GLISA
A NOAA RISA TEAM

Predicting Lake Ice with the Apostle Islands National Lakeshore

Overview

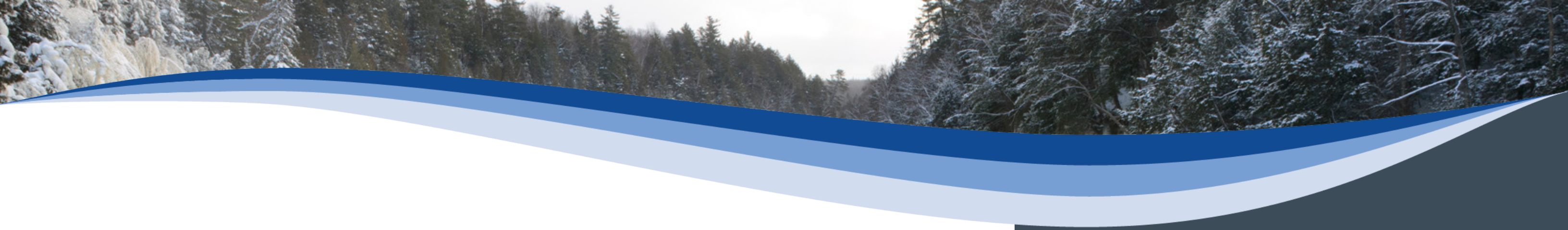
- **Purpose:** To forecast the onset of seasonal ice coverage in Lake Superior to inform Apostle Islands National Lakeshore management and planning.
- **Partner:** National Park Service (NPS), NOAA Great Lakes Environmental Research Laboratory (GLERL), University of Miami
- **People:** Apostle Islands National Lakeshore staff
- **Impact:** Created a new model that can successfully forecast the likelihood that Lake Superior freezes firmly enough to provide safe access to the caves, as well as the date of ice formation.

On Apostle Islands National Lakeshore, along the coast of Lake Superior near the border of Wisconsin and Michigan's Upper Peninsula, ice caves used to be a regular occurrence. Consistently cold weather would allow the caves to form, and visitors could walk on frozen Lake Superior to witness a winter spectacle. A 2018 report by the National Park Service estimates over 250,000 visitors to the park that year, generating $40 million in visitor spending and 576 jobs.The total economic output for that year was calculated to be $48 million, with 98.5% of spending coming from non-local visitors. Ice cover at Apostle Islands used to be certain, but starting in the 1990s a period of variability began with several years of no safe ice cover due to climate change that continues today.

The extreme variability in temperature and ice cover has made planning very difficult for the National Park Service (NPS), which manages Apostle Islands. To open the caves, the park needs to ensure that the lake ice is thick enough to support thousands of visitors. Sending out staff to assess the status of the ice and caves can also be risky. Then there's the question of budgeting—how do you manage the park's financials without knowing whether it will receive revenue from 250,000 visitors, or no visitors at all? In a 2015 scenario planning process to help the NPS envision and prepare for possible future climate conditions, a park official wondered aloud about whether it would be possible to predict ice formation in time for the park to make planning decisions. The question sparked a partnership between Apostle Islands and Great Lakes Integrated Sciences and Assessments (GLISA).

Generally, ice forms through interactions between water levels, temperature, and atmospheric events. To model these dynamics, GLISA staff and partners at the NOAA Great Lakes Environmental Research Laboratory (GLERL) and the University of Miami looked to phenomena such as El Niño and the Arctic

Icicles in Apostle Island Sea Cave. Source: Flickr, Billboard Art Project.



Oscillation (commonly referred to as the Polar Vortex), as well as park-provided historical data on when the caves had formed and Lake Superior had frozen. The team tested multiple types of statistical models, ultimately borrowing one that is more commonly used in the environmental health field. Continuous communication between researchers and Apostle Islands staff helped ensure the model was relevant to the park's physical environment and the NPS's management needs.

The effort has yielded exciting results. The new model can successfully forecast the likelihood that Lake Superior freezes firmly enough to provide safe access to the caves, as well as the date of ice formation. The predictions are extremely localized—a major step forward in modelling capability—and can be made months in advance, in time for the NPS to plan its staff and budget for the upcoming season. Many previous efforts have focused on ice cover on the lake as a whole. By focusing on a small area, it is possible to find relationships between weather and local conditions that make ice formation possible, even in years when conditions are not supportive of lake-wide ice formation. The predictive power of this new model empowers decision-makers at Apostle Islands National Lakeshore in a way not previously possible.

The new model was published in the 2019 The Journal of Climatic Change, and the article received substantial media interest and news coverage. Looking forward, GLISA sees an opportunity to do similar work at other NPS sites, and the ultimate impact could be wide-ranging. GLISA's ongoing work aims to update the model with the most recent data, incorporate a broader suite of predictive variables, and explore offering the forecast via a user interface accessible to the general public.

"These models could be useful not only for supporting safe pedestrian traffic on ice in coastal areas of the Great Lakes, but for large and small-craft vessel navigation, fishing and hunting, and other human activities around the world."

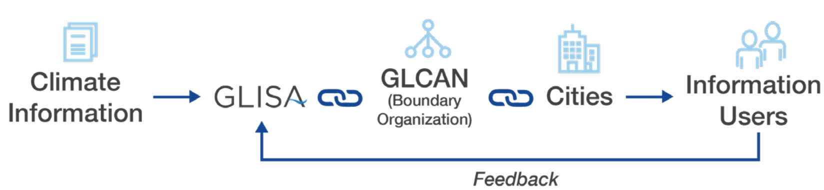
– Richard Rood, GLISA Co-Principal Investigator and Professor, University of Michigan Department of Climate and Space Sciences and Engineering

About GLISA

Advancing Climate Knowledge for Adaptation and Resilience with Great Lakes Communities

Established in 2010, GLISA is a collaboration between the University of Michigan and Michigan State University, supported by the National Oceanic and Atmospheric Administration (NOAA). As one of 11 NOAA Regional Integrated Sciences and Assessments (RISA) teams, GLISA works at the boundary between climate science and decision-makers, striving to enhance Great Lakes communities' capacity to understand, plan for, and respond to climate impacts now and in the future. Our team of social and physical scientists collaborates to:

- Develop usable climate information tailored to stakeholder needs;
- Develop, implement, and evaluate resources and tools to apply climate information to decision-making;
- Facilitate collaborative activities, education, and training and support stakeholder networks; and,
- Investigate emerging climate issues and synthesize findings for practitioners.



Example of GLISA's boundary chain model of stakeholder engagement for the Great Lakes Climate Adaptation Network (GLCAN). Climate information is tailored and moves through different boundary organizations (links in the chain) to connect science to users. Adapted from Lemos et al. 2014.

Great Lakes Integrated Sciences + Assessments (GLISA)
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