A History of Research and Management of the Loggerhead Turtle(*Caretta caretta*) on the South Carolina Coast

Final Report to the U.S. Fish & Wildlife Service

prepared by
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and Margaret E. Hoyle

South Carolina Department of Natural Resources
Division of Wildlife and Freshwater Fisheries
Wildlife Diversity Section

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PREFACE

This report began as a compilation of loggerhead nesting data that had been collected by the various volunteer groups along the South Carolina coast since 1981. In 1995, the Florida Department of Environmental Protection published a similar report. But other, truly landmark, work has been done in South Carolina and some of it is unknown to the scientific community. For example, loggerhead hatchlings were "headstarted" on Fripp Island in the early 1970's. After finding some of these old records, we felt that this report would be much richer if we included them.

We also felt that readers would gain a better understanding of the South Carolina nesting beaches if the information from the volunteer projects was presented on an island by island basis. In this way, the reader can visualize changes that each island may have undergone, both natural and anthropogenic and how each project evolved over time. Therefore the nest protection projects are presented in chapters. We have tabulated the data for each of the beaches from information provided by the volunteers in their annual reports to this department. The accuracy of these data is the sole responsibility of the individuals who submitted the reports. Many individuals have been involved over the years. This report would not exist without the dedicated individuals who rise before dawn and walk the beaches each and every summer and have endured the insects, heat and humidity. We have attempted to include, at the end of each chapter, all of the persons involved. If we have left anyone out, it was unintentional.

There have been other individuals who have shown us the way by their pioneering work. There have been scientists from other states and countries that have come to South Carolina to study our loggerheads. All this has added to the body of scientific knowledge for this species. Some of this information has appeared in the published literature. However, other information is in the "gray" literature and in the popular press, often making it difficult for professionals and lay persons to access the material. The second section of this report is an annotated bibliography of research that pertained to the nesting beaches in South Carolina from 1938 to the present. In cases where the work was published, we have used the abstract so as not to re-interpret the data and conclusions of the author(s).

Another aspect of the South Carolina program is the work done in cooperation with other state and federal agencies. Although not formally funded, it is an important component of our management for recovery of the species. We have placed this information in the section "Technical Guidance".

This then, is the South Carolina story of the loggerhead turtle, our state reptile, which spans almost 60 years. We hope you will enjoy the journey.

Sally Murphy, Sea Turtle Coordinator

DEDICATION

Poet, painter, visionary, and a lover of all things wild.

Bill Baldwin 1914-1992

William A. Baldwin, Jr. was a biologist with the U.S. Fish and Wildlife Service at Cape Romain National Wildlife Refuge in the late 1930's. For several summers, he studied the loggerhead turtles on the refuge beaches. With almost no background literature to guide him, he conducted (along with John Lofton) one the most complete and excellent nesting beach, natural history studies of this species. The most remarkable aspect of his work was the time when it was done. This is the beginning of marine turtle research in the Americas. Bill Baldwin was walking the beaches of Cape Romain before Dr. Archie Carr was walking the beaches of Tortuguero. Although their careers went in different directions with regards to sea turtle con-

servation, the high quality of his research still stands out today. Many reading this report may wonder why we chose Bill Baldwin for this dedication. When the senior author, Sally Murphy, was beginning sea turtle research at the Tom Yawkey Wildlife Center, she read the Baldwin and Lofton report and realized that it could not be improved upon. So her first three years of research to document nest failure, was patterned after their work. As a result of the findings from this research, various management techniques were tried and found to greatly increase nest success. These techniques then became the management actions that are now implemented at all of the volunteer nest protection projects. Thus, Bill Baldwin's legacy is linked to the hundreds of volunteers that walk the beaches today.

ACKNOWLEDGEMENTS

This entire body of work, not just the report preparation, was funded by several sources: Endangered Species Act Section 6 Cooperative Agreement with the U.S. Fish and Wildlife Service, Tom Yawkey Foundation, the state "Check for Wildlife" Fund (donations made by South Carolinians on their tax forms), and state appropriations.

Tom Murphy and John Coker provided support and encouragement over the past two decades. Ken Alfieri and Deborah Mundel Seyle assisted with site visits.

We are grateful for the editorial comments and suggestions from Ruth Boettcher, Charles Tambiah, Karen Eckert, Tom Murphy and Colin Limpus. Joan Drews provided administrative assistance. Meg Hoyle and Karen Swanson are also acknowledged for preparation of maps and graphs and layout.

And finally, most of this project would not have been possible without the continued work of the scores of volunteers who have given so much of their time, energy and emotions.

ABSTRACT

Sea turtle nesting projects in South Carolina date back to the 1930's. In the last decade, the Department of Natural Resources' Wildlife Diversity Section has been standardizing the nesting projects' methodology and the data that is collected. Through annual training seminars and semi-annual site visits, sea turtle project volunteers and employees are updated on the latest scientific information regarding sea turtle conservation and management. Over the years, the number of projects has grown. In 1997, 19 permits were issued to conduct nest protection projects along the South Carolina coast.

Thirty-six percent of the available nesting area in South Carolina is protected in perpetuity through state, federal or private ownership. Not all of these areas have nest protection projects.

Almost half of the 303 km South Carolina coastline is surveyed every morning during the sea turtle nesting season. These patrolled areas encompass approximately 70% of the entire nesting effort in South Carolina. Of the nests laid on beaches with protection projects, over 60% are relocated each year (1994-1997). In 1997, 62.4% of the total nests laid in the state were relocated (n=880). Nest and hatching success rates are reported annually by each project.

A history of each protection project is included within this report, along with the abstracts of research on nesting females in South Carolina, a technical guidance summary, and a summary of the data collected from the protection projects.

INTRODUCTION

Population Status and Distribution

The loggerhead turtle (*Caretta caretta*) is found in temperate and tropical waters worldwide, where they inhabit continental shelves and estuaries. In the Western Hemisphere, loggerheads have been documented as far north as Newfoundland (Squires 1954) and as far south as Argentina (Frazier 1984). The nesting range is within temperate and subtropical regions, rather than in the tropics (NMFS and USFWS 1991).

One of this species' major nesting concentrations is in the southeastern United States. Recently genetic evidence shows that loggerhead females return to nest on the same region of coast where they were hatched (Bowen *et al.* 1993). In the western North Atlantic there are at least four loggerhead sub-populations based on nesting females at the beach (TEWG 1998). They are located at: the Yucatan in Mexico, the Florida panhandle, south Florida from about New Smyrna Beach on the east coast southward to Sarasota on the west coast, and the northern subpopulation from New Smyrna Beach northward to North Carolina.

The loggerhead was listed as a threatened species on 28 July 1978, under the Endangered Species Act of 1973 and the State Nongame Act. The south Florida subpopulation appears stable or slightly increasing. The northern subpopulation has declined since the early 1980's, but since 1989, has shown no detectable trend (TEWG 1998). Given the high site fidelity of nesting females to their natal region and low gene flow between nesting assemblages, most western North Atlantic loggerhead nesting assemblages are vulnerable to extirpation. Should an assemblage be extirpated, regional dispersal will not be sufficient to replenish the depleted one even over thousands of years (Bowen *et al.* 1994). In other words, if we should lose our loggerheads here in South Carolina, they will not be replaced by those in Florida. The south Florida sub-population averages about 64,000 nests yearly, whereas the northern sub-population averages only about 6,200 nests a year, a ten-fold difference. South Carolina's nesting females comprise about 56% of the northern sub-population nesting effort.

Natural History in South Carolina

The loggerhead turtle is the third largest of the sea turtle species after the leatherback and green sea turtle. It was first described by Linnaeus in 1758. The mean curved carapace length of adult females in the southeastern United States is about 39 inches (98.6cm). The dorsal surface is reddish brown while the ventral surface is yellow. Their diet consists primarily of benthic invertebrates (conchs, whelks, clams, horseshoe crabs and several species of crustaceans).

Loggerhead turtles begin appearing in coastal waters in early April. Once mating is completed, males apparently move farther offshore since fewer strand during the late summer and fall months.

Loggerhead females make migrations to the nesting beaches on average every 2.5 years (Richardson and Richardson 1982). Nesting begins generally in mid-May and lasts until mid-August with the mid-point of the season around the summer solstice. Warm or cool spring temperatures can shift the onset of the nesting season by one or two weeks. During the nesting season, females lay an average of 4.1 nests (Murphy and Hopkins 1984) at approximately 14-day intervals. Nests from other populations average 115 eggs (Dodd 1988), however South Carolina data differ from this (see results section). Eggs incubate about 60 days depending on the sand temperature. The natural sex ratio of hatchlings produced on South Carolina beaches is 50:50 (Mrosovsky et al. 1984).

Hatchlings emerge usually at night or sometimes during the day after a rain. They have a brief, 1-3 day swimming frenzy which serves to get them offshore where they become passive travelers in the oceanic current systems. Loggerhead hatchlings from the southeastern U. S. spend perhaps as long as 10-12 years in the pelagic environment and are best documented in waters around the Azores and Madeira (Bolton *et al.* 1994).

Juveniles, once they reach 40-60 cm straight carapace length in size, return to coastal areas of the U. S. where they become benthic feeders. On the South Carolina feeding grounds, there is a mixture of both the northern and the south Florida sub-populations in about a 1:1 ratio (Sears *et al.* 1995). These benthic immatures occupy coastal feeding grounds for a decade or more before returning to make their first nesting migration. Thus, age to first reproduction, when females are ready to nest for the first time, appears to be 20-25 years or longer (TEWG 1998).

METHODS

The techniques used for all beach projects are described in detail in our state *Guidelines for Marine Turtle Permit Holders* (See Appendix A). We would like to acknowledge the Florida Department of Environmental Protection for allowing us to use their guidelines which we have modified for our needs.

Training

Each spring, individuals wishing to conduct nest protection activities apply for a permit from the Department of Natural Resources. Leaders of projects that are already in place must reapply. When the applications have been approved, a training workshop is held in April for all participants. At this workshop, the guidelines are reviewed and questions addressed. Each project leader gives a five minute presentation on their project for the previous season. Problems are discussed by the group and ideas exchanged.

Prior to the nesting season, staff visits projects to train new volunteers. This is done by creating imitation nests and tracks on the beach and having the volunteers locate, move and screen the eggs (simulated by golf or ping pong balls). Some of the more experienced project leaders conduct these training sessions on their own.

During the nesting season, staff makes two site visits to each of the nest protection projects. One is made to assess the volunteers' probing techniques and the handling of eggs and the other is made later in the season to assess nest inventory techniques.

Beach Patrols

Most of the beaches are partitioned into equal segments or zones with permanent posts erected in the dune field. On erosional beaches this is not always possible and posts may have to be replaced each season. Surveys are conducted at dawn on foot, by ATV or other four-wheel drive vehicle. The majority of the projects are run by local residents, who volunteer their time. Surveyors move along the beach at the level of the latest high tide line. When a crawl is found, it is then categorized as a nesting crawl or a false crawl (non-nesting emergence). With nesting crawls, the egg chamber is found using a probe stick. This technique is used only by experienced, well trained, and properly permitted personnel. (This is allowed in South Carolina although some states do not use this method.) A narrow diameter stick (3/4") with a tapered end is gently inserted into the sand to test for the softened area of sand directly above the clutch. Extreme care is exercised when probes are used so that eggs in the clutch are rarely punctured. When the egg chamber is located, each nest is marked using a small stake or plastic flag at a designated distance from the nest. On subsequent patrols, each nest location is monitored for signs of predators and/or hatching.

Relocation of Nests

When necessary, nests are moved in most cases by 9:00 a.m. Nests are relocated to the closest suitable spot unless hatchery use is noted. Only three of the 19 projects use hatcheries. These are beaches with extreme erosion and predation problems. Relocation is allowed only if: 1) the nest will be subject to overwash from spring high tides and 2) the nest is laid in an area with heavy foot traffic that cannot be rerouted, such as at the base of a dune walkover. Eggs are handled one at a time making sure the polar orientation is not changed, and reburied in a similarly formed egg chamber as dug by the female turtle.

Screening of Nests

On beaches with predators, nests must be screened. The basic design for screens is a 3ft x 3ft piece of welded wire ("dog fencing") that has a 4in x 2in mesh. All corners are anchored securely. Projects with more persistent raccoons or foxes use 4ft x 4ft or even a 5ft x 5ft screen. In problem areas, a one foot square piece of 1/2in x 1/2in mesh "hardware cloth" is centered over the egg chamber to keep the predators from digging in from the top. The smaller mesh screen is removed 45 days into incubation or the whole screen is lifted slightly to allow just enough room for hatchlings to crawl out from under it.

Nest Inventories

Inventories of hatched nests are done either 72 hours after the first major hatch or 75 days after deposition. On beaches with less than 120 nests, all nests are inventoried. On beaches that have greater than 120 nests, a 25% stratified sample for the season is inventoried.

The contents of the nest are divided into the following categories: infertile, died early in development, died late in development, died while pipping, dead in nest, live in nest, and empty shells. Nest success is calculated as the number of nests that hatch, divided by the total nests laid. In order for a nest to be categorized as "hatched", it must have a minimum of 10%

hatching success. Hatching success is calculated as the number of hatchlings emerged to the beach surface, divided by the total eggs laid. The total includes eggs that were laid, but did not hatch. Hatching success is calculated for each individual nest, as well as a total for all nests laid.

Reporting

Each nest protection project leader is required to submit a report at the end of the season as a condition of their permit. An outline is provided as a guide (see Appendix B). Once received, the reports are reviewed by staff for completeness. A hard copy is kept on file as well as an electronic version.

RESULTS

The semi-annual site visits and spring workshop help unify and standardize the projects that span over 303 km of coastline. However, data reporting is rarely uniform and the following results are calculated based only on the projects that had complete reporting for multiple years.

Of the 303 km of South Carolina coastline, 108 km are protected in perpetuity through conservation easements on private land or in state or federal ownership. Not all of the protected areas are patrolled daily during the nesting season. Daily, morning patrols occur on 151 km of the coast (Figure 1). In 1995, 1996, and 1997, the percent of nests laid on these project beaches was 65.6%, 67.3%, and 70.0%, respectively (Figure 2). From 1994-1997, project beaches averaged 15.68 nests per kilometer (Figure 3). From 1995-1997, on the reporting beaches, the number of nests relocated to protect them from tidal inundation was 63.7%, 65.7%, and 62.4%, respectively (Figure 4). For these three years combined, the percent of nests relocated was 64.2% (Figure 5).

Though nest protection effort has increased over the years as project areas are added to the network, nest numbers in the state have not proportionally increased (Figure 6). The annual fluctuations are apparent in this figure, but unlike Florida, the nesting population is not showing an increase in South Carolina.

Figure 1. Length of beaches protected and patrolled in SC, 1997

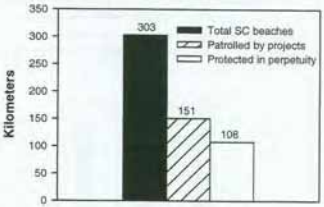


Figure 2. Statewide nesting vs. nests laid on project beaches, 1995-1997.

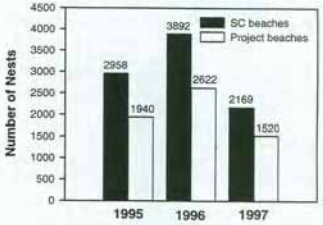


Figure 3. Nesting density on project beaches with and without Cape Island, 1994-1997 average.

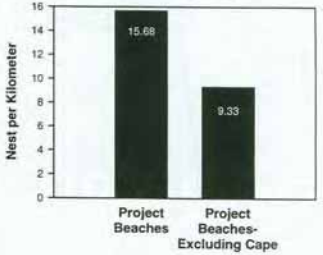


Figure 4. Number of nests laid and relocated on project beaches for each year: 1995-1997 (not all projects included).

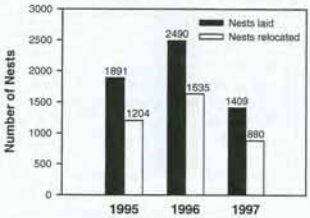
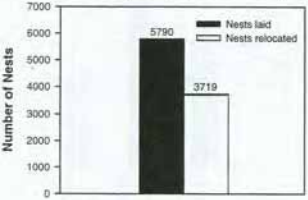


Figure 5. Three-year total for number of nests laid and relocated on project beaches: 1995-1997 (not all projects included).



Due to inconsistencies in the way that projects reported data, only hatching success from 1997 is summarized. Hatching success in 1997 ranged from 46.0% to 87% for all nests on project beaches. The hatching success for relocated nests in 1997 ranged from 49% to 89% and *in situ* nests had a range of 20% to 80%. The 20% success rate was on *in situ* nests that were not protected from mammalian predators.

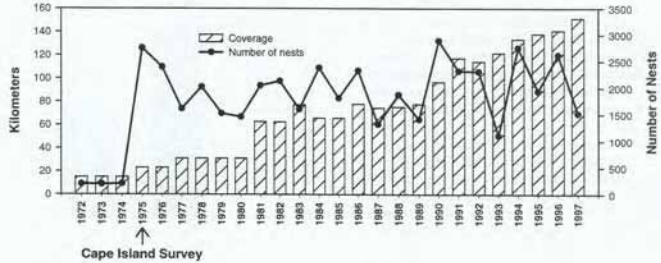
The average clutch size reported for each beach came from the project reports. There were inconsistencies in the way that this number was calculated. Therefore, it was not used to determine the average number of eggs per clutch for the state. The statewide average came from egg counts made on select beaches in 1997. The average clutch size was 126.2 (n=61). Caldwell reported 126 eggs per clutch for Cape Island (n=71)(1959).

The earliest recorded nest laid was on May 4, 1991 and the latest on Sept. 13, 1994. Other species, including leatherback, green, and Kemp's ridley, have nested in South Carolina and are noted in the beach history where the nesting occurred.

CONCLUSIONS

Loggerhead turtle nesting in South Carolina represents 56% of the nests laid by the northern sub-population (TEWG 1998). Thus South Carolina beaches

Figure 6. Number of nests laid and kilometers surveyed per year.



are a significant area for the continued survival of the northern sub-population of loggerhead turtles. The beach protection projects provide an invaluable service by protecting the majority of the nests laid in South Carolina (70% in 1997). Trained volunteers are essential for this extent of beach coverage.

The impact of the protection provided by the sea turtle projects in South Carolina will be realized over time. Since loggerheads reach maturity at an estimated minimum of 20 years, the South Carolina projects are approaching the time when the increased hatchling output should be seen as these turtles come back to nest. However, beach protection has not been synchronous with in-water protection. There is anecdotal evidence that the number of sea turtles in South Carolina's waters is increasing. Upcoming in-water research will focus on the population origin of these loggerheads and possibly provide information regarding the impact of the protection projects.

South Carolina will continue to implement the outlined tasks in the loggerhead recovery plan, which include: monitoring nesting, protecting nests and hatchlings, and safeguarding the nesting habitat of the state's beaches. The explosive growth in the coastal area has changed the character of many barrier island beaches. Beach-front lighting continues to be a concern and is being addressed on a island-by-island basis. As human presence on the nesting beaches increases, public education will be required to minimize impacts.

NEST PROTECTION PROJECTS

The nest protection projects began as an outgrowth of the Sea Turtle Stranding and Salvage Network. The network was started in 1980 by contacting members of the Charleston Natural History Society (an Audubon Society chapter) and Sierra Clubs. While patrolling the beaches to record data on sea turtle carcasses, they noticed that many nests were being destroyed by raccoons and erosion. They asked our department if they could begin protecting nests, since they were already on the beaches each day.

In 1981, there were two projects under governmental authority and five non-governmental ones started by concerned residents on Kiawah, Edisto, Hunting, Fripp and Hilton Head Islands. Neighboring islanders soon learned of these projects and wanted to start ones on their beaches. Ten years later, in 1991, there were thirteen projects. Five were conducted by government entities on public lands and eight were organized by local residents and organizations.

Not only have the projects increased in number, but the scope of their work has expanded into education and outreach. Many have their own printed brochures, tee shirts and "lights out" switch plate stickers. In the course of conducting their daily patrols, volunteers teach thousands of tourist and residents about sea turtles and conservation efforts. As a state agency, it would be impossible for us to implement such a coastwide effort without their assistance.

This chapter contains descriptions of the individual sea turtle nest protection projects that were permitted in the state of South Carolina. They begin at the southern end of the state and end in the north. For each nest protection project, there is a description of the island, including the beachfront habitat and the degree of development. The history of the survey effort is given to allow the reader to see how the different projects evolved. Management techniques, if different from those described in the "Methods" chapter, will appear here. Nesting activities by other sea turtle species are under the heading "Other Species".

Finally, there is a list of the project leaders and the years they served. The list of the volunteers and interns who had "Letters of Authorization" were provided by the project leaders.

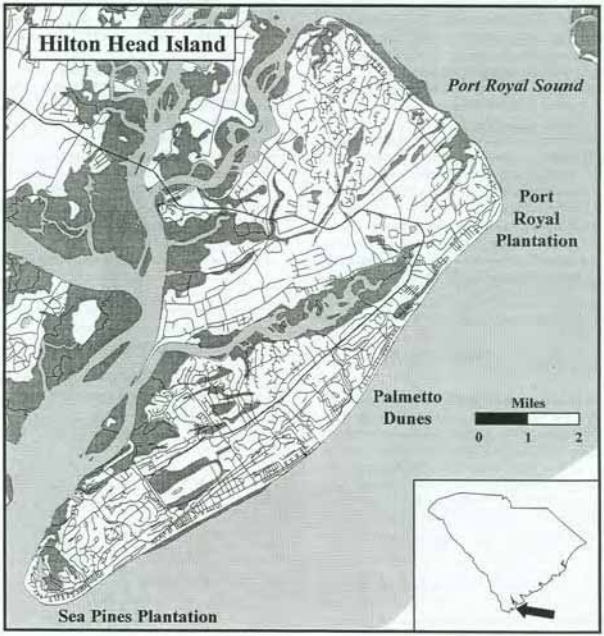
If any sea turtle research was conducted within the project's coverage area, it is presented in the "Other Research" section of this report.

HILTON HEAD ISLAND

DESCRIPTION OF THE PROJECT AREA

Hilton Head Island is the largest barrier island on the South Carolina coast. It is comprised of gated communities, private homes, condominiums, and multi-story, oceanfront hotels. Like most of the barrier islands along the southeast coast, the north and south ends are fairly stable, but the mid-portion is erosional. A rock revetment was constructed on the mid-portion, and beach renourishment in 1990 and 1997 has provided a dry beach here.

Loggerheads nest on all areas of Hilton Head's sandy shore and there are many stretches of good nesting habitat. Although there are small "pocket" beaches on the side of the island facing Port Royal Sound, very little nesting occurs here. Most nests are laid along the ocean-facing beach. Hilton Head Island has 18.5 km of beach on the Atlantic Ocean and 7.2 km of beach on Port Royal Sound. Twenty-three km of beach are regularly patrolled by the current project.



SURVEY HISTORY

The first nest monitoring project in 1981 relied on the public to report sea turtle crawls and strandings. Weekly newspaper ads were used to ask the public for information. No nests were screened or relocated. The monitoring project kept records of nesting locations on file to protect them from heavy equipment being used to build new dunes by beach sand scraping. Poaching was noted as a problem on the few beaches where there is public access.

From 1982-1984, the project concentrated its efforts in Sea Pines Plantation (8 km), with daily surveys conducted at dawn, using a truck. The rest of the island was checked sporadically. No nests were moved or screened.

In 1985 Palmetto Dunes (4.3 km) was covered daily and some nests were relocated. In 1986-1988, 5.6 km of beach, including Burke, Bradley, Folly Field and Port Royal, were added to the area receiving daily, dawn coverage. In 1989, when Dolphin Head Beach was added to the survey area, the entire island was patrolled and managed by the Hilton Head Island Museum (currently known as Coastal Discovery).

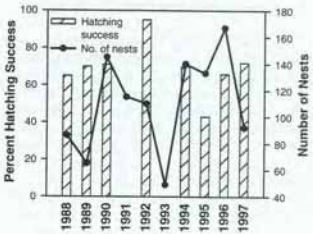
In 1990, Dolphin Head Beach, on Port Royal Sound was dropped from the daily patrols due to the lack of nesting. Renourishment of the central portion of the Atlantic-facing beach occurred during this nesting season. A night patrol team monitored this area and moved nests out of the construction area.

From 1991 to the present, the project continues with daily checks of the beach, (excluding Dolphin Head) by ATV at dawn. Egg poaching still occurs on Hilton Head Island. Coastal Discovery offers beach walks during the nesting and hatching season for a fee, and slide presentations upon request. In 1997, large areas of the beach were renourished during the nesting season. Night patrols were necessary, as they were in 1990, and all nests were moved to Sea Pines Plantation.

OTHER SPECIES

During an aerial survey in the summer of 1981, a non-nesting leatherback crawl was seen in front of the Hyatt Hotel.

Number of Nests and Hatching Success on Hilton Head Island



Project Leader:
1981-1987 Nanci Polk-Weckhorst
1988-present - Ed Drane

Interns:

Patricia Kusmierski
Kim Washok
Cheryl King
Jennifer Turkot
Jim Stevenson
Jeff Hollon
David Drane
Laura Drane
Jennifer Bailey
Edie Phillips

Volunteers:

Robin Bjork
Henry Garbade
Jeff Rupert
John Kennedy
Mr. Krum
Cindy Hykes
Allison Reed
Louanne LaRoache
Charles Wood
Kurt Huggins
Dave Durham
Jamie Patterson
Marie Hartis
Dick Ryan
Tom Bisca
Mary Chapman
Ray Coyne
Jill Foster
Pam Granger-Gale
Robert Butcher
Christine Rozycki
Joy McCain
Ellie Morris
Bob Gale
Sally Krebs
Sara Burden
Jason Fronzack
Phylis Brodie
Matt Fuschow
Bob Pidgeon
Beth Darlington
Kathy Sakus
Niki Stewart
Brent Marinaccio
Phil Sigler

BAY POINT

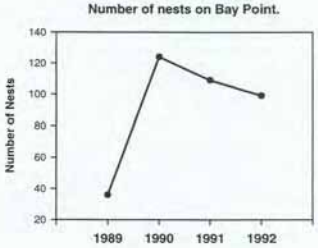
DESCRIPTION OF THE PROJECT AREA

Bay Point Island is a small barrier island on the north side of Port Royal Sound. The 2.1 km beach fronting the sound is backed by a wide dune field, while the ocean-facing beach is littered with fallen trees. Including side beaches, there are 4.8 km of accessible nesting habitat on this privately owned island. Nesting habitat is forming on the Port Royal Sound side of the island. There is one primitive cabin on the ocean facing section of Bay Point beach. During certain seasons of the year, huge mats of dead cord grass (*Spartina alterniflora*) wash ashore creating a thick rack line at the base of the dunes; sometimes preventing nesting turtles from accessing the dunes.

SURVEY HISTORY

In 1989, two volunteers undertook the daunting task of protecting nests on Bay Point. The island is accessible only by boat which must be anchored away from the shore. The volunteers then had to swim to shore in order to survey the beach. The island also lacked a place to secure equipment. The beach was patrolled on foot or on bicycle every other day. Factors that reduced hatching success on Bay Point were raccoons, erosion and ghost crabs. Even with raccoon trapping and nest screening, losses to predation were around 45%. The project continued through 1992 with the volunteers funding the project.

Project Leaders:
1989-1992: Russell Patterson and Scott Cheslak



ST. PHILLIPS ISLAND

DESCRIPTION OF THE PROJECT AREA

St. Phillips Island is a privately owned, beautiful, undeveloped barrier island (see Ackerman 1997). The lush maritime forest is interspersed with lagoons. The only access is by boat. There are fallen trees on the beach and a short rock revetment protects the two houses on the island. The ocean-facing beach is narrow with low dunes. This island is protected in perpetuity by a conservation easement with The Nature Conservancy. There are 2.4 km of ocean facing beach with an additional 1.2 km of beach on the Inlet.

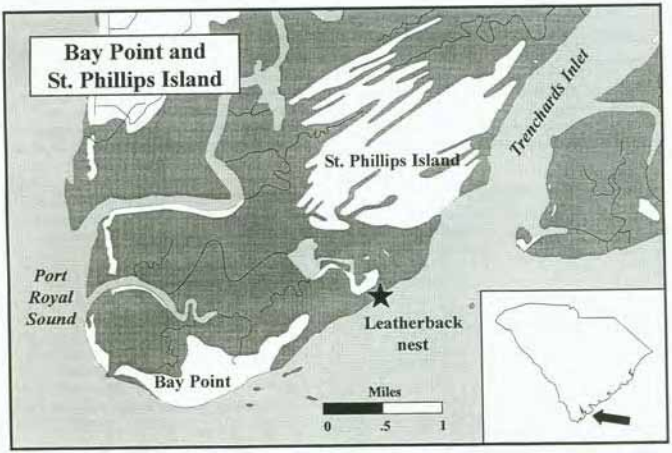
SURVEY HISTORY

This is the newest of the nest protection projects. The island caretaker began monitoring the beach and screening nests in 1996. He continued his nest protection efforts in 1997 with the help of another employee. They patrol the beach in the morning approximately five days a week.

OTHER SPECIES

In 1996, the first state record of a leatherback nest was documented on St. Phillips Island. The nest contained 117 eggs and hatched successfully. However, 30 hatchlings were found dead on the surface of the sand near the nest site. The genetic testing of these hatchlings put them in the most common haplotype group, which occurs throughout the Atlantic Ocean. Tests also indicated that only one male fertilized the clutch (Peter Dutton personal communication).

Project Leader:
1996-1997: Ray Tudor



PRITCHARDS ISLAND

DESCRIPTION OF THE PROJECT AREA

Pritchards Island is a transgressive barrier island that is rapidly eroding. Most of the 4.0 km of beach is littered with fallen trees and the remains of two homes that used to be located within the forest. At high tide, the surf is at the tree line which makes the middle of the beach impassable for the turtle patrol. Therefore, any nests laid south of this point during high tide are prone to raccoon depredation. There is only one short section of dry beach with low dunes where several hatcheries are located.

Pritchards Island was given to The University of South Carolina-Beaufort (USC-B) by Mr. Philip Rhodes in 1983. In 1992, a research facility was constructed for the Center for Coastal Ecology. Their mission "is to educate the citizens of the Lowcountry in all aspects of coastal ecology and to provide increased awareness and preservation of coastal habitats and resources". The only other dwellings on the island besides the research facility is a private home away from the beach and a fishing hut.

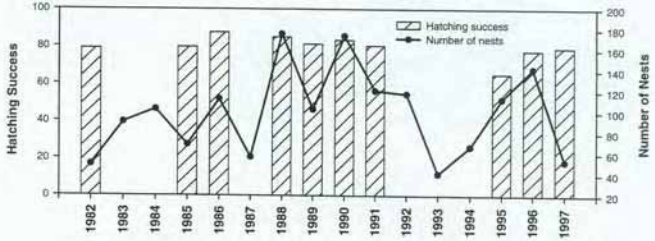
SURVEY HISTORY

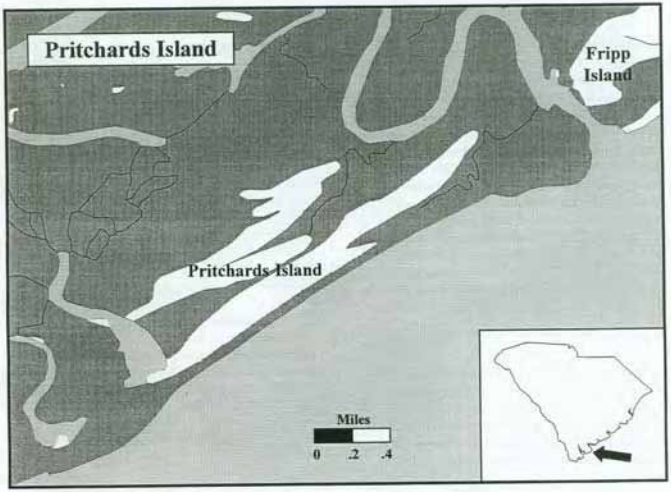
The nest protection project on Pritchards Island began in 1982. The first year, the beach was monitored from mid-May to mid-July with five volunteers. Because of the erosional state of the island and raccoon depredation, the survey was changed to walks at 10:00pm and 3:00am to screen and move nests. The next year the project was active throughout the entire nesting season and nesting females were measured when they were encountered. In 1984, students from USC-B were incorporated into the program to lead the nightly walks. In 1985, after failed attempts at trapping raccoons, hatcheries were used to protect the nests. This was the first year the general public assisted with the project in order to "educate people by personal involvement". The Loggerhead Hilton (which was little more than a screened-porch on pilings containing bunk beds) was constructed to provide housing for volunteers during their overnight stays. About 200 volunteer guests were involved each year. In 1992, a new director and on-site coordinator came to the island. In 1993, the new research facility was completed, which made it possible to accommodate up to 18 volunteers from a wider background, such as Elderhostel. In 1995, the Coastal Zone Education Center directed the project with 250 volunteer guests. USC-Beaufort Center for Coastal Ecology has directed the project since 1996.

OTHER RESEARCH

Jamie Schurbon and Michelle Wieland conducted a study on Pritchards Island in 1996 and 1997. The project description and results can be accessed at www.public.iastate.edu/~schurb/homepage.html. The following is the abstract of this project:

Loggerhead Sea Turtles nest on the beach of Pritchards Island, South Carolina. This project looked at nesting locations and the dates on which





the nests were laid. The beach was divided into 5 sections according to microhabitat specifications. Dates were corresponded to the phase of the moon. Our hypotheses were that loggerheads discriminated against nesting sections that were littered with debris, and that there is no correlation between nesting and phase of moon. Results using Chi-square tests suggested that turtles do nest significantly more in certain sections of the beach, and that there is no significant correlation between nesting and phase of the moon.

Project Leaders:
1982-1991: David McCollum
1982: Ed Caine
1992-1994: Ed Caine
1992-1993: Will Heyman
1994: David Eddins
1995: Elizabeth King and Lynn Corliss
1996-1997: Lynn Corliss

Interns:
Josh Pope
Laura David
Cheryl Wolfe
Jamie Schurbon
Anne Kitchell
Volunteers:
David Jaycox
Heather Dornbrock
Ray "Boogie" Tudor
Cindy Kispert
Lauren Clark
Lane Banks
Andrew Crain
Virginia Bryant
David Gorzynski
Marge Yanker
Justin Widener
Beau Turner
And numerous others

FRIPP ISLAND

DESCRIPTION OF PROJECT AREA

Fripp Island is a gated development consisting of private homes and condominiums with 4.8 km of ocean-facing beach. There was suitable nesting habitat in the early 1970's, as seen in photos from that time. Construction of rock revetments began at the north end of the island in the late 1970's. Each addition of rocks increased the erosion rate south of that point and drastically reduced sea turtle nesting. Currently, the only section of Fripp where there is some nesting habitat is the northern .4 km where a large sand bar has come ashore. There is a dry beach with small dunes seaward of the rocks. However, the remainder of the island has no dunes or dry beach at high tide.

SURVEY HISTORY

In 1979, local residents formed a nest protection group to monitor nests. In 1980, the focus of the project was collecting data on strandings. In 1981 the project started daily morning patrols. At this time, one third of the beach had rock revetments, making this area unavailable to nesting loggerheads.

By 1985, the project had 25-30 volunteers and usable nesting habitat had been reduced to fifty percent of the beach. Nests were screened and 60% of them had to be relocated. The group started presenting regular slide shows in 1987. As stated in the project leader's 1989 report, the southern end is "almost completely revetted".

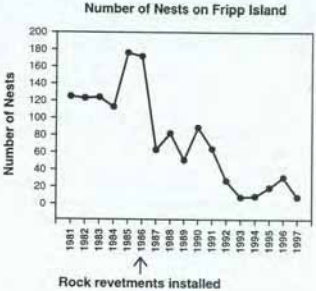
In the early 1990's, raccoon trapping took place to control predation. Also at this time, it was documented that the volunteers were not adhering to the state guidelines and were excavating hatchlings prematurely and releasing them during the day. After several years of re-education about the potential and direct harm this would inflict, they continued this practice. Therefore, their permit was not renewed in 1995.

The project continued in 1995, but with a new project leader that resides, not on Fripp, but on an adjacent island. All nests are moved to the northern end of the beach where dunes have now formed. Raccoon trapping was implemented to control depredation and nests continue to be screened.

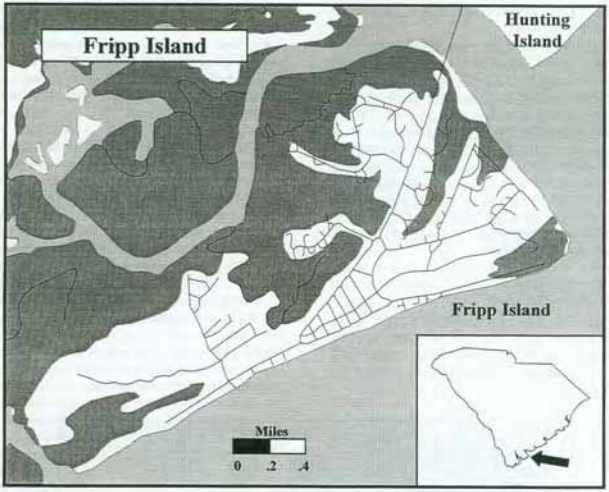
OTHER RESEARCH

In 1970, John Mehrtens, director of the Riverbanks Zoological Park in Columbia, and Jack Kilgore formed the Fripp Island Sea Turtle Conservation Center on the island to "headstart" loggerhead hatchlings. The first year, 500-800 hatchlings were reared for 10 months and released into the Atlantic Ocean in the late spring of 1971. The next year, 40 turtles were flown to Jekyll Island, Georgia by the SC Wildlife and Marine Resources Department because SC coastal waters were too cold for release. From Jekyll Island, the hatchlings were taken by boat to the Gulf Stream for release by the Georgia Department of Natural Resources.

The headstart project continued until 1972 when new ownership of the island ended the Conservation Center's work. The only remaining information on this project is in two articles from *South Carolina Wildlife Magazine* (Culler 1972 and Anonymous 1973).



Project Leaders:
1979-1983 Norine Smoak
1984 Nellie Newman
1985-1989 Dr. Claude Cowan Jr.
1990-1994 Betty Sobol
1995-present Bill Weldner



Volunteers:
Dick Smoak
Bob Garner
Tom and Billy Holme
June Bouvier
Mary Lauffer
Temple and David Smith
Louise and Ed Schneider
Anne Roberts
Mary Oppenheimer
Betty and Earl Griffith
Olga Luster
Lillian Collings
Pres Edwards
Vicky and Lynn Logsdon
Marge Dysart
Margaret and John Birchfield
Mary Fredrick
Nan Atkinson
Dorothy Dugdale
Janell Batzing
Lynn Knaus
Suellen Ryan
Bob Newman
Karen Montano
Ether Farr
Diane Letson
Bev Edwards
Naomi Hroncich
Jack Muhlhauser
Micki McCormak
Kay Cowan
Bill and Marlene Prain
Max Talaska
Gary Bratz
Betty and Dana Dudley
Kami Andrews
El Sobol
Julie Hodgson
Richard Pollitar

HUNTING ISLAND STATE PARK

DESCRIPTON OF THE PROJECT AREA

Hunting Island State Park has 6.4 km of highly erosional, ocean-facing beach. The beach is littered with fallen trees, the remnants of a highway, and exposed marsh peat and stumps. A few cottages at the south end are under life-long leases to individuals. In 1980 and 1991, the beach was renourished; however, there is very little stable nesting habitat left. The island is owned by the state of South Carolina, under the authority of the Department of Parks, Recreation and Tourism (SCPRT) and has about 800,000 visitors a year.

SURVEY HISTORY

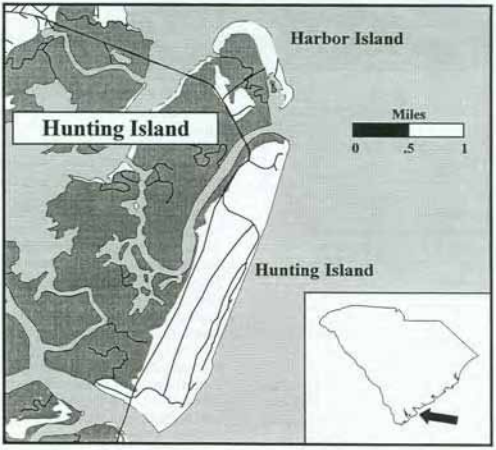
From 1981-1983, the southern 4.8 km of the island were patrolled on foot by a volunteer. In 1984, volunteers patrolled the entire island. Dunes were rebuilt and planted with dune vegetation during the nesting season.

From 1990 to 1995, the state park naturalists volunteered to patrol the entire available nesting habitat before their usual duties. The naturalists integrated nest inventories into their educational programs. They also conducted night walks during the nesting season, and gave interpretive slide presentations. These programs continue at the park.

The 1991 renourishment project used a reduced volume of sand than that used in 1980 and the sand was lost in less than a year. Because of the erosion, it was necessary to start using a hatchery in 1991.

Presently the entire island is monitored and most nests are moved to a hatchery which is located at the north end of the island near the campground.

The Friends of Hunting Island, a volunteer group that assist park personnel, monitored the beach in 1996, under the guidance of park staff. In 1997, The Friends of Hunting Island took over the project in its entirety. Due to management problems the responsibility was returned to the park staff in mid-season.



HARBOR ISLAND

DESCRIPTON OF THE PROJECT AREA

Harbor Island is a small circular barrier island with very little maritime forest. The single family homes and condominiums are situated in the dune fields and thickets. Because it is set back into St. Helena Sound, the 2.4 km of beach do not receive much wave energy. Despite this, a short portion of the beach has an erosional area with no dunes. The beach is accreting on the southern portion.

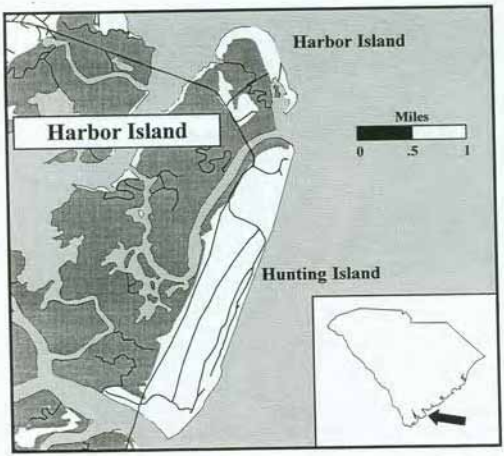
SURVEY HISTORY

The nest protection project was started in 1993. The volunteers walk the entire available nesting habitat every morning, throughout the season. They screen and relocate nests and monitor the emergence of hatchlings. Presentations on the natural history of loggerheads and beach user guidelines are given weekly.

Project Leaders:
1993-present: George & Judy Halleron

Volunteers:

Dick & JoAnna Taylor
Steve & Johanna Sepe
Ivan & Rita Kinne
Johnie Ellis
Jim & Hilda Greene
Cindy Coffin
Bill & Liz Weldner
Jim and Gail Outlaw



OTTER & PINE ISLANDS

DESCRIPTION OF THE PROJECT AREA

Otter and Pine Islands are barrier islands located well inside St. Helena Sound between the South Edisto and Ashepoo Rivers. They are separated from each other by Fishing Creek.

Otter Island is owned by the state of South Carolina under the authority of SCDNR. It is a Heritage Preserve and as such will be protected in perpetuity. The beach is narrow with low dunes interspersed with erosional areas. It has experienced erosional and accretional cycles in the last decade. Otter Island has 7.6 km of beach and from the air, the sand appears pink due to concentrations of crushed coquina shells. There are no modern structures or dwellings on island, but it contains historic and archaeological sites.

Pine Island is privately owned and consists of several narrow beach ridges covered in maritime forest. There are a few, very small pocket beaches that are fronted by *Spartina*, making access for nesting turtles difficult.

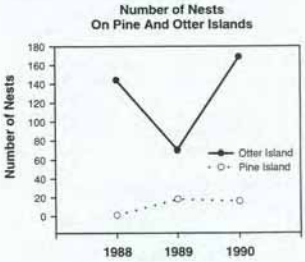
Both Otter and Pine are accessible only by boat. Since they were part of the same project, they will be reported together.

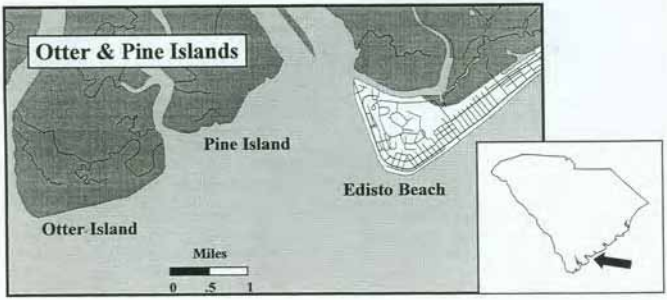
SURVEY HISTORY

From 1988 to 1990, the islands were walked three days a week as early as possible, depending on the tidal cycle. Nests were protected with large screens and relocated when necessary. Raccoons were trapped to reduce the high rate of first night depredation. In the spring of 1997, a raccoon trapping program was restarted by SCDNR staff.

Project Leader:
1988-1990: Deborah Mundell Seyle
Interns:
1990: Leonard Kenyon
Volunteers:

Harry and Alice Hutson	Walker Moore
Joseph Boykin	Roy Mundell
Mike Altine	Dr. Lowell Smythe
David Ellison	David Payne
Michael Jordan	Russell Fox





EDISTO ISLAND

Edisto Island is a large barrier island that lies between the North and South Edisto Rivers. The 18.3 km beach is intersected by several inlets and each project is reported separately here as: Town of Edisto Beach, Edisto Beach State Park, Edingsville Beach, Botany Bay Plantation, and Botany Bay Island.

Town of Edisto Beach

DESCRIPTION OF THE PROJECT AREA

The Town of Edisto Beach consists mainly of single family homes, a majority of which are available for vacation rental. It has 5.7 km of beach on the Atlantic and a 1.9 km beach on the South Edisto River. The beach itself is narrow and steep with rock groins perpendicular to shore. The accumulation of sand on the updrift side of the groins and the loss of sand on the downdrift side, gives the beach a "scalloped" appearance. A combination of houses being built on the primary dunes, and erosion results in turtles sometimes nesting under the decks and porches of the homes. The close proximity of the houses and a road contributes to the lighting problems at Edisto Beach. Mammalian predators are not a problem on the beach. In 1995, prior to nesting season, much of this beach was renourished.

SURVEY HISTORY

In 1982, volunteers began the first nest monitoring program by surveying the beach every second or third day. By the 1984 season, the survey was conducted daily at dawn and the project was supervised by a biologist. In 1985, volunteers started moving nests and by 1989 the experienced volunteers ran the project. Money to cover operating costs was raised from the sale of tee shirts with a loggerhead design. The nesting project encourages a "lights out" campaign during the nesting season that reminds residents and visitors that lights on the front beach disorient hatchlings.

Edisto Beach State Park

DESCRIPTION OF THE PROJECT AREA

Edisto Beach State park is owned by the state of South Carolina and is under the authority of SCPRT. There are camp sites for recreational vehicles nestled within the maritime forest and on the landward side of the primary dunes. The State Park has 2.3 km of beach facing the Atlantic Ocean. The beach is steep, narrow (33-88m), and the sand is mixed with shells. The portion of the beach that is not in the campground is low and backed by a salt marsh. On high tides, hatchlings may view water here and go in the wrong direction. Low, black screening placed on the marsh side of the nests solves this problem. The park received 310,436 visitors in 1997.

SURVEY HISTORY

This beach was monitored regularly from 1981-1989 by summer interns from the Edisto Island Sea Turtle Project. In 1990, supervision of the nest protection project was taken over by the State Park and a summer technician was hired to survey the beach on foot, each morning at dawn. The technician and the park naturalist conduct sea turtle educational programs. Mammalian predation is not a problem.

Edingsville Beach

DESCRIPTION OF THE PROJECT AREA

Edingsville Beach was a popular summer resort in the 1800's, but was destroyed in 1893 by a hurricane. The 2.4 km beach has eroded for over a century, leaving an oyster shell rake with some sand accumulation at both ends. There are no dunes on the beach. A private development of single family homes is separated from the beach by salt marsh, so there are no houses directly on the beach. The development prevents public access to the beach.

SURVEY HISTORY

From 1981-1987, with the exception of 1982, Edingsville Beach was monitored every other day in conjunction with the Edisto Island Turtle Project. Starting in 1996, the beach was monitored by the caretaker associated with the development. The nests do not require screening, and few have to be relocated because the turtles usually crawl to the crest on this extremely narrow beach.

Botany Bay Plantation

DESCRIPTION OF THE PROJECT AREA

A 5,000 acre estate, Botany Bay Plantation is located at the northern end of Edisto Island. The property is owned by the state of South Carolina, but the previous owner has a life estate. The two houses and

farm buildings are not located near the 3.5km beach. The beach is steep, littered with driftwood, and composed mostly of shell. Nesting loggerheads have a difficult time digging an egg chamber in this shelly substrate and often make several aborted egg chambers. It is equally difficult for those monitoring the beach to locate the nests by probing.

Since 1995, South Creek Inlet, which divides the plantation from Botany Bay Island to the north, has filled in with sand, making it continuous with Botany Bay Island. This project is partially funded by the Charleston Natural History Society.

SURVEY HISTORY

In 1981, nests were monitored every other day to determine their fates. In 1982 and 1983, daily, morning patrols, screening and relocating nests were used. From 1984 until 1987, night patrols on an ATV were necessary to prevent first night predation by raccoons.

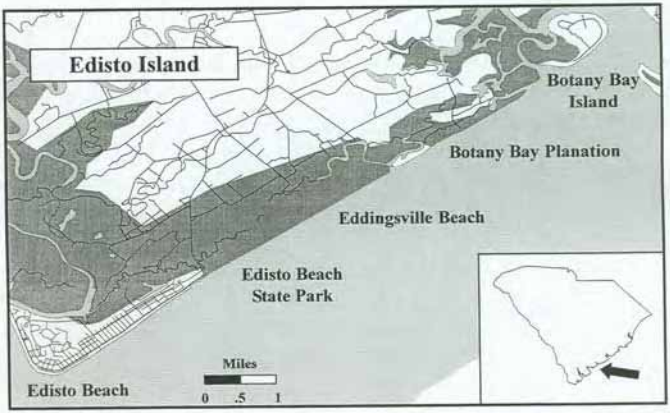
Larger screens were necessary to keep the raccoons from tunneling in from the sides of the standard 3ft. X 3ft. screen. The new screens were 5ft. x 5ft. with a 3ft. x 3ft. center of ½" mesh hardware cloth. This was very effective when staked down on all sides and corners. Prior to emergence, the front of these screens were lifted by two-by-fours to allow the hatchlings to crawl out from under the wire.

There was no project from 1988 to 1991. Partial monitoring resumed only after South Creek inlet started to fill with sand. With each passing year, the inlet continued to close and the protection efforts increased. In 1995, there was complete coverage five days a week, excluding the Least Tern nesting area at the southern end.

Botany Bay Island

DESCRIPTION OF THE PROJECT AREA

Although considered here as part of Edisto Island, Botany Bay Island is actually separated by small creeks and a salt marsh. The owner has placed a conservation easement on the property with The Nature Conservancy and only a few homes will be allowed on the west side of the island. This island is circular in shape and the beach extends from the ocean side around to the North Edisto River. Due to the proximity of the North Edisto River, the beach is highly dynamic. Currently, the beach is accreting and as mentioned

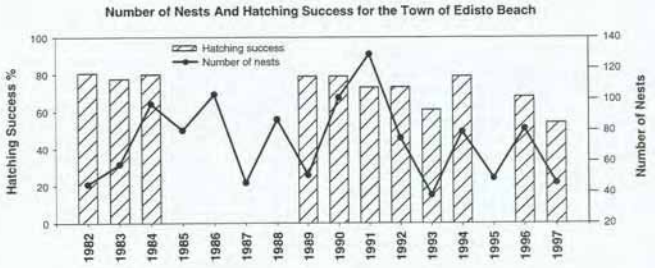


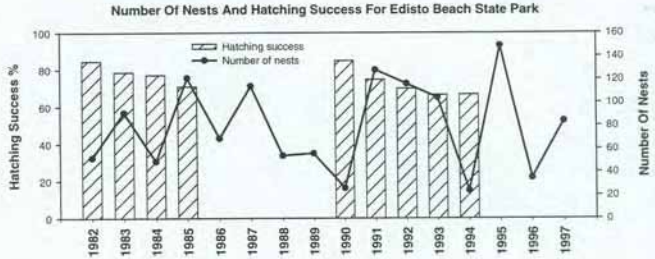
earlier, is now continuous with Botany Bay Plantation.

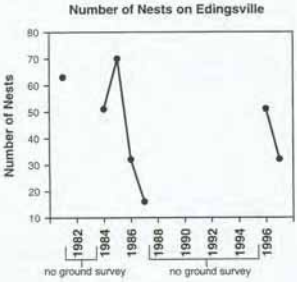
Botany Bay Island has 1.6 km of ocean facing beach, and about 1.2 km. of beach facing the North Edisto River. A tour operation ferries beachcombers over to the island during the turtle nesting season. This has resulted in disturbance to nest protection equipment and litter.

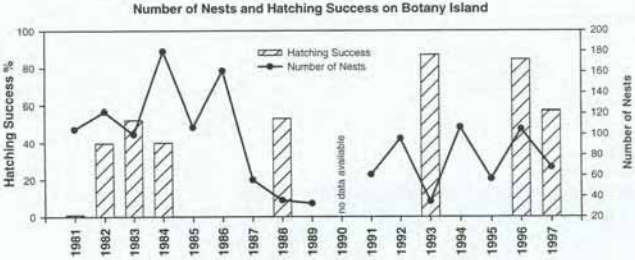
SURVEY HISTORY

With funding from The Nature Conservancy, Botany Bay Island has been monitored since 1988. In 1988, the beach was patrolled on foot two days a week. Surveys were increased to three days a week in 1989 and 1990, either on foot or using an ATV. From 1991 to 1997, the patrols were expanded to five days a week. However, due to problems with personnel, the beach was not patrolled until 16 June in 1997.









Town of Edisto Beach:
Project Leaders:
1982-1986, 1988: Deborah Mundell
1987: Cindy McDougel
1989: Florence Johnston, Frank and Carol Bremer
1990: Florence Johnson, Frank Bremer, Mary Lou Norton
1991: Mary Lou Norton
1992-present: Glenda Chumney
Volunteers:
John Beach
Ginger Lee
Sheila Beardsley
Carol Marshall
George and Nancy Bergmark
Shirley Pazucha
Mary Lee Blair
Jean Reid
Fan Brooke
Pat Soars
Tecla Earnshaw
William Stevens
Jake and Ollie Tingman
Dudley and Fran Currie
Don and Helen Tuttle
Florence Johnston
Carolyn Cypher
Francis White

Ed and Jane Graham
Gretrude Woods
Marvin Hines
Vee Kizer
Ella Holforty
Joe and Lorrine Kirchner
Kert Huggins
Aimee Kornegay
Naomi Irvin
Paul LeBlanc
Ron Chumney
Linda Hirschfield
Mel and Jeanne Kelsey
Frank and Carol Bremer
Micheal Monica Eng
Ann Logan
Gene and Betty Tynes
Bill and Rose Ramsey

Edisto Beach State Park:
Project Leaders:
1981: Deborah Mundell and Ann Starke
1982: Deborah Mundell and Ann Starke
1983-1986, 1988-1989: Deborah Mundell
1987: Cindy McDougal
1990-present: Edisto Beach State Park Superintendent
Interns:
Liz Ferguson
Cathrine Locatis
Kathy Stanford
Dave and Morrison Payne
Robert Norton
Robert Mays
Muff Lyons
Judith Blancett
Marilyn Laserna
Volunteers:
William Callahan
W. Jeff Hofmann
Brian Norris
Margaret Arnold
Brad Wise
Roger Whitmore

Edingsville Beach:
Project Leaders:
1981, 1983-1986: Deborah Mundell
1987: Cindy McDougal
1996-1997: Doug and Anne Henley
Interns:
Liz Ferguson
Catherine Locatis
Mary Elfner

Botany Bay Plantation:
Project Leaders:
1981: Anne Stark and Deborah Mundell Seyle
1982-1986: Deborah Mundell Seyle
1987: Cindy McDougel
1992-1996: Patti Kusmierski
1997: Jennifer Lamar
Interns:
Charlotte Hope
Mary Elfner
Kathy Moore
Patrick Morgan Jr.
Volunteers:
Emily Leland
Mrs. George Pepper
And numerous others

Botany Bay Island:
Project Leaders:
1988-1990: Deborah Mundell
1991-1996: Patti Kusmierski
1997: Jennifer Lamar
Interns:
Leonard Kenyon
Patrick Morgan Jr.
Volunteers:
Dr. Kip Lassiter
Bill and Sally Whitner
The Bohicket Marina
Emily Leland
And numerous others

SEABROOK ISLAND

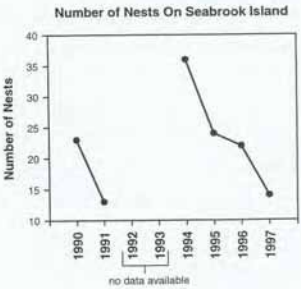
DESCRIPTION OF PROJECT AREA

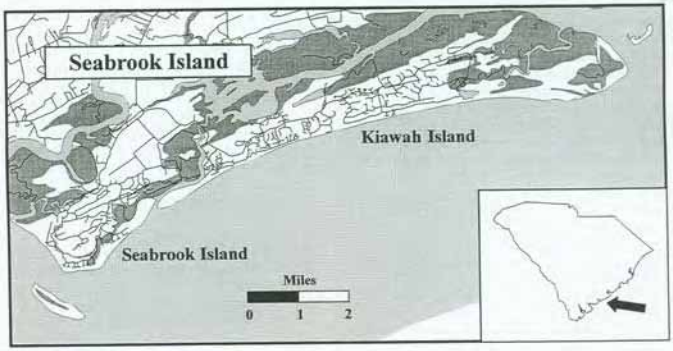
Seabrook Island is a gated, residential resort community with single family homes, condominiums and resort facilities. Camp St. Christopher on Seabrook Island is owned and operated by the Episcopal Diocese of South Carolina. Most camp buildings are located behind the tree line.

Like Botany Bay Island, Seabrook is roughly circular in shape and the 6 km beach extends from the ocean around to the shore of the North Edisto River. The middle portion has a rock revetment while the northern section has a wide dune field between the homes and the nesting beach. Much of this sand was acquired by re-structuring Captain Sam's Inlet and allowing the sand from the south end of Kiawah Island to drift south onto Seabrook. This engineering endeavor has been accomplished twice in the last decade. Residents on this island have conducted a nest protection project since 1990.

SURVEY HISTORY

In 1995, Camp St. Christopher submitted a separate report on the sea turtle nesting activity for the season. Currently, the volunteers at Seabrook monitor this property in conjunction with their morning beach patrols. Mammalian predation was not a problem on Seabrook until 1997. During this season, five of the 14 nests were depredated. The volunteers screened nests in 1998 to prevent predation.





Seabrook Island:
Project Leaders:
1990: Patricia Leonard
1991: Shirley Tilley
1992: Pat Leonard
1993-94: Shirley Tilley
1994-1997: Jan Fetzer & Elizabeth Robertson
Project Leader
Camp St. Christopher 1995: Ken Alfieri
Volunteers:
Suzanne and Jack Schmidt
Ruth and Jack Harth
Tish Moyle
Linda Vancini
Mary Ann Loeffler
Kaye and Fred Ristow
Tim Walsh
Pat Goodwin
Bill Billsback
Marlene Stefani
Betty Nelson
Adrienne and Danny Brooks
June and Jack Beerman
Sue Suffel
Judy and Stan Alexander
Paula Dumas
Dottie and Harvey Sewell
Liz Sampson
Bobbi Papineau
Joan Haugaard
Lin Burnett
Gert Simon
Kathy Eichhorn
Nancy and Claude Smith
Tiffany and Michael Poupore
Tammy and Joe Westmoreland
Audrey King
Allison Ryan
Deann Fryberger
Margie and Hank Lindauer
Babs Hubbeling
Kaye and Fred Ristow
Linda Renken
Lynne Burnette
Alice and Tom Hilton
Edith Lane
Dot Givens
Kevin Brookshire
Mike Mahoney
Anne and Bud Pearson
Anne Cherry
Jamie McMurray
Marie Finley
Mary Lou and Chuck Murphy
Nancy Secoy
Pam Bartenfield
Winn Stoddard
Bill Bradley
Don Ruff
Johanna Huggins
Jason Young
Jean Berner
Kaye and Fred Ristow
Barbara Johnson
Jacque Griseto
Sue and Bob McCaffrey
Alice Coogan
Lyall Watson
Nancy and Bill Dawson
Juna Thompson
Wayne and Lynne Palkovitz
Mara Palkovitz
Hanna Palkovitz
Margot Hyed
Sue Coomer
Tiffany Poupore
Jean Berner
Ann Kent

KIAWAH ISLAND

DESCRIPTION OF PROJECT AREA

Kiawah Island is a private, residential resort with 16km of ocean facing beach. The beach is wide, flat and fairly stable. Sea turtle monitoring activities have taken place on the island since the early 1970's. There are well developed dune fields, and homes are required to be located away from the beach. There are two golf courses on the island that have links that are directly behind the beach. In these sections, lighting on the beach is not a problem since homes are either absent or are located on the landward side of the greens and fairways. However, golf course sprinklers promote vegetation growth on the dunes that often interferes with hatch success through root penetration of the eggs. The regular application of water from the sprinklers influences sand temperature, making these areas not suitable for nest re-location. In other areas, the beach is backed by multi-story condominiums and the Kiawah Inn. The southern most part of the beach is a county park with paid public access. There are no beachfront structures in the park.

SURVEY HISTORY

After initial surveys in 1972, a tagging project and hatchery were operated from 1973-1976 (Talbert et al. 1980). A synopsis of this project is described in the Environmental Inventory of Kiawah Island prepared in the late 1970's. The sharp decline in turtle nests after the start of this project is most likely due to the patrol methods at this time. The beach was patrolled by vehicle, at frequent intervals. Apparently, turtles were disturbed by the constant traffic on the beach. Nesting began to increase at the end of this project in 1975 and continued to rise until 1981.

From 1976 until 1979, no nighttime patrols or tagging were conducted, however, a hatchery was operated by University of South Carolina students in 1976. In 1977, the project came under the supervision of the Kiawah Island Community Association. The only data available from this project is the number of nests per season.

In the early 1980's, paid Kiawah employees ran the turtle project. Night patrols and educational programs were integrated into the program. Funding for this project ended in 1986. The 1987 surveys started late due to the lack of funding, but this was corrected by mid-June. In 1988, residents of Kiawah Island volunteered to manage the turtle program. The 1988 season was delayed until July 4th, because the newly formed volunteer project could not obtain permission to access the beach.

Currently, this group surveys the beach daily and relocates and protects an average of 140 nests per season. In 1993, Dr. Bob Cowgill, director of the volunteer project, summarized the history of the Kiawah Island sea turtle project in a report to SCDNR. This report provided most of the information for this section.

OTHER RESEARCH

In addition to the sea turtle project volunteers' duties of nest relocation, protection, and inventories, they often conduct related research projects. These project reports are submitted to the state coordinator with their annual reports.

The possible correlation between the sizes of the nesting female, egg and hatchlings was examined in an independent study conducted by J.L Pinckney in 1983. No correlation was found between mother size and egg size, but a positive correlation was found between female size and clutch size. This correlation was based on a sample of 68 and was significant at $p < .01$.

When the volunteers began monitoring the beach, predation by raccoons and foxes presented a problem even with screens protecting the nests. In 1991, Cowgill and Hamilton put electric fences around each nest, using motorcycle batteries as the energy source, after the first sign of predator disturbance. In one portion of the beach, where 30% of the nests were depredated in 1990, predation dropped to 5% in 1991 after the installation of electric fences.

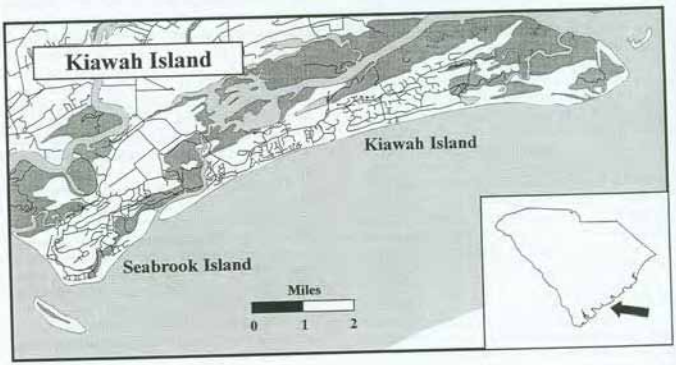
To determine which areas on the beach were best protected from high water tables associated with spring tides, Hamilton and Cowgill conducted a study in 1991 and 1992. Pipes were inserted 24" into the sand and water level measurements were taken during the spring tide. The study determined that relocated nests should be placed landward of the spring tide wrack line.

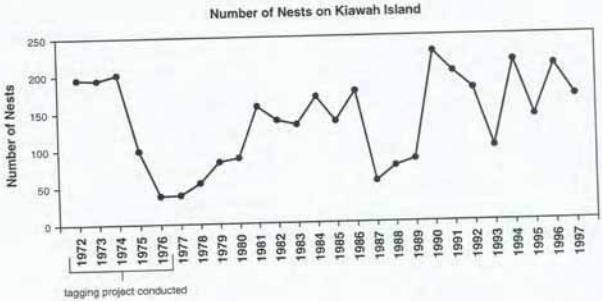
In 1991, Cowgill recorded the plant species that had roots growing into the turtle nests. Low nest success due to root penetration was most often associated with *Atriplex*, Russian thistle, salt grass, and sand spur.

In 1992, Cowgill and Hamilton conducted a nest temperature study. Temperature probes were placed in three nests and in three control locations. This study was expanded in 1995, and examined the inverse re-

lationship between nest temperature and incubation duration. From this data, it was extrapolated that Kiawah had a 1:1 sex ratio of hatchlings.

In 1992, Cowgill explored the possibility of identifying female loggerheads by their tracks in the sand. This could indicate the number of individuals using the beach without tagging each female. Incoming crawls were photographed, but did not yield significant results. A wide-angle lens and a standard frame for each crawl were employed in 1993. From this study, 23 individual females were identified by their crawls.





Project Leaders:
1972-75: Rhett Talbert & Tom McGee
1977: Michael Brown
1978: May Baird
1980-85: Keith Kriet & Sally Pruitt
1986-88: William Botts
1989-1997: Robert Cowgill

Volunteers:
Nadine Agliata
Dottie and Dale Anderson
Bob Ashworth
Ginny Aubrey
Bill Bartlett
Joanne Barrand
Nancy and Carl Beatty
Al and Flor Benjaminson
Harvey Berger
Doris Besok
Marilyn Blizard
Linda Bloodgood
Gloria and John Buckalew
Carol Cameron
Mary Carven
Ellie Cate
Pat Chatburn
Bill Connellee
Bob Coughlan
Vi and Ron Cox
Happy and Browning Crow
Chuck and Ruth Cusick
Audrey DeCook
Maureen Delk
Alice and Henrique Dematos
Roger and Joan Diesing
Maggie Donaho
Marianne Doolittle
Jim and Kathy Dore
Dot Dornseif
Ann and Jack Dover
Marion DuBois
Cathy and Jeff Dufault
Stephanie and Jack Dunfee
Gene and Pat Estes
Francis and Warren Fair
Gloria Fasciano
Richard Fenwick
Mary Bird Ferguson
Cate Freeman
Sybil and Tom Fromme
Lou Frye
Bob and Jean Gallagher
Jan Gantman
Kathleen and John Glinski
Katie Grimm
Jeff Groat
Don and Monica Groves
Elaine Hahne
Ann and Jack Hamilton
Colvin and Sidney Hawkey
La Homa Heisa
Andy Herster
Elliot Hillock
Paul Hoffman
Kathy Hummers
George and Trudi Intemann
Marguerite Isenburg
Margaret Jenkins
Jean and Tap Johnson
Bob Jonathan
Susie Keefe
Kaye and Ron Keller
Lou and Jim Kinney
Lisa Klingel
Jeanie and Tom Koenig
Lydia Lalumia
Arla and Neil Lawson
Frances Leopold
Bill and Ellie Lieberman
Bev and Arnie Liebman
Chris Limbert
Linda Malcolm
Jane McCance
Kathy McCrann
Rosemary McDermott
Marlene and Roger McLaughlin
Glenda McLean
John and Lois McMorris
Ben Matthesen
George Melvin
Veronica and Paul Mellish
Ed and Elsie Meyer
Marge Middleton
Doris and Ben Miller
Sally and Ed Morgan
Ruth and George Muller
Eric Nance
Mary Ann Nelson
Ann O'Connor
Margit and Carl Obern
Bonnie Orenstein
Jim Passino
Cathy and Bill Pence
Pat Pendery
Linda and Joe Pezzulo
Sally Pruitt
Gloria Qualls
Barbara Quinn
Janet Richardson
Ron and Carol Ritchie
Bette Robinson
Sally Robinson
Art and Carol Roso
Claudia Ruedrich
Peggy and John Russo
David Sawyer
Dick and Ellen Sayers
Claire Schausell
Nancy Schuette
Marie and Ralph Schwartz
Paul Schweyer
Nancy Scott
Jane Sheridan
Louise and Al Sill
Jane Smith
Melanie Smith
Karen Snyder
Sandy and Tony Speno
Paula and Ken Stephenson
Tricia Stobie
Dolly Sullivan
Jim Sullivan
Kathy Sullivan
Kay and Vincent Sweeney
Ann Tadler
Linda and Arch Templeton
Fran and Charles Unglesby
George and Kay Walther
B. G. and Mike Walsh
Joan and Kurt Wassen
Mary Wilkin
Margaret Winkleman
Barbara and Harold Winslow
Marvin Woolfe
Beth Wright
Sheri and Marty Yanos
Allison Zacharkiw

FOLLY BEACH

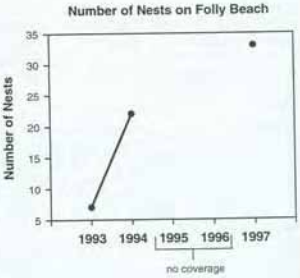
DESCRIPTION OF PROJECT AREA

Folly Beach is a residential community south of Charleston Harbor with 11 km of beach. After the completion of the Charleston jetties in 1895, the natural, erosional retreat of the island accelerated. Rock groins are in place along the length of the beach. From January to May 1993, the 8.6 km beach was renourished.

SURVEY HISTORY

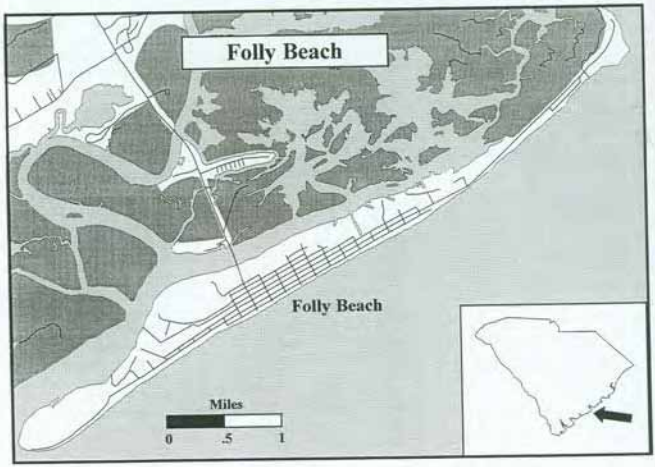
Folly Beach has had sporadic survey coverage since 1993. In 1993 and 1994, the town provided an ATV for a morning nesting patrol. However, patrols did not start until June in 1993.

Currently, the beach is monitored through volunteer walkers and calls from the public. Complete, daily coverage is not ensured. However, a biologist with the U.S. Fish and Wildlife Service volunteered to lead the project in 1997 which led to better coverage.



Project Leaders:
1993-94: Dan O'Brien
1997: Paula Sisson

Volunteers:
Carole and Lola Bennett
Roger Prevost
Barbara Simmons
Nancy Smith



ISLE OF PALMS AND SULLIVANS ISLAND

DESCRIPTION OF PROJECT AREA

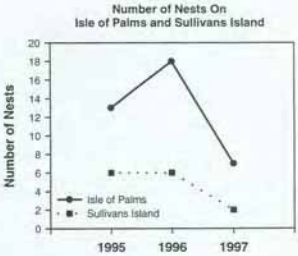
The Isle of Palms and Sullivans Island are residential beach communities north of Charleston Harbor. Breech Inlet separates the two islands. The Isle of Palms has 10 km of beachfront, while Sullivans Island has 5 km. The entire beachfront is developed and nesting is very low on these beaches.

Sullivans Island consists of single family homes. The dune field is wide and the homes are well back from the beach. The north end of the beach is highly eroded with groins and sandbags installed to protect property.

The Isle of Palms also has single family homes, but there are multi-story condominiums on the north end and a pier and commercial area in the center of the island. Much of this island also has homes on the primary dunes. However the dynamic north end near the inlet has gone into an erosional cycle that has left several condominiums on the active beach with sand bags around their foundations.

SURVEY HISTORY

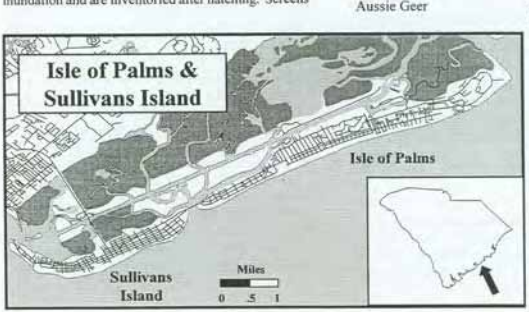
Since 1995, volunteers have monitored these beaches for nesting. These individuals spearhead an active public information campaign. Daily coverage of the entire area is not ensured on the Isle of Palms, but Sullivans Island does have daily coverage by volunteers. Nests are relocated to protect them from tidal inundation and are inventoried after hatching. Screens are not needed as there is no history of mammalian predation.



Project Leaders 1995-1997:
Marge Millman and Mary Ellen Rogers

Volunteers:

Paul Stern	Kay Park
Bonnie and Don Hvrada	Marge Watson
Sue Shankle	Marc Bonin
Ashley Ulrich	Barbara Butler
Terry Fisher	Lee Marcus
Janet Pearlman	Sharon Clark
Patrick Tivnan	Lynda Biel
Lucy and Quaddy Jones	Buddy Bramlett
Alice Gyug	Terry McKelvy
Sherry Ivy	Julia Khoury
Aussie Geer	Melissa Milligan
	Lila Trussler



CAPE ROMAIN NATIONAL WILDLIFE REFUGE

DESCRIPTION OF PROJECT AREA

Cape Romain National Wildlife Refuge has four islands with ocean facing beaches: Bull, Cape, Lighthouse, and Raccoon Key. The western arm of the Cape beach often merges with Lighthouse Island. Cape Island is 9 km long when not joined to the 4.5 km beach of Lighthouse Island. Cape, Lighthouse, Bull, and Raccoon Key have highly erosional beaches with low elevations (Lennon 1996). However, since there is no beachfront development on these islands, turtles are able to place their nests in the dunes behind the erosional areas. Cape Island is the most significant loggerhead nesting beach north of Cape Canaveral with an average 1,000 nests per season. The beach is steep with coarse sand. Long sections of the beach consist of flat, washovers and the nesting turtles tend to wander extensively in these areas.

SURVEY HISTORY

Some of the earliest sea turtle research was conducted on the islands of Cape Romain. In 1938, William Baldwin made observations of turtle nests on Bull Island. He followed the fates of 18 nests during the season. Baldwin and Lofton (1940) wrote a manuscript on the Loggerheads of Cape Romain including information from their initial observations in 1937. The manuscript reports data collected on a variety of loggerhead reproductive behaviors, including mating, nest site selection, egg deposition, incubation, and hatching. It is the earliest comprehensive report on loggerheads.

The Cape Romain refuge reports, dating back to 1940, include a section on the number of loggerhead nests for the season and their hatching success. This information is not based on daily patrols, but does include some interesting anecdotal information. In 1944, the refuge manager reported his impression that there were fewer adult loggerheads in the area. A local shrimper confirmed his suspicion after reporting his incidental turtle catch down from "as many as a dozen" to only one. The manager concludes that "it is possible that local military bombing and patrol-boat activities have been partly responsible" for the decline in nesting females. Apparently, military activities associated with World War II included using swimming sea turtles for target practice.

David Caldwell compiled data from the refuge reports and Baldwin and Lofton's manuscript in a 1959 publication entitled *The Loggerhead Turtles of Cape Romain, South Carolina* (Bulletin of the Florida State Museum 1959). This report details the life-history and biology of loggerheads at Cape Romain as researched by Baldwin and Lofton.

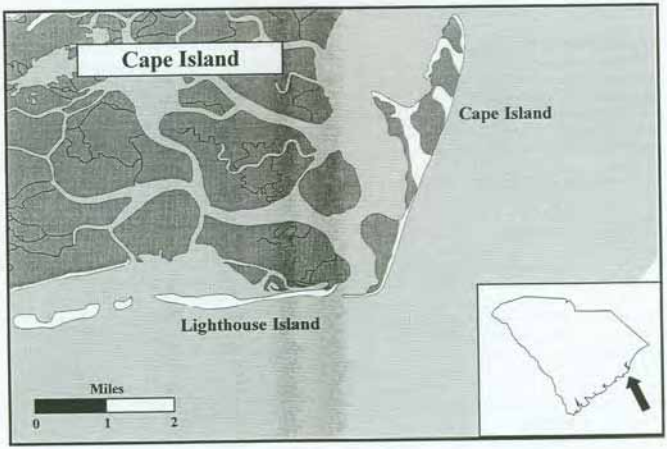
In 1975, a sea turtle management project was initiated on Cape Island. From 1975 through 1979, Cape Island did not have daily coverage; however, the beach was patrolled several times a week, and a nesting estimate was obtained from the numbers recorded during the patrol. Starting in 1980, the project began daily beach patrols. However, some nests are missed due to the project starting late in May.

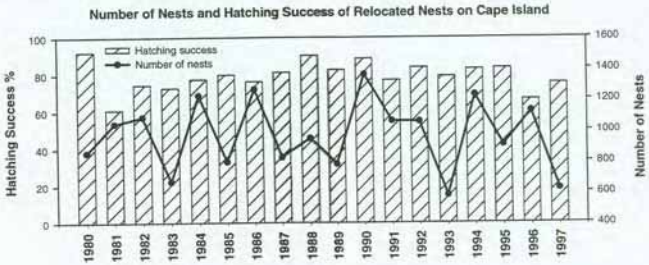
The Cape Island project relocates nests to hatcheries to protect them from erosion and predators. The one hatchery that is not self-releasing, is monitored at night during the hatching season. All other hatcheries are self- releasing. A minimum of 25% of the nests are inventoried to determine hatching success. Raccoons are trapped on Cape Island as part of the loggerhead protection project. Of the four islands in the Cape Romain refuge, only Cape Island has a sea turtle management project. This project is administered and funded by the U.S. Fish and Wildlife Service.

OTHER RESEARCH

Starting in 1969 and continuing through 1979, U.S. Fish and Wildlife Service attempted to increase the loggerheads' breeding range by transplanting nests. Three National Wildlife Refuges received loggerhead nests from Cape Romain: Chincoteague located in Virginia and Maryland, Back Bay in Virginia, and Pea Island in North Carolina. The nests were transferred between the 42nd to 45th day of development. Eggs were packed in coolers and delivered within 24 hours. Depending on the success of the nests marked for relocation, six to ten nests were delivered to each refuge. Nests past 45 days of development had a better relocation success rate than those transferred earlier in their development.

During 1977-1979 Sally Hopkins and Tom Murphy monitored nests on Cape Island to assess biotic and abiotic factors that affect nest success. Raccoons were eating nearly 90% of the nests. Based on these data, the refuge manager began implementing management actions in 1980 to reduce nest losses.





Refuge manager:
George Garris
Turtle staff:
Sarah Dawsey
Stephen Jones
Bryan Collins

Cape Island has numerous volunteers and employees each season who assist with the sea turtle project. The U.S. Fish and Wildlife Service was unable to contribute the names of all the people who have worked on this project throughout the years.

TOM YAWKEY WILDLIFE CENTER

DESCRIPTION OF PROJECT AREA

The Tom Yawkey Wildlife Center is comprised of four islands; only three of them, North, South and Sand Islands, have an ocean-facing beach. This area was given to the state of South Carolina by Tom Yawkey of Boston. The area is managed by SCDNR. All islands are protected in perpetuity from beachfront development.

North Island, the "crown jewel" of the South Carolina coast, is located at the entrance to Winyah Bay. The 15 km beach reflects a textbook beach profile with dune fields that are 100 meters wide in some areas, merging into the salt-pruned thicket community. Some dunes are 3 to 8 meters high and rise above the maritime forest. The north jetty of the Winyah Bay entrance channel is located on North Island and the beach wraps around from the Atlantic Ocean to the Bay. As stipulated in Mr. Yawkey's will, North Island remains pristine with no management activities occurring there. For this reason, there has never been any protection of sea turtle nests on North Island. The only year when data was collected for North Island was 1977, when 79 nests were documented.

Sand Island began forming when the south jetty was constructed in the late 1890's. Sand began to accumulate around this structure, and by the 1950's, salt tolerant plant communities were established on the island. The beach extends from the ocean around to Winyah Bay. There is no maritime forest and wax myrtles are the tallest vegetation. In the late 1970's and early 1980's, the beach consisted of well formed dunes and washover areas. In 1989, Hurricane Hugo completely flattened Sand Island and recovery has been slow. A few dunes have begun to form at the south end. Hurricane Hugo also shifted the inlet between Sand and South Island 1.6 km north, changing the lengths of the two islands. Currently, Sand Island is 2.4 km in length.

South Island is mainly composed of former rice fields, now managed for waterfowl and other wetland species. The 5.6 km beach is wide with well formed dunes which may become scarped during winter storms, but usually rebuild each spring. Because there are maritime forests and wetlands near most of the beach, raccoons, deer, bobcats, foxes and alligators are frequently seen out on the beach.

SURVEY HISTORY

Interest in loggerhead turtles at the Yawkey Center dates back to 1968 when the islands were privately owned by Tom Yawkey. A personal friend of Mr. Yawkey, Thomas Samworth, conducted nest surveys on South and Sand Islands. He recorded: the date laid and date hatched, number of hatchlings, and nest predation. From June 5, 1968 through August 16, 1968, Samworth recorded 204 nests.

Starting in 1977, Sally Hopkins and Tom Murphy with SCDNR monitored North, Sand, and South Islands to assess the biotic and abiotic factors affecting nest success. Cape Island in the Cape Romain National Wildlife Refuge was also included in this study. The study continued only on Sand, South and Cape Islands during 1978 and 1979. Abiotic factors influencing nest success were defined as erosion and inundation. Biotic factors were human, ghost crab, raccoon, and fox predation. Raccoon predation accounted for over 50% of nest loss on the islands monitored (Hopkins and Murphy 1981).

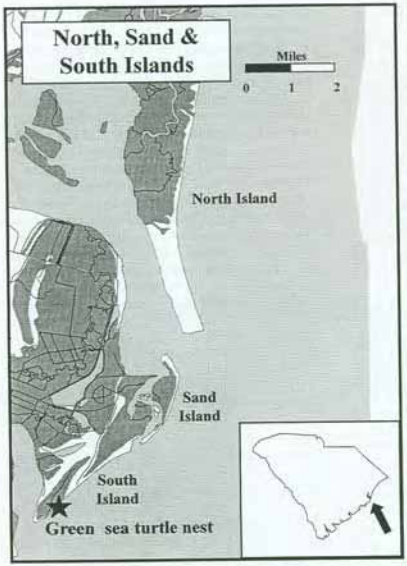
Based on the information from this study, several management practices were tested in order to evaluate their impact on nest success. On South and Sand Islands, from 1980 to 1982, raccoons were removed from the maritime forest and the beach. The removal of raccoons from the beach had the most significant impact, increasing nest success from 11.8% in 1980 to 62.1% in 1981.

Nest relocation and screening also proved to be a management technique that improved nest success. Moving nests away from erosion and inundation increased the number of hatched nests by 18.9% in the first year of the study on South Island. The findings of this study prompted annual nest relocation and screening projects on South and Cape Islands.

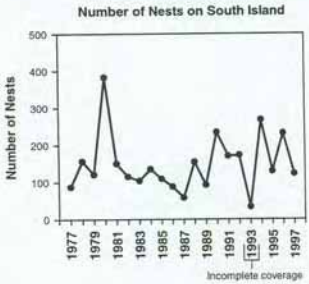
Currently at Yawkey Wildlife Center, only South Island has a sea turtle patrol that is conducted daily by a paid SCDNR technician funded by the Yawkey Foundation. An ATV is used to patrol the beach during the morning survey. In addition to screening and relocating activities to protect nests, raccoon trapping is conducted when needed. A minimum of 25% of the nests are inventoried after hatching to determine hatch success.

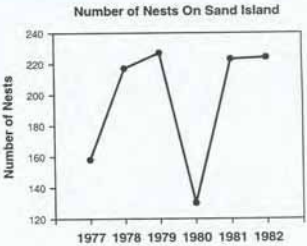
OTHER SPECIES

A confirmed green sea turtle nest was laid on South Island on August 6, 1996. One month later, on September 9, 1996 a green turtle nested north of South Island in Garden City (see the SCUTE report for details).



Interns:
Jason Lehto
John Steele
Teri Watford
Danny Blair Ivey
Jim Davis
Nicolle Rutherford
Meg Hoyle
Leilani Alvarez
Carrie Singer
Stacey Floyd
Kimberly Coker
Alicia Esparza-Webster
Chris Barr
Tim Sawyer
David Jennings
Mark Dulusky
Jane Wyche Hudson
Robert Dunn
William Oldland





NORTHERN GEORGETOWN & HORRY COUNTIES

DESCRIPTION OF PROJECT AREA

South Carolina United Turtle Enthusiasts (SCUTE) monitor approximately 78 km of beach in northern Georgetown and Horry Counties. This area includes the following separately patrolled areas.

Hobcaw Barony is owned by the State of South Carolina, under authority of University of South Carolina. The beach ranges from erosional areas with dead myrtles and no dunes to low dunes at the south end.

DeBordieu Colony is a gated community with single family homes and condominiums. There is a seawall fronting $^{1}/_{3}$ of the beach where prior to renourishment there was no dry beach. The northern part has well developed dunes and dunefields.

Pawleys Island is comprised of single family homes and one condominium complex. The northern $^{2}/_{3}$ of the beach has stable dunes and adequate setbacks. The southern $^{1}/_{3}$ has houses on the active beach.

South Litchfield Beach has homes that are located behind the primary dunes. Erosional areas limit the amount of stable areas for nest relocation. The southern $^{1}/_{3}$ of the beach is a gated community.

Litchfield-by-the Sea is a gated community with several high rise condominiums. The beach is stable with the primary dunes remaining. The older condominiums are not currently in compliance with the lighting ordinance, but this is being corrected. The new condominiums are in compliance with the ordinance.

North Litchfield Beach is a public beach with private homes set behind the secondary dunes. This beach has the most conducive environment for nesting in regards to dunes and lighting. However, fireworks are prevalent during the summer rental season.

Huntington Beach State Park, under the authority of SC PRT, has a protected beachfront with no residential development. The southern portion of the park has a relatively stable dune system, but the north end near the Murrells Inlet jetty is unstable and has few dunes.

Garden City consists of high rise condominiums and homes on the dune field with little suitable nesting habitat or relocation sites. The occasional nest laid at Garden City is relocated to Huntington Beach State Park to improve hatching success.

Surfside Beach consists of high rise condominiums and homes on the dune field which leave little room for sea turtle nesting. Beachfront lighting is a problem in this area.

Long Bay Estates is comprised of private homes with minimal beachfront lighting. It has a relatively stable dune system.

Myrtle Beach State Park, under the authority of SC PRT, has a protected beachfront with no development, but very little nesting. It is a good area for relocating nests laid in other areas of Horry County that would not have a high hatch success due to beachfront lighting or overwash. A naturalist and volunteer program assist in monitoring any nests in this area.

City of Myrtle Beach has high rise condominiums on the dune field leaving little room for sea turtle nesting. The beach is raked every morning at 4:30 am. Hatchlings are known to be disoriented in this area due to the beachfront lighting.

Briarcliff Acres consists of residential homes with minimal beachfront lighting. The dunes are relatively stable and some nests are left *in situ*. Volunteers from this area respond to reports from the public in the northern area of the county.

North Myrtle Beach consists of high rise condominiums on the dune field leaving little room for sea turtle nesting. Prior to the 1997 beach renourishment, there was no dune system remaining. This area is not patrolled daily due to the lack of nesting on this beach.

SURVEY HISTORY

In the late 1980's, a volunteer began the effort to monitor approximately 100 km of beach in Horry County. Most of this area is intensively developed and has very low nesting (11 nests in 1990). There was no standardized methodology for patrolling at this time and the first years were used to survey beaches in order to quantify nesting. A drive to recruit volunteers was very successful with 100 people joining this effort. In 1990, the group expanded it's area to northern Georgetown County and took the name SCUTE for South Carolina United Turtle Enthusiasts. After the area began its recovery from Hurricane Hugo in 1989, trained volunteers began regularly patrolling in 1991.

All beaches except Garden City, Surfside, and North Myrtle Beach are patrolled daily. Due to the low nesting on these three beaches, SCUTE relies on calls from the public to report nests. In Myrtle Beach the tractor drivers raking the beach are trained to look for crawls and report them to SCUTE. In 1996, Garden City had no nests, Surfside had one nest, and North

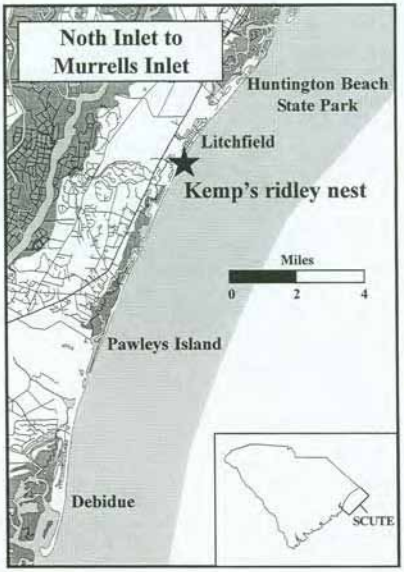
Myrtle Beach had one nest. SCUTE inventories all nests laid during the nesting season.

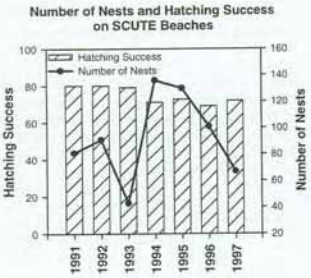
SCUTE actively educates the public about sea turtles by working cooperatively with Santee Cooper, an electricity supplier. Santee Cooper prints "Lights Out For Sea Turtles" bumper stickers and educational pamphlets for SCUTE. SCUTE was instrumental in creating the beachfront lighting ordinance for Georgetown County the first in the state.

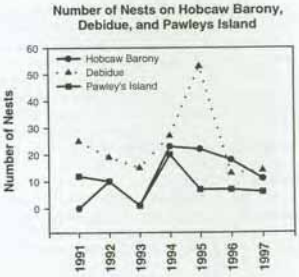
OTHER SPECIES

Georgetown and Horry counties had two highly unusual nests. On May 28, 1992, a Kemp's ridley (*Lepidochelys kempii*) laid 95 eggs at Litchfield-By-The-Sea. This is the first known Kemp's ridley nesting on the eastern seaboard of the United States. The nest hatched successfully after being relocated and screened.

On September 9, 1996, a green sea turtle (*Chelonia mydas*) laid 135 eggs in Garden City. The nest was relocated to Litchfield and then relocated to a SCUTE organizer's house because of the cool fall temperatures. The eggs were kept in sand in an insulated cooler and the temperature was controlled with lightbulbs. Distilled water was used to moisten the nest. Temperature probes monitored conditions in the nest during incubation. The nest produced 129 live hatchlings which were released into the Gulf Stream from a Coast Guard helicopter on December 10, 1996.




Number of Nests and Hatching Success on SCUTE Beaches
Hatching Success
Number of Nests
Hatching Success
Number of Nests
100
80
60
40
20
0
160
140
120
100
80
60
40
20
1991
1992
1993
1994
1995
1996
1997


Number of Nests on Hobcaw Barony, Debidue, and Pawleys Island
Hobcaw Barony
Debidue
Pawley's Island
Number of Nests
60
50
40
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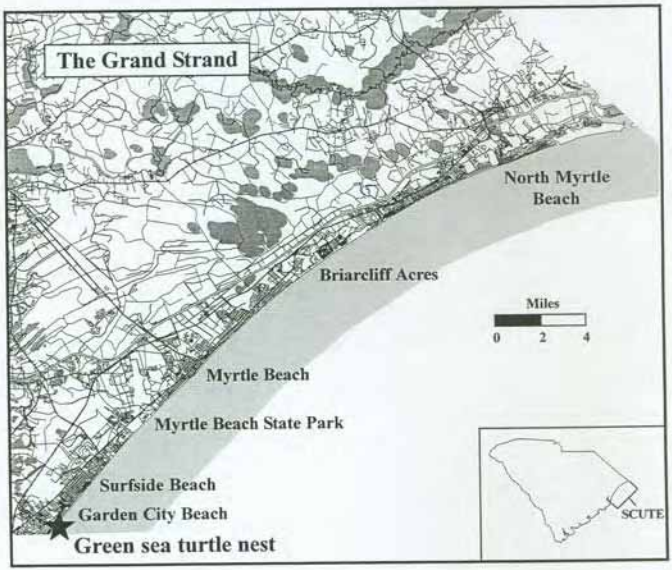
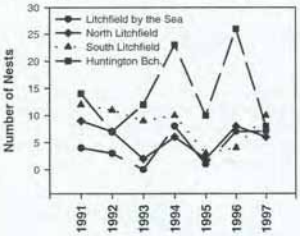
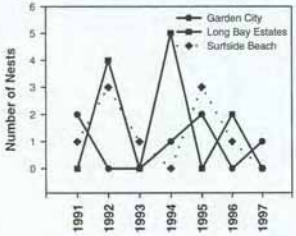
20
10
0
1991
1992
1993
1994
1995
1996
1997


The Grand Strand
North Myrtle Beach
Briarcliff Acres
Miles
0
2
4
Myrtle Beach
Myrtle Beach State Park
Surfside Beach
Garden City Beach
Green sea turtle nest
SCUTE

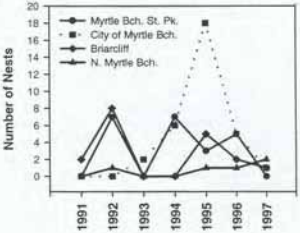
Number of Nests on Litchfield by the Sea, North Litchfield, South Litchfield, and Huntington Beach



Number of Nests on Garden City, Surfside Beach, and Long Bay Estates



Number of Nests On Myrtle Bch. State Park, City of Myrtle Bch., Briarcliff Acres, and N. Myrtle Bch.



Project Leaders:
1980-89: Mike Horton
1990-present: Jeff McClary & Chris Marlow

Volunteers:

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Barbara Schuetter
Sandra Burnett
Jimmy Lanford
Megan LeBoutillier
Rose Norseth
Doyle Gray
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Betsy and Bill Brabson
Ann Malys Wilson
Lee Wilson
Jane Reed
Sue Parsons
Henry Reynolds
Joanne Chivarchi
Nancy Van Buren
Jim and Ann Cutler
Tunnie Bissell
Dan and Kasey Harkins
Steve Roff
Jennifer Cardinal
Shawn Torrens
Keith and Susan Wyndam
Lucy Marlow
Bud Willis
Bob Lowery
Randy Richardson
Reggie Alston
Greg Musgrave
Russ and Joan Gracy
Jean and Donald Wilson
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Gary Varva
John Richardson
Jesse McNeal
Cynthia Bruce
Jane Kessler
Bill and Doris Norman
Dom Grazioli
Bruce burbage
Joan Kelly
Hank and Betty Zilotto
Bonnie Willis
Christopher Aadland
Boo Peace
Tami Thompson
Kathy Riley
Kay Ann White
Wayne White
Luis Insinaras
Scott and Hope Kennedy

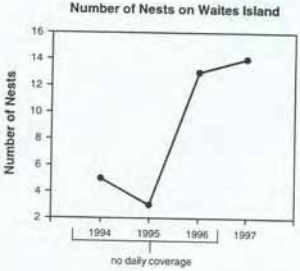
WAITES ISLAND

DESCRIPTION OF PROJECT AREA

Waites Island is the northern most barrier island in South Carolina. Coastal Carolina University owns the southern $^1/_3$ of the island. In 1997, a resort development firm bought a large portion of the northern part of the island. However, at the time of publication, Waites is still undeveloped except for a few private homes off of the beach. The strip development associated with North Myrtle Beach begins south of Waites. The beach on Waites Island is 5.4 km in length. Because of the lack of beachfront development, there are stable dune areas that remain where nests can be moved to suitable nesting habitat.

SURVEY HISTORY

The Waites Island turtle project was started in 1994 by undergraduate students at Coastal Carolina University. At the beginning of the project, students walked the beach several times a week. Student interest increased over the years and by 1997, the beach was walked seven days a week. All nests are inventoried after hatching to determine hatch success.



Project Leader:
1994-present: Dr. Eric Koepfler
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Jennifer Cardinal
Brian Weaver
Cara Rawdon
Henry Garceau
Steve Crosby
Aaron Marine
Sharon Gilman
Lynnly Miller
Diane Tulepani
Amy Bieszke
Gretel Player
Katie Fuhr
Leroy Humphries

OTHER RESEARCH CONDUCTED ON SOUTH CAROLINA BEACHES

The following section includes, in alphabetical order, the abstracts of research that has been conducted in South Carolina. Some of this research was collaborative with the biologists in our section and other projects were conducted independently, but under South Carolina permits. Some of the research was published in the reviewed literature, while other research was in the form of final reports to the U.S. Fish and Wildlife Service.

The projects were quite varied and included such subject areas as: population genetics, aversive conditioning of predators, sex ratios of hatchlings, nest protection techniques and remote sensing of habitat use. Two long-term datasets are worth special mention. The first successful remote tracking of sea turtles was conducted in South Carolina by Tom Murphy beginning in 1977. These studies have spanned over two decades with telemetric monitoring of more than 100 gravid loggerheads. Projects included habitat utilization between nesting events, movements of turtles prior to nesting, the response of turtles to disturbance on the nesting beach, homing movements of turtles translocated 60 km from the nesting beach, post nesting movements and a pilot study on the effects of magnets on homing movements. The latter projects built upon the knowledge gained in the earlier studies.

Aerial surveys to monitor statewide nesting trends have been conducted since 1980 using standardized ground truthed techniques. Twelve flights per summer are flown for three consecutive years on a five-year interval (eg. 1980-82, 1985-87, etc.). These data will be reported in a separate document.

Bowen, Brian, John Avise, James I. Richardson, Anne Meylan, Dimitris Margaritoulis, and Sally Hopkins-Murphy. 1993. Population structure of loggerhead turtles (*Caretta caretta*) in the northwestern Atlantic Ocean and Mediterranean Sea. Conservation Biology 7:834-844.

Abstract : To assess population genetic structure and evolutionary relationships among nesting populations of loggerhead turtles (*Caretta caretta*), we analyzed mitochondrial (mt) DNA variation in 113 samples from four nesting beaches in the northwestern Atlantic Ocean and from one nesting beach in the Mediterranean Sea. Significant differences in haplotype frequency between nesting populations in Florida and in Georgia/South Carolina, and between both of these assemblages and the Mediterranean nesting colony, indicate substantial restrictions on contemporary gene flow between regional populations, and therefore a strong tendency for natal homing by females. Nonetheless, this regional genetic structure appears shallow, indicating recent evolutionary connections among rookeries. Data from tag returns and mtDNA, as well as geological considerations, suggest that over short evolutionary time scales (perhaps a few thousand years), dispersal by female loggerheads is sufficient to allow colonization of appropriate habitat in proximity to established rookeries but is too low to significantly affect the population dynamics of rookeries on a contemporary time scale. These data indicate that nesting populations of the loggerhead turtle must be managed as demographically independent units. The population subdivisions based on mtDNA analyses are concordant with previously reported distinctions between Florida and Georgia/South Carolina nesting populations based on environmental markers, tag recaptures, and morphology.

Caine, Edsel A. 1986 Carapace Epibionts of Nesting Loggerhead Sea Turtles: Atlantic Coast of U.S.A. J. Exp. Mar Biol. Ecol., 1986, Vol. 95 pp. 15-26.

Abstract : A survey of carapace epibionts was conducted on nesting loggerhead turtles, *Caretta caretta caretta* (L.), along a latitudinal gradient from South Carolina to Florida. The three-year survey on 138 turtles yielded 48 epibiotic species representing 6 phyla. Distribution of the epibionts on the carapace and factors that may influence the densities of the epibiont populations are discussed. Two distinct assemblages of carapace epibionts are recognized: a northern population and a southern population. The separation between the two populations is between Cape Canaveral and Daytona Beach, Florida. Indicator species within each carapace community are listed. Due to the nature of colonization by the epibionts, the presence of two distinct carapace communities suggests discrete northern and southern populations of loggerhead turtles along the Atlantic coast of the U.S.A.

{It is interesting to note that Ed Caine's data established the separation of the southern and northern "assemblages" of the loggerheads in the southeastern U.S. at the same location (29° N) that is currently accepted by the Turtle Expert Working Group of the National Marine Fisheries Service and confirmed by Bowen et al. (1993) using mtDNA analysis a decade later.}

Caldwell, David. 1959. The loggerhead turtles of Cape Romain, South Carolina. Bulletin of the Florida State Museum 4:319-348.

Synopsis: Detailed field studies show that Atlantic loggerhead sea turtles, *Caretta caretta caretta* (L.), make exploratory crawls to the beach during the nesting season, and the fact that a turtle is on the beach does not necessarily mean she will nest at that spot, although she apparently will nest in the immediate vicinity on the night she explores, or very shortly thereafter.

Evidence, contrary to popular beliefs, shows no correlation between nesting activity and the stage of the moon, tide, and weather conditions. The physical features of the beach are apparently the most important factors in determining degree of nesting activity.

Details of the nest and of the eggs, their incubation, and hatching are presented for future comparison with other species. An average period of incubation of 55 days is demonstrated in South Carolina, and a growth rate is given for the embryos. Many hazards, such as numerous kinds of predators, roots of vegetation, and unfavorable conditions of temperature and moisture are shown to exist for the eggs and hatchlings, resulting in a high rate of mortality. Considerable variation in size, color, and body form is demonstrated for hatchling loggerheads.

Hopkins, S.R., T.M. Murphy, K.B. Stansell, and P.M. Wilkinson. 1978. Biotic and abiotic factors affecting nest mortality in the Atlantic loggerhead turtle. Proc. Ann. Conf. S.E. Assoc. Fish and Wildl. Agencies 32:213-223.

Abstract : Fates were determined for 458 nests of the Atlantic loggerhead (*Caretta caretta caretta*) on four South Carolina barrier islands. Raccoons (*Procyon lotor*) destroyed 56.1% of the nests overall and from 16.4 to 86.3% on individual islands. Poachers took 47.5% from one island and abiotic factors accounted for 14.2%. Ghost crabs (*Ocypode quadrata*) were not important predators, destroying only 2.4%. The overall hatch was 6.1%. The spatial and temporal aspects of nesting and predation, age of nest when depredated, density of nesting, and feeding efficiency of raccoons are discussed as they relate to the number of nests affected by each factor.

Hopkins, Sally R. and Thomas M. Murphy. 1982. Testing lithium chloride aversion to mitigate raccoon depredation of loggerhead turtle nests. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 36:484-491.

Abstract : Lithium chloride aversive conditioning to reduce raccoon (*Procyon lotor*) predation of loggerhead turtle (*Caretta caretta*) nests was tested under laboratory and field conditions. A total dosage of 1.0 g was determined to produce side effects (diarrhea and emesis) soon after ingestion, and the negative taste reaction to the drug was eliminated when a dosage level of 0.25 g/egg was administered. In separate phases of laboratory testing on 37 raccoons, an aversive conditioned response was observed in only a few individuals. During field testing, there was no significant difference ($t = 1.11$; $P > .05$) between the depredation rate on turtle nests before and after a 3-week period of LiCl treatment. Despite the administration of the drug at an undetectable dosage level with resultant physiological side effects, an effective psychological association of food with illness was not made by raccoons. The use of LiCl as a management technique to reduce raccoon depredation of sea turtle nests appears to have little utility.

Hopkins, Sally R. and Thomas M. Murphy. 1982. Management of loggerhead turtle nesting beaches in South Carolina. Study completion report: S. C. Wildlife and Marine Resources Department.

Abstract: Various marine turtle beach management practices were tested to determine the most efficient means of protecting loggerhead turtle nests from predators and erosion. Trapping and shooting raccoons within the maritime forest did not affect nest predation on the beach. Trapping, conducted on the beach early in the nesting season, along with nest relocation from erosional areas of the beach, markedly improved nest survival. The percentages for hatching success for the three years of the study were: 11.8%, 62.1% and 63.6% for South Island and 8.5%, 60.5% and 44.1% for Sand Island. These results were compared to nest success on the same islands during the previous three years when no beach management was conducted. The merits of the various techniques are discussed along with recommendations for implementation.

Mrosovsky, N., Sally R. Hopkins-Murphy, and James I. Richardson. 1984. Sex ratio of sea turtles: seasonal changes. Science 22:739-741.

Abstract : Sex ratios of hatchling loggerhead turtles *Caretta caretta* taken from South Carolina and Georgia ranged from no females in nests laid in late May to 80 percent females in those laid in early July; the sex ratio decreased to 10 percent females in nests laid in early August. These seasonal changes are consistent with the role of temperature in directing sexual differentiation in various reptiles. The data have implications for understanding the demography of sea turtles and for their conservation.

Murphy, T. Attempts to quantify the relative light distribution on a loggerhead turtle nesting beach. Unpublished data. 1990.

A series of black and white photographs were taken of Cape Island from off shore. A second series was taken at dusk and at night on the nesting beach. This second series was taken from the point at which a turtle had emerged on the nesting beach. A sequential series was taken up the beach towards the dune field and to the left and right of center. Photographs were scanned into a computer format with each pixel assigned a numeric value between 0-266 based on shades of gray. Programs were written to average the values of 100 blocks (10 rows and 10 columns) and quadrants of 10 pixels each (80 rows and 40 columns). These values were used to quantify differences in light distribution patterns for high and low nesting areas of the island. They were also used to compare areas where turtles went once on the beach and the adjacent areas. Difficulties in replicating on film what a turtle actually sees on the beach at night limited our analysis and left several photographic problems unresolved. In addition, no obvious patterns were apparent from usable photography and the project was discontinued in favor of other projects.

Murphy, T. and S. Hopkins. Sonic and radio tracking of nesting *Caretta caretta*. 1981. *In*: Hopkins and Murphy, Reproductive ecology of *Caretta caretta* in South Carolina. Study completion report: SC Wildlife and Marine Resources Department.

This study represents the telemetric monitoring of 37 adult female loggerhead turtles during the 1977-1979 seasons. Information on activity, movements, and habitat utilization is presented. The results represent some of the first at-sea information available for loggerhead turtles. At-sea activity associated with terrestrial emergences is characterized as well as activity patterns and types of movements made during with-in season internesting periods. Telemetric techniques of tagging and monitoring were evaluated.

Murphy, T.M. 1985. Telemetric monitoring of nesting loggerhead sea turtles subjected to disturbance on the beach. Paper presented at Fifth Annual Workshop on Sea Turtle biology and Conservation, 13-16 March, Waverly, GA.

Eleven loggerhead turtles were intercepted on the nesting beach prior to oviposition and equipped with radio transmitters. These turtles were intercepted a total of 65 times following initial instrumentation. Each time the turtle was prevented from nesting, usually by just standing in front of her. The response of the turtles to the prolonged nesting interval was to 1) relocate their nesting site 2) emerge more frequently and 3) attempt nesting in unsuitable habitat. For several turtles this resulted in almost continuous attempts to emerge and nest during the fourth, fifth, or sixth night after instrumentation. While the frequency of emergences increased and the time and distance from emergence to attempted digging was reduced, the amount of disturbance required to cause an aborted emergence did not change dramatically. Activities on the beach which result in prolonged nesting intervals can result in nest site relocation and placement of nests in unsuitable areas.

Murphy, T.M. and S. Hopkins-Murphy. 1990. Homing of translocated gravid loggerhead turtle. P. 123-124. *In*: T.H. Richardson, J.I Richardson, and M. Donnelly (comp.), Proceedings of the Tenth Annual Workshop on Sea Turtle Biology and Conservation, NOAA Tech memo. NMFS-SEFC-278.

Thirty-three *Caretta caretta* were intercepted on the nesting beach prior to oviposition. Each turtle was transported 60 km, fitted with radio transmitters and released. Six turtles provided no useful data due to transmitter failure or detachment. Thus 27 turtles provided information on the response of loggerheads to translocation. Of these 27 turtles, 17 (63%) returned to the home area and 6 (22%) were in route when contact was lost. A total of 23 (85%) of 27 turtles which were translocated showed evidence of returning to the home beach indicating a strong tendency to return to a home or primary beach. Four (15%) showed no movement towards home.

Stancyk, S.E., O.R. Talbert, Jr., and A.B. Miller. 1979. Estimation of loggerhead turtle nesting activity in South Carolina by aerial survey. American Zoologist 19: 954.

Aerial surveys were conducted on the coast of South Carolina during summers, 1976-78, to determine the pattern and intensity of nesting by loggerhead turtles, and to evaluate the utility of aerial surveys as a monitoring technique. Concurrent ground observations were made on Kiawah (1976), Cape and Cedar Islands (1977,78) for verification and standardization of aerial counts. Accuracy of aerial surveys increased if 1) observers were experienced; 2) flights occurred early in the morning; 3) fresh tracks only were counted; 4) between-flight intervals were less than 5 days; and 5) ground truth was carried out on several islands. Nesting activity in South Carolina was greatest on unpopulated, undeveloped beaches, and was concentrated on protected islands in the center of the state. Aerial counts provide a basis for preliminary estimates of the number of nesting females emerging on South Carolina beaches each summer.

Stancyk, S.E., O.R. Talbert, Jr., and J.M. Dean. 1980. Nesting activity of the loggerhead turtle *Caretta caretta* in South Carolina, II: Protection of nests from raccoon predation by translocation. Biological Conservation 18:289-298.

Abstract : Small mammals are significant predators of unhatched marine turtle nests in many parts of the world. Raccoons *Procyon lotor* destroy over 95% of the loggerhead turtle nests laid on some South Carolina beaches. To remove developing eggs from nest-associated clues which could aid raccoons, we transplanted whole and partially preyed-upon nests on Kiawah or Cedar Islands in 1972, 1973, 1977 and 1978. Eggs were moved to man-made cavities near the original nests cavities in erosion-free areas. Care was taken not to transfer clues from the original nests. Predation on wild (control) nests ranged from 55.1% (Cedar, 1978) to 93.8% (Kiawah, 1972). Transplant predation was significantly lower in all cases, ranging from 6.1% (Kiawah, 1972) to 18.7% (Kiawah, 1973). Hatching success of transplants was not significantly different from that of hatchery-reared or

control clutches (60-81%). Transplanting may be an easier, less expensive method for protection of nests from predation or erosion than other procedures such as predator control, chemical aversion conditioning, or hatcheries, and merits further testing at other turtle rookeries.

Talbert, O. Rhett,Jr., Stephen E. Stancyck, John M. Dean, and John M. Will. 1980. Nesting activity of the loggerhead turtle (*Caretta caretta*) in South Carolina I: A rookery in transition. Copeia 4:709-718.

Abstract : Surveys of nesting activity of *Caretta caretta* were performed during nesting seasons from 1972 to 1976 on Kiawah Island, SC. A hatchery, operating from 1973-1976, reduced the effect of raccoon predation on nests and usually yielded a high percentage of hatchlings. Nightly beach patrols from 1973-1976 helped reduce raccoon predation among nests left on the beach; egg poaching ceased during the study period. Nesting females were tagged from 1973-1976 to obtain information on the size of the annual nesting population, in-season renesting, inter-nesting wanderings. A decline in nesting activity from 1973-1976 could not be correlated with any specific human activity, and appears to have reversed itself since 1976. An average of 34.0 ±3.7 adult and adolescent carcasses washed ashore each year. Occurrence of dead turtles was closely related to intensive commercial shrimping activity in nearshore waters. Kiawah Island is undergoing development as a resort, but the builders have followed many of the management recommendations established relative to *Caretta*. This could explain the stabilization of nesting activity since 1976, and indicates that prudent beach development need not inhibit reproduction by *Caretta*.

TECHNICAL GUIDANCE

There are numerous threats to nesting females, eggs and hatchlings that are associated with the beaches. These threats are both natural and anthropogenic. Many times these problems can be solved, not with a great deal of money and technology, but with the use of common sense. Working with other state and federal agencies and the numerous volunteer groups, there have been major accomplishments to solve these problems.

Anthropogenic Factors

Problem: Where erosion threatens coastal property, beach armoring (consisting of sea walls and rock revetments), has been used to protect these sites. This has resulted in the permanent loss in nesting habitat. Approximately 10% of South Carolina's beaches are armored.

Solution: The Beachfront Management Act, passed in 1988, prohibits any new, hard structures to be erected on the beaches. This also includes groins and jetties. Recent challenges to this law, including giant sand tubes, have been denied by the courts.

Problem: Sand fences are erected to help build and stabilize dunes. Improperly placed fences can impede loggerheads from reaching the dunes and/or trap nesting females and hatchlings.

Solution: In 1990, working with staff of the Office of Ocean and Coastal Resources Management (OCRM, formerly Coastal Council), a new sand fence design, which prevents entrapment, was approved and is included in the general permit for these structures. However, some property owners still install them incorrectly and follow-up and correction of this problem by OCRM has not been effective.

Problem: Beach nourishment projects, whether they involve scraped sand or pumped sand, can have negative impacts on loggerhead turtles if conducted during the nesting and hatching seasons. Pipelines and heavy machinery create barriers to nesting females and increase false crawls. Some nests may be smothered with pumped or scraped sand and hatchlings can be crushed by heavy equipment. In addition, nourished beaches are often harder than natural beaches. Where compaction is severe, nesting turtles cannot dig adequate egg chambers. The lights associated with the projects deter nesting and disorient hatchlings.

Solution: South Carolina Department of Natural Resources (SCDNR), in coordination with the U. S. Army Corps of Engineers, U. S. Fish and Wildlife Service and the OCRM, ensures that the timing of these projects avoids the nesting and hatching season and that beaches are tilled to soften them if necessary. Monitoring of hatching success in the new sand is given special attention.

Problem: Artificial beachfront lighting from buildings, streetlights, vehicles and other sources has been shown to cause disorientation of hatchlings. Hatchlings can become trapped in vegetation, run over, preyed upon by local pets, or die from desiccation. Adult females avoid nesting areas that are intensely lit.

Solution: The first lighting ordinance passed in South Carolina was for Georgetown County in 1988. South Carolina Public Service Authority, known as Santee-Cooper, launched a public relations campaign in conjunction with this ordinance. Other power companies have shielded streetlights. In 1990, after Hurricane Hugo, OCRM required communities to submit new beachfront management plans. A "generic" lighting ordinance, fashioned after one used in Florida, was included in these plans. The ordinances are in place in all coastal counties except Horry County which was exempted because of the magnitude of the lighting and the very low level of loggerhead nesting there. Implementation and enforcement by local officials have been disappointing, and much of the education of residents and tourists has been done by the sea turtle project volunteers. They have placed literature as well as switchplate stickers in beachfront cottages. This remains a daunting problem for sea turtle recovery.

Problem: Human presence on the beach can negatively impact nesting loggerheads. Murphy (1985) showed that human disturbance caused nesting turtles to shift to other beaches, delay egg laying and select poor nesting sites. The length of a visitor's stay at a beach has bearing on their ability to become educated on the natural history of sea turtles and how their behavior affects these animals.

Solution: The state parks educate the public by presenting slide shows, providing organized tours by qualified leaders during nest content inventories and conducting a limited number of nighttime beach walks to observe nesting turtles. Volunteer groups pass out brochures, which they have personalized for their projects, to individuals that they encounter on the beach during their morning patrols.

Problem: Despite the protection of the loggerhead by federal and state laws, egg poaching and the clandestine markets for eggs are still present.

Solution: Adequate and active law enforcement efforts are the key to bringing these activities under control. Higher fines and prison terms can be deterrents when well publicized in the local newspapers.

Natural Factors

Problem: On all undeveloped beaches and some developed beaches, a variety of predators destroy incubating eggs and hatchlings. The major predator in South Carolina is the raccoon (*Procyon lotor*). Other predators include the red fox, ghost crab and several species of ants.

Solution: Trapping of predators to reduce the population and then screening of nests to prevent depredation by the remaining animals has proven very successful. If continued over several years, trapping may become unnecessary as new animal recruiting to the beach may not recognize a sea turtle nest as a food source.

Problem: Severe storm events (e.g., tropical storms and hurricanes) may result in significant nest loss, especially if they occur early in the hatching season.

Solution: These events are typically not an annual occurrence and severe storm events are generally experienced after the peak of the hatching season. When viewed over the life time of a loggerhead, these storms do not represent a significant mortality factor to the eggs.

Problem: Nest loss due to erosion or inundation appear to be the principal natural factor which may negatively affect incubating eggs clutches. This has the potential to occur every two weeks on the full and new moon tides. Sand accumulation over the nest may trap hatchlings, especially if the nest is screened.

Solution: Nest protection project volunteers carefully note the areas of beach inundated by these highest spring

tides in late April and early May. In this way, they know that any nest laid seaward of these areas will be inundated, and these nests are moved to higher sites. They also monitor the accumulation of sand over the egg chamber and remove and excess sand prior to the expected hatching date.

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Appendix A

ENDANGERED SPECIES PROGRAM'S SUPPLEMENTAL INFORMATION TO GUIDELINES FOR MARINE TURTLE PERMIT HOLDERS

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES
Endangered Species Programs

INFORMATION FOR MARINE TURTLE PERMIT HOLDERS

The South Carolina Department of Natural Resources (SCDNR) issues permits for activities involving marine turtles in South Carolina under authority granted to the state through a Cooperative Agreement with the U.S. Fish and Wildlife Service under Section 6 of the Endangered Species Act (ESA). All activities must be authorized under Chapter 15 of the South Carolina Code of Laws. Each permit consists of a principal permit holder and up to 25 authorized personnel (unless otherwise stated on the permit), and a list of authorized activities. Only those activities specifically listed on the permit are authorized. Permit holders are expected to know the conditions and responsibilities associated with their permit. Principal permit holders are responsible for insuring that all authorized personnel listed on their permit are thoroughly and properly trained by SCDNR staff or an experienced permit holder. Permit holders are authorized to conduct specific activities depending upon experience, area of investigation and/or demonstrated marine turtle management needs.

The permit issued by the SCDNR or letter of authorization (LOA) must be in the possession of each authorized person at all times while conducting authorized activities. You should also carry identification that will verify that you are the named permit holder. Some wildlife or public safety officers or concerned individuals may perceive that your activity is harmful or unlawful. Please ensure that your response to such situations is thoughtful and reflects the special responsibilities associated with your permit.

The permit does not allow you to act as an employee of SCDNR. Please do not represent yourself as a wildlife or conservation officer unless you have a commission from SCDNR. Distinctive identifying clothing is encouraged and should display the logo or name of your organization or marine turtle project.

Occasionally, a beach nourishment project may occur in your survey area. All such projects are reviewed by SCDNR, the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers and operate under specific requirements which consider the nature, timing and sequence of beach nourishment activities to provide protection to nesting marine turtles, hatchlings, or their nests. If you are approached by a local contractor, individual, or other entity and asked to establish a marine turtle nest relocation or nest protection program in conjunction with a beach construction (including beach cleaning) contact your Marine Turtle Program Coordinator immediately.

Contact the SCDNR Hotline number, 1-800-922-5431 if you think unlawful activities are being conducted. Notify the Marine Turtle Program Coordinator if you suspect egg poaching or other disturbances to nests or nesting female turtles. Do not notify the news media.

Requests for expansion of authorized activities must be submitted in advance and in writing to the Marine Turtle Program Coordinator.

South Carolina Department of Natural Resources
Endangered Species Programs
Guidelines for Marine Turtle Permit Holders

Nesting Beach Monitoring Techniques
TOPIC: NESTING SURVEYS

This activity involves the patrolling of a specific beach area (listed on the permit) to identify, enumerate, and evaluate nesting and non-nesting emergences (false crawls). Nesting surveys should begin shortly after sunrise. Because of potential disturbances to nesting females and the difficulty of locating crawls in the dark, nesting surveys may not be conducted during the night unless specifically authorized by the South Carolina Department of Natural Resources (SCDNR).

Surveyors should move along the beach at the level of the latest high tide line. Upon discovery of a crawl, surveyors shall determine whether or not the crawl was a nesting or non-nesting emergence. Probing a nest is allowed to determine the exact location of the egg chamber only if the surveyor has been trained by SCDNR personnel or another experienced surveyor and possesses a current Letter of Authorization (LOA) under a principal permit holder. Dig down, only with hands, until the top eggs are felt, to verify the exact location of the chamber. Shallow nests may result in some eggs being punctured. If this occurs, remove all broken shells and as much as of the contents as possible and dispose of them. After each crawl is documented, the track should be somehow marked to avoid duplicate reporting. This may be done by use of flagging, sweeping ones feet across the track or crossing the upper part of the track with a survey vehicle.

All permit holders, approved to conduct nesting surveys, may also relocate nests laid in poor sites (too low on beach or near dune crossovers), determine hatching success and examine predation without these activities being specifically listed on the permit. Hatcheries or non-self-releasing screens may not be utilized unless specifically stated on the permit.

The principal permit holder is required to submit a preliminary nesting summary report to SCDNR immediately following each nesting season (31 August) and a full report of all activities at the end of the year (31 December).

South Carolina Department of Natural Resources
Endangered Species Programs
Guidelines for Marine Turtle Permit Holders

Nesting Beach Monitoring Techniques
TOPIC: MARKING NEST LOCATIONS

Marine turtle nests need to be marked so that they can be relocated for nest inventory or protected from hazardous activities such as vehicle traffic or heavy foot traffic. The type of beach (developed or remote) will determine the best techniques for marking nests. Please keep in mind when driving stakes that some undiscovered clutches may be present on the beach. Drive stakes with caution.

1. Marking nest sites to protect buried eggs from hazardous activities, such as beach raking.

The goal of this marking method is to clearly identify a nest area so that activities are directed away from the nest site. The entire disturbed area where the turtle covered should be delineated with markers to protect the clutch. Use four stakes to create a square or rectangle around the disturbed area. These stakes should extend about 36" above the sand. Be sure that the egg chamber is located in the center of this area. Surveyor's ribbon or rope should be tied from the top of one marker to another to create a perimeter around the nest site. Additionally, an official SCDNR sign should be located landward of the nest site. The nest-identifying number and the date the nest was laid can be printed on the wooden post.

2. Marking nest sites to determine nest success.

The goal of this marking method is to allow an investigator to locate the clutch to evaluate the success of a nest either 75 days after the nest was laid or 72 hours after the first hatchling emergence. There are two ways to accomplish this. Once the top of the clutch is found, re-bury it with moist sand and gently pat the sand surface above the eggs with your hand. Replace the dry sand over this area to the depth present before you began and place a temporary marker (sea shell or marsh grass) over the clutch site.

To mark the nest site, measure the exact distance from the precise clutch location to two separate marking stakes on the dune, one landward of the other, so that a straight line between them is pointing directly toward the location of the clutch (like sighting down a rifle barrel).

If concealment of nests is desired measure the exact distance and direction with a compass to two separate marking stakes on the dune, hidden among the vegetation. If one marking stake is discovered and removed there is still one remaining.

Whatever method a particular project decides to use is fine, just as long as it is uniform among all workers. For instance a project may simply choose to place the marking stake 3' landward of the clutch.

On beaches where removal of marking stakes by the pubic is a potential problem, an additional stake, driven deeply and hidden from view, should be placed a measured distance landward of the others. As added insurance, an aluminum marker can be buried hand-deep and 24" from the clutch location in a standardized direction. This metal marker can be found later with a metal detector.

South Carolina Department of Natural Resources
Endangered Species Programs
Guidelines for Marine Turtle Permit Holders

Nesting Beach Monitoring Techniques
TOPIC: NEST RELOCATION

Moving marine turtle eggs creates many opportunities for adverse impacts. Movement alone is known to kill developing embryos by disrupting delicate membranes that attach to the inside of the egg. We also know that the incubation environment greatly influences the developing embryo and that nest relocation can involve the transfer of eggs from an appropriate environment to an inappropriate one.

Nest relocation must be considered a management technique of last resort and if the likelihood of the nest surviving to hatch is nil. The most desirable alternative is to eliminate the problems that prompt relocation of the nest. Normally, the only situation which justifies nest relocation is when a nest is laid seaward of the debris line marking the typical high tide. Foot traffic does not usually cause problems for a nest, but if this traffic is heavy, a nest can be marked so that it is avoided by pedestrians. If a nest is laid near a light that may disorient the hatchlings, the light should be kept off or shielded. If a nest is laid on a beach that is periodically raked with equipment, such as near some resorts, beach raking should be discontinued or the nest should be marked and avoided by the operator. Beach raking is not a valid reason to relocate nests. If a nest is threatened by mammalian predators, it should be screened with a self-releasing screen. Use of hatcheries must receive special authority from SCDNR.

If a nest requires relocation, it should be moved as early in the morning following its deposition as possible. During the first hours after deposition, the potential for movement-induced mortality in marine turtle eggs increases rapidly. Eggs should be moved no later than 12 hours after deposition (turtles may nest as early as 9 PM the preceding night). To relocate a nest, find the location of the egg chamber by gently probing with a tapered, T-handled dowel. Once the eggs are located, carefully remove the sand from around the top eggs. Individual eggs should be gently lifted from the egg chamber and placed into a rigid container with a 2"- 3" layer of moist sand on the bottom. When moving eggs, be sure to maintain each egg's original orientation; do not rotate eggs in any direction and avoid any abrupt movements. As eggs are placed in the container, be sure that they do not roll. The container should be shaded if relocated during the day. When all eggs are in the container, cover them with a layer of moist sand.

Find suitable beach habitat nearby that is successfully used by nesting turtles. Be sure that the new nest site is above the high tide level and is not in dense vegetation. With a posthole digger or cockle shell, dig a new egg chamber to the same depth, size and shape of the original. The shape should resemble an inverted light bulb. (The cockle shell is a good instrument to round out the bottom of the nest if you use posthole diggers). Relocate the eggs into the new egg chamber by transferring them one at a time while continuing to maintain each egg's original orientation. After all the eggs have been transferred into the new egg chamber, cover them with the moist sand excavated from the hole. Dry sand should not be allowed to fall into the egg chamber. Once the eggs are reburied to the upper level of the surrounding moist sand, gently pat the sand surface above the eggs with your hand. Replace the dry sand over this area to the depth present before you began. The relocated nest can then be marked and later evaluated for nest success. Nests in danger of being completely washed away by high tides can be moved to safer areas anytime during incubation.

South Carolina Department of Natural Resources
Endangered Species Programs
Guidelines for Marine Turtle Permit Holders

Nesting Beach Monitoring Techniques
TOPIC: NEST SCREENING

When a nest is at high risk from mammalian predators (e.g., raccoons, foxes, etc.), the eggs and pre-emergent hatchlings may be protected by placing a self-releasing screen over the nest. The screens used for this purpose are typically 4' X 4' pieces of 2" X 4" mesh welded wire (do not use screen with a smaller mesh size as it is likely to trap emerging hatchlings). This type of screen is large enough to keep mammalian predators out, yet it allows hatchlings to escape from the nest unaided. The screen must be centered exactly over the egg chamber to make it less likely that mammalian predators will burrow to the eggs from the side of the screen and to make sure that anchoring stakes places along the edge of the screen will not enter the egg chamber.

To find the location of the egg chamber within the body pit, use the method described under Nesting Surveys. Once the top eggs are located, use moist sand from a similar depth to re-cover the eggs. Dry sand should not be allowed to fall into the nest cavity. Once the egg chamber is re-covered with moist, then dry sand to the original level, mark the center of the egg chamber with a piece of marshgrass. Be sure that this marker is not inserted into the egg chamber. Level the surface of the sand in a 4' X 4' square centered on your temporary marker so that the screen will lay flat. Place the screen on the smoothed sand and work it back and forth until it is not showing. Remove the temporary marker. Using stakes, secure the four corners of the screen. You may use tent stakes or make your own stakes of re-bar, PVC or some other durable material. Even though the corners of the screen should be well away from the egg chamber, do not drive the stakes at an angle in the direction of the egg chamber. Place about 2" of sand on top of the screen after anchoring so that the wire is well covered. Some mammalian predators will not investigate or attempt to dig into a nest if they do not notice the wire. If predators in your area are very persistent and dislodge screens with only four stakes, try using eight stakes and place the four additional stakes midway between the corners. If stakes are easily dislodged, longer stakes may be needed.

Sometimes raccoons will dig into the top layers of eggs through the screening. A smaller square, 1'x 1' of hardware cloth can be added on top to prevent this. This additional screening must be removed at 45 days incubation to avoid hatchlings being trapped. Another method involves elevating the original screen approximately 2" above the sand's surface at 45 days incubation. This can be accomplished by putting driftwood under 3 edges of the screen, leaving the seaward edge open. Maintain screen so that no sand accretion occurs.

Depending on the local situation, you may or may not want to mark screened nests. In some situations, if screened nests are not marked with an appropriate sign, a beach user is likely to discover the screen and think that it should not be on the beach and pull it up. Marking screened nests may also be necessary to prevent people from inadvertently injuring themselves on the screen or on any stakes.

Because stakes and/or screens may become partially or completely dislodged, they should be checked regularly. During the period of anticipated hatching, screens should be checked for sand accumulation. Pull away wind-blown sand to the approximate depth when the nest was laid. After 45 days of incubation, screens should be checked each morning for signs of hatching activity and just in case hatchlings become trapped by them. All screens shall be removed from the beach after hatchling emergence is completed.

South Carolina Department of Natural Resources
Endangered Species Programs
Guidelines for Marine Turtle Permit Holders
Nesting Beach Monitoring Techniques
TOPIC: RESCUE AND RELEASE OF HATCHLINGS

This activity includes salvaging live hatchlings (primarily disoriented hatchlings or those found at the bottom of excavated nests) and ensuring that they reach the water safely. Due to the short duration of the hatchling frenzy period, hatchlings should be released under the conditions that afford them the best chance of survival. There are two situations of hatchling rescue and release and each will be handled differently in order to meet this goal.

Disoriented hatchlings

1. All hatchlings found during darkness shall be released immediately, the same evening they are found. A flashlight may be placed at the water's edge if you come across a disoriented hatching in progress. This will lead the remaining hatchlings in the right direction, while the surrounding area is searched for lost turtles.

2. Hatchlings that are found disoriented during daylight surveys are likely to be dehydrated and weak and will survive better if given a chance to rest in a damp environment. Small Styrofoam or plastic coolers lined with damp sand work well as temporary holding containers. A damp towel should be placed loosely over the top to provide a dark environment. Once placed in a holding container, hatchlings should not be handled or disturbed until they are ready for release. Activity causes increased expenditure of limited energy stores. Release the hatchlings that night at hard dark about 25' from the ocean and monitor their entire trek to the water.

Excavated hatchlings

3. Hatchlings found at the bottom of nests during daylight excavation shall be released immediately on the beach a short distance from the water. Someone should monitor the hatchlings to ensure they are not taken by gulls or ghost crabs. Under natural conditions, (where kind humans do not excavate nests) these hatchlings would not have survived. They are not as fit and may even have genetic defects that prevented them from leaving the nest. Occasionally individual hatchlings may need assistance in reaching the water. In such cases, they may be moved close to the water's edge or placed in the shallows and allowed to swim off on their own.

Hatchlings may not be held in water! If disoriented hatchlings require further holding, please contact the Marine Turtle Program Coordinator for transfer to an authorized staff.

Please report disorientation events to SCDNR as soon as the event is documented. It is very important that we be informed of all disorientation events as they occur.

South Carolina Department of Natural Resources
Endangered Species Programs
Guidelines for Marine Turtle Permit Holders

Nesting Beach Monitoring Techniques
TOPIC: HATCHLING NIGHT PROGRAMS

This activity applies principally to permit holders whose areas are public beaches, such as state parks, or resort areas. Under natural conditions, marine turtle hatchlings emerge in darkness. Although rain or overcast skies can induce daylight emergences, the overwhelming majority of hatchlings emerge in the dark. Nests are not to be dug into at any time, neither during daylight or dark, to see if hatchlings are "ready" to emerge. Nests may only be dug into under the guidelines described in NEST SUCCESS EVALUATION.

Daylight releases of hatchlings are not allowed. Hatchlings may not be released at dusk or at dawn as these are time periods when predatory birds and fishes are particularly active. Hatchlings shall be released on the night they emerge and shall be allowed to crawl to the water on their own.

Artificial lights shall not be utilized during hatchlings releases. This applies to any member of the public observing such releases, as well as all permitted personnel involved in the release. A quick check of the release area with a small flashlight a short time after release will ensure that all hatchlings have reached the water. Occasionally individual hatchlings may need assistance in reaching the water. In such cases, they may be moved close to the water's edge or placed in the shallows and allowed to swim off on their own.

South Carolina Department of Natural Resources
Endangered Species Programs
Guidelines for Marine Turtle Permit Holders

Nesting Beach Monitoring Techniques
TOPIC: NEST SUCCESS EVALUATION

Because marine turtle eggs are subjected to a variety of incubation environments, including many that are affected by human activities, it is very important each nesting season, and on each managed nesting beach, to have some idea of how many eggs actually produced hatchlings. This activity, known as nest success evaluation, involves the excavation of a hatched nest and a determination made of the fate of each egg.

Nest success evaluations may only be conducted either 75 days after the nest was deposited or 72 hours after the first emergence, whichever occurs first. These are minimum waiting periods. If a nest has been subjected to cooler temperatures (tidal inundation, rainfall, shading, cool fronts, etc.), nest success evaluations should not be conducted until 80 days or 96 hours after the first emergence. Digging into a nest before all the hatchlings have emerged exposes them prematurely and is likely to adversely affect their ability to survive. It is vital to allow all hatchlings to emerge naturally before excavating the nest.

On higher density nesting beaches, nest success evaluations do not have to be conducted on every nest, but a minimum of 25% is required. Useful information may be obtained by evaluating a subsample of all nests. However, the subsampling technique must be devised to best represent nest success over the entire nesting season and nesting beach. The easiest way to do this is to mark for evaluation every other nest, or every fourth nests, etc. For this subsampling technique to succeed, a sampling plan based on the number of nests expected has to be devised before the nesting season begins. Once a sampling plan is devised, it has to be followed throughout the nesting season. If needed, the SCDNR's marine turtle program staff is available to help develop a valid sampling plan. Beaches with under 100 nests per season should plan to excavate all nests.

When a nest marked for evaluation is completely depredated (all eggs destroyed), record this (no further evaluation is necessary). This nest is a very important part of your sample to accurately determine overall nest success, do not select another nest as a replacement.

When a nest marked for evaluation is partially depredated, remove and count the depredated eggs. Cover the nest cavity with moist sand, and return the site to its original condition. Record the nest as partially depredated along with the number of eggs that were depredated. When appropriate, evaluate the hatching and emergence success of the remaining eggs.

To conduct a nest success evaluation, begin by excavating the nest. Carefully dig down into the nest chamber with your hands until you reach eggs or eggshells. Do not use shovels or other tools, but you may want rubber gloves. If you encounter live hatchlings before reaching any eggs or eggshells, or if you begin to encounter many live hatchlings among the egg shells, quickly cover the nest cavity with moist sand and return the site to its original condition. Wait at least 72 hours before excavating again. If only a few live hatchlings are encountered during excavation, treat them as described in RELEASE AND RESCUE OF HATCHLINGS.

Carefully remove the contents of the nest and place them in a pile on the sand or in a tray for easier sorting. Separate the contents into the following categories: hatched eggs (=eggshells), live hatchlings, dead hatchlings, pipped eggs with live hatchlings, pipped eggs with dead hatchlings, and unhatched eggs. Pipped eggs are those in which some part of the turtle has broken through the egg but the hatchling is not completely free of its eggshell. Pipped eggs range from those with just a small hole to those with large tears. Pipped eggs are not hatched eggs. An

egg is not considered hatched until the hatchling actually leaves its egg. Each item found in the nest should fit into one and only one, category.

Determine and record the number of eggs that hatched by carefully counting the eggshells. Count each eggshell that is more than 50% complete as one hatched egg and disregard the smaller pieces. Be sure that all the eggshells are completely separated from each other. Subtract the number of dead hatchlings from the total of empty shells. Record the number of live hatchlings. Do not add or subtract live hatchlings from the total since you have already counted its empty shell. The rest of the hatched eggs represents hatchlings that emerged from the nest.

For additional information on management techniques, further separate the unhatched eggs into died early in development (DED) and died late in development (DLD). The majority of unhatched eggs will fall into the DED category. They will appear partially to completely collapsed and no embryo is felt inside. The albumen can still be runny but mostly what is noted is a cottage cheese looking material. A very few eggs will have a "just laid" look. Some are still viable, others may be infertile. In infertile eggs the yolk is intact and the albumen is thick. Record the number of eggs in each of these categories.

Next, determine and separately record the number of pipped eggs that contain live hatchlings, and the number of pipped eggs that contain dead hatchlings. Finally, determine the number of eggs originally present in the nest by adding together the hatched eggs, the pipped eggs and the unhatched eggs. After completing the nest success evaluation, the nest contents should be reburied within the original nest cavity.

If you find live hatchlings in pipped eggs, turtles with yolk sacs or any viable looking eggs, do the following. Rebury the contents of the nest at the bottom of the egg chamber. Add a layer of clean moist sand. Place the viable eggs and hatchlings on this layer of sand and then add more clean, moist sand over them. Cover the area with dry sand and keep the nest location marked. These turtles may never emerge due to unknown genetic or physiological reasons. After a reasonable time (one week), excavate the nest and complete the evaluation.

There are two ways to measure the success of a hatching season. First, is number of nests that produce hatchlings out of the total nests laid (nest success). Second, is the number of live hatchlings that emerge from the nest out of the total eggs deposited (hatching success). Calculate each separately for nests left naturally and for nest relocated.

HATCHING SUCCESS RATE FORMULA

$$\frac{\text{\# total hatched*}}{\text{total eggs}} \times 100$$

* = empty whole egg shell (may have to piece together fragments to equal whole shell)

NEST SUCCESS RATE FORMULA

$$\frac{\text{\# total nests hatched*}}{\text{\# total nest laid}} \times 100$$

* = at least 10% of clutch hatches

Some nests that are laid at the end of the season are subjected to very cool temperatures in the fall, and may never hatch even though the eggs contain live hatchlings. If these nests incubate over 90 days, record them as unhatched.

South Carolina Department of Natural Resources
Endangered Species Programs
Guidelines for Marine Turtle Permit Holders

Nesting Beach Monitoring Techniques
TOPIC: NEST CAGING (SELF-RELEASING)

When a nest is at high risk from predators (e.g., raccoons, foxes etc.), the eggs and pre-emergent hatchlings may be protected by placing a self-releasing cage over the nest. Restraining cages shall provide enough room for all hatchlings to completely emerge from the sand and shall have, on the seaward side of the cage, an area from which hatchlings can readily escape. If hatchlings are to escape through a wire screen, the mesh size shall be no smaller than 2" X 4" (making sure the long edge, 4 inches, is parallel to the sand). If hatchlings are to escape through an opening in the cage, the opening should be 2 inches high and extend along the entire seaward side of the cage. Cages shall be centered exactly over the nest cavity to make it harder for mammalian predators to reach the eggs if they put their paw through the mesh. Make sure that any anchoring stakes places along the edge of the cage will not enter the nest cavity.

The first step in caging a nest is to find the location of the nest cavity within the body pit. Follow the directions under NESTING SURVEYS. Most cages are anchored by burying the outward pointing flanges (see illustration) one half to one foot under the sand's surface. Enough of the cage should be above the sand surface to deter raccoons from reaching eggs through the mesh. Center the cage over the nest cavity and trace the edges of the cage in the sand. The cage should be oriented so that the opposing sides of the cage are either parallel or perpendicular to the shoreline. Remove the cage and carefully dig a trench along the tracing of the edges of the cage. Place the cage into the trench and fill the trench with sand. When completed, the sand around the cage and over the nest cavity should be at the original level. If stakes are used to secure a cage, drive the stakes at an angle away from the nest cavity.

Because cages may become partially or completely dislodged, they should be checked regularly. Self-releasing cages should be checked each morning during the period of anticipated hatching, just in case some hatchlings have become trapped. All cages should be removed from the beach after hatchling emergence is completed and nest success evaluation has been completed.

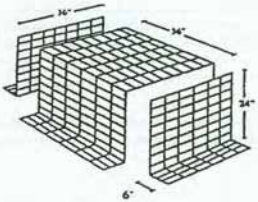

Figure 1. Example of a self-releasing cage. The cage is constructed of 2" x 4" welded utility wire. Hatchlings are able to escape through the mesh of the wire. Cage design courtesy of: The Conservancy.

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCE
MARINE TURTLE PERMIT APPLICATION

This form must be filled out and signed in ink by the applicant. If a question is not applicable, enter N/A.

Applicant:_____

Organization/Agency_____

Mailing Address:_____ **City:**_____ **State:**_____

Zip Code:_____ **County:**_____

Telephone (day):_____ **Telephone (night):**_____

Occupation:_____ **Employer:**_____

To complete the application, it is necessary to respond to all of the following items.

1. Proposed activity and Justification: Please submit a detailed and specific description of the proposed activity. Explain purpose, objectives, methodology and benefits to the state marine turtle recovery program. Also state the duration of activity for which the permit is sought.

2. Experience and Qualifications: Please include a detailed description of qualifications and experience of the applicant that bear on proposed activities. Permits are issued to individuals and are not transferable.

3. Authorized Personnel: A principal permit holder may request that additional personnel be included on a permit. If you propose to make this request, please state which activities each person will conduct. Please note that the principal permit holder is responsible for all activities conducted by persons authorized on the permit.

_____
_____
_____
_____
_____
_____
_____

I certify that the information submitted in this application for a permit is complete and accurate to the best of my knowledge.

_____

Signature **Date**

Mail Completed Application To:
South Carolina Department of Natural Resources
Marine Turtle Program
PO Box 12559
Charleston, South Carolina 29422

ACCEPTANCE OF SCDNR MARINE TURTLE SPECIAL PERMIT

This acknowledges that I have read and understand the enclosed permit and the information contained in 'PERMIT INFORMATION FOR SOUTH CAROLINA MARINE TURTLE PERMIT HOLDERS" and "MARINE TURTLE PERMIT ACTIVITY DEFINITIONS AND GUIDELINES". Acceptance of this marine turtle special permit indicates that I and all authorized personnel listed on my permit agree to abide by all guidelines of the South Carolina Department of Natural Resources that pertain to marine turtle special permits. I understand that it is my responsibility to transmit all future information updates to all authorized personnel listed on my permit.

Signature of Principal Permit Holder **Date**

Printed Name **Permit Number**

Return signature page to: South Carolina Department of Natural Resources
Marine Turtle Program
PO Box 12559
Charleston, South Carolina 29422

RECEIPT OF SIGNATURE PAGE WILL ACTIVATE 1995 MARINE TURTLE PERMIT.

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES
MARINE TURTLE PERMIT PERSONNEL AMENDMENT REQUEST FORM
For Personnel Additions & Deletions

Principal Permit Holder:_____ **Permit #:**_____

Personnel Additions;	**Address & Phone Number:**	****Signature:**
1._____	_____	_____
2._____	_____	_____
3._____	_____	_____
4._____	_____	_____
5._____	_____	_____
6._____	_____	_____
7._____	_____	_____

****All personnel added to the permit must sign this form acknowledging that they have read and understand all of the South Carolina Department of Natural Resources guidelines pertaining to the activities they are authorized to conduct. Personnel amendment requests will not be approved without signatures. Make additional copies if necessary.**

Personnel Deletions (signature not required):

1._____	4._____	7._____
2._____	5._____	8._____
3._____	6._____	9._____

Principal Permit Holder's Signature:_____
Date:_____

MARINE TURTLE PERMIT

Name: _____

Agency/Group: _____

Address: _____

Permit expires: 31 December 1996

( ) New
( ) Renewal, permitted activities unchanged
( ) Renewal, permitted activities amended
( ) Amendment of current permit

Permit #:

Authorized to: (1) conduct stranding/salvage activities, (2) conduct nesting surveys, (3) relocate nests, (4) conduct public turtle watches, (5) rescue and release hatchlings.

Authorized personnel:

General conditions: Permitted individuals must adhere to the SCDNR marine turtle permit guidelines developed under a Section 6 Cooperative Agreement between SCDNR and the U.S. Fish and Wildlife Service.

Special Conditions: None

_____ **Date:** _____

Brock Conrad, Deputy Director
Division of Wildlife & Freshwater Fisheries

cc: George Hines, U.S. Fish & Wildlife Service
SCDNR Law Enforcement
Sally Murphy, Marine Turtle Program Coordinator

Appendix B

OUTLINE FOR NEST PROTECTION ANNUAL REPORT

I. Nesting
- A. Coverage
  1. Starting and ending dates of patrol
  2. Method of patrolling beach (4 wheeler, walk etc.)
  3. How coverage of beach is divided among workers
  4. How often is beach patrolled (daily, time)
- B. Number of nests
  1. *in situ*
  2. Relocated
- C. Number of false crawls
- D. Dates of first and last nests
- E. Nest protection methods
  1. Screening (types and design)
  2. Marking schemes
  3. How often nests are monitored for problems
- F. Methods of marking nests

II. Hatching
- A. Determining emergence activity
  1. On what day of incubation do nests start getting daily checks?
  2. Time of day inventories performed
  3. Dates of first and last hatching
  4. Incubation duration of each nest and average incubation period
- B. Methods used to evaluate nests (all or sample of nests)
- C. Percent of success rate of relocated, *in situ* nests, and total nests laid (use both formulas in the Nest Success Evaluation section of the **Guidelines**.)

III. Problems
- A. Predators
  1. Amount of first night predation
  2. Amount of predation at hatching
  3. Type of predators
- B. Lighting
- C. Overwash or erosion

IV. Workers and Volunteers
- A. Level of training (average years of experience)
- B. Level of involvement
  1. Patrol and notify if crawl seen
  2. Patrol, probe and move eggs
  3. Inventory nests
  4. Data analysis and prepare report

Appendix C

1998 LOGGERHEAD NESTING DATA FORM

Location _____

Length of beach _____ mi / km

Number of days per week patrolled _____

Date first nest laid _____

Date of last nest laid _____

Number of false crawls _____

Number of nests _____ Number relocated _____

Average days of incubation _____ / _____

In situ Relocated

*Hatching success: (Number of turtles that hatched and lived)

_____/_____ ____/____ _____/_____

Total survived / total laid *In situ* / total laid Relocated / total laid

(If nest was relocated, number of eggs hatched should be an exact count. Include nests that had 0% success)

*Nest Success: (Number of nests hatched with at least a 10% hatch success)

_____/_____ ____/____ _____/_____

Total hatched / total laid *In situ* / total laid Relocated / total laid

Avg. number of eggs/clutch _____ (relocated nests only)

Survey beginning date _____

Survey ending date _____

*Please provide the actual numbers

Table 1. Reported Nesting Activity of the Loggerhead Turtle, *Caretta caretta*, in South Carolina, 1975-1997.

LOCATION	Length (km)	Year	# Days Per Week	First Nest Date	Last Nest Date	# of False Crawls	# of Nests	# Relocated	*In situ* # nests hatched	Reloc. # nests hatched	Total # nests hatched	Avg. incubation (days)	*In situ* Hatch %	Relocated Hatch %	Total Hatch %	Avg. Eggs	Survey Start Date	Survey End Date
BAY POINT	5	1989	3	25-May	19-Aug	91	36										18-May	12-Oct
BAY POINT	5	1990	3	8-May	29-Jul	111	124	48									8-May	2-Oct
BAY POINT	5	1991	3	13-May	3-Aug		109	43					45.00	65.00	60.00	99.00	1-May	13-Oct
BAY POINT	5	1992	3	24-May	31-Jul		99	35					41.00	61.00	54.00	100.00	24-May	27-Sep
BOTANY IS	2.6	1981	7			103	105											
BOTANY IS	2.6	1982	7			137	122								0.90	108.00	19-May	14-Oct
BOTANY IS	2.6	1983	7			125	100								39.80	107.00		
BOTANY IS	2.6	1984	7			199	180								52.10	117.00		
BOTANY IS	2.6	1985	7			154	107								40.00	120.00		
BOTANY IS	2.6	1986	7			403	161										17-May	9-Aug
BOTANY IS	2.6	1987	7			65	56											
BOTANY IS	2.6	1988	2			23	36						79.80	81.40				
BOTANY IS	2.6	1989	3			8	33								53.00			
BOTANY IS	2.6	1991	5	16-May	5-Aug	28	61	39								113.00		
BOTANY IS	2.6	1992					96									123.00	5-May	14-Aug
BOTANY IS	2.6	1993	5	28-May	5-Aug	12	35	24										
BOTANY IS	2.6	1994	7	10-May	8-Aug	53	107	56							87.00	123.00	10-May	5-Oct
BOTANY IS	2.6	1995	5	9-May	1-Aug	18	57	32								117.00		
BOTANY IS	2.6	1996	5	20-May	16-Aug	27	105	92					81.00	86.00		116.00	9-May	1-Oct
BOTANY IS	2.6	1997	6		22-Aug	26	68	16							84.40		10-May	4-Nov
															57.00	113.00	16-Jun	5-Nov
BOTANY PLNTN	3.5	1992	3	24-May	7-Aug		54	33										
BOTANY PLNTN	3.5	1993	5	23-May	16-Aug		74	39							85.60	115.00	11-May	3-Nov
BOTANY PLNTN	3.5	1994	7	10-May	10-Aug		102	46							82.00	121.00	10-May	16-Oct
BOTANY PLNTN	3.5	1995	5	10-May	13-Aug	63	56	24					86.00	86.00		117.00		
BOTANY PLNTN	3.5	1996	5	20-May	25-Jul	51	128	71					83.00	76.00		118.00	9-May	1-Oct
BOTANY PLNTN	3.5	1997	6		30-Jul	37	65	14							81.30	117.00	10-May	4-Nov
															61.00	113.00	16-Jun	5-Nov
CAPE	8	1975					2654											
CAPE	8	1976					2359											
CAPE	8	1977					1329											
CAPE	8	1978					1596											
CAPE	8	1979					1093											
CAPE	8	1980				1675	856	480										
CAPE	8	1981	6		1-Aug	2045	1043	480						92.10				
CAPE	8	1982	7		18-Aug	2378	1087	467						61.00		128.00	22-May	16-Sep
CAPE	8	1983	7		25-Aug	1887	667	374						74.50		123.00	16-May	
CAPE	8	1984	7		23-Aug	2478	1224							72.80		122.00	21-May	
CAPE	8	1985	7		19-Aug	1514	796							77.50		123.00	26-May	
CAPE	8	1986	7	11-May	21-Aug	2781	1264	598						80.00		122.00	11-May	
CAPE	8	1987	7		10-Aug	1460	825							76.20		124.00	11-May	
CAPE	8	1988	7		21-Aug	1563	948						5.00	81.20		123.00	20-May	
CAPE	8	1989	7		21-Aug		792	642					12.40	90.20		127.00	21-May	
CAPE	8	1990	7		13-Aug	2365	1361						31.80	82.60		123.00		
CAPE	8	1991	7		16-Aug	2234	1061							88.60		126.00	30-May	
CAPE	8	1992	7			1933	1058	741						77.10		120.00	11-May	
CAPE	8	1993	7			1340	579	500					13.40	83.80		125.00		
CAPE	8	1994	7		11-Aug	2190	1228	871					28.90	78.10		124.00		
CAPE	8	1995	7	9-May	17-Aug	1406	907	737						83.00		125.00	17-May	
CAPE	8	1996	7	15-May	13-Aug	1731	1124	779					27.20	83.50		119.00		
CAPE	8	1997	7	15-May	19-Aug	999	621	420				57.00	3.30	86.50		126.00		
													19.60	75.30	63.00	127.00	15-May	23-Sep

Estimate from recovery plan

Table 1. Reported Nesting Activity of the Loggerhead Turtle, *Caretta caretta*, in South Carolina, 1975-1997 (continued).

LOCATION	Length (km)	Year	# Days Per Week	First Nest Date	Last Nest Date	# of False Crawls	# of Nests	# Relocated	*In situ* # nests hatched	Reloc. # nests hatched	Total # nests hatched	Avg. incubation (days)	*In situ* Hatch %	Relocated Hatch %	Total Hatch %	Avg. Eggs	Survey Start Date	Survey End Date
EDINGSVILLE	2.9	1981	7			83	83								36.50		19-May	14-Oct
EDINGSVILLE	2.9	1984	4			127	51											
EDINGSVILLE	2.9	1985	4			33	70										17-May	16-Aug
EDINGSVILLE	2.9	1986	4			99	32											
EDINGSVILLE	2.9	1987				42	16											
EDINGSVILLE	2.9	1996	7	21-May	2-Aug	40	51	0							38.70		17-May	2-Aug
EDINGSVILLE	2.9	1997	7	12-May	28-Jul	50	32	0	29		29	60.00	73.00		73.00	131.16	12-May	26-Sep
EDISTO	7.5	1982	3				45								80.70	122.00		
EDISTO	7.5	1983	7			33	58								77.60	123.00		
EDISTO	7.5	1984	7			50	97								80.00	124.00		
EDISTO	7.5	1985	7			37	80										14-May	15-Aug
EDISTO	7.5	1986	7			108	103											
EDISTO	7.5	1987	7			33	46						71.10	80.80				
EDISTO	7.5	1988	7			44	87									126.00		
EDISTO	7.5	1989	7	27-May	8-Aug	28	51								79.00		15-May	
EDISTO	7.5	1990	7	15-May	4-Aug	65	101								79.00			
EDISTO	7.5	1991	7	15-May	12-Aug	73	129	57						73.00	73.00	115.00		
EOISTO	7.5	1992	7			48	75								73.20	108.00		
EOISTO	7.5	1993	7			19	38								61.00	107.00		
EOISTO	7.5	1994	7	9-May	4-Aug	60	117								79.00	109.00		
EOISTO	7.5	1995	7	16-May	25-Aug	19	49									131.00		
EDISTO	7.5	1996	7			59	81								68.00	63.44	1-May	
EDISTO	7.5	1997	7	25-May	4-Aug	19	46	0				60.00	54.00		54.00	68.39	1-May	4-Oct
EDISTO SP	2.1	1981	7			70	52					56.00			84.60	118.00	19-May	14-Oct
EDISTO SP	2.1	1982	7				91								78.70	116.00		
EDISTO SP	2.1	1983	7			61	49								77.20	115.00		
EDISTO SP	2.1	1984	7			100	121								71.00	114.00		
EDISTO SP	2.1	1985	7			62	69										17-May	16-Aug
EDISTO SP	2.1	1986	7			131	114											
EDISTO SP	2.1	1987	7			49	54						73.80	86.10				
EDISTO SP	2.1	1988	7			36	56									121.00		
EDISTO SP	2.1	1989	5			34	26								84.90	115.00		
EDISTO SP	2.1	1990	7	9-May	4-Aug	82	128	13							74.80	116.00		
EDISTO SP	2.1	1991	7	10-May	17-Aug	97	116	3							70.00	113.00		
EDISTO SP	2.1	1992	7	21-May	10-Aug	67	104								66.60	117.00		
EDISTO SP	2.1	1993	7	5-Jun	12-Jul	51	24	11							66.80	113.00		
EDISTO SP	2.1	1994	7	9-May	13-Aug	118	149	24						81.10		119.00		
EDISTO SP	2.1	1995	7	10-May	24-Jul	52	35	11					76.00	66.00			1-May	8-Sep
EDISTO SP	2.1	1996	7	15-May	6-Aug	64	84	44								114.00	3-May	10-Oct
EDISTO SP	2.1	1997	7	2-Jun	9-Aug	101	49	15				56.89	79.50	89.00	82.00	123.30	2-May	17-Oct
FOLLY	10.4	1993	7	26-Jun	23-Jul	23	7											
FOLLY	10.4	1994	7	17-May	23-Jul		22	5										
FOLLY	10.4	1997		28-May	16-Aug	15	33	15	14	12	26	61.50	50.00	70.00	79.00	109.50	20-May	15-Sep

Table 1. Reported Nesting Activity of the Loggerhead Turtle, *Caretta caretta*, in South Carolina, 1975-1997 (continued).

LOCATION	Length (km)	Year	# Days Per Week	First Nest Date	Last Nest Date	# of False Crawls	# of Nests	# Relocated	*In situ* # nests hatched	Reloc. # nests hatched	Total # nests hatched	Avg. incubation (days)	*In situ* Hatch %	Relocated Hatch %	Total Hatch %	Avg. Eggs	Survey Start Date	Survey End Date
FRIPP	6	1981	7	17-May	5-Aug		125									115.00	17-May	
FRIPP	6	1982	7			68	123										17-May	
FRIPP	6	1983	7	27-May	25-Aug	106	124	84								127.00		
FRIPP	6	1984	7	13-May	18-Aug	140	113	66								167.00		
FRIPP	6	1985	7	16-May	12-Aug	176	176	105										
FRIPP	6	1986	7	20-May	10-Aug	236	172	130								107.00		
FRIPP	6	1987	7	25-May	29-Jul	111	63	57										
FRIPP	6	1988	7	21-May	24-Aug	151	82	67										
FRIPP	6	1989	7	21-May	25-Aug	88	51	44										
FRIPP	6	1990	7	16-May	31-Jul	169	89	84							80.00			
FRIPP	6	1991	7	17-May	17-Aug	191	64	57										
FRIPP	6	1992	7	26-May	5-Aug	83	27	26										
FRIPP	6	1993	7	27-May	5-Aug	54	8											
FRIPP	6	1994	7	12-May	6-Aug	121	37											
FRIPP	6	1995	7	1-Jun	26-Jul	38	19	18	Late survey start date				40.00	42.00		112.00	1-Jun	15-Aug
FRIPP	6	1996	7	20-May	7-Aug	36	31	30						85.00		126.00	15-May	15-Aug
FRIPP	6	1997	7	25-May	30-Jul	22	8	8		7	7	56.00		77.00	77.00	124.00	15-May	15-Aug
HARBOR	2	1993	7	25-May	1-Aug	22	23											
HARBOR	2	1994	7	11-May	20-Jul	39	43	28					83.90	83.40		126.00		
HARBOR	2	1995	7	17-May	8-Aug	31	44	38					65.50			117.00	7-May	15-Aug
HARBOR	2	1996	7	12-May	3-Aug	46	54	46					88.70			123.00	5-May	18-Aug
HARBOR	2	1997	7	21-May	6-Aug	21	24	22	2	22	24	55.00	62.50	76.30	74.10	73.00	4-May	22-Aug
HILTON HEAD IS	12	1981	7	24-May	5-Aug		41											
HILTON HEAD IS	3.12	1982	7				44										15-May	15-Sep
HILTON HEAD IS	9.6	1983	7	13-May	27-Aug	12	73									121.00		
HILTON HEAD IS	6.84	1984	7			5	33											
HILTON HEAD IS	6.84	1985	7			42	113											
HILTON HEAD IS	19	1986	7			124	65										15-May	15-Aug
HILTON HEAD IS	19	1987	7			53	67	35									15-May	15-Aug
HILTON HEAD IS	19	1988	7	26-May	10-Aug	30	86	48					42.00	66.00	65.00	90.00	15-May	15-Aug
HILTON HEAD IS	19	1989	7	20-May	28-Aug	90	65	31					73.00	60.00	70.00	100.00	15-May	15-Aug
HILTON HEAD IS	24.3	1990	7	13-May	6-Aug	118	145	86					68.00	72.00	71.00	119.00	15-May	15-Aug
HILTON HEAD IS	24.3	1991	7	4-May	27-Jul	100	115	68										
HILTON HEAD IS	24.3	1992	7			110	110	82					88.00	97.00	95.00		15-May	15-Aug
HILTON HEAD IS	24.3	1993	7	31-May	5-Aug	69	49	49						82.00		120.00		
HILTON HEAD IS	24.3	1994	7	18-May	22-Aug	107	140	103					69.00	71.00	70.00	113.00	15-May	15-Aug
HILTON HEAD IS	24.3	1995	7	15-May	30-Jul	156	133	43					40.00	49.00	43.00	108.00	15-May	15-Aug
HILTON HEAD IS	24.3	1996	7	19-May	10-Aug	145	167	95					69.00	64.00	66.00	113.00	15-May	15-Aug
HILTON HEAD IS	24.3	1997	7	16-May	6-Aug	128	92	82			91	65.00	67.00	70.00	72.00	119.00	9-May	15-Aug
HORRY		1990	7	15-Jun	21-Aug	5	11								75.80	111.00		

Table 1. Reported Nesting Activity of the Loggerhead Turtle, *Caretta caretta*, in South Carolina, 1975-1997 (continued).

LOCATION	Length (km)	Year	# Days Per Week	First Nest Date	Last Nest Date	# of False Crawls	# of Nests	# Relocated	*In situ* # nests hatched	Reloc. # nests hatched	Total # nests hatched	Avg. incubation (days)	*In situ* Hatch %	Relocated Hatch %	Total Hatch %	Avg. Eggs	Survey Start Date	Survey End Date
HUNTING	5	1981	7			32	89	20								110.00	12-Jun	6-Sep
HUNTING	5	1982	7			21	96											
HUNTING	8.3	1983	7	10-May	1-Nov	67	101	99										
HUNTING	6.6	1984	7			49	157	63										
HUNTING	6.6	1985	7			61	88	85										
HUNTING	6.6	1986	7			52	41										8-May	
HUNTING	3.3	1987	7			9	23										15-May	1-Oct
HUNTING	2.5	1988	7			8	31										16-May	14-Aug
HUNTING	8.3	1990	6				93	43						78.00			26-May	15-Aug
HUNTING	8.3	1991	7			85	80	29								114.00	15-May	15-Aug
HUNTING	8.3	1992	7	20-May	21-Aug	93	130	60				57.01	61.70	75.38	68.11	117.77	15-May	15-Aug
HUNTING	8.3	1993	7	16-May	13-Aug		52	47							80.70	115.00		
HUNTING	8.3	1994	7	16-May	13-Aug		113	73							90.40	123.00		
HUNTING	8.3	1995	7	6-May	28-Jul	179	87	56					81.10	78.20		107.00	6-May	15-Aug
HUNTING	8.3	1996	7	20-May	31-Jul		55	50					86.00	77.40		126.00	15-May	15-Aug
HUNTING	8.3	1997	7	12-May	6-Aug	62	36	33	1	32	33	57.70	30.30	71.30	67.70	129.81	5-May	15-Aug
IOP/SULL	15	1995	7	28-Jun	4-Aug	3	13	7					95.00				28-Jun	5-Oct
IOP/SULL	15	1996	7	1-Jun	28-Jul	11	24	19					96.00	79.00				
IOP/SULL	15	1997	7	1-Jul	5-Aug	6	9	9						87.00	87.00	112.00	15-May	3-Oct
KIAWAH	15	1972					195											
KIAWAH	15	1973					194											
KIAWAH	15	1974					201											
KIAWAH	15	1975					99											
KIAWAH	15	1976					38											
KIAWAH	15	1977					39											
KIAWAH	15	1978					55											
KIAWAH	15	1979					83											
KIAWAH	15	1980					88											
KIAWAH	15	1981	7	24-May	2-Sep	132	157	142							72.60	118.00	22-May	
KIAWAH	15	1982	7	12-May	15-Aug	103	138	110							78.56			
KIAWAH	15	1983	7	28-May	25-Aug	127	132	79							74.00	122.00		
KIAWAH	15	1984	7	17-May	12-Aug	171	169							67.40		126.00		
KIAWAH	15	1985	7	16-May	12-Aug	126	136							74.40		118.00		
KIAWAH	15	1986	7	13-May	12-Aug	218	176							78.70		119.00		
KIAWAH	15	1987	7	14-May	9-Aug	52	55							76.00		117.00		
KIAWAH	15	1988	7		14-Aug		75										4-Jul	
KIAWAH	15	1989	7	25-May	9-Aug		84									112.00	25-May	13-Aug
KIAWAH	15	1990	7		13-Aug		228							70.00			15-May	15-Aug
KIAWAH	15	1991	7			92	201										15-May	15-Aug
KIAWAH	15	1992	7				178	94					62.80	59.60	49.20			
KIAWAH	15	1993	7	22-May	11-Aug	79	100								72.60		1-May	
KIAWAH	15	1994	7	10-May	6-Aug		215	130							70.50		1-May	
KIAWAH	15	1995	7	14-May	31-Jul	155	141	40					66.50	70.10	67.60	106.00	1-May	
KIAWAH	15	1996	7	21-May	18-Aug	183	209	129							67.60	116.00	1-May	
KIAWAH	15	1997	7	19-May	16-Aug	82	167	72				58.50	66.90	71.80	69.20	116.00	1-May	25-Oct
OTTER	4.3	1988	3			114	144										15-May	15-Oct
OTTER	4.3	1989	3				70									110.00	MAY	OCT
OTTER	4.3	1990	3			187	169									126.00		

Table 1. Reported Nesting Activity of the Loggerhead Turtle, *Caretta caretta*, in South Carolina, 1975-1997 (continued).

LOCATION	Length (km)	Year	# Days Per Week	First Nest Date	Last Nest Date	# of False Crawls	# of Nests	# Relocated	*In situ* # nests hatched	Reloc. # nests hatched	Total # nests hatched	Avg. incubation (days)	*In situ* Hatch %	Relocated Hatch %	Total Hatch %	Avg. Eggs	Survey Start Date	Survey End Date
PINE	0.1	1988	3				1										15-May	15-Oct
PINE	0.1	1989	3				18										15-May	15-Oct
PINE	0.1	1990	3				16										15-May	15-Oct
PRITCHARDS	4	1982	7				50								78.85	112.00	15-May	15-Jul
PRITCHARDS	4	1983	7	20-May	25-Aug	309	91	91								112.00		
PRITCHARDS	4	1984	7	19-May	8-Aug	331	103							80.70		109.00		
PRITCHARDS	4	1985	7			316	69	69							79.50	106.00		
PRITCHARDS	4	1986	7			434	113	113							87.40	104.00	15-May	16-Oct
PRITCHARDS	4	1987	7				57	57						86.20				
PRITCHARDS	4	1988	7				176	176							85.00	112.00		
PRITCHARDS	4	1989	7			144	103	80							81.20	119.00	15-May	15-Aug
PRITCHARDS	4	1990	7	15-May	9-Aug	263	174	159							83.30	118.00		
PRITCHARDS	4	1991	7	17-May	5-Aug		121	109							80.30	115.00		
PRITCHARDS	4	1992	7	20-May	5-Aug	167	118	113						71.70		121.00		
PRITCHARDS	4	1993	7	25-May	24-Jul	138	41	40					90.10	70.30		131.00		
PRITCHARDS	4	1994	7	13-May	26-Jul	191	67	65					23.90	77.90		110.00		
PRITCHARDS	4	1995	7	13-May	14-Aug	114	113	93					25.70	70.00	65.10	121.00	15-May	15-Aug
PRITCHARDS	4	1996	7	13-May	8-Aug	111	142	134					71.20	78.10	77.60	118.00	12-May	20-Aug
PRITCHARDS	4	1997	7	21-May	12-Aug	117	53	51				56.70	66.90	79.70	79.20	118.30	13-May	14-Aug
SAND	4	1977					158											
SAND	4	1978					217											
SAND	4	1979					227											
SAND	4	1980					130											
SAND	4	1981					223											
SAND	4	1982					224											
SCUTE	22.3	1991	7				81	54							80.00	109.00		
SCUTE	22.3	1992	7			73	91	62					81.00	79.00	80.00			
SCUTE	22.3	1993	7	29-May	12-Aug	26	43	25					80.00	78.00	79.00			
SCUTE	22.3	1994	7	12-May	28-Aug		136	87							71.00			
SCUTE	22.3	1995	7	9-May	3-Aug	103	130	89					64.00	81.50	72.60			
SCUTE	22.3	1996	7	21-May	18-Aug		101	74					74.00	68.90		123.00		
SCUTE	22.3	1997	7	24-May	17-Aug	55	67	54				65.60	75.00	73.00	71.80	126.00	1-May	1-Nov
SEABROOK	6.4	1983	7			4	9											
SEABROOK	6.4	1990	7			6	23											
SEABROOK	6.4	1991	7	21-May	13-Jul		13								86.00			
SEABROOK	6.4	1994	7	18-May	13-Sep		37	7										
SEABROOK	6.4	1995	7	17-May	24-Jul	3	24	0									15-May	31-Oct
SEABROOK	6.4	1996	7	24-May	17-Aug	6	22	11									1-May	18-Sep
SEABROOK	6.4	1997	7			5	14	4										

Table 1. Reported Nesting Activity of the Loggerhead Turtle, *Caretta caretta*, in South Carolina, 1975-1997 (continued).

LOCATION	Length (km)	Year	# Days Per Week	First Nest Date	Last Nest Date	# of False Crawls	# of Nests	# Relocated	*In situ* # nests hatched	Reloc. # nests hatched	Total # nests hatched	Avg. incubation (days)	*In situ* Hatch %	Relocated Hatch %	Total Hatch %	Avg. Eggs	Survey Start Date	Survey End Date
SOUTH	4	1977	7				87											
SOUTH	4	1978	7				158											
SOUTH	4	1979	7				121											
SOUTH	4	1980	7				383											
SOUTH	4	1981	7				150											
SOUTH	4	1982	7				115											
SOUTH	4	1983	7	30-May		196	104	57	from recovery plan									
SOUTH	4	1984	7			172	135										6-May	
SOUTH	4	1985	7			135	109											
SOUTH	4	1986	7			285	88											
SOUTH	4	1987	7			91	58										1-May	
SOUTH	4	1988	7			212	154											
SOUTH	4	1989	7	21-May		124	92										1-May	
SOUTH	5.6	1990	7	8-May	16-Aug	658	234	103									14-May	
SOUTH	5.6	1991	7	14-May	15-Aug		170	78							91.80		7-May	
SOUTH	5.6	1992	7	20-May		142	172	69							59.00			
SOUTH	5.6	1993					33		incomplete survey				73.00	69.00	71.00			
SOUTH	5.6	1994	7	9-May	9-Aug	108	267	53					84.00	72.00				
SOUTH	5.6	1995	7	6-May	10-Aug	84	129	13					77.00	83.00		131.00	1-May	15-Aug
SOUTH	5.6	1996	7	19-May	13-Aug	165	231	55					52.14	56.70			3-May	30-Aug
SOUTH	5.6	1997	7	15-May	23-Aug	82	122	66	36	46	82		42.69	48.68	46.27		5-May	25-Oct
WAITES	5.4	1994	7	27-May			5											
WAITES	5.4	1995	7	18-Jun	14-Jul	6	3	3						96.00		105.00	15-May	15-Aug
WAITES	5.4	1996	7	31-May	21-Jul	1	13	6					34.30	82.00			6-May	6-Oct
WAITES	5.4	1997	7	13-Jun	7-Aug	17	14	14		14	14	65.00		93.00	93	119.00	12-May	28-Oct