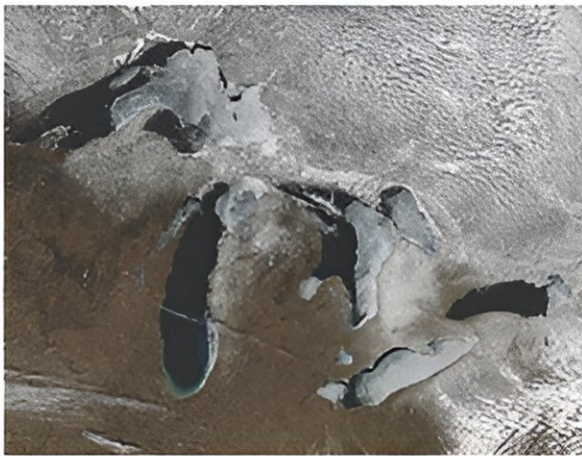


# Researchers investigate how freshwater diatoms stay in the light

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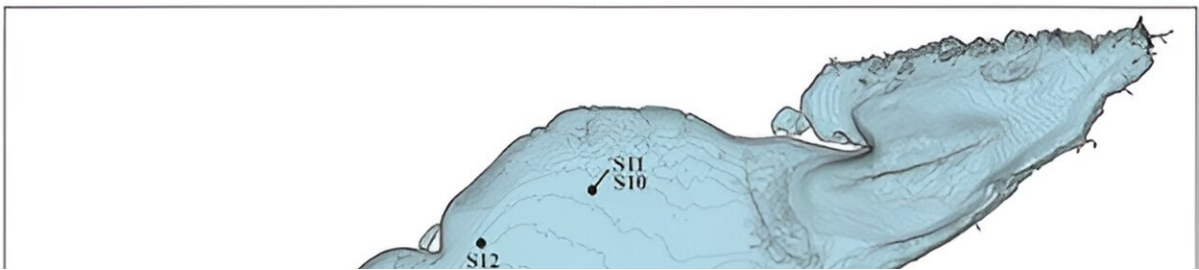
A.



B.



C.



Climatic, spatial and temporal variability across Lake Erie samples. (A) MODIS satellite image (March 16th, 2014) depicting a large amount of ice cover across the Great Lakes. During the winter of 2014, Lake Erie had a mean annual ice cover of ~80%. (B) MODIS satellite image (February 12th, 2023) depicting a lack of ice cover across the Great Lakes. Sediment plumes can be observed throughout Lake Erie (the light brown coloration in the satellite image). During the winter of 2023, Lake Erie had a mean annual ice cover of ~8%. Figures adapted from data retrieved from the NOAA Great Lakes CoastWatch Node

(NOAA 2023). (C) Sample sites across Lake Erie visited throughout winter-spring 2019 and 2020. (D) Historical trends in Lake Erie mean annual maximum ice cover (%). Open circles are years that (to our knowledge) do not have peer-reviewed published planktonic survey data. Solid black circles are years that were previously surveyed in prior published studies. Solid blue circles are years sampled in this study. Figure adapted from data retrieved from the NOAA GLERL database (NOAA-GLERL). Credit: *The ISME Journal* (2024). DOI: 10.1093/ismejo/wrad015

Spring weather brings welcome conditions for flowers and plant life to bloom across the land. The right mixture of temperature, moisture, and light helps keep the green world vibrant.

Underwater plant life generally responds to similar environmental encouragements, but a curious discovery in Lake Erie circa 2012 led microbiologists to study an unseasonal display of winter abundance. Blooms of diatoms—microscopic, photosynthetic algae—were alive and well beneath (and within) the lake's ice cover.

"Some of the main winter-spring diatom bloom formers, like *Aulacoseira islandica*, have a [symbiotic relationship](#) with heterotrophic bacteria capable of forming tiny ice crystals, which over time causes the diatom filaments to become buoyant—just as ice cubes float in your favorite beverage," said Brittany Zepernick, a post-doctoral researcher and SEC Emerging Scholar in UT's Department of Microbiology.

These "diatom ice cubes" float to the Lake Erie ice cover and embed within it, putting them in position to absorb the light needed to perform photosynthesis throughout the winter months. It was good news for diatoms, which are a vital component of the cumulative ecosystem in lakes and oceans across the globe

This curious adaptation is threatened, though, as warming [global temperatures](#) have led to widespread ice decline across the Great Lakes, leaving Lake Erie in a nearly ice-free state in several recent winters and leaving diatoms stuck in murky, light-deprived waters. In these new "climatically uncharted waters," the adaptations that benefitted these winter diatoms for so long suddenly ceased to serve them.

So, what's a diatom to do? Zepernick and colleagues turned to the shores of Lake Erie to investigate the evolving situation. With the help of the US and Canadian Coast Guard, they sampled the ice-covered (in 2019) and ice-free (in 2020) winter waters of Lake Erie to learn how diatoms were responding to changing environmental conditions. They recently [published](#) their work in the *The ISME Journal*.

Two main diatom genera dominate the winter blooms: *Aulacoseira islandica* and *Stephanodiscus* spp.

"The abundance of *Stephanodiscus* spp. was approximately 70 percent lower in the ice-free water column of 2020 compared to the ice-covered water column of 2019," said Zepernick. "Likewise, the abundance of *Aulacoseira islandica* was around 50 percent lower in the ice-free water column compared to the ice-covered water column."



Brittany Zepernick. Credit: University of Tennessee, Knoxville

With ice cover across the Great Lakes at record lows—from around 80% covered in ice in 2018 and 2019 to just 8% covered in 2023—researchers expect this trend will continue in future winters.

The next step is studying how this impacts Lake Erie, which joins the other Laurentian Great Lakes of the US and Canada to cumulatively contain approximately 20% of the globe's fresh water.

"Despite the critical importance of this system, we didn't know diatom blooms even formed in the winter-spring months until around 2012," said Zepernick. "Many researchers have referred to the winter water column as a 'new frontier' or a 'black box.' What we do know is that

diatoms are critically important to regional lake ecosystems and [global climate](#)."

Diatoms make up an estimated 20% of global carbon sequestration and oxygen production, play an enhanced role in global biogeochemical cycles, and represent a critical component of the aquatic ecosystem in freshwater systems.

"Hence, the large-scale changes already underway to the [winter](#)-spring diatom communities in Lake Erie and other lakes across the globe will result in large-scale biological and biogeochemical change," said Zepernick.

The light at the end of the icy tunnel could rely on the diatoms' potential to adapt. Zepernick's recent work indicates they could possibly form clusters with adhesive proteins called fasciclins to "raft" to the surface of the muddy waters via "underwater waves" produced by wind, convection, and underwater currents.

Another adaptation Zepernick hinted at was that diatoms could increase their use of proton-pumping rhodopins (PPRs)—light harvesting, retinal-containing proteins that could serve as an alternative to classical photosynthesis. She is currently attempting to isolate freshwater diatoms from Lake Erie samples that possess PPRs to create a model freshwater diatom-PPR system for further study. Her findings could offer clues to the diatoms' next move in a rapidly changing climate.

"PPRs are a hot topic within marine literature, yet we know very little about how these mechanisms apply to freshwater systems and taxa," she said. "I am interested in elucidating the benefits PPRs may confer to both freshwater and marine diatoms across a variety of emerging—and future—climatic stressors."

**More information:** Brittany N Zepernick et al, Declines in ice cover are accompanied by light limitation responses and community change in freshwater diatoms, *The ISME Journal* (2024). [DOI: 10.1093/ismejo/wrad015](https://doi.org/10.1093/ismejo/wrad015)

Provided by University of Tennessee at Knoxville

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