

5~ IMPACTS ON FISH COMMUNITIES AND COMMERCIAL FISHERIES



Fishermen trowling for smelt

The commercial fishing industry has adjusted to many dramatic changes in Great Lakes fish communities due to exotic species introductions – from around 60,000 metric tons annually around 1900, commercial fish harvests remained near 45,000 tons per year through most of the 20th Century.⁹⁹ In fact, recent restoration efforts have revealed positive results – for example, lake trout are again naturally reproducing in Lakes Michigan and Huron, and are apparently self-sustaining in Lake Superior; burbot populations have come back to some extent in the upper Great Lakes.¹⁰⁰ Restoration efforts must now address the possibility that there will be a loss of basic components in the food web; in particular, the disappearance of *Diporeia* may prove to be the most devastating result of invasive species to date, as well as one of the most challenging blows from which to recover.

The disappearance of *Diporeia* may destroy the link between the best food supply and the fish.¹⁰¹ Following the zebra mussel invasion in Lake Ontario, alewives and rainbow smelt (which feed in part on *Diporeia* there), and juvenile lake trout moved to deeper water. Alewife and rainbow smelt, both fish that support trout and salmon stocks, used to obtain 40% and 11% respectively of their energy budget from *Diporeia*.¹⁰² The shift of these species to deeper water has likely increased the importance of the opossum shrimp in their diets, although it has not necessarily led to increased growth rates in the colder water.¹⁰³ The relationship between this disruption in food levels and selected fish species is discussed below.

LAKE WHITEFISH: Lake whitefish are widely distributed in North American freshwater lakes. They are a staple of the Great Lakes commercial fishery and a mainstay of the traditional Native American diet. Great Lakes whitefish have been subject to at least two major declines, towards the end of the 19th Century, due to overfishing and drainage modification, and in the middle of the 20th Century, due in part to sea lamprey predation.¹⁰⁴ More recently, the average annual commercial lake whitefish harvest from 1995-1999 was over 50% of the total commercial catch in Lake Michigan each year.¹⁰⁵ But following the arrival of zebra mussels in 1989, the average length and weight of these fish decreased in southeastern Lake Michigan.¹⁰⁶ One measure of a fish's size is its condition factor, determined by calculating the ratio of its weight to its length cubed. A lighter, more emaciated fish has a lower condition factor. Figure 12 shows declines in condition factor of three age classes of lake whitefish in Lake Michigan since a population peak in 1992. While reduced growth rates in the 1990s may have been partly attributable



Lake Whitefish

to factors involving the density of the populations, the rapid decline starting in 1995 coincided with significant increases in zebra mussel density in northern Lake Michigan.¹⁰⁷

A very similar pattern is appearing 700 miles away on the eastern end of the Great Lakes chain. Lake whitefish from Lake Ontario's Kingston Basin supported 50% of Lake Ontario's total commercial harvest of all fish species in the 1990s.¹⁰⁸ Since 1993, whitefish body condition, decreased juvenile and adult abundance, poor survival, and reduced production have occurred as lake whitefish shifted to feeding on mussels.¹⁰⁹ Research into the health of Lake Huron lake whitefish in response to decreased abundance of *Diporeia* is underway.¹¹⁰

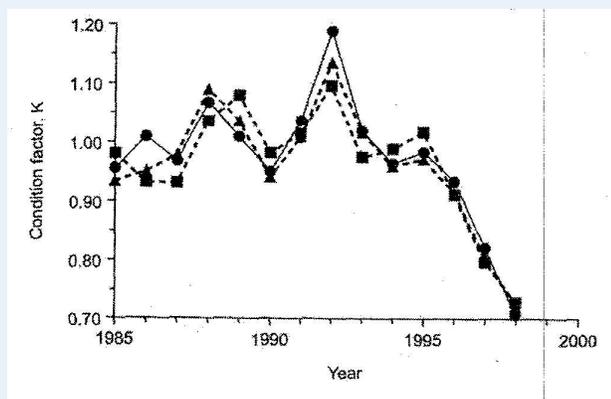


Figure 12: Crash Diet: Following an explosion of zebra mussels in Lake Michigan during the 1990s and the near-disappearance of the water body's prized food source, *Diporeia*, lake whitefish experienced drops in weight in relation to their length — a measurement known as condition factor. Researchers assess the health of fish populations by tracking condition factor. Mean condition factor for age-4 (circles), 5 (triangles), and 6 (squares) lake whitefish from Lake Michigan, 1985-1998 (reproduced with permission from Madenjian et al. 2002.)

LAKE TROUT: Lake trout are native to the Great Lakes and historically supported a significant commercial fishery in all lakes but Lake Erie. As noted previously, the combination of overfishing and sea lamprey predation led to significant declines in lake trout populations. These included a complete collapse of lake trout populations in Lakes Michigan and Huron in the 1940s, and continued declines — that had begun prior to sea lamprey invasion — in Lake Superior. By the mid 1990s, lake trout were considered commercially extinct from all of the lakes except Superior. An additional insult to lake trout in at least one lake came from toxic chemicals: a retrospective assessment indicates that exposures to dioxin-like chemicals (including dioxins, furans, and certain PCBs) alone were sufficiently high to cause complete mortality in lake trout sac fry (i.e., young fish that have not completely absorbed the food sac) in Lake Ontario through the late 1970s.¹¹¹ The combination of chemical control on sea lamprey larvae and stocking

programs (and presumably declining levels of dioxin-like chemicals in Lake Ontario) have brought lake trout populations back to some degree, although only in Lake Superior are lake trout considered to be naturally reproducing at sustainable levels.¹¹²

In the past decade, the disappearance of *Diporeia* has imparted another blow to lake trout. Densities and body condition of lake trout dropped sharply in Lake Ontario's Kingston Basin after 1992, corresponding to the disappearance of *Diporeia* in those waters.¹¹³ Juvenile lake trout eat *Diporeia*, and although adult lake trout do not depend directly on *Diporeia* for food, they do prefer to eat slimy sculpin in the summer months,¹¹⁴ which rely on *Diporeia* for food.¹¹⁵ In the past decade, densities of slimy sculpin have declined by as much as 95% in some waters of Lake Ontario.¹¹⁶ In this same area, only a single specimen of *Diporeia* was collected from 18 lake bottom samples in 1997, where average densities of *Diporeia* had reached levels of 14,000 per square meter before the mussel invasion.¹¹⁷ Scientists believe that drops in productivity through nutrient abatement and reduction in *Diporeia* may have negatively affected slimy sculpin populations,¹¹⁸ with corresponding damage to lake trout.

In addition, zebra mussel colonies on shallow water reefs appear to inhibit successful lake trout spawning while other exotic species (carp, alewife, and round gobies) are potential predators of eggs and fry.¹¹⁹ Recent research has indicated that an adult diet high in alewives has contributed to thiamine deficiency, which can also lead to mortality of lake trout fry.¹²⁰



Lake trout



Yellow perch

YELLOW PERCH: Yellow perch have been important in the commercial fisheries in the four lower Great Lakes for decades, in particular in the past three or four decades in Lakes Huron, Erie and Ontario.¹²¹ Declines in yellow perch in Lake Michigan in the 1970s were attributed to predation of larvae by the exotic alewives. Although populations rebounded in the 1980s, yellow perch recruitment (i.e., the increase in a fish population stock through reproduction, maturing, and migration) has been extremely poor since 1989,¹²² for reasons that are still not clear.¹²³ Poor recruitment resulted in the lake-wide closure of commercial fisheries and reductions in bag limits for recreational anglers by the mid-1990s. In southern Lake Michigan, yellow perch survival and recruitment is closely tied to zooplankton abundance. Density of nearshore zooplankton had declined by a factor of 10 between 1988 and 1990 and remained low during 1996-1998, and may have contributed to yellow perch declines.¹²⁴ Although no firm evidence yet exists, it is possible that declines in *Diporeia* populations in southern Lake Michigan have also contributed to poor recruitment of yellow perch. Because they are also preyed upon by fish such as walleye, muskellunge, northern pike and burbot, yellow perch recruitment failures can affect a number of fisheries.