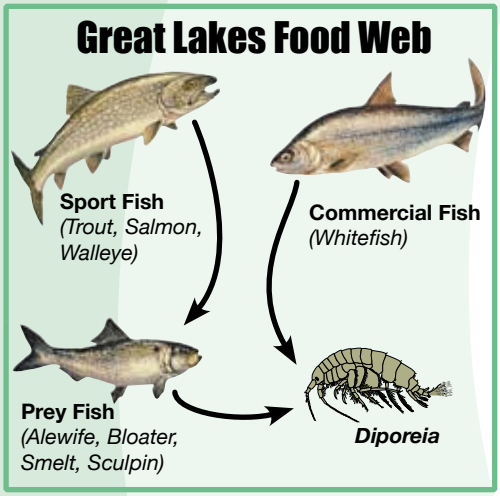
THE IMPACT OF DIPOREIA SPP. DECLINE ON THE GREAT LAKES FISH COMMUNITY

Industry Faces Uncertain Future

Sport Fishing in the Great Lakes is valued at over $4 billion per year, with common catches consisting of lake trout, salmon, walleye, and yellow perch. With the coincident introduction of the zebra mussel and disappearance of the important shrimp-like amphipod *Diporeia*, food available to the Great Lakes fisheries is being disrupted.

Sport fish, such as adult salmon and trout, feed mainly on prey fish such as alewife, bloater, smelt, and sculpin, and these fish rely on *Diporeia* for food. Also, lake whitefish, an important commercial species, feed mostly on *Diporeia* as well. Although other organisms are present on the lake floor, they are not as readily fed upon by fish and are not as rich in calories as *Diporeia*.



Change in the Food Web and Potential Implications

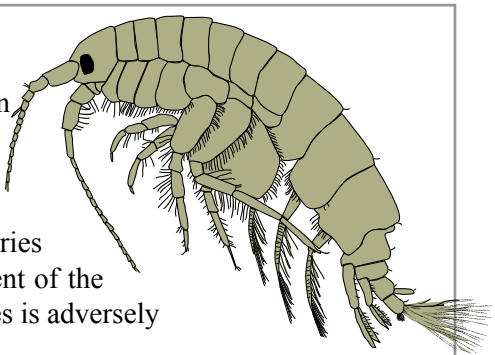
Researchers at NOAA's Great Lakes Environmental Research Lab routinely monitor the abundance of the amphipod *Diporeia* at 160 sites in Lake Michigan. Sampling has been conducted in 1994/95, 2000, and 2005. Data from 2005 shows that *Diporeia* abundance continues to decline and that they are now completely gone from large areas of the lake.

"Exact mechanisms are unclear, but the decline of *Diporeia* is related to the introduction and expansion of the zebra and quagga mussels," says Tom Nalepa, a GLERL biologist who has been sampling Lake Michigan sediments since the early 1980s. One theory is that mussels are outcompeting *Diporeia* for available food. *Diporeia* live in the bottom mud and feed mostly on algae settling from the water column. Now, large concentrations of mussels residing on the lake bottom may be filtering out algae and thereby depriving food to amphipods, according to Nalepa. Yet inconsistent with this theory is the fact that individual *Diporeia* show no signs of starvation. Between 1994 and 2000, *Diporeia* densities declined from an average of 5200 per square meter over the entire lake down to 1800. In 2005, the average density was only 300 per square meter.

While many species of fish will readily eat *Diporeia*, few species can use zebra and quagga mussels for food. Moreover, even if a fish species does eat these mussels, they are provided with a food value much lower than that of *Diporeia*. Evidence suggests that declines in *Diporeia* are having a significant impact on fish populations throughout the Great Lakes.

In Lake Erie, the loss of *Diporeia* was likely a factor in the severe decrease in smelt stocks in the 1990s. The fishery in Lake Erie in the 1980s, before zebra mussels colonized the lake, centered on smelt, walleye, yellow perch, and salmonids. Smelt were particularly abundant, and supported a large commercial fishery in the central and eastern basin until their decline. In addition, the decline of slimy sculpin and young lake trout in Lake Ontario may have been caused by the large loss of *Diporeia*. Estimates of the slimy sculpin and lake trout populations in Lake Ontario showed a 95% decline between the late 1980s and 1996. In Lake Michigan, however, many fish populations are now sacrificing health to feed off zebra mussels. Whitefish, for example, shifted from a diet of 25-75% *Diporeia*, to one of largely zebra mussels.

What is Diporeia?



A tiny, shrimp-like organism, *Diporeia* is normally the dominant benthic invertebrate in most offshore areas of the Great Lakes. *Diporeia* is environmentally sensitive, requiring clean, cold, well oxygenated water for growth and survival. It is native to the Great Lakes, having been present since the receding of the glaciers. *Diporeia* have a high lipid content, with lipids often exceeding 30% of its total weight. As a result, it is rich in calories and a good source of energy for fish. Since *Diporeia* normally make up over 70 percent of the living biomass in healthy lake bottoms in offshore areas, their decline in the Great Lakes is adversely affecting a variety of fish species that depend heavily on them for food.

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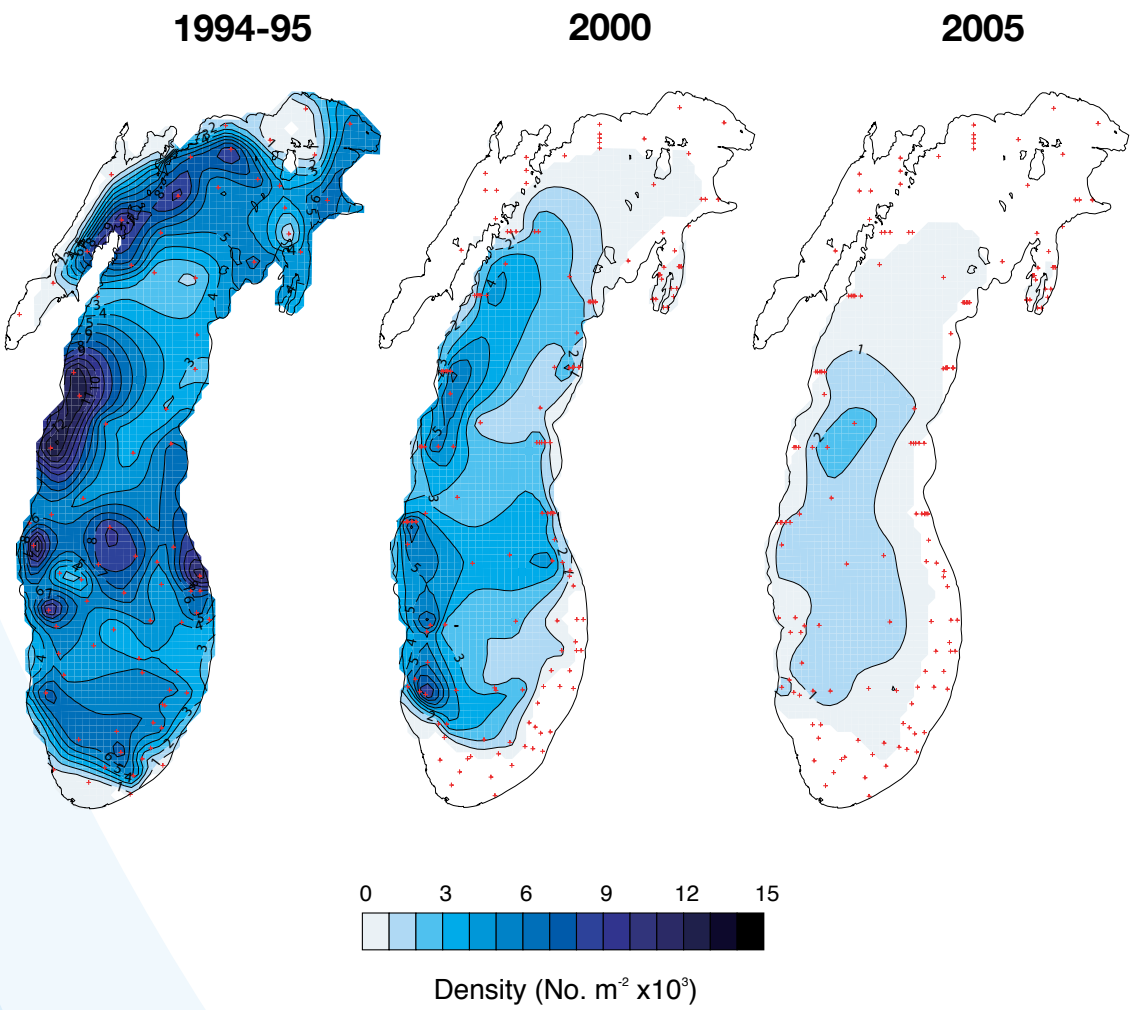
June 2006

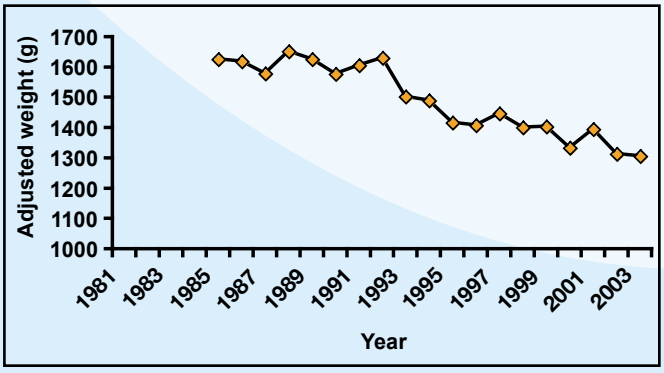


This figure shows *Diporeia* densities in Lake Michigan in the years 1994-1995, 2000, and 2005. Sampling sites are indicated by the small red crosses. Zebra mussels were first found in Lake Michigan in the southwestern portion of the lake in 1989 and quagga mussels were first found in the northern portion in 1997. The decline of *Diporeia* is coincident with the spread of these two species. Quagga mussels are now spreading into deeper regions of the lake and areas with *Diporeia* in 2005 are now at risk.

Declining Fish Health

After the arrival of the zebra mussel and the subsequent decline of *Diporeia* beginning in 1992, whitefish condition and weight-at-age declined. The calorie-rich *Diporeia*, which previously was a staple of the whitefish diet, was replaced by the indigestible shell material of the zebra mussel, which does not contribute to the fish's diet energetically, but does take space in the digestive tract. Moreover, alewife energy density was 23% lower during 2002-2004 (post zebra mussel invasion) compared to 1979-1981 (pre zebra mussel invasion). As a result, a Chinook salmon now needs to eat 22% more alewives to attain an ideal body weight by age 4.

This figure shows the body condition of lake whitefish off Grand Haven and Muskegon in the southeastern part of the lake. The y-axis represents the condition of the fish, measured as the mean weight of a lake whitefish adjusted for length. The graph shows that there has been a steady decline in body condition since 1992.



What is Being Done?

Research efforts continue to focus on the negative response of to zebra and quagga mussels. By better understanding this link, we may better predict the eventual extent and ultimate consequences of the population loss and the potential for the return of if abundances of zebra and quagga mussels decline.

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