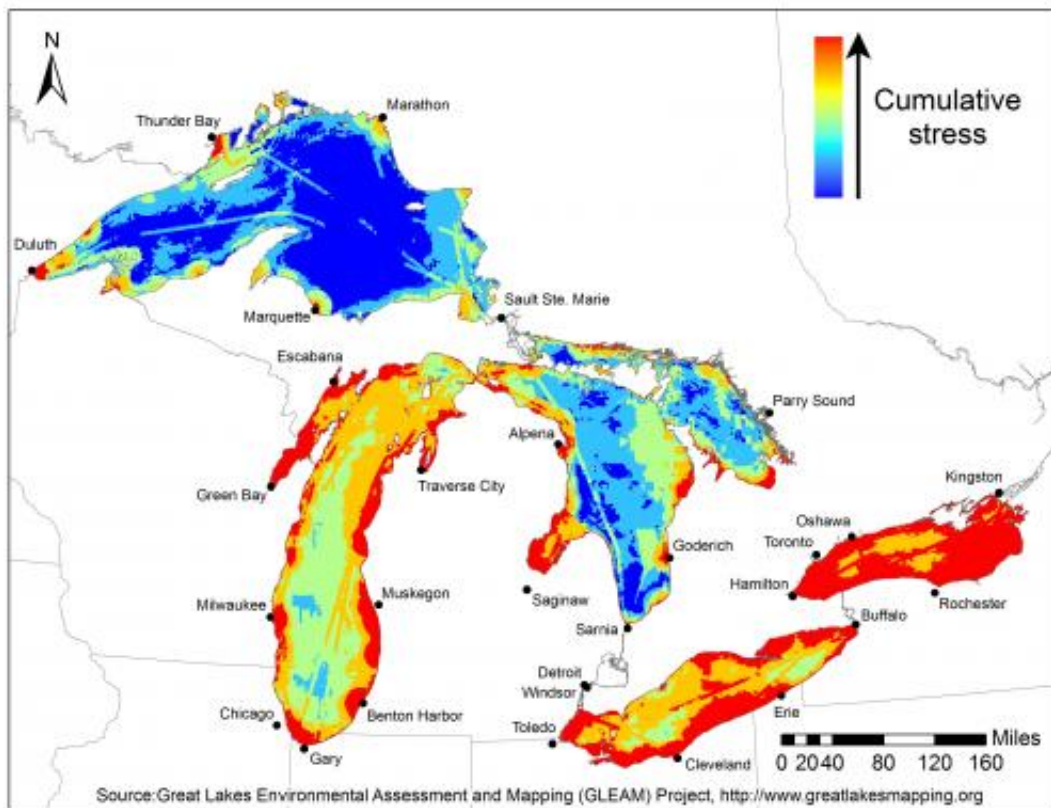# Environmental threat map highlights Great Lakes restoration challenges

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Credit: University of Michigan

A comprehensive map three years in the making is telling the story of humans' impact on the Great Lakes, identifying how "environmental stressors" stretching from Minnesota to Ontario are shaping the future of an ecosystem that contains 20 percent of the world's fresh water.

In an article to be published online Dec. 17 in the [Proceedings of the National Academy of Sciences](#), a group led by researchers at the University of Michigan reports on an expansive and detailed effort to map and cross-compare [environmental stresses](#) and the ecological services provided by the five lakes.

Their efforts have produced the most comprehensive map to date of [Great Lakes](#)' stressors, and also the first map to explicitly account for all major types of stressors on the lakes in a quantitative way.

"Despite clear societal dependence on the Great Lakes, their condition continues to be degraded by numerous [environmental stressors](#)," said David Allan, the project's lead researcher and a professor of aquatic sciences at the University of Michigan's School of Natural Resources and Environment. The map gives federal and regional officials an unprecedented scientific foundation upon which to sustainably manage the Great Lakes, the researchers conclude.

The environmental stress map was developed by a bi-national team of researchers from academia and environmental organizations known as the Great Lakes Environmental Assessment and Mapping (GLEAM) project. The team drew upon the latest and best data from federal and state agencies as well as non-governmental organizations and individual researchers.

The map represents the combined influence of nearly three dozen individual stressors and is incredibly detailed for a region spanning nearly 900 miles, showing impacts at the scale of half a mile. Thirty-four stressors were examined, including [coastal development](#), pollutants transported by rivers from agricultural and [urban land](#), fishing pressure, [climate change](#), [invasive species](#) and [toxic chemicals](#) (the full list is at [www.greatlakesmapping.org](#)).

To rank the relative importance of different stressors to ecosystem health, the team surveyed 161 researchers and natural resource managers from across the basin. Combining the mapping of multiple stressors with their ranking by experts to assess ecosystem health is an emerging new approach.

"Current efforts to conserve, manage and restore the Great Lakes often take a piecemeal approach, targeting threats one by one," Allan said. "We need to recognize that the Great Lakes are affected by multiple environmental stressors, and devise strategies based on a full reckoning."

Their work found high and low "stress" – defined as human impacts like physical, chemical or biological disruptions that potentially have adverse effects on people, plants and animals – in all five lakes. Ecosystem stress is highest closer to shores, but also extends offshore in some areas. Large sub-regions of moderate to high cumulative stress were found in lakes Erie and Ontario as well as in Saginaw and Green bays, and along Lake Michigan's shorelines. In contrast, extensive offshore areas of lakes Superior and Huron, where the coasts are less populated and developed, experience relatively low stress.

The Great Lakes provide a host of human benefits, termed ecosystem services, ranging from recreational and commercial fishing to boating, beach use and birding, with economic values estimated in the tens of billions of dollars annually. Comparing maps of ecosystem services to maps of stress, the researchers found that locations providing human benefits often were disproportionately stressed.

"Basically, our work itemizes the laundry list of things that need to be fixed and where they occur," said co-author Peter McIntyre, who began work on the study as a postdoctoral fellow at the University of Michigan and is now a professor at the University of Wisconsin-Madison's Center for Limnology. "This information can be used in any given location by

local officials and citizen groups."

Technically, the maps are known as high-resolution spatial analyses. Such tools are seen as an effective way to assess humans' impact on ecosystems by measuring environmental stressors and ecosystem services as they vary from place to place. Such approaches are beginning to be applied in coastal ocean management and are expected to help guide similar efforts in the Great Lakes, which are currently the focus of ambitious restoration efforts. When considering restoration investments, these maps allow planners to identify locations where human benefits are greatest and ensure that all relevant stressors are considered.

"The Nature Conservancy and multiple partners are already working to attack many of these stressors in places like western Lake Erie, Green Bay and the coastal areas of Lake Ontario – the very places where nature and people are inexorably linked," said Patrick Doran, a co-author on the paper and the director of conservation for Michigan and the Great Lakes at The Nature Conservancy.

A key goal of the effort was to help lawmakers and natural resource managers better plan Great Lakes-area investments, such as those under the Great Lakes Restoration Initiative, a federal effort initiated in 2009 that is funding hundreds of projects at sites where ecosystem stress is very high. The initiative is the largest investment in the Great Lakes in two decades. Eleven federal agencies developed an action plan to implement the initiative through 2014.

"The cumulative impact map provides a quantitative perspective on how best to protect critical natural resources such as beaches, boating and fishing that support a vibrant tourism industry, as well as commercial fishing which remains important to local economies," Allan said. "Conducting this analysis at the scale of the entire Great Lakes basin fills an important gap in strategic prioritization to protect the Great Lakes

and the services they provide to society."

Some worrisome environmental stressors could not be included due to lack of adequate data across all five Great Lakes, and the team hopes to continue to map additional stressors as data become available. However, the cumulative stress index developed from 34 individual maps is unlikely to change much with new data, as simulations of cumulative stress using subsets of the full set of maps produced similar patterns.

The researchers launched a new website to share their results with policymakers, planners and government officials in the region. The project will continue acquiring data to map stressors currently not included and will regularly update the stress maps. The Great Lakes Environmental Assessment and Mapping project began in 2009 with $500,000 from the Bloomfield Hills, Mich.-based Fred A. and Barbara M. Erb Family Foundation.

Provided by University of Michigan