991b, 1). The leatherback turtle was listed as federally endangered in 1970 (NMFS and USFWS 1992, 6). All three species carry the same state listings as their federal listings (NCWRC n.d., 5).

The Seashore has been consistently monitored for sea turtle nests since 1987. The number of nests has fluctuated greatly, with only 11 nests recorded in 1987 and ~~92~~ nests recorded in ~~2002~~ (NPS 2008c, 2). Of the three species that nest at the Seashore, the loggerhead turtle is by far the most numerous, comprising approximately 94% of the known nests between 1999 and 2007 (NPS 1999, 1; Lyons and Altman 2000, 1; Sayles 2002, 1; Gosh and Lyons 2002, 1; Altman and Lyons 2003, 1; Lyons 2005, 1; K. Sayles, NPS, pers. comm., 2005; NPS 2006b, 5; NPS 2008c, 4). Green turtles and leatherbacks breed primarily in the tropics and are rare nesters at higher latitudes, but they have nested regularly (just less frequently) at Cape Hatteras, comprising only 5% and 1% of the nests, respectively, between 1999 and 2007 (NPS 1999, 1; Lyons and Altman 2000, 1; Sayles 2002, 1; Gosh and Lyons 2002, 1; Altman and Lyons 2003, 1; Lyons 2005, 1; K. Sayles, NPS, pers. comm., 2005; NPS 2006b, 5; NPS 2008c, 4–5). Of the three islands that make up the Seashore, Hatteras Island receives the most nests annually (greater than 60% and typically, greater than 70%) followed by Ocracoke Island and Bodie Island, which since 1999, received a maximum of four nests during 2002 (NPS 1999; Lyons and Altman 2000; Sayles 2002; Gosh and Lyons 2002; Altman and Lyons 2003; Lyons 2005; K. Sayles, NPS, pers. comm., 2005; NPS 2006b, 5; NPS 2008c, 4).

Loggerhead Turtle

The loggerhead sea turtle occurs throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. However, the majority of loggerhead nesting is at the western rims of the Atlantic and Indian oceans. Within the U.S., the loggerhead turtle nests from Texas to Virginia, with the major nesting concentrations found in south Florida. Since being listed, the population in the U.S. Atlantic increased from approximately 14,150 nesting animals in 1983 (NMFS and USFWS 1991a, 2) to between 32,000 and 56,000 animals in 2000 (Ehrhart et al. 2003, 162). Within the northern subpopulation (north Florida to North Carolina), studies in South Carolina and Georgia have documented a decline in the number of nests (Ehrhart et al. 2003, 162–163). However, since standardized surveying began in North Carolina in

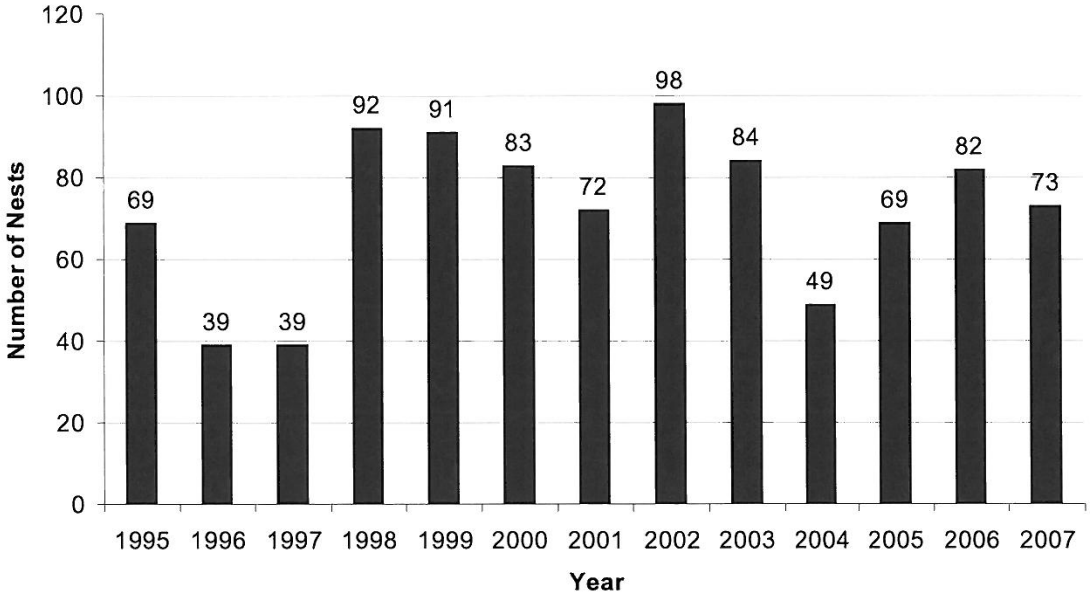
the mid-1990s, the number of loggerhead nests per season has remained fairly stable, averaging 713 nests from 1995 to 2007 (figure 5) (M. Godfrey, NCWRC, pers. comm., 2005 and 2008). (photo of loggerhead)



Source: M. Godfrey, NCWRC, pers. comm., 2005 and 2008

FIGURE 5. NUMBER OF LOGGERHEAD TURTLE NESTS IN NORTH CAROLINA, 1995–2007

At the Seashore, the average number of nests between 1995 and 2007 was 72, with the lowest number of nests occurring in 1996 and 1997 and the highest number of nests occurring in 2002 (figure 6) (M. Godfrey, NCWRC, pers. comm., 2005 and 2008; NPS 1999, 1; Lyons and Altman 2000, 1; Sayles 2002, 1; Gosh and Lyons 2002, 1; Altman and Lyons 2003, 1; Lyons 2005, 1). Only 49 loggerhead nests were laid at Cape Hatteras in 2004; however, that was a poor year for the entire southeast Atlantic Coast (Lyons 2005, 1).



Source: M. Godfrey, NCWRC, pers. comm., 2005 and 2008

FIGURE 6. NUMBER OF LOGGERHEAD TURTLE NESTS AT CAPE HATTERAS NATIONAL SEASHORE, 1995–2007

Loggerhead turtles spend the majority of their life at sea, with only mature females coming ashore to nest every two to three years, on average (Schroeder et al. 2003). The first turtle nests (all turtle species included) typically begin to appear at Cape Hatteras in mid May, and the last nests are usually deposited in late August (NPS 1999, 1; Lyons and Altman 2000, 1; Sayles 2002, 1; Gosh and Lyons 2002, 1; Altman and Lyons 2003, 1; Lyons 2005, 1; K. Sayles, NPS, pers. comm., 2005; NPS 2006b, 4; NPS 2008c, 4). Typical nesting areas for loggerheads tend to be sandy, wide open beaches, backed by low dunes (Miller et al. 2003, 128). Some factors that have been found to determine nest selection include beach slope, temperature, distance to the ocean, sand type, and moisture, though results were occasionally contradictory (Miller et al. 2003, 129).

Although the process of nest site selection is not well understood, a successful nest must be laid in a low salinity, high humidity, well-ventilated substrate that is not prone to flooding or burying because of tides and storms and where temperatures are optimal for development (Miller et al. 2003, 130). At the Seashore, between 1999 and 2007, on average, 37% of the nests found (all turtle species included) were relocated from their original location by Seashore staff. Of those nests, 68% were relocated for natural causes (e.g., in areas prone to flooding [below the high tide line], in an area prone to erosion, etc.), while

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the rest were relocated because of potential human disturbance, primarily because they were within one mile of a lighted fishing pier (NPS 1999, 2; Lyons and Altman 2000, 2; Sayles 2002, 2; Gosh and Lyons 2002, 2; Altman and Lyons 2003,2; Lyons 2005, 2; K. Sayles, NPS, pers. comm., 2005; NPS 2006b, 7; NPS 2008c, 7).

Loggerheads are nocturnal nesters. Females emerge from the ocean and crawl toward the dune line until they encounter a suitable nest site. The female clears away surface debris with her front flippers, creating a "body pit," and then excavates a flask-shaped nest cavity with her hind flippers. Loggerheads throughout the southeastern United States lay an average of 100 to 126 eggs per nest (NMFS and USFWS 1991a, 4). After laying her eggs, the female covers the nest with sand, and she crawls back to the sea.

Individual females may nest one to seven times per nesting season, at an average interval of 14 days (NMFS and USFWS 1991a, 4). The nest incubation period (from laying to hatching) depends on temperature and ranges on average from 63 to 68 days in North Carolina (NMFS and USFWS 1991a, 4). The sex ratio of hatchlings also depends on temperature during incubation. Below 84 °F, more males are produced than females, and above that temperature, more females are produced (Carthy et al. 2003). For this reason, the northern part of the U.S. Atlantic population, which includes North Carolina, apparently provides a disproportionate number of males to the larger population (Mrosovsky et al. 1984; Hanson et al. 1998, 1858).

Hatchling emergence occurs almost exclusively at night (Mrosovsky 1968; Witherington et al. 1990) and may occur over several nights. Upon emerging from the nest, hatchlings primarily use light cues to find and move towards the sea (Witherington and Martin 1996, 6). Once in the water, they swim incessantly out to sea to offshore habitats where they will spend the next phase of their life history.

Green Turtle

The green turtle is a circum-global species in tropical and subtropical waters. The major green turtle nesting colonies in the Atlantic Ocean occur on Ascension Island, Aves Island, Costa Rica, and Surinam (NMFS and USFWS 1991b, 1). Nesting in the United States occurs in small numbers in the U.S. Virgin Islands and on Puerto Rico and in larger numbers along the east coast of Florida, particularly in Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties. North Carolina is near the northern limits of its nesting area. (sidebar: photo of green turtle)

Nesting habits for the green turtle are very similar to those of the loggerhead turtle, with only slight differences. Average clutch sizes range from 110 to 115 eggs although this varies by population, and

females produce clutches in successive years only occasionally. Usually two to four years or more occur between breeding seasons (NMFS and USFWS 1991b, 2).

From 1999 to 2007, there was an annual average of two green turtle nests at the Seashore, with a peak of four nests in 2000.

Leatherback Turtle

Leatherback nesting grounds are distributed circum-globally, with the largest known nesting area occurring on the Pacific Coast of southern Mexico. Nesting in the United States occurs primarily in Puerto Rico, the U.S. Virgin Islands, and southeastern Florida (NMFS and USFWS 1992, 2). (sidebar: photo of leatherback turtle)

Leatherback nesting at the Seashore was first documented in 1998 and has subsequently been documented in 2000, 2002, 2003, 2004 and 2007 (Lyons and Altman 2000, 1; Lyons 2005, 1; NPS 2008c, 4). Since the species has a minimum of two years between nesting cycles, the presence of a leatherback nest in 2003 confirms that more than one female of the species uses the Seashore as a nesting ground. It is also known that more than one individual leatherback nested in North Carolina in 2004 since a leatherback turtle nested at the Seashore the same night the leatherback nest was found at the Seashore (Lyons 2005, 1). The Seashore remains the northernmost nesting location on record for this species (Rabon et al. 2003, 7).

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Leatherback nesting habits are very similar to those of the loggerhead turtle although they tend to begin and end nesting earlier in the year than the loggerhead (NMFS and USFWS 1992, 4). Since 1999, the only two nests laid in April at the Seashore have been leatherbacks (NPS 1999, 1; NPS 2008c, 4). Leatherbacks are thought to migrate to their nesting beach about every two to three years (NMFS and USFWS 1992, 8; Miller 1997). Clutch sizes average 116 eggs, and the incubation period averages 55 to 75 days. It is also reported that leatherback turtles nest an average of five to seven times per year, with an average interval of nine to ten days between nesting (NMFS and USFWS 1992, 8).

Potential Threats – Nesting Environment

Threats to the loggerhead turtle on nesting grounds, as outlined in their recovery plan (NMFS and USFWS 1991a, 5–9), are representative of those also faced by green and leatherback turtles.

Storm events, including hurricanes, may destroy nests because of flooding or piling of eroded sand on the nest site. Beach erosion because of wave action may decrease the availability of suitable nesting habitats (NMFS USFWS 1991a, 5), which leads to a decline in the nesting rate.

A number of predators such as foxes, raccoons, and ghost crabs dig into nests and prey upon incubating eggs, while some predators, including birds, may take considerable numbers of hatchlings just prior to and/or during their emergence from nests.

Crowding of nesting beaches by pedestrians can disturb nesting females and prevent laying of eggs (NMFS and USFWS 1991a, 8). Furthermore, the use of flashlights and beach fires may deter females from coming up on a beach, or interfere with the sea-finding behavior of hatchlings (Witherington and Martin 1996, 4, 12, 37).

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ORV beach driving may harm sea turtles when nests are run over, killing pre-emergent hatchlings, or by increasing sand compaction and thereby decreasing hatching success (NMFS and USFWS 1991a, 8). Beach driving also poses a risk of injury to hatchlings by leaving ruts that trap or disorient hatchlings attempting to reach the ocean (Hosier et al. 1981, 160). Beach driving can disturb adult females and cause them to abort nesting attempts and interfere with sea-finding behavior of hatchlings when headlights are used at night (NMFS and USFWS 1991a, 8). When artificial lighting impairs nesting behavior of nesting females and emerging hatchlings, the affected animals potentially face increased exposure to the elements, exhaustion, and predation.

Artificial lighting on human structures may deter females from coming up on a beach or disorient hatchlings as they emerge from nests and try to find the sea (Witherington and Martin 1996, 2, 13). Beach cleaning can directly destroy nests. Poaching is a problem in some countries, but it occurs at a low level in the United States.

An increased human presence may lead to an increase in the presence of domestic pets that can depredate nests and may lead to an increase in litter that may attract wild predators. Trampling can increase sand compaction that may damage nests or hatchlings.

Recreational beach equipment and furniture can also cause turtles to forego egg laying by hampering or trapping animals attempting to locate a nesting site. They can also trap emerging hatchlings.

The rate of habitat loss because of erosion and escarpment may be increased when humans attempt to stabilize the shoreline, either through renourishment or through placement of hard structures, such as sea walls or pilings. ORV traffic also contributes to habitat loss through erosion, especially during high tides or on narrow beaches where driving is often concentrated on the high beach and foredune (NMFS and USFWS, 1991a, 8). Improperly placed erosion-control structures, such as drift-fencing, can act as a barrier to nesting females. Humans may also introduce exotic vegetation in conjunction with beach development, which can overrun nesting habitat or make the substrate unsuitable for digging nest cavities.

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Threat Occurrences at Cape Hatteras National Seashore

The following data and discussions are from the Seashore annual sea turtle surveying reports, 1999 to 2007, and include all turtle species (NPS 1999, 3–5; Lyons and Altman 2000, 4–6; Sayles 2002, 3–6; Gosh and Lyons 2002, 4–7; Altman and Lyons 2003, 4–6; Lyons 2005, 4–6; K. Sayles, NPS, pers. comm., 2005; NPS 2006b, 11–13; NPS 2008c, 9, 12–14).

The majority of nest losses at the Seashore from 1999 to 2007 were weather-related, particularly due to hurricanes and other storms. During this time frame, six hurricanes caused impacts. In 2003, Hurricane Isabel destroyed 52 of the 87 nests (34 had hatched before the storm); there was so much water and sand movement along the beaches that no evidence of any nests could be found afterwards. The Seashore also felt the effects of numerous tropical storms and hurricanes as they passed by offshore.

Foxes were first seen at the Seashore in 1999, and on Hatteras Island in the winter of 2001 – 2002. Foxes disturbed or destroyed nests in five of the nine years between 1999 and 2007, with the number of nests disturbed or destroyed ranging from 1 to 9 nests per year. Ghost crab predation has been reported sporadically from 1999 to 2007, with 0 to 26 nests per year recorded as having either ghost crab holes burrowed deep into the nest cavity and/or eggshell fragments found on top of the sand in association with crab tracks.

Pedestrian tracks have been recorded inside closures, with counts ranging from 8 to 92 ~~tracks~~ intrusions per year; Pedestrians disturbed or destroyed 2 to 6 nests per year from 1999 to 2007 by digging at the nest site, although none occurred in 2003, and no data were available for 2005.

Violation of closed areas by ORVs has become increasingly common, with 13 to 109 sets of tracks inside closures, and 4 to 146 incidents of fencing vandalism recorded per year. ORVs drove over 4 to 5 nests per year from 2000 to 2002; however, the nests survived. In 2007, two nests were known to have been run over by ORVs before they were found during the morning turtle patrol and fenced off. One nest appeared undamaged, while 4 eggs were crushed in the second nest. During 2004, a total of 10 hatchlings were inadvertently killed by vehicles in two separate incidents.

Dogs disturbed or destroyed 2 nests in 2000, and 5 to 60 sets of tracks per year have been recorded inside closures. Cats have not been observed to predate eggs or hatchlings, but 10 to 50 sets of tracks per year were counted inside closures from 2000 to 2002.

The total number of pedestrian, vehicle, and pet violations are conservative estimates, for often the actual numbers could not be determined. Footprints and tracks are often recorded as a single violation when an undeterminable amount of tracks have been through an area representing multiple violations. Also, tracks

below the expanded nest closures are often washed out by the tide before being discovered by the turtle patrol.

Documented beach fires totaled 174 in 2000 and 773 in 2001. Such fires may misdirect adults and emergent hatchlings. In 2006 an adult turtle crawl was discovered going into the coals of a beach fire, and in 2007, a turtle approached a beach fire which visitors quickly extinguished prior to the turtle laying her nest about 2 feet from the fire site. Several cases of hatchlings being misdirected by lights from villages and other human structures were documented in 1999, 2000, 2002, ~~and~~ 2004, and 2008.

There have also been documented reports in 2000, 2001, 2007 and an unconfirmed report in 2006 of adult turtles aborting nesting attempts when visitors approached the turtles with flashlights, vehicle lights, or flash photography. Because the beaches are not patrolled 24 hours a day, it is likely that more disturbances of this nature occur but go undocumented.

Since 2001, Seashore staff have been tying notices to personal property found on the beach after dawn, advising owners of the threats to nesting sea turtles, and then removing the items when possible if they remain on the beach 24 hours after tagging (NPS 2008c, 14).

SEABEACH AMARANTH

Seabeach amaranth is an annual plant native to barrier-island beaches along the U.S. Atlantic Coast, including those within the Seashore. Historically, seabeach amaranth was found in nine states, from Massachusetts to South Carolina. It was federally listed as threatened by the USFWS in 1993 because of its vulnerability to human and natural impacts and the fact that it had been eliminated from two-thirds of its historic range (USFWS 1996b, 1). Since its listing, seabeach amaranth has reappeared in several states and is currently found in New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, and South Carolina. Despite its reappearance in several states, the plant remains highly vulnerable to the threats that caused its listing, and in some states, populations continue to decline (USFWS 2005, 1).

(sidebar: photo of seabeach amaranth)

This species is listed as threatened by the State of North Carolina (NCNHP 2006, 15). Within North Carolina, from 2002 to 2003, the number of plants increased from 5,700 to 9,300 along 112 miles of beach (Marion n.d., 1), representing only a fraction of the reports of approximately 40,000 plants reported in the late 1980s and 1995. Within the Seashore, seabeach amaranth numbers ranged from 550 to nearly 16,000 plants between 1985 and 1990, but only 1 to 133 individuals were found annually between the years 2000 and 2005, and no plants were documented at the Seashore during 2006 or 2007 (table 8).

TABLE 8. NUMBERS OF NATURALLY OCCURRING PLANTS OF SEABEACH AMARANTH AT CAPE HATTERAS NATIONAL SEASHORE

	1985	1986	1987	1988	1990	1993
Number of seabeach amaranth	550	600	6,883	15,828	3,332	0

	1994	1995	1996	1997	1998	1999	2000
Number of seabeach amaranth	0	1	98	81	265	8	2

	2001	2002	2003	2004	2005	2006	2007
Number of seabeach amaranth	61	133	54	1	2	0	0

Source: Jolls et al. 2004, 81; Lyons 2002, 2; M. Lyons, NPS, per. comm., 2005; NPS 2006c, 1; and NPS 2007c, 1.

Seabeach amaranth is a low-growing annual, with stems that trail along the ground but do not root. The stems are reddish in color, fleshy, grow to 4 to 24 inches in length, and have round, fleshy, dark green leaves (0.4 to 0.6 inches long) clustered near the tips. Plants must recruit annually from seed banks, either in-place or from other source populations dispersed by wind, water, or sediments distributed by anthropogenic (human) factors, such as beach renourishment (Jolls et al. 2004, 14). Seeds must be scarified (the seed coat broken by nicking or abrasion) or cold stratified (chilling for weeks) before germination can occur (Marion n.d., 1). Germination takes place from April through July, initially a small sprig forms that soon begins to branch into a clump. At the Seashore, seedlings are usually visibly detectable beginning in June (M. Lyons, NPS, pers. comm., 2005). Plants are typically 10 to 12 inches in diameter, consisting of 5 to 20 branches, though occasionally a clump may get as large 3 feet or more across, with more than one hundred branches (USFWS 1993, 1; NJDEP 2005, 1).

Flowering begins when plants are of sufficient size, often beginning in June but more typically beginning in July, and continues until the plants die in late fall or early winter. The species is a prolific seed producer, with seed production beginning in July or August and reaching a peak usually in September. Seed production continues until the plant dies. The seeds are relatively large (0.1 inch), believed to be viable for long periods of time (decades), and contained in indehiscent utricles (a fruit pouch that does not split open spontaneously at maturity to release its seed). Though the utricles are normally indehiscent, it is not unusual to see them splitting open, either before or after their detachment from the plant. Splitting or fragmentation of the utricle occurs under conditions of agitation (by wind), abrasion (by sand), or simple loss of integrity over time (USFWS 1996b, 3). (sidebar: seabeach amaranth seeds; indehiscent utricle)

Seed dispersal may occur by wind or water, and naked seeds do not disperse nearly as far from the parent plants as seeds retained in utricles. Seeds may also be dispersed by human activities, such as beach

replenishment programs. Many utricles remain attached to the plant and never disperse, allowing seeds and fruit to pile up around the bases of the parent plants. This primarily occurs at the end of the growing season when the plant dies (USFWS 1996b, 4).

Seabeach amaranth occupies a fairly narrow habitat niche. It is found on sandy ocean beaches, where its primary habitat consists of overwash flats at accreting ends of islands, and at the sparsely vegetated zone between the high-tide line and the toe of the primary dune on noneroding beaches. It is intolerant of competition and does not occur on well-vegetated sites. It is also intolerant of even occasional flooding or overwash. Populations are occasionally found in other habitats, including back dunes, soundside beaches, blowouts in foredunes, and beach-replenishment areas, but these populations tend to be small and temporary (USFWS 1996b, 6; NJDEP 2005, 1). In general, in order to survive, this species needs extensive areas of barrier island beaches and inlets, functioning in a relatively natural and dynamic manner, to allow it to move around in the landscape, occupying suitable habitat as it becomes available (USFWS 1993, 2).

Since 2000, locations where seabeach amaranth has been found within the Seashore include the upper, dry-sand flats at Cape Hatteras Point (Cape Point and South Beach), in a line of small dunes adjacent to the flats at Hatteras Inlet Spit, at Bodie Island Spit, and at the base of dunes on the beach on the northern half of Ocracoke Island. Most areas where the plants have been found were either in established bird closures or other areas closed to vehicular traffic (NPS 2000b, 1; Lyons 2001, 1; M. Lyons, NPS, pers. comm., 2005).

The predominant threat to seabeach amaranth is the destruction or alteration of suitable habitat, primarily because of beach stabilization efforts and storm-related erosion (USFWS 1993, 6). Other important threats to the plant include: (1) beach grooming and some forms of "soft" beach stabilization, such as sand fencing and planting of beach-grasses; (2) vehicular traffic, which can easily break or crush the fleshy plant and bury seeds below depths from which they can germinate; and (3) predation by webworms (caterpillars of small moths) (USFWS 1993, 2). Webworms feed on the leaves of the plant and can defoliate the plants to the point of either killing them or at least reducing their seed production.

what about beach vitex as a threat?

STATE LISTED AND SPECIAL STATUS SPECIES

This section addresses the habitat, diet, reproduction, population trends, and impacts of several species of shorebirds that are listed or recognized as special status species by the state of North Carolina but are not federally listed as endangered or threatened. These species breed on Cape Hatteras as well as in other areas of North Carolina. Species described include American oystercatcher, red knot, Wilson's plover,

and several colonial waterbirds such as least tern, common tern, gull-billed tern, Forster's tern (*Sterna forsteri*), black skimmer, and sooty tern (*Sterna fuscata*).

AMERICAN OYSTERCATCHER

The American oystercatcher is a large (16–18 inches long, 14- 24 ounces) and conspicuous shorebird with long pink legs and a long, bright reddish-orange bill. The upper body is covered with black feathers that contrast with white feathers on the breast and sides. The sexes are similar in appearance although females are slightly larger than males. (sidebar: photos)

Oystercatchers are restricted to marine environments, where they inhabit coastal salt marshes and sandy beaches along the Atlantic seaboard. They feed primarily on bivalve mollusks (Nol and Humphrey 1994; Meyers 2005, 5).

Oystercatchers form pair bonds in February and early March. Courtship takes place in salt marshes and on dunes, beaches, dredge spoils, and oyster bars. They breed from March to August along the Atlantic Coast, from Massachusetts to Florida, in relatively high, open sandy areas with sparse to no vegetation (Nol and Humphrey 1994, 4; Meyers 2005, 5).

American Oystercatcher in North Carolina

A 2007 breeding season survey estimated North Carolina's summer population at 717 individuals, with 339 breeding pairs (Simons and Schulte 2007, 7), and a 2005 survey estimated a winter population of oystercatchers in North Carolina at 647 birds (Brown et al. 2005, 1543). The Outer Banks region of North Carolina is estimated to support 90 breeding pairs, or 27% of the State's oystercatchers (Simons and Schulte 2007, 8). Oystercatcher breeding success in North Carolina has been extremely low — one egg in 32 hatches (Davis et al. 2001, 197). In response to low reproductive rates in 2005, the American oystercatcher was included in the USFWS's Southeastern Coastal Plains–Caribbean Region Report as a species of extremely high conservation concern (USFWS 2000, 4). It was also identified as a Species of High Concern in the U.S. Shorebird Conservation Plan due to low relative abundance, threats on breeding and nonbreeding grounds, and restricted nonbreeding distribution (Brown et al. 2001, 57). It is a Species of High Concern in shorebird conservation plans for the Eastern and Gulf coasts of the United States because of its small population (11,000 individuals) and habitat loss and threats (Schulte et al. 2007, 2). The oystercatcher was designated as a "Species of Special Concern" in North Carolina on May 1, 2008 (Pipkin, pers. comm., 2009).

Habitat Description

In North Carolina, oystercatcher nesting habitat comprises sandy sites characterized by more open substrate with less vegetation, away from water (generally 70–105 feet from the shoreline), and slightly elevated to afford at least a 180° view (Lauro and Burger 1989, 185; Zadusky 1985, 111; Shields and Parnell 1990, 431). Vegetation, which can include smooth cordgrass (*Spartina alterniflora*), salt meadow cordgrass (*S. patens*), marsh elder (*Iva fructescens*) and salt marsh elder (*Baccharis halimifolia*), is variable, with vegetative cover averaging from 23–50% around nest sites (Lauro and Burger 1989, 185). Elevation of nest habitat and distance to the water are both important to nest success because nests can be destroyed by tidal flooding (Lauro and Burger 1989, 185). Oystercatchers are more common in habitat with few predators or no terrestrial predators (e.g., feral or domestic predators) (Nol and Humphrey 1994, 15). Oystercatcher foraging habitats include oyster and mussel bars and intertidal sand and mud flats. Winter and summer foraging habitats are similar (Nol and Humphrey 1994, 4). (sidebar: photos of foraging and nesting habitats)

Diet

The elongated and laterally compressed bill of the oystercatcher is especially suited to allow the bird to prey upon and open marine bivalves (class *Bivalvia*), including oysters (family *Ostreidae*), soft-shell clams (*Mya arenaria*), razor clams (*Ensis directus*), stout razor clams (*Tagelus plebeius*), and ribbed mussels (*Modiolis demissus*). Other items the oystercatcher consumes include marine worms (phylum *Platyhelminthes*), mole crabs (*Emerita talpoida*), sandworms (*Nereis virens*), limpets (order *Patellogastropoda*) jellyfish (phylum *Cnidaria*), sea urchins (phylum *Echinoderm*a), starfish (phylum *Echinoderma*), and crabs (order *Decapoda*) (Bent 1929, 313; Johnsgard 1981, 59; Nol 1989, 430; Nol and Humphrey 1994, 4).

Breeding Biology

The major stages of the oystercatcher nesting cycle include the following: establishment and holding of nesting territories, courtship and copulation, nest scraping and nest building, egg laying and incubation, chick rearing, and fledging. Breeding pairs of oystercatchers begin nesting late February and early March by establishing and holding a nesting territory and then scraping multiple shallow depressions in the sand. Eventually, they choose one scrape to build a nest (Nol and Humphrey 1994, 9; McGowan et al. 2005, 150). Nests are 1.5–2.5 inches deep and 7.0–8.0 inches across. They may contain shell fragments, dead plants, small stones, and beach debris (Baicich and Harrison 1997, 128). In North Carolina, nests are rarely more than 70- 105 feet from water (Lauro and Burger 1989, 188 in Nol and Humphrey 1994) and

are often on an elevated mound, which serves as a lookout for the birds (Baicich and Harrison 1997, 128). Oystercatchers are monogamous and may mate for life (Palmer 1967 in Nol and Humphrey 1994, 8). Oystercatchers can nest in proximity to colonial waterbirds, including, but not limited to, common tern, least tern, and black skimmer.

Both sexes incubate 3 eggs (rarely 2 and 4) for 24–28 days, and incubation may begin after the second egg is laid (Nol and Humphrey 1994, 10, 11) or after the last egg (Baicich and Harrison 1997, 128). Oystercatchers will re-nest if eggs or nestlings are lost early in the season. Both adults brood nestlings that crouch motionless when alarmed, making them difficult to see. Nestlings remain in the nest for one to two days and then move with adults within their nesting territory or into nearby foraging areas, which can be 150 to 600 feet away, depending on the habitat. Chicks fledge in about 35 days, but fledglings rely on adults almost entirely until 60 days old (Palmer 1967 in Nol and Humphrey 1994, 11, 12).

Breeding Performance at Cape Hatteras

At the Seashore, the oystercatcher population has sustained declines in numbers of breeding pairs since the 1990s. As seen by the data presented in table 9, from 1999 to 2007, the number of nesting pairs declined 42% from 41 to 24 pairs on Ocracoke, Hatteras, Bodie, and Green Island (at Oregon Inlet) (Simons and Schulte 2007, 47; table 9). From 1996 to 2007 on Ocracoke Island, there were a total of 96 breeding pairs, 132 clutches, 60 hatched nests, a nest survival of 0.455, 50 fledged chicks, and fecundity of 0.52. From 1997 to 2007, on Hatteras Island, there were a total of 189 breeding pairs, 245 clutches, 99 hatched nests, a nest survival of 0.404, 60 fledged chicks, and fecundity of 0.32. On Bodie Island, there were a total of 25 breeding pairs, 34 clutches, 7 hatched nests, nest survival of 0.206, 5 fledged chicks, and fecundity of 0.20. On Green Island there was a total of 8 breeding pairs, 10 clutches, 7 hatched nests, 0.7 nest survival, 6 fledged chicks, and fecundity of 0.75 (Simons and Schulte 2007, 47; see table 9). The overall trends at Cape Hatteras indicate that oystercatcher nesting attempts could decline to a scattered few per island (less than 5) per year in less than a decade (Meyers 2005, 1). (sidebar: fecundity)

TABLE 9. OYSTERCATCHER BREEDING DATA SUMMARY, CAPE HATTERAS NATIONAL SEASHORE, 1996–2007

Location Year	Number of Breeding Pairs	Numbers of Clutches	Numbers of Nests Hatched	Nest Survival	Numbers of Chicks Fledged	Fecundity
Ocracoke Island						
1996	12	12	8	0.667	8	0.67
1999	15	17	7	0.412	2	0.13
2000	12	17	6	0.353	7	0.58
2001	13	15	11	0.733	17	1.31
2002	12	18	6	0.333	3	0.25

TABLE 9. OYSTERCATCHER BREEDING DATA SUMMARY, CAPE HATTERAS NATIONAL SEASHORE, 1996–2007

Location Year	Number of Breeding Pairs	Numbers of Clutches	Numbers of Nests Hatched	Nest Survival	Numbers of Chicks Fledged	Fecundity
2003	8	12	4	0.333	1	0.13
2004	9	11	7	0.636	8	0.89
2005	5	10	3	0.300	1	0.20
2006	5	8	5	0.625	2	0.40
2007	5	12	3	0.250	1	0.20
Island	96	132	60	0.455	50	0.52
total/avg						
Hatteras Island						
1997	22	26	13	0.500	8	0.36
1999	24	31	7	0.226	3	0.13
2000	23	29	10	0.345	2	0.09
2001	24	28	10	0.357	6	0.25
2002	21	25	3	0.120	4	0.19
2003	14	21	8	0.381	4	0.29
2004	15	18	14	0.778	9	0.60
2005	17	25	13	0.520	10	0.59
2006	14	19	11	0.579	5	0.36
2007	15	23	10	0.435	9	0.60
Island	189	245	99	0.404	60	0.32
total/avg						
Bodie Island						
1996	2	2	1	0.500	2	1.00
1999	2	2	0	0.000	0	0.00
2000	2	3	0	0.000	0	0.00
2001	2	3	1	0.333	1	0.50
2002	3	5	1	0.200	2	0.67
2003	5	5	1	0.200	0	0.00
2004	3	7	0	0.000	0	0.00
2005	2	3	1	0.333	0	0.00
2006	2	2	1	0.500	0	0.00
2007	2	2	1	0.500	0	0.00
Island	25	34	7	0.206	5	0.20
total/avg						
Green Island						
2004	2	3	2	0.667	2	1.00

TABLE 9. OYSTERCATCHER BREEDING DATA SUMMARY, CAPE HATTERAS NATIONAL SEASHORE, 1996–2007

Location Year	Number of Breeding Pairs	Numbers of Clutches	Numbers of Nests Hatched	Nest Survival	Numbers of Chicks Fledged	Fecundity
2005	2	3	2	0.667	0	0.00
2006	2	2	2	1.000	2	1.00
2007	2	2	1	0.5	2	1.00
Island	8	10	7	0.709	6	0.75
total/avg						

Data Available Only for Years Listed (Simons and Schulte 2007, 48)

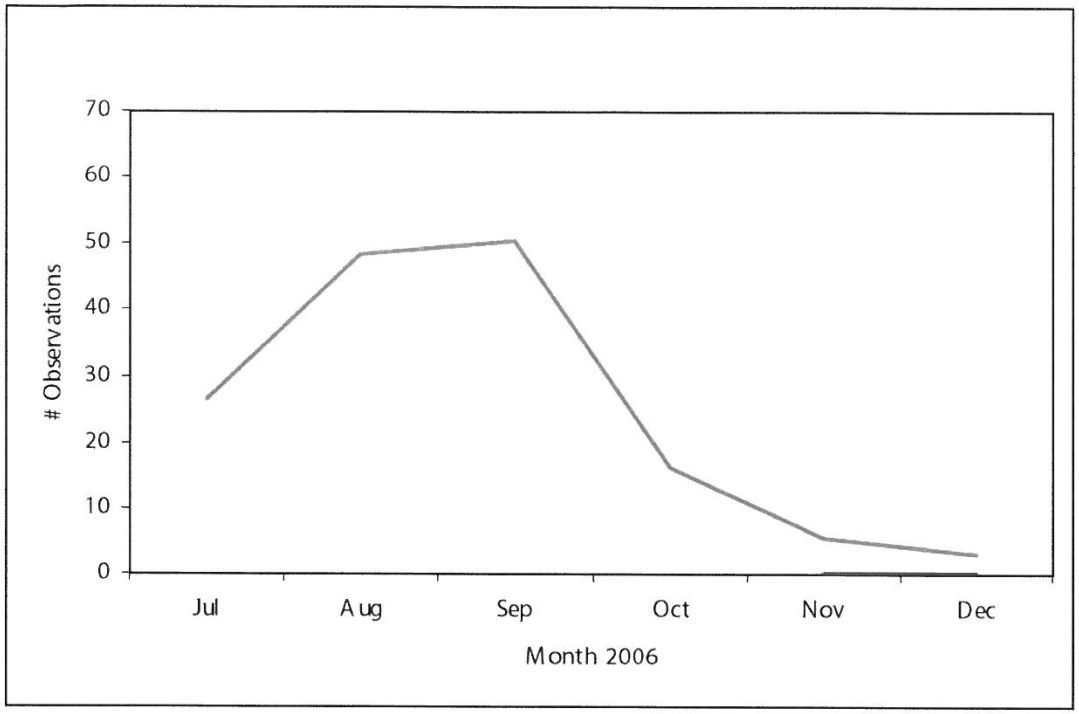
Nonbreeding and Wintering

In September, oystercatchers in the northeastern United States migrate to their wintering grounds, which are located from Virginia south along the Atlantic and Gulf coasts. Oystercatchers in North Carolina and in other southern states appear to be nonmigratory (Meyers 2005, 4). Hence, in the winter, these southern coastal beaches can support large, mixed flocks of migrant and resident oystercatchers (Post and Gauthreaux 1989, 20–21).

Winter and migratory habitat appear to be similar to breeding habitat although there are inadequate data in North Carolina regarding what constitutes preferred habitat in the winter, especially for birds on migration. Limited observations indicate that winter birds roost in open ground without vegetation in areas near foraging habitat (Nol and Humphrey 1994, 4).

The SECN Winter Monitoring Program is conducting a more comprehensive study on wintering shorebirds. Pilot implementation of the SECN Migratory, Wintering, and Beached Shorebird Monitoring Protocol at Cape Hatteras began in mid-July 2006. Results for the oystercatcher, which are depicted on figure 7 and previously included in figure 2, are discussed below.

NPS Southeast Coastal Network (SECN)



Source: NPS 2006a, 10

Breeding? Nonbreeding? or All?

FIGURE 7. NUMBER OF AMERICAN OYSTERCATCHER OBSERVATIONS AT CAPE HATTERAS, JULY 23, 2006 – DECEMBER 6, 2006

The number of American oystercatchers observed decreased from 62 during August/September to approximately ten in late November (figure 7). Approximately 60% of the shorebird observations occurred in mud flats / tidal flats during late summer (figure 2). From September to early December, most observations occurred in the surf zone.

Risk Factors

Causes of American oystercatcher nest failure on the Outer Banks (1995–2007) and the Cape Fear River estuary (2002–2003) in North Carolina (where cause of failure could be determined) were: predation by mammals, 54%; predation by ghost crabs, 3%; avian, 5%, human disturbance, 3%; abandonment, 6%; and storm/tides, 29%. Causes of failure could not be determined for 52% of nest failures (Simons and Schulte 2007, 14)

Human Activity. Current threats to the American oystercatcher throughout its breeding and wintering range are: increasing predators (the threat of which is thought to be linked to human activity) (McGowan and Simons 2006, 491; Simons and Schulte 2007, 2), development of coastal areas, and human disturbance (Nol and Humphrey 1994, 14; Simons and Schulte 2007, 13). Oystercatchers need large, undisturbed beach areas for successful nesting, which frequently exposes them to human disturbance. Disturbance from pedestrians, vehicles, and unleashed pets can cause the abandonment of nest habitat as well as direct loss of eggs and chicks (Meyers 2005, 1). In Cape Hatteras, humans cause failure in the nesting of oystercatchers (Meyers 2005, 1). Studies of the effects of humans and vehicles on the nesting success of American oystercatchers indicate that reproductive impacts such as nest loss can occur, for example, when predators are attracted due to human activity and by the alteration of the activity of incubating adults, which may reduce oystercatcher hatching success (McGowan 2004, 60; Sabine 2005, 293; McGowan and Simons 2006, 485; Sabine et al. 2006, 313; Simons and Schulte 2007, 13).

Recreational activities such as kayaking, camping, and fishing have been known to directly impact productivity of the black oystercatcher (*Haematopus bachmani*) through trampling of nests and eggs or indirectly by interfering with foraging and parental care or by causing abandonment (Tessler et al. 2007, 44). Because of similarities in life history of the black and American oystercatcher, it is likely that these recreational activities can have similar impacts on the American oystercatcher as well. Research on flush responses of oystercatchers to human disturbance indicates that protection of this species requires a buffer distance of up to about 600 feet from nesting areas (Meyers 2005, 9; see table 10).

TABLE 10. BUFFER DISTANCES RECOMMENDED FOR FORAGING AND NESTING AMERICAN OYSTERCATCHERS IN FLORIDA, GEORGIA, AND MAINE

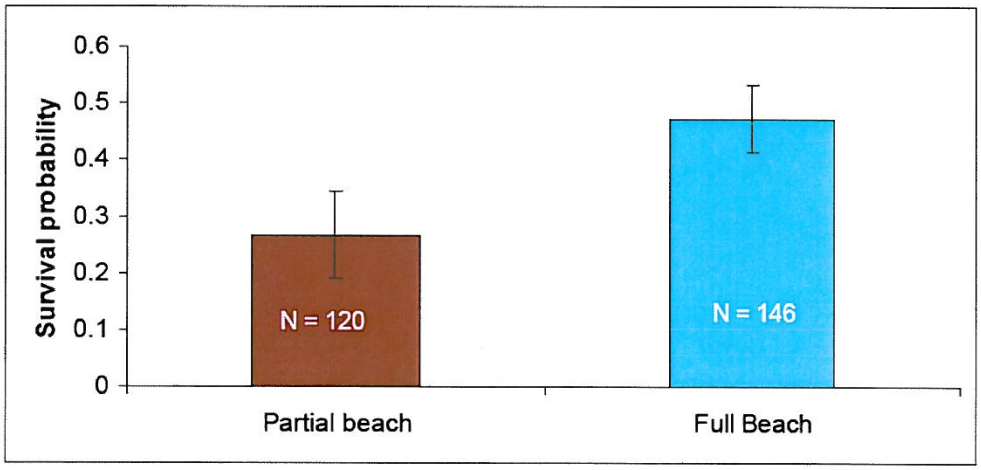
Buffer	Disturbance types	Behavior	Region
590–656 ft. (180–200 m) (Sabine et al. 2006)	Pedestrian, ATV, vehicles, boat, pets	Nesting	Cumberland Island National Seashore, Georgia
100 ft. (30 m) (Dept. Env. Protection, 2008)	Development, vegetation removal	Foraging	Maine
250 ft. (76 m) (Dept. Env. Protection, 2008)	Development, vegetation removal	Roosting	Maine

disregard

TABLE 10. BUFFER DISTANCES RECOMMENDED FOR FORAGING AND NESTING AMERICAN OYSTERCATCHERS IN FLORIDA, GEORGIA, AND MAINE

Buffer	Disturbance types	Behavior	Region
338 ft. (103 m) (Rodgers and Schwikert 2002, 222)	Personal watercraft	Foraging and loafing	West and east coasts of Florida

American oystercatcher reproductive success at Cape Hatteras is impacted by vehicle and pedestrian disturbance. From 1999 to 2007, 47% of chicks in full beach closures on Cape Hatteras survived to fledging, while 27% survived when the beach had an open lane for vehicles and pedestrians (Simons and Schulte 2007, 2; figure 8). Human activity was responsible for 16% of known chick mortality (Simons and Schulte 2007, 25), with 8 percent of that related to vehicle collisions and 8 percent to other disturbance. Several oystercatcher chicks have been killed by ORVs crushing them on the beach (NPS 2003c, 2; NPS 2004, 2). Of the 28 chicks observed during the 2003 breeding season, a total of 20 (71%) were lost, 2 because they were run over by ORVs. Others were believed lost due to the following reasons: fox predation, 1 to 2 to cat predation, up to 3 to weather, and 12 not attributed to any known causes (NPS 2003c, 2). In 2004, 24 nests were located on beaches used by ORVs; of these, 54% hatched. The highest hatching rate was found at sites that did not have ORV use or concentrated pedestrian use. At these sites, the hatching success was found to be 87%, not including nests of unknown fate (NPS 2004, 3).



Source: Simons and Schulte 2007, 26

FIGURE 8. AMERICAN OYSTERCATCHER CHICK SURVIVAL BY CLOSURE TYPE ON CAPE HATTERAS NATIONAL SEASHORE, 1999–2007

Weather and Tides. There have been 11 named hurricanes on the Outer Banks between 1993 and 2007 (NPS 2006, 126; NPS 2006a, 8; NPS 2007a, 6). Storms and high tides can reduce nesting success; overwash accounted for 25% of documented nest failures at Cape Hatteras. However, periodic hurricanes can also benefit oystercatcher nesting success in the long term through habitat generation and predator reduction (Simons and Schulte 2007, 20).

Predation. As previously noted, predation occurs by mammals, 54%; predation by ghost crabs, 3%; avian, 5%, human disturbance, 3%; abandonment, 6%; and storm/tides, 29%. Causes of failure could not be determined for 52% of nest failures (Simons and Shulte 2007, 14) Predators include red fox, mink, striped skunk (*Mephitis mephitis*) dogs, cats, rats (*Rattus* sp.), American crow, and gulls (Nol and Humphrey 1994). More recently, video nest recordings have documented raccoon and ghost crab predation of oystercatcher eggs and nestlings at Cumberland Island National Seashore, Georgia (Sabine et al. 2005, 293). Oystercatchers may lay another clutch if their eggs are lost or destroyed (Nol and Humphrey 1994, 12).

Predation of oystercatchers is thought to be associated with human activities such as ORV use and pedestrian traffic (McGowan and Simons 2006, 491; Simons and Schulte 2007, 2), McGowan and Simons (2006, 486) hypothesized that human recreation might increase the activity of incubating oystercatchers, thereby leading to increased predation rates. Their research found a clear association between recreation and incubation behavior at Cape Hatteras and Cape Lookout during the 2002 and 2003 breeding seasons (McGowan and Simons 2006, 490). ATV traffic was associated with increased rates of trips parents made back and forth to nests and a decrease in duration of incubation. Recreation types such as truck use and pedestrian traffic showed a weaker association with nesting behaviors. Evidence points to a reduction of nest success, the result of an alternation of incubation behavior due to recreational disturbance. McGowan and Simons (2006, 491) hypothesized that mammalian nest predators, which are the main nest predators during this research (Davis et al. 2001, 198), can better locate disturbed nests because adults leave a scent trail when going back and forth to nests. Humans may also support higher mammalian predator populations. For example, raccoon sightings and signs were greater in areas of increased human activity at Cape Lookout (Davis et al. 2001, 200), and raccoon and bobcat (*Lynx rufus*) signs appeared to be more abundant around areas of frequent human activity at Cumberland Island National Seashore, Georgia (Sabine et al. 2006, 312). (sidebar: sign)

Sabine et al. (2006, 312) found predation to be a primary cause of American oystercatcher nest failure at Cumberland Island National Seashore, Georgia. Egg predators included raccoon, bobcat, and American

crow. In areas of frequent human activity, pedestrians were commonly observed in close proximity to nests, causing oystercatchers to leave nests and exposing eggs and chicks to temperature extremes and greater risk of predators.

COLONIAL WATERBIRDS

Colonial waterbirds at the Seashore include gull-billed terns, common terns, least terns, and black skimmers. Gull-billed terns are considered to be "threatened" in North Carolina, while the other three are listed as "Species of Special Concern," by the North Carolina Wildlife Resources Commission and the NPS (Erwin 2005, 1). None of these species is federally listed.

The Seashore was designated a Globally Important Bird Area by the American Bird Conservancy (American Bird Conservancy 2005, 1). This designation recognizes those areas with populations and habitat important at the global level but does not carry any regulatory obligations. Ground-nesting colonial waterbirds breed along the Seashore beaches, which also host nesting sites for other birds, as well as a range of recreational activities for humans. Disturbance of colonies can lead to nesting failure.

Colonial Waterbirds – Descriptions

Gull-billed Tern

The gull-billed tern is a medium-sized (13 to 15 inches long, weighing about 5.6 to 7.0 ounces) waterbird found widely in Eurasia, the Mediterranean, northern Europe, and the United States. In the United States, it occurs as two subspecies, with the Atlantic Coast and Gulf subspecies being designated *Sterna nilotica aranea* and the *van rossemi* subspecies occurring from the Salton Sea in California south to western Mexico (Parnell et al. 1995, 3).

Common Tern

The common tern is a widespread species that can be found across the temperate region of the northern hemisphere. It also occurs in Bermuda and the southern Caribbean region (Nisbet 2002, 1). It is one of the medium-sized, black-capped terns (12 to 14 inches long, weighing 3.8 to 5.1 ounces) (Nisbet 2002, 2). In North America, it is distributed along the Atlantic Coast, the St. Lawrence River, and in most of the Great Lakes (Nisbet 2002, 3).

Least Tern

The least tern is the smallest of the black-capped terns in North America. Five races are recognized in North America, although there are few differences genetically or morphologically among them

(Thompson et al. 1997, 4). The least tern weighs only about 1.7 ounces, on average, and is only 8 to 9 inches in length (Thompson et al. 1997, 2, 31). (sidebar: photo of terns)

Black Skimmer

Black skimmers are the only waterbird on the Atlantic Coast that feeds by skimming along the surface of the water with its lower jaw. It is also unique in that males are on average 35% to 40% larger than females, and both exhibit a high degree of nocturnal behavior. Females average about 9.3 ounces, while males average about 13 ounces. The length of the female ranges from 16 to 24 inches, while length ranges from 19 to 24 inches for males (Gochfeld and Burger 1994, 26). (sidebar: photo)

Colonial Waterbirds in North Carolina

The Outer Banks region of North Carolina supports a large number of colonial waterbird species that depend upon its extensive sounds and the nearshore waters for feeding and its relatively undisturbed islands for nesting. Most species of colonial waterbirds are in jeopardy in North Carolina (Parnell and Committee 1977, 330–373) because of a decline in numbers over the past 20 to 30 years. During the period from 1977 to 2007, the number of gull-billed tern nests declined from approximately 268 to only 90, common terns from 2,761 to 498, and black skimmers from 976 to 555. The number of least tern nests, however, increased from 1,925 to 2,827, and nests of Forster's terns remained stable from 1138 to 1034 nests during the same period (NCWRC database, fide D. Allen, Sue Cameron, pers. comm. 2008). Numbers of most breeding colonially nesting shorebirds within North Carolina have declined over the past 20 to 30 years (Erwin 2005, 1; see table 11). For example, from 1977 to 2007, a period of 28 years, colonial waterbird nesting declined 30%, from 7068 to 5004 nests (table 11).

TABLE 11. COLONIAL WATERBIRD NESTS IN NORTH CAROLINA, 1977–2007

Species	1977	1983	1988	1993	1995	1997	1999	2001	2004	2007	Average
Least Tern	1925	1653	1528	2188	1993	882	1271	1742	2408	2827	1841.7
Forster's Tern	1138	936	933	1610	1117	867	812	1086	828	1034	1036.1
Common Tern	2761	2247	2618	2122	1699	952	888	1131	570	498	1548.6
Gull-billed Tern	268	233	161	155	249	137	154	258	99	90	180.4
Black Skimmer	976	797	743	1084	819	570	681	594	623	555	744.2
Total	7068	5866	5983	7159	5877	3408	3806	4811	4528	5004	

Source: North Carolina Wildlife Resources Commission North Carolina Wildlife Resources Commission. 2008. Colonial Waterbird Database. North Carolina Wildlife Resources Commission, Raleigh, North Carolina.

The beaches of the Seashore have been important in providing suitable habitat for these species (table 12). In 2004, more than half of all nesting black skimmers and common terns in North Carolina were found at the Seashore, as well as one third of the state's gull-billed terns (see tables 11 and 12). From 2004 to 2007, estimated nest numbers for these species declined at Cape Hatteras as follows: black skimmer, 342 to 0; common tern, 376 to 18; and gull-billed tern, 31 to 0. Within the Seashore, no gull-billed tern nests were recorded in 2007, representing a decline from the Seashore's long-term average of about 37 nests. A total of 18 common tern nests were found in 2007, compared to a long-term average of about 487 nests. Least tern numbers have sharply declined at the Seashore, with only 194 nests counted in 2007, compared to the average over thirteen years of study of about 326 nests. Black skimmer nest numbers also decreased in 2007, with no nests counted, down from an average of 225 nests (table 12).

The reasons for the decline in North Carolina's colonial waterbirds are many and include at least the following: mammal and bird predation (i.e., from large gulls, especially herring gulls), human development, beach stabilization, recreational disturbances on the outer and village beaches, and perhaps, impacts on the wintering grounds (Parnell et al. 1995, 13; Erwin 2005, 7).

explain "long-term avg" i.e., from what to what year

TABLE 12. COLONIAL WATERBIRD NESTS AT CAPE HATTERAS NATIONAL SEASHORE, 1977–2007

Species	1977*	1983*	1988*	1992*	1993*	1995	1997	1998	1999	2000	2001	2004	2007***	Avg
Least tern	121	508	450	454	761	342	278	173	355	184	202	212	194	325.6
Common tern	802	763	678	278	422	503	718	715	440	129	573**	376	18	486.8
Gull-billed tern	27	7	26	0	12	58	84	21	103	3	108	31	0	36.9
Forster's tern	382	63	0	0	0	31	0	0	0	0	0	0	0	36.6
Black Skimmer	286	296	144	30	226	139	454	366	306	149	193	342	0	225.4
Sooty tern					1									
Total	695	366	170	30	239	228	538	387	409	152	1076**	373	212	375

*Surveys conducted by J. Parnell, University of North Carolina, Wilmington

**Updated from 2001 report to include nests found on Green Island at Oregon Inlet, which is now included in the Seashore boundary

***North Carolina Wildlife Resources Commission. 2008. Colonial Waterbird Database. North Carolina Wildlife Resources Commission, Raleigh, North Carolina

check math

check errata for Interim Strategy - I think we are using the same erroneous table that was in the Interim Str.

Descriptions of Breeding, Foraging, and Migration/Winter Roost Habitats

Gull-billed Tern

Breeding Habitat. Gull-billed terns typically nest among other tern species on open, sandy-shell beaches, on large barrier islands, on dredge-spoil islands, or on overwash fans (also used by piping plovers) that are mostly devoid of vegetation. They also nest on elevated-shell ridges ("rakes") along the edges of marsh islands that they share with American oystercatchers and common terns (Erwin et al. 1998b, 970; Erwin 2005, 5; Parnell et al. 1995, 4). (sidebar: dredge-spoil islands)

Foraging Habitat. In contrast to other terns, gull-billed terns do not feed primarily on fish but are opportunistic, taking insects on the wing, feeding on a variety of invertebrates, including fiddler crabs (*Uca* sp.), decapods, marine worms, and clams, as well as small marsh fish (Erwin 2005, 5; Parnell et al. 1995, 5.). Consequently, gull-billed terns can be seen feeding over marshes, creeks, and along ocean and bay beaches, as well as over agricultural fields many miles from their nesting site (Erwin 2005, 5; Parnell et al. 1995, 5). (sidebar: decapod)

Migration/Winter Roost Habitat. Little is known of gull-billed tern use of habitat while migrating, except that the habitat is generally considered similar to nesting habitat (i.e., open beach, sand spits) (Erwin 2005, 5). Winter range includes Costa Rica, coastal ponds, lagoons, and Louisiana mudflats (Parnell et al. 1995, 5), and mainly flooded rice fields (Parnell et al. 1995, 5). (sidebar: photos of habitats)

Common Tern

Breeding Habitat. Common terns typically nest on open, sandy-shell beaches on ocean coastal islands, as well as at inland island sites in freshwater lakes, or as in Europe, on rivers (Nisbet 2002, 6). However, they also nest in salt marshes, either on shell or on wrack, especially where human disturbance along the beaches is significant, and even on man-made structures, including large rooftops in urban areas (Erwin 1980).

Foraging Habitat. Common terns prey on small fish and shrimp in inlets and along the coast, often within a few miles of their breeding colonies (Nisbet 2002, 6).

Migration/Winter Roost Habitat. There is little information on habitats used by migrating common terns. However, most continue to feed close to shore. Migration staging areas are known at large sandy spits and bars at a number of North Atlantic sites, with concentrations numbering in the thousands at some places (Nisbet 2002, 6). In winter, common terns migrate to the Caribbean and South America, both coasts of Africa, coasts and islands of the Indian Ocean, the western Pacific from Japan to the Solomon

Islands, New Guinea, and Australia (Nisbet 2002, 3) where they often concentrate in large numbers in coastal lagoons (Nisbet 2002, 5).

Least Tern

Breeding Habitat. Least terns typically select the barest sand- and shell-covered substrates available on coastal, riverine, or dredge-spoil islands (Thompson et al. 1997, 5). They also nest on rooftops in a number of coastal areas, where pea gravel is used as part of the roofing material (Thompson et al. 1997, 5). On coastal barrier islands, they often select colony sites either adjacent to inlets or in overwash areas that are often interspersed among piping plover nests. Unlike common terns, least terns are typically found in small single species colonies, where their nests are often widely spaced (Thomspon et al. 1997). In New Jersey, internest distance ranged from 2 to 66 meters (6 to 216 feet) at the time of egg-laying, and 1 to 60 meters (3 to 197 feet) at the end of incubation (Burger and Gochfeld 1990, 35).

Foraging Habitat. Least tern foraging habitat is similar to that of common terns, except that least terns seldom feed in large flocks.

Migration/Winter Roost Habitat. Least terns migrate from the Outer Banks in August and September, with migration flocks staging at certain sandy island sites (Thompson et al. 1997, 4). In late July or August, remote sandbars or sandy spits serve as roost sites. Least terns winter from Florida through the Caribbean and into Central and South America (Thompson et al. 1997, 6).

Black Skimmer

Breeding Habitat. Black skimmers prefer to nest on open, sandy substrates on barrier and dredge-spoil islands or at the tips of barrier islands (Gochfeld and Burger 1994, 1). They invariably nest with other tern species along the Atlantic Coast (Erwin 1977, 709; 2005, 3). Black skimmers occasionally nest on wrack or on shell ridges in salt marshes and even on rooftops with least terns (Gochfeld and Burger 1994, 12).

Foraging Habitat. Black skimmers feed on small fish, shrimp, and other invertebrates that they capture by skimming the surface with their lower jaws just below the surface of the water. They typically feed very close to their nesting colonies and prefer quiet waters in salt marsh creeks, lagoons, or protected coves and inlets near barrier islands (Erwin 1977, 715; 2005, 7; Gochfeld and Burger 1994, 5).

Migration/Winter Roost Habitat. Black skimmers migrate from the Outer Banks region from September to November, forming very large concentrations on sandy spits and sandbars (Gochfeld and Burger 1994, 1). They winter from Florida through the Caribbean and South America (Erwin 2005, 7; Gochfeld and Burger 1994, 1).

Breeding Biology

Gull-billed Tern

Birds arrive in North Carolina by mid-April. The mating system is monogamous, and like many other waterbirds, gull-bills probably have long-lasting pair bonds. Nest-site establishment and egg laying usually occur in mid- to late May. The nests consist of a shell-lined scrape in the sand or sometimes on wrack in salt marshes. Nests contain from 2 to 3 brownish-blotched eggs (in the U.S., the mean is around 2.2 eggs per nest [Parnell et al. 1995, 11]) that are incubated for 22 to 23 days. Members of a pair share incubation duties, but females take the dominant role. Both parents share brooding duties, and both feed the young, often for an extended period after fledging occurs (birds generally fledge at 26 to 30 days of age). The chicks are highly camouflaged and more mobile (precocial) than either common tern or black skimmer chicks, with which it coexists. The young may leave the immediate area of the nest within a few days if disturbance is high. Pairs may re-nest if a nest is lost early in the breeding season (Erwin 2005, 2).

Common Tern

Birds arrive in North Carolina in late April to early May and begin nesting most years from mid-May to early June (Nisbet 2002, 16). The mating system is monogamous, and like many other waterbirds, common terns probably have long-lasting pair bonds. Clutch sizes vary, but three, medium-dark-brown mottled eggs are the norm. The eggs are incubated for 22 to 23 days. Both sexes incubate and feed the brood. As in other terns, feeding of the young occurs post-fledging and can continue into the fall migration. Upon hatching, the young remain near the nest (unless disturbed) for the entire prefledging period. Renesting may occur if early nests fail. Fledging ranges from about 25 to 30 days. Common terns appear to serve as a social locus for mixed-species colony formation, possibly because of their aggressively protective nature (Erwin 1979, 1054; 2005, 3; Nisbet 2002, 14). Hence, gull-billed terns and black skimmers often nest among common terns (Erwin 2005, 3).

Least Tern

Birds arrive in North Carolina from late March to mid-April. Unlike most other Outer Banks terns, least terns usually nest in single-species colonies, with nests often spread out. Courtship lasts for two to three weeks in April and May, and egg laying occurs from late May until June. Clutch sizes range from 1 to 3 eggs, with 2 the norm in North Carolina. Eggs are highly camouflaged, with the background color beige to light olive brown. Members of a pair share incubation duties, but females take the dominant role. Incubation lasts for 21 to 22 days, and the highly mobile young move from the nest within a few days.

They are able to fly at about 20 days of age. Post-fledging parental feeding can occur for several weeks away from the colony (Thompson et al. 1997, 15; Erwin 2005, 4).

Black Skimmer

Birds arrive in North Carolina from late April to mid-May, and nest building and egg laying usually occur from late May to mid-June (Erwin 1977, 709; 2005, 4; Gochfeld and Burger 1994, 11). Clutch sizes range from 2 to 4 eggs (Erwin 1977, 709). Eggs are light buff with black blotches, and are laid and hatch at different times. Both sexes incubate the eggs, brood, and feed the young. Incubation ranges from 22 to 25 days. The young remain near the nest (unless disturbed) for most of the prefledging period of 28 to 30 days (Erwin 1977, 712). As with other waterbirds, if nests fail early in the season, skimmers will re-nest (sometimes several times). Skimmers are sometimes seen incubating eggs as late as August in the mid-Atlantic region (Burger and Gochfeld 1990, 46). Fledged young are fed by their parents, often right up until migration (Erwin 1977, 715; 2005, 4).

Breeding Performance at Cape Hatteras

Colonial waterbird breeding at Cape Hatteras occurs between May and August. In many cases, colonial waterbirds use areas already closed to the public for breeding American oystercatchers and piping plover. Colonies are commonly composed of small groups of least terns, and the largest and most diverse colony was located at Ocracoke Inlet flats in 2002 (NPS 2002). Surveys of colonial waterbird pairs and nests have been conducted at Cape Hatteras during the years 1973, 1977, 1983, 1988, 1992, 1993, 1995, 1997, 1998, 2000, 2001, and 2004 (NPS 2003b, 1; Erwin 2005, 24; tables 12, 13, 14). Surveys during the period 1977–2004 (table 12) documented the following colonial waterbird nests (low, high, average): least tern (121, 508, 337); common tern (129, 802, 533); gull-billed tern (0, 103, 40); Forster's tern (0, 382, 40); black skimmer (30, 454, 244); sooty tern (0, 1, 1). Estimates of colonial waterbird nesting pairs from select years between 1973 to 2003 reveals that nesting has generally declined since the 1970s (Erwin 2005, 1).

don't we have more recent data? 2007?

TABLE 13. COMMON NOISE SOURCES AND LEVELS

Source	Decibel Level (dB)	Exposure Concern
Leaves rustling	20	Normal safe levels
Soft whisper	30	Normal safe levels
Quiet office; crickets	40	Normal safe levels
Average home; refrigerator; washing machine; bird calls	50	Normal safe levels

what is the relevance of this table? needs context or reference in text to make it meaningful.

move to Noise section on pp. 47-48

TABLE 13. COMMON NOISE SOURCES AND LEVELS

Source	Decibel Level (dB)	Exposure Concern
Conversational speech	65	Normal safe levels
Highway traffic	75	May affect hearing in some individuals depending on sensitivity and exposure length
Noisy restaurant	80	May affect hearing in some individuals depending on sensitivity and exposure length
Average factory	80 to 90	May affect hearing in some individuals depending on sensitivity and exposure length
Pneumatic drill, thunder	100	May affect hearing in some individuals depending on sensitivity and exposure length
Automobile horn	120	May affect hearing in some individuals depending on sensitivity and exposure length
Jet plane	140	Noises at or over 140 dB may cause pain
Gunshot blast	140	Noises at or over 140 dB may cause pain
Centerfire Rifle Shot	160	Noises at or over 140 dB may cause pain

dB = decibels

Source: MN Pollution Control Agency 1999, 5.

relevance? move to p.47 or p.48?

relevance?

TABLE 14. PERCEPTIONS OF INCREASES IN DECIBEL LEVEL

Amount of Change	Decibel Level (dB)
Imperceptible change	1
Barely perceptible change	3
Clearly noticeable change	5
About twice (or half) as loud	10
Fourfold change	20

Source: MN Pollution Control Agency 1999, 7.

terminology - See comment p.33

Nonbreeding and Wintering

Gull-billed Tern

Fledged young and adults usually leave North Carolina's colonies by August, moving north for a short period before turning south for the fall and winter. Little is known of concentration areas during migration or winter although wintering birds are known in Florida and the Gulf coastal region, from western Florida all the way south to Honduras and to Panama on the west coast. The gull-billed tern occasionally winters along the Atlantic Coast of North America as far north as North Carolina (Parnell et al. 1995, 2; Erwin 2005, 2).

Common Tern

Fledged young and adults usually leave North Carolina's colonies in late July to August. They often move north before staging at sandbars near inlets in September and then heading south. Little information is known about winter range, but they are known from Florida south through the Caribbean to Peru and southern Brazil, where tens of thousands have been recorded in late winter (Nisbet 2002, 21).

Least Tern

Fledged young and adults usually leave North Carolina's colonies in late July to August after breeding and also move northward into the New York to New England region before turning south to South America and the Caribbean. However, data are very limited on winter ranges (Thompson et al. 1997, 6). Like other terns, least terns tend to congregate at staging areas along the Gulf Coast in August before departing for the winter (Thompson et al. 1997, 6; Erwin 2005, 4).

Black Skimmer

Fledged young and adults usually leave North Carolina's colonies by early August and disperse northward before heading south. Large flocks congregate at staging areas, often with terns. Adults may remain with their young during fall migration. Most birds from the mid-Atlantic region winter from southern North Carolina to Florida, the Caribbean, and into Central and South America (Gochfeld and Burger 1994, 2; Erwin 2005, 5).

Risk Factors

Human Activity. Ground-nesting colonial waterbirds are particularly vulnerable to impacts from human activities undertaken by ORV riders, pedestrians, photographers, wildlife managers and scientists, and even poachers because of the birds' usually high colony density and co-occurrence with human recreation (Erwin 1980, 39; 2005, 7; Rodgers and Smith 1995, 89; Rodgers and Schwikert 2002, 216). Disturbances affect the animals' ability to feed, rest, and breed by evoking a flush response (Rodgers and Smith 1995, 89; Rodgers and Schwikert 2002, 216). Human activities which have indirect effects include: sonic booms from military operations, aircraft disturbances, the presence of both domestic and feral animals, and the leaving of garbage that subsequently attracts both bird and mammal predators. Even modest disturbances early in the spring, when the birds are first arriving and prospecting for breeding sites, can be highly disruptive to colonial species (Buckley and Buckley 1976, 8, 15). These studies indicate that buffer distances from human disturbances should be approximately 600 feet from nesting areas (Rodgers and Smith 1995, 89; Erwin 1989, 104; 2005, 13).

At Cape Hatteras,
Regarding ORVs, four least tern chicks (between Ramps 23 and 30) and seven black skimmer chicks at Ocracoke Inlet were found dead or dying in vehicle ORV tracks during the 2003 breeding season. In all cases, the chicks were found adjacent to, but outside of, posted closures. Chicks become mobile after hatching, increasing their vulnerability. Colonial waterbird chick mortality from beach vehicles was documented prior to 2003 (NPS 2003c, 3) (Erwin 2005, 7).

Closure Encroachment

There were 105 incidents of visitors encroaching on posted bird closures at Cape Hatteras between mid-April and September of 2003 (NPS 2003c, 3). This number represents a substantial increase to the 52 and 63 incidents recorded in 2001 and 2002, respectively (NPS 2003c, 3) (Erwin 2005). Of the 105 incidents reported, 27 occurred on Bodie Island, 56 on Hatteras Island, and 22 on Ocracoke Island. In 2004, there were 347 individual pedestrians documented within posted resource closures protecting ten colonies. The majority occurred on Hatteras Island, with 103 pedestrian tracks recorded (NPS 2004, 1). In 2005, human disturbance was noted at several colonies (e.g., people hitting golf balls into colonies). In 2006, shoreline closures excluding vehicles and/or pedestrians were established for chicks at six colony sites. Human disturbance was documented at several colony sites impacted nesting success (NPS 2006d, 3). In addition, two sets of tire tracks were observed within a least tern resource closure. See 2008 report

Weather and Tides. There were 11 named hurricanes on the Outer Banks between 1993 and 2007 (NPS 2006, 126; 2006a, 8; 2007a, 6). The effects of major hurricanes caused major declines in water conditions, as well as in marine life, throughout Pamlico Sound in North Carolina for an extended period (Mallin 2000, 1). Winter storms are known to impact shorebirds. High mortality of many coastal bird species was noted after a snowstorm swept the entire North Carolina coast in 1989 (USFWS 1996a, 43). quality level (?)

Predation. Predators of colonial waterbirds include red fox, mink, skunk, dogs, cats, rats, the American crow, gulls, and raccoon. Foxes, raccoons, rats, and feral cats have increased in recent years as human populations have grown in coastal regions (Buckley and Buckley 1976, 37; Erwin et al. 2001, 292; Erwin 2005, 7). The result of this predation has been poor reproduction or major redistributions of species, such as black skimmers, common terns, gull-billed terns, and least terns, (Erwin et al. 2001, 292; Erwin et al. 2003, 1559; Erwin 2005, 7). In addition, gulls are often predators on terns as well as competitors for nesting space (Nisbet 2002, 22). These include great black-backed gulls (*Larus marinus*), herring gulls (*Larus argentatus*), and the smaller laughing gulls (*Leucophaeus atricilla*). In addition, in certain areas, other bird species may prey on terns and skimmers (or their eggs), such as peregrine falcons (*Falco peregrinus*), great-horned owls (*Bubo virginianus*), fish crows (*Corvus ossifragus*), and others (Erwin 2005, 7).

WILSON'S PLOVER

Wilson's plover is a medium-sized, ringed plover of coastal habitats. Its overall length is 6.5 to 7.5 inches, and its weight ranges between 2 and 2.5 ounces. At all times of the year and in all plumages, its bill is entirely black, large, and heavy; its upperparts are generally grayish to grayish brown, and its underparts are white, with a black-to-brownish breast-band. Its legs and feet are flesh-colored to pinkish. It is readily distinguished from other, similar, ringed plovers by its larger size; by its large, heavy, all-black bill; and by its flesh-colored legs. The piping plover is smaller than Wilson's plover, having obviously paler upperparts, orange legs, and a much smaller, stubbier, two-toned bill that has an orange-yellow base and a black tip (Corbat and Bergstrom 2000, 1; Hayman et al. 1986, 287; Howell and Webb 1995, 257). Wilson's plover has no federal protection status in the United States; however, it was classified as a species of conservation concern by the USFWS in 2002. Birds that appear on this list are those that , without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act of 1973 (USFWS 2002a, 1). Brown et al. (2001) list Wilson's plover as a "species of high concern" in their prioritization of shorebird species according to relative conservation status and risk (Brown et al. 2001, 57). Wilson's plover is listed as endangered in Virginia and Maryland, threatened in South Carolina, rare in Georgia, state-protected in Alabama (Audubon 2005, 1), and as a species of special concern in North Carolina [NCAC 10I.0105, Subchapter 101 15A]. (photo of Wilson's and piping plover to show difference)

Distribution

Breeding. Wilson's plover is distributed locally along the Atlantic Coast, from Virginia south to southern Florida, including the Florida Keys, and from southern Florida west along the Gulf Coast to Veracruz, Mexico, the Yucatán, and Belize (Stevenson and Anderson 1994, 213). Breeding locations are uncertain farther south along the Caribbean coast of Central America.

In South America, Wilson's plover breeds locally along the Atlantic Coast, from Colombia south to Brazil, and includes the islands of Trinidad, Aruba, Bonaire, Margarita, and Curaçao, located off the coast of Venezuela (Meyer de Schauensee and Phelps 1978, 71). In the West Indies, it breeds throughout the Bahamas, the Greater Antilles, the Virgin Islands, the Lesser Antilles, and in the Grenadines (Raffaele et al. 1998, 268).

Along the Pacific Coast, Wilson's plover breeds locally along the west coast of Baja California, and from the Gulf of California south to Nayarit, Mexico (Howell and Webb 1995, 256). Farther south along the Pacific Coast, it breeds from Mexico to Ecuador and Peru (Hilty and Brown 1986, 153).

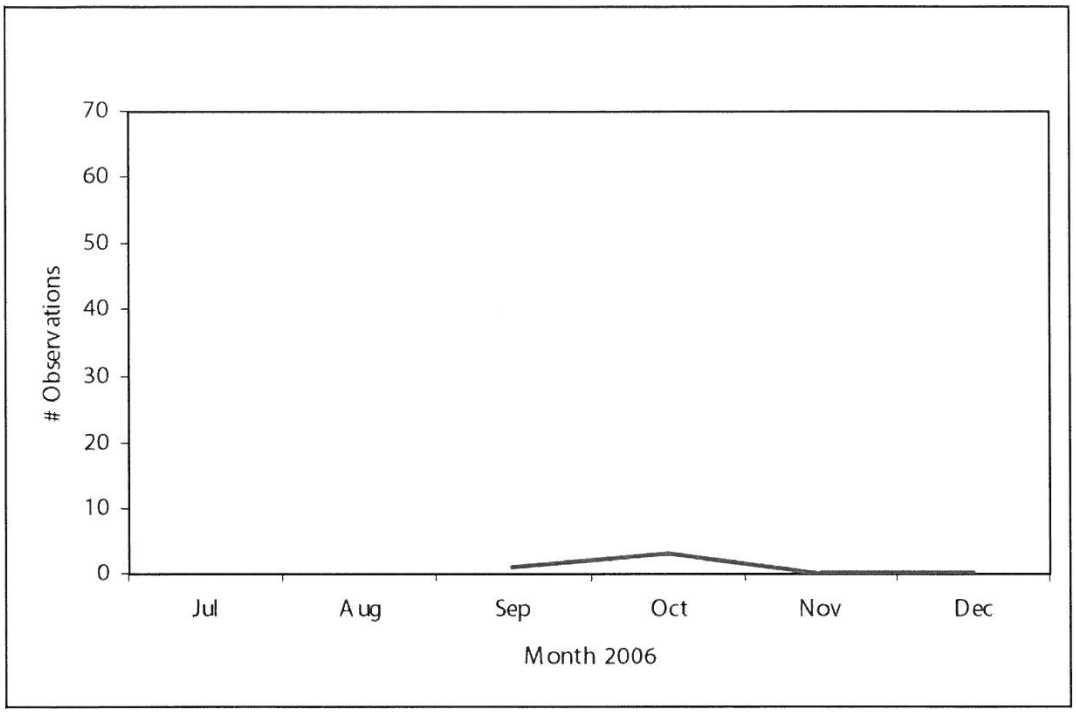
Wintering. Wintering occurs mainly in northeast and central Florida (Corbat and Bergstrom 2000, 2) as well as in west Louisiana and south Texas throughout the remainder of the breeding range (see above), to northern South America (Hayman et al. 1986, 286).There are no data pertaining to Wilson's plover nonbreeding or wintering at the Seashore.

Wilson's Plover in North Carolina and at Cape Hatteras National Seashore

A 2004 survey of the entire coast of North Carolina yielded 232 pairs of Wilson's plover. Of those, Seashore supported just two pair of Wilson's plover on Ocracoke Island. In contrast, in 2004, Cape Lookout National Seashore supported 62 Wilson's plovers, or 26% of North Carolina's population. In 1995, one pair of Wilson's plover was observed holding a territory for the breeding season at Cape Point. However, no nest was searched for, and the pair has not been seen in subsequent years (NPS 2006e, 144). Another area Wilson's plover are found in North Carolina is the North Carolina National Estuarine Research Reserve (Ornes 2007, 1).

More comprehensive surveying of wintering shorebirds is being conducted per the NPS's Southeast Coast Inventory and Monitoring Network (SECN) Winter Monitoring Program. Implementation of the SECN Migratory, Wintering, and Beached Shorebird Monitoring Protocol at Cape Hatteras began in mid-July 2006. Results are shown on figures 2 and 9 and are discussed below.

was it not "searched for" or not "found"?



Source: NPS 2006a, 10

FIGURE 9. NUMBER OF WILSON'S PLOVER OBSERVATIONS AT CAPE HATTERAS NATIONAL SEASHORE, JULY 23, 2006 – DECEMBER 6, 2006

Few Wilson's plover were observed at Cape Hatteras from July to early December (figure 9). Approximately 60% of the shorebird observations occurred in mud flats / tidal flats during late summer. From September to early December, most observations occurred in the surf zone (NPS 2006a, 10).

Habitat Description

Wilson's plover are typically associated with coastal areas of high salinity and sparse vegetation, including salt flats, coastal lagoons, sand dunes, foredunes, and overwash areas above the high-tide line (Tomkins 1944, 260; Hayman et al. 1986, 286; Corbat and Bergstrom 2000, 1). At the Seashore, Wilson's plover breeding sites have only been known to occur within piping plover closures. Hence, all closures, and much of the management of piping plovers, also apply indirectly to Wilson's plover.

Diet

Wilson's plover is a visual feeder of crustaceans, particularly fiddler crabs and some insects (Strauch and Abele 1979, 217; Morrier and McNeil 1991, 601; Thibault and McNeil 1994, 308), which they prey upon at intertidal mudflats, sand flats, ephemeral pools, and shores of brackish ponds. They usually forage at low tide on intertidal mudflats (Strauch and Abele 1979, 217; Thibault and McNeil 1994, 308; Corbat and Bergstrom 2000, 4).

Breeding Biology

Before territories are established in mid-March to early April (Tomkins 1944, 259; Corbat and Bergstrom 2000, 8), Wilson's plovers form pairs, and most breeding territories are established by mid-April. As with the piping plover, the nest is a scrape in sand that requires little construction (Bergstrom 1988, 26). Egg laying peaks from late April through late May (Bergstrom 1988, 28). Re-nesting after failure of the first nest continues through the end of June. The estimated time required to complete a clutch of three eggs is four to six days (Bergstrom 1988, 25; Corbat and Bergstrom 2000, 10).

Reproductive Success at Cape Hatteras National Seashore

There are no data pertaining to Wilson's plover reproductive success at the Seashore.

Risk Factors

Because Wilson's plovers commonly nest on beaches with wide berms, which are also favored by birds like piping plover, Wilson's plovers are subject to disturbances at their nests and roosts by the same factors as those that affect the piping plover, including beachgoers, pets, and ORV traffic on beaches. Wilson's plovers leave their nests when disturbed and are extremely reluctant to return when intruders are anywhere near, a practice that exposes eggs to predation and overheating (Corbat and Bergstrom 2000, 12).

Red Knot

The red knot is a shorebird that breeds in the Canadian Arctic and is known to visit only North Carolina, the Outer Banks, and the Seashore, as well as the entire eastern seaborne of the United States, as a migrant and an occasional winter resident (Harrington 2001, 1). There are five subspecies currently recognized (*Calidris canutus canutus, C.c. rufa, C.c. islandica, C.c. rogersi, C.c. roselaari*) (Harrington 2001, 5, 6). Two of these (*C.c. rufa* and *C.c. roselaari*) are found in the United States but only during migration and in the winter. Southward migration of *C.c. rufa* and *C.c. roselaari* begins in mid July, with

staging occurring along the U.S. Atlantic coasts (Harrington 2001, 5, 6). Only those aspects of the red knot's life pertinent to its management and conservation in North Carolina, the Outer Banks, and the Seashore, are covered in this section. The red knot is not listed as threatened or endangered by the USFWS, but is a federal candidate species. The red knot does not carry state status in North Carolina. (photo: red knot)

Emergency Endangered Listing and Taxonomy

On August 1, 2005, in response to the 80% decline in red knot population over the past 10 years, leading conservation groups filed an emergency petition asking the USFWS to list the red knot as an endangered species under the ESA. The listing request came from an alliance of wildlife groups, including Defenders of Wildlife, New Jersey Audubon Society, American Bird Conservancy, the National Audubon Society, Delaware Audubon Society, Citizens Campaign for the Environment, Audubon New York, Audubon Maryland-DC, and the Virginia Audubon Council. On September 12, 2006, the USFWS announced that it had designated the red knot as a candidate for ESA protection. On February 27, 2008, conservation groups again petitioned the Department of the Interior to list as endangered the *rufa* subspecies of the red knot, and a broader taxon comprising both the *rufa* subspecies and the *roselaari* subspecies (*Calidris canutus roselaari*). Add 2008 elevation in candidate Status rating

Another indication of conservation concern for the red knots is the fact that in August of 2004, the U.S. Shorebird Conservation Plan (2004, 2) published its list of U.S. and Canadian shorebird populations that are considered highly imperiled or of high conservation concern. The Canadian Arctic–Atlantic Coast Population of the red knot was one of eight taxus classified as "Highly Imperiled."

Description

The red knot is characteristically found along the east coast of the United States, with its greatest population-staging on Delaware Bay (Tsipoura and Burger 1999, 635) on its migration from its breeding ground in the Canadian Arctic to the Tierra del Fuego region of Chile and Argentina in South America. It is this subspecies that is the subject of the emergency petition.

Males in breeding plumage have a dark red or salmon breast, throat, and flanks, with a white belly. Their crowns and backs are flecked with gray and salmon (Harrington 1996, 10; 2001, 2; Paulson 1993, 229). Female coloration is similar to that of males, but is typically less intense. Nonbreeding plumage is a plain gray on the head and back, with light fringes of gray and white along the wings, giving an appearance of a white line running the length of the wing when in flight. The breast is white, mottled with gray, and the belly is dull white. For both male and female, the bill is black (year round), and the legs are dark gray to

black (Harrington 1996, 30; 2001, 2). The average weight of the red knot is 5 ounces (which varies considerably through the year), with a body length between 9 to 10 inches.

Range and Migration

Red knots are found in the Arctic regions of Canada during the breeding season, which is mid-June through mid-August. They winter from November to mid-February primarily in two separate areas in South America—Tierra del Fuego in Chile and Argentina, and in Maranhão, northern Brazil (American Bird Conservancy 2005, 9). Additional, smaller numbers of red knots also winter further northwest in French Guiana and in the coastal, southeastern United States, including North Carolina, the Outer Banks, and the Seashore.

Red knots have one of the longest migrations of any shorebirds. Those individuals that overwinter in southern South America embark on their northern migration in February, with peak numbers leaving Argentina and southern Chile in mid-March to mid-April (Harrington 1996, 52; 2001, 2). The first stopover is along the coast of southern Brazil (Vooren and Chiaradia 1990, 20). Their final stopover is the Delaware Bay. Their southward migration from the Canadian Arctic begins in mid-July. They arrive in South America along the coast of the Guianas in mid- to late August (Spaans 1978, 72). From the Guianas, red knots continue to move southward along the Atlantic coastline of South America, and the greater part of the population will continue on to Tierra del Fuego to overwinter (Morrison et al. 2004, 60).

These long-distance migrations can only occur when the birds have access to productive refueling stops, particularly on their northern migrations, which involve fewer stops than the southern ones. For red knots on the eastern seaboard of the United States, Delaware Bay is the most crucial spring stopover because it is the final stop at which the birds can refuel in preparation for their nonstop leg to the Arctic. When they arrive at their final destination, weather conditions can be harsh, and food is scarce. Their fat reserves from the Delaware Bay must sustain them not only during their 2,400 km (1,488 mile) final flight, but also upon arrival in the Arctic until food resources become more plentiful (Baker et al. 2004, 875).

According to representatives from the National Audubon Society, red knots within the Seashore use oceanside beaches for resting and foraging, especially those that are low-angle beaches near larger intertidal zones, including such areas as South Beach (just above the Frisco Ramp), and on the east and west sides of Ocracoke on the oceanside, as well as the soundside areas (inside of the no-ORV closures) on Ocracoke and Bodie Island. Red Knot only use the Seashore in the winter and during spring and fall migration.

needs a qualifier, such as the (primary) final stop, otherwise it sounds like they bypass CAHA on southern migration.

Nonbreeding and Migratory Habitat

Harrington (1996, 34; 2001, 9) describes how, during the winter, the red knot frequents intertidal habitats, notably along ocean coasts and large bays. Both areas usually display high waves or strong currents while supplying a sandy habitat. These areas are selectively chosen in South America, with the most abundant population on the island of Tierra del Fuego in Argentina and Chile (Morrison and Ross 1989, 223, 226, 249, 252).

On migration, the red knot principally uses marine habitats in both North and South America. Coastal habitats along the mouths of bays and estuaries are preferred, providing sandy beaches to forage (Harrington 1996, 70; 2001, 8). High wave energy is associated with these areas (Harrington 2001, 9; Vooren and Chiaradia 1990, 20; Blanco et al. 1992, 203). Red knots are also known to use tidal flats in more sheltered bays or lagoons in search of benthic invertebrates or horseshoe crab eggs (Harrington 1996, 47-78; 2001, 9; Tsipoura and Burger 1999, 635). In some cases, beach habitats are preferred because of high densities of benthic bivalves (Harrington 1996). Red knots also use tidal flats in more sheltered bays or lagoons, where they hunt for benthic invertebrates (Harrington 2001, 9) or for special foods, such as horseshoe crab eggs (Harrington 1996, 70; Tsipoura and Burger 1999, 635). Delaware Bay hosts the largest number of spawning horseshoe crabs in the United States, a primary food source for the red knot. At Delaware Bay, the red knot feed and put on weight needed for winter migration. The increasing human harvest of the horseshoe crab has reduced this food source for red knots, and this dearth is believed to be contributing to the red knot's failure to reach its needed threshold departure weight of 6.3 to 7.0 ounces. Hence, there has been a systematic reduction in the body weight of red knots leaving Delaware Bay for the Arctic, which negatively impacts their ability to survive and breed (Baker et al. 2004, 875).

Risks

Red knots are highly vulnerable to degradation of the resources on which they depend to accomplish their migrations. Morrison et al. (2004, 61) have identified four factors that cause this vulnerability: (1) a tendency to concentrate in a limited number of locations during migration and on the wintering grounds so that deleterious changes can affect a large proportion of the population at once; (2) a limited reproductive output, subject to vagaries of weather and predator cycles in the Arctic, which, in conjunction with a long lifespan, suggests slow recovery from population declines; (3) a migration schedule closely timed to seasonally abundant food resources, such as horseshoe crab eggs during spring migration in Delaware Bay (Tsipoura and Burger 1999, 635), suggesting that there may be limited

flexibility in migration routes or schedules; and (4) occupation and use of coastal wetland habitats that are affected by a wide variety of human activities and developments (Bildstein et al. 1991, 218).

Most disturbingly, 2004 research by Baker et al. (2004, 879) indicated that if red knot populations continue to decline at their present rate, the bird will approach extremely low numbers by 2010, and the probability of near-term extinction will be correspondingly higher than it was in 2004. Research by Niles et al. (2005, 1, 5) supports this extinction trajectory. The evidence strongly suggests that the decline of the red knot closely corresponds to the massive increase in the harvesting of the horseshoe crab on the Delaware Bay over the past decade. At Cape Hatteras, disturbances associated with pedestrians, vehicles, and unleashed pets are documented to have negative impacts on wintering birds such as the red knot (Lyons 1996–2002; NPS 2005a, 15).

SOUNDSCAPES

NATURAL AND HUMAN NOISE LEVELS

Natural soundscapes encompass all the natural sounds that occur in parks, including the physical capacity for transmitting those natural sounds and the interrelationships among park natural sounds of different frequencies and volumes (NPS *Management Policies 2006* [NPS 2006f, sec. 4.9], 56). The NPS works to preserve, to the greatest extent possible, the natural soundscapes of parks. The frequencies, magnitudes, and durations of acceptable levels of unnatural sound varies throughout a park, being generally greater in developed areas (NPS *Management Policies 2006* [NPS 2006f, sec. 4.9, 56]).

Noise can be defined as an unwanted sound, such as one that is loud, unpleasant, unexpected, or undesired. Sounds are described as noise if they interfere with an activity or disturb the person hearing them. Sound is measured in a logarithmic unit called a decibel (dB). Noise levels are most commonly expressed in decibels (dB). The human ear is not equally sensitive to all sound frequencies; therefore, the A-weighted decibel scale (dBa), which is calibrated to the human ear's response, may be used when analyzing noise levels. Table 13 illustrates common sounds and their associated exposure concern.

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Nearly all agencies and organizations with authority over noise-producing sources (including the World Health Organization and the National Research Council) use 55 dB as the threshold for defining day-night sound levels as noise in urban areas (Schomer 2001, 1).

The threshold of perception of the human ear is approximately 3 dB, and a 5- dB change is considered to be clearly noticeable. As shown in table 14, a 10-dB change would be perceived to be twice as loud (MN Pollution Control Agency 1999, 7). When dB are doubled, the sound does not become twice as loud. For

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most people a 10 dB increase in the measured sound level is perceived as being twice as loud, and a 10 dB decrease is perceived as half as loud (MN Pollution Control Agency 1999, 1).

Many factors affect how an individual responds to noise. Primary acoustical factors include the sound level, its frequency, and duration. Nonacoustical factors also play a role in how an individual responds to sounds. These factors vary from the past experience and adaptability of an individual to the predictability of when a noise would occur. The listener's activity also affects how he or she responds to noise (Mestre Greve Associates 1992, 1).

NOISE ATTENUATION

A number of environmental factors mitigate noise emissions in the environment, including absorption of sound by the air and the effect of barriers (structures), hills, and trees on the emitted noise. However, the most important of these factors is likely the distance between the source and the receiver (OPTI 2002, E5-3).

DISTANCE

Noise levels depend on the distance from the noise source and the attenuation of the surrounding environment. As a sound wave travels through the air, the intensity of the sound wave decreases with increasing distance from the source (Henderson n.d., 1). When the distance from a point source is doubled (over a hard surface with no intervening vegetation), the sound level decreases 6 dB (MN Pollution Control Agency 1999, 1; Komanoff and Shaw 2000, 9). For example, if a sound level were 95 dB at 50 feet, it would be 89 dB at 100 feet, and 83 dB at 200 feet. If the surface is "soft," the decrease with distance can increase. The California Department of Transportation (Caltrans, 1998) reports that "soft" sites with soft dirt, grass, or scattered shrubs or trees would experience a decrease in noise levels of 7.5 dB with doubling of distance from a point source, and thicker vegetation strips can reduce noise by up to 10 dB over what would be predicted without the vegetation present.

BARRIERS AND HILLS

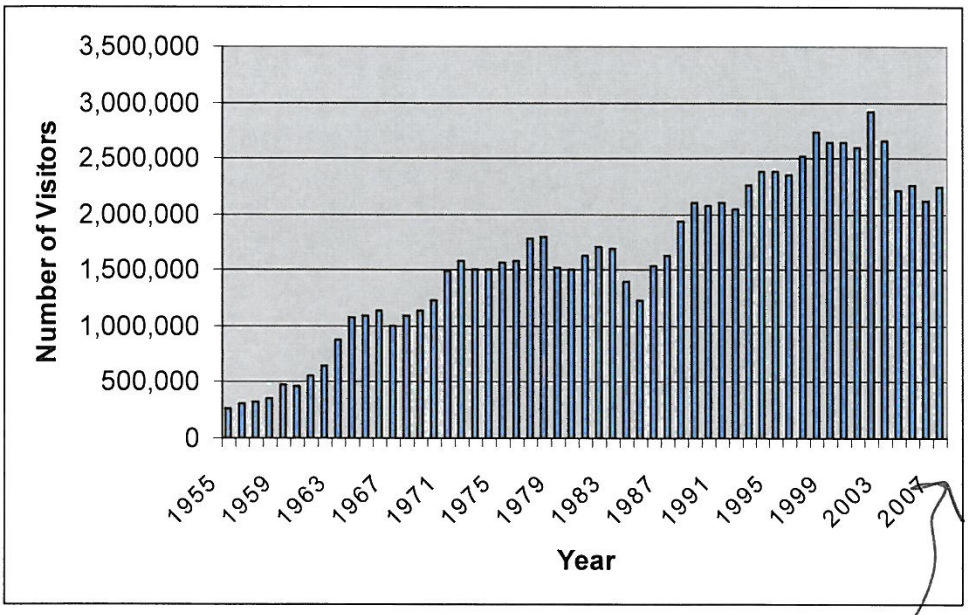
Barriers, such as hills, buildings, and other structures can also attenuate sound in the environment. As sound waves "bend" around obstructions, they lose energy. Therefore, people usually do not hear sounds from sources that are behind hills or buildings. The amount of attenuation provided by an obstruction depends on the how much the sound waves bend. This attenuation is greatest closest to the source, but is less effective at greater distances (OPTI 2002, E5-6).

NOISE LEVELS AT CAPE HATTERAS NATIONAL SEASHORE

Data regarding soundscapes is currently being collected, and the baseline condition will be incorporated once available expected January 2009.

VISITOR USE AND EXPERIENCE

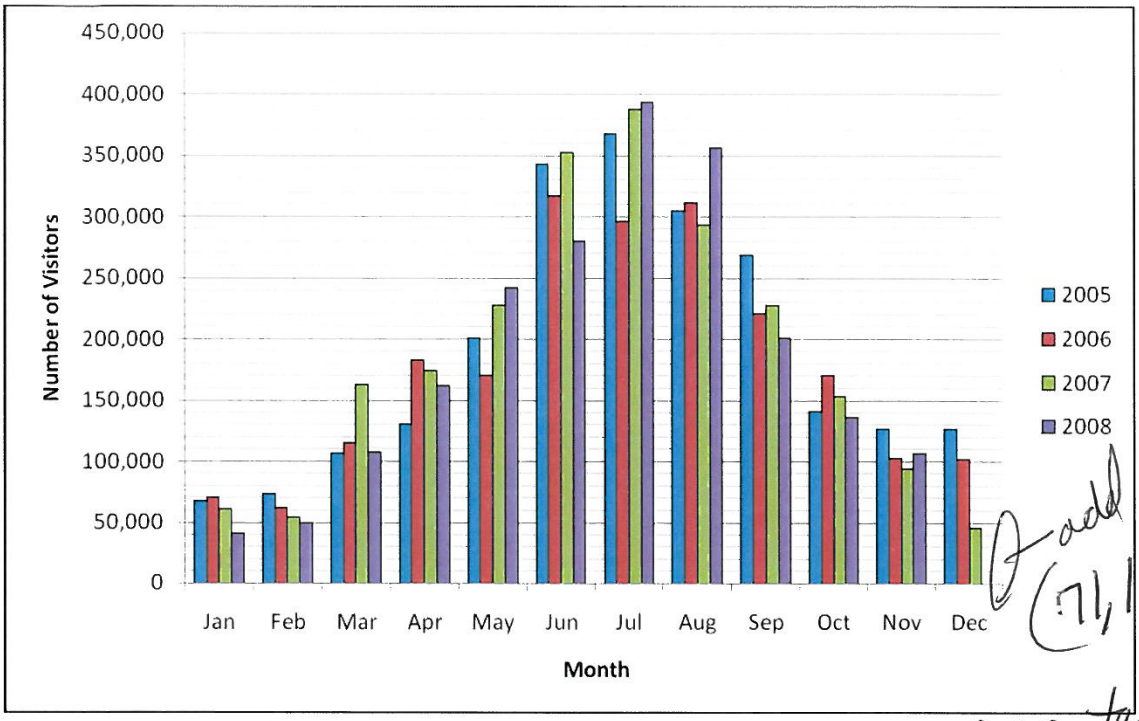
Visitation to the Seashore has shown a relatively steady increase, with occasional dips, particularly in the mid-1980s and recently from 2003 to the present. More than two million visitors have recreated at the Seashore every year since 1990 (see figure 10). Figure 11 illustrates visitor use reports for 2007 and 2008 which indicate that highest use occurs during June, July, and August; this accounts for approximately 46% of the annual recreation visits (based on 2007 data). Another 21% of annual visitation occurs during the fall (September, October, and November); 25% in the spring (March, April, and May); and, 7% in the winter (December through February) (NPS 2008f, 1).



Source: NPS 2008f, 1

FIGURE 10. ANNUAL VISITATION STATISTICS AT CAPE HATTERAS NATIONAL SEASHORE, 1955–2007

Add 2008



Source: NPS 2008F, 1

FIGURE 11. MONTHLY VISITATION FOR CAPE HATTERAS NATIONAL SEASHORE, 2005–2008

VISITOR CHARACTERISTICS

A study conducted by the University of Idaho during one week in July 2002 showed that many visitors (44%) were from North Carolina and Virginia. Approximately 10% were from Ohio, and smaller proportions of visitors came from 29 other states and Washington DC (University of Idaho 2003, 10). Over 50% of visitors were between 30 and 50 years of age (University of Idaho 2003, 8).

RECREATIONAL OPPORTUNITIES AND USE AT CAPE HATTERAS NATIONAL SEASHORE

The Seashore provides a diverse range of recreational opportunities including auto touring, biking, bird watching, boating, camping, fishing, hiking, hunting, kayaking, taking nature walks, ~~snorkeling~~, star gazing, swimming, wildlife viewing, and wind surfing. According to the study conducted by the University of Idaho in 2002, the three most important reasons for visiting the Seashore mentioned most by visitors were the lighthouses, the beach/beachcombing, and fishing. Historical significance and swimming followed closely (University of Idaho 2003, 15). This study also asked visitor groups to list the

CAHA Visitation Report by Calendar Year

2008 December

Month	*2008 Total Visitors Per Month*	*Visitors for Same Month in 2007*	*Monthly % Comparison to 2007*	*2008 YTD Visitors*	*YTD Visitors for Same Month in 2007*	*YTD % Comparison to 2007*
January	42,855	63,073	-32.05%	42,855	63,073	-32.05%
February	51,822	56,892	-8.91%	94,677	119,966	-21.08%
March	110,554	167,919	-34.16%	205,232	287,885	-28.71%
April	168,645	181,584	-7.13%	373,876	469,469	-20.36%
May	258,465	244,211	+5.84%	632,341	713,680	-11.40%
June	295,335	373,472	-20.92%	927,676	1,087,151	-14.67%
July	415,752	409,996	+1.40%	1,343,428	1,497,148	-10.27%
August	376,977	310,481	+21.42%	1,720,405	1,807,628	- 4.83%
September	212,708	240,804	-11.67%	1,933,113	2,048,433	-5.63%
October	141,377	159,694	-11.47%	2,074,490	2,208,126	-6.05%
November	109,481	97,061	+12.80%	2,183,970	2,305,187	-5.26%
December	71,147	48,026	+48.14%	2,255,117	2,353,213	-4.17%
	Dec 2008	*Dec 2007*	*Month of Dec +/-*	*Year-to-Date 2008*	*Year-to-Date 2007*	*Year-to-Date +/-*
Grand Total	*71,147*	*48,026*	*+48.14%*	*2,255,117*	*2,353,213*	*-4.17%*

December 2008

Visitor Centers	Ferry Vehicles	Airplanes	Airplane Passengers	HI LH Climbers	OI LH Climbers	Rec. Boats	Non-Rec. Boats	Vehicles Passing Whalebone	Campers in RV's	Campers in Tents	Group Campers
15,512	1,423	115	288	0	0	8	0	41,007	0	0	0

December 2007

Visitor Centers	Ferry Vehicles	Airplanes	Airplane Passengers	HI LH Climbers	OI LH Climbers	Rec. Boats	Non-Rec. Boats	Vehicles Passing Whalebone	Campers in RV's	Campers in Tents	Group Campers
15,161	1,274	166	415	0	0	2	0	0	0	0	0

Grand Total Buses for December 2008 (ALL PARKS) = 9
Wright Brothers Buses = 7
Grand Total Visitor Center Visitors (ALL PARKS) = 27,013
Hatteras Only Visitor Center Visitors = 9,311

Cape Hatteras Lighthouse and all park campgrounds are closed for the season. **NOTE: Traffic counter was out at Whalebone in Dec 07 with -0- vehicles being reported. This resulted in a large fluctuation in percentages for Dec 08**

Prepared 01/07/09

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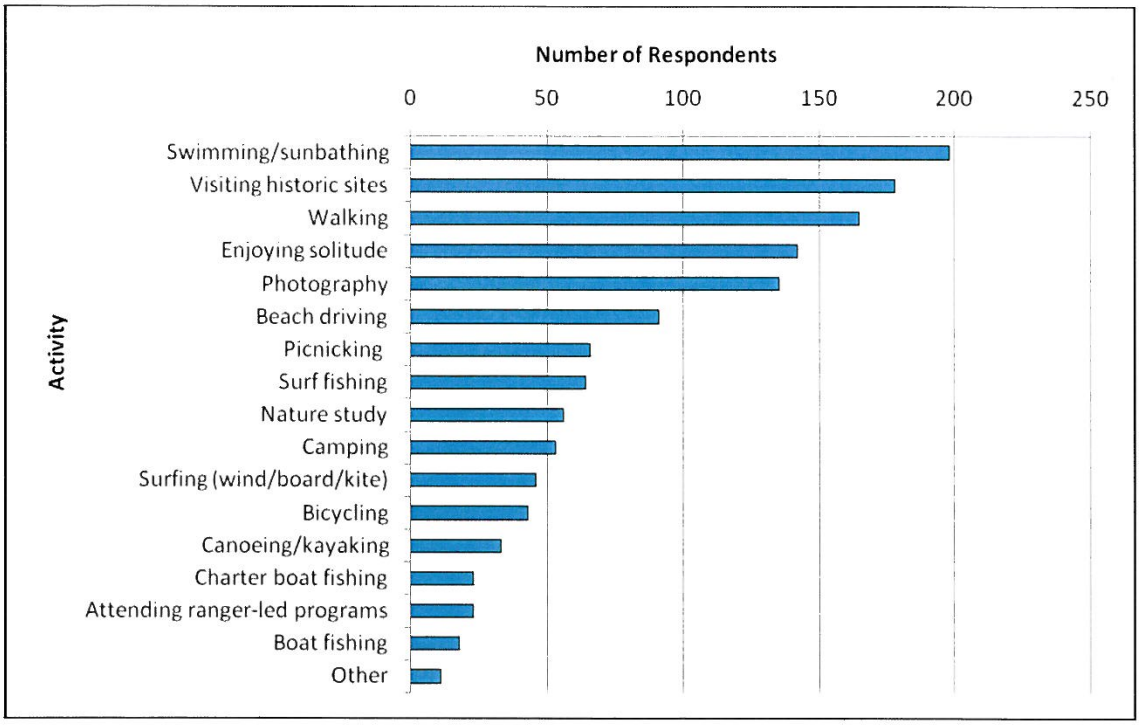
activities in which they participated during their visit to the Seashore, the results of which are displayed below in figure 12. "Other" activities that respondents participated in included viewing the "Lost Colony" play, family time/reunion, clamming/crabbing, shelling, shopping, and history study.



Source: University of Idaho, 2003

FIGURE 12: VISITOR ACTIVITIES SURVEY RESULTS

Major developed facilities, such as visitor centers and campgrounds, as well as more informal visitor use areas at the Seashore that provide for these recreational activities, are shown on the Seashore map in the "Purpose and Need" chapter. Visitor centers are located on each island in association with Ocracoke, Cape Hatteras, and Bodie Island lighthouses, and campgrounds include Ocracoke, Frisco, Cape Point, and Oregon Inlet. Fishing piers are located near Frisco and at Avon and Rodanthe on ~~Cape~~ Hatteras Island, and a major marina is located at Oregon Inlet on Bodie Island. Bathhouses and/or designated swimming beaches are available near Frisco on Cape Hatteras Island, Coquina Beach on Bodie Island, and at on Ocracoke Island north of the village. Information stations, day use areas, and informal recreation opportunities, such as nature trails, are also found throughout the Seashore.

Recreational Fishing

The waters off the Seashore are known throughout the world as highly productive fishing areas. The fish that congregate in the waters off the Outer Banks attract anglers from throughout the region, but largely from North Carolina and Virginia. In the spring and fall, when bluefish (*Pomatomus saltatrix*), spotted sea trout (*Cynoscion nebulosus*), red drum, and other species are present in offshore waters, surf fishermen line the beaches to cast their baits and lures over the incoming breakers and into the schooling fish. Most of the beach and sound is open to fishing as are the fishing piers in the villages of Rodanthe, Frisco and Avon. NPS boat ramps are located at the Oregon Inlet Marina and near the ferry office in Ocracoke village. Charters and head-boat services (boats that carry a large number of anglers that pay by the person) are available at local marinas.

Particularly productive and high demand fishing areas include Ocracoke, Hatteras and Oregon Inlets, and Cape Point, which are often accessed via ORVs. ORV counts at ramps accessing these inlets exceeded those of other beach access ramps. This use is discussed in the "Off-Road Vehicle Use and Access" section that follows below.

Typically, fishing tournaments occur in the spring and fall in locations throughout the Seashore as shown in table 15. Tournament data from 2001 to 2008 indicate that, normally, about eight to nine fishing tournaments occur annually (S. Thompson, NPS, pers. comm, 2008). While data are not available for actual attendance, the fall events are well-attended. For 2005, estimates indicate that more than 720 people participated in one event that lasted for two days. Some tournaments may only have 25 participants, depending on the availability of fish and weather. Restrictions are placed upon the events as to location and times to ensure the availability of recreational areas for other Seashore visitors. These restrictions change from time to time depending on the time of the year, seasonal visitation figures, past experience with the sponsors, and how the proposed event is structured. Typically, Seashore beaches 0.5 mile on either side of Cape Point and 0.5 mile on either side of an inlet are closed to tournament fishing.

Like other Seashore visitors, tournament participants are not allowed in any resource closure areas. Tournaments take place in the designated ORV corridor, which has presented conflict with recreational anglers during the tournaments on a few occasions (NPS 2006e, 153).

TABLE 15. FISHING TOURNAMENTS, 2004–2008

Applicant/Event	Tournament Date	People Authorized	Tournament Location within the Seashore
4 Plus Four Wheel Drive Club	Late April from 2004 to 2008	600	Ocean beaches excluding 0.5 mile either side of Cape Point, 0.5 mile from Hatteras Inlet and Ocracoke Inlet, and 0.5 mile on north side of Oregon Inlet.
Ocracoke Invitational Surf Fishing Tournament	Late April / early May from 2004 to 2008	240	Ocean beach between Ramps 68 and 72.
Outer Banks Association of Realtors	5/20/2005	150	Ocean beach from Coquina Beach to Ramp 4.
Hatteras Village Invitational	Early September from 2006 to 2008	540	Hatteras Island
Hatteras Village Civic Association	9/10/2004 9/9/2005	240	Ocean beaches on Hatteras Island open to 4x4 vehicles from Ramp 43 south and west to 0.5 mile from Hatteras Inlet, but excluding 0.5 mile either side of Cape Point.
Salt Water Grill	9/28/2008	120	Bodie Island
Nags Head Surf Tournament	Early October from 2004 to 2008	240	Ocean beach from Coquina Beach to Ramp 4.
FFFF Tournament	Early October from 2006 to 2008	120	Bodie Island
Capitol City Four Wheelers	Mid-October from 2004 to 2008	600	Ocean beaches excluding 0.5 mile either side of Cape Point, 0.5 mile from Hatteras Inlet, and all areas closed to vehicular access including ramps temporarily closed due to flooding.
Outer Banks Association of Realtors	Mid October from 2006 to 2008	240	Bodie Island
Red Drum Tournament	10/24/2007 10/22/2008	600	Parkwide
Cape Hatteras Anglers Club	11/4/2004 11/3/2005	600	Public ocean beaches excluding 0.5 mile either side of Cape Point, 0.5 mile from Hatteras Inlet and Ocracoke Inlet, and 0.5 mile on north side of Oregon Inlet. Also excluding 0.2 mile on either side of Ramps 1, 4, 23, 27, 30, 34, 43, 49, and 55, and the beaches of Pea Island National Wildlife Refuge.
Cape Hatteras Anglers Club	11/8/2007 11/6/2008	720	Hatteras Island
Outer Banks Angler	11/30/2007 12/5/2008	600	Parkwide
Surf Fishing Info.	12/2/2005	240	Ocean beaches excluding 0.5 mile either side of Cape Point, 0.5 mile from Hatteras Inlet and Ocracoke Inlet, and 0.5 mile on north side of Oregon Inlet, and other closures ordered by the Seashore.

Source: S. Thompson, NPS, pers comm.,2008

1

Off-Road Vehicle Use and Access

As noted in the "Purpose and Need" section, before 1954, local residents and visitors used the beaches for vehicular transportation purposes because there were few formal roads in this remote area. With the paving of NC-12, the completion of the Bonner Bridge connecting Bodie and Hatteras Islands, and the introduction of the State of North Carolina Ferry system to Ocracoke Island, visitor access to the islands resulted in increased vehicle use on beaches for recreational purposes. ORVs were adapted by residents to facilitate commercial netting of fish, and sport fishermen used ORVs to pursue migrating schools of game fish and to reach more productive areas such as Cape Point or the inlets, which are often a mile or more from the nearest paved surface. Presently at the Seashore, ORVs are used for commercial and recreational fishing, sightseeing, travel to and from swimming and surfing areas, and pleasure driving (NPS 2004b, 1).

ORVs access the beach via a system of ramps located off NC-12. This vehicular beach access ramp system provides controlled entry and exit to beach areas. Planks are placed on the dune crossing site to prevent the sand from moving and to prevent the dune from being further breached. The ramps began as an informal system of unimproved access points connecting the roadway to the beaches. Over time, this system was formalized and ramps are now numbered, maintained, and identified on the Seashore's ORV route maps as official vehicle routes for beach access. In the past 34 years, five of the existing 22 NPS ramps were closed to public use. Three were closed because of erosion or storm damage, and two were converted for administrative purposes. During this same period, the NPS added one additional public ramp – Ramp #2 – for a total of 18 open oceanside public access ramps in the Seashore (NPS 2004a, 2). These ramps are listed in table 16 and shown in figures 13 and 14. Each ramp number on the map refers to the approximate mile on NC-12 south of Nags Head on Bodie Island.

TABLE 16. OCEAN BEACH ACCESS

Ramp	Open to Public Use
Ramp 2 (Coquina)	Seasonal
Ramp 4	Year round
Ramp 23	Year round
Ramp 27	Year round
Ramp 30	Year round
Ramp 34	Year round
Ramp 38	Year round
Ramp 43	Year round
Ramp 44	Year round
Ramp 45	Year round

TABLE 16. OCEAN BEACH ACCESS

Ramp	Open to Public Use
Ramp 49	Year round
Ramp 55	Year round
Ramp 57 (Pole Road)	Year round
Ramp 59	Year round
Ramp 67	Seasonal
Ramp 68	Seasonal
Ramp 70	Year round
Ramp 72 (South Point Road)	Year round

Source: NPS 2004b (Off-road Vehicle Beach Access Ramp History), 2

Check with Paul Stevens
Do we consider pole Rd. a ramp? If yes
Why not Salt Pond Road?

Paul Says Both are interdunal
2/11/09

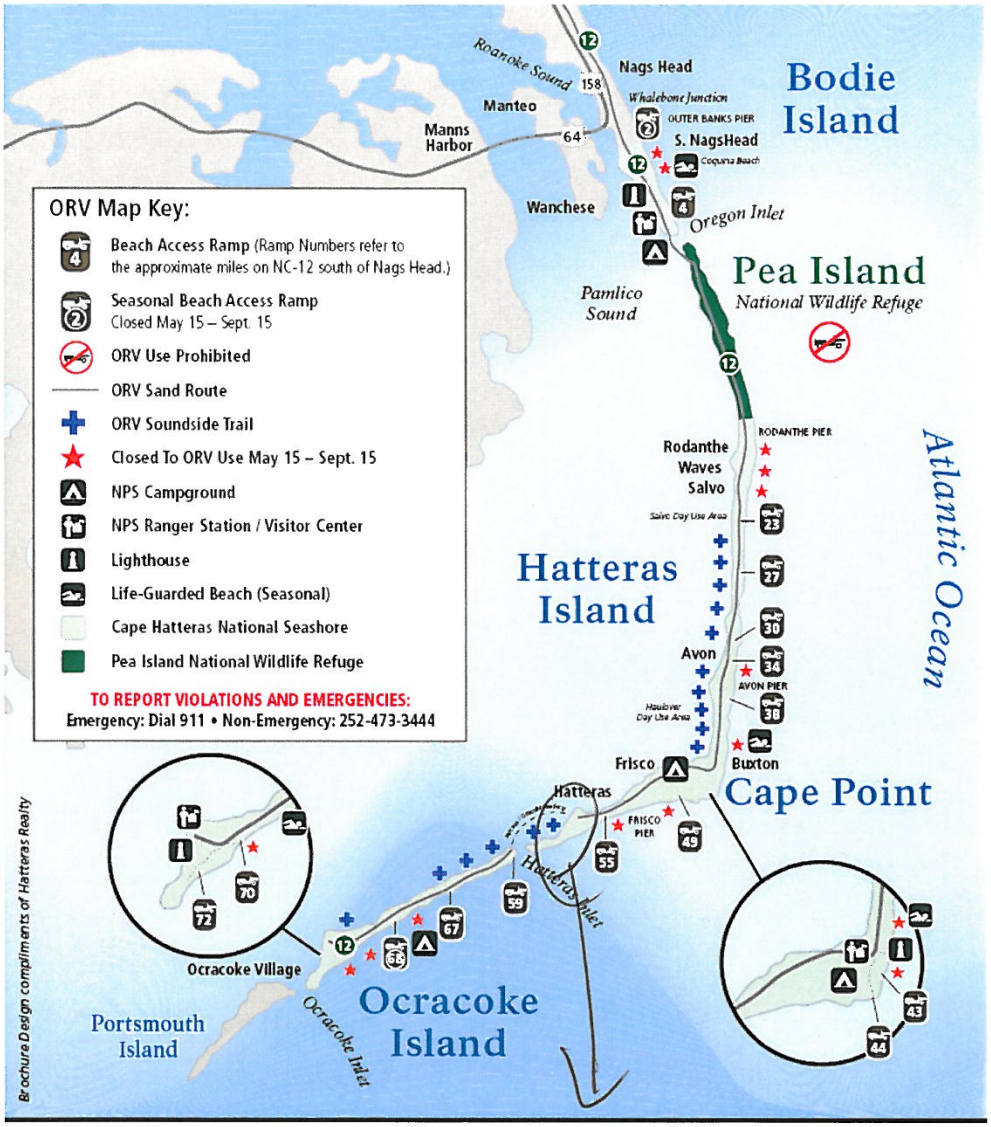
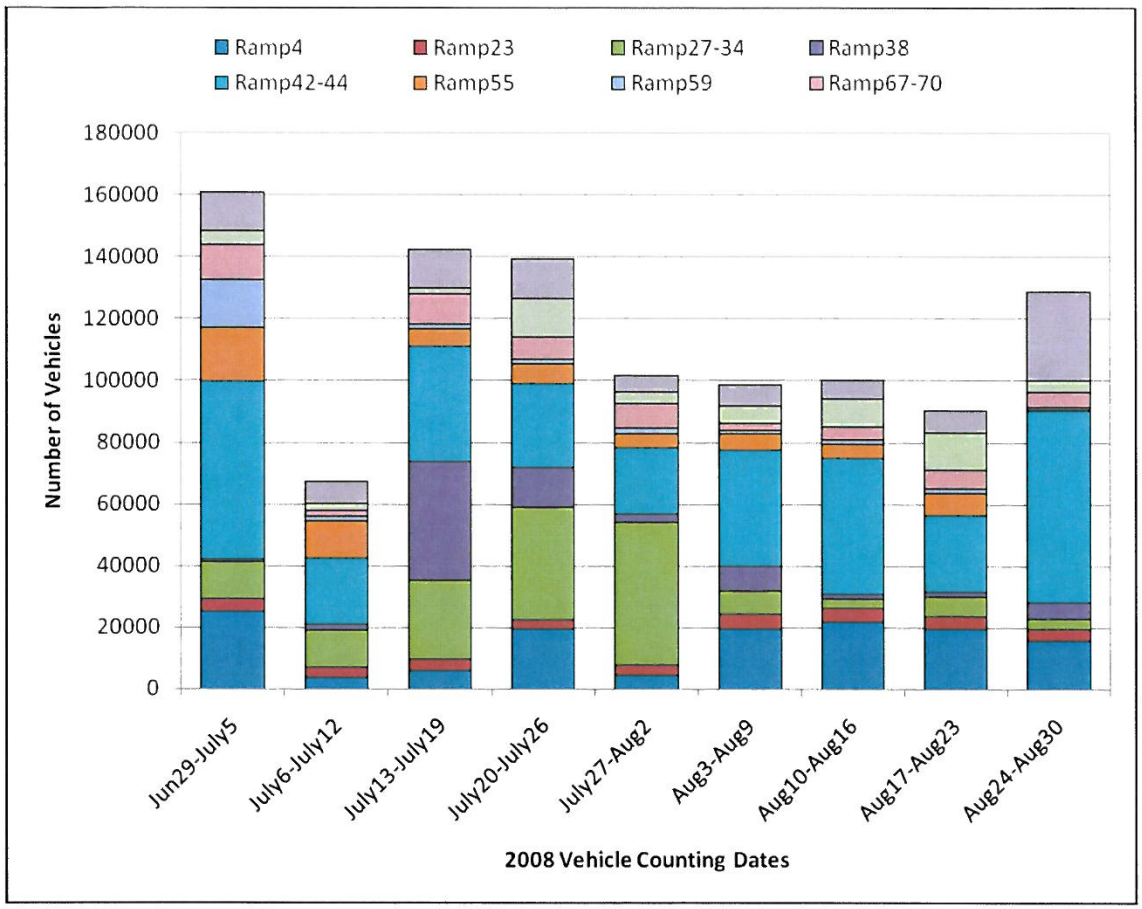


FIGURE 13: OFF-ROAD VEHICLE RAMPS AT CAPE HATTERAS NATIONAL SEASHORE

does not list "ramp 57"?
So only 17 shown;
inconsistent w/ previous
pages.



Note: chart above is from pre-test data. Data will be inserted once RTI counts are completed.

FIGURE 14. OFF-ROAD VEHICLE USE

Closures. A number of areas throughout the Seashore are closed to ORV travel permanently, either due to safety issues or for resource protection purposes. Temporary closures to ORVs also occur along the beaches to protect sea turtles and bird species such as piping plovers, American oystercatchers, and colonial waterbirds. Of the 70 miles of Atlantic Ocean, beaches, and inlets that front Bodie, Hatteras, and Ocracoke Islands, the Seashore encompasses approximately 53 miles of shoreline and inlet, and 50 miles of soundside habitats and beaches. The 13 miles of beach that comprise Pea Island National Wildlife Refuge are within the Seashore boundary and are managed separately and under a different regulatory framework by the USFWS; ORVs are not permitted on Pea Island.

Currently, all the Seashore beaches are open to ORV use during the winter, except a section near the Cape Hatteras Lighthouse, which is closed year round. Some beaches are also closed to ORV use if they

become too narrow. About half (approximately 26 miles) of the beaches are open to ORV use during the summer months. On the soundside, 17 access points are available to ORVs. However, only approximately four miles of soundside areas are open for ORV use because the Seashore prohibits ORV use on vegetated areas, and most of the soundside areas have vegetation. Closures vary from year to year depending on a range of management considerations.

Following Hurricane Isabel, ORV use areas were put in place in March 2004 to protect sensitive habitat that opened up as a result of dune destruction and to provide for more consistent management of breeding and nesting bird closures. These closures did not decrease the sum total of shoreline miles open to ORV access and public recreation nor did it impact the number of ramps open to allow ORV access to Seashore beaches. White posts were placed 150 feet landward from the average, normal high tide line, or if existing, at the vegetation or remnant dune line. Beach areas landward of the post line, although not open to ORV use, are open to pedestrian use (NPS 2004b, 1).

Temporary wildlife closures take place throughout the Seashore, including within areas of ORV and pedestrian use, to comply with protection measures afforded protected nesting sea turtles and shorebirds, particularly the piping plover. These closures are implemented at crucial periods during the life of these species. During these closures, the NPS routes ORV beach traffic around the temporary wildlife closure when possible. ~~Some of these temporary closures necessitate short-term rerouting of traffic around the landward side of the closure area, to provide continued beach access for ORVs.~~ Temporary wildlife closures are closed to both ORV and pedestrian use.

Bird Closures. The open sand flats near the three inlets in the Seashore (Oregon, Hatteras, and Ocracoke) are used by protected bird species and are also favorite fishing areas that visitors access in ORVs. Piping plover ~~and~~ American oystercatcher breeding activity has been documented on and near the ocean beach in all of these locations.

In 2005, a 0.1-mile "pass-through only" section of the ORV corridor was enforced at Bodie Island Spit, to reduce disturbance to plovers foraging at ephemeral pools close to the original corridor boundary. Pedestrians were not allowed in the pass-through zone. At Cape Point, a resource closure was created around a complex of ephemeral pools to protect an oystercatcher brood (the closure extended to approximately 50 feet from the edge of the pools). This closure was later used by a plover brood that hatched to the west. Cape Point was closed to ORVs after the plover brood moved to the ephemeral pool area. At South Ocracoke, the ORV corridor was narrowed in one place to protect a section of ocean intertidal zone where a pair of adult plovers was observed foraging on several occasions. ORVs were

permitted to drive past the protected area in the backshore but were restricted from the shore of the sound (Cohen 2005a, 11).

In 2005, at Hatteras Spit, ORV traffic was ~~only~~ permitted temporarily in the ORV corridor once per hour in convoys escorted by bird observers to reduce the risk of mortality to an oystercatcher brood and to reduce disturbance to an incubating plover nest. ORVs were permitted to park at the tip of the spit, west of the escort corridor. "Gatekeepers" were posted at each end of the escort route to assure that no unescorted ORVs entered the restricted area (NPS 2005b, 2). The spit was closed to recreation at night. Once the plover eggs hatched, Hatteras Spit was closed to ORV traffic until the chicks fledged. The ORV escort program operated in the Hatteras Spit area south of the Pole Road from 7 a.m. until 8 p.m. daily beginning on May 21, 2005 and ending on June 16, 2005 (27 days) (NPS 2006e, 159). Pedestrian access through the escort area was also prohibited.

In 2005, temporary closures also occurred at multiple other beach locations to protect piping plovers, American oystercatchers, terns, and colonial waterbirds from ORV and pedestrian use. These closures occurred on all three islands but were most concentrated on Hatteras Island followed by Ocracoke.

In February 2008, Defenders of Wildlife and the National Audubon Society filed a lawsuit against the NPS alleging inadequacies in management of protected species at the Seashore and failure of the Seashore to comply with the requirements of the ORV executive order and NPS regulations regarding ORV use. However, a consent decree was filed on April 16, 2008 in U.S. District Court (signed on April 30, 2008), whereby the parties involved in the lawsuit agreed to a settlement of the case. The most immediate effect of the Consent Decree was that it established a prohibition on night driving on beaches between the hours of 10 p.m. and 6 a.m. from May 1 through November 15. The consent decree also resulted in buffers being established during portions of the spring and summer around bird breeding and nesting areas; this included creating a 1000 meter (3,280 feet) vehicle perimeter and a 300 meter (984 feet) pedestrian perimeter around piping plover chicks until they have fledged. From May 15 through August 21, 2008, there was an average of 10 miles of oceanfront beach at the Seashore closed to both pedestrians and ORVs. The largest amount of beach closures was reported on May 29, 2008 when 12.8 miles of beach were closed to all users to protect birds exhibiting breeding, nesting, and/or foraging behavior. (Insert photo of typical closures for birds and turtles)

Sea Turtle Closures. Temporary closures to ORVs and pedestrians are implemented during nesting and hatching activities for all three sea turtle species that are known to nest at the Seashore. In May 2008, approximately 10.6 miles of the 66.4 miles at the Seashore were under a resource closure. Generally, ORVs and pedestrians can negotiate around these posted closures. However, when the turtle eggs are

* Add paragraph on the Interim Strategy — issued in Jan 2006, analyzed in July 2007 EA, implemented in 2006 & 2007 w/ nesting closures, buffers, temp. closures, etc.

ready to hatch, the NPS implements a beach closure with fencing from the nest to the water's edge. If sufficient room exists, ORVs and pedestrians can go around the landward side of the fence. In some cases, a full beach closure must be implemented because of the location of a nest relative to a dune or vegetation preventing ORV and pedestrian access through the area. Of the 39 temporary closures, full beach closures were required at 20 locations (NPS 2005d, 3). As mentioned previously, the Consent Decree signed in April 2008 included a prohibition on night driving to protect nesting sea turtles. The Consent Decree also contains provisions for full beach closures in the fall to allow for existing turtle nests to safely hatch.

This sentence needs context (your circumstances) doesn't mean anything as written.

Safety Closures. Areas normally open to ORVs ~~often~~ may close for reasons of safety. Adverse weather conditions can result in narrow beach areas or flooded conditions, among other hazards, necessitating closures to vehicles. In November 2005, safety closures included 1.6 miles on Bodie Island, 27.7 miles on Hatteras Island, and 6.5 miles on Ocracoke Island. However, from May 15 through August 21, 2008, safety closures included a total of 11.1 miles of beach consistently throughout the season. Beaches that are often open to ORV use in the winter are also closed in the summer to protect visitors during the busy summer season in areas such as Hatteras Island villages of Rodanthe, Waves, Salvo, Avon, Frisco, and Hatteras (NPS 2004, 1).

Sounds really high. Is it correct?

CROWDING AND VISITOR ENCOUNTERS

A University of Idaho study indicated that one of the reasons people visited the Seashore was to escape crowds and seek solitude. When asked about crowding, 27% of visitors said they felt "crowded" to "extremely crowded," while 43% of visitors felt "somewhat crowded." Thirty percent of visitors surveyed indicated that they felt "not at all crowded". Many visitor groups (49%) reported that crowding "detracted from" their park experience (University of Idaho 2003, 46).

VISITOR SATISFACTION

To assist the National Park Service in complying with the Government Performance and Results Act (GPRA), a visitor survey was conducted by the University of Idaho Park Studies Unit for the units of the National Park System in FY08. The survey was developed to measure each park unit's performance related to NPS GPRA Goals IIa1 (visitor satisfaction) and IIb1 (visitor understanding and appreciation). Survey cards were distributed at the Seashore to a random sample of visitors from July 1 to July 31, 2008. The report included three categories of data: park facilities (which included visitor centers, exhibits, restrooms, walkways/trails/roads, and campgrounds/picnic areas), visitor services (assistance from park employees, park maps/brochures, ranger programs, and commercial services), and recreational

opportunities (nature/history/cultural learning and outdoor recreation). Overall, the percentage of park visitors satisfied with the facilities, services, and recreational opportunities was 95%. Individually, 93% of visitors were satisfied with park facilities, 85% of visitors were satisfied with visitor services, and 89% were satisfied with recreational opportunities (University of Idaho 2008).

Night Skies

The NPS defines a natural lightscape as "a place or environment characterized by the natural rhythm of the sun and moon cycles, clean air, and of dark nights unperturbed by artificial light. Natural lightscapes, including dark night skies, are not only a resource unto themselves, but are an integral component of countless park experiences." (NPS 2007b, 1) The NPS created the Night Sky Team in 1999 to address increasing alarm over the loss of night sky quality throughout the network of national parks. The Night Sky Team functions as a center of expertise that provides advice, guidance, and technical support in characterizing and preserving park lightscapes (NPS 2007b, 1). According to the Night Sky Team, the Seashore is one of only a handful of sites in the eastern U.S. with a nearly natural regimen of light and dark, where light patterns are made up primarily of the dark sky, moon, and stars (NPS 2008e, 1).

In November 2007, the NPS Night Sky Team visited the Seashore to record preliminary measurements of night sky quality from three sites: the Bodie Island Maintenance Facility (Bodie Island); Boardwalk 27 (Hatteras Island); and the Boardwalk south of Frisco (Hatteras Island) (NPS 2008e, 2). During this visit, the team concluded that the Seashore has better night sky quality as compared to most other NPS units east of the Mississippi River. Furthermore, measurements showed that light pollution sources beyond the Seashore boundary illustrated the need to be aware of the easily impacted night skies (NPS 2008e, 1).

Measurements of the night sky at the Seashore were taken with a CCD camera (a scientific grade digital camera) that captures the known magnitude (a measure of stellar brightness) of known stars as an index to determine the ambient brightness of the nighttime sky. These measurements are influenced by atmospheric conditions, which affect how light travels through the sky. To account for these changes, multiple measurements are taken over a period of time. The initial measurements at the Seashore occurred over two nights, with more planned in the future (NPS 2008e, 2).

Results from the November 2007 measurements found that sky brightness ranged from approaching a natural level of darkness to significantly light polluted, with the potential to threaten the ecological health of the coastal environment in some areas (NPS 2008e, 3). To address those areas where there are high levels of light pollution, the Night Sky Team recommended retrofitting or swapping existing light fixtures in favor of turtle friendly and night sky friendly fixtures, as well as working with park neighbors to enact night sky measures such as lighting ordinances (NPS 2008e, 4).

SOCIOECONOMIC RESOURCES

This section describes the social and economic environment that potentially would be affected by the proposed alternatives. The social and economic environment of a region is characterized by its demographic composition, the structure and size of its economy, and the types and levels of public services available to its citizens.

The socioeconomic environment evaluated for this EIS encompasses the Outer Banks portion of two counties in North Carolina – Dare and Hyde. Hatteras and Bodie Islands are part of Dare County while Ocracoke Island is within Hyde County. This area contains thirteen zip codes, eighteen of the nineteen block groups in Dare County, and one of the four block groups in Hyde County. (Sidebar: definition of block groups)

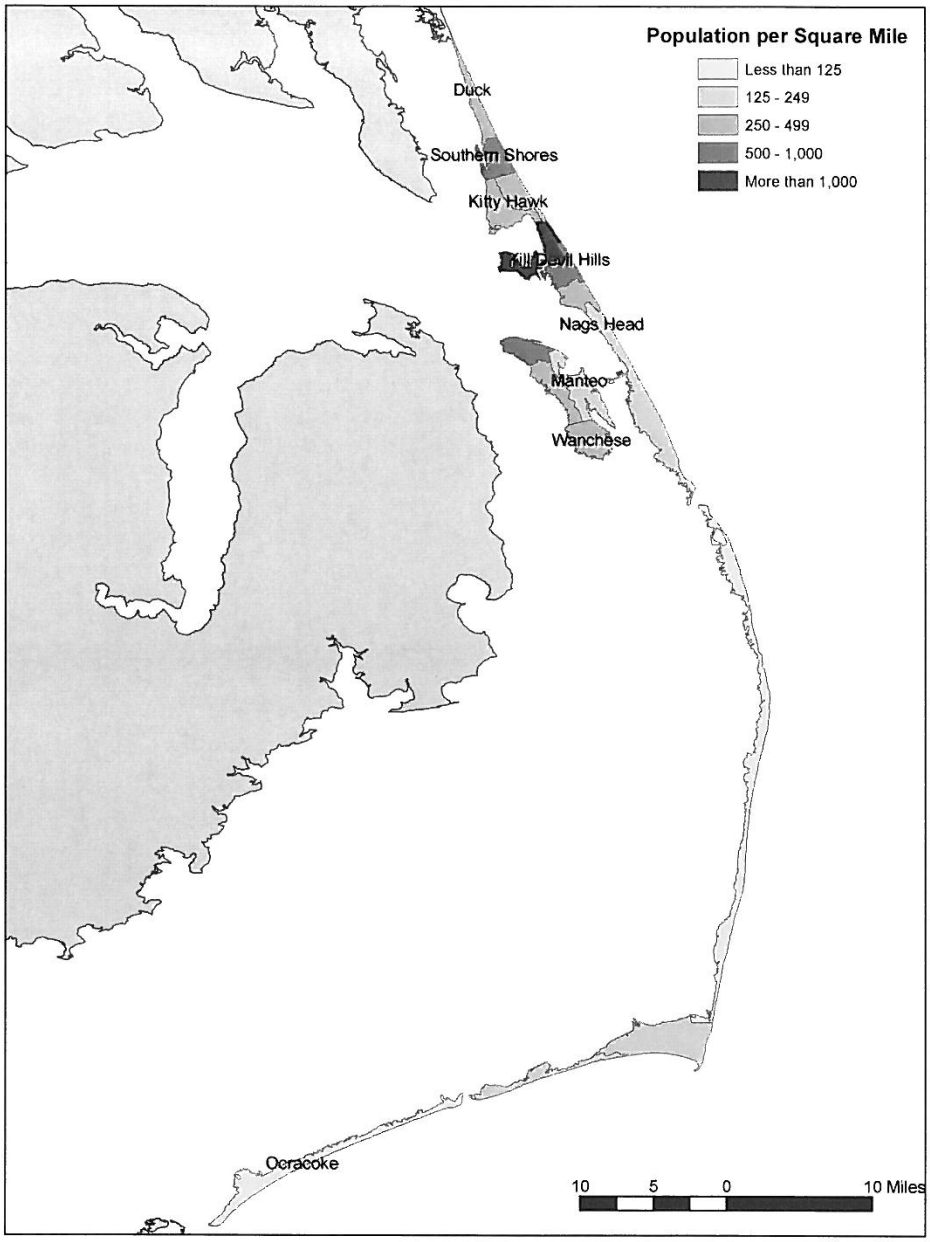
The Outer Banks portion of Dare and Hyde counties forms the economic region of influence (ROI) and defines the geographic area in which the predominant social and economic impacts from the proposed alternatives are likely to take place. Located within this area are towns and villages that would be most affected by the proposed actions, including several villages on Hatteras Islands and ~~Ocracoke~~ (Ocracoke, Hatteras, Frisco, Avon, Buxton, Salvo, Waves, and Rodanthe). The largest towns within the ROI include Nags Head, Kill Devil Hills, and Kitty Hawk. Data not available at the block group or zip code level will be reported at the county level.

Note that data presented are often taken from the U.S. Census Bureau. The census places people according to "usual residence" guidelines, so people are counted where they live most of the year.

DEMOGRAPHICS

The economic ROI is primarily rural in character, although portions of Dare County, especially in the north, are developed with large tracts of vacation homes and small businesses that support the area's robust tourism industry. Much of Dare County's permanent population also resides in this area, the most densely populated portion of the ROI (figure 15).

(add) The ROI includes ... (what townsite).



Source: Environmental Systems Research Institute, Inc. 2002. "2000 Census Block Groups: NC." [CD-ROM]. ESRI Data & Maps 2002.

FIGURE 15. 2000 POPULATION DENSITY BY BLOCK GROUP

In recent years, population trends have differed substantially for Dare and Hyde Counties. Table 17 provides population statistics for the state of North Carolina, Dare and Hyde Counties and the Dare and

Hyde County block groups located on the Outer Banks. Between 2000 and 2007, Dare County's population grew 13%, from 29,967 to 38,348. This is approximately the same percentage change in population as the state of North Carolina as a whole. As a result, the portion of the state population occupying Dare County remained 0.4%. However, during this same time period, the population of Hyde County decreased by 11%, from 5,826 to 5,172 (U.S. Census Bureau 2008c, 1). This represents a population reduction that lowered the portion of the state population occupying Hyde County from 0.07% to 0.06%. The Dare County block groups within the ROI account for 96% of the county's population, while Hyde County block group represents only 13% of the county's population (U.S. Census Bureau 2000a, 1).

TABLE 17. POPULATION STATISTICS

Geographic Area	2000[1]	2007[2]	2015[3]	2029[3]	Percent Change, 2000–2007	Percent Change, 2000–2029
North Carolina	8,049,313	9,061,032	10,263,686	10,855,905	13%	35%
Dare County	29,967	33,776	38,348	40,668	13%	36%
Dare County BGs[4]	28,798	—	—	—	—	—
Hyde County	5,826	5,172	5,033	4,833	-11%	-17%
Hyde County BG[5]	730	—	—	—	—	—

Sources:

[1]U.S. Census Bureau 2000a; generated by RTI International; using American FactFinder; "Census 2000 Summary File 3 (SF3) – Sample Data" <http://factfinder.census.gov>; (December 5, 2008).

[2]Population Division, U.S. Census Bureau 2008c. "Annual Estimates of the Population for Counties of North Carolina: April 1, 2000 to July 1, 2007 (CO-EST2007-01-37)." Release Date: March 20, 2008. <http://www.census.gov/popest/estimates.php>.

[3]Office of State Budget and Management, North Carolina 2008. "Projected Annual County Population Totals."<http://www.osbm.state.nc.us/ncosbm/facts_and_figures/socioeconomic_data/population_estimates.shtm >; (December 4, 2008).

[4]The 18 BGs in Dare County located on the Outer Banks.

[5]The one BG in Hyde County located on the Outer Banks.

According to population projections published by the North Carolina Office of State Budget and Management's State Demographics unit, these population trends are expected to continue into the foreseeable future. By 2029, population in Dare County is expected to increase to 40,668, a 36% increase over population in 2000. On the other hand, the population of Hyde County is expected to fall further to 4,833. This amounts to a 17% decrease when compared to population in 2000 (Office of State Budget and Management North Carolina 2008, 1).

Demographic and economic trends during the last three decades have contributed to growing differences in the population characteristics and income levels in the different areas of the ROI. The rate of change is

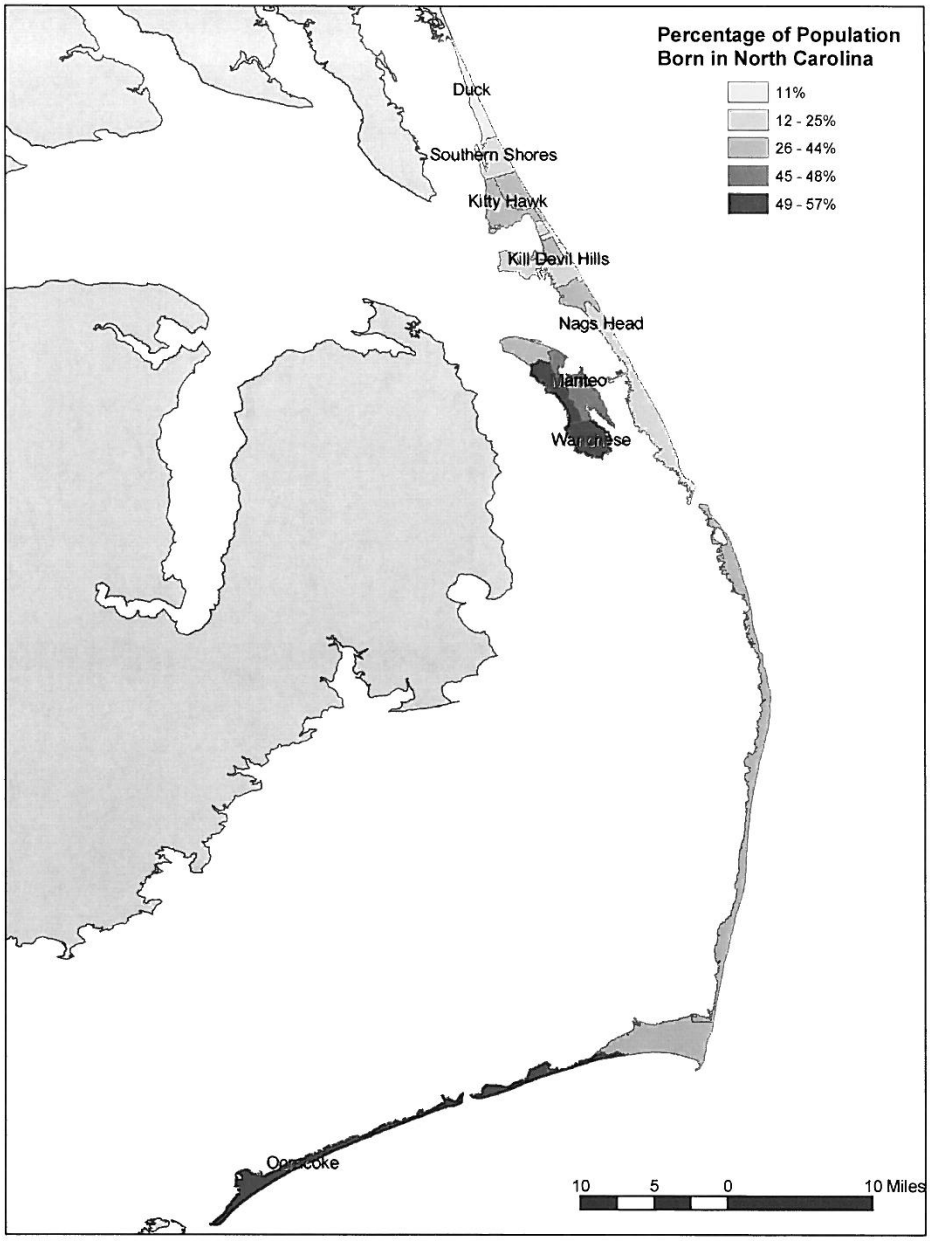
especially rapid in northern Dare County, as indicated by the percentage of residents born in North Carolina, shown in figure 16.

In 1999, the areas within the ROI had a 13% greater per capita income than North Carolina, and 6% greater than the country as a whole (table 18). This distribution varies across the ROI. Ocracoke, southern Dare County, and portions of Roanoke Island all had a lower per capita income than the more densely populated block groups in the northern part of the ROI (figure 17).

TABLE 18. EMPLOYMENT BY SECTOR, 2000

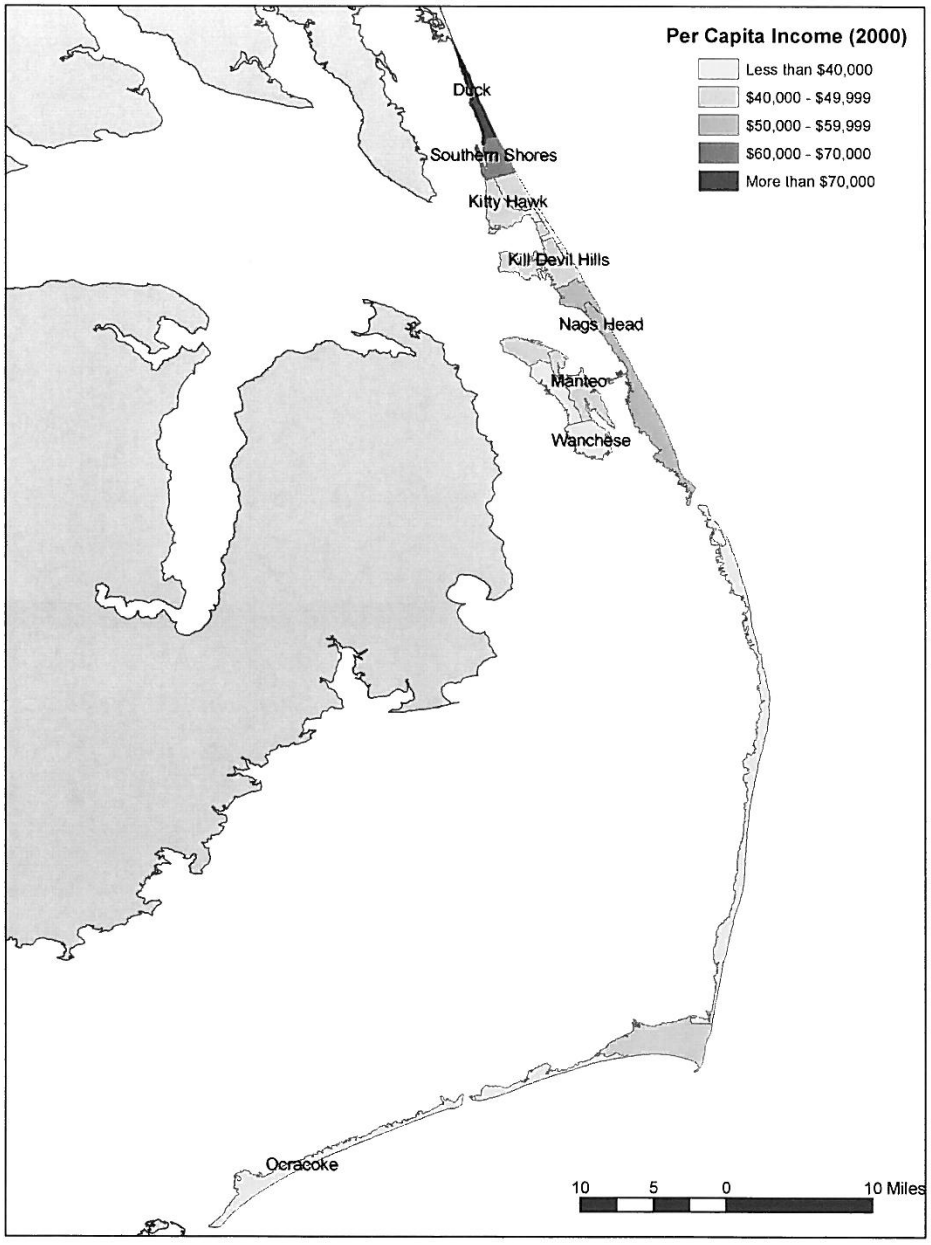
	Number of Employees	Percentage			Difference	
Industry	ROI	ROI	NC	US	ROI-NC	ROI-US
Construction	2,102	14%	8%	7%	5%	7%
Accommodation and food services	1,857	12%	6%	6%	6%	6%
Real estate, rental and leasing	1,078	7%	2%	2%	5%	5%
Retail trade	2,296	15%	12%	12%	3%	3%
Agriculture; forestry; fishing and hunting	491	3%	1%	1%	2%	2%
Public administration	992	6%	4%	5%	2%	2%
Arts; entertainment; and recreation	453	3%	1%	2%	2%	1%
Utilities	162	1%	1%	1%	0%	0%
Management of companies and enterprises	0	0%	0%	0%	0%	0%
Other services (except public administration)	714	5%	5%	5%	0%	0%
Mining	4	0%	0%	0%	0%	0%
Administrative and support and waste management services	432	3%	3%	3%	0%	-1%
Information	379	2%	2%	3%	0%	-1%
Wholesale trade	414	3%	3%	4%	-1%	-1%
Professional; scientific; and technical services	688	4%	5%	6%	0%	-1%
Transportation and warehousing	365	2%	4%	4%	-1%	-2%
Educational services	986	6%	8%	9%	-2%	-2%
Finance and insurance	365	2%	4%	5%	-2%	-3%
Health care and social assistance	890	6%	11%	11%	-5%	-5%
Manufacturing	764	5%	20%	14%	-15%	-9%

Source: U.S. Census Bureau 2000a; generated by RTI International; using American FactFinder; "Census 2000 Summary File 3 (SF3) – Sample Data" <http://factfinder.census.gov>; (December 5, 2008).



Source: U.S. Census Bureau 2000a; generated by RTI International; using American FactFinder; "Census 2000 Summary File 3 (SF3) – Sample Data" <http://factfinder.census.gov>; (December 5, 2008).

FIGURE 16. PERCENTAGE OF RESIDENTS BORN IN NORTH CAROLINA BY BLOCK GROUP, 2000



Source: U.S. Census Bureau 2000a; generated by RTI International; using American FactFinder; "Census 2000 Summary File 3 (SF3) – Sample Data" <http://factfinder.census.gov>; (December 5, 2008).

FIGURE 17. 1999 PER CAPITA INCOME BY BLOCK GROUP

In 2000, the ROI had a minority population of only 6% of the total (table 19). This is less than in North Carolina and the U.S. as a whole, which had 30% and 31% minority populations respectively. The ROI also had a lower percentage of individuals below the poverty level and a lower percentage of individuals without high school diplomas. The distribution of poverty rates by block groups is shown in figure 18.

TABLE 19. ENVIRONMENTAL JUSTICE STATISTICS, 2000

Geographic Area	Per Capita Income	Percent of Population		
		Minority	Below the Poverty Level	Without High School Diploma
United States	$41,994	31%	12%	20%
North Carolina	$39,184	30%	12%	22%
ROI	$44,462	6%	8%	11%

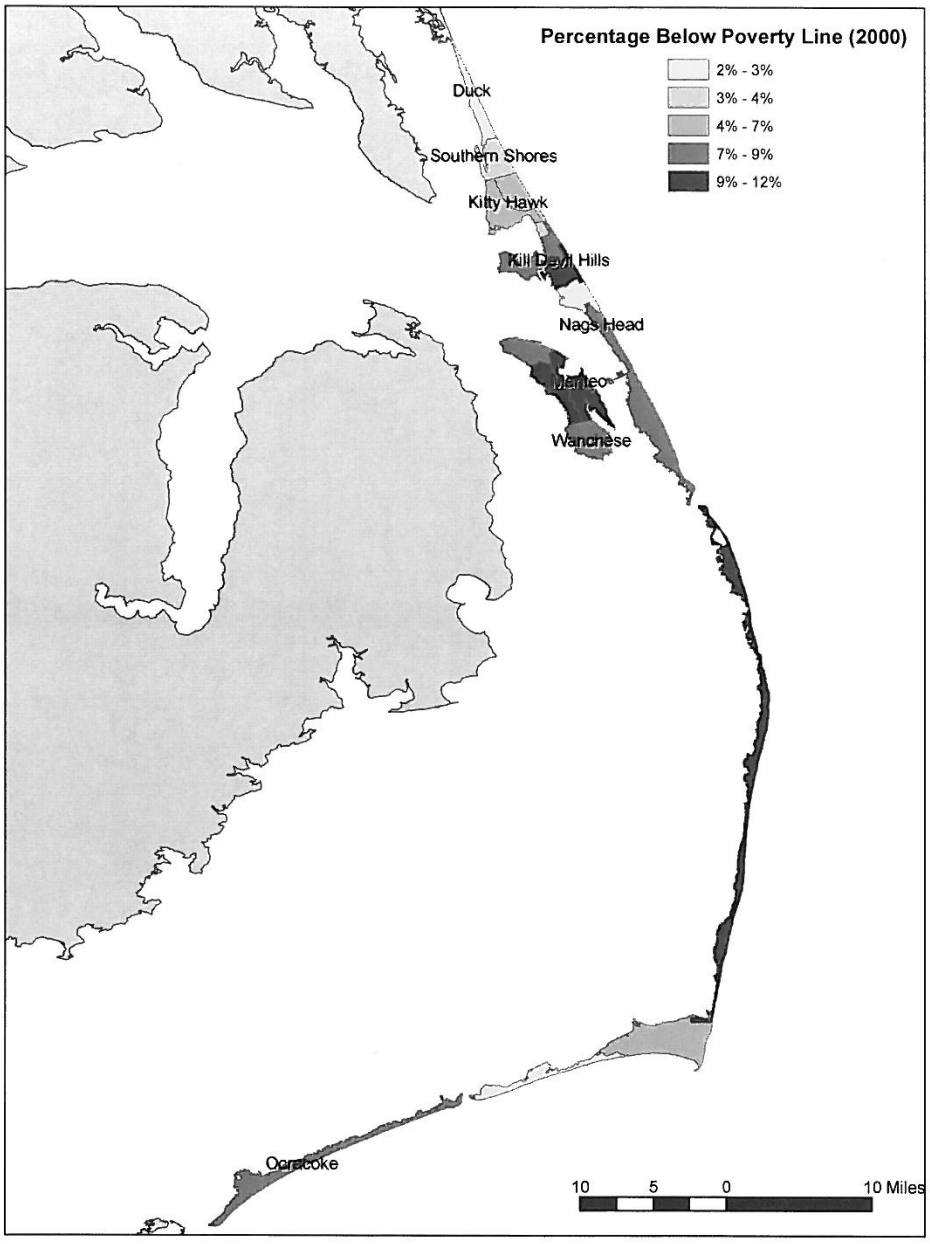
Source: U.S. Census Bureau 2000a; generated by RTI International; using American FactFinder; "Census 2000 Summary File 3 (SF3) – Sample Data" <http://factfinder.census.gov>; (December 5, 2008).

EMPLOYMENT

As noted above, with the exception of the northern portion of Dare County, the ROI is primarily rural. There are no military bases, major federal facilities, state prisons, commercial airports, or four-year colleges in the ROI.

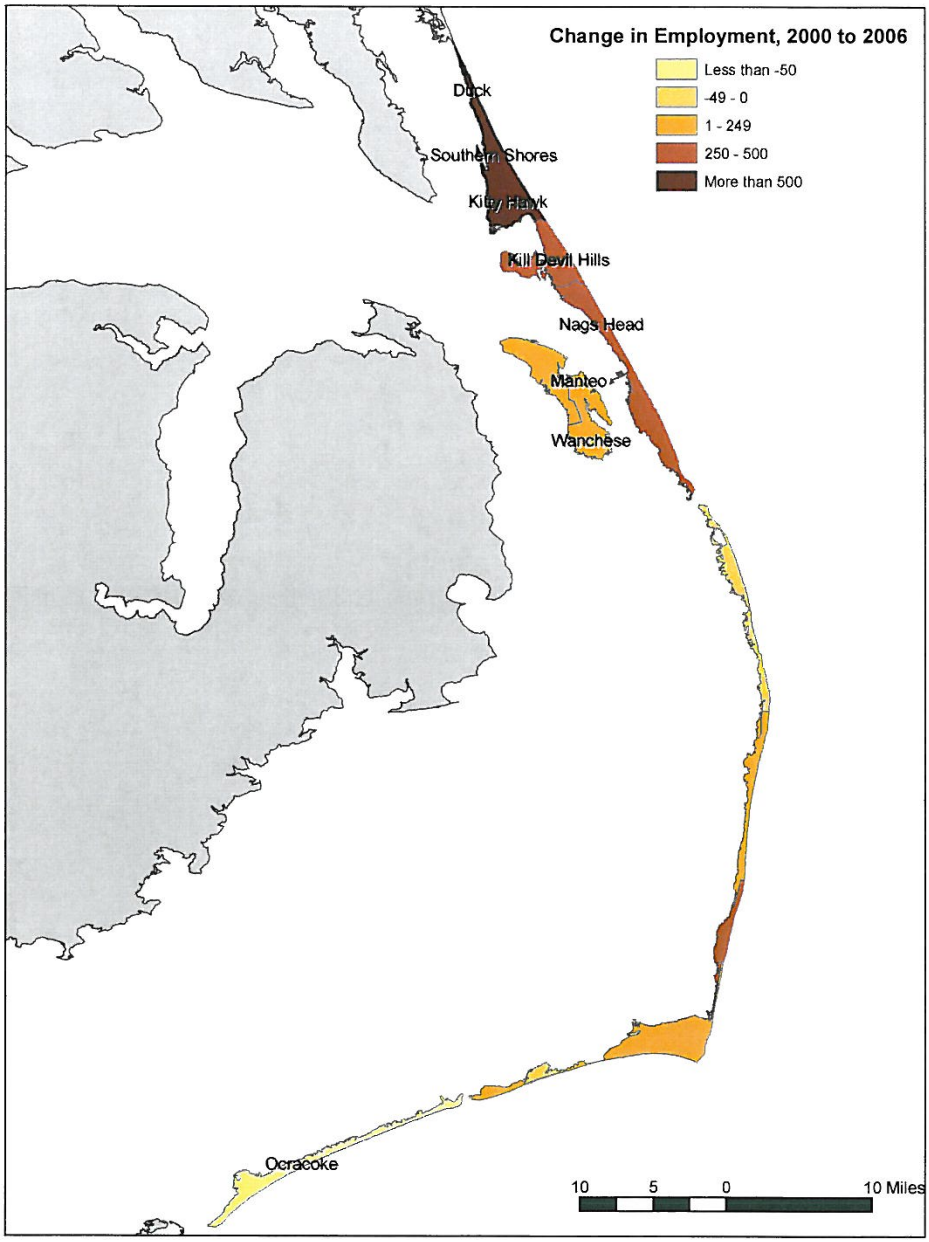
Within the ROI, much of the employment caters to tourists visiting the area. The sectors of construction; accommodation and food services; real estate, rental and leasing; and the retail trade account for 47.52% of the total employment within the ROI in 2000. These sectors only account for 26.50% of employment in the U.S. as a whole (table 18).

The majority of businesses within the ROI are located in the northern three zip codes in Dare County, encompassing the towns of Duck, Southern Shores, Kill Devil Hills and Nags Head. This area accounts for 64.4% of establishments and 70.9% of employment within the ROI and has seen robust employment growth since 2000. Other areas of the ROI have experienced smaller gains or reductions in employment (figure 19). Small businesses are especially important within the ROI, with 81.61% of establishments in the ROI operating with fewer than 10 employees (County Business Patterns 2006, 1).



Source: U.S. Census Bureau 2000a; generated by RTI International; using American FactFinder; "Census 2000 Summary File 3 (SF3) – Sample Data" <http://factfinder.census.gov>; (December 5, 2008).

FIGURE 18. PERCENTAGE OF POPULATION BELOW THE POVERTY LINE BY BLOCK GROUP, 2000



Source: U.S. Census Bureau, 2000b. "County Business Patterns: Zip Code Business Statistics." <http://www.census.gov/epcd/cbp/download/cbpdownload.html>.

FIGURE 19. CHANGE IN EMPLOYMENT BY ZIP CODE

UNEMPLOYMENT

In 2007, an average of 4.7% of the civilian labor force in Dare County was unemployed (1,102 individuals) and 5.6% in Hyde County (153 individuals) (table 20). The unemployment rates for Dare and Hyde counties were similar to the unemployment rates in NC as a whole.

TABLE 20. EMPLOYMENT CHARACTERISTICS, 2007

	North Carolina	Dare County	Hyde County
Labor Force	4,519,186	23,299	2,722
Employment	4,308,624	22,197	2,569
Unemployment	210,562	1,102	153
Unemployment Rate	4.7%	4.7%	5.6%

Source: Bureau of Labor Statistics, 2008. "Local Area Unemployment Statistics." <http://www.bls.gov/lau>; (December 5, 2008).

TOURISM CONTRIBUTIONS TO THE ECONOMY

The economy of the ROI is largely driven by the region's tourist draw, mainly during the summer months. As estimated by the North Carolina Division of Tourism, Film and Sports Development (NCDTFSD), travel expenditures in Dare County have increased faster than the state as a whole (table 21); however travel expenditures in Hyde County have decreased since 2000. In 2007, NCDTFSD estimates that tourism is responsible for 11,250 jobs in Dare County and 370 jobs in Hyde County (NCDTFSD 2008, 22).

TABLE 21. ESTIMATED DOMESTIC TRAVEL EXPENDITURES ($2007 MILLIONS)

Geographic Area	1991	2000	2007	2000 to 2007 CAGR
North Carolina	$10,682.42	$14,531.93	$16,510.75	1.8%
Dare County	$363.44	$601.06	$762.65	3.5%
Hyde County	$17.26	$28.49	$27.29	-0.6%

Source: North Carolina Division of Tourism, Film and Sports Development, 2008. "The Economic Impact of Travel on North Carolina Counties: 2007." Prepared by the Travel Industry Association, 2008. <http://www.nccommerce.com/NR/rdonlyres/98367200-6534-495C-AEEC-0449FCBA8E39/2597/2007EconomicImpactReport_TIA.pdf>.

Housing

In 2000, the ROI had a total of 26,891 housing units, with 97% of these located in the Dare County block groups. The ROI's housing is roughly 54% urban and 46% rural, with 100% of the urban housing units being located in Dare County block groups. Over 50% of the housing units in the ROI are for seasonal, recreational, or occasional use (table 22). The distribution of vacant housing units for seasonal, recreational, or occasional use is shown in figure 20. This is further evidence of the importance of tourism's contributions to the region's economy.

Since 2000, Dare County has experienced a 21% increase in the number of housing units, relative to a 14% change state wide (table 23). However, in October of 2008, Dare County had the fifth highest foreclosure rate of any county in NC, with one in every 679 housing units in foreclosure (RealtyTrac.com 2008, 1).

TABLE 22. HOUSING UNIT STATISTICS, 2000

	United States	North Carolina	ROI
Total	115,904,641	3,523,944	26,891
Urban	89,966,555	2,080,729	14,578
% of Total	78%	59%	54%
Occupied	105,480,101	3,132,013	12,588
Vacant	10,424,540	391,931	14,303
For seasonal, recreational, or occasional use	3,872,468	147,087	13,771
% of Total	3%	4%	51%

Source: U.S. Census Bureau, 2000a; generated by RTI International; using American FactFinder; "Census 2000 Summary File 3 (SF3) – Sample Data" <http://factfinder.census.gov>; (December 5, 2008).

TABLE 23. CHANGE IN HOUSING UNITS

Geographic Area	2000	2007	Percent Change 2000–2007
United States	115,904,641	127,901,934	10%
North Carolina	3,523,944	4,033,468	14%
Dare County	26,671	32,358	21%
Hyde County	3,302	3,478	5%

Sources: Population Division, U.S. Census Bureau, 2008a. "Annual Estimates of Housing Units for the United States and States: April 1, 200 to July 1, 2007 (HU-EST2007-01)." Release Date: August 21, 2008. <http://www.census.gov/popest/estimates.php>.

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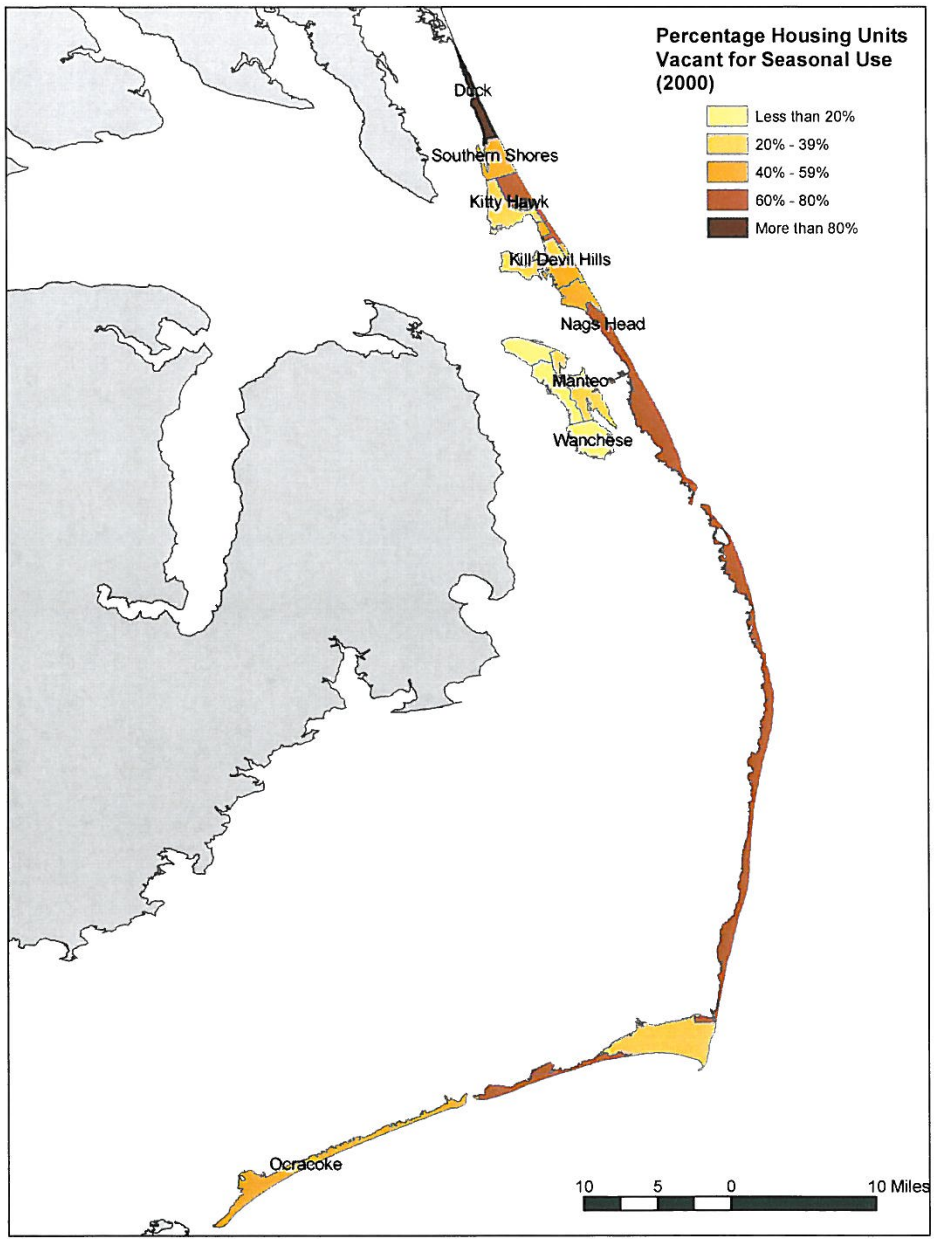

Source: U.S. Census Bureau, 2000a; generated by RTI International; using American FactFinder; "Census 2000 Summary File 3 (SF3) – Sample Data" <http://factfinder.census.gov>; (December 5, 2008).

FIGURE 20. PERCENTAGE OF HOUSING UNITS VACANT FOR SEASONAL, RECREATIONAL, OR OCCASIONAL USE BY BLOCK GROUP, 2000

Quality of Life

Quality of life encompasses those attributes of resources (man-made or naturally occurring) of a region that contribute to the well-being of its residents. The relative importance of these attributes to a person's well-being is subjective (e.g., some individuals consider outdoor recreational opportunities essential to their well-being, others require access to cultural institutions essential to their quality of life, and still others may hold public safety as their primary quality of life concern). Quality of life analyses typically address issues relating to potential impacts of the proposed action on the availability of public services and leisure activities that contribute to the quality of life of an affected ROI's inhabitants. For purposes of this study, the quality of life affected environment includes the natural environment, public schools, law enforcement, medical facilities, and fire protection services.

The natural environment, including beaches and wildlife, provide the primary basis for quality of life on the Outer Banks. As discussed above, beach-related tourism drives the economy of the area. Local residents also receive significant recreational benefits from the areas natural assets. In addition to the Seashore, the ROI includes Jockey's Ridge State Park, and Pea Island National Wildlife Refuge (Outer Banks Chamber of Commerce 2008, 1). There are also public and private beaches, marinas, piers and other recreational outlets.

Within the ROI, there are twelve public schools serving a student population of 4,952 over the 2006–2007 school year (NC School Report Cards 2008). The ROI is served by two county sheriff departments and three town police departments. Within the ROI, there are four fire departments and six volunteer fire departments (Capitol Impact 2008, 1).

Doesn't sound correct, what exactly is the ROI? (Southern shores, Kitty Hawk, KDH, Nags Head Manteo all have PDs)

The Outer Banks Hospital in the town of Nags Head is the only 24-hour emergency hospital in the ROI and was built in 2002. The hospital employs four year-round physicians and, in 2004, hired an additional three physicians during the busier summer months. The hospital's service area includes the entire Outer Banks region (Outer Banks Chamber of Commerce 2005, 1).

SEASHORE MANAGEMENT AND OPERATIONS

Note: Data gaps for LE, Maintenance, and Interpretation, waiting on data from the Seashore.

Seashore management and operations activities related to ORV management fall within the various operational divisions of the Seashore that include: Resource Management, Law Enforcement, Interpretation, and Maintenance. The baseline for park operations and management will be discussed both in term of pre-Consent Decree (pre-2008) and post Consent Decree (2008).

use GAO audit information

Resource Management: Resource management efforts at the Seashore required approximately 10.5 FTE under the interim protected species management plan. This number increased to 13.5 in 2008 with the implementation of measures under the consent decree. Email sent to Thayer B. 12/23/08 for more information.

Law Enforcement

Interpretation

Maintenance

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