LAKE ONTARIO

LAKEWIDE ACTION AND MANAGEMENT PLAN

2021 ANNUAL REPORT

Oswego West Pierhead Lighthouse. Source: Matt McIntosh NOAA.

In this Issue

What is the Lake Ontario LAMP?

Under the 2012 Great Lakes Water Quality Agreement, the Governments of Canada and the United States have committed to restore and maintain the physical, biological, and chemical integrity of the waters of the Great Lakes.

The 2018–2022 Lake Ontario Lakewide Action and Management Plan (LAMP) is an ecosystem-based strategy for protecting and restoring the water quality of Lake Ontario, including the connecting Niagara River and St. Lawrence River to the international boundary. The Lake Ontario Partnership, led by the U.S. Environmental Protection Agency (U.S. EPA) and Environment and Climate Change Canada (ECCC), develops, and implements the LAMP. The Partnership also facilitates information sharing, priority setting, and coordination of multinational protection and restoration activities.

OVERVIEW

In 2021, the Lake Ontario Partnership worked with the International Association for Great Lakes Research to deliver and participate in the virtual State of Lake Ontario (SOLO) Conference in March. The goal was to facilitate interactions between several hundred researchers and managers on diverse topics related to the Lake Ontario ecosystem and water quality. The SOLO conference was a dual milestone for the Lake Ontario Cooperative Science and Monitoring Initiative (CSMI) cycle: it served as a venue for representing the final reporting on work completed during the 2018 CSMI field year and the first priority-setting opportunity for the upcoming 2023 CSMI field year. With contractual support from the International Joint Commission, a science priority-setting workshop was held in June 2021.

The Lake Ontario Partnership will also be participating in the 2022 Great Lakes Public Forum in September in Niagara Falls, Ontario. The Forum is held every three years to engage the public on the state of the Great Lakes, progress achieved over the past three years, and priorities to guide science and actions for the next three years.

Bluffers Park - Panoramic View of Cliff Park (Ontario). Source: Getty Images.

Lakewide management is guided by a shared vision of a healthy, prosperous, and sustainable Lake Ontario in which the waters are used and enjoyed by present and future generations. Although much effort has gone into the protection and restoration of the Lake, some stressors persist, limiting the health, productivity, and use of Lake Ontario and its connecting river systems.

Lake Ontario continues to be a good source of high-quality drinking water, and many toxic chemicals continue to decline in the environment. However, nutrient issues remain a challenge, some chemicals such as PCBs, still pose a threat to human health and the environment, and land-based stressors continue to impact the Lake, including rapid population growth in the western part of the basin.

In the following sections of this Annual Report, the Lake Ontario Partnership provides updates on its activities to reduce chemical contamination, manage nutrients and algae, prevent and control invasive species, and restore and protect habitat and species.

ASSESSING THE NEARSHORE WATERS OF LAKE ONTARIO:

ECCC has completed an assessment of the Canadian nearshore waters of Lake Ontario and the Niagara and St. Lawrence Rivers as part of the Annex 2 Nearshore Framework. An overall assessment of all the Canadian Great Lakes is scheduled to be completed by the end of 2022. *(Figure 1)* The characteristics of the nearshore (depth, substrate, wave energy, coastal sediment cells or compartments within which sediment movement is self-contained, river mouths) were used to delineate 17 distinct Regional Units based on ecosystem type. Existing data were then integrated using a weight of evidence approach to determine the ecological health of each Regional Unit. Eleven individual parameters were evaluated and combined into four categories - coastal processes, contaminants in water and sediment, nuisance and harmful algae, and human use impacts - and then integrated into an overall score. This information will aid local communities to

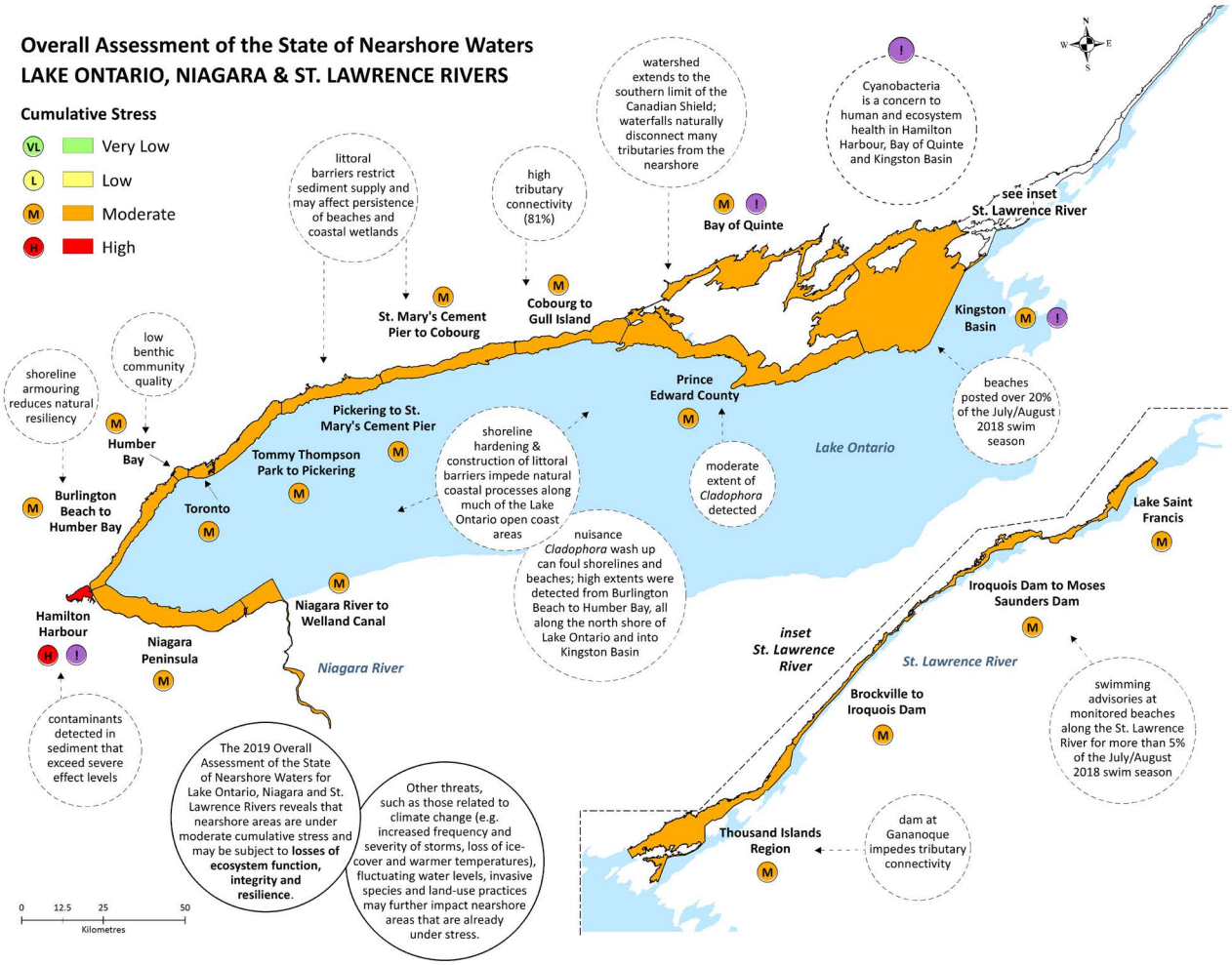


Figure 1: Results of the Canadian Overall Assessment of the state of nearshore waters in Lake Ontario, Niagara River and St. Lawrence River.

take action to improve the state of nearshore waters by identifying areas that are subject to cumulative stress and the sources of the stress. Currently, the methodology, results, and highlight reports for each lake are available upon request and will be posted on Canada's publication website. In the meantime, the data and an online mapping tool can be accessed at: Great Lakes Nearshore Waters Assessment - Open Government Portal. In the United States, the Nearshore Framework and nearshore waters of the Great Lakes are assessed by U.S. EPA's National Coastal Condition Assessment (NCCA). Results of the NCCA assessment of the Great Lakes completed in 2015 were published in 2021 and are available here.

REDUCING CHEMICAL CONTAMINATION

Under Annex 3 of the GLWQA, the U.S. and Canada have identified eight Chemicals of Mutual Concern (CMCs). Significant progress has been made in reducing some CMCs and other toxic chemicals, but some legacy chemicals still pose a threat to human health, biodiversity, and the environment. These chemicals can accumulate in fish tissues and may harm human health if consumption advisories are not followed. Significant work continues in Lake Ontario Areas of Concern (AOCs) to reduce legacy chemicals, such as PCBs, and remove Beneficial Use Impairments (BUIs) tied to chemical contamination. The Lake Ontario Partnership is working on the following activities to monitor chemical contamination as well as raise awareness in the Great Lakes community.

Declines of PFOS and PFOA Concentrations in Nearshore Waters of Western Lake Ontario

The CMCs perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) are synthetic chemicals that are used in a wide variety of industrial and consumer products such as adhesives, cosmetics, cleaning products, and in specialized chemical operations applications such as fire-fighting foams, and in products such as non-stick cookware. Due to their persistence and bioaccumulation potential these chemicals can be found in sediments, water, and air and are a threat to both environmental and human health.

Sampling and analysis in 2018 of Lake Ontario by the Ontario Ministry of the Environment, Conservation and Parks (MECP) Great Lakes Nearshore Monitoring and Assessment Program showed that concentrations of PFOS and PFOA have declined since previous measurements done in 2006. This demonstrates that Risk Management Measures (RMM) to reduce PFOS and PFOA have been successful.

The findings were part of a study (Kleywegt et al., 2020) aimed at measuring the success of RMMs by evaluating per- and polyfluoroalkyl substances (PFAS) (which includes PFOS and PFOA) in source waters and drinking water in Ontario's Great Lakes region. The study found a significant reduction in the sum of 10 measured PFAS concentrations in Lake Ontario, with median concentrations decreasing from 15.6 ng/L in 2006 to 8.3 ng/L in 2018. The highest concentrations in Lake Ontario were found in Hamilton Harbour, and along the Toronto Waterfront where large urban populations are found. In addition, shorter chained compounds (used to replace PFOS and PFOA) are becoming more frequently detected in source waters, suggesting the need for further monitoring to evaluate trends in the Great Lakes.

Binational Efforts to Prevent Exposure to Harmful Chemical Contaminants: Community Engagement on Safe Fish Consumption in Ontario and New Advice on Fish Consumption in New York State

Local coordinators of the Niagara River, Hamilton Harbour, and Toronto and Region Remedial Action Plans (RAPs), with funding from MECP, ECCC, and the Hamilton Port Authority collaborated on a Fish Consumption Engagement Project with several First Nation Communities and the Métis Nation of Ontario. The goal of the project was to raise awareness within the angling community about safe fish consumption and to optimize the ability of the First Nations and Métis to lead community input and participation in the three RAPs. A survey was launched and promoted at a Mississaugas of the Credit First Nation (MCFN) community fish fry, along with other outreach efforts. Of the total number of Indigenous and non-Indigenous anglers surveyed, combined preliminary results indicate that 58% (Niagara River), 11% (Hamilton Harbour), and 30% (Toronto and Region) of survey respondents eat their catch from these respective locations. This engagement fostered positive relationships and encouraged MCFN community participation and input that will inform decision-making regarding fish consumption impairments and associated monitoring and assessments. Ontario's fish consumption guidance is accessible online at: Guide to Eating Ontario Fish.

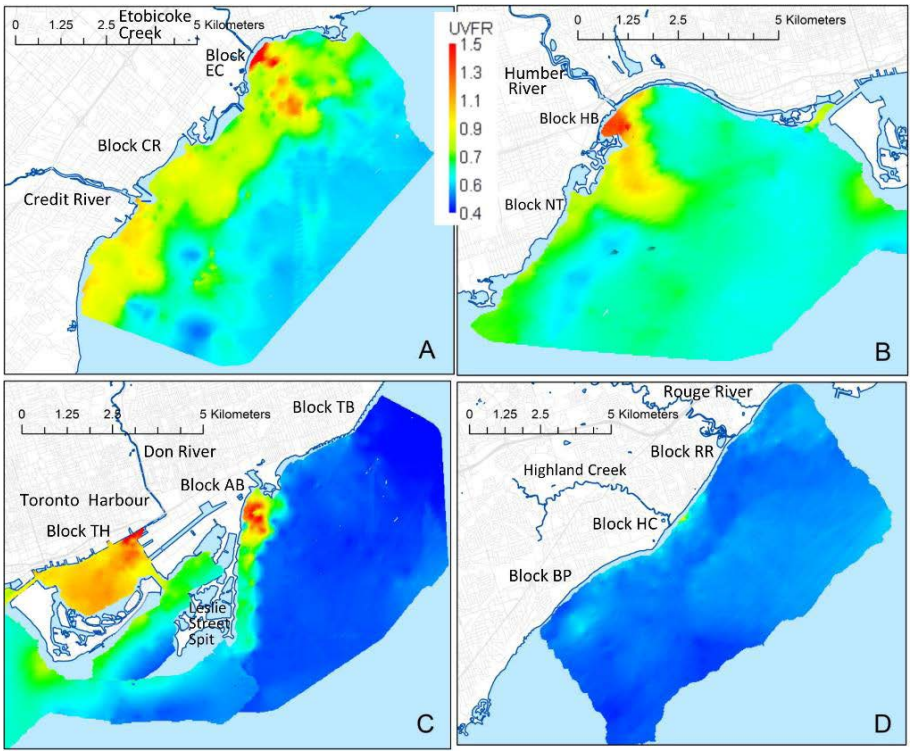
In June 2021, the New York State Department of Health issued **new advice** about eating fish caught in New York waters that indicates it is safe for the entire family to eat fish from Lake Ontario, the Niagara River, and most of the St. Lawrence River. Women under 50 and children under 15 can now eat up to four, one-half pound (0.23 kilograms) meals per month of Brown Bullhead, Rainbow Smelt, Rock Bass, White Sucker, and Yellow Perch. They can also eat up to one, one-half pound (0.23 kilograms) meal per month of Lake Ontario salmon and several other fish species. The previous advice for this sub-population, which had been in place for decades, was to not eat fish of any species from these Great Lakes waters. The new advice highlights the success of banning the use of certain industrial chemicals combined with several decades of diligent efforts by state, provincial, tribal, and federal partners to monitor, assess, and clean up industrial contamination in the Great Lakes basin. The health advice can be found here, and is based on fish contaminant data collected by the New York State Department of Environmental Conservation (NYSDEC). More information on NYSDEC's environmental monitoring can be found here.

MANAGING NUTRIENTS AND ALGAE

Lake Ontario has beaches and nearshore areas that continue to provide good opportunities for swimming and recreational use. However, nutrient issues in the Lake remain a challenge. Offshore phosphorus concentrations are below a desired level and may limit fish productivity. In contrast, nuisance algae (Cladophora) are problematic in some nearshore areas due to both increased water clarity caused by the filtering effects of invasive mussels and excess nutrients. Harmful algal blooms occur in some embayments of the Lake. The Lake Ontario Partnership is working on the following activities to monitor nutrients and address excessive nutrient loading.

Water Quality in the Nearshore of Toronto-Mississauga

In 2018, MECP studied water quality along the Toronto-Mississauga waterfront, describing the impacts of runoff and discharges to the nearshore of the Lake. The study used field sensors and other seasonally deployed instruments to better understand water quality and land-to-lake linkages. Weather-related nutrient loadings from tributaries, storm sewers, and wastewater treatment plant outfalls all contribute to water quality degradation. In general, phosphorus and chlorophyll-a concentrations are higher along the coastline southwest of Toronto Harbour, from the Credit River to Humber Bay, than the coastline to the northeast, from Ashbridges Bay to the Rouge River. However, despite higher nutrient concentrations, the predicted biological response of higher chlorophyll-a concentrations was generally lower than expected. This can be explained by lake



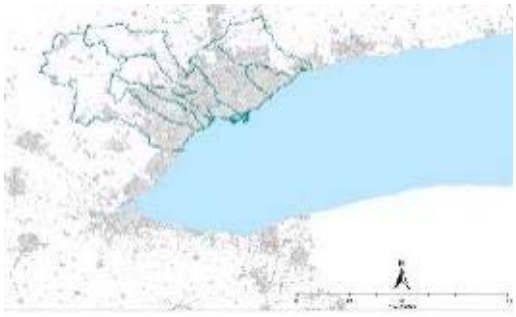


Figure 2. Map of UV fluorescence, used as a surrogate for water quality from sections of the Toronto to Mississauga waterfront from a survey in May 2018. Panels A through D depict conditions from the Credit River (Mississauga) in the west to Rouge River (Scarborough) in the east. Higher UV fluorescence (red) indicates areas where external, land-based loadings affect and degrade water quality. Approximate study location is shown in the top right map. Source: Howell and Benoit, 2021. JGLR; https://doi.org/10.1016/j.jglr.2020.10.012.

circulation patterns and water column layering, strong along-shore mixing, and frequent current reversals. These contribute to variable water quality, and highly changing conditions near shoreline discharge and loading points. (*Figure 2)*

Elevated phosphate concentrations were found at shallow depths suitable for growth of the nuisance algae *Cladophora*. As urban areas expand, monitoring the effects of additional nutrient loading on the growth of algae will need to continue, given the variable but persistent phosphorus enrichment.

The findings of the study were published in two 2021 Journal of Great Lakes Research articles: Loading and lake circulation structures recurrent patterns of water quality on the Toronto – Mississauga waterfront of Lake Ontario; and Nutrient footprints on the Toronto-Mississauga waterfront of Lake Ontario. MECP is planning a future study to examine water quality in Lake Ontario's western basin shoreline from Mississauga to Hamilton.

A member of the MECP field crew (C. Nelligan) prepares a filtered water sample for nutrient analysis during the 2018 Toronto Waterfront Study. Source: MECP

St. Lawrence River Source Water Protection

The St. Lawrence River and its tributaries provide drinking water to hundreds of thousands of people across countless municipalities in the U.S. and Canada. As impacts from shoreline development and agriculture continue across the entire Great Lakes basin, there is increased likelihood for water contamination by nutrient-laden sediments and other harmful pollutants.

Over the last few decades, water quality in Goose Bay in the Town of Alexandria, New York has been on the decline, likely due to increased nutrient loading associated with waterfront development and agricultural activities in the upper watershed. These additional nutrients have led to an excessive amount of aquatic vegetation, hindering boating, swimming, fishing, and dock access. Excess nutrients can also lead to harmful algal blooms (HABs) in Goose Bay's shallow, slow-moving, warm water, posing a health threat to humans, pets, and wildlife. Water quality has also been a longstanding concern facing the Lake of the Isles on Wellesley Island. Past use of phosphate detergents combined with inadequate sewage treatment has led to excessive nutrient contamination in this popular recreational destination. Considering its warm temperatures and lack of flow, Lake of the Isles is particularly susceptible to water quality degradation.

To safeguard these waterways, the Thousand Island Land Trust (TILT), with funding from NYSDEC's Water Quality Improvement Program (WQIP), acquired and will permanently protect approximately 160 acres (65 hectares) and over two miles (3 kilometers) of undeveloped, natural vegetated shoreline and coastal marshland on Number Nine Island in Goose Bay. A second WQIP grant will allow for the permanent protection of 12 acres (5 hectares) on Deer Point Island in Lake of the Isles, as well as the preservation of 1,500 feet (457 meters) of intact natural shoreline and 1,400 feet (423 meters) of marsh frontage along nearby Barnett Creek. Since 2017, TILT has protected approximately 830 acres (336 hectares) with WQIP funding from NYSDEC.

Preserving water quality in Goose Bay and Lake of the Isles. Source: Thousand Islands Land Trust, tilandtrust.org

PREVENTING AND CONTROLLING INVASIVE SPECIES

Invasive species, including the Sea Lamprey, and non-native benthic invertebrates such as zebra and quagga mussels, have significantly changed the habitat and food web in Lake Ontario. Coastal wetlands have been affected by invasive plant species, such as *Phragmites*. However, coastal wetland fish, amphibians and birds show improving trends. Lake Trout populations are improving, due in part to successful Sea Lamprey control. The Lake Ontario Partnership is working on the following activities to prevent and control invasive species.

Early Detection and Monitoring of Benthic Invertebrates

Since 2012, the U.S. Fish and Wildlife Service's (USFWS) Lower Great Lakes Fish and Wildlife Conservation Office (FWCO) has conducted early detection and monitoring surveys for benthic invertebrates in parts of Lake Ontario. Conducting early detection and monitoring surveys for non-native benthic invertebrates is critical as they can outcompete native species for food and other resources. Non-native benthic invertebrates, such as zebra and quagga mussels have proven how nonnative benthic invertebrates can be a serious threat to Lake Ontario and the other Great Lakes.

Lower Great Lakes FWCO staff conducted early detection and monitoring of benthic invertebrate aquatic invasive species in the summer of 2020. A total of 58 sites were surveyed using a variety of passive and active gears including ponars, Hester-Dendy's, rock bags, and sweep nets in the Niagara River, Rochester, NY, and Irondequoit Bay areas. Samples were preserved onsite and invertebrates identified by office staff. Organisms of interest included amphipods, gastropods, and bivalves. The result: FWCO staff found **no** new invasive species!

A USFWS employee collecting a Hester-Dendy. Source: USFWS

For additional information on this survey and other aquatic invasive species surveys being conducted at the Lower Great Lakes FWCO, please see here or here.

Working with Communities to Prevent and Respond to Aquatic Invasive Species in Ontario

Aquatic invasive species (AIS) are recognized as a threat to Ontario's landscape, negatively impacting the environment and affecting recreational, ecological, and economic values. Removal of invasive species from aquatic ecosystems can result in long-term benefits to biodiversity, as well as the quality of recreational activities and reduced costs resulting from AIS impacts to property and infrastructure.

With funding from MECP's Great Lakes Local Action Fund, the Ontario Federation of Anglers and Hunters (OFAH) Invading Species Awareness Program (ISAP) has supported communities interested in removing AIS from local environments - specifically, Water Soldier, Chinese Mystery Snail, and Banded Mystery Snail. ISAP staff provide volunteers and community groups with the training, tools, and on-the-ground support needed to coordinate AIS removal events within their communities in the Lake Ontario watershed.

In 2021 community members attended training workshops which promoted awareness of the target species and trained participants on how to minimize their impacts by removing them from local aquatic ecosystems. Participants learned how to correctly identify the three AIS of interest and learned how to differentiate between these species and their native look-a-like species. Participants also learned how to accurately record sighting information, properly report sightings via the Early Detection and Distribution Mapping System, EDDMapS, and were trained on how to properly remove and dispose of the AIS, according to provincial requirements.

Overall, the project provided communities with practical knowledge and skills to actively engage in

the surveillance, management, and control of AIS. By working with communities to manage AIS, volunteers were empowered to take action and be part of the solution. To learn more about how to spot aquatic invasive species and what you can do, visit the Ontario Invading Species Awareness site, or in the U.S., the New York Sea Grant Great Lakes Invasive Species resource page.

Water Soldier. Source: OFAH 2014

Chinese Mystery Snail. Source: J. Graham 2021

Banded Mystery Snail. Source: ISAP 2021

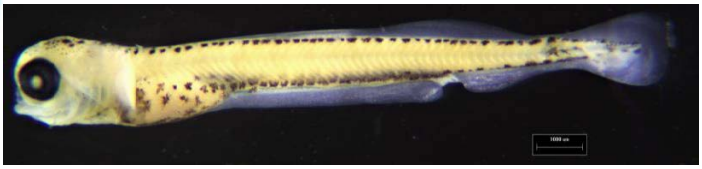
PROTECTING AND RESTORING HABITAT AND SPECIES

Coastal wetlands have been impacted by development, water levels, and invasive species such as *Phragmites*. At the same time, impaired habitat connectivity between tributaries and the Lake are impacting some native species. *Diporeia*, a shrimp-like zooplankton that is an important food source for many fish species, is nearly extirpated from Lake Ontario. However, some native prey fish, such as Deepwater Sculpin, are recovering naturally and restoration efforts for populations of other native prey fish are proving successful. Lake Sturgeon populations are showing some signs of recovery. The Lake Ontario Partnership is working on the following activities to protect and restore habitat and species.

Monitoring Cisco and Lake Whitefish Spawning Habitat in Canadian and U.S. Waters of Lake Ontario

Coregonine (*Coregonus spp.*) fish are important to Great Lakes food webs and fisheries and are central to basin-wide conservation initiatives. Coregonine prey fish were once abundant and available to large predator fish in Lake Ontario. Today, they are limited to isolated regions of the lake in low densities. Lake Ontario binational management objectives include conservation and restoration of spawning stocks of Cisco (*Coregonus artedi*) and Lake Whitefish (*Coregonus clupeaformis*). However, restoration is hampered by a limited understanding of the spatial extent of contemporary spawning habitat and the environmental factors regulating early life success at a lake-wide scale. In spring 2018 under the CSMI, the United States and Canada collected larval fish (ichthyoplankton) to describe the spatial extent of contemporary spawning habitat across Lake Ontario. Statistical models were used to understand which hypothesized environmental characteristics best explained observed larval distributions across habitats.

Between April 10 and May 14, 2018, 1,092 ichthyoplankton tows captured over 2,350 coregonine larvae across 17 sampling areas. *(Figure 3)* Although 95% of catches were in the eastern basin (e.g., Bay of Quinte, ON and Chaumont Bay, NY), larvae were also found in historic south shore spawning areas (e.g., Irondequoit and Sodus Bays, NY). The majority of captured coregonine larvae were Cisco; less than 6% were Lake Whitefish. Statistical



Larval Lake Whitefish (Coregonus clupeaformis) captured in the Bay of Quinte, Lake Ontario, in April 2018. The size range for these larval fish is approximately 13-25 mm. Source: Taylor Brown, Cornell University

analysis demonstrated that both climatic drivers (e.g., ice cover) and local habitat characteristics were important for successful spawning of these species. Strong regional and cross-species variation in larval distributions emphasize the importance of lake-wide assessments for monitoring both the current eastern basin populations and potential expansions into western Lake Ontario habitats. To read more, please see here.

Restoration of spawning habitat has proven successful in bolstering native Great Lakes fish populations. However, little is known about the role of habitat restoration in coregonine reproductive success. The United States Geological Survey (USGS), USFWS, and NYSDEC are collaborating to identify coregonine spawning and nursery habitat to better understand limitations to successful natural reproduction. USGS researchers measured adult egg deposition and subsequent larval emergence surveys in Chaumont Bay using specially designed egg traps and emergence traps. Traps were strategically placed over a variety of habitat types, depths, and substrate (e.g., bedrock, cobble, silt, sand, dreissenid shell fragments) to address questions surrounding optimal conditions for reproductive success. Collections were a resounding success as redesigned egg and emergence traps performed well in the field. This work, completed in April 2021, and published here, will inform a second phase consisting of habitat design and construction to evaluate how habitat modifications might improve reproduction.

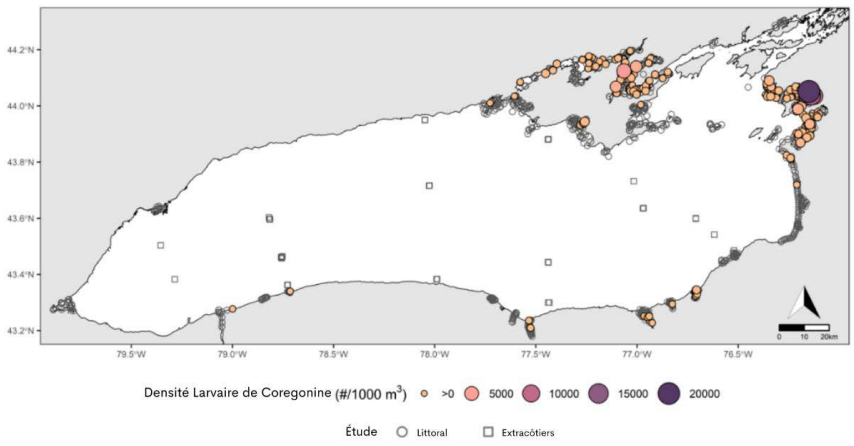


Figure 3. Map depicting larval coregonine sampling locations and observed larval densities in Lake Ontario in Spring 2018. Source: Taylor Brown, Cornell University.

Lake Sturgeon Found Spawning in Genesee River for the First Time in More Than 50 Years

After more than 50 years of being notably absent, in 2021 the USGS found a spawning female Lake Sturgeon in the Lower Genesee River. A field crew from USGS's Tunison Laboratory of Aquatic Science, was responsible for collecting the 61-inch (160 centimeters), 70-pound (31.8 kilograms) female on the shores of the River in Monroe County, NY. Since 2003, NYSDEC has stocked the Lower Genesee River with juvenile Lake Sturgeon to assist in the recovery of this once prolific species. This work is part of a statewide Lake Sturgeon Recovery Plan. The Lower Genesee River is part of the Rochester Embayment AOC, a designation it received under the GLWQA due to significant environmental degradation. The return of spawning Lake Sturgeon to this area signifies success due to local, state, and federal restoration efforts within the AOC. For more information on what you can do to help restore and protect Lake Sturgeon, please see here for resources in the U.S. or here for information in Canada.

Lake Sturgeon eggs. Source: Marc Chalupnicki, USGS

OUTREACH AND ENGAGEMENT

GLWQA Engagement Opportunities

The Lake Ontario Partnership held two *Let's Talk Lake Ontario* public webinars in 2021 to discuss topics such as fighting floatables and trapping trash in the Lake and the nuisance algae, *Cladophora* as well as actions taken to address these Lake issues. You can keep up to date on GLWQA engagement opportunities in the Engagement section of Binational.net. Information on many of our partner organizations' upcoming outreach and engagement opportunities can also be found at the Great Lakes Commission's "Great Lakes Calendar".

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Toronto waterfront (Ontario). Source: Getty Images.