Clean the Bay with Shellfish

By Robert B. Rheault, PhD.

In the aftermath of the anoxia event and fish kill in Greenwich Bay last summer, Governor Carcieri formed a Narragansett Bay and Watershed Commission to evaluate the causes and propose options to improve the habitat and water quality of Narragansett Bay. Excessive nitrogen flowing into the bay (an estimated 9,000 tons per year) has been identified as one of the chief culprits of the fish kill. Excessive nitrogen leads to rich blooms of phytoplankton. These microscopic plants produce oxygen during the day, but at night they consume oxygen and when the blooms crash they can cause severely low oxygen levels.

While great strides have been made in cleaning up the bay since the passage of the Clean Water Act, we have not found an economic way to reduce the amount of nitrogen entering the bay.
The cost of removing nitrogen from sewage in a waste-water treatment plant is about $40 per pound. According to Rich Pelz of Circle C Oyster Ranch in MD (who has a patent on the concept of charging municipalities for Nitrogen removal by his oysters) it costs between $28 and $54 in MD to remove a pound of elemental nitrogen from sewage ($634 per pound of Phosphate). The average person releases about 12 pounds of nitrogen a year. The cost of nitrogen removal adds up quickly, so instead, much of the nitrogen is dumped into the bay in the form of treated sewage. One of the Commission's recommendations is to upgrade nitrogen removal capacity at the bay's 19 treatment facilities at a cost of several million dollars per facility. We hope many of these upgrades will be complete by the end of the decade.

Reducing fertilizer use and properly maintaining septic systems will also reduce the flow of nitrogen into the bay, but once the nitrogen gets into the water it is difficult to remove it. One approach is to use natural processes such as constructed wetlands. Another approach we should be looking at is enhancing the state's shellfish populations. Shellfish contain nitrogen in their shell and tissue and when we harvest shellfish we remove nitrogen from the waterway.

For a relatively small investment we could augment the production and harvest of shellfish, which would have substantial benefits to the health of the bay. By spreading cultured shellfish seed we can increase the natural stocks by as much as one hundred times. This can be done either by private shellfish farms or through public enhancement seeding projects. For every 2,000 oysters or clams that are harvested, about a pound of nitrogen is removed.

So what is the cost of growing and harvesting shellfish? The harvesting is free. Lots of people are willing to help out when it comes to gathering market-size shellfish, whether it is private aquaculture, or the wild harvest or recreational fisheries. The cost of producing seed varies, but if the state were to aggressively fund public enhancement projects the cost would be about $20,000 to $30,000 per million shellfish harvested. This translates to a cost of $40 to $80 per pound of nitrogen removed by harvesting. (See the calculations at www.ECSGA.org) If a private aquaculturist does the work the grower actually pays the state for the privilege of leasing a few acres of bottom.
There are about 0.2 grams of N in a 100gm (wet weight) oyster (about half in the shell and half in the tissue) - or approximately 0.2% nitrogen by weight. For argument's sake let's say clams and oysters are about the same. If five clams hold 1 gram of nitrogen, then 2240 clams hold a pound of Nitrogen.

So what is the cost of growing and harvesting 2240 clams? We can assume harvest is free - lots of people are willing to help out when it comes to removing market size shellfish, whether it is aquaculture or wild harvest or recreational fisheries.

Let's use the clam enhancement model and assume the state is feeling magnanimous and pays for all the upwellers, all the seed and maintenance costs (OK this assumption is probably a stretch but for the sake of argument let's go with it).

An upweller costs $4,000 to $8,000. Amortized over 5 years that is $1,600 / yr.
The labor to raise a million seed to field-plantable size (~20mm clam or 35mm oyster) is about $ 1,000/yr. Seed cost is about $5,000 -$8000 / yr.
Assume 30% to 60% survival to harvest (for lack of a better estimate).
So total annual cost is $10,600 and the annual harvest is 300,000 to 600,000 clams or oysters two to three years out. So you have removed about 134 to 268 pounds of nitrogen at a cost to the state of $40 to $79 per pound of N removed.

Plus you get all the economic activity, production, jobs, taxes...
The harvest value of 300,000 clams is about $40,000 (oysters would be about $100,000).

There are many ancillary benefits to enhancing shellfish production. Jobs would be created in the harvest and processing sectors as well as in the support services such as boatbuilding and outboard repair. The shellfish themselves would have a positive impact on water quality. Shellfish feed by filtering microscopic plants from the water column. A single adult oyster clears over 15 gallons a day and the combined efforts of millions of shellfish can have a dramatic impact.

Many millions of additional clams and oysters in an area like Greenwich Bay would result in improved water clarity, lower bacterial counts and diminished algal blooms. Shellfish also filter silt from the water, which lowers turbidity and allows better light penetration. This helps oxygenate deeper water and can improve eelgrass survival.

There would also be a massive flux of particulate material (phytoplankton) out of the water column into the sediment. The increased organic content of the sediment can lead to increases in denitrification rates (where nitrate and ammonia are transformed into harmless nitrogen gas by bacteria). According to a recent study by researchers in Virginia, nitrogen removal by bacterial denitrification associated with shellfish feces is substantial and can dwarf the nitrogen removed by shellfish harvests.

Tons of carbon are also sequestered in the shells of these delectable bivalves, effectively cutting down on the greenhouse gas carbon dioxide in the atmosphere.

Admittedly, even if we increase the shellfish harvest by hundreds of millions a year we will only be removing a small fraction of the 9,000 tons of nitrogen entering the bay annually, but every little bit helps. While we identify funding sources to implement the larger projects that the Commission recommends, we can start to take small, inexpensive steps right away.

If we lack the funding or technology to prevent nitrogen from entering the watershed then we need to work on ways to remove it. Augmenting shellfish populations may be the best, most cost effective approach.

Robert B. Rheault is the president of Moonstone Oysters, an oyster aquaculture operation in Narragansett, RI. He earned a Masters degree in Zoology from the University of Rhode Island (URI) and a PhD in Biological Oceanography from URI's Graduate School of Oceanography. Rheault currently serves as president of the East Coast Shellfish Growers Association and secretary of the Ocean State Aquaculture Association.