

2002 MARINE TURTLE NESTING SUMMARY
CANAVERAL NATIONAL SEASHORE



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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 % 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.

2002 was the nineteenth year for Canaveral National Seashore's sea turtle nest protection program. Since 1995, park staff has managed to screen over 90% of the several thousand nests deposited each year, reducing nest depredation to as low as 14.4% in 2002. The park's goal is to achieve the 60% 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.

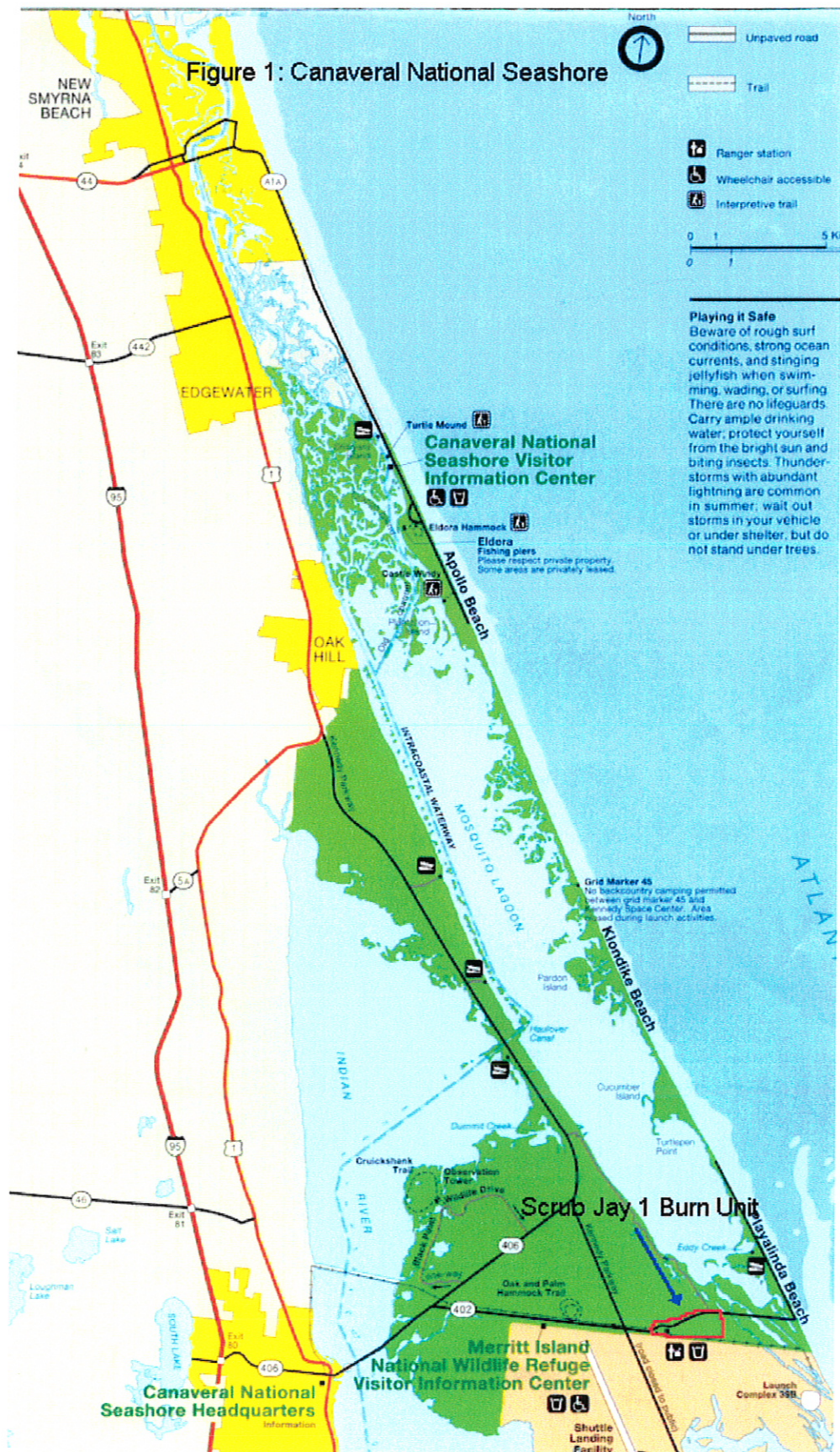
The beach is closed to the public between sunset and sunrise except for occasional guided turtle walks. These walks are limited in size to minimize disturbance to the nesting turtles.

On April 15, 2002, the park initiated sporadic patrols of the South District beach on four-wheeled all-terrain vehicles (ATV's) to record sea turtle emergences (nests and false crawls) and to screen nests. Regular patrols of both districts were implemented on April 29, 2001. 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 12, 2002, 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, number of depredated eggs counted and broken eggs removed from the nest site. 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.



The stake for every twentieth loggerhead and every tenth green nest was marked with white spray paint for each identification. All leatherback nests were marked. 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.

Forty-eight (48) 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 4026 sea turtle nests were deposited at CANA in 2002 - 3161 loggerheads, 857 greens and eight leatherbacks (Table 1). Overall nest density was 82.5 per kilometer for the loggerhead, 22.4 per kilometer for the green and 0.21 per kilometer for the leatherback.

The total number of loggerhead false crawls was 3323 or 86.8 per kilometer, a false crawl to nest ratio of 1:0.95 (Table 1). There were 674 green false crawls or 17.6 per kilometer, a false crawl to nest ratio of 1:1.3. Three leatherback false crawls were recorded, or 0.08 per kilometer, for a false crawl to nest ratio of 1:2.5.

As in former years, the greatest concentration of nesting was noted in the southern half of CANA, with 57.9% (2331) of the nests occurring in the South District (Brevard County) and 42.1% (1695) in the North District (Volusia County) (Table 1). Nesting densities were 134.7 and 70.8 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 2002, 98% (3957) of the 4026 nests deposited at CANA were screened, comprising 3739 undepredated and 218 partially depredated nests (Table 2, Initial Encounter). This included 3093 loggerhead, 856 green and eight leatherback nests.

An additional 68 (1.7%) of the loggerhead and one of the green nests were totally depredated prior to discovery (Table 2, Initial Encounter). No leatherback nests were depredated prior to discovery.

Table 1: 2002 Marine Turtle Crawl Survey, Canaveral National Seashore.

Overall

	Loggerhead	Green	Leatherback	Total
Nests	3161	857	8	4026
False Crawls	3323	674	3	4003
Nest Density (nest/km)	82.5	22.4	0.2	105.1
FC Density (FC/km)	86.8	17.6	0.08	104.5
FC to Nest Ratio	1:0.95	1:1.3	1:2.7	1:1.0

Distribution by District

North District (Volusia County)

	Loggerhead	Green	Leatherback	Total
Nests	1340	352	3	1695
False Crawls	1054	227	1	1282
Nest Density (nest/km)	73.9	19.6	0.21	93.6
FC Density (FC/km)	58.2	12.5	.06	70.8
FC to Nest Ratio	1:1.3	0:1.6	1:3.3	1:1.3

South District (Brevard County)

	Loggerhead	Green	Leatherback	Total
Nests	1821	505	5	2331
False Crawls	2269	447	2	2718
Nest Density (nest/km)	90.1	25.0	0.2	115.4
FC Density (FC/km)	112.3	22.1	0.1	134.7
FC to Nest Ratio	1:0.8	1:1.1	1:2.0	1:0.9

Figure 2a. Nests, False Crawls, Depredations and Tunneling Activity.
Grids 0-44 (North District)-2002

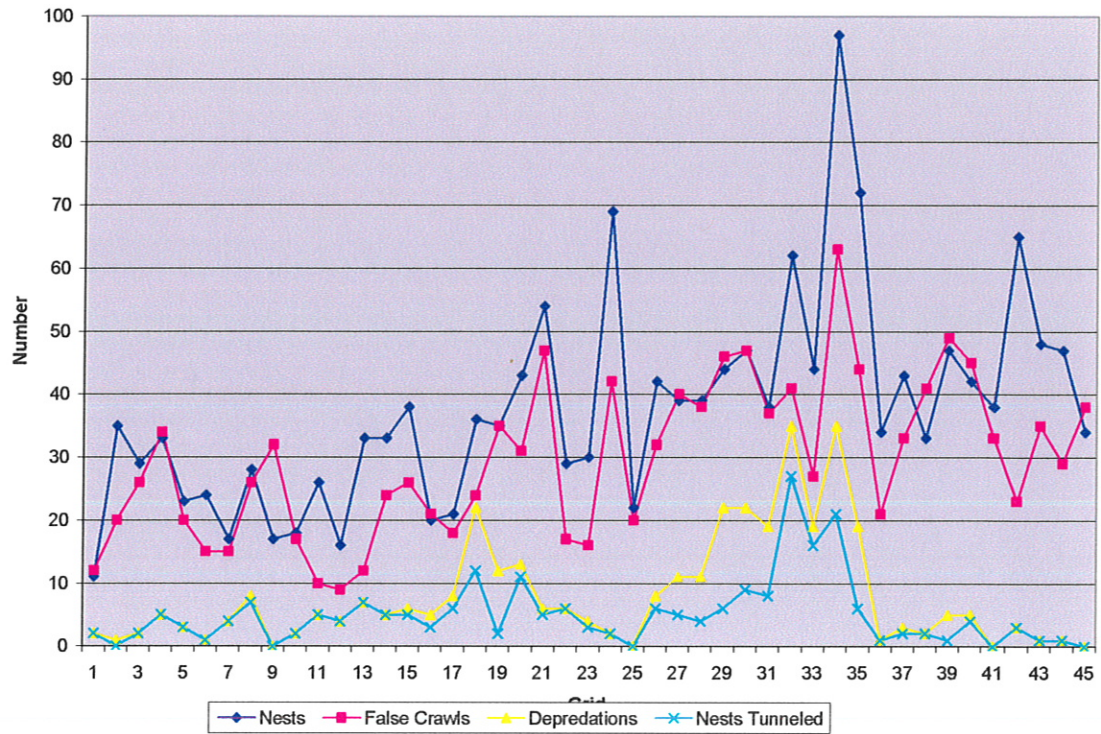


Figure 2b. Nests, False Crawls, Depredations and Tunneling Activity.
Grids 45-94 (South District)-2002

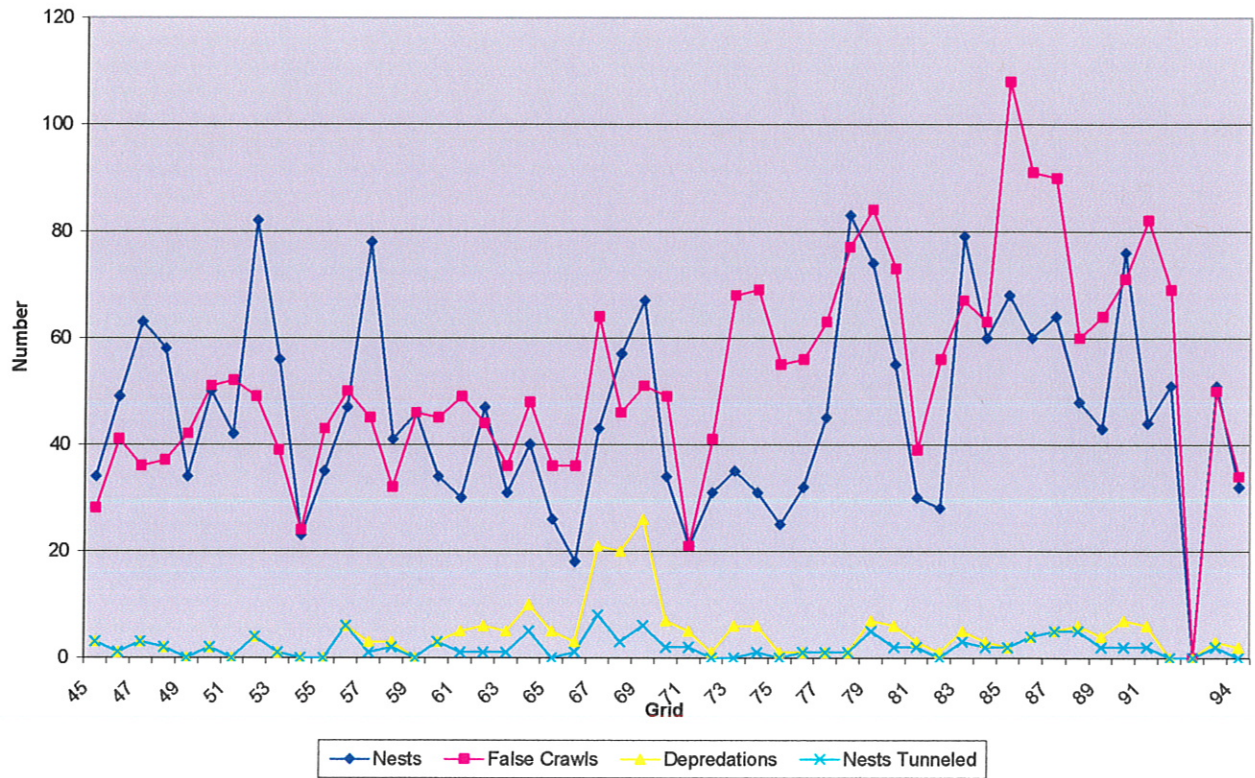


Table 2. Nest Treatment and Depredation, 2002. Canaveral National Seashore.

Initial Encounter

	Loggerhead	Green	Leatherback	Total
Not Dep/Screened	2894 (92%)	837 (98%)	8 (100%)	3739 (93%)
Part Dep/Screened	199 (06%)	19 (02%)	0	218 (05%)
Total Depredation	68 (02%)	1	0	69 (02%)
TOTAL	3161	857	8	4026

Part=Partial Dep=Depredation

Subsequent Depredation (G,I)

Screened Nests

	Loggerhead	Green	Leatherback	Total
North District	216	12	0	228 (14%)
South District	94	8	0	102 (04%)
Total	310	20	0	330 (08%)

Overall Depredation (Initial Encounter and Subsequent Depredation)

All Nests

	Loggerhead	Green	Leatherback	Total
Partial Depredation	392 (12%)*	35 (04%)	0	427 (11%)
Total Depredation	149 (05%)	4 (<1%)	0	153 (04%)
Total	541 (17%)	39 (04%)	0	580 (14%)

* 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 (3274)

By District

	Loggerhead	Green	Leatherback	Total
North District	334	21	0	355 (21%)*
South District	207	18	0	255 (11%)*
Total	541	39	0	580 (14%)

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

Subsequent Depredations

Eight percent (330) of screened nests were partially or totally depredated by predators that reached through the top of the screens to get the upper layers of eggs or tunneled underneath the screens (Table 2, Subsequent Depredation). Tunneling percentages were higher in the North District with 14% (228) of the screened nests depredated, versus 4% (102) in the South District. Sixty-three (02%) of the nests were recorded as being depredated more than once after initial screening (CANA files).

Overall Depredations

The overall depredation rate for both screened and unscreened nests and initial and subsequent depredations was 14%. This included 17% (541) of the loggerheads, 4% (39) of the greens, and no leatherback nests (Table 2, Overall Depredation, All Nests). Specifically, 5% (149) of the loggerhead nests were totally depredated and 12% (392) were partially depredated. Four percent (35) of the green nests were partially depredated and less than 1% (4) were totally depredated.

As in past years, the highest percentage of depredations (partial and total) occurred in the North District, where 21% (355) of the nests were depredated, compared to 11% (255) in the South District (Table 2, Overall Depredation, By District). A small number of problem raccoons ("tunnelers") were removed from the beach during the nesting season.

Monitored Nests

Every twentieth loggerhead nest was marked for excavation after the incubation period to determine hatching success. Of the 161 marked loggerhead nests, 147 (91%) were excavated (Table 3). One hundred and twenty eight (128) of these were un-depredated and 19 partially depredated. Five others (03%) were destroyed by predators and nine (06%) were eroded or of unknown fate (Table 3). Hatching success for undepredated nests was 59% and 33% for partially depredated nests. Combining the two yielded a hatching success rate of 56.5%.

Average clutch size was 100.7 eggs for undepredated nests. If an estimated 503 eggs are added to the unhatched total to represent the five totally depredated nests (5 nests times average clutch size of 100.7 eggs = 503.5 eggs), the adjusted hatching success is 55%.

Based on the above, the estimated number of loggerhead hatchlings produced on CANA's beach in 2002 was calculated as follows:

$(55\% \text{ hatchling success}) \times (100.7 \text{ eggs/clutch}) \times (3161 \text{ nests}) = 175,072 \text{ hatchlings.}$

Every tenth green nest was marked for excavation. Of the 85 marked nests, 80 (94%) were excavated (Table 3). The other five (06%) nests were eroded or of unknown fate (Table 3). Excavations nests included 76 non-depredated and 4 partially-depredated nests. Hatching success was 61 % for undepredated nests and 38% for partially-depredated nests, a combined success rate of 60%.

Average clutch size was 123.0 eggs. The estimated number of green hatchlings was 63,247, based on the formula:

$(60\% \text{ hatchling success}) \times (123 \text{ eggs/clutch}) \times (857 \text{ nests}) = 63,247 \text{ hatchlings.}$

All eight leatherback nests were excavated. Average clutch size was 77.3 eggs and hatching success was 43% (Table 3). None of the leatherback nests were depredated, eroded, or of unknown fate. Estimated number of hatchlings was:

$(43\% \text{ hatching success}) \times (77.3 \text{ eggs/clutch}) \times (8 \text{ nests}) = 266 \text{ hatchlings.}$

Table 3. Hatching Success of marked Nests, 2002. Canaveral National Seashore.

Loggerhead	Non-depredated	Partial Depredation	Overall
Nests marked	137	24	161
Nests Excavated	128	19	147
Total Eggs	12,887	1,573	14,460
Ave. Clutch Size	100.7		
Hatchlings Emerged	7,657	517	8,174
Hatching Success	59.4%	32.8%	56.5%
Nests Destroyed by Depredation	N/A	N/A	5 (3.1%)
Adjusted Hatching Success*	N/A	N/A	54.6%
Eroded/Unknown Fate	9	0	9 (5.6%)

* Adding average clutch size for 5 totally depredated nests to unhatched eggs

Green	Non-depredated	Partial Depredation	Overall
Nests marked	81	4 (4.7%)	85
Nests Excavated	77	3	80
Total Eggs	9,351	220	9,571
Ave. Clutch Size	123.0		
Hatchlings Emerged	5,700	38	5,738
Hatching Success	61.0%	17.3%	60.0%
Nests Destroyed by Depredation	N/A	N/A	0
Eroded/Unknown Fate	5	0	5 (5.9%)

Leatherback	Non-depredated	Depredated	Overall
Nests marked	8	0	8
Nests Excavated	8		8
Total Eggs	61.8		618
Ave. Clutch Size	77.25		77.25
Hatchlings Emerged	266		266
Hatching Success	43%		43%
Nests Destroyed by Depredation	0		0
Eroded/Unknown Fate	0		0

DISCUSSION

Nesting and False Crawl Totals

The 4026 nests recorded at CANA in 2002 (4026) was an increase of more the 700 from 2001 (3274), but still down from the 4400 – 4500 nests observed each year from 1998 – 2000 (Table 4). This upsurge was due to a record number of greens (857), a dramatic increase from the total of seven green nests in 2001. This continued the conspicuous up and down pattern for greens exhibited every year since 1989 (Figure 3).

Loggerhead numbers actually decreased for the third year in a row to 3161 (Table 4). Eight leatherback nests were observed in 2002, a similar amount to the 9 – 10 nests noted the previous three years (Table 4).

In 14 of the past 18 years, loggerhead nests exceeded false crawls; however, in 2002 false crawls slightly exceeded the number of nests with a ratio of 1:0.95 (Table 5). Leatherback nest totals exceeded false crawls for the twelfth time in the 13 years that leatherback crawls have been recorded (Table 5). The green pattern differs from the other two species; in 2002 nests exceeded false crawls for only the ninth time in 18 years (Table 5).

Screening Activity and Nest Depredation

Ninety-eight percent (3957) of the sea turtle nests deposited at CANA in 2002 were screened. Overall nest depredation dropped from 19.9 in 2001 to 14.4% (Table 6). The depredation rate has fluctuated between 29.9 and 14.4% since 1993, when daytime runs were implemented to detect subsequent nest depredations.

Tunneling activity, digging under the screens to reach the eggs, decreased from 9.9% in 2001 to 8.3% in 2002 (Table 6). Since 1985, tunneling has ranged from 18.7% in 1988 to 1.9% in 1990. The unusually high value in 1988 was almost twice that of any prior year.

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). Kramer (1996) noted raccoon breeding occurred in most months of the year at CANA, giving evidence for a potential explosion in the raccoon population at the park. With ample food resources and the absence of natural predators periodic surges in the raccoon population at CANA are inevitable. Although park staff works hard to remove trash, refuse from one million visitors a year adds to the food source. Natural factors, such as distemper, serve to return the raccoon population to lower levels.

Table 4. Sea Turtle Nest Totals, 1984-2002. Canaveral National Seashore.

YEAR	LOGGERHEAD	GREEN	LEATHERBACK	UNKNOWN	TOTAL
2002	3161	857	8		4026
2001	3257	7	10		3274
2000	3892	662	9		4563
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, 1984-2002, Canaveral National Seashore, Titusville, Florida.

FIGURE 3. GREEN SEA TURTLE NESTING TOTALS CANAVERAL NATINOAL SEASHORE
1985-2002

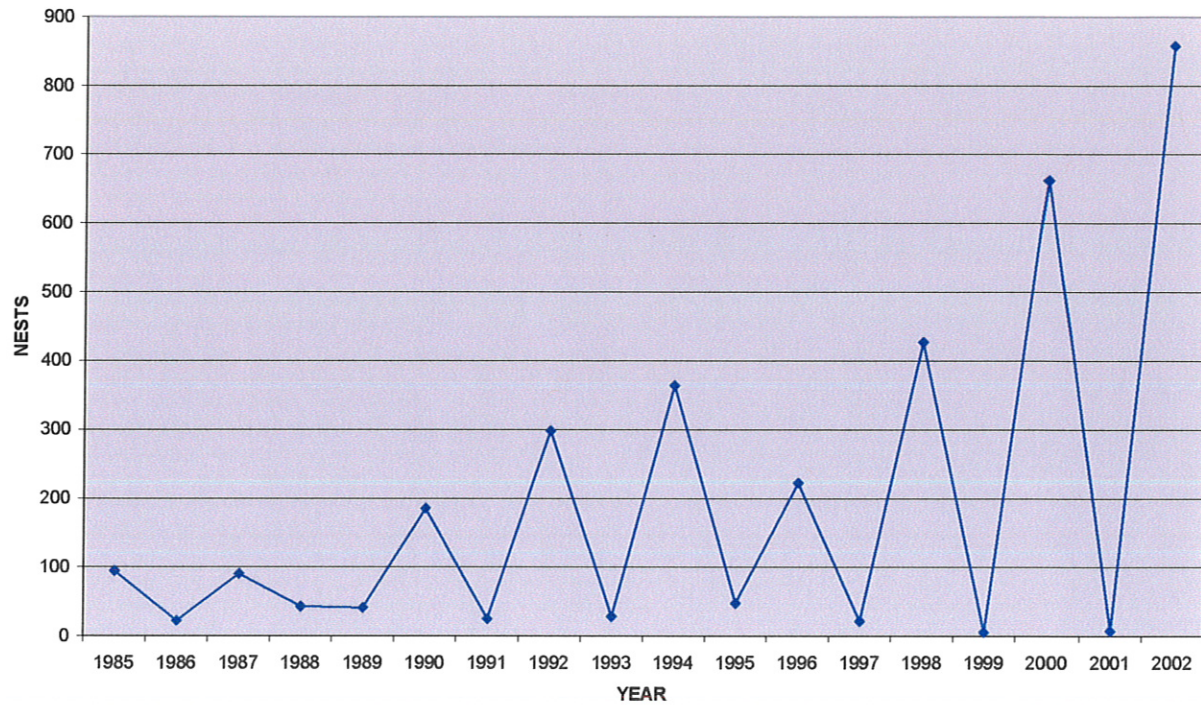


**FIGURE 4. LOGGERHEAD SEA TURTLE NESTING TOTALS CANAVERAL NATIONAL
SEASHORE 1985-2002**

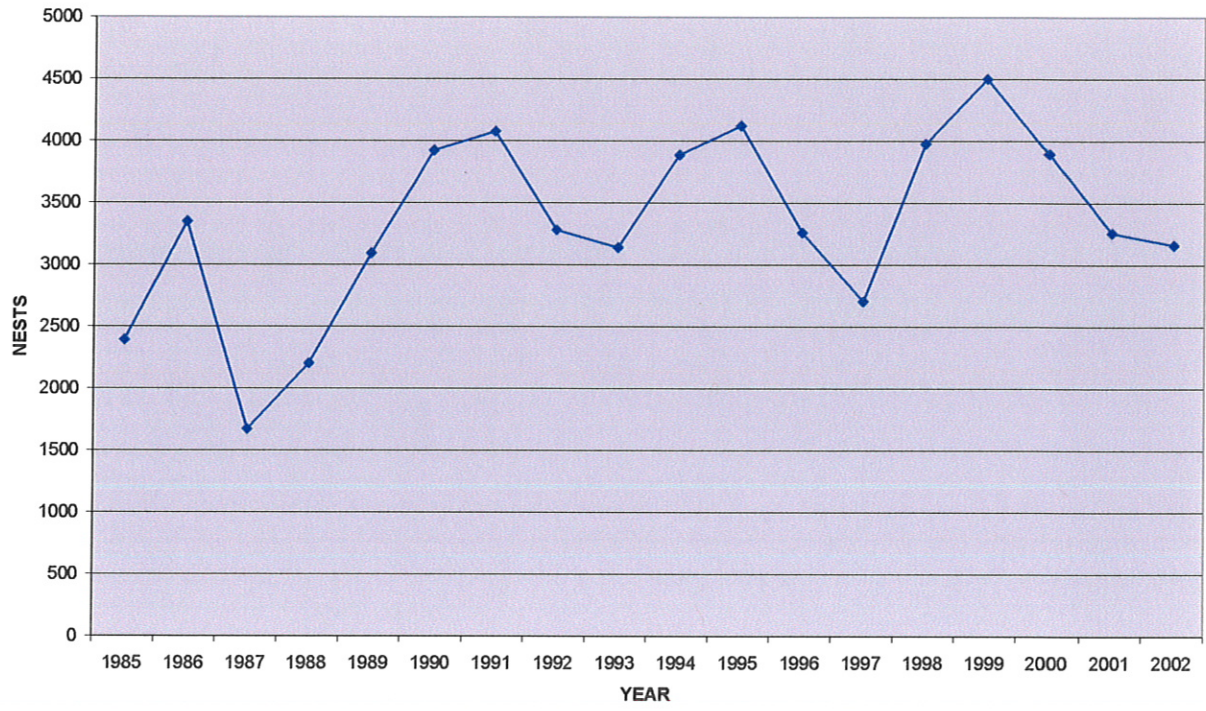


Table 5. False Crawl to Nest Ratio, 1984-2002. Canaveral National Seashore.

Year	Loggerhead	Green	Leatherback
2002	1:0.95	1:1.27	1:2.66
2001	1:1.54	1:0.70	1:5.00
2000	1:1.02	1:0.71	1:3.00
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, 1984-2002, Canaveral National Seashore, Titusville, Florida.

Table 6. Amount of Screening and Depredation of Screened Nests, 1984-2002.
Canaveral National Seashore.

YEAR	NESTS	NESTS SCREENED	SCREENED NESTS DEPREDATED (%)	ESTIMATED OVERALL DEPREDATION (%)
2002	4026	3957(98%)	8.3	14.4
2001	3274	3207 (98%)	9.9	19.9
2000	4563	4304 (94%)	7.2	23.0
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%, as established in the U.S. Fish and Wildlife Service sea turtle recovery plans (NMFS and USFWS 1991). A hatching rate of 59% was recorded for 128 undepredated loggerhead nests. Adding in 19 partially-depredated nests dropped the rate to 57%, and further adding the average clutch size for 5 totally depredated nests reduced the overall estimated rate to 55% (Table 3). These rates were slightly lower than the previous several years, where the non-depredated/partially depredated nest rates ranged from 61 to 64% (Table 7). The 2002 success rate for green nests was 61% for undepredated nests and 60% overall (Table 3). Previous hatching rates ranged from 51 to 71% (Table 7). Leatherback hatching success was 43%, the second highest rate over the last seven years (Table 3 and Table 7).

In 2002, 2001 and 2000, the hatching rate of partially depredated nests was 33, 36 and 37%, respectively. 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), 47% hatched in 2002, 55% in 2001 and 57% in 2000. This indicates that the effort to clean up and screen partially depredated eggs can save a significant portion of the remaining eggs. 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.

Table 7. Comparison of Hatching Success With Previous Years, 1996-2002.
Canaveral National Seashore

	Loggerhead	Green	Leatherback
2002	57%(55%)	60%(N/A)	43%(N/A)
2001	64% (62%)	-	32% (N/A)
2000	61% (56%)	56% (N/A)	38% (N/A)
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)

Initial percentage includes non-depredated and partially-depredated nests.

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

Impact of High Tides

Erosion was less of a factor than the previous several years. Fall storm surges that wiped out nest markers and presumably a significant amount of the nests laid late in the nesting season did not occur in 2002. Less than six percent of the nests marked for excavation were eroded or of unknown fate (Table 3).

ACKNOWLEDGEMENTS

Canaveral National Seashore's sea turtle nest screening program would not be possible without the effort of many dedicated people. Don Mock provided training, maintained supplies and kept the fleet of ATV's running. The seasonal employees, Kristin Kniefl, Michael Daley and Sean McKenna, patrolled the beach each night, dealing with high humidity, bothersome insects and unexpected obstacles, but always accomplishing the task. The four Student Conservation Association (SCA) resource assistants, Kristy Bender, Laurel Pierpont, Amanda Shults and Mairead Maheijan provided regular depredation patrols and maintained the large database. Laurel Knapp, an intern from Western Michigan University, analyzed data and wrote portions of the final report. And then there were the 60 volunteers who sacrificed sleep and comforts to support the cause of sea turtle preservation. Thanks to you all.

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