Chesapeake Bay pollution extends to early 19th century

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Humans began measurably and negatively impacting water quality in the Chesapeake Bay in the first half of the 19th century, according to a study of eastern oysters by researchers at The University of Alabama.

The work, published in *Scientific Reports*, show pollution's effect appears a bit earlier than previously thought, but it generally confirms increasing deforestation and industrialization around the Bay led to water quality issues before the Civil War, which has been shown by other studies with different testing methods.

The study shows using oyster shells from archeological sites is an effective way to measure the environmental impacts of waste input on estuaries, particularly levels of nitrogen that impact the oyster's shell chemistry as it feeds from nutrients in the water, according to the paper.

"We were one of the first to try this on archeological shells, and the first to identify an ancient period of pollution using this method," said Dr. C. Fred T. Andrus, associate professor and chair of the UA department of geological sciences.

"This might be a good way for us to learn what the baseline of clean water looks like. It tells us the natural amount of animal and human waste that should be going into a bay, which matters because the fisheries we depend upon can be greatly damaged by excess nitrogen."

The research was led by Heather Black, a former student in Andrus' lab who earned her bachelor's and master's degrees in geology from UA and is now pursuing a doctorate at Florida International University.

Co-authors on the paper include Andrus; W.J. Lambert, a UA graduate who now runs the Alabama stable isotope laboratory; Dr. Torben Rick, curator of North American Archaeology at the Smithsonian Natural History Museum; and Dr. David P. Gillikin, associate professor of geology at Union College.

Black chose the Chesapeake because of heavy pollution, early colonization in American history and abundance of ancient trash heaps with discarded oyster shells, or shell middens, she said.

Though nitrogen is necessary for life and a healthy part of coastal waterways, too much nitrogen changes the ecosystem. Found in human and animal waste, increasing amounts of nitrogen began to wash into the Bay as the mid-Atlantic region transformed through European settlers.

Despite how critical it is for life, historical levels of nitrogen are hard to assess, and a lot of organic matter is lost over time. Shells, though, are different.

Sitting at the bottom of the bay unable to move and eating much of what washes over it, the eastern oyster has a large tolerance for changes in the water. Serving as a filter as it feeds, the oyster becomes a record of environmental changes by incorporating organic materials into its shell.

Through chemical analysis of the shell's growth bands – which form somewhat similarly to tree rings – scientists can determine some of the environmental conditions during an oyster's lifespan.

Using shells collected during archeological digs by the Smithsonian Institution dating from roughly 1200 to 1900, Black compared the ratios of nitrogen isotopes stored in the shells with modern shells harvested near a dock at the Smithsonian Environmental Research Center in Edgewater, Maryland.

She scraped small amounts of powder from the inside of the shell to get an average nitrogen isotope across the oyster's life. The results show a distinct shift in nitrogen sources between 1800 and 1850, which kicks off a rapid increase in nitrogen through today.

"Most people may think of that kind of pollution – an amount of nitrogen that is kind of off the charts – as not occurring until almost

World War II, but it looks like at 100 years earlier, that kind of heavy impact is already felt," Andrus said.

Earlier research using cores of sediments dug from the floor of the Bay showed similar levels of nitrogen in about the same period, but using shells from archeological sites is easier to date, Andrus said. For one, they date from the archeological site because of adjacent artifacts that correspond with a specific time. In addition, radiocarbon dating the deposits can pinpoint the shells' age.

Sediment, on the other hand, can swirl around and unsettle and accumulate at variable rates, which makes dating less accurate than with shells, he said.

"Every way you measure something has its problems, and we came at this from a different angle," Andrus said. "It's a very robust form of replication that tells us the Chesapeake Bay was polluted earlier than we thought, but the larger implication is it shows that this is a really useful tool for this measurement."

There are already efforts to try this in other coastal waters. Another of Andrus' students performed similar work in Charleston Harbor, and results there show oysters live under similar nitrogen levels now as in prehistoric times, despite an uptick of nitrogen in the mid-20th century, he said.

A paper about that project is pending publication.

For the Chesapeake, remediation efforts are ongoing, and Andrus hopes this work can help with an understanding of what a healthy Bay looks like.

"This work provides information for people interested in remediation to see a healthy target, whereas most of the direct measurements on nitrogen levels only go back to the 1970s," he said. "Those measurements would almost certainly already be the product of waste. Whether or not those are realistic goals to clean the water to depends largely on the body of water, but it least it gives you a framework."

More information: H. D. Black et al. δ^{15}N Values in Crassostrea virginica Shells Provides Early Direct Evidence for Nitrogen Loading to Chesapeake Bay, *Scientific Reports* (2017). DOI: 10.1038/srep44241

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