



Program Overview

The Bald Head Island Conservancy's (BHIC) Sea Turtle Protection Program (STPP) began in 1983 with the objectives of continued saturation tagging of all nesting sea turtles, nest protection, and public education on sea turtles and impending threats to their populations. Nightly beach patrols, including flipper tagging beginning in 1991, passive integrated transponder (PIT) tagging and biopsy skin sampling in 2002, and egg collection for genetic analysis in 2010, have resulted in a long-term dataset, which BHIC interns and sea turtle biologists have used for a variety of sea turtle population and behavior studies. One of only two current saturation tagging programs in North Carolina (along with Bear Island/Hammocks Beach State Park), the Bald Head Island STPP provides a valuable dataset to track the behavior and population trends of nesting loggerheads over time.

Methods of Data Collection and Analysis

During the 2018 season, BHIC staff patrolled the beach from the south side of the BHI marina entrance to the island's boundary with Fort Fisher (near Bluff Island). Full night patrols ran from May 16–August 7, with morning patrols from May 1–May 16 and August 8–September 11. During night patrols, four sea turtle interns conducted nightly patrols in two Honda Side by Side Utility Terrain Vehicles (UTVs): one UTV from the Fort Fisher boundary to Beach Access 35, and the other from Access 35 to the BHI marina. When a nesting turtle was encountered, staff identified tags and applied PIT and/or flipper tags where missing, collected biopsy skin samples (one sample per individual per nesting season), and recorded measurements of carapace length and width. One egg was collected from each egg chamber for genetic analysis. If a nest was laid in a vulnerable area where it was likely to be destroyed over the course of incubation, it was relocated to the closest suitable habitat. All nests were protected by plastic cages immediately after turtle exited to the water and data collection was complete. At least 72 hours after turtles hatched and emerged, BHIC staff conducted a nest excavation. The nest chamber was fully dug out and all contents were inventoried: eggshells, unhatched eggs, and live and dead hatchlings. Eggs and biopsy samples were sent away for genetic and isotope analysis at end of season. All nesting and hatching data were entered into seaturtle.org as well as the BHIC sea turtle database. Statistical analyses were completed in Excel using two-tailed unpaired t-tests.

2018 Nesting Season Summary

The first BHI nest of 2018 was laid on May 18, and the last nest was laid on July 31. BHI had 128 nesting attempts: 76 false crawls and 52 nests (Figure 1). All nests were laid by loggerhead sea turtles. Seven nests (14%) were relocated due to proximity to the high tide line or likely

escarpments. BHI nests hatched between July 10 and September 13 with an average incubation time of 57.3 ± 3.5 days. Eight nests remained when Conservancy staff evacuated for Hurricane Florence on September 13; of these, two hatched, two drowned, and the final outcome is unknown for four. Excluding four nests of unknown outcome, the nest hatching success (HS) was 72.9%, and the emergence success (ES: percent of hatchlings that emerged from nest without human interference) rate was 70.4% with at least 4421 hatchlings assumed to have reached the water. An estimated 5000 people were educated through BHI Conservancy sea turtle education programs including classroom programs, Turtle Walks, Ride Alongs, and nest excavations.

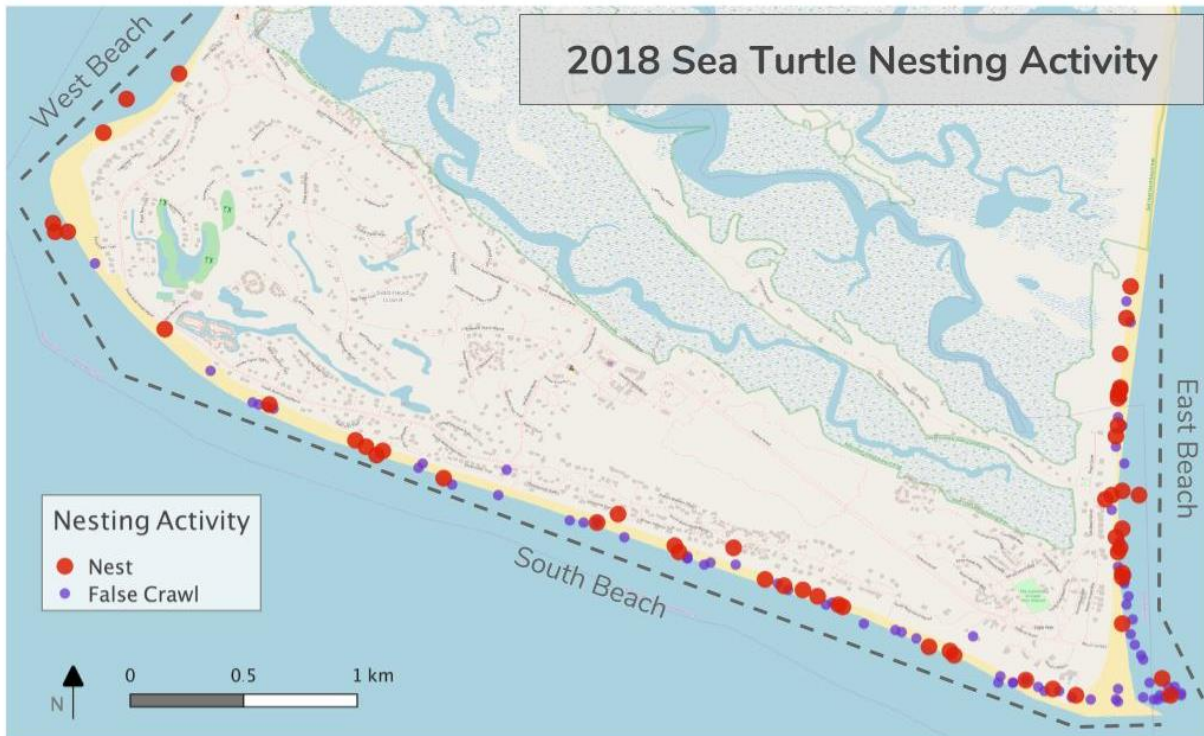


Figure 1. Summary of all sea turtle nesting events on Bald Head Island in 2018. Beach distinctions are indicated by dashed lines. All nesting activity attributed to loggerheads (*Caretta caretta*).

Nest Distribution

The temporal distribution of nesting attempts (including successful nests and false crawls) was similar to past years, with most nesting attempts occurring in June; however, more nests were successfully laid in July (Figure 2). The spatial distribution of nests was similar to previous years, with the majority of nests laid on South Beach

(Figure 3). Of the 52 nests, 28 were laid on South Beach, 21 on East Beach, and 3 on West Beach (2017: 0 nests on West Beach).

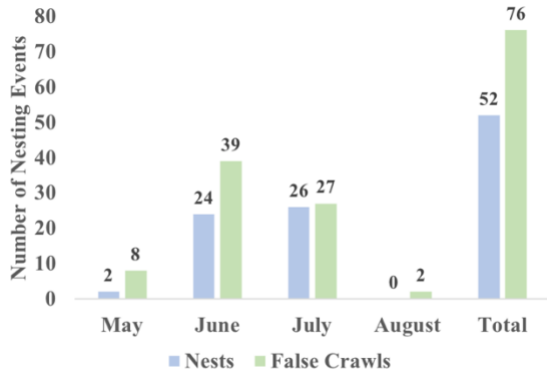


Figure 2. Monthly distribution of all nesting activity (false crawls and successful nesting attempts).

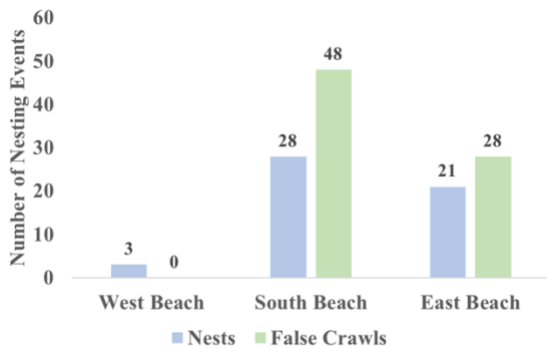


Figure 3. Spatial distribution of all nesting activity (false crawls and successful nesting attempts). The majority of both nests and false crawls occurred on South Beach (Accesses 11–36), with remaining nests and false crawls on East Beach (Accesses 39–42) and West Beach (Accesses 1–11). See Figure Appendix A for map of beach accesses.

Nest Relocations

Nest relocations were conducted for seven of the 52 nests, with 819 total eggs relocated. Staff aimed to complete all relocations immediately after nests were laid to minimize impact of relocation on egg development. For six of the nests, relocations were carried out within six hours of lay; however, one West Beach nest was emergency relocated 45 days after date laid because of beach erosion. In this case, the nest was laid far enough from the high tide

line to justify *in situ* development (3.75m), but an escarpment eroded the beach to the base of nest, which necessitated a later relocation.

All nest relocations were due to nest proximity to high tide line or eroding escarpments, which would have led to tidal inundation or nest erosion. All nests laid on Frying Pan Shoals point (below high tide at access 39) and on the southern side of the Shoals (Accesses 36–39) were relocated, as they would have otherwise been inundated daily (Appendix A). The only nest relocated outside of these areas was on West Beach and due to the rapidly eroding beach during a king tide event. Relocated nests had similar hatch success and emergence success rates to nests developed *in situ* (HS: $t(7)=-0.842$, $p=0.428$; ES: $t(7)=-1.00$, $p=0.351$) although their average incubation time was 54.4 ± 2.07 days, as compared to 57.7 ± 3.48 days for nests incubated *in situ* ($t(8)=-3.04$, $p=0.016$).

Nesting Females

Flipper and/or PIT tag information was collected from nesting turtles for 50 of 52 nests. Based on tag information and nesting intervals, 23 individual nesting females were identified on BHI beaches in 2018. Of these 23 individuals, 39% (9) were new nesters and laid an average of 1.6 ± 0.88 nests each (14 total). The remaining 61% (14 individuals) were previously tagged, return nesters that laid an average of 2.7 ± 1.59 nests each (38 total) (Figure 4). Four legacy turtles returned in 2018: Billie (5 nests), Caroline (5 nests), Lisa (2 nests), and Caretta (4 nests). Billie and Caroline, along

with an unnamed female (47090F520F), were the most active BHI nesters, each laying 5 nests.

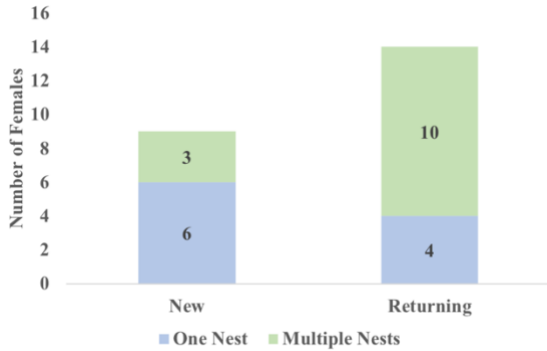


Figure 4. Distribution of new and returning nesting females and nest laying frequency in 2018.

In addition to nesting turtle tag information, standard carapace measurements were recorded for each nesting mother, including straight and curved carapace lengths and widths (Table 1). Returning moms had larger average lengths and widths for all measurements, although they were only significantly larger for two of the length measurements (Appendix B).

Table 1. Season averages for standard carapace measurements (cm) of new and returning nesting females. CNT = curved notch-to-tip, CNN = curved notch-to-notch, CW = curved width, SNT = straight notch-to-tip, SNN = straight notch-to-notch, SW = straight width. Asterisks denote measurements that were significantly different for new and returning nesting females. T-test results in Appendix B.

	CNT*	CNN	CW	SNT	SNN*	SW
All	101.42	100.02	94.05	93.30	91.60	71.26
New	98.70	97.71	91.77	90.98	89.13	69.97
Ret.	103.30	101.62	95.62	94.92	93.31	72.16

False Crawls

There were 76 documented false crawls on BHI in 2018. False crawls include all nesting attempts in which a female emerges from the water but returns to the ocean without laying eggs. False crawls can occur for a number of reasons, both natural and anthropogenic. False crawls in 2018 did not seem to be directly related to any single issue. Large areas of intertidal beach around Frying Pan Shoals, high escarpments throughout the geotextile tube area, individualized nesting behavior, and human interference (e.g., white flashlights on the beach) seemed to trigger these false crawls. The false crawl to nest ratio in 2018 was 1.46, higher than in recent years (2017: 0.88; 2016: 1.03). Overall temporal distribution of false crawls was similar to nesting distribution, with the majority occurring in June and July (Figure 2) and on South Beach (Figure 3).

Turtles were directly observed in 48 of 76 false crawls. Of the 48 observed false crawling turtles, tag information was recorded for 26 false crawls. The rate of interception was lower for false crawls than for successful nests because turtles typically spend less time on the beach during false crawls. Even when a turtle was not observed, false crawls were documented based on the obvious tracks left behind by crawling turtles.

For the 26 false crawls in which tag information was collected, 11 unique individuals were observed. Two of the 11 individuals were not documented to have returned to nest after their final false crawl

on Bald Head Island. It is possible that these turtles either nested unobserved or nested on a different beach. Conservancy staff encountered certain individuals false crawling more frequently, suggesting that some turtles have a higher propensity for false crawling than others. The legacy turtle “Caretta” (PIT: 4B1E382B2A) was easily identifiable by sharkbite markings on her rear carapace, even when tag identification was not recorded, and was frequently observed false crawling. This individual was suspected to have false crawled at least four times over a 2-day period before laying her third nest on July 17.

Nest Hatchings and Excavations

The first nest hatched on July 10, and nest hatchings continued until Hurricane Florence reached the island on September 14. Incubation time ranged from 51 to 66 days, with an average incubation time of 57.3 ± 3.5 days. East Beach nests had a longer average incubation period than South Beach nests ($t(21)=2.91, p=0.008$; Figure 5). Nests on South Beach typically receive more sunlight and thus warmer conditions, contributing to faster development.

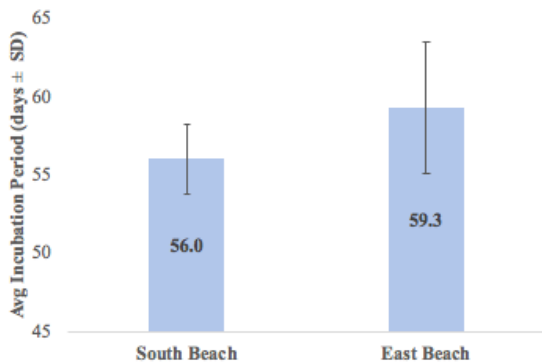


Figure 5. Average incubation period for nests on South and East Beach.

Most nests hatched in August and September, but early hatchings took place in July (Figure 6). Hatchings of nests 44 and 45 were not observed but were assumed to have occurred between September 11–13, and both nests were determined to be successful upon excavation after staff returned to the island following Hurricane Florence. An additional 6–10 nests did not hatch (3 nests undeveloped, 1 nest eroded during August king tide, 2 nests drowned during Hurricane Florence, 4 nests unknown fate during Hurricane Florence).

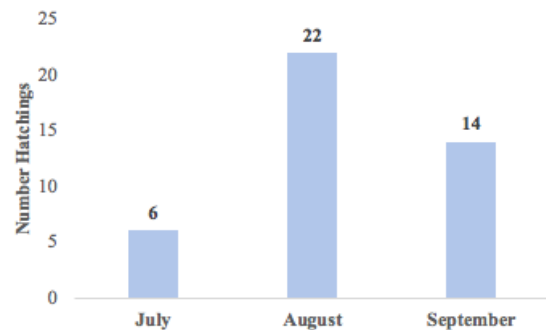


Figure 6. Monthly distribution of nest hatchings up to September 13, 2018.

Excavations were conducted approximately 80–92 hours after hatching or at 70 days if a nest did not hatch. Multiple parameters of nest success were recorded at public nest excavations (Table 2). Average hatching success was 67.3–72.9% with an average emergence success of 65.0–70.4%. Nest success rates are presented as ranges because of the uncertainty surrounding four nests’ outcomes during Hurricane Florence. Nests may have hatched before nests were washed away or dug up by coyotes, but outcomes were unknown. The range is listed as [success assuming all four nests lost]–[success excluding all four nests]. It is assumed that at least two of the unknown

outcome nests were lost during the hurricane, which is why the high end of the range does not assume success in all four nests. In total, at least 4421 hatchlings were assumed to have reached the water.

Excluding four nests of unknown outcome, there was no significant difference between South and East Beach for hatching ($t(34)=-0.937$, $p=0.355$) or emergence success ($t(35)=-0.807$, $p=0.425$). West Beach nests had a hatching success of 0%, as all three nests were laid by the same female, and none of the eggs showed any sign of embryo development upon excavation. There is no reason to suspect that the failure of these nests was caused by nest location.

Table 2. Average and total number of eggs and hatchlings found during nest excavations. HE = hatched eggs (eggshells), UE = unhatched eggs, PE = dead pipped eggs (partially emerged from eggshell), LH = live hatchlings, DH = dead hatchlings, TC = total clutch (eggs laid).

	HE	UE	PE	LH	DH	TC
Avg	91.8	28.7	1.1	2.7	0.6	122.7
Total	4316	1348	52	127	28	5768

Lohmann Lab Research

In addition to the collection of standard nesting and hatching data, research was conducted by PhD candidate Kayla Goforth from UNC Chapel Hill’s Lohmann lab. Goforth’s research assesses the impact of beach orientation on embryo alignment during development in an effort to better understand how the magnetic field impacts embryo orientation. Goforth and research assistants observed embryo development *in situ* at day 40-50 of incubation by candling eggs and marking embryo alignment in

reference to magnetic north. Twenty-one nests were involved in this study: 11 on South Beach (including Nest 30, which was lost) and 10 on East Beach. Of these, 19 nests contained battery-operated temperature data loggers that were placed at the bottom of the egg chamber before oviposition. Data from this study is currently undergoing analysis and will be utilized as part of Goforth’s dissertation.

Hurricane Florence

All nest monitors and staff evacuated BHI by September 12 before Hurricane Florence made landfall on September 14, and did not return to the island until October 1. At the time of evacuation, eight sea turtle nests remained unhatched. Upon return, excavation and observation revealed that two nests hatched successfully before the hurricane came ashore, two nests drowned during the hurricane, and four nests were disturbed beyond the point of effective nest assessment (two were washed away completely and two were dug into by coyotes). The two nests that were eroded completely were laid near the terminal groin (5.3m from high tide line) and on South Beach (11.3m from high tide line), where the beach changed substantially during the storm. Although all nests had reached day 45 of incubation before the hurricane, it is unlikely that more than two of the unknown outcome nests hatched before they were eroded or dug up by coyotes.

Public Education

Educating public audiences remains a priority of the Conservancy’s Sea Turtle Protection Program. Sea turtle programming

in 2018 included “History of BHI Sea Turtles” (45 attendees), “Sea Turtle Biologist in Training” (28 attendees), UTV Patrol Ride-Alongs (124 attendees), Turtle Walks (1210 attendees), and public excavations (3500 estimated attendees). Additionally, informal education occurred

through countless encounters with the public during beach patrols, communications at the Conservancy’s information desk, interactions with visitors, and outreach events that took place beyond Bald Head Island.

Appendix A. Beach Accesses referenced in report. Beach distinctions are indicated by dashed lines.



Appendix B. Results of t-test comparisons of carapace measurements of neophyte and returning nesting moms. Asterisks denote measurements that were significantly different for new and returning nesting females.

	CNT	CNN	CW	SNT	SNN	SW
p	0.046*	0.057	0.143	0.058	0.044*	0.317
t stat	-2.17	-2.07	-1.55	-2.05	-2.19	-1.04
df	15	14	15	15	15	13