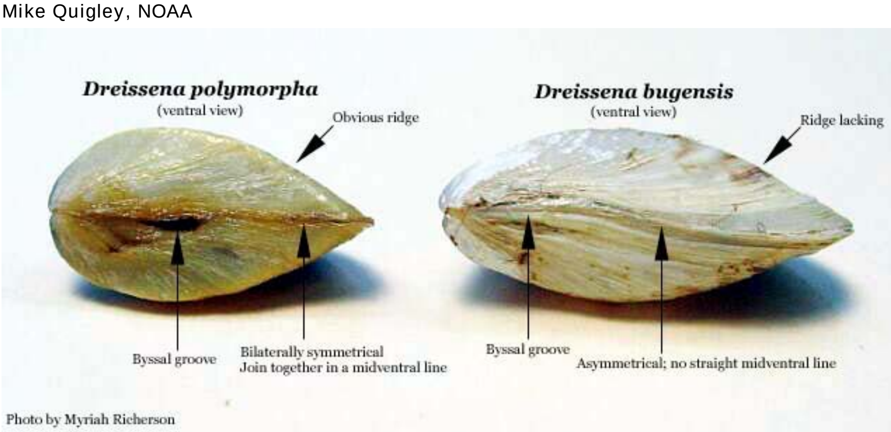
NAS - Nonindigenous Aquatic Species

Dreissena rostriformis bugensis
(quagga mussel)
Mollusks-Bivalves
Exotic to United States

Collection Info
HUC Maps
Point Maps
Fact Sheet

Mike Quigley, NOAA



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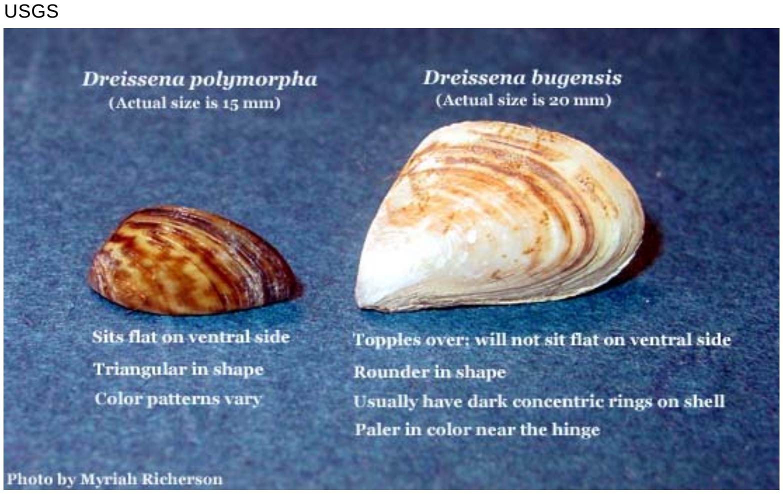


U.S Geological Survey

Dreissena rostriformis bugensis Andrusov, 1897

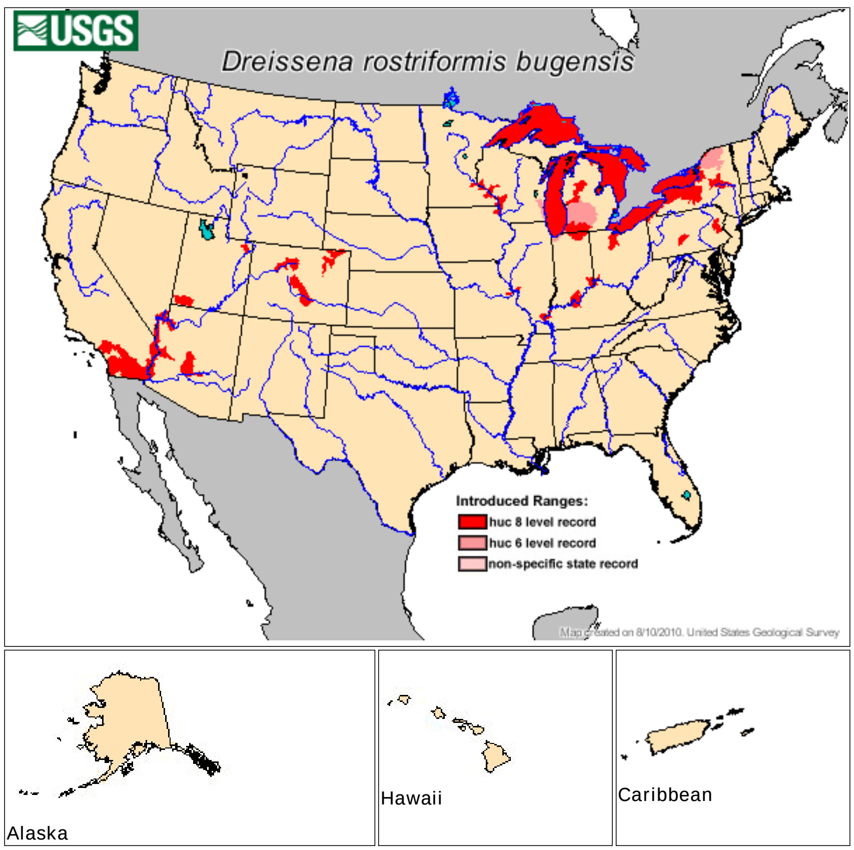
Common name: quagga mussel

Taxonomy: available through ITIS

Identification: *Dreissena rostriformis bugensis* is a small freshwater bivalve mollusk that exhibits many different morphs; yet, there are several diagnostic features that aid in identification. The quagga mussel has a rounded angle, or carina, between the ventral and dorsal surfaces (May and Marsden 1992). The quagga also has a convex ventral side that can sometimes be distinguished by placing shells on their ventral side; a quagga mussel will topple over, whereas a zebra mussel will not (Claudi and Mackie 1994). Overall, quaggas are rounder in shape and have a small byssal groove on the ventral side near the hinge (Claudi and Mackie 1994). Color patterns vary widely with black, cream, or white bands; a distinct quagga morph has been found that is pale or completely white in Lake Erie (Marsden et al. 1996). They usually have dark concentric rings on the shell and are paler in color near the hinge. If quaggas are viewed from the front or from the ventral side, the valves are clearly asymmetrical (Domm et al. 1993). Considerable phenotypic plasticity of all morphological characteristics is known in dreissenid species and this may be a result of environmental factors, meaning the same genotype may express different phenotypes in response to environmental conditions (Claxton et al. 1998).

Size: Reaching sizes up to 4 cm

Native Range: *Dreissena rostriformis bugensis* is indigenous to the Dneiper River drainage of Ukraine and Ponto-Caspian Sea. It was discovered in the Bug River in 1890 by Andrusov, who named the species in 1897 (Mills *et al*. 1996).



Interactive maps: Continental US, Alaska, Hawaii, Caribbean Point Distribution Maps

Nonindigenous Occurrences: Canals built in Europe have allowed range expansion of this species, and it now occurs in almost all Dneiper reservoirs in the eastern and southern regions of Ukraine and deltas of the Dnieper River tributaries (Mills et al. 1996).

The quagga mussel was first sighted in the **Great Lakes** in September 1989, when one was found near Port Colborne, Lake Erie, though the recognition of the quagga type as a distinct species was not until 1991 (Mills et al. 1996). In August 1991, a mussel with a different genotype was found in a random zebra mussel sample from the Erie Canal near Palmyra, New York, and after confirmation that this mussel was not a variety of *Dreissena polymorpha*, the new species was named "quagga mussel" after the "quagga", an extinct African relative of the zebra (May and Marsden 1992). The quagga mussel has since been found in Lake Michigan, Lake Huron, Lake Erie, Lake Ontario, Lake St. Clair, Saginaw Bay, and throughout the St. Lawrence River north to Quebec City. A 2002 survey of Lake Superior did not detect quagga mussel specimens (Grigorovich 2003), but by 2005 the first quagga mussel was confirmed from Lake Superior in Duluth Superior Harbor (Grigorovich et al. 2008). A few inland occurrences have been reported in **Iowa, Kentucky, Michigan, Minnesota, New York**, **Ohio**, and **Pennsylvania.**

The first sighting of quagga mussels outside the Great Lakes basin was made in the Mississippi River between St. Louis, **Missouri** and Alton, **Illinois** in 1995 (S. J. Nichols, pers. comm.). In January 2007, populations of quagga mussels were discovered in Lake Mead near Boulder City, **Nevada** (W. Baldwin, pers. comm.), and in Lake Havasu and Lake Mohave on the **California/Arizona** border (R. Aikens, pers. comm.). This was an extremely large leap in their range and cause for much concern to limited water supplies and endangered fishes in the southwestern US. Late in 2007 and early 2008, quagga mussels were discovered in 15 southern **California** reservoirs (D. Norton, pers. comm.). Veligers were identified from six **Colorado** reservoirs (E. Brown, pers. comm.). In **Utah**, only veligers were collected from Red Fleet Reservoir and just one adult from Sand Hollow Reservoir. They are not considered established in the state.

Means of Introduction: The introduction of *D. r. bugensis* into the Great Lakes appears to be the result of ballast water discharge from transoceanic ships that were carrying veligers, juveniles, or adult mussels. The genus *Dreissena* is highly polymorphic and prolific with high potential for rapid adaptation attributing to its rapid expansion and colonization (Mills 1996). Still, there are other factors that can aid in the spread of this species across North American waters, such as, larval drift in river systems or fishing and boating activities that allow for overland transport or movement between water basins.

Status: The quagga mussel must have arrived more recently than the zebra based on differences in size classes of initially discovered populations, and therefore it seems plausible that the quagga is still in the process of expanding its nonindigenous range (May and Marsden 1992, MacIsaac 1994). In the 1990's, the absence of quagga mussels from areas where zebra mussels were present may have been related to the timing and location of introduction rather than physiological tolerances (MacIsaac 1994). The quagga mussel is now well established in the lower Great Lakes. This species is found in all of the Great Lakes, but has not been found in great numbers outside of the Great Lakes. This could be due to a preference for deeper, cooler water found in the Great Lakes region as compared to the zebra mussel (Mills et al. 1996). There is a gradient of dreissenid domination in Lake Erie, with quagga mussels dominating eastern basins and zebra mussels dominating the western basin . The same type of gradient was observed in southern Lake Ontario with quagga mussel dominating the west and zebra dominating the east (Mills et al. 1999). If the native habitat of D. r. bugensis is to provide any sort of indicator, the quagga mussel will most likely take over areas where the zebra mussel is now established to become the dominant dreissenid of the Great Lakes (Mills et al. 1996). Indeed, this trend does appear to be occurring in the lower Great Lakes. Mean shell size and biomass increased for both dreissenid species from 1992 and 1995 in southern Lake Ontario (Mills et al. 1999). But the increase was sharper in quagga mussel, and they now dominate in southern Lake Ontario where zebra mussel once did (Mills et al. 1999).

Impact of Introduction: Quaggas are prodigious water filterers, removing substantial amounts of phytoplankton and suspended particulate from the water. As such, their impacts are similar to those of the zebra mussel. By removing the phytoplankton, quaggas in turn decrease the food source for zooplankton, therefore altering the food web. Impacts associated with the filtration of water include increases in water transparency, decreases in mean chlorophyll a concentrations, and accumulation of pseudofeces (Claxton et al. 1998). Water clarity increases light penetration causing a proliferation of aquatic plants that can change species dominance and alter the entire ecosystem. The pseudofeces that is produced from filtering the water accumulates and creates a foul environment. As the waste particles decompose, oxygen is used up, and the pH becomes very acidic and toxic byproducts are produced. In addition, quagga mussels accumulate organic pollutants within their tissues to levels more than 300,000 times greater than concentrations in the environment and these pollutants are found in their pseudofeces, which can be passed up the food chain, therefore increasing wildlife exposure to organic pollutants (Snyder et al. 1997). *Dreissena* species ability to rapidly colonize hard surfaces causes serious economic problems. These major biofouling organisms can clog water intake structures, such as pipes and screens, therefore reducing pumping capabilities for power and water treatment plants, costing industries, companies, and communities. Recreation-based industries and activities have also been impacted; docks, breakwalls, buoys, boats, and beaches have all been heavily colonized. Quaggas are able to colonize both hard and soft substrata so their negative impacts on native freshwater mussels, invertebrates, industries and recreation are unclear. Many of the potential impacts of *Dreissena* are unclear due to the limited time scale of North American colonization. Nonetheless, it is clear that the genus *Dreissena* is highly polymorphic and has a high potential for rapid adaptation to extreme environmental conditions by the evolution of allelic frequencies and combinations, possibly leading to significant long-term impacts on North American waters (Mills et al. 1996). *D. r. bugensis* lacks the keeled shape that allows *D. polymorpha* to attach so tenaciously to hard substrata; though, *D. r. bugensis* is able to colonize hard and soft substrata (Mills et al. 1996). The ability to colonize different substratas could suggest that *D. r. bugensis* is not limited to deeper water habitats and that it may inhabit a wider range of water depths where they have been found at depths up to 130 m in the Great Lakes (Mills et al. 1996, Claxton and Mackie 1998).

Remarks: Hybridization between the two species is also a concern. Zebra x quagga mussel hybrids were created by pooling gametes collected after exposure to serotonin in the laboratory, indicating that interspecies fertilization may be feasible (Mills et al. 1996). Although, there is evidence for species-specific sperm attractants suggesting that interspecific fertilization may be rare in nature, and if hybridization does occur, these hybrids will constitute a very small proportion of the dreissenid community (Mills et al. 1996). After years of infestation in Europe and North America, a chemical toxicant for lake-wide control of *Dreissena* has not been developed mainly because it would be deadly to other aquatic life forms. Prechlorination has been the most common treatment for control, but if this method is used to control both zebra and quagga mussels the amount of chlorine used may reach hazardous levels (Grime 1995). Another alternative has been potassium permanganate, especially for drinking water sources, even though chemical controls are not the most environmentally sound solution. Other methods of control include: oxygen deprivation, thermal treatment, exposure and desiccation, radiation, manual scraping, high-pressure jetting, mechanical filtration, removable substrates, molluscicides, ozone, antifouling coatings, electric currents, and sonic vibration. Some industries even built their intake structures and piping at depths too low for zebra mussel colonization; however, when the quagga mussels were discovered at lower water depths these new structures became vulnerable to quagga colonization. Biological control so far has proven to be ineffective in controlling Dreissena species. Predation by migrating diving ducks, fish species, and crayfish may reduce mussel abundance, though the effects are short-lived (Bially and MacIsaac 2000). Other biological controls being researched are selectively toxic microbes and parasites that may play a role in management of Dreissena populations (Molloy 1998). Other prospective approaches to controlling Dreissena populations may be to disrupt the reproductive process, by interfering with the synchronization of spawning by males and females in their release of gametes (Snyder et al. 1997). Another approach would be to inhibit the planktonic veliger from settling, since this is the most vulnerable stage in the life cycle (Kennedy. 2002). Researchers are continuously studying these species to learn more about their life cycle, and environmental and physiological tolerances, with hopes of developing environmentally safe controls that can be used to control Dreissena populations.

Research on control is promising using what may be a lethal bacteria, *Pseudomonas fluorescens*. It is a common soil bacteria found everywhere but harmless to humans.

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Other Resources:

Distinguishing *D. polymorpha* from *D. rostriformis bugensis*

USGS Zebra and Quagga Mussel Distribution Maps

NOAA Sea Grant Nonindigenous Species Site (SGNIS)

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