



Cape Cod National Seashore 2022 Shorebird Monitoring and Management Report



Piping plover chick at Cape Cod National Seashore, Massachusetts.

NPS / HOLLY FISHER

Cape Cod National Seashore 2022 Shorebird Monitoring and Management Report

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Abstract

Cape Cod National Seashore (CACO) plays a crucial role in the conservation of federally and state-listed shorebird species, including the piping plover (*Charadrius melodus*), least tern (*Sternula antillarum*), American oystercatcher (*Haematopus palliatus*), and common tern (*Sterna hirundo*). Monitoring efforts extended along over 50 miles of coastline from Provincetown to Eastham, Massachusetts, focusing on nesting and brood-rearing behaviors.

For the piping plover in the 2022 field season, 117 breeding pairs were recorded, resulting in the laying of 171 nests with 591 eggs; 92 nests successfully hatched, with 189 chicks fledging and an average productivity of 1.62 chicks per pair. Nest losses were mainly attributed to predation and environmental factors, prompting the installation of predator exclosures around 76 nests. The least tern saw 195 breeding pairs with 49 chicks fledged, resulting in a low productivity of 0.25 chicks per pair, primarily affected by predation and human disturbances. Observations of three American oystercatcher pairs revealed a productivity rate of 0.0, caused by predation and abandonment. One common tern pair successfully hatched two chicks, but they were not observed post-hatching, also yielding a productivity of 0.0.

Additional focus on staging and migrating shorebirds revealed the presence of various species, including roseate terns, red knots, and semipalmated sandpipers, with observations noted from mid-July through October. This report describes the monitoring efforts implemented by Cape Cod National Seashore to assess the status of shorebird populations. Data collected on shorebird breeding numbers as well as the status of migrating birds are included. In addition, the report describes the management approaches implemented by Cape Cod National Seashore to protect at-risk species while continuing to provide beach access for visitors.

List of Terms

Brood: A family unit of adults and chicks.

Buffer: The distance between the shorebird activity and the fence line. Established to reduce the amount of disturbance to the birds as they breed, feed, and shelter.

Depredation or Predation: The loss of egg(s), chick(s), or adults due to predators.

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.

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 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. Productivity in this report is measured as the number of chicks fledged divided by the number of breeding pairs within the Park.

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

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

Suitable Habitat: Areas that endangered and threatened species depend on, which 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-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.

Unviable: An egg that failed to hatch, likely undeveloped.

Executive Summary

Cape Cod National Seashore (CACO) manages the protection of federal and state listed beach-nesting and migratory shorebirds, including the piping plover (*Charadrius melodus*), least tern (*Sternula antillarum*), American oystercatcher (*Haematopus palliatus*), and common tern (*Sterna hirundo*). Shorebird and seabird nesting and brood-rearing behaviors were monitored in 2022 on over 50 miles of coastline from Provincetown to Eastham, Massachusetts.

Piping Plover

- 117 breeding pairs were monitored throughout the season.
- 171 nests were laid; 591 eggs were laid. A total of 92 nests hatched.
- Nest loss was primarily due to depredation, followed by environmental factors.
- Predator exclosures were installed around 76 nests.
- 189 chicks fledged; 73 pairs successfully fledged at least one chick, 19 pairs had full brood loss, 32 pairs failed to hatch any chicks.
- Productivity equaled 1.62 chicks fledged per pair.

Least Tern

- 195 breeding pairs were monitored throughout the season.
- Nest loss was primarily due to depredation, overwash, and human disturbance.
- 49 chicks fledged.
- Productivity equaled 0.25 chicks fledged per pair.

American Oystercatcher

- 3 breeding pairs were monitored throughout the season.
- Nest loss was due to predation and abandonment.
- Productivity was 0.0.

Common Tern

- 1 pair of common terns was monitored throughout the season.
- The nest hatched two chicks but they were not seen after hatching.
- Productivity was 0.0.

Staging and Migrating Shorebirds

- Mixed-species flocks consisting of roseate terns (*Sterna dougallii*) and common terns, were observed throughout the park mid-July through September. CACO staff resighted

approximately 145 color banded terns to contribute to data collection on migratory/staging ground importance.

- Mixed groups of migratory shorebirds 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.
- Uncommon sightings include black skimmer, arctic tern, whimbrel, little gull, lesser black backed hull, black legged kittiwake, golden plover, and back tern.

Human Disturbance

- Shorebird staff documented violations regarding human disturbance on nesting territories, nests, and chicks. Data is collected anecdotally during site visits.
 - 48 vehicle violations; including vehicles driving in closed areas in the ORV Corridor, vehicles driving into and dismantling symbolic fencing, and fat tire bikes in closed areas.
 - Over 500 pet violations; including pets in closed areas, pets off leash, and pets harassing wildlife.
 - 54 pedestrian violations; mainly including walking through closed areas.
 - 13 natural resource violations; including finding unextinguished fires on the beach in the morning, finding firework remnants, and making sculptures in closed areas.
 - 13 instances of drones or kites flying in closed areas.
 - 13 instances of symbolic fencing being tampered with (non-vehicle related).

Acknowledgments

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Introduction

Cape Cod National Seashore (CACO or “the park”) provides approximately 50 miles of prime nesting and foraging habitat for beach-nesting birds. The same beaches also provide recreational opportunities for millions of human visitors every year. Some bird species are listed by federal and state agencies as endangered, threatened, or of special concern, such as piping plover, least tern, American oystercatcher, and common tern. Additional threatened and endangered species use CACO beaches as a staging ground to forage and build reserves during migratory stopovers including roseate terns, common terns, and red knots. CACO manages the beaches with the goal of increasing shorebird productivity while providing for visitor access and recreation.

Management practices include (1) 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 (2) 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 federal, private, and town-owned lands with varying beach management and natural resource protection practices. To achieve continuity in beach regulations and make signage and management less confusing to the 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: piping plover, least tern, and American oystercatcher. It also summarizes observations of other species of terns and shorebirds that use CACO as a staging ground during their annual migration.

Shorebird Protection

General Nest Habitat Protection

As required by the Endangered Species Act and CACO Shorebird Environmental Assessment (EA), suitable habitat for breeding piping plovers must be protected prior to the breeding season. The goal of habitat protection is to minimize habitat disturbance in potential breeding areas and enable birds to establish territories and nests in their preferred habitat. 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 “Area Closed: bird use area” to prohibit entry) was installed around these sites before nesting activity was observed. 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).

Methods

General Monitoring Methods

CACO follows the monitoring and protection methods outlined in the United States Fish & Wildlife Service (USFWS) *Piping Plover Atlantic Coast Population Revised Recovery Plan* (USFWS 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). To inform decisions regarding daily operations that affect shorebird management and protection, CACO staff also consult the 2018 Shorebird Management Plan, 2022 Shorebird Management SOP and 2021 Biological Opinion.

Shorebirds and migratory birds were monitored in 25 survey units at CACO from Provincetown to Eastham (Figure 1). Survey units were established for logistical purposes and do not necessarily represent ecologically distinct areas.

Monitoring began in early April. Field staff searched the beaches daily for signs of shorebird nesting activity. To minimize disturbance, observations were made through binoculars or scopes from a distance ranging from 5 to 50 meters. Monitoring methods included searching for territory, nests, chicks, and fledglings outside the symbolic fencing and by walkthroughs of the habitat. Nest 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). Chicks were monitored for age, behavior, and location until fledged. 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 the off-road vehicle (ORV) corridor were monitored at least daily, and sometimes twice a day. In accordance with the Shorebird Management Plan, recreational restrictions were lifted when broods were determined to be fledged or were considered lost after not being observed for five consecutive field days.

Monitoring of breeding shorebirds continued through August and early September, while monitoring of staging and migratory birds went through October. Staging and migratory birds were monitored when flocks greater than 100 were observed and required management, or when staffing and time allowed for observations of resighted bands. Nurseries were also monitored and protected from disturbance and monitored until birds left for migration. In accordance with the Shorebird Management Plan, recreational restrictions were lifted when nurseries and/or staging terns were no longer in use of the area for several observation days. Symbolic fencing was adjusted in response to breeding or staging behaviors and removed when birds were no longer using the area.

Species-Specific Methods–Piping Plover

Monitoring Methods

Monitoring methods include observations from afar and careful walkthroughs of the habitat to locate scrapes, nests, and chicks. Potential breeding pairs are monitored throughout the season. Once a nest was found, the nest was monitored every one to five days (depending on management complexity of site) until hatch. Nest 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). If a nest hatched, chicks were then monitored until fledged. Brood monitoring is critical for understanding the fate of plover chicks including tracking chick movement, identifying timing/causes of chick loss, and observing initial flights. Chick loss was documented, when possible. Piping plover chicks were considered fledged when they were observed in sustained flight for at least 15 meters, irrespective of age (USFWS, 2015). In accordance with the Shorebird Management Plan, recreational restrictions were lifted when broods were determined to be fledged or considered lost after not being observed for five consecutive field days.

Predator Management

Predator management for piping plovers was completed by using exclosures. Exclosures are designed to protect nests from predatory birds and mammals (crows, coyotes, foxes, etc.). Exclosures are circular metal wire fences, with two-inch wide and four-inch-high openings, five feet in height and ten 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 1/4 inch, secured to the metal wire.

To minimize nest abandonment and adult mortality, exclosures are installed after nest completion, where vegetation does not hinder the bird's detection of approaching threats and where the risk of overwash by waves and sand is low (Darrah, 2017). Occasionally, exclosures were installed prior to nest completion if in an area of high predator activity and adults have been observed actively incubating the nest.

Initial exclosure usage was guided using Piperex; a decision support tool for exclosure use which analyzes historical site-specific data to determine probability of hatch success using exclosures at sites. The frequency of exclosing was then adjusted throughout the season based on nest success at each site, predator activity, and staffing.

Flexible Management

Flexible management was implemented once in 2022 at Race Point South. Flexible management reports are sent to USFWS following each subsequent field season. In addition to flexible management use, CACO implemented drive throughs and high tide closures to allow continued recreation and access while providing protection for nests.

Species-Specific Methods–Least and Common Terns

Least terns were monitored typically from outside the symbolic fencing by conducting incubating adults or total adult counts. Incubating counts estimate number of terns incubating an active nest (as determined by observation of actively sitting on a presumed nest). High counts estimated total

number of adults in the area, including those flying overhead. Walk-throughs of the colony were conducted when needed for a census or to inform management. Chicks were monitored from hatch to fledge at least twice a week. Least terns were considered fledged when they were observed in sustained flight for at least 15 meters.

Nests or chicks present within or in proximity to the ORV beach driving corridor were monitored daily when possible.

Nurseries were monitored while surveying for breeding and migratory birds. Symbolic fencing remained in place if specific sections of beach were regularly used by least terns and their recently fledged young.

Species-Specific Methods—American Oystercatchers

Monitoring for American Oystercatcher nests and chicks is similar to methods for piping plovers. Due to the small population size at CACO, American Oystercatcher nests and chicks were often monitored two to four times a week from hatch until fledge. American Oystercatchers were considered fledged when they were observed in sustained flight for at least 100 meters.

Post Breeding/Staging Shorebirds

Monitoring for staging and migratory birds included estimating flock sizes, species composition, age and at times resighting bands. Since flocks greater than 100 staging birds require signage and potential recreational management, areas that were historic staging areas and/or heavily used by recreationalists were monitored more regularly. Migratory and staging birds were monitored using binoculars and scopes from 5 to 50 meters to reduce risk of disturbance.

Data Collection and Quality Control

Data were collected using ArcGIS Field Maps using smartphones and tablets. Field crews also documented all nest checks in writing on nest cards. Data collected using field maps allowed for improved communication across staff as those data sync with ArcGIS Online allowing staff with access to those layers to see the status of nests and breeding colonies. Data collected using Field Maps are downloaded as an Excel spread sheet at the end of the season and those data are compared against data recorded on nest cards.

In addition, field data for piping plovers and least terns are also recorded in a state-managed database system used to track the status of these species across the Commonwealth of Massachusetts. This system is also used by the US Fish and Wildlife Service to gather data and information on the status of piping plovers in Massachusetts.

Prior to submitting or sharing, all data must be reviewed for quality and certified. Data checking is a crucial process that ensures the accuracy, quality, and reliability of data before it is analyzed or used for decision-making. This process typically involves several key steps, including validation, verification, data cleaning and certification. Validation checks the data against predefined rules or formats to ensure it adheres to specified criteria, such as data type and range. Verification involves cross-referencing the data with original sources to confirm its correctness, while data cleaning entails

identifying and correcting errors or inconsistencies, such as duplicates or missing values. Finally, data certification confirms that the data set has gone through all the required QA/QC steps and is ready for publication. The tasks of verification, validation and certification are divided among different staff which improves data integrity by allowing multiple individuals familiar with the data to conduct separate reviews. Ultimately, thorough data checking helps to maintain high data integrity and supports informed decision-making based on reliable information.

Results

Piping Plover

Nesting

The first piping plovers were observed at Coast Guard Eastham on 14 March. They were present at most beaches by early April and continued to arrive until mid-June. Scraping was observed as early as 20 March at Coast Guard Eastham. 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. CACO staff observed a total of 117 breeding pairs in 2022 (Table 1). Most plovers departed by late August, although some remained through October.

The first nest was found on 23 April at Duck Harbor. Nests with eggs were present from 23 April to 29 July. Peak nesting occurred early to mid-June, with a high of 97 active nests at one time on 4 June (Figure 2). Hatch dates ranged from 31 May to 29 July (Figure 2). The first nest to hatch was at Duck Harbor and last nest to hatch was at Armstrong. The average incubation time for nests was 26 days, calculated from the date the first egg in the clutch hatched. Most successful piping plover nests that were found hatched between 22 to 33 days in 2022. One nest at Race Point Beach took 37 days to hatch.

Nesting results are summarized in Table 1. A total of 171 nests were found in 2022. Of the 171 nests that were found, 79 nests (46%) were lost and 92 nests (54%) hatched. Re-nests accounted for 47% (55 nests) of the total nests laid (Table 2). Hatch success was higher for first attempts than renests (60% vs. 47%). Exit 9 had the highest hatch rate in 2022 (100%).

Typically, almost all nests are located before clutch completion, and thus hatch windows could be predicted with high accuracy. In 2022, 30 nests were located after completion (18% of total nests laid) due to the large number of nesting pairs in the park. Locating nests or broods after completion makes predicting hatch dates, fledge dates, and informing management decisions much more difficult. The 171 nests that were found equated to 591 eggs laid. A total of 305 eggs hatched chicks; this was the highest number of eggs hatched in 20 years of monitoring at CACO.

Table 1. Summary of piping plover nesting sites in 2022 at Cape Cod National Seashore.

Site	Total Pairs	Total Nests	Total Eggs Laid	Total Nests Hatched	Total Eggs Hatched	Total Chicks Fledged	Nest Success ^A	Hatch Rate ^B	Fledge Rate ^C	Productivity ^D
Wood End/Long Point	15	20	69	10	34	12	0.50	0.49	0.35	0.80
Herring Cove	2	2	7	2	5	5	1.00	0.71	1.00	2.50
Hatches Harbor	4	5	20	4	16	6	0.80	0.80	0.38	1.50
Race Point North	11	20	71	9	29	14	0.45	0.41	0.48	1.27
Race Point	4	7	26	4	14	10	0.57	0.54	0.71	2.50
Race Point South	2	2	7	1	4	4	0.50	0.57	1.00	2.00
Mission Bell	5	6	21	4	15	11	0.67	0.71	0.73	2.20
Exit 9	3	3	11	3	11	9	1.00	1.00	0.82	3.00
Armstrong	11	16	59	11	37	25	0.69	0.63	0.68	2.27
High Head	4	4	16	4	15	13	1.00	0.94	0.87	3.25
Head of the Meadow	4	8	20	3	9	5	0.38	0.45	0.56	1.25
Coast Guard Truro	7	13	43	7	20	8	0.54	0.47	0.40	1.14
Longnook	2	4	15	2	4	4	0.50	0.27	1.00	2.00
Ballston Beach	2	4	14	1	2	2	0.25	0.14	1.00	1.00
Newcomb Hollow	3	5	13	1	2	2	0.20	0.15	1.00	0.67
Cahoon Hollow	1	1	4	0	0	0	0.00	0.00	0.00	0.00
White Crest	0	0	0	0	0	0	0.00	0.00	0.00	0.00
LeCount Hollow	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Marconi Station	5	7	28	4	14	13	0.57	0.50	0.93	2.60
Marconi Beach	1	1	4	0	0	0	0.00	0.00	0.00	0.00

^A Nest Success = Total Nests Hatched / Total Nests.

^B Hatch Rate = Total Eggs Hatched / Total Eggs Laid.

^C Fledge Rate = Total Chicks Fledged / Total Eggs Hatched.

^D Productivity = Total Chicks Fledged / Total Breeding Pairs.

Table 1 (continued). Summary of piping plover nesting sites in 2022 at Cape Cod National Seashore.

Site	Total Pairs	Total Nests	Total Eggs Laid	Total Nests Hatched	Total Eggs Hatched	Total Chicks Fledged	Nest Success ^A	Hatch Rate ^B	Fledge Rate ^C	Productivity ^D
Nauset Light	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Coast Guard Eastham	8	12	39	5	17	11	0.42	0.44	0.65	1.38
Bound Brook	2	3	10	2	7	6	0.67	0.70	0.86	3.00
Duck Harbor	6	6	20	5	17	8	0.83	0.85	0.47	1.33
Great Island	7	12	38	4	14	14	0.33	0.37	1.00	2.00
Jeremy Point	8	10	36	6	19	7	0.60	0.53	0.37	0.88
Parkwide Totals	117	171	591	92	305	189	0.54	0.52	0.62	1.62

^A Nest Success = Total Nests Hatched / Total Nests.

^B Hatch Rate = Total Eggs Hatched / Total Eggs Laid.

^C Fledge Rate = Total Chicks Fledged / Total Eggs Hatched.

^D Productivity = Total Chicks Fledged / Total Breeding Pairs.

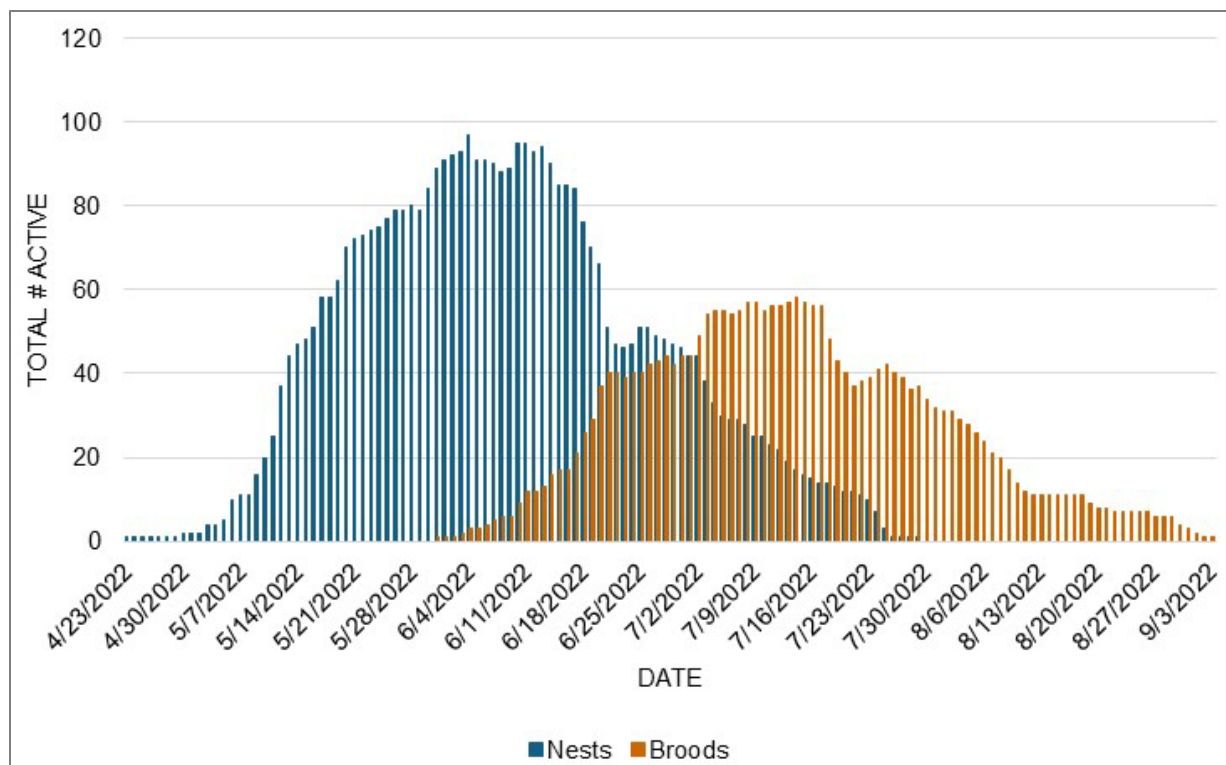


Figure 2. Number of active piping plover nests and broods by date at Cape Cod National Seashore in 2022.

NPS / CACO

Table 2. Summary of piping plover nesting parameters by year from 1993 to 2022 at Cape Cod National Seashore.

Year	Pairs	Nests	Re-nests	Total Eggs Laid	Total Eggs Hatched	Total Chicks Fledged	Renest Rate ^A	Mean Clutch Size ^B	Hatch Rate ^C	Fledge Rate ^D	Egg Success ^E	Productivity ^F
1993	60	75	15	269	179	124	0.20	3.59	0.67	0.69	0.46	2.07
1994	72	105	33	338	226	178	0.31	3.22	0.67	0.79	0.53	2.47
1995	83	114	31	395	242	147	0.27	3.46	0.61	0.61	0.37	1.77
1996	77	116	39	389	148	68	0.34	3.35	0.38	0.46	0.17	0.88
1997	67	107	40	266	126	104	0.37	2.49	0.47	0.83	0.39	1.55
1998	61	No data	No data	No data	No data	110	No data	No data	No data	No data	No data	1.80
1999	72	82	10	289	225	123	0.12	3.52	0.78	0.55	0.43	1.71
2000	64	121	57	415	154	73	0.47	3.43	0.37	0.47	0.18	1.14
2001	76	88	12	317	223	155	0.14	3.60	0.70	0.70	0.49	2.04
2002	97	141	44	428	175	88	0.31	3.04	0.41	0.50	0.21	0.91
2003	84	121	37	450	189	130	0.31	3.72	0.42	0.69	0.29	1.55
2004	85.5	115	30	425	220	124	0.26	3.70	0.52	0.56	0.29	1.45
2005	77	118	41	378	163	87	0.35	3.20	0.43	0.53	0.23	1.13
2006	74	96	22	336	233	122	0.23	3.50	0.69	0.52	0.36	1.65
2007	85	113	22	368	233	143	0.19	3.26	0.63	0.61	0.39	1.68
2008	86	109	22	386	244	158	0.20	3.54	0.63	0.65	0.41	1.84
2009	87	109	25	367	190	60	0.23	3.37	0.52	0.32	0.16	0.69
2010	85	115	30	386	236	137	0.26	3.36	0.61	0.58	0.35	1.61

^A Renest Rate = Renests / Nests.

^B Mean Clutch Size = Total Eggs Laid / Nests.

^C Hatch Rate = Total Eggs Hatched / Total Eggs Laid.

^D Fledge Rate = Total Chicks Fledged / Total Eggs Hatched.

^E Egg Success = Total Chick Fledged / Total Eggs Laid.

^F Productivity = Total Chicks Fledged / Total Breeding Pairs.

Table 2 (continued). Summary of piping plover nesting parameters by year from 1993 to 2022 at Cape Cod National Seashore.

Year	Pairs	Nests	Re-nests	Total Eggs Laid	Total Eggs Hatched	Total Chicks Fledged	Renest Rate ^A	Mean Clutch Size ^B	Hatch Rate ^C	Fledge Rate ^D	Egg Success ^E	Productivity ^F
2011	82	110	47	374	207	90	0.43	3.40	0.55	0.43	0.24	1.10
2012	99	212	108	636	72	30	0.51	3.00	0.11	0.42	0.05	0.30
2013	85	173	89	532	100	46	0.51	3.08	0.19	0.46	0.09	0.54
2014	68	121	54	375	129	52	0.45	3.10	0.34	0.40	0.14	0.76
2015	73	113	44	388	143	64	0.39	3.43	0.37	0.45	0.16	0.88
2016	66	95	29	344	169	124	0.31	3.62	0.49	0.73	0.36	1.88
2017	66	114	48	386	175	119	0.42	3.39	0.45	0.68	0.31	1.80
2018	98	180	82	573	221	139	0.46	3.18	0.39	0.63	0.24	1.42
2019	88	151	64	507	254	151	0.42	3.36	0.50	0.59	0.30	1.72
2020	92	149	58	460	238	171	0.39	3.09	0.52	0.72	0.37	1.86
2021	113	207	95	647	285	145	0.46	3.13	0.44	0.51	0.22	1.28
2022	117	171	55	591	305	189	0.32	3.46	0.52	0.62	0.32	1.62

^A Renest Rate = Renests / Nests.

^B Mean Clutch Size = Total Eggs Laid / Nests.

^C Hatch Rate = Total Eggs Hatched / Total Eggs Laid.

^D Fledge Rate = Total Chicks Fledged / Total Eggs Hatched.

^E Egg Success = Total Chick Fledged / Total Eggs Laid.

^F Productivity = Total Chicks Fledged / Total Breeding Pairs.

Nest Loss

Out of the 171 nests laid, 79 nests failed. The main cause of nest failure was depredation with 43 nests lost, followed by overwash (42), unknown (11), and abandonment (8) (Tables 3–5). The number of nests depredated decreased from 2021 and were mostly from coyote (25%) versus the dominant predator in 2021, crow (30%). In 20 years of monitoring, depredation continues to be the largest cause of nest loss for piping plover nests.

Table 3. Summary of piping plover nests lost to abandonment from 2003 to 2022 at Cape Cod National Seashore. In 2003 and 2007–2013 nests lost to abandonment were not further broken down.

Year	Abandonment: Total	Adult Mortality	Human Disturbance	Predator Disturbance	Unknown
2003	15	3	No data	No data	No data
2004	13	3	0	0	10
2005	11	0	0	0	11
2006	4	1	0	0	3
2007	15	2	No data	No data	No data
2008	8	4	No data	No data	No data
2009	8	0	No data	No data	No data
2010	2	0	No data	No data	No data
2011	9	0	No data	No data	No data
2012	9	0	No data	No data	No data
2013	7	0	No data	No data	No data
2014	5	0	0	0	5
2015	9	3	0	1	5
2016	4	0	3	0	1
2017	6	0	0	0	6
2018	3	0	0	0	3
2019	9	0	1	4	4
2020	11	0	0	3	8
2021	11	0	0	0	11
2022	8	1	1	3	3

Table 4. Summary of piping plover nest loss, and cause of nest loss from 2003 to 2022 at Cape Cod National Seashore. In 2010, 1 nest was lost to multiple causes: 2 eggs to crow and 2 eggs to overwash. In both 2012 and 2018 nests lost due to “other” were trampled by gulls. In 2022, two nests were lost to multiple causes: first nest had 2 eggs lost to overwash and 1 egg to coyote, second nest had 1 egg lost to unknown reasons and 2 eggs to coyote.

Year	Abandonment: Total	Failure to Hatch: Unviable	Mortality of Both Adults	Multiple Causes	Other	Overwash/ Flooding	Predation: Total	Run Over	Sanded Over	Substrate Collapse	Trampling	Unknown Cause	Vandalism
2003	15	0	0	0	0	9	38	0	5	0	0	0	0
2004	13	0	0	0	0	15	27	0	0	0	0	1	0
2005	11	1	0	0	0	20	25	0	11	1	0	0	0
2006	4	0	0	0	0	3	11	0	5	0	0	3	0
2007	15	0	0	0	0	18	10	0	3	0	0	0	0
2008	8	1	0	0	0	4	24	0	3	0	0	0	0
2009	8	1	0	0	0	17	27	0	1	0	0	0	0
2010	2	1	0	1	0	2	39	0	2	0	0	0	0
2011	9	1	0	0	0	8	29	0	0	0	0	2	0
2012	9	0	0	0	2	55	103	0	0	2	1	13	0
2013	7	0	0	0	0	24	103	0	4	3	0	2	0
2014	5	0	0	0	0	14	58	0	2	0	0	4	0
2015	9	1	0	0	0	15	45	0	2	0	0	0	0
2016	4	1	0	0	0	7	32	0	1	0	0	2	0
2017	6	2	0	0	0	17	30	0	0	0	0	6	0
2018	3	3	0	0	1	9	90	0	0	0	0	8	0
2019	9	0	0	1	0	15	47	0	0	0	0	7	0
2020	11	0	0	0	0	9	49	0	0	0	0	11	0
2021	11	0	0	0	0	40	56	0	8	0	0	7	0
2022	8	0	0	1	0	17	42	0	0	0	0	11	0

Table 5. Summary of piping plover nests lost due to predation from 2003 to 2022 at Cape Cod National Seashore.

Year	Predation: Total	Coyote	Crow	Domestic Dog	Fox	Grackle	Gull	Mink	Raptor	Raven	Skunk	Unknown Avian	Unknown Canid	Unknown Predator	Unknown Small Mammal
2003	38	4	5	0	0	0	4	0	0	0	5	5	5	10	0
2004	27	6	12	0	0	0	3	0	0	0	2	0	0	4	0
2005	25	6	5	0	0	0	2	2	1	0	0	0	0	8	1
2006	11	0	9	0	0	0	0	0	0	0	0	0	0	2	0
2007	10	2	4	0	0	0	0	0	0	0	0	0	0	4	0
2008	24	1	9	0	0	0	2	0	0	0	4	0	0	8	0
2009	27	2	18	0	0	0	1	0	0	0	0	0	0	6	0
2010	39	3	28	0	0	0	0	0	0	0	0	0	0	8	0
2011	29	3	24	0	0	0	0	0	0	0	0	0	0	2	0
2012	103	41	35	0	5	0	0	0	0	0	0	0	1	21	0
2013	103	31	24	0	5	1	0	0	0	0	0	0	1	41	0
2014	58	9	19	0	6	0	0	0	0	0	0	0	10	14	0
2015	45	15	15	0	4	0	0	0	0	0	0	0	3	8	0
2016	32	8	12	0	1	0	0	0	0	0	0	0	2	9	0
2017	30	4	19	0	0	0	0	0	0	0	0	0	0	7	0
2018	90	21	56	0	2	1	0	0	0	0	0	0	0	10	0
2019	47	24	14	0	0	0	0	0	0	1	0	0	0	8	0
2020	49	17	22	0	0	0	2	0	0	0	0	0	0	8	0
2021	56	11	37	0	0	0	0	0	0	0	0	1	0	7	0
2022	42	20	13	0	1	0	0	0	0	0	0	1	2	5	0

Egg Loss

A total of 591 eggs were laid of which 302 hatched and 286 were lost. Egg loss followed similar trends as nest loss with most eggs lost to depredation (23%), followed by overwash (11%), unknown (6%), unviable (5%), and abandonment (4%) including adult mortality (1%) (Tables 6–8).

Table 6. Summary of piping plover egg loss, and cause of egg loss from 2017 to 2022 at Cape Cod National Seashore.

Year	Abandonment: Total	Failure to Hatch: Unviable	Mortality of Both Adults	Multiple Causes	Other	Overwash/ Flooding	Predation: Total	Run Over	Sanded Over	Substrate Collapse	Trampling	Unknown Cause	Vandalism
2017	19	28	0	0	0	56	89	0	0	0	0	18	0
2018	9	38	0	0	4	21	258	0	0	0	0	22	0
2019	20	27	0	0	0	47	133	0	0	0	0	26	0
2020	28	25	0	0	0	26	126	0	0	0	0	17	0
2021	24	29	0	0	0	121	143	0	26	0	0	19	0
2022	24	27	0	0	0	64	134	0	0	0	0	37	0

Table 7. Summary of piping plover egg loss due to abandonment from 2017 to 2022 at Cape Cod National Seashore.

Year	Abandonment: Total	Adult Mortality	Human Disturbance	Predator Disturbance	Unknown
2017	19	0	0	0	19
2018	9	0	0	0	9
2019	20	0	4	11	5
2020	28	0	0	11	17
2021	24	0	0	0	24
2022	24	4	3	11	6

Table 8. Summary of piping plover egg loss due to predation from 2017 to 2022 at Cape Cod National Seashore.

Year	Predation: Total	Coyote	Crow	Domestic Dog	Fox	Grackle	Gull	Mink	Raptor	Raven	Skunk	Unknown Avian	Unknown Canid	Unknown Predator	Unknown Small Mammal
2017	89	12	57	0	0	0	0	0	0	0	0	0	0	20	0
2018	258	65	161	0	7	4	0	0	0	0	0	0	0	21	0
2019	133	83	36	0	0	0	0	0	0	4	0	0	0	10	0
2020	126	48	54	0	0	0	7	0	0	0	0	0	0	17	0
2021	143	34	86	0	0	0	0	0	0	0	0	4	0	19	0
2022	134	68	36	0	4	0	0	0	0	0	0	4	7	15	0

Exclosures

A total of 76 exclosures were installed around nests in 2022. Exclosures increased the rate of nest hatching success from 29% for unexclosed nests to 84% for exclosed nests (Table 9). They also successfully decreased the rate of predation from 63% loss due to predation to 8%. The highest cause of nest loss for exclosed nests was due to overwash (7), followed by abandonment (4) and predation (1). Despite successes in increasing hatching, there were at least two adult mortalities associated with exclosures, as well as several abandonments (Table 10).

Table 9. Piping plover nest loss based on predator management in 2022 at Cape Cod National Seashore.

Predator Management Type	Total Number of Nests	Total Number of Nests Lost
Nest Exclosed	76	12
Nest Unexclosed	95	67

Table 10. Cause of piping plover nest loss based on predator management in 2022 at Cape Cod National Seashore.

Nest Loss Cause	Nest Loss Cause: Detail	Nest Exclosed	Nest Unexclosed
Abandonment	Total	4	4
	Adult Mortality	1	0
	Human Disturbance	0	0
	Predator Disturbance	2	1
	Unknown	1	3
Failure to Hatch - Unviable	Total	0	0
Mortality of Both Adults	Total	0	0
Multiple Causes	Total	0	1
Other	Total	0	0
Overwash / flooding	Total	7	10
Predation	Total	1	41
	Coyote	0	20
	Crow	0	13
	Domestic Dog	0	0
	Fox	1	0
	Gull	0	0
	Mink	0	0
	Otter	0	0
	Raptor	0	0
	Raven	0	0

Table 10 (continued). Cause of piping plover nest loss based on predator management in 2022 at Cape Cod National Seashore.

Nest Loss Cause	Nest Loss Cause: Detail	Nest Exclosed	Nest Unexclosed
Predation (continued)	Skunk	0	0
	Unknown Avian	0	1
	Unknown Canid	0	2
	Unknown Predator	0	5
	Unknown Small Mammal	0	0
Run Over	Total	0	0
Sanded Over	Total	0	0
Substrate Collapse	Total	0	0
Trampling	Total	0	0
Unknown Cause	Total	0	11
Vandalism	Total	0	0

Fledging

A total of 189 chicks fledged from 117 breeding pairs at CACO in 2022. Active broods of unfledged chicks were present on CACO beaches from 31 May until 3 September. The peak number of broods occurred on 14 July with 58 active broods (Figure 2). Fledging dates in 2022 ranged from 28 June to 3 September.

Beaches with the highest fledging success rates (100%) were Ballston, Newcomb Hollow, Great Island, Herring Cove, Longnook, and Race Point South. Beaches with the lowest fledging success rates (where nests hatched) were Jeremy Point (37%) and Wood End/Long Point (35%). Out of the 92 nests that hatched successfully, fledge rates for re-nests were similar to fledge rates for first nest attempts, 61% and 64% respectively.

The average age to fledge in 2022 was 31 days. Days to fledge ranged from 23 to 41 days. The last several years staff have observed chicks with developmental delays at several sites. In 2022, a chick at Hatches Harbor was significantly smaller than its siblings but eventually fledged at 41 days old. Sites which had the highest average fledge ages were Hatches Harbor (37 days) and Newcomb Hollow (39 days). Sites which had the lowest average fledge ages were Herring Cove (29.6 days) and Duck Harbor (24.6 days). Chicks typically fledge between 30 and 35 days from CACO beaches, although it is not uncommon for there to be several chicks fledging outside of this age window. A total of 17 chicks fledged over 35 days of age in 2022.

A total of 113 chicks were lost this season. Of the 113 chicks lost, all were lost to unknown causes, although some chicks were found dead on site and observations suggested death by exposure. Beaches with highest numbers of chicks lost were Wood End/Long Point (22) and Race Point North

(15). In terms of percentage, sites with highest chick loss were Wood End/Long Point (65%), Hatches Harbor (63%), Jeremy Point (63%) and Duck Harbor (53%).

Productivity

Of the 117 breeding pairs, 73 pairs (62%) fledged at least one chick, and 44 pairs (38%) had zero productivity. Of the pairs with zero productivity, 18 pairs had complete brood loss, and 26 pairs failed to hatch any eggs.

A total of 117 pairs hatched 305 eggs and fledged 189 chicks for a total productivity of 1.62 chicks fledged per pair.

The observed productivity rate of 1.62 chicks fledged per breeding pair is above the species recovery target of 1.5 (Figure 3). The average productivity over the last five years at CACO is approximately 1.58.

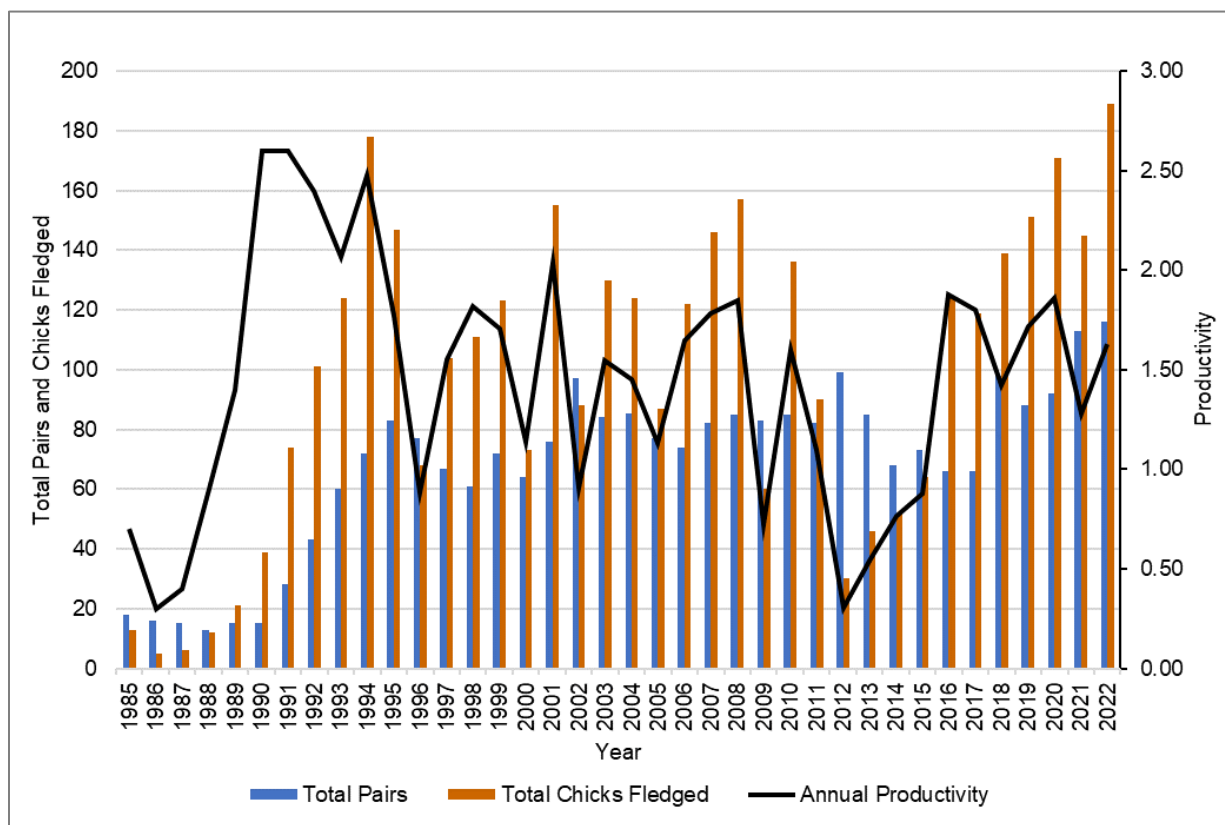


Figure 3. Piping plover pairs, chicks fledged, and annual productivity from 1985 to 2022 at Cape Cod National Seashore.

NPS / CACO

Least Tern

Nesting

In 2022, least terns returned to CACO beaches in early May. The first least tern nest was found on 30 May at Coast Guard Eastham. Least terns continued to nest until mid-August. The highest number of nesting pairs was 194 (Table 11). This was a decrease of 76 pairs from 2021 (Table 12). Colony sizes fluctuated throughout the season, but most were relatively small with 36 or fewer pairs. Armstrong, Head of the Meadow, High Head, Jeremy Point, and Race Point North supported the largest colonies (Table 11).

Table 11. Summary of least tern nesting sites in 2022 at Cape Cod National Seashore.

Site	A Count (6/5–6/19)	B Count (6/20–7/31)	Total Breeding Pairs	Total Chicks Fledged	Productivity ^A
Wood End/Long Point, Breach	1	8	8	0	0.00
Wood End/Long Point, South	1	4	4	0	0.00
Wood End/Long Point, North	2	4	4	1	0.25
Hatches Harbor	0	0	0	0	0.00
Race Point North	24	25	25	9	0.36
Race Point	4	6	6	4	0.67
Race Point South	0	0	0	0	0.00
Mission Bell	0	1	1	0	0.00
Exit 9	0	0	0	0	0.00
Armstrong, North	3	24	24	5	0.21
Armstrong, South	20	20	20	0	0.00
High Head	0	8	8	1	0.13
Head of the Meadow	24	36	36	7	0.19
Coast Guard Truro	8	24	24	3	0.13
Ballston	0	0	0	0	0.00
Newcomb Hollow	0	0	0	0	0.00
Cahoon Hollow	0	0	0	0	0.00
White Crest Beach	0	0	0	0	0.00
LeCount Hollow	0	0	0	0	0.00
Marconi Station	8	7	7	9	1.29
Marconi Beach	0	2	2	0	0.00
Nauset Light Beach	0	0	0	0	0.00
Coast Guard Eastham	10	10	10	6	0.60
Bound Brook	0	0	0	0	0.00
Duck Harbor	0	0	0	0	0.00
Great Island	0	0	0	0	0.00

^A Productivity = Total Chicks Fledged / Total Breeding Pairs.

Table 11 (continued). Summary of least tern nesting sites in 2022 at Cape Cod National Seashore.

Site	A Count (6/5–6/19)	B Count (6/20–7/31)	Total Breeding Pairs	Total Chicks Fledged	Productivity ^A
Jeremy Point, Islands	7	13	13	2	0.15
Jeremy Point, Proper	0	2	2	2	1.00
Parkwide Total	112	194	194	49	0.25

^A Productivity = Total Chicks Fledged / Total Breeding Pairs.

Table 12. Summary of least tern nesting parameters by year from 2007 to 2022 at Cape Cod National Seashore.

Year	Total Breeding Pairs	Total Chicks Fledged	Productivity ^A	Primary Cause of Loss
2007	86	40	0.47	overwash, canids
2008	89	136	1.53	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
2021	270	24	0.09	coyote, overwash, human disturbance
2022	194	49	0.25	coyote, overwash, human disturbance

^A Productivity = Total Chicks Fledged / Total Breeding Pairs.

Chicks began hatching in late June and early July; the first hatch was 22 June at Head of the Meadow. Least terns continued to incubate nests through August.

Fledging

The first least terns fledged on 13 July at Head of the Meadow and the last fledged on 30 August at Head of the Meadow. The 194 pairs fledged 49 chicks yielding a productivity of 0.25 chicks/pair from CACO beaches in 2022 (Table 12). Over the past sixteen years (2007–2022), the least tern population at CACO fluctuated between a high of 270 pairs in 2021 and a low of 52 pairs in 2016 (Table 12). Least tern fledges and productivity were above average in 2022.

Nurseries

Least tern nurseries and migrants were observed starting in early July until mid-September at Race Point North (50 individuals), Race Point (75 individuals), Race Point South (~20 individuals), High Head (10 individuals), Head of the Meadow (12 individuals), Armstrong (~40 individuals), and Jeremy Point (65 individuals).

Symbolic fencing and interpretive signs, including no pet signs, were maintained to protect least terns and their young still using critical habitat later in the breeding season.

Productivity

There were 194 breeding pairs of least terns observed in 2022 (Figure 4).

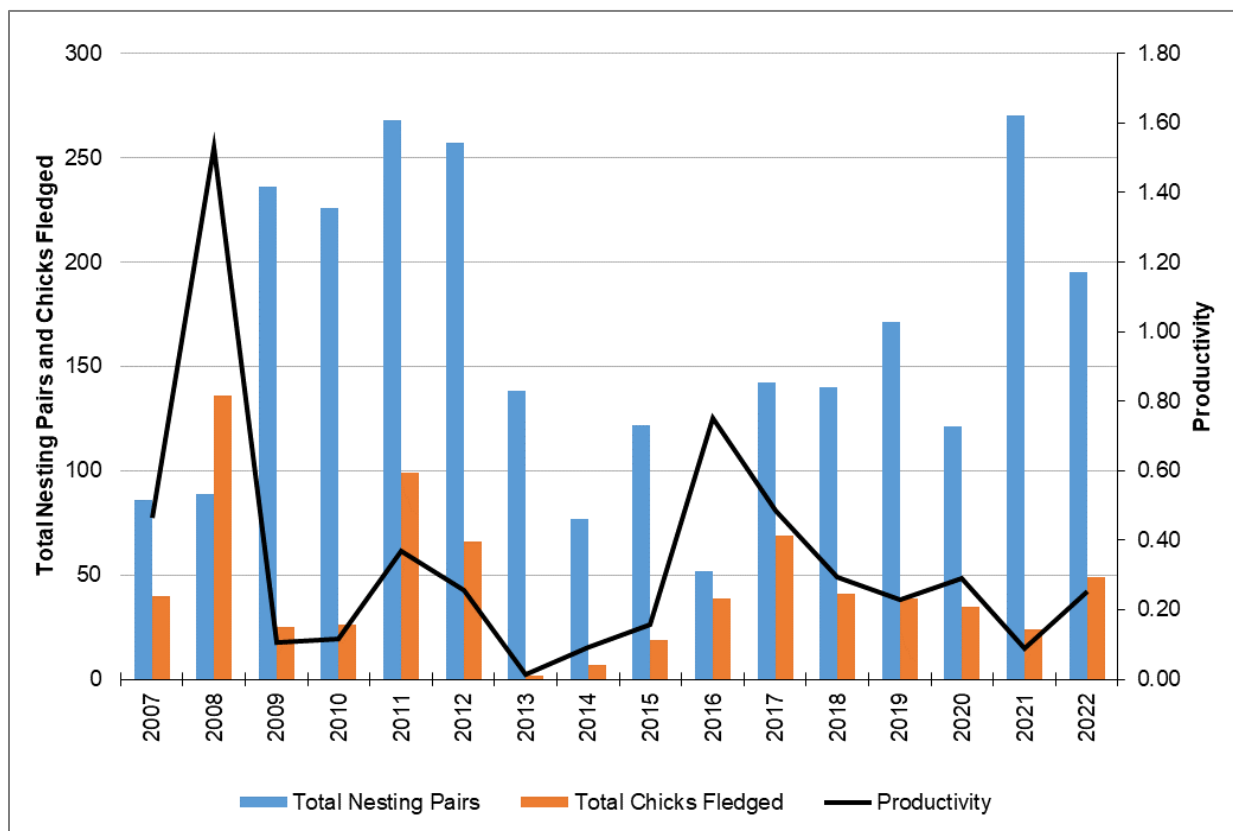


Figure 4. Least tern breeding pairs, chicks fledged and productivity (chicks fledged/nesting pair), by year from 2007 to 2022 at Cape Cod National Seashore.

NPS / CACO

In 2022, least terns nested at 15 different sites at CACO with approximately half of chicks fledged at just three locations: Race Point North (9), Marconi Station (9), and Head of the Meadow (7).

Least tern productivity has been declining at CACO since a spike in 2016. Low productivity has put the species on the USFWS list of conservation concern which could mean listing under the Endangered Species Act in the future.

American Oystercatcher

Nesting

Historically CACO has not been home to more than five pairs of nesting American oystercatchers since 2007. Nesting areas have fluctuated around the park. Since 2014 American oystercatchers have only nested at Jeremy Point in Wellfleet. From 2006 to 2013 their nesting sites also included Coast Guard Eastham and New Island. New Island is currently monitored by the Town of Orleans.

In 2022, Three American oystercatcher pairs were present during the breeding season at CACO. The first oystercatcher nest was found on May 1st at Jeremy Point. A total of six nests were laid by three pairs; only one nest hatched but was unsuccessful in fledging any chicks (Table 13). Of the 6 nests, 5 were lost. Two nests were overwashed, two nests were depredated (one coyote, one corvid), and one nest was abandoned.

Table 13. Summary of American Oystercatcher nesting parameters by year from 2006 to 2022 at Cape Cod National Seashore.

Year	Pairs	Nests	Re-nests	Total Eggs Laid	Total Eggs Hatched	Total Chicks Fledged	Renest Rate ^A	Mean Clutch Size ^B	Hatch Rate ^C	Fledge Rate ^D	Egg Success ^E	Productivity ^F
2006	4	4	0	12	10	2	0.00	3.00	0.83	0.20	0.17	0.50
2007	5	7	2	19	5	3	0.29	2.71	0.26	0.60	0.16	0.60
2008	5	6	1	16	10	4	0.17	2.67	0.63	0.40	0.25	0.80
2009	1	1	0	3	3	0	0.00	3.00	1.00	0.00	0.00	0.00
2010	3	5	2	16	2	0	0.40	3.20	0.13	0.00	0.00	0.00
2011	3	6	3	17	5	0	0.50	2.83	0.29	0.00	0.00	0.00
2012	3	6	3	15	5	0	0.50	2.50	0.33	0.00	0.00	0.00
2013	3	10	7	21	0	0	0.70	2.10	0.00	0.00	0.00	0.00
2014	2	4	3	8	4	0	0.75	2.00	0.50	0.00	0.00	0.00
2015	2	3	1	9	6	3	0.33	3.00	0.67	0.50	0.33	1.50
2016	2	4	2	10	6	3	0.50	2.50	0.60	0.50	0.30	1.50
2017	2	4	2	12	4	2	0.50	3.00	0.33	0.50	0.17	1.00
2018	1	2	1	6	2	0	0.50	3.00	0.33	0.00	0.00	0.00
2019	1	2	1	5	2	0	0.50	2.50	0.40	0.00	0.00	0.00
2020	2	2	0	6	3	1	0.00	3.00	0.50	0.33	0.17	0.50
2021	2	1	0	2	2	2	0.00	2.00	1.00	1.00	1.00	1.00
2022	3	6	3	14	2	0	0.50	2.33	0.14	0.00	0.00	0.00

^A Renest Rate = Renests / Nests.

^B Mean Clutch Size = Total Eggs Laid / Nests.

^C Hatch Rate = Total Eggs Hatched / Total Eggs Laid.

^D Fledge Rate = Total Chicks Fledged / Total Eggs Hatched.

^E Egg Success = Total Chicks Fledged / Total Eggs Laid.

^F Productivity = Total Chicks Fledged / Total Breeding Pairs.

Productivity

One nest hatched in 2022, but the chicks were lost and zero chicks fledged. American oystercatchers were first recorded nesting on CACO beaches in 2002. Since then, one to five pairs have nested in the park each year. Between 2006 and 2022, productivity fluctuated between zero and 1.5 chicks fledged/breeding pair (Figure 5).

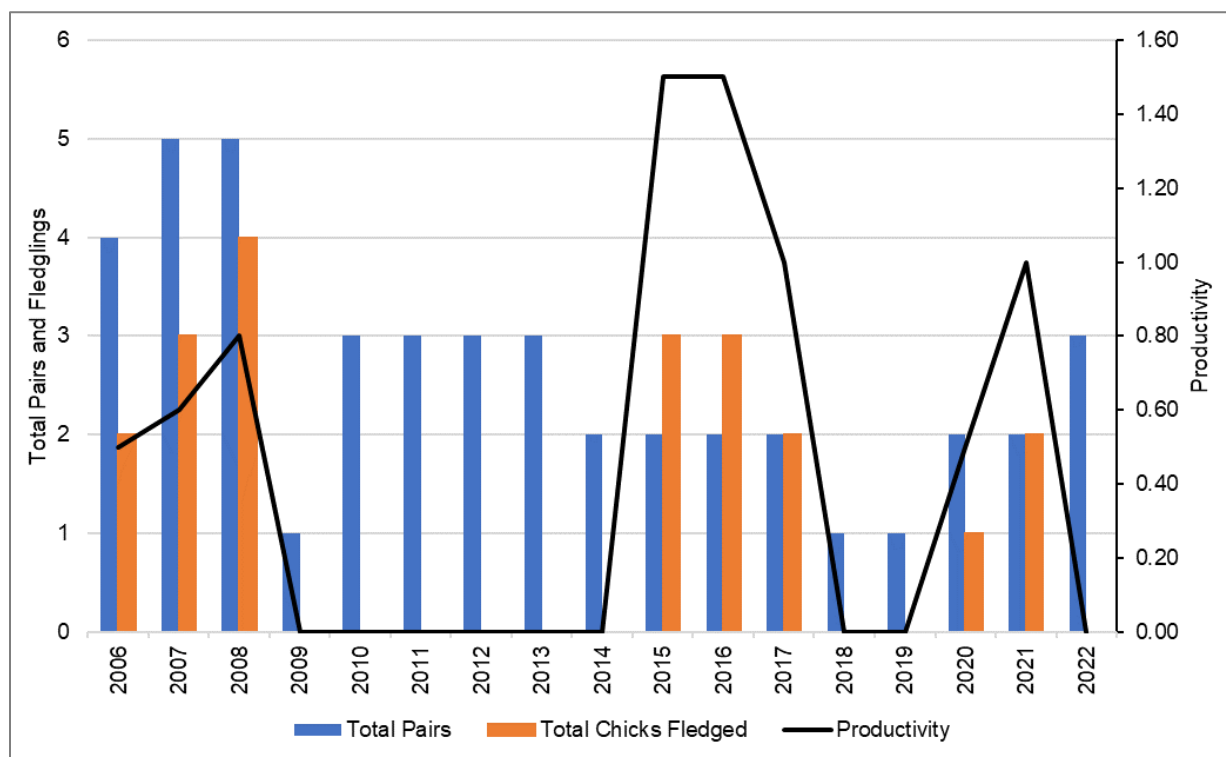


Figure 5. American oystercatcher breeding pairs, chicks fledged, and productivity, from 2006 to 2022 at Cape Cod National Seashore.

NPS / CACO

Migratory, Staging and Post-Breeding Shorebirds

General Staging Counts

Field staff monitor and report general locations of large flocks (greater than 50 individuals), and report estimates of numbers and individual species when conditions allow.

Areas with highest concentrations of mixed Roseate and Common tern flocks included Hatches Harbor and Herring Cove Marsh, Mission Bell, Armstrong and High Head. Mission Bell was a new site for large flocks of terns in 2022 (Table 14).

Table 14. Mixed tern flock estimated high counts by site at Cape Cod National Seashore in 2022.

Site	High Count
Wood End/Long Point	600
Herring Cove	1000
Hatches Harbor	1200
Race Point North	700
Race Point	150
Race Point South	200
Mission Bell	2000
Exit 9	200
Armstrong	4000
High Head	3000
Head of the Meadow	1000
Coast Guard Truro	100
Longnook	100
Ballston Beach	0
Newcomb Hollow	0
Cahoon Hollow	0
White Crest	0
LeCount Hollow	0
Marconi Station	0
Marconi Beach	0
Nauset Light	0
Coast Guard Eastham	0
Bound Brook	0
Duck Harbor	0
Great Island	0
Jeremy Point	1500

Roseate Tern

In 1987, roseate terns were listed as a federally endangered species under the Endangered Species Act of 1973. Researchers estimate that approximately 70% of the entire Northeast 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.

In 2022, Roseate terns were present in mixed flocks from July through October at CACO beaches. Visiting researchers conducted roost counts and resighted banded individuals.

Common Tern

In Massachusetts, the common tern is listed as a Species of Special Concern. There was one nest found at Jeremy Point in 2022. The nest hatched but chicks were never located after hatching. Common terns used to nest frequently on New Island in Orleans, but a nest has not been found in almost a decade.

Red Knot

In 2014, rufa red knots (*Calidris canutus rufa*) were listed as a threatened species under the Endangered Species Act of 1973, with proposed critical habitat designations identified in 2015 within the park. 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.

In 2022, red knots were observed on only a few occasions; at Hatches Harbor (2 total) and Jeremy Point (2 total). It was once common to observe large flocks towards 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 Plover, American Oystercatcher, and Least Tern

CACO shorebird staff 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 20 piping plovers were observed into mid-September. Nonbreeding and staging least terns congregated on park beaches through August and early September. American Oystercatchers were observed at Jeremy Point through mid-September.

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Appendix A. Maps of 2022 Piping Plover Nest Sites at Cape Cod National Seashore

Figures 6 through 31 show the locations of piping plover nests at CACO.

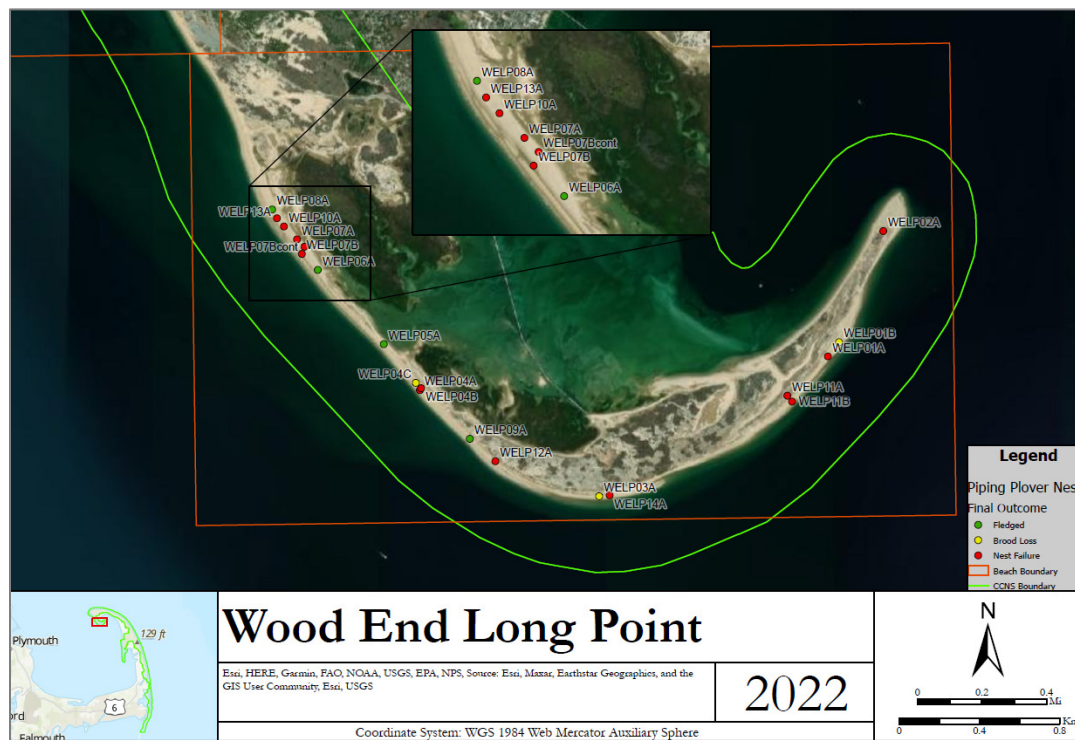


Figure 6. Piping plover nest sites at Wood End Long Point, Cape Cod National Seashore, 2022.
NPS / CACO

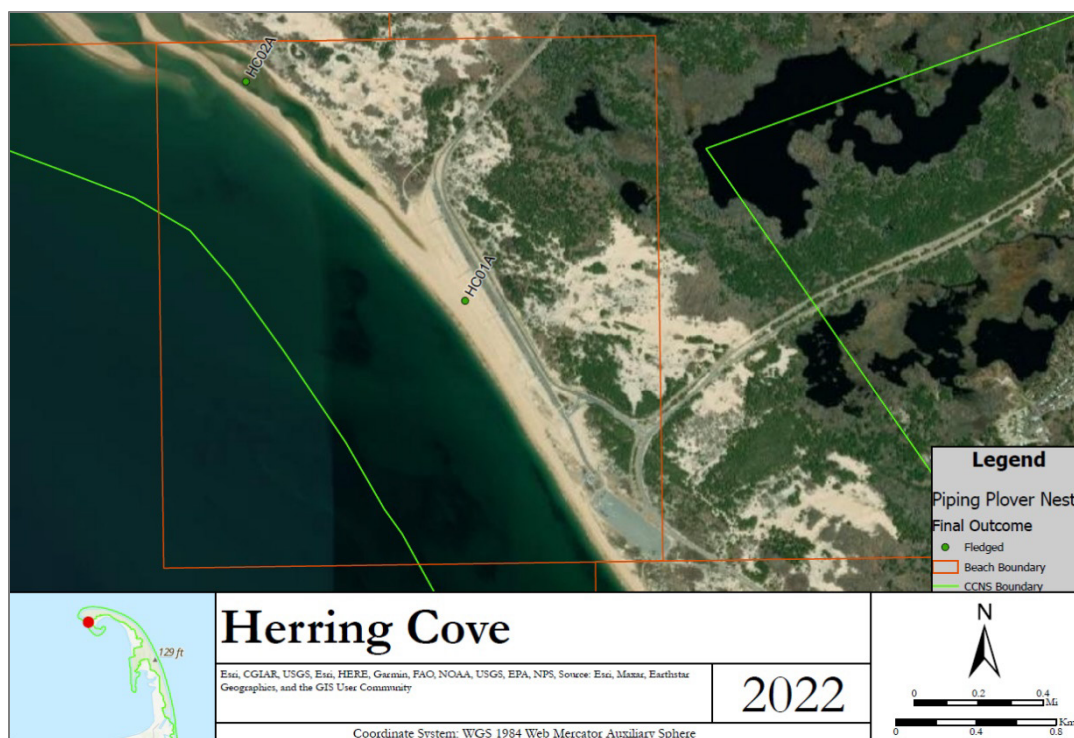


Figure 7. Piping plover nest sites at Herring Cove, Cape Cod National Seashore, 2022.
NPS / CACO



Figure 8. Piping plover nest sites at Hatches Harbor, Cape Cod National Seashore, 2022.
NPS / CACO



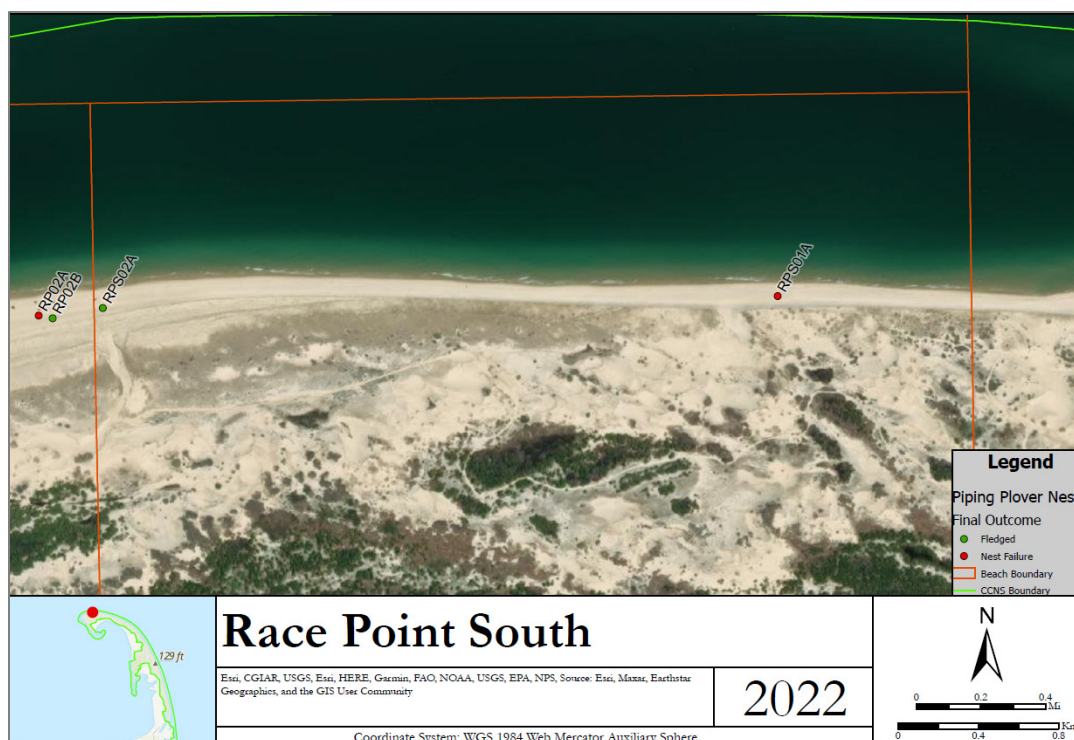


Figure 11. Piping plover nest sites at Race Point South, Cape Cod National Seashore, 2022.
NPS / CACO

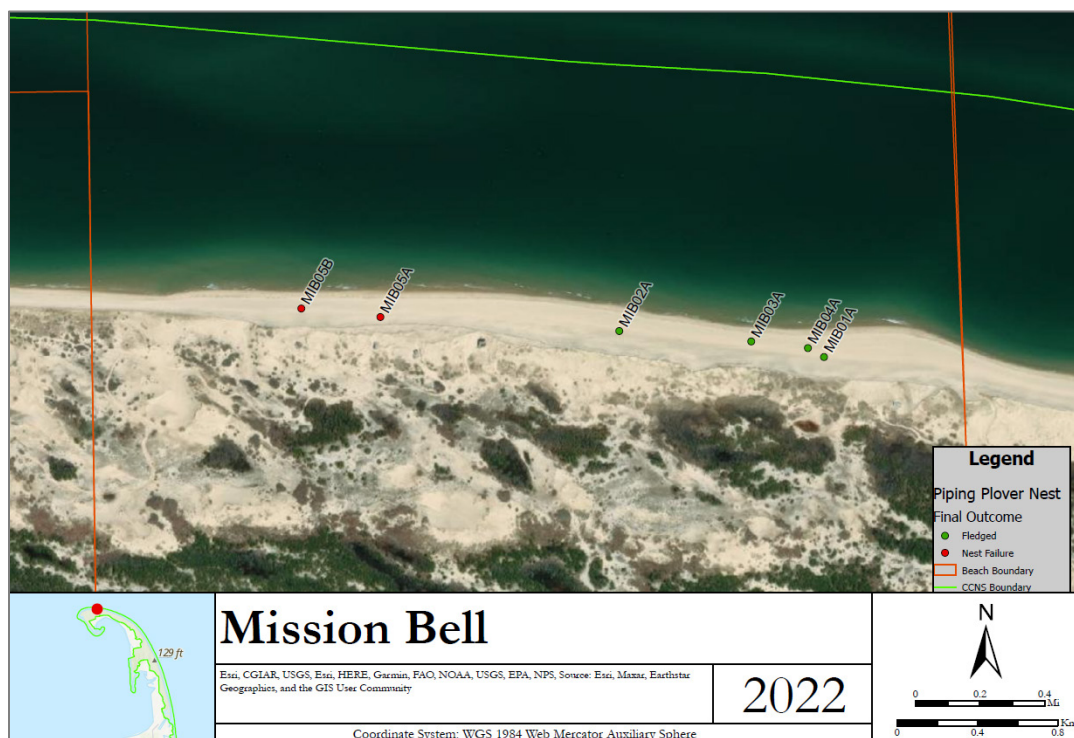


Figure 12. Piping plover nest sites at Mission Bell, Cape Cod National Seashore, 2022.
NPS / CACO



Figure 13. Piping plover nest sites at Exit 9, Cape Cod National Seashore, 2022.
NPS / CACO

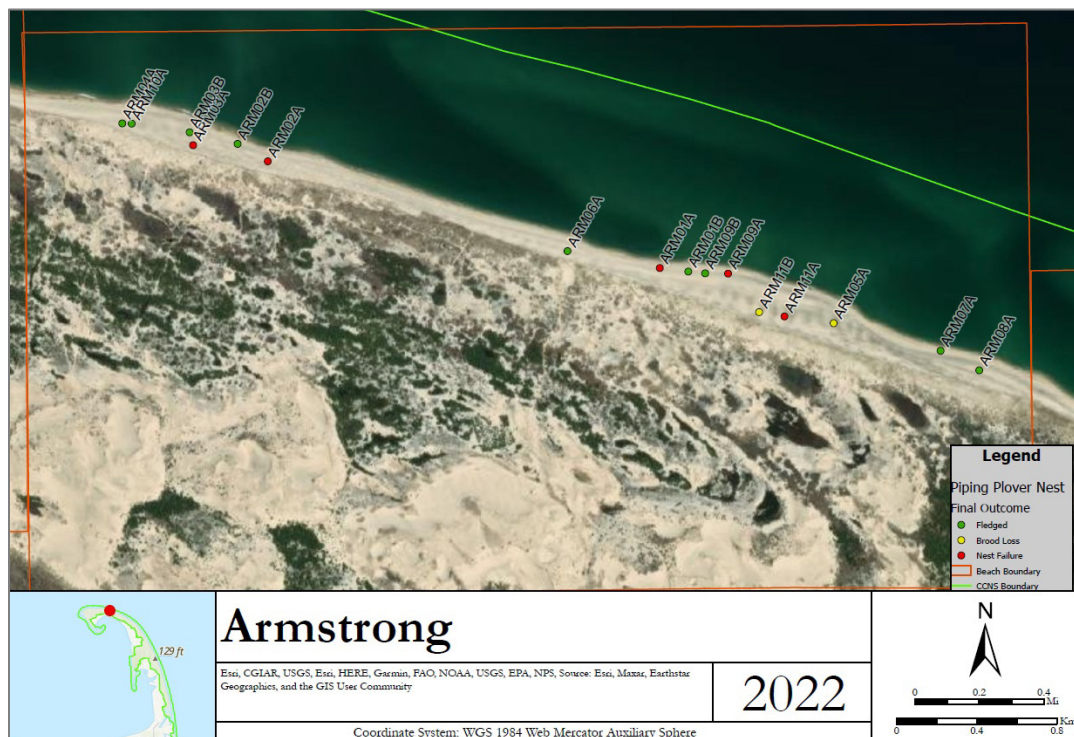


Figure 14. Piping plover nest sites at Armstrong, Cape Cod National Seashore, 2022.
NPS / CACO

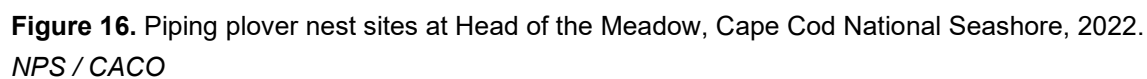
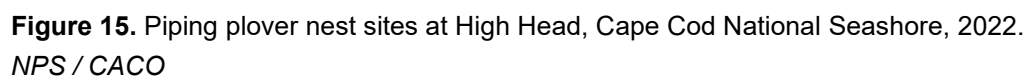




Figure 17. Piping plover nest sites at Coast Guard Truro, Cape Cod National Seashore, 2022.
NPS / CACO

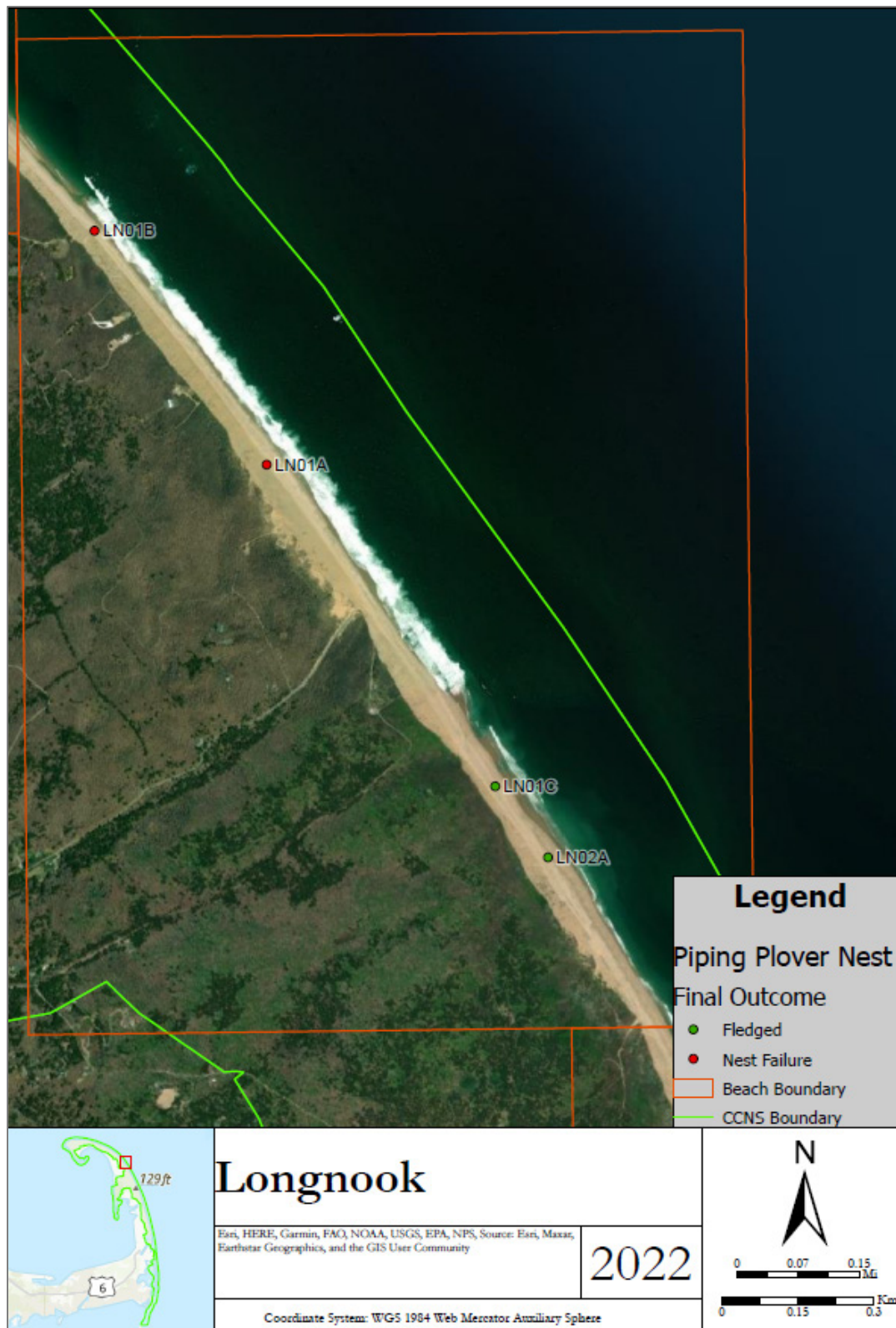


Figure 18. Piping plover nest sites at Longnook, Cape Cod National Seashore, 2022.
NPS / CACO

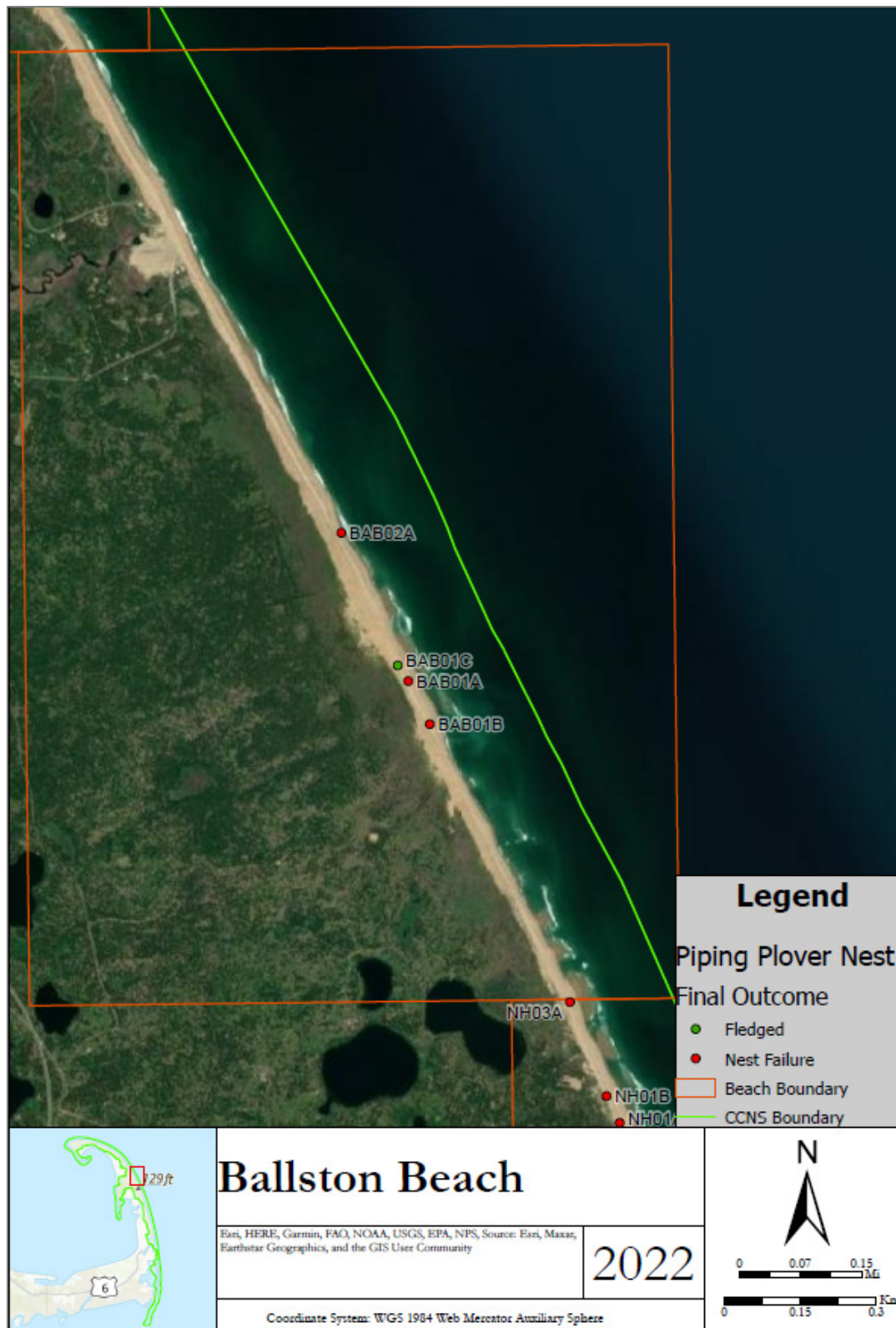


Figure 19. Piping plover nest sites at Ballston Beach, Cape Cod National Seashore, 2022.
NPS / CACO

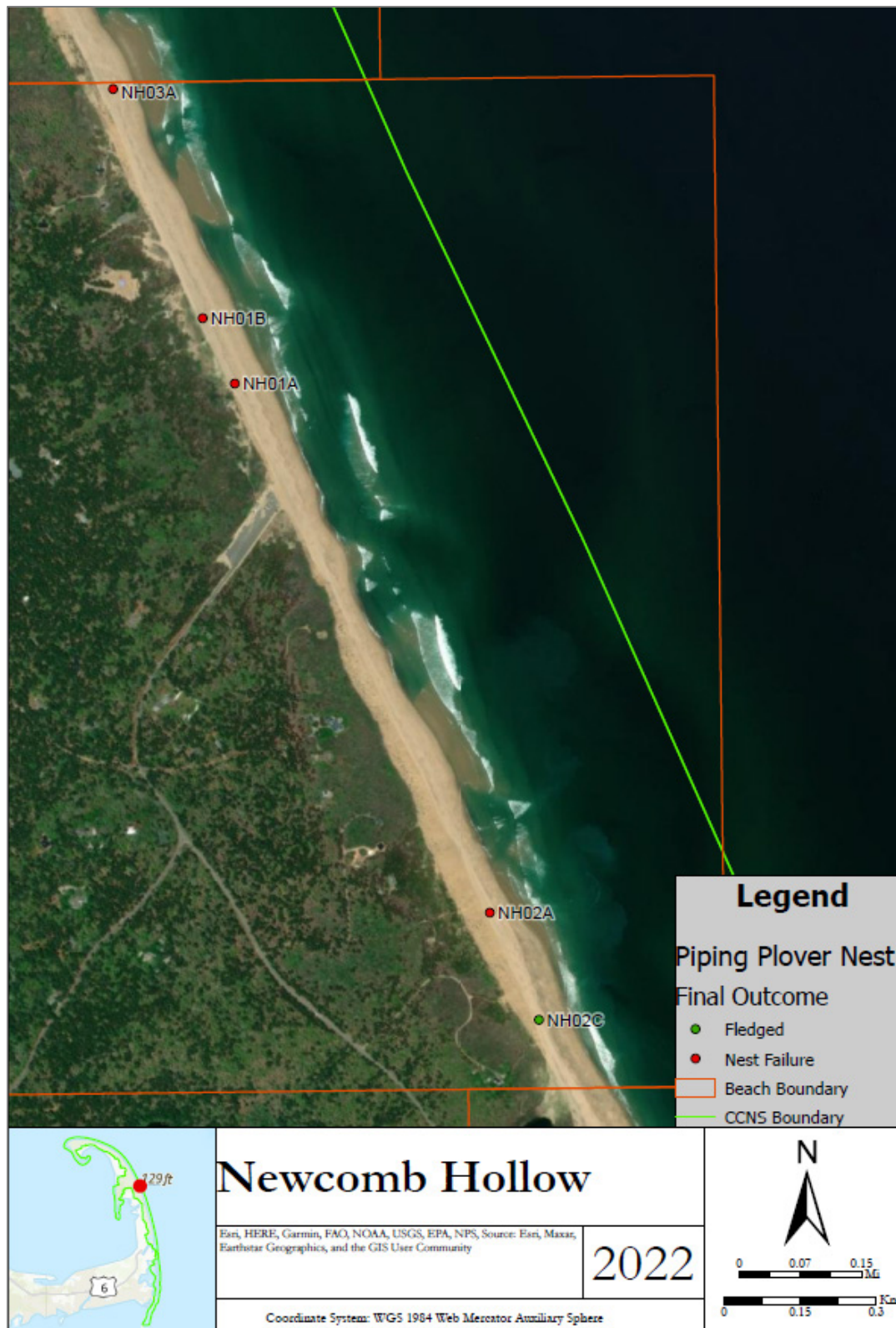


Figure 20. Piping plover nest sites at Newcomb Hollow, Cape Cod National Seashore, 2022.
NPS / CACO

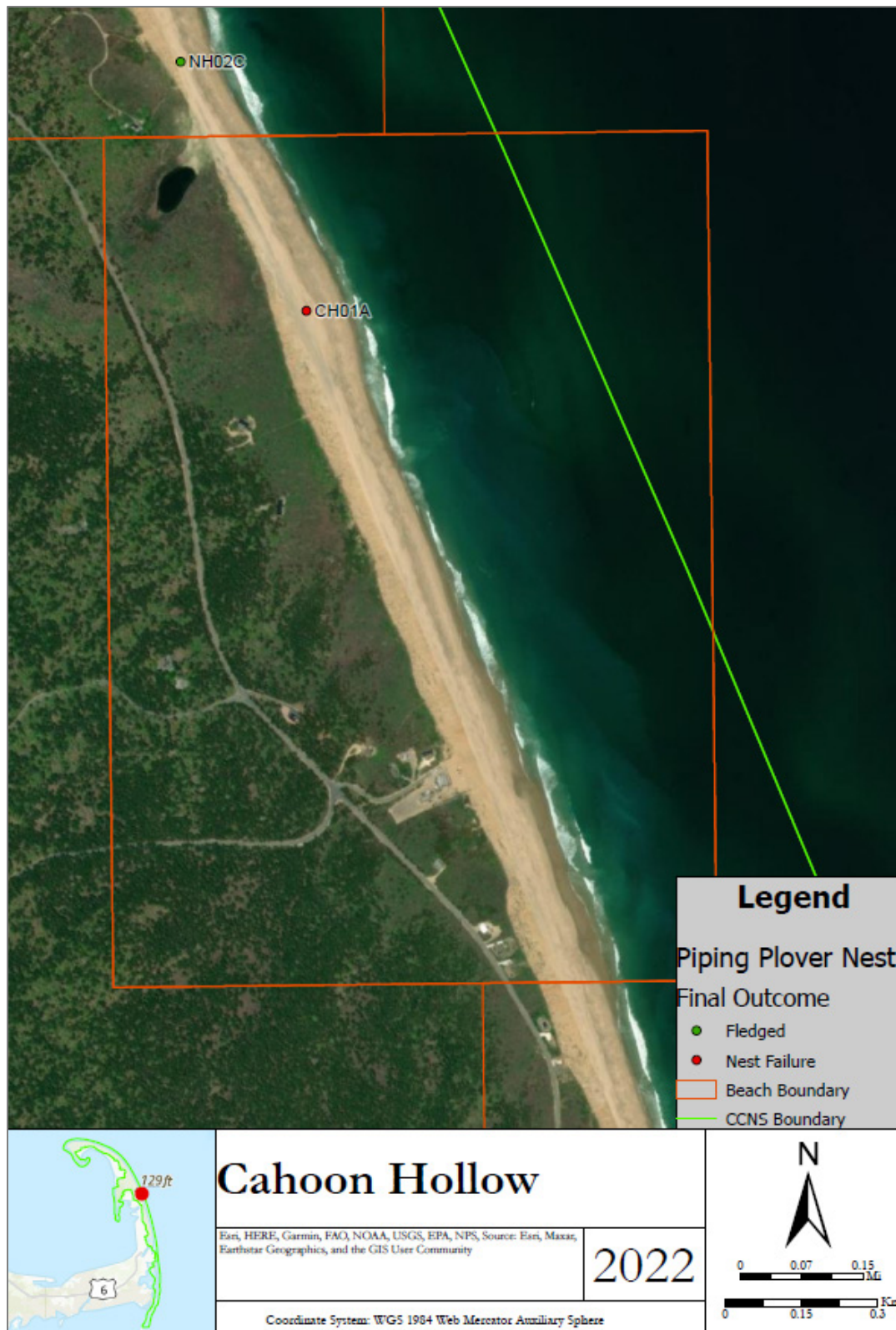


Figure 21. Piping plover nest sites at Cahoon Hollow, Cape Cod National Seashore, 2022.
NPS / CACO

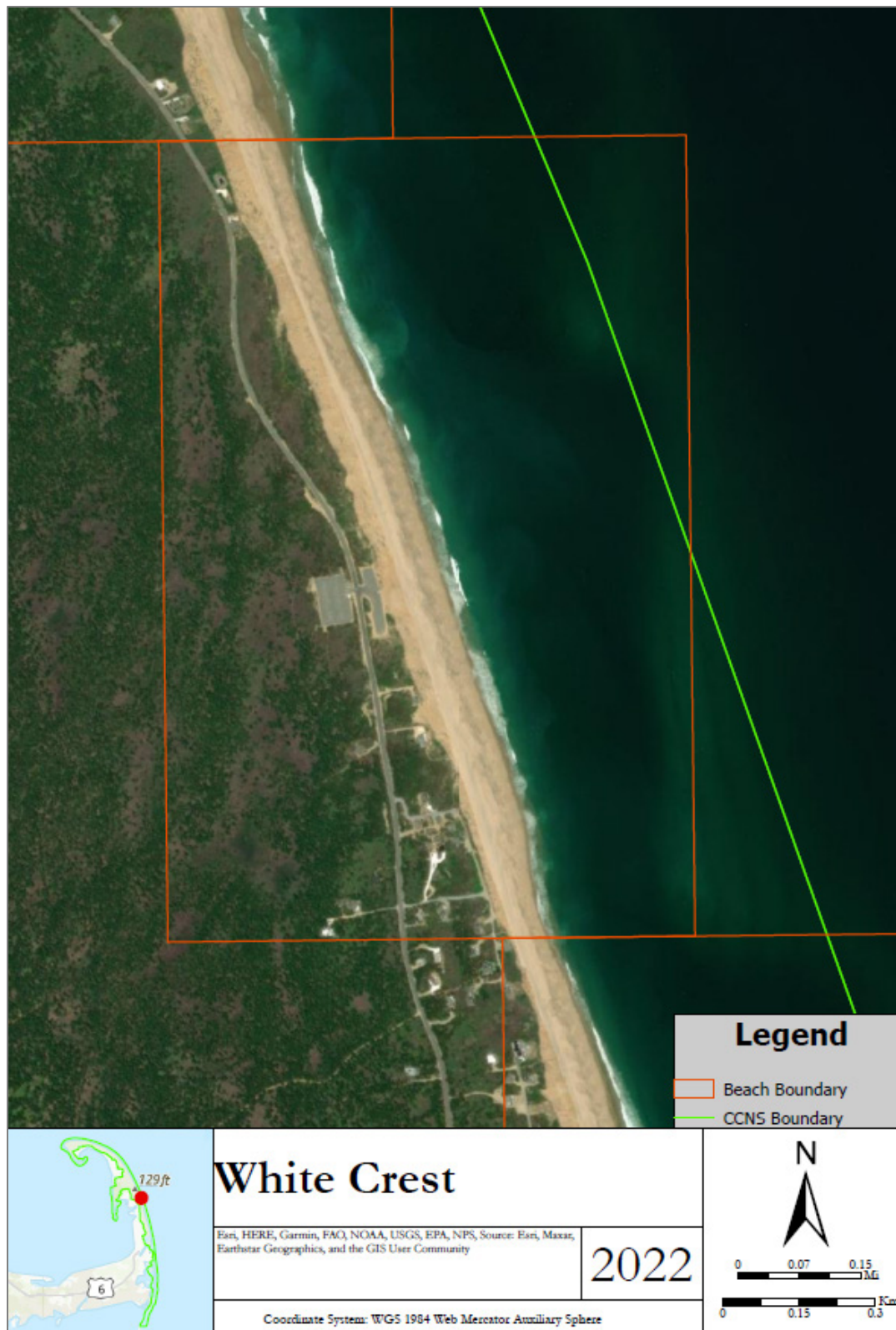


Figure 22. Piping plover nest sites at White Crest, Cape Cod National Seashore, 2022.
NPS / CACO

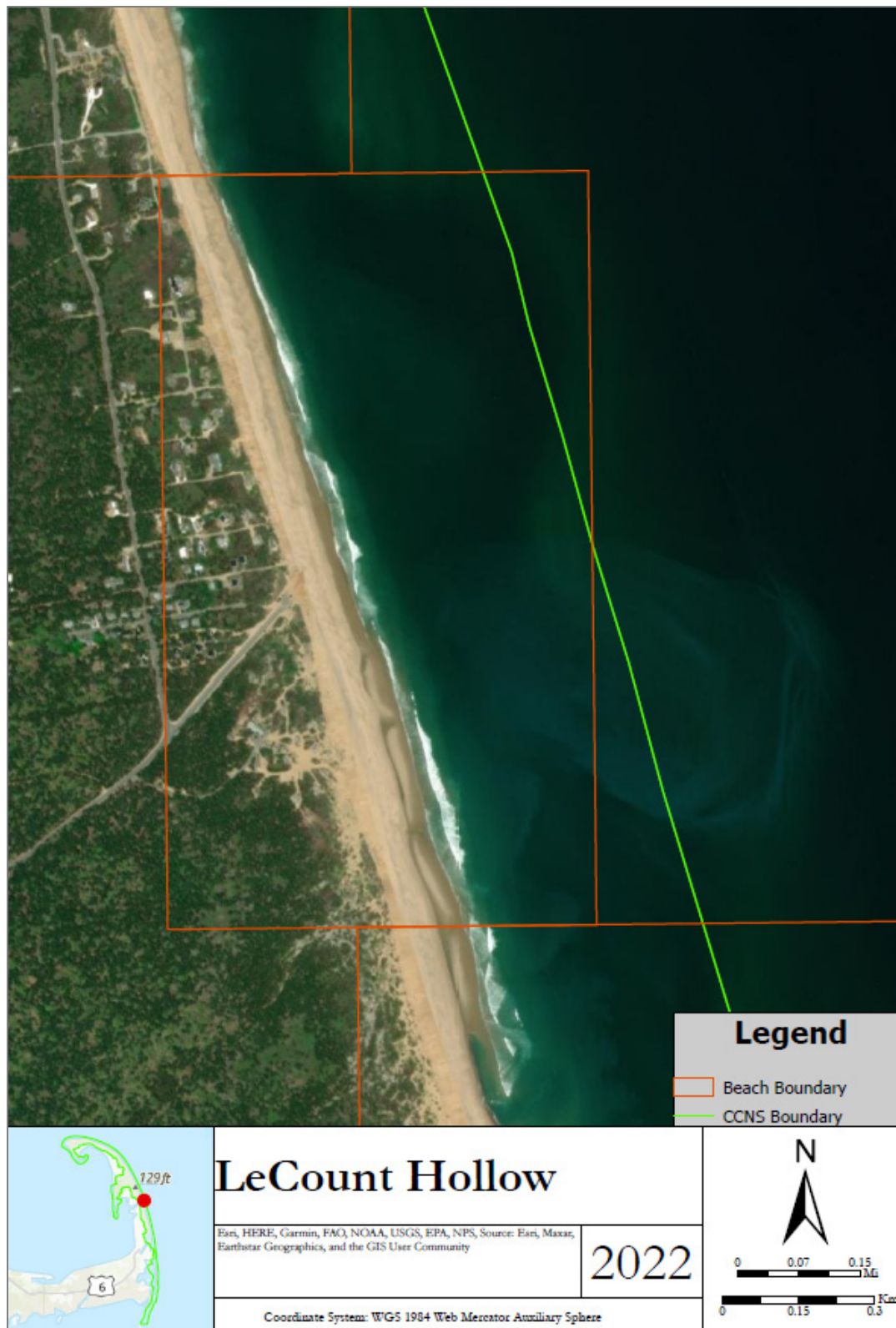


Figure 23. Piping plover nest sites at LeCount Hollow, Cape Cod National Seashore, 2022.
NPS / CACO

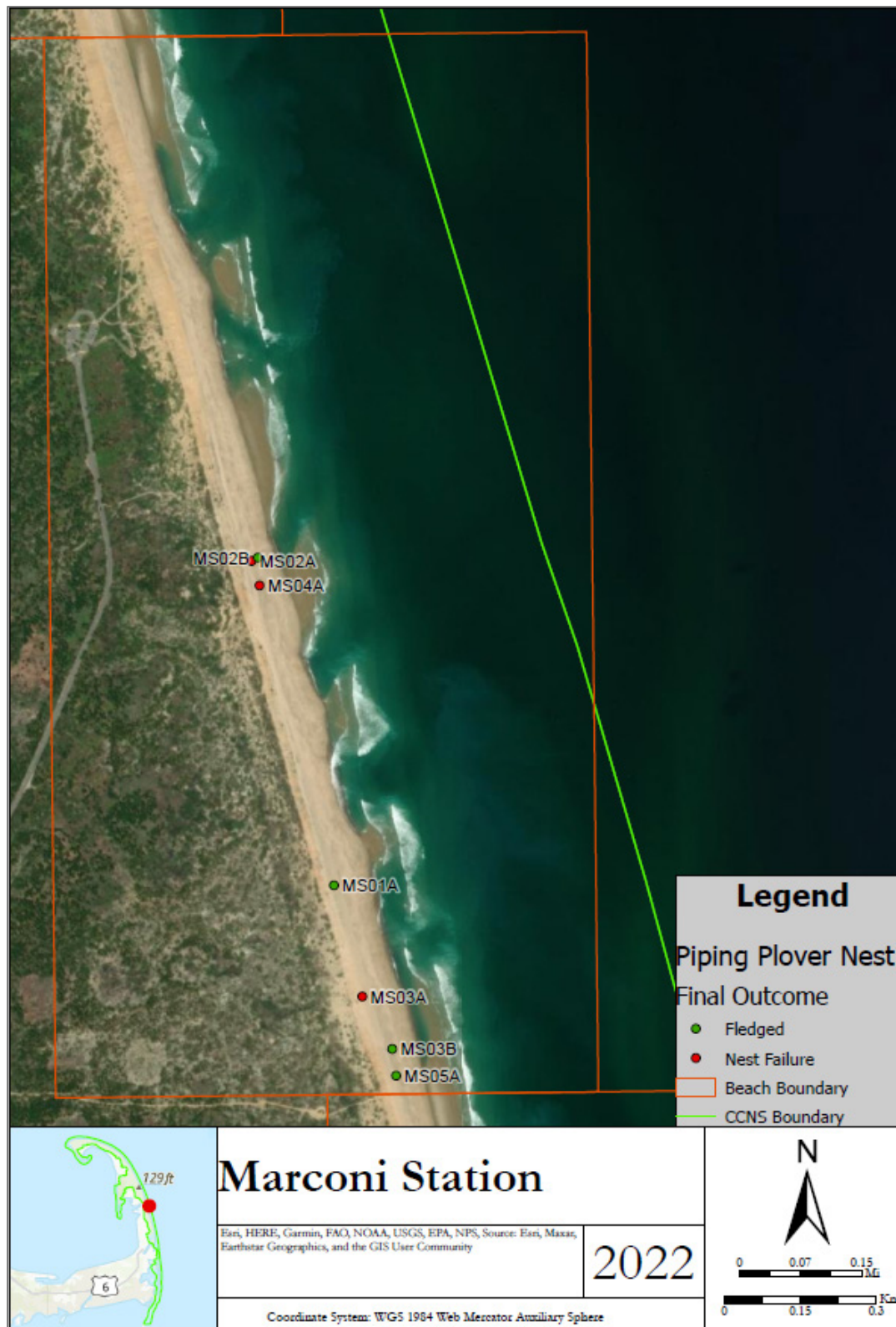


Figure 24. Piping plover nest sites at Marconi Station, Cape Cod National Seashore, 2022.
NPS / CACO

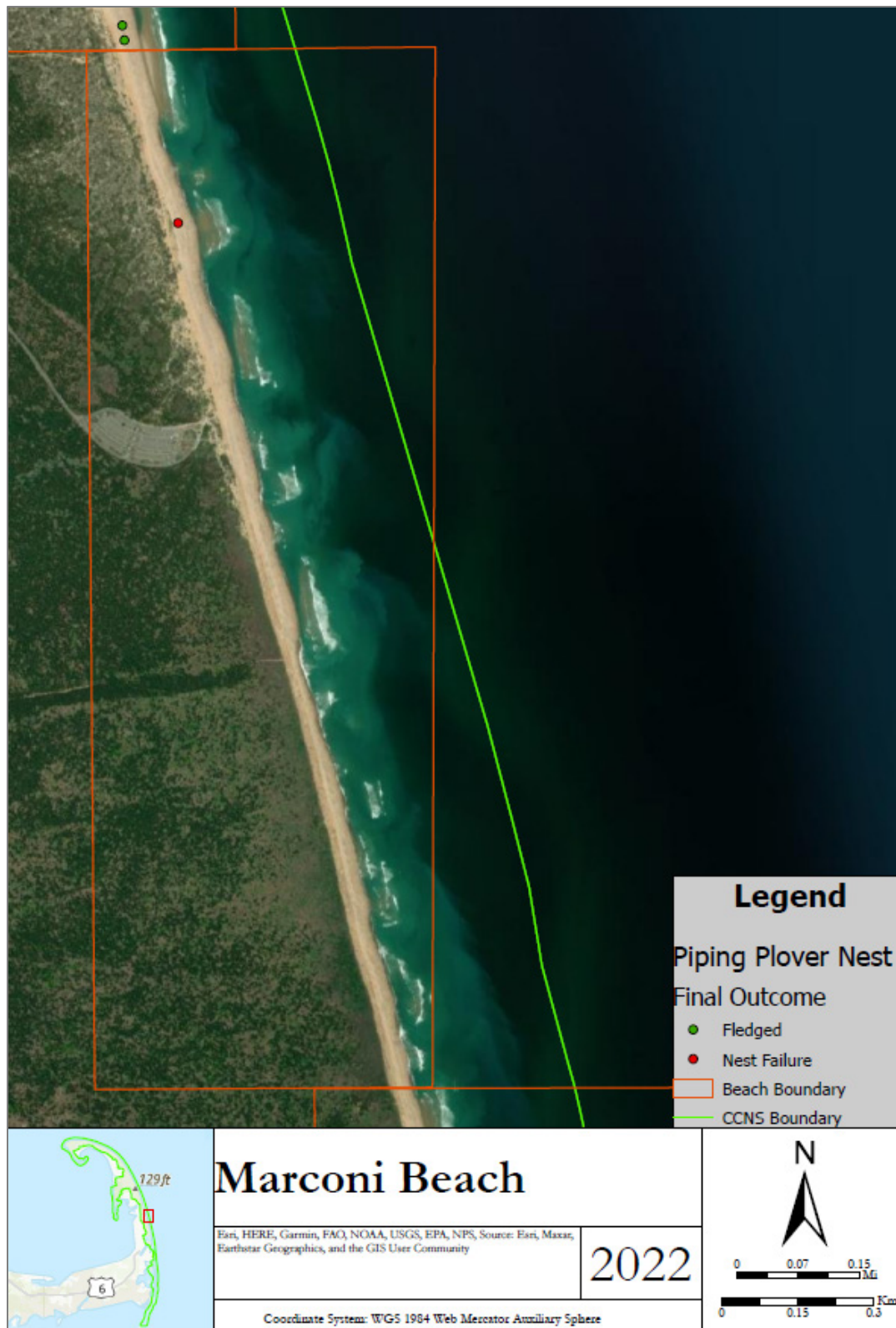


Figure 25. Piping plover nest sites at Marconi Beach, Cape Cod National Seashore, 2022.
NPS / CACO

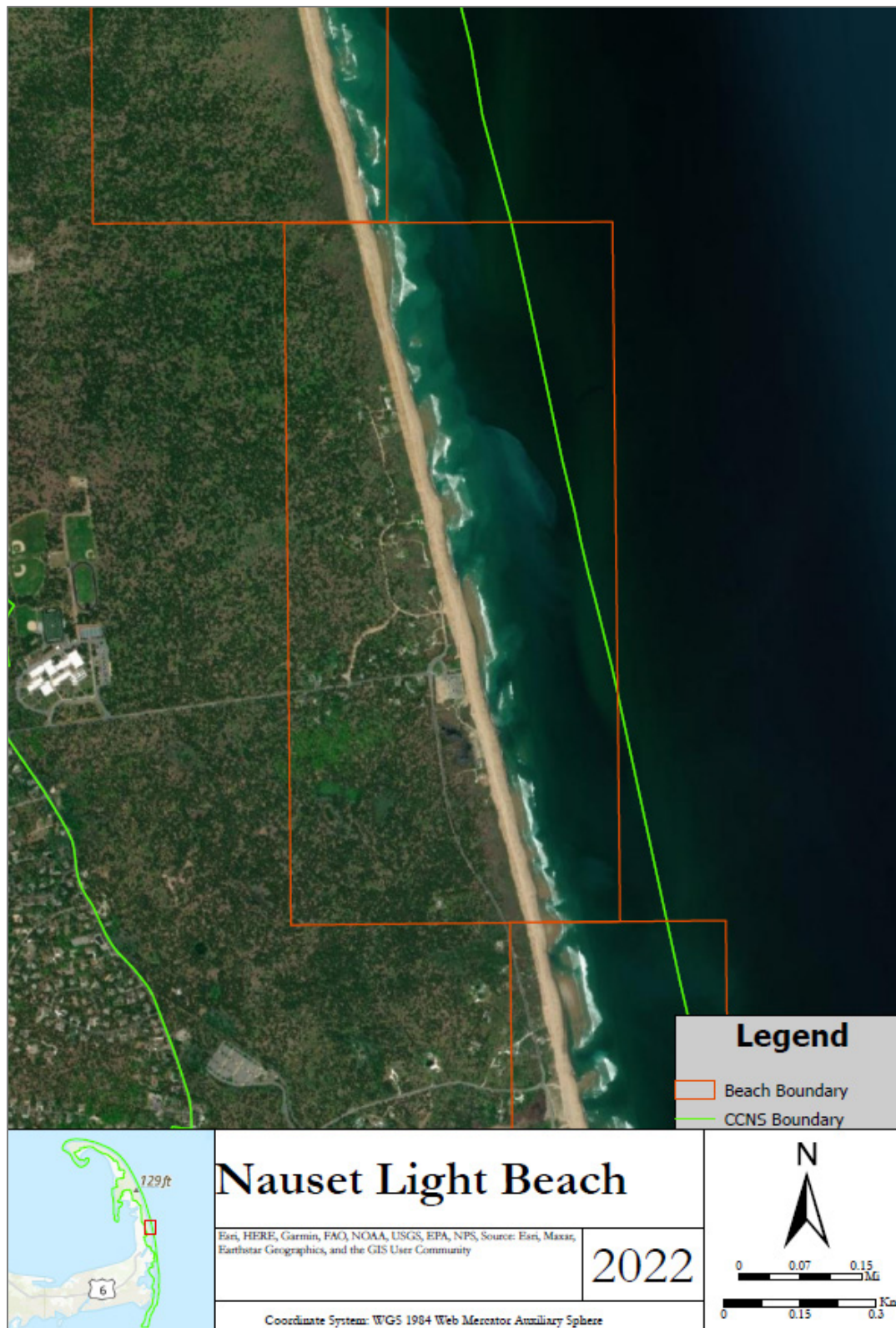


Figure 26. Piping plover nest sites at Nauset Light, Cape Cod National Seashore, 2022.
NPS / CACO



Figure 27. Piping plover nest sites at Coast Guard Eastham, Cape Cod National Seashore, 2022.
NPS / CACO



Figure 28. Piping plover nest sites at Bound Brook, Cape Cod National Seashore, 2022.
NPS / CACO

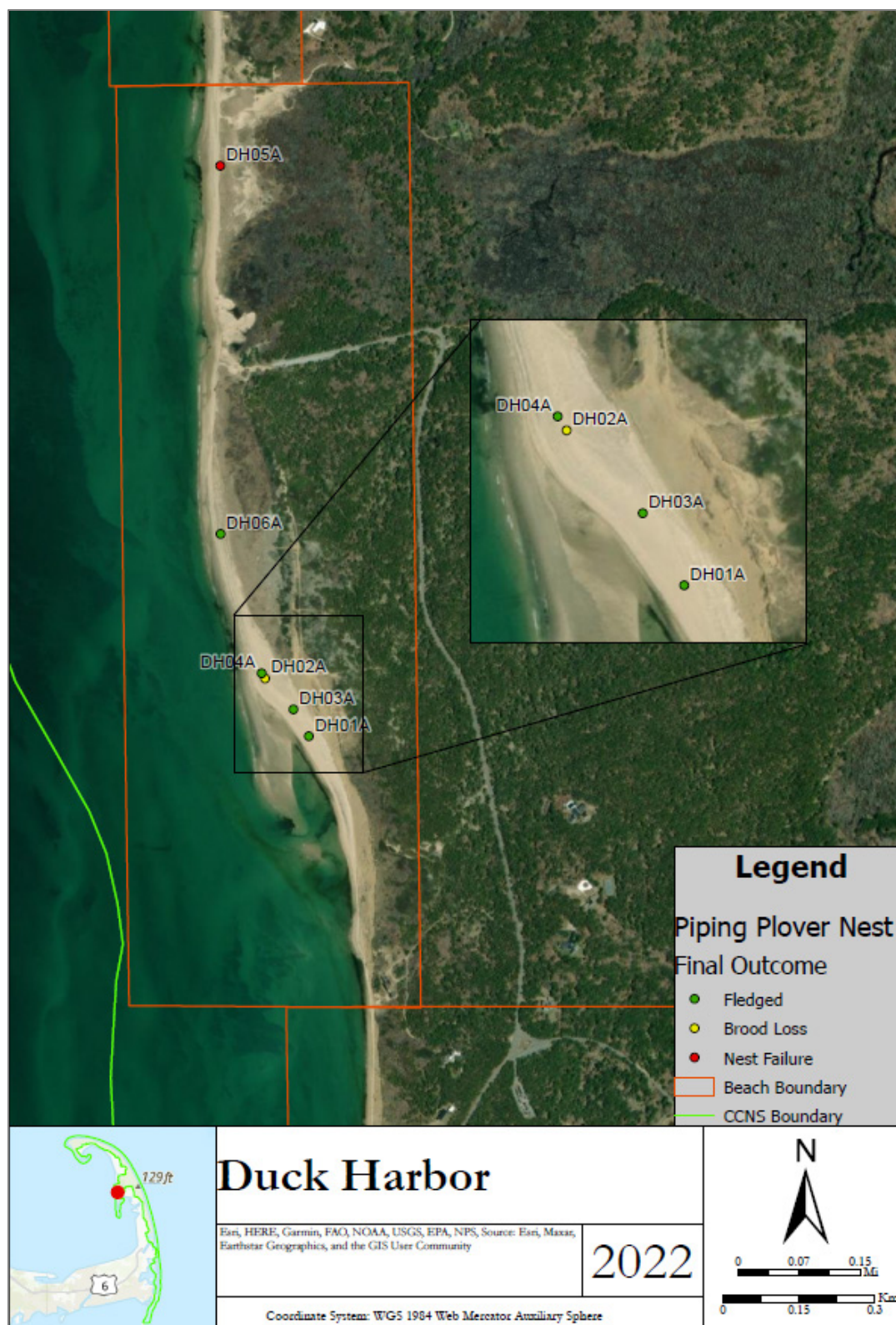


Figure 29. Piping plover nest sites at Duck Harbor, Cape Cod National Seashore, 2022.
NPS / CACO



Figure 30. Piping plover nest sites at Great Island, Cape Cod National Seashore, 2022.
NPS / CACO



Figure 31. Piping plover nest sites at Jeremy Point, Cape Cod National Seashore, 2022.
NPS / CACO

Appendix B. Maps of 2022 Least Tern Nest Sites at Cape Cod National Seashore

Figures 32 through 43 show the locations of least tern nests at CACO.



Figure 32. Least tern nest sites at Wood End Long Point, Cape Cod National Seashore, 2022.
NPS / CACO

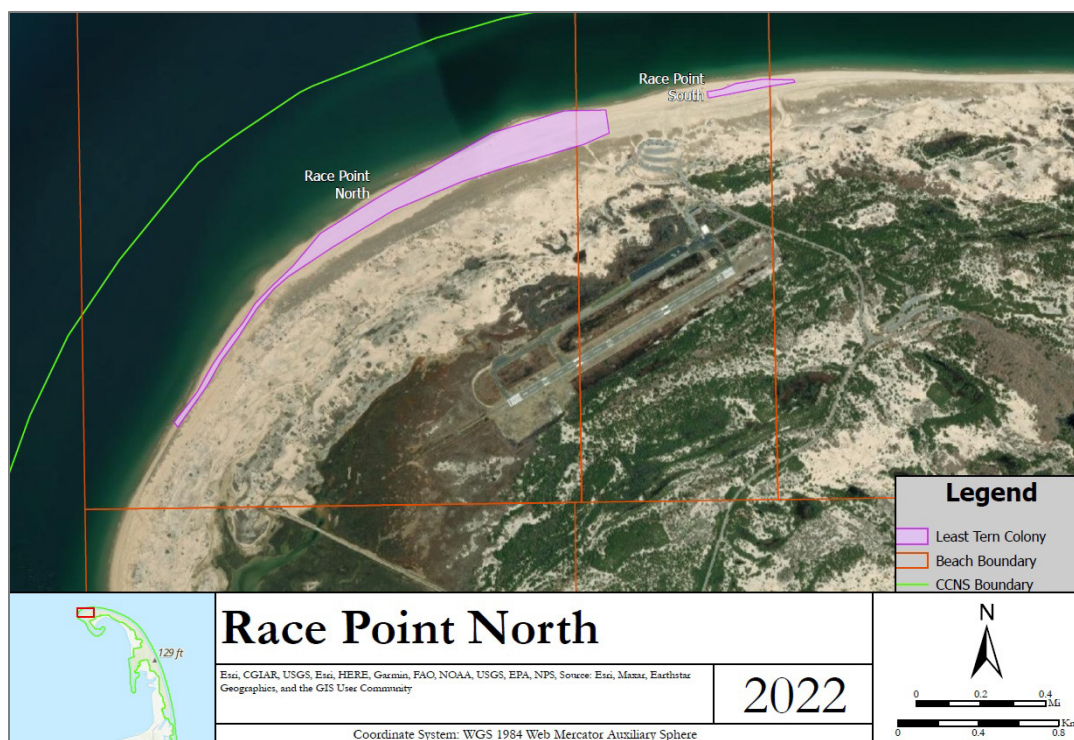


Figure 33. Least tern nest sites at Race Point North, Cape Cod National Seashore, 2022.
NPS / CACO

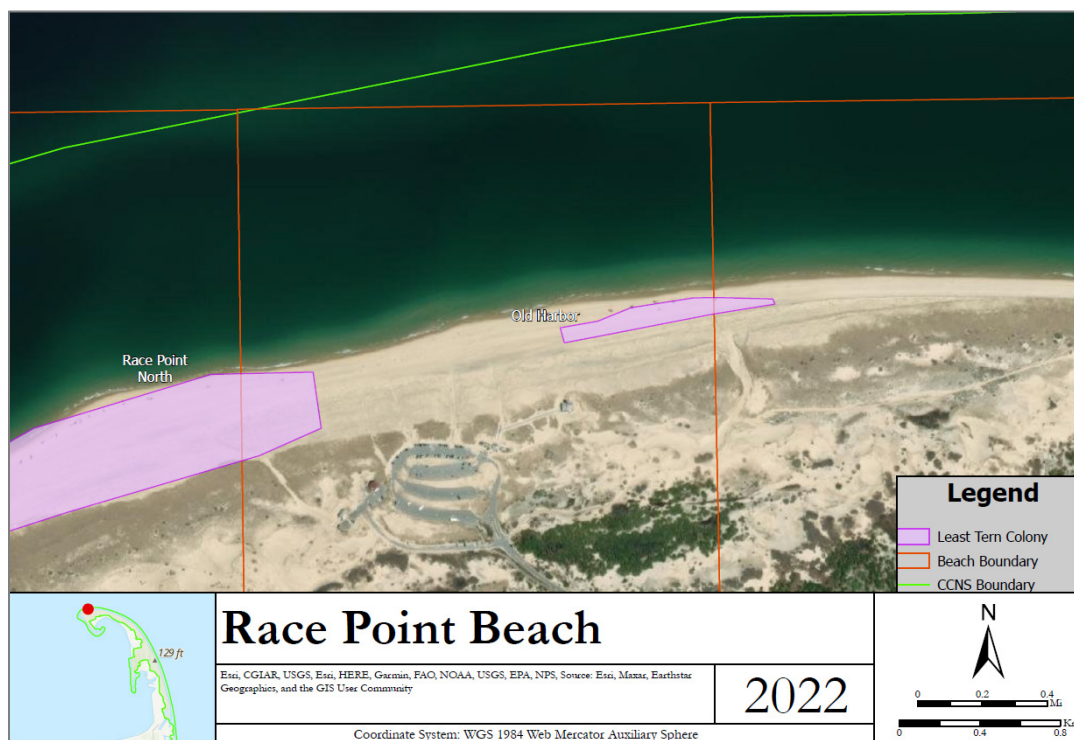


Figure 34. Least tern nest sites at Race Point, Cape Cod National Seashore, 2022.
NPS / CACO



Figure 35. Least tern nest sites at Mission Bell, Cape Cod National Seashore, 2022.
NPS / CACO

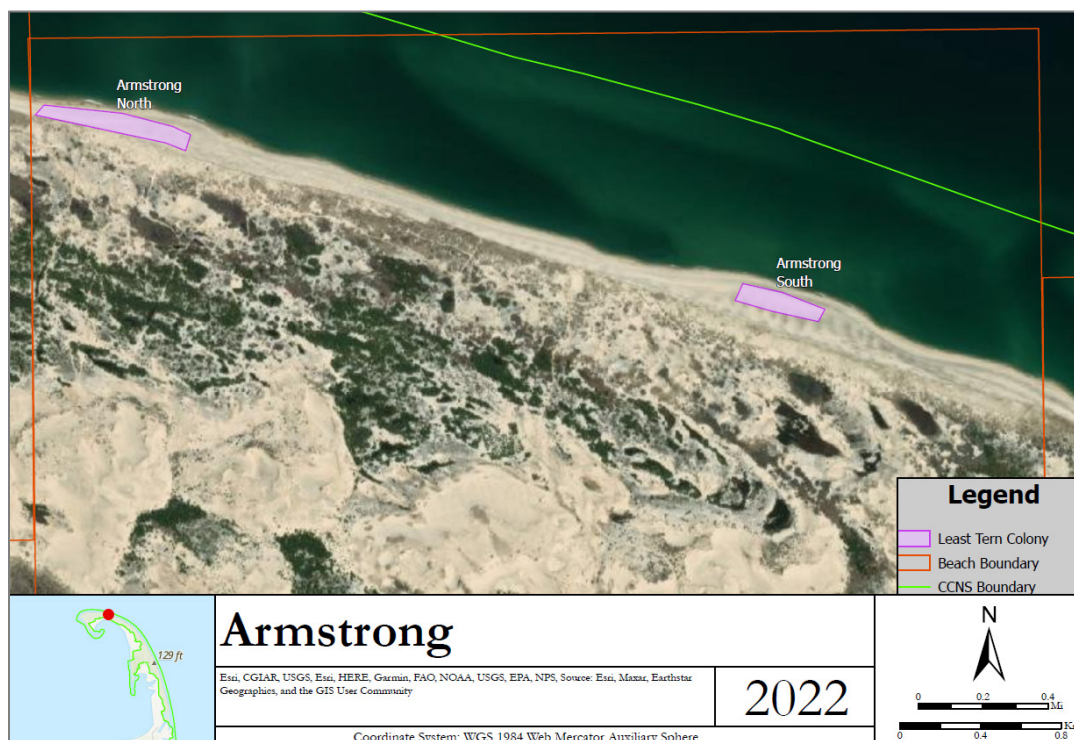


Figure 36. Least tern nest sites at Armstrong, Cape Cod National Seashore, 2022.
NPS / CACO

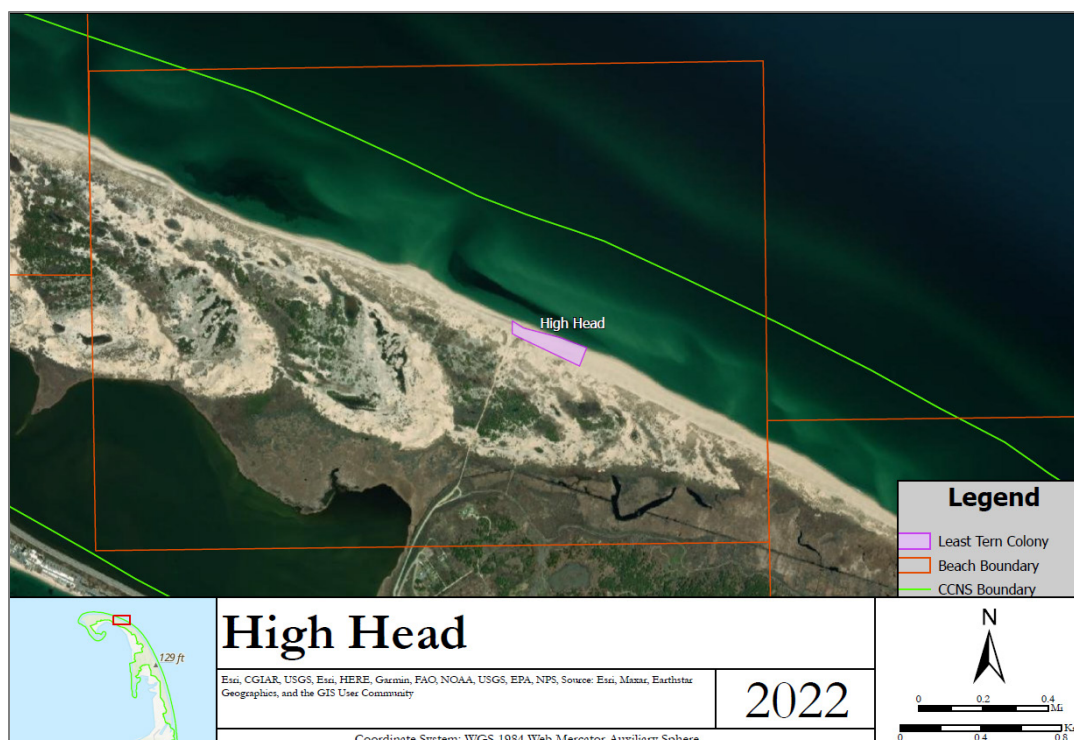


Figure 37. Least tern nest sites at High Head, Cape Cod National Seashore, 2022.

NPS / CACO

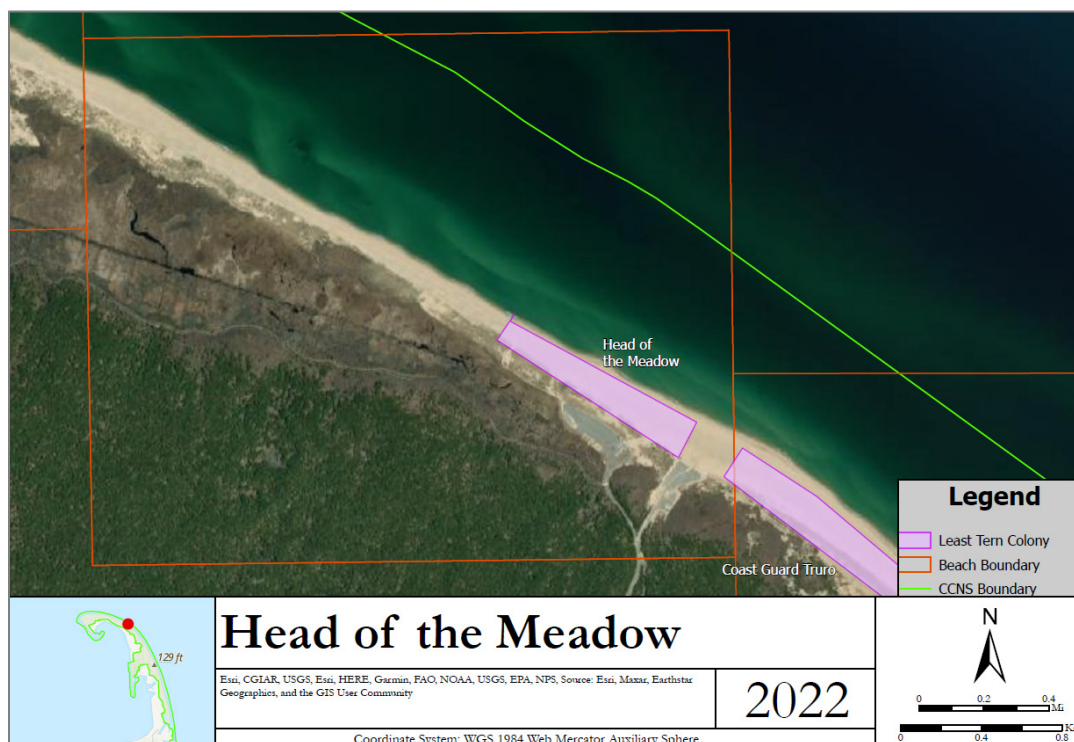


Figure 38. Least tern nest sites at Head of the Meadow, Cape Cod National Seashore, 2022.

NPS / CACO

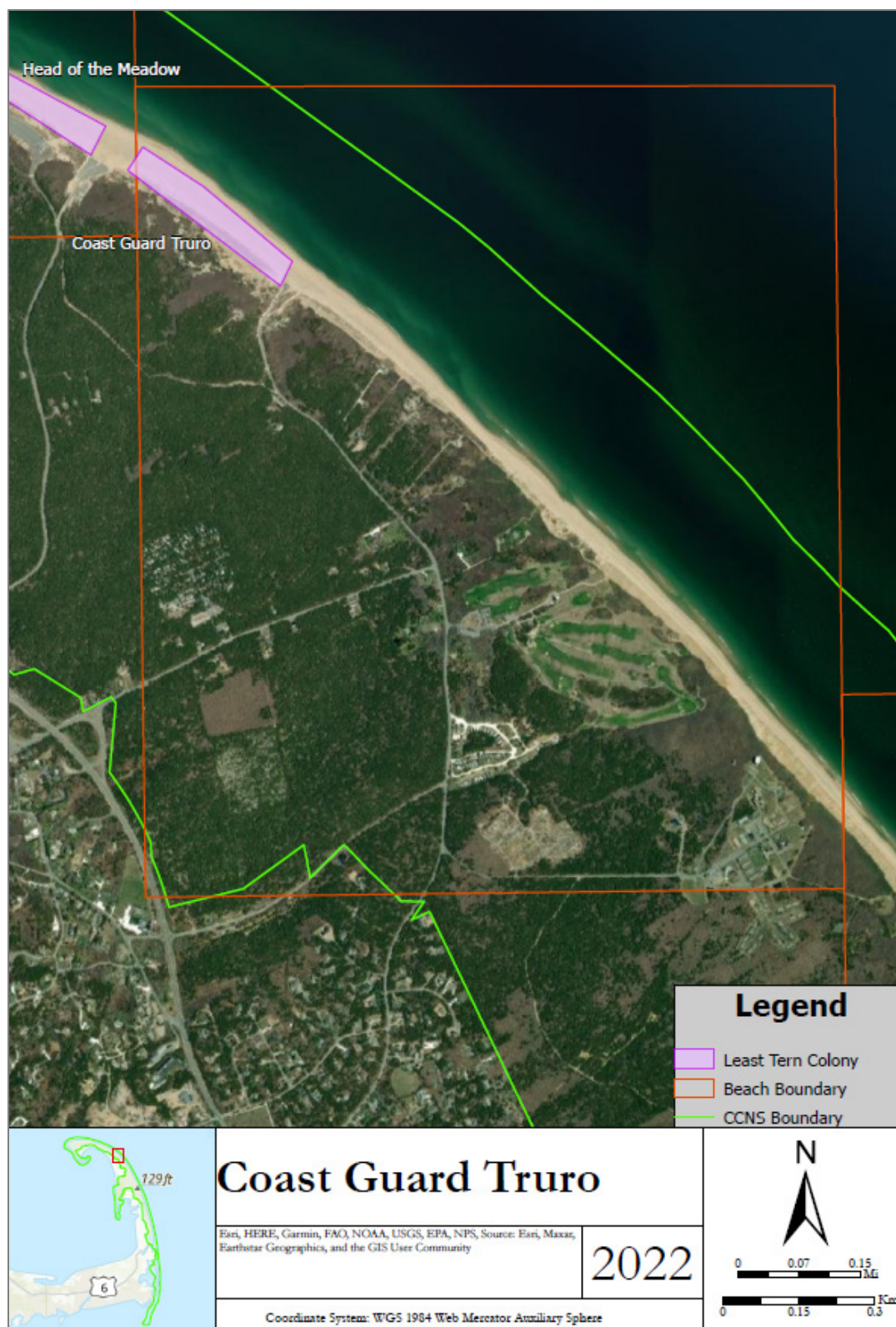


Figure 39. Least tern nest sites at Coast Guard Truro, Cape Cod National Seashore, 2022.
NPS / CACO

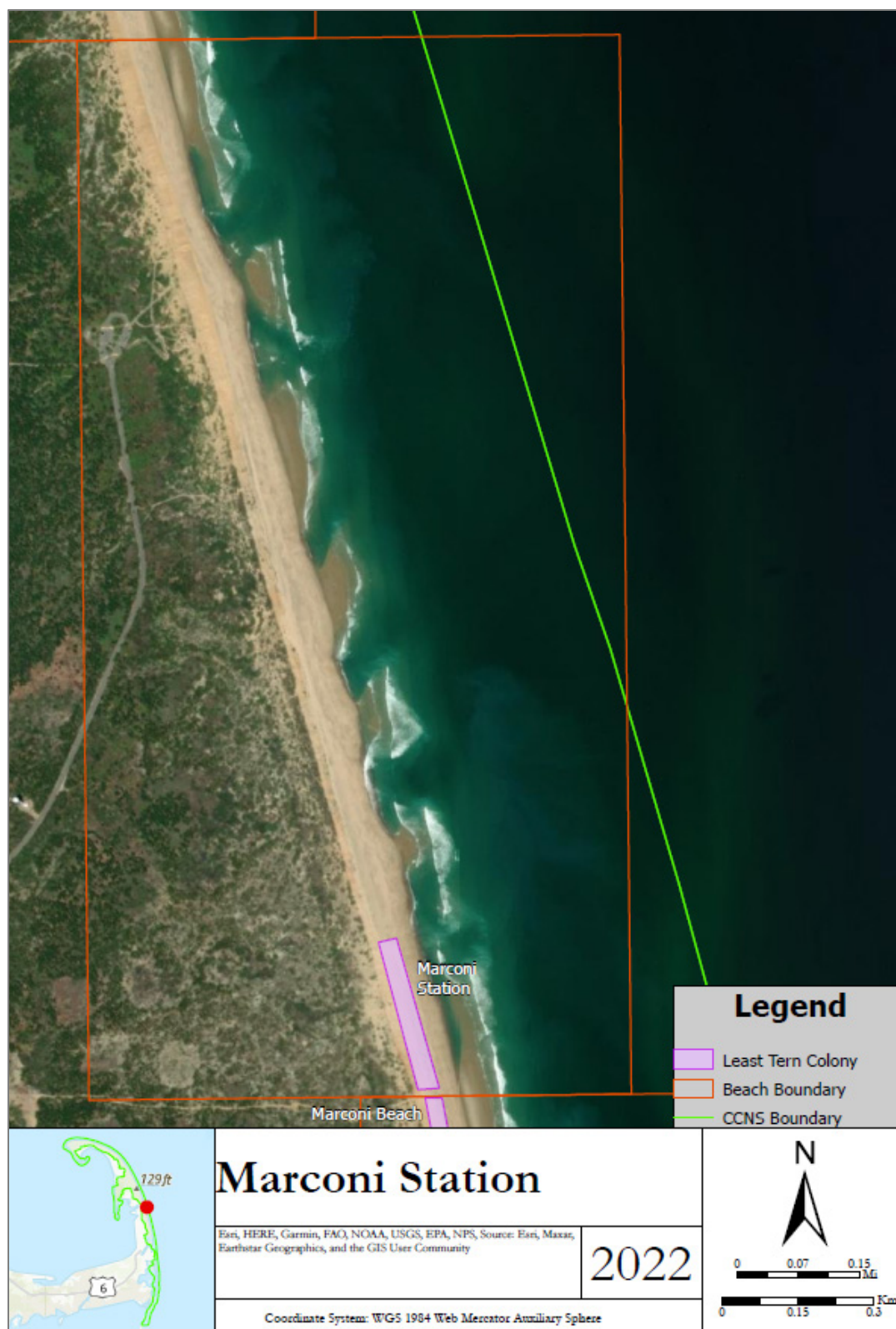


Figure 40. Least tern nest sites at Marconi Station, Cape Cod National Seashore, 2022.
NPS / CACO

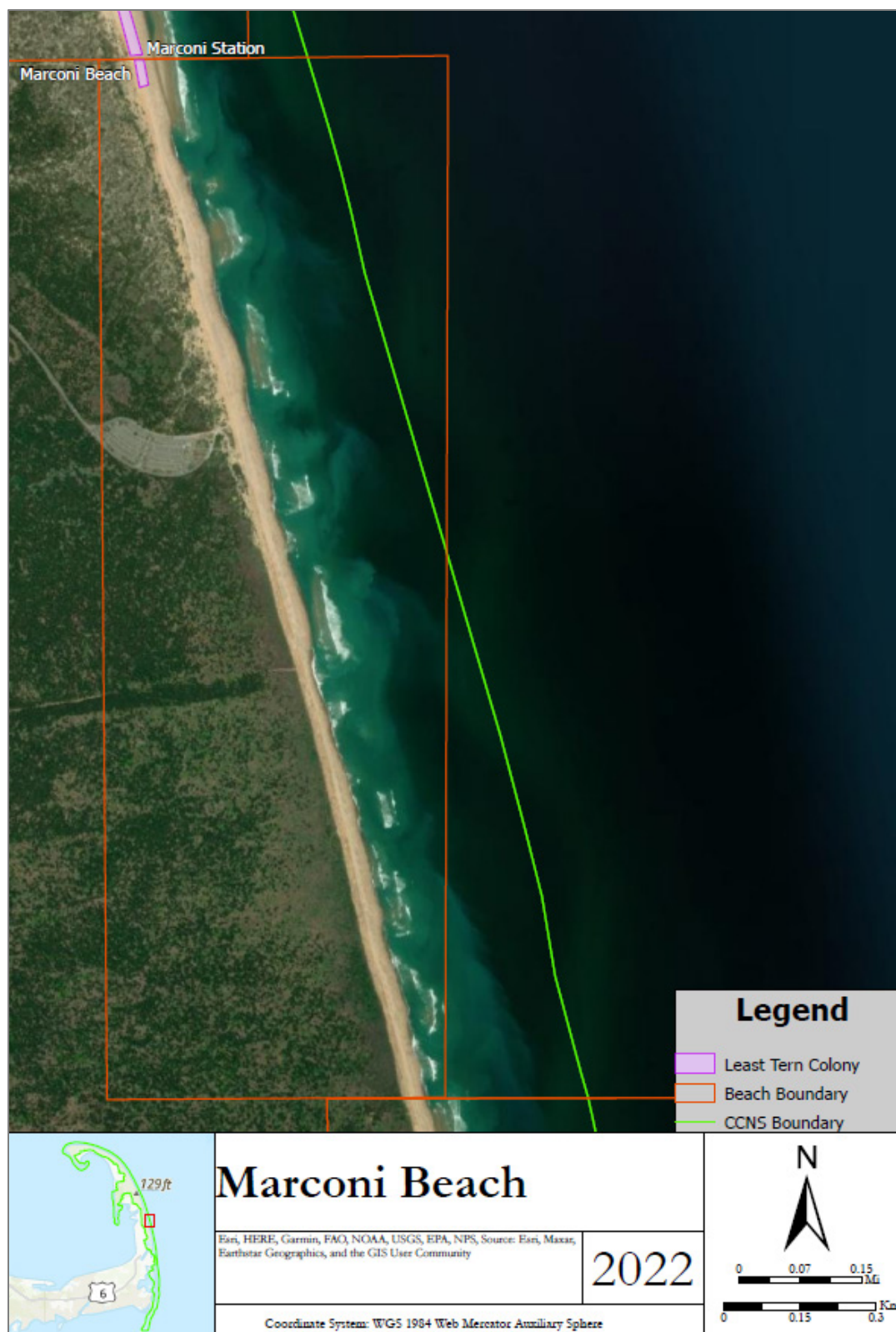


Figure 41. Least tern nest sites at Marconi Beach, Cape Cod National Seashore, 2022.
NPS / CACO

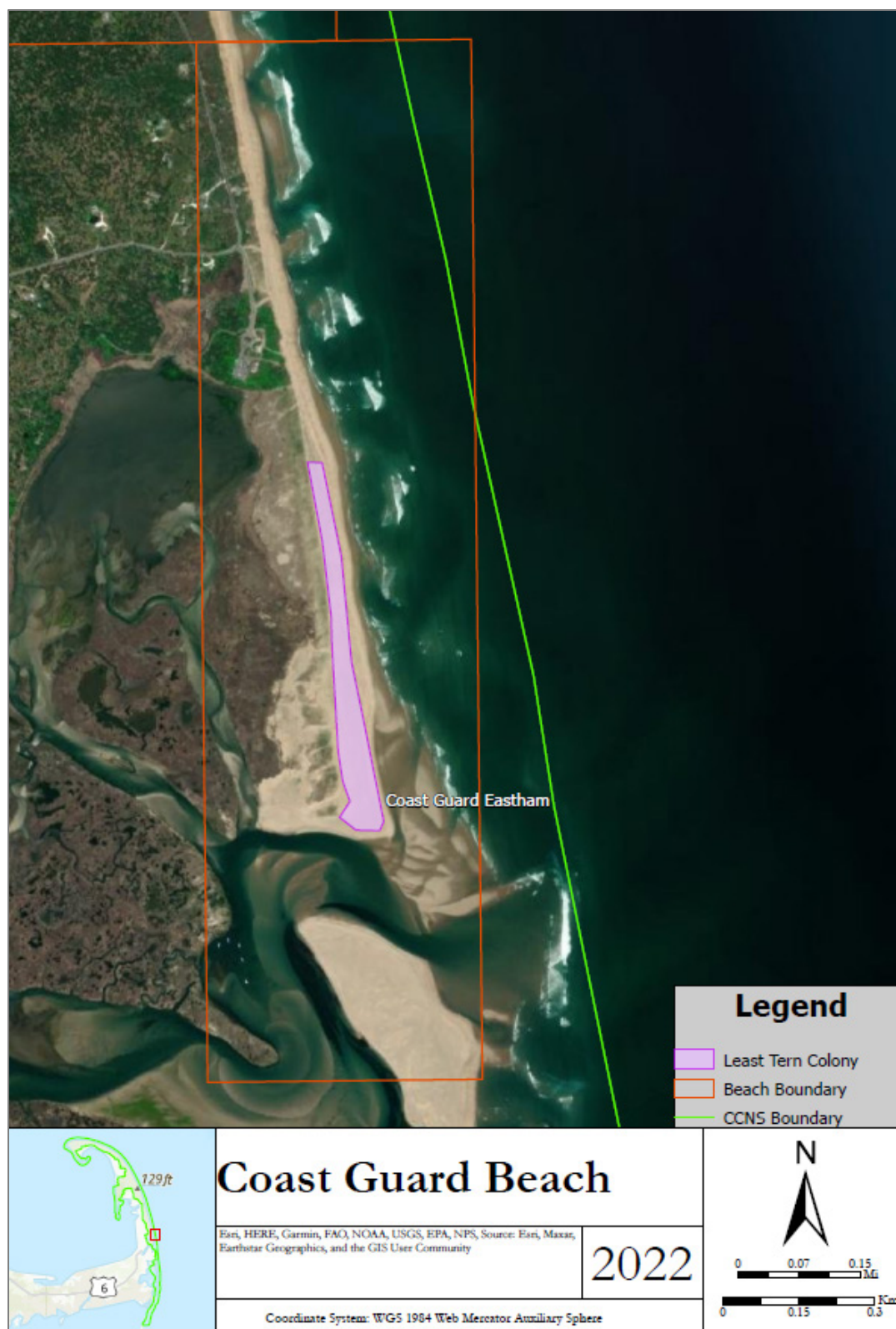


Figure 42. Least tern nest sites at Coast Guard Eastham, Cape Cod National Seashore, 2022.
NPS / CACO



Figure 43. Least tern nest sites at Jeremy Point, Cape Cod National Seashore, 2022.
NPS / CACO

Appendix C. Maps of 2022 American Oystercatcher Nest Sites at Cape Cod National Seashore

Figure 44 shows the locations of American Oystercatcher nests at CACO.



Figure 44. American oystercatcher nest sites at Jeremy Point, Cape Cod National Seashore, 2022.
NPS / CACO

National Park Service
U.S. Department of the Interior



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