Biological 'clock' discovered in sea turtle shells

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In addition to their natural beauty, the shells of two deceased specimens of Hawksbill sea turtles hold clues to the growth rates and sexual maturity of the endangered species. Credit: Duke University, Kyle Van Houtan

Radiocarbon dating of atomic bomb fallout found in sea turtle shells can be used to reliably estimate the ages, growth rates and reproductive maturity of sea turtle populations in the wild, a new study led by Duke University and NOAA researchers finds.

The technique provides more accurate estimates than other methods scientists currently use and may help shed new light on factors influencing the decline and lack of recovery of some endangered sea turtles populations.

"The most basic questions of sea turtle life history are also the most elusive," said Kyle Van Houtan, fisheries research ecologist at NOAA's Pacific Islands Fisheries Science Center and adjunct associate professor at Duke's Nicholas School of the Environment.

Van Houtan and his colleagues analyzed hard tissue from the shells of 36 deceased hawksbill sea turtles collected since the 1950s. The turtles either died naturally or were harvested for their decorative shells as part of the global tortoiseshell trade. The researchers worked with federal agencies, law enforcement and museum archives to obtain the specimens.

The scientists were able to estimate each turtle's approximate age by comparing the bomb-testing radiocarbon accumulated in its shell to background rates of bomb-testing radiocarbon deposited in Hawaii's corals. Levels of carbon-14 increased rapidly in the biosphere from the mid-1950s to about 1970 as a result of Cold War-era nuclear tests but have dropped at predictable rates since then, allowing scientists to determine the age of an organism based on its carbon-14 content.

Van Houtan and his team were able to estimate median growth rates and ages of sexual maturity in the collected specimens by comparing their radiocarbon measurements to those of other wild and captive hawksbill populations whose growth rates were known.

This is the first time carbon-14 dating of shell tissue has been used to estimate age, growth and maturity in sea turtles. Previously, scientists employed other, less precise methods such as using turtle length as a proxy for age, or analyzing the incomplete growth layers in hollow bone tissue.

The researchers published their peer-reviewed research Jan. 6, 2016, in the *Proceedings of Royal Society B*.

Aside from giving scientists a more reliable tool for estimating turtle growth and maturity, Van Houtan believes the new technique sheds light on why some populations—including Hawaiian hawksbills, the smallest sea turtle population on Earth—aren't rebounding as quickly as expected despite years of concerted conservation.

"Our analysis finds that hawksbills in the Hawaii population deposit eight growth lines annually, which suggests that females begin breeding at 29 years—significantly later than any other hawksbill population in the world. This may explain why they haven't yet rebounded," Van Houtan said.

The bomb radiocarbon tests also indicate another red flag, he said.

"They appear to have been omnivores as recently as the 1980s. Now, they appear to be primarily herbivores. Such a dramatic decline in their food supply could delay growth and maturity, and may reflect ecosystem changes that are quite ominous in the long term for hawksbill populations in Hawaii," he said.

Although the new research focused primarily on Hawaiian hawksbills, bomb radiocarbon dating could be used to study other hawksbill populations, or populations from other sea turtle species, worldwide.

More information: 'Time in Tortoiseshell: A Bomb Radiocarbon-validated Chronology in Sea Turtle Scutes,' Kyle Van Houtan, Allen Andrews, T. Todd Jones, Shawn Murakawa, Molly Hagemann. *Proceedings of the Royal Society B*, Jan. 6, 2016. DOI: 10.1098/rspb.2015.2220

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