

TECHNICAL REPORT BCEPD 04-

SEA TURTLE CONSERVATION
PROGRAM
BROWARD COUNTY, FLORIDA
2004 REPORT

Submitted by:

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For the:

BROWARD COUNTY BOARD OF COUNTY COMMISSIONERS
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BIOLOGICAL RESOURCES DIVISION

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INTRODUCTION

Since 1978, the Broward County Environmental Protection Department (BCEPD) 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 BCEPD and conducted by the Nova Southeastern University Oceanographic Center under Marine Turtle Permit #108, issued to the BCEPD by the FWCC.

The BCEPD is especially concerned with any environmental effects of intermittent beach nourishment projects on shorelines and the offshore reefs. As part of this concern, the BCEPD 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 2004 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, 2004. 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,



Figure 1A: The location of Broward County, FL

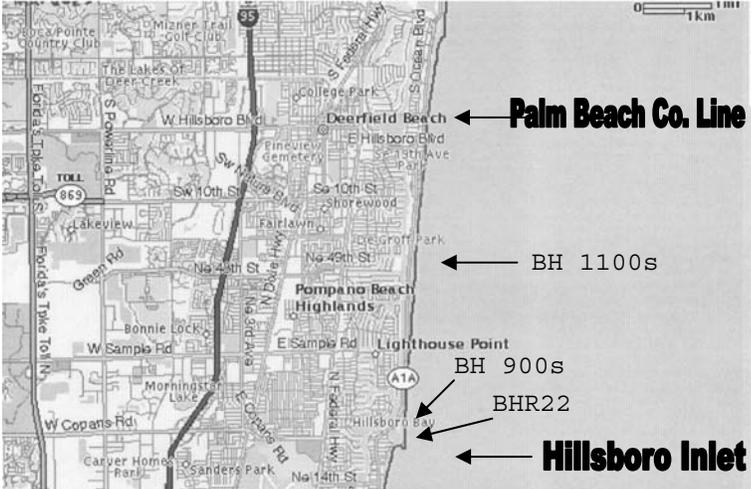


Figure 1B: Northern Broward County.



Figure 1C: North Central Broward County.

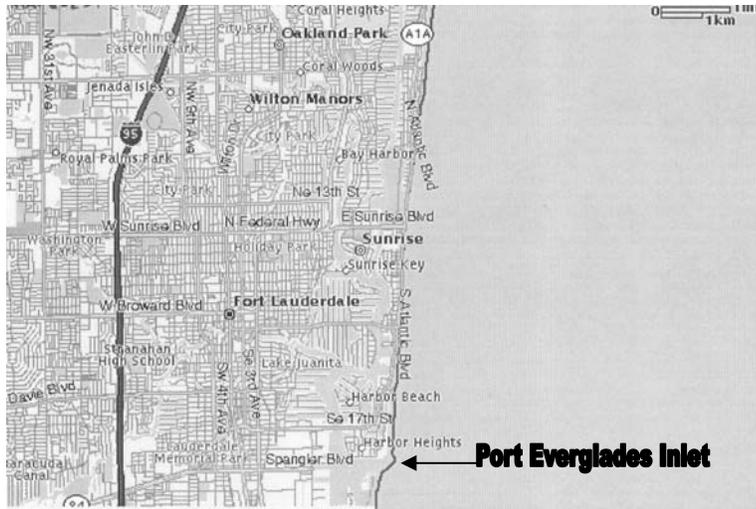


Figure 1D: Central Broward County

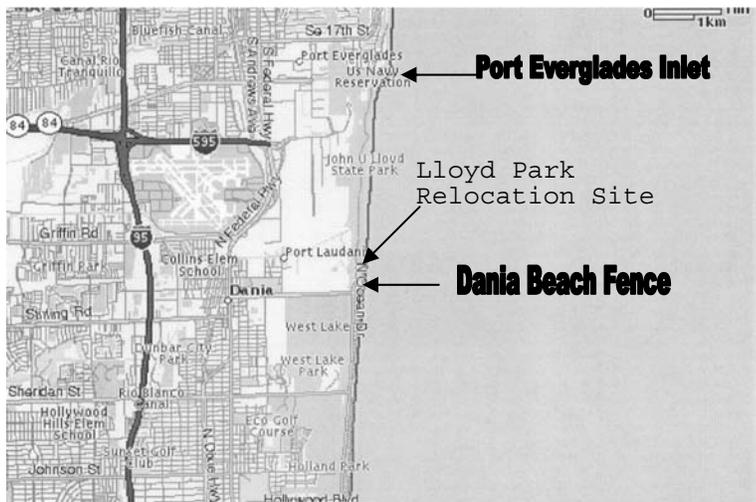


Figure 1E: South Central Broward County, showing the open beach hatchery in Lloyd Park.

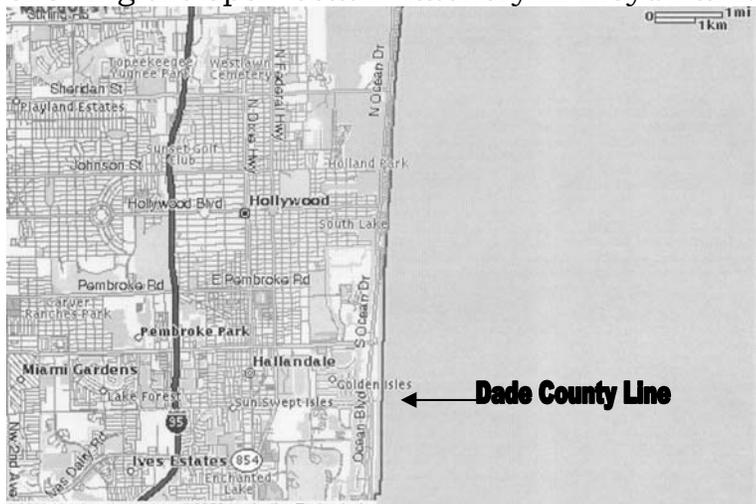


Figure 1F: Southern Broward County

street, or other landmark. These locations were later cross-referenced to the nearest survey marker. Nest and non-nesting (false) crawl locations were also recorded using Global Positioning System (GPS) receivers. In past years, false crawls were not counted unless they extended above the previous high tide line. This year, all false crawls were included, but those that did not reach the high tide line were listed separately.

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. Nests in danger of negative impacts at Hillsboro Beach were individually relocated to safer nearby locations (designated BH) or they were moved to open beach locations 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. Some Hillsboro nests were also moved to a location designated BHR22, near survey marker R22.

Because relocation seems to strongly impact the hatching success of green turtle nests, all nests were left *in-situ* except for those laid less than 10 feet from the high tide line and those found between zones R39 and R78 along the brightly illuminated and heavily traveled Fort Lauderdale strip. Only 8 green turtle nests were relocated while 124 were left in place.

Early nests from Pompano Beach and Fort Lauderdale were relocated to restraining hatcheries. After mid May when the restraining hatcheries were filled, nests were relocated to three open beach locations in Pompano Beach. These were designated BP1, BP2 and BP3 and were located in FDEP zones R27, R29 and R30, respectively. The northerly (BP1) and southerly (BP3) limits of this area are shown in Figure 1C. Each location was subdivided into two sections (designated A and B) that were 40-100 feet apart. Each sub section was expected to received up to 5 rows of 20 nests each. The nests were located with 4 feet between the centers of the egg chambers and marked with stakes and signs (Appendix 4). The

sites were marked with stakes and caution tape but they were not fenced. The layout, nest numbers and dates of each nest relocated to these sub sites are provided in Appendix 3.

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 minimize possible injury to the embryos.

A total of 663 nests were not in danger of negative impacts and were marked with stakes bearing yellow 5.5" X 8.8" sea turtle nest warning signs (Appendix 4) and left *in situ*. After hatching, 239 of these nests (36 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, chain-link fenced hatcheries were located in Pompano Beach near Atlantic Boulevard, at the South Beach municipal parking lot in Fort Lauderdale, or at North Beach Park in Hollywood. Prior to the nesting season, the sand in the hatcheries was dug out to a depth of three feet and replaced with sand from elsewhere on the beach. Early season nests were relocated to the restraining hatcheries but they were not reused after the first round of nests hatched.

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 Pompano Beach, Fort Lauderdale, Hillsboro Beach, Hollywood or Lloyd Park, 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. 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.

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 2004 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 Broward County Coastline Aerial Shore Line Map using the ArcView Geographic Information System (GIS).

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 2004. 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 1979 nests were found in 2004, which was 446 (18.4 percent) lower than in 2003. This was the lowest nest count since 1989 and it fell 580 nests (2.3 standard

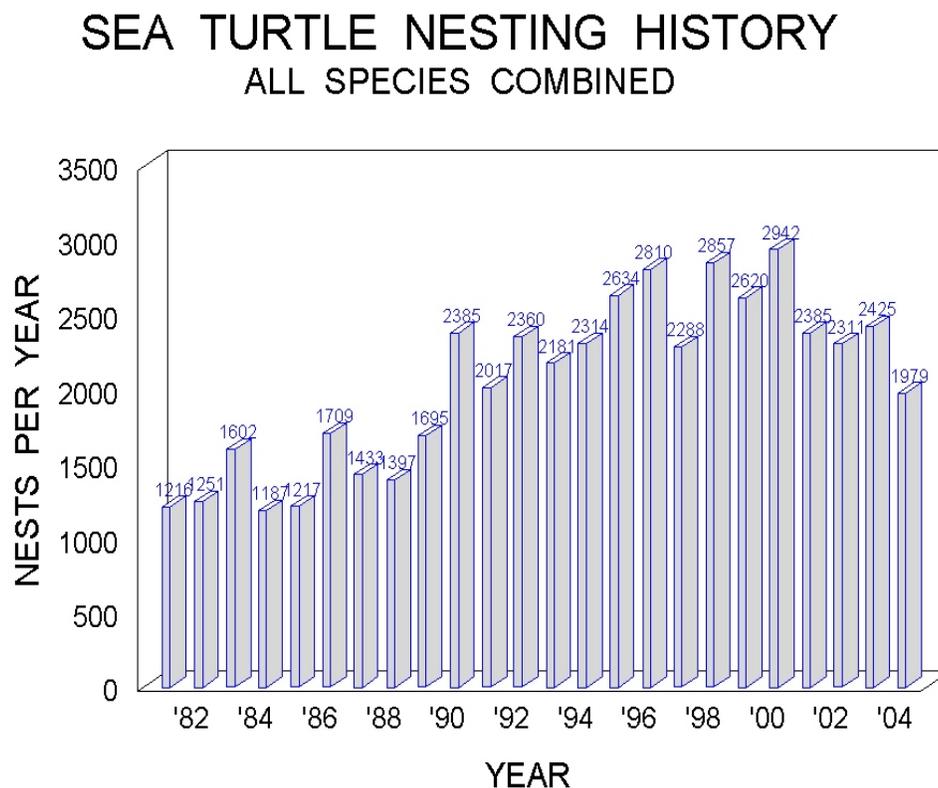


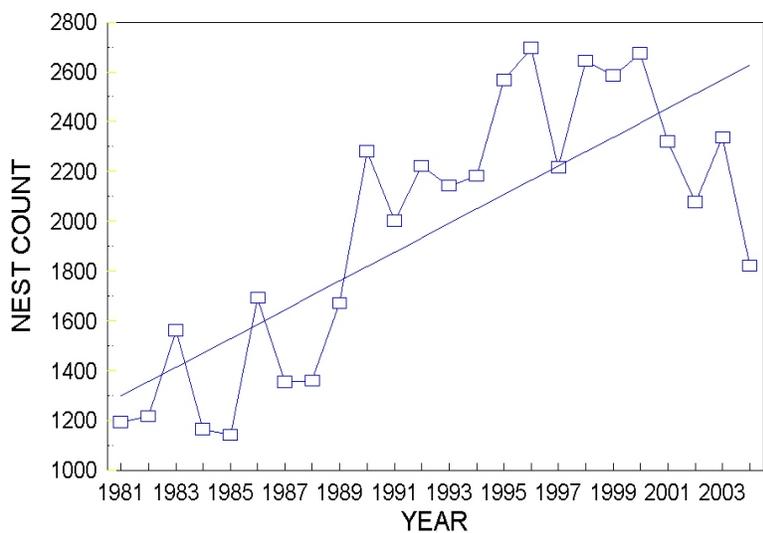
Figure 2: The pattern of total sea turtle nesting in Broward County since full surveys commenced in 1981.

deviations) below the previous 10-year average of 2559. While this was certainly a significant drop it was not unprecedented. Larger one-year declines occurred from 1996 to 1997 and between 2000 and 2001.

Figure 3 shows the yearly nesting trends of loggerhead, green and leatherback sea turtles. The number of loggerhead nests (1822) declined by 513 (22.0 percent) from 2003, which was the largest single year drop

BROWARD LOGGERHEAD NESTS

$r = .776$ $P < .0001$



BROWARD NESTS GREENS AND LEATHERBACKS

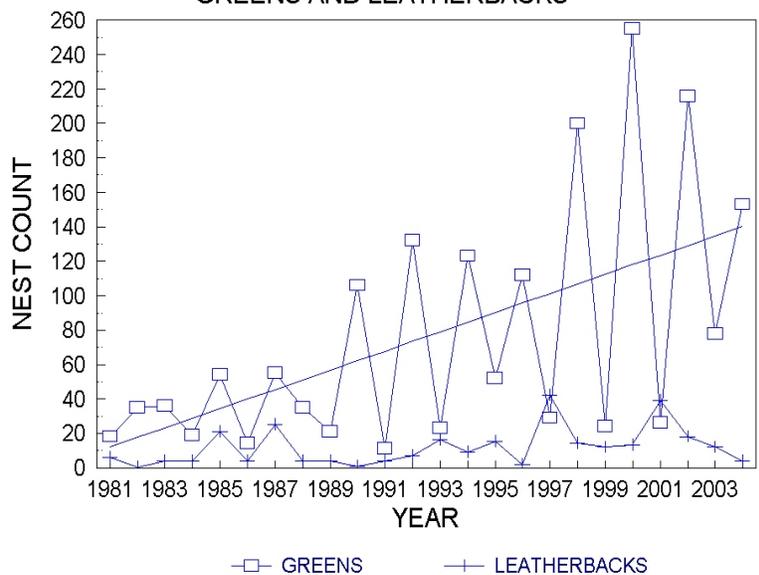


Figure 3: Historical nesting patterns of loggerhead, green and leatherback sea turtles in Broward County since 1981.

since project inception. This year's count fell 607 nests (2.7 standard deviations) below the previous 10-year average. A one-year decrease of only slightly lower magnitude occurred in 1997 and it was followed by a large increase the next year. The overall trend line since 1981 remains highly significant, indicating an average increase of 57.8 nests per year, but the slope of the trend line since 1990 is not significantly different from zero.

Green turtle nesting (Fig. 3) showed its eighth consecutive increase in an even numbered year, but 153 nests was the lowest of the previous three even numbered years. The slope of the 24-year trend line for green turtle nesting remained significantly greater than zero ($r = 0.558$; $P = .002$), suggesting an average increase of 5.6 nests per year since 1981. Four leatherback nests were deposited in 2004, which was below the 24-year average but well within one standard deviation from the mean. The overall nesting trend remains slightly positive ($r = 0.375$, $P = .035$) suggesting an average increase of 0.59 nests per year since 1981 but the trend is tenuous.

Figure 4 shows the seasonal loggerhead nesting pattern. The first and last nests were deposited on 25 April in Fort Lauderdale and on 24 August in Hillsboro Beach. 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. This pattern was exactly the same as in 2003.

The countywide seasonal nesting patterns of greens and leatherbacks are shown in Figure 6 and for the individual beaches in

LOGGERHEAD NESTS

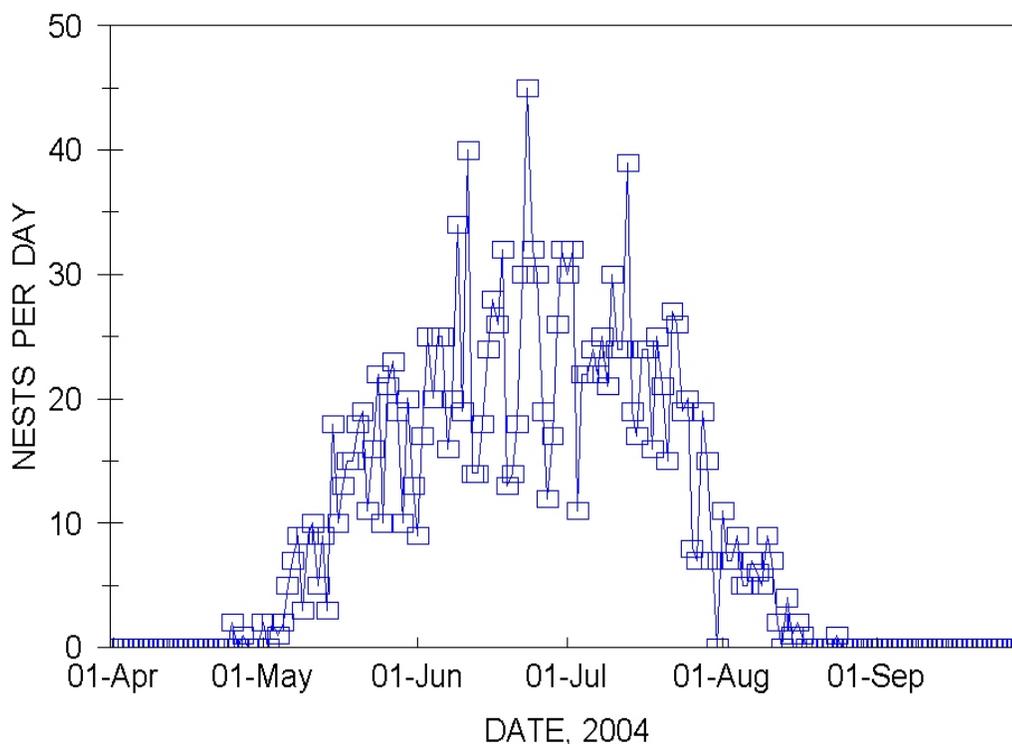


Figure 4: The seasonal pattern of daily loggerhead nesting in Broward County, 2004.

Table 1: Total loggerhead nests and nesting densities expressed as nests-per-kilometer for the 2004 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	587	7.0	83.8	.481	A
Pompano Beach	448	7.7	58.2	.335	B
Ft. Lauderdale	575	10.6	54.2	.312	B
Lloyd Park	136	3.9	34.9	.208	C
Hollywood	76	9.4	8.1	.045	D
OVERALL	1822	38.6	47.2		

Figure 7. The first and last leatherback nests were deposited on 24 March and 6 May, in Pompano Beach and Hillsboro Beach, respectively. The Green turtles nested between 16 May and 18 September in 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 8 shows nest counts for each species in each 1000-foot zone of Broward County beach (1-km zones in Lloyd Park) during 2004. As in previous years, the low nesting zones R2, R24, R34 and R50 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 (R61 to R78) and the entire beach south of R98 were also lightly nested. Loggerheads nested most frequently in zone R21 in the residential section of Hillsboro Beach. This was also the most heavily nested zone in 2002 and 2003. This year's nest distribution was remarkably similar to last years pattern.

Figure 9 and Table 4 present the countywide distribution of nesting success for the three species. Loggerhead nesting success showed no countywide trends. Nesting success was less than 20 percent in zones R10 on Hillsboro Beach, which was badly eroded, R25 just south of the Hillsboro Inlet and R82 in Fort Lauderdale where the beach was very hard and there was a heavy concentration of beach furniture and several lighted tennis courts. In past years, nesting success has been lower in R34 near the Pompano Beach pier (Burney and Ouellette, 2003) but this was not the case this year. There were several zones with low or zero

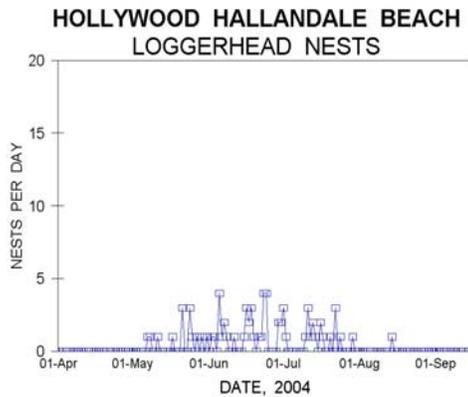
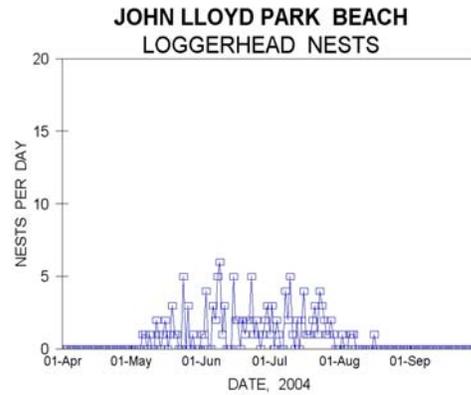
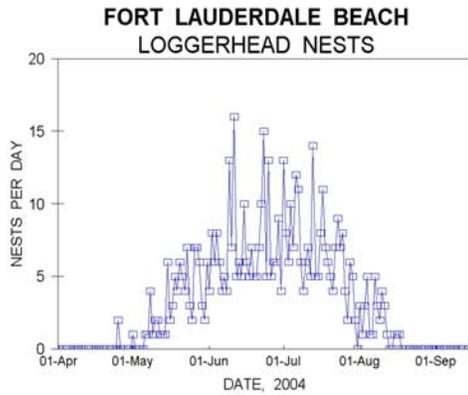
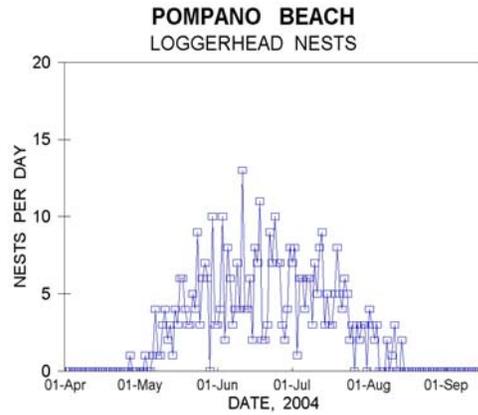
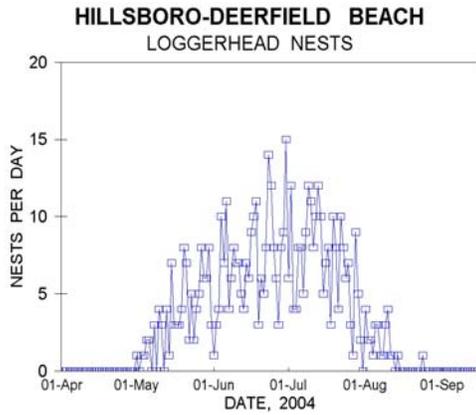


Figure 5: Comparison of the daily loggerhead nesting patterns on the five Broward County beaches in 2004.

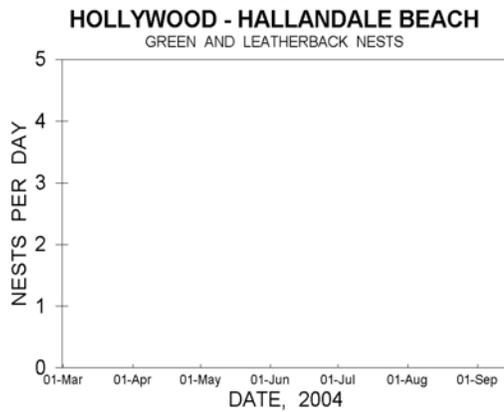
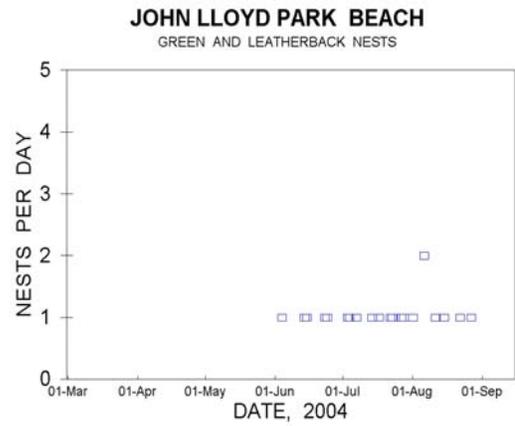
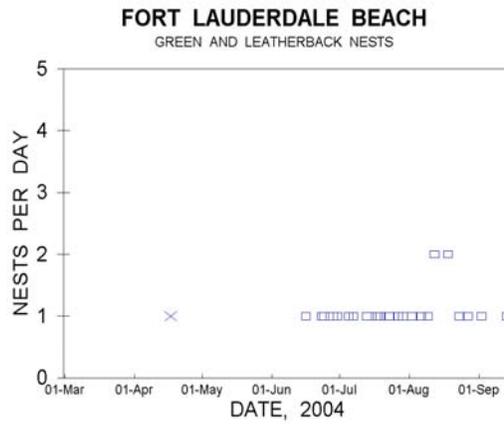
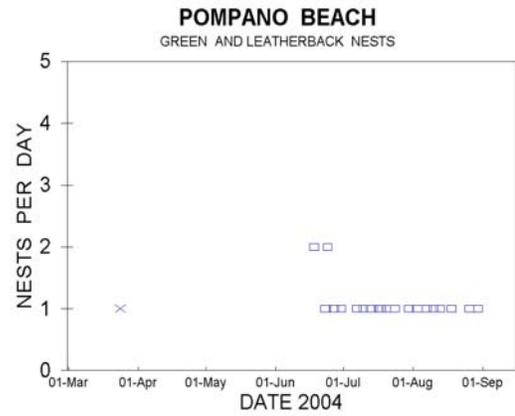
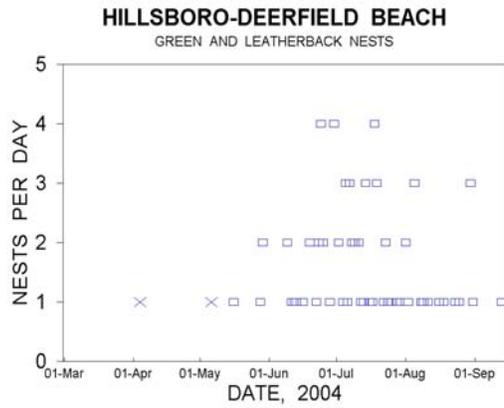


Figure 7: Comparison of the daily nesting patterns of green and leatherback sea turtles on the five Broward County beaches in 2004.



Table 2: Total green turtle nests and nesting densities expressed as nests-per-kilometer for the 2004 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	84	7.0	12.0	.0697 A
Lloyd Park	21	3.9	5.4	.0321 B
Pompano Beach	23	7.7	3.0	.0170 B
Ft. Lauderdale	25	10.6	2.4	.0140 B
Hollywood	0	9.4	0	0
OVERALL	153	38.6	4.0	

Table 3: Total leatherback nests and nesting densities expressed as nests-per-kilometer for the 2004 season. Nest counts were too small for statistical analysis.

BEACH	TOTAL NESTS	BEACH LENGTH (km)	Nests per km	MEAN DAILY NESTS per km
Hillsboro Beach	2	7.0	0.3	.0014
Pompano Beach	1	7.7	0.1	.0007
Ft. Lauderdale	1	10.6	0.1	.0005
Lloyd Park	0	3.9	0	0
Hollywood	0	9.4	0	0
OVERALL	12	38.6	0.3	

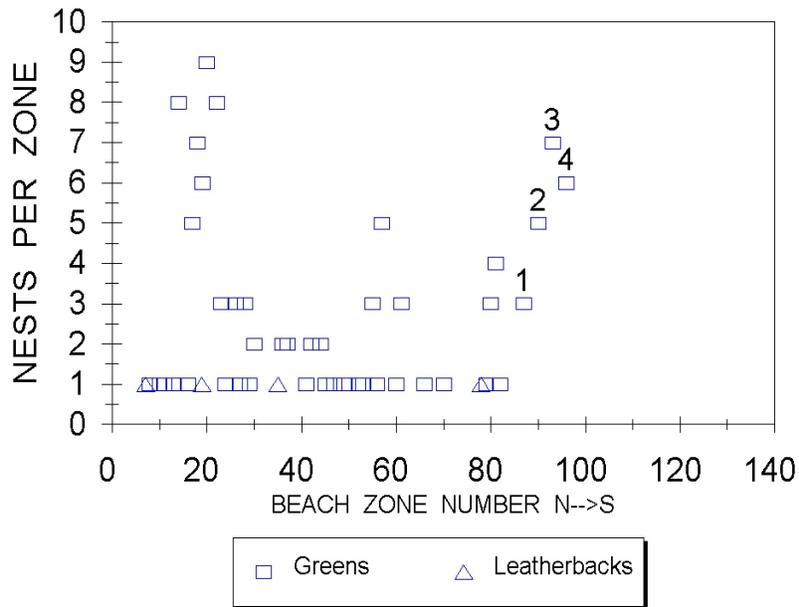
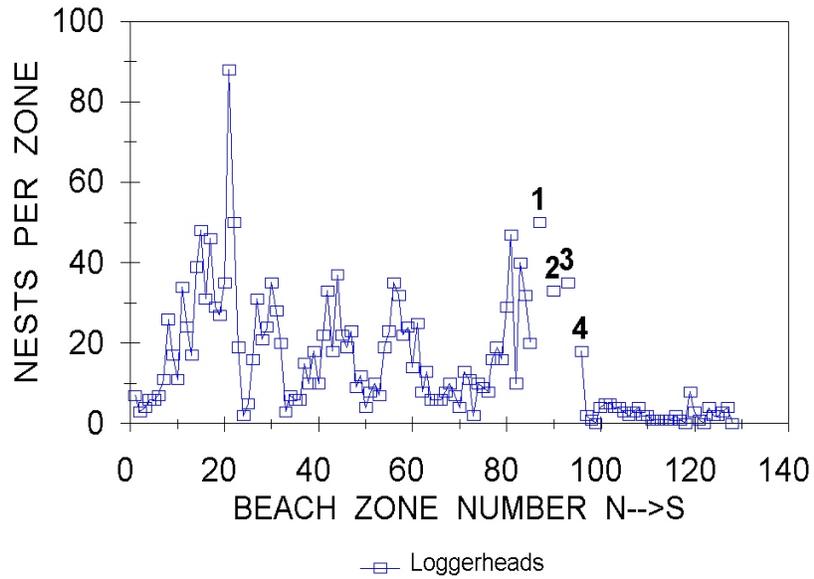


Figure 8: Locations of loggerhead, green and leatherback nests in Broward County, 2004. Numbers 1-4 indicate the four beach zones of John Lloyd Park.

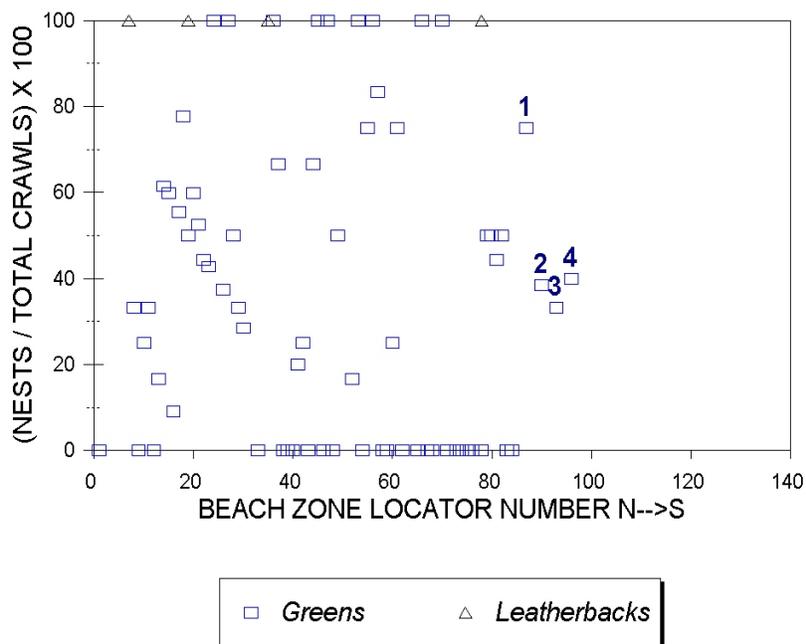
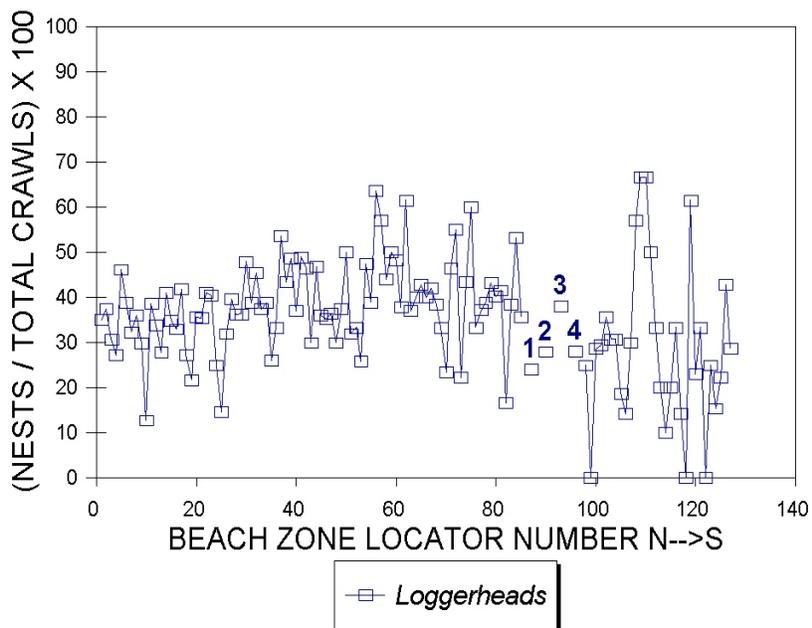


Figure 9: The distribution of the nesting success of loggerhead, green and leatherback turtles across Broward County, 2004. Numbers 1-4 indicate the four beach zones of John Lloyd Park.

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 2004. 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			NK	Greens			Leatherbacks		
	Nests	FC	NS		Nests	FC	NS	Nests	FC	NS
Ft. Lauderdale	575	806	41.6	AB	25	48	34.2	1	0	100
Pompano Beach	448	705	38.9	ABC	23	50	31.5	1	0	100
Hillsboro Beach	587	1166	33.5	ABC	84	91	48.0	2	0	100
Hollywood	76	191	28.5	BCD	0	0	-	0	0	-
Lloyd Park	136	345	28.3	CD	21	32	39.6	0	0	-
OVERALL	1822	3213	36.1		153	221	40.9	4	0	100

predated nests and nests that were unevaluated due to stake removal or washout are also listed. Hurricanes Francis and Jeanne adversely impacted a total of 309 nests.

Compared last year, the release (hatching) success of relocated loggerhead nests decreased 6.3 percentage points to 59.4 percent, while the success of *in situ* loggerhead nests declined by 16.1 points to 63.7 percent (Table 6). The difference between *in situ* and relocated nests decreased from 14.1 percent (higher in *in situ* nests) last year to 4.3 percent in 2004. *In situ* green turtle nests hatched at a rate of 81.2 percent compared to 69.8 percent in relocated nests. The higher hatching success of undisturbed green turtle nests is partially offset by the exposure of the hatchlings to possible misorientation and other dangers. Relocation of nests facing nearly certain destruction is still necessary but green turtle nests should be left in place, except in extreme circumstances. No leatherback nests were relocated but the hatching success of *in situ* nests declined from 79.6 percent in 2003 to 65.8 percent this year. Both of these percentages were based on very few nests (6 and 3, respectively).

Figure 10 shows the seasonal patterns of the hatching success of *in situ* and relocated loggerhead nests. The hatching success of relocated nests showed the usual significant seasonal decline ($P < .001$) but unlike last year, the slope of the trend line for *in situ* nests was almost zero ($P = .491$).

Figure 11 shows the frequency distributions for hatching success in relocated and *in situ* nests. A Mann Whitney U test indicated a significant difference in the medians of these distributions ($Z = 2.81$, $P = .005$) but

Table 5: Total Number of loggerheads, greens leatherback nests relocated or left *in situ* in 2004. Lloyd Park is not included.

	Loggerheads	Greens	Leatherbacks	Totals
RELOCATED				
<u>Open Beach</u>				
Hillsboro Beach				
BH	2	0	0	2
BH900s	130	2	0	132
BH1000s	41	2	0	43
BH1100s	29	0	0	29
BH1200s	1	0	0	1
Pompano Beach				
BP1	247	1	0	248
BP2	267	1	0	268
BP3	259	2	0	261
Lloyd Park Beach	39	0	0	39
<u>Hatcheries</u>				
Pompano	61	0	0	61
Ft. Lauderdale	45	0	0	45
Hollywood	30	0	0	30
TOTALS	1151	8	0	1159
IN SITU				
Hillsboro Beach	384	80	2	466
Pompano Beach	113	21	1	135
Ft. Lauderdale	31	23	1	55
Hollywood	7	0	0	7
TOTALS	535	124	4	663
GRAND TOTALS	1686	132	4	1822

Table 6: Total egg counts, released hatchlings and overall release successes for *in situ* and relocated nests of loggerheads, greens and leatherbacks in 2004, with the numbers of nests and eggs predated, lost and unevaluated due to Hurricanes Frances and Jeanne.

SPECIES	NUMBER OF EGGS	EVAL. NEST S	HATCHLINGS RELEASED	RELEASE SUCCESS (%)		
<i>In situ</i> Nests						
<i>C. caretta</i>	22523	207	14349	63.7		
<i>C. mydas</i>	3232	29	2623	81.2		
<i>D. coriacea</i>	319	3	191	59.9		
Total	26074	239	17163	65.8		
Relocated Nests						
<i>C. caretta</i>	102658	930	60949	59.4		
<i>C. mydas</i>	490	4	342	69.8		
<i>D. coriacea</i>	0	0	0	-		
Total	103148	934	61291	59.4		
Overall						
<i>C. caretta</i>	125181	1137	75298	60.2		
<i>C. mydas</i>	3722	33	2965	79.7		
<i>D. coriacea</i>	319	3	191	59.9		
TOTAL	129222	1173	78454	60.7		
Predated and Unevaluated Nests and Eggs						
	Pred. Nests	Pred. Eggs	Uneval Nests	Uneval Eggs	Uneval Francis	Uneval Jeanne
<i>In Situ</i>						
<i>C. caretta</i>	101	-	88	-	132	7
<i>C. mydas</i>	9	-	26	-	52	8
<i>D. coriacea</i>	0	-	1	-	0	0
Relocated						
<i>C. caretta</i>	103	11700	12	873	91	15
<i>C. mydas</i>	0	0	0	0	3	1
<i>D. coriacea</i>	0	0	0	0	0	0

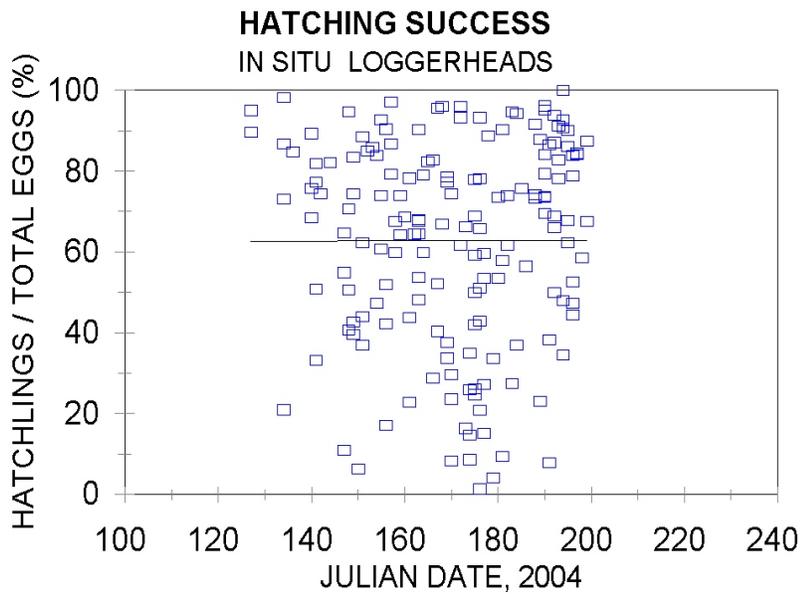
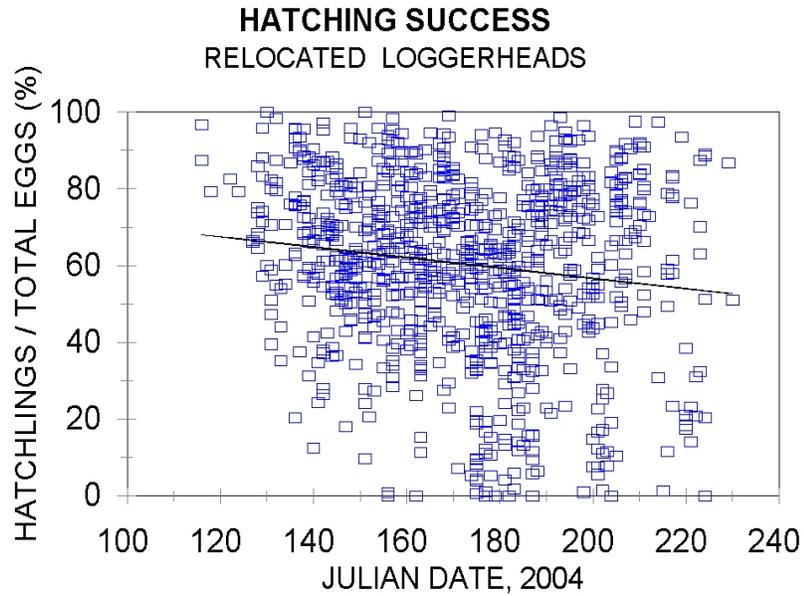


Figure 10: Comparison of seasonal hatching success for relocated and *in situ* loggerhead nests during 2004.

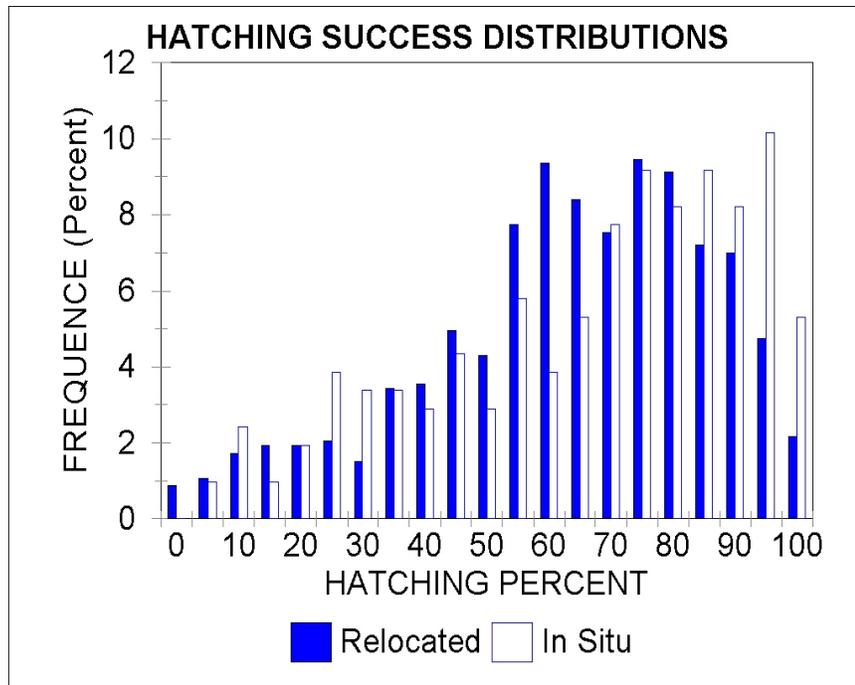


Figure 11: Hatching success frequencies for *in situ* and relocated loggerhead nests in 2004.

the significance level declined from last year when the Z statistic was 9.85.

Figure 12 illustrates the historical patterns of the yearly hatching success of all species combined, since 1981. Overall hatching success of all relocated nests (59.4 %) declined 6.3 points from last year, while the combined success of *in situ* nests dropped by 13.8 points to 65.8 percent.

Table 7 compares emergence success and the percentages of hatchlings and eggs in the post-hatching evaluation categories for relocated and *in situ* loggerhead nests. Tables 8 and 9 give the same results for greens and leatherbacks, respectively.

HATCHING SUCCESS

HISTORICAL PATTERN

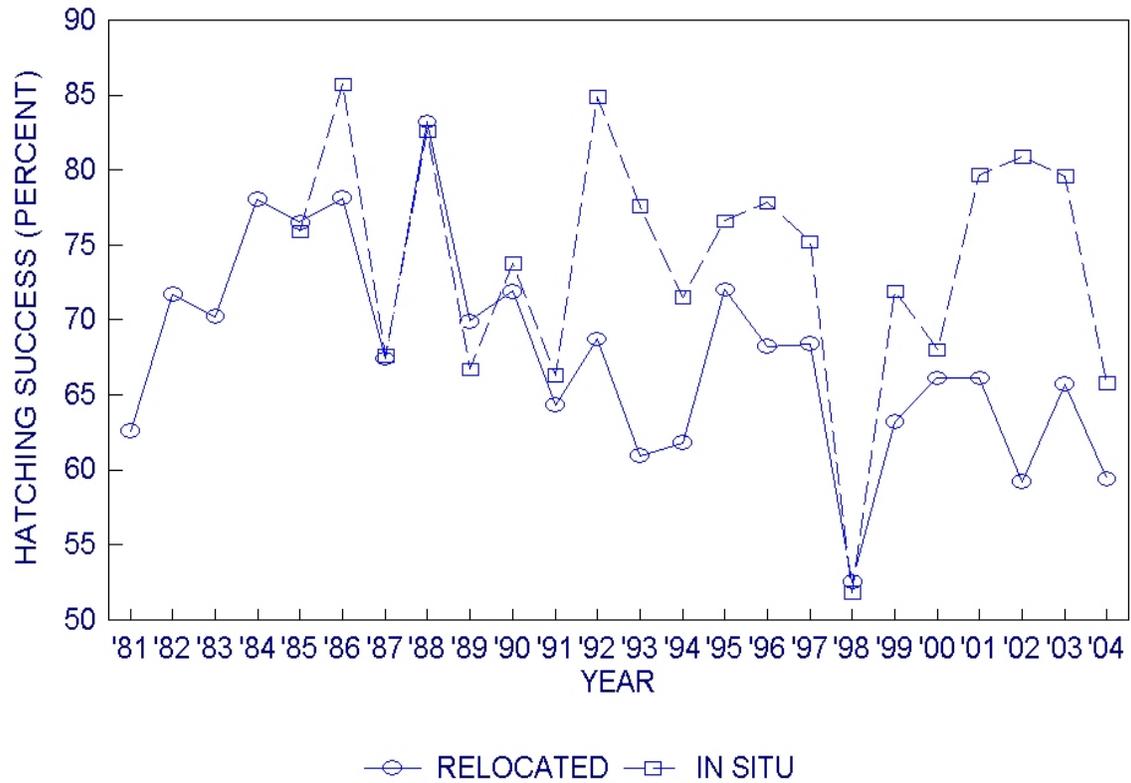


Figure 12: The historical patterns of yearly hatching success for all evaluated *in situ* and relocated sea turtle nests, since 1981.

Table 7: Accounting of the status of all hatched and unhatched eggs in evaluated *in situ* and relocated loggerhead nests during 2004.

Location	Total Eggs	Emerged Hatchlings (%)	LIN (%)	DIN (%)	PIP Live (%)	PIP Dead (%)	VD (%)	NVD (%)
<i>In situ</i> Nests								
Hillsboro Beach	12868	51.1	4.3	1.6	0.4	5.2	20.0	17.5
Pompano Beach	7065	66.4	5.5	1.6	0.6	8.3	12.1	5.6
Ft. Lauderdale	2241	70.3	5.6	2.1	0.5	2.1	11.8	7.5
Hollywood Beach	349	70.2	13.8	2.0	0.6	5.4	3.7	4.3
<i>Overall In situ</i>	22523	58.4	4.9	1.7	0.4	5.8	16.4	12.5
Relocated Nests								
Hillsboro Beach								
BH	256	74.6	0.8	0.0	0.8	5.1	11.7	7.0
BH900s	4554	43.5	3.4	2.5	0.4	5.7	16.9	27.7
BH1000s	297	74.7	0.3	2.0	0.0	4.0	5.4	13.5
BH1100s	785	53.8	3.9	1.3	1.1	3.4	10.4	26.0
BHR22	1948	53.7	5.5	2.8	0.4	9.5	15.5	12.6
<i>Overall Hillsboro</i>	7840	49.3	3.8	2.4	0.5	6.3	15.3	22.6
Pompano Beach								
BP1	25271	49.6	10.6	3.4	1.7	14.6	9.1	10.9
BP2	25740	53.6	7.6	4.8	1.3	10.8	9.5	12.5
BP3	26672	36.2	10.5	4.1	1.8	13.8	17.6	16.1
<i>Overall Pompano</i>	77683	46.3	9.6	4.1	1.6	13.1	12.2	13.2
Lloyd Park Beach	1730	76.9	1.9	0.9	0.2	2.4	11.8	5.8
Hatcheries								
Pompano	6932	50.1	10.9	5.3	1.2	16.7	8.1	7.7
Ft. Lauderdale	4945	58.4	13.3	2.9	1.6	10.9	7.6	5.4
Hollywood	3528	65.4	12.4	1.9	1.9	7.4	5.7	5.3
<i>Overall Hatchery</i>	15405	56.3	12.0	3.8	1.5	12.7	7.4	6.4

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 2004. Abbreviations as in Table 7.

Location	Total Eggs	Emerged Hatchlings (%)	LIN (%)	DIN (%)	PIP Live (%)	PIP Dead (%)	VD (%)	NVD (%)
<i>In situ</i> Nests								
Hillsboro Beach	1870	76.1	4.2	1.1	0.3	2.2	6.7	9.4
Pompano Beach	521	77.4	1.5	1.3	0.0	2.1	6.9	10.7
Ft. Lauderdale	841	81.6	2.1	9.4	0.1	0.2	1.2	5.4
<i>Overall In situ</i>	<i>3232</i>	<i>77.7</i>	<i>3.2</i>	<i>3.3</i>	<i>0.2</i>	<i>1.7</i>	<i>5.3</i>	<i>8.6</i>
Relocated Nests								
Hillsboro Beach								
BHR22	116	37.1	10.3	0.9	2.6	9.5	17.2	22.4
Pompano Beach								
BP2	117	81.2	1.7	0.9	0.0	6.8	4.3	5.1
BP3	257	65.4	7.0	0.0	0.4	6.2	2.3	18.7
<i>Overall Relocated</i>	<i>490</i>	<i>62.5</i>	<i>6.5</i>	<i>0.4</i>	<i>0.8</i>	<i>7.1</i>	<i>6.3</i>	<i>16.3</i>

Table 9: Accounting of the status of all hatched and unhatched eggs in investigated *in situ* and relocated leatherback nests during 2004. Abbreviations as in Table 7.

Location	Total Eggs	Emerged Hatchlings (%)	LIN (%)	DIN (%)	PIP Live (%)	PIP Dead (%)	VD (%)	NVD (%)
<i>In Situ</i> Nests								
Hillsboro Beach	111	65.8	18.9	5.4	0.0	1.8	0.9	7.2
Pompano Beach	107	28.0	0.9	0.0	0.0	0.0	7.5	63.6
Ft. Lauderdale	101	55.4	9.9	0.0	0.0	1.0	22.8	10.9
<i>Overall In situ</i>	<i>319</i>	<i>49.8</i>	<i>10.0</i>	<i>1.9</i>	<i>0.0</i>	<i>0.9</i>	<i>10.0</i>	<i>27.3</i>
Relocated Nests								
None								

DISCUSSION

Yearly Nesting Trends

The number of sea turtle nests deposited in a given year depends on the number of adult females in the nesting population, the fraction of the population that nests in that particular year and the average number of clutches deposited per year by each nesting female. Although this year's decline in loggerhead nesting appears ominous, normal fluctuations in the latter two factors can still explain the nesting decrease. The number of loggerhead nests has declined by almost 32 percent since 2000. However, the average loggerhead clutch frequency varied from 2.81 to 4.18 nests per female per year over a ten-year period on Little Cumberland Island (Frazer and Richardson, 1985). If the clutch frequency in 2000 was at the upper end of this range, the 2674 nests would have been laid by 640 females. If the same 640 females each deposited an average of 2.81 nests, the total would be 1798, which is slightly less than the 2004 nest count. In addition, the interval between nesting migrations for an individual female can range from 1 to 9 years, depending on the time required for sufficient fat reserves to accumulate for vitellogenesis (Miller, 1997). Fluctuations in the remigration interval could easily explain this year's decline.

The large decrease in loggerhead nesting that occurred in 1997 (Fig. 3) may have been due a fluctuation in one or both of these factors because nesting rebounded the next year. However, the fluctuating downtrend observed since 2000 is unprecedented and we should also begin to consider the possibility that it may also suggest a decline in the size of the locally nesting female population. Table 10 compares the

numbers of dead or debilitated turtles documented in Florida from January 1 through July 31, 2003 with the same period for each of the previous 10 years (FFWCC memo, Sept. 23, 2003). The number of stranded loggerheads in 2003 was 88 percent (4 standard deviations) above the previous ten-year mean. If overall mortality has sharply

Table 10: Dead or debilitated sea turtles documented in Florida in 2003, compared with the previous 10 years. Sea Turtle Stranding and Salvage Network monthly update (January 1, 2003 - July 31, 2003).

Species	2003	'93 - '02 Average	% Increase (+) or Decrease (-)	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993
Loggerhead	742	394.3	+ 88 %	520	520	464	330	395	377	423	345	286	283
Green Turtle	333	219.9	+ 51 %	271	303	226	173	215	174	334	248	156	99
Kemp's Ridley	86	56.4	+ 52 %	77	73	82	58	55	49	67	58	28	17
Hawksbill	29	19.4	+ 49 %	21	42	16	25	9	17	17	14	15	18
Leatherback	20	14.1	+ 42 %	24	14	15	10	10	6	18	13	12	19
Unidentified	33	20.2	+ 63 %	16	20	23	14	18	29	31	17	15	19
TOTALS	1243	724.3	+ 72 %	929	972	826	610	702	652	890	695	512	455

Tony Redlow. Florida Fish and Wildlife Conservation Commission Memorandum. September 23, 2003.

increased (only partially reflected in stranding data) this may be reflected in declining nest counts. We hope that this is not the case.

A significant fraction of the green turtle population continued to follow their well established two year nesting interval causing alternating high and low nesting years. Nesting increased this year as expected (Fig. 3). However, fewer nests were deposited this year than any high-nesting year since 1996 and more nests were laid in 2003 than in any previous low-nesting year. This pattern also appeared in 1995 and 1996 when nesting was relatively high for a low nesting year (1995) and relatively low for the following high nesting year (1996). Perhaps some females deviated from the two year cycle and nested a year earlier than most of the population.

Leatherbacks have not failed to nest in Broward County since 1982, but nest counts remain very low. The minimum interval between leatherback nests this year was 11 days. Since the minimum interesting interval for this species is 9 days (Eckert et al., 1989; Miller, 1997) the four nests could have been deposited by a single individual.

Seasonal Nesting Patterns

Except for the magnitude of the nest counts and a slightly later beginning and earlier end, the seasonal loggerhead nesting pattern (Fig. 4) was very similar to last year. The curve was relatively symmetrical and with the midpoint of the season in mid to late June. Peak nesting occurred on 23 June, when 45 nests were deposited. In 2003, maximum nesting occurred on June 25, when 58 nests were found. 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 decreased by 17.1 percent in Hillsboro Beach where erosion is increasing in severity but this decline was less than the countywide decrease of 22 percent.

The seasonal pattern of green turtle nesting in 2004 (Fig. 6) was similar to other high nesting years (Burney and Ouellette, 2002) with nesting beginning in mid May and ending in late September. Maximum nesting occurred on 24 June when 8 nests were deposited countywide. Leatherbacks again nested earlier in the season, from late March to early May.

As in previous years, green turtles nested most heavily in Hillsboro Beach (Fig.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,

were nesting was statistically equivalent. This pattern was identical to last year. No green turtle nests were deposited in Hollywood, which was also the case in 2003. Only one green turtle nested in Lloyd Park in 2003, but there were 21 nests this year. In previous years, nesting densities in Lloyd Park have equaled or exceeded Hillsboro Beach (Burney and Ouellette; 2001, 2002). Leatherbacks nested only in north and central Broward County, with no nesting in Lloyd Park or Hollywood. There has been lower leatherback activity on these beaches for the last four years (Burney and Ouellette, 2001, 2002, 2003).

Countywide 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). Low nested zones are generally characterized by high levels of artificial lighting and nocturnal human activity. (Mattison, 2002).

Green turtles again demonstrated their apparent preference for darker beaches with less nocturnal disturbance but the number of nests has never been large enough to establish such a detailed horizontal nesting pattern (Fig. 8). The same is true for leatherbacks.

Nesting Success

Overall, loggerhead nesting success (Fig. 9, Table 4) decreased from 46.0 percent in 2003 to 36.1 percent this year. This is partially due to this years inclusion of non-nesting crawls that did not extend above the high tide line in the total false crawl count. Without these crawls, overall

loggerhead nesting success was 42.0 percent. Nesting success tended to be higher in the north and central regions, but there was a large amount of statistical overlap between the beaches. Green turtle nesting success fell from 61.4 percent last year to 40.9 percent in 2004. This value rose to 46.1 percent when only false crawls extending above the high tide line were considered. Some beaches have experienced large declines in nesting success over the last few years and some have remained relatively constant. Figure 13 shows the nesting success trends for the five beaches over the last 5 years. Nesting successes on all beaches seems to be trending downward but it seems most severe in Hillsboro Beach and Hollywood. Both beaches have severely eroded sections. Nesting success in Lloyd Park and Pompano Beach remained fairly constant during the previous four years and then declined this year. As in past years, there was no apparent relationship between the countywide loggerhead nest distribution (Fig. 8) and the pattern of nesting success in the 128 zones (Fig. 9) indicating that nesting locations are selected before the crawl begins. Females do not crawl randomly onto the beach and then determine the suitability of the site because this would produce a direct relation between the nesting and nesting success patterns. Nesting success on Hollywood beach was erratic, due to the very low numbers of nests and false crawls in some of the zones.

Hatching Success

The percentage of loggerhead eggs that produced live released hatchlings was 4.3 percentage points lower in relocated nests than in nests left *in situ* (Table 6) but this was much lower than last years difference of 14.1 points. Most of the convergence in the successes of *in situ* and relocated

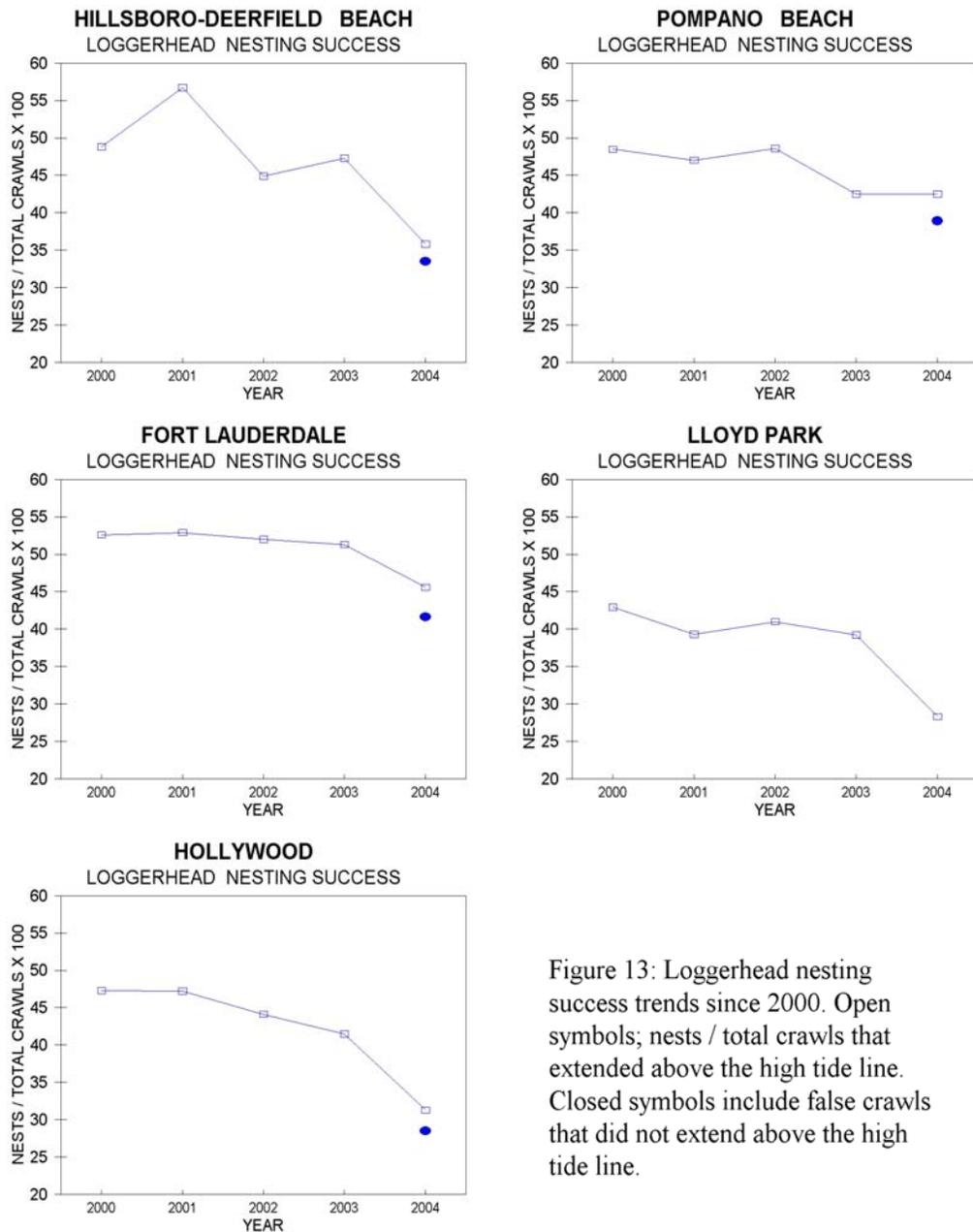


Figure 13: Loggerhead nesting success trends since 2000. Open symbols, nests / total crawls that extended above the high tide line. Closed symbols include false crawls that did not extend above the high tide line.

nests was due to a large, but not unprecedented decrease in the success of *in situ* nests (Fig. 12). Hatching successes of relocated loggerhead nests showed the usual seasonal decline but no significant trend was detected for *in situ* nests (Fig. 10). The seasonal hatching success plot for *in situ* nests usually shows a downtrend similar to relocated nests (Burney and Ouellette, 2003). Early season nests usually have high hatching rates

(>80%) with the proportion of medium and low hatching nests increasing as the season progresses. In 2004, more early-season *in situ* nests hatched at medium and low rates, which flattened the trend and reduced the overall hatching success. In addition, some late season *in situ* nests which often have lower hatching rates were not evaluated because their stakes were washed away by Hurricane Frances. Stake washout also occurred at the Pompano Beach relocation sites, but detailed maps of nest placement (Appendix 3) allowed for the evaluation of many late season nests. This could have contributed to the overall difference in the success of relocated and *in situ* nests.

The hatching success frequency plot (Fig. 11) shown the usual higher percentages of nests with hatching rates of 80 percent or more but frequencies in these categories were less than 10 percent which was considerably lower than last year. There were also unusually high percentages of *in situ* nests hatching at medium or low rates. In 2003, *in situ* nests had frequencies of 1 percent or less in all hatching success brackets below 40 percent. Some were much higher in 2004. The frequencies for relocated nests in these categories were also slightly elevated. The medians of the seasonal distributions of the numbers of evaluated relocated and *in situ* nests were still significantly different (Mann Whitney U test, $P = 0.005$), possibly due to the evaluation of more late season relocated nests, but the *in situ* distribution suggests that incubation conditions may have less suitable this year.

As was found in 2003, the emergence success of loggerhead hatchlings from nests relocated to Pompano Beach (BP1-3) was lower than *in situ* nests (Table 7). This difference was partially offset by the

greater percentages of live in nest and live pipped hatchlings in hatchery nests.

Figure 14 compares the seasonal pattern of LIN and DIN counts in *in situ* and relocated loggerhead nests. Relocated nests showed late season pulses in both categories that were not as evident in *in situ* nests.

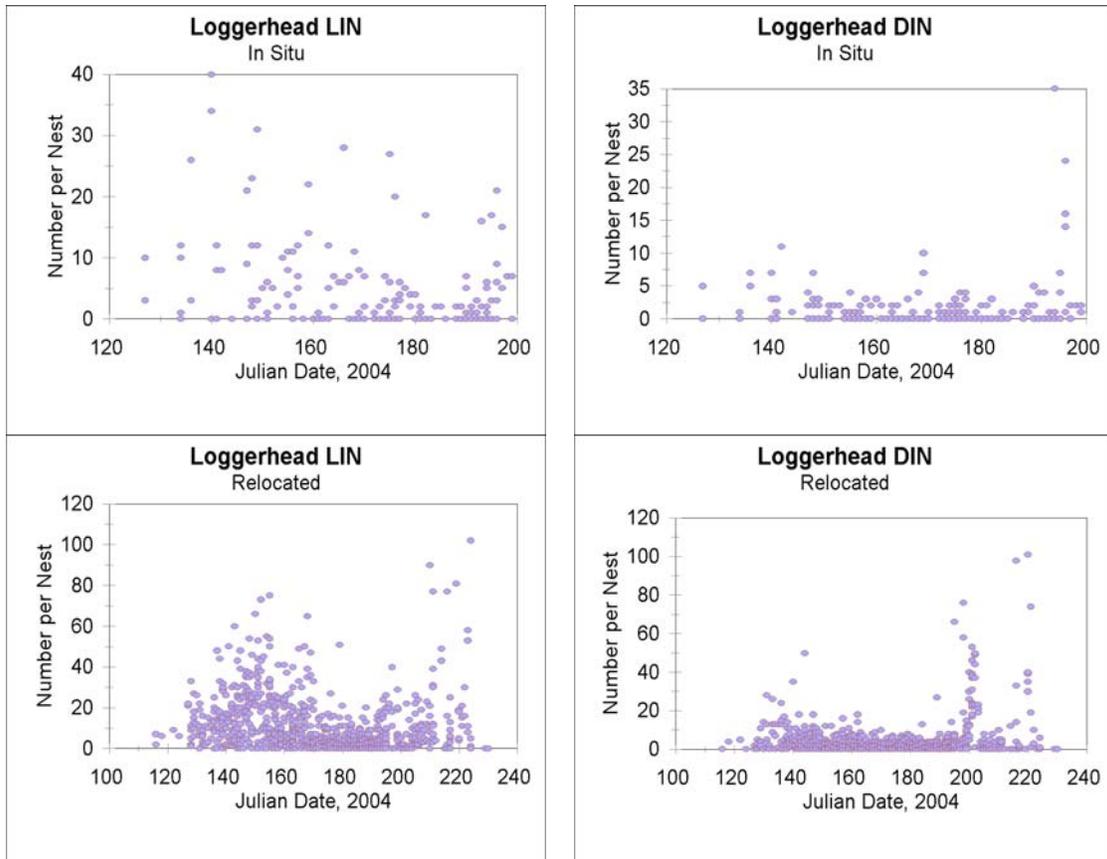


Table 14: Comparison of the numbers of live (LIN) and dead (DIN) hatchlings found in *in situ* and relocated loggerhead nests

Relocated nests that were laid around Julian day 200 (July 18) were adversely impacted (buried) by Hurricane Frances. This also probably caused the smaller increase in DIN for *in situ* nests laid just before Julian day 200. The second DIN pulse from relocated nests deposited around Julian day 220 (August 7) was caused by Hurricane Jeanne. The higher late season LIN counts in relocated nests were due to the increased excavation activity at the relocation sites to rescue buried hatchlings. As

in previous years, pipped-dead and NVD accounted for double digit percentages at all the Pompano Beach relocation sites and the fenced hatcheries except at Hollywood, but the percentages of pipped-dead were generally lower than last year. Since relocated nests were placed at least four feet apart and the Pompano Beach relocation sites were moved slightly from their locations last year, 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.

Comparison of the post emergence nest evaluation categories in relocated and *in situ* green turtle nests (Table 8) shows that the lower emergence rates in relocated nests were primarily due to increased percentages of PIP-dead and NVD. The overall LIN rate in relocated nests was twice that in *in situ* nests, but the numbers were low. Comparisons are tenuous because only 4 relocated nests were evaluated.

The overall hatchling emergence rate from the three evaluated leatherback nests was about 10 percentage points lower than last year. LIN, VD and NVD were the largest unemerged categories. There were no total nest failures in 2004 and no leatherback nests were relocated.

For several years our main relocation sites have been in Hillsboro Beach. Beach erosion has totally eliminated some of these areas and is threatening the others. Beach access by ATV from our storage location at the Hillsboro Club is now impossible. This has forced us to move our main relocation sites to the darkest accessible areas of Pompano Beach, but there was considerable hatchling misorientation due to lights. Next year we are planning for night patrols to minimize hatchling loss but this is only a stopgap measure. Two things are needed to insure the effectiveness of sea turtle conservation in Broward County. Beach

renourishment is essential to reestablish nesting habitat and restore suitable relocation sites in dark areas of Hillsboro Beach. Increased enforcement of coastal lighting regulations is needed to reduce the number of nest relocations that are required.

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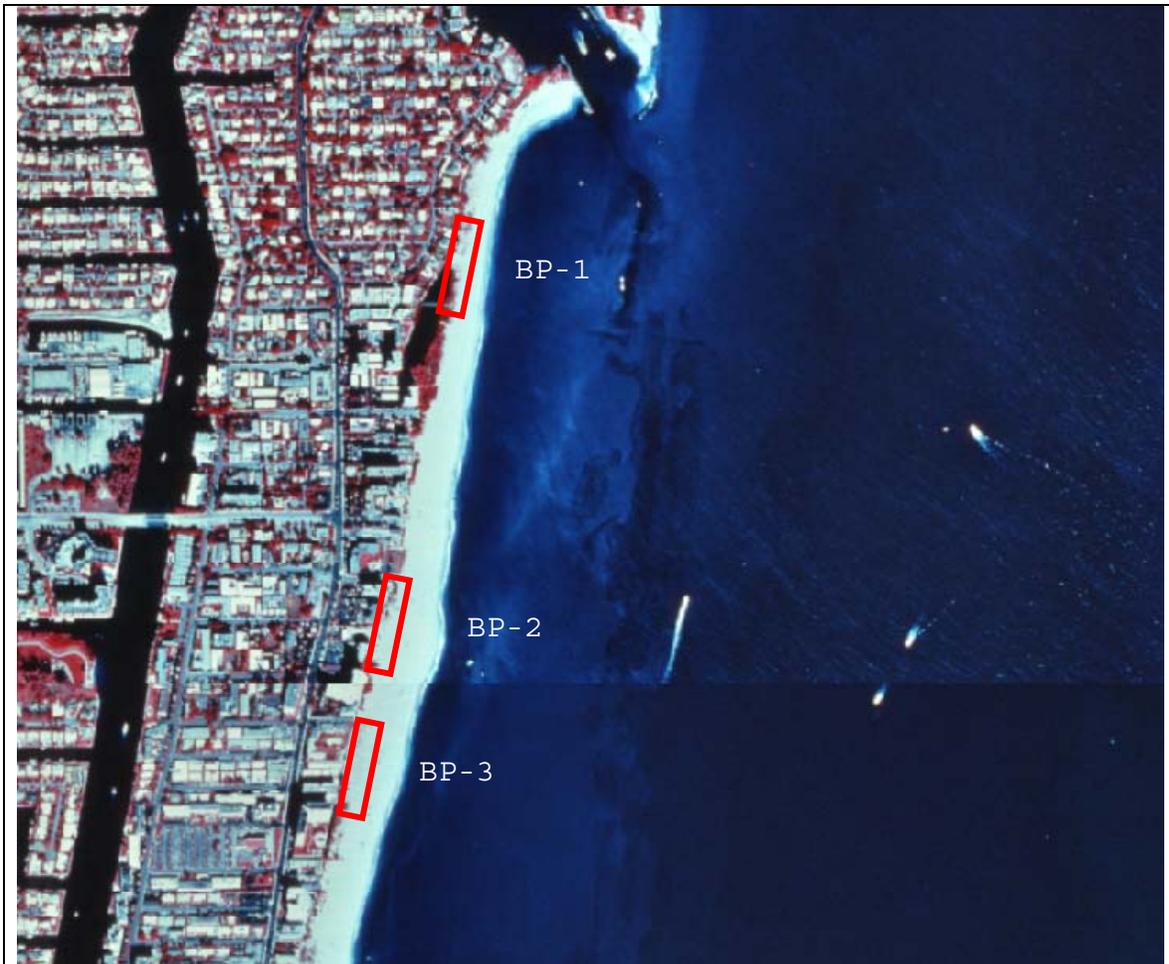
APPENDIX 1: Summary of sea turtle hot-line calls.

SUBJECT	HOT-LINE
ATV ACCIDENTS	3
LIVE STRANDINGS	3
DISORIENTATIONS	25
NEST LOCATIONS	50
POACHING	1
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, and any schools that were visited. Flyers were also distributed to people touring the Oceanographic Center or requesting information by telephone or mail, by brochure holders on all fenced hatcheries and at the 2004 Sea Turtle Symposium in Costa Rica.

Public education talks were conducted on Wednesday and Friday evenings from July 7 to Sept. 3 at the Anne Kolb Nature Center. These slide show presentations were followed by hatchling releases near Greene St. and Cody St. in Hollywood. Turtle talks were also given to groups for a Women's Group at Century Plaza in Pompano and several schools throughout Broward County.



Appendix 3: Precise locations of the open beach hatcheries in Pompano Beach. Each area was divided into two subsections designated A and B, which were 100 feet apart. Hillsboro Inlet is at the top. The northerly and southerly limits of this area are shown in Figure 1C. The nest placement within each subsection follows.

Appendix 4: Sea turtle nest warning sign. Black lettering on yellow background. Actual size is 5.5" X 8.5".



Appendix 5: Sea Turtle Summary Report Forms.