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WHERE HAVE ALL THE OYSTERS GONE?

The fight to save oysters and the habitat that they help maintain

BY DR. SANDRA BROOKE

Oysters are not particularly charismatic creatures; they resemble small rocks, with a gooey interior. These unprepossessing shellfish however have supported coastal communities across the globe for millennia, initially through subsistence harvesting then by large-scale commercial fishing. Food and industry are not the only services oysters provide. Agriculture and urban development release large quantities of nutrients into watersheds, creating dense algal blooms that can cause a variety of ecological problems. Oysters can help mitigate the effects of high nutrient levels by consuming suspended particles, effectively cleaning the water and depositing organic material onto the sediment. The clear water that results from oyster feeding allows the development of seagrass beds, which are important nursery and feeding grounds for many aquatic species.

Oysters will settle on a variety of hard substrates, and they grow quickly, particularly in sub-tropical regions with mild winters. Over time, these cycles of recruitment, growth and mortality create large complex three-dimensional structures that provide habitat for diverse and abundant communities of fishes and invertebrates, some of which are economically important. Reef structures also buffer wave energy and protect adjacent shorelines from erosion. This service is particularly valuable in areas where sea-level rise is threatening to inundate low-lying coastal areas and where development has destroyed natural shoreline buffers, such as salt marshes and coastal woodlands.

For a long time, oysters seemed an endless resource; images of massive piles of oyster shells outside shucking houses were common as oysters were canned and shipped elsewhere for consumption. Today, things are very different; approximately 85% of the world's oyster reefs have been lost, making them among the most imperiled marine habitats in the world. In North America, two oysters have been harvested commercially: the Olympia oyster (which comprises two species: *Ostrea conchaphila* and *O. lurida*) on the west coast, and the Eastern oyster (*Crassostrea virginica*) on the east coast and Gulf of Mexico. Today, there are very few remaining beds of wild Olympia oysters, and the massive reefs formed by the Eastern oyster have been reduced to 10% of historic levels.

What went wrong?

Declines in oyster populations have similarities across species and geographic locations, with the primary cause being overharvesting. In several regions, the fishery had significantly declined or collapsed by the mid-1900s. Oysters are sedentary, readily accessible and have been exploited by coastal communities for centuries. Given these factors, widespread and systematic overharvesting is not surprising. The failure of these populations to recover may be explained in part by their ecology. Oysters are 'ecosystem engineers' and 'foundation species,' creating vast complex intertidal or subtidal structures

that are vital to estuarine communities, forming the substrate and structure necessary for diverse marine communities. Loss of habitat integrity is an unfortunate byproduct of large-scale oyster harvesting. As reef height declines, the remaining habitat is susceptible to sedimentation and hypoxia, which causes physiological stress in the oysters, making them more vulnerable to disease. Reduction in available habitat means there is less settlement space for new recruits, and eventually there are not enough adults in the system to rebuild the reefs. With oyster depletion, water filtration capacity is diminished, causing changes in water quality and impacting multiple components of the estuarine ecosystem. Over-harvesting, coastal development, dredging of navigation channels, deforestation and upstream changes to water flows, and nutrient and pollutant inputs have caused, or contributed to, the loss of shellfish populations worldwide.

Oyster resource management should incorporate habitat sustainability and replenishment, but this is generally not the case. In the U.S. alone, tens of millions of dollars have been spent on restoration of depleted oyster habitats, with the primary goal of recovering commercial fisheries. With few exceptions, funding for these efforts has been short term (often in response to natural or anthropogenic disasters) and insufficient in scope to replace the natural reef area lost. The overall success of these efforts is unclear as post-deployment monitoring data is not always collected and/or available. The Chesapeake Bay is the largest estuary in the United States, with a watershed that extends across six states. That bay ecosystem has been impacted by urban and agricultural runoff that degraded water quality, which was compounded by the collapse of oyster populations from overharvesting. Efforts to restore the Chesapeake Bay were begun in 1967 by the Chesapeake Bay Foundation, and the Chesapeake Bay Program was initiated in 1983. Through these and other programs, such as the Oyster Recovery Partnership, which deploys hatchery-reared larvae and newly settled oysters, called spat, to augment natural recruitment, Chesapeake Bay oysters have started to recover and support a small wild harvest. However, despite many years of effort and significant investment, the oyster populations there are a tiny fraction of their historical levels.

Gulf of Mexico oyster populations have also been significantly depleted but support higher

Spat traps are simple structures made out of oyster shells that offer a place for oyster larvae to settle and develop into spat, aka newly settled oysters.

SOCIAL RESPONSIBILITY


Oyster shells are shoveled off a boat in the hopes that the shells will provide a safe haven for growing oysters to latch onto.

ARE OYSTER FARMS THE ANSWER?

With the widespread decline of wild populations, oyster aquaculture has expanded rapidly to fulfill market demands. Farming can theoretically give wild stocks some respite from harvest and allow them to recover if appropriate restoration approaches are also employed. In contrast with some other aquaculture industries, oyster farming has low environmental impact and some environmental benefits. Farmed oysters do not create point source pollution problems, do not require the use of antibiotics to prevent diseases caused by high stocking densities, and since farmed oysters are often reproductively sterile triploids, the danger of genetic mixing with wild stocks is minimal. Farmed oysters filter the surrounding water, thereby performing similar ecosystem services as wild oysters, and there is anecdotal evidence that improved water quality has allowed seagrasses to develop near oyster aquaculture leases. Increased plastic debris from dislodged aquaculture equipment, the 'eyesore' of large leases that disrupt the view of estuarine waters, and market competition with wild harvesters are some negative aspects of this industry. Expansion of oyster farms across the U.S. is a byproduct of the demise of wild populations, and while they provide some economic and environmental benefits, services such as shoreline protection and habitat provision are not provided by farmed oysters. They are not a substitute for natural reefs.

Oysters are critical to the proper functioning of estuarine ecosystems, but to bring back anything resembling historic levels will require investment in large-scale long-term restoration and collaboration among various resource management and stakeholder groups. This approach has shown some success in the Chesapeake Bay, but it has taken considerable resources and effort for moderate returns. The demise of the humble oyster has made it painfully clear that the economic costs of good stewardship are minor compared to the far greater cost of our mistakes.

commercial harvest than anywhere else in the U.S. In 2010, the Deepwater Horizon wellhead exploded, releasing millions of gallons of oil into the Gulf. Oyster populations were severely impacted, especially in Louisiana. While the oil spill was an ecological and economic disaster for the Gulf of Mexico, the settlement funds from this accident have supported large oyster restoration efforts across all the Gulf states. To date, over $230 million have been spent on oyster restoration and related projects, and this created unprecedented opportunities to coordinate restoration and management approaches across the Gulf of Mexico.

One of the most productive and lucrative oyster fishing areas was Apalachicola Bay in northwest Florida. This large estuary provided 90% of Florida oysters, and they were in high demand for their sweet-salty flavor. A series of droughts from 2007–12 increased predation by marine predators and caused high oyster mortality, but the populations did not rebound when the rains returned. Habitat was depleted as harvest continued, although oyster populations were at critical low levels. In 2013, the wild oyster fishery in Apalachicola Bay was declared a Federal Fishery Disaster, releasing funds for economically impacted oystermen and for oyster reef restoration. Although there is no evidence the Deepwater Horizon oil reached Apalachicola, Florida oil-spill settlement funds have also supported oyster restoration projects in Apalachicola Bay. Despite this significant economic investment, the oysters did not recover, and in late 2020, the Apalachicola Bay was closed for five years to wild oyster harvest.

In 2019, Florida State University was awarded a five-year grant to identify the primary causes of oyster population decline, understand why they are not recovering and use science to develop recommendations for restoration and management of oyster resources. The Apalachicola Bay System Initiative (ABSI) has initiated or completed multiple

Research conducted by ABSI includes rigorous field components, analytical studies in the lab, and field and laboratory experiments. The data from these different components are used in models to help forecast how oysters are likely to respond to a suite of different environmental and management conditions.

scientific projects, including development of high-resolution hydrodynamic models of river flows and estuarine dynamics. These models will be used to investigate effects of different climatic and management scenarios on distribution of environmental conditions, flow regimes and larval dispersal patterns. ABSI is also generating detailed bathymetric maps of historical oyster reefs for comparison with previous mapping efforts to reveal how reef height and footprint has changed over time. The traditional approach to oyster restoration is to place a thin layer of material over a large area. If reefs are structurally depleted, however, it may be a better strategy to place more material over a smaller area, which increases reef height and provides habitat that is less prone to sediment and hypoxia. This spring, the ABSI team worked with local oystermen to deploy a restoration experiment that will test the performance of different materials (oyster shell and different sizes of limestone rock), deployed as mini-reefs (10 meters by 10 meters by 0.5 meters) in the bay. Early observations show encouraging spat settlement, but it remains to be seen if these will survive. The ABSI research hatchery has produced two batches of spat from Apalachicola Bay oysters. These have been deployed on the restoration experiment to assess survival and growth of the hatchery spat versus those from natural recruitment. These experiments will be monitored, and the results used to generate other experiments that will lead to restoration recommendations. Other components of the project will generate decision support tools that can be used by resource managers to inform adaptive ecosystem management approaches. Community engagement, primarily through the Community Advisory Board, is critical to the success of the project and implementation of ABSI recommendations.

More information can be found on the ABSI website: ***marinelab.fsu.edu/absi.***