

# Preserving the legacy of lake ice records: Insights from a long-term community science network

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## Introduction

Lake ice is a critical foundation for many northern communities. Lake ice forms the basis for cultural and recreational activities, from ice fishing and skating to community gatherings (Magnuson and Lathrop 2014; Knoll et al., 2019). In remote communities, seasonal ice cover also provides transportation and essential services, including access to food, fuel, and medical care (Hori et al. 2017). As lake ice becomes less reliable, the ecological, cultural, and social systems connected to it are increasingly disrupted.

Lake ice records collected directly by community scientists, some long before the advent of meteorological stations and even the start of the third Industrial Revolution, reveal that lakes are rapidly losing ice cover. Ice duration has declined by 18 days/century in lakes across the Northern Hemisphere, with rates of ice loss six times faster in the past 25 years (Sharma et al. 2021). Through consistent observations collected over decades to centuries, community scientists have helped build some of the most valuable long-term lake ice records available today (Sharma et al. 2022).

One such effort is the Community Lake Ice Collaboration (CLIC), established in the 1980s by Dr. Kenton Stewart to gather ice-on and ice-off observations from individuals across Maine, Michigan, Minnesota, New York, and Wisconsin (Sharma et al. 2023). These records have been used by scientists to study climate impacts on freshwater systems while also strengthening relationships between researchers and the communities most closely tied to these lakes. In this article, we share five perspectives from community scientists, each with their own

motivations for contributing to scientific research (Figure 1). Together, we highlight the human side of community science and the powerful role individuals play in advancing our understanding of the world in a changing climate.

## Honoring a family legacy

Bill Raaths entered into the world of limnology not through formal training or career ambition, but family connection. Bill Raaths is the brother-in-law of Kenton Stewart, a professor at the University of Buffalo who formally started the CLIC program in the 1980s. With a 15-year age gap, Ken became a big brother to Bill when Ken married Bill's older sister Ardis, shaping his life in lasting ways. Ken was Bill's first introduction to lake science, where he joined Ken on many early mornings of field sampling as a young adult.

Ken's passion for science was contagious, with Bill recalling his mother's refrigerator being crowded with water samples and quickly learning the importance of careful scientific methodology as one mistake meant starting over. These small moments left a lasting impression on Bill, remembering the time, care, and dedication that went into studying lakes.

Although Bill eventually built a successful career in business, his connection to lake science was rooted in these experiences as a young adult with Ken. Years later, after purchasing a cottage on Hills Lake in Wisconsin, Bill began recording ice dates for CLIC in 2013. He was hesitant at first, as this meant early mornings and long drives, a familiar reminder of the commitment and work that was required. However, Bill came to see this participation as a way of carrying forward a small piece of Ken's

life passion.

Over the years, Bill has noticed changes in the lake, with less snow and more variability in snow and ice conditions between years. Still, his motivation to continue monitoring is less rooted in climate advocacy, but more in respect and love for Ken. For Bill, collecting ice data is a way of honoring Ken, preserving the care and discipline that defined his approach to science. In doing so, Bill feels he is maintaining a small but meaningful portion of Ken's legacy, or as he puts it, Ken's "magic."

## Forging a community connection

For Georgina Shafer and Jennifer Tice, Fishers Lake in Three Rivers, Michigan, is more than just a place to live; it is the heart of their community and identity. Both have long ties to the lake, with family histories rooted in the same shoreline. For generations, seasonal activities like skating, swimming, and family gatherings have shaped life along the water. They see it not as a separate place, but an extension of their home and a central part of community life. Their participation in community science through CLIC is closely tied with the continuation of the annual ice pool in Fishers Lake. Each year, community members contribute 25 cents to guess the date of ice-off, with the closest guess securing the winnings.

The ice pool tradition began in the 1970s with Molly Roth, known as the "ice queen," and her family. It then expanded beyond the Roth family to a shared community event as Molly welcomed broader participation and fostered a sense of collective ownership. It is likely that Ken Stewart had contacted Molly in the 1980s, inviting her to contribute these ice-off dates to CLIC and formally linking



Figure 1. Photographs illustrating the diverse culture, recreational, and scientific dimensions of lake ice: (A) appreciating natural beauty, shown by Fishers Lake frozen in winter (photo by Georgina Shafer); (B) fostering community connections, featuring ice boats and a plane landed on the shoreline of frozen Lake Kegonsa (photo by Debra Kundert); (C) winter recreation, depicted through communal ice fishing on Perch Lake (photo by Pat Collins); (D) scientific monitoring, showing members of the Wisconsin DNR beginning spring sampling in Vilas county (photo by Greg Sass); and (E) familial ties, featuring Bill Raaths with his brother-in-law Dr. Ken Stewart, founder of CLIC (photo by Bill Raaths).

the local tradition with long-term scientific records. Now in its 48th year, the ice pool continues to bring the community together while generating invaluable long term ice data. By sustaining this tradition and contributing to CLIC shortly before Molly passed in 2021, Georgina and Jennifer honor Molly's legacy while strengthening community bonds. Their commitment reflects a responsibility to Molly Roth and honoring past traditions, as well as a desire to pass on environmental values to the future generations of people who will live on this lake.

### **Love for the environment**

Pat Collins' long-term monitoring efforts reflect a lifelong interest in environmental systems and the belief in the power of consistent observations. His love for the environment is an extension of his 35 year long career at the Wisconsin Department of Natural Resources. Pat brought this passion home to Perch Lake in Wisconsin, where his family has lived since 1991. Perch Lake is a small, endorheic lake and very sensitive to precipitation making it particularly responsive to changes in the environment.

Pat has recorded ice dates, water levels, water clarity and water quality, viewing his backyard as a personal laboratory. He sees the lake as a living system that is deserving of careful attention. Over time, he and his family have witnessed fluctuations in water levels and a high increase in recreational pressure, reinforcing the importance of maintaining long term records.

This work is deeply meaningful to Pat because it provides undeniable and grounded evidence that lakes are changing in ways that affect people's everyday experiences. He takes pride in contributing his observations to the broader CLIC community, believing sustained local data helps ensure these changes are recognized beyond his own lake and within a broader understanding of a changing world.

### **Fostering lake stewardship**

At Lake Kegonsa in Wisconsin, long-term ice monitoring is embedded in a broader culture of lake stewardship and community care. Through the Friends of Lake Kegonsa Society, a non-profit established in 1988 with roughly 500 members, Debra Kundert and Cathie Taylor help coordinate ice data collection

alongside water quality monitoring, cleanup projects, education, and advocacy, all aimed at protecting the long-term health of Lake Kegonsa.

Ice records on this lake go back to 1902. It is believed that data was initially documented by the University of Wisconsin Centre for Limnology and then later individuals living on the lake. This includes Doug and Ardys Pfundheller and Sheryl Renslo, who independently kept extremely detailed handwritten ice records in a diary, reflecting a long tradition of close observation by lakeside residents. In 2016, the responsibility for recording ice dates formally transitioned to the Friends of Lake Kegonsa Society, ensuring the work would persist beyond a single observer.

Having lived on the lake for decades, Deb and Cathie have witnessed significant changes in development, water quality, and winter weather. For them, a key part of their stewardship is to continue to protect the lake itself, as well as its history. Ensuring these records continue beyond any single person is vital to stewardship, showing a commitment to learning from the past while also preparing future generations to care for the lake. By embedding ice monitoring within a stable organization, they guarantee the data will continue and inform future generations.

### **Commitment to open data science**

Greg Sass' contribution to long-term monitoring stems from his commitment to open science and the communities that depend on these lake systems. As the fisheries research team leader with the Wisconsin Department of Natural Resources, Greg oversees five experimental fisheries research lakes in Vilas County, where ice observations have been recorded consistently since the Northern Highland Fishery Research Area founding in the 1940s.

Although the ice observations were not central to the original research objectives of fisheries-related projects, the continuation of these ice observations are now invaluable since being passed onto CLIC. Greg inherited responsibility for maintaining these records through his position and is committed to carry the work forward until it comes time to pass it on to the next individual. Greg's motivation does not lie in why these records began, but instead ensuring their continuity for

whoever and whatever comes next. Over time, Greg has observed changes in ice duration and variability, recognizing ice cover as one of the most visible environmental signals for lake users with implications for recreation and local winter economies.

Shorter and more variable ice seasons disrupt activities such as ice fishing, snowmobiling, and skiing, creating cascading impacts for tourism-dependent communities in a region with few permanent residents. By contributing data to CLIC, Greg helps ensure that long term records remain widely available for scientific research and public understanding. For him, this data serves as a bridge between scientific observation and lived experience, strengthening awareness, informing local management decisions, and supporting the lakes and communities that rely on them.

### **Conclusions**

Community based monitoring programs such as CLIC highlight the value of community science. Through sustained participation, community scientists generate long-term, *in situ* observational datasets that would otherwise be impossible to maintain through traditional funding sources alone, particularly at the vast spatial scales covered by CLIC community scientists (Lopez et al. 2023). The value of these long-term records is further amplified by the unique scientific insights they provide. *In situ* observations enable researchers to track ice phenology across hundreds of lakes, including smaller systems that are frequently missed by satellites or unrepresented in large-scale analyses.

Many of these community ice records also extend back decades to centuries, making them indispensable for long-term climate assessments (Sharma et al. 2022). Notably, many of the CLIC lakes are located in regions experiencing rapidly warming winters and some lakes are at high risk of losing seasonal ice cover in the coming decades. As a result, community-based monitoring provides critical data for understanding where and how ice regimes are changing.

Beyond the data they generate, community-based monitoring programs foster deep connections between people and the lakes they observe, encouraging stewardship rooted in lived experience and

long-term relationships with the lakes. By grounding scientific research in local knowledge and ongoing observations, these programs help ensure that research remains relevant to the people most directly affected by changing ice conditions.

Partnerships between researchers and community scientists also build trust, strengthening the credibility and impact of scientific findings. In this way, volunteer engagement transforms data collection into a joint initiative that strengthens long-term environmental research and stewardship. As climate change continues to alter freshwater systems, volunteer monitoring programs will remain vital for generating the long-term datasets needed to document these shifts, affirming that meaningful environmental science is built through collaboration with the people whose commitment sustains both the research and the lakes themselves.

### Acknowledgements

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**Faith Ferrato** is a Research Assistant in the Department of Biology at York University working in the field of limnology. She recently completed a Master of Science degree at York University, where her research focused on lake ice phenol-

ogy and how changing climate conditions influence freshwater ecosystems. Faith now works on collaborative research projects that use long-term datasets to examine climate-driven changes in lake ice and their implications for northern aquatic systems.



**Sapna Sharma** is a Professor and York Research Chair in Global Change Biology in the Department of Biology at York University. Her research aims to understand how lakes worldwide respond to climate change, including rapid ice loss, warming water temperatures, degrading water quality, and changing fish distributions. She is also a dedicated science communicator aiming to create more inclusive science communities, for example by founding SEEDS, an outreach program for refugee families, and serving as the Inaugural Founding Academic Director of the United Nations Institute for Training and Research (UNITAR) Global Water Academy. Sapna can be reached at [sharma11@yorku.ca](mailto:sharma11@yorku.ca).



**Patrick Collins** has been a member of the Community Lake Ice Collaboration for 30+ years. Before he retired, he worked for the Wisconsin Department of Natural Resources as an environmental hydrogeologist. He enjoys hiking, biking, camping and spending time with his family and friends.



**Debra Kundert** is a retired Registered Nurse, Ultrasonographer who is enjoying lake life on Lake Kegonsa in southern Wisconsin. She volunteers her time on the Friends of Lake Kegonsa Society Board of Directors. Deb has been involved with numerous activities including organizing several educational presentations, performing end of pier water monitoring, installing Wood Duck houses, and monitoring the lake’s ice events.



**Bill Raaths** retired as CEO and Chair of the Board of Great Northern Corporation, a leading packaging business headquartered in Appleton, Wisconsin. Bill is a graduate of the University of Wisconsin-Madison and a Vietnam veteran. Bill attributes his love for lakes to the many trips to Wisconsin and New York collecting lake samples with his brother-in-law and program founder, Ken Stewart.



**Georgina Shafer** is a retired Geographic Information Systems (GIS) Specialist with a background in Earth Science and Hydrogeology. She has led Fisher Lake's participation with the Community Lake Ice Collaboration (CLIC) since 2020; and along with her retired Environmental Engineer husband Eric, has collected data for the Cooperative Lakes Monitoring Program (CLMP) since 2010. She hopes to instill her love of the environment and nature with her grandchildren and future generations. You can contact Georgina at [goldin.shafer@gmail.com](mailto:goldin.shafer@gmail.com).



and in 1970, she and her husband, Emerson, bought their first lake house on Lake Kegonsa, the 5th lake of the chain of lakes connected by the Yahara River. Cathie joined the Board of Friends of Lake Kegonsa Society (FOLKS) in 2011 and was active on the Board until 2023. Having lived on this lake for 55 years, she has observed many changes. But nothing has changed her love for living on this lake and doing what she can to make sure it remains healthy for all of us to enjoy.

**Greg Sass** is Fisheries Research Team Leader and Director of the Northern Highland Fishery Research Area in the Office of Applied Science with the Wisconsin Department of Natural Resources based in Boulder Junction, WI. His research primarily focuses on fisheries management and ecology, whole-lake experiments, and long-term ecological studies. You can contact Greg at [Gregory.sass@wisconsin.gov](mailto:Gregory.sass@wisconsin.gov).



**Cathie Taylor** grew up within walking distance to three of the five lakes surrounding Madison, WI – Lake Mendota, Lake Monona, and Lake Wingra, and spent summers swimming at their beaches with her friends. It was always her dream to live on a lake



**Jen Tice** is a retired English teacher and public librarian with a broad background in the sciences. She is a prolific reader of nonfiction, especially Great Lakes geology. Jen has lived on Fisher Lake for 48 years and has family who live on the lake. Jen considers the lake to be an extension of her front yard and seeks to nurture the lake just as she does her family and gardens. Her favorite hobby is rock and fossil collecting.



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