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THE RELATIONSHIP OF LOGGERHEAD NESTING PATTERNS AND MOON PHASE IN BROWARD COUNTY, FLORIDA

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Several authors have attempted to relate sea turtle nesting patterns with lunar or tidal phases. Some have reported that no such relationships exist (Baldwin and Lofton, 1959; Davis and Whiting, 1977). Talbert et al. (1980) found higher loggerhead nesting densities near the times of the new and full moons (spring tides) during one year, but not the following season. Fretey and Girondot (1989) reported a similar visual correlation of moon phase and leatherback nesting densities on one part of Ya:lima:po beach (French Guiana) but not on other sections. Certainly, factors including (but not limited to) tidal and nontidal currents, offshore beach obstructions, beach slope, weather conditions and human disturbance could account for some of this lack of consensus. Inconsistent methods of data analysis may also play a role. This report outlines the data analysis used to reveal a statistically significant relationship between moon phase and nightly loggerhead nesting densities in Broward County.

Sunrise surveys of five beach sections spanning the county (38.6 km) were conducted daily from 21 April to 15 September, 1989 during the Broward County Sea Turtle Conservation Project (Burney et al., 1989). Counts of nests and false crawls were recorded. The raw nesting data were plotted (Figure 1, squares) and smoothed with a three-point centered moving average, which revealed peaks, roughly corresponding to the times of the new and full moons (Figure 1, curve.a). The seasonal trend in this parameter was described with a 10th order polynomial regression (Figure 1, curve b).

Moon phase (M) was quantified using a linear transformation of the moon age. The untransformed moon age parameter, derived from Kepler, a public domain astronomy program, varies from 0 to 1, with 0, .25, .5, .75 and 1 corresponding to the new, first quarter, full, third quarter and new (last waning) moon phases, respectively. M was derived by first multiplying the moon age for each day by 4. The integer portion of each number was subtracted from values with even integers, and 1 plus the integer value was subtracted from values with odd integers. The absolute value of each result was taken. M has a value of 0 on the new and full moons and 1 on the first and third quarter moons, and varies linearly between phases. Burney et al. (1989) used a different transformation based on a sine function of moon age. The current transformation is superior because it varies linearly between moon phases. M was scaled by a factor of 10 for plotting (Figure 1, curve c), but not for correlation analysis. Figure 1 shows a striking inverse visual correlation between the smoothed nesting data (moving average) and M (curves a and c) during peak season (19 May to 6 August).

To quantify this correlation, the polynomial regression value was subtracted from the three-point moving average nest count for each day of the study, to remove the seasonal trend from the latter data. The detrended moving average nesting data were compared to M by linear correlation analysis (Figure 2). Positive points on the ordinate indicate average nesting densities greater than the seasonal trend defined by the polynomial regression. Near the full or new moons (M <.15), all points are positive. Conversely, near the quarter moons (M > .85), all points are negative, indicating average nesting below the seasonal trend. The correlation coefficient (r) was highly significant, confirming the statistical association of moon phase and fluctuations in loggerhead nesting densities in the combined 1989 Broward County data.

The same analyses were conducted on data from the five separate beaches. Correlation coefficients (n=80) and significance levels (P) for one-tailed comparisons of M versus three-point average nesting, as well as total nest for each beach, are given below.

Beach	Total Nests	r	P
Hillsboro	522	-.597	<<.001
Pompano	423	-.253	.012
Ft.Lauderdale	479	-.389	<.001
Lloyd Park	130	-.239	.016
Hollywood	141	-.012	n/s

The relationships were significant at all beaches except Hollywood (including Dania and Hallandale) which had the lowest nesting density (0.103 nests/km/day). The differences in the significance of the relationships may be related to the degree of beach-front development, lighting and nocturnal human disturbance, but this is difficult to quantify. All areas except Hillsboro and Lloyd Park are heavily developed with high-rise buildings and beach-front businesses. A beach renourishment project was in progress at Lloyd Park.

The finding of a statistically significant relationship between moon phase and nightly nesting densities is important for sea turtle conservation program in Broward County (and possibly elsewhere) because intense beach-front lighting and heavy beach use require that most nests (82.1% this year) be relocated. Future coordinators of these very labor intensive projects can anticipate heavier nesting near full and new moons, and allocate personnel and equipment resources more efficiently.

The influence of the moon on sea turtle nesting patterns must operate via the tides. Moon light is clearly not the causative agent because increased nesting also associated with new moons. However, the correlation of the heights of the nocturnal high tides with the smoothed nesting data was not as significant as the moon relationships. We are currently working on a multivariate model involving tide heights, ranges, times and possibly tidal currents.

LITERATURE CITED

Baldwin, W.P.,Jr. and J.P Lofton, Jr. 1959. The loggerhead turtle of Cape Romain South Carolina. In: D.K. Caldwell and A. Carr (coordinators), The Atlantic Loggerhead Sea Turtle, Caretta caretta caretta (L.), in America. Bull. Fla. State Mus. Biol. Sci. 4: 319-348.

Burney, C.M., C. Mattison and L. Fisher. 1989. Sea Turtle Conservation Project, Broward County, Florida. 1989 Report. Broward County Erosion Prevention District, Environmental Quality Control Board, Fort Lauderdale, Florida. 58 pp.

Davis, G.E. and M.C. Whiting. 1977. Loggerhead sea turtles nesting in Everglades National Park, Florida, U.S.A. Herpetologica 33: 18-28.

Fretey, J. and M. Girondot 1989. Hydrodynamic factors involved in choice of nesting site and time of arrivals of leatherbacks in French Guiana, p 227-229, In: S.A. Eckert, K.L. Eckert and T. Richardson (compilers), Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Tech. Memo. NMFS-SEFC-232.

Talbert, O.R., Jr., S.E. Stancyk, J.M. Dean and J.M. Will. 1980. Nesting activity of the loggerhead turtle (Caretta caretta) in South Carolina. I: A rookery in transition. Copeia 1980: 709-718.

Figure 1: The seasonal pattern of the number of daily sea turtle nests (squares) in Broward County, showing the three-point centered moving average (a), and tenth-order polynomial regression trend line (b), compared to M, the moon phase parameter (c). Maxima in M fall on quarter moons; minima indicate full or new moons.

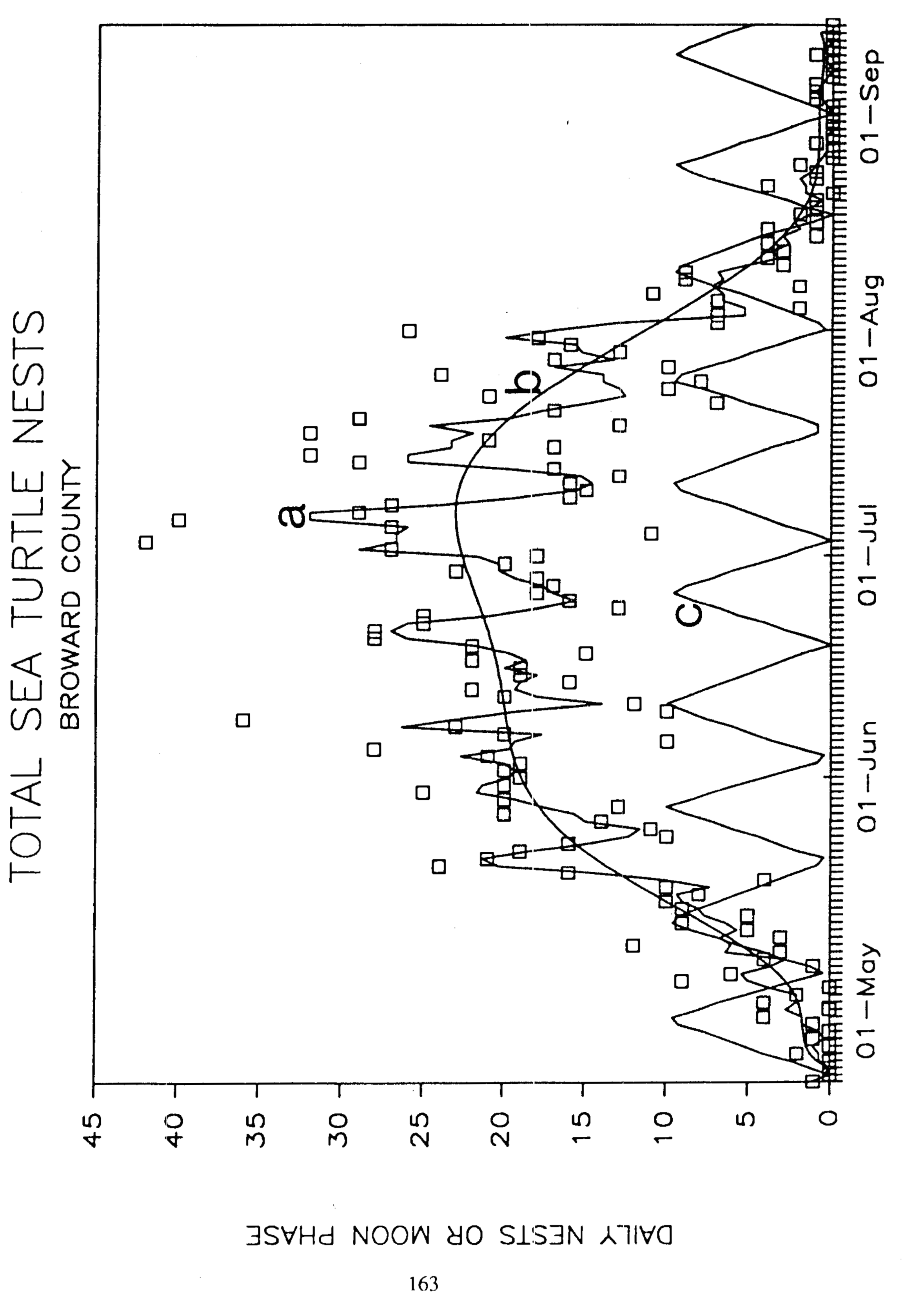

Figure 2: The statistical relationship between the detrended moving average nesting pattern and the moon phase parameter (M), with the linear regression line, correlation coefficient (r), number of data (n) and significance level (P).