

1994 MARINE TURTLE NEST
SCREENING PROGRAM AT
CANAVERAL NATIONAL SEASHORE
FLORIDA

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ABSTRACT

In 1994 Canaveral National Seashore completed the eleventh year of its sea turtle nest screening program. A total of 4252 nests were deposited along its 23.25 miles of beach. This included 3886 loggerhead (Caretta caretta), 364 green (Chelonia mydas) and two leatherback (Dermochelys coriacea) sea turtle nests.

For the second consecutive year, the beach was divided into four replicate blocks - each with three treatment areas: 1) raccoon removal, 2) nest screening and 3) nest screening plus conditioned taste aversion (CTA). The amount of nest depredation was calculated in each treatment area to determine the most effective nest protection strategy.

A total of 1723 (41 percent) of the nests deposited at CANA were screened to prevent nest depredation. Four percent (69) of the screened nests were impacted (totally or partially depredated). Of the 2529 unscreened nests, 29 percent (728) were impacted by predators. Overall, for screened and unscreened nests, 19 percent (797) were impacted and 81 percent (3455) were undepredated.

Nest depredation was lowest in the nest screening areas of three of the four replicate blocks. In those three blocks, depredation was highest in two of the screening plus CTA areas and one of the raccoon removal areas. In the fourth block, depredation was highest in the nest screening area and lowest in the screening plus CTA area.

A total of eight percent (295) of the loggerhead and five percent (20) of the green nests were excavated to determine hatching success. One of the two leatherback nests was excavated. Loggerhead nests exhibited an average clutch size of 108.9 eggs, while the average clutch size of the green nests was 129.25 eggs. The leatherback nest contained 96 eggs. Hatching success, as determined by an egg count, was 70 percent for the loggerhead, 81 percent for the green, and 80 percent for the leatherback.

An estimated 296,230 loggerhead, 38,108 green and 154 leatherback hatchlings were produced at Canaveral National Seashore in 1994.

INTRODUCTION

Canaveral National Seashore (CANA) receives 3,000-4,000 sea turtle nests each year. These are primarily loggerhead (Caretta caretta), with a few green (Chelonia mydas) and an occasional leatherback (Dermochelys coriacea).

Nest depredation by the raccoon (Procyon lotor) is a serious threat. In the early 1980's, over 95 percent of the nests were depredated by raccoons (McMurtray 1986). As a result, the park implemented a nest screening program in 1984.

Between January 1993 and November 1994, field work was conducted by the University of Georgia (UGA) to obtain critical information about the raccoon population at CANA and to explore three methods of nest protection. CANA modified past screening efforts to accommodate the needs of the study (see Study Sites and Methods). The results (still undergoing analysis) will be used to design a long range strategy for protecting both sea turtle nests and the fragile seashore ecosystem.

An attempt was made to simplify this report from previous years. Rather than treat nests as partially or totally depredated, depredated nests were simply categorized as impacted to determine effectiveness of treatment strategies. Hatching success, the most critical value, was obtained by excavating a representative sample of nests to determine percentage of hatched eggs.

STUDY SITES AND METHODS

Canaveral National Seashore is located along the east-central coast of Florida with Bethune Beach to the north and Kennedy Space Center to the south (Figure 1). The northern 11.25 miles of beach is situated in Volusia County, the southern 12 miles in Brevard County.

The beach is essentially undeveloped with only a few artificial lights and a number of boardwalks to protect the dune vegetation. The dune is well developed along most of the beach and is stabilized by a thick growth of sea oats (Uniola paniculata), sea grape (Coccoloba uvifera), saw palmetto (Serenoa repens) and other dune species. The beach is closed to the public between sunset and sunrise except for occasional guided turtle walks. These walks are limited in size to minimize disturbance to the nesting turtles.

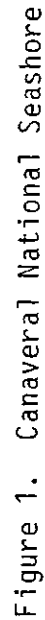
On May 15, the park initiated patrols to record sea turtle nests and false crawls. The 24 mile stretch of beach was covered utilizing four-wheeled all-terrain vehicles (ATV's). Two teams, each consisting of a ranger and a volunteer, worked from 11:00 p.m. to 7:00 a.m., seven nights a week, screening turtle nests and recording data. In addition, daytime patrols were conducted at least four times a week to record any additional depredations to recorded nests. On August 16, night patrols were switched to daytime and combined with the depredation patrols, due to a decrease in nesting activity.

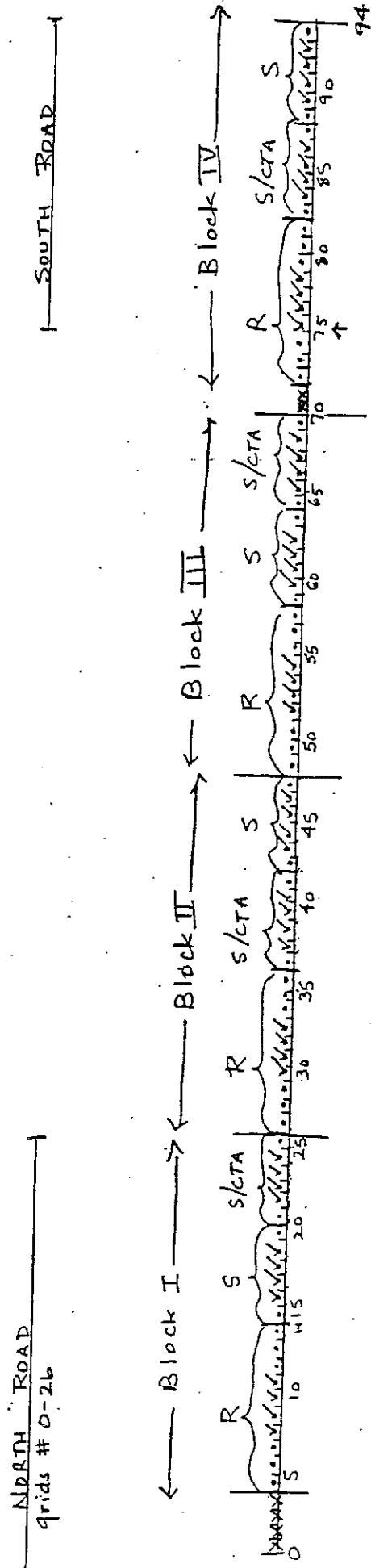
Initial data collection for each nest included: date, nest number, species, grid (the beach was divided into 94 quarter mile sections), number of eggs depredated, if any, and sighting/treatment. Sighting/treatment referred to the condition of the nest (undepredated, partially depredated or totally depredated) and the subsequent treatment (screened or unscreened). Each nest was marked with a numbered stake for later identification. Date and grid location of each false crawl was also recorded.

Due to the study on alternate nest protection strategies, not all undepredated nests were screened. The beach was divided into four replicate blocks (Figure 2). In each block, three treatment areas were established. These were: 1) a removal area, where raccoons were removed and nests were left unscreened. 2) a screening area, where two-thirds of the sea turtle nests were screened; 3) a screening and conditioned taste aversion (CTA) area, where two-thirds of the nests were screened and eggs injected with estrogen were set out on the dune.

The screening procedure consisted of placing a 4 feet x 4 feet wire mesh screen over the nest and staking down the corners with three foot sections of #3 rebar. The rebar was bent over near one end to

Merritt Island





Removal area = 2.5 miles (10 grids) per block
 Screening area = 1.5 miles (6 grids) per block (67% screen)
 Screening plus CTA = 1.5 miles (6 grids) per block (67% screen)
 Exclusion areas = grids 0-3 (100% screen)
 grids 70-71 (100% screen)

Figure 2. Nest Protection and Raccoon Treatment Areas

form a 70 degree angle. The 2 inches x 4 inches mesh size was large enough to allow hatchlings to emerge while discouraging raccoon attempts to reach the eggs. Partially depredated nests that retained a significant number of intact eggs had the broken eggs removed and were covered with clean sand.

During depredation patrols, all new nest depredations were recorded, the number of destroyed eggs counted and all destroyed eggs bagged and removed from the beach. The latter was done to deter raccoons from easily relocating any remaining eggs and to prevent counting depredations more than once. As with the initial discovery of partially depredated nests, if a significant number of viable eggs remained, the nest was cleaned and covered with clean sand.

The stake for every tenth nest was marked with spray paint for easy identification. After 65 days or evidence of hatching the nests were excavated and each unhatched egg and empty shell (hatched egg) was counted to calculate average hatching success for the entire beach.

Nests were relocated if time permitted for one of three reasons: 1) they had been deposited near the surf line and were in danger of being inundated or washed away; 2) the nest was located at the base of a heavily travelled boardwalk; 3) the nest had been partially depredated and required major clean up of broken egg shells and yolk. Pits approximating the natural nest cavity were dug near the base of the dune. The eggs were then carefully transferred, buried and, if applicable, screened in the usual manner.

An attempt was made to remove individual raccoons that had learned to tunnel under screens or that repeatedly depredated unscreened nests. All raccoons were captured using Tomahawk live-traps.

RESULTS

A total of 4252 sea turtle nests were deposited at CANA in 1994 - 3886 loggerhead, 364 green and 2 leatherback (Table 1). Overall nest density was 167.1 per mile (103.6 per kilometer) for the loggerhead and 15.7 per mile (9.7 per kilometer) for the green (Table 2).

Table 1. Turtle Nest and False Crawls
Canaveral National Seashore - 1994.

<u>Species</u>	<u>False Crawls</u>	<u>Nests</u>	<u>False Crawl Nest Ratio</u>
Loggerhead	2425	3886	1:1.60
Green	264	364	1:1.38
Leatherback	0	2	
Total	<u>2689</u>	<u>4252</u>	<u>1:1.58</u>

The total number of loggerhead false crawls was 2425, yielding a false crawl to nest ratio of 1:1.60 (Table 1). There were 264 green turtle false crawls, equalling a false crawl to nest ratio of 1:1.38.

The greatest concentration of nesting occurred in the South District (Table 2). Sixty-one percent (2593) of the nests or a density of 216.1 nests per mile was noted on the southern 12 miles of beach compared to 39 percent (1659) or a density of 147.5 nests per mile for the northern 11.25 miles of beach. Seventy-two percent (261) of the 364 green sea turtle nests were deposited in the South District and 28 percent (103) in the North District.

Table 2. Nesting and False Crawls in the North and South Districts - Canaveral National Seashore - 1994.

	South	North	Total
Grids	<u>45 - 94</u>	<u>0 - 44</u>	<u> </u>
Loggerhead			
Nests	2331 (60%)	1555 (40%)	3886
Nest Density	194.25/mi	138.2/mi	167.1/mi
False Crawls	1540	885	2425
FC Density	128.3/mi	78.7	104.3/mi
Green			
Nests	261 (72%)	103 (28%)	364
Nest Density	21.75/mi	9.2/mi	15.7/mi
False Crawls	175	89	264
FC Density	14.6/mi	7.9/mi	11.5/mi
Leatherback			
Nests	1	1	2
False Crawls	0	0	0
All Species			
Nests	2593 (61%)	1659 (39%)	4252
Nest Density	216.1/mi	147.5/mi	182.9/mi
False Crawls	1715	974	2689
FC Density	142.9/mi	86.8/mi	115.7/mi
DEP Nests	322 (40%)	475 (60%)	797
DEP Incid	412 (39%)	632 (61%)	1044

FC Density = False Crawl Density
 DEP Nests = Depredated Nests
 DEP Incid = Total Incidences of Depredation

The two leatherback nests were located in grids 43 and 50, 2 miles apart. Deposited on May 28 and June 6, they may represent the actions of a single individual.

Grid 33 of the North District had the greatest number of nests with 97 (CANA files). Five grids had between 80 and 89 nests - grids 48, 51, 52, 56 and 89. Four grids had between 70 and 79 nests - grids 20, 50, 54 and 81. As can be seen, an area of high nest concentration occurred about midway in the park, between grids 48 and 56, where six of the nine grids had 70 or more nests. The fewest number of nests were recorded in grids 6 through 9 and 11 with totals ranging from 18 to 22.

The highest density of false crawls also occurred in the South District (Table 2). Of the 16 grids exhibiting 40 or more false crawls, 14 were located in the South District (Table 3). Grids 33 and 28, contained the highest number of false crawls in the North District, with 40 false crawls apiece. When false crawl to nest ratio is calculated, grids 62 and 69 had the highest ratio with one false crawl per every 0.95 and 0.98 nests, respectively (Table 3). Grid 28 exhibited the lowest value with one false crawl per every 2.43 nests.

Table 3. Grids Exhibiting 40 or more False Crawls
 Canaveral National Seashore - 1994.

<u>Grid</u>	<u>False Crawls</u>	<u>Nests</u>	<u>FC to Nest Ratio</u>
85	58	59	1:1.02
52	57	85	1.49
86	48	80	1.67
50	48	70	1.46
54	46	79	1.72
64	46	49	1.07
62	44	42	0.95
84	44	50	1.14
91	44	51	1.16
57	43	67	1.56
69	43	42	0.98
80	42	63	1.50
83	42	53	1.26
60	41	66	1.61
28	40	41	1.03
33	40	97	2.43

Ninety-seven percent (4119) of the nests were undepredated at the time of initial discovery while three percent (133) were either partially or totally depredated (Table 4). Forty-one percent (1723) of the nests were screened. Subsequently four percent (69) of the screened nests and 25 percent (595) of the unscreened nests were impacted (Table 5). Overall impact rate for all nests was 19 percent (797). Eight of the 364 green sea turtle nests were depredated, four initially and four later in the incubation period.

Table 4. Sighting/Treatment Upon Initial Encounter
Canaveral National Seashore - 1994.

I Sighting

	<u>Loggerhead</u>	<u>Green</u>	<u>Leatherback</u>	<u>Total</u>
Unimpacted	3757 (97%)	360 (99%)	2 (100%)	4119 (97%)
Impacted	129 (03%)	4 (01%)	0	133 (03%)
Total	<u>3886</u>	<u>364</u>	<u>2</u>	<u>4252</u>

II Treatment

Screen	1398*(36%)	323#(89%)	2 (100%)	1723 (41%)
Not screen	2488 (64%)	41 (11%)	0	2529 (59%)
Total	<u>3886</u>	<u>364</u>	<u>2</u>	<u>4252</u>

* Includes 33 nests that were partially depredated upon initial discovery, cleaned up and screened.

Includes 2 nests that were partially depredated upon initial discovery, cleaned up and screened.

Table 5. Total Number of Nests Impacted by Raccoons
Canaveral National Seashore - 1994.

	<u>Loggerhead</u>	<u>Green</u>	<u>Leatherback</u>	<u>Total</u>
Initial Impact*	129 (03%)	4 (01%)	0	133 (03%)
Subsequent Impact				
Screened#	67 (05%)	2 (>01%)	0	69 (04%)
Unscreened+	593 (25%)	2 (05%)	0	595 (25%)
Overall Total@	<u>789 (20.3%)</u>	<u>8 (02%)</u>	<u>0</u>	<u>797 (19%)</u>

* Percentages based on 3886 loggerhead, 364 green and 2 leatherback nests (See Table 4).

Numbers includes six loggerhead and one green turtle nest that were partially depredated, cleaned up and screened. Percentages based on 1398 loggerhead and 323 green nests (See Table 4).

+ Numbers include 22 loggerhead and one green turtle nest that were partially depredated, cleaned up and screened. Percentages based on 2359 loggerhead and 37 green nests - the 129 loggerhead and 4 green nests impacted on initial discovery were subtracted from 2488 and 41 listed in Table 4, respectively.

@ Numbers include 28 loggerhead and two green turtle nests that were partially depredated, cleaned up and screened.

A total of 1044 incidences of depredation, involving 797 nests occurred in 1994 (Table 2). Of these, 632 (61 percent) occurred in the North District and 412 (39%) in the South District.

Grids exhibiting the highest depredation rates were grids 33, 13 and 34 with 68, 46 and 41 depredations respectively (Table 6). Ten additional grids in the North District exceeded 20 depredations while only five grids in the South District had 20 or more. Of the 797 depredated nests, 192 (173 unscreened and 19 screened) were depredated more than one time (CANA files).

Table 6. Grids Exhibiting 20 or More Depredations or High Tunnelling Activity - Canaveral National Seashore.

<u>Grid</u>	<u>Depredation Events</u>	<u>Grid</u>	<u>Tunnelling Events</u>
33	68	17	9
13	46	18	5
34	41	22	4
23	32	37	4
28	31	93	4
35	28	14	3
40	28	21	3
32	23	23	3
81	22	36	3
91	22	39	3
18	21	58	3
20	21	83	3
27	21	87	3
22	20	92	3
26	20	20	2
52	20	68	2
78	20	73	2
93	20	84	2
		89	2
		91	2

Sixty-nine nests were impacted by tunnelling (burrowing under the screens to reach the egg cavity) (Table 5). This behavior was widely scattered over the beach at low frequencies (0-4 incidents per grid) with the highest incidents of 9 and 5 occurring in grids 17 and 18 respectively (Table 6 and CANA files). No instances of tunnelling were observed between grids 40 - 57, a length of four and one-half miles.

To determine the effectiveness of each nest protection strategy, raccoon depredation was calculated in each treatment area of the four replicate blocks (Table 7). Depredation was lowest in the nest screening area of three of the four blocks. The removal area of Block II (Grids 26-35) exhibited the highest depredation rate of 51 percent while the lowest percentage of nests (04%) were impacted in the nest screening area (Grids 42-47) of the same block. In Blocks I and III, the nest screening plus CTA areas exhibited the highest amount of depredation while the removal areas were second and the nest screening areas third. In Block IV, depredation was highest in the nest screening area, second highest in the removal area and lowest in the screening plus CTA area.

Additional results and analysis of the protection strategies will be presented by UGA in its final report.

Table 7. Impacted Nests by Block and Treatment Area
Canaveral National Seashore - 1994.

Block I	<u>Removal</u>	<u>Screen</u>	<u>Screen + CTA</u>
Grids	4 - 13	14 - 19	20 - 25
S	16	130 (+2)*	134 (+16)*
U	248	72	99
Total N	<u>264</u>	<u>202</u>	<u>233</u>
SI	0/16 (00%)	11/132* (08%)	16/150* (11%)
UI	68/248 (27%)	36/72 (50%)	57/99 (58%)
Total I	<u>68/264 (26%)</u>	<u>47/202 (23%)</u>	<u>73/233 (31%)</u>

Block II	<u>Removal</u>	<u>Screen + CTA</u>	<u>Screen</u>
Grids	26 - 35	36 - 41	42 - 47
S	27	180 (+11)*	213
U	407	117	92
Total N	<u>434</u>	<u>297</u>	<u>305</u>
SI	1/27 (04%)	6/191* (03%)	1/213 (>01%)
UI	218/407 (54%)	61/117 (52%)	10/92 (11%)
Total I	<u>219/434 (51%)</u>	<u>67/297 (23%)</u>	<u>11/305 (04%)</u>

Table 7 (continued).

Block III	<u>Removal</u>	<u>Screen</u>	<u>Screen + CTA</u>
Grids	48 - 57	58 - 63	64 - 69
Screened	79	185 (+5)*	144
Unscreened	573	98	91
Total N	<u>652</u>	<u>283</u>	<u>235</u>
SI	0/79 (00%)	8/190* (04%)	6/144 (04%)
UI	75/573 (13%)	17/98 (17%)	32/91 (35%)
Total I	<u>75/652 (12%)</u>	<u>25/283 (09%)</u>	<u>38/235 (16%)</u>

Block IV	<u>Removal</u>	<u>Screen + CTA</u>	<u>Screen</u>
Grids	71 - 81	82 - 87	88 - 93
Screened	32	213	197 (+1)*
Unscreened	460	137	133
Total N	<u>492</u>	<u>350</u>	<u>330</u>
SI	2/32 (06%)	9/213 (04%)	16/198* (08%)
UI	73/460 (16%)	35/137 (26%)	42/133 (31%)
Total I	<u>75/492 (15%)</u>	<u>44/350 (13%)</u>	<u>58/330 (18%)</u>

S = Screened Nests

U = Unscreened Nests

Total N = Total Nests Deposited

SI = Screened Nests Impacted

UI = Unscreened Nests Impacted

Total I = Total Nests Impacted

* Number in parentheses are nests that were partially depredated prior to initial discovery, cleaned up and screened. They were included in the category of unscreened nests impacted prior to screening and in the category of screened nests after treatment.

A total of 392 loggerhead nests were marked for excavation (Table 8). Of these, 158 were screened and 234 were unscreened. Thirteen percent (50) of the marked nests were totally depredated, three percent (10) were inundated or eroded and nine percent (33) were of unknown fate. Altogether 295 or seven percent of the total number of loggerhead nests were excavated. Mean clutch size was 108.9 eggs and the hatching rate was 83 percent.

Table 8. Hatching Success - Canaveral National Seashore - 1994.

	<u>Loggerhead</u>	<u>Green</u>	<u>Leatherback</u>
Marked Nests	392	24	
Nests Excavated	295	20	1
Total Eggs	32,151	2528	96
Average Clutch Size	108.9	129.25	96
Hatched	26,714	2105	77
Hatching Success	83%	81%	80%
Nests Destroyed	50	0	0
Nests Not Relocated	33	3	
Inundated/Eroded	12	1	
Est. Overall Success*	71%	---	---

* (# of destroyed nests) (Average clutch size) added to total number of eggs i.e. $(50)(108.9) = 5445 + 32,151 = 37,596$

Adding the average clutch size for the 50 destroyed nests to the total of unhatched eggs lowered the loggerhead hatching success to an estimated 71 percent (Table 8). Marked screened nests had an estimated hatching success of 77 percent versus 66 percent for the unscreened nests (Table 9).

Table 9. Screened Versus Unscreened Loggerhead Nests
Canaveral National Seashore - 1994.

	<u>Screened</u>	<u>Unscreened</u>
Nests Excavated	139	156
Total eggs	15,007	17,144
Average Clutch Size	108.0	109.9
Hatched	12,497	14,217
Hatching Success	83.3%	82.9%
Nests Destroyed	10	40
Inundated/Eroded	6	4
Nest Not Relocated	9	24
Est. Overall Success*	77%	66%

* (# of destroyed nests)(Average clutch size) added to total number of eggs:

For screened nests = $(10)(108) = 1080 + 15,007 = 16,087$

For unscreened nests = $(40)(109.9) = 4396 + 17,144 = 21,540$

A total of 20 green sea turtle nests (05 percent of the total) were excavated with an average clutch size of 129.25 and a hatching success of 81 percent (Table 8). Three other marked nests could not be located and one was inundated. One of the two leatherback nests was excavated with a clutch size of 96 eggs (Table 8).

The estimated number of loggerhead sea turtle hatchlings produced at CANA was determined as follows:

(71 percent hatching success)(108.9 eggs/clutch)(3886 nests) = 300,462 hatchlings.

For the green sea turtle, the estimate was as follows:

(81 percent hatching success)(129.25 eggs/clutch)(364 nests) = 38,108 hatchlings.

DISCUSSION

The total of 4252 nests at CANA in 1994 was the most recorded since park personnel began monitoring in 1984 (Table 8). Loggerhead totals were slightly lower than in 1990 and 1991; however, the green sea turtle exceeded its previous high of 298 nests in 1992 by 22 percent. The two leatherback nests were the most recorded in a single year since three were observed in 1986.

Table 10. Sea Turtle Nesting at Canaveral National Seashore
1984-1994.

<u>Year</u>	<u>Loggerhead</u>	<u>Green</u>	<u>Leatherback</u>	<u>Unknown</u>	<u>Total</u>
1994	3886	364	2		4252
1993	3140	28	0		3168
1992	3279	298	0		3577
1991	4074	25	1		4100
1990	3922	185	1		4108
1989	3091	41	1		3133
1988	2203	43	0	4	2250
1987	1670	90	1	15	1776
1986	3349	22	3		3374
1985	2389	94	0	25	2508
1984	(Individual breakdown not available)				2125

(From Bryant 1986a, 1986b, 1987 and 1988 and Stiner 1990, 1991a, 1991b, 1993 and 1994)

Several patterns remained the same from previous years. The greatest concentration of nests (61 percent) was in the South District and the highest depredation rate was in the North (Table 2). Grid 33 again had one of the highest nest totals; in 1994 it ranked first (Table 3) and in 1993 it ranked third out of 94 grids (Stiner 1994). For the ninth time in eleven years the number of nests again exceeded false crawls (Table 11).

The loggerhead false crawl to nest ratio was 1:1.60, the greatest differential recorded to date (Table 11). The green sea turtle ratio was 1:1.38, the third highest ratio over the last 10 years. Between 1984 and 1994, false crawls have outnumbered nests only twice for each species - 1986 and 1988 for the loggerhead and 1986 and 1987 for the green.

Table 11. False Crawl to Nest Ratio at Canaveral National Seashore
1984-1994.

<u>Year</u>	<u>Loggerhead</u>	<u>Green</u>	<u>Average</u>
1994	1:1.60	1:1.38	1:1.58
1993	1:1.46	1:1.87	1:1.46
1992	1:1.43	1:1.10	1:1.39
1991	1:1.10	1:1.66	1:1.10
1990	1:1.31	1:1.17	1:1.30
1989	1:1.53	1:3.00	1:1.55
1988	1:0.94	1:1.16	1:0.94
1987	1:1.02	1:0.72	1:1.015
1986	1:0.98	1:0.76	1:0.97
1985	1:1.22	1:1.02	1:1.20
1984	--	--	1:1.24

(From Bryant 1986a, 1986b, 1987 and 1988 and Stiner 1990, 1991a, 1991b, 1993 and 1994)

Overall nest depredation dropped from 29 percent in 1993 (Stiner 1994) to 19 percent in 1994 (Table 5). One factor may be a decline in the raccoon population. During 1994, fewer road-killed raccoons were observed and both MINWR and UGA experienced lower trapping success than the previous year (Meyers 1994 and Ratnaswamy 1994, pers. comm.). A number of sick and scrawny raccoons were noted by both MINWR and UGA staff, suggesting at least a minor outbreak of distemper or other disease. The impact of two years of selected trapping by UGA may also have been an influence. Whether the raccoon population responds with an increase in reproductive rate over the next several years remains to be seen.

During the 1994 season, the lowest depredation rates were observed in the nest screening areas of three blocks and the removal area of a fourth (Table 7). In comparison, the previous year depredation was least in the nest screening areas of two blocks, the removal area of another and virtually identical for the nest screening and nest screening plus CTA areas of a fourth (Stiner 1994).

During the 1993 and 1994 seasons, nest screening proved to be an effective deterrent to nest depredation which also allowed the raccoon to remain as an important component of the seashore ecosystem. However, screening is labor-intensive and costly and may be difficult to maintain in an era of budgetary reductions.

Why the CTA treatment was not more successful is unknown. Possibly, rather than serve to deter depredation, it may encourage raccoons to search for eggs along the beach. It did appear that some individuals developed an aversion to ingesting eggs (Ratnaswamy 1994, pers. comm.) but overall it did not translate into a reduction of nest depredation. The final report by UGA will discuss the above phenomena in more depth.

The amount of tunnelling dropped from 7.6 percent in 1993 to 4.3 percent in 1994, the same amount recorded in 1992 (Table 12). Tunnelling was absent or rare on certain sections of the beach and tended to be clumped on others. This reinforces the idea that tunnelling is a learned behavior exhibited by certain individuals. The greatest number of incidents occurred in grid 17 with nine and grid 18 with five (Table 6). Tunnelling increased dramatically in grids 87-93 with 15 in 1994 compared to only two incidents in 1993. In contrast, tunnelling incidents in grids 60-69 dropped from 37 in 1993 to five in 1994. Home range data from the UGA study may identify particular individuals with areas of high tunnelling activity.

Table 12. Number of Screened Sea Turtle Nests and Depredation Rate
Canaveral National Seashore - 1984 -1994.

<u>Year</u>	<u>Number of Nests</u>	<u>Number of Nests Screened</u>	<u>Screened Nests Depredated (%)</u>
1994	4252	1724 (41%)	4.3
1993	3168	1221 (39%)	7.6
1992	3579	2213 (62%)	4.3
1991	4100	1507 (37%)	3.3
1990	4108	1547 (38%)	1.9
1989	3132	1030 (33%)	3.4
1988	2250	887 (39%)	18.7
1987	1776	766 (43%)	7.2
1986	3374	1517 (45%)	3.7
1985	2508	1023 (41%)	5.0
1984	2125	213 (19%)	---

* 93% were screened in the North District
() = Percent of column total

In 1994, a major change was made in the way depredation data was interpreted. In prior years, an attempt was made to designate nests as partially or totally depredated. Originally, if 20 or more eggs were destroyed, the nest was considered totally depredated. However, it was noted that a number of these nests produced hatchlings. That raised the difficult question of exactly when a nest should be considered completely depredated - 20 eggs, 50 eggs, half of the clutch? After consultation with sea turtle biologists from several agencies, it was determined that nests should simply be called depredated or impacted, without trying to assign total or partial depredation. This combined figure could be compared from year to year to determine amount of raccoon depredation and effectiveness of nest protection efforts.

Hatching success, the other important figure for management purposes, will be determined by tracking 10 percent of the nests through the incubation period. If any of these are partially or totally depredated, the damaged eggs will be counted, placed in a bag and removed from the beach. After 70 days these nests will be excavated and all hatched and unhatched eggs counted. Eggs previously recorded as depredated will be added to the unhatched total giving an accurate estimate of hatching success.

Conclusion

CANA is nearing a crossroads in its sea turtle nest protection program. Field work for a two year study by UGA on raccoon biology and sea turtle nest protection has been completed. A final report is due in the fall of 1995. It will include important information on CANA's raccoon population and recommendations on viable ways to protect sea turtle nests. At that time, it is hoped that CANA can implement a long term program to protect both sea turtles and the natural ecosystem, of which the raccoon is an important part. In the interim, CANA will screen all undepredated nests during the 1995 season.

In order to conduct the study on alternative nest protection strategies, it was necessary to leave a significant percentage of the nests unscreened. Together UGA and CANA were able to do this while restricting depredation to 29 percent in 1993 and 19 percent in 1994. This was a credit to the field personnel of both agencies who worked hard to coordinate efforts and seek a solution to this difficult problem.

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