AFFECTED ENVIRONMENT

This chapter of the environmental assessment describes existing environmental conditions in the areas potentially affected by the alternatives. This section will describe the following resource areas: federally listed and special status wildlife and plant species, state listed and special status wildlife and plant species, wildlife and wildlife habitats, visitor use and experience, socioeconomics, and seashore management and operations. Potential impacts are discussed in the "Environmental Consequences" section following the same order. For analyses purposes, the affected environment represents the environment existing in 2004.

FEDERALLY LISTED SPECIAL STATUS WILDLIFE AND PLANT SPECIES

PIPING PLOVER

The piping plover (*Charadrius melodus*) 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 and Elliot-Smith 2004). Two genetic races (Haig and Elliot-Smith 2004) 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 the Gulf Coast, from Florida to Mexico, and the Caribbean, with the greatest number of wintering birds to be found in Texas (Haig and Elliot-Smith 2004).

Piping plover (*Charadrius melodus*)

(Johnathan Cohen, Virginia Tech University)

Fewer than 3,000 breeding pairs of piping plovers were detected in the U.S. and Canada in 2001 (Haig and Elliot-Smith 2004). 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).

Habitat loss, caused by human development and recreation, and low reproductive rates, caused by human disturbance and predation, were considered to be the primary causes of the decline (Haig 1992; Haig and Elliot-Smith 2004). Disturbance and predation were intensively managed after the listing, and the population rose to 1,676 pairs by 2003 (USFWS 2004), but was still short of the recovery goal of 2,000 pairs (USFWS 1996a).

The population south of New Jersey is less densely populated than the north and was estimated at 203 pairs in 2003, well short of the regional goal for the southern Atlantic Coast of 400 pairs (see table 10). North Carolina experienced more than a 50% decline in breeding pairs from 1989 to 2003 (see table 10; USFWS 2004b) for reasons discussed in the Risk Factors section below.

Piping Plover in North Carolina

North Carolina is presently the only state on the Atlantic Coast that has piping plovers during all phases of the annual cycle (Cohen 2005a), the stages of which include the establishment and holding of territories, courtship and copulation, nest scraping and nest building, egg laying, incubation, and chick

rearing and fledging. The first published account of breeding piping plovers in North Carolina is from 1960, when a pair was found on Ocracoke Island (Golder 1985). At Cape Hatteras National Seashore, four nests and one brood were observed in 1984, and five chicks were confirmed fledged that year (Golder 1985). Nine pairs were counted in 1986 (Golder 1986), and 10 pairs in 1987 (Cooper 1990). The piping-plover population reached a high of 15 pairs in 1989, and subsequently varied between 11 and 14 pairs through 1996, after which a sharp decline began. The population reached a low of 2 breeding pairs in 2002 and 2003, with only three breeding pairs reported in 2004 (Lyons 2001; Lyons 2002a; Lyons 2003; Lyons 2004), and two in 2005 (Cohen 2005a).

TABLE 10: SOUTHERN REGION (INCLUDING NORTH CAROLINA) PIPING PLOVER POPULATION TRENDS

	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	1	201
1991	5	17	131	40	1	194
1992	2	24	97	49	-	172
1993	2	19	106	53	1	181
1994	4	32	96	54	-	186
1995	5	44	118	50	-	217
1996	6	61	87	35	0	189
1997	4	60	88	52		204
1998	6	56	95	46		203
1999	4	58	89	31		182
2000	3	60	96	24	0	183
2001	6	60	119	23		208
2002	6	60	120	23		209
2003	6	59	114	24		203
2004a	7	66	152	20		245
					GOAL	**400**

Source: http://www.fws.gov/northeast/pipingplover/index.html

Source: [a] http://www.fws.gov/northeast/pipingplover/status/preliminary.04.pdf

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

Habitat Description

On the Atlantic Coast, piping plovers nest in sand, gravel, or cobble substrates in backshore, dune, interdune blowout, overwash fan, and barrier flat zones of open or sparsely-vegetated beaches (Haig 1992). Nests' sites may have little or no slope (Cairns 1982, Burger 1987), although nesting does occur on lower-elevation dunes (Cairns 1982). On wide beaches, piping plovers nest in the open to maintain a wide field of view, but on narrower beaches, eggs can be laid in clumps of vegetation (Cairns 1982). Where beaches are wide, piping plovers tend to nest far from the tide line to reduce risk of nest overwash, but this places nests closer to vegetated dunes, where risk of predation is high (Burger 1987). All piping-plover breeding sites at Cape Hatteras National Seashore were designated as critical habitat for wintering

birds, as defined by the Endangered Species Act (ESA) (Federal Register 2001) until 2004, when a court decision vacated the designation for Oregon Inlet, Cape Point, Hatteras Inlet, and Ocracoke Island (Cape Hatteras National Seashore Access Preservation Alliance vs. U.S. Dept. of the Interior, 344 F. Supp. 2d 108 [D.D.C. 2004]). In the winter and on migration, piping plovers tend to be found associated with wide beaches and inlet habitats, foraging in moist, substrate habitat that includes both low- and high-wave energy intertidal zones, mud flats, moist sand flats, ephemeral pools, shores, and brackish ponds (Cohen 2005a; Haig, Nicholls and Baldassarre 1990; Wilkinson and Spinks 1994; Haig and Elliot-Smith 2004).

Diet

Piping plovers feed primarily on terrestrial arthropods and benthic worms (Haig 1992). Adults forage both day and night (Staine and Burger 1994), but young chicks are brooded during the night and, therefore, feed by day (Wolcott and Wolcott 1999). During territory establishment, foraging adults exhibit a preference for a moist, substrate habitat (MOSH) that particularly includes mud flats, sand flats, ephemeral pools, and shores of brackish ponds, and excludes the high-wave energy intertidal zone (Cohen 2005a). Broods forage primarily on damp sand flats or MOSH (Coutu et al. 1990), where their percent time spent foraging and prey abundance were much higher than in other habitats (Kuklinski et al. 1996).

Broods spend more time foraging in the wrack, sparse vegetation, wet-sand flat, and overwash areas than expected, based on the percent availability of those habitats (Kuklinski et al. 1996). Chicks with access to MOSH survived better than chicks without such access in Virginia (Loegering and Fraser 1995), Rhode Island (Goldin and Regosin 1998), and, in some years, in New York (Elias et al. 2000). Burger (1994) found that having access to a diversity of foraging habitat zones available to broods reduced the impact of human disturbance, because it provided opportunities for chicks to escape disturbances and still forage.

Breeding Biology

The eggs, chicks, and incubating adults are highly camouflaged (Haig 1992; Haig and Elliot-Smith 2004). On the Atlantic Coast, breeding-territory establishment and courtship generally begin in late March, the first nests are initiated in late April, and the brood-rearing period extends from late May to mid-August (Cohen 2005b). In more densely populated beaches in the northern end of the Atlantic Coast breeding range, most pairs establish within a day or two of the birds' arrival in early spring, whereas pairs on sites in the mid-Atlantic, with fewer birds, can take several days or weeks to become established (Haig and Elliot-Smith 2004).

Piping plovers are monogamous, though retention of the same mate between breeding seasons is variable. The nest is built by the male and consists of a shallow scrape in sandy substrate that may or may not be lined with pebbles and shell fragments. Four is the normal clutch size, and one egg is laid every other day until the clutch is complete. Replacement eggs are not reported. If one or more eggs are lost, the pair continues to incubate the remaining eggs (Haig and Elliot-Smith 2004). Incubation is shared by males and females, and typically commences the day of clutch completion, but sometimes, instead, when the next-to-last egg is laid.

The length of incubation ranges from 25 to 29 days, and a pair will re-nest multiple times if successive clutches are destroyed, but re-nesting after the chicks hatch is rare (Haig and Elliot-Smith 2004). Chicks leave the nest scrape within a few hours of hatching, and never return except when a nest hatches at night (Wolcott and Wolcott 1999). Members of a breeding pair share brood-rearing duties, though some females desert broods within 5 to 17 days (Haig and Elliot-Smith 2004). Although chicks follow adults to a foraging habitat, they forage for themselves. Fledging-time ranges from 21 to 35 days (Cohen 2005a). Adults and young depart the breeding grounds from mid-July to early September.

Breeding Chronology and Performance at Cape Hatteras National Seashore

No published accounts exist of breeding piping plovers in North Carolina from 1902 to 1960, when a pair was found on Ocracoke Island (Golder 1985). Four nests and one brood were discovered within the

boundaries of the seashore in 1984 incidental to surveying for other species, and 5 chicks were known to have fledged that year (Golder 1985). Nine pairs were counted in 1986, again incidentally (Golder 1986), and 10 pairs were discovered in 1987 during specific surveys for the plover (Cooper 1990). In 1989, piping plovers were observed to lay 50% of their nest attempts on the ocean beach, 37% on the dune toe, and 5% (1 nest) in an overwash (Coutu et al. 1990). Six primary nesting sites at Cape Hatteras National Seashore include:

- Bodie Island Spit at the south end of Bodie Island
- Cape Hatteras Point (Cape Point)
- South Beach
- Hatteras Spit (on Hatteras Island)
- North tip of Ocracoke Island
- South tip of Ocracoke Island (NPS unpublished data 2004).

Locally breeding piping plovers arrive at Cape Hatteras National Seashore in mid-March, begin courting and pairing in April, and begin to scrape and build nests in the third week of April (Coutu et al. 1990).

Bodie Island Spit had one pair of breeding piping plovers in 1996, 1997, 2001, 2002, and 2004. Mean nest survival (nests that hatched at least one egg/nests laid) was 40%, mean chick survival (chicks fledged/eggs hatched) was 0%, and mean reproductive rate (chicks fledged/pair) was 0.00. In 2005, there was evidence of territory prospecting by at least one pair at Bodie Island Spit, but no eggs or chicks were produced (Cohen 2005a).

Cape Point had 4 to 6 breeding pairs of piping plovers per year from 1992-1996, after which the number of pairs declined to 1 pair per year by 2001. No pairs were found at this site from 2002 to 2004. Mean nest survival was 64%, and mean chick survival was 37%. The reproductive rate ranged from 0.00 in 2001 to 1.70 fledglings/pair in 1999, and averaged 0.85. In 2005, there was evidence of territory prospecting by at least two pairs at Cape Point. Ultimately, one nest was confirmed that fledged 3 chicks (Cohen 2005a).

South Beach had one pair of piping plovers per year from 1993 to 1999. Mean nest survival was 93%, and mean chick survival was 36%. The reproductive rate ranged from 0.00 (in several years) to 2.0 fledglings/pair (in 1998 and 1999), and averaged 0.67. There is no evidence of nesting at South Beach from 2000 to 2005 (Cohen 2005a).

At Hatteras Spit, 3 to 5 pairs nested per year from 1992 to 1998, and 1 to 2 pairs nested from 1999 to 2004, including one pair in 2004. Mean nest survival was 40%, and mean chick survival was 22%. The reproductive rate ranged from 0.00 (in several years, including 2002 to 2004) to 2.00 fledglings/pair in 2001, and averaged 0.47. In 2005, there was evidence of territory prospecting by at least one pair at Hatteras Spit, and two pairs at Cape Point. Ultimately, nests were found for one pair at Hatteras Spit. Ultimately, one nest was confirmed that fledged 3 chicks (Cohen 2005a).

North Ocracoke had 1 to 4 breeding pairs per year from 1992 to 1996. Mean nest survival was 36%, and mean chick survival was 43%. The reproductive rate ranged from 0.00 to 0.50 fledglings/pair, and averaged 0.30. There was no evidence of nesting at North Ocracoke in 2005 (Cohen 2005a).

South Ocracoke had 1 to 2 breeding pairs from 1995 to 1999 and 1 breeding pair in 2003 to 2004. Mean nest survival was 67% and mean chick survival was 25%. The reproductive rate ranged from 0.00 (in several years) to 4.00 fledglings/pair in 1998, and averaged 0.70. In 2005, there was evidence of territory prospecting by at least one pair at South Ocracoke, but no eggs or chicks were produced (Cohen 2005a).

Chick survival has been highly variable and increasingly low across all six Cape Hatteras National Seashore sites (Mayer and Ryan 1991; Patterson et al. 1991; Loegering and Fraser 1995; Goldin and

Regosin 1998). Except at South Beach; however, where nest survival was 100% in all years but one, nest survival varied greatly, with predation and disturbance the likely causes of nest, egg, and chick loss (Lyons 2001; Lyons 2002a; Lyons 2003; Lyons 2004). In fact, since 1989, reproductive performance at Cape Hatteras National Seashore, (which has averaged 0.70 fledglings per breeding pair) is well below the recovery goal set by the U.S. Fish and Wildlife Service (USFWS) of 1.5 fledglings per breeding pair. According to USFWS, a population would need a minimum annual production of 1.2 fledglings per breeding pair to sustain a viable population of piping plovers at Cape Hatteras National Seashore. Indeed, the steady decline in the local breeding population (see figure 5) is likely a reflection of the low productivity and resultant lack of recruitment over the intervening decade (Lyons 2001; Lyons 2002a; Lyons 2003; Lyons 2004).

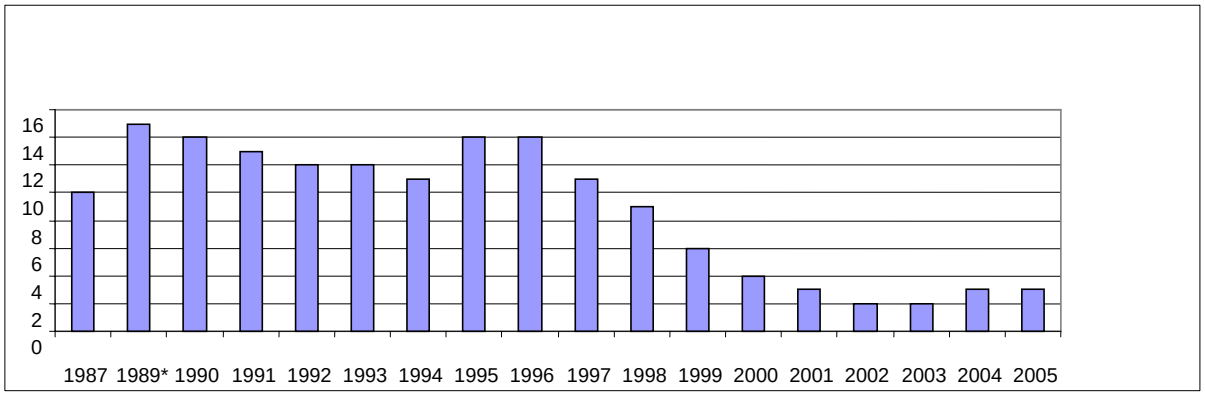


FIGURE 5: NUMBER OF PIPING PLOVER NESTING PAIRS, CAPE HATTERAS NATIONAL SEASHORE, 1987 - 2005

Nest Loss/Abandonment

Two nests (67%) were abandoned in 2001. At Bodie Island, red fox tracks were found around the predator exclosure for several days prior to nest abandonment, and crows were sighted at, and on top of, this exclosure on the day the nest was abandoned, though it is not known if the crows caused the plovers to abandon the nest (Lyons 2002a). The Cape Point nest was abandoned the day after a fox tried to dig around the predator exclosure. Fox tracks were frequently observed at the site before and after the nest was found. The eggs were examined approximately two weeks after abandonment (Lyons 2002a).

Two nests (67%) out of three produced were lost in 2002. The one breeding pair located at Hatteras Inlet spit initiated both. The initial nest was being incubated when waves washed over and flooded the nest. The scattered eggs were collected and placed in an artificial scrape made within the predator closure. However, the adults did not return to the eggs. The pair's second nest containing one egg was lost to unknown causes, though predation was implicated. A predator exclosure had not yet been placed on this nest, because it was lost before the clutch achieved the 3 or 4 egg minimum (Lyons 2003).

Though 2003 only produced 2 piping plover nests, the lowest since plover surveying began at Cape Hatteras National Seashore in 1989, no nests were lost or abandoned in 2003 (Lyons 2004).

Nonbreeding and Wintering

In addition to supporting a local breeding population, Cape Hatteras National Seashore also hosts migrating and overwintering piping plovers from all three of the North American breeding populations

(the threatened Atlantic Coast and Great Plains populations, and the endangered Great Lakes population). However, the distribution and abundance of nonbreeding and wintering populations at Cape Hatteras National Seashore are less well documented than the local breeding population. Documenting and protecting nonbreeding, wintering piping plovers and their habitat is a priority that is articulated in the recovery plans for all three North American breeding populations (USFWS 1988; USFWS 1996a; USFWS 2003).

Wintering piping plovers on the Atlantic Coast select wide beaches in the vicinity of inlets that are associated with a high-percent area of MOSH (Nicholls and Baldassarre 1990; Wilkinson and Spinks 1994). Because tide, and fall-and-winter storm regimes, often cause piping plovers to move among habitat patches, a diversity of habitat patches may be important to over-wintering populations (Burger 1994; Nicholls and Baldassarre 1990).

From 2000 to 2005, the greatest number of nonbreeding piping plovers at Cape Hatteras National Seashore occurred during the fall migration, which begins in July and peaks between July and September (see table 11). The fall migration counts were highest at South Ocracoke, followed by Oregon Inlet (Bodie Island Spit, Pea Island National Wildlife Refuge, and, formerly, Green Island, which is now largely unusable because of vegetation growth), then Hatteras Spit and Cape Point. Fall migration may last until November (Cohen 2005a).

The first, banded, winter residents have appeared in August, although wintering birds may arrive in July. The nonbreeding population from December to January most likely consists entirely of winter residents. The size of the resident wintering population at Cape Hatteras National Seashore is not precisely known, but it may be on the order of 20 to 35 birds (see table 11) (Cohen 2005a). In the winter of 2004/2005, the maximum numbers seen were about 50% of the recent norm. But whether this observed difference was because of a difference in survey methodology is unknown. The highest counts of wintering birds were at Oregon and Ocracoke Inlets. Based on a sample of banded birds, winter residents can be present until April (Cohen 2005a).

Spring migrants first appear in February or early March, and their numbers peak in late March or April (see table 11). Sites at Oregon Inlet have had the highest abundance of spring migrants, followed by Ocracoke Inlet, with lesser numbers at Hatteras Spit and Cape Point (Cohen 2005a).

TABLE 11: MEDIAN AND MAXIMUM NONBREEDING BIRDS SEEN / DAILY SURVEY DURING FALL, WINTER, AND SPRING, SELECTED SITES AT CAPE HATTERAS NATIONAL SEASHORE, 2000 TO 2005

	Month	Oregon Inlet	Cape Point/ S. Beach	Hatteras Inlet	Ocracoke Inlet	All Sites
Median	Jul	0.49	0.18	0.45	2.21	5.67
	Aug	0.68	0.31	0.13	3.76	6.43
	Sept	0.66	0.07	0.38	4.22	5.67
	Oct	0.36	0.00	0.86	1.81	3.33
	Nov	0.82	0.00	0.07	1.00	4.21
	Dec	0.77	0.00	0.00	2.07	2.88
	Jan	0.25	0.00	0.00	1.00	1.18
	Feb	3.33	0.00	0.00	1.00	4.33
	Mar	1.25	0.00	0.00	0.75	2.75
	Apr	1.89	0.00	0.62	1.31	3.60
Maximum	Jul	32	5	21	56	56
	Aug	34	6	14	72	72
	Sept	16	5	4	37	37

TABLE 11: MEDIAN AND MAXIMUM NONBREEDING BIRDS SEEN / DAILY SURVEY DURING FALL, WINTER, AND SPRING, SELECTED SITES AT CAPE HATTERAS NATIONAL SEASHORE, 2000 TO 2005

	Month	Oregon Inlet	Cape Point/ S. Beach	Hatteras Inlet	Ocracoke Inlet	All Sites
	Oct	12	1	28	31	31
	Nov	15	0	8	12	15
	Dec	17	0	7	15	17
	Jan	18	0	1	11	18
	Feb	14	0	0	18	18
	Mar	12	3	4	8	12
	Apr	25	3	7	11	25

Source: Cohen 2005a

NOTE: Not all sites were surveyed each day (typically, only one or two were surveyed), so the numbers in the table provide only a rough idea of the total size of the nonbreeding population (Cohen 2005a).

Risk Factors

Small populations face a heightened risk of extinction compared to large populations, because they are more vulnerable to the following: (1) random environmental variations, such as storms; (2) reduction in genetic variations that limit a species ability to adapt to local conditions; (3) sudden, random drops in birth and death rates; and, (4) an impaired ability at finding suitable mates (Lande 1988).

Given the vulnerability of the small piping plover population at Cape Hatteras National Seashore to random events, the persistence of the population will depend increasingly on controlling all sources of mortality to adults, eggs, and chicks. Predators, human disturbance, and access to foraging habitat, have been identified in past research as contributing to impaired reproductive success at Cape Hatteras National Seashore (Coutu et al. 1990; Kuklinski et al. 1996). There may be evidence that piping plovers are finding it increasingly difficult to attract mates (known as the "Allee effect"), since surveying reports from 2001 to 2003 and 2005 indicate that unpaired birds displaying territorial behavior were observed in the prelaying period at several sites (Lyons 2001; Lyons 2002a; Lyons 2003). Thus, providing a disturbance-free environment early in the season may help piping plovers to establish territories and attract mates (Cohen 2005b).

In 1990, research indicated that enforcement levels were not adequate to keep pedestrians, pets, and off-road vehicles (ORVs) out of restricted piping-plover breeding areas (Coutu et al. 1990). In 1996, potential disturbance sources appeared to remain outside of protected areas, and predation, rather than disturbance, was considered the major direct threat to reproductive success (Kuklinski et al. 1996), although fieldwork did not begin until May 30 and missed the first part of the nesting season. In that year, nest predation varied among sites and was most severe at Hatteras Spit. Nest abandonment increased from 2000 to 2002 compared to previous years, but of the two nests laid in 2003, none was lost. Abandonment was sometimes associated with predator trails circling nest exclosures (Lyons 2002a; Lyons 2003; Lyons 2004). One nest was lost to flooding in 2002. In 2001 to 2003, the reasons for loss of the two nests were unknown. After the disappearance of some chicks, predator trails were found where the brood was last seen, including red fox, domestic dog, and cat (Lyons 2002a; Lyons 2003).

Human pedestrians and joggers occasionally destroy nests or kill chicks, either by intentional vandalism or by accident (Patterson et al. 1991; Houghton et al. unpublished). ORVs can run over adults, nests, and chicks, some of which may run or crouch in vehicle tracks in response to danger. Piping plover chicks are difficult to see in this situation because of their camouflaging (Melvin et al. 1994). Human development

and recreation can result in loss and/or degradation of breeding habitats (Haig 1992). ORV use has been demonstrated to destroy the wrack line (Goldin 1993), thereby degrading an important foraging habitat. Breeding and nonbreeding piping plovers are subject to disturbance (disruption of normal activities) by ORVs, pedestrians, and unleashed pets.

Rates and sources of mortality and disturbance, and the responses of piping plovers to disturbance in the nonbreeding season, have not been specifically assessed at Cape Hatteras National Seashore. However, it is known that piping-plover foraging and roosting habitats are used by pedestrians and ORVs outside of the breeding season (Cohen 2005b). The potential, therefore, exists for mortality of piping plovers from being run over by ORVs (Melvin et al. 1994), as well as from domestic pets. Furthermore, disturbance from ORVs, unleashed pets, and pedestrians, to roosting and foraging birds may reduce foraging efficiency or alter habitat use, thereby increasing the risk of nutritional or thermal stress (Zonick 2000).

Weathers and Tides. There have been 10 named hurricanes on the Outer Banks between 1993 and 2005 (Jeff Cordes, Biologist, NPS Cape Lookout National Seashore, pers. comm., R. Podolsky, Louis Berger Group, Inc., October 11, 2005). Hurricanes and other ocean storms can lead to unusually high tides, and subsequent flooding can overwash piping-plover nests (Haig 1992). Indeed, some piping plovers that nest too closely to mean high-tide, may lose their nests on normal high tides (Cohen 2005b). Storms can also result in widespread mortality of chicks (Houghton et al. unpublished). In one study done at the Cape Hatteras National Seashore, air temperature was not a factor limiting productivity (Kuklinsi et al. 1996).

In addition to these direct effects of storms on piping-plover nests, flooding because of extraordinarily high tides or storm-surges may also alter habitat enough to render it unsuitable for nesting. This may lead to the abandonment of habitat within or between breeding seasons (Haig and Oring 1988).

Predation. Predation is a primary factor limiting reproductive success of the piping plover (Haig 1992). Predation of eggs, chicks, and/or adults include, but is not necessarily limited to, mink, red fox, striped skunks, opossum, domestic dogs, feral and domestic cats, crows, and gulls (Haig 1992), and birds-of-prey (Murphy et al. 2003a). Ghost crabs have occasionally been implicated in the loss of nests (Watts and Bradshaw 1995) and chicks (Loegering 1995). Anecdotal evidence indicates that ghost crabs may be more of a problem in North Carolina than at sites further north (Cohen 2005a). Predators in piping-plover habitat can also lead to piping plovers' abandoning territories within and between breeding seasons (Cohen 2005b).

Human Activity. The impact of predation has been postulated to be greater on beaches with high human use, because the presence of pets and trash that may attract wild predators is correlated with the presence of humans (USFWS 1996a). In some studies, beaches with high levels of human disturbance had lower reproductive rates than less-disturbed beaches (Cairns 1982; Flemming et al. 1988). At other sites, disturbance did not affect reproductive rate (Patterson et al. 1991; Hoopes 1993; Burger 1994), although pedestrians, kites, and ORVs caused a decrease in brood-foraging behavior in Massachusetts (Hoopes 1993) and New Jersey (Burger 1994).

Documented violations of protected areas by pedestrians began to increase sharply after 2000, but this may have been because of increasing vigilance in the recording of such incidents (Lyons 2002a; Lyons 2003; Lyons 2004). Approximately 50 to 60 incidents of ORVs entering protected areas were recorded each year from 2000 to 2002, and in 2003, the symbolic fence was vandalized by an ORV, and several instances of ORVs within the protected area were observed (Lyons 2002a; Lyons 2003; Lyons 2004).

In New York, the response of incubating adults to the presence of humans near the nest was found to be highly variable and average nest success was unrelated to the number of disturbance sources observed within 100 meters of nests (Houghton et al. unpublished). However, piping plovers may be more sensitive to disturbance in the Atlantic Coast southern recovery unit, as evidenced by longer flush distances in response to disturbance sources at Assateague Island National Seashore (Loegering 1992). In Texas, piping plovers avoided foraging on sandflats close to areas of high human use (Drake et al. 2001). Zonick

(2000) found that the number of piping plovers was lower on disturbed bayside flats than undisturbed flats, and that piping plovers experienced lower foraging efficiency when disturbed. Other unpublished data support the assertion that winter habitat selection is negatively correlated with human activities and development.

ORV use may affect the beach through sand displacement and compaction, which may lead to steeper dune profiles (Anders and Leatherman 1987), which, in turn, may prove less suitable for piping-plover nesting. Destruction of the wrack line by ORVs may negatively impact reproductive success because of loss of important habitat used for foraging and cover (Goldin 1993).

Beach and dune renourishment projects can alter the profile of beaches, causing increased erosion and habitat loss (Leatherman and Allen 1995).

Indeed, along most of Cape Hatteras National Seashore, important dune-creation projects have been carried out, beginning in the 1930s, which may be affect the ability of Cape Hatteras National Seashore to support piping plovers (Steve Harrison and Bob Trick, NPS, pers. comm. with R. Podolsky, LBG, September 4, 2005). Furthermore, beach stabilization prevents normal storm processes, such as overwash fan formation, thereby leading to long-term loss of MOSH and accelerated vegetative succession in potential nesting habitat (Dolan et al. 1973). Construction of human structures on beaches eliminates breeding territories, and may result in an increased level of human disturbance of, and predation on, remaining pairs (Houghton et al. unpublished).

Research, surveying, and even protective management activities can sometimes expose piping plovers to a risk of disturbance at breeding sites (Mabee and Estelle 2000). For example, adult birds may be more vulnerable to predation within exclosures (Murphy et al. 2003a) depending on the local predator pool and the type of exclosure used. Adults may also abandon exclosed nests more frequently (A. Hecht pers. comm. as cited in Haig and Elliot-Smith 2004).

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 only coming ashore 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 Cape Hatteras National 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 only known to occur 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). 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). The leatherback turtle was listed as federally endangered in 1970 (NMFS and USFWS 1992). All three species carry the same state listings (NCWRC 2004).

Of the three species that nest at the seashore, the loggerhead turtle is by far the most numerous, comprising approximately 96% of the known nests between 1999 and 2004 (NPS 1999; Lyons and Altman 2000; Sayles 2002; Gosh and Lyons 2002; Altman and Lyons 2003; Lyons 2005). 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 3% and 1% of the nests, respectively, between 1999 and 2004 (NPS 1999; Lyons and Altman 2000; Sayles 2002; Gosh and Lyons 2002; Altman and Lyons 2003; Lyons 2005). Of the three islands that make up the Cape Hatteras National 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).

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 animals in 1983 (NMFS and USFWS 1991a) to between 32,000 and 56,000 animals in the year 2000 (Ehrhart et al. 2003). 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). However, since standardized surveying began in North Carolina in the mid-1990s, the number of loggerhead nests per season has remained fairly stable, averaging 731 nests from 1995 to 2004 (see figure 6) (M. Godfrey, NCWRC, unpublished data). At Cape Hatteras National Seashore, the average number of nests between 1995 and 2005 was 71, with the lowest number of nests occurring in 1996 and 1997 and the highest number of nests occurring in 2002 (see figure 7) (M. Godfrey, unpublished data; NPS 1999; Lyons and Altman 2000; Sayles 2002; Gosh and Lyons 2002; Altman and Lyons 2003; Lyons 2005). Only 46 loggerhead nests were laid at Cape Hatteras in 2004; however, that was a poor year for the entire southeast Atlantic Coast (Lyons 2005).

Loggerhead Turtle (*Caretta caretta*)

(http://www.fws.gov/caperomain/Turtles/capeislandturtles.htm)

Loggerhead turtles spend the majority of their life history at sea, with only mature females coming ashore to nest every 2 to 3 years, on average (Schroeder et al. 2003). The first turtle nests (all turtles species included) begin to appear at Cape Hatteras in mid May, and the last nests are deposited in late August (NPS 1999; Lyons and Altman 2000; Sayles 2002; Gosh and Lyons 2002; Altman and Lyons 2003; Lyons 2005). Typical nesting areas for loggerheads tend to be sandy, wide, open beaches, backed by low dunes (Miller et al. 2003). 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).

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). At Cape Hatteras National Seashore, between 1999 and 2004, 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 the rest were relocated because of potential human disturbance, primarily because they were within one mile of a lighted fishing pier (NPS 1999; Lyons and Altman 2000; Sayles 2002; Gosh and Lyons 2002; Altman and Lyons 2003; Lyons 2005).

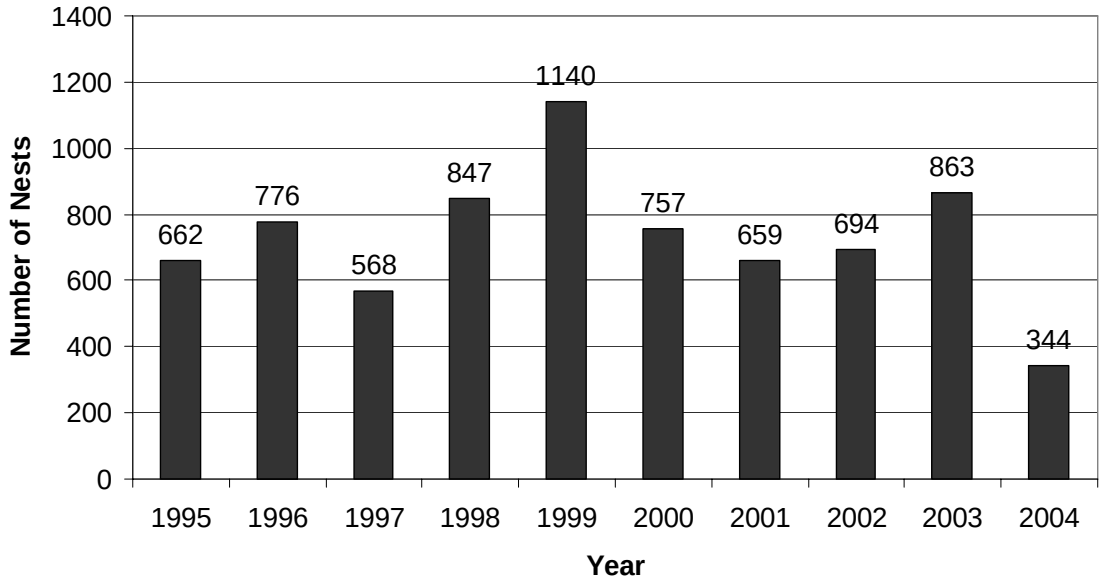


FIGURE 6: NUMBER OF LOGGERHEAD TURTLE NESTS IN NORTH CAROLINA (FROM 1995 TO 2004)

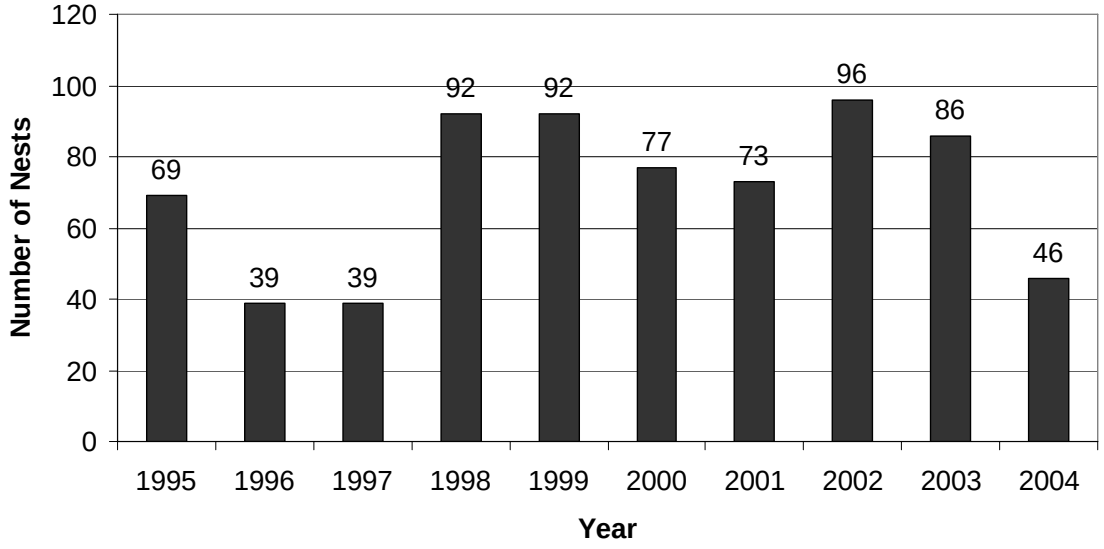


FIGURE 7: NUMBER OF LOGGERHEAD TURTLE NESTS AT CAPE HATTERAS NATIONAL SEASHORE (FROM 1995 TO 2004)

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 U.S. lay an average of 100 to 126 eggs per nest (NMFS and USFWS 1991a). After laying her eggs, the female covers the nest with sand, using all four flippers. Once the nest-covering phase is complete, she crawls back to the sea.

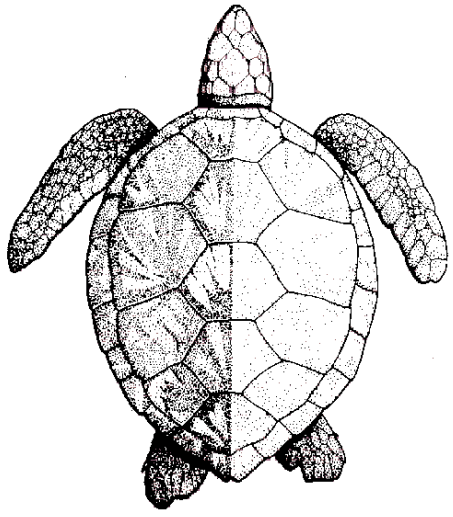
Individual females may nest one to seven times per nesting season, at an average interval of 14 days (NMFS and USFWS 1991a). The nest incubation period (from laying to hatching) depends on temperature, and ranges on average from 63 to 68 days in North Carolina (NMFS and USFWS 1991a). The sex ratio of 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).

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). 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). 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.

Nesting habits for the green turtle are very similar to the loggerhead turtle, with only slight differences. Average clutch sizes range from 110 to 115 eggs, though this varies by population, and only occasionally do females produce clutches in successive years. Usually two, three, four or more years occur between breeding seasons (NMFS and USFWS 199b).



Green Turtle (*Chelonia mydas*)

(http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/green-sea-turtle.htm)

From 1999 to 2004, there was an annual average of two, green turtle nests at Cape Hatteras National 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).

Leatherback Turtle (*Dermochelys coriacea*)

(http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/leatherback-sea-turtle.htm)

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

Leatherback nesting habits are very similar to the loggerhead turtle, though they tend to begin and end nesting earlier in the year than the loggerhead (NMFS and USFWS 1992). Leatherbacks are thought to migrate to their nesting beach about every two to three years (NMFS and USFWS 1992; 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).

POTENTIAL THREATS – NESTING ENVIRONMENT

Threats to the loggerhead turtle on nesting grounds, as outlined in their recovery plan (NMFS and USFWS 1991a), 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 (Steinetz et al. 1998), which leads to a decline in the nesting rate.

Predation by mammals, birds, and ghost crabs may eliminate productivity on beaches where it is not managed.

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

Beach driving by off-road vehicles (ORVs) may harm sea turtles by running over nests, which may increase sand compaction and decrease hatching success, or kill pre-emergent hatchlings (NMFS and USFWS 1991a). Beach driving also poses a risk of injury to females and strand turtles by leaving ruts that trap or disorient hatchlings attempting to reach the ocean (Hosier et al. 1981). Beach driving can also disturb adult females and cause them to abort nesting attempts and interfere with sea-finding behavior of hatchlings, if headlights are used at night (NMFS and USFWS 1991a). 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). Beach cleaning can directly destroy nests. Poaching is a problem in some countries, and 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 placement of hard structures, such as sea walls or pilings. ORV traffic may alter the beach profile, leading to steeper fore dunes, which may be unsuitable for nesting. 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.

THREAT OCCURRENCES AT CAPE HATTERAS NATIONAL SEASHORE

The following data are from the Cape Hatteras National Seashore annual sea-turtle surveying reports, 1999 to 2004, and include all turtle species (NPS 1999; Lyons and Altman 2000; Sayles 2002; Gosh and Lyons 2002; Altman and Lyons 2003; Lyons 2005).

The majority of nest losses at Cape Hatteras National Seashore from 1999 to 2004 were weather-related, particularly hurricanes and other storms. During this time frame, impacts were felt from six hurricanes, and in 2003, Hurricane Isabel destroyed so many nests that losses because of other sources were difficult to document.

Foxes were first seen at Cape Hatteras National Seashore in 1999, and on Hatteras Island in the winter of 2001/2002. Foxes disturbed or destroyed 1 to 9 nests per year from 1999 to 2004, except in 2000 and 2004, when no predation was reported. Ghost-crab predation has been reported sporadically, with crabs seen at 0 to 17 nest sites per year from 1999 to 2004, and observed predation of 0 to 3 nests per year. Pedestrian tracks have been recorded inside closures, and counts ranged from 8 to 92 trails per year. Pedestrians disturbed or destroyed 2 to 6 nests per year from 1999 to 2004 by digging them up, though none occurred in 2003.

Violation of closed areas by ORVs has become increasingly common, with 29 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, although the nests survived. 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. Documented beach beachfires totaled 174 in 2000 and 773 in 2001. Such fires may misdirect adults and emergent hatchlings. Several cases of hatchlings being misdirected by lights from villages and other human structures were documented in 1999, 2000, 2002, and 2004.

EXISTING PROTECTION MEASURES

Patrolling and management of the sea turtles at the seashore follow the guidelines, where appropriate, set forth in the individual sea turtle recovery plans (NMFS and USFWS 1991a, 1991b, 1992) and the North Carolina Wildlife Resources (NCWRC) Handbook for Sea Turtle Volunteers in North Carolina (NCWRC 2002). The seashore hires four Student Conservation Association (SCA) interns each year to help conduct sea turtle surveying. Seashore biologists, along with the four interns, conduct daily surveys on Bodie,

Hatteras, and Ocracoke Islands for turtle crawls and nests from June 1 to August 31. To cover the approximately 64 miles of seashore they use all-terrain vehicles (ATVs) and ORVs. Details of existing protection measures are provided in the description of alternative A, no-action alternative, in "Chapter 2, Alternatives."

SEABEACH AMARANTH

Seabeach amaranth (*Amaranthus pumilus*) is an annual plant, native to barrier-island beaches along the U.S. Atlantic Coast, including those within the Cape Hatteras National Seashore. Historically, seabeach amaranth was found in nine states, from Massachusetts to South Carolina, but was federally listed as threatened by the U.S. Fish and Wildlife Service 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). 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).

Seabeach Amaranth (*Amaranthus pumilus*)

(http://nc-es.fws.gov/plant/seabeach2.jpg)

This species is also listed as threatened by the State of North Carolina. Within North Carolina, from 2002 to 2003, the number of plants increased from 5,700 to 9,300, along 112 miles of beach (Cohen 2005a). However, these numbers represent only a fraction of the reports of approximately 40,000 plants reported in the late 1980s and 1995. Within Cape Hatteras National Seashore, seabeach amaranth numbers ranged from 550 to nearly 16,000 plants between 1985 and 1990, but only 1 to 133 individuals have been found annually since the year 2000 (see table 12).

TABLE 12: NUMBERS OF NATURALLY OCCURRING PLANTS OF SEABEACH AMARANTH AT CAPE HATTERAS NATIONAL SEASHORE

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

	1995	1996	1996	1997	1998	1999
number of seabeach amaranth	1	98	98	81	265	8

	2000	2001	2002	2003	2004	2005
number of seabeach amaranth	2	61	133	54	1	2

Source: Jolls et al. 2004; Lyons 2002b; and M. Lyons, NPS, per. comm. S. Smith, Louis Berger Group, Inc., October 7, 2005.

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 from sediments distributed by anthropogenic (human) factors, e.g., beach re-nourishment (Jolls et al. 2004). Seeds must be scarified (the seed coat broken by nicking or abrasion) or cold stratified (chilling for weeks) before germination can occur (Baskin and Baskin 1998; Blazich 2005; Jolls et al. 2001). Germination takes place from April through July, initially forming a small sprig that soon begins to branch into a clump. At Cape Hatteras National Seashore, seedlings are usually visibly detectable beginning in June (M. Lyons, NPS, pers. comm., S. Smith, Louis Berger Group, Inc., Sept. 28, 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 over one hundred branches (USFWS 1993; NJDEP 2005).

Flowering begins when plants are of sufficient size, often beginning in June, but more typically beginning in July, and continuing 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 are 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).

Seed dispersal may occur by wind or water, though 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 are never dispersed, 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).

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 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 and NJDEP 2005). 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, in order to allow it to move around in the landscape occupying suitable habitat as it becomes available (USFWS 1993).

Since 2000, locations where seabeach amaranth has been found within the Cape Hatteras National Seashore includes 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; Lyons 2001; M. Lyons, NPS, pers. comm., S. Smith, Louis Berger Group, Inc., October 7, 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). Other important threats to the plant include: (1) beach grooming; 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). 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.

STATE LISTED AND SPECIAL STATUS SPECIES

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 comprised of black feathers that contrast with white feathers on the breast and sides. The sexes are similar in appearance though females are slightly larger than males.

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

Oystercatcher form pair bonds in February and early March and courtship takes place in salt marshes, 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, Meyers 2005).

AMERICAN OYSTERCATCHER IN NORTH CAROLINA

North Carolina supports approximately 327 pairs of American oystercatchers. The Outer Banks region of North Carolina is estimated to support 90 breeding pairs or 27% of the State's oystercatchers (Simon et al. 2004), along 100 miles of beach (Cameron and Allen 2004). Oystercatcher breeding success in North Carolina has been extremely low — one egg in 32 hatches (Davis et al. 2001). In response to low reproductive rates in 2005, the American oystercatcher was included in the U.S. Fish and Wildlife Service's Southeastern Shorebird Conservation Plan as a species of special concern (Meyers 2005).

American Oystercatcher (*Haematopus palliates*)

(www.fws.gov/ r5snep/bch_hab.htm)

Habitat Description

In North Carolina, oystercatcher nesting habitat comprises sandy sites characterized by more substrate and less vegetation, farther from water (70-105 feet), and slightly elevated (to afford at least a 180˚ view (Lauro and Burger 1989, Zaradusky 1985, Shields and Parnell 1990). Vegetation, which can include; Spartina, Ammophila, Lathyrus, Solidago, is variable and averages 23–50% around some nest sites (Lauro and Burger 1989). Elevation of nest habitat and distance to the water are both important to nest success (Lauro and Burger 1989). Distance to nearest other American oystercatcher nest depends on habitat, but typical inter-nest distances range from 400 to 625 feet (Lauro and Burger 1989). Oystercatchers are more common in habitat with few predators, especially areas without domestic dogs and cats (Nol and Humphrey 1994). 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).

Diet

The elongated and laterally compressed bill of the oystercatcher is especially suited to allow opening and preying upon marine bivalves including; oysters, soft-shell clams, razor clams, stout razor clams, and

ribbed mussels. Other items include, marine worms, mole crabs, sandworms, limpets, jellyfish, sea urchins, starfish, or crabs (Bent 1929, Tomkins 1944, Cadman 1979, Johnsgard 1981, Nol 1989).

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, incubation, chick rearing and fledging. Breeding pairs of oystercatchers begin nesting late February and early March by establishing and holding a nesting territory and than scraping multiple shallow depressions in the sand. Eventually, they choose one scrape to build a nest (Nol and Humphrey 1994, McGowan et al. 2005). Nests are 1.5-2.5 inches deep and 7-8 inches across and may contain shell fragments, dead plants, small stones, and beach debris (Baicich and Harrison 1997). In North Carolina, nests are rarely more than 70−105 feet from water (Lauro and Burger 1989 in Nol and Humphrey 1994) and are often on an elevated mound, which serves as a lookout for the birds (Baicich and Harrison 1997). Oystercatchers are monogamous and may mate for life (Palmer 1967 in Nol and Humphrey 1994). 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) or after the last egg (Baicich and Harrison 1997). 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 1−2 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 depend on adults almost entirely until 60 days old (Palmer 1967 in Nol and Humphrey 1994).

Breeding Performance at Cape Hatteras

At Cape Hatteras National Seashore (Cape Hatteras) the oystercatcher population has sustained declines in numbers of breeding pairs since the 1990s. On Hatteras Island, nesting pairs declined from 24 to 15 from 1999 to 2004 (Simon et al. 2004). Reproductive success for Cape Hatteras has also been very low with less than 0.1 fledged per breeding pair. At Cape Hatteras in 2003, 27 (67%) of the 43 nests were located in areas normally used by ORVs. Of these, 13 nests (48%) successfully hatched and three nests (11%) produced fledglings. Six (86%) of the seven oystercatcher fledglings at Cape Hatteras were found in areas seasonally closed to ORV traffic. The overall trends at Cape Hatteras indicate that oystercatcher nesting attempts could decline to a scattered few per island per year (less than 5) in less than a decade (Meyers 2005).

Nonbreeding and Wintering

In September, oystercatchers in northeastern United States migrate to their wintering grounds from Virginia south along the Atlantic and Gulf coasts. Oystercatchers in North Carolina and in other southern states appear to be non-migratory (Meyers 2005). Hence, in the winter, these southern coastal beaches can support large, mixed flocks of migrant and resident oystercatchers (Kain 1987, Post and Gauthreaux 1989).

Winter and migratory habitat appear to be similar to breeding habitat though there are inadequate data in North Carolina regarding what constitutes preferred habitat in the winter and especially for birds on migration. Limited observations indicate that winter birds roost in open ground without vegetation in areas near foraging habitat (Tomkins 1944, Nol and Humphrey 1994).

Risk Factors

At Cape Hatteras, more than 51% of oystercatcher nest losses are from undetermined causes but of the 49% that are known, predation accounts for 67%, overwash 25%, abandonment 5%, and vehicles less than 2% (Simon et al. 2004).

Human Activity. Current threats to the American oystercatcher throughout its breeding and wintering range are increasing predators (which is thought to be largely linked to human activity); development of coastal areas; and human disturbance (Bent 1929, Tomkins 1944, Nol and Humphrey 1994). 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). In Cape Hatteras, oystercatcher have no nesting and fledging success in day-use areas that have heavy pedestrian use (Meyers 2005). Furthermore, in 2001 and 2002, no breeding activity was found on beaches adjacent to villages that are known to have the highest concentrations of pedestrians on the seashore.

In addition to habitat loss from human disturbance, there have been cases of direct loss from ORVs running over chicks. For example, of the 28 chicks observed during the 2003 breeding season, two (out of a total of 20) were lost due to being run over by ORVs. Eight oystercatcher chicks have been documented in the last two years as mortality caused by ORVs crushing them on the beach (Meyers 2005).

Currently, there are only a few studies of the effects of humans and vehicles on the nesting success of American oystercatchers (McGowan 2004, Sabine 2005). Studies of colonial nesting waterbirds such as common terns and black skimmers indicate that set-back distances should be approximately 600 feet from nesting areas (Rogers and Smith 1995, Erwin 1989).

Weathers and Tides. There have been 10 named hurricanes on the Outer Banks between 1993 and 2005 (Jeff Cordes, Biologist, NPS Cape Lookout National Seashore, pers. comm. R. Podolsky, Louis Berger Group, Inc., October 11, 2005). Storms and high tides reduce nesting success and overwash accounted for 25% of documented nest failures at Cape Hatteras.

Predation. At Cape Hatteras, predation accounts for over 60% of the known nest failures including mammal predation (60%), bird predation (5%), and ghost crabs (less than 2%) (Simon et al. 2004). Predators include red fox, mink, skunk, dogs, cats, rats, 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 (Sabine et al. 2005). Oystercatchers may lay another clutch if predators depredate their nests early in the season (Nol and Humphrey 1994).

COLONIAL WATERBIRDS

Colonial waterbirds at Cape Hatteras National 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 “species of special concern,” by the North Carolina Wildlife Resources Commission and the NPS (Erwin 2005). None of these species is federally listed.

Cape Hatteras National Seashore was designated a Globally Important Bird Area by the American Bird Conservancy to reflect this diversity (American Bird Conservancy 2005). 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. Disturbance of colonies can lead to nesting failure. Therefore, the Waterbird Conservation for the Americas, an international voluntary partnership, North American Colonial Waterbird Conservation Management Plan recommends a minimum buffer of 150 feet to the nearest nest (Erwin 2005).

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).

Common Tern (*Sterna hirundo*)

(http://www.mbr-pwrc.usgs.gov/id/htmsl/h0700pi.jpg)

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). It is one of the medium-sized, black-capped terns (12 to 14 inches long, weighing 3.8 to 5.1 ounces) (Nisbet 2002). In North America, it is distributed along the Atlantic Coast, the St. Lawrence River, and in most of the Great Lakes (Nisbet 2002).

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). The least tern weighs only about 1.5 ounces, on average, and is a mere 8 to 9 inches in length (Thompson et al. 1997).

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 average 35% to 40% larger than females, and both exhibit a high degree of nocturnality. Females average about 9.3 ounces, while males average about 13 ounces. The length of the female ranges from 16 to 24 inches, while it is 19 to 24 inches for males (Gochfeld and Burger 1994).

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 et al. 1977) because of a decline in numbers over the past 20 to 30 years During the period from 1977 to 2004, gull-billed terns declined from approximately 268 to only 99 pairs, common terns from 2,760 to only 570 pairs, and black skimmers from 976 to 623 pairs. Least terns however, increased from 1,925 to 2,408 pairs in the same period (NCWRC database, fide D. Allen). Numbers of most breeding birds within North Carolina have declined over the past 20-30 years. During the period 1977 to 2004, Gull-billed terns declined from approximately 268 to only 99 pairs, common terns from 2760 to only 570 pairs, and black skimmers from 976 to 623 pairs; however, least terns increased from 1925 to 2408 pairs in the same period (NCWRC database, fide D. Allen). Populations of colonial beach nesting waterbirds have declined in North Carolina and at Cape Hatteras National Seashore. Colonial waterbird nest numbers naturally fluctuate between years; however, there has been a clear decline in beach nesting species in North Carolina over the past 28 years (table 13). The seashore beaches are important in providing suitable

habitat for these species. In 2004, over 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 (Cameron 2004). Within the seashore, 31 gull-billed tern nests were recorded in 2004, representing a 23% decline from the seashore's long-term average (table 14). A total of 376 common tern nests were found in 2004, representing a 27% decline from the seashore's long-term average. Least tern numbers have sharply declined at the seashore, with only 212 nests counted in 2004. This is a 37% decline from the average. Only black skimmer nest numbers increased in 2004. The 342 nests counted reflect a 40% rise above the seashore's average.

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., competition from large gulls, especially herring gulls), human development, beach stabilization, recreational disturbances on the outer and village beaches, and, perhaps, mortality on the wintering grounds (Parnell et al. 1977; 1995; Erwin 1994, 2005).

TABLE 13: COLONIAL WATERBIRD NESTS IN NORTH CAROLINA (1977 – 2004)

Species	1977	1983	1988	1993	1995	1997	1999	2001	2004	Average
Least tern	1925	1653	1528	2188	1992	882	1271	1742	2408	1732
Common tern	2761	2247	2618	2122	1699	952	888	1131	570	1665
Gull-billed tern	268	233	161	155	249	137	154	258	99	190
Forster's tern	1138	936	933	1660	1117	867	812	1086	828	1042
Black Skimmer	976	797	743	1084	819	570	681	594	623	765
Total	**7068**	**5866**	**5983**	**7209**	**5876**	**3408**	**3806**	**4811**	**4528**	**5394**

Compiled by North Carolina Wildlife Resources Commission

TABLE 14: COLONIAL WATERBIRD NESTS AT CAPE HATTERAS NATIONAL SEASHORE (1977 – 2004)

Species	1977*	1983*	1988*	1992*	1993*	1995	1997	1998	1999	2000	2001	2004	Avg
Least tern	121	508	450	454	761	342	278	173	355	184	202	212	337
Common tern	802	763	678	278	422	503	718	715	440	129	573**	376	533
Gull-billed tern	27	7	26	0	12	58	84	21	103	3	108	31	40
Forster's tern	382	63	0	0	0	31	0	0	0	0	0	0	40
Black Skimmer	286	296	144	30	226	139	454	366	306	149	193	342	244
Sooty tern					1								1
Total	**695**	**366**	**170**	**30**	**239**	**228**	**538**	**387**	**409**	**152**	**1076****	**373**	

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

**Updated from 2001 report to include nests found on Green Is at Oregon Inlet which is now included in Cape Hatteras National Seashore boundary

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; Erwin 2005).

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, decapods, marine worms, and clams, as well as small marsh fishes (Erwin et al. 1998b). 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).

Migration/winter roost habitat. Little is known of gull-billed tern habitat use while on migration, except that it is generally considered similar to the above (Erwin 2005).

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, in rivers (Nisbet 2002). However, they also nest in salt marshes, either on shell or on wrack, especially where human disturbance along the beaches is significant (Erwin 1990; 2005), and even on man-made structures, such as old piers or channel markers (Burger and Gochfeld 1991

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

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). In winter, common terns migrate to the Caribbean and South America, where they often concentrate in large numbers in coastal lagoons (Nisbet 2002).

Least tern

Breeding habitat. Least terns typically select the most bare sand- and shell-covered substrates available on coastal, riverine, or dredge-spoil islands (Thompson et al. 1997). 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). 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 (Thompson et al. 1997).

Foraging habitat. It is similar to 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). 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).

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). They invariably nest with other tern species along the Atlantic Coast (Erwin 1977; 2005). Black skimmers occasionally nest on wrack or on shell ridges in salt marshes, and even on rooftops with least terns (Gochfeld and Burger 1994).

Foraging habitat. Black skimmers feed on small fishes, 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 in protected coves and inlets near barrier islands (Erwin 1977; 2005; Gochfeld and Burger 1994).

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). They winter from Florida through the Caribbean and South America (Erwin 1990; 2005; Gochfeld and Burger 1994).

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]) that are incubated for 22 to 23 days. Both 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).

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). 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. Re nesting 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 aggressive, protective nature (Erwin 1979; 2005; Nisbet 2002). Hence, gull-billed terns and black skimmers often nest among common terns (Erwin 2005).

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 2 to 3 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. Both 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; Erwin 2005).

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; 2005; Gochfeld and Burger 1994). Clutch sizes range from 2 to 4 eggs (Erwin 1977). 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). 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). Fledged young are fed by their parents, often right up until migration (Erwin 1977; 2005).

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. Most of the colonies were comprised of small groups of least terns. The largest and most diverse colony was located at Ocracoke Inlet flats (Erwin 2005).

Colonial waterbird breeding surveys have been conducted at Cape Hatteras since 1977 by Cape Hatteras staff, NCWRC, and Dr. James Parnell of the University of North Carolina (NPS 2003b). The 2003 colonial waterbird breeding survey found 11 active colonies at the seashore, the same as were found in 2002. Of the colonies found, one was on Bodie Island, eight were on Hatteras Island (five on east-facing beaches and three on south-facing beaches), and two on Ocracoke Island. Species breeding on Cape Hatteras beaches in 2003 included least tern, common tern, gull-billed tern, and black skimmers (Erwin 2005).

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 (Parnell et al. 1995; Erwin 2005).

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).

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). 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; Erwin 2005).

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; Erwin 2005).

Risk Factors

Human Activity. All ground-nesting, colonial waterbirds are highly vulnerable to direct human activities such as ORVs, aircraft disturbances, pedestrians, photographers, wildlife managers and scientists, and even poachers (Buckley and Buckley 1976; Erwin 1990; 2005). Indirect effects from human activity include such factors as sonic booms from military operations, 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). These studies indicate that set-back distances should be approximately 600 feet from nesting areas (Rogers and Smith 1995; Erwin 1989, 2005).

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 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 has been documented prior to 2003 (Erwin 2005).

Incidents of visitors encroaching on posted bird closures at Cape Hatteras were documented between mid-April and September of 2003 (Erwin 2005). These closures not only represented sites where colonial waterbirds nested, but also where the American oystercatcher and the federally threatened piping plover nested. These illegal entries were not witnessed but documented, based on vehicle or pedestrian tracks left behind. A total of 105 incidents were recorded of ORVs entering posted bird closures in 2003. This number represents a substantial increase to the 52 and 63 incidents recorded in 2001 and 2002, respectively (Erwin 2005). Of the 105 incidents reported, 27 occurred on Bodie Island, 56 on Hatteras Island, and 22 on Ocracoke Island.

Weathers and Tides. There have been 10 named hurricanes on the Outer Banks between 1993 and 2005 (Jeff Cordes, Biologist, NPS Cape Lookout National Seashore, pers. comm., R. Podolsky, Louis Berger Group, Inc., October 11, 2005.). The effects of major hurricanes (e.g., Floyd in 1999) caused major declines in water conditions, as well as in marine life, throughout Pamlico Sound in North Carolina for an extended period (Mallin 2000).

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; Chabreck 1988; Erwin et al. 2001; Erwin 2005). The result of this predation has been poor reproduction or major redistributions of species (Erwin et al. 2001; Erwin 2005). In addition, gulls are often predators on terns as well as competitors for nesting space (Nisbet 2002). These include great black-backed gulls, herring gulls, and the smaller laughing gulls. In addition, in certain areas, other bird species may prey on terns and skimmers (or their eggs), such as peregrine falcons, great-horned owls, fish crows, and others (Erwin 2005).

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 to 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; and its legs and feet are flesh-colored to pinkish. It is readily distinguished from other, similar, ringed plovers by its larger size; large, heavy, all-black bill; and flesh-colored legs. The piping plover is smaller, has obviously paler upperparts, orange legs, and a much smaller, stubbier, two-toned bill (its base is orange-yellow, and its tip is black) (Corbat and Bergstrom

Wilson's Plover (*Charadrius wilsonia*)

(http://www.audubonwildlifesociety.org/images/Plover-Wilsons-Sandy-Hook-.jpg)

2000; Hayman et al. 1986; Howell and Webb 1995). There is no federal protection status in the U.S. The Wilson's plover is listed as endangered in Virginia and Maryland, threatened in South Carolina, rare in Georgia, and state-protected in Alabama. Brown et al. (2000) list Wilson's plover as a "species of high concern" in their prioritization of shorebird species according to relative conservation status and risk (Corbat and Bergstrom 2000).

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). 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). 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).

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). Farther south along Pacific coast, it breeds in El Salvador (Thurber et al. 1987) and Panama, while in South America, it breeds along the entire Pacific Coast, from Colombia south to Peru (Hilty and Brown 1986).

Wintering. Wintering occurs mainly in northeast and central Florida (Robertson and Woolfenden 1992) 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).There are no data pertaining to Wilson's plover nonbreeding or wintering at Cape Hatteras National 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, Cape Hatteras National Seashore supported 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 were observed holding a territory for the breeding season at Cape Point. However, no nest was searched for, and the pair have not been seen in subsequent years (Lyons 2005 personal communication).

Habitat Description

Wilson's plover are typically associated with coastal areas of high salinity and sparse vegetation, including salt flats, coastal lagoons, sand dunes, predunes, and overwash areas above the high-tide line (Tomkins 1944; Johnsgard 1981; Bergstrom 1982; Hayman et al. 1986; Corbat 1990; Corbat and Bergstrom 2000.

At Cape Hatteras National Seashore, Wilson's plover's 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; Morrier and McNeil 1991; Thibault and McNeil 1994), 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; Thibault and McNeil 1994; Corbat and Bergstrom 2000).

Breeding Biology

Before territories are established in mid-March to early April (Tomkins 1944; Bergstrom 1988), Wilson's plovers form pairs, and most breeding territories are established by mid-April (Corbat 1990). As with the piping plover, the nest is a scrape in sand that requires little construction (Bergstrom 1982). Egg-laying can peak from late April through late May (Bergstrom 1982). 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 3 to 5 days (Bergstrom 1988; Corbat and Bergstrom 2000). There are no data pertaining to the timing of Wilson's plover breeding at Cape Hatteras National Seashore.

Reproductive Success at Cape Hatteras National Seashore

There are no data pertaining to Wilson's plover reproductive success at Cape Hatteras National Seashore.

Risk Factors

Because Wilson's plovers commonly nest on beaches with wide berms, which are also favored by beachgoers like piping plover, Wilson's plovers are subject to disturbances at their nests and roosts by beachgoers, pets, and off road vehicle (ORV) traffic on beaches. Wilson's plovers leave their nests when disturbed and are extremely reluctant to return when intruders are anywhere near, thereby exposing eggs to predation and overheating (Corbat and Bergstrom 2000).

RED KNOT

The red knot is a shorebird that breeds in the Canadian Arctic and is known to only visit North Carolina, the Outer Banks, and Cape Hatteras National Seashore, as well as the entire eastern seaborne of the United States, as a migrant and an occasional winter resident (Harrington 2001). Therefore, only those aspects of the red knot's life history pertinent to its management and conservation in North Carolina, the Outer Banks, and at Cape Hatteras National Seashore, will be covered in this section. The red knot is not listed as threatened or endangered by the U.S. Fish and Wildlife Service.

Red Knot (*Calidris canutus rufa*)

(http://www.audubon.org/News/press/North_east_birds%5CRed_Knot.jpg)

EMERGENCY ENDANGERED LISTING AND TAXONOMY

On August 1, 2005, in response to the 80% decline in red knot population over the past ten years, leading conservation groups filed an emergency petition asking the U.S. Fish and Wildlife Service to list the red knot as an endangered species under the

Endangered Species Act. The listing request comes 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.

Another indication of conservation concern for the red knots is the fact that in August of 2004, the U.S. Shorebird Conservation Plan (2004) 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

There are five (Morrison et al. 2004) or four (Harrington 2001) subspecies of the red knot currently recognized. Two of these (*Calidris canutus rufa* and *Calidris canutus roselaari*) are found in the United States but only during migration and in the winter. The red knot, is characteristically found along the east coast of the United States, with the greatest population-staging on Delaware Bay (Tsipoura and Burger 1999) 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 crown is flecked with gray and salmon, as is their back (Harrington 1996, 2001; Paulson 1993). 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, 2001). The average weight of the red knot is 5 ounces (which varies a lot 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 (Baker et al. 2005). Additional, smaller numbers of birds also winter further northwest in French Guiana and in the coastal, southeastern United States, including North Carolina, the Outer Banks, and the Cape Hatteras National 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, 2001). The first stopover is along the coast of southern Brazil (Vooren and Chiaradia 1990). 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). 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).

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 seabird 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 final flight, but also upon arrival in the Arctic until food resources become more plentiful (Baker et al. 2004).

According to representatives from the National Audubon Society, red knots within Cape Hatteras National Seashore will use oceanside beaches, 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.

Nonbreeding and Migratory Habitat

Harrington (1996, 2001) 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).

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, 2001). High-wave-energy is associated with these areas (Harrington et al. 1986; Vooren et al. 1990; Blanco et al. 1992). 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 et al. 1986; Harrington 1996, 2001; Tsipoura and Burger 1999). 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 et al. 1986) or for special foods, such as horseshoe crab eggs (Harrington 1996; Tsipoura and Burger 1999). 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 harvest of the horseshoe crab has reduced this food source and is believed to be contributing to the red knot's failure to reach their 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. 2005).

Risks

Red knots are highly vulnerable to degradation of the resources on which they depend to accomplish their migrations (Myers et al. 1978). Morrison et al. (2004) 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), 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). The single-most important cause of the red knot 's decline appears to be the acceleration of the harvesting of horseshoe crabs on the Delaware Bay that began in the 1990s.

Most disturbingly, research by Baker et al. (2004) indicates that if red knot populations continue to decline at their present rate, the bird would become extinct by, or near, 2010. New research by Niles et al. (2005) confirms that this extinction trajectory remains on track. 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.

WILDLIFE AND WILDLIFE HABITATS

In addition to the federally-listed threatened and endangered species and other protected species detailed in this assessment, a variety of other wildlife species depend on the habitats within Cape Hatteras National Seashore. Although a large number and variety of species, including more than 360 species of birds, use the seashore at some point within their life cycle, only a small fraction have strong links to this interim protected species management strategy. This section describes the mammalian predators, such as grey and red fox; invertebrate species that inhabit the intertidal sand flats, wrack line, and moist substrate habitat; and other bird species that use the same habitat as the species identified for protection under this proposed strategy.

MAMMALIAN PREDATOR SPECIES

From 2002-2005 the NPS undertook trapping to remove mammalian predators from Bodie Island and Hatteras Island. In 2002, 12 foxes were removed from Hatteras Island by U.S. Dept. of Agriculture (USDA) Wildlife Services personnel, and another 16 from Bodie Island. USDA officials believed there was still one fox left near South Beach, and a number of foxes on Bodie Island. In 2003, 15 foxes were removed from Bodie Island and 1 from Hatteras, as well as three opossums and one raccoon at Hatteras. Cape Hatteras National Seashore staff removed one feral cat from near Hatteras Inlet. Although a number of foxes were still believed to be on Bodie Island, no fox tracks were seen in plover habitat after trapping began in 2002. In addition, feral cats are serious predators on the islands and prey on colonial waterbird colonies year after year.

Year	Predator Species	Native to Cape Hatteras National Seashore (Y/N)	Number Removed
2002	Red fox	N	28
2003	Red fox	N	16
2004	Red fox	N	9
2004	Grey fox	N	6

INVERTEBRATES

Many of the protected bird species found within Cape Hatteras National Seashore feed upon invertebrates. Some, like the colonial waterbirds, feed over the open waters of the ocean, inlets and sounds, capturing small fish, shrimp and other invertebrates. However, the piping plover, Wilson's plover, red knot, American oystercatcher, and the gull-billed tern (a colonial waterbird) feed on invertebrates in the beach zones that are subject to ORV use. The areas of concentrated foraging include moist sands of sand flats, island spits, and the intertidal zone as well as the wrack line (drift line). Wrack lines are 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 cooler, moist habitat suitable for many invertebrates such as amphipods, beetles, mites, worms, flies, and spiders. 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 upper most 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.

Invertebrates on sandy beaches can be classified into two groups, meiofauna and macrofauna. Meiofauna live and feed among the sand grains and are an important part of the food chain. Meiofauna are less than 1.0 mm in size and are either juveniles of larger macrofauna or exist as meiofauna for their entire life history. On high energy beaches of coarse sand, the meiofauna can extend deep into the sediment. However, in low energy situations, such sand flats with fine sand, oxygen is the major limiting factor and the meiofauna is concentrated in the surface layers of the sand (Stephenson 1999). Some common meiofauna include copepods, oligochaetes, and some polychaetes.

Macrofauna are invertebrates larger than 1.0 mm 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). 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, variations in the penetrability of the sand, and from species actively aggregating (Stephenson 1999). Zonation across a beach results from exposure, changing wave energy levels and sand water content and stability (Stephenson 1999). Exposed sandy beaches are typically dominated by crustaceans, while polychaetes become increasingly dominant with decreasing exposure and dominate in very protected areas (Stephenson 1999). Ruppert and Fox (1988) found that high energy, intertidal beaches in the southeastern United States may have as many as 20 – 30 invertebrate species, while within the boundaries of Cape Hatteras National Seashore, Dolan and Donoghue (1996) found mole crabs, coquina clams, and ghost crabs to be important invertebrates in the beach community of Pea Island National Wildlife Refuge.

Invertebrates are also found within the wrack line. 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, while others migrate back and forth between the beach grass and the wrack, while still others migrate back and forth with the swash. However, the dynamics of the fauna on sandy beaches has never been completely investigated (Steinback in-prep).

OTHER BIRD SPECIES

Nearly 400 species of birds have been sighted within Cape Hatteras National Seashore and its surrounding waters (Cohen et al. 2005). This impressive number is due to several factors: a location on the Eastern Flyway, varied habitats, and strong winds and storms that often bring exhausted vagrants to the seashore. Some of these birds can be seen year round. Many spend only summer or winter seasons at the seashore. Thousands of shorebirds pass by during spring and fall migrations between North and South America. The seashore has recently been designated a Globally Important Bird Area by the American Bird Conservancy because of the importance of the seashore habitats to bird breeding, migration, and wintering (Watson 2003).

Coastal dunes and barrier island ecosystems are major features at Cape Hatteras National Seashore. Large numbers of migratory and nesting bird species are found on barrier islands (Stalter and Odum 1993 as cited in NPS 2005c). Coastal marshes are critical to overwintering populations of many waterbirds. In addition, migration routes of 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 (Stalter and Odum 1993 as cited in NPS 2005c).

Studies documenting the seasonal abundance, distribution, and relative importance of shoreline habitats to shorebirds on the Outer Banks of North Carolina recorded 21 species of shorebirds. The most abundant were sanderling, red knot, and willet. As an assemblage, shorebirds were most abundant in May and August. Peak numbers for each species were recorded between April-May and July-September. The

greatest numbers were recorded on North Beach and the lowest on South Beach (1992) and Bodie Island (1993). Shorebird abundance was greater during fall (68 birds/km) than in spring (50 birds/km). Patterns of abundance of the 8 most abundant species were examined in detail. Black-bellied plovers, willets, whimbrels, ruddy turnstones, and sanderlings were most abundant on North Beach. North Core Banks, at Cape Lookout National Seashore, harbored the highest numbers of piping plovers, American oystercatchers, and red knots. American oystercatchers and whimbrels were substantially more abundant during spring than fall, whereas willet and sanderlings were more abundant during fall. The Outer Banks emerged as an important staging area for the Atlantic populations of piping plovers, whimbrels, and sanderlings when compared to seven other areas along the eastern U.S. coast. The importance of the area to sanderlings was reaffirmed by return rates of 58%, most returning to the beach stretch where they were banded (Dinsmore et al. 1998). Findings from the 1998 study confirm that the Outer Banks of North Carolina provide a critical link in the migratory path of several shorebird species.

Migratory birds are also often found throughout the seasons on the way to and from their destination. During the winter months, the common loon, pied-billed grebe, northern gannet, tundra swan, as well as Canadian geese are common sights at the seashore. For the summer migratory season, several varieties of herons, Audubon's shearwater, and the barn swallow populate the Cape Hatteras shores. While less frequently sighted, several additional species of shearwaters, grebes, herons, ducks, geese, hawks, eagles, including the bald eagle, falcons, sandpipers and gulls also inhabit the island at one point or another throughout the year. Rarely birds like the tropical masked booby and the magnificent frigate bird can also be spotted.

VISITOR USE AND EXPERIENCE

Visitation at Cape Hatteras National Seashore (seashore) has grown steadily over the years, increasing from 264,500 visitors in 1955 to approximately 2.2 million visitors in 2004 (NPS 2005). Visitor use reports for 2005 indicate that through October approximately 2.1 million visitors had journeyed through the seashore. Highest use occurs during June, July, and August and accounts for approximately 45% of the annual recreation visits (based on 2004 data). Another 23% of annual visitation occurs during the fall (September, October, and November); 22% in the spring (March, April, and May); and, 9% in the winter (December through February) (NPS Public Use Statistics Office 2005a).

A study was performed by East Carolina University (ECU) for the National Park Service (NPS) to determine how visitors use the Cape Hatteras National Seashore (Vogelsong 2003). Data was collected on the distribution and character of use as well as on visitor attitudes toward visitor density, other activities, ORV use, satisfaction, and other factors. Data collection was collected over the course of a year from mid-May 2001 through mid May 2002, and included counts at multiple locations throughout the seashore of visitors, parked vehicles, and ORVs. Approximately 1,681 interviews were conducted throughout the year at 23 different locations within the seashore, including Hatteras Island and Ocracoke lighthouses, Coquina Beach, developed facilities, walkovers, fishing piers, the Ocracoke campground, and 10 ORV ramps. Much of the data in this "Visitor Use and Experience" section is derived from this study.

Visitor counts conducted during this study (Vogelsong 2003) indicated that, on average, each vehicle in the seashore carries approximately 2.26 occupants. When extrapolated to all vehicles entering the seashore, it was estimated that approximately 2.25 million visitors entered the seashore during 2003. NPS visitation records indicate approximately 2.8 million visitors in 2003 (NPS 2005).

Approximately 2.09 million visitors entered the seashore along North Carolina Highway 12 (NC-12) southbound. The remaining visitors entered the seashore from Cedar Island or Swan Quarter on the Ocracoke Ferry. The areas that received the greatest number of visitors occurred at developed attractions that easily accommodated many visitors. Oregon Inlet Marina had the highest vehicle count, averaging approximately 145 parked vehicles at any one time. The lighthouses, visitor centers, and fishing piers also attracted higher levels of use. Semi-developed areas such as Coquina beach received moderate levels of use (average of 29 vehicles). Generally, non-developed areas, including the walkovers, supported relatively little visitor use in comparison to other locations. The exception is the spits of land adjacent to the inlets within the seashore that receive heavy amounts of ORV use (discussed below) (Vogelsong 2003).

VISITOR CHARACTERISTICS

Visitors sampled during 2001 and 2002 were primarily men (70%), approximately 30 to 50 years in age, and were visiting the seashore with at least two other people. Although most visitors were from North Carolina and Virginia (62%), they traveled more than 300 miles to reach the seashore and averaged a one-week stay. The majority visited the seashore one to three times annually (Vogelsong 2003). Another study conducted by the University of Idaho during one week in July 2002, also showed that many visitors (44%) were from North Carolina and Virginia. Approximately 10% were from Ohio, and smaller proportions of visitors came from other 29 states and Washington, DC. Over 50% of visitors were between 30 and 50 years of age (University of Idaho 2002).

RECREATIONAL OPPORTUNITIES AND USE AT CAPE HATTERAS NATIONAL SEASHORE

A diverse range of recreational opportunities are provided at the seashore, including auto touring, biking, bird watching, boating, camping, fishing, hiking, hunting, kayaking, nature walks, snorkeling, star gazing, swimming, wildlife viewing, and wind surfing. Based on results from surveys distributed during 2001 and

2002 (Vogelsong 2003), recreational fishing was the primary activity reported by most visitors (see table 15). In the survey it was possible for respondents to have more than one primary purpose, resulting in more responses to the primary purpose questions than number of surveys taken. This was followed by sunbathing, swimming, beach driving, camping, and visiting lighthouses. Many of the activities identified by visitors such as beach driving and bird watching are secondary in nature and are not the primary reason for their trip to the seashore (Vogelsong 2003). According to the University of Idaho study (2002), the three most important reasons for visiting Cape Hatteras National Seashore mentioned most by visitors was the lighthouses, the beach, and then fishing. Historical significance and swimming followed closely. The most common reasons for visiting were the lighthouses, swimming, and opportunities for escaping crowds and seeking solitude (University of Idaho 2002).

A third study commissioned by the Outer Banks Preservation Association (OBPA) in 2002 and 2003 indicated that visitors to the Outer Banks identified the following activities as the most popular: beachcombing (76%), walking/jogging (69%), swimming (54%), sunbathing (54%), and beach fishing (60%). However, those who beach fish do almost every day during their visit (95%). These results are based on a survey of 438 visitors to Hatteras and Ocracoke Islands (OBPA 2004).

TABLE 15: VISITOR PARTICIPATION IN ACTIVITIES[a]

Activity	Primary Purpose for Visit	Participated or Planned to Participate
Beach (ORV) driving	66	783
Bird watching	6	316
Bicycling	4	187
Camping	43	180
Fishing (commercial, recreational, and tournament)	389	760
Hunting	0	5
Jogging/walking for exercise	3	439
Kayaking or canoeing	3	118
Motor boating	1	79
Nature-related or environmental programs	0	75
Picnicking	2	323
Sailing	1	17
Shell collecting	7	608
Special Events	1	87
Sunbathing	112	731
Surfing	18	143
Swimming	94	757
Visiting lighthouses	26	521
Walking for enjoyment	14	677
Walking the dog	1	197
Windsurfing	14	36
Other (reading, time with family, shopping, etc.)	2	51

Source: Vogelsong 2003

[a] Derived from 1,681 visitor surveys

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 in 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 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 of Cape Hatteras National Seashore are known throughout the world as highly productive fishing areas. The fish that congregate in the waters off the Outer Banks attract fishermen from throughout the region, but largely from North Carolina and Virginia. In the spring and fall, when bluefish, spotted sea trout, red drum, and other species are located 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 "head") are available at local marinas.

Visitor counts by recreational activity show that recreational fishing is a dominant visitor use within the seashore. The Rodanthe and Avon fishing piers averaged approximately 34 and 25 visitors at one time, respectively, with maximum visitors counted between 200 and 250 at one time (Vogelsong 2003). Particularly productive and high demand fishing areas include Ocracoke, Hatteras and Oregon Inlets and Cape Point that are often accessed via ORVs. Off-road vehicle 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 on table 16. Tournament data from 2001 to 2005 indicates that normally about eight fishing tournaments occur annually and while data is not available for actual attendance, the fall events are well attended, and for 2005 estimates indicate that more than 720 fishermen participated in one event that lasted for two days. Some tournaments may only have 25 participants, depending on the availability of fish and good weather. Restrictions are placed upon the events as to location and times to ensure the availability of recreational areas for other visitor to the seashore. 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, pers. comm., D. Otto, Louis Berger Group, Inc., December 20, 2005).

TABLE 16: FISHING TOURNAMENTS IN 2004/2005

Applicant	Address	Tournament Date	People Authorized	Tournament Location within the Seashore
Cape Hatteras Anglers club	Buxton, NC	November 3	720	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 2/10th 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.
4 Plus Four Wheel Drive Club	Glen Allen, VA	April 23	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.
Hatteras Village Association	Hatteras, NC	September 9	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.
Nags Head Surf Fishing Club	Nags Head, NC	October 6	240	Ocean beach from Coquina Beach to Ramp 4.
Outer Banks Association of Realtors	Nags Head, NC	May 20	150	Ocean beach from Coquina Beach to Ramp 4.
Ocracoke Invitational Surf Fishing Tournament	Ocracoke, NC	May 4	240	Ocean beach between Ramps 68 and 72.
Capitol City Four Wheelers	Richmond, VA	October 15	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.
Surf Fishing Info.	Rodanthe, NC	December 2	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: Fishing tournament data, NPS 2005

OFF-ROAD VEHICLE USE AND ACCESS

As noted in "Purpose and Need," 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. Off-road vehicles 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).

Off-road vehicles access the beach via a system of ramps located off of 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 the dune from being further breached (OBPA 2005). 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). These ramps are listed in table 17 and shown in figure 8. Each ramp number on the map refers to the approximate mile on NC-12 south of Nags Head on Bodie Island.

TABLE 17: 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
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 2004a (Off-road Vehicle Beach Access Ramp History)

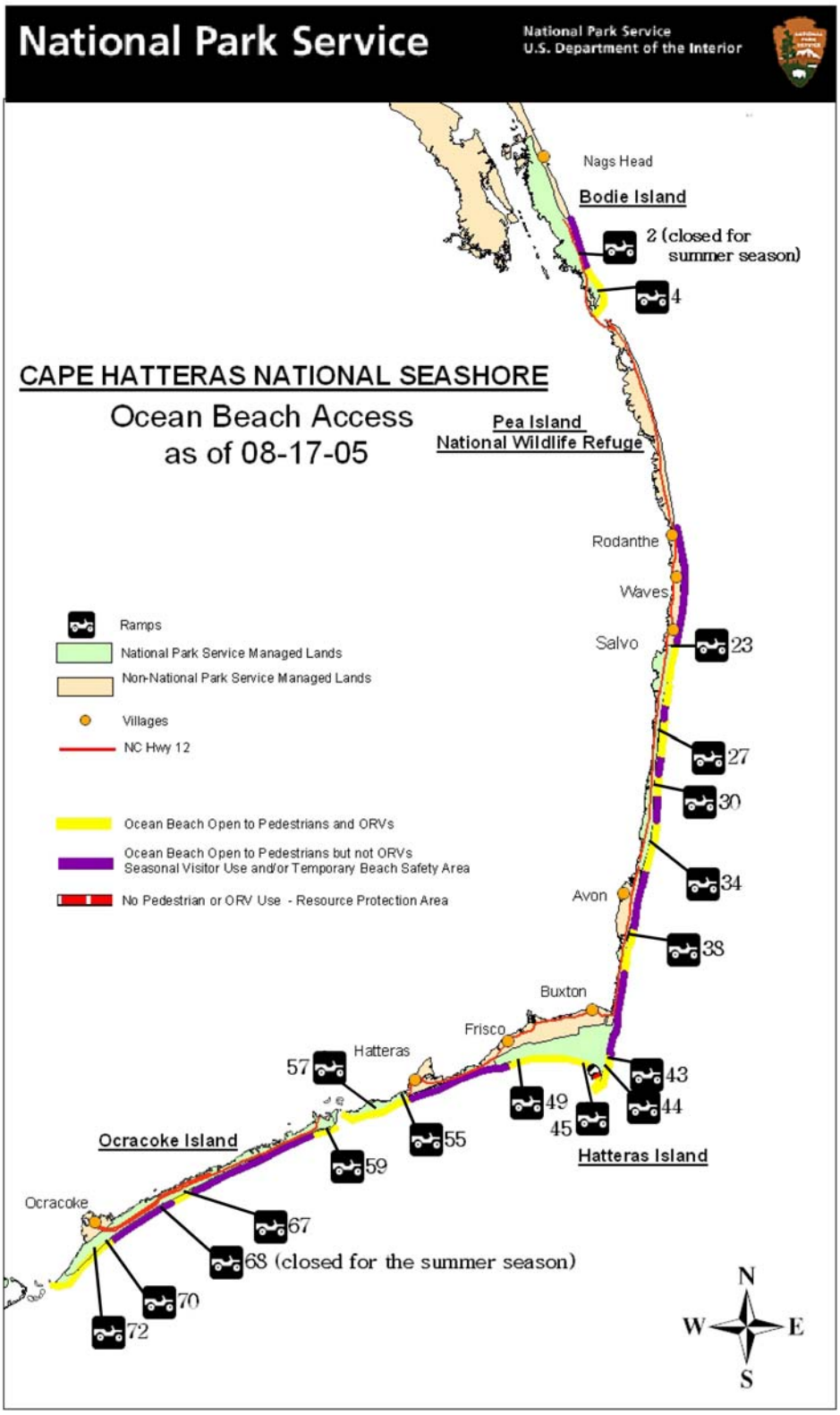


FIGURE 8: OFF-ROAD VEHICLE RAMPS AT CAPE HATTERAS NATIONAL SEASHORE

Off-Road Vehicle Use. Table 18 indicates that an average of 251.8 ORVs were counted on seashore beaches at any one time during the 2001 and 2002 visitor surveys and counts. On an annual basis, this daily figures indicates that approximately 10% of total seashore visitation or roughly 91,907 ORVs frequent seashore beaches. The total number of ORV users is based on 2.26 visitors per vehicle. Assuming this number is accurate plus or minus 20%, a more reasonable estimate of ORV beach use would include a range of 73,256 to 110,288 ORVs or 166,300 to 249,450 visitors annually (Vogelsong 2003). Of the visitors surveyed, 1,276 or approximately 76% indicated they owned or rented an ORV. Of these ORV owner/renters, 90% (or 68% of all surveys) spent some time on the beach driving at Cape Hatteras National Seashore (Vogelsong 2003).

The greatest average numbers of ORVs at any one time, as shown in table 18, were at Ramps #43, 44, and 45 at Cape Point (average of 86 ORVs); Ramp #4 at Oregon Inlet (70.2 ORVs); Ramp #72 at South Point near Ocracoke Inlet; and, Ramp #55 near the Hatteras Inlet. These four sites accounted for more than half of the average ORV counts (252/day) that use the seashore at one time. Other more popular ORV ramps included Ramp #49 near Frisco Campground and Ramp #70 near Ocracoke. Other oceanside ORV ramps, although easily accessible, received low use in comparison to the inlet access points. Although counted as often as other access points, the soundside ramps were rarely used (Vogelsong 2003).

Off-Road Vehicle and Pedestrian Closures. A number of areas throughout the seashore are closed to ORV travel on a permanent basis 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, Cape Hatteras National 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 Cape Hatteras National Seashore boundary, and are managed separately and under a different regulatory framework by the U.S. Fish and Wildlife Service.

Currently, all Cape Hatteras National 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 Cape Hatteras National 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 or 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).

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 history 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 in order to provide continued beach access for ORVs. Temporary wildlife closures are closed to both ORV and pedestrian use.

TABLE 18: VISITOR COUNTS AT CAPE HATTERAS NATIONAL SEASHORE – MAY 2001 TO MAY 2002

Location	Minimum	Maximum	Average
Number of Visitors at Each Location			
Coquina Beach	0	392	51.5
Frisco Bath	0	109	19.2
Roadanthe Fishing Pier and beach area	0	250	34.0
Pea Island Walkover (oceanside 3 miles south of VC)	0	68	9.9
Hatteras Island Walkover (ramp #27)	0	171	21.8
Avon Fishing Pier and beach area	0	200	24.6
Average number of Visitors at one time	0	649	107.8
Number of Seashore Vehicles at Each Location			
Whalebone Junction Information Center	0	17	6.0
Pea Island Walkover	0	36	4.6
Oregon Inlet Marina	0	357	145.0
Ocracoke Lighthouse/Visitor Center (combined)	2	155	57.2
Ocracoke Island Walkovers	0	153	42.7
Haulover Day Use Areas	0	117	20.8
Hatteras Island Walkover (ramp #37)	0	29	2.9
Hatteras Island Lighthouse/Visitor Center (combined)	0	225	82.5
Hatteras Island Day Use Area	0	20	4.9
Frisco Bathhouse	0	65	13.4
Coquina Beach	0	124	29.2
Bode Island Lighthouse and Visitor Center	1	57	24.2
Number of Campers at Ocracoke Campground	0	120	51.5
Average number of Parked Vehicles at one time	1	1111	320.4
Number of ORVs at each Ramp			
Ramp# 4 (Oregon Inlet)	0	353	70.2
Ramp# 23	0	68	12.5
Ramp# 27	0	33	5.9
Ramp# 30	0	27	3.8
Ramp#34	0	54	12.3
Ramp# 38	0	86	11.7
Ramps #43, 44, and 45 (Cape Point)	0	234	86.2
Ramp #49 (near Frisco Campground)	0	271	37.49
Ramp #55 and #57 (Pole Road - Hatteras Inlet)	0	158	45.6
Ramp #59	0	14	3.3

TABLE 18: VISITOR COUNTS AT CAPE HATTERAS NATIONAL SEASHORE – MAY 2001 TO MAY 2002

Location	Minimum	Maximum	Average
Ramp #67	0	28	5.2
Ramp #68 (near Ocracoke Campground)	0	19	3.3
Ramp #70	0	131	31.6
Ramp #72 (South Point – Orcacoke Inlet)	0	153	52.7
Total # of ORVs at 3 soundside ramps	0	5	0.4
Average Number of ORVs at one time	0	1288	251.8

Source: Vogelsong 2003

Note: Counts were conducted throughout the year from May 2001 to May 2002. Data collectors counted visitors, parked vehicles, ORVs, and people per vehicle. Minimum and maximum counts represent the number of visitors observed at the time data was collected. The average represents the total number of visitors counted at each site during the study period, divided by the number of times the site was counted. The minimum, maximum, and average represent the year of data and are not daily figures.

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)

In 2005, at Hatteras Spit, ORV traffic was only permitted 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. "Gate keepers" were posted at each end of the escort route to assure that no unescorted ORVs enter the restricted area (NPS 2005b). 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 AM until 8 PM daily beginning on May 21, 2005 and ending on June 16, 2005 (27 days) (Michelle DeMatteo, NPS, pers. comm.., D. Otto, Louis Berger Group, Inc., November 07, 2005). 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 (NPS 2005c).

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 Cape Hatteras National Seashore. Approximately 39 temporary closures were implemented in ORV use areas in 2005. Generally, ORVs and pedestrians can negotiate around these posted closures. However, when the turtle eggs are 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).

Safety closures. Areas normally open to ORV use often close for reasons of safety. Adverse weather conditions can result in narrow beach areas or flooded conditions, among other hazards, and necessitate 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 Ocracoke Island (Email communication 11/15/05). 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).

OTHER RECREATION USES

As shown in table 18, other areas with high average visitor or vehicle counts include Ocracocke and Hatteras Island lighthouses and visitor centers, Coquina Beach, and Ocracoke Campground. Swimming, sunbathing, and visiting lighthouses are also major uses as suggested by the results of the visitor survey. Several of the walkovers that provide access to the seashore's beaches were also popular based on parked vehicle counts.

CROWDING AND VISITOR ENCOUNTERS

Visitors in the study indicated that, for the most part, they did not feel crowded by other seashore users and found the number of people on the beach during their visits to be quite acceptable. Although visitors were satisfied by the current seashore use levels, they also indicated they would have liked to see fewer people on the beach. Thus, although they are relatively pleased with the numbers of users they are encountering, visitors to the Cape Hatteras National Seashore like uncrowded beaches and prefer low densities of users (Vogelsong 2003). This finding is consistent with the results of University of Idaho study (2002) that indicated one of the reasons people visit the seashore is to escape crowds and seek solitude.

It was also determined how visitors perceived crowding while participating in the 13 most reported primary activities participated in by seashore visitors, including recreational fishing and beach driving, and at different locations throughout the seashore. Crowding perceptions were similar across these activities, except that boaters indicated that other visitors enhanced their experience and surfers desired to see fewer people.

VISITOR SATISFACTION

Visitors are highly satisfied with their trips to Cape Hatteras National Seashore based on the 2001 and 2002 survey results (Vogelsong 2003). Only 7% of visitors indicated that there were too many people on the beach and that the number of people at the seashore reduced their enjoyment. Similarly, only, 11.9% felt there were too many ORVs at the beach. Regarding existing conflict, the most visitors reported that the behavior of other visitors at the seashore did not interfere with their experience. A number of visitors (16.7%) stated that ORVs came closer to their group than they would like and approximately one-third of visitors indicated that ORVs affected their experience to some degree. However, approximately 59.2% of visitors agreed that ORV use does not effect their enjoyment of the seashore. Nearly all respondents (96.5%) thoroughly enjoyed their trip to the seashore and indicated that is was well worth the money spent (93.4%) (Vogelsong 2003).

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 strategy/EA encompasses two counties in coastal North Carolina—Dare and Hyde. These counties form the economic region of influence (ROI) and define the geographic area in which the predominant social and economic impacts from the proposed alternatives are likely to take place. Located within these counties are towns and villages that would likely be most affected by the proposed actions, including several villages on Hatteras Island (Ocracoke, Hatteras, Frisco, Avon, Buxton, Hatteras, Frisco, Salvo, Waves, and Rodanthe). The largest towns within the ROI include Nags Head, Kill Devil Hills and Kitty Hawk. Information in this section focuses on characteristics of the two counties relevant to the alternatives.

DEMOGRAPHICS

The two counties comprising the economic ROI are primarily rural in character, although portions of Dare County, especially in the north, are quite 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.

Demographic and economic trends during the last three decades have contributed to growing differences in population characteristics and income levels between the two counties. As a leading tourist destination in North Carolina, Dare County has a substantially larger transient and resident population of the two jurisdictions. Its resident population is changing much more quickly than Hyde County, as indicated by the statistic that in 2000 that only 35% the Dare County residents had been born in North Carolina, compared to almost 79% of the residents in Hyde Country (2000 Census).

With a population of 5,521, Hyde County is the second smallest county in North Carolina, and ranks 2,803 out of out of 3,141 counties and county equivalents (boroughs and parishes) in the nation. In contrast, with a population of 33,518 in 2004, Dare County ranked 68 out of the 100 North Carolina Counties and was the 1,324th largest county nationally. More importantly, growth rates for the two counties have diverged greatly over the past three decades. Whereas the population of Hyde County increased by only 4.6% during the period 1970 to 2000, Dare County's population increased by more than 328% during that same period. As shown in table 19, the population of Hyde County increased from 5,571 in 1970 to 5,826 in 2000, an increase of just 255 persons in 30 years. Concurrently, the population of the Dare County increased from 6,995 to 29,967. Since 2000, the Hyde County population has actually decreased while the Dare County population grew by more than 10%. Population data for North Carolina and the United States are also provided in table 20 for comparison purposes.

TABLE 19: HISTORICAL POPULATION LEVELS

Location	1970	1980	1990	2000	2004
Dare County	6,995	13,377	22,746	29,967	33,518
Hyde County	5,571	5,873	5,411	5,826	5,521
ROI	12,566	19,250	28,157	35,793	39,039
North Carolina	5,084,411	5,880,086	6,632,448	8,049,313	8,541,221
United States	203,211,926	226,545,805	248,709,873	281,421,906	293,655,404

Source of 1970, 1980, 1990, and 2000 data: US DOC, Census, 2000
Source of 2004 data: US DOC, Census, 2005

Recent demographic forecasts by the North Carolina State Demography Section (North Carolina, 2005) projected continued population growth for Dare County, but virtually no increase for Hyde County. As seen in table 20, Hyde County is projected to have almost the same population in 2020 as it did in 2005. The Dare County population is projected to increase at about 2% per annum for the period 2005 to 2020.

TABLE 20: POPULATION PROJECTIONS FOR THE COUNTIES

	July 2005	July 2010	July 2015	July 2020	Annual % Change 2005-2010	Annual % Change 2010-2015	Annual % Change 2015-2020
Hyde	5,607	5,600	5,618	5,644	-0.02	0.06	0.09
Dare	35,145	39,370	43,235	47,278	2.3	1.9	1.8
ROI	40,752	44,970	48,853	52,922	2.0	1.7	1.6

Source: North Carolina State Demographic Section 2005

EMPLOYMENT

As noted above, with the exception of the northern portion of Dare County, the two counties are primarily rural. There are no military bases, major federal facilities, state prisons, commercial airports, or four-year colleges in either. The ROI economy is driven primarily by small businesses, typically employing fewer than 10 workers. In Hyde County only 8 out of 168 businesses operate with more than 20 employees (2003 County Business Patterns). Hyde County's rural character is further distinguished by the fact that almost 14% of the jobs in the County are in the fishing and forestry sector. Nationally, only 0.6% of the civilian labor force is engaged in these activities. The other important major job producing sectors in Hyde County are government and government enterprises, accommodation and food services, construction, agriculture, and retail trade. The public sector generates more than 26% of the total employment in Hyde County. About 19% of the Hyde County workforce is classified as professionals (North Carolina Rural Economic Development Center, 2004)

In Dare County, retail trade, accommodations and food services, and real estate sectors are the major sources of employment. Together, these three sectors generated approximately 45% of the County's jobs in 2003. In contrast to Hyde County, public sector employment accounts for only 10.6% of the total jobs. Dare County has a higher percentage of the workforce (30%) classified as professional as does Hyde County.

Table 21 presents total employment in the two counties and the percentage distribution of jobs by sector. As seen in the table, those sectors related to tourism, such as retail trade and accommodations are major drivers of private sector employment in both counties. Manufacturing and high technology sectors contribute little to the overall employment status of the region.

TABLE 21: EMPLOYMENT IN DARE AND HYDE COUNTIES

Industry Sector	Dare County (Number)	Dare County (Percent)	Hyde County (Number)	Hyde County (Percent)
Agric. Ser., Forestry, Fishing	D	D	428	13.7
Mining	D	D	0	0
Construction	3,074	11	218	7
Utilities	88	0.3	D	D
Manufacturing	651	2.3	123	3.9
Wholesale Tr.	458	1.6	128	4.1

TABLE 21: EMPLOYMENT IN DARE AND HYDE COUNTIES

Industry Sector	Dare County (Number)	Dare County (Percent)	Hyde County (Number)	Hyde County (Percent)
Retail Trade	4,215	15.1	213	6.8
Trans and Warehousing	290	1	D	D
Information	342	1.2	D	D
Finance and Insurance	649	2.3	27	0.9
Real Estate	3,637	13.1	73	2.3
Prof. Tech. Services	D	D	42	1.3
Mgmt. of Companies	D	D	D	D
Adm. And Waste Services	1,550	5.6	D	D
Educational Services	116	0.4	13	0.4
Health Care	914	3.3	131	4.2
Arts and Recreation	796	2.92	44	1.4
Accommodations Food Services	4,691	16.9	318	10.2
Other Services	1,419	5.1	D	D
Government	2,590	10.6	826	26.5
Total Employment	27,285	100	3,116	100

Source: BEA 2005

D= Not shown to avoid disclosure of confidential information

Hyde County unemployment rate has increased in recent years from 5.9% in 2000 to an average of 6.9% in 2004. Dare County unemployment rates have also drifted upward from 4.2% in 2000 to an average of 4.5% in 2004. Because of Hyde County's smaller population and workforce, that County is more likely to experience larger annual variations than Dare County. Nonetheless, Hyde County's 2004 unemployment rate was substantially higher than the 2004 national unemployment rate of 5.5%.

TOURISM CONTRIBUTIONS TO THE ECONOMY

The economy of Dare and Hyde Counties is largely driven by the region's tourist draw, mainly during the summer months. The region has, in fact, experienced an almost uninterrupted and rapid growth in this sector for more than a decade. For example, the North Carolina Department of Commerce (NCDC) has estimated that since 1990, annual revenues generated by the tourism sector have increased from $243.8 million dollars to $644.8 million, an increase of 264%. The vast majority (96%) of the counties' tourism revenue is generated in Dare County where Cape Hatteras National Seashore, Wright Brothers Memorial, and Fort Raleigh are all located. The remaining 4% was generated in Hyde County where Ocracoke Island, Lake Mattamuskeet, and the Ocracoke Island Lighthouse are located (NCDC 2004).

As described above, the accommodations and food and real estate sectors are major sources of employment in both counties, but especially in Dare County. Unsurprisingly, these sectors are also major the major sources of direct revenue, with Duck, Kill Devil Hills, and Nags Head in Dare County as the primary destinations of tourists remaining overnight. In 2004, these three towns generated more than $156.2 million in occupancy receipts, which accounted for about 60% of the region's total occupancy revenue for that year. Most of the occupancy receipts in these towns as well as in the rest of the county are derived from the rental of vacation homes. For example, in 2004, approximately $193.6 million in ROI revenues were generated in real estate (recreational home rental) compared to $46.9 million from hotels and motels (Outer Banks Chambers of Commerce 2005).

Tourism in the region generates much of the Region's employment. The NCDC estimated that in 2004, 11,330 jobs in the ROI were attributable to tourism. Accordingly tourism-related jobs accounted for 40% of all jobs in Dare County and for 13% of all jobs in Hyde County, based on total employment estimates for the two counties. The tourist sector is also a major source of government revenues. According to the NCDC, tourism provided almost $65 million in tax revenue during 2004.

TOURISM ACTIVITIES AND EXPENDITURES

Tourists visit the Cape Hatteras Region to participate in a broad range of activities associated with the national seashore, the historic sites associated with the Wright brothers' first flight, and other local attractions. Although no data exist to estimate expenditures by activity (e.g., fishing, swimming, ORV driving), the 2003 Cape Hatteras National Seashore Visitor Use Study (Vogelsong 2003), provides a general overview of visitor activity preference and the subsequent contribution of tourists to the local economy.

The Visitor Use Study estimated that 2.25 million visitors entered the national seashore during the year 2003 and that approximately 10% of the visitors, or approximately 225,000, used ORVs. Respondents to the survey indicated that recreational fishing was the primary activity, followed by sun bathing and swimming. Other activities ranging from beach driving to shell collecting were frequently cited as activities the respondents were planning to partake, however, few individuals indicated that these activities were their primary activity.

The study also was used to create a profile of the average visitor. The major finding included that, on average, visitors to the Cape Hatteras National Seashore traveled more than 300 miles and the average length of stay was approximately one week long.

Finally, the study surveyed visitor expenditures by category. On average, visitors spend $511 per day and $1,868 per visit. Expenditures for accommodations and food and beverage accounted for nearly 50% of the daily expenditures. Shopping, transportation, and "other" expenditures accounted for the remainder of daily costs to visitors. A second study, conducted for the Outer Banks Preservation Association (Neal 2005), focused on tourist activities in the Lower Outer Banks, and found similar levels of spending by visitors. Respondents to that survey indicated that visitors' average spending per week totaled $1,963. These expenditure estimates further indicate the enormous contribution of tourism to the regional economy

PERSONAL INCOME AND UNEMPLOYMENT

The economic status of the Hyde and Dare Counties also diverged in terms of income creation. Whereas the per capita income of Dare County has increased relative the national per capita income (PCI) during the period 1993 to 2003, Hyde County has continued to lag. As shown in table 22 while both counties have PCI levels lower than the United States, Dare County has been able to substantially reduce the gap in the last decade. While, Hyde County's PCI decreased from 67.8% of the national PCI in 1993 to 65.3% in the year 2003, Dare County's PCI has increased to almost 94% of the national PCI. The poverty rate in Hyde County was almost double that of Dare County (15. 4% versus 8% in 2000). As another indicator of relative wealth, the 2000 Census reported that nearly 12% of the residents of Hyde County received food stamps compared to only 1.8% in Dare County.

HOUSING

Housing Characteristics for the two counties are summarized in table 23, which identifies both owner-occupied and renter-occupied homes, along with median home values, for each county in the ROI. The housing units identified in the table include all structure types (e.g., single-family homes, apartments, and mobile homes). Housing was reviewed on a regional basis because the growth the region has experienced a growth in housing values and numbers.

TABLE 22: PER CAPITA INCOME OF THE ROI, NORTH CAROLINA, AND THE UNITED STATES

	2003 Per Capita Income	1993 Per Capita Income*	Percentage US Per Capita Income - 2003	Percentage US Per Capita Income - 1993
Dare	$29,466	$23,052	93.6	84.8
Hyde	$20,564	$18,438	65.3	67.8
North Carolina	$28,071	$24,926	89.2	91.7
United States	$31,472	$27,181	100	100

Source: BEA 2004; * Adjusted for inflation.

TABLE 23: HOUSING CHARACTERISTICS FOR DARE AND HYDE COUNTIES

	Dare County	Hyde County
Total Housing Units	26,671	3,302
Occupied Housing Units	12,690	2,185
Owner-occupied	9,460	1,713
Renter-occupied	3,230	472
Vacant Housing Units	13,981	1,117
Vacant for Seasonal, Recreational, or Occasional Use	13,355	666
Median Home Value (Owner-occupied)	128,600	60,100

Source: Census 2000

As major tourist destinations, both counties housing stock include a large proportion of vacation homes. In 2000, more than half of the housing units in Dare County and more than 20% of the units in Hyde County were classified as seasonal or vacation homes. In comparison, only about 3% of the housing units nationally are classified vacation or seasonal units.

As with other economic indicators, the two counties have very different housing markets. Hyde County's housing market could be characterized as stagnant, with only an estimated 90 units added between 2000 and 2004. The estimated median value of owner-occupied units in Hyde County was $60,100, almost half of nationwide median value of $119,600.

At the end of 2004, it was estimated that the total number of housing units in Dare County increased to 30,555, an increase of almost 15% since the 2000 Census. Many of the new units are likely to be vacation homes. The medium value of owner-occupied housing units in Dare County was more than double the medium value of housing units in Hyde County. With a medium value of $128,600, Dare County homes exceeded the national medium value of owner-occupied homes.

QUALITY OF LIFE

Quality of life encompasses those attributes or 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 quality of life of an affected ROI's inhabitants. For purposes of this study, the quality of life affected environmental includes public schools, law enforcement, medical facilities, and fire protection services.

SCHOOLS

The ROI has two public school districts (one in each county) with a total of 15 primary and secondary schools serving a student population of about 2,700. The Hyde County Schools in the ROI have student/teacher ratios lower than the state and national averages of 16.8 and 15.9, respectively, with an average of 7.7 (NCReport card 2005). Each county's public school district provides education facilities for those students residing in the small towns throughout the counties in pre-kindergarten through 12th grade.

The Dare County Schools are operating at capacity. Since 2003 the district has been expanding the square footage of its buildings by 43% through construction of new schools and additions to existing structures (Dare County Schools 2005). The Hyde County schools are operating at or below capacity.

The public school districts in the two counties receive funding from local, state, and federal sources. However, the most revenues to public schools are provided through the Public School Finance Act of 1994 (as amended). The legislation provides for school funding via state taxes, vehicle registration taxes, and local property taxes. Both counties receive the majority of their funds from the state. Hyde County is the smallest school district in the state of North Carolina with an average of 667 students per day. As a result, they have a high per pupil expenditure of $12,000 (NCReport card, 2005).

PUBLIC SAFETY

Police Services

Table 24 shows an ROI total of 212 law enforcement personnel, including sheriffs, deputies, police officers, dispatchers, and other staff. Together these law enforcement personnel cover a land area of about 1,000 square miles and a population of almost 36,000. This averages out to about 1 law enforcement employee per 5 square miles of the ROI, and about one staff per 170 people in the ROI.

Fire Services/EMS

Fire protection services in the ROI are provided through both career and volunteer fire departments in Dare and Hyde counties. Approximately 290 and 83 staff and volunteers man fire departments in Dare and Hyde County, respectively. Many of the fire departments have mutual aid agreements to provide fire-fighting assistance when needed.

A central emergency dispatch and response 911 service is available in both counties in the ROI. One emergency medical technician (EMT) is employed by Hyde County and is stationed in Swan Quarter (Hyde County Gov 2004). The Dare County Emergency Medical Service operates 8 ambulances and one emergency helicopter with 8 stations throughout the county. An advanced life support (ALS) equipped ambulance responds to every call (Dare County Gov 2004).

TABLE 24: POLICE RESOURCES

Agency	Full-Time Employees
Dare County[1]	
County Sheriffs Dept	142
Kill Devil Hills	23
Manteo	6
Nags Head	20
Hyde County[2]	
County Sheriff's Office	21
Total ROI	**212**

[1] Source: Capitol Impact 2004; [2] Source: Hydecounty.org 2004

Health Care Facilities

The Outer Banks Hospital in the town of Nags Head, Dare County is the only 24-hour emergency care hospital in the ROI and was built in 2002. The hospital employs 4 year-round physicians and hires an additional 3 physicians during the busier summer months. The hospital's service area includes the entire Outer Banks region. The hospital has 17 beds in the emergency room and 19 beds in the acute care department. There are additional beds in the Labor and Delivery Department. In total, Dare County employs 40 physicians and Hyde County employs 2 (Outer Banks Chambers of Commerce 2001).

SEASHORE MANAGEMENT AND OPERATIONS

Seashore operations, as it relates to species management, is comprised of Interpretation, Resource Management, and Law Enforcement Divisions and their staffs in the Bodie Island, Hatteras Island, and Ocracoke Island districts of the seashore. Within each of these divisions, both staff time and financial resources partially dictate the level of resource protection that can occur. Species-management activities at the seashore have varied over the past three years, but the level of staffing to accomplish these activities has remained relatively constant.

Although there have been variations, 2004 is representative of typical resource-management activities. During this time period, natural resource management activities consisted of surveying and management of protected species of birds and turtles, as well as interpretive programs to inform seashore visitors about these species. The following discussion details typical resource-management responsibilities and associated costs for the Interpretation, Resource Management, and Law Enforcement Divisions. Staffing and funding for these divisions, as it relates to protected species management activities, is shown in table 3 in the "Alternatives" chapter.

INTERPRETATION DIVISION

Staff in the Interpretation Division engage in the following resource-management activities, listed with their associated approximate annual costs: (1) interpretive programs at the Visitor's Center-$5,000; (2) creation of a television program-$3,500; (3) full-page articles in the seashore's newspaper-$4,600; (4) website maintenance and postings-$5,000; (5) notices to tackle shops and other interested parties-$10,000; (6) press releases-$5,000; and (7) turtle education programs-$3,000. The typical amount of interpretation staff time spent on resource-management activities ranges from 2% to 40% of the total time, with most staff spending between 2% and 15%. The interpretation staff time for resource-management activities totals approximately $43,000, with an additional $10,500 required for materials and supplies, such as printing, TV time, speakers, and so on (F. Davis, NPS, pers. comm., K. Lusby, Louis Berger Group, Inc., December 01, 2005), all of which includes the activities listed above. The total approximate cost for interpretation staff time and materials is $53,240 per year.

RESOURCE MANAGEMENT DIVISION

Natural resource management staff responsibilities include surveying and management of the endangered species found at the seashore, as detailed in "Chapter 2, Alternatives." Natural resource management staff is made up of three, full-time employees, four seasonal employees among the three districts, and four Student Conservation Association interns among the three districts. Total staff costs for natural resource management is approximately $156,000. In addition to staff time, an additional $67,500 is required for materials and supplies, such as vehicle rental costs, signage, stakes and strings, cameras, film, Student Conservation Association housing, radios, cell phones, airplane costs, and the U.S. Department of Agriculture predator-removal contract, which is approximately $4,500 per year (R. Clark, NPS, pers. comm., L. Gutman, Louis Berger Group, Inc., December 01, 2005). The total approximate cost for resource-management staff time and materials is $223,500 per year.

LAW ENFORCEMENT DIVISION

For law enforcement, a total of 16 staff across the three districts, Fort Raleigh, Wright Brothers, and headquarters, spend a portion of their time on resource management activities. These activities include, but are not limited to, answering phone calls regarding resource-management concerns, responding to incidents and violations, and conducting special operations in response to the level of compliance by the public (N. Martinez, NPS, pers. comm., L. Gutman, Louis Berger Group, Inc., November 22, 2005). The cost of law-enforcement staff time for natural resource management is $52,948. An additional $59,182 is required for materials and supplies, such as vehicle rental costs, signage, cell phones, airplane costs, and

miscellaneous supplies. Law enforcement staff work with 16-hour coverage, and response to closure violations is included in their duties. This response may be delayed because of emergency or other incidents that must take priority, such as fatalities and injuries. The total cost for law-enforcement staff time and materials is $112,130 per year.

ADDITIONAL AND UNFORESEEN STAFF REQUIREMENTS

Occasionally, conditions are such that the seashore staff implement additional species-protection measures that go beyond typical species management. These additional measures include staff from the Interpretation, Resource Management, and Law Enforcement Divisions. An example of these measures is the escort program that was implemented in 2005.

This program involved closing the Hatteras spit area south of the Pole Road to all public entry from 8:00 PM to 7:00 AM daily. From 7:00 AM to 8:00 PM, ORVs were escorted from the beach adjacent to the southern end of the Pole Road, along the ocean beach for approximately two miles, to Hatteras Inlet. ORVs were escorted each hour, on the hour, in small groups, as piping plover activity allowed. Staff are required to provide an escort to lead the ORVs through the area, in a vehicle, with staff at each end of the escort route to assure that no unescorted ORVs entered the area, and with observers to document the behavioral activity of each pair of piping plovers.

During this time, 24-hour, law-enforcement staffing were also utilized to provide the needed enforcement for the escort program and nighttime closure. Total staff requirements for the escort program to cover two shifts and 24-hour law enforcement included two escorts, four staff at the ends of the closure, two observers at a minimum (one per shift, per pair of plovers), and three law-enforcement personnel (NPS 2005).

During the time that this program was in place, the level of resource management, interpretation, and law enforcement staff did not increase, resulting in a decrease in some of the typical surveying and management activities. Other unforeseen situations can involve emergencies that require the resources of the law enforcement staff, which can cause delays or the inability to respond to resource violations.

FUNDING SOURCES

The seashore will use existing base operating funds to sustain current levels of staffing and will seek project funds to support enhanced staffing and services related to this interim management strategy. Project fund requests are subject to review and approval at the regional and/or Washington level. Potential fund sources include Federal Land Recreation Enhancement Act funds generated from recreation fees, regional and Washington natural resources project funds, and other appropriate fund sources as can be identified.