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Sea Turtle Conservation Program, Broward County, FL 1990 Report

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SEA TURTLE CONSERVATION PROJECT BROWARD COUNTY, FLORIDA 1990 REPORT

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For the:

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ACKNOWLEDGEMENTS

We thank the **Erosion Prevention District** of the **Office of Natural Resource Protection** and especially **Lou Fisher** who administered the project and solved several problems.

We gratefully acknowledge the dedicated efforts of **Michael Biggie, Don Boyeu, John Braker, Anthony Fuschetto, Dave Gilliam, Judith Hicklin, Donna Hoewenthal, Lyn Howell, Jenny Kappel, Bill Lang, Bill Margolis, Kathy Maxson, Bob Miller, Ashley Mon, Mark Anthony, J. O'Neill, Lynette Oster, Matthew Sanfilippo, Kim Stuckel, Terry Thompson, Brenda Bush-Turri, and Bob and Jeannie Wershoven,** who helped with the field surveys, night releases, stranded turtles, and/or hatchery sand replacement. Their dedication and hard work has made the project a success. We gratefully thank the owner and employees of **Competition Cycle, Dania, FL** who kept the all- terrain vehicles running and provided support whenever a problem arose. We also acknowledge the park employees and volunteers (especially **Donny Norman**)of the Broward County Parks and Recreation Division at **Hollywood North Beach Park** and the personnel of **John U. Lloyd State Recreation Area**, especially **Carmen Duesler**, who provided data from this beach. We would also like to thank the following people for their assistance and cooperation:

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Pompano Beach Maint. Dept. and **Public Works Dept.**

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The Florida Marine Patrol

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INTRODUCTION

Since 1978, the Broward County Erosion Prevention District (BCEPD) of the Broward County Environmental Quality Control Board has provided for the conservation of endangered and threatened sea turtle species within its area of responsibility, according to provisions of the dredge and fill permits issued to the District by the U.S. Army Corps of Engineers, the Florida Department of Environmental Regulation and the Florida Department of Natural Resources. 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 species under the U.S. Endangered Species Act and Florida Law Chapter 370.

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 Natural Resources (FDNR), which subsequently issues permits to individuals, universities and government agencies. This project was administered by the BCEPD and conducted by the Nova University Oceanographic Center under Marine Turtle Permit #129, issued to the BCEPD by the FDNR Institute of Marine Research, St. Petersburg, Florida. The BCEPD is especially concerned with any environmental effects of intermittent beach renourishment projects on shorelines and the offshore reefs. As part of this concern, the District 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 program during 1990.

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 on 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	DNR 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

Except in John Lloyd Park, all nests were located by using DNR survey markers 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 number or other land mark. These locations where later cross referenced to the nearest survey marker.

The beach at John U. Lloyd State Recreation Area was surveyed by park personnel, who provided these data. 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

during the previous two years, to assess the effects of a completed beach renourishment project on nesting patterns.

Surveyors used all-terrain vehicles which could carry four to eight turtle nests in plastic buckets. The usual method was to mark and record nests and false crawls on the first pass along the beach and then dig and transport endangered nests 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 recording, crawl marks were obliterated to avoid duplication.

Endangered nests 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 the root systems might interfere with successful emergence of the hatchlings.

Especially due to definition 3, 100% of the nests at Pompano, Fort Lauderdale, and Hollywood-Hallandale were considered endangered and relocated to hatcheries or dark beach locations. Nests to be relocated were carefully dug by hand, and transported in buckets containing sand from the nest chamber. Chamber depth was measured in order to rebury nests at their original depth. They were then transferred to artificial egg chambers of the same dimensions, lined with sand from the natural nest. Care was taken to maintain the natural orientation of each egg.

Nonendangered nests, mostly on Hillsboro beach, were marked and left in-situ. After hatching, 162 of these nests were excavated. 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, piped eggs, eggs with arrested or no visible development, and hatchlings dead in the nest.

Hatchery Operations

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

Nests displaying a depression over the egg chamber, indicating eminent hatchling emergence, were covered with a screen cage or 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 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 and the high percentage of relocated nests, the Pompano and Fort Lauderdale hatcheries quickly filled. After May 26, eggs from Fort Lauderdale and Pompano were relocated to Hillsboro Beach. By mid August, space again became available in the hatcheries, and open beach relocation ceased. Hatched nests in the hatcheries were completely dug out along with the surrounding sand and replaced with fresh sand before new

egg chambers were dug. Old sand was spread outside the hatchery. Fresh sand was obtained elsewhere on the beach.

Data analysis

The data was compiled, analyzed and plotted primarily with Lotus 123. The historical trend in county-wide total and *C. caretta* yearly nesting densities from 1981 to 1990 was determined by linear regression and correlation analyses. Total nests were calculated per km for the entire county and for each of the five beach areas. The average number of nests per day county-wide and for each beach were calculated and compared to each other with 1-way analysis of variance (ANOVA) and Student-Newman-Keuls (SNK) tests (at the .05 significance level), and to 1989 data with t-tests (Zar, 1974). Daily nesting success (nests/total crawls) patterns were plotted and mean daily nesting success between beaches were compared. Seasonal fecundity trends for *C. caretta* were analyzed by relating clutch size with the Julian date of clutch deposition by linear correlation analyses.

Overall hatching success (live hatchlings/total eggs) was calculated and compared with previous years. Hatching success rates for relocated and in-situ nests were also compared for *C. caretta* and *C. mydas*.

The county-wide seasonal hatching success pattern was investigated by plotting the hatching success of each relocated nest versus the Julian date of its deposition. Linear correlation and regression analyses were used to analyze trends. The same analyses were preformed for relocated and in situ nests.

Nesting and nesting success patterns in John Lloyd State Recreation Area were plotted and compared to data collected before (1988), during (1989) and after (1990) a beach renourishment project.

RESULTS

A total of 2388 sea turtle nests were surveyed county-wide in 1990. Of these, 2281 were *C. caretta*, 106 were *C. mydas* and 1 was a *D. coriacea* nest. Table 1 lists the total number of nests and false crawls for each species at each beach.

Figure 1A shows the yearly total nest count from Broward County since 1981 when coverage of the entire county commenced. Figure 1B gives the trend line, fit to the yearly nesting data. The trend has a positive slope significantly greater than zero at the 98.7 percent confidence level (P = .013). Figure 2A shows the yearly nesting pattern and trend for *C. caretta*. There is a positive trend, at the 98.5% confidence level (P=.015). The county-wide historical nesting patterns of *C. mydas* and *D. coriacea* are shown in Figure 2B.

Figure 3A and 3B give the locations of *C. caretta* and *C. mydas* nests, respectively. DNR survey markers (locator numbers) 1 and 128 are at the Palm Beach and Dade County lines, respectively. The locator numbers corresponding to each beach are given in Materials and Methods. Data from the four zones of Lloyd Park are also shown.

Figure 4A shows the daily sea turtle nesting patterns of *C. caretta* in Broward County during 1989 and 1990. In 1990, *C. caretta* nested from 22 April (Hollywood-Hallandale) to 31 August (Pompano). Figure 4B shows the seasonal patterns of *C. mydas* nesting in 1989 and 1990. *C. mydas* nesting began sooner (May 13), ended later (September 12) and achieved much higher densities in 1990 than the previous year. Both the first and the last *C. mydas* nests of the season were laid on Hillsboro-Deerfield beach. The single *D. coriacea* nested at Hillsboro-Deerfield on May 9.

Table 1: Total nests and false crawls (FC) for three sea turtle species in each of five Broward County beach areas during 1990.

BEACH	*C.caretta*		*C.mydas*		*D.coriacea*	
	Nests	FC	Nests	FC	Nests	FC
Hillsboro	664	345	76	54	1	0
Pompano	735	618	7	8	0	0
Ft.Laud.	582	487	3	2	0	0
Lloyd Park	162	378	18	15	0	2
Hollywood-Hall.	138	97	2	4	0	0
OVERALL	2281	1925	106	83	1	2

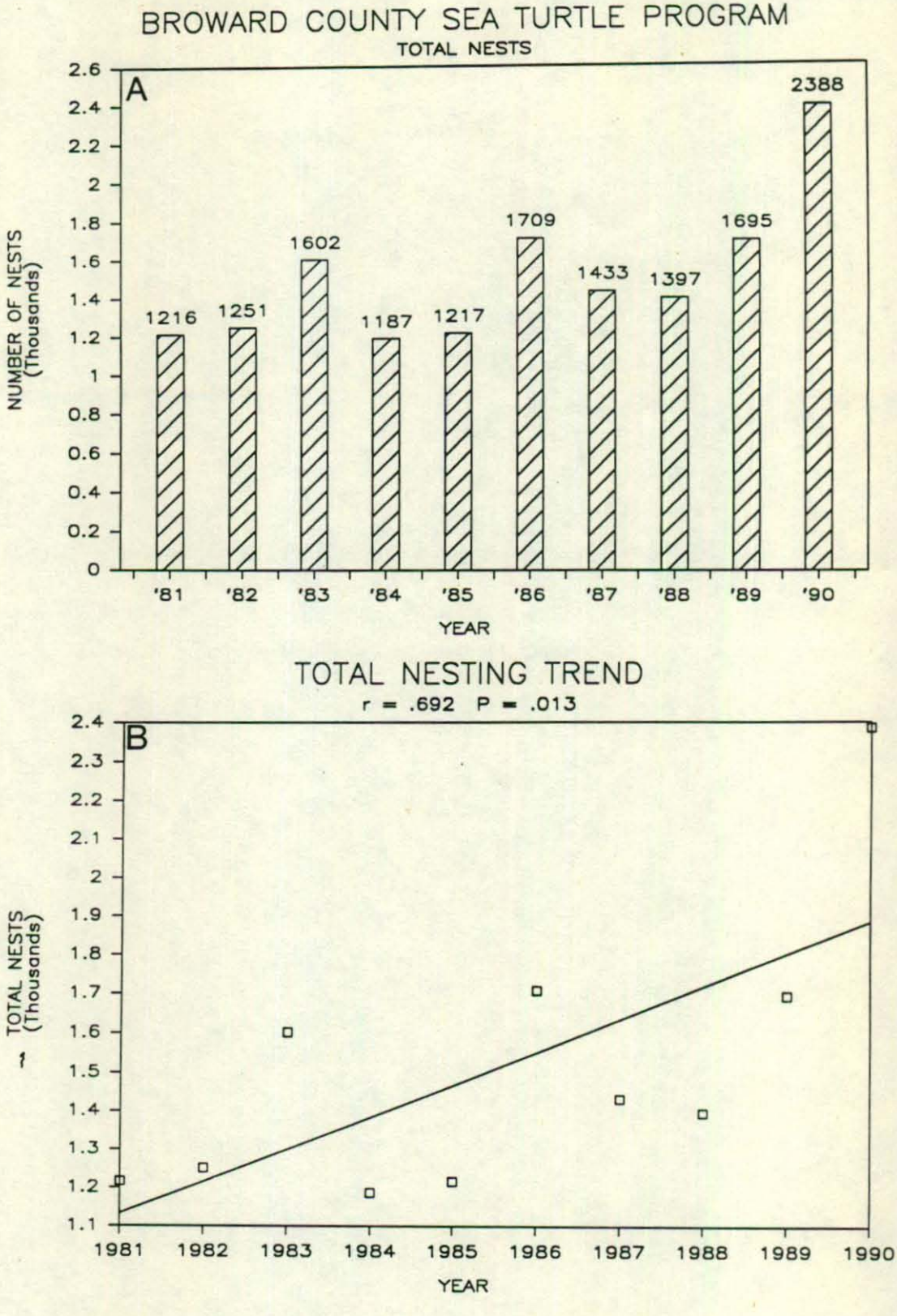


Figure 1: The historical pattern (A) and statistical trend (B) of total sea turtle nesting in Broward County since full surveys began in 1981.

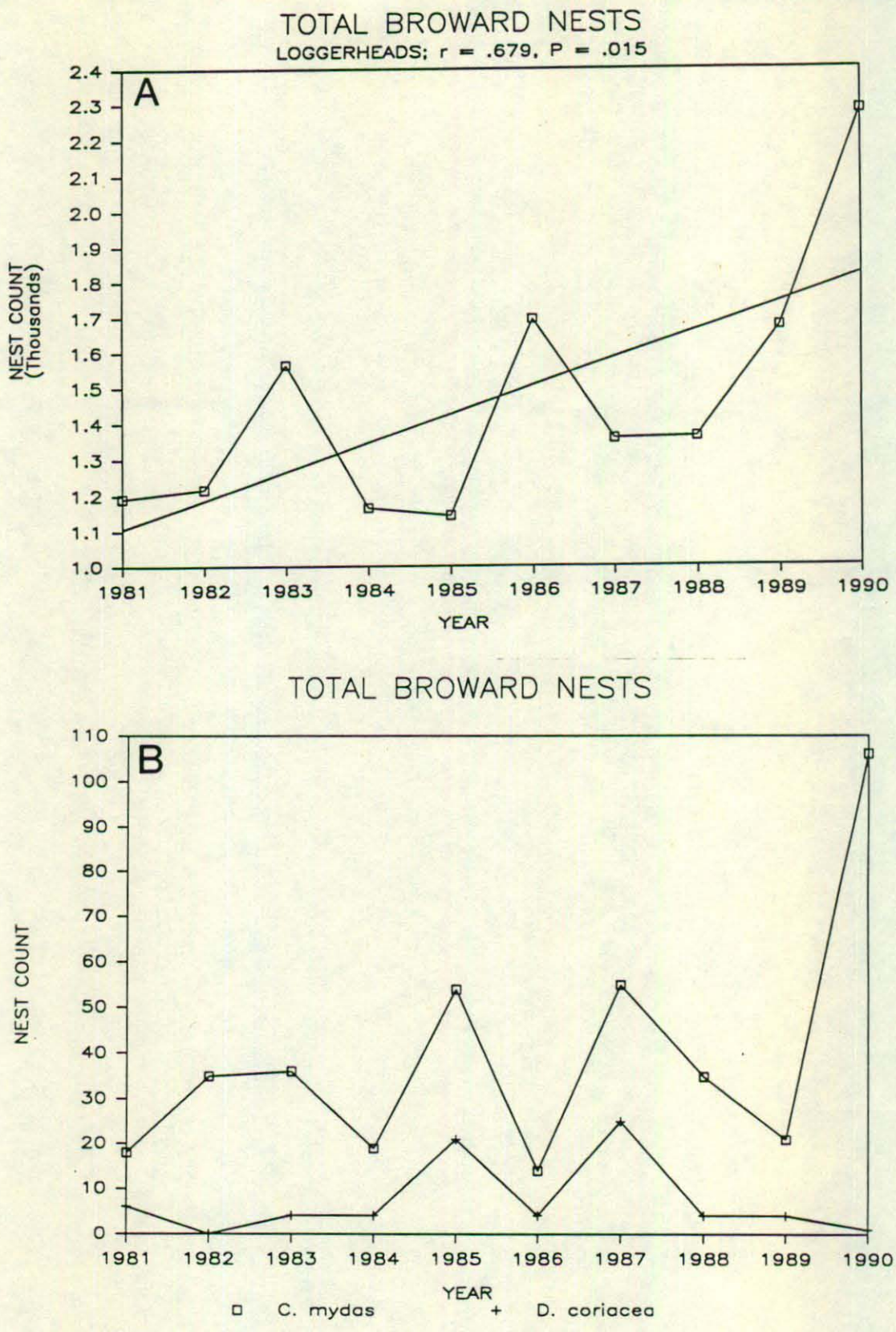


Figure 2: Historical nesting patterns for *C. caretta* (A) and *C. mydas* and *C. coriacea* (B) in Broward County since 1981

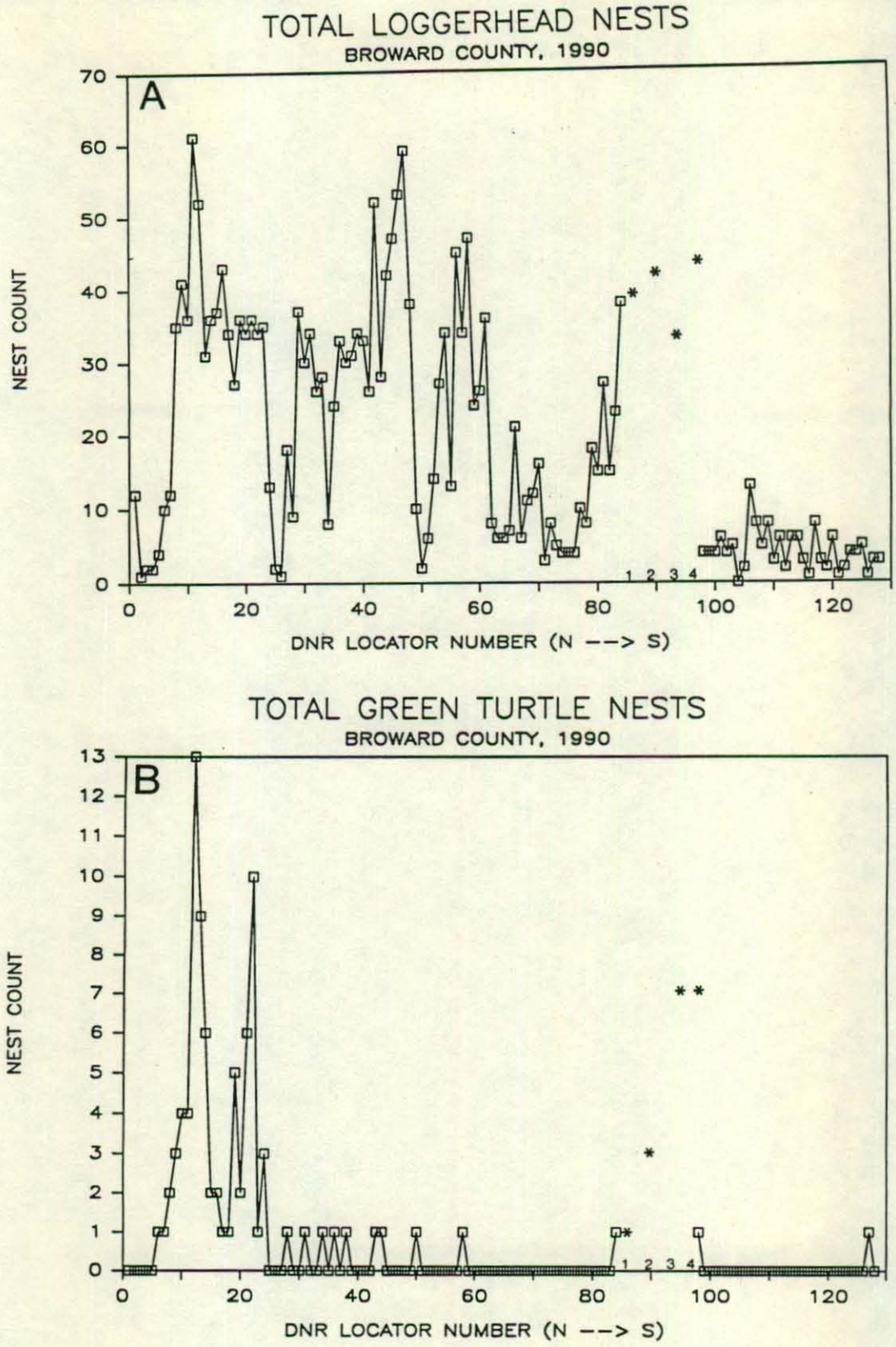


Figure 3: Locations of *C. caretta* (A) and *C. mydas* (B) nests in Broward County, 1990, listed by DNR monument numbers. Nest counts in the four zones of John Lloyd state Recreation Area are shown with asterisks.

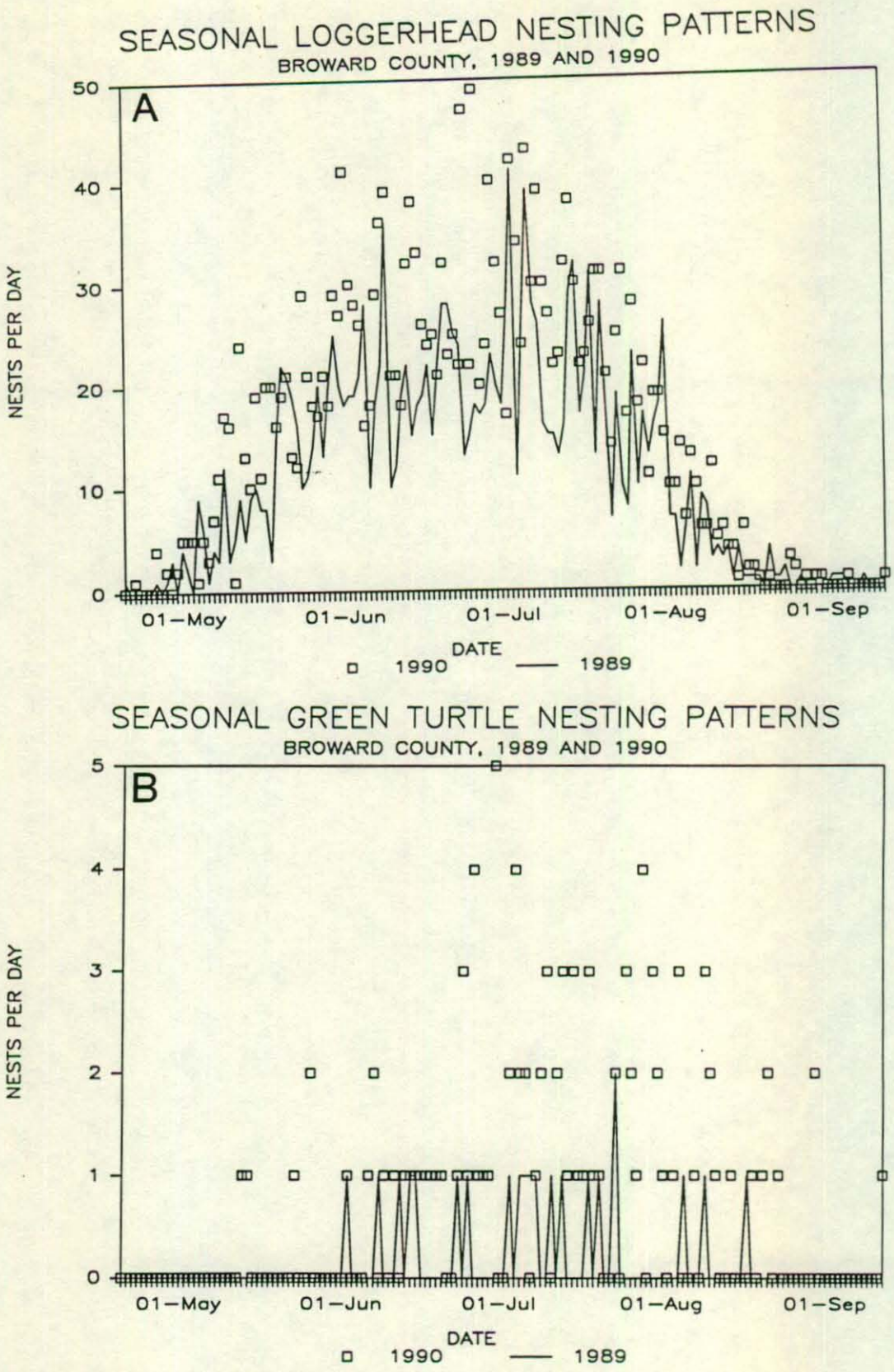


Figure 4: Comparison of seasonal daily nesting patterns of *C. caretta* (A) and *C. mydas* (B) for 1989 (lines) and 1990 (squares) in Broward Counts.

Figure 5A-E shows the 1990 seasonal nesting patterns of *C. caretta* on the individual beaches. Figures 6A and 6B give the seasonal nesting patterns of *C. mydas* at Hillsboro-Deerfield and John Lloyd State Park beaches, respectively. These were the only areas where *C. mydas* nesting was sufficient to warrant graphic display. Table 2 gives *C. caretta* nest totals for the individual beaches expressed per kilometer for the entire season, and as mean daily nests-per-kilometer, to allow SNK comparisons. Table 3 gives nesting density data for *C. mydas*. No SNK analysis was preformed because of the low number of data south of Hillsboro. Over 71% of the county-wide *C. mydas* nests were deposited on Hillsboro-Deerfield beach.

Figure 7 illustrates the seasonal pattern of daily *C. caretta* nesting successes in Broward County. Similar plots for the individual beaches are given in Figure 8A-E. Table 4 gives total and mean daily nesting success for *C. caretta* on the five beaches.

The county-wide seasonal pattern of the daily nesting success of *C. mydas* is shown in Figure 9. Figures 10A-B present similar data from Hillsboro-Deerfield and Lloyd Park beaches, respectively. Total and mean daily nesting success for *C. mydas* on each beach are shown in Table 5.

Figure 11A illustrates the county-wide seasonal trend in *C. caretta* fecundity. There was a slight, but significant decline in the number of eggs-per-clutch during the season. Figure 11B shows the same data for *C. mydas*. The slight positive trend is not significant ($P = .18$). Figure 12A-E show the seasonal patterns of *C. caretta* fecundity for each beach.

Figure 13 shows the seasonal pattern of daily hatching successes of all excavated *C. caretta* eggs in the county. Hatching success declined significantly over the course of the summer. Figure 14A-E gives the seasonal hatching percent pattern for the five beaches. Hatching success declined significantly

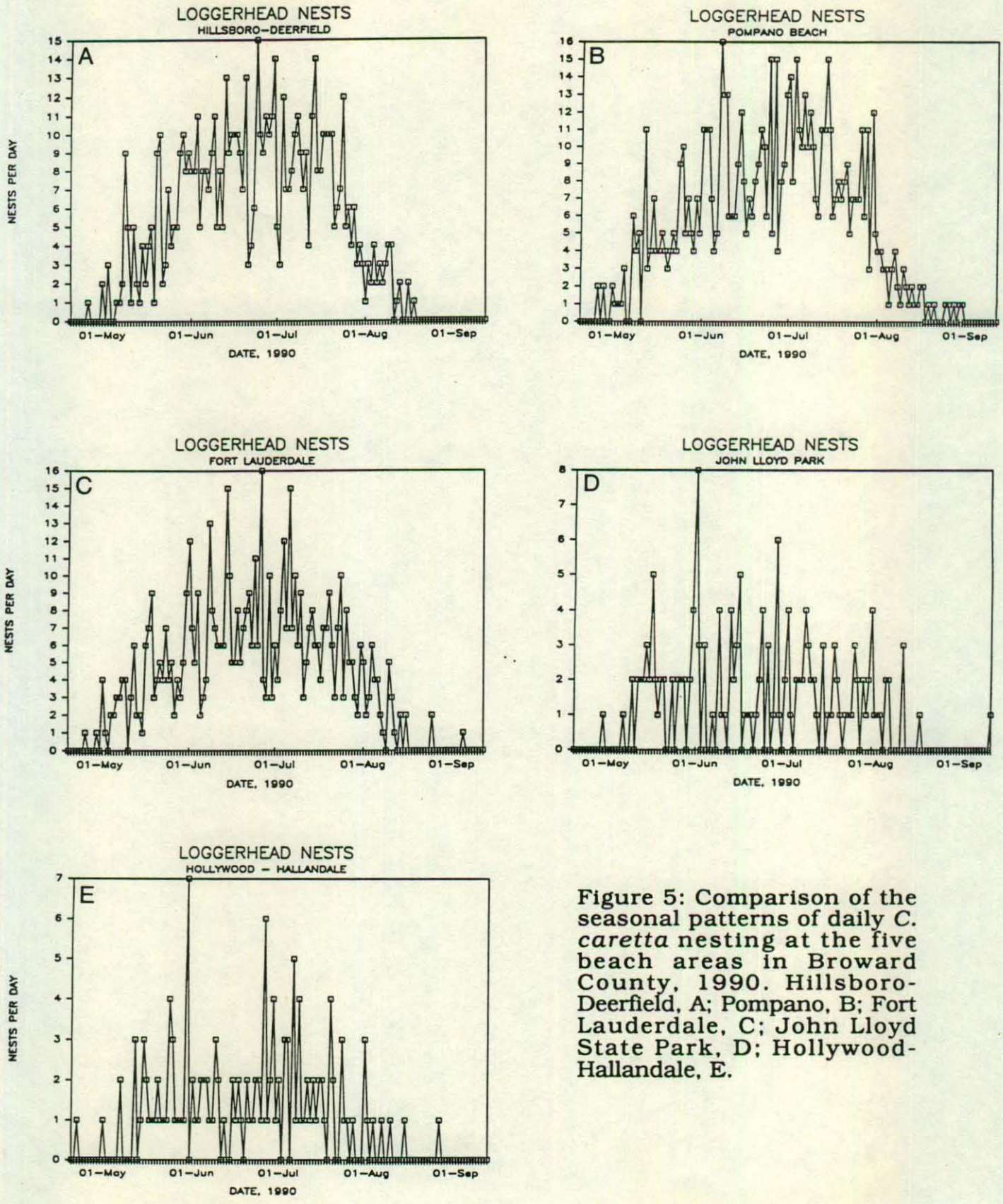


Figure 5: Comparison of the seasonal patterns of daily *C. caretta* nesting at the five beach areas in Broward County, 1990. Hillsboro-Deerfield, A; Pompano, B; Fort Lauderdale, C; John Lloyd State Park, D; Hollywood-Hallandale, E.

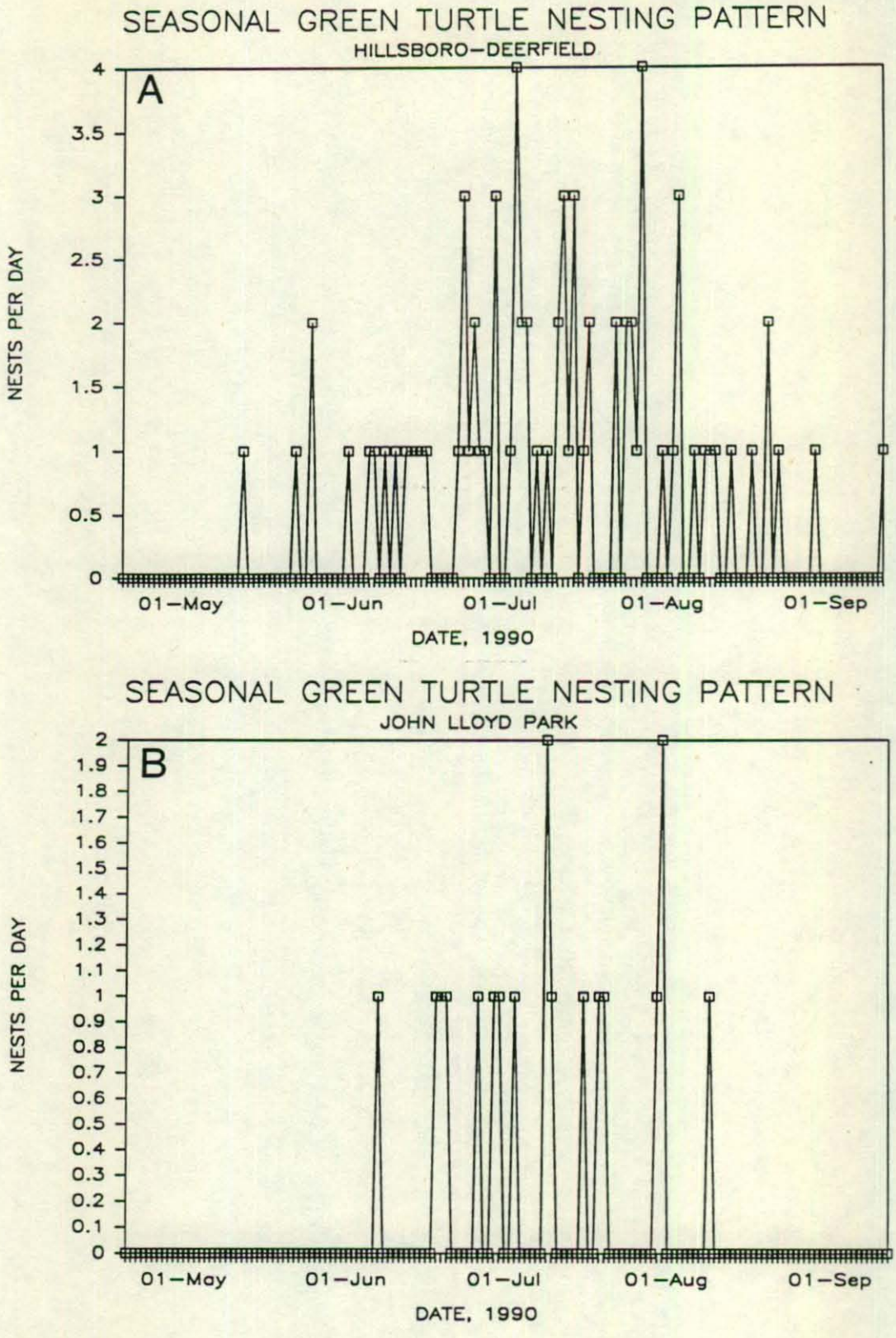


Figure 6: The seasonal patterns of daily *C. mydas* nesting on Hillsboro-Deerfield (A) and John Lloyd State Park (B) beaches during 1990. Nesting on other Broward County beaches was insufficient to justify graphic display.

Table 2: Total *C. caretta* nests and nesting densities expressed as nests-per-kilometer for the 1990 season and as the average of the per-kilometer nesting densities for each day of the season. Vertical lines at the right overlap groups where means were not distinguishable in a SNK test at alpha = .05.

BEACH	TOTAL NESTS	BEACH LENGTH (km)	NESTS per (km)	MEAN DAILY NESTS per(km)	
Hollywood-Hall.	140	9.4	14.9	.101	|
Lloyd Park	162	3.9	41.5	.285	|
Ft.Laud.	582	10.6	54.9	.376	|
Hillsboro	664	7.0	94.9	.651	|
Pompano	735	7.7	95.5	.654	|
OVERALL	2281	38.6	59.1	.413	

Table 3: Total *C. mydas* nests and nesting densities expressed as nests-per-kilometer for the 1990 season. Data were too few for a SNK test of mean daily nesting densities.

BEACH	TOTAL NESTS	BEACH LENGTH (km)	NESTS per (km)
Hillsboro	76	7.0	10.9
Pompano	7	7.7	0.9
Ft.Laud.	3	10.6	0.3
Lloyd Park	18	3.9	4.6
Hollywood-Hall.	2	9.4	0.2
OVERALL	106	38.6	2.7

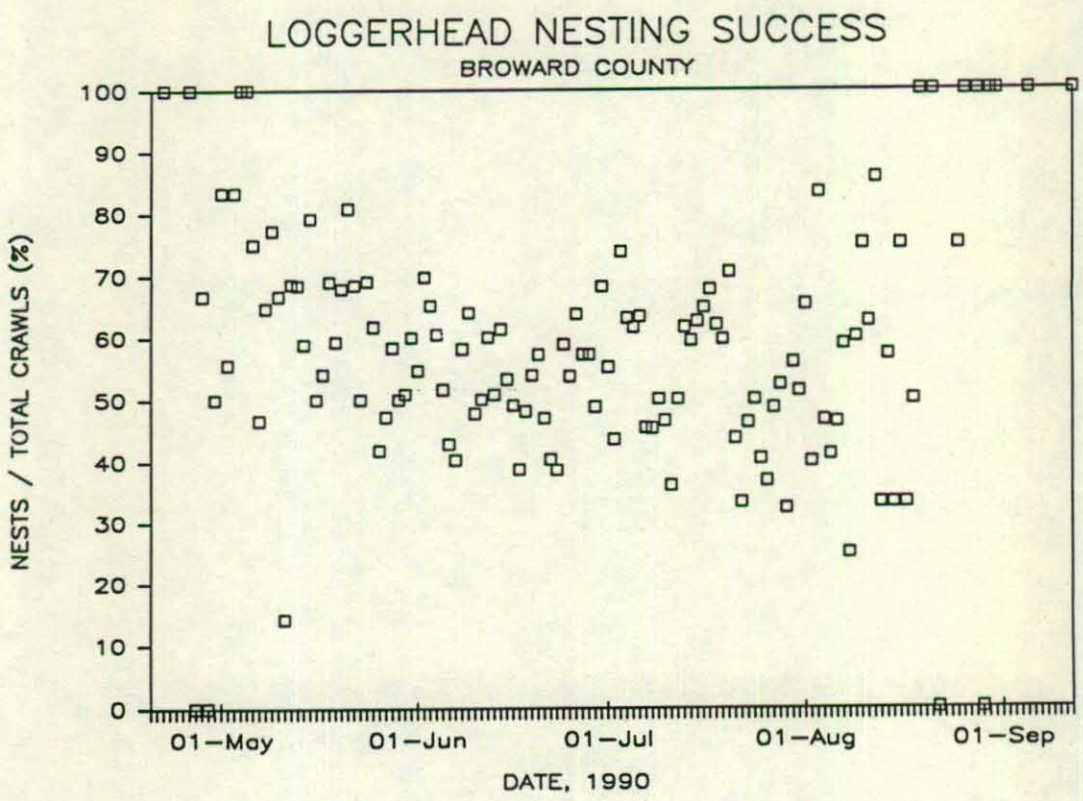


Figure 7: The County-wide pattern of *C. caretta* total daily nesting success (total nests/total crawls) in Broward County, 1990.

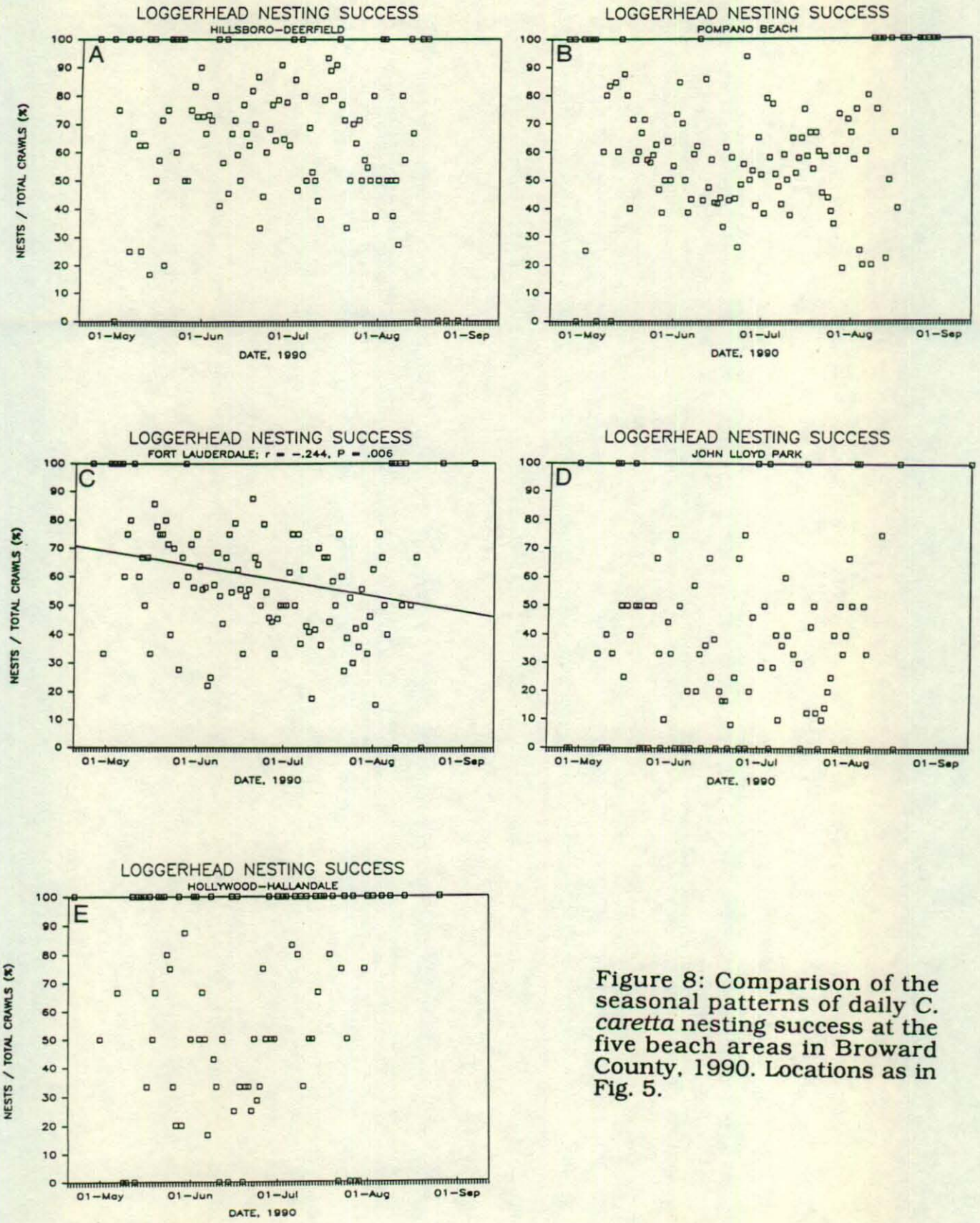


Figure 8: Comparison of the seasonal patterns of daily *C. caretta* nesting success at the five beach areas in Broward County, 1990. Locations as in Fig. 5.

Table 4: Total and mean daily nesting success (%) for *C. caretta* at the five Broward County beaches during 1990. Vertical lines at the right overlap groups where mean daily nesting success were not distinguishable in a SNK test at alpha = .05.

BEACH	NESTS	TOTAL CRAWLS	TOTAL NESTING SUCCESS	MEAN DAILY NESTING SUCCESS	
Lloyd Park	162	540	30.0	36.2	I
Ft.Laud.	582	1069	54.4	59.5	|
Pompano	735	1353	54.3	61.4	|
Hollywood-Hall.	138	235	58.7	64.4	|
Hillsboro	664	1009	65.8	65.9	|

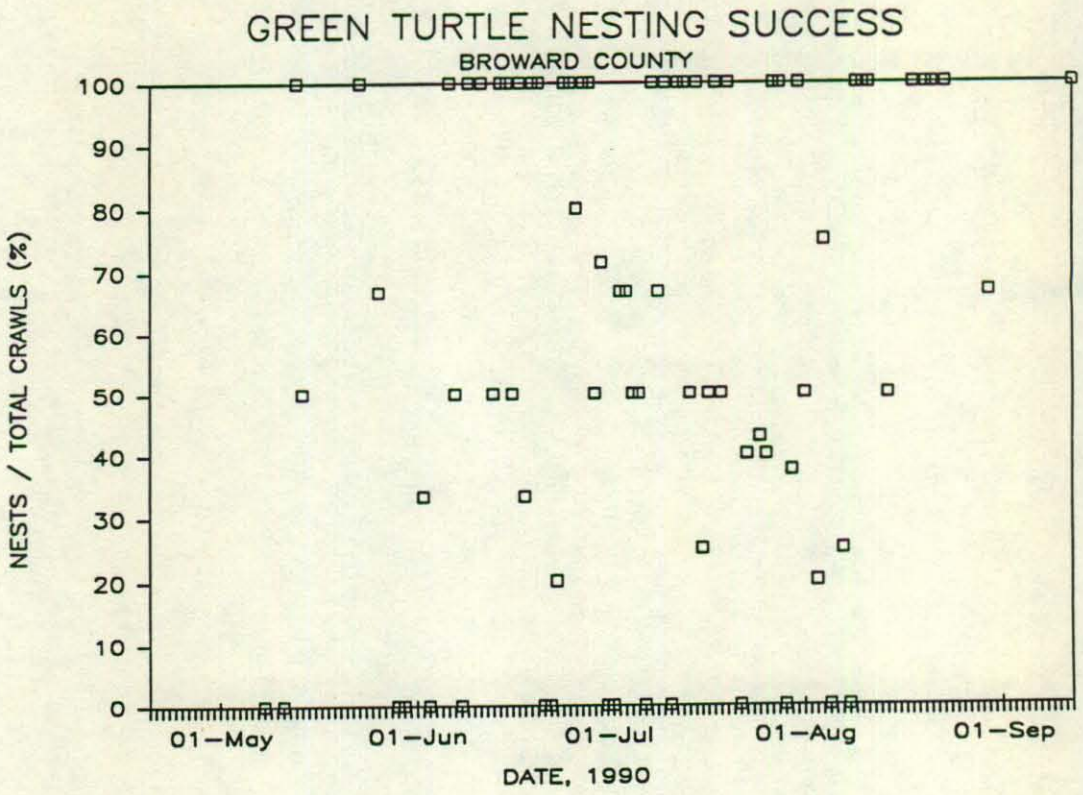
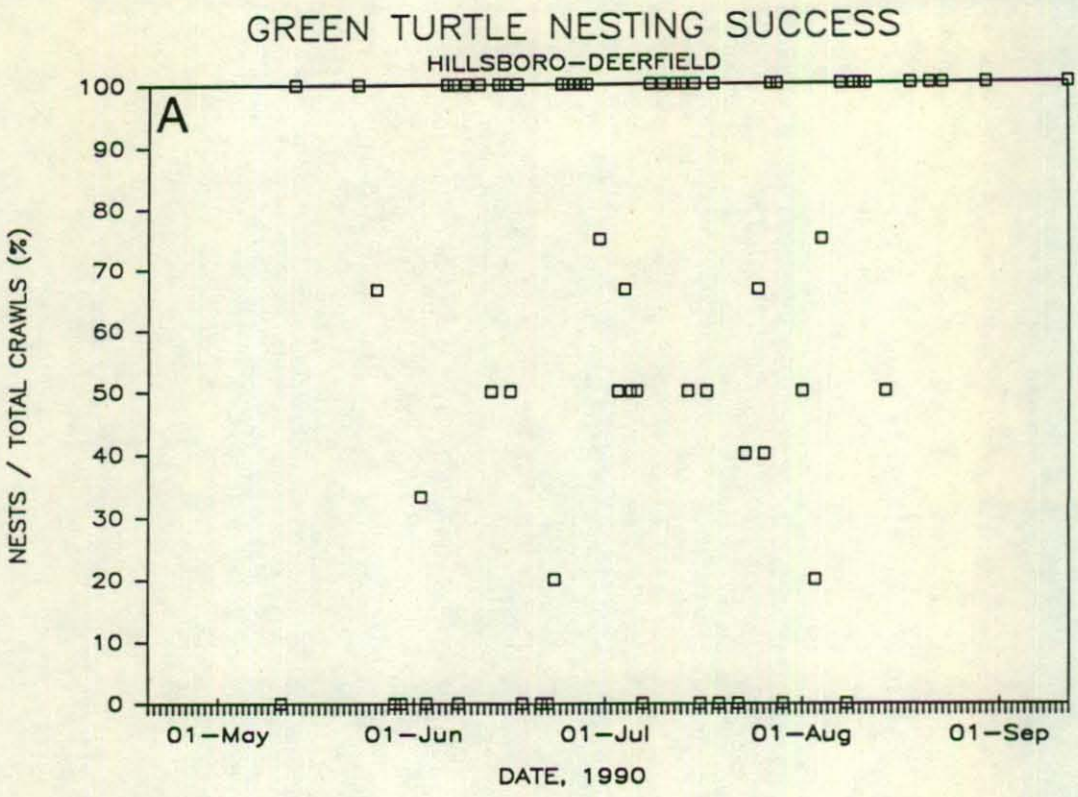


Figure 9: The County-wide pattern of *C. mydas* daily nesting success (total nests/total crawls) in Broward County, 1990.



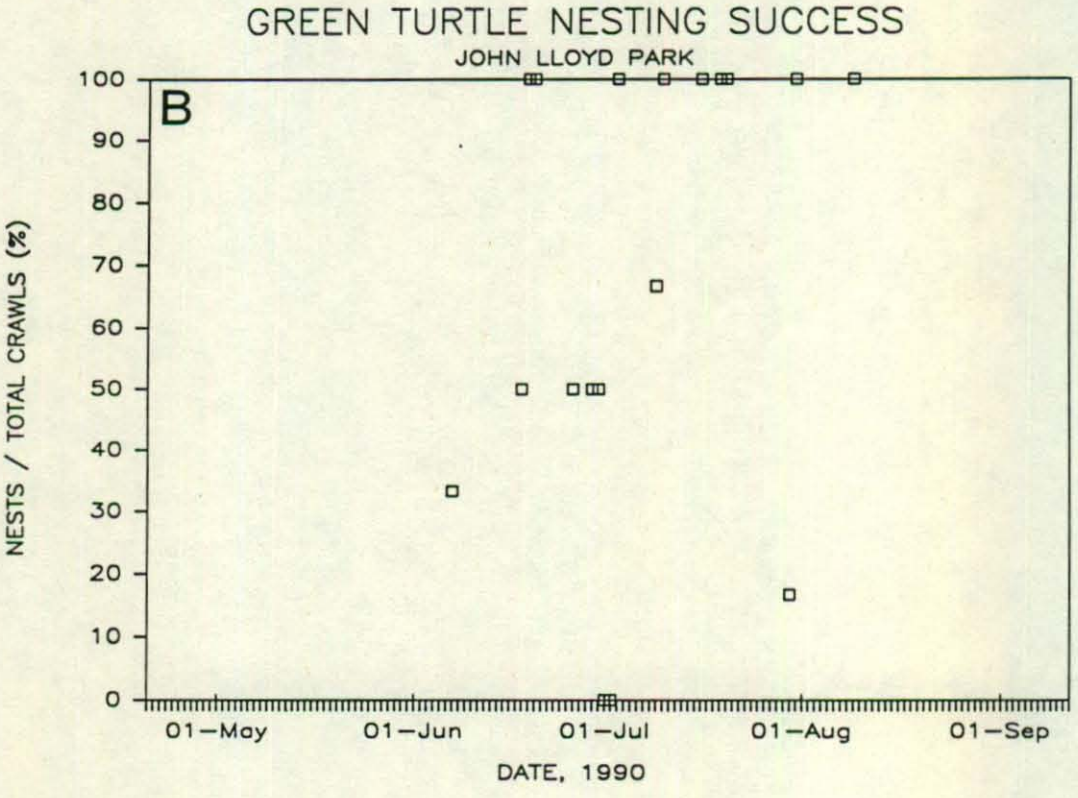


Figure 10: The pattern of daily nesting success for *C. mydas* on Hillsboro-Deerfield (A) and John Lloyd State Park (B) beaches in 1990.

Table 5: Total and mean daily nesting success (%) for *C. mydas* at the five Broward County beaches during 1990. A 1-way ANOVA showed no significant differences in mean daily nesting successes.

BEACH	NESTS	TOTAL CRAWLS	TOTAL NESTING SUCCESS	MEAN DAILY NESTING SUCCESS
Hillsboro	76	130	58.5	63.3
Pompano	7	15	46.7	52.8
Ft.Laud.	3	5	60.0	60.0
Lloyd Park	18	33	54.5	67.6
Hollywood-Hall.	2	6	33.3	50.0

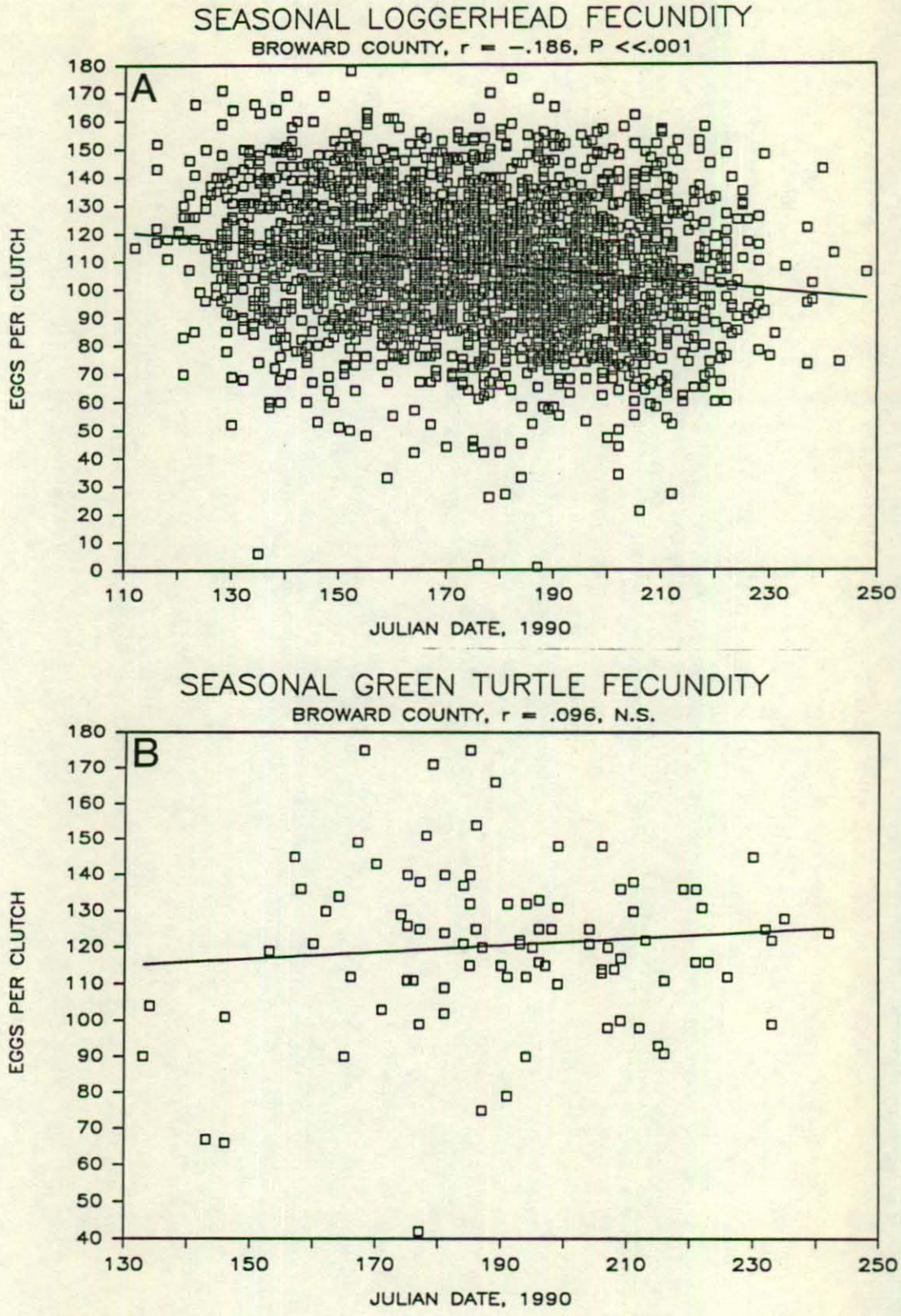


Figure 11: Seasonal fecundity (eggs per clutch) patterns for *C. caretta* (A) and *C. mydas* (B) during the 1990 nesting season in Broward County, listed by Julian Date.

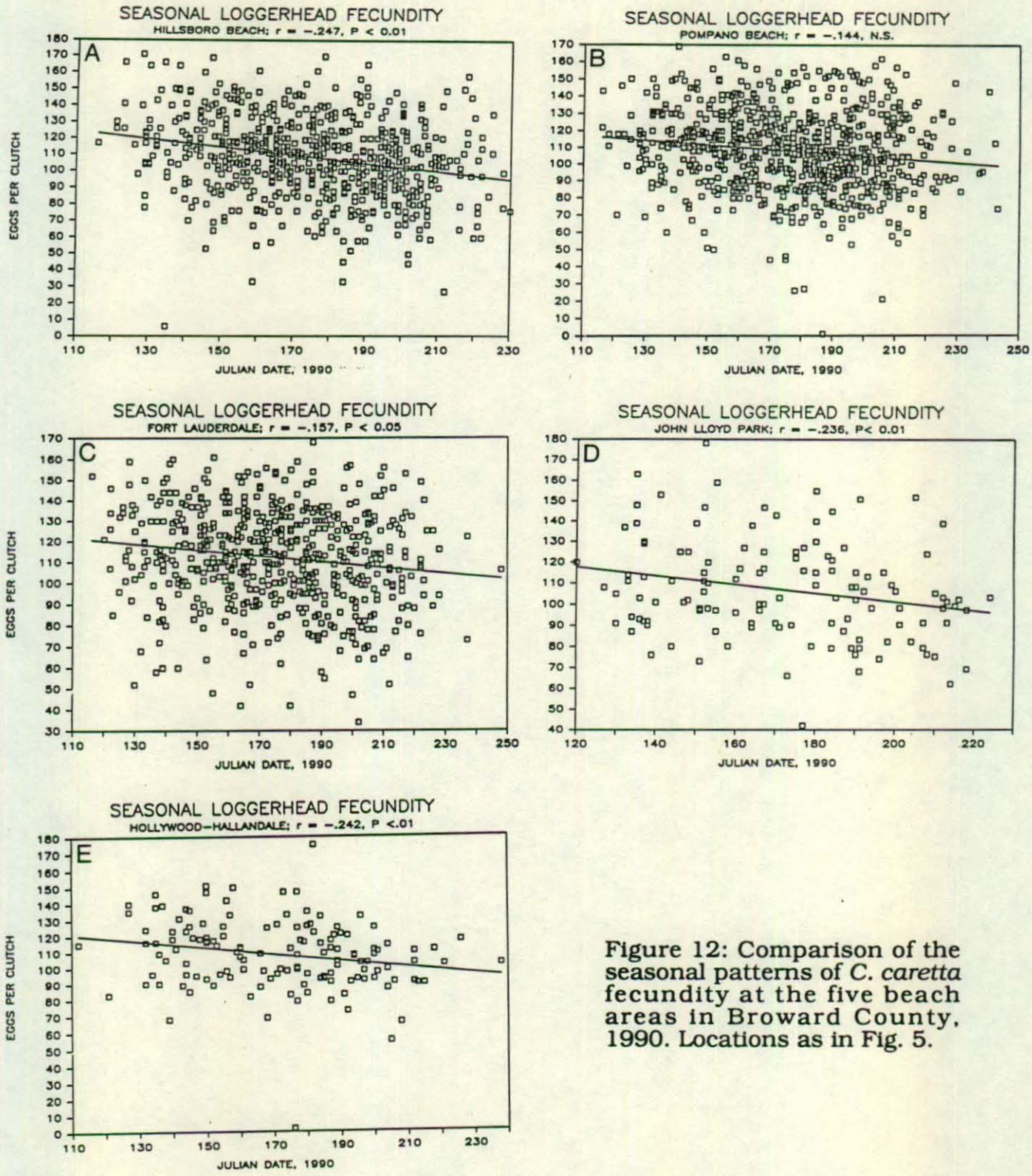


Figure 12: Comparison of the seasonal patterns of *C. caretta* fecundity at the five beach areas in Broward County, 1990. Locations as in Fig. 5.

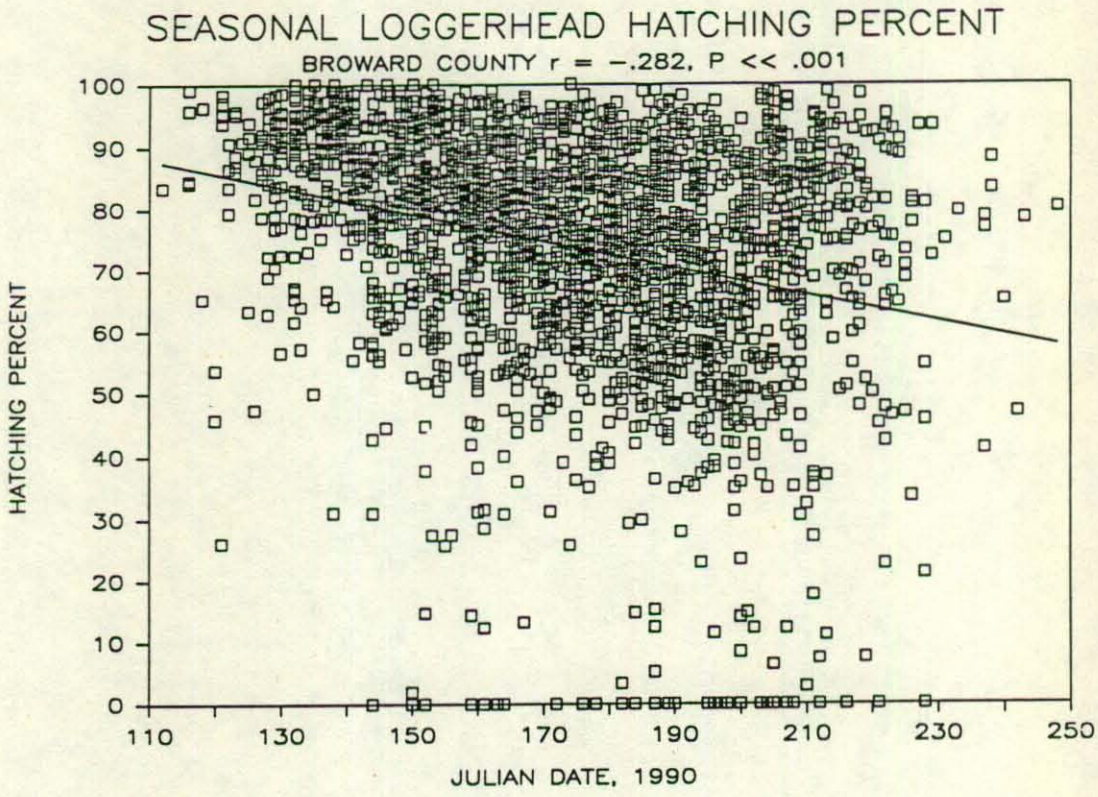


Figure 13: The County-wide seasonal trend in hatching success for *C. caretta* in Broward County, 1990.

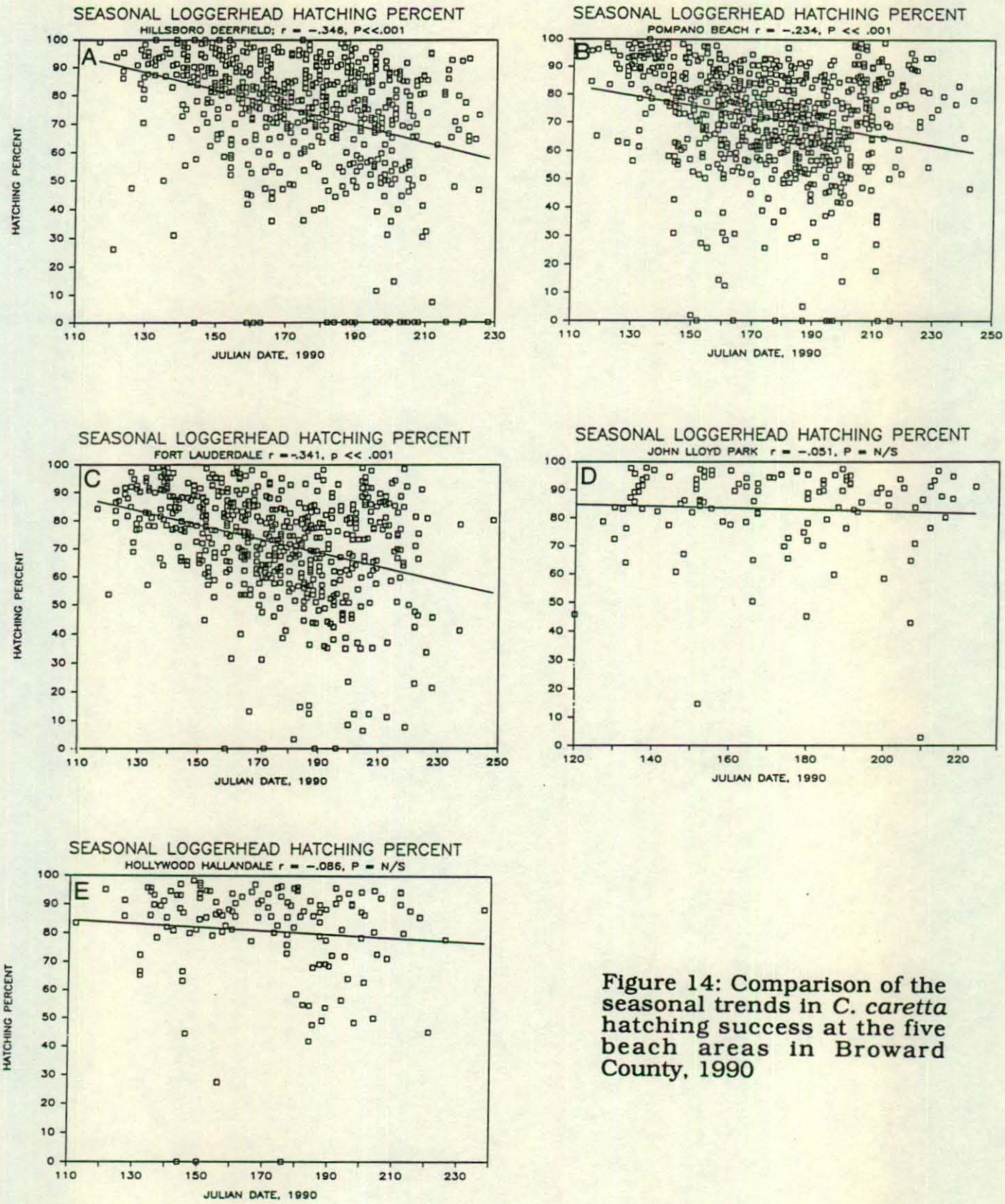


Figure 14: Comparison of the seasonal trends in *C. caretta* hatching success at the five beach areas in Broward County, 1990

at the three northern beaches, but not at John Lloyd Park or Hollywood-Hallandale.

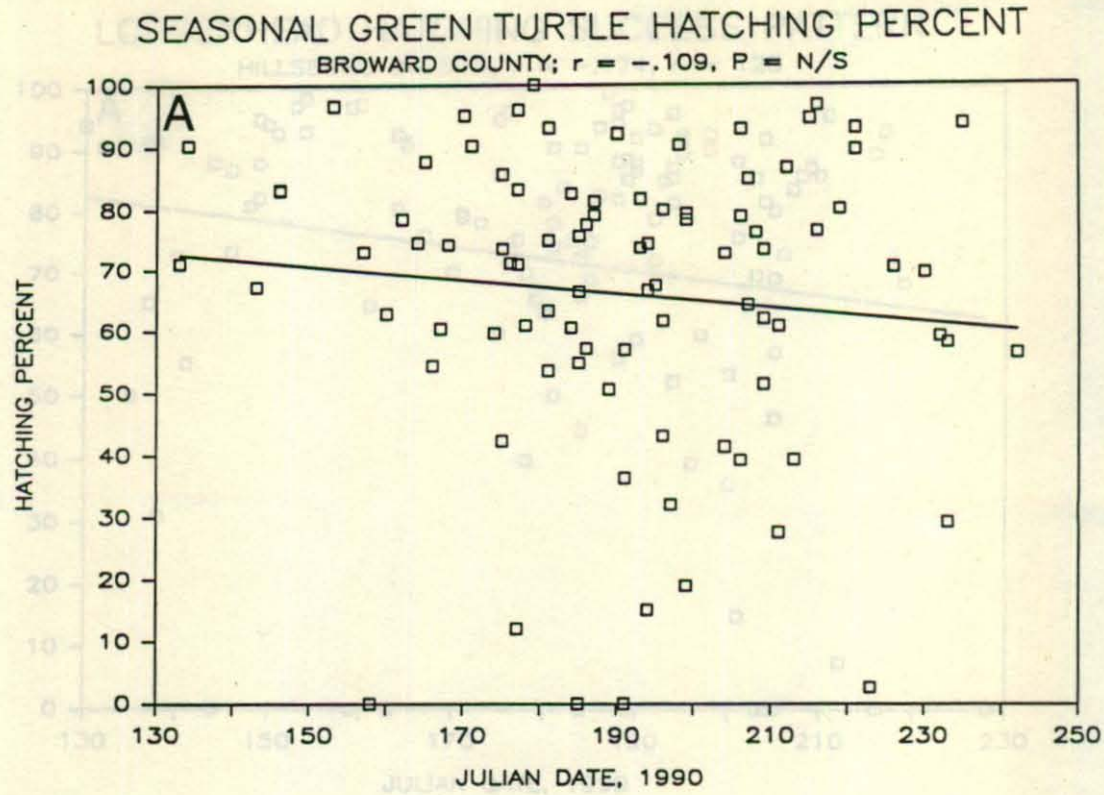
Seasonal hatching success patterns for all excavated *C. mydas* nests for the total county and Hillsboro-Deerfield beach are given in Figure 15A-B. The declining trends were not significant at the .05 level.

Figures 16A-B compare seasonal daily hatching success patterns for Hillsboro in-situ and relocated *C. caretta* nests, respectively. Figures 17A-B make the comparison for total in situ and relocated *C. mydas* nests. Table 6 8gives hatching success data for all *C. caretta* and *C. mydas* relocated and excavated in situ nests. The single in situ *D. coriacea* nest is also included.

Figure 18 gives the historical pattern of hatching success since fenced beach hatcheries were first employed in 1981. There is no significant difference between the overall hatching percents for in-situ (73.1%) and relocated (71.8%) nests.

Table 7 gives an accounting of nest relocation operations at each beach. Figure 19 gives yearly hatchling release totals for the Broward County Sea Turtle Program since 1978. With only one exception, there has been an increasing number of hatchlings released each year since 1978. The trend shows an exponential increase.

Figure 20A shows the total number of sea turtle nests deposited in the four zones of John Lloyd State Park during 1988, 1989 and 1990. Unlike the previous years, there was an almost uniform nesting distribution in 1990, with slightly heavier nesting in zone 4, farthest to the south. Figure 20B gives the distribution of in-situ and relocated nests in the park.



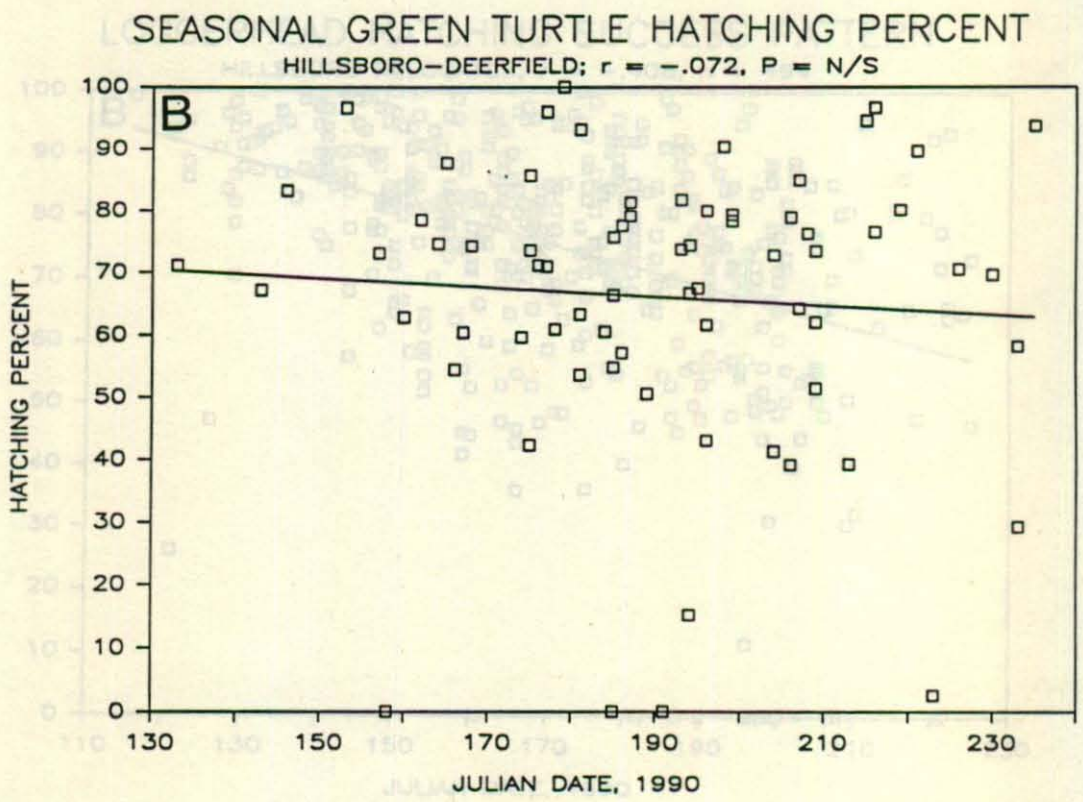


Figure 15: Seasonal *C. mydas* hatching success patterns for Broward County (A) and Hillsboro-Deerfield (B) beaches, 1990.

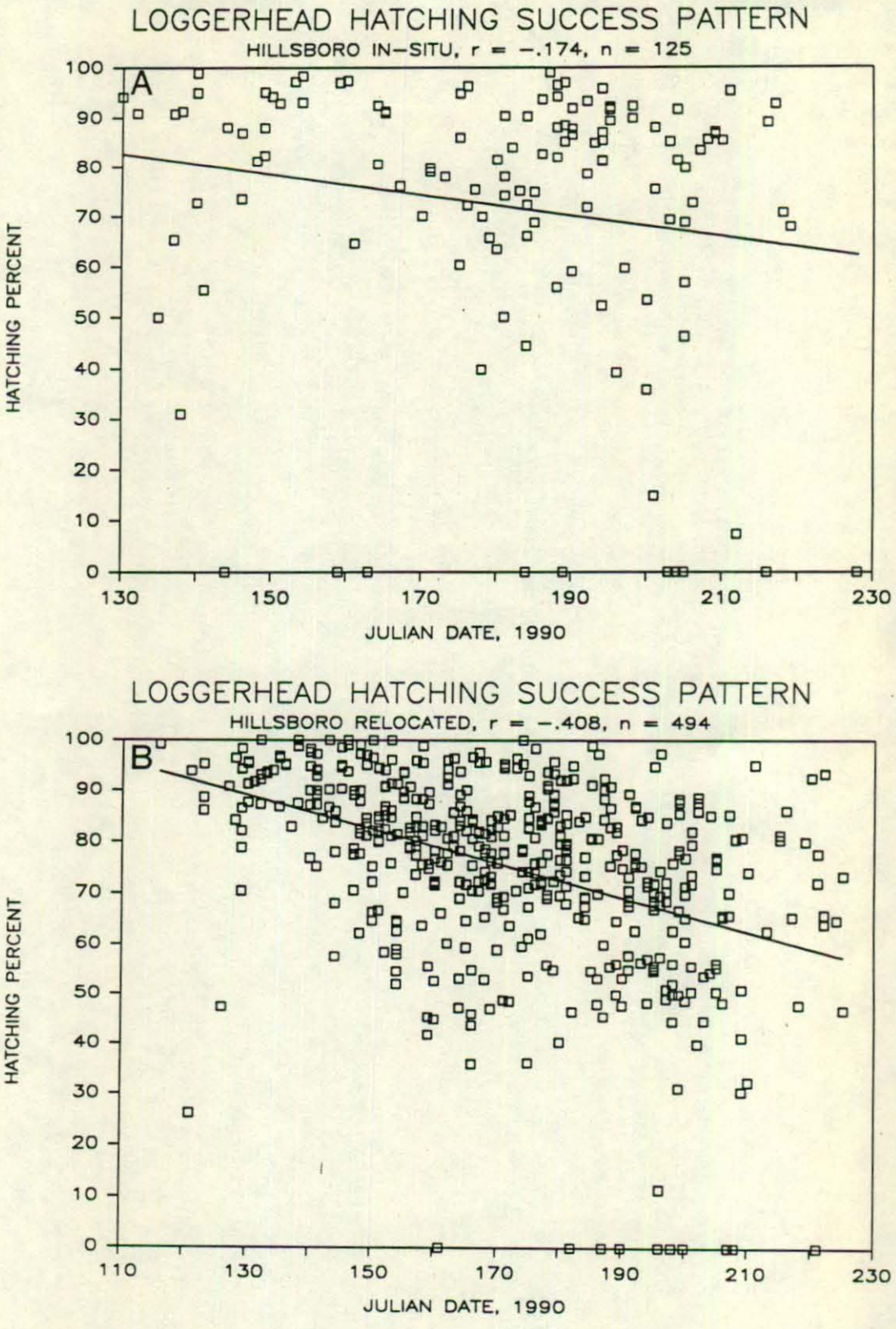


Figure 16: Seasonal *C. caretta* hatching success patterns from (A), in-situ (natural) and (B), relocated nests at Hillsboro-Deerfield Beach, 1990

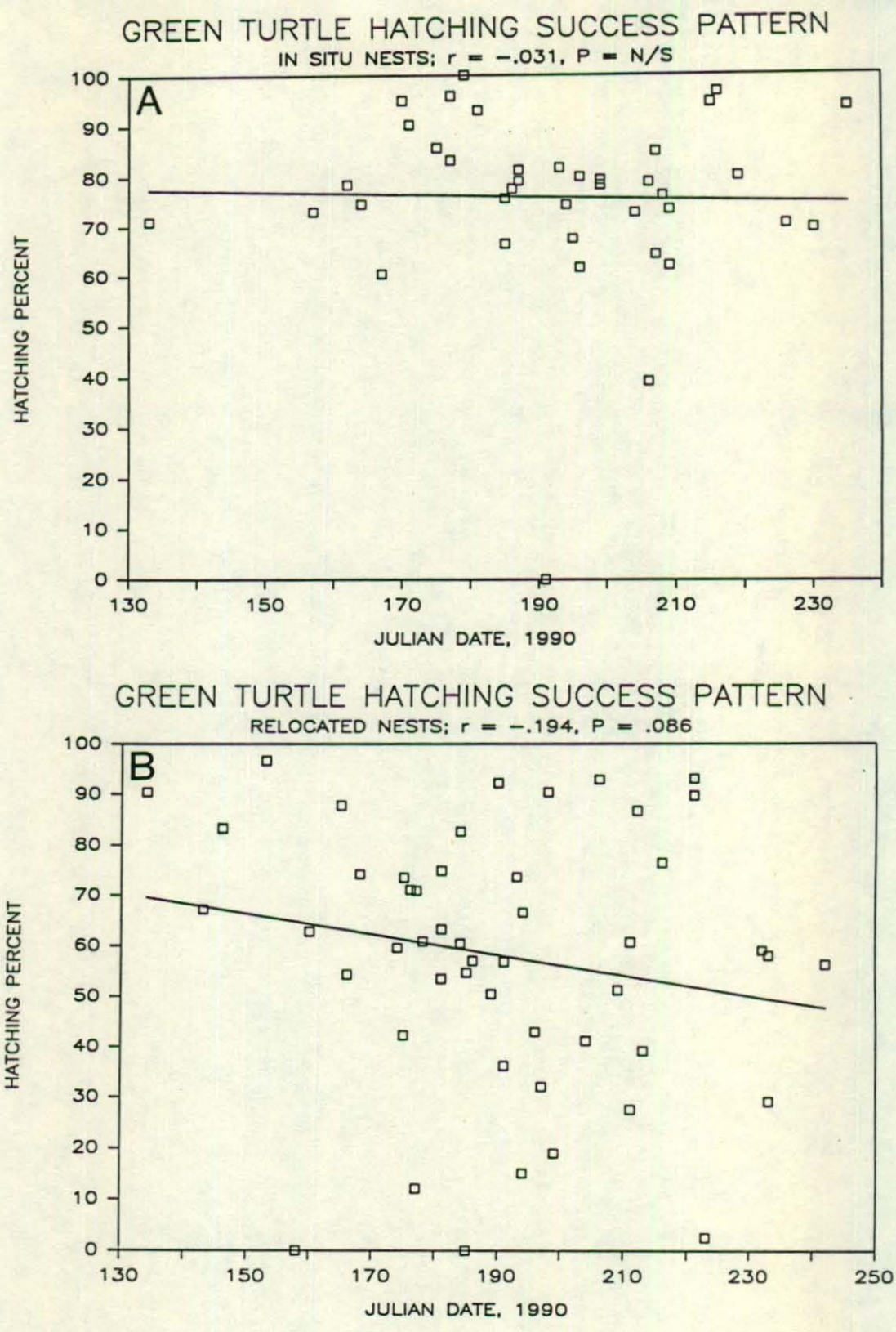


Figure 17: Seasonal *C. mydas* hatching success from in situ (A) and relocated (B) nests in Broward County, 1990.

Table 6: Total egg counts, released hatchlings and overall and mean daily hatching successes for in situ and relocated nests of *C.caretta*, *C.mydas* and *D.coriacea*. There were no relocated *D.coriacea* nests.

SPECIES	NUMBER OF EGGS	TURTLES RELEASED	HATCH SUCCESS PERCENT	MEAN DAILY SUCCESS	n	SD
IN SITU NESTS						
C.caretta	13709	10043	73.3	72.4	132	27.0
C.mydas	4673	3539	75.7	76.0	39	17.4
D.coriacea	78	42	53.8	53.8	1	
RELOCATED NESTS						
C.caretta	228587	165130	72.2	74.1	2040	18.5
C.mydas	6307	3590	56.9	58.4	51	25.7
OVERALL						
C.caretta	242296	175173	72.3	74.0	2172	
C.mydas	10980	7129	64.9	66.0	90	
D.coriacea	78	42	53.8	53.8	1	

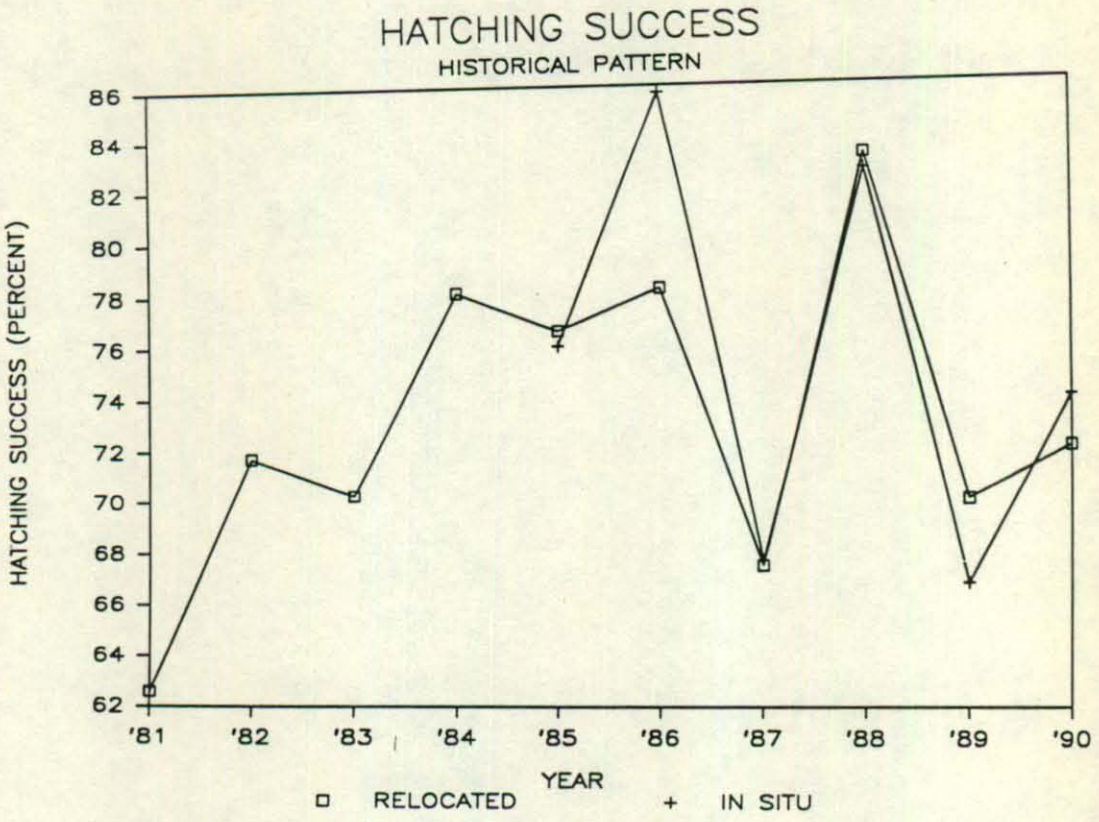


Figure 18: The historical patterns of yearly hatching success in relocated and in-situ (natural) nests since fenced beach hatcheries were first employed in 1981.

Table 7: Comparison of overall nest relocation and hatching results by beach for all species combined.

Beach	Nests Moved	Total Eggs Moved	Eggs Lost or Dest.*	Hatchlings Released	Overall Hatch Percent#
Hillsboro	558	61544	2731[1]	43308	70.4
Pompano	742	80466	1155[2]	56646	70.4
Ft.Laud.	580	65272	361[3]	46417	71.1
Lloyd Park	116	12426	251[4]	10115	81.4
Hollywood-Hall	140	15186	0	12234	80.6
Overall	2136	234894	4498	168720	71.8

* Eggs from nests which were relocated outside of hatcheries and could not be found because of removal of the markers are termed "lost". Many of these probably hatched normally. Eggs from partially predated nests are termed "destroyed", although some eggs hatched successfully.
# Hatchlings released / (Total eggs moved - Lost or Destroyed)

[1] 451 eggs lost, 2280 eggs destroyed
[2] 1155 eggs destroyed
[3] 2 nests lost (egg # unknown), 361 eggs destroyed
[4] 251 eggs destroyed

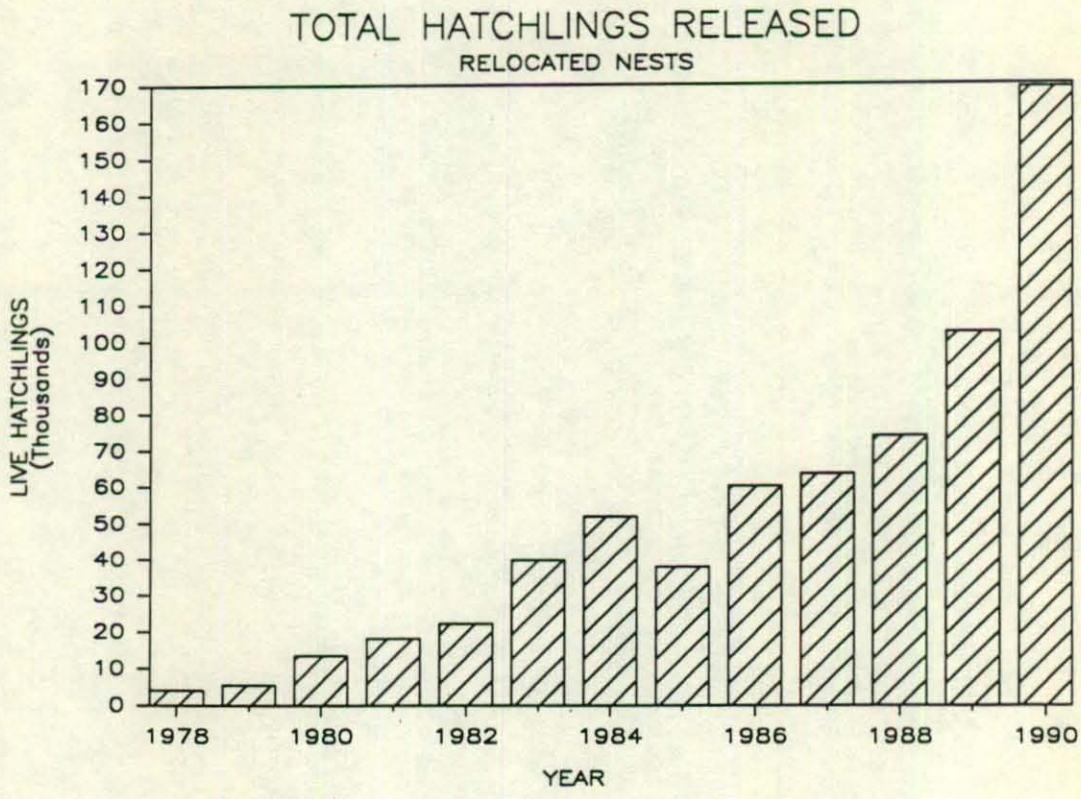


Figure 19: The yearly number of live hatchlings released from relocated nests since the beginning of the Broward Co. Sea Turtle Conservation Program. 1978, 4133; 1979, 5509; 1980, 13,430; 1981, 18,057; 1982, 22,058; 1983, 39,745; 1984, 51,814; 1985, 37,817; 1986, 60,181; 1987, 63,575; 1988, 73959; 1989, 102,260; 1990, 168,720.

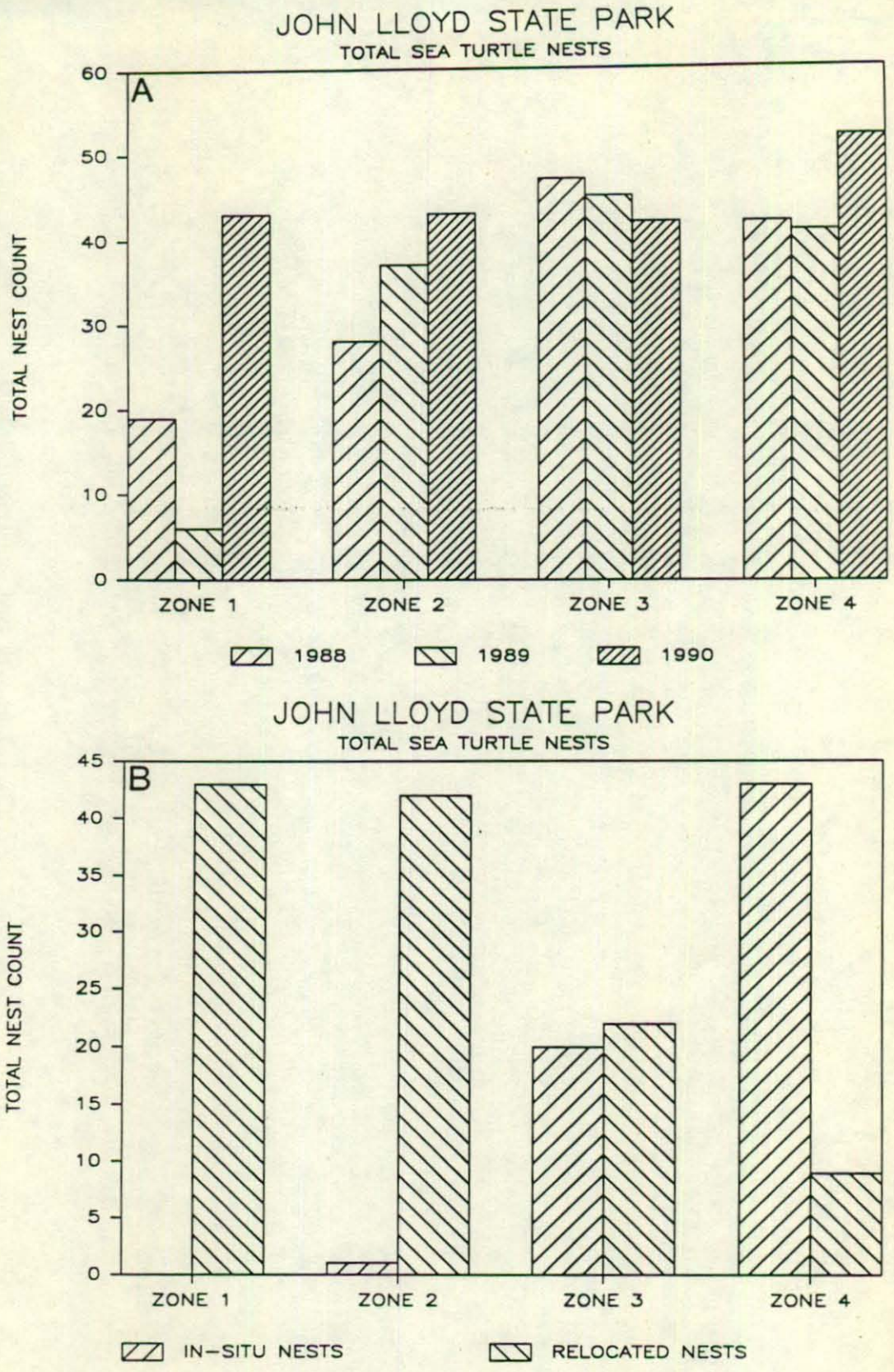


Figure 20: Comparison of total sea turtle nesting in the four zones of John Lloyd State Recreation Area in 1988 (pre renourishment), 1989 (renourishment project in progress), and 1990 (post renourishment) (A), and the total number of nests relocated and left in-situ in the four zones in 1990 (B).

DISCUSSION

1990 was a record breaking sea turtle year in Broward County. The nest count (95.5% *C. caretta*, Table 1) represents a 40% increase from the previous year and was more than 4 standard deviations (69%) above the previous nine-year average (Fig 1A). The trend lines based on yearly total and *C. caretta* nest counts (Figs. 1B and 2A) now show statistically significant positive slopes ($P = .013$ and .015, respectively). While this does not indicate the trend will continue, it is encouraging. Even more encouraging was the density of *C. mydas* nesting (Fig. 2B), which nearly doubled the previous maxima in 1985 and 1987. Although the slope of the ten-year trend line for *C. mydas* nesting is not significantly different from zero ($P > .05$), the nesting density in 1990 was more than three times the mean of the previous nine years (31.8 nests per year), and exceeded this value by almost five standard deviations. *D. coriacea* nesting was down from previous years, but no special significance can be attached to this, because numbers have been historically low.

There are several possible explanations for the increased nesting activity of *C. caretta* and *C. mydas*. It is possible that the increase was due to a greater number of first-time-nesting females, perhaps the fruit of past conservation projects or some natural circumstance with a positive effect on recruitment. However, this is not a definite conclusion. Individual females do not usually nest every year (Ehrhart, 1981). The nesting frequency may be influenced by food availability (Wood and Wood, 1980). It is possible that a chance coincidence of the nesting patterns of a large proportion of the population produced record nesting without an increase in the adult turtle population. Similarly, increased food abundance may have caused a portion of the population to nest more frequently than in the past, which could cause increased nesting densi-

ties without a proportionate increase in the population size. In addition, the population nesting in Broward may have been augmented by adults from another population.

Although the cause of the increased nesting can not be determined with the data at hand, some observations can be made. If random chance was the cause, this coincidence must have occurred simultaneously in two separate species. This does not seem likely. Likewise, if increased energy (food) availability increased the nesting frequency of part of the population, this would have to affect two species with quite different food requirements.

The distribution of *C. caretta* nests (Fig 3A) in the county shows the usual north-south decline (Burney and Mattison, 1989). Some locations on all beaches north of Hollywood-Hallandale were especially active and some were very quiet. Such patchy distributions have been observed previously in Broward Co. (Fletemeyer, 1985). North of Dania Beach (locator 98) the minima in Figure 3A seem to correspond to the locations of piers, inlets and an area where highway A1A runs immediately adjacent to the beach (locators 64-78). These factors do not appear to explain the low nesting on Dania and northern Hollywood beaches where lighting and disturbance are relatively low. An attempt to more rigorously explain this distribution in terms of ambient lighting, pedestrian and vehicular traffic, beach characteristics and offshore bottom contours is underway. *C. mydas* clearly preferred dark, relatively undisturbed nesting locations because it nested mostly in the residential section of Hillsboro Beach and in the south end of John Lloyd Park, where these conditions prevail (Fig 3B, Table 3).

Although *C. caretta* nesting densities were significantly higher than in 1989, Figure 4A shows no discernible difference in the timing of the beginning or end of the nesting season, or in the overall shape of the seasonal patterns

between 1989 and 1990. The duration and shape of the daily nesting patterns at the individual beaches (Fig. 5A-E) were also very similar to those in 1989 (Burney and Mattison, 1989). If the increased nesting in 1990 was due to the import of animals from a different *C. caretta* population, they behaved like the previous years population in this regard. *C. mydas* nested over a considerably longer period and with much greater frequency than in 1989 (Fig. 4B).

C. caretta nesting densities (Table 2) at Hillsboro-Deerfield and Pompano were statistically indistinguishable and significantly greater than the more southerly beaches, despite heavy beach front development in Pompano. As in 1989, Hollywood-Hallandale had significantly lower nesting densities than at the other beaches. Nesting at Lloyd Park and Fort Lauderdale was not significantly different and intermediate in density. Relative nesting densities at the individual beaches can not be explained in terms of the general level of beach-front development in these areas. However, this may influence a turtles selection of a precise nesting location along a stretch of beach.

Unlike 1989, the county-wide seasonal pattern of daily nesting success seemed to decline slightly during the summer (Fig 7). While this was not significant at the .05 level, a significant seasonal decline was observed at Fort Lauderdale. The cause of this phenomenon, which did not affect adjacent beaches, is unknown.

Mean daily nesting success of *C. caretta* was significantly lower at John Lloyd State Park, compared to the other county beaches, which were statistically indistinguishable from each other (Table 4). Lloyd Park nesting success was also significantly (t-test, $P = .04$) less than its value of 45.1 percent for 1989 (Burney and Mattison, 1989). The higher number of false crawls at Lloyd Park was caused by a cliff (up to six feet high) left by erosion of sand from a 1989 beach renourishment project. This denied many turtles access to the beach above the high tide line.

Nesting success of *C. mydas* showed no seasonal decline county wide ((Fig. 9) or at Hillsboro-Deerfield or Lloyd Park beaches (Fig. 10A-B). A 1-way ANOVA showed no significant ($P > .05$) differences in mean daily nesting success between beaches(Table 5). Unlike *C. caretta*, *C. mydas* nesting in Lloyd Park was almost exclusively in the southern section where the eroded cliff did not exist.

C. caretta clutch sizes declined slightly over the season (Fig 11A). This has been observed previously (Lebuff and Beatty, 1971; Caldwell,1959). The pattern is virtually identical to that from 1989 (Burney and Mattison, 1989). Patterns at the individual beaches (Fig. 12) were also extremely similar to those in 1989. Unlike *C. caretta*, *C. mydas* clutch size showed no significant seasonal trend (Fig. 11).

As found in 1989 (Burney and Mattison, 1989), county-wide *C. caretta* hatching success declined seasonally (Fig. 13). This may be due to warmer sand temperatures later in the season or to the production of eggs with lower viability in the later clutches. There were no instances of nonhatching nests (zero hatching percent) deposited during the first month of the season. Thereafter, the number of zero and low hatching nests increased until late in the season. This declining trend was seen at all beach areas north of Lloyd Park, but not at the more lightly nested southern beaches (Fig 14A-E). Although there was a suggestion of a seasonal decline in overall *C. mydas* hatching success (Fig 15A-B), the trends were not significant at the .05 level. As with *C. caretta*, no nonhatching nests were deposited early in the nesting season.

The seasonal patterns of hatching success for in situ and relocated *C. caretta* nests at Hillsboro beach are similar (Fig 16A-B). The difference in slopes is not significant. As in 1989, both showed significant declines. The overall mean daily hatching success for *C. caretta* in situ nests was not signifi-

cantly different from that for the relocated nests (Table 6). However, mean daily hatching success for the 39 excavated in-situ *C. mydas* nests (76.0%) was significantly greater ($P < .001$) than for the 51 relocated nests (58.4%). This difference was not observed in 1989, possibly due to the low number (3) of in situ *C. mydas* nests excavated. This is the first year that sufficient *C. mydas* data for such a comparison has been available.

There was no apparent seasonal decline in the hatching success of in situ *C. mydas* nests (Fig. 17A) but there was a weakly significant seasonal reduction in the hatching success of relocated nests (Fig 17B). Early in the season, the hatching success of relocated and in situ *C. mydas* nests was similar (Fig 17A-B). Throughout the season, some relocated nests hatched with successes similar to in situ nests. This suggests that the lower mean hatching success in relocated nests was not due to a systematic mistake in egg handling, egg chamber construction or reburial. Although the actual cause remains unknown, the seasonal decline in the hatching success of the relocated nests leads to speculation that some of these nests, incubating later in the season, may have been adversely affected by the warmer sand temperatures of late summer. Why this did not affect all relocated nests remains unclear. It is worth noting that the hatching success of the relocated nests would have been much lower (due to sea water inundation, root encroachment, ants or predation) if they had not been moved to safer locations.

A total of 234,894 eggs from 2,136 nests (89.4% of total nests) were relocated (Table 7) and 168,720 live hatchlings were released (not including hatchlings from in situ nests). Overall hatching success was 71.8 percent (Table 7), which was well within the range of the previous nine years (Table 18). The exponential increase in released hatchlings during the past 10 years (Fig. 19) is due both to higher nesting densities and a greater emphasis on nest relocation in recent years. Most of the relocations were due to beach lighting

that would disorient hatchlings. Only 451 eggs (and two nests of unknown egg count) were lost due to misplaced or removed markers. A total of 4047 eggs were listed as destroyed, mostly in nests partially predated by foxes at Hillsboro beach.

Figure 20A gives sea turtle nesting levels and distributions in John Lloyd State Recreation Area, before, during and after a beach renourishment project in the summer of 1989. The uniform nest distribution in 1990 and the elevated numbers in the north (Zones 1 and 2), which was most affected by the renourishment project and by erosion due to the Port Everglades Jetty, would suggest that the net effect on sea turtle nesting in the Park has been positive. However, the intensity of nesting between years is not directly comparable because there were many more nesting females in the area in 1990 than the previous years. The uniform distribution of nests in the four zones does indicate that the renourishment project did not have a devastating effect on nesting. The fact that nesting densities were not significantly different at Lloyd Park and Fort Lauderdale beaches (Table 2) leads to the same conclusion. It was probably beneficial in zone 1 which had a severe lack of sand prior to renourishment. However, Figure 20B shows that all but one nest deposited in zones 1 and 2 were relocated, usually because they were deposited below the cliff. Without an intensive relocation effort, these nests would have been lost because storm waves inundate the base of the cliff. We conclude that intense human intervention can compensate for the less-than-ideal nesting conditions in northern John Lloyd Park.

The low nesting success at Lloyd Park (Table 3) was primarily caused by the cliff which deterred many turtles from nesting. Prior to the nesting season (April 20) the sand above the cliff was tilled by the Erosion Prevention District to allow nesting on the renourished sand. Since turtles unable to nest in

northern Lloyd Park most probably nested elsewhere, this may not have had an adverse affect on overall nesting.

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

MAY 1 - SEPTEMBER 30, 1990

SUBJECT	HOT-LINE	BEEPER	NOVA
EMERGENCES:			
Nesting	24	19	0
Hatchlings	9		1
NEST LOCATIONS	90	36	23
STRANDINGS	5	1	2
POACHING			1
VOLUNTEERS	280	10	171
OTHER **	28		56
OVERALL	436	65	254

** Including calls from the media, injured land turtles, and all other unclassified or multi reason calls.

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

Two thousand turtle 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. The project manager gave a total of four turtle talks at elementary schools.