

FILTER FEEDING BIVALVES

AS PROCESSORS OF COASTAL WATERS

By Michael A. Rice*

In most of North America, commercial shellfish aquaculture and shellfish restoration efforts are conducted in coastal public trust waters that require approval by a governmental body of some sort that is responsible for the permitting or licensing of such activities. Frequently such approval proceedings are deliberative in nature and the public is invited for comment as part of the permitting process. And often times, the public attendees of such hearings are completely unfamiliar with what the project is all about, or even worse, might be misinformed and espousing an exaggerated view about the potential negative impacts of aquaculture in the public waterways. Many of the concerned citizens may have read articles about environmental damage caused by some forms of aquaculture in far-away places, or they may have heard from a local public aquarium or environmental conservation organization that somehow farming of fish and shellfish in public waters is environmentally damaging and thus, not acceptable. However, in the context of public hearings, the rhetoric of “environmental threat” is frequently

used as a proxy for simple social unacceptability of the project. This is because in many jurisdictions, the potential for official denial based upon environmental threat of a proposed project is a legally more defensible

argument than a project proposal based upon some vague not-in-my-backyard (NIMBY) claim.

To counter much of this rhetoric of environmental threat in public meetings, shellfish farmers and shell-

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Figure 1. Filter feeding oysters have the ability to filter black colloidal graphite (Aquadag) particles in the 10_μm size range from seawater. Twenty four oysters held in about 5 gallons (about 20 liters) of seawater can clear the tank of graphite in less than an hour. Photo by Michael A. Rice

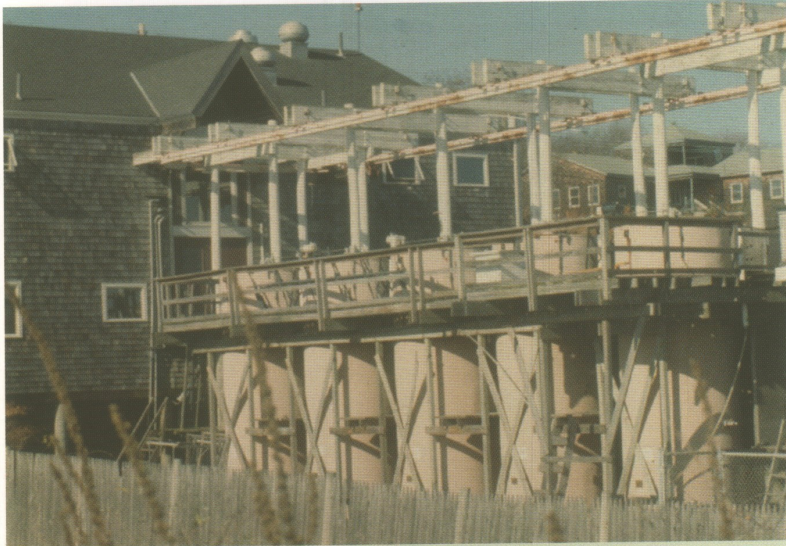


Figure 2. The Marine Ecosystems Research Laboratory (MERL) mesocosm tanks at the Narragansett Bay Campus of the University of Rhode Island circa 2000. Photograph from Wikimedia Commons.

fish restoration biologists alike have been quick to point out that oysters, clams, mussels and other bivalves are filter feeders that get their food by pumping water and by extracting phytoplankton and detritus particles from the water stream to serve as their food. In the filter feeding process, large populations of bivalves will process considerable volumes of water. Indeed, as early as 1877 pioneering marine ecologist Karl August Möbius in his classic monograph *Die Auster und die Austernwirtschaft (The Oyster and Oyster Farming)* was first to describe the filter feeding of oysters and oyster reef ecology.

In more modern times (1982) James Cloern working in San Francisco Bay, and Charles Officer, Ted Smayda and Roger Mann working in Chesapeake and Narragansett Bays pointed out that filter feeding mollusks could remove particles from estuarine waters, affect phytoplankton populations, and act as an intermediary in cycling inorganic nutrients within the ecosystem. In 1988 Roger Newell published some calculations showing that the decline of oyster populations in Chesapeake Bay over the past century has decreased the

amount of water being filtered and processed by the oysters considerably, with the oysters in the late 19th Century filtering the entire volume of water of the Bay in just 3 or 4 days. But by the 1980s, his calculations showed that it took well over a year for the reduced population of Chesapeake oysters to filter the same volume of Bay waters. The formidable filtration capacity of populations of bivalves can be demonstrated over time in aquaria as a nice visual of this effect in the accompanying figure, and a nice time lapse video of the process can be found at the YouTube website here: <https://www.youtube.com/watch?v=saAy7GfLq4w>.

If one extrapolates these visuals of bivalves filtering and clarifying waters of an aquarium, there is a great temptation to conclude that back in the “good old days” of massive oyster populations acting as natural filters of the estuaries, the waters might have been much clearer than they are now. And of course, one of the expected outcomes of a massive public project to restore oyster populations to Chesapeake Bay in the 1990s and early 2000s was that the water would be much clearer with more oysters.

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But unfortunately it did not really work out that way, mostly because the story is not quite as simple as the oysters just filtering the water. From an ecological standpoint, so much more is also going on in the estuary.

Back in the summer of 2000 in order to test the idea that Narragansett Bay waters were much clearer 90 years earlier when oyster populations were 100 times more abundant, my student Jennifer Mugg Pietros devised a study using experimental mesocosm tanks that were 7 cubic meters in seawater volume. Into three of the tanks she put 200 oysters each, and three more of the tanks had no oysters. The 200 oysters-per-tank density was chosen to approximately match the relative filtration rate of the estimated oyster population in Narragansett Bay in 1910. Then for a five month period she monitored a whole host of water quality parameters and the amounts of sediments being deposited onto all tank bottoms that were clean initially. Additionally, she made some laboratory measurements of ammonia excretion rates by the oysters. She found that over the course of the experiments, there was no significant difference between the tanks with oysters and the control tanks in terms of amount of ammonia and other inorganic nitrogenous nutrients or the amount of chlorophyll in the water or the amount of particulate organic material in the water. But there was a profound difference in the species

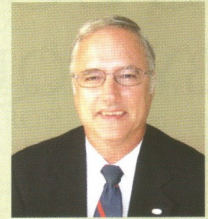
composition of phytoplankton between the oyster tanks and the oyster-free control tanks, and tanks with oysters collected more bio-deposit sediments on the bottom (for details see Pietros & Rice, 2003, *Aquaculture* 220:407-422).

To some extent, results of no differences in chlorophyll levels and particulate organic carbon in the water between the oyster tanks and oyster-free controls might be somewhat surprising given the “I-can-see-it-for-myself” aspect of the small aquarium demonstrations. But as it turned out, the amount of nitrogen in the ammonia being excreted by the oysters quite closely matched the amount of organic nitrogen expected to be in the new-growth phytoplankton in the tanks with oysters. In other words, one conclusion drawn from Ms. Pietros’s experiment is that as the oysters were excreting ammonia, that ammonia in turn was instantly taken up and incorporated into the tissues of rap-

idly growing opportunistic species of phytoplankton. So was the water in Narragansett Bay substantially clearer at the turn of the 20th Century than it was at the turn of the 21st? Probably *not*.

These findings in no way diminish the ecological importance of oysters and other filter feeding bivalves within estuarine and coastal ecosystems. Bivalves have a profound role in controlling the boom & bust cycles of seasonal phytoplankton blooms, and the increased rates of sediment deposition to the bottom by bivalves are an important “coupler” between the water column and the bottom that stimulates the rates of decomposition and other processes in the sediments. Shellfish farmers and shellfish restoration biologists alike are making a good contribution to the management of coastal ecosystems by increasing the amount of shellfish in the water. After all, the thousand-fold decline of oyster populations on the

Eastern Seaboard of the United States and elsewhere due to overfishing and pollution during the 20th Century was a not an environmentally positive development. But, it is important to keep in mind that the whole story about the ecological role of bivalves is a bit more complicated than just the often heard simple shorthand of “bivalves are good filter feeders that can clean the water.” **END**



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