IAGLR
LAKES Letter

HUMAN HEALTH & LARGE LAKES

WINTER 2024

"Of increasing concern is whether, and how, aquatic or environmental microorganisms acquire and maintain resistance to the dwindling suite of effective antimicrobial compounds available to treat them in the event of an infection." p. 16.

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Dear IAGLR members and friends,

The months prior to the annual conference are likely the busiest time for the IAGLR team as well as the committee looking after the program and the local arrangements. The program for IAGLR 2024 is almost ready to share, and registration will open in a few days. The program offers many opportunities to enjoy Windsor, including its new national urban park, and even see research vessels docked near the convention center. We are planning an outside social on the waterfront on Wednesday night, which should be a lot of fun. With close to 50 sessions, 600 abstracts and three outstanding plenary speakers, the conference is shaping up to be a great event. I invite you to check out the conference website for more information.

At its meeting in early February, the IAGLR Board of Directors reviewed and adopted the organization's core values. These values capture the heart of our culture and collectively provide a guidepost to drive and shape our activities. I encourage you to visit our website to review them, as well as our beliefs, mission, and vision.

As you may recall, IAGLR is a member of the Consortium of Aquatic Science Societies, which is perhaps best known for holding the Joint Aquatic Sciences Meeting (JASM), last held in 2022. The next JASM is now scheduled for 2028, with the location to be determined in the coming months. We also volunteered to manage the books for the consortium, which recently welcomed its 10th member. In addition, we are involved in several committees on publications, communication, DEI, and conferences.

Speaking of publications, I invite you to dive into this new issue of *Lakes Letter*. Focusing on human health, it provides an aperçu of the upcoming conference! We also welcome your ideas about future topics of interest.

Lastly, please join us in welcoming Nicole Wood to our team. Nicole is our new communication coordinator and will help increase our presence on social media. Learn more about Nicole on page 4, and make sure to say *hi* to her at the conference in May!

Wishing you a good end of winter (maybe winter is already done this year). I'm looking forward to seeing you in a few months.

Jérôme Marty,
Executive Director

LAKES Letter
WINTER 2024

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On the Cover

Research team aboard the RV *Uvumbuzi* in Lake Victoria, Kenya. Credit: Edgar Marumbu/ Steve Kioko. See story on page 10.

Features

IAGLR presents brief on pollution management to House of Commons committee in Canada

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. In December, Executive Director Jérôme Marty presented the brief, which provides five recommendations for the Great Lakes centered on nutrients, contaminants of emerging concern (CECs), and microplastics:

1. Consider adding CECs (e.g., pharmaceutical and personal care products, pesticides, and per-and polyfluoroalkyl substances) and microplastics to the list of Chemicals of Mutual Concern in Annex 3 of the Great Lakes Water Quality Agreement.
2. Invest in research to better understand the fate, behavior, and toxicity of emerging contaminants to support informed regulations.
3. Consider climate change as an accelerator for pollutant production and toxicity.
4. Engage with First Nations and Métis on water monitoring and management.
5. Adopt a comprehensive approach for Great Lakes Science.

IAGLR has been invited to contribute additional briefs related to freshwater priorities. Please reach out if you have suggestions on topics.

JGLR call for papers on Great Lakes Connecting Waters

You're invited to submit a paper for a special section of the *Journal of Great Lakes Research* titled "Great Lakes Connecting Waters." Submissions will be accepted June 1–September 1, 2024. View the Call for Papers for details.

Communication staff updates

PAULA MCINTYRE has taken on additional responsibilities as strategy advisor for IAGLR. In this new role, McIntyre will support the executive director and IAGLR Board of Directors in their strategic planning and fundraising efforts. She will continue to serve as communication director and *Lakes Letter* editor. McIntyre has been with IAGLR for 24 years.

In January, we welcomed **NICOLE WOOD** as our new communication coordinator. She has taken over managing our social media presence and IAGLR E-Notes, helping to promote our conference, journal, and other initiatives. Wood spent her undergrad and grad school years at Central Michigan University, where she led teams of students on the Great Lakes Coastal Wetland Monitoring Program. You may recognize Wood from her SciComm Monday interviews of scientists from around the world, including many from the Great Lakes. She also uses her scicomm skills to help improve public health communications through her work at the Michigan Public Health Institute.

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SHARED LAKES: ONE WATER, ONE HEALTH • 2024

IAGLR

WINDSOR, ONTARIO

MAY 20-24, 2024

49 Sessions

~600 Presentations

Field trips

Networking

Banquet, Barbecue & IAGLR Business Lunch

Exhibits

Sponsorships & advertising opportunities

Registration opens in March. Save with early-bird rates through April 2.

iaglr.org/iaglr2024

3 PLENARY SPEAKERS

Tracie Baker
University of Florida

Kelsey Leonard
University of Waterloo

Palencia Mobley, P.E.
Mode Collective

Hosted by the University of Windsor's Great Lakes Institute for Environmental Research

Are you interested in leadership and service?

Run for the 2024–25 IAGLR Board of Directors

We're seeking candidates for the following positions:

Nominations due Friday, March 15

Secretary
(4-year term)

International Regular Member
(3-year term)

International Student Member
(2-year term)

U.S. Student Member
(2-year term)

Alfred Achieng
International Member
(2021–24)

"I am extremely grateful to have served as IAGLR's international board member. I was privileged to be a part of an exemplary team of board members with diverse knowledge and experience in various research fields related to large lakes and to work alongside the extraordinary staff, committed to the cause of the association with decades of experience in planning, coordinating, and managing IAGLR's activities. I have grown and gained experience in leadership and management of international organizations and learned a great deal from the various conferences on the advances in research in aquatic science. I have met colleagues and collaborators—people who have made permanent contributions to my career as a scientist and hopefully have become lifelong friends."

Les Warren
Student Member
2022–24

"It has been an awesome experience to serve on the IAGLR Board of Directors as the U.S. student representative. I have not only been able to assist IAGLR in succeeding post-pandemic, but I have also grown as a young researcher by making connections with fellow IAGLR members and learning the background logistics of the organization. While serving my term, I never once felt that my input as a student member wasn't valued, and I was truly helping change the organization for the better. In the future, I hope to be able to serve again as a non-student representative!"

View the Call for Nominations

NEW MEMBER PROFILE

Christine Atuhaire

Ph.D. Student, Makerere University, Kampala, Uganda

About my work

My research centers on the remote sensing of plastic litter. Using advanced satellite and aerial imagery techniques, I aim to map, quantify, and analyze the spatial distribution of plastic debris in aquatic environments. This study contributes essential insights into the extent of plastic pollution, offering valuable data for informed environmental policies and effective mitigation strategies.

Inspiration for this work

I was motivated by my deep concern for environmental sustainability and the escalating global issue of plastic pollution. Witnessing the detrimental impact of plastic litter on ecosystems fueled my commitment to contribute meaningful insights through advanced technologies. Therefore, by leveraging remote sensing, I aim to provide actionable data for effective environmental conservation and policy initiatives, fostering a cleaner and healthier planet for future generations.

Something else about myself

I am enthusiastic about collaborative efforts and knowledge exchange within the IAGLR community, aiming to contribute valuable insights to the collective understanding and conservation of the Great Lakes. I am looking forward to engaging in discussions and shared initiatives for the betterment of our cherished freshwater resources.

NEW MEMBER PROFILE

Katie Rousseau

Smart Great Lakes Liaison, Great Lakes Observing System

About my work

For the past four years, I've been coordinating the work of the Smart Great Lakes Initiative, which aims to advance technology applications that improve our understanding, use, conservation, and management of the Great Lakes. In 2021, the initiative completed the Common Strategy for Smart Great Lakes, which includes 10 goals, 14 objectives and 42 actions. More recently, I've been working with partners to implement the strategy. In addition, I manage a number of projects for GLOS with legislative, educational, and environmental justice components. I also help plan events and assist in communications work.

Inspiration for this work

After completing my graduate degree in geography and planning at the University of Toledo, I started working for American Rivers, a national conservation nonprofit. My first task was to lead the Rain Garden Initiative of Toledo-Lucas County with people I just met. It was in this role where I learned to work with and manage partners to accomplish shared goals. I found that I enjoy bringing together people with various backgrounds and skill sets to address water challenges.

Something else about myself

I really like to share what I'm learning about the Great Lakes with my family. So, a lot of our family activities and vacations revolve around water. We like to vacation in northern Michigan and the Upper Peninsula to look for rocks, fish, and enjoy the beautiful landscapes. A favorite activity closer to home is releasing Lake Sturgeon in the Maumee River every year.

IN MEMORIAM

Ronald A. Hites

The Great Lakes lost a prominent scholar and great scientist and mentor with the passing of Ronald A. Hites on January 5, 2024. Hites was a distinguished professor emeritus at Indiana University with a joint appointment in the Environmental Sciences program of the O'Neill School of Public and Environmental Affairs and in the Department of Chemistry from 1979 until 2020, when he retired after a 51-year scientific career.

A member of the International Association for Great Lakes Research since 1981, Hites served on the IAGLR Board of Directors from 2006 through 2010, including for a year as president beginning in 2008. He was an associate editor for the *Journal of Great Lakes Research* (JGLR) from 2018 through 2024. In 2016, he received IAGLR's highest honor, the Lifetime Achievement Award.

"Ron was a leader in Great Lakes contaminant research for decades," notes JGLR Editor Bob Hecky. "JGLR was fortunate to have him serve as associate editor right up to the time of his passing. IAGLR and JGLR will miss him greatly."

Hites made seminal contributions to the Great Lakes community and the discipline of environmental organic chemistry in North America and worldwide. He pioneered new methods of measuring trace levels of (potentially) toxic persistent organic pollutants in the environment based on gas chromatographic mass spectrometry. Much of his research focused on the application of these advanced methods to environmental forensics studies of organic pollution in the air of the Great Lakes region. His research investigated the sources, fates, and effects of trace levels of persistent organic pollutants in the environment. Detailed accounts of his contributions, impact, and mentorship can be found in the peer-reviewed literature. These include a 2015 article titled "The Journey of Ronald A. Hites," published in *Environmental Science and Technology,* where he served as an associate editor from 1990 to 2018.

Hites and his research group conducted the U.S. portion of the Great Lakes Integrated Atmospheric Deposition Network (IADN) from 1994 through 2020 for the U.S. Environmental Protection Agency (EPA). In so doing, he established IADN as the world's leading research and monitoring atmospheric program for organic pollutants. IADN is now led by EPA and Indiana University. Hites' research activity provided world-leading scientific understanding and policy choices on the role of the atmosphere in contaminating the North American Great Lakes and, by extension, locations worldwide.

Hites' peers and the research community refer to him as the "father of environmental chemistry" as he is widely recognized as the father of modern environmental mass spectrometry—technology that he advanced and applied throughout his career.

Hites also earned a reputation as a "chemical comedian" due to his witty, playful nature, notes long-time colleague and former IAGLR President Robert Letcher. His good humor endeared him to many, including the numerous students he supervised over the years.

"Ron was always very approachable and gregarious, in part due to his comedic banter," Letcher recalls. "When I first met Ron during my Ph.D. days, it was intimidating to meet such a giant of environmental science. However, my anxiety melted away with his disarming charm. When he realized that I was from Canada, he immediately quipped, 'You're from Canada, eh? You know, I am one quarter Canadian.'"

Hites fell in love with science after an enjoyable science class with a great teacher in a Detroit elementary school (Hites 2015). He went on to get his B.A. in 1964 from Oakland University in Michigan. He then attended Massachusetts Institute of Technology (MIT), where he studied organic analytical chemistry, earning his Ph.D. in 1968. He went on to a postdoctoral fellowship at the U.S. Department of Agriculture before returning to MIT as a staff researcher in 1969 to work on the Viking project, which landed a mass spectrometer on Mars in 1976.

With the dawning environmental movement and formation of the EPA, Hites realized that mass spectrometry could be useful for analyzing environmental pollutants. He started with a simple project, studying water taken once a week from the Charles River in front of MIT. Analyses showed the presence of polycyclic aromatic hydrocarbons, and Hites published these results in *Science* in 1972. This research to identify and quantify previously unsuspected pollutants in environmental samples was immediately recognized as novel and significant.

Hites joined the MIT faculty as an assistant professor of chemistry in 1972.

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KUDOS

Congratulations to the following IAGLR members!

MARY-CLAIRE BUELL (Trent University and Collective Environmental) for her recent appointment to the Great Lakes Observing System Board of Directors.

ALEXANDER DUNCAN (Centre for Indigenous Fisheries, University of British Columbia) successfully advanced to Ph.D. candidacy in November 2023.

MARC GADEN for being named the new executive secretary of the Great Lakes Fishery Commission.

RYAN GROW (Lakehead University) successfully defended his Ph.D. titled "The Contribution of Fish Movement to Ecosystem Function in Lake Superior."

ROBERT STERNER (University of Minnesota-Duluth) on his retirement as director of the Large Lakes Observatory. Sterner began as an assistant professor at the University of Texas at Arlington in 1988 and moved to the University of Minnesota Twin Cities in 1994. He has been director of LLO since 2014. Sterner was one of the founders of the field of ecological stoichiometry, and his interests have centered on plankton biogeochemistry with work on Lake Superior beginning in 1995.

ROCHELLE STURTEVANT, Andrea Vander Woude, Ashley Elgin, Brandon Krumwiede, and Jennifer Day—as members of the 2022 State of the Great Lakes indicators team—received the FY22 EPA Region 5 Regional Administrator Award for Excellence for outstanding international collaboration in assessing and reporting the status of Great Lakes health using environmental indicators for the 2022 Great Lakes Public Forum.

Welcome new members!

The following members joined IAGLR between November 2023 and January 2024.

Anjana Adhikari	Brianna Ellis	Katie Rousseau
Christine Atuhaire	Jill Johnson	Judy Speery
Ryanne Cimatu	Shubham Kumar	Charlotte Ward
Navjot Dhaliwal	Stephanie Messeder	Brittany Zepernick
Emilia DiBiasio	Harrison Ngige	Jake Zunker

HITES continued from p. 8

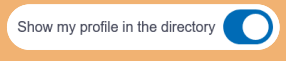
He remained until 1979, when he joined Indiana University as a professor in the School of Public and Environmental Affairs and the Chemistry Department. He was appointed Distinguished Professor of Public and Environmental Affairs in 1989 and a Distinguished Professor of Chemistry in 1997. He supervised the research of about 90 graduate students and postdocs.

Hites was a fellow of the American Chemical Society, the Society of Environmental Toxicology and Chemistry, and the American Association for the Advancement of Science. He received the 1993 Founders Award from the Society of Environmental Toxicology and Chemistry and the 1991 Award for Creative Advances in Environmental Science and Technology from the American Chemical Society. In 1988, Hites spearheaded the creation of the *Journal of the American Society for Mass Spectrometry* while serving as president of that society. The Ron Hites Award is given annually for the best paper in that journal. Indiana University recognized his contributions with the Bicentennial Medal in 2020. In 2022, the O'Neill School created the Ron Hites Prize in Environmental Science, which recognizes individuals who have made significant contributions toward solving complex environmental problems.

Have you used the new IAGLR member directory?

This benefit is available only to current members who opt in:

- Renew for 2024
- Set your prefences to show your profile in the directory



- Fill out your profile for best results!

Now you'll not only show up in search results, you'll be able to conduct your own searches. It's a great time to find people you'd like to meet at IAGLR 2024!

iaglr.org/membership

Cyanobacterial blooms in the Winam Gulf of Lake Victoria

Lessons for Western Lake Erie?

by GEORGE BULLERJAHN

Professor Emeritus and Director, NIH/NSF Great Lakes Center for Fresh Waters and Human Health, Bowling Green State University

THE WINAM GULF OF LAKE VICTORIA in Kenya is routinely plagued with toxic cyanobacterial harmful algal blooms (cHABs) commonly attributed to *Microcystis* and *Dolichospermum*. Local rural residents typically drink water directly from the lake, so cHABs may present threats to human health as well as to livestock. The Gulf is a shallow, hydrologically distinct portion of Lake Victoria and, as such, is similar to western Lake Erie. Both point and nonpoint nutrient sources are drivers of the blooms, which can occur year-round due to the equatorial location of the lake. Since climate change has contributed to longer growing seasons for cHABs in Lake Erie, we proposed that the Winam Gulf was ideal for a comparative study with western Lake Erie, as the Gulf might afford a glimpse of what Lake Erie may be like in future decades.

Above: Research team aboard the RV *Uvumbuzi* in Homa Bay. Credit: Edgar Marumbu/Steve Kioko. Background photo: cHABs in Lake Victoria. Credit: George Bullerjahn.

Students Mercy Chepkirui (Kisii University), Kate Brown (Bowling Green State University) and Julia Obuya (Maseno University) measuring cyanotoxins by the ELISA method. Photo by George Bullerjahn.

An American, Canadian & Kenyan Partnership

With funding from the National Science Foundation, we partnered with Kisii University (Kenya) and the Kenyan Marine and Fisheries Research Institute (KMFRI) to sample Lake Victoria in June 2022 and 2023. The program afforded opportunities for a contingent of North American graduate students to work side by side with a cohort of Kenyan grad students. George Bullerjahn and Kefa Otiso (Bowling Green State University) and Mike McKay and Ken Drouillard (University of Windsor) led the North American team. Ted Lawrence of the African Center for Aquatic Research and Education assisted with logistics. In 2022, nine American students from seven different institutions worked with 10 Kenyan students, and in 2023, seven American students from seven institutions nationwide collaborated with seven Kenyans. The Kenyan cohort focused on teaching the North Americans about the ecology of the African Great Lakes, while the Americans exposed the Kenyans to the omics methods we employ to study the cHABs.

In 2022, research centered on two four-day trips around the Winam Gulf aboard the KMFRI research vessel (RV) *Uvumbuzi*. We primarily encountered *Dolichospermum* blooms throughout and sampled local fish populations through several trawls. In 2023, the sampling occurred during a single six-day cruise that covered all Gulf stations, plus several sites in the open waters of Lake Victoria, enabling us to compare microbial communities both in the Gulf and the open lake. Overall, our objectives were twofold: first, to determine the composition, genomics, and toxicity of cyanobacterial communities throughout the Gulf, and second, to assess the levels of persistent contaminants in fish. Highlights of our research included the discovery of a potentially toxic *Raphidiopsis* bloom near a turbid river mouth in the eastern Gulf. Student Kate Brown (Bowling Green) identified copies of the *cyrA* gene required for the synthesis of the potent toxin cylindrospermopsin at concentrations exceeding 10^6 L^{-1}, identifying a potential novel threat to the water supply. Due to limited resources, rural and urban residents do not rely on water treatment plants to provide potable water, so the detection of cylindrospermopsin genes may indicate that serious impacts to human health exist due to previously undocumented *Raphidiopsis* cHABs. Indeed, follow-up studies in 2023 identified the presence of cylindrospermopsin in Gulf waters. This information has been shared with our Kenyan colleagues to allow continued monitoring for the toxin. Such knowledge is helpful because it allows the local residents to adjust their water treatment process to remove that type of toxin, a relatively straightforward process if they know it's there.

Another positive result emerged from the fisheries study, led by Drouillard and his Kenyan student, Dennis Otieno. Examining mercury concentrations across fish of different life stages, they detected mercury in fish, but at levels

"The detection of *Raphidiopsis* is relevant to a warming Lake Erie, as this typically subtropical genus has recently been sporadically detected in inland lakes in southeast Michigan and Ohio. It may be that *Raphidiopsis* spp. and the toxins it can produce become endemic in Lake Erie within a few decades."

well below concern for human consumption. Lake Victoria fish have lower levels of mercury than fish consumed from the Laurentian Great Lakes. Reflecting the success of the research, to date four manuscripts have been submitted to peer-reviewed journals, with several more papers in preparation.

With residual funds from the NSF grant, a brief sampling trip occurred in early February to extend the dataset regarding the *Raphidiopsis* blooms. The trip confirmed the presence of cylindrospermopsin, and we await sequencing data to confirm the presence of *Raphidiopsis*. The detection of *Raphidiopsis* is relevant to a warming Lake Erie, as this typically subtropical genus has recently been sporadically detected in inland lakes in southeast Michigan and Ohio. It may be that *Raphidiopsis* spp. and the toxins it can produce become endemic in Lake Erie within a few decades.

A lasting benefit of the trips beyond the scientific outcomes was engaging with our Kenyan colleagues as well as experiencing Kenyan culture and viewing the beautiful Kenyan landscape. Students exchanged ideas about differences in tropical vs. temperate limnology, and the American students got to tour Nakuru National Park and the Great Rift Valley on the way to and from Lake Victoria. We thank BGSU professor Kefa Otiso and our Kenyan faculty partners Anakalo Shitandi, Reuben Omondi, Albert Getabu (all Kisii University), Christopher Aura Mulanda, Chrisphine Nwamweya (both KMFRI), and Lewis Sitoki (Technical University of Kenya) for their help in educating our students about Kenya and its history, as well as sharing their expertise in field research on the African Great Lakes.

See the story Turning the Tide for more information on this project.

Top right: Ken Drouillard (Professor, University of Windsor) and James Achiya (KMFRI) sampling fish for persistent contaminants.

Bottom right: Students and crew shuttling to the ship on a beautiful morning in Homa Bay, Kenya. Photos by George Bullerjahn.

Advancing molecular technologies and microbial water quality assessment in the Great Lakes Basin

by THOMAS A. EDGE and JOAN B. ROSE

More than 110 years after a 1913 collaboration among 17 Canadian and U.S. microbiology labs, the International Joint Commission (IJC) is seeking to advance another basinwide assessment of microbial water quality across the Great Lakes.

While sewage releases, beach postings, and waterborne disease burdens continue, the scale and diversity of fecal pollution sources have changed significantly. New waterborne pathogens have emerged, and new health concerns like harmful algal blooms (HABs) and the spread of antimicrobial resistance have become widespread.

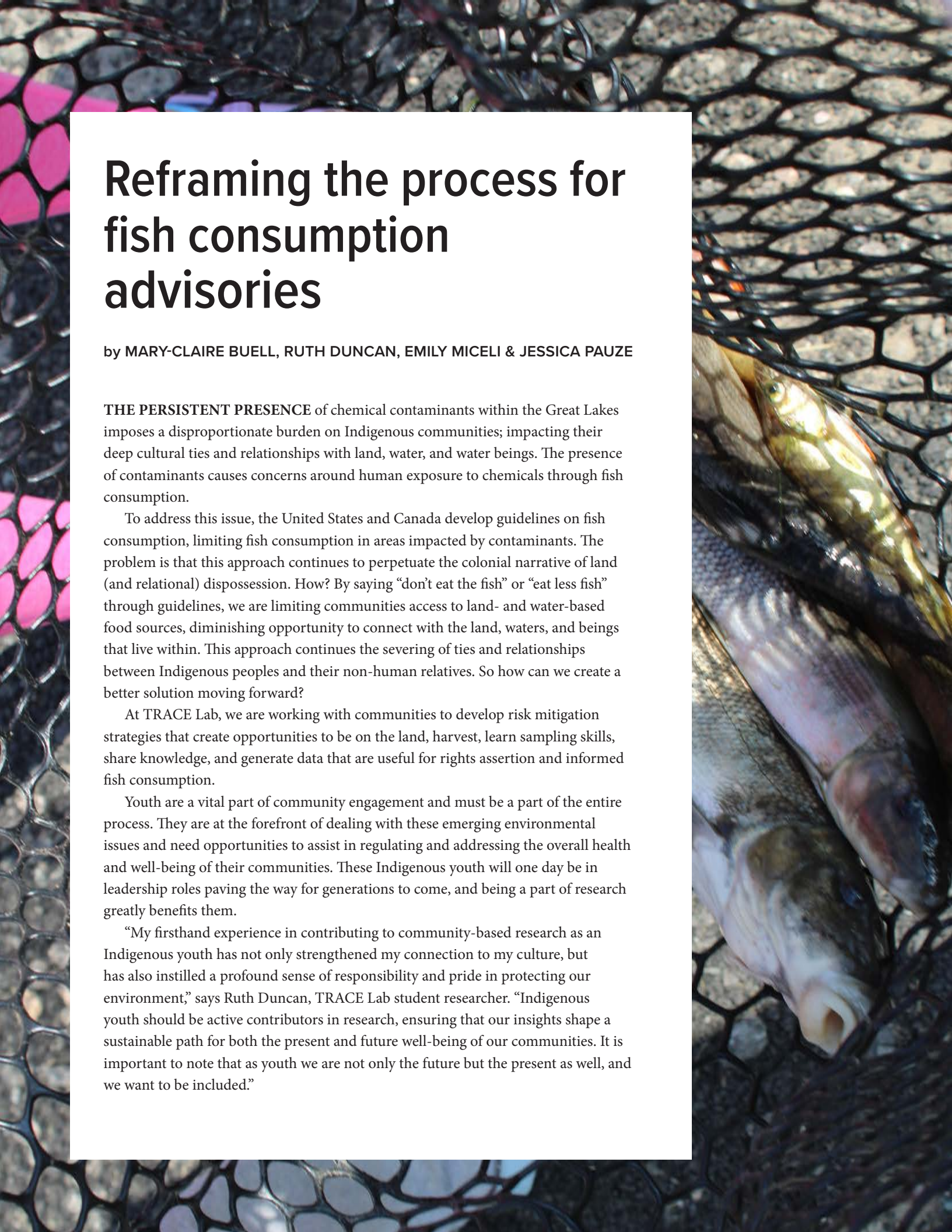
Fortunately, there have also been many advances in molecular and genomics technologies to better assess microbial water quality and the implications of changing microbial communities (microbiomes) in aquatic ecosystems.

In 2022, the IJC convened four workshops with scientists and water policy experts to explore how a new Great Lakes Microbial Water Quality Assessment could demonstrate the use of advanced molecular and genomics technologies for a basinwide assessment of microbial water quality and human and ecosystem health risks. The workshops identified technologies that are ready for progressing microbial source tracking, HABs assessment, and metagenomic analyses of microbial communities. Lab capacity and applications of PCR were best documented for fecal pollution source identification by microbial source tracking. However, lab capacity and active research using PCR and DNA sequencing were also identified throughout the basin for HABs assessment and metagenomics analyses.

The IJC will continue over the next three years to facilitate binational dialogue to develop a plan to validate and harmonize application of molecular technologies and modernize microbial water quality assessment for a large basin study across the Great Lakes.

Thomas A. Edge is an adjunct professor in the Department of Biology at McMaster University. Joan B. Rose is a professor and Homer Nowlin Endowed Chair in Water Research at Michigan State University, where she directs the MSU Water Alliance. Edge and Rose are co-chairs of the IJC's Health Professionals Advisory Board.

Unsafe swimming conditions due to high bacterial levels at Bayfront Park Beach in Hamilton, Ontario. Photo by Thomas Edge.



Reframing the process for fish consumption advisories

by MARY-CLAIRE BUELL, RUTH DUNCAN, EMILY MICELI & JESSICA PAUZE

THE PERSISTENT PRESENCE of chemical contaminants within the Great Lakes imposes a disproportionate burden on Indigenous communities; impacting their deep cultural ties and relationships with land, water, and water beings. The presence of contaminants causes concerns around human exposure to chemicals through fish consumption.

To address this issue, the United States and Canada develop guidelines on fish consumption, limiting fish consumption in areas impacted by contaminants. The problem is that this approach continues to perpetuate the colonial narrative of land (and relational) dispossession. How? By saying "don't eat the fish" or "eat less fish" through guidelines, we are limiting communities access to land- and water-based food sources, diminishing opportunity to connect with the land, waters, and beings that live within. This approach continues the severing of ties and relationships between Indigenous peoples and their non-human relatives. So how can we create a better solution moving forward?

At TRACE Lab, we are working with communities to develop risk mitigation strategies that create opportunities to be on the land, harvest, learn sampling skills, share knowledge, and generate data that are useful for rights assertion and informed fish consumption.

Youth are a vital part of community engagement and must be a part of the entire process. They are at the forefront of dealing with these emerging environmental issues and need opportunities to assist in regulating and addressing the overall health and well-being of their communities. These Indigenous youth will one day be in leadership roles paving the way for generations to come, and being a part of research greatly benefits them.

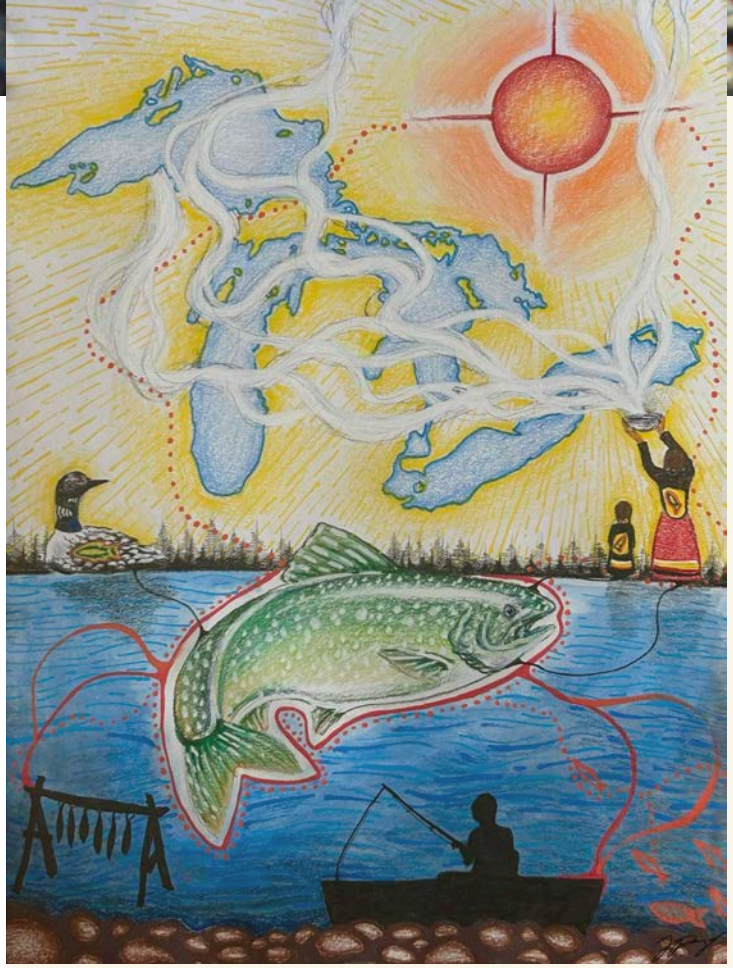
"My firsthand experience in contributing to community-based research as an Indigenous youth has not only strengthened my connection to my culture, but has also instilled a profound sense of responsibility and pride in protecting our environment," says Ruth Duncan, TRACE Lab student researcher. "Indigenous youth should be active contributors in research, ensuring that our insights shape a sustainable path for both the present and future well-being of our communities. It is important to note that as youth we are not only the future but the present as well, and we want to be included."

By co-designing and implementing contaminant surveillance programs, we work together with communities to map areas of importance, visit those areas, involve youth, and harvest and sample consciously with only small portions of fish taken for analysis; the rest can be eaten. This process often involves engaging health professionals as well. The guidelines produced from this approach end up being more specific geographically and typically do not employ a one-size-fits-all recommendation like seen in current government-produced guidelines. This sometimes results in slightly different consumption recommendations, but ultimately the major difference is the process.

Our goal is to support community efforts to protect and/or restore relationships with fish, the land, and waters. It is essential that the whole process prioritizes community knowledge and opportunities to connect with the water and land, reducing opportunities for colonial harm. We are asking our fellow Great Lakes researchers to ask themselves, "How does Western science perpetuate the colonial narrative? Whose perspectives, world views, and values have not been considered?" Reflect on this, but please also act on this by seeking knowledge equity in your research, policy, and decision making.

All authors are affiliated with the TRansdiciplinary Action confronting Contaminants in the Environment (TRACE) Lab, Trent University, Ontario, Canada. Mary-Claire Buell is an assistant professor cross-appointed with the Trent School of the Environment and Department of Forensic Science. Ruth Duncan is undergraduate student researcher and member of the Chippewas of Nawash Unceded First Nation. Emily Miceli is a Master of Science student. Jessica Pauze is an illustrator and undergraduate student researcher and member of Garden River First Nation (Ketegaunseebee).

> **"It is essential that the whole process prioritizes community knowledge and opportunities to connect with the water and land."**



Artist's statement: This drawing illustrates the relationship between people and fish for sustenance, culture, health, and sovereignty. Sustenance is represented through a fish drying rack and the placement of fish inside the loon and the human beings depicted in the drawing. The purpose of this is to show fish not only as a food source but also to symbolize the spiritual connection and sustenance that comes from consuming fish from your territory. Culture and ceremony are shown through the fisherman and the figures holding a smudge bowl up to the Great Lakes, symbolizing a cleansing of the water bodies. I chose to use spirit lines to connect all of these elements together because spirit is such an integral part of Anishinaabe culture and way of life. These spirit lines work to show how each element in the environment is interconnected and related to one another. The goal of this illustration is to help you reflect on your own understanding of the relationship people have with fish and how consumption advisories can jeopardize this relationship. Everything is interconnected. Contamination in fish is not only an issue of consumption and physical health, but an issue of Indigenous sovereignty on Turtle Island.

~ Jessica Pauze

One Water, One Health

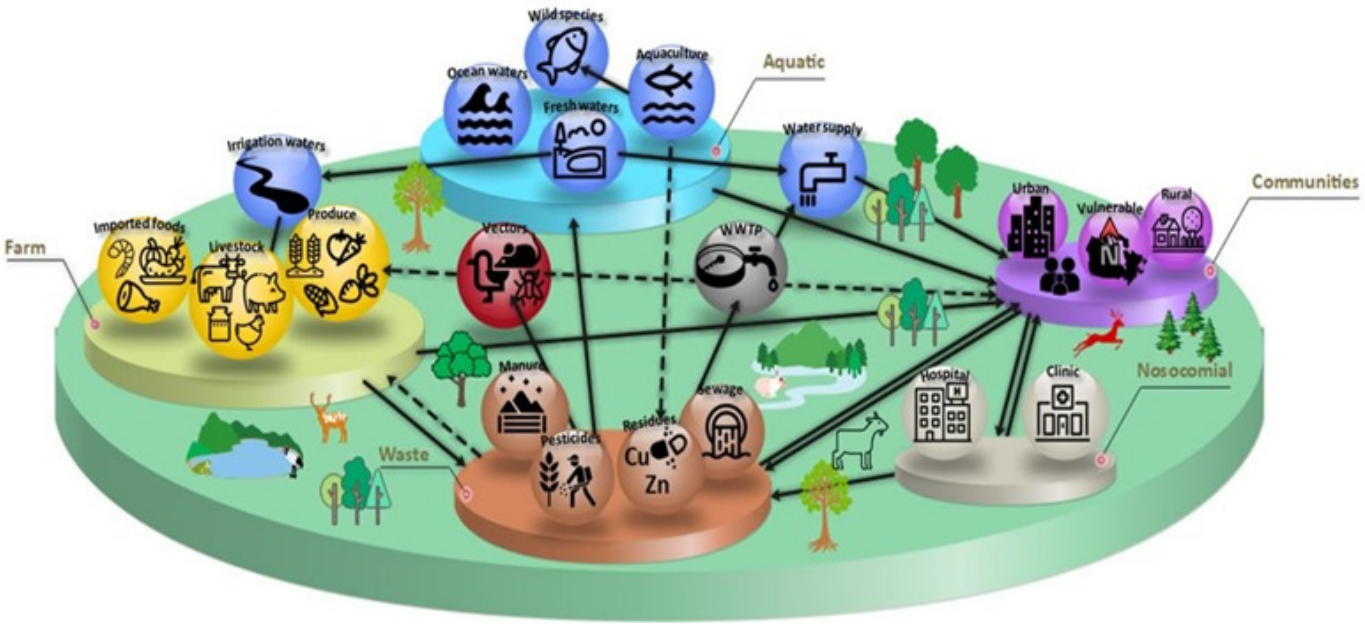
Investigating antimicrobial resistance in Great Lakes

by THOMAS REID & JORDYN BROADBENT

Out of sight, out of mind is the perfect idiom for microorganisms.

When enjoying the first summer swim in a favorite lake, one does not think of the invisible world of microbes in the surrounding water and sediment. However, the ubiquity of microbes throughout Earth's biosphere—and our own bodies—is as guaranteed and critical to the functioning of life itself as the rising and setting of the sun. This fact underpins the much touted "One Health" research paradigm, which states that human, animal, and environmental health are all inextricably linked by the material (e.g., water) and organisms that flow within and between these compartments (see figure below). Unseen aquatic microbial communities not only shape the natural world by driving global ecological services and complex biogeochemical cycling but are also reservoirs of well-known pathogens and other microorganisms that under specific circumstances opportunistically cause disease in humans or animals.

Of increasing concern is whether, and how, aquatic or environmental microorganisms acquire and maintain resistance to the dwindling suite of effective antimicrobial compounds available to treat them in the event of an infection. Antimicrobial resistance (AMR) is a natural survival function of microorganisms. Yet it can be enhanced when microorganisms share genetic information with one another or are exposed to antimicrobial compounds and a small proportion of resistant organisms survive and proliferate. The threat to human life of untreatable microbial infections is so severe that the World Health Organization declared AMR a "State of Emergency" in 2015. Recent projections estimate 1.95 million global deaths as directly attributed to AMR, with an estimated 4.95 million deaths associated with AMR (Murray et al. 2019).



The drivers and flow of antimicrobial resistance throughout the One Health continuum. Used with permission from GRDI-AMR2.

In Canada, the projected AMR-attributed mortality rate for 2050 is 396,000 lives, while healthcare-related costs and impacts to GDP are projected to balloon to CAN$120 billion and CAN$388 billion, respectively (Council of Canadian Academies 2019).

To combat this crisis, it is fundamental to understand the role and impact of environmental AMR on human health. To do so, we must consider areas in which human activities intersect with aquatic systems, such as wastewater effluents and run-off that contains antimicrobials widely used in healthcare, food production, and agriculture, as well as the manufacturing and disposal of these compounds. These discharges carry residues and/or metabolites of antimicrobials that persist in water, soil, and sediment, and potential antibiotic resistant bacteria (ARB) and genes (ARGs) that humans and animals excrete in biological wastes. With elevated levels or more severe types of AMR (above natural baselines) in the environment, the emergence of novel or opportunistic pathogens is possible, and/or selective pressures are produced that alter natural biodiversity, diversity of function, and subsequently broader ecological services (Larsson et al. 2023).

With these troubling scenarios gaining increasing global attention, in 2020 the Government of Canada established the second iteration of a Shared Priority Project on Antimicrobial Resistance through the Genomics Research and Development Initiative (GRDI-AMR2 2024). Under this project umbrella, Canadian federal agencies including Agriculture and Agrifood Canada, Canada Food Inspection Agency, Fisheries and Oceans Canada (DFO), Environment and Climate Change Canada (ECCC), Health Canada, and Public Health Agency of Canada closely collaborate to address the burden, dynamics, and risks of AMR across the Canadian One Health spectrum. In the spirit of One Health, this marks the first-time participation of DFO and ECCC in concerted investigation of AMR, helping to leverage their respective expertise to confirm or assign weight (i.e., risk) and directionality to the proposed vectors of environmental AMR burden and transmission within the One Health "confusogram" picture on the previous page.

ECCC scientists/technicians sampling the water and sediments for unseen microbes at one of Lake Erie's many north shore beaches.

For this project, ECCC has specific focus on priority waterbodies across Canada (encompassing all ecozones), including the Lower Great Lakes, to confirm the background burden of AMR in these environments (i.e., what might be naturally present) and the influence of various contamination sources on driving the abundance and diversity of ARGs (pictured above). While Canada is not a major global producer of antimicrobials or pharmaceuticals, these compounds/metabolites are still detected from wastewater effluents and various manufacturing activities (Kleywegt et al. 2019), with growing evidence showing that recreational waters harbor diverse ARG/ARBs influenced by various anthropogenic inputs (Kraemer et al. 2022). This poses real potential for resistant organisms to colonize the humans and animals that use these waters (Nappier et al. 2020). As the Great Lakes support our society domestically and abroad, these compounds and ARBs/ARGs are free to cross international borders, necessitating a collaborative effort to understand the impact of pollution on AMR transmission risks.

While this work is foundational and will by no means be completed at the end of the five-year project, the intent is to inform the prioritization of specific ARG targets and/or environmental sites for future study, surveillance, and potential mitigation strategies. Engagement with environmental stakeholders who are concerned with the stewardship and safety of Canada's water resources is recognized as critical to supporting the "One Health" of the Canadian public, animals, and ecosystems. Included in that list of stakeholders are those of us who look forward all year to our first swim or fish of the season, surrounded by the invisible, but powerful, world of microorganisms.

Thomas Reid and Jordyn Broadbent are with the Watershed Hydrology and Ecology Research Division, Environment and Climate Change Canada.

Example sources of PFAS. Image by Hope Charters.

Risk, Uncertainty, Action:

Navigating PFAS and other contaminants of emerging concern

by AMANPREET KOHLI, CAROLYN FOLEY & SARAH ZACK

Scientists are constantly identifying chemicals that have the potential to impact the environment, but it can be hard to know when and how to share information about contaminants of emerging concern (CECs) with those whose health or livelihoods may be negatively affected by them. While CECs may have been manufactured for decades, like legacy contaminants such as PCBs and heavy metals, only recently have they been determined to be—or have the potential to be—persistent, bioaccumulative, and toxic, thus warranting further investigation.

Where PFAS are found.

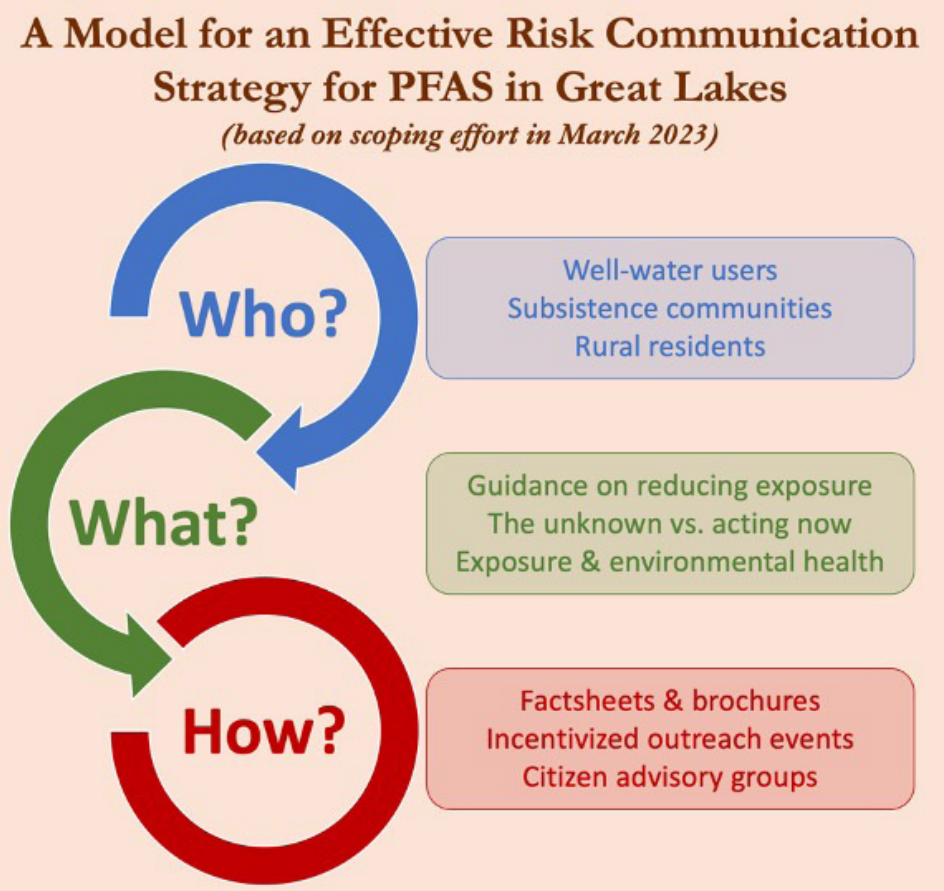
Pharmaceuticals and personal care products, microplastics, and bisphenol A have all been a focus in recent years, but the latest family of CECs to grab the headlines is per- and polyfluoroalkyl substances (PFAS). From The New York Times to Last Week Tonight with John Oliver, the number of news sources covering this issue has skyrocketed. In this article, the term *PFAS* represents a group of 10,000+ manufactured per- and polyfluoroalkyl substances and their related compounds. PFAS were created to make people's lives more convenient, as they are resistant to water, oil, stains, and heat. PFAS have been widely used in clothing, kitchenware, food packaging, cosmetics, carpets, paints, and firefighting foams, and they are ubiquitous in the environment. The Centers for Disease Control and Prevention reports PFAS to be present in the blood of at least 97% of Americans. While the mechanism of PFAS toxicity remains under study, epidemiological evidence suggests PFAS are associated with negative health outcomes including risk of cardiovascular and thyroid issues, suppression of immune response, decreased infant birth weights, and cancer.

In the Laurentian Great Lakes, PFAS have been detected at concerning levels in drinking water and fish. As millions in the United States, Canada, and First and Tribal nations benefit from the Great Lakes and connecting waterways, PFAS are a major cause for concern. Similar to other CECs, socioeconomic issues related to the exposure and mitigation of PFAS can be significant

and wide-ranging. Marginalized and lower-income communities often bear a disproportionate pollution burden, and though it is not clear that PFAS exposure varies directly with economic status, costs associated with treating individuals affected by PFAS-related health problems or environmental remediation may be a significant burden for low-income households. Racial and ethnic minority groups with traditional cultural practices related to fishing, or communities dependent on fishing for sustenance, may also be disproportionally affected by PFAS exposure from fish consumption due to bioaccumulation potential. Further, PFAS contamination can affect the agricultural economy and the farming community by contaminating the soil and water used for irrigation.

A community-specific approach to engagement is critical to address CECs, as exposure reduction measures designed for one community may not be suitable for others. Through a Great Lakes-wide scoping effort, Illinois-Indiana Sea Grant (IISG) helped identify pressing research questions related to PFAS exposure and mitigation. Manufacturers of PFAS, workers exposed to PFAS-filled products (e.g., firefighters), and those who live near major sources of PFAS (e.g., airports) were identified as some of the communities who are at high risk from exposure to PFAS but relatively well-aware of the potential risks. On the other hand, anglers and seafood consumers (particularly from tribal and subsistence communities), residents in rural areas served by municipal water and well water, and lower income households were identified as some of the communities who are at high risk from exposure to PFAS but least aware of the risks. Effectively addressing the socioeconomic impacts of PFAS requires effort from environmental toxicologists and epidemiologists, various levels of the government, and industry.

A key need that emerges with new CECs is early communication with those experiencing exposure. The evolving scientific understanding of PFAS demands that caution be exercised during risk communication. However, it is important to increase awareness and address concerns in vulnerable communities early on. What information needs to be communicated and how it needs to be communicated are key elements of an effective risk communication strategy. From the scoping effort in March 2023, IISG suggests a model for an effective risk communication strategy for PFAS in Great Lakes (see adjacent figure). Further, with support from the National Sea Grant Office and NOAA, IISG is supporting four research projects to fill information gaps in this area. Specifically, researchers will assess best practices in communicating PFAS-risks with recreational anglers in Chicago, Illinois, and Benton Harbor, Michigan; evaluate PFAS messaging to the public, with special emphasis on Latino populations in Wisconsin; develop an online risk assessment tool to help residents of Michigan, New York, and Pennsylvania gain a better understanding of PFAS exposure; and assess and compare PFAS-related state laws and regulations in the Great Lakes and Lake Champlain regions to explore policy challenges. Socioeconomic aspects of CEC mitigation will also be featured during a session at IAGLR's Conference on Great Lakes Research this May.



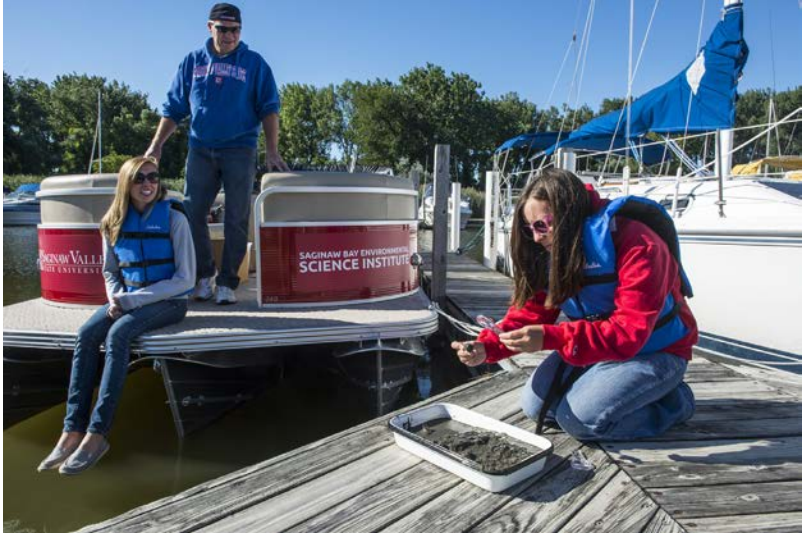
Amanpreet Kohli is the PFAS research & outreach associate, and Carolyn Foley research coordinator, at Illinois-Indiana Sea Grant, Purdue University. Sarah Zack is pollution prevention extension specialist at Illinois-Indiana Sea Grant, University of Illinois at Urbana-Champaign.

SVSU to construct first university environmental research station on Lake Huron

Saginaw Valley State University will build a US$10 million environmental science research station along the Saginaw River, near where it flows into Saginaw Bay in Bay County, Michigan. The State of Michigan designated US$7.5 million in capital outlay funding for the station, with the remaining $2.5 million coming from SVSU. This will be the first university environmental research station on Lake Huron. Construction of the 10,000-square-foot facility is expected to begin in the fall of 2025 on property owned by Dow on the west side of the river, south of the Michigan Department of Natural Resources boat launch.

SVSU has a long history of partnering with the Bay County Health Department as well as state and federal agencies to test water quality at public beaches and to study and improve the watershed. The research station will provide a learning laboratory for SVSU students and faculty as well as visiting scientists and partner agencies throughout the Great Lakes Bay Region.

"By providing a laboratory with direct water access, the new station will enable real-time, on-site measurements of the Saginaw River and Bay," notes David Karpovich, chemistry professor and director of the university's Saginaw Bay Environmental Science Institute. "Our current Saginaw Bay-related research includes studying tributary nutrient transport as part of the Saginaw Bay Monitoring Consortium and undertaking beach testing and microbial source tracking in collaboration with the Michigan Department of Environment, Great Lakes, and Energy and MiNET."



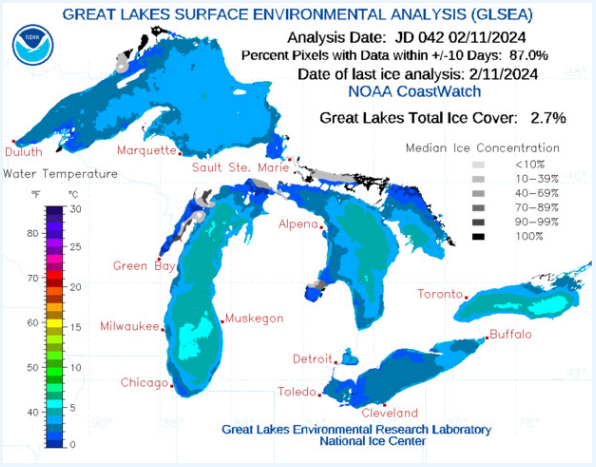
SVSU student researchers. Photo courtesy SVSU.

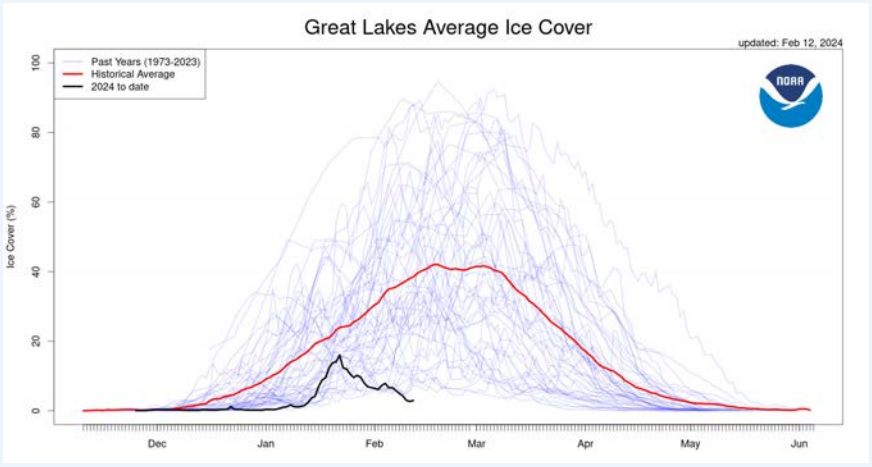
In addition, through enhanced access to Saginaw Bay, SVSU will be able to scale up K–12 outreach through its Dow Science and Sustainability Education Center.

"We are thrilled to build upon our relationships in the region that are contributing to improved public health and a better ecological understanding of our Saginaw Bay watershed," says SVSU President George Grant Jr.

Great Lakes ice levels reach historic low

After weeks of declining ice cover, on February 12 the Great Lakes reached the lowest level of ice cover basinwide for mid February since records began 51 years ago. That morning, the National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Laboratory recorded just 2.69% ice cover. Lakes Superior, Michigan, and Huron were at historic record lows as of that date. Lakes Erie and Ontario were tied with their records and falling to near ice-free conditions. Ice-level records go back to 1973.





GREAT LAKES BENEFACTOR PROFILE:

Meet NOAA's Great Lakes Environmental Research Laboratory

IAGLR welcomes back the National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Laboratory (GLERL) as a Platinum-Level Great Lakes Benefactor this year. We are pleased to profile the agency as it celebrates its 50th year and acknowledge its role in cutting-edge Great Lakes science, observations, data collection, and modeling for decision making.

What is GLERL?

GLERL is part of the National Oceanic and Atmospheric Administration and is headquartered in Ann Arbor, Michigan. GLERL makes critical observations and conducts groundbreaking research and modeling to advance knowledge of the Laurentian Great Lakes. Since 1974, GLERL's scientific advancements have changed what is known about the Great Lakes environment and how the lakes are managed.

What benefit does GLERL bring to the Great Lakes region?

The Great Lakes are a vital freshwater resource that spans the U.S. and Canadian border and enriches the lives of more than 34.5 million people who live, work, and recreate in the basin. From research on ballast water transport of invasive species to work on the changing ecosystem due to dreissenid mussels, GLERL's science has impacted how we collectively manage the Great Lakes. Understanding the fragile, complex, and interconnected nature of the Great Lakes is important now more than ever as we face the uncertainty of dynamic, human-induced stressors and a changing climate. Science, service, and stewardship at GLERL will continue to contribute to an awareness and understanding that spans across the region.

What type of research does GLERL do?

The science program at GLERL is foundational to and interwoven across core research goals of the Great Lakes region. The agency's approach to scientific research—integrated around physical, chemical, and biological interactions—serves as a framework to address the complex environmental challenges posed by a large lake system in a state of flux, as well as a model for other freshwater and coastal ecosystems. GLERL research detects changes in the ecosystem, provides data and modeling for more advanced forecasts, and drives innovation. Through partnerships and collaborations within the private sector and greater integration into academia, GLERL is strengthening its programs in omics, uncrewed systems, Great Lakes acidification, and stakeholder engagement.

Is there a new research direction you would like to highlight?

An important new aspect of Great Lakes research involves winter water sampling and under-ice sampling to increase our understanding about what is happening to the ecosystem during the winter, and how the condition and activity of the lakes during the winter impact the observed ecosystem during the warmer months. Because of ice, winter observations have been difficult, and new technology and uncrewed systems are enabling us to take important measurements during this time.

How are you celebrating GLERL's 50th anniversary?

During GLERL's golden anniversary year, the agency will celebrate the people who have made GLERL one of the world's leading freshwater laboratories with a half-century of cutting-edge technology, scientific accomplishment, and tools used throughout the region and beyond. Plans include a special session at IAGLR's 67th Annual Conference on Great Lakes Research in Windsor this May.

Why did GLERL become a benefactor of IAGLR?

GLERL has been a long-time partner with IAGLR as we work together to carry out our mutual interest in Great Lakes research. In addition to supporting IAGLR with office space in the GLERL facility, this partnership is essential for carrying out GLERL's mission. IAGLR creates a large lake science community that is essential for sharing research and venues for additional science collaboration across the globe. By partnering with IAGLR, GLERL engages with the premier body of researchers studying large lake ecosystems.

Great Lakes Benefactors value large lake research and demonstrate their commitment to IAGLR and the research community through a significant ongoing annual contribution. For their commitment, Great Lakes Benefactors receive multiple benefits. We invite you to join GLERL and become a Great Lakes Benefactor. Please visit our website or contact IAGLR Executive Director Jérôme Marty to learn more about this opportunity. Join us to help advance understanding of the world's great lake ecosystems.

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