

TECHNICAL REPORT DPEP 03-

SEA TURTLE CONSERVATION  
PROGRAM  
BROWARD COUNTY, FLORIDA  
2003 REPORT

Submitted by:

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For the:

BROWARD COUNTY BOARD OF COUNTY COMMISSIONERS  
DEPARTMENT OF PLANNING AND ENVIRONMENTAL  
PROTECTION  
BIOLOGICAL RESOURCES DIVISION

## TABLE OF CONTENTS

LIST OF TABLES	ii
LIST OF FIGURES	iii
ACKNOWLEDGEMENTS	iv
INTRODUCTION	1
MATERIALS AND METHODS	3
RESULTS	11
DISCUSSION	31
REFERENCES	**
APPENDICES	
1. Summary of Hotline Calls	**
2. Summary of Educational Activities	**
3. Sea Turtle Nest Marker Sign	**
4. Layout of open beach hatcheries	**
5. Sea Turtle Summary Report Forms	**

## LIST OF TABLES

Table 1: Total loggerhead nests and nesting densities expressed as nests-per-kilometer for 2003.	15
Table 2: Total green sea turtle nests and nesting densities expressed as nests-per-kilometer for 2003.	19
Table 3: Total leatherback nests and nesting densities expressed as nests-per-kilometer for 2003.	19
Table 4: Total nests, false crawls and percent nesting success for three sea turtle species in each of five Broward County beach areas during 2003.	22
Table 5: The total number of nests relocated to Hillsboro Beach, fenced hatcheries, or left <i>in situ</i> .	24
Table 6: Total egg counts, released hatchlings and overall hatching successes for <i>in situ</i> and relocated nests of all species in 2003.	25
Table 7: Accounting of all categories of hatched and unhatched loggerhead eggs from relocated and <i>in situ</i> nests, for each beach during 2003.	29
Table 8: Accounting of all categories of hatched and unhatched green turtle eggs from relocated and <i>in situ</i> nests, for each beach during 2003.	30
Table 9: Accounting of all categories of hatched and unhatched leatherback eggs from relocated and <i>in situ</i> nests, for each beach during 2003.	30

## LIST OF FIGURES

Figure 1: Site location map of Broward County	4-5
Figure 2: The historical sea turtle nesting pattern in Broward County since full surveys began in 1981	11
Figure 3: Historical nesting patterns of loggerheads, greens and leatherbacks in Broward County, 1981-2003.	12
Figure 4: The seasonal pattern of daily loggerhead nest counts in Broward County, 2003.	14
Figure 5: Comparison of the daily loggerhead nesting patterns on the five Broward Co. beaches during 2003.	16
Figure 6: The seasonal patterns of daily green and leatherback nest counts in Broward County, 2003.	17
Figure 7: Comparison of the daily nesting patterns of greens and leatherbacks on the Broward County beaches, 2003.	18
Figure 8: Locations of loggerhead, green and leatherback nests in Broward County, 2003, listed by DEP locator number.	20
Figure 9: The horizontal distribution of average loggerhead, green and leatherback nesting success on each beach segment identified by the DEP survey markers in 2003.	21
Figure 10: Comparison of the seasonal patterns of loggerhead hatching success in relocated and <i>in situ</i> nests during 2003.	26
Figure 11: Comparison of hatching success frequencies for <i>in situ</i> and relocated loggerhead nests in 2003.	27
Figure 12: The historical patterns of yearly hatching success in all investigated relocated and <i>in situ</i> nests since 1981.	28

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Code Inspector Richard Kirby and the Pompano Beach Code Enforcement Division, District 11, for their persistent help with lighting issues.

## INTRODUCTION

Since 1978, the Broward County Department of Planning and Environmental Protection (DPEP) has provided for the conservation of endangered and threatened sea turtle species within its area of responsibility. Broward County is within the normal nesting areas of three species of sea turtles: the loggerhead sea turtle (*Caretta caretta*), the green sea turtle (*Chelonia mydas*) and the leatherback sea turtle (*Dermochelys coriacea*). The loggerhead is listed as a threatened species, while the green and leatherback 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 Fish and Wildlife Conservation Commission (FWCC), Bureau of Protected Species Management, Tallahassee, Florida. This project was administered by the DPEP and conducted by the Nova Southeastern University Oceanographic Center under Marine Turtle Permit #108, issued to the DPEP by the FWCC.

The DPEP is especially concerned with any environmental effects of intermittent beach nourishment projects on shorelines and the offshore reefs. As part of this concern, the DPEP has maintained the sea turtle conservation program in non-nourishment years to provide a continuous database and for monitoring of completed nourishment projects.

A contract to operate the program is issued based on a review of submitted bids. Nova Southeastern University was awarded the contract to conduct the 2003 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 survival,
- 2) to accurately survey sea turtle nesting patterns to document 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

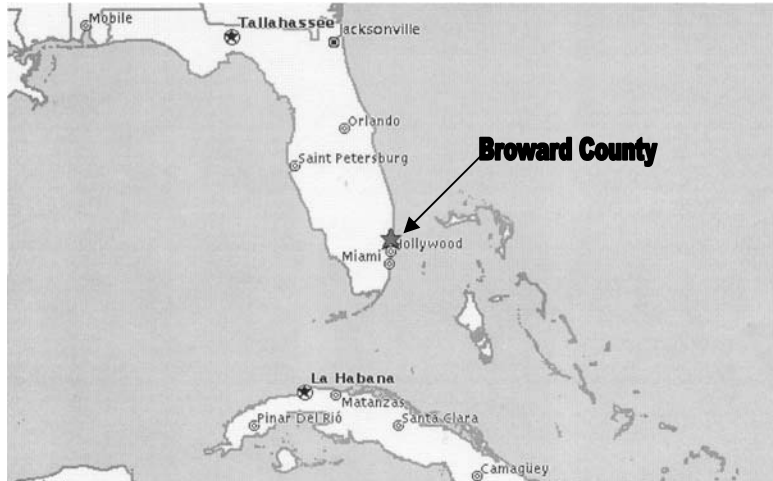
### Beach Survey

Daily beach surveys commenced one half hour before sunrise. For survey purposes the County was divided as follows:

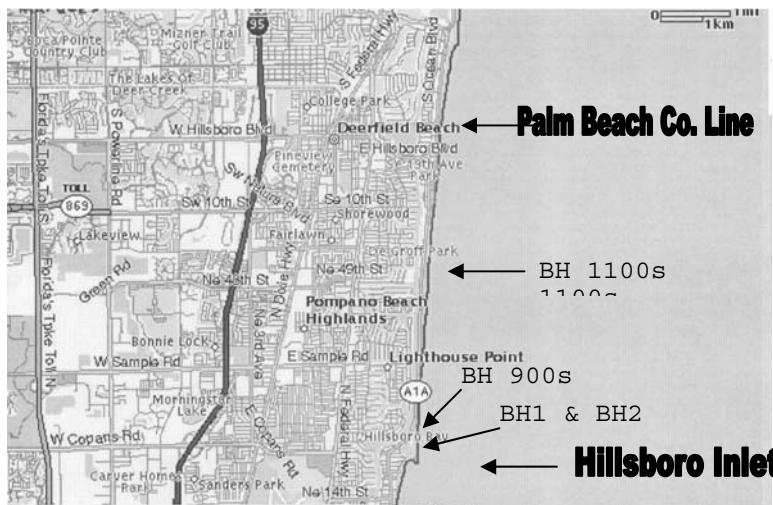
BEACH	BEACH LENGTH (km)	BOUNDARIES	DEP SURVEY MARKER #
Hillsboro-Deerfield Beach	7.0	Palm Beach Co. line to Hillsboro Inlet	R1-24
Pompano Beach	7.7	Hillsboro Inlet to Commercial Blvd.	R25-50
Fort Lauderdale	10.6	Commercial Blvd. to Port Everglades Inlet	R51-85
John U. Lloyd Park	3.9	Port Everglades Inlet to Dania Beach fence	R86-97
Hollywood-Hallandale	9.4	Dania Beach fence to Miami Dade Co. line	R98-128

The location of Broward County and the positions of the boundary lines above are shown in Figure 1 A-F.

Daily surveys of Hillsboro-Deerfield, Pompano, Fort Lauderdale and Hollywood-Hallandale beaches commenced on March 1, 2003. Surveys continued through September 30th. The beach at John U. Lloyd State Park was patrolled by park personnel who provided the data from that area. Except in Lloyd Park, nest locations were referenced to FDEP beach survey monuments numbered consecutively from R1 to R128 (N to S). Marker numbers corresponding to each beach area are listed above. Each nest location was initially recorded relative to the nearest building, street,



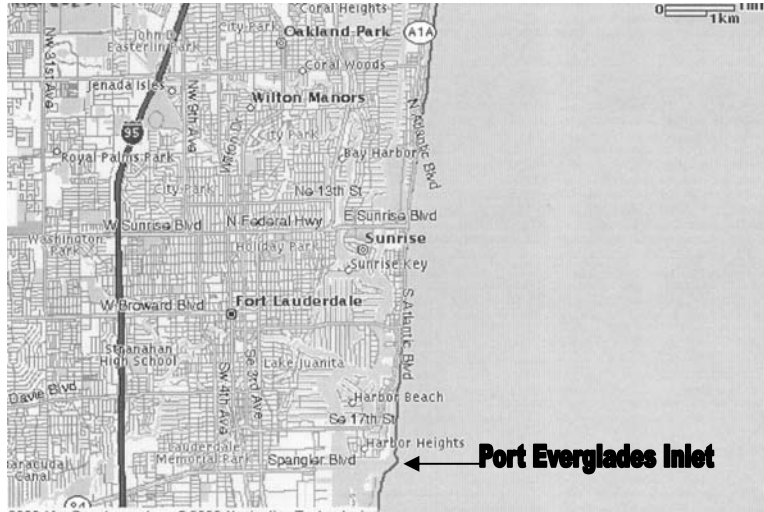
**Figure 1A:** The location of Broward County, FL



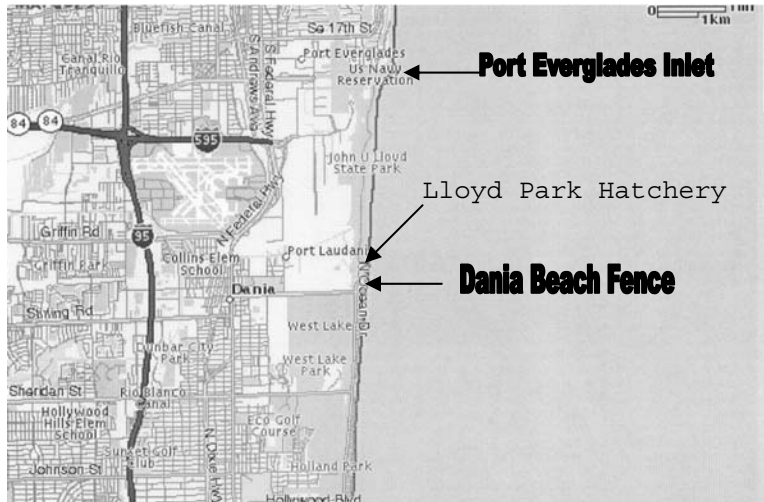
**Figure 1B:** Northern Broward County.



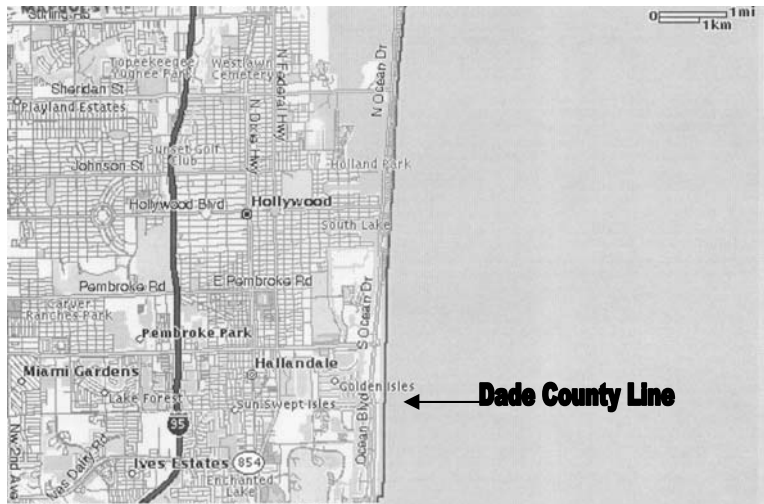
**Figure 1C:** North Central Broward County.



**Figure 1D:** Central Broward County



**Figure 1E:** South Central Broward County, showing the open beach hatchery in Lloyd Park.



**Figure 1F:** Southern Broward County

or other landmark. These locations were later cross-referenced to the nearest survey marker. Nest and false crawl locations were also recorded using Global Positioning System (GPS) receivers.

In John Lloyd Park, four 1-km zones (zone 1 farthest north) were used for recording nest locations due to the relative lack of beach landmarks. This was also done to provide continuity with the data collected in Lloyd Park during previous years.

Surveyors used four-wheeled all-terrain vehicles (ATVs) that carried up to five turtle nests per trip 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 nests in danger of negative impacts on the return pass. Due to early beach cleaning in Fort Lauderdale, two workers picked up the nests on the first pass. Nests were transferred to a third person who transported them to their destination by car. Early in the season, nests were often transported directly on the ATVs to fenced beach hatcheries. When there were many nests requiring relocation, additional trips were occasionally necessary. After recording all pertinent information, the crawl marks were obliterated to avoid duplication.

Nests in danger of negative impacts were defined as follows:

- 1) a nest located within 10 feet of the previous evening wrack line,
- 2) a nest located near a highway or artificially lighted area defined as a beach area where a surveyor can see his shadow on a clear night, and
- 3) a nest located in an area subject to beach nourishment.

Especially due to definition 2, most of the nests discovered at Pompano Beach, Deerfield Beach, Hollywood-Hallandale Beach, and Fort Lauderdale beaches were considered to be in danger of negative impact and therefore were relocated to fenced beach hatcheries or to unfenced beach locations in Hillsboro Beach and Pompano Beach. Two small relocation sites (designated BH1 and BH2) were located respectively at the north and south ends of the Hillsboro Club near FDEP survey marker R23, immediately north of the Hillsboro Inlet (Figure 1B). Because of severe erosion at the Hillsboro Club, nests from other beaches were also relocated to the open beach adjacent to homes with house numbers in the 900s, 1000s and 1100s on Highway A1A. These locations were designated BH900s, BH1000s and BH1100s, respectively. The locations of the most southerly and northerly limits of this area (BH900s and BH1100s, respectively) are shown in Figure 1B. Nests in danger of negative impacts that were deposited on Hillsboro Beach were individually relocated to less hazardous nearby locations on that beach (designated BH). In cases where there was no nearby safe location, Hillsboro nests were transported by ATV to the nearest open beach hatchery location.

Because of the reduced relocation space in Hillsboro Beach, nests from Fort Lauderdale and Pompano Beach were also relocated to three open beach hatcheries in Pompano Beach. These were designated BP1, BP2 and BP3 and were located in FDEP zones R26, R28 and R30, respectively. The northerly (BP1) and southerly (BP3) limits of this area are shown in Figure 1C. Each location was subdivided into three sections (designated A, B and C) which were 100 feet apart. Each sub section received 5 rows of 20 nests each. The nests were located with 4 feet between the centers of the egg chambers and the sites were marked with

stakes and caution tape. The layout, nest numbers and dates of each nest relocated to these sub sites are provided in Appendix 4.

Because the size of the restraining hatchery in Hollywood was greatly reduced due to erosion, Hollywood nests were also relocated to an open beach site just north of the Dania Beach fence in John Lloyd State Park (Figure 1E). These nests were protected with self-releasing flat screens, but the success of the screens in preventing raccoon predation was limited.

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 and recorded. 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, to prevent possible injury to the embryos.

Nests that not in danger of negative impacts were marked with stakes bearing yellow 5.5" X 8.8" sea turtle nest warning signs (Appendix 3) and left *in situ*. After hatching 262 of these nests (43 percent) were excavated for post emergence examination. The number of hatchlings released from each nest was determined as the total number of eggs minus the number of hatchlings found dead in the nest (DIN), dead pipped eggs with partially emerged hatchlings (DPIP), and unhatched eggs showing visible (VD) or no visible development (NVD). The number of hatchlings alive in the nest (LIN) and live pipped eggs (LPIP) were included in the number of hatchlings released but were subtracted from this number to determine the number which naturally emerged from each nest. Hatching success was defined as the number of released hatchlings divided by the total number of eggs.

### Restraining Hatcheries

As in previous years, early nests were transferred to chain-link fenced hatcheries located in Pompano Beach near Atlantic Boulevard, at the South Beach municipal parking lot in Fort Lauderdale, or at North Beach Park in Hollywood. After hatching, all hatchery nests were dug up, and counts of spent shells, live hatchlings, dead hatchlings, live and dead pipped eggs and eggs with arrested or no visible development were made.

Hatchery nests displaying a depression over the egg chamber were covered with a bottomless plastic bucket to retain hatchlings, although the turtles sometimes escaped these enclosures by digging around them. After hatching commenced, the hatcheries were checked three times each night between 9:00 and 11:00 PM, midnight and 2:00 AM and again between 3:00 and 5:00 AM. Hatchlings found in the evening were released that same night in dark sections of Fort Lauderdale, Hillsboro Beach, Hollywood or Lloyd Park beaches by allowing them to crawl through the intertidal zone into the surf. Hatchlings discovered in the morning in the hatcheries were collected and held indoors in dry plastic buckets in a cool, dark place until that night, when they were released as above.

The Pompano and Fort Lauderdale hatcheries were filled with nests by mid May. Thereafter, nests from these beaches were relocated to open beach hatcheries in Hillsboro Beach and Pompano Beach. Hollywood nests were relocated to the south end of John Lloyd Park after the restraining hatchery filled. Hatched nests in the restraining 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 were compiled, analyzed and plotted primarily with Quattro Pro, version 8 (Corel Corp. Ltd.) and Statistica, release 5.1 (StatSoft, Inc.). The countywide yearly nesting densities from 1981 to 2003 for the three species were plotted and trends were assessed by linear regression and correlation analyses. Seasonal nesting patterns and nesting densities were calculated for each beach (nests per km) and the beaches were compared using 1-way analysis of variance (ANOVA) and Newman-Keuls (NK) tests at the 0.05 significance level. The total number of nests deposited by each species in the beach segments corresponding to each FDEP survey marker was tabulated and plotted. GPS positions for most nests and false crawls were also plotted on the 1996 Broward County Coastline Aerial Shore Line Map using the ArcView Geographic Information System (GIS) but due to the size of the printouts, these data will be presented as a separate DPEP report.

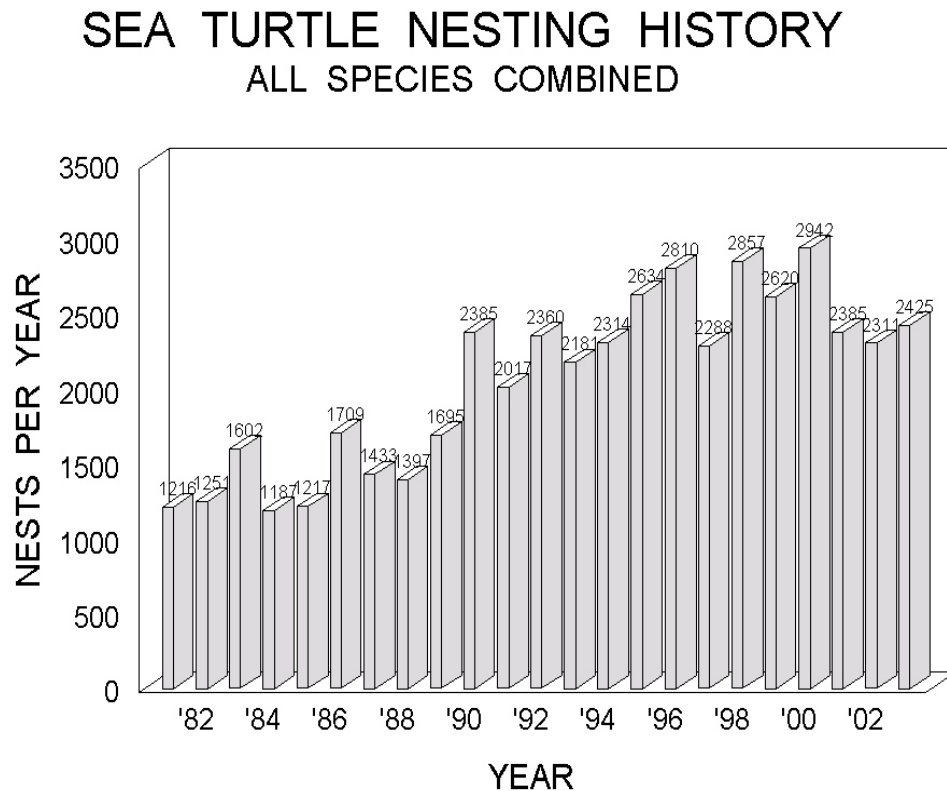
Total nesting success (nests/total crawls) for each species at each beach was computed and the mean daily nesting success of loggerheads and greens at each beach was compared by ANOVA and NK analyses. The average nesting success in each zone was also plotted versus its FDEP survey number. The numbers of eggs and live hatchlings of each species in relocated and evaluated *in situ* nests were recorded and the hatching successes were determined. The overall hatching success of all eggs from relocated and *in situ* nests were plotted from 1981 through 2003. The frequency distribution of the hatching success of *in situ* and relocated loggerhead nests were plotted and compared with the Mann-Whitney U-test. The mean hatching percentages and proportions of the post-hatching egg categories (LIN, LPIP, DIN, DPIP, VD and NVD) were tabulated by



species from nests deposited or relocated at each of the individual beaches or relocation sites.

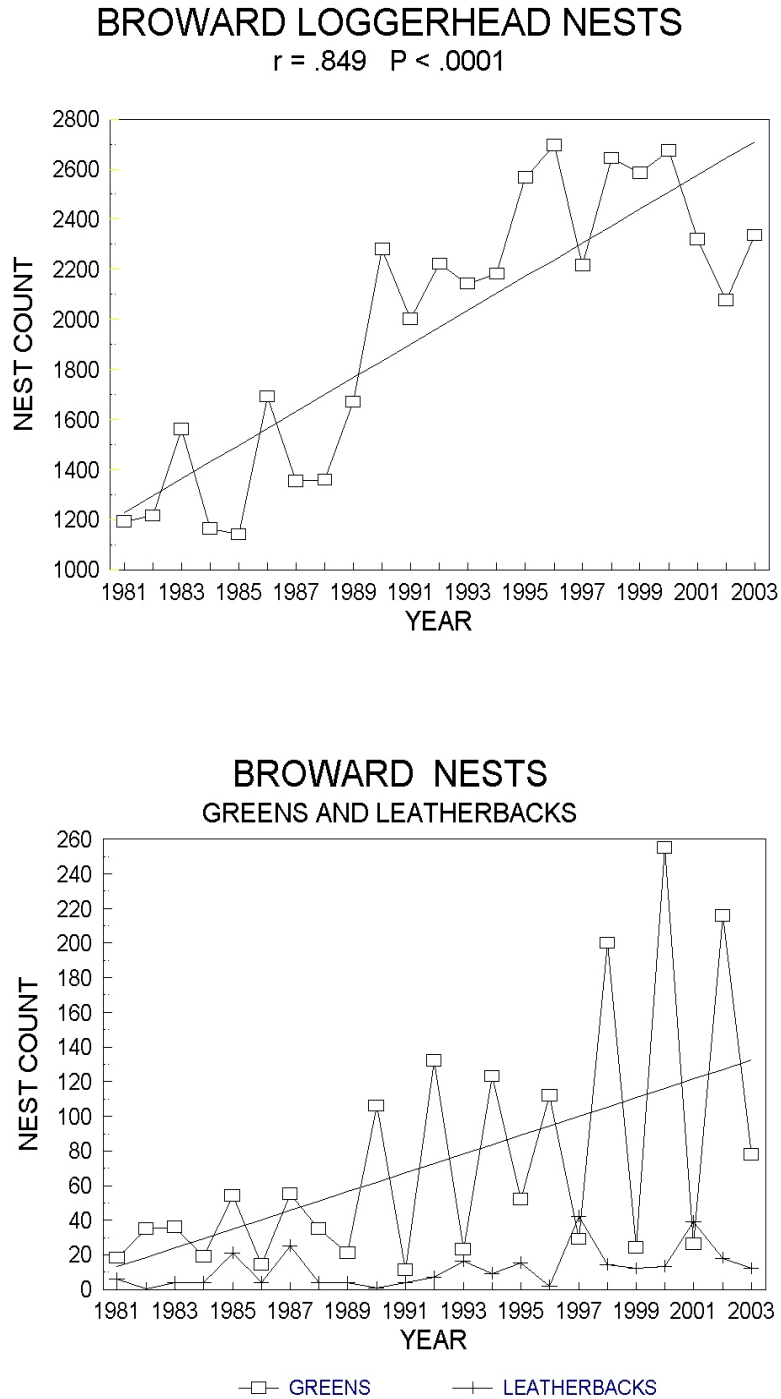
## RESULTS

Figure 2 shows the historical trend in the total number of sea turtle nests deposited in Broward County since 1981. A total of 2425 nests were found in 2003, representing a small increase (4.9 percent) increase from 2002. While this year's count was 17.6 percent below the record number in 2000, it is only 4.3 percent below the previous ten year average of 2534.



**Figure 2:** The pattern of total sea turtle nesting in Broward County since full surveys commenced in 1981.

Figure 3 shows the yearly nesting trends of loggerhead, green and leatherback sea turtles. The loggerhead nest count of 2335 rebounded by 12.4 percent from the ten-year low the previous year. While still



**Figure 3:** Historical nesting patterns of loggerhead, green and leatherback sea turtles in Broward County since 1981.

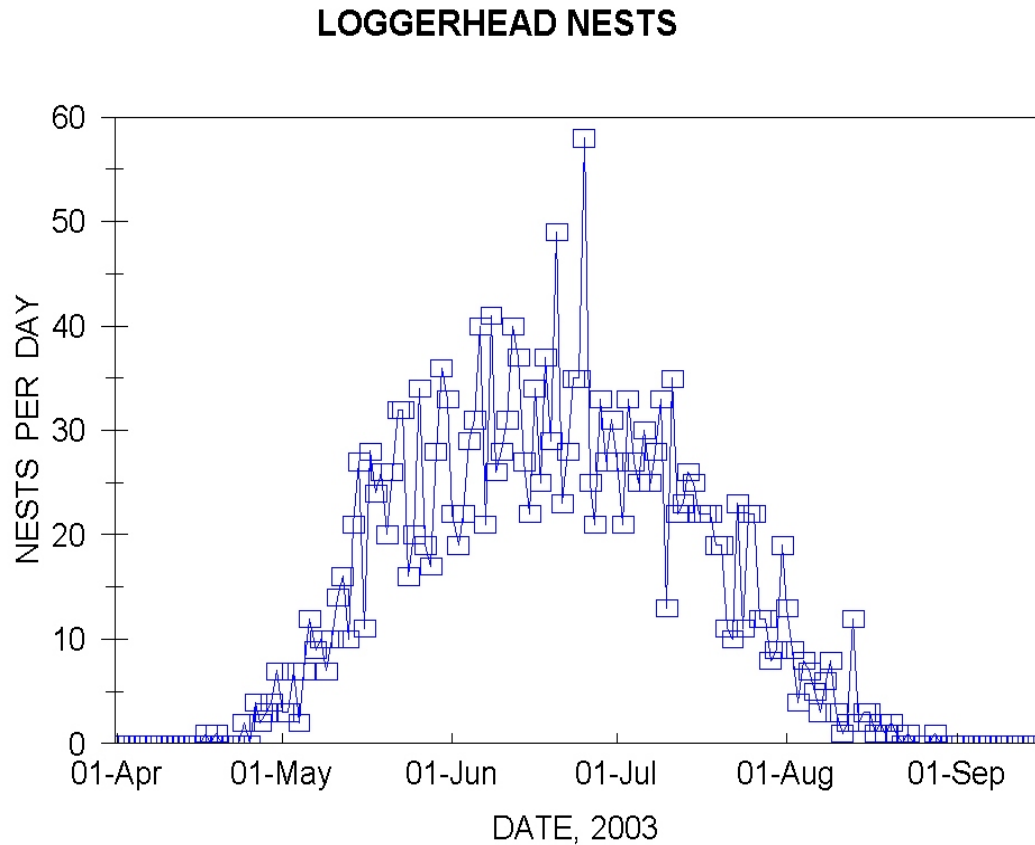
below the trend line (Fig. 3) this year's total was only 3.1 percent below the previous ten year average of 2410. The trend line remains highly significant and its slope indicates an average increase of 67.4 nests per year since 1981.

Green turtle nesting declined from last year, but this was predictable, due to the alternating high-low nesting pattern that began in 1990 (Fig. 3). This year completed the seventh consecutive high-low cycle, with lower nesting in odd numbered years. However, the 77 nests this year was the highest count of all the low-nesting years. The slope of the 23-year trend line for green turtle nesting remained significantly greater than zero ( $r = 0.523$ ;  $P = .005$ ), suggesting an average increase of 5.43 nests per year since 1981. Twelve leatherback nests were deposited in 2003, which was identical to the 23 year average. While there is a slightly positive nesting trend ( $r = 0.459$ ,  $P = .014$ ) suggesting an average increase of 0.76 nests per year since 1981, the trend is tenuous due to the low numbers of nests.

Figure 4 shows the seasonal loggerhead nesting pattern. The first and last nest were deposited on 17 April in Hillsboro Beach and on 28 August in Hollywood. Table 1 and Figure 5 give the total loggerhead nesting densities and seasonal patterns for the five beaches. Nesting densities (mean daily nests/km) was highest in Hillsboro Beach, followed by Pompano Beach and Fort Lauderdale which were not statistically different. Nesting was significantly lower in Lloyd Park and lowest of all in Hollywood. Despite ongoing beach erosion, nesting increased 25.3 percent in Hillsboro Beach.

The countywide seasonal nesting patterns of greens and leatherbacks are shown in Figure 6 and for the individual beaches in Figure 7. The first and last leatherback nests were deposited on 19 March and 10 May, in

Hillsboro Beach. The Green turtles nested between 30 May (Pompano Beach) and 28 September (Hillsboro Beach). Nesting densities for greens and leatherbacks are shown in Table 2 and Table 3, respectively. Nesting by greens was significantly higher in Hillsboro Beach, while Pompano Beach, Fort Lauderdale and Lloyd Park were statistically equivalent. There were no green or leatherback nests deposited in Hollywood.



**Figure 4:** The seasonal pattern of daily loggerhead nesting in Broward County, 2003.

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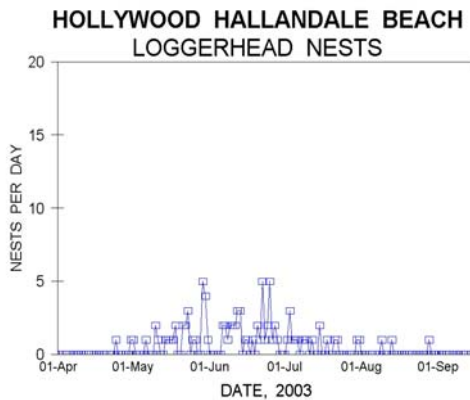
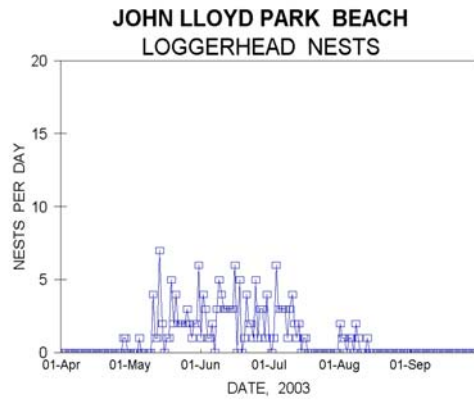
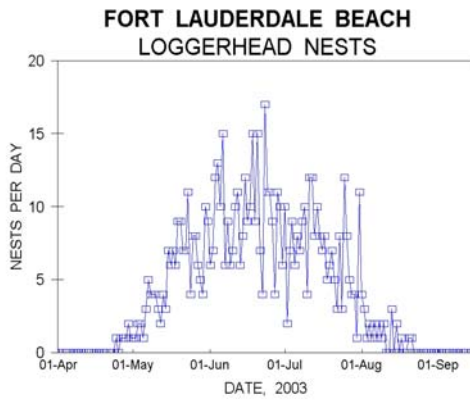
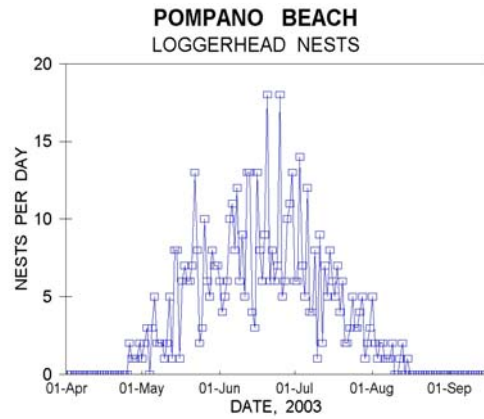
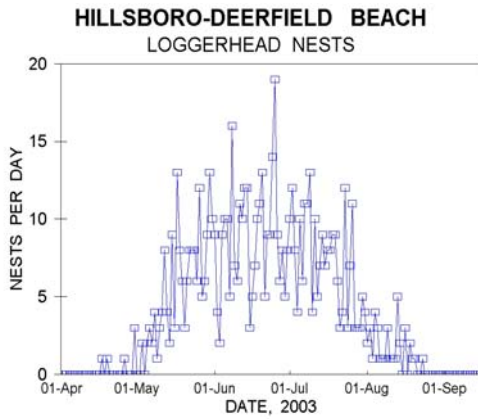
**Table 1:** Total loggerhead nests and nesting densities expressed as nests-per-kilometer for the 2003 season. Beaches with the same NK designation letters were not significantly different in a Newman-Keuls test ( $\alpha = .05$ ) of mean daily nesting per km. Beaches with different NK letters had significantly different nesting densities.

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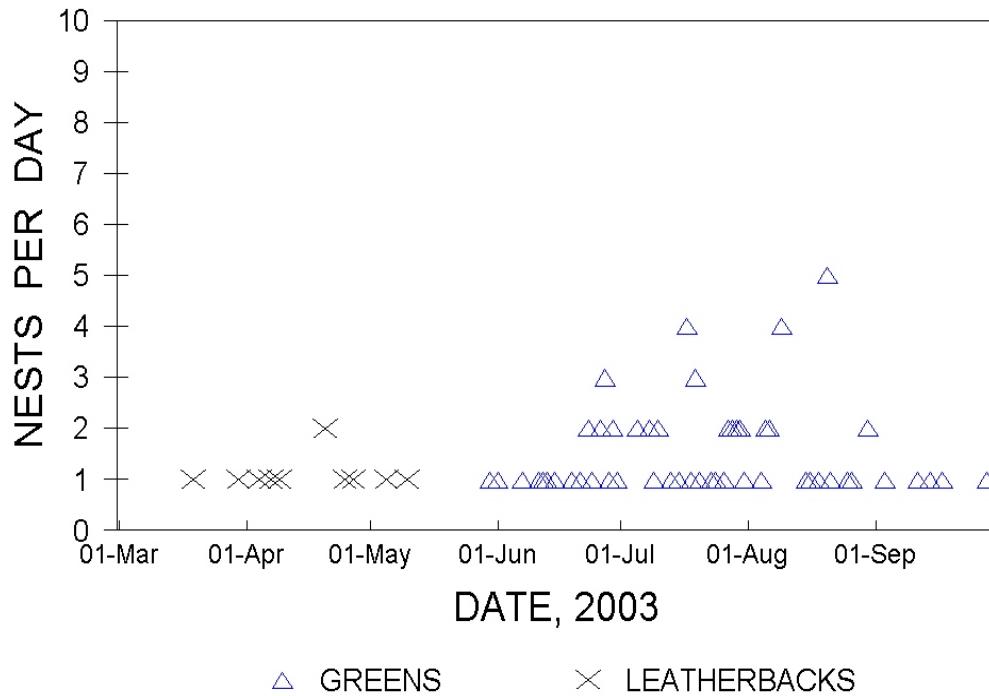
BEACH	TOTAL NESTS	BEACH LENGTH (km)	Nests per km	MEAN DAILY NESTS per km with NK Designation Letter	
Hillsboro Beach	708	7.0	101.1	.595	A
Pompano Beach	610	7.7	79.2	.458	B
Ft. Lauderdale	714	10.6	67.4	.394	B
Lloyd Park	201	3.9	51.5	.270	C
Hollywood	102	9.4	10.9	.059	D
OVERALL	2335	38.6	60.5		

Figure 8 shows nest counts for each species in each 1000-foot zone of Broward County beach (1-km zones in Lloyd Park) during 2003. As in previous years, the low nesting zones R-2, R-24, R-34 and R-50 are near the Deerfield Beach Pier, the Hillsboro Inlet, the Pompano Beach Pier and the Commercial Boulevard pier, respectively. The beach along the Fort Lauderdale strip (R-61 to R-78) and the entire beach south of R-98 were also lightly nested. Loggerheads nested most frequently in zone R-21 in the residential section of Hillsboro Beach. This was also the most heavily nested zone in 2002.

Only 4 loggerhead nests were deposited in zone R25 but the nest count increased to 17 in R-26 and 32 in zone R27. This area was nourished with dredged sand as part of the Hillsboro Inlet Improvement Project in 2002. Nesting at R25 is usually lower, possibly due to the proximity of the inlet, but the nesting because of the inlet, but the average nest count in R-26 and R-27 (24.5) was nearly identical to the average nest per zone in the remainder of Pompano Beach (24.3).



**Figure 5:** Comparison of the daily loggerhead nesting patterns on the five Broward County beaches in 2003.



**Figure 6:** The seasonal pattern of daily green and leatherback nesting in Broward County, 2003.

Figure 9 and Table 4 present the countywide distribution of nesting success for the three species. Loggerhead nesting success showed no county-wide trends are evident, but there was lower success in zone R-34 near the Pompano Beach pier. Nesting successes of zero occurred in R-73 on the Fort Lauderdale strip and in R-102 and R-121 in Hollywood, where there was very little exposed beach. Nesting success was 100 percent in R-24 and R-50, near the Hillsboro Inlet and the Commercial Boulevard pier, but there was little overall sea turtle activity in these areas. Loggerhead nesting success was highest in Fort Lauderdale and Hillsboro Beach which were statistically equivalent, and significantly lowest in Lloyd Park. Hollywood and Pompano Beach formed an intermediate statistical group.

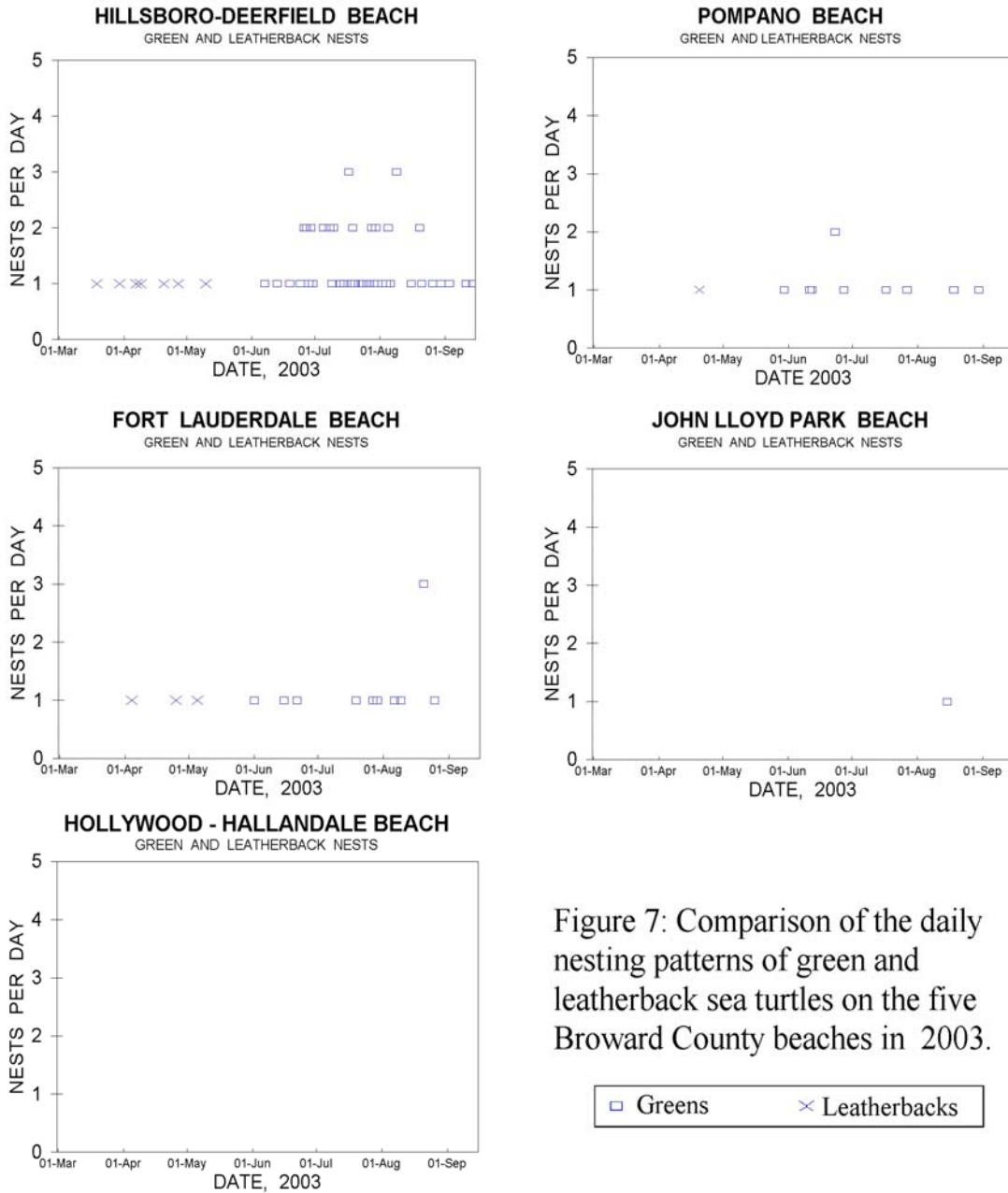


Figure 7: Comparison of the daily nesting patterns of green and leatherback sea turtles on the five Broward County beaches in 2003.

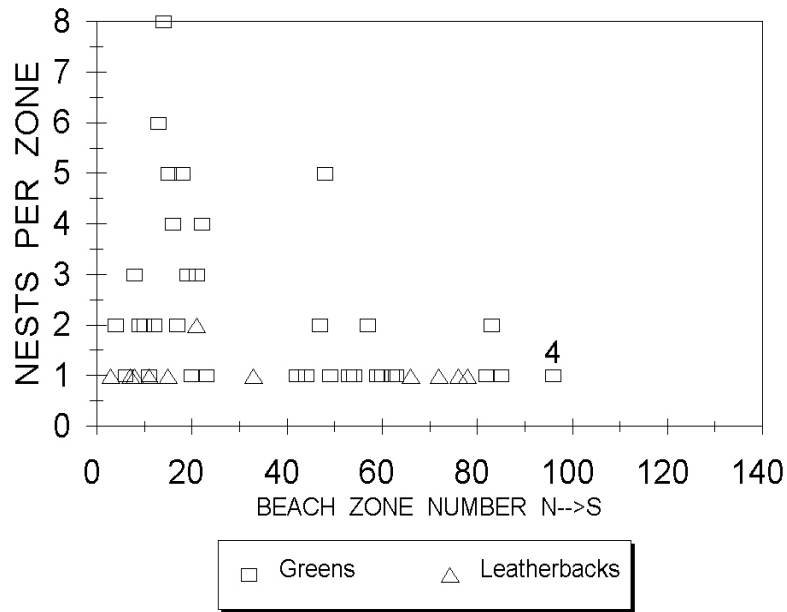
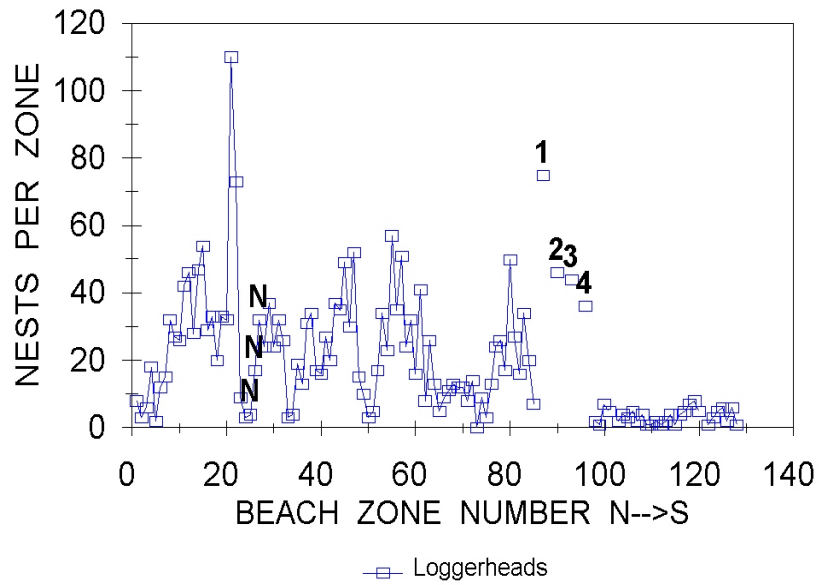


**Table 2:** Total green turtle nests and nesting densities expressed as nests-per-kilometer for the 2003 season. Beaches with the same NK designation letters were not significantly different in a Newman-Keuls test (alpha = .05) of mean daily nesting per km. Beaches with different NK letters had significantly different nesting densities.

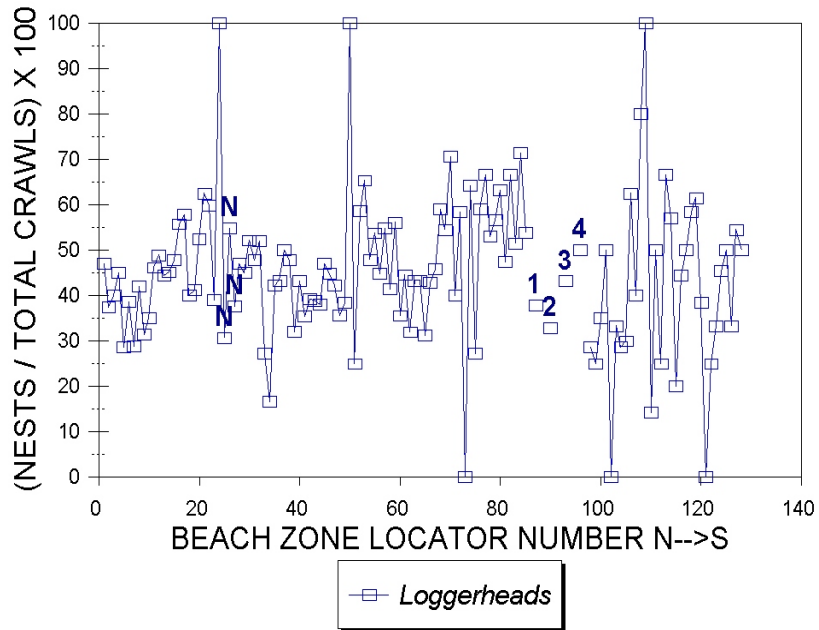
BEACH	TOTAL NESTS	BEACH LENGTH (km)	Nests per km	MEAN DAILY NESTS per km with NK Designation Letter
Hillsboro Beach	55	7.0	7.8	.0451 A
Pompano Beach	10	7.7	1.3	.0077 B
Ft. Lauderdale	12	10.6	1.1	.0067 B
Lloyd Park	1	3.9	0.3	.0015 B
Hollywood	0	9.4	0	0
OVERALL	78	38.6	2.0	

**Table 3:** Total leatherback nests and nesting densities expressed as nests-per-kilometer for the 2003 season. Beaches with different NK letters had significantly different nesting densities.

BEACH	TOTAL NESTS	BEACH LENGTH (km)	Nests per km	MEAN DAILY NESTS per km with NK Designation Letter
Hillsboro Beach	7	7.0	1.0	.0050 A
Ft. Lauderdale	4	10.6	0.4	.0014 B
Pompano Beach	1	7.7	0.1	.0007 B
Lloyd Park	0	3.9	0	0
Hollywood	0	9.4	0	0
OVERALL	12	38.6	0.3	



**Figure 8:** Locations of loggerhead, green and leatherback nests in Broward County, 2003. Numbers 1-4 indicate the four beach zones of John Lloyd Park. Points in zones R25-R27 that were renourished prior to the 2002 nesting season are marked with the letter N.



**Figure 9:** The distribution of the nesting success of loggerhead, green and leatherback turtles across Broward County, 2003. Numbers 1-4 indicate the four beach zones of John Lloyd Park. Points in zones R25-R27 that were renourished prior to the 2002 nesting season are marked with the letter N.

**Table 4:** Total nests, false crawls (FC) and percent nesting success (NS) for three sea turtle species on each of five Broward County beaches during 2003. Newman-Keuls (NK) designations for loggerheads as in Table 2. One-way ANOVA detected no significant differences in nesting success for greens or leatherbacks.

BEACH	Loggerheads			Greens			Leatherbacks		
	Nests	FC	NS	Nests	FC	NS	Nests	FC	NS
Ft. Lauderdale	714	677	51.3	12	9	57.1	4	1	80.0
Hillsboro Beach	708	788	47.3	55	30	64.7	7	0	100
Pompano Beach	610	826	42.5	10	9	52.6	1	1	50.0
Hollywood	102	144	41.5	0	1	0	0	1	0
Lloyd Park	201	311	39.2	1	0	100	0	0	-
OVERALL	2335	2746	46.0	78	49	61.4	12	3	80.0

(Table 4). Loggerhead nesting success in the renourished zones (R-25 to R-27, Fig. 9) was not significantly different than for the remainder of Pompano Beach (ANOVA,  $P = 0.77$ ). One-way ANOVA showed no significant differences in the nesting success of greens or leatherbacks throughout the County (Table 4).

Table 5 gives the number of nests for each species that were relocated to Hillsboro Beach or to fenced hatcheries, as well as the numbers of nests left *in situ*. Table 6 lists the number of eggs and released hatchlings from evaluated *in situ* and relocated nests. The numbers of predated nests and nests that were unevaluated due to stake removal or washout are also listed.

Compared to 2002 values, the release success of relocated loggerhead nests increased 6.0 percentage points to 65.7 percent, while the success of *in situ* loggerhead nests declined by 1.0 point to 79.8 (Table 6). The difference between *in situ* and relocated nests is still highly significant but its magnitude decreased by 7.0 points to 14.1 percent. The gap between the release success of green turtle nests was also reduced, compared to 2002. The success of *in situ* nests declined 3.6 points to 77.2 percent, while the success of relocated nests increased 17.3 points to 66.0 percent. Compared to 2002, the difference this year declined 20.9 points to 11.2 percent, however the number of evaluated green turtle nests this year was relatively low (Table 6). Eggs from 6 evaluated *in situ* leatherback nests produced 79.6 percent live hatchlings, down 1.3 points from last year, but the one relocated leatherback nest failed completely, with all 98 of the eggs showing no visible development.

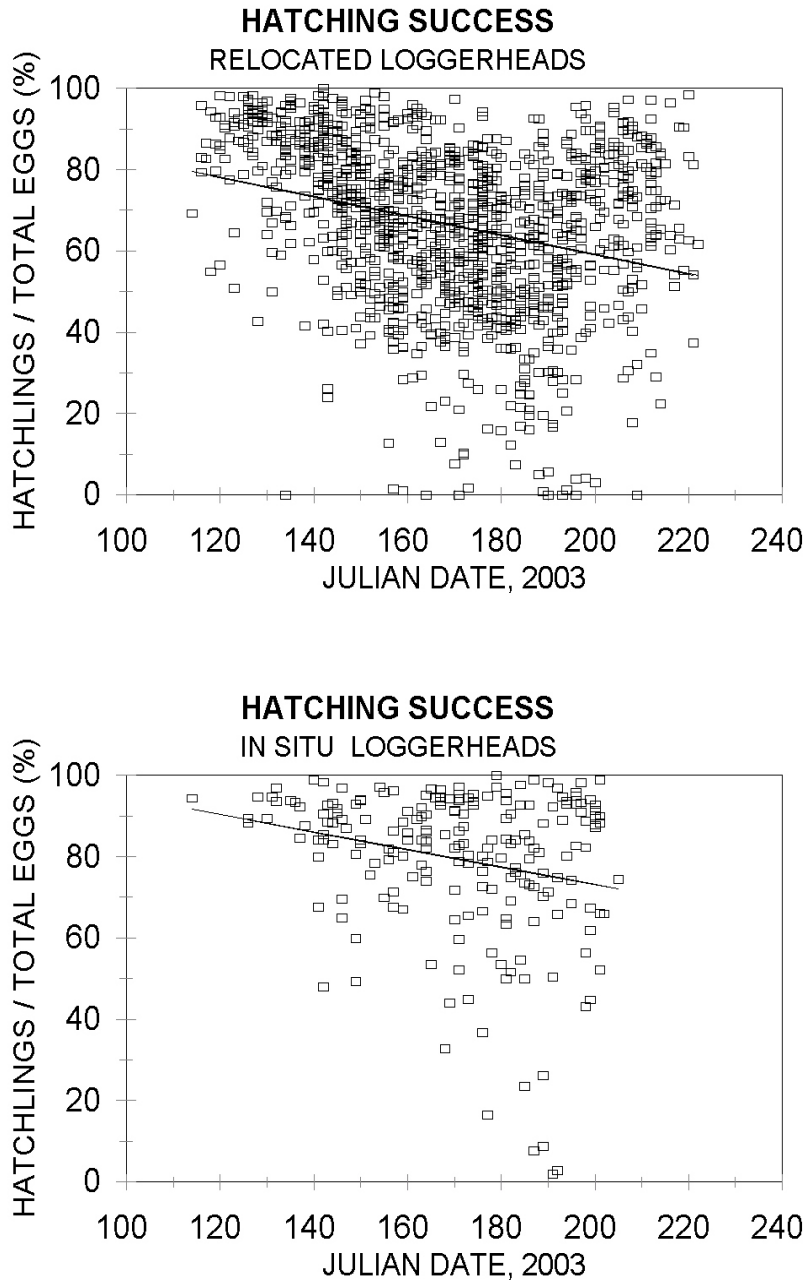
**Table 5:** Total Number of loggerheads, greens leatherback nests relocated to Hillsboro beach or fenced hatcheries or left *in situ* in 2003. Lloyd Park is not included.

	Loggerheads	Greens	Leatherbacks	Totals
<b>RELOCATED</b>				
<u>Open Beach</u>				
Hillsboro Beach				
BH	11	0	0	11
BH1	4	0	0	4
BH2	1	0	0	1
BH900s	104	3	0	107
BH1000s	47	5	0	52
BH1100s	282	10	0	292
Pompano Beach				
BP1	298	6	0	304
BP2	293	4	0	297
BP3	299	3	0	302
Lloyd Park Beach	57	0	0	57
<u>Hatcheries</u>				
Pompano	54	0	0	54
Ft. Lauderdale	45	0	1	46
Hollywood	32	0	0	32
TOTALS	1527	31	1	1559
<b>IN SITU</b>				
Hillsboro Beach	452	43	7	502
Pompano Beach	116	1	1	118
Ft. Lauderdale	26	2	3	31
Hollywood	13	0	0	13
TOTALS	607	46	11	664
GRAND TOTALS	2134	77	12	2223

**Table 6:** Total egg counts, released hatchlings and overall release successes for *in situ* and relocated nests of loggerheads, greens and leatherbacks in 2003.

SPECIES	NUMBER OF EGGS	EVAL. NESTS	HATCHLINGS RELEASED	RELEASE SUCCESS (%)
<b><i>In situ</i> Nests</b>				
<i>C. caretta</i>	26795	247	21388	79.8
<i>C. mydas</i>	1025	9	791	77.2
<i>D. coriacea</i>	687	6	509	74.1
Total	28507	262	22688	79.6
<b>Relocated Nests</b>				
<i>C. caretta</i>	131993	1214	86754	65.7
<i>C. mydas</i>	1865	16	1231	66.0
<i>D. coriacea</i>	98	1	0	0
Total	133956	1231	87985	65.7
<b>Overall</b>				
<i>C. caretta</i>	158788	1460	108142	68.1
<i>C. mydas</i>	2890	25	2022	70.0
<i>D. coriacea</i>	785	7	509	64.8
TOTAL	162463	1492	110673	68.1
<b>Predated and Unevaluated Nests and Eggs</b>				
	Predated Nests	Pred. Eggs	Unevaluated Nests	Unevaluated Eggs
<b><i>In Situ</i> Nests</b>				
<i>C. caretta</i>	196	-	165	-
<i>C. mydas</i>	14	-	23	-
<i>D. coriacea</i>	1	-	4	-
<b>Relocated</b>				
<i>C. caretta</i>	288	33079	25	2785
<i>C. mydas</i>	12	1398	3	300
<i>D. coriacea</i>	0	0	0	110

Figure 10 shows the seasonal patterns of the hatching success of *in situ* and relocated loggerhead nests. Hatching success in both groups showed very significant seasonal declines but the slope of the regression

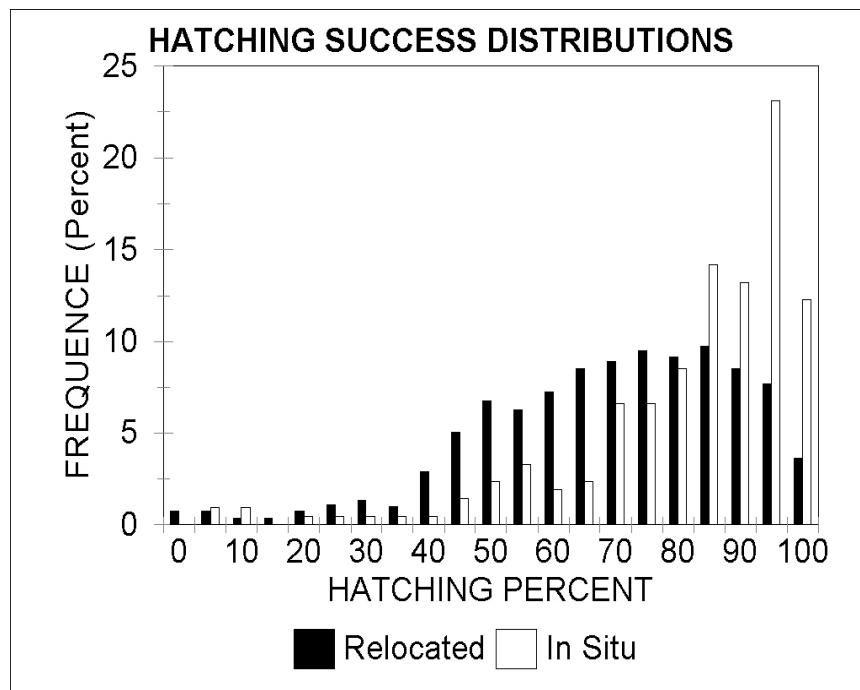


**Figure 10:** Comparison of seasonal hatching success for relocated and *in situ* loggerhead nests during 2003.



lines were almost identical and not statistically different ( $P = .358$ ). This was different than last year, when the success of relocated nests declined more rapidly than for *in situ* nests.

Figure 11 shows the frequency distributions for hatching success in relocated and *in situ* nests. A Mann Whitney U test indicated a very significant difference in the medians of these distributions ( $Z = 9.85$ ;  $p < .001$ ).



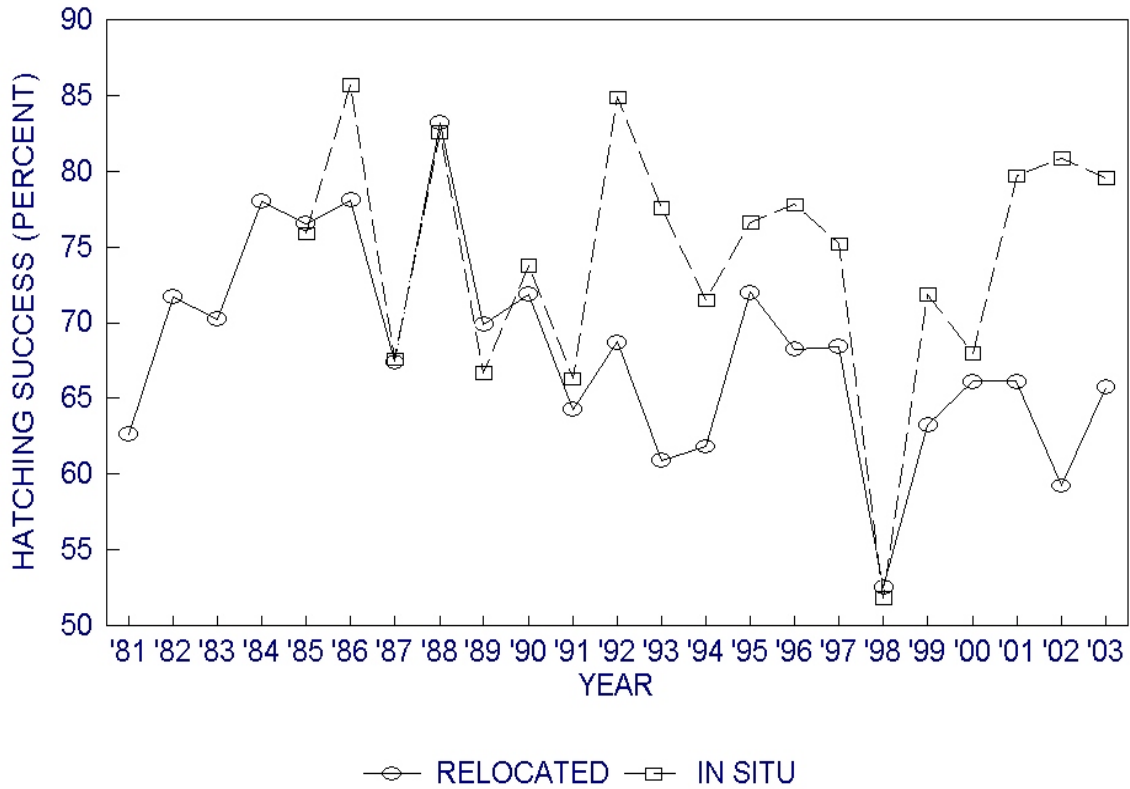
**Figure 11:** Hatching success frequencies for *in situ* and relocated loggerhead nests in 2003.

Figure 12 illustrates the historical patterns of the yearly hatching success of all species combined, since 1981. Overall hatching success of all relocated nests (65.7 %) increased 6.0 points from last year, while the combined success of *in situ* nests declined 1.3 points to 79.6 percent.

Table 7 compares emergence success and the percentages of hatchlings and eggs in the post-hatching evaluation categories for

# HATCHING SUCCESS

## HISTORICAL PATTERN



**Figure 12:** The historical patterns of yearly hatching success for all evaluated *in situ* and relocated sea turtle nests, since 1981.

relocated and *in situ* loggerhead nests. Tables 8 and 9 give the same results for greens and leatherbacks, respectively.

**Table 7:** Accounting of the status of all hatched and unhatched eggs in evaluated *in situ* and relocated loggerhead nests during 2003.

Location	Total Eggs	Emerged Hatchlings (%)	LIN (%)	DIN (%)	PIP Live (%)	PIP Dead (%)	VD (%)	NVD (%)
<b><i>In situ</i> Nests</b>								
Hillsboro Beach	14547	70.4	5.2	1.8	0.6	5.1	6.9	10.2
Pompano Beach	9739	76.2	5.8	3.2	0.4	4.2	4.5	5.8
Ft. Lauderdale	1476	88.6	3.5	1.7	0.2	0.5	2.7	2.8
Hollywood Beach	1033	82.0	8.6	1.0	0.2	1.8	2.2	4.2
<i>Overall In situ</i>	26795	74.0	5.5	2.3	0.5	4.4	5.6	8.0
<b>Relocated Nests</b>								
Hillsboro Beach								
BH	376	73.4	16.0	1.9	0.0	0.5	3.2	5.1
BH900s	3678	58.7	6.3	2.0	1.0	6.7	8.7	16.6
BH1000s	1606	51.7	11.7	1.7	3.4	14.4	8.4	8.8
BH1100s	15197	64.4	5.6	1.6	0.9	7.9	7.3	12.4
<i>Overall Hillsboro</i>	20857	62.6	6.4	1.7	1.1	8.1	7.6	12.7
Pompano Beach								
BP1	32232	47.8	12.0	2.4	2.6	15.1	7.0	13.1
BP2	30605	43.1	17.7	3.0	3.1	14.5	5.9	12.7
BP3	32098	42.7	14.0	3.3	2.8	16.0	8.4	12.9
<i>Overall Pompano</i>	94935	44.6	14.5	2.9	2.8	15.2	7.1	12.9
Lloyd Park Beach	1021	49.2	11.9	2.1	1.3	2.3	14.9	18.5
<b>Hatcheries</b>								
Pompano	6289	77.2	4.4	1.3	0.9	5.0	1.4	9.8
Ft. Lauderdale	5222	77.7	6.5	1.3	1.6	4.6	1.3	7.1
Hollywood	3669	71.0	9.9	1.6	1.8	4.7	2.8	8.1
<i>Overall Hatchery</i>	15180	75.9	6.5	1.4	1.4	4.8	1.7	8.5

**Emerged Hatchlings** - Percentage of hatchlings released minus DIN and LIN

**DIN** - Hatchlings found dead in the nest when it was excavated

**LIN** - Hatchlings found alive in the nest when it was excavated

**PIP-Live** - Live hatchlings that partially emerged from their eggs.

**PIP-Dead** - Dead hatchlings that partially emerged from their eggs.

**VD** - Unhatched eggs with signs of visible embryo development when opened

**NVD** - Unhatched eggs with no signs of embryo development

**Table 8:** Accounting of the status of all hatched and unhatched eggs in investigated *in situ* and relocated green sea turtle nests during 2003. Abbreviations as in Table 7.

Location	Total Eggs	Emerged Hatchlings (%)	LIN (%)	DIN (%)	PIP Live (%)	PIP Dead (%)	VD (%)	NVD (%)
<b><i>In situ</i> Nests</b>								
Hillsboro Beach	1025	75.6	1.3	0.9	0.3	4.1	8.5	9.4
<b>Relocated Nests</b>								
Hillsboro Beach								
BH900s	101	71.3	5.0	9.9	3.0	2.0	3.0	5.9
BH1000s	149	56.4	4.0	2.7	0.7	7.4	10.7	18.1
BH1100s	119	19.3	31.9	1.7	3.4	3.4	35.3	5.0
Pompano Beach								
BP1	617	56.1	12.8	1.3	3.9	16.0	3.1	6.8
BP2	489	43.1	20.0	6.1	4.3	15.1	2.9	8.4
BP3	390	32.6	21.3	3.1	1.5	13.3	9.5	18.7

**Table 9:** Accounting of the status of all hatched and unhatched eggs in investigated *in situ* and relocated leatherback nests during 2003. Abbreviations as in Table 7.

Location	Total Eggs	Emerged Hatchlings (%)	LIN (%)	DIN (%)	PIP Live (%)	PIP Dead (%)	VD (%)	NVD (%)
<b><i>In Situ</i> Nests</b>								
Hillsboro Beach	604	67.5	4.8	2.0	0.3	1.8	1.8	21.7
Ft. Lauderdale	83	84.3	0.0	0.0	0.0	0.0	1.2	14.5
<b>Relocated Nests</b>								
Hatcheries								
Ft. Lauderdale	98	0.0	0.0		0.0	0.0	0.0	100

## DISCUSSION

### Yearly Nesting Trends

This year's loggerhead nest count recovered from last year's loss. The unprecedented two year decline which began in 2000 did not continue for a third year (Fig.3). While the 2003 number of nests was 17.6 percent below the number recorded in 2000, it was only 75 nests below the previous 10 year average. The trend in yearly loggerhead nesting since 1990 has is almost flat and not significantly different from zero ( $P = 0.141$ ). Fluctuations since then could have been caused by relatively small changes in the proportions of the female population nesting in a given year or the average number of nests deposited per nesting female. Over a 10 year period, mean observed clutch frequency varied from 2.39 to 3.42 nests per female per year on Little Cumberland Island, Georgia (Frazer and Richardson, 1985). Such variation would more than explain the fluctuations in Broward County since 1990.

A large decline in green turtle nesting was expected this year because of the alternating pattern established over more than a decade (Fig 3). Apparently, a large proportion of the females have maintained a synchronized two year remigration interval. However, this year set the record for the number of green turtle nests deposited in a low-nesting (odd numbered) year. While this might suggest an increase in the number of nesting females, it could also easily be caused by fluctuations in the factors mentioned above. The leatherback nest count declined slightly from last year but, was identical to the 23 year average.

### Seasonal Nesting Patterns

The seasonal pattern of loggerhead nesting in Broward County (Fig. 4) again conformed to the historical norm, showing a relatively symmetrical bell-shaped curve with the first nest in mid April, the last nest in late August and the midpoint of the season in Mid June. Peak nesting occurred on the night of 24-25 June, when 58 nests were deposited. Seasonal nesting at the individual beaches (Fig. 5) was similar to previous years. Loggerhead nesting densities throughout Broward County were highest in the north and declined toward the south (Table 1). Nesting in Hillsboro Beach was expected to decline due to ongoing beach erosion, but instead it increased by over 25 percent from last year.

The seasonal pattern of green turtle nesting in 2002 (Fig. 6) was similar to the last low-nesting year (2001) (Burney and Ouellette, 2001) with nesting beginning in late May and ending in late September. Leatherbacks again nested earlier in the season, from mid March to mid May.

As in previous years, green turtles nested most heavily in Hillsboro Beach (Figure 7), possibly due to the reduced beachfront lighting and nocturnal human activity. Mean daily nesting densities (Table 2) were significantly lower in Pompano Beach, Fort Lauderdale and Lloyd Park, where nesting was statistically equivalent. No green turtle nests were deposited in Hollywood. This year was unusual because only one green turtle nested in Lloyd Park. In previous years, nesting densities in Lloyd Park have equaled or exceeded Hillsboro Beach (Burney and Ouellette, 2001, 2002). Leatherback nesting densities (Fig. 7, Table 3) were highest in Hillsboro and significantly lower in Pompano Beach and Fort Lauderdale. There was no leatherback nesting in Lloyd Park and

Hollywood. There has been lower leatherback activity on these beaches for the last three years (Burney and Ouellette, 2001, 2002).

#### County-wide Nest Distribution

The distribution of loggerhead nests in the 128 survey zones (Fig. 8) continues to highlight shoreline features identifiable since 1981. As in past surveys, beaches near piers, inlets, the Fort Lauderdale strip and throughout Dania, Hollywood and Hallandale remained lightly nested. This pattern has been discussed previously (Burney and Mattison, 1992; Mattison et al., 1993). As discussed last year (Burney and Ouellette, 2002) a significant fraction of the variance in the nesting pattern in zones R-1 through R-84 can be explained by a the combined influence of beachfront lighting and the ease of public beach access.

The number of green turtle nests has never been large enough to establish such a detailed horizontal nesting pattern (Fig. 8), except for their apparent preference for darker beaches with less nocturnal disturbance. The same is true for leatherbacks.

#### Nesting Success

Overall, loggerhead nesting success (Fig. 9, Table 4) decreased slightly from 47.2 percent in 2002 to 46.0 percent in 2003. Nesting success was significantly highest in Fort Lauderdale and Hillsboro Beach, with lower and statistically overlapping levels in the rest of the County. The steep decline in nesting success in Hillsboro Beach, from 56.7 percent in 2001 to 44.9 percent in 2002 (Burney and Ouellette, 2002) did not continue. Despite continuing beach erosion, nesting success In Hillsboro Beach increased to 47.3 percent in 2003. Lower nesting success was found near piers and along the Fort Lauderdale strip, which have

increased beachfront lighting and nocturnal pedestrian traffic, as well as in parts of Hollywood which were severely eroded. Nesting success on Hollywood beach was erratic, due to the very low numbers of nests and false crawls in some of the zones.

The overall green turtle nesting success of 61.4 percent (Table 4) increased dramatically from 38.6 percent last year but there was no statistical differences county wide. Compared to last year, the increases were especially large in Pompano Beach and Hillsboro Beach which jumped by 26.2 and 27.6 percentage points, respectively. Leatherback nesting success increased from 75 percent last year to 80 percent in 2003, but there were only 12 nests and 3 false crawls.

#### Hatching Success

The percentage loggerhead eggs that produced live released hatchlings 14.1 points lower in relocated nests than in nests left *in situ* (Table 6). The difference was statistically significant, but was 7.0 points lower than the difference in 2002, mostly due to an increase in the success of relocated nests (Fig. 12). Hatching successes of both *in situ* and relocated loggerhead nests showed the usual seasonal declines (Fig. 10) but unlike last year, the slopes of the regression lines were virtually identical, suggesting that the relocation process did not accelerate the rate of decline. The medians of the seasonal distributions of the number of evaluated relocated and *in situ* nests were not significantly different (Mann Whitney U test,  $P = 0.207$ ) so the difference in the success of relocate and *in situ* nests can not be attributed to the evaluation of a larger proportion of late-season *in situ* nests. The hatching success distributions for *in situ* and relocated loggerheads (Fig. 11) showed the usual characteristics. While there was a large statistical difference in the medians, the difference



was not caused by significantly higher proportions of nests with successes below 40 percent, suggesting that relocation did not cause catastrophic nest failure. *In situ* nests had much higher frequencies of nests with 85 percent or higher hatching success rates. Relocated nests had higher frequencies in the intermediate percentages. There were lower proportions of low-success (< 40%) nests in 2003 than in 2002 (Burney and Ouellette, 2002). The difference in the hatching success of *in situ* and relocated nests was not caused by high frequencies of low-success relocated nests. Relocated nests had higher success frequencies in the 40-80 percent range and lower success above 80 percent, relative to *in situ* nests.

The traditional BH1 and BH2 relocation sites in Hillsboro Beach (Fig. 1B) were almost completely eroded, so most Hillsboro Beach nests requiring relocation were moved to the beach adjacent to houses in the 900 and 1100 blocks of Highway A1A and most nests from Pompano Beach and Fort Lauderdale were moved to BP1, BP2 or BP3 in Pompano Beach. Each of the Pompano Beach open hatcheries received just under 300 nests (Table 5). Table 7 shows that the emergence success of loggerhead hatchlings from nests relocated to BP1-3 were lower than *in situ* nests. This difference was partially offset by the greater percentages of live-in-nest and live pipped hatchlings in hatchery nests. Hatchlings may have a more difficult time escaping the artificial egg chambers, but this was not reflected in higher percentages of dead-in-nest hatchlings. Most hatchlings that did not emerge from the egg chambers survived until excavated three days after first emergence. Nests in the restraining hatcheries were also excavated three days after first emergence and they had higher emergence and lower LIN percentages (Table 7), but these were all early-season nests, which had higher overall success rates (Fig. 10).

As in previous years, pipped-dead and NVD accounted for the highest percentages of failed eggs nests relocated to open beach hatcheries in Hillsboro Beach and Pompano Beach. These percentages were significantly higher than for *in situ* nests. Since relocated nests were placed at least four feet apart and this was the first use of the Pompano Beach relocation sites, it is unlikely that the higher percentages of failed eggs was due to hatchery crowding or poor incubation conditions caused by the remains of old nests. Since the overall post emergence evaluation percentages for nests relocated to restraining hatcheries were very similar to *in situ* nests, the higher percentages of failed eggs in nests relocated to other areas were not entirely caused by the relocation process.

Comparison of the post emergence nest evaluation categories in relocated and *in situ* green turtle nests (Table 8) was similar to loggerheads. Overall emergence was lower in nests relocated to Pompano Beach, but this was partially offset by higher percentages of live-in-nest and live pipped, which were released. The percentages of dead pipped eggs at the Pompano relocation sites was significantly greater than for *in situ* nests, but this category was similar to *in situ* for relocated nests at Hillsboro Beach. These comparisons are tenuous because of the low number of evaluated nests (Table 6).

The six evaluated *in situ* leatherback nests (Table 9) had higher proportions of undeveloped eggs than the *in situ* nests of the other species. The single relocated nest failed completely in the Fort Lauderdale restraining hatchery. It is not known if this was due to relocation or infertility.

The severity of erosion in Hillsboro Beach has increased since last year. The relocation site at the Hillsboro Club is now unusable. This forced

the establishment of open beach hatchery areas in Pompano Beach. These were located in zones where with minimal beach front lighting, as determined by monthly beach lighting surveys. Still, there were \*\*\*\* hatchling misorientation events from nests in these hatcheries. **Need more from Amber about the timing and number of these misorientations.**

\*\*\*\*\* to here 11/21/03 determined that If erosion continues unabated, there will be a *critical* shortage of suitable Hillsboro Beach relocation sites. Enforcement of beach lighting restrictions in Pompano Beach may allow more nests to be left *in situ*. Some progress in lighting reduction was made in a few locations this year, but too late in the season to help the relocation problem. If there is expanded compliance next season, a greater number of nests could be left *in situ*, and new relocation areas might be established. A solution to this problem must be found.

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**APPENDIX 1:** Summary of sea turtle hot-line calls.

SUBJECT	HOT-LINE
ATV ACCIDENTS	1
LIVE STRANDINGS	3
DISORIENTATIONS	3
NEST LOCATIONS	80
POACHING	2
OTHER	>300
OVERALL	> 400

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

Flyers were distributed along the beach, primarily to people who approached workers with questions and at the turtle talks, which usually attracted crowds. Flyers were also distributed to people touring the Oceanographic Center or requesting information by telephone or mail and by brochure holders on all fenced hatcheries.

Public education talks were conducted on Wednesday and Friday evenings from July 18 to Sept. 14 at the Anne Kolb Nature Center. These slide show presentations were followed by hatchling releases near Greene St. in Hollywood. Turtle talks were also given to groups at the Hillsboro Club, the Institute of Retired Professionals at NSU and at several high schools.

**Appendix 3:** Sea turtle nest warning sign. Black lettering on yellow background. Actual size is 5.5" X 8.5".



## **Appendix 4:** Sea Turtle Summary Report Forms