STATE OF THE GREAT LAKES 2005

WHAT IS THE STATE OF THE GREAT LAKES FOOD WEB?

Introductions and invasions of non-native aquatic species, harvest and stocking of top predator fish, elevated nutrient levels, and presence of contaminants can disrupt the Great Lakes food web, impacting fisheries, wildlife, and ecosystem health.

The Issue

The Great Lakes comprise the world's largest freshwater ecosystem, and a healthy, complex food web is critical to the overall health of this ecosystem. Disruptions to the Great Lakes food web have occurred due to introductions and invasions of non-native aquatic species, harvest and stocking of top predator fish, elevated nutrient levels, and contaminants.

Major features of the Great Lakes food web

A food web is composed of all the interconnected feeding and habitat relationships in an ecosystem. Green plants and algae (phytoplankton) transform solar energy into organic matter, which can be transferred to top predator fish and birds through many pathways. Phytoplankton are consumed by plant-eating animals such as crustaceans and fish larvae (types of zooplankton). Zooplankton are consumed by other animals, including predatory zooplankton and preyfish. Preyfish are food for predator fish such as walleye, salmon, and lake trout. Another key component of the food web is the bottom-dwelling crustacean *Diporeia,* the dominant prey item of whitefish and various preyfish species in offshore waters. The burrowing mayfly, *Hexagenia*, is also an important food web link to nearshore fish species, such as yellow perch and walleye.

Lake trout. Photo: Fisheries and Oceans Canada.

Phytoplankton (left), zooplankton (center), and *Diporeia* (right).
Photos: U.S. EPA Great Lakes National Program Office.

Disruptions of the Great Lakes food web

The species distributions and the feeding and habitat interactions in the Great Lakes food web can be disrupted in many ways, including:

Non-native aquatic species. The 169 known non-native aquatic species in the Great Lakes have been disrupting the Great Lakes food web for decades. Non-native alewive and rainbow smelt preyfish impact native preyfish through predation and competition for food. Sea lamprey prey on lake trout. Zebra and quagga mussel feeding activities impact phytoplankton and zooplankton in the water and invertebrates in the sediments. Non-native predatory zooplankton prey on native zooplankton.

Harvesting and stocking of top predator fish. Overharvesting of lake trout contributed to the decline of this native top predator by the 1950s and allowed non-native alewife to become the dominant preyfish. Coho salmon, Chinook salmon, rainbow trout, and brown trout were introduced to the Great Lakes in the 1960s as top predators primarily to control alewife and rainbow smelt populations. The non-native top predator fish can compete with native fish for food and habitat.

Elevated nutrient levels. Phytoplankton growth in the Great Lakes is controlled, in part, by the naturally-occurring nutrient phosphorus. Municipal, industrial, and agricultural wastewater inputs can elevate natural phosphorus levels, resulting in algae blooms.

Contaminants. Once introduced into the waters of the Great Lakes, some chemical contaminants can be accumulated by algae and subsequently transferred through the food web to top predator fish and birds. Contaminants can also directly affect organisms.

The Indicators and Assessment

Phytoplankton and zooplankton

Phosphorus load reductions in the 1970s and 1980s contributed to substantially reduced algae blooms and improved spawning and nursery habitat for many Great Lakes fish. As a result of improvements to sewage treatment plants, use of reduced phosphorus detergents, and changes in agricultural practices, average phosphorus concentrations in most open waters of the Great Lakes in 2003 were at or below target levels set in 1978. Zebra and quagga mussels also appear to have reduced phytoplankton populations in some areas of the Great Lakes. Non-native invasive species pose a threat to the Great Lakes zooplankton community.

Macroinvertebrates

Diporeia populations have declined dramatically in Lakes Michigan, Huron, and Ontario over the past 12 years and are now rare in Lake Erie. Declines in slimy sculpin and lake trout abundance and deteriorating whitefish health are linked to the scarcity of *Diporeia.* In the early to mid-1900s, *Hexagenia* abundance declined in many Great Lakes habitats impacted by excess nutrients or contaminated sediments. *Hexagenia* populations in areas of Lakes Erie and Ontario are recovering.

Preyfish

Native preyfish populations in all of the Great Lakes except Lake Superior are declining, attributable to dominance of non-native alewife and rainbow smelt, *Diporeia* declines, and perhaps negative interactions with zebra and quagga mussels.

Top predators

Controls on sea lamprey populations contributed to restoration of lake trout to most areas of Lake Superior. Improved water quality and habitat quality, along with fishery management programs, led to recovery of walleye in many areas of the Great Lakes in the 1980s. Populations generally have declined from the mid-1990s to present, however. Levels of legacy contaminants such as PCBs, DDT, and mercury have declined in Great Lakes lake trout and walleye since the 1970s, but may still be high enough to impair fish-eating birds such as the bald eagle.

Current Actions

After the ballast water-introductions of Eurasian ruffe and zebra mussels in the 1980s, voluntary ballast management measures for ships in the Great Lakes began, followed by mandated regulations in 1993. Monitoring of phosphorus concentrations in the Great Lakes continues. Monitoring and research programs are investigating the declines of *Diporeia* and preyfish stocks. Development of alternative sea lamprey controls is underway. Stocking of Atlantic and Chinook salmon, lake trout, and walleye is one of the principal tools used by Great Lakes fisheries management to ensure that top predator fish and preyfish populations are balanced.

Actions Needed

To restore the Great Lakes food web, the following actions are needed:

- Prevention of further non-native species introductions and control of the abundance and distribution of existing invasive species
- Research to determine the optimal stocking amounts of non-native salmon and prey species to support self-sustaining top predator fish communities
- Protection or reestablishment of rare or eliminated native preyfish to increase the diversity of preyfish populations
- Maintenance of the capacity of existing sewage treatment plants to control phosphorus loadings to the Great Lakes in the face of growing human populations

To Learn More

For further information related to the Great Lakes food web, refer to the ***State of the Great Lakes 2005*** report which, along with other Great Lakes references, can be accessed at **www.epa.gov/glnpo/solec**.

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