U.S. Department of the Interior
National Park Service
Natural Resource Information Division

Fact Sheet

The Zebra Mussel

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The zebra mussel (*Dreissenia polymorpha*) is an exotic mollusk that is threatening the environmental health of freshwater lakes and rivers in the United States. Adult zebra mussels are characterized by a semi-D shaped, bivalved shell with light and dark brown or black banding (stripes) and are no larger than 5 cm (2 inches).

The accidental introduction of this species is believed to have been made in 1985 or 1986 when transoceanic ships discharged ballast water with microscopic zebra mussel larvae (veligers) into Lake St. Clair at the southern end of Lake Erie, Michigan. Since that time, zebra mussels have spread rapidly throughout the Great Lakes and waterways of 19 states, including the Hudson, Illinois, Mississippi, Ohio, and Tennessee rivers. The mussel is now pushing its range westward via the Arkansas River and other tributaries.

The rapid dispersal of the zebra mussel is attributed in part to its high reproductive rate and its planktonic larval stage that, unlike that of native freshwater mollusks, does not require a host fish for development and maturation. Because they do not need a host fish, zebra mussels adapt to new bodies of water, irrespective of local fish assemblages.. Flowing waters carry the veligers downstream and thereby further the range expansion of the mussel. Distribution of the species from infested to noninfested waters is accelerated by commercial and recreational vessels because the adult and juvenile mussels have the ability to attach themselves to hard surfaces, including boat hulls and boating equipment. This ability to attach to hard surfaces has exacted burdensome economic and ecological tolls.

Adverse Effects

Zebra mussels are prolific and successful colonizers. Colonies grow rapidly wherever oxygen and particulate food are available, calcium levels are adequate, and currents are not too swift. As a few individuals begin to grow, they in turn serve as a substrate for settling veligers and additional colonization. Extensive mats of zebra mussels with densities as high as 30,000-70,000 mussels/m^2 (2,787-6,503 mussels/ft^2) can form.

Where zebra mussels concentrate, they can block intake pipes to industrial and water treatment plants and to recreational boats, spoil beaches and marinas, crowd out native species, and alter aquatic ecosystems. A survey by the Zebra Mussel Information Clearing House in 1995 revealed that 339 water-dependent facilities spent more than $69 million to monitor, remove, and control this exotic mussel (O'Neill 1995). Conservation agencies too have incurred exorbitant costs from attempts to prevent adverse effects on aquatic resources.

Zebra mussels favor native mussels as a substrate for settling, which can be lethal to the native species because they are thereby prevented from feeding, growing, moving, respiring, and reproducing. By 1990, all native mussels in Lake St. Clair were encrusted by zebra mussels, which in some instances caused the extirpation of local species (Masteller and Schloesser 1991).

Researchers predict that the invasion of zebra mussels will reduce the native mussel species in the Mississippi River basin by 50 percent within the decade. Because native mussels have an important role in nutrient cycling and sediment mixing, the accelerated decline of freshwater mussels could seriously affect the ecology of affected river systems.

As filter feeders, zebra mussels are capable of extracting large amounts of phytoplankton from the water column for food. A single adult can filter about 1 L (1.07 qt) of water per day. A consequence of this is the removal of phytoplankton from the water column, which would otherwise be available as food to native mussels, fishes, and other aquatic organisms. (Beckett 1994). This competition for phytoplankton, the base of the food chain, may cause long-term harm to aquatic systems. For example, the densities of planktonic diatom densities in western Lake Erie were 15 percent less in 1990-91 than in the mid-1980s (Beeton 1992). Clearly, the removal of phytoplankton from the water column by zebra mussels has implications beyond the producer and primary consumer trophic levels. Many zooplankton and rotifers feed on phytoplankton. By decreasing the zooplankton foodbase, zebra mussels can deprive larval fishes and other aquatic invertebrates of an essential food source (Beckett 1994). The extensive filtering of zebra mussels has also increased sunlight penetration, which encourages aquatic plant growth in many areas. In 1993, Griffiths reported changes in plant and fish communities in Lake St. Clair that favored pike (*Esox* spp.) and bass (*Micropterus* spp.), which feed on walleye (*Stizostedion vitreum*) fry.

Life History

Adult zebra mussels reach reproductive maturity within 1 year (shell lengths at this stage are greater then 8 mm (0.3 inches); Claudi and Mackie 1994) and begin spawning when the water temperature is 14-20°C (57-68°F). A mature female can produce 30,000 veligers per season, not all of which, however, reach reproductive maturity (Ohio Sea Grant 1992). Spawning normally occurs in early summer (June-mid July), but a second spawning in fall (August-October) has also been documented. The veligers are spewed into the water column where they freely float for 2-3 days. They then settle and attach themselves to any solid natural or humanmade substrate. Attachment is by a tuft of fibers called *byssall threads* (produced by a gland in the foot) that secretes an adhesive substance that anchors the veligers. Juveniles can break away, generate new threads, and drift to new areas of attachment. In contrast, native adult freshwater mussels in the United States do not have the ability to attach themselves to hard surfaces. The life span of adult zebra mussels ranges from 2 to 5 years.

Limiting Factors

Salinity, calcium, pH, temperature, and dissolved oxygen are limiting factors for the survival and growth of zebra mussels and can be used to determine the risk of infestation. Because they are freshwater bivalves, zebra mussels can only colonize and reproduce in areas of relatively low salinity (less than 10 parts per thousand). They are however able to tolerate some salinity for short periods, which raises their potential dispersal through high-salinity areas (North Carolina Sea Grant 1997).

Because these parameters can vary daily and seasonally and do vary spatially, the collection of measurements in several locations over an extended period of time is important for determining the extent of potential infestation. Assessments of infestation risk must be made in consideration of various factors, for example, frequency of access by boats from other water bodies, multiple fishing derbies, ease of boating access, and proximity to infested waters.

Threshold levels of zebra mussel growth and reproduction (Claudi and Mackie 1994; North Carolina Sea Grant 1997).

	Mussels		
Parameter	**reproduce**	**may survive**	**probably do not survive**
Salinity (ppt)	0-5	5-10	>10
Calcium (mg/L)	>15	9-15	<9
pH	7.4-8.7	6.5	<6.8 or >9.5
Temperature (°C)	12-31	9-27	<15 or >32
Dissolved Oxygen (ppm)	8-12	4-8	<4

Control

Because the zebra mussel is an exotic species, the number of natural predators is not sufficient to control population sizes, and environmentally safe *in situ* controls (chemicals) in lakes or rivers are also not available. Agencies are exploring the feasibility of cleaning and relocating infected native mussels from areas with small infestations, and researchers continue to explore ecologically safe controls that target the reproductive cycle of the zebra mussels. Preventive measures are the most effective (and least costly) method of preventing zebra mussel infestations. Monitoring, which provides early detection, and public education should be implemented in all areas with potential for infestation. Although low reproduction may not be furthered in areas with low potentials for infestation, zebra mussels could be introduced and hence could be unknowingly transported to non-infested area.

PVC (polychlorinated vinyl) multiplate stations or cement blocks are commonly used for sampling adult mussels. Sampling of veligers requires plankton nets and a dissecting microscope with a polarizing light source. Where the risk is medium to high, a control plan should supplement monitoring and education. Control in lakes and rivers should include pressurized hot water (110 F) rinses of boats, trailers, and other equipment; restricted access to vessels and equipment that were inspected for zebra mussels or were decontaminated; and regulations that prohibit the transport of aquatic nuisance species from infested waters into non-infested waters.

If a boat, trailer, fishing gear, diving gear, or other equipment has been operated in zebra mussel infested waters, the following precautions are recommended: removal of any visible vegetation from the boat, propeller, trailer, and other components (zebra mussels can attach to aquatic vegetation); flushing of the engine cooling system, live wells, and bilge with hot water; and thorough rinses of other portions of the vessel. Water hotter than 37.8°C (110°F) will kill veligers, and 54.4°C (130°F) will kill adults. Salt or chlorine must not be used because they are toxic to other organisms. The boat exterior must be visually checked for mussels if it has been docked in infested waters, and the inspection must include the hull, trim tabs, motor mounts, and swim platforms. The surface should be felt and, if it feels gritty, young microscopic veligers may be attached. Removed zebra mussels must be properly discarded. Bait must not be re-used, and bait buckets must not be emptied into the water.

Additional Reading and Resources

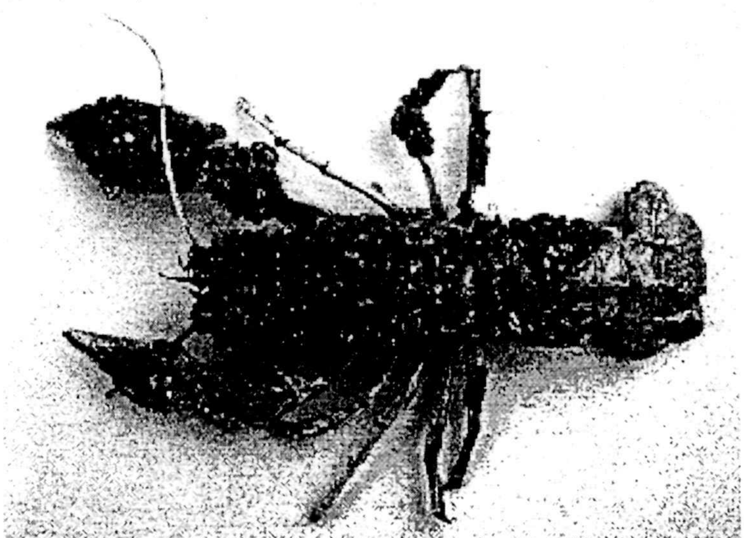
Claudi, R., and G. L. Mackie. 1994. A practical manual for zebra mussel monitoring and control. CRC Press, Inc., Boca Raton, Florida. 225 pp.

Marsden, J.E. 1992. Standard protocols for monitoring and sampling zebra mussels. Illinois Natural History Survey Biological Notes: 138. 40pp.

O'Neill, C. R. 1996. The zebra mussel: impacts and control. Cornell Cooperative Extension Information Bulletin 238.. 62pp.

Zebra Mussel Clearing House
New York Sea Grant Extension
250 Hartwell Hall
SUNY College at Brockport
Brockport, NY 14420-2928
800/285-2285
zmussels@cce.cornell.edu
(distribute a variety of fact sheets, books, slides , and educational material)

Zebra Mussel Information System (CD-ROM)
Department of the Army
Waterways Experiment Station, Corps of Engineers
3909 Halls Ferry Road
Vicksburg, Mississippi 39180-6199
http://www.ansc.purdue.edu/sgnis/



Crayfish encrusted with zebra mussels

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North Carolina Sea Grant. 1997. Zebra mussel colonization: North Carolina risks. Raleigh, North Carolina. 3 pp

Ohio Sea Grant. 1992. Boaters: Take action against zebra mussels. OHSU-FS-054, Columbus, Ohio. 2 pp.

O'Neill, Charles. 1995. *Dreissena!* New York Sea Grant Extension, Brockport, New York. 7(2):1-5.

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