A Changing Lake Huron

The Lake Huron Food Web

The source of food for all living things in Lake Huron are microscopic aquatic plants called algae. Every other living organism in the lake must either eat live or dead algae directly or eat another organism that depends on algae. Although algae can reach nuisance levels under certain conditions, it is essential to the life of the lake. All aquatic animals in the lake are connected to algae through a food web (Fig. 1).

Phosphorus and Fish Biomass

Phosphorus is an essential nutrient required for algae growth. The total weight of all living fish, termed the fish biomass, is positively related to total phosphorus, but other factors change the amount of fish biomass that can be sustained (Fig. 2). These modifying factors include changes to food web structure caused by invasions (e.g., quagga mussels), habitat availability, water clarity, level of fishing, stocking, predator-prey balance, weather, and fisheries management practices. Lake Huron total phosphorus levels vary widely across the lake. A good indicator of overall change is long-term monitoring of offshore (> 40m deep) total phosphorus levels in the spring and summer.

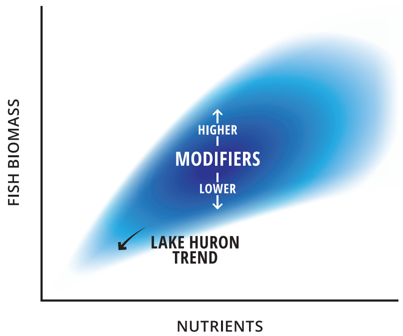

Figure 2
Conceptual relationship between nutrients and fish biomass

Total phosphorus declined by 50% from 1995 to 2003 (4 mg/L to 2 mg/l). Levels have since increased slightly and stabilized at approximately 2.5-3.0 mg/L. The decline in nutrients means that Lake Huron can support less overall fish biomass than it did before 2000 (Fig. 2).

> *Lake Huron can support less overall fish biomass than it did before 2000.*

Food Web Trophic Transfer Efficiency

A food web can be organized into trophic (energy) levels (Fig. 3, overleaf). Living algae and organic material are the first, or lowest, trophic level (TL-1). Small animals, like small zooplankton, quagga mussels, and *Diporeia* consume algae and represent TL-2. Larger zooplankton and prey fish, like fish-hook flea, spiny water flea, *Mysis*, and small fish like rainbow smelt, alewife and bloater are secondary consumers or TL-3. Larger fish that consume smaller fish are categorized as TL-4 and so on, up to the largest predator fish such as lake trout, lake whitefish, rainbow trout, Chinook salmon and walleye.

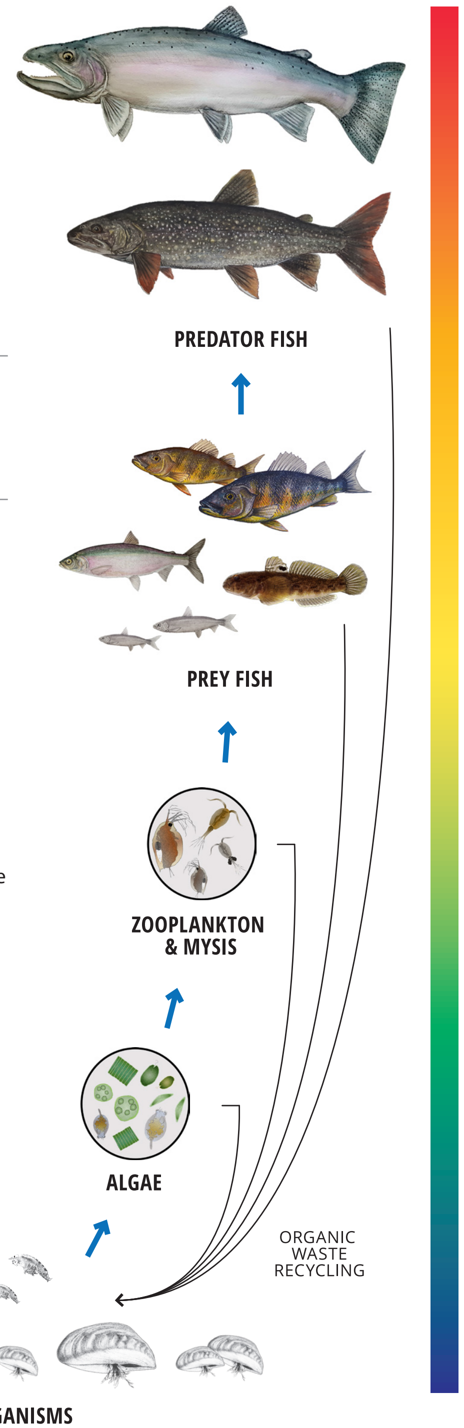

Figure 1
A simplified Great Lakes food web
Original photos and illustrations provided by: C. Brant, NYSDEC, and MI Sea Grant

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Because some energy is lost each time a higher trophic level organism consumes a lower trophic level organism, food webs organized this way have a pyramid shape (Fig. 3). Scientists believe that on average about 9% of the food energy at TL-3 (small fish, large zooplankton and *Mysis*) is transferred to higher trophic levels (TL-4 and TL-5 combined; Fig. 3) in the Great Lakes. This percentage of energy moving up the food web is called "trophic transfer efficiency." Before the collapse of alewife, the Lake Huron food web had a lower than average trophic transfer efficiency of 6% (Fig. 4). Following the collapse of alewife in 2003, the trophic transfer efficiency dropped to 3-4% but increased to 5% in 2015. The food web is producing 2x fewer predator fish for a given level of nutrients than is average for the Great Lakes.

Figure 5
Percent of TL-1 (total of all algal and organic material produced) transferred to Lake Huron fish species.

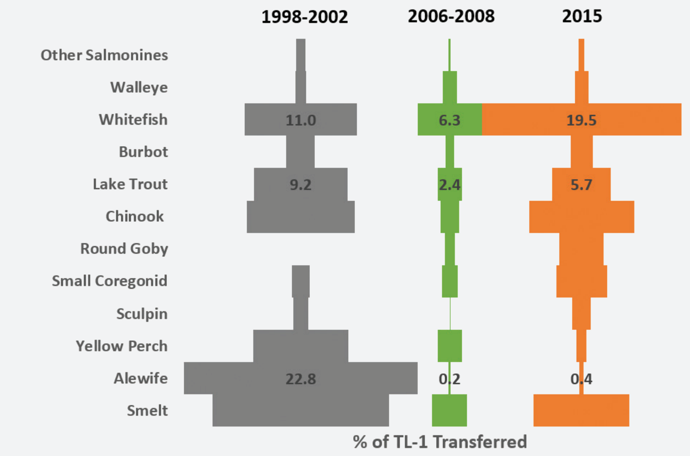
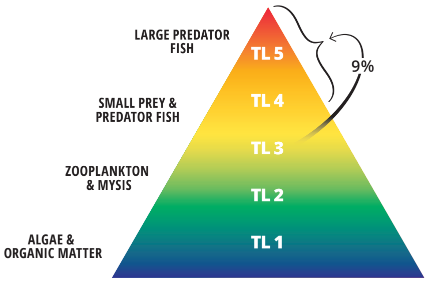


Figure 3
A trophic pyramid



The Lake Huron ecosystem has changed, and continues to do so. Nutrients have declined, water clarity has increased, the food web has been disrupted, and populations of some desirable species of fish have declined.

Trophic Transfer to Specific Fish Species

Higher biomass of a specific fish species requires food web structures that channel sufficient energy from the bottom of the pyramid (TL-1; Fig. 3) to the species of interest. This can be estimated as the percentage of all algal and organic material produced (TL-1) transferred to specific species (Fig. 5). During 1988-2003, the Lake Huron food web supported abundant prey fish species and though quagga mussels were well established, the food web was functioning. Thus, a high percentage of algal production was channeled to predator fish (bigger bars, Fig. 5). In 2003, the collapse of alewife and other changes resulted in much less efficient trophic transfer (smaller bars, Fig. 5). For example, lake trout received only 2.4% of TL-1 production after the alewife collapse (2003) versus 9.2% just before the collapse (1998-2002) (Fig. 5). The most recent data for 2015 indicate overall trophic transfer efficiency improved (increase in bar width, Fig. 5) with increases specifically to lake trout (5.7%) and lake whitefish (19.5%, Fig. 5).

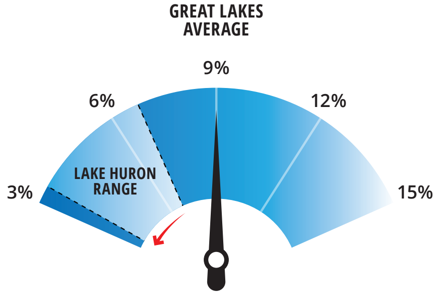


Figure 4
Lake Huron (LH) transfer efficiency compared to Great Lakes average

Fisheries Management Implications

The Lake Huron ecosystem has changed, and continues to do so. Nutrients have declined, water clarity has increased, the food web is disrupted, and populations of some desirable species of fish have declined. Fisheries and environmental management activities can help sustain and improve fisheries. The Lake Huron Committee, with partner agencies, seeks to achieve a balanced, proactive approach to rehabilitate the food web, improve water quality, minimize impacts of invasive species, and develop and sustain fisheries. Important considerations for managers in this changing Lake Huron ecosystem include:

- Lower abundances of important fish species should be expected due to reduced nutrients and a disrupted food web.
- Rehabilitation of native prey may improve food web function and increase trophic transfer efficiency.
- Non-native mussels have altered food web structure and impede production of some desirable species.
- Nearshore and bay fisheries are responding positively to food web changes.
- Research to better understand how food web changes affect fisheries is needed.

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