

## Phase One Summary and Results

# The effects of vegetation on leatherback (*Dermochelys coriacea*) nest productivity at Sandy Point, St. Croix

Jeremy Conrad<sup>1,2</sup>, Jeanne A. Garner<sup>1</sup>, and Jeanette Wyneken<sup>2</sup>

<sup>1</sup>WIMARCS, Frederiksted, St. Croix

<sup>2</sup>Florida Atlantic University, Boca Raton, FL

### Introduction

One of the primary goals of the leatherback project on (SPNWR) is to maximize productivity measured by hatching and emergence success. These measures of productivity are directly related to the maternal investment in each nest and the nesting environment. This project focuses on the nest environment and examines the effects that vegetation has on that environment and nest productivity. The invasion of the nest by both native and non-native (exotic) vegetation may have adverse effects on sea turtle nest productivity. Vegetation may increase embryonic mortality and decrease emergence success rates by means of competition for space and moisture in the soil. Nests that are laid or relocated in or around vegetation may suffer from dehydration if roots out compete eggs for moisture.

Vegetation may also have adverse effects on the nest temperature. Godfrey (1997) observed nests that were laid in vegetation were significantly warmer and produced 100% females. An increase in temperature due to vegetation can influence hatchling sex ratios.

Vegetation may also affect the emergence of hatchlings from the nest. Nests that are laid in or around vegetation are more susceptible to invasion by roots (Whitmore & Dutton, 1985). Nests that are invaded with roots can entrap hatchlings as they attempt to emerge, resulting in injury and/or death. Hatchlings that successfully emerge may then experience difficulties in

orientation and sea finding due to physical and visual barriers related to the vegetation (Godfrey, 1997). The emerged hatchlings may also become entrapped by vegetation on the surface of the beach, which can prolong travel times to the surf, adding surface exposure to predators and high temperatures after sunrise (Godfrey, 1997).

Beach vegetation can also effect the nesting environment by reducing suitable nesting habitat. This habitat loss could effectively decrease hatching and emergence success rates by limiting the area of suitable habitat for relocated and *in-situ* nests.

Relocated nests at SPNWR are a vital component of maximizing productivity since these nests would otherwise be lost to erosion or tidal inundation. In 2005, 46.7% of all nests were relocated and 43.8% of all hatchlings were produced from relocated nests (Garner et al, 2005). Over the past few years, the suitable nesting habitat for *in-situ* and relocated nests has decreased due to the change in erosion patterns and the spread of vegetation seaward. The erosion zone is a 600-meter long stretch of beach that historically erodes during the leatherback nesting and hatching season and then accretes again in the winter months. However, this cycle of erosion has not taken place for the past three years and the erosion zone has grown seaward from the primary vegetation line to the high water mark. This recent growth of the beach, complimented by the lack of erosion, created an environment in which the vegetation spread. By the middle of the leatherback-nesting season 2006, the vegetation had covered approximately 75 – 80% of the erosion zone, as measured seaward from the primary vegetation line to the high water line. A high water table dominated the remaining 20% of the erosion zone, which when coupled with the persistent threat of erosion, rendered the erosion zone an unsuitable nesting location. If the only area available for relocated nests becomes the same area hosting the majority of the *in-situ* nests, then an increase in nest density per area will result. Maximizing nest density in a given area

could serve to increase bacterial loads and competition for nest oxygen and moisture, as well as, decrease hatching success and hatchling fitness. This study documented the extent of the impacts of vegetation on nests and investigated options for vegetation removal in the erosion zone at SPNWR.

## **Methods**

Phase one of the effects of vegetation on leatherback nest ecology began on March 23 and continued through August 12, 2006.

### Test and Control Plots.

All plots were located in the beach section historically known as the erosion zone. Four 40m wide by 20m long experimental plots, covered with vegetation, were surveyed and selected for this experimental study. The criteria for selecting the plots were (i) consistent coverage of vegetation throughout each plot and (ii) a primary or dominant species of vegetation. The dominant species of vegetation was *Ipomoea pes-caprae* (also known as “goat’s foot” or “railroad vine”). An additional 40m that was naturally free of vegetation served as the control.

### Treatments.

The control plot was left natural and was not treated at any time throughout the experiment. Of the four vegetated plots, two were left untreated and the vegetation was allowed to grow undisturbed, stakes 151-153 and 160-162. The other two plots, stakes 153-155 and 162-164, were treated with a mechanical removal of the vegetation. The mechanical removal of the vegetation began on March 25, 2006 and totaled 110 man-hours of labor. The mechanical removal encompassed the horizontal length of the 40-meter plot and it extended approximately 20-meters vertically from the stake line. Mechanical removal of the vegetation entailed the cutting of vines with a machete and physically pulling the vine out of the ground. Each vine was

removed by hand and care taken to pull the entire vine out of the ground. The vine was traced to its origin and gripped at the point where the stalk meets the surface of the sand. The vine pullers used both hands to grab the roots as they become exposed. This was essential to ensure the maximum removal of the root ball.

#### Photo-documentation.

Each experimental plot, including the control, was photographed before, during, and after vegetation removal. Photos were then taken twice a month throughout the experiment to document any re-growth of vegetation in the mechanically cleared plots.

#### Nest relocations.

A minimum of seven nests were collected and relocated into each of the five 40m sections. These relocated nests were collected from a variety of different mothers to control for differences in clutch quality. Relocation techniques and nest dimensions followed those described by Dutton (1992). Each nest relocation site was randomly selected in each of the 40 x 20 experimental plots. The relocations took place over a three-week span and were selected for relocation due to the mother's poor nest site selection. Relocations that took place in the vegetated plots began with the clearing of one meter of vegetation to simulate a leatherback's body pit. The remaining vegetation was left to continue to grow naturally and photographs were taken of the nest excavation to document the extensive root systems in the nests. All roots were broken during the relocation and the eggs counted and placed in the egg chamber. After the relocation, each nest was allowed to incubate undisturbed.

#### Moisture content.

Moisture content of the plots was monitored by two different methods: rainfall and water table measurements. Two rain gauges were installed and the rainfall was recorded nightly. The

second method used to monitor moisture in the nests was the measurement of the water table. Three water table measuring devices were designed and installed 10-meters from the stake line. These water table devices were buried 90 cm below the surface of the sand. The 90 cm mark is well below the average depth, 75cm, of a leatherback's nest. Water table measurements were taken weekly. A third method of moisture measurement implementing the use of data loggers to record the moisture content and temperature in the nest was proposed but not implemented due to insufficient funds.

#### Nest Excavation.

On the 57<sup>th</sup> day of incubation we began to monitor the nest nightly for emergence and signs of predation. Signs of predation prior to, or concurrent with the emergence were noted. These included hatched shells on the sand's surface, signs of non-human digging in the nest, and predatory tracks leading to and away from the nest. Predators were identified as night heron, mongoose, and dogs. Once the main emergence began, any signs of disorientation were monitored and recorded. Signs of disorientation included live hatchlings and hatchling tracks leading away from the ocean. When signs of disorientation were observed, the direction of the orientation was recorded. All entangled, lost, or dead hatchlings were recorded and all live hatchlings were retrieved and released. The day after the observed emergence, the nest was excavated and all nest contents were inventoried. All unhatched eggs were opened and the embryonic development staged per Dutton et al 1985. Hatching and emerging success rates for each nest were determined (Garner et al, 2005). Photographs were also taken during the excavation to document the extent of the root systems in the nest and how the roots enveloped the eggs.

## **Results**

A total of 40 nests were relocated in the experimental plots. Of these 40 nests, five have been removed from the statistical analysis. Dogs predated two of the nests, which compromised the integrity of the excavation data. One nest was relocated near the primary berm and beyond the water table measuring devices. This nest became inundated by the water table and resulted in a 0% hatch success. The remaining two nests were removed due to a large discrepancy in the relocation egg counts between relocation and excavation. The exclusion of these nests has resulted in a total of 35 nests.

### Moisture contents

All water table measurements were zero and demonstrated no signs of the water table at 90 cm below the surface of the sand. These measurements were taken 10m from the stake line.

### Hatchling productivity

Statistics regarding hatchling productivity in experimental plots are summarized in Table 1. The first experimental plot that was covered with vegetation and did not receive any treatment (stake 151-153) had a hatch success of 27.19% (22.29% standard deviation, min = 0.00%, max = 60.47%) and an emergence success rate of 22.52% (18.46% standard deviation, min = 0.00%, max = 47.67%, N = 7). The second experimental plot that contained vegetation and did not receive any treatment (stake 160-162) had a hatching success of 47.96% (31.80% standard dev., min = 13.75%, max = 87.69%) and an emergence success rate of 40.31% (31.80% standard dev., min = 11.25%, max = 84.62%, N = 6). The first experimental plot that received mechanical treatment for the vegetation (stake 153-155) had a hatch success of 40.57% (standard dev. 19.38%, min = 8.89%, max = 59.21%) and an emergence success rate of 33.19% (standard dev. 21.46%, min = 2.22%, max = 56.58%, N = 5). The second plot that received mechanical

treatment (stake 162-164) had a hatch success of 36.42% (25.07% standard dev., min = 0.00%, max = 64.58%) and an emergence success of 28.04% (24.35% standard dev., min = 0.00%, max = 58.33%, N = 9). The control plot, which was free of any vegetation, had a hatch success of 39.19% (20.06% standard dev., min = 0.00%, max = 47.31%) and an emergence success rate of 36.22% (18.70% standard dev., min = 0.00, max = 46.34%, N = 8). The spreading vegetation invaded the control plot during the two-month incubation period of the nests. This resulted in five of the eight nests being invaded with roots upon excavation.

**Table 1.** Average hatch and emergence success for experimental plots.

|                              | <b>Vegetated<br/>(151-153)</b> | <b>Vegetated<br/>(160-162)</b> | <b>Vegetation<br/>Removed<br/>(153-155)</b> | <b>Vegetation<br/>Removed<br/>(162-164)</b> | <b>Control 1<br/>(165-167)</b> |
|------------------------------|--------------------------------|--------------------------------|---|---|--------------------------------|
| Hatch Success (Average)      | 27.19%                         | 47.96%                         | 40.57%                                      | 36.42%                                      | 39.19%                         |
| Hatch Success (St. Dev.)     | 22.29%                         | 31.80%                         | 19.38%                                      | 25.07%                                      | 20.06%                         |
| Emergence Success (Average)  | 22.52%                         | 40.31%                         | 33.19%                                      | 28.04%                                      | 36.22%                         |
| Emergence Success (St. Dev.) | 18.46%                         | 31.80%                         | 21.46%                                      | 24.35%                                      | 18.20%                         |

Undeveloped eggs per nest differed for the experimental plots. The two plots that were treated with mechanical removal of vegetation (stakes 153-155 and 162-164) had an average of 24.00 and 22.56 undeveloped eggs per nest. The two plots that were covered in vegetation and left untreated (stakes 151-153 and 160-162) had an average of 14.71 and 11.17 undeveloped eggs per nest respectively. The control plot had 21.38 undeveloped eggs per nest.

#### Hatchling survivability.

The initial analysis of this data has revealed a trend regarding fitness and survivability of the hatchlings that encounter roots in the nest and vegetation on the surface of the sand. Nests that were exposed to growing root systems demonstrated a decrease in the total number of hatchlings that successfully emerged from the nest. Of the 35 nests relocated for this experiment

32 were exposed to root systems including the five nests in the control plot. Of these 32 nests, only three of them had 100% of the hatchlings emerge from their nest. Of the 27 nests that were relocated in the four vegetated plots and were exposed to roots, only two of the nests had all of the hatchlings emerge from their nest and 14 of the 27 nests had at least 1 dead hatchling upon excavation. This is compared to three of the eight nests that were relocated in the control plot, which experienced 100% of the hatchlings emerging from their nest, and only one of the eight nests had at least one dead hatchling upon excavation. A majority of the live hatchlings found in the nest may not have made it out of the nest if it had not been excavated.

## **Discussion**

The first phase of the effects of vegetation on leatherback nesting ecology provided valuable data regarding hatchling production and survivability. We hypothesized that the nests relocated in the vegetated plots that did not receive any treatment would have the lowest hatching and emergence success rates due to the extensive untreated vegetation and root systems. This was demonstrated for the plot between stakes 151-153. However, this was not the case for the other vegetated plot that did not receive any treatment. The plot between stakes 160-162 had the highest hatch and emergence success rates of any of the experimental plots, 47.96% and 40.31% respectively. This result cannot be easily explained and will need further investigation and more in depth research that includes data depicting the environmental factors, i.e. moisture and temperature inside the nest. We hope to gather this information in the second phase of this experiment with the deployment of data loggers in the nests.

Another prediction was that the control plot would have the highest hatch and emergence success rates. This was not the case. The control plot had the second highest hatch and

emergence success rates. More interesting however, is that the hatch and emergence success rates for the control plot were very similar to the two vegetated plots that received mechanical treatment for vegetation. Initially, this would indicate that the mechanical removal of the vegetation was effective in producing similar success rates as the control plot, which was not inhabited with vegetation prior to the relocation of nests. However, five of the eight nests in the control plot were inundated with roots at the time of excavation. Sprawl of vegetation may have deterred the comparison of the control plot to other experimental plots, due to a lack of significantly different factors among the plots with regards to vegetation/ root invasion. Phase two of this experiment will implement a mechanism for deterring the growth of vegetation into the control plot. The control plot did demonstrate the most efficient emergence success when compared to its own hatch success. The difference between the control plot's hatch and emergence success rates was 2.97%. The next smallest difference between a plot's hatch and emergence success rates was 4.67%. The three nests in the control plot that were not impacted by any roots can account for this difference. Two of these nests also had 100% of the hatchlings emerge. This is significant when compared to the remaining 32 nests in this experiment, which were all impacted by roots and only had two nests that demonstrated the same 100% hatchling emergence. A decrease in fitness and survivability was observed due to the vegetation's root systems.

The initial analysis of this data (Table 1.) also revealed that four of the experimental plots, including stakes 153-155 and 162-164 with vegetation removed, stakes 151-153 with vegetation, and stakes 165-167, the control, exhibited hatch and emergence success similar to or below that of all other relocated nests at Sandy Point in 2006. This includes the remaining relocated nests that were laid (and excavated) throughout the season that were not involved in

any of the experimental plots (n=163). The hatch and emergence success rates for all remaining relocated non-experimental nests at Sandy Point were 41.39% and 35.97% respectively (Garner et al., 2006). Plot 160-162 did exhibit a slightly higher hatch and emergence success (Table 1.) than non-experimental, relocated Sandy Point nests. This plot, however, also had an increased standard deviation when compared to other plots, so the increased success in this area is most likely not statistically significant. In spite of an increased hatch success, this plot still demonstrated a large decrease in emergence success. Vegetation in the plot was most likely the reason behind this result. All nests in experimental plots exhibited hatch and emergence successes significantly lower than those historically observed at Sandy Point (Garner et al., 2005). This initial analysis may indicate that vegetation and associated root systems, do have a significant detrimental affect on the leatherback's nesting ecology as originally hypothesized, however further in-depth research of the environmental factors in the nest need to be addressed.

The second phase of this experiment will take place in 2007 and will be organized in the same manner, as was phase one. However, the addition of two 40 x 20-meter vegetated plots will be implemented. These plots will be treated with an herbicide three months prior to the start of the leatherback season. This three-month window will provide ample time for the residual herbicide to breakdown and no longer be a viable threat to nests that are located in those treated plots. The herbicide will serve to effectively kill the root systems, which can remain intact and alive using mechanical methods. Residual roots can then begin to grow new sprouts allowing for the mechanically "removed" vegetation to re-grow. Herbicide will hopefully prevent this occurrence. The other four 40 x 20-meter vegetated plots will be set up the same as they were in phase one, with two of the plots being treated with mechanical removal of the vegetation and the other two vegetated plots to be left to grow naturally. Two nests in each plot will be fitted with a

data logger to collect data regarding the environmental impacts, temperature and moisture, of the vegetation on the nest ecology. This will provide an insight into how vegetation can directly affect embryonic development, mortality and hatch success. The second phase will also continue to collect data regarding any behavioral effects that the vegetation has on the nesting leatherbacks. This data is collected by means of recording crawl lengths from the ocean in relation to the vegetation line, number of successful vs. unsuccessful nest attempts in the vegetation, and amount of time spent on the beach attempting to nest. At the conclusion of this two-phase experiment, we intend to provide U.S. Fish and Wildlife Services with a detailed report documenting the impacts of vegetation on leatherback nest ecology. Recommendations for management strategies regarding treatment or removal of vegetation will be provided in order to maximize the suitable nesting habitat and productivity of our endangered leatherback sea turtle.

This experiment was conducted under USFWS permit #41526-2006-07 and VIDPNR Permit #STX020-06.

### **Literature Cited**

- Dutton, P.H., C.D. Whitmore, and N. Mrosovsky. 1985. Masculinisation of leatherback turtle (*Dermochelys coriacea*) hatchlings from eggs incubated in styrofoam boxes. Biol. Conserv. 31:249-264.
- Dutton, P.H., D.L. McDonald, and R.H. Boulon, Jr. 1992. Tagging and nesting research of leatherback sea turtles (*Dermochelys coriacea*) on Sandy Point St. Croix, U.S. Virgin Islands, 1992. U.S. Fish and Wildlife Publication. 24pp
- Garner, J.A, S.A. Garner, and W. Coles. 2005. Tagging and nesting research of leatherback sea turtles (*Dermochelys coriacea*) on Sandy Point St. Croix, U.S. Virgin Islands, 2005. U.S. Fish and Wildlife Publication. 58pp.

Garner, J.A, S.A.Garner, and W. Coles. 2006. Tagging and nesting research of leatherback sea turtles (*Dermochelys coriacea*) on Sandy Point St. Croix, U.S. Virgin Islands, 2006. U.S. Fish and Wildlife Publication. In Prep.

Godfrey, M.H. 1995. Beach vegetation and seafinding orientation of turtle hatchlings. *Biol. Conserv.* 74:29-32

Godfrey, M.H. 1997. Estimating the time between hatching of sea turtles and their emergence from the nest. *Chel. Cons. Biol.* 2(4):581-585.

Whitmore, C.P., and Dutton P.H. (1985). Infertility, embryonic mortality, and nest-site selection in Leatherback and Green sea turtles in Suriname. *Biol. Conserv.* 34:251-272.