As sea turtles have become endangered, more knowledge regarding sea turtle nesting habits and hatch success rates is critical to support their viability as a species. Increased research will allow specialists and volunteers to better protect nests, and allow more effective relocation of nests when necessary.

METEROLOGICAL AND OCEANOGRAPHIC FACTORS IMPACTING SEA TURTLE NESTING

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Abstract

Little is known about why sea turtle mothers pick specific days to nest. As sea turtles have become endangered, more research is critical to support their survival. Increased information could allow specialists and volunteers to better protect nests, and allow more effective relocation of nests when necessary. In order to better understand the timing of sea turtle nesting, various statistical tests were run on meteorological and oceanographic data, as well as other nest site data, over a five-year period on the beaches of North Carolina from Corolla to South Nags Head. These tests included a Pearson Correlation Test, Regression Analysis, and a Baron and Kenny Mediator model. Several statistically significant correlations between weather factors were present in the analysis. These logical correlations would appear in any weather-related research and were not considered relevant for this study. Analysis centered on variables that showed a significant correlation with hatch success. It was determined that the closer to the dunes the nest is laid, the greater the hatch success rate. In addition, when nests were laid on days with no precipitation, the hatch success rate was greater. A mediator model analysis was used to explore the relationship between proximity of the nest to the dunes, precipitation and hatch success. This analysis demonstrated that precipitation influenced where the nests were laid, which in turn influenced hatch success rate. These findings demonstrate that with continued research, predictors of hatch success may be used to positively influence hatch success rates in sea turtles' northernmost nesting grounds.

Introduction

Sea turtles play a pivotal role in a healthy ocean. They graze on the ocean's sea grass, which prevents it from building up. This is helpful in a variety of ways. First, it prevents the sea grass from piling up and building up large quantities of nitrogen in the water. Nitrogen, like many minerals, can be very bad for life in larger quantities, so a thriving sea turtle population is imperative for ocean life to survive and thrive. Sea turtle grazing also benefits the populations of the oceans by limiting a lethal pathogen that spreads across the ocean by long sea grass strands. By grazing the grass and keeping the stalks short, the sea turtles help prevent a number of other species from going extinct (McClenachan, Jackson, & Newman, 2006).

As sea turtles gradually began to go extinct, being officially declared at risk with the Endangered Species Act of 1973, this pathogen began to spread rapidly, causing several other species to become at risk. Over time, as the sea turtle population has gradually regained in numbers among the seven species, the pathogen has been significantly reduced. Sea turtles also contribute greatly to the health of coral reefs. Sea sponges pose a threat to the health of a coral reef system, and by consuming the sponges, hawksbill sea turtles help protect the reefs. Many species are not equipped to consume the sponges easily, but the hawksbills have adaptations to counter the sponges' defenses (McClenachan et al., 2006).

While sea turtle hatchlings have a low survival rate, there is also an undeniable negative human impact on sea turtles. A large portion of the footprint of humanity comes in the form of litter. Sea turtles often consume pieces of trash mistaken for food, trash which then coats their stomach linings, preventing them from digesting, and eventually leading to death by starvation. Aside from pollution, human hunting patterns have also caused devastation to the sea turtle population. Over-hunting caused a steep decline in sea turtles, driving several species into extinction (McClenachan et al., 2006). But dangers for sea turtles don't just end in the past, but include the probable dangers of climate change. The gender ratio of sea turtles is determined by the incubation temperature of their nest. There is a median temperature that is relatively close between the species, in a range of 28.6 to 29.7 degrees Celsius (Kaska, Downie, Tippett, &

Furness, 1998). Any higher than this median temperature, and the brood will produce more females than males, and vice versa. An uneven distribution of the gender ratio will hinder the species' ability to reproduce, ultimately causing a decline in the population (Matsuzawa, Sata, Sakamoto, & Bjorndal, 2001). Because of this, global warming poses a distinct threat to the future of sea turtles all around the world (Saba, Stock, Spotila, Paladino, & Tomillo, 2012).

Very few sea turtle hatchlings make it to adulthood. Volunteers make great efforts to preserve sea turtles. Organizations such as the Network for Endangered Sea Turtles (N.E.S.T.) educate the general public in order to protect sea turtle nest sites. Volunteers patrol the beaches in the early morning looking for signs of a sea turtle crawl. Later, N.E.S.T. volunteers will "nest sit", camping out at night to protect the nest from predators as well as people, and to guide the turtles when they hatch (K. Clark, N.E.S.T. Volunteer Training, June 20th 2017). The N.E.S.T. organization in Corolla has collected data on the positioning, incubation time, and hatch success rates of individual nests (Clark, 2016). The Army Corps of Engineers in Duck, has collected meteorological and oceanographic data on days that the sea turtles have nested, and this data was analyzed for this experiment (United States Army Corps of Engineers, 2012-2016).

The actual nesting process is generally understood, as is the journey which sea turtles take prior to returning to specific areas to nest (Miller, Limpus & Godfrey, 2003). However, little is known about why turtles nest on the days that they do. If sea turtle volunteers could better predict the days that sea turtles are going to nest, it would save work on days when nesting is unlikely, and allow the volunteers to be more alert and responsive on days with higher chances. Increased volunteer efficiency would lead to a larger impact on the safety of nesting sea turtles, and thus a more robust population. More information on the impact of different variables on the overall success of a sea turtle nest could also potentially increase the effectiveness of sea turtle nest relocations (Pfaller, Limpus, & Bjorndal, 2008). This research focused on looking for correlations in the data on days that nests were laid, in order to attempt to understand the mother's decision-making process. When sea turtle mothers need to nest, the ideal day to nest will combine warmer air temperatures, lower wind speeds, no precipitation, and warmer water

Methods and Materials

Since previously collected data was used in the experiment, the first step was to compile and integrate data from various sources which had not previously been complied and analyzed in this manner. The division of the Network for Endangered Sea Turtles (N.E.S.T.) in Corolla, North Carolina, had compiled data on nest site location and hatch success results for 2012-2016. Historical meteorological data from Weather Underground, and oceanographic data recorded by the Army Corps of Engineers research facility in Duck, NC, was collected for each nesting date.

Data was collected for a variety of variables by N.E.S.T., including the date the nest was laid, the latitude and longitude of the nest, as well as the nest's distance from both the dunes and the high tide line. The month of the year was also used as a variable, as a means of dividing the data seasonally. The data for the distance to the dunes was calculated by finding the center of the nest, then extending measuring tape from the center of the nest to the base of the dunes. Measurements were also taken from the center of the nest to the most recent high tide line. Data was also collected by N.E.S.T. for the number of eggs in each nest, as well as the hatching success rate. Data for these variables was collected post-exodus by the N.E.S.T. volunteers, who recorded total eggs in the nest, as well as how many eggs hatched. The number of days of incubation time for each nest was also recorded (Clark, 2016).

Data collected from the Weather Underground database consisted largely of historical weather information gathered on the days nests were laid. Data was collected for nests along a

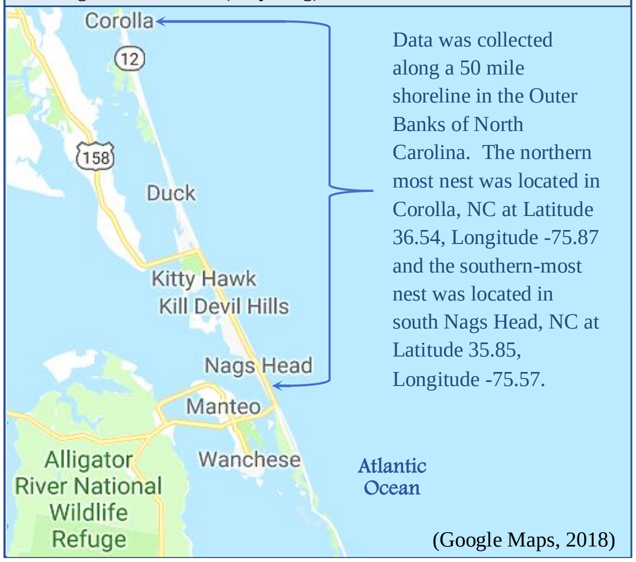


Figure A: Map showing geographic area where sea turtle nests data was collected in the northern Outer Banks of North Carolina during nesting season months (May-Aug) between 2012-2016.

50-mile shoreline in the Outer Banks of North Carolina, as shown in Figure A. Weather data was retrieved from two different stations, depending on which the nests were closest to. The first three variables collected were the maximum, minimum, and average air temperatures in the area for the day (Weather Underground, 2012-2016). This was to see if there was any correlation between nesting dates and temperature, and to see if sea turtle mothers used any of the three measures as an indicator for an appropriate day to nest. Since sea turtles survey the beach where they intend to nest during the day, it seems possible they could look for a specific temperature during the day, or look for days within a specific range (Miller et al., 2003). Air temperatures for each day were recorded, as sea turtles surface for air periodically. In addition, data was taken for precipitation, sea level pressure, max wind speed, and the average humidity. Data was also collected from the Duck Research Pier maintained by the Army Corps of Engineers. The research pier data was collected for water salinity, sea level pressure and average water temperature for the days that nests were laid (United States Army Corps of Engineers, 2012-2016). Data was first compiled and integrated using Microsoft Excel. Next, variables were defined and a data set was created in SPSS. The SPSS statistical analysis tools were then used to analyze the data. The first test used to analyze the data was the Pearson Bivariate Correlation Test. This test was used to look for correlations between any two variables on nesting days, in order to construct a better picture of what days lead to a successful nest in the long term. A baseline of a p-value of .05 was used to determine significance. The next test step was a regression analysis on the variables correlated with hatch success to determine predictor significance. Then a Baron and Kenny Mediator Model analysis was performed to determine if any of the significant variables had a mediating effect on the other (Baron & Kenny, 1986). Additional analysis was done using excel to plot mean averages of variables over time looking for trends or patterns in the data.

Results

The Pearson Correlation Test was run by inputting all compiled variables and generating a bivariate correlation test to identify any significant correlations between variables. The highlighted variables, shown in Appendix, Table 1 with values within a range of (0, .05), show a significant correlation to one another. In addition, looking at the Pearson Correlation value shows whether the correlation is negative or positive. A negative Pearson Correlation value signifies a negative correlation, and therefore an inverse relationship, while a positive Pearson Correlation value shows a positive correlation, which is a direct relationship.

This study focused on the variables that had a direct correlation with the overall hatch success rate as shown in Table A. Correlations between meteorological or oceanographic

Table A: Pearson bivariate correlation test identifying statistical significance (p-value .05) between oceanographic, meteorological and other variables related to sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016

		Latitude	Longitude	Nest2 dunes	Nest2 tides	Maximum Air Temp	Minimum Air Temp	Mean Air Temp	Average Humidity	Sea Level Pressure	Maximum Wind Speed	Precipitation	Salinity PSU	Water Temp C	Months	Hatch Success	Egg Number	Incubation Time
Nest2 dunes	Pearson Correlation	.048	.141	1	-.282**	.009	.133	.079	.022	-.018	.034	.191*	.183	-.101	-.022	-.284**	.073	.074
	Sig. (2-tailed)	.588	.110		.001	.919	.132	.370	.801	.842	.700	.030	.103	.373	.806	.008	.505	.536
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Maximum Air Temp	Pearson Correlation	.074	.092	.009	.135	1	.464**	.705**	-.230**	-.437**	.083	-.189*	.357**	.050	.055	.243*	-.055	-.251*
	Sig. (2-tailed)	.403	.298	.919	.125		.000	.000	.009	.000	.349	.032	.001	.660	.533	.024	.615	.033
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Average Humidity	Pearson Correlation	-.024	-.120	.022	-.179*	-.230**	.144	-.036	1	.095	-.174*	.297**	-.152	.173	.274**	-.237*	.033	.064
	Sig. (2-tailed)	.783	.173	.801	.042	.009	.103	.682		.283	.047	.001	.175	.125	.002	.028	.763	.590
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Precipitation	Pearson Correlation	-.062	-.042	.191*	-.257**	-.189*	.046	-.046	.297**	-.096	.111	1	.051	-.090	.212*	-.341**	.125	.025
	Sig. (2-tailed)	.485	.632	.030	.003	.032	.603	.604	.001	.276	.207		.648	.429	.015	.001	.250	.837
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73

variables that would always be present in nature were considered in the analysis but ultimately excluded for this hatch success study. Several results stood out from this analysis. First, there were no oceanographic variables that showed statistical significance of any kind with hatch success. This result suggests that ocean salinity, water temperature and sea level pressure do not influence sea turtle nesting results. There were three meteorological variables that showed significant correlations with hatch success. These variables were maximum air temperature, average humidity and precipitation. Maximum air temperature was positively correlated with hatch success while average humidity and precipitation were negatively correlated. In addition, nest to dunes was negatively correlated with hatch success.

Once the correlations to hatch success were identified, regression analysis was run on each variable to determine the strength of the predictor variable. Both the significance values and coefficient of determination values demonstrate that nest to dunes and precipitation are stronger predictors of hatch success than average humidity or maximum air temperature, as shown in Table B, Outputs A and B as compared to Table C, Outputs C and D.

Table B: Linear regression analysis identifying predictor variable significance (p-value .05) for Precipitation, and Nest Distance to Dunes and dependent variable Hatch Success for sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016

OUTPUT A

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.341[a]	.116	.106	.33330	.116	11.044	1	84	.001

a. Predictors: (Constant), Precipitation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.227	1	1.227	11.044	.001[b]
	Residual	9.331	84	.111		
	Total	10.558	85			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), Precipitation

OUTPUT B

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.284[a]	.081	.070	.33988	.081	7.397	1	84	.008

a. Predictors: (Constant), Nest2dunes

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.855	1	.855	7.397	.008[b]
	Residual	9.704	84	.116		
	Total	10.558	85			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), Nest2dunes

Table C: Linear regression analysis identifying predictor variable significance (p-value .05) for Maximum Air Temp and Humidity, and dependent variable Hatch Success, for sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016

OUTPUT C

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.243[a]	.059	.048	.34389	.059	5.280	1	84	.024

a. Predictors: (Constant), MaxAirTemp

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.624	1	.624	5.280	.024[b]
	Residual	9.934	84	.118		
	Total	10.558	85			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), MaxAirTemp

OUTPUT D

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.237[a]	.056	.045	.34442	.056	5.005	1	84	.028

a. Predictors: (Constant), AvgHumidity

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.594	1	.594	5.005	.028[b]
	Residual	9.965	84	.119		
	Total	10.558	85			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), AvgHumidity

Discussion and Conclusions

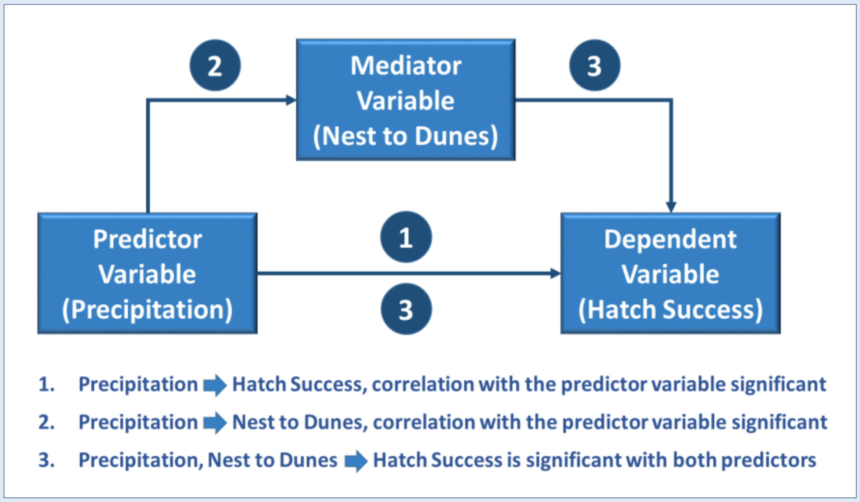
Based on the statistical analysis and my observations while performing field research, precipitation is the meteorological variable that was investigated further. It is unlikely that maximum air temperature on the day the nest was laid is a significant factor, as temperature is known to effect nest success over the total nesting period, not just on the day the nest is laid (Segura & Cajade, 2010). Humidity falls into the same category and is correlated with hatch success simply because of its direct correlation with precipitation.

Precipitation has a negative correlation with hatch success. This means that the less rain that falls, the more successful the nest tends to be. Part of the reason for this negative correlation is that rain comes with storms, especially during nesting season. I personally witnessed a sea turtle mother nesting during a powerful thunderstorm, and she appeared disoriented by the lightening and strong heavy rain, with an unusual crawl pattern as she returned to the ocean. Rain could also potentially affect the sand that sea turtle mothers dig into or the placement of the nest, which could have negative implications for hatch success. In addition to the correlation with hatch success, precipitation also has a positive correlation with nest to dunes measurements.

Nest to dunes was also analyzed further because of what appeared to be an obvious causal relationship with hatch success. Nest to dunes was negatively correlated to hatch success. This means, that the closer the nest is to the dunes, the greater the hatch success rate. It is logical to assume that the closer the nest is to the dunes and the further away from the high tide line, the less likely the nest will get washed out by high tides. In addition, because nest to dunes was correlated with precipitation, further investigation into these relationships was warranted.

In order to explore the relationship between nest to dunes, precipitation and hatch success, a mediating variable test was run (Baron & Kenny, 1986). This model is described here

Figure B: Diagram illustrating the steps performed in a Baron and Kenny Model Hypothesis test which demonstrates a mediating variable effect between the predictor variable of precipitation and the mediator variable of nest distance to dunes, for sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016.



in Figure B. Step one was to run a linear regression analysis for independent variable (precipitation) and dependent variable (hatch success), as shown in Table B, Output A. The second step was to run a regression analysis with independent variable (precipitation) and dependent variable (nest to dunes), as shown in Table D, Output E. The last step was to run a multi-variable regression analysis with independent variables (nest to dunes, precipitation) and dependent variable (hatch success), as shown in Table D, Output F.

Table D: Linear regression analysis identifying predictor variable significance (p-value .05) for Precipitation and dependent variable Nest to Dunes

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	.191[a]	.036	.029	9.13095	.036	4.846	1	128	.030

a. Predictors: (Constant), Precipitation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	404.038	1	404.038	4.846	.030[b]
	Residual	10671.908	128	83.374		
	Total	11075.946	129			

a. Dependent Variable: Nest2dunes
b. Predictors: (Constant), Precipitation

OUTPUT E

Multi-variable linear regression analysis identifying predictor variable significance (p-value .05) for Precipitation and Nest to Dunes distance and dependent variable Hatch Success

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	.400[a]	.160	.140	.32686	.160	7.912	2	83	.001

a. Predictors: (Constant), Precipitation, Nest2dunes

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.691	2	.845	7.912	.001[b]
	Residual	8.868	83	.107		
	Total	10.558	85			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), Precipitation, Nest2dunes

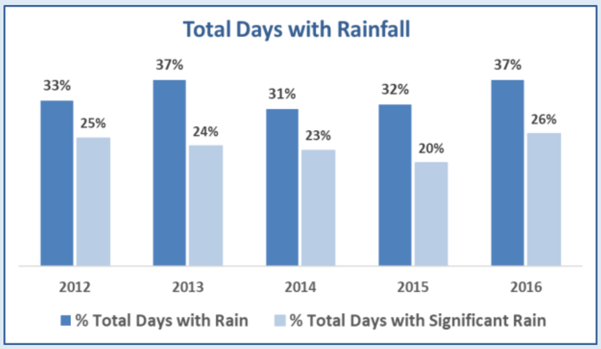
OUTPUT F

Data is for sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016

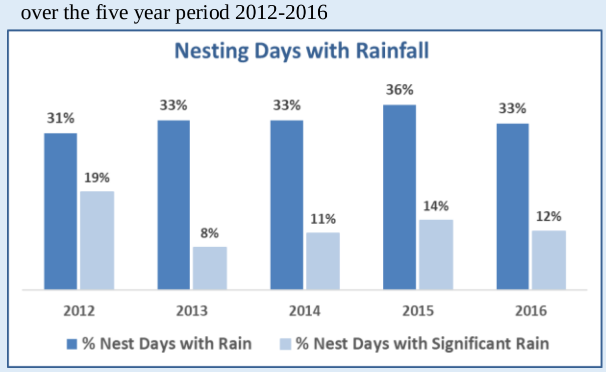
In each test, the predictor was significant. This analysis indicates that in addition to nest to dunes and precipitation being predictors of hatch success, precipitation also influences nest to dunes, which in turn influences hatch success. This is known as a mediating effect, meaning the closer to the dunes the nest is laid, the greater the hatch success rate. In addition, when nests are laid on days with no precipitation, they are more likely to be laid closer to the dunes, which improves the hatch success rate.

Because precipitation plays both a direct and indirect role in hatch success, further analysis of precipitation was conducted. Over the five-year period that data was collected, precipitation days were analyzed for each year during the nesting period, as seen in Graphs A & B. On average, during the five year period, it rained on 34% of all days and 33% of days nests

Graph A: Percentage days with rainfall compared to days with significant rainfall (> .1 inch) during the nesting season (May-Aug) for sea turtle nests in the northern Outer Banks of North Carolina over the five year period 2012-2016



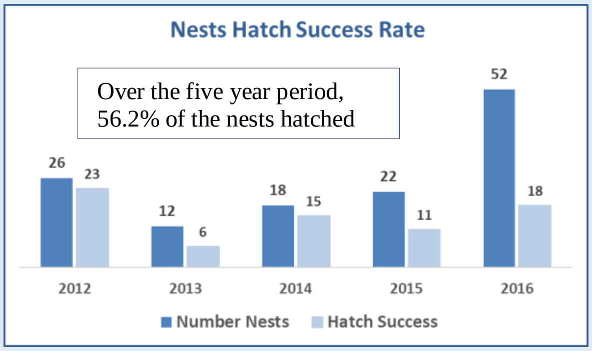
Graph B: Percentage days with rainfall compared to days with significant rainfall (> .1 inch) on days nest were laid (May-Aug) for sea turtle nests in the northern Outer Banks of North Carolina over the five year period 2012-2016



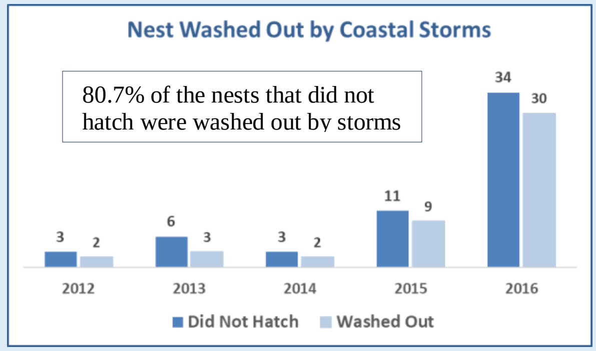
were laid. However, when days with minimal precipitation, as defined by less than .10 inch, are excluded, these percentages are much different. On average, during the five year period, there was significant precipitation on 26% of all days but nests were laid on only 12% of days with more than .10 inch of precipitation. This significant difference suggests that turtles may avoid nesting on days with heavy rain and more significant storms.

While the hatch success sample size was adequate for statistical analysis, several nests, especially in 2016, lacked hatch success data due to being washed out by storms, as seen in graphs C & D. In order to estimate whether or not these missing data points had any significant effect on the outcomes of the analysis, the mean hatch success data was calculated, and input for the nests with missing data. The bivariate correlation analysis was run again on the four major

Graph C: Average number of sea turtle nests laid compared to average number of nests that hatched in the northern Outer Banks of North Carolina over the five year period 2012-2016



Graph D: Average number of sea turtle nests that did not hatch compared to nests washed out by storms in the northern Outer Banks of North Carolina over the five year period 2012-2016



variables, as shown in Table E. This new analysis supports the prior conclusions. The same correlatios with similar levels of significance were present in the analysis.

Table E: Pearson bivariate correlation test identifying statistical significance (p-value .05) between oceanographic, meteorological and other variables related to sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016. The test includes the addition of mean averages for nests that did not have hatch success data because the nest were washed out by storms.

		Latitude	Longitude	Nest2 dunes	Nest2 tides	Maximum Air Temp	Minimum Air Temp	Mean Air Temp	Average Humidity	Sea Level Pressure	Maximum Wind	Precipitation	Salinity PSU	Water Temp C	Months	Hatch Success	Egg Number	Incubation Time
Hatch Success	Pearson Correlation	.045	-.084	-.260**	-.076	.201*	-.036	.055	-.203*	-.037	-.150	-.266**	-.176	.129	.041	1	-.128	-.151
	Sig. (2-tailed)	.609	.344	.003	.390	.022	.682	.531	.020	.673	.090	.002	.115	.255	.647		.146	.085
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	131	131	131

Overall, the hypothesis is partially proven. The portion of the hypothesis that stated an ideal day would include warmer air temperature and no precipitation was correct. The two other variables included in the hypothesis, water temperature and wind speeds, showed no significant correlation with hatch success. The hypothesis also didn't include variables not related to weather, omitting a significant finding, as a corellation between nest to dunes distance and hatch success was uncovered. In addition, a mediating effect was demonstrated between nest to dunes distance and precipitation. Precipitation significantly influenced the distance the nest was laid from the dunes, which influenced hatch success. In conclusion, these research findings are important. Predictors of hatch success can be used to determine how to relocate sea turtle nests when necessary, in order to positively influence success rates in the northernmost nesting grounds, and ultimately preserve the species as global warming impacts male to female ratio.

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Appendix

Appendix Table 1: Pearson bivariate correlation test identifying statistical significance (p-value .05) between oceanographic, meteorological and other variables related to sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016. This analysis includes all variables analyzed in this research study

		Latitude	Longitude	Nest2 dunes	Nest2 tides	Maximum Air Temp	Minimum Air Temp	Mean Air Temp	Average Humidity	Sea Level Pressure	Maximum Wind	Precipitation	Salinity PSU	Water Temp C	Months	Hatch Success	Egg Number	Incubation Time
Latitude	Pearson Correlation	1	.081	.048	.128	.074	-.054	.008	-.024	.047	.014	-.062	-.050	-.002	-.090	.053	.002	-.294*
	Sig. (2-tailed)		.361	.588	.146	.403	.538	.925	.783	.599	.874	.485	.655	.987	.310	.627	.988	.012
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Longitude	Pearson Correlation	.081	1	.141	.058	.092	.040	.089	-.120	-.197*	.022	-.042	.124	.039	.033	-.084	-.031	-.088
	Sig. (2-tailed)	.361		.110	.515	.298	.652	.316	.173	.025	.803	.632	.269	.728	.712	.440	.774	.461
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Nest2 dunes	Pearson Correlation	.048	.141	1	-.282**	.009	.133	.079	.022	-.018	.034	.191*	.183	-.101	-.022	-.284**	.073	.074
	Sig. (2-tailed)	.588	.110		.001	.919	.132	.370	.801	.842	.700	.030	.103	.373	.806	.008	.505	.536
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Nest2 tides	Pearson Correlation	.128	.058	-.282**	1	.135	.159	.218*	-.179*	.039	-.134	-.257**	.068	.083	.042	-.189	-.191	-.034
	Sig. (2-tailed)	.146	.515	.001		.125	.071	.013	.042	.657	.130	.003	.547	.462	.636	.081	.078	.775
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Maximum Air Temp	Pearson Correlation	.074	.092	.009	.135	1	.464**	.705**	-.230**	-.437**	.083	-.189*	.357**	.050	.055	.243*	-.055	-.251*
	Sig. (2-tailed)	.403	.298	.919	.125		.000	.000	.009	.000	.349	.032	.001	.660	.533	.024	.615	.033
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Minimum Air Temp	Pearson Correlation	-.054	.040	.133	.159	.464**	1	.881**	.144	-.341**	.068	.046	.238*	.240*	.313**	-.039	-.021	-.090
	Sig. (2-tailed)	.538	.652	.132	.071	.000		.000	.103	.000	.444	.603	.032	.032	.000	.718	.844	.447
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Mean Air Temp	Pearson Correlation	.008	.089	.079	.218*	.705**	.881**	1	-.036	-.422**	.079	-.046	.374**	.244*	.275**	.065	.028	-.169
	Sig. (2-tailed)	.925	.316	.370	.013	.000	.000		.682	.000	.374	.604	.001	.029	.002	.549	.799	.152
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Average Humidity	Pearson Correlation	-.024	-.120	.022	-.179*	-.230**	.144	-.036	1	.095	-.174*	.297**	-.152	.173	.274**	-.237*	.033	.064
	Sig. (2-tailed)	.783	.173	.801	.042	.009	.103	.682		.283	.047	.001	.175	.125	.002	.028	.763	.590
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Sea Level Pressure	Pearson Correlation	.047	-.197*	-.018	.039	-.437**	-.341**	-.422**	.095	1	-.340**	-.096	-.334**	.094	-.026	-.041	-.065	.076
	Sig. (2-tailed)	.599	.025	.842	.657	.000	.000	.000	.283		.000	.276	.002	.408	.768	.708	.550	.523
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Appendix Table 1 (cont.): Pearson bivariate correlation test identifying statistical significance (p-value .05) between oceanographic, meteorological and other variables related to sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016. This analysis includes all variables included in the study

		Latitude	Longitude	Nest2 dunes	Nest2 tides	Maximum Air Temp	Minimum Air Temp	Mean Air Temp	Average Humidity	Sea Level Pressure	Maximum Wind	Precipitation	Salinity PSU	Water Temp C	Months	Hatch Success	Egg Number	Incubation Time
Maximum Wind Speed	Pearson Correlation	.014	.022	.034	-.134	.083	.068	.079	-.174*	-.340**	1	.111	.222*	-.226*	-.212*	-.173	.007	.050
	Sig. (2-tailed)	.874	.803	.700	.130	.349	.444	.374	.047	.000		.207	.046	.044	.016	.111	.948	.674
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Precipitation	Pearson Correlation	-.062	-.042	.191*	-.257**	-.189*	.046	-.046	.297**	-.096	.111	1	.051	-.090	.212*	-.341**	.125	.025
	Sig. (2-tailed)	.485	.632	.030	.003	.032	.603	.604	.001	.276	.207		.648	.429	.015	.001	.250	.837
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Salinity PSU	Pearson Correlation	-.050	.124	.183	.068	.357**	.238*	.374**	-.152	-.334**	.222*	.051	1	-.393**	-.105	-.244	-.046	.090
	Sig. (2-tailed)	.655	.269	.103	.547	.001	.032	.001	.175	.002	.046	.648		.000	.350	.075	.742	.554
	N	81	81	81	81	81	81	81	81	81	81	81	81	80	81	54	54	46
Water Temp C	Pearson Correlation	-.002	.039	-.101	.083	.050	.240*	.244*	.173	.094	-.226*	-.090	-.393**	1	.333**	.175	.092	-.439**
	Sig. (2-tailed)	.987	.728	.373	.462	.660	.032	.029	.125	.408	.044	.429	.000		.003	.210	.511	.003
	N	80	80	80	80	80	80	80	80	80	80	80	80	80	80	53	53	45
Months	Pearson Correlation	-.090	.033	-.022	.042	.055	.313**	.275**	.274**	-.026	-.212*	.212*	-.105	.333**	1	.051	-.068	.102
	Sig. (2-tailed)	.310	.712	.806	.636	.533	.000	.002	.002	.768	.016	.015	.350	.003		.640	.536	.389
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	86	86	73
Hatch Success	Pearson Correlation	.053	-.084	-.284**	-.189	.243*	-.039	.065	-.237*	-.041	-.173	-.341**	-.244	.175	.051	1	-.128	-.290*
	Sig. (2-tailed)	.627	.440	.008	.081	.024	.718	.549	.028	.708	.111	.001	.075	.210	.640		.241	.013
	N	86	86	86	86	86	86	86	86	86	86	86	54	53	86	86	86	73
Egg Number	Pearson Correlation	.002	-.031	.073	-.191	-.055	-.021	.028	.033	-.065	.007	.125	-.046	.092	-.068	-.128	1	-.112
	Sig. (2-tailed)	.988	.774	.505	.078	.615	.844	.799	.763	.550	.948	.250	.742	.511	.536	.241		.343
	N	86	86	86	86	86	86	86	86	86	86	86	54	53	86	86	86	73
Incubation Time	Pearson Correlation	-.294*	-.088	.074	-.034	-.251*	-.090	-.169	.064	.076	.050	.025	.090	-.439**	.102	-.290*	-.112	1
	Sig. (2-tailed)	.012	.461	.536	.775	.033	.447	.152	.590	.523	.674	.837	.554	.003	.389	.013	.343	
	N	73	73	73	73	73	73	73	73	73	73	73	46	45	73	73	73	73

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Appendix, Table 2: Linear regression analysis, including coefficients, identifying predictor variable significance (p-value .05) for Precipitation, Maximum Air Temp, Humidity and Nest Distance to Dunes for dependent variable Hatch Success, for sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.284[a]	.081	.070	.33988	.081	7.397	1	84	.008

a. Predictors: (Constant), Nest2dunes

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.855	1	.855	7.397	.008[b]
	Residual	9.704	84	.116		
	Total	10.558	85			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), Nest2dunes

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	.832	.069		12.043	.000	.694	.969
	Nest2dunes	-.011	.004	-.284	-2.720	.008	-.019	-.003

a. Dependent Variable: HatchSuccess

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.341[a]	.116	.106	.33330	.116	11.044	1	84	.001

a. Predictors: (Constant), Precipitation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.227	1	1.227	11.044	.001[b]
	Residual	9.331	84	.111		
	Total	10.558	85			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), Precipitation

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	.710	.038		18.854	.000	.635	.785
	Precipitation	-.509	.153	-.341	-3.323	.001	-.814	-.205

a. Dependent Variable: HatchSuccess

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.237[a]	.056	.045	.34442	.056	5.005	1	84	.028

a. Predictors: (Constant), AvgHumidity

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.594	1	.594	5.005	.028[b]
	Residual	9.965	84	.119		
	Total	10.558	85			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), AvgHumidity

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	1.275	.272		4.690	.000	.734	1.816
	AvgHumidity	-.009	.004	-.237	-2.237	.028	-.016	-.001

a. Dependent Variable: HatchSuccess

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.243[a]	.059	.048	.34389	.059	5.280	1	84	.024

a. Predictors: (Constant), MaxAirTemp

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.624	1	.624	5.280	.024[b]
	Residual	9.934	84	.118		
	Total	10.558	85			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), MaxAirTemp

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	-.601	.556		-1.082	.282	-1.707	.504
	MaxAirTemp	.015	.006	.243	2.298	.024	.002	.027

a. Dependent Variable: HatchSuccess

Appendix, Table 3: Linear regression analysis, with coefficients, identifying predictor variable significance (p-value .05) for Precipitation and dependent variable Nest to Dunes

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.191[a]	.036	.029	9.13095	.036	4.846	1	128	.030

a. Predictors: (Constant), Precipitation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	404.038	1	404.038	4.846	.030[b]
	Residual	10671.908	128	83.374		
	Total	11075.946	129			

a. Dependent Variable: Nest2dunes
b. Predictors: (Constant), Precipitation

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	13.482	.845		15.950	.000	11.809	15.154
	Precipitation	7.209	3.275	.191	2.201	.030	.729	13.688

a. Dependent Variable: Nest2dunes

Multi-variable linear regression analysis, with coefficients, identifying predictor variable significance (p-value .05) for Precipitation and Nest to Dunes distance and dependent variable Hatch Success

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.400[a]	.160	.140	.32686	.160	7.912	2	83	.001

a. Predictors: (Constant), Precipitation, Nest2dunes

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.691	2	.845	7.912	.001[b]
	Residual	8.868	83	.107		
	Total	10.558	85			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), Precipitation, Nest2dunes

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	.825	.066		12.412	.000	.693	.957
	Nest2dunes	-.008	.004	-.216	-2.084	.040	-.016	.000
	Precipitation	-.433	.155	-.290	-2.798	.006	-.740	-.125

a. Dependent Variable: HatchSuccess

Data is for sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016

Appendix Table 4: Pearson bivariate correlation test identifying statistical significance (p-value .05) between oceanographic, meteorological and other variables related to sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016. This analysis includes all variables included in the study and mean averages for nests that did not have hatch success data because the nest were washed out by storms.

		Latitude	Longitude	Nest2 dunes	Nest2 tides	Maximum Air Temp	Minimum Air Temp	Mean Air Temp	Average Humidity	Sea Level Pressure	Maximum Wind	Precipitation	Salinity PSU	Water Temp C	Months	Hatch Success	Egg Number	Incubation Time
Latitude	Pearson Correlation	1	.081	.024	.105	.074	-.054	.008	-.024	.047	.014	-.062	-.050	-.002	-.090	.045	.001	-.192*
	Sig. (2-tailed)		.361	.783	.235	.403	.538	.925	.783	.599	.874	.485	.655	.987	.310	.609	.989	.029
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	130	130	130
Longitude	Pearson Correlation	.081	1	.148	.035	.092	.040	.089	-.120	-.197*	.022	-.042	.124	.039	.033	-.084	-.030	-.063
	Sig. (2-tailed)	.361		.094	.692	.298	.652	.316	.173	.025	.803	.632	.269	.728	.712	.344	.732	.479
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	130	130	130
Nest2 dunes	Pearson Correlation	.024	.148	1	-.255**	.037	.109	.087	-.027	-.050	.091	.229**	.246*	-.110	-.036	-.260**	.086	.031
	Sig. (2-tailed)	.783	.094		.003	.679	.216	.326	.760	.568	.303	.009	.027	.331	.684	.003	.331	.724
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	130	130	130
Nest2 tides	Pearson Correlation	.105	.035	-.255**	1	.050	.182*	.196*	-.068	.043	-.090	-.176*	-.023	.127	.114	-.076	-.089	.046
	Sig. (2-tailed)	.235	.692	.003		.572	.038	.025	.440	.629	.309	.045	.840	.261	.196	.390	.314	.600
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	130	130	130
Maximum Air Temp	Pearson Correlation	.074	.092	.037	.050	1	.464**	.705**	-.230**	-.437**	.083	-.189*	.357**	.050	.055	.201*	-.046	-.182*
	Sig. (2-tailed)	.403	.298	.679	.572		.000	.000	.009	.000	.349	.032	.001	.660	.533	.022	.600	.038
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	130	130	130
Minimum Air Temp	Pearson Correlation	-.054	.040	.109	.182*	.464**	1	.881**	.144	-.341**	.068	.046	.238*	.240*	.313**	-.036	-.023	-.090
	Sig. (2-tailed)	.538	.652	.216	.038	.000		.000	.103	.000	.444	.603	.032	.032	.000	.682	.799	.308
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	130	130	130
Mean Air Temp	Pearson Correlation	.008	.089	.087	.196*	.705**	.881**	1	-.036	-.422**	.079	-.046	.374**	.244*	.275**	.055	.021	-.148
	Sig. (2-tailed)	.925	.316	.326	.025	.000	.000		.682	.000	.374	.604	.001	.029	.002	.531	.811	.092
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	130	130	130
Average Humidity	Pearson Correlation	-.024	-.120	-.027	-.068	-.230**	.144	-.036	1	.095	-.174*	.297**	-.152	.173	.274**	-.203*	.024	.034
	Sig. (2-tailed)	.783	.173	.760	.440	.009	.103	.682		.283	.047	.001	.175	.125	.002	.020	.787	.700
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	130	130	130
Sea Level Pressure	Pearson Correlation	.047	-.197*	-.050	.043	-.437**	-.341**	-.422**	.095	1	-.340**	-.096	-.334**	.094	-.026	-.037	-.060	.057
	Sig. (2-tailed)	.599	.025	.568	.629	.000	.000	.000	.283		.000	.276	.002	.408	.768	.673	.500	.516
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	130	130	130

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Appendix Table 4 (cont.): Pearson bivariate correlation test identifying statistical significance (p-value .05) between oceanographic, meteorological and other variables related to sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016. This analysis includes all variables included in the study and mean averages for nests that did not have hatch success data because the nests were washed out by storms.

		Latitude	Longitude	Nest2 dunes	Nest2 tides	Maximum Air Temp	Minimum Air Temp	Mean Air Temp	Average Humidity	Sea Level Pressure	Maximum Wind	Precipitation	Salinity PSU	Water Temp C	Months	Hatch Success	Egg Number	Incubation Time
Maximum Wind Speed	Pearson Correlation	.014	.022	.091	-.090	.083	.068	.079	-.174*	-.340**	1	.111	.222*	-.226*	-.212*	-.150	.008	.042
	Sig. (2-tailed)	.874	.803	.303	.309	.349	.444	.374	.047	.000		.207	.046	.044	.016	.090	.927	.633
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	130	130	130
Precipitation	Pearson Correlation	-.062	-.042	.229**	-.176*	-.189*	.046	-.046	.297**	-.096	.111	1	.051	-.090	.212*	-.266**	.097	.004
	Sig. (2-tailed)	.485	.632	.009	.045	.032	.603	.604	.001	.276	.207		.648	.429	.015	.002	.271	.966
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	130	130	130
Salinity PSU	Pearson Correlation	-.050	.124	.246*	-.023	.357**	.238*	.374**	-.152	-.334**	.222*	.051	1	-.393**	-.105	-.176	-.063	.068
	Sig. (2-tailed)	.655	.269	.027	.840	.001	.032	.001	.175	.002	.046	.648		.000	.350	.115	.577	.549
	N	81	81	81	81	81	81	81	81	81	81	81	81	80	81	81	81	81
Water Temp C	Pearson Correlation	-.002	.039	-.110	.127	.050	.240*	.244*	.173	.094	-.226*	-.090	-.393**	1	.333**	.129	.110	-.302**
	Sig. (2-tailed)	.987	.728	.331	.261	.660	.032	.029	.125	.408	.044	.429	.000		.003	.255	.330	.007
	N	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Months	Pearson Correlation	-.090	.033	-.036	.114	.055	.313**	.275**	.274**	-.026	-.212*	.212*	-.105	.333**	1	.041	-.061	.042
	Sig. (2-tailed)	.310	.712	.684	.196	.533	.000	.002	.002	.768	.016	.015	.350	.003		.647	.492	.635
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	130	130	130
Hatch Success	Pearson Correlation	.045	-.084	-.260**	-.076	.201*	-.036	.055	-.203*	-.037	-.150	-.266**	-.176	.129	.041	1	-.128	-.151
	Sig. (2-tailed)	.609	.344	.003	.390	.022	.682	.531	.020	.673	.090	.002	.115	.255	.647		.146	.085
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	131	131	131
Egg Number	Pearson Correlation	.001	-.030	.086	-.089	-.046	-.023	.021	.024	-.060	.008	.097	-.063	.110	-.061	-.128	1	-.108
	Sig. (2-tailed)	.989	.732	.331	.314	.600	.799	.811	.787	.500	.927	.271	.577	.330	.492	.146		.218
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	131	131	131
Incubation Time	Pearson Correlation	-.192*	-.063	.031	.046	-.182*	-.090	-.148	.034	.057	.042	.004	.068	-.302**	.042	-.151	-.108	1
	Sig. (2-tailed)	.029	.479	.724	.600	.038	.308	.092	.700	.516	.633	.966	.549	.007	.635	.085	.218	
	N	130	130	130	130	130	130	130	130	130	130	130	81	80	130	131	131	131

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Appendix, Table 5: Linear regression analysis identifying predictor variable significance (p-value .05) for predictor variables Precipitation and Nest Distance to Dunes and dependent variable Hatch Success.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.260[a]	.068	.061	.27730

a. Predictors: (Constant), Nest2dunes

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.716	1	.716	9.312	.003[b]
	Residual	9.842	128	.077		
	Total	10.558	129			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), Nest2dunes

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.778	.043		18.283	.000
	Nest2dunes	-.008	.003	-.260	-3.052	.003

a. Dependent Variable: HatchSuccess

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.266[a]	.071	.064	.27685

a. Predictors: (Constant), Precipitation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.748	1	.748	9.759	.002[b]
	Residual	9.810	128	.077		
	Total	10.558	129			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), Precipitation

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.697	.026		27.211	.000
	Precipitation	-.310	.099	-.266	-3.124	.002

a. Dependent Variable: HatchSuccess

Data is for sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016. The test includes the addition of mean averages for nests that did not have hatch success data because the nests were washed out by storms.

Appendix, Table 6: Linear regression analysis identifying predictor variable significance (p-value .05) for Precipitation and dependent variable Nest to Dunes distance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.229[a]	.052	.045	9.17870

a. Predictors: (Constant), Precipitation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	596.432	1	596.432	7.079	.009[b]
	Residual	10783.819	128	84.249		
	Total	11380.251	129			

a. Dependent Variable: Nest2dunes
b. Predictors: (Constant), Precipitation

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	12.720	.850		14.971	.000
	Precipitation	8.759	3.292	.229	2.661	.009

a. Dependent Variable: Nest2dunes

Multi-variable linear regression analysis identifying predictor variable significance (p-value .05) for Precipitation and Nest to Dunes distance and dependent variable Hatch Success

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.336[a]	.113	.099	.27158

a. Predictors: (Constant), Precipitation, Nest2dunes

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.191	2	.596	8.077	.000[b]
	Residual	9.367	127	.074		
	Total	10.558	129			

a. Dependent Variable: HatchSuccess
b. Predictors: (Constant), Precipitation, Nest2dunes

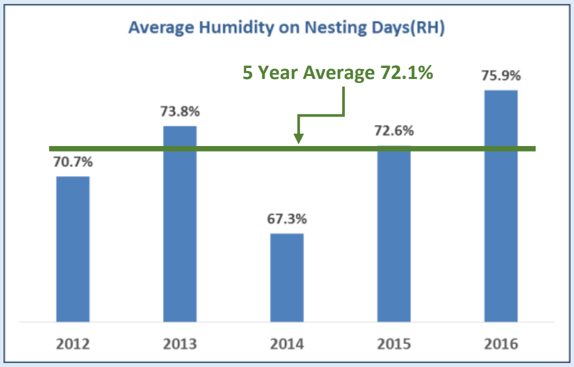
Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.779	.042		18.680	.000
	Nest2dunes	-.006	.003	-.211	-2.452	.016
	Precipitation	-.254	.100	-.218	-2.539	.012

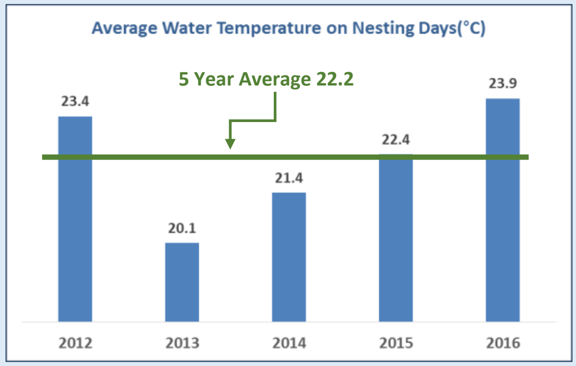
a. Dependent Variable: HatchSuccess

Data is for sea turtle nests located in the northern Outer Banks of North Carolina between 2012-2016. The test includes the addition of mean averages for nests that did not have hatch success data because the nests were washed out by storms.

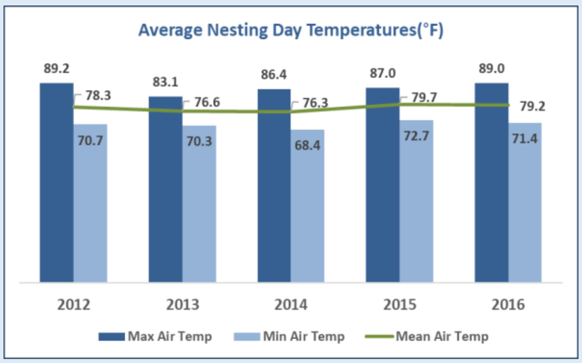
Appendix, Graph 1: Average humidity on days sea turtle nests were laid in the northern Outer Banks of North Carolina between 2012-2016



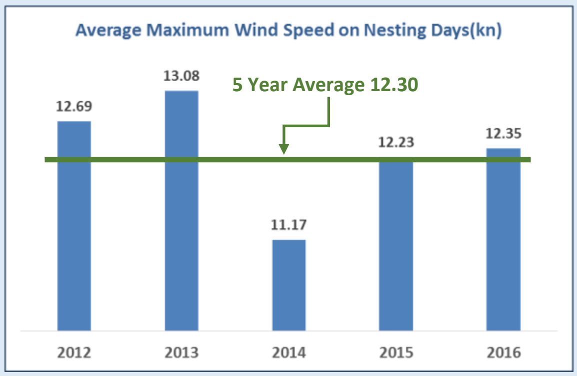
Appendix, Graph 2: Average water temperature on days sea turtle nests were laid in the northern Outer Banks of North Carolina between 2012-2016



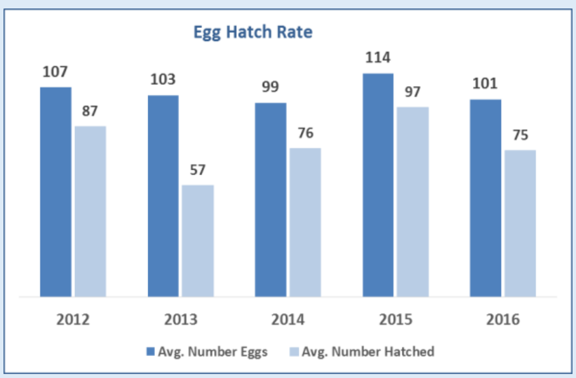
Appendix, Graph 3: Average air temperatures on days sea turtle nests were laid in the northern Outer Banks of North Carolina between 2012-2016



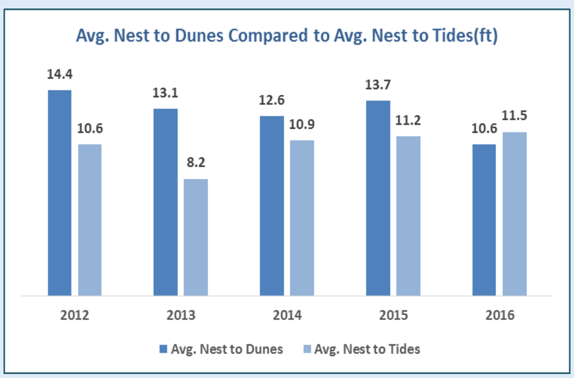
Appendix, Graph 4: Average wind speed on days sea turtle nests were laid in the northern Outer Banks of North Carolina between 2012-2016



Appendix, Graph 5: Average number of eggs laid compared to average number of eggs hatched for sea turtle nests in the northern Outer Banks of North Carolina between 2012-2016

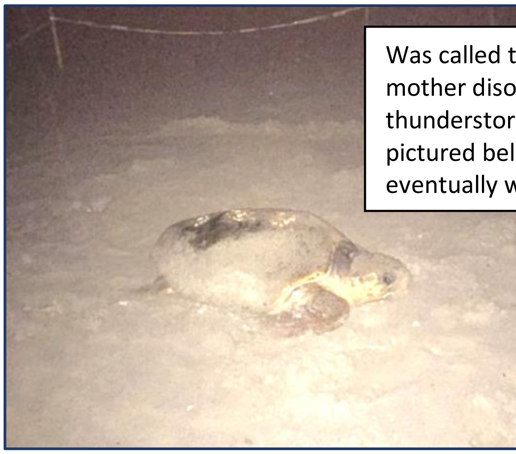


Appendix, Graph 6: Average nest distance from the dunes compared to average nest distance from the last high tide for sea turtle nests laid in the northern Outer Banks of North Carolina between 2012-2016



Photographs of Field Research Activities

All photographs taken by researcher and J.T. Griffith

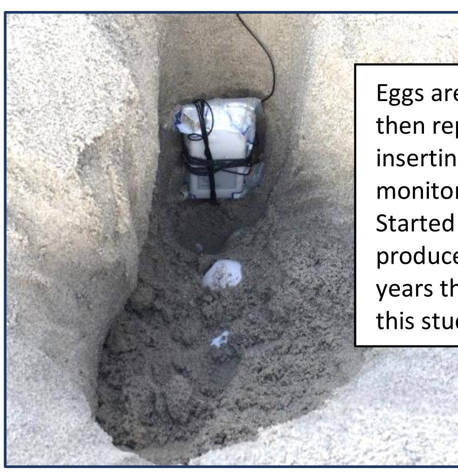


Was called to assist a Loggerhead mother disoriented in a thunderstorm. This nest is pictured below and was eventually washed out.

Taking nest to dunes measurement

Using DolphinEar hydrophones to monitor nest activity

Counting shells to gather hatch success data



Eggs are removed and then replaced after inserting nest temperature monitoring equipment. Started in 2017 and will produce data in future years that could further this study.

Nest of Loggerhead pictured above eventually washed out