Techical Report

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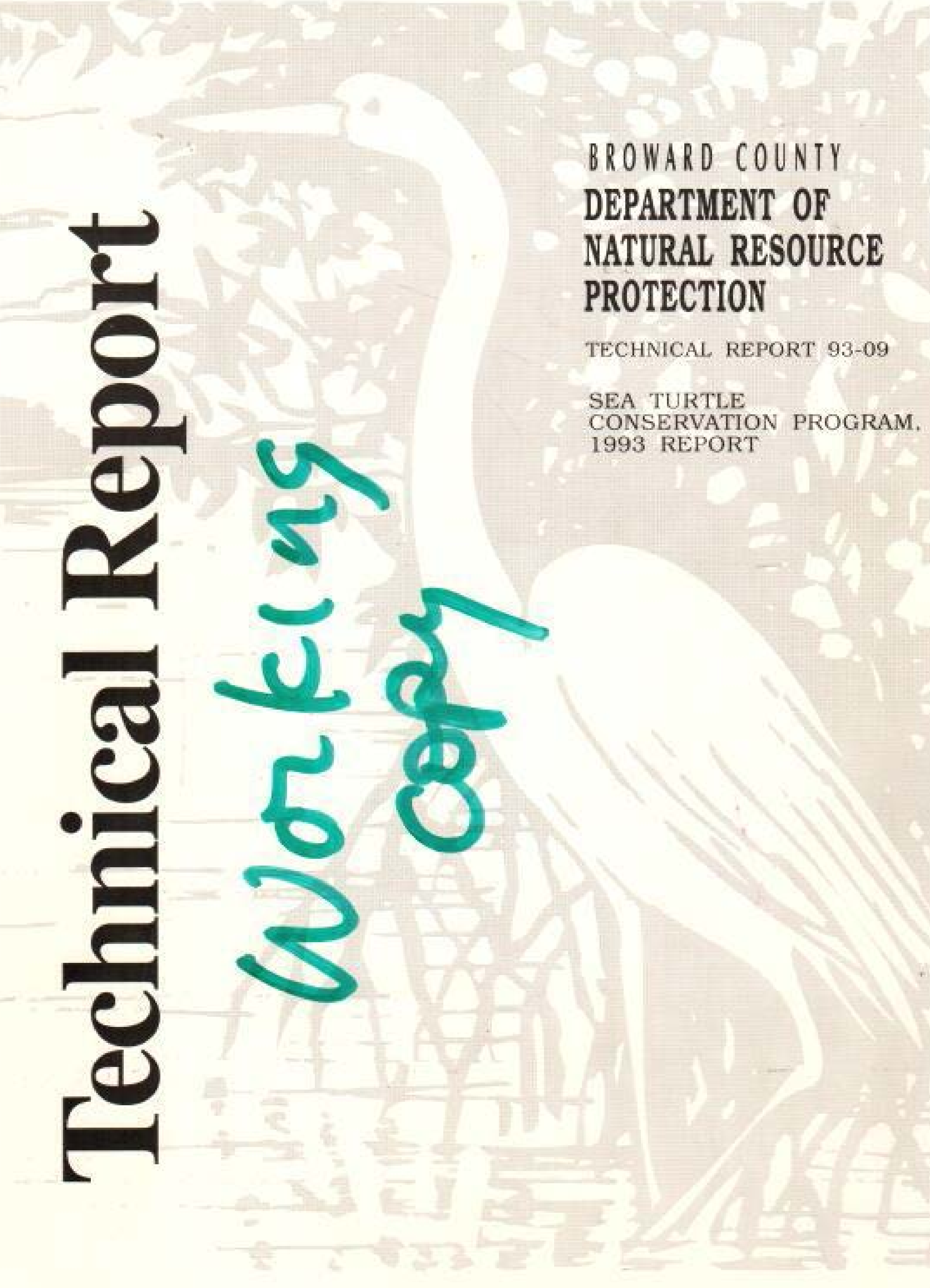

BROWARD COUNTY

DEPARTMENT OF NATURAL RESOURCE PROTECTION

TECHNICAL REPORT 93-09

SEA TURTLE CONSERVATION PROGRAM, 1993 REPORT

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SEA TURTLE CONSERVATION PROGRAM BROWARD COUNTY, FLORIDA 1993 REPORT

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For the:

BROWARD COUNTY BOARD OF COUNTY COMMISSIONERS

DEPARTMENT OF NATURAL RESOURCE PROTECTION

BIOLOGICAL RESOURCES DIVISION

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

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INTRODUCTION

Since 1978, the Broward County Department of Natural Resource Protection (BCDNRP) has provided for the conservation of endangered and threatened sea turtle species within its area of responsibility. Broward County is within the nesting areas of three species of sea turtles: *Caretta caretta* (the loggerhead sea turtle), *Chelonia mydas* (the green sea turtle) and *Dermochelys coriacea* (the leatherback sea turtle). *C. caretta* is listed as a threatened species, while *C. mydas* and *D. coriacea* are listed as endangered under the U.S. Endangered Species Act, 1973, and Chapter 370, F.S.

Since these statutes strictly forbid any disturbance of sea turtles and their nests, conservation activities involving the relocation of nests from hazardous locations (especially necessary along heavily developed coasts) require permitting by the U.S. Fish and Wildlife Service (USFWS). In Florida, this permit is issued to the Florida Department of Environmental Protection (FDEP), which subsequently issues permits to individuals, universities and local government agencies. This project was administered by the BCDNRP and conducted by the Nova University Oceanographic Center under Marine Turtle Permit #129, issued to the BCDNRP by the FDEP Institute of Marine Research, St. Petersburg, Florida. The BCDNRP is especially concerned with any environmental effects of intermittent beach renourishment projects on shorelines and the offshore reefs. As part of this concern, the BCDNRP has maintained the sea turtle conservation program in non-renourishment years to provide a continuous data base.

Operation of the program is competitively bid and a contract award

is issued based on a selection committee review of submitted bids through a weighted point factor procedure. Nova University was awarded the contract to conduct the 1993 program.

In addition to fulfilling statutory requirements, the purposes of the project were:

1) to relocate eggs from nests deposited in sites threatened by natural processes or human activities and thus maximize hatchling recruitment,

2) to accurately survey sea turtle nesting patterns to determine any historical trends and assess natural and anthropogenic factors affecting nesting patterns and densities,

3) to assess the success of sea turtle recruitment and of hatchery operations in terms of nesting success, hatching success and total hatchlings released,

4) to dispose of turtle carcasses, respond to strandings and other emergencies and maintain a hot-line for reporting of turtle incidents, and

5) to inform and educate the public about sea turtles and their conservation.

MATERIALS AND METHODS

Beach Survey

Daily beach surveys commenced at sunrise, except at Fort Lauderdale where early beach cleaning required a slightly earlier start. For survey purposes the county was divided as follows:

BEACH	LENGTH (km)	BOUNDARIES	DEP SURVEY MARKER #
Hillsboro-Deerfield	7.0	Palm Beach Co. line to Hillsboro Inlet	1-24
Pompano	7.7	Hillsboro Inlet to Commercial Blvd.	25-50
Ft.Lauderdale	10.6	Commercial Blvd to Port Everglades Inlet	51-84
Lloyd Park	3.9	Port Everglades Inlet to Dania Beach fence	86-97
Hollywood-Hallandale	9.4	Dania Beach fence to Dade Co. Line	98-128

Daily surveys of Pompano Beach began on April 15th. Patrols of the other beaches commenced on April 20th. All surveys continued through September 15th. Nests were located using DEP beach survey bench marks numbered consecutively from 1 to 128 in Broward County. Marker numbers corresponding to each beach area are listed above. Each nest was initially located relative to the nearest building, street, or other land mark. These locations were later cross referenced to the nearest survey marker.

The beach at John U. Lloyd State Recreation Area was surveyed by park personnel, who provided the data for that area. Due to the relative lack of land marks in the park, four 1 km zones (zone 1 farthest north) were used for recording nest locations. This was also done to provide continuity with the data collected in Lloyd Park during the previous three years, to assess the effects of a completed beach renourishment project on nesting patterns.

Surveyors used four-wheeled all-terrain vehicles which can carry four to eight turtle nests in plastic buckets per trip. The usual method was to mark and record nests and false crawls on the first pass along the beach and then dig and transport nests in danger of negative impacts on the return pass. Due to early beach cleaning in Fort Lauderdale, nests were picked up on the first pass, with help from a second person who transported the eggs by car. When there were many nests requiring relocation, and no road support, additional trips were occasionally necessary. After measuring the flipper-to-flipper track width (as an index of turtle size), crawl marks were obliterated to avoid duplication.

Nests in danger of negative impacts were defined as follows:

1) a nest located within 20 feet of the mean high water line,

2) a nest located in an area with a high level of pedestrian traffic,

3) a nest located near a highway or artificially lighted area defined as a beach area where a worker can see his shadow on a clear night,

4) a nest located in an area subject to beach renourishment,

5) a nest deposited directly in existing, dense vegetation where roots might interfere with successful emergence of the hatchlings.

Especially due to definition 3, 100% of the nests at Pompano, and Fort Lauderdale beaches were considered to be in danger of negative impact and therefore were relocated to hatcheries or dark beach locations on Hillsboro

beach. Nests to be relocated were carefully dug by hand, and transported in buckets containing sand from the natural nest chamber.

The depths of the natural egg chambers were measured. The eggs were then transferred to hand-dug artificial egg chambers of similar dimensions, which were lined with sand from the natural nest. Care was taken to maintain the natural orientation of each egg.

Those nests not in danger on Hillsboro and Lloyd Park beaches, were marked and left *in situ*. After hatching, 269 of these nests were excavated for post emergence examination. Hatching (actual emergence) success for *in situ* nests was defined as the percentage of spent shells (assumed to have yielded live hatchlings) compared to the sum of spent shells, pipped eggs, eggs with arrested or no visible development, and hatchlings found dead in the nest.

Hatchery Operations

As in previous years, eggs were transferred to one of three chain-link fenced hatcheries located at Pompano beach near Atlantic Blvd., at the South Beach municipal parking lot in Fort Lauderdale, or at North Beach Park in Hollywood. A self-releasing hatchery, located in Lloyd Park, was operated by park personnel. After hatching, all hatchery nests were dug, and counts of spent shells, hatchlings dead in the nest, pipped eggs and eggs with arrested or no visible development were made.

Hatchery nests displaying a depression over the egg chamber, indicating eminent hatchling emergence, were covered with a bottomless plastic bucket to retain hatchlings, although the turtles sometimes escaped these enclosures by digging around them. Hatching success was defined as the percentage of relocated eggs resulting in live released turtles. After hatching commenced, the hatcheries were checked each night between 9 PM and midnight. After counting, hatchlings were released that same night in dark sections of Fort Lauderdale, Hillsboro, Hollywood or Lloyd Park beaches by allowing them to crawl

through the intertidal zone into the surf. Hatchlings discovered at dawn in the hatcheries were collected and held indoors in dry styrofoam boxes in a cool, dark place until that night, when they were released as above.

Because of the high nesting density early in the season and the high percentage of relocated nests, the Pompano and Fort Lauderdale hatcheries quickly filled. After about June 1, nests from Fort Lauderdale and Pompano were relocated to Hillsboro Beach, for the remainder of the season. Hatched nests in the hatcheries were completely dug out along with the surrounding sand and replaced with fresh sand. The sand from the old nests was spread outside the hatchery. Fresh sand was obtained from elsewhere on the beach.

Data analysis

The data was compiled, analyzed and plotted primarily with Quattro Pro software. County-wide yearly nesting densities from 1981 to 1993 for *C. caretta*, *C. mydas*, and *D. coriacea* were plotted and trends were assessed by linear regression and correlation analyses. Seasonal nesting patterns of *C. caretta* were plotted for each of the five beaches. Nesting densities were calculated per km for each beach and the data (except for *D. coriacea*) were compared with 1-way analysis of variance (ANOVA) and Student-Newman-Keuls (SNK) tests (at the .05 significance level) (Zar, 1974). The total number of nests deposited by each species in the beach segments corresponding to each DEP survey marker was tabulated and plotted. Total nesting success (nests/total crawls) for each species at each beach was computed and the mean daily nesting successes of *C. caretta* at each beach was compared by ANOVA and SNK analyses. The total nesting success in each beach segment was plotted versus its DEP survey number.

The mean hatching success of *C. caretta* nests deposited at the individual beaches was compared by ANOVA and SNK analyses. Overall hatching success of relocated and *in situ* nests of the three sea turtle species were compared by

one-way ANOVA. *C. caretta* hatching success at the hatcheries and the Hillsboro relocation site were compared with ANOVA.

The total number of relocated nests, eggs, lost or destroyed eggs and hatchlings released were tabulated and compared. An accounting of the status of all eggs from investigated *in situ* and relocated nests at each beach was prepared, with unsuccessful eggs listed as dead-in-nest (DIN), partially emerged hatchling (PIP), unhatched with visible development (VD) and eggs showing no visible development (NVD). The numbers of *in situ* and relocated eggs in each of these categories (also including successful eggs) were compared using a large-sample hypothesis test of population proportions (percent test) (Weiss and Hassett, 1991).

RESULTS

Figure 1 gives the historical trend of total sea turtle nest counts in Broward County. A total of 2,181 sea turtle nests were counted county-wide in 1993. This was down slightly from 1992, but 1993 nest count was still the third highest since surveys began. This was the fourth consecutive high nesting year. The mean nest count for 1990 thru 1993 (2,236) is 3.9 standard deviations above the mean of the previous 9 years. This is a very significant difference (t-test; t= 6.8, P<< .001). Figure 2 shows the nesting trends for the three species. The trend line for *C. caretta* has a strongly positive slope, which is highly significant (P < .001). *C. mydas* nesting has been extremely variable and was much lower in 1993 than in 1992. A similar precipitous nesting decline occurred from 1990 to 1991. *D. coriacea* nesting was up from last year, and has increased steadily since 1990, but the nest numbers are low and there is no overall significant trend. Figure 3 gives the seasonal pattern of daily *C. caretta* nesting. The pattern is similar to past years.

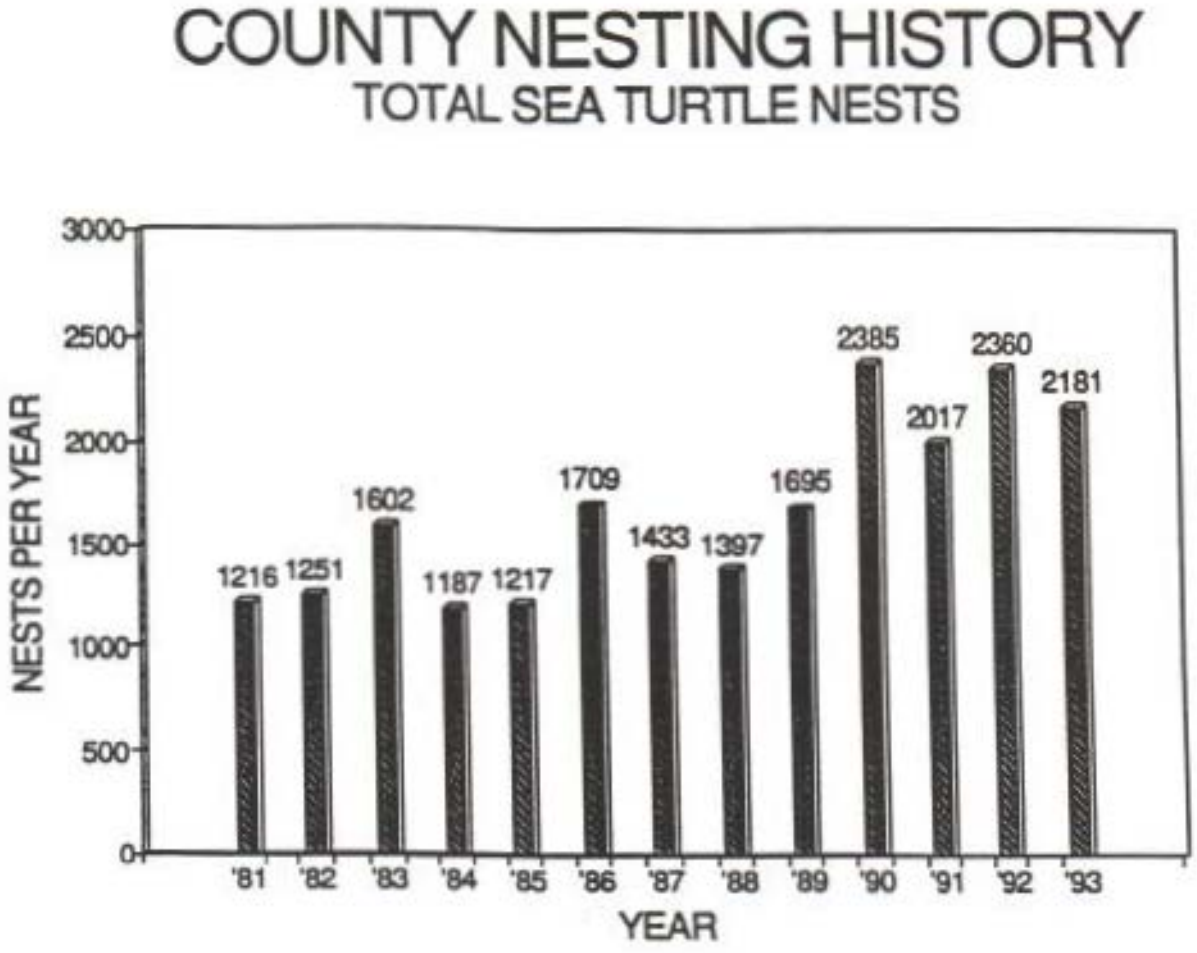


Figure 1: The historical pattern of total sea turtle nesting in Broward County, since full surveys commenced in 1981.

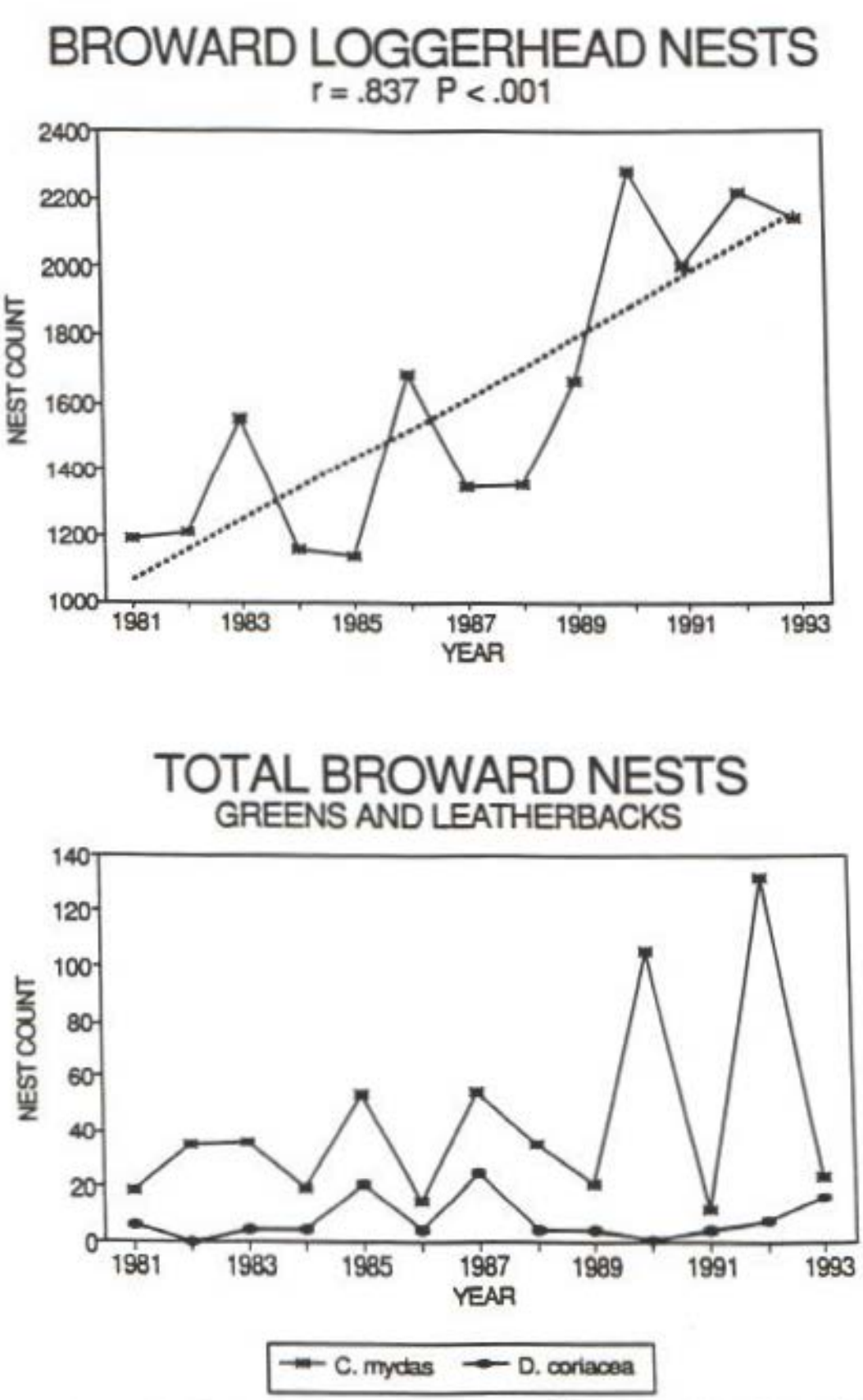


Figure 2: Historical nesting patterns for *C. caretta*, *C. mydas* and *D. coriacea* in Broward County since 1981.

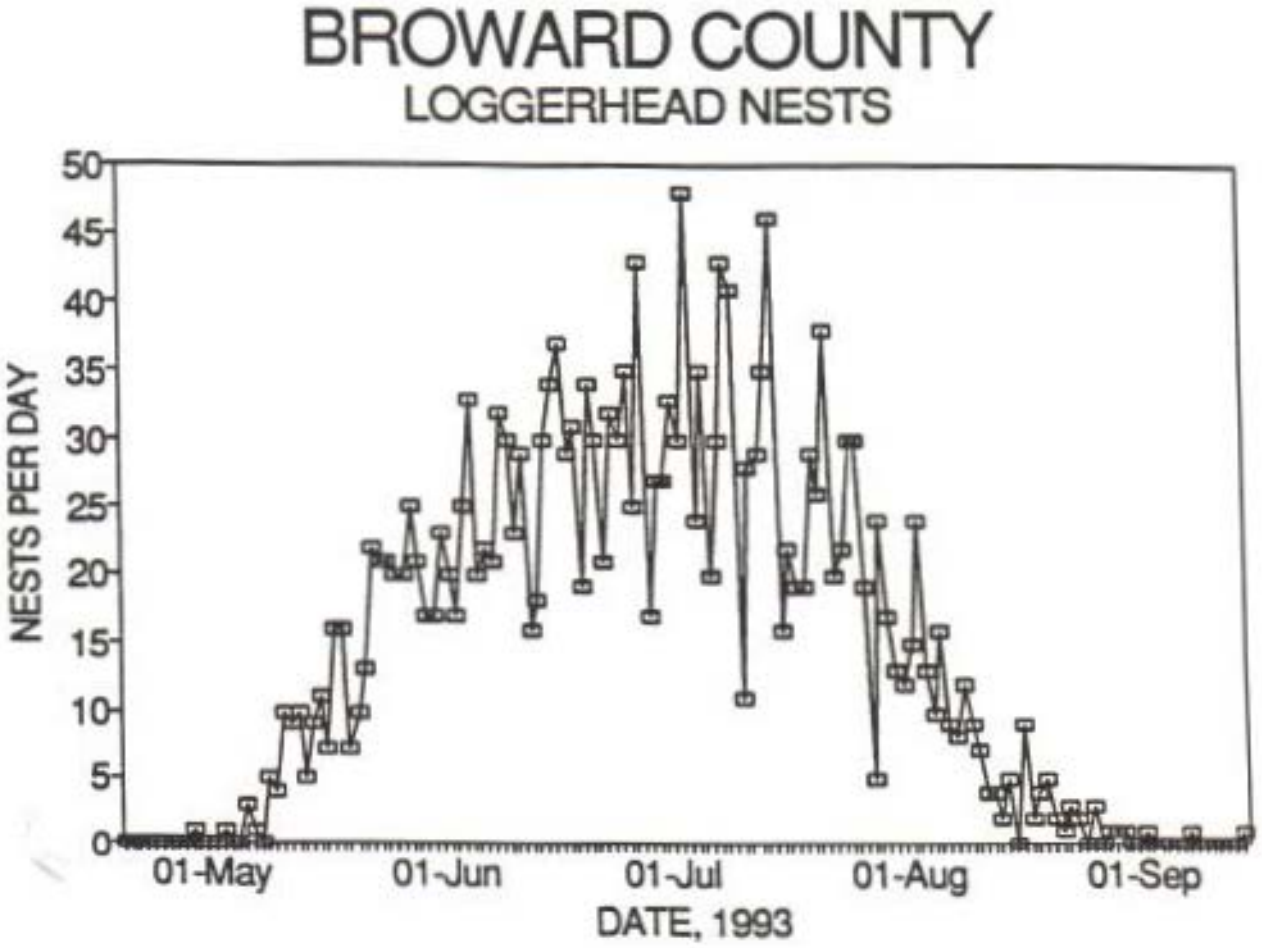


Figure 3: The seasonal pattern of daily *C. caretta* nesting in Broward County, 1993.

Table 1 and Figure 4 give the total *C. caretta* nesting densities and seasonal patterns for the five beaches, respectively. Nesting densities per kilometer were lowest at Hollywood-Hallandale beach and highest at Pompano and Hillsboro. Nesting densities at all beaches, except Hillsboro and Pompano, grouped separately in the SNK analysis (Table 1).

The county-wide seasonal nesting patterns for *C. mydas* and *D. coriacea* are shown in Figure 5 and for the individual beaches in Figure 6. The first *C. mydas* nest was deposited on June 30. In the two heavy-nesting years (1990 and 1992), nesting commenced earlier, in mid May or early June (Burney and Mattison, 1990, 1992a). As in previous years, *D. coriacea* nested in the early part of the *C. caretta* season, beginning in April. Table 2 gives the nest counts, nests per km and nests per km per day for *C. mydas*. As in 1992, nesting densities were greatest on Hillsboro and Lloyd Park beaches.

Table 3 gives the distribution of *D. coriacea* nesting. Of a total of 16 nests, 10 were in Hillsboro, but all beaches received at least one nest.

Figure 7 shows the horizontal distribution of *C. caretta*, *C. mydas*, and *D. coriacea* nesting. The *C. caretta* nesting pattern was amazingly similar to past years and has been discussed previously (Burney and Mattison, 1990, 1991, 1992a; Mattison, Burney and Fisher, 1993).

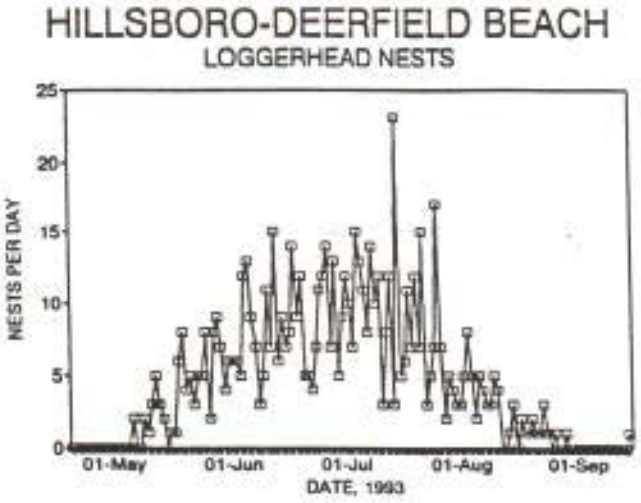
Figure 8 and Table 4 give the county-wide distribution of nesting success for the three species. Low *C. caretta* nesting successes again occurred on the beach at the Hillsboro Inlet (locator # 25) and in Hollywood and Hallandale, which were also areas of low nesting activity. *C. caretta* nesting success was significantly lower at Lloyd Park than for any other beach, while nesting success on the other beaches was statistically indistinguishable (Table 4). Unlike last year, there was no *C. mydas* activity on Pompano or Hollywood-Hallandale beaches.

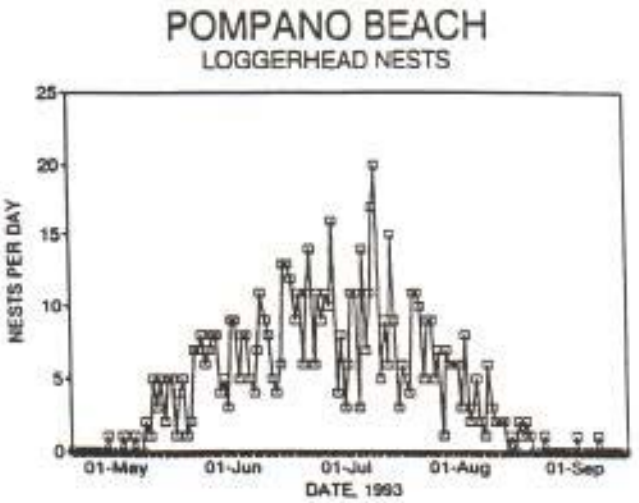
1994 in Red.

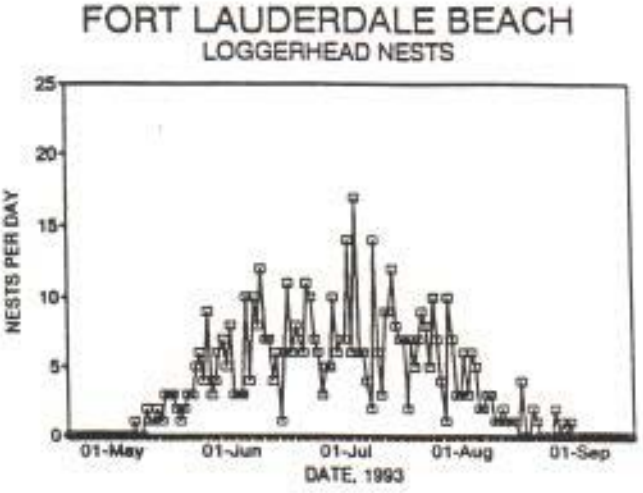
Working on This

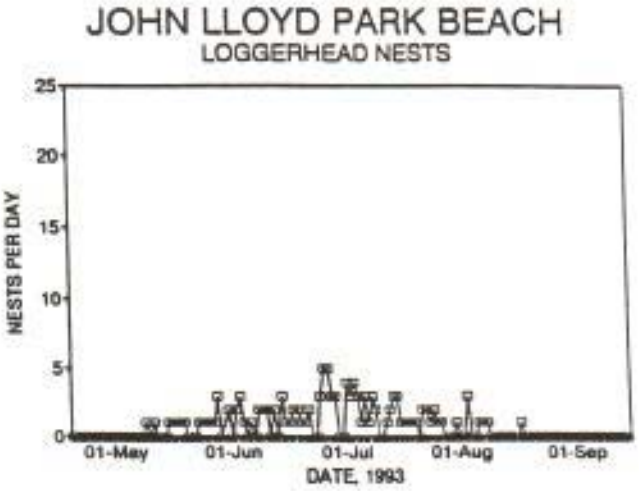
Table 1: Total *C.caretta* nests and nesting densities expressed as nests-per-kilometer for the 1993 season. Vertical lines at the right overlap groups where means were not distinguishable in a SNK test (alpha = .05) of mean daily nesting per km.

BEACH	TOTAL NESTS	BEACH LENGTH (km)	NESTS per km	DAILY MEAN NESTS /km
Hollywood-Hall.	97	9.4	10.3	.069
Lloyd Park	120	3.9	57.9	.206
Ft.Laud.	550	10.6	51.9	.348
Pompano	676	7.7	87.9	.589
Hillsboro	699	7.0	99.9	.670
OVERALL	2142	38.6	55.5	.372









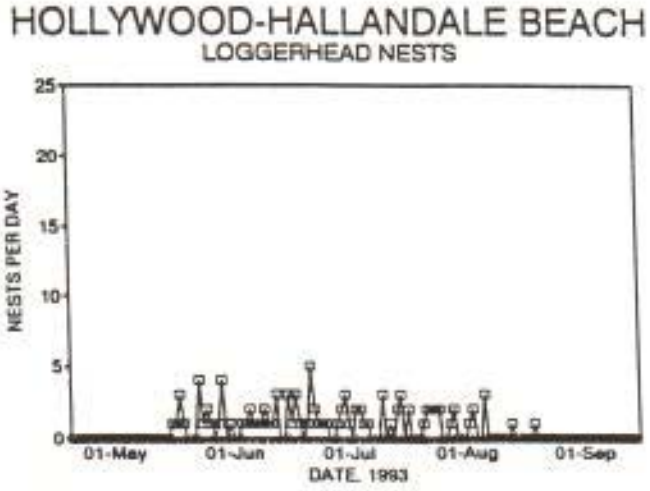


Figure 4: Comparison of the daily nesting patterns of *C. caretta* at the five Broward County beaches during 1993

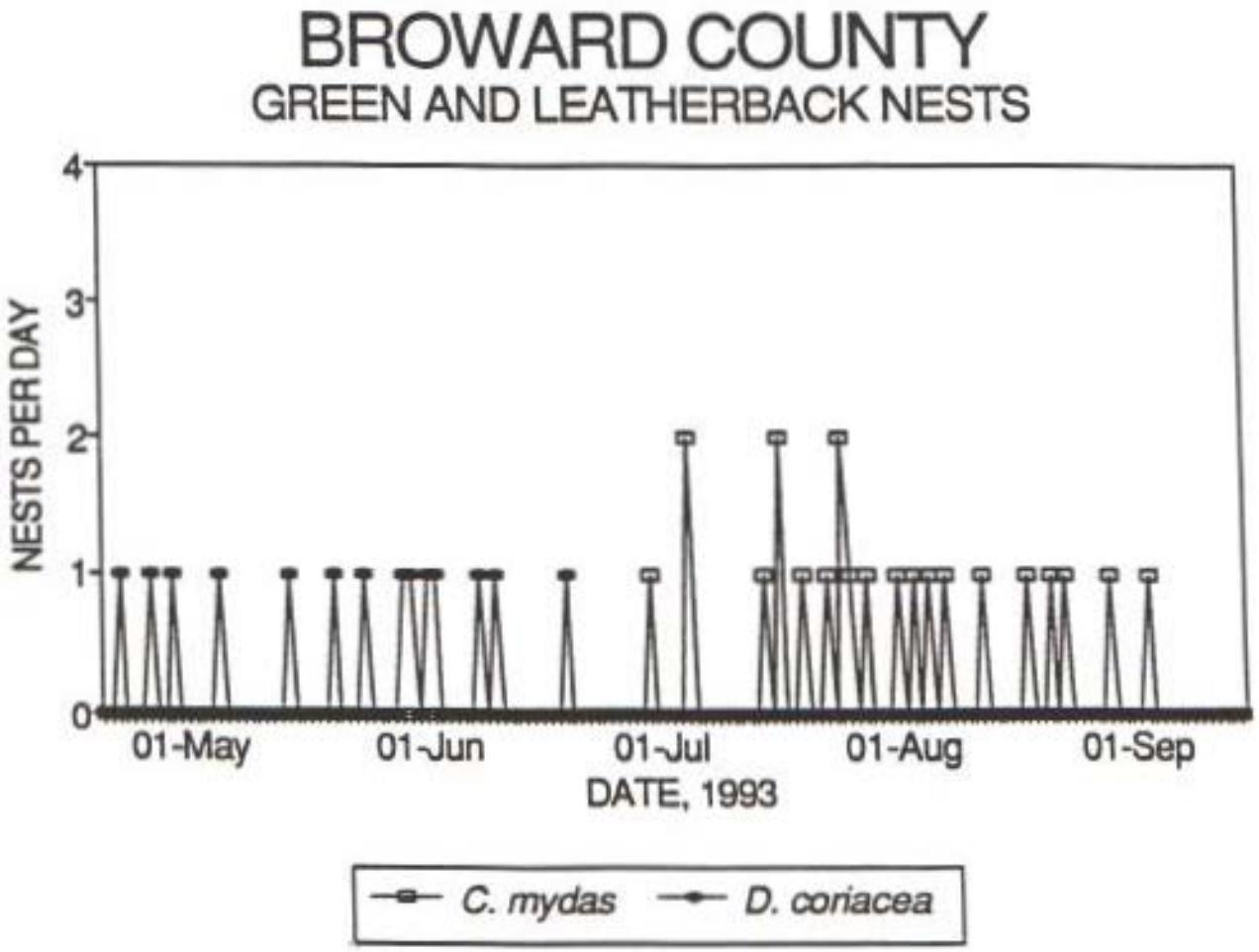


Figure 5: The seasonal patterns of daily *C. mydas* and *D. coriacea* nests in Broward County, 1993

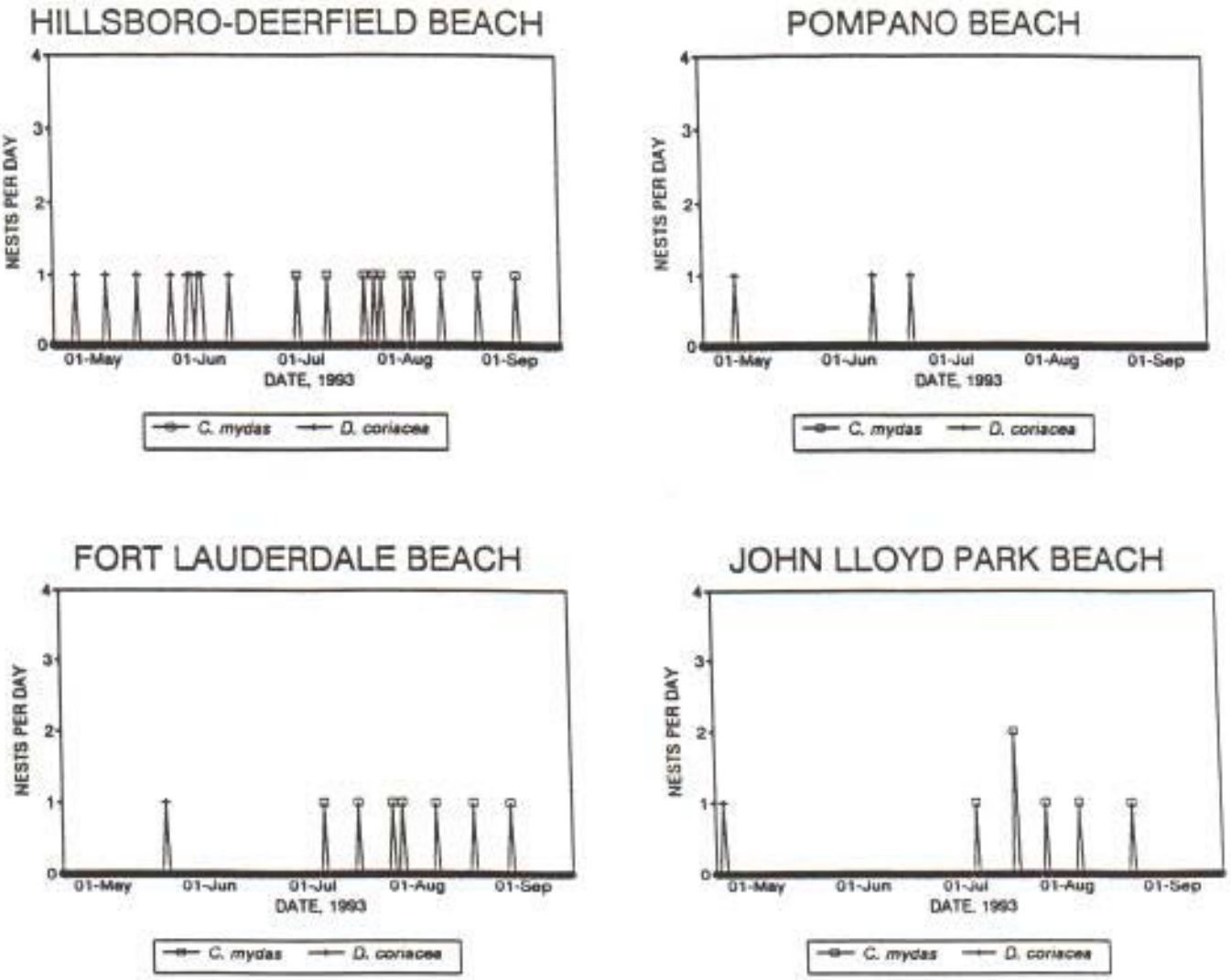


Figure 6: Comparison of the daily nesting patterns of *C. mydas* and *D. coriacea* at the Broward County beaches during 1993. One *D. coriacea* nested on Hollywood beach on 13 April.

Table 2: Total *C.mydas* nests and nesting densities expressed as nests-per-kilometer for the 1993 season. Data were too few for a reliable SNK comparison of mean daily nesting densities.

BEACH	TOTAL NESTS	BEACH LENGTH (km)	NESTS per km
Hollywood-Hall	0	9.4	0
Pompano	0	7.7	0
Lloyd Park	6	3.9	1.5
Ft. Laud.	7	10.6	0.7
Hillsboro	10	7.0	1.4
OVERALL	23	38.6	0.6

Table 3: Total *D. coriacea* nests and nesting densities expressed as nests-per-kilometer for the 1993 season. Data were too few for a reliable SNK comparison of mean daily nesting densities.

BEACH	TOTAL NESTS	BEACH LENGTH (km)	NESTS per km
Pompano	03	7.7	.39
Lloyd Park	1 1	3.9	.26
Ft. Laud.	1 1	10.6	.09
Hollywood-Hall	0 1	9.4	.11
Hillsboro	7 10	7.7	1.3
OVERALL	9 16	38.6	0.41

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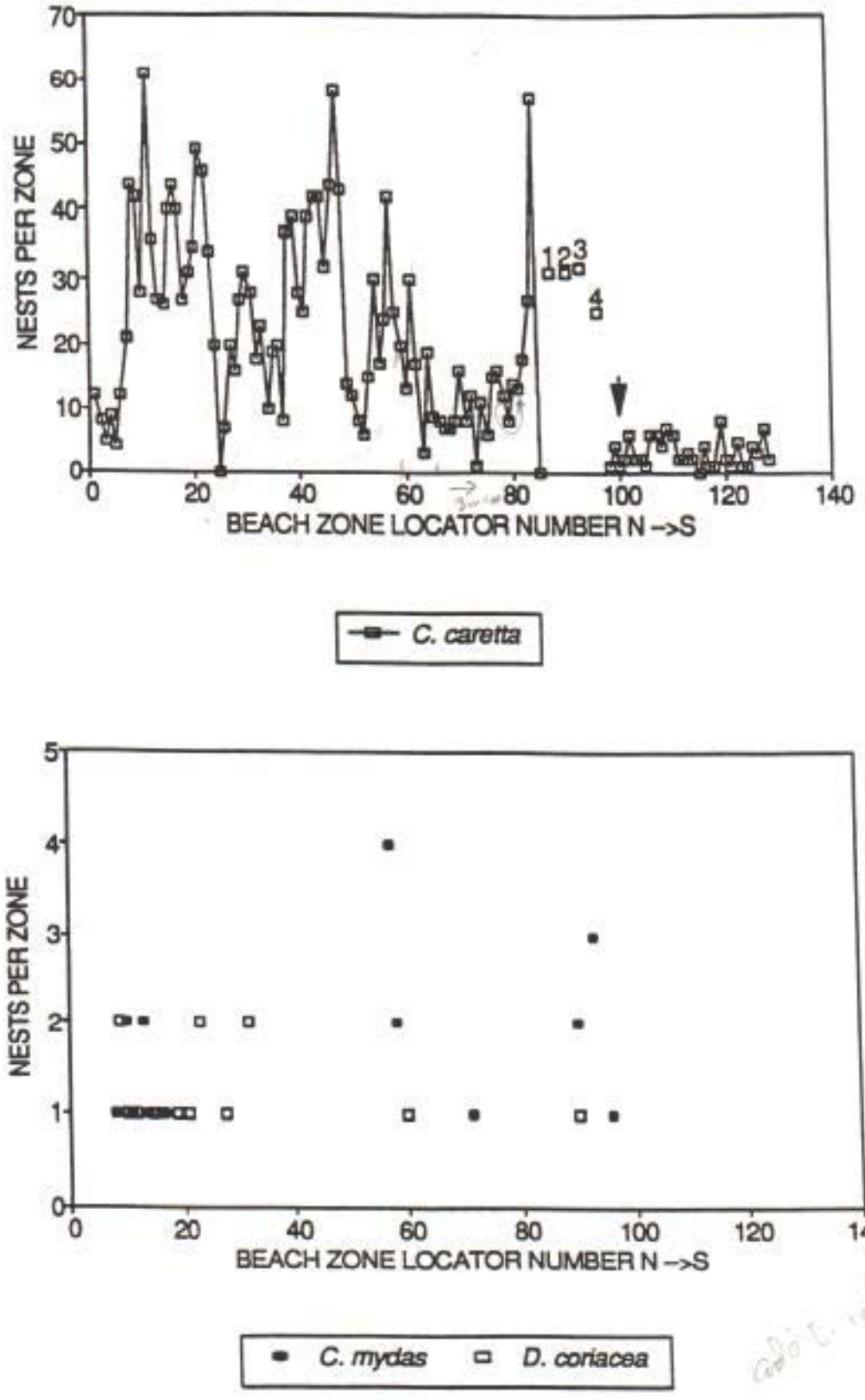


Figure 7: Locations of *C. caretta*, *C. mydas* and *D. coriacea* nests in Broward County, 1993. Numbers 1-4 indicate the 4 beach zones at Lloyd Park. Arrow at top indicates the northern limit of the Hollywood beach renourishment project in 1991.

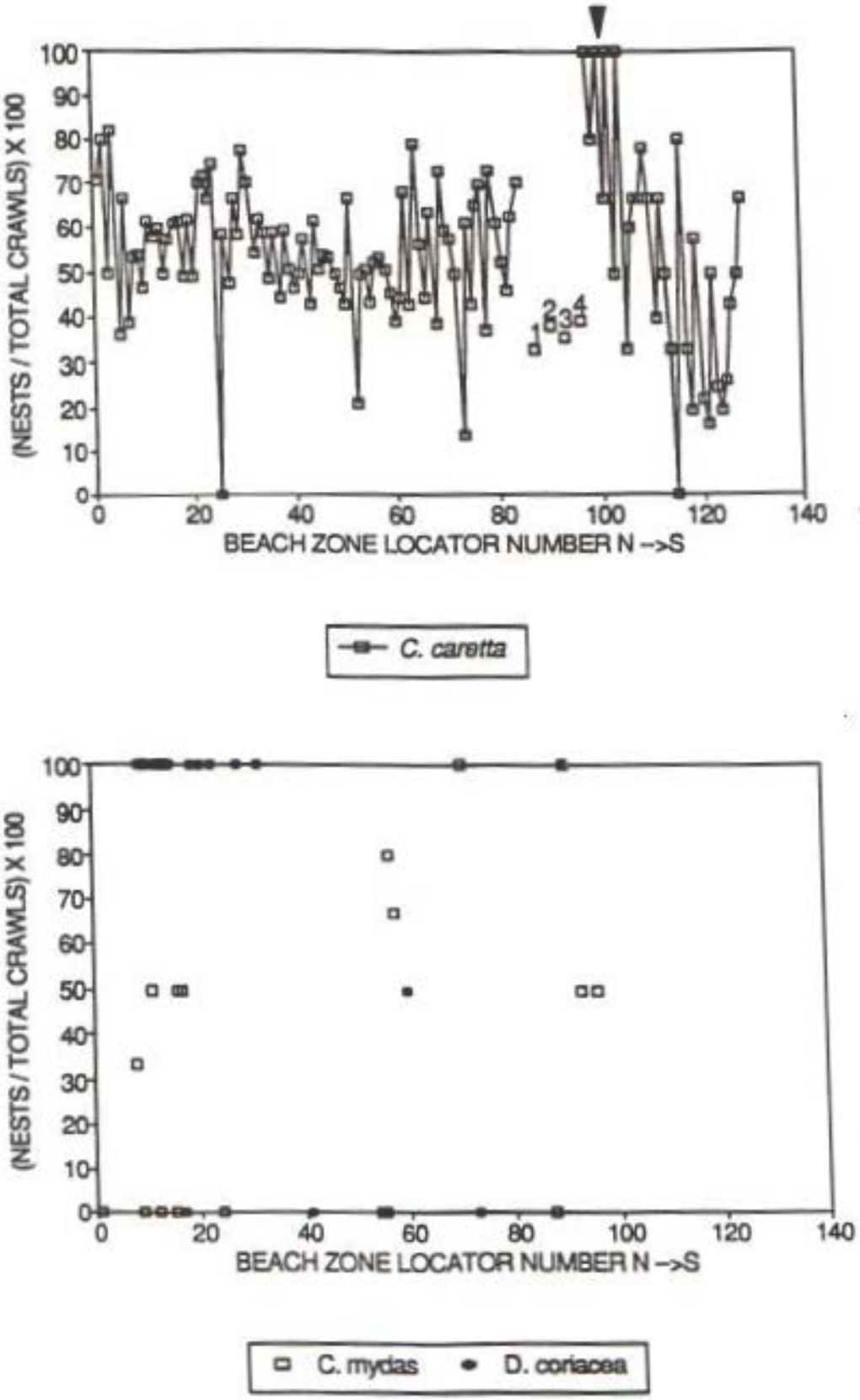


Figure 8: The horizontal distribution of mean nesting success of the three sea turtle species in 1993. Numbers 1-4 indicate the 4 beach zones at Lloyd Park. Arrow at top indicates the northern limit of the Hollywood beach renourishment project in 1991.

1994 in red.

Table 4: Total nests, false crawls (FC) and percent nesting success (NS) for three sea turtle species in each of five Broward County beaches during 1993. Vertical lines for *C. caretta* overlap beaches where mean daily nesting successes were not distinguishable in a SNK test. *C. mydas* and *D. coriacea* nesting was too sparse for reliable statistical comparisons.

BEACH	*C.caretta*			*C.mydas*			*D.coriacea*		
	NESTS	FC	NS	NESTS	FC	NS	NESTS	FC	NS
Lloyd Park	120	208	36.6	6	5	54.5	1	0	100
Holly-Hall.	97	92	51.3	0	0		1	0	100
Ft.Laud.	550	480	53.4	7	4	63.6	1	2	33.3
Pompano	676	583	53.7	0	0		3	1	75.0
Hillsboro	699	504	58.1	10	13	43.5	10	1	90.9
OVERALL	2142	1867	53.4	23	22	51.1	16	4	80.0

w/o Lloyd 2022 1659 17 15

54.9% NS w/o Lloyd

CC 3681 Total Crawls w/o Lloyd

2054 totals w/o Lloyd

Table 5 gives the total numbers of nests for each species that were relocated to Hillsboro beach or fenced hatcheries, as well as the numbers and location of nests left *in situ*. Most nests relocated from Pompano and Fort Lauderdale beaches were taken to Hillsboro, because of hatchery space limitations.

Table 6 compares the mean hatching success of relocated *C. caretta* nests at the 5 beaches. Hatching success was distinctly lower for nests relocated to Hillsboro Beach, and statistically indistinguishable between the other beaches. Figure 9 illustrates the seasonal patterns of *C. caretta* hatching success for relocated and *in situ* nests. Both patterns show the usual inverse trend of hatching success versus date of nest deposition, but there was a higher proportion of low-hatching nests in the relocated group. Table 7 gives the numbers of eggs from investigated *in situ* and relocated nests for all species, with the numbers of hatchlings released and the overall hatching success. Of the 187,024 *C. caretta* eggs relocated, 27,785 were from nests which were either partially predated or could not be investigated because of stake removal (lost). In several cases, stakes were knocked over by turtles crawling into the relocation site. Most of these lost nests probably hatched successfully. Nests predated by foxes and raccoons were usually only partially destroyed. While some hatchlings emerged from these nests, they were not included in hatching success calculations. Several nests were apparently removed by poachers on the nights they were deposited. All such suspected instances were immediately reported to the marine patrol and one poacher was apprehended.

Table 8 gives the post-hatching nest investigation data for all *in situ* and relocated *C. caretta* nests for all beaches, and Table 9 shows the results of the statistical analyses comparing the proportions of eggs in each category for *in situ* and relocated nests at Hillsboro beach. The difference in the proportions of

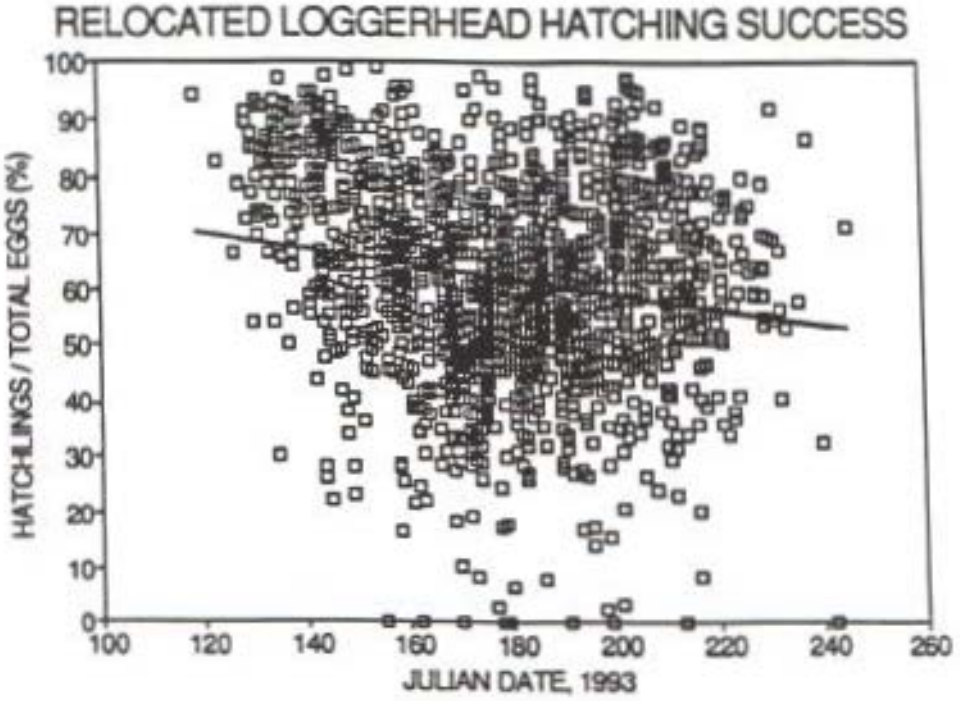
Table 5: Total Number of *C.caretta*, *C. mydas* and *D. coriacea* nests relocated to Hillsboro beach or fenced hatcheries, or left *in situ*.

	C. caretta	*C. mydas*	*D. coriacea*
RELOCATED			
Open Beach			
Hillsboro	1488	8	6
Hatcheries			
Pompano	59	0	1
Ft.Laud.	60*	0	0
Lloyd Park	5	1	0
Hollywood	97	0	0
Totals	1709	9	7
IN SITU			
Open Beach			
Hillsboro	318	9	8
Lloyd Park Ft. Laud.	115	5	1
Totals	433	14	9
Totals	2142	23	16

* Includes one nest sent to the Museum of Discovery and Science

Table 6: Mean hatching successes of *C.caretta* nests relocated to hatcheries or to the open beach relocation site at Hillsboro beach. Vertical lines at the right overlap groups where means were not distinguishable in a SNK test (alpha = .05).

BEACH	TOTAL NESTS	MEAN HATCH PERCENT	
Hillsboro	1488	58.1	|
Ft. Lauderdale	59	75.2	|
Hollywood-Hall	97	76.0	|
Pompano	59	79.8	|
Lloyd Park	5	87.9	|
OVERALL	1708	60.5	



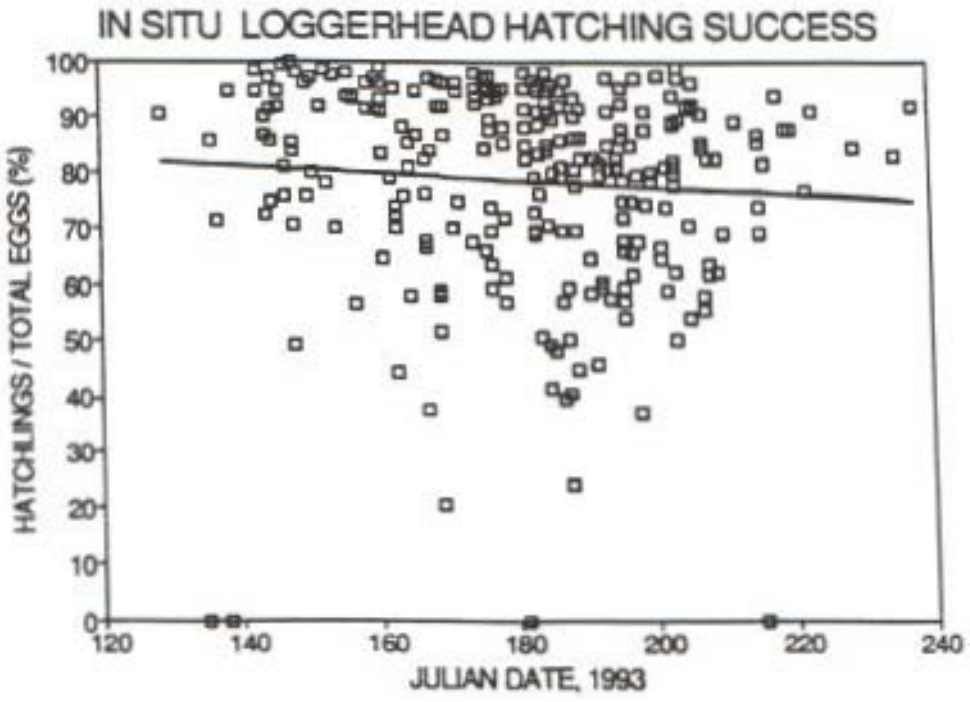


Figure 9: Comparison of the seasonal patterns of *C. caretta* hatching success in relocated and *in situ* nests during 1993.

Table 7: Total egg counts, released hatchlings and overall hatching successes for *in situ* and relocated nests of *C.caretta*, *C.mydas* and *D.coriacea* in 1993.

Species	NUMBER OF EGGS	EGGS LOST/ DEST.	n*	NUMBER TURTLES RELEASED	HATCH SUCCESS PERCENT
***In Situ* Nests**					
C. caretta	28143	N/A	259	21976	78.1
C. mydas	789	N/A	739	543	68.8
D. coriacea	282	N/A	32	157	55.7
Total	29214		269	22676	77.6
Relocated Nests					
C. caretta	187024	27785	1451	97305	61.1
C. mydas	1105	132	843	399	41.0
D. coriacea	722	0	72	256	35.4
Total	188851	27917	1466	97960	60.9
Overall					
C. caretta	215167	27785	1710	119281	63.7
C. mydas	1894	132	15	942	53.5
D. coriacea	1004	0	10	413	41.1

* n = The number of nests actually investigated for hatching success percent.

Table 8: Accounting of the status of all hatched and unhatched eggs in investigated *in situ* and relocated *C. caretta* nests during 1993.

Location	Total Eggs	Live Hatch %	DIN %	PIP %	VD %	NVD %	HL %
***In Situ* Nests**							
Hillsboro	16755	72.5	2.1	5.0	7.2	13.3	n/a
Lloyd Park	11388	86.3	0.7	2.3	0	10.7	n/a
Relocated Nests							
Hillsboro	134298	58.1	2.3	15.3	6.6	17.2	0.4
Pompano	6859	79.8	2.9	6.6	3.6	7.1	0.6
Ft. Lauderdale	6832	75.2	2.1	9.0	2.1	11.3	0.3
Lloyd Park	596	87.9	0.5	0.3	0	11.2	0
Hollywood	10654	76.0	1.7	5.5	2.5	13.2	1.1

Live Hatch - All eggs which produced live hatchlings, including hatchlings found live in nest and live piped which were freed and released
DIN - Hatchlings found dead in the nest when it was excavated
PIP - Dead hatchlings which only partially succeeded in emerging from their eggs
VD - Unhatched eggs with signs of visible embryo development
NVD - Unhatched eggs with no signs of visible embryo development
HL - Eggs accidentally lost during relocation

	HATCH	DIN	PIP	VD	NVD
In situ	16570	355	1170	133	5642
Relox	80194	3218	16220	10636	22127

Table 9: Comparison of hatching and all categories of egg failure results for investigated *in situ* and relocated nests at Hillsboro Beach, using the large-sample hypothesis test for two population proportions (percent test). Abbreviations as in Table 8.

	IN SITU	RELOCATED	Z	P
Eggs	16755 25050	134298 132842		
Live Hatch	12147 66.1 16570	78076 80194 60.4	35.7 17.2	<< 10^{-6}
DIN	347 355 1.4	3197 3218 2.4	2.5 9.8	.006
PIP	837 1170 4.7	20557 16220 12.7	36.1 -35.0	<< 10^{-6}
VD	1198 13135.2	8827 106368.0	2.8 -15.1	.003
NVD	2226 564222.5	23135 22127 16.7	12.9 -31.2	<< 10^{-6}

1994

additional 450 eggs lost in transit

How to do for 94?

In Panel!

live hatchlings to total investigated eggs was very significantly lower in the relocated nests ($P<<10^{-6}$). The proportions of each category of unsuccessful egg (which did not produce a live hatchling) were all significantly greater in the relocated nests. The percentages of PIP and NVD eggs were very significantly higher in the relocated nests. Figure 10 shows the historical trends in hatching success for *in situ* and relocated nests since 1981. The hatching success of both *in situ* and relocated nests declined about the same percentage from 1992, but the relocated success was slightly below the 1981 historical minimum.

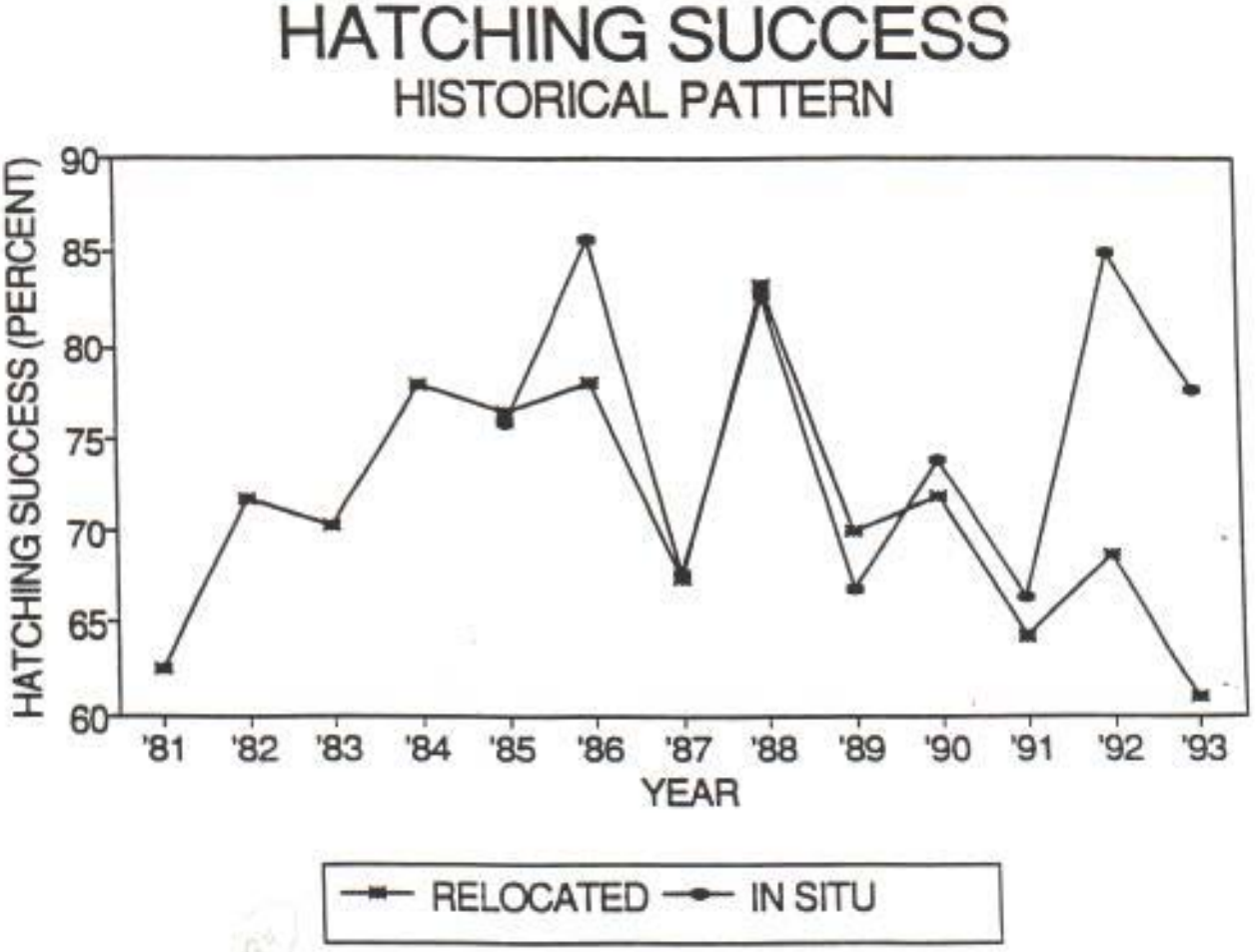


Figure 10: The hsitorical patterns of yearly hatching success in all investigated *in situ* and relocated nests since 1981.

DISCUSSION

For the past four years, *C. caretta* nesting densities have been significantly higher than the 1981-1989 average. This clearly suggests that the population of nesting females has increased or that the individual females in the population have been nesting more frequently. This consistency strongly argues against the hypotheses that higher nesting densities have resulted from the coincidental nesting of a large proportion of the female population in the same year. If this were the case, there would be fewer females nesting during the following season, because sea turtles usually do not nest every year (Ehrhart, 1981). Whether the increased nesting is due to an increased number of newly mature females, augmentation from another population, or more frequent nesting of the individual females due to better nutrition (Wood and Wood, 1980) is impossible to determine without long-term tagging studies. The consistent, highly significant positive trend in *C. caretta* nesting densities (Fig. 2) strongly suggests that random processes are not the cause.

The status of *C. mydas* is much less clear. The number of *C. mydas* nests declined from 132 in 1992 to only 23 in 1993. Figure 2 shows that a similar fluctuation occurred from 1990 to 1991 and possibly from 1985 to 1986. In these two instances, nesting densities returned to equal or greater levels on the following years (1987 and 1992). This pattern is consistent with an alternate year nesting pattern involving the bulk of the adult females. If this hypothesis holds, *C. mydas* should nest in record numbers in 1994.

D. coriacea nesting has increased consistently for the last three years (Fig. 2). Although this represents a statistically significant trend, the low nest counts and the magnitude of past nesting fluctuations render any conclusions very doubtful.

The seasonal pattern of *C. caretta* nesting in 1993 was very similar to previous years, with mid-season occurring in early July. There was an underlying fortnightly nesting periodicity related to moon phase and tide timing, which has been observed and discussed previously (Burney and Mattison, 1989; Margolis, 1993; Burney, Mattison and Fisher, 1993). Nesting densities were again highest at Hillsboro and lowest at Hollywood-Hallandale beaches (Table 1; Fig. 4). This year, nesting at Hillsboro and Pompano were not statistically different, but all other beaches were separate statistical groups. *C. mydas* and *D. coriacea* again preferred Hillsboro beach (Tables 2-3).

The nesting success of *C.caretta* was statistically uniform over the entire county, except for Lloyd Park beach which was significantly lower (Table 4). The reason for the lower nesting success at Lloyd Park is unclear. This year, the steep eroded beach cliff, which has characterized the north end of the beach due to the proximity of the Port Everglades jetty, was partially leveled by park personnel. It was thought that this cliff has been responsible for reducing nesting success in past years, because success has been much lower in zone 1 where the cliff was highest. This year, *C.caretta* nesting success in zone 1 was similar to the other zones (Fig 8) but overall nesting success was still low. The *C. caretta* nest count was down by 46.9 percent from 1992, while *C. caretta* nesting was down only 3.6 percent for the entire county. It is possible that some Lloyd park false crawls were actually nesting crawls. This could account for the disproportionate drop in nesting from last year, and the much lower nesting success compared to the rest of the county.

The horizontal distribution of *C. caretta* nesting (Fig. 7) is also very similar to past years. The causes for the consistently higher and lower nested locations, involving the extent of beach-front lighting, pedestrian and vehicular traffic and development, have been discussed previously (Burney and Mattison

1990, 1991, 1992a; Mattison, Burney and Fisher, 1993). As in past seasons, the horizontal distribution of nesting success (Fig. 8) was unrelated to the nesting pattern (Fig. 7). The statistically uniform county-wide nesting success (except at Lloyd park, discussed above) indicates that the preferred and avoided nesting sites (Fig. 7) are recognized by the females before they emerge from the sea. Poorly nested locations are not usually characterized by a higher proportion of false crawls.

The hatching success of relocated *C. caretta* nests was statistically uniform everywhere except Hillsboro beach, where it was much lower (Table 6). Differences between the hatching success of relocated and *in situ C. mydas* and *D. coriacea* nests were also dramatic (Table 7), although based on fewer data. It is clear that nests relocated to the mass relocation site at Hillsboro beach hatched at lower rates than nests left *in situ* or relocated elsewhere. A relocated nest can fail for several reasons: 1) poor genetic viability, infection or infertility, 2) poor incubation conditions at the relocation site, or 3) bad relocation technique.

The first reason seems unlikely because there should be no difference in the proportions of low-viability or infertile nests which would be relocated or remain *in situ*. Still, Tables 8 and 9 show that there was an extremely significant increase in the proportion of NVD eggs in nests relocated to Hillsboro beach, relative to Hillsboro *in situ* nests. If these eggs were infertile, it is difficult to understand why their percentage is much greater in relocated nests. If development was arrested because of the shock of relocation, why was hatching success higher in the nests relocated to hatcheries?

Bad technique can never be ruled out, except to note that most of the workers were veterans of at least one previous nesting season, and new workers were trained by very experienced personnel. In addition, the same workers who relocated nests to Hillsboro also relocated nests to the Pompano and Fort

Lauderdale hatcheries, where hatching success was not affected (Table 6). Far more eggs were relocated from Pompano and Fort Lauderdale beaches to the Hillsboro site (116,014) than were moved from Hillsboro Beach to the site (18,284). The hatching success of eggs relocated to Hillsboro from Pompano Beach (59.3%) and from Fort Lauderdale (57.7%) was much lower than for nests moved to the Pompano and Fort Lauderdale hatcheries (Table 6). As in 1992, the hatching success of nests moved to Hillsboro Beach did not seem to be related to the distance of relocation. The mean hatching successes of nests moved from Pompano and Fort Lauderdale beaches were slightly higher than for nests relocated from Hillsboro beach (55.4%), where no road transportation was involved. We conclude that sloppy relocation technique was not the primary cause of the poor hatching success at Hillsboro, unless the workers used different technique at Hillsboro than at the Fort Lauderdale and Pompano hatcheries (unlikely). There was a very significant increase in the percentage of pipped eggs in relocated nests when compared to *in situ* nests from Hillsboro Beach (Tables 8-9). One explanation might be that sand in the relocated nests was packed too tightly. The DIN percentage in relocated nests was significantly higher than *in situ* (Table 9) but the actual difference was small (2.3% relocated; 2.1% *in situ*). If tightly packed sand was the cause of the increased PIPed percentage, it should have also caused a higher DIN proportion.

We are left with the remaining possibility of poor incubation conditions at the relocation site. Hatching success at this site was lower than for *in situ* nests in 1992 (Burney and Mattison, 1992a). The cause was thought to be the reduced hatching success of nests unknowingly placed in close proximity to the decaying remains of an old nest. Relocation of the relocation site was discussed at that time, but it was thought that the wave action from Hurricane Andrew, and a subsequent storm, had effectively changed the sand at the site and that it would be safe to use it one more year. This assumption was not entirely

correct, because workers reported finding remains of a few old nests in the very highest sections of the relocation site. However, the lower sections must have been cleared of old nests, because unhatched eggs and spent shells littered the beach after the 1992 storms. Therefore, there should have been fewer instances of nest failure because of the proximity of old nests in 1993 than in 1992. However, nesting success declined still further in 1993. It is clear that the relocation site must be moved, or that other measures must be taken.

Mass relocation of nests from other beaches to Hillsboro Beach was initiated because of the inadequate size of the Pompano and Fort Lauderdale hatcheries after nesting density increased sharply in 1990 (Fig. 1). The Hillsboro site was selected because it is currently the only dark, private beach where we have been granted access. It is possible to move the site to the south of the current location on the same property. It may be possible to use a divided site, half to the north and half south of the current location.

The use of an open-beach mass relocation site has disadvantages. It certainly attracts terrestrial predators (foxes and raccoons) and it *may* concentrate marine predators which feed on the swimming hatchlings. However, we see no viable alternative to open beach relocation at this time because the building of fenced beach hatcheries of adequate size is impractical and caging of individual nests in lighted beach areas, would require night patrols to check the cages. This would also be impractical because it would double the work load, could interfere with nesting sea turtles, and probably would not be allowed by local governments.

There is one location on Fort Lauderdale beach which is usually dark enough to leave nests *in situ* (between DEP markers R59-R61). For the last three years, all nests in this area have been relocated because the markers of *in situ* nests were always removed, increasing the threat of nest damage by beach cleaning equipment, and there were some disorientation cases. Nest

caging in dark beach areas would be feasible because the seaward edge of the cage could be lifted just prior to hatching so the hatchlings could self-release and the cages would not have to be checked at night. All such efforts to avoid relocation should be employed. However, there were only 63 *C. caretta* and 1 *D. coriacea* nests deposited in this area in 1993, out of 1708 total relocated nests. There is another similarly dark area on northern Hollywood beach (DEP markers R104-R105), possibly extending north to marker R98. However there were only 19 *C. caretta* nests between markers R98 and R105 this year. Until a comprehensive beach lighting policy that would reduce hatchling disorientation instances to acceptable levels is implemented, there seems to be no alternative to mass nest relocation.

As in previous years, we have analyzed the nesting and hatching data to uncover any possible affects of beach renourishment. We have been monitoring two renourishment projects, one at John U. Lloyd State Recreation Area (Lloyd beach) in 1989 and another at Hollywood-Hallandale beach in 1991. No rigorous analysis of Lloyd park data was conducted this year, because such studies in previous years showed no biologically significant differences between zone 4 which was not renourished, and zone 3 which was (Burney and Mattison 1991,1992a, 1992b). Figure 7 shows that slightly fewer *C. caretta* nests were deposited in zone 4 than in zone 3 this year. Also, Figure 8 shows no important differences in nesting success between zone 4 and the renourished beach sections. Hatching success of the *in situ* nests at Lloyd beach was the highest in the county (Table 6). Likewise, we can discern no detrimental effects of the 1991 renourishment of Hollywood-Hallandale beaches. Figure 7 shows no difference in *C. caretta* nesting densities in the area of Dania beach just north of the renourishment project (north of the arrow in Fig. 7) (DEP locator numbers 98-101), and the renourished area to the south. Figure 8 shows higher *C. caretta* nesting success in the unrenourished area (north of the arrow), but the

zone of high nesting success extends well into the renourished section as well (south of DEP monument 101). This area is the darkest and least developed section of this beach, which probably accounts for the higher nesting success. Again, we find no evidence that the two-year-old Hollywood-Hallandale renourishment project is adversely affecting sea turtle nesting.

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APPENDIX 1: SUMMARY OF SEA TURTLE HOT-LINE, BEEPER & NOVA CALLS

SUBJECT	HOT-LINE	NOVA
EMERGENCES:		
Nesting		6
Hatchlings	3 8	
NEST LOCATIONS	16 120	8
STRANDINGS	8 12	
POACHING	2	4
VOLUNTEERS	12 6	15
OTHER **	86 2,000	8
OVERALL	125	41

** Including calls from the media, residents concerned about land turtles in pools, all-terrain vehicle breakdowns and repairs, and all other unclassified, requests for information, and multi reason calls.

APPENDIX 2: **Summary of Educational/Public Information Activities**

Flyers were distributed in a timely manner along the beach, mostly to people who approached workers with questions and at the night turtle releases at Pompano and Fort Lauderdale, which usually attracted crowds. Flyers were also placed in beach-front business establishments and some were distributed to people touring the Oceanographic Center or requesting information by phone or mail.

During July through mid August,a weekly sea turtle release and informational seminar was given by Cathy Mattison or Dr. Dale Vicha, at Hollywood North Beach Park. These were well attended. The project director and principle investigator gave a total of five sea turtle presentations at local schools.

Hatchlings were also provided for the bi-weekly sea turtle walks held at John Lloyd State Recreation Area, where they were properly released.

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