

1998 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.

1998 was the fifteenth 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 1, 1998, 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.

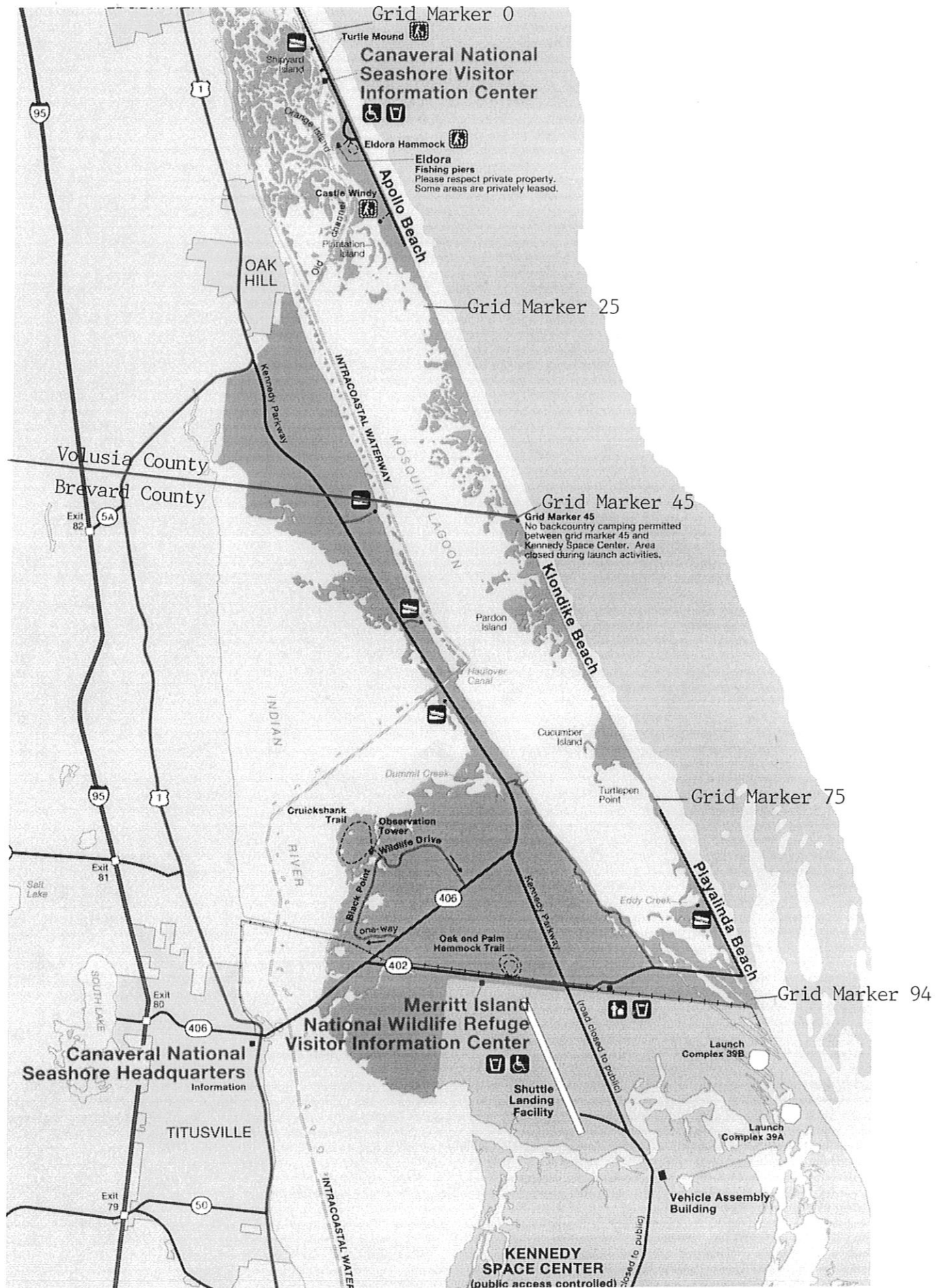


Figure 1. Canaveral National Seashore

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 (11) 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 4408 sea turtle nests were deposited at CANA in 1998 - 3976 loggerhead, 427 green and five leatherback (Table 1). Overall nest density was 103.8 per kilometer for the loggerhead and 11.1 per kilometer for the green.

The total number of loggerhead false crawls was 4006 or 104.6 per kilometer, a false crawl to nest ratio of 1:1 (Table 1). There were 826 green false crawls or 21.6 per kilometer, a false crawl to nest ratio of 1:0.5. Eight leatherback false crawls were recorded, for a false crawl to nest ratio of 1:0.63.

As in former years, the greatest concentration of nesting was noted in the southern half of CANA with 62% (2720) of the nests occurring in the South District (Brevard County) and 38% (1688) in the North District (Volusia County) (Table 1). Nesting densities were 134.7/km and 93.3/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 1998, 96 percent (4233) of the 4408 nests deposited at CANA were screened, comprising 3835 undepredated and 398 partially depredated nests (Table 2, Initial Encounter). This included five leatherback, 425 green and 3803 loggerhead nests.

A total of 4.4 percent (173) of the loggerhead nests were totally depredated and 9.5 percent (378) were partially depredated prior to discovery (Table 2, Initial Encounter).

Of the 427 green sea turtle nests, two were totally depredated and 20 (05%) were partially depredated prior to discovery (Table 2, Initial Encounter). None of the five leatherback nests were depredated.

Table 1: 1998 Marine Turtle Crawl Survey, Canaveral National Seashore.

Overall

	Loggerhead	Green	Leatherback	Total
Nests	3976	427	5	4408
False Crawls	4006	826	8	4840
Nest Density (nest/km)	103.8	11.1	0.1	115.1
FC Density (FC/km)	104.6	21.6	0.2	126.4
FC to Nest Ratio	1:1	1:0.5	1:0.6	1:0.8

Distribution by District

North District (Volusia county)

	Loggerhead	Green	Leatherback	Total
Nests	1534	151	3	1688
False Crawls	1217	329	1	1547
Nest Density (nest/km)	84.8	8.3	0.2	93.3
FC Density (FC/km)	67.2	18.2	0.1	85.5
FC to Nest Ratio	1:1.3	1:0.5	1:3.0	1:1.1

South District (Brevard County)

	Loggerhead	Green	Leatherback	Total
Nests	2442	276	2	2720
False Crawls	2789	497	7	3293
Nest Density (nest/km)	120.9	13.7	0.1	134.7
FC Density (FC/km)	138.1	24.6	0.3	163.0
FC to Nest Ratio	1:0.9	1:0.6	1:0.3	1:0.8

Figure 2a. Nests, False Crawls, Depredations, and Tunneling Activity.
Grids 45 - 94 (South District) - 1998.

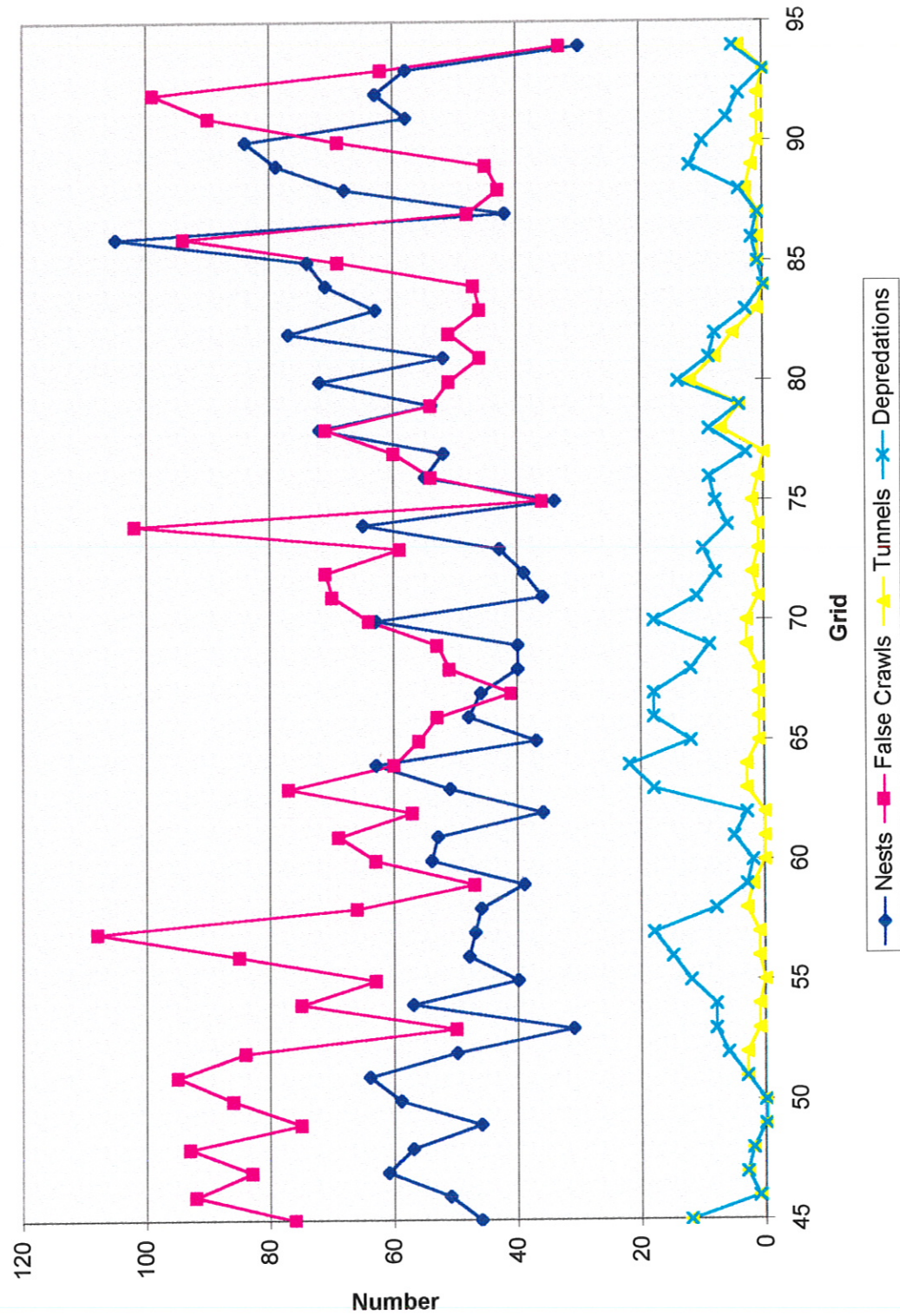


Figure 2b. Nests, False Crawls, Depredations, and Tunneling Activity.
Grids 0 - 44 (North District) - 1998.

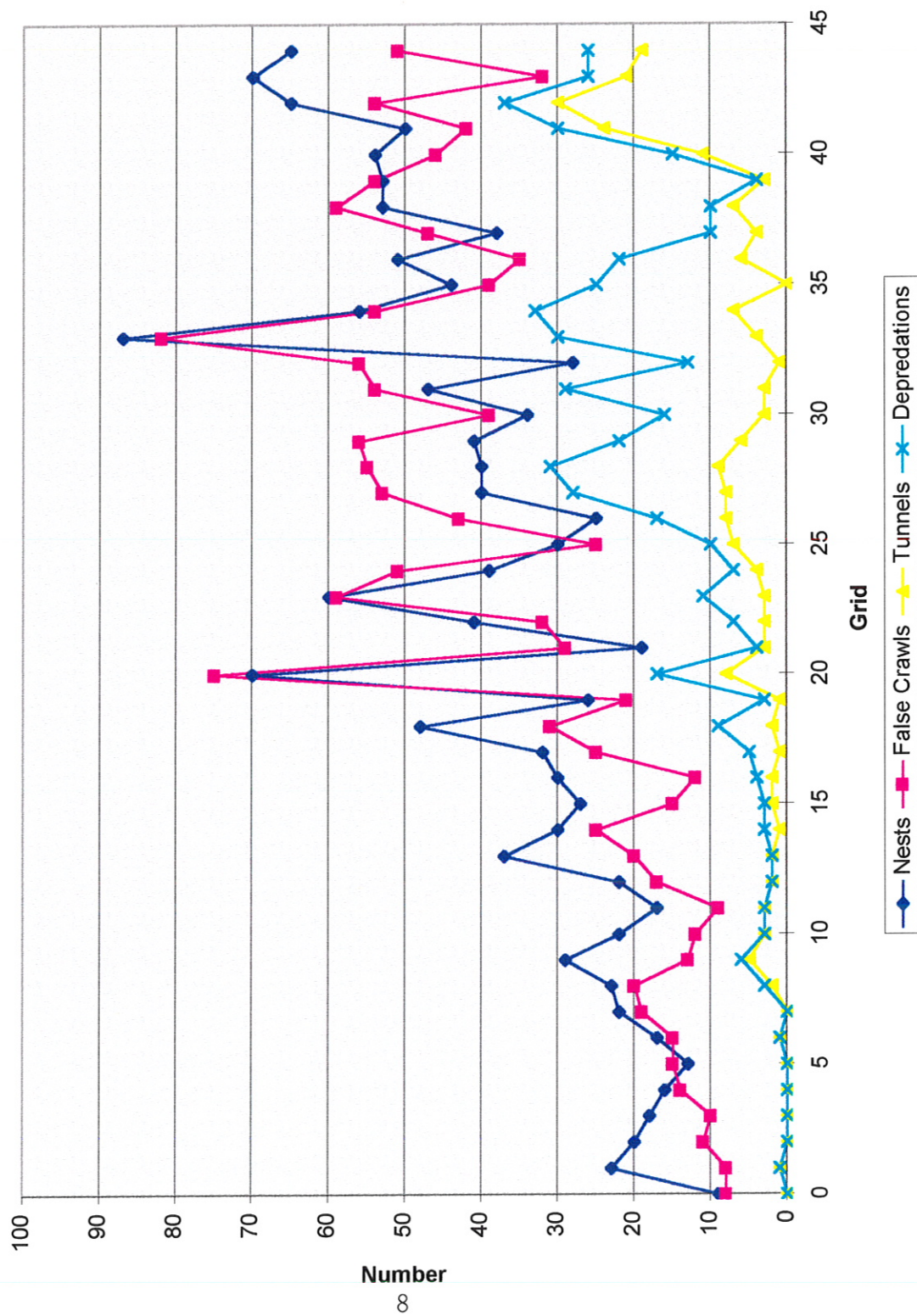


Table 2. Nest Treatment and Depredation, 1998. Canaveral National Seashore.

Initial Encounter

	Loggerhead	Green	Leatherback	Total
Not Dep/Screened	3425 (86 %)	405 (95%)	5 (100%)	3835 (87%)
Park Dep/Screened	378 (10%)	20 (05%)	0	398 (09%)
Total Depredation	173 (4 %)	2 (<01%)	0	175 (04%)
TOTAL	3976	427	5	4408

Part=Partial Dep=Depredation

Subsequent Depredation

Screened Nests

	Loggerhead	Green	Leatherback	Total
North District	201	9	1	211 (13%)
South District	93	2	0	95 (04%)
Total	294	11	1	306 (07%)

Overall Depredation (Initial Encounter and Subsequent Depredation)

All Nests

	Loggerhead	Green	Leatherback	Total
Partial Depredation	621 (16%)*	30 (07%)	0	651 (15%)^
Total Depredation	196 (05%)	2 (<01%)	1 (20%)	199 (04%)
Total	817 (21%)	32 (07%)	1 (20%)	850 (19%)

* Percentages in species columns are derived from total number of nests for that species

^ Percentages in Total column are derived from total number of nests for all species (4408)

By District

	Loggerhead	Green	Leatherback	Total
North District	474	19	1	494 (29%)*
South District	343	13	0	356 (13%)*
Total	817	32	1	850 (19%)

* Percentages are derived from total number of nests in each district

Subsequent Depredations

Seven percent (306) 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 (211) of the screened nests being depredated versus four percent (95) in the South District.

Only 31 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, 21 percent (817) of the loggerhead and seven percent (32) of the green nests were either partially or totally depredated during the 1998 season (Table 2, Overall Depredation, All Nests). Specifically, five percent (196) of the loggerhead nests were totally depredated and 16 percent (621) were partially depredated. Of the 32 depredated green nests, seven percent (30) were partial and less than one percent (two) were total. One (20%) of the leatherback nests was totally depredated.

As in past years, the highest percentage of depredations (partial and total) occurred in the North District, where 29 percent (494) of the nests were depredated, compared to 13 percent (356) in the South District (Table 2, Overall Depredation, By District). Including the single leatherback depredation, 19 percent (850) of the nests deposited at CANA were either partially or totally depredated.

A total of 23 problem raccoons were removed from the beach during the nesting season.

Monitored Nests

Every tenth nest was marked for excavation after the incubation period to determine hatching success. Of the 391 marked loggerhead nests, 362 (92%) were excavated (Table 3). Sixty-three were partially depredated, 10 were totally depredated and 19 were of unknown fate. Average clutch size was 100.3 eggs/clutch. Hatching success for the total number of eggs counted (including depredated eggs) was 64 percent. Calculating in an estimated 1000 unhatched eggs from the nests destroyed by depredation (10 nests times average clutch size of 100.3 eggs = 1003 eggs) yields an adjusted hatching success of 62 percent.

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

$(62\% \text{ hatchling success}) \times (100.3 \text{ eggs/clutch}) \times (3976 \text{ nests}) = 247,252 \text{ hatchlings.}$

Table 3. Hatching Success of marked Nests, 1998. Canaveral National Seashore.

1998

	Loggerhead	Green	Leatherback
Nests marked	391	45	5
Nests Excavated	362	38	3
Total Eggs	36,316	4,607	207
Ave. Clutch Size	100.3	121.2	69
Hatchlings Emerged	23,083	3,280	115
Hatching Success	64%	71%	56%
Nests Partially Dep.	63 (16%)	3 (07%)	0
Nests Destroyed	10 (03%)	0	1
Adj Hatching Success	62%	N/A	42%
Unknown Fate	19 (05%)	7(16%)	1

Dep = Depredated

Adj = Adjusted

Thirty-eight of the 45 green sea turtle nests marked for excavation were evaluated; the remaining seven were of unknown fate (Table 3). Three of the 38 nests were partially depredated. Average clutch size for the excavated nests was 121.2 eggs and hatching success was 71 percent.

For the green sea turtle, an estimated number of hatchlings was calculated as follows:
 $(71\% \text{ hatchling success}) \times (121.2 \text{ eggs/clutch}) \times (427 \text{ nests}) = 36,744 \text{ hatchlings.}$

Three of the five recorded leatherback nests were excavated. Clutch sizes were 78, 73 and 56 eggs, with an average of 69.0 eggs/clutch (Table 3.) Of the 207 eggs laid, 115 hatched for a hatching success of 56 percent. One nest was totally depredated. Calculating in 69 more unhatched eggs (average clutch size) yields an adjusted hatching success of 42 percent. For the three excavated nests, an additional 22, 19 and 20 small, undeveloped eggs were recorded, respectively).

DISCUSSION

Nesting and False Crawl Totals

The 4408 nests recorded at CANA in 1998 were the highest total since surveys began in 1984 (Table 4). This was in contrast to 1997, when the number of nests dropped to the second lowest amount (2727) in the previous 10 years. True to form, green sea turtle nesting activity increased significantly, after a one year decline, to 427 in 1998 from 21 in 1997. This continued the consistent up and down pattern, exhibited every year except one (1989) since 1985 (Figure 3).

Loggerhead numbers also increased from 2702 in 1997 to 3976 in 1998, following two years of decline from a high of 4121 in 1995 (Table 4). The loggerhead nesting pattern fluctuates like the green although it is less predictable (Figure 4).

The five leatherback nests recorded in 1998 were the most observed since the program began (Table 4). Three or more leatherback nests have been recorded in each of the last three years and at least one leatherback nest has been reported in 10 of the last 13 years.

The false crawl to nest ratio for the loggerhead rose from 1:1.19 in 1997 to 1:0.99 or almost one-to-one in 1998 (Table 5). The number of nests at CANA has exceeded false crawls in 11 of the last 14 years. The other two years that it did not, were also almost one-to-one (1988 and 1986, being 1:0.94 and 1:0.98, respectively). The green sea turtle false crawl to nest ratio also increased from 1:0.72 in 1997 to 1:0.52 in 1998. This was the largest ratio of false crawls to nests that the park has recorded and fifth time in the last 14 years that green false crawls exceeded nests. There were eight leatherback false crawls (Table 1), a false crawl to nest ratio of 1:0.63 (CANA files). In 1997, all four leatherback crawls resulted in nests.

Table 4. Sea Turtle Nest Totals, 1984-1998. Canaveral National Seashore.

YEAR	LOGGERHEAD	GREEN	LEATHERBACK	UNKNOWN	TOTAL
1998	3976	427	5		4408
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, 1984-1998, Canaveral National Seashore, Titusville, Florida.

FIGURE 3. GREEN SEA TURTLE NESTING TOTALS
 CANAVERAL NATIONAL SEASHORE 1985 - 1998

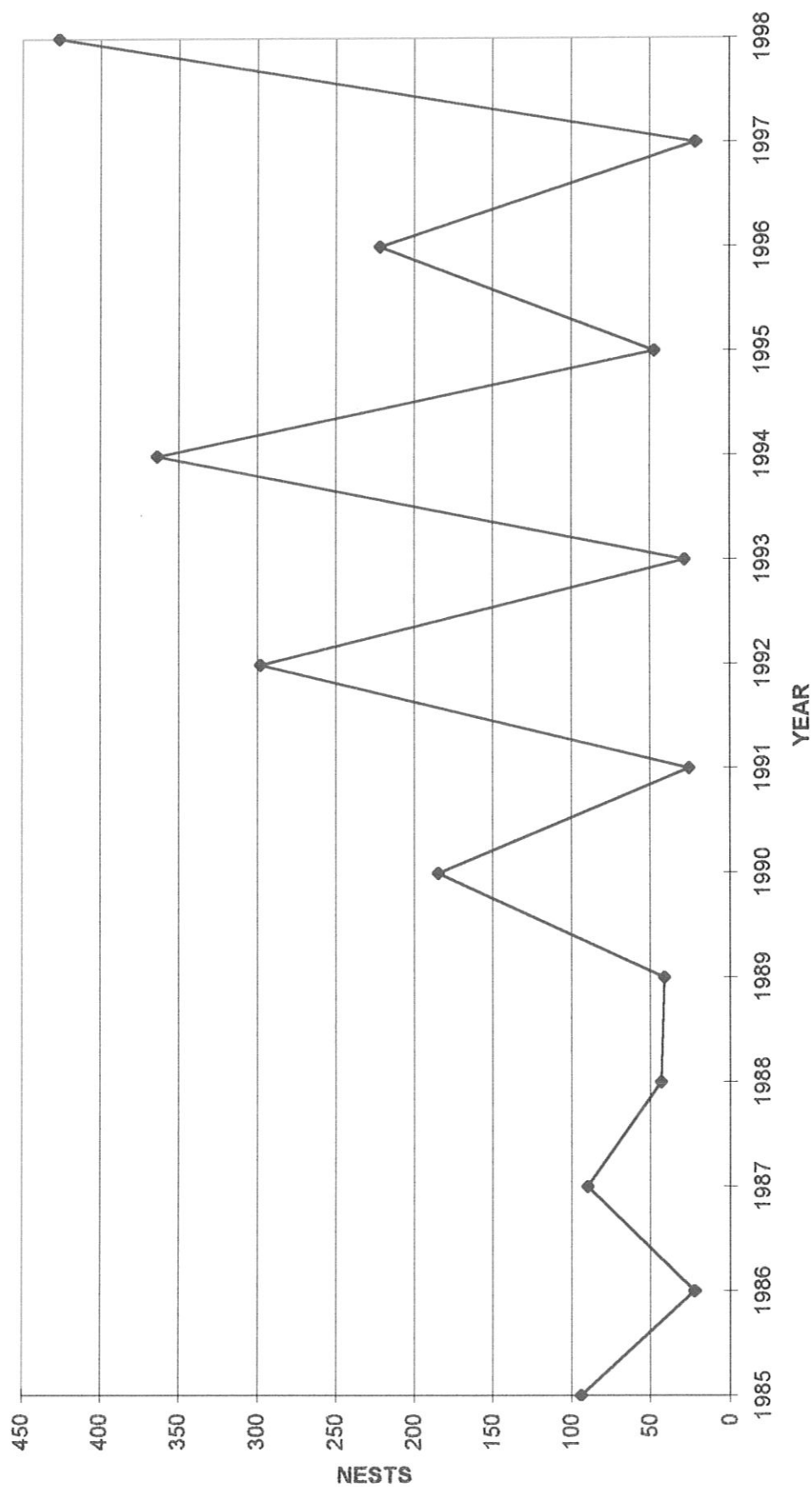


**FIGURE 4. LOGGERHEAD SEA TURTLE NESTING TOTALS
CANAVERAL NATIONAL SEASHORE 1985 - 1998**

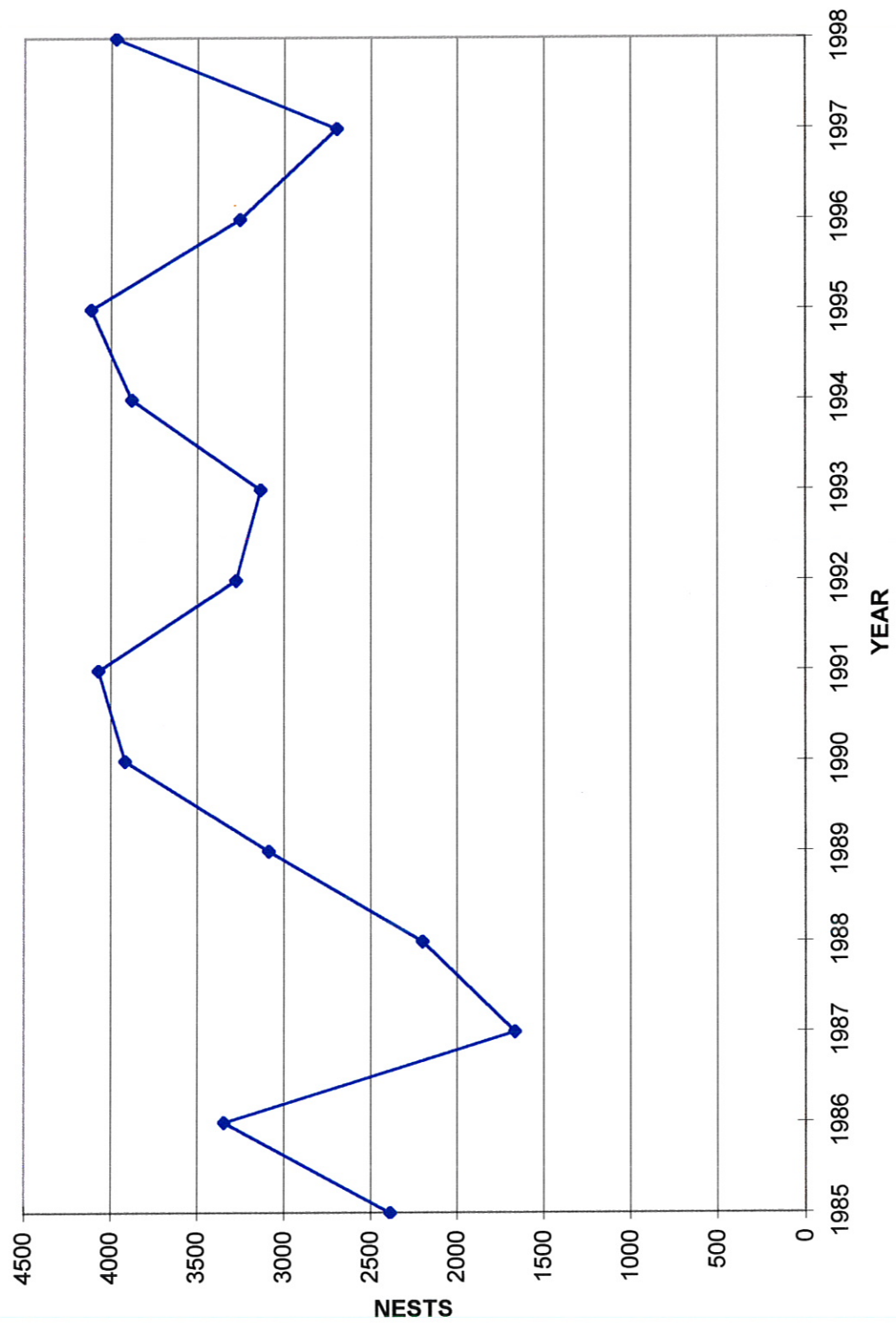


Table 5. False Crawl to Nest Ratio, 1984-1998. Canaveral National Seashore.

Year	Loggerhead	Green	Overall
1998	1:0.99	1:0.52	1:0.91
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, 1984-1998, Canaveral National Seashore, Titusville, Florida.

Screening Activity and Nest Depredation

Ninety-six percent (4233) of the sea turtles deposited at CANA in 1998 were screened, the greatest percentage screened since the screening program began (Table 6). The previous high was 95 percent in 1995. Overall nest depredation also dropped from 29.9 percent in 1997 to 19.3 percent in 1998 (Table 6). The depredation rate has fluctuated between 29.9 and 14.8 percent since 1993, when daytime runs were implemented to detect subsequent depredations to nests.

Tunneling activity, digging under the screens to reach the eggs, also declined from 9.6 percent in 1997 to 7.2 percent in 1997 (Table 6). Since 1985, tunneling has ranged from 18.7 percent in 1988 to 1.9 percent in 1990. The unusually high value in 1988 was almost twice that of any prior year.

The yearly oscillations in depredation and tunneling are likely tied to periodic fluctuations in the raccoon population and number of experienced animals foraging on the beach (i.e. individuals that have learned to tunnel). In 1997, an unusually large number of raccoons was noted at CANA and the adjacent Merritt Island National Wildlife Refuge (pers comm, CANA and Refuge staff). For whatever reason, less animals were seen in 1998. There is always potential for outbreaks in the raccoon population at CANA. Kramer (1996) noted breeding in most months of the year at CANA. There are ample food resources and natural predators are absent. Although park staff works hard to remove trash, refuse from one million visitors a year adds to the food source. When periods of little disease coincide with the above, periodic surges in the raccoon population at CANA are inevitable. Natural factors, such as distemper, serve to return the raccoon population to lower levels.

Table 6. Amount of Screening and Depredation of Screened Nests, 1984-1998.
Canaveral National Seashore.

YEAR	NESTS	NESTS SCREENED	SCREENED NESTS DEPREDATED (%)	ESTIMATED OVERALL DEPREDATION (%)
1998	4408	4233 (96%)	7.2	19.3
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

A sample of 9.1 percent (362) of the loggerhead, 8.8 percent (38) of the green and 38 percent (3) of the leatherback sea turtle nests were excavated to determine hatching success (Table 3). This was the third 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.

The target level for hatching success was 60 percent, as called for in the U.S. Fish and Wildlife Service sea turtle recovery plans (NMFS and USFWS 1991). This was achieved for two species, the loggerhead and green, which yielded hatching rates of 62 (adjusted) and 71 percent, respectively (Table 3). The loggerhead rate was reduced slightly from 64 to 62 percent by adding in an average clutch size of 100.3 eggs for the 10 marked nests that were totally depredated. Leatherback success was 56 percent, based on excavation of three nests, or an estimated 42 percent, after adding in 69 eggs (average clutch size) to the egg total for one depredated nest. All three species showed improvement over 1996 and 1997 levels (Table 7). Leatherback hatching success continued to remain below the other species.

Sixty-seven partially depredated loggerhead nests were excavated (CANA files). Fifty-four percent (2426) of the undamaged eggs hatched. Thus cleaning up and screening partially depredated nests can save a significant portion of the remaining eggs. Adding broken eggs, counted at the time of screening or during daytime depredation patrols, reduced overall hatching success for partially depredated nests to 36 percent, much lower than hatching success for undepredated nests (Table 3), but worth the effort when time allowed.

Table 7. Calculated Hatching Success (1996-1998). Canaveral National Seashore.

	Loggerhead	Green	Leatherback
1998	64% (62%)	71% (N/A)	56% (42%)
1997	55% (49%)	51% (N/A)	23% (N/A)
1996	59% (53%)	65% (N/A)	27% (N/A)

() = Adjusted hatching success, adding in average clutch size for totally depredated nests

Future Trends

Since 1998 was an "up" year for green sea turtle nesting activity, the number of nests is expected to decrease significantly in 1999, based on the pattern exhibited in Figure 3. Loggerhead activity is harder to predict; however, trends seem to go in at least two year cycles (Figure 4). If this holds true in 1999, there should be an increase in the number of loggerhead nests. Leatherback nesting is sporadic but has increased slightly 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, 1999.

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