Shorebird Monitoring and Management at Cape Cod National Seashore 2008

Prepared by:
Mary Hake
Cape Cod National Seashore
Wellfleet, MA 02667

Reviewed: Shelley Hall **Date:** 10/17/11
Chief, Natural Resources

Concurred: _____ **Date:** 10/17/11
Superintendent

TABLE OF CONTENTS

Abstract.....iii

INTRODUCTION..... 1

POPULATION AND PRODUCTIVITY..... 1

Piping Plovers
Nest Search and Incubation Monitoring..... 1
Brood Monitoring and Productivity.....4
Population Trends.....5

Least Terns.....6

Common Terns.....7

American Oystercatchers.....8

Post Breeding Common and Roseate Terns.....9

MANAGEMENT AND PROTECTION.....10

Predation Management.....10

Recreation Management.....13
Habitat Protection.....13
Kites.....13
Pets.....14
Pedestrians and Boat Landing.....15
Off-Road Vehicles..... 16
Park Beach Operations/Essential Vehicles.....17

EDUCATION, OUTREACH, AND PUBLIC INVOLVEMENT.....17

LITERATURE CITED..... 19

FIGURES..... 21
Figure 1. Weekly Active Piping Plover Nests, 2008
Figure 2. Number of Piping Plover Breeding Prs. & Nest Productivity 1985-2008
Figure 3. Number of Least Tern Pairs, 2000 – 2008

TABLES..... 23
Table 1. Summary of Piping Plover Breeding Success, 2008
Table 2. Piping Plover Nest Loss Totals, 2008
Table 3 Piping Plover Egg Loss Totals, 2008.
Table 4. Fate of Exclosed and Unexclosed Piping Plover Nests, 2008
Table5. Summary of Piping Plover Nesting Parameters, 2000-2008

Appendix A – Maps of Piping Plover and American Oystercatcher Nests.....27

Abstract:

In 2008, shorebird nesting and brood-rearing at Cape Cod National Seashore (Seashore) was monitored on 18 beaches from Provincetown to Orleans. Observations of piping plovers (*Charadrius melodus*) began mid-March. Egg-laying began in the fourth week of April. Peak nesting occurred during the last week in May. A total of 86 nesting pairs attempted 109 nests, 69 of which were successful. A total of 158 chicks fledged for a productivity of 1.84 chicks fledged/nesting pair. A total of 40 nests failed before hatching. The three main factors affecting nest failure were predation (60%), overwash/sanded over (17%) and adult mortality (4%). The leading causes of all nest loss to predation before exclosures were installed were American crow (*Corvus brachyrhyncos*) (38%), unidentified predator (33%), and skunk (*Mephitis mephitis*)(17 %). Predator exclosures were erected around 74 nests, but nine were subsequently removed before eggs hatched due to three exclosure-related adult mortalities. Thirty-five nests were not exclosed. Of these 35, 24 failed to hatch.

Least tern (*Sterna antillarum*) colonies increased slightly on Seashore beaches. A total of 136 pairs of least terns nested in five small colonies from Eastham to Provincetown. Predators and overwash were the major causes of nest loss. Productivity was higher than in past years, but still low (less than one chick per pair). One pair of common tern (*Sterna hirundo*) nested unsuccessfully on New Island, Orleans. A total of five pairs of American oystercatchers (*Haematopus palliates*) nested in Eastham and Wellfleet, fledging a total of five chicks.

From July through mid-September, anywhere from 2,000 up to approximately 20,000 migrating/staging common terns and roseate terns (*Stera dougallii*) were observed at the Seashore. Based on counts of color-banded roseate terns, researchers estimated that 60% or more of the entire Northwest Atlantic Coast breeding population of roseate terns used Seashore beaches and mudflats during at least part of the post-breeding dispersal/pre-migration period.

Pets were prohibited on all South District beaches where nesting shorebirds were present. Leashed pets were permitted on North District beaches. A total of 279 dogs were observed off leash, most frequently on oceanside beaches and Wood End and Long Point.

Thirty-five pairs of plovers nested within the Off-Road Vehicle (ORV) corridor in Truro and Provincetown. The vehicle corridor remained open until chicks hatched. Sections of beach were closed to vehicles when chicks hatched and remained closed until the chicks could fly. ORV access at the Seashore is guided by rules developed in 1998 through a negotiated rule making (NegReg), the 2006 Environmental Assessment: Options for Managing ORV Access (NPS 2007a) and the associated Finding of No Significant Impact (FONSI) (2007b).

INTRODUCTION

Cape Cod National Seashore was authorized by congress in 1961 as a unit of the National Park Service (NPS). The Park preserves approximately 44,600 acres of upland, wetland, tide lands, and nearshore waters located on Outer Cape Cod. As reflected in the Seashore's General Management Plan, this unit of the National Park System was established, in part, to protect the area's outstanding natural resources including federal and state listed sensitive species.

The Seashore provides miles of prime feeding, nesting, and roosting habitat for beach-nesting birds, including the federally threatened piping plover, the least tern and common tern, both listed by the Massachusetts Division of Fisheries and Wildlife (MDFW) as a species of special concern, and the American oystercatcher, identified by the U. S. Fish and Wildlife Service (USFWS) as a Bird of Conservation Concern in the United States (USFWS 2008).

Shorebirds were monitored on 24 beaches in the Seashore from Provincetown to Eastham, encompassing approximately 43.4 miles of beach. For staffing and operational purposes, these beaches are divided into two districts. The North District includes all NPS beaches located in Provincetown and Truro (Wood End/Long Point, Race Point North, Race Point South, High Head, and Ballston). The South District includes all NPS beaches located in Eastham and Wellfleet (Coast Guard, Nauset Light Beach, Marconi Beach, Marconi Station, LeCount Hollow, White Crest, Cahoon Hollow, Newcomb Hollow, Bound Brood, Duck Harbor, Great Island and Jeremy Point) and New Island in Orleans.

For nesting piping plover, the Seashore follows the monitoring and protection methods outlined in the U.S. Fish and Wildlife Service Piping Plover Atlantic Coast Population Revised Recovery Plan (1996) and Erwin (2003). For nesting terns, the Massachusetts State guidelines for monitoring and protection (Blodget and Melvin 1996) were followed in 2008. These guidelines were also applied to the protection and management of American oystercatchers.

During the nest location phase, Seashore monitors search the beach for shorebird nest scrapes, and tracks in the sand. To provide accurate predictions of hatching dates, beaches were monitored daily to find nests before clutch completion. The ability to predict hatching dates is important especially along the ORV corridor where vehicles are allowed to pass nesting areas until chicks hatch. All plover nests along the ORV corridor and nearly all other shorebird nests and colonies throughout the Seashore were monitored daily, often from a distance to reduce disturbance.

POPULATION AND PRODUCTIVITY MONITORING

PIPING PLOVER

Nest Search and Incubation Monitoring

Results

Eighty-six pairs of piping plovers were monitored on 18 beaches in the Seashore in 2008 (Table 1, Appendix A). Piping plovers were first observed on Seashore beaches on 20 March and most

beaches had plovers present by mid-April. Plovers continued to arrive into mid-June. The first nest was found on 25 April. Peak nesting for the Seashore occurred during a two week period from 25 May to 7 June (Figure 1), one week earlier than in 2007. A total of 109 nests were found during the 2008 nesting season. Of these, 69 hatched at least one chick and 40 failed (Table 2). The most frequent cause of nest loss was predation (24 nests), followed by overwash (4), adult mortality (4), sanded over (3), abandonment of unexclosed nests (2), abandonment of exclosed nest (2) and non-viable (1). The estimated breeding population of piping plovers is based on the number of pairs found with a nest and any pairs that exhibited courtship and territorial behaviors (scraping, aerial calls) for longer than two weeks.

The 109 piping plover nests contained a total of 386 eggs. Of these, 244 eggs hatched. The remaining 142 were lost to various causes, primarily predation, non-viable eggs, adult mortality, and overwash (Table 3). Although overall hatching success was 63%, this varied among beaches. At the 14 beaches where nesting occurred, it ranged from 0.0% at White Crest to 100% at Race Point North, Marconi Beach and Newcomb Hollow (Table 1).

Circular and canopy style predator exclosures were installed around 74 of the 109 nests (Table 4). However, exclosures were subsequently removed from nine nests after adult plovers were found dead near three exclosures and concerns arose regarding adult plover mortality associated with exclosure use. Three of these nests hatched and six were lost to predators (Table 4).

Of the 65 nests that remained exclosed throughout incubation, 11 (17%) failed to hatch any eggs. The causes of nest loss in exclosed nests were: adult mortality (3), overwash (3), abandonment (2), and being sanded-over (2), and non-viable (1). Exclosed nests were monitored every day to ensure there were no complications such as adult mortality or predators keying onto exclosures. A total of 35 nests were never exclosed. Of those nests, 69% were unsuccessful (Table 4).

There were four cases of adult plover mortality, three of which are believed to be exclosure-related. On 31 May – 1 June, three dead adult plovers were found outside three canopy exclosures on Coast Guard Beach. The carcasses were partially eaten. Two of the carcasses were found under the canopy, the third approximately four feet from the canopy. High winds made tracking difficult. There were no visible signs (tracks) of predators for one of the nests; the other two had faint canid tracks near the exclosure and under the canopy. The cause of mortality was undetermined due to lack of defined predator tracks near the exclosures. The forth plover mortality occurred 5 July at a unexclosed nest at Wood End. There were no visible predator tracks leading up to or around the dead adult. The area outside of the symbolic fencing was heavily covered by human and dog tracks. The bird experienced trauma to its head.

Most nests were located along the upper beach in open sandy habitat. However, a few pairs nested in more vegetated or interior locations and not all of these nests were found. In these cases staff observed pairs courting and feeding along the beach and then flying into interior sections of the beach. These plovers were not tracked to avoid accidentally crushing the nests which are difficult to see in the dense vegetation. In 2008, two pairs of piping plover, one at Wood End/Long Point and the other at Race Point North, successfully hatched chicks from nests that were not located. It is believed both pairs nested within a densely vegetated interior section of

the beach. One pair of plovers at Ballston Beach exhibited these behaviors and was counted as a nesting pair, but a nest was never found.

Discussion

Based on recent trends (2000 – 2008) in piping plover nesting at the Seashore, 2008 was a better than average year for parameters related to successful nesting. The number of pairs (86), nests (109), eggs laid (386), and successful nests (69) were fairly typical in being close to the middle of the range of values recently recorded for these parameters. However, both the nest success rate (63%) and hatching rate (63%) were relatively high (both were third highest during this period) and the proportion of renests (21%), was the second lowest, indicating that more first nests were successful. This is especially true at High Head, Race Point North and South, where all 30 pairs succeeded in their first nesting attempt. The net result of these relatively high rates of success was that in 2008, as in 2007-06 (when these parameters were also high), a record number of hatchlings (244) were produced (Table 5).

Over the past nine years, the three main factors affecting nest and egg loss were predation, overwash, and abandonment of nest after being exclosed. On average, 46% of nests were lost each year, mainly to these factors. In 2008, nest loss was slightly lower at 37%.

In most recent years, overwash had been among the top two causes of nest loss. In 2008, it was one of the third leading causes (10%) along with skunk predation and exclosure related adult mortality. This is down from 39% in 2007. As in 2007, shifting sand and changes in beach morphology continue to make several historic nesting beaches very narrow, creating unsuitable habitat that is more susceptible to washover by tides and storms. In 2008, some bay and ocean beaches continued to erode at an accelerated rate including Coast Guard Beach and sections of ocean beach in Wellfleet. Although shorebird nests were vulnerable to overwash on these beaches, the decline in nests lost to overwash in 2008 is most probably because there was only one severe storm, and it hit relatively early (9-10 May) in the nesting season. In previous years, two to three major storms have hit during peak nesting season, washing out or sanding over many nests. These late season storms set back nesting chronology and re-nesting occurs later in the season when there is an increased level of human activity on beaches.

The narrowing of beaches may also explain the lack of nesting activity in 2008 on some beaches that have historically supported nesting plovers, such as the beaches from the north end of LeCount Hollow to Cahoon Hollow. There was also no nesting activity between the north end of Ballston Beach and Coast Guard Beach, Truro.

Although some beaches saw a decrease in nesting pairs, Duck Harbor saw an increase. From 2003- 2007, this beach supported one to two nesting pairs of plovers with average yearly productivity of 2.3 chicks/pair. In 2008, the number of nesting pairs rose to seven. This may be due, in part, to the relatively high productivity over the past five years, as well as the remoteness of this beach and abundant wrack that supports marine invertebrates associated with high food availability

Brood Monitoring and Productivity

Results

Hatching dates of piping plovers ranged from 3 June to 21 July. Fledging dates ranged from 1 July to 24 August. Of the 244 plover chicks that hatched, 158 fledged, resulting in an overall fledging success of 65%. By beach, fledging success ranged from 0% at LeCount Hollow and Newcomb Hollow to 100% at Marconi Beach. Parkwide productivity was 1.84 chicks fledged/nesting pair (158 chicks fledged from 86 pairs) and ranged from 0.0 at LeCount and Newcomb Hollow to 3.50 chicks/pair at Marconi Beach (Table 1, Figure 2). For the third consecutive year, productivity at Duck Harbor exceeded 2.0 chicks fledged per pair.

Chick mortality factors were extremely difficult to assess. In the majority of cases when chicks were lost, there was no evidence as to cause. A chick was presumed dead if it was not seen for the remainder of the season. A brood was considered lost when there was no sign of any the chicks after five consecutive days of searching. As in years past, most chick mortality occurred within the first 10 days after hatching. In 2008, there was evidence to suggest mortality factors for two of the 86 chicks lost. On 18 June, a brood of four, six day old chicks were observed at Duck Harbor. Approximately 15 minutes later, a crow was observed chasing the chicks. The chicks ran into nearby beachgrass while the adult plovers exhibited distress behaviors. Shorebird staff chased the crow away. Although there was no direct observation of the crow eating a chick, there were only three chicks observed the following day. A second 31 day old fledgling was accidentally killed along the Pole Line Road at Race Point North when it was run over by a vehicle on 4 July.

Discussion

Based on recent trends (2000 – 2008) at the Seashore, 2008 was a very good year for chick survival and productivity (Table 5). The number of fledglings (158) was the highest during this period and the fledging rate (65%) was the 3rd highest. The resultant productivity (1.84 fledglings/nesting pairs), was the 2nd highest during this recent period, but less than during the period from 1990 thru 1994 when productivity exceeded 2.0 each year (Figure 2).

Although productivity was high in 2008, regression analysis of annual productivity from over the past twenty years (1989 – 2008) shows a statistically significant decline in the annual productivity (slope of the regression line = -0.474378, p-level = 0.034578). The five year average productivity is not statistically significant, but also shows a decline in plover productivity over the twenty year time period. It is difficult to be certain why productivity has declined since the late 1980's, but it may be due to increased number of predators, especially crows and coyotes.

Marconi Beach had the highest fledging success and productivity in the park, fledging all seven chicks that hatched from two broods. Over the past eight years (2000 – 2008), productivity on this beach has ranged from over two chicks fledged per pair in 2001 and 2005, to zero productivity in 2003 and 2007. Number of nesting pairs has also varied at this site from a high of

eight pairs in 2000 to no nesting pairs in 2004. The fluctuation in productivity and number of nesting pairs may be due to changes in beach morphology and predator pressures.

In 2008, one pair each at LeCount Hollow and Newcomb Hollow hatched a total of six chicks (four chicks and two chicks respectively). All six chicks were lost by the tenth day after hatching. Since 2001, productivity at LeCount Hollow has varied, but has slowly declined from a high of 3.0 chicks/ pair in 2003 to 2.0 chicks/pair from 2005 – 2007, 1.0 chicks per pair in 2007, and 0.00 chicks fledged in 2008. The one pair at Newcomb Hollow has not fledged any chicks since 2003 when productivity was still low at 1.0 chicks per pair. It is difficult to determine what is causing this high rate of chick mortality. Possibilities include crows, coyote, and dogs off leash, all of which are commonly observed on these beaches.

As in most years, brood monitoring was challenging. Chicks are highly mobile and difficult to locate, especially in dense vegetation. Another factor affecting brood monitoring was human disturbance. Human activity prevents chicks from foraging, separates chicks from adults, increases chicks' vulnerability to predation, and causes thermal stress (Weston and Elgar 2007 Burger 1990). Young chicks are vulnerable to human disturbance and observations of chicks running away from humans were common. On several occasions, adult plovers were observed engaged in distress calls and broken wing displays when beachgoers approached chicks. Often chicks would disperse in several directions away from the perceived threat. This was true on several narrow sections of beach such as Great Island and Coast Guard Beach. Human activity can be high on these beaches and the buffer protecting the birds is small, especially at high tide. Besides disturbing the chicks from feeding, resting etc, there is also the possibility of a pedestrian accidentally stepping on a one to two day old chicks, whose innate response at that age is to crouch down in the sand to hide.

In general, most piping plover chicks fledge at 25-27 days (Blodget and Melvin 1996). However, in 2008, 24 of 69 (35%) broods took much longer (30–38 days) to fledge. Nineteen of these 24 (79%) were in the ORV corridor. Reasons for this slow rate of growth and development are unknown. Nests that hatch later in the season (after the first week in July) seem to have delayed fledging. This could be related to prey availability, time spent shading during peak temperature periods, and increased human disturbance (July receives the largest number of beach users).

Population Trends

Results

Eighty-six pairs of piping plovers were monitored on 18 beaches in the Seashore in 2008. Piping plovers were first observed on Seashore beaches on 20 March and most beaches had plovers present by mid-April. Plovers continued to arrive into mid-June. Most plovers left Seashore beaches by late August.

Discussion

In 1985 when the Seashore began a piping plover monitoring and protection program, only 18 pairs nested on beaches managed by the Seashore. Productivity (number of chicks fledged per nesting pair) in 1985 was less than 1 fledgling/pair (Figure 2). Over the next several years, numbers of plovers nesting in the Seashore decreased slightly while numbers of plovers nesting in the state remained relatively stable. Eventually, numbers of nesting plovers increased, both at the Seashore and throughout Massachusetts. Since 2000, the number of nesting pairs has ranged from 64 to 97, and the 86 pairs nesting in 2008 is above the mean of 81 for this recent period. Similarly, productivity at the Seashore rose from 0.3 in 1986 to a high of 2.6 fledged chicks per pair in 1991. In recent years (2000-2008) annual productivity has ranged from 0.91 to 2.04, with a mean of 1.49 fledged per pair (Table 5). Productivity in 2008 (1.84) exceeds this mean and is the second highest in this time period, meeting the USFWS minimum recovery goal of achieving a five year average productivity of 1.5 fledged chicks/pair.

LEAST TERNS

Nest Search and Incubation Monitoring

Results

Least terns returned to the Seashore during the second week of May. Egg laying began the first week in June, with most least terns on eggs by mid-June. The numbers of pairs in each colony were counted within two standardized periods defined by MDFW ("A-count" from June 5 – 20 and "B-count" after 20 June). The "A" count totaled 89 pairs and the "B" count 110 pairs. There were a total of seven small colonies in each of the two counts.

Colony size and location shifted throughout the season. In late June ("B"- count), a small colony of approximately 13 pairs at Marconi Station was predated by coyote over a two week period. Shortly thereafter, a colony formed at Marconi Beach which is believed to be the Marconi Station colony. The colony at Race Point North increased in size from 12 pairs during the "A" count to 42 pairs in the "B" count. It is uncertain where these new pairs came from.

Predators were a major cause of nest loss. Tracks indicated coyote to be the main predator; crow, skunk and gull (*Larus* sp.) were also observed up to nest bowls and through the colonies. Nests were also frequently lost to astronomic high tides and storms.

Race Point North and Jeremy Point supported the largest colonies (42 and 32 pairs respectively). Coast Guard Beach Eastham, Marconi Station, High Head, Peaked Hill, Wood End, and Long Point supported small colonies ranging from 4-18 pairs each.

Brood Monitoring and Productivity

Results

The first chick hatched on 26 June at Jeremy Point. The last chicks hatched the second week of August at Marconi Beach. Productivity was low on South District beaches, fledging four to eight chicks per site. Eleven chicks were observed at Marconi Beach on 11 August, but by 19 August only three chicks were observed. It is difficult to determine what killed the chicks, but crows were commonly observed in the area and fresh coyote tracks were also observed. Beaches in the north district faired much better. Peaked Hill had the highest productivity with approximately eight chicks fledging from the relatively small colony of 10-14 pairs. Field observations suggest that Race Point North had the best productivity in four years. On most days, good numbers of chicks and fledglings were observed. Coyotes and their tracks were commonly observed on High Head and Wood End/Long Point which had fair to low productivity. Re-nesting attempts continued through late August.

Discussion

Since 2003, least terns have had poor productivity (.035 chicks/pair) and the number of nesting pairs has declined sharply (Figure 3). Reasons for this decline include the narrowing of beaches causing frequent overwash of nests and intense predation on eggs and chicks, especially by coyotes. Human disturbance may also be a factor.

Increased human activities affect coastal nesting species directly by disturbing incubating and brooding birds (Erwin el al.1981; Faanes 1983). Terns are especially vulnerable to human disturbances during courtship and territory establishment. Stationary human activity such as picnicking, sunbathing or camping too close to nesting terns keep the birds agitated and away from their nests (Blodget and Melvin 1996). In addition to interfering with behaviors that defend the colony from predation, persistent human disturbance can cause colony abandonment.

COMMON TERNS

Results

Common terns were first sighted on 13 May at Jeremy Point. In 2008, one pair nested on New Island, Orleans. A three egg nest was found on 4 June. This nest was lost to an unidentified predator on 25 June. A two egg re-nest was found on 10 July. The pair was observed incubating the two eggs on 27 July. The nest disappeared subsequently. No chicks were ever observed. Predators observed in this area include coyotes, gulls and skunks.

Discussion

Over the past ten years, a few pairs of common terns (five or fewer) have nested within or near least tern colonies at Jeremy Point, Race Point North, and Wood End, but the majority of nesting has historically occurred on New Island, Orleans. In 1999, 2176 pairs nested on this small

island. This number sharply declined by over 50% in both 2000 and 2001 (1078 and 495, pairs respectively) and productivity was low due to intense egg predation from coyotes, gulls, skunks, and ants. As the number of common terns nesting on New Island declined during these two years, Monomoy National Wildlife Refuge in Chatham, Massachusetts gained thousands of nesting pairs, presumably some of the New Island birds.

In 2002, for the first time in 20 years (Trull pers. comm.) common terns did not nest on New Island. It is clear that predation is the main reason for the decline of common terns and other shorebird nesting on New Island. Over the past five years, shifting sand has connected New Island to Nauset Beach and during low tide this "island" is more accessible to a variety of mammals, including humans. Electric fencing may be an effective tool to reduce mammalian predation but not practical due to limited staff and the logistics of getting there. In 2005, a small colony of approximately eight pairs returned to New Island. Only one chick was observed and it is unknown if it fledged. Predators were believed to be the cause of egg/chick loss. In 2006 and 2007 small colonies nested on New Island (4 pairs and 8 pairs respectively). In both years, all nests were predated by late June.

Other sites that have supported nesting common terns include Coast Guard Beach, Eastham and Race Point North. In 2002, a colony of 112 pairs formed at the southern tip of Coast Guard Beach in Eastham and one pair attempted to nest on Race Point North. These birds from the two sites were likely from the New Island colony and fared no better than the New Island colony. Based on field observations of animal tracks on the island, gulls, skunks and coyotes were the likely predators of nests.

The last nesting attempts on Race Point North occurred in 2003 and 2004. In both years, one pair nested and was likely predated by a coyote.

AMERICAN OYSTERCATCHERS

Results

The first American oystercatchers (2) were observed on 11 April 2008 at the southern tip of Jeremy Point, Wellfleet. Courtship behavior and nest scrapes were observed the third week in April. The first nest was laid 29 April on Jeremy Point. A total of five pairs nested; three at Jeremy Point, one on New Island, Orleans and one at Coast Guard Beach, Eastham. A total of five chicks fledged from these sites.

The pair at Coast Guard lost their first nest to an unknown predator on 6 May. Their second nest was lost to possible crow predation on 5 June. This pair left the area shortly after losing their second nest.

The three pairs at Jeremy Point successfully hatched chicks on their first nesting attempt. A total of eight eggs were laid and seven hatched (one egg was infertile). Three chicks, one from each pair, were lost to unknown causes. A total of four chicks fledged; two pairs fledged one chick and the third pair fledged two chicks. One chick that fledged on 30 July (at 30 days of age) remained with its parent through September.

The pair on New Island nested on the northeast side of the island. On 21 June, two recently hatched chicks and one egg were observed in the nest bowl. On 22 June, there were no eggs, just small pieces of shell and wet sand near the nest. No chicks were observed that day, but adults were exhibiting distress behaviors, presumably protecting their young. One chick was observed after the initial observation on 21 June and successfully fledged..

Discussion

Oystercatchers were first recorded nesting on Seashore beaches in 2002, with two pairs at Jeremy Point and one pair at Coast Guard Beach. All three pairs were unsuccessful in fledging any chicks. From 2003 through 2005, the number decreased to two pairs, both at Jeremy Point. During these years, most eggs were lost (predated or washed over). A few hatched, but the chicks disappeared less than one week after hatching. In 2006, the number of nesting pairs doubled to four, including one nest at New Island. Productivity was better, with one chick fledging from Jeremy Point and one from New Island. Productivity in 2007 was still low (0.6 chicks fledged/nesting pair), but better than past years.

Oystercatchers had their most productive nesting season in 2008, with total productivity at 1.0 chicks/pair. Jeremy Point had the highest productivity, 1.25 chicks/pair. This may be due, in part, to pairs successfully hatching chicks early in the season on their first nesting attempt.

The North American population of American oystercatchers is estimated at only about 11,000 birds (Brown *et al.* 2005). Like plovers and terns, this species is vulnerable to disturbance from human recreational use of shoreline habitats. The U.S. Shorebird Conservation Plan designates American oystercatcher as a "Species of High Concern," due to low relative abundance, threats on non-breeding grounds, and rather restricted non-breeding distribution (Brown et al. 2001). Because of this, great effort was made in 2008 to reduce human disturbance during incubation and chick rearing including public outreach through personal contacts and signage.

POST BREEDING COMMON AND ROSEATE TERNS

In late summer, thousands of migrating shorebirds and terns (including the federally endangered roseate tern and the state listed common tern) congregate on the mudflats and beaches of Nauset Marsh/Coast Guard Beach, Jeremy Point, and Hatches Harbor/Herring Cove to feed and rest. These areas are among the most important staging and roosting areas for these birds on Cape Cod (Hadden 1999, Trull et al. 1999). In 2007, Massachusetts Audubon's Coastal Waterbird Program (CWP), Antioch New England, and U. S. Geological Service Patuxent Wildlife Research Center initiated a multi-year cooperative study of roseate tern habitat use and post-breeding movements. In 2008, from July through mid-September, anywhere from 2,000 up to approximately 20,000 terns were observed at the Seashore (15,000- 20,000 on Nauset Marsh/Coast Guard Beach, 8000 at Hatches Harbor/Herring Cove and 2,600 on Jeremy Point) (B. Harris, pers. comm.). This represents 50-60% of the Northwest Atlantic Coast breeding population of roseate terns using Seashore beaches and intertidal areas during at least part of the post-breeding dispersal/pre-migration period. The ratio of roseate and common terns in these

large flocks was variable, depending on time of day and tide phase, but overall roseate terns made up 5%- 30% of the flocks. (Blake pers. comm).

In 2008, through symbolic fencing and signage, sections of intertidal zone along Race Point South were temporarily closed to vehicles and pedestrians. Signs guided visitors along the upper beach away from the birds reducing disturbance to the staging shorebirds. Additional signs were placed around staging area at Coast Guard Beach, Eastham and Jeremy Point.

MANAGEMENT AND PROTECTION

PREDATOR MANAGEMENT

Piping Plover Nest Protection

Methods

Historically, the Seashore has focused on non-lethal predator management through the use of exclosures around nests. In 2008, two predator exclosure designs were used:

1. Circular Exclosure – This design has been used at CACO since the early 1990's. The circular exclosure is 10' in diameter and 3' high, constructed of 2" x 4" wire fencing. A ½" plastic mesh bird netting is secured to the top.

2. Canopy Exclosure - This design uses 2" x 4" fencing to create a 4' x 4' square exclosure, 3 feet high. A heavy gauge plastic 2" x 2" deer netting is secured over the top and extends for 4 feet from all sides creating a canopy. The canopy is secured with wooden and steel posts. An additional 4' x 6' piece of fencing is attached to two of the sides creating a second, domed top.

With concurrence from the MDFW (Melvin, pers. comm.), some incomplete clutches were exclosed to reduce the chance of predation on eggs. If the nest was then abandoned, the re-nest was not exclosed until the pair was actively incubating eggs. Exclosures were removed around actively incubated nests if the birds didn't return 20 minutes after exclosure installation.

Nests were not exclosed when they were: (1) located in thick vegetation, (2) located on the side of a dune or cliff that precluded installation of an exclosure due to slope or nest location; or (3) when a group of exclosed nests were abandoned on a single day at a particular site and there were concerns about adult plover mortality associated with exclosure use.

Results

Predator exclosures were installed around 74 of the 109 nests. Fifteen nests had circular exclosures and 59 had canopy exclosures, nine of which were removed before the eggs hatched. Of the 65 nests that were exclosed until hatching, 54 (83%) successfully hatched. By exclosure type, nest success rates for these 65 nests were 80 % for canopy and 93% for circular. Of the

nine nests that had the canopy exclosure removed during incubation, the nest success rate was 33 %. This low rate of nest success is similar to that of nests that were not exclosed, 31% (Table 4).

Most pairs accepted the exclosure, but two nests were abandoned after exclosure installation. One circular exclosure was placed around a four egg nest on their third nesting attempt at Wood End/Long Point. The adult birds did not return to incubate and exclosure was removed 20 minutes after installation. Even after the exclosure was removed, the pair never returned to the nest. It is difficult to determine what caused this abandonment, but it may have been exclosure related or the fact that it was getting late in the nesting season. The pair was not seen again. The second abandonment occurred at a four egg nest on Coast Guard Beach. Two possible reasons for this abandonment include crow harassment and weather. Crow tracks were observed circling under the canopy around the outside of the exclosure and a storm with high winds and rains occurred the night before. This pair was monitored closely and eventually re-nested.

Predators were the largest cause of egg loss in 2008, responsible for 57 % of all egg loss (Table 3). Among predators, crows caused the greatest losses (37 % of all predation). Crows are opportunistic and adaptable feeders and over the past several years, their population appears to have increased. Groups of crows were commonly observed foraging along beaches. Their tracks blanketed the sand, and on several occasions, active scrapes with numerous plover tracks had fresh crow tracks right up to the scrape. It appeared that crows took the egg(s) before resource management staff found the nest. Because crows were such a threat, finding the nest soon after the first egg was laid was a high priority, so that predator exclosures could be immediately installed. In conjunction with a shift from circular to canopy exclosures in recent years, aggressive use of exclosures may be why the percent of re-nests from 2006-2008 was below the mean of 28%, with 2008 having the second lowest (21%) in recent years (Table 5). Undetermined predators and skunk predation were the second and third leading causes of egg loss to predators (31% and 19% respectively, Table 3). Because we are unlikely to directly observe egg predation, we rely on animal tracks to identify egg predators. On rainy and windy days, tracking is poor and it is impossible to identify the specific predator.

Skunk predation in 2008 was the highest ever recorded at the Seashore. Four nests totaling 15 eggs, representing 17% of all predated nests and 19% of all predated eggs were lost at Coast Guard Beach (Tables 2 and 3). From 2000 – 2004, skunk tracks were common on Coast Guard Beach, especially on the north end, and skunk predation represented, on average, 5% of overall nest predation, with a high of 13% in 2003. From 2005 – 2007, no nests were lost to skunk and field observations (tracks) suggested that skunks were on the decline. The increase in skunk predation in 2008 may be attributed to the skunk population rebounding from distemper, a highly contagious and fatal disease to skunks and other mammals that spread throughout Cape Cod several years ago.

Coyotes and their tracks were observed inside most nesting areas, especially at Wood End/Long Point. Increased coyote presence and predation of plover nests seemed to coinciding with the onset of least tern nesting. Most likely, coyotes are attracted to tern colonies due to the concentration and abundance of eggs.

In addition to the loss of eggs and nests to predators, there were four documented adult mortalities due to predation. Due to the increased number of adult mortalities associated with the use of circular exclosures, the Seashore started using some canopy style exclosures in 2004. From 2004 – 2006, there was no adult mortality associated with canopy exclosures. During that same period, there were four deaths associated with circular exclosures. The first loss of an adult associated with a canopy exclosure occurred in 2007. This number tripled in 2008. For the first time since 2004, the rate of exclosure-related deaths from canopy exclosures was higher than that of the circular design, 0.0% to 6.0% respectively. Although the rate of exclosure related mortality from 2004-2008 is still higher for circular exclosures than canopy style, 3.01 to 2.42 respectively (Table 6), the increase in death each year from canopy exclosures may warrant the discontinuation of all exclosures which would cause a substantial decline in nest success and productivity.

Discussion

In the late 1990's, the Seashore began installing predator exclosures around individual piping plover nests. Since then, this non-lethal method of predator management has been a relatively effective, short term solution to protect the eggs.

Piping plovers, terns, and oystercatchers nest on the ground, usually in the open sand, making them vulnerable to a host of predators. Solitary nesters such as plovers and oystercatchers defend themselves from predators with camouflage and distraction displays while the colonial nesting terns utilize mobbing techniques and camouflage. For the past several years, weekly district shorebird reports suggest that crows are the greatest threat to plover eggs. On most weeks, the report identifies groups of crows (especially during April and May) hunting within plover nesting areas. Most weekly reports also discuss the abundance of crow tracks in nesting areas. In 2008, crows were the largest source of nest predation, accounting for 38% of all nests lost to predation (Table 3).

Even with predator exclosures being quickly installed around nests, some before clutch completion, the rate of nests lost to predation in 2008 (60% of all nest loss) was the highest in nine years. It is clear that predators, especially crows, have a major impact on nest success. Moreover, the use of predator exclosures appears to have come with a price, an increased number of adult mortalities. Since 2002, there have been at least ten adult mortalities associated with the use of circular and canopy exclosures at the Seashore. Although the number of adult deaths seem low considering that 100's of nests were exclosed during these years, the loss of breeding adults has a much greater impact on the population than the loss of eggs or chicks. Thus, there is a conflict in that actions taken to protect nests (and eggs) place adults at greater risk and the benefit of exclosures may not outweigh the risks. This has already happened at other sites, such as Crane's Beach in Ipswich, MA, where managers can no longer safely use exclosures. At Crane's Beach, where canopy exclosures were developed, they initially were successful in reducing adult mortality associated with the use of circular exclosures. However, after a few years, adult mortality associated with the use of canopy exclosures increased dramatically, to the point where the loss of adults was more damaging to the population than their value in protecting nests and eggs (Inglefinger, pers. comm.).

Protection for Least Tern Chicks

One of the most effective strategies used by terns to protect eggs and chicks from predators is to nest in large colonies. Any predator that enters the colony is attacked by the large group of birds until the predator (or perceived threat) leaves. As colony size has decreased over the past several years along Seashore beaches, this behavior has become ineffective and predators appear undeterred by the few birds defending the nesting area.

Starting in 2007, triangular plywood tern shelters (25" x 8" x 8") were placed inside colonies to provide shade and shelter to the chicks. Shelter design was taken from the U.S. Fish and Wildlife Service Tern Management Handbook, Coastal Northeast United States and Atlantic Canada (2004). In 2008, thirty-two tern shelters were distributed among three colonies (Coast Guard Eastham, Marconi Station, and Jeremy Point). Chicks were observed using the shelters but it is difficult to determine if shelters increased chick survival.

RECREATION MANAGEMENT

Habitat Protection

Historic shorebird nesting habitat along Race Point North and Race Point South was posted with symbolic fencing and signs by 15 April when the ORV corridor opens to permit holders. Historic shorebird nesting habitat on Coast Guard (Eastham), Great Island, New Island, and Jeremy Point was posted with symbolic fencing and signs by the third week of April. Symbolic fencing was placed around all areas where shorebirds were observed exhibiting courtship behavior and/or where active scrapes and nests were present. Symbolic fencing is used to identify and protect shorebird nesting habitat. Five foot wooden posts were placed 40'-50' apart and connected by a line of cotton twine to delineate nesting habitat. Plastic and wooden "Area Closed- Bird Use Area" informational signs are affixed to every second or third post. Various shorebird and natural resource informational and regulatory signs were posted at the entrance of most beaches and at the nesting sites.

Kites

When kites are flown in or near nesting habitat, plovers exhibit the same behaviors as when avian predators are present (Hoopes et al. 1992). Both hand held kites and those used in kite surfing/boarding simulates the flight of birds of prey. The use and launching of these different types of kites could cause the birds to shift or abandon breeding territories, flush incubating birds off nests, cause nest abandonment, disturb feeding adults or chicks, or physically harm eggs or unfledged chicks. To prevent disturbance from kites, hand-held kite flying is prohibited on all beaches within 500' of any shorebird nesting sites.

Kites used for kite surfing are also becoming popular on bayside beaches in Wellfleet, especially at the "Gut" (NPS and town owned beach) and Duck Harbor. It is also gaining popularity along Wood End/Long Point. Field observations suggested this sport is becoming more of threat to nesting shorebirds. These large kites range in size from 7–69 square feet and include multiple 80-100 foot long lines to attach the kite. They are launched from the beach on windy days and used

to pull a kite surfer over the water on a small board. Five hundred feet may be adequate for hand held kites, but this distance is likely inadequate to prevent plovers from flushing off the nest. Even when kites were initially launched away from a nesting area, shorebird monitors observed kite surfers coming ashore after capsizing and re-launch their kite in front of nesting areas. In some cases, this could be up to ¼ mile from the initial launch site. Because of these concerns, in 2008, the Seashore began to seasonally ban kite surfing from 1 April until the last chick fledged (which was 15 August in 2008) on all bayside beaches in Wellfleet.

Additionally, at the request of the Seashore, the launching of hang/para-gliders is temporarily banned from Wellfleet town beaches from April 15 – through Labor Day. These kites disturb nesting plovers and terns when they fly low along the coastline directly over nesting areas.

Pets

Pets are required to be on a six-foot leash anywhere they are allowed within the Seashore. As it is every year, the south side of Coast Guard Beach, Eastham was closed to pets on 1 April. Since the 1990's, this section of beach re-opened to pets when the last shorebird chick fledged. In 2008, this pet closure was extended until Columbus Day to protect staging shorebirds.

Pet closure dates were also extended at Jeremy Point. Historically, this section of beach was closed as soon as shorebirds exhibit breeding behaviors, usually by mid-April and opened when the last shorebird chick fledged. In 2008, it was closed to pets from 1 April and remained closed to protect staging shorebirds until Columbus Day.

Sections of bay and ocean beach in Eastham and Wellfleet were also temporarily closed to pets as needed to protect nesting areas. "No Pet Area" signs are posted perpendicular to the water approximately 50 meters away from the symbolic fencing, extending down into the intertidal zone. These signs were moved as necessary to reflect the closures in effect at any one time. These sections of beach were closed until all the chicks fledged. Beaches that did not have nesting shorebirds remained open to leashed pets. A press release was submitted to local media to inform the public of these temporary restrictions.

In 2008, a total of 279 dogs were observed off leash by shorebird monitors from 27 April to 24 August. Of that total, 215 dogs were observed off leash in the South District and 64 dogs were observed off leash in the North District.. Unleashed dogs were encountered most frequently on the oceanside beaches (Nauset Light Beach, LeCount and Newcomb Hollow, Race Point North and Wood End and Long Point), as well as bayside beaches (Great Island and Duck Harbor) and Hatches Harbor.

For the second year, shorebird monitors handed out dog biscuits to pets that were observed on leash. This provided an opportunity to talk with pet owners about the importance of keeping their pets leashed and thank them for complying with park regulations. Pet owners appeared to appreciate the recognition and positive feedback from park personnel and seemed more willing to keep their pets leashed after the encounter. Increased enforcement and the closure of Race Point North and Race Point South to vehicles may have decreased the number of dogs off leash on these beaches.

Pedestrian and Boat Landing Restrictions and Detours

Erosion continues to narrow beaches, especially in the South District. Where beaches are extremely narrow, it was not always possible to provide sufficient buffer within the symbolic fencing (especially at high tide) to prevent incubating shorebirds from getting off their nest when pedestrians pass by. At sites where this occurred, beaches were closed at times of high tide or small sections of beach were completely closed. Where possible, detours were established to allow visitors access to other sections of beach. Informational/directional signs were erected informing visitors of these closures. Areas were opened immediately if the nest(s) that caused the closure hatched or were lost. These closures have been very effective, with high visitor compliance.

The east and west side (north end before the washout) at Jeremy Point was closed to pedestrians at high tide from 5 May to 20 June to protect nesting plovers, terns and oystercatchers. On 23 May, the east side was re-opened but the west side remained closed until 14 August. Pedestrians could access either side at low tide when there was adequate exposed beach between the nesting birds and the pedestrians. However, at high tide, the symbolic fencing often extends into the water, making it impossible for pedestrians to pass.

To protect a pair of American oystercatchers nesting on a narrow section of beach, 0.1 mile along the west side of the southern tip of Jeremy Point (south of washout) was closed at high tide (17 June – July 2) to pedestrians. This section of beach was reopened when the chicks hatched and interpretive signs were placed requesting that people not linger near the nesting area to reduce chick disturbance.

Approximately 200 feet of the southern tip (east and west side) of Coast Guard Beach in Eastham was closed to pedestrian, boats and kayaks at high tide from 9 May to 14 May to protect two pair of nesting piping plover and one pair of American oystercatchers. Because of the location of the nests, symbolic fencing could not be extended far enough to provide an adequate buffer between the nest and visitors. On May 14, the east side was re-opened due to the loss of the plover nest; the west side remained closed to protect the oystercatcher nest. The west side was re-opened on June 5 when the oystercatcher nest was predated. Throughout the closure, signs were posted directing visitors to a path just north of the tip to access both the ocean and Nauset Marsh side of the beach.

A narrow section of Coast Guard Beach, just south of the protected (life-guarded) beach was closed at high tide from 3 July to 26 July to protect nesting shorebirds. To provide the necessary buffer between the people and incubating shorebirds, fencing was extended low down on the beach. At high tide, the fencing closest to the water was covered by the rising tide. Visitors could access the southern section of Coast Guard Beach by taking a detour along Nauset Marsh or walking in the shallow water, outside the symbolic fencing.

The distal tips of barrier spits have long been important sites for piping plovers and colonial nesting shorebirds. In recent years, these once remote beaches have become a popular destination for boaters. Now, on any given day in the summer, it is not uncommon to see motor boats,

kayaks and canoes along the shoreline barbecuing, picnicking, playing sports, and sun bathing. Food scraps that could attract predators are left on the beach. In addition, once onshore, boaters' activities tend to be focused around one location for an extended period of time resulting in prolonged periods of disturbance to nesting shorebirds in contrast to the short-term transient disturbance associated with walkers and hikers.

Up until 2008, boats were allowed to land anywhere on Jeremy Point, although the east side of the southernmost tip appears to be the most concentrated landing point. In 2008, to better protect nesting shorebirds and manage the boats and the people that come ashore to recreate on this narrow spit of shoreline, the Seashore designated 0.3 miles of the southernmost tip of Jeremy Point as a boat landing area. Sections of narrow beach with nesting shorebirds were closed to boat landing. Large signs were placed in the intertidal zone to inform boaters of this closure. Part of the northernmost section of Jeremy Point (approximately 0.5 miles) was closed to boat landing from 18 June to 13 October to protect nesting and staging shorebirds.

Due to narrow beaches, portions of the southern tip of Coast Guard were closed to boat landing from 9 May to 5 June to protect nesting shorebirds. This closure occurred early in the season when day time temperatures were cool and recreational boating activities was low. This beach was open to boat landing the remainder of the nesting season.

Off –Road Vehicles

Off-road vehicle (ORV) access is permitted along a designated beach corridor in Provincetown and Truro. Off-road vehicle access at the Seashore is guided by rules developed in 1998 through a negotiated rule making (NegReg), 2007 Environmental Assessment: Options for Managing ORV Access (NPS 2007a) and the associated FONSI (2007b). Permit applicants receive some education about nesting piping plover and terns. A total of 3,957 ORV/SCV permits were issued in 2008 (1,598 seasonal permits and 2,294 weekly permits).

The ORV corridor was open to vehicles during the egg laying and incubating phase of the nesting season in areas where there was an adequate protective buffer between the incubating shorebirds and vehicles. To provide accurate predictions of hatching dates, beaches were monitored daily to find nests before clutch completion. To determine the actual date of hatching and ensure that chicks are found as immediately as possible after hatching, piping plover nests along the ORV corridor are checked twice a day starting two days prior to the estimated hatching date. As nests hatched, sections of the beach were closed to vehicles to protect the flightless chicks. These vehicle closures typically extended 0.2 miles from the nest location. However, actual closure limits for each brood were adjusted based on beach morphology, brood behavior, or other conditions as appropriate to ensure the chicks were protected. All chicks were monitored daily, noting their movements, location, and number in each brood. Broods adjacent to ORV corridor closures were often monitored twice a day, in the mornings and evenings, to ensure that there was an adequate protective buffer between the flightless chicks and ORVs. Vehicle closures were lifted on sections of beach if broods demonstrated repeated and sustained flight for at least 15 meters or if chicks moved out of the area or had not been observed for five consecutive days. Additional information on ORV management can be found in the 2008 Off-Road Vehicle Activity Report (NPS 2008).

Park Beach Operations/Essential Vehicles

Seashore staff uses vehicles on beaches when shorebirds are nesting in support of public beach operations, monitoring and protecting threatened and endangered species, enforcing park regulations and providing visitor safety.

The Seashore takes several precautions to minimize the risk of driving vehicles in areas with nesting shorebirds as outlined in the 1998 NegRegs, the 2007 ORV Environmental Assessment (NPS 2007a) and the associated FONSI (2007b).. In addition, all designated staff driving on beaches are knowledgeable of shorebird biology, identification and current nesting locations, and are trained and certified in the safe operation of the vehicle (including ATV's). To reduce accidentally crushing adults and chicks, the use of vehicles on beaches with nesting shorebirds is avoided or minimized and speed limits are reduced.

EDUCATION, OUTREACH, AND PUBLIC INVOLVEMENT

Educating the public about shorebird biology and human factors affecting shorebirds is important for gaining local support and facilitates their recovery. In 2000, an outreach program to local schools, featuring a slide presentation and interactive activity demonstrating the impacts of disturbance to plover and other shorebirds was initiated. This program was based on an existing lesson plan from the USFWS. Since 2000, this program has been presented to close to 5,000 individuals (mostly elementary school students and youth groups) throughout the Lower Cape. In 2008, 20 programs were given to 42 classes reaching 653 individuals.

On-site interpretation was initiated in 2008 when several pairs of plovers and a small colony of least terns nested on a section of the protected, life-guarded beach at Coast Guard Beach in Eastham. Due to the narrow beach, symbolic fencing had to be extended down into the intertidal zone to provide an adequate buffer between the birds and the constant flow of foot traffic. At low to mid tides, visitors walking past the nesting area could easily pass by but, at high tide, the fencing was partially under water. At times of high tide, visitors had the option of walking in the water or following a signed, detour route around Nauset Marsh to access the southern sections of the beach. During June and July, when high tide coincided with peak beach visitation (11a.m. - 4 p.m.), Seashore staff and volunteers were stationed at the closure to explain the detour to passing beachgoers. A spotting scope was set up for visitors to view nesting shorebirds from a distance and props, including a paper mache piping plover and real and mock eggs, were placed nearby in the sand. A photo album with pictures of the nesting birds was also used. This type of informal interpretation was very effective in reaching a broad range of visitors to a resource that is often overlooked. An estimated 675 visitor contacts were made.

Volunteers donated a total of 650 hours to the Seashore's shorebird management program. Volunteers worked closely with Shorebird Biological Technicians and SCA's in field operations from April through September.

FUTURE MANAGEMENT CONSIDERATIONS

Management recommendations for the 2009 shorebird nesting season were submitted to the park's Superintendent for review.

LITERATURE CITED

Blodget B. G and S. M Melvin 1996. Massachusetts Tern and Piping Plover Handbook, a manual for stewards. Mass. Div. of Fisheries and Wildlife. Natural Heritage and Endangered Species Program. Westborough, MA.

Brown, S., S. Schulte, B. Harrington, B. Winn, J. Bart, and M. Howe. 2005. Population size and winter distribution of eastern American Oystercatchers. Journal of Wildlife Management 69: 1538-1545.

Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. The U.S. Shorebird Conservation Plan, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA.

Burger, J. 1990. Foraging behavior and the effects of human disturbance on the piping plover (*Charadrius melodus*). Journal of Coastal Research, 7(1), 39-52. Fort Lauderdale, FL.

Erwin R. M., J. Galli, and J. Burger, 1981. Colony site dynamics and habitat use in Atlantic coast seabirds. Auk 98:550-561.

Erwin R. M. 2003. Waterbird monitoring protocol for Cape Cod National Seashore and other Coastal Parks, Refuges, and protected areas. A protocol for the Long term Coastal Ecosystem Monitoring Program at Cape Cod National Seashore. Unpublished report submitted to Cape Cod National Seashore, South Wellfleet, MA .

Faanes, C.A., 1983. Aspects of nesting ecology of Least Terns and Piping Plover in Central Nebraska. Prairie Naturalist, 15, 145-154.

Hadden, S.W. 2001. Waterbird Inventory and Monitoring: Report on Protocol Implemention and Development at Cape Cod National Seashore. Unpublished report submitted to Cape Cod National Seashore, South Wellfleet, MA.

Hoopes, E.M., C.R. Griffin, and S.M. Melvin. 1992. Relationships between human recreation and Piping Plover foraging ecology and chick survival. Unpublished report. University of Massachusetts, Amherst, Massachusetts.

Melvin, S.M. and J.P. Gibbs. 1994. Viability analysis for the Atlantic Coast population of Piping Plovers. Unpublished report to the U.S. Fish and Wildlife Service, Sudbury, Massachusetts.

National Park Service 2007a Environmental Assessment: Options for Managing ORV Access Cape Cod National Seashore. Wellfleet MA.

National Park Service. 2007b FONSI and alternative Selection for Options for managing ORV Access. Cape Cod National Seashore. Wellfleet MA.

National Park Service. 2008. Cape Cod National Seashore. Off-Road Vehicle Activity Report. Wellfleet, MA.

Trull, P., S. Hecker, M.J. Watson, and I.C.T. Nisbet. 1999. Staging of roseate terns Sterna dougallii in the post-breeding period around Cape Cod, Massachusetts, United States. Atlantic Seabirds 1: 145 to 158.

U.S. Fish and Wildlife Service. 2004. Tern Management Handbook, Coastal Northeastern United States and Atlantic Canada. U.S. Fish and Wildlife Service, Hadley, Massachusetts.

U.S. Fish and Wildlife Service. 1996. Piping Plover (Charadrius melodus), Atlantic Coast Population, revised recovery plan. USFWS. Hadley, Massachusetts.

U.S. Fish and Wildlife Service. 2008. Birds of Conservation Concern. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia.

Weston, M.A. and M.A. Elgar. 2007. Responses of incubating hooded plovers (*Thinornis rubricollis*) to disturbance. Journal of Coastal Research 23:569-576.

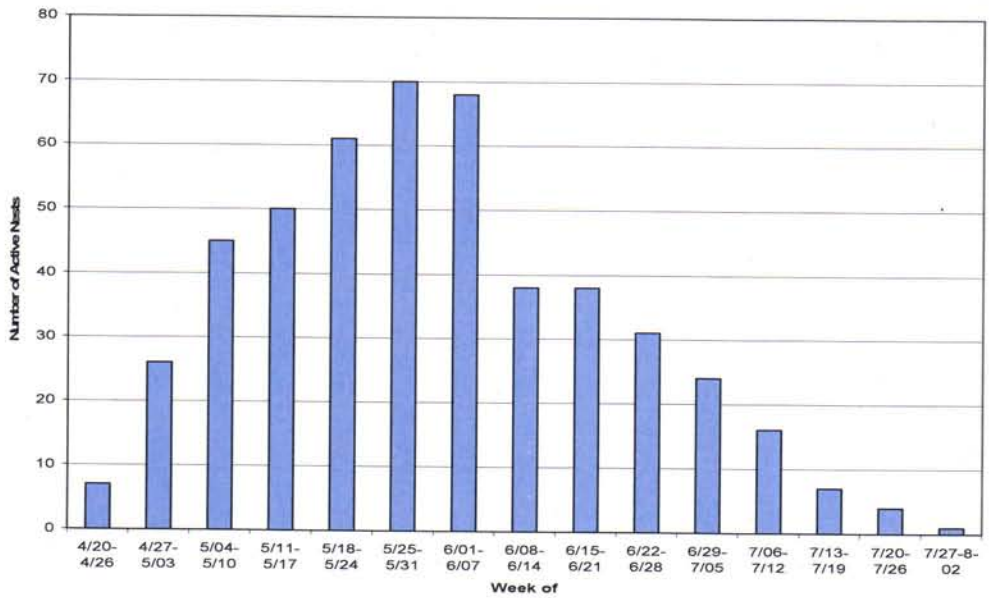


Figure 1. Weekly Active Plover Nests for Cape Cod National Seashore, 2008.

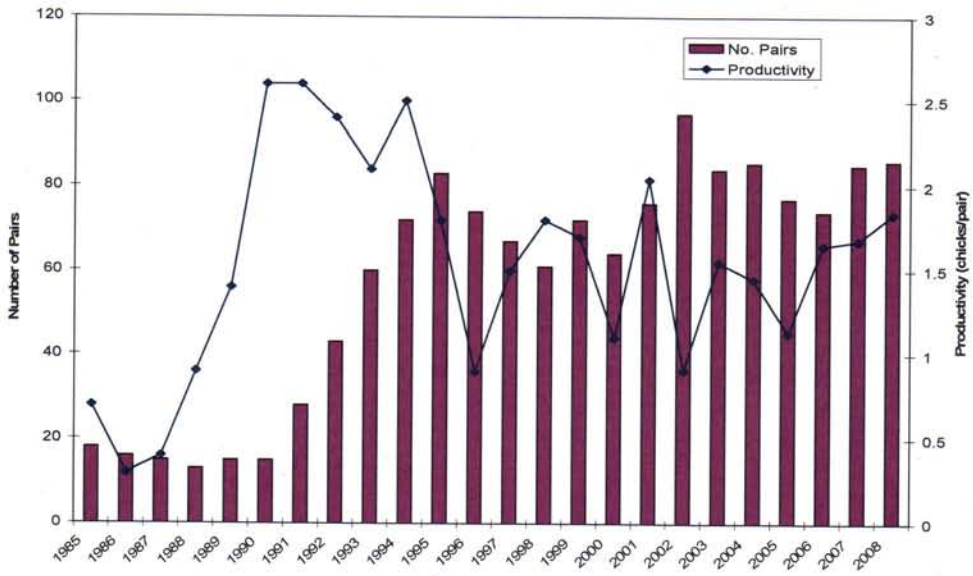


Figure 2. Number of Piping Plover Pairs and Nest Productivity on Cape Cod National Seashore from 1985 – 2008.

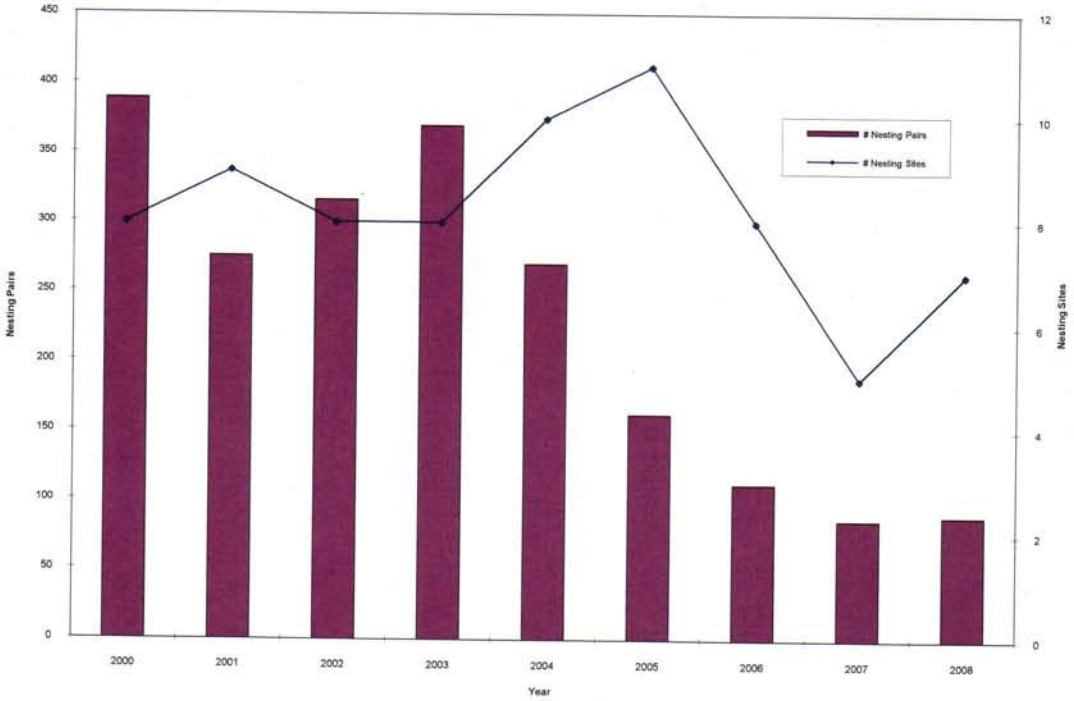


Figure 3. Number of Nesting Pairs and Sites of Least Terns, 2000-2008.

Table 1. Summary of Piping Plover Breeding Success, Cape Cod National Seashore, 2008.

Site	No. Pairs	No. Nests [1]	No Eggs Laid	No. eggs Hatched	No. Fledged per site	Hatching Success [2]	Fledging Success [3]	Productivity [4]
Coast Guard	17	33	117	28	19	0.24	0.68	1.12
Nauset Light	0	0	0	0	0	0.00	0.00	0.00
Marconi Beach	2	2	7	7	7	1.00	1.00	3.50
Marconi Station	3	3	12	9	7	0.75	0.64	2.33
LeCount	1	1	3	2	0	0.67	0.00	0.00
White Crest	1	1	2	0	0	0.00	0.00	0.00
Cahoon Hollow	0	0	0	0	0	0.00	0.00	0.00
Newcomb Hollow	1	1	4	4	0	1.00	0.00	0.00
New Island	0	0	0	0	0	0.00	0.00	0.00
Bound Brook	2	3	11	7	5	0.64	0.71	2.50
Duck Harbor	7	9	32	25	16	0.78	0.64	2.29
Great Island	4	4	15	11	10	0.73	0.91	2.50
Jeremy Point	6	8	28	22	13	0.79	0.59	2.17
Wood End/Long Pt	11	14	41	23	8	0.56	0.35	0.73
Race Point North	11	11	42	42	30	1.00	0.71	2.73
Race Point South	13	13	49	45	33	0.92	0.73	2.54
High Head	6	6	23	19	10	0.83	0.53	1.67
Ballston Beach	1	0	0	0	0	0.00	0.00	0.00
TOTAL	**86**	**109**	**386**	**244**	**158**	**0.63**	**0.65**	**1.84**

[1] Includes re-nests
[2] Total number of eggs hatched/total number of eggs laid
[3] Total number of chicks fledged/total number of eggs hatched
[4] Total number of chicks fledged/total number of nesting pairs

Table 2. Piping Plover Nest Loss Totals, Cape Cod National Seashore, 2008.

Nests					Loss By Cause	
# Nests	# Hatched	# Lost	% Lost	Cause of Loss	# Lost	% Lost
109	69	40	37%			
				Predation	24	60%
				Overwash	4	10%
				Adult Mortality	4	10%
				Sanded Over	3	7%
				Abandoned (exclosed)	2	5%
				Abandoned (unexclosed)	2	5%
				Non-viable	1	3%
				Predation Types		
				Crow (unexclosed)	9	38%
				Unknown Predator (unexclosed)	8	33%
				Skunk	4	17%
				Gull (sp.) (unexclosed)	2	8%
				Coyote (unexclosed)	1	4%

Table 3. Piping Plover Egg Loss Totals, Cape Cod National Seashore, 2008.

Eggs				Loss by Cause	
Total #	# Lost	% Lost	Cause of Loss	# Eggs Lost	% Lost
386	142	37%			
			Predation	81	57%
			Non-viable	15	11%
			Adult Mortality	14	10%
			Overwash	12	8%
			Sanded-over	10	7%
			Abandoned (exclosed)	8	6%
			Abandoned (unexclosed)	2	1%
			Predation Types		
			Crow	30	37%
			Unknown Predator	25	31%
			Skunk	15	19%
			Coyote	6	7%
			Gull	5	6%

Table 4. Fate of Exclosed and Unexclosed Piping Plover Nests, Cape Cod National Seashore, 2008.

Total Nests	# Successful	# Unsuccessful	% Successful	Type of Nest Protection	% Unsuccessful	Cause of Failure	# Lost	% Lost
50	40	10	80%	Canopy Exclosure	20%	Overwash	3	30%
						Adult Mortality	3	30%
						Sanded-over	2	20%
						Abandonment	1	10%
						non-viable	1	10%
9	3	6	33%	Canopy Exclosure subsequently removed	67%	Predation	6	100%
						Type of Predation		
						Unknown predator	4	80%
						Crow	2	20%
15	14	1	93%	Circular Exclosure	7%	Abandonment	1	100%
35	11	24	31%	Unexclosed	69%	Predation	18	78%
						Abandonment	3	13%
						Overwash	1	3%
						Sand-over	1	3%
						Adult Mortality	1	3%
						Type of Predation		
						Crow	7	41%
						Skunk	4	23%
						Unknown predator	4	18%
						Gull	2	12%
						Coyote	1	6%

Table 5. Summary of Piping Plover Nesting Parameters at Cape Cod National Seashore, 2000 – 2008.

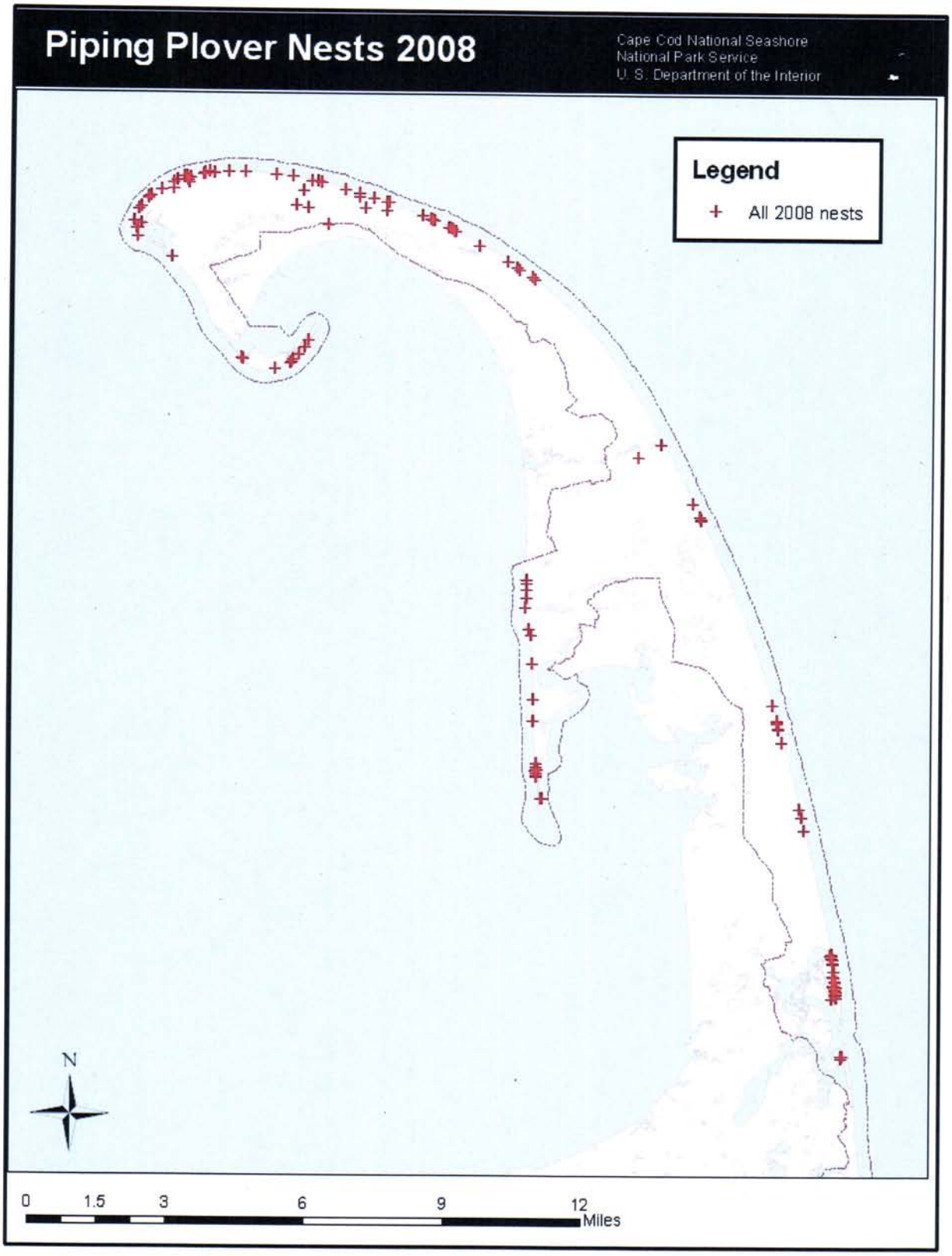
Year	# Pairs	# Nests	# Eggs Laid	# Successful Nests	# Eggs Hatched	# Chicks Fledged	Nest Success Rate	% Renests	Hatch Rate	Fledge Rate	Productivity
2000	64	121	415	48	154	73	40%	47%	37%	47%	1.14
2001	78	88	317	61	223	155	69%	11%	70%	70%	2.04
2002	97	141	428	57	175	88	40%	31%	41%	50%	0.91
2003	84	121	450	54	189	130	45%	31%	49%	69%	1.55
2004	85.5	115	425	59	220	124	51%	26%	52%	56%	1.45
2005	77	118	378	49	163	87	42%	35%	43%	53%	1.13
2006	74	96	336	70	233	122	73%	23%	69%	52%	1.65
2007	85	113	368	67	233	143	59%	25%	63%	61%	1.68
2008	86	109	386	69	244	158	63%	21%	63%	65%	1.84
mean	**81**	**114**	**389**	**59**	**204**	**120**	**54%**	**28%**	**54%**	**58%**	**1.49**
median	**81**	**117**	**386**	**59**	**220**	**124**	**51%**	**26%**	**52%**	**56%**	**1.55**

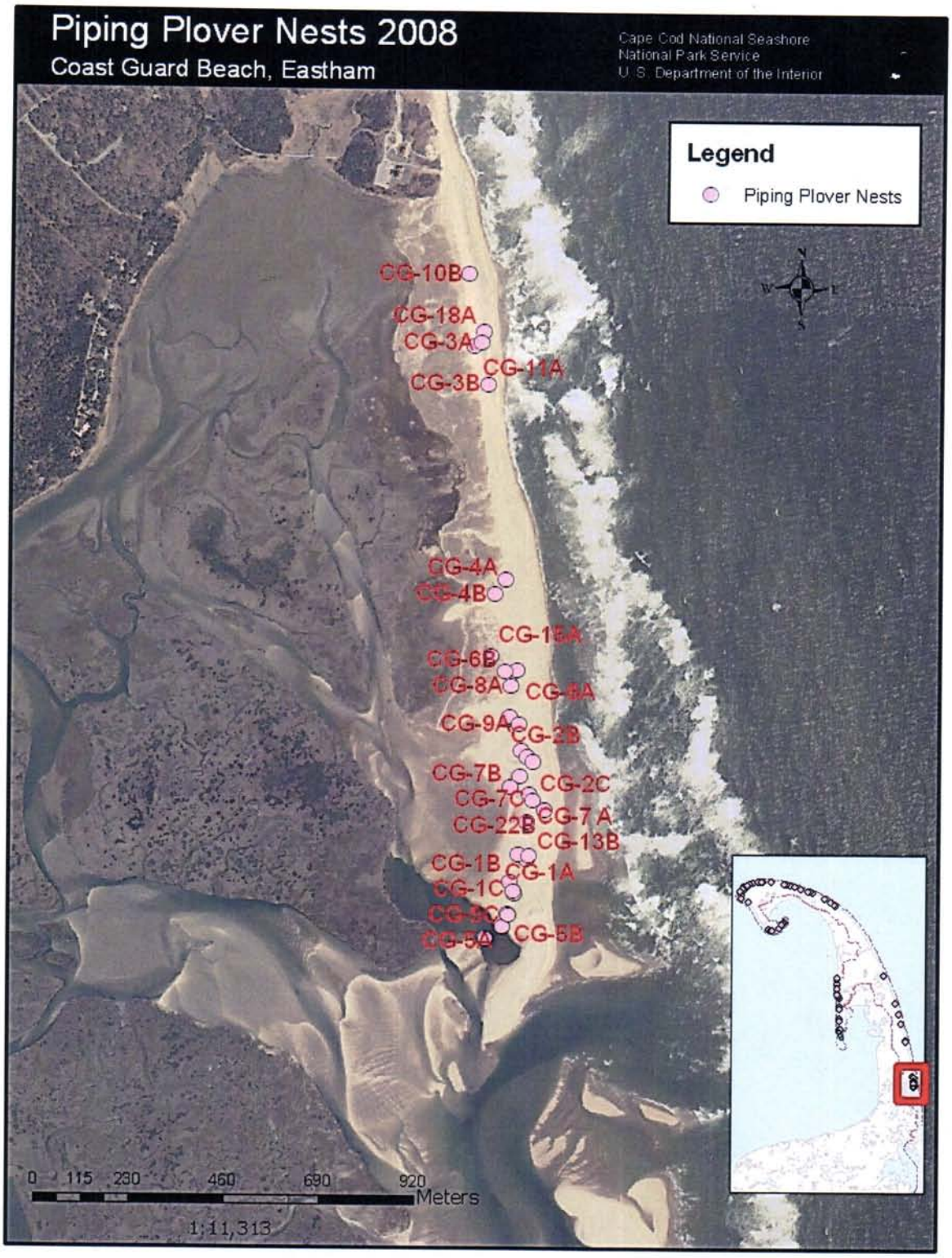
Table 6. Summary of Adult Mortality by Exclosure Type, Cape Cod National Seashore, 2000 – 2008.

Year	# Circular	# Deaths	Rate	# Canopy	# Deaths	Rate
2000	92	0	0.00%			
2001	70	0	0.00%			
2002	77	1	1.30%			
2003	57	2	3.51%			
2004	57	3	5.26%	5	0	0.00%
2005	35	0	0.00%	12	0	0.00%
2006	32	1	3.13%	46	0	0.00%
2007	27	1	3.70%	52	1	1.92%
2008	15	0	0.00%	50	3	6.00%
Overall	462	8	1.73%	165	4	2.42%

APPENDIX A

Maps of 2008 Piping Plover and American Oystercatcher Nest Sites at Cape Cod National Seashore


Piping Plover Nests 2008
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
All 2008 nests
N
0
1.5
3
6
9
12
Miles

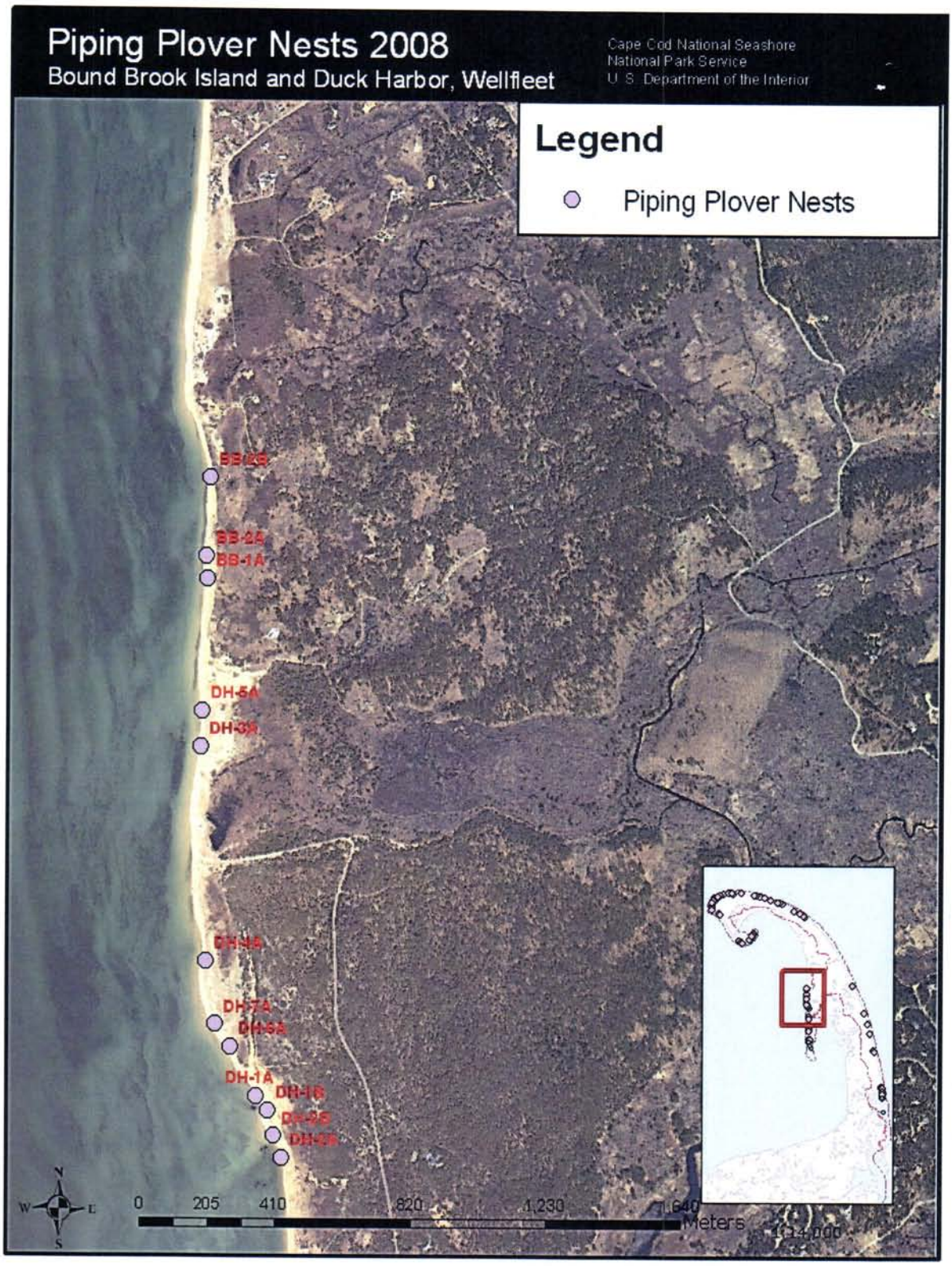

Piping Plover Nests 2008
Coast Guard Beach, Eastham
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nests
CG-10B
CG-18A
CG-3A
CG-11A
CG-3B
CG-4A
CG-4B
CG-15A
CG-6B
CG-8A
CG-6A
CG-9A
CG-2B
CG-7B
CG-2C
CG-7C
CG-7 A
CG-22B
CG-13B
CG-1B
CG-1A
CG-1C
CG-5C
CG-5A
CG-5B
0 115 230 460 690 920
Meters
1:11,313

Piping Plover Nests 2008
Marconi Beach, Wellfleet
Cape Cod National Seashore
National Park Service
U.S. Department of the Interior
Legend
Piping Plover Nests
N
W
E
S
WB-1A
WB-2A
0 160 320 640 960 1,280
Meters
1:15,721

Piping Plover Nests 2008
Marconi Station and LeCount Hollow, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nests
0 170 340 680 1,020 1,360
Meters
1:14,000

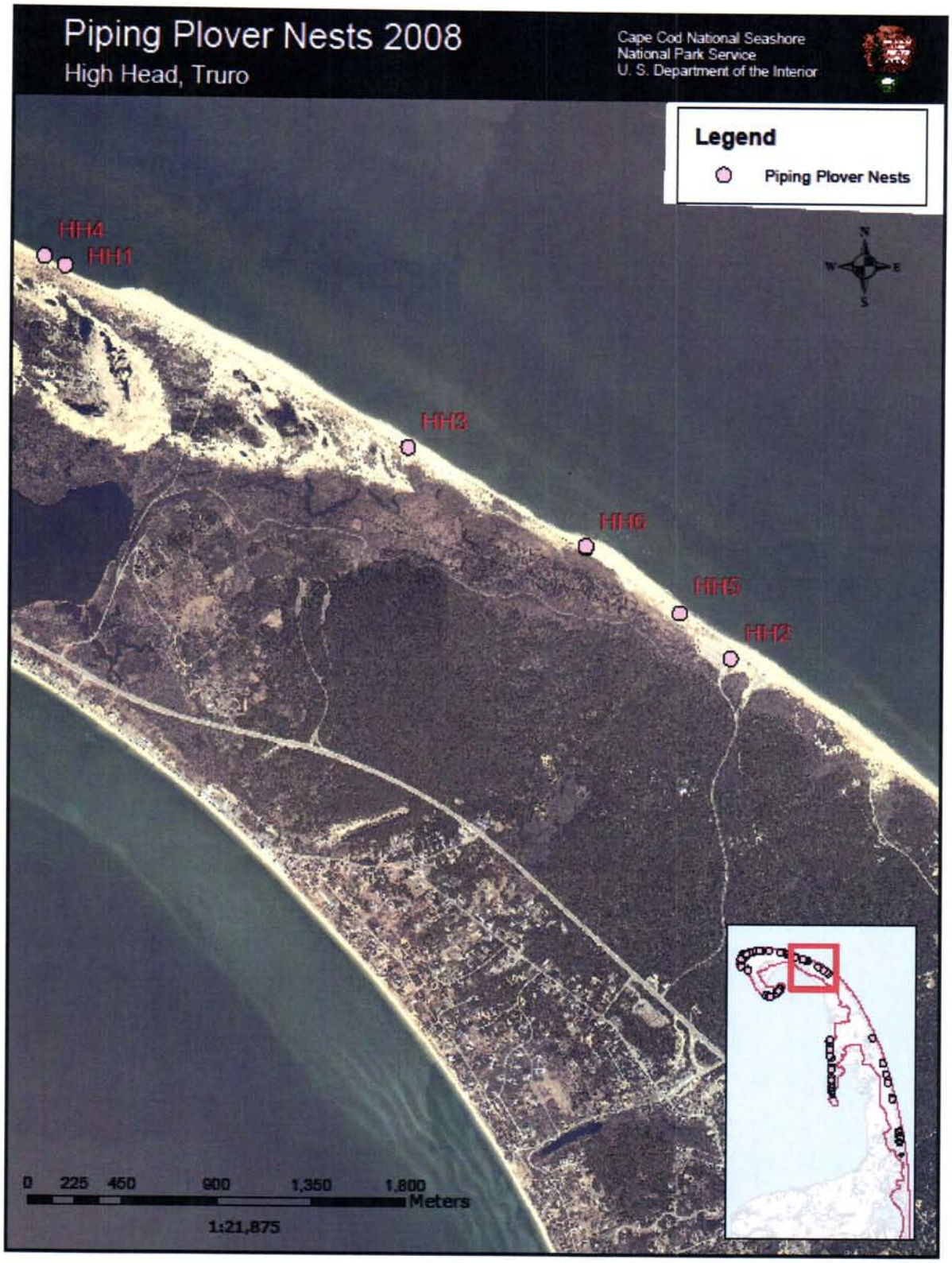
Piping Plover Nests 2008
White Crest Beach, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover
WC-1A
0 30 60 120 180 240
Meters
1:3,423

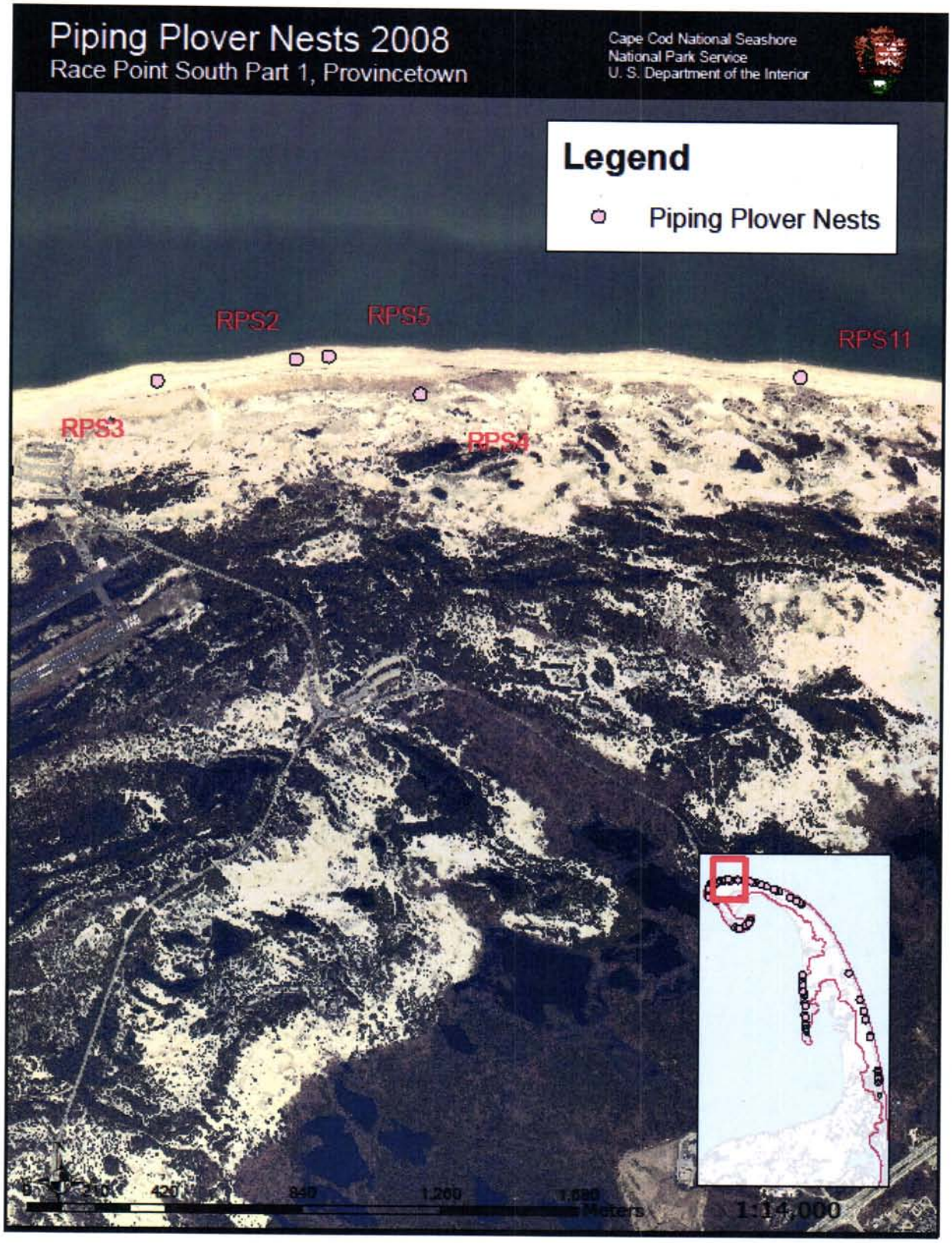
Piping Plover Nests 2008
Newcomb Hollow Beach, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nests
N
W
E
S
NH-1A
0 130 260 520 780 1,040
Meters
1:14,000

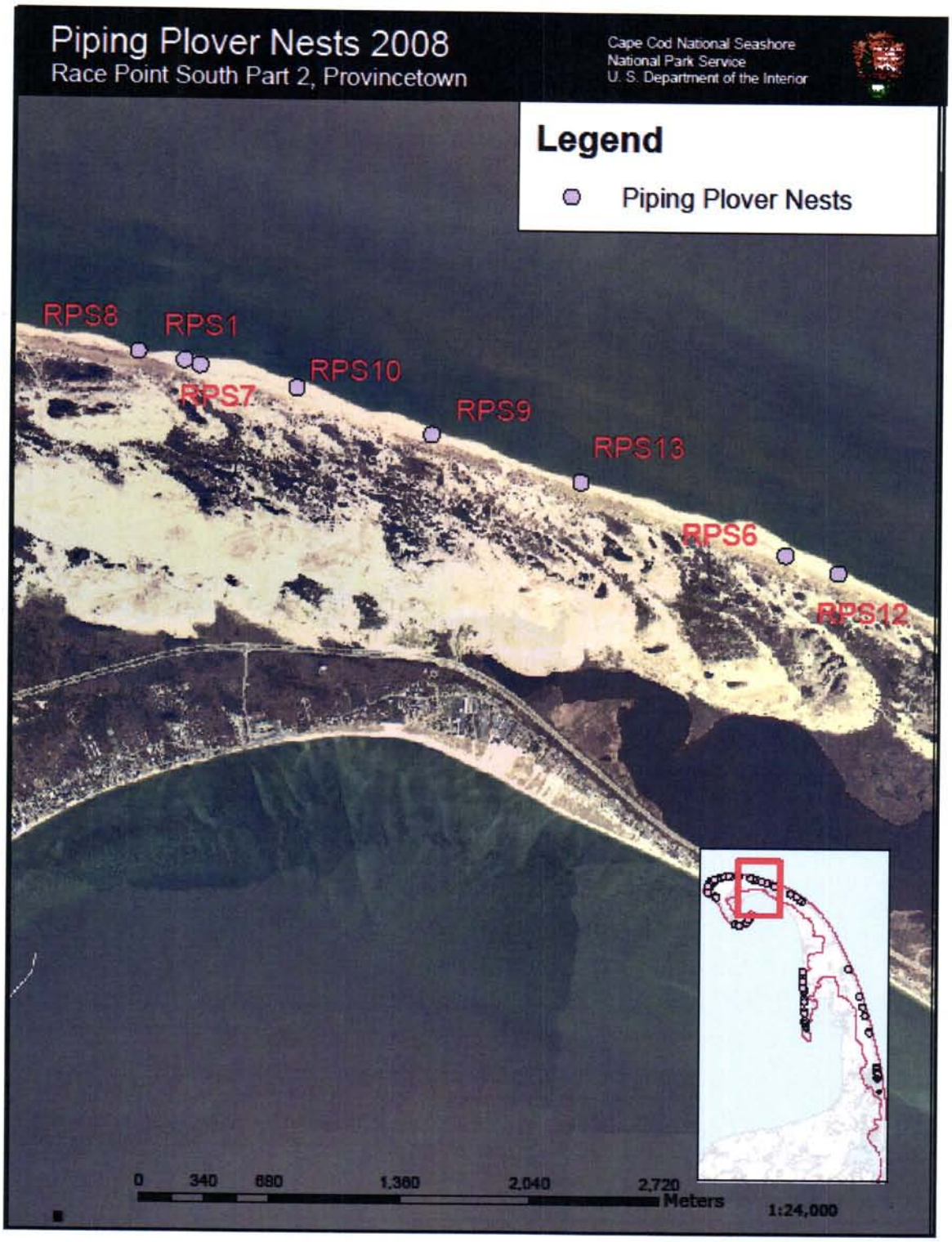

Piping Plover Nests 2008
Bound Brook Island and Duck Harbor, Wellfleet
Cape Cod National Seashore
National Park Service
U.S. Department of the Interior
Legend
Piping Plover Nests
BB-2B
BB-2A
BB-1A
DH-5A
DH-3B
DH-1B
DH-7A
DH-6B
DH-1A
DH-1B
DH-2B
DH-2A
N
W
E
S
0
205
410
820
1,230
1,640
Meters

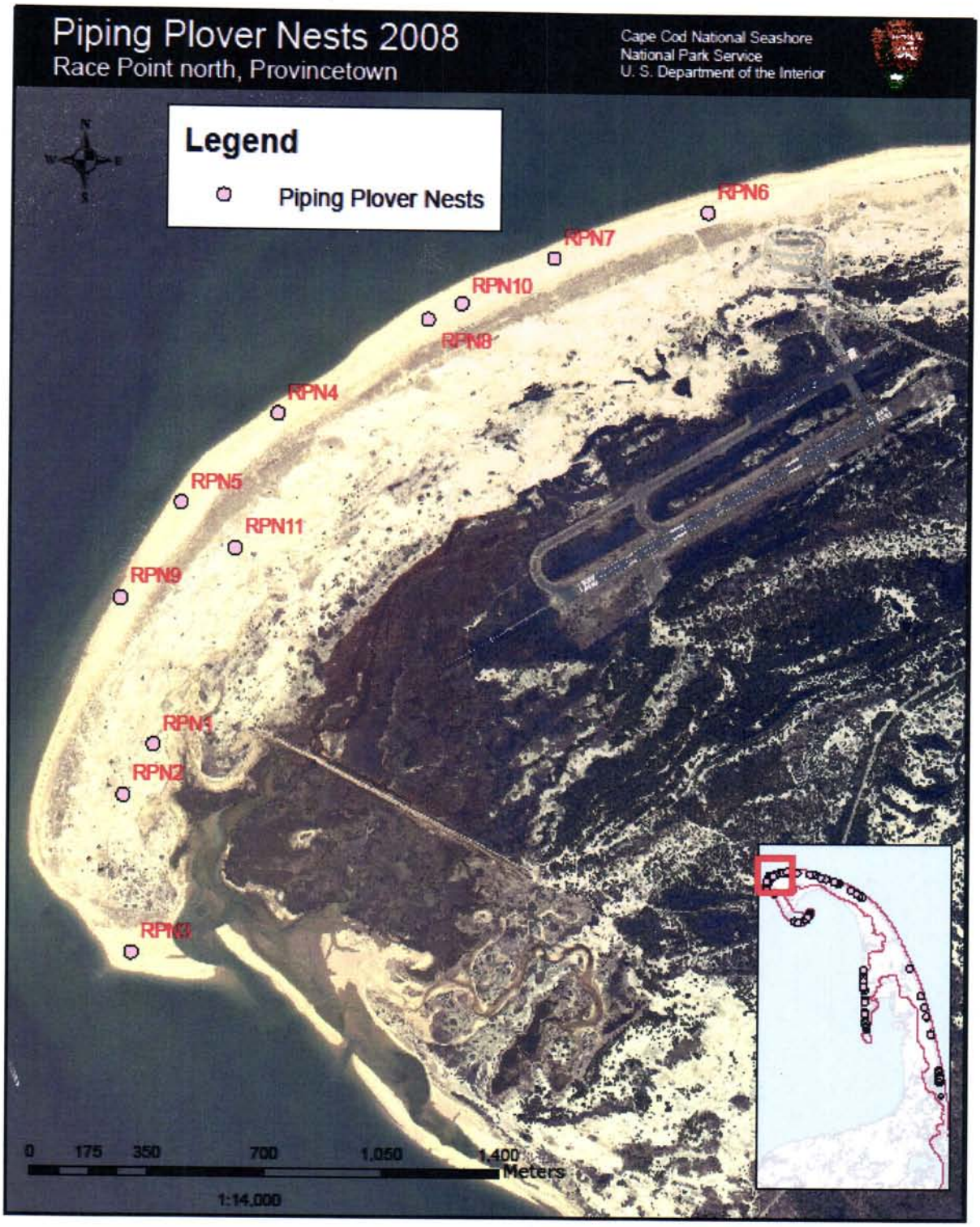
Piping Plover Nests 2008
Great Island, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nest Sites
GI-2A
GI-3A
GI-1A
GI-4A
N
W
E
S
1:10,429
0
150
300
600
900
1,200
Meters

Piping Plover Nests 2008
Jeremy Point, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nests
N
W
E
S
JP-3A
JP-6A
JP-1A
JP-2A
JP-4A
JP-5B
JP-5A
JP-2B
0 95 190 380 570 760
Meters
1:10,429


Piping Plover Nests 2008
High Head, Truro
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nests
HH4
HH1
HH3
HH6
HH5
HH2
N
W
E
S
0 225 450 900 1,350 1,800
Meters
1:21,875

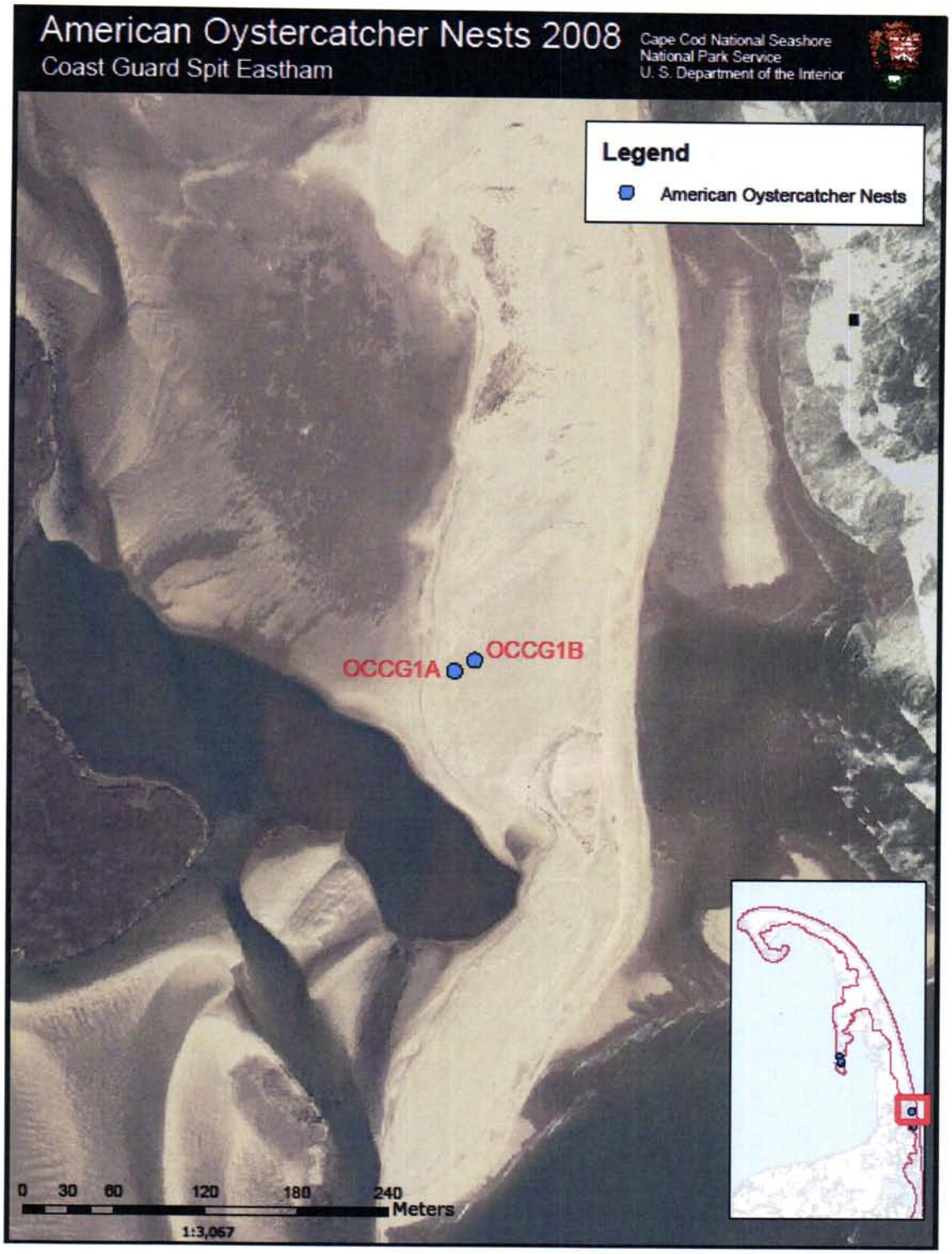

Piping Plover Nests 2008
Race Point South Part 1, Provincetown
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nests
RPS2
RPS5
RPS11
RPS3
RPS4
0 210 420 840 1,260 1,680
Meters
1:14,000

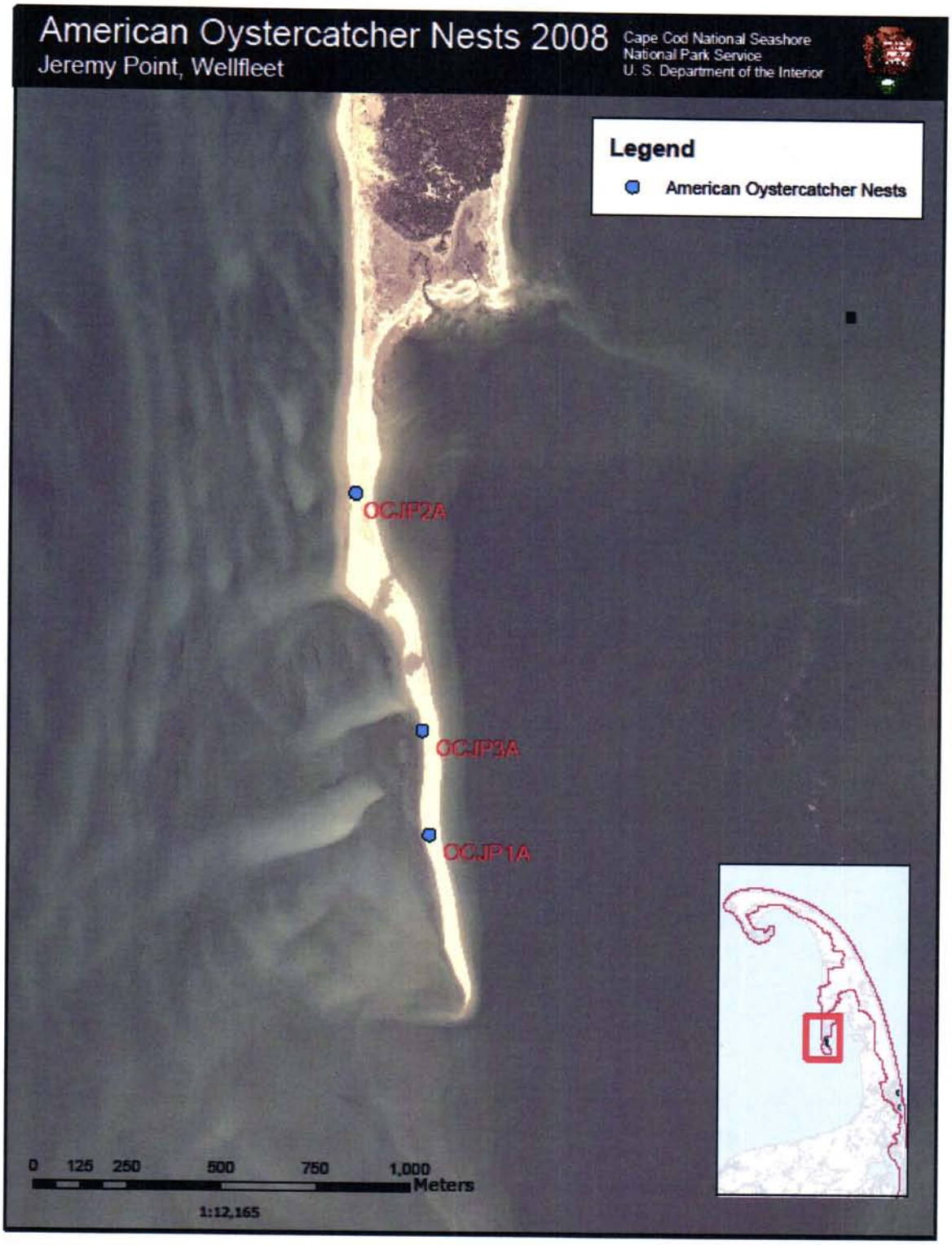

Piping Plover Nests 2008
Race Point South Part 2, Provincetown
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nests
RPS8
RPS1
RPS7
RPS10
RPS9
RPS13
RPS6
RPS12
0
340
680
1,360
2,040
2,720
Meters
1:24,000


Piping Plover Nests 2008
Race Point north, Provincetown
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nests
RPN6
RPN7
RPN10
RPN8
RPN4
RPN5
RPN11
RPN9
RPN1
RPN2
RPN3
0 175 350 700 1,050 1,400
Meters
1:14,000

Piping Plover Nests 2008
Wood End, Provincetown
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nests
0 750 1,500 3,000 4,500 6,000
Meters

American Oystercatcher Nest 2008
New Island, Orleans
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
American Oystercatcher Nest
NI-OC
0
137.5
275
550
825
1,100


American Oystercatcher Nests 2008
Coast Guard Spit Eastham
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
American Oystercatcher Nests
OCCG1A
OCCG1B
0 30 60 120 180 240
Meters
1:3,067


American Oystercatcher Nests 2008
Jeremy Point, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
American Oystercatcher Nests
OCJP2A
OCJP3A
OCJP1A
0 125 250 500 750 1,000
Meters
1:12,165