FALL 2017
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GEORGIAN BAY FOREVER

Protecting your water.

WATER LEVELS, WATER QUALITY AND ECOSYSTEMS

WHAT'S CONTAMINATING OUR FISH?

Photo Credit: Eric McIntyre

Also Inside:

THREATS TO THE WATER OF GEORGIAN BAY

By Heather Sargeant

Over the last year, we reached out to scientific experts, interested stakeholders, other research materials, and you about threats to the water of Georgian Bay in order to drive the relevancy of our education, research, and project initiatives. We took the results of this outreach and grouped them into five over-arching "Big Bucket" Great Lakes threats: pollution, climate change, nutrients imbalance, human impact (BUI–Beneficial Use Impairments) and invasive species.

Within those five large buckets were many specific issues. Georgian Bay Forever narrowed down a list of 15 to focus on the following six threats with a view that we will monitor threats and change them as needed.

1. Reduction in ecosystem biodiversity.
2. Coastal wetland destruction and degradation by invasive Phragmites.
3. Extreme water level fluctuations beyond historical norms related to climate change.
4. Plastics pollution, particularly microplastics.
5. Native fish population collapse.
6. Unacceptable levels of phosphorus and bacteria in water.

We're applying it

You've seen this focus in work already through the year, particularly this summer at Phragmites training and cuts. If you want to learn more, explore our **2016 Annual Report** released in June, which includes ongoing efforts for 2017 at: http://gbf.org/annual-report-2016/.

Topics for another day

What we haven't covered in this issue is the story of the collapse of Lake Trout in the 20th century including change due to overfishing, wood harvesting and sawmill operations, invasive species like sea lamprey and alewives, declining lake levels, habitat degradation and more.

In this issue

You will notice articles that link to Lake Trout. One article investigates new risks to Lake Trout due to climate change. Other articles focus on legacy chemical contaminants levels being monitored in Lake Trout and Walleye. There are only two native trout populations in Lake Huron that have survived. In this century, while there have been some successful rehabilitation efforts in Parry Sound, "Georgian Bay lake trout rehabilitation is not progressing, with relative abundance remaining low and stable and the proportion of wild fish slightly decreasing."[1] The importance of vigilant data-gathering and monitoring to reign in detrimental human impacts on native fish, ecosystem health and biodiversity is evident.

Find survey results on Threats to the Water of Georgian Bay at: http://bit.ly/GBthreats

[1] Arunas Liskauskas. Management Biologist, Upper Great Lakes Management Unit, August 25, 2017

GEORGIAN BAY FOREVER

Georgian Bay Forever is a community response to the growing need for major research and education to sustain the Georgian Bay aquatic ecosystem and the quality of life its communities and visitors enjoy.

We help monitor the Bay's well being, throughout the seasons, year after year.

We fund the research needed to protect the environmental health of Georgian Bay and the surrounding bodies of water. Using our research findings, we inform and educate the general public and governments about threats to environmental health and propose possible solutions.

Through workshops, seminars and online, we are educating the Georgian Bay community. By teaming up with reputable institutions, we enhance the credibility of our research and strengthen our ability to protect what's at stake.

Georgian Bay Forever is a registered Canadian charity (#89531 1066 RR0001). We work with the Great Lakes Basin Conservancy in the United States, as well as other stakeholder groups all around the Great Lakes.

Deeply rooted and broadly drawn, Georgian Bay Forever is steered by lifelong devotees of the Bay. We are committed advocates, educators, environmentalists, realists, idealists, and of course, residents.

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Canadian citizens may send their donations to the address above.

U.S. citizens wishing to make a donation to support our work can do so by giving to:
Great Lakes Basin Conservancy
PO Box 504, Gates Mills, OH
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This newsletter is just a snapshot of our work. For the most up-to-date information on our projects, longer versions of newsletter articles and breaking news about Georgian Bay, please become a regular visitor to our website and Facebook page.
GBF.ORG

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Follow us on

MESSAGE FROM THE CHAIR

By Anne Randell

Next year will be my 40th year of enjoying the pristine waters of beautiful Georgian Bay with my husband and family. My children were only one and three when we purchased our Pointe au Baril cottage and now they have kids of their own who know and love the Bay just like we do. Like you, we are concerned about extreme water levels, water quality and the increasing presence of invasive species and we want to ensure that the waters of Georgian Bay remain drinkable, fishable and swimmable for generations to come.

As the new Chair of Georgian Bay Forever, I am pleased to represent our organization at many levels. GBF supports research and partnerships within the Great Lakes community in a variety of ways. Just one example is our ongoing work with the Eastern Georgian Bay Stewardship Council on the Fish Habitat Assessment Study being conducted in all Georgian Bay tributaries. This will provide valuable information on spawning and nursery habitat and how climate resiliency can be created to improve fish habitat. Another important area is our ongoing work on Phragmites eradication up and down the Bay with a variety of different partners, working together to maximize results. As well, on the international front, GBF is a respected member of the Executive Committee for the Great Lakes Water Quality Agreement, ensuring that our voice is heard on this critical topic.

These and other important initiatives are why I decided to get involved with Georgian Bay Forever. I would like to thank our previous Chair, Peter Singer, for his leadership and commitment over the past two years. Under his guidance and dedication, GBF has continued to grow and provide meaningful scientific research and education related to the waters of Georgian Bay. Thanks also to our Board and Committee members who give tirelessly as volunteers to help protect, enhance and restore Georgian Bay, as part of the Great Lakes. And a heartfelt thanks to our donors, without whom none of this would be possible. As a charitable organization, we rely on donations to fund our many critical projects and services. We are eternally grateful to all of our donors, whose generosity and support speaks volumes about how important our beautiful Georgian Bay is to all of us. We thank you!

As I write this, I am enjoying yet another spectacular Georgian Bay sunset. To me, there is nothing that compares to the breathtaking beauty that Mother Nature creates night after night on the water—although not on quite as many nights as we would have liked this summer. In spite of more rain and cooler weather than usual, there is still no place else on earth that I would rather be!

PEERING BENEATH THE WAVES... OUR AQUATIC FRIENDS NEED GBF'S ONGOING WORK

By David Sweetnam, Executive Director

Protecting Georgian Bay waters goes deeper than the tranquility of a beautiful sparkling afternoon, a gorgeous sunset or even the awesome energy we see crashing onto the rocks when we look across the stormy waters. To the thousands of species immersed in the life-sustaining waters of their home—Georgian Bay—our terrestrial world is beyond their consciousness as theirs is most of the time to us.

Spending time beneath the waves with a mask and snorkel or deeply immersed with a scuba tank for a visit to our aquatic neighbourhoods can dramatically alter our perspective on the Bay. It also exposes the dramatic declines in fish and aquatic organisms that Georgian Bay has experienced over the past centuries. Fish populations are estimated to be only one percent of their historical levels. While we look out from our comfortable chairs at the beautiful water, we must be vigilant that our work does not stop until our vision for a Bay that is 100 times more abundant becomes reality once again.

> "Fish populations are estimated to be only one percent of their historical levels."

Peering beneath the waves to look at the chemical and physical properties of the water is part of the important scientific work GBF performs to protect our water. Tools that improve our reach are critical to our success. One such tool that we need funds to purchase is the autonomous underwater vehicle. It can be deployed to fly beneath the waves for up to twelve hours—while collecting second by second readings—enabling us to paint a more accurate picture of our Bay as it undergoes tremendous changes from global warming, invasive species, raw sewage overflows and chemical pollutants.

Our numerous research, project partners and volunteers better inform the story of our Bay every day. But as you'll see in this issue, our aquatic friends need champions to help protect their world, and we can all do something to help.

BAY FISH
THEIR HEALTH IS LINKED TO OUR HEALTH

By Heather Sargeant

Heather Sargeant fishing on one of several rainy days in the summer of 2017

Like many of you, I grew up catching and eating fish from Georgian Bay. As I grew older, we fished less as fish were harder to catch and less plentiful.

While I love a family fishing trip, my joy in landing a big one is tempered by my concern and love for these creatures. We most often practice "catch and release", and since my idea-rich university days long ago, 'staying close to your food sources' has also stuck with me. Theory does not always match practice, but my personal responsibility for the interconnection between all living things becomes very concrete when eating fish personally caught. Their health is linked to our health.

Fish populations are protected through monitoring, legal restrictions and fishing limits due to many detrimental human stressors and practices. As populations grow and global warming continues, working together on further protections is critical.

Why are there advisories on eating fish?

The reason for Ontario advisory, "Eating Ontario Fish 2017-18 guide" (ontario.ca), is to highlight the risks associated with human health when consuming too much fish containing contaminants from human sources.

ONTARIO FISH ADVISORIES

The Eating Ontario Fish 2017–18 guide provides advice based on fish size, species and location of catch. There are some general tips including:

a) Smaller fish tend to be much less contaminated than larger fish.
b) Leaner fish species such as Bass, Pike, Walleye, Perch and panfish tend to have much lower contaminants than fatty species like Salmon and Trout.
c) Eat panfish or whitefish from inland locations. At inland locations, top-predatory fish such as Pike and Walleye generally have greater contaminants than panfish or whitefish
d) For other great tips, please visit: ontario.ca/page/eating-ontario-fish-2017-18

Here are a couple of examples of fish types and recommendations by locations:

GB4. Southern Georgian Bay from south of Lion's Head to south of the Moon River mouth. (44°49'29"N 80°26'31"W)

- Lake Trout (35–40 cm) — general population 16 meals per month, sensitive population (women of child-bearing age and children under 15) 16 meals per month.
- Largemouth Bass (35–40cm) — general population 12 meals, sensitive population 4 meals.
- These are not additive. You need to estimate how much you would eat in each category per month and keep track.
- E.g., 2 of the above specified Lake Trout as a general person + 3 of Largemouth Bass as specified 2/16 × 100 = 12.5% + 3/12 × 100 = 25%. Total: consumed 37.5% of monthly advised fish. As a sensitive audience 2/16 × 100 = 12.5% + 3/4 × 100 = 75%. Total: consumed 87.5% of monthly advised fish.

GB4a—Collingwood Harbour—harbour area. (44°30'50"N 80°13'33"W.)

- Lake Trout 35–40 cm, (not listed, assumption not found in this area).
- Smallmouth Bass (30–35 cm) — general population 12 meals per month, sensitive population (women of child-bearing age and children under 15) 8 meals per month.
- Common Carp (40–45 cm) — general population 2 meals per month, sensitive population 0 meals.
- Again, these are not additive. To calculate your recommended allowance, you need to estimate how much you would eat in each category per month and keep track.
- E.g., 2 of the above specified Smallmouth as a general person + 1 Common Carp as specified 2/12 × 100 = 16.7% + 1/2 × 100 = 50%. Total: consumed 66.7% of monthly advised fish—too much. As a sensitive audience, you could only consume the smallmouth safely 2/8 × 100 = 25%, NO CARP.

To calculate your recommended allowance visit: ontario.ca/page/eating-ontario-fish-2017-18

WHAT ABOUT FISH HEALTH?

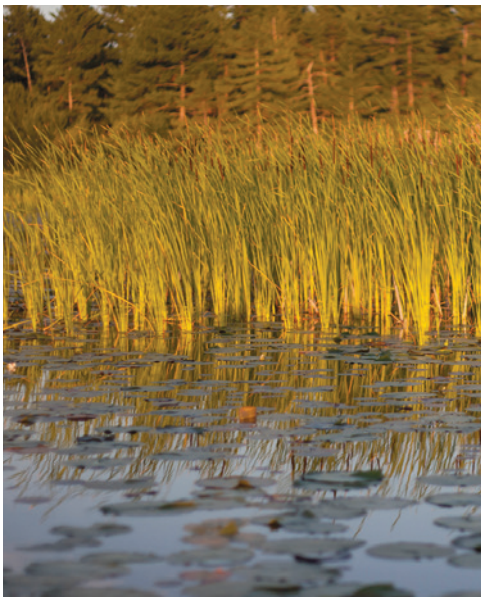
While the province's advisories concern themselves with the edible portions of fish for human consumption, we also need to be concerned with the health of animals in our waters. Environment and Climate Change Canada's (ECCC) monitoring program measures the levels of contaminants in all portions of the fish for the purpose of determining risk to the environment and to the animals who live in it.

We contacted **Daryl McGoldrick, Environmental Scientist and leader of the National Fish Contaminants Monitoring and Surveillance Program**, about contaminants in Lake Huron and Georgian Bay to learn more about what's in the fish in our water.

Here are some questions and excerpts from the report he authored with D.J Murphy, *Concentration and distribution of contaminants in lake trout and walleye from the Laurentian Great Lakes.*[1]

GBF: What was the purpose of your report?

"Biomonitoring programs for persistent, bioaccumulative, and/or toxic chemicals of concern in fish tissues have been operated by the governments of Canada and the United States in the Great Lakes since the 1970's. The objectives of these programs are to assess concentrations of harmful chemicals in whole body top predator fish as an indicator of ecosystem health and to infer potential harm to fish and fish consuming wildlife in the Great Lakes Basin. Chemicals of interest are selected based upon national and binational commitments, risk assessment, and regulation, and include a wide range of compounds. This review summarizes all available data generated by Environment Canada and the United States Environmental Protection Agency for chemicals measured in whole body homogenates of Lake Trout (Salvelinus namaycush) and Walleye (Sander vitreus) for the time period spanning 2008 to 2012 from each of the five Great Lakes."



GBF: What in general did your report find?

"The [report] summary shows that concentrations of legacy compounds, such as, POPs [Persistent Organic Pollutant] listed in the Stockholm Convention and mercury continue to dominate the chemical burden of Great Lakes fish. This assessment, and others like it, can guide the creation of environmental quality targets where they are lacking, optimize chemical lists for monitoring, and prioritize chemicals of concern under agreements such as the Great Lake Water Quality Agreement [GLWQA] and the Stockholm Convention.

When I talked with Daryl in August, I asked him about updates since 2012. He talked about a few points, which will be noted in the chart on the next page. The Annex in GLWQA that deals with chemicals of mutual concern will likely focus on reduction and not specific targets, and many are in draft form for comment at this time. Specific targets are easier to set by regional bodies. GBF has identified legacy chemicals in his report *that have also been named* chemicals of mutual concern (noted with a *). Daryl notes, "There are currently no binational targets for the chemicals of mutual concern in the agreement. We currently use either the Canadian Federal Environmental Quality Guidelines (FEQGs) or Canadian Environmental Quality Guidelines developed by the Canadian Council of Ministers of the Environment (CCME) to put the levels of contaminants we measure into context of risk to the environment."

[1] McGoldrick, D.J., Murphy, E.W., Concentration and distribution of contaminants in lake trout and walleye from the Laurentian Great Lakes (2008e2012), Environmental Pollution (2015), http://dx.doi.org/10.1016/j.envpol.2015.12.019

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

GBF: HELP ME UNDERSTAND...

What are legacy contaminants?

These chemicals stay in the environment for a really, really long time after they have been deposited there. Daryl has noted that these are essentially the "dirty dozen" that were established in the Stockholm Convention (http://chm.pops.int/TheConvention/ThePOPs/The12InitialPOPs/tabid/296/Default.aspx). Legacy contaminants can also be distinguished from *emerging contaminants* that can end up in our water through common everyday use. These can tend be so small that older filtering systems can't catch them. Examples include: pharmaceuticals and personal care products.

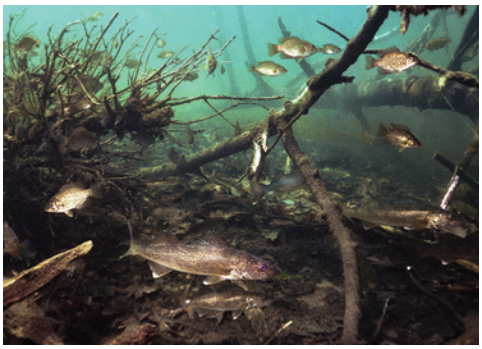
What is the Stockholm Convention?

According to the official website, http://chm.pops.int, the Stockholm Convention on Persistent Organic Pollutants (POPs) was brought into force in May 2004. The process began in 1995 with the recognition by the United Nations Environment Program (UNEP) Governing Council that POPs were significant threats to human and environmental health. 12 POPs were initially established for international action to minimize the risks. There are 181 parties to the Convention including Canada and the European Union, but not the United States.

What is the Great Lakes Water Quality Agreement (GLWQA)?

Signed in 1972, the US Environmental Protection Agency defines GLWQA as "a commitment between the United States and Canada to restore and protect the waters of the Great Lakes. The Agreement provides a framework for identifying binational priorities and implementing actions that improve water quality. EPA coordinates U.S. activities that fulfill the Agreement." There have been 3 amendments; the latest in 2012 to further ensure "the chemical, physical, and biological integrity" of the Great Lakes' water quality programs. In includes 10 Annexes. Annex 3 is *Chemicals of Mutual Concern* which focuses on reducing release of agreed chemicals in order to protect human and environmental health.

SUMMARY SNAPSHOT OF LEGACY CONTAMINANTS



Here is a summary snapshot of some of the report outs and conclusions for contaminants listed in *Concentration and distribution of contaminants in lake trout and walleye from the Laurentian Great Lakes*.

(Source unless otherwise stated.) The snapshot focuses on Lake Huron as it is most shared with Georgian Bay. It does not list all the information or chemicals discussed in the report.

Contaminant/Definition	Concentration and concern level at time of study (2008 to 2012)
Mercury * Source: Largely atmosphere. GBF Add: coal-fired plants, biggest source, also cement kilns, chlor-alkali plants (chlorine bleach, laundry detergent etc.), trash incinerators, gold-mining.	• 2nd highest contaminant in Lake Huron at 168 ng/g. • No binational or environmental quality targets in fish for the Great Lakes, however concentrations in studied fish are below 1987 GLWQA levels of 500 ng/g for health of fish consuming wildlife. • The National Wildlife Federation states that unsafe levels can impact development and functioning of the central nervous system and can be very harmful to pregnant and breast-feeding women and children. When we look at fish, they can have problems releasing and depositing their eggs and spawning. • Trend: Was declining, but may be increasing in certain areas like Lake Erie. • Update to 2015: Further evidence of decline in certain Great Lakes such as L. Huron. "When the lakes are examined individually, Lakes Superior and Huron, which are dominated by atmospheric Mercury (Hg) inputs and are more likely than the lower lakes to respond to declining emissions from areas surrounding the GL, have significant decreasing trends with rates between 5.2 and 7.8% per year from 2004 to 2015."[1]
Polychorinated biphenyls (PCBs)* Source: Toxic chemicals, bioaccumulative, used as "coolants and lubricants in electrical and other equipment". Also used commonly as plasticizers in products like adhesives, paints, caulks.	• Although banned in Canada and the US in 1979, the sum of PCB concentrations from 2008–2012, are significantly the highest of all contaminants. In Lake Huron, they were found to be 653 ng/g. • While declining, PCBS regularly impact fish advisories as they still almost always exceed the target of 100 ng/g established for Great Lakes fish in the 1987 amendment to the Great Lakes Water Quality Agreement (GLWQA, 1987). • Trend: Declining, but huge amount left in our Great Lakes environment from long period of industrial use before bans and restrictions. • Update from Daryl—these continue to decline at around 3–4% a year, but there is still a large abundance.
Organochlorine pesticides (OC) Includes DDT and relatives DDE and DDD, chlordanes, toxaphene, and mirex. Source: Widely used in the past, persist in the environment, toxic impacts to wildlife.	• Bans and restrictions began in the 1970s to 1991, when all uses banned. DDT (+ DDE and DDD) is the most abundant. Lake Huron concentrations were measured at 130 ng/g. • No current binational targets for DDT and its metabolites in fish from the Great Lakes. • Observed concentrations were below the binational target set out in the 1987 amendment to the GLWQA of 1.0 ug/g but almost always exceed the tissue residue guideline for the protection of wildlife consumers of aquatic organisms of 14 ng/g established by the Canadian Council of the Ministers of Environment. • Find further breakdowns of the other less abundant chemicals chlordanes, toxaphene, and mirex in the study. • (Note—The OCs are generally legacy pesticides whose usage have been phased-out or restricted in North America and current levels are below levels of concern. They were not included in the list of chemicals of mutual concern for these reasons.)

[1] Chuanlong Zhou, Mark D. Cohen. Bernard A. Crimmins, Hao Zhou,Timothy A. Johnson, Philip K. Hopke, and Thomas M. Holsen, "Mercury Temporal Trends in Top Predator Fish of the Laurentian Great Lakes from 2004 to 2015: Are Concentrations Still Decreasing?", Environmental Science and Technology, DOI: 10.1021/acs.est.7b00982 Environ. Sci. Technol. 2017, 51, 7386−7394.

Contaminant/Definition	Concentration and concern level at time of study (2008 to 2012)
Siloxanes compounds (aka D4, D5, D6) Source: Common ingredients in many personal care products, cosmetics, industrial and dry cleaning fluids.	• Detected in many countries in wildlife recently. • D5 tends to be found at higher levels than D4 and D6. D5 in Lake Huron was 17 ng/g. • Only measured by Environment Canada, no data for L. Michigan. • Only D4 is listed as a toxic substance in the Canadian Environmental Protection Act 1999 and found to be dangerous for the environment, but not at levels harmful to humans. • No environmental objectives or guides for levels in fish at the time of the study. • Siloxanes are monitored in Canada under the Chemicals Management Plan (CMP).
Polybrominated diphenyl ethers compounds (PBDEs)* Tetra-, penta-hexa. Source: Flame retardants in consumer products.	• Regulated in Canada with voluntary phase out by major producer. • Lake Huron (43 ng/g). • Average concentrations from 2008 to 12 did not exceed the Canadian Federal Environmental Quality Guideline (FEQG) for fish tissue for tetra- (88 ng/g) or hexa-BDE (420 ng/g) but exceeded the fish tissue FEQG for penta-BDE (1.0 ng/g) in every lake. • Trend: Widespread in environment and toxic. Levels plateaued in early 2000s in Great Lakes fish, some declines in certain Lakes.
Perfluorinated compounds* Source: Used as surfactants in manufacturing, grease and stain repellents on textiles, in aqueous firefighting foams, personal care products.	• Most abundant is perfluorooctane sulfonate (PFOS) whose concentration for Lake Huron was at 27 ng/g. • Greater where populations are more dense. • No binational targets or guidelines for fish. • Canada has developed environmental quality guidelines for both the levels present in fish and for wildlife consumers of fish. In the study period, there were no exceedences of fish tissue guidelines, however, the guidelines for mammalian (4.6 ng/g) or avian (8.2 ng/g) wildlife diet were frequently exceeded. • Trend: Persistent in the environment, some bioaccumulate. In L. Ontario, levels of PFCs have stopped increasing, but declines have not been observed.
Polychlorinated Alkanes (PCAs) Aka chlorinated paraffins. Classified by length of alkane chain, note these descriptions, i.e. Medium chain (C10-C13) MCPCAs and Short chain (C10-C13) SCPCAS * Source: Used in additives in lubricants, metal cutting fluids, paints and plastics, have flame retardant properties.	• In Canadian Lakes, the medium chain, MCPCAs, has higher concentrations, about 12 ng/g for Lake Huron. • Included in the Toxic Substances Control Act (TSCA) by the USEPA. GFA add, SCPCAs were added to the Toxic Prohibition of Certain Toxic Substances Regulations, 2012. • No binational or environmental quality targets in fish for the Great Lakes. • Levels of MCPCAs unchained, some decline in some Lakes of SCPCAs. • Update–Since the report, there have been FEQG guidelines set.

*These compounds that are listed as a chemicals of mutual concern by GLWQA (Great Lakes Water Quality Agreement. See what that means at https://gbf.org/2016/06/22/protection_from_chemicals/
Note : ng/g = one billionth of a gram (µg/g) one millionth of a gram (1×10−6)

GBF: Report Conclusion

Generally your report concluded legacy organic pollutants still dominate the chemical composition of top predator fish, however that legacy POPs and some contaminants are slowing, declining or "stabilized".

GBF notes that some of the chemicals compounds noted are now part of the "Chemicals of Mutual Concern" which both countries will work together on reducing their release and impact. There are chemicals such as some siloxanes compounds that are being monitored; potential guidelines may evolve if quantities increase.

What's coming next?

Daryl introduced us to Chelsea Rochman from the University of Toronto Rochman Lab. Her lab works on the Fate of Plastic Debris and Associated Chemical Contaminants. When she gets back from the Arctic, we are going to talk to her about the lab's research as it relates to freshwater and ecosystems.

What is GBF doing on water quality?

GBF has commissioned a study on the effects of open cage aquaculture on the local food web in four areas of Georgian Bay. Two graduate students are also coordinating literature on this topic in freshwater systems into a report.

Continued on next page →

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

By John M. Plumb, PhD.
Fishery Biologist
Western Fisheries Research Center
United States Geological Survey
July 24, 2017

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.

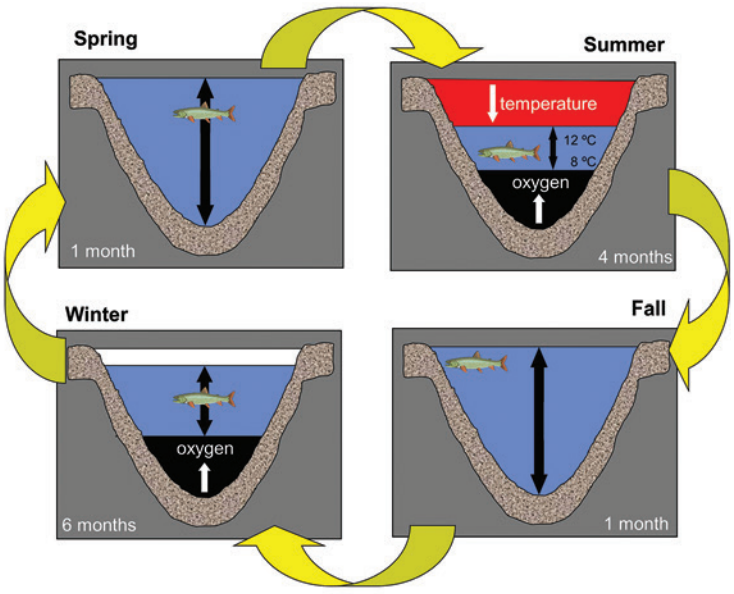
> "...fishery and lake scientists have long-viewed lake trout as a look-out species for the effects of climate change on north temperate lakes..."

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.



RICH AND DAWN DRAYTON AND FAMILY

Three generations of Draytons enjoy summers on Georgian Bay at the mouth of 12 Mile Bay, on the edge of the open. Perched on a high point of their island, the cottage offers breathtaking views that span from Christian Island, to the Westerns and the sunsets beyond.

As a girl, Dawn remembers being a guest at the Humphrey's Island in Snug Harbour. The cool clean water, the rocks and the island were never to be forgotten. Her fondest memories were of swimming off rock ledges and floating on the island pond on a homemade raft. And she will never forget finding a dead moose that had to be removed by local representatives of MNR.

Dawn introduced Rich to the Bay when they rented Laycock's cottage on Fritz island in Woods Bay. The original red and white cottage was filled with American memorabilia and fishing and hunting trophies. It was there that Rich developed his love of the Bay.

Over a four-year period they rented various cottages up and down the shoreline searching for the perfect island to call their own. They bought their nine-acre island from the Osler family in 1983—a dream come true. As well as having a magnificent view, no one had ever inhabited the island before. That first year Dawn, Rich and their three children, Jamie, Mike and Liz, camped near the little sandy beach while they planned, dreamt and finally started to build their cottage home.

From the beginning, Dawn and Rich's three children felt at home on Georgian Bay. They all spent time at Camp Hurontario, just five minutes away. Learning to swim, waterski, fish and build tree forts are just a few of the memorable activities.

Jamie, the eldest son, proposed to his wife, Jen, on the rocks in front of their island. Their wedding gift was a commissioned painting by neighbouring artist Ed Bartram of the view from the proposal site. Their three young children have energetically taken to Georgian Bay living, swimming and exploring shorelines for turtles and washed up treasures. Recently Jamie has made a bigger commitment to the area becoming a Director with Georgian Bay Association.

Mike and his wife, Judy, have two young children. They love the tranquil rugged island landscape allowing quality time together,

> "The water is what it's really about."

building meaningful relationships and enduring memories with loved ones. One of Mike's fondest memories is working for the Township of the Archipelago as a sewage system inspector—the best summer job ever! It gave him the opportunity to explore every nook and cranny of the secret places the Bay had to offer.

Liz loves to share the island with her friends and many of them have grown up at the cottage along with her. Her career has allowed her to live in amazing places like San Francisco, Hong Kong, Beijing and New York, but she always missed her summers on the Bay. Now that she's back in Toronto, she takes every opportunity to be at the cottage. The majestic views and healing effect of being in the water make it her favourite place on earth.

From left to right: Elizabeth, Dawn, Rich, Tyler (boy hiding face), Jamie, Chloe (little girl in front of Jamie) Jenn and Bryce (in mom's arms). Michael, Judy, Julia and brand new baby, Emily, are missing

The Draytons are serious about their love of their island and Georgian Bay, but they also have a humour-filled outlook as evidenced by the sign hanging in the cottage that reads, "Remember, as far as anyone knows, we're a nice normal family!"

When asked why they support GBF and our efforts to protect the water, the family responded,"It's about building and defining your own living space in a natural environment surrounded by water. The water is what it's really about. We all feel very strongly about doing what we can to ensure that the water—as clean and pristine as it is now—is here for generations to come. GBF is working hard towards this goal, not only for our descendants, but for everyone's. This is why we made a pledge to support their work."

GBF NEEDS YOUR SUPPORT—NOW MORE THAN EVER

Our world, our water, our air—it's all we have.

Our health and wellbeing, our very existence as humans rely on the health and wellbeing of the air we breathe, the food we eat and the water we drink. We cannot survive on this planet if we poison those resources or degrade them irreparably. We have already seen some devastating effects of climate change on our precious resources and have had enough scares in recent years to know that we ALL need to do better.

Our government resources are limited.

Funding for environmental protection measures have been cut back significantly, both in Canada and the United States. The Canadian Government has largely had to push back the work of engaging in protection activities onto ENGOs like Georgian Bay Forever, but is unable to provide the necessary funds to complete the work required. Georgian Bay Forever receives no core operational funding for our projects and applies routinely for specific project funding, competing with other organizations that work to make a difference.

Protecting what we have for future generations is our responsibility and we must take it seriously and act quickly.

This is where you, our funders and donors, come in.

Your donations provide the means for us to engage in projects that protect your water, the plants and all of the creepy crawly, slimy, slippery, feathered and furry creatures who call our Bay, home. Our government does what it can to support this work but the reality is this—if GBF fails in our efforts to protect the water, through our projects and research programs, there is no one else coming behind us to complete our work. There is no safe guard in place. If your water is important to you, for whatever reason you hold the Bay dear, please don't let us fail.

Think about how you can help.

There are many ways: through an annual gift, monthly donation, volunteering or a legacy gift in your will. Call and talk to us about options. Let's explore how you can help preserve this one world and all the resources that we share!

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"THE BAYKEEPER" INDICATES THAT GEORGIAN BAY FOREVER IS A MEMBER OF THE WATERKEEPER ALLIANCE, A GLOBAL MOVEMENT OF ON-THE-WATER ADVOCATES WHO PATROL AND PROTECT OVER 100,000 MILES OF RIVERS, STREAMS AND COASTLINES IN NORTH AND SOUTH AMERICA, EUROPE, AUSTRALIA, ASIA AND AFRICA. FOR MORE INFORMATION GO TO WATERKEEPER.ORG

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