

Sleeping Bear Dunes

Resource Brief

Midwest Region
National Park Service
U.S. Department of the Interior



Re-setting the Reef: Quagga Mussel Removal in Good Harbor

Of all the invasive species in the Great Lakes, zebra and quagga mussels are arguably the best known, and for good reason.

Following their discovery in Lake St. Clair in the late 1980s, zebra mussels rapidly spread through the Great Lakes, colonizing nearshore areas, clogging municipal and industrial water intakes, and littering lake bottoms and beaches. Soon after, the even more adaptable quagga mussel arrived, greatly expanding invasive mussel distribution and engineering some of the biggest ecological changes in Great Lakes history.

Voracious filter feeders, these mussels have the capacity to filter all the water in Lake Michigan in less than two weeks, greatly reducing the abundance of plankton—the base of the food web for a number of higher organisms, including fish. Their presence has also provided ideal growing conditions for a native seaweed-like algae called *Cladophora*, invited the establishment of the invasive round goby, and been linked to outbreaks of avian botulism and tens of thousands of waterbird deaths.

A Surprising Observation

In the mid-2000s, the National Park Service (NPS) and the University of Wisconsin–Milwaukee’s School of Freshwater Sciences (UWM) began intensive monitoring and research of the nearshore waters at Sleeping Bear Dunes National Lakeshore. In 2010, we established a nearshore monitoring station on nearby Good Harbor Reef (*see map at right*).

Several years ago we began to notice something surprising: rocks scraped for mussel and algae samples were not being quickly recolonized by invasive mussels. Perhaps the now-abundant round gobies were eating the mussels faster than the mussels could reproduce.

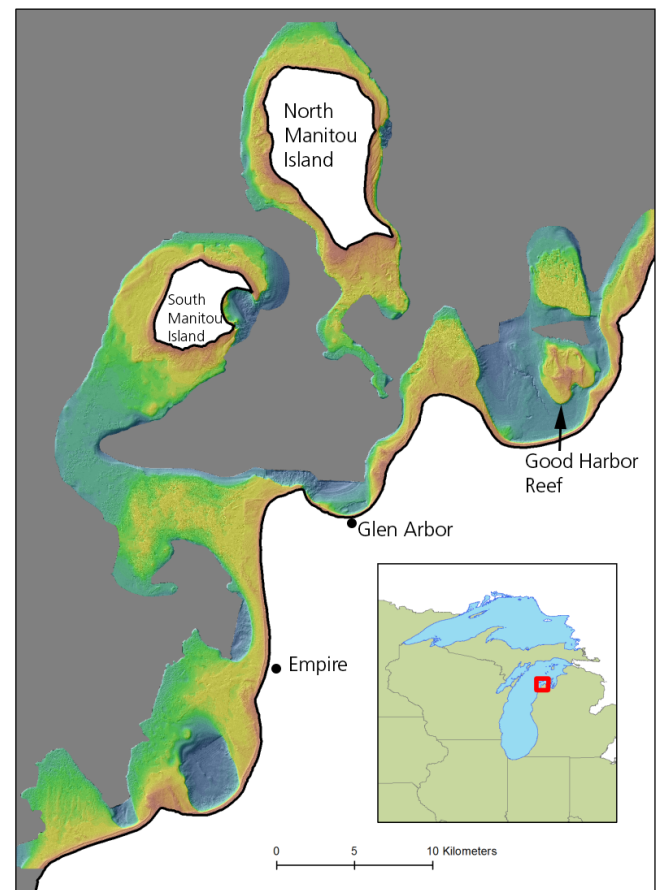
This gave us an idea: could small patches of reef be cleared of mussels and restored to pre-invasion conditions? And if so, what impact might that have on mussel-related management issues, like nuisance *Cladophora*, invasive round gobies, and native fish restoration?

A Clean Start

Starting in 2016, divers from the NPS, UWM, and the local community set to work clearing mussels from rocks at an experimental plot on Good Harbor Reef. Over the course of the summer, we **removed close to one million mussels** from 430 square-feet (40 square-meters) of the reef, leaving behind mainly bare rock. We set up instruments



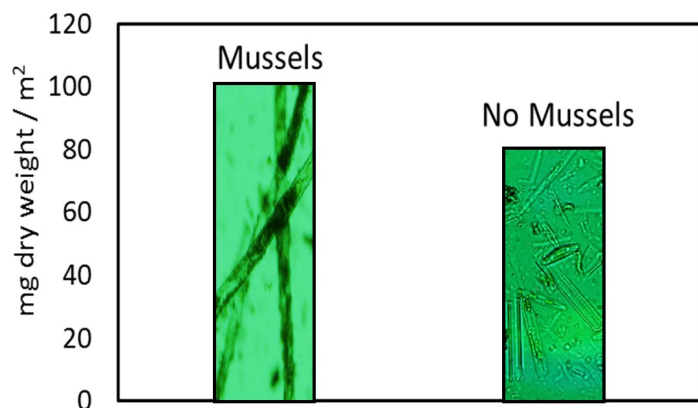
A rock encrusted with quagga mussels and *Cladophora* algae.
NPS/B. LAFRANCOIS.



Lake bottom habitat along the shore of Sleeping Bear Dunes National Lakeshore, including Good Harbor Reef. MAP BY NATIONAL PARK SERVICE AND NORTHWESTERN MICHIGAN COLLEGE

to monitor conditions at the experimental site and a nearby control (un-scraped) site, and returned periodically to assess the abundance and size of invasive mussels and the amounts and types of algae and invertebrates present.

Initial results look promising. The experimental site has not been recolonized by invasive mussels. The amount of algae is lower at the experimental removal site than at the control site, and algae composition has shifted away from nuisance *Cladophora* and toward diatoms, a preferred food source for many aquatic organisms (*see graph*).



Algae biomass at Good Harbor Reef. The experimental removal site (“No Mussels”) had less algal biomass and more diatoms (*pictured*) in 2017 than the control site (“Mussels”, with *Cladophora* pictured).

Parks For Science

Good Harbor Reef serves as a natural laboratory to monitor ongoing changes in the Lake Michigan ecosystem and to test ideas about reef and native species restoration. New partnerships with the University of Michigan and the Michigan Department of Natural Resources will expand our work to explore how the microbial and fish communities respond to mussel removal. Together these efforts are helping to “re-set” Good Harbor Reef and lay the groundwork for larger-scale ecosystem restoration efforts throughout the Great Lakes.

Collaborators

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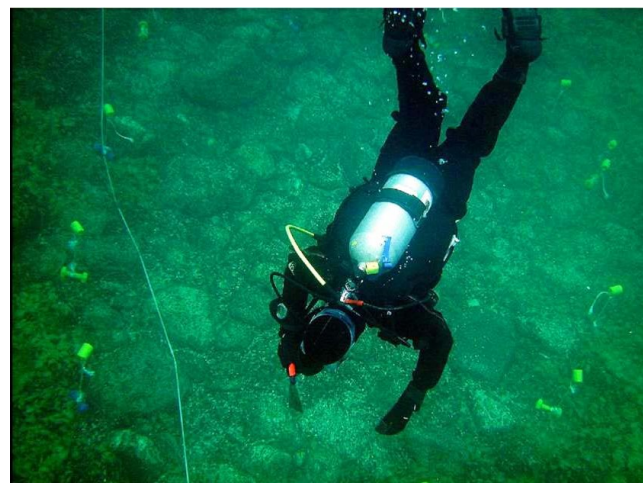
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Round gobies, an invasive fish species that eats zebra and quagga mussels, are found in high densities on invasive mussel beds in Lake Michigan. PHOTO © HARVEY BOOTSMA.



A diver clears invasive mussels from the experimental mussel removal plot at Good Harbor Reef. PHOTO © BEN TURSCHAK



A nearshore monitoring system with continuous water quality sensors and an underwater time-lapse camera, at Good Harbor Reef. Note the gobies on the bare rock. PHOTO © HARVEY BOOTSMA