National Park Service
U.S. Department of the Interior

Shorebird Monitoring at Cape Lookout National Seashore

2018 Annual Report

ON THE COVER
A gull-billed tern in flight at Cape Lookout National Seashore.
Photography by NPS

Shorebird Monitoring at Cape Lookout National Seashore

2018 Annual report

Jon Altman and Chelsey Stephenson

National Park Service
Cape Lookout National Seashore
131 Charles Street
Harkers Island, NC 28589

Editing and Design by
Tani Hubbard

National Park Service &
Northern Rockies Conservation Cooperative
12661 E. Broadway Blvd.
Tucson, AZ 85748

Please cite this publication as:

Altman, J., and C. Stephenson. Shorebird monitoring at Cape Lookout National Seashore: 2018 annual report. National Park Service, Cape Lookout National Seashore, Harkers Island, NC.

January 2020

U.S. Department of the Interior
National Park Service

Contents

Page

Figures . . . iv
Tables . . . iv
Appendices . . . v
Executive Summary . . . vi
Piping Plovers . . . vi
American Oystercatchers . . . vi
Colonial Waterbirds . . . vi
Red Knots . . . vi
Introduction . . . 1
Resource Protection Areas . . . 2
Cape Lookout National Seashore Interim Protected Species Management Plan . . . 2
Piping Plover (*Charadrius melodus*) Management and Monitoring . . . 3
Background . . . 3
Methods . . . 3
Monitoring . . . 3
Management . . . 4
Results . . . 5
Productivity . . . 5
Nest Failures and Chick Mortality . . . 6
Beach Protection Zones and Brood Foraging . . . 8
Migrating and Wintering Piping Plovers . . . 8
Predator Management . . . 8
Banding . . . 8
Discussion . . . 9
American Oystercatcher (*Haematopus palliates*) Management and Monitoring . . . 11
Background . . . 11
Methods . . . 11
Monitoring . . . 11
Management . . . 12
Results . . . 13
Productivity . . . 13
Nest Failures and Chick Mortality . . . 13

Contents (continued)

Page

Predator Management . . . 13

Banding . . . 15

Discussion . . . 15

Colonial Waterbird Management and Monitoring . . . 17

Background . . . 17

Methods . . . 17

Monitoring . . . 17

Management . . . 17

Results . . . 18

Discussion . . . 19

Red Knot (*Calidris canutus rufa*) Monitoring . . . 21

Background . . . 21

Methods . . . 21

Results . . . 21

Discussion . . . 22

Conclusions and Recommendations . . . 25

Literature Cited . . . 27

Figures

Page

Figure 1. The number of piping plover breeding pairs and number of chicks fledged by year in Cape Lookout National Seashore, 1989–2018. 7

Figure 2. The number American oystercatcher breeding pairs and number of chicks fledged by year at Cape Lookout National Seashore, 2004–2018. 16

Figure 3. Least Tern window census counts (June 5–20) at Cape Lookout National Seashore, 2006–2018. 20

Figure 4. Number of red knots counted at Cape Lookout National Seashore in 2018. 22

Figure 5. Total number of red knots counted in each mile section from 2007 to 2018 at Cape Lookout National Seashore. 23

Tables

Page

Table 1. Piping plover reproductive success data by occupied nesting areas in 2018 at Cape Lookout National Seashore. 5

Table 2. Summary of Cape Lookout National Seashore piping plover reproductive success data, 2000–2018. 6

Table 3. Causes of nest failure in 2018 at Cape Lookout National Seashore. 7

Table 4. Nonbreeding piping plover at Cape Lookout National Seashore in 2018. 8

Table 5. American oystercatcher reproductive success by island in 2018 at Cape Lookout National Seashore. 13

Table 6. Summary of Cape Lookout National Seashore American oystercatcher reproductive success, 2004–2018. 14

Table 7. Causes of nest failure in 2018 at Cape Lookout National Seashore. 14

Table 8. Recorded nest predators in 2018 at Cape Lookout National Seashore. 14

Table 9. Causes of American oystercatcher nest failure at Cape Lookout National Seashore, 2013–2018. 15

Table 10. Summary of colonial waterbird colonies at Cape Lookout National Seashore in 2018. 18

Table 11. Red knot relative abundance on North Core Banks in Cape Lookout National Seashore, 1992–2018. 22

Table B-1. North Core Banks productivity data for 2018, Cape Lookout National Seashore. 33

Table B-2. South Core Banks productivity data for 2018, Cape Lookout National Seashore. 34

Table C-1. Nonbreeding piping plover monthly counts at Cape Lookout National Seashore, 2008–2018. 35

Table E-1. South Core Banks productivity data for 2018, Cape Lookout National Seashore. 40

Table E-2. North Core Banks productivity data for 2018, Cape Lookout National Seashore. 42

Table E-3. Shackleford Banks productivity data for 2018, Cape Lookout National Seashore. 45

Appendices

Page

Appendix A. Piping Plover Maps 28
Appendix B. 2018 Piping Plover Productivity Data 33
Appendix C. Monthly Counts of Nonbreeding Piping Plovers, 2008–2018 35
Appendix D. American Oystercatcher Maps 38
Appendix E. 2018 American Oystercatcher Productivity Data 40
Appendix F. Colonial Waterbird Map 46
Appendix G. Red Knot Maps 47

Executive Summary

Cape Lookout National Seashore, located on the southern Outer Banks of North Carolina from Ocracoke Inlet to Beaufort Inlet, contains many ecologically important habitats, such as marshes, intertidal flats, and beach areas that support a variety of shorebirds including threatened species and species of special concern. Piping plovers (*Charadrius melodus*), American oystercatchers (*Haematopus palliates*), colonial waterbirds, and red knots (*Calidris cantus rufa*) are monitored and managed at the seashore to promote successful reproduction and to protect their habitat. Shorebird monitoring and management is conducted in compliance with the Cape Lookout National Seashore Interim Protected Species Management Plan.

Piping Plovers

Twenty-four pairs of piping plovers nested throughout the Seashore in 2018. The birds at the Seashore accounted for 75% of the nesting pairs in North Carolina. Twenty-one pairs nested on North Core Banks and three pairs nested on South Core Banks. A total of 30 nests were identified. Egg laying was initiated on April 29 and the last chick was fledged on August 21. Nineteen nests hatched and produced a total of 20 fledglings. Productivity was 0.83 chicks fledged per pair. Since 2000, fledge rates have ranged from 0.15 to 1.04 per pair at the Seashore with a mean productivity rate of 0.57 from 2000 to 2018.

American Oystercatchers

Sixty-nine pairs of American oystercatchers nested throughout the ocean beach habitat of the Seashore in 2018. A total of 123 nests were identified. Egg laying was initiated on April 14 and the last chick was fledged on August 24. Twenty-eight nests hatched and produced a total of 39 fledglings. This represents a 0.57 fledge rate per pair. Since 2004, fledge rates have ranged from 0.00 to 0.86 per pair at the Seashore with a mean productivity rate of 0.48 from 2004 to 2018.

Colonial Waterbirds

Fourteen colonies were identified in the Seashore in 2018: seven on South Core Banks, six on North Core Banks, and one colony on Morgan Island. Nine were least tern (*Sterna antillarium*) colonies, one was a black skimmer (*Rynchops niger*) colony, and four were mixed species colonies. Least terns, black skimmers, common terns (*Sterna hirundo*), gull-billed terns (*Gelochelidon nilotica*), royal terns (*Thalasseus maxima*), and sandwich terns (*Thalasseus elegans*) all nested within the Seashore. Productivity was low for seven of the colonies, medium for one colony, high for one colony, and five colonies had no productivity.

Red Knots

In 2018, red knot spring migration peaked on May 25 with 2,296 birds counted across South Core Banks and North Core Banks. Fall migration peaked on August 25 with 232 red knots counted. North Core Banks averaged 261 birds per survey throughout the survey period and South Core Banks averaged 106 birds per survey.

Introduction

Cape Lookout National Seashore was established to preserve the natural resources of a natural barrier island system off the North Carolina coast from Ocracoke Inlet to Beaufort Inlet. The Seashore is 56 miles long and consists of three main barrier islands that are subject to ocean overwash and inlet formation. North Core Banks is approximately 23 miles long, extending from Ocracoke Inlet to Ophelia Inlet. South Core Banks 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 island, Shackleford Banks, is 9 miles long and has an east-west orientation with a higher dune system and larger areas of vegetation. Shackleford Banks faces the Atlantic Ocean on the south side and the Back Sound on the north side.

The Seashore 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 are federally listed as threatened. The Seashore also supports 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 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*]). The Seashore was designated a Globally Important Bird Area by the American Bird Conservancy in 2001 (Audubon 2017) in recognition of the value of the Seashore for bird migration, breeding, and wintering.

The Seashore 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 impacted the breeding success of nests and broods at the Seashore as well. The Seashore 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.

Looking north from the lighthouse on South Core Banks at Cape Lookout National Seashore. NPS/Francesca Peay

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, providing 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 protections 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.

Cape Lookout National Seashore Interim Protected Species Management Plan

The Interim Protected Species Management Plan (IPSMP) was adopted in 2006 and provides requirements on monitoring and managing protected species in the Seashore. The IPSMP includes establishment of temporary nesting closures, buffer distances, and wildlife protection zones. The IPSMP also outlines a required monitoring schedule for the protected species of concern. In 2017, the Seashore established an Educational 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.

Piping Plover (*Charadrius melodus*) Management and Monitoring

Background

The piping plover (*Charadrius melodus*) is listed as a federal threatened species by the U.S. Fish and Wildlife Service (1985). Piping plover monitoring at Cape Lookout National Seashore began with a baseline study in 1989 (Fraser et al. 1990). Monitoring has continued annually by Seashore staff since 1992. The park is a significant nesting area, containing 75% of the nesting pairs in the state of North Carolina (Schweitzer 2018).

The Seashore also serves as a wintering and migratory site; there are three designated wintering critical habitat units within the Seashore. Piping plover 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 piping plover monitoring results for 2018 and comparisons to results from previous years.

Methods

Monitoring

The Interim Protected Species Management Plan/ Environmental Assessment (IPSMP/EA) contains management guidelines and monitoring protocols (NPS 2006). 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 with a GPS unit and the Seashore's mile marker system. Nest locations were marked inconspicuously with on-site

Piping plover at Cape Lookout National Seashore. NPS

Winter piping plover and sanderlings at Cape Lookout National Seashore. NPS

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 was found at full clutch then the estimated hatch date was 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 one to three days to monitor the status of incubation and document any losses. When nests were lost, Seashore staff checked the area for signs of predation or other causes of nest failure. Nests were monitored daily for hatching when they were near their estimated hatch date. When a nest hatched, broods were monitored daily until they fledged or were lost. The number of chicks and their locations were recorded daily. If broods were not seen at their last known location, then the search expanded to other possible foraging locations in the area. When broods were not found, the search continued for seven more days to be certain of the fate. Fledging, when chicks are capable of strong sustained flight, occurs from 25 to 35 days after hatch. Monitoring stopped once chicks were fledged.

Counts of wintering and migrating piping plovers were made monthly, near the 15th of each month, from August to March during the non-breeding season. The ocean beach, inlets, and soundside sandy beaches of each island were surveyed. Seashore staff searched for banded birds on the 5th, 15th, and 25th of August, September, and October during the fall migration. Additional band resight surveys were completed by a knowledgeable Seashore volunteer and permitted researcher. Hurricane Florence and limited staffing precluded some planned surveys in 2018.

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, Old Drum Inlet, New Drum Inlet, Ophelia Island, Plover Inlet, Cape Point, and Power Squadron Spit were posted. These areas include the upper beach, dunes, sand flats, and mud flats. The active ocean sections in

front of the nesting areas are not a part of the nesting habitat closure and are open for recreational use with some limitations.

The one-mile north end of South Core Banks ocean beach (Plover Inlet nesting site) is closed to vehicles once chicks hatch. The ocean beach is exceptionally narrow at this nesting site and chicks can quickly move to 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. 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 reopened once all chicks were either lost or fully fledged (strong flight observed).

Predator Management

Nests were protected with predator exclosures if the topography of the location was suitable and monitoring was sufficient (daily to semi-daily); some nesting sites may only be accessible once a week to once every two weeks depending on the time of year. Exclosures were circular, 10 ft in diameter, made of 4 x 2-in mesh wire fence, anchored with steel rebar, and topped with ¾-in mesh bird netting. Use of predator exclosures and monitoring adhered to the Piping Plover (*Charadrius melodus*) Atlantic Coast Population Revised Recovery Plan, Appendix F (USFWS 1996).

Prior to the 2017 season, the Seashore conducted infrequent predator management due to the lack of trained technicians and staff availability. In 2017, the Seashore entered into an Interagency Agreement with the United States Department of Agriculture (USDA) Wildlife Services to conduct predator removal in response to high predation rates in the 2017 season. USDA Wildlife Services removed 12 coyotes and 6 raccoons from South Core Banks in August and September of 2017. In 2018, the Seashore signed another Interagency Agreement with USDA Wildlife Services to continue mammalian predation removal efforts. Coyotes on South Core Banks were the primary target followed by raccoons on South Core Banks and North Core Banks as a secondary target.

Banding

Seashore staff recorded band resights of individuals and nesting pairs 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 Seashore staff to track individual nesting patterns and movements of birds throughout the Seashore.

Results

Productivity

A total of 24 pairs of piping plovers nested at the Seashore in 2018. Twenty-one pairs nested on North Core Banks, and three pairs nested on South Core Banks. Birds nested in five distinct areas (Table 1). The four-mile area around Ophelia Inlet, from Plover Inlet to Old Drum Inlet, contained the highest number of nesting pairs.

There were 30 nesting attempts made in 2018. The earliest nest initiation was on April 29 and the latest was on June 27. Twenty six nests were on North Core Banks and four were on South Core Banks. Of the 30 nests, six were renests. Nineteen nests hatched and 20 chicks fledged from 14 different broods. The average clutch size was 3.62 eggs and 56 of 105 known

Table 1. Piping plover reproductive success data by occupied nesting areas in 2018 at Cape Lookout National Seashore.

Island	Nesting Area	Number of Pairs	Hatch Success	Fledge Success (chicks/pair)
North Core Banks	Portsmouth Flats	7	40 %	0.29
North Core Banks	Old Drum Inlet	5	83%	1.40
North Core Banks	New Drum Inlet	7	87%	1.43
North Core Banks	Ophelia Island	2	100%	0.00
South Core Banks	Plover/Ophelia Inlet	3	25%	0.33

eggs hatched. Productivity for the Seashore was 0.83 chicks fledged per nesting pair. Table 2 contains nesting success data from 2000 to 2018. Figure 1 illustrates the number of pairs and chicks fledged from 1989 to 2018. Refer to Appendix A for detailed maps of nests and nesting sites (2017 DOQQ base layers). Appendix B contains individual nest productivity data for 2018.

Nest Failures and Chick Mortality

In 2018, predator exclosures were used to protect 26 (87%) nests. Of the nests with exclosures, 18 (69%) hatched, six were lost to predation, one was lost to weather, and one appeared infertile. Predator exclosures were not used on four (13%) nests. Of the nests without exclosures, only one hatched (25%). In total, 11 nests didn't hatch; three were lost to unknown reasons, one was lost to weather/flooding, three nests were lost to mink predation, two nests were lost to raccoon predation, one was lost to ghost crab predation and one was likely infertile/unknown. Table 3 shows causes of nest losses for all nests.

Due to the mobile nature of precocial chicks and lack of prolonged observations, the cause of chick mortality is largely unknown. Five of the hatched nests suffered complete brood loss. All 36 chick losses were classified as unknown.

Table 2. Summary of Cape Lookout National Seashore piping plover reproductive success data, 2000–2018.

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

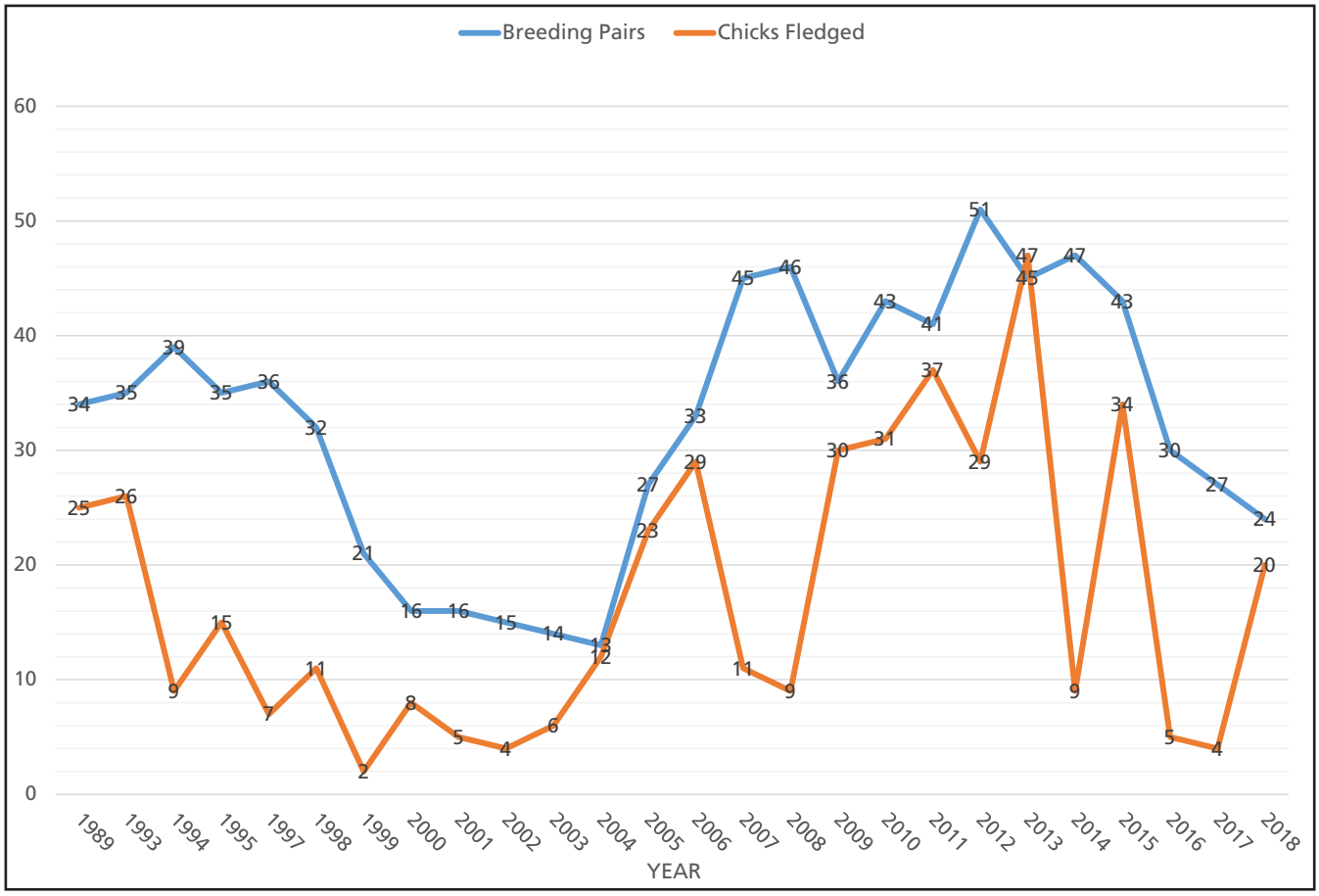

Figure 1. The number of piping plover breeding pairs and number of chicks fledged by year in Cape Lookout National Seashore, 1989–2018.

Table 3. Causes of nest failure in 2018 at Cape Lookout National Seashore.

Nesting Site	Nests	Lost	Predation	Weather	Abandoned	Unknown
Portsmouth Flats	10	6	2	1	0	3
Old Drum Inlet	6	1	0	0	0	1
New Drum Inlet	8	1	1	0	0	0
Ophelia Island	2	0	0	0	0	0
Plover Inlet	4	3	3	0	0	0
Total	**30**	**11**	**6**	**1**	**0**	**4**

Beach Protection Zones and Brood Foraging

The area between Ophelia Inlet and Ramp 24 (one mile in length) was established as a protection zone; the only vehicle use was by National Park Service staff monitoring piping plover chicks from June 4 to July 5. The protection zone began the day the first nest hatched at Ophelia Inlet (South Core Banks), and remained in place until the last chick was fledged, confirmed lost, or moved out of area. The second ocean beach wildlife protection zone was established from mile 19.17 to Ophelia inlet from June 8 to July 19. The zone was expanded north to mile 18.71 when a second brood of chicks was spotted on the beach outside the closure. A third brood was observed on the ocean beach at New Drum within the second ocean beach wildlife protection zone.

Three broods foraged on the ocean beach in 2018. These chicks used both the ocean beach and sound-side mudflats in the Old Drum and New Drum area. All other chicks from 16 broods foraged on sound-side beach, sand flats, mudflats and ephemeral pools in areas that were off-limits to vehicles and in most cases all entry.

Migrating and Wintering Piping Plovers

In 2018, 21 surveys were conducted in the Seashore. March surveys were missed and Hurricane Florence interrupted the September surveys. In addition to the monthly counts, band resight surveys were conducted on the 5th, 15th, and 25th days of peak migration months (August, September, and October). A volunteer also conducted band resight counts on North Core Banks in coordination with Seashore staff when possible, but sometimes separate. In total, 599 birds were recorded from 225 observations throughout the year. The highest count of 182 birds was during the fall migration on August 15 (Table 4). A total of 107 banded individuals were identified from 203 observations. Of the 599 nonbreeding birds recorded, 34% (203) were banded bird resight observations. Band origins show that resights included 63 United States Atlantic coast birds, 21 Canadian Atlantic coast birds, 13 New Jersey state-specific birds, 8 Great Lakes birds, and 2 Bahamas birds. Appendix C lists nonbreeding surveys results from 2008 to 2018.

Predator Management

USDA Wildlife Services conducted trapping sessions at the Seashore in March, June, and July 2018. A total of five coyotes and six raccoons were euthanized on South Core Banks during March and June trapping efforts. Twenty-seven raccoons were trapped and euthanized on North Core Banks during June and July trapping efforts. There was no trapping on Shackleford Banks.

Banding

Virginia Tech Shorebird laboratory researchers trapped and banded seven new adults from five nests with individual field readable codes. Eight previously banded adults from seven nests were recaptured and resampled. Four chicks from two different broods were banded. All four chicks successfully fledged. Of the 48 individuals nesting in the Seashore, 32 (67%) were banded and 16 (33%) were unbanded; this includes individuals banded in 2018. Only three (12%) pairs were completely unbanded, while 21 (88%) had at least one of the pair banded. See Appendix B for nesting pair band data and 2018 chick bands.

Table 4. Nonbreeding piping plover at Cape Lookout National Seashore in 2018. NCB = North Core Banks, SCB = South Core Banks, and SB = Shackleford Banks.

Island	January	February	March	August	September	October	November	December
NCB	0	9	–	161	31	40	3	0
SCB	0	1	–	19	3	0	0	2
SB	0	0	–	2	0	9	8	5
Total	**0**	**10**	**–**	**182**	**34**	**49**	**11**	**7**

Discussion

The habitat at New Drum Flats and Old Drum Flats/ Inlet continues to provide excellent nesting and foraging opportunities in the breeding season. This high quality nesting habitat, from Old Drum to Plover Inlet, contained 71% (17 pairs) of the nesting pairs in 2018. Portsmouth Flats, another important area, continued to provide nesting habitat on North Core Banks for seven pairs (29%). The north tip of North Core Banks at Ocracoke Inlet continues to erode and there was little nesting habitat available; no breeding activity was documented there. Cape Point, Power Squadron Spit, and Kathryn-Jane flats did not attract nor hold nesting pairs in 2018.

The number of breeding pairs in the Seashore decreased from 27 in 2017 to 24 in 2018. Two females initially nested at nearby Cape Hatteras National Seashore, but later paired up with males on Portsmouth Flats and initiated nesting on June 22 and June 27. The search for banded birds came after the coast-wide breeding pair census and increased the total number of breeding pairs found at Cape Lookout National Seashore in 2018. This is the sixth year of declining breeding pairs from the high of 51 pairs in 2012. This may be the result of high nest predation rates and low productivity in recent years at the Seashore. The number of pairs has ranged from a low of 13 in 2004 to a high of 51 in 2012. Since 2006 with the implementation of the IPSMP, the average number of pairs has been 39 with a range of 51 to 24 pairs. This is the first year that the IPSMP biological opinion performance measure of 25 or more pairs was not reached. The 24 pairs did meet the one nest per breeding pair minimum performance measure and produced 30 nests (1.25 nest per pair).

Hatch success increased in 2018 for piping plover nests in the park: 63% of the nests and 53% of the eggs hatched successfully. The 2017 and 2016 nest hatch success was only 30% and 32%, respectively. Only four unknown nest losses were recorded in 2018 as compared to higher unknown nest losses of 19 and 15 in 2017 and 2016, respectively. The main difference in 2018 was increased monitoring ability and predator exclosure use on middle core banks since Old Drum Inlet closed in 2018, allowing daily access. Six predation-related nest losses accounted for 54% of 2018 total losses, including two predator exclosures breached by raccoons. These breaches are a new development and have not occurred before at the Seashore. In response, staff buried predator exclosures deeper (depth increased from four inches

Piping plover chicks and eggs at Cape Lookout National Seashore. NPS

to eight inches) and replaced rusted exclosures with new exclosures. In 2018, 26 nests (87%) had predator exclosures, more than any on record since 1997. Predator exclosures have generally been effective in increasing hatch success. From 1997 to 2018, 70% of the nests protected with exclosures hatched, compared with a 36% hatch rate of the nests left unprotected.

The fledging success for piping plovers at the Seashore was 0.83 chicks fledged per nesting pair in 2018. This productivity rate was above the target of 0.75 chicks fledged per pair performance measure set in the biological opinion of the IPSMP. The productivity (20 fledglings) in 2018 was above the long-term average. The average fledge rate from 2000 to 2018 is 0.57 chicks per breeding pair. While the Seashore productivity is lower than the 1.50 fledged chicks per pair productivity level called for in the U.S. Fish and Wildlife Service piping plover recovery plan, some sites are more productive than others (USFWS 1996). The New Drum Flats site had the highest fledge success rate on the Seashore; seven nesting pairs produced ten fledglings for a productivity of 1.43 fledged chicks per pair. Old Drum flats, with five pairs that produced seven fledglings, a fledge success rate of 1.40 chicks per pair, had the second highest productivity. Site-by-site reproductive successes for 2018 can be compared in Table 1.

American Oystercatcher (*Haematopus palliates*) Management and Monitoring

Background

American oystercatchers (*Haematopus palliates*) are ground-nesting shorebirds that are native to North Carolina. They are common nesters throughout Cape Lookout National Seashore, 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 (2014). Their choice of nesting habitat makes them particularly vulnerable to disturbance by park visitors and off-road vehicles.

Monitoring American oystercatcher nesting at the Seashore began in 1995. A researcher from Duke University studied nesting on South Core Banks 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 Seashore staff have also recorded vehicle traffic chick mortality (Schulte and Simons 2015). Since 1997, NCSU and Seashore staff have conducted censuses, monitored nesting success, and banded American oystercatchers primarily on the Core Banks of the Seashore. In 2018, American oystercatcher monitoring was conducted solely by Seashore staff. Monitoring and management follow the methods in the Seashore's Interim Protected Species Management Plan (IPSMP). Data in this summary are presented from the last fifteen breeding seasons, 2004 to 2018, during which all of the Seashore was monitored regularly.

Methods

Monitoring

The Interim Protected Species Management Plan/ Environmental Assessment (IPSMP/EA) contains management guidelines and monitoring protocols (NPS 2006). Following this protocol, park staff conducted surveys of Shackleford Banks for nesting birds twice a week beginning in April. Daily surveys of nesting habitat on the North and South Core Banks also began in April and breeding monitoring continued daily until the end of the nesting season. All ocean habitat and accessible interior and sound-side habitats were monitored for breeding activity. Marsh islands were not monitored.

Nesting pair of American oystercatchers at Cape Lookout National Seashore. NPS

The locations of all nests found were recorded in decimal degrees with a GPS unit and the Seashore's mile marker system. 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 one to three days to monitor the status of incubation and document losses. When a nest was lost, Seashore staff checked 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 x 20-ft 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 because there is concern that predators might learn to associate posts with nests and small posted areas may also unnecessarily attract curious park visitors and cause disturbance.

In addition to the closure area around each nest, a 600-foot buffer was established 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-in 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, signs were placed on the beach warning of the presence of flightless chicks and reducing the speed limit to 15 mph. Broods were monitored daily and closed sections of beach were reopened once all chicks were either lost or fully fledged with strong flight observed.

Banding

Park staff recorded band resights of individuals and nesting pairs in the Seashore throughout the breeding season. In addition, trained biologists and technicians captured and banded American oystercatcher adults and chicks throughout the Seashore under North Carolina State University's banding permit. Banding allows researchers to track population demographics, breeding patterns, habitat requirements, and survival. It also allows Seashore staff to track individual nesting patterns and movements of birds throughout the Seashore. Band resights and banding efforts are tracked and shared with partners through the American Oystercatcher Band Database. (Find details about American oystercatcher band combinations at the website).

American oystercatcher chick and eggs. NPS

Predator Management

Prior to the 2017 season, the Seashore conducted infrequent predator management due to the lack of trained technicians and staff availability. In 2017, the Seashore entered into an Interagency Agreement with the United States Department of Agriculture (USDA) Wildlife Services to conduct predator removal in response to high predation rates in the 2017 season. USDA Wildlife Services removed 12 coyotes and 6 raccoons from South Core Banks in August and September 2017. In 2018, the Seashore signed another Interagency Agreement with USDA Wildlife Services to continue mammalian predation removal efforts. Coyotes on South Core Banks were the primary target followed by raccoons on South Core Banks and North Core Banks as a secondary target.

Results

Productivity

In 2018, 69 pairs of American oystercatchers nested at the Seashore; 33 pairs on South Core Banks, 29 pairs on North Core Banks, and seven pairs on Shackleford Banks (Appendix D, Appendix E, and Table 5). 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 14 and the last nest was found on June 11.

One hundred and twenty-three nests were documented throughout the Seashore. Hatch success was 21% (out of 62 nests) for South Core Banks, 28% (out of 53 nests) for North Core Banks, and 0% (out of 8 nests) for Shackleford Banks. North Core Banks produced the highest fledge rate of 0.90 fledglings per nesting pair, South Core Banks produced 0.39 fledglings per nesting pair, and Shackleford Banks produced no fledglings. A total of twenty-eight nests hatched in the Seashore and fledged 39 chicks in 2018, producing an overall fledge rate of 0.57 chicks per pair (69 breeding pairs in total). Since 2004, fledge rates at the Seashore have ranged from 0.00 to 0.86 chicks per pair with a mean rate of 0.48 per pair from 2004 to 2018 (Table 6).

Nest Failures and Chick Mortality

Ninety-five nests failed in the 2018 breeding season. Fifty-one nests (54%) were lost to predation, 36 (38%) were lost due to unknown causes, three (3%) were flooded, three (3%) were abandoned, and two (2%) were lost due to human interactions (Table 7). The nests lost to human interactions included a nest that was abandoned due to disturbance by visitors camping outside of the 600-ft buffer area on South Core Banks, and a nest on North Core Banks that failed when an egg was presumably taken by visitors. Predation by a variety of animals accounted for the majority of nest failures in the Seashore; 27 by coyote, 14 by raccoon, four by ghost crab, one by cat, one by nutria, one by an avian predator, and three by unknown predators (Table 8).

Due to the mobile nature of precocial chicks and lack of prolonged observations, the cause of chick mortality is largely unknown. Seven of the hatched nests suffered complete brood loss. Only two known causes of chick loss were documented and both were on South Core Banks. Ants killed one chick shortly after hatching and another chick died after being run over by an ATV driven by a Seashore volunteer during daily turtle patrol.

Predator Management

USDA Wildlife Services conducted trapping sessions at the Seashore in March, June, and July 2018. A total of five coyotes and six raccoons were euthanized on South Core Banks during March and June trapping efforts. Twenty-seven raccoons were trapped and euthanized on North Core Banks during June and July trapping efforts. There was no trapping on Shackleford Banks.

Table 5. American oystercatcher reproductive success by island in 2018 at Cape Lookout National Seashore.

Island	Breeding Pairs	Total Nests	Nests Hatched	Chicks Fledged	Fledge Rate
South Core Banks	33	62	13 (21%)	13	0.39
North Core Banks	29	53	15 (28%)	26	0.90
Shackleford Banks	7	8	0 (0%)	0	0
Total	**69**	**123**	**28 (23%)**	**39**	**0.57**

Table 6. Summary of Cape Lookout National Seashore American oystercatcher reproductive success, 2004–2018.

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

Table 7. Causes of nest failure in 2018 at Cape Lookout National Seashore.

Island	Predation	Flooding/Storms	Abandoned	Human Interaction	Unknown
South Core Banks	27	0	2	1	19
North Core Banks	22	3	1	1	11
Shackleford Banks	2	0	0	0	6
Total	**51**	**3**	**3**	**2**	**36**

Table 8. Recorded nest predators in 2018 at Cape Lookout National Seashore.

Island	Coyote	Raccoon	Nutria	Ghost crab	Avian	Cat	Unknown Predator
South Core Banks	26	1	0	0	0	0	0
North Core Banks	0	13	1	4	0	1	3
Shackleford Banks	1	0	0	0	1	0	0
Total	**27**	**14**	**1**	**4**	**1**	**1**	**3**

Banding

Thirty-eight chicks were captured by Seashore staff and banded with individual field readable codes. Under the guidance of North Carolina Audubon biologist Lindsay Addison, seven previously unbanded adult American oystercatchers were trapped and banded. One previously banded adult was trapped and had its damaged bands replaced. Of the 138 individuals nesting in the Seashore, 72 (52%) were banded, 59 (43%) were unbanded, and seven (5%) were not identified. Only 17 (25%) pairs were completely unbanded, 50 (72%) had at least one of the pair banded, and two (3%) pairs were unknown. See Appendix A for nesting pair resight data and 2018 chick bands.

In 2018, 10 new individuals nested at the Seashore. Dark Green 68, CUK, YR, CM0, CLT, CFK, CLN, CUF, and CUH were all banded as chicks within the Seashore between 2012 and 2015. Two of these individuals, Dark Green CUH and CUF, are siblings that fledged from the same brood on South Core Banks in 2015. Dark Green MA was banded on North Rock Island at Ocracoke Inlet in 2010. This was the first year of confirmed breeding for all new individuals.

Discussion

The 2018 American oystercatcher breeding season yielded an above average fledge success rate of 0.57 chicks per pair. Predation remains the largest known cause of nest loss for the sixth year in a row since 2013 (Table 9). Eighty-six percent of known nest losses were due to predation in the 2018 season. Mammalian predators are the biggest concern, and accounted for 87% of predation events where the predator was identified. Coyote continues to be the predominant predator on South Core Banks, accounting for 44% of nest losses on that island. However, following the removal of 17 coyotes between August 2017 and June 2018, hatch success on South Core Banks increased from 0% in 2017 to 21% in 2018.

On North Core Banks, raccoon was the predominant predator accounting for 25% of nest losses. Although 27 raccoons were removed from North Core Banks in June and July 2018, this was too late in the season to have a significant influence on 2018 productivity. Shackleford Banks continues to produce the lowest fledge success in the Seashore. Although 75% of nest loss causes were unknown due to low-level monitoring, heavy predation is suspected to be responsible for the poor productivity on Shackleford Banks.

Adverse weather events had minimal impact on American oystercatcher productivity in the 2018 season, resulting in the loss of three nests; one from a storm tide and two from heavy rain. Negative human interaction accounted for two nest losses and the loss of one chick by off-road vehicle (ORV). A cause was not identified for 38% of nest failures in the Seashore.

Although there was one less breeding pair in 2018 than 2017, American oystercatcher breeding pair counts continue to have an upward trend (Figure 2). The number of fledged chicks has recovered to average levels after a record low of zero in 2017.

Table 9. Causes of American oystercatcher nest failure at Cape Lookout National Seashore, 2013–2018.

Year	Total Nests	Nests Lost	Predation	Flooding/ Storms	Human Interaction	Abandoned	Unknown
2013	104	72	21 (29%)	3	1	1	46
2014	87	49	15 (30%)	6	0	1	27
2015	112	75	41 (54%)	0	0	4	30
2016	121	104	68 (65%)	2	2	2	30
2017	133	128	76 (59%)	16	1	7	33
2018	123	95	51 (54%)	3	2	3	36

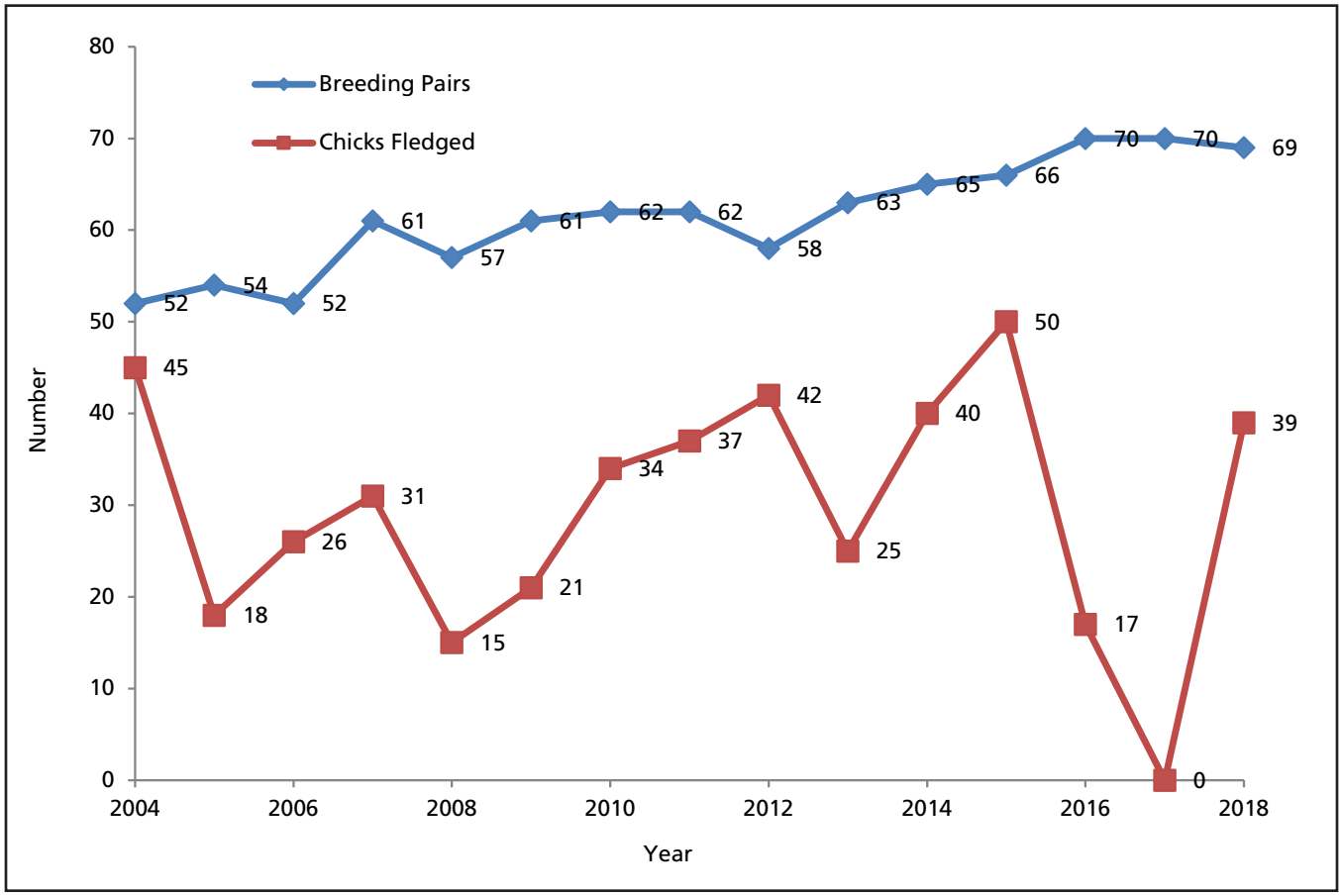

Figure 2. The number American oystercatcher breeding pairs and number of chicks fledged by year at Cape Lookout National Seashore, 2004–2018.

Colonial Waterbird Management and Monitoring

Background

The inlet spits, sandflats, inshore islands, and the point of Cape Lookout National Seashore 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 in the Seashore in single-species and mixed-species colonies.

Methods

Monitoring

In 2018, 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 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, number of nests, chicks, and fledglings were 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. The colony on Morgan Island was not monitored regularly, but a complete chick count during banding operations allowed for a breeding pair estimate based on one egg/chick produced by one pair (Baicich and Harrison 1997).

The Seashore participated in the state-wide annual least tern census from June 5 to June 20. All colonies that were active on Core Banks during the window were counted by the staff biologist or biological science technicians and results were shared with state biologists. Morgan Island was not included in the census.

Management

Historical nesting sites were signed and closed to pedestrian and vehicle entry by April 1, 2018. Reoccurring nesting sites include Morgan Island, Power Squadron Spit, Cape Point, Ophelia Inlet, New Drum Inlet Flats, Old Drum Inlet Flats, Kathryn-Jane Flats,

Black skimmer at Cape Lookout National Seashore. NPS

and Portsmouth Flats. In addition to reoccurring nesting sites, all additional potential nesting habitat in the Seashore 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.

Results

Fourteen colonial waterbird colonies were observed within the Seashore in 2018 (Table 10). Six colonies were on North Core Banks, seven were on South Core Banks, and one colony was on Morgan Island (Appendix F). There were no colonies on Shackleford Banks. Of the 14 colonies, 10 were single-species colonies and four were multi-species colonies. Six species of colonial waterbirds nested in the Seashore included the least tern, black skimmer, common tern, gull-billed tern, sandwich tern and royal tern. Colonial waterbirds occupied seven of eight reoccurring nesting sites that were posted at the beginning of the season. There was no nesting activity at Power Squadron Spit. Five additional colonies were observed outside of these posted areas and were subsequently posted. Seven colonies were ranked as low success, five colonies had no success, one colony had medium success and the Morgan Island colony had high success.

Three hundred and ninety-four pairs of least terns were counted in the Seashore during the annual least tern census window. In addition, 52 black skimmer pairs, 13 common tern pairs, and 5 gull-billed tern pairs were also counted during the census.

Table 10. Summary of colonial waterbird colonies at Cape Lookout National Seashore in 2018. NCB = North Core Banks, SCB = South Core Banks, MI = Morgan Island, 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
1	NCB	2.73	Portsmouth Flats	32 LETE	40 LETE	low
2	NCB	6.44	Kathryn-Jane Flats	5 LETE	20 LETE	none
3	NCB	9.22	upper beach	4 LETE	13 LETE	low
4	NCB	10.25	upper beach	N/A	3 LETE	none
5	NCB	18.77	Old Drum Flats	24 LETE, 30 BLSK	35 LETE, 0 BLSK	low
6	NCB	21.90	New Drum Flats	8 LETE	22 LETE	low
7	SCB	23.39	Ophelia Inlet	N/A	8 BLSK	low
8	SCB	23.4	Ophelia Inlet	82 LETE	138 LETE	low
9	SCB	23.5	Tern Island	232 LETE, 22 BLSK, 13 COTE, 5 GBTE	232 LETE, 22 BLSK, 13 COTE, 5 GBTE	medium
10	SCB	24.82	North End	6 LETE	25 LETE	none
11	SCB	26.78	upper beach	N/A	6 LETE	low
12	SCB	36.2	open beach shellbed	1 LETE	1 LETE	none
13	SCB	43.65	Cape Point	N/A	8 LETE, 2 COTE, 1 BLSK	none
14	MI	–	Morgan Island	N/A	1091 ROTE, 144 SATE	high

Least tern chicks. NPS

Discussion

Productivity in colonial waterbird colonies is difficult to determine. Low numbers of chicks were observed at seven of the fourteen colonies. These seven colonies were rated as having low productivity. No hatching and/or chicks were observed at five of the colonies and were rated as having no productivity. The Morgan Island colony was not monitored regularly, but two chick banding operations provided a high productivity rating. Fledges were observed at the New Drum and Tern Island colonies, but it is unknown if these were fledglings of the colony or fledglings that arrived from other areas.

Low success overall appears to be a result of predation and flooding events throughout the season. Mink activity was recorded at colony 8 at Ophelia Inlet and the North End colony 10 on South Core Banks. It is suspected that coyote and raccoon are also common colonial waterbird predators, however additional monitoring is required to determine the extent. The largest numbers of colonial waterbirds were seen on Tern Island and Morgan Island, likely because colonial waterbirds prefer nesting sites free of mammalian predators.

Mid-June and late July flooding events impacted Old Drum and Tern Island colonies. Colony 7 at Ophelia Inlet and the Tern Island colony were both active prior to the landfall of Hurricane Florence on September 14, 2018. Storm surge from Hurricane Florence overwashed both these sites and destroyed any active nests and chicks.

The least tern window census in 2018 recorded 394 breeding pairs, an increase from a low of 148 pairs in 2017 (Figure 3). Fifty-nine percent of least tern pairs during the census window were located on Tern Island, highlighting the importance of this new nesting site. However, there has been an overall decline in least tern nesting pairs since a peak count of 789 pairs in 2010.

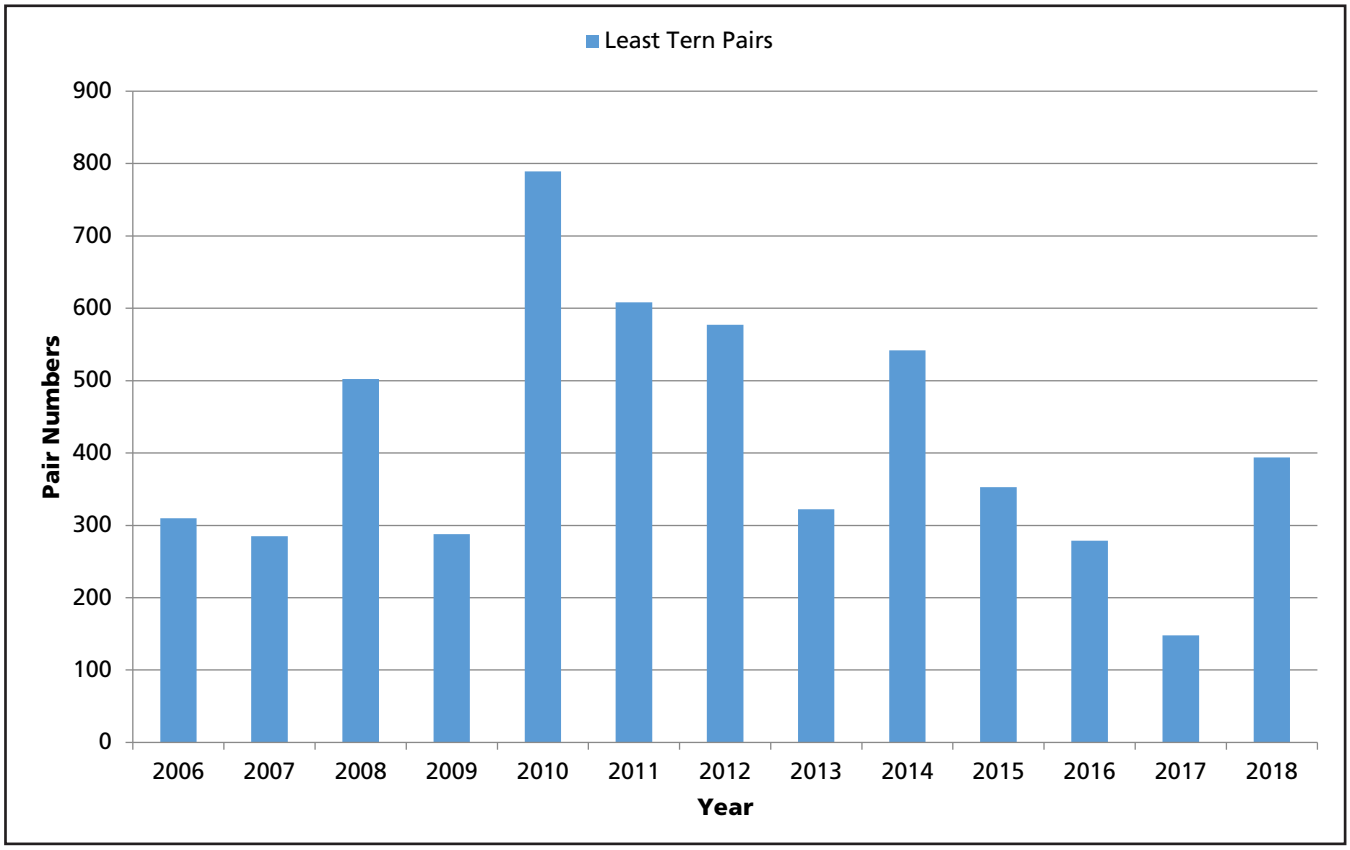

Figure 3. Least tern window census counts (June 5–20) at Cape Lookout National Seashore, 2006–2018.

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 Cape Lookout National Seashore as a stopover site during spring and fall migration. While not as important as some other coastal sites, the Seashore may still contribute to the survival of this species.

Previous monitoring of red knots at the Seashore was limited to surveys as part of a broader shorebird study in 1992 and 1993. North Core Banks had greater numbers of red knots than anywhere else in the Outer Banks (relative density of 34 birds per kilometer; Dinsmore et al. 1998), 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 entire ocean beach and inlet areas on North Core Banks and South Core Banks 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 each month from March 15 to June 5 and from July 15 to October 15. Surveys were not performed on South Core Banks from Sept 15 to October 5 and North Core Banks from Sept 15 to Sept 25 due to impacts from Hurricane Florence. Partial surveys were performed from October 5 to October 25 due to inaccessibility of Core Banks from mile 19 to mile 24.

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.

Results

Spring migration counts of red knots peaked on May 25 with 2,296 birds counted across the Core Banks (Figure 4). Fall migration peaked on August 25 with

A flock of red knots on an intertidal flat during spring migration at Cape Lookout National Seashore. NPS

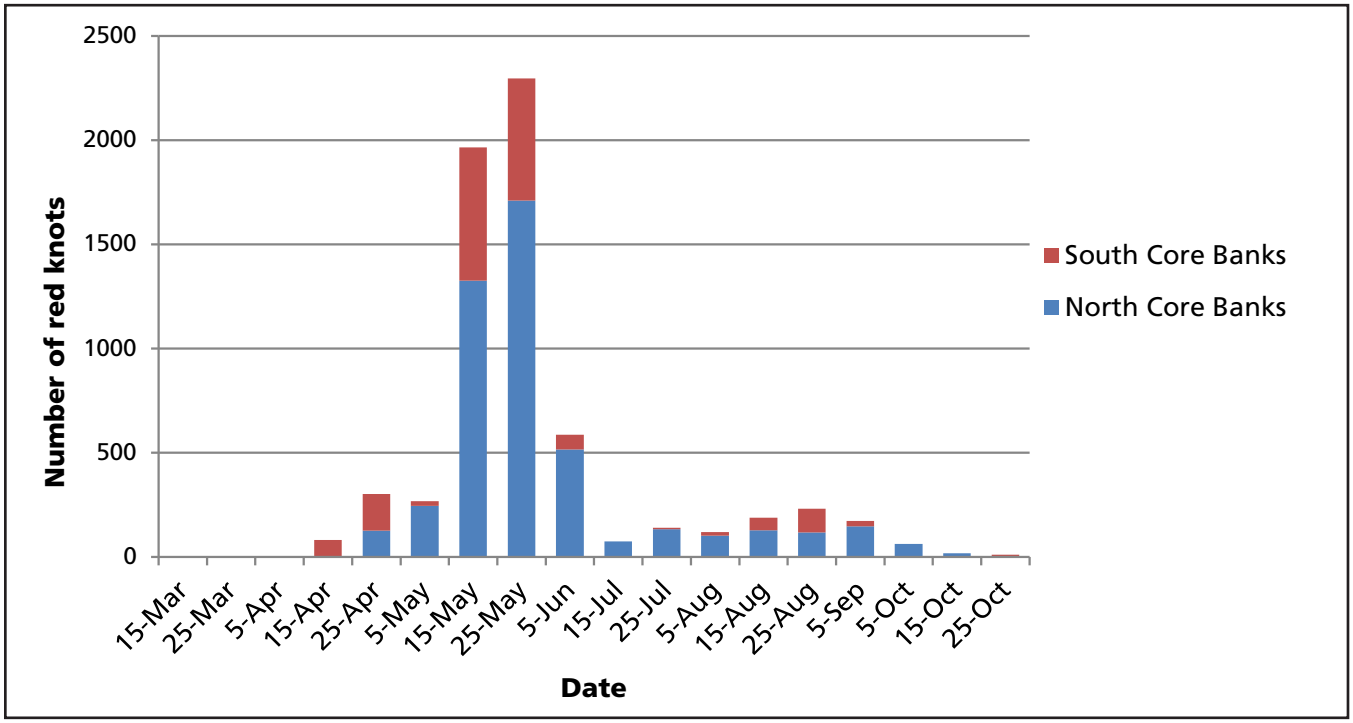

Figure 4. Number of red knots counted at Cape Lookout National Seashore in 2018.

232 red knots counted across the Core Banks. Spring migration from March 15 to June 5 averaged 611 birds across both islands. The fall migration from July 15 to October 15 averaged 119 birds across both islands.

Red knots were distributed over the length of Core Banks, with highest concentrations at the north end of North Core Banks (Appendix G; Figures 4 and 5). North Core Banks averaged 261 birds per survey throughout the survey period, and the highest count of 1,710 birds was on May 25, with a relative abundance of 48 birds per kilometer (Table 11) South Core Banks averaged 106 birds per survey across the survey period, and the highest count of 639 red knots was on May 14, with a relative abundance of 17 birds per kilometer.

Discussion

Monitoring in 2018 confirmed the importance of the Seashore as a stopover site for red knots, particularly during the spring migration. During peak spring migration, 2,296 birds utilized the Seashore. The relative abundance of red knots on North Core Banks during peak spring migration was 48 birds per kilometer compared to 34 birds per kilometer in 1992–1993 (Table 11). Although this is the fifth highest relative abundance recorded since 1992, relative abundance has shown an annual decline since a high of 89 birds per kilometer in 2014.

Table 11. Red knot relative abundance on North Core Banks in Cape Lookout National Seashore, 1992–2018.

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

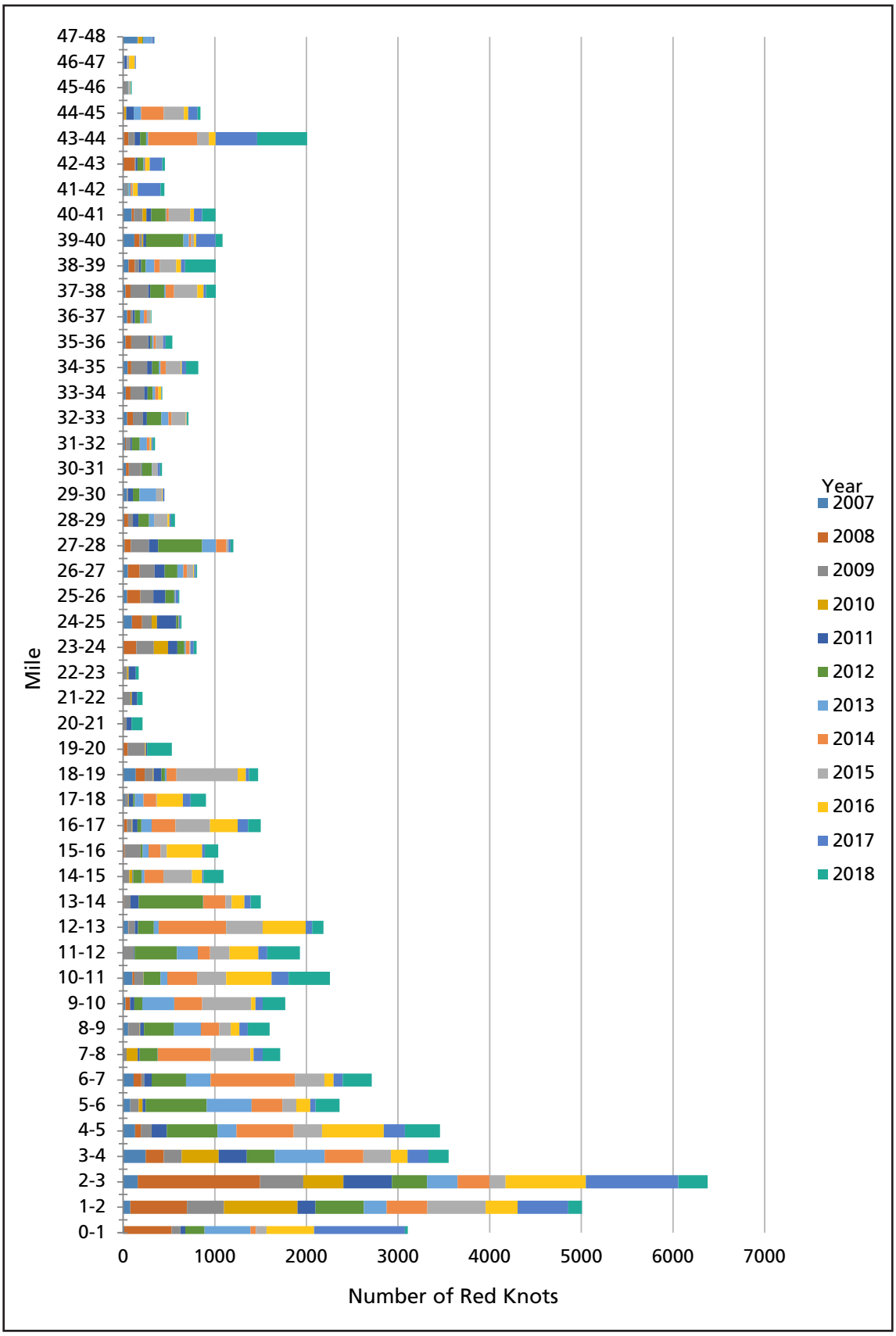

Figure 5. Total number of red knots counted in each mile section from 2007 to 2018 at Cape Lookout National Seashore.

North Core Banks averaged more birds overall and had the highest peak counts. Monitoring data from 2006 to 2017 reveals the highest counts consistently occur from Ocracoke Inlet to mile 7 on North Core Banks. The highest concentration of red knots on South Core Banks occurred between miles 43 and 44. These data highlight the importance of the Seashore, particularly the north end of North Core Banks, 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.

Conclusions and Recommendations

Recent predator management efforts have led to an increase in shorebird fledge success across Cape Lookout National Seashore. Predator removal resulted in a significant increase in American oystercatcher productivity from 0.0 fledged chicks per pair in 2017 to 0.57 per pair in 2018. In addition, increased predator exclosure use resulted in a rise in piping plover fledge success from 0.15 fledged chicks per pair in 2017 to 0.83 per pair in 2018. However, predation continues to be the predominant cause of shorebird nest failure. Coyote, raccoon, and mink continue to have significant impacts on American oystercatchers, piping plovers, and colonial waterbirds on South Core Banks, while raccoon is the primary concern on North Core Banks.

The Seashore should continue to sign Interagency Agreements with USDA Wildlife Services to conduct mammalian predator management. Coyote and mink trapping on South Core Banks should remain the highest priority, although raccoon trapping on North Core Banks should continue. 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.

Hurricane Florence made landfall on the Seashore on September 14, 2018. Although this storm did negatively impact one late season black skimmer colony, it resulted in significant positive geomorphological changes to the Seashore. Storm surge moved sand from the oceanside to the interior portions of the island, expanding existing overwash sites and creating new overwash fans that are expected to improve nesting habitat in subsequent breeding seasons.

After Hurricane Isabel in 2003, piping plover pair numbers and productivity spiked for several years due to the habitat renewal of the sand flats. A similar spike in nesting activity is expected to occur in the 2019 season and onward, requiring an increased monitoring and management effort. Additional resource management staff will be needed to monitor additional and improved nesting habitat and to better understand the impacts of Hurricane Florence

American oystercatcher chicks. NPS

on shorebird productivity. Piping plover predator exclosure deployment requires two to three trained employees per nest. 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 wildlife protection zones for nests and chicks. There were three piping plovers broods that used the ocean beach and required immediate protection zones in 2018.

Additional staff are also needed to better 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 should be tracked, and chick numbers and ages should be documented. It is recommended that monitoring staff levels should be increased to six qualified employees on the Core Banks to ensure Interim Protected Species Management Plan (IPSMP) daily monitoring and management requirements are met.

Lastly, shorebird banding programs should continue across Core Banks. Banded individuals increase the accuracy of breeding bird and productivity monitoring data at the Seashore. Since Virginia Tech began piping plover banding in 2015, pair movements between nesting sites within the Seashore, pair movements between the Seashore and Cape Hatteras National Seashore, and movements between Atlantic states have 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 nonbreeding piping plovers can be used to study migratory and winter use of Cape Lookout National Seashore. It appears that North Core Banks is a major migratory use area and it should 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 in Seashore management efforts and long-term population monitoring.

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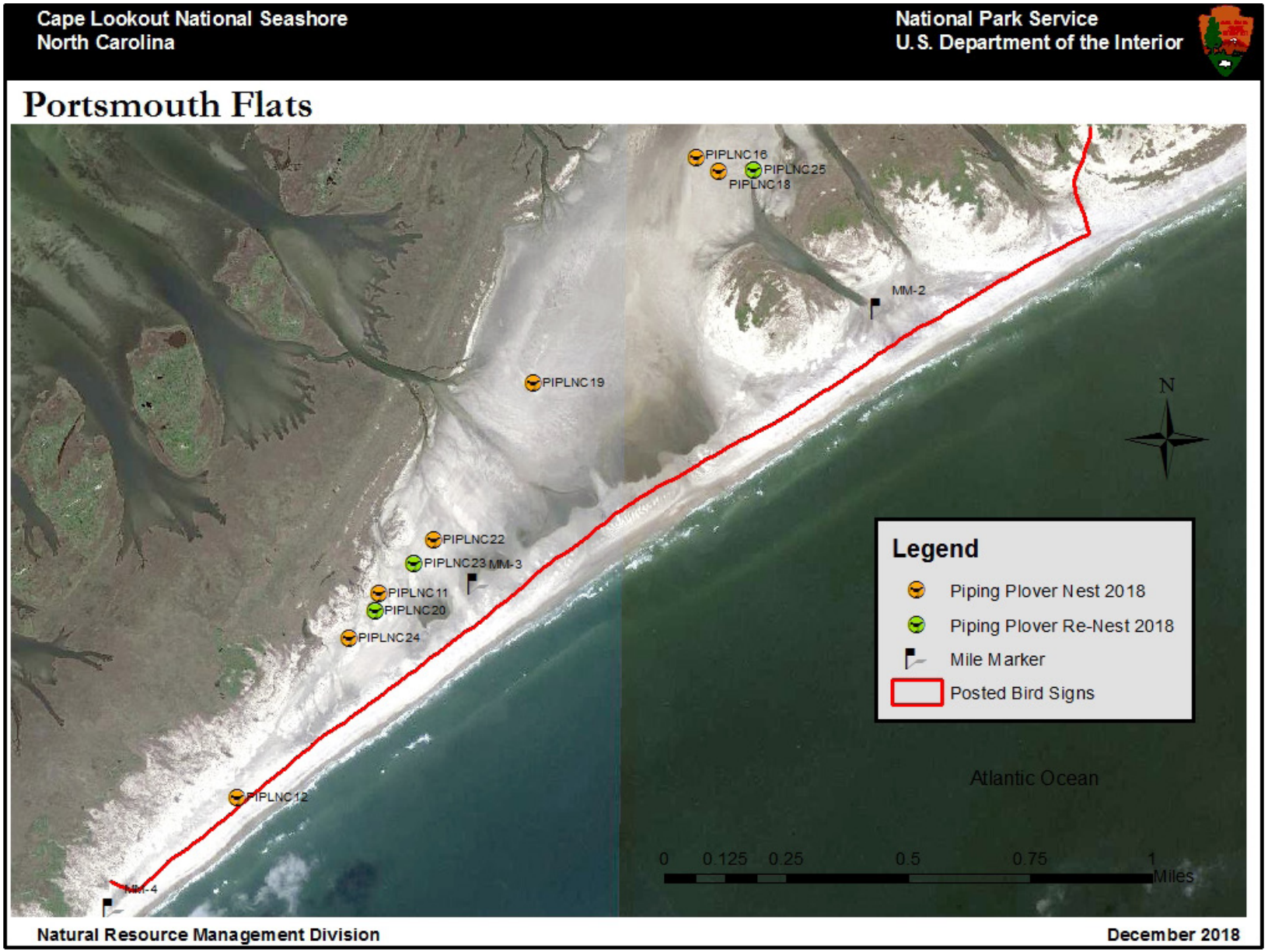
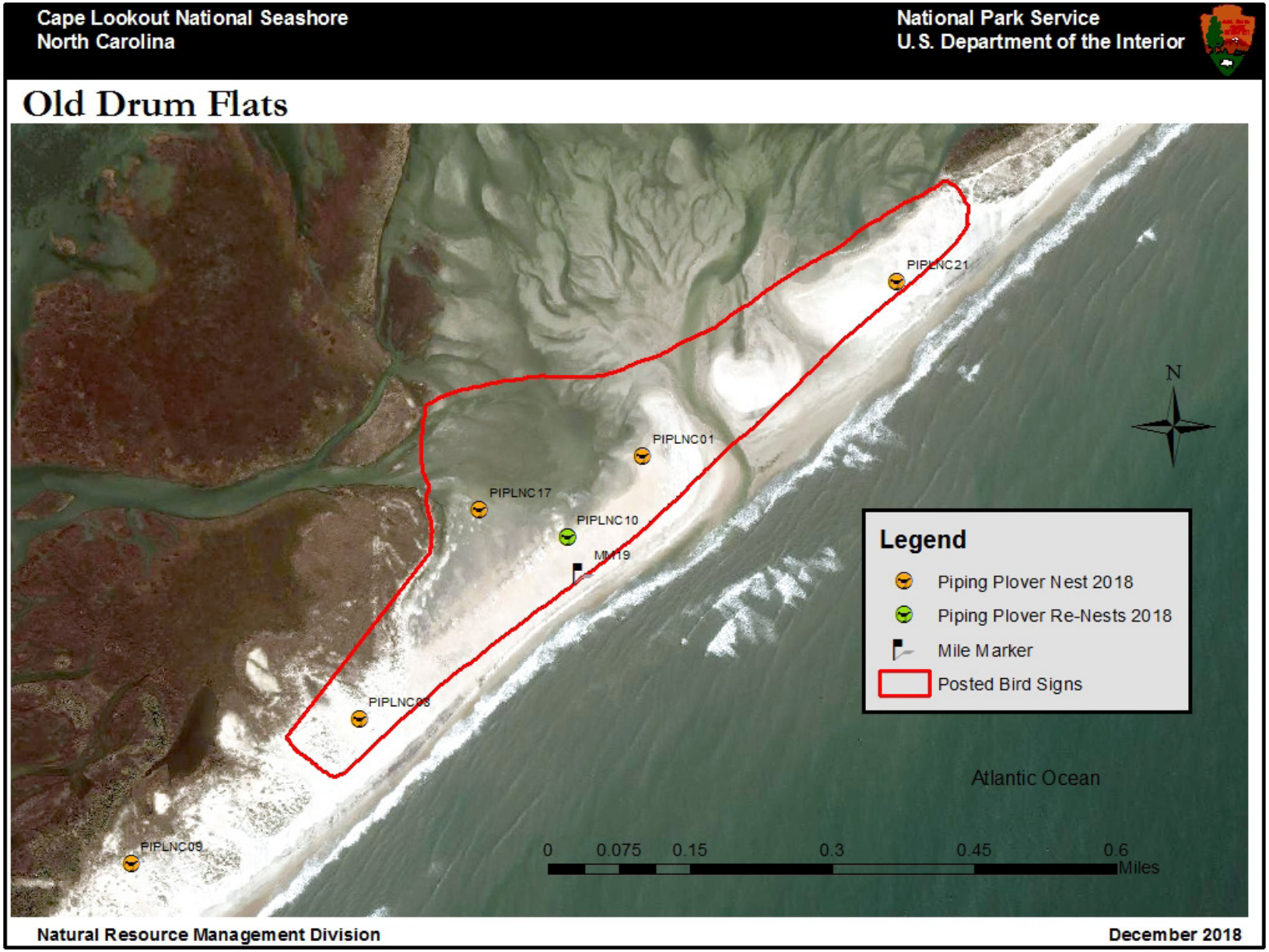
Appendix A. Piping Plover Maps



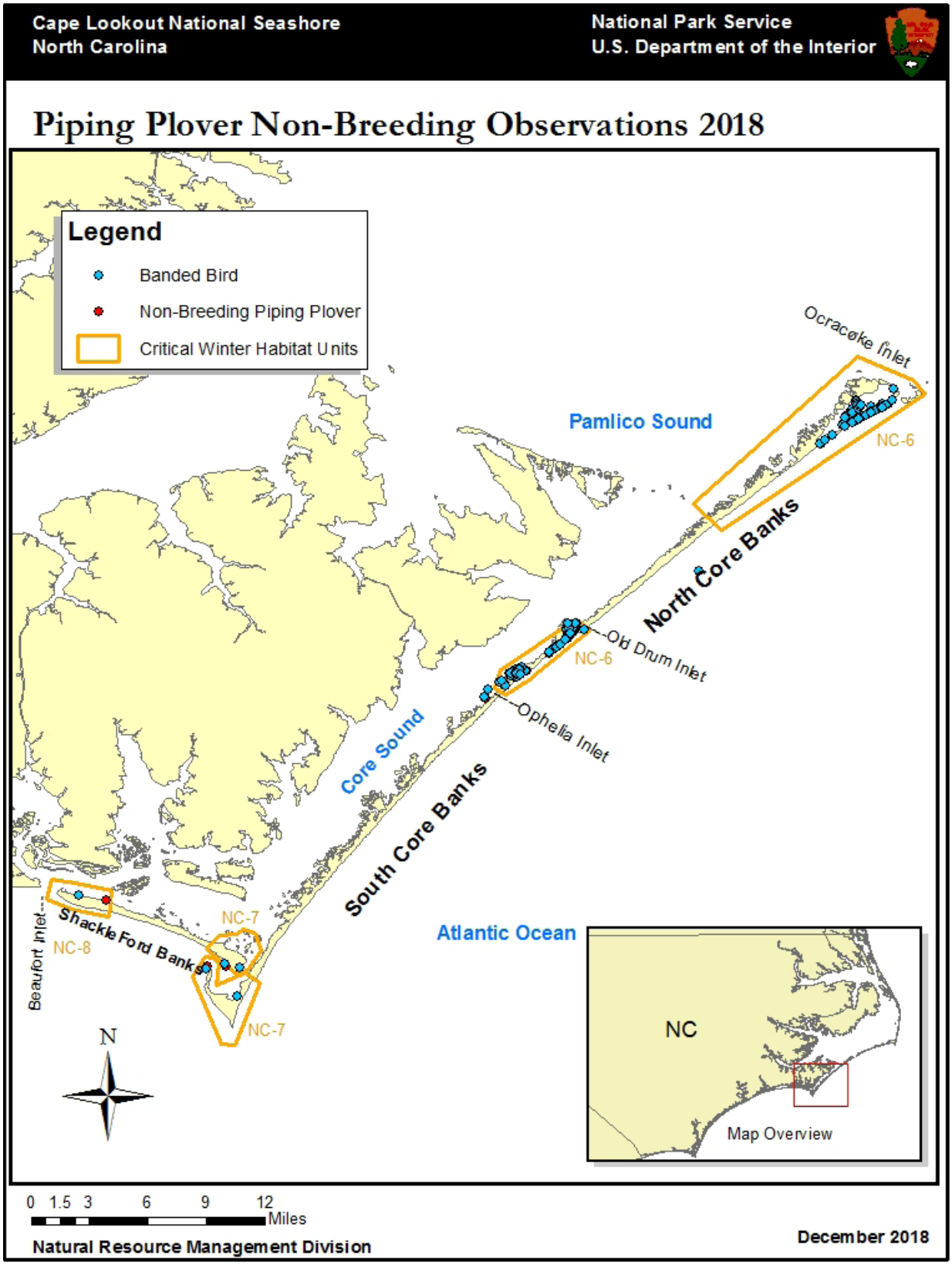
Map A-1. Portsmouth Flats piping plover nest locations in 2018.



Map A-2. Old Drum Flats piping plover nest locations in 2018.

Map A-3. New Drum Flats and Ophelia Island piping plover nest locations in 2018.

Map A-4. Plover Inlet piping plover nest locations in 2018.



Map A-5. Non-breeding piping plover locations in 2018.

Appendix B. 2018 Piping Plover Productivity Data

Table B-1. North Core Banks productivity data for 2018, Cape Lookout National Seashore. North Core Banks totals: 21 breeding pairs, 26 total nests, 18 hatched nests, 19 fledged. Band identification codes, when present, are listed for adults and chicks; UNB = unbanded, UNK = unknown, M = male, and F = female.

Nest	Pair	Adult 1	Adult 2*	Site	Mile	Found Date	Exclosure Date	Eggs Laid	Clutch Fate	Outcome Summary
PIPLNC1	1	UNB	UNK	Old Drum	18.88	5/2/2018	N/A	1	Fail	Unknown
PIPLNC2	2	Gf(JPX)F	Gf(320)M	New Drum	21.81	5/4/2018	5/5/2018	4	Hatch	Fledged 2 chicks Gf(4JC) and Gf(EC3)
PIPLNC3	3	Gf(715)M	Gf(0HM)F	New Drum	21.84	5/5/2018	5/6/2018	4	Hatch	Fledged 2 chicks Gf(558) and Gf(0TX)
PIPLNC4	4	UNB	UNB	New Drum	22.02	5/5/2018	5/9/2018	3	Hatch	Fledged 1 UNB chick
PIPLNC5	5	Gf(M4C)F	UNB M	New Drum	21.66	5/8/2018	5/9/2018	4	Fail	Raccoon breached predator exclosure
PIPLNC6	6	Gf(Y8L)M	Gf(PEU)F	New Drum	21.9	5/8/2018	5/15/2018	3	Hatch	Fledged 2 UNB chicks
PIPLNC7	7	Gf(KCK)F	Gf(01V)M	Ophelia	22.81	5/10/2018	5/11/2018	4	Hatch	Brood failed, unknown
PIPLNC8	8	Gf(PYU)M	UNB F	Old Drum	19.28	5/15/2018	5/23/2018	3	Hatch	Fledged 2 UNB chicks, ocean beach
PIPLNC9	9	Gf(0KK)F	LG,-:RY,-	Old Drum	19.57	5/15/2018	5/15/2018	4	Hatch	Fledged 1 UNB chick, ocean beach
PIPLNC10	1	Gf(LPY)F	UNB M	Old Drum	19	5/16/2018	5/18/2018	3	Hatch	Fledged 3 UNB chicks
PIPLNC11	10	Gf(A5P)F	UNB M	Portsmouth	3.2	5/19/2018	N/A	3	Fail	Unknown
PIPLNC12	11	Gf(840)M	Gf(NY8)F	Portsmouth	3.66	5/19/2018	5/22/2018	4	Hatch	Brood failed, unknown
PIPLNC13	12	Gf(HAC)F	UNB M	Ophelia	22.64	5/23/2018	5/24/2018	4	Hatch	Brood failed, unknown
PIPLNC14	5	Gf(M4C)F	Gf(P17)M	New Drum	21.53	5/26/2018	5/26/2018	4	Hatch	Fledged 1 UNB chick, ocean beach
PIPLNC15	13	Gf(33C)F	Gf(Y2J)M	New Drum	22.05	5/26/2018	5/31/2018	4	Hatch	Fledged 1 UNB chick
PIPLNC16	14	Gf(XK2)F	Gf(0M6)M	Portsmouth	2.49	5/27/2018	5/27/2018	4	Fail	Nest Flooded
PIPLNC17	15	Gf(E3V)M	UNB F	Old Drum	19.13	6/5/2018	6/5/2018	3	Hatch	Brood failed, unknown
PIPLNC18	16	Gf(3E8)M	Gf(8C5)F	Portsmouth	2.44	6/6/2018	6/7/2018	4	Fail	Raccoon breached predator exclosure
PIPLNC19	17	Gf(H7H)M	Gf(4M0)F	Portsmouth	2.73	6/7/2018	6/7/2018	3	Hatch	Fledged 1 UNB chick
PIPLNC20	10	Gf(A5P)F	UNB M	Portsmouth	3.22	6/9/2018	N/A	4	Fail	Unknown
PIPLNC21	18	UNB	UNB	Old Drum	18.56	6/19/2018	6/21/2018	4	Hatch	Fledged 1 UNB chick
PIPLNC22	19	Gf(NH5)F	UNB M	Portsmouth	3.13	6/23/2018	6/25/2018	4	Fail	Ghost crab predation
PIPLNC23	10	Gf(A5P)F	UNB M	Portsmouth	3.14	6/23/2018	6/23/2018	4	Hatch	Brood failed, unknown
PIPLNC24	20	Gf(J0T)F	UNB M	Portsmouth	3.29	6/27/2018	7/1/2018	3	Fail	Unknown

Table B-1 (continued). North Core Banks productivity data for 2018, Cape Lookout National Seashore. North Core Banks totals: 21 breeding pairs, 26 total nests, 18 hatched nests, 19 fledged. Band identification codes, when present, are listed for adults and chicks; UNB = unbanded, UNK = unknown, M = male, and F = female.

Nest	Pair	Adult 1	Adult 2	Site	Mile	Found Date	Exclosure Date	Eggs Laid	Clutch Fate	Outcome Summary
PIPLNC25	16	Gf(3E8)M	Gf(8C5)F	Portsmouth	2.39	6/28/2018	6/28/2018	4	Hatch	Fledged 1 UNB chick
PIPLNC26	21	UNB	UNB	New Drum	22.18	6/29/2018	N/A	UNK	Hatch	Fledged 1 UNB chick, missed nest

Table B-2. South Core Banks productivity data for 2018, Cape Lookout National Seashore. South Core Banks totals: 3 breeding pairs, 4 total nests, 1 hatched nests, 1 fledged. Band identification codes, when present, are listed for adults and chicks; UNB = unbanded

Nest	Pair	Adult 1	Adult 2	Site	Mile	Found Date	Exclosure Date	Eggs Laid	Clutch Fate	Outcome Summary
PIPLSC1	1	Pf(3X)	UNB	Plover Inlet	23.58	5/10/2018	5/10/2018	4	Fail	Mink predation
PIPLSC2	2	Gf(C15)	UNB	Plover Inlet	23.6	5/15/2018	5/15/2018	4	Hatch	Fledged 1 UNB chick
PIPLSC3	3	Gf(6XA)	UNB	Plover Inlet	23.74	5/27/2018	6/1/2018	4	Fail	Mink predation
PIPLSC4	1	Pf(3X)	UNB	Plover Inlet	23.6	6/22/2018	6/22/2018	4	Fail	Mink predation

Appendix C. Monthly Counts of Nonbreeding Piping Plovers, 2008–2018

Table C-1. Nonbreeding piping plover monthly counts at Cape Lookout National Seashore, 2008–2018.

Date	North Core Banks	South Core Banks	Shackleford Banks	Seashore 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

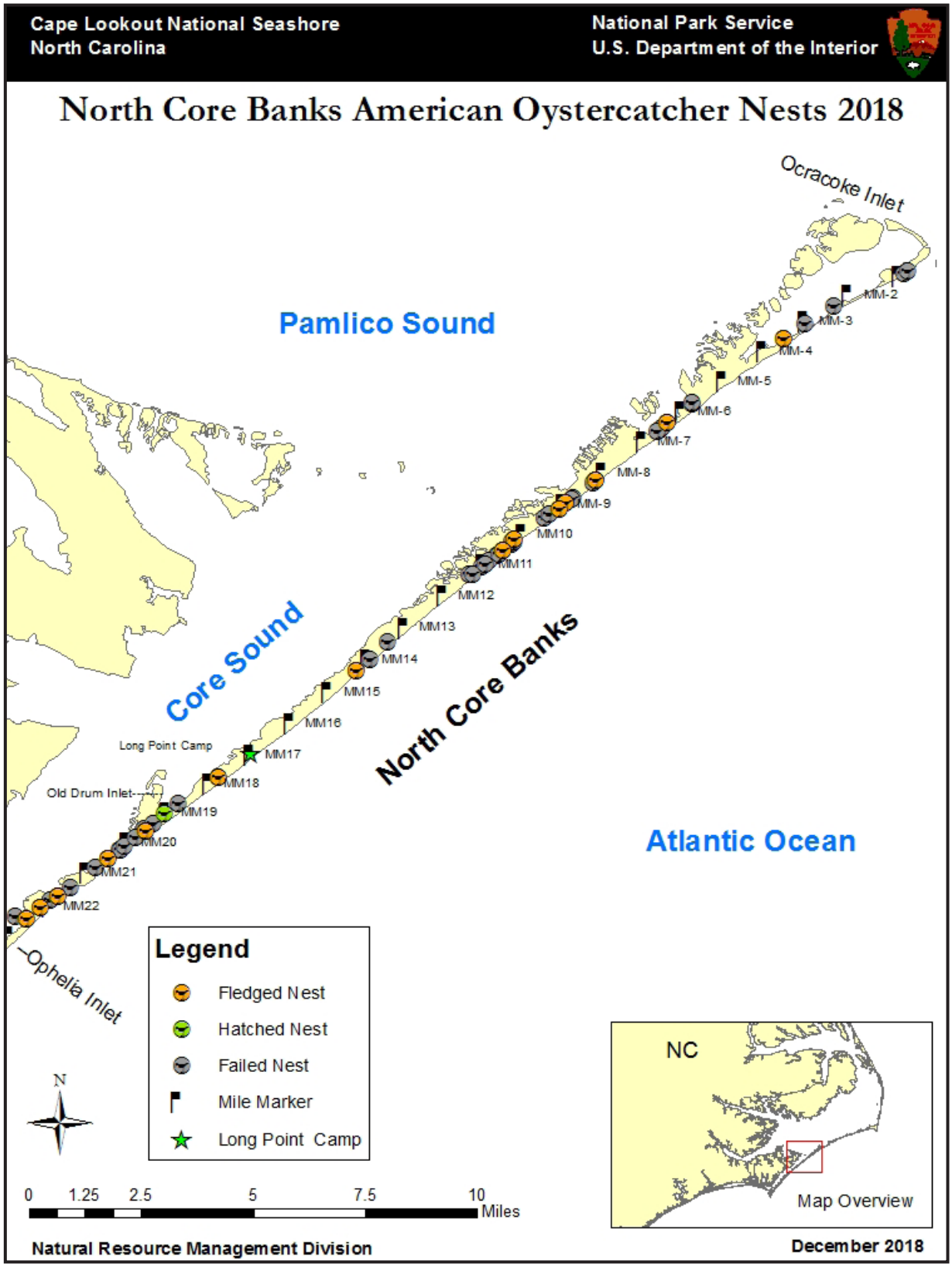
Table C-1 (continued). Nonbreeding piping plover monthly counts at Cape Lookout National Seashore, 2008–2018.

Date	North Core Banks	South Core Banks	Shackleford Banks	Seashore Total
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

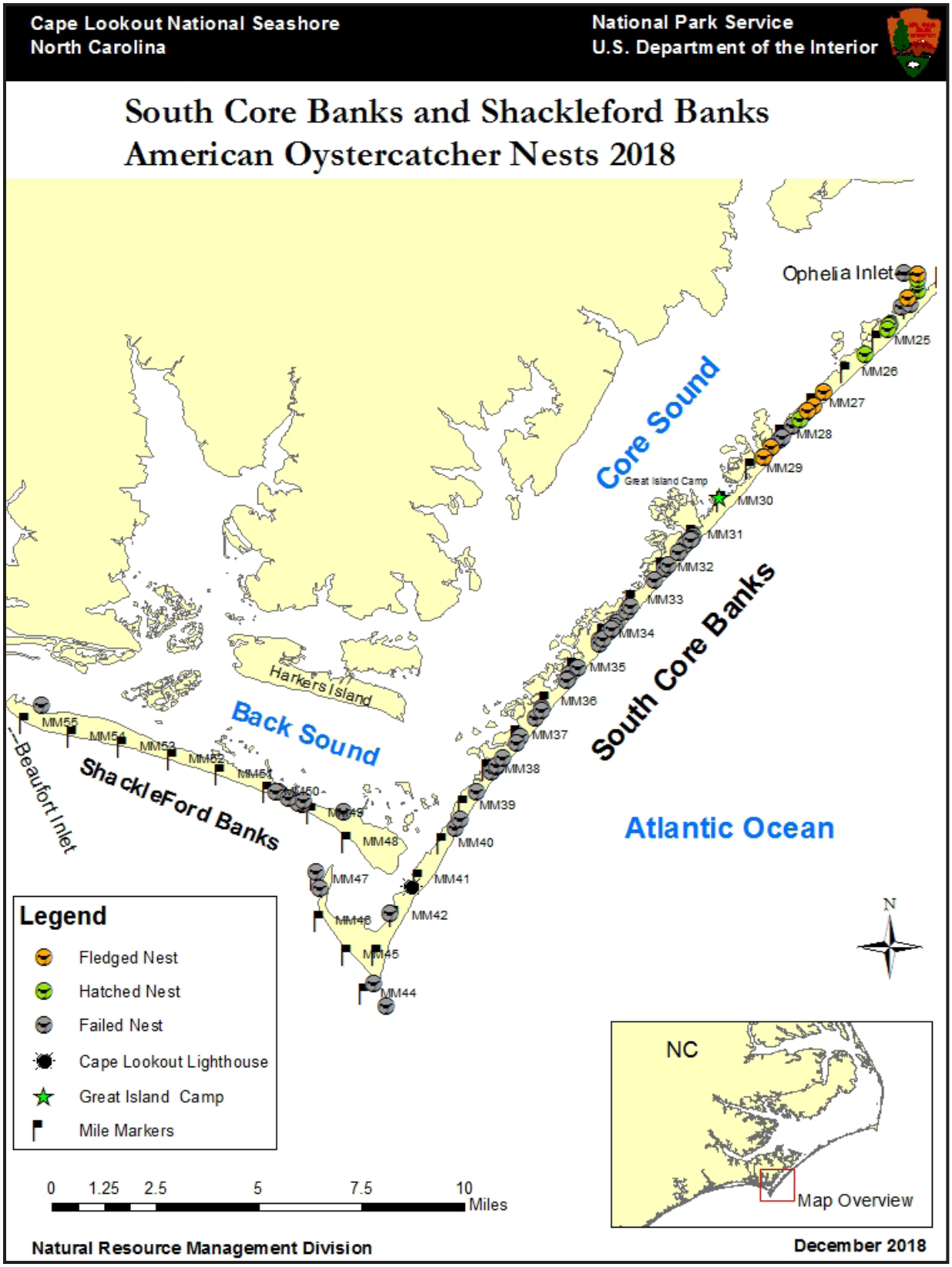
Table C-1 (continued). Nonbreeding piping plover monthly counts at Cape Lookout National Seashore, 2008–2018.

Date	North Core Banks	South Core Banks	Shackleford Banks	Seashore Total
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

Appendix D. American Oystercatcher Maps



Map D-1. North Core Banks American oystercatcher nest locations in 2018.



Map D-2. South Core Banks and Shackleford Banks American oystercatcher nest locations in 2018.

Appendix E. 2018 American Oystercatcher Productivity Data

Table E-1. South Core Banks productivity data for 2018, Cape Lookout National Seashore. South Core Banks totals: 33 breeding pairs, 62 total nests, 13 hatched nests, 13 fledged. Band identification codes, when present, are listed for adults and chicks; UNB = unbanded and UNK = unknown.

Nest	Pair	Adult 1	Adult 2	Mile	Found Date	Eggs	Closure	Outcome Summary
1	1	DG(AP)	DG(AR)	33.65	4/14/2018	1	600’ buffer	Nest failed 4/14, unknown cause.
2	2	DG(AL)	UNB	23.60	4/15/2018	3	interior	Brood failed 6/15, unknown cause.
3	1	DG(AP)	AG(AR)	33.92	4/17/2018	2	600’ buffer	Nest failed 5/6, coyote predation.
4	3	DG(K0)	UNB	32.04	4/17/2018	3	600’ buffer	Nest failed 5/8, unknown cause.
5	4	DG(C39)	DG(C3A)	28.43	4/18/2018	3	600’ buffer	Fledged 3 chicks, DG(C70), DG(C71), and DG(C72), on 6/25 at day 41.
6	5	UNB	UNB	31.20	4/19/2018	1	600’ buffer	Nest failed 4/19, unknown cause.
7	6	DG(LN)	DG(33)	24.67	4/21/2018	3	interior	Brood failed 5/19, unknown cause.
8	7	DG(WP)	UNB	24.00	4/21/2018	3	interior	Nest failed 5/15, unknown cause.
9	8	DG(PW)	R(5F)	39.62	4/21/2018	2	600’ buffer	Nest failed 5/14, coyote predation.
10	9	DG(L2)	DG(R8)	38.06	4/21/2018	3	600’ buffer	Nest failed 5/7, unknown cause.
11	10	DG(CF7)	DG(UJ)	27.11	4/22/2018	4	600’ buffer	Fledged 1 chick, DG(C78), on 6/28 at day 37.
12	5	DG(CL9)	UNB	31.09	4/22/2018	3	600’ buffer	Nest failed 5/8, coyote predation.
13	11	DG(J9)	UNB	37.05	4/26/2018	3	600’ buffer	Nest failed 5/7, coyote predation.
14	12	DG(J0)	DG(CAN)	35.24	4/27/2018	3	600’ buffer	Nest failed 5/24, raccoon predation.
15	13	DG(CFE)	UNB	31.37	4/27/2018	3	600’ buffer	Nest failed 5/8, coyote predation.
16	14	DG(NF)	UNB	33.27	4/28/2018	3	600’ buffer	Nest failed 5/7, unknown cause.
17	15	DG(68)	UR- red	36.21	4/28/2018	3	600’ buffer	Nest failed 5/11, coyote predation.
18	16	DG(CEF)	DG(C3C)	27.37	4/29/2018	3	600’ buffer	Nest failed 5/5, abandoned.
19	17	DG(TC)	UNB	27.76	5/1/2018	2	600’ buffer	Nest failed 5/9, coyote predation.
20	18	DG(CFA)	UNB	26.73	5/1/2018	3	600’ buffer	Fledged 2 chicks, DG(C7A) and DG(C7C), on 7/3 at day 38.
21	19	UNB	UNB	42.00	4/30/2018	3	none	Nest failed 5/8, unknown cause.
22	20	DG(CHJ)	UNB	34.22	5/3/2018	2	600’ buffer	Nest failed 5/8, unknown cause.
23	21	UNB	UNB	23.40	5/3/2018	3	interior	Fledged 1 chick, DG(C7E), on 7/4 at day 39.
24	22	DG(MC)	UNB	23.90	5/3/2018	3	interior	Fledged 1 chick, UNB, on 7/1 at day 43.

Table E-1 (continued). South Core Banks productivity data for 2018, Cape Lookout National Seashore. South Core Banks totals: 33 breeding pairs, 62 total nests, 13 hatched nests, 13 fledged. Band identification codes, when present, are listed for adults and chicks; UNB = unbanded and UNK = unknown.

Nest	Pair	Adult 1	Adult 2	Mile	Found Date	Eggs	Closure	Outcome Summary
25	23	DG(CUK)	DG(YP)	35.02	5/4/2018	3	600’ buffer	Nest failed 5/17, coyote predation.
26	24	DG(CJR)	DG(KR)	28.14	5/5/2018	2	600’ buffer	Nest failed 5/9, coyote predation.
27	25	DG(CP)	DG(C3L)	44.45	5/5/2018	3	600’ buffer	Nest failed 5/15, coyote predation.
28	26	DG(CC6)	DG(CHL)	46.80	5/6/2018	2	600’ buffer	Nest failed 5/9, coyote predation.
29	27	DG(WK)	UNB	23.47	5/10/2018	3	interior	Brood failed 6/7, cause unknown.
30	28	DG(YR)	UNB	43.64	5/13/2018	2	interior	Nest failed 5/17, coyote predation.
31	29	DG(CM0)	UNB	24.62	5/14/2018	3	interior	Nest failed 5/19, unknown cause.
32	9	DG(L2)	DG(R8)	38.64	5/18/2018	3	600’ buffer	Nest failed 5/22, coyote predation.
33	1	DG(AP)	DG(AR)	33.66	5/18/2018	3	600’ buffer	Nest failed 5/30, coyote predation.
34	5	DG(CL9)	UNB	31.13	5/18/2018	3	600’ buffer	Nest failed 5/25, unknown cause.
35	11	DG(J9)	UNB	37.20	5/19/2018	3	600’ buffer	Nest failed 5/24, coyote predation.
36	20	DG(CHJ)	UNB	34.29	5/19/2018	2	600’ buffer	Nest failed 5/30, coyote predation.
37	14	DG(NF)	UNB	33.32	5/19/2018	3	600’ buffer	Nest failed 5/30, coyote predation.
38	3	DG(K0)	UNB	31.91	5/19/2018	3	600’ buffer	Nest failed 6/1, coyote predation.
39	16	DG(C3C)	DG(CEF)	27.28	5/20/2018	3	600’ buffer	Fledged 3 chicks, DG(C7L), DG(C7M), and DG(C7N), on 7/21at day 40.
40	13	DG(CFE)	UNB	31.58	5/20/2018	3	600’ buffer	Nest failed 5/25, unknown cause.
41	15	DG(68)	UR- red	36.50	5/22/2018	3	600’ buffer	Nest failed 5/30, coyote predation.
42	24	DG(CJR)	DG(KR)	28.18	5/23/2018	3	600’ buffer	Nest failed 6/7, unknown cause.
43	30	DG(CLT)	UNB	28.71	5/25/2018	2	600’ buffer	Fledged 2 chicks, DG(C7P) and DG(C7R), on 7/24 at day 36.
44	8	DG(PW)	R(5F)	39.38	5/27/2018	1	600’ buffer	Nest failed 5/30, coyote predation.
45	31	UNB	UNB	47.18	5/29/2018	2	interior	Nest failed 6/6, coyote predation.
46	32	DG(CUF)	DG(CFK)	25.50	5/31/2018	2	600’ buffer	Brood failed 6/27, ants predated chick.
47	6	DG(LN)	DG(33)	24.74	6/2/2018	3	interior	Brood failed 7/15, unknown cause.
48	9	DG(L2)	DG(R8)	37.91	6/3/2018	2	600’ buffer	Nest failed 6/6, coyote predation.
49	7	DG(WP)	UNB	23.98	6/4/2018	3	interior	Nest failed 6/5, unknown cause.
50	5	DG(CL9)	UNB	31.18	6/5/2018	3	600’ buffer	Nest failed 6/15, coyote predation.

Table E-1 (continued). South Core Banks productivity data for 2018, Cape Lookout National Seashore. South Core Banks totals: 33 breeding pairs, 62 total nests, 13 hatched nests, 13 fledged. Band identification codes, when present, are listed for adults and chicks; UNB = unbanded and UNK = unknown.

Nest	Pair	Adult 1	Adult 2	Mile	Found Date	Eggs	Closure	Outcome Summary
51	23	DG(CUK)	DG(YP)	35.34	6/6/2018	3	600’ buffer	Nest failed 6/15, unknown cause.
52	11	DG(J9)	UNB	37.90	6/8/2018	1	600’ buffer	Nest failed 6/10, unknown cause.
53	15	DG(68)	UR- red	36.27	6/9/2018	2	600’ buffer	Nest failed 6/19, coyote predation.
54	20	DG(CHJ)	UNB	34.16	6/9/2018	2	600’ buffer	Nest failed 6/18, unknown cause.
55	3	DG(K0)	UNB	32.39	6/11/2018	3	600’ buffer	Nest failed 6/19, coyote predation.
56	14	DG(NF)	UNB	33.19	6/15/2018	2	600’ buffer	Nest failed 6/19, coyote predation.
57	1	DG(AP)	DG(AR)	33.85	6/16/2018	2	600’ buffer	Nest failed 6/18, unknown cause.
58	11	DG(J9)	UNB	37.65	6/19/2018	2	600’ buffer	Nest failed 7/25, unknown cause.
59	24	DG(CJR)	DG(KR)	28.09	6/23/2018	2	600’ buffer	Nest failed 7/18, human disturbance.
60	17	DG(TC)	UNB	27.53	6/23/2018	2	600’ buffer	Brood failed 7/28, unknown cause.
61	12	DG(CAN)	DG(J0)	35.38	6/28/2018	2	600’ buffer	Nest failed 7/8, cause unknown.
62	33	UNB	UNK	23.50	6/5/2018	1	interior	Nest failed 6/21, abandoned.

Table E-2. North Core Banks productivity data for 2018, Cape Lookout National Seashore. North Core Banks totals: 29 breeding pairs, 53 total nests, 15 hatched nests, 26 fledged. Band identification codes, when present, are listed for adults and chicks; UNB = unbanded and UNK = unknown.

Nest	Pair	Adult 1	Adult 2	Mile	Found Date	Eggs	Closure	Outcome Summary
1	1	UNB	UNB	20.25	4/21/18	3	600’ buffer	Nest failed 4/25, flooded by storm tide.
2	2	DG(M8)	UNB	19.6	4/21/18	3	600’ buffer	Nest failed 5/16, raccoon predation.
3	3	DG(CE)	DG(C3E)	17.78	4/22/18	3	600’ buffer	Fledged 2 chicks, DG(C76) and DG(C77), by 7/3 at day 43.
4	4	DG(P5)	DG(C3F)	22.23	4/23/18	3	600’ buffer	Fledged 3 chicks, DG(C74), DG(C75), and UNB, on 7/3 at day 43.
5	5	DG(RR)	DG(73)	9.52	4/24/18	3	600’ buffer	Nest failed 4/27, ghost crab predation.
6	6	DG(CMP)	DG(F3)	5.82	4/25/18	2	interior	Nest failed 5/16, raccoon predation.
7	7	DG(TF)	UNB	21.95	4/26/18	3	interior	Nest failed 5/18, unknown cause.
8	8	DG(C3H)	UNB	6.64	4/27/18	3	600’ buffer	Nest failed 5/8, flooded from heavy rain.
9	9	DG(W5)	DG(TL)	10.34	4/28/18	2	600’ buffer	Nest failed 5/2, raccoon predation.
10	10	DG(CE1)	DG(T3)	10.73	4/29/18	1	600’ buffer	Nest failed 5/1, raccoon predation.
11	11	DG(CCE)	UNB	8.82	4/30/18	2	600’ buffer	Nest failed 5/2, raccoon predation.

Table E-2 (continued). North Core Banks productivity data for 2018, Cape Lookout National Seashore. North Core Banks totals: 29 breeding pairs, 53 total nests, 15 hatched nests, 26 fledged. Band identification codes, when present, are listed for adults and chicks; UNB = unbanded and UNK = unknown.

Nest	Pair	Adult 1	Adult 2	Mile	Found Date	Eggs	Closure	Outcome Summary
12	12	DG(CE3)	UNB	6.44	5/1/18	3	interior	Fledged 1 chick, DG(C79), on 7/5 at day 38.
13	13	DG(M0)	UNB	19.41	5/2/18	2	600′ buffer	Nest failed 5/22, raccoon predation.
14	14	UR-DG(TN)	DG(CLN)	18.77	5/3/18	1	interior	Nest failed 5/3, abandoned.
15	10	DG(CE1)	DG(T3)	10.92	5/4/18	1	600′ buffer	Nest failed 5/4, raccoon predation.
16	11	DG(CCE)	UNB	8.27	5/5/18	1	600′ buffer	Nest failed 5/7, unknown cause.
17	15	DG(CA)	UNB	8.87	5/6/18	3	600′ buffer	Nest failed 5/9, ghost crab predation.
18	1	UNB	UNB	20.23	5/7/18	3	600′ buffer	Nest failed 5/12, unknown.
19	5	DG(RR)	DG(73)	9.4	5/8/18	3	600′ buffer	Nest failed 5/19, raccoon predation.
20	10	DG(CE1)	DG(T3)	10.67	5/9/18	1	600′ buffer	Nest failed 5/10, nutria predation.
21	16	DG(AN)	UNB	22.73	5/10/18	3	interior	Nest failed 5/12, unknown cause.
22	17	UR-Red	UNB	11.39	5/11/18	3	600′ buffer	Nest failed 5/18, unknown predator.
23	18	UNB	UNB	14.36	5/12/18	3	600′ buffer	Fledged 1 chick, DG(C7J), on 7/21 by day 46.
24	19	UNB	UNB	20.85	5/11/18	1	600′ buffer	Nest failed 5/12, human interaction.
25	20	UNB	UNB	10.26	5/14/18	2	600′ buffer	Fledged 1 chick, DG(C7K), on 7/18 at day 43.
26	11	DG(CCE)	UNB	8.34	5/15/18	3	600′ buffer	Nest failed 5/16, raccoon predation.
27	21	UNB	UNK	0.96	5/16/18	2	600′ buffer	Nest failed 5/13, raccoon predation.
28	22	DG(???)	UNK	14	5/13/18	2	600′ buffer	Nest failed 5/16, raccoon predation.
29	9	DG(TL)	DG(W5)	10.32	5/18/18	1	600′ buffer	Nest failed 5/18, unknown cause.
30	23	UNB	UNB	20.14	5/19/18	2	600′ buffer	Nest failed 5/31, unknown cause.
31	10	DG(CE1)	DG(T3)	11.1	5/20/18	2	600′ buffer	Nest failed 5/22, unknown predator.
32	24	DG(CFX)	DG(CY)	3.6	5/21/18	3	600′ buffer	Fledged 1 chick, DG(C63), on 7/27 by day 42.
33	15	DG(CA)	UNB	8.99	5/22/18	3	600′ buffer	Fledged 1 chick, DG(C7Y), on 7/31 by day 43.
34	8	DG(C3H)	UNB	6.57	5/23/18	3	600′ buffer	Nest failed 6/13, unknown predator.
35	16	DG(AN)	UNB	22.56	5/24/18	3	interior	Fledged 3 chicks, DG(C61), DG(C62), and DG(C66). DG(C61) fledged on 8/3 by day 49. DG(C62) fledged 8/10 by day 56. DG(C66) found dead on 8/16 at day 62, no flight observed.
36	25	DG(MA)	UNB	2.44	5/25/18	3	interior	Nest failed 6/7, raccoon predation.

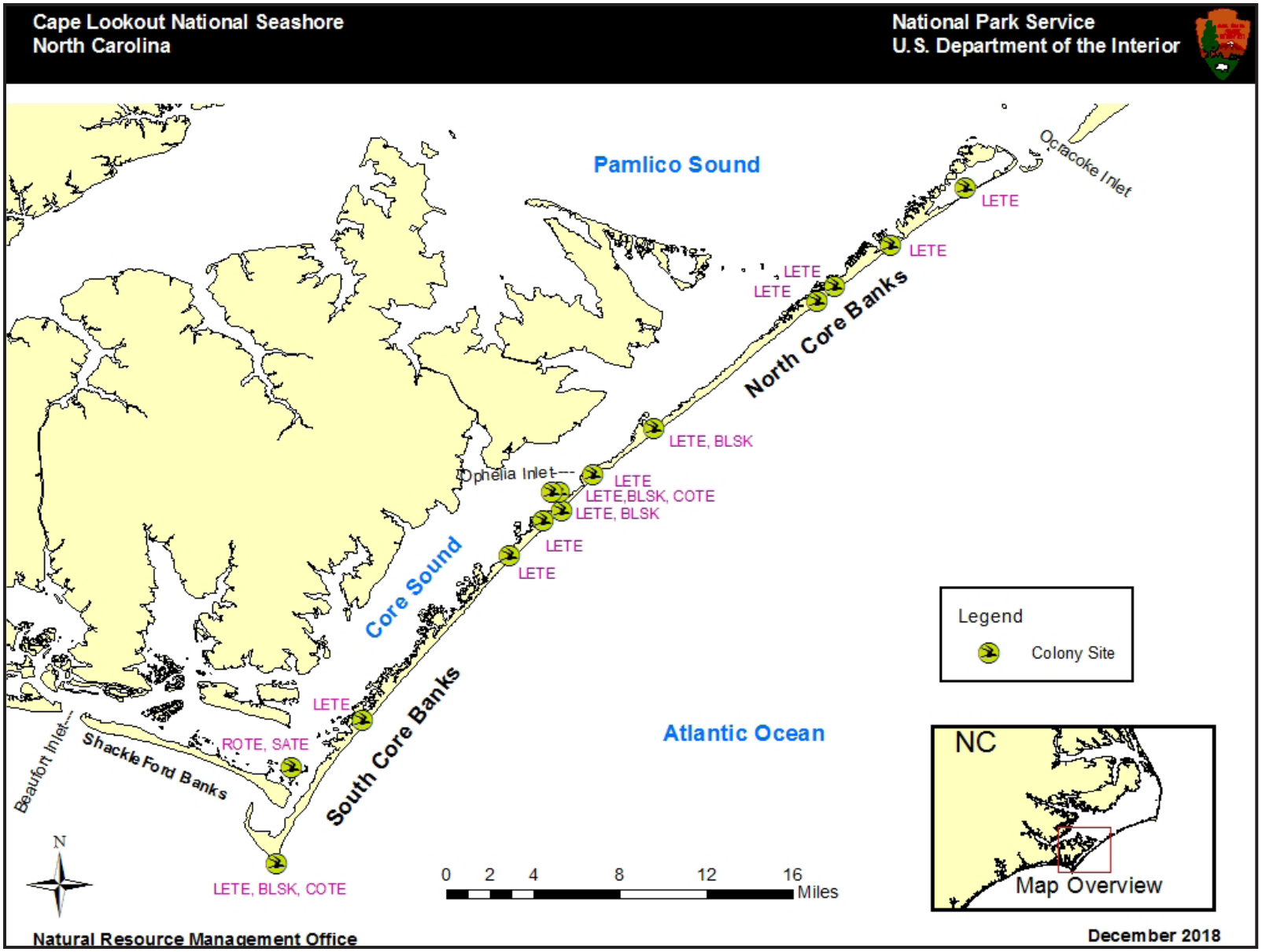
Table E-2 (continued). North Core Banks productivity data for 2018, Cape Lookout National Seashore. North Core Banks totals: 29 breeding pairs, 53 total nests, 15 hatched nests, 26 fledged. Band identification codes, when present, are listed for adults and chicks; UNB = unbanded and UNK = unknown.

Nest	Pair	Adult 1	Adult 2	Mile	Found Date	Eggs	Closure	Outcome Summary
37	1	UNB	UNB	20.56	5/26/18	3	600’ buffer	Fledged 3 chicks, DG (C7W), DG (C70), and DG(C7X), on 7/27 by day 41.
38	21	UNB	UNK	0.83	5/27/18	2	600’ buffer	Nest failed 6/1, ghost crab predation.
39	9	DG(TL)	DG(W5)	10.28	5/28/18	2	600’ buffer	Nest failed 6/7, cat predation.
40	11	DG(CCE)	UNB	8.26	5/29/18	3	600’ buffer	Fledged 2 chicks, DG(C6H) and UNB, on 8/7 by day 47.
41	7	DG(TF)	UNB	21.79	5/30/18	3	600’ buffer	Fledged 2 chicks, DG(C7H) and DG(C7F), on 8/3 by day 43.
42	17	UR-Red	UNB	11.36	5/31/18	2	600’ buffer	Nest failed 6/26, unknown cause.
43	2	DG(M8)	UNB	19.62	6/1/18	3	600’ buffer	Fledged 3 chicks, DG(C7T), DG(C68) and DG(C65), on 8/7 by day 46.
44	26	UNB	UNB	13.5	6/2/18	2	600’ buffer	Nest failed 6/12, unknown cause.
45	10	DG(CE1)	DG(T3)	11.03	6/3/18	2	600’ buffer	Nest failed 6/4, unknown cause.
46	5	DG(RR)	DG(73)	9.19	6/4/18	3	600’ buffer	Fledged 1 chick, DG(C64), on 8/8 at day 42.
47	6	DG(F3)	DG(CMP)	5.79	6/5/18	2	interior	Nest failed 6/15, unknown cause.
48	13	DG(M0)	UNB	19.11	6/6/18	3	interior	Brood failed 6/29, unknown cause.
49	27	UNB	UNB	21.48	6/7/18	1	600’ buffer	Nest failed 7/7, unknown cause.
50	28	UNB	UNB	3.09	6/8/18	1	interior	Nest failed 6/13, flooded by heavy rain.
51	29	DG(CUH)	UNB	19.85	6/9/18	2	600’ buffer	Nest failed 7/4, ghost crab predation.
52	8	DG(C3H)	UNB	6.7	6/10/18	2	interior	Nest failed 6/28, raccoon predation.
53	10	DG(CE1)	DG(T3)	10.57	6/11/18	2	600’ buffer	Fledged 2 chicks, DG(C6E) and DG(C6A), on 8/24 at day 45.

Table E-3. Shackleford Banks productivity data for 2018, Cape Lookout National Seashore. Shackleford Banks totals: 7 breeding pairs, 8 total nests, 0 hatched nests, 0 fledged. Band identification codes, when present, are listed for adults; UNB = unbanded and UNK = unknown.

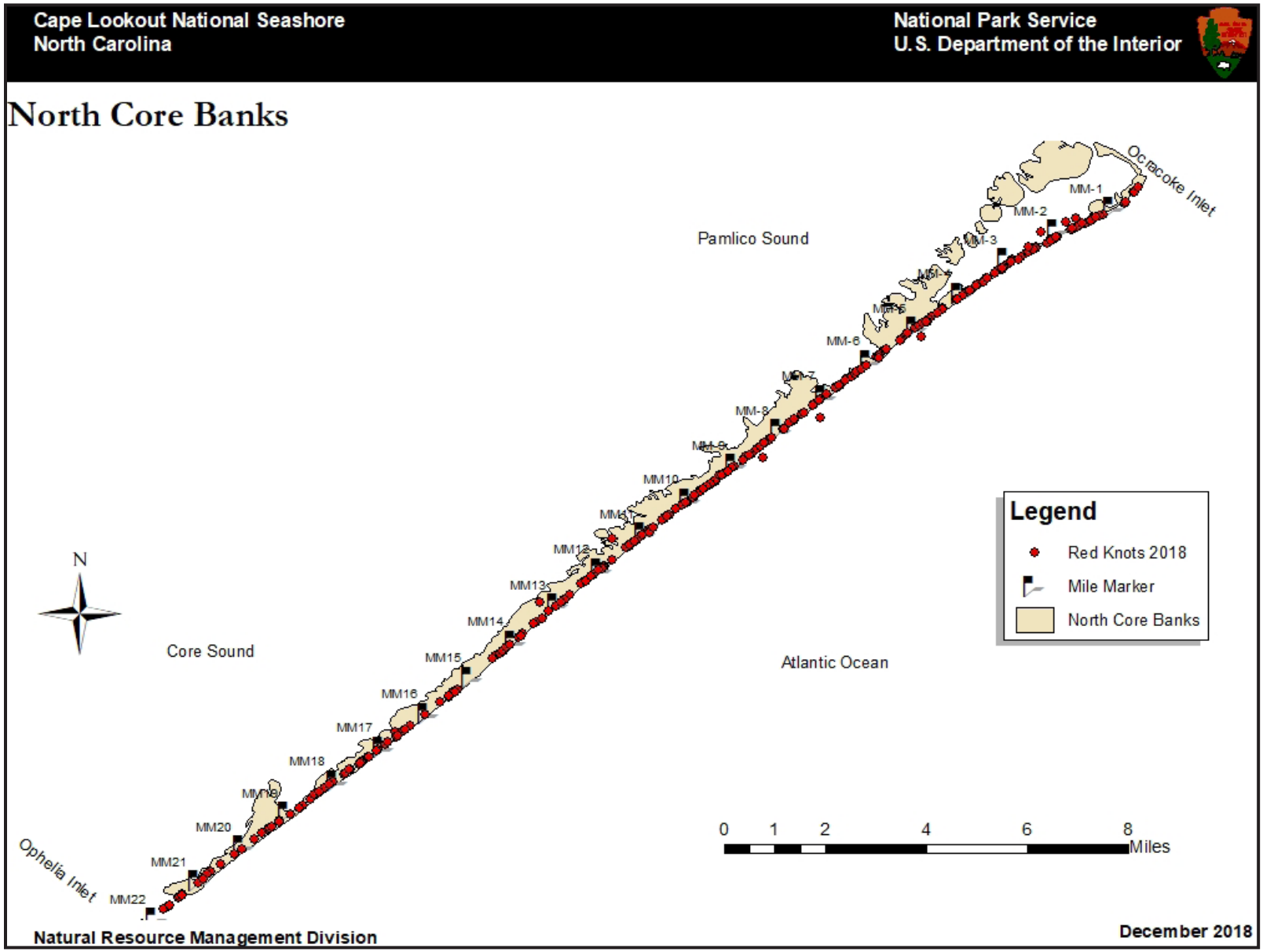
Nest	Pair	Adult 1	Adult 2	Mile	Found	Eggs	Closure	Comments
1	1	UNB	UNB	49.89	4/27/18	3	none	Nest failed 5/3, avian predation.
2	2	UNB	UNB	49.36	4/27/18	1	none	Nest failed 5/3, unknown cause.
3	3	UNB	UNB	48.5	5/3/18	3	none	Nest failed 5/11, coyote predation.
4	4	R (1J)	UNB	55	5/11/18	2	modified closure	Nest failed 6/20, unknown cause.
5	5	UNK	UNK	49.99	5/11/18	1	none	Nest failed by 5/22, unknown cause.
6	6	UNB	UNB	49.44	5/11/18	2	none	Nest failed by 5/22, unknown cause.
7	7	UNK	UNK	49.68	5/14/18	1	none	Nest failed by 5/22, unknown cause.
8	6	UNB	UNB	49.41	6/1/18	2	none	Nest failed 6/11, unknown cause.

Appendix F. Colonial Waterbird Map

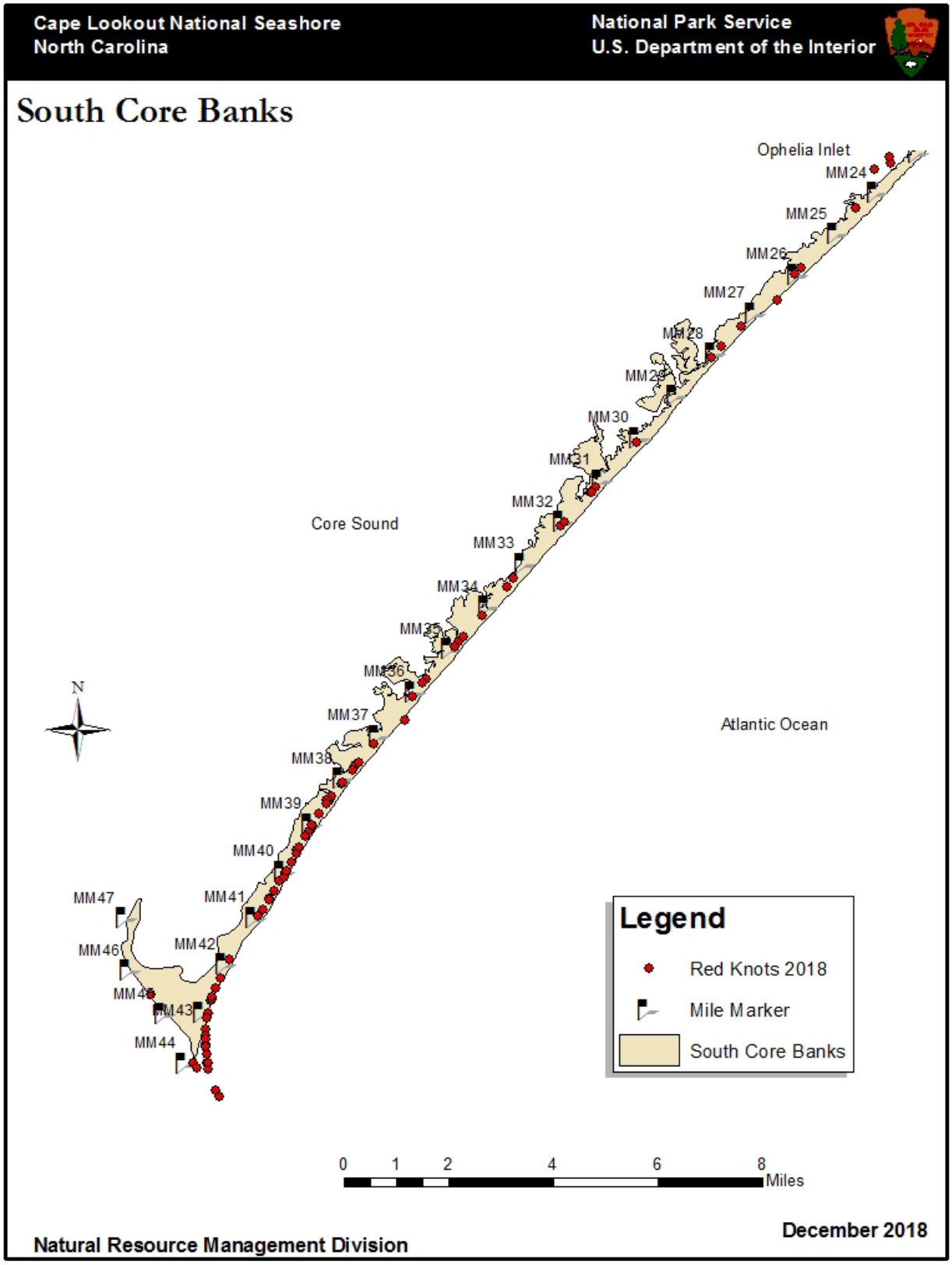


Map F-1. Cape Lookout National Seashore waterbird colony locations in 2018.

Appendix G. Red Knot Maps



Map G-1. Geographic distribution of red knots counted on North Core Banks in 2018.



Map G-2. Geographic distribution of red knots counted on South Core Banks in 2018.

Cape Lookout National Seashore
January 2020

National Park Service
U.S. Department of the Interior

Cape Lookout National Seashore
131 Charles St.
Harkers Island, NC 28531