



Cape Cod National Seashore 2020 Shorebird Monitoring and Management Report

Natural Resource Report NPS/CACO/NRR—2023/2517





ON THIS PAGE

American oystercatcher chick
NPS / K. BURKE

ON THE COVER

Piping plover chick
NPS / K. BURKE

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Natural Resource Report NPS/CACO/NRR—2023/2517

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Executive Summary

Cape Cod National Seashore (CACO) manages the protection of federal and state listed beach-nesting shorebirds (piping plover [*Charadrius melodus*], least tern [*Sternula antillarum*], and American oystercatcher [*Haematopus palliatus*]), and various migrating shorebird species following procedures outlined in the 2018 Shorebird Management Plan/EA and associated Finding of No Significant Impact (FONSI) (NPS 2018). This report summarizes monitoring results from the 2020 field season.

Piping plover, least tern, and American oystercatcher nesting and brood-rearing behaviors were monitored over 43 miles of coastline from Provincetown to Orleans, Massachusetts.

Piping plover:

- 92 breeding pairs were observed (third highest number of pairs since 2003)
- 171 chicks fledged (highest number of fledged chicks since 2003); 61 pairs successfully fledged at least one chick
- Park-wide average productivity = 1.86 chicks fledged/pair (second highest productivity since 2003); USFWS Northeastern piping plover population annual recovery target rate is 1.5 chicks fledged/pair
- Depredation accounted for 61% of nest failures
- Predominant nest predators were Eastern coyote and corvids (American crow and fish crow)
- Predator exclosures were installed around a total of 82 nests. Exclosures improved nest success from a hatch rate of 13% for unexclosed to 73% for exclosed nests. Exclosures reduced predation rates from 78% for unexclosed nests to 18% for exclosed nests.

Least tern:

- Least terns nested at a total of 12 sites from Eastham to Provincetown
- 121 breeding pairs were observed (lowest number of pairs since 2016)
- 35 chicks fledged (lowest number of chicks fledged since 2015)
- Average productivity = 0.29 chicks fledged/breeding pair
- Depredation, mainly by coyote, was the principal cause of egg loss
- Cause of chick loss is difficult to determine, but depredation by coyote was often suspected

American oystercatcher:

- Two pairs nested at Jeremy Point, Wellfleet
- Two nests were laid, one per pair, one nest hatched and the second was depredated
- One chick fledged, productivity = 0.5 chicks fledged/breeding pair
- Depredation by crow was the main cause of egg loss
- Cause of chick loss is unknown

Staging migrating terns and shorebirds:

- Large mixed-species flocks including those with up to approximately 2,000 individuals of the federally endangered roseate tern (*Sterna dougallii*) and the state-listed species of concern common tern (*Sterna hirundo*), were observed throughout the park mid-July through October
- Large mixed flocks of up to 1,000 individuals including red knot, semipalmated sandpipers, piping plovers, black-bellied plovers, semipalmated plovers, sanderlings, and other shorebird species were observed throughout the park mid-July through October

Human Disturbance: due to limits in staffing in 2020 as a result of COVID-19 limitations, less data was collected on human violations than in 2019. The following observations are a minimum estimate based off the collection of data on some days, but not all, by shorebird staff in 2020.

- 122 pedestrian violations were documented, combination of individuals observed inside the symbolic fenced area and fresh pedestrian tracks from a recent violation. In addition, there were at least 140 observations of people in high tide closures at just one site (Head of the Meadow).
- 301 dogs off leash were documented from April through September (72 in the South District and 229 in the North District). Unleashed dogs were encountered most frequently at Longnook (45), Herring Cove (36), and Ballston (34).
- 371 pet violations, pets in designated “No Pet” areas, were documented. The majority of the incidents were physically observed or secondarily by observations of fresh pet tracks in “No Pet” areas. Dogs in “No Pets” areas were encountered most frequently at Coast Guard Truro (91), Longnook (51), and Head of the Meadow (44).
- At least 6 instances of vehicles driving in closed areas at Coast Guard Truro, High Head, Hatches Harbor, and Race Point North. These incidents involved driving by unfledged piping plover or least tern chicks at Coast Guard Truro, High Head, and Race Point North, as well as driving through symbolic fencing in the vicinity of unfledged piping plover or least tern chicks and/or nests at High Head, Race Point North, and Hatches Harbor.

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List of Terms

Brood: *A family unit of adults and chicks. Also, the act of sheltering chicks beneath the adult as a form of protection.*

Buffer: *The distance between the shorebird activity and the fenceline or vehicle. Established to reduce the amount of disturbance to the birds to breed, feed, and shelter.*

Complete/Incomplete nest: *A complete nest is a nest that has reached its full potential egg number or active incubation is observed and no further eggs are added to the clutch. An incomplete nest is a nest that is lost before it reaches the full clutch. Complete nests typically are four eggs but may be less depending on whether eggs were lost before completion or the capacity of the female (some birds lay less eggs toward the end of the season).*

Depredation: *The loss of eggs due to predator.*

Exclosure: *A tool used to protect piping plover nests from predation. Typically made of a circular wire cage, held into the sand by posts or rebar, and covered with netting on top. Exclosures are a useful tool to keep predators from getting to the eggs but are more visible.*

Fledge: *The stage in a chick's life when the feathers and wing muscles are sufficiently developed for flight as well as the act of raising chicks to a fully-grown state by the chick's parents. For purposes of data collection and management decisions, a chick is fully fledged when it is observed in sustained flight over 15 meters regardless of age.*

Flexible Management: *A management strategy in which there is a reduction or elimination of protective measures in specific high-visitation areas to accommodate visitor use, in exchange for increased protective measures elsewhere.*

ORV: *Off Road Vehicle*

Oversand Corridor: *Vehicle driving on the beach areas.*

Productivity-*the rate of production for a species or population over a given period of time. Productivity in this report is measured as the number of chicks fledged out of the number of breeding pairs at CACO.*

Scrape: *Small, shallow depressions in the sand or gravel in which shorebirds and seabirds lay their eggs.*

SCV: *Self-contained vehicle.*

Staging: *the act of resting, feeding, loafing by groups of birds in preparation for migration.*

Suitable Habitat: *Areas in which endangered and threatened species depend that provide the necessary features for nesting. For shorebirds, this typically includes areas of open sand, cobble, or dune above the high tide line that are unlikely to be washed by the tide.*

Symbolic Fencing: *A mechanism used to identify and protect shorebird nesting and staging habitat and provide a buffer between birds and human disturbance. Typically consists of 5 or 6-foot wooden posts with 'Area Closed-Bird Use Area' signs affixed to the posts and connected by a line of cotton twine.*

Take: *From Section 3(18) of the Federal Endangered Species Act: To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.*

Introduction

Cape Cod National Seashore (CACO) provides approximately 43 miles of prime habitat for beach-nesting birds that breed on beaches used by millions of human visitors every year. Some of the species are listed by federal and state agencies as endangered, threatened, or of special concern, such as piping plover, least tern, and American oystercatcher. Additional threatened and endangered species use CACO beaches as a staging ground to forage and build reserves during migratory stopovers: the roseate tern, common tern, and red knot. CACO manages the beaches with the goal of increasing shorebird productivity while providing for visitor access and recreation. Management practices include those designed to keep people and pets out of nesting areas (e.g., temporary beach closures, off-road-vehicle restrictions, symbolic fencing and signs) and those designed to reduce predation on birds (e.g., predator exclosures around nests and pet restrictions). These practices are adjusted day-to-day and are informed by ongoing monitoring.

CACO 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, CACO regularly communicates and coordinates with adjacent landowners.

CACO shorebird staff monitor the timing, survival, and reproductive success of shorebirds throughout the breeding season (spring–fall). This document summarizes biological data for three species of breeding shorebirds. It also summarizes observations of other species of terns and shorebirds that use CACO as a staging ground during their annual migration.

Shorebird Protection and Monitoring Methods

General Nest Habitat Protection

Habitat assessments were conducted prior to the onset of the breeding season to identify suitable habitat for beach-nesting shorebirds. Those assessments and historic nesting locations were used to demarcate pre-nesting areas closed to recreational activities. Symbolic fencing, wooden posts connected by string and signs (“bird use area”) to prohibit entry, were installed around these sites before nesting activity was observed. These closures helped to minimize habitat disturbance in potential breeding areas and enabled birds to establish territories and nests in their preferred habitat. The closures were modified throughout the season to maintain a sufficient buffer around nests and to provide adequate protection for staging areas used by migratory birds (NPS 2012).

General Monitoring Methods

CACO follows the monitoring and protection methods outlined in the U.S. Fish & Wildlife Service (USFWS) *Piping Plover Atlantic Coast Population Revised Recovery Plan* (1996), a protocol designed specifically for CACO (Erwin 2003), and *The Massachusetts Tern and Piping Plover Handbook: A Manual for Stewards* (Blodget and Melvin 1996) for nesting least terns. To inform decisions regarding daily operations that affect shorebird management and protection and that are not addressed by these two documents, CACO staff also consult the 2018 Shorebird Management Plan and Standard Operating Procedure (SOP).

Shorebirds were monitored in 27 survey units at CACO from Provincetown to Orleans. Survey units were established for logistical purposes and do not necessarily represent ecologically meaningful differences. Beaches are divided into two districts, again for logistical purposes. The North District (ND) includes all CACO beaches located in Provincetown and Truro (Figure 1): Wood End/Long Point (WELP), Herring Cove (HC), Hatches Harbor (HAH), Race Point (RP), Race Point North (RPN), Race Point South (RPS), Mission Bell (MIB), Exit 9 (E9), Armstrong (ARM), High Head (HH), Head of the Meadow (HOM), Coast Guard Truro (CGT), Longnook (LN) and Ballston north section (BAB). The South District (SD) includes all CACO beaches located in Eastham and Wellfleet (Figure 2): Coast Guard Beach Eastham (CGE), Nauset Light Beach (NL), Marconi Beach (MB), Marconi Station (MS), LeCount Hollow (LH), White Crest (WC), Cahoon Hollow (CH), Newcomb Hollow (NH), Ballston Beach south section (BAB), Bound Brook (BB), Duck Harbor (DH), Great Island (GI), and Jeremy Point (JP). New Island in the town of Orleans is considered a SD site but in 2020 it was monitored and included in the town of Orleans data; there was one pair that laid their second nest attempt on New Island, three eggs laid and hatched, and one chick fledged.

Due to COVID-19, staffing for the shorebird program was reduced to 60% of the typical team size. Staff were instructed to prioritize protection measures over monitoring which resulted in fewer site visits, less detailed monitoring notes, and alterations in management strategies (for example, exclosures were installed before reaching full clutches in some cases due to inability to get to sites for several days). The beaches had more visitors than usual, in particular during the shoulder seasons, which created huge challenges for the shorebird staff.

Monitoring began in early April. Field staff searched the beaches daily for signs of shorebird nesting activity (e.g., nesting behavior, nest scrapes, and concentrated tracks on the upper beach). In a typical season, almost all nests are located before clutch completion, and thus hatch windows could be predicted with high accuracy. In 2020, there was an increase in the number of complete nests found as well as two broods for which a nest was never found. This makes predicting hatch dates, fledge dates, and informing management decisions much more difficult. Shorebird nests, broods, and colonies were generally monitored every one to two days to ensure restrictions on visitor use were applied or lifted in a timely manner in areas of high visitation. Nests and broods in Off-Road Vehicle (ORV) corridors were monitored at least daily, and often twice a day. Symbolic fencing was adjusted in response to breeding or staging behaviors. To minimize disturbance, observations were made through binoculars from a distance of 5 to 30 meters.

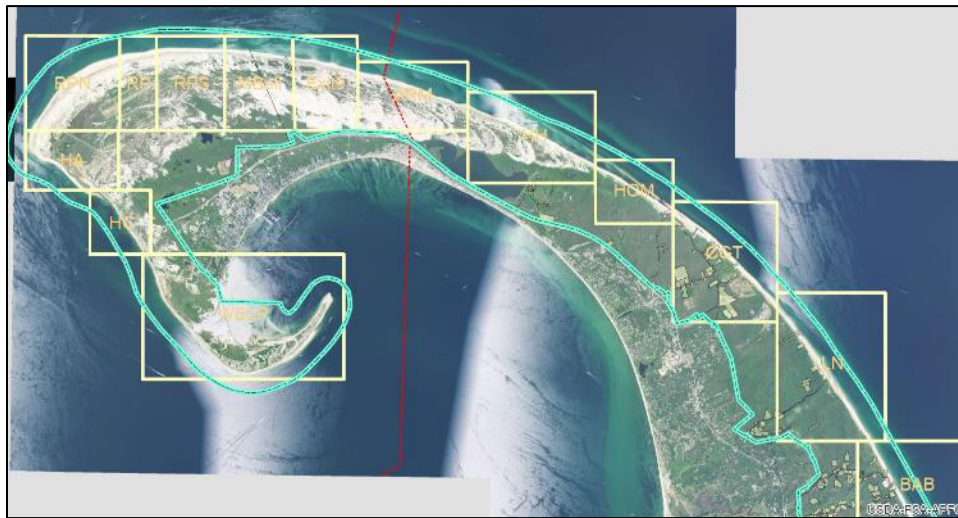


Figure 1. North District Survey Unit Map, Woodend/Long Point to Ballston.



Figure 2. South District Survey Unit Map, Ballston to Coast Guard Eastham.

Species-specific Methods

Piping Plover

The piping plover was federally listed under the Endangered Species Act in 1986. Its breeding range extends from Newfoundland to North Carolina, and wintering range extends from North Carolina to the Bahamas and West Indies. The Atlantic coast piping plover population size began to decline in the late 1800s due to unregulated hunting and the millinery trade. The population rebounded with the introduction of the Migratory Bird Treaty Act in 1918; however, the population declined again due to beach development and increased recreational use of breeding habitat. The Atlantic coast population is currently listed as federally Threatened.

Monitoring Methods

Brood monitoring is critical for understanding the fate of plover chicks including tracking chick movement, identifying causes of chick loss, and observing initial flights. Accordingly, shorebird technicians monitor the status of piping plover broods daily when staffing allows. Piping plover chicks are considered fledged when they are observed in sustained flight for at least 15 meters, irrespective of age (USFWS 2015). In accordance with the Shorebird Management Plan, recreational restrictions are lifted when broods are determined to be fledged or are considered lost after not being observed for five consecutive days.

Nest loss and egg loss events were recorded independently due to the potential for multiple causes for egg loss from one nest (e.g., two different predators, or unviable eggs). Chick loss was documented when possible, but unknown for most. Documenting the cause of chick mortality presents additional challenges compared to nest loss because chicks are highly mobile, hard to track, hide from potential predators such as pedestrians and dogs, and may go unobserved for days at a time.

Predator Management

CACO staff use predator exclosures as a protection tool for piping plover nests. These exclosures were designed to protect nests from predatory birds and mammals (crows, coyotes, foxes, etc.). They were made of welded metal wire with 2-inch wide and 4-inch high openings, ranging from four to five feet in height and seven feet in diameter, buried in the sand and stabilized with wood posts or rebar. The top of the exclosure is covered with bird netting, with holes no bigger than half an inch, secured to the metal wire. In a typical season, to minimize the risk of nest abandonment and adult mortality, exclosures are installed after nest completion, where vegetation did not hinder the bird's detection of approaching threats (e.g., predators), and where the risk of overwash by waves and sand was low (Darrah and Cohen 2017). In 2020, nests were exclosed once egg incubation was observed, regardless of whether the clutch was complete or not. Nests were frequently predated before staff could return to the site. Staffing and operation limitations made exclosing nests difficult. Initial exclosure usage in the North and South District was evaluated using *Piperex*; a decision support tool for exclosure use; the frequency of exclosing was then adjusted throughout the season based on nest success in particular areas and the ability of staff to get to the site with sufficient people to install the exclosure.

Least Terns

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. The Massachusetts least tern population size increased from 1985 to 2001, declined for several years, and then increased sharply after 2006. However, because initial counts were often conducted using inferior survey techniques and less inclusive survey coverage area than recent years, 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 an average of 2,960 pairs (Mostello et al. 2019). In the mid-1970s–1980s, the population of nesting least terns at CACO generally ranged from 200 to 600 pairs.

Monitoring Methods

Due to concerns of predators keying into human scents or visual clues during monitoring activities in the nesting areas (e.g., footprints leading up to a nest), visual estimates of least tern colony size were made from outside the symbolic fencing several times per week (i.e., a count of incubating adults, and unfledged chicks). Nests or chicks present within or in proximity to the ORV beach driving corridor were monitored daily. Shorebird staff occasionally walked through colonies to obtain better estimates of numbers of nests and chicks than could be obtained from more distant visual observations. The number of pairs in each colony was reported based on pairs present and incubating

adult counts during two standard periods defined by Massachusetts Division of Fisheries and Wildlife (“A-count” from June 5–20 and “B-count” after June 20). Similar to plovers, least terns are considered fledged when they are observed in sustained flight for at least 15 meters. In accordance with the Shorebird Management Plan, recreational restrictions are lifted when chicks are determined to be fledged or are considered lost after not being observed for five consecutive days. In most cases, the cause of chick loss is unknown.

American Oystercatchers

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, USFWS 2008). The American oystercatcher population has undergone a substantial range expansion along the Atlantic Coast, reaching Massachusetts in 1969. The 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 2003. In 2011, observers reported totals of > 418 adults and > 202 pairs of American Oystercatchers at 110 sites in Massachusetts (Melvin 2012) but the American oystercatcher is still an uncommon bird at CACO.

Monitoring Methods

Monitoring for American Oystercatcher nests and chicks is similar to methods for piping plovers. Due to the small population size at CACO, American Oystercatchers are often monitored daily. Nest loss and egg loss events were recorded independently due to the potential for multiple causes for egg loss from one nest (e.g., two different predators, or unviable eggs). In accordance with the Shorebird Management Plan, recreational restrictions are lifted when broods are determined to be fledged or are considered lost after not being observed for five consecutive days. In most cases, the cause of chick loss is unknown.

Post Breeding/Staging Shorebirds

Background

In late summer/early fall, thousands of migrating shorebirds congregate on mudflats and beaches along CACO to feed and rest. While dozens of species use CACO during migration, three of the most notable are the federally endangered roseate tern, state-listed common tern, and the federally threatened red knot. Nauset Marsh, Coast Guard Beach in Eastham, Jeremy Point, Hatches Harbor, Herring Cove marsh, Race Point North, and Wood End/Long Point are particularly important sites, as they represent the most important staging areas for these birds on Cape Cod (Hadden 2001, Trull et al. 1999, Jedrey et al. 2010).

Management Methods

Areas that have been historically important to nesting, staging and migratory shorebirds such as Coast Guard Beach (Eastham), Jeremy Point, and Hatches Harbor were closed to pets from April 1st–October 15th. As in past years, sections of upper beach and intertidal zone with concentrations of staging and migrating shorebirds or nurseries were posted with symbolic fencing and/or signs to reduce human disturbance throughout CACO. In addition, to reduce disturbance to migratory and

staging birds, areas were closed to pets when greater than 100 migratory birds were observed in an area. Interpretive and “No Pet” signs were installed on metal channel posts placed throughout the marsh at Hatches Harbor and Herring Cove South. Additional signage for oversand corridor users on pet restrictions were installed at Hatches Harbor spit for the newly implemented pet closure from April 1st–October 15th. These management practices are guided by the 2018 Shorebird Management Plan, 2007 ORV Environmental Assessment/Finding of No Significant Impact and the 1993 *Appendix A: Guidelines for Managing Recreational Use of Beaches to Protect Piping Plovers, Terns, and Their Habitats in Massachusetts* (Blodget and Melvin 1996).

Beaches where staging and migrating shorebirds required signage in 2020 included: Coast Guard Beach in Eastham, Jeremy Point, Race Point North, Race Point, Mission Bell, Head of the Meadow, Herring Cove, Coast Guard Truro, Armstrong, and Hatches Harbor. Additional areas which had smaller flocks but required signage were Race Point South, Exit 9, Newcomb Hollow, Marconi Station, and Duck Harbor.

Results

Piping Plover Nesting

The first piping plovers were observed at Coast Guard Beach (Eastham) on March 21st. They were present at most beaches by early April and continued to arrive until mid-June. Scraping was observed as early as the first week of April (April 6th). The total number of breeding pairs was determined by the number of pairs observed nesting or exhibiting territorial or nesting behavior for at least two weeks. Most plovers departed by late August, although some remained through September and late October.

The first nest was found on May 5th at Wood End (initiation date of May 3rd). Peak nesting occurred June 9th–June 15th, with a high of 78 nests on June 13th (Figure 3). Nests with eggs were present from May 3rd to August 4th. Hatching dates ranged from June 12th to July 18th (Figure 3). Nests that were active after July 18th failed to hatch. Hatch dates in 2020 were two weeks later for first hatch and two weeks earlier for last hatch than in 2019. Hatch success in the past several years has heavily relied on the use of exclosures. With limited staff in 2020, exclosures took longer to put up around most nests since staff were not able to visit every site every day. This resulted in later successful hatching nests. The average incubation time for nests was 26.7 days, calculated from the date the first egg in the clutch hatched. All successful piping plover nests that were found hatched between 24 and 30 days in 2020. Most nests were located on the berm with no vegetation (within a 2-meter radius).

Nesting results are summarized in Table 1. Ninety-two breeding pairs laid 149 nests (equaling 460 total eggs), of which 80 nests (54%) were lost and 69 nests (46%) hatched. Of those that were lost, 48 nests (60%) were lost before complete (refer to glossary for nest complete definition). Re-nests accounted for 39% (58) of the total nests laid (Table 2). Nest success of re-nests was approximately equal to first nests (48% vs 45%).

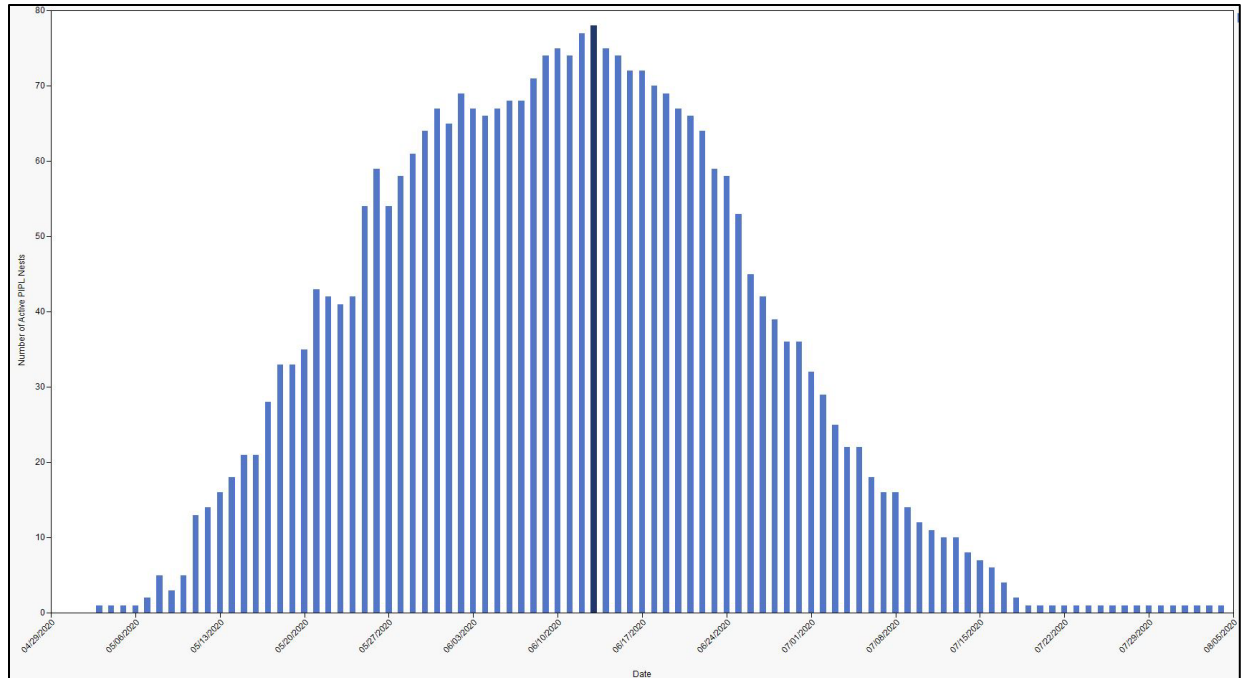


Figure 3. Number of active piping plover (*Charadrius melodus*) nests by date at CACO, 2020.

Of the 92 breeding pairs, 61 pairs (66%) fledged at least one chick, and 31 pairs (34%) had zero productivity (8 pairs had complete brood losses and 23 pairs failed to hatch any eggs). This was an increase in failed pairs from 25 in 2019 to 31 in 2020. The increase was mostly from pairs that failed to hatch any eggs. In 2020, the South District had a total of 15 pairs (54% of the total 28 pairs) that had zero productivity compared to the North District that had a total of 18 pairs (28% of the total 64 pairs) that had zero productivity. North District beaches had approximately twice as many breeding pairs and nests, and roughly three times the number of chicks fledged.

A total of 460 eggs were laid, of which 53% hatched (Table 1). Of the 222 failed eggs, predation was the most common cause for egg loss (57%). Most predation of eggs was by Eastern coyote (38%) and crows (43%), though gull and other unknown predators contributed to egg loss (Table 3). Other causes of nest loss included abandonment (13%), overwash (11%), failure to hatch (11%), and unknown causes (8%). Of the failure to hatch, 9 (4%) were documented unviable and 16 (9%) were documented as unknown reason for failure to hatch because staff was not able to dissect. All eggs documented as unviable were dissected after nest was no longer active (adults no longer tending for minimum of five days) and revealed only partial development and yolk. (Table 4). Additionally, fewer eggs were in completed nests in 2020 compared to 2019 (384 vs 442 respectively), indicating eggs were being lost prior to detection and the subsequent nests contained smaller clutch sizes.

Table 1. Summary of piping plover (*Charadrius melodus*) nest success at CACO, 2020.

Site	Pairs	Nests	Eggs laid	Nests hatched	Eggs hatched	Chicks fledged	Hatch rate ¹	Fledge rate ²	Productivity ³
Ballston Beach	1	1	4	1	4	2	100%	50%	2.00
Bound Brook	1	1	4	1	4	4	100%	100%	4.00
Cahoon Hollow	0	1	1	0	0	0	0%	0%	0.00
Coast Guard (Eastham)	9	11	39	6	20	10	51%	50%	1.11
Duck Harbor	4	5	17	3	11	7	65%	64%	1.75
Great Island	3	8	23	0	0	0	0%	0%	0.00
Jeremy Point	3	3	12	3	12	10	100%	83%	3.33
Lecount Hollow	0	0	0	0	0	0	0%	0%	0.00
Marconi Beach	2	2	8	2	7	0	88%	0%	0.00
Marconi Station	4	9	27	3	9	4	33%	44%	1.00
Nauset Light	0	0	0	0	0	0	0%	0%	0.00
Newcomb Hollow	1	3	8	1	3	3	38%	100%	3.00
New Island	0	0	0	0	0	0	0%	0%	0.00
White Crest	0	0	0	0	0	0	0%	0%	0.00
South District Totals	28	44	143	20	70	40	49%	57%	1.43
Armstrong	9	15	45	7	26	16	58%	62%	1.78
Coast Guard (Truro)	7	9	24	6	16	14	67%	88%	2.00
Exit 9	3	8	16	2	6	5	38%	83%	1.67
Hatches Harbor	2	2	8	1	3	2	38%	67%	1.00
Herring Cove	2	2	8	2	7	7	88%	100%	3.50
Head of the Meadow	3	10	22	2	6	5	27%	83%	1.67
High Head	4	8	23	2	7	6	30%	86%	1.50

¹ Total number of eggs hatched /total number of eggs laid.

² Total number of chicks fledged/ total number of eggs hatched.

³ Total number of chicks fledged/ total number of nesting pairs.

Table 1 (continued). Summary of piping plover (*Charadrius melodus*) nest success at CACO, 2020.

Site	Pairs	Nests	Eggs laid	Nests hatched	Eggs hatched	Chicks fledged	Hatch rate ¹	Fledge rate ²	Productivity ³
Longnook	1	2	5	1	4	2	80%	50%	2.00
Mission Bell	3	4	14	3	11	9	79%	82%	3.00
Race Point	4	7	24	4	14	13	58%	93%	3.25
Race Point North	14	19	67	12	43	28	64%	65%	2.00
Race Point South	2	4	9	1	2	2	22%	100%	1.00
Wood End/ Long Point	10	15	52	6	23	22	44%	96%	2.20
North District Totals	64	105	317	49	168	131	53%	78%	2.05
Grand Totals	92	149	460	69	238	171	52%	72%	1.86

¹ Total number of eggs hatched /total number of eggs laid.

² Total number of chicks fledged/ total number of eggs hatched.

³ Total number of chicks fledged/ total number of nesting pairs.

Table 2. Summary of piping plover (*Charadrius melodus*) nesting parameters by year from 2003 to 2020 at CACO.

Year	# Pairs	# Nests Laid	# Successful Nests (%) ¹	% Renests ²	# Eggs Laid	# Eggs Hatched (%) ³	# Chicks Fledged (%) ⁴	Productivity ⁵
2003	84	121	54 (45%)	31%	450	189 (42%)	130 (69%)	1.55
2004	85.5	115	59 (51%)	26%	425	220 (52%)	124 (56%)	1.45
2005	77	118	48 (41%)	35%	378	163 (43%)	87 (53%)	1.13
2006	74	96	70 (73%)	23%	336	233 (69%)	122 (52%)	1.65
2007	82	113	66 (58%)	25%	368	233 (63%)	146 (63%)	1.78
2008	85	109	70 (64%)	21%	386	243 (63%)	157 (65%)	1.85
2009	83	108	54 (50%)	20%	362	186 (51%)	60 (32%)	0.72
2010	85	115	68 (59%)	26%	386	235 (61%)	136 (58%)	1.60
2011	82	110	61 (55%)	25%	378	210 (56%)	90 (43%)	1.10
2012	99	212	27 (13%)	53%	636	72 (11%)	30 (42%)	0.30
2013	85	173	30 (17%)	51%	532	100 (19%)	46 (46%)	0.54
2014	68	121	38 (31%)	45%	375	129 (34%)	52 (40%)	0.76
2015	73	113	41 (36%)	39%	388	143 (37%)	64 (45%)	0.88
2016	66	95	48 (51%)	31%	344	169 (49%)	124 (73%)	1.88
2017	66	114	53 (46%)	42%	386	176 (46%)	119 (68%)	1.80
2018	98	180	66 (37%)	46%	573	221 (39%)	139 (63%)	1.42
2019	88	151	73 (48%)	42%	507	254(50%)	151(59%)	1.72
2020	92	149	69(46%)	39%	460	238(52%)	171(72%)	1.86
mean	82	129	55(46%)	34%	426	190(46%)	108 (56%)	1.33
median	83.5	115	57(47%)	33%	386	200(50%)	123 (57%)	1.50
min	66	95	27 (13%)	20%	336	72 (11%)	30 (32%)	0.30
max	99	212	73 (73%)	53%	636	254 (69%)	171 (73%)	1.88

¹ Percent (%) = number of successful nests/total number of nests

² Percent (%) = number of renests (including continuation nests)/total number of nests

³ Percent (%) = number of eggs hatched/total number of eggs laid

⁴ Percent (%) = number of chicks fledged/number of eggs hatched

⁵ Percent (%) = number of chicks fledged/number of nesting pairs

Table 3. Summary of piping plover (*Charadrius melodus*) egg loss, and cause of egg loss from 2016 to 2020 at CACO.

Year	# Eggs lost	Number of eggs lost by cause (Percentage of total lost)						Percent depredated by species (Percentage of total predated)							
		Overwash/ Sanding Over	Abandonment	Unviable	Unknown	Other ¹	Predation	Crows	Coyote	Gull	Skunk	Fox	Unknown Predator	Grackle	Raven
2016	175	25 (14%)	12 (7%)	10 (6%)	13 (7%)	0 (0%)	115 (66%)	45 (39%)	29 (25%)	0 (0%)	0 (0%)	4 (3%)	37 (32%)	0 (0%)	0 (0%)
2017	211	56 (24%)	12 (5%)	31 (13%)	14 (6%)	0 (0%)	98 (42%)	62 (63%)	12 (12%)	0 (0%)	0 (0%)	0 (0%)	24 (24%)	0 (0%)	0 (0%)
2018	352	22 (6%)	10 (3%)	34 (10%)	23 (7%)	4 (1%)	259 (74%)	161 (62%)	65 (25%)	0 (0%)	0 (0%)	7 (3%)	22 (8%)	4 (2%)	0 (0%)
2019	253	47 (19%)	22 (9%)	22 (9%)	26 (10%)	0 (0%)	136 (54%)	36 (26%)	86 (63%)	0 (0%)	0 (0%)	0 (0%)	10 (7%)	0(0%)	4 (3%)
2020	222	25(11%)	29(13%)	9(4%)	17(8%)	16(9%)	126(57%)	54(43%)	48(38%)	7(6%)	0(0%)	0(0%)	17(13%)	0(0%)	0(0%)

¹ Other in 2016, nest sanded over during high winds; Other in 2018, nest crushed by gull; Other in 2020, eggs failed to hatch but were not able to check for viability.

Table 4. Summary of piping plover (*Charadrius melodus*) nest loss, and cause of nest loss from 2003 to 2020 at CACO.

Year	# Unsuccessful Nests	Number of nests lost by cause (Percentage of total lost)						Percent depredated by species							
		# Overwash/ Sanding Over (%)	# Abandonment (%)	# Unviable (%)	# Unknown (%)	# Other ¹ (%)	# Depredation (%)	Crows	Coyote	Gull	Skunk	Fox	Unknown Predator	Grackle	Raven
2003	67	13 (19%)	16 (24%)	0 (0%)	0 (0%)	5 (7%)	33 (49%)	15%	27%	12%	15%	0%	30%	0%	0%
2004	56	15 (27%)	13 (23%)	0 (0%)	0 (0%)	0 (0%)	28 (50%)	43%	21%	11%	7%	0%	18%	0%	0%
2005	70	33 (47%)	11 (16%)	1 (1%)	0 (0%)	4 (6%)	21 (30%)	24%	29%	10%	0%	0%	38%	0%	0%
2006	26	8 (31%)	4 (15%)	0 (0%)	3 (12%)	0 (0%)	11 (42%)	82%	0%	0%	0%	0%	18%	0%	0%
2007	47	24 (51%)	12 (26%)	0 (0%)	2 (4%)	0 (0%)	9 (19%)	44%	22%	0%	0%	0%	33%	0%	0%
2008	39	8 (21%)	8 (21%)	1 (3%)	1 (3%)	0 (0%)	21 (54%)	43%	5%	5%	19%	0%	29%	0%	0%
2009	54	16 (30%)	9 (17%)	1 (2%)	2 (4%)	1 (2%)	25 (46%)	68%	4%	4%	0%	0%	24%	0%	0%
2010	47	3 (6%)	2 (4%)	1 (2%)	3 (6%)	0 (0%)	38 (81%)	74%	5%	0%	0%	0%	21%	0%	0%
2011	49	8 (16%)	9 (18%)	1 (2%)	2 (4%)	0 (0%)	29 (59%)	83%	10%	0%	0%	0%	7%	0%	0%
2012	185	55 (30%)	9 (5%)	0 (0%)	13 (7%)	5 (3%)	103 (56%)	34%	40%	0%	0%	5%	21%	0%	0%
2013	143	28 (20%)	7 (5%)	0 (0%)	2 (1%)	2 (1%)	103 (72%)	23%	30%	0%	0%	5%	40%	1%	0%
2014	83	16 (19%)	5 (6%)	0 (0%)	4 (5%)	0 (0%)	58 (70%)	33%	16%	0%	0%	10%	41%	0%	0%
2015	72	17 (24%)	8 (11%)	1 (1%)	0 (0%)	1 (1%)	45 (63%)	33%	33%	0%	0%	9%	25%	0%	0%
2016	47	7 (15%)	4 (9%)	1 (2%)	2 (4%)	1 (2%)	32 (68%)	38%	25%	0%	0%	3%	28%	0%	0%
2017	61	17 (28%)	6 (10%)	2 (3%)	6 (10%)	0 (0%)	30 (49%)	63%	13%	0%	0%	0%	23%	0%	0%
2018	114	9 (8%)	3 (3%)	3 (3%)	8 (7%)	1 (1%)	90 (79%)	62%	23%	0%	0%	2%	11%	1%	0%
2019	78	15 (19%)	9 (12%)	0 (0%)	7 (9%)	0 (0%)	47 (60%)	30%	51%	0%	0%	0%	17%	0%	2%
2020	80	9 (11%)	11 (14%)	0 (0%)	11 (14%)	0 (0%)	49 (61%)	45%	35%	4%	0%	0%	16%	0%	0%
Total	1318	301	146	12	66	20	772	46%	22%	3%	2%	2%	24%	0%	0%

¹ Other in 2016, nest sanded over during high winds; Other in 2018, nest crushed by gull.

Banded Plovers

No banded plovers nested at CACO in 2020. In comparison, four banded birds nested at CACO in 2019 and two in 2018, one of which had nested at CACO for several seasons in a row from 2015 to 2019.

Exclosure Results

There were 101 nests that reached completion (refer to glossary for nest complete definition). Predator exclosures were installed around 74 of these complete nests; the remaining 27 were unexclosed (Table 5). The percentage of nests exclosed was higher in the North District (58% exclosed) than the South District (48%) in 2020. Exclosures significantly increased the rate of hatching success (73% vs 13%) and decreased the rate of predation (78% vs. 18%). Only 22 (27%) exclosed nests were lost with the highest cause for loss being abandonment (50%) followed by overwash (27%), and predation (18%) (Table 6). This was almost double the percent lost in 2019, demonstrating that exclosures can lose their effectiveness over time as predators learn how to compromise them. Hatch rate per completed nest was significantly higher among exclosed nests than unexclosed nests (81% vs. 33%). Exclosed nests accounted for a higher proportion of all fledglings this season than unexclosed nests (85% vs. 15%).

Table 5. Piping plover (*Charadrius melodus*) exclosure nest loss results, CACO, 2020.

Predator Management Type	Total Number of Nests	Total Number of Nests Lost
Nests Exclosed (Complete)	74	14
Nests Exclosed (Incomplete)	8	8
Nests Unexclosed (Complete)	27	18
Nests Unexclosed (Incomplete)	40	40

Table 6. Cause of piping plover (*Charadrius melodus*) nest loss, CACO, 2020.

Cause of failure	Exclosed (Complete)	Exclosed (Incomplete)	Unexclosed (Complete)	Unexclosed (Incomplete)
Depredated	3	1	16	29
Coyote	2	1	7	7
Crow	0	0	8	14
Fox	0	0	0	0
Unknown	1	0	0	7
Gull	0	0	1	1
Overwash	5	1	0	3
Abandoned	6	5	0	0
Unknown	0	1	2	8
Unviable	0	0	0	0
Crushed	0	0	0	0
Sanded Over	0	0	0	0

Fledging Results

Of 238 eggs that hatched from 92 breeding pairs, a total of 171 chicks fledged (fledge rate = 72%) resulting in an overall productivity rate of 1.86 chicks fledged/breeding pair (Table 1). Active broods of unfledged chicks were present on CACO beaches from June 12th until August 29th, peak number of broods occurred from July 10th to July 16th, with a high of 62 broods on July 16th (Figure 4). Fledging dates in 2020 ranged from July 14th to August 29th. The average number of days, from hatch to fledge, was 33.6 in 2020 (34 days in the ND and 33 days in the SD). Out of the 69 nests that hatched successfully, fledge rates for re-nests were similar to fledge rates for first nest attempts, 70% and 73% respectively.

A total of 67 chicks were confirmed lost this season: 37 chicks in the North District and 30 chicks in the South District. Of the 67 chicks lost, all were lost to unknown causes. Chick survival in 2020 was better than in 2019 when 103 chicks were lost, 14 of which were found dead.

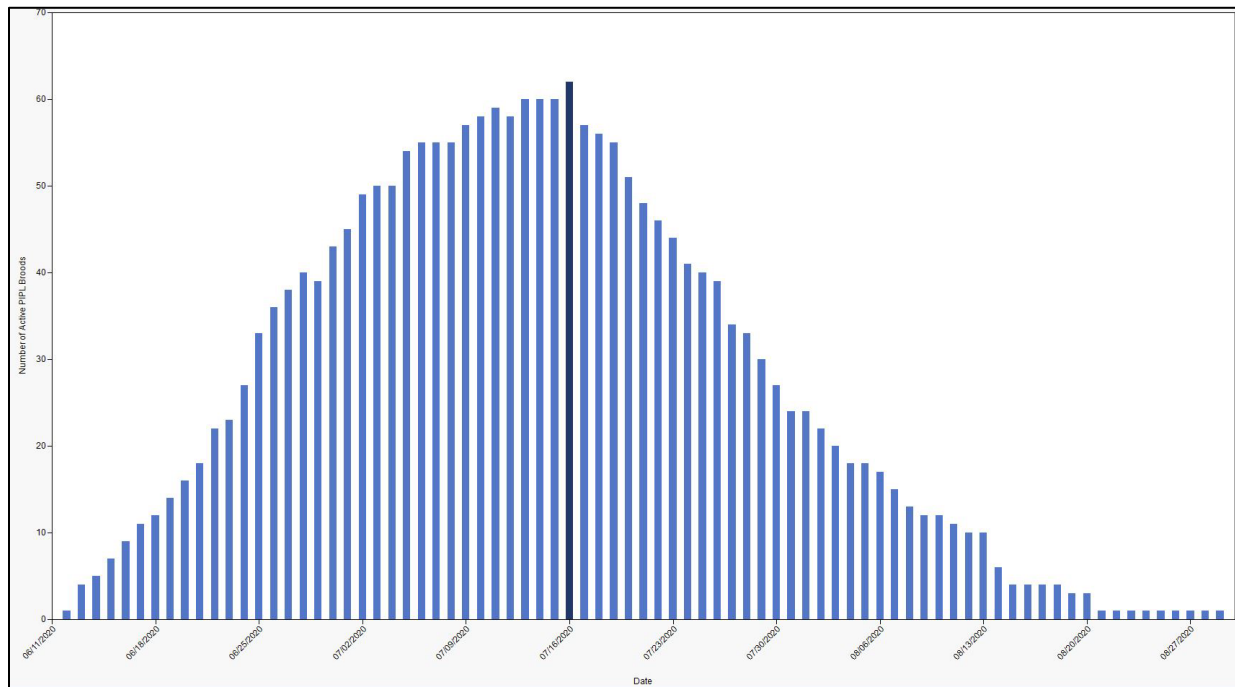


Figure 4. Number of active piping plover (*Charadrius melodus*) broods by date at CACO, 2020.

Least Tern Nesting

In 2020 least terns returned to CACO beaches during the second and third full weeks of May. The first least tern was observed on May 11th at Race Point. The first least tern nests were found on May 29th at Head of the Meadow and Armstrong. Most were incubating eggs by early June. Re-nesting attempts continued throughout late August. The highest number of incubating adults at all sites was 121 with total breeding pair counts of 111 for the “A” count and 121 for the “B” count (Table 7). This was a drop in approximately 50 pairs from 2019. Colony sizes fluctuated throughout the season, but most were relatively small with 40 or fewer pairs. Race Point North, Coast Guard Eastham, and

Armstrong supported the largest colonies with high incubating counts of 30, 19, and 14 incubating adults, respectively (Table 7).

Table 7. Least tern (*Sternula antillarum*) breeding pair counts and fledging success, CACO, 2020.

Site	A Count ¹	B Count ²	Incubating Adult Count ³	# Chicks Fledged
Armstrong	15	14	14	2
Ballston	0	0	0	0
Bound Brook	0	0	0	0
Cahoon Hollow	0	0	0	0
Coast Guard Beach (Eastham)	11	19	19	4
Coast Guard Beach (Truro)	20	10	10	6
Duck Harbor	0	0	0	0
Exit 9	5	12	12	3
Great Island	0	0	0	0
Hatches Harbor	0	1	1	2
Head of the Meadow	8	6	6	1
High Head	0	0	0	0
Jeremy Point	0	0	0	0
Lecount Hollow	0	0	0	0
Marconi Beach	0	0	0	0
Marconi Station	3	7	7	5
Mission Bell	0	7	7	6
Nauset Light Beach	0	0	0	0
Newcomb Hollow	0	0	0	0
Race Point North	40	30	30	6
Race Point	8	8	8	0
Race Point South	1	6	6	0
White Crest Beach	0	0	0	0
Wood End/Long Point	0	1	1	0
Total	111	121	121	35

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

³ "Incubating Adult Counts" are highest counts of incubating adults observed at a particular site for the whole season

Chicks began hatching in late June; the first hatch was June 21st at Armstrong. The first least terns fledged July 12th at Armstrong and the last fledged September 16th at Mission Bell. The 121 pairs produced 35 chicks yielding a productivity of 0.29 chicks/pair from CACO beaches in 2020 (Table 7). Over the past fourteen years (2007–2020), the least tern population at CACO fluctuated between a

high of 268 pairs in 2011 and a low of 52 pairs in 2016 (Table 8). The average number of pairs over this time span is 152 pairs and average number of fledges over this time span is 46. Least tern pairs and fledges were below average in 2020.

Table 8. Least tern (*Sternula antillarum*) productivity at CACO, 2007–2020.

Year	# Nesting Pairs	# Chicks Fledged	Productivity	Primary Cause of Loss
2007	86	40*	0.45*	overwash, canids
2008	89	<136*	>1*	overwash, coyote
2009	236	25	0.11	overwash, coyote
2010	226	26	0.12	coyote
2011	268	99	0.37	coyote
2012	257	66	0.26	coyote
2013	138	2	0.01	coyote
2014	77	7	0.09	coyote
2015	122	19	0.16	coyote
2016	52	39	0.75	coyote
2017	142	69	0.49	overwash, coyote
2018	140	41	0.29	coyote
2019	171	39	0.23	coyote
2020	121	35	0.29	coyote

* estimate

American Oystercatcher Nesting

Observations of American oystercatchers have been low at CACO with between one and five pairs nesting in the park over the past 14 seasons (2007–2020) (Table 9). Nesting has been observed only in the South District at Jeremy Point in Wellfleet, Coast Guard Beach in Eastham, and New Island in Orleans. Two American oystercatcher pairs nested at CACO in 2020 at Jeremy Point. The first pair initiated their nest on April 25th, the nest hatched all three eggs on May 28th, and fledged one chick on July 28th. The second pair's nest was initiated on June 5th and depredated by crow on June 18th. Productivity for American oystercatchers was 0.5 in 2020 (Table 9).

Table 9. American oystercatcher (*Haematopus palliatus*) productivity at CACO, 2007–2020.

Year	# Nesting Pairs	# Chicks Fledged	Productivity	Primary Cause of Loss
2007	5	3	0.60	overwash, unk. predator
2008	5	5	1.00	unk. predator, crow
2009	1	0	0.00	unk. predator
2010	2	0	0.00	coyote
2011	2	0	0.00	coyote
2012	3	0	0.00	coyote, gull
2013	3	0	0.00	overwash, coyote, unknown
2014	2	0	0.00	coyote, unk. predator
2015	2	3	1.50	coyote, unk. predator
2016	2	3	1.50	coyote, unk. predator
2017	2	2	1.00	overwash, coyote
2018	1	0	0.00	coyote
2019	1	0	0.00	coyote
2020	2	1	0.5	crow

Post-Breeding Shorebirds

General Results

The following results are estimates because CACO staff does not systematically collect data on numbers of individual staging migrant species. Field staff monitor and report general locations of large flocks > 50, and report estimates of numbers and individual species.

Flocks of common and roseate terns were observed staging throughout the park from mid-July to early October in 2020. Mixed flock high counts for CACO sites include: ~200 at Race Point South, ~1,350 at Race Point North, ~1,800–2,000 at Hatches Harbor/Herring Cove marsh, ~340 at High Head, ~720 at Armstrong, ~500 at Head of the Meadow, ~450 at Exit 9, ~180 at Wood End/Long Point, ~800 at Mission Bell, ~400 at Coast Guard Truro, ~50 at Longnook, ~1,200 at Jeremy Point, ~85 at Newcomb Hollow, ~150 at Ballston, ~200 at Duck Harbor, ~500 at Marconi Station, and ~1,000 at Coast Guard Eastham/Nauset Marsh.

Roseate Tern

Researchers estimate that approximately 70% of the entire Northwest Atlantic breeding population of roseate terns and their fledglings use CACO beaches from mid-July through October for staging (Jeff Spendelow, USGS personal communication, 5 November 2018). During staging, roseate terns must build up fat reserves required for their long migration to South America (more than 7,000 km). Survival of young roseate terns 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).

Common Tern

The common tern is listed by the Massachusetts Division of Fisheries and Wildlife (MDFW) as a Species of Special Concern. In Massachusetts, from 1985 to 2003, common tern numbers rose steadily in Massachusetts. Since then, however, the population has been stable at about 16,000–17,000 pairs. Since 1985, population size has ranged from 6,483 to a high of 18,059 pairs in 2017 (Mostello et al. 2019).

No common terns nested at CACO in 2020. Many were observed in mixed flocks from July through October.

Red Knot

The Rufa red knot (*Calidris canutus rufawas*) was listed as a threatened species under the Endangered Species Act in 2014, with critical habitat designations identified in 2015. CACO 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. Historically, the greatest concentrations of red knots within CACO have been observed in Eastham at Coast Guard Beach and Nauset Marsh, along the ocean beach in Truro and Provincetown, and in Hatches Harbor. In 2020, there were no flocks of red knots observed on CACO beaches, but several were observed foraging at Coast Guard Eastham and Armstrong. It was once common to observe large flocks toward the end of the summer throughout the park; the drop in presence of red knots is a concern for this species as CACO is an important foraging and migratory site.

Piping Plovers and Least Terns

CACO shorebird biologists not only monitor piping plover and least tern nesting areas, but also feeding, staging, roosting, and nursery areas. Groups of post-breeding piping plovers were observed in late summer, feeding and resting throughout the park; most notably at Armstrong Beach, where groups of up to 27 piping plovers were observed in late August. At least 9 of the 27 piping plovers were observed at Armstrong Beach until October 5th. Smaller groups of migrating piping plovers were observed including, 14 at Coast Guard Eastham on August 16th, eight (8) at Exit 9 on September 16th, seven (7) at Coast Guard Beach Truro on August 20th, seven (7) at Mission Bell on September 11th, and seven (7) at Marconi Station on August 25th. Least tern nurseries were observed starting in late July until mid-September at Coast Guard Truro (30–50 individuals), Head of the Meadow (15–20 individuals), Armstrong (20–30 individuals), Exit 9 (15 individuals), Mission Bell (10–30 individuals), Race Point South (15–35 individuals), Race Point (30 individuals), Race Point

North (30–100 individuals), Hatches Harbor (10 individuals), Coast Guard Beach Eastham (20–50 individuals), Marconi Station (75–100), and Jeremy Point (25–130 individuals). Symbolic fencing and/or interpretive signs were installed to protect least terns and piping plovers still using critical habitat later in the breeding season.

Discussion

Piping Plovers

The observed productivity rate of 1.86 chicks fledged per breeding pair was just above the species recovery target of 1.5 and is consistent with a multi-year pattern of annual fluctuations above and below the target (Table 2). The five-year average productivity in 2020 is above the target rate at 1.72, which is the highest since 1997 (Figure 5).

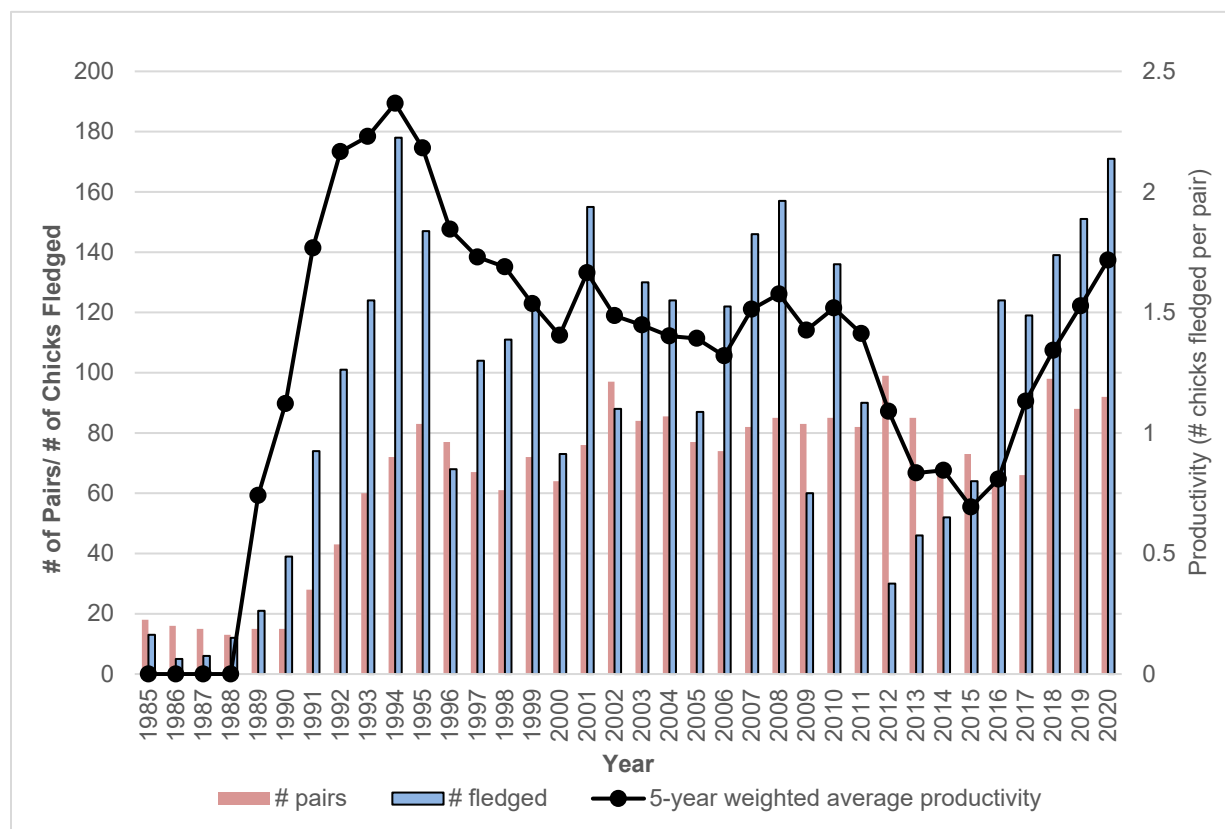


Figure 5. Number of piping plover (*Charadrius melodus*) pairs, chicks fledged, and overall productivity (chicks fledged/nesting pair) from 1985 to 2020 at CACO.

Over the past 18 years, the top three factors causing nest failure has been predation, overwash, and abandonment (Table 4). Predation has consistently been the greatest cause of nest failure during that time frame, including in 2020 (61%) and in 2019 (60%), (Table 4). The fledge rate in 2020 was slightly higher than it was in 2019, increasing from 59% to 72%, possibly due to the higher number of pairs observed over the past two years (Table 2).

The use of predator exclosures around piping plover nests in 2020 resulted in reduced nest depredation. Although exclosure use has become a common tool for piping plover protection efforts, there is concern that the use of exclosures may draw the attention of the public as well as increase the number of adult mortalities, abandonments, and depredations. Depredations of exclosed nests may be caused by predators learning to associate the exclosure structure with a food supply. Coyotes jumped

into and depredated four plover nests in the North District. Two additional nests had evidence of coyotes circling the exclosures and one where a coyote dug around the outside in attempt to enter. One exclosed nest in the South District was depredated by an unknown predator that was able to get inside the exclosure. Additionally, one exclosure at Coast Guard Eastham was tampered with by humans and the egg subsequently gone, although it is unclear if humans removed the egg or if a predator entered the exclosure after it was tampered with (Figure 6).

There were four instances of possible adult mortalities associated with exclosures, in which nests were abandoned, all in the hatch window, without any apparent cause based off tracking. Several had evidence of coyote and one was within close proximity of the oversand route where adult plovers had regularly been observed foraging. The nest was abandoned within its hatch window with no evidence of predator tracks around the nest and fully developed chicks within the eggs.

In addition to predators being able to enter the exclosures, some predators check exclosures regularly for hatching resulting in chick loss. There were three instances of possible chick predation in which the eggs were found as hatched but chicks were either never observed or did not survive past 1–3 days. Evidence suggests that coyotes targeted these exclosures and could have depredated chicks as they exited the safety of the exclosure (RPN02C, RPN12A, ARM2C). Additionally, one instance of possible chick predation by crow was suspected for a nest in South District (CGE06B). Despite these issues, our results strongly indicate that exclosures substantially increase nest success and reduce predation.



Figure 6. Images of an exclosure that had been tampered with, netting ripping and tracks inside, suspected human ripped the netting and then the egg was lost either by human or predator, unknown (NPS photos by Abby Burke).

In 2020, there was also an instance of a “stunted” chick, or a chick that appeared very small for their age. One chick at Race Point North was observed as being small for its age on August 15th at 29 days old. The chick only began attempting flight on August 24th at 38 days old and eventually fledged at 43 days old on August 29th (Figure 7). A similar situation occurred in 2019 with two stunted chicks (one at Armstrong and one at Race Point North). Unfortunately, neither chick made it to fledge but coincidentally were also the last chicks to hatch at those sites in 2019. This may suggest that later

hatch dates can result in smaller chicks, or longer time to develop due to increased stress/disturbance from the public or possible changes in food supply toward the end of the breeding season.



Figure 7. Race Point North “stunted” chick. Photo was taken on 8/18/20 when the chick was 32 days old. Its tail and flight feathers were still not fully developed, making the chick easier to track at the end of the season when many migrant piping plovers were in the area. Chick was observed in flight over 15 meters at 43 days old. (NPS photo by Keegan Burke).

In 2020, CACO had the third highest number of breeding pairs observed and the highest number of chicks fledged in 18 years of monitoring (Table 2, Figure 5). Productivity and fledge rate were second highest in 18 years as well, with the highest being in 2016. Further investigation is needed to determine factors influencing the number of pairs and fledge rates in a given season. The higher number of pairs could be due to higher productivity during the last several seasons along the U.S. Atlantic Coast and at CACO. Recovery and viability of piping plover populations requires both an increase in abundance and a sustained level of annual productivity. Fledge rate variability is often more difficult to determine as a result of not being able to track individual chicks at CACO daily or through their development. Potential factors may include less predation on chicks, more food, more experienced adults to care for young, or breeding closer together creating a more cooperative protection with alerts. There also has been an increased use of symbolic fencing later into the

breeding season to provide refuge for chicks, perhaps causing better chick survival by reducing disturbance.

Least Terns

The total number of breeding pairs of least terns observed in 2020 was 50 pairs lower than in 2019, and the third lowest number of pairs since 2009. The five-year running average number of pairs for 2016–2020 was 125. Low numbers of breeding pairs may be due to low productivity in recent years, intense predation on eggs and chicks, and the fragmentation of colonies due to human disturbance at prime nesting areas.

The number of fledged chicks had been trending upward from a low of 2 fledges in 2013 to a high of 69 fledges in 2017 (Figure 8). Since 2017 however, there has been a decreasing trend each year with number of fledges from 69 in 2017 to 35 in 2020. Additionally, the number of chicks fledged remains low with productivity over the past five years averaging 0.41 chicks fledged/breeding pair. Least terns are relatively long-lived, meaning 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).

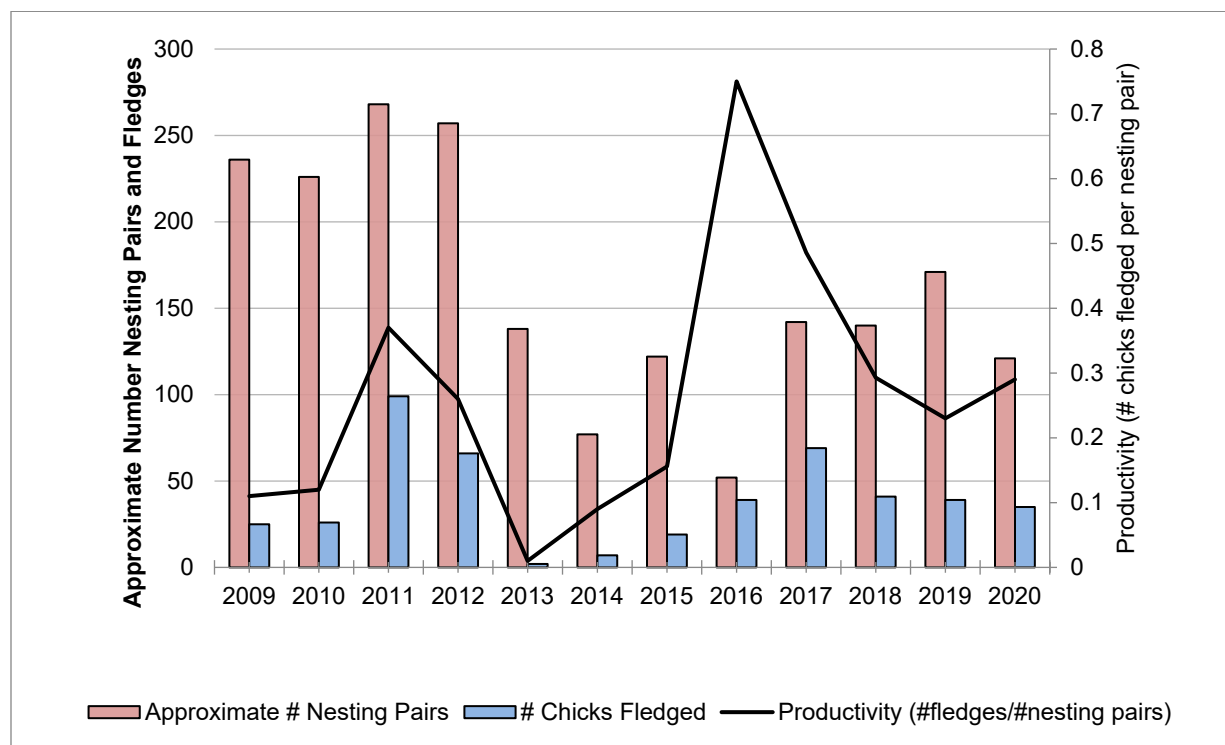


Figure 8. Least tern (*Sternula antillarum*) breeding pairs, chicks fledged and productivity (chicks fledged/nesting pair), by year from 2009 to 2020 at CACO.

In 2020 least terns nested at 12 different sites at CACO with approximately 50% of chicks fledged at just three locations: Race Point North (6), Coast Guard Truro (6) and Mission Bell (6). This was the highest number of nesting sites recorded since 2015. The increase in nesting sites is not necessarily a

success for least tern colonies, but rather displays the amount of fragmentation occurring at many of the nesting sites.

The colonial defensive strategy used by adult terns as a means of protecting eggs and chicks is called ‘mobbing’. Adult terns react as a group to any perceived threat that comes close to the colony and use mobbing and defecating on intruders to deter potential predators from the area. Colony sizes at CACO have decreased perhaps to the point where there are insufficient numbers of adults to mob and successfully deter predators away from a nesting area. 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 wash-overs. Colony fragmentation may also occur when pedestrian access paths are made through the tern’s preferred nesting habitat, possibly dividing the colony up into smaller, less effective groups to deter predators. This occurs at sites such as Head of the Meadow and Armstrong, where the only accesses from the parking lot or dune shacks fringe or dissect the tern colony. Pathway closures and high tide closures to provide adequate buffer were installed, but largely ignored by the public in 2020. Least terns were frequently observed off of their nests and/or away from their chicks due to increased visitation on the beaches. Even though closures were well marked, some visitors did not adhere to. Unfortunately, increased disturbance to nesting shorebirds has an adverse effect on their success. When threatened, least terns will “dive-bomb” pedestrians or people that get too close. This leaves chicks and nests vulnerable to predation, and adults end up using energy reserves thus having to forage more frequently. Increased human disturbance was also observed at Race Point South, impacting a piping plover chick and several least tern nests. In 2020 several large predation events occurred which limited least tern productivity. The majority of the Head of the Meadow colony moved to Coast Guard Truro North fairly early in the nesting season. The following instances were due to coyote predation. The colony at Coast Guard Truro was reduced drastically in mid-June but somewhat recovered. Race Point North, Exit 9, and Armstrong all had depredation events at the end of July; Race Point North and Exit 9 had a few pairs renest after the depredation but Armstrong never recovered. The last remaining nests at Race Point South and Race Point were wiped out by coyote by mid-August. Additionally, the colony at Coast Guard Eastham was reduced in early June, by crow depredation. Tracks were observed, and eggshell fragments were found in the colony. Coyote tracks were also observed inside the colony throughout the season. Field observations of physical tracks, scat, and individuals of Eastern coyote within the least tern colonies at CACO suggest the coyotes visited colonies almost daily and preyed on nests or chicks. Eastern coyotes may develop search patterns that are highly effective in locating ground nesting bird nests in open habitat. With the seemingly increasing numbers of predators (Eastern coyote and two species of crow) in the area, more robust protective measures may be required in the future.

Determining the cause of chick mortality is more difficult than attributing causes of nest loss. Chicks move, are difficult to track, and can hide and go unobserved for days, but it is likely that chicks are lost by depredation or exposure. Tracking evidence suggests the same species that are preying on eggs are also preying on chicks (mainly Eastern coyotes). Least tern chicks take longer than piping plover chicks to become mobile, thus making them more vulnerable to exposure if unable to reach shelter or an adult. After a mid-August storm with high winds and high surf, impacted Marconi Station habitat and the last few chicks that were less than a week old were not observed again. The

high frequency of visitation to colonies by predators combined with daily human disturbances adds stress to nesting least terns and may be responsible for late re-nesting efforts into August, movement onto sub-standard nesting habitat, and fragmentation of colonies.

American Oystercatcher

American oystercatchers were first recorded nesting on CACO beaches in 2002. Since then, 1–5 pairs have nested in the South District each year. Between 2007 and 2020, productivity fluctuated between zero and 1.5 chicks fledged/breeding pair (Table 9, Figure 9). 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).

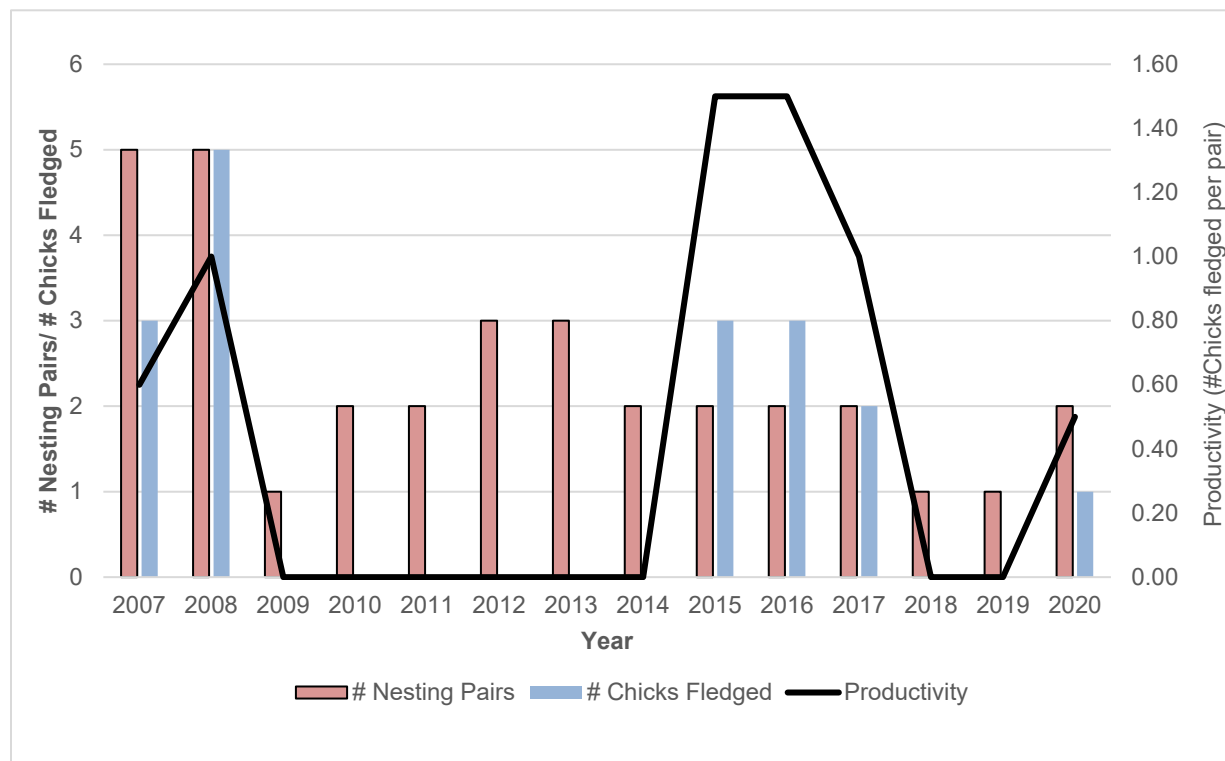


Figure 9. American oystercatcher (*Haematopus palliatus*) breeding pairs, chicks fledged, and productivity, by year from 2007 to 2020 at CACO.

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

At CACO, 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

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 and domestic dogs. In 2020, the one American oystercatcher chick to fledge took 60 days to fly, above the average for Massachusetts of 35–45 days (Murphy 2010). The delay in fledging was likely due the high disturbance rate at Jeremy Point from recreational boats landing and the frequency of pet violations, pets either brought by boaters or pet closure signs ignored. Additionally, the second pair of American oystercatchers were frequently disturbed from incubating the nest due to recreational boat landing, pets, and violations of the high tide closure in front of the nest area. The 2018 Shorebird Management Plan allows for a boat closure on Jeremy Point but due to lack of staffing to implement and lack of enforceability, the closure was not established.

Human Disturbance and Violations

Park staff do their best to manage beach habitat to reduce impacts on shorebirds but it is impossible to prevent violations. Human disturbance and violation observations are recorded during the season. Due to staffing constraints in 2020, violations were not always recorded as monitoring and protection took priority. Despite less recording, there still was a noticeable increase in violations in 2020, most likely a result of the COVID-19 restrictions and encouragement to recreate or gather outside. Documented cases of pedestrian violations in the symbolic fencing occurred at every site in 2020 (Figures 10 & 11). In addition, vandalism and the removal of signs occurred at Newcomb Hollow, White Crest, Head of the Meadow, Hatches Harbor, Herring Cove, Exit 9, Coast Guard Truro, Armstrong, and Race Point.



Figure 10. COVID 19 presented new challenges for the shorebird program. Face masks and other trash were commonly observed on symbolic fencing; this not only created a safety hazard for staff having to move fencing, but also can reduce the integrity of the fencing and/or disturb birds by movement or attracting predators (photo on the left taken at Hatches Harbor, Provincetown). Pedestrian violations were also high in 2020. Some beaches you could not even distinguish where the symbolically fenced area was due to such high pedestrian traffic in the closed area (photo on the right taken at Head of the Meadow Beach, Truro).



Figure 11. Least tern nest narrowly missed being stepped on by domestic dog and pedestrian trespassing into the symbolic fencing (NPS photo by Abby Burke).

Vehicles were observed backing into and/or knocking over fencing as well as noncompliance with speed limits, delineator posts and drive-thru areas. There were several instances of vehicles driving into closed symbolically fenced areas within feet of nests, unfledged chicks, and through a least tern nursery. In addition, there were multiple instances of vehicles and/or UTVs driving in areas that were completely closed to vehicles to protect unfledged piping plover and least tern chicks (Race Point North, High Head, Longnook, and Coast Guard Truro).

While dogs off leash appear to be declining from previous years, dogs in ‘No Pets’ areas were consistently observed on an almost daily basis in both districts. It is hard to say definitively whether any of these violations led to nest abandonment or reduced productivity, but instances like these do affect behavior which can impact nest and chick success. Pets in no pet areas were observed separating chicks from adults, splitting broods and flushing adults and chicks from refuge, making them more susceptible to loss.

Education and Outreach

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, over 800 visitor contacts were made by shorebird technicians in the field during regular monitoring duties.

Due to COVID-19, volunteers were limited in 2020. One volunteer assisted biological technicians and park staff with fencing and daily field observations from April through September, donating over 1,000 hours to the monitoring efforts. Three additional volunteers assisted with outreach and focused on pet restrictions at Coast Guard Beach in Eastham from May 24th to September 22nd, totaling 725 hours, contacting 3,107 visitors, and 130 pet contacts.

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Appendix A. Maps of 2020 Piping Plover, Least Tern, and American Oystercatcher Nest Sites at Cape Cod National Seashore

South District

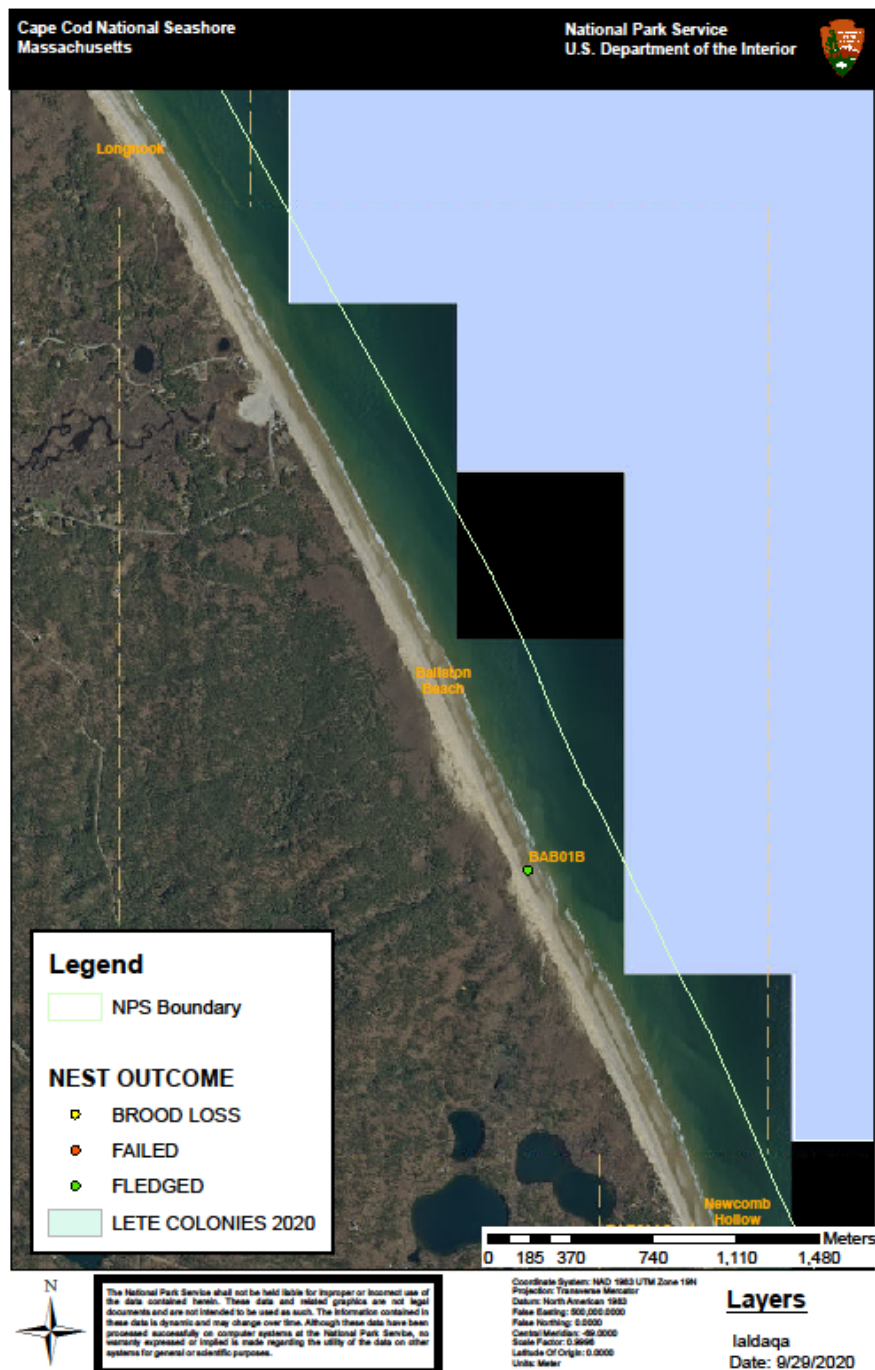


Figure A-1. South District: Ballston Beach.



Figure A-2. South District: Bound Brook.



Figure A-3. South District: Cahoon Hollow.



Figure A-4. South District: Coast Guard Eastham.

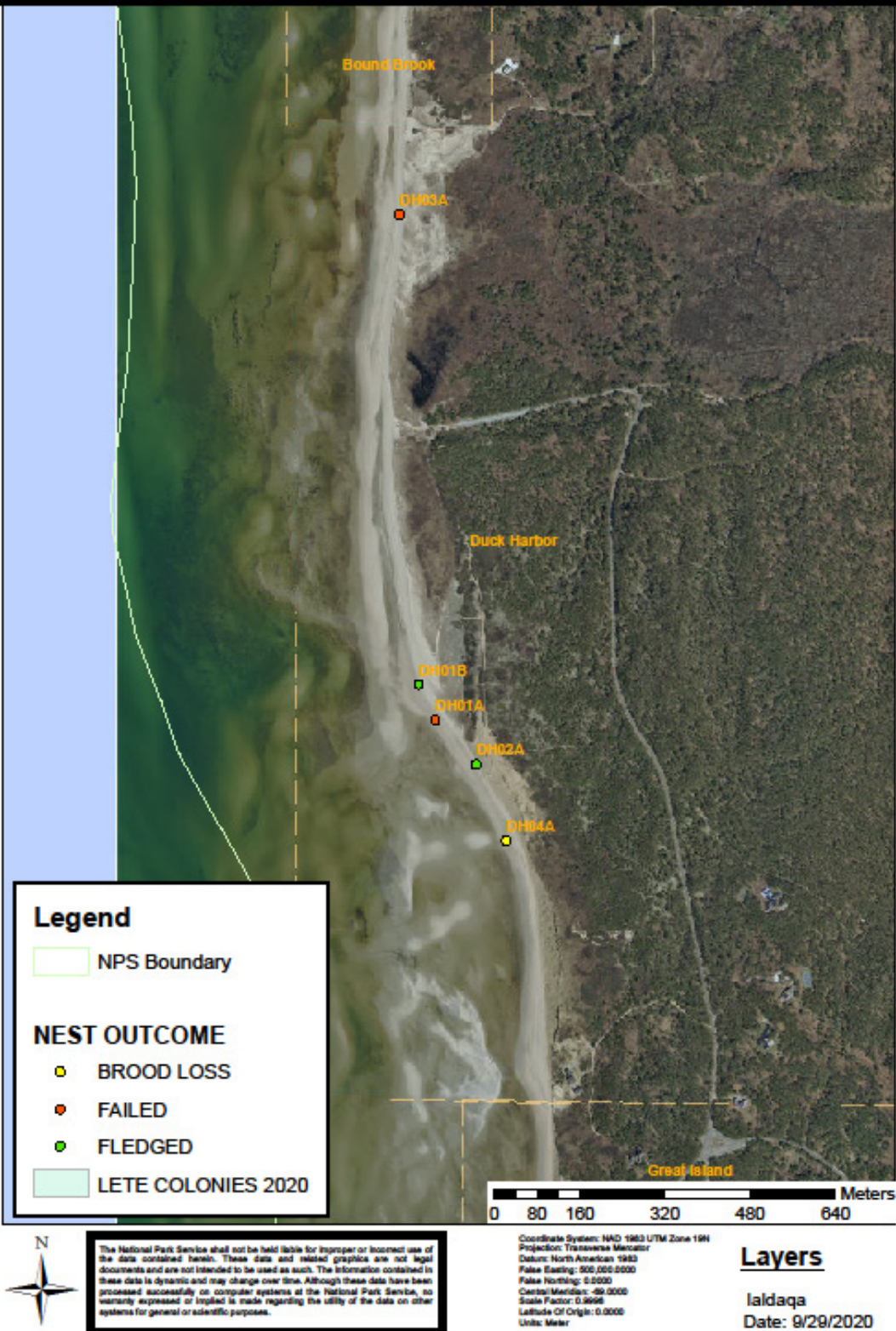


Figure A-5. South District: Duck Harbor.



Figure A-6. South District: Great Island.



Figure A-7. South District: Jeremy Point.

South District: Lecount Hollow

No map generated due to no nesting activity.

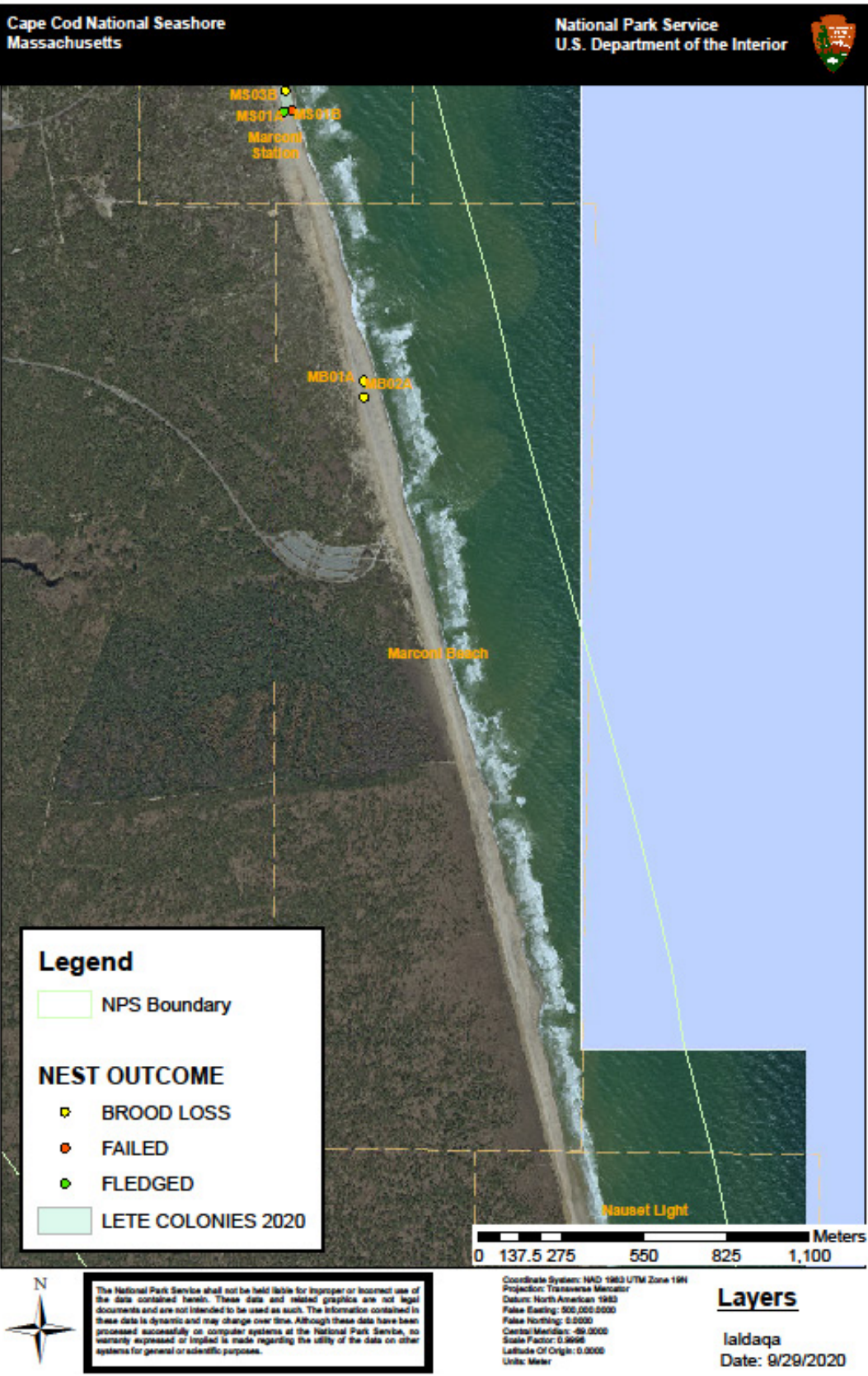
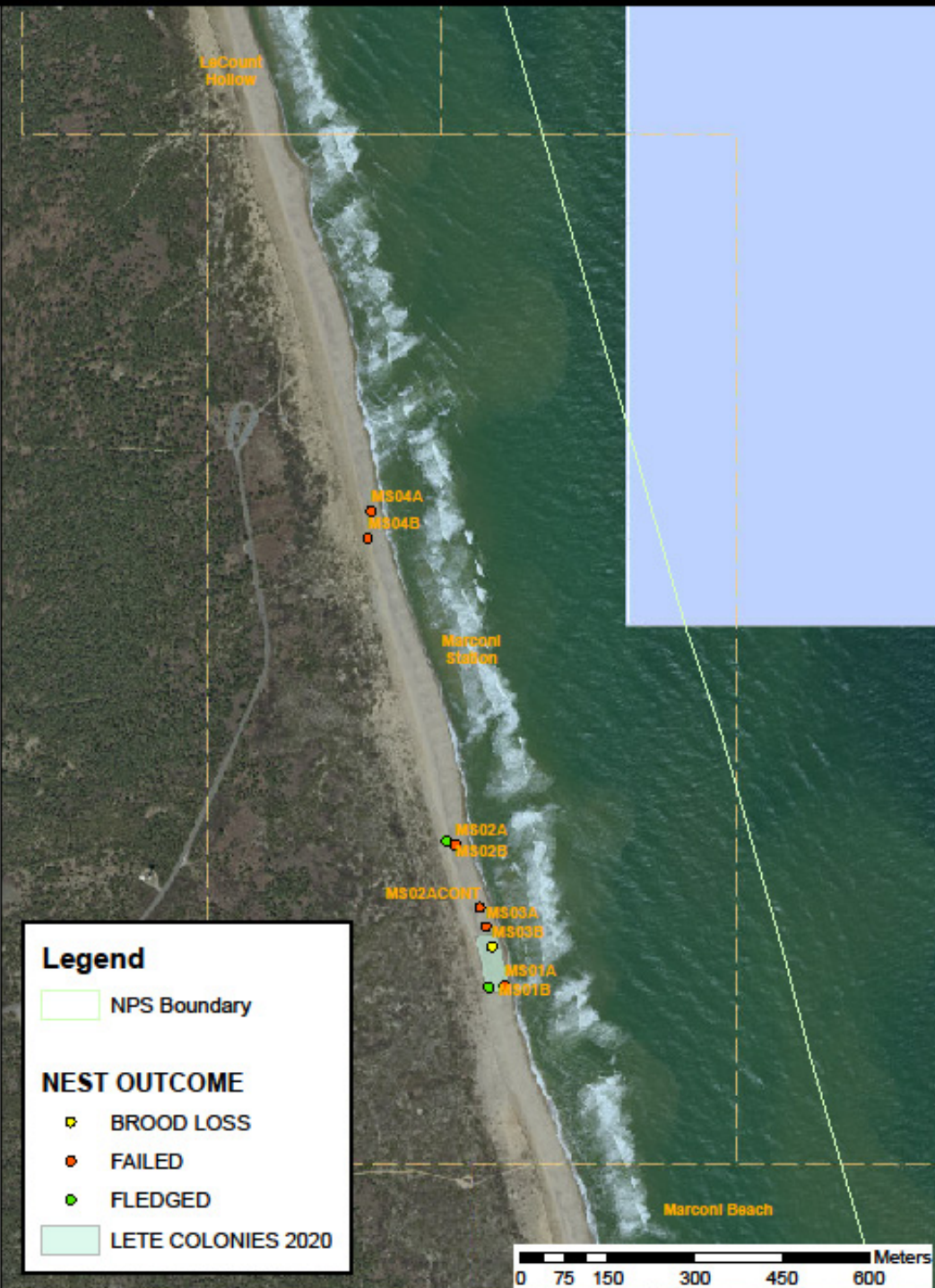


Figure A-8. South District: Marconi Beach.



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Coordinate System: NAD 1983 UTM Zone 18N
Projection: Transverse Mercator
Datum: North American 1983
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -69.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Layers

laldaq
Date: 9/29/2020

Figure A-9. South District: Marconi Station.

South District: Nauset Light

No map generated due to no nesting activity.

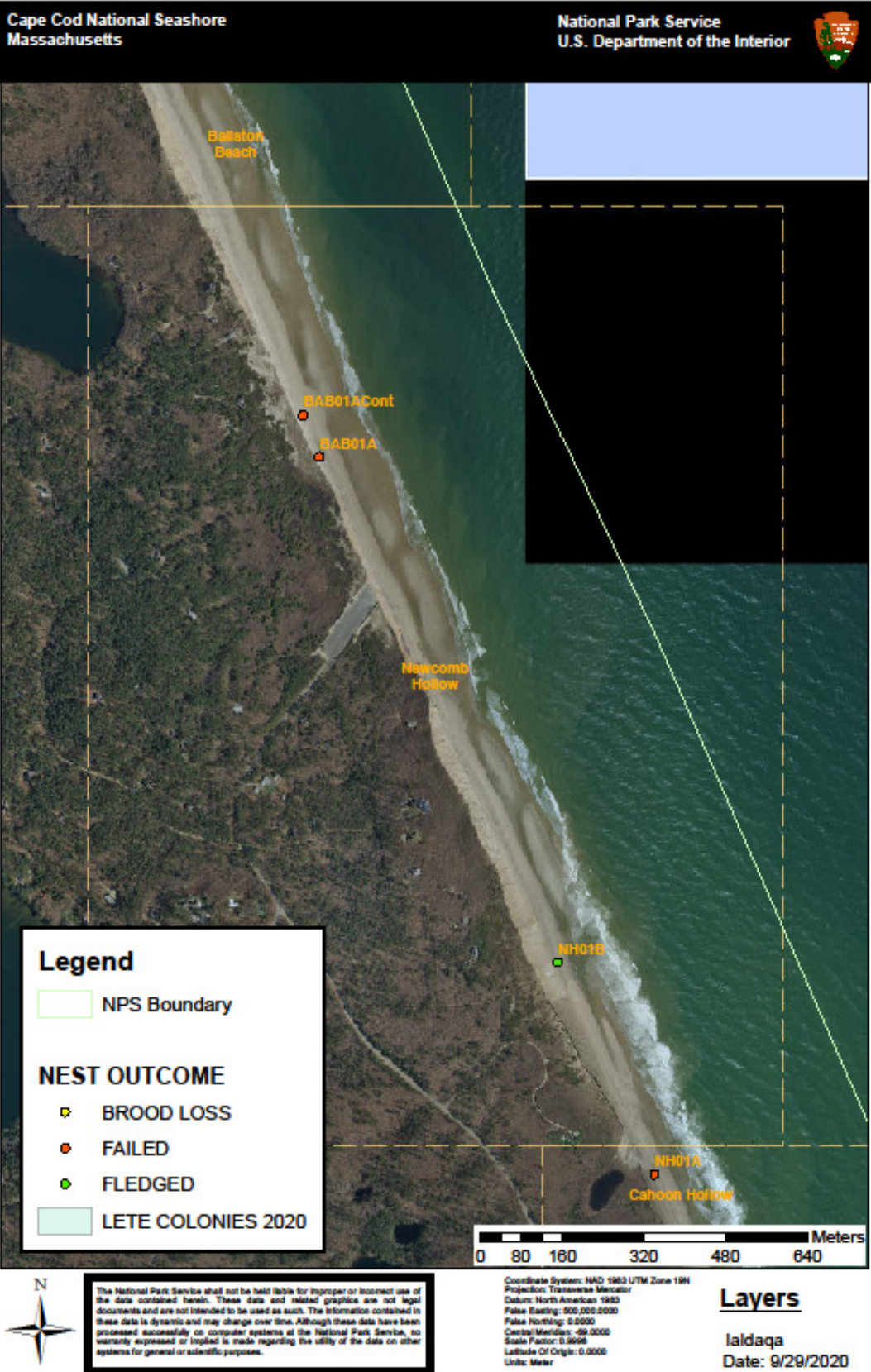


Figure A-10. South District: Newcomb Hollow.

South District: White Crest

No map generated due to no nesting activity.

North District

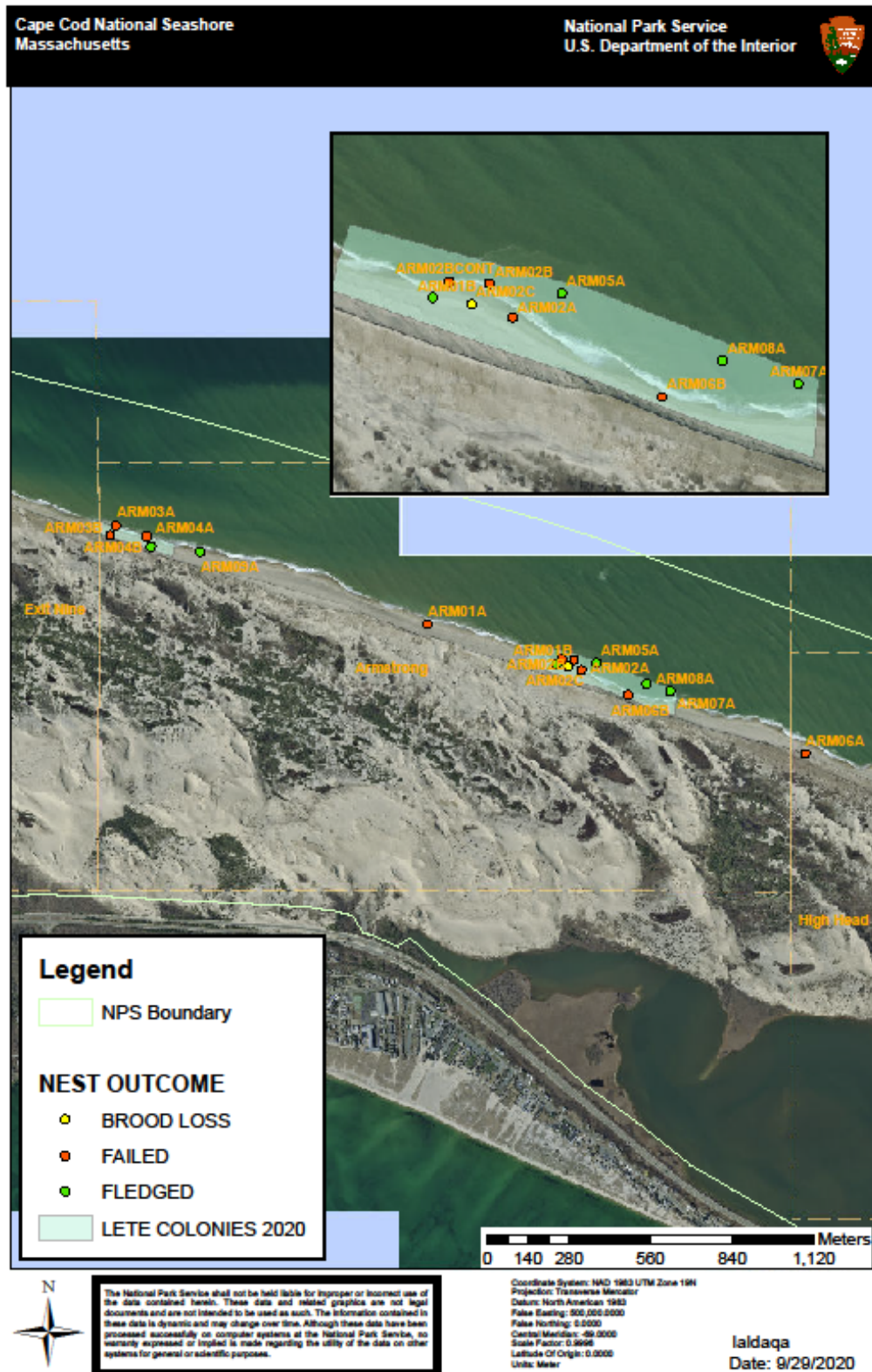


Figure A-11. North District: Armstrong.



Figure A-12. North District: Coast Guard Truro.

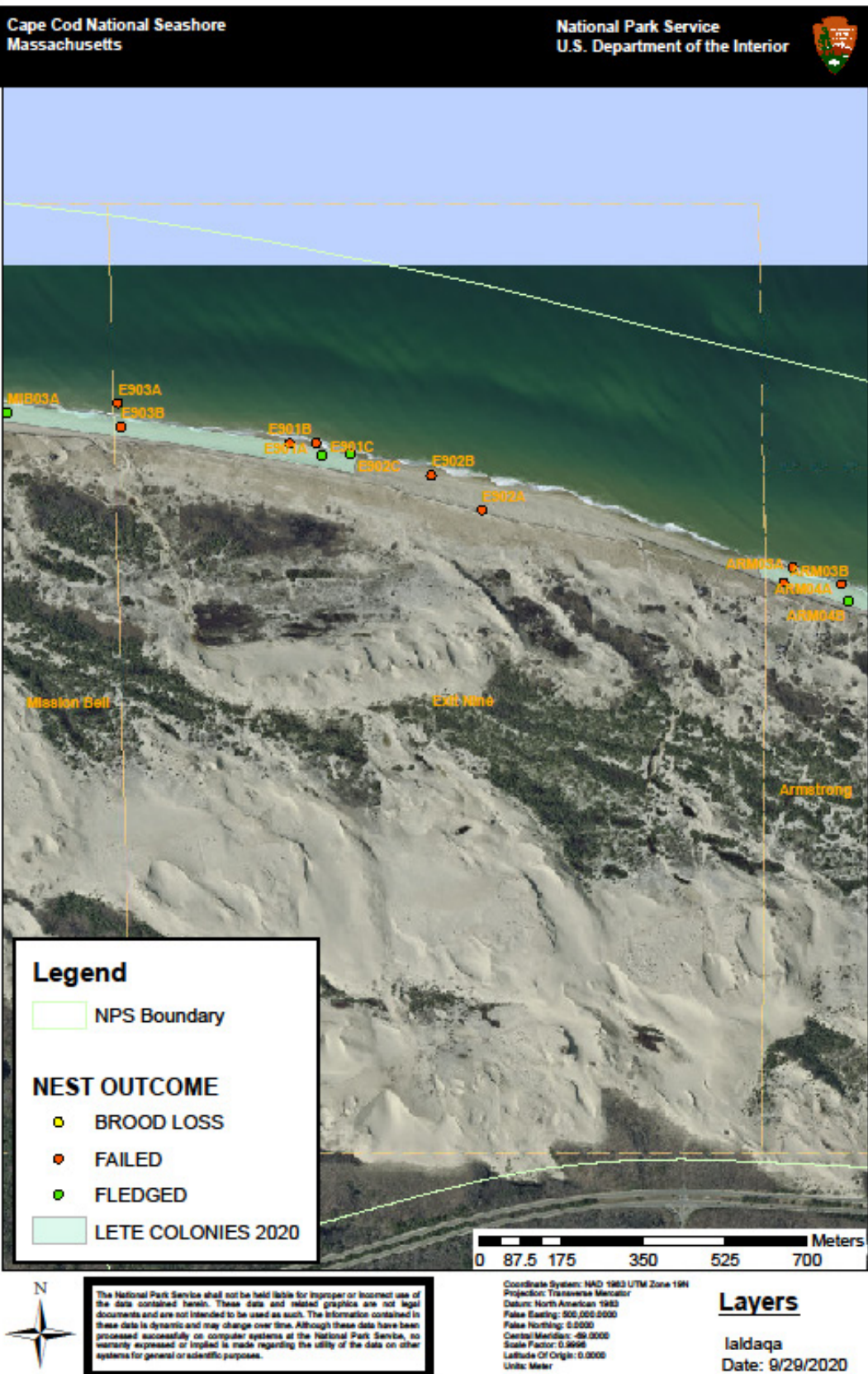


Figure A-13. North District: Exit 9.



Figure A-14. North District: Hatches Harbor.



Figure A-15. North District: Herring Cove.

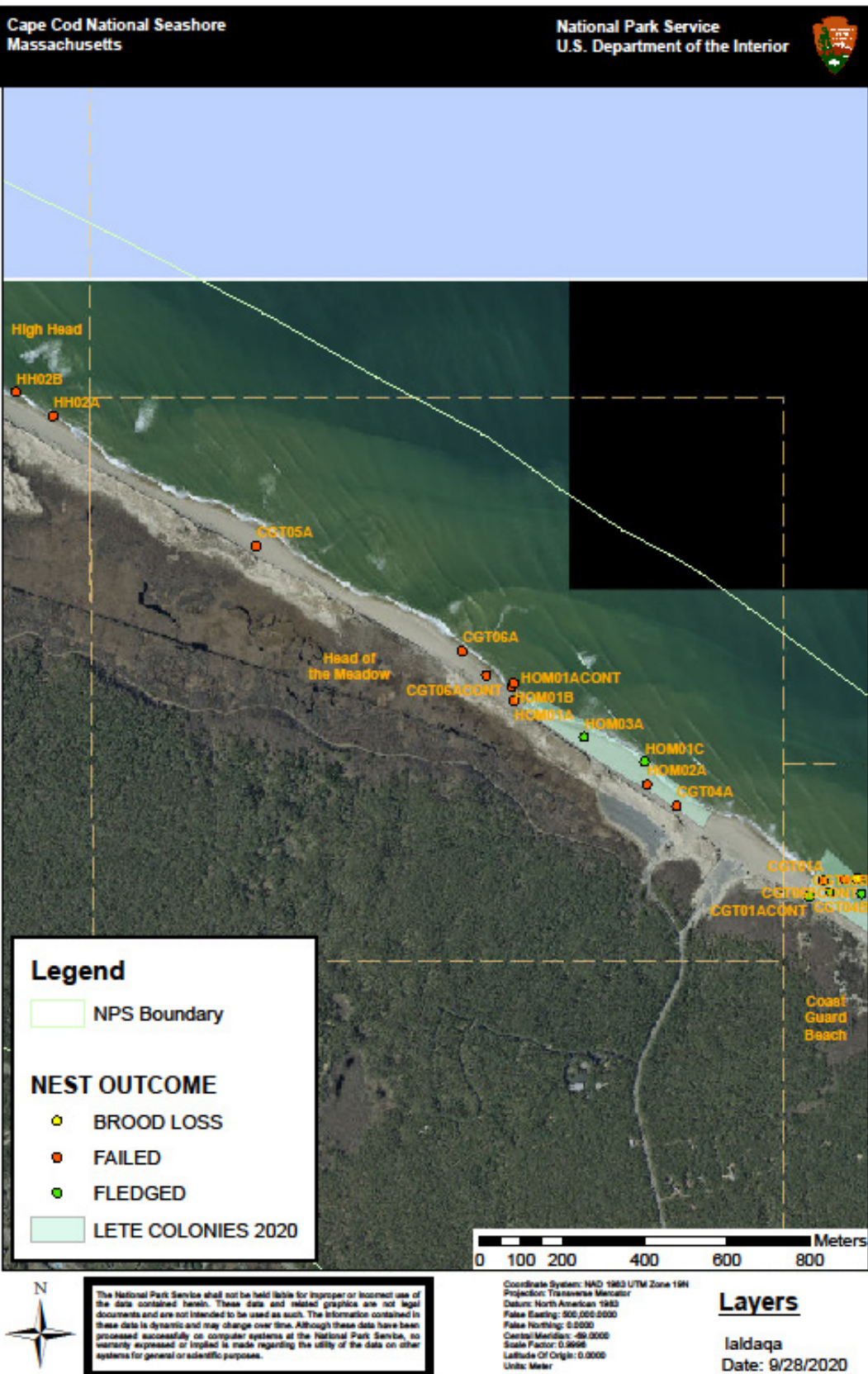


Figure A-16. North District: Head of the Meadow.

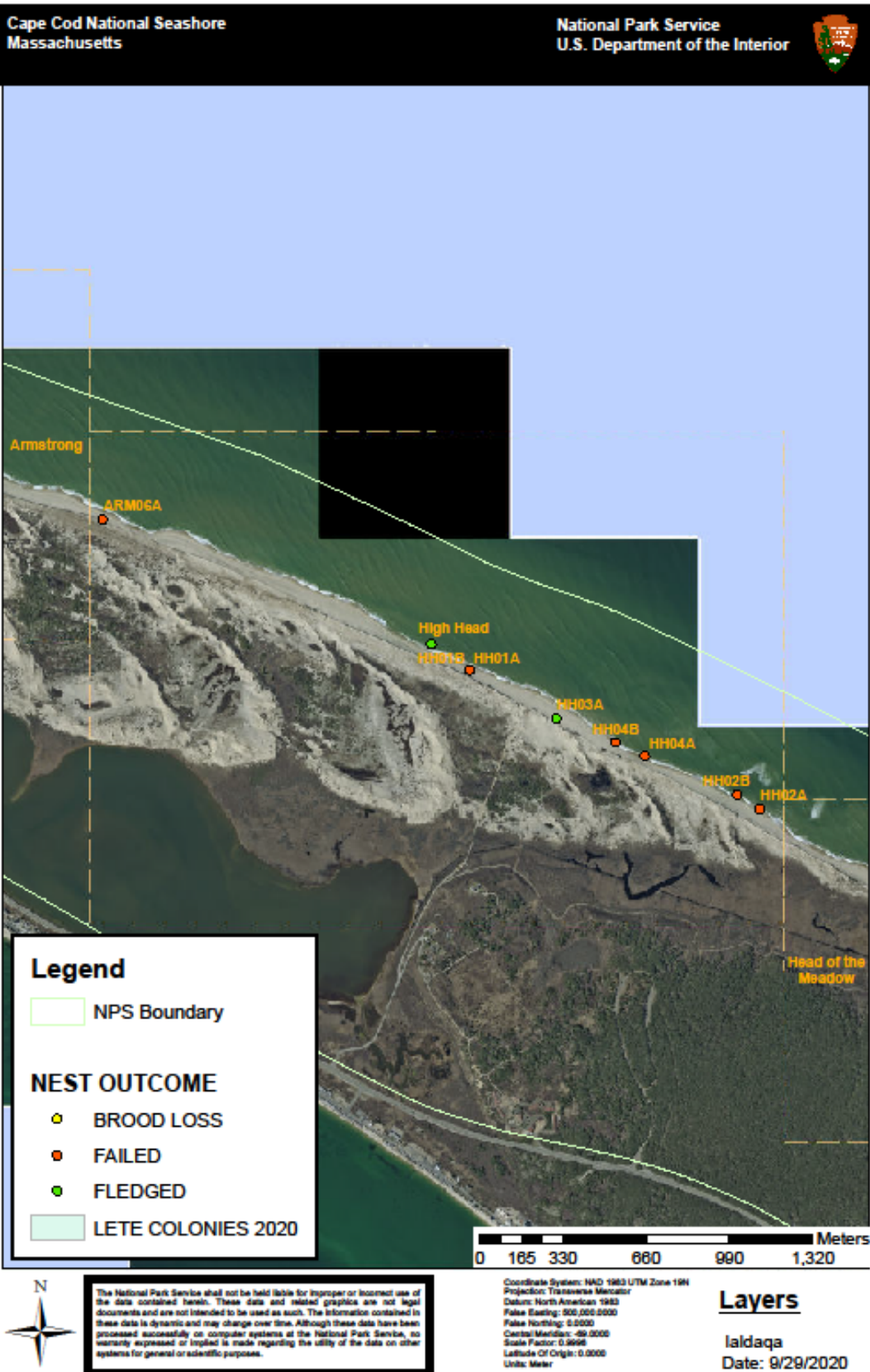


Figure A-17. North District: High Head.



Figure A-18. North District: Longnook.

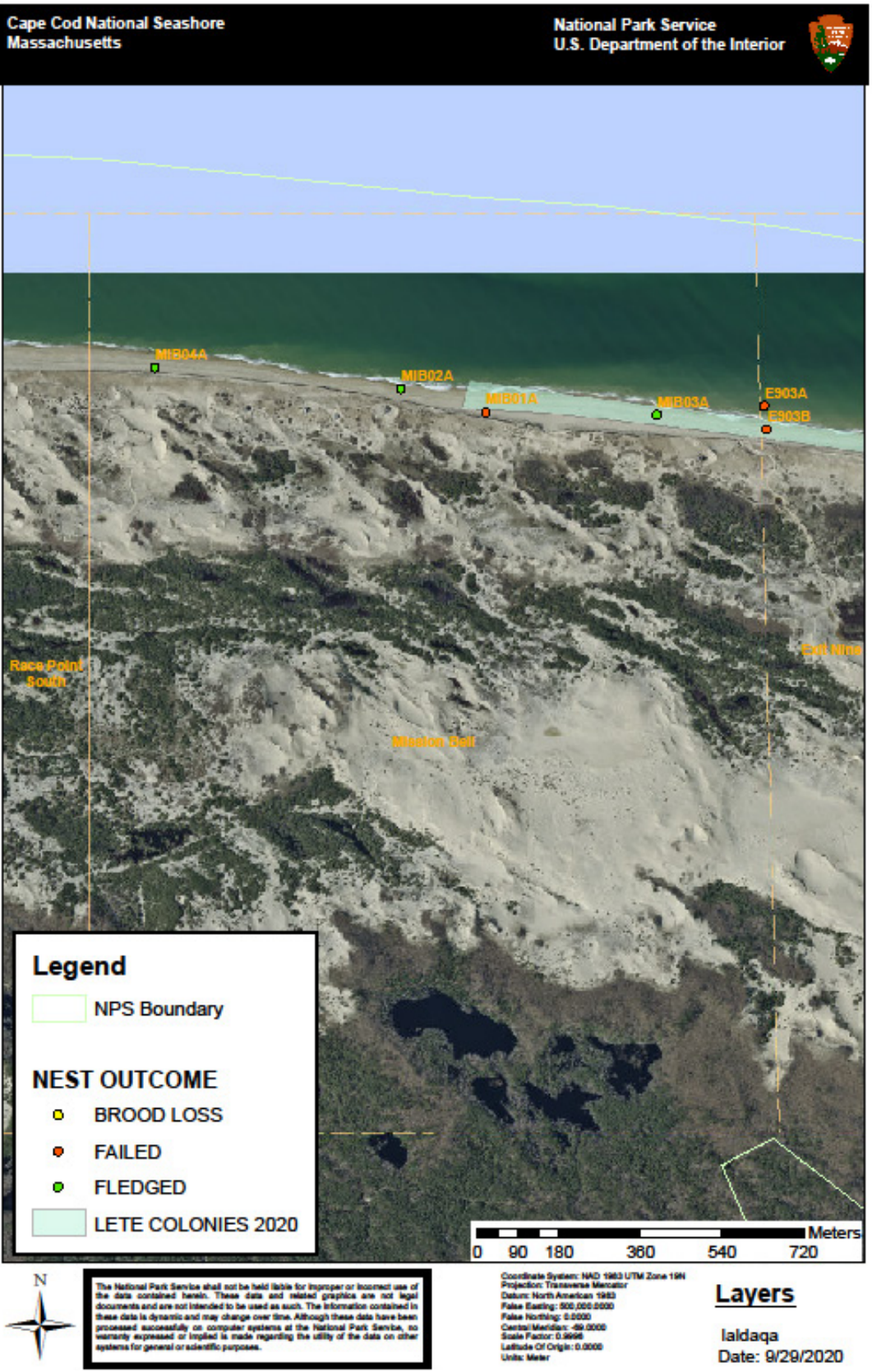


Figure A-19. North District: Mission Bell.



Figure A-20. North District: Race Point.

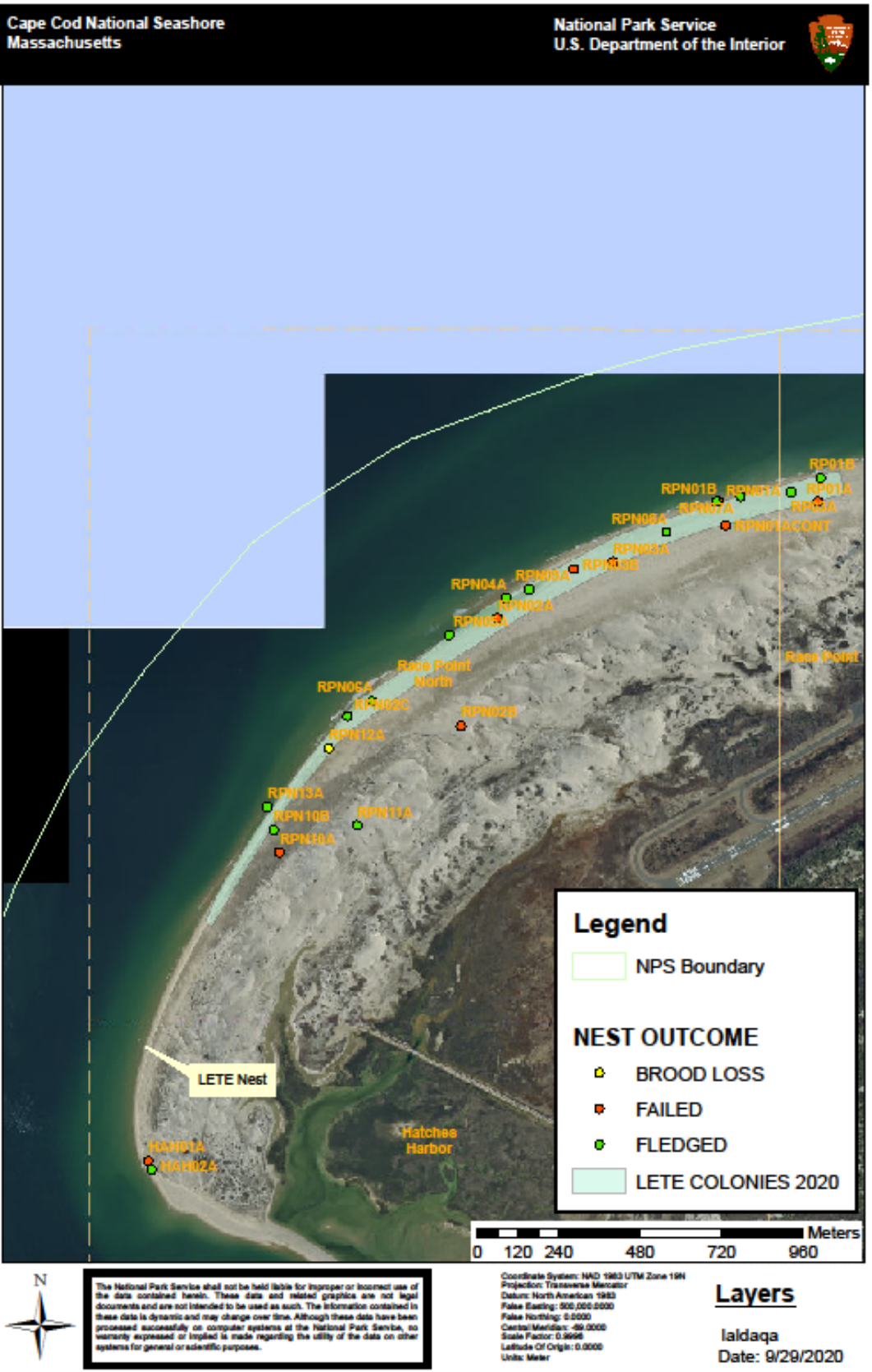


Figure A-21. North District: Race Point North.

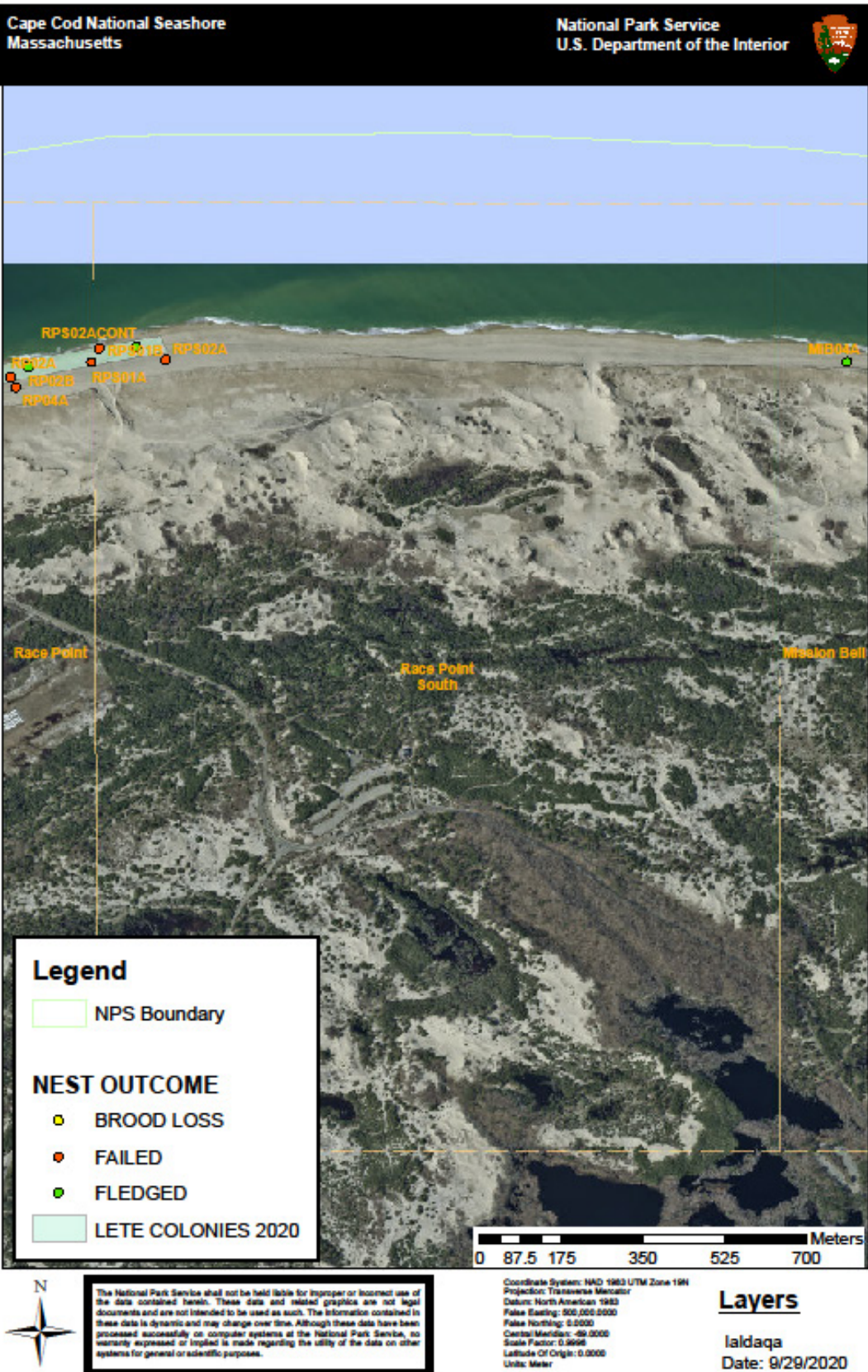


Figure A-22. North District: Race Point South.

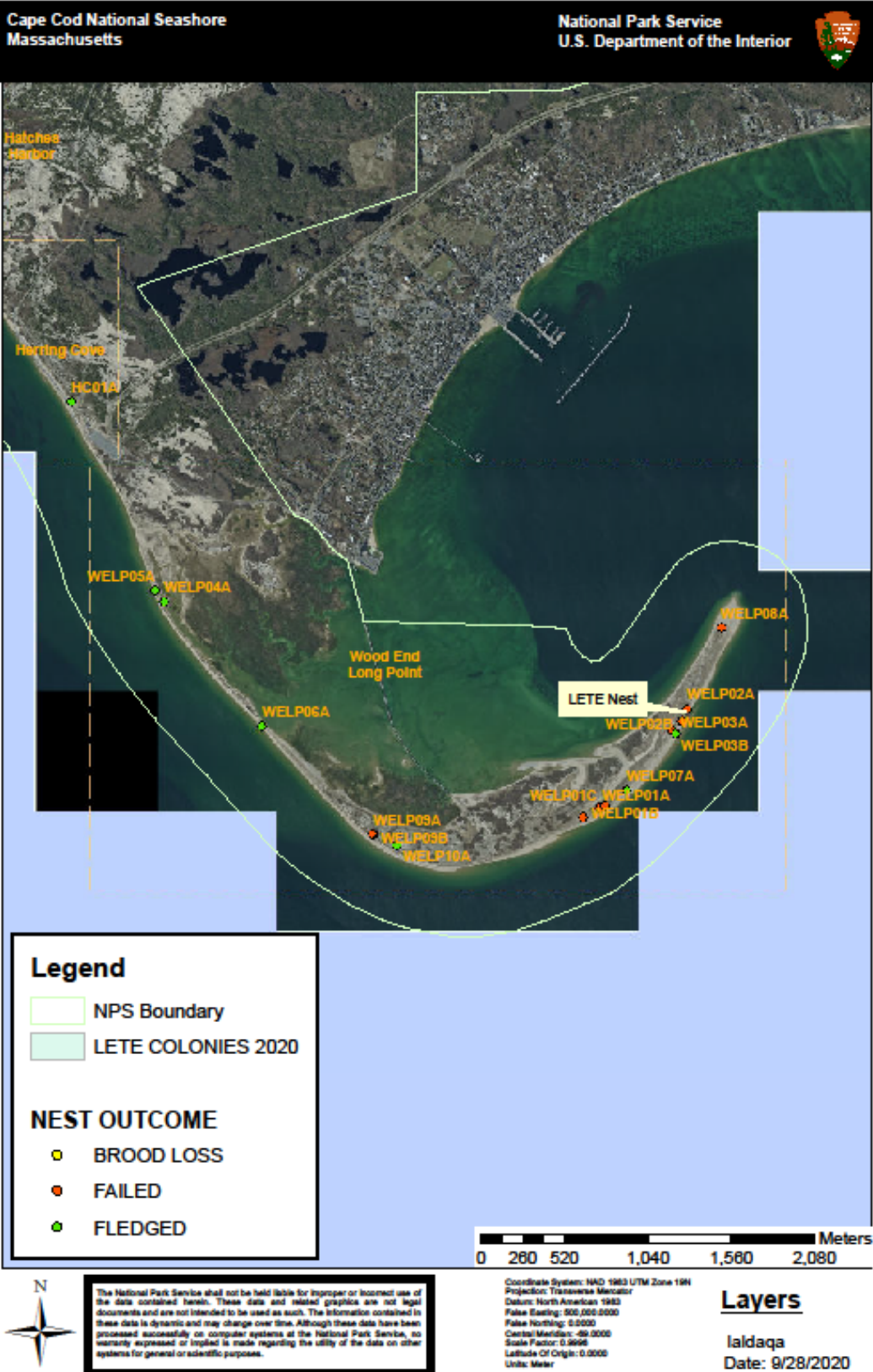


Figure A-23. North District: Wood End/ Long Point.

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NPS 609/188392, May 2023

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