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Zebra Mussels

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This NebGuide describes the biology of zebra mussels and the impact of their introduction to the United States. It discusses their occurrence in Nebraska along with eradication attempts, and suggests methods to control their spread.

Background

Since the late 1980s, zebra mussels have been spreading in the lakes and rivers of the United States. Zebra mussels were first discovered in North America in 1988 in Lake St. Clair, a relatively small lake that connects two of the Great Lakes — Lake Erie and Lake Huron. By 1990, zebra mussels had spread through all five of the Great Lakes. They are now established in many smaller lakes in the Great Lakes region and many of the large navigable rivers in the central and northeastern U.S. Zebra mussel adults or larvae have been found in about 30 states, including Nebraska. Due to their record of spreading rapidly upon entering a new area, zebra mussels are a potential economic and environmental threat to Nebraska waters.

Non-Native and Invasive Species

The zebra mussel (scientific name *Dreissena polymorpha*) and the closely related species, the quagga mussel (*Dreissena rostriformis bugensis),* originated in Eastern Europe and Western Asia and are not native to North America. A species is native to a particular region if it lives there as the result of natural processes with no human intervention. An introduced or non-native species typically is introduced to a new area as a result of human activity, either intentionally or accidentally. In the case of zebra and quagga mussels, the introduction to the U.S. was accidental. They were probably brought to the Great Lakes as stowaways in the ballast water of a cargo ship that came from Europe or Asia. Ballast water is taken aboard to maintain stability and is discharged when new cargo is added to the ship. Consequently, when ballast water is emptied, species such as the mussels can be introduced to a new area.

In addition to being non-native to the U.S., zebra and quagga mussels are classified as invasive species. A non-native species is considered invasive when it causes, or is likely to cause, economic or environmental harm, or harm to human health. Not all introduced species become invasive; those that do are highly adaptable or lack natural controls such as disease or competitors in their new environment. An invasive species is able to out-compete and displace native species, often spreading rapidly to dominate the invaded region. Invasive species disrupt ecological processes and threaten biological diversity. They can cause tremendous economic hardship because of money spent on prevention, control, and eradication. It was reported by Pimentel, Zuniga, and Morrison in the journal *Ecological Economics* in 2005 (52:273-288) that the estimated yearly cost due to invasive species and their control is nearly $120 billion in the U.S. alone.

Invasive Mussel Biology

Zebra and quagga mussels are mollusks — animals with shells — like snails or clams. These are small animals; zebra mussels are usually less than 1 inch long (*Figure 1*). The shells of adult zebra mussels are yellowish to brownish, often striped

Photo by Karie Decker, Nebraska Invasive Species Project

Figure 1. The size of a zebra mussel relative to a quarter.

Photo by Karie Decker, Nebraska Invasive Species Project

Figure 2. When viewed from the side, Zebra mussel shells are D-shaped.

in a dark and light pattern, hence the name zebra mussels. They can also have shells without stripes. The underside of the shell is flat and when the mussel is seen from the side, you notice the "D-shaped" shell (*Figure 2*). Quagga mussels are a little larger and rounder, and do not have flat-bottomed shells.

Zebra and quagga mussel populations can increase very quickly, compounding their threat as an invasive species. Spawning usually takes place in the spring and summer but can occur year-round where water temperatures are warm (above 50°F). A female produces up to 40,000 eggs in a reproductive cycle. Under the right conditions, one female can produce up to one million eggs per spawning season. Females release eggs into the water, and males release sperm to fertilize the eggs. The fertilized eggs float along until they hatch into microscopic, free-swimming larvae called veligers. Veligers can drift in the water for three to four weeks. As the veligers develop into juveniles, they begin to settle out and attach themselves to hard structures. Depending on their growth rate, zebra mussels are sexually mature in several weeks to one year, and have a life span of up to nine years (but typically only live two to three years).

Zebra and quagga mussels can be spread to new locations during any of their life stages. Free floating fertilized eggs or veligers could be present in bait buckets, live wells, or other containers filled from an infected water body. Because they can't be seen by the naked eye, they can be unknowingly released if this water is emptied into a different body of water, such as when water from a live well or bait bucket is moved from one lake to another.

These mussels also can be transported after they have attached to boats or other equipment left in the water. When the equipment is moved, the mussels are moved along with it. If conditions are cool and humid, adult mussels can live for several days out of water, long enough to survive a trip to another river or lake.

Zebra and quagga mussels attach to objects by byssal threads, which are produced by a special organ, the byssal gland. These threads are very strong and protrude between the two halves of the shell. The mussels use byssal threads to firmly attach themselves to underwater surfaces. Adult zebra and quagga mussels are usually found attached to objects or each other by these byssal threads. They are the only freshwater mollusks in the U.S. that can tightly cling to solid objects, such as submerged rocks, dock pilings, boat hulls, or water intake pipes, by using byssal threads. Both species prefer hard or rocky surfaces, including the shells of native mollusks, but quagga mussels are able to colonize soft substrates such as sand.

Economic and Environmental Impacts

Since their introduction into the Great Lakes, zebra mussels have caused billions of dollars in damage. One of the biggest problems with zebra and quagga mussels is their ability to clog the water pipes of power plants, water supply plants, and industrial facilities. They attach and grow inside the pipes in such numbers that water flow is severely restricted. Great Lakes water treatment plants and power plants spend millions of dollars each year to keep their intake pipes clear of mussels. Mussels can grow on many other manmade structures, including inside irrigation pipes. Fishing gear left in water for long periods can be ruined and boat engines can become clogged with larvae and adult mussels. Attached zebra and quagga mussels also speed up the deterioration of dock and pier supports. They can completely encrust any object in the water.

In addition to human impacts, zebra mussels negatively affect other species of wildlife. Native mussels have been found with more than 10,000 zebra mussels attached to them. A heavily colonized native mussel can lose its ability to feed because it can't open its shell, and so eventually dies. According to the U.S. Fish and Wildlife Service, zebra mussels can harm native mussels by interfering with their feeding, growth, movement, respiration, and reproduction. In the Great Lakes, in areas where zebra mussel densities are highest, native mussel populations have declined. This is likely due, at least in part, to the fact that zebra mussels seem to prefer to attach to calcareous materials such as the shells of other mussels, limestone, and concrete. Declines in native mussel populations harm animals that feed on native mussels, and disturb the native ecosystem.

Zebra and quagga mussels alter and harm aquatic environments in many other ways. They primarily eat phytoplankton (tiny plants such as algae). They are filter feeders, meaning they suck in water, filter out the phytoplankton, and release the filtered water. The material they don't want or don't digest (such as silt, organic debris, or undesirable plankton) is covered in mucus and expelled. This waste material is called pseudofeces to differentiate it from feces, which contains digested waste. Both feces and pseudofeces are rich in nutrients (e.g., phosphorus) and can also contain toxic substances that may have been filtered out of the water. Accumulations of pseudofeces and feces change the environment on the lake bottom and affect the community of microorganisms living there.

Because they filter so much water, zebra and quagga mussels can develop concentrations of contaminants that are in

the water. Zebra mussels have been shown to accumulate heavy metals and chlorinated organic compounds within their bodies. Some waterfowl and fish will eat zebra and quagga mussels, creating the potential for the contaminants to work their way up the food chain.

An adult mussel can filter about a liter (one quart) of water a day. They are very efficient filter feeders and remove substantial amounts of phytoplankton from the water. This decreases the food available for zooplankton (tiny aquatic animals) and impacts the entire food chain, including fish that eat zooplankton. Native and game fish species rely on phytoplankton and zooplankton as a food source, especially during their early growth stages. Without this resource, fish populations suffer dramatically.

Large numbers of mussels can increase water clarity because they remove so much algae. Increased water clarity also increases the depth of light penetration into the water, which in turn can cause an overgrowth of rooted aquatic plants which couldn't grow before because of low light levels. Overgrowth of rooted plants can be problematic for boaters, particularly in shallow water.

Even though zebra and quagga mussels chiefly consume algae, they seem to reject blue-green algae and discard it as pseudofeces when it is ingested. This is important because some forms of blue-green algae create problems. When blue-green populations explode, as in a blue-green algae bloom, the result can be green, pea soup-like, scummy water. Blue-green algae can also produce toxins that are harmful to humans, pets, and wildlife. According to research reported by the U.S. Environmental Protection Agency, in some instances, the numbers of blue-greens increase when zebra or quagga mussels are present.

Photo by Bobbi Holm

Figure 3. Sign from Lake Mead, Nev., which is infested with quagga mussels. Lake Mead is an unfortunate example of our ability to transport aquatic invasive species over long distances.

Distribution and Eradication Attempts

As of February 2012, zebra and quagga mussels infested waterbodies in about 30 states, as reported by the U.S. Geological Survey Nonindigenous Aquatic Species information resource. Updated distribution maps can be found online at *nas.er.usgs.gov/*. Within the U.S., there has been only one successful eradication of zebra/quagga mussels; Millbrook Quarry, a small waterbody in Virginia. In Nebraska, zebra mussels have been found in two reservoirs, Offutt Base Lake (Offutt Air Force Base) and Zorinsky Lake (Omaha), and in the Missouri River. At Offutt Base Lake, the zebra mussels were chemically treated with copper sulfate (which required a special-use permit) to eradicate the population, but adults were identified in the lake again during the fall of 2010. To manage the infestation in Omaha, Zorinsky Lake was drawn down approximately 20 ft to freeze/dry out the zebra mussels during the winter of 2010. As of February 2012, all tests were negative for zebra mussels, and the lake has re-opened. Future testing will determine if the eradication attempt was successful. Invasive mollusk larvae have been identified in the Missouri River as far upstream as above Gavin's Point Dam. However, further DNA testing is required to determine if the infestation above Gavin's Point Dam represents zebra/quagga mussels or Asian clams (another aquatic invasive species).

Stopping the Spread of Invasive Mussels

Getting rid of zebra or quagga mussels is very difficult and expensive (and often times impossible), so the best defense is to prevent their spread (*Figure 3*). Boaters and others who enjoy water recreation should remember to **CLEAN, DRAIN,** and **DRY** their equipment when removing it from the water. This includes boats, trailers, jet skis, waders, and any other equipment that comes in contact with the water. CLEAN off any plants, animals, or mud that you see clinging to your equipment. Pressure washing with hot (140°F or hotter) water is very effective at killing mussels. DRAIN all water from live wells, bilges, and any other water-holding compartments onto the ground near the body of water just visited. Empty bait buckets into the trash. If possible, allow equipment to DRY for at least five days before using it in a different body of water. A complete guide of recommended techniques for watercraft decontamination can be found at *snr.unl.edu/invasives/boater.htm*.

Even if zebra or quagga mussels have not been found in the rivers or lakes you visit, make **CLEAN, DRAIN,** and **DRY** your standard practice. As of 2011, zebra mussels have been found in two Nebraska lakes. However, surrounding states such as Colorado, Iowa, and Kansas have infestations in multiple water bodies. By practicing **CLEAN, DRAIN,** and **DRY**, you can help prevent the spread of these unwanted species (*Figure 4*).

In Nebraska (and several other states), it is illegal to possess, import, export, purchase, sell, or transport aquatic invasive species — including zebra and quagga mussels. Many states also have boat inspection stations to intercept and decontaminate any boats at high risk of spreading aquatic invasive species.

Photo by Karie Decker, Nebraska Invasive Species Project.

Figure 4. You can help prevent the spread of aquatic invasive species, including zebra and quagga mussels.

Monitoring and Reporting Infestations

An easy and inexpensive method to monitor for zebra or quagga mussels is to suspend a length of PVC pipe in a body of water. The pipe can be hauled out of the water on a regular basis to look for attached mussels. Also periodically check lake shorelines stabilized with rock or concrete as this will be a likely area of mussel colonization if an invasion occurs. If you find evidence of their occurrence in Nebraska, contact the Nebraska Invasive Species Project through their website, *www.snr.unl.edu/invasives*; by email, *invasives@unl.edu*; or by phone, 402-472-3133. Or call the National Invasive Species Hotline, 1-877-STOP-ANS (1-877-786-7267).

While zebra and quagga mussels are of major concern, other potential aquatic invasive species include animals, plants, insects, and diseases. Visit the Nebraska Invasive Species Project website for more information on zebra mussels and other invasive species, *www.snr.unl.edu/invasives*. Also, be sure to watch the informational video produced by the Nebraska Game and Parks Commission (*www.youtube.com/watch?v=q5U2HoaNsFQ*).

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