Weekly Report – June 13, 2025

Cooperative Institute for Satellite Earth System Studies (CISESS)

NOAA/NESDIS/STAR

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PUBLICATIONS

Examining Chlorophyll Changes in the Great Lakes

Citation: Nezlin, Nikolay P., **SeungHyun Son**, **Christopher W. Brown**, Prasanjit Dash, Caren E. Binding, Ashley K. Elgin, and Andrea VanderWoude, 2025: Regime shifts in satellite-derived chlorophyll within the Laurentian Great Lakes. *J. Great Lakes Res.*, **51**(3), 102573, https://doi.org/10.1016/j.jglr.2025.102573.

Summary: The Laurentian Great Lakes are one of the largest freshwater systems in the world, containing 21% of the world's surface fresh water supply. This ecosystem has experienced increasing eutrophication since the time of the first European settlers to the early 1980s, with phosphorus loading to the lakes the main culprit responsible for the reduction in water quality. The U.S./Canada Great Lakes Water Quality Agreement was signed in 1972, resulting in the reduction of phosphorus loading to the lakes. As a result, phytoplankton levels significantly decreased. This situation was exacerbated by the introduction of invasive zebra and quagga mussels via the ballast water discharged from transoceanic ships. These mussels eat planktonic organisms and sequester phosphorus needed by phytoplankton to thrive. Other studies have examined changes in bioproductivity (with chlorophyll biomass, *Chl-a*, as its proxy) of the Great Lakes by field sampling or analyzing satellite retrievals of reflectance. However, most have focused on individual lakes or covered short time periods. In their paper published in the *Journal of Great Lakes Research*, CISESS Scientists SeungHyun Son and Christopher Brown and colleagues used the most recent version of the Ocean Colour Climate Change Initiative (OC-CCI) dataset, a dataset merging ocean-color products from different satellite sensors, to analyze spatiotemporal variations in *Chl-a* concentration in all five Great Lakes for the period 1997–2022. For each lake, breakpoints in regime shift, i.e., when a switch from a decreasing *Chl-a* trend to a stable or increasing *Chl-a* trend occurred, were identified, as well as the magnitudes of the regime shifts. Each lake painted a different picture of change over time, depending on the lake's biogeochemical properties, shape, and bathymetry. They report that the colonization of Lakes Michigan, Huron, and Ontario by mussels was the driving force behind the changes in *Chl-a* concentration over the period studied. For Lakes Superior and Erie, the regime change was either small or not detectable. Although the OC-CCI dataset is not well calibrated for near-shore shallow waters, overall, this dataset and the methodology described in the paper are reliable resources to detect regime shifts in different parts of the world, including major lakes.

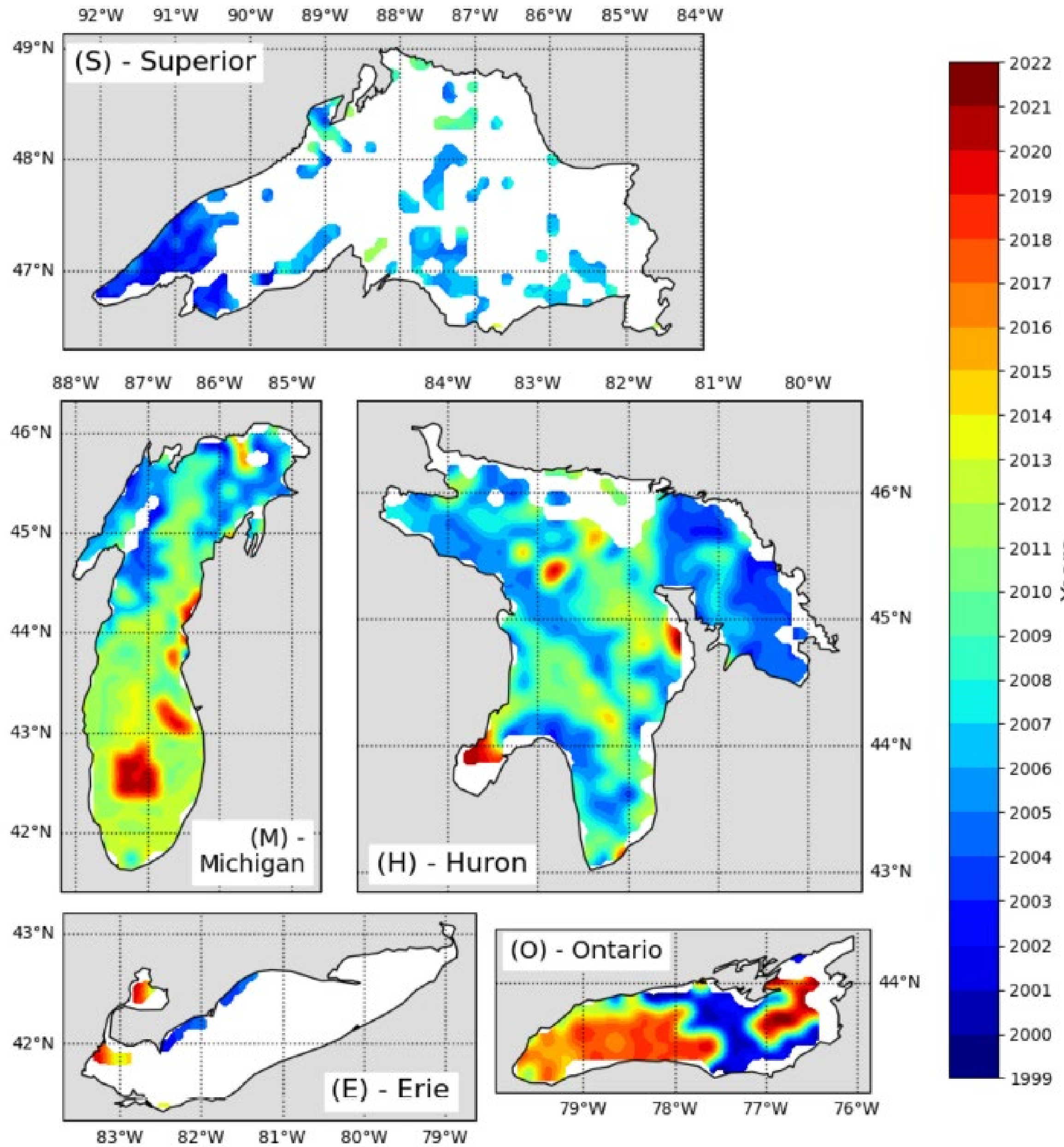

Figure. Maps of the year in which Chl-a concentrations stabilized at a lower level in each Great Lake. White indicates that no significant decrease in Chl-a was detected during the study period (1997–2022).

(SeungHyun Son, CISESS, shson@umd.edu, Funding: ORS; Christopher Brown, CISESS, cbrown12@umd.edu, retired)

An Updated Assessment of Ocean Acidification

Citation: Findlay, Helen S., Richard A. Feely, **Li-Qing Jiang**, Greg Pelletier, and Nina Bednaršek, 2025: Ocean acidification: another planetary boundary crossed. *Glob. Change Biol.*, **31**(6), e70238, https://doi.org/10.1111/gcb.70238.

Summary: Ocean acidification (OA) is one of nine planetary processes nearing a boundary that could lead to unacceptable environmental change. OA is a serious problem for marine organisms, especially those that produce calcium carbonate shells or skeletons like corals and crustaceans, among others. The aragonite saturation state (Ω_{Arag}) has become the key indicator for OA. In planetary boundary assessments, the boundary for OA is set at 80% of the pre-industrial Ω_{Arag} value, i.e., a 20% reduction from the pre-industrial surface ocean average. CISESS Scientist Li-Qing Jiang and colleagues examine in detail whether this boundary for OA is reasonable, and in general, provide an improved OA planetary boundary assessment, including adding uncertainty to the OA planetary boundary. They suggest that a revised boundary of 10% reduction from pre-industrial conditions is more representative. They note that the entire surface ocean had passed this boundary by the 2000s.

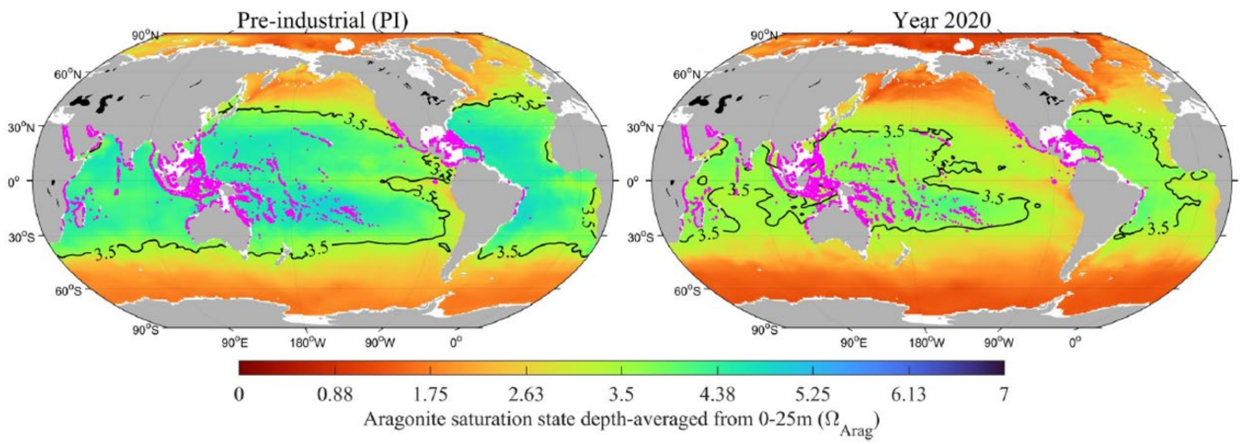

Figure. Maps of surface ocean aragonite saturation state (Ω_{Arag}): (left) Pre-industrial Ω_{Arag} and (right) year 2020 Ω_{Arag}. The black contour is the 3.5 contour showing regions that can be considered marginal conditions for coral systems, with coral reef distributions overlaid on each map in magenta dots.

(Li-Qing Jiang, CISESS, liqing.jiang@noaa.gov, Funding: NCEI)

(Maureen Cribb, CISESS, mcribb@umd.edu, Funding: CISESS Task I)