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Shorebird Monitoring and Management at Cape Hatteras National Seashore

2017 Annual Report

Natural Resource Report NPS/CAHA/NRR—2018/1651



ON THE COVER
A mating pair of American oystercatchers exhibiting territorial behavior towards a third bird at Cape Hatteras National Seashore
Photography by NPS

Shorebird Monitoring and Management at Cape Hatteras National Seashore

2017 Annual Report

Natural Resource Report NPS/CAHA/NRR—2018/1651

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Executive Summary

Cape Hatteras National Seashore (Seashore), located on the Outer Banks of North Carolina from Nags Head, NC to Oracoke Inlet, contains many ecologically important habitats such as marshes, tidal flats, and riparian areas that support a variety of shorebirds, including threatened species and species of special concern. Piping plovers (*Charadrius melodus*), American oystercatchers (*Haematopus palliatus*), colonial waterbirds, and Wilson's plovers (*Charadrius wilsonia*) are monitored and managed at the Seashore to promote successful reproduction and to protect their habitat. Shorebird monitoring and management is conducted in compliance with the Cape Hatteras National Seashore Off-Road Vehicle Management Plan, as amended by the Review and Adjustment of Wildlife Protection Buffers Environmental Assessment (NPS 2010a, 2010b, 2015a, 2015b).

Piping Plovers

In 2017, there were six pairs of piping plovers and 12 nests identified; seven were re-nests from failed nest attempts. The first nest was found on April 16, 2017 and the last active nest was documented as failed on July 16, 2017. Reasons for nest loss were mostly unknown, but some loss occurred from ghost crab depredation, abandonment, and overwash. Three nests hatched and produced a total of 10 chicks. Two chicks successfully fledged from one brood, resulting in a fledge rate of 0.33 chicks per breeding pair. Chick loss was attributed to ghost crab depredation, infanticide, or unknown reasons. Since 1997, fledge rates have ranged from zero to two chicks per pair at the Seashore. The mean fledge rate from 1997–2017 is 0.66 chicks per pair.

American Oystercatchers

Twenty-four pairs of American oystercatchers nested at the Seashore in 2017. A total of 53 nests were identified which includes re-nests from failed nest attempts. The first nest was found on April 10, 2017 and the last chick was fledged on August 18, 2017. Nine of the 53 nests hatched and produced a total of 15 chicks. Two pairs of American oystercatchers were each successful in fledging one chick which represents a 0.08 fledge rate per pair; the lowest fledge rate to date. Since 2001, fledge rates have ranged from 0.08 to 1.3 chicks per pair at the Seashore with a mean fledge rate per pair of 0.55 from 2011–2017.

Colonial Waterbirds

Sixteen colonies were identified at the Seashore in 2017: 10 on Hatteras Island, one on Bodie Island, one on Green Island, and four on Ocracoke Island. Two colonies hosted multiple species and least terns nested in the remaining 14 colonies. Observations from peak nest surveys produced a total of 189 least tern nests with 17 chicks, 90 common tern nests with 10 chicks, 14 gull-billed tern nests in one colony on Oracoke Island with 25 chicks, 214 black skimmer nests with 32 chicks, 149 white ibis nests with 78 chicks, and 11 tricolored heron nests with 17 chicks. Productivity in colonial waterbird colonies is very difficult to determine. Of the 16 documented colonies, colonial waterbird fledges or juveniles were observed in seven of them, but it is undetermined if these fledges were from the monitored colonies or passing through from other areas. Five colonies contained least tern fledges while black skimmer fledges were only observed on Ocracoke's South Point. White ibis and tricolored heron fledges were observed on Green Island.

Wilson's Plover

In 2017, one Wilson's plover pair and two nests were identified. All nests were found on South Point, Ocracoke Island. The first nest was found on April 29, 2017 and the last chick was lost on June 29, 2017. One nest was abandoned on May 7, 2017 and the second nest hatched a maximum of three chicks; these plovers are evasive and difficult to observe so it can not be confirmed if all three eggs in this nest hatched. No chicks fledged. This is consistent with recent years of Wilson's plover nesting at the Seashore. Nest losses have been attributed to abandonment, predation, or overwash events, but the cause for chick mortality is almost always unknown.

Human Disturbance

Throughout the 2017 season, resource management staff documented 150 pedestrian, 20 ORV, and 34 dog, boat or horse intrusions in protected areas including all prenesting areas and wildlife protection buffers. These numbers are conservative since sites are not monitored continuously, weather erases tracks, and staff does not disturb incubating pairs or young in order to document disturbance. It is important to note that most of the resource protection areas contained multiple bird species, including oystercatchers, colonial waterbirds, and piping plovers.

Most human violations in resource protection areas were not witnessed, but documented based on vehicle, pedestrian, or dog tracks left in the sand. Pedestrian entry most often required visitors to lift or stoop under the string that connected all posted signs, while vehicular entry required visitors to drive through or around a sign boundary. Visitors' unleashed dogs are also a threat to protected species and continue to be an issue of significant concern. Human activity was not identified as a cause of any of the nesting loss in any of the nests observed on the Seashore in 2017 and it cannot be determined if the intrusions had a disturbance effect on the monitored bird species.

Predator Observations

Depredation by mammals, birds, and ghost crabs have affected the success of many nests and broods over the years at the Seashore. During the 2017 breeding season, predator management by trapping was not implemented due to the lack of a trained technician on staff. Nests and broods were allowed to progress with naturally occurring predators within their range of habitat. Predator exclosures were built around piping plover and Wilson's plover nests to reduce predator pressure.

Field staff documented any natural signs (e.g., track or scat) of predators when they walked through the protected areas for surveys to determine if predator pressure may have affected the status of a particular nest or brood. Mammalian depredation events can be difficult to assess as there are rarely remains that would indicate the type of predator. The constantly shifting sands driven by wind often obliterate tracks, and when tracks are present, soft sands can make determining species problematic. Avian depredation is also difficult to detect due to minimal physical signs available to observe. Ghost crab depredation was responsible for some of the lost piping plover nests (nine nests lost) and chicks. Fifteen of the 44 American Oystercatcher nests lost were depredated (12 by unknown canid, two by fox, one by feral cat and ghost crab). Nine of the 16 waterbird colonies had predator interactions including from gulls, fox, ghost crabs, raccoons, nutria, coyotes, and opossums. The one lost Wilson's plover nest was due to abandonment, but chick loss was likely from predators.

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We would like to thank David Hallac, Stacey Sigler, Jon Altman and Kristin Legg for reviewing this report and our partners, Matthew Godfrey and Sara Schweitzer, with the North Carolina Wildlife Resources Commission who provided technical assistance throughout the year.

Introduction

Cape Hatteras National Seashore (Seashore) was established to preserve significant segments of unspoiled barrier islands along the Outer Banks of North Carolina from Nags Head, NC to Ocracoke Inlet. The Seashore's 67-mile long series of dynamic barrier islands face the Atlantic Ocean on the east side and the Pamlico sound on the west side. The Seashore contains ecologically important ecosystems, such as marshes, tidal flats, and riparian areas, including habitats for the piping plover (*Charadrius melodus*), a species federally listed as threatened. Habitats also support the gull-billed tern (*Gelochelidon nilotica*), a species listed as threatened by the North Carolina Wildlife Resources Commission (NCWRC), and NCWRC special concern species including American oystercatchers (*Haematopus palliatus*), Wilson's plovers (*Charadrius wilsonia*) and colonial waterbirds (e.g., least terns [*Sternula antillarum*], common terns [*Sterna hirundo*], and black skimmers [*Rynchops niger*]). The Seashore is designated a Globally Important Bird Area (Audubon 2017), a designation that recognizes areas with populations and habitats important at the global level.

With over two million visitors each year, the Seashore is a popular recreation destination and visitors participate in a variety of activities including beach recreation, fishing, hiking, hunting, boating, nature study, photography, wildlife viewing, and off-road vehicle (ORV) use on beaches. Shorebirds, both breeding and nonbreeding, are affected by human disturbances, habitat loss, and predation. Human disturbance, direct or indirect, may lead to the abandonment of nests or loss of chicks. Depredation by mammals, birds, and ghost crabs have affected the success of many nests and broods over the years at the Seashore as well. The Seashore monitors and manages shorebirds and their habitat to meet conservation goals including promoting successful reproduction. Shorebird nesting and foraging areas are protected with closures and buffers and ORVs are regulated on the Seashore

Resource Protection Areas

Resource protection areas include pre-nesting closures and wildlife protection buffers. Pre-nesting closures protect known potential shorebird breeding habitat from human activity and are established prior to breeding activity where nesting has occurred more than once in the past five years. These areas are temporarily closed to public entry during the nesting



View looking south to Cape Point from Cape Hatteras Lighthouse before it was moved to its current location in 1999, Cape Hatteras National Seashore. NPS

season. Pre-nesting closures provide a disturbance free area for birds to establish territories and nest in their preferred habitat. Buffers are set up using barriers during the brood rearing phase around nesting and foraging areas to protect birds from direct and indirect human sources of mortality including human recreation and ORV use. Between breeding seasons, there are resource closures to protect migrating and wintering piping plovers on the Seashore.

Cape Hatteras National Seashore Off-Road Vehicle Management Plan

The ORV Management Plan protects resources, minimizes conflict among users, and promotes visitor safety. The ORV Management Plan includes establishment of areas temporarily closed to public entry (such as pre-nesting closures and wildlife protection buffers required for nesting shorebird adults and chicks) and requires that ORVs have a permit to drive on Seashore beaches (NPS 2010a, 2010b). The ORV Management Plan was developed from 2007–2010 and was accompanied by a special regulation detailing requirements for ORV use at the Seashore.

The National Defense Authorization Act of 2014 directed the Seashore to conduct a review of established wildlife protection buffers and modify them, based on peer-reviewed science, to the shortest duration possible and the smallest area possible. The Seashore made a decision to implement modified wildlife buffers (NPS 2015a, 2015b) in June of 2015 and those buffers were partially implemented in 2015 and fully implemented in 2016. Copies of the plan and related documents are available at http://parkplanning.nps.gov/caha.



Off-road vehicle (ORV) on the beach, Cape Hatteras National Seashore. NPS

Piping Plover (*Charadrius melodus*) Management and Monitoring

Background

Piping plovers are small shorebirds that prefer to nest in wide, flat, sandy beaches with very little vegetation. They typically lay 3 to 4 eggs in a shallow scrape in the sand. Upon completion of the clutch, the pair incubates the nest for 27–30 days (Cairns 1982). Within hours of hatching, chicks are able to move about and feed on their own (Cairns 1982). The Atlantic population was listed as threatened under the Endangered Species Act in 1986 (USFWS 1985). Monitoring focuses on locating and protecting breeding territories to aid in determining nest and brood success.

The Seashore manages and monitors piping plovers following the Piping Plover Management at Cape Hatteras National Seashore Standard Operating Procedures (PIPL SOP, NPS 2014b) and the Cape Hatteras National Seashore Off-Road Vehicle Management Plan, as amended by the Review and Adjustment of Wildlife Protection Buffers Environmental Assessment (NPS 2010a, 2010b, 2015a, 2015b).

Management

Prenesting Closures

In 2017, Seashore staff evaluated all potential breeding habitat for piping plovers and recommended prenesting closures by March 1. Areas of suitable habitat that have had individual piping plover nests in more than one of the past five years and new habitat that was particularly suitable for shorebird nesting (such as the habitat at new inlets or overwash areas) were posted as prenesting closures using symbolic fencing (string between posts) or with other closure signs by March 15 (NPS 2010a, 2010b, 2015a, 2015b).

Breeding Piping Plover Management

Wildlife protection buffers extend 50 m around nests or breeding behavior (i.e., scraping, territorial, courtship, or mating). The 2015 modification to the ORV management plan reduced the wildlife buffers when unfledged chicks were present; buffers were reduced from 1000 m to 200–500 m in ORV areas based on extensive monitoring and from 300 m to 100 m in vehicle-free areas (NPS 2010a, 2010b, 2015a, 2015b).



Piping plover at Cape Hatteras National Seashore. NPS



Piping plover nest with eggs at Cape Hatteras National Seashore. NPS

Predator exclosures, which have been used at the Seashore since 1994 to reduce predator pressure on piping plover nests and nesting adults, were constructed around nests when clutches reached three or more eggs. The circular exclosures (approximately 10 ft in diameter), consist of 2-inch x 4-inch welded-wire fence, anchored by steel rebar and topped with a 3/4-inch mesh netting to dissuade avian predators. Exclosures were installed following the guidelines established in the U.S. Fish & Wildlife Service Piping Plover Recovery Plan (USFWS 1996, Appendix F). Thereafter, the nests were briefly approached once weekly to inspect the exclosure, verify the number of eggs, and check for signs of predators (PIPL SOP; NPS 2014b).

Migrating and Winter Piping Plover Management

In the fall, and to a lesser degree in the spring, large numbers of piping plovers migrate through the Seashore. Winter resource closures are established on points and spits to provide protection for migrating and wintering piping plovers that utilize the Seashore as foraging grounds. The resource closures are installed in locations based on habitat (i.e. mud flats) used by wintering piping plovers in more than one of the past five years. Winter resource closures that restrict both ORV and pedestrian access were established at the end of breeding season and upon removal of the prenesting closures at Bodie Island Spit and Ocracoke's South Point (NPS 2010a, 2010b, 2015a, 2015b).

In addition to the winter resource closures, permanent Vehicle Free Areas (VFA), especially those at Bodie Island Spit, Cape Point, South Beach and North Ocracoke, also provide relatively undisturbed areas for migratory and wintering piping plovers.

Monitoring

Breeding Piping Plover Monitoring

Daily nest monitoring began in early March 2017 and occurred from at least 75–100 m away when any piping plovers were present in the area to minimize disturbance to incubating birds, but close enough to be able to document incubation, nest abandonment, and abnormal behavior. Morning and evening monitoring began five to seven days prior to the expected hatch date. During ORV access hours, brood monitoring was continuous at Cape Point; broods were monitored as early as 6:00 a.m. and monitoring extended to dusk. This continuous monitoring occurred because there was a probability that the chicks from the first piping plover nest might move to within 200 m of ORV activity. However, this did not occur because the chicks were lost.

The second plover brood was also intensively monitored because the resource closure was the smallest size (200 m) and only a very thin strip of thick, grassy vegetation provided a natural barrier between chicks and any open ORV areas. Observers stayed in the general area where the broods were last seen before it was dark and exited the area once all ORVs vacated the area for the night (9:00 p.m.). Observers documented brood status, behavior, individual bird and brood movements, human disturbance, predator interactions, and significant environmental events.

During daily observations, field technicians documented foraging locations for piping plover chicks. Since chicks were not observed continuously from dawn to dusk or during the night, actual territories may be larger than recorded. On occasions where chicks were lost soon after hatching, foraging territory outside the immediate vicinity of the nest could not be determined due to lack of direct observations. At Cape Point, an established grid system at the historical breeding territories with points located 75 m apart was utilized by staff to obtain more accurate locations for individual birds and chick movement from a distance without disrupting their regular behavior patterns. This grid system was established in 2013 and uses 75-m x 75-m squares that assist staff in monitoring daily movements on piping plover broods to estimate the size of the areas the birds use. The grid system consists of PVC piping installed at 75-m intervals with predator deterrents on top of the pipes. (PIPL SOP; NPS 2014b). The individual brood foraging areas designate the area in which the brood was observed on any given day until they fledged or were determined to be lost (PIPL SOP; NPS 2014b).

Migrating and Wintering Piping Plover Monitoring

Survey methods for monitoring migratory and wintering shorebirds are conducted in accordance with the Southeast Coast Network Inventory & Monitoring Network protocol (Byrne et al. 2009). Migrating and wintering piping plover monitoring was conducted spring 2016 through spring 2017, though monitoring did not occur on all survey dates due to limited staffing. Surveys were not conducted in June when all the piping plovers present were assumed to be breeders and not migrants.

Per the Southeast Coast Inventory and Monitoring Network protocol, transect sampling consisted of a two-tiered approach comprised of high-intensity and low-intensity sampling. High-intensity sites were sampled on a weekly basis whereas the low-intensity sites were sampled on a monthly basis. There are approximately 660 potential surveys with 220 and 440 surveys distributed to high- and low-intensity sampling sites, respectively. Semi-permanent transect locations have been established along the entire ocean shoreline. The majority of transects were one mile in length and were numbered Park Mile 0 through Park Mile 74. Some transects at points and spits vary in length due to the constantly changing shorelines and, therefore require more than one transect due to a larger topographical area. Surveys were performed by trained technicians.

In addition to our transect monitoring, an experienced volunteer conducted weekly plover counts during spring migration in March and April. Piping plovers were counted utilizing a spotting scope and individuals were recorded as banded, unbanded, or not scanned. The surveys were performed to provide total piping plover counts using locations at a particular time and to monitor for banded birds. If the observer was not able to clearly see above and below both leg joints when searching for color bands or flags, the bird was counted as "not scanned." Band combination and a GPS location for each banded piping plover were recorded. For large groups of piping plovers, mostly found on South Point, the count and band survey were divided into separate tasks. A total count was taken and then the area was visually divided into smaller areas demarcated by landmarks. The observer spent approximately eight to ten hours scanning the smaller areas and identifying as many bands as possible.



Banded piping plover at Cape Hatteras National Seashore. NPS

Results and Discussion

Breeding Piping Plovers

Productivity

In 2017, nesting was identified at four sites: Bodie Island Spit on Bodie Island, Cape Point on Hatteras Island, North Ocracoke Island, and South Point on Ocracoke Island (Appendix A; Appendix B). The first nest of the 2017 breeding season was discovered on April 16 and the last active nest was lost on July 16.

Six breeding pairs were observed which produced 12 identified nests. Three nests successfully hatched at least one chick. A total of 33 eggs were documented, of which ten hatched for a hatch rate of 30% (Table 1). The average incubation period was 30 days and ranged from 27 to 32 days (this calculation excludes nests found at full clutch because exact age of the eggs is unknown).

Nest Failures and Chick Mortality

Nine nests (75%) were lost prior to hatching and eight chicks (80%) were lost prior to fledging. Three out of 12 nests produced chicks. A total of two chicks fledged from one brood/nest (Table 1). The age at fledging was 29 days for both chicks. Two chicks fledged from six breeding pairs yielding a fledge rate of 0.33 chicks fledged per breeding pair (Figure 1). Reason for nest loss was mostly unknown; however, some loss occurred from ghost crab depredation, abandonment, and overwash. Chick loss was attributed to ghost crab depredation, infanticide, or unknown reasons. During the 2017 breeding season, a bachelor male piping plover was observed foraging at Cape Point. In May, a piping plover nest hatched and the brood moved into the bachelor male's foraging territory. The bachelor piping plover aggressively defended his territory against the brood and his actions contributed to the loss of four chicks. This type of behavior is known as infanticide.

Since 1997, fledge rates have ranged from 0.0 to 2.0 chicks per pair at the Seashore. The mean rate from 1997-2017 was 0.66 chicks per pair. The fledge rate for 2017 was 0.33 chicks/pair. Chick loss, similar to previous years, was difficult to determine. The majority of chick mortality occurred soon after hatching; loss occurred from three to seven days after hatching with an average of 4.3 days.

Chick Movement

The furthest observed distance traveled by the two broods this season from their respective nests (straight line distance) was approximately 525 m (site 17PIPLHI01) and 615m (site 17PIPLHI05). The estimated size of the foraging areas for the broods was calculated at 5.75 hectares (site 17PIPLHI01) and 4.00 hectares (site 17PIPLHI05). Brood foraging areas were considered to be any area they were observed feeding in once they left the nest site after hatching.

Migrating and Wintering Piping Plovers

From April 2016 through March 2017 (excluding the month of June) 91 surveys were conducted at six high-intensity sites on the points and spits (Park Miles 4, 5, 45, 46, 58, and 59). A total of 49 piping plovers were found during all surveys; eight were observed in ORV areas, 36 in resource protection areas, and five in vehicle free areas. Twenty-four of the plovers were observed in high-intensity sampling sites and 25 were observed in low-intensity sampling sites.

In the separate counts conducted by a volunteer for the Seashore, a total of ten weekly piping plover counts occurred during the 2017 fall migration from

Table 1. Piping plover nest and chick success at Cape Hatteras National Seashore in 2017.

Location	Breeding Pairs	Total Nests	Nests Hatched	Nests Lost/ Abandoned	Total Eggs	Total Eggs Hatched	Total Chicks Fledged	Total Chicks Lost
Bodie Island Spit	1	1	0	1	4	0 (0%)	0	0
Cape Point	3	5	3	2	17	10 (59%)	2	8
South Beach	0	0	0	0	0	0 (0%)	0	0
North Ocracoke	1	1	0	1	1	0 (0%)	0	0
South Point	1	5	0	5	11	0 (0%)	0	0
TOTAL:	**6**	**12**	**3**	**9**	**33**	**10 (30%)**	**2**	**8**

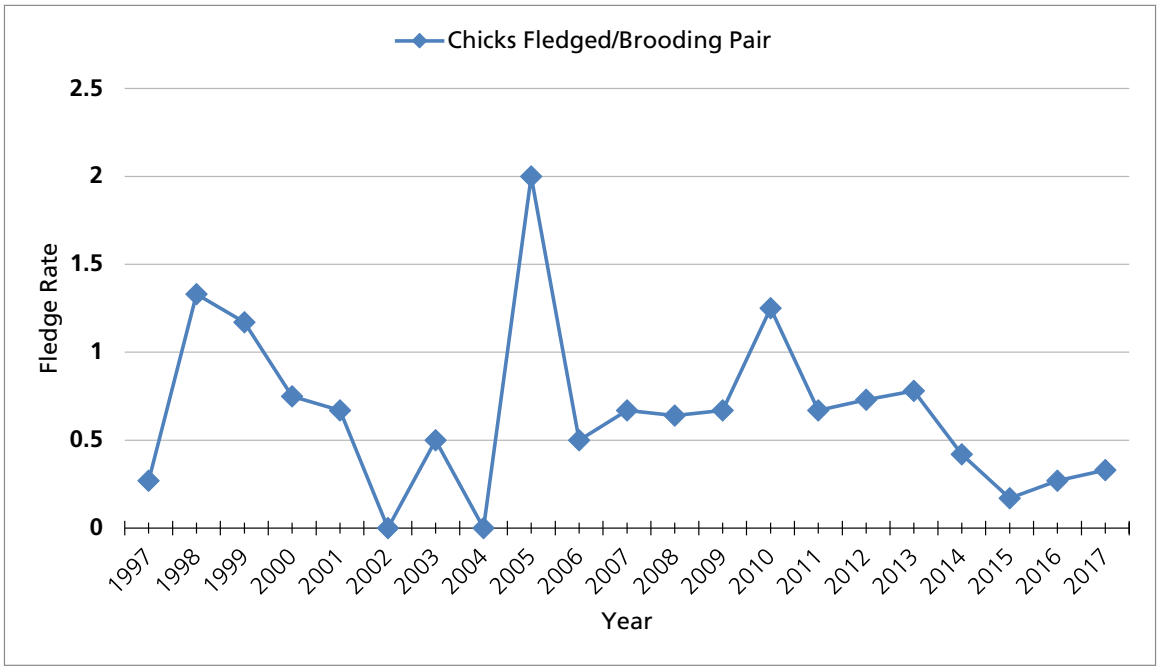


Figure 1. Piping plover fledge rate (chicks fledged per pair) at Cape Hatteras National Seashore from 1997 to 2017.

August 5 through September 3. The majority of piping plovers were observed on Ocracoke's South Point; the minimum piping plover count during the survey period was 125 individuals and the maximum was 182 individuals (Table 2). Banded piping plovers were also documented during these counts. Twenty-one individuals were banded in the north Atlantic states and Canadian provinces, twelve originated from the south Atlantic, and one was banded in the Great Lakes region (S. Maddock, personal communication; Table 3). Multiple birds stayed on Ocracoke's South Point for two, three, or four weeks. This demonstrates the importance of the South Point area on Ocracoke Island as a fall migration stopover site for piping plovers and may be the only site on the Atlantic coast where such large numbers can be observed during migration.

Table 2. 2017 South Point fall migration piping plover counts, Cape Hatteras National Seashore.

Date	Total Number	# Banded
8/5	132	17
8/11	148	23
8/18	182	26
8/26	134	29
9/3	125	24

Table 3. Origins of banded piping plovers observed at South Point, Cape Hatteras National Seashore in 2017.

Banding Origin	Number of PIPL Observed
New Jersey	4
New York	4
Rhode Island	3
Massachusetts	2
New Brunswick	4
Nova Scotia	3
Prince Edward Island	1
Michigan	2
North Carolina	10
Bahamas at Joulter Cays	2

American Oystercatcher (*Haematopus palliatus*) Management and Monitoring

Background

Oystercatchers are ground-nesting shorebirds native to North Carolina. As with many shorebirds, their numbers have been in sharp decline over the past 20 years. The American oystercatcher is designated as a Special Concern Species by the North Carolina Wildlife Resources Commission and a Species of High Concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001). Throughout its range, habitat loss and fragmentation due to beach development has resulted in nesting attempts in marginal habitat. Marginal habitat is thought to lead to an increased number of unsuccessful nesting attempts from breeding pairs. ORV use on the beach can lead to direct mortality of chicks and eggs and pedestrian disturbance can indirectly cause loss of nests or chicks. The main cause of direct mortality of chicks and eggs in the Seashore is believed to be mammalian predators.

The park manages and monitors American oystercatchers following the American Oystercatcher Monitoring at Cape Hatteras National Seashore document (NPS 2017) and the Cape Hatteras National Seashore Off-Road Vehicle Management Plan, as amended by the Review and Adjustment of Wildlife Protection Buffers Environmental Assessment (NPS 2010a, 2010b, 2015a, 2015b).

Management

Prenesting Closures

In 2017, Seashore staff evaluated all potential breeding habitat for American oystercatchers and recommended prenesting closures by March 1. Areas of suitable habitat that have had individual American oystercatcher nests in more than one of the past five years and new habitat that was particularly suitable for shorebird nesting (such as the habitat at new inlets or overwash areas) were posted as prenesting closures using symbolic fencing (string between posts) or with other closure signs by March 15 (NPS 2010a, 2010b, 2015a, 2015b).

Breeding American Oystercatcher Management

Wildlife protection buffers extend 150 m around American oystercatcher breeding behavior (scrapes or nests) and 200 m around unfledged chicks. In



American oystercatcher at Cape Hatteras National Seashore. NPS



American oystercatcher nest with eggs at Cape Hatteras National Seashore. NPS

some circumstances, an ORV corridor was established to allow for vehicle passage in front of nests when there was no other way to get around the nest on a route. As chicks commenced their movement away from the nest sites, the protection areas were expanded when necessary to ensure adequate buffers (NPS 2010a, 2010b, 2015a, 2015b).

Breeding pairs of American oystercatchers were located through daily surveys of potential habitat on both ocean-side and sound-side beaches. Birds were monitored closely for nesting when observed regularly at the same location or when demonstrating territorial or breeding displays. If nests or scrapes were found, observers marked the location with a handheld GPS unit (NPS 2017). Resource closures were installed (or modified) as necessary to maintain the required buffer distances (NPS 2010a, 2010b, 2015a, 2015b).

Nonbreeding American Oystercatcher Surveys

Nonbreeding American oystercatchers are classified as lone birds or pairs of birds that are unassociated with nests at the Seashore. Three surveys were conducted in all park districts on June 1, 3, and 5 to account for nonbreeding American oystercatchers. The locations of individuals and pairs were estimated after the breeding season concluded using a hand-held GPS. Presence of color bands/flags was recorded as well. After the conclusion of the breeding season the highest daily number of nonbreeding American oystercatchers for the Seashore was reported.

Banding

In addition to carrying out actions indicated by the ORV Management Plan, trained technicians banded American oystercatcher adults and chicks under North Carolina State University's banding permit. Banding aids in tracking survival of individuals, determining breeding success of individual pairs, documenting movement of young birds to other areas, and determining breeding site fidelity. Banded birds also allow North Carolina State University and the Seashore staff to coordinate data with scientists from other states to examine genetics, migration patterns, and long-term survival rates of American oystercatchers.

Monitoring

Pairs with active nests were monitored daily from at least 75–100 m away when any American oystercatchers were present in the area to minimize disturbance to incubating birds, but close enough to be able to document incubation, nest abandonment, and abnormal behavior. Each nest was observed closely near expected hatch dates for signs of chicks. Expected hatch dates were calculated from an average nest incubation period of 29 days from first egg laid or 24 days from last egg laid (Baicich and Harrison 1997). If an incubating bird was not observed on the nest, the nest was checked for the presence of eggs and, if the eggs were missing, the area was inspected for signs of predators. Once hatched, staff attempted to observe each chick daily for the purposes of detecting presence/loss, fledge success, and to ensure that proper buffers were in place (NPS 2017).



American oystercatcher chicks at Cape Hatteras National Seashore. NPS

Results and Discussion

Breeding American Oystercatchers

Productivity

In 2017, 24 pairs of American oystercatchers nested at the Seashore: one pair on Bodie Island, 11 pairs on Hatteras Island, 10 pairs on Ocracoke Island, and two pairs on Green Island. The first nest of the season was found on April 10 and the last nest was found on June 20.

Eighteen breeding pairs held territories within the prenesting closures and 42 of the 53 nesting attempts occurred inside the prenesting closures (Appendix C; Appendix D). Altogether, these pairs produced a total of 53 nests, including re-nests, of which nine nests hatched. Two pairs were successful in each fledging one chick which represents a 0.08 fledge rate per pair (Table 4). This fledge rate represents a decrease from previous years (Figure 2). For the nine nests with known start dates, the average incubation period was 29 days. Chicks fledged 42 days after hatching on average.

Table 4. Summary of American oystercatcher reproductive success at Cape Hatteras National Seashore from 2011 to 2017.

Year	Breeding Pairs	Total Nests	Nests Hatched	Successful Pairs (at least 1 chick fledged)	Number of Chicks Fledged	Fledge Rate
2011	23	26	22	17	28	1.2
2012	22	30	18	11	15	0.68
2013	27	42	19	10	15	0.55
2014	26	38	18	8	9	0.35
2015	25	43	19	11	13	0.52
2016	26	41	13	9	12	0.46
2017	24	53	9	2	2	0.08

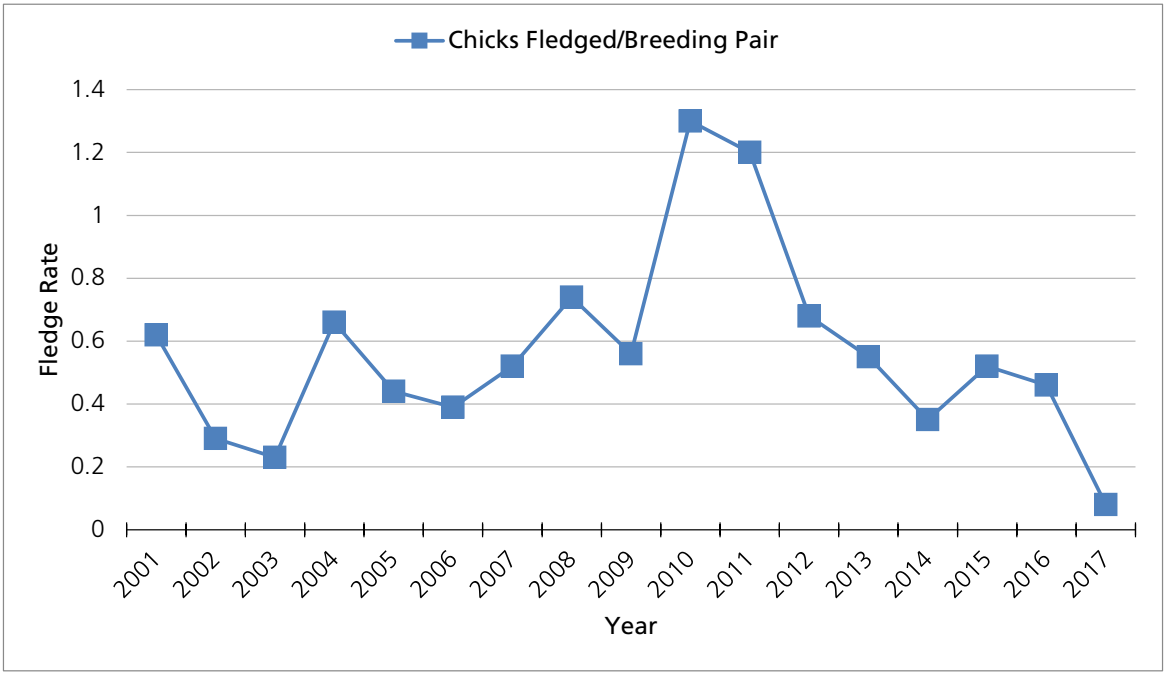


Figure 2. Fledge rate (chicks fledged per pair) for American oystercatchers breeding at Cape Hatteras National Seashore from 2001 to 2017.

Nest Failures and Chick Mortality

Forty-four nests were lost in the 2017 breeding season. Eleven nests were lost to overwash, four nests were abandoned, 15 nests were depredated, and 14 were lost to unknown causes. Of the 15 nests lost to depredation, 12 were taken by unknown canid species, two by foxes, and one nest was depredated by both a feral cat and ghost crabs. The most likely canid predators at the Seashore are coyote and fox. Mammalian, ghost crab, or avian predators (e.g., gulls and crows) are believed to be responsible for the other 14 nests lost to unknown causes. Additionally, the low hatch success and fledge rate is attributed to increased predation by mammals. The high number of recent predation incidents could also be responsible for the increased number of nests. Of the 24 pairs with known nesting dates, 18 pairs (75%) re-nested at least once after their first nest was lost.

Determining cause of chick loss is even more difficult than determining cause of nest loss. In the 2017 season, there were seven complete brood failures and two partial brood failures. Thirteen chicks were lost to unknown causes and one was lost to mink predation. Chicks can move large distances and it is sometimes difficult to locate them. Environmental conditions surrounding the brood site may obscure evidence of predation and searches for missing chicks may be hampered since many types of disturbances can cause the chicks to hide out of view.

Nonbreeding American Oystercatcher Surveys

The peak count during the June survey window for nonbreeding American oystercatchers was 27 individuals on June 5 (Table 5). Two were observed on Bodie Island, 11 on Hatteras Island, and 14 on Ocracoke Island. Some banded birds that were reproductively mature did not nest, possibly due to their inability to find, establish, and hold a territory, or inability to find a mate of breeding age.

Table 5. Nonbreeding American oystercatcher survey results during the predetermined dates in June 2017 at Cape Hatteras National Seashore.

Date	Bodie	Hatteras	Ocracoke	Totals
6/1	3	9	7	19
6/3	1	7	4	12
6/5	2	11	14	27

Banded American Oystercatchers

In 2017, four new pairs and one new individual joined the Seashore's breeding population for a total of 24 American oystercatcher pairs. Of the four new pairs, two pairs had been observed at the Seashore in previous years but this was their first season to nest.

A total of 222 American oystercatchers have been banded at the Seashore since 2002, consisting of 52 adults and 170 chicks. Four adults and one chick were banded in 2017. As a result of this long-term cooperative banding project with North Carolina State University, the Seashore has begun to document banded chicks surviving to adulthood and joining the breeding population. Banded birds enable staff to identify breeding pairs and unpaired individuals with confidence.

Colonial Waterbird Management and Monitoring

Background

Colonial waterbirds are bird species that nest in large groups, referred to as colonies, and obtain their food from the water. Terns, gulls, pelicans, skimmers, and wading birds are all examples of colonial waterbirds. The Seashore's beaches provide traditional nesting habitat for several species of special concern as well as state-listed species, including the common tern (*Sterna hirundo*), least tern (*Sterna antillarum*), and black skimmer (*Rynchops niger*). Less common nesters include the gull-billed tern (*Gelochelidon nilotica*), white ibis (*Eudocimus albus*), and tricolored heron (*Egretta tricolor*).

The park manages and monitors colonial waterbirds following the Colonial Waterbird Management at Cape Hatteras National Seashore Standard Operating Procedures (CWB SOP, NPS 2014a) and the Cape Hatteras National Seashore Off-Road Vehicle Management Plan, as amended by the Review and Adjustment of Wildlife Protection Buffers Environmental Assessment (NPS 2010a, 2010b, 2015a, 2015b).

Management

Prenesting Closures

In 2017, Seashore staff evaluated all potential breeding habitat for colonial waterbirds and recommended prenesting closures by April 1. Areas of suitable habitat that have had concentrations of more than 10 colonial waterbird nests in more than one of the past five years and new habitat that is particularly suitable for shorebird nesting (such as the habitat at new inlets or overwash areas) were posted as prenesting closures using symbolic fencing (string between posts) or with other closure signs by April 15. Because colonial waterbird colonies may shift locations from year to year, ORV ramps and pedestrian access points that have had colonies in more than one of the past five years will remain open until scraping or nesting is observed (NPS 2010a, 2010b, 2015a, 2015b).



Least tern at Cape Hatteras National Seashore. NPS



Common tern eggs. NPS

Breeding Colonial Waterbirds

The ORV Management Plan does not specify what parameters constitute an active colonial waterbird colony. The CWB SOP states that, "each distinct group of nesting colonial waterbirds will be considered a colony and receive a name designation if there are two or more nests within 200 m or less of one other." Also, activity that triggers a resource closure must include physical evidence of established breeding such as a scrape or a nest; behavior alone (e.g. copulation or fish-flashing) will not suffice. Least tern buffers are 100 m for breeding behavior (scrapes or nests) and unfledged chicks (NPS 2010a, 2010b, 2015a, 2015b). Other protected colonial waterbird species receive a 180 m buffer for all breeding activity and unfledged chicks (NPS 2014a, 2015a). Resource closures were modified as the colonies expanded to maintain the required buffer sizes from the outermost scrapes, nests, or chicks in the colony.

Monitoring

After identifying suitable nesting habitat and installing prenesting closures, colony activity surveys and monitoring took place on all Seashore beaches. Colonial waterbirds were observed for courtship behaviors, such as fish flashing, copulation, and scraping. Data collection began when physical scrapes were observed and a resource closure was installed around the area. Trained technicians observed the colony area daily from at least 75–100 m away from. Efforts were made to minimize entry into colonies to prevent colony disturbance.

Colonies were surveyed during the peak nesting period for each species, which generally is during the first part of June for tern species, but can be later for species such as black skimmers (NPS 2010a, 2010b, 2015a, 2015b).

The highest nest count was reported as the nesting peak; timing of nesting peak varies based on the start date of the colony and progression of the colony. Additional surveys occurred when a colony start date was early or delayed; when predator influence, storms or weather significantly impacted colony sites; and when the colony grew and more accurate information regarding breeding estimates was obtained. If chicks were observed prior to the first week of June, then it was acceptable to perform a walk-through survey. The distance from the outermost scrapes, nests, or chicks to the resource closure boundary were checked during observation periods to ensure all scrapes, nests, or chicks were within the specified buffer areas.

Results and Discussion

Colonies

In 2017, 16 colonies were identified at the Seashore; 10 on Hatteras Island, one on Bodie Island, one on Green Island, and four on Ocracoke Island (Table 6; Appendix E). If not already present, a resource closure was installed to provide the colony with protection. Per the ORV Management Plan, locations of colonies containing more than 10 colonial waterbird nests in more than one of the past five years will be considered for future placement of prenesting closures (NPS 2010a, 2010b, 2015a, 2015b).

Table 6. Colonies observed during the 2017 breeding season at Cape Hatteras National Seashore.

Location	Observed Colonies	Colonies Containing > 10 nests
Bodie Island	1	0
Green Island	1	1
Hatteras Island	10	2
Ocracoke Island	4	2
Total	**16**	**5**

Table 7. Nests, eggs, and chicks observed per species during peak nesting surveys in 2017 at Cape Hatteras National Seashore.

Least tern	189	286	17
Common tern	90	171	10
Gull-billed tern	14	29	25
Black skimmer	214	464	32
White ibis*	149	–	78
Tricolored heron*	11	–	17

* Denotes species observed nesting for the first time.

Observations from peak nest surveys (Table 7) produced a park total of 189 least tern nests with 17 chicks, 90 common tern nests with 10 chicks, 14 gull-billed tern nests with 25 chicks, 214 black skimmer nests with 32 chicks, 149 white ibis nests with 78 chicks, and 11 tricolored heron nests with 17 chicks. The multi-species colony on Green Island was the most species-diverse and highest nest-producing colony on the seashore, containing nests from black skimmers, common terns, and, as of 2017, white ibis and tricolored herons. Large numbers of laughing gulls (*Leucophaeus atricilla*) continue to nest on Green Island (staff from the North Carolina Wildlife Resources Commission documented 1,373 nests during one survey). Other nesting species on Green Island include snowy egrets (*Egretta thula*), herring gulls (*Larus argentatus*), great black-backed gulls (*Larus marinus*), and boat-tailed grackles (*Quiscalus major*). This season's second multi-species colony was on Ocracoke and is the only colony with gull-billed tern nests on the Seashore. The remaining colonies were comprised only of least terns.

Four colonial waterbird breeding locations were established and deemed lost before colony status could officially be achieved prior to the walk-through survey dates.

- Site 17-CWB-BH01 on Hatteras Island was active (least tern scrapes only) from May 1–May 28. This colony was affected by a predator, likely coyote based on observed tracks, before reaching the peak nest count survey window.
- Site 17-CWB-BH03 on Hatteras Island was active (least tern scrapes only) from June 4–June 5. Adults abandoned this potential nesting site prematurely due to a severe weather event (wind).
- Site 17-CWB-BH04 on Hatteras Island was active (least tern scrapes only) from June 22–June 25. The nest site was abandoned for unknown reasons.
- Site 17-CWB-HI08 on Hatteras Island was active (one least tern nest) from July 10–July 17. A breeding adult was observed incubating consistently for one week. Incubation ceased suddenly and the nest was lost for unknown reasons.



Least tern chicks. NPS



Black skimmer. NPS

Productivity

Productivity in colonial waterbird colonies is very difficult to determine. While it is certain multiple colonies fledged chicks, there are no definitive numbers for colonial waterbird productivity at the Seashore. The uncertainty remains as to whether or not the observed fledged chicks (or juveniles, very similar in appearance) are from a particular colony or just passing through from elsewhere. Of the 16 documented colonies, colonial waterbird fledges or juveniles were observed in seven of them. Five colonies contained least tern fledges while black skimmer fledges were only observed on Ocracoke's South Point, totaling about 125 fledges. On Green Island, 11 white ibis and five tricolored heron fledges were observed.

Two walk-through nest abundance surveys were performed during the 2017 peak breeding and nesting season. These surveys were performed for each colony to aid in refining nest counts and to more accurately classify colonies. Resource Management staff make a great effort to quantify nest numbers by documenting birds in incubating posture as an alternative to conducting more frequent walk-through counts outside of peak nesting (CWB SOP, NPS 2014a).

Nest Failures and Chick Mortality

Three factors at the Seashore are believed to contribute to the loss of nests or chicks on a yearly basis: predator disturbance, abandonment, and weather. On multiple occasions, more than one of these occurred. Predator interactions were documented in nine of 16 colonial waterbird colonies; predators include gulls (six interactions), unknown fox species (four interactions), ghost crab (four interactions), raccoon (three interactions), nutria (two interactions), coyote (two interactions), opossum (one interaction), and unknown predators (one interaction). Perpetual predator issues that affect localized colonies include coyote disturbance on Bodie Island Spit and mink on Ocracoke Island. Persistent pressure from predators has historically proven to result in abandonment of nests and/or colony failure. Overwash from significant tidal events affected six colonies, resulting in either colony failure or colony reformation at a later date. During the 2017 colonial waterbird breeding season, there was one significant weather event, a Nor'easter (July 30–August 3), that may have negatively affected nesting or chicks at the Seashore.

Historical Comparison

Figures 3-6 show historical numbers of documented nests for commonly observed nesting species of colonial waterbirds. Nesting tern species at the Seashore continue to struggle overall, even though common terns produced equal nest counts to the 2016 breeding season. The least tern nesting activity continues to decrease on the Seashore. Quality and quantity of suitable nesting habitat was likely the primary factor causing low least tern numbers. Much of the traditional habitat at the points/spits (where the largest least tern colonies have occurred in the past) has given way to expanding dune systems, thus eliminating the sandy shell-beds that this species depends on for nesting. Significant weather events (i.e. direct impacts from hurricanes) have been absent in recent years or have failed to wash over the dunes and reestablish the important shell-bed habitat. Many historical nesting locations are also experiencing increased vegetation and what little habitat remains attracts a low number of breeding adults.

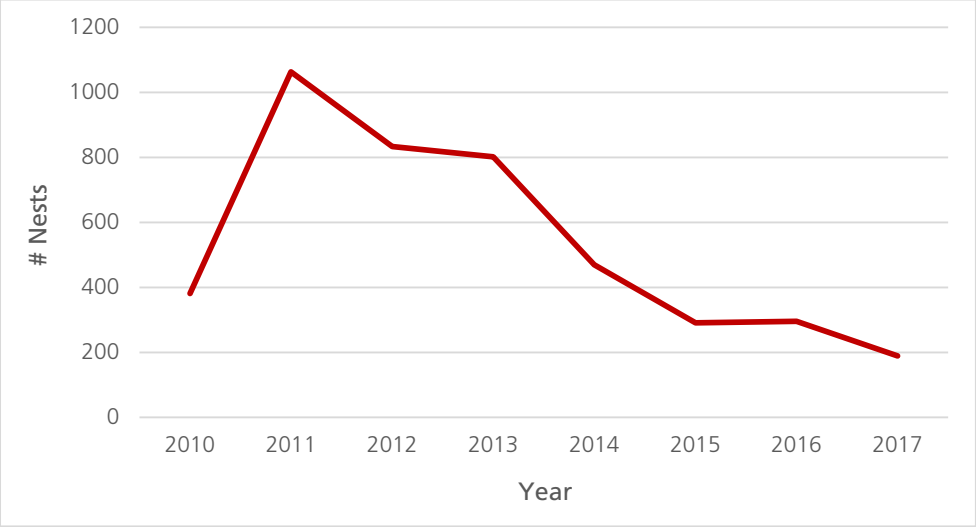


Figure 3. Historic least tern peak nest counts at Cape Hatteras National Seashore, 2010–2017.

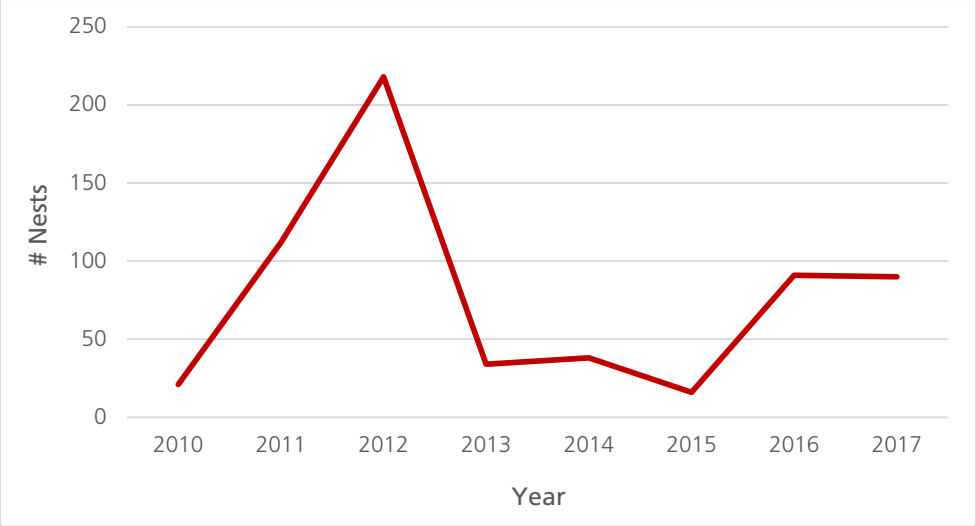


Figure 4. Historic common tern peak nest counts at Cape Hatteras National Seashore, 2010–2017.

There were two multi-species colonies observed this season that contained all of the nesting common terns and black skimmers. The first, Ocracoke's South Point, had all of the gull-billed terns detected on the Seashore, in addition to least terns, common terns and a robust black skimmer colony. The number of Black skimmer nests continues to increase in historically used areas, but black skimmers have not utilized other suitable habitat throughout the Seashore. In the second multi-species colony on Green Island, most of the Seashore's common tern nests were observed in addition to black skimmers, white ibis, and tricolored herons. The installation of yearly prenesting closures and maintenance of appropriate wildlife protection buffers may have had a positive influence on the number of colonial waterbird pairs nesting at the Seashore by providing less human disturbance within nesting habitat.

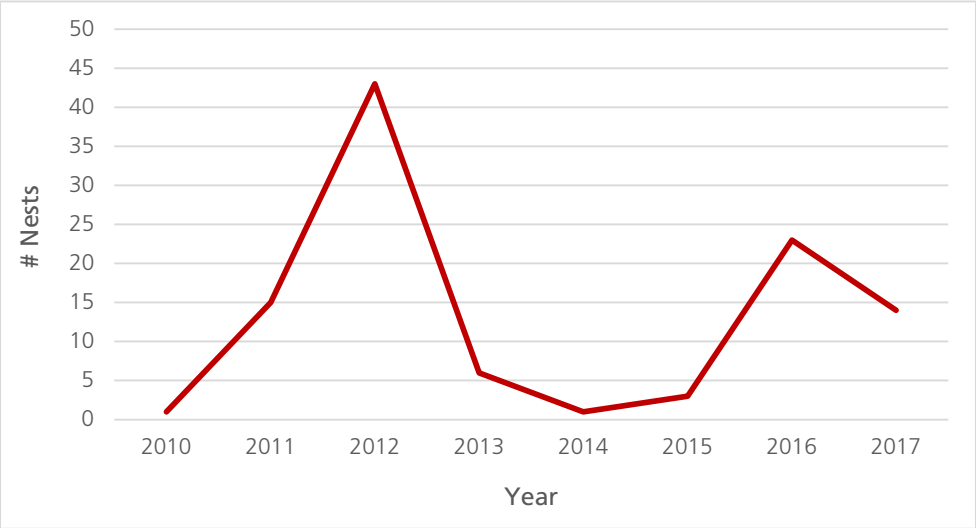


Figure 5. Historic gull-billed tern peak nest counts at Cape Hatteras National Seashore, 2010–2017.

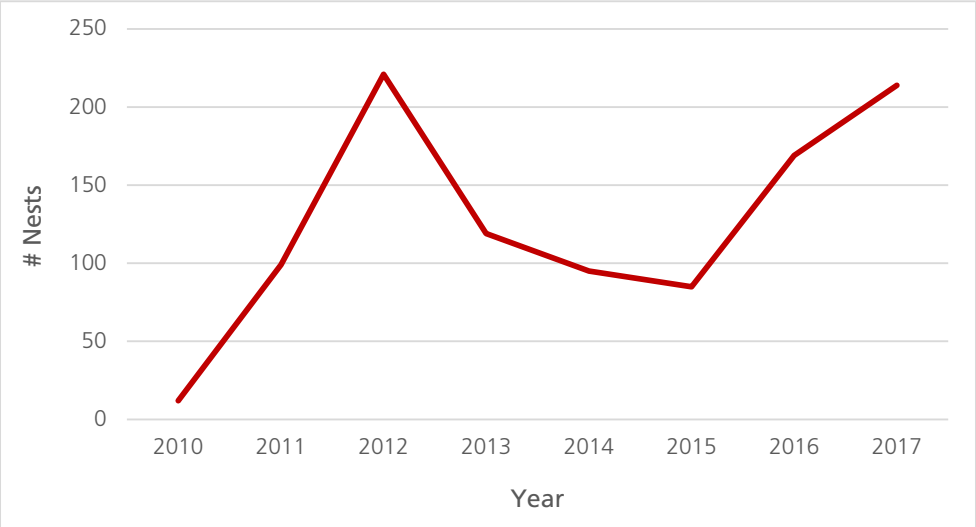


Figure 6. Historic black skimmer peak nest counts at Cape Hatteras National Seashore, 2010–2017.

Wilson's Plover (*Charadrius wilsonia*) Management and Monitoring

Background

The Wilson's plover is a ground-nesting shorebird native to North Carolina. Wilson's plovers generally lay two to three eggs in a small, shallow depression or scrape. The pair can take up to five days from the laying of the first egg to completion of the clutch (Bergstrom 1988). When all of the eggs are laid, the pair incubates the nest for 23–27 days until hatching. Both the eggs and chicks are cryptic in coloration which makes them difficult to locate. Chicks are precocial and follow the adults to locations where they forage for crustaceans, particularly fiddler crabs, and insects found in and on the sand. The Wilson's plover is listed as a Species of Special Concern in North Carolina. Plover nesting habitat is vulnerable to destruction from development, erosion, and weather events (tropical storms, extreme high tides). Disturbance from recreational activities can cause plovers to abandon their nests leaving their eggs exposed to predation and overheating.

The Seashore manages and monitors Wilson's plovers following the same procedures for piping plovers in the Piping Plover Management at Cape Hatteras National Seashore Standard Operating Procedures (PIPL SOP, NPS 2014b) and the Cape Hatteras National Seashore Off-Road Vehicle Management Plan, as amended by the Review and Adjustment of Wildlife Protection Buffers Environmental Assessment (NPS 2010a, 2010b, 2015a, 2015b).

Management

Prenesting Closures

In 2017, Seashore staff evaluated all potential breeding habitat for Wilson's plovers and recommended prenesting closures by March 1. Areas of suitable habitat that have had individual Wilson's plover nests in more than one of the past five years and new habitat that was particularly suitable for shorebird nesting (such as the habitat at new inlets or overwash areas) were posted as prenesting closures using symbolic fencing (string between posts) or with other closure signs by March 15 (NPS 2010a,S 2010b, 2015a, 2015b). Prenesting closures for piping plovers and other species protected all Wilson's plover habitat in 2017 and prior years.



Wilson's plover. NPS

Breeding Wilson's Plovers

Wildlife protection buffers are 50 m for breeding behavior (scrapes or nests) and 100 m (pedestrian) for unfledged chicks. As chicks commenced their movement away from the nest sites, the protection areas were expanded when necessary to ensure adequate buffers (NPS 2010a).

Field staff monitor for Wilson's plover arrival and breeding behavior in early March. Predator exclosures were constructed around nests when clutches reached three or more eggs. The circular exclosures (approximately 10 ft in diameter), consisted of 2-inch x 4-inch welded-wire fence anchored by steel rebar and topped with a ¾-inch mesh netting to dissuade avian predators. Exclosures were installed following the guidelines established in the U.S. Fish & Wildlife Service Piping Plover Recovery Plan (USFWS 1996, Appendix F). Thereafter, the nests were briefly approached once weekly to inspect the exclosure, verify the number of eggs, and check for signs of predators. Predator exclosures have been used at the Seashore since 1994 to reduce predatory pressure on piping plover nests and nesting adults and were used to protect Wilson's plovers beginning in 2009 with the first documented nest at the Seashore.

Monitoring

Daily nest monitoring began in early March and occurred from at least 75–100 m away when any piping plovers were present in the area to minimize disturbance to incubating birds, but close enough to be able to document incubation, nest abandonment, and abnormal behavior. Morning and evening monitoring began five to seven days prior to the expected hatch date. Due to the alert and protective nature of adults, the pairs were rarely observed incubating but were documented outside the exclosure. Observation times were minimized to reduce disturbance to the nesting pair.

After hatching, staff attempted to monitor the broods daily. The predator exclosure was removed once the adults and chicks left the nest site and moved on to the foraging grounds. Adults prefer to forage with their chicks in vegetated intertidal mudflats where the chicks can easily be concealed for safety. Broods were assumed to be in areas where adults were documented being territorial with other shorebirds.

Results and Discussion

Breeding Wilson's Plovers

Productivity

In 2017, one Wilson's plover pair and two nests were identified. All nests were found on South Point, Ocracoke Island (Appendix F). One nest was abandoned on May 7. The second nest hatched a minimum of three chicks. No chicks were fledged (Table 8). Due to the evasive behavior and mobility of the broods, an exact number of chicks hatched is unknown. The first nest was discovered on April 29 and the last nest was found on June 4 (Appendix G).

Table 8. Summary of Wilson's plover reproductive success at Cape Hatteras National Seashore, 2009–2017.

Year	Breeding Pairs	Total Nests	Nests Hatched	Successful Pairs (at least 1 chick fledged)	Number of Chicks Fledged	Fledge Rate
2009	1	1	1	0	0	0
2010	2	2	2	1	2	1.0
2011	1	1	1	0	0	0
2012	4	4	2	2	4	1.0
2013	4	4	3	3	3	0.75
2014	3	3	2	0	0	0
2015	4	3	2	0	0	0
2016	3	3	2	0	0	0
2017	1	2	1	0	0	0

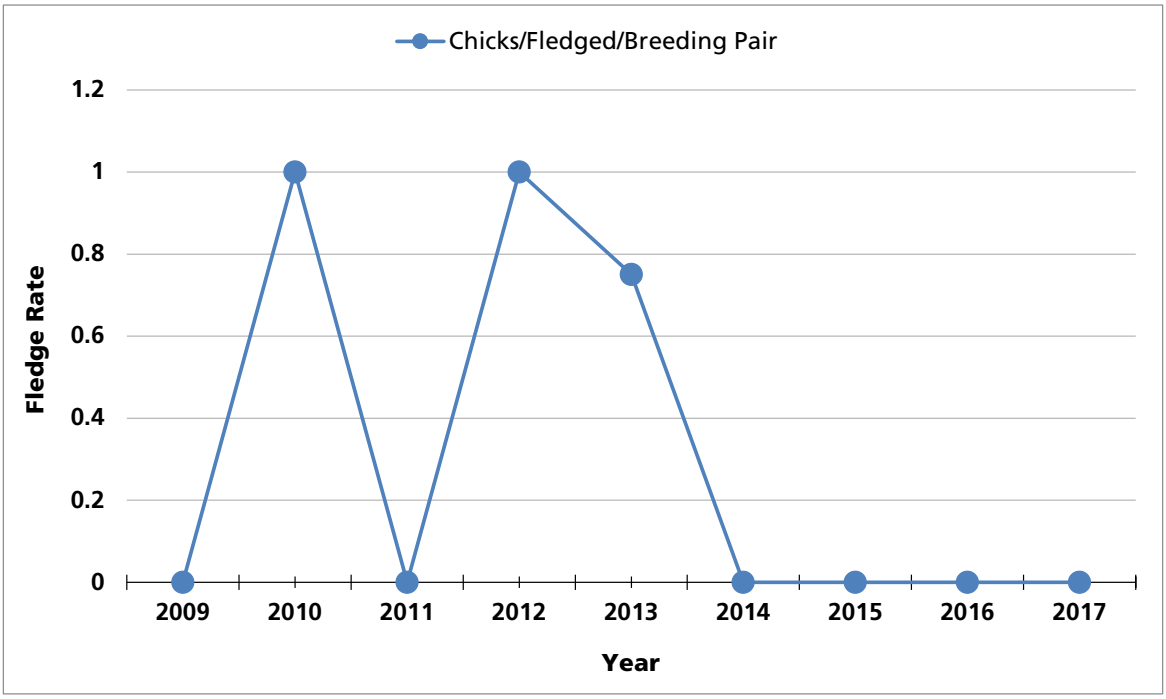


Figure 7. Fledge rate (chicks fledged per pair) for Wilson's plovers breeding at Cape Hatteras National Seashore from 2009 to 2017.

Since 2009, fledge rates have ranged from 0.0 to 1.0 chicks per pair at the Seashore. The mean rate from 2009–2017 was 0.31 chicks per pair. The fledge rate for 2017 was 0.0 chicks/pair (Figure 7). The average time to fledge was 28 days, but some broods were not observed with fledged chicks until more than 35 days after hatching.

Nest Failures and Chick Mortality

In 2017, one Wilson's plover nest was abandoned. Of the three hatched chicks, all were lost prior to fledging and all losses were attributed to unknown causes. Determining the cause of chick mortality is difficult due to the tendency of Wilson's plover broods to spend most of their time within vegetation. Mammalian, ghost crab, and/or avian predators are believed to be responsible for the losses.

Banded Wilson's Plovers

While the Seashore does not participate in banding Wilson's plovers, there are several projects throughout the southeastern United States that band Wilson's plovers with unique color band combinations. Scientists study the banded birds to gain a better understanding of movement patterns related to migration, nesting, wintering, and foraging. Since 2012, there have been 11 individuals with color bands observed at the seashore. Five individuals have been attributed to four separate nests since 2012. The banded birds enable staff to identify pairs, broods and unpaired individuals with confidence. No banded Wilson's plovers were observed nesting in 2017.

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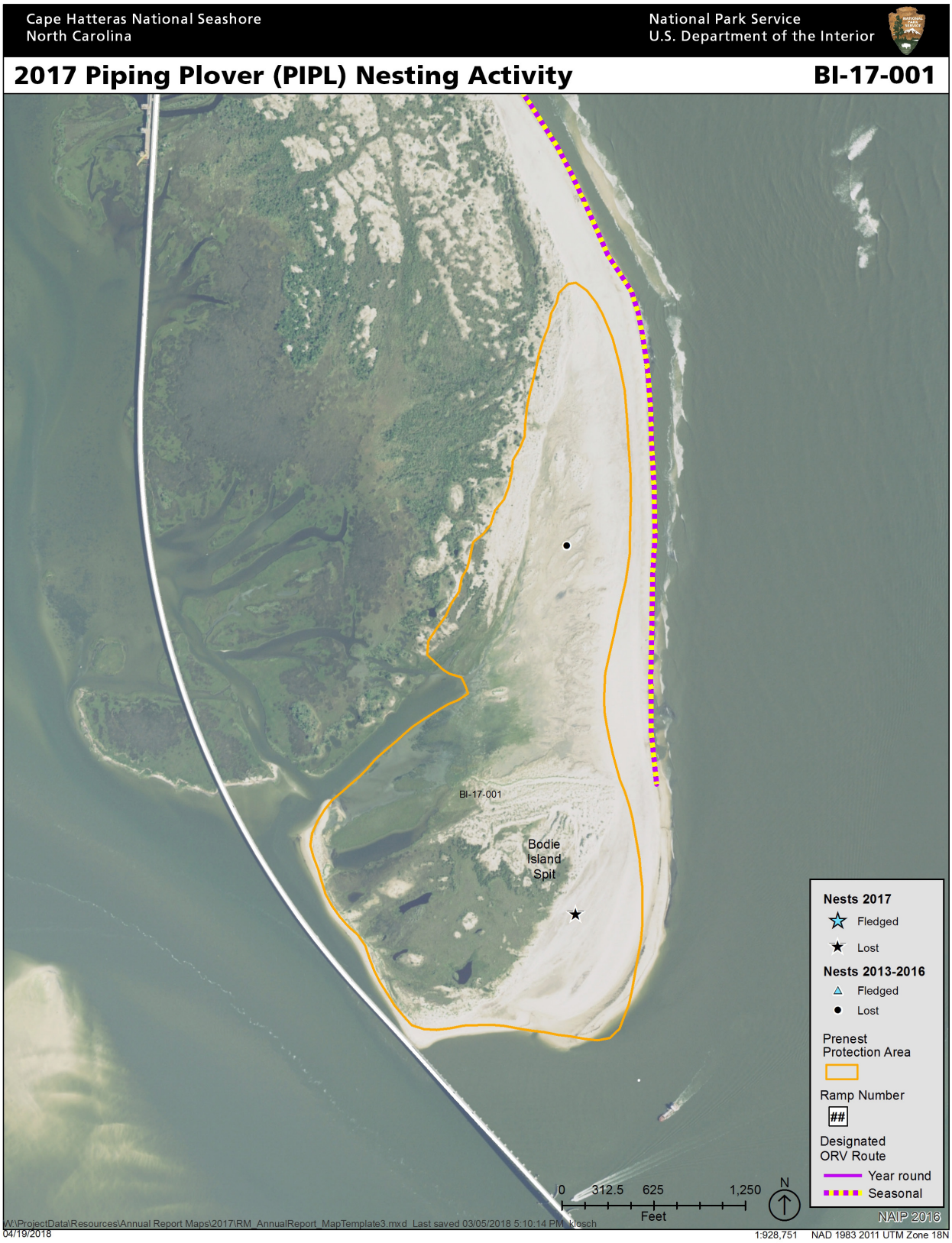
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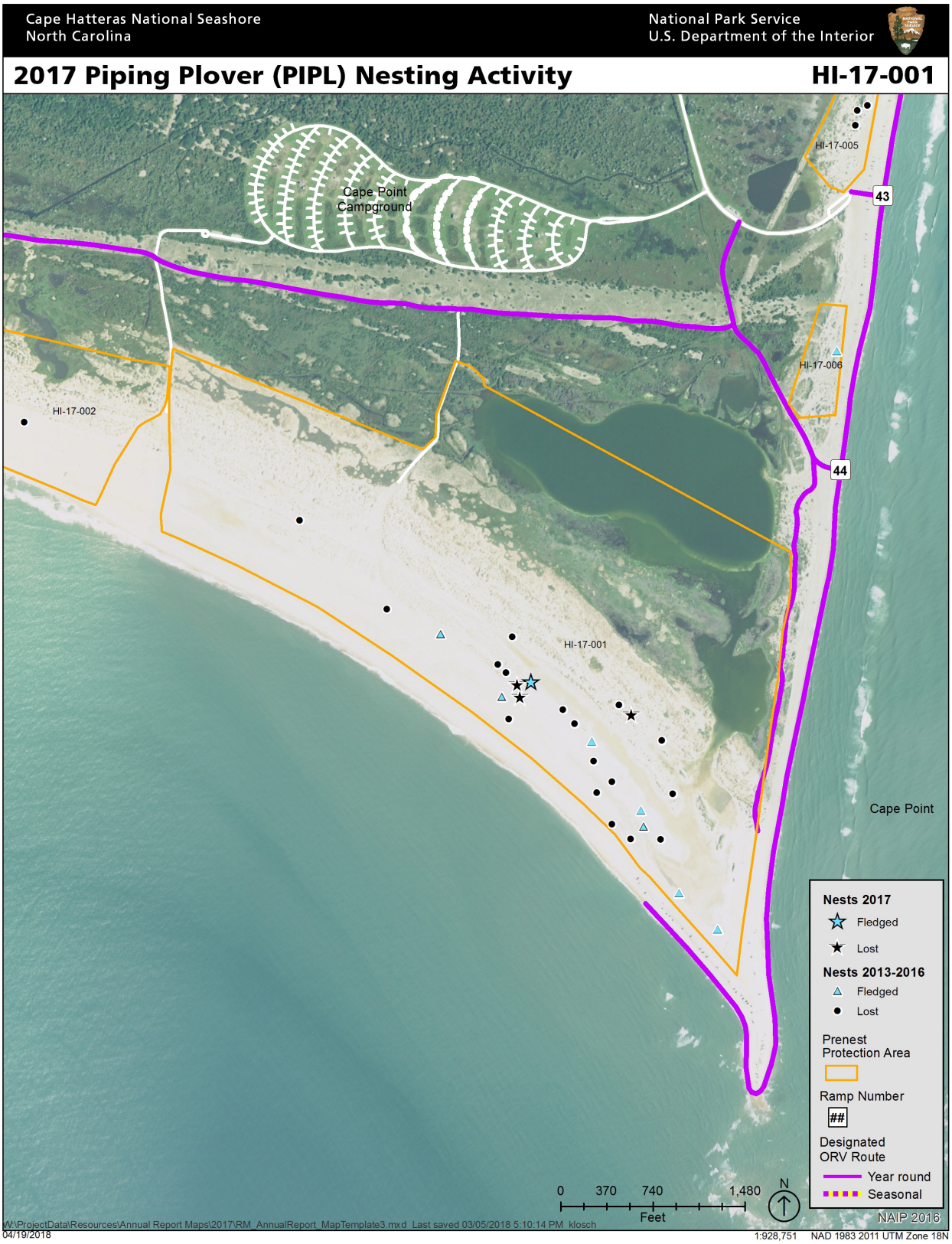
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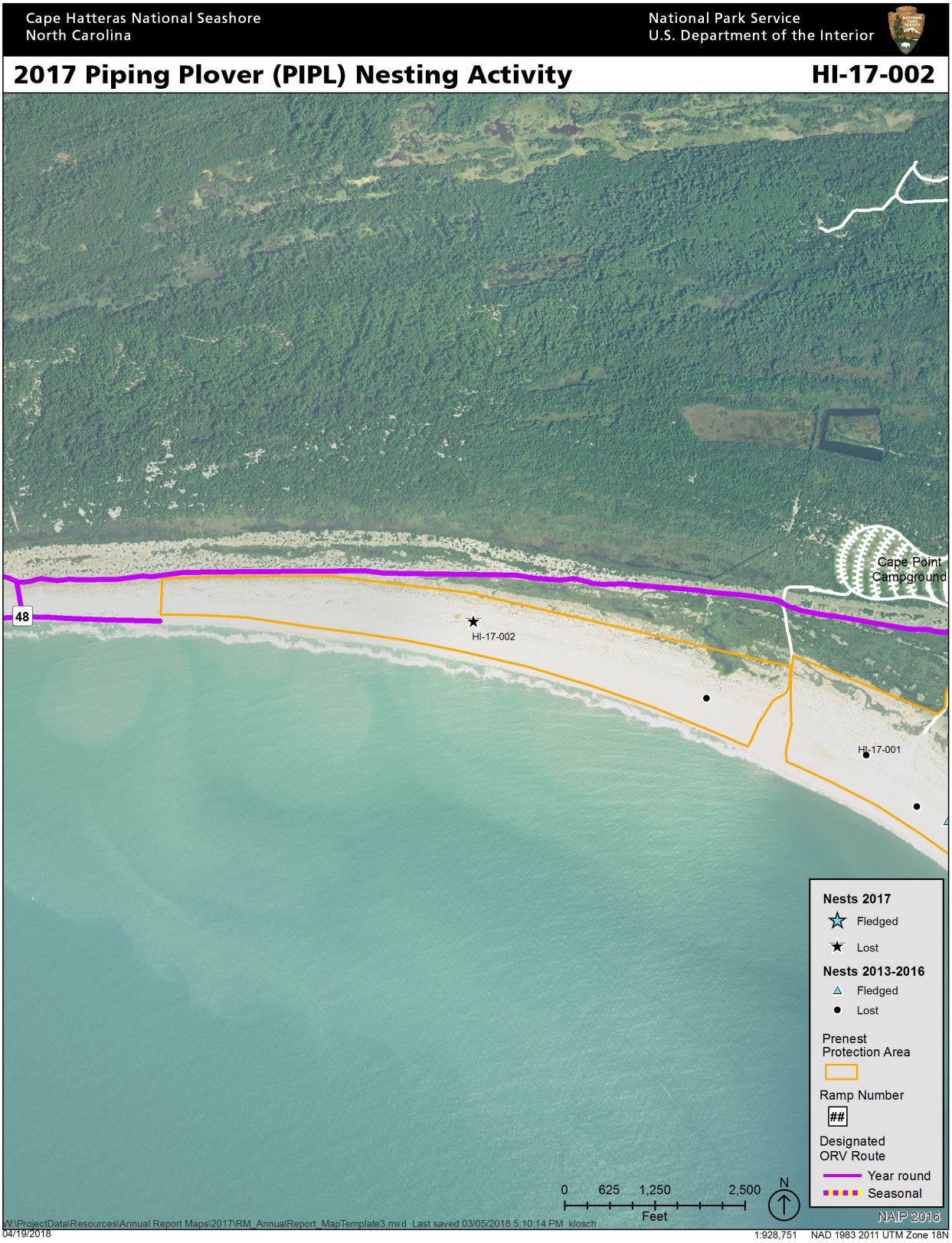
Appendix A. Piping Plover Maps



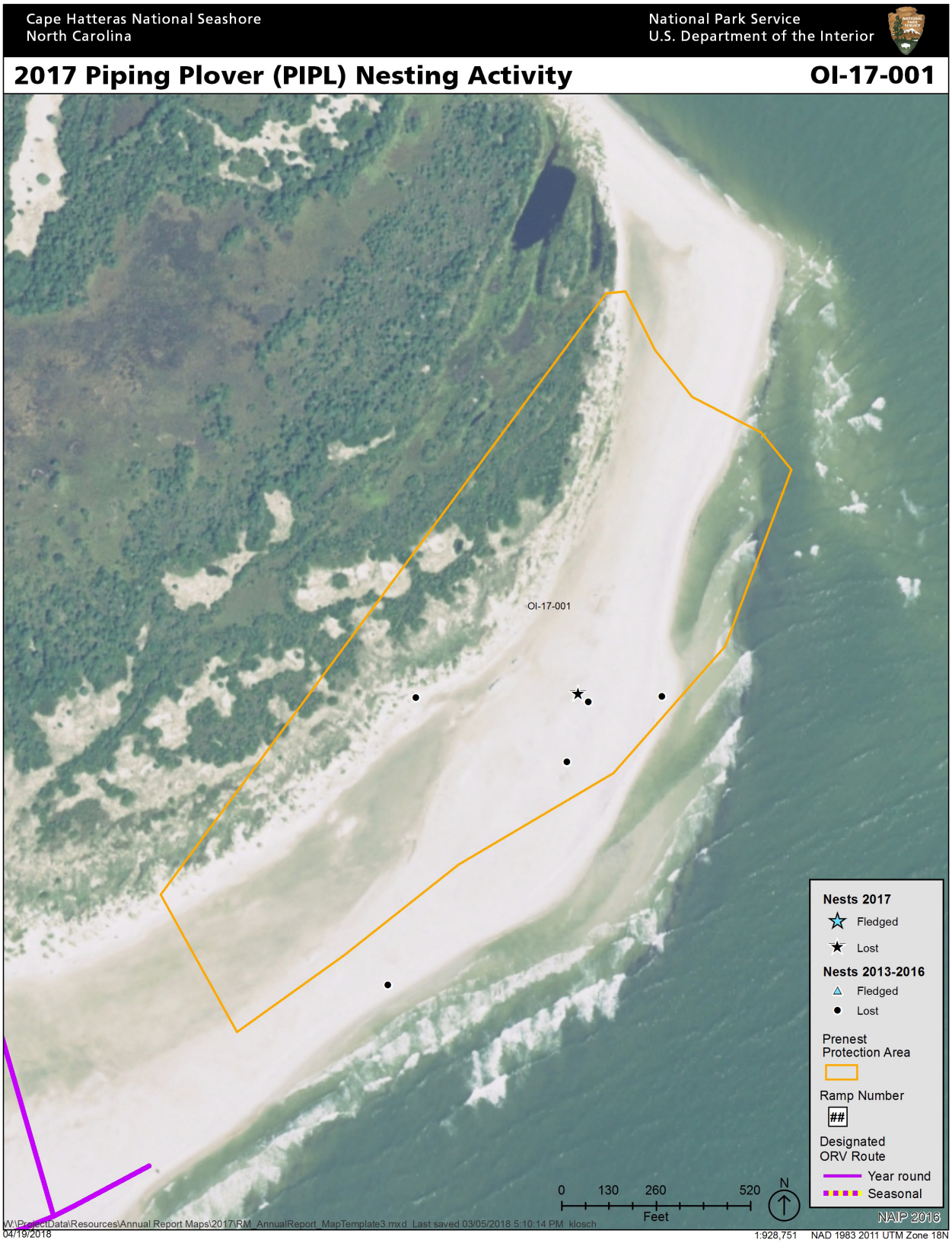
Map A-1. Bodie Island site 17-001 piping plover nesting activity, 2013–2017.



Map A-2. Hatteras Island site 17-001 piping plover nesting activity, 2013–2017.



Map A-3. Hatteras Island piping plover nesting activity, 2013–2017.



Map A-5. Ocracoke Island site 17-001 piping plover nesting activity, 2013–2017.



Map A-6. Ocracoke Island site 17-005 piping plover nesting activity, 2013–2017.

Appendix B. 2017 Piping Plover Productivity Data

Table B-1. Bodie Island Spit piping plover productivity data for 2017. Bodie Island Spit totals: 1 piping plover pair, 1 nest, 4 eggs, 0 chicks, and 0 fledglings. Seashore totals: 6 piping plover pairs, 12 nests, and 2 fledglings.

Nest #	Pair #	Location	Start Date	Total # Eggs	Date Exclosure Installed	Hatch Date	Total # Chicks	# Fledged	Fledge Date	Date Lost, # Eggs/chicks Lost, Reason
17PIPLBI01	BI01	Bodie Island Spit	6/14	4	6/14	N/A	–	–	–	7/9, 2 eggs lost, unknown; 7/14, 1 egg lost, unknown; 7/16, 1 egg lost, unknown

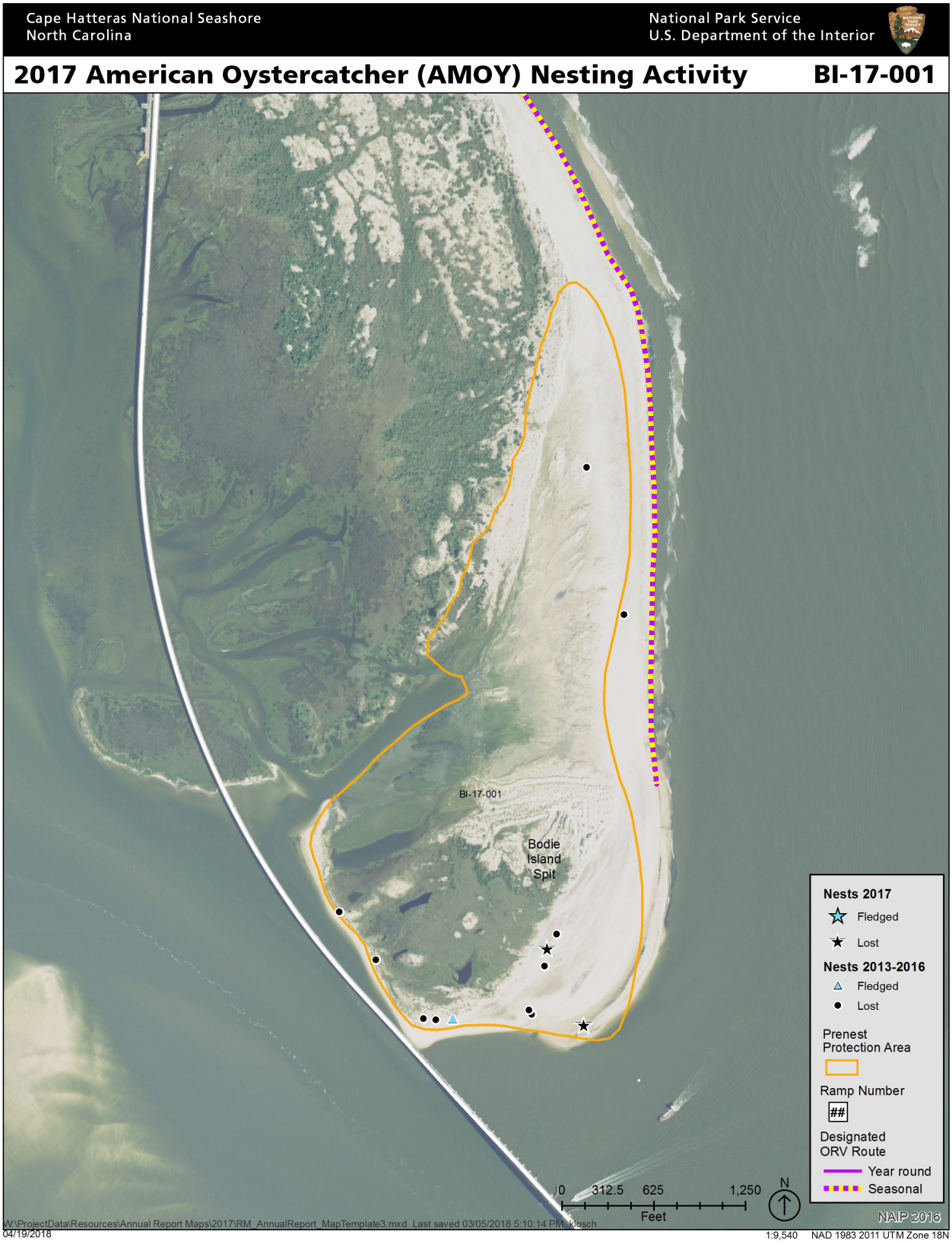
Table B-2. Hatteras Island piping plover productivity data for 2017. Hatteras Island totals: 3 piping plover pairs, 5 nests, 17 eggs, 10 chicks, and 2 fledglings. Seashore totals: 6 piping plover pairs, 12 nests, and 2 fledglings.

Nest #	Pair #	Location	Start Date	Total # Eggs	Date Exclosure Installed	Hatch Date	Total # Chicks	# Fledged	Fledge Date	Date Lost, # Eggs/chicks Lost, Reason
17PIPLHI01	HI01	Cape Point	4/16	4	4/20	5/17	4	N/A	–	5/19, 2 chicks lost, ghost crab; 5/21, 1 chick lost, ghost crab; 5/21, 1 chick lost, ghost crab
17PIPLHI02	HI02	Cape Point	5/11	4	5/14	N/A	–	–	–	5/15, 1 egg lost, unknown; 5/24, 3 eggs lost, abandoned
17PIPLHI03	HI01	Cape Point	6/4	3	6/7	N/A	–	–	–	6/11, 2 eggs lost, unknown; 6/22, 1 egg lost, abandoned
17PIPLHI04	HI03	Cape Point	6/6	3	6/12	7/6	3	N/A	–	7/8, 1 chick lost, unknown; 7/10, 1 chick lost, unknown; 7/12, 1 chick lost, unknown
17PIPLHI05	HI01	Cape Point	6/26	3	6/27	7/20	3	2	8/17	7/22, 1 chick lost, unknown

Table B-3. Ocracoke Island piping plover productivity data for 2017. Ocracoke Island totals: 2 piping plover pairs, 6 nests, 12 eggs, 0 chicks, and 0 fledglings. Seashore totals: 6 piping plover pairs, 12 nests, and 2 fledglings.

Nest #	Pair #	Location	Start Date	Total # Eggs	Date Exclosure Installed	Hatch Date	Total # Chicks	# Fledged	Fledge Date	Date Lost, # Eggs/chicks Lost, Reason
17PIPLOI01	OI01	North Ocracoke	4/21	1	N/A	N/A	–	–	–	4/25, 1 egg lost, overwash
17PIPLOI02	OI02	South Point	5/1	2	N/A	N/A	–	–	–	5/6, 2 eggs lost, overwash
17PIPLOI03	OI02	South Point	5/7	2	5/13	N/A	–	–	–	5/28, 2 eggs lost, abandoned
17PIPLOI04	OI02	South Point	5/31	1	N/A	N/A	–	–	–	6/2, 1 egg lost, unknown
17PIPLOI04a	OI02	South Point	6/4	1	N/A	N/A	–	–	–	6/5, 1 egg lost, unknown
17PIPLOI05	OI02	South Point	6/11	2	N/A	N/A	–	–	–	6/23, 2 eggs lost, ghost crab
17PIPLOI06	OI02	South Point	7/2	3	N/A	N/A	–	–	–	7/6, 3 eggs lost, ghost crab

Appendix C. American Oystercatcher Maps



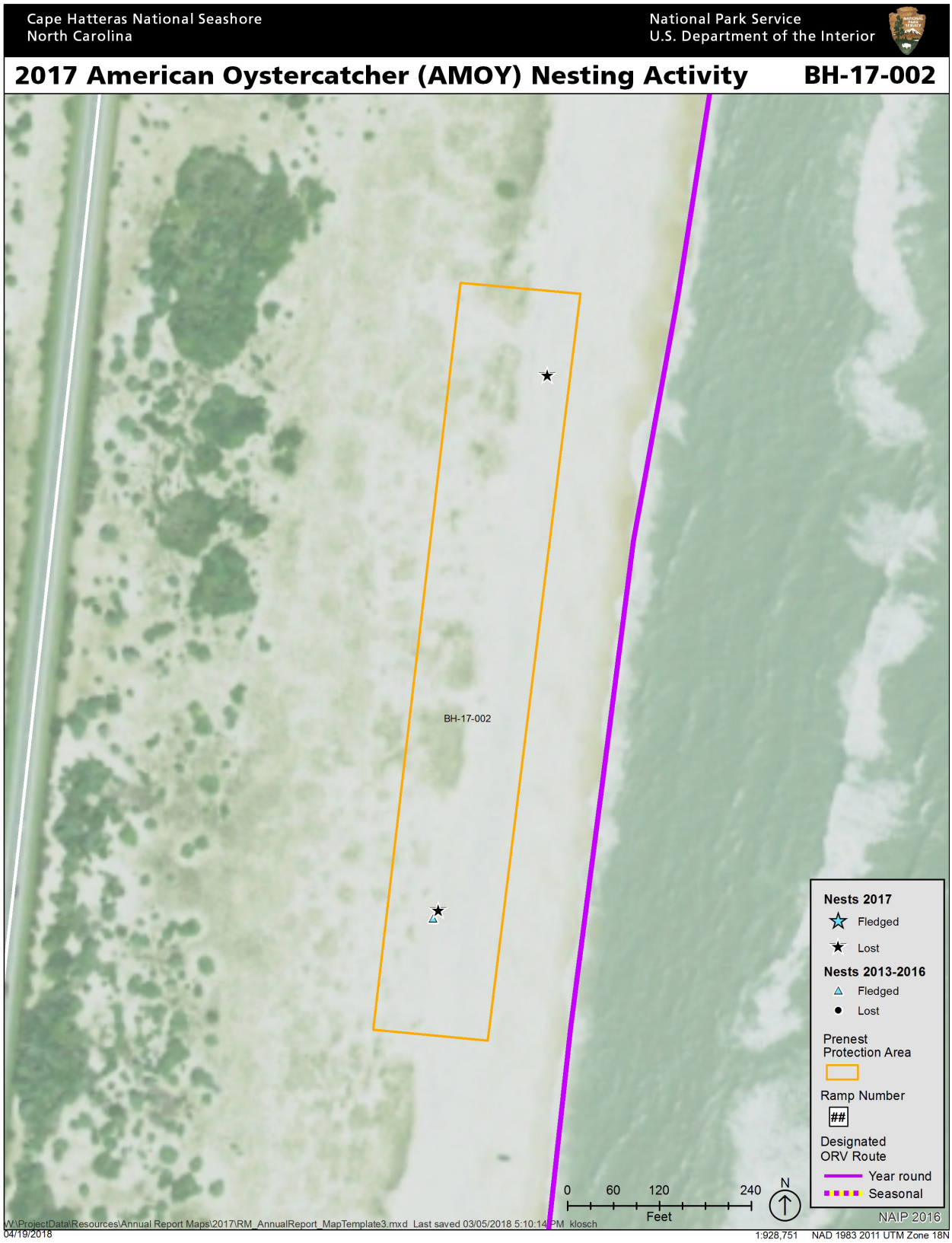
Map C-1. Bodie Island site 17-001 American oystercatcher nesting activity, 2013–2017.



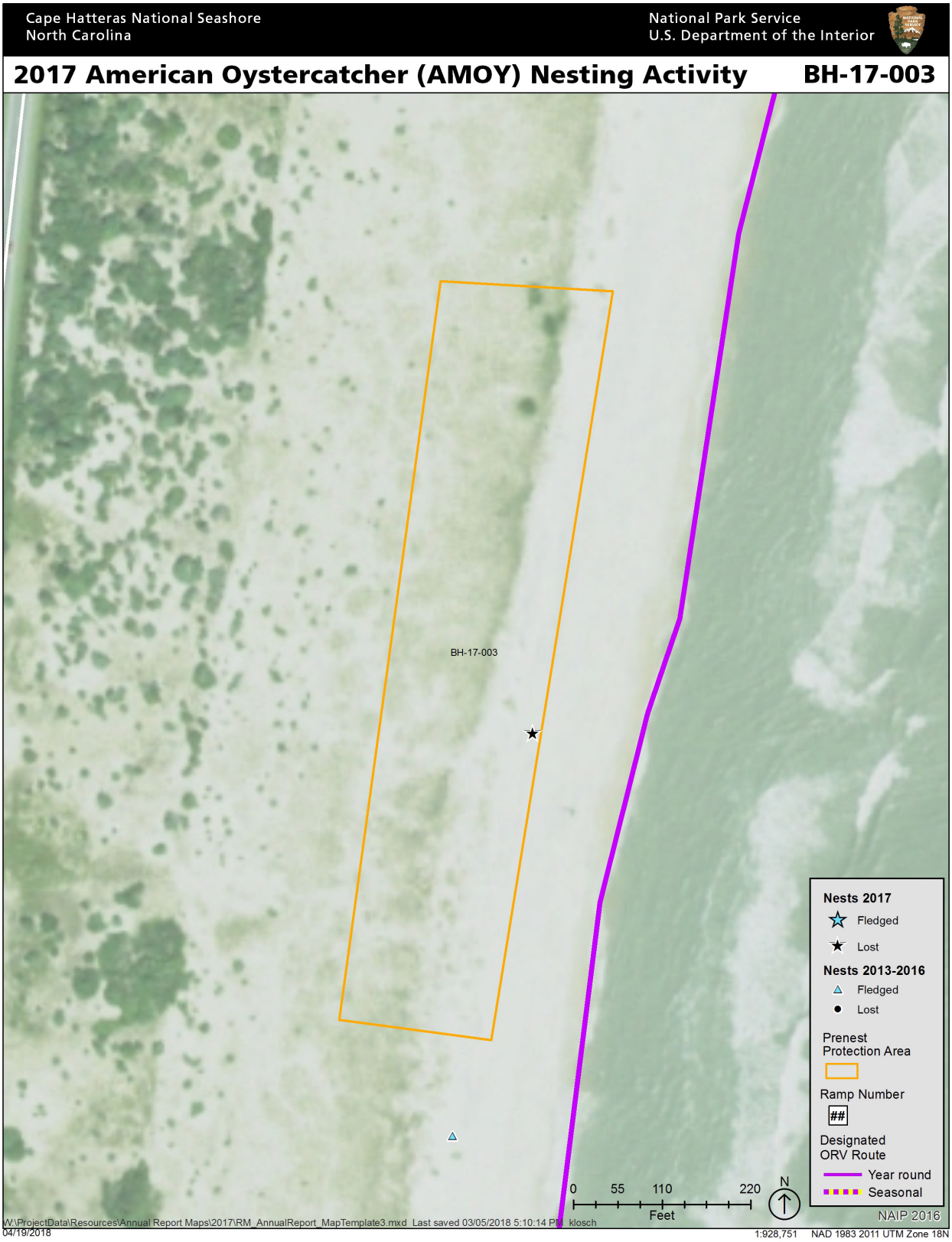
Map C-2. Green Island site 17-001 American oystercatcher nesting activity, 2013–2017.



Map C-3. Bodie Hatteras site 17-001 American oystercatcher nesting activity, 2013–2017.



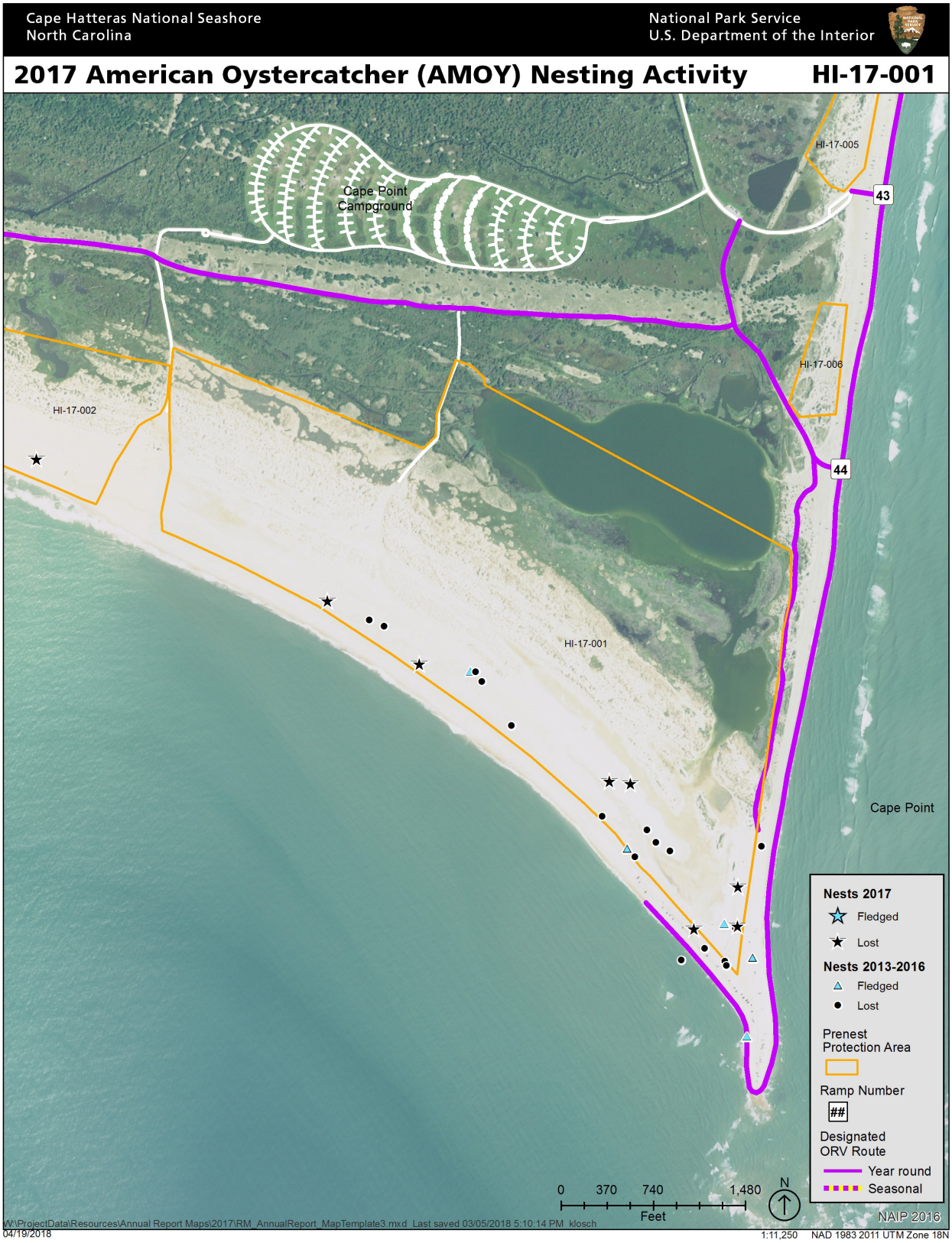
Map C-4. Bodie Hatteras site 17-002 American oystercatcher nesting activity, 2013–2017.



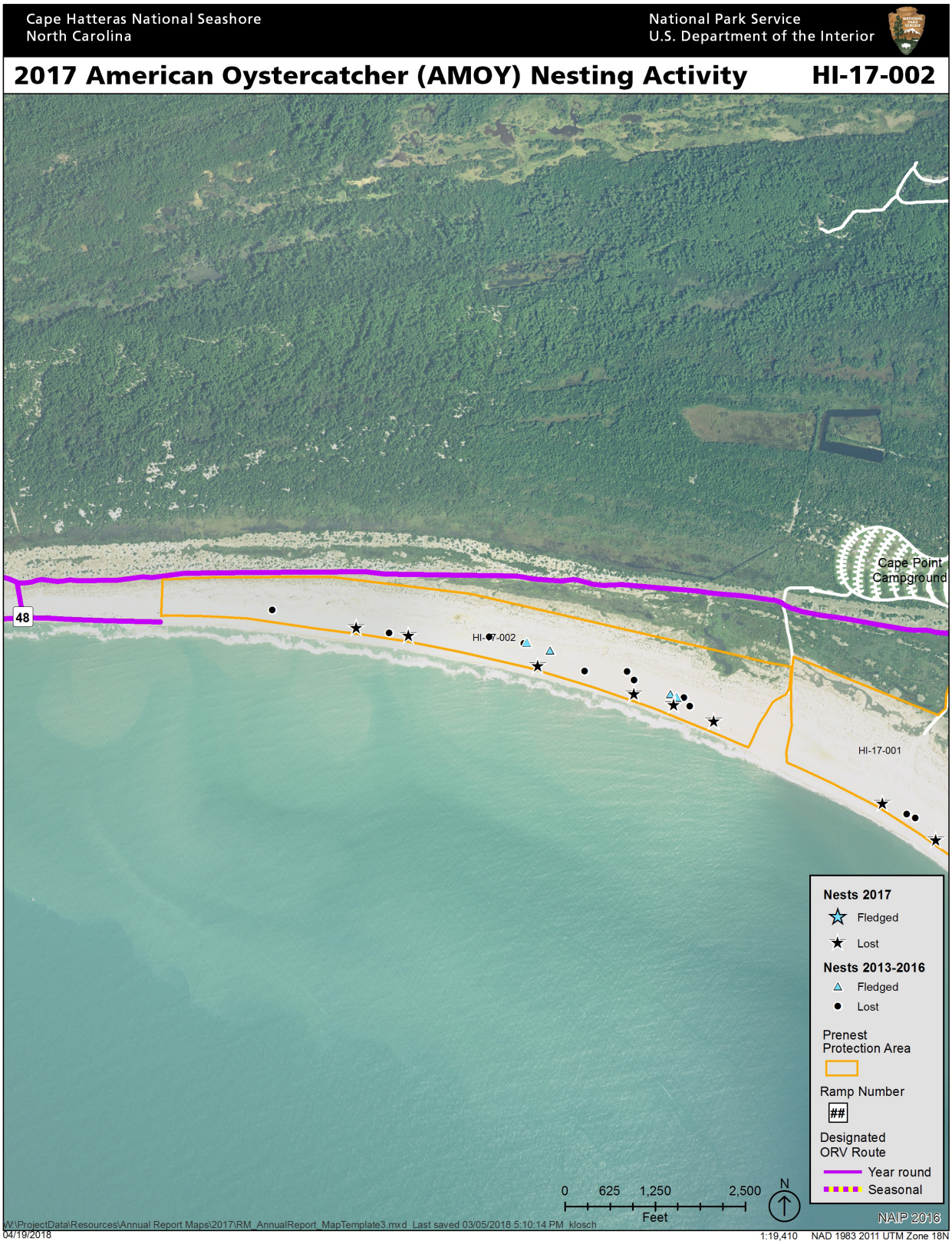
Map C-5. Bodie Hatteras site 17-003 American oystercatcher nesting activity, 2013–2017.



Map C-6. Bodie Hatteras site 17-004 American oystercatcher nesting activity, 2013–2017.



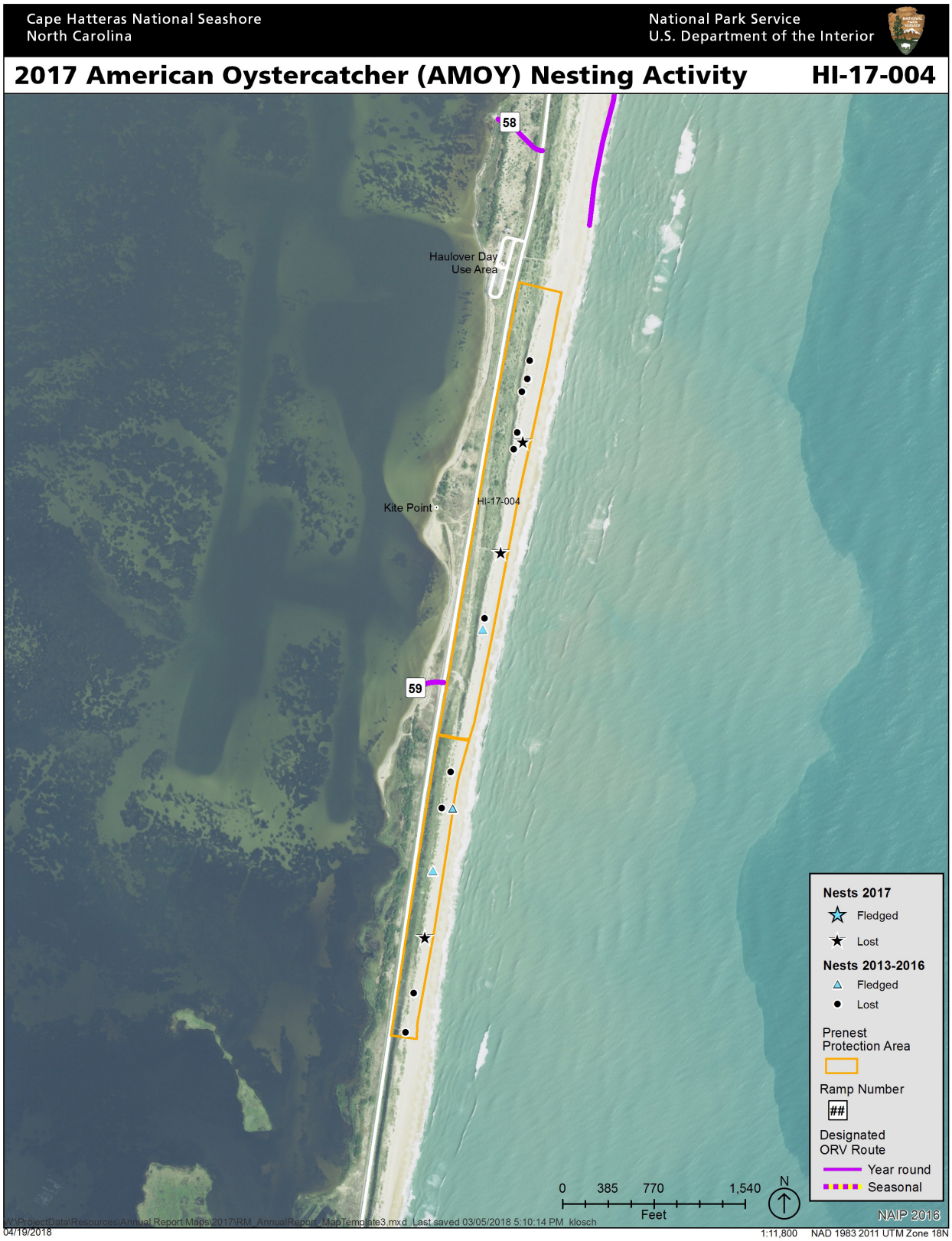
Map C-7. Hatteras Island site 17-001 American oystercatcher nesting activity, 2013–2017.



Map C-8. Hatteras Island site 17-002 American oystercatcher nesting activity, 2013–2017.



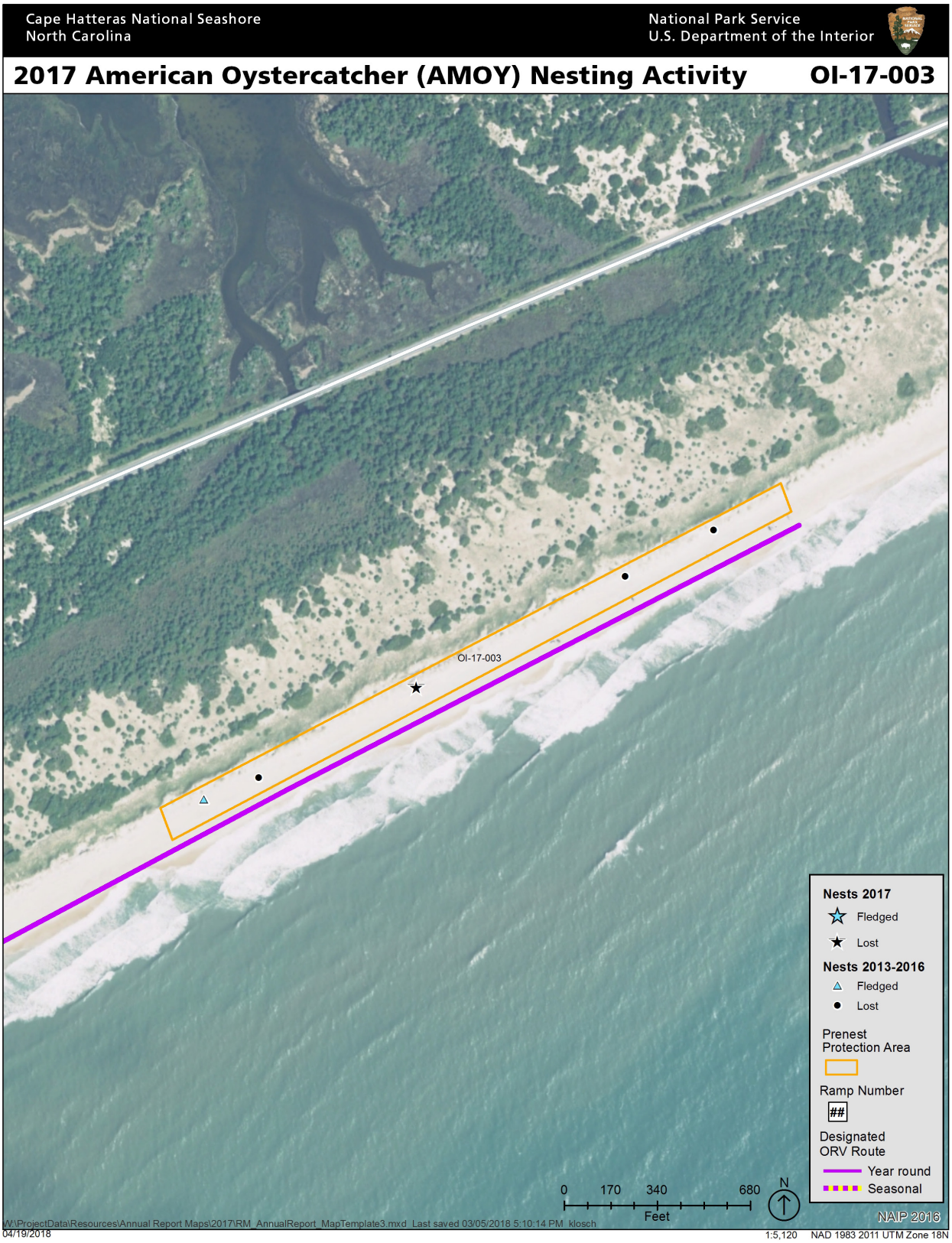
Map C-9. Hatteras Island site 17-003 American oystercatcher nesting activity, 2013–2017.



Map C-10. Hatteras Island site 17-004 American oystercatcher nesting activity, 2013–2017.



Map C-11. Ocracoke Island site 17-001 American oystercatcher nesting activity, 2013–2017.



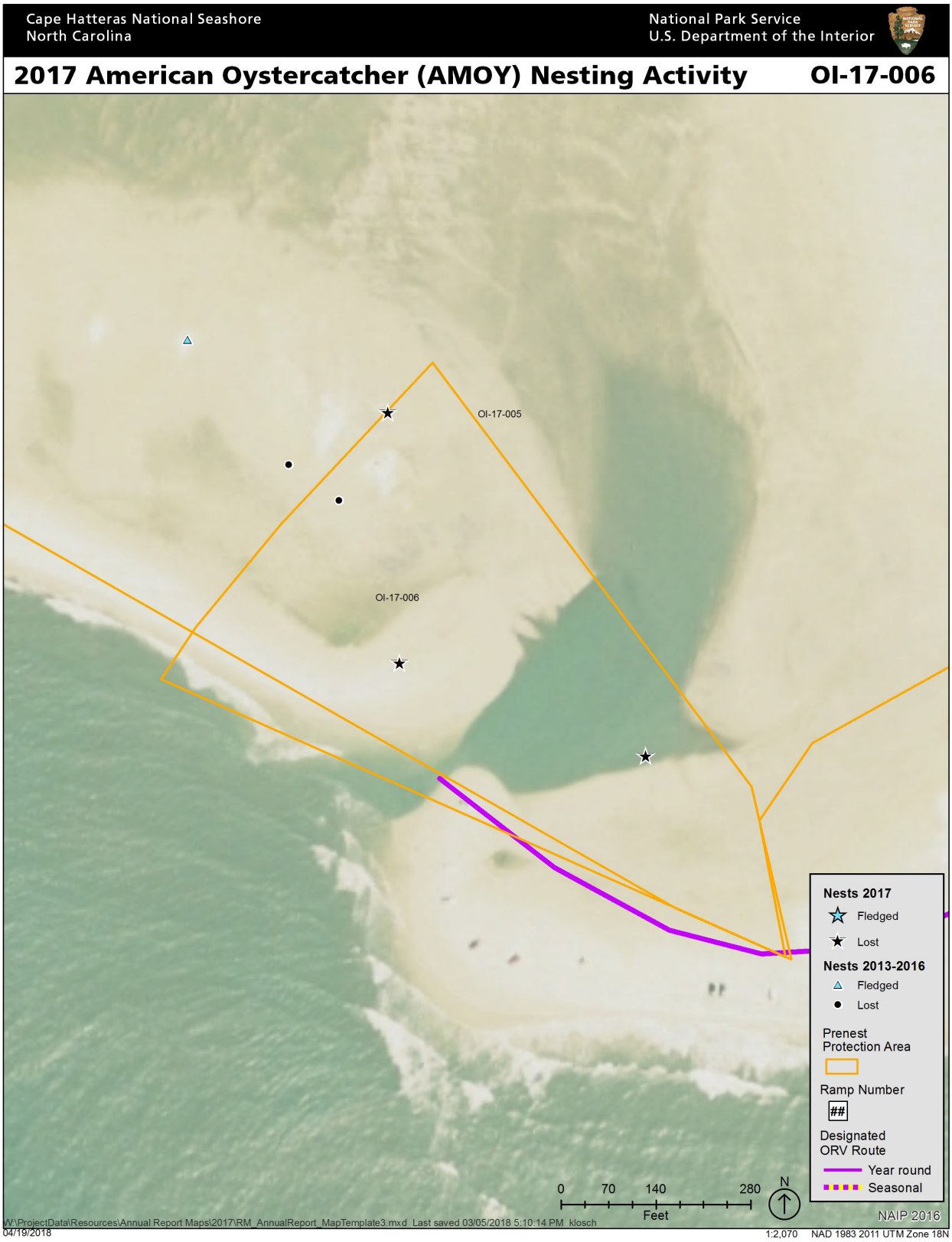
Map C-12. Ocracoke Island site 17-003 American oystercatcher nesting activity, 2013–2017.



Map C-13. Ocracoke Island site 17-004 American oystercatcher nesting activity, 2013–2017.



Map C-14. Ocracoke Island site 17-005 American oystercatcher nesting activity, 2013–2017.



Map C-15. Ocracoke Island site 17-006 American oystercatcher nesting activity, 2013–2017.



Map C-16. Ocracoke Island site 17-001 American oystercatcher nesting activity, 2013–2017.



Map C-17. Ocracoke Island site 17-008 American oystercatcher nesting activity, 2013–2017.

Appendix D. 2017 American Oystercatcher Productivity Data

Table D-1. Green Island American oystercatcher productivity data for 2017. Green Island totals: 2 American oystercatcher pairs, 4 nests, 5 eggs, 1 chick, 1 fledgling, 3 nests lost. Seashore totals: 24 American oystercatcher pairs, 53 nests, and 2 fledglings. All bands are darvic green (DG) unless otherwise noted.

Nest #	Pair #	Bands	Location	Start Date	Total # Eggs	Hatch Date	Total # Chicks	# Fledged	Fledge Date	Date Lost, # Eggs/Chicks Lost, Reason
17AM07GI01	GI01	11/UM	S end of GI	4/20	1	–	–	–	–	4/28, 1 egg lost, unknown
17AMOYGI02	GI01	11/UM	SE end of GI	5/19	1	–	–	–	–	5/26, 1 egg lost, overwash
17AMOYGI03	GI02	UNB/UNB	W side GI	5/19	1	–	–	–	–	5/26, 1 egg lost, overwash
17AMOYGI04	GI02	UNB/UNB	W side GI	6/9	2	7/8	1	1	8/18	7/2, 1 egg lost, unknown

Table D-2. Bodie Island American oystercatcher productivity data for 2017. Bodie Island totals: 1 American oystercatcher pair, 2 nests, 3 eggs, 0 chicks, 0 fledglings, 1 nest lost, 1 nest abandoned. Seashore totals: 24 American oystercatcher pairs, 53 nests, and 2 fledglings. All bands are darvic green (DG) unless otherwise noted.

Nest #	Pair #	Bands	Location	Start Date	Total # Eggs	Hatch Date	Total # Chicks	# Fledged	Fledge Date	Date Lost, # Eggs/Chicks Lost, Reason
17AMOYBI01*	BI01	UNB/UNB (CXM)	1.4 mi S R4	4/27	2	–	–	–	–	5/11, 2 eggs lost, abandoned
17AMOYBI02	BI01	UNB/UNB (CXM)	1.6 mi S R4	6/11	1	–	–	–	–	6/12, 1 egg lost, canid

* One adult banded CXM

Table D-3. Bodie Hatteras American oystercatcher productivity data for 2017. Bodie Hatteras totals: 4 American oystercatcher pairs, 10 nests, 27 eggs, 0 chicks, 0 fledglings, 10 nests lost. Seashore totals: 24 American oystercatcher pairs, 53 nests, and 2 fledglings. All bands are darvic green (DG) unless otherwise noted.

Nest #	Pair #	Bands	Location	Start Date	Total # Eggs	Hatch Date	Total # Chicks	# Fledged	Fledge Date	Date Lost, # Eggs/Chicks Lost, Reason
17AMOYBI02	BI01	UNB/UNB (CXM)	1.6 mi S R4	6/11	1	–	–	–	–	6/12, 1 egg lost, canid
17AMOYBH01	BH02	27/UNB (CXR)	0.8 mi N R 30	4/14	3	–	–	–	–	4/24, 3 eggs lost, unknown
17AMOYBH02	BH01	L9/UNB	0.8 mi S R27	4/15	3	–	–	–	–	4/20, 3 eggs lost, canid
17AMOYBH03	BH03	UNB/UNB (CXN/CXP)	0.5 mi N R27	4/15	3	–	–	–	–	4/23, 3 eggs lost, canid
17AMOYBH04	BH04	CAE/UNB	0.4 mi S R23	4/27	3	–	–	–	–	5/6, 3 eggs lost, abandoned
17AMOYBH05	BH01	L9/UNB	0.8 mi S R27	5/3	3	–	–	–	–	5/24, 3 eggs lost, canid
17AMOYBH06*	BH02	27/UNB (CXR)	1.0 mi S R27	5/3	3	–	–	–	–	5/27, 3 eggs lost, canid
17AMOYBH07	BH03	UNB/UNB (CXN/CXP)	0.6 mi N R27	5/4	1	–	–	–	–	5/12, 1 egg lost, abandoned
17AMOYBH08	BH03	UNB/UNB (CXN/CXP)	1.1 mi N R27	5/14	3	–	–	–	–	5/24, 3 eggs canid
17AMOYBH09	BH01	L9/UNB	0.8 mi S R27	6/7	2	–	–	–	–	6/29, 2 eggs, canid
17AMOYBH10	BH02	27/UNB (CXR)	0.8 mi N R30	6/9	3	–	–	–	–	6/25, 3 eggs lost, canid

* One adult banded CXR

Table D-4. Hatteras American oystercatcher productivity data for 2017. Hatteras totals: 7 American oystercatcher pairs, 18 nests, 41 eggs, 6 chicks, 0 fledglings, 18 nests lost. Seashore totals: 24 American oystercatcher pairs, 53 nests, and 2 fledglings. All bands are darvic green (DG) unless otherwise noted.

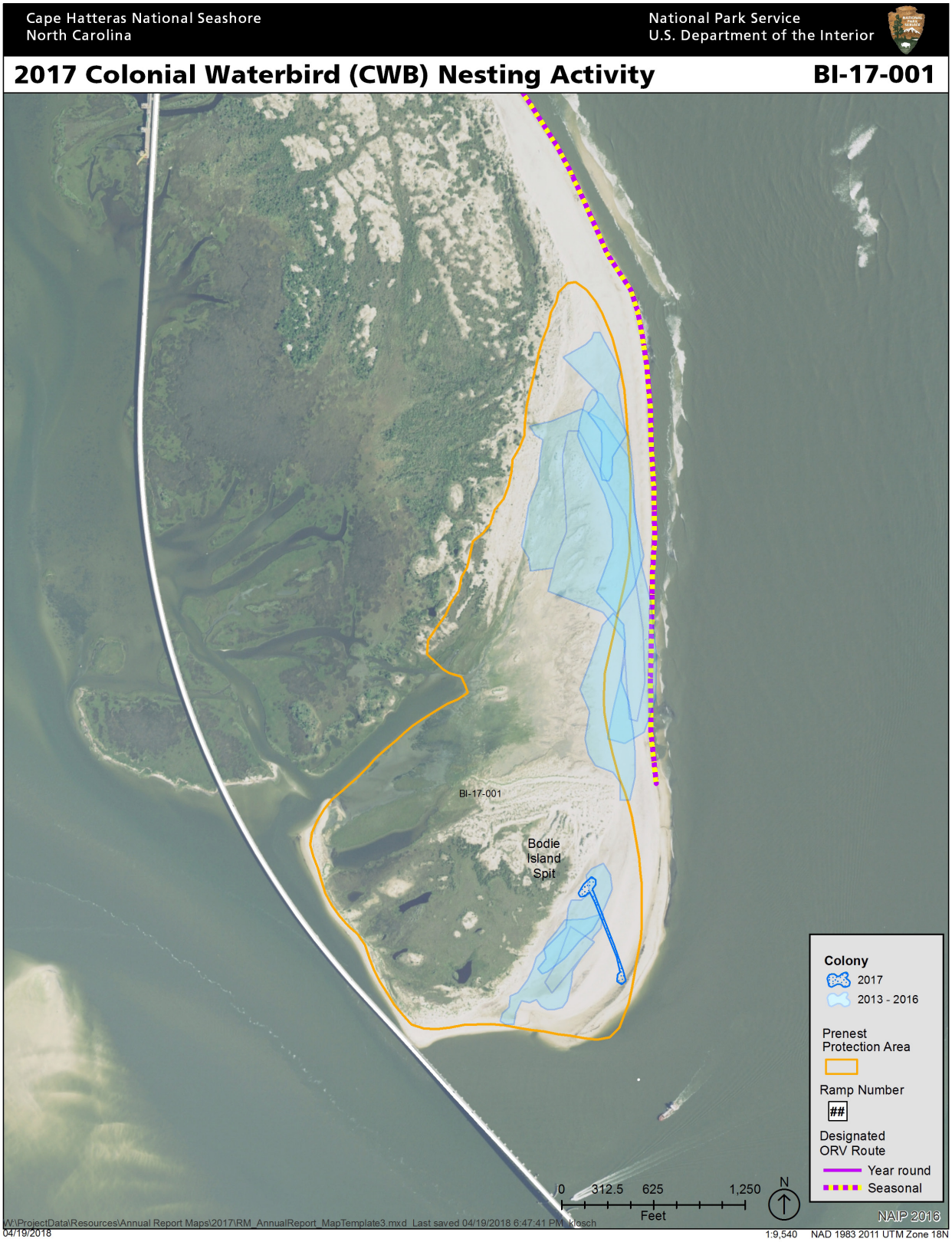
Nest #	Pair #	Bands	Location	Start Date	Total # Eggs	Hatch Date	Total # Chicks	# Fledged	Fledge Date	Date Lost, # Eggs/Chicks Lost, Reason
17AMOYHI01	HI01	AT/UNB	0.23 mi S SBPK	4/10	3	5/10	2	–	–	5/11, 1 chick lost, unknown; 5/22, 1 chick lost, unknown; 6/2, 1 chick lost, mink
17AMOYHI02	HI02	H2/XT	0.87 mi E R48	4/16	3	–	–	–	–	5/1, 3 eggs lost, fox
17AMOYHI03	HI03	R0/CM2	0.41 mi W R45	4/18	3	–	–	–	–	5/3, 3 eggs lost, fox
17AMOYHI04	HI04	H3/OrHT	0.77 mi E SPRd	4/19	3	–	–	–	–	4/25, 3 eggs lost, overwash
17AMOYHI05	HI05	99/WN	2.68 mi S R38	4/19	3	5/22	2	–	–	5/22, 1 egg lost, abandoned; 5/22, 1 chick lost, unknown; 5/25, 1 chick lost, unknown
17AMOYHI06	HI06	LY/UNB	1.88 mi S R38	4/21	3	–	–	–	–	5/19, 2 eggs lost, feral cat; 5/22, 1 egg lost, ghost crab
17AMOYHI07	HI07	L6/LA	0.57 mi ESPRd	4/28	2	–	–	–	–	4/30, 2 eggs lost, canid
17AMOYHI08	HI04	H3/OrHT	0.64 mi S R44	5/8	3	–	–	–	–	5/16, 2 eggs lost, canid; 5/19, 1 egg lost, canid
17AMOYHI09	HI07	L6/LA	0.13 mi W SPRd	5/10	2	–	–	–	–	5/19, 2 eggs lost, canid
17AMOYHI10	HI02	H2/XT	1.01 mi E R48	5/13	2	–	–	–	–	5/26, 2 eggs lost, overwash
17AMOYHI11	HI03	R0/CM2	0.2 mi W R45	5/15	3	–	–	–	–	5/28, 3 eggs lost, canid
17AMOYHI12	HI04	H3/OrHT	0.69 mi S R44	5/30	2	–	–	–	–	6/16, 2 eggs lost, unknown
17AMOYHI13	HI07	L6/LA	0.22 mi E SPRd	6/1	1	–	–	–	–	6/2, 1 egg lost, unknown
17AMOYHI14	HI06	LY/UNB	2.04 mi S R38	6/5	1	–	–	–	–	6/7, 1 egg lost, unknown
17AMOYHI15	HI02	H2/XT	0.68 mi W R45	6/10	3	–	–	–	–	6/12, 1 egg lost, unknown; 6/19, 2 eggs lost, unknown
17AMOYHI16	HI03	R0/CM2	0.31 mi W R45	6/15	1	–	–	–	–	6/19, 1 egg lost, unknown
17AMOYHI17	HI07	L6/LA	0.55 mi E SPRd	6/17	1	–	–	–	–	6/21, 1 egg lost, unknown
17AMOYHI18	HI01	AT/UNB	0.22 mi S SBPK	6/20	2	7/20	2	–	–	7/22, 1 chick lost, unknown; 7/30, 1 chick lost, unknown

Table D-5. Ocracoke Island American oystercatcher productivity data for 2017. Okracoke Island totals: 10 American oystercatcher pairs, 19 nests, 44 eggs, 8 chicks, 1 fledgling, 14 nests lost. Seashore totals: 24 American oystercatcher pairs, 53 nests, and 2 fledglings. All bands are darvic green (DG) unless otherwise noted.

Nest #	Pair #	Bands	Location	Start Date	Total # Eggs	Hatch Date	Total # Chicks	# Fledged	Fledge Date	Date Lost, # Eggs/Chicks Lost, Reason
17AMOYOI01	OI01	N7/UNB	O.2 mi S R67	4/14	2	–	–	–	–	4/25, 2 eggs lost, overwash
17AMOYOI02	OI02	TW/UNB	1.56 mi S R72	4/19	2	–	–	–	–	4/25, 2 eggs lost, overwash
17AMOYOI03	OI03	CCH/L4	0.4 mi N R59	4/21	3	–	–	–	–	4/25, 3 eggs lost, overwash
17AMOYOI04	OI04	UNB/UNB S R70	0.7 mi N R72	4/22	2	–	–	–	–	4/25, 2 eggs lost, overwash
17AMOYOI05	OI05	XL/UNB	1.8 mi S R72	4/22	1	–	–	–	–	4/25, 1 egg lost, overwash
17AMOYOI06	OI06	87/UNB	Spoil Dune	4/27	1	–	–	–	–	4/29, 1 egg lost, unknown (avian?)
17AMOYOI07	OI07	CL/UNB	0.7 mi N R67	4/30	2	5/30	1	–	–	5/21, 1 egg lost, unknown; 5/31, 1 chick lost, unknown
17AMOYOI08*	OI03	CCH/L4	0.3 mi N R59	5/6	3	6/4	2	–	–	6/4, 1 egg lost, abandoned; 6/18, 1 chick lost, unknown; 7/8, 1 chick lost, unknown
17AMOYOI09	OI06	87/UNB	Spoil Dune	5/6	3	–	–	–	–	5/31, 3 eggs lost, unknown
17AMOYOI10	OI02	TW/UNB	0.5 mi S R72	5/7	3	–	–	–	–	5/17, 1 egg lost, unknown; 5/25, 2 eggs lost, unknown (mink? raccoon?)
17AMOYOI11	OI04	UNB/UNB S R70	0.6 mi N R72	5/7	3	–	–	–	–	5/26, 3 eggs lost, overwash
17AMOYOI12	OI05	XL/UNB	1.8 mi S R72	5/7	2	–	–	–	–	5/25, 2 eggs lost, overwash
17AMOYOI13	OI08	MN/UNB	1.2 mi S R72	5/7	3	–	–	–	–	5/26, 3 eggs lost, unknown (probable raccoon)
17AMOYOI14	OI01	N7/UNB	0.7 mi S R68	5/10	2	–	–	–	–	6/7, 1 egg lost, unknown; 6/9, 1 egg lost, unknown
17AMOYOI15	OI09	HA/UNB	1.2 mi S R72	5/11	2	–	–	–	–	5/29, 2 eggs lost, unknown (probable raccoon)
17AMOYOI16	OI10	LM/UNB	1.5 mi S R72	6/2	3	6/25	3	–	–	6/25, 1 chick lost, unknown; 7/6, 2 chicks lost, unknown
17AMOYOI17	OI02	TW/UNB	1.6 mi S R72	6/10	2	7/5	1	1	8/15	7/5, 1 egg lost, abandoned
17AMOYOI18	OI05	XL/UNB	1.8 mi S R72	6/11	2	7/5	1	–	–	7/5, 1 chick lost, unknown; 7/5, 1 egg lost, abandoned
17AMOYOI19	OI06	87/UNB	Spoil Dune	6/15	3	–	–	–	–	6/22, 3 eggs lost, abandoned

* One chick banded (7/1) C40

Appendix E. Colonial Waterbird Maps



Map E-1. Bodie Island site 17-001 colonial waterbird nesting activity, 2013–2017.



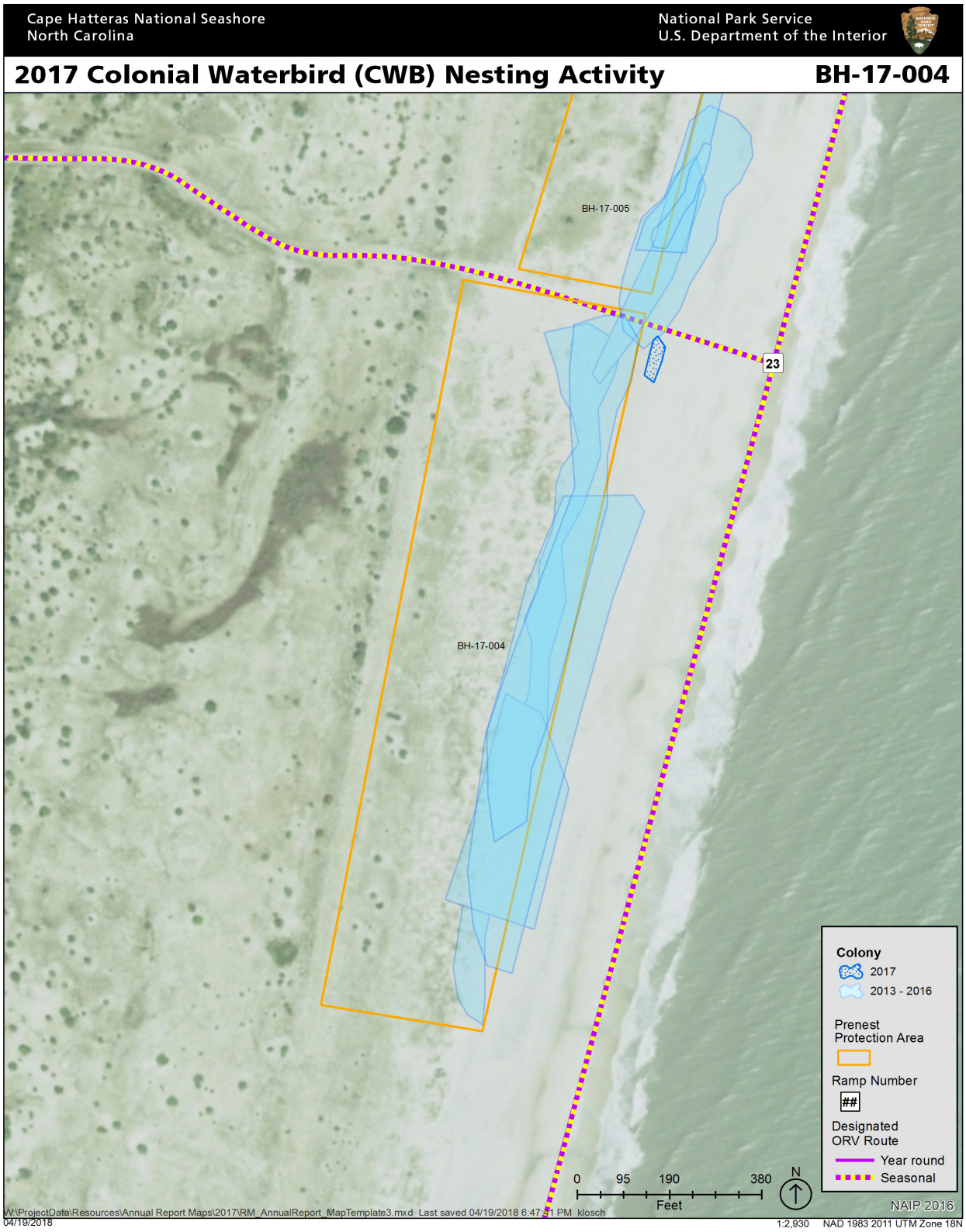
Map E-2. Green Island site 17-001 colonial waterbird nesting activity, 2013–2017.



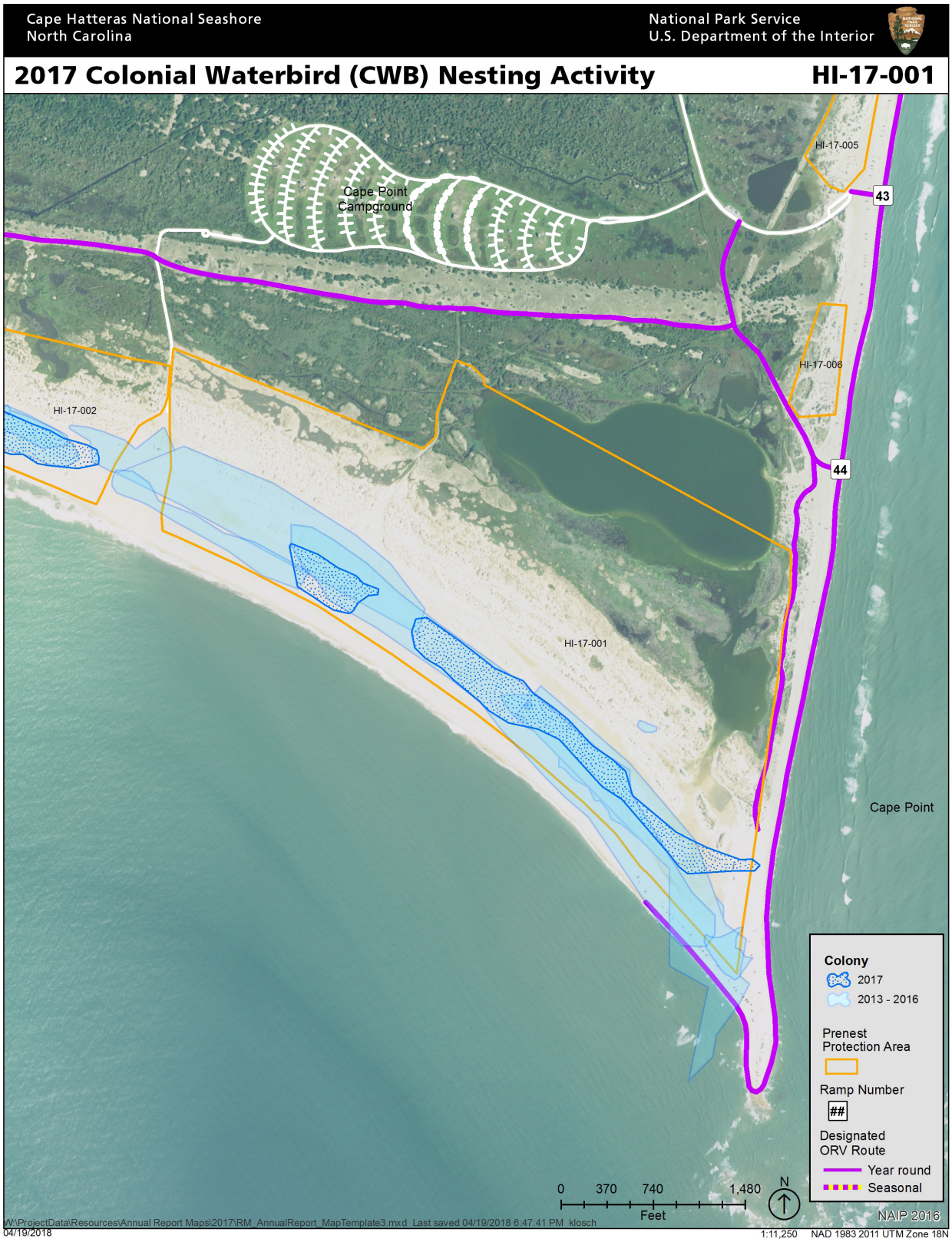
Map E-3. Bodie Hatteras site 17-001 colonial waterbird nesting activity, 2013–2017.



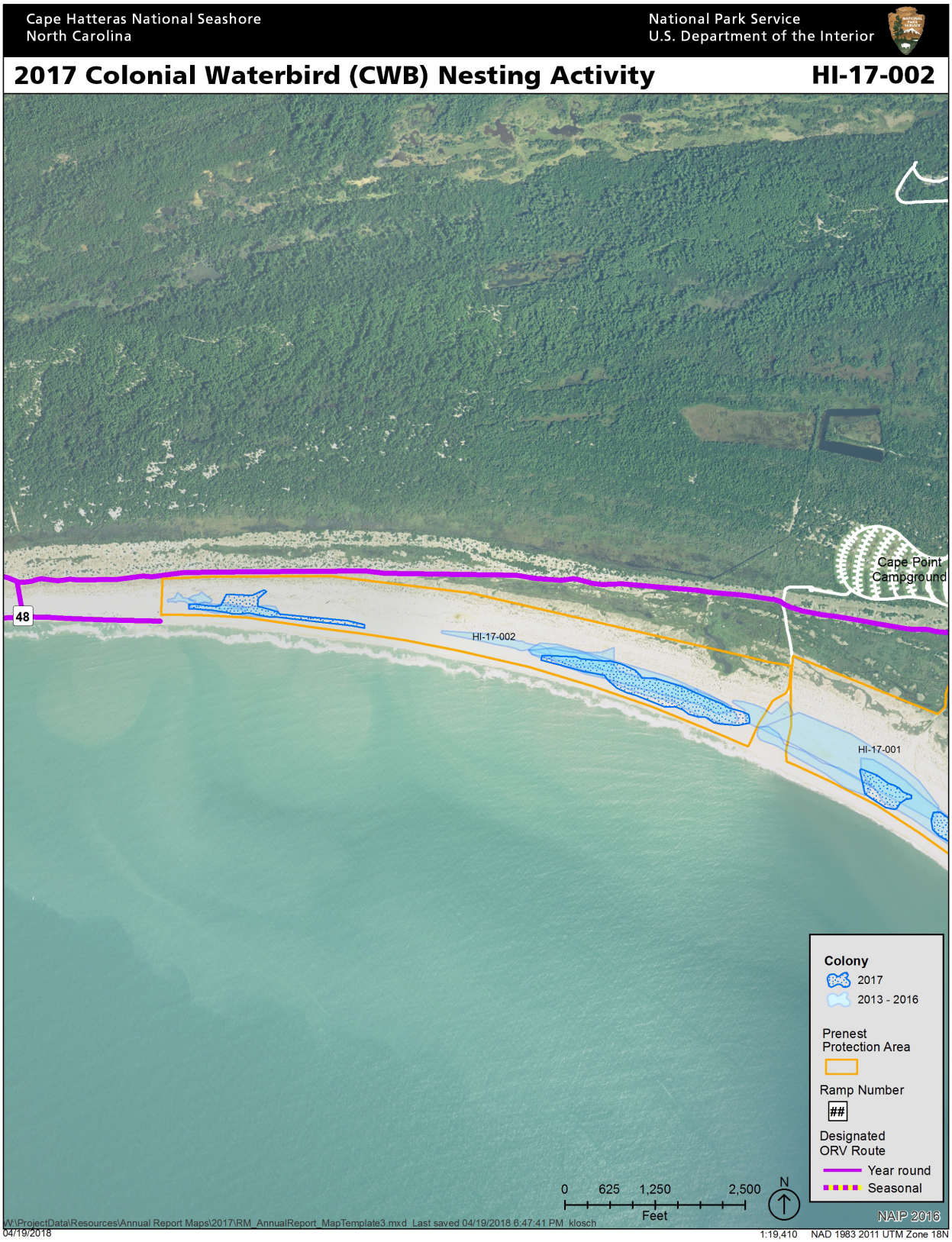
Map E-4. Bodie Hatteras site 17-002 colonial waterbird nesting activity, 2013–2017.



Map E-5. Bodie Hatteras site 17-004 colonial waterbird nesting activity, 2013–2017.



Map E-6. Hatteras Island Site 17-001colonial waterbird nesting activity, 2013–2017.



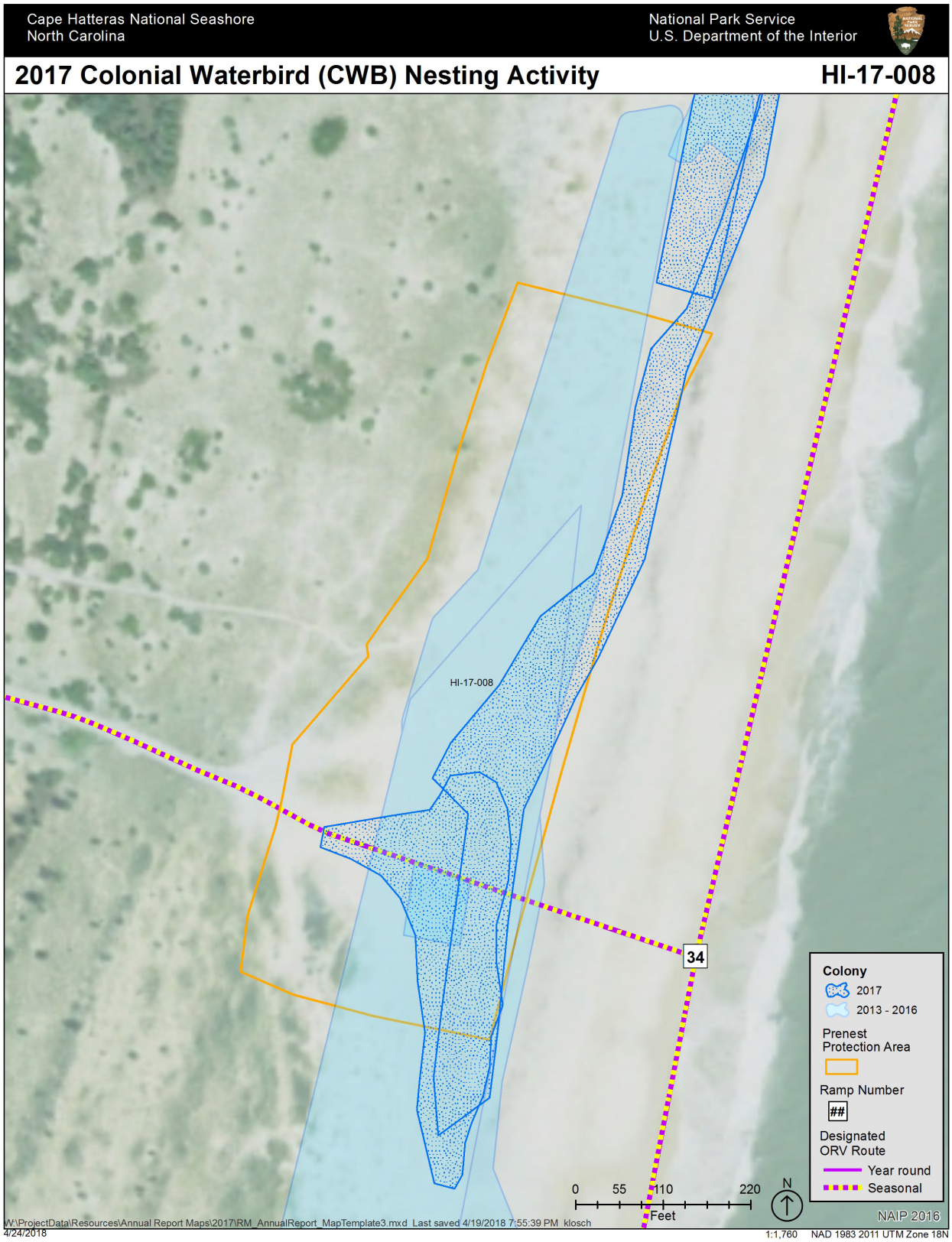
Map E-7. Hatteras Island site 17-002 colonial waterbird nesting activity, 2013–2017.



Map E-8. Hatteras Island site 17-004 colonial waterbird nesting activity, 2013–2017.



Map E-9. Hatteras Island site 17-007 colonial waterbird nesting activity, 2013–2017.



Map E-10. Hatteras Island site 17-008 colonial waterbird nesting activity, 2013–2017.



Map E-11. Ocracoke Island site 17-001 colonial waterbird nesting activity, 2013–2017.



Map E-12. Ocracoke Island site 17-005 colonial waterbird nesting activity, 2013–2017.



Map E-13. Ocracoke Island site 17-008 colonial waterbird nesting activity, 2013–2017.

Appendix F. Wilson's Plover Maps



Map F-1. Ocracoke Island site 17-005 Wilson's plover nesting activity, 2013–2017.

Appendix G. 2017 Wilson's Plover Productivity Data

Table G-1. Ocracoke Island Wilson's plover productivity data for 2017. Ocracoke Island totals: 1 Wilson's plover pair, 2 nests, 5 eggs, unknown # of chicks (up to 3), and 0 fledglings. Seashore totals:1 piping plover pair, 2 nests, and 0 fledglings.

Nest #	Pair #	Location	Start Date	Total # Eggs	Hatch Date	Total # Chicks	# Fledged	Fledge Date	Date Lost, # Eggs/chicks Lost, Reason
17WIPLOI01	OI01	1.1 mi S R72	4/29	2	–	–	–	–	5/7, 2 eggs lost, abandoned
17WIPLOI02	OI01	1.08 mi S R72	6/4	3	6/28	unk 3?	–	–	6/29, unknown # of chicks lost, unknown

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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