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Loggerhead Sea Turtle Late Nesting Ecology in Virginia Beach, Virginia

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The loggerhead sea turtle (*Caretta caretta*) is the only recurrent nesting species of sea turtle in southeastern Virginia (Lutcavage & Musick, 1985; Dodd, 1988). Inasmuch as the loggerhead is a federally threatened species, the opportunity to gather data on its nesting ecology is important for establishing appropriate management strategies.

Loggerhead females deposit eggs on a 2-4 year cycle, and produce an average of 1-7 nests in any one breeding season (Ehrhart, 1979; Dodd, 1988; Ernst et al., 1994). Nesting in southeastern Virginia generally occurs from late May through July, with an occasional nest produced in August. Data from other locations in the southeastern United States indicate that eggs incubate for an average of 60-65 days (range = 59-78) in natural and transplanted nests (Ernst et al., 1994), and from 70-85 days in hatchery-reared nests (Mrosovsky & Yntema, 1980; Blanck & Sawyer, 1981).

Temperature-dependent sex determination in loggerheads is well documented (Mrosovsky & Yntema, 1980; Standora & Spotila, 1985; Mrosovsky & Provancha, 1989, 1992). Studies of loggerheads in Florida by Mrosovsky & Provancha (1989, 1992) suggest that hatchling ratios are strongly female-biased, and Georgia and South Carolina populations produce female-biased hatchlings (Mrosovsky et al., 1984). Pivotal incubation temperatures are 29-30 C; males are produced at cooler temperatures and females at warmer temperatures (Mrosovsky & Provancha, 1992). Given the generally cooler temperatures found in northern climates, it is possible that loggerhead nests in southeastern Virginia (where mean sand temperatures are approximately 27-28 C) are a source of male hatchlings (DeGroot & Shaw, 1993).

Data on loggerhead nesting ecology on the beaches of Back Bay National Wildlife Refuge (BBNWR), Virginia Beach, Virginia and adjacent beaches immediately north and south of BBNWR have been gathered since 1970. Beginning in 1993, funding from the U. S. Army Corps of Engineers, Norfolk, Virginia, has provided salaries for trained U. S. Fish and Wildlife Service personnel at BBNWR to conduct daily patrols along a 16-24 km stretch of beach from May through August. Patrol personnel searched for turtle crawls and nests. Environmental data (e.g., temperature of air and sand,

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weather conditions, and location), as well as data on turtle crawl dimensions (e.g., length and width), were taken at the nesting site. All nests were then excavated and the eggs transported to a protected beach location at BBNWR where they were placed in an artificial nest with the identical dimensions as the original and in the same intra-nest location (i.e., egg deposition order was maintained) from which they were collected (DeGroot & Shaw, 1993; Cross et al., 1998).

Given the cool temperatures associated with the incubation of loggerhead eggs in southeastern Virginia (DeGroot & Shaw, 1993), clutches produced in the month of August ("late nests") were at risk due to excessively cold temperatures through October, when hatchlings would be expected to emerge. To reduce nesting mortality, late nests were excavated from their protected location (generally during September), placed into artificial nesting containers, and removed to a heated building. The sand in the nest was maintained at approximately 27-28 C, which represented the temperature of a natural nest on the BBNWR beach. Hatchlings from these nests were later released at their natal beach (Cross et al., 1998). It should be noted that we were not providing a "head-start" program, as was strongly recommended against by Frazer (1992); turtles were released immediately after hatching.

Hatching success was high for the 1995 late nest, and for the first late nest of 1996; however, the second late nest of 1996 had low hatching success (Table 1). It should be noted, however, that all fertile eggs hatched (by inspection of all eggs in the nest), and that all hatchlings were vigorous upon release.

Because of cool sand temperatures in September, the incubation period was nearly 20 days longer than average for late nests (1995 mean = 62 days, n = 8; 1995 late nest = 81 days; 1996 late nests = 80 and 81 days -- these were the only two nests produced in 1996). The incubation period associated with eggs exposed to cool temperatures lasts as long as 3.5 months, resulting in very low hatching success (Blanck & Sawyer, 1981). Moving the eggs to an artificial incubation chamber when sand temperatures were low (<23 C) for 2-3 consecutive days greatly increased hatching success. The additional 20 days of incubation time did not appear to affect hatching success.

Mean incubation temperatures were below the pivotal range of 29-30 C reported by Mrosovsky & Provancha (1991) for loggerheads in the southeastern United States, suggesting that southeastern Virginia may be an important source of male hatchlings. However, no hatchlings were sacrificed to determine sex and we can only speculate that the majority of hatchlings from BBNWR were males. Of course, to maintain a nesting population, some females must also be produced, and the recurrent nesters at BBNWR provide evidence that this is the case.

The decision to move nests to a protected location at BBNWR was based on our belief that a sound management strategy for the loggerhead was to ensure that we maximized the number of hatchlings produced while striving for management activities that would reduce natural mortality in this species. Though this type of active management activity is controversial, we believe our strategy is justified for several reasons: (1) The beaches at BBNWR are very narrow compared to more southern nesting locations. Therefore, there is a high

TABLE 1.—Late nesting data for the loggerhead sea turtle (*Caretta caretta*) in 1995 and 1996 at Back Bay National Wildlife Refuge, Virginia Beach, Virginia. Hatching success is the ratio of total number of hatchlings released to the total number of eggs produced, expressed as a percentage.

Nest construction date	Nest hatching date	Number of eggs produced	Number of eggs hatched	Number of infertile eggs	Number of hatchlings released	Hatching success (%)
14 Aug 1995	03 Nov 1995	84	81	3	79[a]	94
07 Aug 1996	25-26 Oct 1996	123	109[b]	10	109	88
09 Aug 1996	26-29 Oct 1996	138[c]	57	80	57	42

[a]Two hatchlings died prior to release.

[b]Four dead hatchlings were found in the nest.

[c]One egg was donated to the Virginia Institute of Marine Science (Gloucester, Virginia) for genetic study.

probability that nests will fail due to being seaward of (or on) the beach debris line, and hence be destroyed during high tide. (2) Given that part of the beach we monitor for nests is in a popular summer vacation area, nests potentially can be destroyed by beach landscaping activity and heavy foot traffic. (3) The beaches at BBNWR are open to wildlife- oriented activities (e.g., fishing, wildlife viewing, etc.). Additionally, special use permits allow some North Carolina residents to make limited vehicle trips on the beach. Both of these activities, neither of which can be eliminated, increase the probability of nest failure. (4) BBNWR is at the northern limit of the loggerhead's nesting range (DeGroot & Shaw, 1993), and hence few nests are produced on our beach. Therefore, our desire is to manage for high hatching success with the goal of increasing the number of nests on the beaches of BBNWR, to educate the public about the importance of reducing beach impacts, and to increase public awareness and participation in conservation efforts.

Moving turtle nests and the use of artificial incubation chambers for late nests has proven successful at BBNWR. If southern populations of loggerheads produce female- biased clutches, then enhancing the survival of loggerheads in more northern regions, which presumably produce more males, is an important step in the management of this species. Given the uncertainty of genetic diversity in Virginia loggerhead populations, limited knowledge of reproductive ecology in this region, and the importance and influence of multiple paternity in this species (Harry & Briscoe, 1988; Bollmer et al., 1999), management strategies should focus on enhancing survivorship of all nests in Virginia. If moving nests to protected locations, and artificially incubating late nests increases hatching success in our geographical area, then this program has contributed to the conservation and recovery of the threatened loggerhead.

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