International Efforts to Study and Understand the Great Lakes Ecosystem:

Nutrients and Invertebrates

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Lake Ontario Watershed. *Image credit Loriann Cody*

Lake Ontario is complex, and it has countless things to study, and ways to study them. Scientists in the Cooperative Science and Monitoring Initiative (CSMI; Fact Sheet 1 in this series) took multiple approaches to their research in 2013. The focus of this Fact Sheet is on nutrients and the base of the food web.

Where Does the Water in Lake Ontario Come From and What Is In It?

- Lake Ontario receives much of its water from Lake Erie and also from rainfall, streams and rivers (tributaries), and water flowing over the land.
- The water in Lake Ontario is habitat for small organisms that use sunlight and nutrients like phosphorus and nitrogen to grow.
- Nutrients tend to be more concentrated near the shore of Lake Ontario because that is where nutrient-rich water enters the lake (especially the south shore where there are relatively more people and agricultural activity).
- Nutrients are crucial for forming the base of the food web, and the balance between too many, and too few nutrients can affect the quality of the water and the level of productivity.

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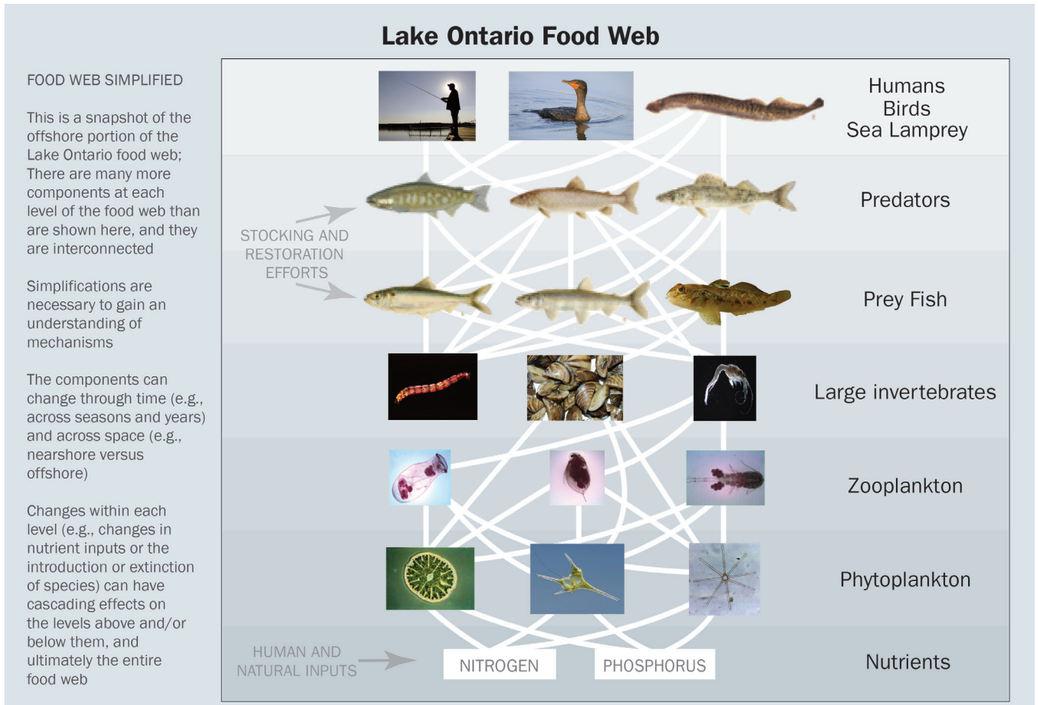
Cooperative Science and Monitoring Initiative Fact Sheet # 2 of 4

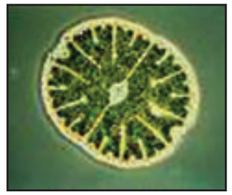
Forming the Base Of the Food Web: Phytoplankton



Lake Ontario Food Web *image credit Loriann Cody*

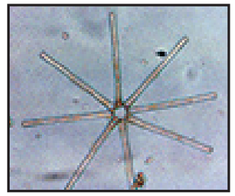
- The base of the food web is made up of tiny organisms suspended in the water called phytoplankton, and also what are called benthic algae that are attached to the lake bottom.
- In general, these organisms are single-celled and microscopic, but there are billions of them in Lake Ontario and they provide food for animals that are higher in the food chain.
- Phytoplankton are the main food source for many organisms in Lake Ontario, and most use photosynthesis to make their own food, which is why they are also called primary producers.
- There are many different types of phytoplankton, but some groups considered important include:

Green algae: Cell with green chlorophyll a and b, hence the name, green algae.

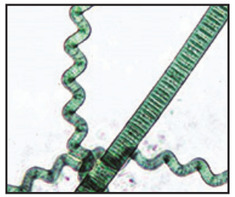


Dinoflagellates: Many different species, but individuals have one or more flagella or swimming "arms."

Diatoms: Single-cell with a wall made of silica, found essentially everywhere there is water.



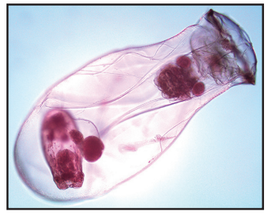
Cyanobacteria: Also known as blue-greens, usually not edible and can cause harmful blooms.



Moving Up the Food Chain: Zooplankton

- Zooplankton are animals found in the water column that generally consume phytoplankton or other, smaller zooplankton.
- Zooplankton are an important food resource in Lake Ontario and they support many invertebrate and fish species, but their numbers have declined in Lake Ontario since the 1990's.
- Like phytoplankton, there are many different kinds of zooplankton in Lake Ontario, for example:

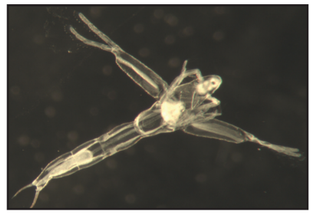
Rotifers: Near microscopic animals that float freely, but may also attach or move along surfaces with their "foot". They have cilia (small hairs) near their mouths to help them feed.



Daphnia: Crustaceans commonly found in fresh water. They are often a preferred prey item of small fish and some invertebrates.

Copepods: Crustaceans that swim in the water column or walk along the lake bottom. They generally eat phytoplankton, but some also eat other copepods or other small zooplankton.

Leptodora kindtii: This predatory crustacean can get large (almost an inch long!) and consumes zooplankton like juvenile *Daphnia* by engulfing them in a "feeding basket".



Larger Invertebrates Found On the Lake Bottom

- Unlike organisms suspended in the water column (loosely termed "plankton"), benthic organisms are those that live on the bottom of the lake.
- These "benthic invertebrates" are often larger than zooplankton like *Daphnia*, and can be seen more easily with the naked eye.
- Many of these organisms represent important components of the food web, transporting nutrients and energy to different locations in Lake Ontario and/or providing food for fish:

Diporeia: Amphipods that live in deep water (often more than 100 feet) and feed on parts of zooplankton that settle to the bottom. Previously plentiful, their numbers have declined dramatically in Lake Ontario.

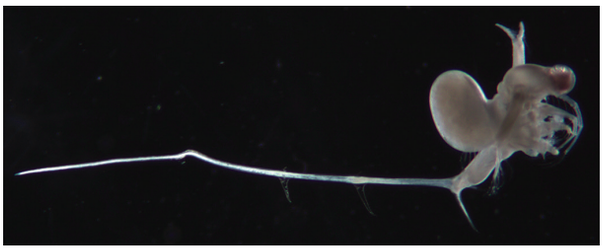
Dipterans: Insects (two-winged flies and mosquitos), that live on the lake bottom as larvae and swim to the surface as pupae. They then hatch as adults that we often see. They are a food source for many fish in Lake Ontario.

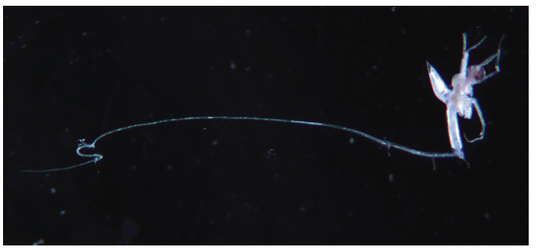
Mysis diluviana: Also called possum shrimp due to the presence of a brood pouch, this species spends the day on the bottom of the lake, and migrates to the surface at night, often feeding on zooplankton.

Newcomers: Invasive Invertebrates Impacting Natives and Energy Flow

- Lake Ontario has experienced introductions of plants, invertebrates, and fish for more than 100 years, and that may continue into the future.
- These introductions can impact native species and food web processes at large scales.
- Some invertebrate invaders and their impacts in Lake Ontario include:

Spiny water flea (left) and fishhook water flea (right): These species were introduced in Lake Ontario in the 1990's and they compete with other zooplankton and fish for food. They also eat native zooplankton. Their hooks catch on fishing gear, making angling difficult. They are a food item for many fish species in Lake Ontario, but their long appendages make them more difficult to consume, especially for small fish.





Zebra and quagga mussels: These *Dreissenid* mussels attach to surfaces, building up and creating costs associated with equipment maintenance and damage. They arrived in the 1980's, and filter phytoplankton and zooplankton which concentrates nutrients at the bottom of the lake (benthification). These nutrients were essentially lost, until another invader capable of eating the mussels (Round Goby) spread throughout the Great Lakes in the 1990's. Other fish eat Round Goby; this story isn't over yet!

Left: Zebra mussels *image credit Chuck O'Neill, New York Sea Grant*

Right: Quagga mussels *image credit Brittney Rogers, New York Sea Grant*

Image credit Matt Paufve; Great Lakes Environmental Research Laboratory; Atlas of Inland Fishes of New York; New York State Department of Environmental Conservation Biological Survey Series; US Geological Survery; Eric Lind; The Lake Scientist; Peter Thompson

Putting It All Together

- This fact sheet is an oversimplification to illustrate how the base of the food web is formed, but in reality, the process is complex and involves physical, biological, and chemical interactions.
- The Lake Ontario food web will continue to change as species (natives and new non-natives) interact with their changing environment (e.g., declining phosphorus and productivity since the 1970's in response to concerns about excessive nutrient loading), and with each other.
- The findings from CSMI 2013 and other results will be considered to update and refine the research focus for the next CSMI in Lake Ontario (2018).
- Monitoring and understanding how environmental and food web changes may influence Lake Ontario will help managers and stakeholders prepare for, and forecast what the future might hold for Lake Ontario and the organisms that call it home.

References

More information about the Lake Ontario Cooperative Science and Monitoring initiative can be found at: www.nyseagrant.org/csmi

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