Nesting Activities by the Loggerhead (*Caretta caretta*) at Back Bay National Wildlife Refuge, Virginia

Kathryn A. DeGroot and James H. Shaw

Department of Zoology, Oklahoma State University, Stillwater, OK 74078
Received: 1992 Aug 19; Revised: 1993 Feb 17

This paper presents results from a preliminary study on nesting activities of the loggerhead (*Caretta caretta*) at Back Bay National Wildlife Refuge in Virginia Beach, VA. Nesting occurred between May 29 and August 12, 1991. The top layers of eggs in nine nests were at depths comparable to those in loggerhead nests in Florida, near the southern end of the species' breeding range along the U.S. Atlantic coast. Measurements of crawl width along with intervals between nestings indicated that the 9 nests were made by at least six individual females. Comparisons of crawl widths to clutch sizes suggested that the size of female loggerheads is not related to clutch size. The relative importance of loggerhead nests in Virginia is discussed in relation to temperature-related sex determination of offspring and the possible effects of global warming.

INTRODUCTION

Of the six species of sea turtles found along the shores of the United States, five occur in the Atlantic Ocean. All of these are listed as either threatened or endangered (*1*) from pollution, exploitation, poor fishing practices, habitat modification, or some combination thereof. Conservation efforts have been hampered in part by incomplete knowledge of the population dynamics and life histories of sea turtles. Since sea turtles come ashore only to lay eggs, nesting provides a rare opportunity to learn about them (*2*).

The loggerhead, *Caretta caretta*, is the only species of sea turtle nesting off the Atlantic waters of Back Bay National Wildlife Refuge. Although isolated instances of loggerhead nesting have been recorded as far north as New Jersey (*2*), the 7-mile stretch of beach studied occurs near the northern edge of the established nesting range for this species in the U.S. Loggerheads commonly occur during summers in and around Chesapeake Bay, but most of them are immature (*3*).

Like many other reptiles, the loggerhead has temperature-dependent sex-determination during incubation (*4*). Because the loggerhead is a threatened species, any skewing of sex ratios of remaining populations can affect the species' long-term survival prospects. Thus, alterations in the relative amounts of nesting in the northern, middle, and southern beaches along the Atlantic can skew the sex ratio, as could rising temperatures from global warming.

Samples of hatchling loggerheads at Cape Canaveral, FL, over three consecutive years revealed strong female-biases of 87-99.9% (*5,6*). In South Carolina and Georgia, female hatchlings accounted for 80% of loggerheads from clutches laid in early July, the season's peak, to 10% a month later (*7*). These patterns suggest that nesting by loggerheads in Virginia, although much less frequent, could be of particular importance in compensating for heat-induced female biases in offspring produced farther south.

We measured nesting characteristics for loggerheads at the Back Bay National Wildlife Refuge near Virginia Beach, VA, during the summer of 1991. Resulting measurements permitted us to compare depths of nests with those found elsewhere (*2*). We also compared crawl widths (the widths made by nesting females in beach sand) and nesting intervals to estimate the minimum number of female loggerheads nesting during the year at Back Bay NWR.

METHODS

U.S. Fish and Wildlife Service personnel patrol beaches at Back Bay NWR at least once every 24 h during the loggerhead nesting season (May though September). They look for crawls and follow them to locate nests. Eggs from these nests are routinely excavated and moved to sites that protect them from vehicles, predators, and high tides.

We used a metric tape to measure crawl widths at four points: at the tide mark, the nest site, and midway along each of the two crawls, the entrance crawl and return crawl. The average of these four measurements represented the crawl width. As nests were excavated, we measured from the ground level of the sand to the top layer of eggs. Following removal of all eggs, we then measured from the top of the ground level to the bottom of the empty nest.

TABLE 1. Data[a] for loggerhead turtle nests, Back Bay National Wildlife Refuge, Virginia.

Date	Depth of Top level of Eggs, cm	Depth of Bottom of Nest, cm	Crawl Width, cm	Clutch Size
5/29	25.5	96.5	112	145
6/28	28.0	45.5	99	75
7/02	25	53	100	140
7/15	30	60	107	114
7/25	25	50	100.5	91
7/27	31	48	94	113
7/28	30	48	107	136
8/09	20	45	96	93
8/12	25	53	122	124
MEAN	26.6	55.4	104.2	114.6
s.d.	3.5	16.0	8.8	24.3

[a] Measurements were taken on dates given, 1991, within hours of nesting.

RESULTS AND DISCUSSION

The mean depth to the top layer of eggs from nests at Back Bay, 26.6 cm (Table 1), compares closely with the average of 27.9 cm, found for loggerhead nests in Florida (*2*). However, the mean depth at Back Bay NWR of 55.4 cm is 10.9 cm greater than the corresponding average for a Florida sample (*2*). This difference was influenced by the unusually deep nest of 71.0 cm measured on May 29 (Table 1).

Individual females may come ashore to construct nests and lay eggs several times during a season at intervals averaging 13-14 days (*8*). Thus, crawl widths approximately the same size to and from nests deposited at roughly 2-week intervals, could have been made by the same female. Three of the 9 nests could have represented a second visit (i.e., clutches deposited on 7/2 and 7/25, clutches on 7/15 and 7/28, and those on 7/27 and 8/9). These results suggest that at least six females laid eggs at Back Bay NWR, and that no more than half of them laid a second clutch.

The nests in our sample showed no correlation between crawl width and clutch size [($r = 0.49$, $t = 1.4$, $df = 7$, $P > 0.20$) (Table 1)]. This pattern suggests that size (and age in indeterminate growers) may not correlate with egg production. However, carapace lengths of females correlated with egg production at a rookery on the Greek island of Cephalonia (*9*).

Along the Atlantic coast, the proportion of males in samples of loggerhead hatchlings seems to increase with latitude (*6,7*), a pattern predicted on the basis of lower incubation temperatures in more northern beaches. Given the current geographical distribution of breeding, the overall sex ratio may be strongly biased in favor of females, making more northern sites like Back Bay NWR increasingly critical for producing males. This latitudinal pattern, however, is at least partly confounded by variation in sex ratios by season, with higher proportions of males produced from clutches deposited early and late in the nesting season (*7*). Global warming could skew the sex ratios of hatchlings even farther.

ACKNOWLEDGMENTS

We thank the U.S. Fish and Wildlife Service for supporting this work in part through their Cooperative Education Program. We also thank the personnel of the Back Bay National Wildlife Refuge for their critical assistance.

REFERENCES

1. USDI, Endangered and Threatened Wildlife and Plants, USDI Fish and Wildl. Serv. 50 CFR 17.11 and 17.12 (1984).
2. Dodd, C.K., Synopsis of the Biological Data on the Loggerhead Sea Turtle *Caretta caretta* (Linneaus 1758). U.S. Fish and Wildl. Serv. Biol. Rep. **88**(14), 35-82 (1988).
3. Lutcavage, M., and Musick, J.A., Aspects of the Biology of Sea Turtles in Virginia. *Copeia* **1985,** 449-456 (1985).
4. Spotila, J.R., Standora, E.J., and Morreale, S.J., Methodology for the Study of Temperature Related Phenomena Affecting Sea Turtles. U. S. Fish and Wildl. Serv. End. Spp. Rep. **11**, 1-51 (1983).
5. Mrosovsky, N., and Provancha, J., Sex

Ratio of Loggerhead Sea Turtles on a Florida Beach. *Can. J. Zool*. **67**, 2533-2539 (1989).

6. Mrosovsky, N., and Provancha, J., Sex Ratio of Hatchling Loggerhead Sea Turtles: Data and Estimates from a 5-year Study. *Can. J. Zool*. **70**, 530-538 (1992).
7. Mrosovsky, N., Hopkins-Murphy, S.R., and Richardson, J.I., Sex Ratio of Sea Turtles: Seasonal Changes. *Science* **225**, 739-741 (1984).
8. Frazer, N. B., A Model for Assessing Mean Age-Specific Fecundity in Sea Turtle Populations. *Herpetologica* **40,** 281-291 (1984).
9. Hays, G.C., and Speakman, J.R., Reproductive Investment and Optimum Clutch Size of Loggerhead Sea Turtles *(Caretta caretta). J. Anim. Ecol.* **60**, 455-462 (1991).