

THE ZEBRA MUSSEL

An Unwelcome Irrigation System Invader

By ALEX LUDWIG
CGIA

The Zebra Mussel (*Dreissena polymorpha*) is a new invader of North American fresh surface waters that has the potential to pose a serious threat to golf course irrigation systems, agricultural and non-agricultural irrigation systems, and other industries throughout North American fresh surface waters. The following article will touch on the Zebra Mussels origin, introduction to North America, biology, impacts on irrigation systems, and methods of control.



ZEBRA MUSSELS

Origin / Introduction to North America

In 1769, the first described populations of Zebra Mussels were reported in Asia within the drainage basins of the Black, Caspian and Aral Seas. By the late 1700s, they had expanded their range into inland waterways throughout Europe. Zebra mussels were first discovered in the Great Lakes region of North America in 1988. It is believed that trans-oceanic ships originating from overseas freshwater ports carried the mussels in freshwater ballast that was discharged into freshwater ports of the Great Lakes. By 1994, the zebra mussel expanded its range to incorporate the Mississippi, Illinois, Tennessee, Ohio, St. Lawrence, Mohawk, Hudson, and Susquehanna Rivers, the Erie Canal, and the Finger Lakes region of New York State. While their expanding range still continues, it is predicted that zebra mussels will ultimately infest most freshwater areas of North America. This increased distribution range can be attributed mainly by human-mediated means, such as ships and other vessels, fishing activities, amphibious planes, and recreational equipment.

Biology / Life Cycle

Zebra mussels are small (2 inches and smaller) bivalve mollusks with elongated shells typically marked with alternating light and dark stripes, hence the name zebra. However, their marking pattern can vary greatly to where there are no stripes at all. The mussels grow to their maximum size by the first year, and live an average of 3 to 5 years. Their life cycle can vary dramatically based on environmental conditions but in general it is as follows: eggs (up to 1 million produced annually) are expelled by the females into the water, and fertilized by the males usually in the spring and summer, depending on water temperature. Fertilized eggs are typically 40 to 70 microns long and emerge as veligers (larvae) in 3 to 5 days and are free swimming for up to 1 month. Veligers then start settling to the bottom where they crawl about by means of a foot, searching for a suitable substrate (water intakes, bedrock, boat hulls, etc.) to attach to. Veligers can experience upwards of 99% mortality due to hypoxia, temperature shock and failure to locate a suitable substrate while settling. A successfully attached juvenile zebra mussel starts developing the typical double shell appearance. Juveniles are able to detach and reattach to substrates by means of byssal fibers near the foot, but as they approach adulthood and sexually mature, they

become sessile. Only about 2 percent of all zebra mussels survive to adulthood. Zebra mussels can tolerate a wide range of environmental conditions. They inhabit freshwater, and in some instances brackish water usually at depths of 6 to 25 feet, and in some instances at depths up to 160 feet, depending on light intensity, water temperature and availability of food. The major factors that limit the abundance and distribution of zebra mussels are temperature, pH, dissolved oxygen and calcium content.

For reproduction, zebra mussels prefer water temperatures between 68° and 77°F, pH to be between 7.4 and 8.7, oxygenated waters above 25% saturation, and calcium (Ca²⁺) levels above 25 ppm (parts per million). Interestingly, zebra mussels have invaded all 11 Finger Lakes in New York State except for Canadice Lake. It is believed the low levels of dissolved calcium in the lake water are inhibiting its establishment.

Impacts on Golf Course Irrigation Systems

The main impacts associated with zebra mussel colonization of golf course irrigations systems include: increased electro-corrosion of steel and cast iron pipe and fittings; loss of intake head;

"The main impacts associated with zebra mussel colonization of golf course irrigations systems include: increased electro-corrosion of steel and cast iron pipe and fittings; loss of intake head; obstruction of valves, pipe, sprinklers and irrigation components."

obstruction of valves, pipe, sprinklers and irrigation components. Zebra mussels colonize in various parts of the irrigation system including water intakes, turbines, pump end screens, box screens, wet wells, strainers, and surfaces of pipes thus diminishing the flow rate through these components. Unless preventive measures are taken, these infestations can lead to costly repairs. Water intakes and pipe networks are ideal mussel habitats. The continuous flow of water into intakes and throughout the piping system provides the mussels with a continuous source of food and oxygen, while the structures themselves protect the mussels from predation and ice scour. Adults have a difficult time attaching and remaining attached when water velocities exceed 6.6 ft. per second, but in the case of good irrigation system design, velocities of 5 ft. per second should not be exceeded. When mature zebra mussels die, they detach and are carried downstream where they can end up trapped at the base of a sprinkler head. Both alive and dead, the zebra mussel can wreak havoc on an irrigation system, so various control measures must be taken.

(Continued on Page 12)

Zebra Mussels -

(Continued from Page 11)

Methods of Control

Great Lakes industries have spent millions of dollars combating and preventing zebra mussel damage. There have been many control methods investigated to combat these problems, but little research on the effects, impacts and control within golf course irrigation systems has been done. Depending on the situation, some methods work better than others. Many of these control measures are extremely costly and detrimental to the environment. Below is a list of different control methods for the removal of existing colonies and the prevention of further infestations. I will only discuss in detail the ones that may be applied to golf course irrigation systems.

Filters & Screens

Inline filters and screens are very effective in keeping adult zebra mussels out of distribution lines, but the veligers are too small for filters and screens to work. The filter or screen mesh size would need to be 40 micron or smaller to keep the tiny veligers out. This size mesh would most likely result in loss of head in distribution lines, or the filter or screen would constantly be cleaning and backwashing thus handicapping the system efficiency. Filtration of intake water at the source can be accomplished through the use of several different forms of buried intakes or sand filters. These types of intake filters known as Ranney Wells, are either drilled vertically and laterally into a good sand or gravel aquifer near a lake or river. Ranney wells consist of porous intake pipes laid in trenches excavated into the bed of a lake or river and backfilled with a graded sand and gravel media (infiltration galleries); or are comprised of a flowing water source entering a surface trench or basin filled with a graded sand and gravel media with the pumping conduit either beneath the trench and basin, at the outflow end, or in the center (surface sand filter).

Acid Injection

Golf courses equipped with acid injection stations can inject a nitrogen-based acidic liquid to their irrigation system. The acidic liquid must lower the water pH below 6.9 to prevent veligers from surviving. The bullet points below give you an idea of the effects of differing pH levels.

- ☐ Below 6.8 - low risk of infestation
- ☐ 6.8 to 7.4 - moderate risk of infestation
- ☐ 7.4 to 9.0 - high risk of infestation
- ☐ 9.0 to 10 - low risk of infestation
- ☐ Threshold value for adult survival 6.5
- ☐ Threshold value for veliger survival 6.9
- ☐ Incipient lethal level for veligers 7.4
- ☐ Value for massive infestation 8.0

Chemical Oxidants

(Chlorine, and Potassium permanganate (KMnO₄))

Chlorine: The use of chemical oxidants, particularly chlorine has been used widespread for the control of zebra mussels in distribution pipes and water intakes. Chlorine can be introduced into a system in three ways: gas (chlorine dioxide (CL₂)); liquid (sodium hypochlorite (NaOCl)), and solid (Ca (Ocl₂)). Chlorine dioxide gas (CL₂) is drawn into the system from the tank by a vacuum created from the flow of water past the emitter (where

the chlorine is mixed with water). A sodium hypochlorite (NaOCl) solution is introduced into the system as a liquid via a chemical feed pump. The solid Ca (Ocl)₂ granules. Chlorine should be introduced into the system as soon after discharge as possible so that all components are safe from infestation. Chlorine should be introduced into the irrigation system continuously while irrigating. Feeding the system continuously will mean that whether the system is running or at rest, the water will still contain chlorine to keep zebra mussels from attaching and developing. Potassium permanganate (KMnO₄): Potassium permanganate has also been considered a viable method to control zebra mussels in distribution pipes and water intakes. It is generally mixed with water in a slurry tank and dispensed into the system via a chemical feed pump. Studies show that intermittent shock treatments with chemical oxidants are less effective than continuous treatment. In the intermittent treatments, the zebra mussels closed their shells when exposed to the oxidant and opened them after the treatment, thus effectively avoiding the treatment. However, it does not appear that mussels can ensure their survival by keeping their shells closed during continuous exposure to oxidants. They eventually open their shells and become exposed to the oxidant.

Dewatering & Desiccation

(freezing, heated air)

When irrigation systems are winterized (dewatering), the warm air from the compressors desiccates the adult zebra mussels and they soon die and detach from the substrate. With severe infestations, this method will require a control measure described below called Flushing.

Flushing

Some golf courses have such severe infestations that flushing is needed. Established zebra mussel colonies that are killed from dewatering and desiccation during winterization, or chemical shock treatment, are carried to the base of sprinkler heads during spring irrigation system start up, and severe clogging can occur. This mandates that sprinklers and quick coupling valves be removed, so the irrigation system can be flushed with water.

Mechanical Removal

The zebra mussel infestation of water intakes and distribution pipes can seriously limit the water flow to irrigation systems. Mechanical removal of the mussels, and or replacing certain components might be required to restore the original flow.

Coatings

(toxic and non-toxic)

Toxic antifouling coatings can be applied to water intake screens, valves and pipes. These coatings incorporate compounds such as cuprous oxide or tributyl tin oxide (TBTO), which are harmful to non-target species. Local agencies may prohibit or regulate the use of toxic coatings on water intakes. Research has found that only a few non-toxic coating types have been effective at preventing or reducing water intake fouling: soft silicone "foul-release" paints, hard copper-epoxy paints and zinc galvanizing.

Construction Materials

Pipe and components that are constructed of copper, brass,

(Continued on Page 13)

Zebra Mussels -

(Continued from Page 12)

and galvanized metal can act as deterrents to zebra mussel attachment because of the toxic nature of certain metal ions. Low free surface energy plastics with frictionless properties like ultra-high molecular weight (UHMW) polyethylene, and silicone rubber m-polymer are available in sheets, coatings, or as fabricated components.

Ultraviolet Light

Medium pressure mercury lamps (MP) generating high intensity UV light have been proven successful in inhibiting the settlement of veliger zebra mussels in water intakes.

Ozone Treatment

Dissolved ozone in water solution is pumped into the water intakes where it is blended into the intake water. Research has indicated that ozone treatment is an effective process for veliger zebra mussel control.

"The zebra mussel is now well established throughout the Great Lakes and their connecting channels, as well as in numerous inland river and lake systems in North America. There is no way to eliminate the small mollusk in these surface waters without harming other life forms, so we must assume that the zebra mussel is here to stay."

Summary and Conclusions

The zebra mussel is now well established throughout the Great Lakes and their connecting channels, as well as in numerous inland river and lake systems in North America. There is no way to eliminate the small mollusk in these surface waters without harming other life forms, so we must assume that the zebra

mussel is here to stay. While their expanding range still continues, it is predicted that zebra mussels will ultimately infest most freshwater areas of North America. The task now is to control its impacts on ecosystems and water uses. The article above will give readers an introduction to the zebra mussel and its control in golf course irrigation systems. Note that new control alternatives will most likely be developed as a result of the invasion of the zebra mussel into North America.

Readers should supplement this fact sheet by referring to research reports available from Sea Grant, federal, state and local environmental management regulatory agencies, and researchers. Listed below are a few resources on zebra mussels.

Superior Tech Products

Call US. We cover most of your needs.

Soft Goods

Floratine
GroPower Organics
Turf Health Liq. Fert
Turf Health Gran. Synthetics
SipcamAdvan

Hard Goods

GreensGroomer
Turfline
JRM
DryJect
Soil H₂O Meter

Testing Services

Soil, Water, Disease, Tissue & Physical Soil.

952-546-3678

Fax 952-542-9187

1-866-896-3678