Cape Romano Complex Sea Turtle Program Annual Report 2017

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Abstract

Loggerhead sea turtles nest along the west coast of Florida, including the Cape Romano Complex located within Rookery Bay National Estuarine Research Reserve (NERR). This set of barrier islands is surveyed each nesting season between the months of May and October. All nests and false crawls are documented, and all verified nests were caged. Nests were checked throughout the season for wash overs, inundations, wash outs, and depredation events and were recorded when applicable. All nests were evaluated after an emergence was observed or 80 days after they were laid. During the 2017 season there were 135 nests and 126 false crawls. A total of 70 nests had hatchlings emerge, 3 nests hatched but did not have hatchlings emerge, 31 nests were washed out, 23 nests did not hatch, and 8 nests were completely depredated. The high number of wash overs, inundations, and wash outs can be attributed to the two unnamed storm events in May and June, as well as Tropical Storm Emily and Hurricane Irma.

Introduction

There is a total of seven species of sea turtles, five of which inhabit Florida's waters. These five include: Kemp's ridley (*Lepidochelys kempii*), hawksbill (*Ertmochelys imbricata*), leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), and loggerhead (*Caretta caretta*) sea turtles. The leatherback, green, and loggerhead sea turtles are the three species that are found to nest annually on Florida's beaches.

The United States has the largest concentration of nesting loggerheads in the world (Spotila, 2004). Florida's beaches represent 90% of the loggerhead sea turtle nesting in the United States (Florida Fish and Wildlife Conservation Commission, 2015). Loggerhead sea turtles are protected under federal and state laws. This species was listed as threatened under the Endangered Species Act (ESA) in 1978 (Conant et al, 2009). The state of Florida listed loggerheads under the Florida Endangered and Threatened Species Act of 1977 (Witherington et al., 2009). Under the ESA, the loggerhead sea turtle population is broken into nine Distinct Population Segments (DSP), where four are listed as threatened and five are endangered (NMFS and USFWS, 2011). The Northwest Atlantic population has been divided into five recovery units and Rookery Bay NERR is within the Peninsular Florida Recovery Unit (NMFS and USFWS, 2011). A number of objectives were established as a part of the recovery plan after recognizing threats to this specific population of loggerhead sea turtles (NMFS and USFWS, 2011). These threats included fisheries bycatch, boat strikes, beach erosion, debris/oil pollution, light pollution, and predation by other species (NMFS and USFWS, 2011).

To protect against some of these threats, Collier County has implemented a special lighting ordinance during the official sea turtle nesting season (May 1-October 31) that requires lights not to shine on the beach at night. The use of self-releasing cages on certain beaches has also been implemented with permission from FWC to protect nests against predators. Rookery Bay NERR covers 110,000 acres of habitat ranging from uplands to mangrove swamps. Rookery Bay NERR boundaries begin south of Naples, Florida and continue through the Ten Thousand Islands, just west of Everglades City. The Cape Romano Complex within Rookery Bay NERR, is a set of dynamic barrier islands just south of Marco Island.

Loggerhead sea turtles have carapace lengths from 85-124cm in length and between 175-440 pounds (Spotila, 2004). They have a large head with strong jaws which help them consume crabs, mollusks, and other invertebrates as a part of their diet (Spotila, 2004). Their feeding grounds range from estuaries, continental shelf, and the open ocean (Spotila, 2004). They can be found in all oceans, excluding the arctic, and nest in subtropical and temperate regions including the Southeast United States, Mexico, Oman, Australia, Southern Africa, the Mediterranean, and Japan (Dodd, 1988; Spotila, 2004).

Loggerhead sea turtles reach sexual maturity between 25 to 35 years of age. Female loggerheads crawl up on the beach at night to deposit their eggs. They begin this process by creating a body pit with their front flippers (Johnson et al., 1996). Next, they dig an egg chamber with their rear flippers and then proceed to deposit their eggs (Johnson et al, 1996). Once the eggs are deposited, the female will cover them with sand using her back flippers and then use her front flippers to disguise the nest area to deter predators. Loggerheads lay an average of 112 eggs in each clutch (Spotila, 2004). Predators of eggs and hatchings can include raccoons, ghost crabs, and coyotes (Dodd, 1988). Females lay an average of four nests throughout the season and will return to natal nesting grounds every 2-4 years (Spotila, 2004).

The eggs incubate and develop over an average period of 60 days. The temperature during the middle third of incubation will determine the sex of the hatchling. For loggerhead sea turtles along the east coast of the United States, the pivotal temperature is 29° C (Mrosovsky, 1988). Temperatures above 32° C will produce females and temperatures below 27° C will produce males. At 29° C, a mix of males and females will be produced. Rainfall or inundations can cool the nest temperature and potentially influence the sex of the hatchlings that are produced. Once fully developed, the eggs will hatch and the hatchlings will remain underground for a few days, slowly moving to the surface. Once it begins to get dark, and temperatures cool, the hatchlings will emerge from the nest cavity to make their way to the water. They will use the brightest horizon to lead them to the ocean (Spotila, 2004). Nests that are located in more urban areas are susceptible to disorientation due to beach lighting and urban glow (Dodd, 1988). The disorientation can lead to the mortality of hatchings due to either exhaustion, dehydration, or capture by predators (Tuxbury and Salmon, 2005; Witherington and Martin, 2000). If large amounts of water make it into the egg chamber from either rain or inundations, embryo mortality can occur (Kraemer and Bell, 1980). The hatched eggs, unhatched eggs, and dead hatchlings that are left in the nest cavity after hatching will provide nutrients for vegetation that will help keep the beach and dunes intact (Hannan et al., 2007).

For the lucky individuals that make it to the water, they will catch ocean currents to the floating Sargasso Sea in the Atlantic Ocean. Not much information is known about this life stage, except that individuals use the floating beds of *Sargassum* as a safe haven from predators and feed on microorganisms that also inhabit the *Sargassum*. Approximately 6-12 years later, juveniles will migrate to nearshore waters to feed on bottom dwelling invertebrates and bivalves (Spotila, 2004). At this age they are about the size of a dinner plate. The diet of juvenile and adult loggerhead sea turtles is unique compared to the other six species of sea turtles. When feeding on organisms such as mollusks, clams, conchs, and whelks, the pieces that are not consumed will become an important calcium food source to other organisms (Spotila, 2004). Once they reach sexual maturity, both males and females will migrate to the mating grounds which is either along the migration route or just off of the nesting beaches (Spotila, 2004).

Although one might think at this point individuals are in the clear because they are big enough to not be eaten by predators, this is not the case. Threats to individuals at all life stages include fisheries bycatch, disease, boat strikes, and global warming (Witherington et al., 2009). Pollution is another unfortunate threat that should also be recognized. Ingestion of plastic debris can cause gut compaction and result in death (Lutcavage et al., 1997). Positive strides forward in decreasing these threats include the use of turtle excluder devices on shrimp trawlers, lighting codes during nesting season, and education. Although we have gained large amounts of knowledge about these charismatic animals, there is still a lot to learn. Conservation efforts are key while research is continued in order to protect sea turtles and prevent them from going extinct.

Study Area

Sea turtle nesting surveys were conducted on the Cape Romano Complex within Rookery Bay NERR, south of Naples in Collier County, Florida. The Cape Romano Complex is a chain of barrier islands consisting of about 10 kilometers of shoreline that is broken up into six different sections (Figure 1). The shoreline of these barrier islands are a part of a dynamic system which changes on an annual basis depending on weather patterns.

Figure 1. Map of surveyed beaches within the Cape Romano Complex of Rookery Bay NERR.

There is a variety of flora and fauna on the Cape Romano Complex. Wildlife primarily consists of raccoons (*Procyon lotor*) and ghost crabs (*Ocypode quadrata*). There are also a variety of birds that utilize the beaches for feeding, resting, and nesting. A few of these species include: great blue herons (*Ardea herodias*), snowy egrets (*Egretta thula*), reddish egrets (*Egretta rufescens*), willets (*Tringa semipalmata*), sanderlings (*Calidris alba*), least terns (*Sternula antillarum*), ruddy turnstones (*Arenaria interpres*), and multiple species of plovers. Vegetation includes sea oats (*Uniola paniculata*), sea grapes (*Coccoloba uvifera*), railroad vine (*Ipomoea pes-carprae*), and sea purslane (*Sesuvium portulacastraum*). The tree communities making up these barrier islands include red mangroves (*Rhizophora mangle*), black mangroves (*Avicennia germinans*), white mangroves (*Languncularia racemose*), and the invasive Australian pines (*Casuarina equisetifolia*).

Methods

Nesting surveys began on May 1st and continued through the middle of August. Once nesting was over, the remaining nests were observed until September for emergence events. Rookery Bay NERR interns, staff, and volunteers departed from the Goodland field station at approximately 8AM and drove by boat to the Cape Romano Complex to complete surveys five days a week. Additionally, staff from Collier County Parks and Recreation completed the survey on Tuesdays if conditions allowed.

During each survey, the six sections of beach were walked in search of sea turtle crawls. When a crawl was found, it was analyzed in order to determine if it was a nest or a false crawl. Global Positioning System (GPS) locations of all false crawls were recorded and then the crawl was smoothed out with a rake in order to eliminate confusion on future surveys. If a crawl was determined to be a nest, the next step was to verify where the clutch was located. Manual digging with hands was done when locating the clutch to ensure that no eggs were broken during this process. Data collected included: GPS, distance to the vegetation and mean high water line, presence of a scarp, and the beach where it was located. The nest then received an identification number based on the beach and how many nests already existed. When the clutch was located, self-releasing wire cages were constructed using zip ties and placed around the clutch (Figure 2). These cages were 3' x 3' x 3' with mesh large enough to allow for hatchlings to crawl through after hatching. Along the bottom on each side of the cage, the wire was folded approximately six inches out. Trenches were dug approximately eight inches deep, and the cage was placed and buried (Figure 3). With the bottom edged folded out and buried, this prevented raccoons from digging underneath and destroying the nest. Predators that the cage cannot deter include ghost crabs and fire ants. For nests where the clutch could not be located, a flag labeled with the date and identification number was placed near the nest area.

During incubation, any evidence of predation, wash overs, inundation, or wash outs were recorded. Evidence of predation included ghost crab holes within the nest area, observation of fire ants, or scattered egg shells from raccoons.

Nests were checked when their estimated hatch date was approaching. Emergence events were determined when there was a depression within the nest area. When this was observed, nests were excavated and evaluated three days later. This allowed time for any straggler hatchlings left in the nest to make it out on their own. Nests that did not have an emergence event observed were evaluated 70 days after their lay date, or 80 days if the nest was washed over/inundated during incubation. Data recorded during evaluations included: hatched and unhatched eggs, pipped eggs, live and dead hatchlings. All unhatched eggs were opened to determine if development had begun or not. If live hatchlings were found, they were released on the beach so they could crawl to the water. If five or more hatchlings were found in a nest they were put in a covered bucket with damp sand and released later that night at sunset on South Marco Beach.

Figure 2. Rookery Bay Reserve volunteers assembling self-releasing cage.

Figure 3. Rookery Bay Reserve intern and volunteers burying self-releasing cage around clutch.

Results

During the 2017 nesting season there were 135 nests and 126 false crawls documented on the Cape Romano Complex (Figure 4, Figure 10).

Figure 4. Map of the Cape Romano Complex and the locations of nests (yellow) and false craws (red).

Of the 135 nests, 70 emerged, 3 hatched, 23 were unhatched, 31 washed out and 8 were totally depredated (Figure 8 and Figure 9). There were four storm events that affected the success of the nests (Table 1). The impacts of the storms included wash overs, inundations, and total wash outs. A nest wash over event is when a nest has had the tide briefly wash over the nest area, whereas an inundation is where a nest has been saturated in water for an extended period of time. A wash out is where a nest is completely lost due to storm surge and/or beach erosion. There were two unnamed storm events, May 24-25 and June 4-8, causing a total of 40 wash overs along the Cape Romano Complex (Table 1). Tropical Storm Emily occurred July 31-August 1, resulting in 28 wash overs, 2 inundations, and 1 wash out. Hurricane Irma (September 8-11) caused two inundations and the remaining 30 nests to wash out. Table 1 shows the total wash overs, inundations, and wash outs for each storm on the six Cape Romano Complex beaches. For the 2017 season there were a total of 68 wash over, 4 inundations, and 31 wash out events.

Table 1. Damages caused by storm events in the 2017 nesting season.

Date	Storm Name	Beach	Washovers	Inundations	Wash outs
5/24-5/25	No name	Cape Romano	4	0	0
		Morgan Beach	5	0	0
		Morgan Island	0	0	0
		New Beach	0	0	0
		Blind Pass	1	0	0
		Kice Island	3	0	0
6/4-6/8	No name	Cape Romano	8	0	0

		Morgan Beach	7	0	0
		Morgan Island	0	0	0
		New Beach	0	0	0
		Blind Pass	3	0	0
		Kice Island	9	0	0
7/31-8/1	Tropical Storm Emily	Cape Romano	0	0	0
		Morgan Beach	5	0	0
		Morgan Island	1	0	0
		New Beach	0	0	0
		Blind Pass	9	2	1
		Kice Island	13	2	0
9/8-9/10	Hurricane Irma	Cape Romano	0	0	4
		Morgan Beach	0	0	1
		Morgan Island	0	0	1
		New Beach	0	0	0
		Blind Pass	0	0	7
		Kice Island	0	2	17

With the storm events resulting in a high number of wash overs, inundations, and wash outs, the success of the remaining nests was low. From the 70 nests that emerged, approximately 4355 hatchlings emerged and successfully made it out of the nest (Figure 5, Table 2). From the six data loggers placed along the Cape Romano Complex beaches we can observe the temperature trends throughout the season (Figure 11 and Figure 12). Figure 11 shows the temperature trends over time, here we can see that the temperatures dropped during the multiple storm events. Figure 12 shows the average sand temperatures for each data logger from April 25th-September 5th.

There was a total of five sea turtle strandings during the nesting season. There was one Kemps Ridley, one Green, and three Loggerhead sea turtles that were found dead along the Cape Romano Complex. For each stranding, basic information was recorded, this included the general location, GPS point, and basic morphometric measurements. The turtles were then buried on the beach and information reported to FWC for their records.

In addition to the five sea turtle strandings, there was one manatee stranding. The manatee was brought back to the Goodland field station where a necropsy was conducted by FWC and Rookery Bay NERR staff.

Raccoons are considered a nuisance species, as they destroy sea turtle nests by digging the eggs up and eating them. When this occurs in a concentrated area the Reserve's stewardship team initiates efforts to remove them. A total of 3 raccoons were removed from the Cape Romano beach in the month of April. This season there were a total of 8 nests completely depredated, 3 partially depredated by raccoons. Two of the complete depredations were nests that were already caged. On these occasions a raccoon found a weak spot in the wiring of the cage, and was able to get in and eat the entire nest. In addition to raccoons destroying eggs, roots from nearby vegetation can impede egg development. This can occur by roots encasing the eggs and desiccating them or roots invading the egg shells causing hatchling development to cease. This occurred to eggs in five separate nests.

This season the Cape Romano Complex contributed data to two research projects. First, a researcher from The Fish and Wildlife Research Institute (FWRI) is studying the foraging grounds of female loggerhead sea turtles during the non-breeding season. In order to do this, unhatched eggs were taken during nest evaluations from 18 nests. Three to five unhatched eggs were taken from each sampled clutch and kept in a cooler until returning to the field station where they were then kept in the freezer. Eggs that seemed to not have any development were taken first, if the resulting unhatched eggs did not have any undeveloped, then eggs with late stage embryos were taken. Samples were taken from approximately every fourth nest laid. If eggs were too far deteriorated, samples from the next evaluation were taken. An additional researcher from FWRI is conducting research on hatchling orientation. An app was used on an iPad to collect data on hatchling's paths to the water. This data will be used to determine if hatchlings are orientating strongly in a certain direction and to determine if there is a potential anthropogenic light source that is causing them to do this. On urbanized beaches light pollution can be life threatening to hatchlings. The disorientation can lead to the mortality of hatchings due to either exhaustion, dehydration, or capture by predators (Tuxbury and Salmon, 2005; Witherington and Martin, 2000). Although the beaches along the Cape Romano Complex are not urbanized, there is the potential that urban glow from the Marco Island and/or Naples could be impacting the direction the hatchlings are orientating to the water.

An Adopt-A-Nest program was started last season, in which people could donate $250 towards the Cape Romano turtle program and call a nest their own. There was a total of 14 nests adopted for the 2017 season.

Figure 13. Adopt-A-Nest name tag on caged sea turtle nest.

A 3-D printed turtle with a unique name of the adopter's choice was made, and then placed onto nests throughout the Cape Romano Complex (Figure 13). Adopters received updates throughout the season with the placement of their turtle tag as well as the results of the nest.

Discussion

The Cape Romano Complex is a set of dynamic barrier islands that are very susceptible to erosion in high wave action events (Roelvink, 2009). It should also be recognized that the beach width for the Cape Romano Complex is fairly narrow. Therefore, nests are at a higher risk for wash overs, inundations, or wash outs with the slightest amount of wind coming off the Gulf of Mexico. We can see how sensitive these beaches are to storms with the number of wash overs, inundations, and wash outs that occurred due to these events. There were only 15 more nests in 2017 compared to 2015 (Table 2). Yet the number of hatchlings produced in 2017 was close to double of that in 2015 (Table 2). Each of these seasons experienced multiple storm events. In 2015 there was an unnamed storm from July 24-31 and Tropical Storm Erika from August 25-29. With these storms occurring at the end of nesting season and the beginning of hatching season this resulted in low hatchling production. Although in 2017 we experienced double the amount of storms, the first two occurred early enough in the nesting season to allow for nesting females to continue nesting and make up for any damage that occurred. Even though Tropical Storm Emily occurred at the end of nesting season/beginning of hatching season, only a portion of the nests were washed over. Sea turtle nests can tolerate being washed over, although it may decrease the success of the nest, it will not always cause 0% success. With Hurricane Irma occurring late in the hatching season, this allowed for as many nests as possible to hatch and increase the number of hatchlings to make it to the Gulf of Mexico. In short, the timing of the storms is everything when it comes to hatchling emergence success. The later the storms occur in the season, the more nests hatch, thus increasing hatchling production.

Looking at the long-term dataset for the Cape Romano Complex, nesting varies among the beaches as suitable nesting habitat varies each season (Figure 6). The habitat availability may also impact the total number of crawls and successful nesting attempts (Figure 7).

Nests that are laid closer to the water are at a higher risk of inundation and/or washing out (Wood and Bjorndal, 2000). At the same time, nests that are placed higher on the beach in vegetated areas are at a higher risk of desiccation by roots and predation by wildlife (Wood and Bjorndal, 2000). Inundation and large rainfall events can impact sea turtle embryos by either decreasing the hatch success or lowering nest temperatures. Large amounts of water that enters the egg chamber from either rain or inundations by the Gulf of Mexico can cause embryo mortality at all life stages (Kraemer and Bell, 1980). The second unnamed stormed that occurred in the beginning of June resulted in nearly 20 inches of rainfall for Collier County. This could have caused a large portion of the nests not to hatch that were laid prior to this storm event. In the Ten Thousand Islands it was found that hatch success decreased with increased inundation, sand water salinity, and sand water content (Foley et al., 2006). During the 2017 season all unhatched eggs were opened during evaluations to determine if eggs had developed or not during the incubation period. In cases where most of the unhatched eggs had stopped developing at the same time, the stage at which the embryo had died could be correlated with the storm events which may have caused the embryo to cease development.

Inundations and rainfall can also decrease the temperature of the egg chamber. Depending on the stage at which the embryos are in development, this can potentially alter the sex of the hatchlings that are produced if the nest hatches successfully. The decreased temperatures attributed to the storm events seen in Figures 11 and 12 show the temperatures decreased below the pivotal temperature of 29° C to ~25° C. If this decreased temperature was during the thermosensitive stage of development, this could have potentially increased the number of male hatchlings produced (Schmid, 2008).

In conclusion, although this year did not hold the highest record of nests, it ranked third in hatchling production. The high hatchling production can be attributed to the type of storm damage that occurred as well as the timing of the storms throughout the season. It is important for organizations such as Rookery Bay NERR to continue to monitor and study sea turtle nesting trends in order to further our understanding of this charismatic creature and strengthen conservation efforts.

Acknowledgements

This season would not have been possible without our Friends of Rookery Bay sea turtle intern Jennifer Gooch, and our NOAA five colleges intern Taylor Irwin. In addition, they could have not been able to be complete their responsibilities without the hard work of the Rookery Bay volunteers that came out daily on turtle patrol throughout the season. Thanks to Rookery Bay staff who volunteered their time to assist on turtle patrol. I would also like to thank Collier County Parks and Recreation Department, particularly Maura Kraus, Mary Toro, and Markus Hennig for conducting weekly surveys.

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Appendix I: Historical Trends

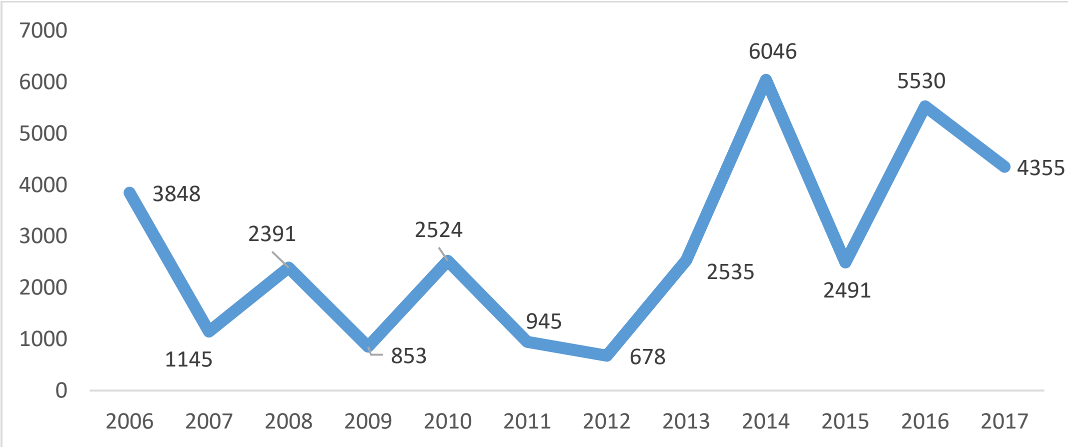


Figure 5. Number of emerged hatchlings from 2006 to 2017.

Table 2. Total number of nests and the number of emerged hatchlings from 2006-2017.

Year	Total Nests	Total Number Of Emerged Hatchlings
2006	66	3,848
2007	35	1,145
2008	82	2,391
2009	43	853
2010	60	2,524
2011	63	945
2012	80	678
2013	84	2,535
2014	109	6,046
2015	120	2,491
2016	207	5,530
2017	135	4,355

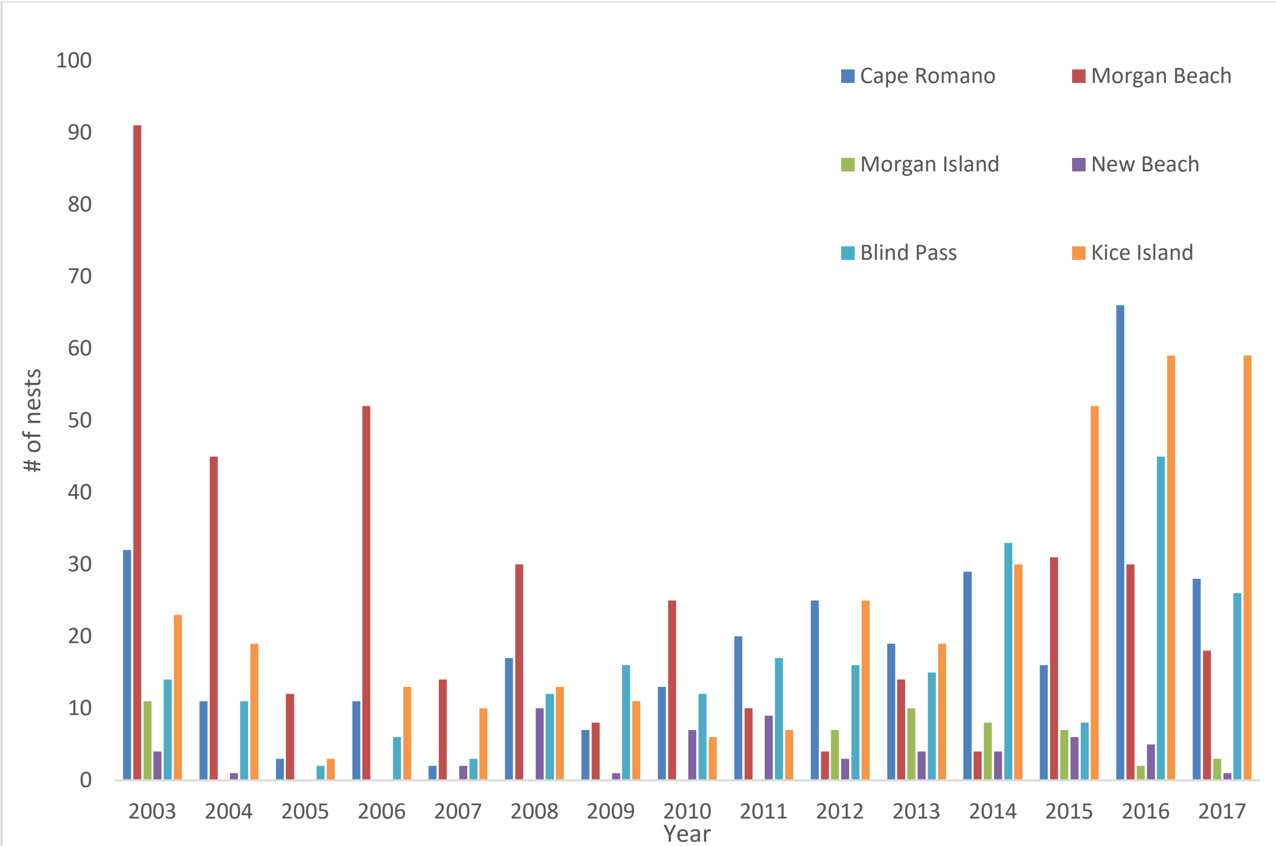


Figure 6. Number of nests per beach per year from 2003-2017 on the Cape Romano Complex.

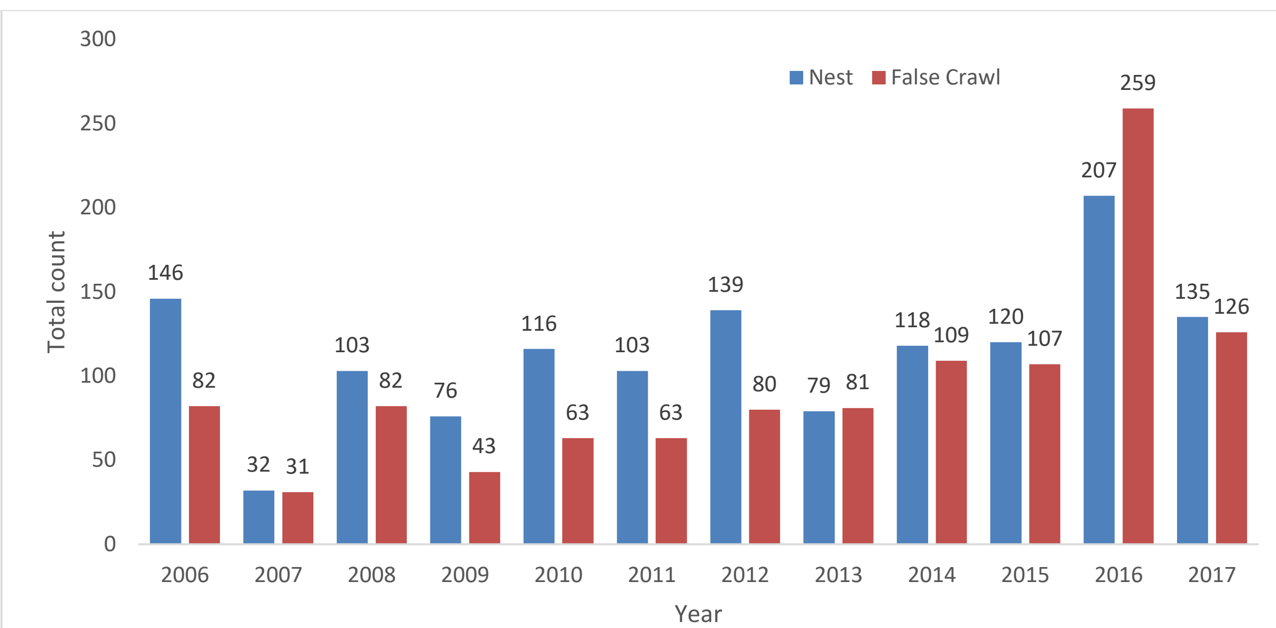


Figure 7. Nest (blue) and false crawl (red) totals from 2006-2017.

Appendix II: 2017 Results

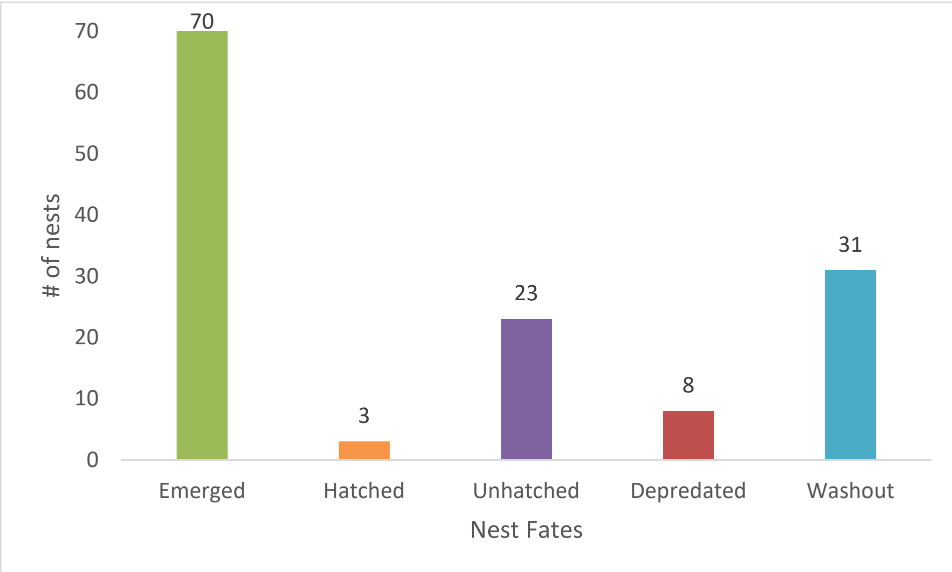
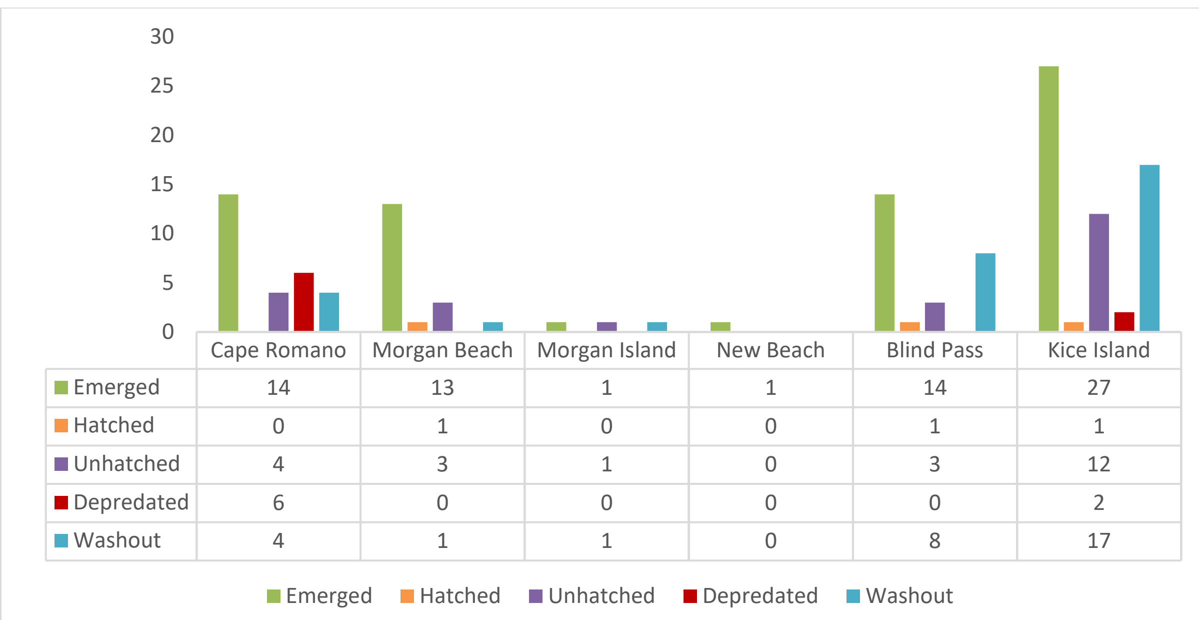


Figure 8. 2017 Cape Romano Complex total nest fates.



	Cape Romano	Morgan Beach	Morgan Island	New Beach	Blind Pass	Kice Island
Emerged	14	13	1	1	14	27
Hatched	0	1	0	0	1	1
Unhatched	4	3	1	0	3	12
Depredated	6	0	0	0	0	2
Washout	4	1	1	0	8	17

Figure 9. Nest fates by beach for the 2017 season.

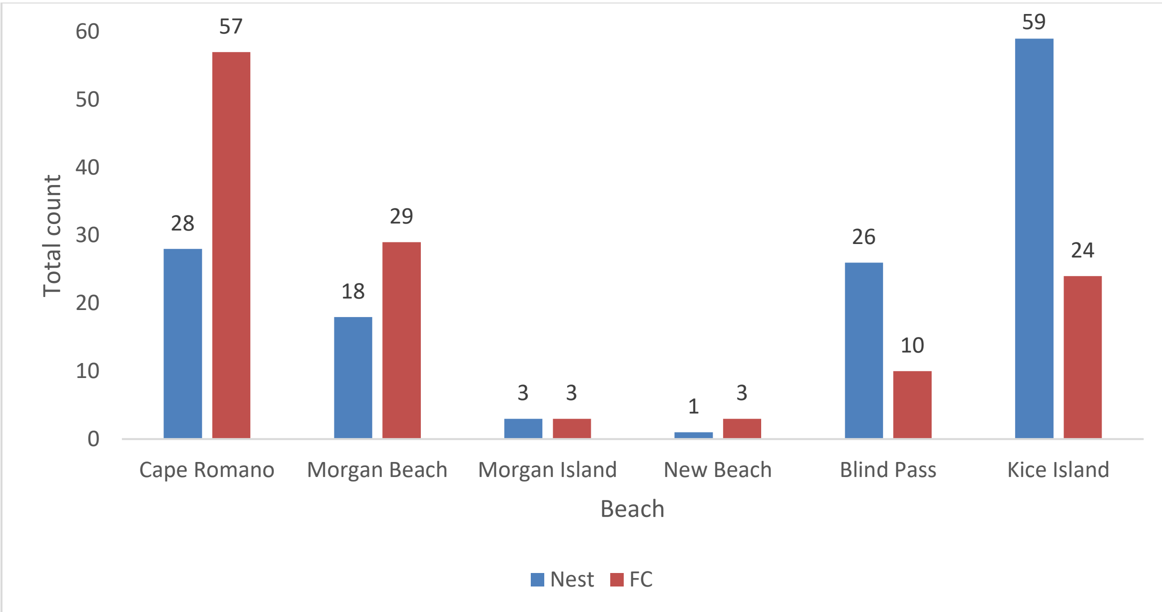


Figure 10. Nests and false crawls by beach for the 2017 season.

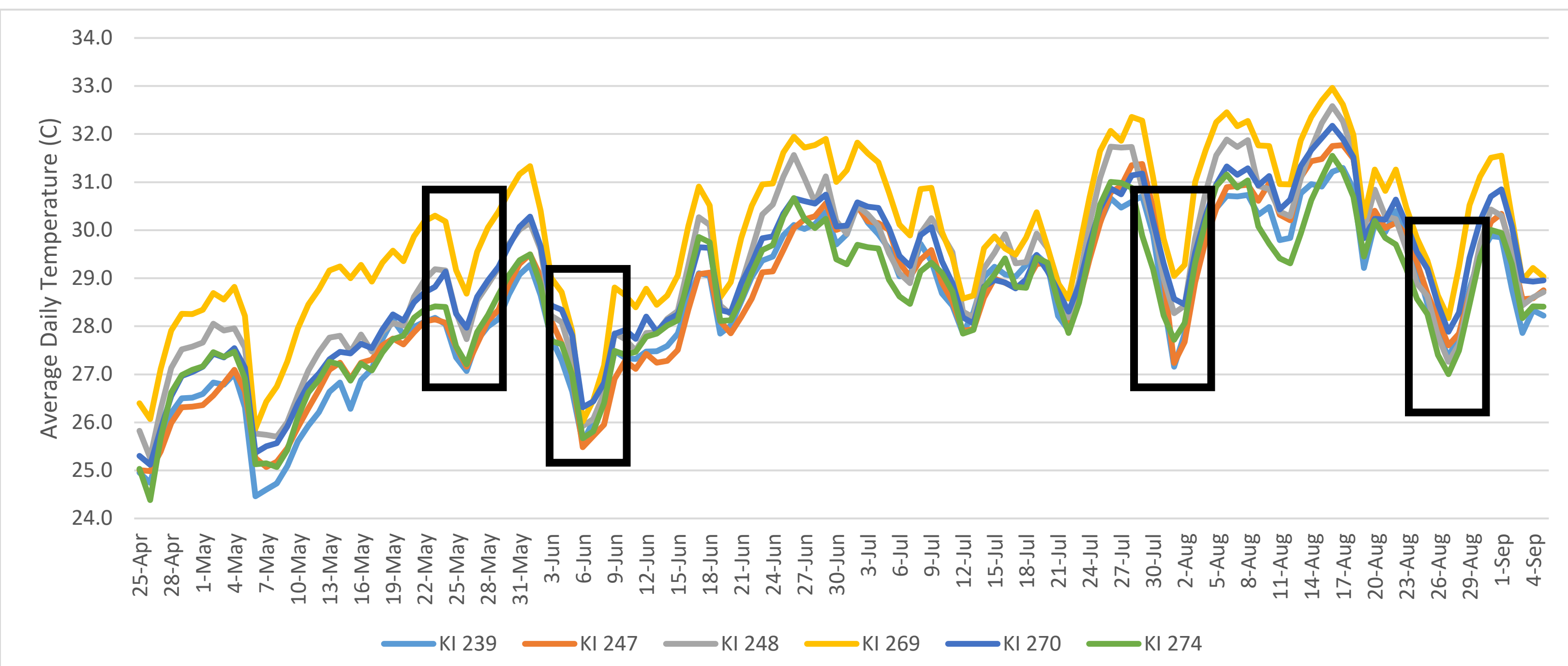


Figure 11. Data logger temperature from April 25th through September 5th on the Cape Romano Complex. The black boxes represent the storm events that occurred on May 24-25, June 4-8, July 31-August 1. August 23-28 there was a large rain event which is represented by the last black box.

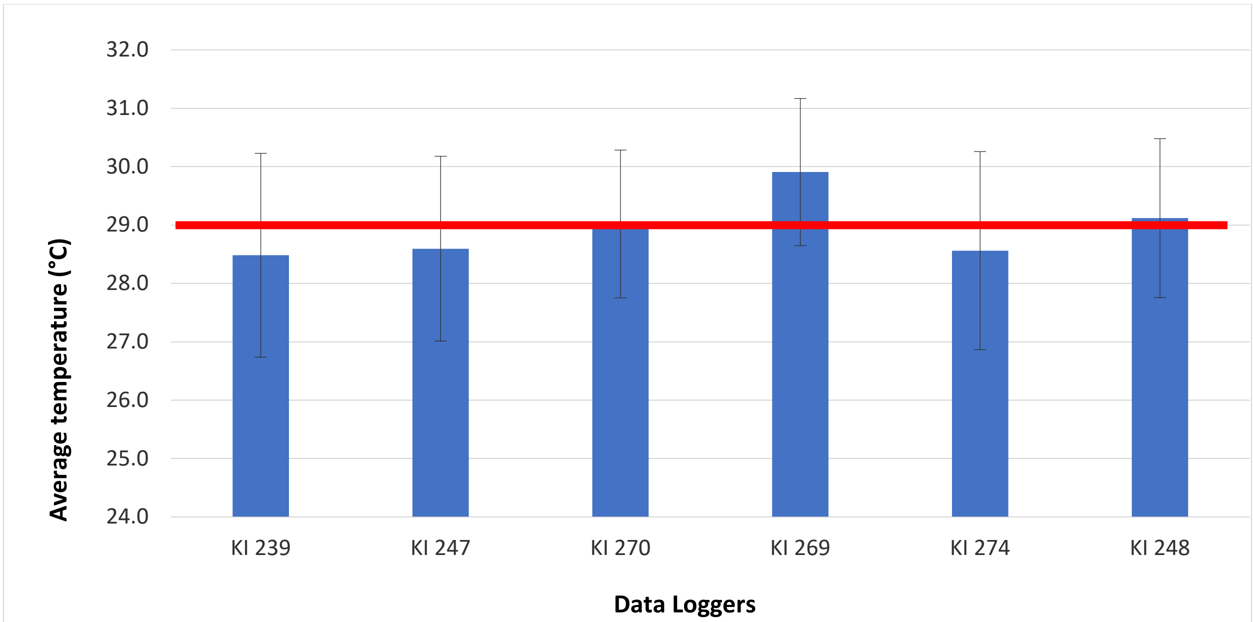


Figure 12. Average sand temperature for each data logger on the Cape Romano complex from April 25- September 5. The error bars represent standard deviation. The red line illustrates the pivotal temperature.