Zebra Mussels Threaten Inland Waters: An Overview

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Zebra mussels (*Dreissena polymorpha*) were first discovered in the Great Lakes in 1988. Within one year, they colonized nearly every firm object in Lake Erie. Zebra mussels quickly spread to parts of all the Great Lakes. Expansion to inland waters continues at an alarming rate. For example, in 1992 zebra mussels made their way out of Lake Michigan into the Mississippi River basin via the Chicago Sanitary Shipping Canal — an artificial channel that connects the Great Lakes drainage basin with the watershed drained by the Mississippi River. At the end of the 1992 season, zebra mussels were found in isolated pockets from Minneapolis to St. Louis. They spread up the tributaries of the Mississippi River, often hundreds of miles, by way of recreational watercraft and barges. Today, they have spread overland to hundreds of inland lakes in 28 states.

Zebra mussels cost the U.S. economy at least $1 billion annually. They clog water intakes for municipalities and industries, foul boat hulls, motors, water-related equipment and shipwrecks. They can decrease property values. Sharp shells can litter beaches, cut feet and affect recreation and tourism. Overall, zebra mussels harm our environment, recreation and the economy of communities that depend upon healthy lakes and rivers.

**Zebra Mussel History**

Zebra mussels have been spreading to western and central European waterways for nearly 200 years. While we can learn a lot from looking at how zebra mussels behave in Europe, zebra mussels face different ecosystems in North America often making comparisons and predictions complicated.

Zebra mussels are native to freshwater lakes and rivers of western Russia including the northern part of the Caspian Sea, which is a freshwater waterbody. Canals built during the late 1700s allowed them to spread throughout Eastern Europe and during the 1800s, canals were built across the rest of Europe. The Canals made shipping more efficient, but as an unintended consequence also allowed rapid expansion of the zebra mussel's range. By the 1830s, these mussels covered much of Europe and Britain.

Successful introduction of zebra mussels into the Great Lakes probably occurred in 1985 or 1986, after transoceanic ships discharged contaminated ballast water from foreign ports into lakes St. Clair and Erie. Freshwater ballast, picked up in European ports, contained zebra mussel larvae and possibly juveniles, along with several other harmful aquatic invasive species (AIS). Being a temperate, freshwater species, they found the plankton-rich lakes St. Clair and Erie to their liking. Zebra mussels extensively colonized all of the Great Lakes, except Lake Superior.

Lake Superior is not ideal zebra mussel habitat. While they have been found at nine locations around Lake Superior, only two locations are known to be reproducing: the harbors of Duluth-Superior and Thunder Bay. All other locations are open to the influence of this big lake with its colder, less productive and low dissolved calcium level water that zebra mussels need for creating their shells.

**Zebra Mussel Biology**

They are small freshwater mussels. Young settled juveniles feel like sandpaper on smooth surfaces. Adults range from 1/2 up to nearly 2 inches long with highly variable dark and light stripes; or are solid brown or yellow. Other than their "cousin" the quagga mussel, they are the only freshwater mussel that firmly attach to hard surfaces.

The mussel's reproductive cycle is one key to its rapid spread and high abundance. Egg production starts when water temperature warms to about 54 degrees F. A fully mature female mussel may produce several hundred thousand eggs per season.

Eggs are fertilized outside the mussel's body and within a few days develop into free-swimming larvae called veligers. Nearly invisible to unaided eye, veligers remain suspended in the water for three to four weeks, drifting with the currents. If they don't settle onto firm objects, they die, and in fact, most do. Those that find a hard surface quickly attach themselves and transform into the typical, D-shape, double-shelled mussel. Generally, zebra mussels grow roughly a little over 2/5th of an inch per month. Within a year, a zebra mussel can grow up to an inch and become sexually mature. Some can grow as large as 1.5 inches or more. European studies report mussels may live four to six years, but in Lake Erie three years seems to be the maximum, and the average is much less.

Zebra mussels produce a tuft of fibers known as a byssus, or byssal threads, from a gland in their foot. The byssus protrudes between the two halves of the shell. These threads attach to hard surfaces with a powerful glue that anchors the mussels in place. Small juveniles, referred to as translocators, can actually break away from their attachments and generate new, buoyant threads that allow them to drift short distances with currents.

Any hard surfaces can be colonized by zebra mussels — rock, metal, wood, vinyl, glass, rubber, fiberglass, paper, plants, and other mussels. Beds of zebra mussels in some areas of Lake Erie contain between 30,000 and 70,000 mussels per square meter. Near water intakes, densities can be as high as 700,000 mussels per square meter.

Zebra mussels can establish regardless of depth or winter temperatures. Colonies grow rapidly wherever oxygen and particulate food is available and water currents are not too swift — generally less than six feet per second. Colonies are rare in wave-washed and ice-scoured zones, except for the sheltered undersides of rocks, nooks and crevices. Zebra mussels avoid bright light so it rare to find them in well sunlit waters. Greatest densities are found at depths ranging from 6 to 45 feet, but can even be found at 100 feet.

Zebra mussels also colonize soft bottoms. Hard objects, such as pieces of native mussel shells and even dead zebra mussel shells, act as a base for settling veligers allowing them to gain footholds even on sandy or muddy bottoms. As a few mussels begin to grow, they form barnacle-like colonies and in this way can form extensive mats of zebra mussel carpets on lake and river bottoms.

**Zebra Mussels Harm the Environment**

Zebra mussels are filter feeders. They strain water for the food they need. Unwanted food is rejected and bound into mucous pellets called pseudofeces. Vast amounts of pseudofeces in heavily colonized areas provide food for native as well as other aquatic invasive species. Each adult zebra mussel can filter more than one liter of water per day. Most types of phytoplankton, bacteria and some small zooplankton are consumed. Small fish, such as young sportfish or forage fish like minnows, depend on this food for survival and growth. Feeding by zebra mussels can remove so much microscopic plants and animals from the base of the food web that they can starve native fish and wildlife in lakes and rivers.

Scientists and boaters now often see great increases in water clarity in inland lakes and rivers like what was seen in Lake Erie between 1989 and 1991. Since sunlight now penetrates deeper and with more intensity, shallow bays are being recolonized by rooted native and sometimes invasive aquatic plants. Often, these aquatic plants are growing more densely and at great depths completely changing the habitat. In the fall, aquatic plants laden with zebra mussels can wash on shore creating disposal issues. Impacts due to greatly increased water clarity has been observed due to zebra mussels in rivers and lakes across the country. Native North American mussels and clams have suffered greatly when they are encrusted with zebra mussels. Sometimes several thousand zebra mussels can be found on a single native mussel. In lakes St. Clair and Erie and in many rivers, zebra mussels have severely reduced populations of native mussels and clams. Some mussel species in the St. Croix River and elsewhere are very rare and are officially listed as endangered. As they spread, zebra mussels threaten the extinction of at least 30 freshwater mussels. Losses of crayfish and snails have been implicated by zebra mussel colonization.

Thirty years ago, the extent of profound impacts due to zebra mussels could not have been predicted. Today, scientists know that zebra mussels can cause increases in toxic blue-green algae, including Microcystis, which produces a poison that causes liver damage when ingested by humans and wildlife. Decaying algae can make waters uninhabitable by causing low levels of dissolved oxygen that result in fish kills. Since 1998, induced algae blooms can trigger botulism type E outbreaks that have killed tens of thousands of loons and other waterfowl.

**Zebra Mussels Affect Industry and Recreation**

Costs to manage, control and monitor for zebra mussel, and its cousin the quagga mussel, in the U.S. are more than $1 billion per year. Because zebra mussels prefer hard surfaces at moderate water depth, water intake structures, such as those used by power plants and city treatment plants, are susceptible to clogging by zebra mussels. In the late 1980s and early 1990s, some municipal drinking water facilities located on Lake Erie reported major reductions in pumping capacity and occasional shutdowns caused by encrusted zebra mussels. Control costs are operation specific. A drinking water plant may spend about $320,000 per year while a nuclear power plant may spend $2 million per year for zebra mussel control and maintenance. Today, zebra mussels can usually be controlled at power, municipal drinking and manufacturing plants and irrigation facilities using a variety of strategies, technologies and chemicals. However, those costs are typically passed along to consumers each time electricity and water are used.

Recreational users of waters infested with zebra mussels can be harmed. Unprotected docks, breakwalls, boat bottoms, and engine outdrives can provide hard surfaces zebra mussels need to colonize and grow. Across the country, there have been many reports of boat engines overheating because cooling water inlets are clogged by zebra mussels. Boaters need to frequently inspection these areas. Anti-fouling paints containing copper or tin are effective in preventing zebra mussel build-up, but their use is banned in Michigan, and restricted in other states (contact your state's Department of Agriculture or Department of Natural Resources) because they can harm other aquatic life.

Zebra mussels can bioaccumulate polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and heavy metals due to their filtering capacity. As a result, this has implications for human health. PAH concentrations in some recreational fish have increased 11 to 18 fold in Lake Erie, which approach limits for fish consumption advisories. Research also shows that concentrations in waterfowl increased.

In summary, zebra mussels are harmful bioengineers. They form mats of shells physically changing the structure of lakes and rivers they infest. They re-route nutrients, which alters capacity of habitats to sustain native species. They reduce food for fish, kill native mussels, crayfish and snails, foul plants, beaches, boats, lifts, docks and swim platforms, and clog water intakes.

**Prevention and Containment**



While there may be a perception that zebra mussels are everywhere and nothing can be done, nothing could be further from the truth. Zebra mussels can be prevented from spreading to new waters and contained where they currently exist. Key ways they spread by watercraft are: attached to aquatic plants, fouled boat hulls and other equipment, and in contaminated water.

By following the guidelines below, you can prevent the spread of zebra mussels and other aquatic invasive species by helping to *Stop Aquatic Hitchhikers!TM* It's easy. More boaters are doing it. Just Clean, Drain, Dispose, Dry everywhere, every time.

**What You Can Do**

* **Learn** to recognize [zebra and quagga mussels](http://www.seagrant.umn.edu/ais/mussel#id).

**Follow Minnesota Aquatic Invasive Species Laws:**

* **Clean** all aquatic plants, animals and mud from watercraft, trailers, docks, lifts, anchors and other recreational equipment *before leaving access*.
* **Drain** water-related equipment (boat, ballast tanks, portable bait containers, motor) and drain bilge, livewell and baitwell by removing drain plugs before leaving water access. *Keep drain plugs out while transporting watercraft*.
* **Dispose** of unwanted bait, worms and fish parts in the trash.

**Also Recommended:**

* **Spray** watercraft and equipment with high-pressure water, or
* **Rinse** with very hot water, or
* **Dry** for at least 5 days.

**Report New Sightings** — note exact location; place specimens in a sealed plastic bag; and call a Minnesota DNR Invasive Species Specialist (see [www.mndnr.gov/invasives/contacts.html](http://www.mndnr.gov/invasives/contacts.html)), 1-888-MINNDNR or (651) 259-5100; or the MN Sea Grant Program in Duluth, (218) 726-8712.

**Know the rules!**

Specimens are needed to confirm sightings, but some jurisdictions prohibit possession of thesemussels and other invasive animals and plants. InMinnesota, possession and transport of any Dreissena is illegal, exceptwhen providing themto SeaGrant or DNR for identification. Unauthorized introduction of invasive mussels, fish or plants into the wild is illegal. Protect your property and our waters.