

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

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.

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

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.

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Zebra Mussels -

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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,

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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.

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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.



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Konzem Named GCSAA Chief Operating Officer

Richard Konzem, who has more than 30 years of managerial experience, primarily in intercollegiate athletics, has been named chief operating officer for the Golf Course Superintendents Association of America (GCSAA). Konzem officially began on October 17.



Konzem comes to GCSAA from Rockhurst University, located in Kansas City, Mo., where he has served as director of athletics since November 2007. During his tenure at Rockhurst,

Konzem served on the NCAA Division II Men's Golf Regional Advisory Committee and had student-athletes from eight of 11 teams compete in NCAA postseason.

"I am pleased and excited to have Richard join the GCSAA team," GCSAA Chief Executive Officer Rhett Evans said. "He has an impressive track record of success supporting and facilitating a performance-driven culture among a group of diverse and talented individuals. That will

serve the association well as he oversees the day-to-day operations of association programs with a focus on serving the GCSAA membership."

Konzem will be responsible for developing, implementing and executing key member programs that support the achievement of the association's mission, vision and operational goals. He will serve on the association's executive team and oversee the professional development; membership; strategic communications; corporate marketing, sales and business development; environmental programs; and events and meeting planning departments. He will also represent GCSAA in a variety of industry and allied association events, programs and activities.

"I am honored to join the GCSAA staff and look forward to working with it, the board of directors and members," Konzem said. "As an avid golfer, I have the utmost respect for the professionals who manage the game's playing field. It is certainly a challenging profession, and one of great value to the industry."

Konzem began his career in fundraising and event management in the University of Southern California Trojan athletic department. He returned to his

undergraduate alma mater in 1981, serving in a variety of capacities for 23 years. He rose to the position of senior associate athletics director, including a stint as interim athletics director in the summer of 2001. He was a primary sports administrator at KU during six NCAA Final Four appearances in basketball including the 1988 NCAA Championship, three bowl games, and a College World Series in both baseball and softball.

As senior associate athletic director at Kansas, Konzem supervised men's and women's basketball, football, baseball, the Williams Educational Fund (with \$5 million in annual scholarship donations), athletic ticket staff and the events and facilities staff. Konzem recently completed terms on the Kansas Sports Hall of Fame Board of Directors, the Sunflower State Games Board of Directors, the United Way of Douglas County and the City of Lawrence Parks and Recreation Advisory Board. He was a member of the Leadership Kansas Class in 2004. Konzem and his wife, Debbie, chaired the 2006 United Way Campaign in Lawrence, raising \$1.65 million. He was also the media coordinator for the Kansas Open Golf Tournament (1991-96).



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Before Grass, Greens Came in All Varieties

By JAMES HANSEN
Superintendent News

In the early 1900s putting greens in America were not necessarily made of turf, nor were they necessarily green. For some early golf courses, builders simply scalped off areas of suitable size for the putting surfaces.

For others, especially in the south and southwest, greens were made of sand. In some cases, such as Donald Ross Pinehurst Number 2 Course, the sand was oiled; but in most cases it was not. (Pinehurst kept its sand greens until 1935 when Ross replaced them with grass during a complete remodeling. Sawdust was even used with fair results.

In 1921, two of the country's leading turfgrass specialists, Charles V. Piper and Russell A. Oakley of the U.S. Department of Agriculture, wrote in the U.S. Golf Association's Bulletin of the Green Section that, "it is surprising indeed the more experimentation along this line (i.e. the

use of waste products) has not been conducted since there are so many parts of the country where grass greens cannot be maintained or can be maintained only at a prohibitive cost."

One of the most curious materials ever to be used for a putting green was cotton seed hulls. In the late 1910s, in north central Mexico, an Anglo-American cotton company built a course with cotton-seed hull greens near Tlahualilo, about forty miles from Torreon.

Maintaining grass greens in the dry bed of a prehistoric lake, in a region receiving less than eight inches of rain annually, was out of the question - as were sand greens because of the high winds. So the manager of a cotton business, T.M. Fairbairn, turned to a product that he had in abundance and had to dispose of anyway.

One might think that the outer shell-

like covering of cotton seed would make a pretty rough surface, but the USDA observer who putted on the greens wrote that they were "a fast surface very much like that of a billiard table." A considerable amount of lint came with the hulls, binding the mass together. Few weeds penetrated it. It also shed water from the occasional rainstorm and stood up to strong winds.

Cottonseed greens were tried in various locations in the deep south in the 1920's, notably in Texas and Alabama. The basic technique of surface construction involved placing the hulls on the ground, tamping them by hand, and then rolling them into a mat.

(Editor's Note: This article was re-printed from the December 1999 issue of Superintendent News.)

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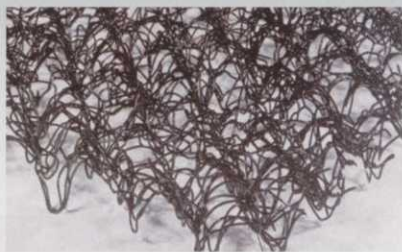
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IMPORTANT INFORMATION ABOUT THE AMMONIUM NITRATE SECURITY PROGRAM

By **JOE SPITZMUELLER**
Minnesota Department of Agriculture

The Department of Homeland Security (DHS) Ammonium Nitrate announced rulemaking to establish an ammonium nitrate security program; part of DHS's efforts to secure potentially dangerous materials. A DHS flier containing a schedule of DHS listening sessions on the proposed rule is available, although no sessions are scheduled in Minnesota.

Little ammonium nitrate is used in Minnesota, however, this information may be useful.

More information about the Ammonium Nitrate Security Program is available on the DHS web page. The link is <http://www.dhs.gov/files/programs/ammonium-nitrate-security-program.shtm>.

(Editor's Note: Joe Spitzmueller can be reached at 651-201-6546 or joseph.spitzmueller@state.mn.us.)



THE IMPRELIS HERBICIDE ISSUE, captured the attention of an interested crowd at the September 15 MTGF / UM Field Day at TROE Center in St. Paul.

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MGCSA NEWS

By SCOTT TURPINEN

Executive Director

Minnesota Golf Course Superintendents' Association

The MGCSA website is in the process of being upgraded. You will soon see a Shopping Cart and a Member's Only Section. This section ensures privacy and enables members to register and pay for events via the website. Information that only MGCSA members can access will be available in this section, such as Superintendent job postings. The program is called ppSD2. It is an unencrypted, PHP/MySQL-based software solution to control access to content.

MGCSA LOGO SHIRTS

MGCSA logo golf shirts are now for sale. An order form can be found at www.mgcsa.org. Assorted colors are available.

AWARDS & RECOGNITION BANQUET SET DEC. 7

Committee Chair Scottie Hines, CGCS, Windsong Farm Golf Club, and Host Superintendent Tom Proshek have the Annual MGCSA Awards & Recognition Banquet set for December 7 at Brackett's Crossing Country Club in Lakeville. Invitations will be mailed to MGCSA members in November.

MGCSA HOSPITALITY NIGHT AT GIS IN LAS VEGAS

The GCSAA Golf Industry Show is set for Feb. 27 through March 2 in Las Vegas. The Trade Show will be held Feb. 29 - March 1. The Hospitality Night is scheduled on Wed., Feb. 29 at Gordon Biersch from 6:30 -9:30 pm. Registration forms and sponsorship opportunities will be forwarded in December and January.

JOB POSTINGS & CLASSIFIED ADS

A valuable tool for members are our Job Postings and Classified Ads sections on www.mgcsa.org. If you post a job or an ad, please contact the office when the position has been filled or the equipment has been sold or obtained.

SUPERINTENDENT JEFF PINT TAKES 7TH AT MID-AM

Jeff Pint, Superintendent at New Prague Golf Course and a 5-time MGCSA champion, finished tied for 7th place in the 24th MGA Mid-Amateur Championship by shooting rounds of 77, 74 and 79. Pint is tied for 59th place in the yearly MGA Player Point's race.

WHERE ARE YOU?

A major issue for associations in general and the MGCSA in particular is a decline in attendance at MGCSA-sponsored events. This year, attendance at the monthly meetings have been about 50-60% of previous years. This is also an alarming trend of other associations throughout Minnesota and the United States. The MGCSA Board discussed possible reasons for low attendance, including: a challenging summer, lower budgets, smaller staffs, taking time from work, and paying for their own expenses. Please take a minute and email your thoughts to the MGCSA office or any Board Member.

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Musser Turf Foundation Launches Website Simplifying Grad Student Award Program

The Musser International Turfgrass Foundation has launched a website, www.musserfoundation.org, to make information about the group's mission and graduate student award program easily available to all interested parties.

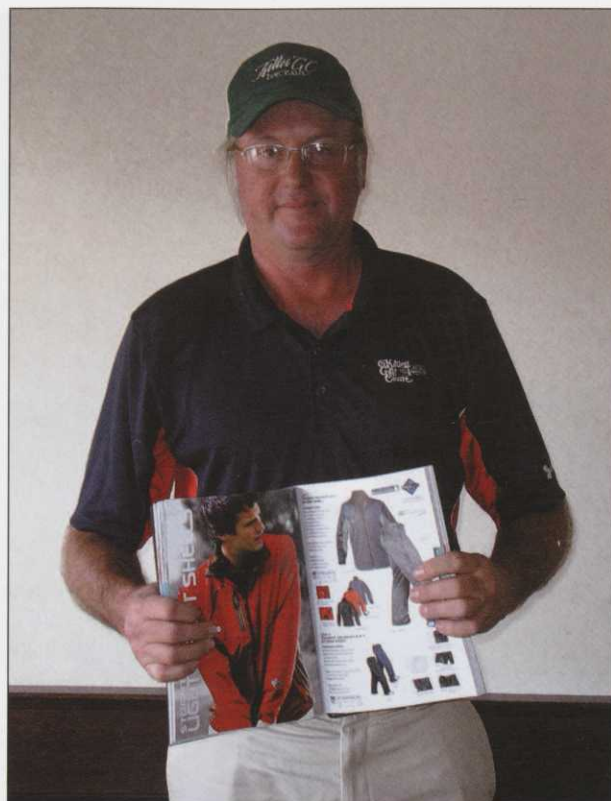
Frank Dobie, the General Manager/ Superintendent of The Sharon Golf Club (of Ohio) and President of the Musser Foundation Board, said the site will make it easier for turf doctoral candidates and others in the industry to find out more about the organization and the process of applying for the prestigious Musser Award of Excellence. "We're pleased that we're now able to effectively spread the word about the Foundation to more potential applicants, supporters and those with an interest in the history of turfgrass research," said Dobie.

In addition to information on

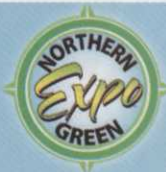
the mission, history and application process, the site also includes a list of previous Award of Excellence recipients dating back to 1989. Many of the past recipients are now leading agronomic researchers and educators at universities and other institutions around North America.

The Foundation has also recently created a Facebook page (Musser International Turfgrass Research Foundation) and a Twitter feed (@musserturfgrass) to allow individuals to keep up to date on the group's activities.

The Musser International Turfgrass Foundation is dedicated to fostering turfgrass management as a learned profession. Named in memory of turfgrass scientist H. Burton Musser, the Foundation acknowledges and rewards those individuals who have demonstrated excellence in the doctoral phase of their turfgrass science education and research.



BRETT WENZEL, an Assistant Superintendent at Keller Golf Course, won rain gear from CycleWorks Golf Supply in a raffle at the 2nd Annual Wee One Benefit Golf Outing at North Oaks Golf Club on October 3.



Highlights from the Northern Green Expo 2012 Seminar Schedule

Below is a selected list of topics geared toward golf course superintendents that will be highlighted at the Northern Green Expo in January 2012!

Management

- Keynote: Radical Engagement for Greater Results
- Golf: Managing your Manager, Committee and Boards
- Time Management Techniques for the Green Industry

- Developing a Sustainable Golf Course Model
 - Pesticides, Perception and Society
 - Should Henry Be Out There?
 - Most Common Problems Encountered During Golf Course Site Visits

- Uncovering the Architectural History of Your Golf Course
- Golf Course Design, Renovation, and Maintenance & Local Case Studies
- Human Resource Management: In Focus

Turf

- Waitea Patch Management Strategies
- Turfgrass Research Update
- Identifying and Troubleshooting Turf After Cut Appearance Issues
- Biorational Control of Dollar Spot
- Turf Weed Control: New Products
- Calibration Calculations, Equipment and Applications
- Golf Course: Growing Great Turf in the Shade
- Pesticide Recertification (A & E)

Grounds

- Stormwater Management: Reclamation & Re-Use - Target Field Case Study
- Back to the Basics: Asphalt & Concrete
- Raingarden Maintenance
- Creation and Protection of Wetlands
- Small Engine Repair
- Maintaining Natives

Water

- Irrigation Basics – The Occasional Repair
- Wire Locating/Tracking
- Irrigation Troubleshooting: 2 Wire
- Weather Based Controls
- Water Conservation/Efficiency
- Aquatics Recertification (F)



A complete schedule-at-a-glance can be found online at www.NorthernGreenExpo.org.