

1997 MARINE TURTLE NESTING SUMMARY CANAVERAL NATIONAL SEASHORE

INTRODUCTION

Canaveral National Seashore is an important nesting area for several species of threatened and endangered sea turtles. These are primarily the loggerhead (Carretta caretta), with a lesser number of green (Chelonia mydas) and an occasional leatherback (Dermochelys coriacea). Nest depredation, primarily by raccoons, is a serious threat, with depredation rates exceeding 90 percent in the early 1980's. In 1984, the park implemented a nest screening program to protect nests while allowing the raccoon to remain as an integral part of the seashore ecosystem. In 1993 and 1994, the University of Georgia compared three methods of nest protection, screening, predator removal and conditioned-taste-aversion (Ratnaswamy 1995; Warren 1996). They found screening to be most effective and compatible with National Park Service guidelines and objectives.

1997 was the fourteenth year for Canaveral National Seashore's sea turtle nest protection program. Since 1995, park staff has managed to screen over 90 percent of the several thousand nests deposited each year, reducing nest depredation to less than 30 percent. The park's goal is to achieve the 60 percent hatching rate targeted in the loggerhead and green sea turtle recovery plans (NMFS and USFWS 1991) without removing predators from their important role in the barrier island ecosystem.

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 18.1 kilometers (11.25 miles) of beach is situated in Volusia County and the southern 20.2 kilometers (12.5 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 was divided into 94 quarter-mile long grids by placing numbered four by four posts along the dune line. These grids provide a reference point for documenting nest locations.

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 6, the park initiated patrols on four-wheeled all-terrain vehicles (ATV's) to record sea turtle emergencies (nests and false crawls) and to screen nests. The 24 miles of beach was divided into two 12 mile segments, each covered by a team consisting of a ranger and a volunteer. The teams worked from 11:00 p.m. to 7:00 a.m. seven nights a week. In addition, daytime patrols were conducted at least three times a week to document any subsequent depredations to recorded nests. On August 05, patrols were switched to 4:00 a.m. to noon, due to a decrease in nesting and to enhance nest excavation activities.

Initial data collected for each nest included: date, nest number, species, grid, number of eggs depredated and sighting/treatment. Sighting/treatment referred to the condition of the nest upon discovery (undepredated, partially depredated or totally depredated) and the subsequent treatment (nest screened or left unscreened). Each nest was marked with a numbered stake for later identification. Date and grid location of each false crawl was also recorded.

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 form a 70 degree angle. The 2 inches x 4 inches mesh size was large enough to allow hatchlings to emerge while discouraging attempts by predators 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 daytime patrols, all new nest depredations were recorded, the number of depredated eggs counted and all broken eggs removed from the beach. The latter was done to deter predators from easily relocating any remaining eggs and to prevent counting depredations more than once. If a significant number of viable eggs remained, broken eggs were removed and the nest was re-covered with clean sand.

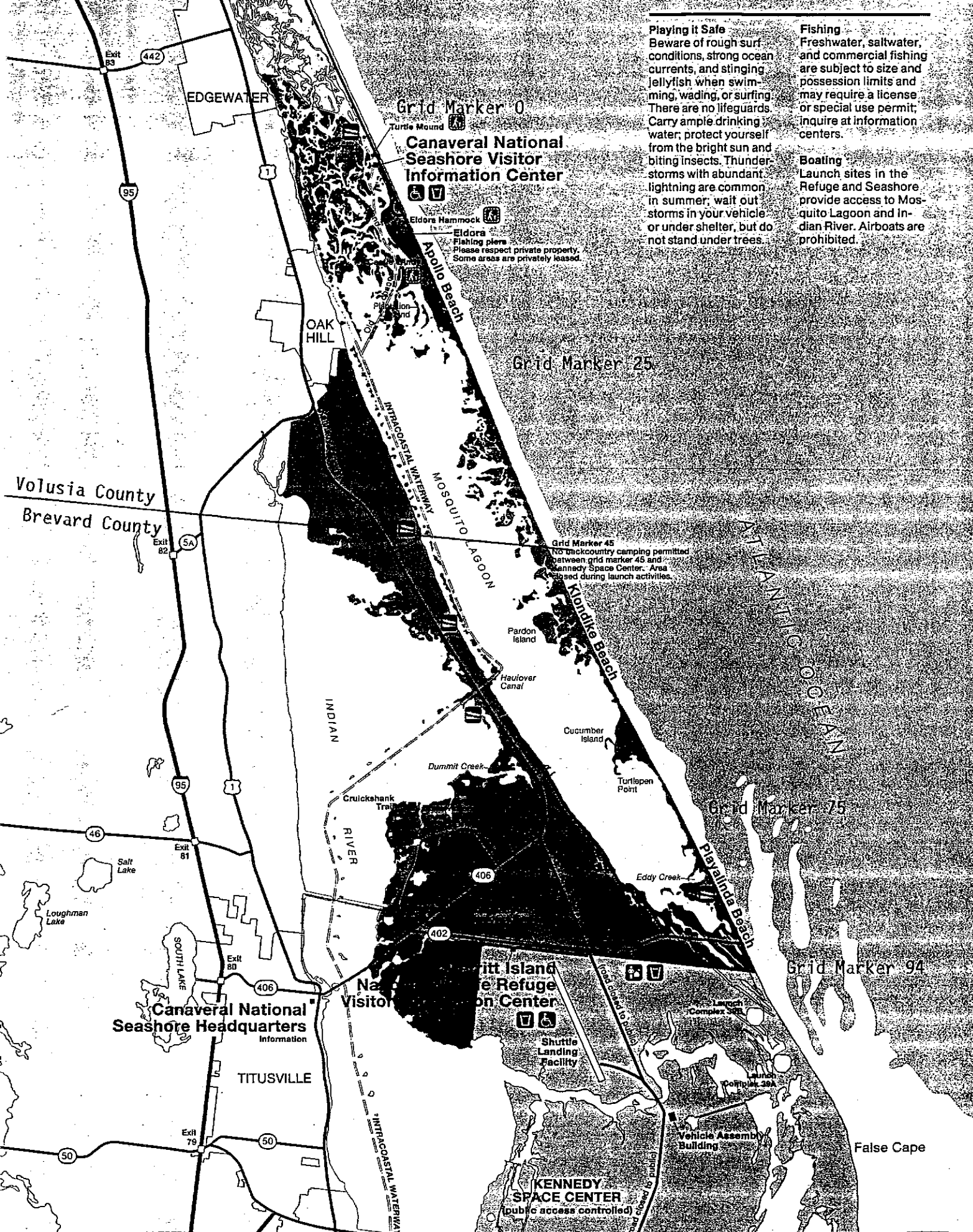


Figure 1. Canaveral National Seashore

The stake for every tenth nest was marked with white spray paint for each identification. After a minimum of 70 days, or 3 days after evidence of hatching, the nests were excavated and the following information recorded: number of hatchlings emerged (empty eggshells), number of unhatched eggs, number of live hatchlings in nest, number of dead hatchlings in nest and number of pipped eggs (hatchling still partially in eggshell). Depredated eggs recorded during daytime runs were added to the total of unhatched eggs prior to analysis. This data was then used to calculate average hatching success for the entire beach.

A small number of nests (9) were relocated for one of three reasons: 1) the nest was located at the base of a heavily traveled boardwalk; 2) the nest cavity and eggs had been fouled by the contents of broken eggs; 3) the nest was in imminent danger of erosion. Pits approximating the natural nest cavity were dug near the base of the dune. The eggs were then carefully transferred, buried and screened in the usual manner.

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

RESULTS

Nesting and False Crawl Totals

A total of 2727 sea turtle nests were deposited at CANA in 1997 - 2702 loggerhead, 21 green and four leatherback (Table 1). Overall nest density was 70.5 per kilometer for the loggerhead and 0.6 per kilometer for the green.

The total number of loggerhead false crawls was 2272 or 59.3 per kilometer, a false crawl to nest ratio of 1:1.2 (Table 1). There were 29 green false crawls or 0.8 per kilometer, a false crawl to nest ratio of 1:0.7.

As in former years, the greatest concentration of nesting was noted in the southern half of CANA with 66% (1812) of the nests occurring in the South District (Brevard County) and 34% (915) in the North District (Volusia County) (Table 1). Nesting densities were 89.7/km and 50.6/km respectively. Figures 2a and 2b show the number of nests and false crawls by individual grids for the entire beach.

Initial Sighting and Nests Screened

In 1997, 92 percent (2507) of the 2727 nests deposited at CANA were screened, comprising 2114 undepredated and 393 partially depredated nests (Table 2, Initial Encounter). This included four leatherback, 21 green and 2482 loggerhead nests.

Eight percent (217) of the loggerhead nests were totally depredated and 14 percent (390) were partially depredated prior to discovery (Table 2, Initial Encounter).

Of the 21 green sea turtle nests, none were totally depredated and three (14%) were partially depredated prior to discovery (Table 2, Initial Encounter). None of the four leatherback nests were depredated.

Table 1: 1997 Marine Turtle Crawl Survey

Overall

	Loggerhead	Green	Leatherback	Total
Nests	2702	21	4	2727
False Crawls	2272	29	0	2301
Nest Density (nest/km)	70.55	0.55	0.10	71.20
FC Density (FC/km)	59.32	0.76	n/a	60.08
FC to Nest Ratio	1:1.19	1:0.75	n/a	1:1.19

Distribution by District

North District (Volusia county)

	Loggerhead	Green	Leatherback	Total
Nests	906	8	1	915
False Crawls	843	15	0	858
Nest Density (nest/km)	50.06	0.44	0.06	50.55
FC Density (FC/km)	46.57	0.83	n/a	47.40
FC to Nest Ratio	1:1.10	1:0.53	n/a	1:1.07

South District (Brevard County)

	Loggerhead	Green	Leatherback	Total
Nests	1796	13	3	1812
False Crawls	1429	14	0	1443
Nest Density (nest/km)	88.91	0.64	0.15	89.70
FC Density (FC/km)	70.74	0.69	n/a	71.40
FC to Nest Ratio	1:1.26	1:0.93	n/a	1:1.26

Figure 2a. Nests, False Crawls, Depredations, and Tunneling Activity.
Grids 45 - 94 (South District) - 1997.

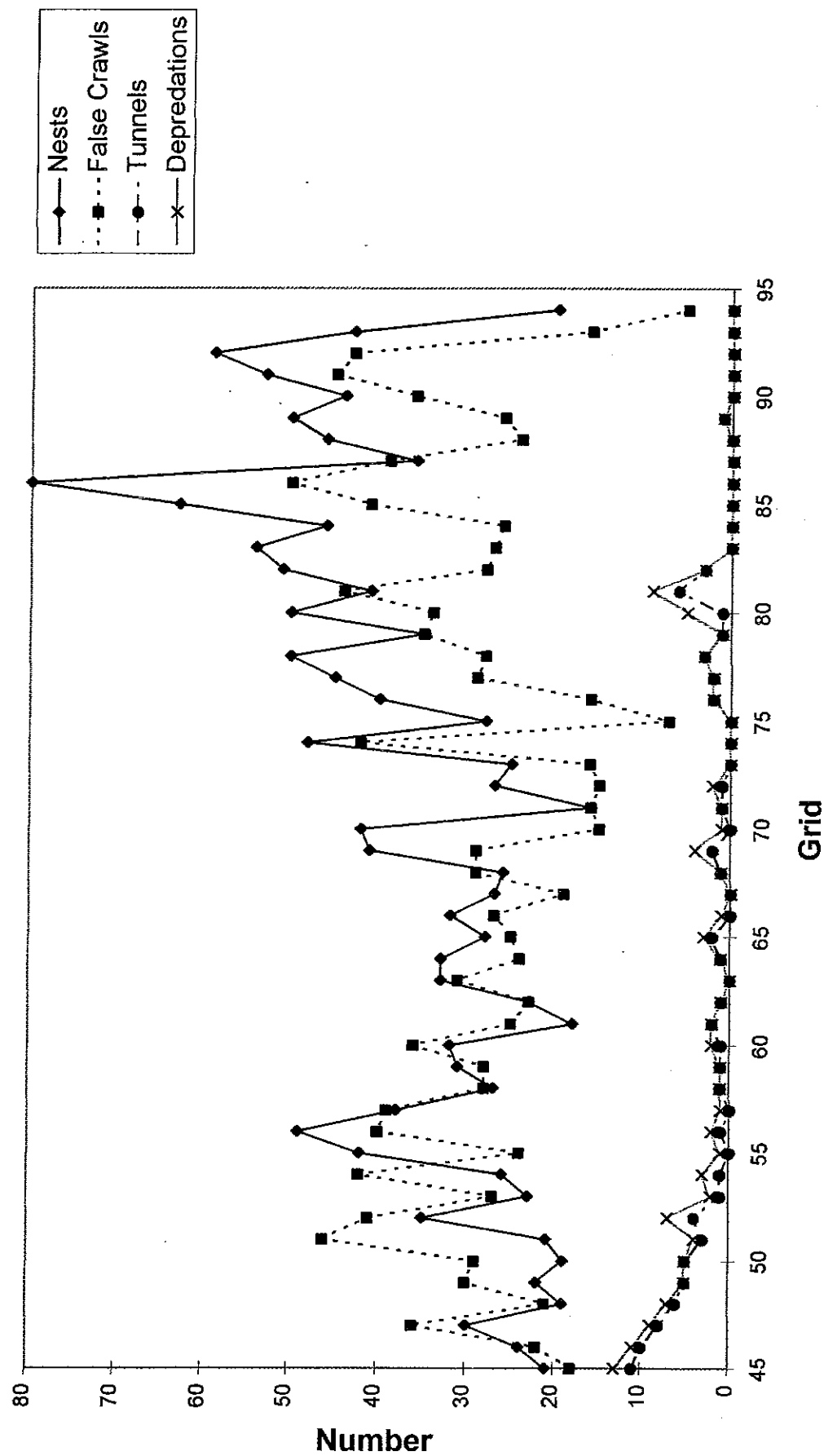


Figure 2b. Nests, False Crawls, Depredations, and Tunneling Activity.
Grids 0 - 44 (North District) - 1997.

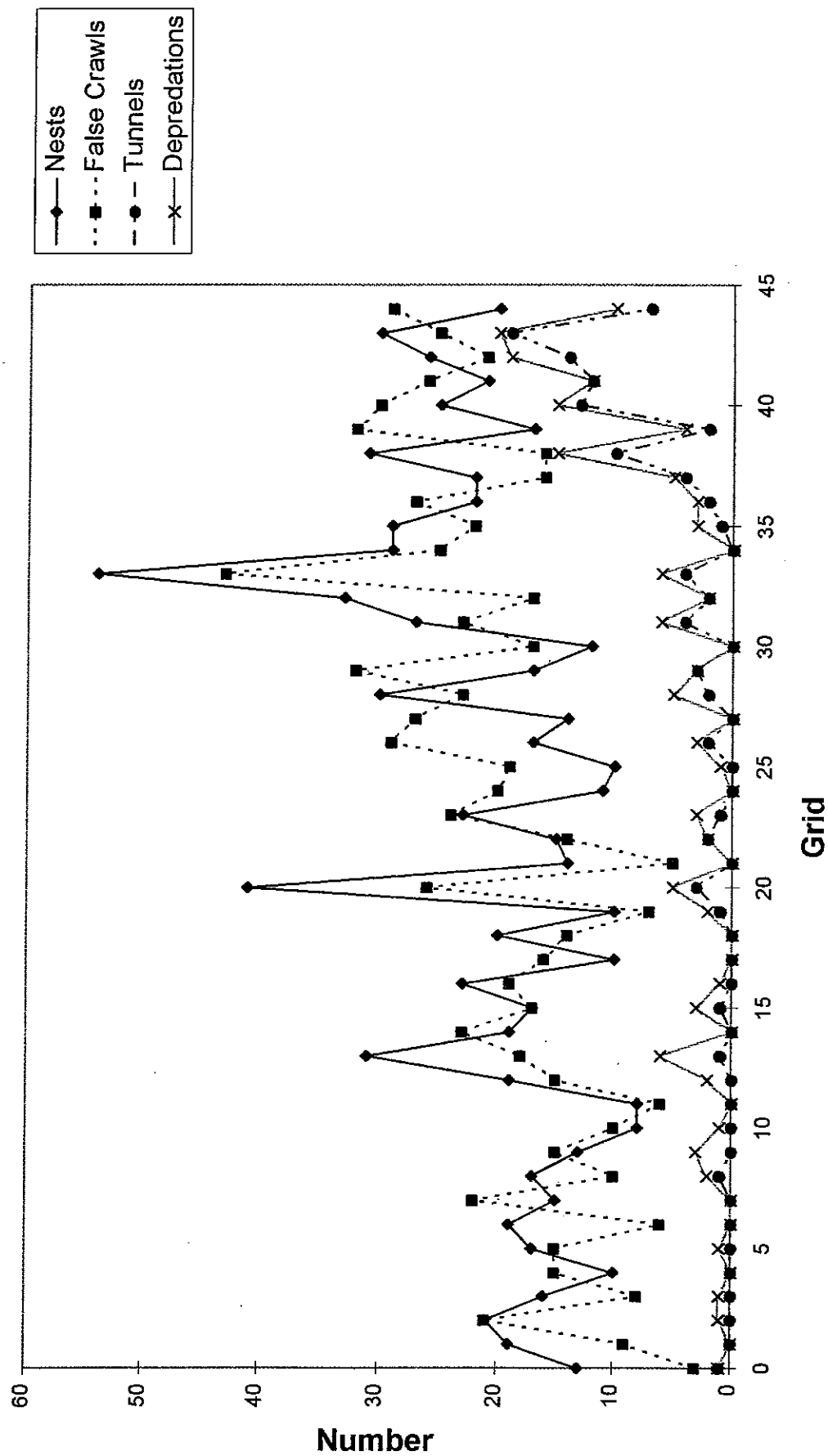


Table 2. 1997 Nest Treatment and Depredation

Initial Encounter

	Loggerhead	Green	Leatherback	Total
Not Dep/Screened	2092 (77%)	18 (86%)	4 (100%)	2114 (78%)
Park Dep/Screened	390 (14%)	3 (14%)	0	393 (14%)
Total Depredation	217 (08%)	0	0	217 (08%)
Not Dep/Not Screened	3 (<1%)	0	0	3(<1%)
Part Dep/Not Screened	0	0	0	0
TOTAL	2702	21	4	2727

Part=Partial Dep=Depredation

Subsequent Depredation

Screened Nests

North District	108	1	0	109 (13%)
South District	131	0	0	131 (08%)
Total	239	1	0	240 (10%)

All Nests

Partial Depredation	479	3	0	482(18%)
Total Depredation	334	0	0	334 (12%)
Total	813	3	0	816 (30%)

Subsequent Depredations

Ten percent (240) of the screened nests were depredated by predators that had learned to tunnel underneath the screens (Table 2, Subsequent Depredation). Tunneling was higher in the North District, with 13 percent (109) of the screened nests being depredated versus eight percent (131) in the South District.

Only 18 nests were recorded as being depredated more than once (CANA files). This indicates that the effort to clean up and screen partially depredated nests does protect remaining eggs and if the clutch has not been fouled too badly by broken eggs may allow some to hatch.

Overall, including both initial and subsequent depredations, 813 (30%) of the loggerhead and three (14%) of the green nests were either partially or totally depredated during the 1996 season (Table 2, Overall Depredation). Specifically, 12 percent (334) of the loggerhead nests were totally depredated and 18 percent (479) were partially depredated. The three green nest depredations were all partial.

As in past years, the highest percentage of depredations occurred in the North District, where 35% (318) of the nests were depredation, compared to 27% (498) in the South District (Table 2, Overall Depredation).

A total of 59 problem raccoons were removed from the beach during the nesting season.

Monitored Nests

Every tenth nest was marked excavation after the incubation period to determine hatching success. Of the 259 marked loggerhead nests, 218 (eight percent of the total number deposited) were excavated (Table 3). Thirty six percent (30) of the marked loggerhead nests were depredated (12 percent partially and 24 percent totally).

Average clutch size for the 218 excavated loggerhead nests was 103.2 eggs/clutch (Table 3). Hatching success for the total number of eggs counted (including depredated eggs) was 55.2 percent.

Table 3. HATCHING SUCCESS OF MARKED NESTS

	Loggerhead	Green	Leatherback
Nests marked	259	21	4
Nests Excavated	218	19	4
Total Eggs	22,495	1936	252
Ave. Clutch Size	103.2	101.9	63
Hatchlings Emerged	12,428	1005	58
Hatching Success	55%	51.2%	23.0%
Nests Partially Dep.	61 (24%)	4(19%)	0
Nests Destroyed	30 (12%)	0	0
Unknown Fate	13 (05%)	1(07%)	0

Dep = Depredated

Nineteen of the 21 green sea turtle nests marked for excavation were evaluated; the remaining two were of unknown fate (Table 3). Four of the 19 nests were partially depredated. Average clutch size for the excavated nests was 100.2 eggs and hatching success was 51.2 percent.

All four of the leatherback nests were excavated. Clutch sizes were 62, 75, 53 and 65 eggs, with an average of 63.0 eggs/clutch (Table 3.) Of the 252 eggs laid, 58 hatched for a hatching success of 23.0 percent. None of the leatherback nests were depredated.

An estimated number of loggerhead hatchlings was calculated, based on the hatching success of marked nests. This was done as follows:

$(55.2\% \text{ hatchling success}) \times (103.2 \text{ eggs/clutch}) \times (2702 \text{ nests}) = 153,923 \text{ hatchlings.}$

For the green sea turtle, an estimated number of hatchlings was calculated as follows:

$(51.2\% \text{ hatchling success}) \times (100.2 \text{ eggs/clutch}) \times (21 \text{ nests}) = 1,077 \text{ hatchlings.}$

DISCUSSION

Nesting and False Crawl Totals

In 1997, overall and loggerhead nesting totals declined at CANA for the second straight year (Table 4.) The total of 2727 nests was the lowest observed since 1987, when 1776 nests were recorded, and third lowest since record keeping began in 1984. Green sea turtle nesting activity dropped over 90 percent from 222 in 1996 to 21 in 1997. This continued the pattern of an increase in green turtle nest numbers one year and a decrease the next, exhibited every year except one (1989) since 1985 (Figure 3). If the pattern holds, green nesting activity should increase significantly in 1998.

The nesting pattern for loggerheads is less clearly defined; however, nest numbers have not decreased at CANA more than two years in a row since record keeping began in 1984 (Figure 4). This would indicate that an increase in loggerhead nesting activity is probable in 1998.

The four leatherback nests recorded in 1997 were the most observed since the program began (Table 4). In 1996 and 1986, three leatherback nests were recorded. At least one leatherback nest has been reported in nine of the last 13 years.

The false crawl to nest ratio for the loggerhead dropped from 1:1.32 in 1996 to 1:1.19 in 1997. Although lower than the previous year, the number of nests exceeded false crawls for the eleventh time in 13 years (Table 5). The green sea turtle false crawl to nest ratio of 1:0.72 was slightly less than the prior year's ratio of 1:0.77. This was the fourth time since 1985 that green false crawls exceeded nests. All four leatherback crawls resulted in egg deposition.

Table 4. TURTLE NESTING AT CANAVERAL SEASHORE 1984-1997

YEAR	LOGGERHEAD	GREEN	LEATHERBACK	UNKNOWN	TOTAL
1997	2702	21	4		2727
1996	3260	222	3		3485
1995	4121	47	1		4169
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	*				2125

* = Individual breakdown not available.

Taken from yearly Sea Turtle Nesting Summaries, 1984-1997, Canaveral National Seashore, Titusville, Florida.

FIGURE 3
GREEN SEA TURTLE NESTING AT CANAVERAL NATIONAL SEASHORE, 1985-1997

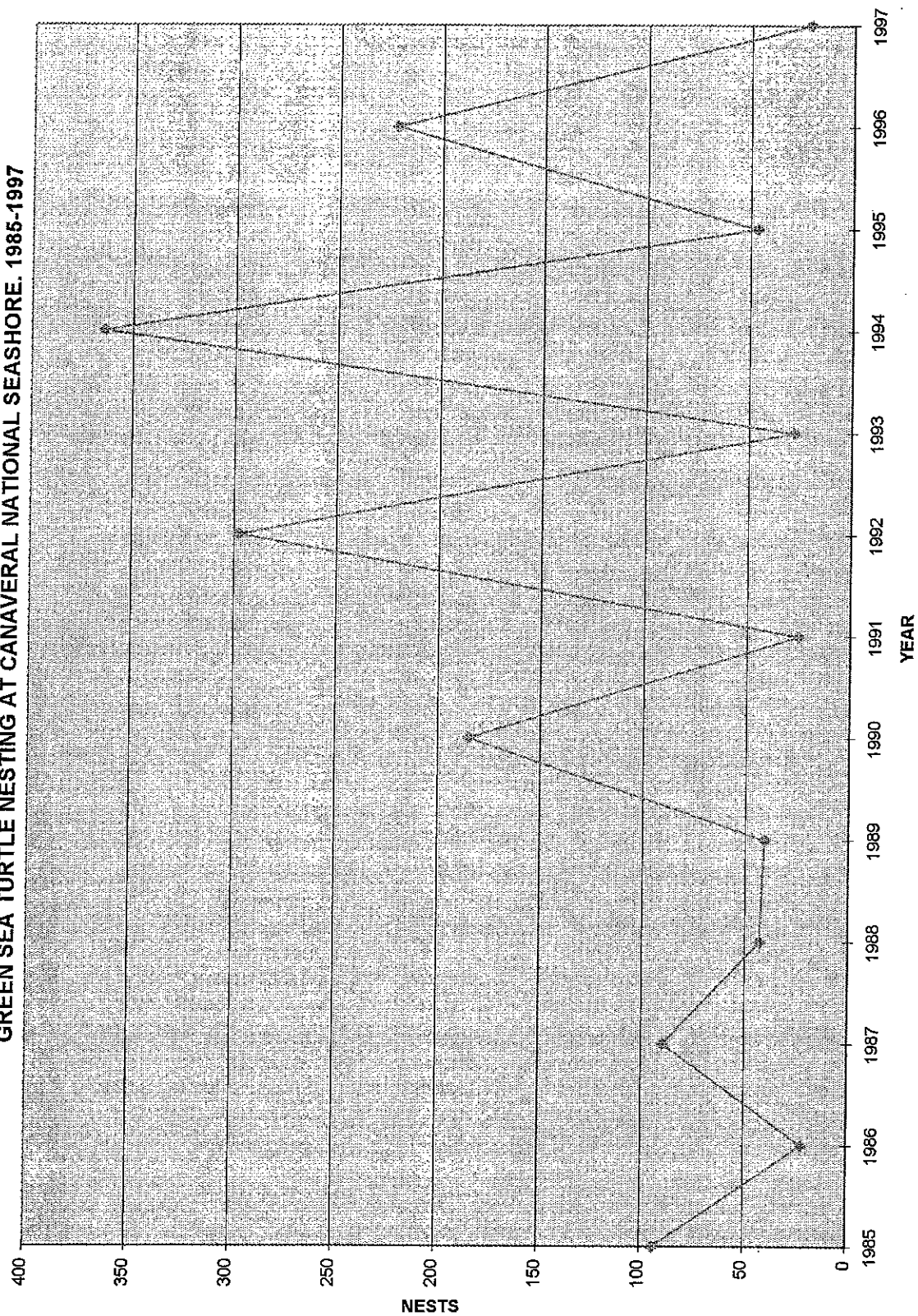


FIGURE 4
LOGGERHEAD SEA TURTLE NESTING AT CANAVERAL NATIONAL SEASHORE. 1985-1997

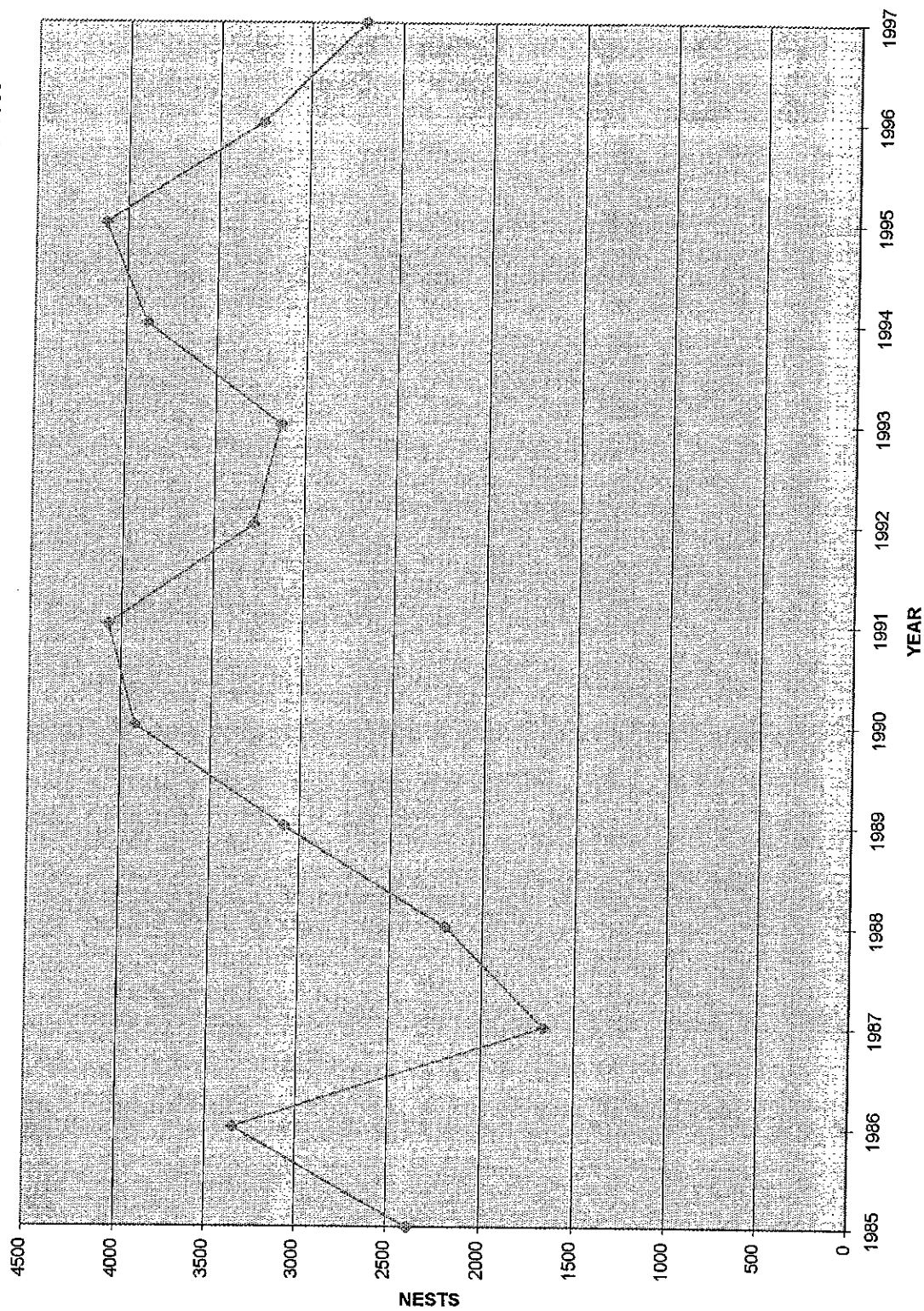


Table 5. False Crawl to Nest Ratio 1984-1997

Year	Loggerhead	Green	Overall
1997	1:1.19	1:0.72	1:1.19
1996	1:1.32	1:0.77	1:1.26
1995	1:1.36	1:1.21	1:1.36
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

Taken from yearly Sea Turtle Nesting Summaries, 1984-1997,
Canaveral National Seashore, Titusville, Florida.

Screening Activity and Nest Depredation

Ninety-two percent (2510) of the sea turtles deposited at CANA in 1997 were screened. This matched the previous year's efforts and was only slightly less than the 95 percent achieved in 1995 (Table 6). However, nest depredation increased significantly from 19.7 percent in 1996 to 29.9 percent in 1997 (Table 6). This was the greatest amount since 1988 when 64.1 percent of the nests were depredated; however, the number was very close to the depredation rate of 28.6 percent recorded in 1993.

Tunneling activity, digging under the screens to reach the eggs, also increased from 5.7 percent in 1996 to 9.6 percent in 1997 (Table 6). This too was the highest value recorded since 1988, when 18.7 percent of the screened nests were depredated.

Several factors may be responsible for the increase in depredation and tunneling noted during the 1997 season. First was an apparent increase in the raccoon population at CANA. Raccoon sightings were noticeably more frequent than in the previous several years, both on the Seashore and the adjacent Merritt Island National Wildlife Refuge (pers comm, CANA and Refuge staff). Kramer (1996) noted that the raccoon appears to breed most months of the year at CANA. This, when combined with the ample food resources of the seashore, absence of natural predators and periods of little disease will encourage periodic surges in the raccoon population at CANA. Natural factors, such as distemper, will eventually return the raccoon population to lower levels.

Another factor influencing nest depredation was beach erosion. Unlike 1995 and 1996, when sand accumulated on the beach over the course of the summer, sand was consistently washed away during the 1997 season. This made the eggs much more accessible to foraging animals, in some cases completely uncovering the clutches.

A third possible factor was the presence of a larger number of "educated" raccoons who had learned to dig up sea turtle nests and particularly to tunnel under screens. Digging and tunneling are learned activities, as evidenced by the lack of nest depredation the year after U.S. Fish and Wildlife Service staff removed raccoons from the southern half of CANA's beach in 1989 (Table 6). Raccoon tracks increased on the beach in the latter half of 1990, as new individuals moved into the trapped area; however, little digging for eggs occurred until the next year (1991).

The amount of tunneling activity varies from year to year. With the exception of 1988, when 18.7 percent of the screened nests were depredated, the yearly number of screened nests depredated has ranged between 1.9 and 9.6 percent (Table 6).

Raccoons are intelligent and adaptable animals. A percentage of individuals will eventually learn to tunnel under the screens. When occasional years of high raccoon population level occur, a corresponding increase in depredation of screened and unscreened nests must be expected. Still, a non-depredation rate of 70 percent or better is a vast improvement over the rates observed prior to implementation of the screening program. Eventually, a food shortage

or diseases, such as distemper, will reduce the raccoon population and the depredation level should decrease.

Table 6. AMOUNT OF SCREENING AND DEPREDACTION OF SCREENED NESTS.

1984 - 1997

YEAR	NESTS	NESTS SCREENED	SCREENED NESTS DEPREDATED (%)	ESTIMATED OVERALL DEPREDACTION (%)
1997	2727	2510(92%)	9.6	29.9
1996	3485	3198 (92%)	5.7	19.7
1995	4169	3975 (95%)	4.8	14.8
1994	4252	1724 (41%)	4.3	18.7
1993	3168	1221 (39%)	7.6	28.6
1992	3579	2213 (62%)	4.3	11.6 *
1991	4100	1507 (37%)	3.3	13.9 *
1990	4108	1547 (38%)	1.9	9.2 *
1989	3132	1030 (33%)	3.4	17.5
1988	2250	887 (39%)	18.7	64.1
1987	1776	766 (43%)	7.2	58.7
1986	3374	1517 (45%)	3.7	47.3
1985	2508	1023 (41%)	5.0	41.7
1984	2125	213 (19%)	----	65.0

* Daytime runs to check secondary nest depredation were not conducted on a regular basis.

Hatching Success

Eight percent (218) of the loggerhead, 90 percent (19) of the green and 100 percent (4) of the leatherback sea turtle nests were excavated to determine hatching success (Table 3). This was the second consecutive year that hatching success was determined by an egg count of marked nests, rather than the number of nests that showed signs of hatching. It is believed that this is a more accurate way to calculating actual hatching success. To ensure that all eggs in the marked nests were accounted for, daytime patrols were implemented at least three times a week to record any eggs lost to nest depredation.

Hatching rates of 55.2, 51.2 and 23.0 percent were recorded for the loggerhead, green and leatherback nests, respectively (Table 3). This compared to success rates of 58.6, 64.5 and 27.3 percent, respectively, in 1996. As can be seen, hatching success declined 3.4 percent for the loggerhead and 13.3 percent for the green sea turtle. While this exceeded 50 percent, it was still below the 60 percent target level called for in the U.S. Fish and Wildlife Service Sea turtle recovery plans. Hatching success for the small number of leatherback nests increased slightly from 23 to 27 percent but still remained significantly below the other two species.

An increase in nest depredation over the previous three years, as discussed in the previous section, contributed to the decline in nesting success. Diseases, such as distemper, or other natural factors should eventually reduce the raccoon population to prior levels. Nest erosion was also higher in 1997 and varies in impact from year to year. CANA has come close to reaching 60 percent hatching success the past two years. It will continue its efforts to protect as many sea turtle nests as possible while allowing the raccoon to remain as a natural component of the seashore ecosystem.

The question has been raised over whether it is worthwhile to expend energy to clean up and screen partially depredated nests. Some people feel that a partially depredated nest will be repeatedly depredated until all the eggs are destroyed or that yolk spilled from broken eggs will promote the growth of fungi, fouling the remaining eggs. This would undoubtedly be true if the nest were left alone. However, if at least a quarter or more of the clutch remained, CANA staff attempted to salvage the remaining eggs. Broken eggs, were carefully removed, the remaining clutch was covered with clean sand and the nest was screened.

Of the 612 nests recorded as partial depredations, 433 or 71 percent showed signs of hatching. The remaining 179 were either totally depredated or of unknown fate. Fifty-one partially depredated nests (48 loggerhead and three green) were excavated at the end of the season. Of 3631 eggs remaining in the nests, 1610 or 44.3 percent hatched. This was below the average loggerhead hatching success of 55 percent (Table 3) but still considered worth the effort.

Future Trends

The number of green sea turtle nests dropped from 222 in 1996 to 21 in 1997 (Table 4). If the trend of alternating increases and decreases exhibited since 1988 continues, green sea turtle nesting should increase significantly in 1998 (Figure 3). Loggerhead totals have not declined more than two years in a row since 1985 (Figure 4). Consequently, loggerhead nesting activity which dropped in 1996 and 1997, should also increase in 1998. Leatherback nesting is sporadic and difficult to predict but has increased over the past few years. A few leatherback nests are likely. In an effort to record any early nesting leatherbacks, the park will conduct occasional beach patrols beginning in February, 1998.

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