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NATIONAL SAVE THE SEA TURTLE FOUNDATION

Making more turtles one season at a time – Insights from 28 years of loggerhead nesting at Keewaydin Island, Florida

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Nearly everybody who has presented public outreach talks about sea turtles is asked questions that relate to how long sea turtles live, what they eat, how many nests they lay and how many eggs are in each nest. These are great questions, and we certainly enjoy answering them, but underlying those inquiries is the broader question of how many nests, eggs and ultimately adults an individual marine turtle, like a loggerhead, might produce over its reproductive life. Thanks to one particularly persistent loggerhead who has visited the Keewaydin beach 10 times since 1988, we have at least an inkling of what at least some of these amazing animals are capable of accomplishing over their long reproductive lives.

How did we get all this information? Like sea turtles, this effort requires persistence over time. The Conservancy of Southwest Florida has been monitoring loggerhead nesting activity on a beach in Keewaydin Island, located on the SW coast of Florida, since 1983 **(Figure 1)**. Each female encountered at the beach is given a flipper and PIT (Passive Integrative Transponder) tag for personal identification (see article by Kate Mansfield, Outreach Vol. 3, Issue 2, about tracking turtles through space and over time). Their shell length and width is also measured. Additional data are also recorded, including whether she nested or returned to the sea without digging a nest (a "false crawl") and, if she nested, where along the length of beach the nest was located and its fate, as some nests are destroyed by storms or predators while others survive to produce hatchlings. After the hatchlings depart, the nest contents are analyzed to determine the number of eggs each female deposited (her "clutch size"), and the number of hatchlings that she produced (her nest "success"). Loggerheads typically return to nest at 2-3 year intervals, nest 4-5 times during each nesting season, and produce clutches that average around 100 eggs per nest.

We have, over the years, gradually accumulated data on the reproductive performance of individual turtles nesting at Keewaydin Island. Because these efforts have continued for so long, and because we have records from known individuals, we are in a unique position to describe not only the differences in nest success among individuals, but also to document the impressive accomplishments of particularly successful females (at least as far as nesting activity is concerned) over time. We don't know how many of those hatchlings actually survived to become adults (a measure of a female's reproductive success), but it is likely that a female producing more hatchlings could be a female that also produces more adults. Of course, over 150 years ago, Charles Darwin described these differences as indicative of which individuals were most successful (their "fitness") in the struggle for survival.

Our ability to obtain all-inclusive data on nesting and hatchling production from individual remigrant turtles, as well as the vagaries of night work on the beach, result in some limitations on our ability to obtain complete records. Also, some females vary in beach fidelity while others vary in the number of years separating consecutive nesting periods. Some females loose their tags and others simply nest and depart before we discover them. Nevertheless, and in spite of these problems, as of 2011 we've documented over 120 individual females that have nested on Keewaydin over multiple reproductive seasons since 1985. Of these; approximately 63 of them nested over 3-5 reproductive cycles. Although this information is valuable, it is less revealing than what we've learned from females with longer nesting histories, particularly as it relates to nest numbers and egg production over a turtle's reproductive life, which is estimated to span on average about 30 years.

In 2007 we assessed the long-term nest and egg production of 117 remigrant Keewaydin loggerheads that had deposited 639 nests. A statistical analysis of our records revealed that as they grew older, individual females showed no changes in their clutch sizes, nor did they show changes in the average number of nests they laid during each reproductive season. This suggests that sexually mature loggerheads are not only reproductively active throughout their lives, but that individuals show consistent differences in their reproductive contributions to the next generation.

For some perspective, we'll here summarize the nesting data from a representative assemblage of 6 females that nested repeatedly at Keewaydin Island for periods spanning up to 25 seasons **(Table 1)**. There is all manner of variability among these datasets with the two extremes represented by Tracy and Emily. Tracy was seen nesting in 1988 and was not seen again until 2003. As far as we know, she has not been back since. Even data on turtles that return with regularity may lack detail. Bailey has been with us for 19 seasons and has laid 19 confirmed nests; however, on average, only 56% of her eggs produced hatchlings that reached the Gulf, a rather modest nest success rate. Conversely, Doodler, a turtle we've known for 17 seasons, has had much better success. Over her nine nesting seasons during that time span, she laid 27 nests. About 90% of her eggs produced hatchlings that reached the Gulf. Beth has been seen during 7 reproductive cycles and laid 28 nests. However, only 49% of her eggs produced hatchlings that crawled to the Gulf. Lindsay, first tagged in 1987, has returned eight times; however, only nine of her nests have been documented and their mean hatchling success of ~ 30 % was quite low. She was seen most recently in 2011, when she nested once.

Clearly, from the standpoint egg production and nest success, there is a significant amount of variability in the success of individual turtles, as measured by the number of hatchlings they've produced that entered the Gulf of Mexico to begin their travels. Those of us who work on nesting beaches are well aware of all the variables that can affect nest success. For reasons we cannot explain, some of these turtles just seem to be better at it than others or live charmed lives when it comes to nesting. Whatever the case may be, their reproductive life histories tell us in very unambiguous terms that they consistently place many eggs in a lot of nests over many time spans of many years.

Figure 1. Left, Keewaydin (white arrow) is a long, narrow barrier island located on the southwest coast of Florida, just south of Naples. It is within the Rookery Bay National Estuarine Research Reserve and is managed by their staff.

Table 1. Vital statistics describing the reproductive activity of six loggerhead females observed by the authors over 28 years of study at Keewaydin Island, Florida. Females produce many nests, each containing many eggs, but not all the nests or eggs result in hatchlings that enter the Gulf of Mexico. This table projects estimates of the "nest success" for each female over her reproductive lifetime (right column). Differences among females are great! See the text for details.

Female (years observed)	Seasons Tracked	Nesting Cycles	Confirmed Nests	Estimated Additional Nests	Total Nests	Mean Clutch Size	% eggs to Departing Hatchlings	Estimated Hatchling Production (over 30 y reproductive life)
Tracy 1988-2003	16	2	6	7	13	70	22	200
Lindsay 1987-2011	25	8	9	11	21	133	30	838
Bailey 1991-2009	19	8	19	14	33	113	56	2068
Beth 1993-2009	17	7	28	26	54	117	49	3096
Emily 1988-2011	24	10	37	11	60	120	81	5832
Doodler 1995-2011	17	9	27	26	53	137	90	6535

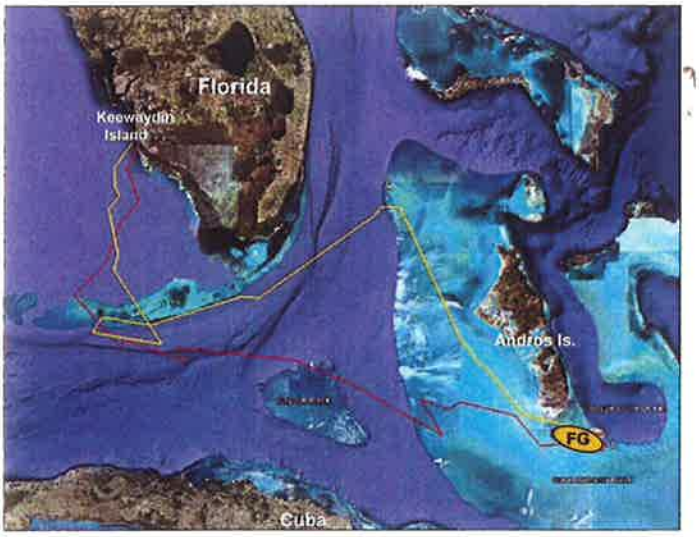

Figure 2. Emily's migratory tracks between Keewaydin Island and her foraging grounds just south of Andros Island (FG) after nesting in 2009 (red) and 2011 (yellow). While her route each year differed, her destination remained the same.

With the exception of the unusual 16 year gap between observed reproductive cycles by Tracy, the other turtles in this group have returned fairly regularly. Some are likely more site-specific; others may nest on differing inter-annual cycles, and some we've concluded are simply sneaky. What we've realized, though, is that even after 30 years, really complete datasets on the cohort of inter-annual nesters that visit Keewaydin Island are indeed rare, which brings us to our very persistent and currently most successful hatchling producer - a loggerhead named Emily. She was first tagged in 1988 and has since returned to nest on Keewaydin at least 10 times. Of her 37 known nests (average of 120 eggs per nest, or 4,440 eggs) over a time span of 24 years, a remarkable number (33 nests) resulted in hatchlings. (Three nests were washed out by storms while another was destroyed by feral hogs.) The remaining 33 nests contained 3,963 eggs, which resulted in 3,218 hatchlings (nest success if ~ 81 %) that crawled from those nests down the beach and swam away into the Gulf of Mexico.

Now that's a lot of eggs and hatchlings, but there's little doubt there were more. We base this both on observed false crawls as well as gaps of greater 20 days between nesting events. The mean number of days between nesting events for the Keewaydin loggerheads is 11 days. These data strongly suggest that Emily very likely deposited at least 11 additional nests (either elsewhere or on Keewaydin Island, but not found) for a grand total of 48 nests containing an estimated 5,832 eggs. Given her historic nest success of 81%, it's not unreasonable to predict that those 11 nests yielded another 1,320 eggs. Those additional eggs (assuming all of these unseen nests survived) would have resulted in an additional 1,069 hatchlings reaching the Gulf of Mexico. If all the nests had survived, her estimated hatchling production would be 5,832 **(Table 1)**. However, 4 nests didn't survive so an estimate based upon 55 surviving nests over 30 years is more realistic, and would result in 5,846 hatchlings (81 % of the eggs) in all. Using the standard yardstick of 1 in a 1,000 hatchlings surviving to adulthood, she's produced four replacement adult loggerheads since 1988. If we consider that one or maybe two of her offspring may have reached adulthood only recently, perhaps we can all better appreciate the scope of Emily's life, particularly since we have no way of knowing how old she was when we first encountered her.

We can take these estimates a reasonable step further. Emily regularly revisits Keewaydin at two year intervals and has consistently laid 4-5 nests during each of her reproductive cycles. Assuming she'll revisit Keewaydin three more times, she could lay 12 to 15 more nests containing 1,440 to 1,800 eggs, respectively. So over her reproductive life she could potentially lay 60 nests containing 7,200 eggs. If all those nests survive, the result would be an estimated 5,832 hatchlings, growing into 5 or 6 replacement adults. Keep in mind, these are very simple estimates. However, the 24 seasons of data upon which they are based is a good start.

This brief analysis and the remarkably complete dataset from what is certainly a physiologically robust loggerhead has given us some profound insight into how the premature loss of the reproductive potential by individual loggerheads via anthropomorphic factors (such as pollution, incidental capture in fisheries, nest poaching, or loss of suitable nesting beach habitats) impairs the ability sea turtles to sustain their populations. Marine turtles must produce lots of eggs and hatchlings throughout their long lives just to maintain their populations at equilibrium. While Emily is not representative of all loggerheads, she is part of a cohort of individual female loggerheads that show us how many offspring must be produced so that marine turtles can persist.

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Seen a mink? Tell FWC

They're rarely seen in the wild but they do exist in Florida. They're mink.

Florida Fish and Wildlife Conservation Commission (FWC) biologists are asking for the public's help in locating these small, fast, semi-aquatic creatures.

Because their size and behavior keeps them out of sight, understanding where mink are in Florida, and how many mink live in the state, is extremely challenging to biologists.

"If members of the public report their sightings of these elusive animals, it would be invaluable to our research," said Jesse Boulerice, FWC biologist in Lake City. "The more people we have looking for mink, the more information we can gather."

Fisherman, boaters and other water recreationists are asked to be particularly watchful for mink and report any sightings. These sightings will be used to identify areas where mink are more common in Florida and help biologists pinpoint locations to focus mink research. The Everglades mink is listed in Florida as a threatened species.

Mink are typically found near, in and around sources of water, although they can also be found on dry land.

"They have a long sleek body, thick tail, small ears and small eyes," Boulerice said. "Mink are between 1 and 2.5 feet long and weigh up to 4 pounds. These animals are dark-chocolate brown to black in color and sometimes have a patch of white along the chin and throat."

Mink can be confused with otters. Otters look and behave similar to mink but are much larger in size (10-30 pounds). Weasels are also similar to mink, but are smaller and have brown fur along their backs and yellow along the entire belly.

Being strictly carnivorous, mink forage in and along the edges of water, eating fish, frogs, crayfish, crabs and even muskrat and other small mammals. Historically, mink were hunted and used to make mink-fur apparel.

The FWC has created an online database link for anyone to report sightings of mink in Florida at:

https://public.myfwc.com/hsc/mink.

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As for the rest of Emily's story, she was outfitted with satellite tags in 2009 and 2011. In both instances, she returned to the same foraging area on the Great Bahama Bank southeast of Andros Island near the Tongue of the Ocean **(Figure 2)**. The routes she took to reach her foraging area varied somewhat; however, the straight-line distances for 2009 and 2011 were almost identical 547 and 535 km, respectively. She certainly knows where she wants to go. In 2009, her last documented nest was on July 9, but her satellite tag data indicated that she was still near Keewaydin on July 20, which suggested she nested again before departing. She arrived at her foraging ground around August 6 so it took her 17-18 days to cover the approximately 948 km she swam to reach her destination. In 2011, her last documented nest was on June 27; however, satellite tag data indicated that she was still near Keewaydin on July 11, which again suggested that she nested once more before departing. This time the route she took covered roughly 803 km and required 16 days to complete. It was a more direct path this time as she crossed the Cay Sal Bank passing through the Muertos Cays and Dog Rocks. With respect to her demonstrated fidelity to her foraging grounds, one may ask when it was that she first established this foraging area. Was it early on as a dinner-plate sized juvenile shortly after the pelagic phase of her life ended, as a larger sub-adult, or later as an adult?

Acknowledgements

As we wrote this article, we couldn't help but wonder just how many people participated in collecting the information that, collectively, has told us the stories prompted by the turtles nesting at Keewaydin Island, and their champion Ms. Emily. For her it turned out to be a lot of folks: 31 interns, 2 volunteers, and 2 Conservancy staff. Those summers now cover a generation, and there are lots of memories and good stories to tell. We've often wondered if their encounters with Emily may have influenced their perception of wildlife, and their lives as well. After all it was they who did most of the sweating and swatting on the Keewaydin beach, and they who documented the comings and goings of a whole lot of turtles. Thanks to them we had this story to tell.

Funding for the Emily's satellite tags came from donations by members and supporters of the Conservancy of Southwest Florida, and a grant from the Marine Turtle Grants Program. Kate Mansfield helped us start the satellite tagging work and Katrina Phillips identified the foraging areas. Our thanks to you all!