

The vital role of long-term large lake research

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A decadal-scale science strategy for the Great Lakes

by Gail Krantzberg and Val Klump

THE INCREASING STRESS on freshwater resources across other North America—prolonged droughts, wildfires, agricultural productivity losses, aquatic ecosystem collapse—has led many to label the Great Lakes region as a potential “climate refuge” almost entirely because of an abundant supply of freshwater. The population of the Great Lakes region and its reliance on the waters of these “inland seas” are only projected to increase. The use of the lakes for the transport and international trade of petrochemicals, grain harvests, coal, iron ore, and a wide variety of other commodities, along with recreation, drinking water, waste disposal, fisheries harvest and consumption, and energy production, results in an unavoidable set of complex interdependences.



This complexity and the Great Lakes' vast size and intricate governance require coordinated and integrated multinational research programs and infrastructure on par with that devoted to oceans. In 2018, the International Joint Commission's Science Advisory Board undertook development of the first-ever comprehensive decadal-scale science strategy for the Great Lakes via a series of forums, surveys, and workshops involving a broad spectrum of the scientific and research management community.

The goal was to establish a roadmap for placing the Great Lakes region on a sound scientific footing for ensuring effective management and permanent sustainability of the system. The importance of acquiring a fundamental understanding of the functioning of this unique ecosystem is hard to overstate and represents the challenge facing contemporary scientific, resource management, and political communities. Science today has numerous new tools with the potential to unlock many of the questions posed and to fill gaps in our knowledge at resolutions and precisions previously unavailable to the study of the Great Lakes. These tools and the practitioners who will wield them can usher in a renaissance of Great Lakes science with benefits that extend far beyond the next decade.

It is estimated that the additional investment needed to accomplish the goals and vision over the next decade is approximately \$100 million per year, two-thirds of which is projected to be invested directly in the research enterprise via new and enhanced programs in process studies, monitoring, data management, and centers of excellence. The remaining third is directed at updating and supporting the Great Lakes research fleet, observing systems, and associated analytical capacity.

Many research initiatives will require effort that extends beyond the time frame of an individual project or even a decadal-scale commitment and will require interdisciplinary groups and networks of professionals working across institutional boundaries. Fostering our ongoing understanding of the Great Lakes would benefit from the creation of a number of permanent centers of excellence that focus on long-term, basin-scale, interdisciplinary, and cross-cutting approaches in key evolving areas of research, modeling, socioeconomic analysis, data acquisition, diversity, and coordination across knowledge systems.

continued

A NOTE FROM THE EXECUTIVE DIRECTOR



Since last August, I have had the opportunity to deep dive into the operations of IAGLR, meeting members of the board in person in Windsor, participating in the planning of the 2023 conference, and working with and learning from our amazing staff. I've benefited from past experiences with the association, both as a program committee member for the 2012

conference and as president in 2014.

Defining the role of the executive director continues to mature, as this position is new (IAGLR has had only two other EDs for a short time in the past), and this topic will be on the agenda of the next board meeting for further refinement. In this role, I hope to be helpful not only to our board, committee members, and staff by providing operational support, but to our members by expanding the reach and impact of the association, and, by extension, the value of large lake science. I am particularly interested in positioning IAGLR as a resource for decision makers looking for advice to support and develop evidence-based policies.

Of course, IAGLR's value as a resource lies in the strength and diversity of our membership. We've recently engaged with [ACCESS+](#), an initiative funded by the National Science Foundation that seeks to extend the breadth and number of STEM professional societies engaged in addressing diversity, equity, and inclusion. IAGLR was invited to assess our own diversity efforts, and the results helped to identify areas where we need to improve. By taking part in this cohort of scientific societies, we are able to share experiences and access resources. For example, we were eligible to compete for a mini grant and were awarded \$1,000, which will be applied to support our first IDEA+ scholarships (see page 3). Our engagement in these efforts is supported by our [Inclusion, Diversity, Equity, and Accessibility + Committee](#).

In the coming weeks, we are looking forward to launching the new membership portal, as well as the call for abstracts for the annual conference. We welcome sponsors and exhibitors, as well as Great Lakes Benefactors and individuals to support our work. We are in the midst of identifying a new lead editor for the *Journal of Great Lakes Research* and hiring a new conference coordinator. This month I had the opportunity to represent IAGLR at the Canadian Science Policy Centre conference and share about how young professionals can bridge science and policy. And in December, IAGLR will be part of an invited session at the World Science Forum with our colleagues from the African Center for Aquatic Research and Education.

This combination of strengthening our internal capacity and taking advantage of external opportunities to showcase the value of large lake science makes for a promising new year!

Best wishes,

Jérôme Marty

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Over the last 50 years, through efforts aligned with the 1972 Great Lakes Water Quality Agreement, Canada and the United States have dedicated billions of dollars to cleaning up legacy environmental pollution, restoring lost habitats, and dealing with stresses like invasive species. These investments have remarkably improved the integrity of the Great Lakes ecosystem, yet clearly it will take more than a decade to complete cleanup and restore degraded areas throughout the basin.

To place ourselves in a position where the need for restoration is moot, however, will require a far better understanding of how this system functions, how it will respond to inevitable changes, and what proactive response strategies will entail. For many of these new stresses, the vulnerability and threats they represent are simply not known. Adverse impacts, however, are not a given, and avoiding future restoration is unquestionably of immense economic, environmental, and social value.

The next step is to formulate and take action on a Great Lakes science plan that is transnational in scope, organization, and governance structure; promotes an integrated program of competitive, peer-reviewed science; defines the research capital investments necessary for the execution of the plan; fosters a scientific, technical, and professional workforce trained in Great Lakes natural and social science; and determines the nature of a consortium of Great Lakes centers of excellence, including the governance and management structure to establish viable and inclusive institutions. We plan to discuss these next steps at a town hall meeting at IAGLR's Conference on Great Lakes Research in Toronto next May.

Ultimately, the Great Lakes Decadal Science Strategy is not just about science. It is about ensuring and protecting the health and prosperity of the people. Unlike many freshwater reservoirs around the globe, the Great Lakes will be here 100, 500, and 1,000 years from now—a perspective that places a decadal strategy within its proper context.

[Gail Krantzberg](#) is professor of engineering and public policy at [McMaster University](#). [Val Klump](#) is a professor emeritus in and former dean of the [University of Wisconsin-Milwaukee's School of Freshwater Sciences](#).

New scholarships; deadline reminders for applications, award nominations

Announcing two new scholarships!

We are thrilled to announce two new scholarships designed to promote **diversity, equity, and inclusion** in IAGLR and the Great Lakes community. For more information, please visit the following pages where application information will be posted soon.

- [IDEA+ Presenter Scholarship](#)
- [IDEA+ Research Scholarship](#)

Apply for a scholarship

Each year, IAGLR awards scholarships to students showing great promise early in their research careers. Learn more about our current scholarships and apply by **December 1**.

- [Norman S. Baldwin Fishery Science Scholarship](#)
- [David M. Dolan Scholarship](#)
- [IAGLR Scholarship](#)

To apply, view the Regulations and Application Procedures for each scholarship linked above. Please help us spread the word to students studying large lakes of the world!

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.

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 48 by **January 15** for consideration.



Adapting to Climate Change

MAY 8–12, 2023

Abstract submission opens early December

Start planning what you'd like to present at next year's Conference on Great Lakes Research. Abstract submission will open in early December and run through January 24. We welcome submissions for both oral and poster presentations. Although we encourage authors to submit abstracts within specific sessions, we also consider general contributions. Given space limitations and to provide the chance for everyone to present, you may submit only one abstract as first author (no limit on the number as co-author). There is a \$50 fee to submit an abstract. We're looking forward to seeing what you've been up to!

Enjoy the spotlight!

Your organization can gain visibility at the conference and show your support for large lake research in several ways:

- [Become a sponsor](#)
- [Exhibit](#) at the conference
- Fund a specific event or item
- [Place an ad](#) in the Program Book—Act fast to secure one of two premium full-color spots!
- Become a [Great Lakes Benefactor](#)—Enjoy sponsor / exhibitor benefits and more

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

iaglr.org/iaglr2023

KUDOS

Congratulations to the following IAGLR members for their accomplishments!

CATHERINE FEBRIA (University of Windsor) for her successful appointment to the [Multidisciplinary Expert Panel](#) of the international Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services for a three-year term. “I will help effectively promote and mobilize science into policy at all scales for the benefit of our planet’s biodiversity and future generations,” Febria says.

JOHN HARTIG (University of Windsor) on the publication of two new books, [Rouge River Revived; How People Are Bringing Their River Back to Life](#), co-edited with Jim Graham, and [Great Lakes Champions: Grassroots Efforts to Clean Up Polluted Waterways](#).

DONNA KASHIAN (Wayne State University) for her recent appointment to the International Joint Commission Science Advisory Board.

TOM JOHENGEN (University of Michigan) for his upcoming retirement

from the School for Environment and Sustainability, where he served as both research scientist within the Cooperative Institute for Great Lakes Research over the past 31 years and director of Michigan Sea Grant since 2019.

MICHAEL TWISS for his new role as the inaugural Dean of the Faculty of Science at Algoma University. Twiss retired from Clarkson University after 20 years, most recently as chair of the Department of Biology. In his new position, Twiss looks forward to cultivating cross-cultural learning between Indigenous communities and other communities.


ED VERHAMME, president of Freeboard Technology, which recently won a [Best of Tech Award](#) from the Greater Cleveland Partnership. The LimnoTech startup was recognized in the “Best Supporter of the Tech Community” category for its exemplary efforts to bring new technology to the region and apply it to Lake Erie.

Welcome New Members

(Joined August–October 2022)

Mark App
Nicole Berry
Luis Chiodo, Sr
Benjamin Davidson
Alexander Duncan
Matthew Faust
Jonathan Kolak
Jon Kostelic
Pubudu Kumarage
Nicole Pesse
Ronald Rossmann
Cody Sheik
Jennifer Shore
Lisa Tomlinson
Amy Van Zanen

We're glad you're here!

 Submit kudos to lakesletter@iaglr.org

2023 IAGLR membership drive is on

Thank you for supporting IAGLR with your annual membership! Our members hail from many countries and disciplines, and they come together to create a vibrant community to learn about and advance large lake science. This diversity is our strength, and we value each one of you as a member of the IAGLR community.

[Renew your membership](#) and enjoy the following benefits:

- **CONFERENCE REGISTRATION DISCOUNT**

We are looking forward to your participation in IAGLR 2023, our first in-person gathering in four years!

- **JOURNAL OF GREAT LAKES RESEARCH**

Don't forget—your electronic archive dates back to 1975!

- **NETWORKING, CONNECTION & COMMUNICATION**

Distributed to all current members and publicly archived on our website, *Lakes Letter* is just one example of how we connect and celebrate our members. In addition, our *IAGLR E-Notes* email newsletter provides regular updates on news, jobs, events, and more.

- **STUDENT OPPORTUNITIES**

We offer several awards and scholarships, two student positions on the IAGLR Board of Directors, subsidized conference attendance, as well as deeply discounted membership rates. Our commitment to students provides invaluable experiences early in their careers.

- **MEMBER PORTAL & DIRECTORY**

Getting ready to open for the new year, our new member portal will include the **IAGLR Membership Directory** to make it even easier to network with other members.

Why wait? [Renew today!](#)

NEW MEMBER SPOTLIGHT

Ruth Duncan

Junior Aquatics and Fisheries Specialist, Environmental Collective; Trent University, Chippewas of Nawash Unceded First Nation

About my work

I'm currently a second-year student at Trent University.

Over the past two years, I've had the opportunity to work for [Environmental Collective](#) on community-based research with the Chippewas of Nawash Unceded First Nation.

Bima'azh ("track" or "follow along" in Ojibway) is a research project investigating lake whitefish behaviour at culturally relevant habitats in Lake Huron. By using smart technology (e.g., underwater remotely operated vehicle and acoustic telemetry) and Indigenous Ecological Knowledge, we can respond directly to community concerns.



Inspiration for this work

Research that is so closely tied to my community has been a gratifying experience. It gives me pride knowing that my work is helping my community and a fish central to my people's history. My ancestors have fished the waters I work in for millennia, and shared history and future in Saukiing Anishinaabekiing (our territory) continuously inspires me to continue on in STEM and fisheries science.

Something else about myself

Aside from cross-country skiing, I enjoy creating videos about my culture and issues in Canada. Last October, a film I helped produce won the award for top documentary at the Forest City Youth Film Festival. Titled [We Are Still Here](#), the film serves as a reminder to all that Indigenous Peoples are still here and thriving.

Why I joined IAGLR

I joined IAGLR while attending JASM 2022. I joined IAGLR to have opportunities to network, meet other fisheries professionals, and hold space for Indigenous People in fisheries.

Pubudu Kumarage

Senior Faculty Member, Rajarata University of Sri Lanka

About my work

As a researcher, I am working on environmental and water-resource-related modeling of inland and coastal water bodies. Human activities and rapid development projects have caused a huge impact on the aquatic ecosystems that had thrived with the lakes in my region. My primary objective is modeling the pollutant transport and identifying the harmful accumulations that can affect the sensitive fauna. I also am on a team studying the environmental impacts of recent maritime accidents that occurred along the western coast of the island.

Inspiration for this work

My original background is in fluid dynamics and water resources. I wanted

to use my expertise to conserve the environment, as we don't have a planet B as the plan B.

Something else about myself

Although time consuming, data collection and collaborative work are the most interesting parts of the whole process. In our group discussions, I get the opportunity to learn how similar problems have been tackled in other parts of the world. Thanks to the knowledge sharing, I was able to use new practices and computational tools in most of my studies.

Why I joined IAGLR

I am delighted to be a member of IAGLR, with its focus on research about the




largest freshwater system in the world. It is wonderful how novel techniques are being used to study and protect the Great Lakes and the freshwater ecosystem. I am excited to connect with other members from whom I will be able to learn a lot, and to share my experiences as well.

SUBMERGED SINKHOLES OF LAKE HURON

Two decades of exploring underwater karst geoparks

by Bopi Biddanda and Steven Ruberg

IMAGINE YOU COULD ENTER A TIME PORTAL and see what life was like about three billion years ago in the oxygenless, sulfurous ocean. Much of the biosphere was barely a thin benthic film of life in the shallow seas and hidden away in the patchy thermal vents of the deep sea. Well, time, water, microbes, and geology have indeed conspired to create a modern-day equivalent. Underwater sinkholes in the Laurentian Great Lakes basin vent oxygen-poor and sulfur-rich groundwater that fuels the growth of mat worlds resembling life in early Earth's shallow seas and deep-sea vents. This groundwater percolates through limestone aquifers that contain approximately 400-million-year-old marine evaporites, the salts left over by the seas once covering the basin. As the groundwater passes through, it gains sulfates and density and loses oxygen, venting this remix under Lake Huron. The result? Fascinating underwater, geobiological parks abound where some of life's most enduring questions may be addressed.



A dynamic tapestry of microbial mats in the Middle Island Sinkhole at 23-meters depth soon after dusk, when the matscape is in the process of switching from purple to white. Here, filamentous, purple-pigmented cyanobacteria cover the mat surface during the day harvesting sunlight for photosynthesis, and white sulfur-oxidizing bacteria emerge at night to use hydrogen sulfide for chemosynthesis. (Foreground width is about one meter across, and the height of the raised mat hill in the middle is about 20 centimeters.) Similar mat worlds may have first fixed carbon dioxide and oxygenated our planet in the early biosphere. Credit: Phil Hartmeyer, NOAA-Thunder Bay National Marine Sanctuary.

Intriguing clues to our biosphere's beginnings

In 2001 maritime archeologists serendipitously discovered what appeared to be limestone karst features within the Thunder Bay National Marine Sanctuary. Since then, many submerged sinkholes have been discovered there in locations extending from shallow sunlit depths to deep waters of Lake Huron where no light penetrates. Conditions vary from the oxygenated, self-nourishing mat surface down to the oxygenless, methane-producing sediments. Here, photosynthesis is closely balanced by respiration, with some net oxygen production occurring late in the day—enough to oxygenate the environment over deep time. Furthermore, sinkholes are sinks for carbon where mat microbes' daily vertical migrations facilitate burial and preservation of settling organic matter in underlying sediments, thus amplifying the biological pump. The daily lifestyle of these sinkhole microbes offer many clues to how life on the early biosphere might have functioned.

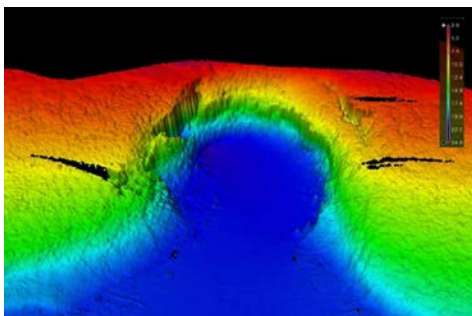
Contribution to extant biodiversity & physiologies

A diverse assembly of bacteria and archaea, along with viruses, characterizes the microbial mats of Lake Huron's sinkholes. A limited number of protists and even low-oxygen-tolerant invertebrates such as tardigrades and nematodes occur at the periphery of the sinkholes where groundwater mixes with lake water. Here, primary producers include motile filamentous cyanobacteria that photosynthesize and bacteria that chemosynthesize. The sediment below the mat includes layered niches of, for example, sulfate-reducing bacteria and methane-producing bacteria. Indeed, omic studies into the composition of these communities, particularly proteomics, suggest that the mat communities are functionally diverse and versatile and could harbor secondary metabolites of pharmacological potential.

Models of early Earth, deep sea & extraterrestrial life

Extending from shallow to deep waters, Lake Huron's sinkholes serve as working models for life in early Earth's shallow seas and as analogs of life around deep-sea sulfur vents, all with relatively easy access. Indeed, ROV footage around deep sinkholes reveals

Multibeam 3-D image of Middle Island Sinkhole in Lake Huron showing circular 23-meter-deep sinkhole with surrounding fissures and cracks. Foreground scale is about 600 meters. Credit: Brian Link, NOAA Office of Coast Survey.



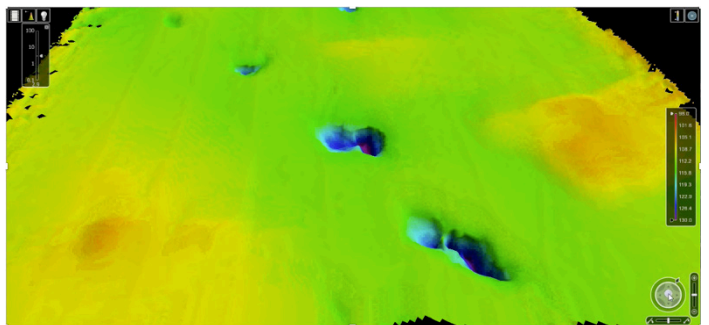
White chemosynthetic mats resembling the microbial life found in deep sea vents in the aphotic Isolated Sinkhole, Lake Huron at 94 meters. Foreground scale approximately 100 centimeters. Credit: Dwight Coleman, Institute for Exploration.

white benthic mats of chemosynthetic bacteria similar to what deep-sea submersibles find around deep-sea vents where, presumably, life first originated. Furthermore, it is quite possible that life in extraterrestrial habitable planets might be in the form of underwater mat worlds, and Great Lakes sinkholes may serve as useful analog test sites on Earth prior to space voyages.

Research hotspot for life's unresolved questions

Hard-to-find submerged sinkholes may be abundant in all four lower Great Lakes, given the limestone karst bedrock underlying these lakes. Thus, collectively their contribution to Great Lakes biodiversity, physiologies, water quality, and even water levels are of interest. A recent article in the *Journal of Great Lakes Research*, "[Tango in the Mat World](#)," vividly showcases the diel vertical migration of sinkhole microbes, describes the light-chemical cues that underlie such mass movement, and discusses the planetary level implications of their tiny one-millimeter journeys. Still, we have a very limited understanding of these recently discovered ecosystems, and many basic science questions relating to their structure, function, and significance remain unanswered. We welcome collaborations from the geoscience community for addressing these and other intriguing geobiological questions.

Bopi Biddanda, Annis Water Resources Institute, Grand Valley State University, Michigan, and Steve Ruberg, Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, Michigan.



A portion of the newly discovered field of over two dozen deepwater karst features, including a pair of twin sinkholes, in offshore Lake Huron mapped by multibeam surveying at approximately 120 meters depth. Foreground scale is about 2.5 kilometers. Credit: Tyanne Faulkes, NOAA Office of Coast Survey.



U.S. Fish & Wildlife Service sea lamprey control agent Sheyenne Nagy measures the lampricide application rate in a tributary to the Manistique River in the Upper Peninsula of Michigan. Lampricides are one of the two primary control methods for invasive sea lampreys in the Great Lakes. Credit: Andrea Miehl, GLFC.

Reaping the rewards of long-term research:

Sea lamprey, science, and successful invasive species control

by Andrea Miehl and Jill Wingfield

ONE HUNDRED AND ONE years ago during another blustery November on the Great Lakes, an ominous event occurred. Commercial fisher Alexander Crewe noticed a slimy, tubular-shaped fish attached to the side of a lake whitefish he captured from Lake Erie. This unusually shaped fish with an even more unusual habit of drinking the blood of other fish was later identified as a sea lamprey. Like a trickle that becomes a torrent during a raging storm, early sea lamprey observations like Crewe's were the harbingers of an invasion that would eventually number in the millions in the Great Lakes. And the consequences of sea lamprey invasion were catastrophic, rippling throughout food webs and coastal economies. With the sea lampreys' energetic demand adapted to parasitizing large fish in their native Atlantic Ocean, Great Lakes fish were far outmatched. Within only a few decades, the combined pressure of sea lamprey parasitism, over-harvest, and habitat alteration caused commercial fisheries to collapse and the economies of coastal communities dependent on those fisheries to crumble.

continued

Yet, what was once one of the worst tragedies in the Great Lakes soon became one of the greatest success stories. Sea lamprey invasion gave rise to a collective realization that the health of the Great Lakes would require ongoing cooperation among governments, scientists, and users of the resource. The invasion thereby became the catalyst for a tremendous scientific exploration of Great Lakes fish populations and the development of the collaborative fishery management regime that exists today. Sea lamprey populations have been reduced to approximately 10% of their historic highs through a control program coordinated by the Great Lakes Fishery Commission and implemented through a variety of partnerships. This program is now recognized as the only reported successful aquatic vertebrate invasive species control program at an ecosystem scale. Thus, out of despair came victory.

The commission's sea lamprey control program would not be where it is today without a strong commitment to research and scientific innovation. Since the mid-1900s, researchers have worked tirelessly to discover, adapt, and hone methods to control sea lamprey. Today, sea lamprey populations are controlled through the integration of multiple techniques targeting several life stages—specifically, barriers to block migratory adults from accessing spawning habitat and selective toxicants, called lampricides, used to control the larval stage.

The future of sea lamprey control—and valuable Great Lakes fisheries—will depend on a continued commitment to research. Currently researchers are developing new lampricides, testing portable seasonal barriers, and creating barriers that allow for the selective passage of desirable fish while blocking sea lampreys. Additional projects are identifying ways to control other sea lamprey life stages and applying new trap designs for assessment and control. Researchers are also exploring how we can turn the sea lampreys' keen sense of smell against them by manipulating behavior with attractants (pheromones), repellents (alarm cues), and chemicals capable of blocking the sea lampreys' responses to pheromones (pheromone antagonists). With the sequencing of the sea lamprey genome complete, researchers are now also studying whether sea lampreys could be controlled through genetic techniques. Most recently, many of these experimental tactics are being explored in a supplemental control framework where their use would enhance the effectiveness of lampricides and barriers.

When the first researchers began developing control methods for sea lampreys in the mid-1900s, many described their work as a “mission” or “calling.” They tackled seemingly far-fetched projects, worked themselves to exhaustion, and pushed the metaphorical envelope of science to have the chance to save Great Lakes fisheries from a menace. Though decades have passed, that pioneering spirit has never left the scientific community. Dedicated researchers still work around the clock and test seemingly wild ideas to continue the legacy of successful sea lamprey control and sustainable fishery management.

Andrea Miehl, communications associate, and Jill Wingfield, communications director, Great Lakes Fishery Commission.



An invasive sea lamprey, top, attached to a lake trout. Each sea lamprey can kill up to 40 pounds (18 kilograms) of Great Lakes fish.

At bottom, invasive sea lampreys from the Great Lakes. Sea lampreys are parasitic fish native to the Atlantic Ocean. Credit for both photos: Andrea Miehl, GLFC.

GREAT LAKES BENEFACTOR PROFILE:

Meet the Great Lakes Fishery Commission

[Great Lakes Benefactors](#) provide vital support for IAGLR to carry out its mission. IAGLR recently welcomed its first platinum-level benefactor, the Great Lakes Fishery Commission. Here we profile the commission and its role in Great Lakes science, sea lamprey control, and fishery management.

What is the Great Lakes Fishery Commission?

The [Great Lakes Fishery Commission](#) was established in 1955 by the Canadian/U.S. Convention on Great Lakes Fisheries. The commission coordinates fisheries research, controls invasive sea lampreys, and facilitates cooperative fishery management among state, provincial, Tribal, and federal agencies. The commission has ensured an ongoing, robust working relationship between Canada and the United States for the benefit of the fishery and the millions of citizens who depend on the resource for food, subsistence, recreation, and income.

What benefit does the commission bring to the Great Lakes region?

The Great Lakes are a binational treasure that attract millions of anglers, support valuable commercial and charter fishing, are a mainstay for Indigenous Peoples, and are the very fabric of a healthy environment. Protecting Great Lakes fisheries—which are valued at over \$7 billion annually—is at the heart of the commission's work. Healthy, vibrant Great Lakes fisheries are good for the economy and the environment.

What type of research does the commission fund?

Managing and sustaining the Great Lakes fishery depends on understanding the natural and human-induced factors that affect the lakes. The commission supports [three types of scientific activities](#): fishery research, sea

lamprey research, and science transfer. The commission funds research conducted by scientific and technical personnel in universities, private consulting firms, and federal, provincial, state, and Tribal agencies. See the current request for proposals on page 13 and contact research@glfc.org with any questions.

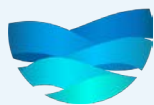


Is there a new research direction you would like to highlight?

One of our exciting new research endeavors is the [Supplemental Sea Lamprey Control Initiative](#), or SupCon. Supplemental controls are tactics applied along with the two primary sea lamprey control tools—lampricides and barriers. This control strategy is based on the integration and synergy of multiple technologies to contain or remove adult migrant, juvenile outmigrant, and larval sea lampreys.

Why did the commission become a benefactor of IAGLR?

Our partnerships are essential for carrying out our mission. The success of the sea lamprey control program and maintenance of sustainable fisheries in the future will rely on technologies and techniques developed by the scientific community. By partnering with IAGLR, the commission engages with the premier body of researchers studying large lake ecosystems. IAGLR is a conduit, connecting us with established researchers, new talent, and people who care about healthy Great Lakes ecosystems as much as we do.



GREAT LAKES BENEFACTORS

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 such as conference registrations, exhibit space, and sponsor visibility, as well as other promotional opportunities throughout the year.

We invite you to join the Great Lakes Fishery Commission 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.



Juvenile lake sturgeon at the Black River Stream Side Research facility being fed blood worms just prior to release. Credit: Douglas Larson.

20 years of Lake Sturgeon research, outreach, and management on the Black River

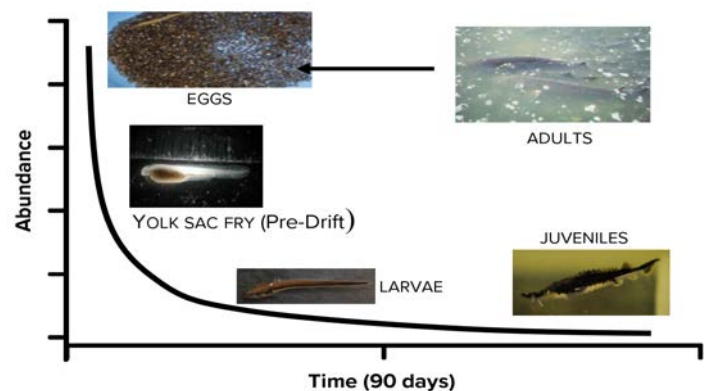
by Kim Scribner and Edward Baker

Over the past 20 years, or approximately one lake sturgeon generation, researchers from Michigan State University (MSU) and the Michigan Department of Natural Resources (DNR) have studied lake sturgeon reproduction, physiology, behavior, and genetics. Work has largely focused on understanding factors affecting recruitment in the Black Lake population in Cheboygan County, Michigan. Research, restoration hatchery production, and outreach and educational programs have been conducted in cooperation with stakeholder groups, especially Sturgeon For Tomorrow, and the hydroelectric industry (Tower Kleber Limited Partnership).

A survey conducted in 1997 showed the population of lake sturgeon in Black Lake had decreased by 66% over several decades. This alarming decline triggered statewide efforts to restore lake sturgeon in Black Lake. Collaborative research led by MSU began in 2003. Since then, researchers have secured 23 grants totaling about \$4.8 million and resulting in 64 publications. Seven M.S. and six Ph.D. students and over 100 hourly seasonal technical staff have been trained over the period.

Lake sturgeon exhibit a classic Type III mortality function whereby high levels of mortality are realized at the egg, free embryo, and larval stages (see figure). A portion of the research has focused on reproductive responses of adults to environmental factors that affect mortality during early life stages. Adults experience strong pressure to time and locate reproduction to maximize the probability of offspring survival, and reproductive decisions are tied to cues in the environment (e.g., temperature, discharge, day length). The consequences of reproductive decisions are particularly important for species with delayed sexual maturity, like lake sturgeon, as these species are also most susceptible to rapid environmental change because of long generation times.

The research is unique in that we integrate molecular genetic assays with field and experimental studies. Genetic determination of parentage allows estimations of relative reproductive success of males and females. Next generation sequencing of predator stomach contents allows estimation of dietary composition



The fundamental management question is how can an organism that is so highly fecund not be able to replace themselves (very low natural recruitment) – Answer - many predators eat sturgeon during early life periods (as eggs and larval fish)

and levels of larval lake sturgeon mortality. We have adapted molecular assays to determine lake sturgeon sex. We have developed analyses of behavioral and physiological responses to stress. In addition, to explain the variability in phenotypic traits, we have developed quantitative genetic analyses to determine the proportional influence of genetics and the environment.

Another major emphasis of work at the site is production of lake sturgeon juveniles for restoration stocking into the Cheboygan and Saginaw river systems. Each year, 1,500 juveniles are produced and 500 stocked into Mullett and Black lakes and across four tributaries to the Saginaw River. Additional fish are provided for rearing by a tribal hatchery for release into Burt Lake.

The Black River hatchery is open for public tours, the largest of which are held in early May during the spawning season and in mid-August when hatchery juveniles are released. We generally have around 1,000 visitors per year. Background about our 20-year anniversary can be found via this short [DNR video](#). Learn more about our [outreach, K-12 education, and community science initiative](#) and the [Black Lake project](#).

Kim Scribner, departments of Fisheries and Wildlife and Integrative Biology, Michigan State University, and Edward Baker, Fisheries Division, Michigan Department of Natural Resources.

LakeBed 2030: a call for Great Lakes high-resolution mapping and bathymetry

The fourth annual Lakebed 2030 conference was held September 28–30 in Traverse City, Michigan, at Northwestern Michigan College's Great Lakes Water Studies Institute. This conference emphasizes the need for high-resolution mapping and bathymetry throughout the Great Lakes, along with strategies to archive and catalog these data.

With more than 200 people in attendance from multiple countries, the event included 12 on-water demonstrations showing some of the latest marine technologies, along with multiple talks regarding mapping projects, strategies, and future plans. [Recordings from the conference](#) are available online.

U.S. Senator Gary Peters kicked off the conference with welcoming remarks, followed by a keynote address by Rear



At left, Rear Admiral Ben Evans, director of the NOAA Office of Coast Survey, provides keynote address. At right, a Seafloor Systems Autonomous Surface Vessel conducting multibeam sonar operations in the NMC harbor. Credit: Northwestern Michigan College.

Admiral Ben Evans, director of the NOAA Office of Coast Survey (OCS). Evans emphasized the importance of connecting regional mapping initiatives, along with the work conducted by OCS throughout the Great Lakes and the U.S. [exclusive economic zone](#).

[Lakebed 2030](#) continues to be a driving force toward 100 percent coverage of the Great Lakes. Next year's Lakebed 2030 conference will be held September 19–21 in Traverse City. For more information, contact Hans Vansumeren at hvansumeren@nmc.edu.

BOOK REVIEW:

The story of water

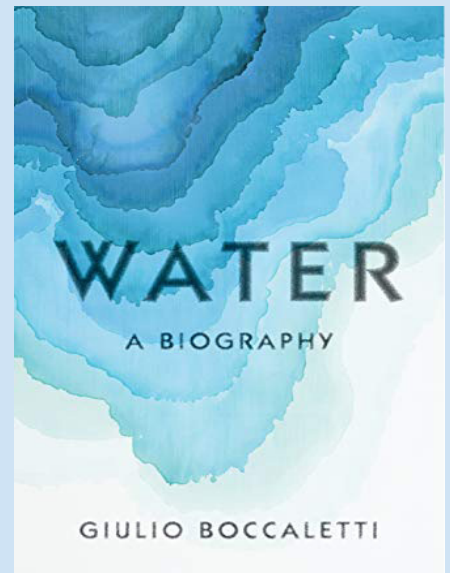
by Audrey Whitaker, Jillian Greene, Ian Stone, Nate Dugener, Janie Cook, Tony Weinke, and Bopi Biddanda

THE HISTORY OF HUMANITY is intimately bound to water in an abiding social contract. Author Giulio Boccaletti argues that the biography of water is sociopolitical rather than technological. *Water: A Biography* examines human history through the lens of water—from the dawn of civilization to modern hydrologic states, with droughts, floods, and political turmoil occurring in between—relentlessly shaping human lives, societies, and history.

By probing the deep history of water and humans, the book paints a captivating story through the ages. Boccaletti chronicles each stage of civilization (from nomadic hunter-gatherers to sedentary pastoral societies to city states) along with examples (such as ancient Sumer and Rome and modern China and the United States), and how these societies were shaped by their relationship with water.

A major concern is that *Water* has ignored large geographic regions such as much of Latin America and Southeast Asia, where vital water-human co-evolution stories have played out independently over time. Nevertheless, the many worldwide historical and current contexts covered in *Water* are even more relevant today, as freshwater resources and the myriad ecosystem services they provide are ubiquitously threatened by the combined assault of anthropogenic pressures and climate change.

Throughout human history, the waterscape has transformed us, and we have altered it. Boccaletti's *Water* reminds us of the remarkable power water has to alter our existence, even as attempts are made to bend water to our will. The story of water has defined every aspect of life and will continue to do so.



Water: A Biography by Giulio Boccaletti (Pantheon Books, New York, 2021, p. 378, ~\$20).

All authors are at the Annis Water Resources Institute, Grand Valley State University.



CALL FOR PROPOSALS

<http://www.glfc.org/for-researchers.php>



The Great Lakes Fishery Commission's research programs consist of a portfolio of basic (discovery, descriptive, or hypothesis generation) and applied (descriptive or hypothesis-driven) research organized by designated theme areas.

Fishery Research Themes

- Human Dimensions of Great Lakes Fishery Management
- Re-establishment of Native Deepwater Fishes
- Physical Processes and Fish Recruitment in Large Lakes
- Energy Dynamics of Great Lakes Food Webs
- Council of Lake Committees Research Priorities

Sea Lamprey Research Themes

- Barriers and Trapping
- Lampricides
- Assessment
- Chemosensory Communication Systems
- Genetic Control

CALL FOR SPECIAL TOPICS

Fishery research projects focused on: use of mixed methods, coregonine conservation and restoration, and climate change.

Sea lamprey research projects focused on: production potential of newly opened habitats.

Investigators are encouraged to leverage the Great Lakes Acoustic Telemetry Observation System (<https://glatos.glos.us/>).

Proposals due by January 15, 2023



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Season of Giving

November 29 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 55 years.

“Participating in IAGLR meetings was one of the biggest influences on my Great Lakes career,” notes Margaret Lansing, a fellowship winner, award recipient, and career-long IAGLR member. “I am making it a point to give back to IAGLR and hope other fellowship recipients will consider doing the same when they are in a position to do so.”

To add your support, please view our [giving opportunities](#) and select the one that best fits your interests:

- Foster **diversity, equity, and inclusion** in the large lake research community (NEW!)
- Support **student scholarships**
- Contribute to the **endowment** fund
- Make a one-time **general donation**
- Join all our staff and sign up for the **Sustainers Circle Monthly Giving Program**

No matter which option you choose, we appreciate your support!



A gift to IAGLR is a gift that gives twice

2022 Annual Meeting of the African Great Lakes Stakeholder Network

February 13-14, 2023
Dar es Salaam, Tanzania



Information and registration at:
agl-acare.org/2022annualmeeting