

EVALUATION OF THE MARINE TURTLE
NESTS SCREENING PROGRAM
AT CANAVERAL NATIONAL SEASHORE, FLORIDA
IN 1986

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ABSTRACT

Canaveral National Seashore completed the third year of the Marine Turtle Nests Screening program in 1986. Marine turtles deposited 3374 nests on the 23.25 miles of beach. This unprecedented number of nests included 22 green turtle (Chelonia mydas) and three leatherback (Dermochelys coriacea) nests. Both species are endangered. The remaining 3349 nests were deposited by loggerhead turtles (Caretta caretta), a threatened species.

Rangers placed wire mesh screens over 1517 turtle nests (45 percent of the total nests deposited) to prevent raccoons (Procyon lotor) from depredating the turtle eggs. Of these screened nests, 1450 (95.6%) hatched successfully. Of the 1857 unscreened nests, only 101 (5.4%) hatched successfully. Combining the successful screened and unscreened nests, 1551 nests hatched and emerged successfully. This represents a hatching success of 46 percent.

Analysis of 172 hatched nests revealed that an average (mean) of 87 hatchlings emerged from each nest. Approximately 134,937 hatchlings emerged from nests. Loss of hatchlings to ghost crabs was estimated to be approximately one percent.

Raccoons disturbed 57 (3.7%) of the screened nests. Thirty-nine of the disturbed nests failed to hatch. In previous years, raccoons were depredating up to seven percent of the screened nests.

The cost per hatchling (134,937 hatchlings/\$30,000 project cost = \$0.22) is lower than other projects that manipulate eggs (nests relocation, incubation, etc.). The screening of turtle nests allows large numbers of hatchlings to enter the ocean without detrimental effects to the ecosystem by not selecting against a native population (raccoons).

INTRODUCTION

Canaveral National Seashore is a pristine stretch of beach extending from Bethune/New Smyrna Beach in Volusia County to the Kennedy Space Center Security Beach in Brevard County. This 23.25 mile beach is characterized by well defined dunes covered with native vegetation. No construction or development is present with the exception of seven private homes on the north end and numerous public access boardwalks throughout the Seashore. No beach armoring is present within the Seashore.

Soon after the National Park Service assumed control of the area in 1975, park rangers began to note large concentrations of marine turtle nests (approximately 100 per mile), primarily loggerhead (Caretta caretta), a threatened species and a smaller number of green (Chelonia mydas) turtle nests. The Florida green turtles are currently on the endangered species list. These early reports also documented extensive devastation of the newly deposited turtle nests by raccoons (Procyon lotor). Starting in 1981, the University of Georgia conducted beach surveys to document turtle nesting and raccoon depredation. The study also attempted to determine an effective nest protection technique. Using this research, the National Park Service initiated a turtle nest screening program in 1984. Two seasonal workers conducted nesting surveys five days per week and screened 213 turtle nests.

In 1985 working seven days per week, six workers screened 1023 nests. Of the screened nests, 839 (82%) hatched successfully.

In 1986, six workers collected nesting data (beach surveys) seven days per week, screened newly deposited nests and monitored the outcome of a sample of unscreened (control) nests.

METHODS

Study Area

Canaveral National Seashore is one of the largest turtle rookeries in the United States that is lacking development of any type. With the exception of the seven private single family homes located at the northern boundary there are no sources of artificial lighting and the sand dune is not armored in any way. No vehicles, except ranger operated all terrain vehicles, are allowed on the beach. There is no public entry after sunset and with the exception of ranger guided turtle watch programs, no humans are on the beach until 4:00 AM when rangers start patrolling the beach. One team of rangers began at the south end of the Seashore, while a second team started from the north end. Both teams worked toward the Brevard/Volusia County line. The 12.0 miles in Brevard County (south end of the Seashore) is known locally as Playalinda Beach. The 11.25 miles in Volusia County is referred to as Apollo Beach. Quarter mile grids had previously been established and permanently marked. Grid 0 starts at the north boundary at Bethune Beach. The south boundary, Grid 93, is the Kennedy Space Center Security Beach. See map.

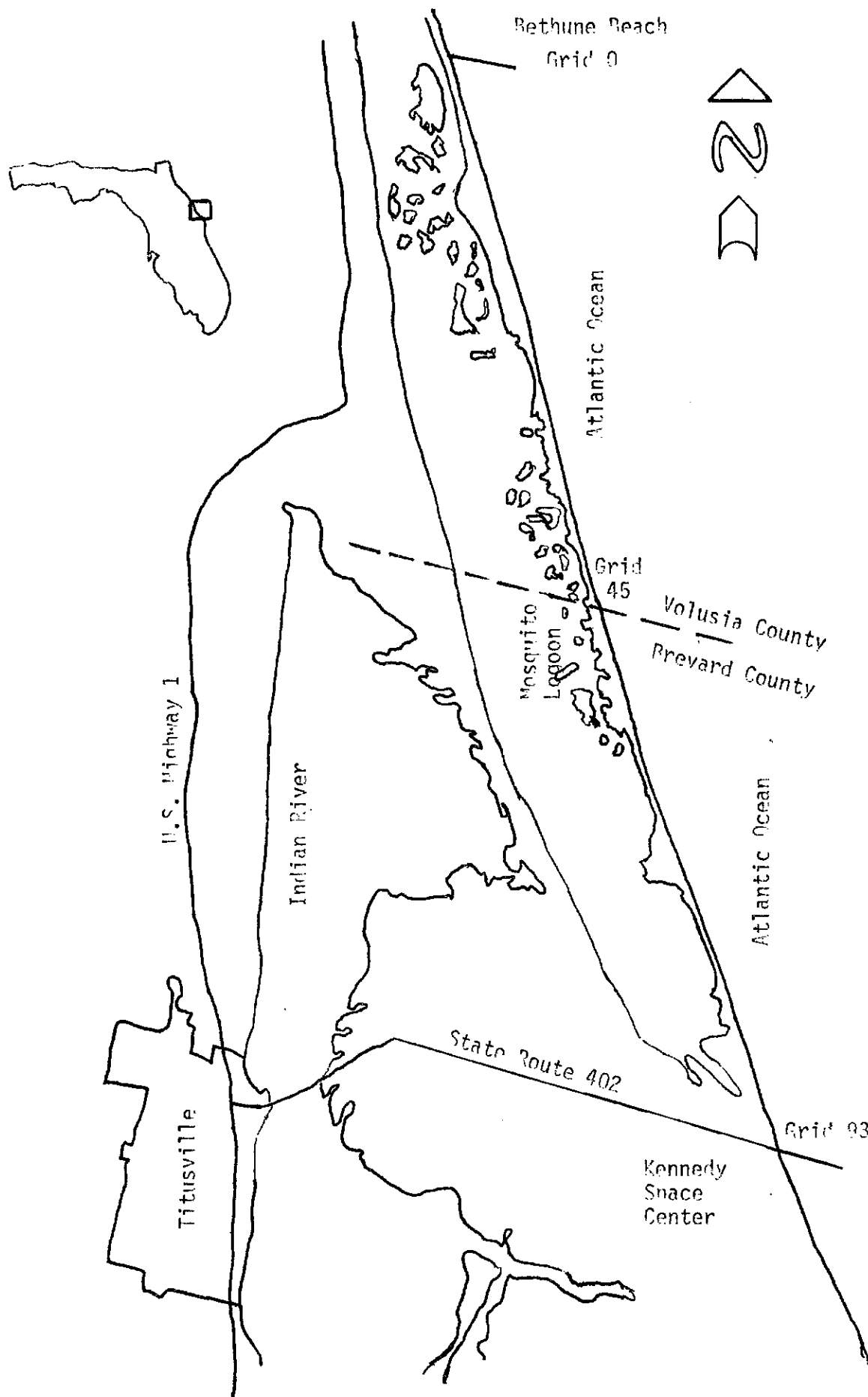
Nesting Data Collection

During each morning's patrol, any previously unrecorded turtle activity was noted on data sheets. Turtle crawl activity was divided into three categories: (1) false/aborted crawl; (2) nest/depredated; (3) nest/not depredated. Also recorded were the grid location, date, species and ranger's name. Identification of species was done by visual examination of the crawl. In several instances, rangers were unable to readily determine the species due to some abnormality of the crawl. In such cases the species was listed as "undetermined". After the data sheets were completed, the crawl was obliterated by driving an all terrain vehicle over it. Nesting data was collected daily, except holidays, from 5 May through 10 September 1986.

Screening

In order to screen a turtle nest, it proved essential to probe for the egg cavity. Once the cavity was located, rangers dug by hand into the cavity. This was necessary to determine if eggs were actually present and to assure that any eggs broken by probing were removed. After the undamaged eggs were reburied, the sand was leveled. A precut 4x4 feet section of galvanized welded-wire screen was centered over the nest. The mesh size, 2x4 inches, permits hatchlings to escape unaided, which allows the screen to remain in place for the entire incubation period.

The screen corners were anchored with 36 inch sections of #3 rebar, driven into the sand with a hammer. After the screen was in place, it was covered with one inch of sand. This is for



aesthetic purposes and to impede rust formation on the screen. A wooden stake with the nest number, species, grid location, date and distance (in feet) to the nest was placed at the edge of the dune. Thereafter, the screened nests were visually checked daily for predation, tampering, hatching or emergence.

When encountering a depredated nest, rangers would count damaged eggs. If less than 15 eggs were broken, rangers would remove damaged eggs, recover the nest cavity and screen the nest.

Screening of nests started on 11 May and ceased on 19 July 1986.

Nest Relocation

Occasionally turtle nests were deposited low in the surf zone where succeeding tides and waves would repeatedly inundate the nests. Since experience indicated that these eggs would be washed away or fail to hatch, rangers relocated these low nests. Experience had likewise indicated that eggs deposited in the dunes in the immediate vicinity of vegetation would not hatch due to root intrusion (Ehrhart and Witherington, 1986). Therefore, these eggs were relocated by rangers.

In either instance, eggs high or low on the beach were moved to a suitable location within 50 feet of the natural nest. Rangers would dig a cavity approximately 10 feet seaward of the dune line. Eggs excavated from the natural nests were counted and carefully placed in the man-made cavity. After the cavity was covered with sand, the nest was screened using the same technique described for a natural nest.

Sample Nest Marking

After the screening operation ceased on 19 July, workers continued to collect daily nesting data. All screened nests were observed daily to check for raccoon depredation, ghost crab intrusion, hatching/emergence or human tampering. Any fresh nest encountered that was not depredated by raccoons was marked by a wooden stake. These unscreened marked nests were checked daily for depredation, hatching or emergence.

Nest Excavation

Three days after a nest hatched/emerged, the screen was removed and the eggs were excavated. Rangers counted empty (hatched) and unhatched eggs. Live hatchlings were noted and released. No attempt was made to determine if unhatched eggs were fertile or developed.

If a nest was unhatched after 68 days, workers excavated the nest. The unhatched eggs were examined for plant root intrusion and random eggs were opened and examined visually.

Hatchling Emergence

No attempt was made to count the number of hatchling tracks radiating from a nest. Tracks of predators, dead hatchlings and signs of hatchling disorientation were noted.

RESULTS

Nesting

Data collected between 5 May and 10 September indicated that 3374 nests were laid on the beaches of Canaveral National Seashore. The mean nesting density was 145 nests per mile or 90 nests per kilometer. There were 3464 false crawls. The nest to false crawl ratio of 1:1.03 is similar to those ratios of previous years (1:1.20 in 1984 and 1:0.83 in 1985). Table 1 summarizes crawl and nesting activity.

Table 1 1986 Turtle Crawl and Nest Summary, Canaveral National Seashore

<u>Species</u>	<u>Number of Nests</u>	<u>Number of False Crawls</u>
Loggerhead	3331 (98.7%)	3403 (98.2%)
Green	22 (0.7%)	29 (0.8%)
Leatherback	3 (0.1%)	0 (0.0%)
Undetermined Species	18 (0.5%)	32 (0.9%)
Total	3374 (100%)	3464 (99.9%)

Green turtles accounted for only 0.7% of the total nests. The 22 green nests is a marked decrease from the 94 green nests laid in 1985, but only one fewer than the number of green nests deposited in 1984. This trend was reported by other observers on Florida's east coast (D. George, PanAm Services Inc./CCAFS. pers. comm; L. Ehrhart, Univ. of Central Florida, pers. comm.).

The 3331 loggerhead turtle nests was the largest number ever recorded for the Seashore. This represents a 39% increase over 1985. Leenhouts (1986) reported a 37% increase for 1986 over 1985 for loggerhead nests on the security beach of the Kennedy Space Center and D. George (pers. comm.) reported an increase at Cape Canaveral Air Force Station.

Three leatherback (Dermochelys coriacea) nests were recorded, all in the Volusia County segment of the Seashore. The only previous leatherback nesting on the Seashore was in 1983.

Whenever the species identification was unsure, rangers listed the crawl as "undetermined species". In most instances the crawls had some visual abnormality, perhaps caused by a missing or mutilated flipper. It is believed that many of the "undetermined species" crawls were loggerhead turtles.

In at least seven instances turtles nested in daylight hours.

The seven occurrences were scattered throughout the nesting season and occurred between 9AM and 5PM. No pattern was evident in the locations selected for daytime nestings.

Nesting turtles failed to bury all the eggs in a clutch a minimum of five times. In four instances, the eggs in the nest cavity were covered and then the female turtle would deposit additional eggs (range 1 to 73) on the surface of the sand. In one instance, a nest cavity with four eggs was found unburied.

Twelve Hour Predation Rate

Nests depredation rates were calculated by recording the number of fresh nests that were depredated. Provancha and Provancha (1985) refer to this figure as the twelve hour predation rate as it represents nests that were deposited and depredated within twelve hours previous to the morning crawl surveys. Mean 12 hour predation rate (number of nests depredated divided by total number of nests) was 45.6%.

Nest Relocation

Thirty two nests were relocated. Twenty five of the relocated nests were originally deposited near vegetation in the sand dune. Six nests were relocated from the surf's edge and one nest was moved from near a public boardwalk where pedestrian traffic would have adversely affected the nest. The total number of eggs relocated was 3397 with the mean clutch size of 106 eggs per nests. Range: 74 - 142 eggs per clutch.

Predators

Raccoons (Procyon lotor) are the major predator on turtle eggs and hatchlings. Ghost crabs (Ocypode quadrata) were reported by Ehrhart and Witherington (1986) to destroy 2 percent of loggerhead eggs in south Brevard County. Rangers at Canaveral regularly reported ghost crabs in or near nest cavities. No attempt was made to quantify the destruction caused by ghost crabs but it was believed to be insignificant (less than 1 percent).

Ghost crabs and raccoons depredated post-emergence hatchlings. Records indicate that 1490 hatchlings were killed by ghost crabs and/or raccoons. The dead hatchlings (range 1-60, mean 10) were counted from 147 nests. The mortality of 1.1 percent of emerging hatchlings is probably underestimated since many hatchling carcasses were not counted due to being pulled down a ghost crab hole, being eaten away from the crawl zone, etc.

Feral swine (Sus scrofa) were not present on the beaches of the Seashore with one exception when a solitary hog walked a short distance on the beach at the south end of the study area. The

hog did not disturb any turtle nests.

Human disturbance of eggs or hatchlings was not a factor at the Seashore. In four cases, park visitors removed or loosened screens covering nests, allowing raccoons to depredate the four clutches.

Screening

Rangers placed wire screens over 45% of the nests deposited on Canaveral National Seashore. The 1517 nests screened represent an increase of 48% over the number of nests screened in 1985. Screening dates were 7 May through 19 July, inclusive. Table 2 summarizes screening results.

Of 1517 nests screened, 109 (7.2%) had been partially depredated prior to the screens being placed over the nests. All partially depredated and screened nests were loggerhead.

Table 2 1986 Turtle Nests Screened, Canaveral National Seashore

	Turtle Species			
	<u>Loggerhead</u>	<u>Green</u>	<u>Leatherback</u>	<u>Undetermined Spec.</u>
Partial Depredated/ Screened	109	0	0	0
Not Depredated/ Screened	1396	8	1	3
Total screened	1505	8	1	3
TOTAL	1517			

Predation of Screened Nests

Fifty-seven (3.7%) of the screened nests were subsequently depredated by raccoons. Methods of raccoon disturbance to the screened nests occurred in two patterns. On 19 occasions (1.2%) raccoons reached down through the screens and were able to remove a small number of eggs, usually less than 10. In these instances, broken eggs were removed and the screens replaced after adding sand in order to increase the distance between the egg cavity and the screen. Eighteen of these disturbed screened nests hatched and emerged successfully.

Thirty-eight screened nests were destroyed by raccoons digging a tunnel into the egg cavity starting from outside the edge of the

screen. These 38 screened nests were totally destroyed and did not hatch.

Nineteen of the 57 screened nests breached were within 48 hours of the initial placement of the screens. The remaining 39 depredated nests were breached between day 3 - 56 of the incubation period. See Appendix 1.

Marked Unscreened (Control) Nests

The placement of screens ceased on 20 July. From that date until 15 August, rangers placed wooden markers on every other fresh nest encountered and monitored these marked nests until their outcomes were determined. Of the 344 nests monitored, 175 (51%) were depredated within 12 hours of deposition. Table 3 gives the outcome of the 344 marked unscreened nests.

Table 3 Outcome of Control Nests, Canaveral National Seashore

<u>Outcome of Nest</u>	<u>Number</u>	<u>Percent</u>
Depredated		
Within 12 hours	175	50.9
13 - 48 hours	37	10.8
2 - 5 days	23	6.7
6 - 30 days	9	2.6
31 - 60 days	17	4.9
Unknown fate	40	11.6
Hatched	43	12.5
Total	344	100.0

Incubation Period

The first 1000 screened nests that hatched successfully were used to calculate the mean incubation period. The incubation period was defined as the period from deposition of the eggs to the first emergence, no matter how few hatchlings emerged, as the conclusion of the incubation period. The mean incubation period is given in Table 4.

Table 4 1986 Incubation Period, Canaveral National Seashore

Hatching dates	07/07/86 - 09/18/86
Mean incubation length	53.7 days
Number of nest	1000
Range	32 - 67 days

Outcome of Nests

Of the 1517 nests that were screened to thwart raccoon depredation, 1450 hatched and emerged successfully. Table 5 gives the outcome of the screened nests.

Table 5 Outcome of Screened Nests, 1986, Canaveral National Seashore

<u>Outcome</u>	<u>Number</u>	<u>Percent</u>
Hatched	1450	95.6
Root intrusion	7	0.5
Humans removed screens/ raccoons depredated	4	0.3
Inundated or eroded	7	0.5
Raccoons tunnelled under screens	38	2.5
Failed to hatch (perhaps infertile)	2	0.1
Unable to relocate	9	0.5
Total Screened Nests	1517	100.0

In addition to the 1450 screened nests hatching, an additional 101 unscreened nests hatched. This figure is extrapolated from Table 3, Outcome Of Control Nests. Eight hundred eleven nests were deposited after the screening process ceased on 19 July. Table 3 shows that 12.5% of the control nests hatched for an estimated 101 hatched unscreened nests.

The hatching of 1551 nests represents a hatching success of 46 percent. Hatching success of the 1857 unscreened nests (101 nests successful) was 5.4 percent.

Excavations

Rangers excavated 178 nests in order to determine the number of eggs and the hatching/emerging success. Four green nests, two leatherback nests and 172 loggerhead nests were excavated. Counts were made of unhatched eggs, hatched eggs, live and dead hatchlings found within the nests cavities. Live hatchlings were released, but for statistical purposes, were counted as dead. Tables 6 through 9 give excavation results.

Table 8 Non-Predated Loggerhead Nests Excavations, Canaveral
National Seashore

Number of nests excavated	127
Total number of eggs counted	14,147
Mean clutch size	111.4
Total unhatched eggs	3,088
Total hatched eggs	11,059
Mean number of hatchlings	87.1
Mean number of unhatched eggs	24.3
Mean hatching success	78.3%

Table 9 Partial Depredated Loggerhead Nests Excavation
Canaveral National Seashore

Number of nest excavated	45
Total number of eggs counted	4,470
Mean clutch size (how many eggs remaining after depredation)	99.3
Total number of unhatched eggs	1,501
Total number of hatched eggs	2,969
Mean number of emergences/hatchlings	66.0
Mean number of unhatched eggs	33.4
Hatching success	66.4%

Accuracy of Excavations

The counting of hatched and unhatched eggs in a post emergence nest has been questionable as to the accuracy of the number of empty eggs. In order to assess the accuracy of the post emergence egg counts, 16 clutches were counted within 12 hours of deposition as these nests were being relocated. The 16 nests were then counted three days after emergence. Comparison of initial counts and the counts made after emergence shows a 4.68 percent error in counting. Although this technique is not as accurate as would be desired, the small percent error indicates that post emergence egg counts offer a convenient method to determine the clutch size and hatching success. Appendix 1 shows the 16 nests that were counted.

DISCUSSION

Nesting

The 3374 nests deposited on Canaveral National Seashore represent a figure substantially higher than previous years. There were 39.4 percent more nests this year than 1985 and 57.8 percent more than 1984 levels. Table 11 gives nesting numbers for the three years where data is available for the entire length of the beach.

Table 11 Total Nests By Year, Canaveral National Seashore

<u>Year</u>	<u>Loggerhead</u>	<u>Green</u>
1984	2111	23
1985	2389	94
1986	3331	22

Leenhouts (1986) reported a 34 percent increase in total nests from 1985 and a 39 percent increase over 1984. D. George (PanAm Service, Cape Canaveral Air Force Station, pers. com.) reported a 20 percent increase in total 1986 nesting when compared to 1985. Ehrhart (pers. com.), working in Melbourne Beach, reported a slight increase in nesting numbers for 1986 over the 1985 level. Marcus (pers. com.) reported a 12 percent increase at Hobe Sound National Wildlife Refuge.

Loggerhead nesting densities vary widely on a year-to-year basis. At present there seems no way to predict how many nests will be deposited on a yearly basis. Many study areas in Florida reported record numbers of loggerhead nests in 1985 and even higher nesting numbers in 1986. This two year trend indicates either a substantial recruitment in the adult female population or the results of coinciding cycles in nesting activity among groups of females as suggested by Ehrhart and Witherington (1986).

The number of green turtle nests dropped to nearly the same number counted in 1984. The decline in green nests appears to agree with the suggestion of Ehrhardt and Witherington that nesting cycles of groups of females may coincide. They correctly predicted 1986 to be a "poor" year for greens as compared to 1985.

Ehrhart and Witherington (1986) reported that green turtles avoid lighted areas. Canaveral National Seashore has no artificial light sources except for seven private homes on the north end of the Seashore. These homes will eventually be re-

moved. The pristine condition of the Seashore's beach will grow in importance as a turtle rookery as the coastal development of Florida increases. The roughly 41 miles of federally owned beach (National Park Service, NASA and U.S. Air Force) will represent the longest stretch of undeveloped and unarmored beach on Florida's east coast.

Twelve Hour Predation Rates

Table 12 shows the twelve hour predation rates broken down by counties.

Table 12 Depredation Rates By Counties, Canaveral National Seashore

Year	Brevard County	Volusia County
1984	65%	N/A
1985	54%	28%
1986	51%	37%

As in 1985, the screening effort was equal in each county (same number of workers beginning at the same hour). The total number of nests laid in each county was not equal (1990 nests in Brevard County vs. 1384 nests in Volusia County).

Using a simple mathematical model, rangers in Volusia County should have screened fewer nests than their counterparts in Brevard County since there were fewer nests deposited. However the number of nests screened by both crews were nearly equal (765 screened in Brevard vs. 752 in Volusia). The lower twelve hour predation rate in Volusia County for both 1985 and 1986 may be explained by the appearance of raccoons visually sighted by rangers. Raccoons in Volusia County apparently were affected by some bacterial/viral infestation as reported by Bryant (1986). Evidence of further or continuing infestation within the raccoon population was not visible in 1986, however the population apparently declined due to the "disease" and has not recovered to the 1984 levels.

Predation Rates 1985 Verses 1986

Appendix 2 shows the nesting density for each one-quarter mile grid for both 1985 and 1986. Generally, a grid that had a higher density of nesting in 1985 had a relatively high density of nesting in 1986.

Appendix 3 shows twelve hour predation rates for each one-quarter mile grid. Predation rates ranged from 0 to 92 percent in 1985 and 0 to 85 percent in 1986.

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APPENDIX 1

The following graph shows the time interval between the time that nests were screened and when the screened nests were depredated by raccoons. Two nests were screened by turtle watch groups immediately after nests deposition. These two screened nests were tunnelled into by raccoons by the following morning when rangers collected data. Thus the entry at "0" days.

Item	Quantity	Unit	Value	Remarks
1. 1000	1000	kg	1000	1000
2. 1000	1000	kg	1000	1000
3. 1000	1000	kg	1000	1000
4. 1000	1000	kg	1000	1000
5. 1000	1000	kg	1000	1000
6. 1000	1000	kg	1000	1000
7. 1000	1000	kg	1000	1000
8. 1000	1000	kg	1000	1000
9. 1000	1000	kg	1000	1000
10. 1000	1000	kg	1000	1000
11. 1000	1000	kg	1000	1000
12. 1000	1000	kg	1000	1000
13. 1000	1000	kg	1000	1000
14. 1000	1000	kg	1000	1000
15. 1000	1000	kg	1000	1000
16. 1000	1000	kg	1000	1000
17. 1000	1000	kg	1000	1000
18. 1000	1000	kg	1000	1000
19. 1000	1000	kg	1000	1000
20. 1000	1000	kg	1000	1000
21. 1000	1000	kg	1000	1000
22. 1000	1000	kg	1000	1000
23. 1000	1000	kg	1000	1000
24. 1000	1000	kg	1000	1000
25. 1000	1000	kg	1000	1000
26. 1000	1000	kg	1000	1000
27. 1000	1000	kg	1000	1000
28. 1000	1000	kg	1000	1000
29. 1000	1000	kg	1000	1000
30. 1000	1000	kg	1000	1000
31. 1000	1000	kg	1000	1000
32. 1000	1000	kg	1000	1000
33. 1000	1000	kg	1000	1000
34. 1000	1000	kg	1000	1000
35. 1000	1000	kg	1000	1000
36. 1000	1000	kg	1000	1000
37. 1000	1000	kg	1000	1000
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64. 1000	1000	kg	1000	1000
65. 1000	1000	kg	1000	1000
66. 1000	1000	kg	1000	1000
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68. 1000	1000	kg	1000	1000
69. 1000	1000	kg	1000	1000
70. 1000	1000	kg	1000	

APPENDIX 2

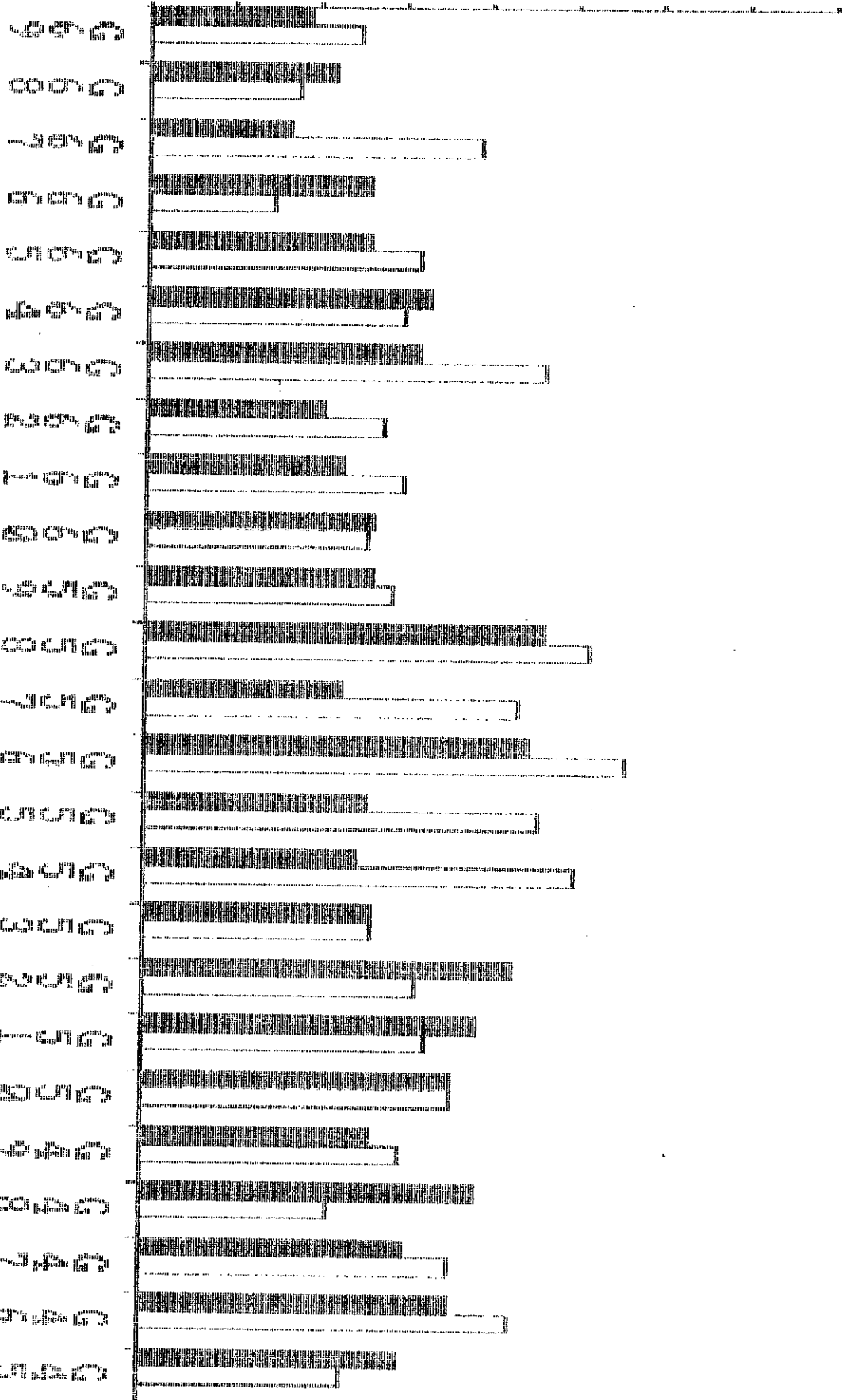
This chart shows the loggerhead nests that were relocated due to low position near the surf line or high on the beach in the dunes. Nests were excavated after emmergence and the eggs recounted. Results indicated that this method of egg counting gives a degree of error of (plus or minus) 4.68 percent.

Nest Number	# Eggs Relocated	Empty Eggs	Unhatched Eggs	Total Excav.	# Eggs Diff.	Percent Diff.
P021	107	74	23	97	10	-9.3
P020	99	86	21	107	8	+8.1
P167	105	80	22	102	3	-2.9
P187	120	96	24	120	0	0
P195	101	69	24	93	7	-6.9
P240	84	72	14	86	2	+2.4
P308	90	74	14	88	2	-2.2
P281	119	99	24	123	4	+3.4
A165	84	63	20	83	1	-1.2
A235	77	64	5	69	8	-10.4
A028	140	97	26	113	17	-12.1
P518	118	99	14	113	5	-4.2
P517	142	128	5	133	9	-6.3
A516	126	115	12	127	1	+0.8
A432	91	86	5	91	0	0
A498	80	80	5	85	5	+6.3

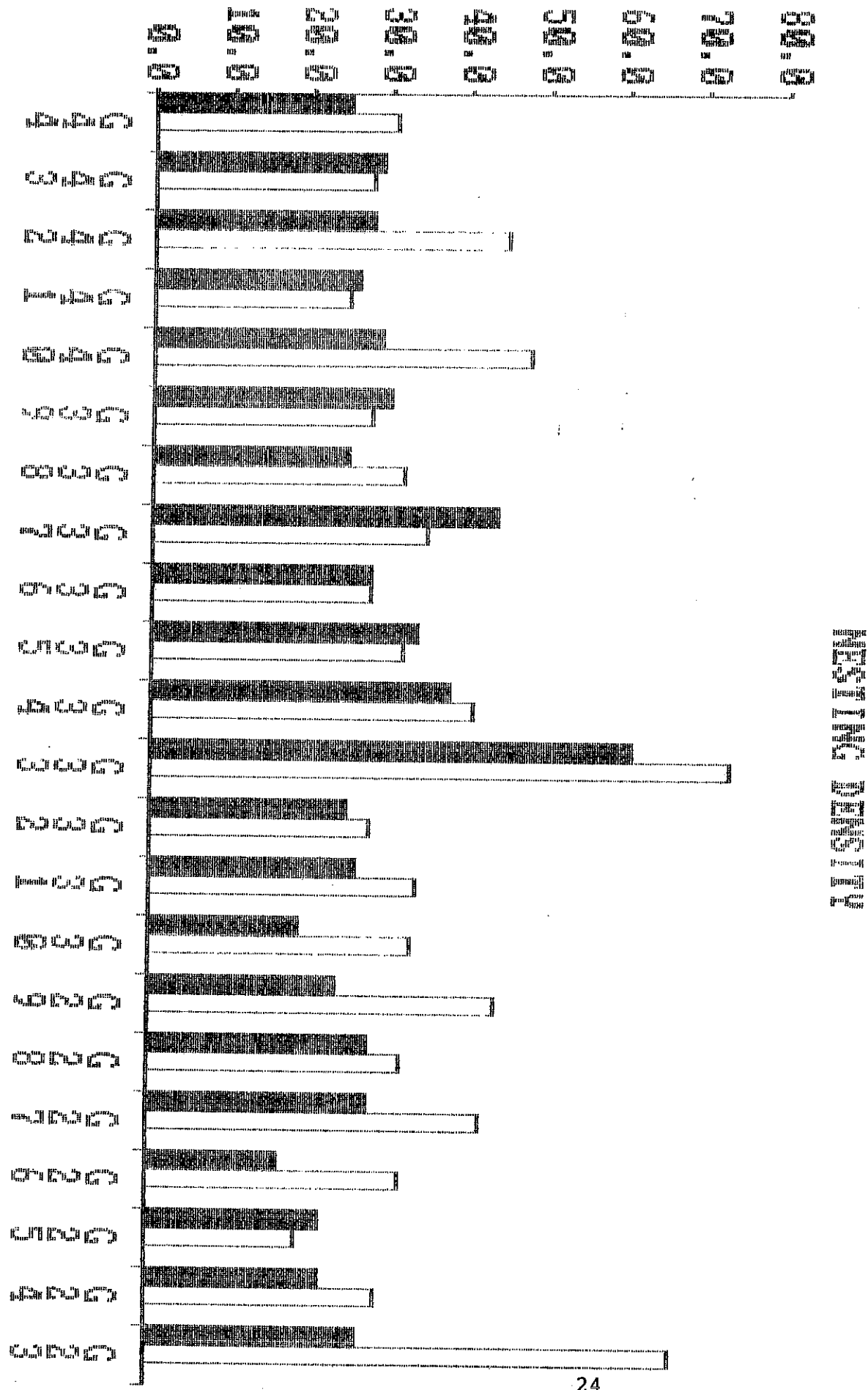
APPENDIX 3

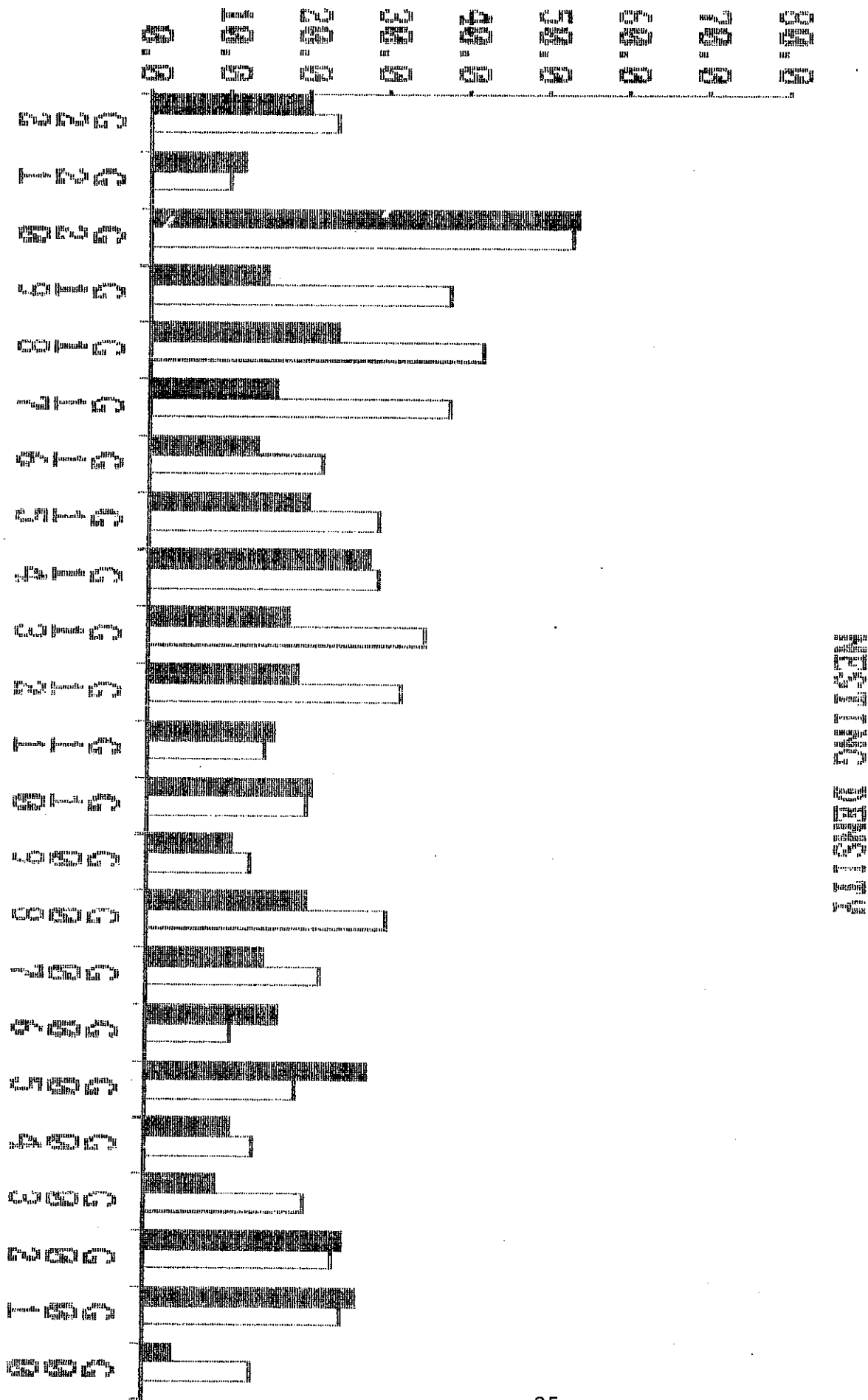
The following four graphs show the nesting density for each quarter mile grid for 1985 and 1986. Grid 93 is the southern most segment adjacent to the Kennedy Space Center. Grid 00 is at the north end of the study area, adjacent to Bethune Beach.

2000 2000 2000 2000 2000 2000 2000 2000 2000



2000 2000 2000 2000 2000 2000 2000 2000 2000





APPENDIX 4

The following four graphs show twelve hour predation rates for each one quarter mile grid for 1985 and 1986. Grid 93 is at the south end of the study area, adjacent to the Kennedy Space Center. Grid 00 is at the north end of the area, adjacent to Bethune Beach.

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