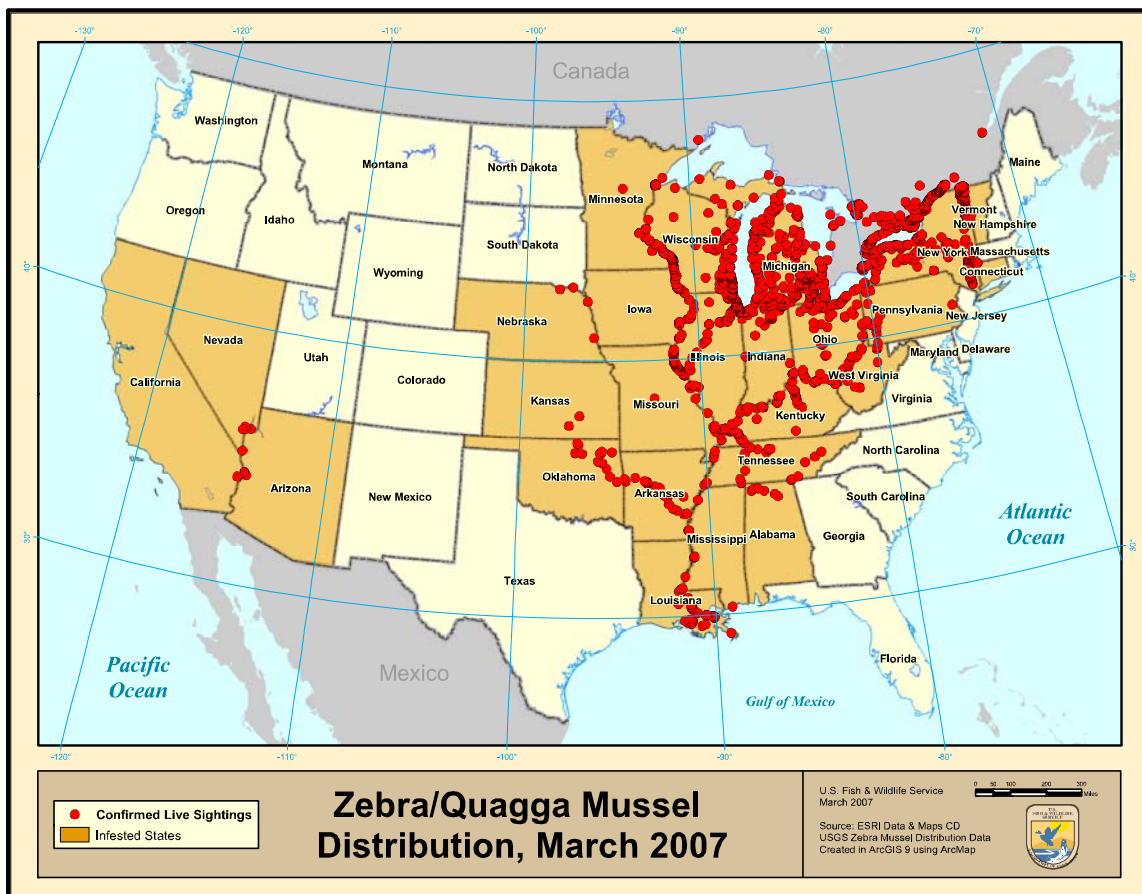


Western Quagga Mussels

Background Information

- Quagga Mussels were found in early January 2007 in Lake Mead National Recreation Area¹
 - Populations have subsequently been found throughout the Boulder Basin of Lake Mead
 - Also in other Lower Colorado River lakes
 - Lake Mohave, AZ/NV²
 - Lake Havasu, AZ/CA
 - Copper Basin Reservoir, CA³
 - These lakes supply irrigation and drinking water to Southern Nevada, Southern California, and Southern Arizona
 - Also Found in Fish Hatcheries
 - Nevada State Fish Hatchery on Lake Mead
 - Willow Beach National Fish Hatchery



General Biology

- **Species Names**
 - Zebra mussels, *Dreissena polymorpha*
 - Quagga mussels, *Dreissena rostriformis bugensis*
- **Size**
 - Microscopic to about two inches long
- **Lifespan**
 - Typically up to 5 years
- **Reproductive potential**
 - May spawn all year if conditions are favorable
 - Peak spawning typically occurs in Spring and Fall
 - A few individuals can produce millions of eggs and sperm
- **Life Cycle**
 - Embryos are microscopic (< 100 microns)
 - Larval stage is planktonic (free floating), carried with currents
 - Adult stage attaches to hard surfaces with threads (like marine mussels), but can detach and move to new habitat
- **Impacts**
 - *Ecological*
 - As filter feeders, these species remove food and nutrients from the water column very efficiently, leaving less or nothing for native aquatic species
 - They have the potential of collapsing entire food webs
 - *Economic*
 - These species clog pipes, ruin boat motors, and damage aquatic recreational equipment
 - Once established in a lake, routine maintenance is necessary and perpetual
 - Management costs are enormous, particularly for industrial raw water users like power stations and water supply agencies

Frequently Asked Questions

- **What's the difference between Quagga Mussels and Zebra Mussels?**
 - *Short Answer: Not Much*
 - These are two species within the same genus *Dreissena*
 - Zebra Mussels invaded North America First (in mid-1980s)⁴
 - Quagga Mussels invaded a few years later (1989)⁵
 - There are morphological differences, but they are subtle
 - There are ecological differences, but more research is needed on North American quagga mussels to assess these differences
 - The practical implications of zebra and quagga mussels are essentially identical
- **Where did they come from?**
 - *Short Answer: Eurasia*
 - Zebra Mussels came from the Black and Caspian Sea Drainages
 - Quagga Mussels came from the Dneiper River Drainage in the Ukraine
- **What temperatures can zebra mussels and quagga mussels tolerate?**
 - *Short Answer: Between 1-30°C (33-86°F)*
 - **Heat Tolerance**⁶
 - Zebra Mussels can survive in waters as warm as 30°C (86°F)
 - Quagga Mussels may be able to survive in waters as warm (need more research)
 - **Cold Tolerance**⁶
 - Both zebra mussels and quagga mussels can survive cold waters near freezing, but cannot tolerate freezing.
 - Zebras need waters above 12°C (54°F) in order to reproduce
 - Quaggas need waters above 9°C (48°F) in order to reproduce
 - **Temperature Preference**⁶
 - Zebra Mussels survive and reproduce best in waters near approximately 18°C (64°F)
 - Quagga Mussels survive and reproduce best in waters slightly cooler, approximately 16°C (61°F)

- **What other physiological tolerances do zebra and quagga mussels have?**⁶
 - **Salinity:** needs to be low (< 5 PPT)
 - **Calcium:** needs to be high (> 25mg/liter)
 - **pH:** needs to be high (in the range of 7.4 – 9.5)
 - **Oxygen:** both species can temporarily survive low oxygen concentrations
 - Zebra mussels need > 25% of full oxygen saturation to grow and reproduce
 - Quagga mussels are more tolerant of low oxygen concentrations than zebra mussels
 - **Water Velocity:** needs to be low (< 2 m/sec)⁷
 - **Substrate:** both species prefer hard surfaces
 - Quagga mussels can tolerate living in soft sediments, but zebra mussels seldom do
- **What do they eat?**
 - *Short Answer: Algae and bacteria in the water column*
 - Both species are filter feeders
 - Quagga mussels are more efficient filter feeders than zebra mussels
- **What eats zebra mussels and quagga mussels?**
 - *Short Answer: No natural predators in North America*
 - Many species do eat these mussels, including diving ducks, red-eared sunfish and some catfish, but predators cannot keep up with the explosive reproductive potential of these invasive mussels
- **What Depths can you find zebra and quagga mussels?**
 - *Short Answer: At any depth, but quaggas mussels can be found deeper*
 - Zebra mussels are typically found from just below the surface to about 12 meters (40 feet)
 - Quagga mussels are typically found at any depth as long as oxygen is present
 - Both species prefer to avoid light and are usually found in shaded areas or below the depth that light penetrates water
- **Why aren't they a problem in Europe?**
 - *Short Answer: They are, but most Europeans have been dealing with them for over 200 years. Their industrial facilities were designed with these in mind.*

- **How do they spread?**

- *Short Answer: Larvae flow downstream. Adults attach to recreational boats and equipment (anchors, bait buckets, etc).*
 - Eggs and larvae will naturally flow downstream of established populations.
 - Larvae can also be transported in water carried by recreational boats, trailers, and other aquatic equipment.
 - Adults can also be spread by recreational boats, trailers, and aquatic equipment.
 - Adults can survive out of water for weeks if temperatures remain cool and humidity remains high.
 - Quagga mussels were probably transported overland at least 1000 miles from their source population (most likely the Great Lakes)
 - Resident boats (those boats that are moored or held in a slip) are much more likely to harbor zebra and quagga mussels than day boats (boats that are removed from the water after each use).

- **How can we prevent additional spread?**

- *Short Answer: Educate boaters.*
 - Preventing downstream invasions is practically impossible.
 - Convincing recreational boaters to clean their boats and equipment before transporting them to new waters is essential.
 - Simple steps are necessary every time a boat is retrieved from a lake or other water body:
 - Remove all aquatic plants, animals, and mud from everything that came in contact with water.
 - Drain all water, including bilges, live-wells, cooling water from the motor.
 - Clean and dry everything that came in contact with water
 - Dispose of any live bait.
 - If mussels are seen attached to a boat or other recreational equipment, it must be decontaminated using more stringent guidelines.
 - A decontamination protocol is attached.

- **Where can I learn more?**

- www.100thMeridian.org
 - The 100th Meridian Initiative is a cooperative effort between state, provincial, and federal agencies to prevent the westward spread of zebra mussels and other aquatic nuisance species in North America. The associated website is the official coordination point for information regarding zebra and quagga mussel spread to the western United States.

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Decontamination Protocol

For Boats and other Recreational Equipment Potentially Contaminated with Zebra/Quagga Mussels

Step 1: DRAIN

Bilges, wet wells, live wells, and any other compartments that could hold water from an infested field collection site should be drained of water at the boat ramp before leaving the area. If a boat has carried water from another location, remove all water and treat it with household bleach (> 5% sodium hypochlorite) at a concentration of 3 oz of bleach per 5 gallons of water for a minimum of 1 hour before disposing in wastewater drain. Never dump water to the ground.

Step 2: PURGE

In order to kill and purge larvae that may be in the engine's cooling system, run disinfecting water through the motor for at least 1 minute. Disinfecting water should be either 1) a bleach solution using household bleach (> 5% sodium hypochlorite) at a concentration of 3 oz of bleach per 5 gallons of water, or 2) tap water heated to > 140 °F. Running bleach through an engine may violate the terms of the engine's warranty, so hot water is recommended.

Step 2: SCRUB

Scrub all surfaces with soapy water to remove any clinging material (plants, animals, mud, etc.), then visually inspect and remove anything remaining. Pay special attention to cracks and crevices in which mussels may become trapped, and aquatic plants harboring juvenile mussels that may be present on trailers or propellers. Since adult zebra/quagga mussels can close up and survive for extended periods of time under toxic external conditions, chemical disinfecting as a means to kill adult mussels may require a contact time of several days. Thus, chemical disinfectants are not recommended for killing adult mussels. At this step, the goal is to remove any and all living organisms as well as mud and other debris.

Step 3: WASH

Hose down everything with hot high pressure water, including boat, anchors, trailer, and anything else that came in contact with the water. Pay particular attention to trailer pads made of carpet and foam rubber, which could trap tiny mussels. Temperature and exposure time determine the effectiveness of temperature treatments. Live steam, boiling, and hot (> 140 °F) power washing are all believed to be effective against all zebra/quagga mussel life stages. Work a small section at a time with a minimum exposure of 3 min at full heat for each area.

Step 4: DRY

After thorough scrubbing, power washing and visual inspection, dry the boat and all equipment and keep everything out of the water for at least 2 weeks if temperature is below 70 °F or 1 week if weather is warm (> 70 °F) and dry (< 40% relative humidity). In winter, freezing may be used as an effective tool. Adult zebra/quagga mussels have a relatively low tolerance to freezing. Exposing boats and equipment to continually freezing temperatures for a recommended period of three days should produce 100% mortality.

Information Sources

¹National Park Service Press Release 1-07, January 10, 2007

²Invasive Mussel Update, NPS Digest, National Park Service, January 23, 2007

³USGS Nonindigenous Aquatic Species Database, Collection ID 237660

⁴Zebra Mussel Fact Sheet, USGS Nonindigenous Aquatic Species Program

⁵Quagga Mussel Fact Sheet, USGS Nonindigenous Aquatic Species Program

⁶McMahon, R.F. 1996. The Physiological Ecology of the Zebra Mussel, *Dreissena polymorpha*, in North America and Europe. *American Zoologist* 36:339-363

⁷O'Neill, C.R. 1993. Control of Zebra Mussels in Residential Water Systems. Sea Grant: Coastal Resources Fact Sheet