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Shorebird Monitoring and Management at Cape Lookout National Seashore

2023 Annual Report

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Photo 1. Two adult piping plovers fight off a ghost crab at their nest inside a predator exclosure. Photo taken with motion-sensor trail camera. NPS photo.

Acknowledgments

We would like to thank our field staff members Karen Altman, Patrick Carr, Samantha Pepe, Andrea Knapp, Gabrianna Lucas, Rachael Rankin, and Alanna Richman for their tenacious efforts monitoring and protecting shorebirds at Cape Lookout National Seashore.

Introduction

Cape Lookout National Seashore (CALO) was established to preserve the natural resources of a natural barrier island system off the North Carolina coast from Ocracoke Inlet to Beaufort Inlet. CALO's 56 miles of shoreline is informally divided into three management units and the configuration of these units is subject to ocean overwash and inlet formation. North Core Banks (NCB) is approximately 23 miles long extending from Ocracoke Inlet to Ophelia Inlet. In 2023, NCB was divided into two islands by Evergreen Inlet at mile 3. These two islands are included together as part of the NCB management unit for data collection and analysis purposes. South Core Banks (SCB) extends southward from Ophelia Inlet almost 24 miles to Barden Inlet. Core Banks, NCB and SCB, have a northeast to southwest orientation and exhibit a low-profile landscape. The Atlantic Ocean is to the east of Core Banks and Core Sound and Pamlico Sound are to the west. The third unit, Shackleford Banks (SB), is 9 miles long and has an east-west orientation with a higher dune system and larger areas of vegetation. The Atlantic Ocean is to the south of SB and Back Sound is to the north.

CALO contains ecologically important habitats, such as sand flats, beaches, intertidal zones, and marshes that are critical to shorebirds. These habitats support the piping plover (*Charadrius melodus*) and red knot (*Calidris cantus rufa*), both species federally listed as threatened (USFWS, 1985; USFWS, 2014). Habitats also support the gull-billed tern (*Gelochelidon nilotica*), a species listed as threatened by the North Carolina Wildlife Resources Commission (NCWRC), and NCWRC special concern species including the American oystercatcher (*Haematopus palliates*) and colonial waterbirds (royal terns [*Thalasseus maxima*], sandwich terns [*Thalasseus elegans*], least terns [*Sterna antillarium*], common terns [*Sterna hirundo*], and black skimmers [*Rynchops niger*]) (NCWRC, 2014). CALO was designated a Globally Important Bird Area by the American Bird Conservancy in 2001 in recognition of the value CALO provides to bird migration, breeding, and wintering (Audubon, 2017).

CALO is also a popular recreation destination and attracts hundreds of thousands of visitors annually. Recreational activities include fishing, shelling, hunting, wildlife viewing, boating, beach recreation, surfing, photography, nature study, and off-road vehicle (ORV) use on the beaches. Shorebirds are affected by human disturbances, habitat loss, and predation. Human disturbance, both direct and indirect, may result in nest or chick loss. Depredation by mammals, birds, and ghost crabs have influenced the breeding success of nests and broods at CALO, as well. CALO monitors and manages shorebirds, habitat, and predators to promote successful reproduction to achieve population recovery of declining species. Shorebird nesting and foraging areas are protected with closures, buffers, and regulations.

Cape Lookout National Seashore Off-road Vehicle Management Plan

The 2016 Cape Lookout National Seashore Off-road Vehicle Management Plan (ORV Plan) establishes ORV management practices and procedures and provides requirements on monitoring and managing protected species at CALO (NPS, 2016). The ORV Plan includes establishment of temporary nesting closures, buffer distances, and wildlife protection zones. The ORV Plan also

outlines a required monitoring schedule for the protected species of concern. In 2021, CALO established a paid permit requirement for ORV users to drive on the beach. ORV users must sign the permit attesting to their understanding of the ORV routes, rules, and management for protected species.

Resource Protection Areas

Resource protection areas include nesting closures and wildlife protection zones. Nesting closures protect current and potential shorebird breeding habitat from human disturbances and are established prior to breeding activity where nesting has occurred in the past five years or as new breeding activity is discovered according to species. These areas are temporarily closed to public entry during the nesting season. The closures provide a disturbance free area for birds to establish territories and nest in optimal habitat. The closures are adjusted to meet disturbance buffer requirements as needed. Wildlife protection zones are established during the brood rearing phase around nesting and foraging areas to protect birds from direct and indirect human sources of recreational vehicle use mortality. Outside of the breeding season there are general resource closures to protect migrating and wintering piping plovers and their habitats.

Predator Management

Since 2017, CALO has entered into annual interagency agreements with the United States Department of Agriculture's (USDA) Wildlife Services to conduct predator removal targeting coyotes and raccoons to benefit nesting shorebirds and sea turtles. Predator management was delayed until after the shorebird nesting season at CALO in 2023 due to contracting delays. USDA Wildlife Services removed a total of four coyotes and eight raccoons in September of 2023 on SCB. No mammalian trapping occurred on SB and NCB in 2023. A total of 48 coyotes and 189 raccoons have been removed from CALO by USDA Wildlife Services between 2017 and 2023.

In 2023, CALO staff piloted the targeted removal of ghost crabs around piping plover nests using Fripps traps (Natoli, 2012). CALO staff set a total of 127 traps around 14 piping plover nests and captured and removed 51 ghost crabs.

Resource Violations

Resource management staff record resource violations they observe throughout the breeding season. In 2023, staff recorded a total of 230 violations. One hundred and seventeen were on NCB, 112 were on SCB, and one was on SB (see Appendix A, Map A1). Staff observed 64 pedestrians in bird closures, 28 vehicles in bird closures, 39 vehicles in turtle closures, 60 dogs off leash, one incident of visitors feeding wildlife, and 38 vehicles operating otherwise out of bounds. Resource staff corrected 84 of these observations and severe offenses were reported to law enforcement. Resource staff are unable to correct violations that are observed after-the-fact by the presence of tire tracks or footprints within closed areas.

Piping Plover (*Charadrius melodus*) Management and Monitoring

Background

The piping plover is listed as a federally threatened species by the U.S. Fish and Wildlife Service (USFWS, 1985). Piping plover monitoring at CALO began with a baseline study in 1989 (Fraser et al., 1990). Monitoring has continued annually by CALO staff since 1992. The park is a significant nesting area, containing approximately 80% of the nesting pairs in the state of North Carolina (Johnson, 2021). CALO also serves as a wintering and migratory site. There are three designated wintering critical habitat units within the CALO boundary (USFWS, 2008). Monitoring focuses on documenting reproductive success, implementing methods to increase the productivity of this threatened species, and non-breeding use surveys. This report contains a summary of monitoring results for 2023, comparisons to results from previous years, and discussions based on long-term monitoring of piping plovers at CALO.

Methods

Monitoring

The ORV Plan contains management guidelines and monitoring protocols (NPS, 2016). Following these protocols, park staff conducted daily surveys of posted nesting habitat beginning in April. Potential habitat outside posted areas was monitored and posted as necessary. Breeding territories and pairs were identified based on observed breeding behavior. Behavior such as territorial displays, elliptical flights, nest scraping, high stepping, and copulation was recorded. Nests were located and monitored daily until they hatched or were lost.

Once nests were identified, the locations of the nests were recorded using a Geographic Information System (GIS). Nest locations were marked inconspicuously with onsite objects like sticks or shells to facilitate follow-up checks. The number of eggs in the nest were monitored to determine nest initiation and full clutch completion. Full time incubation starts at clutch completion and averages 27 days. An estimated hatch date is assigned to each nest. If the nest is found at full clutch then the estimated hatch date is 25 days from nest discovery. Information about the habitat type was noted. Adults were surveyed for bands and any band codes were recorded. Motion-triggered trail cameras were installed at some exclosed nests to aid in monitoring.

Nests were checked every one to three days to monitor the status of incubation and document losses. Nest checks were recorded in the GIS. When nests were lost, CALO staff would check the area for signs of predation or other causes of nest failure. Nests that near their estimated hatch date were monitored daily for hatching. When a nest hatched, broods were monitored daily until they fledged or were lost. The number of chicks and location were recorded daily in the GIS. The last know location of broods were checked daily and if broods were not seen at that location, then the search expanded to other possible foraging locations in the area. Unaccounted for broods were searched for for seven days after the last sighting to be certain of the fate. Fledging occurs from 25-35 days after hatch. The fledge date is recorded when chicks are capable of strong sustained flight. Monitoring stops once chicks are fledged.

Counts of wintering and migrating piping plovers were made monthly from August to March during the non-breeding season. The counts were made near the 15th of each month. The ocean beach, inlets and soundside sandy beaches of each island were surveyed. Banded birds were searched for on the 5th, 15th, and 25th of August, September, and October during the fall migration.

Management

Nesting Closures

Management actions for piping plovers included closing nesting habitat, closing ocean beach foraging zones for chicks, predator exclosures for nests, predation management, and banding. Bird Sanctuary signs were used to close all known piping plover habitat to pedestrian and vehicular entry by April 1. Portsmouth Flats, Kathryn-Jane Flats, Swash Inlet, the ponds at Mile 10 and Mile 15, Old Drum Inlet, New Drum Inlet, Ophelia Spit, Plover Inlet, Cape Point, and Power Squadron Spit were posted by April 1. These areas include the upper beach, dunes, sand flats, and mud flats. The active ocean beach in front of the nesting areas is not a part of the nesting habitat closure and are open for recreational use with some limitations. Additional closures were posted during the breeding season for new breeding activity at Mile 14 and Mile 17 on NCB.

In accordance with the ORV Plan, the northern mile of SCB at the Plover Inlet site is closed to vehicles once chicks hatch. The ocean beach is exceptionally narrow at this nesting site and chicks can quickly move to the oceanside. All other locations require chick presence on the beach to trigger an ocean beach foraging protection zone closure. These protection zones close sections of the ocean beach to vehicles to maintain the required 600-foot buffer between chicks and vehicle traffic. Pedestrian traffic is allowed in these foraging protection zones. NPS administrative use vehicles are allowed in the ocean beach closures to meet work requirements. Broods were monitored daily, and closed sections of beach were re-opened once all chicks were either lost or fully fledged with strong flight observed.

Predator Management

In addition to regular predator removal activities, CALO staff protected some nests with predator exclosures if the topography of the location was suitable for exclosures and the location was accessible by vehicle. Exclosures were circular, 10 feet in diameter, made of 4”x 2” mesh wire fence anchored with steel rebar and were topped with ¾” mesh bird netting. Use of predator exclosures and monitoring adhered to the Piping Plover (*Charadrius melodus*) Atlantic Coast Population Revised Recovery Plan (USFWS, 1996).

Banding

CALO staff recorded band re-sights of individuals and nesting pairs at CALO throughout the year. Research staff from the Virginia Tech Shorebird Laboratory were permitted to band breeding pairs and chicks. Banding allows researchers to track population demographics, breeding patterns, habitat requirements, and survival. It also allows CALO staff to track individual nesting patterns and movements of birds throughout the park.

Results

Productivity

A total of 31 piping plover breeding pairs were confirmed nesting at CALO in 2023. Twenty-six pairs nested on NCB and five pairs on SCB. One additional pair was on territory for the entire season on NCB but a nest was never located. This unconfirmed pair is not included in productivity calculations. Birds nested in 10 distinct areas (Table 1). There were 44 documented nesting attempts made in 2023. The earliest nest initiation was on April 21 and the latest was on June 30. Thirty-six nests were on NCB and eight were on SCB. Of the 44 nests, 13 were re-nests. Fifteen nests hatched and four chicks fledged from three different broods. A total of 117 eggs were documented with an average clutch size of 2.72 eggs. Field staff observed 32 hatched chicks but estimated an additional 11 chicks likely hatched but were lost before being observed. Productivity for CALO was 0.13 chicks fledged per breeding pair, compared to an average productivity of 0.55 over the previous 23 seasons. Table 2 contains nesting success data from 2000 to 2023. Figure 1 illustrates the number of pairs and chicks fledged from 1989 to 2023. Refer to Appendix A, Map A2 for a detailed map of nests and nest sites and Appendix B, Tables B1 and B2 for individual nest productivity data for 2023.

Table 1. Piping plover reproductive success data by nesting site in 2023.

Island	Nesting Area	Number of Pairs	Hatch Success	Fledge Success (chicks/pair)
North Core Banks	Portsmouth Flats	5	0.25	0.00
North Core Banks	Kathryn-Jane Flats	7	0.38	0.00
North Core Banks	Swash Inlet	2	1.00	0.5
North Core Banks	Mile 10	1	1.00	1.00
North Core Banks	Mile 14	1	0.00	0.00
North Core Banks	Mile 15	2	0.5	0.00
North Core Banks	Old Drum Inlet	3	0.14	0.00
North Core Banks	New Drum Inlet	3	0.40	0.00
North Core Banks	Ophelia Spit	2	0.5	0.00
South Core Banks	Plover Inlet	5	0.25	0.40

Table 2. Summary of piping plover reproductive success data at CALO from 2000 to 2023.

Year	Total Nests	Breeding Pairs	Total Eggs	Nests Hatched		Eggs Hatched		Chicks Fledged		Fledge Rate (Chicks/pair)
				#	%	#	%	#	%	
2000	18	16	65	12	67%	43	66%	8	19%	0.5
2001	19	16	64	8	42%	24	38%	5	21%	0.31
2002	20	15	65	13	65%	43	66%	4	9%	0.27
2003	15	14	55	7	47%	23	42%	6	26%	0.43
2004	13	13	44	11	85%	37	84%	12	32%	0.92
2005	31	27	105	24	77%	69	66%	23	33%	0.85
2006	37	33	125	29	78%	87	70%	29	33%	0.88

2007	58	45	173	29	50%	79	46%	11	14%	0.24
2008	57	46	179	31	54%	88	49%	9	10%	0.20
2009	45	36	145	24	53%	83	57%	30	36%	0.83
2010	58	43	204	34	59%	98	48%	31	32%	0.72
2011	48	41	157	35	73%	102	65%	37	36%	0.90
2012	66	51	207	36	54%	98	47%	29	30%	0.57
2013	52	45	173	30	58%	97	56%	47	48%	1.04
2014	57	47	190	28	49%	88	46%	9	10%	0.19
2015	56	43	209	32	57%	105	50%	34	32%	0.79
2016	41	30	133	13	32%	23	17%	5	22%	0.17
2017	44	27	104	13	30%	27	26%	4	15%	0.15
2018	30	24	105	19	63%	56	53%	20	36%	0.83
2019	33	24	112	20	61%	65	58%	15	23%	0.62
2020	30	22	103	21	70%	65	63%	15	23%	0.68
2021	41	32	142	22	54%	68	47%	11	16%	0.34
2022	43	27	138	16	37%	38	28%	6	16%	0.22
2023	44	31	117	15	34%	43	37%	4	9%	0.13

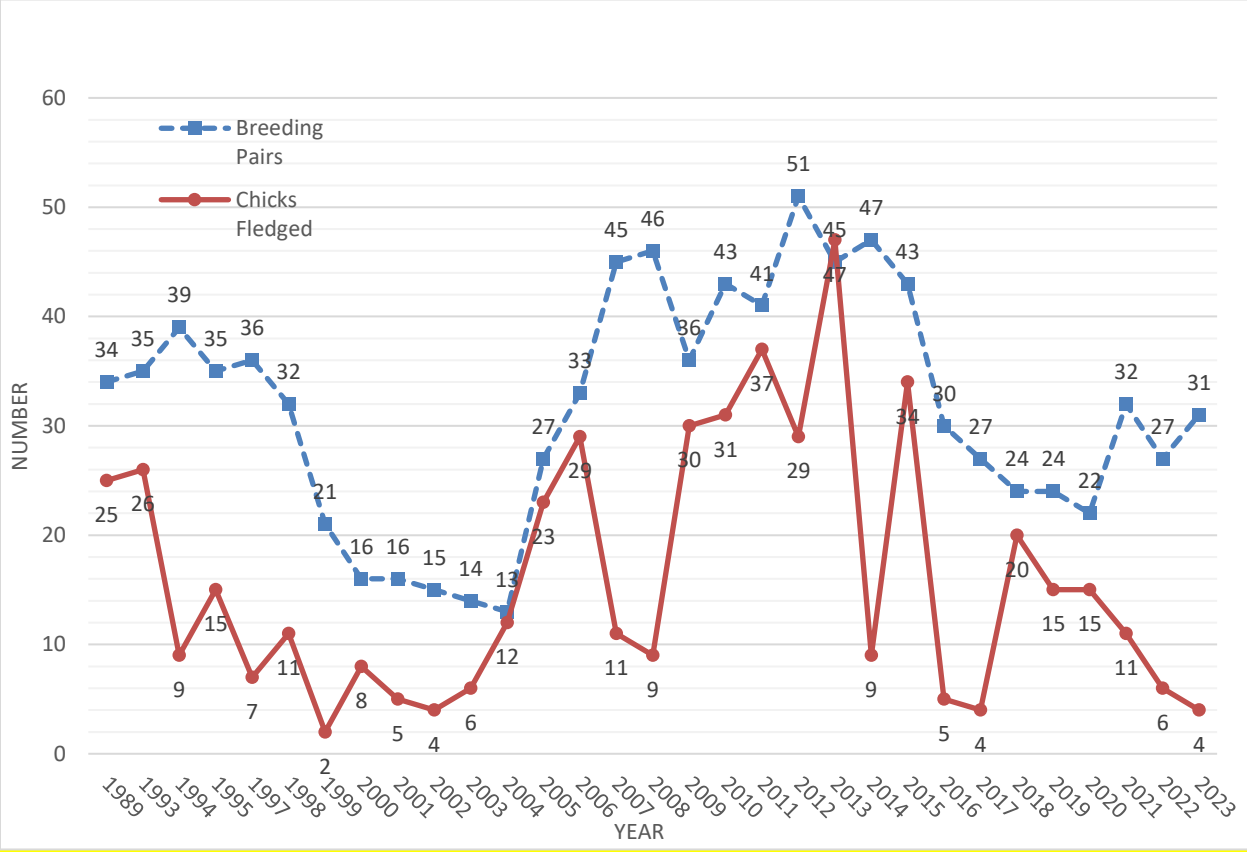

Figure 1. The number of piping plover breeding pairs and number of chicks fledged by year at CALO from 1989 to 2023.

Nest Failures and Chick Mortality

In 2023, predator exclosures were used to protect 22 (50%) nests. Of the nests with exclosures, fourteen (64%) hatched. Five exclosed nests were lost to flooding, two were lost to ghost crab predation, and one was lost to an unknown reason. Predator exclosures were not used on 22 (50%) nests and only one of these nests hatched (5%). In total, 29 nests did not hatch; 12 were lost to unknown reasons, 10 were lost to flooding, six were predated, and one was abandoned (Table 3). Of the six predated nests, five were by ghost crab and one was by a coyote.

Due to the mobile nature of precocial chicks and lack of prolonged observations, the cause of chick mortality is largely unknown. Park staff estimated that 43 chicks hatched in 2023 and four of those survived to fledging (9%). Twelve of the hatched nests suffered complete brood loss. All 39 chick losses were classified as unknown.

Table 3. Causes of piping plover nest failure in 2023.

Nesting Site	Nests	Total Lost	Predation	Weather	Abandoned	Unknown
Portsmouth Flats	8	6	2	2	0	2
Kathryn-Jane Flats	8	5	2	1	0	2
Swash Inlet	2	0	0	0	0	0
Miles 10	1	0	0	0	0	0
Mile 14	1	1	0	1	0	0
Mile 15	2	1	0	0	0	1
Old Drum Inlet	7	6	0	2	0	4
New Drum Inlet	5	3	1	1	0	1
Ophelia Spit	2	1	0	0	0	1
Plover Inlet	8	6	1	3	1	1
Total	**44**	**29**	**6**	**10**	**1**	**12**

Beach Protection Zones and Brood Foraging

The area between Ophelia Inlet and mile 25, 1.8 mile in length, was established as a protection zone for piping plover, American oystercatcher, and colonial waterbird chicks from May 23 to August 16. This area was closed to recreational ORV's and only NPS monitors were allowed to operate vehicles in this area. Piping plover chicks were present at Ophelia Inlet from June 21, when the first nest hatched, to August 16, when the last brood fledged. On NCB, piping plover chicks did not use the ocean beach and there were no wildlife protection zones established for plovers during the 2023 season.

Chicks from all broods foraged on soundside beaches, sand flats, mudflats, ponds, and ephemeral pools in areas off-limits to vehicles and, in most cases, all entry. In 2023, brood locations were recorded in a GIS to track brood movements and home ranges. Foraging ranges were calculated for broods that fledged at least one chick using the Minimum Bounding Geometry tool in ArcGIS Pro. Brood foraging ranges for the three broods that fledged were 1.10 acres, 2.83 acres, and 12.01 acres

(see Appendix A, Map A3). The farthest distance traveled away from the nest for all brood observations was 0.32 miles in which a brood at Old Drum traveled from their nesting site to open foraging flats before being lost.

Migrating and Wintering Piping Plovers

Park wide non-breeding piping plover surveys were conducted monthly January through March and August through December in 2023. A total of 1,017 piping plovers were documented during non-breeding surveys from 181 separate observations (see Appendix A, Map A4; Appendix C). The highest number of non-breeding piping plovers were recorded in August with 354 birds seen at CALO (Table 4).

Of the 1,017 birds observed, 701 (69%) were recorded as unbanded and 104 (10%) were recorded as banded. Of the 104 observations of banded birds, field staff obtained full band combinations for 90. Two-hundred and twelve (21%) birds were recorded as unknown banding status. Staff recorded banded birds from both the Atlantic Coast and Great Lakes piping plover populations.

In addition to monthly surveys, staff recorded an additional 88 observations totaling 451 piping plovers during 2023. These were typically opportunistic sightings, some occurring during the breeding season, and did not follow any survey protocol.

Table 4. Number of non-breeding piping plover individuals observed during non-breeding surveys each month of 2023.

Island	January	February	March	August	September	October	November	December
NCB	23	8	49	163	140	58	23	15
SCB	24	0	30	156	82	82	28	27
SB	3	0	37	35	19	6	0	9
Total	**50**	**8**	**116**	**354**	**241**	**146**	**51**	**51**

Banding

Virginia Tech Shorebird Laboratory researchers trapped and banded five new adults from four nests with individual field readable codes. One previously banded adult was recaptured and resampled. No chicks were banded in 2023. Of the 61 individuals nesting at CALO, 34 (56%) were banded and 27 (44%) were unbanded. One banded female nested with two different males. Seven (23%) pairs were completely unbanded while 24 (77%) pairs had at least one individual banded. Of note, one of these banded birds has nested at CALO during eight nesting seasons. GF(A5P) is a female that was banded as a chick in 2015 and has produced four fledglings since 2016. Another bird, GF(0M6), is a male that has fledged three chicks over 7 breeding seasons. See Appendix B for nesting pair band combinations.

Egg Floating

When nests are found at full clutch the stage the incubation is unknown. Egg floating can be used to estimate the incubation age of the nest. Trained CALO staff may float eggs for certain nests that are

found at full clutch when management decisions need to be based on estimated hatch dates or when suitability for trapping needs to be assessed. In 2023, CALO staff floated eight eggs from four nests.

Discussion

With a productivity of only 0.13 chicks per breeding pair, the 2023 season had the second lowest piping plover productivity recorded at CALO. In 1999 the productivity rate was 0.11 chicks per breeding pair, only 2 chicks were fledged from 21 pairs. Low productivity in 2023 was the result of both poor hatch success and poor chick survival. Only 34% percent of nests laid hatched, compared to an average of 57% in the prior 23 seasons. Similarly, only 9% of chicks that hatched survived to fledge, compared to the 23-year average of 25%.

Known factors driving poor hatch success were weather and ghost crab predation while the cause of 41% of nest losses remained unknown. Weather events led to the majority of known nest losses and these events were mostly tide and wind driven and not associated with large storm events. These type of regular high tide events may be increasing due to climate change and sea level rise. The second largest known impact to piping plover nests was ghost crab predation. Motion-sensor trail cameras were installed at 19 piping plover nests in 2023. Ghost crab predation was recorded by trail camera for one nest and suspected for four other nests. In addition to direct predation of eggs at nests, ghost crabs also disturbed incubating adults. Cameras captured many instances of plover adults fighting off ghost crabs within predator exclosures, resulting in adult energy expenditure and exposure of the eggs to temperature fluctuations. In one extreme example, 27 separate interactions were recorded of piping plover adults fending off ghost crabs at their nest. In one of those interactions, the ghost crab is seen picking up and then dropping an egg. This nest eventually hatched after losing one egg during incubation, but the chicks were quickly lost. These observations demonstrate that ghost crabs can cause significant disturbance for incubating plovers, even if they do not result in direct predation of eggs.

Ghost crab traps were installed at 14 piping plover nests resulting in the removal of 51 ghost crabs from piping plover habitat. Of the 14 nests with traps installed, 10 hatched and 4 failed. Of the 30 nests that did not receive traps, 5 hatched and 25 failed. However, traps installation was not randomly assigned, varied throughout the season based on workload and level of ghost crab activity at nests, and only exclosed nests received traps. Therefore, a cause-and-effect relationship cannot be determined based on these results. When considering only exclosed nests the effect is much less pronounced. Of exclosed nests that did not receive ghost crab traps an equal number hatched and failed. A structured and randomized study would need to be conducted to determine if ghost crab trapping has a positive benefit to piping plovers at CALO. Despite trapping efforts, hatch success and fledge success remained very low in 2023.

Unfortunately, predator exclosures do not protect against weather or ghost crabs. Thirty-six percent of exclosed nest still failed to hatch in 2023. In addition, only 50% of nests received predator exclosures primarily due to nests failing before exclosures could be installed. At CALO, nests are required to have at least 3 eggs before an exclosure can be installed. Of the 22 nests that were not exclosed, 16 (73%) of those failed before 3 eggs were reached and most of those failures were due to unknown causes. Due to fear of attracting predators, cameras are not installed on nests until an

exclosure has been established at the nest, so we know little about what causes these early failures. One hypothesis is that because adults are not tending the nest full time before clutch completion, nest are being left unprotected from ghost crabs and other small predators.

Chick survival continues to be a problem at CALO with only 9% of hatched chicks surviving to fledge in 2023. Unfortunately, little is known about chick survival at CALO. Although ghost crab and gull-billed tern predation has been recorded in past years no observations were documented this year. Other factors including disturbance and habitat availability may play role in chick survival. In 2023, most chick loss was sustained very early in the brood rearing phase. A targeted chick study that aims to determine the cause of chick failure is needed to better understand chick survival dynamics at CALO.

Piping plovers continue to colonize new sites on NCB since the restructuring of the habitat during Hurricane Dorian in 2019. Plovers were documented nesting at new ponds at mile 5 (an extension of the Kathryn-Jane site), mile 14, and mile 15. Interestingly, two sites created by Hurricane Dorian, Swash and mile 10, were the only sites to produce fledglings on NCB. The larger traditional nesting sites did not produce any chicks. It's unknown why these smaller pond sites were more successful, but one hypothesis is that more vegetation at ponds provide better cover from avian predators such as gull-billed terns compared to open flats near colonial waterbird colonies. This demonstrates that these ponds are of potential significance to nesting piping plovers at CALO. The University of North Carolina is currently studying these ponds to help CALO managers determined if and how they should be managed.

CALO continues to be an important stopover site for migrating piping plovers in the fall. CALO staff counted a high of 354 piping plovers in August of 2023. Though short of the previous years record count of 481, the 2023 migration counts are the second highest recorded at CALO. Concentrations of plovers were highest at the Plover Inlet site on SCB and Evergreen Inlet area on NCB. Though CALO may be in a slump for plover productivity, the habitat does appear to be recruiting increased numbers of migrating plovers.

CALO continues to see a downward trend in piping plover productivity over the past decade, with 2023 being a historically poor year, despite pair counts remaining stable since 2016. More intensive research and management may be required to correct this negative trend. However, piping plover monitoring and management is time intensive and only accounts for a fraction of the duties for biological monitors on Core Banks. Limited staff must balance nest searching, predator exclosure installation, camera installation, and ghost crab trapping efforts with monitoring requirements of other species. With nests failing early in incubation, it can be assumed that nests fail before being detected by staff. In addition, brief observations of broods are not informative of the cause of chick loss. An increase in staffing levels would not only lead to be better monitoring of piping plovers, but also allow for more effective management such as additional camera monitoring to fill in data gaps and more structured ghost crab trapping to determine effectiveness. In addition, collaboration with research institutions to answer questions about chick survival, population trends, impacts of climate change, and predator dynamics could better inform piping plover management at CALO.

American Oystercatcher (*Haematopus palliates*) Management and Monitoring

Background

American oystercatchers are ground-nesting shorebirds that are native to North Carolina. They are common nesters throughout CALO, particularly on the ocean beach. They have been listed since 2008 as a North Carolina Special Concern species by the NCWRC (NCWRC, 2014). Their choice of nesting habitat makes them particularly vulnerable to disturbance by park visitors and off-road vehicles.

Monitoring American oystercatcher nesting at CALO began in 1995. A researcher from Duke University studied nesting on SCB and found low reproductive success (Novick, 1996). The research documented chick mortality caused by off-road vehicles. Researchers from North Carolina State University (NCSU) and CALO staff have also recorded vehicle traffic chick mortality (Schulte and Simons, 2015). Between 1997 and 2015, NCSU and CALO staff have conducted censuses, monitored nesting success, and banded American oystercatchers primarily on the Core Banks. Between 2016 and 2023, solely CALO staff conducted American oystercatcher monitoring. Monitoring and management are conducted following CALO's ORV Plan. Data in this summary report are presented from the last 20 breeding seasons, 2004 to 2023, during which all barrier island habitat at CALO was monitored regularly.

Methods

Monitoring

The ORV Plan contains management guidelines and monitoring protocols (NPS, 2016). Following this protocol, park staff conducted surveys of SB for nesting birds twice a week beginning in April. Daily surveys of nesting habitat on NCB and SCB also began in April and breeding monitoring continued seven days per week until the end of the nesting season. All ocean habitat and accessible interior and soundside habitat was monitored for breeding activity. Marsh islands were not monitored or included in this report.

Once nests were identified, the locations of the nests were recorded using a GIS. Nest locations were marked inconspicuously with either a stake or objects like sticks or shells to facilitate follow-up checks. Information about the habitat type was also noted. Adults were surveyed for bands and any band codes were recorded.

Nests were checked every 1 to 3 days to monitor the status of incubation and document losses. Daily nest checks were recorded in the GIS. When a nest was lost, CALO staff would check the area for signs of predation or other causes of nest failure. When a nest hatched, chicks were monitored daily until they fledged or were lost. For reporting purposes, chicks were considered fledged at 35 days old based on a standard established by the American Oystercatcher Working Group in 2010. For management purposes, chicks were considered fledged when strong flight was observed.

Management

Nesting Closures

Management actions for oystercatchers on Core Banks included closing a 20’ by 20’ area around a nest with “Bird Sanctuary” signs if the nest was in danger of being run over by off-road vehicles or stepped on by pedestrians. Generally, nests found in the dunes were not posted. There is concern that predators might learn to associate posts with nests. Small posted areas may also unnecessarily attract curious park visitors and cause disturbance.

In addition to the closure around the nest, a 600-foot buffer was established around each nest to reduce disturbance. McGowan and Simons (2006) found evidence that human recreational disturbance can alter incubation behavior. This buffer allowed vehicle and pedestrian traffic to pass by on the lower beach by the ocean shoreline, but prevented stopping, parking, or camping near the nest that could reduce nest attendance by parents. The buffer zone was defined by two sets of 18” X 18” yellow signs placed on each side of a nest. Nests located in interior areas and within previously established wildlife closures did not receive buffer signs.

One day before the expected time of hatch, the ocean beach in that area was closed to vehicles with traffic routed to the backroad, a sand trail behind the primary dunes. In areas where there is no backroad, Bird Sanctuary signs were expanded to create a closed area for broods on the upper beach while allowing traffic to travel on the lower beach with a lowered speed limit of 15mph. In these areas, signs were posted on the lower beach to warn ORV operators of the presence of chicks in the area. In all areas, broods were monitored daily and closed sections of beach were re-opened once all chicks were either lost or fully fledged with strong flight observed.

Banding

Park staff recorded band re-sights of individuals and nesting pairs at CALO throughout the breeding season. In addition, trained biologists and technicians captured and banded American oystercatcher adults and chicks under a current USGS banding permit. Banding allows researchers to track population demographics, breeding patterns, habitat requirements, and survival. It also allows CALO staff to track individual nesting patterns and movements of birds throughout the park. Band re-sights and banding efforts are tracked and shared with partners through the American Oystercatcher Band Database. Details on American oystercatcher band combinations can be found at the website: http://www.amoywg.org/banding-re-sighting/.

Results

Productivity

In 2023, 54 pairs of American oystercatchers nested at CALO, 29 pairs on NCB and 25 pairs on SCB (Table 5, Appendix A, Map A5; Appendix D). There was no breeding activity documented on SB. Counts were for pairs on or near the ocean beach and did not include marsh islands. The first nest of the season was found on April 6 and the last nest was found on June 29.

Eighty-nine nests were documented at CALO; 42 on NCB and 47 on SCB. Hatch success was 36% for NCB and 9% for SCB. NCB produced 0.55 chicks per nesting pair while SCB produced 0.04 chicks per breeding pair. A total of 19 nests hatched at CALO and fledged 17 chicks producing an overall fledge rate of 0.31 for the seashore. (Table 5). Since 2004, fledge rates have ranged from 0.00 to 1.17 per pair with a mean rate of 0.51 from 2004-2023 (Table 6, Figure 2).

Table 5. American oystercatcher reproductive success by island in 2023.

Island	Breeding Pairs	Total Nests	Nests Hatched	Chicks Fledged	Fledge Rate
South Core Banks	25	47	4	1	0.04
North Core Banks	29	42	15	16	0.55
Shackleford Banks	0	0	0	0	N/A
Total	**54**	**89**	**19**	**17**	**0.31**

Table 6. Summary of American oystercatcher reproductive success data at CALO from 2004-2023.

Year	Total Nests	Nests Hatched	Breeding Pairs	Chicks Fledged	Fledge Rate
2004	71	38 (54%)	52	45	0.86
2005	66	26 (39%)	54	18	0.33
2006	70	23 (33%)	52	26	0.50
2007	99	21(21%)	61	31	0.51
2008	91	17 (19%)	57	15	0.26
2009	83	20(24%)	61	21	0.34
2010	113	28 (25%)	62	34	0.55
2011	114	29 (25%)	62	37	0.60
2012	99	31 (31%)	58	42	0.72
2013	104	32 (31%)	63	25	0.40
2014	87	39 (37%)	65	40	0.62
2015	112	37 (33%)	66	50	0.76
2016	121	17 (14%)	70	17	0.24
2017	133	5 (4%)	70	0	0.0
2018	123	28 (23%)	69	39	0.57
2019	84	33 (39%)	58	32	0.55
2020	85	28 (33%)	49	27	0.55
2021	74	40 (54%)	54	63	1.17
2022	81	20 (25%)	46	7	0.15
2023	89	18 (20%)	54	17	0.31

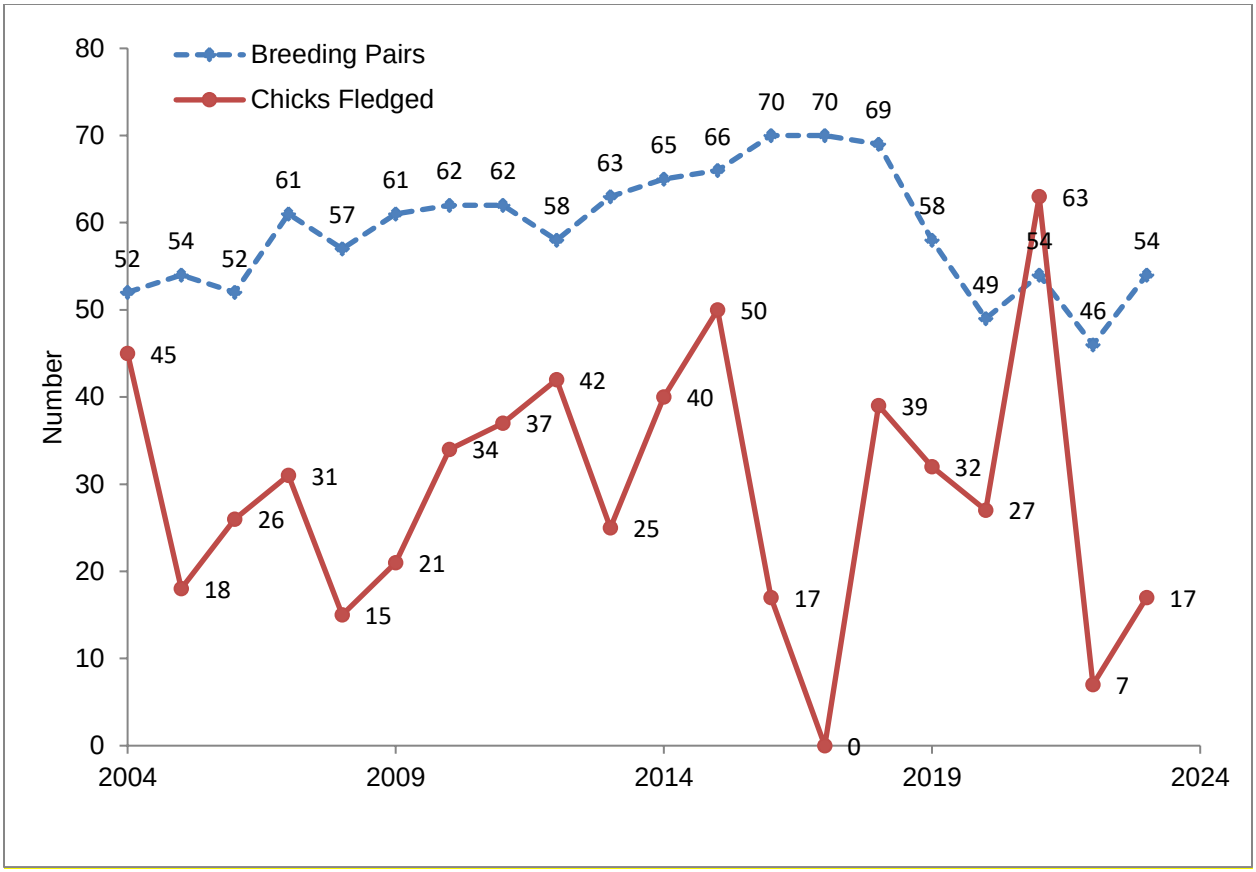

Figure 2. The number of American oystercatcher breeding pairs and number of chicks fledged by year at CALO between 2004 and 2023.

Nest Failures

Seventy nests failed in the 2023 breeding season. Thirty-four (48%) were lost due to predation, 23 (32%) were due to unknown causes, nine (13%) were due to weather, and four (6%) were abandoned (Table 7). Coyote was the primary predator in 2023, accounting for 20 nest loses (Table 8). Five additional nests were predated by ghost crabs, seven by unidentified predators, one by raccoon, and one by an avian predator. Two nests were abandoned on SCB after the adults were captured as part of a research project, another was abandoned after the eggs were moved to avoid flooding, and a fourth nest was abandoned due to unknown reasons. Causes of American oystercatcher nests failures from 2013 to 2023 are described in Table 9.

Table 7. Causes of American oystercatcher nest failure in 2023.

Island	Predation	Flooding/Storms	Abandoned	Unknown
South Core Banks	22	6	4	11
North Core Banks	12	3	0	12
Shackleford Banks	0	0	0	0
Total	**34**	**9**	**4**	**23**

Table 8. Recorded American oystercatcher nest predators in 2023.

Island	Coyote	Raccoon	Ghost crab	Avian	Unidentified Predator
South Core Banks	17	0	0	1	4
North Core Banks	3	1	5	0	3
Total	**20**	**1**	**5**	**1**	**7**

Table 9. Causes of American oystercatcher nest failure, 2013-2023.

Year	Total Nests	Nests Lost	Predation	Flooding/ Storms	Human Interaction	Abandoned	Unknown
2013	104	72 (69%)	21 (29%)	3	1	1	46
2014	87	49 (56%)	15 (30%)	6	0	1	27
2015	112	75 (67%)	41 (54%)	0	0	4	30
2016	121	104 (86%)	68 (65%)	2	2	2	30
2017	133	128 (96%)	76 (59%)	16	1	7	33
2018	123	95 (77%)	51 (54%)	3	2	3	36
2019	84	51 (61%)	25 (49%)	0	0	3	23
2020	85	57 (67%)	18 (32%)	2	1	3	30
2021	74	34 (46%)	15 (44%)	2	2	3	12
2022	81	61 (75%)	20 (33%)	17	1	6	17
2023	89	70 (77%)	34 (49%)	9	0	4	23

Chick Mortality and Movement

CALO staff observed 41 chicks from 19 hatched nests. However, chicks are often difficult to detect and can be lost before technicians are able to observe them. CALO staff estimates that 48 chicks likely hatched. Seventeen of these 48 chicks successfully fledged, with a chick survival probability of 35%. Seven of the hatched nests suffered complete brood loss. Due to the mobile nature of precocial chicks and the lack of prolonged observations, the cause of chick loss is largely unknown. However, it is strongly suspected that a significant weather event led to the loss of one brood, while coyote predation may have contributed to the loss of other broods.

In 2023, brood locations were recorded in the GIS when chicks were spotted by observers. Brood ranges, the entire area used by the chicks from hatching until fledging, were calculated for all broods that fledged at least one chick using the Minimum Bounding Geometry tool in ArcGIS Pro. Brood range sizes extended from 1.31 acres to 37.78 acres, with an average size of 11.60 acres (See Appendix A, Map A6). The farthest distance a brood traveled from their nest site was 0.42 miles.

Banding

Nineteen chicks on Core Banks were captured by CALO staff and banded with individual field readable codes. An additional three chicks were banded from unmonitored broods on Morgan Island. Five previously unbanded adult American oystercatchers were trapped and banded on Core Banks. On SCB, two adults were outfitted with location-tracking backpacks as part of a permitted research

project. Of the 108 individuals nesting at CALO, 78 (72%) were banded, 30 (28%) were unbanded, and two (2%) had unknown banding status. One adult was recorded as banded but the full code combination was not obtained. Only one (2%) known pair had both adults unbanded and 53 (98%) had at least one of the pair banded. See Appendix D for nesting pair re-sight data and 2023 chick bands.

Discussion

American oystercatcher productivity was below average in 2023, driven primarily by coyote predation on SCB. Productivity on NCB was 0.55 chicks per pair, which is consistent with the 20-year average of 0.51 chicks per pair. Though NCB did experience predation and weather-related nest losses, these losses are commensurate with levels expected during a normal breeding season. In contrast, SCB produced only 0.04 chicks per pair and SB had no breeding activity. This extremely low productivity was primarily due to coyote predation of nests, resulting in the loss of at least 17 nests on SCB. Coyotes are also suspected predators of American oystercatcher chicks, though this has yet to be confirmed by field observations. Coyote pressure is suspected to be the main factor precluding American oystercatcher nesting on SB. However, American oystercatchers have had successful years in the past while coyotes were present on SCB. It's unclear why coyotes will target American oystercatcher nests more in some years and less in others.

CALO is currently partnering with NCSU to study coyote populations and movements throughout the seashore. This study should inform managers on population size, density, age structure as well as describing how coyotes utilize the islands. In addition, CALO continues to partner with USDA Wildlife Services to continue the trapping and removal of coyotes. The NCSU study is expected to inform USDA Wildlife Services trapping efforts to improve coyote management at CALO. Pro-active and regular predator management, primarily focused on coyotes, will be necessary to maintain American oystercatcher nesting populations at CALO.

Colonial Waterbird Monitoring and Management

Background

The inlet spits, sandflats, inshore islands, and the point at CALO provide nesting habitat for several species of colonial waterbirds. The least tern (*Sternula antillarum*), common tern (*Sterna hirundo*), gull-billed tern (*Gelochelidon nilotica*), black skimmer (*Rynchops niger*), sandwich tern (*Thalasseus elegans*) and royal tern (*Thalasseus maxima*) nest at CALO in single species and mixed species colonies.

Methods

Management

Historical nesting sites were signed and closed to pedestrian and vehicle entry by April 1. Reoccurring nesting sites include Morgan Island, Power Squadron Spit, Cape Point, Ophelia Inlet, New Drum Inlet, Old Drum Inlet, Kathryn-Jane Flats, and Portsmouth Flats. In addition to

reoccurring nesting sites, all additional potential nesting habitat at CALO was monitored and closures were installed once breeding activity was observed.

Closures were adjusted and expanded throughout the breeding season to maintain a 150-ft buffer between the closure boundary and the nearest nest. If chicks were present on the lower beach vehicles were restricted and/or detoured to avoid flightless chicks. Closures were removed when breeding activity ended.

Monitoring

Colonies on Core Banks were monitored daily to ensure protection within closure boundaries. Colony counts were conducted weekly. Breeding pairs were counted by either a perimeter count of incubating pairs or a total number adult count. Total adult counts were then divided by two to ascertain the number of breeding pairs. No correction factor was employed in the results. The assumption being that all birds present within the breeding colony site are there as breeders. When observed, the number of nests, chicks, and fledges was also recorded. Point locations were obtained for the center of each colony and recorded in a GIS. Fledge success for each colony was observationally rated as high, medium, low, none, or unknown.

CALO participated in the state-wide annual least tern census from May 14 to June 4. CALO staff counted all colonies that were active on Core Banks during the window and results were shared with state biologists.

Results

In 2023, 31 colonial waterbird colonies were observed at CALO (Table 10). Seventeen colonies were on NCB, 14 were on SCB, and one was on Morgan Island (Appendix A, Map A7). There were no colonies on SB. Morgan Island was surveyed for royal and sandwich tern pairs during the census count, but no regular monitoring was conducted. Of the 31 colonies, eighteen were single species colonies and thirteen were multi-species colonies. Six species of colonial waterbird nested at CALO that included the least tern, black skimmer, common tern, sandwich tern, royal tern, and gull-billed tern. Twenty colonies occupied reoccurring nesting sites that were posted at the beginning of the season. Eleven colonies were observed outside of the posted areas and were subsequently posted. Seventeen colonies were ranked as no success, seven had low success, six had medium success, and two had high success.

Four hundred and thirty-four pairs of least terns were counted at CALO during the annual least tern census window (Figure 3). In addition, 2,352 royal terns, 565 sandwich terns, 168 black skimmer pairs, 63 gull-billed tern pairs, and 21 common tern pairs were counted during the census window.

The only colonies rated as high success were the mixed-species colonies at Morgan Island and the North Old Drum colony on NCB. Peak pair counts of each species at North Old Drum throughout the season were 391 black skimmers, 120 least terns, 80 common terns, and 70 gull-billed terns at this colony. Peak chick counts throughout the season were 110 black skimmer chicks, 24 gull-billed tern

chicks, 14 common tern chicks, and one least tern chick. In collaboration with North Carolina Audubon, 104 black skimmer chicks were banded at this colony.

Table 10. Summary of colonial waterbird colonies at CALO in 2023 from north to south. LETE=least tern, BLSK= black skimmer, COTE= common tern, GBTE= gull-billed tern, ROTE = royal tern, SATE = sandwich tern.

ID	Island	Mile	Site	Census Pairs Count	Peak Pairs Count	Success
NC17	NCB	0.27	Ocracoke Inlet	-	15 LETE	None
NC09	NCB	2.54	North Portsmouth	134 BLSK, 12 GBTE, 8 LETE, 2 COTE	152 BLSK, 8 GBTE, 8 LETE, 4 COTE	Medium
NC05	NCB	3.64	South Portsmouth	4 LETE	40 LETE	Low
NC07	NCB	5.92	High Hills	31 LETE	41 LETE, 1 BLSK	Medium
NC11	NCB	6.70	Kathryn-Jane	15 LETE, 1 BLSK	42 LETE	Low
NC14	NCB	9.25	Swash	3 LETE	24 LETE	Low
NC12	NCB	10.48	Mile 10	1 LETE	5 LETE	Medium
NC04	NCB	11.04	Mile 11	8 LETE	16 LETE	Medium
NC16	NCB	15.37	Mile 15	-	24 LETE	Medium
NC08	NCB	15.96	Mile 16	5 LETE	5 LETE	None
NC02	NCB	18.84	North Old Drum	10 LETE, 6 COTE, 5 GBTE	391 BLSK, 34 GBTE, 15 COTE	High
NC01	NCB	19.38	South Old Drum	28 LETE, 1 COTE	85 LETE	Low
NC13	NCB	21.31	Mile 21	2 LETE	2 LETE	None
NC06	NCB	21.71	North New Drum	2 LETE	12 LETE	None
NC03	NCB	21.89	New Drum Flats	6 LETE	38 LETE	None
NC15	NCB	22.92	North Ophelia	-	8 LETE	None
NC10	NCB	23.37	South Ophelia	13 LETE	38 LETE	None
SC09	SCB	23.79	Florence Island	47 GBTE, 12 COTE, 10 BLSK	155 BLSK, 88 GBTE, 26 COTE, 12 LETE	None
SC01	SCB	24.50	North Plover Inlet	61 LETE	59 BLSK, 58 LETE, 10 GBTE	None
SC04	SCB	24.78	South Plover Inlet	94 LETE	20 LETE, 35 BLSK, 3 GBTE, 2 COTE	Low
SC08	SCB	24.94	Ophelia Inlet Hook	-	4 COTE	Medium
SC05	SCB	28.24	Mile 28	9 LETE	15 LETE	None
SC07	SCB	30.64	Mile 30	-	12 LETE	None
SC14	SCB	31.34	Mile 31	-	17 LETE	None
SC02	SCB	34.73	Mile 34	2 LETE	2 LETE	None
SC11	SCB	35.51	Mile 35	14 LETE, 1 BLSK	20 LETE, 1 BLSK	None
SC13	SCB	39.00	Mile 39	17 LETE, 1 BLSK	17 LETE, 1 BLSK	None
SC10	SCB	43.49	East Cape Point	93 LETE	97 LETE, 40 BLSK	Low
SC03	SCB	43.90	West Cape Point	21 BLSK	67 LETE, 4 COTE	Low
SC12	SCB	46.45	Mile 46	5 LETE	5 LETE	None

SC06	SCB	47.22	Power Squadron Spit	3 LETE	8 LETE	None
MI01	MI		Morgan Island	2352 ROTE, 565 SATE	No count	High

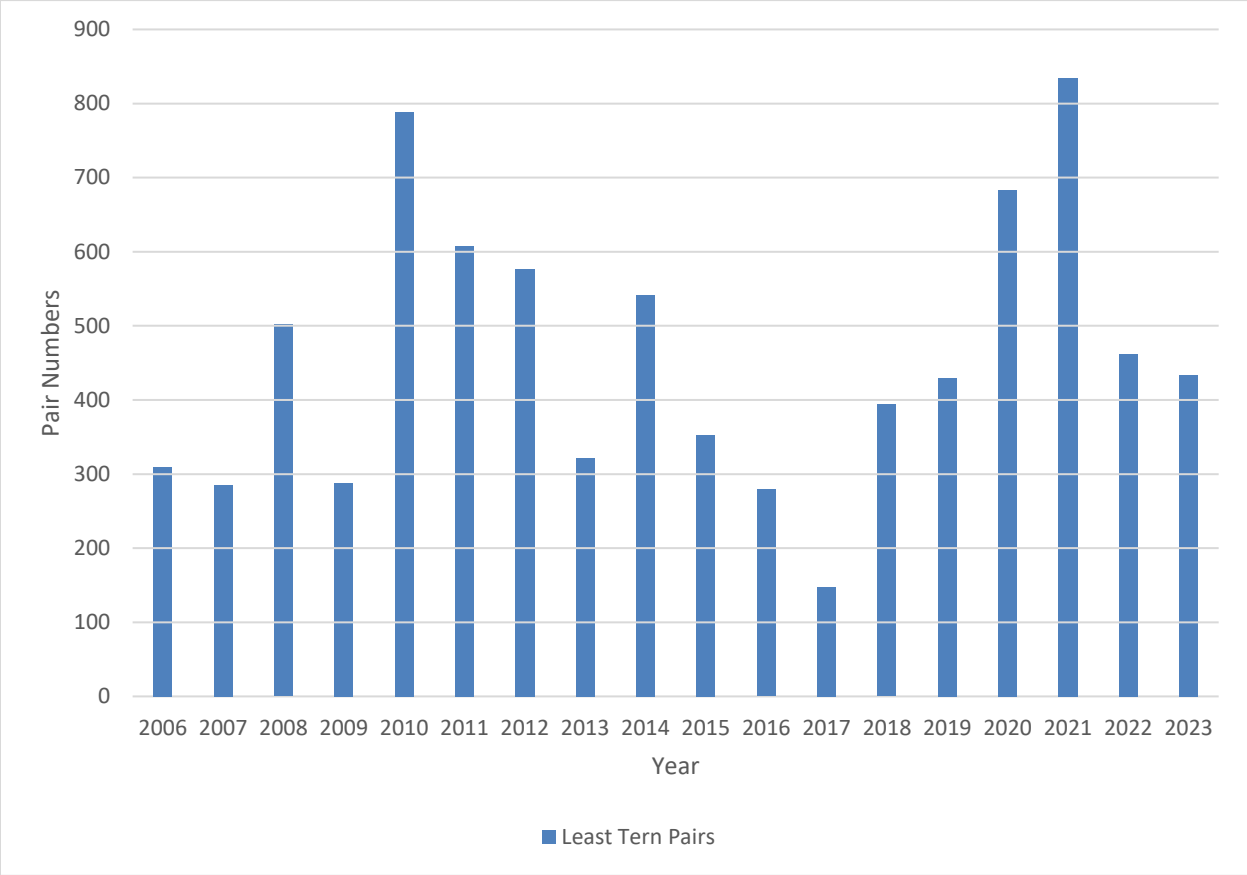

Figure 3. Least tern window census counts at CALO from 2006 to 2023.

Discussion

In 2023, the highly successful mixed colony at Old Drum was an exception to the generally poor productivity trend throughout the rest of Core Banks. The North Old Drum colony was thought to be the largest black skimmer colony in North Carolina, though pair counts are difficult to determine state-wide due to the asynchronous nature of nesting and movement between sites. Though current monitoring protocols at CALO do not allow for the calculation of quantitative productivity estimates, CALO staff did observe high numbers of black skimmer chicks, gull-billed terns chicks, and common terns chicks that were presumed to have fledged. Interestingly, least terns had no observed productivity at this site despite high numbers of pairs and nesting attempts. It's unclear why black skimmers, common terns, and gull-billed terns were successful at this colony but least terns were not. Unfortunately, tropical storm Idalia caused the overwash of this colony on August 30, resulting in the loss of nests and unfledged chicks and ending all breeding activity for the season prematurely.

Least tern pairs were down for a second year in a row after an all time high in 2021. However, the 2023 pair count of 434 pairs remains consistent with the average of 459 from the previous 17 seasons. Again, while productivity is difficult to quantify at CALO, it is thought that 2023 produced very few least tern chicks. It's unclear why least terns did poorly at CALO in 2023.

Red Knot (*Calidris canutus rufa*) Monitoring

Background

Serious declines in the population of red knots (*Calidrus canutus rufa*) led the U.S. Fish and Wildlife Service to provide protection under the Endangered Species Act. In December 2014, the red knot was designated as a threatened species (USFWS, 2014). Red knots use CALO as a stopover site in spring and fall migration. While not as important as some other coastal sites, CALO may still contribute to the survival of this species.

Previous monitoring of red knots at CALO was limited to surveys as part of a broader shorebird study in 1992 and 1993 (Dinsmore et al., 1998). NCB had greater numbers of red knots than anywhere else in the Outer Banks and reported a relative density of 34 birds per kilometer, but surveys in that study did not include any of the areas south of New Drum Inlet.

Methods

Surveys for red knots were made of the ocean beach on Core Banks, NCB and SCB, beginning in mid-March through the end of October. Survey frequency and timing followed the International Shorebird Census guidelines for spring and fall. Counts were done near the 5th, 15th, and 25th of the month from March 15 to June 5 and from July 15 to October 25. In 2023, the two-mile section of beach between Ocracoke Inlet to Evergreen was not included in surveys due to irregular access across Evergreen Inlet.

Surveys were conducted by the park biologist or biological science technicians who have experience identifying shorebirds. Surveys were at different times of day, tides and weather conditions. Monitors recorded the number of red knots observed, the mile location, the latitude and longitude, the amount of human disturbance, tide level, and the accuracy of the count in a GIS.

Results

Spring migration counts peaked on May 15 with 1,985 birds counted across the Core Banks (Figure 4). Fall migration peaked on August 5 with 64 red knots counted across the Core Banks. Spring migration from March 15 to June 5 averaged 689 birds across both islands. The fall migration from July 15 to October 15 averaged 26 birds across both islands.

NCB averaged 190 birds per survey throughout the survey period. SCB averaged 134 birds per survey. NCB had the highest count of 1,459 birds on May 25, with a relative abundance of 46 birds per kilometer (Table 11). SCB had the highest count of 941 red knots on May 15, with a relative

abundance of 24 birds per kilometer. Red knots were distributed over the length of Core Banks from 2006 to 2023 (Figure 5; Appendix A, Map A8).

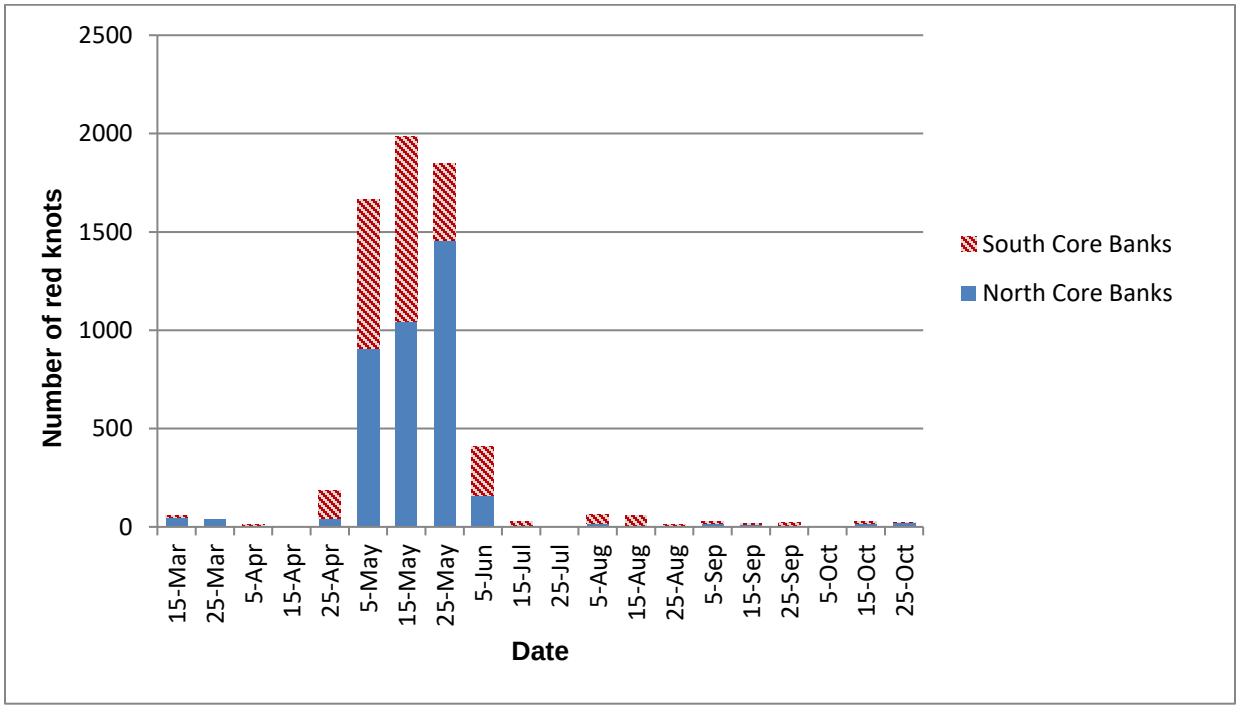

Figure 4. Number of red knots counted at CALO in 2023.

Table 11. Red knot relative abundance on NCB from 1992-2023.

Year	Date	Peak Count	Kilometers	Relative Abundance
1992-1993	-	-	34	34
2006	May 5	618	30.3	20
2007	May 15	718	30.6	23
2008	Apr 15	1287	30.6	42
2009	May 25	525	36	14
2010	May 15	927	36	26
2011	May 15	648	36	18
2012	April 25	1370	29.8	46
2013	May 25	854	29.8	29
2014	May 15	2666	29.8	89
2015	May 15	2201	29.8	74
2016	May 15	2124	29.8	71
2017	May 15	1741	29.8	58
2018	May 25	1710	36	48
2019	May 5	395	36	11

2020	May 5	999	25.7	39
2021	May 15	954	25.7	37
2022	May 25	2210	32	69
2023	May 25	1459	32	46

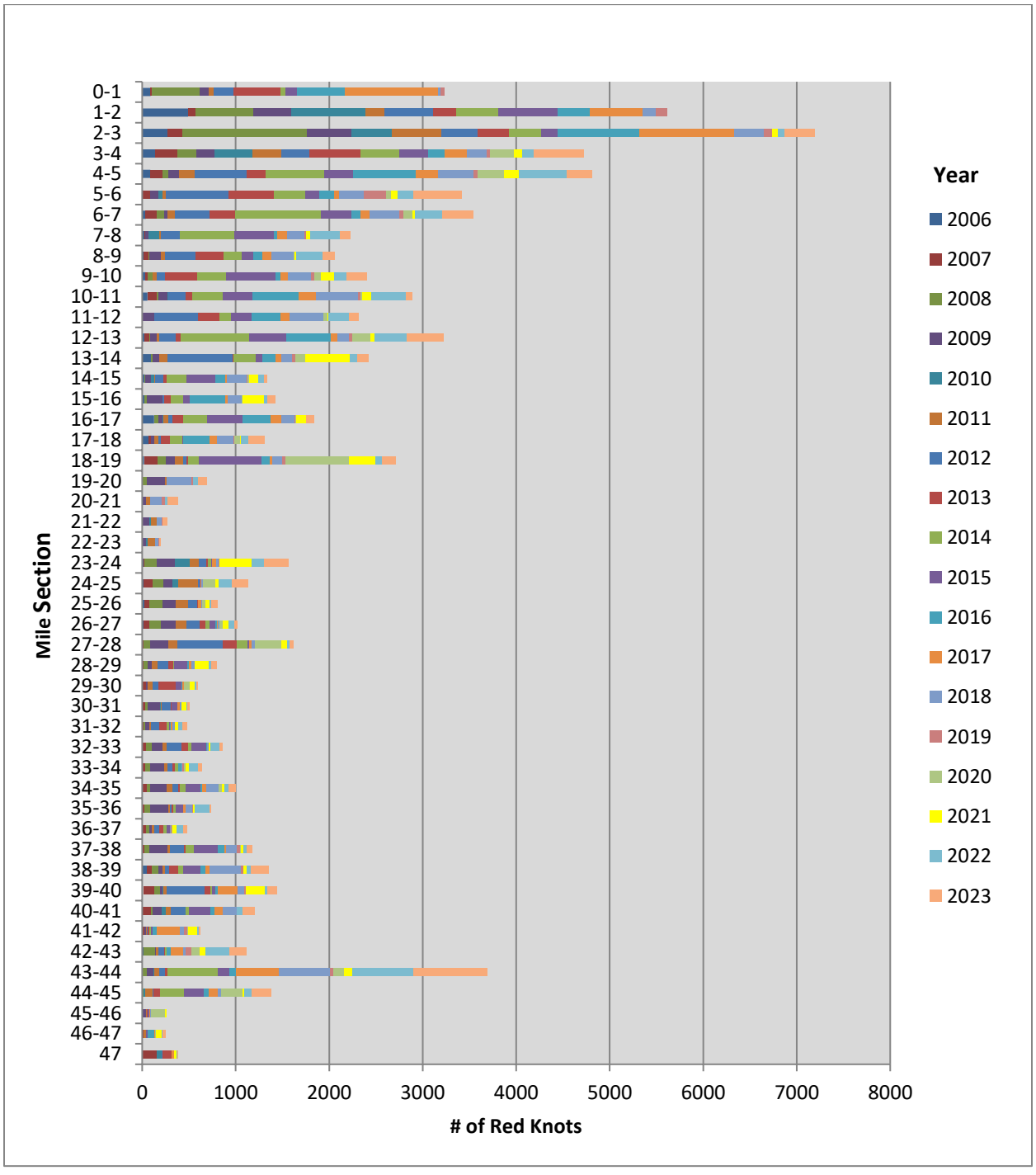

Figure 5. Total number of red knots counted in each mile section from 2006 to 2023.

Discussion

Monitoring in 2023 confirmed CALO as a stopover site for red knots, particularly during the spring migration with a peak count of 1,915 birds seen on May 15. Though not a record year, 2023 was consistent with the average relative abundance since monitoring began in 1992. Peaks in abundance were seen around Evergreen Inlet and mid-island on NCB and then at Ophelia Inlet and Cape Point on SCB. Mile 43-44, which includes Cape Point, had the highest number of birds observed within one mile, which is a shift from the typical distribution pattern that normally favors the north end of NCB. This indicates that high-quality foraging habitat must be concentrated on the east side of Cape Point. This data highlights the importance of CALO as a stopover site for migrating red knots. Although the Outer Banks may not be as important as some other sites in the region such as Delaware Bay, it still provides habitat that may be important for the recovery and long-term survival of red knots.

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

Wilson's plover pairs were surveyed annually at the same time as the piping plover window census of June 1 to June 9 from 2007 to 2016. Wilson's plovers are now surveyed at a minimum of every three years in line with the NCWRC coast wide survey, with additional annual surveys conducted when time allows. A park-wide survey was conducted in 2023 and recorded a total of 84 pairs and 12 singles (Table 12). Pairs were counted in the same nesting areas as piping plovers and any additional habitat throughout the park. Nests and broods were recorded when found or observed opportunistically, but nest and brood fates were not tracked. Twelve nests and two broods were recorded during the 2023 season. Though pair numbers were down from a record high in 2021, Wilson's plover pairs appear stable to increasing at CALO since 2007 (Figure 6).

Table 12. Wilson's plover census results June1-9, 2023.

Island	Nesting Area	Number of Pairs	Singles
North Core Banks	Ocracoke Inlet	1	0
North Core Banks	Portsmouth Flats	15	1
North Core Banks	Kathryn-Jane Flats	8	1
North Core Banks	Mile 10	1	0
North Core Banks	Old Drum Inlet	8	1
North Core Banks	Miles 20	2	1
North Core Banks	New Drum Inlet	13	1
North Core Banks	Ophelia Island/Spit	4	1
South Core Banks	Plover Inlet	10	3
South Core Banks	Miles 41	1	0

South Core Banks	Cape Point	0	0
South Core Banks	Power Squadron Spit	7	1
Shackleford Banks	Barden Inlet	3	1
Shackleford Banks	Corral Area	2	1
Shackleford Banks	Whale Creek Bay	4	0
Shackleford Banks	Middle Island	2	0
Shackleford Banks	Beaufort Inlet	3	0

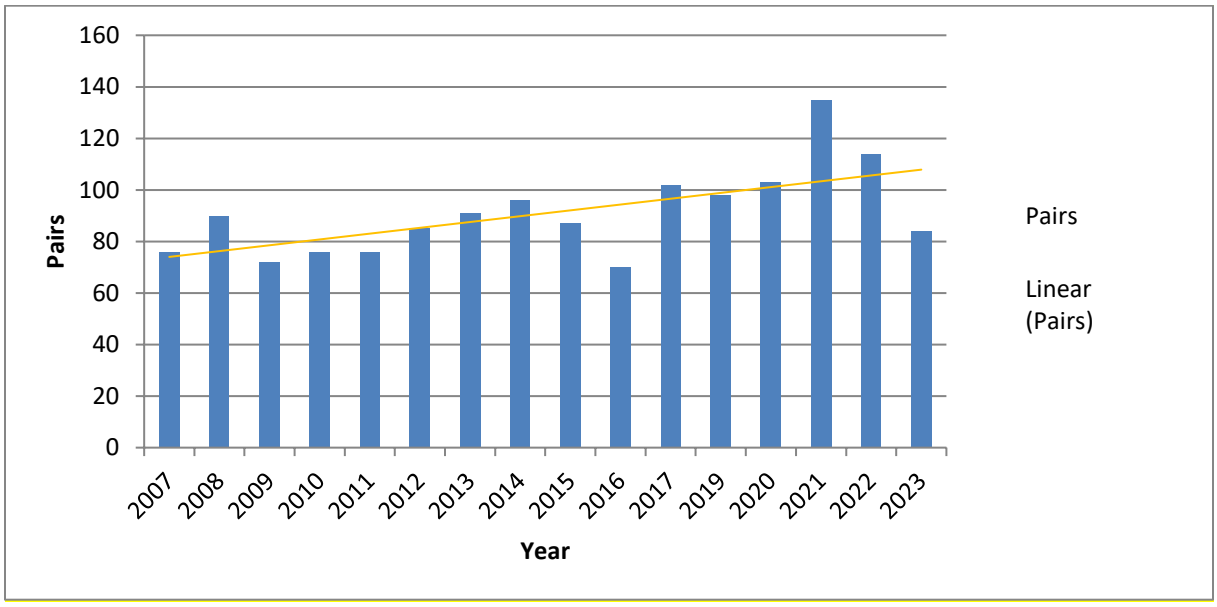

Figure 6. Number of Wilson's plover counted at CALO 2007- 2023

Conclusions and Recommendations

Results for shorebird and colonial waterbird productivity at CALO in 2023 were mixed. The highlight of the season was the North Old Drum mixed colony, being the largest black skimmer colony in the state and producing relatively high numbers of black skimmer, common tern, and gull-billed tern chicks. Wilson's plovers, red knot, and least tern numbers were consistent with long term monitoring averages. However, American oystercatcher and piping plover productivity was below average in 2023, with piping plover productivity being one of the worst years on record.

In the case of poor American oystercatcher success, the leading factor is clearly coyote predation on SCB. It is recommended that CALO continue to partner with USDA Wildlife Services to remove coyotes throughout the seashore. Trapping should be focused in the spring before breeding activity

begins. In addition, CALO should utilize the results of the NCSU coyote study to further inform and improve coyote management.

For piping plovers, the cause of low productivity is less clear and likely a combination of several factors. As the majority of nest failures were due to unknown causes in 2023, is it recommended that trail cameras continue to be installed on piping plover nests to try to fill this data gap. In addition, a randomized study on ghost crab trapping to determine the efficacy of this intervention at CALO could inform manager if trapping is a beneficial way to spend limited resources. Targeted research is needed to understand piping plover population dynamics at CALO and to determine the source of poor chick survival and productivity. It is recommended that CALO partner with a research institution to attempt to answer these questions. An increase in monitoring staff would allow for more accurate monitoring, including of new nesting areas created by Hurricane Dorian, and more effective management interventions such as trail camera installation, ghost crab trap installation, and the management responses to brood movements.

Lastly, shorebird banding programs should continue across Core Banks. Banded individuals allows for the accurate monitoring of breeding birds and productivity thus improving the quality of data collected at CALO. Since Virginia Tech began piping plover banding in 2015, pair movement between nesting sites along Core Banks, pair movement between CALO and Cape Hatteras National Seashore, and movement between Atlantic states has been documented. There is more to learn about the piping plover breeding population such as survivorship and site fidelity that require multiple years of study. In addition, banded non-breeding piping plovers can be used to study migratory and winter use of CALO. It appears that NCB is a major migratory use area, and it should continue to be studied to determine the details and duration of use in relation to the greater Atlantic flyway. Banding of American oystercatcher and black skimmer chicks and adults should also be continued to assist CALO management efforts and long-term population monitoring.

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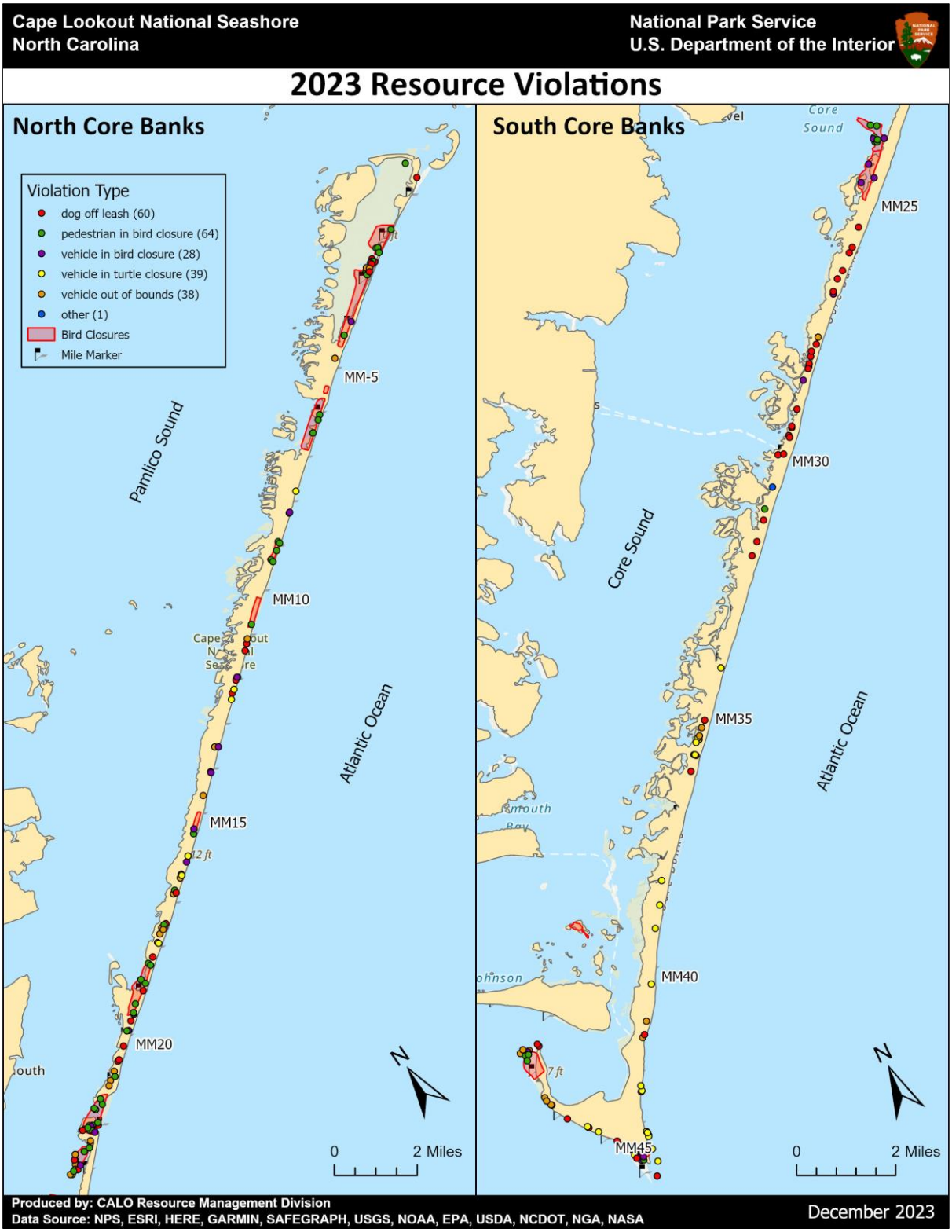
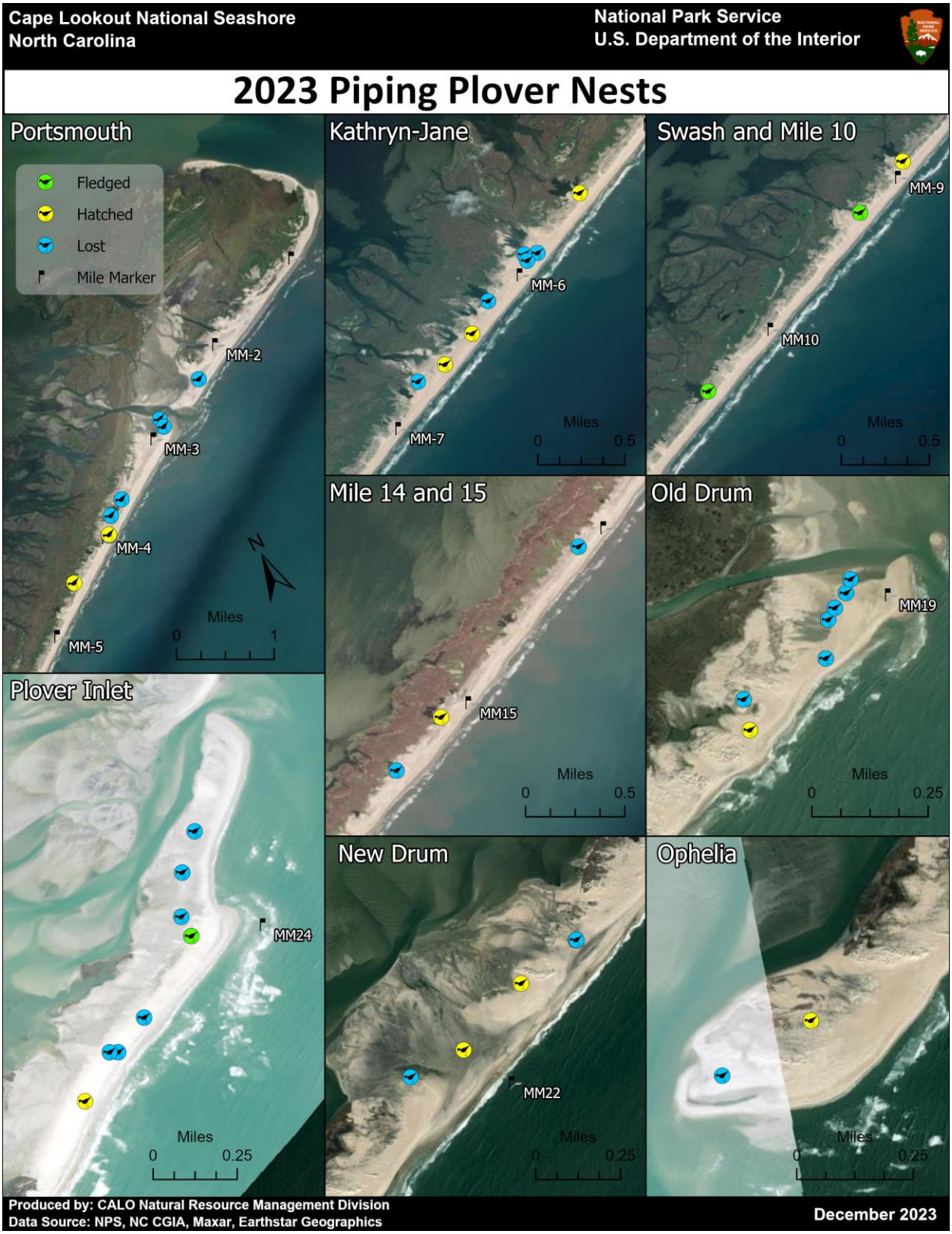
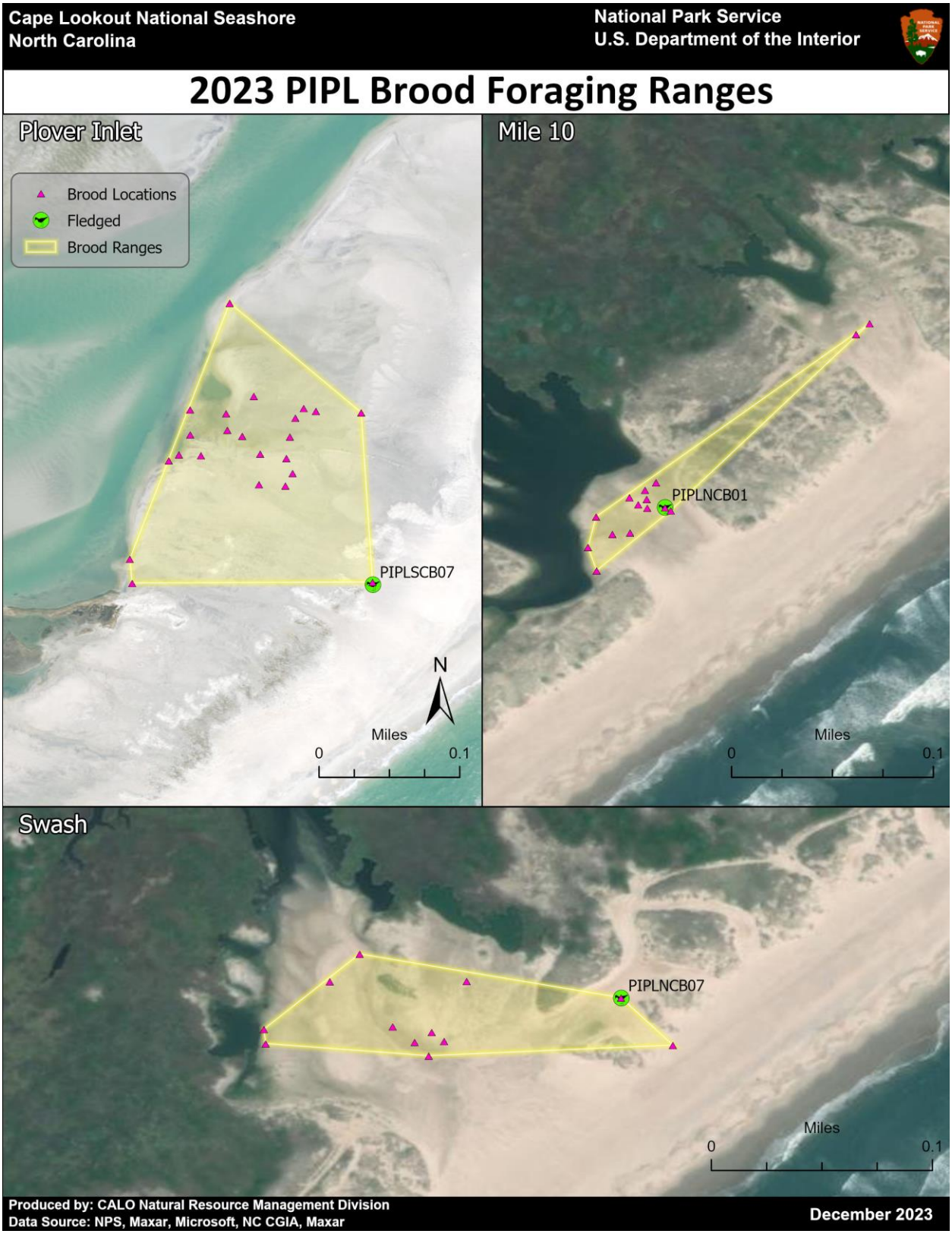
Appendix A. Maps



Map A1. Resource violations at CALO in 2023. One observation from Shackleford Banks not shown.

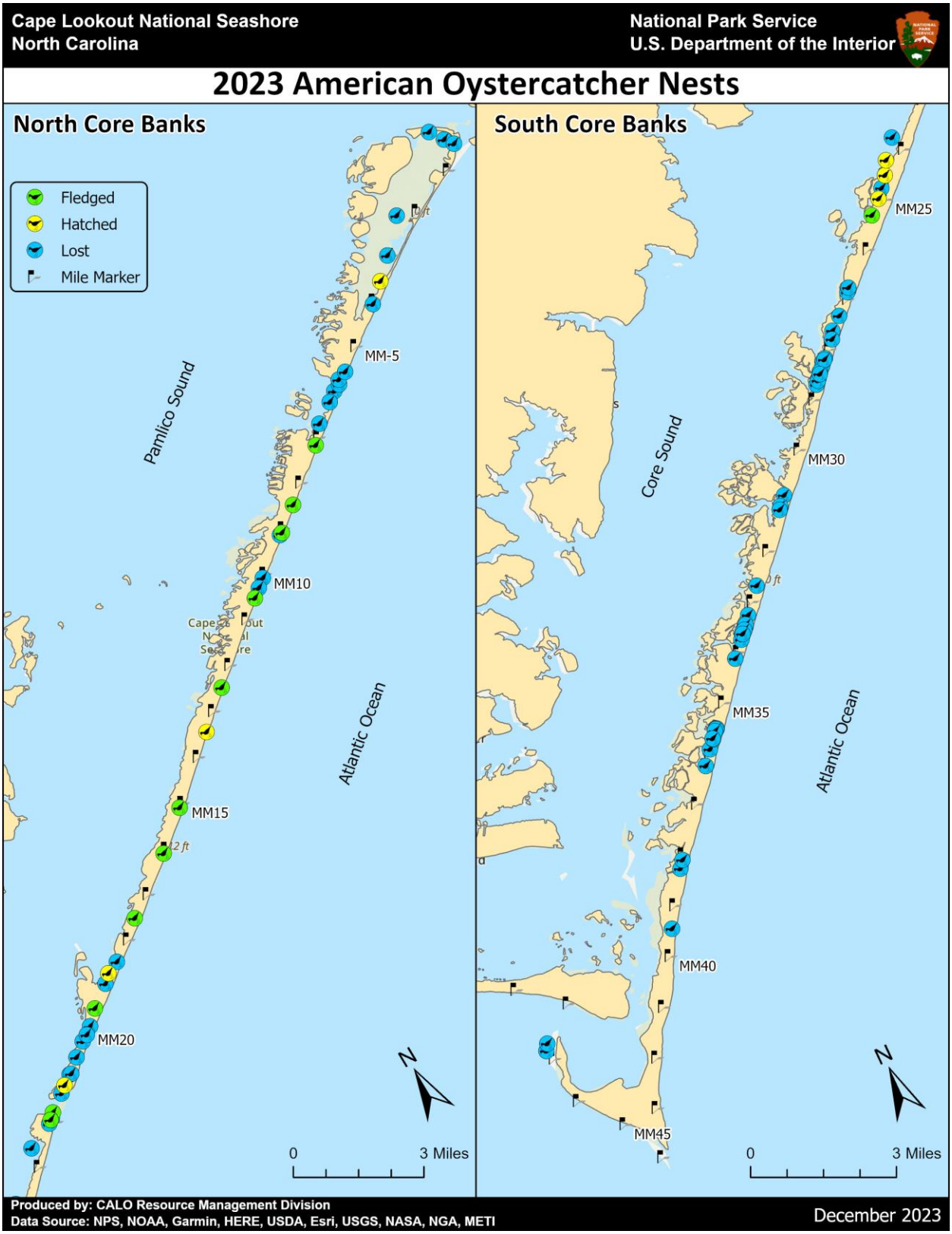


Map A2. Piping plover nest locations at CALO in 2023.



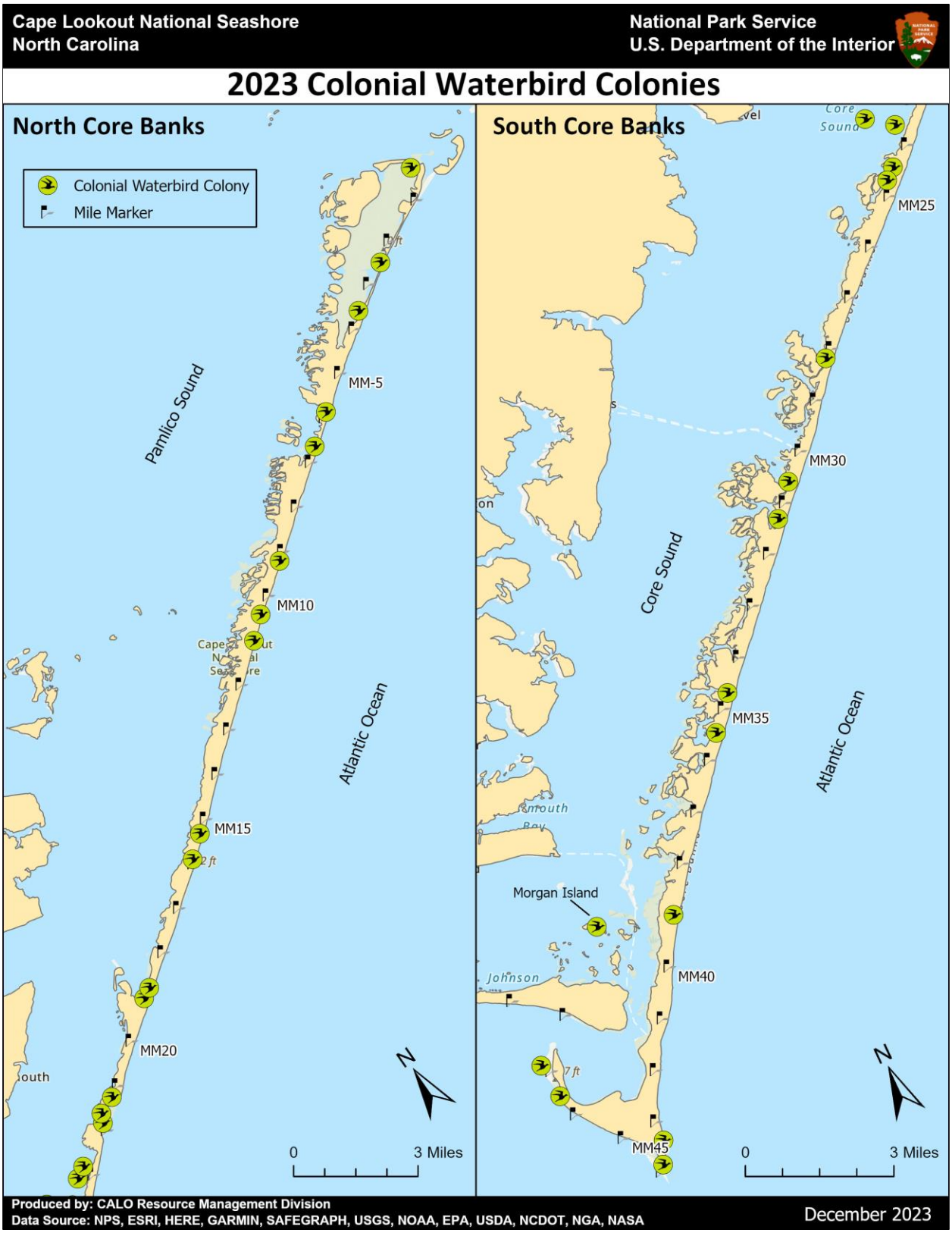
Map A3. Piping plover chick foraging ranges for broods that fledges at least one chick at CALO in 2023.

Map A4. Non-breeding piping plover locations at CALO in 2023.

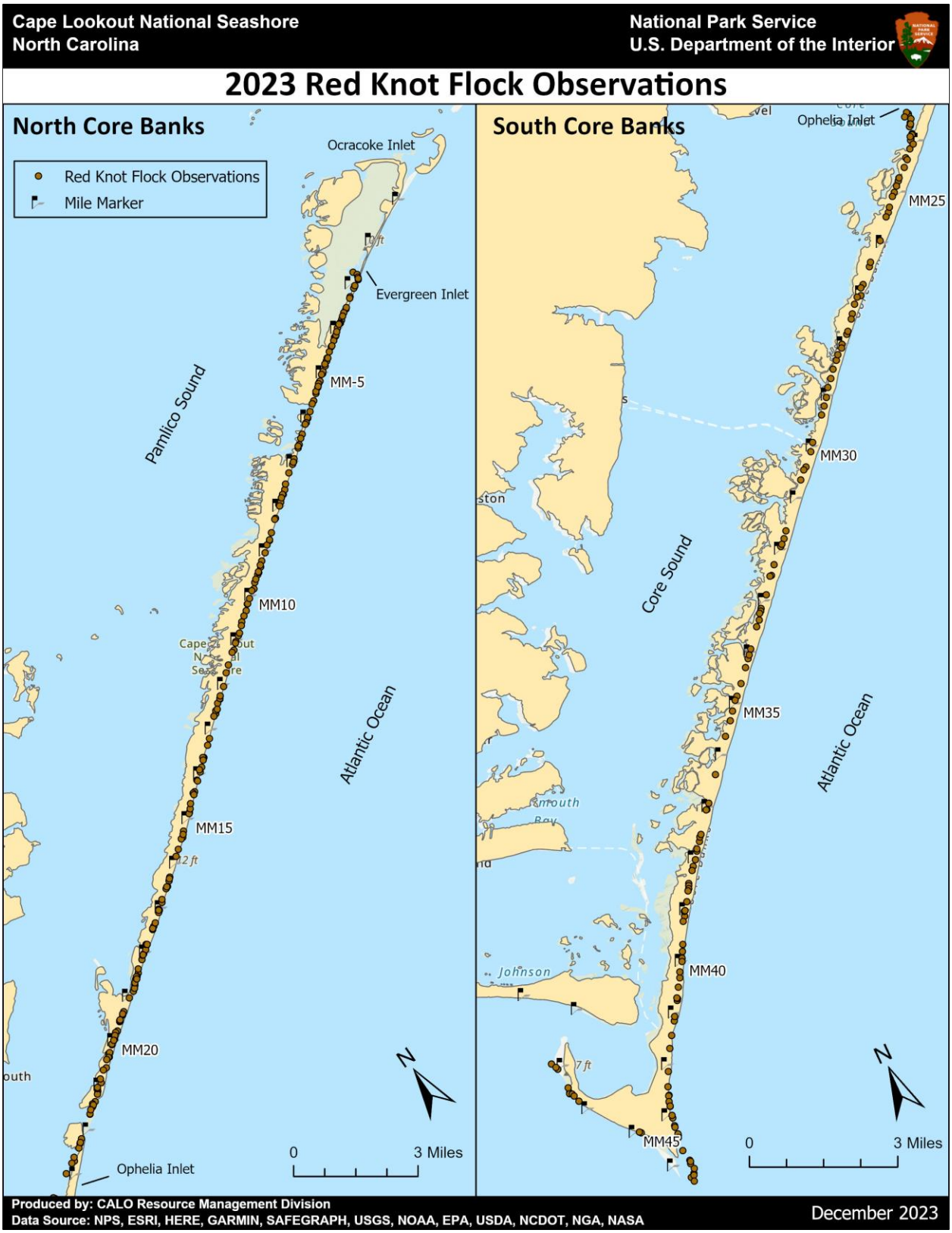


Map A5. American oystercatcher nests at CALO in 2023.

Map A6. American oystercatcher brood foraging ranges for a subset of broods that fledged at least one chick at CALO in 2023. Not all fledged broods are shown.



Map A7. Colonial waterbird colony locations at CALO in 2023.



Map A8. Red knot flock observations at CALO in 2023.

Appendix B. 2023 Piping Plover Productivity Data

Table B1. North Core Banks productivity data for 2023. North Core Banks totals: 26 breeding pairs, 36 total nests, 12 hatched nests, 2 fledged chicks.

Nest ID	Pair	Mile	Site	Adult 1	Adult 2	Found Date	Exclosure Date	Eggs Laid	Nest Fate	Outcome Summary
PIPLNCB01	1	10.46	Mile 10	GF(54N)	UNB	04/21/23	05/03/23	4	Fledged	Fledged 1 UNB chick on 6/30/23 at 29 days old.
PIPLNCB02	2	21.75	New Drum	GF(LYJ)	UNB	04/24/23	05/03/23	4	Hatched	Brood failed 6/20/23 at 12 days old due to unknown cause.
PIPLNCB03	3	4.00	Portsmouth	GF(2H7)	UNB	04/24/23	N/A	2	Lost	Nest failed 4/25/23 due to unknown cause.
PIPLNCB04	4	8.90	Swash	GF(A79)	GF(P6A)	04/26/23	05/03/23	3	Hatched	Brood failed 6/15/23 at 10 days old due to unknown cause.
PIPLNCB06	6	5.90	Kathryn Jane	GF(V4P)	GF(A5P)	04/28/23	N/A	1	Lost	Nest failed 5/1/23 due to flooding.
PIPLNCB05	5	19.12	Old Drum	GF(938)	UNB	04/28/23	N/A	2	Lost	Nest failed 5/2/23 due to unknown cause.
PIPLNCB07	7	9.29	Swash	GF(0M6)	GF(4M3)	04/29/23	05/13/23	3	Fledged	Fledged 1 UNB chick on 7/4/23 at 26 days old.
PIPLNCB08	8	6.76	Kathryn Jane	GF(X79)	GF(T0L)	05/02/23	N/A	2	Lost	Nest failed 5/25/23 due to ghost crab predation.
PIPLNCB09	9	19.35	Old Drum	GF(9KT)	KG:RY	05/04/23	N/A	4	Lost	Nest failed 5/24/23 due to unknown cause.
PIPLNCB10	10	19.08	Old Drum	GF(2P2)	UNB	05/06/23	N/A	1	Lost	Nest failed 5/8/23 due to severe weather.
PIPLNCB11	11	22.22	New Drum	GF(L5C)	GF(PEU)	05/08/23	05/08/23	3	Lost	Nest failed 6/14/23 due to unknown cause.
PIPLNCB12	10	19.09	Old Drum	GF(2P2)	UNB	05/12/23	N/A	2	Lost	Nest failed 5/14/23 due to unknown cause.
PIPLNCB13	5	19.18	Old Drum	GF(938)	UNB	05/12/23	05/13/23	4	Lost	Nest failed 5/28/23 due to severe weather.
PIPLNCB14	12	14.17	Mile 14	GF(4NE)	UNB	05/20/23	05/29/23	4	Lost	Nest failed 6/7/23 due to flooding and severe weather.
PIPLNCB15	13	21.61	New Drum	UNB	UNB	05/22/23	N/A	2	Lost	Nest failed 5/28/23 due to flooding.
PIPLNCB16	14	2.39	Portsmouth	GF(C2A)	GF(U9J)	05/24/23	N/A	3	Lost	Nest failed by 6/5/23 due to flooding.
PIPLNCB17	9	19.39	Old Drum	GF(9KT)	KG:RY	06/02/23	06/07/23	4	Hatched	Brood failed 7/8/23 at 7 days old due to unknown cause.
PIPLNCB18	15	2.86	Portsmouth	GF(5JM)	UNB	06/03/23	N/A	3	Lost	Nest failed 6/5/23 due to flooding.
PIPLNCB19	13	21.6	New Drum	UNB	UNB	06/08/23	N/A	2	Lost	Nest failed 6/18/23 due to ghost crab predation.
PIPLNCB20	16	22.91	Ophelia	UNB	UNB	06/10/23	N/A	1	Lost	Nest failed 6/14/23 due to unknown cause.

PIPLNCB21	17	22.74	Ophelia	LC:LL	UNB	06/10/23	N/A		Hatched	Nest location not found but 1-3 day old chick observed on 6/10/23. Brood failed on 6/24/23 at 15 days old due to unknown cause.
PIPLNCB23	5	19.23	Old Drum	GF(938)	UNB	06/11/23	N/A	2	Lost	Nest failed 6/18/23 due to unknown cause.
PIPLNCB22	18	6.64	Kathryn Jane	GF(K4E)	UNB	06/11/23	06/17/23	4	Hatched	Brood failed 7/12/23 at 3 days old due to unknown cause.
PIPLNCB24	19	6.44	Kathryn Jane	GF(CXM)	GF(7KM)	06/11/23	06/24/23	4	Hatched	Brood failed 6/17/23 at 5 days old due to unknown cause.
PIPLNCB25	20	5.95	Kathryn Jane	UNB	UNB	06/11/23	N/A	1	Lost	Nest found failed on 6/11/23, failed due to unknown cause.
PIPLNCB26	20	5.96	Kathryn Jane	UNB	UNB	06/11/23	N/A	2	Lost	Nest failed 6/28/23 due to unknown cause.
PIPLNCB27	3	3.82	Portsmouth	GF(2H7)	UNB	06/13/23	N/A	1	Lost	Nest failed 6/15/23 due to ghost crab predation.
PIPLNCB28	21	15.46	Mile 15	UNB	UNB	06/14/23	N/A	4	Lost	Nest failed 6/25/23 due to unknown cause.
PIPLNCB29	22	6.22	Kathryn Jane	GF(662)	GF(CE3)	06/15/23	06/24/23	4	Lost	Nest failed 7/8/23 due to ghost crab predation
PIPLNCB30	23	15.16	Mile 15	GF(ALP)	GF(58X)	06/16/23	06/16/23	4	Hatched	Brood failed on 7/12/23 at 1 day old due to unknown cause.
PIPLNCB31	24	4.51	Portsmouth	GF(UUM)	GF(5VN)	06/16/23	06/26/23	3	Hatched	Brood failed 7/15/23 at 2 days old due to unknown cause.
PIPLNCB32	11	22.00	New Drum	GF(L5C)	GF(PEU)	06/29/23	07/03/23	3	Hatched	Brood failed 7/30/23 at 1 day old due to unknown cause.
PIPLNCB33	25	5.52	Kathryn Jane	GF(A79)	UNB	07/02/23	07/03/23	4	Hatched	Brood failed 7/27/23 at 3 days old due to unknown cause.
PIPLNCB34	15	2.82	Portsmouth	GF(5JM)	UNB	07/04/23	N/A	2	Lost	Nest failed 7/17/23 due to unknown cause.
PIPLNCB35	26	3.64	Portsmouth	GF(6JN)	UNB	07/04/23	N/A	1	Lost	Nest failed 7/12/23 due to coyote predation.
PIPLNCB36	3	3.99	Portsmouth	GF(2H7)	UNB	07/07/23	07/08/23	3	Hatched	Brood failed 7/24/23 at 10 days old due to unknown cause.

Table B2. South Core Banks productivity data for 2023. South Core Banks totals: 5 breeding pairs, 8 total nests, 2 hatched nests, 2 fledged chicks.

Nest ID	Pair	Mile	Site	Adult 1	Adult 2	Found Date	Exclosure Date	Eggs Laid	Nest Fate	Outcome Summary
PIPLSCB01	1	24.45	Plover Inlet	UNB	UNB	05/04/23	05/05/23	3	Lost	Nest failed 5/28/23 due to severe weather.
PIPLSCB02	2	24.51	Plover Inlet	UNB	UNB	05/04/23	N/A	1	Lost	Nest found abandoned 5/4/23 due to unknown reason.

PIPLSCB03	2	24.53	Plover Inlet	UNB	UNB	05/09/23	05/09/23	4	Lost	Nest failed 6/2/23 due to ghost crab predation.
PIPLSCB04	3	23.91	Plover Inlet	UNB	UNB	05/11/23	05/11/23	3	Lost	Nest failed 5/20/23 due to flooding.
PIPLSCB05	4	24.70	Plover Inlet	OY:KO	UNB	05/22/23	05/24/23	3	Hatched	Brood failed 6/24/23 at 3 days old due to unknown reason.
PIPLSCB06	5	24.00	Plover Inlet	GF(JHY)	UNB	05/22/23	05/22/23	3	Lost	Nest failed 6/5/23 due to flooding.
PIPLSCB07	5	24.06	Plover Inlet	GF(JHY)	UNB	06/18/23	06/20/23	3	Fledged	Fledged 2 UNB chicks on 8/16/23 at 34 days old.
PIPLSCB08	3	23.78	Plover Inlet	UNB	UNB	06/30/23	N/A	1	Lost	Nest fail 7/18/23 due to unknown cause.

Appendix C. Monthly Counts of Non-Breeding Piping Plovers 2008-2023

Table C1. Total number of non-breeding plovers observed on North Core Banks, South Core Banks, and Shackleford Banks during each monthly survey from 2008 to 2023

Date	North Core Banks	South Core Banks	Shackleford banks	CALO Total
January-08	0	2	11	13
February-08	0	6	10	16
March-08	6	6	10	22
August-08	41	28	17	86
September-08	16	20	10	46
October-08	25	9	20	54
November-08	11	4	9	24
December-08	9	7	8	24
January-09	6	18	13	37
February-09	2	9	12	23
March-09	10	17	-	27
August-09	83	26	2	111
September-09	144	33	10	187
October-09	22	19	13	54
November-09	18	12	12	42
December-09	12	14	23	49
January-10	17	8	11	36
February-10	8	5	11	24
March-10	-	10	6	16
August-10	125	23	4	152
September-10	70	32	17	119
October-10	35	13	4	52
November-10	8	19	9	36
December-10	4	3	6	13
January-11	6	2	7	15
February-11	7	0	8	15
March-11	12	8	13	33
August-11	81	26	0	107
September-11	29	8	20	57
October-11	26	19	6	51
November-11	7	3	11	21
December-11	2	4	11	17
January-12	0	2	5	7

February-12	0	2	10	12
March-12	5	1	-	6
August-12	82	32	4	118
September-12	112	7	9	128
October-12	0	3	12	15
November-12	3	7	5	15
December-12	6	6	2	14
January-13	-	4	3	7
February-13	4	0	10	14
March-13	5	9	4	18
August-13	93	6	15	114
September-13	115	15	23	153
October-13	17	-	-	17
November-13	6	5	5	16
December-13	12	3	4	19
January-14	0	12	0	12
February-14	0	0	9	9
March-14	7	42	4	53
August-14	98	44	9	151
September-14	69	12	1	82
October-14	12	12	0	24
November-14	13	6	4	23
December-14	4	14	3	21
January-15	2	9	4	15
February-15	-	-	-	-
March-15	-	21	19	40
August-15	95	15	15	125
September-15	42	20	8	70
October-15	17	3	14	34
November-15	0	4	8	12
December-15	5	18	2	25
January-16	10	16	9	35
February-16	15	13	9	37
March-16	2	15	8	25
August-16	-	-	10	10
September-16	30	17	25	72
October-16	10	31	3	44
November-16	2	20	1	23
December-16	0	2	1	3
January-17	7	0	2	9

February-17	-	-	-	-
March-17	-	-	-	-
August-17	46	0	8	54
September-17	68	2		70
October-17	24	22	14	60
November-17	8	1	11	20
December-17	11	4	10	25
January-18	0	0	0	0
February-18	9	1	0	10
March-18	-	-	-	-
August-18	161	19	2	182
September-18	31	3	0	34
October-18	40	0	9	49
November-18	3	0	8	11
December-18	0	2	5	7
January-19	-	-	-	-
February-19	4	22	13	39
March-19	23	11	9	43
August-19	127	-	-	127
September-19	7	34	2	43
October-19	4	16	6	26
November-19	11	7	3	21
December-19	0	3	13	16
January-20	-	-	-	-
February-20	8	0	3	11
March-20	1	7	0	8
August-20	220	46	7	273
September-20	79	37	2	118
October-20	16	14	0	30
November-20	14	26	3	43
December-20	5	8	18	31
January-21	12	20	7	39
February-21	15	13	10	38
March-21	12	5	1	18
August-21	78	53	20	151
September-21	135	44	25	204
October-21	54	27	27	108
November-21	30	3	2	35
December-21	29	3	1	33
January-22	4	14	1	19

February-22	3	2	0	5
March-22	40	1	2	43
August-22	381	91	9	481
September-22	117	304	6	427
October-22	34	51	8	93
November-22	21	20	11	52
December-22	34	51	3	88
January-23	23	24	3	50
February-23	8	0	0	8
March-23	49	30	37	116
August-23	163	156	35	354
September-23	140	82	19	241
October-23	58	82	6	146
November-23	23	28	0	51
December-23	15	27	9	51

Appendix D. 2023 American Oystercatcher Productivity Data

Table D1. North Core Banks productivity data for 2023. North Core Banks totals: 29 breeding pairs, 42 total nests, 15 hatched nests, 16 fledged chicks.

Nest	Pair	Adult 1	Adult 2	Mile	Found Date	Eggs	Closure	Outcome Summary
AMOYNCB01	1	DG(P5)	UNB	22.17	04/06/23	2	600' buffer	Nest failed 4/11/23 due to flooding.
AMOYNCB02	2	DG(EKH)	UNB	15.15	04/18/23	3	600' buffer	Fledged 1 chick, DG(EU0), on 7/5/23 at 44 days old.
AMOYNCB03	3	DG(C93)	UNB	20.66	04/19/23	3	600' buffer	Nest failed 5/3/23 due to predation by an undetermined predator.
AMOYNCB04	4	DG(TF)	UNB	21.94	04/19/23	3	interior	Fledged 1 chick, DG(EWW), on 7/4/23 at 49 days old.
AMOYNCB05	5	DG(CCE)	UNB	6.76	04/19/23	2	interior	Nest failed 4/26/23 due to unknown cause.
AMOYNCB06	6	DG(CY)	UNB	3.65	04/19/23	3	interior	Brood failed 5/28/23 due to unknown cause.
AMOYNCB07	1	DG(P5)	UNB	22.00	04/24/23	2	600' buffer	Nest failed 5/22/23 due to unknown cause.
AMOYNCB08	7	DG(M0)	UNB	19.60	04/24/23	3	600' buffer	Fledged 1 chick, DG(EU2) on 7/2/23 at 45 days old.
AMOYNCB09	8	DG(CEA)	DG(CML)	13.48	04/25/23	3	600' buffer	Brood failed on 6/9/23 due to unknown cause.
AMOYNCB10	9	DG(EKK)	UNB	3.05	04/25/23	3	interior	Nest failed 5/23/23 due to unknown cause.
AMOYNCB11	10	DG(CA)	UNB	8.53	04/25/23	3	600' buffer	Fledged 2 chicks, DG(C66) and DG(C8C), on 7/9/23 at 46 days old.
AMOYNCB12	11	DG(CY6)	DG(C5W)	12.53	04/26/23	3	600' buffer	Fledged 1 chick, DG(C7X), on 7/7/23 at 44 days old.
AMOYNCB13	12	DG(T3)	DG(CE1)	10.57	04/26/23	3	600' buffer	Fledged 1 chick, DG(EWE), on 7/12/23 at 48 days old.
AMOYNCB14	13	DG(WF)	DG(CK0)	9.18	04/26/23	3	600' buffer	Nest failed 5/3/23 due to coyote predation.
AMOYNCB15	14	DG(C07)	DG(C08)	21.00	04/27/23	3	600' buffer	Nest failed 5/11/23 due to ghost crab predation.
AMOYNCB16	15	DG(EKE)	UNB	17.58	04/28/23	3	600' buffer	Fledged 2 chicks, DG(C8A) and DG(C8K), on 7/6/23 at 41 days old.
AMOYNCB17	16	DG(CE3)	UNB	6.07	04/28/23	3	interior	Nest failed 5/20/23 due to unknown cause.
AMOYNCB18	17	DG(EH6)	UNB	10.14	04/28/23	3	600' buffer	Nest failed 5/4/23 due to ghost crab predation.
AMOYNCB19	18	DG(CMP)	DG(C7T)	5.90	04/29/23	1	600' buffer	Nest failed 5/3/23 due to unknown cause.
AMOYNCB20	19	DG(CEL)	UNB	20.00	05/01/23	3	600' buffer	Nest failed 5/20/23 due to unknown cause.
AMOYNCB21	20	DG(TN)	UNB	18.83	05/02/23	3	interior	Brood failed 6/2/23 due to unknown reason.
AMOYNCB22	21	DG(C96)	UNB	21.24	05/02/23	3	600' buffer	Brood failed 6/4/23 due to unknown cause.
AMOYNCB23	22	DG(EJ9)	UNB	22.75	05/02/23	3	interior	Nest failed 5/7/23 due to unknown cause.
AMOYNCB24	23	DG(EWA)	UNB	16.14	05/04/23	2	600' buffer	Fledged 2 chicks, DG(EWL) and DG(EWK), on 7/15/23 at 48 days old.
AMOYNCB25	24	UNB	UNB	0.10	05/05/23	2	none	Nest failed by 5/12/23 due to unknown cause.
AMOYNCB26	25	DG(CL1)	UNB	0.46	05/05/23	3	none	Nest failed by 5/22/23 due to unknown cause.

AMOYNCB27	26	UNB	UNK	2.44	05/05/23	3	none	Nest failed 5/9/23 due to unknown cause. One adult was not identified.
AMOYNCB28	27	DG(CE0)	UNB	4.10	05/05/23	2	600' buffer	Nest failed 6/5/23 due to unknown cause.
AMOYNCB29	28	DG(CUP)	UNB	19.06	05/06/23	3	interior	Nest failed 5/14/23 due to raccoon predation.
AMOYNCB30	5	DG(CCE)	UNB	7.21	05/06/23	3	600' buffer	Fledged 2 chicks, DG(EWC) and DG(EWH), on 7/20/23 at 45 days old. Chick DG(EWM) found dead before fledging.
AMOYNCB31	18	DG(CMP)	DG(C7T)	5.77	05/10/23	2	interior	Nest failed 5/30/23 due to ghost crab predation.
AMOYNCB32	13	DG(WF)	DG(CK0)	9.12	05/14/23	2	600' buffer	Fledged 2 chicks, DG(EWR) and DG(EU4), by 7/20/23 at 45 days old.
AMOYNCB33	29	DG(EC4)	DG(C00)	5.60	05/15/23	1	600' buffer	Nest failed 6/23/23 due to unknown cause.
AMOYNCB34	17	DG(EH6)	UNB	10.36	05/17/23	3	600' buffer	Nest abandoned on 5/28/23 due to severe weather.
AMOYNCB35	3	DG(C93)	UNB	20.30	05/22/23	3	600' buffer	Nest failed 5/29/23 due to predation by an undetermined predator.
AMOYNCB36	14	DG(C07)	DG(C08)	21.00	05/25/23	3	600' buffer	Nest failed 6/17/23 due to flooding.
AMOYNCB37	16	DG(CE3)	UNB	6.28	05/30/23	3	interior	Nest failed 6/19/23 due to coyote predation.
AMOYNCB38	1	DG(P5)	UNB	22.00	06/04/23	2	interior	Fledged 1 chick, DG(EWF), last seen on 8/9/23 at 42 days old.
AMOYNCB39	25	DG(CL1)	UNB	0.48	06/05/23	1	none	Nest failed 6/19/23 due to ghost crab predation.
AMOYNCB40	3	DG(C93)	UNB	20.15	06/16/23	1	600' buffer	Nest failed 6/24/23 due to unknown cause.
AMOYNCB41	21	DG(C96)	UNB	21.44	06/16/23	2	interior	Nest failed on 6/20/23 due to predation but an unknown predator.
AMOYNCB42	20	DG(TN)	UNB	18.57	06/16/23	2	600' buffer	Nest failed 6/24/23 due to ghost crab predation

Table D2. South Core Banks productivity data for 2023. South Core Banks totals: 25 breeding pairs, 47 total nests, 4 hatched nests, 1 fledged chick.

Nest	Pair	Adult	Adult	Mile	Found	Eggs	Closure	Outcome Summary
AMOYSCB01	1	DG(K0)	UNB	33.53	04/07/23	3	600' buffer	Nest failed 4/10/23 due to flooding.
AMOYSCB02	2	DG(CL9)	UNB	31.17	04/14/23	3	600' buffer	Nest failed 4/28/23 due to flooding.
AMOYSCB03	3	DG(C3A)	DG(CUM)	28.36	04/14/23	3	600' buffer	Nest failed 5/2/23 due to coyote predation.
AMOYSCB04	4	DG(YP)	DG(AP)	33.74	04/15/23	3	600' buffer	Nest failed 4/29/23 due to severe weather.
AMOYSCB05	5	DG(CK1)	UNB	30.94	04/16/23	3	600' buffer	Nest failed 5/10/23 due to coyote predation.
AMOYSCB06	6	DG(CUK)	DG(CJR)	28.27	04/17/23	3	600' buffer	Nest failed 5/2/23 due to unknown cause.
AMOYSCB07	7	UR-Red	R(AHJ)	36.28	04/18/23	1	600' buffer	Nest failed 4/25/23 due to unknown cause.
AMOYSCB08	8	DG(CYL)	DG(C5R)	47.21	04/18/23	2	interior	Nest failed 4/26/23 due to predation by an undetermined predator.
AMOYSCB09	9	DG(YM)	UNB	28.62	04/19/23	3	600' buffer	Nest failed 5/3/23 due to coyote predation.
AMOYSCB10	10	DG(JH)	UNB	39.50	04/20/23	2	600' buffer	Nest failed 4/25/23 due to unknown cause.
AMOYSCB11	11	DG(CRK)	DG(CK6)	27.67	04/22/23	3	600' buffer	Nest failed 5/3/23 due to coyote predation.

AMOYSCB12	1	DG(K0)	UNB	33.30	04/24/23	3	600' buffer	Nest lost 5/1/23 due to unknown cause.
AMOYSCB13	12	DG(J0)	DG(CAN)	35.50	04/26/23	2	600' buffer	Nest lost 5/1/23 due to unknown cause.
AMOYSCB14	13	R(5F)	DG(R8)	38.31	04/26/23	3	600' buffer	Nest lost 5/1/23 due to unknown cause.
AMOYSCB15	14	DG(LN)	DG(33)	25.00	04/26/23	3	interior	Brood failed 5/31/23 due to unknown cause.
AMOYSCB16	15	DG(EMN)	DG(CFA)	25.41	04/28/23	3	600' buffer	Fledged 1 chick, DG(C35), on 7/15/23 at 50 days old. Chick DG(CH6) last seen on 6/30/23 at 34 days old.
AMOYSCB17	16	DG(C68)	UNB	28.75	04/28/23	3	600' buffer	Nest failed 5/2/23 due to coyote predation.
AMOYSCB18	17	DG(CNC)	DG(CM0)	24.63	04/29/23	3	interior	Brood failed 6/14/23 due to unknown cause.
AMOYSCB19	18	DG(C53)	DG(CUL)	34.14	05/03/23	3	600' buffer	Nest failed 5/11/23 due to coyote predation.
AMOYSCB20	19	DG(UJ)	DG(C77)	26.95	05/03/23	3	600' buffer	Nest failed 5/24/23 due to coyote predation.
AMOYSCB21	20	DG(AL)	UNB	24.40	05/03/23	3	interior	Brood failed 5/28/23 likely due to severe weather.
AMOYSCB22	21	DG(CEF)	DG(EMP)	27.37	05/06/23	3	600' buffer	Nest failed 5/24/23 due to coyote predation.
AMOYSCB23	8	DG(CYL)	DG(C5R)	47.32	05/10/23	2	interior	Nest failed 6/3/23 due to abandonment.
AMOYSCB24	2	DG(CL9)	UNB	31.15	05/13/23	3	600' buffer	Nest failed 5/8/23 due to unknown cause.
AMOYSCB25	6	DG(CUK)	DG(CJR)	28.21	05/13/23	3	600' buffer	Nest failed 5/20/23 due to flooding.
AMOYSCB26	1	DG(K0)	UNB	33.48	05/13/23	3	600' buffer	Nest failed 5/20/23 due to predation by an undetermined predator.
AMOYSCB27	4	DG(YP)	DG(AP)	33.79	05/13/23	3	600' buffer	Nest failed 5/20/23 due to severe weather.
AMOYSCB28	7	UR-Red	R(AHJ)	35.99	05/13/23	3	600' buffer	Nest failed 5/18/23 due to unknown cause.
AMOYSCB29	13	R(5F)	DG(R8)	38.13	05/13/23	2	600' buffer	Nest failed 5/20/23 due to avian predation.
AMOYSCB30	9	DG(YM)	UNB	28.60	05/14/23	3	600' buffer	Nest failed 5/24/23 due to unknown reason.
AMOYSCB31	11	DG(CRK)	DG(CK6)	27.83	05/14/23	3	600' buffer	Nest failed 6/9/23 due to coyote predation.
AMOYSCB32	22	DG(CET)	DG(EKM)	23.91	05/17/23	2	interior	Nest failed 5/29/23 due to flooding.
AMOYSCB33	3	DG(C3A)	DG(CUM)	28.48	05/18/23	3	600' buffer	Nest failed 6/7/23 due to coyote predation.
AMOYSCB34	16	DG(C68)	UNB	28.66	05/18/23	2	600' buffer	Nest failed 5/24/23 due to coyote predation.
AMOYSCB35	23	DG(C02)	DG(C0W)	32.72	05/18/23	3	600' buffer	Nest failed 5/25/23 due to unknown cause.
AMOYSCB36	12	DG(J0)	DG(CAN)	35.53	05/22/23	1	600' buffer	Nest failed 5/25/23 due to abandonment.
AMOYSCB37	24	DG(CCF)	DG(C60)	24.80	05/22/23	2	interior	Nest failed 6/3/23 due to abandonment.
AMOYSCB38	25	DG(CJR)	UNB	28.24	05/31/23	2	600' buffer	Nest failed 7/2/23 due to coyote predation.
AMOYSCB39	1	DG(K0)	UNB	33.58	06/01/23	2	600' buffer	Nest failed 6/17/23 due to coyote predation.
AMOYSCB40	4	DG(YP)	DG(AP)	33.69	06/01/23	2	600' buffer	Nest failed 6/23/23 due to abandonment.
AMOYSCB41	2	DG(CL9)	UNB	31.22	06/01/23	2	600' buffer	Nest failed 6/19/23 due to coyote predation.
AMOYSCB42	9	DG(YM)	UNB	28.54	06/05/23	2	600' buffer	Nest failed 6/26/23 due to coyote predation.

AMOYSCB43	19	DG(UJ)	DG(C77)	26.79	06/05/23	1	600' buffer	Nest failed 6/10/23 due to coyote predation.
AMOYSCB44	26	DG(EEK)	UNB	35.76	06/10/23	2	600' buffer	Nest failed 6/14/23 due to predation by an undetermined mammal.
AMOYSCB45	12	DG(J0)	DG(CAN)	35.56	06/10/23	2	600' buffer	Nest failed 6/14/23 due to predation by an undetermined mammal.
AMOYSCB46	12	DG(J0)	DG(CAN)	35.60	06/29/23	2	interior	Nest failed 7/11/23 due to coyote predation.
AMOYSCB47	26	DG(EEK)	UNB	35.77	07/01/23	1	interior	Nest failed 7/23/23 due to unknown cause.