WATER ONLINE

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Four Zebra Mussel Myths And Where They Went Wrong

By David Hammond

Ridding water bodies and infrastructure of the invasive species is difficult and costly for water utilities and power generation facilities — a real concern that is complicated by fake news.

Zebra mussels are fearsome creatures, considering their small size. They are hardy. They breed in massive numbers. They spread rapidly. Their tenacity in clinging to hard surfaces such as intake screens and pipelines has earned them recognition as one of North America's most costly and damaging aquatic nuisance species.[1]

Like all fearsome creatures, zebra mussels come with their own set of myths. These are the stories we tell ourselves about zebra mussels, usually in preparation to battle them. They are not necessarily false stories, but they are not always true, either. Knowing the difference is critical to developing efficient and cost-effective zebra mussel management strategies.

Why Are Zebra Mussels A Threat?

Zebra mussels are considered an invasive species because they displace local species and disrupt the natural balance of the watersheds they infest. It is not uncommon for divers to find native mollusks completely smothered by zebra mussels. When so many zebra mussels breed and die, they litter shorelines with a carpet of razor-sharp shells that cut barefooted bathers and walkers.

Zebra mussels are also incredibly efficient filter feeders. One tiny zebra mussel can filter up to one liter of water per day. That may not seem like much, but the impact is significant when the zebra mussel population reaches thousands of individuals per square foot. Their filter-feeding often improves water clarity, but reduces the amount of food available to other organisms.

Mounting evidence even links zebra mussels to increasingly frequent and severe harmful algal blooms.[2] Zebra mussels can feed on green algae, while allowing less-palatable cyanobacteria to pass through their digestive systems. They also transfer nutrients either into the water column or to their pseudofeces, a process that can create a more favorable environment for cyanobacteria.

Economic losses from the zebra mussel invasion are especially severe for water treatment and power generation facilities. The annual cost of invasive mussel control at water treatment plants ranges from $44,000 initially to $30,000 after control procedures are optimized.[3] Estimates for power generation facilities are considerably higher, with nuclear power plants topping the list at a whopping $833,000 per year.[4]

Clearly, we must manage zebra mussels effectively when they are present and do our best to stop them from spreading further. To do so, it is important to understand the myths that can accompany them. Otherwise, these myths actually discourage fully informed decisions about when, where, and how best to control zebra mussels.

Zebra Mussel Myth #1: Zebra Mussels Cannot Be Eradicated

The notion that zebra mussels cannot be eradicated once they infest a lake appears again and again in the media. It often shows up before zebra mussels themselves are detected. Its purpose at this stage is to increase awareness, heighten vigilance, and instill fear. If you cannot get rid of zebra mussels once they arrive, you had better work hard to keep them out.

This is sound reasoning. Prevention programs involving boat inspections and Clean-Drain-Dry campaigns are the first and best lines of defense. Should prevention fail, however, the perception that zebra mussels are invincible can foreclose on opportunities to knock them out before they become firmly established. Rapid-response programs should be included as a second line of defense in zebra mussel prevention plans.

A growing body of evidence suggests that effective control and even complete eradication of invasive mussels is both feasible and cost-effective under certain conditions. The size of the lake and the extent of the infestation are key factors. For recently infested lakes larger than 500 acres, eradication appears achievable through rapid-response efforts (i.e., immediately treating the portion of the lake where invasive mussels have been discovered).

Rapid-response projects using chemical molluscicides have usually proven successful at eradicating invasive mussels within the treatment area. Zebra mussel larvae, called veligers, are actually very weak. Many introductions fail and die out. Even small additional pressures on a young population can prevent it from gaining a permanent foothold, especially if enacted within weeks or months, as opposed to years. Targeted treatments can fall short of expectations, however, if the treatment area is not large enough, and zebra mussels are later discovered outside the treatment zone.

Even when zebra mussels are discovered in more than one part of a lake, it does not always follow that there is a firmly established and reproducing population. Genomics research has taught us that invasive mussels may well come from more than one vector.[5] This is important because discovery of more than one group of mussels in a lake is sometimes used as a justification for canceling proactive control measures. Rapid-response efforts ought to remain on the table in these cases.

Lakewide treatments are more economical and practical for lakes of 500 acres or fewer. In 2010, the Army Corps of Engineers drained a 337-acre lake in Omaha, NE, to expose and kill zebra mussels. Although veligers were detected five years later, most people familiar with the case believe they were reintroduced after the lake was replenished.

Draining is not always practical, of course, but there are less-dramatic and less-drastic ways to eliminate invasive mussels. The Susquehanna River Basin Commission recently eradicated quagga mussels from an entire lake in Pennsylvania using a low-dose, ionic copper treatment. Posttreatment eDNA analyses and in situ sampling confirmed that the treatment eliminated the quagga mussel infestation with minimal impact on the lake's rich population of fish and other organisms. At 29 acres and 115 feet deep, the Pennsylvania lake is believed to be the largest waterbody from which quagga mussels have ever been eradicated.[6]

Potash has also been used to successfully eradicate invasive mussels from small lakes. Its cost is approximately four to 10 times that of ionic copper, and the molluscicidal effects linger for 10 to 30 years. Invasive mussels are unlikely to recolonize during this time frame, but neither will native mussels, crustaceans, or non-target zooplankton sensitive to high salt concentrations.[7] These ecological tradeoffs need to be considered, but potash is a viable option in some situations.

We are still relatively early in the learning curve of eradication experiences. Each project brings new lessons and insights, and there is tangible evidence that control is possible. Unfortunately, lakes larger than 500 acres that are fully infested are not currently good candidates for eradication. In those lakes, we must instead learn how best to manage invasive mussels.

Zebra Mussel Myth #2: Zebra Mussels Must Be Eradicated

Once zebra mussels or quagga mussels are widely distributed throughout a large lake, there is little hope for eradication with currently available methods. In these cases, it is important to let go of the myth that invasive mussels must be eradicated. This myth feeds a common, but mistaken, perception that control measures are costly and futile once invasive mussels are firmly established.

Managing zebra mussels in vital infrastructure such as water treatment plants obviously requires a more practical strategy. Intake structures and pipelines occupy only a small portion of most lakes, yet they attract large populations of invasive mussels. Targeted control of zebra mussels in these spaces is often the best that can be done and all that is necessary to keep water flowing.

This is Dave Taylor's approach. Taylor directs the Waurika Lake Master Conservancy District in Oklahoma. The WLMCD supplies water to six neighboring cities through 100 miles of pipeline extending from Waurika Lake. An unchecked zebra mussel infestation at the source would be devastating, but eradication from the lake is impractical. The lake covers thousands of acres and the cost to eradicate has been estimated at $12 million. Instead, the district treats its raw water for zebra mussels as it enters the pumping station. This prevents zebra mussels from colonizing the pipelines and infesting downstream water treatment plants, while keeping operating costs low.

A similar approach to high-value recreational areas makes better sense, both economically and environmentally, than simply canceling all control efforts once zebra mussels are established. Seasonal or periodic efforts to knock back zebra mussels around docks, marinas, and beaches could preserve these spaces for human use, while reducing the overall impact of the infestation on a lake's ecosystem. The same method that keeps zebra mussels out of water destined for our taps could help keep our beaches free of razor-sharp shells.

Zebra Mussel Myth #3: Zebra Mussel Control Systems Should Be Engineered

Good engineering is absolutely vital for the smooth operation of any water treatment plant or power generation facility, but time and zebra mussels wait for no one — not even engineers. Developing and installing new technologies takes time — sometimes years. Without immediate control measures in place, zebra mussels have that much more time to wreak havoc.

A single female zebra mussel can expel 40,000 eggs in a reproductive cycle and up to a million in a spawning season. The density of a zebra mussel colony can exceed 100,000 mussels per square meter. Their ability to multiply exponentially can quickly add up to disaster for unprepared utilities, especially in warmer climates, where spawning can occur year-round.

Early detection and rapid response are critical. As invasive mussels colonize new territories, it is not uncommon for utility staff to be mulling over control options when mussels are suddenly found deep within the pumping and treatment infrastructure. Engineered solutions like antifouling screens can take months to design and install and still leave downstream processes vulnerable. Prevention and control plans should account for this reality by including more immediate zebra mussel mitigation strategies.

Officials in Bell County, TX, acted quickly to control zebra mussels using a simple chemical feed system. The Bell County Water Control and Improvement District implemented a program that maximized uptime and eliminated zebra mussels from the entire length of their intake pipeline from Lake Belton. The program uses low doses of ionic copper for full durational control of zebra mussels. This brings up the final zebra mussel myth.

Zebra Mussel Myth #4: Copper Kills Fish

Copper is toxic to fish at high concentrations. That much is true. But copper is also a natural element that is approved for use in drinking water. When used efficiently, at concentrations well below the minimum for drinking water, it is not a threat to fish or to the larger ecosystem.

The myth that copper inevitably kills fish stems mainly from some unfortunate instances of overdosing with conventional copper sulfate (granular $CuSO_4 \cdot 5H_2O$), an inefficient method of delivering copper. When too high a dose is applied or too large an area of a lake is treated, fish can die from overexposure to copper ions or from oxygen depletion caused by bacterial decomposition of algae.

This is what happened in a Nebraska lake in 2008-09. High doses of copper sulfate were applied to the lake on two separate occasions. Subsequent tests indicated that the treatments were successful at eliminating zebra mussels, but 21 different species of fish died, totaling 40,000 pounds. Mussels were again detected in the lake in 2014, although it is not known whether they survived the treatments or were reintroduced. The project contributed to the perception that treatment with copper requires a willingness to sacrifice fish cohabiting the water body.

Not all copper is created equal, however. Liquid copper in the form of cupric ions (Cu++) has emerged as an environmentally friendlier and more surgical tool in the effort to stop zebra mussels. Formulated as the most biologically available form of copper, acid-stabilized ionic copper is effective against invasive mussels at substantially lower concentrations. Additionally, advancements in chemistry and treatment methodology now allow it to be dispersed in precise doses to avoid concentrations that would harm fish populations.

The Susquehanna River Basin Commission's experience in Pennsylvania shows that eradication of invasive mussels is possible with copper concentrations that are nontoxic to fish. Copper concentrations remained well below the U.S. EPA limit of 1.0 mg/L in open waters throughout the treatment. Post-eradication sampling showed that the fish and zooplankton populations in the lake continued to thrive, illustrating that ionic copper is a valuable weapon in the fight against invasive mussels.

Don't Be Myth-Led

Zebra mussels are fearsome creatures, but not as invincible as these myths make them out to be. Prevention is critical. Eradication is possible. Control is achievable.

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