

CAPE LOOKOUT NATIONAL SEASHORE
2016 SEA TURTLE MONITORING AND MANAGEMENT REPORT



Coyote (*Canis latrans*) predation at South Core Banks nest activity 492. NPS Photo 2016.

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INTRODUCTION

Cape Lookout National Seashore (CALO) began monitoring marine turtles in 1976. Baseline data was collected for a portion of South Core Banks during an extensive six-year study from 1978 – 1983. Nesting turtles were tagged and nests marked during nightly patrols. Since 1984 Cape Lookout has conducted daytime monitoring to document strandings, protect nest sites, relocate nests in danger of being flooded and protect hatchlings. Cape Lookout is a significant northern nesting beach and supports among the highest number of loggerhead sea turtle (*Caretta caretta*) nests in North Carolina. The seashore also provides nesting habitat for leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), and Kemp's ridley (*Lepidochelys kempii*) sea turtles. Each year data have been collected, analyzed, and presented to management in hopes of better protecting the marine turtle population. This report will summarize the 2016 project and consolidate many years of data. In addition to providing CALO with management data, the information gathered on CALO beaches continues to be an important link for many state, federal, and private Atlantic coast sea turtle managers.

COOPERATING AGENCIES

Cape Lookout National Seashore cooperates with numerous agencies, including the North Carolina Wildlife Resources Commission (NCWRC), the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) on sea turtle protection. The North Carolina Sea Turtle Program Coordinator receives all original stranding reports and annual nesting activity reports. NCWRC also issues Cape Lookout National Seashore an Endangered Species permit for possession and disposition of stranded marine turtles and relocation of nests.

SITE DESCRIPTION

Cape Lookout National Seashore is located in the southern Outer Banks of North Carolina between Beaufort and Ocracoke Inlets. The seashore consisted of four barrier islands during the nesting season. The northernmost island, North Core Banks (NCB) is approximately 18 miles long, extending from Ocracoke Inlet to Old Drum Inlet. The last 4 miles of NCB extends from Old Drum Inlet to Ophelia Inlet and is referred to as Middle Core Banks (MCB). 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 fourth island, Shackleford Banks (SB) is 9 miles long and has an east-west orientation with a higher dune system and larger areas of vegetation. All islands in the park are subject to constant and dramatic change by the actions of wind and waves.

METHODS

NCB, SCB, and SB were monitored regularly for turtle nesting activity. Student Conservation Association interns and NPS staff patrolled NCB and SCB daily searching for nesting activity from May 1st to September 15th. Each patrol began early in the morning so that the island was checked for turtle activity by 12:00 PM. The MCB section of NCB was monitored irregularly due to difficult access. Shackleford Banks was monitored three times a week. Sea turtle crawl activities were recorded and nests were marked according to protocol. Sea turtle monitoring and management is outlined in the Interim Protected Species Management Plan (National Park Service 2006). In addition to these program procedures the seashore participated in a genetic mark-recapture study of nesting female loggerheads using DNA derived from eggs. The study was coordinated by the

NCWRC for North Carolina and included the other Northern Recovery Unit states of Georgia and South Carolina. One egg from each nest was collected and preserved so DNA could be sampled at the University of Georgia genetic laboratory. As part of this study sea turtle crawl and nest activity was entered into an online database at www.seaturtle.org.

Nest losses to tidal flooding and predation are the primary threats to nesting success at CALO. Nests laid in the tidal wash zone, primary berm, and back swale are considered in danger of erosion or tidal flooding. Nests laid in locations subject to repeated flooding were relocated to a higher elevation on the primary dune in accordance with the 2nd Revision of the Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (2008). Relocated nests were moved into the nearest of six designated areas and vehicles were detoured to the back road around these areas when nests neared hatching. Vehicle detours were also erected around nests that were not relocated. Vehicle free zones provide a rut-free corridor from the nest site to the ocean, preventing hatchlings from being run over or becoming entrapped in tire ruts and dying from predation or desiccation (Hosier et al. 1981, Lamont et al. 2002, Van de Merwe et al. 2012). Camping and campfires were also not permitted in the protection zones to prevent disturbance of hatchlings by artificial lights (Peters and Verhoeven, 1994).

Any signs of predation were noted and the approximate numbers of eggs or hatchlings destroyed were recorded. To discourage raccoon (*Procyon lotor*) predation, wire screens anchored by rebar were placed over all nests. Nests and possible nests were monitored for hatching activity through November. Nests were excavated after hatching to determine nest success. Possible nests were

treated similarly. If a possible nest hatched it was added to the nest category: if it failed to show hatching activity after 75-80 days the site was excavated, then classified as a nest if eggs were found or as a crawl if no eggs were found.

RESULTS

This report includes monitoring data from 1990 to present when monitoring became standardized following the USFWS Index Nesting Beach program.

NESTING RESULTS

The first recorded nesting activity in 2016 was on May 19 and the last on August 24, for a 98 day nesting season. A total of 837 activities were documented of which there were 352 nests and 485 false crawls, (Table 1.). All 352 were loggerhead nests. Figure 1 illustrates the daily nesting activity for the season. Mapped original nest locations are in Appendix 1.

Table 1. 2016 Sea Turtle Activities by Study Area.

	North Core Banks	South Core Banks	Shackleford Banks	CALO Total
NESTS	123	208	21	352
CRAWLS	147	325	13	485

The number of nests found in 2016, 352, was the highest on record and well above the annual average of 148 nests for CALO (Fig. 2 and 3). South Core Banks continued to have more nests than the other islands in 2016 (Figure 4.).

Figure 1. Daily Number of Nests at 7 Day Increments from May 18 to August 24.

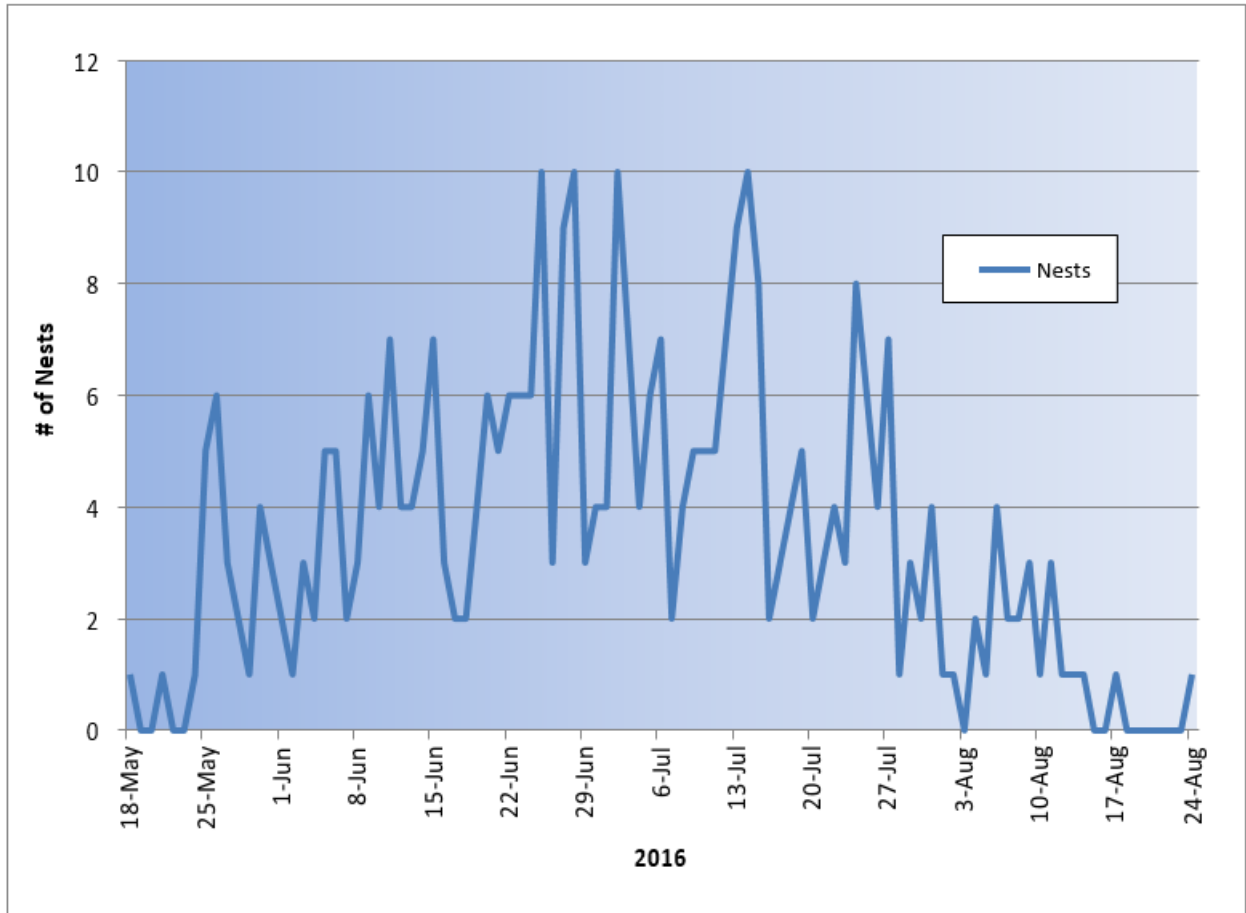


Figure 2. Cape Lookout Sea Turtle Activities 1990-2016

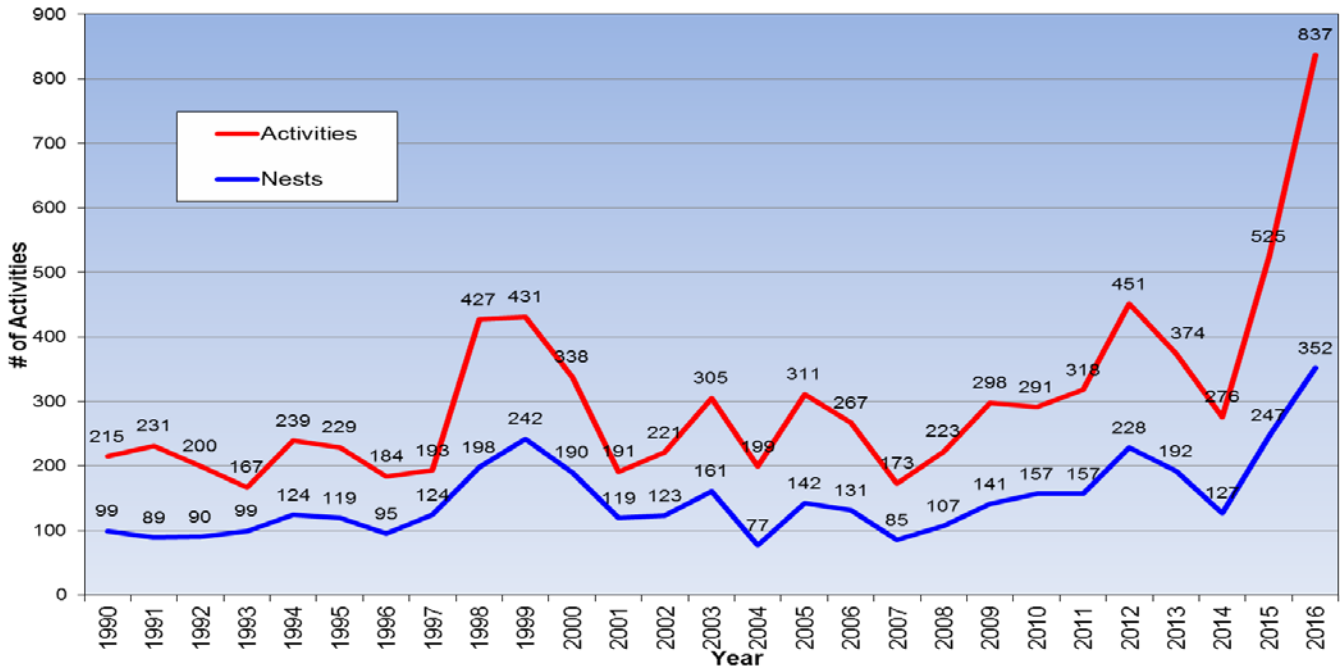


Figure 3. Cape Lookout Sea Turtle Nests 1990-2016

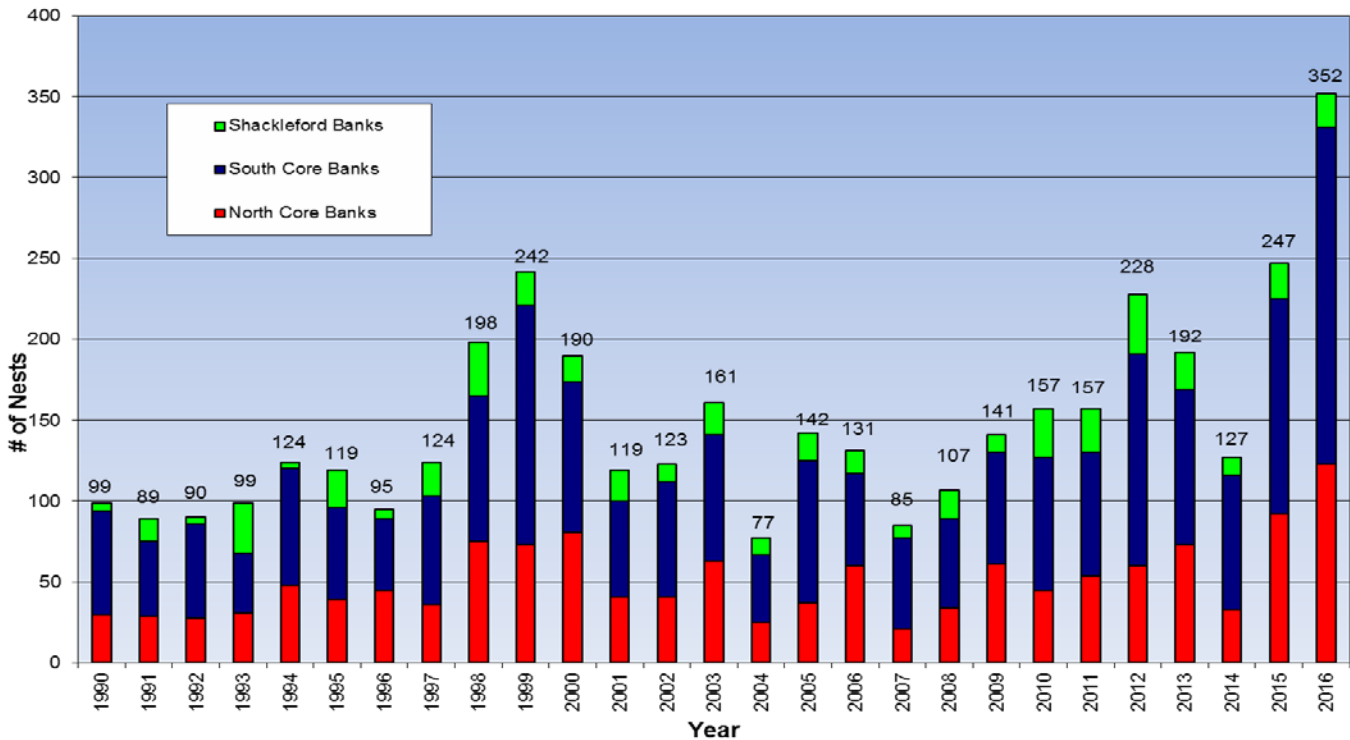
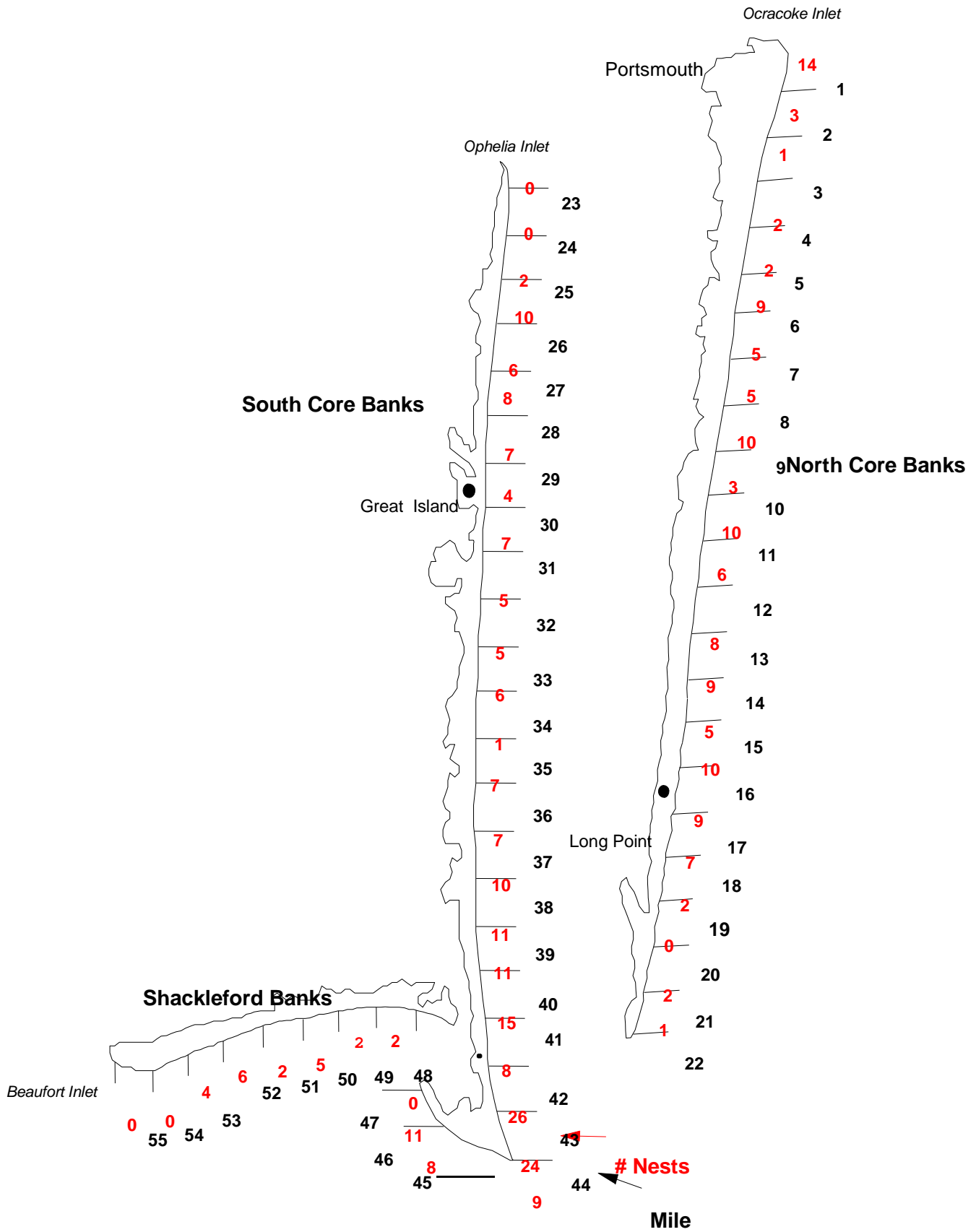


Figure 4. 2016 Turtle Nests by Mile Section



HATCHING RESULTS

Nest monitoring activity involved observing nest and dig sites for signs of hatching, recording relevant data, and excavating the site. Hatch information is used to determine if predators, human disturbance, or environmental occurrences have adversely affected a nest.

The nest hatching period for 2016 began July 18th and ended October 19th - a total of 93 days. The last nest was inventoried on November 10th at day 78 of incubation on South Core Banks. A known total of 36,047 eggs, 24,092 hatchlings, and 923 hatched dead were counted. The total hatch success, number of total hatched eggs divided by number of total eggs, was 67%. The total emergence success of 64% (23,169 emerged) was calculated by subtracting the total hatched dead from the total hatched and dividing by the total number of eggs (Table 2). This is the same calculation for each individual nest emergence success. The emergence success reported on www.seaturtle.org for Cape Lookout is 59%, which subtracts live hatchlings that were still in the nest. CALO has not traditionally subtracted the live hatchlings in the nest which receive emergence assistance and to remain consistent with 27 years of data will report emergence success based on the traditional calculation. The emergence success range for an individual nest was from 0% to 100%. The average clutch size was 107 eggs. It took an average of 55 days for nests to incubate to hatch. The range of incubation was from 45 days to 70 days. Fifteen nests were lost to erosion events with unknown clutch sizes. A total of 109 nests were over-washed by the ocean at least once. Seventy seven of these 109 nests hatched. The emergence success for these 109 flooded nests was 40%.

In order to account for the 15 nests lost with unknown egg counts we have calculated an estimated emergence success of 62 % in 2016 (Table 2). The average clutch size for the seashore was given to those nests as the number of eggs, allowing them to be calculated into the estimated emergence success. The seashore total of 15 lost nests at an average clutch of 107 eggs equals 1,605 eggs with 0% emergence success.

Table 2. SEA TURTLE HATCH SUMMARY 1990-2016

Year	Nests	Avg. Clutch	Flooded	Avg. Incu	Eggs	Emerged	EMR % *	Est.Total EMR%**
1990	99	115	1	57	10,376	7,369	71%	69%
1991	89	115	6	62	8,393	5,197	62%	61%
1992	90	114	4	63	9,419	6,791	73%	71%
1993	99	115	9	59	10,365	7,544	74%	74%
1994	124	120	3	62	14,459	11,296	79%	79%
1995	119	115	38	57	12,357	6,157	51%	47%
1996	95	115	16	65	10,091	5,602	57%	53%
1997	124	122	3	63	14,824	10,740	73%	73%
1998	198	114	39	62	19,672	13,315	69%	61%
1999	242	116	90	62	23,224	11,751	53%	44%
2000	190	111	2	67	19,527	13,471	69%	65%
2001	119	113	5	65	12,358	9,555	79%	75%
2002	123	119	7	61	13,657	10,758	79%	75%
2003	161	119	45	65	16,440	10,067	61%	53%
2004	77	104	36	64	7,309	3,139	43%	40%
2005	142	111	54	60	12,423	6,569	53%	42%
2006	131	125	19	61	14,808	10,843	73%	66%
2007	85	109	19	60	8,759	6326	72%	68%
2008	107	111	60	60	11063	6868	62%	57%
2009	141	116	77	64	15130	7574	50%	46%
2010	157	105	80	57	14666	7956	54%	49%
2011	157	114	30	56	12910	8186	63%	46%
2012	228	111	84	62	25293	16,188	64%	64%
2013	192	108	35	64	19,744	13,409	68%	65%
2014	127	114	52	65	13,077	7,028	54%	49%
2015	247	112	121	59	26,160	14,935	57%	54%
2016	352	107	109	55	36,047	23,169	64%	62%

*emergence success for nests with known egg and hatch totals

**includes an estimate of egg totals for nests lost and not excavated

In 2016, a total of 92 (26%) nests were relocated. The emergence rate for relocated nests was 60% and the emergence rate for non-relocated nests was 66% (Table 3). Of the 247 nests, 234 were inventoried and 13 nests were washed away/predated with an unknown egg count and/or unknown success.

Table 3. 1990-2016 EMERGENCE SUCCESS FOR RELOCATED vs. NON-RELOCATED NESTS

YEAR	PERCENT OF NESTS RELOCATED	EMERGENCE RATE-RELOCATED	EMERGENCE RATE-NON RELOCATED*	PERCENT OF NESTS EXCAVATED
1990	69%	71%	74% (67%)	94%
1991	63%	57%	76% (72%)	97%
1992	43%	71%	76% (74%)	97%
1993	54%	74%	73% (73%)	90%
1994	79%	80%	73% (73%)	96%
1995	55%	61%	38% (31%)	86%
1996	73%	56%	64% (48%)	89%
1997	74%	69%	86% (86%)	95%
1998	59%	77%	55% (41%)	85%
1999	51%	49%	59% (40%)	79%
2000	63%	66%	74% (61%)	93%
2001	50%	81%	76% (68%)	89%
2002	45%	73%	84% (77%)	93%
2003	41%	47%	75% (58%)	86%
2004	44%	63%	23% (20%)	97%
2005	34%	42%	61% (42%)	79%
2006	39%	85%	64% (54%)	90%
2007	24%	79%	70% (65%)	95%
2008	30%	57%	64% (57%)	92%
2009	25%	61%	46% (41%)	92%
2010	13%	75%	51% (45%)	89%
2011	27%	36%	78% (49%)	62%
2012	22%	74%	61% (61%)	99.5%
2013	28%	61%	71% (67%)	95%
2014	29%	69%	46% (40%)	90%
2015	16%	54%	58% (53%)	94%
2016	26%	60%	66% (62%)	96%
<i>AVERAGES</i>	<i>44%</i>	<i>65%</i>	<i>65% (56%)</i>	<i>90%</i>

* Number in parentheses is an estimate including nests with unknown egg totals

Since 1990 the twenty seven year average emergence success is 65% for relocated nests and 65% for non- relocated nests (Table 3).

Predation

In 2016, staff recorded predation by coyotes (*Canis latrans*) at five nests. An additional eight nests had digging attempts by coyotes at the nests, but were unsuccessful. All coyote digging attempts and two predation events took place on SCB. Though coyote presence has not been documented on NCB three coyote sea turtle nest depredations were recorded for NCB. Raccoons unsuccessfully dug at 14 nests, but did predate 28 nests. All but one raccoon predation event took place on NCB. Ghost crab predation took place throughout the seashore impacting 36 nests.

Human Disturbance

Off-road vehicles disregarding beach closures threaten the survival of hatchlings. Hatchlings are at risk of being directly crushed and/or becoming trapped in tire ruts. At night vehicle lights could disorientate hatchlings (Cox et al., 1994). In 2016 only one vehicle in turtle closure violation was recorded.

STRANDINGS

Collecting information from stranded turtles is also an important phase of the CALO Sea Turtle Monitoring Program. CALO documents strandings, collects data for the North Carolina Sea Turtle Project Coordinator and the National Marine Fisheries Service (NMFS) and assists in the transportation of live strandings to rehabilitation facilities.

In 2016, 997 strandings occurred at CALO. All strandings were reported to the NCWRC and were documented with a “Sea Turtle Stranding and Salvage Network” stranding report. Green turtles accounted for the majority of the strandings (938). There were also 40 loggerheads, 12 Kemp’s ridleys, 5 unknowns, and 2 leatherbacks. 932 turtles were stranded on the inshore soundside and 65 turtles were stranded on the offshore oceanside. There were 576 live strandings and 297 fresh dead strandings. The major cold stun event occurred in January 2016 with 914 strandings. Some of these live stranded turtles were immediately transferred to a Coast Guard Cutter and released in warm water offshore. Typically, however, cold stun turtles are transported out of the park, assessed by wildlife veterinarians at the NC State Center for Marine Sciences and Technology and sent to Topsail Sea Turtle Hospital or NC Aquarium at Pine Knolls Shore for rehabilitation. Turtles were scanned for external and Passive Integrated Transponder (PIT) tags. Figure 5, Figure 6, and Table 5 provide stranding data by year and species from 1990 to 2016.

Figure 5. Sea Turtle Stranding Totals at CALO (1990-2016) with a simply linear regression line.

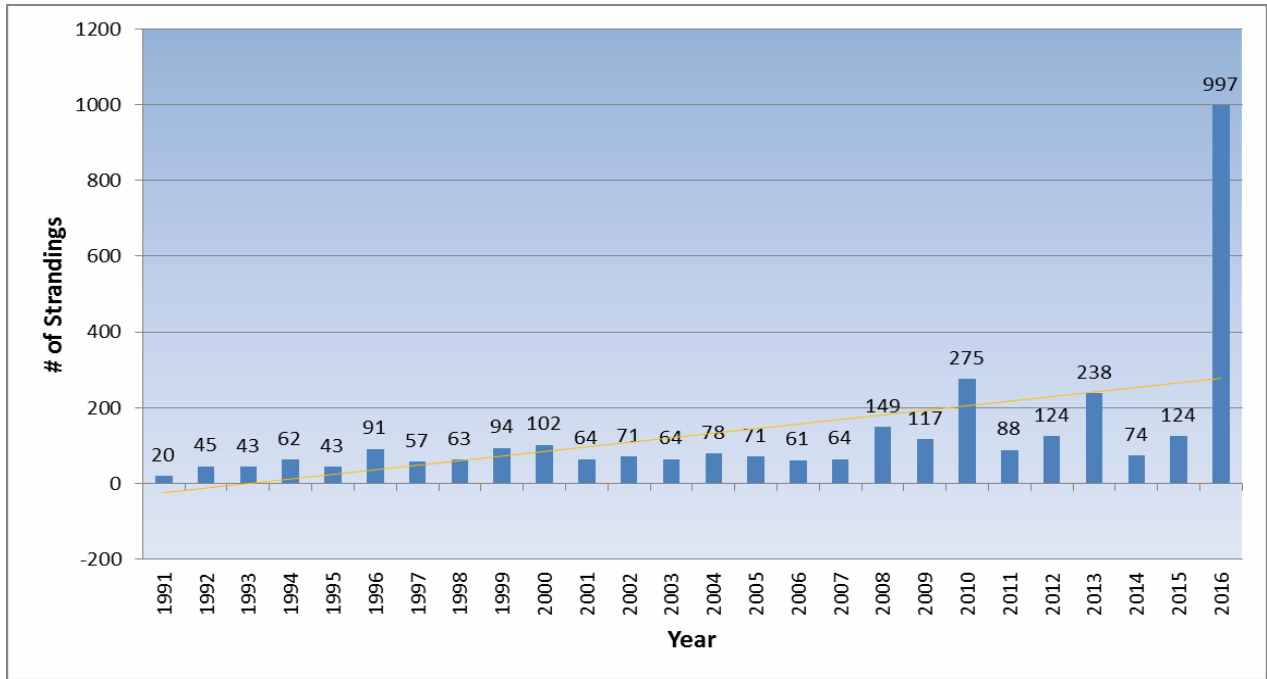


Figure 6. 2016 Sea Turtle Strandings at CALO by Month.

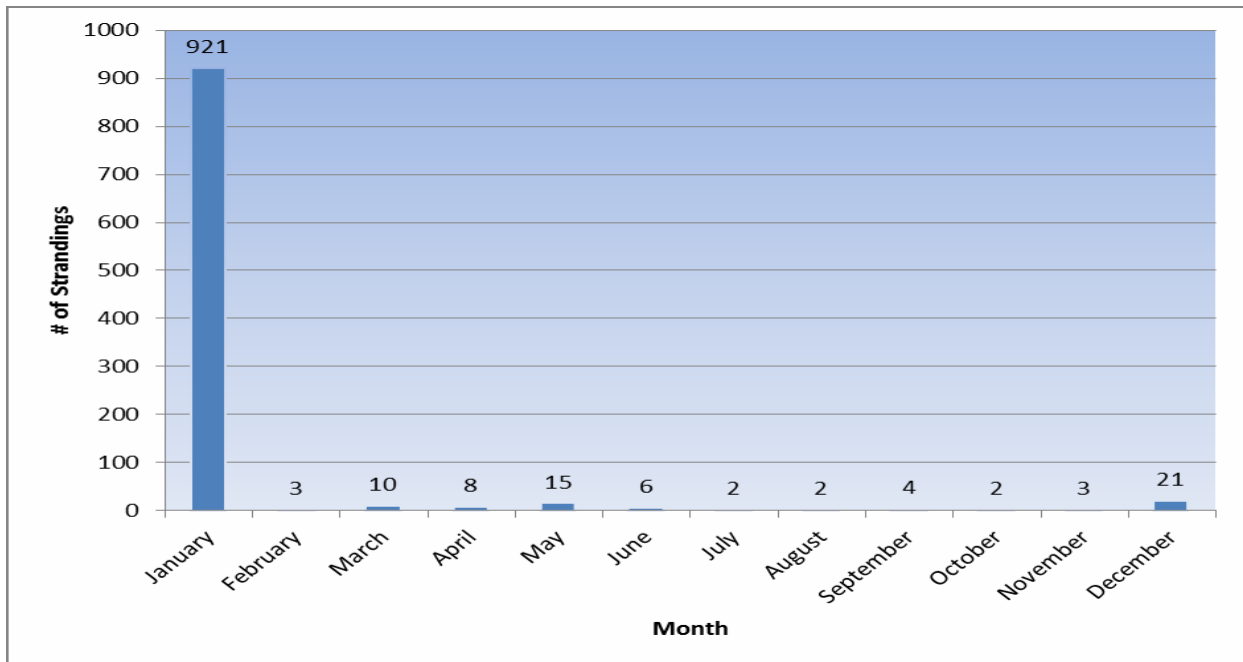


Table 5. CALO SEA TURTLE STRANDINGS 1990 – 2016

YEAR	Stranding Totals	Logger-head	Green	Kemp's Ridley	Leather-back	Hawksbill	Unknown
1990	43	33	7	1	2	0	0
1991	20	16	2	1	0	0	1
1992	45	30	13	1	1	0	0
1993	43	29	6	5	2	0	1
1994	62	30	24	5	2	0	1
1995	43	27	7	6	1	0	2
1996	91	63	21	4	3	0	0
1997	57	49	1	7	0	0	0
1998	63	43	8	12	0	0	0
1999	94	36	41	15	2	0	0
2000	102	46	40	11	4	0	1
2001	64	38	15	9	2	0	0
2002	71	33	26	5	7	0	0
2003	64	44	9	7	2	1	1
2004	78	45	28	4	1	0	0
2005	71	37	21	6	0	2	5
2006	61	35	16	8	0	0	2
2007	64	19	38	1	0	0	6
2008	149	29	116	2	0	0	3
2009	117	36	66	14	0	0	1
2010	275	131	116	27	0	0	0
2011	88	18	44	26	0	0	0
2012	124	25	73	25	1	0	0
2013	238	26	187	23	1	0	1
2014	74	24	32	17	0	0	1
2015	124	23	78	21	1	0	1
2016	997	40	938	12	2	0	5

DISCUSSION

The nesting and hatching season started on May 19th and ended on October 19th, lasting 154 days. Though nests were monitored until November 10th, they did not hatch after October 19th. The average incubation rate of 55 days in 2016 was 6 days earlier than the 27 year average of 61 days. The earliest hatch was at day 45 and 48 nests hatched before or on day 50 of incubation. The incubation period decreases with increasing ambient temperature (Bustard and Greenham, 1968). The management plan calls for closed areas around the nests at day 50 to allow for tire ruts to smooth out before hatching. However there needs to be flexibility in barricade application to allow for higher summer temperatures that speed up incubation. Barricades should be erected at day 40-45 if nesting season air temperatures are above average and nests are showing signs of early hatching.

Nest predation events in 2016 are of major concern both from coyotes and raccoons as the data indicate. A coyote's ability to dig further and deeper under wire screens could make protection of nests difficult in the future. Limited removal of coyote and raccoons would meet the 2008 USFWS sea turtle recovery plan objective 7 to minimize that nest predation.

The majority of the 2016 nesting and hatching season were relatively free of direct tropical storm impacts with only 14 nests washed away during Tropical Storms Colin and Hermine and Hurricane Matthew. Ninety six percent of the nests were inventoried. There were a total of seven undetected nest that were later discovered after the lay date, primarily after hatching. Given the high frequency of nesting activity and lower staff levels in 2016 it is not surprising that nests were initially missed.

The past nine years has seen a higher number of stranded sea turtles (Figure 5). 2016 was record year for strandings with the major cold stun stranding event in January with 914 total strandings. The majority of turtles stranded on the inshore beaches of Cape Lookout Bight and were juveniles. There has also been a trend of more juvenile greens and Kemp's ridley than loggerheads in the past ten years at the seashore. November, December, and January continue to be the busiest months of the year for strandings.

The seashore continued to participate in the genetic mark-recapture study of the northern recovery unit of sea turtles in 2016. Preliminary results can be viewed at www.seaturtle.org. The study has 80.7% of the DNA samples assigned with 103 individual nesting females documented in 2016. The mean nest per female was 3.17 nests with a maximum of 6 nests assigned to one female. The mean interesting period was 13.68 days.

U.S. Fish and Wildlife Service Biological Opinion and Performance Measures

The USFWS provided CALO a biological opinion that included two performance measures on sea turtles for the 2006 Interim Protected Species Management Plan. The first performance measure requires that the sea turtle false crawl to nest ratio is less than or equal to 1:1 (annually). In 2016, there were 485 false crawls and 352 nests for a ratio of 1.4: 1. The second performance measure states that CALO should have 20 percent or greater of the state's total sea turtle nests for the last five years. There was an average of 1183 nests for the last five years in North Carolina. In 2016 CALO had 30% of the state's total sea turtle nests for the previous five years.

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APPENDIX I
2016 GIS SEA TURTLE ACTIVITY MAPS

Figure 7. 2016 North Core Banks Sea Turtle Activities.

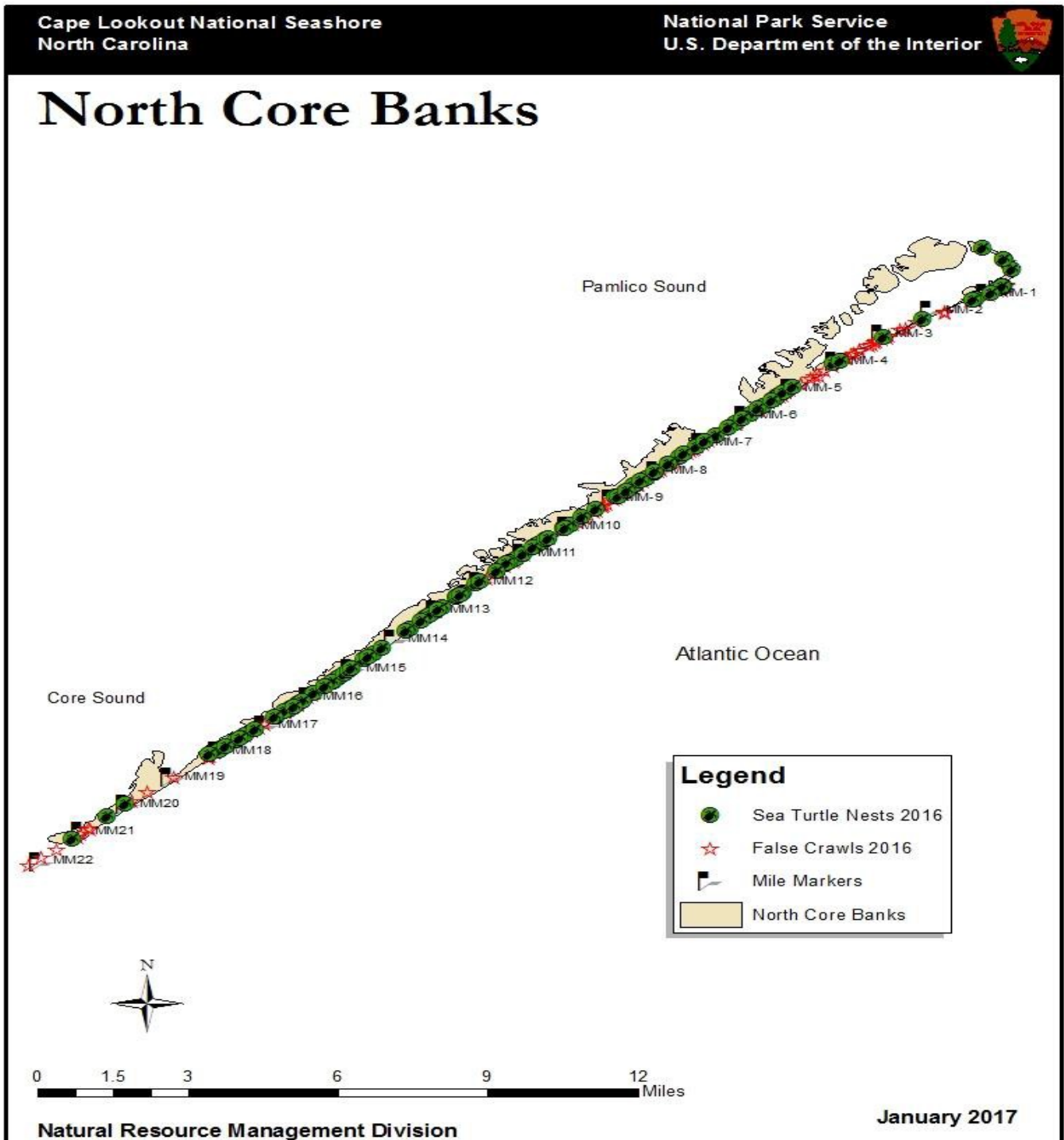


Figure 8. 2016 South Core Banks Sea Turtle Activities.

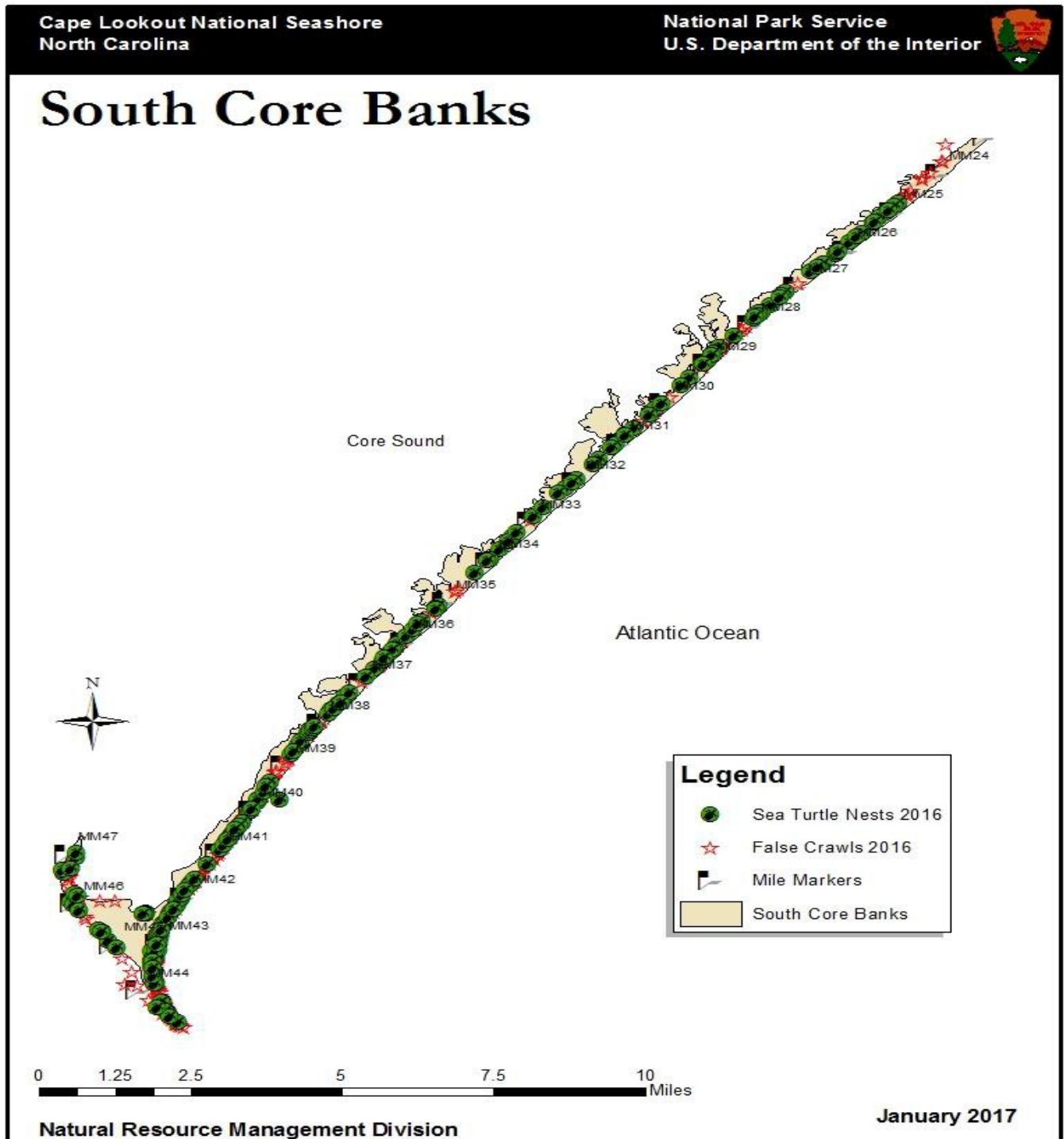


Figure 9. 2016 Shackleford Banks Sea Turtle Activities.

