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Loggerhead Sea Turtle Nesting Activity Driven by Recent Climate Conditions And Returning Nesting Females

New research indicates that for loggerhead sea turtles in the Northwest Atlantic, the number of returning nesting females in the population and favorable climate conditions in the year or two prior to the nesting year are strongly related to the number of nests produced by these animals in a given year. Also, in what may be good news for loggerheads, nesting increases since 2008 may be a recovery response in this threatened population. The study published December 5 in the journal PLOS ONE.

Vincent Saba, a research fishery biologist at NOAA's Northeast Fisheries Science Center (NEFSC), and his study co-authors used annual nest counts from Florida and a time-series of climate data in turtle-nesting population models. These models were then used to assess observed changes in nest counts and to project future nesting trends in the Northwest Atlantic loggerhead sea turtle population, the largest in the world.

"Our study suggests that the cumulative survival from hatchling to maturity, which may take 30 years, combined with present-day climate effects on mature females, has a greater influence on annual nesting population size than does the exclusive impact of survival during the first year of life as hatchlings," Saba said. "The first year of life represents only 3 percent of the time elapsed through age 31."

The study suggests that protection for older juveniles and sub-adults to ensure they reach maturity and breed multiple times is at least as important as protecting hatchlings. These results have major implications for management strategies aimed at the recovery of Northwest Atlantic loggerheads and the projected recovery rates of this population, which is considered threatened under the U.S. Endangered Species Act.

Sea turtles are long-lived, late maturing species that occur throughout the global oceans. Estimated survival rates for loggerhead sea turtles in the Northwest Atlantic are very low; less than 0.2 percent of turtles born in a given year survive to age 30. Because the reproductive value is highest for sea turtles that have reached or are approaching maturity, management strategies protecting these life stages from human threats are critical. Although data are limited to tagging data from nesting beaches, they suggest loggerheads may be reproductively active for 25 years or more.

Nearly 90 percent of all loggerhead nesting in the Northwest Atlantic occurs in Florida. Nest count data between 1989 and 2012 are derived from 15 index beaches located on the east coast of Florida between Canaveral National Seashore and Boca Raton.

The authors used observed nest counts between 1989 and 2012 to model the importance of first-time nesters (aged 31), to future nesting numbers. To do this, they projected

the number of nesting females up to 2020 and 2043 based on the estimated number of hatchlings produced between 1989 and 2012. The decline in the annual nest counts observed between 1998 and 2007 was not projected to occur during 2029-2038. This suggests that annual nesting variability and trends are influenced more by returning nesters, older females, than by first-timers. If first-timers contributed more to nesting variability and trends, a decline in the years 2029-2038 would be expected.

Saba and colleagues found that adult female sea turtles are greatly influenced by environmental conditions—referred to as "climate forcing"-- when it comes to annual reproductive activity. Not all female sea turtles in the population nest each year, a phenomenon attributed by some researchers to climate-driven changes in energy consumption at foraging areas in the year(s) prior to nesting. Limited tagging data from nesting beaches suggest that the reproductive longevity of loggerheads may exceed 25 years.

"This study offers a different perspective than earlier work that suggested most of the annual variability in loggerhead sea turtle nest counts in Florida between 1989 and 2010 could be explained by climate forcing on hatchling survival," said Saba, a member of the NEFSC's Ecosystem Assessment Program. "We reached a much different conclusion. The annual variability and trends in loggerhead nesting numbers in Florida are associated with long-term survival at sea from hatchling to maturity, combined with climate-driven changes in mature female foraging areas within a year or two before nesting."

Saba and colleagues used population models to evaluate the relative influence of climate indices including the Atlantic Multidecadal Oscillation, the North Atlantic Oscillation, and the El Niño Southern Oscillation. They then tested for differences in model fits using annual nest count data to see how the model performed with respect to environmental factors. They also assessed the relative contribution of first-time nesters to projected annual nest counts. Lastly, they created a survival matrix to compare the relative importance of survival in the first year of life relative to the next 30 years before maturity was reached.

With passage of the U.S. Endangered Species Act (ESA) in 1973, protection measures have been implemented for all loggerhead life stages. Since the lowest annual loggerhead nest count data from Florida's index beaches occurred thirty years after the ESA was enacted, the authors suggest that the nesting decline that occurred during 1998-2007 was a lagged response to historical human-induced mortality impacts on juveniles and adults. The subsequent increase in nest counts since 2008 reflects a potential recovery response.

Saba, who has conducted modeling studies on the impacts of climate change on endangered leatherback turtles in the eastern Pacific Ocean, says the Northwest Atlantic loggerhead study offers a new approach in understanding how climate variability affects sea turtle populations.The study should also help management efforts aimed at protecting these populations because it suggests that the protection of large juveniles and adults should be a priority.

In addition to Saba, authors of the study include Michael Arendt and Jeffrey Schwenter of the South Carolina Department of Natural Resources, and Blair Witherington and Anne Meylan of the Florida Fish and Wildlife Conservation Commission. Lead author Arendt is also a graduate student at the University of South Carolina.

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