



Zebra Mussels and Other Nonindigenous Species

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The Nonindigenous Species Problem

Transported from Europe as stowaways in the ballast water of transoceanic ships, zebra mussels (*Dreissena* sp.) pose significant social, economic and ecological concerns for the Great Lakes and other inland North American waters. The prolific mollusk tends to biofoul and restrict the flow of water through intake pipes, disrupting supplies of drinking, cooling, processing and irrigating water to the nation's domestic infrastructure. The mussel also attaches to boat hulls, docks, locks, breakwaters and navigation aids, increasing maintenance costs and impeding waterborne transport.

Besides these commerce-related disruptions, heavy infestations of zebra mussels also can alter freshwater ecosystems, possibly defeating aquatic resource restoration and development efforts. First observed in the mid-1980s in Lake St. Clair, zebra mussels are no longer just a Great Lakes problem. Carried mainly by the downstream flow of water and commercial and recreational boat traffic, zebra mussels now inhabit the waters of 20 states and the Canadian provinces of Ontario and Québec.



By the year 2000, the mussel was infesting most stretches of the Mississippi, Illinois,

Ohio, Mohawk, Hudson, St. Lawrence, Cumberland, Tennessee, Arkansas and rivers and had begun colonizing tributaries like the Missouri, Allegheny, Monongahela, Wabash and St. Croix rivers. Zebra mussels also had colonized New York's Finger Lakes, Lake Champlain, Wisconsin's Lake Winnebago, Kentucky Lake, and nearly 100 smaller inland lakes in seven of the eight states bordering the Great Lakes.

While the zebra mussel invasion and its immense impact on the Great Lakes ecosystem has focused attention on the issue, the introduction of nonindigenous (exotic) species is not a new problem. An estimated 130 nonindigenous species have been introduced to the Great Lakes, most of them arriving since the St. Lawrence Seaway opened in 1959. Several of these species -- including the sea lamprey, alewife, smelt, carp and milfoil -- have contributed to massive changes in Great Lakes fish and plant communities.

Nor is the introduction of nonindigenous species a problem isolated to the Great Lakes. An estimated 350 nonindigenous species of marine and estuarine plants and animals have been introduced to U.S. coastal waters. These invaders can be a serious threat to native biotic communities and important fishspecies.

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Sea Grant's Response

The six Sea Grant programs that form the Great Lakes Sea Grant Network have frequently taken a leadership role in addressing nonindigenous species issues through research, education and outreach activities. The network was among the first to react to the zebra mussel invasion. Within a month of the first confirmed sighting in Lake Erie, Sea Grant-funded scientists were researching ways to control the mussel.

Individual Great Lakes Sea Grant programs initiated pilot research projects in 1988, 1989 and 1990 to better understand the biology and ecological and economic impacts of the zebra mussel, and to develop control technologies. Network programs continue to coordinate the research they fund and work closely with federal and state agencies to avoid duplication of effort and maximize the value of every dollar spent. Besides conducting research, the network provides the region's major nonindigenous species outreach and education programs. Since 1991, the [National Sea Grant College Program](#) has funded research to address this growing national problem. Most of this work has been conducted by scientists associated with Great Lakes Sea Grant Network programs. A decade later, these programs continue to fund a variety of research, extension, education and communications projects.

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Control and Prevention

Most scientists believe that zebra mussels cannot be eradicated, so the goal now is to learn to control or accommodate them. Better strategies to prevent the spread of zebra mussels as well as the introduction of other undesirable nonindigenous species are still needed. The quagga mussel, believed to be a new species of zebra mussel, was found in Lakes Erie and Ontario in the early 1990s and today infests the St. Lawrence River as far downstream as Montreal. Quaggas also have been found at about a half-dozen sites on Lakes Michigan and Huron, mostly around the Straits of Mackinac. The vehicles for this spread are numerous and include the hundreds of thousands of recreational boats trailered to and from the Great Lakes each year, and commercial vessels moving between ports.

Sea Grant research is currently identifying economic incentives to prevent the further spread of zebra mussels and alternatives for preventing future introductions of other nonindigenous species.

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Ecological Impacts

Zebra mussels are filter feeders. Each adult is capable of filtering a liter of water per day, removing almost every microscopic aquatic plant (phytoplankton or algae) and animal (zooplankton). Zebra mussel colonies in Lake Erie have reached astounding densities of 70,000 per square meter, and experts estimate that Lake Erie's zebra mussel population filters the entire volume of the lake's western basin once a week. The mussel has increased Lake Erie's water clarity up to 600 percent and reduced some forms of phytoplankton, the basis of the lake food web, by as much as 80 percent. The increased water clarity has allowed light to penetrate deeper into the water column, allowing rooted aquatic vegetation to increase greatly in density. Bottom-dwelling (benthic) forms of algae appear to be increasing, as do several forms of insect-like benthic organisms. Researchers have also found that zebra mussels even colonize the shells of freshwater clams and have almost totally eliminated some native species in certain areas.

Because of the huge volumes of water they filter and their high body-fat content, zebra mussels accumulate about 10 times more [PCBs and other toxic contaminants](#) than native

mussels. These contaminants are transferred up the food-chain to waterfowl and fish that eat zebra mussels. This potential to significantly affect contaminant cycling is of great concern in the Great Lakes, where health advisories already exist for consumption of some species of fish.

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Impacts on Commerce and Industry

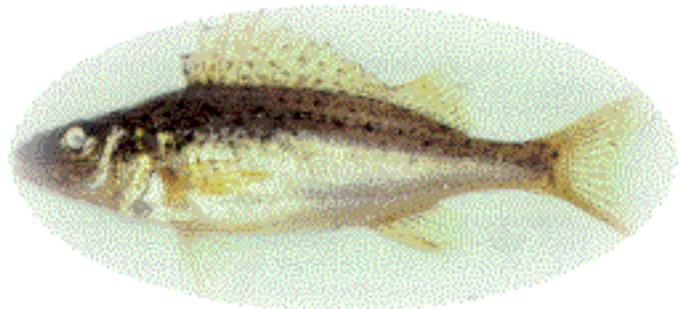
Zebra mussels rapidly colonize water intakes, forming layers up to eight inches thick. Such infestations along Lake Erie have disrupted the water supply to Monroe, Mich., on several occasions. Millions of dollars are being spent annually by Great Lakes cities and industries to unclog intake pipes and prevent further infestation. Much research is underway to help in this endeavor, and more is needed.

Hot water has been shown to be an effective treatment for zebra mussels, but it is not always a practical alternative. Chlorine is probably the most popular treatment currently in use, but increased chlorination clearly contradicts the efforts of the Great Lakes community to reduce the amount of chlorine entering the ecosystem. Research has shown potassium, bromine, ozone and ultraviolet light to be possible alternatives to chlorine. To date, more than 30 other compounds have also been studied to determine their potential effectiveness against zebra mussels as well as environmental side-effects.

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Other Nonindigenous Nuisance Species

The list of exotic species is very long. However, the [Eurasian ruffe](#) ([Gymnocephalus cernuus](#)) warrants particular attention because of its great potential for outcompeting other species and its undesirability as a forage fish, which could have a very adverse effect on the Great Lakes' multibillion-dollar sport fishery.



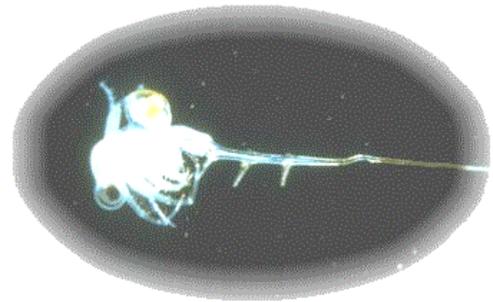
The ruffe was first observed in 1986 in the St. Louis River harbor on Lake Superior at Duluth, Minn. Sea Grant research between 1988 and 1991 showed the population of ruffe to explode from about 100,000 to more than two million. During this three-year period, the forage fish population decreased two- to three-fold, and yellow perch and walleye populations also declined dramatically. If the ruffe succeeds in spreading throughout the other Great Lakes and to inland waters of North America, its impact on the sport fishery and tourism economies could be catastrophic.



Another recent invader causing considerable concern is the [round goby \(*Neogobius melanostomus*\)](#), a small bottom-dwelling fish with a large head resembling that of a tadpole. First discovered in Lake St. Clair in 1990, presumably also introduced via ballast water from transoceanic vessels, the round goby and the tubenose goby have spread to Lakes Erie, Michigan and Superior and to many rivers,

including the Mississippi watershed. Round gobies are thriving in the Great Lakes Basin because they are aggressive, voracious feeders that can forage in total darkness. The round goby takes over prime spawning sites traditionally used by native species competing with native fish for habitat and changing the balance of the ecosystem.

On the smaller-can-be-bigger problem list are two nonindigenous species of predatory zooplankton likewise introduced via ballast water, the spiny waterflea (*Bythotrephes cederstroemii* shown at right) and most recently the fishhook waterflea (*Cercopagis pengoi*). Both are already a notorious nuisance for fouling fishing lines - indicative of their astonishing abundance - but the biggest threat they pose is at the very foundation of the native food web, where they prey voraciously on native zooplankton and thus deprive larval fish of food, while larger fish find them unpalatable as prey because of their namesake spiny and fishhook tails.



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The Outreach Response

The outreach (Extension, Advisory Services and Communications) components of the

Great Lakes Sea Grant Network have taken the lead in developing public awareness of the zebra mussel problem and ways to slow its spread. These outreach efforts have enhanced the ability of researchers and the media to track and report on progress made in mitigating the mollusk's adverse effects on water supplies, industrial processing, transportation and recreation.

Each Great Lakes Sea Grant program established a zebra mussel information center -- a single contact point and depository that coordinates and disseminates information to researchers, management agencies, businesses, news media and the public. Together, these centers track, confirm and record the progress of zebra mussel infestations at the state and national level. This information is disseminated via news releases, newsletters, magazine articles, radio and television programs, workshops, World Wide Web sites, public presentations, award-winning educational materials, and news media interviews. Specific outreach activities include:

- [Sea Grant Non-Indigenous Species \(SGNIS\) World Wide Web Site](#) -- In late 1996, the Great Lakes Sea Grant Network established the SGNIS, a comprehensive and searchable online collection of research publications and educational materials about zebra mussels and other aquatic exotic species produced by Sea Grant programs and other research institutions nationwide .

All materials available through this site have been through rigorous scientific review to ensure the quality of the information provided. It also has links to other Web sites that focus on nonindigenous species.
- [Zebra Mussel Information Clearinghouse](#) [now the [National Aquatic Nuisance Species Clearinghouse](#)] - Launched by New York Sea Grant with grants from private power and industrial interests, this clearinghouse is now the nation's primary archive of zebra mussel information. This specialized library publishes a bimonthly research periodical, *Dreissena!* (renamed *Aquatic Invaders* in 2001), and it can be contacted via a toll-free nationwide telephone number (800/285-2285) and the U.S. power industry's email system (EPRINet). The clearinghouse is recognized and used by the U.S. Fish & Wildlife Service, U.S. Army Corps of Engineers and other agencies as the nation's "track-mapper" of the mussels' spread.
- [Zebra Mussel Update Newsletter](#) - The ZMU was a 4- to 8-page quarterly



national Sea Grant newsletter published from 1990 to 1997 by the University of Wisconsin Sea Grant Institute in cooperation with Ohio Sea Grant and Brunswick Marine. The

ZMU reported on the spread of the zebra mussel throughout North America, the latest research results and control efforts. Nearly 10,000 copies of each issue of the Zebra Mussel Update were distributed free of charge to subscribers throughout the Great Lakes region and beyond. Subscriber surveys indicated the ZMU had more than 100,000 readers by 1996.

- **Exotic Species Graphics Library** -- Michigan Sea Grant operates a graphics library of slides, photographs, illustrations and videotapes of zebra mussels and other nonindigenous species. These materials are available to all interested media, schools, agencies and organizations nationwide. About 1,200 graphics were provided in response to more than 200 requests during 1991-92.
- **Interregional Training** -- Great Lakes outreach staff are assisting Sea Grant programs, agencies and industries in other regions to deal with the zebra mussel threat. They have conducted educational programs in more than a dozen states, including Connecticut, New Hampshire, New Jersey, Delaware, North Carolina, Virginia, Tennessee, Pennsylvania, Vermont, Louisiana, Mississippi and Arkansas. These programs include training on implementing standardized mussel monitoring programs for early warning/detection.

- **International Zebra Mussel Conferences** -- The Great Lakes Sea Grant Network helped sponsor and host the first and each successive annual zebra mussel research and outreach conferences from 1989 through 1996.



In 1997, the scope of the seventh international conference, held in New Orleans and hosted by [Louisiana Sea Grant](#), was expanded to address other aquatic nuisance species as well. Cosponsored by Sea Grant and a dozen other organizations, the [11th International Conference on Aquatic Invasive Species](#) is slated for February 25-28, 2002, at the Hilton Alexandria Mark Center, Alexandria, Va.

- **Over a Million Publications** -- Since 1990, Great Lakes Sea Grant outreach specialists have produced and distributed more than a million copies of various publications and other [education materials](#) about the zebra mussel and other nonindigenous species. These publications describe the potential effects, identification and control of the zebra mussel and other exotic organisms.

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Proven Record

The real and potential threats of nonindigenous aquatic species to native species and the biodiversity of aquatic communities nationwide will continue to be a significant problem for decades to come. With the knowledge and experience gained on the Great Lakes, the Sea Grant network has proven it can effectively lead the nation in responding to these and other threats to our Great Lakes and coastal resources.

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[More about the Great Lakes Sea Grant Network](#)

More about Zebra Mussels and Other Exotic Aquatic Nuisance Species
on the [Sea Grant Non-Indigenous Species](#) Web site



More about [Zebra Mussels](#) and [Other Invasive Species](#) in the Great Lakes
on the [Great Lakes Information Network](#)



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www.seagrant.wisc.edu/communications/GreatLakes/GLnetwork/exotics.html