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ZEBRA MUSSELS

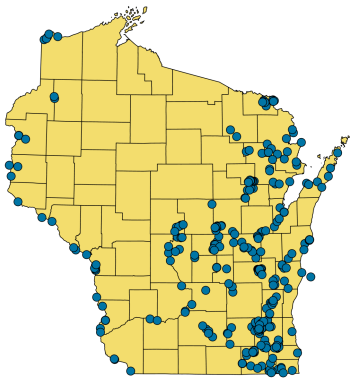
What are zebra mussels?

Zebra mussels (*Dreissena polymorpha*) are small (1/8-inch to 2-inch) mollusks native to the Caspian Sea, Black Sea, and Sea of Azov. They were accidentally introduced into the Great Lakes in the mid-1980s, most likely as larvae (also known as veligers) in discharged ballast water of commercial cargo ships, and spread to inland waterbodies through recreation, research, connectivity, etc. Zebra mussels have a distinctive "D"-shaped shell with alternating dark- and light-colored zigzag stripes, similar to a zebra. Spawning begins in the spring when water temperatures reach 12°C (~54°F). They are dioecious, meaning that male and female reproductive organs are on to a separate individuals, and they reproduce by releasing eggs and sperm into the water column. Female zebra mussels can produce up to 1 million eggs per year. The larval veligers hatch in 3 to 5 days and develop byssal threads (strong, rootlike protein structures) soon afterwards, which allow them to attach tightly to surfaces. Veligers can spend up month free-floating in the water column before finding suitable habitat to attach onto using their byssal threads. The free-floating larval stage, large number of offspring zebra mussels, and byssal attachment allows them to quickly spread and establish throughout a waterbody following introduction.

Adult zebra mussel (photo credit: USGS)

Where are they found?

Zebra mussels are found in all the Great Lakes, along the Mississippi and Wisconsin Rivers, and about 300 inland lakes and rivers, most of which are located in the southern and eastern portions of the state. They are often found on hard surfaces, like rocks, docks, shells, and wood, but can attach to any solid surface, including submerged aquatic plants, native invertebrates, and each other. Zebra mussels thrive in hard-water lakes and need calcium to build their shells, grow, and reproduce. Researchers applied a zebra mussel habitat suitability model to >11,500 lakes across Wisconsin and the Upper Peninsula of Michigan. They found that many of the study lakes were unsuitable for zebra mussel establishment due to low calcium levels (< 10 mg/L). An interactive map of the study lakes and their suitability classifications can be found in the UW-Madison Center for Limnology's AIS Smart Prevention Tool.



Wisconsin lakes and rivers with verified zebra mussel populations as of 2022

How do zebra mussels differ from quagga mussels?

Zebra mussels are similar to quagga mussels (*Dreissena bugensis*), another invasive mollusk species introduced to the Great Lakes via ballast water. Quagga mussels are slightly larger and rounded. Quagga mussels are also generally paler in color near the shell hinge. While both mussels have similar impacts on lake ecosystems, quagga mussels don't attach to hard surfaces like zebra mussels and are able to colonize a wider range of habitats. Quagga mussels can survive lower oxygen and temperatures allowing them to inhabit deeper water. While byssal threads allow zebra mussels a higher rate of spread, quagga mussels have mostly displaced zebra mussels in the lower Great Lakes. Quagga mussels were documented in Lake Geneva (Walworth Co.) in 2024, which is the first inland Wisconsin lake where they have been verified.

Adult zebra mussel (left) and adult quagga mussel (photo credit: USGS)

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How do they spread?

Zebra mussels can hitchhike on boats and trailers, allowing them to travel long distances between waterbodies. They may also be attached to any unremoved plants or hiding in mud. Adults can survive outside of water for several days in moist conditions. Zebra mussel veligers can also be carried to other waterbodies by currents or by residual water left in boating and fishing equipment (e.g., live wells, bilge pumps, engine cooling systems, bait buckets).

Photo credit: Paul Skawinski

What are the impacts of zebra mussels?

Zebra mussels are very effective filter feeders and can impact plankton and algae populations. While their presence can lead to a temporary increase in water clarity, they may deplete the food supply for fish and other aquatic organisms. Additionally, zebra mussels avoid consuming blue-green algae, potentially increasing the likelihood of toxic harmful algal blooms. Zebra mussels can attach to the shells of native mussels, effectively smothering them and negatively impacting their population. Zebra mussels can clog pipes, damage recreational equipment, and cut swimmers' bare feet. Since the byssal threads are so strong, removing them from docks and other hard structures can be very difficult and time-consuming; a handheld paint scraper may be helpful in dislodging attached zebra mussels.

Long term population dynamics of zebra mussels are often unpredictable. Zebra mussel populations can rapidly increase following introduction, but in some instances have been subsequently observed to decline in the following years. For example, zebra mussel populations have sharply declined in Lake Michigan within the past 15 years. Every lake ecosystem is unique, so it is impossible to anticipate how a zebra mussel invasion might impact any individual lake.

What can be done to manage them?

Reporting invasive species is a first step towards containing their spread, and implementing simple aquatic invasive species prevention steps can reduce impacts from invasive species even when other management options are unavailable. Currently, there are no viable options for zebra mussel eradication in lakes or rivers. While several pesticidal control options have been developed, including copper compounds (EarthTec® QZ), the bacterium *Pseudomonas fluorescens* strain CL145A (Zequanox®), and potassium chloride (potash), they are often prohibitively expensive and there are very few in-lake scientific studies on their efficacy when used for zebra mussel control. Of the experimental studies that have been done, all show that complete elimination of zebra mussels in lake systems is likely impossible even if zebra mussels appear to be confined to one small area of the lake. Additionally, some products may be harmful to native plants and animals; copper compounds are toxic to fish and aquatic invertebrates, and *Pseudomonas fluorescens* strain CL145A can be toxic to both fish and bivalve larvae/juveniles. Due to the lack of documented long-term control efficacy, as well as the potential risk to non-target species, the Wisconsin Department of Natural Resources (DNR) does not currently support the use of pesticides to control zebra mussels in lakes or rivers. However, the DNR is closely following progress on the research and development of new zebra mussel control technologies and will continue to reevaluate new information and products as they become available; learn more about zebra mussel control research being conducted at the Minnesota Aquatic Invasive Species Research Center. Any product which claims to kill, control, repel, mitigate, or prevent zebra mussels would be considered a pesticide and must be registered with the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP). In addition, the proposed use of any pesticidal product in a Wisconsin waterbody would also require an approved Chapter NR 107 permit for the control of aquatic organisms.

Physical control options (e.g., benthic mats, manual removal, water level drawdown, dredging) may be effective at controlling zebra mussels at a localized site or structure. However, like the currently available pesticidal control options, they are often expensive and can have negative impacts on native plants and animals. In addition, some of these physical control options may also require an approved permit from the DNR Waterways program.

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How can I help prevent the spread of zebra and quagga mussels?

The best way to keep a lake free of zebra and quagga mussels is to prevent their establishment by draining any residual water from your boat and recreational equipment before leaving a waterbody. If you visit a lake that is known to have zebra or quagga mussels, it is also recommended that you take one of the following decontamination steps:

- Clean your boat and equipment with high-pressure hot water, or
- Saturate boat and equipment surfaces with a ~500 ppm bleach solution (approximately 2 ½ tablespoons of household bleach (5.25% sodium hypochlorite) in 1 gallon of water) for 10 minutes, or
- Allow your boat and equipment to dry out of water for at least 5 days.

Lakefront property owners should take the same precautions when moving structures between lakes. If you buy a used dock, swim raft, or boat lift, make sure to inspect and decontaminate it before moving it from one waterbody and placing it in another.

Property owners on lakes with zebra or quagga mussels can protect their boats and equipment from damage by keeping the equipment out of water when not actively in use. If your boat is moored, you can protect your engine from mussel establishment by running it at low speeds (~4 ½ mph) at least twice a week for 10-15 minutes. Veligers may plug engine intakes on a boat left in the water; you can contact an engine repair facility for advice on clearing them.

The Clean Boats, Clean Waters (CBCW) program provides an opportunity for lake groups concerned about aquatic invasive species spread to educate recreational users about prevention steps they can take; learn more about the program and how you can get involved here.

The Wisconsin Citizen Lake Monitoring Network (CLMN) supports volunteers monitoring lakes for zebra and quagga mussels, including early detection of new populations and tracking the abundance of established zebra and quagga mussel populations over time. This information allows lake managers and scientists to better understand the impacts of zebra and quagga mussels on Wisconsin's lakes. In time, this information may help lead toward more effective options for zebra and quagga mussel prevention and control. The CLMN protocols are available online in written and video formats.

For more information:

Invasive Mussel Collaborative: invasivemusselcollaborative.net

AIS Smart Prevention Tool, University of Wisconsin-Madison Center for Limnology: uwlimnology.shinyapps.io/AISSmartPrevention2

Zebra Mussel Research, Minnesota Aquatic Invasive Species Research Center: maisrc.umn.edu/zebra-mussels

Experimental Control of Zebra Mussels in Minnesota, Minnesota Department of Natural Resources: dnr.state.mn.us/invasives/aquaticanimals/zebramussel/zebra-mussel-pilot-project.html

Zebra Mussels, United States Geological Survey, Nonindigenous Aquatic Species Database: nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=5

Zebra Mussel, Wisconsin Department of Natural Resources: dnr.wisconsin.gov/topic/Invasives/fact/Zebra.html

Boat, Gear and Equipment Decontamination and Disinfection, Wisconsin Department of Natural Resources: dnr.wisconsin.gov/topic/Invasives/disinfection.html

Photo credit: Travel Wisconsin

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