

LIFE HISTORY OF THE LOGGERHEAD SEA TURTLE, *CARETTA CARETTA* (REPTILIA: CHELONIIDAE), IN THE ATLANTIC

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With 1 figure

ABSTRACT: The life history of the loggerhead sea turtle (*Caretta caretta* LINNAEUS, 1758) in the Atlantic is reviewed with special emphasis on recent research on the pelagic-stage. The pelagic-stage loggerheads in the eastern Atlantic are believed to be an early life history stage of the nesting population of the southeastern U.S.A. This relationship is based on complementary size class distributions and mitochondrial DNA analyses now underway. Movement patterns with respect to the North Atlantic Gyre system are substantiated by recaptures of tagged turtles. The duration of the pelagic stage--the time it takes a loggerhead to grow from 5 to 50 cm--is estimated from both recaptures of tagged turtles and length frequency analysis. Both techniques yielded similar estimates of 10-12 years.

LIFE CYCLE OF THE LOGGERHEAD

The loggerhead sea turtle (*Caretta caretta* LINNAEUS, 1758) has a complex life cycle during which the turtles occupy a number of terrestrial and marine habitats, including high-energy beaches and pelagic and benthic foraging grounds. In the Atlantic, the major nesting beaches are in the southeastern U.S. where approximately 50,000 to 70,000 nests are deposited each year during the nesting season from mid-May through August (NATIONAL MARINE FISHERIES SERVICE & U.S. FISH AND WILDLIFE SERVICE, 1991). Copulation takes place in the water off the nesting beaches during the early part of the nesting season.

Female loggerheads come ashore at night to excavate nest cavities approximately 60 cm deep in the sand (DODD, 1988) into which they oviposit a mean of 115 eggs (EHRHART, 1982). The nesting process takes about 1.5 hr (HAILMAN & ELOWSON, 1992). Each female nests 3 to 4 times during each nesting season (FRAZER & RICHARDSON, 1985) at approximately 14-day intervals (HIRTH, 1980). Females are not reproductively active every

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year; rather, they reproduce at intervals of two or more years (DODD, 1988).

Egg clutches incubate for 49 to 76 days, depending on temperature (DODD, 1988). Hatchlings (4.5 cm carapace length) emerge, usually at night (WITHERINGTON et al., 1990), and move rapidly to the ocean. When they enter the water, they begin to swim rapidly away from the shore. They swim nearly continuously for 24 to 36 hours (WYNEKEN & SALMON, 1992) which, it is believed, takes them far enough offshore so that they are incorporated into the Gulf Stream Current (WITHERINGTON, 1994). It is hypothesized that those post-hatchlings that are in the eastern-most portion of the Gulf Stream become incorporated in the Azorean Current, and eventually the North Atlantic Gyre system (CARR, 1986, 1987). This gyre system would carry the turtles from the southeast U.S. waters, past the Azores, Madeira, Canary Islands, and, perhaps, the Cape Verde Islands, before bringing them back to the western Atlantic. During this period, the turtles are often associated with sargassum weedlines in regions of convergences, drift-lines or frontal zones in which they find food and shelter.

Loggerheads do not reappear in the western Atlantic until they reach a size of 50 to 55 cm carapace length. At that time, they enter benthic foraging habitats and feed on a variety of benthic invertebrates (MORTIMER, 1982). They grow slowly (FRAZER & EHRHART, 1985) until they reach sexual maturity at a minimum straight carapace length of 81 cm (WITHERINGTON, 1986) and make their first migration to the nesting beach.

RESEARCH ON PELAGIC-STAGE LOGGERHEADS IN THE EASTERN ATLANTIC

For many years, the location of loggerheads between 5 and 50 cm carapace length was a mystery and Carr referred to this lifestage as the "lost year" (CARR, 1986, 1987). We now believe that the loggerheads in the eastern Atlantic are part of the population that reproduces in the southeastern U.S. The first line of evidence in support of this hypothesis is the size distributions of loggerheads in the eastern and western Atlantic. As can be seen in Figure 1, the size distributions from the two regions are complementary.

The data on size distribution of loggerheads in the eastern Atlantic are derived from a collaboration we established with the commercial tuna fleet based in Horta, Azores, in 1990. From 1990 through 1992, the tuna fleet tagged and measured over 700 loggerheads in the waters around the Azores. The size distribution of loggerheads did not vary among years (BOLTEN et al., 1993). Thus, we can conclude that small turtles recruit to the eastern Atlantic each year and larger turtles (50-55 cm carapace length) leave the eastern Atlantic, presumably for benthic foraging grounds in the western Atlantic.

The second line of evidence is based on population genetics. Preliminary analysis of mitochondrial DNA (mtDNA) restriction fragment length polymorphisms (RFLP) has provided initial confirmation that the loggerheads in the eastern and western Atlantic belong

to the same population. We are now evaluating the mtDNA sequence patterns to confirm this relationship (BOLTEN et al., in prep.).

The third line of evidence is based on recaptures of tagged sea turtles. Each leg of the hypothesized travel route in the North Atlantic Gyre system has been documented by recapture of a tagged turtle. A loggerhead tagged in Madeira in June 1990 was recaptured in the Canary Islands in February 1993 (BJORNDAL et al., 1994). A loggerhead tagged in the Canary Islands in June 1987 was recaptured in Cuba in November 1987 (BOLTEN et al., 1992b). A large loggerhead (73.1 cm straight carapace length) was tagged in Florida in August 1986 and recaptured in the Azores in 1988 (ECKERT & MARTINS, 1989). Although this turtle was larger than the size class originally hypothesized to move from the western to the eastern Atlantic, this recapture suggests that loggerheads may make multiple circuits in the North Atlantic gyre system.

There is also a recapture to support movement of loggerheads from the Atlantic into the Mediterranean, as hypothesized by BOWEN et al. (1993) based on genetic analysis of Atlantic and Mediterranean loggerhead nesting populations. A loggerhead tagged in the Azores in July 1986 was recaptured off Sicily in August 1991 (BOLTEN et al., 1992a).

The sightings of Kemp's ridleys in the eastern Atlantic also support the hypothesized travel route, because Kemp's ridleys only reproduce along the east coast of Mexico. Kemp's ridleys have been recorded from the Azores (BRONGERSMA, 1982; BOLTEN & MARTINS, 1990), Madeira (BRONGERSMA, 1982), and Malta (BRONGERSMA & CARR, 1983).

Based on our hypothesis of the movement patterns of the eastern Atlantic loggerheads, we would predict that as the turtles move in the North Atlantic gyre, the carapace length of the smallest size class in each successive region would increase. Preliminary comparison of size ranges of turtles in the Azores and in Madeira support this prediction (BOLTEN et al., 1993). This prediction should be tested for other regions, for example, for the Canary Islands and Cape Verde Islands.

The duration of the pelagic stage has been a critical missing value in the development of demographic models for loggerhead sea turtles (FRAZER, 1986; CROUSE et al., 1987). In our research, we have used two methods to estimate the length of time loggerheads spend in the pelagic stage in the eastern Atlantic. First, by calculating growth rates for recaptured loggerheads, we can estimate the duration of the pelagic stage by calculating the number of years it takes for a sea turtle to grow from 5 to 50 cm carapace length. Second, by using length frequency analysis (MULTIFAN computer program [OTTER RESEARCH LTD., 1992]) on the size distributions of loggerheads in the Azores, we can determine the number of age classes present in the population, and, thus, the number of years spent in this habitat. MULTIFAN was used successfully to estimate growth rates and number of age classes for a green turtle (*Chelonia mydas* LINNAEUS, 1758) population in a study that compared extensive tag and recapture data with length frequency analysis (BJORNDAL & BOLTEN, 1995; BJORNDAL et al., 1995). Both techniques--recapture of tagged loggerheads and length

frequency analysis--yielded similar estimates of 10 to 12 years duration in the eastern Atlantic (BOLTEN et al., in prep.).

Much research remains to be conducted on the biology of the pelagic-stage loggerheads in the Atlantic. Clearly, this work must continue to be based on collaborations among the nations of the region because the Atlantic loggerhead population is a resource that is shared among many countries. If loggerheads are to continue to survive in the Atlantic, it will require cooperation among these nations.

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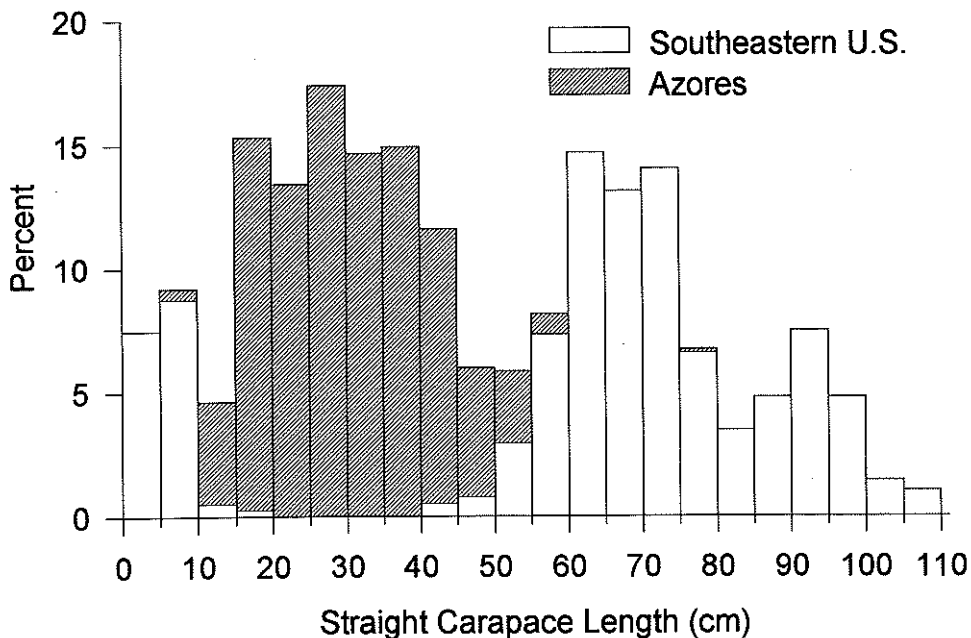


Figure 1 - Size distribution (straight carapace length) of loggerheads around the Azores (BOLTEN et al., 1993) and the southeastern U.S. (adapted from CARR, 1987). The southeastern U.S. loggerheads include post-hatchlings seen off Florida beaches, juvenile and adults captured in benthic habitats in southeastern U.S., and adult females on nesting beaches in Florida.