

1999 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 (McMurtray 1986). 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.

1999 was the sixteenth 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 04, 1999, 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 9, 1999, 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.

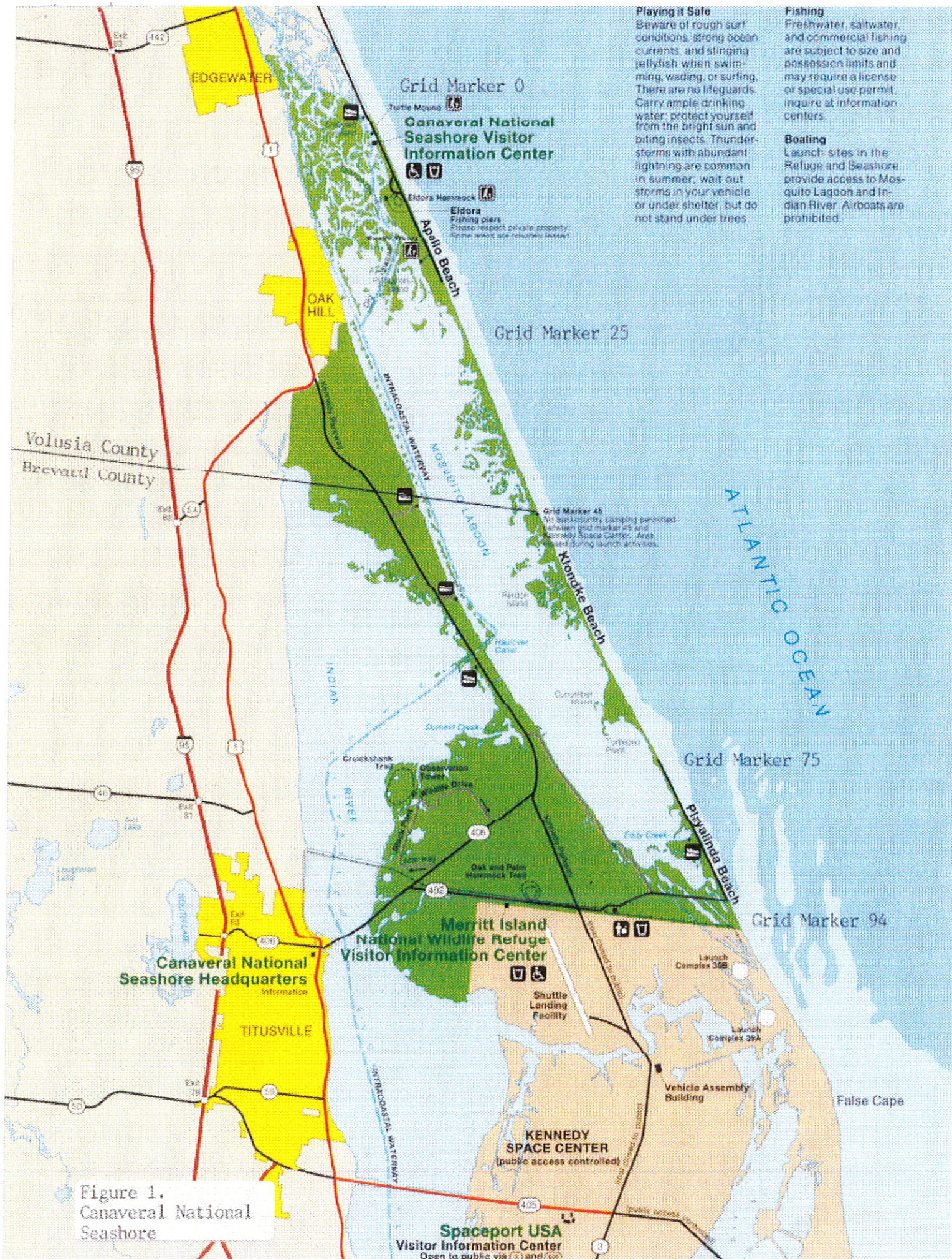


Figure 1.
Canaveral National
Seashore

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.

Thirty-five (35) nests 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 how to repeatedly tunnel under the screens. These raccoons were captured using Tomahawk live-traps.

RESULTS

Nesting and False Crawl Totals

A total of 4515 sea turtle nests were deposited at CANA in 1999 - 4501 loggerhead, nine leatherback and five green (Table 1). Overall nest density was 117.5 per kilometer for the loggerhead. Leatherback and green nest densities were both under 0.5 per kilometer.

The total number of loggerhead false crawls was 3748 or 97.9 per kilometer, a false crawl to nest ratio of 1:1.2 (Table 1). There were eight green false crawls or 0.2 per kilometer, a false crawl to nest ratio of 1:0.6. Three leatherback false crawls were recorded, for a false crawl to nest ratio of 1:3.0.

As in former years, the greatest concentration of nesting was noted in the southern half of CANA with 64% (2909) of the nests occurring in the South District (Brevard County) and 36% (1606) in the North District (Volusia County) (Table 1). Nesting densities were 144.0 and 88.7 per kilometer 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 1999, 95 percent (4311) of the 4515 nests deposited at CANA were screened, comprising 3817 undepredated and 494 partially depredated nests (Table 2, Initial Encounter). This included nine leatherback, five green and 3804 loggerhead nests.

A total of 204 (4.5%) of the loggerhead nests were totally depredated and 493 (11%) were partially depredated prior to discovery (Table 2, Initial Encounter).

One of the five green nests was partially depredated prior to discovery (Table 2, Initial Encounter). None of the nine leatherback nests were depredated.

Table 1: 1999 Marine Turtle Crawl Survey, Canaveral National Seashore.

Overall

	Loggerhead	Green	Leatherback	Total
Nests	4501	5	9	4515
False Crawls	3748	8	3	3759
Nest Density (nest/km)	117.5	0.1	0.2	117.9
FC Density (FC/km)	97.9	0.2	0.1	98.1
FC to Nest Ratio	1:1.2	1:0.6	1:3.0	1:1.2

Distribution by District

North District (Volusia county)

	Loggerhead	Green	Leatherback	Total
Nests	1601	2	3	1606
False Crawls	1354	2	2	1358
Nest Density (nest/km)	88.5	0.1	0.2	88.7
FC Density (FC/km)	74.8	0.1	0.1	75.0
FC to Nest Ratio	1:1.2	1:1.0	1:1.5	1:1.2

South District (Brevard County)

	Loggerhead	Green	Leatherback	Total
Nests	2900	3	6	2909
False Crawls	2394	6	1	2401
Nest Density (nest/km)	143.6	0.1	0.3	144.0
FC Density (FC/km)	118.5	0.3	<0.1	118.9
FC to Nest Ratio	1:1.2	1:0.5	1:6.0	1:1.2

Figure 2a. Nests, False Crawls, Depredations and Tunnelling Activity.
Grids 00 - 44 (North District) - 1999.

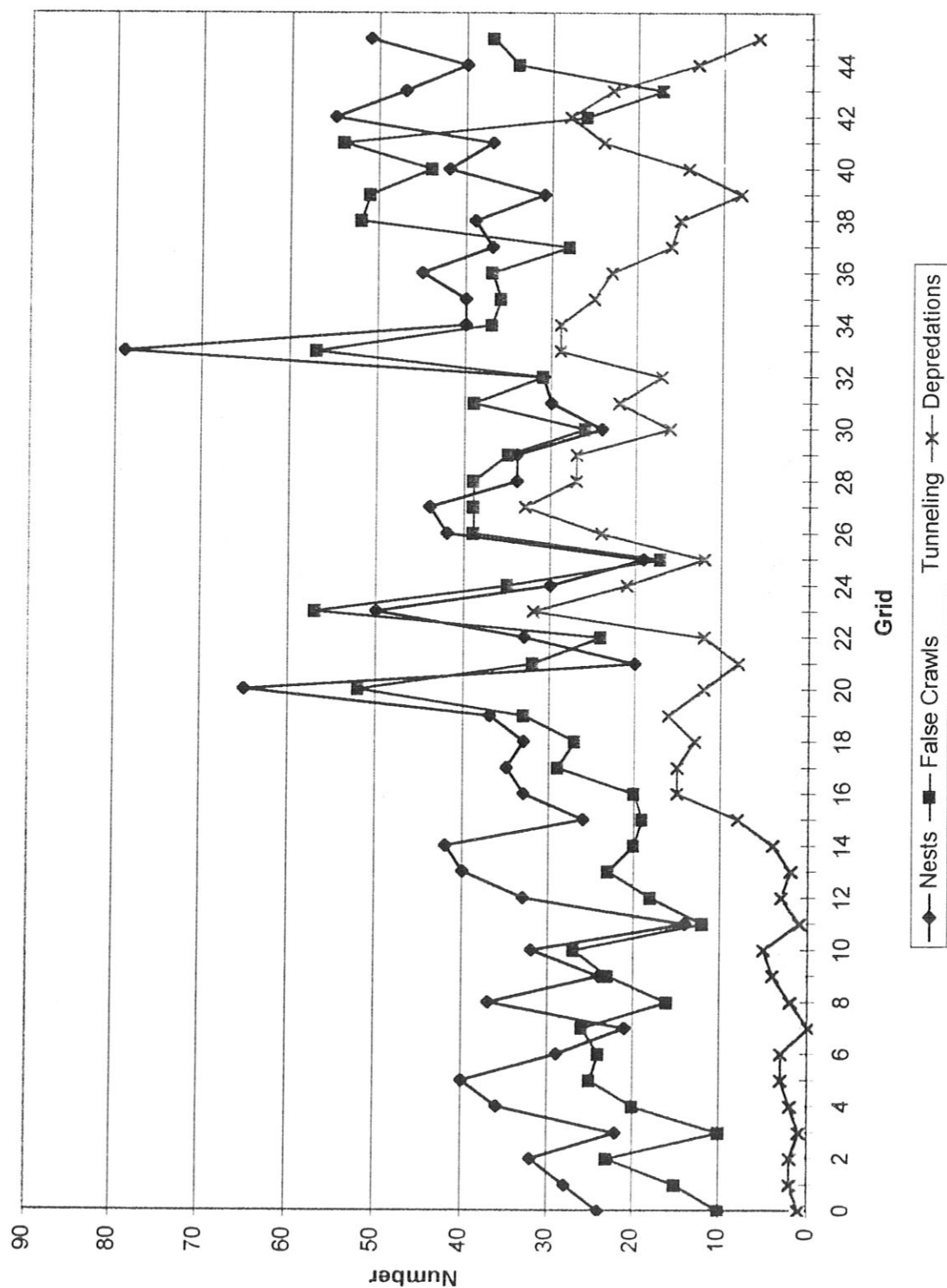


Figure 2b. Nests, False Crawls, Depredations and Tunnelling Activity.
Grids 45 - 94 (South District) - 1999.

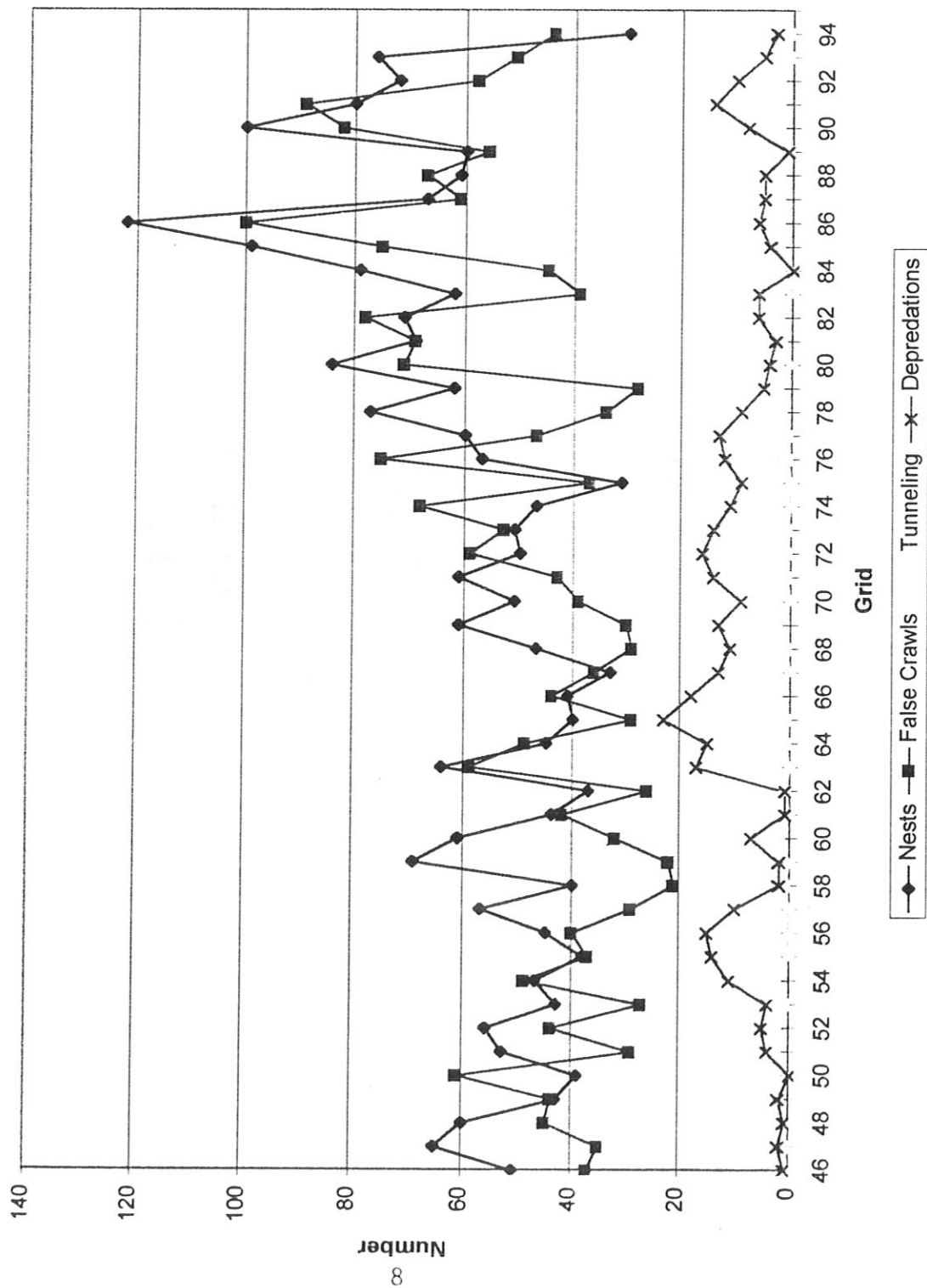


Table 2. Nest Treatment and Depredation, 1999. Canaveral National Seashore.

Initial Encounter

	Loggerhead	Green	Leatherback	Total
Not Dep/Screened	3804 (85%)	4 (80%)	9 (100%)	3817 (85%)
Part Dep/Screened	493 (11%)	1 (20%)	0	494 (11%)
Total Depredation	204 (04%)	0	0	204 (04%)
TOTAL	4501	5	9	4515

Part=Partial Dep=Depredation

Subsequent Depredation

Screened Nests

	Loggerhead	Green	Leatherback	Total
North District	255	0	0	255 (17%)
South District	102	0	0	102 (04%)
Total	357	0	0	357 (08%)

Overall Depredation (Initial Encounter and Subsequent Depredation)

All Nests

	Loggerhead	Green	Leatherback	Total
Partial Depredation	731 (16%)*	1 (20%)	0	732 (16%)^
Total Depredation	269 (06%)	0	0	269 (06%)
Total	1000 (22%)	1 (20%)	0	1001 (22%)

* 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 (4515)

By District

	Loggerhead	Green	Leatherback	Total
North District	603	1	0	604 (38%)*
South District	397	0	0	397 (14%)*
Total	1000	1	0	1001 (22%)

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

Subsequent Depredations

Eight percent (357) 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 17 percent (255) of the screened nests being depredated versus four percent (102) in the South District. Fifty-four (54) nests were recorded as being depredated more than once (CANA files).

Overall, including both initial and subsequent depredations, 22 percent (1000) of the loggerhead, 20 percent (01) of the green and none of the leatherback nests were either partially or totally depredated during the 1999 season (Table 2, Overall Depredation, All Nests). Specifically, six percent (269) of the loggerhead nests were totally depredated and 16 percent (731) were partially depredated. The green depredation was a partial.

As in past years, the highest percentage of depredations (partial and total) occurred in the North District, where 38 percent (604) of the nests were depredated, compared to 14 percent (397) in the South District (Table 2, Overall Depredation, By District). Including the single green depredation, 22 percent (1001) of the nests deposited at CANA were either partially or totally depredated.

A total of seven problem raccoons ("tunnelers") 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 450 marked loggerhead nests, 352 (78%) were excavated (Table 3). Two-hundred-and-seventy-seven (277) of these were undepredated and 75 partially or totally depredated. Hatching success for undepredated nests was 62% and 29% for depredated nests. Combining the two yields a hatching rate of 55%.

Average clutch size was 100.0 eggs for undepredated nests and 100.9 for depredated nests. If an estimated 900 eggs are added to the unhatched total to represent nine totally depredated nests where an egg count could not be made (9 nests times average clutch size of 100.0 eggs = 900 eggs), the adjusted hatching success is 53%.

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

$(53\% \text{ hatchling success}) \times (100 \text{ eggs/clutch}) \times (4501 \text{ nests}) = 238,553 \text{ hatchlings.}$

Ninety-eight nests were of unknown fate (Table 3). Approximately 80 of these were eroded away or the nest marker lost in September during the storm surges from Hurricanes Floyd and Irene.

Table 3. Hatching Success of marked Nests, 1999. Canaveral National Seashore.

Loggerhead

	Non-depredated	Depredated	Overall
Nests marked	349	101	450
Nests Excavated	277	75	352
Total Eggs	27,697	7,568	35,265
Ave. Clutch Size	99.9	100.9	100.2
Hatchlings Emerged	17,058	2,172	19,230
Hatching Success	62%	29%	55%
Nests Destroyed by Depredation	N/A	11	11
Adjusted Hatching Success*	N/A	26%	53%
Eroded/Unknown Fate	72 (21%)	26(26%)	98(22%)

* Adding average clutch size for 9 totally depredated nests where egg count not possible

Green

	Non-depredated	Depredated	Overall
Nests marked	4	1	5
Nests Excavated	3	1	4
Total Eggs	345	82	427
Ave. Clutch Size	115.0	82.0	106.7
Hatchlings Emerged	222	14	236
Hatching Success	64%	17%	55%
Nests Destroyed by Depredation	N/A	0	0
Eroded/Unknown Fate	1 (25%)	0	1 (20%)

Leatherback

	Non-depredated	Depredated	Overall
Nests marked	9	0	9
Nests Excavated	8	0	8
Total Eggs	508	0	508
Ave. Clutch Size	63.5	0	63.5
Hatchlings Emerged	148	0	148
Hatching Success	29%	0	29%
Nests Destroyed by Depredation	N/A	0	N/A
Eroded/Unknown Fate	1 (11%)	0	1 (11%)

Four of the five green sea turtle nests were evaluated, with one being partially depredated (Table 3). For the three undepredated nests, average clutch size was 115.0 eggs and hatching success was 64 percent. Eighty-two eggs were counted for the depredated nest, with a hatching rate of 17 percent. Overall, the four excavated nests yielded 236 hatchlings, a success rate of 55 percent. The fifth nest was deposited very late in the season and presumed lost to Hurricane Floyd.

Eight of the nine leatherback nests were excavated. Average clutch size was 63.5 eggs with a hatching success of 29 percent and a total of 148 hatchlings (Table 3). No leatherback nests were depredated.

DISCUSSION

Nesting and False Crawl Totals

The 4515 nests recorded at CANA in 1999 was the highest total since surveys began in 1984 (Table 4). This surpassed the previous high noted in 1998 by 107 nests. The high number was due to a record number of loggerheads (4501) and occurred despite a sharp decline in green sea turtle nesting activity from 427 in 1998 to five in 1999. True to form, the green continued the up and down pattern exhibited every year except one (1989) since 1985 (Figure 3).

Loggerhead numbers increased for the second year in a row (Table 4). The loggerhead nesting pattern fluctuates like the green, although it is less predictable (Figure 4). The nine leatherback nests recorded in 1999 were the most observed since the program began (Table 4). While still low, leatherback totals have increased each of the last four years and at least one leatherback nest has been reported in 10 of the last 14 years.

With a false crawl to nest ratio of 1:1.20, the number of loggerhead nests exceeded false crawls for the twelfth time in the last 15 years (Table 5). The three years that it did not, were also almost one-to-one (1998-1:0.99; 1988-1:0.94; and 1986-1:0.98). While green false crawls exceeded nests in 1999 (1:0.63), nests have exceeded false crawls in nine of the past 15 years (Table 5). Leatherback nest totals exceeded false crawls in seven of 10 years; only once did false crawls exceed nests.

Screening Activity and Nest Depredation

Ninety-five percent (4311) of the sea turtles deposited at CANA in 1999 were screened, the greatest numeric amount since the screening program began (Table 6). Overall nest depredation rose from 19.3 percent in 1998 to 22.2 percent (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 rose slightly from 7.2 percent in 1998 to 8.2 percent in 1999 (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). There is always potential for an explosion in the raccoon population at the park. 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 4. Sea Turtle Nest Totals, 1984-1999. Canaveral National Seashore.

YEAR	LOGGERHEAD	GREEN	LEATHERBACK	UNKNOWN	TOTAL
1999	4501	5	9		4515
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, 1984-1999, Canaveral National Seashore, Titusville, Florida.

FIGURE 3. GREEN SEA TURTLE NESTING TOTALS
 CANAVERAL NATIONAL SEASHORE 1985 - 1999

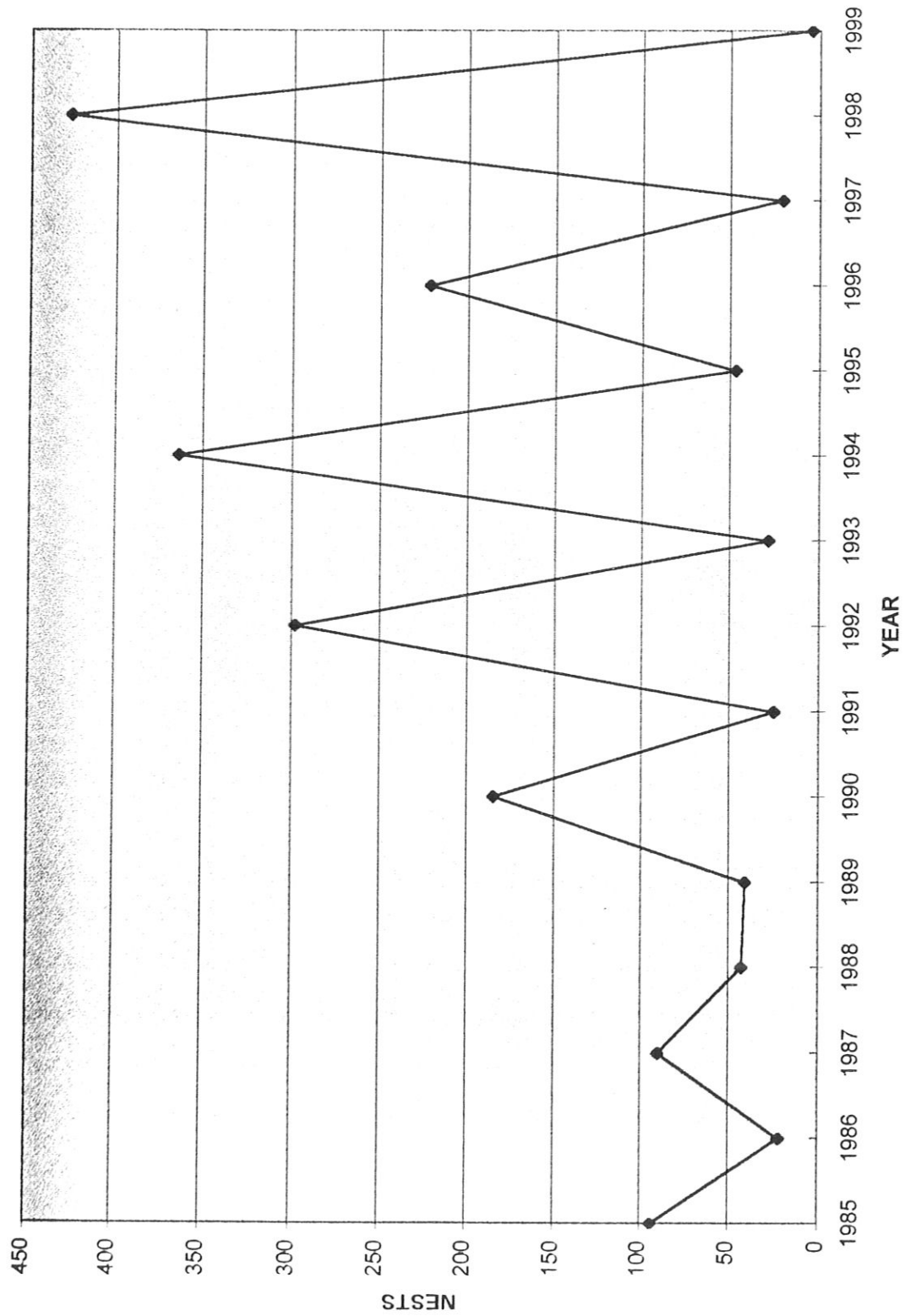


FIGURE 4. LOGGERHEAD SEA TURTLE NESTING TOTALS
CANAVERAL NATIONAL SEASHORE 1985 - 1999

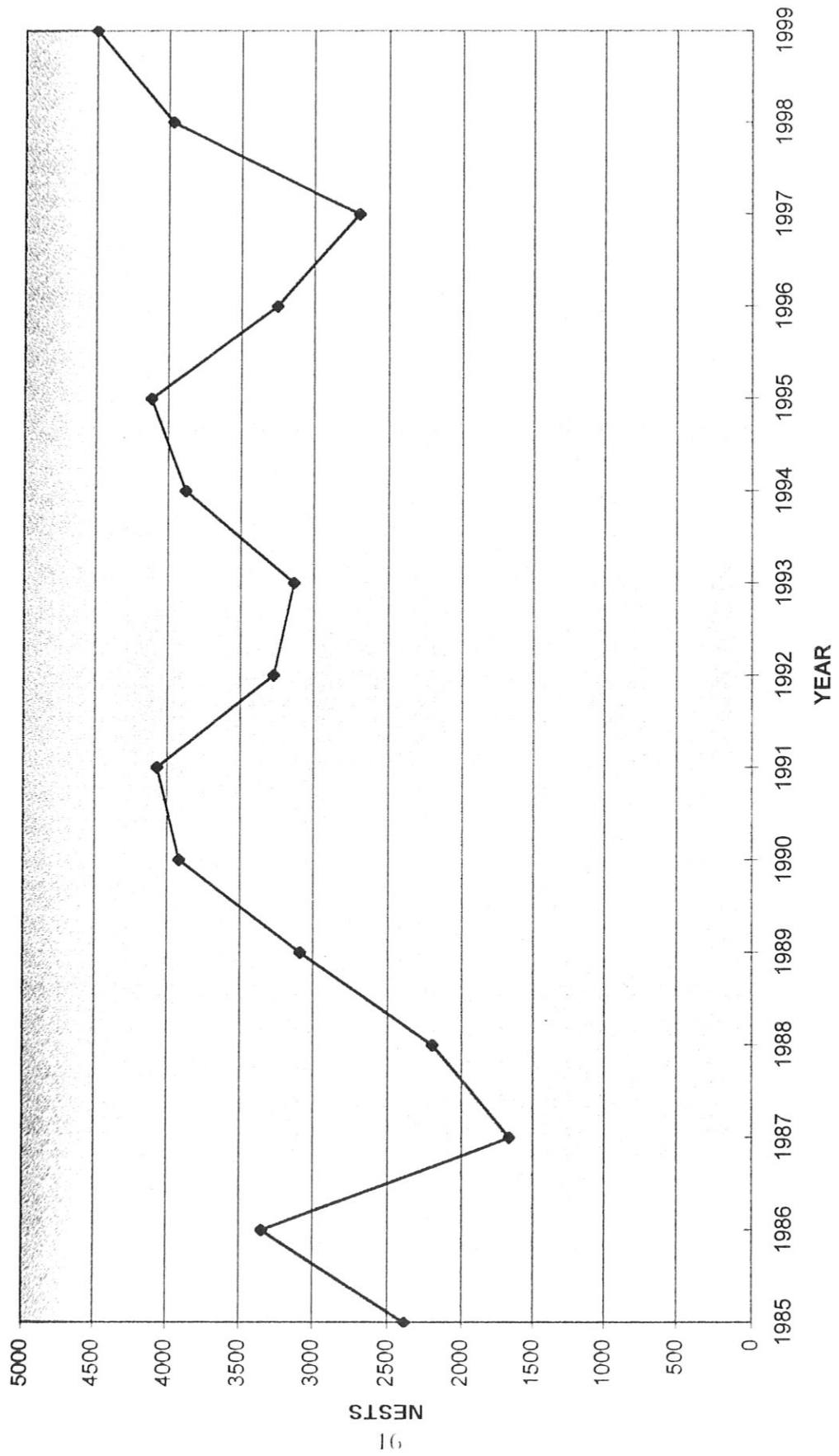


Table 5. False Crawl to Nest Ratio, 1984-1999. Canaveral National Seashore.

Year	Loggerhead	Green	Leatherback
1999	1:1.20	1:0.63	1:3.00
1998	1:0.99	1:0.52	1:0.63
1997	1:1.19	1:0.72	0:4.00
1996	1:1.32	1:0.77	1:1.00
1995	1:1.36	1:1.21	0:1.00
1994	1:1.60	1:1.38	0:2.00
1993	1:1.46	1:1.87	--
1992	1:1.43	1:1.10	--
1991	1:1.10	1:1.66	0:1.00
1990	1:1.31	1:1.17	1:1.00
1989	1:1.53	1:3.00	--
1988	1:0.94	1:1.16	--
1987	1:1.02	1:0.72	0:1.00
1986	1:0.98	1:0.76	0:3.00
1985	1:1.22	1:1.02	--
1984	--	--	--

Taken from yearly Sea Turtle Nesting Summaries, 1984-1999, Canaveral National Seashore, Titusville, Florida.

Table 6. Amount of Screening and Depredation of Screened Nests, 1984-1999.
Canaveral National Seashore.

YEAR	NESTS	NESTS SCREENED	SCREENED NESTS DEPREDATED (%)	ESTIMATED OVERALL DEPREDATION (%)
1999	4515	4311 (95%)	8.2	22.2
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

The target level for hatching success was 60 percent, established in the U.S. Fish and Wildlife Service sea turtle recovery plans (NMFS and USFWS 1991). This was achieved for undepredated loggerhead and green nests, which yielded hatching rates of 62 and 64 percent, respectively (Table 3). The success rate for partially depredated nests was much lower, 29 percent for 75 partially depredated loggerhead nests and 17 percent for one green nest. However, most of the unhatched eggs were those destroyed by predators prior to discovery. Of the undamaged eggs remaining in the nests (after broken eggs were removed and the nest screened), 41 percent hatched. This indicates that the effort to clean up and screen partially depredated eggs can save a significant portion of the remaining eggs. Combining totals from partially depredated, totally depredated and undepredated nests lowered overall hatching success to 53 and 55 percent.

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 fact that average clutch size for undepredated and partially depredated loggerhead nests was within a single egg (99.9 and 100.9) (Table 3) indicates that keeping a tally of depredated eggs throughout the season and adding them to the total clutch size when excavations are done is a fairly accurate indicator of actual clutch size.

Leatherback success was 29 percent, considerably below the other two species, based on excavation of eight nests (Table 3). Depredation was not a contributing factor to this low success rate. Comparison with 1996 to 1998 observations, reveals equally low values in three of the last four years (Table 7). Loggerhead hatching success remained between 55 and 65 percent during that that period. Green hatching success observations were more variable, fluctuating between 51 and 71 percent.

Table 7. Comparison of Hatching Success With Previous Years, 1996-1999.
Canaveral National Seashore

	Loggerhead	Green	Leatherback
1999	62% (53%)	64% (55%)	29% (N/A)
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)

() Percentages in parentheses are adjusted hatching rates, adding in average clutch size for totally depredated nests.

Impact of Storm Surges

Two hurricanes impacted sea turtle nests at CANA during the 1999 season. Hurricane Floyd reached its closest offshore position on September 14 and 15. Although it did not hit directly, the storm surge battered area beaches, damaging park boardwalks and washing away sea turtle nest markers and nests. Numerous sea turtle eggs were seen washed from the nests and deposited behind the dune. At the time of the storm, approximately 800 (18%) of the 4515 nests were still unhatched. A thorough search of the beach after the hurricane moved northward revealed only 37 marked nests. All of these were on the northern half of the beach, which was not hit as severely as the southern half. Additional nests may have survived the storm surge but could not be located since the markers were washed away. Periodic beach patrols were made to detect any emergencies from unmarked nests, but none were seen.

Twenty-nine (29) of the 37 recovered nests were excavated. Thirteen nests produced hatchlings for an overall hatching success of 28 percent. It is almost a certainty that these nests weathered the storm (versus hatching before the storm) since the oldest nest was deposited only 53 days prior to the storm. Evidence of the eight remaining nests was obliterated by Hurricane Irene, which hit CANA in October.

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