

---

# MANAGEMENT OF LOGGERHEAD TURTLE NESTING BEACHES IN SOUTH CAROLINA

Sally R. Hopkins & Thomas M. Murphy

STUDY COMPLETION REPORT  
October 1, 1980 through September 30, 1982  
E-1, Study No. VI-A-2



S.C. Wildlife and Marine Resources Department  
Division of Wildlife and Freshwater Fisheries  
Jefferson C. Fuller, Jr.  
Director

---

MANAGEMENT OF LOGGERHEAD TURTLE NESTING BEACHES IN SOUTH CAROLINA

Study Completion Report



Sally R. Hopkins and Thomas M. Murphy

October 1, 1980 through September 30, 1982

E-1, Study No. VI-A-2

Submitted December 16, 1983

LIST OF TABLES

	Page
Table 1. Fates of 240 loggerhead turtle nests laid on two barrier islands in South Carolina, 1980. . . . .	8
Table 2. Fates of 383 loggerhead turtle nests laid on two barrier islands in South Carolina, 1981. . . . .	9
Table 3. Fates of 331 loggerhead turtle nests laid on two barrier islands in South Carolina, 1982. . . . .	10

LIST OF FIGURES

	Page
Figure 1. Location map of the study area. . . . .	4

## 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.

## MANAGEMENT OF LOGGERHEAD TURTLE NESTING BEACHES

### INTRODUCTION

Predators on the eggs of sea turtles vary worldwide depending on the locality, but small mammals were determined to be the most destructive in a review paper by Stancyk (1982). Raccoons (Procyon lotor) are the major predator on nests of the loggerhead turtle (Caretta caretta) throughout its range in the southeastern United States (Gallagher et al. 1972, Davis and Whiting 1977, Richardson 1978, Talbert et al. 1980). Nest predation ranged from 7.8% on Hutchinson Island in 1967 (Gallagher et al. 1972) to 85% at Cape Sable in 1972 (Davis and Whiting 1977). In a prior study (Hopkins et al. 1978 and Hopkins and Murphy 1981), the types and extent of factors associated with nest failure on four South Carolina islands were quantified. Raccoon predation ranged from 16.1% (Sand Island, 1978) to 95.9% (Cape Island, 1978). The mean predation rate over the three years for all four islands studied was 59.4%.

Various management techniques to protect nests from raccoons have been tried. Davis and Whiting (1977) reported predation reduced to 25% at Cape Sable, Florida on a portion of the beach where experimental, daily trapping was conducted. LiCl aversive conditioning proved unsuccessful in deterring raccoons from eating eggs (Hopkins and Murphy, in press). Application of human and bobcat urine to newly laid nest sites on Cape Romain, South Carolina indicated some protection, but sample sizes were limited (Gonzales and Garris 1980, Brame et al. 1981). Transplantation (Stancyk et al. 1980, Gonzales and Garris 1980, and Brame et al. 1981) was tested on several islands in South

Carolina with varying results. Screening of nests after relocation provided almost complete protection on Pritchards Island, South Carolina (McCollum, 1982).

Many coastal barrier islands in South Carolina are erosional in the center portion (Brown 1977). Erosion and inundation were the second greatest causes of nest mortality on the four islands in our previous study (Hopkins et al. 1978) at 13.9%. Hopkins and Murphy (1981) also found that factors resulting in nest failure were compensatory. Protecting nests from raccoons would probably suffice on non-erosional beaches or where the tidal amplitude is not great. Controlling raccoons on many South Carolina beaches, however, would result in more nests being destroyed by erosion and the goal to achieve higher production of hatchlings on these beaches would not be fully realized.

The objective of this study was to determine the most effective way to increase production of hatchlings by reducing raccoon predation in conjunction with other nest protection methods. By addressing our attention to all factors, we hoped to nullify their compensatory nature and achieve a higher success for nests on these islands, greater than 50% if possible.

#### ACKNOWLEDGEMENTS

Thanks are expressed to J. Coker, R. Dunn and W. Oldland for their able technical assistance. This work was supported in part by a grant from the Yawkey Foundation, the South Carolina Nongame Tax Check Off, and Section 6 Endangered Species funds for which we are also grateful.

#### METHODS AND MATERIALS

The study areas comprised two barrier islands on the South Carolina coast in Georgetown County. Both islands are part of the Tom Yawkey Wildlife Center (Figure 1). A detailed description of each island is provided in Hopkins et

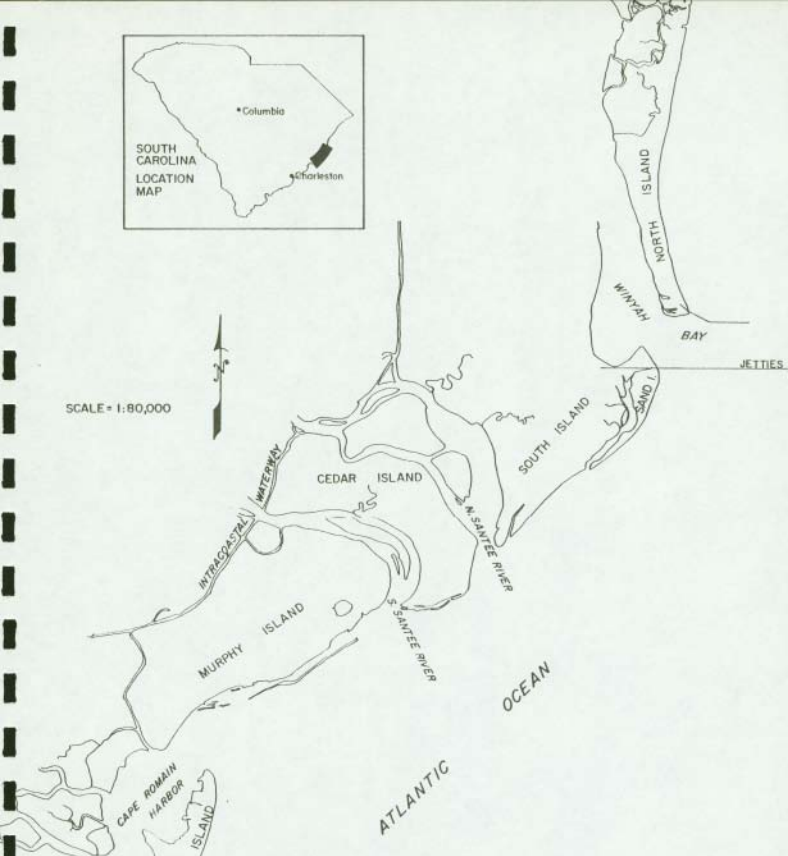


Figure 1. Location map of the study area.



al. (1978). South Island is a beach ridge barrier island and is undergoing severe erosion along the central portion of the beach. Sand Island is without maritime forest since it has only recently accrued. It also is undergoing severe erosion on the eastern or seaward side but is prograding on the northern or Winyah Bay side.

Rifles and #2 long spring leg-hold traps were used to remove raccoons in 1980, but leg-hold traps were the primary method used in 1981-82. Nest monitoring on both islands was conducted as described in Hopkins et al. (1978). The body pit of emergences was probed with a pointed dowel to locate the nest cavity. A small hole was dug by hand to verify the presence of eggs. Nests were marked with numbered flags which were offset 1 m on a specified compass direction from the nest. New nests were marked and previously marked nests were checked for disturbance on each beach survey. When the fate of a nest was determined, the date and cause were recorded. Any undisturbed nest which had not hatched after 70 days was excavated to determine the cause of its failure.

In 1980, raccoons were removed in the maritime forest on South Island from 14 January to 19 April and were trapped directly on the beach from 9 July to 31 July. Due to limitations in personnel, trapping was not conducted on Sand Island during 1980, but nests were monitored to determine levels of predation and hatching success. In 1981, trapping was conducted on Sand and South Islands directly on the nesting beach from 5 May to 2 June. In 1982, trapping was conducted on South and Sand Islands from 10 May to 23 May by setting traps on game trails approaching the beach. After 23 May, traps were set directly in the body pits of nests that were partially depredated by raccoons the previous night.

Traps were set in areas of high raccoon use in the prescribed manner. A hole, sufficient for the size of the trap, was dug about 10 cm deep. The bait was placed at the bottom and the set trap placed over this. A small square of wax or tissue paper was placed over the trigger and jaws of the set trap and gently sprinkled with sand until all parts of the trap were covered. The anchor chain, which was attached to a piece of driftwood as a drag, was likewise covered. Traps were baited with either blue crab (Callinectes sapidus) or canned cat food. Trapped raccoons were destroyed and buried on the beach.

In 1981 and 1982, nests laid in sites subject to erosion were relocated to safer locations the first morning after they were laid. Nests laid low on the berm were moved directly inland to the side of a dune, if one was present. If areas were devoid of dunes, nests were moved to the nearest dunal area. Nests to be relocated were dug up, and the eggs were placed in a cotton bag. New nest cavities were dug to the same dimensions of a natural nest, using the valve of a cockle shell as described by Stancyk et al. (1980). The bag was lowered into the cavity, and the eggs were gently deposited as the bag was withdrawn. Nests were covered and marked in a manner similar to natural nests.

## RESULTS AND DISCUSSION

### Trapping

In 1980, 203 raccoons were removed from the maritime forest at South Island during the winter and spring. This was done by shooting raccoons at feeders (85 animals) and by trapping (118 animals). During the first part of the turtle nesting season, 27 May to 8 July, predation from raccoons plus multiple predators (raccoons and the ghost crabs, Ocypode quadrata) was 91.6%

(N=71). The percentage for "multiple predators" was included because it was not always possible to discern which predator had entered the nest first. This 91.6% was similar to the predation for these 2 categories from the previous three years, 87.3%, 90.4% and 88.5% for 1977, 1978 and 1979, respectively. It was apparent that the removal effort in the maritime forest during the winter and spring had not affected nest predation.

When trapping was conducted directly on the nesting beach during July, 20 raccoons were removed (16 males and 4 females). The subsequent predation from 9 July to 12 October was 48.8% for both raccoons plus multiple predators (N=39). The overall predation for the entire season for both of these categories was 76.4%, with a hatching success of 11.8% (Table 1).

The predation of monitored nests (N=130) on Sand Island remained at about the same level as previous years, but the major predator was the red fox (Vulpes fulva), not the raccoon (Table 1). The combined predation loss for all natural predators (excluding 11.5% taken by humans) was 76.9%.

Since raccoon removal in the interior of South Island did not effectively reduce nest predation, trapping was conducted directly on the beach in subsequent years.

In 1981, trapping was conducted on both Sand and South Islands from 5 May to 2 June. During this time two foxes (one male and one female) and 3 raccoons (two male and one female) were removed from Sand Island. Eight raccoons (seven males and one female) were trapped on South Island. The results, shown in Table 2, are striking when compared to previous years. The hatch on South Island increased from 11.8% in 1980 to 62.1% in 1981. This higher hatch was due to the combination of raccoon removal and transferring nests to non-erosional nest sites.

Table 1. Fates of 240 loggerhead turtle nests laid on two barrier islands in South Carolina, 1980.

	South Island N=110 %	Sand Island N=130 %	Total N=240 %
Abiotic Factors (erosion & inundation)	2.7	3.1	2.9
Biotic Factors			
Raccoons	54.6	6.9	28.8
Ghost Crabs	6.4	5.4	5.8
Foxes	0.0	34.6	18.7
Multiple predators	21.8	30.0	26.3
Humans	2.7	11.5	7.5
Hatched	<u>11.8</u>	<u>8.5</u>	<u>10.0</u>
Totals	100.0	100.0	100.0

In 1982, trapping was conducted on South and Sand Islands from 10 May to 23 May using traps on game trails approaching the beach. Three male raccoons and one female were caught in this manner. After 23 May, traps were set directly in the body pits of nests that were partially depredated the previous night. Four male raccoons and two female raccoons were caught this way from 14 June to 20 July. Of the 10 raccoons caught, nine were on South Island and one was on Sand Island. The lower overall hatch (50.5%) was due in part to extreme high tides and increased predation by humans (Table 3).

Davis and Whiting (1977) and Hopkins et al. (1978) found that nest predation was highest within 2-3 days of laying. Early season raccoon removal delayed most of the raccoon predation on South Island until after mid July. This resulted in an undisturbed incubation for the majority of the nests laid each season. Predator activity on both islands often involved nests which were in the process of hatching, and only a few hatchlings were killed at this

Table 2. Fates of 383 loggerhead turtle nests laid on two barrier islands in South Carolina, 1981.

	South Island			Sand Island			Totals		
	Natural N=124 %	Transferred N=26 %	Total N=150 %	Natural N=206 %	Transferred N=27 %	Total N=233 %	Natural N=330 %	Transferred N=53 %	Total N=383 %
Abiotic Factors (erosion & inundation)									
Accroon	11.3	7.7	10.7	2.4	0.0	2.1	5.8	3.8	5.5
Frost	2.4	0.0	2.0	1.5	3.7	1.7	1.8	1.9	1.8
Frost-creebs	0.0	0.0	0.0	2.4	0.0	2.1	1.5	0.0	1.3
Frost-creebs	3.2	3.8	3.3	3.4	0.0	3.0	3.3	1.9	2.4
Abiotic Predators	5.7	0.0	4.7	12.6	11.1	12.5	10.0	5.7	11.0
Humans	-	7.7	1.3	-	7.4	0.9	-	7.4	1.0
Transfer Mortality	0.0	0.0	0.0	1.0	0.0	0.9	0.6	0.0	0.5
Plant Roots									
Hatched	58.9	76.9	62.1	58.3	77.8	60.5	58.5	77.4	61.1
Totals	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9



time. Predation of nests immediately prior to hatching has been reported previously for raccoons, (Hopkins et al. 1978), for foxes (Bustard 1972) and for dogs (Fowler 1979).

Another measure of reduced predator activity was the average duration in days that nests remained on the beach before they were depredated. Considering only those nests without the involvement of ghost crabs, the average duration for depredated nests in 1981 was 15.9 days (N=15) and 22.2 (N=10) days for South Island and Sand Island, respectively. In 1982 the average duration for depredated nests was 19.5 days for South Island and 16.1 days for Sand Island. In contrast, when no trapping was conducted on Sand Island in 1980, the average duration was 8.0 days (N=53). On South Island this same year, trapping was started in July, and the average duration for depredated nests was 3.6 days (N=60).

Trapping success (number of animals trapped per total trap-nights) was 16% in 1980 for South Island, 5% and 10% for Sand and South Islands in 1981 and 3% for both islands combined in 1982. Both the low numbers and the low efficiency are below what is economically feasible for a commercial trapper but proved to be effective as a management tool to protect nests.

#### Nest Relocation

Nest relocation was conducted on 53 of 383 nests deposited on Sand and South Island during 1981 (Table 2). The number of nests which hatched was 18.9% greater for relocated nests versus natural nests. This increased hatch was largely a result of protection from erosion. A slight reduction in the predation level was noted for relocated nests, however, this difference represented only 2 nests.

During 1982, 106 of 331 nests were relocated on both islands (Table 3). The difference in hatching again favored the relocated nests with 21.6% more of these nests being successful. Relocated nests again had less erosional loss (14.0%). However, an unexpected benefit to relocated nests was the striking difference in those taken by humans. This reduction in poaching was probably related to the lack of visual sign of the turtle crawl and the inability of poachers to determine the age of a transferred nest. This occurred despite the fact that relocated nests were marked by offset flags.

The higher percentage of relocated nests taken by raccoons reflects the continued loss of suitable nesting habitat. Lack of adequate dunes resulted in the concentration of relocated nests in some areas. After raccoons found one nest, they keyed in on these areas and a disproportionate number of nests was destroyed before all the raccoons could be trapped.

During 1980 and 1981, personnel at the Cape Romain NWR relocated 20 nests each season. Predation on these nests was 26% and 70% respectively. This compares to 41% predation on 94 controls in 1981 and a 26% predation on 66 control nests in 1980. Their results, like ours, reflect the compensatory interaction of predation and erosion.

Nest relocation or transplantation was considered to be the most cost effective, minimally manipulative technique for reducing nest predation (Stancyk et al. 1980). However, most predation takes place the night nests are laid. On Cape Island first-night predation ranged from 51-83% during 1977-79 (Hopkins and Murphy, 1981). Stancyk et al. (1980) reported first-night predation at 65.9% on Kiawah Island (1972) and at 55.1% on Cedar Island in 1978. Therefore without nightly patrols, first-night predation would leave



few nests the next morning to relocate. If relocation were done at night, it would be labor intensive, with added disturbance on the beach to nesting turtles a possibility.

During our study, nest relocation was found to be a useful technique when used in combination with raccoon control. Trapping, conducted prior to the onset of nesting, removed sufficient raccoons so that first-night predation was not high. This allowed for nest relocation to be done during the day, avoiding disturbance at night to nesting turtles. Relocation provided protection from erosion and human poaching. The low level of erosional losses is particularly dramatic given the fact that all moved nests were judged likely to be flooded at their original location. Relocation might also provide a suitable method for reducing poaching, particularly if nests are unmarked. The utility of relocation for protection from raccoons remains in doubt. While the percentage of nests taken by raccoons was higher for relocated nests, due mainly to learned behavior and unnaturally high densities, the low overall level of raccoon predation precludes any realistic comparison of predation levels.

#### Screening

A limited number of nests (17) were protected by screening in an experiment incidental to this study, but the results indicate the effectiveness of screens in reducing raccoon predation. A 1 m. square piece of 2 x 4 inch mesh welded wire was placed over the center of the nest and anchored at the corners. When covered with a layer of sand, raccoons appeared to be unaware of their presence as long as the wire was not exposed. All 17 nests incubated undisturbed by raccoons and hatched successfully.

## SUMMARY

In a prior study, information was gained which showed very low production of hatchlings from Sand and South Islands. Relative to the remainder of the nesting beaches in South Carolina, these two islands rank among the top five in density and among the top ten in number of nests laid each season. Because of this these two islands were considered important. Their potential for better hatchling production was high with proper management. We knew that proper management would require several actions because of the compensatory nature of the factors affecting nest survival, as documented in our prior study. This study evaluated the various management actions to determine the most cost efficient and effective means of increasing hatchling production from Sand and South Islands.

Removal of raccoons by trapping prior to or early in the nesting season reduced first-night predation and increased the number of nests which survived to hatch. Given the low number of raccoons that were removed to effect the enormous difference in predation levels, trapping was found to be the most economical and feasible management technique for these two islands. Trapping was not labor intensive when adjusted to the level and spatial distribution of raccoon activity.

Nest relocation was found an effective technique for protection from erosions and poachers, but requires additional testing to prove its effectiveness for control of predation by raccoons and foxes.

Screening appeared to provide better protection from predators, but would likely be more labor intensive than trapping if all nests were covered. Both relocation and screening allowed for hatchlings to emerge naturally when the correct mesh size was used for screens. The success of long term, saturation screening has not been documented.

By reducing first-night predation, trapping made the other two techniques more feasible. All three techniques can be conducted during daylight without the possibility of disturbing nesting turtles.

Marine turtles have a very long generation interval and it may take as long as 20 to 25 years for a hatchling to reach adult size. Management techniques applied to increase hatchling recruitment may not be apparent for many years. Therefore in order to be justified and sustained by agencies and groups in future years, management practices must be effective and cost efficient. Those described were cost efficient and effective in that the stated objective of the study was accomplished.

#### RECOMMENDATIONS

1. Begin trapping with either leg-hold or live traps at least two weeks prior to the onset of the nesting season, setting traps along access trails used by raccoons.
2. Once nesting has commenced, and if predation is still prevalent, set traps over partially depredated nests or around new nests. Traps set in late afternoon can be checked at dawn concurrent with turtle patrols to record nesting effort or to monitor strandings. Trapping effort also need not be continuous but can be concentrated in relation to predator activity, both temporally and spatially.

3. On erosional beaches, move as many nests as feasible the morning after they are laid to safer locations well landward of expected spring tides.

4. On non-erosional beaches or where extra protection is desired, place screening over each nest. Screens should be 1 meter square, made of 2" x 4" mesh welded dog wire, anchored on the corners and then covered with sand to obscure the nest location.


5. While these recommendations have been directed mainly at raccoon predation, they should also be considered for any small mammal which is a turtle nest predator.

## LITERATURE CITED

- Brame, W. P., G. C. Fringeli and G. R. Garris. 1981. Nesting and management of Atlantic loggerhead turtles on Cape Island, South Carolina in 1981. Annual Report to the U. S. Fish & Wildl. Ser. 21 pp mimeo.
- Brown, P. J. 1977. Variations in South Carolina coastal morphology. S.E. Geol. 18(4):249-264.
- Bustard, H. R. 1972. Sea turtles - their natural history and conservation. London: Collins Sons & Co., Glasgow, Scotland. 220 pp.
- Davis, G. E. and M. C. Whiting. 1977. Loggerhead sea turtle nesting in Everglades National Park, Florida. USA. Herpetologica 33(1):18-28.
- Fowler, L. E. 1979. Hatching success and nest predation in the green sea turtle, Chelonia mydas, at Tortuguero, Costa Rica. Ecology 60(5):949-955.
- Gallagher, R. M., M. L. Hollinger, R. M. Ingle and C. R. Futch. 1972. Marine turtle nesting on Hutchinson Island, Florida in 1971. Fla. Dept. Nat. Res. Special Sci. Report, 37:1-11.
- Gonzales, P. D. and G. R. Garris. 1980. Nesting and management of Atlantic loggerhead turtles on Cape Island, South Carolina in 1980. Annual Report to the U. S. Fish & Wildl. Ser. 21 pp mimeo.
- Hopkins, S. R. and T. M. Murphy. 1981. Reproductive ecology of Caretta caretta in South Carolina. Study Completion Report, S. C. Wildl. & Mar. Res. Dept. 1-97 pp.
- 
- in press. Testing of lithium chloride aversion to mitigate raccoon depredation of loggerhead turtle nests. Proc. Ann. Conf. S. E. Assoc. Fish & Wildl. Agencies.
- Hopkins, S. R., T. M. Murphy, Jr., 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 & Wildl. Agencies 32:213-223.
- McCollum, David. 1982. Scientific and educational aspects of a loggerhead nesting study, Pritchards Island, Beaufort County, South Carolina. In: S. R. Hopkins (ed.) Loggerhead Turtle Projects in South Carolina. Annual Reports to South Carolina Wildl. & Mar. Res. Dept. 49 pp mimeo.
- Richardson, J. I. 1978. Results of a hatchery for incubating loggerhead sea turtles (Caretta caretta) eggs on Little Cumberland Island, Georgia. In: 1978 G. E. Henderson (ed.) Proc. of the Florida and Internat. Conf. on Sea Turtles, 24-25 July, 1976, Jensen Beach, Fla. Fla. DNR Publ. No. 33, 66 pp.

- Stancyk, S. E. 1982. Non-human predators of sea turtles and their control. In: 1982 Karen A. Bjorndal (ed.) *Biology and Conservation of Sea Turtles* Proc. World Conf. Sea Turtle Conserv., 26-30 Nov. 1979, Wash., D.C. Smithsonian Inst. Press, 583 pp.
- Stancyk, S. E., O. R. Talbert and J. M. Dean 1980. Nesting activity of the loggerhead turtle Caretta caretta in South Carolina, II. Protection of nests from raccoon predation by transplanted. *Biol. Conserv.* 18 (1980):289-298.
- Talbert, O. R. Jr., S. E. Stancyk, J. M. Dean and J. M. Will. 1980. Nesting activity of the loggerhead turtle Caretta caretta in South Carolina I. A rookery in transition. *Copeia*, 1980:709-719.

Submitted by:

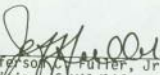
  
Sally R. Hopkins, Project Leader

Reviewed by:

  
Thomas S. Kohlsaad, Supervisor, Nongame & Heritage Trust Section

Approved by:

SOUTH CAROLINA WILDLIFE & MARINE RESOURCES DEPARTMENT

  
Jefferson C. Fuller, Jr., Director  
Division of Wildlife and Freshwater Fisheries