International Efforts to Study and Understand the Great Lakes Ecosystem:

Fish and Fisheries

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Atlantic Salmon swimming upstream. *Image credit Walter Baxter*

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 fish and their prey.

Fish Facts

- Significant changes in the dominant fish species in Lake Ontario have occurred over the past two centuries because of harvest, pollution, introduced species, and stocking.
- These changes often coincide with shifts in the food web structure and energy flow in Lake Ontario.
- Fish are often classified by characteristics like their feeding behavior, or the area of the lake they prefer, but their roles can switch seasonally, at different stages of their lives, and in response to changes in the ecosystem.
- Unfortunately, some species of fish have disappeared from Lake Ontario, but efforts from scientists, managers, and stakeholders have helped to maintain the ecological functionality of the diverse fish community that remains, and provided recreational opportunities for anglers and their families.

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A Fish Story

About 200 years ago, five native species were especially important to the Ontario fishery: Lake Trout, Lake Sturgeon, Lake Whitefish, Cisco (Lake Herring), and Atlantic Salmon. As a result of harvest, introduced species, pollution, Sea Lamprey (a parasitic fish), and other stressors, these populations declined. This left room for an efficient plankton eater (Alewife) to dominate the Lake Ontario fish community. However, Alewife often died by the millions, rotting on shores throughout the Great Lakes in the 1960's and 1970's. They also caused declines in water clarity by eating the zooplankton that would have otherwise kept phytoplankton populations in check.

With few predators to control Alewife, the solution was to replace the functional role of native predators by stocking large numbers of non-native salmon (like Chinook and Coho), and trout (Rainbow and Brown). This, combined with Sea Lamprey control, appeared successful, and fisheries were somewhat consistent.

Then in the 1980's, zebra and quagga mussels were introduced to the Great Lakes. These filter feeders consume phytoplankton, competing for food and nutrients with zooplankton that Alewife rely on heavily. The mussels concentrate energy at the bottom of the lake (benthification), and that energy was essentially lost from the open water food web. Enter yet another invader: the Round Goby, fish capable of eating mussels that have further altered the Lake Ontario food web. The next phase of the Lake Ontario food web and fishery is yet to be seen, but researchers are working hard to forecast what the future will hold.

Dead alewives in Burnham Harbor, Lake Michigan, June 1967. Rapid temperature changes encountered by the fish in lake waters, a fungus, and blue-green algae were all listed as possible causes of the die-off but no one cause was singled out. *Image credit Bob Langer; courtesy of Chicago Sun-Times, NOAA Central Library*

Fish Faces: Who Is Who and What Do They Do?

The following are just some examples of groups of important fish species in Lake Ontario and information about what makes them special and the role that they play in the Lake Ontario food web and fishery. A reminder: although this information generally applies to these fish species, their role can change over time as they grow, their environment changes, and the Lake Ontario food web changes.

The Native Predators

American Eel: This fish species grows to adulthood in freshwater and migrates to the ocean (Sargasso Sea) to spawn.

Atlantic Salmon: This important fish was harvested heavily in the 1800's and is now designated as a Species of Greatest Conservation Need.

Smallmouth Bass: This predator eats fish and invertebrates like crayfish. They tend to stay in the nearshore area of Lake Ontario.

Lake Trout: This species lives in deep, cold water. Rehabilitation is being attempted because of previous population declines.

Burbot: This species tends to live on the lake bottom. It is the only cod-like (gadiform) fish species in freshwater and it is a formidable predator.

Walleye: This species is a popular sport fish among anglers, and is currently targeted by many for harvest and consumption.

The Stocked Predators

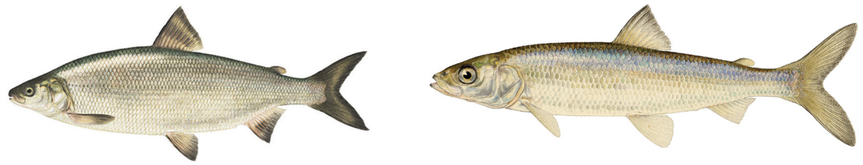
Chinook Salmon: Originally stocked to control Alewife, this fish is a favorite of stream and lake anglers. Stocking still occurs (~2 million fish a year), but they also reproduce naturally.

Other predators (left to right: **Coho Salmon**, **Rainbow Trout** and **Brown Trout**) were also stocked in Lake Ontario to control increasing Alewife populations. Important lake and stream fisheries now exist for these species as well.

Although other fish are stocked in Lake Ontario, these non-natives now support an economically important fishery even though they were originally stocked to fill an ecological role in the absence of native predators: that role being the consumption of Alewife.

The Open Water Forage Fish

Lake Whitefish (left) and **Cisco** (or **Lake Herring** right) are two of several closely related species that made up the offshore forage base in Lake Ontario until the 1900's when their numbers began to decline and they experienced collapses. Currently, the numbers of these fish are a fraction of what they were historically and restoration efforts are underway.



Alewife (left) and **Rainbow Smelt** (right) outcompeted other fish (like Cisco and Lake Whitefish) for food and replaced them in Lake Ontario. Alewife became especially abundant, but they were prone to die-offs, and predators are stocked to control their numbers. Alewife dominated the offshore fish catches during the 2013 CSMI.

The Benthic (Bottom) Forage Fish

Native **Slimy Sculpin** (left) and **Deepwater Sculpin** (right) live in the deep areas (about 100 to 600 feet) of Lake Ontario. Deepwater Sculpin were rare in the 1970's and Slimy Sculpin were common. Slimy Sculpin numbers declined with the disappearance of an important food resource (the amphipod *Diporeia*) in the 1990's, and the increase in competitive Round Goby. Recently, the Deepwater Sculpin population is showing signs of recovery.

Introduced **Round Goby** increased in number rapidly in the Great Lakes after they were first observed in 1990. They eat the introduced quagga mussels in Lake Ontario, which few other fish can do. They spend winter in deep water, and move to shallow water in warmer months. This allows for the energy from the mussels they eat to transfer to fish that eat Round Goby in deep water (e.g., Lake Trout) and shallow water (e.g., Smallmouth Bass).

Some Noteworthy Fish

Lake Sturgeon: The largest freshwater fish in Lake Ontario, these huge fish can live over 100 years. Their numbers were dramatically reduced, but efforts are being made to restore this species.

Sea Lamprey: This parasitic fish has been implicated in the decline of trout, salmon, and whitefish; millions are spent annually to control them with chemical treatments.

Native Muskellunge (left) and **Yellow Perch** (right) are very popular among anglers. The Muskellunge can reach up to 70 pounds, and is also known as the "fish of 10,000 casts" because they are difficult to catch. Yellow Perch are caught relatively easily, and for many this is the first fish they catch. They are prized for their good flavor and they are both an important predator and prey species in Lake Ontario.

The Two "Biggest" Little Fish in Lake Ontario Today:

Round Goby (left) numbers have increased greatly in Lake Ontario, displacing native species like Slimy Sculpin, and eating eggs of some predators like Smallmouth Bass. Importantly, Round Goby do not stay in one place, they move from shallow to deep water in the fall. They also eat mussels, and when Goby are eaten by other fish, this energy goes from what was a "dead-end" and enters the food web. CSMI found that Yellow Perch and Smallmouth Bass eat mostly Goby, and Goby also make up a significant portion of Lake Trout and Brown Trout diets. This means some sport fish in Lake Ontario are actually fueled by energy from mussels that are eaten by Goby that are in turn eaten by sport fish.

Alewife (right) are the most numerous fish in the open water areas of Lake Ontario, competing with native fish like Cisco and Lake Whitefish. However, Chinook, Coho, and Atlantic salmon, and Brown, Rainbow, and Lake trout generally eat more Alewife than anything else. But, changes in Lake Ontario water clarity and temperature, seem to be causing Alewife to use food resources from deeper water, and this changes how they interact with predators. Alewife are also sensitive to the cold, and two severe winters (2013-14 and 2014-15) lowered their numbers, resulting in a reduction in predator stocking to balance numbers of predators and prey so as not to crash the Alewife population.

CSMI has gained new insights about Round Goby and Alewife. Due to their importance in Lake Ontario, these fish are studied extensively to provide managers with information for appropriate decision-making. CSMI provides an opportunity to continue this monitoring and learn even more.

Image credit Atlas of Inland Fishes of New York; New York State Department of Environmental Conservation Biological Survey Series; Peter Thompson; Inland Fishes of New York (Online)

References

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

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