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# Hints from the fossil record on how to re-oyster the Chesapeake

February 20 2017, by Joseph Mcclain

The old shell game: Joshua Zimmt '17 helps paleontologist Rowan Lockwood sort through the many, many shell fossils recovered from ancient oyster reefs. Lockwood presented ideas for re-oystering the Chesapeake based on conservation paleontology principles. Credit: Stephen Salpukas

Rowan Lockwood is extracting pearls of data from long-dead oysters.

Lockwood, a professor in William & Mary's Department of Geology, has strung those data pearls together to craft a set of suggestions for the re-oystering of today's Chesapeake Bay. She discussed her findings in Boston on Feb. 17 at the Annual Meeting of the American Association for the Advancement of Science, the world's largest general scientific society.

The presentation, "Oysters Past and Present, and the Future of the Chesapeake Bay," drew on the study of more than 4,000 fossil oysters that lived between 80,000 and 500,000 years ago. The work is an example of an emerging subdiscipline known as conservation paleontology.

"Conservation paleontology is just like conservation biology, only with older stuff," Lockwood explained. "The idea is to use the fossil record, the archaeological record—maybe even the historical record—to help us restore biodiversity, to understand why some organisms and populations are currently struggling."

In situations such as oyster restoration in the Chesapeake Bay, a conservation paleontology approach is necessary to establish a true baseline for the restoration of an ecosystem. Lockwood said that most ecological managers establish baselines based on what the Chesapeake looked like 100 or 200 years ago.

## A better baseline

"As a paleontologist, that's way too young for me," she said. "I want to understand what the Bay was like before humans started having an impact, maybe 10,000 years ago. I want to look back and see how the ecosystems functioned for thousands and tens of thousands of years. And I want to see how the ecosystem responded naturally to things like climate change and sea-level rise."

Lockwood offers some tangible evidence of what a prehistoric Chesapeake was like. She shows one of her specimens, an enormous half-million year old oyster, saying, "It could serve as a doorstop."

Oysters of such a size were the rule, not the exception, in the prehistoric Chesapeake, and Lockwood says that her studies show that the Bay was full of such mammoth oysters. A conservation-paleontology approach provides the necessary context to understand the true baseline ecosystem, she explained.

"We live in the modern times, and we are trapped in the mindset of thinking that what we see today is natural, when in reality humans have been affecting the earth now for thousands of years," Lockwood said. "A manager of the Chesapeake Bay has never seen a healthy oyster reef. They've never seen anything close to a natural oyster reef. The only way to understand how oysters are supposed to function is to go back in time."

Lockwood's conservation-paleontology "time machine" reveals more than large numbers of large oysters. Working with a set of William & Mary undergraduate researchers, she has used a set of laboratory techniques to extract a number of interesting data points on the ancient oysters of the Chesapeake. They learn how long each oyster lived through a process known as sclerochronology. Sawing the fossil shells in half allows researchers to count growth bands, much like tree rings. But the gray and white growth bands in oyster shells are more complex than tree rings.

"It's not enough to simply count the bands, because oysters stop growing when it gets cold," Lockwood said. "In some places they stop growing when it gets too warm. In some places they stop growing when they get too much fresh water."

## How to age an aged oyster

Lockwood took some oysters to the lab of collaborator Fred Andrus, a geoarcheologist at the University of Alabama. Andrus had instrumentation that allowed her to drill into the white and gray growth bands, taking samples.

"I can put those samples in a mass spectrometer, and that lets me measure the isotopes of oxygen. Those isotopes of oxygen allow me to reconstruct temperature through time," she explained. "So I can tell you how cold the winters were and how warm the summers were 400,000 years ago."

Lockwood found that the size of her ancient oysters is solely a function of a long life; the growth rate is no different than the oysters in today's Chesapeake. Her study includes a range of oyster fossils from Delaware down to North Carolina.

She said that a modern oyster in the Bay lives five or six years, on average, before being harvested or dying of disease. By comparison, her Chesapeake Bay fossil specimens lived particularly long lives. "We're talking 30, 35 years old," she said. "These are big, honkin' grandma oysters."

There are no big, honkin' grandpa oysters. Oysters are sequential hermaphrodites, she explained: They all are born male, then change sexes as they grow to a certain size. Lockwood stressed that individual oyster size has enormous conservation implications.

"Because, if you're an oyster, the bigger you are, the more offspring you have," she said. "As these things grow in size, and grow in age, they're having more and more offspring."

Lockwood added that contemporary research on oysters, including studies done by faculty at William & Mary's School of Marine Science at VIMS, suggest that larger oysters are developing some degree of tolerance to MSX and Dermo, diseases that have killed off many native oysters in the Chesapeake. Additional evidence shows that some of the oyster populations are evolving disease tolerance through natural selection.

Lockwood told her AAAS audience that what the Chesapeake Bay needs is reefs covered with these old female oysters, happily filtering the water and producing lots of spat—oyster larvae. She acknowledges that it's unrealistic to think that the Bay will ever regain its prehistoric oyster population, but evidence points in the same direction: If you want to boost the oyster population of the Chesapeake, the bigger oyster is the better oyster.

## More older breeding oysters

She offered a set of recommendations for improving the Chesapeake's oyster stock through increasing the size of individual oysters. Oyster fishing targets the larger specimens, which Lockwood said are precisely the fertile shellfish that a conservationist would want to protect.

One idea is to institute maximum-size or slot-limit regulations designed to preserve the big female breeders. Lockwood noted such rules would be effective where the shellfish are harvested by hand at low tide, less so in areas where dredging and other larger-scale fisheries are used.

Current fisheries regulations have a minimum-size limit, protecting the younger oysters. Lockwood suggests maximum or slot limits could be part of a rethinking of regulations and other conservation actions to encourage protection of the breeding grandma oysters.

"When you look at where we spend our conservation dollars on Chesapeake Bay oysters, we spend it all on their early life stages," she said. "We put a lot of shell on the bottom of the Bay, hoping that larva will settle there. We also raise larva in the lab, then release them in the

Bay."

Worthy as such spat-centric initiatives are, Lockwood points out that the odds for the survival of any one oyster larva are in the neighborhood of one in 10,000—under the best of conditions.

"So would you rather put your money into the survival of one in 10,000, or would you rather put your money into the preserving of the larger, older oyster who has already lived 10 years and who has already earned her place in the survival of the fittest?" she asked.

Lockwood suggested increasing the numbers and sizes of oyster sanctuaries in the Bay. She also advises siting sanctuaries and replanting sites with regard to anticipated sea-level rise.

Oyster preserves, off-limits to harvesting, would not only allow the residents to grow to their full potential, but might also help to mitigate the effects of the two diseases plaguing native oysters in the Chesapeake.

"If you look in the areas of the bay where people are not fishing—usually because those are areas where the pollutant loads are too high for the oysters to be eaten—we have really large oysters," she said. "And they are starting to evolve disease tolerance."

She said that the disease tolerance is a result of natural selection. Oysters in protected grounds could be expected to not only grow to grandma size, but also to pass on to their multitudinous offspring some of those genes that convey disease tolerance.

Lockwood pointed out that there has been a great deal of success in "protect the adult" strategies applied to other species. She cited the example of sea turtles, where populations have rebounded more quickly when conservation strategies were switched from a focus on nest sites and hatching events to protecting adults from poaching and boat strikes.

"But Chesapeake Bay oysters are part of a much more complex system," she said. "There are so many variables at play here, including the socio-cultural aspects. But from a purely ecological standpoint, I would say we're not doing a great job. Oysters are really struggling, and I would like to see us shift our funding into approaches that quantitatively appear that they would yield a lot more success."

Lockwood is one of two William & Mary researchers who presented work at the AAAS meeting. The other is Anne Charity Hudley, who spoke on "Educator Linguistic Ideology About African-American English in STEM Contexts" in a Feb. 19 session.

Lockwood's presentation was part of a three-scientist panel. The session was organized by William & Mary alumna Susan Kidwell '76, whom Lockwood described as "one of the preeminent paleontologists in the world" and a pioneer of conservation paleontology concepts. The third member of the panel is Jacquelyn Gill of the University of Maine.

The AAAS conference staff has shown a great deal of enthusiasm for Lockwood's presentation. She is being featured in a podcast and was asked to give a "Clams and Catastrophes" stage show presentation at Family Science Days, the weekend outreach program that's a part of the AAAS meeting.

Provided by The College of William & Mary