DISCUSSION

Yearly Nesting Trends

This year's loggerhead nest count recovered from last year's loss. The unprecedented two-year decline that 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 line for yearly loggerhead nesting since 1990 is almost flat and its slope is not significantly different from zero (P = 0.141). Fluctuations since 1990 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, were 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).

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). 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 (Mattison, 2002).

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 were no statistical differences countywide. 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.

Hatching Success

The percentage of loggerhead eggs that produced live released hatchlings was 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 numbers 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) were similar to previous years (Burney and Ouellette, 2001,2002). 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.

Table 7 shows that the emergence success of loggerhead hatchlings from nests relocated to Pompano Beach (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 was not 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, but the eggs showed no signs of embryonic development.

The severity of erosion in Hillsboro Beach has increased since 2002. 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 with minimal beachfront lighting, as

determined by monthly beach lighting surveys. Still, there were 90 hatchling misorientation events involving the 890 relocated and 83 *in situ* nests in these zones. Some of these events may have been due to urban sky glow on cloudy nights, but the misorientation reports most frequently cited lights from hotels, condominiums, resorts and streetlights as the causes.

There is now a critical shortage of suitable relocation sites. Some progress in lighting reduction was made this year, but beachfront lighting remains a serious 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. This would improve hatching success and enhance the long-term success of sea turtle conservation in Broward County.

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