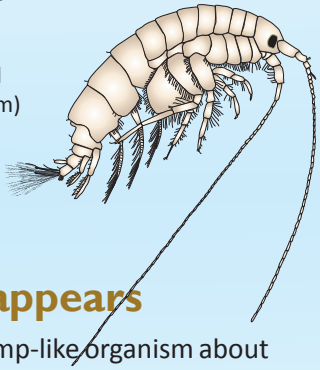
Invasive Mussels

Dramatically Changing the Great Lakes Ecosystem

Many people think of zebra mussels as the most destructive invasive species in the Great Lakes, when in fact they have been "out-musseled" by the closely related quagga. Both are native to Eastern Europe and were introduced to the Great Lakes via ballast water discharged from ships. Zebra mussels arrived in the 1980s and caused widespread ecological and economic damage. Quagga mussels arrived in the 1990s and have since outcompeted zebra mussels. Unlike zebra mussels, quaggas have the ability to adapt to cold temperatures and live in soft sediments like mud instead of requiring hard surfaces. Quaggas also have a longer siphon, the body part that sucks in water to filter out food. Because of these differences, quagga mussels are able to colonize deeper areas of the Great Lakes and have almost entirely replaced zebra mussels in many places. The dominant quagga mussel has become so widespread that the species has completely changed the Great Lakes ecosystem - with harmful impacts to native organisms.

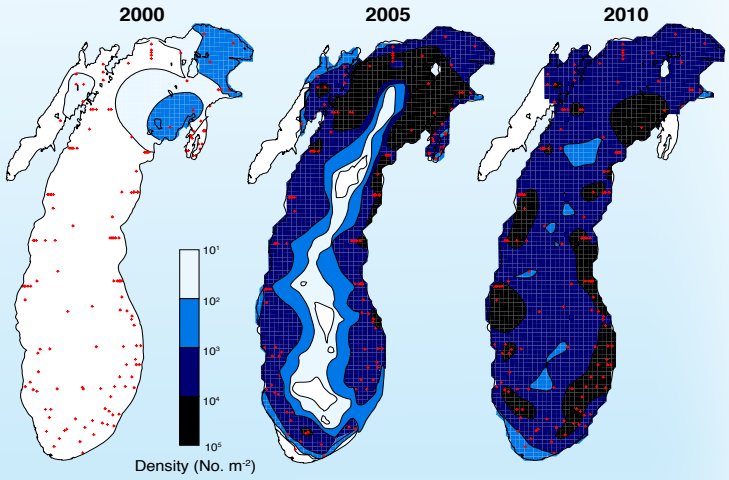
As quaggas spread...

Populations of the invasive quagga mussel are expanding in every Great Lakes except Lake Superior. Scientists at NOAA's Great Lakes Environmental Research Laboratory (GLERL) have monitored populations of invasive mussels since 1990. These maps illustrate how quickly quagga mussels have become dominant in Lake Michigan in only 10 years. Current densities in the lake are as high as **35,000 mussels per square meter**.



Diporeia (actual size up to 10 mm)

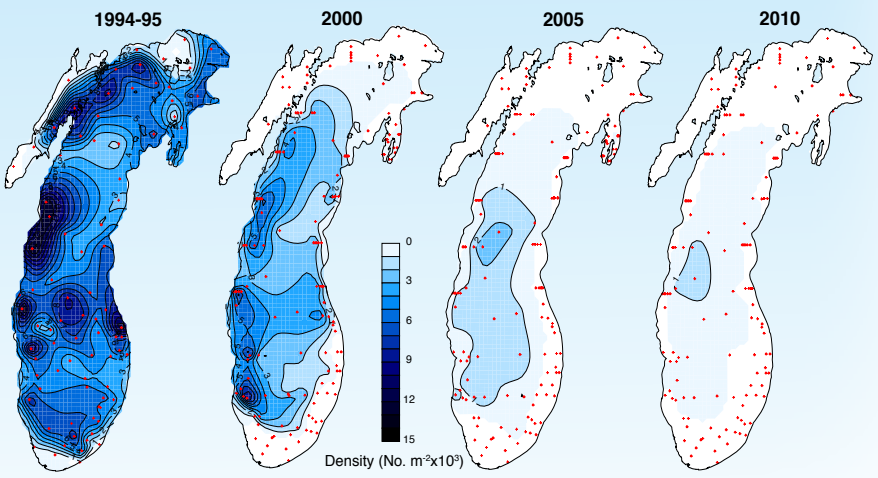
Lake Michigan Quagga Mussel Density



...*Diporeia* disappears

Diporeia is a native shrimp-like organism about the size of your pinky nail that Great Lakes fish once relied on for food. Researchers at GLERL documented a dramatic decline in *Diporeia* populations in Lake Michigan at the same time invasive quagga mussel populations were expanding. In just 15 years, *Diporeia* densities declined from an average of 5,200 per square meter to only **82 per square meter**. Although exact reasons are unclear, scientists believe it is related to the introduction and expansion of invasive mussels.

Lake Michigan *Diporeia* Density



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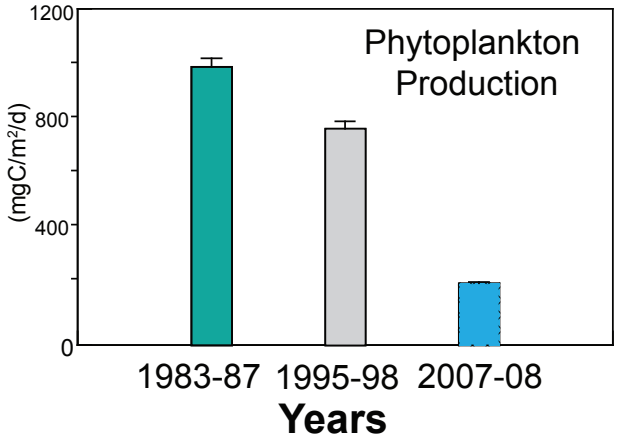
Food Production is Decreasing

Quagga mussels are efficient filter feeders that are depleting food supplies for native species and are negatively impacting Great Lakes fish. Phytoplankton, or tiny floating plants, are eaten by *Diporeia* and other tiny animals called zooplankton. Small fish, in turn, rely on zooplankton for food, and large fish such as salmon eat small fish. Recent research by GLERL scientists shows that in southern Lake Michigan, quagga mussels are eating massive quantities of phytoplankton, particularly in spring, greatly reducing food production in the lake (see graph to the right). Coupled with the loss of *Diporeia*, the food available to fish has declined dramatically, negatively impacting their health.



Springtime primary production of phytoplankton (measured in mg carbon/ m^2/day) in southern Lake Michigan has declined since the mid-1990s.

Fish Health is Declining

The food available for these lake whitefish has declined. The fish in the center is normal; the top and bottom fishes are underfed. Photo credit: Ontario Ministry of Natural Resources.

Decreases in food availability due to invasive mussels are affecting fish populations across the Great Lakes. In Lake Michigan, for example, some fish have been forced to shift to a diet of the less-nutritious invasive mussels. The health of lake whitefish, an important commercial species, has recently declined due to the invasion of quagga and zebra mussels (see photograph above).

Economic Implications

Recreational fishing in the Great Lakes is valued at over $7 billion per year. As quagga and zebra mussels erode the base of the food web, this fishery is at risk. Recent increases in nuisance algal blooms, encouraged by invasive mussels, also have serious economic implications. Algal blooms keep people away from beaches, damaging the tourism industry that forms the basis of the Great Lakes economy.

Harmful Algal Blooms are Increasing

The size and number of harmful algal blooms in the Great Lakes has increased in recent years. Quagga and zebra mussels promote the growth of bottom-dwelling algae by increasing sunlight penetration to the lake bottom, and also by changing nutrient cycling. One type of harmful algal bloom is caused by a species called *Cladophora*, which grows on the lake bottom and washes up on the beach in large clumps after it dies. These clumps are smelly and unsightly, and can harbor bacteria that are harmful to humans and wildlife.

Cladophora covering a Lake Michigan beach
Photo © John Karl, University of Wisconsin Aquatic Sciences Center.

The Importance of Research and Monitoring

GLERL researchers study aquatic invasive species and harmful algal blooms to better understand their impacts in the Great Lakes ecosystem. GLERL has also monitored environmental and ecological parameters in Lake Michigan since 1980 and is beginning a monitoring program in Lake Huron. These research and monitoring programs provide valuable data that help decision makers find solutions to improve the health of the Great Lakes.

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