Chelonian Conservation and Biology, 2000, 3(4):693–698

Do Wire Cages Protect Sea Turtles from Foot Traffic and Mammalian Predators?

Melissa L. Mroziak[1], Michael Salmon[1,3], and Kirt Rusenko[2]

[1]*Department of Biological Sciences, Florida Atlantic University, Box 3091, 777 Glades Road, Boca Raton, Florida 33431 USA;*
[2]*Sea Turtle Program, Gumbo Limbo Environmental Complex, 1801 North Ocean Boulevard, Boca Raton, Florida 33432 USA;*
[3]*Corresponding Author for Reprint Requests [Fax: 561-297-2749; E-mail: Salmon@fau.edu]*

Abstract. – **All sea turtle nests at Boca Raton, Palm Beach Co., Florida, U.S.A., are exposed to foot traffic from visitors that use the beach, and to predators (raccoons, foxes, and skunks) that feed upon the eggs and hatchlings. To protect the nests, managers have covered them with square wire cages anchored in the sand. We compared the fate of caged and uncaged nests exposed to high and low levels of foot traffic, and to high and low levels of predation. We found no evidence that foot traffic posed a threat to the nests. Predators (mostly raccoons) used the cages as landmarks to locate nests. Predators reduced hatchling productivity on the beach more during the year of our study (1996) than during the following year when cages were not used. We conclude that the cages used failed to protect the nests. We recommend that at this and at other sites where similar conditions exist, management efforts should shift away from efforts to discourage mammalian predators and toward efforts to reduce predator populations adjacent to the nesting beach.**

Key Words. – **Reptilia; Testudines; Cheloniidae; *Caretta caretta*; sea turtle; nesting; predation; conservation; management; nest cages; Florida; USA**

Florida's southeast coast serves as a nesting ground for three species of sea turtles: the loggerhead (*Caretta caretta*), the green turtle (*Chelonia mydas*), and the leatherback (*Dermochelys coriacea*; Meylan et al., 1995). All are listed as threatened (loggerhead) or endangered (leatherback and green turtle) by the United States Department of the Interior.

Current stresses on sea turtles that reach the coastal U.S.A. include exploitation (by fishermen in other countries), ongoing incidental capture, and habitat modification by humans (Magnuson et al., 1990). The elimination of large mammalian predators (such as the Florida panther, *Felis concolor coryii)* has probably contributed to an explosion in the populations of small and medium-sized mammalian predators (raccoon, *Procyon lotor*; gray fox, *Urocyon argenteus*; and spotted skunk, *Spilogale putorius*). These now consume turtle eggs and feed upon hatchlings at many nesting beaches (Stancyk, 1982).

At urban nesting beaches, managers formulate strategies that protect nests from two dangers: predators and human foot traffic on the beach. At Boca Raton, Florida, the city manages 7 km of beach where, on average, about 900 loggerhead nests are deposited each summer. Half of the beach is located in front of public parks where raccoon and foxes thrive, and where foot traffic is high. Since 1977, the city has protected nests from these dangers by covering them from above with square wire cages, open at the bottom. However the effectiveness of this method of cage protection has not been ascertained. In fact, cage use at sea turtle nesting beaches without determining their efficacy has become routine (Lucavage et al., 1996; but see Addison and Henricy, 1994; Addison, 1997).

This study was undertaken to provide answers to three questions. (1) Do foot traffic and predation threaten sea turtle nests? (2) Do wire cages of the kind used at Boca Raton protect the nests from these threats? (3) Is the use of cages the best management alternative? Since nest caging is common in the United States and elsewhere, our study has broad management implications.

MATERIALS AND METHODS

Boca Raton's nesting beach is divided into 10 zones (A–J), each 800 m in length (Fig. 1). Our study site was confined to zones A–H. Zones A–B and D–E are bordered by city parks; zone F is located adjacent to a golf course; zones C, G, and H are located in front of buildings (private homes, condominiums, and a resort).

Zones vary in their exposure to beach foot traffic, as well as their likelihood of predatory attacks on the nests. We identified two zones each of high and low beach traffic, and two zones each of high and low likelihood of predation. In each zone, we paired two nests in close proximity. One was an experimental nest, covered by a cage, while the second was a control nest, left uncovered. Each nest was inspected daily until the hatchlings emerged or a predation event occurred. We used loggerhead nests placed on the beach between May and August 1996 as subjects.

Cage Deployment. — Wire cages (76.0 cm square, 107 cm tall, 5 x 10 cm mesh) were centered above the egg chamber, then anchored in the sand by burying the side panels in a trench dug to a depth of approximately 30 cm. Anchored cages were difficult for raccoons or other predators to move or lift. The buried panels also prolonged efforts by the predators to locate the egg chamber. This inconvenience or difficulty often reduces (but does not eliminate) raccoon predation .(Addison, 1997).

Foot Traffic and Nest Fate. — From 15 May until 8 October 1996 we counted the number of human beach users in each zone over a one hour period. Counts were made for 21 weeks (21 May – 6 October), two to six days each week, during equal numbers of morning and afternoon surveys.

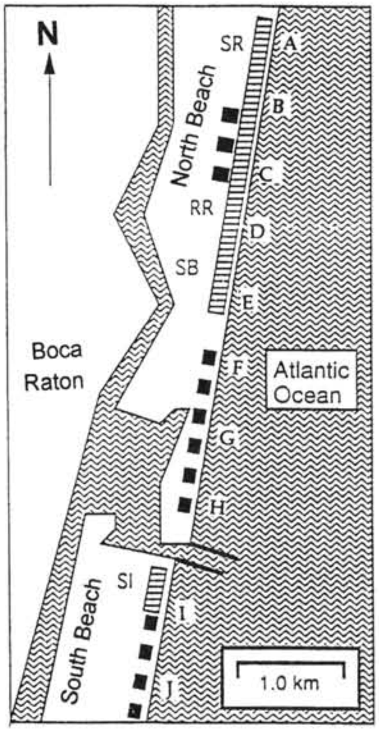

Figure 1. Map of Boca Raton's beach on the southeast coast of Florida (26°22'N, 80°07'W). Hashed lines are the four public parks (SR = Spanish River; RR = Red Reef; SB = South Beach; SI = South Inlet); solid squares are buildings; A–J = research zones.

Since the morning and afternoon counts for each zone were statistically identical ($X^2 = 1.106$, d.f. = 1, n.s.), they were pooled to determine a daily mean. Daily means were used to calculate a weekly mean. At the end of week 7, the two zones with the highest average foot traffic (B and E) were designated as the "high traffic" zones, while two with the lowest averages (C and D) were designated as the "low traffic" zones.

Fifty-eight pairs of nests were used in the four traffic zones. Nest pairs were composed of either natural or relocated nests. Relocated nests were used to increase the nest pair sample size. Natural nests were separated spatially by no more than 15 m, and in deposition date by no more than ± 2 days. Relocated nests also differed in deposition date by no more than 2 days, were separated by no less than 4.0 m, and positioned so that the uncaged nest was to the south of its caged control. The number of natural and relocated nest pairs in the high traffic zones was: B, 9 natural and 7 relocated pairs; and E, 12 and 5. In the low traffic zones they were: C, 7 and 6; and D, 7 and 5.

When relocating nests, we followed the prevailing (1996) guidelines of the Florida Department of Environmental Protection (now, the Florida Fish and Wildlife Conservation Commission). Clutches were relocated within 12 hrs of deposition. Eggs were placed in a chamber whose upper margin was about 35 cm below the sand surface, and whose bottom was about 58 cm below the sand surface. For clutches close to average size (101 eggs), the chamber's maximum diameter was 25 cm; chambers were slightly narrower for smaller clutches, and slightly wider for larger clutches (recommended by R. Carthy, *pers. comm.*).

Three days after the hatchlings emerged, the nest contents were excavated to determine nest fate (the number of emerged hatchlings [turtles that left the nest], live or dead hatchlings inside the nest, pipped eggs [shell broken by the neonate, still inside the egg], or unhatched eggs). These numbers were converted into proportions. Chi-square tests (Sokal and Rohlf, 1995) were used to compare nest fate proportions among caged and uncaged nests.

Predation. — Data from the 1994 and 1995 nesting seasons were used to determine whether nests at some beach zones were exposed to more frequent predation. We found no statistical differences between years in the distribution of predation (Kolmolgorov-Smirnov tests, D = .075, d.f. = 1, n.s.; Siegel, 1956) and therefore pooled the data. Attacks within two "high predation" zones (D and E) occurred over three times more often than at two "low predation" zones (B and C).

During the 1996 nesting season, nests were inspected daily to determine (1) when and where predation occurred, and (2) the identity of the predator (raccoon, skunk, or fox based upon the tracks left in the sand; Imes, 1995). Kolmolgorov-Smirnov tests were used to determine if the 1996 predation distribution by zone differed from the 1994–95 distribution.

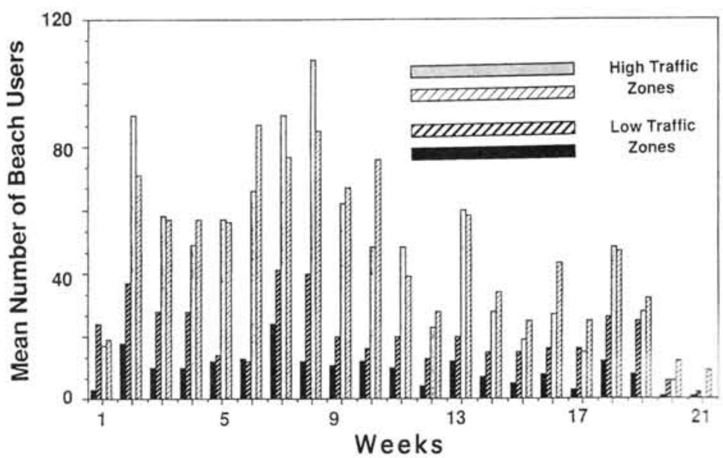

Figure 2. Number of beach users in the two high (B, E) and the two low (C, D) foot traffic zones, 1996. Means are based upon 2–6 observations per week over 21 weeks (21 May – 8 October).

Ninety pairs of nests were placed in the two high and the two low predation zones, using the protocols described above. The number of natural and relocated nest pairs in each zone was: D, 15 natural and 9 relocated; E, 13 and 13; B, 15 and 7; and C, 10 and 8. We used X^2 tests to compare the proportion of predation on caged vs. uncaged nests in the same zone, and on caged and uncaged nests located in different zones. If predation did not completely destroy a nest, its contents were assayed three days after the hatchlings emerged to determine nest fate. A Kruskal-Wallis test (Sokal and Rohlf, 1995) was used to determine if the number of emerged hatchlings was significantly reduced by these incomplete predations.

To determine when during incubation predation was most likely to occur, incubation periods were divided into 20% segments of their duration (thus normalizing for seasonal [temperature induced] differences in incubation time). The number of predations during each segment was then compared to a hypothetically uniform distribution of predation by Kolmolgorov-Smirnov tests.

Decoy Cages. — Preliminary results suggested that predators were more likely to depredate caged rather than uncaged nests. To investigate this possibility, we placed 32 decoy cages (identical to those protecting clutches, but not covering a nest) on the beach between 9 and 31 July. Decoy cages were constructed of new wire mesh to eliminate contamination by chemical cues from previously relocated sea turtle nests. Eighteen cages were placed in zones D and E and 14 in zones B and C. Cages were inspected daily for predation until mid-October.

RESULTS

Foot Traffic in the Zones. — On average about 20 beach users/hr were observed in the low traffic zones (C and D), while about 50 beach users/hr were observed in the high traffic zones (B and E; Fig. 2). Public school opened after week 11. Use of the beach thereafter gradually declined in all zones through week 22, when observations ended.

Foot Traffic and Nest Fate. — There were no statistical differences in nest fate proportions among the caged and uncaged nests located in the high traffic zones (zone B, χ^2 = 2.98, d.f. = 3, n.s.; zone E, χ^2 = 1.69, d.f. = 3, n.s.; Fig. 3). In one low traffic zone (C), nest fates of caged and uncaged nests did not differ statistically (χ^2 = 0.386, d.f. = 3, n.s.). In the other low traffic zone (D), about twice as many eggs (22%) failed to hatch in the caged compared to the uncaged (10%) nests (χ^2 = 7.863, d.f. = 3, $p < 0.05$). However, the proportion of hatchlings that emerged from these nests was statistically identical (73% caged; 71% uncaged; χ^2 = 0.458, d.f. = 3, n.s.).

Spatial Distribution, Impact, and Sources of Predation. — From 1994–96, most predation occurred in zones D–F (Fig. 4). Percentage distributions for all years were statistically identical (Kolmolgorov-Smirnov D = 0.083, d.f. = 2, n.s.). In 1996, 257 of the 901 nests (29%) placed on the beach were depredated. Many nest were repeatedly attacked, yielding a total of 506 predations. Of the 901 nests deposited on the beach, 93 (10.3%) were completely destroyed while 164 (18.2%) were partially depredated.

Tracks (Imes, 1995) were again used to identify the predators. Raccoons were responsible for 88%, gray foxes for 11%, and spotted skunks for 1% of all predations.

Temporal Distribution of Predation. — During the 1994 and 1995 nesting seasons, most (ca. 60%) attacks occurred during the last 20% of the incubation period (Fig. 5). However, the number of recorded observations (n = 25) was small. Predations during the 1996 nesting season were not uniformly distributed (Kolmolgorov-Smirnov D = 0.139, $p < 0.05$); most occurred during the first 20% or the last 20% of incubation.

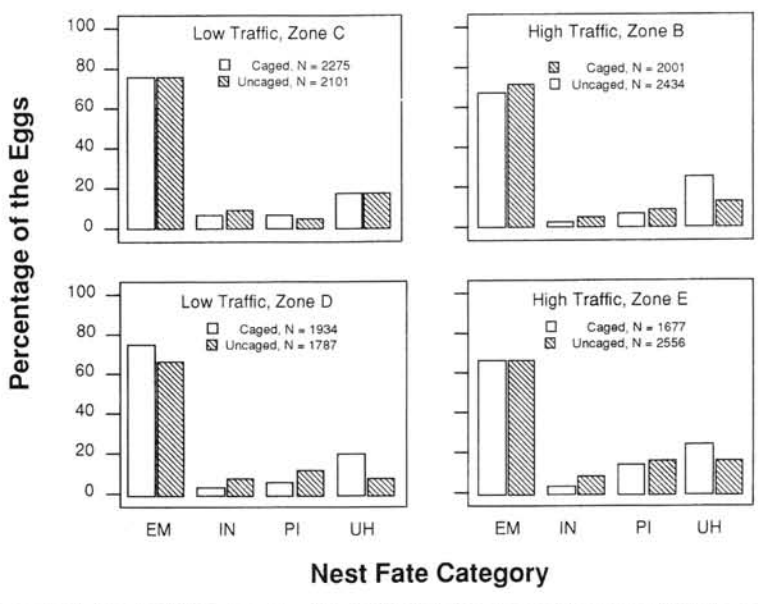

Figure 3. Nest fate proportions in the four traffic zones. N = the number of eggs present in the nests. Columns show the percentage of eggs that resulted in emerged hatchlings (EM), hatchlings found in the nest (IN), pipped eggs (PI), and unhatched eggs (UH).

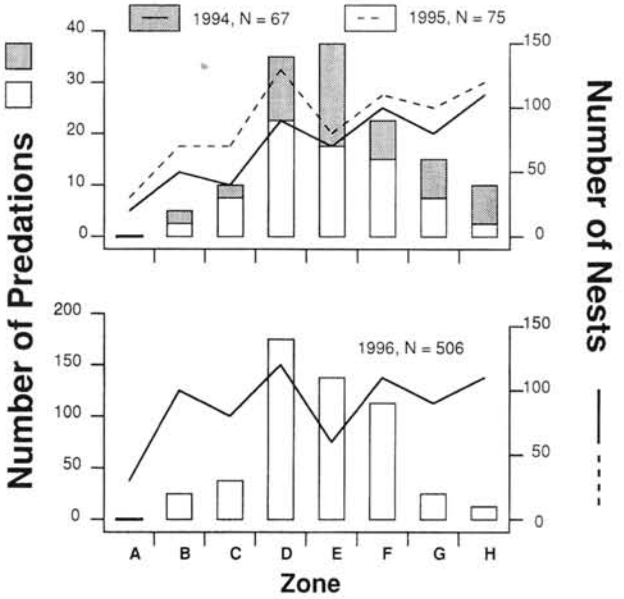

Figure 4. Numbers of predations and nests in zones A–H during the 1994 and 1995 nesting seasons **(top)**, and 1996 **(bottom)**. Left axis (vertical shaded and unshaded bars): distribution of predation by zone; right axis (solid and dashed lines): distribution of nests by zone over the same years.

Caging and Predation. — In the two high predation zones, more of the caged (> 40%) than uncaged (< 10%) nests were depredated (Fig. 6). At the two low predation zones, fewer (< 25%) nests were attacked, but again, significantly more caged than uncaged nests were predated ($\chi^2 = 6.253$, d.f. = 1, $p < 0.05$). The proportion of depredated nests totally destroyed was statistically indistinguishable among the caged (11 of 29 nests; 38%) and uncaged (1 of 3 nests; 33%) nests ($\chi^2 = 1.94$, d.f. = 1, n.s.).

When nests were not disturbed by predators, the average number of hatchlings that emerged from caged and uncaged nests (ca. 80) did not differ (Fig. 7). Predation on uncaged nests ($n = 8$) was infrequent. Predation on caged nests (resulting in partial or complete nest destruction) significantly reduced the average number of hatchlings that emerged from each nest (from ca. 80 to ca. 50; Kruskal-Wallis H = -43.7, d.f. = 2, $p < 0.01$)

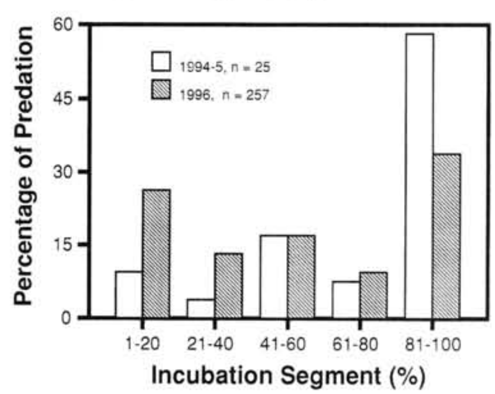

Figure 5. Distribution of predations on caged nests as a function of incubation segment during the 1994–95 and the 1996 nesting seasons.

Decoy Cages. — More than half (10 of 18) of the decoy cages in the high predation zones were "depredated" by raccoons. Most of these (7 of 10) were depredated repeatedly. In the low predation zones, less than half (6 of 14) of the decoy cages were depredated and fewer than half of these (2 of 6) were depredated repeatedly.

DISCUSSION

Nest Caging and Foot Traffic. — Prior to this investigation, it was assumed that foot traffic on the beach reduced the survival of sea turtle nests at Boca Raton. Beach users might accidentally injure nests by penetrating the egg chamber with umbrella posts, or by exposing and moving the eggs (after digging holes in the sand). In high traffic areas, sand compaction might be increased, making it more difficult for hatchlings to emerge. Debris left in or on the sand might also impede hatchling emergence (Magnuson et al., 1990).

However, we found no evidence at Boca Raton that foot traffic affected nest survival. For example, we were unable to detect any differences between the average number of hatchlings that left uncaged vs. caged nests within any traffic zone. We also failed to detect such differences in comparisons between uncaged nests exposed to high and low levels of foot traffic (Fig. 3). We conclude that at this study site, foot traffic posed no threat to the nests.

The temporal pattern of human beach use at Boca Raton favors nest survival as beach use decreases after schools open in early August (Fig. 2), when most nests are present. In addition, the parks are closed at night, reducing beach access. At other nesting beaches, human usage might remain consistently high and, as a consequence, have a greater impact upon nest survival.

Cages and Predation. — Several species of predatory mammals can locate sea turtle nests, then consume the eggs and hatchlings (Stancyk, 1982). At Boca Raton, both the spatial (Fig. 4) and the temporal (Fig. 5) distribution of predation over three years was similar. Raccoons most often depredated nests shortly after deposition, or near the time of emergence. Similar temporal patterns of attack have been noted elsewhere (Fowler, 1979; Stancyk et al., 1980).

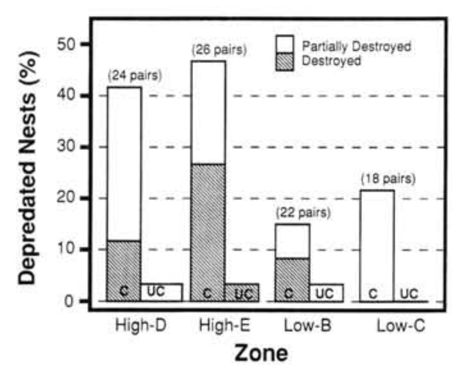

Figure 6. Proportion of caged (c) and uncaged (uc) nests that were partially (open bars) and completely (hatched bars) depredated in the high and low predation zones.

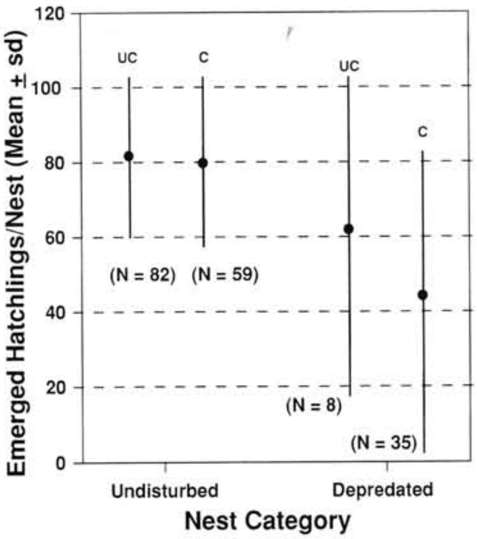

Figure 7. Mean (± SD) number of hatchlings that emerged from caged (c) and uncaged (uc) nests that were undisturbed (left) or depredated (right). N = the number of nests in the sample.

Raccoons are known to patrol beaches at night, locate nesting females, and even consume eggs while the females are ovipositing. They also can locate recently deposited nests by searching in areas of newly disturbed sand (i.e., the turtle's body pit). Raccoons might use olfactory cues (the odor of cloacal fluids) to locate egg chambers. We speculate that towards the end of incubation, nests might be found by detecting the sounds (or vibrations) of hatchlings digging their way to the surface, odors released by hatchlings that have broken out of their shells, or the smell of turtles that have previously emerged. Nests that have been reburied in fresh sand, excluding both visual (body pit and tracks made by the female) and odor cues, are rarely located by raccoons (Stancyk et al., 1980).

Predation occurred most often on the beaches in front of Red Reef and South Beach Parks. Raccoons are abundant in those areas and, as ecological opportunists, are likely to take advantage of the many favorable microhabitats present in most park areas (MacClintock, 1981). Dense vegetation and walkways in the park may be used as hiding places, shelters, and for shade; trees can serve as convenient sleeping sites. More food (waste from picnics; handouts from beach users) is generally available in park habitats than in surrounding residential areas. At condominiums and private resorts, containers holding waste may be more securely closed, placed in less exposed areas, and emptied more frequently than those in the parks. Most condominium apartments are also empty during the summer (nesting) season, further reducing quantities of available waste.

There was relatively little predation in zones A and B even though this area was also adjacent to a park site (Spanish River; Fig. 1). But this park, unlike the others, is located to the West of the ocean highway (A1A) that parallels the beach. To reach the beach, raccoons must cross the highway where many are killed by cars. In contrast, both Red Reef and South Beach Parks are located on the East side of the highway where raccoons can directly access the beach.

Cages and Nest Protection. — A significant proportion (about 40%) of all nest predation at Boca Raton occurred during the middle 60% of incubation, suggesting that nests could be located in the absence of chemical cues. Since caged nests were depredated more frequently than uncaged nests, we suspected that the cages might act as guideposts for locating nests. Predation upon decoy cages confirmed that raccoons focused on the cages. Raccoons are intelligent and resourceful predators, with a keen ability to recognize shapes and associate them with reward (Fields, 1932). Because cages have been used to protect nests at Boca Raton since 1977, there has been ample time for such an association to become established.

At Boca Raton, each undisturbed nest produced about 80 hatchlings (Fig. 7). Given an average of 900 loggerhead nests per season, about 72,000 turtles could possibly reach the sea from this beach annually. In 1996, 257 of 901 nests (29% of the total) were either partially of completely depredated. Among the depredated nests, productivity was reduced by an average of 30 turtles per nest (Fig. 7). We estimate that predation (despite the use of cages) reduced hatchling productivity at the beach by ca. 7700 turtles (30 hatchlings x 257 nests), or 10.7%.

The Florida Fish and Wildlife Conservation Commission monitors all management procedures used by Florida municipalities to protect sea turtle nests. It discourages any "unnecessary nest manipulations," including caging. After examining the data from 1996, they requested that cage use be suspended at Boca Raton during the 1997 nesting season. In 1997, predation levels decreased to 6.2%, but in 1998 they rose again to levels that were comparable (12%) to the 1996 nesting season. These data, then, show that predators can locate nests by cage position when cages are present (1996), and can find nests by alternative cues when cages are absent (1998). Thus nest caging, at least at Boca Raton, fails as a long-term solution.

Management Lessons. — Management strategies at sea turtle nesting beaches share the same goal: to decrease potential threats to the turtles, and to increase the proportion of hatchlings that emerge from those nests and reach the sea. Such efforts are essential to recovery plans for sea turtles (Heppell, 1997). But management practices, as well as the assumptions underlying their use, should be evaluated with dispatch. Cages were used at Boca Raton for 20 years before this study was done. Had our study been done earlier, the money and time devoted to caging could have been used to explore other, more effective, management alternatives.

In general, management practices that center on symptoms rather than causes often fail ("halfway technology" [Frazer, 1992]). For example, placing cages over nests exposed to artificial lighting does not protect hatchlings from the effects of photopollution. To solve that problem, artificial lighting must be controlled (Adamany et al., 1997). Cages of different design have been successfully deployed to discourage predators on the west coast (Key Island) of Florida (Addison, 1997). But at that site there are fewer nests and the compact sand makes it difficult for raccoons to dig to the egg chamber. At Boca Raton nesting density is much greater, and all nests are deposited in soft sand. At sites such as these, solutions must focus on the cause: an abundance of predators adjacent to a rich (and accessible) source of prey (turtle eggs).

An Alternative Approach. — We suggest as a management alternative a long-term plan based upon three goals. First, the size of the fox and raccoon populations must be determined, relative to the carrying capacity of the parks. Numbers are currently unknown but are probably high. Standard procedures could be used to obtain estimates (i.e., mark and recapture [Skalski and Robson, 1992] or sightings at food stations [Pedlar et al., 1997]). Most reported densities for raccoons range from a high of 1 per 5 ha to a low of 1 per 43 ha (Loetze and Anderson, 1979), depending upon the availability of food and water (MacClintock, 1981). If, as seems likely, numbers of raccoons and foxes in the parks are too high, managers can set goals to determine by how much they should be reduced. Immediate culling is not an option at Boca Raton for reasons of public acceptance. An alternative might be to capture and castrate the males or to insert long-lasting hormonal implants in females that prevent ovulation. These procedures would significantly decrease raccoon numbers within a generation (5 to 7 years; MacClintock, 1981). Counts every 2–3 years thereafter could be used to maintain quotas. The result should be a healthier population of raccoons and foxes, and reduced predation at the nesting beach.

Second, a decision must be made regarding how much loss of sea turtle eggs to predators is "acceptable." Raccoons and foxes are natural predators of sea turtle nests in the southeastern U.S. (Stancyk et al., 1980). Thus this decision should be made from the perspective of managing and maintaining both the turtles and the park mammalian population (an ecosystem approach). However, we believe that these decisions should be biased in favor of threatened (loggerhead) and endangered (green turtle and leatherback) species.

Finally, public education (in the form of kiosks and signage) should be used to remind park visitors not to feed wildlife. So, also, would new regulations urging park visitors to take their food scraps home. In this way the public is involved and participates in efforts to preserve populations of mammals in the parks and turtles on the beaches.

ACKNOWLEDGMENTS

This study was completed by MLM as a requirement for the Masters degree in biology at Florida Atlantic University. We thank the City of Boca Raton (through the efforts of Steve Bass) and the John K. Bastien Society for financial support. We received assistance at the beach from Angela Barker, Callie Buchanan, David Fowler, Carly Pfistner, Scott Reynard, and Trish Sposato. Comments from Peter Lutz, Alex Marsh, and Jeanette Wyneken improved the thesis. Suggestions by the editors (Anders G.J. Rhodin and Peter C.H. Pritchard) and a referee (David Addison) improved the manuscript.

LITERATURE CITED

ADAMANY, S.L., SALMON, M., AND WITHERINGTON, B.E. 1997. Behavior of sea turtles at an urban beach III. Costs and benefits of nest caging as a management strategy. Florida Scient. 60:239-253.

ADDISON, D.S. 1997. Galvanized wire cages can prevent nest depredation. Marine Turtle Newsletter 76:8-11.

ADDISON, D.S. AND HENRICY, S. 1994. A comparison of galvanized wire mesh cages vs. flat chain-link screen in preventing *Procyon lotor* depredation of *Caretta caretta* nests. In: Bjorndal, K.A., Bolten, A.B., Johnson, D.A., and Eliazar, P.J. (Compilers). Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation NOAA Technical Memorandum NMFS-SEFC-351, p. 174.

FIELDS, P.E. 1932. A comparison of white rats and raccoons with respect to their visual discrimination of certain geometrical figures. In: Concept Formation. Department of Psychology, Stanford University, Stanford, CA, pp. 341-355.

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION. 1996. Nest caging. In: Marine Turtle Conservation Guide for Permit Holders. Marine Research Publications, St. Petersburg, FL, pp. 16-19.

FOWLER, L.E. 1979. Hatching success and nest predation in the green sea turtle, *Chelonia mydas*, at Tortuguero, Costa Rica. Ecology 60:946-955.

FRAZER, N.B. 1992. Sea turtle conservation and halfway technology. Conserv. Biol. 6:179-184.

HEPPELL, S.S. 1997. On the importance of eggs. Marine Turtle Newsletter 76:6-8.

IMES, R. 1995. Animal Tracks: Identifying, Interpreting, and Exploring Animal Trails. Running Press Book Publishers, Philadelphia, PA.

LOETZ, J. AND ANDERSON, S. 1979. *Procyon lotor*. Mammalian Species 119:1-8.

LUTCAVAGE, M.E., PLOTKIN, P., WITHERINGTON, B., AND LUTZ, P.L. 1997. Human impacts on sea turtle survival. In: Lutz, P.L. and Musick, J.A. (Eds.). The Biology of Sea Turtles. Boca Raton, FL: CRC Press, pp. 387-409.

MAGNUSON, J.J., BJORNDAL, K.A., DUPAUL, W.D., GRAHAM, G.L., OWENS, D.W., PETERSON, C.H., PRITCHARD, P.C.H., RICHARDSON, J.I., SAUL, G.E., AND WEST, C.W. 1990. Decline of the Sea Turtles: Causes and Prevention. Washington: National Academy Press, 259 pp.

MACCLINTOCK, D. 1981. A Natural History of Raccoons. Charles Scribner's Sons, NY.

MEYLAN, A.B., SCHROEDER, B., AND MOSIER, A. 1995. Sea turtle nesting activity in the state of Florida, 1979-1992. Fla. Mar. Res. Publ. 52:1-51.

PEDLAR, J.H., FAHRIG, L., AND MERRIAM, H.G. 1997. Raccoon habitat use at two spatial scales. J. Wild. Manag. 61:102-111.

SIEGEL, S. 1956. Nonparametric Statistics for the Behavioral Sciences. Macgraw-Hill, New York.

SKALSKI, J.R., AND ROBSON, D.S. 1992. Techniques for Wildlife Investigation: Design and Analysis of Capture Data. San Diego, CA: Academic Press.

SOKAL, R.R. AND ROHLF, F.J. 1995. Biometry. W.H. Freeman, New York.

STANCYK, S.E. 1982. Non-human predators of sea turtles and their control. In: Bjorndal, K.A. (Ed.). Biology and Conservation of Sea Turtles. Washington, DC: Smithson. Inst. Press, pp.139-152.

STANCYK, S.E., TALBERT, O.R., AND DEAN, J.M. 1980. Nesting activity of the loggerhead turtle *Caretta caretta* in South Carolina, II. Protection of nests from raccoon predation by transplantation. Biol. Conserv. 18:289-298.

Received: 16 November 1998
Reviewed: 15 February 2000
Revised and Accepted: 20 March 2000