IAGLR
LAKES Letter

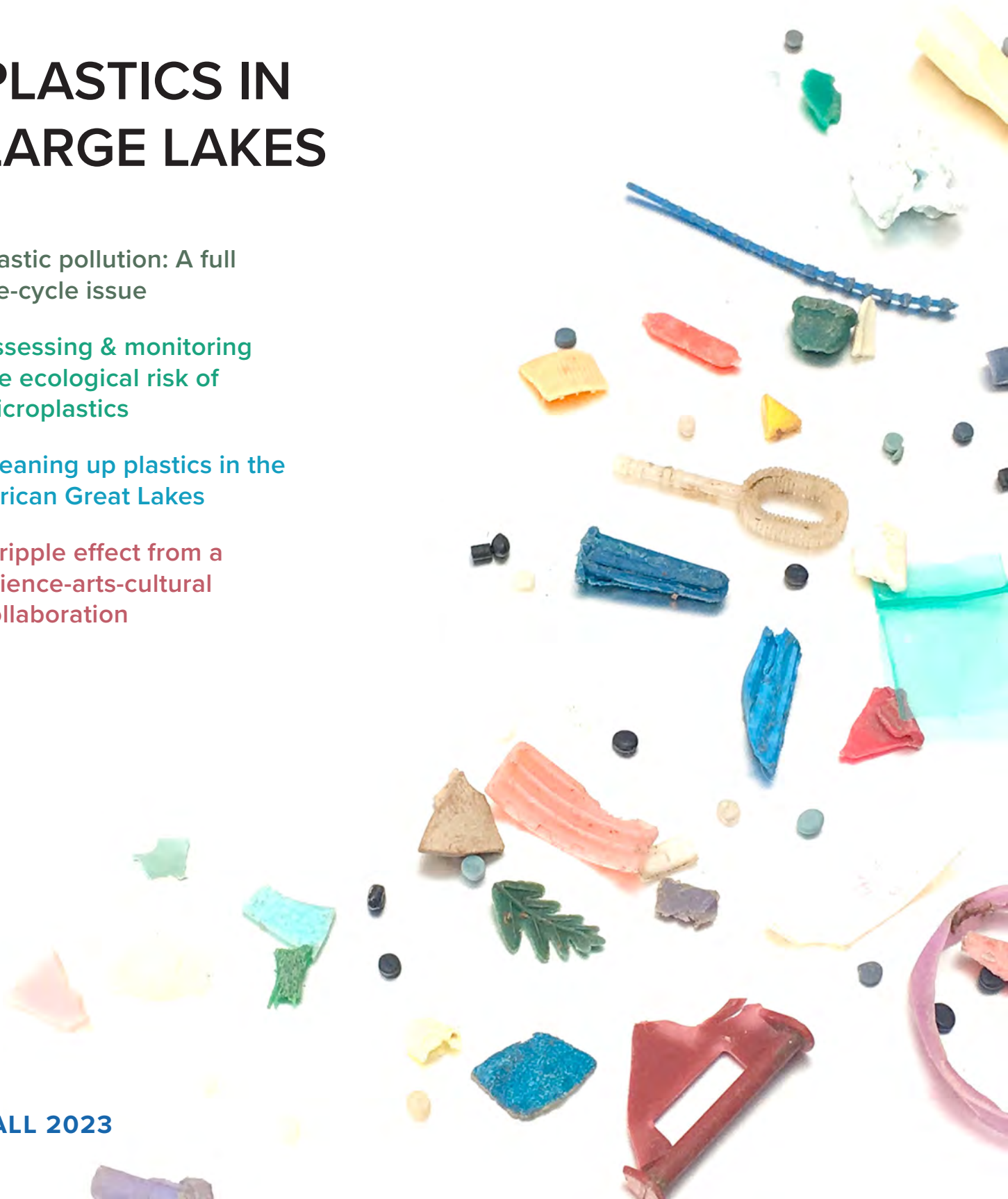
PLASTICS IN LARGE LAKES

Plastic pollution: A full life-cycle issue

Assessing & monitoring the ecological risk of microplastics

Cleaning up plastics in the African Great Lakes

A ripple effect from a science-arts-cultural collaboration



FALL 2023

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Dear Members and Friends of IAGLR,

Although a month remains in 2023, IAGLR has already wrapped up year-end financial planning. With our fiscal year starting in October, we devoted time at the IAGLR Board of Directors' fall meeting to report on our finances and set the budget for the coming fiscal year. I am pleased to say that we ended FY2023 without a loss. Revenues from our annual conference and additional royalties from our journal contributed to our financial stability.

We're getting ready to open the IAGLR 2024 Call for Abstracts in December. With more than 50 sessions proposed, we look forward to a well-attended conference in Windsor, Ontario. We're working hard to offer a full hybrid experience to allow attendees both to present and attend online. The local committee is currently looking at side activities that will be offered on the Wednesday afternoon, when we will take a break from the regular sessions.

This month, IAGLR was invited to appear as a witness before the Standing Committee on Environment and Sustainable Development of the House of Commons in Canada to address pollution management. Our brief—prepared by staff with support from board members and our editors—provided five recommendations for the Great Lakes that centered on nutrients, contaminants of emerging concern, and microplastics. We'll share our submission on the website soon.

Speaking of microplastics, this issue of *Lakes Letter* explores plastics in large lakes, including the Laurentian and African Great Lakes. I hope you enjoy the issue and learn something new. I also encourage you to take our brief survey about *Lakes Letter*. You can find the link on page 5.

Please note that the search for a new editor has formally begun, with applications due by January 31.

As we end 2023, I would like to invite you to renew your membership (and continue to explore the features of our new member portal) so that you can continue enjoying the benefits of being part of the IAGLR community.

Happy holidays. I look forward to reconnecting with you in the new year!

Jérôme Marty,
Executive Director

LAKES *Letter*
FALL 2023

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On the Cover

Plastic fragments and industrial plastic pellets gathered from strandlines of Great Lakes beaches. Credit: Tegan Moore, 2019.

SHARED LAKES: ONE WATER, ONE HEALTH • 2024 •

IAGLR

WINDSOR, ONTARIO

MAY 20-24, 2024

ABSTRACT SUBMISSION OPENS IN DECEMBER

Start planning what you'd like to present at next year's most anticipated Great Lakes research event!

- 53 sessions proposed
- Abstract submission open **through January 12**

Your research matters. Let's explore the future of large lakes together!

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How can your organization make a splash at the conference?

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  (Act fast to secure limited premium spots!)
- Become a Great Lakes Benefactor for extra benefits

If you're interested in sponsoring a specific activity, being an exclusive sponsor of an IAGLR event, or inquiring about in-kind donations, contact Jérôme Marty at jmarty@iaglr.org.

iaglr.org/iaglr2024

2024 IAGLR membership is open!

Enjoy the following benefits as an IAGLR member:

- **New** IAGLR Member Directory
- *Journal of Great Lakes Research* subscription and reduced rates to publish open access
- *Lakes Letter*
- *IAGLR E-Notes*
- Student opportunities and support
- Discounted registration for IAGLR 2024
- Networking and connection
- Opportunity to serve on the IAGLR Board of Directors

Your membership supports and enriches the association and the large lake research community!

When you join IAGLR, you join a community of people devoted to understanding the world's large lake ecosystems.

Why wait? Renew today!

Call for nominations for awards

Help us recognize excellence in large lake research. We're seeking nominations by **March 1** for the following awards:

- IAGLR Lifetime Achievement Award
- John R. (Jack) Vallentyne Award
- IAGLR Large Lake Champion Award

For details on how to nominate a candidate, please review the Call for Nominations for each award available from the links above.

Nominate a notable JGLR paper

We also present three awards for the most notable papers published in the previous year's volume of the *Journal of Great Lakes Research*:

- Chandler-Misener Award
- Elsevier Student Award
- Elsevier Early Career Scientist Award

Nominate a paper from volume 49 by **January 15** for consideration.

How are we doing with *Lakes Letter?*

It's been nearly two years since we relaunched *Lakes Letter,* and we'd love to get your feedback. Please visit the following link by **December 8** to take a quick survey:

https://www.surveymonkey.com/r/iaglrLL23

KUDOS

Congratulations to the following IAGLR members!

ROBIN DEBRUYNE (USGS Great Lakes Science Center) was awarded the 2023 American Fisheries Society Fish Habitat Section Rising Star Award during the American Fisheries Society conference held in Grand Rapids, Michigan, in August. Robin was recognized for her leadership and technical support provided to several fish habitat restoration projects in the Great Lakes basin, her high level of scholarly productivity, professional service, and mentorship of graduate students and young professionals. The Rising Star Award recognizes the outstanding early-career contributions of students and early professionals in the field of fish habitat conservation.

ABRAHAM FRANCIS (Clarkson University Environmental Science & Engineer Ph.D. student and NDN Collective Changemaker Fellow) is author of the book chapter "Telling of Kaniatarowanenneh (St. Lawrence): Storying Akwesasronon Relationship with the River" in the newly published book *Land as Relation: Teaching and Learning through Place, People, and Practices*, edited by Margaret Kress and Kahente Horn-Miller. Francis is an Indigenous scholar currently studying Indigenous and Eurocentric approaches to shoreline environmental management along the St. Lawrence River in the Mohawk Territory of Akwesasne.

BRENNA FRIDAY and **KATRINA LEWANDOWSKI** (both Ph.D. students in the Kashian Lab, Wayne State University) were recently announced as finalists for the 2024 John A. Knauss Marine Policy Fellowship program sponsored by the National Oceanic and Atmospheric Administration's National Sea Grant College Program. They will join 84 early-career professionals selected for placement in federal government offices throughout Washington, D.C., beginning in February. Friday is a Ph.D. candidate examining the effects of harmful algal blooms on amphibian populations. Lewandowski is a Ph.D. candidate investigating how environmental stressors may affect two separate populations of invasive quagga mussels, and how the abundance of mussel veligers has affected Great Lakes food webs.

JORDAN HARTMAN (University of Illinois Urbana-Champaign) recently completed her Ph.D. in Natural Resources and Environmental Sciences. Her research examined the spread and impact of eastern banded killifish, an invasive species in Lake Michigan and connected waters.

ANDREA KIRKWOOD (Ontario Tech University) was awarded the University Research Excellence Chair in Urban Water. The program recognizes and rewards the high-quality research and scholarly achievements of Ontario Tech faculty members.

DEBORAH LEE (director of NOAA's Great Lakes Environmental Research Laboratory), is being credentialed as an Envision Sustainability Professional by the Institute for Sustainable Infrastructure. She is the first NOAA employee with this credential and joins a group of more than 3,400 engineering professionals nationwide with this credential.

DAVID REID (NOAA, Great Lakes Environmental Research Laboratory) for being recognized by NOAA and partners for career achievements in aquatic invasive species research that has had significant positive impacts on the health of the Great Lakes. Reid's work provided scientific evidence to support the improvement of ballast water management legislation for shipping in the Great Lakes, contributing to a sharp decline in the introduction of new aquatic invasive species into the Great Lakes basin.

Welcome New Members

The following members joined IAGLR between August and October 2023. We're glad you're here!

Zephaniah Ajode
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Alemu Ayano
Charles Balagizi
Anthony Basooma
Yvonne Bigengimana
Mubwebwe Arthur Bisimwa
Simon Buhungu
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Harrison Ngige
Lambert Niyoyitungiye
Loziwe Njobvu- Chilufya
Winifred Nkalubo
Asante Nkhata
Nabintu Noella
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William Okello
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Masilya Pascal
Ajok Paska
Harris Phiri
Richard Rugadya
Nzigire Rutakaza
Kamakune Sandrine
Baraka Chrisostom Sekadende
Asilatu Shechonge
Amon Shoko
Oscar Wembo
Tekle Worako

MEMBER PROFILE

Heather Dettman

Senior Science Advisor, Multi-Partner Research Initiative, Natural Resources Canada

About my work

Since 1990, I have been a research scientist with Natural Resources Canada (NRCan) where I have developed expertise in analyses of petroleum products including oil sands bitumen. My research topics have included studies of refinery corrosion, petroleum upgrading and refining process upsets, bioprocessing, and diesel fuel analysis. In 2013, I led the development of oil spill science facilities and projects at the NRCan CanmetENERGY lab in Devon, Alberta. In 2022, I became the senior science advisor for the NRCan Multi-Partner Research Initiative (MPRI), a research funding program aiming to help the Canadian and international spill science community address priority response knowledge and technology gaps.

Inspiration for this work

My Ph.D. was in biochemistry from the University of Alberta where I used nuclear magnetic resonance (NMR) spectroscopy to study protein-membrane interactions. After an NSERC postdoctoral fellowship at Yale University, I became manager of the University of Ottawa Chemistry Department NMR Facility. After a few years, I helped staff at the NRCan CanmetENERGY lab in Ottawa with their NMR instrument. They soon offered me a job, and so began my work with "earth-processed biomass," petroleum.

Something else about myself

I have always liked water. By the age of 16, I had become a lifeguard and swimming instructor and obtained

scuba certification. At camp I learned to paddle a canoe and then during graduate school, a kayak. When at Yale, I began windsurfing and have taken lessons for sailing in Victoria. Despite living at a land-locked location, my work to improve oil spill science to protect water is also personal.

MEMBER PROFILE

Harris Phiri

Lake Tanganyika Science Advisory Group

About my work

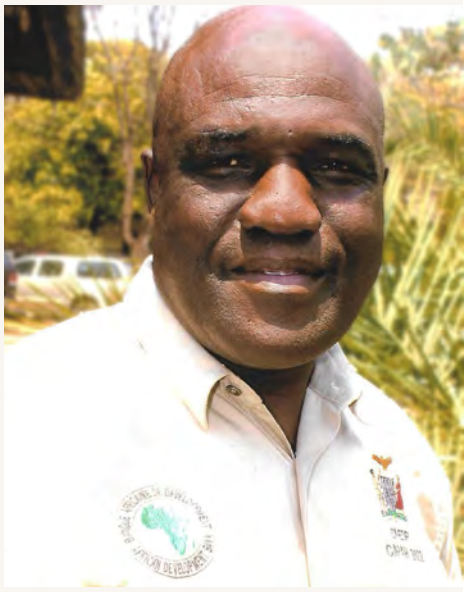
I recently retired from formal employment as director of the Department of Fisheries in Zambia. I worked there for 34 years, rising through the ranks. Prior to that, I worked as a researcher on Lake Tanganyika and other water bodies in the country. My areas of experience included conducting studies on fish population dynamics, frame surveys, ecological surveys, gillnet surveys, and limnological surveys. My expertise includes freshwater ecology; conservation biology; fish stock assessment; project planning, management, and evaluation; and fisheries management, among others. I have authored and co-authored several papers on Lake Tanganyika.

Inspiration for this work

My interest in conservation works and nature in general inspired me to join the Department of Fisheries after graduation from university. I started getting involved in conservation works while I was an undergraduate student at the University of Zambia. This interest was further enhanced when I met several renowned scientists from around the world at a conference in Bujumbura in 1991.

Something else about myself

I enjoy interacting with other professionals in aquatic sciences and beyond, and so I find moments at meetings quite enriching. I also enjoy being around nature, both aquatic and terrestrial. My hobbies include listening to music, traveling, reading, and playing board games like chess and drafts.



MEMBER PROFILE

Lisa Sonnenburg

Cultural Resource Management Advisor, Parks Canada

About my work

I have been studying submerged archaeological landscapes since 2004 and have managed to do this on four of the five Great Lakes! I am currently the cultural resource management advisor for Lake Superior National Marine Conservation Area, which covers over 10,000 square kilometers of water and includes 600 islands. This work is a collaborative effort with Indigenous and non-Indigenous knowledge holders and communities, academic institutions, and government departments to document and protect the cultural resources for current and future generations.

Inspiration for this work

I first became interested in submerged landscapes during my undergraduate degree at Lakehead University when I found out that a stone tool was recovered off the coast of Haida Gwaii, in an area that was above water during the early Holocene. I was fortunate to pursue this type of research during my graduate degrees at McMaster University and a post-doctoral fellowship at the University of Michigan. I spent five years in the consulting industry before joining Parks Canada in 2020.

Something else about myself

Twenty-five years ago, I moved to a small community on the north shore of Lake Superior to work as a figure skating instructor. That's when I first fell in love with the Great Lakes.

Chart the course for the JGLR's future!

Dive into a transformative role as LEAD EDITOR for the *Journal of Great Lakes Research*, shaping the forefront of aquatic sciences globally.

This exciting opportunity to help shape the field of large lake studies calls for an **experienced scholar in this field with editorial experience**.

The JGLR is the leading peer-reviewed publication of scholarship on large lakes of the world and has a broad disciplinary scope including physics, chemistry/chemical contamination, biology, and human use of the lakes. The lead editor oversees the content of the journal and seeks to publish the highest quality work possible from potential authors in diverse subject matters reflecting the interests of our members related to research/scholarship relevant to large lakes of the world.

Manage Journal Content

3-Year Term

Part-time Position

Remote Work

Start as soon as January 2025

Interested candidates should **review details of the position** and are encouraged to contact the current lead editor, Dr. Robert (Bob) Hecky (editor@iaglr.org) for perspective on the position.

Apply by January 31, 2024, for full consideration.

The *Journal of Great Lakes Research*

Advancing understanding of the world's large lake ecosystems

iaglr.org/journal

PLASTIC POLLUTION

A FULL LIFE-CYCLE ISSUE

by SHERRI MASON
DIRECTOR OF SUSTAINABILITY, PENN STATE BEHREND

A DOZEN YEARS AGO, I had the opportunity to co-teach an environmental science field course focused on the Laurentian Great Lakes aboard the U.S. Brig *Niagara*, a replica War of 1812 tall ship based in Erie, Pennsylvania. While out in the vast open waters of Lake Erie I wondered, *As much as we have heard about plastic pollution within the world's oceans, is there plastic in the Great Lakes?* The following year, my colleagues and I would set out aboard that same vessel to answer that question, leading to an unfortunate answer and, as all science does, to a lot more questions.

As one of the first freshwater plastic pollution researchers, I now frequently give talks to the public on plastics as an environmental issue. I think most people expect to hear about how plastic is polluting every nook and cranny of our earthly home. And while that is certainly true, increasingly, I want to talk about a more important reality: plastic pollutes at every step of its life cycle. This isn't just an end-of-life issue. It is a full-cycle material issue, and one that is moving to my backyard.

Above: Where it all began. The U.S. Brig *Niagara*, a replica War of 1812 tall ship, sailing Lake Erie in 2012. Credit: Sherri Mason. Background photo by 5Gyres, courtesy of Oregon State University.

FOSSIL FUEL'S PLAN B: PLASTICS

I live in Pennsylvania, a state that receives substantial national attention, especially during presidential election cycles, because of its prominent hydrofracking industry. While hydrofracking is most well-known as a method to extract natural gas (i.e., methane) from shale reserves, shallower (and less thermally mature) shale reserves tend to have a higher proportion of "wet" gas components (ethane, propane, and butane) relative to methane. Extraction of these wet gas components means hydrofracking is not just about energy, it is about plastics. As such, we are not only seeing a build-out of hydrofracking wells, but also the plastics industry.

In November 2022, a multibillion-dollar ethylene cracker plant built by the Shell corporation started its operations in Beaver County, Pennsylvania, just north of Pittsburgh, creating polyethylene plastic from wet hydrofracked gas. Within only a few months, this facility had already been fined $10 million for violations of state air quality regulations. These violations are reminiscent of my childhood. I grew up in Texas, a bit north of another area in which the growth of fossil fuel refining also led to the growth of a related and connected plastics industry—an area of the United States known infamously as "Cancer Alley." The build-out that is emerging in Pennsylvania leads one to wonder if our future can be seen by looking south.

In addition to the operational Shell ethylene cracker plant, Encina is planning a plastics "advanced recycling" facility in Point Township, Pennsylvania, and the International Recycling Group (IRG) has proposed a supersized plastics sorting facility in Erie. Both facilities are focused on end-of-life plastics with significant potential impacts on freshwater systems. Beyond the atmospheric issues of "advanced recycling," the Encina facility is being planned to be built within the floodplain of the Susquehanna River, which is known to regularly flood. While the IRG facility is planned to be located a few miles from the shores of Lake Erie, the resulting flaked, post-consumer, mixed plastic waste is expected to be transported by boat across the Great Lakes for use as a supplement to coke in steel mills.

These industries bookend the already extensive plastics manufacturing throughout the region. Such businesses rely on a feedstock of pre-production plastic pellets (known as "nurdles") that originate from fossil fuel refining and are well-known to be lost as they are vacuumed from one storage container to another (i.e., train to truck, and truck to silo). However unintentional these losses may be, rainwater still carries them from land to lake in dramatic numbers.

As transportation is increasingly going electric, plastics are the Plan B for the fossil fuel industry, and much of that new build-out is happening right here in Pennsylvania, with impacts on air and water, including the Great Lakes.

"Plastic pollutes at every step of its life cycle. This isn't just an end-of-life issue. It is a full-cycle material issue, and one that is moving to my backyard."

The Shell ethylene cracker facility in Beaver County, Pennsylvania, along the shores of the Ohio River. Credit: Mark Dixon.

A FULL LIFE-CYCLE ISSUE

It is important to see plastics as a full life-cycle issue, especially as we still grabble with understanding myriad sources and pathways that release and transport them throughout the globe. Understanding the sources is complicated given the prominence of plastic in our lives and the local-to-regional nature of particular sources to particular waterways. For example, when we surveyed a remote lake in Mongolia (Lake Hovsgol), the dominant microplastics within the water were heavily influenced by the local fishing industry, while in Lake Superior (USA) the microplastic loading is largely owing to fibers, which seem to be transported to the lake through the air and atmospheric deposition. In more urban areas, run-off is the prominent source. But even the "removal" of plastics through the wastewater treatment process only moves plastics from the wastewater into the sludge, which is then commonly applied to agricultural fields as fertilizer, giving a second life to the microplastic pollution as a soil contaminant.

All of this plastic—whether in our air, our soil, or our water—eventually makes its way into us through the air we breathe, the water we drink, and the food we eat. Microplastics have been found within our blood, our lungs, our brain, and even on both the maternal and fetal sides of the placental boundary. While understanding the impacts of our plasticized world on human health is still in its infancy, the initial studies don't look good. For one, we have to consider plastic for what it is—a mixture. These polymers have been implicated as factors in various neurological disorders like Alzheimer's disease. In addition, we need to consider myriad chemicals (current estimates of ~10,000) used in the manufacture of plastic products. Many of these chemicals are known to mimic hormones, leading to a wide variety of human health implications, from cancer to reproduction issues to obesity to autism.

"All of this plastic—whether in our air, our soil, or our water—eventually makes its way into us through the air we breathe, the water we drink, and the food we eat. "

Above: Pre-production plastic pellets released during transport from train car to semi-truck. The train cars used to come to Erie, Pennsylvania, from Louisiana but now increasingly come from the Shell facility in Beaver County, Pennsylvania. Credit: Sherri Mason.

Solutions to plastic pollution are as varied as the sources. Reducing our individual plastic usage by finding reusable alternatives is something we can all do that has real impact. After all, every bit of plastic found in our lakes ultimately comes from us. Adding filters to washing machines, like we have on dryers, would help to reduce the flow of fibers into our waterways. The Break Free from Plastic Pollution Act, a suite of legislative bills, has been reintroduced in the U.S. Congress for a third time. The heart of this legislation is extended corporate responsibility, which has been shown to be very effective in car battery and electronics recycling. It would change the landscape of packaging away from single-use plastics toward the use of reusable, recyclable, and compostable commercial packaging materials. Chief among all of these solutions is the need to reduce our usage of this material. As a chemist, I can understand its appeal; as a human and lover of our lakes, I advocate for finding alternatives, using less, and moving to a circular economy.

A dozen years ago, sailing the incredibly beautiful Great Lakes, a simple question crossed my mind. In working to answer that question, the lakes are speaking through me, and other researchers like me, revealing to us the impact we are having and pointing us on another course. Will we listen?

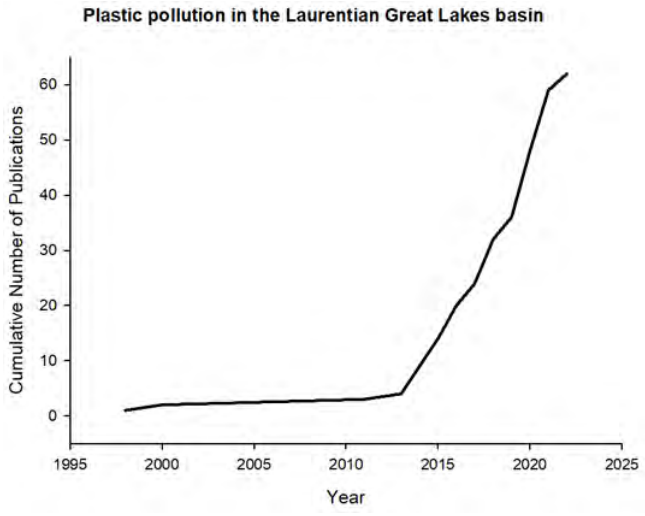
An International Joint Commission initiative

Developing frameworks for monitoring and assessing the ecological risk of microplastics in the Laurentian Great Lakes

by EDEN HATALEY, KAREN KIDD, CHELSEA ROCHMAN & REBECCA ROONEY

IT IS NOW UNDERSTOOD that plastics, particularly microplastics, are present across the Laurentian Great Lakes basin, on shorelines and in surface waters, sediments, and biota, including birds, fish, and mussels. Over the past decade, the scientific body of literature on plastic pollution in the region has grown to over 60 publications. Studies report on levels of contamination across the Great Lakes and their watersheds, the effects on local wildlife, the sources, transport, distribution, and fate of plastics in the basin, and the use of policies and guidelines to address the issue. What remains less well understood are long-term and spatial trends in contamination levels, real-time and future risk, and the best approach for managing plastics accordingly. The International Joint Commission's (IJC) Great Lakes Science Advisory Board is increasing its efforts to tackle these gaps in understanding and addressing the issue of microplastics in the Great Lakes, specifically.

In 2015, the IJC's Great Lakes Water Quality Board started a Microplastics Watching Brief, which summarizes points of interest related to microplastics and plastics more broadly in the region, spanning science, policy, and media. In 2016, the IJC hosted a workshop on microplastic pollution in the Great Lakes, its purpose to compile local progress and gaps and develop recommendations for addressing the challenges posed by microplastics in the region. The workshop was attended by 33 experts from the United States and Canada representing diverse sectors, including academia, government, industry, and non-governmental organizations. Together they developed 10 recommendations spanning actions related to science and research, policy and management, and education and outreach for the IJC to review and present to Canadian and American federal departments for consideration.



The cumulative number of publications on plastic pollution in the Laurentian Great Lakes basin, including papers published until June 2022. Data from McIlwraith et al., 2023.

Today, in response to and with consideration of the outcomes of the 2016 workshop (as well as global progress on the issue), the Great Lakes Science Advisory Board has put together a workgroup focusing on the environmental monitoring and ecological risks of microplastics in the Great Lakes. The workgroup, co-led by the authors of this article, began in early 2023 and comprises subject matter experts from the United States and Canada. The general objective of the workgroup is to develop and propose coordinated frameworks for microplastics monitoring as well as ecological risk assessment and management in the Great Lakes.

As a first task, the workgroup has drafted a literature review to synthesize recent advances and knowledge in plastics science, including current knowledge on Great Lakes-specific monitoring data, field and lab methods used for measurement, and toxicity data for relevant species, as well as the associated knowledge gaps. In support of this, the workgroup held a session at the 2023 IAGLR annual conference in Toronto, Ontario, to bring together researchers to share the latest information on plastics in the Great Lakes. The session comprised 22 presentations and 17 posters

covering diverse topics, including monitoring, method development, and toxicity testing.

Additionally, the workgroup is hosting two workshops, one to create a framework for monitoring microplastic pollution in the Great Lakes and another to develop a framework for ecological risk assessment and management. The first workshop, held in Ann Arbor, Michigan, this past September, was a success, and products will include harmonized monitoring guidelines for field methods, quality assurance and quality control, and reporting requirements for microplastics in water, sediments, and biota in lakes and tributaries. The workshop participants also discussed key considerations in monitoring program design, including capturing spatial and temporal variability and enabling source apportionment and opportunities to incorporate microplastics into existing Great Lakes monitoring programs.

The second workshop, which will be held this coming January in Windsor, Ontario, will focus on adapting existing ecological risk assessment and management frameworks for microplastics in surface water and sediments for application with Great Lakes monitoring data.

The workgroup has been fortunate to have the opportunity to learn from and collaborate with other groups doing similar work on microplastics monitoring harmonization and ecological risk assessment from across the United States, in California (the Southern California Coastal Water Research Project) and Chesapeake Bay (the Chesapeake Bay Plastic Pollution Action Team).

Participants at the first workshop on microplastics monitoring held in Ann Arbor, Michigan, in September 2023.

The project of this workgroup will run until early 2024. Products will include tools needed to initiate a long-term monitoring program for microplastics in the Great Lakes and a risk assessment framework for understanding how contamination may impact local resources and wildlife. The project report will be submitted to the IJC commissioners to inform the commission's advice to the governments of the United States and Canada. If adopted, these tools will provide information on tracking the extent of microplastic pollution and its impact as a contaminant.

Eden Hataley is a Ph.D. candidate in the Department of Physical and Environmental Sciences at the University of Toronto Scarborough. Karen Kidd is a professor in the Department of Biology and the School of Earth, Environment, and Society at McMaster University. Chelsea Rochman is an assistant professor in the Department of Ecology and Evolutionary Biology at the University of Toronto. Rebecca Rooney is an associate professor in the Department of Biology at the University of Waterloo.

Products will include tools needed to initiate a long-term monitoring program for microplastics in the Great Lakes and a risk assessment framework for understanding how contamination may impact local resources and wildlife.

Volunteers conducting a brand and waste audit after a cleanup of the landing site on the Lake Tanganyika shore.

Clean Shores, Great Lakes

Preventing microplastics from entering the African Great Lakes through citizen science cleanups

by BAHATI MAYOMA, CONRAD SPARKS & FARHAN KHAN

All photos courtesy of Clean Shores, Great Lakes Project.

THE AFRICAN CONTINENT is home to some of the largest freshwater bodies and holds about a third of the total global freshwater resources. The major African Great Lakes (AGL), namely Victoria, Tanganyika, and Nyasa (Malawi), form a unique ecoregion that plays vital ecological and economic roles for the riparian communities and the global hydrological cycle at large. The lakes support amongst the highest levels of freshwater biodiversity with hundreds of endemic aquatic species and also huge human populations that rely on the freshwater resources. The AGL support the livelihood of 40 million people across eight bordering countries (Tanzania, Kenya, Uganda, Malawi, the Democratic Republic of the Congo, Burundi, Zambia, and Mozambique). The AGL connect the heart of Africa to the open ocean and the doorstep of Europe through the Mediterranean Sea and the Atlantic and Indian oceans via the Nile, Congo, and Zambezi Rivers, respectively.

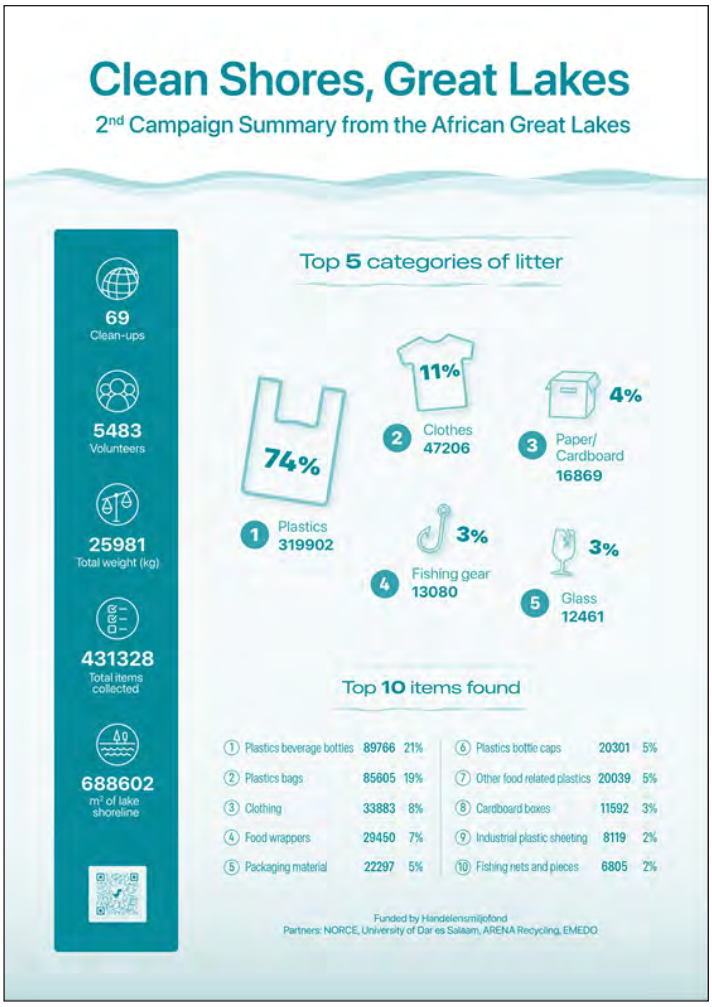
Thus, plastic and microplastic pollution in these waters has major ramifications and has already been documented on AGL beaches (Mayoma et al., 2019; Egessa et al., 2020), in water (Ngupula et al., 2014), and in fish (Biginagwa et al., 2016). The 2016 study by Biginagwa and coauthors was the first to show the presence of microplastics in the digestive tracts from Nile perch and Nile Tilapia from the AGL, specifically Lake Victoria. This study started the urgency to address the issue of plastic pollution in the region, and in particular, what can be done to mitigate the problem.

Clean Shores, Great Lakes Project

The Clean Shores, Great Lakes (CSGL) project was formed to address microplastics before they enter the Great Lakes water by reducing litter, especially plastic litter, along the Tanzanian shorelines of the AGL. Funded by the Norwegian Retailers' Environment Fund (Handelens Miljøfond) under the Reduce Plastic Litter Internationally program, the project was led by the Norwegian Research Centre (NORCE) and University of Dar es Salaam (UDSM), with EMEDO (Environmental Management and Economic Development Organization) and ARENA Recycling Industry. The project aimed to (1) conduct a campaign of coordinated cleanups; (2) train and mobilize local communities as environmental ambassadors through active involvement in the cleanups; (3) record cleanup data through citizen science to pinpoint hotspots and sources of litter; (4) promote circular economy and sustainable solutions; and (5) provide data-led advice to regional and national policy makers on mitigation strategies.

Implemented from February to September 2023, the project targeted beaches, drainage ditches, rivers, markets, and landing (fishing) sites. Importantly, our cleanups were designed not to disrupt people's livelihoods, so we started early (typically 7 or 8 a.m.) and worked for only a couple of hours. This model attracted many volunteers including jogging clubs, scouts, market traders, and many more members of the community.

The results of the campaign surpassed our expectations. Over 5,000 volunteers joined us as we cleaned up 69 sites (nine



Before (left) and after cleanup (right) of Kamanga Beach on the Lake Victoria shore.

Top: One of the primary school environmental clubs visited during the cleanup of Lake Nyasa in Kyela District. **Middle:** Bahati Mayoma (country project coordinator) introducing the project during the dissemination workshop in Mwanza in September 2023. **Bottom:** Stakeholders following the discussion during the dissemination workshop.

sites more than initially planned), totaling an area of over 680,000 m^2 of Great Lakes shoreline, equivalent to over 150 football fields. Plastics were the biggest category of litter (74%), with bottles and carrier bags comprising 40% of all litter. Brands from three local manufacturers accounted for 60% of all plastic litter collected, and sites associated with fishing activities were generally more polluted than other types of sites.

Dissemination and Education

The project's aims were clear in going beyond just cleanups. At the end of our second campaign, we hosted our dissemination workshop in Mwanza, close to Lake Victoria. Attended by key stakeholders from government departments, non-governmental organizations, local and international academics, and affected communities, such as fishermen, we shared the magnitude of our efforts. The assembled audience members were shocked at the scale of plastic pollution and resolute in their determination to find lasting strategies for mitigation. The workshop was covered by various Tanzanian media outlets, and together with our social media accounts, the impact of the project has been tremendous within Tanzania and further afield.

A school outreach program was also implemented extensively to impart knowledge to students at a young age, with much effort devoted to waste management hierarchy and the circular economy concept, in particular the 4 R's (refuse, reduce, reuse, and recycle), at the household and school levels. The use of available materials locally, such as abandoned plastic containers to grow vegetables and make home gardens during demonstration, attracted the great attention of the community.

We have reached the end of our initial two years of funding, but are actively seeking support to continue the project. If you want to know more visit the Clean Shores, Great Lakes website or contact Farhan Khan (fakh@norceresearch.no, NORCE) or Bahati Mayoma (bsosthenes@yahoo.com, UDSM).

Bahati Mayoma is affiliated with the School of Aquatic Sciences and Fisheries Technology, University of Dar es Salaam (Tanzania). He and Conrad Sparks are affiliated with the Centre for Sustainable Oceans, Cape Peninsula University of Technology (South Africa). Farhan Khan is with the Department of Climate & Environment, Norwegian Research Center.

A ripple effect caused by a science-arts-cultural collaboration

Plastic pollution in the Great Lakes watershed

by PATRICIA CORCORAN, KIRSTY ROBERTSON, KELLY JAZVAC & SARA BELONTZ

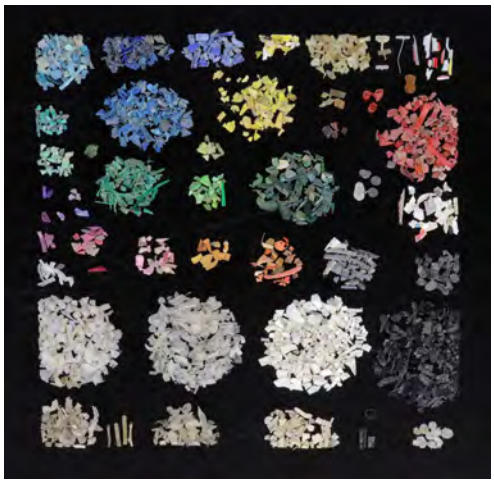
Above: Installation View, *Plastic Heart: Surface All the Way Through*, Canadian Cultural Centre, Paris, France. Credit: Vincent Royer, 2022. **Below left:** Plastiglomerate from Kamilo Beach, Hawaii. Credit: Patricia Corcoran.

AN UNLIKELY COLLABORATION that began in 2012 has led to a prolific body of published and exhibited works by a Canadian group of scientists, artists, and cultural workers known as the Synthetic Collective. When earth scientist Patricia Corcoran and visual artist Kelly Jazvac stepped onto the sand of Kamilo Beach, Hawaii, in 2013, neither realized the significance of what they would find. Their fieldwork, guided by descriptions from environmental thought leader, oceanographer, and boat captain Charles Moore, resulted in the naming of an anthropogenic product symbolizing humankind's impact on the planet's natural systems—*plastiglomerate* (pictured at left). Stones composed of sand grains, volcanic lithic fragments, and shelly, coral, woody, and plastic debris were held together in a matrix of once molten plastic. Since then, the Synthetic Collective and their collaborators have embraced interdisciplinarity in their investigation of plastic pollution in the Laurentian Great Lakes.

The group uses a harmonized approach of engaging with plastic pollution from multiple interwoven perspectives. Their tangible results include scientific and art publications, but more importantly, bring a greater awareness of the distribution, sources, and threats of plastic debris through media (e.g., National Geographic Magazine), museum presentations (e.g., Smithsonian National Museum), and art exhibitions (e.g., Kelly Jazvac's *Recent Landscapes* displayed at the Louis B. James Gallery, New York).

Although samples of plastiglomerate have been and are showcased at various museums around the globe, the Synthetic Collective's foremost exhibit thus far has been *Plastic Heart: Surface All the Way Through*, which opened at the Art Museum at the University of Toronto in September 2021 and moved to the Canadian Cultural Centre in Paris, France, in November 2022. The exhibit used the Synthetic Collective's 2018 scientific investigation of plastic debris on 66 Great Lakes beaches as a starting point to explore the roles of plastics and plastic pollution in the art world. The artists joined the scientists in sampling the beaches and the scientists joined the artists in developing the museum exhibit.

In the gallery space, the 7,268 pellets collected from a 10m^2 quadrat along the strandline of Baxter Beach near Sarnia, Ontario, made their way into a floor work by artist Tegan Moore that mimicked the shape of the quadrat and included a soundtrack of the soft sound of pellets being counted and characterized. Other works by Synthetic Collective members similarly repurposed and reinterpreted the sampling study for an art audience, whereas other artists were commissioned to visualize the collected data. Data visualizer Skye Morét, for example, mounted coloured bars on a wall with an outline of the Great Lakes made from previously used rope. The protrusion of each bar from the wall corresponded to the number of pellets collected from each beach. Morét's work showcased how data visualization could repurpose materials. The exhibit itself sought to have as low a carbon and waste footprint as possible, and to use few plastics in shipping or installation. Walls were not painted, holes were left in the walls from previous exhibitions, vinyl labeling was replaced with handwritten signage, video works were shown on tablets to lessen the exhibit's energy usage, and the waste created during the installation was included in the gallery space.



Historical artworks and specimens from medical collections showed extensive degradation—microcrazing, embrittlement, and discoloration—that occurs even if plastic artworks and artefacts are held in near ideal museum storage conditions. Degradation effects are also studied by science members of the Synthetic Collective, but rather, the degradation of plastic debris while in the environment. As plastic debris, and especially microplastics (particles <5 mm), are often buried in landfills and under sediment and the water column, the chief degradation agent, UVB light, does not affect the polymers. This results in preservation of plastic debris in the sedimentary record, which is a profound marker of the Anthropocene, a proposed epoch marked by the activities of humans on Earth's natural ecosytems.

Moving forward, the Synthetic Collective will continue to investigate, convey, and mobilize change with respect to plastic pollution in the Laurentian Great Lakes watershed. Together with academic, public, Indigenous, industry, and government collaborators, the team is exploring plastic pollution in tributaries, stormwater ponds, soils, and air in the region while foregrounding a collaborative working model that lessens the carbon footprint of research and outputs.

Patricia Corcoran, Kirsty Robertson, University of Western Ontario; artist Kelly Jazvac, Concordia University; and Sara Belontz, California State University San Marcos.

Top: Kelly Wood, *Great Lakes: Accumulations*, digital photographs/water-based ink on cotton rag paper, 2020, courtesy of the artist. **Middle:** Sampling for pellets on the strandline of Lake Huron, photo credit: Tegan Moore, 2018. **Bottom:** Sara Belontz, *Fragments and pellets from a 1x10 m sample area, Bronte Beach, Oakville*, 2019, 2–7 mm plastic fragments, pre-production pellets.

Learning from the last decade of microplastics research in the Laurentian Great Lakes: Tools needed for the future of microplastics management

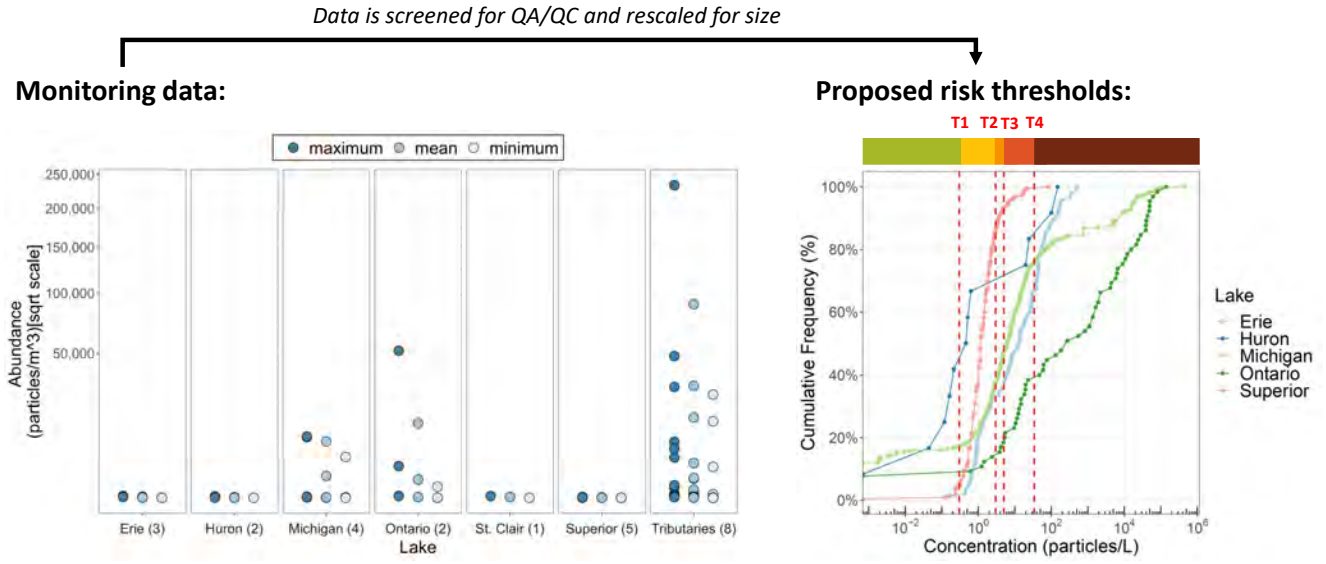
by Eden Hataley, University of Toronto Scarborough, & Chelsea Rochman, University of Toronto

In 2020, in response to a request from the Canadian federal government, we synthesized the state of the science on plastic pollution in the Laurentian Great Lakes. We used the data to write sub-indicator reports for plastic pollution as if it were among the pollutants used to report on the state of the Great Lakes under Annex 10 of the Great Lakes Water Quality Agreement. The sub-indicator reports highlighted gaps in the monitoring and ecological risk assessment of plastics in the Great Lakes, both of which are essential to informing management action. As a follow-up, we published this work as a pair of papers that explored these themes further, focusing on microplastics only.

In the first paper, led by Hayley McIlwraith, we synthesized research published across the region to better understand microplastic contamination in the Great Lakes and the methods researchers typically use to measure it. Our synthesis shows that microplastics are widespread throughout the Great Lakes basin, in water, sediment, and wildlife. Additionally, the methods used to measure microplastics differ across and within matrices, making data comparability between studies, and thus deciphering trends in environmental contamination, difficult.

In the second paper, we applied an ecological risk assessment and management framework for microplastics in aquatic environments recently developed by experts in the field to the Great Lakes by comparing proposed risk thresholds to regional monitoring data, both available in the primary literature. Our analysis shows that most microplastic concentrations reported in water samples collected across the region exceed the proposed risk thresholds, whereas all microplastic concentrations reported in sediment samples remain below the proposed risk thresholds.

Together, these two papers show the need for (1) harmonized and/or standardized methods for monitoring microplastics in the region to increase data quality and comparability and make it possible to determine spatial and temporal trends in environmental contamination as well as exposure levels and (2) a risk assessment and management framework for microplastics adapted for the Great Lakes to better understand risk and inform how the contaminant is managed locally. Fortunately, the International Joint Commission is currently facilitating work on both needs through a binational workgroup (see article, page 13).



Microplastics monitoring data for surface water and sediment reported in each study synthesized in the first paper [left] was screened against a set of pre-defined quality criteria and rescaled to the whole microplastic size range (i.e., 1-5,000 µm; see Koelmans et al., 2022 for an overview of this risk assessment framework) before being compared to the proposed risk thresholds in the second paper [right]. The results shown here assess the risk of food dilution from exposure to microplastics in surface water.

Litter to pollution in Great Lakes: Levels and factors

by Varun Kasaraneni, Gannon University

Urban litter is one of the primary sources of litter and plastic pollution in surface waters, though quantifications of this pathway are limited. For this study, storm runoff samples were collected for eight events over spring, summer, and fall seasons (0.14–1.29 inches of rain) from seven locations (two commercial, two industrial, three residential). Macro-litter (>5 mm) from the samples was separated into nine categories (smoking-related materials, paper, textile, plastic, metal, glass, wood, construction material, and others). Samples were also analyzed for microplastics in the size range of 300 µm to 5 mm.

Our research data indicates that low-income and commercial locations contribute significantly higher amounts of macro-litter (3–20 times more) and macro-plastics (6–11 times more) compared to other locations. Microplastics counts per 10,000 gallons of runoff range from 43 to 58,512, with commercial and industrial locations having the highest quantities. Higher amounts of litter were found in samples collected in spring and fall seasons. The spring and summer samples had significantly more microplastics.

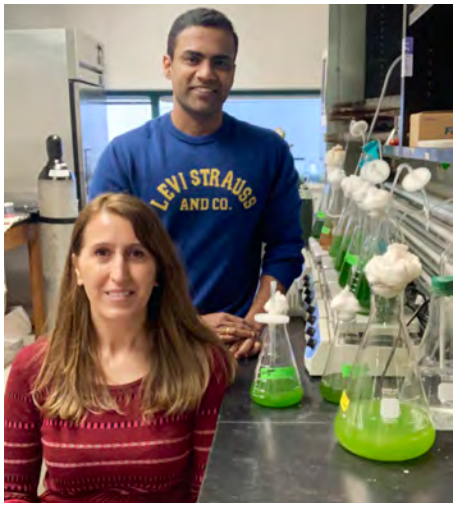
Future efforts related to marine debris should put emphasis on reducing and preventing the debris from entering the Great Lakes. This could be achieved by developing solutions to capture and remove litter and microplastic in stormwater infrastructure, implementing better waste management practices, and providing additional resources to areas that contribute higher quantities of litter. Placing more trash receptacles and signage at commercial locations and having industries develop and implement best practices to prevent raw materials from entering the environment are also solutions.

Research unearths microplastics and algae nexus in the Great Lakes

Wayne State University's Kishore Gopalakrishnan, a bioprocess engineer, is diving deep into an exploration of microplastics and harmful algal blooms (HABs) within the Great Lakes. With his academic foundation from the University of Canterbury in New Zealand, Gopalakrishnan is working in Donna Kashian's ecotoxicology lab to unravel the environmental fate of microplastics.

Gopalakrishnan's research uncovers the interplay between cyanobacteria and microplastics. In part, microplastics can trigger the release of extracellular polymeric substances (EPS) in cyanobacteria, altering its buoyancy and positioning in the water column. Kishore also delves into how microplastics affect the growth of HAB-forming cyanobacteria, which use microplastics as platforms for biofilm growth and as a source of carbon. These biofilms provide a sheltered environment for cyanobacteria, potentially fueling HABs. These interactions lead to microplastics aggregating and sinking and can provide pathways for microplastics to enter the food chain when mistaken for food.

Gopalakrishnan's research illuminates the complex interaction between microplastics and cyanobacteria, shedding light on potential consequences for the Great Lakes ecosystem. His research raises concerns about plastics entering the aquatic food chain through their intricate connections with algae, which could ultimately impact human health. This research carries implications for policy makers and the general public, guiding decisions on plastic waste management, pollution control, and food safety. It underscores the urgency of developing strategies to combat the harmful effects of microplastics and HABs while deepening our understanding of the mechanisms at play.



Kishore Gopalakrishnan and Donna Kashian in the lab at Wayne State University.

New center to focus on climate resilience in boundary water areas

The Great Lakes will take center stage with the launch of the Global Center for Climate Change Impacts on Transboundary Waters, a transnational initiative focused on climate change resilience in areas with waters spanning international boundaries. Lead investigators are located at the University of Michigan and McMaster University with partnerships with several First Nations and other institutions. The center is led by Drew Gronewold (U-M) and Gail Krantzberg (McMaster).

The center will receive US $7.75 million over the next five years from the Global Centers program (a joint initiative of the National Science Foundation, the Natural Sciences and Engineering Research Council of Canada, and other partners). Initially, it will focus on the Great Lakes region, with an emphasis on Indigenous communities.

"We will apply what we learn there from coast to coast to coast where those responsible for shared waters are struggling," notes Krantzberg. "With an external international advisory board, we will be able to address transboundary challenges for climate change adaptation. This requires a collaborative, integrated approach involving international cooperation, policy alignment, and shared responsibility for building resilience against the impacts of a changing climate."

Challenges arise when there's a lack of consensus, cooperation, or shared responsibility among institutions, Indigenous nations, and other orders of government, according to Krantzberg.

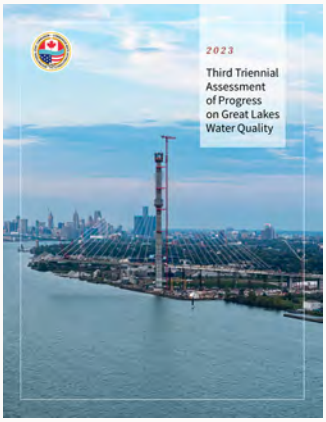
"Co-creating adaptation strategies with the involvement of diverse actors adds complexity to transnational adaptation efforts," she says. "Yet the center is all about engaging various stakeholders and rights holders. We focus on building trust, developing and sharing knowledge, and providing adaptive strategies that learn from Indigenous knowledge sharers and provide practical tools to local governments. Harmonizing policies and enabling compatible approaches to adaptation is critical for addressing shared vulnerabilities."

The center will draw on relationships and policies from transboundary watersheds and Indigenous Territories along the entire U.S.-Canada border (orange and green regions, respectively). The Great Lakes basin (blue) serves as an initial area of focus. Directly funded project partners are identified as black dots, with Indigenous partners highlighted by a purple ring. All of North America's transboundary basins are highlighted in light grey for reference. Courtesy of U-M.

IJC recommends three key actions to address Great Lakes water quality

Every three years, the International Joint Commission (IJC) makes recommendations to the Canadian and U.S. federal governments on how best to improve Great Lakes water quality. Under the Great Lakes Water Quality Agreement, the IJC assesses the governments' progress on water quality and other environmental and health-related factors and issues a report on its findings to guide future action. In its Third Triennial Assessment of Progress on Great Lakes Water Quality (TAP) released November 9, the IJC honed in on three key recommendations:

- Ensure that First Nations, Métis, and Tribal governments are full, active partners in the Great Lakes Water Quality Agreement review process to better empower Indigenous engagement and leadership on Great Lakes water quality issues.
- Increase climate resiliency throughout the region by developing basinwide goals, adopting accountable and transparent performance metrics and working to achieve them with local, regional, and provincial governments, regional watershed authorities, and other stakeholders.
- Proactively support and actively participate in the continued development of a 10-year Great Lakes Science Plan that works toward managing, funding, governing, and implementing a coordinated and comprehensive binational science initiative.



Honoring Mike Fraker by supporting future scientists

Michigan Sea Grant's research program manager Michael Fraker was a well-respected scientist and dedicated researcher, administrator, advisor, colleague, and friend. In the months since his passing, many current and former colleagues have shared their appreciation for his commitment and passion for Great Lakes science, particularly mentoring the next generation of scientists.

Fraker's family and colleagues celebrated his life at a memorial event in Ann Arbor on September 29, 2023. The memorial event also marked the launch of the Michael Fraker Student Research Memorial Fund. The fund, initiated by a gift from Fraker's family and matched by Michigan Sea Grant, will support and expand student opportunities, including undergraduate internships, graduate student research fellowships, and more. The fund is managed by Michigan Sea Grant at the University of Michigan.

Please consider honoring Faker's passion for student research and engagement by contributing to the Michael Fraker Student Research Memorial Fund.

Organize a special section in the *Journal of Great Lakes Research*

Highlight presentations from a conference session. Solicit contributions around a topic of interest. The possibilities are endless! Please contact the editors at editor@iaglr.org to discuss your ideas.

Published in 2023

Advancing Africa's Great Lakes Freshwater Research *(December 2023)*

Status and Approaches to Assess Lake Erie Central Basin Hypoxia (*October 2023)*

Bridging Indigenous and Non-Indigenous Knowledge Systems *(June 2023)*

Lake of the Woods—Five Years of Research (2016–2021) (*February 2023)*

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November 28 kicks off a season of generosity with Giving Tuesday, a day when people around the world make a donation to the organizations and causes they hold dear. We invite you to share your love of large lakes by supporting IAGLR. Year-end giving is a wonderful opportunity to invest in the future of the association and the students and scientists we have served for 56 years. To add your support, please view our giving opportunities and select the one that best fits your interests:

- Support student scholarships
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- Sign up for the Sustainers Circle Monthly Giving Program
- Foster diversity, equity, and inclusion in the large lake research community
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No matter the amount or the option you choose, we appreciate your support!

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