Shorebird Monitoring and Management
Cape Cod National Seashore

2013

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Executive Summary

This report summarizes the 2013 shorebird nesting season for Cape Cod National Seashore (hereinafter "Seashore"). Piping plover (*Charadrius melodus*), least tern (*Sternula antillarum*), common tern (*Sterna hirundo*) and American oystercatcher (*Haematopus palliates)* nesting and brood-rearing were monitored on 25 beaches on over 40 miles of coastline from Provincetown, MA to Orleans, MA. The first piping plovers were observed on Seashore beaches on 27 March, the first nest was found on 28 April, and peak nesting occurred the week of 9 June. A total of 85 nesting pairs attempted 173 nests, with 30 pairs successful at producing at least one chick and 55 pairs failing to produce any hatchlings. There was one, suspected adult mortality at Race Point South in 2013. Predation accounted for 72% (103/143) of nest failures and overwash accounted for 17% (24/143). Eastern coyote (*Canis latrans)* and American crow (*Corvus brachyrhynchos*) were the main predators accounting for 30% (31/103) and 23% (24/103) respectively, of all nests lost to predators. Predator exclosures were not used in 2013 due to the increasing frequency of predators keying into exclosures in past years, which causes nest abandonment and increased risk of adult mortality. Overall, 46 chicks fledged, for a productivity of 0.54 chicks fledged/ nesting pair. Poor nesting success, coupled with low fledging success, accounted for low productivity at the Seashore in 2013. Over the 20 breeding seasons since 1994, even though the total population of nesting pairs has increased within the Seashore (with 2012 being a record high year), there has been a statistically significant decline in piping plover productivity, with the five year weighted average annual productivity declining 0.046 fledglings/pair each year.

A total of 136 pairs of least terns nested in 11 colonies from Eastham to Provincetown. Productivity was nearly zero with only two chicks fledged from 136 nesting pairs. Three pairs of American oystercatchers nested at the Seashore; a total of ten nests were laid and productivity was zero. One pair of common terns nested on New Island, Orleans but was unsuccessful. Post-breeding/staging roseate terns (*Sterna dougallii*) and common terns were present in large numbers at the Seashore from mid-summer through mid-fall. In addition, thousands of north and southbound migrating shorebirds were observed on Seashore beaches, including 200 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 kitesurfing was banned on bayside beaches from 1 April until the last chicks fledged, 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 shorebirds. The use of ORVs was permitted during the egg laying/incubation phase of nesting, given there was an adequate buffer between the nest and passing ORV"s. 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 tern and common tern (both listed by the Massachusetts Division of Fisheries and Wildlife (MDFW) as a *Species of Special Concern*), and the American oystercatcher, identified by the U. S. Fish and Wildlife Service (USFWS) as a *Bird of Conservation Concern* in the United States (USFWS 2008).

The Seashore is also an important staging and migratory stopover-site for thousands of terns, including the federally endangered roseate tern, and many other shorebird species, including the red knot (a species proposed for listing under the Endangered Species Act), 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 flavipe*). 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 which are still dependent on their parents for food and 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 in the Seashore from Provincetown to Orleans, encompassing approximately 44 miles of beach. Staffing consisted of: the Resource Management Specialist; Shorebird Program Lead, one permanent Lead Shorebird Biologist in each district; 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 thirteen volunteers, donating a total of 850 hours.

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* (Blodget and Melvin 1996). To inform decisions regarding daily operations that affect shorebird management and protection, the Seashore consults the 2012 SOP (NPS 2012).

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 (NegReg) (DOI 1998), and the 2007 Environmental Assessment: Options for Managing ORV Access (NPS 2007a) and 2007 FONSI (NPS2007b).

During the nest location phase, monitors searched the beaches for signs of shorebird nesting activity (e.g., nest scrapes, concentrated tracks on the upper beach). In order to maximize the accuracy of hatch date predictions, most beaches were monitored daily so that the majority of nests were located before clutch completion. The accurate prediction of hatch dates 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 then every two days; however, to reduce the risk of monitors providing cues to predators (i.e., scent, human footprints up to nest), 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, a silt fence was installed around the perimeter of the lot on 15 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 85 nesting pairs of piping plovers were monitored on 25 beaches in the Seashore in 2013 (Table 1 and Appendix A - Maps). The first piping plover was observed on 27 March at Race Point South. 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 28 April at Hatches Harbor. Peak nesting for the Seashore occurred the week of 9 June (Figure 1). Hatching dates of piping plovers ranged from 7 June to 27 July. The majority of nests were laid along the upper beach, in open sandy habitat, but one notable nest at Ballston Beach was laid approximately 50 meters up a steep sand scarp.

The breeding population of piping plovers was calculated based on the number of pairs observed nesting at the Seashore (including one pair at High Head that scraped for over a month that may have had a nest that was depredated before it was found). 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).

A total of 173 nests were found in 2013; 106 in the North District and 67 in the South District. Of the 84 pairs of piping plovers that laid eggs, 30 pairs produced at least one chick, while 54 pairs failed to produce any chicks (Table 1). Of the 143 nests lost, 59 were in the South District and 84 were in the North District. In the South District, re-nests accounted for 46% of total nests (31/67) and in the North, re-nests accounted for 55% (58/106) of total nests. One pair at Coast Guard Beach in Eastham re-nested four times (five total nesting attempts).

The 173 piping plover nests contained a total of 532 eggs, of which 100 hatched. Of the 432 remaining eggs, 426 were lost to various causes, primarily predation (76%; 322/426), and 6 eggs were unviable (failed to hatch) (Table 3). Overall, hatching success was 19% (100/532) (Table 1).

Predation accounted for 72% (103/143) of failed nests, followed by overwash (17%; 24/143), abandonment (5%; 7/143), sanding over (3%; 4/143), cliff erosion (2%; 3/143), and unknown causes (1%; 2/143). Of the 103 nests lost to predation, 30% (31/103) were lost to coyote, 23% (24/103) to American crow, 40% (41/103) to unknown predators, 5% (5/103) to red fox (*Vulpes vulpes*), 1% (1/103) to Common Grackle (*Quiscalus quiscula*), and 1% (1/103) to an unknown canid species (Table 2).

There was one, suspected adult mortality in 2013. Several adult piping plover feathers from different body parts (wing, breast, etc.) were discovered at predated nest RPS 1B on June 10th. There were fresh crow tracks leading up to and surrounding the nest bowl. Shorebird staff combed the area for a carcass but never found one. Two crows were observed about 0.1 miles south of the nest when the feathers were discovered. This area was also thoroughly searched but no dead adult was ever found. The only other predator tracks in the area were from coyote, about 20ft away from the nest. Because of the density of crow tracks in the area and the absence of other predator tracks directly around the nest site, we think the adult may have been killed by a crow.

Discussion

Over the last ten years (2004-2013), the three main factors affecting nesting success have been predation, overwash, and abandonment/adult mortality (Table 4). Nesting success in 2013 was the second lowest in those ten years (17%; 30/173) with 2012 having the lowest nesting success at 13% (Table 5).

Over the past five years, crows depredated the majority of nests at the Seashore. In the last ten years, instances of coyote predation ranged from one to six nests between 2004 and 2011, 41 nests in 2012, and 31 in 2013 (Table 4).

Coyotes were the leading cause of nest predation in 2013. The 31 nests lost to coyote predation this season (Table 2) are exceeded in the past ten years only by the 41 lost to coyotes in 2012. 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. Population trends for Massachusetts provided by MDFW (2004) indicate an increasing trend in the coyote population.

The American crow population appears to be increasing as well, 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).

In 2013, crows were the second leading cause of egg loss (Table 3). Groups of crows were commonly observed foraging along oceanside beaches from Eastham to Provincetown, and on the bayside of Wellfleet. Shorebird staff routinely observed crows in the early morning, feeding on food scraps left by

people on high-visitation beaches. It was previously 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, over the past several years, including 2013, large numbers of crows have been observed regularly on North District beaches, suggesting that crows are abundant throughout the park.

It appears that the two main shorebird predators, American crow and Eastern coyote are thriving in the Seashore. Both of these predators/scavengers have broad diets and take advantage of food from human sources, such as food waste, handouts and road kills. These "subsidized" predators often reach populations beyond the natural capacity of the landscape, and exert unnaturally high levels of predator pressures on many species, including ground nesting shorebirds.

In an attempt to minimize cues available to these and other predators (e.g., scent trails or visible human foot prints leading to nests), nest monitoring staff purposefully decreased the frequency of nest checks in 2013. Less frequent nest checks decreased the probability that a nest monitor would observe the ephemeral signs of nest predation (e.g., identifiable predator tracks in the sand), which led to a greater number of nests lost to "unknown" predators in 2013 (Table 4). However, one could infer that many of the predation events for which there was insufficient evidence to identify the species of predator, may also be attributed to the most commonly-observed nest predators (i.e., coyotes, crows), but it should be noted that these losses are not represented in the species-specific predation rates reported here.

In recent years, major storms (nor"easters) have become more frequent during peak shorebird nesting activities. In 2012, overwash was the greater cause of nest loss (30%, 55/185), mainly due to a storm during the first week in June, washing over 42 piping plover nests. Although there were no notable storms in 2013, overwash still accounted for more nest loss than in most of the last ten years (17%, 24/143) (Table 4). This increase is likely due to the narrowing of some beaches due to storm events and sea level rise.

Brood Monitoring

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. On several occasions in 2013, adult piping plovers were observed engaged in distress calls and broken wing displays when beachgoers were within 10 meters of chicks. Chicks would disperse in several directions away from the 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 the beachgoer and plover broods to come in close contact with each other, increasing the frequency and probability of human disturbance.

Causes of chick mortality are extremely difficult to assess. In the vast majority of cases, the cause of chick loss is unknown. A chick was presumed dead if it was not seen for the remainder of the season. For ORV management, sections of beach were re-opened to vehicles when an entire brood was not seen in the area for five consecutive days.

On August 8th, a chick from Exit 9 appeared disoriented, unable to walk and was lying in the wrack line when shorebird staff arrived to monitor. Shorebird monitors watched the chick for three hours and saw it hobble around occasionally while being brooded intermittently by an adult. After weighing options to take the injured to chick to a rehabilitation center or leave it in the care of its plover parents, the Park decided to leave the chick in the care of its parents. From August 9th through August 13th, the chick seemed to have made a full recovery and was observed feeding by the water and walking normally;

however, on August 14th and August 15th, it appeared lethargic, disoriented and wobbly on its legs once again. The chick did not fledge and was last seen on August 15th.

Fledging dates ranged from 8 July to 20 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, this does not seem to be the case at the Seashore, or at some other piping plover breeding locations in the region. 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, and 76% (16/21) of fledged broods in 2013. Chicks averaged 34 days to fledge in 2012, and 32 days to fledge in 2013. Two broods in 2013 took as long as 37 days to fledge. 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.

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, plovers chicks are considered fledged at 25 days old).

Use of Feeding and Roosting Habitats

Seashore biologists not only survey piping plover nesting areas, but also monitor piping plover feeding, staging, and roosting habitats throughout the park. Groups of post-breeding piping plovers were seen in late summer, feeding and resting throughout the park, including three notable occasions at Armstrong where groups of 14, 17, and 19 plovers were observed (27 August, 3September, and 18 September respectively). Smaller groups of piping plovers were observed in the South District 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 100 plover chicks that hatched at the Seashore in 2013, 46 chicks fledged (46%). Fledging success ranged from 0% at White Crest, Head of the Meadow, Mission Bell, and Old Harbor, to 100% at Great Island. It is worth noting that although Great Island had the highest fledging success, this number represents the lone nest that hatched out of the fifteen nesting attempts from eight pairs at this site. All other nests on Great Island were lost to predation or washed over.

Park-wide, productivity was 0.54 fledged chicks/nesting pair (46 fledged chicks from 85 nesting pairs) (Table 1). Productivity was higher in the North District (0.67 fledged/pair) than in the South District (0.36 fledged/pair) (Table 1).

Discussion

There were 14 fewer piping plover pairs nesting on the Seashore in 2013 than in 2012. The decrease in the number of pairs is likely due to poor piping plover productivity along the U.S. Atlantic Coast in 2012, which was the lowest productivity since the species" listing in 1986.

In 2013, the fledging rate (46%) was 7 percentage points lower than the mean for the past ten years (53%) and the fourth lowest of this period (Table 5). However, measures of success during incubation (nest

success) in 2013 (17%) were even less when compared to the ten year mean (48%). Another indicator of low nest success is the renest rate; renest rates in 2012 and 2013 (53% and 51%, respectively) were the highest in the past decade, and double the median value (26%) for this parameter during this time period (Table 5). It appears that egg predation (leading to reduced hatch rate) is the predominant driver of decreased productivity on the Seashore in recent years. For example, fledge rates from 2011 - 2013 (42% - 46%) were fairly consistent, but hatch rates in 2012 and 2013 (11 % and 19%, respectively) were drastically lower than in 2011 (56%), as was overall productivity (0.30 and 0.54 in 2012 and 2013, respectively, and 1.10 in 2011). Thus, record low nest/hatching success coupled with below average fledging success in 2012 and 2013 account for the lowest productivity the Seashore has experienced since the late 1980s, when piping plovers were listed (Table 6).

As discussed in previous sections, reasons for the low nest/hatching success in 2013 are likely due to the abundance of predators and predation. The difference between productivity in the North District (0.67) and the South District (0.36) is likely due to higher predator pressures in the South District in 2013.

It has been suggested that the lack of predator exclosures around all nests in both 2012 and 2013 led to this poor nesting success and ultimately poor productivity levels for these years. While the Seashore, like many organizations involved in piping plover management, is evaluating predator exclosure use for future years, shorebird biologists throughout their nesting range are reducing or eliminating the use of exclosures all together at their sites. In a scenario like the Seashore is currently experiencing (i.e., high predator levels with predators keying-in on exclosures); if exclosures were used, hatching success may increase but the probability of nest abandonment and/or adult mortality would also be higher. In addition, a higher hatching success does not necessarily translate to higher productivity levels because the same predators that are eating the eggs are likely eating the chicks. When exclosures are not used, hatching success is likely to decrease, but the probability of adult mortality associated with exclosure use is eliminated.

Overall productivity at the Seashore in 2013 (0.54) was the third lowest it‟s been since plover management began in 1985, with lower productivities of 0.30 recorded in 1986 and 2012 (Table 6). A pair‟s reproductive success in a given breeding season is dependent upon successfully hatching chicks that then survive to fledge. Thus, failure during either the incubation or brooding (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.

At the Seashore, annual productivity 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 6, Figure 2). 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). The 5-year weighted average productivity in 2013 was 0.83, which is the lowest it has been at the Seashore since 1989. For the five-year period ending with 2013, the average productivity at the Seashore was 0.83 chicks fledged/pair/year. Since the year 2000, five-year annual productivity has fallen below the recovery goal with only a few exceptions (Table 6). When viewed over a 20 year period (1994-2013), the five-year weighted average annual productivity has declined significantly by 0.0457 chicks/pair/year ($p < 0.0001$, $F_{1,18} = 34.35$, $r^2 = 0.6561$) (Figure 3). Though the number of nesting pairs at the Seashore has not drastically changed in recent years, productivity is in great decline and Cape Cod National 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 is a conservation concern, considering the Seashore supports over 15% of the Massachusetts breeding piping plover population.

Least Terns

Population Trends

The least tern is listed by the MDFW as a species of special concern and as a *Bird of Conservation Concern* by the USFWS. Least tern numbers in Massachusetts increased from 1985 to 2001, declined for several years, and then increased sharply after 2006. 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-1970"s – 1980"s, the population of nesting least terns at the Seashore generally ranged from 200- 600 pairs. Over the past ten years (2004 – 2013) at the Seashore, the least tern population has fluctuated between a low of 86 nesting pairs in 2007 and a high of 268 pairs in 2011 (Figure 4). In 2013, the population of nesting least terns within the Seashore declined by nearly half compared to 2012 (136 and 257 respectively) (Figure 4). 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). Furthermore, 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 (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 each colony and counting nests 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 the Seashore on 9 May at Jeremy Point. Egg laying began on 30 May, with most least terns on eggs by early June. Renesting attempts continued through the beginning of August. Approximately 138 pairs had nests during the "A" count and 111 pairs had nests during the "B" count. There were a total of 11 nesting colonies from Eastham to Provincetown (Table 7).

Colony sizes fluctuated throughout the season but most were relatively small with fewer than 30 pairs. Coast Guard Beach in Eastham supported the largest colony with 46 nesting pairs. Most colonies were depredated and multiple nesting attempts occurred throughout the season. On 11 June, during the "A" census window, 29 nests were counted at Head of the Meadow and by the next day, 12 June; all nests had been depredated by coyote. On two occasions, crows were observed flying into the least tern colony at

Head of the Meadow and taking eggs from known nests. There were smaller nesting colonies at Marconi Beach, Great Island, Jeremy Point, Ballston Beach, Race Point South (including: Old Harbor, Armstrong, High Head and Mission Bell), Race Point North, and Wood End; these beaches supported a range of 1 - 29 nesting pairs (Table 7).

The first least tern chicks hatched on 12 July at Wood End and the last chicks hatched on 9 August at Armstrong. Least terns are considered fledged when they are capable of flight. Of the 136 pairs of least terns, only two chicks fledged (0.01 chicks/pair) from Seashore beaches in 2013; one at Armstrong and one at Marconi Beach (Table 7).

Discussion

Least tern productivity has varied over the past ten years, but has generally been poor, with less than one chick fledged/pair. The low productivity of least terns is likely 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.

Predators are a major cause of nest loss. In most years, predator pressure is so intense that very few nests hatch, causing continuous re-nesting. Predator tracks were observed daily throughout the colonies and leading up to the nests, indicating that coyotes were the predominant least tern nest predator in the North District. In the South District, coyote and American crow were the main least tern predators. Coyotes seem to be attracted to tern colonies due to the concentration and abundance of eggs. It is more difficult to determine specific predators of least tern chicks, but it seems likely that they are the same species that prey on the eggs. Field observations suggested that colonies were visited daily by coyotes, most often resulting in a loss of nests or chicks. Coyotes can develop a search pattern that is highly effective in locating ground nesting birds in open habitat. Coyotes may also be attracted to the smells of garbage, food wastes and storage, and food cooking associated with human recreation near tern colonies. The increasing abundance of fish remains being left on the beach by fishermen during the nesting season may also attract coyotes to these beaches.

The colonial nesting strategy used by terns and other seabirds evolved as a means of protecting eggs and chicks of the colonial nesting 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 in effective in very small colonies, because an insufficient number of adults are available to mob the predator, and thus predators are undeterred from the nesting area. The colony sizes of nesting least terns at the Seashore have decreased over the years, and this is likely a major contributor to the observed increase in predation, and 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).

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 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. Since 2009, one or two pairs have unsuccessfully nested on New Island each year.

Nesting Population and Productivity

Results

The first common tern was observed flying over the water at Hatches Harbor on 8 May. One pair nested unsuccessfully on New Island, Orleans. It seems likely that the nest was lost to predation due to the high density of predator tracks throughout the site.

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 has experienced a dramatic range expansion along the Atlantic Coast, reaching Massachusetts only 40 years ago. However, this northward range expansion may well 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 ten years (2004-2013), 2-5 pairs of oystercatchers have nests each year. Nesting has only occurred in the South District at Jeremy Point, Coast Guard Beach in Eastham, and New Island, Orleans.

Nesting Population and Productivity

Results

The first American oystercatcher was observed on 30 March at Great Island. A total of three pairs of oystercatchers nested at the Seashore in 2013; two pairs at Jeremy Point and one pair on New Island in Orleans. The first nest was found on 27 April at Jeremy Point. The two pairs at Jeremy Point laid a total of eight nests; four nests each. Of the eight nests, none were successful; four were depredated by coyote and four were washed over. Because access was logistically challenging, New Island was not monitored frequently. The pair on New Island made at least two nest attempts and both nests were lost to unknown causes.

Discussion

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 2013, 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). Even so, continued low reproductive success is always a 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 (i.e., "stage"). Nauset Marsh/Coast Guard Beach, Jeremy Point, Hatches Harbor and Wood End/Long Point are particularly important, as they represent the most important staging and roosting areas for these birds on Cape Cod (Hadden 2001, Trull et al. 1999). While dozens of species use the Seashore during fall migration, one of the most notable is the federally endangered roseate tern, found within large flocks of staging common terns.

A multi-agency study initiated in 2005, expanded in 2007, and continuing through 2013, indicates that more than 90% of the entire Northwest Atlantic breeding population of roseate terns and their fledglings use Seashore beaches from mid-July through October (Jeff Spendelow, USGS, and Ellen Jedrey, MAS, personal communication, November 7, 2011).

In 2013, from the beginning of July through the beginning of October, shorebird staff conducted surveys of staging terns and shorebirds throughout the park. Hundreds of terns (predominately common and roseate) were observed at Head of the Meadow, Armstrong, Exit 9, Race Point South and Jeremy Point throughout the post-breeding season, and thousands were observed at Hatches Harbor, Race Point North, High Head, Coast Guard in Eastham/Nauset Marsh, and Marconi Beach. Notable counts include: 3,500 at Armstrong on 19 August; 1,500 at Hatches Harbor on 27 August; 7,500 at High Head on 21 August; 6,000 at Race Point North on 25 August; 5000-7,000 at Coast Guard in Eastham/Nauset Marsh Estuary on 31 July, 5 August, and 21 August; 600 at Marconi Beach on 22 August; and 345 on Jeremy Point on 30 August. In the North District, the highest percentage of roseate terns (within mixed flocks) was observed at Hatches Harbor and Race Point North. In addition to collecting data on flock size, composition, and movement, Seashore staff and researchers documented disturbances to staging and migrating shorebirds from dogs, pedestrians, oversand vehicles, and boats.

As part of a long term roseate tern post-breeding study within the U.S., researchers from U.S. Geological Survey (USGS), Massachusetts Audubon Society (MAS), and U.S. Fish and Wildlife Service (USFWS) conducted counts of staging terns and surveyed for color-banded roseate terns along Seashore beaches from late July until the middle of September. From 2011-2013, many roseate terns were banded in the Northeastern US, and Nova Scotia, Canada. These terns received three-character, plastic bands (a new type of band that is easier to read in the field than previous banding schemes). At least 60% of the roseate fledglings, and a number of roseate adults that received these plastic, field readable bands in 2013 were observed and resighted by researchers, volunteers, and Park staff on staging grounds throughout the region. Almost all of the resights came from locations within the Seashore, demonstrating the importance of the Seashore for staging terns (Dr. Jeff Spendelow, personal communication, October 8, 2013). A more detailed three-year study on the importance of the Seashore to staging roseate terns is planned for 2014.

Thousands of other migrating shorebirds including: red knot, whimbrel, short-billed dowitcher, semipalmated plover, sanderling, and sandpiper spp., were present on Seashore beaches from the end of July through the beginning of October (Table 8). A flock of 200 red knots were observed along three miles of beach between Armstrong and Head of the Meadow on August 22, 2013. Monitors were surveying this area regularly, from the middle of April through the middle of September, for piping plover and least tern activity, but knots were only seen in large numbers on this one day.

The largest concentrations of migratory shorebirds were observed at Race Point North, Race Point South (Armstrong), High Head, Jeremy Point, Wood End, and Coast Guard, Eastham (Nauset Marsh complex). As part of a migrating shorebird survey effort in Massachusetts and along the Atlantic coast led by USFWS and Manomet Center for Coastal Studies, the Seashore also participated in two standardized shorebird surveys at Coast Guard, Eastham/Nauset Marsh, High Head, and Head of the Meadow in September and October.

Management and Protection

Predator Management

Piping Plover Nest Protection

Results

In the past, predator exclosures were erected around incomplete clutches due to the high frequency of egg predation. Predator exclosures were not used in 2013. However, most nests were depredated before they were complete, and in addition many empty scrapes were found with predator tracks running through them suggesting some nests may have been depredated before being found by monitors.

In 2013, 81% (432/532) of all eggs laid subsequently failed, including 426 eggs that were lost to overwash, predation, etc. and six eggs that were unviable. The two main causes of egg loss were predation (76%; 322/426) and overwash (17%; 72/426) (Table 3). Of the 100 eggs that hatched, 46 chicks fledged (Table 1). There were no known adult mortalities in 2013 (Table 9).

Discussion

Historically, the Seashore has focused on non-lethal predator management through the use of exclosures around nests; however, in 2012 and 2013, exclosures were not used on the Seashore due to past and present observations and conditions including: (1) Exclosures can greatly increase nest survival; however, their benefits may be outweighed by the increased frequency of predators keying into them, causing nest abandonment, hatchling predation, and an increased risk of adult mortality; (2) When predators have keyed into an exclosure and the exclosure has been removed (due to concerns about adult mortality), the nest is usually lost to predation soon after removal.

In addition, it is not advantageous to put the adult birds at risk to protect the eggs only to have the chicks depredated once they leave the safety of the exclosures. Typically, with long-distance migratory species, survival of hatch-year individuals is much lower than of adults. Therefore, it remains critical to protect adults that have already reached sexual maturity to provide the highest probability of recruitment success in the long-term. In part, because of the need to protect adults, USFWS guidance on exclosure use is that the “default” assumption now is that exclosures should not be used except in situations where an extremely compelling reason to deploy them exists.

Additionally, through field observations, we have anecdotal evidence that once an exclosed nest is keyed into by predators that nest and other exclosed nests in the surrounding area are at greater risk of abandonment, hatchling mortality, and adult mortality. Because exclosures may act as a visual cue to predators, their use can increase the impacts of predation. Thus, when there are signs of predators keying into exclosures, exclosures need to be immediately removed, but when they are, the nests usually succumb to predation within 24 hours of exclosure removal. In addition to trying to avoid adult mortality and the negative effects of exclosure use on productivity, the Seashore‟s choice to discontinue exclosure use in 2012 and again 2013 will provide valuable nest success data we can use in conjunction with exclosed nest success data to evaluate the positive and negative effects of exclosure use on piping plover recruitment. In addition, it is not advantageous to put the adult birds at risk to protect the eggs only to have the chicks depredated once they leave the safety of the exclosures. Typically, with long-distance migratory species, survival of hatch-year individuals is much lower than of adults. Therefore, it remains critical to protect adults that have already reached sexual maturity to provide the highest probability of recruitment success in the long-term. In part, because of the need to protect adults, USFWS guidance on exclosure use is that the "default" assumption now is that exclosures should not be used except in situations where an extremely compelling reason to deploy them exists.

It is clear that predators, especially crows and coyotes, have a major impact on productivity at the Seashore. Furthermore, while crow and coyote sign at depredated nests have allowed observers to record these species as the cause of nest failure for the majority of nests, there are many other cases where crows and coyotes are likely responsible for nest lost but observers are unable to document this due to poor tracking conditions.

Protection for least tern chicks

To reduce chick predation, "tern shelters" have been placed inside some least tern nesting colonies that lacked sufficient ground vegetation for the chicks to hide in. The triangular plywood shelters 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.

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.

Posting of suitable and historic shorebird nesting habitat with symbolic fencing and signs began on 26 March at Head of the Meadow 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, Coast Guard Beach in Eastham, Duck Harbor, Bound Brook, Great Island, Jeremy Point and New Island. Symbolic fencing was placed around most areas of suitable habitat, where nests and active scrapes were found, and where shorebirds were observed exhibiting courtship and territorial behavior.

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 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 staging and migrating shorebirds along the upper and lower (intertidal) beach (e.g. Coast Guard Beach in Eastham, Jeremy Point, and Marconi Beach). On most beaches where shorebirds were no longer nesting, the removal of symbolic fencing began on 1 July.

The importance of retaining symbolic fencing to protect resting migrants from disturbance, especially on high visitor use beaches, can be seen at the southern tip of Coast Guard Beach, Eastham. Hundreds of shorebirds including semipalmated plovers, sanderlings and semipalmated sandpipers were regularly observed resting inside the fencing, especially at high tide. In addition, up to eight whimbrels were observed inside the fencing during this time period along the northern section of Coast Guard, feeding on caterpillars along the dune ridge.

Temporary Pedestrian/Parking Lot/Boat Landing Closures and Detours

Storm 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 was a problem, sections of beaches were temporarily closed during a 3-4 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 (e.g. Coast Guard Beach in Eastham, Jeremy Point, Great Island, and Head of the Meadow).

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. Jeremy Point and Great Island). Where possible, detours were established to provide visitor access around nesting areas. In addition, shorebird staff and volunteers were sometimes stationed at or near these closures to provide information about the closure and educational material about the shorebird program.

In 2013, sections of Head of the Meadow, Great Island, Jeremy Point, and Coast Guard Beach in Eastham were temporarily closed or detoured to pedestrians from early May through July to protecting nesting shorebirds. Certain access paths at Head of the Meadow were closed to pedestrians to protect piping plovers and least terns nesting close to the paths.

Hand-held Kites/Kite Surfing

To prevent disturbance to nesting birds, kites and kite flying (including kites used for kite surfing) is prohibited on all beaches within 200 meters of any shorebird nesting areas. In addition, kite surfing is prohibited on Cape Cod Bayside beaches and Cape Cod Bay waters within the Seashore from 1 April until the last chicks have fledged in the area. One exception is a small section of beach owned by the town of Wellfleet, at Duck Harbor, where kite surfers can launch their kites and take a direct route, one quarter mile offshore, outside of park boundaries (NPS 2012). Signs were posted explaining these restrictions.

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.

Pets

Pets are required to be on a six-foot leash at all times, anywhere they are allowed within the Seashore, all year long. In addition, a number of areas are closed to pets to protect park resources. The south side of Coast Guard Beach in Eastham and 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. Signs were posted along the high tide line, on the marshside of Hatches Harbor spit. The oceanside of the 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 perpendicular to the water, approximately 50 meters away from the symbolic fencing, 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.

Shorebird monitoring staff recorded a total of 490 dogs off leash on Seashore property (239 in the South District and 251 in the North District) Unleashed dogs were encountered most frequently at Newcomb Hollow (68), Coast Guard in Truro, (40), Lecount Hollow (37), and Hatches Harbor (35) (Table 1).

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 (NegReg) (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 4,082 ORV/SCV permits were sold in 2013 (1,492 seasonal permits and 2,590 weekly permits) (NPS 2013a).

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. 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 m) on each side of a brood of plover chicks and 0.06 miles (91 m) 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 2013, 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. Two broods of piping plover chicks regularly traveled over two miles between Coast Guard in Truro and Longnook.

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 2013 Off-Road Vehicle Activity Report (NPS 2013).

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 "NegReg" 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, especially chicks < five days old, the use of vehicles on beaches with nesting shorebirds is avoided or minimize, and speed limits are reduced.

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. No piping plover nests were flexibly managed in 2013.

Management and Protection of Post Breeding Shorebirds

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

While dozens of species use the Seashore during fall migration, one of the most notable is the federally endangered roseate tern, found within large flocks of staging common terns. The roseate tern has experienced a 20% population decline since 2000. Reasons for this decline are unclear, but research suggests a major factor limiting population recovery may be low survival rates of young birds during the first year or two of life. It has also been established that young roseate terns‟ migration (more than 7,000 km) and overwintering survival depends on parental care after the young have fledged and through migration. Adults care for young at staging areas, and disturbance in these areas can cause birds 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.

In addition to collecting data on flock size, composition, and movement, Seashore staff and researchers documented disturbances to staging and migrating shorebirds from dogs, pedestrians, oversand vehicles, and boats.

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, Marconi Beach, High Head, Race Point North and Hatches Harbor. Pet closures were also implemented at several beaches

At Hatches Harbor, educational signs (“Give „em a Break”) 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, “Give „em a Break” signs and “No Pet” signs were installed on metal channel “U” posts placed throughout the marsh at Hatches Harbor.

Education, Outreach, and Public Involvement

Educating the public about natural and human impacts threatening nesting and staging shorebirds is important for gaining local support of shorebird management and facilitating their recovery. In March, the Seashore‟s Natural Resource Specialist and Lead Biological Technician visited local elementary schools throughout the Lower Cape and gave a presentation with an interactive classroom activity, demonstrating the impacts of disturbance to nesting shorebirds. A total of 16 programs were given to 555, third-seventh grade students.

In addition, two, 12 week, Student Conservation Association (SCA) interns were hired to provide informal interpretive services. The interns spent the majority of their time designing and developing educational material on shorebird conservation, manning a display table at the visitor centers or on beaches with high visitation, and giving several public interpretive programs. In addition, when a temporary closure/detour was needed at Coast Guard Beach in Eastham, the interns set up the shorebird information table at or near the high tide closure/detour. This not only ensured compliance, but provided an opportunity to advance visitor understanding of the park‟s shorebird program. Interns also gave several public programs at the Salt Pond Visitor Center. Several thousand visitor contacts were made throughout the summer.

Fourteen volunteers donated a total of 850 hours to the Seashore‟s shorebird management program. Volunteers were stationed at high tide closures, monitored nesting areas, and assisted biological technicians and SCA interns with field operations, from April through August.

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, the Seashore offered support to the town of Wellfleet in managing and protecting 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 shorebird on these town-owned sections of beach. Seashore staff worked closely with town managers, 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 2012, a letter was sent to all beachfront private property landowners within park boundaries regarding 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.

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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 2013.

SITE	PAIRS	NESTS[1]	EGGS LAID	NESTS HATCHED	EGGS HATCHED	CHICKS FLEDGED	HATCH RATE[2]	FLEDGE RATE[3]	PRODUCTIVITY[4]	DOGS OFF LEASH
BOUND BROOK	0	0	0	0	0	0	0%	0%	0	3
CAHOON HOLLOW	0	0	0	0	0	0	0%	0%	0	21
COAST GUARD (EASTHAM)	4	11	34	1	4	3	12%	75%	0.75	21
DUCK HARBOR	2	3	11	0	0	0	0%	0%	0.00	7
GREAT ISLAND	8	18	53	1	2	2	4%	100%	0.25	13
JEREMY POINT	7	15	38	0	0	0	0%	0%	0	0
LECOUNT HOLLOW	0	0	0	0	0	0	0%	0%	0	37
MARCONI BEACH	10	14	52	5	18	8	35%	44%	0.80	35
MARCONI STATION	0	0	0	0	0	0	0%	0%	0	2
NAUSET LIGHT	0	0	0	0	0	0	0%	0%	0	14
NEWCOMB HOLLOW	2	2	7	0	0	0	0%	0%	0	68
NEW ISLAND	2	2	5	0	0	0	0%	0%	0	0
WHITE CREST	1	2	4	1	3	0	75%	0%	0	13
SOUTH DISTRICT TOTALS	**36**	**67**	**204**	**8**	**27**	**13**	**13%**	**48%**	**0.36**	**234**
ARMSTRONG	5	11	36	3	10	6	28%	60%	1.20	9
BALLSTON BEACH	8	19	50	5	16	11	32%	69%	1.38	7
COAST GUARD (TRURO)	2	4	15	2	7	3	47%	43%	1.50	40
EXIT 9	4	6	21	0	0	0	0%	0%	0.00	5
HATCHES HARBOR	1	3	12	0	0	0	0%	0%	0.00	35
HEAD OF THE MEADOW	5	12	38	1	4	0	11%	0%	0.00	19
HIGH HEAD	5*	8	25	2	7	4	28%	57%	1.00	10
LONGNOOK	2	3	9	1	3	2	33%	67%	1.00	31
MISSION BELL	0	3	7	1	2	0	29%	0%	0.00	8
OLD HARBOR	1	1	4	1	4	0	100%	0%	0.00	6
RACE POINT NORTH	6	14	45	2	8	1	18%	13%	0.17	21
RACE POINT SOUTH	1	2	8	0	0	0	0%	0%	0.00	34
WOODEND/LONGPOINT	9	20	58	4	12	6	21%	50%	0.67	33
NORTH DISTRICT TOTALS	**49***	**106**	**328**	**22**	**73**	**33**	**22%**	**45%**	**0.69**	**258**
GRAND TOTALS	**85***	**173**	**532**	**30**	**100**	**46**	**19%**	**46%**	**0.55**	**492**

[1] A "nest" is defined by individual scrapes with eggs. In 2012, each initial nest, renest, continuation nest and their respective outcomes are counted as separate "nests" with separate outcomes.
[2]Total number of eggs hatched /total number of eggs laid.
[3]Total number of chicks fledged/ total number of eggs hatched.
[4]Total number of chicks fledged/ total number of nesting pairs.
*Total pair # includes a pair at High Head 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 renests.

Table 2. Piping Plover (*Charadrius melodus*) nest fates, and causes of nest loss, at Cape Cod National Seashore in 2013.

Nests					Loss By Cause	
# Laid	# Hatched	# Lost	% Lost[1]	*Cause*	# Lost	% Lost[2]
173	30	143	83%			
				Predation	103	72%
				Overwash	24	17%
				Abandoned	7	5%
				Unknown	2	1%
				Stepped on by Gull	0	0%
				Cliff Erosion	3	2%
				Stepped on by Human	0	0%
				Sanded Over	4	3%
					143	**100%**
				Predation Types	*# Lost*	*% Lost[3]*
				Coyote	31	30%
				Crow	24	23%
				Unknown	41	40%
				Fox	5	5%
				Canid	1	1%
				Grackle	1	1%
					103	**100%**

[1]total number nests lost/total number nests laid.
[2]number of nests lost to a particular cause/total number of nests lost.
[3]number 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 2013.

Eggs						Loss By Cause	
# Eggs	#Unviable	# Hatched	# Lost	% Lost[1]	*Cause*	# Lost	% Lost[2]
532	6	100	426	80%			
					Predation	322	76%
					Overwash	72	17%
					Abandoned	11	3%
					Unknown	4	1%
					Cliff Erosion	6	1%
					Sand Over	11	3%
					Total	426	100%
					Predation Types	# Lost	% Lost[3]
					Coyote	100	31%
					Crow	72	22%
					Unknown	132	41%
					Fox	14	4%
					Canid	2	1%
					Grackle	2	1%
					Total	322	100%

[1]total number eggs lost/total number eggs laid.
[2]number of eggs lost to a particular cause/total number of eggs lost.

Table 4. Summary of Piping Plover (*Charadrius melodus*) nest loss, and cause of nest loss, at Cape Cod National Seashore from 2003-2013.

					Number Nests Lost to:						% Depredated Nests Lost to:					
Year	**# of pairs**	**Total Nests**	**# Successful Nests**	**# Unsuccessful**	**Overwash/ Sanding Over**	**Abandonment[1]**	**Non-viable**	**Unknown**	**Other**	**Predation**	**Crows**	**Coyote**	**Gulls**	**Skunk**	**Fox**	**Unknown Predator**
2003	84	121	54	67	13	16	0	0	5	33	15%	27%	12%	15%	0%	30%
2004	85.5	115	59	56	15	13	0	0	0	28	43%	21%	11%	7%	0%	18%
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%
Total	**922.5**	**1390**	**607**	**783**	**211**	**100**	**5**	**28**	**17**	**421**	**73%**	**42%**	**6%**	**5%**	**10%**	**61%**

[1]Includes nests abandoned due to adult mortality.

Table 5. Summary of Piping Plover (*Charadrius melodus*) nesting parameters by year at Cape Cod National Seashore from 2003-2013.

Year	# Pairs	# Chicks Fledged	Productivity[1]	# Nests Laid	# Successful Nests	Nest Success Rate[2]	% Renests[3]	# Eggs Laid	# Eggs Hatched	Hatch Rate[4]	Fledge Rate[5]
2003	84	130	1.55	121	54	45%	31%	450	189	42%	69%
2004	85.5	124	1.45	115	59	51%	26%	425	220	52%	56%
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%
mean	84	103	1.24	126	55	48%	31%	422	189	48%	53%
median	84	122	1.45	115	59	51%	26%	386	210	52%	53%
min	74	30	0.30	96	27	13%	20%	336	72	11%	32%
max	99	157	1.85	212	70	73%	53%	636	243	69%	69%

[1]number of chicks fledged/number of nesting pairs.

[2]number of successful nests/total number of nests.

[3]number of renests (including continuation nests)/total # nests .

[4]number of eggs hatched/total number of eggs laid.

[5]number of chicks fledged/number of eggs hatched.

Table 6. Number of Piping Plover (*Charadrius melodus*) breeding pairs, annual nest productivity, and 5-year weighted average productivity, at Cape Cod National Seashore from 1985-2013.

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

Table 7. Number of Least Tern (*Sternula antillarum*) pairs, and fledging success, at 11 colony sites at Cape Cod National Seashore in 2013.

	A Count[1]	B Count[2]	# Chicks Fledged
Armstrong	0	3	1
Ballston	0	4	0
Coast Guard, Eastham	46	38	0
Great Island	2	20	0
Head of the Meadow	29	0	0
High Head	0	5	0
Jeremy Point	16	1	0
Marconi Beach	8	21	1
Mission Bell (part of Race Point South)	6	0	0
Old Harbor (part of Race Point South)	1	0	0
Race Point North	29	18	0
Wood End	1	1	0
Totals	138	111	2

[1]"A-Counts" are taken within the state census wind of June 5-20.
[2]"B-Counts" are taken outside the state census window; after June 20.

Table 8. Migratory shorebird observations at Cape Cod National Seashore in 2013, 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
8/1/13	Race Point North	LESA, PIPL, SAND, SEPL, SESA	mixed flock, 1000s observed
8/9/13	High Head	BBPL, LESA, PIPL, SAND, SEPL, SESA	mixed flock, ~2,500
8/17/13	Marconi Beach, White Crest	SEPL, SESA	mixed flock, ~700
8/22/13	High Head	REKN	200
8/29/13	High Head, Armstrong	LESA RUTU SAND SEPL SESA	300 50 1,050 250 500
8/30/13	Jeremy Point	SEPL SAND	50 160
9/12/13	Jeremy Point	SAND BBPL	300 100
9/18/13	Armstrong	BBPL PIPL SEPL SESA	2 19 200 25
	Lecount Hollow	SEPL, SESA	385

Table 9. Summary of Piping Plover (*Charadrius melodus*) adult mortality, by nest predator exclosure type used, at Cape Cod National Seashore from 2003-2013.

Year	# Circular Erected	# Deaths	Rate[1]	# Canopy Erected	# Deaths	Rate[2]
2003	57	2	4%	0	0	0%
2004	57	3	5%	5	0	0%
2005	35	1	3%	12	0	0%
2006	32	1	3%	46	0	0%
2007	27	1	4%	52	1	2%
2008	15	0	0%	50	3	6%
2009	39	0	0%	38	2	5%
2010	49	0	0%	29	0	0%
2011	43	1	2%	26	2	8%
2012	0	0	0%	0	0	0%
2013	0	0	0%	0	0	0%

[1]number of deaths related to circular exclosure use/total number of circular exclosures used.
[2]number deaths related to canopy exclosure use/total number of canopy exclosures used.

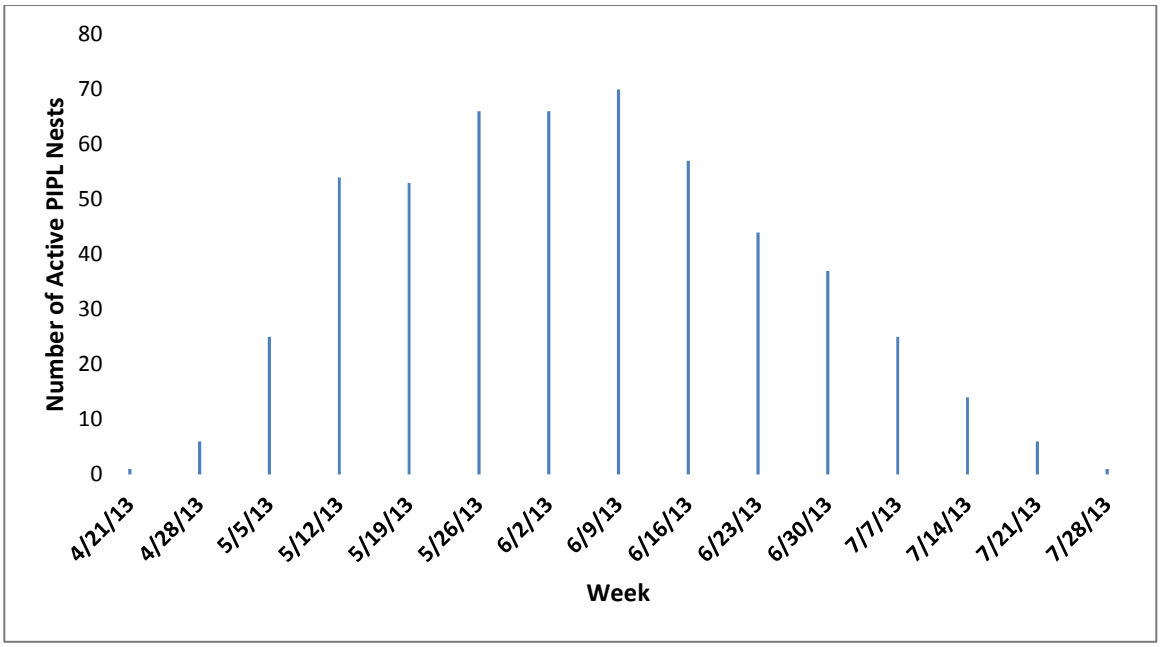


Figure 1. Active Piping Plover (*Charadrius melodus*) nests, by week, in 2013 at Cape Cod National Seashore.

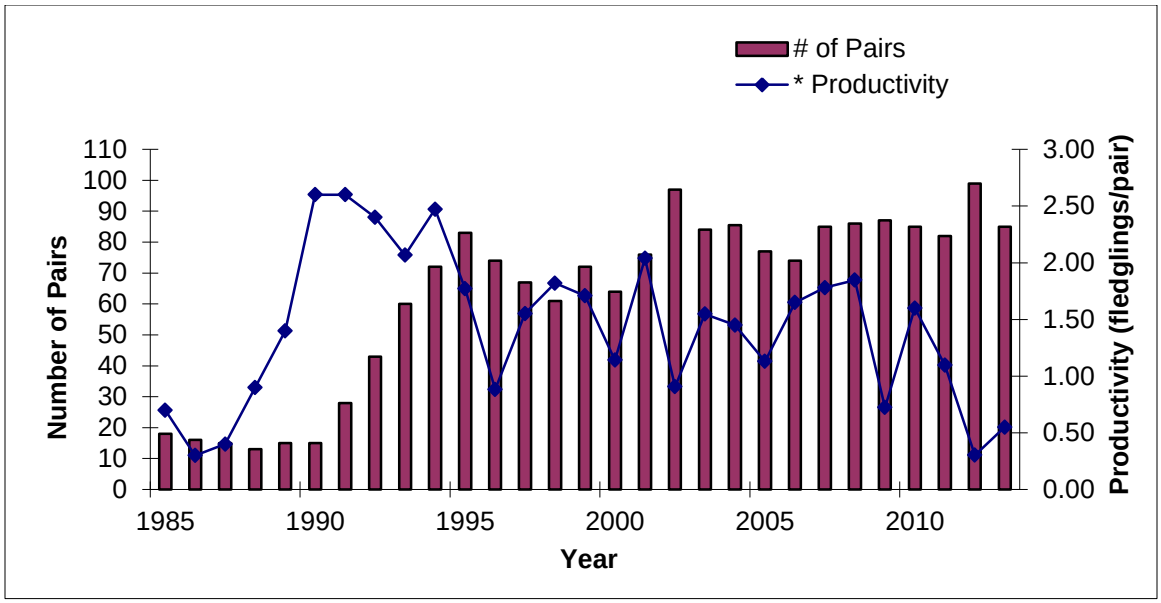


Figure 2. Number of Piping Plover (*Charadrius melodus*) pairs, and nest productivity, at Cape Cod National Seashore from 1985 – 2013.

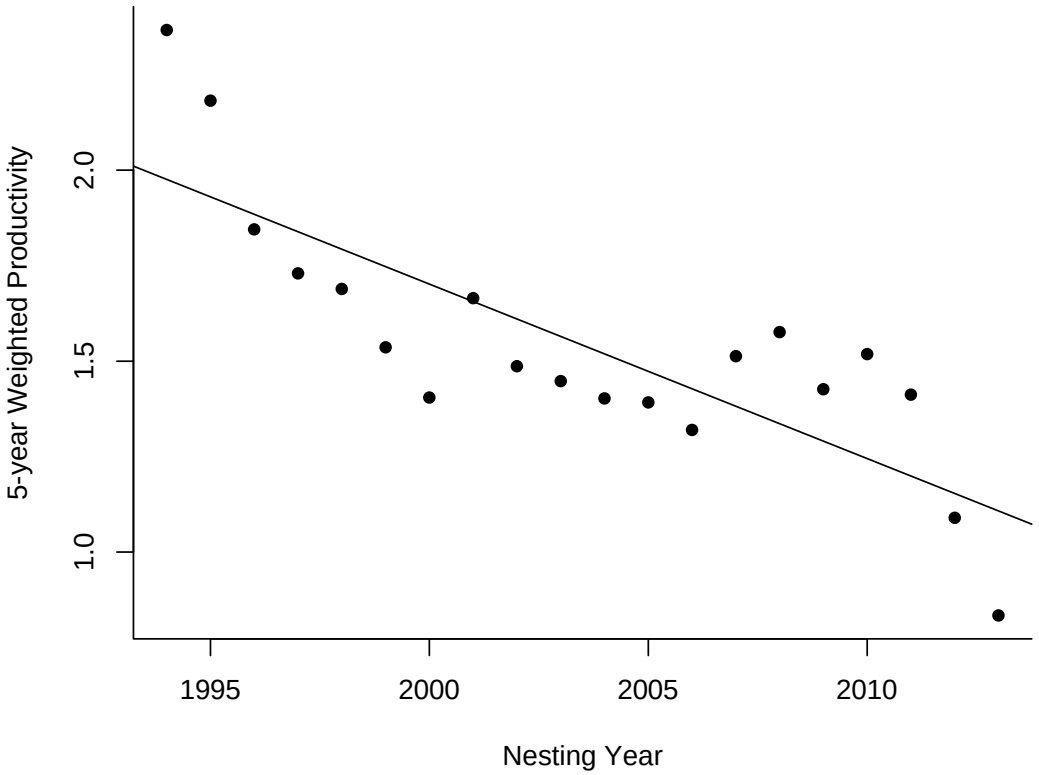


Figure 3. Piping Plover (*Charadrius melodus*) 5-year productivity regression, Cape Cod National Seashore, 1994-2013 (y = - 0.0457*x + 93.0439).

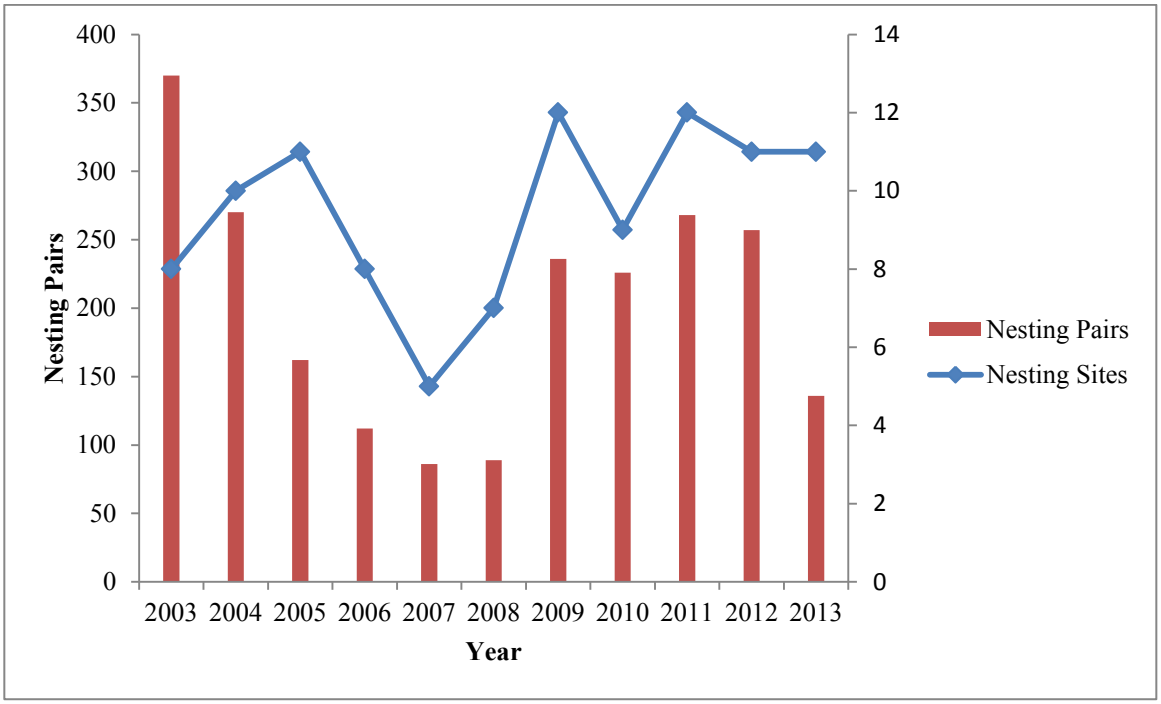
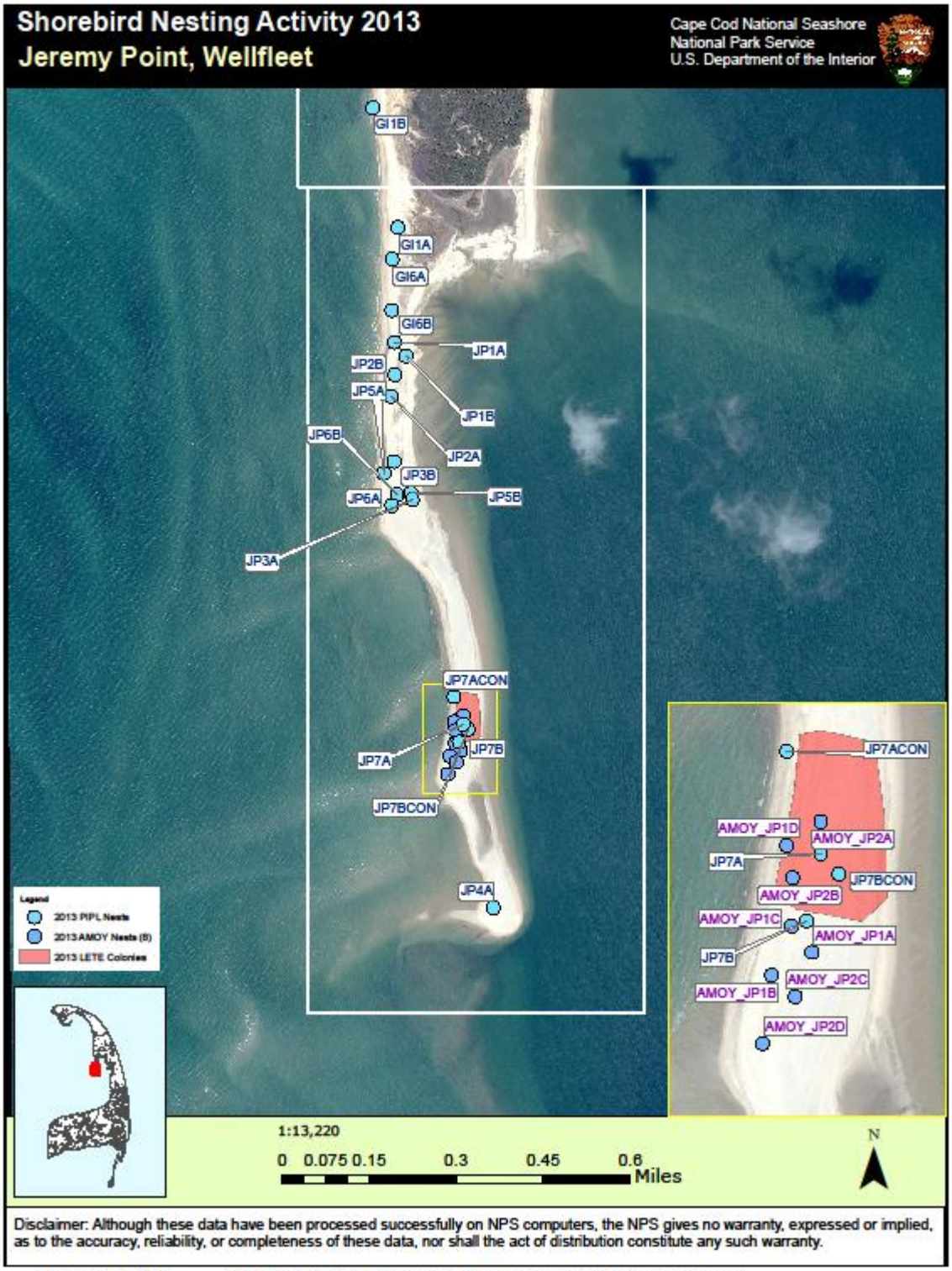


Figure 4. Number of Least Tern (*Sternula antillarum*) pairs, and number of Least Tern nesting sites, by year on Cape Cod National Seashore from 2003-2013.

Appendix A. Maps of 2013 Piping Plover, Least Tern, Common Tern and American Oystercatcher Nest Sites at Cape Cod National Seashore.



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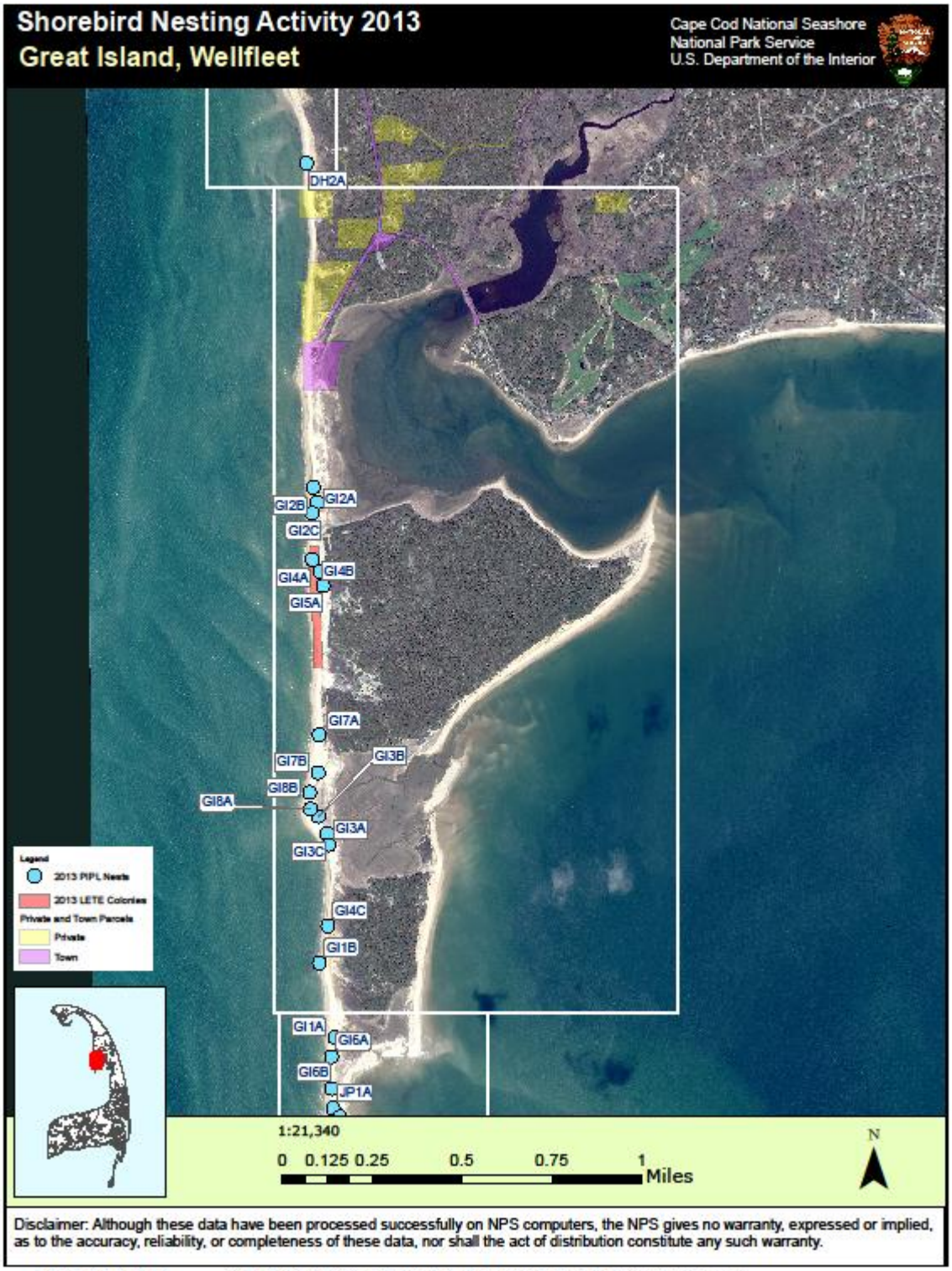

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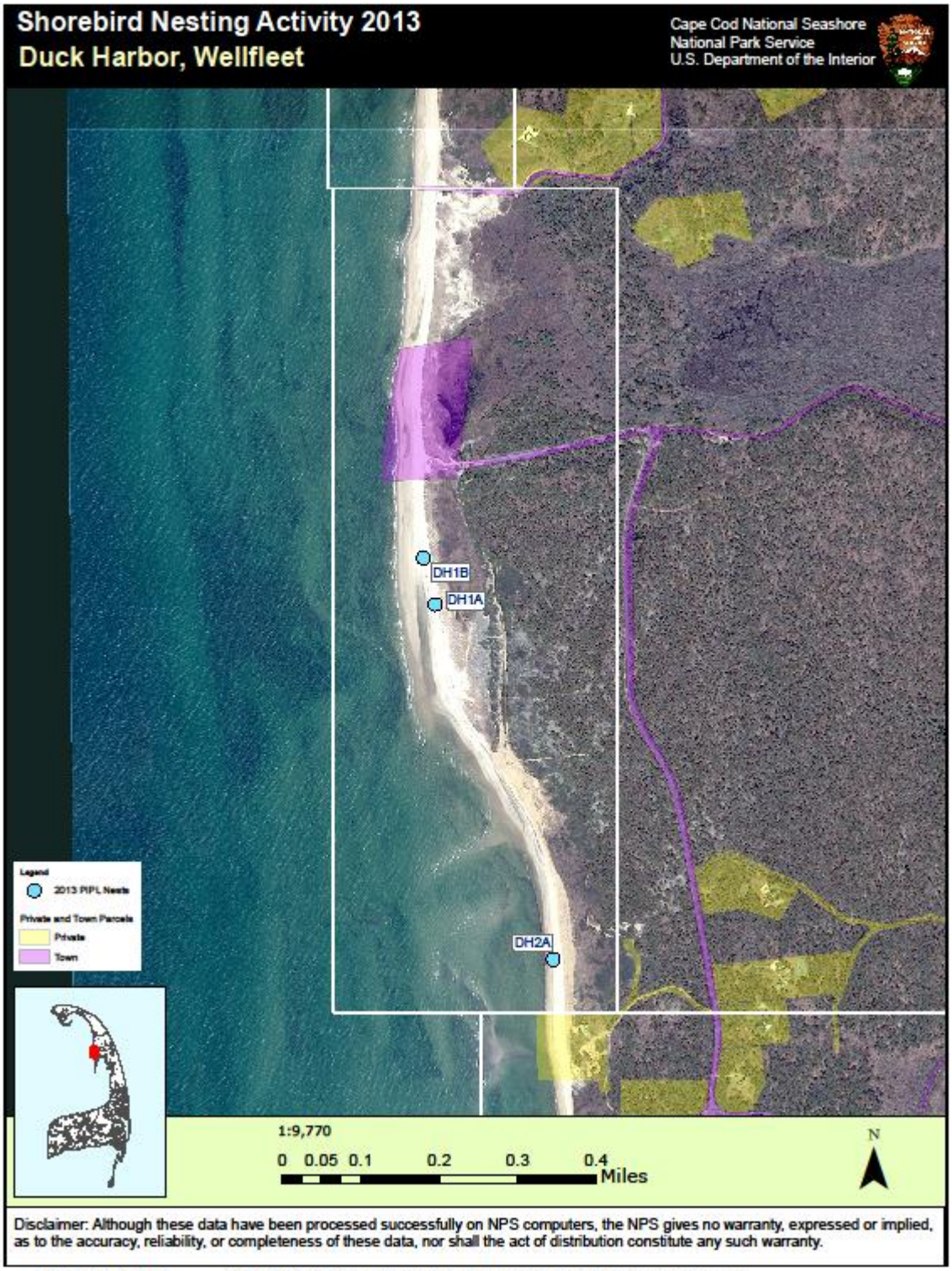

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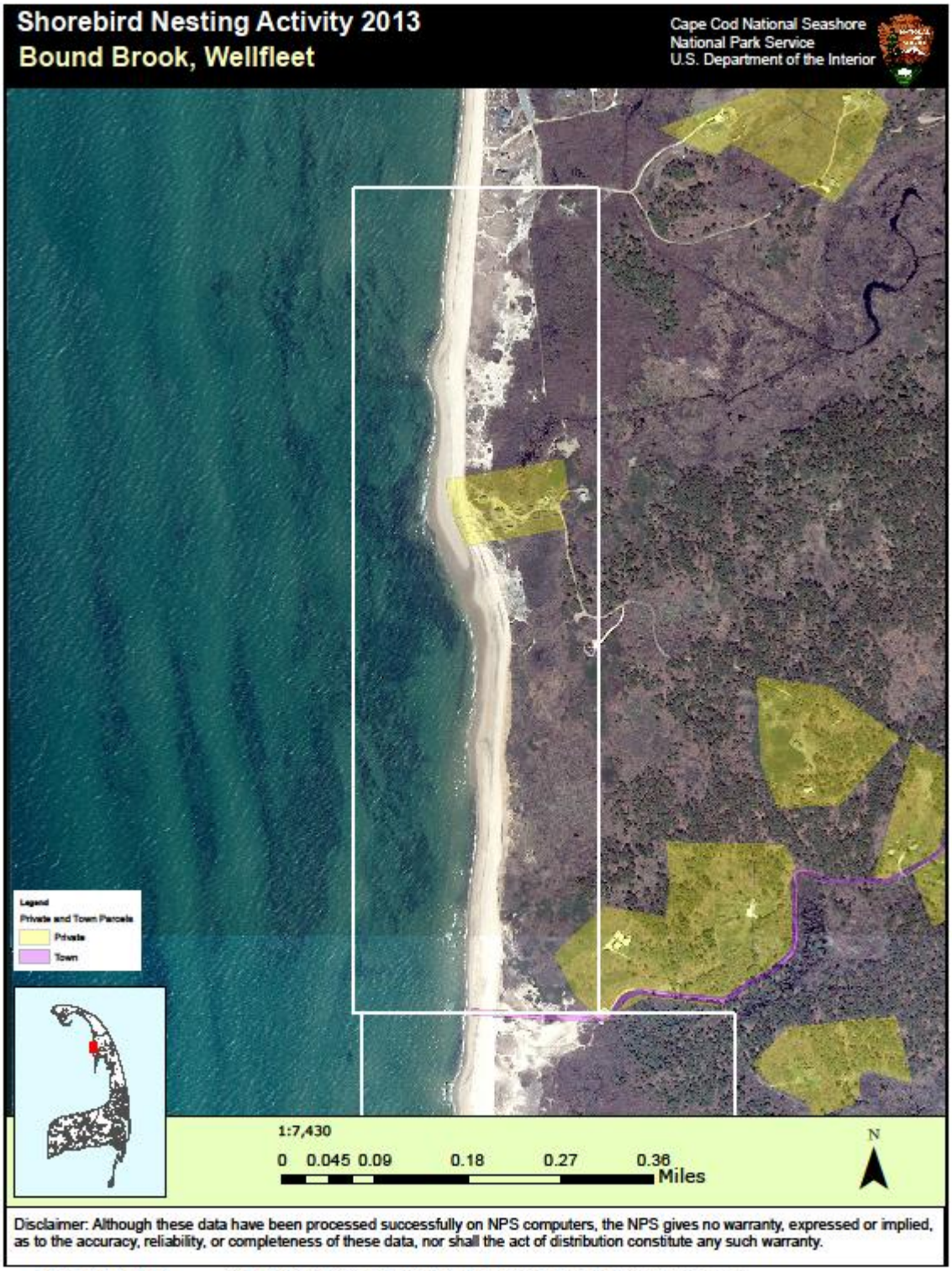

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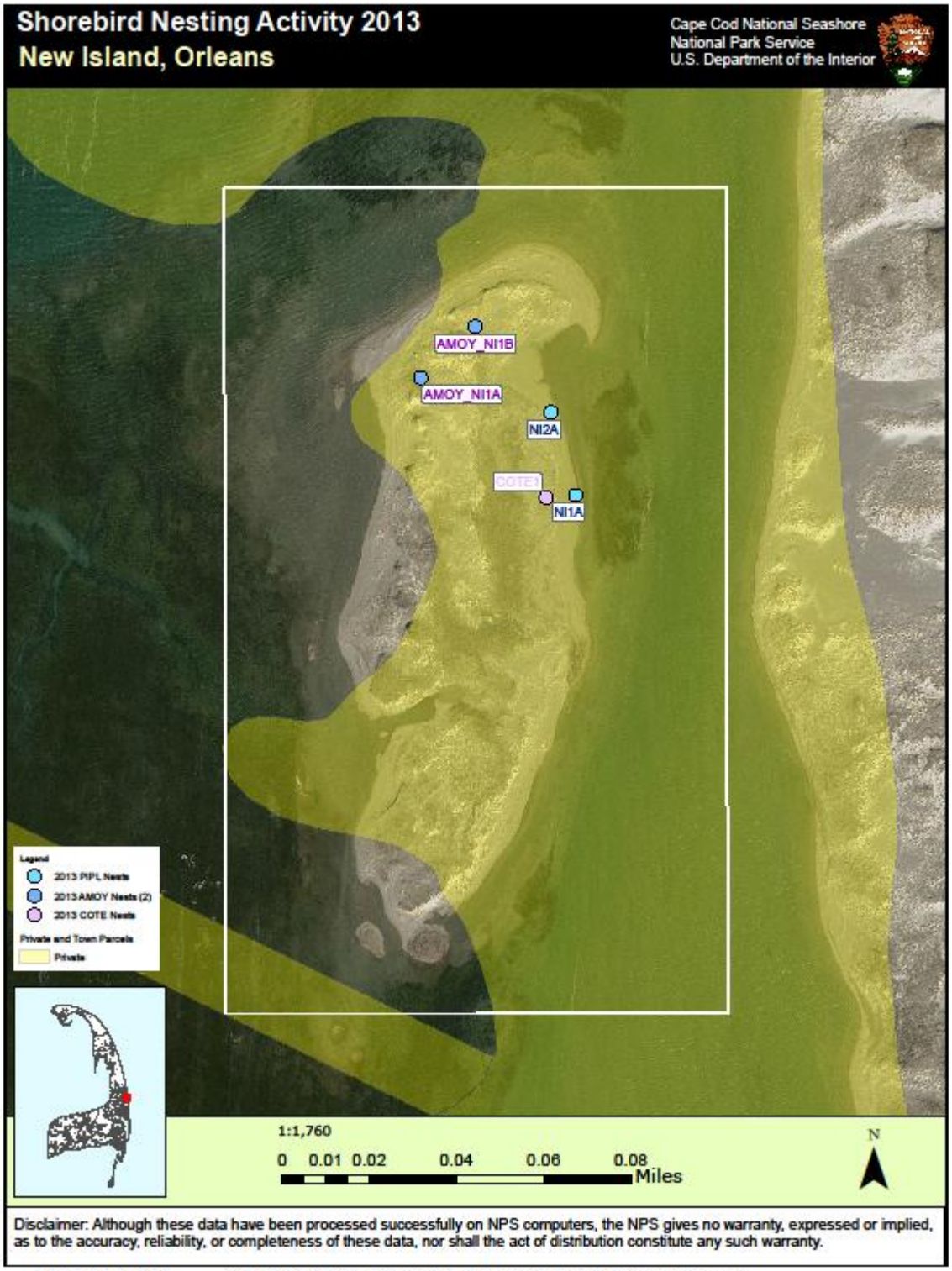

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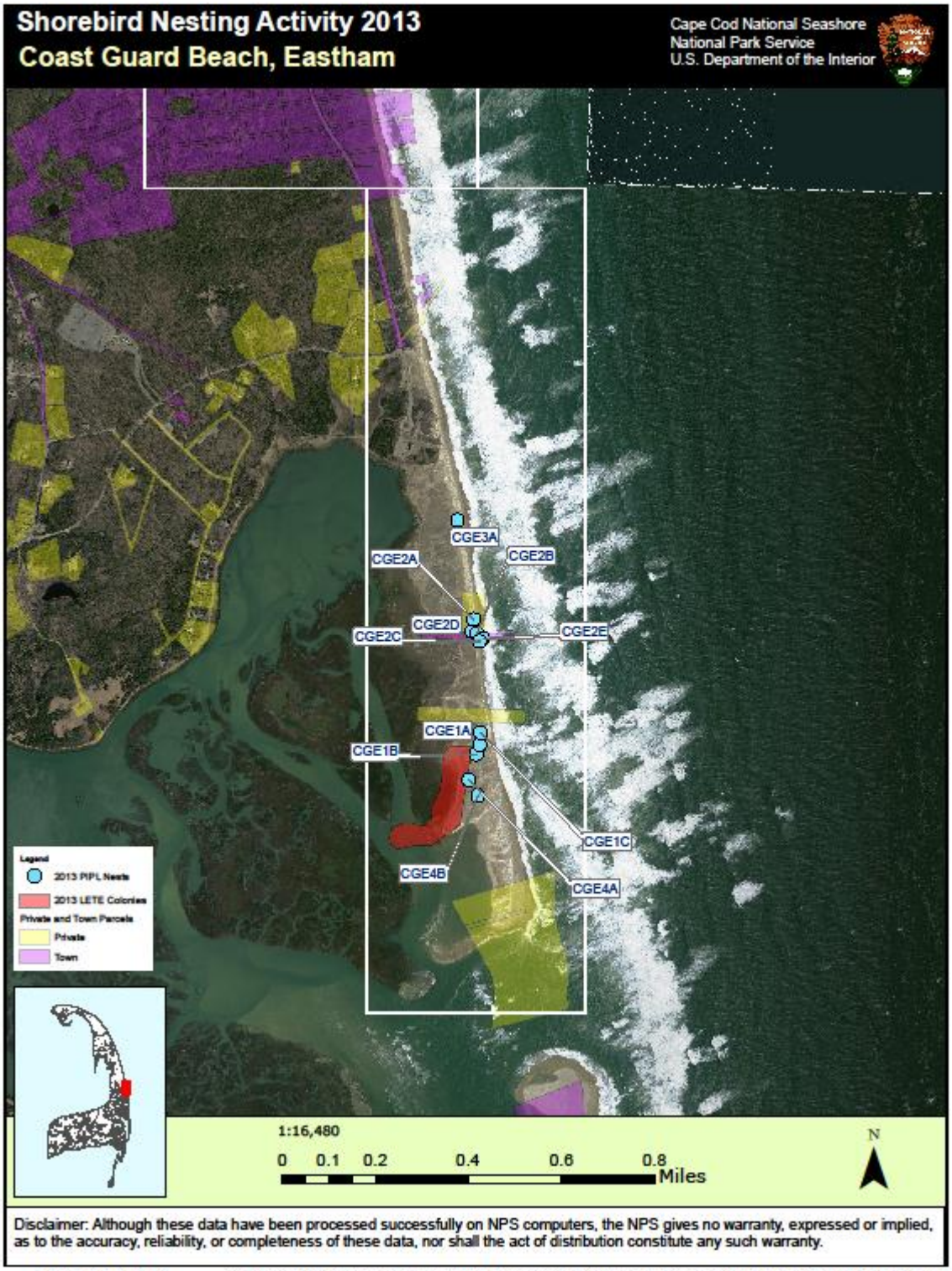

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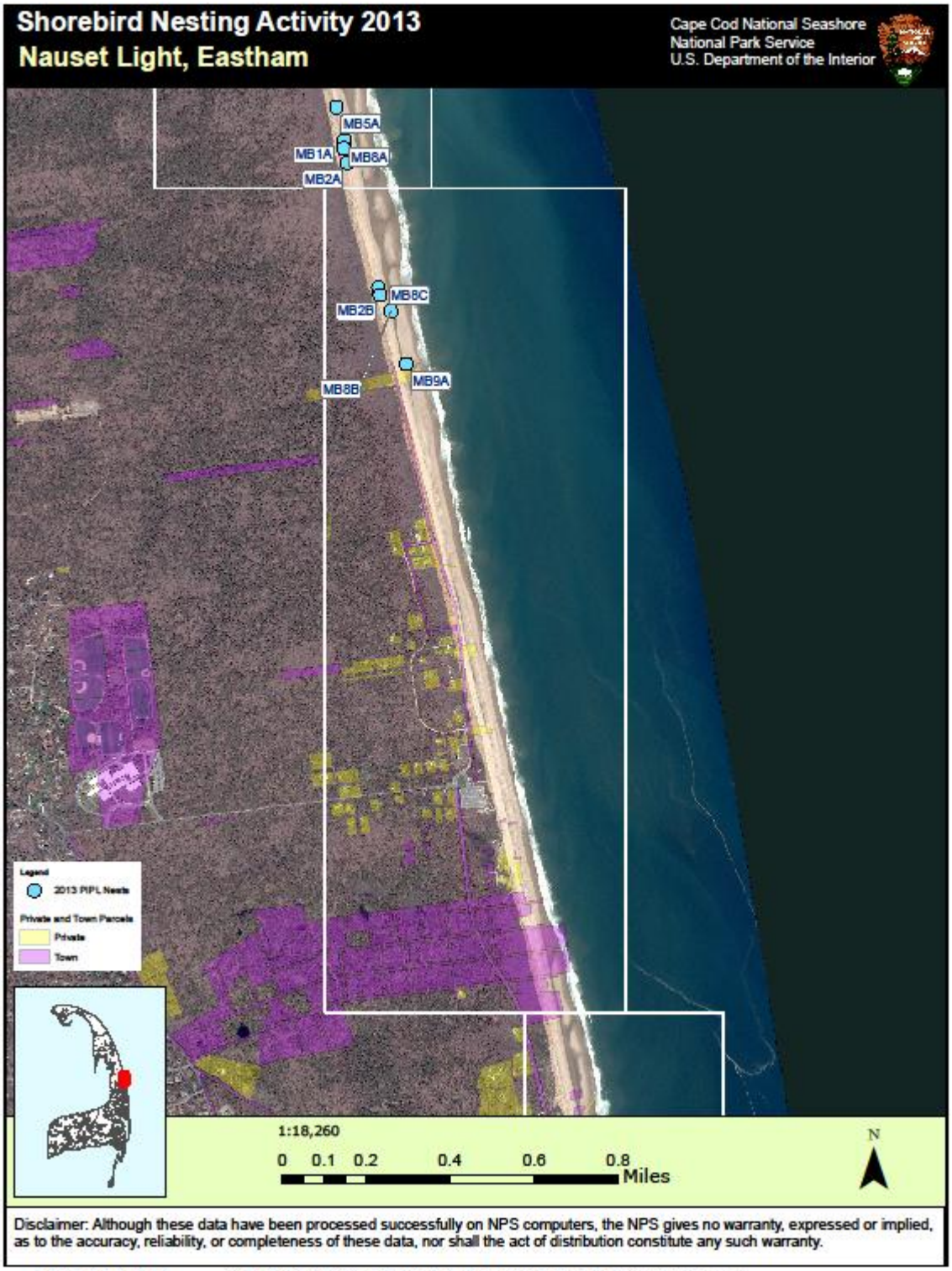

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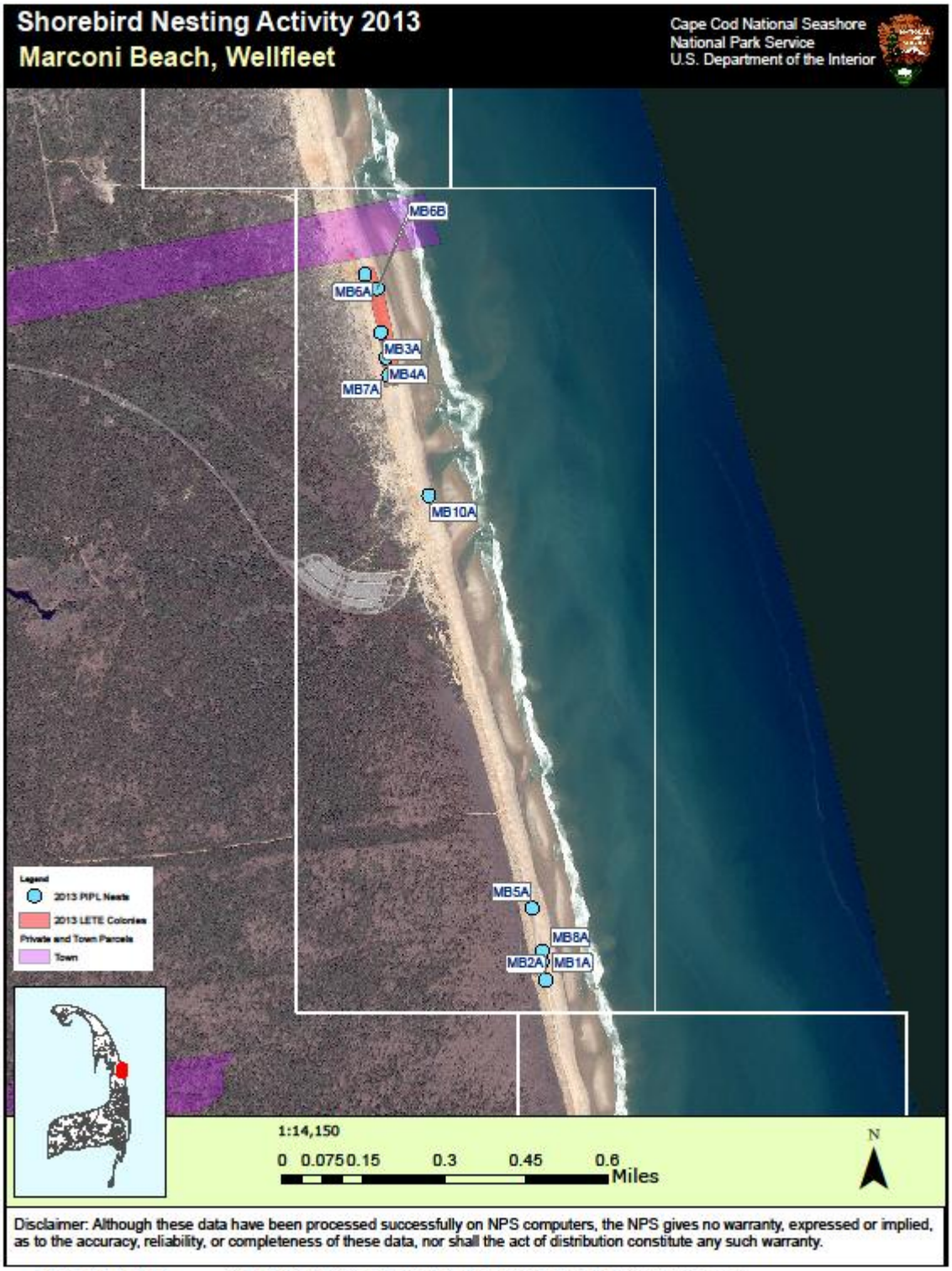

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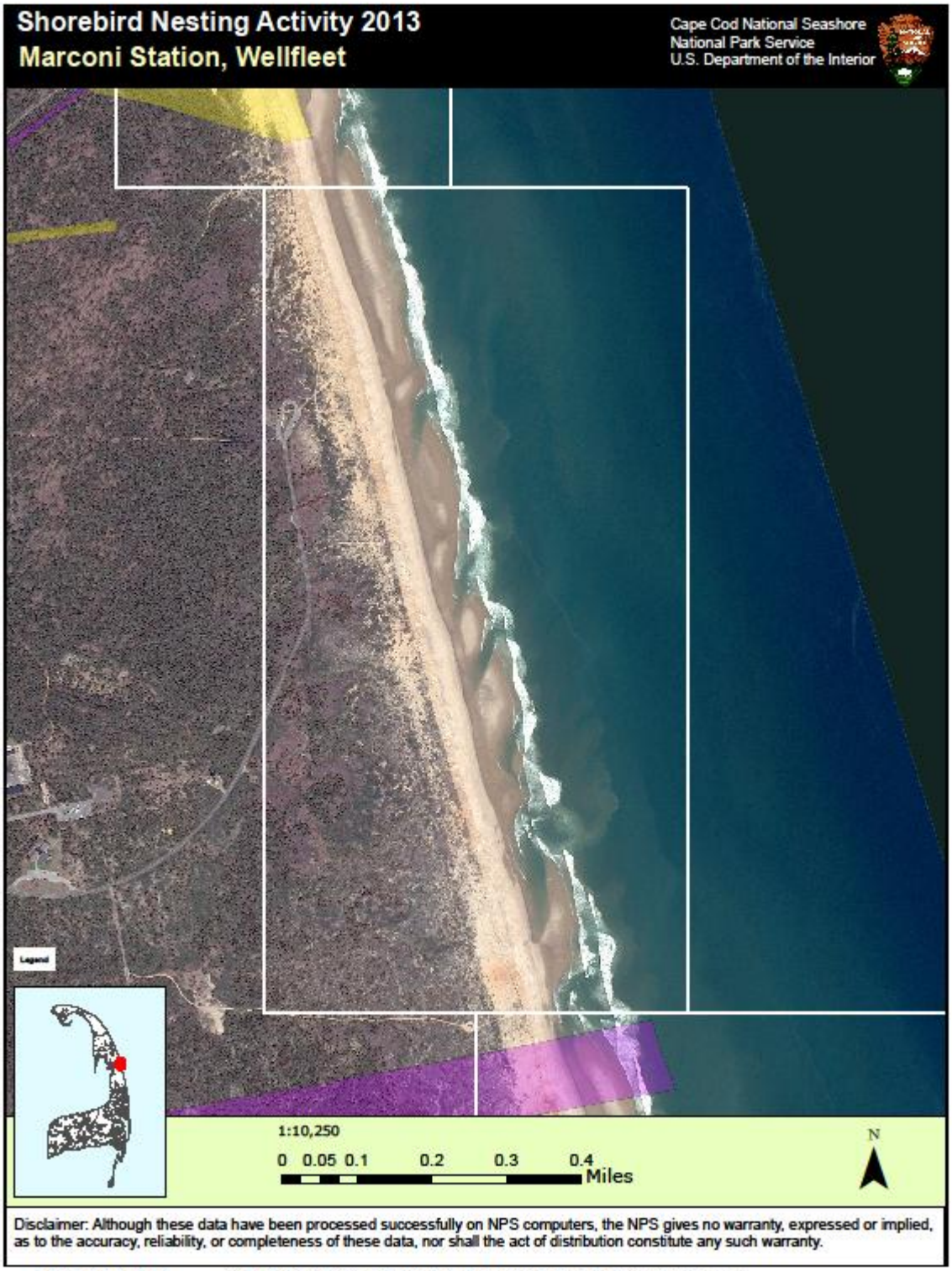

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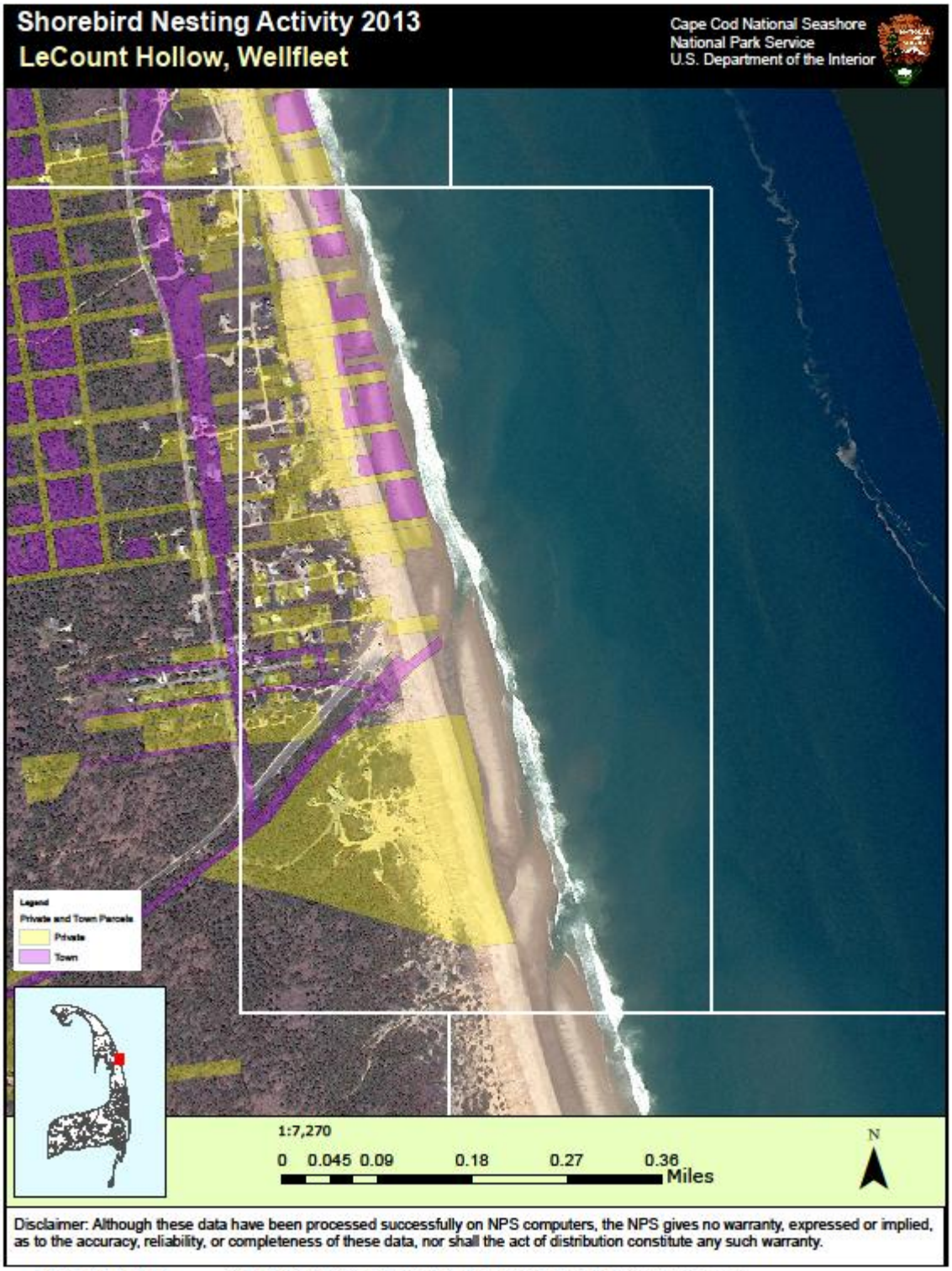

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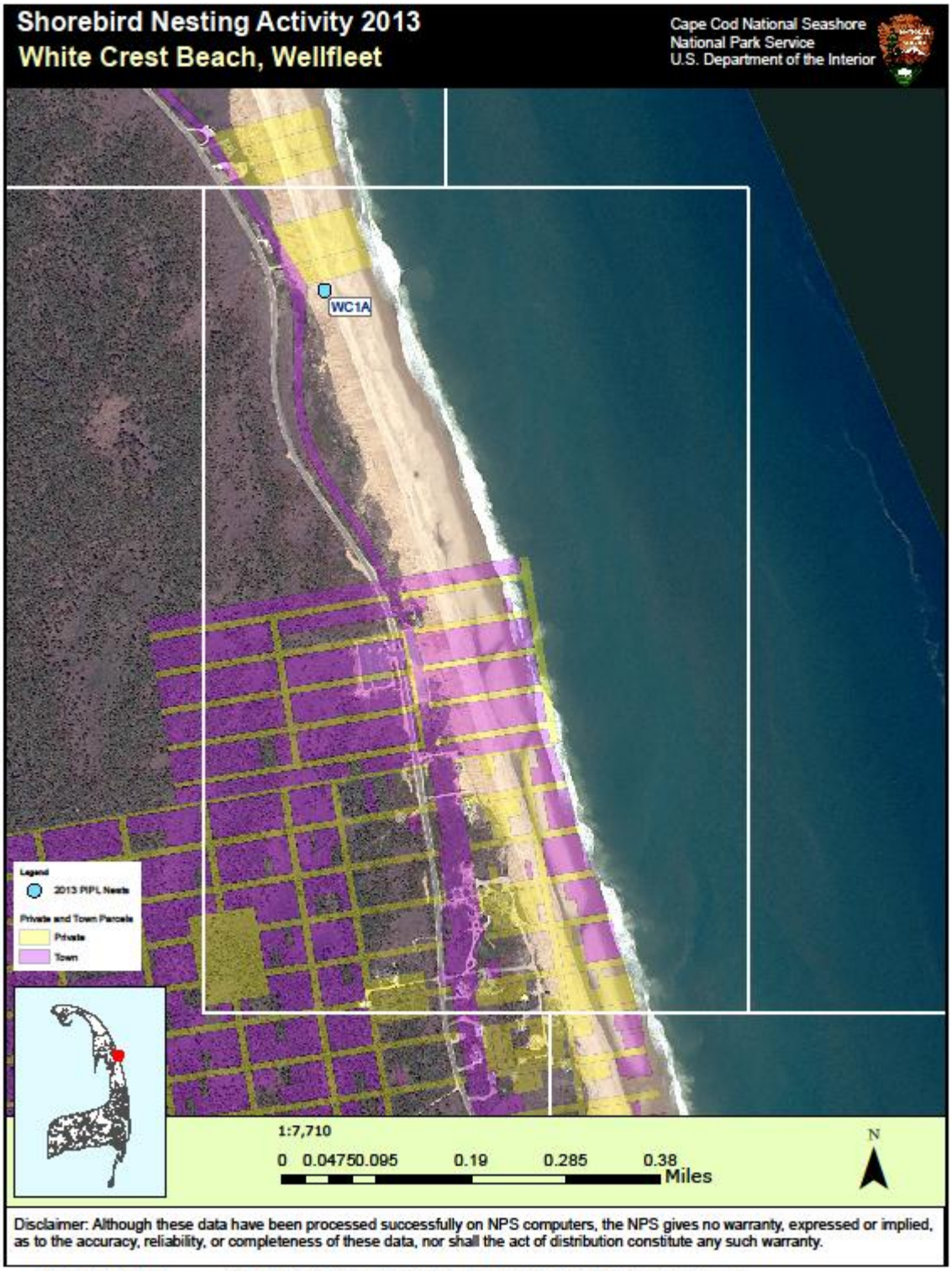

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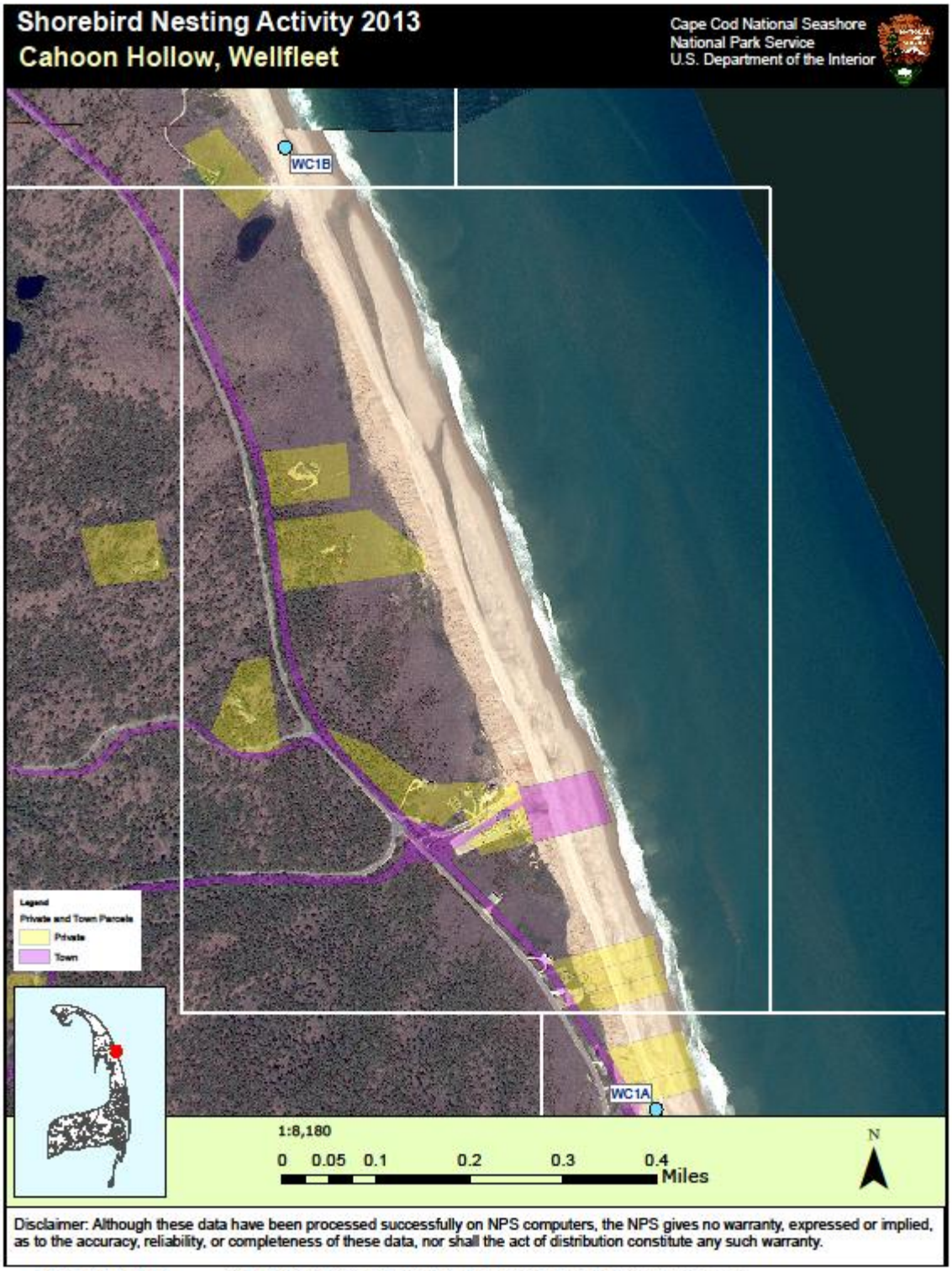

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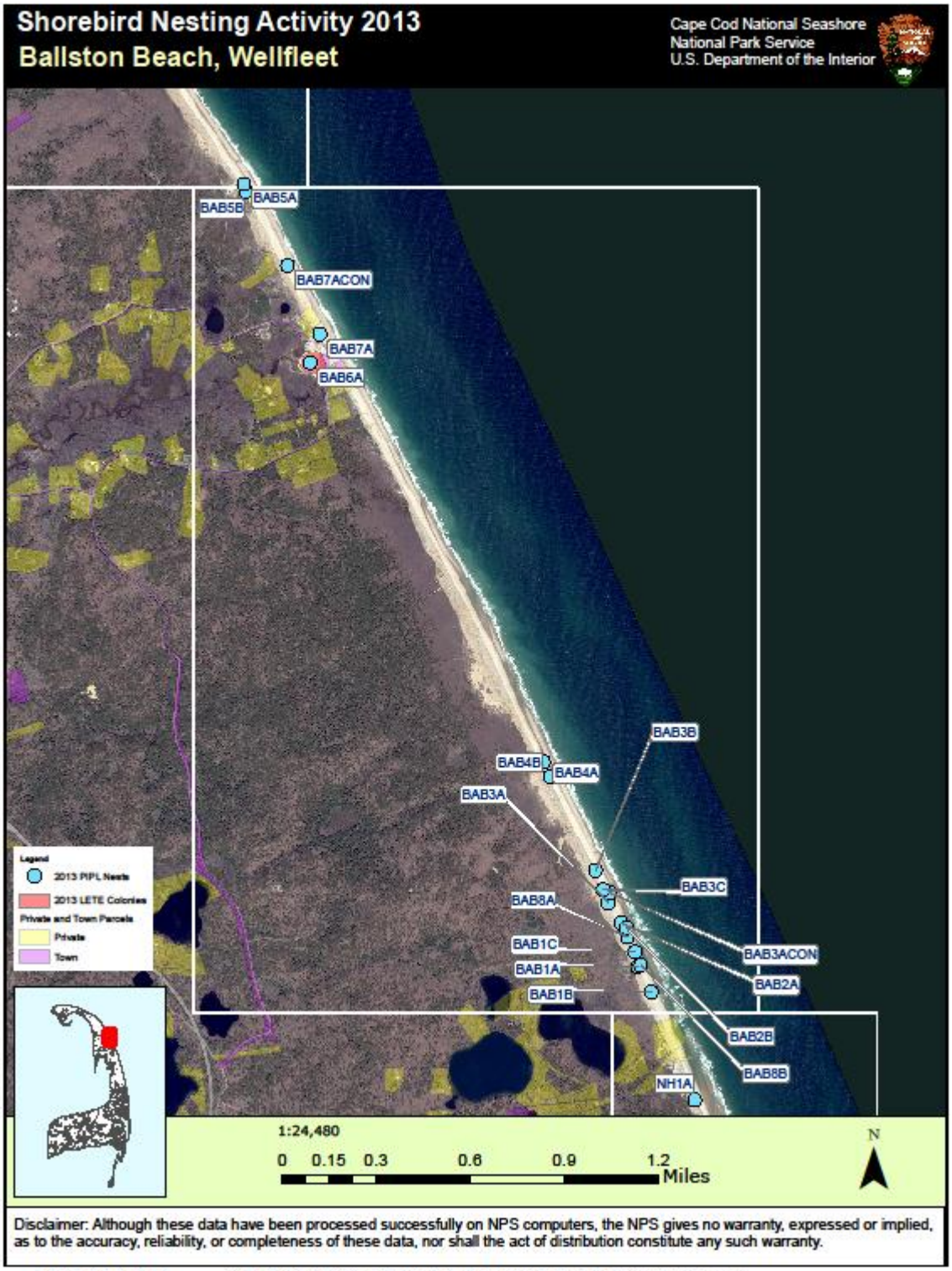

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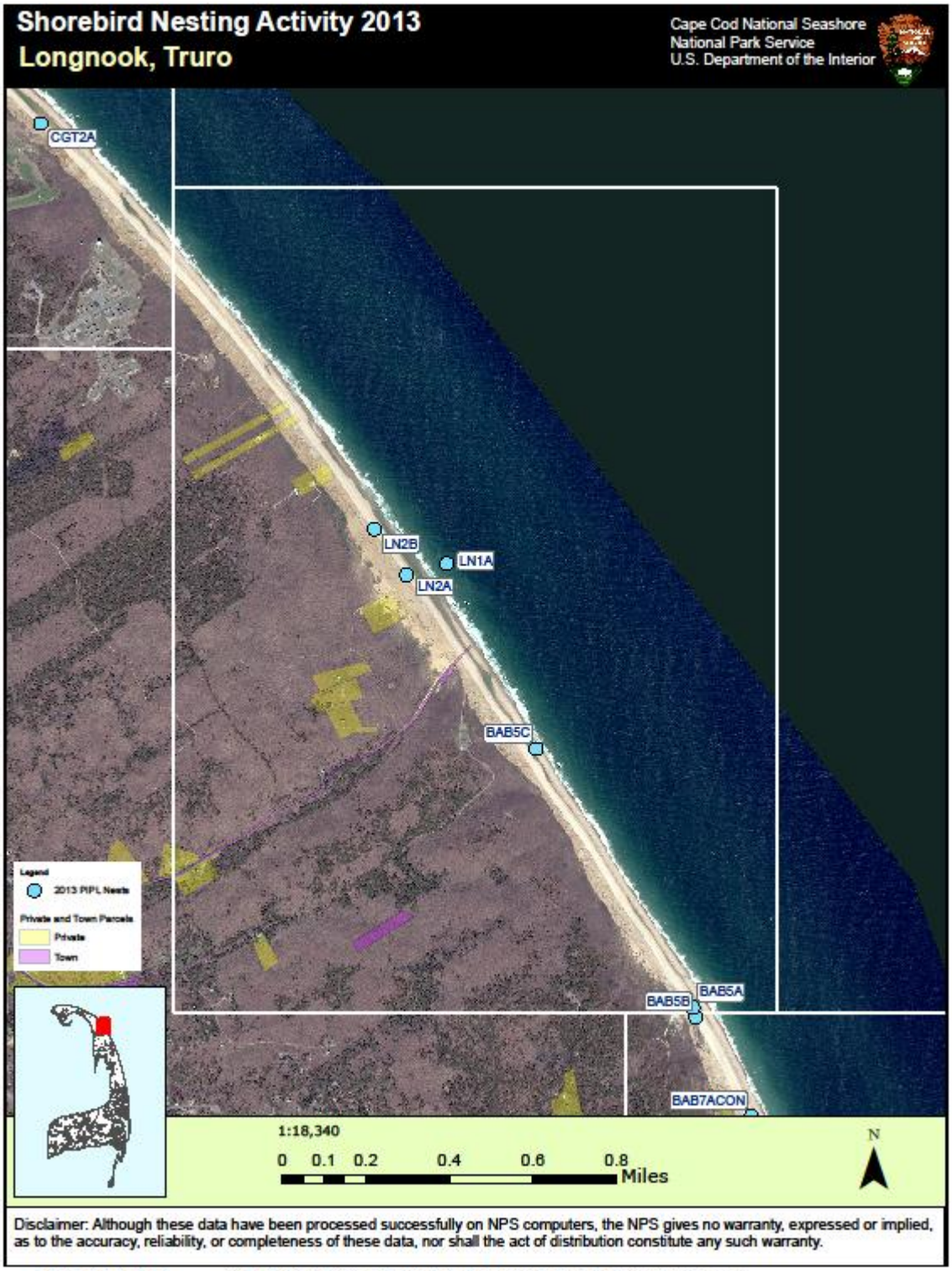

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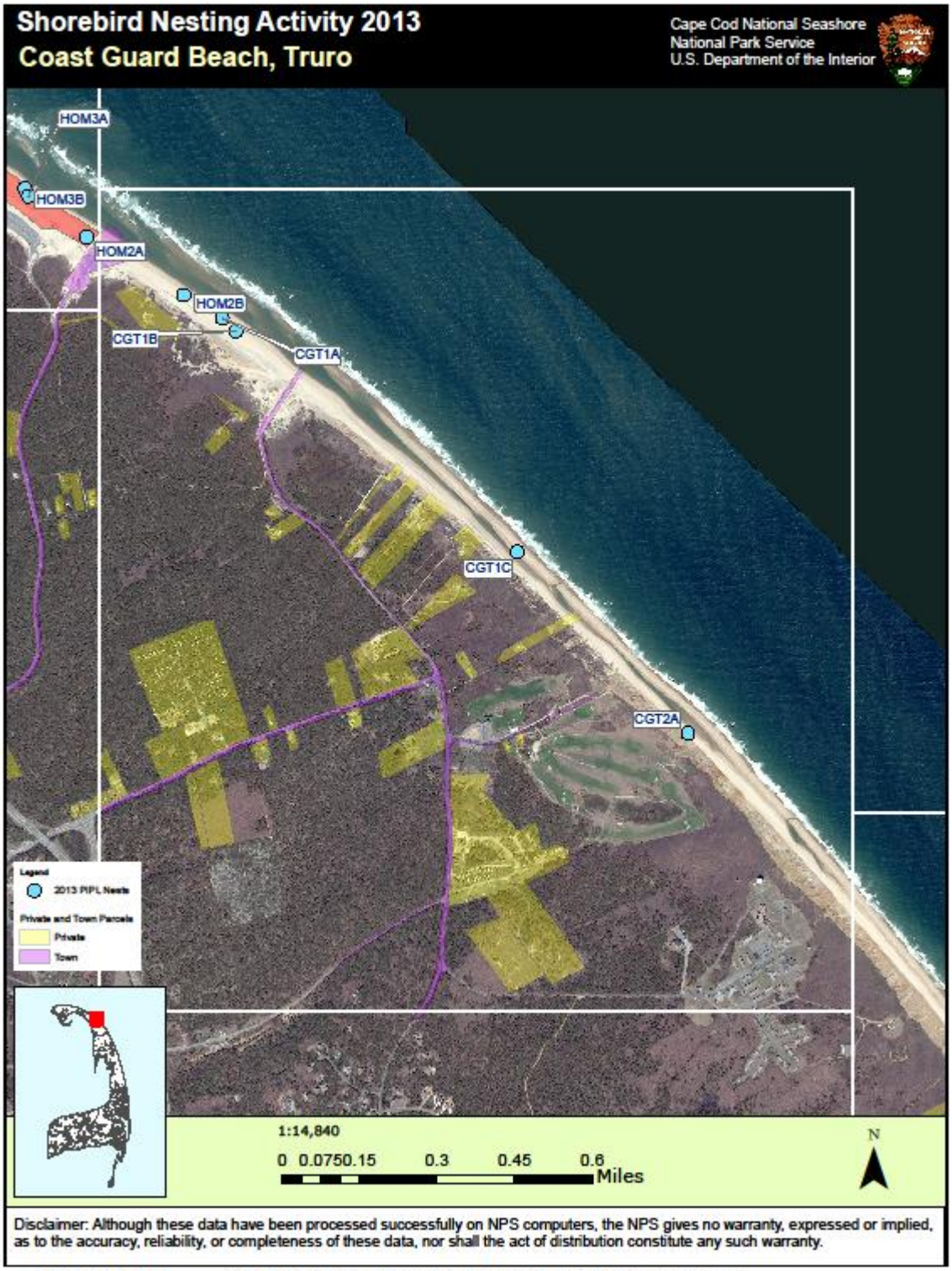

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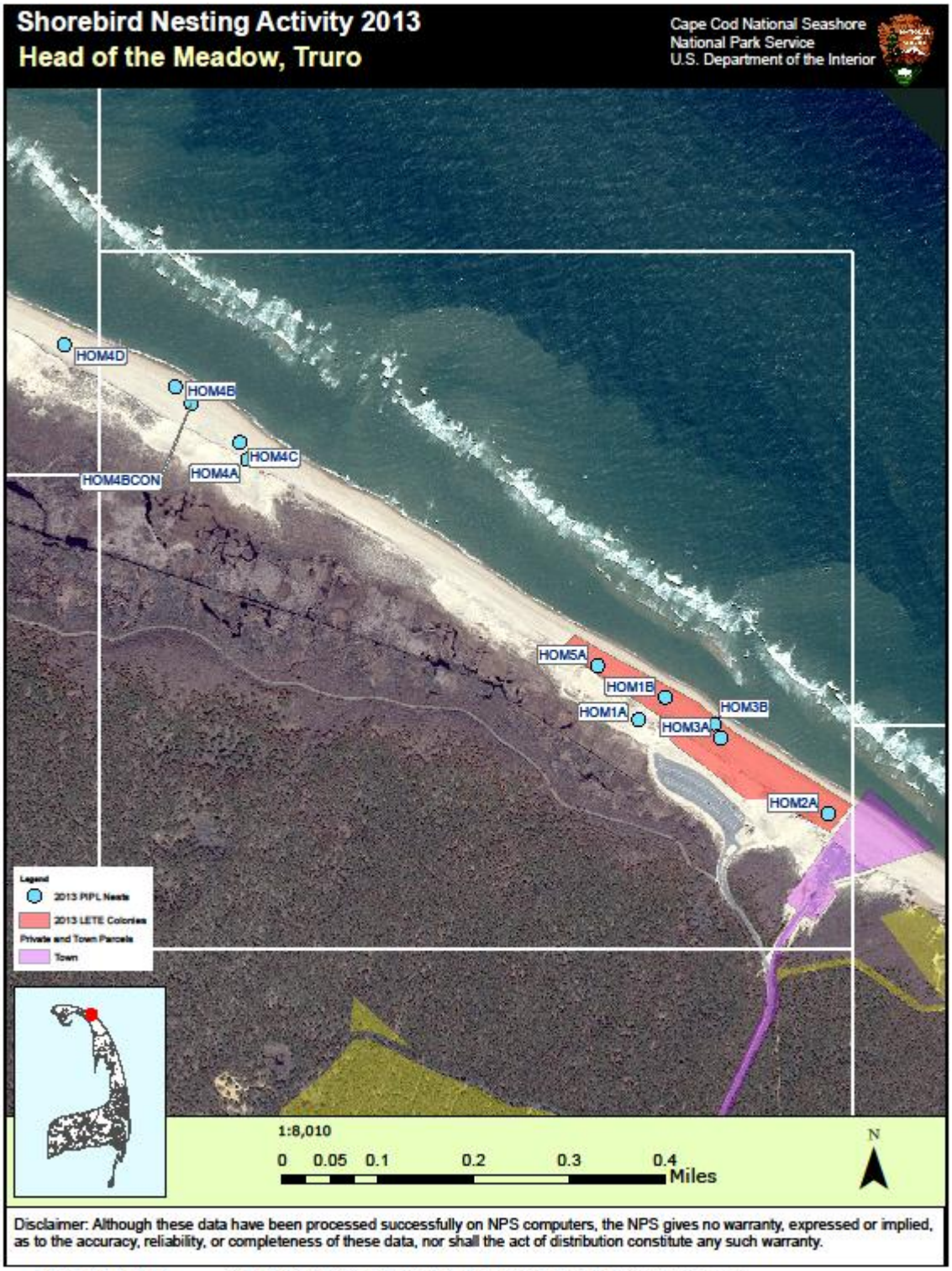

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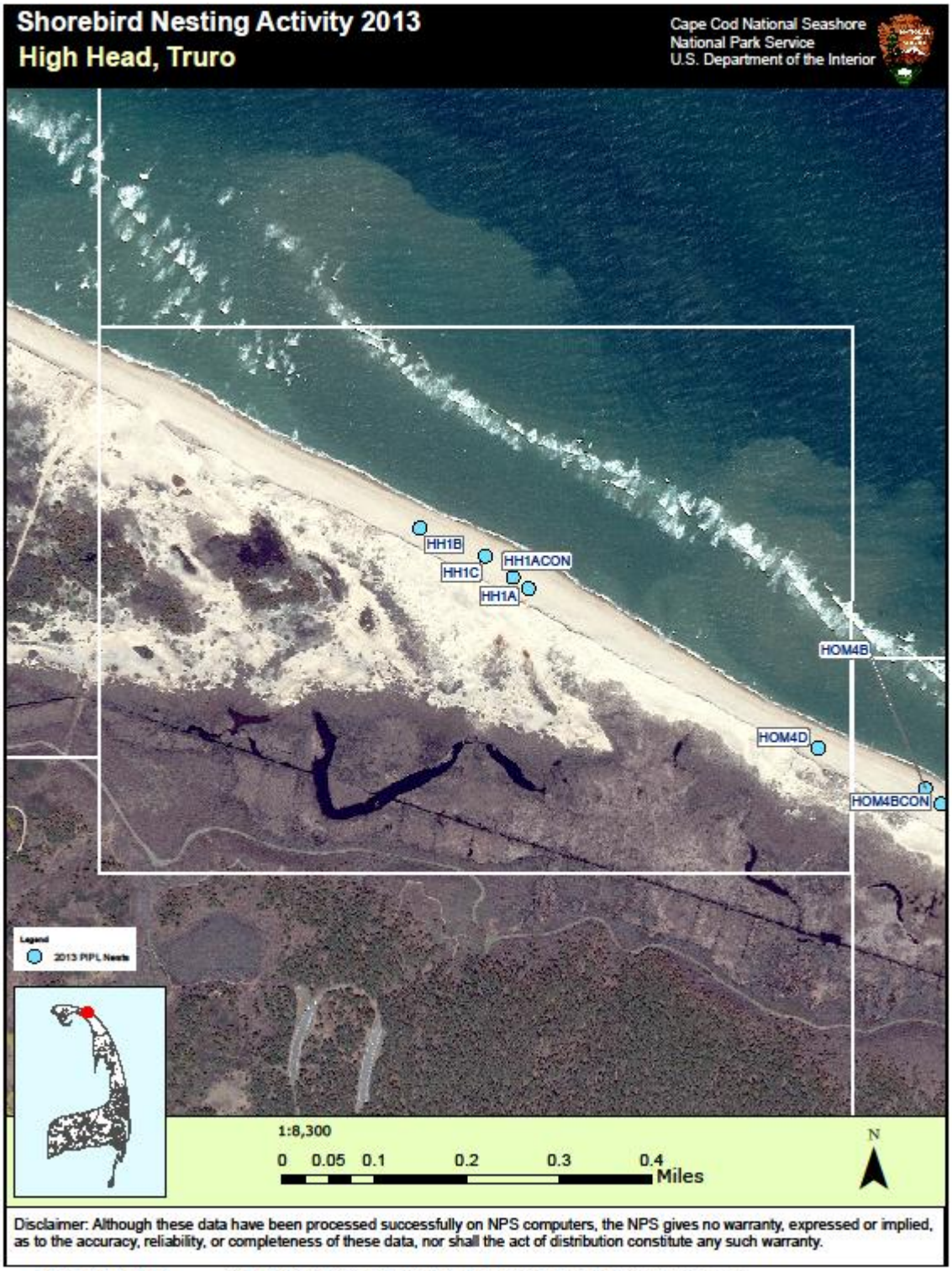

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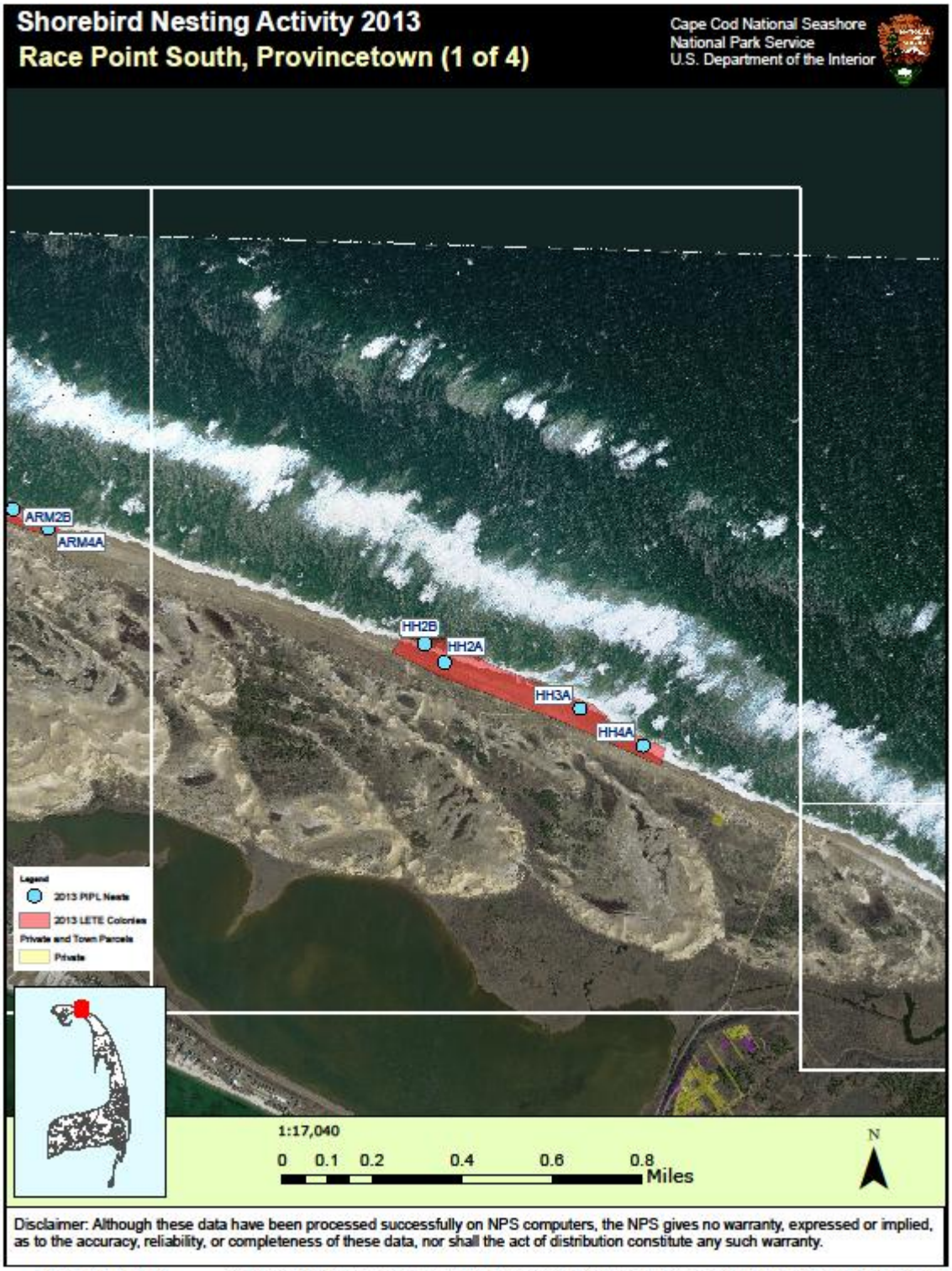

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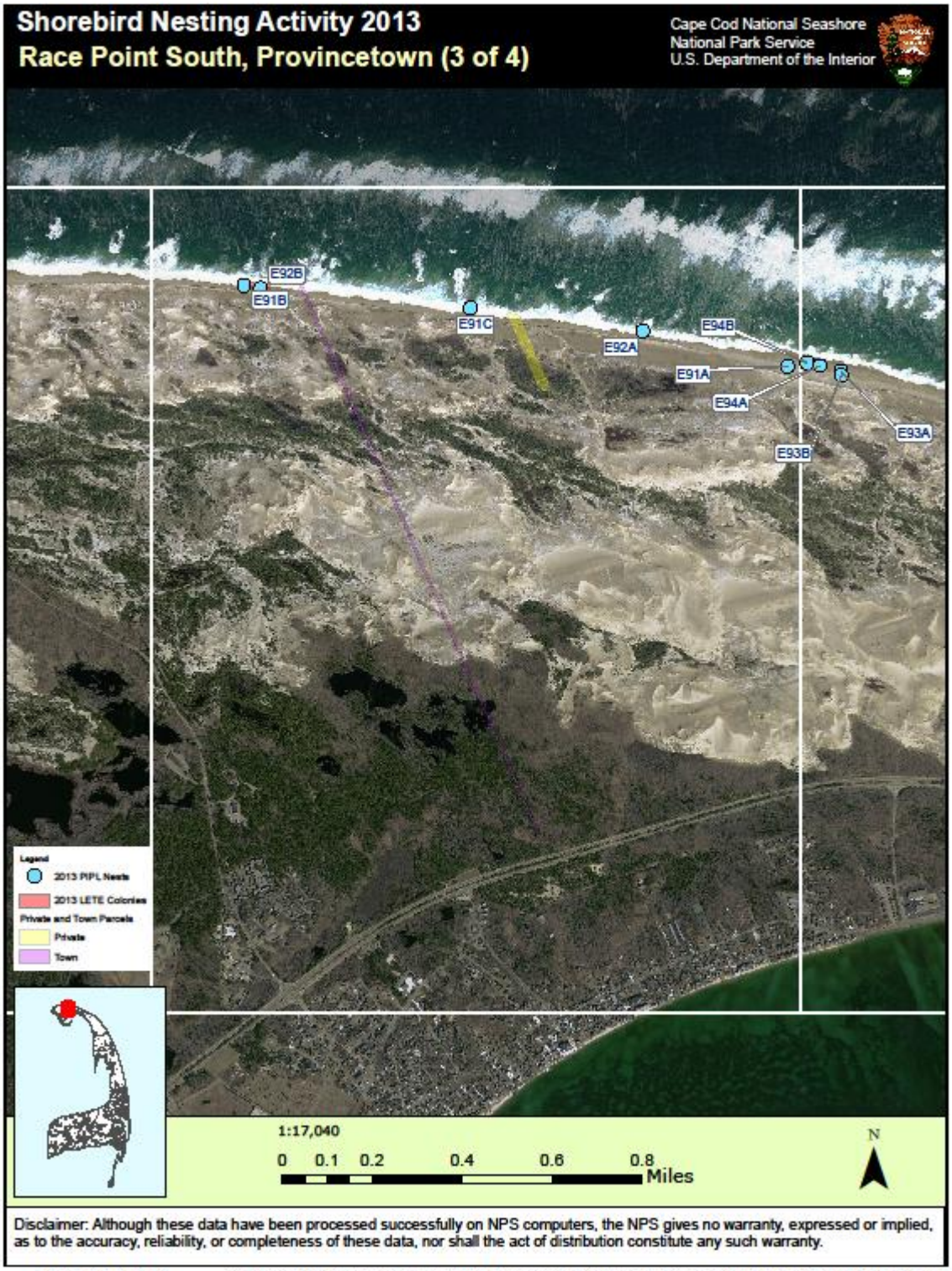

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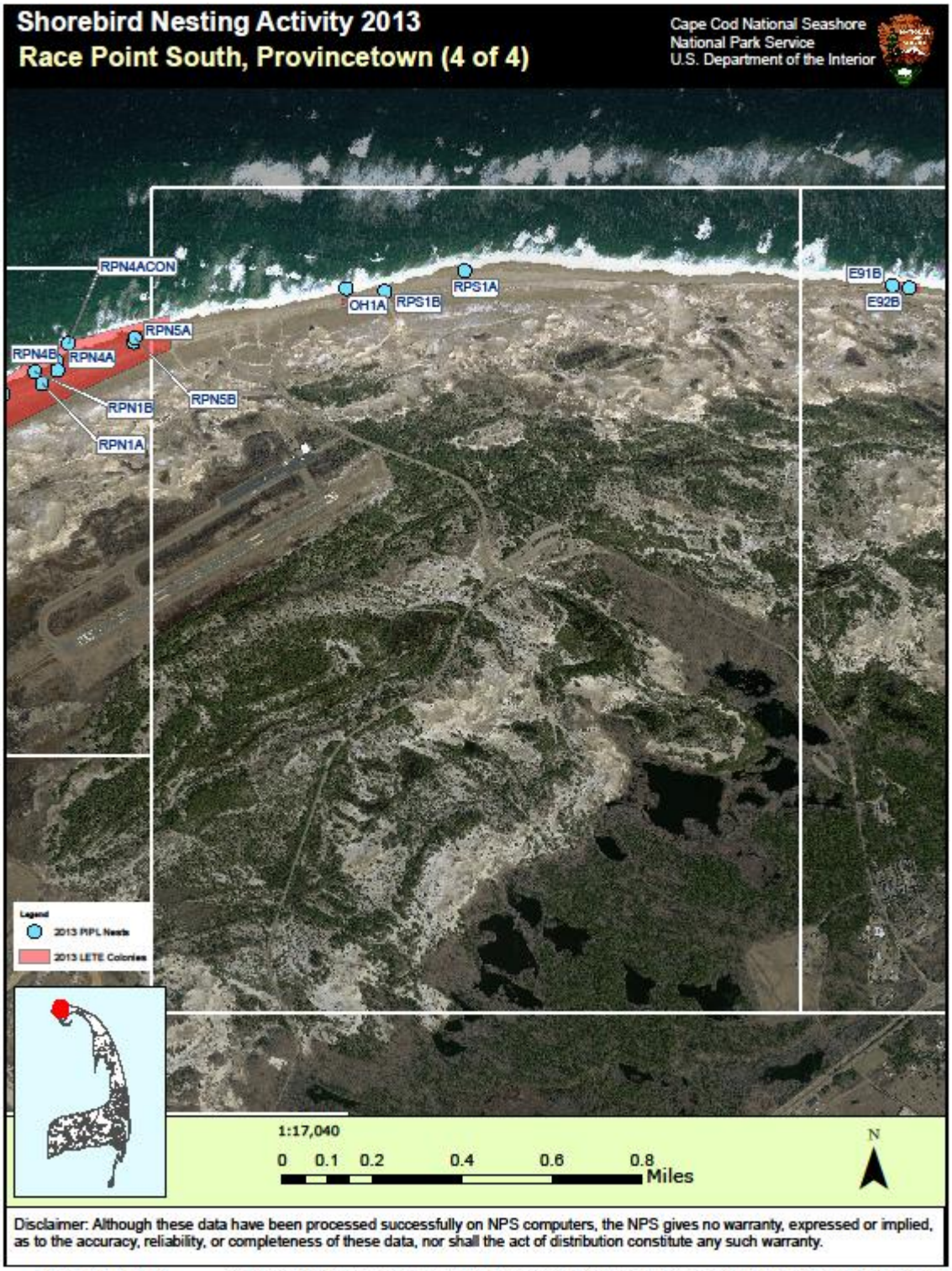

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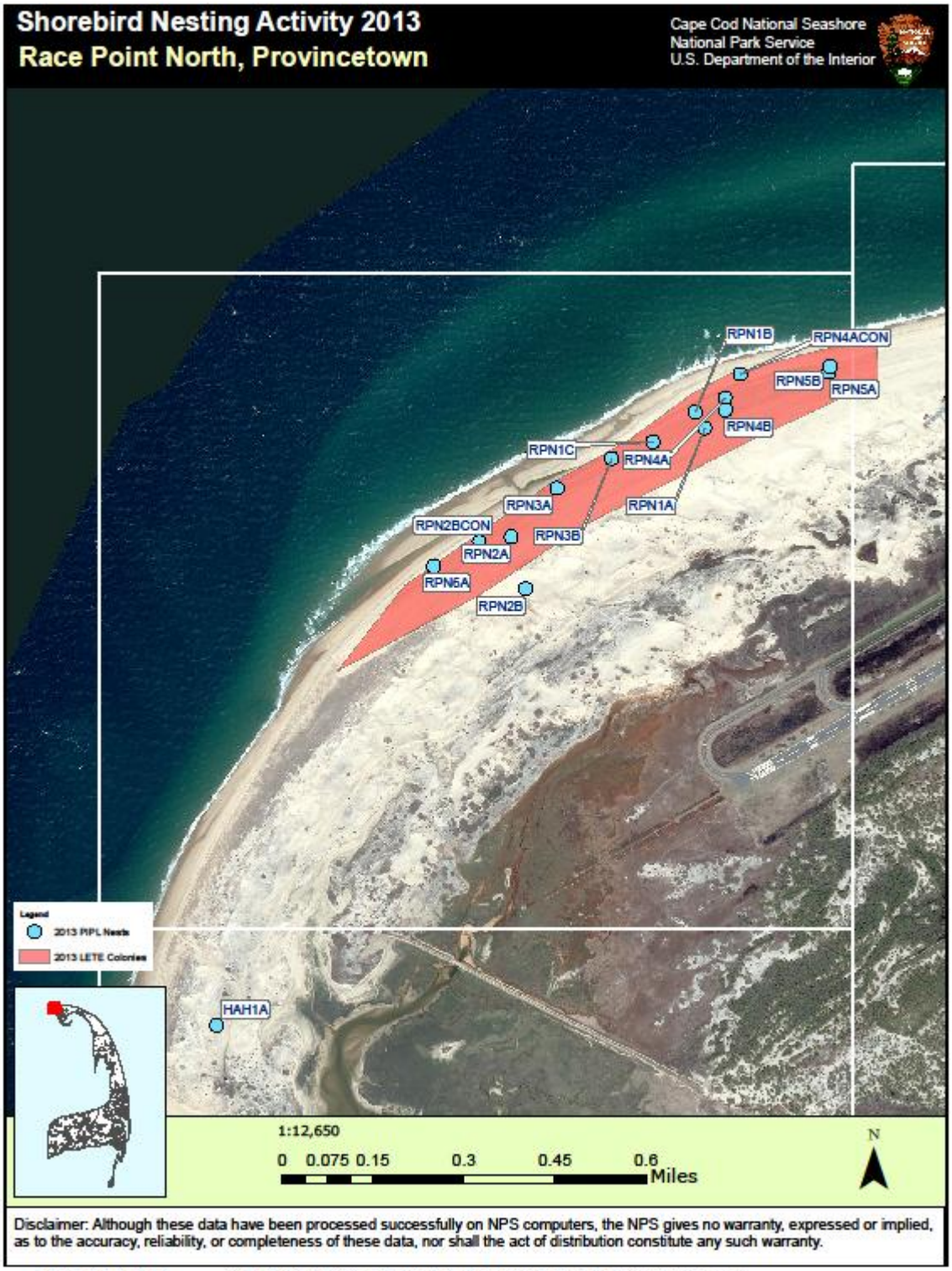

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Appendix B. Agreement between the Town of Wellfleet and the National Park Service (NPS), Cape Cod National Seashore (CCNS) for shorebird management support

- 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 finding 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