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Chesapeake's oyster reefs have taken a shellacking

Shell habitat is being lost faster than oysters can replenish it

By Karl Blankenship

Suited in yellow rain gear, with hoods pulled up for protection against a stiff fall breeze, a small group of biologists prepared to dig into a mound of oysters piled onto clean, white tables.

Fortunately, they weren't looking for dinner. The oysters were small, mostly dead, and were often coated in black, sulfuric-smelling muck.

The biologists sorted and measured oysters one by one, chanting their findings to a clipboard-wielding recorder who listed every detail.

"Old box, 43." (A dead oyster, 43 millimeters long.)

"72." (A live oyster, 72 mm long.)

"Spat 28." (A 28 mm baby oyster.)

But many samples contained more mud than oysters. Each batch had to be hosed down, with water flying everywhere, to wash off the worst of the muck. That's a sign the oysters had been silted over or sunk into the sediment.

Since the Virginia patent tong survey began in 1993, samples of mud-covered shell have become more common. And it has led some scientists to a sobering conclusion: In many areas, oyster shell habitat is being lost faster than it can be replaced by today's diminished oyster population.

The observation has given rise to a new term: The shell budget. Or, more accurately, the calcium carbonate budget - the material oyster shells are made from. In this accounting system, most Virginia tributaries are running deficits.

"That's one of the biggest findings that has come out of 18 years of survey work," said Jim Wesson, who oversees oyster restoration programs for the Virginia Marine Resources Commission. "The shell budget is controlling everything."

On the survey boat, Wesson pointed to a site in the Great Wicomico River where the commission had planted 500,000 bushels of oyster shells a decade earlier. "We never thought they would sink," he said. But now, the hydraulic tongs were pulling up samples from the site that were largely mud.

It's not news that oyster habitat in the Chesapeake is in bad shape. Scientists have estimated that more than 90 percent of the reefs in what was once known as the "Great Shellfish Bay" are gone.

But now, recent papers using data from the Virginia survey show that outside of a couple of small bars on the James River, most oyster bars are in a downward spiral of shell loss that is difficult to reverse. As shell disappears, there are fewer places for baby oysters, or spat, to land, meaning there are fewer oysters to produce more shell.

"Once you start down this path, it reinforces and accelerates, and that is truly problematic," said Roger Mann, a longtime oyster researcher at the Virginia Institute of Marine Science who has written several papers dealing with the shell budget in recent years.

The situation in Maryland is unknown - the state uses a different survey technique that can't be used

to calculate the shell balance. But officials there are concerned as well, and this year Mann and Maryland Department of Natural Resources biologists hope to begin a survey to start calculating a shell budget for the states' oyster grounds.

"The whole issue of the shell budget and losing oyster ground is becoming a very real problem," said Mitch Tarnowski, a shellfish biologist with the Maryland DNR. "In some - not all - areas where we do surveys, we need to really scratch around to find oysters and, in some cases, to even find shell. Some of these areas are definitely disappearing."

The implication is that oyster shell - already in short supply for restoration projects - may be even harder to get in the future. It also means fewer habitats not only for oysters, but for the host of animals and plants that call an oyster reef home.

"Anything that lives around hard substrates or requires it for part of its life cycle is therefore going into a degraded system," Mann said.

In addition, when algae and other life in the Bay die, sink to the bottom and decompose, the process makes sediment more acidic. Calcium from the natural decay of oyster shells helps to neutralize that acidity - much like antacids in the stomach. But with less shell, there is less ability to neutralize that acidity around reefs, affecting what organisms are present.

"Even if you are not interested in oysters, you should be worried that you don't have as much buffering capacity in surface sediments," Mann said. "It all comes down to oyster shells, and the fact that we don't have enough of them."

Oysters are one of the few species that build their own habitat. Living oyster larvae pull calcium carbonate out of the water and build shells that keep getting bigger as long as they live. Those shells create the solid surface that future oyster larvae need to land on and grow.

The first oyster larvae to wash into the newly formed Bay around 10,000 years ago likely attached to a few rocks or other substrates. Larvae then began growing on those oysters, forming reefs. Over hundreds - perhaps thousands - of years their numbers dramatically expanded until they became the dominant feature in the Chesapeake, with towering reefs that in some places were above water during low tides. Oysters on those reefs could live a decade or more, and sometimes reach a foot in length.

After European settlement, reefs underwent heavy harvest pressure. But the impact of that habitat loss was partly offset by good oyster reproduction. That equation changed in recent decades when the oyster diseases MSX and Dermo began taking a huge toll on oyster populations, killing many before they reached market size. The situation was worsened by the long-held view of management agencies that, since oysters were going to die anyway, it was all right to continue harvesting them - neglecting the fact that continued harvest was further reducing shell habitat.

The smaller populations were less able to keep up with increased rates of siltation, further reducing the amount of suitable habitat for new oysters.

As a result, reefs that once contained large numbers of big, old oysters with thick shells today are dominated by small, thin-shelled oysters that often don't survive to reach the 3-inch market size. Mann and Eric Powell, director of the Haskin Shellfish Research Laboratory at Rutgers University, have estimated that oyster shells lose about one-third of their weight each year, so shells from small oysters disappear quickly.

As old oysters with thick shells disappeared from the population because of disease and harvest, maintenance of the shell budget in many areas hinges on the production of large numbers of small oysters almost every year. That generally doesn't happen. In many areas, reefs cannot grow vertically fast enough to keep from sinking into, or being buried by, sediment.

As a result, the downward spiral becomes self-reinforcing. Less habitat means, even when oyster reproduction is good, there are fewer and fewer places for spat to land and begin growing. That means less opportunity to push the calcium carbonate balance to the positive side of the ledger sheet.

Shells are lost to a number of factors: They naturally dissolve in water over time; harvest directly removes them; oyster drills, barnacles, sponges and other organisms break them down; sedimentation buries them in muck; and predators such as cownose rays and blue crabs literally take a bite out of the shell budget.

Maryland oysters are generally subject to less predation and fewer fouling organisms, and in many places disease pressure is less severe. But spat sets in Maryland are poorer, on average, than those in Virginia, making it difficult to replace old oysters that continue to be lost to harvest and disease, said Roger Newell, a longtime oyster researcher at the University of Maryland Center for Environmental Science.

"It is the lack of clean shell out there that is still limiting [new oyster production], which is what Roger Mann says," Newell said. "He is completely right."

The situation will grow worse over time. Newell and other scientists recently reported that climate change is causing the Bay to gradually become more acidic, also leading to reduced oyster shell growth.

Meanwhile, oysters need to grow even faster, Mann said, to maintain their relative position in the water column when faced with rising sea levels.

Right now, it's unknown exactly how far out of balance the Bay's shell budget is, but Mann said the deficit would be "a very large number, and very scary." His rough calculations suggest Virginia's portion of the Bay alone could be losing tens of thousands of tons of shell each year.

Breaking the downward spiral is difficult, but not impossible, many scientists say. Some caution against assuming that the shell balance is already tipped in an unwinnable equation.

"Those things are sobering and need to be paid attention to, but I don't think any of it concludes that we cannot have a positive shell balance," said Mark Luckenbach, a VIMS scientist who has studied oyster reef ecology and reef restoration.

Restoration projects often have taken place at marginal sites. Instead, Luckenbach said, sites should be selected where they have the least mortality from predators such as cownose rays, where sedimentation rates are lowest, and where fertilization rates are highest to increase production. Even then, he said, successful restoration may mean continued maintenance over time, rather than building a project and letting it try to survive on its own.

"'Sustainable' might mean we recognize that it takes a small amount of continued intervention along the way," Luckenbach said. Shell, for instance, may need to be added every other year until a reef can "turn the corner" and maintain itself, he said. "All of that argues toward working in the few best places and not spreading the limited resources around really broadly."

Mann also argues that restoration strategies should be rethought, with more emphasis being placed on improving areas that are in good condition in an effort to tip the local balance sheet to the positive side.

"We tend to think about refurbishing marginal areas," he said. "I think we need to refurbish and stabilize the areas that are already productive but potentially not keeping up. You start basically by looking at good areas and you make them better."

Mann and Luckenbach, and some other scientists, worry that the goal set forth in a federal Bay strategy last year, stemming from an executive order by President Barack Obama calling for stepped up federal involvement in Bay restoration, may literally result in spreading available shell resource too thin.

The strategy calls for restoring native oyster populations in 20 tributaries by 2025.

Stephanie Westby, oyster restoration coordinator with the National Oceanic and Atmospheric

Administration's Chesapeake Bay Office, said federal agencies are taking shell balance issues into consideration in developing their plans, and that achieving a shell balance while meeting the federal strategy's restoration goals "are not necessarily mutually exclusive."

Oyster reefs once covered hundreds of thousands of acres in the Bay, and oysters are considered a keystone species, one that plays a critical role in maintaining the structure of the estuary's ecological community. Federal officials say the strategy was intended to set a bold goal to drive coordinated efforts and investments by federal and state agencies and nonprofit organizations in a massive effort to bring back the bivalve, the habitat it provides and its water-filtering capabilities.

"The idea is that we need to scale up," Westby said. "The idea is to try to get to a point where you can see some real results in an entire restored tributary."

But the worsening oyster shell situation, she and others agree, will make all projects more challenging. Many restoration projects have used so-called fossil shells which are hundreds or thousands of years old and are dredged from the bottom of the Bay. But even they are in short supply. For decades, Maryland maintained a shell balance on many reefs by replenishing them annually with dredged shells, but those shell supplies are nearly exhausted and the programs halted. Shells dredged from some areas also tend to be brittle and less durable than "fresh shell." Alternate substrates such as concrete reef balls or clean debris from demolition projects can help. But none work as well as oyster shell, and they tend to be expensive.

"There is only one way that you can get enough substrate that makes much sense," Luckenbach said, "and that is for a living oyster to pull the calcium out of the water column and build the shells."

For many places, that day still seems a long way off. On the survey boat, as the day wore on, scores of tonged samples had been analyzed; but on average, the biologists found fewer than 7 adults per cubic meter scooped from the bottom - a sharp drop from the previous couple of years. Ominously for the future, there were even fewer spat than adults. "That," Mann concluded, "was the most pathetic morning I've ever spent on this boat."

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