Shorebird Monitoring and Management
Cape Cod National Seashore
2015

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1 Executive Summary

Piping plover (*Charadrius melodus*), least tern (*Sternula antillarum*), and American oystercatcher (*Haematopus palliates*) nesting and brood-rearing behaviors were monitored at Cape Cod National Seashore (Seashore). Monitoring took place on 25 beaches extending over 43 miles of coastline from Provincetown to Orleans, Massachusetts. The first piping plover was observed March 20, 2015 at Coast Guard Beach in Eastham, the first nest was found on April 25, 2015, with the highest number of nests present during the week of May 10, 2015. A total of 73 nesting pairs of piping plovers produced 113 nests, with 40 pairs successfully producing at least one chick, 29 pairs failing to produce any hatchlings, and four pairs failing to produce any eggs. Predation accounted for 63% (45/72) of nest failures and overwash accounted for 21% (15/72). The predominant nest predators identified were Eastern coyote (*Canis latrans var.*), red fox (*Vulpes vulpes*) and crows (American crow/*Corvus brachyrhynchos* and fish crow/*Corvus ossifragus*). Mammalian predators accounted for 49% (22/45) of nests depredated, avian predators accounted for 33% (15/45) and 18% of depredated nests lost to unidentified predators. Predator exclosures were installed around 31 piping plover nests. There were three adult plover mortalities at exclosed nests. Of the 31 exclosed nests, 58% (18) hatched eggs and 42 (13) failed. Adult mortalities were documented at 10% (3) of the exclosed nests. Of the 82 unexclosed nests, 28% (23) were successful in hatching eggs, while 72% (59) failed. Of the 59 unexclosed nests that failed, 69% (41) were lost to predation. Overall, 64 piping plover chicks fledged from 73 nesting pairs (i.e., productivity of 0.88 chicks fledged/pair). Productivity was higher for exclosed nests compared to unexclosed nests, with 28 fledglings (0.97 fledglings/pair) and 36 fledglings (0.65 fledglings/pair) respectively. Overall, nest daily survival rate and nest success (point estimate) was 0.96 and 0.29, respectively. However nest success was higher for exclosed nests (0.54) than for unexclosed nests (0.21). Poor nesting and fledging success were attributed mainly to predation. The five year weighted average annual productivity also shows a downward trend in productivity since 1994, when it was 2.37 to present where it is 0.69 fledglings/pair. In fact, 2015 had the lowest five-year weighted average productivity in the over 25 years of data collection.

A total of 122 pairs of least terns, state listed species of special concern, nested in 18 colonies from Eastham to Provincetown. Productivity was poor with only 19 chicks fledged. Two pairs of American oystercatchers nested at the Seashore; a total of three nests were laid and three chicks fledged. Predation was the main cause of egg and chick loss for both the least terns and American oystercatchers.

The seashore is also an important staging area for migratory sea- and shorebirds. Large mixed flocks, some identified as over 10,000 individuals, of the federally endangered roseate tern (*Sterna dougallii dougallii*) mixed with the common tern (*Sterna hirundo*), a federally listed species of concern, were observed throughout the park in 2015. Large flocks arrive here mid-summer through mid-fall from their breeding grounds to the north. During this critical period, the terns need to rest and build body mass and fat reserves necessary to for their long migration to South America all while caring for their fledglings. The federally threatened red knot (*Calidris canutus rufa*), is also among those species that utilize the seashore as an important staging area along their migration to South America. During this time, it is essential to minimize disturbance to all migratory species utilizing the park.

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: Most 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 at Duck Harbor. Pets are required to be leashed at all times on Seashore property. In addition, some 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.

2 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 habitat for beach-nesting birds, including the Atlantic population of piping plover (federally and state listed as threatened), the least and common tern (state listed 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), semipalmed plover (Charadrius semipalmatus), black-bellied plover (Pluvialis squatarola), semipalmed 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 migrations.

3 Methods

3.1 Pre-nesting closures

Habitat assessments were conducted prior to the onset of the breeding season. Suitable nesting habitat was identified and pre-nesting closures were established to protect these areas beginning March 31st, and continuing throughout the season as beaches accreted and more suitable habitat became available. These sites were protected by the installation of symbolic fencing consisting of wooden posts, “bird use area” signs prohibiting entry, and string connecting the posts, establishing a boundary around these areas. These pre-nesting closures helped to minimize habitat disturbance in potential breeding areas and also enabled birds to establish territories and nests in their preferred habitat. These closures were then modified throughout the season in order to meet the buffer requirements of the 2012 SOP and to provide adequate protection for staging areas utilized by migratory birds.
3.2 Piping Plover Nest Protection
To protect nesting shorebirds, symbolic fencing was placed around most areas of suitable nesting habitat where nesting had occurred historically, and where nests and active scrapes were found and 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).

3.2.1 Predator Exclosures
A total of 31 piping plover nests were exclosed from predators in 2015. 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).

3.3 Monitoring
Shorebirds were monitored on 25 (reporting unit) beaches at the national seashore from Provincetown to Orleans, across approximately 43 miles of beach. Seashore beaches are divided into two districts for monitoring purposes. 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, Long Nook, 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.

The Seashore follows the monitoring and protection methods outlined in the USFWS’s Piping Plover Atlantic Coast Population Revised Recovery Plan (1996), as well as protocols designed specifically for the Seashore (Erwin 2003), for nesting piping plovers, and The Massachusetts State Guidelines for Monitoring and Protection of Tern and Plovers (Blodget and Melvin 1996) for nesting least terns. 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 beginning April 18th for signs of shorebird nesting activity (e.g., behavior, 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).

A total of 31 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. We collected data on environmental factors that may play a role in productivity and adult mortality rates among nest sites.

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 Beach in 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. A report on our findings will be completed by 2017.

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, in order to reduce disturbance. Most shorebird nests and tern colonies located outside of the ORV corridor were checked no less than every two days.

4 Population and Productivity

4.1 Piping Plovers

4.1.1 Nesting and Hatching Success

Results

A total of 73 nesting pairs of piping plovers were monitored on 25 beaches in the Seashore (Table 1 and Appendix A). The first piping plover was observed on March 20, 2015 at Coast Guard Beach in 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 April 25, 2015 at Newcomb Hollow. Peak nesting for the Seashore occurred the week of May 10, 2015 (Figure 1). Hatching dates of piping plovers ranged from 28 May to 7 August, 2015. The majority of nests were located along the upper beach, in open sandy or in sparse vegetation.

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. Instances of nest loss and egg loss were calculated independently due to eggs from some nests being lost to more than one cause (e.g., two different predators) (Tables 2 and Table 3).

There were 73 pairs of piping plovers that laid a total of 113 nests; 58 nests in the North District and 55 nests in the South District. The 113 piping plover nests contained a total of 388 eggs, of which 37% (143) hatched and 63% (245) did not hatch. Of the 245 failed eggs, 2% (4) were unviable (failed to hatch) and 98% (241) were lost to other causes. The two main causes of egg loss were predation at 61% (150) and overwash at 18% (43) (Table 3).

Of the 73 pairs of piping plovers that nested, 40 pairs produced at least one chick, 29 pairs failed to produce any chicks, and 4 pairs failed to produce eggs (Table 1). Of the 72 nests lost, 34 were in the South District and 38 were in the North District. Overall, re-nests accounted for 39% (44/113) of the total nests, with 38% (21/55) being renests in the South District and 40% (23/58) being renests in the North District. Hatch rate was significantly higher for exclosed nests (58%) than for unexclosed nests (28%) with an overall hatch rate of 36%.

Of the unexclosed nests, predation accounted for 69% (42/61) of failed nests, followed by overwash at 21% (13/61), abandonment at 7% (4/61), and one nest loss each attributed to unviability an unknown cause. Of the 42 unexclosed nests lost to predation, 45% (19/42) were lost to canids, 33% (14/42) to crow, and 22% (9/42) to unidentified predators. Of depredated nests, 63% (12/19) were lost to Eastern coyote, 21% (4/19) to red fox and 16% (3/19) to an unidentified canid. (Table 2).
Predator exclosures were installed around 31 nests. Of the 31 exclosed nests, 58% (18) hatched eggs and 42% (13) failed. Of the exclosed nests that failed, 15% (2) were overwashed, 15% (2) were sanded over, 31% (4) were attributed to direct predation (three to Eastern coyote and one to American crow) and 38% (5) were abandoned. Adult mortalities were documented at 10% (3) of the exclosed nests (one each at Ballston Beach, Great Island, and Race Point South). Abandonments were classified as such: 20% (1) verified adult mortality, 40% (2) suspected adult mortalities, 20% (1) abandoned due to canid harassment, and 20% (1) abandoned for an unknown cause; 46% (6) of those failed exclosed nests were lost either directly to predators or abandoned due to predator harassment. Of the 82 unexclosed nests, 28% (23) were successful in hatching eggs, while 72% (59) failed; and 69% (41) of those failed unexclosed nests were lost to predators. Predation rates were disparate between exclosed and unexclosed nests, with 31% of exclosed nests and 50% of unexclosed nests depredated (abandoned nests were counted separately from depredated nests, although predatory harassment may have influenced the abandonment). The rate of abandonment was higher at exclosed nests, with 16% of exclosed and 4.9% of unexclosed nests abandoned (Table 4). Of the abandoned nests, 33% (3) had adult mortalities associated with them and were exclosed. The rate of overwash was 15% and 21% for exclosed nests, and unexclosed nests, respectively (Table 4).

Daily nest survival was 0.98 for exclosed nests and 0.95 for unexclosed nests. Accounting for a 33-day period from initiation to hatch, point estimates of nest success for these daily survival rates are 0.21 for unexclosed nests and 0.54 for exclosed nests. While nest survival increased with exclosure use in 2015, adult mortality associated with exclosure use did occur in at least two instances, and at this point it is still unclear how exclosure use affects overall population growth, given that it typically increases productivity as well as adult mortality. An ongoing study of sites across the Atlantic coast including the Seashore, aims to model the effects on population growth of exclosure use in relation to multiple variables, and will hopefully shed some light on this question.

**Discussion**

Over the last thirteen years (2003-2015), the top three factors causing nest failure have been predation, overwash, and abandonment with 524, 244 and 113 lost respectively of 937 unsuccessful nests (Table 5). In 2015, 36.2% of the monitored nests were successful (41 successful/113 total nests), which is higher than the last three-year average (2012-2014) of 18.9% (32 avg. successful/169 avg. total nests per year), but lower than the past 10-year average (2005-2014) of 41.4% (53 avg. successful/128 avg. total nests per year) (Table 5).

In 2015, predation accounted for 63% (45 depredated/72 total unsuccessful) of all failed piping plover nests (Table 2). Eastern coyote and crow predation accounted for the loss of 270 piping plover nests, or 36 of all failed piping plover nests over the last ten years and 42% (30 confirmed predator loss/72 total unsuccessful nests) of all failed nests in 2015 (Table 2). Mammalian predation (Eastern coyote, red fox, and unknown canid) and avian predation (American crow, fish crow) combined, accounted for 82.2% (37/45) of the depredated nests. If predator tracks were obscured or obliterated by wind, rain, or overwash, or were otherwise present but distorted to the extent that a species could not be identified, nest loss is attributed to an unknown predator or an unknown cause. In the case where canid predation was identified to be the cause of a nest loss but confirmation to species of canid could not be determined, nest loss was attributed to an unknown canid. Red fox, unknown canid and unknown predators attributed to 9% (4/45), 7% (4/45) and 18% (8/45) respectively to all nests lost in 2015 (Table 2). Of the depredated nests lost to canids, 15 (68%), 4 (18%) and 3 (14%) were as attributed to Eastern coyote, red fox, and unknown canid, respectively (Table 2). Crows have been the predominant predator of piping plover nests over the past ten years, but over the past five years Eastern coyote predation has been on the rise and surpassed crow predation in 2012 and 2013 (Table 5). In 2015, combined mammalian predation (Eastern coyote, red fox, and unknown canid) was the leading cause of nest loss (Table 2).
In recent years, major storms (nor’easters) have become more frequent and intense 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 portion of nests being lost to overwash or sanding over. Overwash and sanding over accounted for 21% (15/72) of all nest loss in 2015 (Table 2).

### 4.1.2 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 tracking brood movement, calculating fledge dates, and identifying causes of chick loss. Human disturbance (pedestrians, ORV’s, dogs off leash) can make brood monitoring difficult in visitor use areas. Disturbance typically causes chicks to disperse, making it harder for observers to track them, and possibly making them more vulnerable to predators or exposure. Chicks will often disperse in several directions away from a perceived threat. Brood monitoring is especially 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. Documenting the cause of chick mortality presents additional challenges compared to nest loss. Chicks move, are hard to track, and are able to hide and go unobserved for days at a time. In the majority of cases, the cause of chick loss is unknown. A chick is presumed dead if it is not observed for five consecutive visits, and sections of beach along the ORV corridor are re-opened to ORVs when an entire brood is not observed in the area for five consecutive days.

Fledging dates ranged from 6 July to 12 September. 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 appears to be higher. In recent years, it has been common for piping plover chicks to fledge later than 27 days of age. At the Seashore, the pre-fledge period exceeded 30 days for 70% (28/40) of fledglings in 2011, 75% (9/12) of fledglings in 2012, 76% (16/21) of fledglings in 2013, 45% (13/29) of fledglings in 2014, and 56% (15/27) of fledglings in 2015. Furthermore, in 2015 the pre-fledge period exceeded 27 days in 85% (23/27) of fledglings. From 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, 30 days in 2014 and 31 days in 2015. More research is needed to determine which factors influence the length of the pre-fledge period in plover chicks; Catlin et al. (2012) suggests that it is affected by environmental conditions. Another possibility is that even though the Seashore protects shorebirds from visitor disturbance in their nesting habitat, it does not protect them as much in the foraging habitat. Pedestrians are allowed to walk along beaches where piping plover chicks are present. Perhaps the longer pre-fledge times are related to an inability of chicks to reach daily caloric needs due to disturbances by visitors. For example, this season, a visitor was observed walking a leashed dog inside a no pet zone approximately 10 meters from unfledged piping plover chicks. This action by the pedestrian with a dog led to limited foraging time for the unfledged chicks that remained hiding in the vegetated foredune for an extended period of time.

### 4.1.3 Fledging Success, Productivity and Population Trends

#### Results

Of the 143 plover chicks that hatched at the Seashore in 2015, 64 chicks fledged (45%) (Table 1).

Park-wide, productivity was 0.88 fledged chicks/nesting pair (64 fledged chicks from 73 nesting pairs) (Table 1). Productivity was higher in the North District (0.95 fledged/pair) than in the South District (0.80 fledged/pair) (Table 1).
A total of 29 pairs had 31 nests with predator exclosures and produced a total of 31 fledglings yielding a productivity rate of 1.07 (31/29) chicks/pair, and 55 pairs had 82 nest without exclosures and produced 33 fledglings yielding a productivity rate of 0.60 (33/55) chicks/pair. The overall hatch rate (eggs hatched/total eggs laid) was 37% (143/388). Hatch rate for exclosed nests was 53% (63/119) and 30% (80/269) for unexclosed nests. The overall fledge rate (chicks fledged/total eggs hatched) was 45% (64/143), with 44% (28/63) from exclosed nests and 56% (35/63) from unexclosed nests.

**Discussion**

There were five more piping plover pairs nesting on the Seashore in 2015 than in 2014. The number of breeding pairs (73) on the Seashore in 2015 was the second lowest since 2000, higher only than last year’s 68 pairs. The decrease in the number of pairs is likely due to poor piping plover productivity over the last several years along the U.S. Atlantic Coast and at the Seashore, with 2012 having the lowest productivity (0.30) since the species’ listing in 1986.

In 2015, the fledging rate (45%) was 4.4 percentage points lower than the mean for the past ten years (49%) (Table 6). Hatch rate (hatched nests/total nests) in 2015 was 36%, which was higher than in the previous three years (31%, 17% and 13% in 2014, 2013 and 2012 respectively), but was still the fourth lowest in the past ten years and 10 percentage points lower than the mean (46%) from the past ten years (Table 6).

The use of exclosures around piping plover nests marginally reduced nest predation in 2015 and may also be responsible for three adult piping plover mortalities associated with exclosure use. (See Fledging Success, Productivity and Population Trends section in the report for discussion on exclosure use). Although exclosure use has become synonymous with piping plover protection efforts, there is an emerging concern that the use of exclosures may also increase the number of adult mortalities, abandonments and depredations. These types of events may be associated with what researchers are calling ‘smart’ predators (predators that are learning to exploit exclosures (Hecht et al. 2014). A pair’s productivity in a given breeding season is dependent upon successfully hatching chicks that survive to fledge. However, the comparably low fledge rate in 2015 is another indicator that exclosure use only addresses one aspect of productivity, hatch success, by decreasing predation of nests. Failure, during either the incubation or the rearing (pre-fledge) stages, limits productivity within the breeding site and affects overall population recruitment. Recovery and viability of piping plover populations requires both an increase in abundance and a sustained level of annual productivity.

Although no population estimates are available for mammalian predators at the Seashore, field observations suggest that the population is robust and on the rise. Over the past several years, Eastern coyotes and red foxes were regularly observed on beaches in the middle of the day, and their tracks commonly blanketed the sand in both districts. Eastern coyotes expanded their range into Massachusetts in the 1940’s and 50’s following the extirpation of large predators throughout the U.S. during that time, and are now well-established statewide (excluding Martha’s Vineyard and Nantucket), with range expansion into eastern Massachusetts and Cape Cod in the 1970s (Way 2001).

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 was estimated at 110,000 crows statewide based on breeding bird survey (BBS) data in 2004(Rich et al). 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. Additionally, shorebird staff often observed crows feeding on food scraps left by people, especially on ORV and lifeguarded (high volume pedestrian) 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 in recent years suggest that crows are now abundant in both districts. From 2005-2009, of the total plover nests laid, 5% (13 nests) were lost to crow in the North District and 11% (30 nests) were lost to crow in the South District. Comparatively, of the total nests laid (842) over the last five years from 2010-2015, 7% (62 nests) were lost to crow in the North District and 10% (83 nests) were lost to crows in the South District. This season, shorebird staff witnessed a crow taking eggs from a piping 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. In addition, common ravens (Corvus corax), a very adaptable species has been dramatically increasing in New England over the past couple of decades. Just in the last few years they have been found nesting north and west of Boston. In 2015, ravens were observed throughout the park with a few sightings in the south district (Great Island, Marconi and Nauset Light, and more regular sightings in the North District (Head of the Meadow, Pilgrim Heights and Race Point/Hatches Harbor area).

It appears that populations of synanthropic predators (Eastern coyote, red fox, American crow and recent increase in fish crows and common raven) have been thriving, and likely steadily increasing at the Seashore. These predators/scavengers have broad diets and take advantage of anthropogenic food sources, such as beachgoer and fisherman food waste, visitor handouts, dumpsters, trash cans, and road kills. They utilize these food sources not only in park but also in adjacent towns. These “subsidized” predators often reach populations beyond the natural capacity of the landscape, and may exert unnaturally high levels of predation pressure on many species, including ground nesting shorebirds. In addition, garbage cans without lids and overflowing dumpsters in parking areas, adjacent to nesting areas may contribute to increased predator presence at shorebird nesting sites.

In 2015, overall productivity at the Seashore was 0.88, the highest it has been in the last four years (Figure 2). 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 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 achieve the relatively small recovery goal population of 2,000 pairs with minimal extinction risk (USFWS 1996, 2009). For the five-year period ending with 2015, the average productivity at the Seashore was 0.73 chicks fledged/pair/year. 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 21-year period (1995-2015), the five-year weighted average annual productivity has declined significantly ($p < 0.0001, F_{1,19} = 46.74, r^2 = 0.711$) (Figure 3). 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.
4.2 Least Terns

4.2.1 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 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). Since 1985, numbers of nesting least terns in Massachusetts have ranged from 2,109 to 4,309 pairs with a mean of 2,914 pairs (Mostello 2014). 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 (Figure 4).

In 2015, the population of nesting pairs of least terns was 122 within the Seashore, an increased by 45 pairs from 2014 (77) (Figure 4). This year,18 nesting sites were identified, up from 11 in 2014. 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).

4.2.2 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 size 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 May 9, 2015 at Coast Guard Beach in Eastham. Least terns were scraping by May 21, 2015 and the first egg was found on May 25, 2015 at Coast Guard in Eastham, with most least terns on eggs by early June. Re-nesting attempts continued throughout the late August. Approximately 122 pairs had nests during the “A” count and 88 pairs had nests during the “B” count (Table 8).

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 during the census windows with 32 nesting pairs.

The first least tern chicks hatched on June 20, 2015 at Coast Guard Beach in Eastham, and the last chicks hatched on August 12, 2015 at Jeremy Point. Least terns are considered fledged when they are observed in sustained flight for at least 15 meters. Of the 122 pairs of nesting least terns, nineteen chicks fledged (0.16 chicks/pair) from Seashore beaches in 2015: Coast Guard, Eastham (7), Great Island (2), Head of the Meadow (2), Jeremy Point (1), Race Point North (3), and Race Point South (4) (Table 8).
One least tern pair at Middle Meadow (Great Island) in 2015 nested inside a piping plover nest exclosure no longer in use by a plover. The nest was discovered with one egg, and at that time the netting on top of the exclosure was removed but the exclosure left intact. The nest eventually hatched two eggs and fledged one chick.

**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). This low productivity is due to intense predation on eggs and chicks, and high levels of human disturbance at prime nesting areas. With the increase in subsidized predators (Eastern coyote, red fox, and two species of crow) in the area, more robust protective measures may be required in the future. In addition, the narrowing of beaches and increased frequency of late spring/summer storms limits the available habitat and makes nesting areas more vulnerable to washovers.

Field observations made mainly through tracking in 2015 suggest that most least tern colonies at the Seashore were visited almost daily by Eastern coyotes, most often resulting in a loss of nests or chicks. Eastern coyotes seem to be attracted to tern colonies due to the concentration and abundance of eggs and/or chicks, and can develop a search pattern that is highly effective in locating ground nesting bird nests in open habitat. Eastern 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 or hung on symbolic fencing (which was observed in 2015 at Race Point North and South), may also attract predators to these nesting areas. 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. Documenting the cause of chick mortality presents additional challenges compared with documenting causes of nest loss. Chicks move, are difficult to track, and can hide and go unobserved for days, but it is likely that the same species (mainly Eastern coyotes) that are preying on eggs are also preying on chicks. This high rate of visitation to colonies by predators combined with daily human disturbances adds stress to nesting shorebirds and may be responsible for re-nesting efforts into August and into sub-standard nesting habitat. For example, at one of our busiest beach accesses, Head of the Meadow, least terns were often observed off nests, ‘mobbing’ an almost constant stream of visitors along narrow paths and in close proximity to their nests. Fewer least terns were observed in those areas and seemed to be nesting along narrower beaches to the north.

The colonial nesting strategy used by terns as a means of protecting eggs and chicks by adult members of the colony is called ‘mobbing’ which is a collective defense effort. Adults react as a group to any perceived threat that comes close to the colony and use mobbing behavior (dive bombing and defecating on intruders) to deter the potential predator. 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. Some areas that have multiple beach access paths leading to the beach immediately fragment any nesting tern colonies. By not closing paths leading through the tern’s preferred habitat, typically lends that area to a lower colony count or even possibility of colony abandonment due to the high rates of disturbance associated with these areas. The typical size of a single colony of colonial nesting seabirds such as terns typically ranges from the thousands to tens of thousands of individuals. Therefore, if threats to reproductive success go unmitigated until the decline in the population is apparent, it is often too late to achieve a population rebound in the absence of drastic and costly measures.

**4.3 Common Terns**

**4.3.1 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 in Massachusetts. Since then, however, the
population has been fairly stable (with the exception of 2012) at about 16,000-17,000 pairs. Since 1985, population size has ranged from 6,483 to 16,829.5 pairs (mean, 12,782 pairs) (Mostello 2014).

No common terns nested at the Seashore in 2015. 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 Eastern 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 or 2015.

4.3.2 Nesting Population and Productivity

Results
There were no nesting common terns in 2015.

4.4 American Oystercatchers

4.4.1 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 nested 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, MA.

4.4.2 Nesting Population and Productivity

Results
Two pairs of American oystercatchers nested at the Seashore in 2015, both at Jeremy Point. The first oystercatcher was observed on 4 April at Jeremy Point, and the first nest for both pairs was found on May 5, 2015. The first pair lost its first three egg nest to Eastern coyote on May 13, 2015. That pair’s renest (three eggs) was found on May 25, 2015 and subsequently hatched three chicks on June 22, 2015. One chick from that brood was lost at the end of June and the other two chicks fledged on August 3, 2015. The second pair hatched two chicks from the first three-egg nest on May 30, 2015. The hatching of the third egg was delayed and the third chick was found hatched out but dead close to the nest bowl on June 3rd. One of the two remaining chicks was lost on June 12, 2015, and the other remaining chick fledged on July 22, 2015. Cause of chick loss is unknown. This is the first year since 2008 that the Seashore has fledged any American oystercatchers.

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 Eastern 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 was zero, and in 2015 productivity was 1.5. Over the years, Eastern 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 for many years in a row, 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, 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).

At the Seashore, boat recreation at Jeremy Point is a major source of disturbance to incubating oystercatchers. In addition, while dogs are prohibited seasonally on Jeremy Point, shorebird monitors do observe dogs (often unleashed) brought in by boaters. Unleashed dogs pose a serious threat to unfledged oystercatcher chicks, which are larger and lack the cryptic coloration of other ground-nesting shorebird species, making them more noticeable to predators including domestic dogs. For logistical reasons, law enforcement rarely patrols Jeremy Point, and even shorebird monitor presence is limited to a short period of time in the early part of the day. Restrictions on boat landing at Jeremy Point may need to be considered in the future in order to adequately protect the beach-nesting bird species there.

4.5 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 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 Race Point North 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, Jedrey et al. 2010).

In addition, whimbrel, short- and long-billed dowitcher, semipalmated plover, black-bellied plover, ruddy turnstone, sanderling, and sandpiper spp., were present on Seashore beaches from the end of July through late – October/early November. The largest mixed flocks of common and roseate terns were observed at Race Point North (2000+ terns), Race Point South (~2800 terns), High Head (1500 + terns), Jeremy Point, Wood End, Hatches Harbor and Coast Guard, Eastham (Nauset Marsh complex). Flocks of common and roseate terns reached peak numbers in early September, with the largest flocks being at Hatches Harbor (~8,000 – 10,000 terns), and at Jeremy Point (~2,500 terns). Approximately 1,000 terns were also observed at Coast Guard in Eastham/Nauset Marsh. A flock of ~75 black terns also was observed staging for several weeks in late August to early September at Jeremy Point. Mixed flocks of semipalmated plovers, semipalmated sandpipers, sanderlings, and others, peaked in flocks of ~1,000 at Coast Guard in Eastham in late August and Jeremy Point in early September.

4.5.1 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 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 they 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 has funded a research project to document flock size, composition, and movement, and if disturbance (both anthropogenic and non-human influenced) stressors to juvenile roseate terns during this period are affecting the recovery of this endangered species. The project, which began 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 2015, researchers conducted surveys of staging terns and shorebirds throughout the park. Hundreds of terns (predominately common and roseate) were observed at Armstrong, Exit 9, and Race Point South throughout the post-breeding season, and thousands were observed at Jersey Point, Hatches Harbor, Race Point North, Head of the Meadow, Coast Guard in Eastham/Nauset Marsh, and North Beach in Chatham. Preliminary results from this study show 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 complex and Jersey Point. Terns were observed throughout the park into late fall. A mixed flock of over a thousand was observed at Race Point North in early November.

4.5.2 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 since 2012, hundreds have been seen along the ocean beach in Truro and Provincetown. In 2014, a flock of 120 red knots was regularly observed at Coast Guard Beach in Eastham, most often feeding on exposed peat in the intertidal zone. There was no exposed peat in 2015, and only one flock of approximately 20 red knots was observed on July 25, 2015, flying over Coast Guard Beach and landing in Nauset Marsh. In addition, in 2015 small numbers of knots were observed along seashore beaches, but fewer than in recent years.

5 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, one of the 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 14 programs were given to 455 third through fifth grade students.

Five volunteers donated a total of 432 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.
6 Tables and Figures
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 2015.

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<th>EGGS LAID</th>
<th>NESTS</th>
<th>EGGS HATCHED</th>
<th>EGGS HATCHED</th>
<th>CHICKS FLEDGED</th>
<th>HATCH RATE²</th>
<th>FLEDGE RATE³</th>
<th>PRODUCTIVITY⁴</th>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>N/A</td>
<td>N/A</td>
<td>6</td>
</tr>
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<td>2</td>
<td>2</td>
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<td>43%</td>
<td>0%</td>
<td>0.00</td>
<td>14</td>
</tr>
<tr>
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<td>6</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td>N/A</td>
<td>0.00</td>
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<td>0.00</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
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<td>N/A</td>
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<td>75%</td>
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<td>54%</td>
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<td>66</td>
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<td>32%</td>
<td>55%</td>
<td>0.95</td>
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<td>113</td>
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<td>143</td>
<td>64</td>
<td>37%</td>
<td>45%</td>
<td>0.88</td>
<td>598</td>
</tr>
</tbody>
</table>

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.

*Total pair # includes a pair at Jeremy Point that were present for the entire season but for which a nest with eggs was never found
*Nests hatched include a nest from a pair that is not included in the pair count for Newcomb because it showed up later in the season (not present at Newcomb during the index count).
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 2015.

| Nests       | Loss By Cause |          |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |        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          |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |              |             

<table>
<thead>
<tr>
<th>Cause</th>
<th>Lost</th>
<th>% Lost³</th>
</tr>
</thead>
<tbody>
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<td>Predation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern coyote</td>
<td>15</td>
<td>33%</td>
</tr>
<tr>
<td>Crow</td>
<td>15</td>
<td>33%</td>
</tr>
<tr>
<td>Unknown</td>
<td>8</td>
<td>18%</td>
</tr>
<tr>
<td>Red fox</td>
<td>4</td>
<td>9%</td>
</tr>
<tr>
<td>Canid</td>
<td>3</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>100%</td>
</tr>
</tbody>
</table>

¹total number nests lost/total number nests laid
²number of nests lost to a particular cause/total number of nests lost
Table 3. Piping plover (*Charadrius melodus*) egg fates, and causes of egg loss, at Cape Cod National Seashore in 2015.

<table>
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<tr>
<th>Eggs</th>
<th>Loss By Cause</th>
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<td># Hatched</td>
</tr>
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<td>388</td>
<td>143</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Predation Types</th>
<th># Lost</th>
<th>% Lost³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern coyote</td>
<td>57</td>
<td>38%</td>
</tr>
<tr>
<td>Crow</td>
<td>48</td>
<td>32%</td>
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<tr>
<td>Unknown</td>
<td>20</td>
<td>13%</td>
</tr>
<tr>
<td>Red fox</td>
<td>13</td>
<td>9%</td>
</tr>
<tr>
<td>Canid</td>
<td>12</td>
<td>8%</td>
</tr>
<tr>
<td>Grackle</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td><strong>150</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

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 4. Fate of exclosed vs. unexclosed nests of piping plover (*Charadrius melodus*) at Cape Cod National Seashore in 2015.

<table>
<thead>
<tr>
<th></th>
<th>total nests</th>
<th># successful (%)</th>
<th># failed (%)</th>
<th># washed/ sanded over (%)</th>
<th># abandoned (%)</th>
<th># crow depredated (%)</th>
<th># canid depredated (%)</th>
<th># unknown (%)</th>
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</thead>
<tbody>
<tr>
<td>Exclosure Installed</td>
<td>31</td>
<td>18 (58%)</td>
<td>12 (42%)</td>
<td>4 (13%)</td>
<td>5 (17%)</td>
<td>0 (0%)</td>
<td>3 (10%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Exclosure Removed</td>
<td>1</td>
<td>0 (0%)</td>
<td>1 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Never Excluded</td>
<td>82</td>
<td>23 (28%)</td>
<td>59* (72%)</td>
<td>13 (16%)</td>
<td>4 (5%)</td>
<td>14 (17%)</td>
<td>19 (23%)</td>
<td>8 (10%)</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>113</td>
<td>41 (36%)</td>
<td>72 (64%)</td>
<td>17 (15%)</td>
<td>9 (8%)</td>
<td>15 (13%)</td>
<td>22 (19%)</td>
<td>8 (7%)</td>
</tr>
</tbody>
</table>

*Includes one nest that was unviable


<table>
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<th>Year</th>
<th># of pairs</th>
<th>Total Nests</th>
<th>Successful</th>
<th>Unsuccessful</th>
<th>Overwash/Sanding</th>
<th>Abandonment¹</th>
<th>Non-viable</th>
<th>Unknown</th>
<th>Other²</th>
<th>Predation</th>
<th>Coyote</th>
<th>Gull</th>
<th>Skunk</th>
<th>Fox</th>
<th>Predator</th>
<th>Unknown</th>
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<tbody>
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<td>2003</td>
<td>84</td>
<td>121</td>
<td>54</td>
<td>67</td>
<td>13</td>
<td>16</td>
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<td>0</td>
<td>5</td>
<td>33</td>
<td>15%</td>
<td>27%</td>
<td>12%</td>
<td>15%</td>
<td>0%</td>
<td>30%</td>
</tr>
<tr>
<td>2004</td>
<td>85.5</td>
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<td>59</td>
<td>56</td>
<td>15</td>
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<td>0</td>
<td>0</td>
<td>28</td>
<td>43%</td>
<td>21%</td>
<td>11%</td>
<td>7%</td>
<td>0%</td>
<td>18%</td>
</tr>
<tr>
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<td>70</td>
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<td>21</td>
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<td>29%</td>
<td>10%</td>
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<td>0%</td>
<td>38%</td>
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<tr>
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<td>43%</td>
<td>5%</td>
<td>5%</td>
<td>19%</td>
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<tr>
<td>2009</td>
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<td>54</td>
<td>54</td>
<td>16</td>
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<td>2</td>
<td>1</td>
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<td>0%</td>
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<td>1</td>
<td>3</td>
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<td>38</td>
<td>74%</td>
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<td>0%</td>
<td>0%</td>
<td>0%</td>
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<td>103</td>
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<td>30%</td>
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<td>5%</td>
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<td>33%</td>
<td>33%</td>
<td>0%</td>
<td>0%</td>
<td>9%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
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<td>524</td>
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<td>3%</td>
<td>3%</td>
<td>2%</td>
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</tr>
</tbody>
</table>

¹Includes nests abandoned due to adult mortality
²"Other" in 2015: exclosed nest was dug around at perimeter of exclosure by canid and subsequently abandoned

<table>
<thead>
<tr>
<th>Year</th>
<th># Pairs</th>
<th># Chicks Fledged</th>
<th>Productivity¹</th>
<th># Nests Laid</th>
<th># Successful Nests</th>
<th>Nest Success Rate²</th>
<th>% Renests³</th>
<th># Eggs Laid</th>
<th># Eggs Hatched</th>
<th>Hatch Rate⁴</th>
<th>Fledge Rate⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>84</td>
<td>130</td>
<td>1.55</td>
<td>121</td>
<td>54</td>
<td>45%</td>
<td>31%</td>
<td>450</td>
<td>189</td>
<td>42%</td>
<td>69%</td>
</tr>
<tr>
<td>2004</td>
<td>85.5</td>
<td>124</td>
<td>1.45</td>
<td>115</td>
<td>59</td>
<td>51%</td>
<td>26%</td>
<td>425</td>
<td>220</td>
<td>52%</td>
<td>56%</td>
</tr>
<tr>
<td>2005</td>
<td>77</td>
<td>87</td>
<td>1.13</td>
<td>118</td>
<td>48</td>
<td>41%</td>
<td>35%</td>
<td>378</td>
<td>163</td>
<td>43%</td>
<td>53%</td>
</tr>
<tr>
<td>2006</td>
<td>74</td>
<td>122</td>
<td>1.65</td>
<td>96</td>
<td>70</td>
<td>73%</td>
<td>23%</td>
<td>336</td>
<td>233</td>
<td>69%</td>
<td>52%</td>
</tr>
<tr>
<td>2007</td>
<td>82</td>
<td>146</td>
<td>1.78</td>
<td>113</td>
<td>66</td>
<td>58%</td>
<td>25%</td>
<td>368</td>
<td>233</td>
<td>63%</td>
<td>63%</td>
</tr>
<tr>
<td>2008</td>
<td>85</td>
<td>157</td>
<td>1.85</td>
<td>109</td>
<td>70</td>
<td>64%</td>
<td>21%</td>
<td>386</td>
<td>243</td>
<td>63%</td>
<td>65%</td>
</tr>
<tr>
<td>2009</td>
<td>83</td>
<td>60</td>
<td>0.72</td>
<td>108</td>
<td>54</td>
<td>50%</td>
<td>20%</td>
<td>362</td>
<td>186</td>
<td>51%</td>
<td>32%</td>
</tr>
<tr>
<td>2010</td>
<td>85</td>
<td>136</td>
<td>1.60</td>
<td>115</td>
<td>68</td>
<td>59%</td>
<td>26%</td>
<td>386</td>
<td>235</td>
<td>61%</td>
<td>58%</td>
</tr>
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<td>2011</td>
<td>82</td>
<td>90</td>
<td>1.10</td>
<td>110</td>
<td>61</td>
<td>55%</td>
<td>25%</td>
<td>378</td>
<td>210</td>
<td>56%</td>
<td>43%</td>
</tr>
<tr>
<td>2012</td>
<td>99</td>
<td>30</td>
<td>0.30</td>
<td>212</td>
<td>27</td>
<td>13%</td>
<td>53%</td>
<td>636</td>
<td>72</td>
<td>11%</td>
<td>42%</td>
</tr>
<tr>
<td>2013</td>
<td>85</td>
<td>46</td>
<td>0.54</td>
<td>173</td>
<td>30</td>
<td>17%</td>
<td>51%</td>
<td>532</td>
<td>100</td>
<td>19%</td>
<td>46%</td>
</tr>
<tr>
<td>2014</td>
<td>68</td>
<td>52</td>
<td>0.76</td>
<td>121</td>
<td>38</td>
<td>31%</td>
<td>45%</td>
<td>375</td>
<td>129</td>
<td>34%</td>
<td>40%</td>
</tr>
<tr>
<td>2015</td>
<td>73</td>
<td>64</td>
<td>0.88</td>
<td>113</td>
<td>41</td>
<td>36%</td>
<td>39%</td>
<td>388</td>
<td>143</td>
<td>37%</td>
<td>45%</td>
</tr>
</tbody>
</table>

|^ mean 82 | 96 | 1.18 | 125 | 53 | 46% | 32% | 415 | 181 | 46% | 51% |
| max     99 | 157 | 1.85 | 212 | 70 | 73% | 53% | 636 | 243 | 69% | 69% |

¹number of chicks fledged/number of nesting pairs
²number of successful nests/total number of nests
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 1985-2015.

<table>
<thead>
<tr>
<th>Year</th>
<th># pairs</th>
<th>5-year average pairs</th>
<th># fledged</th>
<th>annual productivity</th>
<th>5-year weighted average productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>18</td>
<td>13</td>
<td>13</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>16</td>
<td>5</td>
<td>5</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>15</td>
<td>6</td>
<td>6</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>13</td>
<td>12</td>
<td>12</td>
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</tr>
<tr>
<td>1989</td>
<td>15</td>
<td>15.40</td>
<td>21</td>
<td>1.40</td>
<td>0.74</td>
</tr>
<tr>
<td>1990</td>
<td>15</td>
<td>14.80</td>
<td>39</td>
<td>2.60</td>
<td>1.12</td>
</tr>
<tr>
<td>1991</td>
<td>28</td>
<td>17.20</td>
<td>74</td>
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<td>1.77</td>
</tr>
<tr>
<td>1992</td>
<td>43</td>
<td>22.80</td>
<td>101</td>
<td>2.40</td>
<td>2.17</td>
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<tr>
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<td>68</td>
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<td>1.73</td>
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<td>1.45</td>
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<tr>
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<td>81.30</td>
<td>124</td>
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<td>1.40</td>
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<td>83.90</td>
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<td>1.39</td>
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<td>1.32</td>
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<td>1.51</td>
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<td>1.58</td>
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<td>136</td>
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<td>1.52</td>
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<td>1.41</td>
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<td>1.09</td>
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<td>0.83</td>
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<td>52</td>
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<td>0.84</td>
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<tr>
<td>2015</td>
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<td>0.69</td>
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<td>A Count¹</td>
<td>B Count²</td>
<td># Chicks Fledged</td>
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<td>----------</td>
<td>------------------</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Long Point Lighthouse (Wood End/Long Point)</td>
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<td>0</td>
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</tr>
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<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>122</strong></td>
<td><strong>88</strong></td>
<td><strong>19</strong></td>
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<td></td>
</tr>
</tbody>
</table>

¹"A-Counts" are taken within the state census window, on June 15-16
²"B-Counts" are taken outside the state census window; after June 20

<table>
<thead>
<tr>
<th>Year</th>
<th># Nesting Pairs</th>
<th># Chicks Fledged</th>
<th>Productivity</th>
<th>Primary Cause of Loss</th>
</tr>
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<tbody>
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<td>2007</td>
<td>86</td>
<td>40*</td>
<td>0.45*</td>
<td>Overwash, canids</td>
</tr>
<tr>
<td>2008</td>
<td>136</td>
<td>&lt;136*</td>
<td>&gt;1*</td>
<td>Overwash/Eastern coyote</td>
</tr>
<tr>
<td>2009</td>
<td>236</td>
<td>25</td>
<td>0.11</td>
<td>Overwash/Eastern coyote</td>
</tr>
<tr>
<td>2010</td>
<td>226</td>
<td>26</td>
<td>0.12</td>
<td>Eastern coyote</td>
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<tr>
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<td>268</td>
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<tr>
<td>2012</td>
<td>257</td>
<td>66</td>
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<td>Eastern coyote</td>
</tr>
<tr>
<td>2013</td>
<td>138</td>
<td>2</td>
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<td>Eastern coyote</td>
</tr>
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<td>2014</td>
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</tr>
<tr>
<td>2015</td>
<td>122</td>
<td>19</td>
<td>0.16</td>
<td>Eastern coyote</td>
</tr>
</tbody>
</table>

Figure 1. Active piping plover (*Charadrius melodus*) nests, by week in 2015 at Cape Cod National Seashore.
Figure 2. Number of piping plover (Charadrius melodus) pairs, and productivity (chicks fledged/nesting pair) at Cape Cod National Seashore from 1985 – 2015.
Figure 3. Piping plover (*Charadrius melodus*) 5-year productivity regression, Cape Cod National Seashore, 1995-2015 (y = - 0.0444*x + 90.4644).
Figure 4. Number of least tern (Sternula antillarum) pairs and number of least tern nesting sites, by year on Cape Cod National Seashore from 2003-2015.
Note: The high number of nesting sites this year may be due to higher rates of human and predator disturbance leading to colony fragmentation into sub-prime habitat.
Figure 5. Highly-concentrated domestic dog prints within ~ 15 m of a piping plover (*Charadrius melodus*) nest at the southern tip of Coast Guard Beach in Eastham. Note: Dog prints in sparse clump of grass toward back of photo. This section of beach was seasonally closed to pets. The nest was abandoned on the same day that the dog prints were observed. A depredated adult was also found within ~ 25 m of the nest site.
7 Appendix

7.1 Appendix A. Maps of 2014 Piping Plover, Least Tern, and American Oystercatcher Nest Sites at Cape Cod National Seashore.
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Legend
- Piping Plover Nest
- PRIVATE AND TOWN OWNED LAND
- PRIVATE
- TOWN

Bound Brook

Date: 9/20/2015
Cape Cod National Seashore
National Park Service
U.S. Department of the Interior

Piping Plover Nests 2015

Coast Guard Truro

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Great Island

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Date: 9/29/2015
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7.2 **Appendix B. Agreement between the Town of Wellfleet and the National Park Service (NPS), Cape Cod National Seashore 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.

- GPS Waypoints will be taken at all nests locations will be.

- 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.
7.3 Appendix C. Agreement between the Town of Truro and the National Park Service (NPS), Cape Cod National Seashore 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

7.4 Appendix D: Recreation Management

7.4.1 Habitat Protection

Pre-nest fencing is installed around suitable habitat by April 1st (or soon after) of each year, regardless of shorebird activity. In addition, to protect nesting shorebirds, symbolic fencing was placed around suitable habitat where nests and active scrapes were found or where shorebirds were observed exhibiting courtship or territorial behavior. 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. 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-nest fencing excluded four lifeguarded beaches to provide more consistent recreational/pedestrian use.

Pre-fencing of suitable and historic shorebird nesting habitat began on 1 April at Coast Guard Beach 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 visitation 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 2015, shorebird staff, made multiple observations of visitors entering protected/closed shorebird use areas for recreational purposes, as well as documented vandalism to symbolic fencing. In the North District, there were many 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, especially at lifeguarded and SCV area beaches. At the life-guarded sections of Head of the Meadow, symbolic fencing to protect least terns was reduced to allow for visitor access along a narrow section of beach, and did not provide an adequate buffer to prevent disturbance of the incubating terns.

Throughout the season, shorebird staff documented acts of vandalism in shorebird use areas. The north district documented at five separate cases (in different locations) where string between fence posts for long stretches of beach was cut or entire sections of fencing removed. In the south district, some examples of violations in protected habitat include: a large drawing in the sand inside the symbolic fencing at Coast Guard in Eastham; a long stretch (several hundred meters) of symbolic fencing was pulled up and thrown into the ocean at Marconi Beach; boaters at Jeremy Point went inside the symbolic fencing (in close proximity to nesting least terns and oystercatcher and plover broods) to light off fireworks over the July 4th weekend; a heavy concentrations of what appeared to be domestic dog prints were found inside the symbolic fencing in close proximity to an newly-abandoned piping plover nest and a depredated adult plover at the southern tip of Coast Guard (which is closed to pets seasonally but used heavily by boaters) (Figure 5). These violations were reported the Visitor and Resource Protection rangers and case incident reports were filed.

7.4.2 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 2015, sections of Coast Guard in Truro, Coast Guard in Eastham, Old Harbor, Race Point South (Armstrong), Race Point North, Wood End, Head of the Meadow, 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 and north of Head of the Meadow from 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.

### 7.4.3 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 are prohibited (NPS 2015a). 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 2015a). 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. Despite the seasonal ban on kite surfing, kite surfers were observed in violation on several occasions, and on one occasion ticketed by law enforcement in the south district.

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 area. Although there were no nesting birds in these areas at the time, this activity has been observed disturbing nesting least terns at the Seashore in years past (M. Hake per. comm.) crush eggs and chicks if they landed inside the nesting area. 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.

### 7.4.4 Pets

Pets are required to be on a six-foot leash at all times within the Seashore, all year long. There are also a number of areas that are closed to pets seasonally 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 and staging and migrating 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 2015, a total of 78 written warnings for pet violations were issued (45 in South District, and 33 in North District) and 43 violation notices (35 in South District, and 8 in North District) were issued. Shorebird monitoring staff recorded a total of 598 dogs off leash on Seashore beaches from April through September (289 in the South District
and 309 in the North District). Unleashed dogs were encountered most frequently at Coast Guard in Truro (85), Lecount Hollow (84), and Newcomb Hollow (66) (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.

7.4.5 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 (NegRegs) (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 4189 seasonal and weekly ORV/SCV permits were sold in 2015 (NPS 2015).

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. 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.

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).

7.4.6 Park Beach Operations/Essential Vehicles
Seashore staff routinely operate vehicles on beaches with nesting and staging shorebirds while performing 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 impacts to nesting shorebirds, as outlined in the 1998 “NegRegs” 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 the risk of 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).

**7.4.7 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.

In May 2010, the US Fish and Wildlife Service issued a biological opinion and incidental take statement for the national seashore to flexibly manage a very limited number of piping plovers nesting on or near high visitation beaches where the beach has eroded to the point where 164-foot (50-meter) buffers around plover nests would render the beach unusable to visitors at high tide. The biological opinion has been extended to cover management through the 2019 piping plover nesting season.

To date, flexible management has only been used once, in 2010, since the permit was granted.

**7.4.8 Management and Protection of Post Breeding Shorebirds**

In 2015, 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 disturbing flocks of staging shorebirds on the exposed mudflats, interpretive signs were affixed to buoys mid-channel on the marsh side of the spit.

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, Cahoon Hollow, Newcomb Hollow, Ballston Beach, Duck Harbor, Jeremy Point, Race Point North and Race Point South.

**7.4.9 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 2015, 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-owned and managed lands inside the Seashore.

In addition, in the Spring 2015, 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.
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