

Shorebird Monitoring and Management
Cape Cod National Seashore

2014



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Executive Summary

This report summarizes the 2014 shorebird nesting, migrating and staging activities at Cape Cod National Seashore (Seashore).

Piping plover (*Charadrius melodus*), least tern (*Sternula antillarum*), and American oystercatcher (*Haematopus palliatus*) nesting and brood-rearing were monitored on 25 beaches, on over 43 miles of coastline from Provincetown to Orleans. The first piping plover was observed on 23 March, the first nest was found on 29 April, and peak nesting occurred the week of 9 June. A total of 68 nesting pairs attempted 121 nests, with 38 pairs successfully producing at least one chick and 30 pairs failing to produce any hatchlings. Predation accounted for 70% (58/83) of nest failures and overwash accounted for 16% (13/83). Canid species (*Canis latrans* and *Vulpes vulpes*) and American crow (*Corvus brachyrhynchos*) were the predominant predators accounting for 45% (26/58) and 33% (19/58) respectively of all nests lost to predators. Predator exclosures were installed around 32 nests. There was one adult mortality at an exclosed nest at Wood End/Long Point. Of the remaining 31 exclosed nests, 77% (24) hatched eggs and 23% (7) failed. Of the 89 unexclosed nests, 16% (14) were successful in hatching eggs, while 84% (75) failed; and 80% (60) of those failed unexclosed nests were lost to predators. Nest success estimates were significantly higher for exclosed nests (73%) than for unexclosed nests (8%). Overall, 52 piping plover chicks fledged from 68 nesting pairs with productivity of 0.76 chicks fledged/pair. Productivity was higher for exclosed nests compared to unexclosed nests with 34 fledglings (1.06 chicks/pair) and 18 fledgling (0.5chicks/pair) respectively. Poor nesting and fledging success due mainly to predation, accounted for low productivity. The five year weighted average annual productivity also shows a downward trend in productivity with a loss of 0.042 fledglings/pair each year. A total of 77 pairs of least terns nested in 11 colonies from Eastham to Provincetown. Productivity was poor with only seven chicks fledging. Two pairs of American oystercatchers nested at the Seashore; a total of four nests were laid and no chicks fledged. Predation was the main cause of egg and chick loss for both the least tern and American oystercatcher.

Post-breeding/staging roseate terns (*Sterna dougallii*) and common terns (*Sterna hirundo*) were present in large numbers at the Seashore from mid-summer through mid-fall. In addition, thousands of migrating shorebirds were observed on beaches, including a regularly-observed flock of up to 111 red knots (*Calidris canutus rufa*).

A detailed description of how the park manages recreational activity during the shorebird nesting season is outlined in the Park's 2012 Shorebird Management Standard Operating Procedures (SOP) (NPS 2012). A summary of these activities is as follows: Suitable and historic nesting habitat was posted with symbolic fencing prior to the arrival of nesting birds. On sections of beach that were extremely narrow or where birds nested close to access points, temporary pedestrian or boat landing detours or closures were implemented to prevent pedestrian disturbance during the incubation phase of nesting. The use of hand-held kites was prohibited within 200 meters of shorebird nesting areas and kite surfing was prohibited on all open waters and on all ocean and bayside beaches within the Seashore from 15 March through 15 October, with the exception of a section of town-owned beach in Wellfleet. Pets are required to be leashed at all times on Seashore property, and additional sections of beach were temporarily closed to pets to protect nesting and migrating/staging shorebirds. The use of off-road vehicles (ORVs) was permitted during the egg laying/incubation phase of nesting, given there was an adequate buffer between the nest and passing ORVs. Sections of the ORV corridor were closed when unfledged chicks were present and re-opened once chicks fledged.

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, tidal lands, and near shore waters located on Outer Cape Cod. As reflected in the Seashore's General Management Plan, this unit of the NPS was established, in large part, to protect the area's outstanding natural resources, including wildlife and their habitats.

The Seashore provides miles of prime feeding, nesting, and roosting habitat for beach-nesting birds, including the federally threatened piping plover, the least 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).

The Seashore is also an important staging and migratory stopover-site for thousands of terns, including the federally endangered roseate tern, common tern, and many other shorebird species including the federally threatened red knot, whimbrel (*Numenius phaeopus*), least sandpiper (*Calidris minutilla*), short-billed dowitcher (*Limnodromus griseus*), semipalmated plover (*Charadrius semipalmatus*), black-bellied plover (*Pluvialis squatarola*), semipalmated sandpiper (*Calidris pusilla*), and lesser yellowlegs (*Tringa flavipes*). The latter four species are identified by the USFWS as a *Bird of Conservation Concern* in the United States (USFWS 2008). Staging terns, including young fledglings that are still dependent on their parents for food, as well as other shorebirds, use Seashore beaches and intertidal flats to rest and feed in order to generate the body mass and fat reserves necessary to fuel their long migration.

Methods

Shorebirds were monitored on 25 (reporting unit) beaches at the national seashore from Provincetown to Orleans, encompassing approximately 43 miles of beach. Staffing consisted of: the Resource Management Specialist; one permanent Lead Shorebird Biologist in each of the two districts; three, full-time, 18-week seasonal Biological Technicians (one in the South District and two in the North District); four, full-time, 16-week Student Conservation Association interns (two in each district); and 17 volunteers.

For staffing and operational purposes, Seashore beaches are divided into two districts. The "North District" includes all NPS beaches located in Provincetown and Truro: Wood End/Long Point, Hatches Harbor, Race Point North, Race Point South, Exit 9, Armstrong (part of Race Point South), High Head, Head of the Meadow, Coast Guard Beach in Truro, Longnook, and Ballston. The "South District" includes New Island in Orleans, MA, as well as all NPS beaches located in Eastham and Wellfleet: Coast Guard Beach, Nauset Light Beach, Marconi Beach, Marconi Station, LeCount Hollow, White Crest, Cahoon Hollow, Newcomb Hollow, Bound Brood, Duck Harbor, Great Island, and Jeremy Point.

For nesting piping plovers, the Seashore follows the monitoring and protection methods outlined in the U.S. Fish and Wildlife Service's *Piping Plover Atlantic Coast Population Revised Recovery Plan* (1996), as well as protocols designed specifically for the Seashore (Erwin 2003). For nesting least terns, the Seashore follows *The Massachusetts State Guidelines for Monitoring and Protection of Tern and Plovers* (Blodgett and Melvin 1996). To inform decisions regarding daily operations that affect shorebird management and protection, the Seashore consults the 2012 SOP (NPS 2012).

Monitors searched the beaches daily for signs of shorebird nesting activity (e.g., nest scrapes and concentrated tracks on the upper beach) in order to locate nests. Almost all nests were located before

clutch completion, and thus hatch windows could be predicted with relative accuracy. Shorebird nests were generally monitored every one to two days. The majority of nest checks occurred from a distance, with observations through binoculars, in order to reduce disturbance to incubating birds and minimize predator cues (e.g., scent trails, footprints leading up to nests). When it was necessary to approach nests to determine nest content, monitors walked along wide trajectories past nests, but never created paths directly up to, or dead-ending at a nest. A subset of nests were protected using predator exclosures which were installed at the onset of incubation.

A total of 32 piping plover nests were exclosed as part of a multi-year study which began in 2014, aimed at assessing the effects of predator exclosures on piping plover productivity and mortality. We collected data from environmental factors that were thought to play a role in productivity and adult mortality rates among nest sites, including percent vegetation cover within a ten-meter radius of the nest site, distance to the nearest least tern colony, width of beach, degree of recreational use in the area, ORV presence/absence, and distance to parking lots and residential developments.

Ten beaches were chosen for the study because they historically supported the highest number of breeding pairs (four or more) from which to sample: Wood End/ Long Point, Race Point North, Race Point South, Armstrong, Head of the Meadow, Ballston Beach, Marconi Beach, Coast Guard, Eastham, Great Island, and Jeremy Point. The first two qualified nests found at each site were exclosed during the first time period (27 April – 31 May), and the first qualified nest found at each site was exclosed during the second time period (1 June – 5 July), so that both early-and late-season nesting attempts were adequately represented in the sample. If, at a chosen site, there were insufficient nesting attempts to meet the exclosed nest quota for a given time period, the next available qualified nest at an adjacent site was exclosed instead. Shorebird staff will repeat this study, following the same methodology in 2015-16. A report on our finding will be completed by 2017.

In addition, to better understand the presence/absence of different predators at plover nest locations, and the response of nesting plovers to predator presence, a graduate student from the University of Michigan deployed game cameras at randomly selected exclosed nests throughout the Park. Several cameras were also placed at unexclosed nests. The cameras were placed 25-50 feet from individual piping plover nests (majority placed at exclosed nests) and memory cards were changed on a regular basis. Currently, the data is being compiled and the photos are being reviewed. Preliminary photos revealed people walking up to exclosed nests in both districts, a Northern Harrier perched on an exclosure at Race Point North, a crow perched on an exclosure, and coyotes visiting at least six exclosed nests in both districts.

The accurate prediction of hatch windows is important, especially along the ORV corridor, where vehicles have access to areas directly adjacent to nesting areas until chicks hatch. All plover nests along the ORV corridor were monitored daily, often from a distance in order to reduce disturbance. Most shorebird nests and nesting colonies located outside of the ORV corridor were checked no less than every two days; however, to reduce the risk of monitors providing cues to predators, some nests and colonies were checked less frequently or from greater distances.

To prevent piping plover chicks from entering the parking lot at Head of the Meadow this season, silt fencing was installed around the perimeter of the lot on 28 May and remained up through July. A set of stairs was positioned over the silt fencing at the main southern pedestrian path to provide pedestrian access to the beach.

Population and Productivity

Piping Plovers

Nesting and Hatching Success

Results

A total of 68 nesting pairs of piping plovers were monitored on 25 beaches in the Seashore (Table 1 and Appendix A - Maps). The first piping plover was observed on 23 March at Coast Guard, Eastham. Piping plovers were present at most beaches by early April, with birds continuing to arrive into mid-June. Most plovers left Seashore beaches by late August, although some remained through September.

The first nest was found on 29 April at Race Point North. Peak nesting for the Seashore occurred the week of 9 June (Fig. 1). Hatching dates of piping plovers ranged from 3 June to 24 July. The majority of nests were laid along the upper beach, in open sandy or sparsely vegetated habitat.

The breeding population of piping plovers was calculated based on the number of pairs observed nesting at the Seashore, including pairs that were present at a site for more than two weeks that exhibited courtship or territorial behavior during this period. This season, one pair at Race Point North scraped for over a month and may have had a nest that was depredated before it was found. This pair was included in the total count of nesting pairs in 2014. Instances of nest loss and egg loss were calculated separately because eggs from some nests were lost to more than one cause (e.g., two different predators) (Tables 2 and 3).

67 pairs of piping plover laid a total of 121 nests; 85 in the North District and 36 in the South District. The 121 piping plover nests contained a total of 375 eggs, of which 34% (129) hatched and 66% (246/375) of all eggs laid subsequently failed. Of the 246 remaining eggs, 96% (236) were lost to various causes and 4% (10) were unviable (failed to hatch). The two main causes of egg loss were predation (70%; 165/236) and overwash (14%; 33/236) (Table 3).

Of the 67 pairs of piping plovers that nested, 38 pairs produced at least one chick, while 29 pairs failed to produce any chicks (Table 1). Of the 83 nests lost, 19 were in the South District and 64 were in the North District. In the South District, re-nests accounted for 25% of total nests (9/36) and in the North, re-nests accounted for 53% (45/85) of total nests.

Of the 32 piping plover nests that were exclosed, nest success estimates were significantly higher for exclosed nests (73%) than for unexclosed nests (8%).

Of the unexclosed nest, predation accounted for 70% (58/83) of failed nests, followed by overwash (16%; 13/83), abandonment (6%; 5/83), unknown causes (5%; 4/83) and sanding over (4%; 3/83). Of the 58 nests lost to predation, 33% (19/58) were lost to crow, 22% (13/58) to unidentified predators, 19% (11/58) to unidentified canid species, 16% (9/58) to coyote (*Canis latrans*), and 10% (6/58) to red fox (*Vulpes vulpes*) (Table 2).

Of the 32 exclosed nests, one was removed at Wood End due to an adult mortality. A dead adult piping plover was found approximately ten feet from its exclosed nest on 16 June. There were fresh fox tracks around the carcass and around the enclosure when the bird was discovered. The carcass was sent to USGS National Wildlife Health Center for necropsy and results indicated traumatic injury due to a predation

event. In order to protect the other adult that continued to incubate this nest, the enclosure was removed on 16 June, and the nest was depredated the following day.

Of the remaining 31 enclosed nests, 77% (24) hatched eggs and 23% (7) failed. Of the enclosed nests that failed, three were overwashed, three were abandoned, and one was depredated when a fox dug under the enclosure. Of the 89 unenclosed nests, 16% (14) were successful in hatching eggs, while 84% (75) failed; and 80% (60) of those failed unenclosed nests were lost to predators. While predation rates were highly disparate between enclosed and unenclosed nests, rates of overwash were comparable, with 10% of enclosed and 15% of unenclosed nests overwashed. Rates of abandonment were also similar, but slightly higher at enclosed nests, with 10% of enclosed and 2% of unenclosed nests abandoned (Table 4).

Discussion

Over the last ten years (2005-2014), the top three factors causing nest failure have been predation, overwash, and abandonment/adult mortality (Table 5). In the past three years, nest success was 10%-60% lower than in any of the past ten years (Table 5).

In 2014, predation accounted for 70% of all failed piping plover nests (Table 2). Collectively, coyote and crow predation accounted for the loss of 270 piping plover nests, or 36% of all failed plover nests in the past ten years, and 28 (34%) of all failed nests in 2014 (Table 5). However, instances of species-specific predation are documented only insofar as they can be confirmed in the field. For example, if predator tracks have been obscured or obliterated by wind, rain, or overwash, or are otherwise present but distorted to the extent that a species cannot be identified, nest loss is attributed to an unknown predator or an unknown cause. Unidentifiable predators accounted for an additional 27% of all nest loss in the past ten years, many of which were likely crows and coyotes whose prints at the nest site were indiscernible (Table 5).

American crow was the leading cause of nest predation (Table 2). The crow population appears to be increasing, most likely due to their ability to adapt to, and benefit from, human development (Marzluff et al. 2001). The American crow population in Massachusetts is estimated at 110,000 crows statewide based on breeding bird survey (BBS) data (Rich et al. 2004). From 1966 - 2007, trend data from the BBS indicates that the number of crows in the Commonwealth of MA has increased at an annual rate of 1.2% (Sauer et al. 2008). Similarly, the Christmas Bird Count survey indicates an increase in the American crow population in Massachusetts since 1966 (NAS 2010). Crows were regularly observed by shorebird staff throughout the season foraging on the ground in protected nesting areas along Seashore beaches, and crow tracks were found in high concentrations in nesting areas on a daily basis. On 10 May, on the southern tip of Coast Guard in Eastham 30-40 crows were observed foraging on the upper beach, some inside the symbolic fencing (Fig. 2). Additionally, shorebird staff often observed crows feeding on food scraps left by people, especially on high-visitation beaches.

It has been suggested that crow populations are larger in the South District, relative to the North District, due to the higher concentrations of people and more development, and to a lesser extent because of the greater availability of nesting and roosting trees. However, nest loss data coupled with observations of crows on beaches throughout the park over the last five years suggest that crows are now abundant in both districts. From 2005-2009, of the total nests laid, 13 nests (5%) were lost to crow in the North District and 30 nests (11%) were lost to crow in the South District. Comparatively, of the total nests laid over the last five years (2010-2014), the North District has lost 57 nests (12%) to crows and the South District has lost 73 nests to crows (27%). This season, shorebird staff witnessed a crow taking eggs from a plover nest at Coast Guard Beach in Truro, and crow tracks were observed leading up to or through many depredated nest bowls. In addition, the fish crow (*Corvus ossifragus*), a more southern species than the common crow, is expanding its range northward and appears to be increasing at the Seashore. This crow's call was

heard much more frequently than in past years throughout the park, including on beaches with nesting shorebird.

Crows have been the predominant predator of piping plover nests over the past ten years, but over the past five years coyote predation has been on the rise and surpassed even crow predation at least in 2012 and 2013 (Table 5). Coyotes were responsible for at least 16% (9/58) of all depredated nests in 2014, but an additional 19% (11/58) of depredated nests were traced back to an unidentifiable canid (i.e., canid tracks at a nest bowl could be attributed to either coyote, fox, or domestic dog, but species could not be positively identified based on tracks) (Table 2). Although no population estimates are available for coyotes at the Seashore, field observations suggest that the population is robust and growing. Over the past several years, coyotes were regularly observed on beaches in the middle of the day, and coyote tracks commonly blanketed the sand in both districts. Coyotes are native to Massachusetts, and are now well-established statewide (excluding Martha's Vineyard and Nantucket), with range expansion into western and central Massachusetts occurring in the 1950s, and into eastern Massachusetts and Cape Cod in the 1970s.

It appears that populations of the two main shorebird predators, American crow and Eastern coyote, have been thriving, and likely steadily increasing, at the Seashore. Both of these predators/scavengers have broad diets and take advantage of anthropogenic food sources, such as beachgoer and fisherman food waste, visitor handouts, dumpsters and trash cans, and road kills. These "subsidized" predators often reach populations beyond the natural capacity of the landscape, and exert unnaturally high levels of predation pressure on many species, including ground nesting shorebirds.

The use of exclosures around piping plover nests reduced nest loss to predators. (See Fledging Success, Productivity and Population Trends section in the report for discussion on exclosure use).

In recent years, major storms (nor'easters) have become more frequent during peak shorebird nesting activities. This coupled with the narrowing of some beaches due to storm events and sea level rise resulted in a larger proportion of nests being lost to overwash or sanding over. Overwash and sanding over accounted for 19% (16/83) of all nest loss in 2014 (Table 2). Although there were no major nor'easters at the Seashore in 2014, Hurricane Arthur passed within 75 miles of Cape Cod after making landfall in North Carolina earlier in the calendar year than any hurricane on record in that state (NOAA 2008). Arthur made landfall in North Carolina on the evening of 3 July as a category 2 hurricane, before heading north and passing Cape Cod during the late evening hours of 4 July. Low tide fell at approximately 11:15 PM that evening, coinciding with the majority of potentially storm surge-producing winds associated with the storm. That fortuitous timing is likely the reason that only five plover nests were lost during this hurricane.

Brood Monitoring

For management purposes, piping plover chicks are considered fledged when they are observed in sustained flight for at least 15 meters (for the State records, plover chicks are considered fledged at 25 days old). Brood monitoring is critical for determining location of broods, fledging dates, fledging rates, and causes of chick mortality. Because piping plover chicks are highly mobile and difficult to locate, especially in dense vegetation, brood monitoring is challenging. Human disturbance can also affect brood monitoring by causing chicks to disperse, making it harder to keep track of them. Chicks will often disperse in several directions away from a perceived threat. Brood monitoring is even more difficult on narrow beaches with high human visitation. The lack of dry beach, especially at high tide, forces beachgoers and plover broods to come in close contact with one another, increasing the frequency and probability of human disturbance.

Causes of chick mortality are extremely difficult to assess. In the majority of cases, the cause of chick loss is unknown. A chick is presumed dead if it disappears before 25 days of age. Sections of beach along the corridor are re-opened to ORVs when an entire brood is not seen in the area for five consecutive days.

Fledging dates ranged from 8 July to 23 August. Although MA State guidelines for piping plovers (Blodget and Melvin 1996) suggest that most plover chicks fledge at 25 to 27 days of age, the fledging age at the Seashore and in some other piping plover breeding locations in the region appears to be higher. In recent years, it has been common for piping plover broods to fledge later than 27 days of age. For example, in 2011 in the town of Duxbury, MA, of 35 chicks that hatched from 9 nests, 19 survived to fledge. Age of fledging ranged from 31 to 42 days old, with most chicks taking over 35 days to fledge. At the Seashore, the pre-fledge period exceeded 30 days in 70% (28/40) of fledged broods in 2011, 75% (9/12) of fledged broods in 2012, 76% (16/21) of fledged broods in 2013, and 45% (13/29) of fledged broods in 2014. Over the past five years (2010-2014), the average age for a piping plover chick to fledge at the Seashore was 31 days old (number of days after hatching). Average chick fledge age was 34 days in 2012, 32 days in 2013, and 30 days in 2014. More research is needed to determine which factors influence the length of the pre-fledge period in plover chicks, but Catlin et al. (2012) suggests it appears to be affected by environmental conditions.

Use of Feeding and Roosting Habitats

Seashore biologists not only monitor piping plover nesting areas, but also piping plover feeding, staging, and roosting areas. Groups of post-breeding piping plovers were observed in late summer, feeding and resting throughout the park, including three notable occasions at Race Point South (Armstrong area), where groups of 5-12 plovers were observed in mid-late August. Smaller groups of piping plovers were observed including five at the southern tip of Coast Guard Beach on 31 July, and a group of six at Jeremy Point on 7 September.

Fledging Success, Productivity and Population Trends

Results

Of the 129 plover chicks that hatched at the Seashore in 2014, 52 chicks fledged (40%). Fledging success ranged from 0% at Jeremy Point and Head of the Meadow, to 100% at Longnook (Table 1).

Park-wide, productivity was 0.76 fledged chicks/nesting pair (52 fledged chicks from 68 nesting pairs) (Table 1). Productivity was higher in the South District (1.07 fledged/pair) than in the North District (0.56 fledged/pair) (Table 1).

A total of 32 pairs with predator exclosures around the nests produced a total of 34 fledglings (productivity $34/32 = 1.06$). The remaining 36 pairs that did not have nest exclosures produced a total of 18 fledgling (productivity $18/36 = 0.5$). Hatch rate (number eggs hatched/number eggs laid) was 74% (87/118) from exclosed nests and 16% (42/257) from unexclosed nests. Fledge rate (number chicks fledged/number eggs hatched) was 39% (34/87) for exclosed nests and 43% (18/42) for unexclosed nests.

Discussion

There were 17 fewer piping plover pairs nesting on the Seashore in 2014 than in 2013. The number of breeding pairs (68) on the Seashore in 2014 was the lowest since 2000, and the third lowest since 1993. The decrease in the number of pairs is likely due to poor piping plover productivity for the last several years along the U.S. Atlantic Coast with 2012 having the lowest productivity since the species' listing in 1986.

In 2014, the fledging rate (40%) was 9 percentage points lower than the mean for the past ten years (49%), and the second lowest of this time period (Table 6). Nest success (proportion of successful nests to total observed nests) in 2014 was 31%, which was higher than in the previous two years (17% and 13% in 2013 and 2012, respectively), but was still the third lowest in the past ten years and 15 percentage points lower than the mean (46%) from the past ten years (Table 6)

The use of nest exclosures on a subset of nests in 2014 is likely responsible for the uptick in nest success in 2014 from the previous two years, when exclosures were not used. A pair's reproductive success in a given breeding season is dependent upon successfully hatching chicks that survive to fledge. However, the comparably low fledge rate in 2014 is another indicator that exclosure use only addresses one aspect of productivity (i.e., the predation of nests), while predation of chicks remains a limiting factor for reproductive success. Thus, failure during either the incubation or rearing (pre-fledge) stages will reduce individual reproductive success, and in turn limit productivity within the breeding site and affect overall population recruitment. Recovery and viability of piping plover populations requires both an increase in abundance and a sustained level of annual productivity.

Overall productivity at the Seashore in 2014 (0.76) was comparable to what it was when plover management began in 1985 (Fig. 3). Annual plover productivity at the Seashore increased dramatically in the initial years of the plover management program but has been trending downward more recently, with 25-year lows of 0.30 chicks fledged/pair in 2012 and 0.54 chicks fledged/year in 2013 (Table 7). However, because annual productivity can be so variable, a preferable measure of productivity is the five-year weighted average of annual productivity. This measure reduces the effect of annual variability and combines the results for five years into a single weighted average. For the Atlantic Coast population of piping plovers, viability models estimate that a five-year average annual productivity of 1.5 chicks fledged/pair/year is needed to maintain the relatively small recovery goal population of 2,000 pairs with minimal extinction risk (USFWS 1996, 2009). For the five-year period ending with 2014, the average productivity at the Seashore was 0.84 chicks fledged/pair/year, which is the second lowest it has been at the Seashore since 1989 (with 2013 being the lowest). Since 2000, the five-year annual productivity has narrowly reached the recovery goal four times in the past 15 years (Table 7). When viewed over a 20 year period (1995-2014), the five-year weighted average annual productivity has declined significantly by 0.0426 chicks/pair/year ($p < 0.0001$, $F_{1,18} = 36.14$, $r^2 = 0.6675$) (Fig. 4). Productivity is in great decline and the Seashore is no longer achieving the USFWS recovery goal of a five year average annual productivity of 1.5 fledged chicks/pair/year.

It is hard to predict what this decline in productivity will have on the breeding population at the Seashore and the overall recovery of the species. But continued low reproductive success at the Seashore is a conservation concern, especially considering that the Seashore supports over 14% of the Massachusetts breeding piping plover population.

Least Terns

Population Trends

The least tern is listed by the Massachusetts Division of Fisheries and Wildlife (MDFW) as a species of special concern and as a *Bird of Conservation Concern* by the United States Fish and Wildlife Service (USFWS). Least tern numbers in Massachusetts increased from 1985 to 2001, declined for several years, and then increased sharply after 2006. However, because initial counts were often done with inferior survey techniques and less inclusive survey coverage area, early increases in numbers do not necessarily indicate increasing populations (Thompson et. al 1997). From 1985 to 2011, population size in Massachusetts has ranged from 2,109 to 4,309 pairs (with the highest year occurring in 2011 with a mean

of 2,881 pairs) (Mostello 2012). In the mid-1970s – 1980s, the population of nesting least terns at the Seashore generally ranged from 200- 600 pairs. Over the past ten years (2005 – 2014) at the Seashore, the least tern population has fluctuated between a high of 268 pairs in 2011 and a low of 77 pairs in 2014 (Fig. 5).

In 2014, the population of nesting least terns within the Seashore declined by nearly half compared to 2013 (77 and 136 respectively) (Fig. 5). Because least terns are relatively long-lived, the effect of poor productivity on population status is delayed. Thus, annual reproductive success is just as critical an indicator of least tern's population stability, as annual numbers of individuals counted (Thompson et. al 1997).

Brood Monitoring and Productivity

Methods

Due to concerns of predators keying into human scents or visual clues (e.g., footprints leading up to a nest) during monitoring activities in the nesting areas, visual estimates of least tern colony sizes were made from outside the symbolic fencing several times per week. Shorebird staff occasionally walked through colonies to get better estimates of numbers of nests and chicks. The number of pairs in each colony was estimated by walking through colony and counting nests, or by counting incubating birds with a spotting scope from outside the colony, during two standardized periods defined by Massachusetts Division of Fisheries and Wildlife (“A-count” from June 5-20 and “B-count” after June 20).

Results

Least terns returned to the lower Cape, including Seashore beaches, during the second week of May. The first least tern was observed on 10 May at Coast Guard, Eastham. Egg laying began on 30 May, with most least terns on eggs by early June. Renesting attempts continued through the beginning of August. Approximately 39 pairs had nests during the “A” count and 77 pairs had nests during the “B” count. There were a total of 11 nesting colonies from Eastham to Provincetown (Table 8).

Colony sizes fluctuated throughout the season but most were relatively small with fewer than 30 pairs. Wood End/Long Point supported the largest colony during the census windows with 29 nesting pairs. To be consistent between districts and to minimize double counting pairs that may have moved after losing a nest, we chose dates around 6/9 for the A count and dates around 7/7 for the B count. Armstrong had a high count of 36 nesting pairs on 7/18 but this count was not included in Table 8 because it was taken outside of the defined census windows. Most colonies were depredated and multiple nesting attempts occurred throughout the season. On July 13-14, wind driven high tides overwashed the entire Wood End/Long Point colony and 22 nests were lost. There were smaller nesting colonies at Coast Guard, Eastham, Marconi Beach, Great Island, Jeremy Point, Ballston Beach, Head of the Meadow, Race Point South (including: Old Harbor and Armstrong), and Race Point North; these beaches supported a range of 1 - 29 nesting pairs (Table 8).

The first least tern chicks hatched on 28 June at Wood End and the last chicks hatched on 21 August at Armstrong. Least terns are considered fledged when they are observed in sustained flight for at least 15 meters. Of the 77 pairs of nesting least terns, only seven chicks fledged (0.09 chicks/pair) from Seashore beaches in 2014: Coast Guard, Eastham (1), Great Island (2), Head of the Meadow (1), Old Harbor (1), Race Point North (1), and Wood End/Long Point (1)(Table 8).

Discussion

Least tern productivity throughout the park has varied over the past ten years, but has generally been poor, with less than one chick fledged/pair (Table 9). The low productivity of least terns is due to intense predation on eggs and chicks, mainly by coyotes. In addition, the narrowing of beaches and increased frequency of late spring/summer storms make nesting areas more vulnerable to wash-overs.

Field observations in 2014 suggest that most tern colonies at the Seashore were visited almost daily by coyotes, most often resulting in a loss of nests or chicks. Coyotes seem to be attracted to tern colonies due to the concentration and abundance of eggs, and can develop a search pattern that is highly effective in locating ground nesting bird nests in open habitat. Coyotes may also be attracted to the scent of garbage, food waste and food storage, and food cooking associated with human recreation near tern colonies. Fish remains left on the beach by fishermen during the nesting season may also attract coyotes to these beaches. While predator sign at a nest bowl can indicate the cause of nest loss, it is more difficult to identify predators of least tern chicks once they hatch, but it is likely that the same species (mainly coyotes) preying on eggs are also preying on chicks.

The colonial nesting strategy used by terns and other seabirds evolved as a means of protecting eggs and chicks of the colonial species by a collective defensive effort by the adults in the colony. Adult members of the colony react as a group to any predator (or perceived threat) that comes in close proximity to the colony and use mobbing behavior to deter the intruder. However, the colonial nesting strategy is ineffective with very small colonies, because an insufficient number of adults are available to mob and deter the predator. The typical size of a single colony of colonial nesting seabirds such as terns can range from the thousands to tens of thousands of individuals. The colony sizes of nesting least terns at the Seashore have decreased over the years and continuous disturbance by predators fragments and disperses existing colonies, further hindering the ability of the colony to defend itself. In addition, a high predation rate, which drives down colony size, makes the birds even more vulnerable to further predation, and likely a major contributor to the plummeting reproductive success of least terns at the Seashore.

Common Terns

Population Trends

The common tern is listed by the MDFW as a *Species of Special Concern*. In Massachusetts, from 1985 to 2003, common tern numbers rose fairly steadily, then stabilized at about 16,000-17,000 pairs. Since 1985, population size has ranged from 6,483 to 16,760 pairs (with a mean of 12,427 pairs) in the state (Mostello 2012).

No common terns nested at the Seashore in 2014. However, over the past ten years, a few common tern pairs (<10) have nested within or near least tern colonies at Jeremy Point, Coast Guard Beach in Eastham, Race Point North, and Wood End, but the majority of nesting has historically occurred on New Island, Orleans. In 1999, 2176 pairs of common terns nested on this small island. This number sharply declined by over 50% in both 2000 and 2001 (to 1078 and 495 pairs, respectively), and productivity was low due to intense egg predation from coyotes, gulls, striped skunks, and ants. In 2002, for the first time in 20 years, common terns did not nest on New Island (Peter Trull, pers. comm.). More recently, nine pairs attempted to nest on New Island in 2009, but all nests were lost to predation. From 2009-2013, one or two pairs of common terns have unsuccessfully nested on New Island each year, but none were observed in 2014.

Nesting Population and Productivity

Results

There were no nesting common terns.

American Oystercatchers

Population Trends

In the United States, the American oystercatcher is designated a *Species of High Concern* and is one of the most uncommon species of breeding shorebirds in North America due to a restricted range, small population size, widespread habitat loss, and threats during the breeding and non-breeding seasons (Brown et al. 2001). In addition, it is listed as a “*Bird of Conservation Concern*” by the USFWS (2008). The oystercatcher population has undergone a substantial range expansion along the Atlantic Coast, reaching Massachusetts only 40 years ago. However, this northward range expansion may be a re-colonization of formerly occupied habitat (Forbush 1912). The eastern U.S. population of oystercatchers was estimated by Brown et al. (2005) at about 11,000 birds. In 2011, observers reported totals of > 418 adults and > 202 pairs of American Oystercatchers at 110 sites in Massachusetts. The American oystercatcher is still an uncommon bird at the Seashore. Over the last eleven years (2004-2014), 2-5 pairs of oystercatchers have nests at the Seashore each year. Nesting has only occurred in the South District at Jeremy Point, Coast Guard Beach in Eastham, and New Island in Orleans.

Nesting Population and Productivity

Results

Two pairs of American oystercatchers nested at the Seashore in 2014, both at Jeremy Point. The first oystercatcher was observed on 19 April, and both pairs were scraping by 29 April; the first nest was found on 14 May. This nest and a second nest attempt were depredated by coyote before the pair’s third nest attempt hatched one chick on 12 July; the chick was last observed on 18 July. The second oystercatcher pair hatched two of three eggs from its first nest attempt on 10 July; the third egg was depredated by coyote immediately following hatching of the other two eggs. One chick from this brood survived 16 days (until 26 July) and the other chick was last observed at 27 days of age (6 August). Cause of chick loss is unknown.

Discussion

American oystercatchers were first recorded nesting on Seashore beaches in 2002. Since then, two to five pairs have nested in the South District each year. During these years, most nests were lost to predation (predominately coyote) or overwash. A few nests hatched over this time period, but the chicks disappeared before fledging, often within the first week. Predation was the likely cause of chick loss. From 2006 – 2008, productivity was better, but still low with an average of 0.53 chicks fledged/nesting pair. From 2009 through 2014, productivity has been zero. Over the years, coyote predation has been the main cause of nest loss and the likely cause of chick loss when nests have hatched. American oystercatchers are a long-lived species that benefits from high annual adult survival and variable annual productivity. The latter could be considered a benefit because modeling results have shown that as variability in productivity decreases, the probability of population decline increases (Davis 1999). However, consistently low reproductive success such as that observed at the Seashore should raise concern.

Threats to American oystercatchers during the breeding and non-breeding seasons include direct habitat loss, pressure from recreational disturbance, increases in nest predators, potential contamination of food resources, and alteration of habitat through beach stabilization. Unfortunately, the relative impact of each threat on oystercatcher population is poorly understood (Schulte et al. 2007).

Post Breeding/Staging Shorebirds

In late summer/early fall, thousands of migrating shorebirds congregate on mudflats and beaches along the Seashore to feed and rest. While dozens of species use the Seashore during fall migration, two of the most notable are the federally endangered roseate tern and the federally threatened red knot. Nauset Marsh/Coast Guard Beach, Jeremy Point, Hatches Harbor and Wood End/Long Point are particularly important sites, as they represent the most important staging and roosting areas for these birds on Cape Cod (Hadden 2001, Trull et al. 1999).

In addition whimbrel, short-billed dowitcher, semipalmated plover, sanderling, and sandpiper spp., were present on Seashore beaches from the end of July through mid-October (Table 10). The largest concentrations of migrants were observed at Race Point North, Race Point South (Armstrong), High Head, Jeremy Point, Wood End, and Coast Guard, Eastham (Nauset Marsh complex).

Roseate Tern

Research estimates that 75% of the entire Northwest Atlantic breeding population of roseate terns and their fledglings use Seashore beaches from mid-July through October (Jeff Spendelow, USGS, pers. comm). This behavior, where birds rest and feed in one geographic location during migration, is called “staging”. During this period they must build up adequate fat reserves required for their long migration to South America (more than 7,000 km). It has also been established that young roseate terns’ migration and overwintering survival depends on parental care, both on staging grounds after the young have fledged, as well as throughout migration. Disturbance to staging areas can cause flocks to flush and young birds to be separated from their parents. Even if this displacement is only temporary, it forces both adults and young to expend valuable energy stores needed for their long migration.

The Northwest Atlantic roseate tern population has declined more than 20% since 2000, despite extensive management efforts at breeding colony sites. Studies confirm that most mortality of this species takes place away from breeding sites, during migration or on wintering grounds. However, little information is available about causes of death during these periods. Results from a 20-year study of adult survival, and a review of recent productivity data, strongly suggest that post-fledging survival during the first year of life could be a major factor limiting population recovery (Lebreton et al. (2003), Nisbet & Spendelow (1999), Spendelow et al. (2008, 2010) USFWS (2010), and Spendelow et al. 2014 unpublished data).

Given this species unexplained decline and the need for more information during the staging period, NPS received funding to begin a research project, documenting flock size, composition, and movement, as well as how disturbance (both anthropogenic and non-human influenced) stressors to juvenile roseate terns during this period are negatively impacting the recovery of this endangered species. The project, beginning in 2014, is three-year collaboration between the U.S. Geological Survey, Massachusetts Audubon Society, Virginia Tech University, and State University of N.Y., College of Environmental Science and Forestry.

From the beginning of July through mid-October in 2014, researchers conducted surveys of staging terns and shorebirds throughout the park. Hundreds of terns (predominately common and roseate) were observed at Armstrong, Exit 9, Race Point South and Jeremy Point throughout the post-breeding season, and thousands were observed at Hatches Harbor, Race Point North, Head of the Meadow, Coast Guard in Eastham/Nauset Marsh, Marconi Beach, and North Beach in Chatham (Table 11). The highest percentage of roseate terns (within mixed flocks) in the North District was observed at Hatches Harbor and Race Point North, and in the South District at Nauset Marsh and Jeremy Point.

Red Knot

The red knot was listed as a threatened species under the Endangered Species Act in December of 2014, with critical habitat designations to be identified in 2015. The Seashore provides essential staging and foraging habitat for red knots, which can be found in the greatest numbers during fall migration (mid-July through October), using sandy ocean beaches and tidal mudflats to feed and rest. When red knots are observed, data on location, flock size, composition, and movement, are recorded.

Historically, the greatest concentrations of red knots within the Park have been observed at Coast Guard Beach in Eastham, and in Nauset Marsh, although from 2012-2014, hundreds have been seen along the ocean beach in Truro and Provincetown. A flock of between 100 and 120 were regularly observed at Coast Guard Beach in 2014 (Table 10). As part of a long term study to identify important migration stop-over sites throughout Cape Cod and on their wintering grounds, scientists from USFWS captured five red knots, 11 sanderlings, three black-bellied plovers, one short-billed dowitcher, and one semipalmated sandpiper at the southern tip of Coast Guard Beach in Eastham on 22 September, and affixed tracking devices to all five red knots.

Management and Protection

Predator Management

Piping Plover Nest Protection

To protect nesting shorebirds, symbolic fencing was placed around most areas of suitable habitat where nests and active scrapes were found and where shorebirds were observed exhibiting courtship or territorial behavior. In addition, some sections of narrow beach with nesting shorebirds were temporarily closed or a detour was implemented if an adequate buffer to prevent disturbance to the incubating bird could not be attained (see section on Recreation Management page 18, for details).

A total of 32 piping plover nests were exclosed in 2014. Nests were exclosed according to USFWS Atlantic Coast Piping Plover Revised Recovery Plan (USFWS 1996). To minimize the risk of nest abandonment and adult mortality, nests were only exclosed once birds were actively incubating eggs, when vegetation did not obscure the incubating bird's detection of approaching threats (e.g., predators), and when the risk of overwash was low (Predator Exclosure Session, Atlantic Coast Piping Plover and Least Tern Workshop, Shepherdstown, West Virginia, January 2012).

As with past years, no other form of predator management was implemented at the Seashore in 2014.

Protection for least tern chicks

To reduce chick predation, "tern shelters" can be placed inside least tern nesting colonies that lack sufficient ground vegetation for the chicks to hide in. These shelters are made of triangular plywood and are approximately 25" x 8" x 8", with a 7" x 8" opening for the chicks to enter. This design was taken from the U.S. Fish and Wildlife Service Tern Management Handbook, Coastal Northeast United States and Atlantic Canada (2004). In past years, tern chicks were observed using the shelters, which can provide shade and protection from predators. In 2013, three tern shelters were placed near three least tern nests at Great Island a few days before nests were due to hatch. Two of these nests were depredated by coyote the day after the shelters were placed. The remaining shelter was removed that same day. It is difficult to determine whether the coyotes keyed into a new object on the beach or human scent, but this speculation cannot be dismissed. Because of these concerns, no other shelters were placed in least tern nesting

colonies in 2014, but beach debris already present at colony sites was occasionally propped up to provide shaded areas whenever possible.

Recreation Management

Habitat Protection

To protect nesting shorebirds, symbolic fencing was placed around most areas of suitable habitat where nests and active scrapes were found and where shorebirds were observed exhibiting courtship or territorial behavior. In addition, some sections of narrow beach with nesting shorebirds were temporarily closed, or a detour was implemented if an adequate buffer to prevent disturbance to the incubating bird could not be attained.

Pre-fencing is defined as fencing installed around suitable habitat by April 1st (or soon after) of each year, regardless of shorebird activity. Some portions of suitable habitat on beaches outside the ORV corridor that receive relatively little pedestrian visitation may not be pre-fenced. Additionally, with concurrence from USFWS, pre-fencing was excluded four lifeguarded beaches to provide more consistent recreational/pedestrian use.

Pre-fencing of suitable and historic shorebird nesting habitat began on 3 April at Coast Guard in Eastham and Race Point and continued through mid-April to include: Wood End, Herring Cove, Hatches Harbor, Exit 9, Armstrong, High Head, Head of the Meadow, Coast Guard Beach in Truro, Longnook, Ballston, Newcomb Hollow, Cahoon Hollow, White Crest, Marconi Station, Marconi Beach, Nauset Light, Duck Harbor, Bound Brook, Great Island, Jeremy Point and New Island.

Symbolic fencing is used to identify and protect shorebird nesting habitat. Five or six-foot wooden posts were placed 40'-50' apart, connected by a line of cotton twine to delineate nesting habitat. Plastic and wooden "Area Closed- Bird Use Area" informational signs were affixed to every second or third post. In cases where nests were located less than 50 meters from the high tide line and birds were being disturbed by passersby, a secondary fence line (using 6 foot signed posts with no string) was erected in the intertidal zone and this section of beach was closed during high tide. Signs informing visitors of the "high tide closure" were posted on each side of the closure. A variety of shorebird and natural resource informational and regulatory signs were also posted at the entrance to most beaches and nesting sites. Symbolic fencing remained up on some sections of beach through September to protect late nesting least terns as well as staging and migrating shorebirds along the upper and lower (intertidal) beach (e.g. Coast Guard Beach in Eastham, Jeremy Point, Head of the Meadow, Hatches Harbor and Race Point North). If on June 30th no eggs or chicks are present, symbolic fencing specific to piping plover protection would be removed starting on July 1st.

The importance of retaining symbolic fencing to protect resting migrants from disturbance, especially on high visitor use beaches, was apparent at the southern tip of Coast Guard Beach in Eastham, at Jeremy Point, and on western sections of Race Point North. For example, hundreds of semipalmated plovers were observed resting inside the fencing at Jeremy Point in the late summer. In the North District, (from 10 August through the end of September) there was a temporary lower beach closure approximately 0.4 miles west of the Race Point North ORV access to protect 1,000 to 2,000 staging common and roseate terns; pedestrians were able to walk along the upper beach to pass by this area.

In 2014, shorebird staff observed an increase in the number of visitors entering protected/closed shorebird use areas for recreational purposes as well as an increase in vandalism to symbolic fencing. In the North District, there were at least four instances of beachgoers walking inside fenced areas to recreate or retrieve beach debris, coming within feet, or in some cases inches of stepping on piping plover or least

tern nests. On two occasions visitor footprints were observed leading up to enclosed nests in the north district north district and in one case, a game camera directed at a nest at Wood End captured a young man walking up to an enclosed nest (Fig. 6). In the South District, bare footprints and sand castles were found inside the fencing in a least tern colony at Jeremy Point, and on several occasions high concentrations of footprints were found inside the fencing at a least tern colony at Coast Guard in Eastham (Fig. 7). One Seashore volunteer reported a visitor at Coast Guard in Eastham walking under the fencing and up to a day-old least tern chick in a nest bowl to take a photo of it. At the Marconi Beach least tern colony, shorebird staff observed a visitor walking inside the fencing for hundreds of meters, and coming within inches of stepping on a least tern nest (Fig. 8). On another occasion, a visitor reported two pedestrians walking through the Marconi tern colony collecting what appeared to be rocks. A beach fire at Duck Harbor was found still burning one morning about 50 meters from an active plover nest, with ~7 posts of symbolic fencing removed and burned, and liquor and beer bottles littering the nesting area. There were also two instances of unauthorized vehicle tracks driving the bay side beach in Wellfleet from Truro southward, most of the way to Jeremy Point. There were several other examples of visitor presence inside closed, fenced areas in both districts. Law enforcement staff was notified of most of these violations and case incident reports were taken.

Staff also noticed an increase in the amount of vandalism to symbolic fencing. The North District documented at least five separate cases (in different locations) where people cut the string between fence posts for long stretches of beach or removed sections of fencing entirely. In the south district, “no kite/kite surfing” signs were pulled up or ripped off on an almost daily basis at Duck Harbor during the month of May.

In addition, there were two more serious violations documented in 2014. One involved an unauthorized ATV driven by Wellfleet town employees on sections of beach with unfledged piping plover chicks. This incident was investigated by Seashore law enforcement rangers, and the town employees were issued a written warning. The second incident involved a Truro education program employee entering a posted, closed shorebird nesting area with a group of students. The group came within six inches of stepping on a piping plover nest. A formal investigation by Seashore law enforcement rangers was filed and charges were issued.

Temporary Pedestrian/Parking Lot/Boat Landing Closures and Detours

Erosion continues to narrow beaches at the Seashore. Where beaches were extremely narrow, or birds nested close to access points, it was not always possible to provide a sufficient buffer within the symbolic fencing to prevent pedestrian disturbance during the incubation phase of nesting. At sites where this occurred, sections of beaches were temporarily closed during a 1-3 hour window around high tide. Pedestrians were able to access the area at low tide when there was adequate exposed beach. Where possible, detours were established to provide visitor access around nesting areas.

In 2014, sections of Coast Guard, Truro, Coast Guard, Eastham, Old Harbor, Race Point South (Armstrong), Race Point North, Wood End, Jeremy Point, Duck Harbor, Newcomb Hollow, Great Island, and Marconi Beach were temporarily closed or detoured to pedestrians, at high tide, from early May through the middle of August. Certain access paths at Race Point South (Armstrong) were closed to pedestrians to protect piping plovers and least terns nesting close to the paths.

Some sections of beach were completely closed at all tides due to concerns that visitors might not be off the beach in time to safely pass the nesting area without disturbing the nesting birds at high tides (e.g. Great Island and Coast Guard in Eastham). Detours were established to provide visitor access around nesting areas.

In addition, to protect 1,000 to 2,000, staging common and roseate terns, there was a temporary lower beach closure approximately 0.4 miles west of the Race Point North ORV access from 10 August through the end of September. Pedestrians were able to walk along the upper beach to pass by this area. Shorebird staff and volunteers were sometimes stationed at or near this closure to provide information about the closure and educational material about the shorebird program.

Hand-held Kites/Kite Surfing

To prevent disturbance to nesting birds, hand-held kites, model planes or any other airborne devices above or within 200 meters of any area designated by signs as a “closed shorebird nesting” area (NPS 2014). In addition, kite surfing is prohibited on all open waters and on all ocean and bayside beaches within the Seashore from 15 March through 15 October, except for a small section of beach owned by the town of Wellfleet, at Duck Harbor. Provided there are no nesting birds within 200 meters of the town-owned beach at Duck Harbor, kite surfers can launch their kites and take a direct route, one quarter mile offshore, outside of park boundaries (NPS 2014). 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 gliders disturb nesting plovers and terns when they fly low along the coastline, directly over nesting areas.

Kite surfers were observed violating the recent ban by shorebird staff on five different occasions and by law enforcement staff on several more occasions, especially at Lecount Hollow, Newcomb Hollow, and Coast Guard in Eastham. On one occasion, a kite surfer angrily accosted one of the shorebird staff as she approached him to inform him of the ban, and then later when he approached her again as she was working on sign maintenance in the area. Law enforcement responded.

At Coast Guard Beach in Truro, there were several observations of para gliders making several passes above the beach and along the cliffs in posted shorebird nesting areas. Although there were no nesting birds in these areas at the time, this activity could disturb incubating birds. In addition, para gliders were observing bouncing off the cliffs, which could cause debris (i.e., rocks) to roll down the cliff and crush nests located on the cliff or at the base of the cliff.

Pets

Pets are required to be on a six-foot leash at all times, anywhere where they are allowed within the Seashore, all year long. There are a number of areas that are closed to pets to protect park resources. The south side of Coast Guard Beach in Eastham and all of Jeremy Point are closed to pets from 1 April through 30 September to protect nesting and migrating shorebirds. The marsh area of Hatches Harbor was closed to pets from 1 July through 30 September, while the ocean side of the Hatches Harbor spit remained open to leashed pets.

Additional sections of bay and ocean beaches were also temporarily closed to pets, as needed, to protect nesting areas. “No Pet Area” signs were posted in a row perpendicular to the water, approximately 50 meters away on either side of the nesting area, extending down into the intertidal zone. The only exception to this was along the ORV corridor where a dog inside a vehicle can pass pet closures to access areas of beach beyond closures that are open to pets. These sections of beach were closed to pets until all chicks in the area fledged. Signs informing visitors of temporary pet closures were moved as necessary to reflect the closures in effect at any one time. Beaches that did not have nesting shorebirds remained open to leashed pets.

Non-compliance of pet regulations continues to be a serious problem. In 2014, a total of 97 written warnings for pet violations were issued (47 in South District, and 49 in North District) and 61 violation

notices (54 in South District, and 8 in North District) were issued. Shorebird monitoring staff recorded a total of 597 dogs off leash on Seashore beaches from 16 April through 8 September (303 in the South District and 294 in the North District). Unleashed dogs were encountered most frequently at Newcomb Hollow (64), Coast Guard in Truro, (48), Lecount Hollow (64), and Herring Cove/Wood End (74) (Table 1). Dogs were also observed by shorebird staff on multiple occasions within areas seasonally closed to pets at Coast Guard in Eastham, Jeremy Point, and Hatches Harbor.

Off-Road Vehicles

Off-road vehicle access is permitted along a designated beach corridor in Provincetown and Truro. ORV access at the Seashore is guided by rules developed in response to Executive Orders 11644 and 11989 with Seashore-specific details provided in the 1985 ORV management plan, as modified through negotiated rule making (Neg Regs) (DOI 1998), and the 2007 Environmental Assessment: Options for Managing ORV Access (NPS 2007a) and 2007 FONSI (2007b). Permit applicants receive information about nesting piping plovers and terns. A total of 4,049 seasonal and weekly ORV/SCV permits were sold in 2014 (NPS 2014).

The ORV corridor was open to vehicles during the egg laying and incubating phase of the shorebird nesting season in areas where there was an adequate protective buffer between the incubating shorebirds and vehicles. However, sections of the corridor were temporarily closed or rerouted to protect staging and migrating terns, red knots and other shorebirds.

To determine the actual date of hatching and to ensure that chicks are found immediately after hatching, plover nests along the ORV corridor were 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 (322 meters) on each side of a brood of plover chicks and 0.06 miles (91 meters) on each side of a brood of least tern chicks. Actual closure limits for each brood were adjusted based on beach morphology and brood behavior to ensure chicks were protected.

All plover chicks were monitored daily, noting their movements, location, and numbers in each brood. Plover 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 plover chicks and ORVs. In 2014, field observations of unfledged plover chick movements suggested that plover broods tended to move greater distances along the beach when there were no neighboring nesting birds keeping them within a defined territory. One brood of piping plover chicks at High Head traveled 0.4 miles from their nest within 24 hours of hatching.

For management purposes, piping plover and least tern chicks are considered fledged when they are observed in sustained flight of at least 15 meters. In addition, as outlined in 1996 State Guidelines (Blodget and Melvin 1996), rearing or nursery areas used by unfledged or recently fledged tern chicks were identified by symbolic fencing, and all access by vehicles into these nursery areas was prohibited.

Vehicle closures were lifted on sections of beach when chicks fledged or the chick(s) were not seen for five consecutive days. Additional information on ORV management can be found in the 2014 Off-Road Vehicle Activity Report (NPS 2014).

Park Beach Operations/Essential Vehicles

Seashore staff routinely operate vehicles 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 vehicle use in areas with nesting shorebirds, as outlined in the 1998 “Neg Regs” and the 2012 SOP (NPS 2012). In addition, all designated staff driving on beaches are knowledgeable of shorebird biology, identification, and current nesting locations, and are required to comply with the Seashore’s SOP for ATV use (NPS 2010b), including completing the on-line “Introduction to Basic ATV operations and the ATV Rider Course,” along with a one day field training course given by a certified “off-highway vehicle trainer” (NPS 2010c) and an eight hour on-the-job training by riding alongside an experienced rider.

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. Essential vehicles refrain from driving on sections of beach when piping plover chicks <5 days old are present (2012 SOP).

Flexible Management

In accordance with Section 7 of the Endangered Species Act of 1973, the Seashore initiated formal consultation in January 2010 on implementation of flexible management for piping plovers at two beaches for the 2010-11 nesting seasons. The proposed action would allow the Seashore some flexibility in managing a very limited number of piping plovers nesting on or near high visitation beaches where the beach has eroded to the point that fully protecting piping plovers would render the beach unusable to visitors at high tide. More specifically, flexible management actions would be limited only to sections of beach that included a pedestrian access point and a life-guarded area, with the goal of providing visitors with guarded beach areas for swimming and sunbathing that may not be accessible when an active shorebird nest was in close proximity.

On May 11, 2010, The U.S. Fish and Wildlife Service issued a Biological Opinion (BO), granting permission for this action. The BO determined that the flexible management proposed for a total of 400 meters of suitable piping plover habitat, affecting no more than three pairs of piping plovers within the Seashore, was not likely to jeopardize the continued existence of the Atlantic Coast piping plover population or the New England recovery unit.

In 2012, the Seashore requested an extension to the 2010 BO addressing flexible management of piping plovers. A letter sent by USFWS on 25 April 2012, formally amended the BO to extend through 31 December 2014. Since the issuing of the BO in 2010, the Seashore has flexibly managed one pair of piping plovers at Marconi beach in 2010. No piping plover pairs have been flexibly managed from 2011-2014.

Management and Protection of Post Breeding Shorebirds

In 2014, Seashore staff and researchers collected data on flock size, composition, location, and movement, as well as documented disturbances by dogs, pedestrians, ORV’s, boats kite flying and other airborne devices.

As in past years, some sections of upper beach and intertidal zone with concentrations of staging and migrating shorebirds were posted with symbolic fencing and/or signs to reduce human disturbance including: Coast Guard Beach in Eastham, Jeremy Point, Race Point North, and Hatches Harbor. Pet closures were also implemented at several beaches.

At Hatches Harbor, to discourage beachgoers from approaching too close to staging shorebirds, interpretive signs were affixed to buoys mid-channel on the marsh side of the spit in hopes of deterring beachgoers from crossing the channel and disturbing flocks of staging shorebirds on the exposed mudflats. In addition, interpretive and “No Pet” signs were installed on metal channel “U” posts placed throughout the marsh at Hatches Harbor. These interpretive signs were also posted on either side of large staging flocks of terns and other shorebirds at Coast Guard in Eastham, Marconi Beach, Marconi Station, White Crest, Cahoon Hollow, Newcomb Hollow, Ballston Beach, Jeremy Point, Race Point North and Race Point South.

Education, Outreach, and Public Involvement

Educating the public about impacts threatening nesting and staging shorebirds is important for garnering local support for management and protection efforts, thereby facilitating shorebird recovery. Along with day to day impromptu field interactions with visitors by shorebird staff, two Lead Biological Technicians visited local elementary schools throughout the Outer Cape in March. Park staff engaged the students with a PowerPoint presentation along with an interactive classroom activity, demonstrating the impacts of disturbance to nesting shorebirds. A total of 13 programs were given to 325 third through fifth grade students.

Seventeen volunteers donated a total of 1,185 hours to the Seashore’s shorebird management program. Volunteers assisted biological technicians and SCA interns with field operations from April through August and staffed the shorebird information and outreach table at Salt Pond Visitor Center. The table was set up for 15 days from 2 July through 21 August. A total of 1,680 visitor contacts were made.

Managing Shorebirds on non-NPS land

The Seashore encompasses a matrix of private, federal and town owned lands with varying beach management and natural resource protection practices. In order to achieve continuity in beach regulations and make signage and management less confusing to the general public, the Park has increased communication and coordination with adjacent landowners.

In 2011, town of Wellfleet accepted the offer from the Seashore to help manage and protect nesting shorebirds on town property within park boundaries (Appendix B). The town of Truro adopted a similar agreement in 2013 (Appendix C). In both agreements, the towns followed the management practices used by the Seashore and the Seashore agreed to take the lead role in protecting any nesting shorebirds on these town-owned sections of beach. Seashore staff worked closely with town managers in 2014, providing regular updates and site visits when needed. The towns of Orleans and Chatham take the lead role in the protection and management of nesting shorebirds on town-managed Seashore land.

In addition, in the Spring 2014, a letter was sent to all beachfront private property landowners within park boundaries requesting permission to allow NPS to install symbolic fencing on their land (if needed) to protect nesting shorebirds. Landowners could deny this request by contacting the park.

Table 1. Summary of piping plover (*Charadrius melodus*) productivity parameters, and number of dogs off leash reported by nesting site at Cape Cod National Seashore in 2014.

Site	Pairs	Nests ¹	Eggs Laid	Nests Hatched	Eggs Hatched	Chicks Fledged	Hatch Rate ²	Fledge Rate ³	Productivity ⁴	Dogs Off Leash
Coast Guard (Eastham)	4	4	16	4	15	8	94%	53%	2.00	25
Bound Brook	1	2	8	0	0	0	0%	0%	0.00	0
Cahoon Hollow	0	0	0	0	0	0	0%	0%	N/A	16
Duck Harbor	2	2	8	1	4	1	50%	25%	0.50	17
Great Island	3	3	12	3	12	8	100%	67%	2.67	9
Jeremy Point	2	4	9	2	6	0	67%	0%	0.00	5
Lecount Hollow	1	1	2	0	0	0	0%	0%	0.00	64
Marconi Beach	7	9	33	6	23	12	70%	52%	1.71	21
Marconi Station [†]	0	1	4	0	0	0	0%	0%	N/A	8
Nauset Light	1	2	8	1	2	0	0%	0%	0.00	41
Newcomb Hollow	3	5	14	0	0	0	0%	0%	0.00	64
New Island	1	1	4	0	0	0	0%	0%	0.00	No Data
White Crest	2	2	3	0	0	0	0%	0%	0.00	33
South District Totals	27	36	121	17	62	29	51%	47%	1.07	303
Armstrong	5	10	29	3	10	5	34%	50%	1.00	8
Ballston Beach	8	24	61	5	18	5	30%	28%	0.63	30
Coast Guard (Truro)	3	5	17	2	7	1	41%	14%	0.33	48
Exit 9	0	0	0	0	0	0	0%	0%	0.00	7
Hatches Harbor	0	0	0	0	0	0	0%	0%	0.00	22
Head of the Meadow	1	2	7	1	4	0	57%	0%	0.00	33
High Head	3	7	24	1	3	1	13%	33%	0.33	21
Longnook	1	2	6	1	3	3	50%	100%	3.00	15
Race Point North	7	11	38	2	5	2	13%	40%	0.29	8
Race Point South	4	5	19	4	12	5	63%	42%	1.25	28
Wood End/Long Point	9	19	53	2	5	1	9%	20%	0.11	74
North District Totals*	41	85	254	21	67	23	26%	34%	0.56	294
Grand Totals	68	121	375	38	129	52	34%	40%	0.76	597

¹ A "nest" is defined by individual scrapes with eggs. In 2014, each initial nest, reneest, continuation nest and their respective outcomes are counted as separate "nests" with separate outcomes.

²Total number of eggs hatched /total number of eggs laid.

³Total number of chicks fledged/ total number of eggs hatched.

⁴Total number of chicks fledged/ total number of nesting pairs.

[†]No pairs at Marconi Station, but one pair from Lecount Hollow laid a reneest at Marconi Station

*Total pair # includes a pair at Race Point North that scraped for over a month but for which a nest with eggs was never found

NOTE: # of pairs only reflects type A nests, not reneests

Table 2. Piping plover (*Charadrius melodus*) nest fates, and causes of nest loss, at Cape Cod National Seashore in 2014.

<u>Nests</u>				<i>Cause</i>	<u>Loss By Cause</u>	
<u># Laid</u>	<u># Hatched</u>	<u># Lost</u>	<u>% Lost¹</u>		<u># Lost</u>	<u>% Lost²</u>
121	38	83	69%			
				Predation	58	70%
				Overwash	13	16%
				Abandoned	5	6%
				Unknown	4	5%
				Sanded Over	3	4%
					83	100%
				<u><i>Predation Types</i></u>	<u># Lost</u>	<u>% Lost³</u>
				<i>Crow</i>	19	33%
				<i>Unknown</i>	13	22%
				<i>Canid</i>	11	19%
				<i>Coyote</i>	9	16%
				<i>Fox</i>	6	10%
					58	100%

¹total number nests lost/total number nests laid

²number of nests lost to a particular cause/total number of nests lost

³number of nests lost to a particular predator/total number of nests lost to predation

Table 3. Piping plover (*Charadrius melodus*) egg fates, and causes of egg loss, at Cape Cod National Seashore in 2014.

# Laid	# Hatched	# Unviable	# Lost	% Lost ¹	<i>Cause</i>	# Lost	% Lost ²
375	129	10	236	63%			
					Predation	165	70%
					Overwash	33	14%
					Abandoned	14	6%
					Unknown	15	6%
					Sand Over	9	4%
						236	100%
					<i>Predation Types</i>	<i># Lost</i>	<i>% Lost³</i>
					<i>Crow</i>	48	29%
					<i>Canid</i>	35	21%
					<i>Unknown</i>	35	21%
					<i>Coyote</i>	25	15%
					<i>Fox</i>	22	13%
						165	100%

¹total number eggs lost/total number eggs laid

²number of eggs lost to a particular cause/total number of eggs lost

³number of eggs lost to a particular predator/total number of eggs lost to predation

Table 4. Exclosed vs. unexclosed nest fates of piping plover (*Charadrius melodus*) at Cape Cod National Seashore in 2014.

	total nests	# successful (%)	# failed (%)	# washed/sanded over (%)	# abandoned (%)	# crow depredated (%)	# canid depredated (%)	# unknown (%)
Exclosure Installed	31	24 (77%)	7 (23%)	3 (10%)	3 (10%)	0 (0%)	1 (3%)	0 (0%)
Exclosure Removed	1	0 (0%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)
Never Exclosed	89	14 (16%)	75 (84%)	13 (15%)	2 (2%)	19 (21%)	23 (26%)	18 (20%)
TOTALS	121	38 (31%)	83 (69%)	16 (13%)	5 (4%)	19 (16%)	25 (21%)	18 (15%)

Table 5. Summary of piping plover (*Charadrius melodus*) nest loss, and cause of nest loss, at Cape Cod National Seashore from 2005-2014.

Year	# of pairs	Total Nests	# Successful Nests	# Unsuccessful	<u>Number Nests Lost to</u>					<u>Percentage Depredated Nests Lost to</u>						
					Overwash/Sanding Over	Abandonment ¹	Non-viable	Unknown	Other Predation	Crows	Coyote	Gulls	Skunk	Fox	Unknown Predator	
2005	77	118	48	70	33	11	1	0	4	21	24%	29%	10%	0%	0%	38%
2006	74	96	70	26	8	4	0	3	0	11	82%	0%	0%	0%	0%	18%
2007	82	113	66	47	24	12	0	2	0	9	44%	22%	0%	0%	0%	33%
2008	86	109	70	39	8	8	1	1	0	21	43%	5%	5%	19%	0%	29%
2009	83	108	54	54	16	9	1	2	1	25	68%	4%	4%	0%	0%	24%
2010	85	115	68	47	3	2	1	3	0	38	74%	5%	0%	0%	0%	21%
2011	82	110	61	49	8	9	1	2	0	29	83%	10%	0%	0%	0%	7%
2012	99	212	27	185	55	9	0	13	5	103	34%	40%	0%	0%	5%	21%
2013	85	173	30	143	28	7	0	2	2	103	23%	30%	0%	0%	5%	40%
2014	68	121	38	83	16	5	0	4	0	58	33%	16%	0%	0%	10%	22%
TOTAL	821	1275	532	743	199	76	5	32	12	418	42%	23%	1%	1%	4%	27%

¹Includes nests abandoned due to adult mortality

Table 6. Summary of piping plover (*Charadrius melodus*) nesting parameters by year at Cape Cod National Seashore from 2005-2014.

Year	# Pairs	# Chicks Fledged	Productivity¹	# Nests Laid	# Successful Nests	Nest Success²	% Renests³	# Eggs Laid	# Eggs Hatched	Hatch Rate⁴	Fledge Rate⁵
2005	77	87	1.13	118	48	41%	35%	378	163	43%	53%
2006	74	122	1.65	96	70	73%	23%	336	233	69%	52%
2007	82	146	1.78	113	66	58%	25%	368	233	63%	63%
2008	85	157	1.85	109	70	64%	21%	386	243	63%	65%
2009	83	60	0.72	108	54	50%	20%	362	186	51%	32%
2010	85	136	1.60	115	68	59%	26%	386	235	61%	58%
2011	82	90	1.10	110	61	55%	25%	378	210	56%	43%
2012	99	30	0.30	212	27	13%	53%	636	72	11%	42%
2013	85	46	0.54	173	30	17%	51%	532	100	19%	46%
2014	68	52	0.76	121	38	31%	45%	375	129	34%	40%
mean	82	93	1.14	128	53	46%	32%	414	180	47%	49%
media											
n	82.5	88.5	1.11	114	57.5	53%	26%	378	198	53%	49%
min	68	30	0.54	96	27	17%	20%	336	72	11%	32%
max	99	157	1.85	212	70	73%	53%	636	243	69%	65%

¹number of chicks fledged/number of nesting pairs

²number of successful nests/total number of nests observed

³number of renests (including continuation nests)/total number of nests

⁴number of eggs hatched/total number of eggs laid

⁵number of chicks fledged/number of eggs hatched

Table 7. Number of piping plover (*Charadrius melodus*) breeding pairs, annual nest productivity, and 5-year weighted average productivity, at Cape Cod National Seashore from 1985-2014.

Year	# Pairs	5-year Average Pairs	# Fledged	Annual Productivity	5-year Weighted Average Productivity
1985	18		13	0.70	
1986	16		5	0.30	
1987	15		6	0.40	
1988	13		12	0.90	
1989	15	15.40	21	1.40	0.74
1990	15	14.80	39	2.60	1.12
1991	28	17.20	74	2.60	1.77
1992	43	22.80	101	2.40	2.17
1993	60	32.20	124	2.07	2.23
1994	72	43.60	178	2.47	2.37
1995	83	57.20	147	1.77	2.18
1996	77	67.00	68	0.88	1.84
1997	67	71.80	104	1.55	1.73
1998	61	72.00	111	1.82	1.69
1999	72	72.00	123	1.71	1.54
2000	64	68.20	73	1.14	1.40
2001	76	68.00	155	2.04	1.66
2002	97	74.00	88	0.91	1.49
2003	84	78.60	130	1.55	1.45
2004	85.5	81.30	124	1.45	1.40
2005	77	83.90	87	1.13	1.39
2006	74	83.50	122	1.65	1.32
2007	82	80.50	146	1.78	1.51
2008	85	80.70	157	1.85	1.58
2009	83	80.20	60	0.72	1.43
2010	85	81.80	136	1.60	1.52
2011	82	83.40	90	1.10	1.41
2012	99	86.80	30	0.30	1.09
2013	85	86.80	46	0.54	0.83
2014	68	83.80	52	0.76	0.84

Table 8. Number of least tern (*Sternula antillarum*) pairs, and fledging success, at 11 colony sites at Cape Cod National Seashore in 2014.

	A Count¹	B Count²	# Chicks Fledged
Armstrong	0	11	0
Ballston	7	5	0
Coast Guard, Eastham	1	6	1
Great Island	9	1	2
Head of the Meadow	0	3	1
High Head	0	0	0
Jeremy Point	4	0	0
Marconi Beach	2	4	0
Old Harbor (part of Race Point South)	8	1	1
Race Point North	5	17	1
Wood End/Long Point	3	29	1
Totals	39	77	7

¹"A-Counts" are taken within the state census window of June 5-20

²"B-Counts" are taken outside the state census window; after June 20

Table 9. Least tern (*Sternula antillarum*) Productivity at Cape Cod National Seashore, 2007-2014.

Year	# Nesting Pairs	# Chicks Fledged	Productivity	Primary Cause of Loss
2007	86	40*	0.45*	overwash, canids
2008	136	<136*	>1*	overwash, coyotes
2009	236	25	0.11	overwash, coyotes
2010	226	26	0.12	coyotes
2011	268	99	0.37	coyotes
2012	257	66	0.26	coyotes
2013	138	2	0.01	coyotes
2014	77	7	0.09	coyotes

*estimate only

Table 10. Migratory shorebird observations at Cape Cod National Seashore in 2014, by date; species include Least Sandpipers (LESA), Piping Plovers (PIPL), Sanderlings (SAND), Semipalmated Plovers (SEPL), Semipalmated Sandpipers (SESA), Black-bellied Plovers (BBPL), Red Knots (REKN), Ruddy Turnstones (RUTU).

Date	Location	Species	Approximate # Observed
7/29/2014	High Head	REKN	8
7/31/2014	Armstrong	REKN	5
8/5/2014	Coast Guard Eastham	SESA, SEPL, SAND	mixed flock, 300
8/6/2014	Cahoon Hollow	SESA, SAND	mixed flock, 500
8/10/2014	Jeremy Point	SAND	100
		SESA	30
		SEPL	50
		BBPL	20
		RUTU	50
8/11/2014	High Head	SAND, SEPL, SESA, LESA, RUTU	mixed flock, 500
8/12/2014	Marconi Beach	SESA	50
		SAND	450
8/13/2014	White Crest	SESA, SAND	mixed flock, 500
8/16/2014	Coast Guard Eastham	REKN	111
8/17/2014	High Head	REKN	59
		SAND, SEPL, SESA, LESA, RUTU	mixed flock, 500
8/19/2014	Armstrong	REKN	25
8/21/2014	Armstrong	REKN	19
8/25/2014	Race Point North	REKN	25
		BBPL, SEPL, SESA	mixed flock, 50
8/26/2014	Race Point North	REKN	36
9/9/2014	Race Point Lifeguarded Beach	REKN	36
9/13/2014	Coast Guard Eastham	REKN	49
9/13/2014	Race Point South	REKN	39
9/15/2014	Coast Guard Eastham	WHIM	8
10/14/2014	Jeremy Point	SAND, BBPL, SESA, SEPL	mixed flock, 475
10/15/2014	Race Point North	SAND,SEPL,SESA, RUTU, BBPL	mixed flock, 150

Table 11. Number of mixed flocks of roseate terns (*Sterna dougallii*) and common terns (*Sterna hirundo*) observed at Cape Cod National Seashore, 2014.

Date	Location	Approximate # Observed
7/6/2014	Hatches Harbor	1,000
7/31/2014	Race Point North	2,000
8/5/2014	Marconi Station	1,000
8/6/2014	Cahoon Hollow and Newcomb Hollow	550
8/11/2014	Ballston	300
8/17/2014	Race Point North	3,000
8/21/2014	Jeremy Point	600
8/30/2014	North Beach, Chatham	10,000-12,000
9/6/2014	Coast Guard, Eastham	500
9/8/2014	Nauset Marsh	4,000
9/16/2014	Hatches Harbor	1,000
9/17/2014	Race Point North	1,500
10/15/2014	Race Point North	600

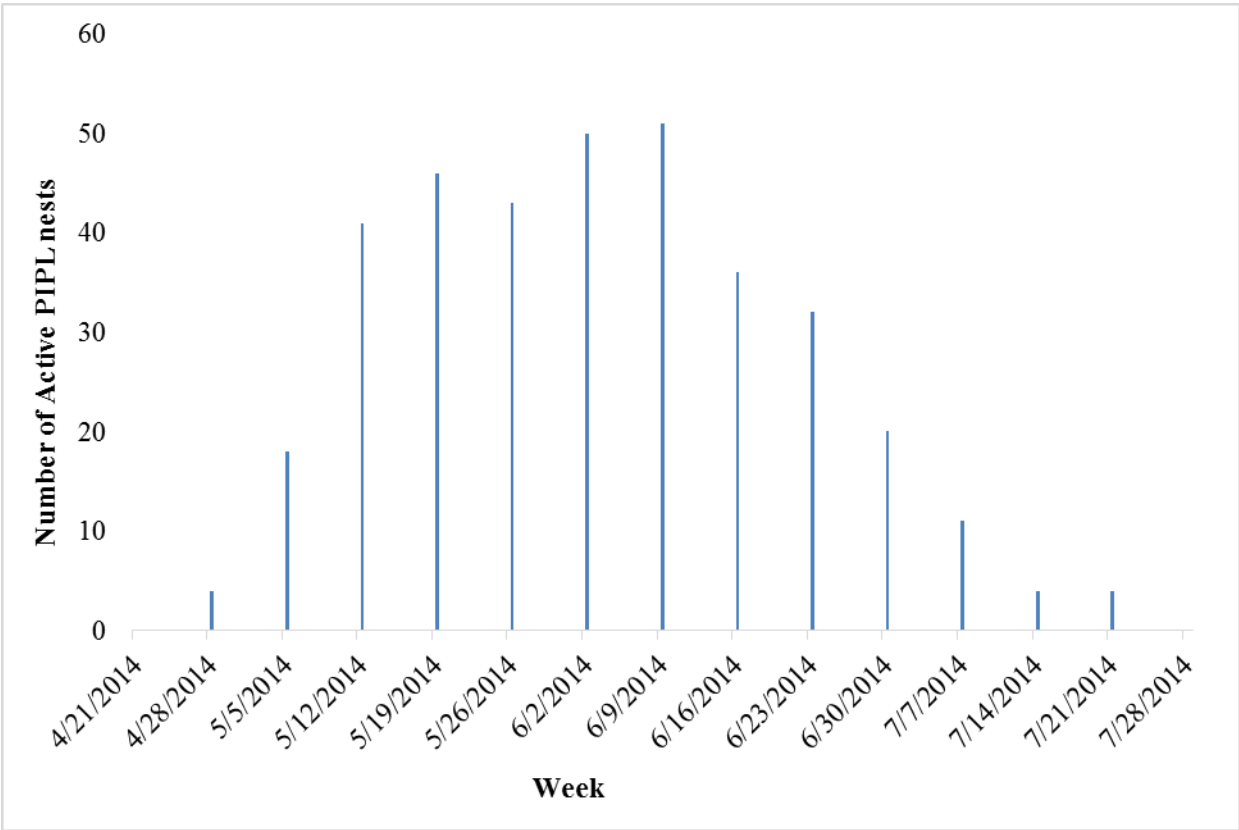


Figure 1. Active piping plover (*Charadrius melodus*) nests, by week in 2014 at Cape Cod National Seashore.



Figure 2. Crows foraging in shorebird nesting area inside symbolic fencing at Coast Guard Beach in Eastham on 10 May 2014.

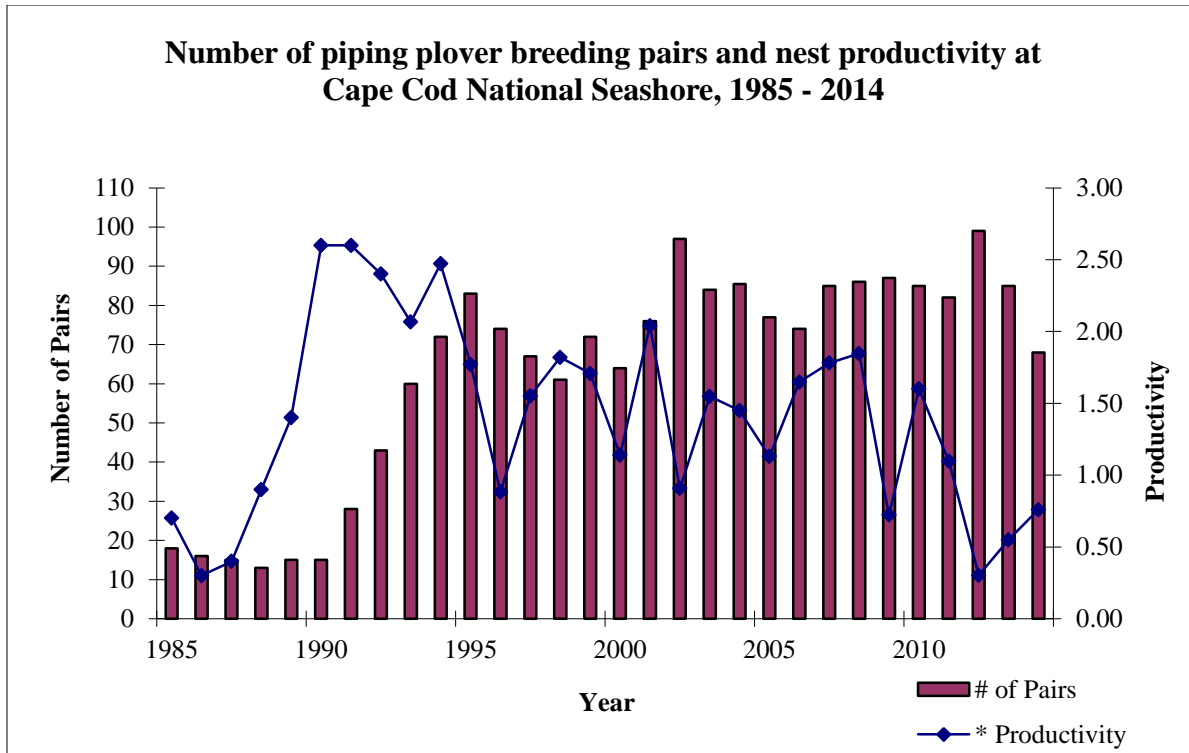


Figure 3. Number of piping plover (*Charadrius melodus*) pairs, and nest productivity, at Cape Cod National Seashore from 1985 – 2014.

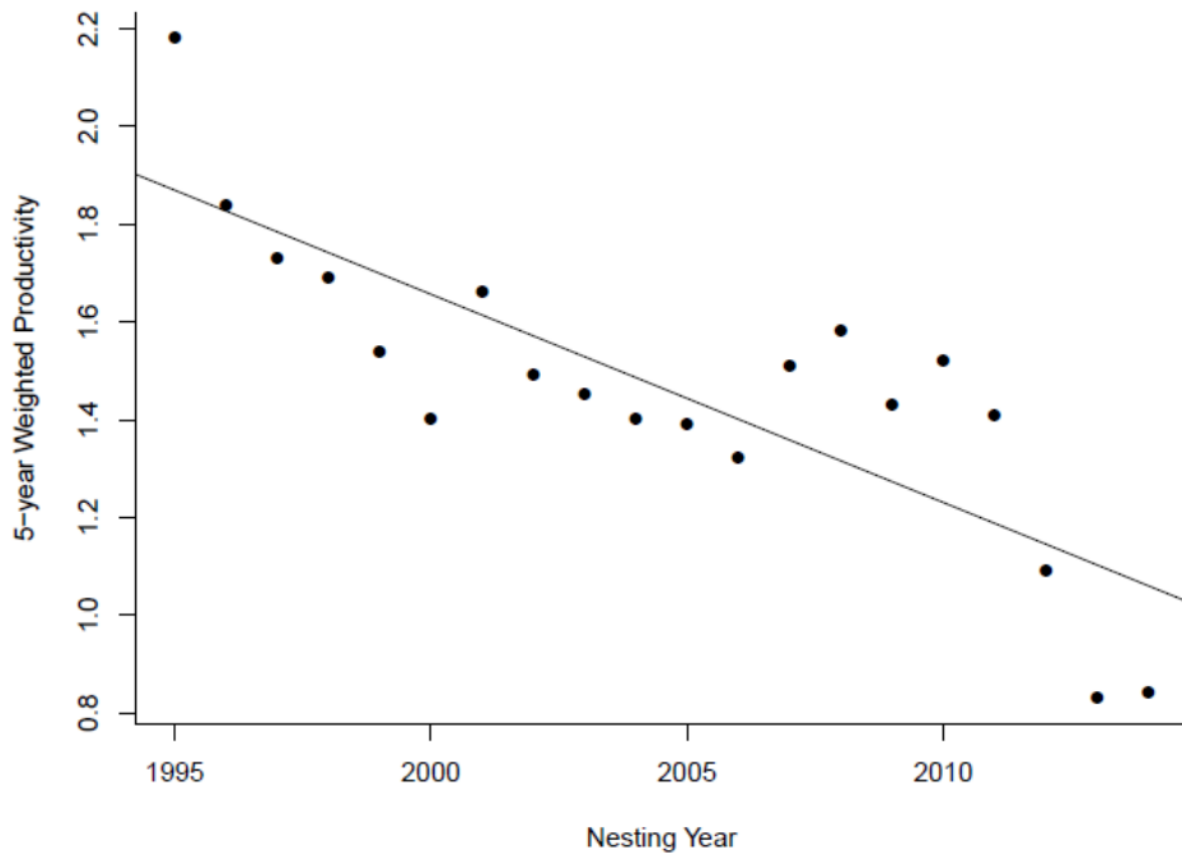


Figure 4. Piping plover (*Charadrius melodus*) 5-year productivity regression, Cape Cod National Seashore, 1995-2014 ($y = -0.0426*x + 86.8899$).

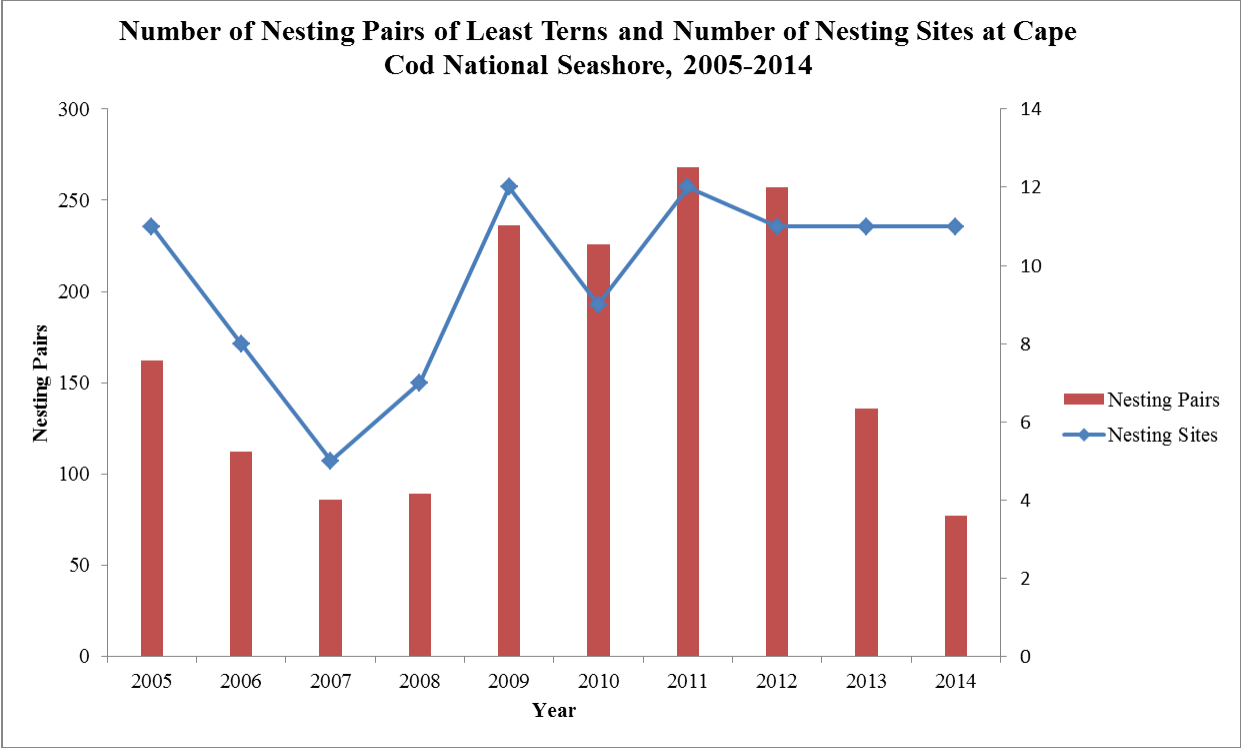


Figure 5. Number of least tern (*Sternula antillarum*) pairs and number of least tern nesting sites, by year on Cape Cod National Seashore from 2005-2014.



Figure 6. Man walking up to exclosed piping plover (*Charadrius melodus*) nest at Wood End, Cape Cod National Seashore, 2014



Figure 7. Newly-hatched least tern (*Sternula antillarum*) chick (circled) amidst bare footprints from beach-goers inside symbolic fencing at a colony site at Coast Guard Beach in Eastham, Cape Cod National Seashore, 2014.

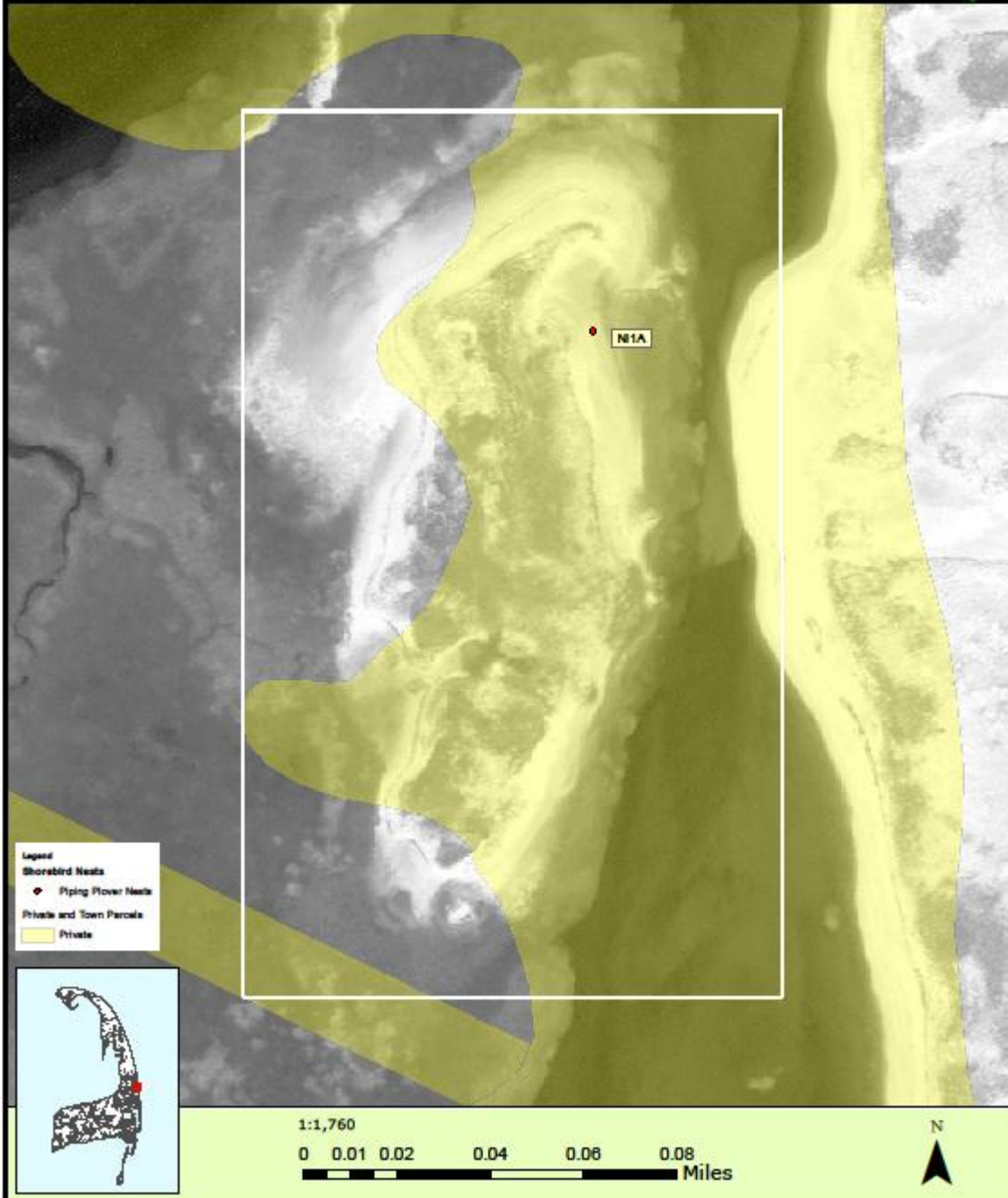


Figure 8. Footprints from a visitor who was observed walking inside the symbolic fencing at a least tern (*Sternula antillarum*) colony at Marconi Beach, Cape Cod National Seashore, 2014. The visitor came within one meter of an active least tern nest (circled).

Appendix A. Maps of 2014 Piping Plover, Least Tern, and American Oystercatcher Nest Sites at Cape Cod National Seashore.

Shorebird Nesting Activity 2014 New Island, Orleans

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



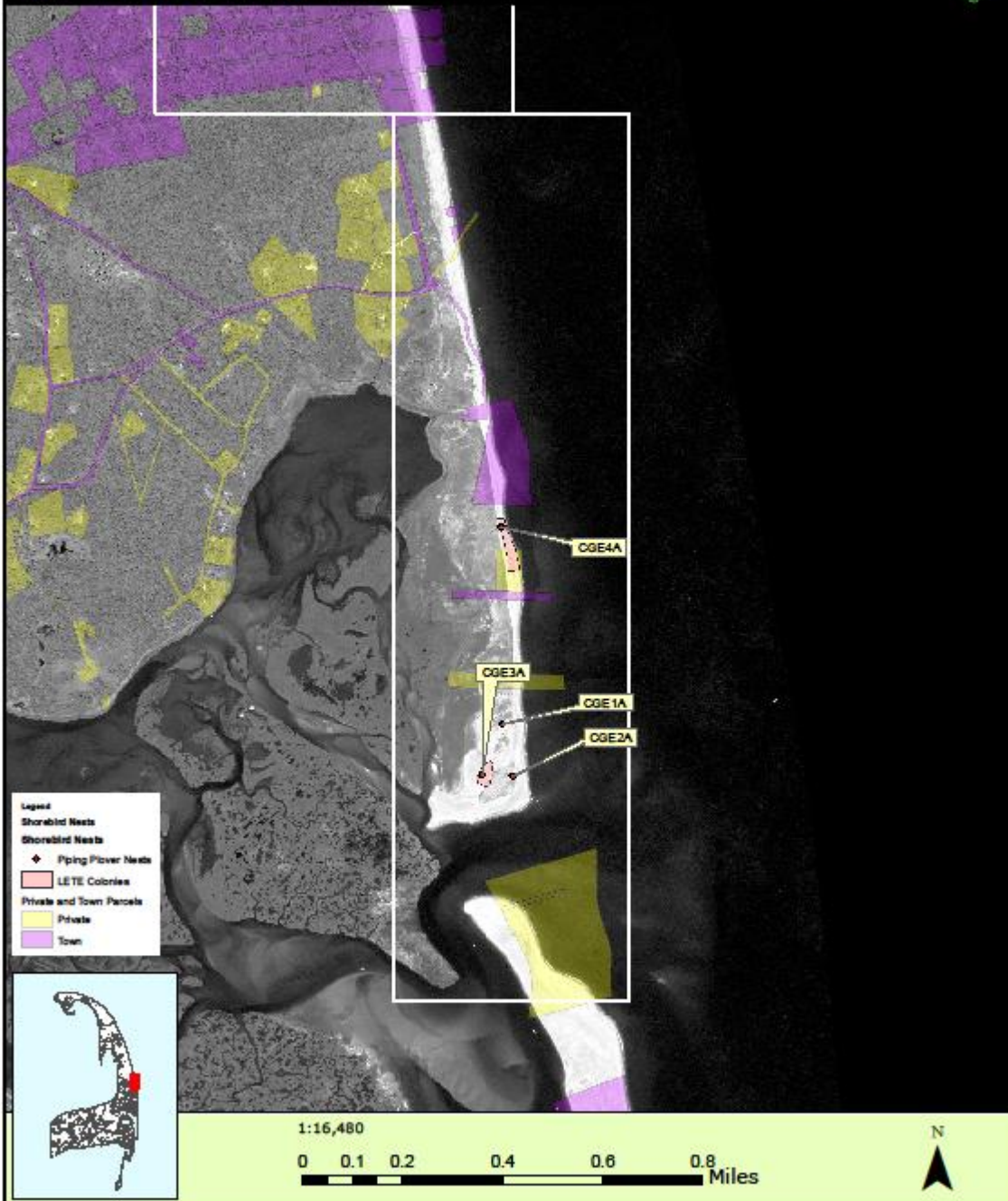
Disclaimer: Although these data have been processed successfully on NPS computers, the NPS gives no warranty, expressed or implied, as to the accuracy, reliability, or completeness of these data, nor shall the act of distribution constitute any such warranty.

Date: 2014-09-11

Path: X:\GIS\CACO_Shorebirds_2014.mxd

Shorebird Nesting Activity 2014 Coast Guard Beach, Eastham

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



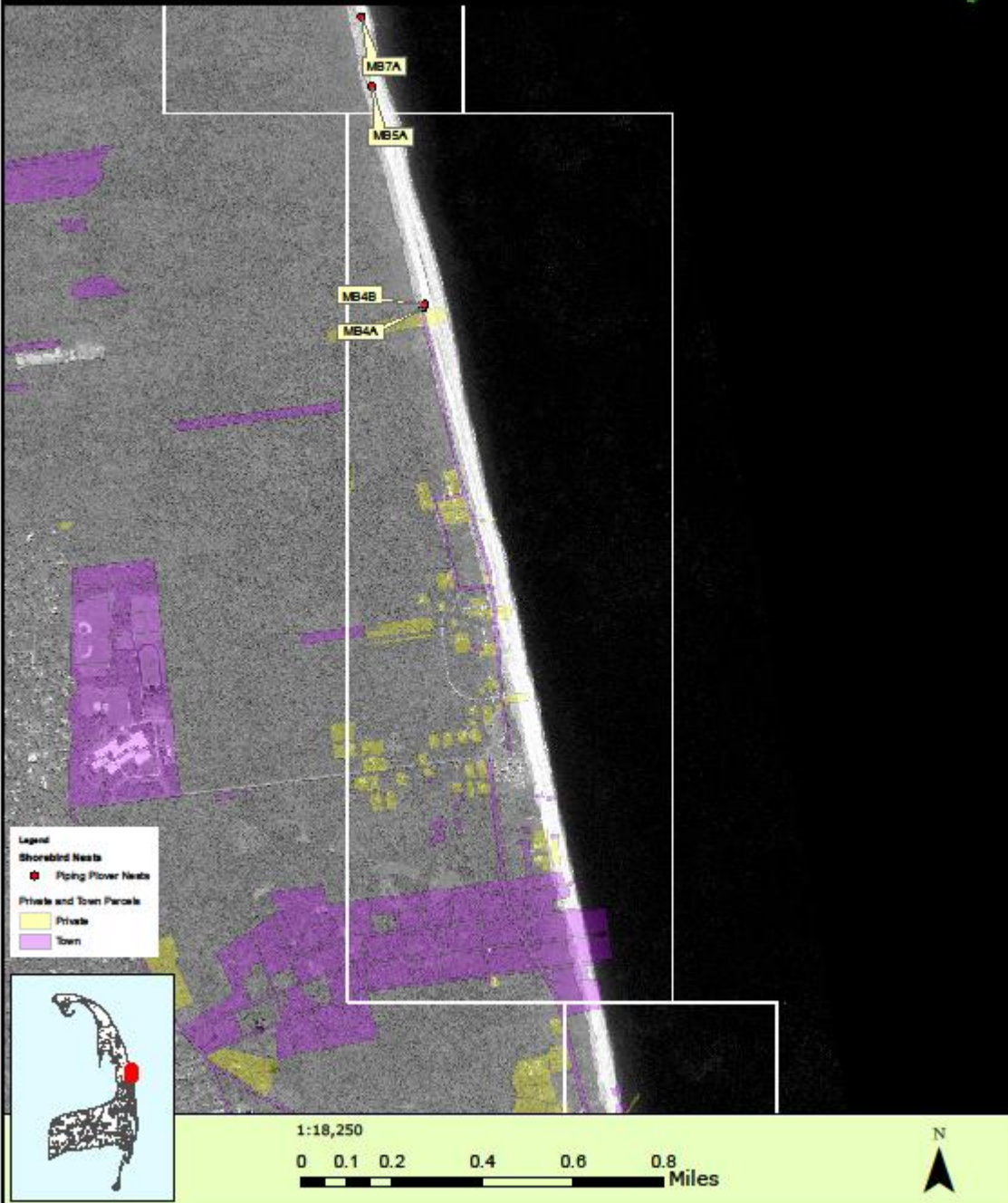
Disclaimer: Although these data have been processed successfully on NPS computers, the NPS gives no warranty, expressed or implied, as to the accuracy, reliability, or completeness of these data, nor shall the act of distribution constitute any such warranty.

Date: 2014-10-14 Path: X:\GIS\CACO_Shorebirds_2014.mxd

Shorebird Nesting Activity 2014

Nauset Light, Eastham

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



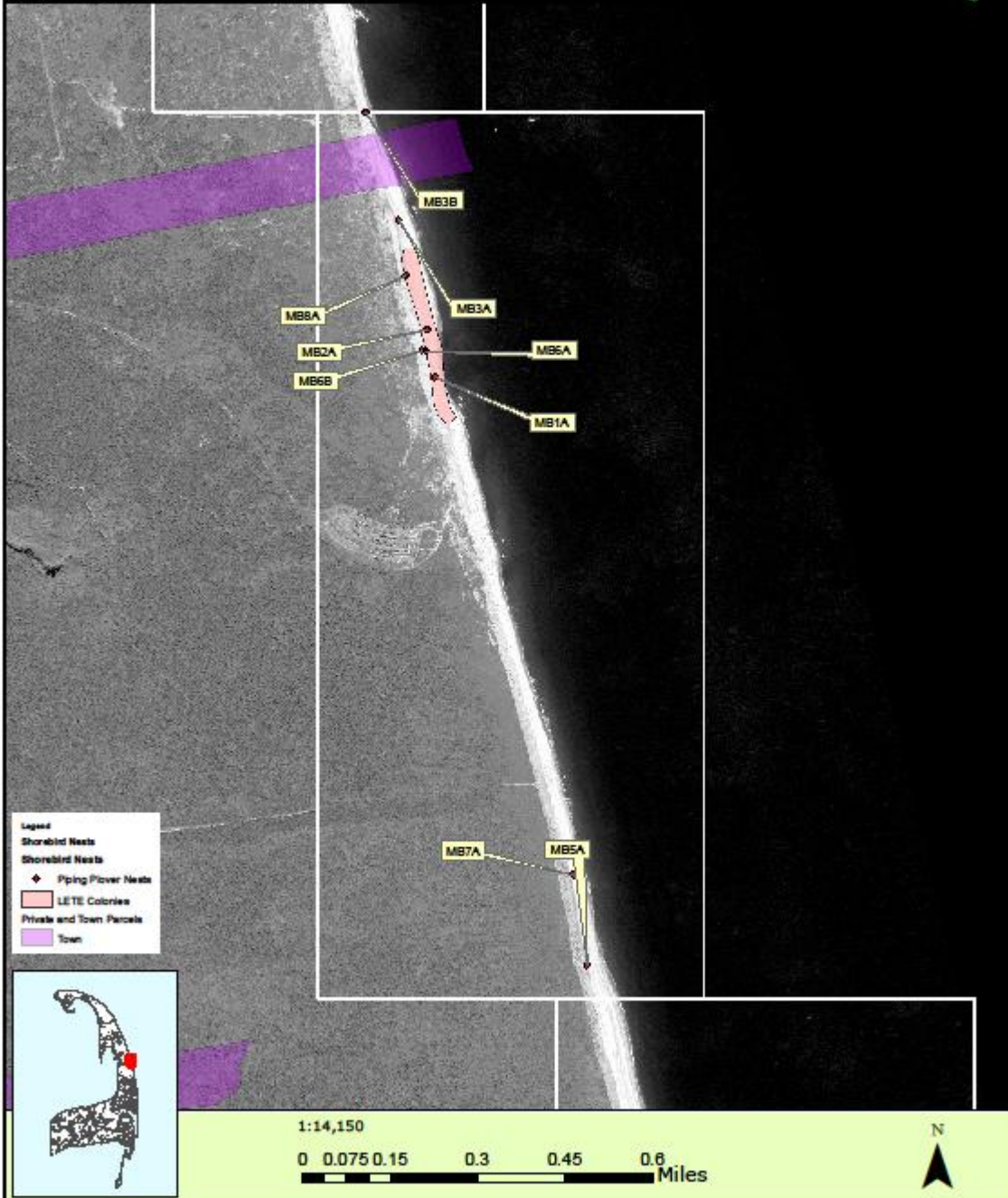
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Shorebird Nesting Activity 2014 Marconi Beach, Wellfleet

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



Legend
 Shorebird Nests
 Shorebird Nests
 ◆ Piping Plover Nests
 LETA Colonies
 Private and Town Parcels
 Town

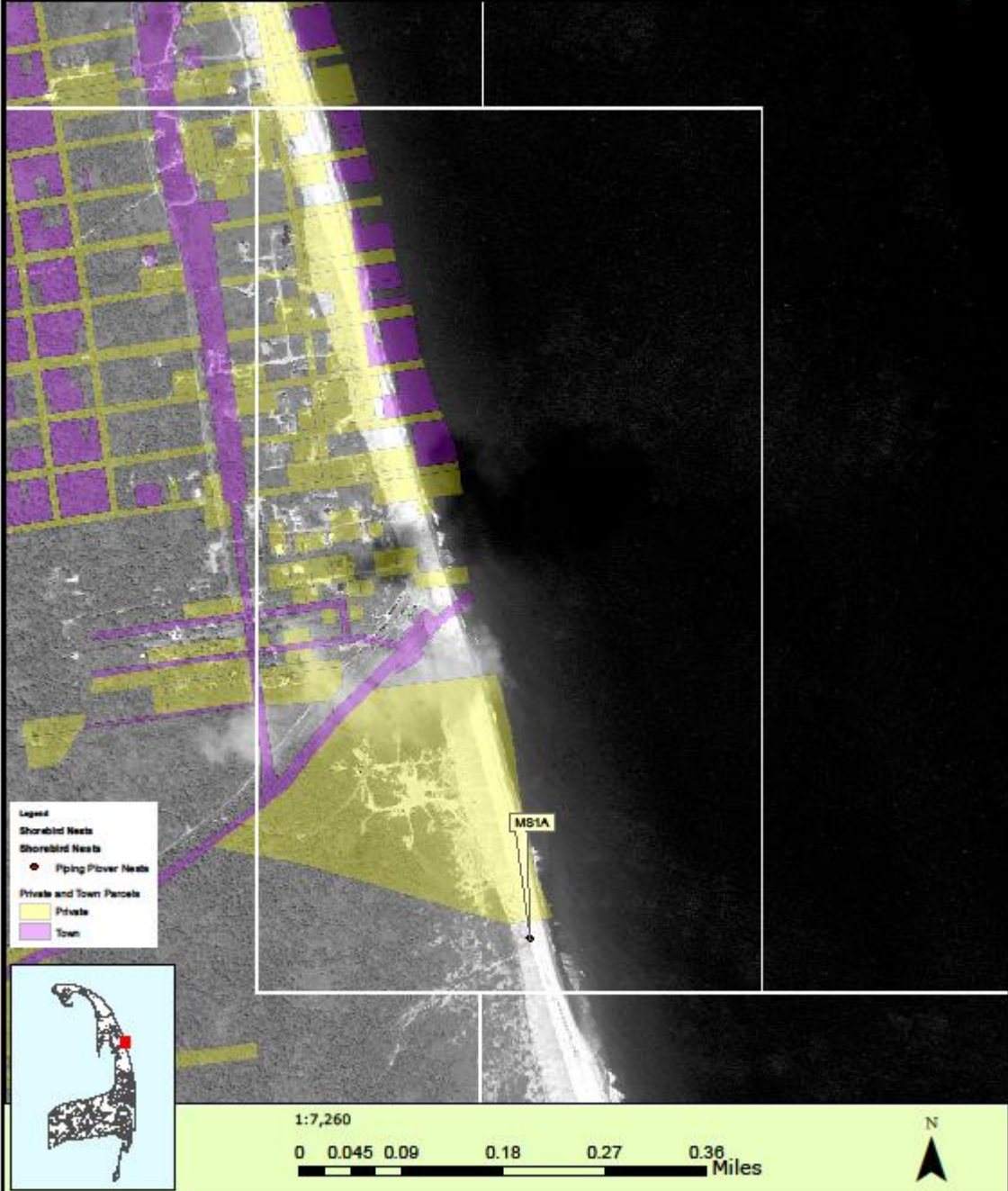


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Shorebird Nesting Activity 2014 LeCount Hollow, Wellfleet

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



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Shorebird Nesting Activity 2014

White Crest Beach, Wellfleet

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



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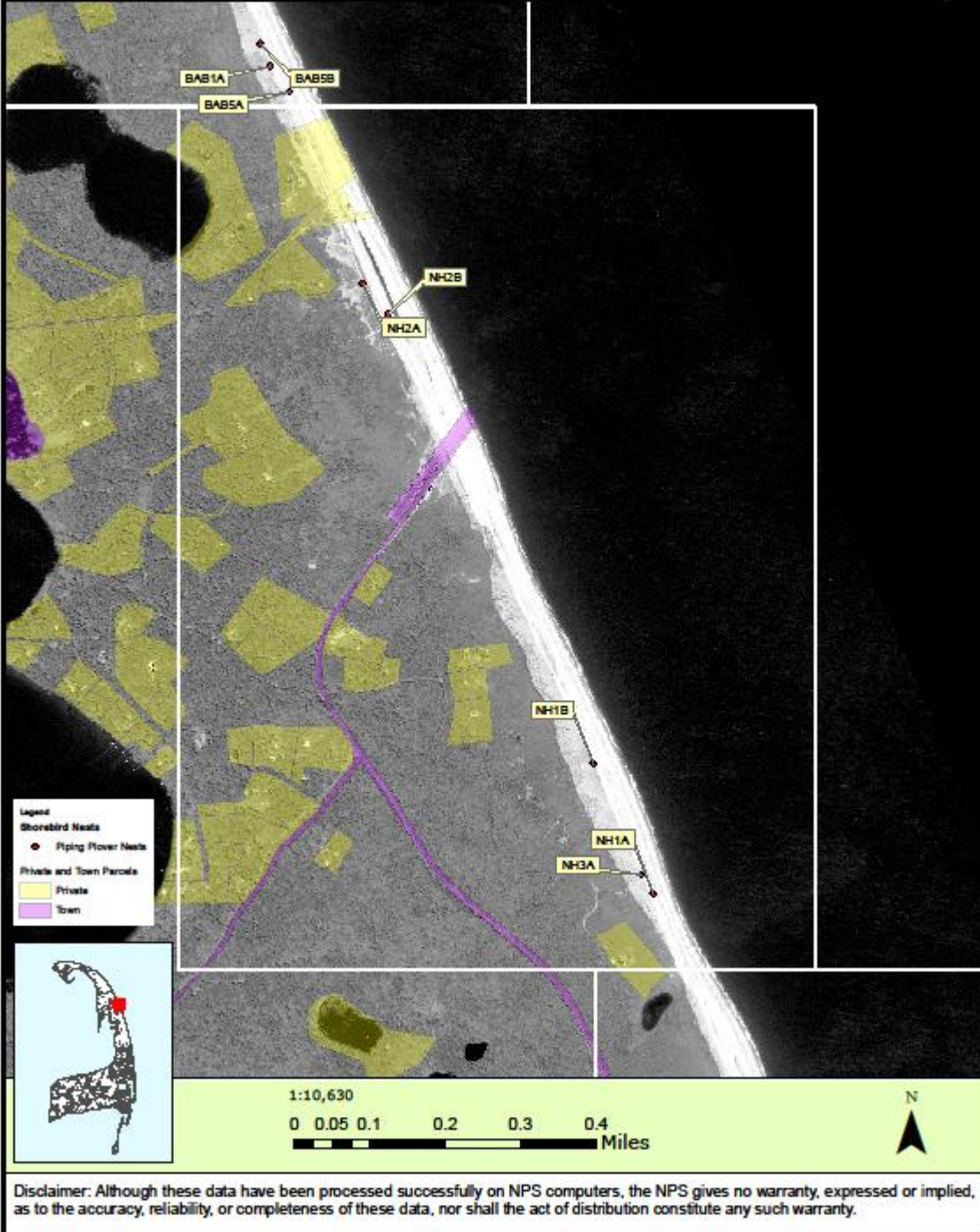
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Shorebird Nesting Activity 2014

Newcomb Hollow, Wellfleet

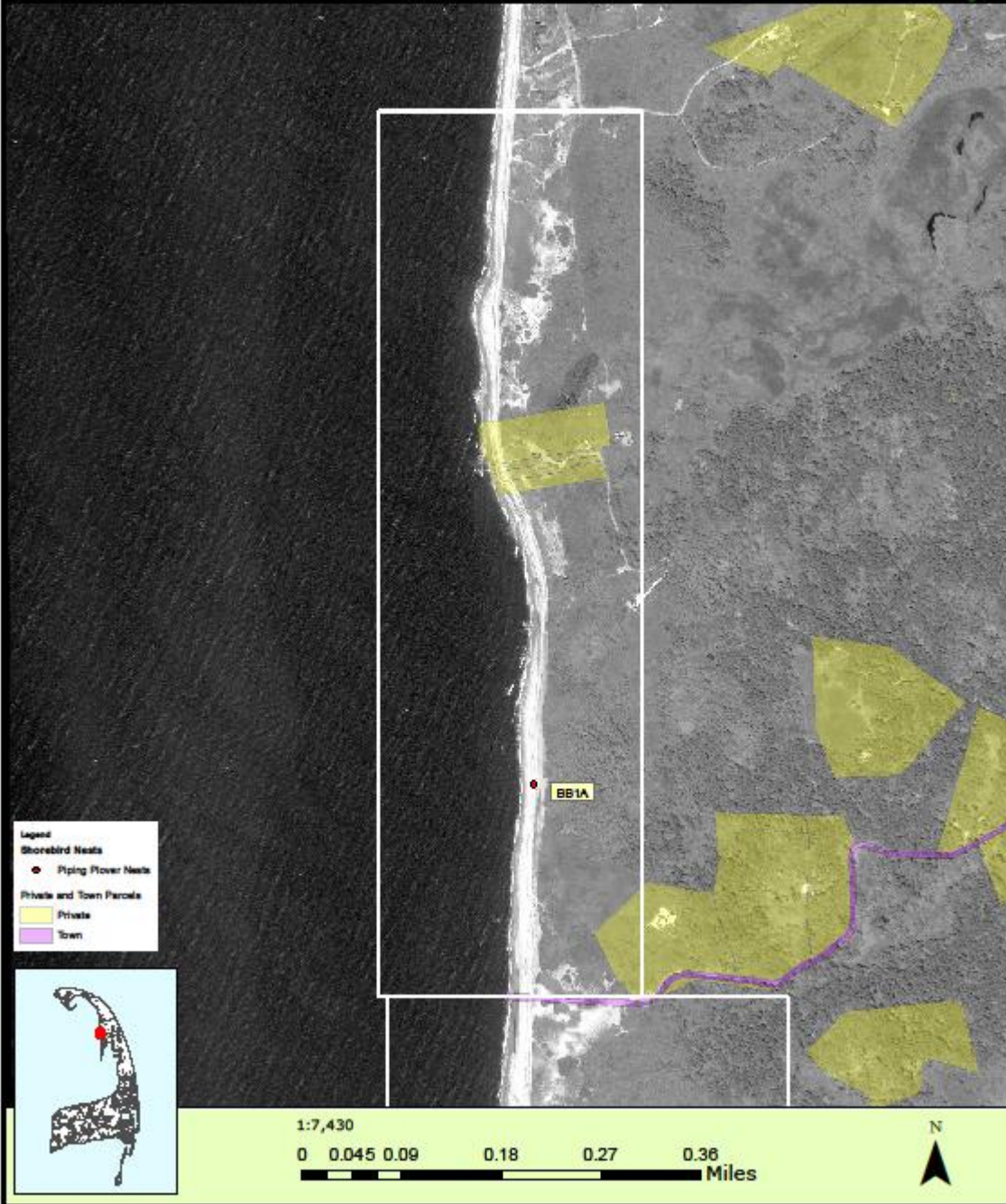
Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



Shorebird Nesting Activity 2014

Bound Brook, Wellfleet

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



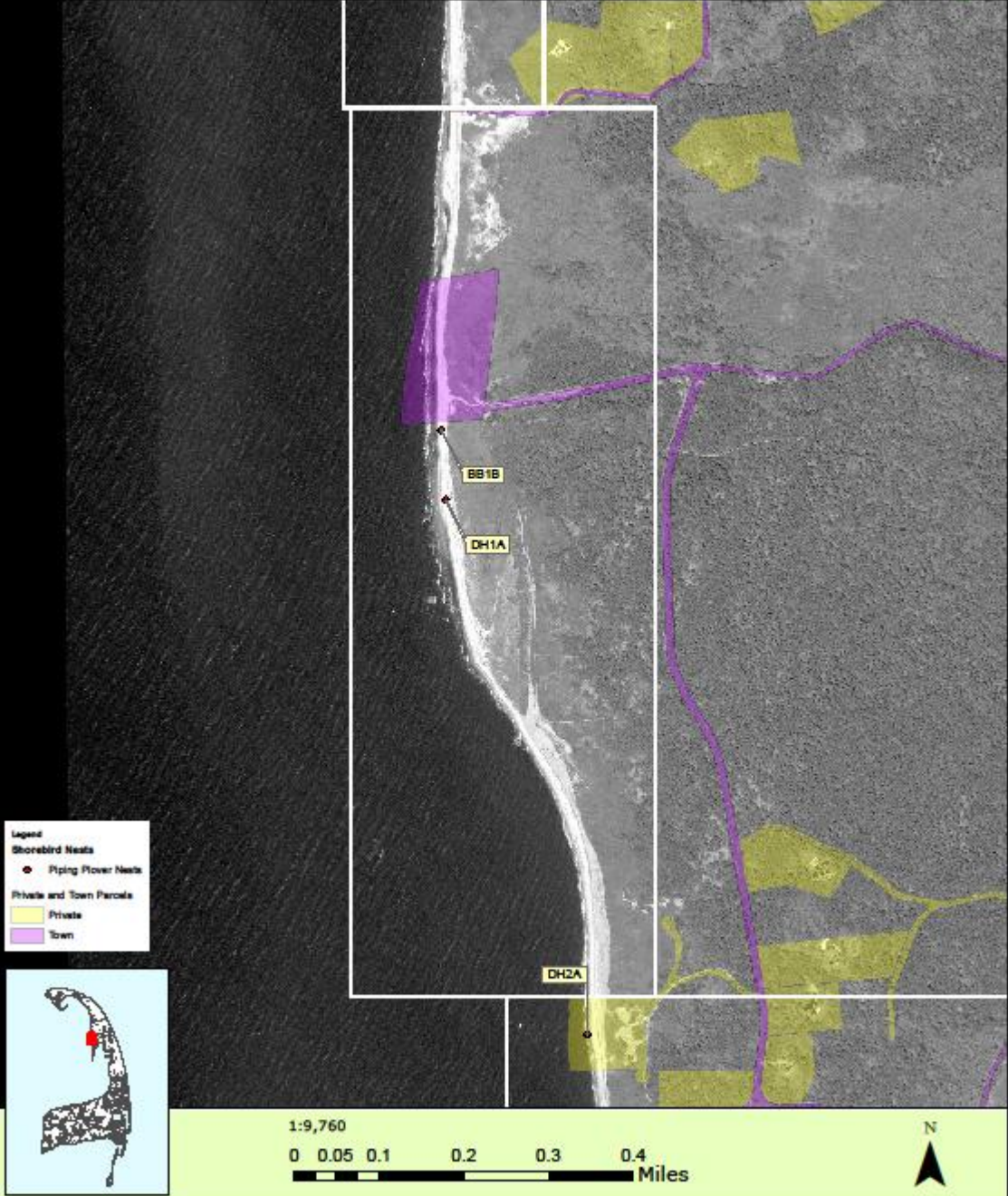
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Shorebird Nesting Activity 2014 Duck Harbor, Wellfleet

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



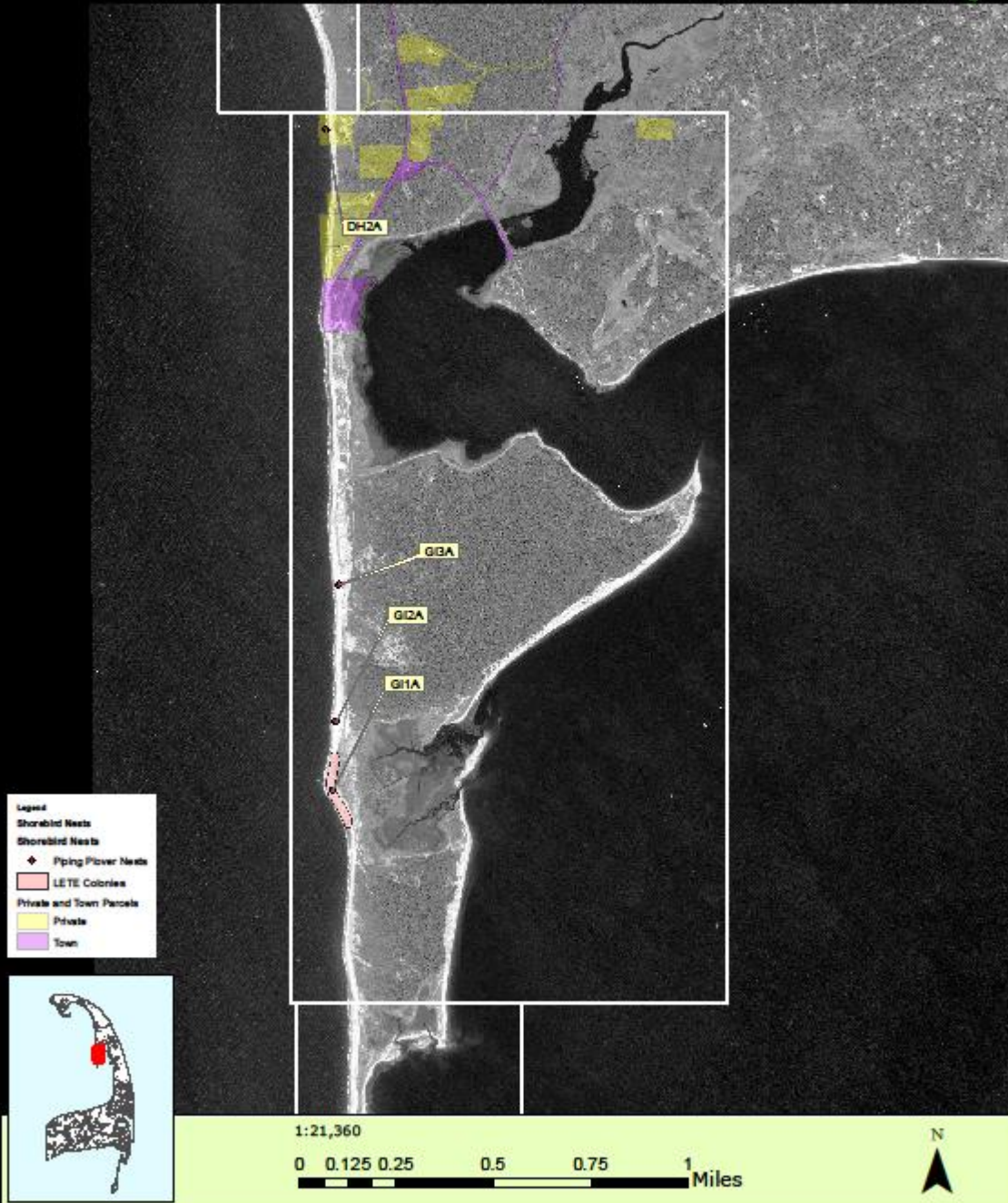
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Shorebird Nesting Activity 2014 Great Island, Wellfleet

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



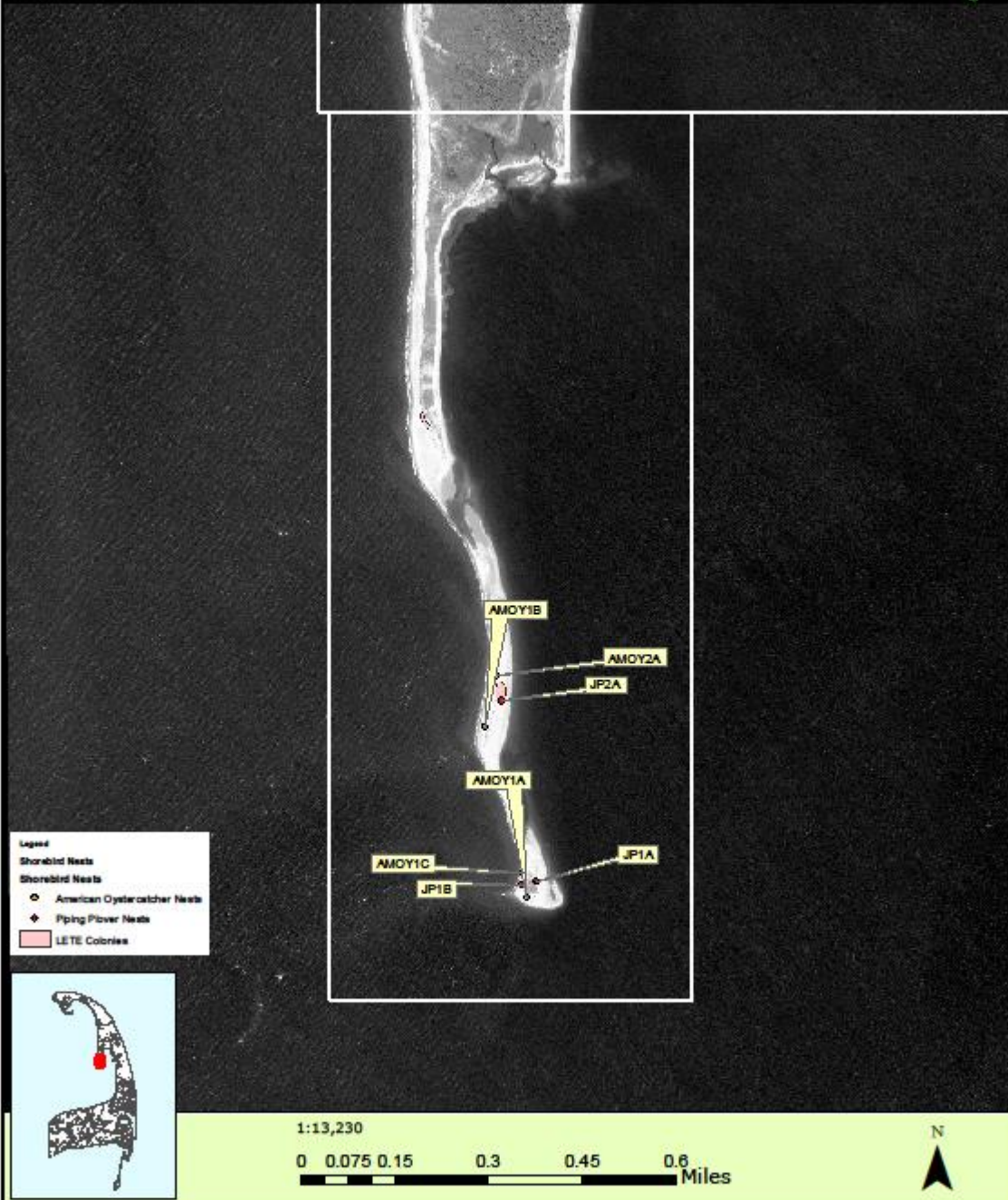
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Shorebird Nesting Activity 2014 Jeremy Point, Wellfleet

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



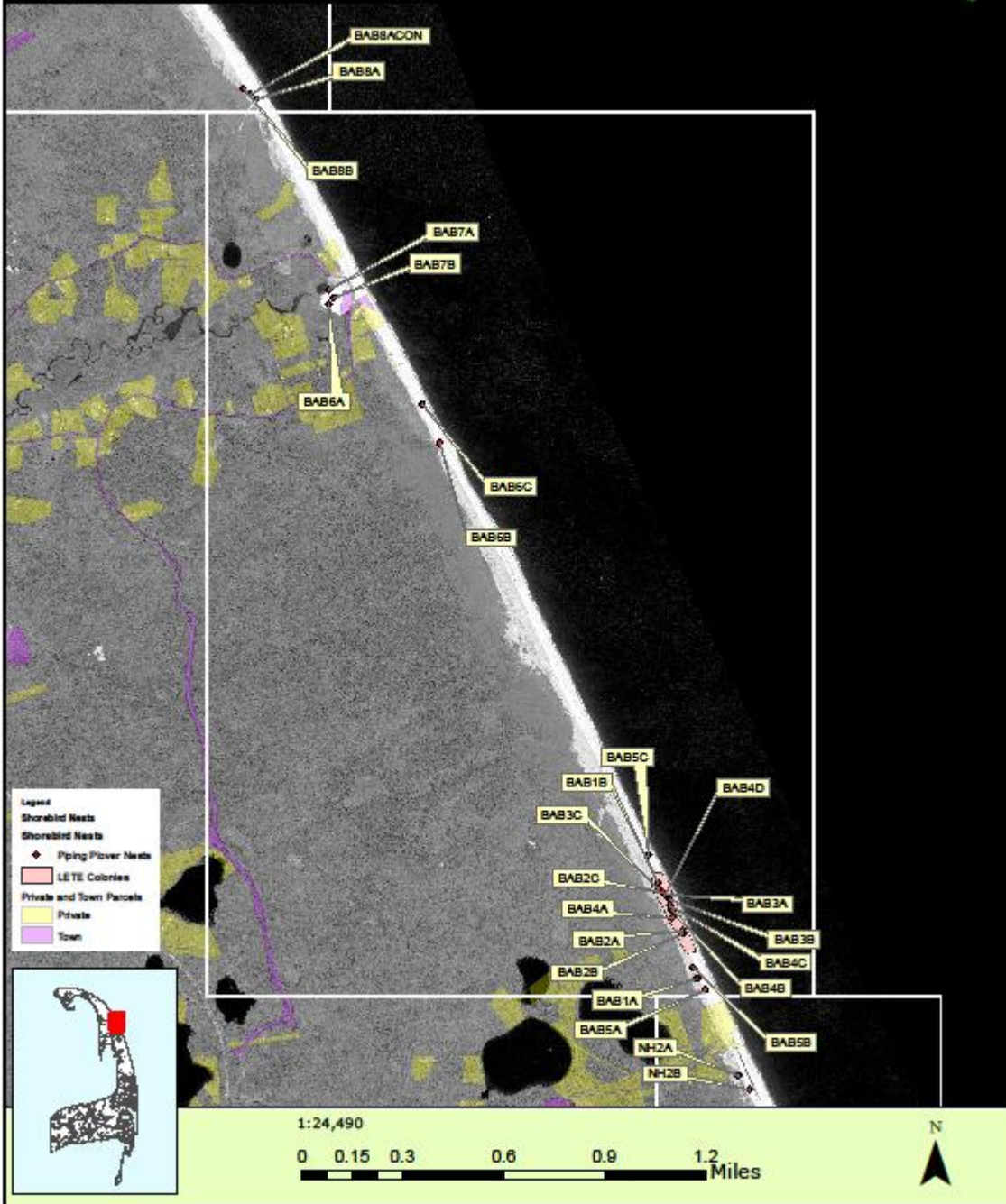
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Shorebird Nesting Activity 2014 Ballston Beach, Wellfleet

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



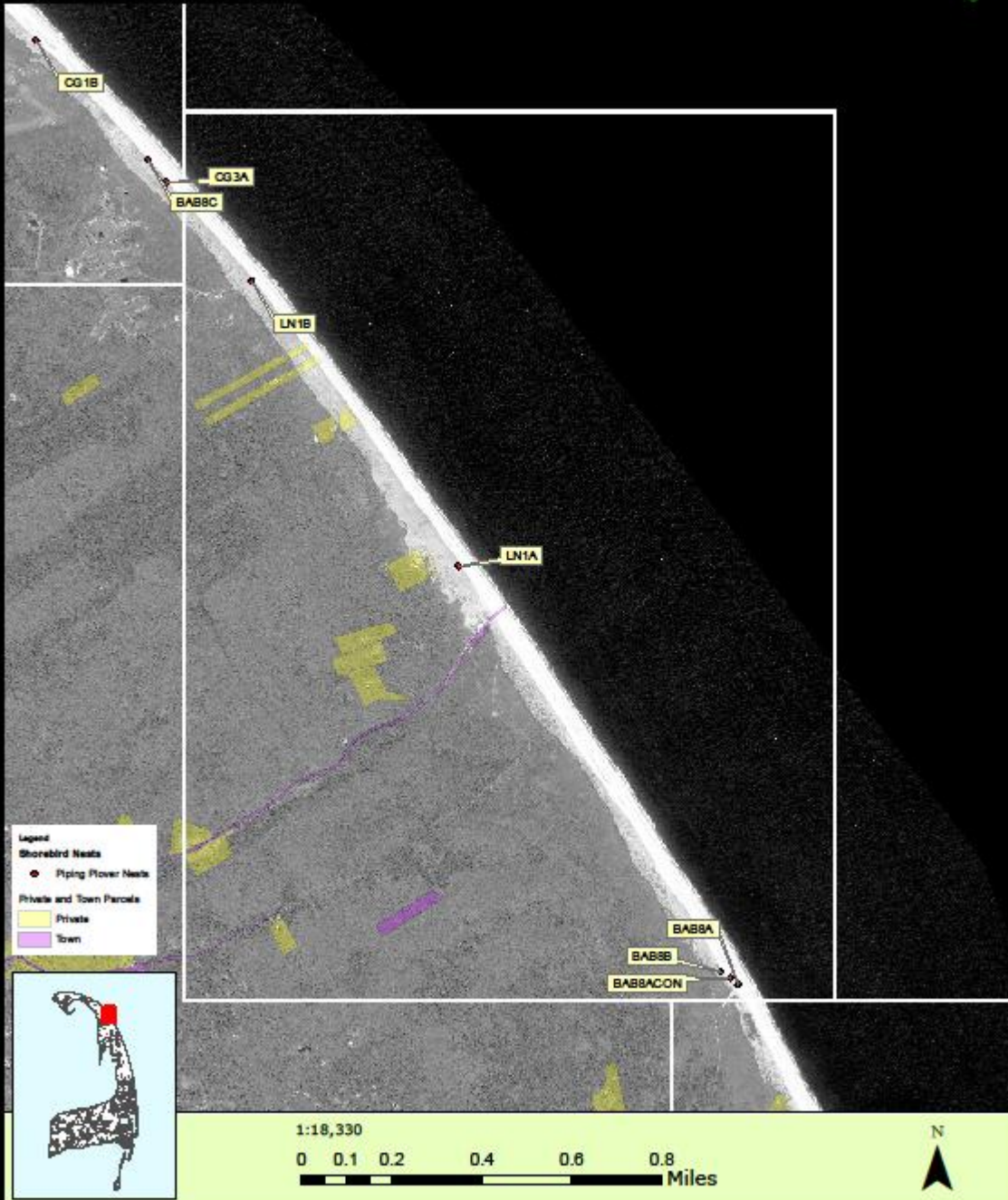
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Shorebird Nesting Activity 2014 Longnook, Truro

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



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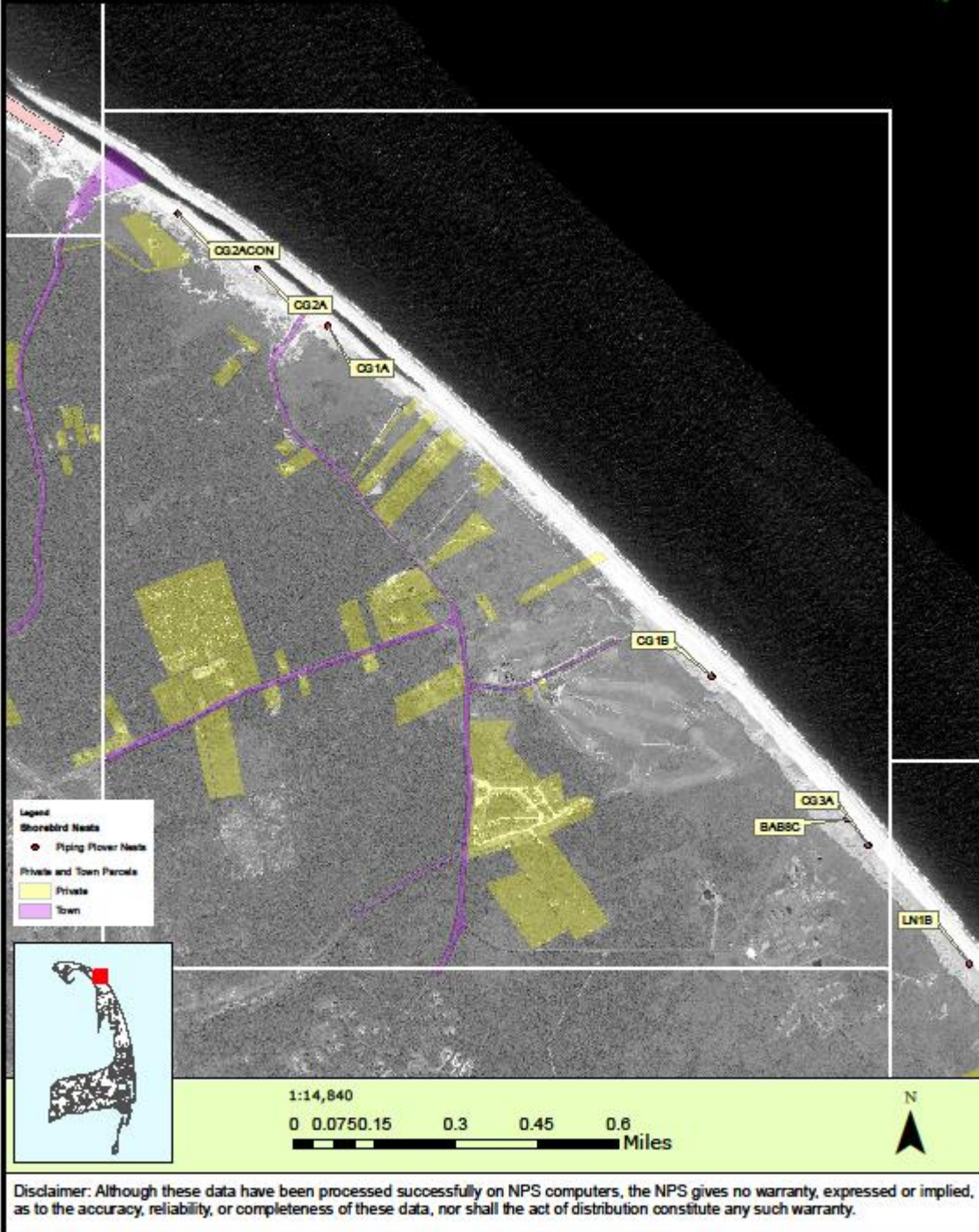
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Shorebird Nesting Activity 2014

Coast Guard Beach, Truro

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



Shorebird Nesting Activity 2014

Head of the Meadow, Truro

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



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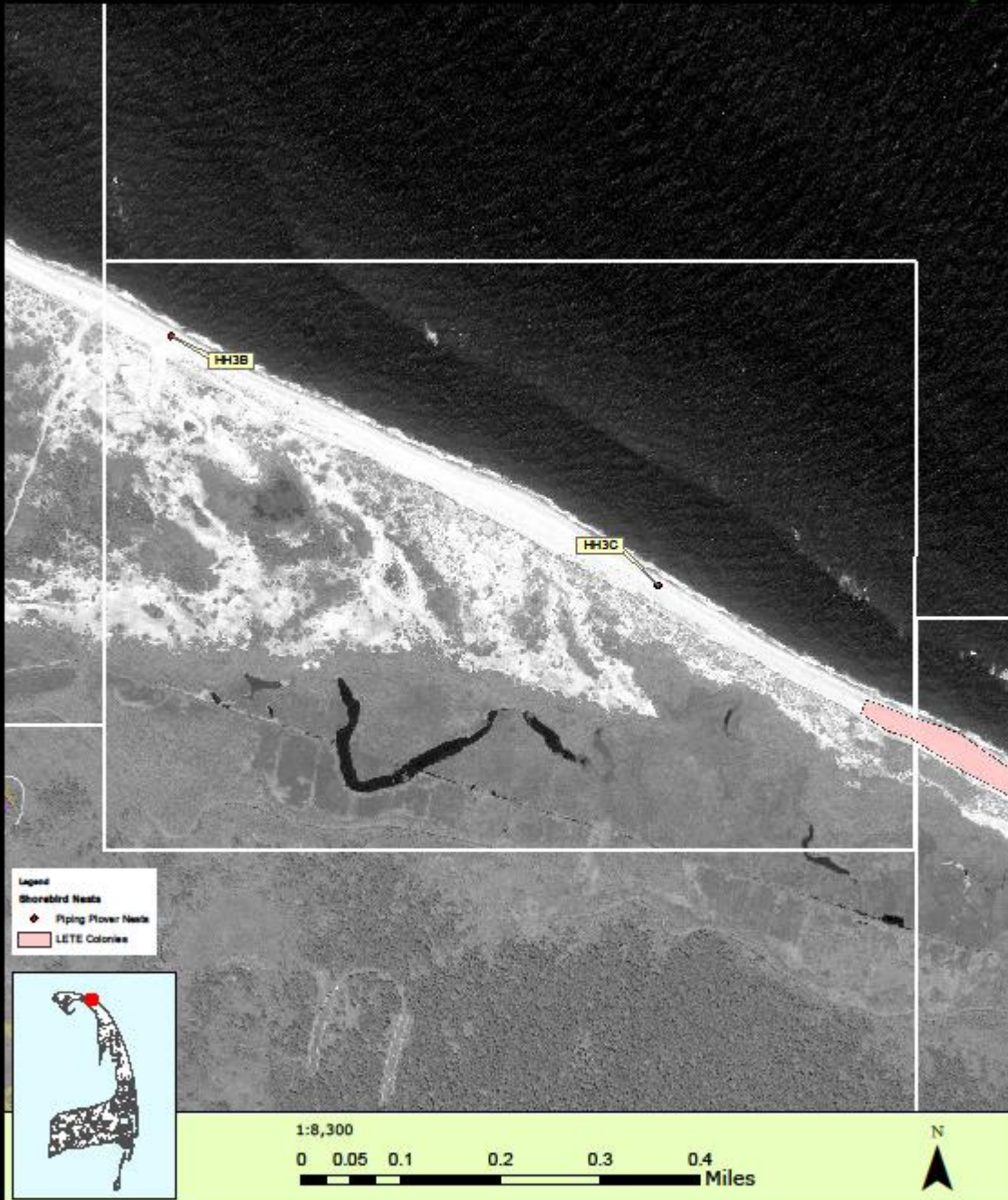
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Shorebird Nesting Activity 2014

High Head, Truro

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



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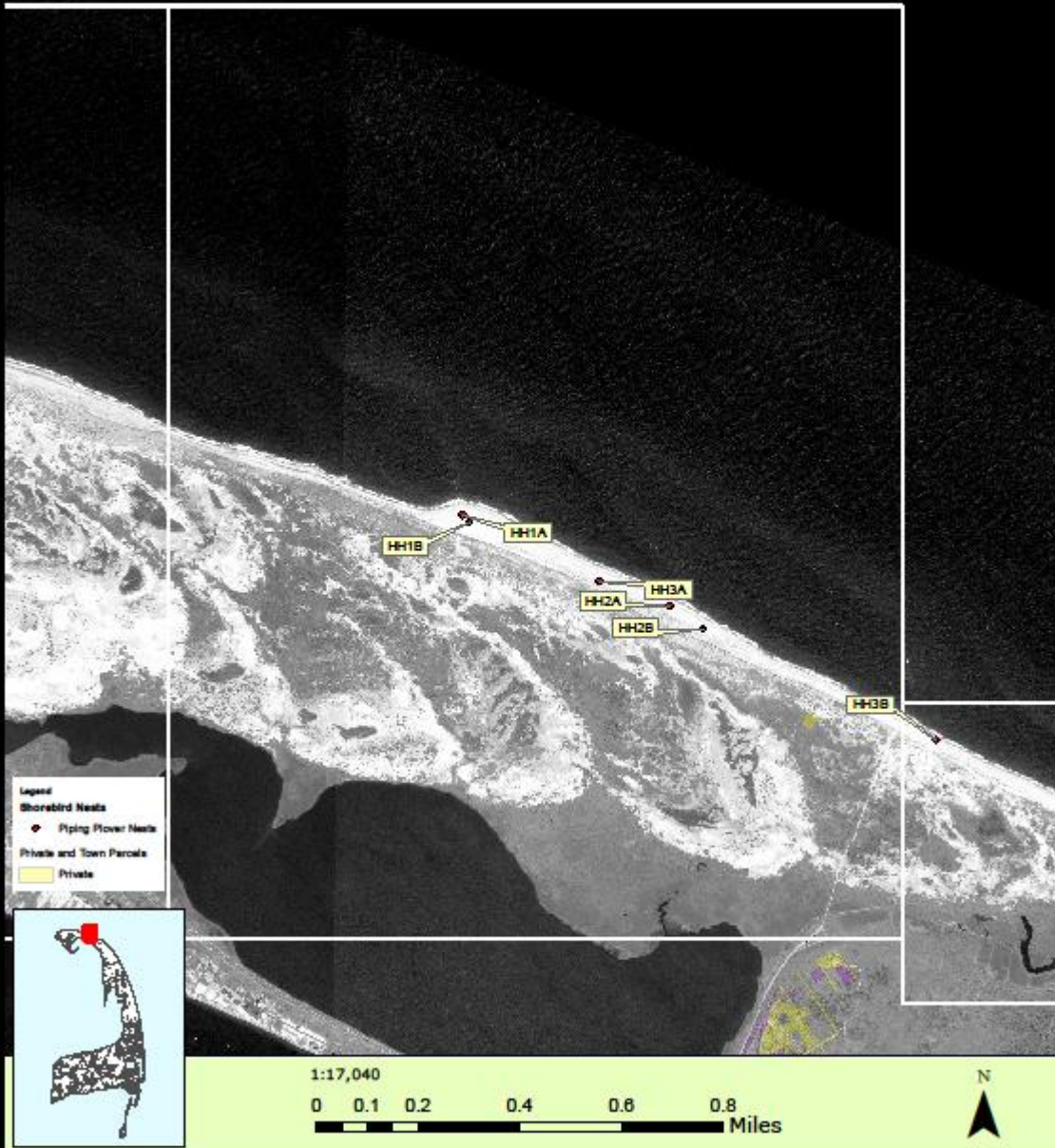
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Shorebird Nesting Activity 2014

Race Point South, Provincetown (1 of 4)

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



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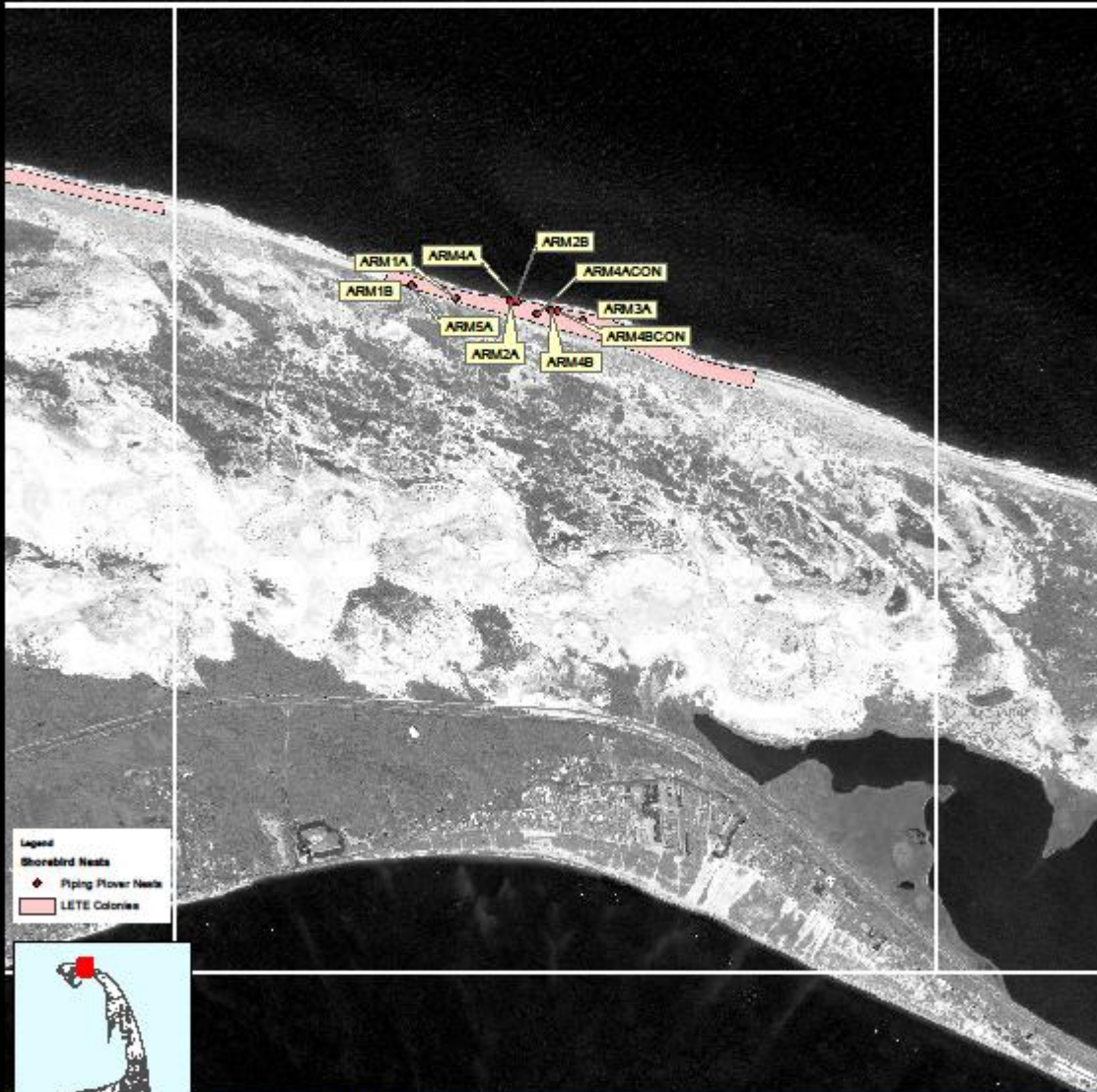
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Shorebird Nesting Activity 2014

Race Point South, Provincetown (2 of 4)

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



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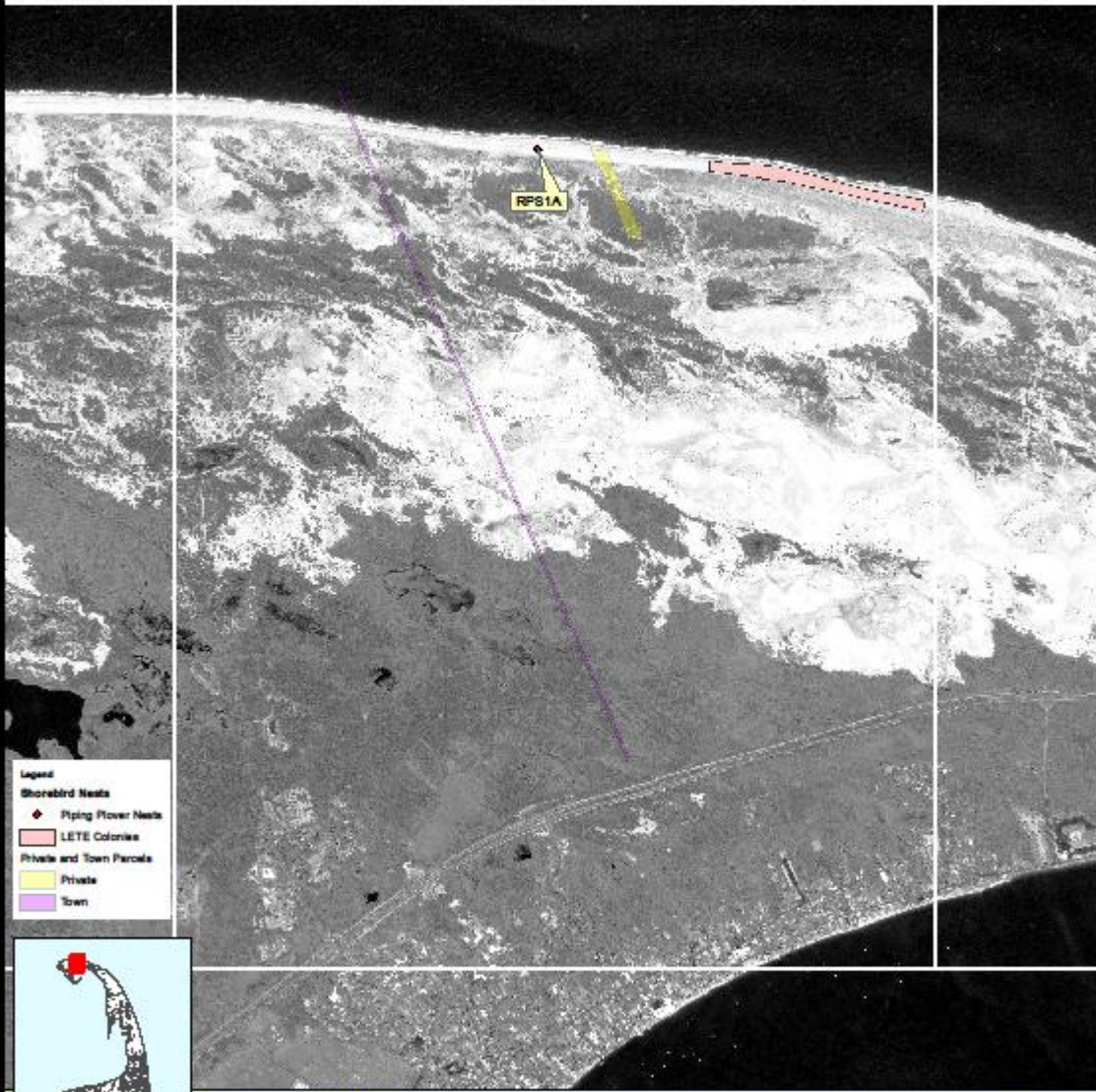
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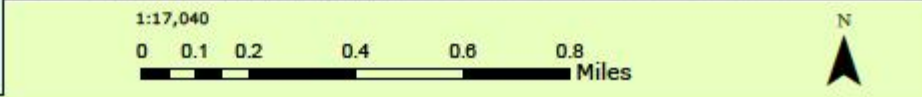
Shorebird Nesting Activity 2014

Race Point South, Provincetown (3 of 4)

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



- Legend
- Shorebird Nests
 - Piping Plover Nests
 - LETA Colonies
 - Private and Town Parcels
 - Private
 - Town



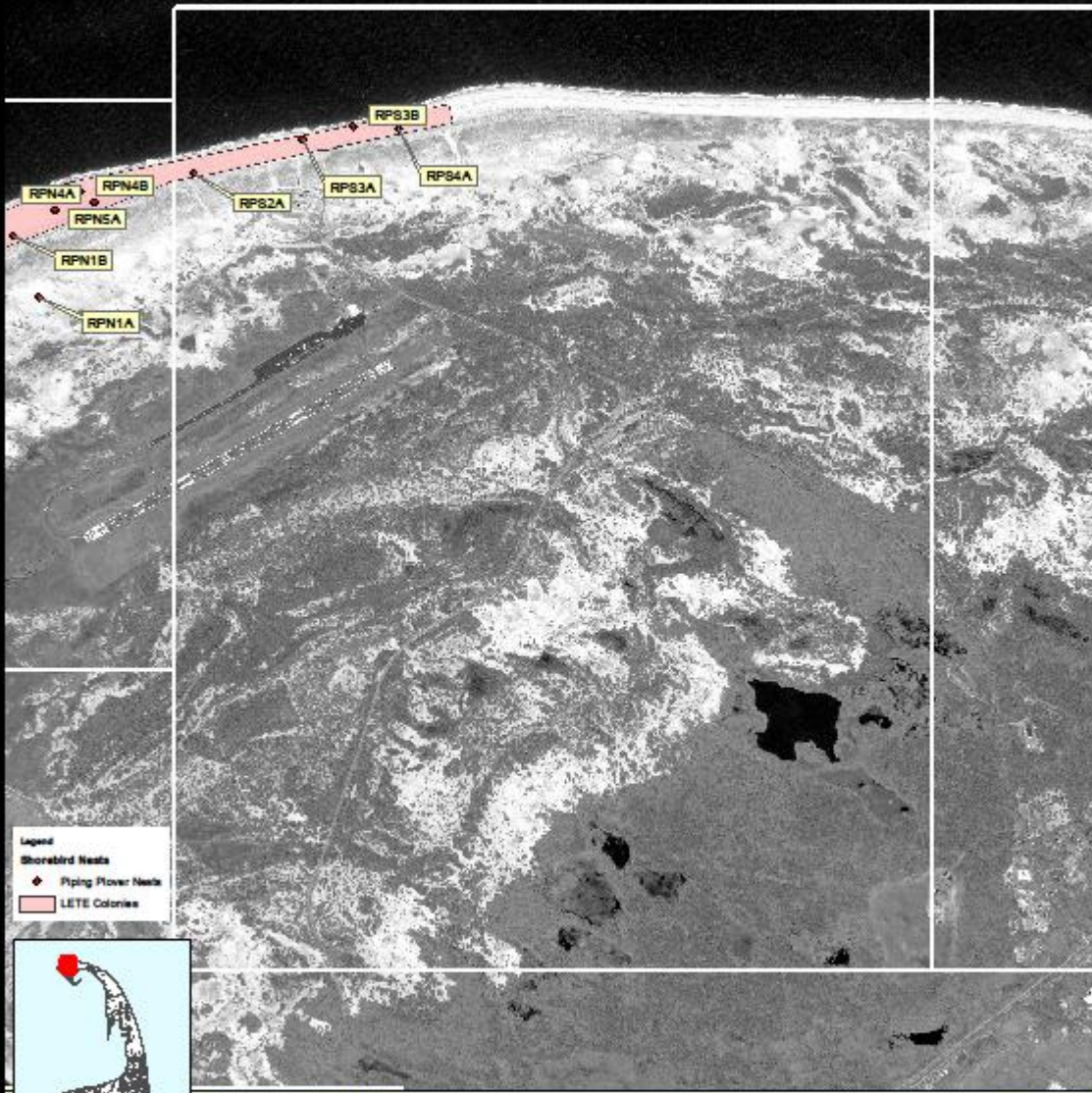
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Date: 2014-09-11 Path: X:\GIS\CACO_Shorebirds_2014.mxd

Shorebird Nesting Activity 2014

Race Point South, Provincetown (4 of 4)

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior

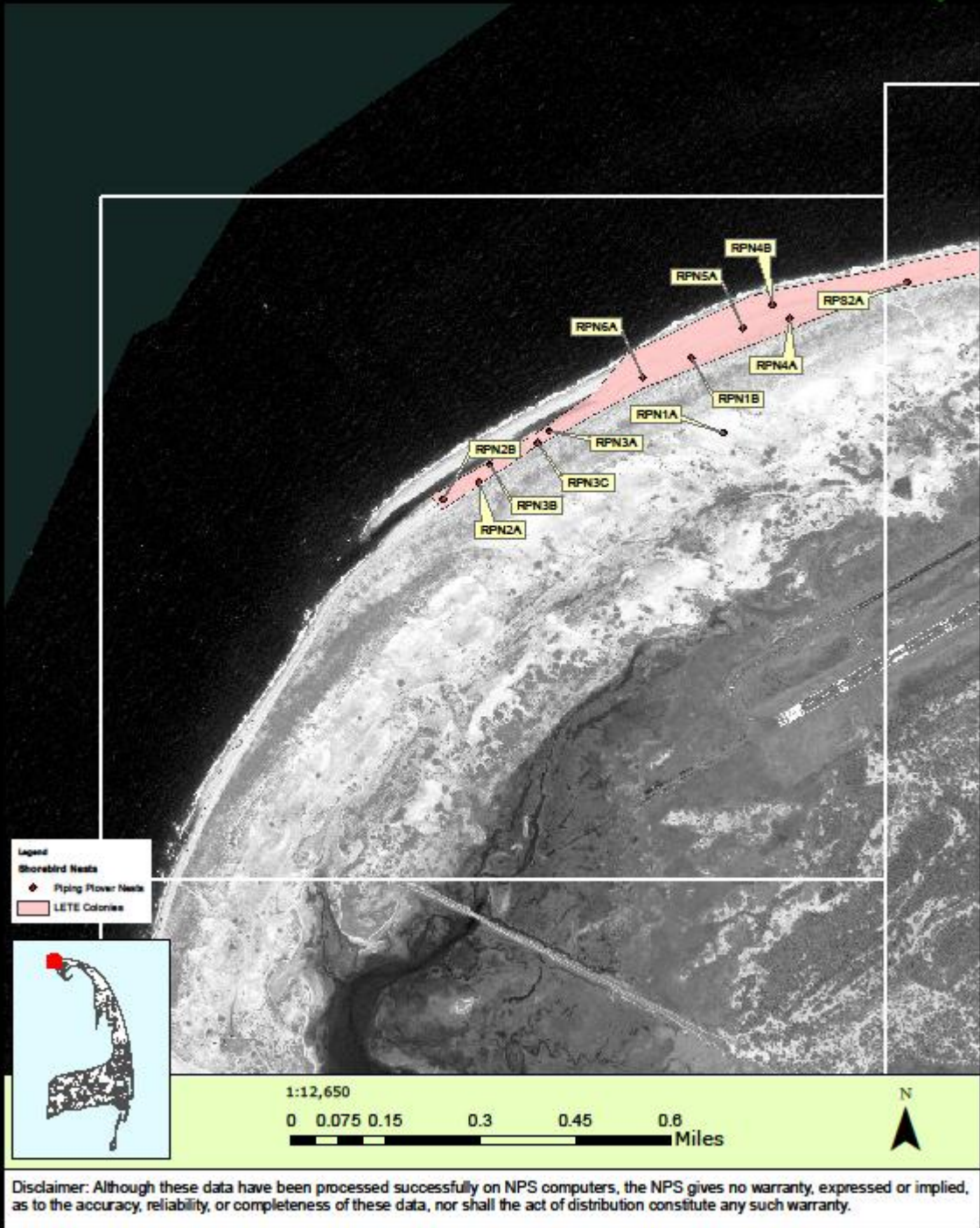


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Date: 2014-09-11 Path: X:\GIS\CACO_Shorebirds_2014.mxd

Shorebird Nesting Activity 2014 Race Point North, Provincetown

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



Shorebird Nesting Activity 2014 Hatches Harbor, Provincetown

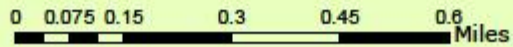
Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



Legend



1:12,650



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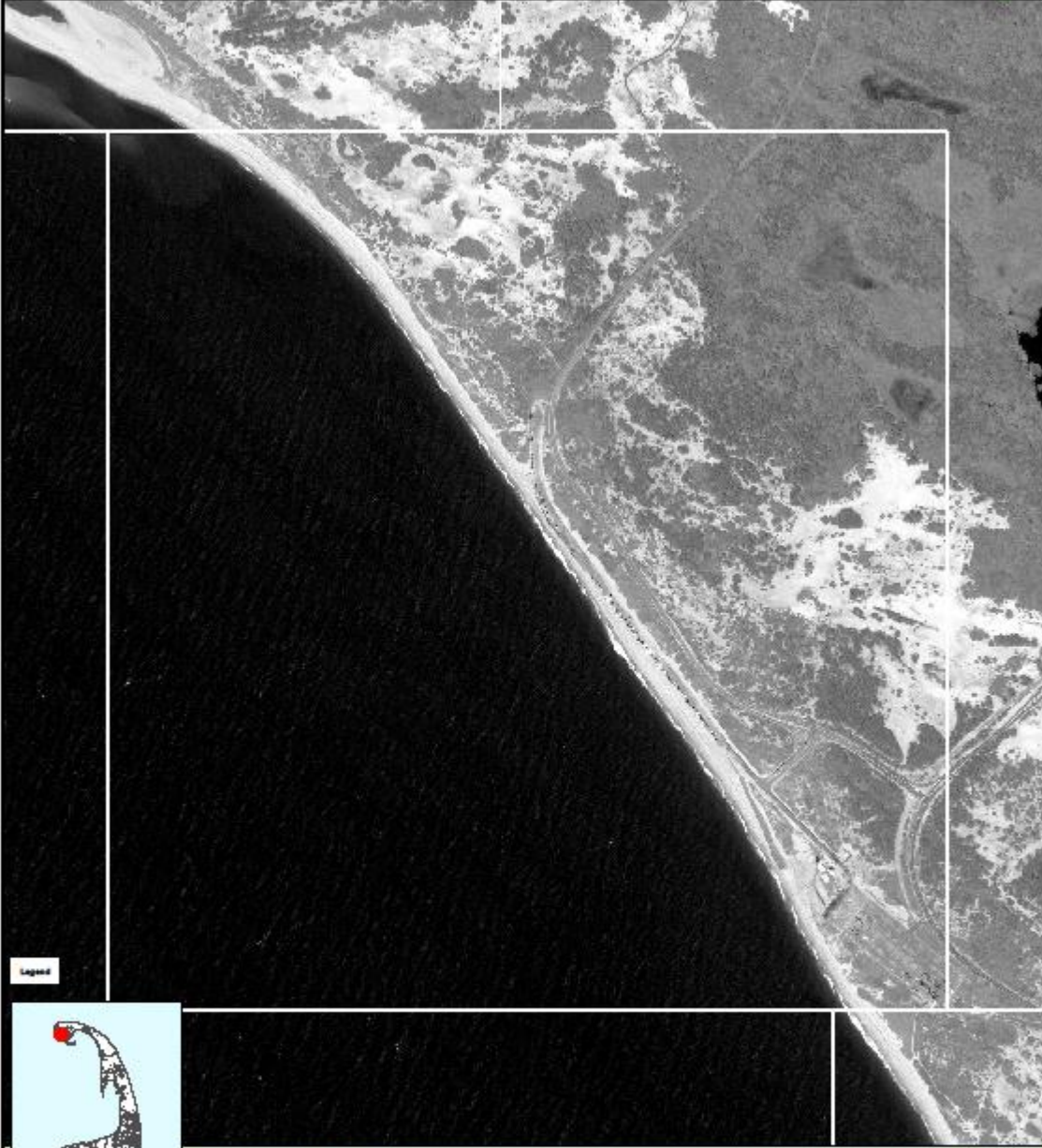
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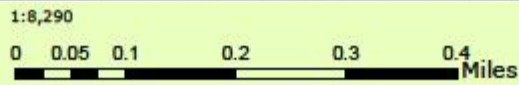
Shorebird Nesting Activity 2014

Herring Cove, Provincetown

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



Legend

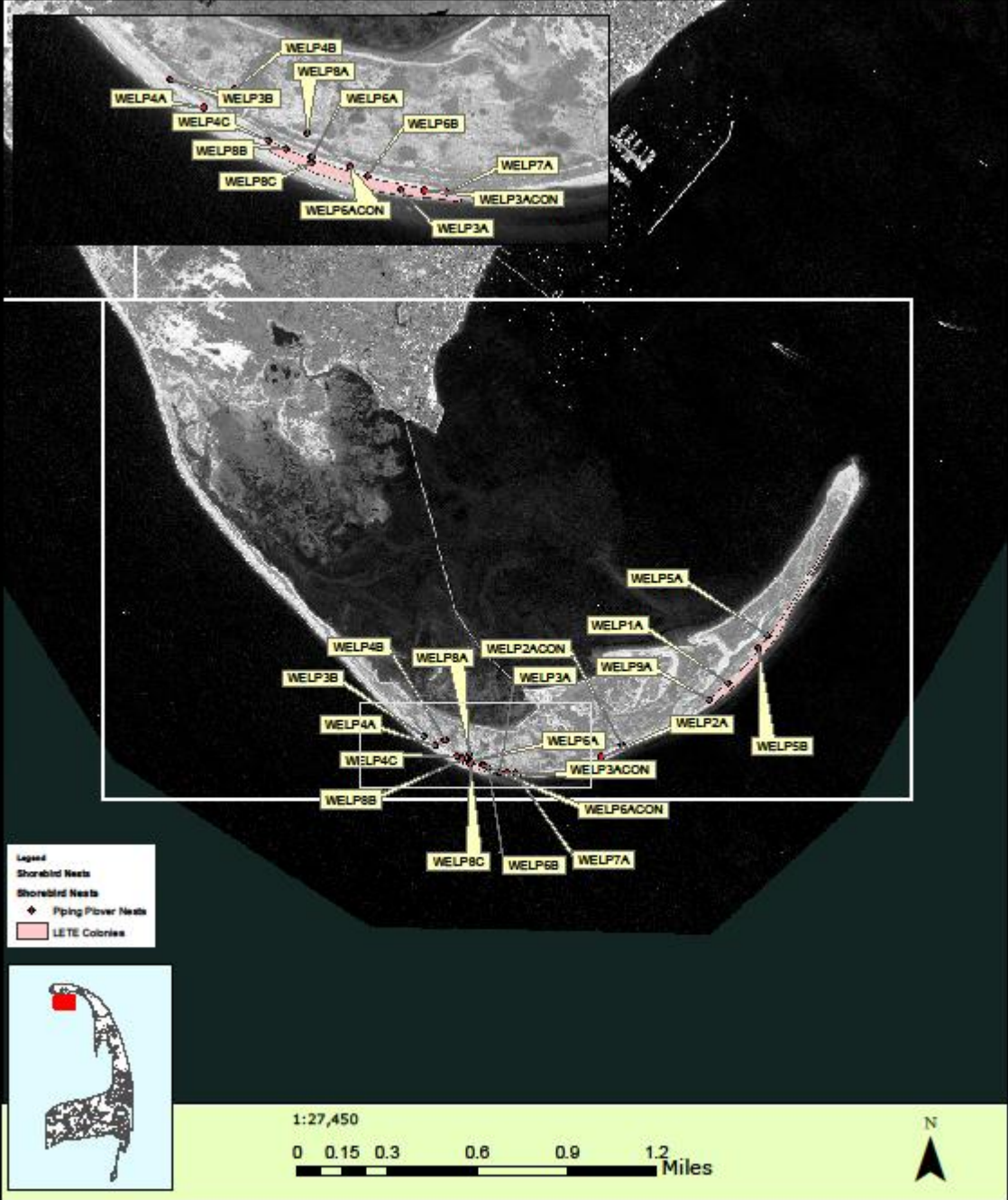


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Date: 2014-10-14 Path: X:\GIS\CACO_Shorebirds_2014.mxd

Shorebird Nesting Activity 2014 Wood End Long Point, Provincetown

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



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Appendix B. Agreement between the Town of Wellfleet and the National Park Service (NPS), Cape Cod National Seashore (CCNS) for shorebird management support

- Beaches are monitored 4- 7 days/week during the shorebird nesting season (April – end of August).
- In early April, informational signs and symbolic fencing are installed at Duck Harbor around historic plover nesting habitat (north of pedestrian access). Additional symbolic fencing and signs will be installed around all areas where shorebirds are observed exhibiting courtship behavior and/or where active scrapes and nests are present.
- Efforts will be made to allow pedestrian access past nesting shorebirds. But, where beaches are narrow, it is not always possible to provide a sufficient buffer to prevent disturbance between the incubating birds and pedestrians. These sections of beach may need to be temporarily closed to pedestrians or during times of high tide. If possible, a detour will be established around nest(s). These areas would re-open to pedestrian access no later than 1-3 days after the chicks hatch. (Note: this scenario has not yet occurred on any Wellfleet town beach).
- Predator exclosures will be installed around most piping plover nests. Nests will not be exclosed when they are: (1) located in thick vegetation, (2) located on the side of a dune or cliff that precluded us from installing 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 will be removed or not installed if field observations suggest predators are keying into the exclosure. Both exclosed and unexclosed nests are checked 5-7 days/week.
- All nests locations will be GPS'd.
- All chicks are generally monitored daily until fledged, noting their movements, location and number in each brood.
- Pet closures extending down into the intertidal zone will occur when nests and unfledged chicks are present. Area will re-open to pets when chicks fledged.
- Hand-held kites and kites used in kite surfing/boarding are prohibited within 200 meters of posted shorebird nesting areas.
- The Seashore will submit annual census reports on breeding piping plovers on Wellfleet town land to the Massachusetts Natural Heritage Program. The Atlantic Coast piping plover census will be performed June 1-9 and findings reported to the U.S Fish and Wildlife Service.
- All shorebird nests found on town land will be reported to Wellfleet Natural Resource Health and Conservation agents. NPS will work closely with the town to provide regular updates throughout the nesting season.
- Wellfleet will purchase town signs to be posted for shorebird areas on town lands.

- Lifeguards will not drive ATVs on beaches with unfledged shorebird chicks unless responding to a life-threatening emergency.

Appendix C. Agreement between the Town of Truro and the National Park Service (NPS), Cape Cod National Seashore (CCNS) for shorebird management support

Ballston Beach – As a part of their agreement with the Town of Truro to manage shorebirds on Town property at Ballston Beach, Massachusetts Audubon Society (MAS) will install and maintain symbolic fencing around suitable shorebird habitat, monitor for bird activity (i.e., checking for piping plover tracks, courtship and territorial displays, scrapes/nests), install regulatory and informational signage (e.g., temporary pet/kite restrictions) and silt fencing, if needed, and install and maintain symbolic fencing around active shorebird nests on National Seashore managed property. Specific areas of NPS property will include the new sand overwash area (adjacent to the Town parking lot) and the front ocean beach. The MAS will take the lead role in monitoring day to day shorebird nesting activity throughout the season and provide updates to the CCNS on a regular basis.

Head of the Meadow – The Town of Truro will be responsible for decisions about the use and physical installation of shorebird fencing on Town property at Head of the Meadow Beach. It is anticipated that, when necessary, the MAS will be installing and maintaining symbolic fencing around suitable shorebird habitat and nests and installing regulatory and informational signage and silt fencing, if needed. The CCNS will take the lead role in day to day monitoring (i.e., checking for piping plover tracks, courtship and territorial displays, scrapes/nests) of shorebird activity on this town-owned section of beach and provide updates to the MAS/Truro on a regular basis.

Other Atlantic-side Town-owned beaches in Truro – The CCNS will assist the Town of Truro with shorebird management and protection on Atlantic-side beaches, including Coast Guard Beach and Longnook. For these beaches, the CCNS will extend its shorebird management activities to install and maintain symbolic fencing around suitable shorebird habitat, monitor for bird activity (i.e., checking for piping plover tracks, courtship and territorial displays, scrapes/nests), install regulatory and informational signage (e.g., temporary pet/kite restrictions) and install and maintain symbolic fencing around active shorebird nests on Town of Truro property, where needed. The CCNS will take the lead role in day to day monitoring of these town-owned sections of beach and provide updates to the MAS/Truro on a regular basis.

CCNS shorebird management support for the town of Truro will include:

- Monitoring shorebird activity 4- 7 days/week from April – end of August.
- The possible installation of predator exclosures around piping plover nests. Nests will not be exclosed when, for example: (1) they are located in thick vegetation, (2) they are located on the side of a dune or cliff that precluded us from installing an exclosure due to slope or nest location; (3) 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; or (4) expert opinion has determined that an exclosure is inappropriate for a given place or time. Exclosures will be removed or not installed if field observations suggest predators are keying into the exclosure. Both exclosed and un-exclosed nests are checked 5-7 days/week.
- The landowners will be asked to contribute signage and supplies (i.e., posts/string).
- All nest locations will be collected with a global positioning system.

- All chicks will generally be monitored daily until fledged, noting their movements, location, and number in each brood.
- Pet closures extending down into the intertidal zone will occur when nests and unfledged chicks are present. Areas will re-open to pets when chicks have fledged.
- Hand-held kites and kites used in kite surfing/boarding will be prohibited within 200 meters of posted shorebird nesting areas.
- Lifeguards will not drive ATVs on beaches with unfledged shorebird chicks unless responding to a life-threatening emergency.
- The CCNS will assist the MAS in the Atlantic Coast piping plover census performed June 1-9 and the MAS will be responsible to report findings to the U.S Fish and Wildlife Service.
- All shorebird nests found on town land will be reported to the MAS and Truro Natural Resource Health and Conservation agent. The CCNS will work closely with these agencies and provide regular updates throughout the nesting season.
- At the end of the nesting season, the CCNS will provide Mark Farhety, MAS shorebird project leader, all shorebird data collected by CCNS shorebird staff on Truro beaches. The MAS will be responsible to submit annual census reports on breeding piping plovers on Truro town land to the Massachusetts Natural Heritage Program.

May 08, 2013

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