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TEXAS braces for MUSSELL MENACE

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INTRODUCTION

Over the past few decades, invasive species such as giant salvinia, salt cedar, red fire ants, nutria and hydrilla have trespassed Texas, creating significant ecological and economic challenges. Each year, the Lone Star State spends millions of dollars fighting the spread of these species. This fight is growing with the spread of what could be one of the most costly invasive species – Zebra Mussels.

In 2009, zebra mussels were confirmed in Lake Texoma. Since that time, they have spread to six other Texas lakes, including Lakes Ray Roberts, Lewisville, Bridgeport, Belton and Lavon. The U.S. Geological Survey (USGS) also detected zebra mussel DNA in Lakes Grapevine, Fork and Tawakoni.[1]

In the 1990s, U.S. Congressional researchers estimated that zebra mussel infestation in the Great Lakes region cost industries, businesses and communities more than $5 billion dollars.[2] At the time, many biologists believed zebra mussels were a cold water species and could not survive in warm waters. However, these tenacious creatures have shown a remarkable ability to adapt and have spread to warmer climates. If they are left unchecked, the same scenario that happened in the Great Lakes area is possible in Texas, and these costs could be passed onto taxpayers.

BACKGROUND

Zebra mussels *(Dreissena polymorpha)* are small freshwater mollusks that originated in the streams of Russia. About the size of a fingernail, they get their name from a distinctive zebra-striped pattern commonly seen on their shell. They entered the United States in 1988 in Lake St. Clair through the ballast water of trans-Atlantic ships.[3] Soon, these mussels spread like wildfire due to their ability to reproduce quickly.

Mature zebra mussels produce hundreds of thousands of eggs a year during the reproductive season, with some females capable of producing up to a million eggs.[4] Once fertilized, eggs develop into microscopic veligers. These veligers free-float with currents for a few weeks and then quickly grow to adult size before attaching themselves to sand, silt and other hard surfaces using strong, elastic strings in their shells called byssals. Within a year, these adult mussels reproduce again, multiplying their population further.

With no natural predators, zebra mussels spread rapidly in the Great Lakes area, primarily by clinging to boats or other vessels that travelled between waterways. By 1990, zebra mussels were found in all the Great Lakes.[5] The following year, zebra mussels found their way into Midwest river systems fed by the Great Lakes. By 1994, more than 20 states reported records of zebra mussels in various water bodies. In recent years, nine more states have reported zebra mussel findings. Today, more than 600 lakes and reservoirs have zebra mussels.[6]

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EFFECTS OF ZEBRA MUSSELS

The ecological and economic effects of zebra mussels can be enormous. They can impact a lake and alter its ecosystem by filtering substantial portions of algae that are used by other animals in the food chain, causing a decline in local fish and bird populations. Their ability to rapidly colonize on any hard surface poses a significant risk to existing freshwater mussels. Zebra mussels attach themselves to the native mussel shells and make it impossible to feed, breathe or breed, eventually killing them. In addition to colonizing native mussels and clams, zebra mussels also attach to slow-moving species such as crayfish.

Recreational lake users are also affected. Zebra mussels colonize on hulls, engines and steering components of boats and other recreational equipment, and if left unchecked, can damage boat motors and restrict cooling. Boats can be impacted by increased drag caused by thousands of mussels. They can also make beaches hazardous with their sharp shells.

Zebra mussels also attach themselves to pipes and water intake structures, severely affecting the water supply industry. They can grow so densely that they can clog up intake screens, reduce pipe diameter and increase the roughness of pipes, which can lead to reduced water flow and other maintenance issues. In the 1990s, plants in the Great Lakes area reported significant reductions in pumping capabilities and occasional shutdowns.[7] From 1989 to 1994, facilities that used surface water in the Great Lakes region spent almost $120 million to control zebra mussels.[8]

Zebra mussels can also cause water quality issues. By filtering certain types of algae, the mussels clear up the water and allow sunlight to penetrate deeper, which promotes the growth of other types of algae that are deeper in the water. While these algae are killed during the treatment process, their by-products can lead to taste and odor issues in the water delivered to homes and businesses.

MONITORING IS CRITICAL

Given these impacts, early detection and monitoring for zebra mussels in a lake or reservoir is critical. A simple way to monitor zebra mussels is to examine the bottoms, edges and shorelines of streams or lakes. Rocks, crevices, docks, vegetation in the water, and outcroppings provide visual cues for adult mussels. Another method is tying a rope to a substrate, such as a concrete block or a brillo pad, and checking it periodically for zebra mussel colonization. In North Texas, USGS certified scuba divers search for juvenile and adult zebra mussels on water intake structures, boat ramps, marina flotation and support devices, or other submerged structures.[9] Advanced techniques include water sample collection with plankton tow nets to capture veligers followed by laboratory analysis, and water-quality sampling to measure physicochemical properties critical for zebra mussel survival and growth.[10]

RESPONSE PLANNING

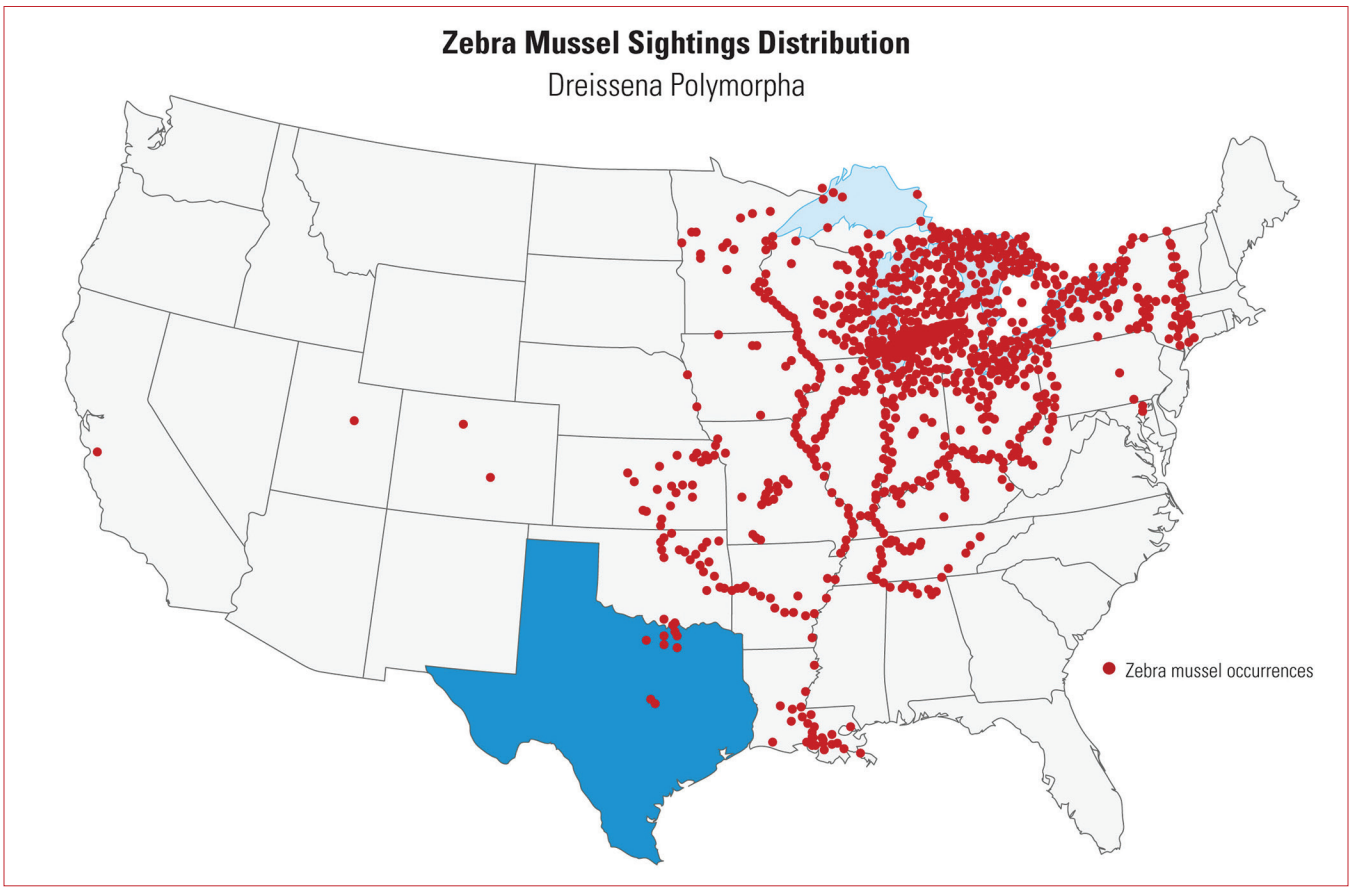
The USGS, Texas Parks and Wildlife Department (TPWD), and many other agencies and individual utilities are presently engaged in zebra mussel monitoring throughout Texas. The data, in addition to giving an account of the presence and location of zebra mussels, indicate how rapidly zebra mussels are moving within a river basin. For a surface water utility located in a river basin with zebra mussels, this information can be the basis for a proactive effort to assess the potential risk of zebra mussel problems. Response planning gives a utility a head-start on being prepared. The Great Lakes experience showed that zebra mussels can colonize very rapidly, leaving little time for an effective response. Surface water utilities that are potentially vulnerable to zebra mussels should consider preparing a response plan.

CONTROL STRATEGIES

Once zebra mussels are found, what should authorities do to prevent their colonization? This January, the TPWD enacted new regulations requiring boaters approaching or leaving waterways in 30 Central and North Texas counties to drain all water from watercraft, sailboats or any other vessel used to travel on public waters.[11] The rule was already in effect in 17 other Northeast Texas counties. Working with several water authorities in the state, TPWD also developed a public awareness campaign to remind boaters to clean, dry and drain their vessels before traveling from one lake to another.

When zebra mussels are present in a utility's supply source, some type of control strategy is needed to prevent zebra mussels from colonizing on and within intakes, pumps, raw water conveyances and treatment plant facilities. Control strategies must be carefully planned and designed to be effective and environmentally safe. Often, more than one control method needs to be incorporated using sequential or parallel operation. Some commonly used control strategies are:

- **Chemical Oxidants:** A popular and effective way to prevent zebra mussel colonization is using chemical oxidants. Chlorine is one of the most widely used agents because of its low cost and easy availability. Other chemical oxidants commonly used include bromine, sodium or potassium permanganate, and chlorine dioxide.



- **Electrical Current:**
  Another control strategy used to prevent zebra mussel settlement and attachment is applying a cathodic current on the system's steel surfaces. The electrical currents deter the mussels from settling.
- **Coatings:**
  Specialized coatings can also be effective in controlling zebra mussels. Metallic coatings such as zinc, copper and brass are toxic to zebra mussels and prevent them from settling.
- **Mechanical Cleaning:**
  Physical removal of zebra mussels from the surface using wire brushes, scrapers, or other means such as power washing is another alternative, especially if mussels have already settled on a structure.

Other control strategies that can be implemented include thermal, biological, copper ionization, ultra-violet radiation, filtration and acoustic vibration.

LIMITATIONS

While these control strategies prevent proliferation and colonization of zebra mussels in water supply systems, there are also limitations. To produce the best results, control strategies must be implemented after taking into consideration several factors such as the site, level of zebra mussel infestation, water quality, the type of facility and operation, costs, permitting requirements and environmental regulations. Water authorities need to consider the following limitations while determining control strategies:

- **Downstream Environmental Impacts:**
  If chemical injection is used, there can be side effects due to the discharge of toxic materials into the environment. For example, while chlorine is an effective chemical, it is also known to combine with various organic compounds to form by-products such as trihalomethanes (THM), a carcinogenic compound, in certain water chemistries.
- **Timing of Treatment:**
  Technically, systems need to be fully protected during zebra mussel spawning seasons, which are governed by water temperature. The ability to monitor and react at the proper time is important to an economical approach. Otherwise, authorities may spend money on chemical treatments that offer no real protection benefits.
- **Overprotection:**
  If cathodic protection is used, there is potential danger in over-protecting the system. If the applied charge is too high, then damage to the structure could occur. Accordingly, application of cathodic protection must be maintained in the correct range.
- **Vulnerability:**
  There are various ways to protect different systems (heat treatment, coatings, chemical injection, cathodic protection etc.). Application of these alternatives can be at different physical locations in the system. If not properly located and sequenced, portions of a system can be left under protected and thus more vulnerable to infestation.
- **Costs:**
  Strategies such as mechanical cleaning can be labor-intensive or effective only in places that are accessible, and they have to be done periodically. Also, it doesn't prevent the further proliferation of zebra mussels, which can result in additional cost and system impact. Additionally, removal and disposal of zebra mussel shells can be an issue. Other treatments such as thermal, microfiltration, coatings, and UV light can be expensive.

CASE STUDY

Following the discovery of zebra mussels at Lakes Ray Roberts and Lewisville, the Upper Trinity Regional Water District is taking a proactive and aggressive approach to protect their raw water facilities, including the Thomas E. Taylor Regional Water Treatment Plant, the joint intake pump station on Lewisville Lake, and the raw water pipeline from the intake to the plant.

To this end, the District hired Lockwood, Andrews & Newnam, Inc. (LAN), a planning, engineering and program management consulting firm headquartered in Houston, to perform a zebra mussel study and recommend appropriate control strategies. After a thorough evaluation of the facilities, LAN engineers, who have worked on more than 40 zebra mussel mitigation projects over the last two decades, recommended the following solutions:

- Coat the existing screens with a copper-based coating that complies with EPA standards for drinking water. The copper coating will minimize the colonization of zebra mussels on intake screens.
- Purchase a new coated screen. If colonization occurs, with a spare screen on hand an existing screen can be removed for mechanical cleaning and replaced with the new screen without significant interruption to service.
- Upgrade the existing cathodic protection system on the intake structure to serve as a repellant to the mussels.
- Inject sodium permanganate into the water at the intake structure to protect the raw water pipeline and downstream treatment facilities from mussel colonization

The combination of these strategies will optimize the District's ability to prevent or minimize zebra mussel colonization at the joint intake pump station, prevent zebra mussels

from establishing themselves in the raw water pipeline, and maintain appropriate raw water quality. Additionally, the District is also working with LAN to protect the Tom Harpool Regional Water Treatment Plant and a raw water pipeline it operates transferring water from Lake Chapman, in the event of a zebra mussel infestation in the future. Should that happen, the recommended approach is to inject sodium hypochlorite at a chemical storage and injection facility previously constructed upstream of the Tom Harpool Regional Water Plant. This will prevent zebra mussel buildup in the line and also at the plant.

From North Texas to the Gulf Coast, agencies and utility owners are evaluating response alternatives. Several owners have completed, or are completing, vulnerability studies to evaluate susceptible infrastructure in their respective systems. Others are planning a stepped or sequential response to zebra mussels as they continue to spread, with various triggers identified and responsive actions prepared for immediate action. LAN recently completed a comprehensive response plan for the Coastal Water Authority in the Gulf Coast region as part of permitting requirements by the Corps of Engineers. That plan is another example of risk identification and proactive asset management, preparing for the pending threat.

CONCLUSION

Abraham Lincoln once said, "Give me six hours to chop down a tree, and I will spend the first four sharpening the axe." In Texas, now is the time to sharpen the axe for this fight. The big questions utility owners face are (1) when to start sharpening and (2) how sharp does the axe need to be. Those answers will be unique to various owners, but while it may be impossible to eradicate zebra mussels, preventing their colonization within facilities and limiting the economic impact is possible. A victory on that front will require state authorities, municipal water suppliers and concerned citizens working together to first sharpen, then wield the right axe.

"WHILE IT MAY BE IMPOSSIBLE TO ERADICATE ZEBRA MUSSELS, PREVENTING THEIR COLONIZATION AND LIMITING THE ECONOMIC IMPACT IS POSSIBLE."

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