IAGLR
LAKES Letter

This issue explores the unique challenges of winter research and makes the case for a coordinated, collaborative approach to do more.

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The state of winter limnology in the Great Lakes

by **Andy Bramburger**

WINTER is the least well-studied season in natural systems. Accordingly, the patterns and processes of ecosystem function during the cold, frozen months are poorly understood. The nature of temperate lakes, being seasonally frozen with unstable ice cover, makes them logistically challenging and potentially dangerous to study in winter, and winter fieldwork can be demanding. As Ted Ozersky, lead of the recently formed Great Lakes Winter Network (GLWiN; see page 6) puts it, "Many limnologists, like most people, would rather spend a winter's day curled up next to the fire with a good book and a better Scotch than soaked and cold, standing in the middle of some frozen lake." Despite this, many researchers have contributed to a growing body of knowledge on the physics, biogeochemistry, and biology of frozen lakes, as attested by articles in this issue. New initiatives like GLWiN promise to help fill in the many remaining knowledge gaps.

As in many systems, the characteristics of winter are changing in the Great Lakes. Despite their large size, they are among the most rapidly warming lakes on the planet, with implications for the extent, thickness, and duration of seasonal ice cover. Changing ice cover is seen as a key variable that regulates mixing regimes, underwater light climates, and biotic responses. However, predicting the effects of seasonal ice loss and associated changes is complicated by the relative paucity of data generated during winter. The Great Lakes are not simply scaled-up versions of smaller lakes, and winter physical processes are distinct and not well-characterized. For instance, the dynamics of ice formation on large lakes can be remarkably sensitive to meteorological stressors. Strong wind mixing associated with autumn and winter gales can decompose surface layers of near 0°C water, bringing warmer water from depth and delaying ice formation. As such, ice formation in large lakes requires a much deeper portion of the water column to be near 0°C than in their smaller counterparts. Complex interactions among wind-driven mixing, precipitation, and water column characteristics make ice formation in the Great Lakes spatially and temporally variable, and ice drift further contributes to the patchiness of ice-cover patterns on the lakes.

When and where the surface of the Great Lakes does freeze, ice cover increases *albedo*, or the reflectiveness of the surface, slows radiative warming and evaporative cooling, and prevents wind mixing. These conditions dampen nearshore resuspension events that contribute to water column nutrient levels and transport sediments to deep zones of the lake. The presence of ice also allows for the development of weak, inverted thermal stratification. This, like summer stratification, influences the distribution and availability of nutrients and other materials in the water column. However, too few studies have been conducted to allow for generalizations across the system.

Differences in snow depth, as well as ice thickness, color, and transparency, influence the intensity and spectral signature of underwater light. Several recent studies have shown that under-ice assemblages can be vibrant and dynamic, and they likely represent distinct entities rather than remnants of open-water communities. The Great Lakes are no exception to this trend. In high-ice years, sympagic (ice-associated) diatoms abound, forming large blooms that can fuel late-winter / early-spring pelagic food webs. Alternatively, sinking of these blooms is responsible for substantial export of organic material to the sediments, where they may play an important role in summer geochemistry. While the rates of nutrient and carbon assimilation under ice are lower than in summer, they are not negligible,

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2022 Conferences

Join us for four IAGLR conferences next year! Make sure to renew your membership to enjoy discounted registration.

MARCH 16–18

State of Lake Erie Conference
Cleveland, Ohio | Hybrid

Registration opens in December.

iaglr.org/sol/sole22/

MAY 14–20

IAGLR | JASM 2022
Grand Rapids, Mich. | Hybrid

Call for Abstracts online; deadline January 10.

Start planning your submissions for IAGLR | JASM 2022! The Call for Abstracts is now online and the submission site will open in early December. You're invited to submit an in-person oral presentation (12-minute talk or 5-minute lightning talk), an in-person poster presentation, or a virtual presentation available for asynchronous viewing only. Note that *all* presenters are required to submit a prerecorded version of their talk. Please direct any questions related to abstracts submission to Tricia Fry, Program Committee Coordinator, at tfry@fisheries.org.

iaglr.org/iaglr2022/

SEPTEMBER 12–18

ELLS-IAGLR Joint Conference
Petrozavodsk, Russia | Hybrid

Registration now open.

This conference will explore the theme *Implications of Climate Change and Human Impact on Large Lakes* in person at the Karelian Research Centre and online via Zoom and Teams.

iaglr.org/ells-iaglr/2022

OCTOBER 24–26

State of Lake Michigan Conference
Traverse City, Mich.

Save the date.

iaglr.org/sol/solm22

We hope you'll join us!

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and contribute to longer-lived repositories of materials (e.g., sediments, fisheries, etc.).

The relative importance of winter processes to overall Great Lakes ecosystem function, however, is almost completely unexplored. The Laurentian Great Lakes represent approximately one-fifth of the planet's surface freshwater, and as temperate, dimictic lakes, have been frozen several months per year for much of their existence. Our ability to predict how this important resource will respond to ongoing climate change necessitates better understanding of how winter processes contribute to year-round dynamics. Researchers who are interested in winter limnology point out the urgent need for these studies (see page 11 for a call to prioritize and coordinate winter research). Ice metrics are monotonically declining, and we run the risk of no longer having lake ice to study before we truly understand its importance.

Andy Bramburger is president of IAGLR and a research scientist with Environment and Climate Change Canada.

Dropping a Secchi Disk under the ice. Photo by Andy Bramburger.

IAGLR board acts to strengthen organization through staffing changes, funding opportunities

Through its recent strategic planning efforts, the IAGLR Board of Directors has focused on enhancing the organization's sustainability through effective staffing and new funding opportunities to support the vital work of the association.

IAGLR is unique in bringing together people from multiple disciplines and experiences around a shared interest in understanding the world's large lake ecosystems. This multidisciplinary approach is needed more than ever to address the increasingly complex challenges facing these precious ecosystems. Over the past 54 years, IAGLR has served as a vital member-driven organization within the Great Lakes community through its conferences, journal, scholarships, awards, and other initiatives. Yet the COVID-19 pandemic brought into focus the need for IAGLR to strengthen its capabilities so that it can be flexible and adaptive in continuing to serve its members and the large lake research community into the future. To do so requires a dedicated, engaged team and solid funding.

Staffing changes

As a first step toward strengthening the IAGLR team, the board is pleased to announce the recent hire of Paula McIntyre, longtime contractor for IAGLR. McIntyre has worked with the association for 22 years on communication initiatives and organizational strategy and will continue in her role as communication director. The association recognized her service last year by awarding McIntyre the Anderson-Everett Award. She joins IAGLR Business Manager Wendy Foster on staff, becoming the second employee in association history.

In addition, the board is moving forward with hiring an executive director in 2022 and has retained a firm to help with a national search. The Executive Director Search Committee, under the leadership of Trevor Pitcher (University of Windsor), is currently finalizing a job description, which is expected to be posted this winter, with a hiring decision by summer. The board will also review the conference coordinator role to determine how best to fulfill this crucial position.

New funding opportunities

To support the vital work of IAGLR, the board recognized the need to revisit our funding strategies. As we added new services over the past several years—including the State of Lake conference series and *Lakes Letter*—our funding approaches were becoming increasingly fragmented. In addition, we had streamlined our membership options to focus on individuals, dropping the "Sustaining Member" category in the process. A different approach to funding was needed.

We went back to the drawing board, and what emerged is a new, coordinated approach that will allow major supporters to shape their giving experience by customizing the perks they receive as part of their donor package. In addition, we simplified the opportunity for sustained giving at accessible levels by creating a monthly giving program. The collective impact of many people giving at an amount that makes sense for them cannot be underestimated. The board is pleased to present these new giving opportunities:

GREAT LAKES BENEFACTORS PROGRAM

Our benefactors value large lake research and demonstrate their commitment to IAGLR through a significant annual contribution. They receive multiple, customized benefits for their commitment.

SUSTAINERS CIRCLE MONTHLY GIVING PROGRAM

These committed donors make convenient monthly contributions to provide funding stability for our operations.

For more information, please visit iaglr.org/giving.

Promotional opportunities

Organizations and businesses interested in connecting with our members have two opportunities to do so.

1. **Take out an ad** in *Lakes Letter*, with discounted rates when you run your ad in multiple issues.
2. **Exhibit at our conferences**

Donors taking part in the Great Lakes Benefactors program may also select these options from the list of available perks associated with their giving package.

KUDOS

Congratulations to the following IAGLR members on their accomplishments.

HEATHER DAWSON (University of Michigan-Flint) for her promotion to professor of biology. She also was selected for UM's carbon neutrality University Units Leadership Council. The council will inform implementation of UM's goal to achieve carbon neutrality across its three campuses.

GREGORY DICK (University of Michigan) for being selected as the new director of the Cooperative Institute for Great Lakes Research.

ALEX DUNCAN (Centre for Indigenous Fisheries, University of British Columbia), current IAGLR board member, for joining the Centre for Indigenous Fisheries as its first Ph.D. student and receiving the Joseph-Armand Bombardier Canada Graduate Scholarship from the Social Sciences and Humanities Research Council this year.

SARAH LAROCQUE (Fisheries and Oceans Canada) for being named a Governor General's Gold Medalist for academic excellence at the graduate level (Ph.D.) at the University of Windsor.

JAMES OUTA for completing his Ph.D. at the University of Vienna, Austria, and being appointed a postdoctoral research fellow at the Department of Zoology, University of Johannesburg, South Africa.

ED VERHAMME (LimnoTech) for being promoted from project engineer to a principal of the firm.

Submit kudos to lakesletter@iaglr.org

Welcome new IAGLR members

The following members joined IAGLR between August and October 2021. Welcome to IAGLR!

David Borgeson
Jana Levison
Hilda Mogaka
Markelle Morphet
Naftaly Mwirigi
Dominique Rumball
Edna Waithaka

2022 IAGLR membership drive is on—renew today!

Thank you for supporting IAGLR with your annual membership! As you know, 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. We value your participation in the IAGLR community and are happy to announce enrollment for 2022 is now open. **Renew your membership and celebrate all the reasons you benefit from being an IAGLR member**:

Conference registration discounts

We are looking forward to your participation in next year's four IAGLR conferences!

Networking, connection & communication

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

Journal of Great Lakes Research

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

Student participation and support

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.

Need another incentive to join IAGLR? Last but not least, we are working on a new and improved Member Portal! This will include the **IAGLR Membership Directory**. Coming soon, you will be able to browse the directory by expertise and geographical areas to make it even easier to network with other members.

Why wait? Renew today!

NEW MEMBER SPOTLIGHT

Jana Levison

Associate Professor
Water Resources Engineering,
Morwick G360 Groundwater Research Institute, School of Engineering,
University of Guelph

ABOUT MY WORK

My research focuses on groundwater quantity and quality, with emphasis on rural groundwater systems, climate change impacts on groundwater, and source water protection. Most of my research sites are in the Great Lakes basin in southwestern Ontario. Currently, some specific topics we're focusing on include investigating 1) N and P transport in groundwater-surface water interacting systems in the Lake Huron basin; 2) impacts of climate change on agricultural N transport in the Lake Erie basin; 3) delivery of chloride to Lake Ontario via groundwater transport pathways; and 4) a source water protection and risk assessment framework for a First Nations community situated in the Lake Huron basin.

WHY IAGLR?

Attending IAGLR conferences and reading and publishing in the *Journal of Great Lakes Research* are of great interest to me and my research group. I particularly like the interdisciplinary nature of the organization, since integration of different fields is necessary to tackle the challenging water issues we face now and into the future.

Dominique Rumball

Master's Student
University of Toronto Scarborough

ABOUT MY WORK

I am an MSc student supervised by Dr. Nicholas Mandrak at University of Toronto Scarborough and a member of the FishCAST NSERC CREATE Training Program. My research focuses on evaluating the effectiveness of restoration projects for fish species at risk across Southwestern Ontario.

WHY IAGLR?

I joined IAGLR to continue exploring my appreciation and understanding of large lake ecosystems. As a member, I look forward to interacting with a diversity of individuals and working together to create a sustainable future for all.

Collecting benthic samples in the Apostle Islands. Photo by Ted Ozersky.

The Great Lakes Winter Network

Working together to learn more about the Great Lakes in winter

by **Ted Ozersky**

WINTER is both the most rapidly changing and the least well-understood period in the seasonal cycle of the Laurentian Great Lakes. Rising winter air temperatures and changing precipitation patterns are leading to the loss of ice cover, alterations to stratification patterns, and changing inputs of water, sediment, and nutrients from the land. Unfortunately, lack of detailed winter-period studies leaves many open questions about how these changes are affecting the physics, chemistry, and biology of the Great Lakes (see cover article). A better understanding of winter on the Great Lakes is urgently needed to forecast what the future holds for these important ecosystems and the services they provide.

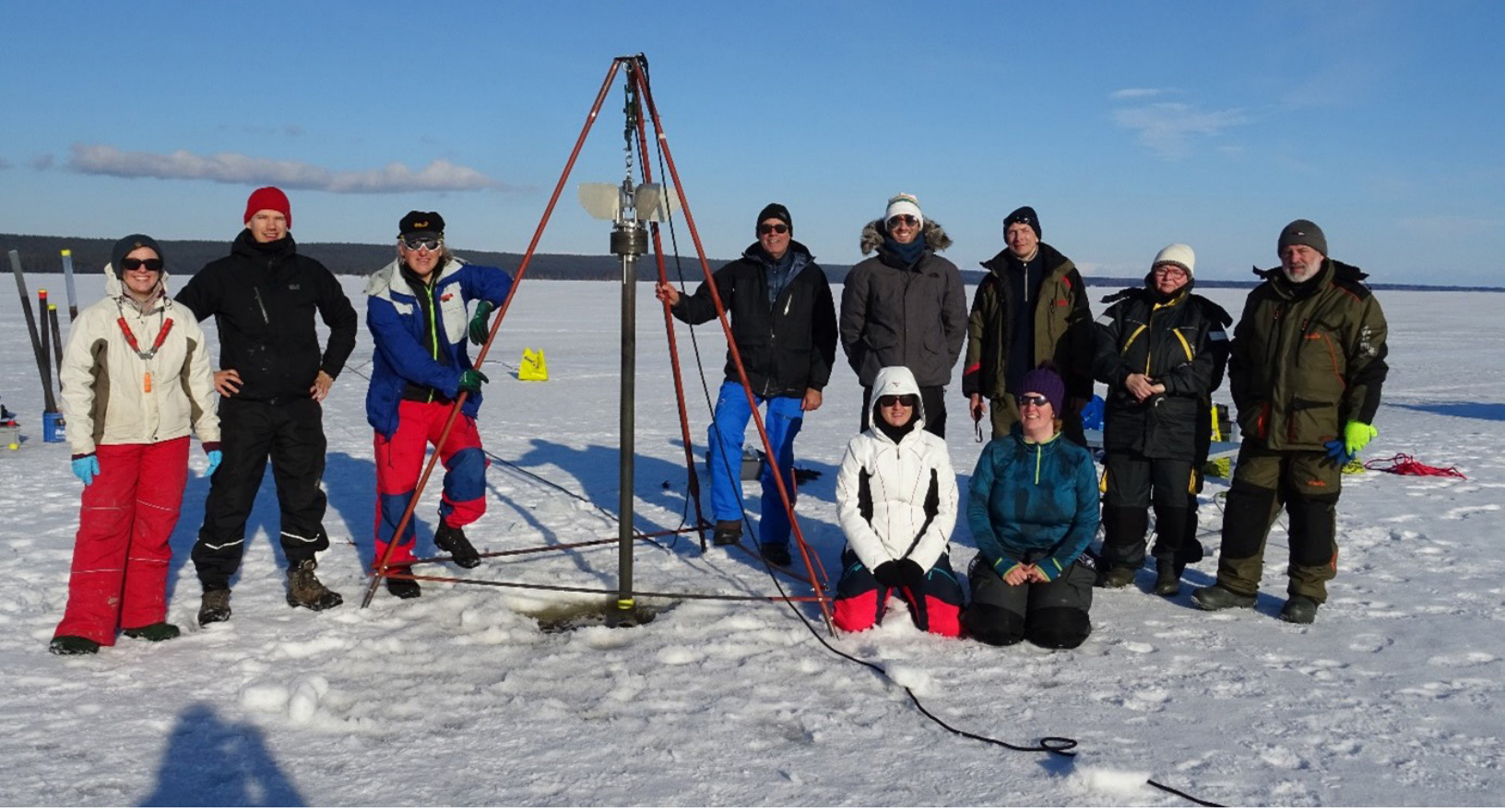
A key reason for the existing winter knowledge gap on the Great Lakes is the danger and difficulty of winter research on these large and dynamic systems. Overcoming the logistical challenges of winter research will require close cooperation across research groups in the Great Lakes basin. Such cooperation is critical to efficiently use existing research infrastructure (e.g., access to U.S. and Canadian Coast Guard icebreakers and data from instrumented buoys), share information about winter-specific sampling methods, and collaborate on projects spanning large spatial scales or limnological subfields.

One existing effort for increased collaboration on the topic of winter is the Great Lakes Winter Network (GLWiN), which formed at a winter limnology workshop sponsored by the Cooperative Institute for Great Lakes Research (CIGLR) in 2019. GLWiN is composed of academic and government Great Lakes scientists and has the goal of increasing information exchange and collaboration on the topic of winter limnology of the Great Lakes.

This winter, with support from CIGLR, members of GLWiN will conduct coordinated sampling across all five Great Lakes. As part of this "Winter Grab" (inspired by the recent "HAB grab" on Lake Erie), scientists will collect information about the physical and chemical environment and biological communities at a dozen sites spanning large trophic gradients. They will also work with drinking water treatment plants to collect additional water samples from many more locations around the Great Lakes. The results of this collaboration will help provide missing baseline information about how winter conditions vary across the Great Lakes and address questions about the way changing environmental conditions are affecting the Great Lakes ecosystem.

If you'd like to participate in Winter Grab or join the GLWiN mailing list, email tozersky@d.umn.edu. We are always excited to welcome more winter limnology enthusiasts to our network!

Ted Ozersky is an associate professor of biological limnology at the University of Minnesota Duluth.



Three different teams joined to retrieve sediment cores © Natacha Tofield-Pasche/ EPFL 2016.

AN INTERDISCIPLINARY PROJECT

Investigating life under the ice in Lake Onego, Russia

by **Natacha Tofield-Pasche**

THANKS to funding from the FEEL Foundation for Water Research in Lake Geneva, we had the unique opportunity to work on the ice of Lake Onego, the second largest lake in Europe. Our Russian-Swiss project investigated physical and biogeochemical dynamics under the ice. The diverse research topics consisted of water physics, biology, chemistry, lake ecosystem, carbon cycling, paleolimnology, remote sensing, and climate change. Seven subprojects were conducted by 75 specialists from 12 different research institutions in Russia, Switzerland, France, Germany, and Sweden. The opportunity to collaborate with such a diversity of disciplines, cultures, and individuals made for an amazing experience.

The Center of Limnology at the École Polytechnique Fédérale de Lausanne (EPFL) and the Northern Water Problems Institute (NWPI) organized the joint field expeditions. In March 2015, 2016, and 2017, the NWPI installed an ice camp for two weeks in the middle of Petrozavodsk Bay, which measures 7 by 15 kilometers. The camp was composed of one to two tents warmed by a stove, one tent to store the material, and one tent for the toilets. A rotating team ensured a 24-hour presence on the ice for regular measurements. Around the camp, different moorings and a meteorological station were deployed from the ice. The scientists came onto the ice via hovercraft during the day to take their samples or profiles and to carry out experiments. The researchers also benefited from close access to NWPI laboratories. While the main camp was the major study site, we also investigated different sites within the bay and in the more central part of the lake. Thanks to the local experience from NWPI, the logistics, safety, and the work on the ice were a success.

During the project, we tried to promote as many interdisciplinary interactions as possible between all scientists. For this, we had regular joint meetings by videoconference between Switzerland and Russia, as well as intensive exchanges during two-days retreats in Switzerland. The highlights were the fieldworks with their amazing collaborative atmosphere: researchers were helping each other, discussing their results, learning from other disciplines, and having fun together. Most of the European researchers worked for the first time on the ice. Thus, they greatly benefited from the Russian experience, techniques, and know-how. Some scientists even started to investigate frozen lakes back home, and others continued to build on the knowledge acquired on the under-ice convections in Lake Onego. On a personal level, we also got to know new scientists, which sometimes led to further collaborations that persisted beyond this project. Overall, this multidisciplinary project had a great collaborative atmosphere that generated positive outcomes for this project and, hopefully, for the future.

Water sampling in Petrozavodsk Bay, with the hovercraft in the background © Natacha Tofield-Pasche/ EPFL 2016.

One of the key lessons that we learned is that the conditions below the ice were highly dependent on the quality of the ice (with or without snow cover), the weather conditions, and the hydrology of the large river entering the bay. We therefore observed large variabilities between the three investigated years. This project also managed to characterize in detail under-ice convections and their implications for ecosystem development. We could also evaluate the impacts of the ice-covered period on ecosystem functioning and carbon emissions after ice break-up. Researchers presented this project during nine talks in a session on winter limnology at the 2018 ELLS-IAGLR conference in Evian. For the detailed scientific outcomes, please refer to the special issue *Life under ice in Lake Onego (Russia) – an interdisciplinary winter limnology study* in Inland Waters (2019).

Natacha Tofield-Pasche is a limnologist and the operational director of the Center of Limnology at EPFL- École Polytechnique Fédérale de Lausanne in Switzerland.

Ice camp in March 2017 © Hannah Chmiel / EPFL 2017.

Photo by Mat Levine, The Nature Conservancy of New York.

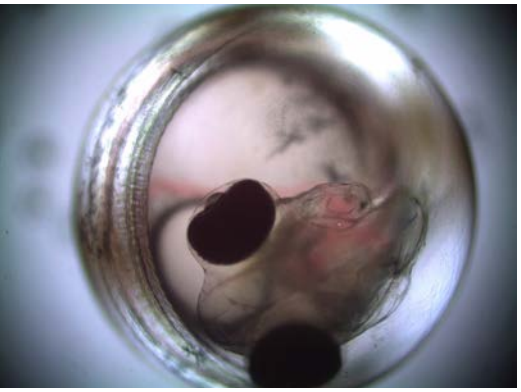
Winter wakes

by **Ellen George**

IT IS LATE FALL, and the lake is beginning to sleep. The tourists have packed up, the ice cream shops lining the shore are dark and shuttered. Empty boats, cocooned in their winter wrappings, stand in neat rows beside abandoned piers. The summer field season has ended, and the scientists, technicians, and interns have crept back to their offices, preparing for a long winter illuminated by the dull glow of computer screens.

In the midst of this slumber, the winter ecologist wakes. Instead of being pushed indoors by November's frigid breath, we are called outward, excitement building along with the thickening carpet of fallen leaves. This is our season.

Winter ecology is not for the faint of heart. It breeds resilience, a toughness that comes from venturing out onto the frozen lake when the rest of the world has called it quits. Winter fieldwork teaches invaluable lessons in resilience, flexibility, and innovation for those brave enough to face it.



Cisco eggs, Ellen George holding a cisco, and the frosty dash of the boat. Photos courtesy of Ellen George.

This resilience is mirrored in the ecosystem that we study. While the lake in winter may appear frozen and dead, it is teeming with life. Cold water species such as cisco and whitefish, rarely seen in the warm summer months, move inshore to spawn in late November and early December. These species were once some of the most abundant fishes in the Great Lakes, before overfishing and habitat destruction drove them to near disappearance from both our lakes and our social memory. By the end of the last century many people had given up on the cisco. I, however, am constantly amazed by the resilience of these little fish. In eastern Lake Ontario, a population that was once thought to have disappeared is surging back. Every winter Chaumont Bay fills with thousands of silvery bodies, crowding onto the shoals that have sheltered their eggs for millennia. They pack into the bay as water temperatures plummet, bringing the bay back to life even as the winter swells begin to roll and the ice creeps in from the shoreline. The more we search, the more we find, Ice Age remnants spreading out across the shoals and rocky islands of eastern Lake Ontario. They thrive in the extremes, holding on to their place in the ecosystem just as they hold on to our hearts and minds.

In the early morning hours, I slowly turn my skiff out toward the open lake. In the distance I hear low booms from late-season duck hunters, their shotguns muffled and fuzzy in the freezing air. I glide past a forgotten buoy frozen in the ice: "No wake." Thin skim ice, clear as glass, bends and ripples over the gentle waves created by the boat. The ice is so thin and flexible that it doesn't even crack.

Flexibility is an important skill for winter ecologists. It's already rare for things to go completely right in warm seasons. Throw subzero temperatures and tempestuous weather into the mix, and things can go south quickly. One day we arrived at the lake to find it covered in a glaring sheet of smooth, bare ice. After only a few minutes the snowmobile we used to tow our 200-pound egg sampling pump ground to a halt, a cloud of acrid smoke billowing up from behind. Without any snow on the ice to cool the track, the rubber snowmobile treads had melted. While equipment melting is unusual, things freezing solid is a constant frustration. Pump valves, chainsaw blades, and boat winches are in a perpetual cycle of sticking, freezing, and being thawed out. Once, in an effort to modernize, we started bringing an iPad along to log GPS points. It turns out that iPads, like summer interns, don't enjoy spending a day outside in -20°F weather. For the rest of the season the iPad lived inside my survival suit, nestled deep within the many layers next to the tools, hose fittings, and other essential errata that couldn't survive the Lake Ontario winter. When I peeled off my layers at the end of the day, the contents of an entire toolbox clattered out.

Flexibility is a skill, and like any skill it needs to be practiced. One of the greatest skills winter fieldwork has given me is the ability to admit when I'm wrong. Once we are free to recognize our mistakes, we can move on to innovating a solution. When we first began looking for cisco in Chaumont Bay, we designed an expensive and time-consuming radio telemetry project. The project consisted of tagging adult cisco captured near the assumed spawning shoals and then tracking their movements by boat. About two weeks into the project the weather shifted, and the bay froze solid. We were left with no boat, no cisco, and no data. After trekking around atop the frozen bay, radio receiver in hand, and still not picking up any signals, we had to admit to ourselves that this project wasn't working. Instead of dwelling on it, we got creative. Sure, we couldn't find fish, but did that really matter anyway? The important thing wasn't where the fish were, it was where the eggs were. We completely scrapped the old project and designed a new approach, using a specially designed pump to collect eggs through the 1-meter-thick lake ice.

It's been several years since I first began chasing cisco around Chaumont Bay. Today interest in these scrappy little fish is growing, with more researchers braving the Great Lakes winter to study them. As their cold-weather experiences challenge them to become more resilient, flexible, and innovative scientists, I hope that their efforts can also help build a more resilient Great Lakes ecosystem.

Ellen George is a graduate program instructor at Paul Smith's College in New York.

A SEASON OVERLOOKED

A call to prioritize and coordinate winter research

by **Michael Twiss and Marguerite Xenopoulos**

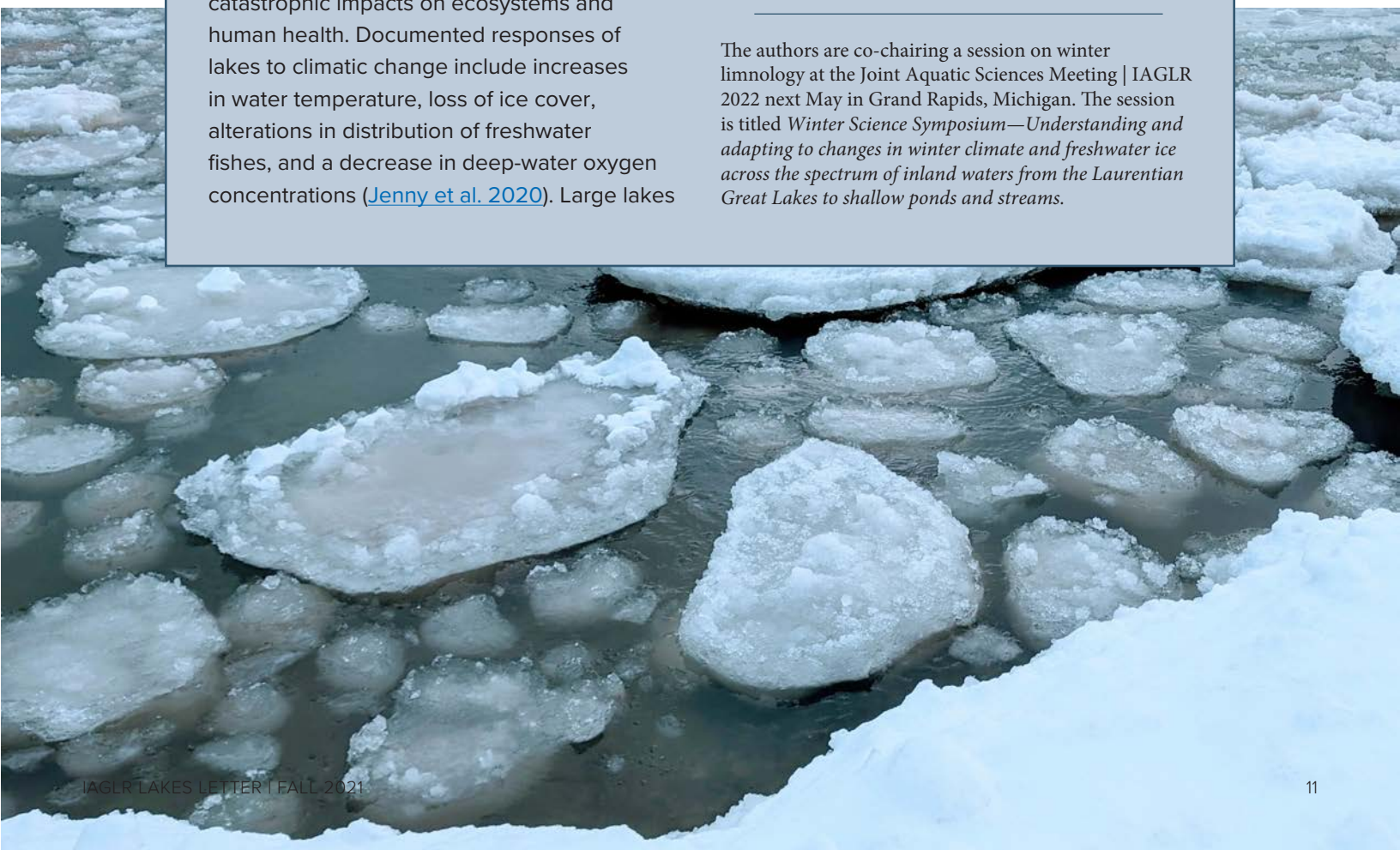
WITHIN THE RESEARCH COMMUNITY, winter is an overlooked season across the Great Lakes-St. Lawrence River system and other temperate large lakes (e.g., in North America, alpine Europe, Karelia, and Siberia). Observations during winter are particularly challenging; they require specialized equipment, highly qualified personnel, and experts to coordinate approaches that identify and target research priorities. As a result, we often base our management decisions on models derived from ice-free observations.

Yet the need for winter research has never been greater. The 2021 Intergovernmental Panel on Climate Change report emphasized the importance of limiting global temperature within the next decade to reduce catastrophic impacts on ecosystems and human health. Documented responses of lakes to climatic change include increases in water temperature, loss of ice cover, alterations in distribution of freshwater fishes, and a decrease in deep-water oxygen concentrations (Jenny et al. 2020). Large lakes are the most vulnerable to ice cover loss and warm at the fastest rates (Sharma et al. 2019). Understanding our relationship with these rapidly changing large aquatic ecosystems requires better approaches to studying and understanding large lake systems in winter.

One of the greatest needs is long-term data on large lakes and their watersheds in winter and adjacent seasons to better understand the influence of climate change on chemical, physical, and biological integrity. We call on the great lake community to rise to this challenge to prioritize and coordinate our efforts before another season passes.

Michael Twiss is a professor and chair of the biology department at Clarkson University and former IAGLR president. Marguerite Xenopoulos is a biology professor and Canada Research Chair in Global Change of Freshwater Ecosystems at Trent University.

The authors are co-chairing a session on winter limnology at the Joint Aquatic Sciences Meeting | IAGLR 2022 next May in Grand Rapids, Michigan. The session is titled *Winter Science Symposium—Understanding and adapting to changes in winter climate and freshwater ice across the spectrum of inland waters from the Laurentian Great Lakes to shallow ponds and streams.*



Embedding with the "Guardians of the Great Lakes"

by **R. Michael McKay**

Ice-breaking capabilities of the U.S. Coast Guard (USCG) render their vessels safe and reliable platforms for monitoring and research on ice-covered coastal seas. Since 2009, we have collaborated with the officers and crew of USCGC *Neah Bay* to investigate lower food web dynamics during winter in Lake Erie.

Ice cover on the Great Lakes has declined precipitously over the past half-century consistent with a warming climate. On Lake Erie, the shallowest of the Great Lakes, this has resulted in a higher frequency of low-ice winters, thus compromising any seasonal resets that may occur. While winter presents a logistical barrier to better understanding the lake ecosystem, combined U.S. and Canadian Coast Guard winter operations in the Great Lakes provide an opportunity to advance our knowledge.

Our most recent full sampling season partnering with *Neah Bay* demonstrated the tremendous value of this relationship. Winter 2019–20 was uncommonly mild in the region, thus offering a window to the future low-ice state of Lake Erie predicted in climate models. With no federal, state, or provincial agencies having the capability to monitor the lake between December and March, this unique event may have passed without investigation save for the partnership with *Neah Bay* facilitating monthly sampling along transects between Cleveland and Detroit. Beyond the unique state of the lake that winter and spring, the onset of the COVID-19 pandemic in late winter 2020 meant that data acquired from *Neah Bay* may be some of the only early season in-lake observations that year, as agency spring monitoring efforts were paused. While winter science operations with *Neah Bay* were paused last year due to the ongoing pandemic, we look forward to renewing our winter surveillance with the "Guardians of the Great Lakes" in the coming months.

Captain William "Bill" Woityra (Commanding Officer USCGC *Polar Star*; formerly CO USCGC *Neah Bay*) measuring light penetration through ice in Lake Erie in support of our winter science partnership. This activity was conducted with *Neah Bay* beset in Lake Erie central basin ice for an ice-safety training exercise. Photo: U.S. Coast Guard.

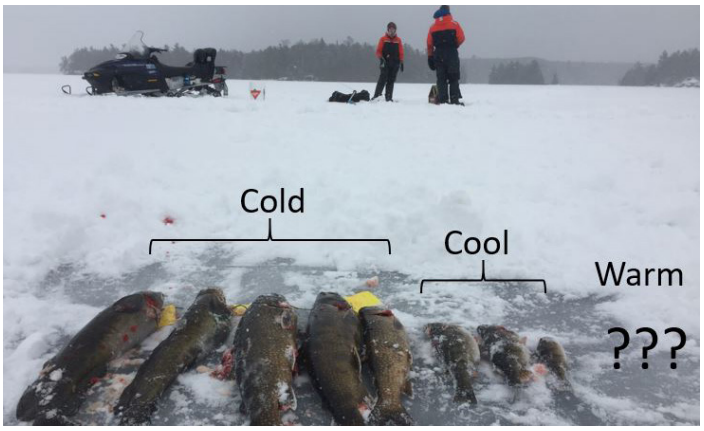
R. Michael McKay, Great Lakes Institute for Environmental Research, University of Windsor and Great Lakes Center for Fresh Waters and Human Health, Bowling Green State University

Winter shapes fish behavior and species interactions

For temperate fishes, winter is a dramatically different environment than all other seasons: temperatures decline to near freezing, light is reduced, and, in some systems, oxygen and prey density also decline. As any ice angler can attest, fishes respond differently to these winter conditions; some remain active, while others become inactive (see image). However, the ecological consequences of differential responses to winter in fish communities remain poorly studied.

Our paper demonstrates how fish habitat use and activity differ from summer to winter and vary among coexisting species. Specifically, using acoustic telemetry, we show that lake trout (*Salvelinus namaycush*) move nearshore into littoral habitats and remain active throughout the winter. In contrast, smallmouth bass (*Micropterus dolmieu*), a littoral warm-water species, move to slightly deeper water and dramatically reduce their activity rates, weakening the potential for interspecific competition in this species pair. Activity patterns for lake trout and burbot (*Lota lota*), two cold-water species, are also shown to diverge throughout the year.

We argue that winter could play a widespread role in promoting coexistence in freshwater fishes. Periods of low temperature, light, and oxygen provide rich opportunities for species to diverge, and these divergent responses to winter appear widespread both across and within thermal guilds. Alarmingly, competition models developed in our study suggest that shorter winters, already arising under a changing climate, threaten this seasonally mediated coexistence. Quantifying how diverse physiological and ecological responses to winter vary across species and populations and shape species interactions from small to large lakes remains a fruitful avenue for future research.



Fishes respond differently to winter conditions. Species that remain active during winter tend to belong to the cold- and cool-water thermal guilds. Species that reduce their activity, making them challenging to catch under the ice, tend to belong to the warm-water thermal guild. Photo: Bailey McMeans.

By Bailey McMeans, University of Toronto Mississauga

Filling data gaps: A project to measure winter oxygen and carbon dioxide levels in western Lake Erie

Lake Erie faces an onslaught of stressors including climate change, eutrophication, invasive species, and harmful algal blooms. Two dissolved gases, oxygen (O_2) and carbon dioxide (pCO_2), can act as tracers of the past (e.g., temperature, wind, metabolic history), influencers of the present (e.g., fisheries and harmful algal bloom impacts), and indicators of the future (e.g., improve modelling of lake processes and climate). Despite the importance of these gases, large data gaps exist throughout the year. Measurements of O_2 and pCO_2 are particularly limited in the winter, when ice cover and harsh conditions hinder sampling efforts.

To help remedy this, a team from Oberlin College headed to South Bass Island for the 2020 winter term. A pump off the dock at Stone Laboratory continuously supplied flow-through water for sonde measurements and discrete sampling of a suite of biogeochemical parameters including pH and alkalinity. In addition, we assessed the balance of photosynthesis and respiration of the water column using an Equilibrator Inlet Mass Spectrometer, which continuously measures the water's oxygen-argon ratio, or biologically driven oxygen signal.

During January, we derived pCO_2 values ranging from 380-525 μatm, with this lake region on average behaving as a source of CO_2 to the atmosphere at this time. As the season progressed, we observed a shift to net autotrophic conditions with daily variability tied to storm events and fleeting ice. Our study season was a particularly low ice year, so may be reflective of more common conditions in the future. Work is ongoing to amass winter O_2 and pCO_2 data from more locations and years and connect winter processes to spring and summer dynamics and blooms.

By Rachel Eveleth, Oberlin College, Oberlin, Ohio

Winter and summer bathymetric distribution and diet of benthic fishes in Grand Traverse Bay, Mich.

We set micro-mesh gill nets from December 2015 to August 2016 in Grand Traverse Bay and used a remotely operated vehicle to document distributions and diets of benthic fishes. Gill nets captured 1,952 fish of 19 species, with alewife *(Alosa pseudohargenus)* (29%), rainbow smelt *(Osmerus mordax)* (24%), and round gobies *(Neogobius melanstomous)* (17%) most abundant. Alewives migrated to depths of greater than 100 meters during winter and 20 meters during summer. Round gobies migrated to deep water by December, then to less than 20 meters during summer. The largest individuals led the migration.

Video showed round gobies composed 88 percent, alewife 6 percent, and deepwater sculpin *(Myoxocephalus thompsoni)* 7 percent of observations in 70–125 meters and 15, 73, and 12 percent, respectively in 166–191 meters. The proportion of round gobies increased with increasing quagga mussel densities, but maximum densities were observed around objects, such as trees. Many round gobies were found near dead fish, presumably for food and shelter (see photo). One deepwater sculpin guarding a nest was found on March 16, 2021, marking the first time this behavior was observed.

Presumed lake whitefish *(Coregonus clupeformis)* carcass surrounded by many round gobies, December 22, 2015, in 122 meters of water in the west arm of Grand Traverse Bay, Lake Michigan. Photo courtesy of Marine Technology/ Northwestern Michigan College.

Round goby winter diet was insects, fish, quagga mussels *(Dreissenia bugensis)*, and *Mysis*. Round gobies did not eat fish eggs or larvae. Predator winter diets included alewives, round gobies, and *Coregonus* spp. *Mysis* were most abundant on sand and occurred in schools. Quagga mussel densities were inversely related to depth, and they formed large, dense colonies (druses) in March not seen in December. Through this research, we elucidated a better understanding of the winter distribution and diet of benthic fishes and predators that may be used to monitor fish abundance and year-class strength.

By David Jude, University of Michigan, and Hans Van Sumeren and John Luchco, Northwestern Michigan College.

Earlier winter-spring runoff leads to lower summer primary production in temperate lakes

Winter conditions are changing rapidly, and such changes have the potential to impact lake ecosystems across seasons. However, how these changes may play out on a global scale is difficult to quantify. Hydrologists have documented earlier runoff occurring in watersheds worldwide, but we do not fully understand the ecological impacts of earlier runoff on receiving bodies, such as lakes. A group of researchers from the Global Lakes Ecological Observatory Network (GLEON) explored how changes in spring runoff timing affected summer chlorophyll-a (a proxy for phytoplankton biomass). The study was published in the October issue of Global Change Biology.

We compiled long-term monitoring data sets from 41 temperate lakes across North America and Europe that included stream runoff measurements, summer chlorophyll-a, and several covariates. We found that years with earlier runoff had lower summer chlorophyll-a. Years with early runoff also tended to have more protracted runoff and lower runoff volume. Although early runoff correlated with early ice-out, ice-out timing was not related to summer chlorophyll-a. The result that lower summer productivity occurs with earlier runoff is likely linked to changes in nutrient input timing and availability. For example, lower-volume winter melting events that happen in early runoff years may contain nutrients that are quickly flushed out of a lake, taken up by heterotrophic bacteria, or taken up by sinking diatoms. In contrast, years with later runoff that occurs in a concentrated "spring flood" may be more available for entrainment in the upper water column, where they are available to summer phytoplankton. Our results suggest that winter conditions set the stage for open-water phytoplankton growth in lakes.

Early spring ice loss on Otsego Lake, New York. Photo by Kiyoko Yokota.

By Allison Hrycik, Great Lakes Center, SUNY Buffalo State College.

New Centre for Indigenous Fisheries

The Centre for Indigenous Fisheries (CIF) was launched at the University of British Columbia in the Institute for the Oceans and Fisheries in early 2021. The CIF is led by Dr. Andrea Reid (citizen of Nisga'a Nation) serving as the principal investigator, and Professor Emerita Dr. Dianne Newell serving as the interim director. The CIF aims to become a national and international hub for Indigenous fisheries research and work. Since its launch, several students at both the graduate and undergraduate level have joined the CIF with involvement from faculty, Indigenous community partners, and fisheries professionals.

Youth from Gingolx (the village of Dr. Reid's family) aboard the MV Gikumi in the Portland Inlet on British Columbia's North Coast in 2018. Photo by Andrew Stewart.

"We are working toward a future where culturally significant fish and fisheries are valued and protected in the long-term," explains Dr. Reid. "Our research is fundamentally community centered, employing both Indigenous research methodologies as well as tools and understandings from both Indigenous and Western sciences. This research will be done *with* communities, not *on* them—with their permission, oversight, and in response to community needs. Indigenous knowledges, methods, and values will fundamentally steer what we do, how we do it, and where we go."

The CIF's new Ph.D. student, Alexander Duncan (member of the Chippewas of Nawash Unceded First Nation and member of the IAGLR Board of Directors) plans to be the first CIF member to focus on the Great Lakes. His research will center on Indigenous perspectives and input on sea lamprey control in both Canada and the United States.

Smart Great Lakes Initiative seeks case study examples

The Great Lakes Observing System (GLOS) has developed the "Common Strategy for Smart Great Lakes" that charts a course for how the Smart Great Lakes Initiative (SGLi) will advance technology applications that improve understanding, use, conservation, and management of our relationships with the Great Lakes system. Working to facilitate access to real-time and historical Great Lakes data for all of those in the region, the SGLi seeks case studies of how these technologies can support better decision making, management, and conservation in the Great Lakes basin and open waters. Launched in October 2019, the initiative has worked to combine smart technologies—including remote sensors, artificial intelligence, cloud computing, and advanced data management and analysis—to improve the way people learn about and respond to lake events, stressors, and management challenges. Example case studies can be found at www.glos.org/priorities/smart-great-lakes. Do you have a potential case study or story of how these technologies might benefit the Great Lakes and those who live here? Please contact Katie Rousseau (katie@glos.org).

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