FLORIDA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

PROJECT STATUS REPORT

1. TITLE: Biology of nesting sea turtles along the Florida panhandle

2. PROJECT OFFICER:

3. PRINCIPAL INVESTIGATOR: Raymond R. Carthy

4. CO-PRINCIPAL INVESTIGATOR:

5. RESEARCH WORK ORDER #: 197B

6. FUNDING AGENCY: USFWS

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8. **REPORTING PERIOD FOR DELIVERABLES: 09/1/00 to 12/31/00**

9. **ABSTRACT OF PROJECT**(maximum 4000 characters):

The property managed by Eglin Air Force Base (EAFB) along Cape San Blas is a unique ecosystem, from the dynamics of the landscape to the plant and animal communities utilizing the habitats. In addition to being an extraordinarily dynamic system, this area supports several threatened and endangered species including the loggerhead sea turtle (*Caretta caretta*), Piping Plover (*Charadrius melodus*), and Snowy Plover (*Charadrius alexandrinus*). This system therefore, represents a natural laboratory and a unique opportunity to examine effects of coastal erosion and accretion on biological communities.

Formation and maintenance of barrier islands require abundant sand supplies. Since present sea level has stabilized in the past 4,000 to 5,000 years, there has been very little new sand added to barrier islands along the northern Gulf of Mexico. The result is that portions of these barrier islands are being eroded by several forces, thus creating extraordinarily dynamic systems (Hayes 1979, Campbell 1984). Species that rely on these systems for survival must cope with these changes if long-term use of barrier islands is required. One group of animals dependent upon barrier islands are nesting sea turtles.

10. **OBJECTIVES OF PROJECT (maximum 4000 characters):**

Final Report
Research Work Order 197b
Margaret M. Lamont
March 30, 2001

INTRODUCTION

Formation and maintenance of barrier islands require abundant sand supplies. Since sea level has stabilized in the past 4,000 to 5,000 years, little new sand has been added to barrier islands along the northern Gulf of Mexico. The result is that portions of these barrier islands are eroding, thereby creating extraordinarily dynamic systems (Hayes 1979, Campbell 1984). Species that rely on these systems for survival must cope with these changes.

One group of animals greatly dependent on barrier island beaches is sea turtles. Sea turtles use the beach during only two stages of their life: hatchlings and nesting adults. Hatchlings spend a short time on the beach after they emerge from the egg chamber. Nesting females emerge once every two to four years to dig a nest and deposit eggs. Although time spent on beaches is minimal, this habitat is critical to successful reproduction and survival of sea turtles.

Specific beaches may be more important to certain sea turtles. It has been suggested that throughout their lives, female turtles return to their natal beach to nest (Carr 1967). This allows turtles to place their eggs in an area already proven successful. Not all sea turtle species exhibit the same degree of site fidelity however. In southeastern Australia, flatback turtles (*Chelonia depressa*) are associated with specific nesting beaches. On a 1.54 km beach along Mon Repos, Australia, the average distance between individual nests of flatback turtles was 0.36 km (Limpus et al. 1984). Green turtles also express strong site fidelity. After conducting a survey of 11 beaches on Wan-An Island off Taiwan, Wang and Cheng (1999) found 71% of green turtles laid subsequent nests on the same beach they laid their first nest. In Florida, Johnson (1990) found the mean distance between sequential nesting events in green turtles was 1.8 km with 65% of these intervals at or less than the average. The cues these species use to re-locate their original nesting beach are unknown, however researchers have suggested several factors that could contribute to site fidelity.

It has been suggested that turtles use vision, olfaction, and offshore topography as cues in returning to their original nesting site (Ehrenfeld and Carr 1967, Johnson 1994). Turtles have been observed lifting their heads during their nesting emergence and making what appears to be a visual appraisal of the beach, and Ehrenfeld and Carr (1967) found blindfolded post-nesting green turtles had difficulty re-locating the sea. Besides vision, turtles may use olfaction to locate their original nesting site. Carr and Giovannoli (1957) published observations of adult green turtles in Costa Rica that appeared to smell the sand during their ascent of the nesting beach, which indicates turtles may use smell as a cue. Finally, Limpus et al. (1992) suggested turtles show an affinity to a particular location just offshore of the nesting beach. This would allow turtles to remain in the area of their original nesting site, which may make returning to the nesting site easier. All of these factors may contribute to the site fidelity expressed by many species of sea turtles.

Dramatic changes in nesting beaches and the surrounding oceanographic patterns may, however, greatly influence female sea turtles attempting to return to their natal nesting beaches. In general, beaches are unstable environments influenced by wave action and tidal patterns, however barrier island beaches are even more dynamic. These systems serve as barriers to the mainland to protect it from the daily patterns of waves and tides, and from more intense seasonal storms. Beaches along Cape Cod, Massachusetts are eroding from 0.3 to 2.5 m per year (US Army Corps of Engineers 1973) and the western end of Matagorda Island, Texas erodes three to five m per year (Wilkinson 1965). West Timbalier Island, Louisiana has migrated nearly 1.5 km seaward since 1907 (Kaufman and Pilkey 1983). Changes in barrier island beaches through erosion and accretion occur because of sand movement. Nesting sea turtles depend on this sand to incubate their eggs, and may rely on sand characteristics to locate their nesting beaches, therefore, barrier islands may make these processes more difficult.

One area that may provide a significant challenge to nesting turtles is Cape San Blas, Florida. Cape San Blas is part of a barrier island chain extending along the northern Gulf of Mexico. This system was most likely formed by offshore shoal aggradation after the stabilization of sea level nearly 5,000 years ago and is maintained by several forces, including tides, ocean currents, and winds (Swift 1975, Otvos 1980). These forces also drive the dynamic pattern of accretion and erosion that occurs along Cape San Blas. The eastern beach of Cape San Blas undergoes accretion, whereas the northern coast experiences the greatest natural rate of erosion in Florida. From June 1994 to September 1995, the north beach lost approximately 10 m (Lamont et al. 1997). This dynamic pattern may introduce challenges to nesting sea turtles.

Although it is extremely dynamic, Cape San Blas supports the greatest density of nesting loggerhead turtles along the Florida panhandle. From 1993 to 1996, Cape San Blas recorded the greatest number of sea turtle nests per kilometer in northwest Florida, with 7.7 per kilometer in 1993, 11.3 in 1994, 12.5 in 1995, and 5.2 in 1996 (FMRI 1996). Although these numbers are small, they are significant. In 1998, Encalada et al. (1998) reported loggerhead turtles nesting along the Florida panhandle are genetically distinct from turtles nesting along the east and west coast of the Florida peninsula. The turtles nesting along Cape San Blas have done so long enough to permit genetic distinction, which indicates they have been able to continue nesting through the changes this barrier island has undergone.

Sea turtles nesting along Cape San Blas typically lay along the eroding north beach rather than the accreting east beach. Of the 53 nests laid along Cape San Blas in 1994, 32 (60%) were laid along the north beach. This trend increased in the following nesting seasons, with 67% laid along north beach in 1995, 76% in 1996, and 87% in 1997. How the pattern of erosion and accretion along this beach influenced the nesting patterns of these turtles is unknown.

To determine how the dynamic system off Cape San Blas affects its unique group of nesting sea turtles we assessed:

1. changes in beach topography,
2. changes in offshore topography,
3. current flows and direction,
4. tidal patterns,
5. sand composition and origin,
6. sea turtle nesting pattern, and
7. structure of the sea turtle group nesting along Cape San Blas,

METHODS

Sea turtle surveys

Daily morning surveys for sea turtle nests were conducted from May 15 through September 15. Nests were observed for hatching, and nest evaluations were conducted from mid-July to October 31. In addition, night surveys were conducted from approximately 2100 to 0600 every night during the nesting season (May 15 to August 10). When a nesting turtle was located, she was identified to species, curved carapace length and width were measured, and her location was recorded. To allow individual identification, an Inconel flipper tag was placed in both front flippers. Finally, a GPS point was taken at the nesting location.

Topography

Topographical measurements occurred along the north and east beach of Cape San Blas property biweekly during sea turtle season and once a month throughout the remainder of the year. Transits originated at four Fish and Wildlife Conservation Commission (FWCC) benchmarks. Heights were recorded using a laser transit and were documented every five meters along the transect, as far into the Gulf of Mexico as possible.

Currents

During the 2000 summer season, buoys were deployed weekly at the four FWCC benchmarks to determine nearshore current patterns and velocities. Buoys consisted of a frozen grapefruit. Grapefruits were launched from the water's edge using a modified slingshot attached to the rear of a four-wheel drive pickup truck. The buoys were observed as long as possible by personnel who were onshore. Every 15 minutes, time, distance, and wind speed and direction were recorded. In addition, launch and retrieval locations were recorded with a GPS unit.

Tides

Tidal patterns off the eastern and northern beaches of Cape San Blas were recorded using a Hydrolab DataSonde 3 data logger. Off the east beach, this equipment was strapped to a screw anchor that was placed in the seabed approximately 150 feet offshore. Off the north beach, the water monitor was strapped to a piling approximately 200 feet offshore. In each location, the monitor was programmed to record water level, salinity, and temperature every 15 minutes. In 1998, the logger was placed off north beach from June 21 to June 29, July 6 to July 19, and July 19 to August 16. In 1999, it recorded off north beach from June 18 to June 27. In 2000, the monitor was placed off the east beach from June 20 to June 23 and from August 6 to August 8. After deployment, the monitor was retrieved and the information was transferred to an Excel spreadsheet and plotted to display changes over time. Tidal heights gathered from the water monitor were then compared to the historical heights published by the National Oceanographic and Atmospheric Administration (NOAA). Tidal heights from Pensacola Bay, Pensacola, Florida were retrieved from NOAA. Times were altered to adjust for the geographical distance between Port St. Joe and Pensacola. Times for falling tides were reduced by 51 minutes and for rising tides by 24 minutes. Tidal heights were multiplied by 1.1. Tidal patterns from NOAA were graphed against those recorded by the water monitor.

Sand Analysis

To assess particulate size and quality of sand sources both offshore and onshore along Cape San Blas, sand samples were collected from the mean high water mark and in front of the dune system at each FWCC benchmark. Cores were constructed from two-inch PVC and were gathered to a depth of one foot. Samples were also collected from the tip of the St. Joseph Peninsula, and every five miles to the entrance of St. Joseph State Park (Eagle Harbor). In addition, sand was collected from the bottom of the Apalachicola River at the mouth and one-mile upstream. Samples were collected at the center of the channel and along the east and west sides. After collection, sand was dried in a warm oven, and then separated by grain size in a sand shaker.

RESULTS

A mean of 65 nests were laid on Cape San Blas in 1998, 1999, and 2000, and of those, a mean of 78.1% were observed at oviposition. Of the 111 turtles that were tagged, 27 (24.3%) nested more than once, and 8 (7.2%) nested three or more times. The mean distance between successive nests was 1.14 km. Of the 153 nests laid, 94 (61.4%) were laid on West Beach and 59 (38.6%) were laid in East Beach.

Tidal information was gathered off West Beach for 54 days in 1998 and 9 days in 1999, and off East Beach for five days in 2000. Tidal patterns gathered from the water monitor off both beaches were nearly identical to those provided by the National Oceanographic and Atmospheric Administration. The diurnal tidal pattern observed off Cape San Blas was synchronous between West and East Beaches. Comparison of tidal patterns and timing of sea turtle nesting for all three years revealed 150 (98%) turtles nested on a rising tide and three (2%) on a falling tide. No turtles nested on a falling tide in 1998, one turtle did so in 1999, and two turtles nested while the tide was falling in 2000.

Oceanographic observations were collected for 57 days from May through August 2000. Along West Beach, the current traveled west on 21 (36.8%) days and east on 36 (63.2%) days. When the current flow was west (W), the wind blew primarily from the NE, E, SE or S (85.7%), and when it traveled east it blew most often from the SW, W, NW or N (81%; $p < 0.0001$). Along East Beach, the current traveled west on 14 (25.4%) days and east on 41 (74.6%) days. When the current flow was westerly, the wind blew from the N, NE, E, or SE as often (50%) as when it blew from the NW, W, SW, or S (50%).

However, when the current traveled east, the wind blew primarily from the NW, W, SW, or S (80.5%; $p = 0.013$). Along West Beach, turtles nested almost equally on E (45; 46.8%) and W (51; 53.1%) winds. On East Beach, however, turtles nested more frequently during W winds (47; 82.5%) than E winds (10; 17.5%; $p < 0.011$).

From July 1998 to August 2000, West Beach lost 8.6 m of sand along the entire profile. Individual points along the profile differed; the greatest loss (-1.86 m) occurred 30 meters from the benchmark whereas the first 15 m of the profile gained 0.67 m. During this time, East Beach gained 0.38 m of sand along the entire profile. The greatest gain (0.61 m) occurred 35 m from the benchmark, while the greatest loss (0.18 m) was documented 45 m from the benchmark.

DISCUSSION

One strategy for reproductive success adopted by species inhabiting harsh environments is to produce many, small offspring in several different clutches throughout the season, thereby increasing the probability that at least one offspring will survive to reproductive maturity. In addition, these species often exhibit site fidelity, which allows them to place their eggs in an area already proven successful.

Sea turtles on Cape San Blas lay an average 109 eggs in as many as four nests per season, with a mean inter-nesting interval of 14.5 days. The turtles nesting in this region, do not however, exhibit strong site fidelity. On Cape San Blas, the mean distance between successive nests was 1.12 km, however the study site encompassed only five km. It is likely that many of the turtles tagged on Cape San Blas nested in the region but outside the study boundaries. Species such as the green turtle (*Chelonia mydas*) that typically nest on more stable beaches exhibit high site fidelity and often re-nest within an average 0.6 k m of their original nesting site (Miller 1997). On a barrier island beach in South Carolina, loggerhead turtles also expressed low site fidelity, with a mean distance between successive nests of 3.2 km (Talbert et al. 1980). Possibly, strong site fidelity is not as important to sea turtles nesting along unpredictable coasts as it is to species nesting on more stable beaches.

Strong site fidelity may actually reduce the success of loggerhead turtles nesting on barrier island beaches. The barrier island of which Cape San Blas is a part was formed approximately 5,000 years ago, and although this area frequently changes, it has persisted (Campbell 1984). Individual areas along the barrier island may increase or decrease in size, however the system itself endures. On a barrier island, a female turtle may lose all of her nests in one season if she places them on one small section of beach that subsequently experiences severe erosion. If she places them throughout the system, she may increase the chances that one of her nests will incubate safely.

Exhibiting strong site fidelity on a barrier island beach may also require more energy than on a stable beach because turtles must overcome the dynamic forces acting on these systems. Because the water surrounding Cape San Blas is shallow, this system is wind driven. In this area, wind causes tidal ranges to average two feet higher than normal (four feet total; Stauble 1971). Turtles nesting along Cape San Blas may travel onshore with the rising tide, thereby reducing the distance they must crawl and saving energy.

Wind driven tides may save energy, but most likely do not affect site fidelity. Wind driven currents may, however. On Cape San Blas, when the wind blew from the east (SE, E, NE) the current traveled most often towards the west, and a west (W, SW, NW) wind typically resulted in an eastward current ($p < 0.013$). If turtles approach Cape San Blas from the west, they could nest on West Beach with little energy expenditure. However, to nest on East Beach under an east wind would require swimming against the current and over the shoals, which may reduce the amount of energy available for nesting. Turtles nested on West Beach almost equally during an east wind (46.9%) and a west wind (53.1%), however on East Beach they nested less often on an east wind (17.5%) than they did on a west wind (82.5%). The wind conditions under which a turtle first emerged would influence her ability to nest again in that location. If she originally nested on East beach on a west wind, she would have to return to East Beach to re-nest. However, if the wind pattern shifted during the inter-nesting interval and blew from the east, she would have to spend the energy to travel against the current and across the shoals.

Results of this study indicate loggerhead turtles nesting along Cape San Blas may exhibit low site fidelity to increase chances of reproductive success and reduce energy expenditure. Increasing sample sizes, gathering information on the offshore topography along this region, and determining from which direction turtles are approaching the beach may provide further information about the response of nesting sea turtles to barrier island dynamics.

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