Georgian Bay Forever on Water Quality and Ecosystem Health.

Part of our mission is to help inform you about what's in the water and the work of other researchers, institutions and governments that are responsible for water health. The other part of our mission is to work on projects that help protect the water of Georgian Bay and its ecosystems where gaps or problems exist. Here are a couple of projects we are working on thanks to your ongoing support:

The good news is that Georgian Bay water is good quality, but we need to keep it that way. Therefore effective water quality monitoring is critical.

We've been working with the Georgian Bay Biosphere Reserve and other partners to standardize water quality testing with a focus to phosphorus monitoring. Too much, or too little of this nutrient has harmful consequences including the development of nuisance or toxic algal blooms. The results of this work will be published in the 2018 State of the Bay Report for eastern and northern Georgian Bay.

We are also raising money to purchase an autonomous underwater vehicle. The vehicle would enable us to generate a three dimensional view of the water and obtain detailed chemical and physical measures of pH levels, temperature, dissolved oxygen, conductivity, blue green algae, turbidity, etc. and collect bathymetry data with high resolution scanning sonar. These are areas that are often gaps in testing, or require a lot of resources, or are subject to some human error. This vehicle will allow us to conduct water quality testing using many more indicators than we currently do, with little to no human error, to quickly assess if the areas being tested are under stress, or if the underwater landscape is changing due to unforeseen impacts.

The quality of the water is important not only for human health, but also, of course, for the health of all the living things in it. It is all interconnected. We are continuing to work with the University of Guelph to build an aquatic database of all living things in the water of Georgian Bay. We'll need this in order to see changes, or model impacts that can result from human stressors like the contaminants you've been reading about. We can then bring these results to decision makers who require expert analysis in order to make good stewardship decisions.

FISH THAT HAVE BEEN BARCODED FOR THE GEORGIAN BAY AQUATIC LIBRARY INCLUDE:

DNA BarCoded Fish Species	Common Name
Ambloplites rupestris	Rock bass
Ameiurus nebulosus	Brown bullhead
Catostomus commersonii	White sucker
Coregonus clupeaformis	Lake whitefish
Exox lucius	Northern Pike
Etheostoma exile	Iowa darter
Etheostoma nigrum	Johnny darter
Fundulus diaphanus	Banded killifish
Labidesthes sicculus	Brook silverside
Lepomis gibbosus	Pumpkinseed
Micropterus dolomieu	Smallmouth bass
Micropterus salmoides	Largemouth bass
Morone americana	White perch
Neogobius melanostomus	Round goby
Notropis atherinoides	Emerald shiner
Notropis rubellus	Rosyface shiner
Notropis stramineus	Sand shiner
Perca flavescens	Yellow perch
Pimephales notatus	Bluntnose minnow
Pomoxis nigromaculatus	Black crappie
Salvelinus namaycush	Lake trout
Sander vitreus	Walleye

We need your help to fund these important tools, so we can continue to protect the great quality of water in Georgian Bay and the ecosystems it supports.

LAKE TROUT AND CLIMATE CHANGE

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Understanding how climate change may affect lake trout populations throughout their range requires an understanding of how lakes change as air and water temperatures increase. If you've ever taken a deep dive into a lake in summertime you may have felt a change from warm surface water to the deeper colder water. This temperature difference is the result of a process known as thermal stratification and it is common in northern lakes. In summertime, thermal stratification results in a warm layer of water near the surface, followed by a layer of water referred to as the thermocline which has changing water temperatures, and once sufficient depth is attained, temperatures remain cold and stable (about 4–5°C) to the lake's bottom.

Changes in air temperature impact lake trout populations.

Changes in future air temperatures can alter when and how a lake stratifies over the summer months and this may impact lake trout populations. This is because future summers are predicted to become longer and warmer as result of climate change and this may cause lakes to stratify earlier in the year and sustain higher near-surface temperatures later in the year than they have in the past. The colder, middle and deep layers of water are thought to be especially important to lake trout in summer because they provide a refuge from near-surface water

http://chm.pops.int/Countries/StatusofRatifications/PartiesandSignatoires/tabid/4500/Default.aspx <Stockholm Convention>
https://www.epa.gov/glwqa/glwqa-annexes. Environmental Protection Agency

temperatures that often exceed the fish's biological requirements. Like most fish, lake trout are "cold-blooded", also known as heterothermic animals, whose body temperature and metabolism depend on the surrounding water temperature. They are also long-lived, late maturing, and large-bodied fish that require relatively cold (4-12°C) and highly-oxygenated (> 4 mg/L) water to survive and flourish, and so, fishery and lake scientists have long-viewed lake trout as a look-out species for the effects of climate change on north temperate lakes. A strong association has been documented between the amount of cold deep water in a lake and the number of lake trout that the lake can sustain. Greater growth by lake trout has also been observed when springtime conditions are cooler and for extended periods, as these conditions are thought to provide the fish with greater access to food in shallower more productive areas of a lake for longer periods of time. As a result, extended summers and reductions in the amount of cold, deep water under future climate change could lead to relatively smaller or fewer lake trout than there are today.

Dissolved oxygen dispersion critical to lake trout may change.

In addition to access to cold water, a sufficiently high concentration of dissolved oxygen is another important biological requirement for lake trout that is expected to change in lakes under future climate change. Dissolved oxygen concentrations in lakes are primarily dependent on spring weather conditions, nutrient (phosphorus) loading, and the strength and duration of spring turnover. Spring turnover refers to the mixing of the lake that occurs in springtime and it is what enables oxygen diffusion and, in part, determines deep-water oxygen concentrations available for lake trout in the cooler and deeper water during summer months. The amount of time a lake maintains a uniform temperature and density throughout its water column in spring is what determines how well oxygen-depleted deep water can be mixed and exposed to the air-water interface by wind action. As a result, a shorter and faster-warming spring could lead to less oxygen available to lake trout during summer. Research on dissolved oxygen concentrations within the Laurentian Great Lakes suggest greater periods of very low oxygen concentrations under future climate change scenarios. Well-developed shoreline bays in these large lakes may be particularly prone to periods of low oxygen concentrations and higher temperatures. Warmer temperatures can also lead to increased bacterial activity and decay at the lake's bottom which can further reduce oxygen concentrations. So, if turnover periods are shortened due to faster-warming springs, then more severe and frequent periods of low oxygen concentrations could represent an additional stress to lake trout during summer months.

> "...fishery and lake scientists have long-viewed lake trout as a look-out species for the effects of climate change on north temperate lakes..."

Enables other fish to out compete with lake trout.

Perhaps the most significant potential threat to lake trout populations pertains to how climate change may improve habitat for introduced fishes that can better compete with lake trout as water temperatures increase and become less favourable to lake trout. Smallmouth and rock bass, for example, have a higher temperature tolerance than lake trout, and have been documented to decrease the use of shallow shoreline habitats by lake trout, and in turn, the growth and number of lake trout in a lake. Of particular note, there has been a startling increase in the number of lakes with introduced smallmouth bass since 1950 throughout Canada. In 1950, less than 50 lakes in western Ontario contained small mouth bass, but by 2000 hundreds of lakes in western Ontario contained small mouth bass. The potential range for these fish is expected to increase as water temperatures become warmer and more favourable to this species. In a similar fashion, native sport-fish species such as walleye also have a higher temperature tolerance than lake trout, and could also gain a competitive advantage over lake trout as temperatures increase and summers become longer. Consequently, the expansion of introduced fishes and improved habitat for fish that favour warmer water is thought to represent one of the most serious future and ongoing threats to lake trout populations in both small and large lakes.

The effects of climate change on lake trout may be compounded by our on-going alteration and exploitation of lake resources that further stress the health and quality of our lakes and inland bays. In the southern parts of the species range, many lake trout populations are already subjected to habitat alterations and high exploitation rates that are near or exceed sustainable levels. Also, most sport fish and other fishes of concern within the Great Lakes are supported by hatchery production, and higher air temperatures and longer summers could also hinder hatchery production for lake trout and other desirable species. So it is important to remember that persistent increases in temperature and longer summers will combine with other existing impacts such as over fishing, water pollution, introductions of exotic species, and human freshwater needs that can exacerbate the potential for negative impacts to our lakes and lake trout populations, including the potential for extirpation of some populations. These effects may, in turn, require more strict levels of protection.

As stakeholders of our lakes and fisheries, deciding between these choices will likely become increasingly pressing into the future.