



Shorebird Monitoring and Management at Cape Lookout National Seashores

2021 Annual Report

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Photo credit: NPS, Morgan Barnes

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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 2021, NCB was divided into three islands by Evergreen Inlet at mile 3 and Old Drum Inlet at mile 19. These three islands are all 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. The Core Banks have a northeast to southwest orientation and exhibit a low profile landscape. The Core Banks face east toward the Atlantic Ocean and toward the Pamlico and Core Sounds on the west side. 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. SB faces south towards the Atlantic Ocean and towards Back Sound on the north side.

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 American oystercatchers (*Haematopus palliatus*) and colonial waterbirds (royal terns [*Thalasseus maximus*], sandwich terns [*Thalasseus elegans*], least terns [*Sterna antillarum*], 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 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 activity 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 Wildlife Services (WS) to conduct predator removal targeting coyotes and raccoons to benefit nesting shorebirds and sea turtles. WS conducted predator trapping on NCB, SCB, and SB in 2021. WS removed a total of eight coyotes and sixty-eight raccoons. Two coyotes were removed from NCB, four from SCB, and two from SB. A total of 36 coyotes and 130 raccoons have been removed from CALO by WS between 2017 and 2021.

Resource Violations

Resource management staff on Core Banks record resource violations they observe throughout the breeding season. In 2021, staff recorded a total of 211 violations, 150 on SCB and 61 on NCB (see Appendix A, Map A1). Staff observed 50 dogs off leash, 40 pedestrians in bird closures, 39 vehicles in turtle closures, 28 vehicles in bird closures, and 14 vehicles in the dunes. Forty other resource-related violations were recorded for variety of offenses. Resource staff corrected 90 of these observations and severe offenses were reported to law enforcement.

Piping Plover (*Charadrius melodus*) Management and Monitoring

Background

The piping plover is listed as a federal 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 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 2021, 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 this protocol, 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 were recorded. Locations of nests were recorded and monitored daily until they hatched or were lost.

Once nests were identified, the locations of the nests were recorded in decimal degrees 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.

Nests were checked every 1 to 3 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. 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 location 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. The Portsmouth flats, Kathryn-Jane flats, Swash Inlet, Old Drum Inlet, New Drum Inlet, Ophelia Island, 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 are not a part of the nesting habitat closure and are open for recreational use with some limitations. An additional closure was posted during the breeding season for new breeding activity at mile 15 on NCB.

At the north end of SCB at the Plover Inlet nesting site a mile of beach 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. The chicks are required to have a 600-foot vehicle free buffer, but the buffer stops vehicle traffic at that location. 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 conducted by WS, CALO staff protected 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 32 breeding pairs of piping plovers were documented at CALO in 2021. Twenty-seven pairs nested on NCB and four pairs on SCB. An additional territorial pair occupied the Ophelia Island site on NCB for the duration of the breeding season, built nest scrapes, but a nest was never documented. Birds nested in eight distinct areas (Table 1). The north half of NCB contained the

highest density of breeding pairs with 18 pairs between Ocracoke Inlet and the Swash Inlet nesting site.

There were 41 nesting attempts made in 2021. The earliest nest initiation was on April 15 and the latest was on June 20. Thirty-five nests were on NCB and six were on SCB. Of the 41 nests, 10 were re-nests. Twenty-two nests hatched and 11 chicks fledged from 8 different broods. The average clutch size was 3.46 eggs and 68 of 142 known eggs hatched. Productivity for CALO was 0.34 chicks fledged per breeding pair. Table 2 contains nesting success data from 2000 to 2021. Figure 1 illustrates the number of pairs and chicks fledged from 1989 to 2021. Refer to Appendix A, Map A2 for a detailed map of nest and nest sites and Appendix B for individual nest productivity data for 2021.

Table 1. Piping plover reproductive success data by nesting site in 2021.

Island	Nesting Area	Number of Pairs	Hatch Success	Fledge Success (chicks/pair)
North Core Banks	Portsmouth Flats	8	0.44	0.25
North Core Banks	Kathryn-Jane Flats	8	0.67	0.88
North Core Banks	Swash Inlet	2	1	1
North Core Banks	Mile 15	1	1	0
North Core Banks	Old Drum Inlet	3	0.4	0
North Core Banks	New Drum Inlet	5	0.33	0
North Core Banks	Ophelia Island	1	0	0
South Core Banks	Plover Inlet	4	0.67	0

Table 2. Summary of piping plover reproductive success data at CALO from 2000 to 2021.

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

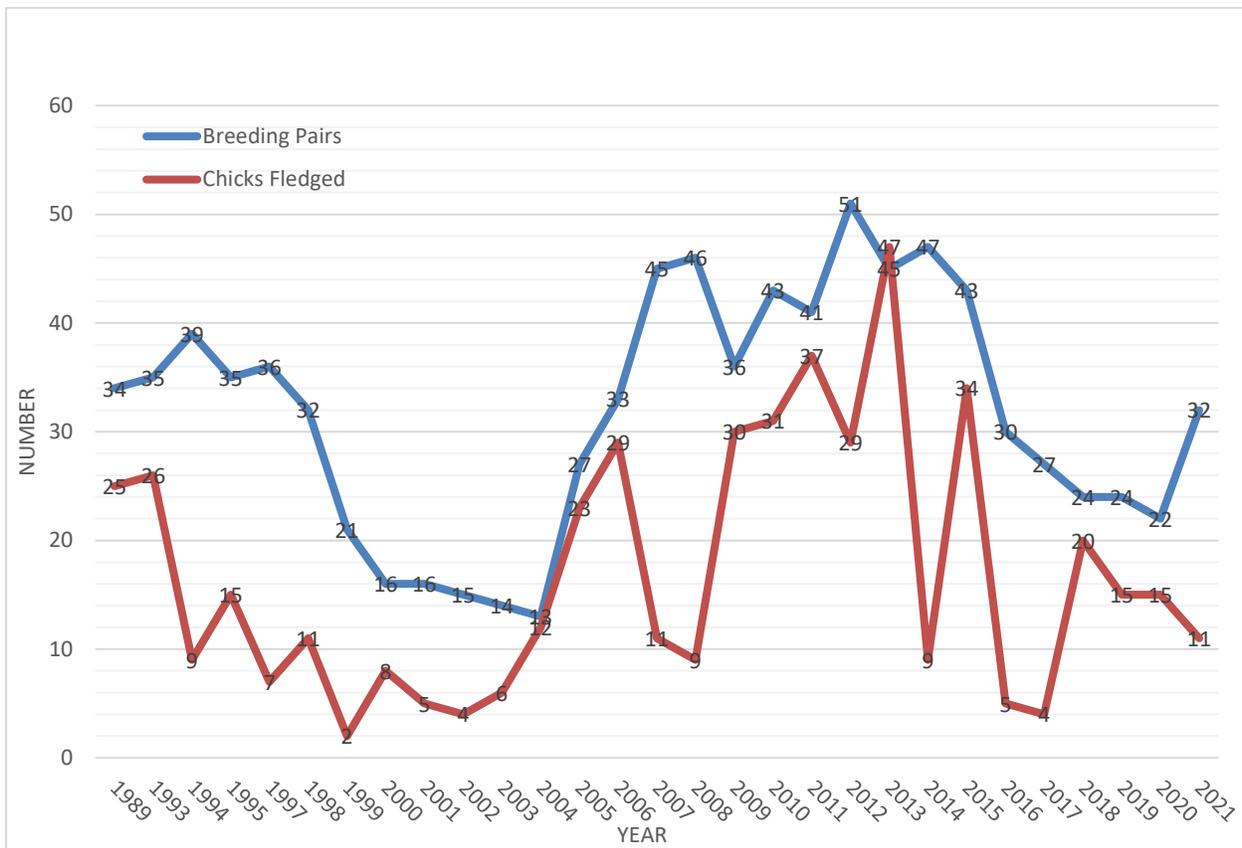


Figure 1. The number of piping plover breeding pairs and number of chicks fledged by year at CALO from 1989 to 2021.

Nest Failures and Chick Mortality

In 2021, predator exclosures were used to protect 22 (54%) nests. In 2021, exclosures were not installed on the sections of NCB between Ocracoke Inlet and Evergreen Inlet and between Old Drum Inlet and Ophelia Inlet, as these sites were only accessible by kayak. Of the nests with exclosures, 17 (77%) hatched. One exclosed nest was lost to flooding and a second exclosed nest was abandoned, and three others were lost to unknown reasons. Predator exclosures were not used on 19 (46%) nests. Of the nests without exclosures, only five hatched (26%). In total, 19 nests did not hatch; 11 were

lost to unknown reasons, three were predated, three were lost due to flooding, and two were abandoned (Table 3). Of the three predated nests, one was predated by a coyote, one was by ghost crab, and one was by an undetermined predator.

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 68 chicks hatched in 2021 and eleven of those survived to fledging (16%). Fourteen of the hatched nests suffered complete brood loss. All 57 chick losses were classified as unknown.

Table 3. Causes of piping plover nest failure in 2021.

Nesting Site	Nests	Total Lost	Predation	Weather	Abandoned	Unknown
Portsmouth Flats	9	5	1	1	0	3
Kathryn-Jane Flats	9	3	0	0	1	2
Swash Inlet	2	0	0	0	0	0
Miles 15	1	0	0	0	0	0
Old Drum Inlet	5	3	1	1	0	1
New Drum Inlet	9	6	0	0	1	5
Ophelia Island	0	N/A	N/A	N/A	N/A	N/A
Plover Inlet	6	2	1	1	0	0
Total	41	19	3	3	2	11

Beach Protection Zones and Brood Foraging

The area between Ophelia Inlet and Ramp 24, 1 mile in length, was established as a protection zone for piping plover, American oystercatcher, and colonial waterbird chicks from May 17 to August 19. 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 May 31, when the first nest hatched, to July 1, when the last brood failed. However, the beach closure was established on May 17 to protect American oystercatcher chicks and extended to August 19 to protect American oystercatcher and colonial waterbird chicks. On NCB, a wildlife protection zone was established between Evergreen Inlet at mile 3 to mile 6.81 after a brood was observed on the ocean beach on June 16. This closure was removed on June 27 after all chicks were confirmed fledged.

One brood foraged on the ocean beach in 2021. These chicks used both the ocean beach and interior mudflats and ponds at Kathryn Jane Flats. Chicks from the other 21 broods foraged on soundside beaches, sand flats, mudflats, ponds, and ephemeral pools in areas off-limits to vehicles and, in most cases, all entry.

Migrating and Wintering Piping Plovers

Park wide non-breeding piping plover surveys were conducted each month in 2021 in January through March and August through December. A total of 626 piping plovers were documented during non-breeding surveys from 109 separate observations (see Appendix A, Map A3; Appendix C). The highest number of non-breeding piping plovers were recorded in September with 204 birds seen at CALO (Table 4).

Of the 626 birds, 427 were recorded as unbanded and 82 (13%) were recorded as banded. Of the 82 banded birds, field staff obtained full band combinations for 64 birds. One hundred and nine 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 100 observations totaling 752 piping plovers during 2021. 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 each month of 2021.

Island	January	February	March	August	September	October	November	December
NCB	12	15	12	78	135	54	29	29
SCB	20	13	5	53	44	27	3	3
SB	7	10	1	20	25	27	2	1
Total	39	38	18	151	204	108	34	33

Banding

Virginia Tech Shorebird Laboratory researchers trapped and banded nine new adults from twelve nests with individual field readable codes. Three previously banded adults were recaptured and resampled. Eight chicks from five different broods were banded. Six of the banded chicks successfully fledged. Of the 60 individuals nesting in the Seashore, 36 (60%) were banded, 22 (36%) were unbanded, and two (3%) were unknown. Two females nested with different males between their first and second nests. Six (19%) pairs were completely unbanded while 24 (77%) pairs had at least one of the pair banded. Both adults had unknown banding status for one pair. See Appendix B for nesting pair band data and 2021 chick bands.

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. In 2021, CALO staff floated a total of nine eggs from four different nests.

Discussion

Piping plover nesting pairs increased by 45% between 2020 and 2021, from 22 pairs to 32 pairs. Hurricane Dorian in 2019 broadly restructured the piping plover nesting habitat on NCB and plovers

continue to re-colonize new sites on that island. The pair count at Kathryn-Jane Flats increased from four pairs in 2020 to nine pairs in 2021. Portsmouth Flats also increased in pair count from four to nine between 2020 and 2021. Two pairs colonized the Swash Inlet site at mile 9 for the first time in several decades and a pond at mile 15 was used for nesting for the first time. However, pair numbers did decrease at other sites such as Old Drum Inlet and New Drum Inlet. Structural changes of the habitat from Hurricane Dorian led to increased recruitment of nesters and also resulted in a shift of nesting density from the bottom half of NCB to the top half of NCB.

While pair numbers increased in 2021, hatch success, chick survival, and fledge success all went down. Overall productivity decreased to 0.34 in 2021 compared to 0.68 in 2020. The northern portion of NCB between Evergreen Inlet (mile 3) and Swash Inlet area (mile 9), produced all 11 fledglings from the 2021 season. No chicks fledged from the southern portion of NCB from Old Drum to Ophelia Inlet, an area previously known to be a highly successful, or from Plover Inlet on SCB. Poor hatch success on the southern portion of NCB is likely due, in part, to the lack of predator exclosures. These sites were typically accessed by kayak across Old Drum Inlet, making transportation of predator exclosures difficult. The re-opening of Old Drum Inlet in 2019 has also precluded predator removal actions by WS in this area for the past two years. It is recommended that predator removal continue at CALO and that management efforts focus on the southern end of NCB once this site is again accessible by vehicle. In addition, an increase in monitoring staff would allow more frequent use of predator exclosures at locations with limited access.

Poor chick survival is a major driver in CALO's low piping plover productivity. Only 16% (11) of an estimated 68 chicks survived to fledging. Little is known about the cause of chick loss at CALO, but predation by ghost crabs and avian predators is suspected based on observations at other sites. Gull-billed tern nesting activity has increased at CALO over the past three years and this may be a source of chick predators, particularly between Old Drum Inlet and Ophelia Inlet. However, gull-billed tern predation on piping plover chicks was not observed. Broods are typically only observed for a few minutes each day to count the number of chicks and record the location. Increasing staff levels to provide longer and more frequent brood observations may provide better information on the source of chick loss. However, a targeted study on chick mortality by a partner agency or research agency would provide the most detailed information for CALO managers.

American Oystercatcher (*Haematopus palliatus*) 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 North Carolina Wildlife Resource Commission (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 2021, 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 18 breeding seasons, 2004 to 2021, during which all of 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 in decimal degrees 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 North Carolina State University's 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 2021, 54 pairs of American oystercatchers nested at the Seashore, 24 pairs on SCB and 30 pairs on NCB (Table 5, Appendix A, Map A4; Appendix D). There was no American oystercatcher breeding activity 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 5 and the last nest was found on June 24.

Seventy-four nests were documented throughout the Seashore; 33 on SCB and 41 on NCB. Hatch success was 52% for SCB and 56% for NCB. SCB produced 1.50 fledglings per nesting pair and NCB produced 0.90 fledglings per nesting pair. Forty nests hatched at CALO and fledged 63 chicks producing an overall fledge rate of 1.17 (Table 5). Since 2004, fledge rates have ranged from 0.00 to 1.17 per pair with a mean rate of 0.53 from 2004-2021 (Table 6, Figure 2).

Table 5. American oystercatcher reproductive success by island in 2021.

Island	Breeding Pairs	Total Nests	Nests Hatched	Chicks Fledged	Fledge Rate
South Core Banks	24	33	17 (52%)	36	1.50
North Core Banks	30	41	23 (56%)	27	0.90
Shackleford Banks	0	0	N/A	N/A	N/A
Total	54	74	40 (54%)	63	1.17

Table 6. Summary of American oystercatcher reproductive success data at CALO from 2004-2021.

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

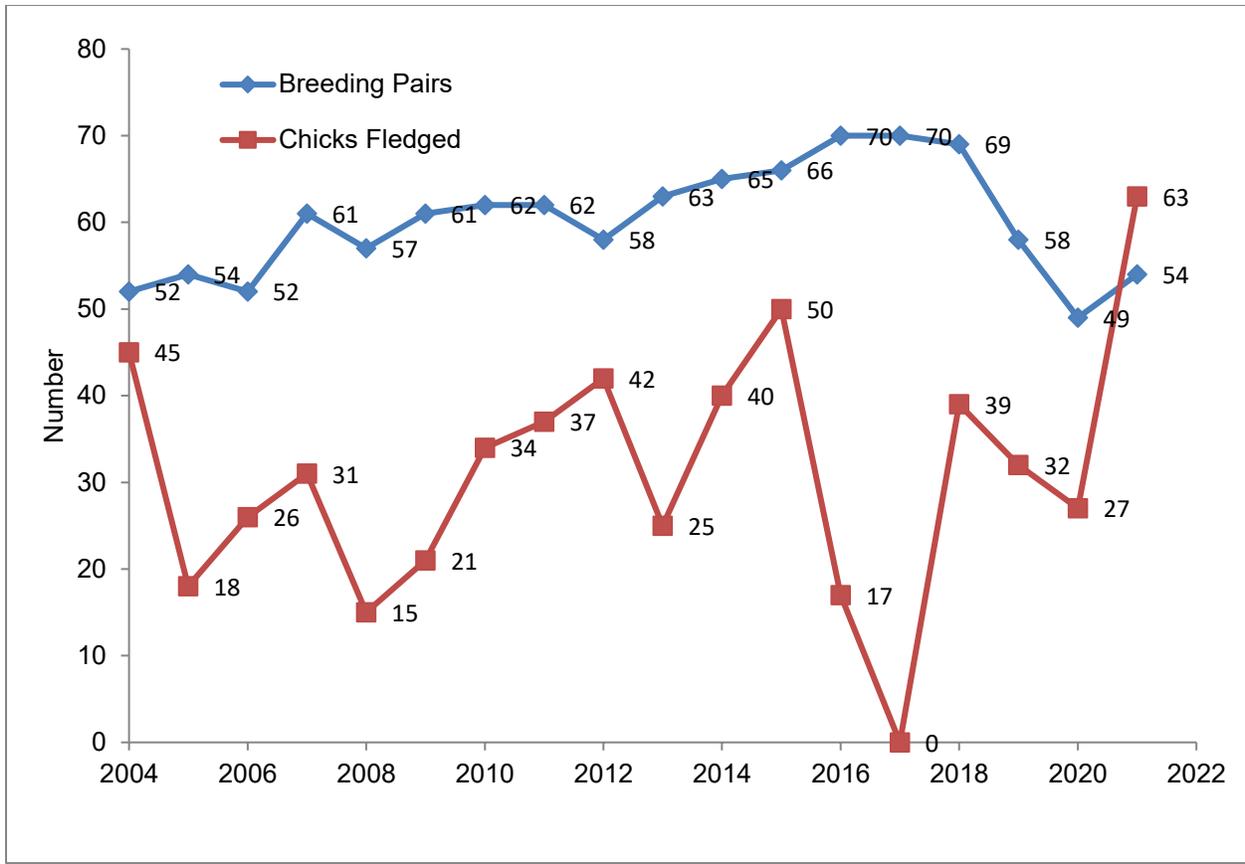


Figure 2. The number American oystercatcher breeding pairs and number of chicks fledged by year at CALO between 2004 and 2021.

Nest Failures and Chick Mortality

Thirty-four nests failed in the 2021 breeding season. Fifteen (44%) nests were lost due to predation, 12 (35%) due to unknown causes, three (9%) were abandoned, two (6%) were flooded, and two (6%) were lost due to human interactions (Table 7). Predation by a variety of animals occurred; nine by coyote, three by ghost crab, two by raccoon, and one by an undetermined mammalian predator (Table 8). One nest was crushed by an ORV before it was detected by CALO staff and another nest was abandoned after visitors set up camp within the restricted buffer zone around the nest. Causes of American oystercatcher nests failures from 2013 to 2021 are described in Table 9.

Park staff observed 87 chicks from 40 hatched nests. However, chicks are often difficult to detect and can be lost before technicians are able to observe them. CALO staff estimates that 102 chicks likely hatched. Sixty-three of these 102 chicks successfully fledged, with a chick survival probability of 62%. Due to the mobile nature of precocial chicks and the lack of prolonged observations, the cause of chick mortality is largely unknown. Seven of the hatched nests suffered complete brood loss and all chick losses were due to unknown causes.

Table 7. Causes of American oystercatcher nest failure in 2021.

Island	Predation	Flooding/Storms	Abandoned	Human Interaction	Unknown
South Core Banks	9	1	1	2	3
North Core Banks	6	1	2	0	9
Total	15	2	3	2	12

Table 8. Recorded American oystercatcher nest predators in 2021.

Island	Coyote	Raccoon	Ghost crab	Undetermined Mammal
South Core Banks	9	0	0	0
North Core Banks	0	2	3	1
Total	9	2	3	1

Table 9. Causes of American oystercatcher nest failure, 2013-2021.

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

Banding

Sixty chicks were captured by CALO staff and banded with individual field readable codes. Four previously unbanded adult American oystercatchers were trapped and banded on Core Banks and two of these adults were fitted with GPS data loggers as part of a research project. Another adult was banded and fitted with a data logger on Morgan Island. Of the 108 individuals nesting at CALO, 74 (69%) were banded, 34 (31%) were unbanded, and two were banded (2%) but with unknown combinations. Only 2 (4%) pairs were completely unbanded and 52 (96%) had at least one of the pair banded. See Appendix D for nesting pair re-sight data and 2021 chick bands.

Discussion

The 2021 American oystercatcher breeding season yielded the highest productivity and fledge success on record. CALO fledged 63 American oystercatcher chicks with a productivity of 1.17 chicks per breeding pair, compared to the previous record years of 0.86 productivity in 2004 and 50 chicks fledged in 2015. The total number of nesting pairs also increased slightly by five pairs in 2021, turning around a previous downward trajectory since 2018. High productivity in 2021 is

attributed to both high hatch success and high chick survival. Fifty-four percent of nests laid successfully hatched, compared to an average hatch success of 26% from 2004-2020. First nests are typically the most successful and survival of early season nests can promote high productivity during the breeding season overall. A lack of spring storms and hurricane landfalls contributed to high hatch success of early season nests.

Hatch success was consistent across NCB and SCB. However, chick survival was more variable across the two islands. SCB had an unusually high chick survival probability of 82%, fledging 36 of 44 chicks, with all hatched nests producing at least one fledge. A high concentration of successful pairs at the north end of SCB contributed significantly to this bumper crop of fledges. The northern five miles of SCB has a concentration of 2.4 pairs per mile between Ophelia Inlet (mile 24.00) and mile 29.00 producing a total of 25 fledges. A single mile stretch in this area between mile 28 and mile 29 produced 10 fledges from four pairs. In contrast, a four mile stretch on NCB between mile 19 and Ophelia Inlet (mile 23) housed 3 pairs per mile but only produced six fledges.

While NCB hatched more chicks than SCB, chick survival was lower at 47% and seven hatched nests experienced complete brood losses. ORV management for American oystercatcher chicks on NCB remains challenging since Hurricane Dorian destroyed significant portions of the backroad in 2019. Only three of the sixteen broods on NCB between Evergreen Inlet and Old Drum Inlet received full beach closures where ORVs were detoured to the backroad behind the dunes and broods were completely separated from vehicle traffic. The other thirteen broods received closures on the upper beach and interior portions of the island but vehicle traffic was allowed through the area along the lower beach. Chicks were documented outside closures and exposed to vehicles and three of these broods suffered complete brood losses. However, no collisions with ORVs were documented and brood loss was also common on NCB in areas without ORVs.

High nest and chick survival, particularly on SCB, are thought to be the result of regular and consistent predator trapping efforts. Regular predator trapping began in 2017 and continued through the 2021 season. While coyote activity persisted on SCB during the 2021 season, field staff noted little coyote presence on the northern end of the island where productivity was highest. Limited monitoring on sections of NCB due to inlets formed by Hurricane Dorian in 2019 resulted in many nest failures having unknown causes, but predation is suspected to be the main cause of nest failure. SB failed to attract nesting American oystercatchers in 2021, likely due to high levels of coyote activity. Trapping of coyotes should continue on SB in an effort to lower predator levels and attract breeding shorebirds back to this island. A regular predator management program should continue on Core Banks to maintain the high productivity seen in 2021.

Alterations of nesting and brood rearing habitat may have also contributed to high success in the 2021 season. Hurricane Florence in 2018 and Hurricane Dorian in 2019 significantly overwashed the north end of SCB and regenerated open sand flats at Ophelia Inlet. Consecutive impactful hurricanes may have also altered predator populations and dynamics on Core Banks. There were no hurricane landfalls or large spring tide events at CALO in 2021 resulting in low incidence of nest flooding.

Two nests failed on SCB due to visitor interactions. One nest was crushed by an ORV before technicians were able to find and protect the nest. Another nest was abandoned after visitors camped within 50 feet of the nest, in violation of the buffer area installed by park staff. Increased technician staff would provide better coverage of the beach and quicker detection and protection of nests. Four technicians were responsible for monitoring 54 pairs of oystercatchers, on top of other species monitoring, and workloads can be burdensome particularly when nest initiation for many pairs occur simultaneously, as it did in 2021. Additional staff would also allow for more regular coverage of areas on NCB that are difficult to access. Increased law enforcement staff would facilitate better enforcement of resource protection zones and reduce disturbance to American oystercatchers.

Colonial Water bird 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 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. GPS point locations were obtained for the center of each colony. 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 15 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 2021, 22 colonial waterbird colonies were observed at CALO (Table 10). Twelve colonies were on NCB, nine were on SCB, and one was on Morgan Island (Appendix A, Map A5). There were no colonies on SB. Morgan island was posted for nesting activity and royal tern and sandwich terns nesting activity was observed but no pair count or productivity monitoring was conducted. Of the 22 colonies, seventeen were single species colonies and five 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. Fifteen colonies occupied reoccurring nesting sites that were posted at the beginning of the season. Seven colonies were observed outside of the posted areas and were subsequently posted. One colony at Ocracoke Inlet did not receive a bird closure. Four colonies were ranked as no success, seven had low success, six had medium success, four had high success, and one had unknown success.

Eight hundred and thirty-five pairs of least terns were counted at CALO during the annual least tern census window (Figure 3). In addition, 92 black skimmer pairs, 48 common tern pairs, and 34 gull-billed tern pairs were counted during the census window.

Table 10. Summary of colonial waterbird colonies in the Seashore in 2021. 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
NC12	NCB	0.00	Ocracoke Inlet	1 LETE, 7 BLSK, 16 COTE, 1 GBTE	1 LETE, 7 BLSK, 16 COTE, 1 GBTE	low
NC11	NCB	2.61	North Portsmouth	9 LETE	9 LETE	none
NC02	NCB	3.00	Portsmouth Mile 3	59 LETE	60 LETE	high
NC08	NCB	3.60	Portsmouth Mile 3.6	10 LETE	10 LETE	low
NC07	NCB	4.00	Portsmouth Mile 4	3 LETE	4 LETE	none
NC10	NCB	5.89	High Hills	21 LETE	37 LETE	medium
NC03	NCB	6.76	Kathryn Jane Flats	29 LETE	39 LETE	medium
NC04	NCB	15.07	Mile 15	8 LETE	13 LETE	low
NC01	NCB	18.68	Old Drum North	78 LETE, 9 BLSK, 5 COTE, 1 GBTE	173 LETE, 38 BLSK, 5 COTE, 4 GBTE	high
NC06	NCB	19.11	Old Drum South	15 LETE	38 LETE	low
NC05	NCB	22.00	New Drum Flats	41 LETE	41 LETE	low
NC09	NCB	22.73	Ophelia Spit	20 LETE	20 LETE	low
SC06	SCB	24.00	North Plover Inlet	130 LETE, 76 BLSK, 23 COTE, 32 GBTE	203 LETE, 90 BLSK, 18 COTE, 50 GBTE	high
SC01	SCB	24.87	South Plover Inlet	357 LETE, 4 COTE	375 LETE, 8 COTE	high
SC05	SCB	30.50	Mile 30	3 LETE	40 LETE	medium
SC03	SCB	35.60	Mile 35	15 LETE	22 LETE	low

SC04	SCB	36.27	Mile 36	20 LETE	20 LETE	medium
SC02	SCB	38.07	Mile 38.07	1 LETE	1 LETE	none
SC08	SCB	38.71	Mile 38.71	-	8 LETE	medium
SC09	SCB	39.10	Mile 39.10	-	4 LETE	none
SC07	SCB	43.73	Cape Point	15 LETE	33 LETE	medium
MI01	MI	-	Morgan Island	not surveyed	ROTE, SATE (no count)	unknown

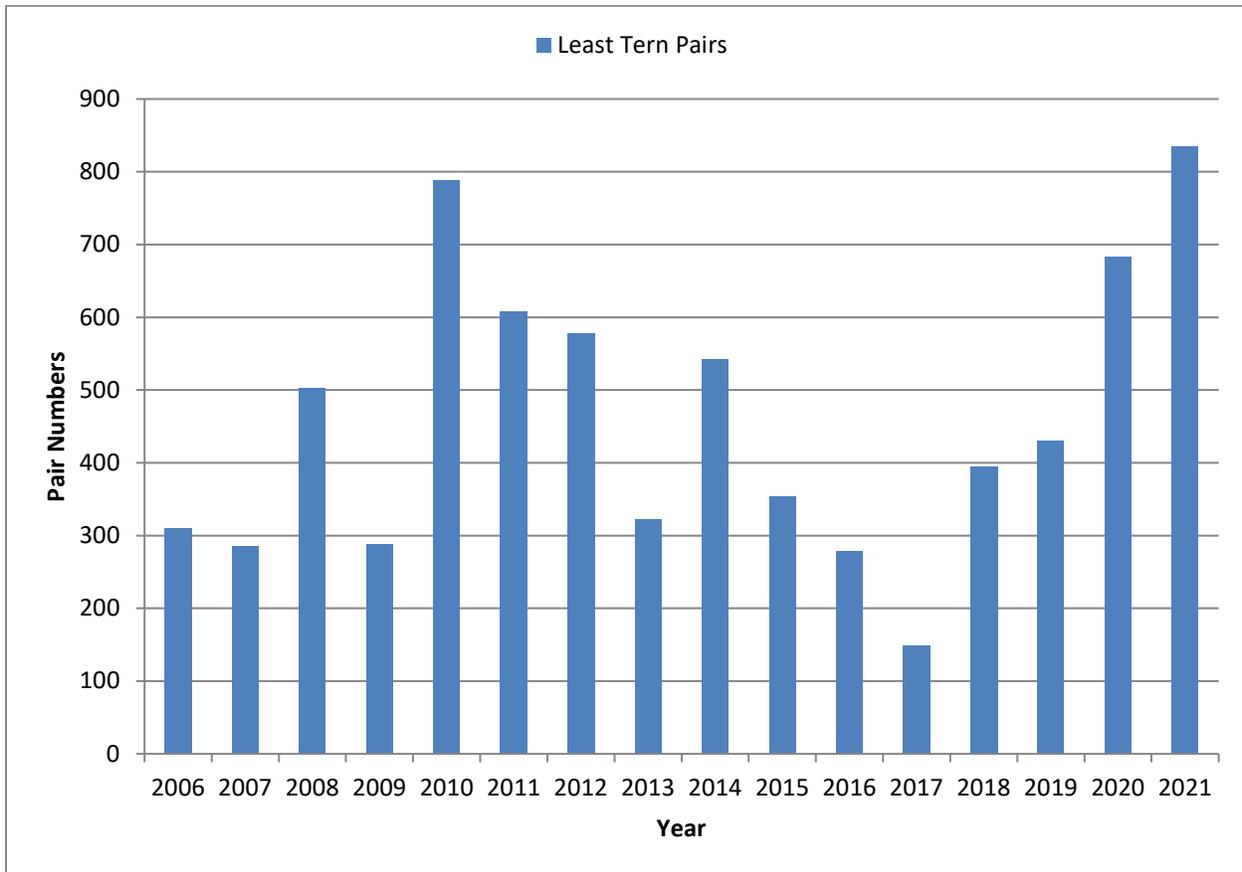


Figure 3. Least tern window census counts at CALO from 2006 to 2021.

Banding

Black Skimmer chicks were banded on NCB and SCB in coordination with North Carolina Audubon. A total of 65 chicks were banded on SCB during two visits and 35 chicks were banded on NCB during two visits.

Discussion

Productivity in colonial waterbird colonies is difficult to determine. Four colonies were rated as high success, two on NCB and two on SCB. All four of these colonies were located at terminal ends of the

islands close to inlets. These four colonies produced high numbers of least tern and black skimmer fledges, and common tern and gull-billed tern chicks were also documented. The other 17 colonies on Core Banks recruited relatively low numbers of pairs and success was rated from medium to none. Coyote activity was recorded in colonies on the southern half of SCB. Low least tern pair numbers at Cape Point, compared to other years, is attributed to high coyote activity in the area. There was no colonial nesting activity at Power Squadron Spit on SCB likely due to the same reason.

The May least tern census recorded 835 breeding pairs at CALO, the highest recorded. The bulk of these pairs (68%) were located at Ophelia Inlet on SCB and Old Drum Inlet on NCB. There has been a steady increase in least tern pairs at CALO since 2018 following a period of decline between 2010 and 2017. An increase in pair recruitment is suspected to be due to habitat improvements created by Hurricane Florence and Hurricane Dorian and consistent predator management efforts.

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 and inlet areas on Core Banks, NCB and SCB, beginning in mid-March and ending mid-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 15. In 2021, surveys on NCB were only conducted between miles 3 and 19 due to limited access across inlets formed by Hurricane Dorian.

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 Geographic Information System (GIS).

Results

Spring migration counts peaked on May 15 with 1,843 birds counted across the Core Banks (Figure 4). Fall migration peaked on August 25 with 47 red knots counted across the Core Banks. Spring migration from March 15 to June 5 averaged 362 birds across both islands. The fall migration from July 15 to October 15 averaged 21 birds across both islands.

NCB averaged 97 birds per survey throughout the survey period. SCB averaged 78 birds per survey. NCB had the highest count of 954 birds on May 15, with a relative abundance of 37 birds per kilometer (Table 11). SCB had the highest count of 889 red knots on May 15, with a relative abundance of 23 birds per kilometer. Red knots were distributed over the length of Core Banks from 2007 to 2021 (Figure 5; Appendix A, Map A6).

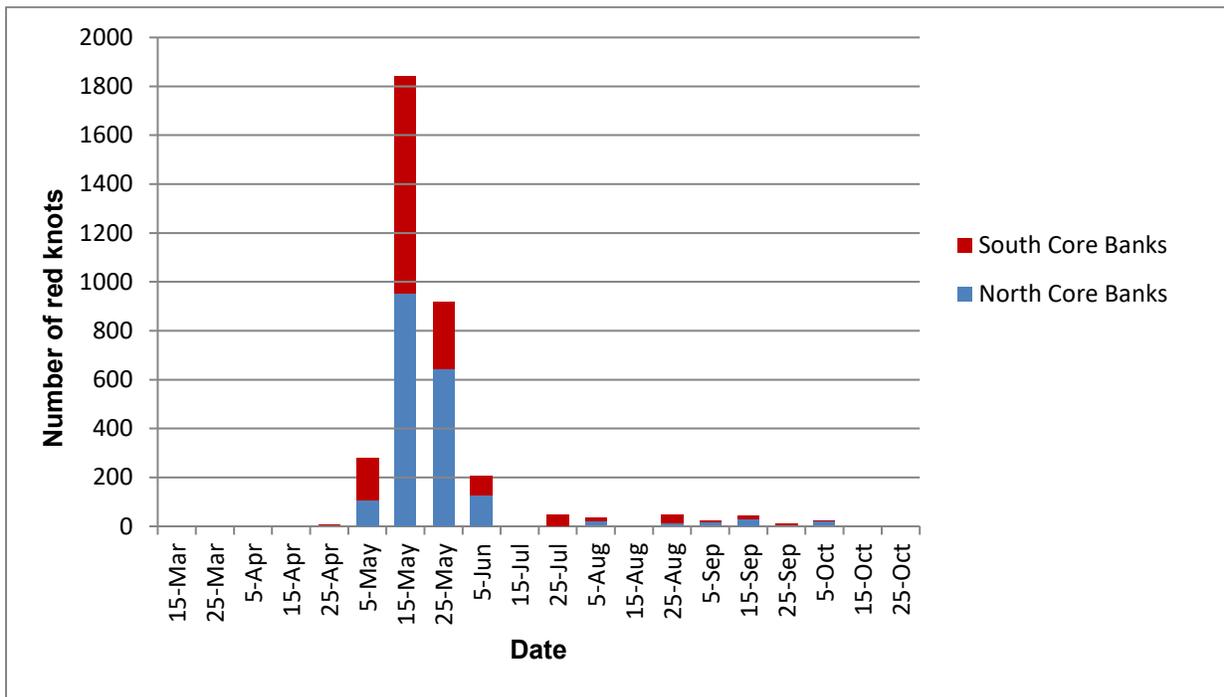


Figure 4. Number of red knots counted at CALO in 2021.

Table 11. Red knot relative abundance on NCB from 1992 2021.

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

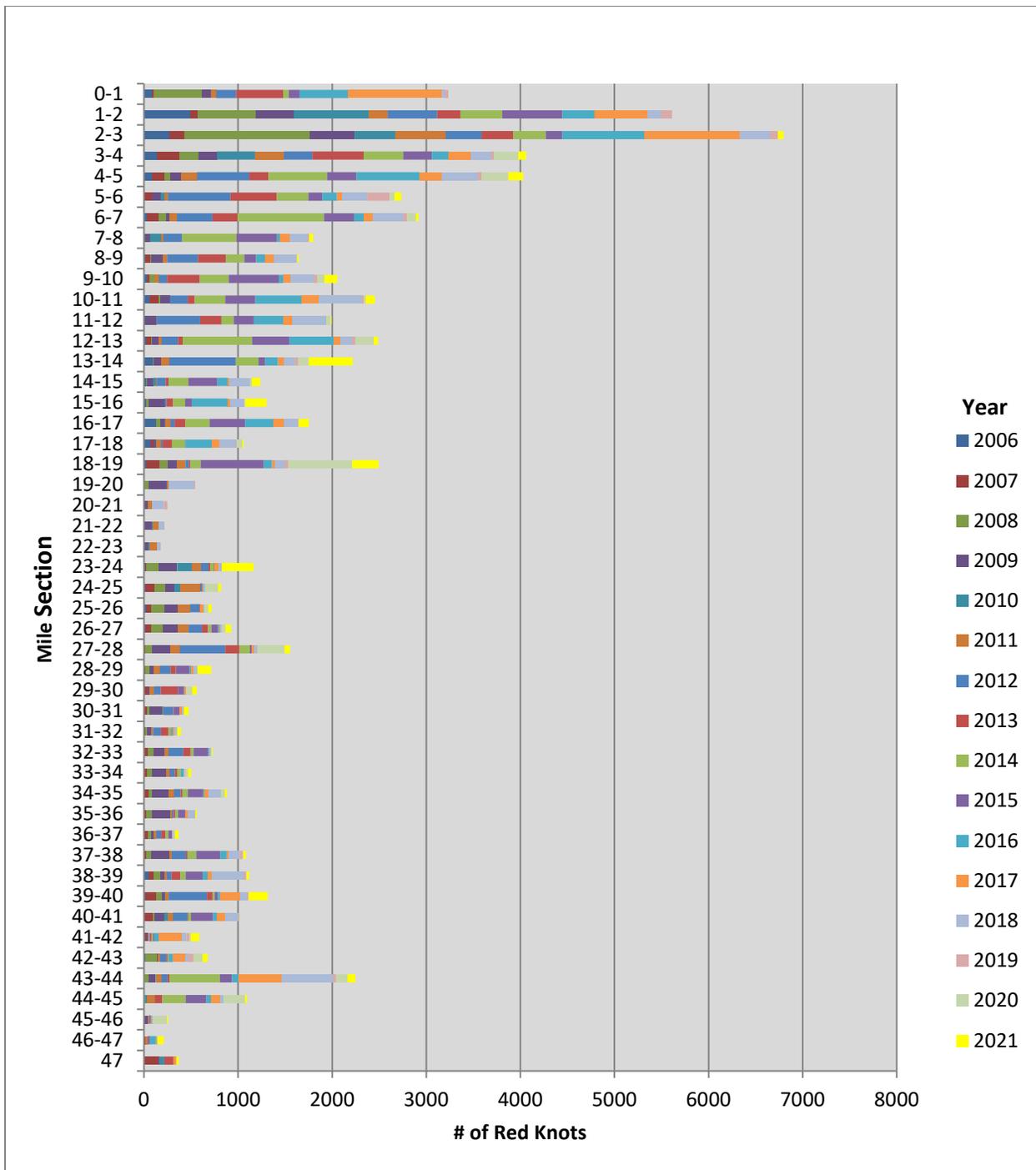


Figure 5. Total number of red knots counted in each mile section from 2007 to 2021.

Discussion

Monitoring in 2021 confirmed CALO as a stopover site for red knots, particularly during the spring migration. A total of 3,488 red knots were observed during 2021 and NCB averaged slightly more birds per survey than SCB, with 97 birds per survey and 78 birds per survey, respectively. Peak spring migration counts on May 15 recorded 1,843 birds utilizing the shoreline of Core Banks. The

relative abundance of red knots on NCB was 37 birds per km which is consistent with an average of 40 birds per km between 1992 and 2021 (Table 11). The highest number of birds were seen within the mile 13 area of NCB, followed by the north end of SCB around mile 24 (Figure 5). However, these numbers are likely skewed as the north end of NCB from Ocracoke Inlet to mile 3 was not included in the 2021 surveys due to limited access across Evergreen Inlet. This area is typically where the highest number of red knots have been observed. 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 2021 and recorded a total of 135 pairs and 6 singles (Table 12). Pairs were counted in the same nesting areas as piping plovers and any additional habitat throughout the park. The section of NCB between Ocracoke Inlet and mile 3 was not surveyed due to limited access. Nests and broods were recorded when found or observed opportunistically, but nest and brood fates were not tracked. Sixteen nests and 12 broods were recorded during the 2021 season. Wilson’s plover pairs appear stable to increasing at CALO since 2007 (Figure 6).

Table 12. Wilson’s plover census results June1-9, 2021.

Island	Nesting Area	Number of Pairs	Singles
North Core Banks	Ocracoke Inlet	Not surveyed	Not surveyed
North Core Banks	South Portsmouth Flats	10	1
North Core Banks	Kathryn-Jane Flats	10	1
North Core Banks	Swash Inlet	1	0
North Core Banks	Mile 15	1	0
North Core Banks	Mile 17.5	1	0
North Core Banks	Old Drum Inlet	18	0
North Core Banks	New Drum Inlet	11	1
North Core Banks	Ophelia Island/Spit	22	0
South Core Banks	Plover Inlet	20	0
South Core Banks	Mile 25-27	7	0

South Core Banks	Mile 41	1	0
South Core Banks	Cape Point	2	0
South Core Banks	Power Squadron Spit	15	0
Shackleford Banks	Barden Inlet	6	1
Shackleford Banks	Corral Area	0	1
Shackleford Banks	Whale Creek Bay	2	0
Shackleford Banks	Middle Island	5	0
Shackleford Banks	Beaufort Inlet	3	1

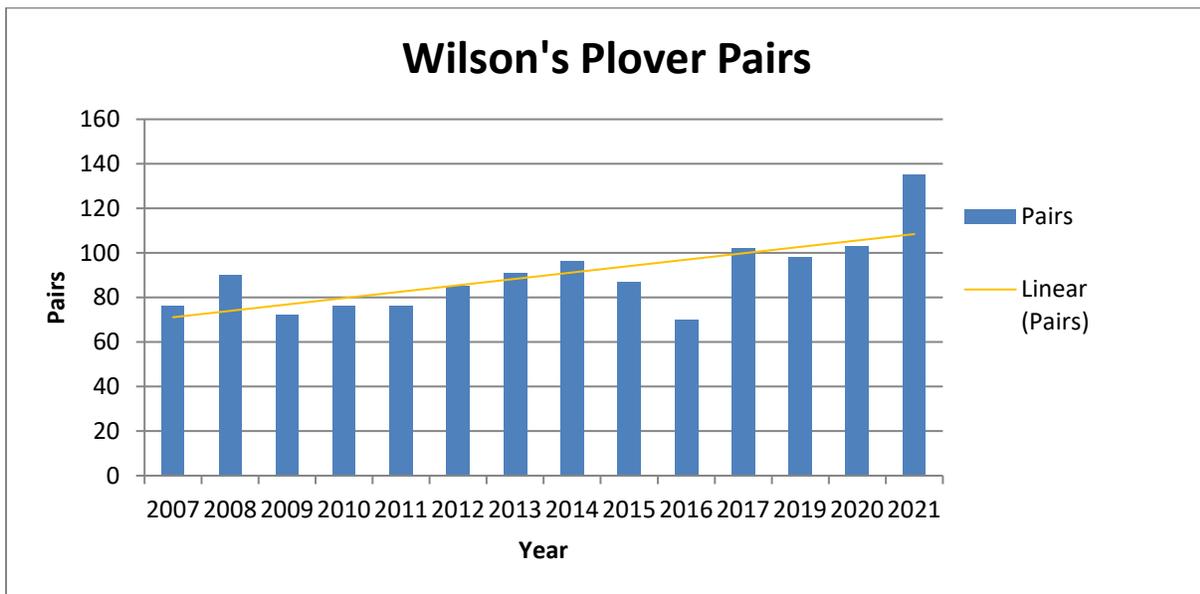


Figure 6. Number of Wilson’s plover counted at CALO 2007- 2021.

Conclusions and Recommendations

Overall, 2021 was a productive year for shorebirds and colonial waterbirds at CALO. The season produced a record number of American oystercatcher chicks and recruited a record number of least tern pairs and Wilson’s plover pairs. There was also an increase in piping plover and American oystercatcher pairs on Core Banks. However, piping plover productivity remains low at 0.34 chicks per pair, well below the USFWS recovery goal of 1.50.

Nesting success at CALO appears to be due to a combination of predator management and habitat improvements caused by recent storm events. WS has removed 37 coyotes and 134 raccoons since 2017. Predator removal activities occur both pre-season and during the breeding season across all three island units. Predator removal has resulted in a significant increase in American oystercatcher

productivity from 0.0 in 2017 to 1.17 in 2021. However, predation continues to be the predominant cause of nest failure for American oystercatcher nests, with coyotes causing the failure of nine nests on SCB in 2021. Coyote activity is likely also preventing American oystercatcher nesting on SB. The cause of piping plover nest failure was largely unknown in 2021, though a coyote was documented to predate one nest before it was exclosed on SCB. A lack of predator exclosures and predator removal on the southern portion of NCB due to inaccessibility across Old Drum Inlet likely resulted in higher predation levels in that area. There was limited coyote activity on NCB in 2021 and racoons and ghost crabs were the main predators for known nest losses. CALO should continue to sign Interagency Agreements with WS to conduct mammalian predator management. Coyote trapping is the highest priority, with SCB and SB needing particular attention to maintain shorebird productivity. Predator management should also be conducted during winter and early spring, as opposed to summer, to provide the most effective predator management for nesting birds. Furthermore, piping plover predator exclosure use should continue on the majority of nests to the extent practicable.

Storm events are known to rejuvenate beach nest bird habitat by clearing vegetation and creating overwash areas suitable for nesting. Successive and impactful storm events, Hurricane Florence in 2018 and Hurricane Dorian in 2019, have appeared to provide these types of habitat improvements. The breaching of dunes and creation of interior ponds on NCB has resulted in the re-colonization of historical nesting sites and colonization of new sites by piping plovers. However, the creation of ponds has precluded the reestablishment of a backroad in many areas on NCB, making ORV management for shorebird broods challenging. In addition, breaks in dunes create continuous foraging habitat from the marsh to the ocean tideline and both piping plover and American oystercatcher broods were seen to utilize all the habitat types across the width of the island. This makes it particularly difficult to separate ORVs from shorebird broods while retaining vehicle access along NCB. CALO staff should continue to adaptively monitor each shorebird brood on NCB and re-establish backroad sections where possible as ponds diminish over time.

Hurricane Dorian created Evergreen Inlet at mile 3 and Old Drum Inlet at mile 19, breaking NCB into three separate islands. Monitoring staff accessed the northern and southern portions of NCB by kayak across the inlets and had limited transportation at these smaller sites. Limited access to these sites resulted in limited monitoring efforts, many unknown nest failures, and a lack of predator exclosures. One pair of piping plovers were observed on territory throughout the season at Ophelia Inlet but a nest was never documented, although it is suspected that failed nests were likely missed between visits to the site.

Relatively low monitoring staff levels continue to be a challenge at CALO. Five biological science technicians and two 3-month interns were responsible for monitoring and managing 32 pairs of piping plovers, 54 pairs of American oystercatchers, 21 colonial waterbird colonies, and 293 sea turtle nests across four islands and 48 miles of habitat. This includes an additional technician above baseline staff level. Staff must regularly check shorebirds nests, survey for new nests, monitor for hatching, and check broods daily. This rigorous monitoring schedule determines management actions such as adjusting or establishing wildlife protection zones for nests and chicks. In addition, piping plover predator exclosure deployment requires two to three trained employees per nest. This is

problematic when there is only one technician on each island during some workdays, particularly early in the nesting season. Exceptionally high visitation levels on SCB in 2021 required immediate detection of American oystercatcher nests so that closures can be established before nests are destroyed or abandoned. On NCB, staff must monitor all areas of the island for new piping plover nesting activity outside of established bird closures. Piping plover nesting near the ocean tideline also required intensive brood monitoring by NCB staff, with some broods requiring multiple checks each day. One piping plover brood required an immediate beach closure on NCB when chicks were observed foraging at the ocean tideline and exposed to ORV traffic. Additional staff are also needed to accurately determine nesting success of colonial waterbirds. Due to the difficulty of determining colony success from weekly pair counts, increased monitoring of colonies is recommended. Colonies should be frequently surveyed for nests, nest fates tracked, and chick numbers and ages should be documented. It is recommended that monitoring staff levels should be increased to eight qualified biological science technicians on the Core Banks to ensure the ORV Plan daily monitoring and management requirements are met.

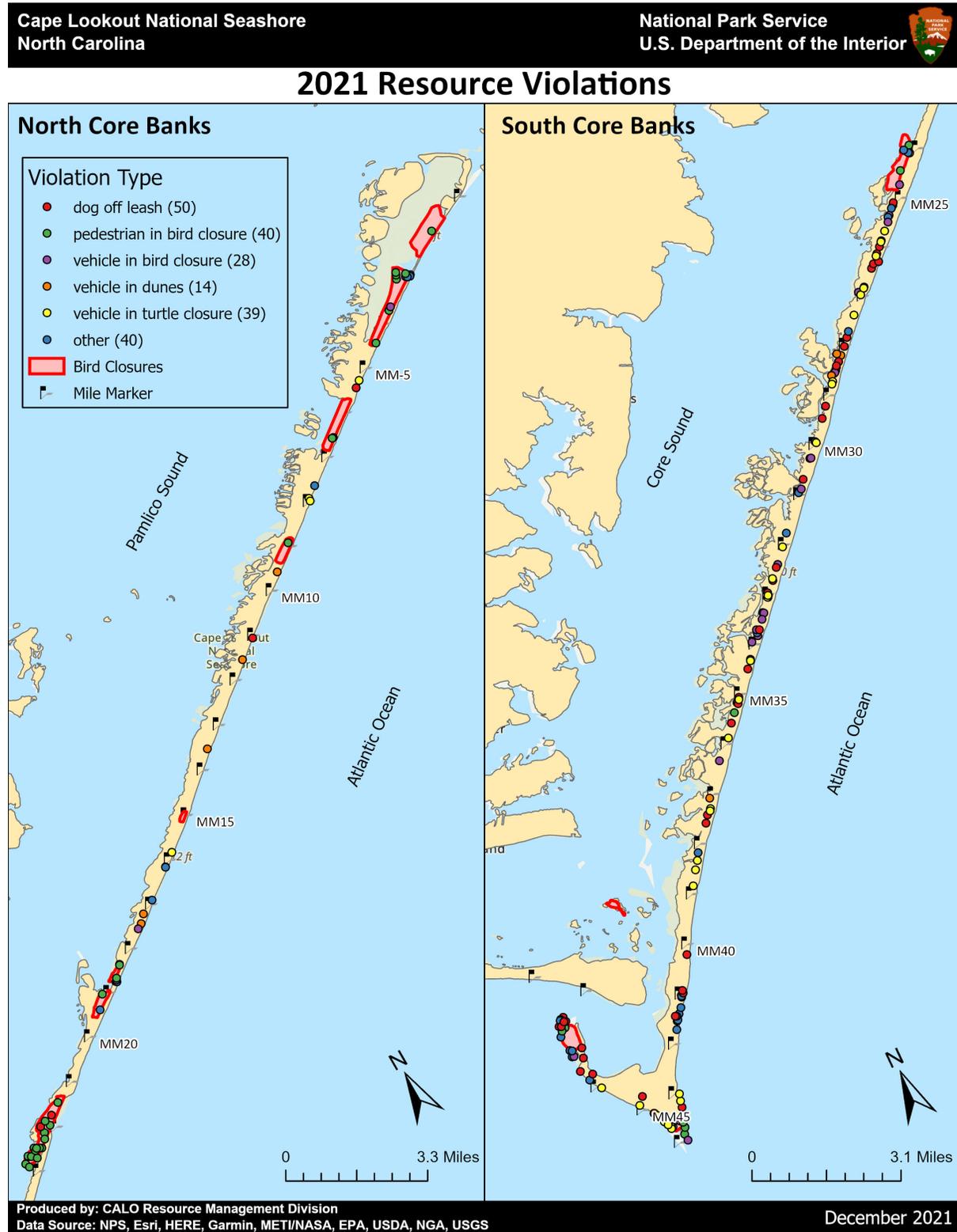
Lastly, shorebird banding programs should continue across Core Banks. Banded individuals allow for the accurate monitoring of breeding birds and productivity thus improving the quality of data collected at CALO. Since Virginia Tech began piping plover banding in 2015, pair movement between nesting sites 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 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 2021.



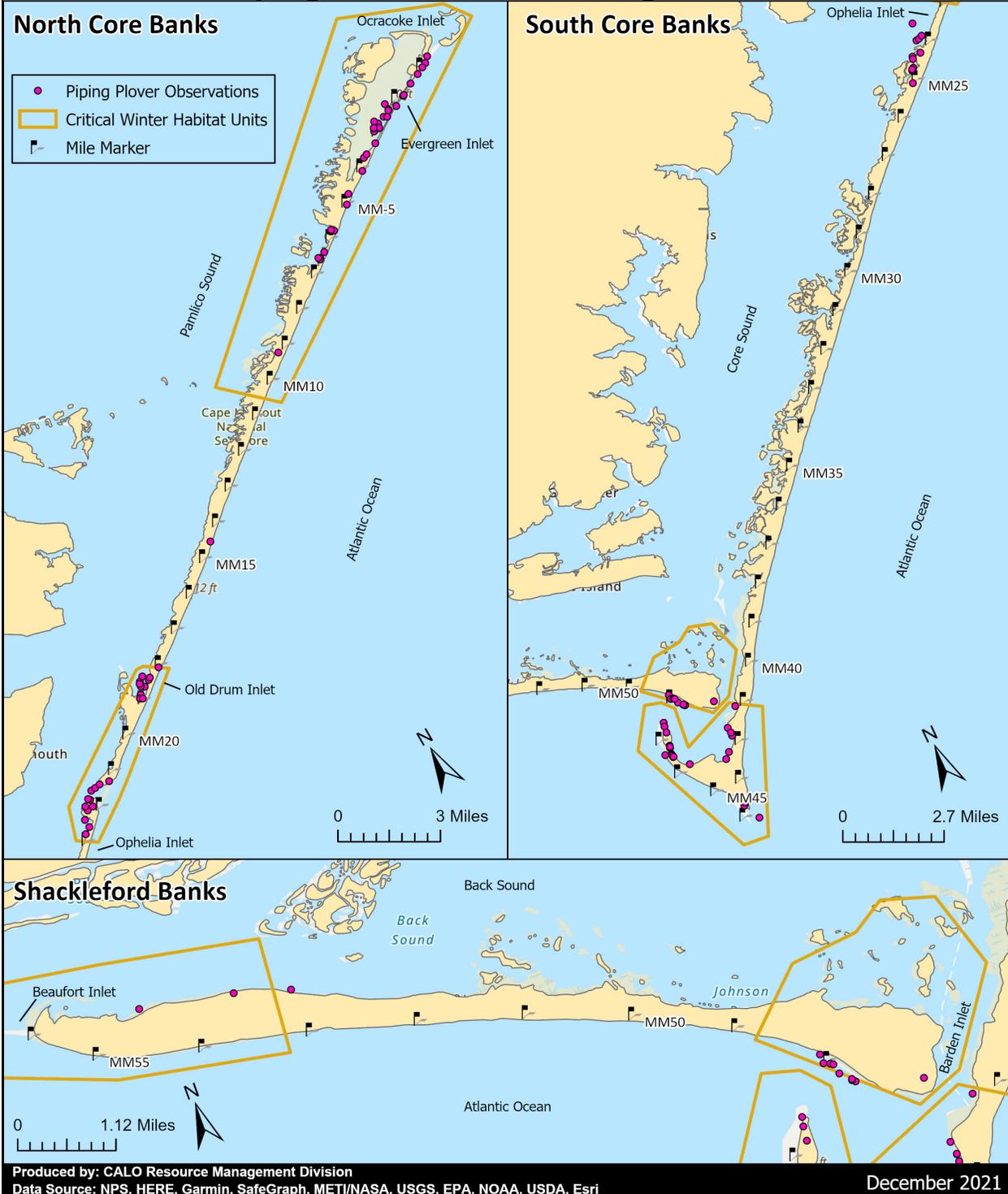
2021 Piping Plover Nests



Map A2. Piping plover nest locations at CALO in 2021.



2021 Piping Plover Non-Breeding Observations





2021 American Oystercatcher Nests

North Core Banks

- Fledged
- Hatched
- Lost
- Mile Markers



South Core Banks





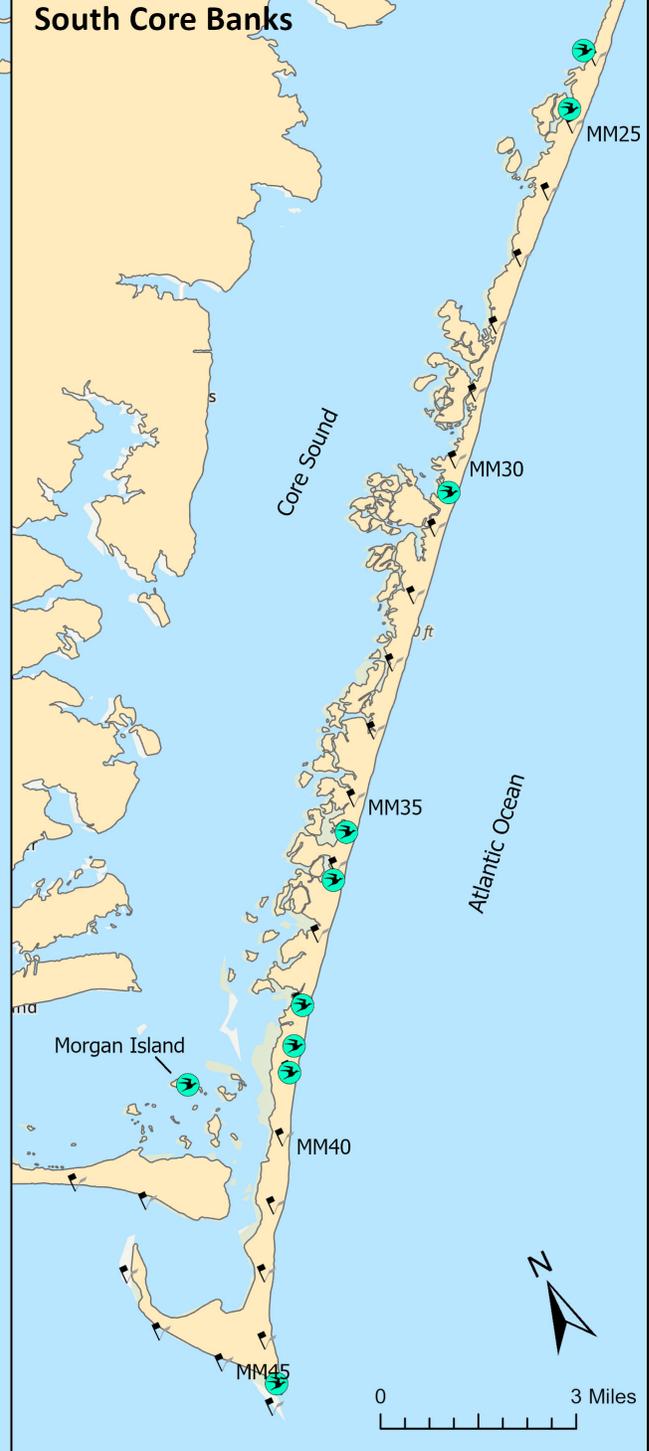
2021 Colonial Waterbird (CWB) Colonies

North Core Banks

- CWB Colony
- Mile Markers

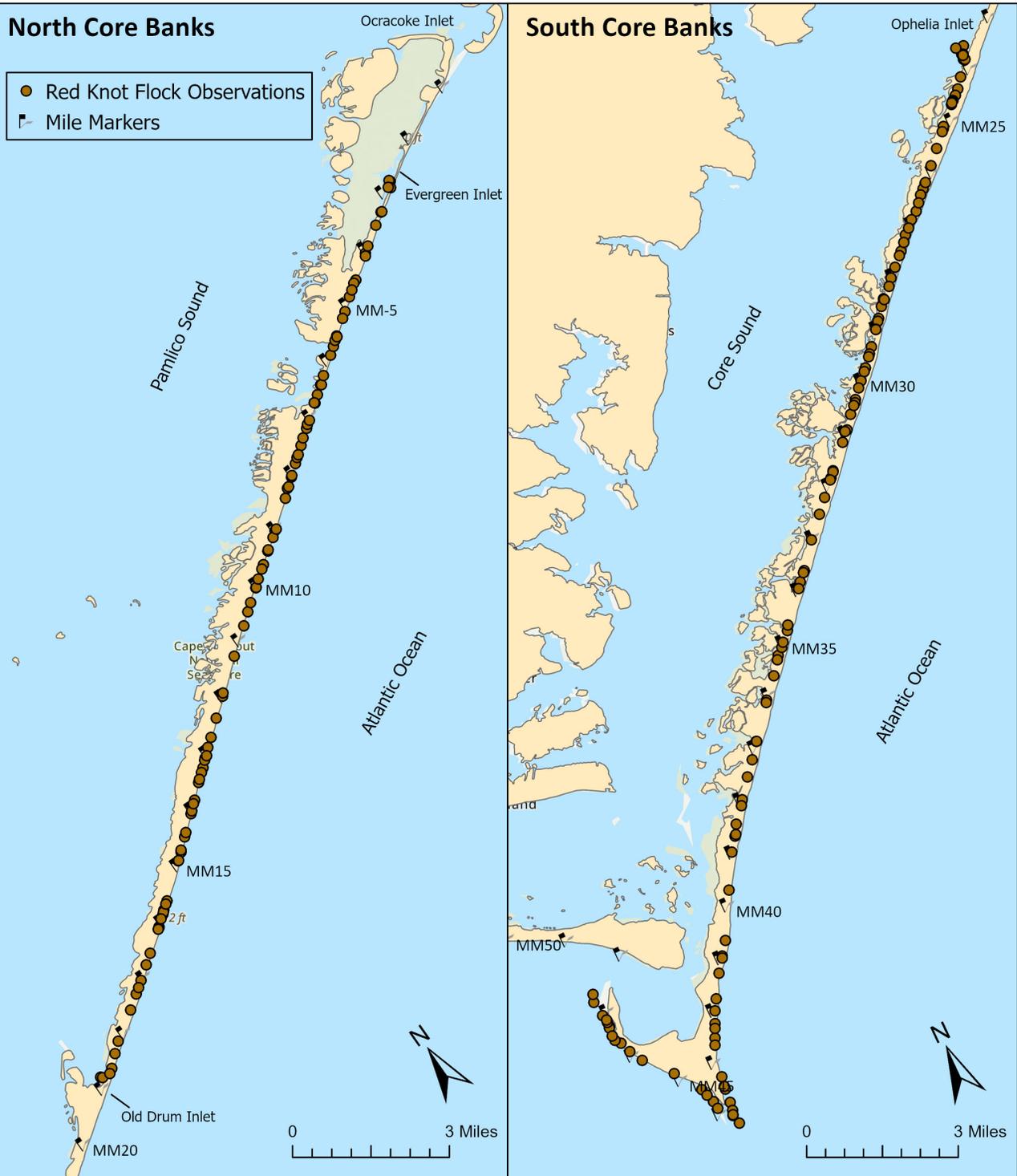


South Core Banks





2021 Red Knot Flock Observations



Appendix B. 2021 Piping Plover Productivity Data

Table B1. North Core Banks productivity data for 2021. North Core Banks totals: 27 breeding pairs, 35 total nests, 17 hatched nests, 11 fledged chicks.

Nest ID	Pair	Mile	Site	Adult 1	Adult 2	Found Date	Exclosure Date	Eggs Laid	Nest Fate	Outcome Summary
PIPLNC01	1	2.10	Portsmouth	GF(0M6)	GF(4M3)	04/17/21	N/A	4	Lost	Nest failed on 5/25/21 due to unknown cause.
PIPLNC02	2	6.50	Kathryn Jane	GF(CXM)	UNB	04/19/21	04/27/21	3	Fledged	Fledged 1 UNB chick on 6/17 by 28 days old.
PIPLNC03	3	6.78	Kathryn Jane	GF(X79)	GF(T0L)	04/19/21	04/20/21	3	Fledged	Fledged 3 UNB chicks on 6/12 by 26 days old.
PIPLNC04	4	3.63	Portsmouth	GF(2H7)	GF(NPH)	04/20/21	04/21/21	4	Fledged	Fledged 1 chick, GF(YC4), on 6/20 by 33 days old.
PIPLNC05	5	6.61	Kathryn-Jane	GF(NY8)	UNB	04/22/21	04/27/21	3	Lost	Nest failed on 5/1/2021 due to unknown cause, despite being exclosed.
PIPLNC06	6	19.34	Old Drum	GF(9KT)	KG:RY	04/23/21	N/A	4	Lost	Nest failed 5/7/2021 due to undetermined predator.
PIPLNC07	7	5.77	High Hills	UNK	UNK	04/24/21	N/A	1	Lost	Nest failed 4/25/2021 due to unknown cause.
PIPLNC08	8	5.89	High Hills	GF(26N)	GF(4X3)	04/27/21	05/04/21	4	Fledged	Fledged 2 chicks, GF(4NE) and GF(112), on 6/27/21 at 28 days old.
PIPLNC09	9	21.72	New Drum	GF(XJ1)	GF(V3K)	04/28/21	N/A	4	Lost	Nest failed 6/18/2021 due to unknown cause.
PIPLNC10	10	5.95	High Hills	GF(YAE)	GF(V4P)	04/30/21	05/04/21	4	Hatched	Brood failed 6/14/2021 due to unknown cause.
PIPLNC11	11	6.08	High Hills	GF(3PE)	OK:LG	05/03/21	05/04/21	4	Hatched	Brood failed on 6/10/21 due to unknown cause.
PIPLNC12	12	6.36	Kathryn-Jane	UNB	UNB	05/04/21	05/06/21	4	Lost	Nest failed on 5/18/21 due to abandonment.
PIPLNC13	13	9.18	Swash	GF(P6A)	UNB	05/05/21	05/08/21	4	Fledged	Fledged 1 chick, GF(KXE), on 6/30/21 by 28 days old.
PIPLNC14	14	3.25	Portsmouth	GF(A5P)	GF(5JM)	05/06/21	05/06/21	4	Fledged	Fledged 1 chick, GF(AMT), on 6/25/21 by 36 days old.
PIPLNC15	15	21.80	New Drum	UNB	UNB	05/07/21	N/A	3	Lost	Nest failed on 5/18/21 due to unknown cause.
PIPLNC16	16	21.77	New Drum	GF(715)	GF(M4C)	05/07/21	N/A	4	Hatched	Brood failed by 5/26/2021. Chicks not observed but suspected to have hatched.
PIPLNC17	17	22.14	New Drum	GF(L5C)	GF(PEU)	05/11/21	N/A	3	Lost	Nest failed on 5/18/21 due to unknown cause.
PIPLNC18	5	6.67	Kathryn-Jane	GF(NY8)	UNB	05/13/21	05/15/21	4	Fledged	Fledged 1 chick, GF(9JY), on 7/7/21 by 29 days old.

PIPLNC19	18	4.00	Portsmouth	GF(HVY)	UNB	05/16/21	05/24/21	4	Hatched	Brood failed by 6/23/21 due to unknown cause.
PIPLNC20	19	3.21	Portsmouth	GF(J6N)	GF(C2A)	05/18/21	05/19/21	4	Hatched	Brood failed by 6/17/21 due to unknown cause.
PIPLNC21	20	19.15	Old Drum	GF(938)	UNB	05/22/21	N/A	4	Hatched	Brood failed by 7/6/21 due to unknown cause.
PIPLNC22	21	18.47	Old Drum	UNB	UNB	05/26/21	N/A	1	Lost	Nest failed on 5/27/21 due to unknown cause.
PIPLNC23	22	21.85	New Drum	GF(54N)	UNB	05/26/21	N/A	4	Lost	Nest failed by 6/5/21 due to unknown cause.
PIPLNC24	9	21.75	New Drum	GF(XJ1)	GF(V3K)	05/26/21	N/A	4	Lost	Nest failed by 7/3/21 due to unknown cause. Lost 3 eggs before the last egg was abandoned.
PIPLNC25	23	15.12	Mile 15	GF(A79)	UNB	05/28/21	05/29/21	4	Hatched	Brood failed on 6/27/21 due to unknown cause.
PIPLNC26	1	2.15	Portsmouth	GF(0M6)	GF(4M3)	05/31/21	N/A	2	Lost	Nest failed on 6/26 due to flooding.
PIPLNC27	21	18.66	Old Drum	UNB	UNB	06/04/21	06/05/21	3	Lost	Nest failed on 6/15 due to flooding.
PIPLNC28	17	22.14	New Drum	GF(L5C)	GF(PEU)	06/05/21	N/A	4	Hatched	Brood failed by 6/29/21 due to unknown cause.
PIPLNC29	24	9.06	Swash Inlet	UNB	UNB	06/10/21	06/11/21	3	Fledged	Fledged 1 UNB chick on 7/31/21 at 26 days old.
PIPLNC30	25	4.51	Portsmouth	GF(6MX)	GF(M4C)	06/10/21	06/13/21	4	Lost	Nest failed on 7/12/21 due to unknown cause.
PIPLNC31	26	3.87	Portsmouth	GF(2H7)	UNB	06/12/21	06/17/21	3	Lost	Nest failed on 7/12/21 due to unknown cause.
PIPLNC32	6	19.40	Old Drum	GF(9KT)	KG:RY	06/18/21	N/A	4	Hatched	Brood failed on 7/20/21 due to unknown cause.
PIPLNC33	22	21.89	New Drum	GF(54N)	UNB	06/18/21	N/A	4	Lost	Nest failed on 7/6/21 due to unknown cause.
PIPLNC34	15	21.81	New Drum	UNB	UNB	06/18/21	N/A	4	Hatched	Brood failed by 7/6/21 due to unknown cause.
PIPLNC35	27	2.38	Portsmouth	GF(U9J)	GF(VE8)	06/26/21	N/A	4	Lost	Nest failed on 7/14/21 due to ghost crab predation.

Table B2. South Core Banks productivity data for 2021. South Core Banks totals: 4 breeding pairs, 6 total nests, 4 hatched nests, 0 fledged chick.

Nest ID	Pair	Adult 1	Adult 2	Site	Mile	Found Date	Exclosure Date	Eggs Laid	Nest Fate	Outcome Summary
PIPLSC01	1	GF(JHY)	UNB	Plover Inlet	24.00	04/25/21	05/03/21	4	Hatched	Brood lost on 6/9/21 due to unknown cause.
PIPLSC02	2	UNB	UNB	Plover Inlet	24.50	04/30/21	N/A	2	Lost	Nest failed on 5/15/21 due to coyote predation.
PIPLSC03	3	UNB	OY:KO	Plover Inlet	24.90	05/06/21	05/10/21	4	Hatched	Brood failed on 6/11/21 due to unknown cause.
PIPLSC04	2	UNB	UNB	Plover Inlet	24.39	05/28/21	05/31/21	3	Hatched	Brood failed on 6/29/21 due to unknown cause.
PIPLSC05	4	UNB	UNB	Plover Inlet	24.58	06/12/21	06/14/21	4	Hatched	Brood failed on 7/1/21 due to unknown cause.
PIPLSC06	1	GF(JHY)	UNB	Plover Inlet	23.94	06/22/21	N/A	1	Lost	Nest failed 6/25/21 due to flooding.

Appendix C. Monthly Counts of Non-Breeding Piping Plovers 2008- 2020

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 2021

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	3	0	8	11
March-20	1	7	0	8
August-20	220	218	7	445
September-20	284	104	2	390
October-20	16	14	0	30
November-20	23	21	3	47
December-20	7	10	18	35
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

Appendix D. 2021 American Oystercatcher Productivity Data

Table D1. North Core Banks productivity data for 2021. North Core Banks totals: 30 breeding pairs, 41 total nests, 23 hatched nests, 27 fledged chicks.

Nest	Pair	Adult 1	Adult 2	Mile	Found Date	Eggs	Closure	Outcome Summary
AMOYNC01	1	DG(CCE)	UNB	6.73	04/15/21	3	600' buffer	Fledged 1 chick, DG(ENT), on 6/17/21 by day 34
AMOYNC02	2	DG(TF)	UNB	21.81	04/16/21	1	interior	Nest failed on 4/23/21 due to unknown cause
AMOYNC03	3	DG(CY)	DG(CFX)	3.7	04/17/21	3	600' buffer	Fledged 2 chicks, DG(ENN) and DG(ENP), on 6/25/21 by day 40
AMOYNC04	4	DG(CNN)	DG(CMP)	5.92	04/18/21	3	600' buffer	Fledged 2 chicks, DG(EN0) and DG(ENE), on 6/25/21 by day 40
AMOYNC05	5	DG(EH6)	UNB	10.38	04/20/21	3	600' buffer	Fledged 2 chicks, DG(ENY) and DG(ENH), on 6/30/21 by day 38
AMOYNC06	6	DG(RR)	DG(WF)	9.15	04/20/21	5	600' buffer	Brood failed by 6/14/21 due to unknown cause.
AMOYNC07	7	DG(CEA)	DG(CML)	13.3	04/21/21	3	600' buffer	Nest failed on 5/10/21 due to weather and being buried
AMOYNC08	8	DG(EKK)	UNB	3.13	04/21/21	3	interior	Nest failed on 5/19/21 due to abandonment
AMOYNC09	9	DG(M0)	UNB	19.61	04/23/21	3	interior	Nest failed on 5/18/21 due to unknown cause
AMOYNC10	10	DG(C93)	DG(C94)	20.38	04/23/21	2	none	Nest failed on 5/7/21 due to ghost crab predation
AMOYNC11	11	DG(C07)	DG(C08)	21	04/23/21	3	none	Fledged 2 chicks, both UNB, on 6/24/21 by day 37
AMOYNC12	12	DG(P5)	UNB	22.59	04/23/21	3	interior	Brood failed on 6/5/21 due to unknown causes
AMOYNC13	13	DG(C97)	UNB	22.76	04/23/21	2	interior	Nest failed on 5/11/21 due to unknown causes
AMOYNC14	14	DG(T3)	DG(CE1)	10.6	04/24/21	3	600' buffer	Brood failed on 5/24/21 due to unknown causes
AMOYNC15	15	DG(CA)	UNB	8.66	04/24/21	4	600' buffer	Fledged 1 chick, DG(EP1), on 6/30/21 by age 38
AMOYNC16	16	DG(EKE)	UNB	17.64	04/27/21	3	600' buffer	Fledged 3 chicks, DG(ENX) DG(ENW) DG(EUH), on 7/1/21 by age 39
AMOYNC17	2	DG(TF)	UNB	21.79	04/28/21	3	interior	Fledged 2 chicks, DG(EN1) and DG(EN2), on 7/3/21 by day 42
AMOYNC18	17	DG(EKH)	UNB	15.08	04/30/21	3	600' buffer	Fledged 1 chick, DG(EP0), last seen on 7/5 at 38 days old, flight not observed.
AMOYNC19	18	DG(WM)	UNB	0.61	05/01/21	3	none	Nest failed on 5/10/21 due to unknown causes
AMOYNC20	19	DG(MA)	UNB	1.53	05/01/21	2	none	Brood likely failed. Chick last seen on 6/17/21 at 28 days old, limited monitoring access to site.
AMOYNC21	20	DG(CE0)	UNB	4.07	05/01/21	2	600' buffer	Brood failed on 6/16/21 due to unknown causes
AMOYNC22	21	DG(TN)	UNB	18.89	05/06/21	3	interior	Nest failed on 5/10/21 due to raccoon predation
AMOYNC23	22	DG(CUH)	UNB	19.91	05/07/21	3	none	Fledged 2 chicks, DG(EP3) and DG(EP4), on 7/11/21 by day 44
AMOYNC24	23	DG(C96)	UNB	21.45	05/07/21	2	none	Nest failed on 5/11/21 due to ghost crab predation

AMOYNC25	24	DG(CLF)	UNB	0	05/10/21	3	none	Nest failed on 7/4/21 due to unknown causes
AMOYNC26	25	DG(CE3)	UNB	6.08	05/13/21	2	interior	Fledged 2 chicks, DG(EUK) and EG(EUL), on 7/17/21 by day 43
AMOYNC27	26	DG(CY6)	DG(C5W)	12.61	05/13/21	3	600' buffer	Fledged 2 chicks, DG(EP7) and DG(EP8), on 7/18/21 by day 40
AMOYNC28	27	DG(CL1)	UNB	0.8	05/19/21	3	none	Fledged 1 chick, DG(EP6), on 7/14/21 by day 36
AMOYNC29	7	DG(GEA)	DG(CML)	12.82	05/22/21	2	600' buffer	Fledged 2 chicks, DG(EUN) and DG(EUM), on 7/25/21 by day 37
AMOYNC30	28	UNB	UNB	22.64	05/22/21	2	interior	Nest failed on 5/30/21 due to unknown cause.
AMOYNC31	10	DG(C93)	DG(C94)	20.7	05/22/21	1	none	Nest failed on 5/30/21 due to unknown cause.
AMOYNC32	23	DG(C96)	UNB	21.29	05/26/21	1	none	Nest failed on 6/5/21 due to unknown cause.
AMOYNC33	9	DG(M0)	UNB	19.51	05/27/21	2	interior	Brood failed by 6/27/21 due to unknown cause.
AMOYNC34	13	DG(C97)	UNB	22.93	05/27/21	2	interior	Nest failed on 6/5/21 due to unknown cause.
AMOYNC35	14	DG(T3)	DG(CE1)	10.57	06/05/21	3	600' buffer	Fledged 1 chick, DG(EP5), on 8/10/21 at 39 days old.
AMOYNC36	29	DG(CUP)	UNB	19.19	06/05/21	2	interior	Nest failed on 6/18/21 due to ghost crab predation.
AMOYNC37	21	DG(TN)	UNB	18.49	06/13/21	3	600' buffer	Fledged 1 chick, DG(EP2). Chick was last seen on 8/15/21 at 39 days old, flight was not confirmed but suspected.
AMOYNC38	8	DG(EKK)	UNB	3.24	06/13/21	3	interior	Nest failed on 6/13/21 due to abandonment. Nest was already abandoned when it was found.
AMOYNC39	18	DG(WM)	UNB	0.44	06/17/21	3	none	Brood failed by 7/14/21 due to unknown cause.
AMOYNC40	30	DG(C93)	UNB	20.11	06/18/21	2	none	Nest failed on 6/27/21 due to raccoon predation.
AMOYNC41	12	DG(P5)	UNB	22	06/24/21	1	interior	Nest failed on 6/27/21 due to predation by an undetermined mammal.

Table D2. South Core Banks productivity data for 2021. South Core Banks totals: 24 breeding pairs, 33 total nests, 17 hatched nests, 36 fledged chicks.

Nest	Pair	Adult	Adult	Mile	Found	Eggs	Closure	Outcome Summary
AMOYSC01	1	DG(K0)	UNB	33.45	04/05/21	3	600' buffer	Fledged 2 chicks, DG(EKY) and DG(EKX), on 6/13/21 by 41 days
AMOYSC02	2	DG(R8)	R(5F)	38.28	04/07/21	2	600' buffer	Nest Failed 5/2/21 due to coyote predation.
AMOYSC03	3	DG(UNK)	DG(UNK)	33.86	04/08/21	2	600' buffer	Nest failed 4/10/21 after campers set up 3 tents within 75 feet of nest. Adults were not observed at nest from that day on.
AMOYSC04	4	DG(CL9)	UNB	31.81	04/09/21	1	none	Nest failed on 4/9/21, egg run over by ORV
AMOYSC05	5	DG(YP)	DG(AP)	33.73	04/12/21	3	600' buffer	Fledged 2 chicks DG(EPE) and DG(EPH) on 6/23/21, day 43
AMOYSC06	6	DG(CAN)	DG(J0)	35.61	04/12/21	3	600' buffer	Fledged 2 chicks, DG(EPA) and DG(EPF) on 6/17/21, day 39.
AMOYSC07	7	R(AHJ)	-,-:R,-	36.2	04/12/21	3	600' buffer	Fledged 2 chicks, DG(EPC) and DG(EKN) on 6/17/21, day 40.
AMOYSC08	8	DG(CNU)	UNB	32.45	04/13/21	2	600' buffer	Nest lost on 5/6/21 to coyote predation.
AMOYSC09	9	DG(CUM)	DG(C3A)	28.42	04/15/21	3	600' buffer	Fledged 3 chicks, DG(EN7), DG(EN8) and DG(EN9) on 6/22/21, day 39

AMOYSC10	10	DG(LN)	DG(33)	24.8	04/16/21	3	interior	Nest failed 5/12/21 due to coyote predation
AMOYSC11	4	DG(CL9)	UNB	31.42	04/16/21	3	600' buffer	Fledged 2 chicks, DG(EN5) and DG(EN6) on 6/23/21, day 39
AMOYSC12	11	DG(CFA)	DG (EMN)	25.4	04/18/21	3	600' buffer	Fledged 3 chicks, DG(ENL), DG(ENR), DG(ENU), on 6/26/21, day 39.
AMOYSC13	12	DG(CJR)	DG(CUK)	28.27	04/19/21	3	600' buffer	Fledged 2 chicks, DG(EN3) and DG(EN4) on 6/26/21, day 40.
AMOYSC14	13	DG(YM)	UNB	28.56	04/20/21	3	600' buffer	Fledged 2 chicks, DG(ENF) and DG(ENM) on 6/26/21, day 37.
AMOYSC15	14	DG(CF7)	DG(UJ)	26.84	04/22/21	4	600' buffer	Fledged 3 chicks, DG(ENC), DG(ENJ) and DG(ENK) on 7/1/21, day 43.
AMOYSC16	15	DG(CNC)	DG(CM0)	24.56	04/22/21	3	interior	Nest failed 5/13/21 to coyote predation.
AMOYSC17	16	DG(CK6)	DG(CRK)	27.67	04/26/21	3	600' buffer	Fledged 3 chicks on 7/9/21, DGEUE), DG(EUF) and UNB, day 45.
AMOYSC18	17	DG(CEF)	DG(EMP)	27.48	04/26/21	3	600' buffer	Nest failed 4/26/26, abandoned due to unknown reason.
AMOYSC19	18	DG(CUF)	DG(CLT)	28.72	04/26/21	3	600' buffer	Fledged 2 chicks, DG(EUA) and DG(EUC) on 6/30/21, day 39.
AMOYSC20	19	DG(CK1)	UNB	30.84	04/30/21	2	600' buffer	Nest failed 5/6/21 due to unknown causes.
AMOYSC21	20	DG(C56)	UNB	37.34	04/30/21	1	600' buffer	Nest failed 5/2/21 due to coyote predation.
AMOYSC22	21	UNB	UNB	47.47	05/04/21	3	interior	Fledged 1 chick, DG(ENA), on 6/24/21, day 41.
AMOYSC23	22	DG(AL)	UNB	24.4	05/08/21	3	interior	Fledged 3 chicks, DG(EH7), DG(EH8) and DG(EH9) on 6/14/21, day 38.
AMOYSC24	23	DG(PW)	UNB	39.1	05/15/21	3	600' buffer	Failed 6/10/21 due to coyote predation.
AMOYSC25	2	DG(R8)	R(5F)	38.38	05/17/21	3	600' buffer	Failed 6/10/21 dur to coyote predation.
AMOYSC26	17	DG(CEF)	DG(EMP)	27.14	05/20/21	2	600' buffer	Nest failed on 6/13/21 due to unknown causes.
AMOYSC27	19	DG(CK1)	UNB	30.84	05/20/21	3	600' buffer	Nest failed 6/2/21 due to coyote predation.
AMOYSC28	8	DG(CNU)	UNB	32.34	05/20/21	3	600' buffer	Nest failed 6/2/21 due to coyote predation.
AMOYSC29	10	DG(LN)	DG(33)	25.12	05/28/21	2	600' buffer	Fledged 2 chicks DG(C6C) and DG(CAW) on 8/6/21, by day 46.
AMOYSC30	24	DG(EKM)	UNB	24	05/28/21	2	interior	Fledged 1 chick, DG(ET4) on 7/31/21, day 40.
AMOYSC31	15	DG(CNC)	DG(CM0)	24.5	06/01/21	3	interior	Fledged 1 chick DG(C6P) on 8/9/21, by day 49.
AMOYSC32	8	DG(CNU)	UNB	32.75	06/16/21	1	600' buffer	Nest failed 6/24/21 due to weather/flooding.
AMOYSC33	19	DG(CK1)	UNB	30.89	06/17/21	2	600' buffer	Nest failed 6/23/21 due to unknown reasons.