Shorebird Monitoring and Management
Cape Cod National Seashore
2009

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Abstract:

This report summarizes the 2009 shorebird nesting season for Cape Cod National Seashore (Seashore). Piping plover (*Charadrius melodus*) nesting and brood-rearing were monitored on 24 beaches from Provincetown to Orleans. Observations of piping plovers began mid-March. Egg-laying began in the fifth week of April. Peak nesting occurred during the last week of May. A total of 87 nesting pairs attempted 109 nests, 55 of which were successful. A total of 60 chicks fledged for a productivity of 0.70 chicks fledged/nesting pair. A total of 54 nests failed before hatching. American crows (*Corvus brachyrhyncos*) were the main egg predators before exclosures were installed. Predator exclosures were erected around 66 nests. Thirty-two nests were not exclosed. Of the 32 unexclosed nests, 30 failed to hatch. Nesting pairs of least tern *(Sterna antillarum*) increased from previous years. A total of 236 pairs of least terns nested in 12 small colonies from Eastham to Provincetown. Predators and overwash were the major causes of least tern nest loss. Productivity was low, approximately 0.10 chicks/pair. Nine pairs of common terns (*Sterna hirundo*) nested unsuccessfully on New Island, Orleans. One pair of American oystercatchers *(Haematopus palliates*) nested on Jeremy Point, Wellfleet. The chicks were lost the day after hatching. Post-breeding/staging roseate terns (*Stera dougallii*) were present in large numbers at Hatches Harbor, Nauset Marsh, Coast Guard, Eastham, Wood End, and Jeremy Point.

Dogs were prohibited on all beaches where nesting shorebirds were present except for within the oversands vehicle corridor. During daily patrols, 506 dogs were observed off leash, most frequently on LeCount Hollow and Nauset Light Beach.

Thirty-nine pairs of piping plovers and 85 pairs of least terns 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 until the chicks could fly. Off-road vehicle access at the Seashore is guided by rules developed in 1998 through a negotiated rule making (NegReg), the 2007 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 species of special concern, and the American oystercatcher, a species 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, Herring Cove, Hatches Harbor, Race Point North (including Old Harbor), Race Point South, Exit 9, Armstrong, High Head, Dead Forest, Head of the Meadow, 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 2009. 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

PIPING PLOVERS

Nest Search and Incubation Monitoring

Results

Eighty seven pairs of piping plovers were monitored on 24 beaches in the Seashore in 2009 (Table 1 and Appendix A). Piping plovers were first observed on Seashore beaches on 14 March and most beaches had plovers present by mid-April. Plovers continued to arrive into mid-June. The first nests were found on 29 April. Peak nesting for the Seashore occurred during a two week period from 31 May to 13 June (Figure 1). Most nests were located along the upper beach in open sandy habitat. However, a few pairs nested in more vegetated or interior locations. 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.

A total of 109 nests were found during the 2009 nesting season. Of these, 55 hatched at least one chick and 54 failed (Table 2). The most frequent cause of nest loss was predation (27), followed by overwash (15), abandonment of exclosed nests (6), becoming sanded over (3), abandonment of unexclosed nests (2), and non-viable (1).

The 109 piping plover nests contained a total of 367 eggs. Of these, 190 eggs hatched. The remaining 177 were lost to various causes, primarily overwash, predation, and abandonment of exclosed nests (Table 3). Although overall hatching success was 52%, this varied among beaches, ranging from zero at Marconi Station, Cahoon Hollow, Newcomb Hollow and Bound Brook to 100% at Hatches Harbor, Old Harbor, Dead Forest and Head of the Meadow (Table 1).

Circular and canopy style predator exclosures were installed around 77 of the 109 nests (Table 4). However, exclosures were subsequently removed from eleven nests after three adult plovers were found dead near their exclosures and concerns arose regarding predator related adult plover mortality associated with exclosure use. Post exclosure removal, three of these nests hatched and eight were lost to predators or overwashed in a storm (Table 4).

Of the 77 exclosed nests, 21% failed to hatch. The main causes of loss to exclosed nests include overwash and abandonment. Exclosed nests were monitored more often to increase detection of potential complications associated with the exclosures such as exclosure-related mortalities or predators keying into exclosures. A total of 32 nests were not exclosed. Of those nests, 94 % were unsuccessful.

There were three cases of adult plover mortality in the Seashore in 2009 and all three were likely exclosure- related. On 27 May, a dead adult was found approximately 2' outside a canopy exclosure on Wood End. There were dog/coyote tracks in the area. The carcass was sent to the U.S. Geological Service- National Wildlife Health Center in Madison, WI for necropsy. Results showed the female plover died of trauma, probably due to predation. The bird had extensive

fractures including a crushed skull, ruptured organs. The exclosure was immediately removed and the remaining adult continued to incubate the nest until the nest was predated on 31 May.

The second adult mortality occurred on 4 June, along the edge of a canopy exclosure at Wood End. The bird appeared to have died from a puncture wound to the back. There were no predator tracks in the area. The puncture wound and the lack of predator tracks indicates the mortality may have been caused by an avian predator. This nest was in the process of hatching the day of the adult mortality. The remaining adult stayed with the brood until the last chick was lost on 10 June.

A third adult plover was found dead on 11 June at Jeremy Point. A pile of feathers along with sections of intestines were found under the canopy exclosure. Large heron tracks were observed under the canopy which suggests great blue heron (*Ardea herodius*) predation. This nest was also in the process of hatching the day of the adult mortality. The remaining adult stayed with the brood. One chick fledged.

There were also two exclosure related adult mortalities on the day the eggs were hatching in 2008. Reasons for this increase in adult mortality on/during the hatch date may be that the adult plovers are hyper vigilant to the eggs and newly hatched chicks, defending their young and not flying away when confronted by a predator. The predators may also be hearing and seeing the chicks peeping out of the egg shell, attracting them to the nest.

In 2009, two pair of plovers at High Head and one pair at Head of the Meadow exhibited courtship and territorial behavior (including scraping) for several weeks but a nest was never found.

Discussion

Since 1985, productivity has fluctuated from a high of 2.6 in 1990 and 1991 to a low of 0.3 in 1986 (Figure 2). Regression analysis of annual productivity from 1990 – 2009 shows a statistically significant decline in the annual productivity (slope of the regression line = -0.646403, p – level = 0.002073). The five year average productivity ending in those years also shows a statistically significant decline in plover productivity over the twenty year time period (slope of the regression line = - 0.551734, p-level = 0.011669).Factor that likely affected yearly productivity include predator pressures, storm frequency and beach morphology.

Based on more recent years (2000-2009) the number of nesting pairs (87), nests (109) eggs laid, successful nests (55), nest success rate (53%) and hatch success rate (52%) were fairly typical in being relatively close to the middle of the range of values recently recorded for these parameters (Table 5). In 2009, the proportion of renests (20%) was the second lowest during this period, and would seem to indicate that most first nests were successful. This was generally the case in the North District where there were only five confirmed renesting attempts. Compared to the North Distirct, the South District lost more nests due to its narrow beaches causing washover and to intense crow predation. This was especially true at Marconi Station and Duck Harbor where the proportion of renests were 64% and 42% respectively. If you removed the three pairs of plovers that exhibit breeding behaviors for several weeks but never nested as well as the six pairs that

stopped laying after a first failed nesting attempt, the proportion of renests would increase to 28% but still within the average range recorded over the past ten years.

Over the past ten years, the three main factors affecting nest and egg loss were predation, overwash, and abandonment of nest after being exclosed. On average, 50 % of nests were lost each year. In 2009, nest loss was 50% with predation being the leading cause of nest loss eight of the ten years, predominately by crow. In 2009, crows accounted for 67 % of nest predation. Crows are ubiquitous and opportunistic feeders. Their population appears to be increasing, most likely due to their ability to adapt and benefit from the development of the surrounding landscape (Marzluff et al. 2001).

Groups of crows were commonly observed foraging along beaches especially on Wellfleet bay and oceanside 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 were observed, suggesting that crows took the egg(s) before the nests were found. For the past several years, finding nests soon after the first egg was laid was a high priority so that predator exclosures could be immediately installed. The aggressive use of exclosures over the past four years around incomplete nests may be why the percent of renests has been below the mean of 27%, and among the lowest in recent years (Table 5).

In addition to crow predation on unexclosed piping plover nests, two nests (7 %) were lost to coyote (*Canis latrans*) and one nest (4 %) was lost to gull (*Larus* sp.). Six other nests were lost to unidentified predators (22%).

Due to the frequency and severity of storms and the narrowing of some beaches, overwash was the second leading cause of nest loss (28 %) in 2009. In eight of the last ten years, overwash has been one of the top two causes of nest lost. Overwash affects complete and incomplete nests equally, whereas predators generally prey on incomplete nests and are less able to prey on nests once they are exclosed. As a result, nest loss to overwash can represent a greater loss of reproductive effort. The high incidence of overwash loss may be related to changes in beach morphology. Several beaches have become very narrow creating habitat that is more susceptible to overwash by tides and storms. In 2009, a three day nor'easter starting on 20 June had the greatest impact on nesting birds because of its intensity and duration.

Late season storms like the 20 June storm tend to decrease productivity by setting back nesting chronology. Re-nesting pairs have to contend with the increased levels of human activity that occur during the summer. The narrowing of beaches may also explain the reduction of nesting pairs on some beaches. Coast Guard Beach, Eastham saw the most dramatic decrease from 17 nesting pairs in 2008 to only seven nesting pairs in 2009. Over the past few years, this beach has eroded, making the site less suitable for nesting.

Brood Monitoring and Productivity

Results

Hatching dates of piping plovers ranged from 31 May to 27 July. Fledging dates ranged from 26 June to 27 August. Of the 190 plover chicks hatched, 60 survived to fledge, resulting in an overall fledging success of 32%. By beach, fledging success ranged from 0% at Marconi Station, Cahoon Hollow, Newcomb Hollow, Bound Brook, Dead Forest and Coast Guard, Truro to 88% at Duck Harbor. Parkwide, productivity was 0.70 chicks fledged/nesting pair (60 chicks fledged from 87 pairs) and ranged from 0.0 at Marconi Station, Cahoon Hollow, Newcomb Hollow and Bound Brook to 1.71 at Coast Guard Beach (Table 1, Figure 1). For the past three years, Duck Harbor had greater than 2.0 chicks fledge per pair. In 2009, that dropped to 1.0 chicks per pair but was still the third most productive site in the park. The loss of nests at Duck Harbor, especially to crows was the reason for the decrease in productivity. Once a nest hatched, the chicks did well, most likely due to the abundant amount of food (wrack) and relatively low human disturbance.

Chick mortality factors were extremely difficult to assess. In the majority of cases when chicks are lost, there was no evidence as to why. 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 the chicks after five consecutive days of searching.

In 2009, five chicks were found dead out of the 130 chicks lost. Carcasses were sent to the U.S. Geological Survey - National Wildlife Health Center in Madison, WI for necropsy. Results suggest that one chick died of non-predator related trauma. Another appeared to have died from choking on a long, thin slightly flexible but fairly hard object of unknown origin that was found in the esophagus. Salmonella bacteria found in multiple tissues was likely cause of death for a chick found at Exit 9. Necropsy results from two other chicks were inconclusive.

Discussion

2009 had the lowest chick survival in over 20 years. The number of fledglings (60) and the overall fledge rate (32%) were among the lowest ever recorded at the Seashore. In looking at more recent years (2000 – 2009), the hatch rate (52%) was close to the middle of the range of values recently recorded for this parameter, with 190 chicks from 367 eggs. Up until the end of June, chick survival was relatively good considering the unseasonable cold, wet weather and frequent storms. During this time, chick development seemed slower than past years and may have been influenced by inclement weather inhibiting the chicks ability to feed.

Prior to the 20 June nor'easter, there were twenty-one plover nests (eleven in the South District and ten in the North District) and 103 plover chicks (31 in the South District and 72 in the North District). After the storm, fifteen plover nests (71%) were washed or sanded over, with relatively equal nest lost in both districts. Only 50 of the 103 chicks could be accounted for; a loss of 53 chicks (or 52 % of all chicks). The North District lost forty-seven chicks and the South District lost six.

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 which often causes brood dispersal. Young chicks are extremely reactive 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. An even more serious and potentially deadly threat to chicks occurs on narrow beaches with high human visitation. The lack of dry beach, especially at high tide, forces the beachgoer and plover broods to come in close contact with each other, increasing the frequency and probability of human disturbance.

In general, most piping plover chicks fledge at 25 to 27 days (Blodget and Melvin 1996). However, in 2009 it was not uncommon for broods to take 30–38 days to fledge. Reasons for this slow rate of growth and development are unknown. In 2009, the unseasonable cold, wet weather and frequent storms may have influenced chick development by inhibiting their ability to feed.

For the purposes of vehicle management, vehicles are not allowed on beaches supporting unfledged plover chicks. As outlined in the Atlantic Coast Piping Plover Recovery Plan (1996), Appendix G, plover chicks are considered fledged at 35 days of age or when observed in sustained flight for at least 15 meters, whichever occurs first.

In 2009, a plover chick in the vehicle corridor at Race Point North met the criteria for fledging, but when approached by shorebird staff in a vehicle, it crouched down in the sand rather than fly, and didn't get out of the way of the vehicle. This chick was located on a section of beach that was closed to vehicles due to other unfledged shorebirds in the area. Over the past several years, broods seem to be developing more slowly and it's likely that we may have broods that reach the 35-day mark and still need a little more time to develop the ability to avoid vehicles.

Population Trends

Results

Eighty seven pairs of piping plovers were monitored on 24 beaches in the Seashore in 2009. Piping plovers were first observed on Seashore beaches on 14 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 chick fledged per pair (Figure 2). Over the next several years, numbers of plovers nesting in the Seashore decreased while numbers of plovers nesting in the state remained relatively stable. Eventually, numbers of nesting plovers rose markedly, both at the Seashore and throughout Massachusetts. Productivity at the Seashore rose from 0.3 in

1986 to a high of 2.6 fledged chicks per pair in 1990 and 1991. For the next 18 years (1992 - 2009) the number of nesting plovers has risen and although productivity fluctuates, it has generally met or come close to the federal recovery goal of achieving a five year average productivity of 1.5 fledged chicks/pair. In 2009, the Seashore saw an increase in population of one pair from the previous year, but productivity dropped from 1.84 chicks fledged/ pair to only .70 chicks fledged/pair. This drop in productivity was likely due to several factors including intense predator pressures, narrow beaches, frequent storms and unseasonably, cold weather.

LEAST TERNS

Nest Search and Incubation Monitoring

Results

Least terns returned to the Seashore during the first week of May. A total of 236 pairs nested in 13 small colonies from Eastham to Provincetown. Egg laying began the third week in May, with most least terns on eggs by mid-June. Unfortunately, all of these nests were either washed over or predated. Visual estimates of colony size were made from outside the symbolic fencing several times per week. Shorebird staff may walk inside the colony 1-2 times per week to count nests and or chicks.

The numbers of pairs in each colony were estimated during two standardized periods defined by MDFW ("A-count" from June 5 – 20 and "B-count" after 20 June). The "A-count" totaled 236 pairs in 12 colonies and the "B-count" had 147 pairs in eight colonies. All colonies were small, ranging in size from 69 at Coast Guard Beach in Eastham to one pair at Head of the Meadow and Marconi Beach. There was a good deal of renesting and reshuffling of nesting locations after the "A" count due to intense predation of eggs and nests being washed over.

Tracks leading up to nests indicated coyote to be the main predator. Gull sp., crow, opossum (*Didelphis marsupialis*) and raccoon (*Procyon lotor*) tracks were also observed in colonies. Observations suggest that colonies were visited daily by coyotes, most often resulting in loss of nests. Smaller colonies (<10 individuals) and isolated nests seemed to have a higher probability of survival Tracks running in a straight line past nests in the smaller colonies suggested that coyotes were passing through rather than targeting these areas

Nests were frequently lost to astronomic high tides and storms. A major storm event on 20-24 June washed over approximately 95% of all nests in the Seashore. A second major storm on 22 August washed over all remaining nests The constant loss of nests prolonged the nesting season into September.

On Race Point North, a pair of least terns defended and incubated several small rocks from mid July through early September. It is unclear why these birds would expend so much time and effort. One explanation could be that they were young, inexperienced birds that may have lost a nest and perhaps confused the rocks for their eggs.

Brood Monitoring and Productivity

Results

Due to the intense predator pressures and the loss of nests to overwash, the first successful least tern chick to hatch didn't occur until 18 July. In most years, chicks have been present by the first week in July. Peak hatching occurred the first week in August. The last chicks hatched at Wood End the third week of August. The first chicks fledged the second week in August at LeCount Hollow and the last chicks fledged at Wood End the second week in September.

On 27 July, a least tern nest was abandoned eleven days after nest initiation in the dunes directly in front of the parking lot side of the Head of the Meadow. There was no predator or human tracks near the two egg nest the day of abandonment.

As outlined in the Massachusetts Tern and Plover Handbook (Blodget and Melvin 1996) "Least terns are considered fledged when they are capable of flight". A total of 25 chicks from 236 nesting pairs fledged from seven beaches; LeCount Hollow (5), Wood End/Long Point (5) and High Head (5) , Race Point North (4), Head of the Meadow (3), Marconi Beach (2) and Exit 9 (1). Total productivity was estimated at 0.11 chicks fledged per pair for the season (236 pairs/25 fledged chicks).

Discussion

The Seashore saw the greatest number of nesting least terns in 2009 since 2004 (236 and 275 respectively) (Figure 3). Four years prior to 2009, populations ranged from a low of 80 nesting pairs in 2007 to a high of 162 nesting pairs in 2005, with an average over the four years of 111 nesting pairs. Even though the number of nesting least terns increased in 2009, productivity continues to be poor. Reasons for this decline in productivity include the narrowing of beaches causing frequent over washing of nests and intense predation on eggs and chicks, especially by coyotes.

A dead adult least tern was collected on 29 July at Race Point North. The bird was intact and there were fresh coyote/dog tracks up to the bird. The carcass was sent to the U.S. Geological Survey- National Wildlife Health Center in Madison, WI for necropsy. Results suggest the cause of death was trauma due to predation, with multiple puncture wounds present and hemorrhage in both lungs. Although the report doesn't specify predator, it was probably canid, due to the tracks observed at the kill site.

It is difficult to determine causes of tern chick mortality Coyote is suspected due to daily observations of fresh tracks through most colonies.

COMMON TERNS

Nesting Population and Productivity

Results

Common terns were first sighted on 8 May at Race Point North. In 2009, approximately nine pairs nested on New Island, Orleans in late June. It is believed that these birds may have moved from a small colony on Nauset Beach, Orleans after nests were washed over from the 20 June storm. These nests disappeared by mid-July. Coyote and fox (*vulpes fulva*) were the probable source of egg predation. No chicks were ever observed.

Discussion

In 2002, for the first time in 20 years there were no nesting common terns on New Island (Trull pers. comm). It is clear that predator pressure is the main reason for the decline of common tern and other shorebird nesting on New Island. Over the past six years, shifting sand has connected New Island to Nauset Beach and during low tide this "island" is more accessible to a variety of mammals. Electric fencing may be an effective tool to reduce mammalian predation but is not practical due to limited staff and the logistics of access. In 2005, after three years, 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 and chick loss. From 2006 - 2009, small colonies ranging in size from 1-9 pairs attempted to nest on this site. All nests were lost to predation. It is clear that predators have made it virtually impossible to fledge any chick from this once productive site.

AMERICAN OYSTERCATCHERS

Population and Productivity

Results

The first American oystercatcher was observed on March 29, 2009 at the southern tip of Coast Guard Beach, Eastham. One pair nested at the southern tip of Jeremy Point. The nest was found on 9 May. Three chicks hatched on 13 June and were gone the following day. Tracking was poor, but predation was the probable cause of chick loss.

A second pair of American oystercatchers was observed 9 May just south of the nesting pair at the southern tip of Jeremy Point. Fresh scrapes were observed but a nest was never found. The pair disappeared by 20 May.

Discussion

The American oystercatcher has experienced a dramatic range expansion along the Atlantic Coast, reaching Massachusetts only 40 years ago. The Massachusetts population continues to grow with the largest concentrations occurring on the islands associated with Cape Cod and

Boston Harbor. At the same time, recent evidence shows this species is declining in its core areas and has recently been named as a species of concern by the U.S Shorebird Conservation Plan due to low relative abundance, threats on non-breeding grounds, and rather restricted non-breeding distribution (Murphy 2009). Like plovers and terns, this species is also vulnerable to disturbance from human recreational use of shoreline habitats. Because of this, great effort was made in 2009 to reduce human disturbance during incubation and chick rearing including public outreach through personal contacts and signage.

POST BREEDING SHOREBIRDS including Common and Roseate Terns

In late summer/early fall, thousands of migrating shorebirds and terns congregate on the mudflats and beaches along the Seashore to feed and rest before migration. Nauset Marsh/Coast Guard Beach, Jeremy Point, Hatches Harbor, and Wood End/Long Point are particularly important, as they represent the most important staging and roosting areas for these birds on Cape Cod (Hadden 2001, Trull et al. 1999).

In the late summer/early fall of 2009, Massachusetts Audubon's Coastal Waterbird Program (CWP) and U.S Geological Survey at Patuxent Wildlife Research Center (USGS) made several site visits to the Seashore as part of a long term study of post-breeding tern movements. They spent a total of 510.5 hours documenting the number of common, roseate, least, forsters, black and arctic terns on Seashore beaches. These site visits included 252 hours (over 52 days) spent at Hatches Harbor, 207 hours at Nauset Marsh (over 40 days), 10 hrs at Coast Guard Beach in Eastham (3 days), 35 hrs at Wood End (10 days), and 6.5 hrs at Jeremy Point (3 days).

During these site visits, high counts of approximately 5,000 terns were observed at Hatches Harbor, 5,000 at Nauset Marsh, 4,000 at Coast Guard Beach, 20,000 at Wood End, and 1,200 on Jeremy Point. On August 1, a total of 2,500 terns were observed at Hatches Harbor, with an estimate of 30% of this flock being roseate terns. This estimate means that approximately 12.5% of the entire Atlantic coast roseate tern population (estimated to be 6,000 individuals in 2008), was present at Hatches Harbor at this time (unpublished summary from Massachusetts Audubon, 2009).

Flocks of approximately 1000-4000 were observed almost daily at Hatches Harbor throughout the month of August, upwards of 10% or more of the entire roseate tern Atlantic coast population. The ratio of roseate and common terns in these large flocks was variable, depending on time of day and tidal phase, but overall roseate terns made up 5%- 80% of the flocks. On August 15-16, 2009, Dr. Jeff Spendelow (USGS) observed young, mostly metal-banded roseate terns from Connecticut, New York, Massachusetts, New Hampshire, Maine and Nova Scotia at Hatches Harbor. This represented birds from the entire, endangered Northwest Atlantic Coast breeding population (unpub. summary from Massachusetts Audubon, 2009).

In addition to counting numbers of terns at Hatches Harbor, biologists from Mass Audubon and USGS recorded a variety of disturbances negatively impacting shorebirds. During a total of 32 days of observation, significant disturbances were recorded on 14 days (43%); of these

disturbance days, 7 of them (50%) included at least one disturbance caused by a leashed or unleashed dog.

When the flocks of terns were disturbed by dogs, part or all of the flock vacated the area and didn't return during the observation period. On nice weather days and weekends, 50 cars or more (maximum count of 100 vehicles counted on 4 August) were observed on the outer beach at Hatches Harbor. The majority of human and dog disturbance occurred in and around the bay side intertidal flats after vehicles began to arrive on the beach. In addition, this area was a popular spot for dog owners to play fetch with their unleashed dogs (Jedrey unpub. 2009).

In 2009, through symbolic fencing and signage, sections of intertidal zone with staging shorebirds at Coast Guard Beach, Eastham, Jeremy Point and Hatches Harbor were temporarily closed to pedestrians. Signs guided visitors along the upper beach away from the birds in order to reduce disturbance.

MANAGEMENT AND PROTECTION

PREDATION MANAGEMENT

Piping Plover Nest Protection

Methods

Historically, the Seashore has focused on non-lethal predator management through the use of exclosures around nests. In 2009, two predator exclosure designs were used:

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

2. *Canopy Exclosure* - This design uses 2 x 4 inch fencing to create a 4 x 4 foot square exclosure, 3 feet high. A heavy gauge plastic 2 x 2 inch 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 foot piece of fencing is attached to two of the sides creating a second, domed top.

With concurrence from the MDFW (Melvin, pers. comm.) the majority of incomplete clutches were exclosed to reduce the chance of predation on eggs. If the nest was then abandoned, the renest was not exclosed until the pair was actively incubating eggs, to increase the likelihood that the pair would return to the nest after the exclosure was installed. If, after fifteen minutes they didn't return to the nest after the exclosure was installed, the exclosure was removed.

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 regarding adult plover mortality associated with exclosure use. Exclosures were also removed if tracking or direct observations indicated that "smart predators" were keying into the exclosures harassing incubating adults.

Results

Predator exclosures were installed around 77 of the 109 piping plover nests (Table 4) although eleven were removed before the eggs hatched due to predators "keying" into the exclosure. Thirty-six nests had circular exclosures and 30 had canopy exclosures. Of the 66 nests that were exclosed until hatching, 50 (76%) successfully hatched young. By exclosure type, nest success rate were 77% for canopy and 75% for circular exclosures. Of the eleven nests that had the canopy exclosure removed during incubation, success rate was 27%. Without the use of exclosures, a nest had very little chance of eluding a predator. Of the thirty two unexclosed nests, thirty (94%) failed to hatch.

Most pairs accepted the exclosures, but two incomplete nests were abandoned within a day or two after exclosure installation, presumably a response to placement of the exclosure. These pairs were monitored closely and eventually renested. To minimize the risk of a second nest abandonment, exclosures were not placed around these nests until birds were actively incubating eggs. Both of these pairs renested (a total of three renests), but nests were lost (predated or washed over) before exclosures could be placed around nests.

In 2009, two additional canopy exclosed nests with complete clutches were abandoned. The cause of abandonment may have been due to crow or coyote harassment outside the exclosure. At Bound Brook, a four egg nest was abandoned on 19 May. Two sets of coyote (or fox) tracks were observed under the canopy. There were no signs of the predator digging under the exclosure or pouncing. One plover was observed near the nest, but not defending it. This pair eventually renested but the eggs were washed over. On 13 May, a canopy exclosure was placed around an incomplete nest (two eggs) at Duck Harbor. This pair accepted the exclosure and laid an additional two eggs. Crows were commonly observed in the area. On 28 May, Seashore staff observed several crows alongside (not under) the canopy of the exclosure. As the crows approached the exclosure, the incubating plover got off the nest to defend it. The crows were then scared away by Seashore staff and the plover resumed incubation. The following day, four crows were observed near the nest and the nest was abandoned. Fresh coyote tracks were also observed near the exclosure. This pair moved to Great Island and lost its renest to washover.

Crows were also suspected of predating plover chicks. On 8 June at Marconi Beach, three newly hatched chicks were observed in the nest bowl inside an exclosure. The following day, no chicks were observed but the sand around the exclosure was disturbs and there were numerous crows tracks around the exclosure. Crows were also observed in the area. It is likely the crows ate the chicks as they left the safety of the exclosure.

In 2004, due to the increased number of adult mortalities associated with the use of circular exclosures, the Seashore started using some canopy style exclosures. 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 plover associated with a canopy exclosure occurred in 2007. This number tripled in 2008 and 2009 with the loss of three adults each year.

From 2004 - 2008, the overall rate of exclosure related mortality was higher for circular exclosures than canopy style, 3.01 to 2.42 respectively (Table 6). In 2009, for the second consecutive year, there were no adult mortalities associated with the use of circular exclosures but the rate of deaths from canopy exclosures more than tripled (0.0% to 7.89 respectively). With the loss of three adult birds in 2009 due to the use of canopy style exclosures, the overall rate of deaths double for canopy exclosures when compared to the circular type (3.45% to 1.60%).

Discussion

In 2008 and 2009, crow accounted for the greatest loss to nest predation (38% and 67% respectively)(Table 3). The review of the past several years of weekly district reports suggests that crows are the greatest threat to plover eggs. Most weeks, the report note groups of crows (especially during April and May) hunting within plover nesting areas. These reports also discuss the abundance of crow tracks in nesting areas. The number of nests lost to crow predation would even be higher in most years if we did not install predator exclosures around nests soon after they were discovered. These nests were often incomplete, before the plovers were actively incubating the eggs. Even with predator exclosures being quickly installed around nests, some even before clutch completion, predation accounted for the greatest number of nests lost in 2009 (38%) (Table 2).

It is clear that predators, especially crows, have a major impact on nest success. Of the twenty seven nests that were lost to predators in 2009, eighteen were lost to crow. Moreover, the use of predator exclosures appears to have come with a price, an increased number of adult mortalities associated with exclosed nests. Since 2002, there have been at least fifteen adult mortalities associated with the use of circular and canopy exclosures at the Seashore. Although the number of adult deaths seems low considering that over 700 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, the benefits of exclosures may not outweigh the risks placed on the adult birds and warrant the discontinuation of all exclosures, which would cause a substantial decline in nest success and productivity

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) left. 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.

In 2009, approximately 20 tern shelters were distributed to six colonies (Marconi Beach, LeCount Hollow, Head of the Meadow, High Head, Race Point North and Wood End) when the chicks hatched to provide shade and protection from predators. The triangular shelter is approximately 25" x 8" x 8" and

made of plywood. There is a small 7" x 8" opening for the chicks to enter the shelter. Shelter design was taken from the U.S. Fish and Wildlife Service Tern Management Handbook, Coastal Northeast United States and Atlantic Canada (2004).

RECREATION MANAGEMENT

Habitat Protection

Historic shorebird nesting habitat was posted with symbolic fencing and signs 3 April on Race Point North and Race Point South, and by the third week of April on Coast Guard, Eastham, Great Island, New Island, and Jeremy Point. Symbolic fencing was placed around all other areas where nests and active scrapes were found, and where shorebirds were observed exhibiting courtship behavior. 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. A variety of shorebird and natural resource informational and regulatory signs were also posted at the entrance to most beaches and 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/-boarding/surfing are also seasonally banned on all bayside beaches in Wellfleet from 1 April until the last chick fledges.

Additionally, at the request of the Seashore, hang-gliders and para-gliders are temporarily banned from launching along 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. In addition, a number of areas are closed to pets to protect park resources. In 2009, the south side of Coast Guard Beach, Eastham and Jeremy Point were closed to pets on 1 April to protect nesting plovers. In 2009, beaches remained closed through Columbus Day to protect the thousands of terns and other shorebirds utilizing the mudflats and beaches for feeding and resting during migration.

Additional sections of bay and ocean beaches were also temporarily closed to pets as needed to protect nesting areas. In 2009, this also included North District beaches which, prior to 2009,

were open to leashed pets through the nesting season. "No Pet Area" signs were 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 chicks fledged.

The exceptions to the seasonal dog ban were beaches that allowed ORV use (High Head, Race Point North and South and Hatches Harbor). Hundreds of ORV and Self Contained Vehicles (SCV) permits had already been issued prior to the Park's inclusion of this regulation in the North District. For 2009, dogs were allowed on leash in these areas until chicks hatched. Dog closures went into place when the traditional vehicle closures took place (when chicks hatched). Signs informing visitors of this temporary pet closure were installed and moved as necessary to reflect the closures in effect at any one time. Sections of beach were closed until all 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 2009, a total of 506 dogs were observed off leash by shorebird monitors from 15 April to 28 August by shorebird monitors. Unleashed dogs were encountered most frequently in the South District at LeCount Hollow and Nauset Light (67 and 41 respectively) and Herring Cove and Hatches Harbor in the North District (48 and 38 respectively).

On 2 September, a dead immature young of the year roseate tern was found on the the northern end of Hatches Harbor inside a symbolically fenced off area used by staging terns. Human and canid tracks were found next to the carcass. The carcass was sent to the U.S. Geological Survey-National Wildlife Health Center in Madison, WI for necropsy. Results suggest the cause of death was fungal pneumonia and air sacculitis, caused by infection with the fungus *Aspergillus fumigatus.* There was also evidence of acute trauma with bruising in the pectoral muscles and a broken rib. More than likely this bird died from the infection and the trauma came from a coyote/dog post mortem.

For the past three years, shorebird monitors hand out dog biscuits to pets that were observed on leash. This provided an opportunity to talk with the 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.

Pedestrians and Boat Landing

Winter storm erosion continues to narrow beaches in the South District. Where beaches were extremely narrow, it was not always possible to provide sufficient buffer within the symbolic fencing (especially at high tide) to prevent pedestrian disturbance of nesting birds. At sites where this was a problem, beaches were closed at times of high tide. Where possible, detours were established to allow visitors access to other sections of beach. Informational/directional signs were erected informing visitors of these closures. These closures have been very effective with high visitor compliance. At low tide, there was adequate exposed beach between the nesting

birds and the pedestrians. However, at high tide, the symbolic fencing often extended into the water making it impossible for pedestrians to pass.

Some sections of beach had to be completely closed at all tides due to concerns that day hikers who start at low tide may not be off the beach in time to safely pass the nesting area without disturbing the nesting birds. Where possible, detours were established to allow visitors access to other sections of beach. Informational/directional signs were also installed to informing visitors of these closures. On beaches with high visitation, seashore staff and volunteers were posted at these closures which have resulted in high visitor compliance.

Jeremy Point (north of the overwash area) was closed at high tide from 14 May to 11 July. The east side of Jeremy Point was closed 17 July to protect a small colony of least terns. It was re-opened on 24 July when all nests were washed over in a storm. A 0.1 mile section along the southern tip of Jeremy Point (south of the overwash) was closed 10 May to 14 June to pedestrians and boat landing to protect a pair of American oystercatchers nesting on this narrow section of beach.

Great Island from the "Gut" south to the northern end of Jeremy Point was closed at high tide to protect nesting piping plovers from 4 June to 13 June. A total closure (at both low and high tides) went into effect 14 June to 24 July, when a new plover nest was found and a colony of least terns formed at Middle Meadow (Great Island). Throughout these closures, visitors could use an alternative route via the inland trail to access Jeremy Point.

The entire south side (0.5 miles) of Coast Guard Beach, Eastham was closed at high tide (5 June to 3 July) to protect nesting piping plovers and least terns. An alternative route to Nauset Marsh was available to visitors.

Some isolated nests occurred on remote narrow beaches where human disturbance was minimal. In these cases, pedestrians were allowed to pass under the symbolic fencing at high tide. Signs explained the need to move quickly and to stay as close to the water's edge as possible. All nests were exclosed so there was no threat of a visitor accidentally stepping on the nest.

Off-Road Vehicle

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), 2006 Environmental Assessment: Options for Managing ORV Access (NPS 2007a) and the associated FONSI (NPS 2007b). Permit applicants receive some education about nesting piping plovers and terns. A total of 4,011 ORV/SCV permits were issued in 2009 (1,473 seasonal permits and 2,538 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 determine the actual date of hatching and ensure that chicks are found as immediately as possible after hatching, piping plover and least tern 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 extended 0.2 miles on each side of the brood for piping plover chicks and 0.91 m from either side of lines drawn through the outermost nests in the colony and perpendicular to the long axis of the beach for least tern chicks. These vehicle closures were adequate for most nesting. 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.

Field observations of unfledged chick movements in both piping plovers and least tern suggest that broods tend to move greater distances along the beach when there are no neighboring nesting birds keeping them within a defined territory. There were several cases of this in 2009 including a brood of three, flightless piping plover chicks nesting 0.25 miles north of the pedestrian beach access at Ballston Beach. The flightless chicks went missing on 21 July. After days of searching, the brood was found eight days later, approximately 3.2 miles south of their nest site. At Race Point North, there were two separate instances where a brood of least tern chicks moved over 0.3 miles from their nest in a 25 day period. It was not uncommon for chicks to move 0.1 miles overnight.

For piping plovers and least terns, vehicle closures were lifted once broods demonstrated repeated and sustained flight of 15 meters or more. Additionally, fledged least tern chicks that were still being fed by adults on a beach resulted in a continuation of a vehicle closure on that beach.

Additional information on ORV management can be found in the 2009 Off-Road Vehicle Activity Report (NPS 2009).

Park Beach Operations/Essential Vehicles

Seashore staff in vehicles routinely operates on beaches that host shorebird nesting, in order to perform their functions 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 and 2007 FONSI (NPS 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 the human factors affecting shorebirds is important for gaining local support and facilitating their recovery. In early spring, an outreach program featuring a Powerpoint presentation and interactive activity demonstrating the impacts of disturbance to nesting shorebirds was presented to local schools. A total of 827 elementary grade students and teachers took part in this program (13 programs were given to 35 classes)

In additional to classroom visits, an educational opportunity arose when sections of narrow beach had to be closed to protect nesting shorebirds. Seashore staff and volunteers were often stationed at these closures. This not only ensured compliance, but, provided an opportunity to educate the visitor about the nesting shorebirds, their management and protection. A spotting scope was often set up for the visitor to view the nesting shorebird 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 as an educational tool. This type of informal "on site" interpretation was very effective in reaching a broad range of visitors to a resource that is often overlooked. Over 5000 visitor contacts were made at these closures.

Volunteers donated a total of 350 hours to CACO shorebird management program. Volunteers worked closely with Shorebird Biological Technicians and Student Conservation Association interns (SCAs) in field operations from April through August.

FUTURE MANAGEMENT CONSIDERATIONS

Management recommendations for the 2010 shorebird nesting season was submitted to the park's Superintendent for review.

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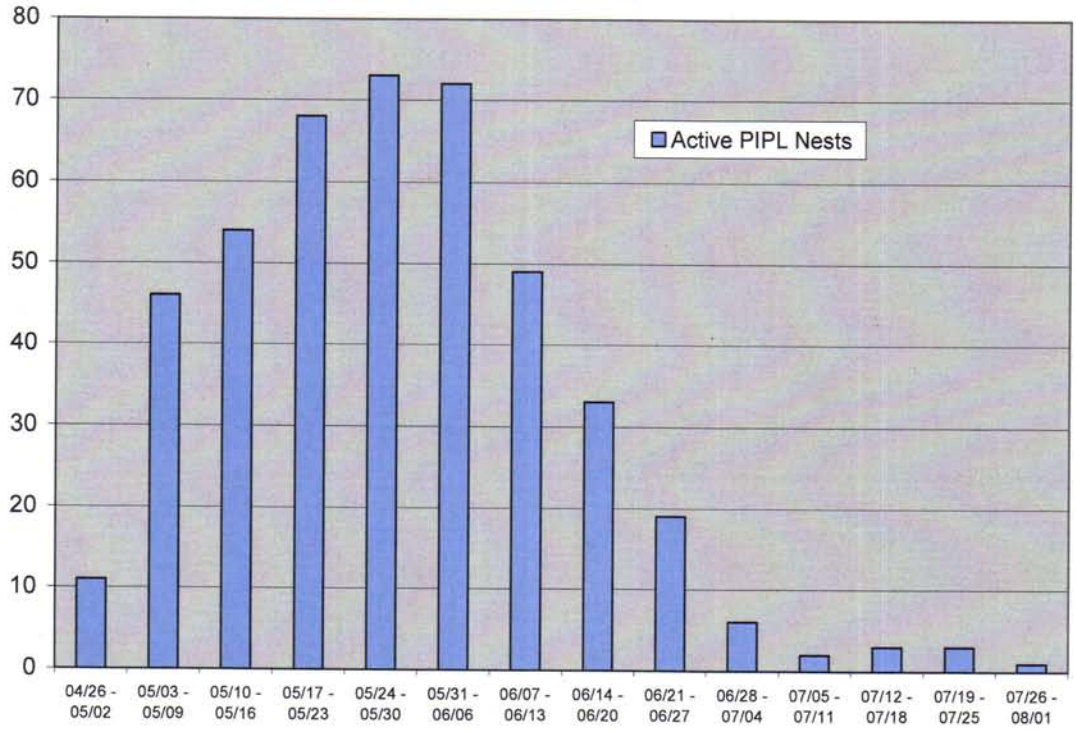


Figure 1. Weekly Active Plover Nests for Cape Cod National Seashore, 2009.

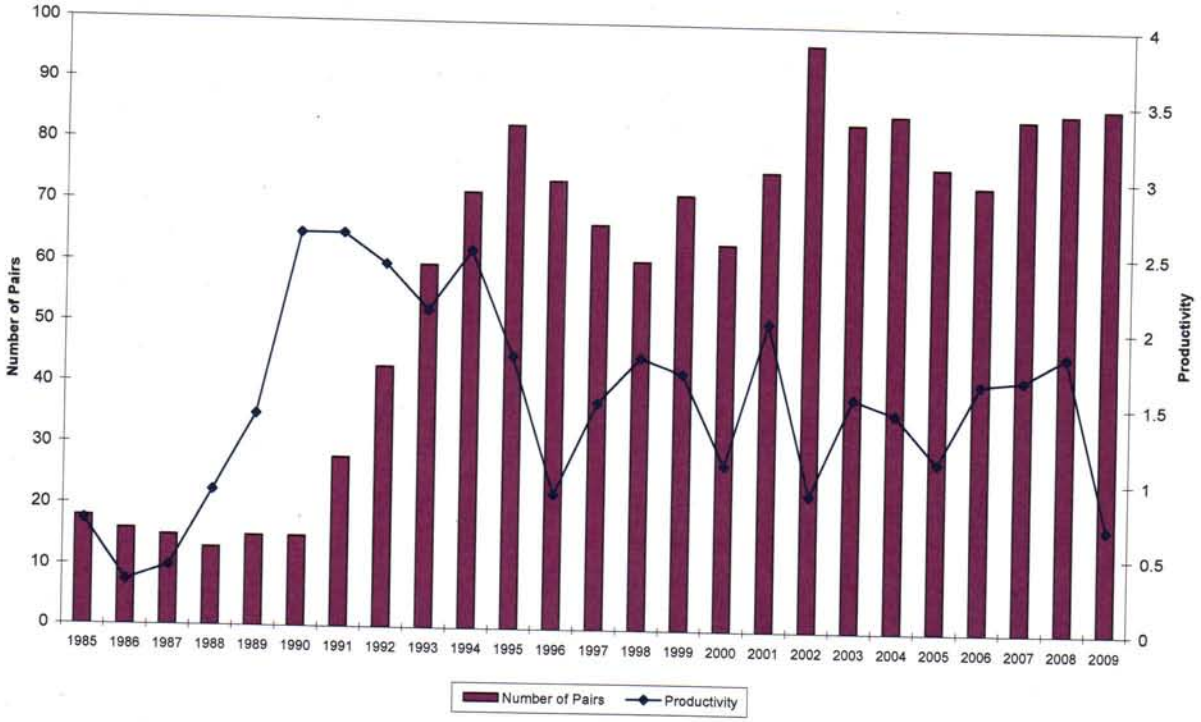


Figure 2. Number of Piping Plover Pairs and Nest Productivity on Cape Cod National Seashore from 1985 – 2009.

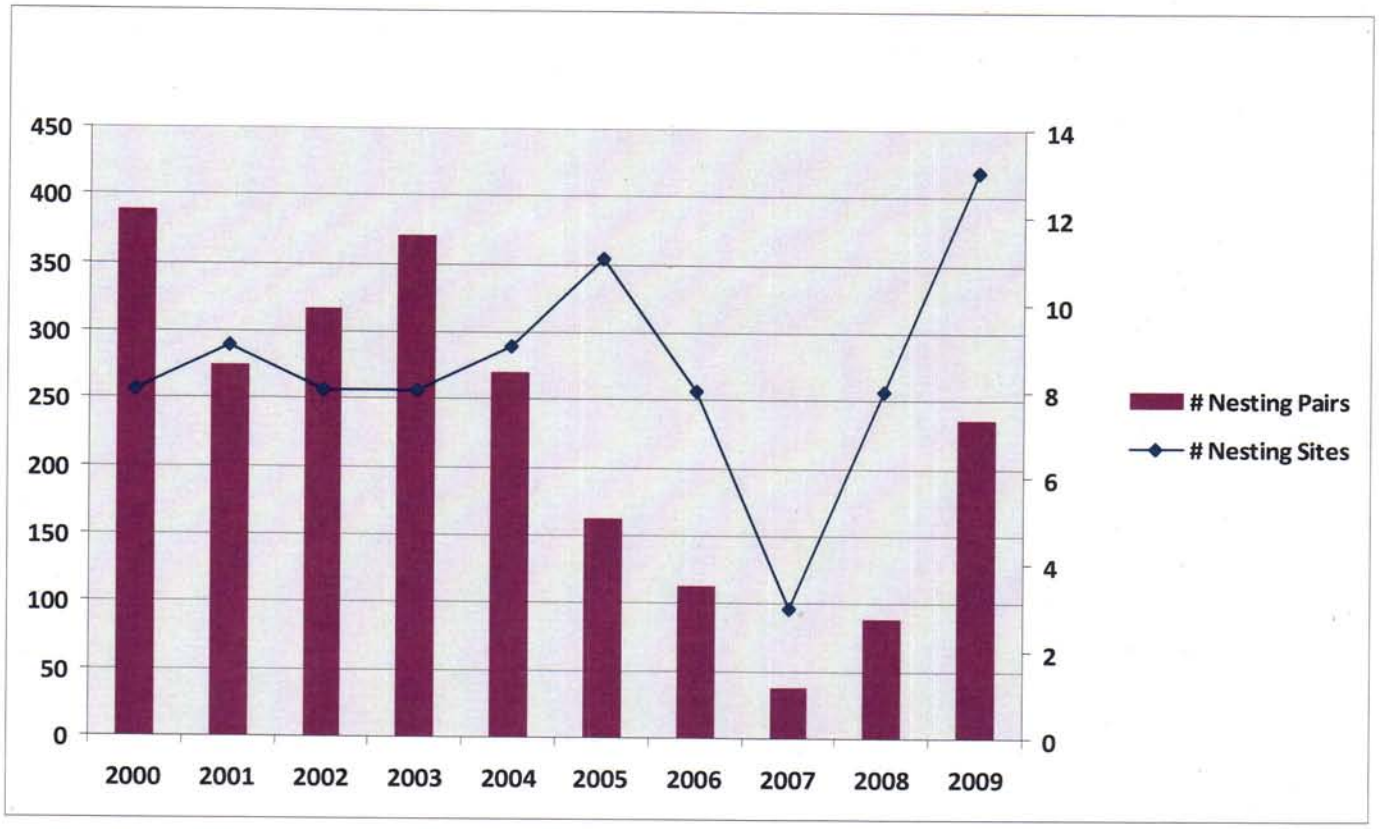


Figure 3. Number of Nesting Pairs and Sites of Least Terns, 2000-2009.

Table 1. Summary of Piping Plover Breeding Success, Cape Cod National Seashore, 2009

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 Beach	7	8	32	21	12	0.66	0.57	1.71
Nauset Light Beach	0	0	0	0	0	0	0.00	0.00
Marconi Beach	5	7	24	12	3	0.5	0.25	0.60
Marconi Station	4	11	18	0	0	0	0.00	0.00
LeCount Hollow	2	2	6	3	1	0.5	0.33	0.50
White Crest	0	0	0	0	0	0	0.00	0.00
Cahoon Hollow	1	1	4	0	0	0	0.00	0.00
Newcomb Hollow	1	1	4	0	0	0	0.00	0.00
Bound Brook	2	4	14	0	0	0	0.00	0.00
Duck Harbor	7	12	36	8	7	0.22	0.88	1.00
Great Island	1	1	4	3	0	0.75	0.00	0.00
Jeremy Point	6	9	31	11	4	0.35	0.36	0.67
Wood End/Long Pt	9	11	40	21	6	0.53	0.29	0.67
Hatches Harbor	2	2	8	8	3	1.00	0.38	1.50
Race Point North	9	10	35	27	3	0.77	0.11	0.33
Old Harbor	2	2	8	8	3	1.00	0.38	1.50
Race Point South	3	3	12	10	2	0.83	0.20	0.67
Exit 9	7	8	27	21	6	0.78	0.29	0.86
Armstrong	1	1	4	3	0	0.75	0.00	0.00
High Head	10	8	29	16	4	0.55	0.25	0.40
Dead Forest	1	1	4	4	0	1.00	0.00	0.00
Head of the Meadow	3	2	8	8	1	1.00	0.33	0.33
Coast Guard	1	1	4	0	0	0.00	0.00	0.00
Ballston Beach	3	4	15	6	5	0.40	0.83	0.67
TOTAL	**87**	**109**	**367**	**190**	**60**	**0.52**	**0.32**	**0.70**

[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, 2009

No. Nests	Nests: No. Hatched	Nests: No. Lost	Nests: % Lost	Cause	Per Cause: No. Lost	Per Cause: % Lost
109	55	54	50%			
				Predation	27	50%
				Overwash	17	31%
				Abandoned (exclosed)	6	11%
				Sanded over	1	5%
				Abandoned (unexclosed)	2	4%
				Non-viable	1	2%
				Predator Types (unexclosed)		
				Crow (unexclosed)	18	67%
				unknown predator (unexclosed)	6	22%
				Coyote (unexclosed)	2	7%
				Gull (unexclosed)	1	4%

Table 3. Piping Plover Egg Loss Totals, Cape Cod National Seashore, 2009

No. Nests	No. Total	Eggs No. Lost	Eggs % Lost	Cause	Per Cause: No. Eggs Lost	Per Cause: % Lost
109	367	177	48%			
				Overwash	55	31%
				Predation	51	29%
				Abandoned (excl)	16	9%
				Non-viable	23	13%
				Abandoned (unexcl)	7	4.0%
				Unknown	16	9.0%
				Sanded over	9	5.0%
				Predation Types		
				Crow	40	78%
				Coyote	8	16%
				Opossum	2	4%
				Gull	1	2%

Table 4. Fate of Exclosed and Unexclosed Piping Plover Nests, Cape Cod National Seashore, 2009.

Type of Nest Protection	Total	Number Successful	Number Unsuccessful	% Successful	% Unsuccessful	Cause of Failue	No. Lost	% Lost
Circular Exclosure	36	27	9	75%	25%	Infertile	1	11%
						Overwash	7	78%
						Abandoned	1	11%
Canopy Exclosure	30	23	7	77%	23%	Overwash	3	43%
						Abandoned	3	43%
						Unknown	1	14%
Unexclosed	32	2	30	6%	94%	Crow	16	53%
						Unknown Predator	6	20%
						Overwash	4	13%
						Abandoned	2	7%
						Sanded Over	1	3%
						Gull (sp?)	1	3%
Circular exclosed initially, then removed	3	2	1	67%	33%	Washed over	1	100%
Canopy exclosed initially, then removed	8	1	7	13%	88%	Coyote	2	29%
						Washed over	2	29%
						Crow	2	29%
						Abandoned	1	13%

Table 5. Summary of Piping Plover Nesting Parameters at Cape Cod National Seashore, 2000-2009.

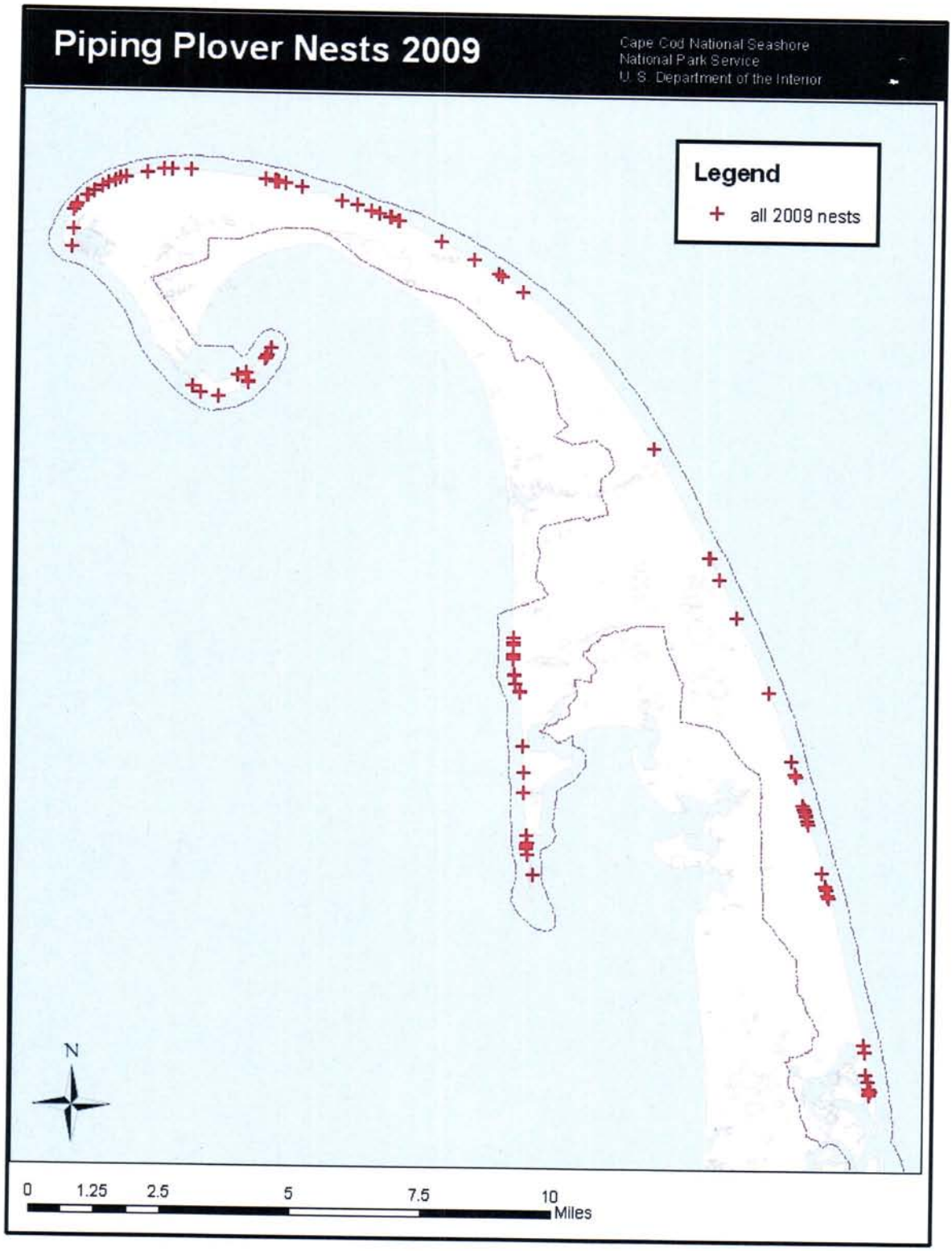
Year	# Pairs	# Nests	# Eggs Laid	# Successful Nests	# Hatched	# Fledged	Nest Success Rate	% Renests	Hatch Rate	Fledge Rate	Productivity
2000	64	121	415	48	154	73	40%	47%	37%	47%	1.14
2001	78	88	317	61	223	155	69%	11%	70%	70%	2.04
2002	97	141	428	57	175	88	40%	31%	41%	50%	0.91
2003	84	121	450	54	189	130	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
2009	87	109	367	55	190	60	50%	20%	52%	32%	0.70
mean	82	113	387	59	202	114	53%	27%	54%	56%	1.41
median	85	114	382	58	205	123	51%	25%	52%	55%	1.50

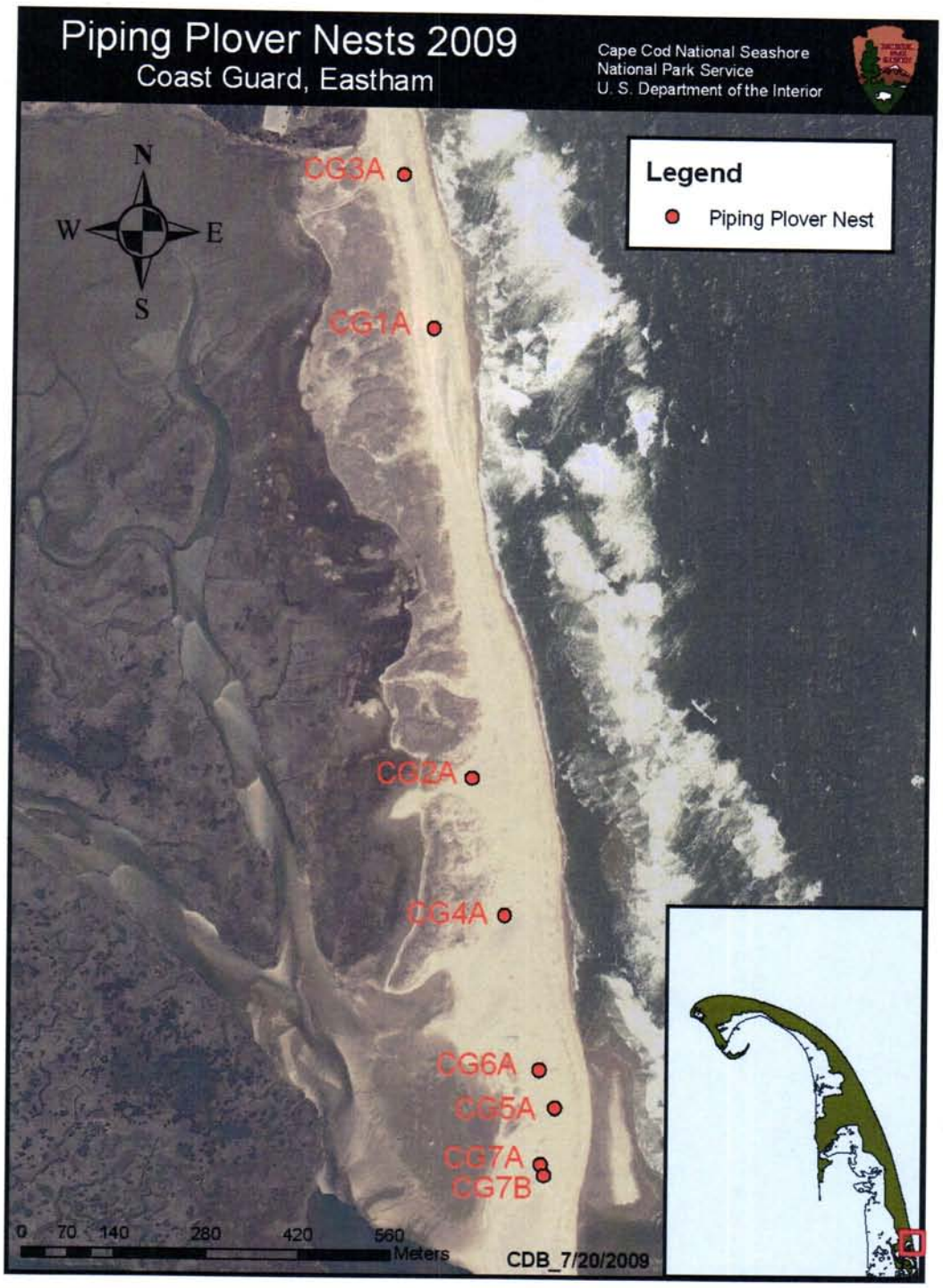
Table 6. Summary of adult mortality by exclosure type, 2000-2009.

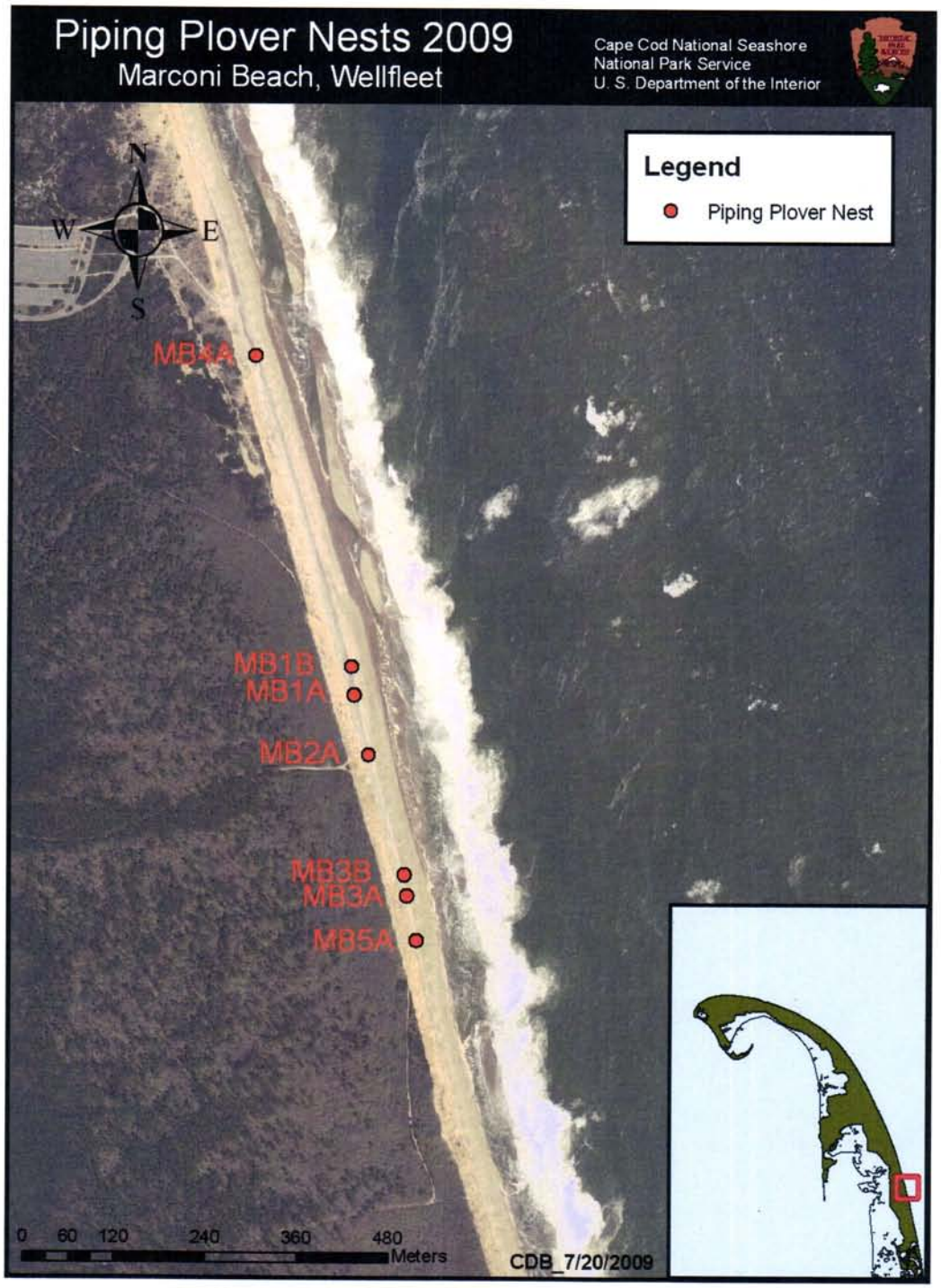
Year	# Circular	# Deaths	Rate	# Canopy	# Deaths	Rate
2000	92	0	0.00%	0	0	
2001	70	0	0.00%	0	0	
2002	77	1	1.30%	0	0	
2003	57	2	3.51%	0	0	
2004	57	3	5.26%	5	0	0.00%
2005	35	0	0.00%	12	0	0.00%
2006	32	1	3.13%	46	0	0.00%
2007	27	1	3.70%	52	1	1.92%
2008	15	0	0.00%	50	3	6.00%
2009	39	0	0.00%	38	3	7.89%
Overall	501	8	1.60%	203	7	3.45%

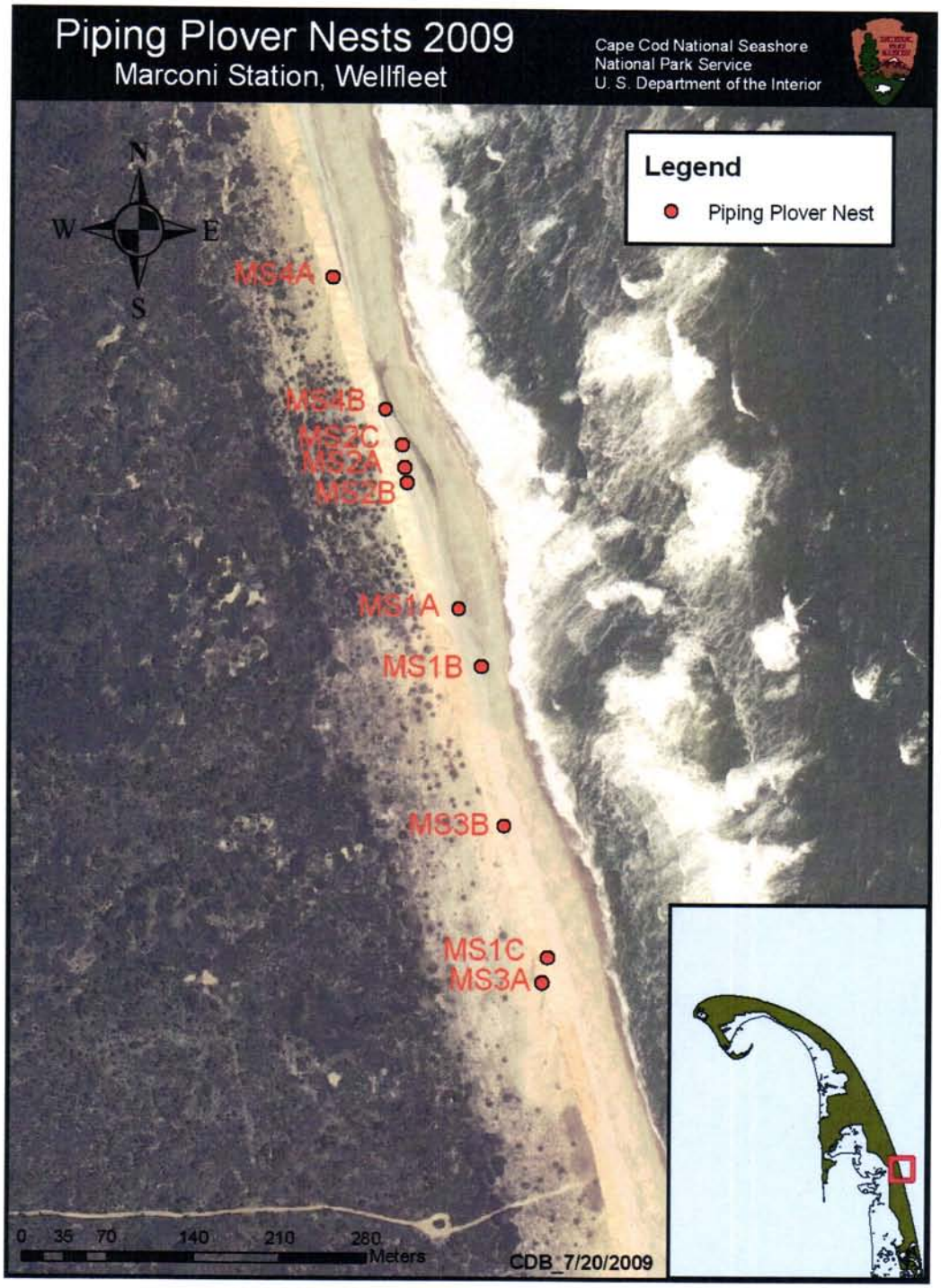
APPENDIX A

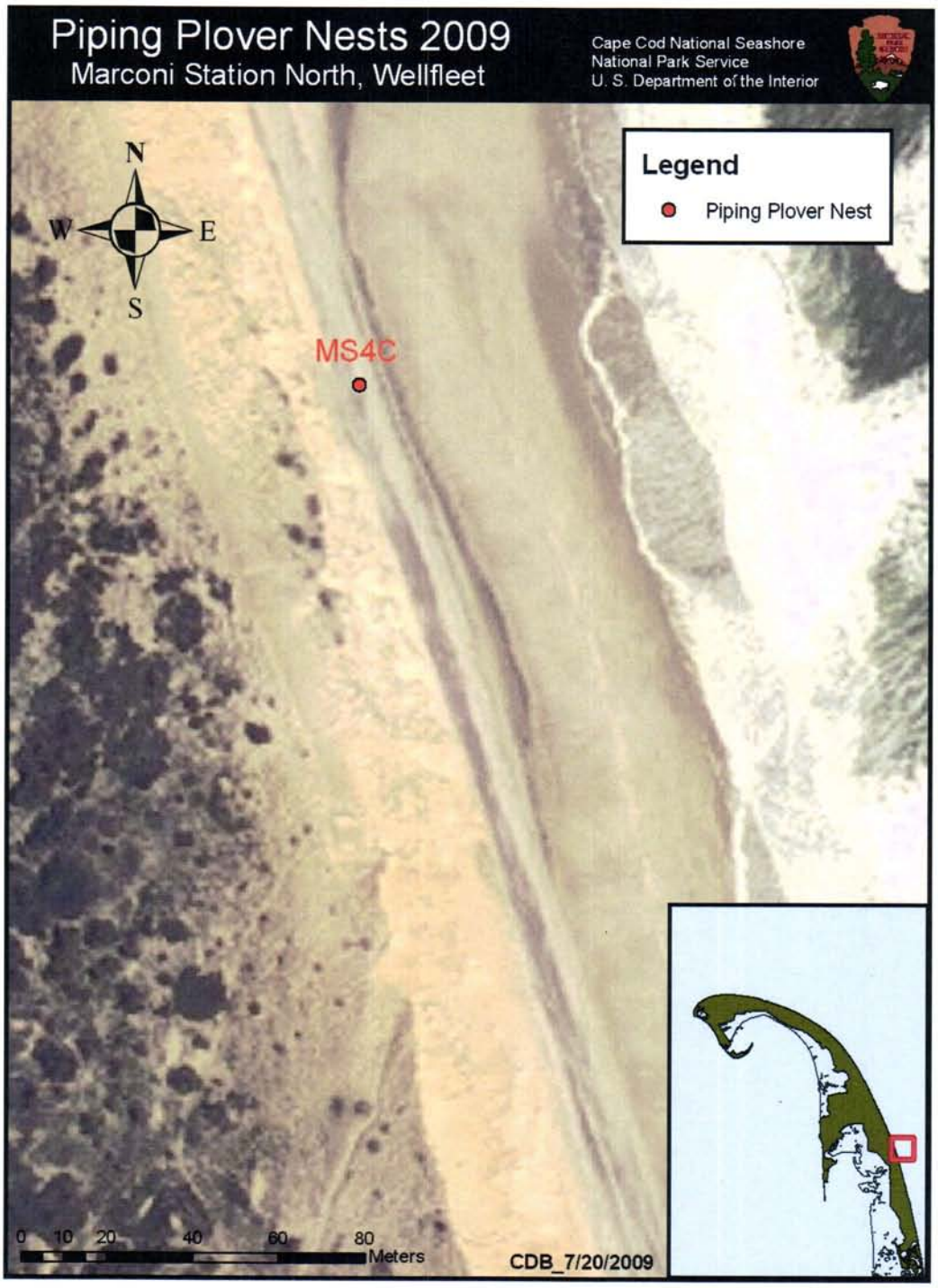
Maps of 2009 Piping Plover and American Oystercatcher Nest Sites
at Cape Cod National Seashore

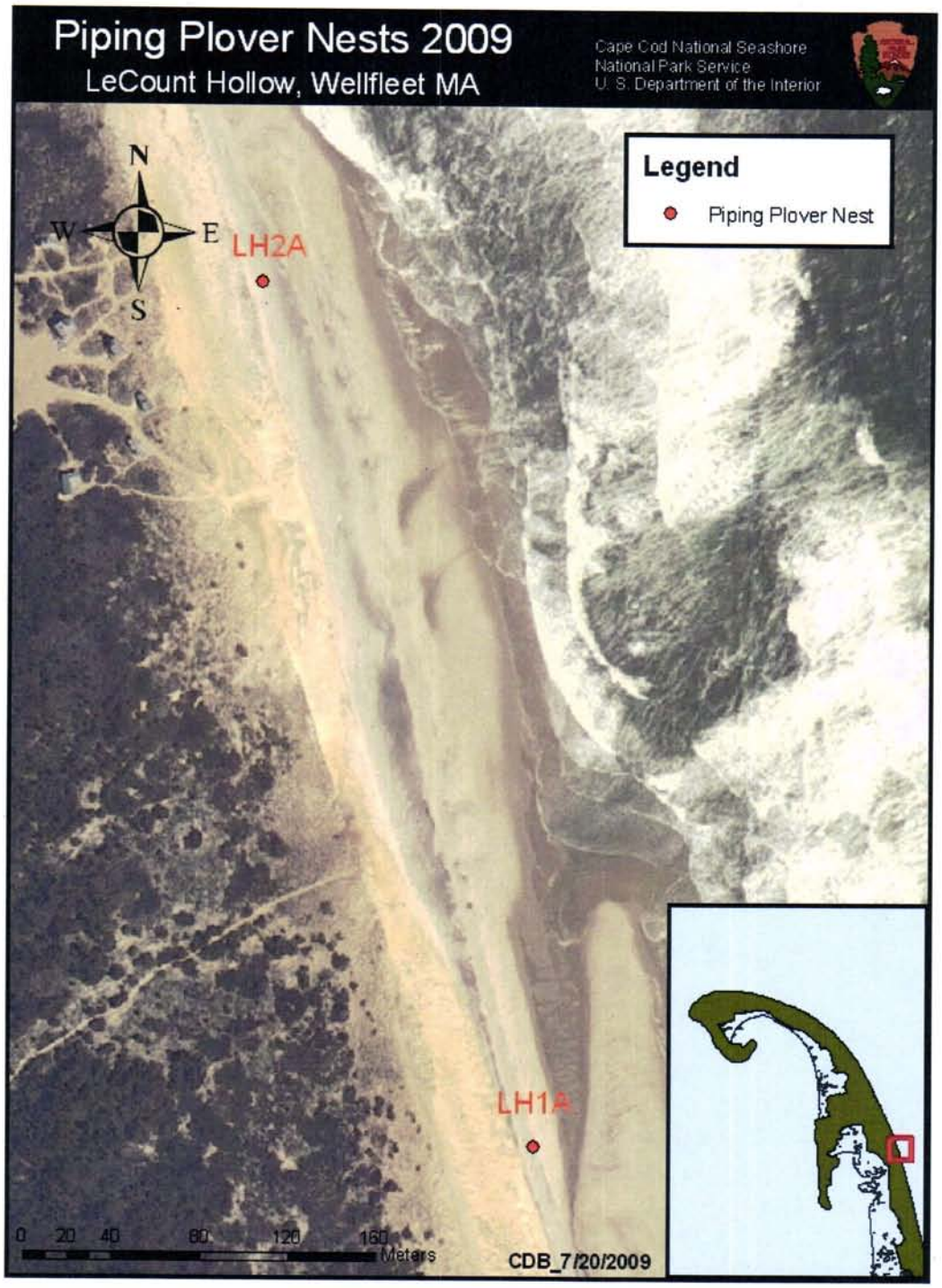

Piping Plover Nests 2009
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
all 2009 nests
N
0
1.25
2.5
5
7.5
10
Miles


Piping Plover Nests 2009
Coast Guard, Eastham
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nest
CG3A
CG1A
CG2A
CG4A
CG6A
CG5A
CG7A
CG7B
0 70 140 280 420 560
Meters
CDB_7/20/2009


Piping Plover Nests 2009
Marconi Beach, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nest
N
W
E
S
MB4A
MB1B
MB1A
MB2A
MB3B
MB3A
MB5A
0 60 120 240 360 480
Meters
CDB_7/20/2009


Piping Plover Nests 2009
Marconi Station, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nest
MS4A
MS4B
MS2C
MS2A
MS2B
MS1A
MS1B
MS3B
MS1C
MS3A
0 35 70 140 210 280
Meters
CDB_7/20/2009

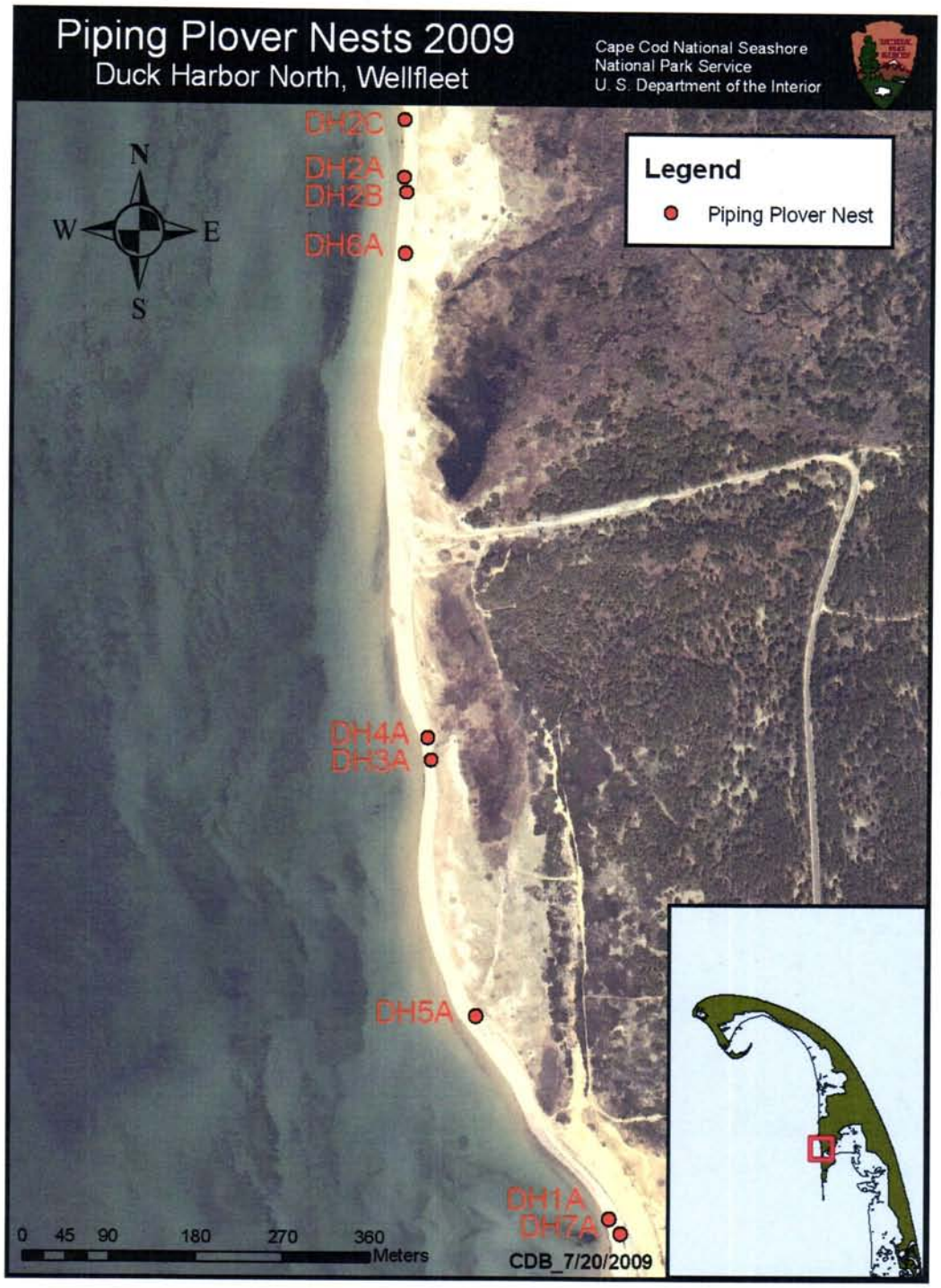

Piping Plover Nests 2009
Marconi Station North, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nest
MS4C
0 10 20 40 60 80
Meters
CDB_7/20/2009


Piping Plover Nests 2009
LeCount Hollow, Wellfleet MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nest
N
W
E
S
LH2A
LH1A
0 20 40 80 120 160
Meters
CDB_7/20/2009

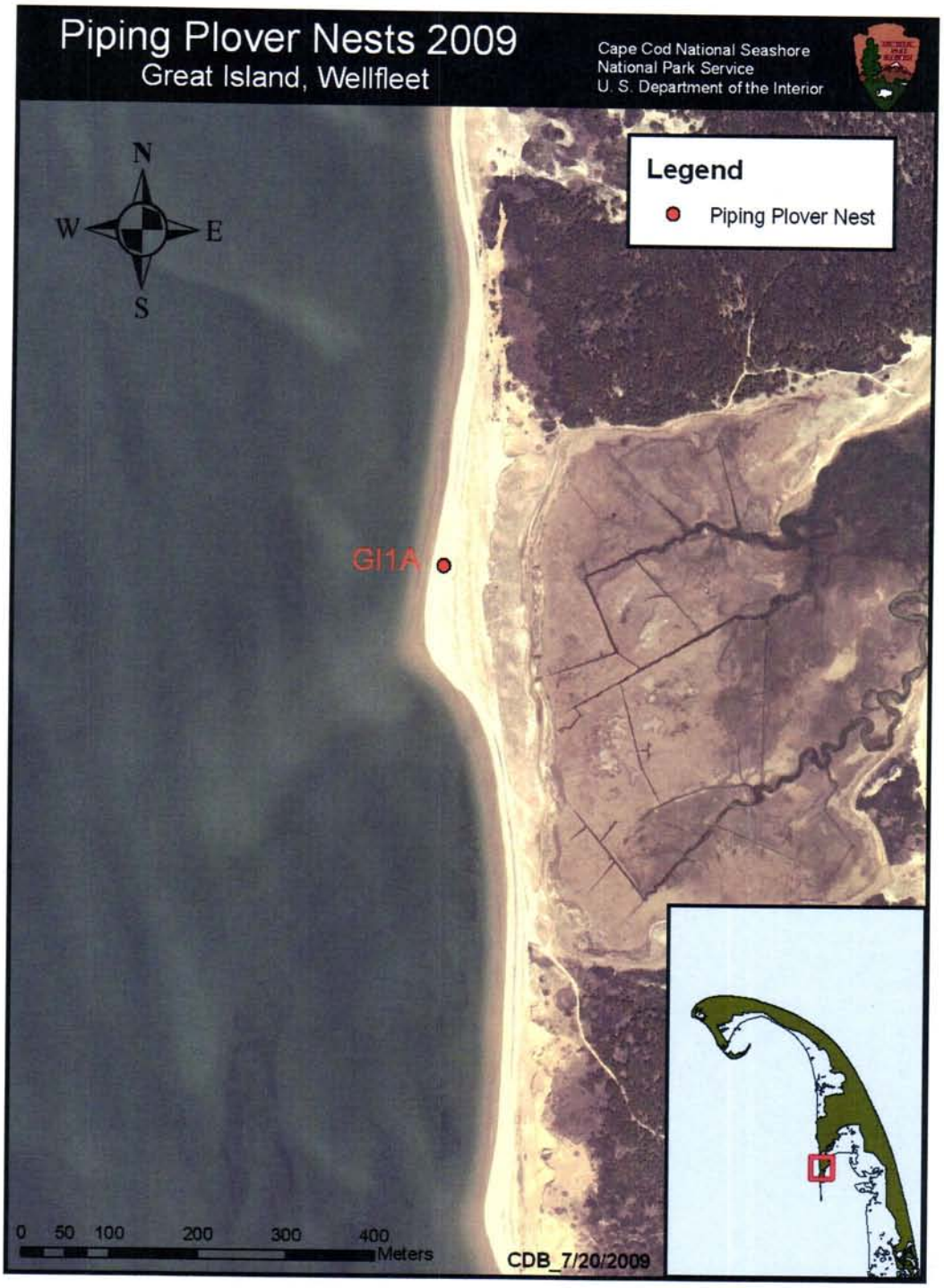
Piping Plover Nests 2009
Cahoon Hollow, Wellfleet MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nest
CH1A
0 30 60 120 180 240
Meters
CDB_7/20/2009

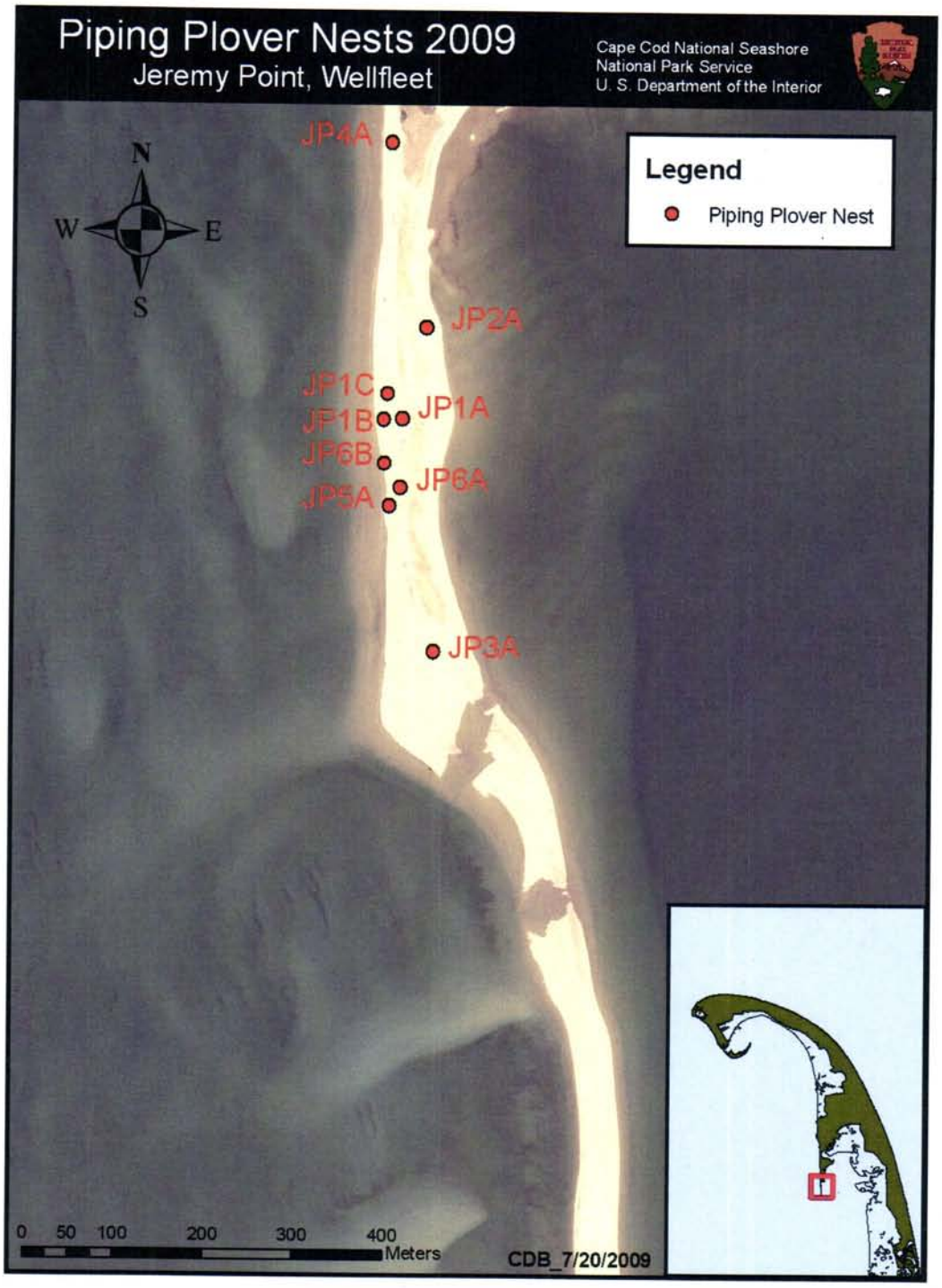
Piping Plover Nests 2009
Necomb Hollow, Wellfleet MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nest
NH1A
0 30 60 120 180 240
Meters
CDB_7/20/2009

Piping Plover Nests 2009
Bound Brook, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nest
BB2A
BB2B
BB1A
BB1B
0 12.5 25 50 75 100
Meters
CDB_7/20/2009


Piping Plover Nests 2009
Duck Harbor North, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
DH2C
DH2A
DH2B
DH6A
DH4A
DH3A
DH5A
DH1A
DH7A
Legend
Piping Plover Nest
0 45 90 180 270 360
Meters
CDB_7/20/2009

Piping Plover Nests 2009
Duck Harbor South, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
DH6B
DH3B
Legend
Piping Plover Nest
0 45 90 180 270 360
Meters
CDB_7/20/2009

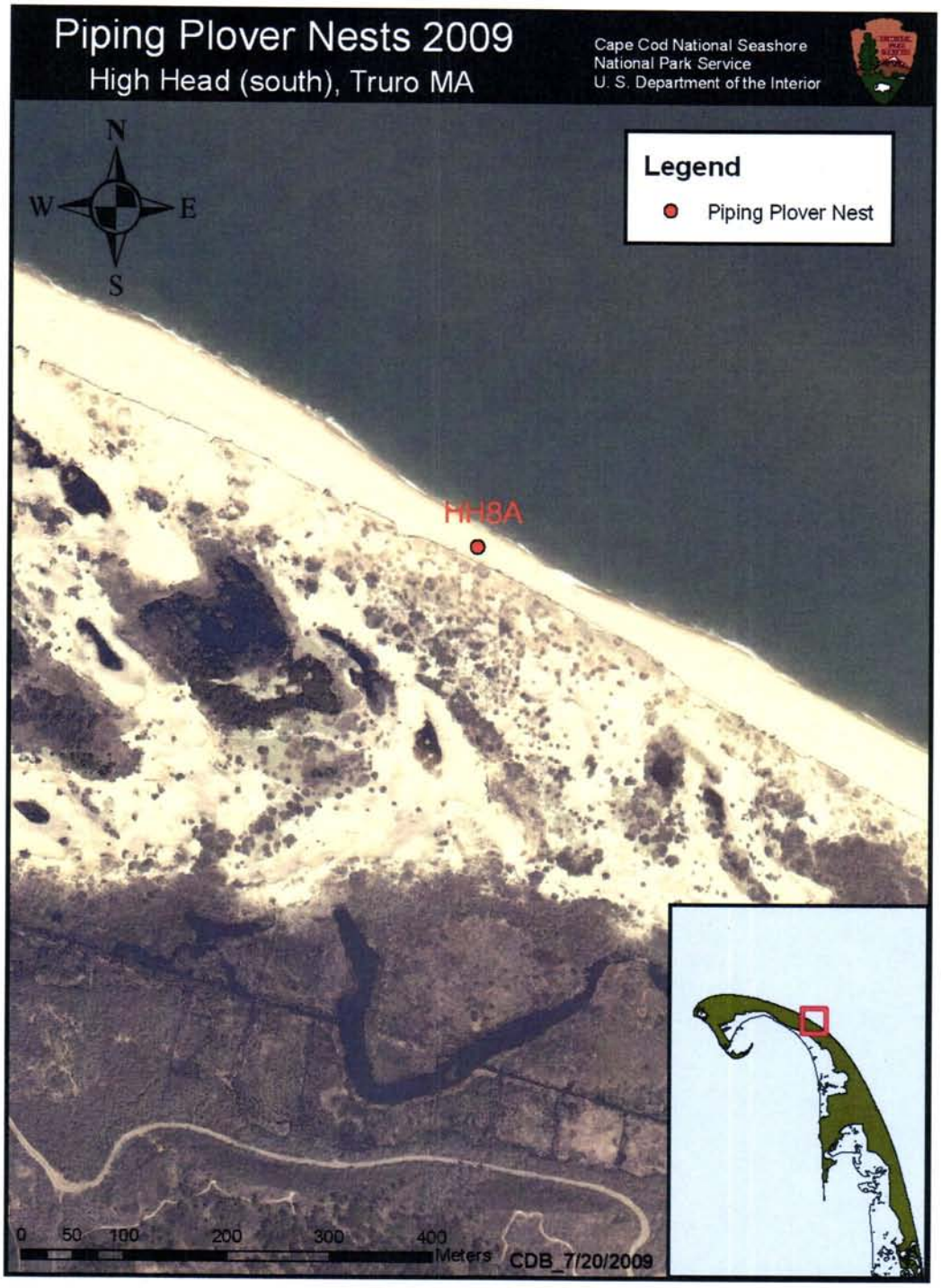

Piping Plover Nests 2009
Great Island, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nest
GI1A
0 50 100 200 300 400
Meters
CDB_7/20/2009

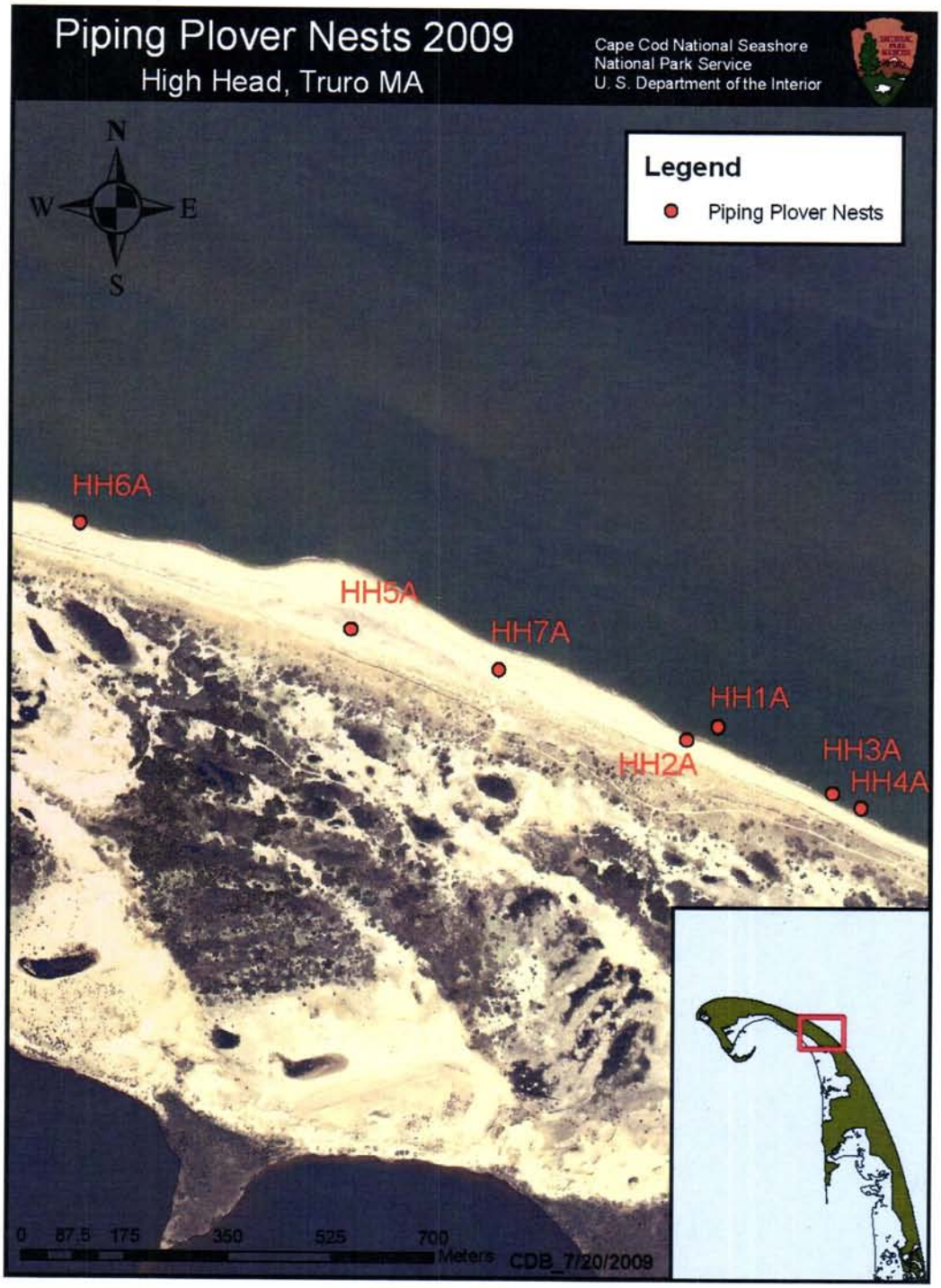

Piping Plover Nests 2009
Jeremy Point, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nest
JP4A
JP2A
JP1C
JP1B
JP1A
JP6B
JP6A
JP5A
JP3A
0 50 100 200 300 400
Meters
CDB_7/20/2009

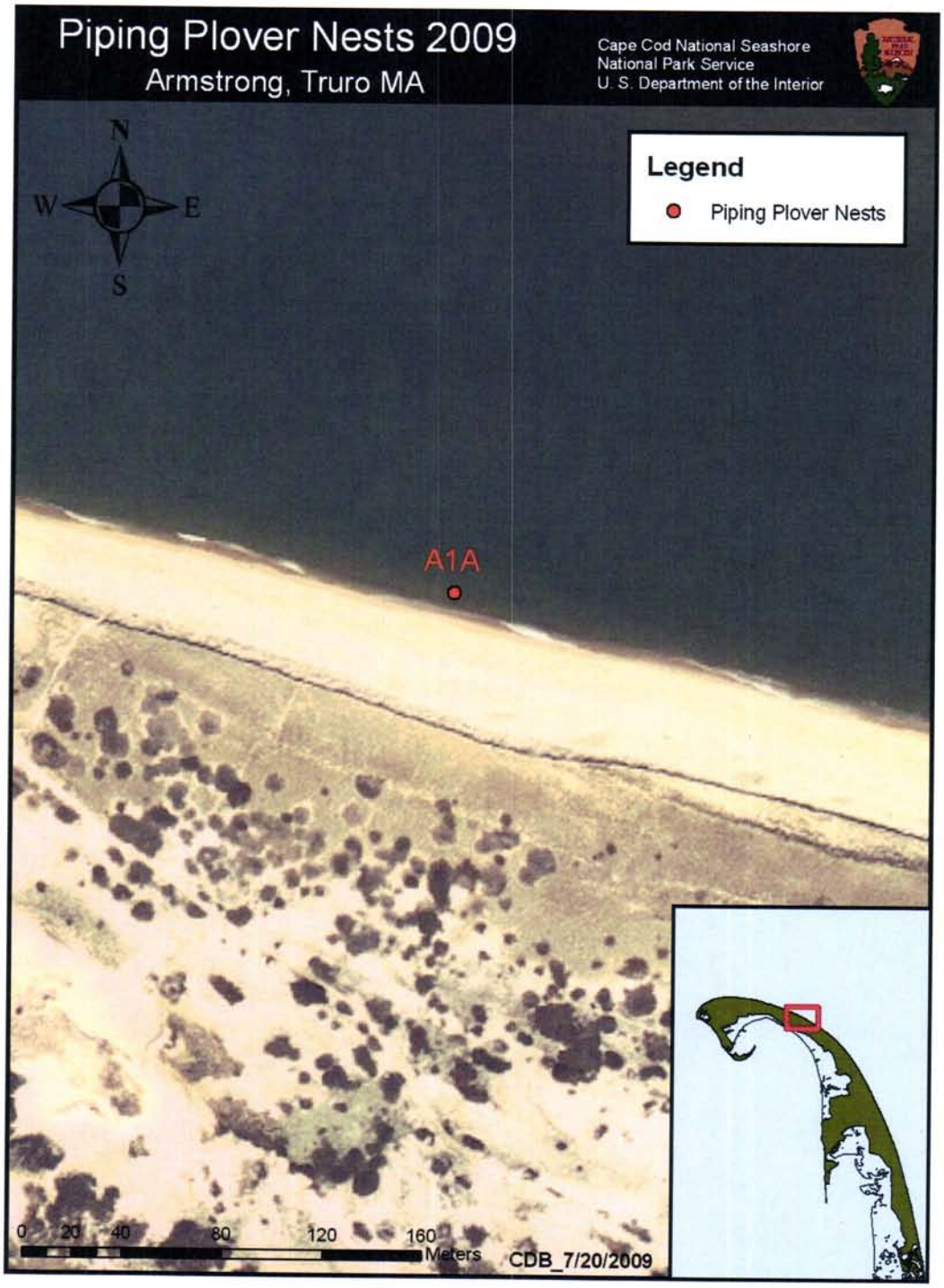
Piping Plover Nests 2009
Ballston, Truro MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nest
BAL3A
BAL1B
BAL1A
BAL2A
N
W
E
S
0 215 430 860 1,290 1,720
Meters
CDB_7/20/2009

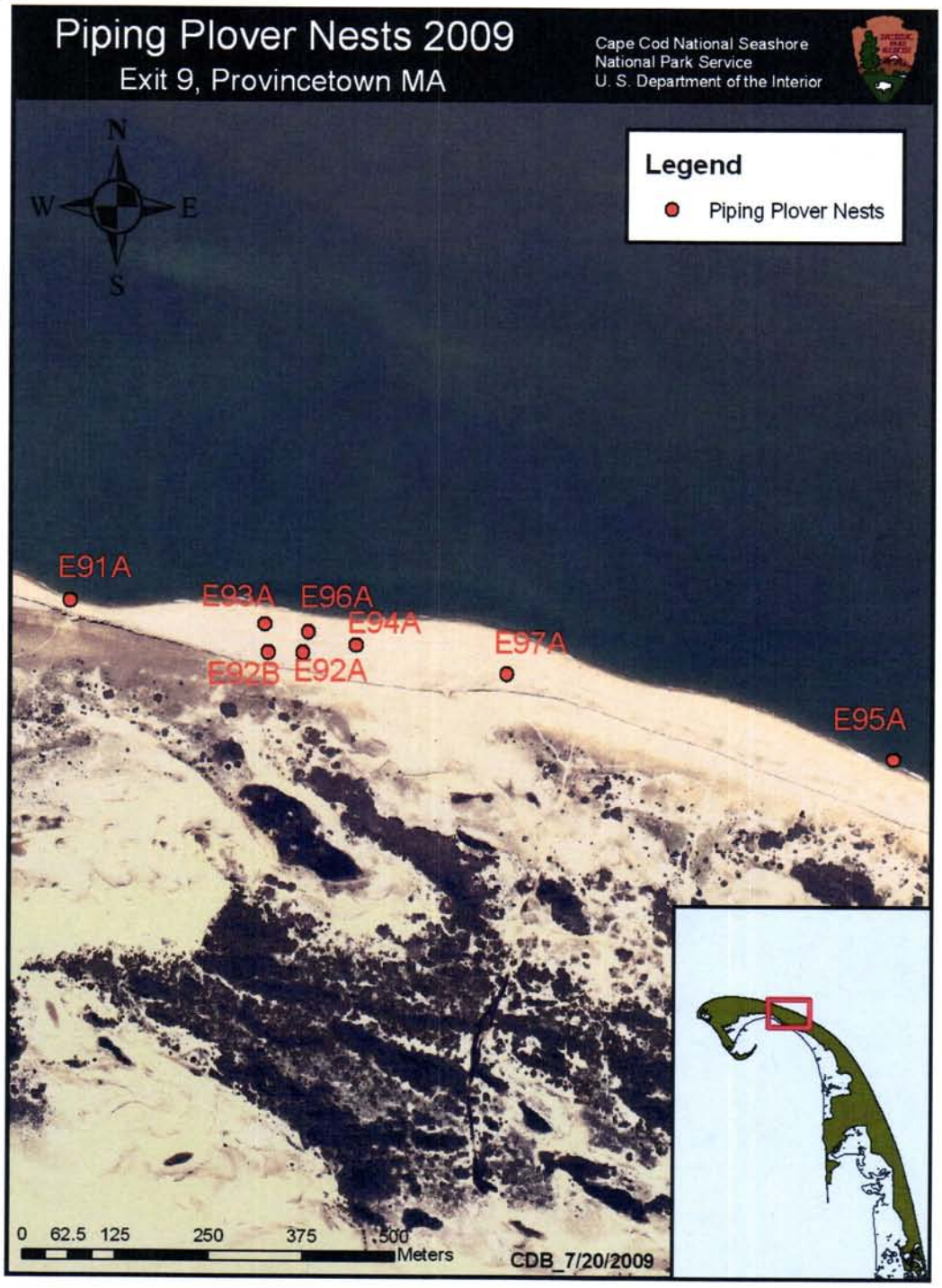
Piping Plover Nests 2009
Coast Gaurd, Truro MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nests
CG1A
0 10 20 40 60 80
Meters
CDB_7/20/2009

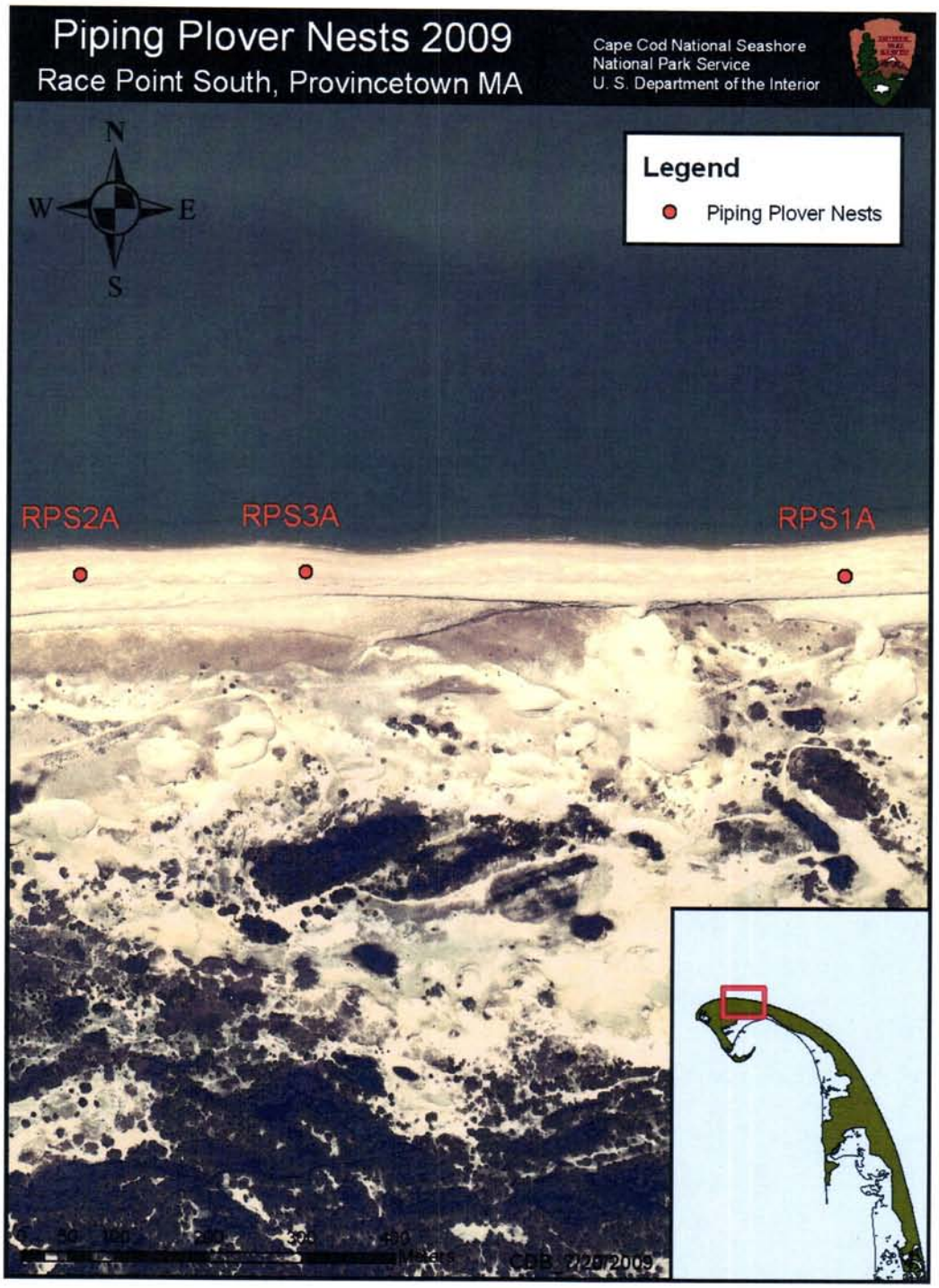
Piping Plover Nests 2009
Dead Forest, Truro MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nests
DF1A
0 20 40 80 120 160
Meters
CDB_7/20/2009

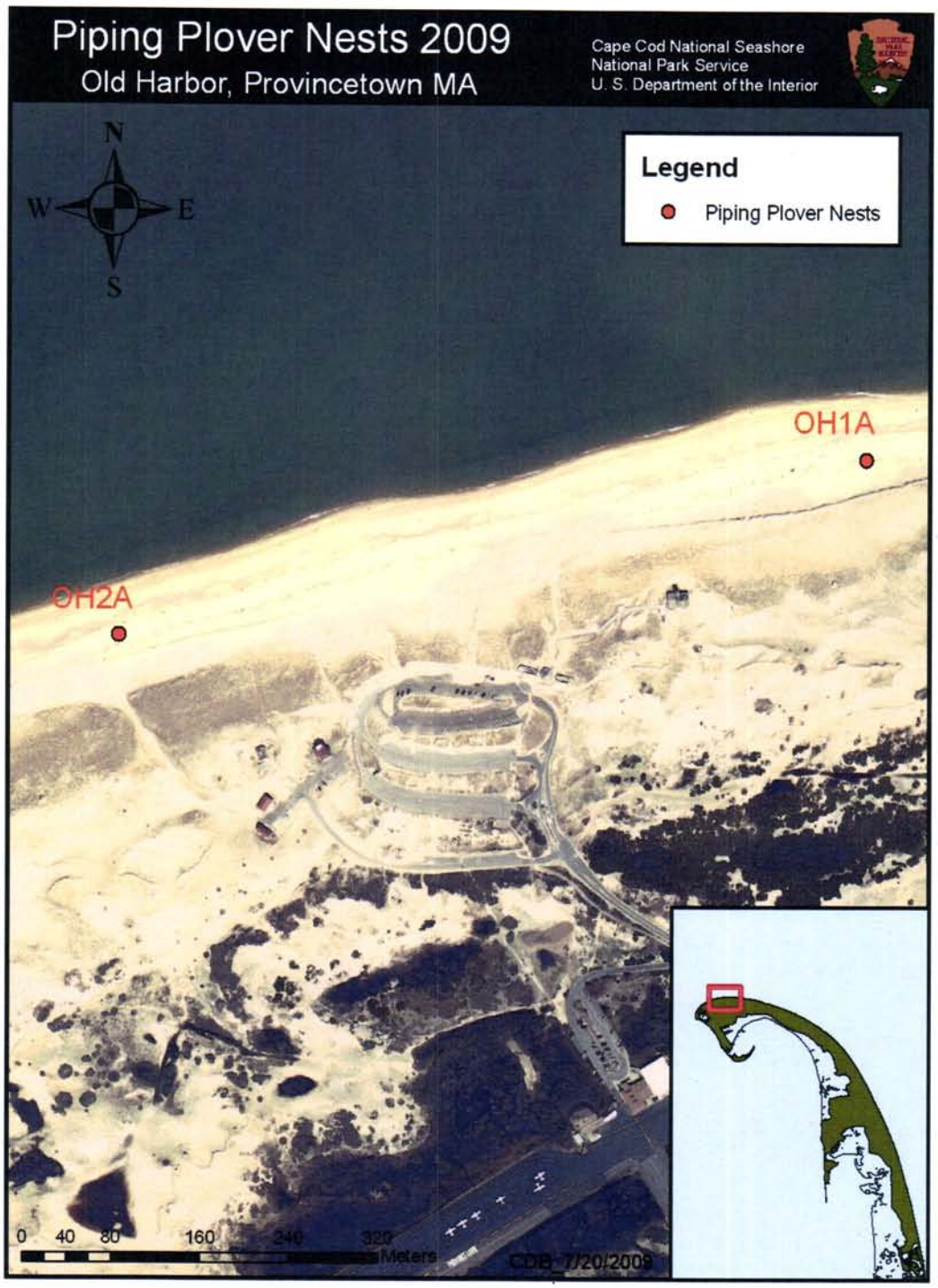

Piping Plover Nests 2009
High Head (south), Truro MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nest
HH8A
0 50 100 200 300 400
Meters
CDB_7/20/2009

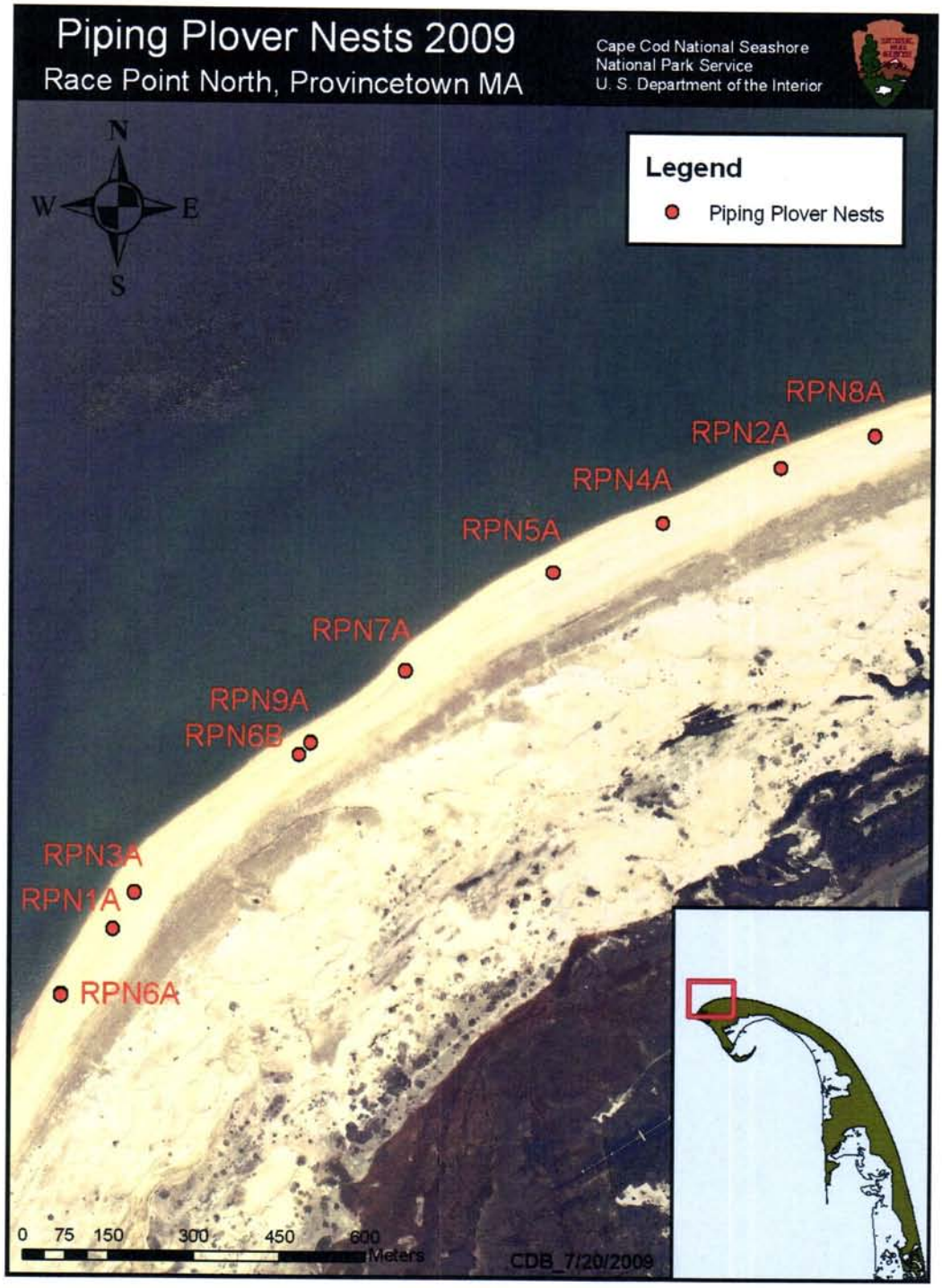

Piping Plover Nests 2009
High Head, Truro MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nests
HH6A
HH5A
HH7A
HH1A
HH2A
HH3A
HH4A
0 87.5 175 350 525 700
Meters
CDB_7/20/2009


Piping Plover Nests 2009
Armstrong, Truro MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nests
A1A
0 20 40 80 120 160
Meters
CDB_7/20/2009


Piping Plover Nests 2009
Exit 9, Provincetown MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nests
E91A
E93A
E96A
E94A
E92B
E92A
E97A
E95A
0 62.5 125 250 375 500
Meters
CDB_7/20/2009

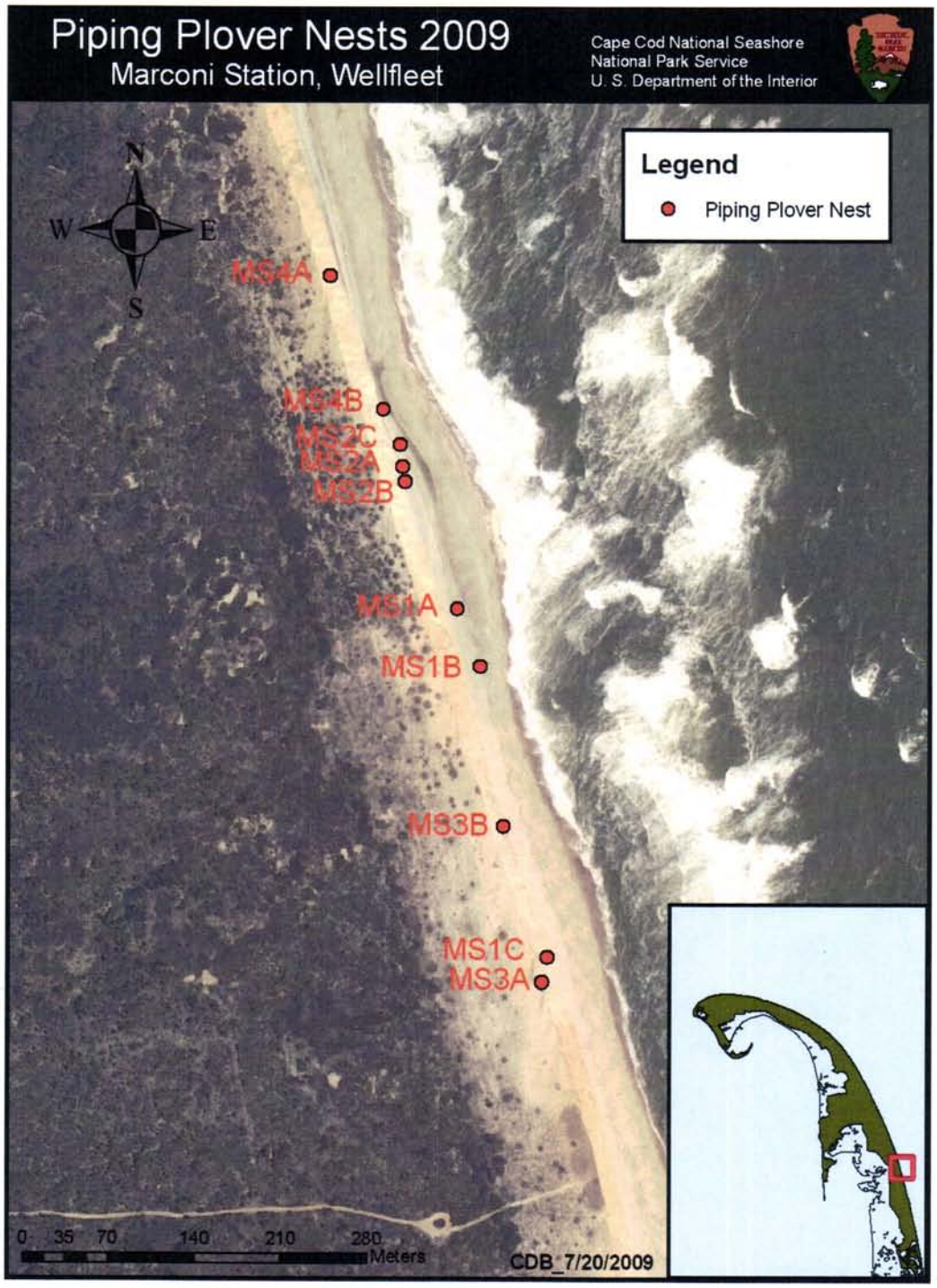

Piping Plover Nests 2009
Race Point South, Provincetown MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nests
RPS2A
RPS3A
RPS1A
CDB 2/27/2009


Piping Plover Nests 2009
Old Harbor, Provincetown MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nests
OH1A
OH2A
0 40 80 160 240 320
Meters
CDB 7/20/2009


Piping Plover Nests 2009
Race Point North, Provincetown MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nests
RPN8A
RPN2A
RPN4A
RPN5A
RPN7A
RPN9A
RPN6B
RPN3A
RPN1A
RPN6A
0 75 150 300 450 600
Meters
CDB_7/20/2009

Piping Plover Nests 2009
Hatches Harbor, Provincetown MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nests
HAH2A
HAH1A
0 50 100 200 300 400
Meters
CDB_7/20/2009

Piping Plover Nests 2009
Hatches Harbor, Provincetown MA
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
N
W
E
S
Legend
Piping Plover Nest
WELP6B
WELP6A
WELP5B
WELP5A
WELP7A
WELP8A
WELP9A
WELP4A
WELP1A
WELP3A
WELP2A
0 145 290 580 870 1,160
Meters
CDB_7/20/2009


Piping Plover Nests 2009
Marconi Station, Wellfleet
Cape Cod National Seashore
National Park Service
U. S. Department of the Interior
Legend
Piping Plover Nest
N
W
E
S
MS4A
MS4B
MS2C
MS2A
MS2B
MS1A
MS1B
MS3B
MS1C
MS3A
0 35 70 140 210 280
Meters
CDB_7/20/2009