FROM GREAT TO GROSS:

A *CLADOPHORA* RISK ANALYSIS IN THE GREAT LAKES




They're Great!

The Great Lakes, also known as the Laurentian Great Lakes, are the largest surface freshwater system on Earth. Located both in the United States and Canada, they span more than 750 miles from east to west. The Great Lakes basin is home to 10% of the US population and over 30% of the Canadian population, as well as a diverse wildlife community. The lakes are a popular recreational destination, where visitors can go boating, swimming and fishing.

Cla-don't-*phora*

Cladophora algae poses a risk to the Great Lakes for a number of reasons. There was a previous outbreak of *Cladophora* in the Great Lakes in the 1980s, which was brought under control with the amendment of the Great Lakes Water Quality Agreement in 1983 and stricter regulations on phosphorus loading.

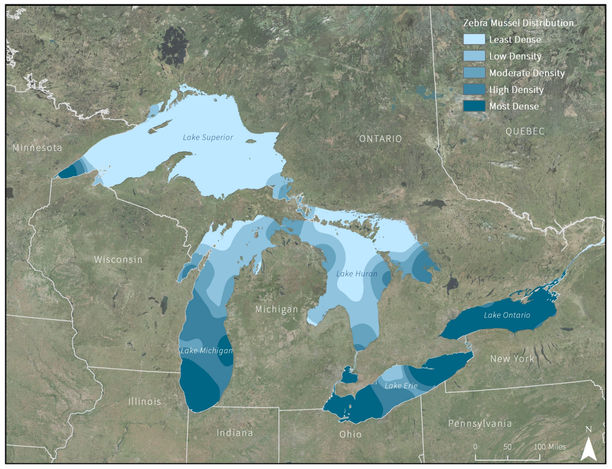
Unsightly: When it detaches from the rocky substrate it grows on, *Cladophora* gathers along the shoreline forming large, stinky mats. In addition to being unsightly, these mats may also provide the ideal habitat for harmful bacteria to grow.

Dangerous: Avian botulism is a paralytic disease of birds that has become increasingly common in the Great Lakes. Outbreaks occur when birds ingest toxins produced by *Clostridium botulinum*, which can grow in the decaying *Cladophora* algal mats.

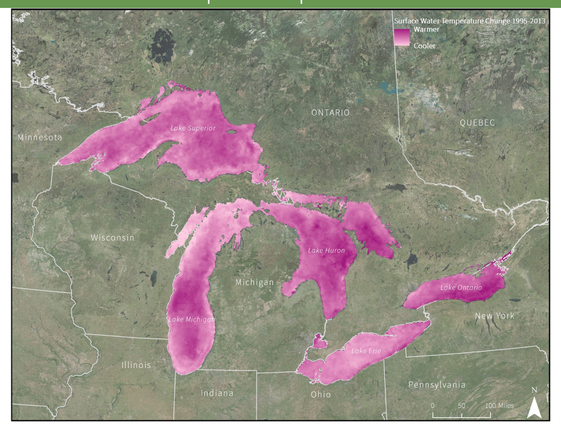
Harmful to humans: *Cladophora* harbors high levels of *E. coli* bacteria, and may encourage the growth of other human pathogens as well. There is also the potential for economic losses as a result of reduced recreational days.

Zebra Mustn't

Zebra mussels are small shellfish named for the striped pattern of their shell. They are believed to be the biggest contributing factor to the current outbreak of *Cladophora* that is happening in the Great Lakes today. Zebra mussels provide hard substrate for the *Cladophora* to grow on, as well as alter the phosphorus cycle which may make phosphorus more available to the *Cladophora*. Zebra mussel pseudofeces can also act as a fertilizer. Finally, because they're filter feeders, they help clear the water which allows light to penetrate deeper, expanding the benthic range of the *Cladophora*. The density of zebra mussel sightings was calculated using Kernel Density.



Super Superior

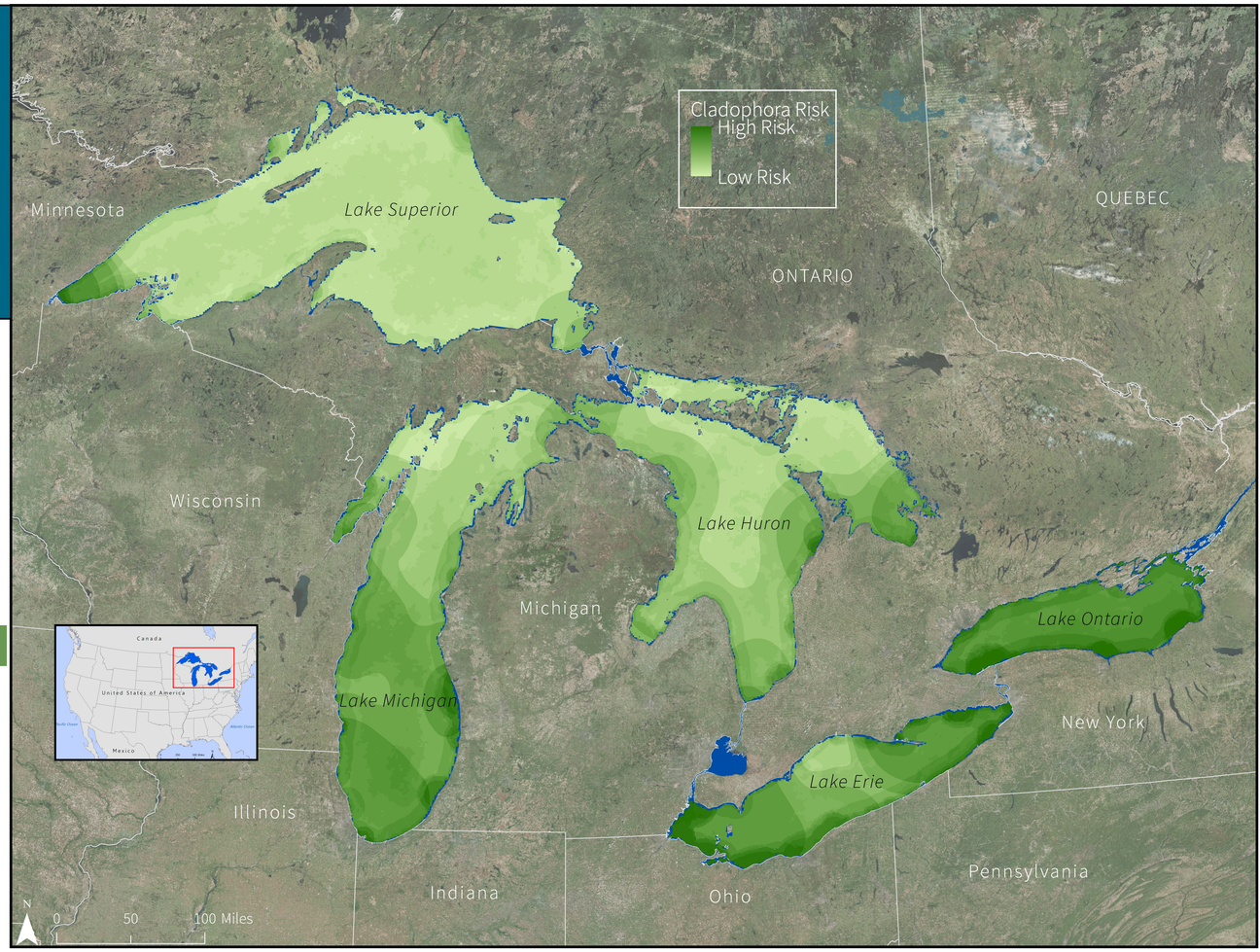


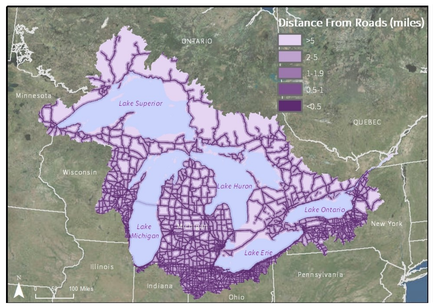
This risk analysis shows that Lake Superior is at the least risk overall for *Cladophora* infestation. Coastal areas tend to be at higher risk, although *Cladophora* are able to grow in deeper waters as well. Because the phosphorus analysis was somewhat conjectural, the risk distribution is likely somewhat different than shown. There is ongoing research by the Great Lakes Environmental Assessment and Mapping Project on how water currents influence phosphorus propagation. Despite these limitations, this analysis provides useful information on which areas of the Great Lakes may have the highest risk for *Cladophora* infestations. The Great Lakes serve as a stop-over point for some migratory bird species, so this analysis could provide insight into which species may be threatened by *Cladophora* growth along their usual migratory routes.

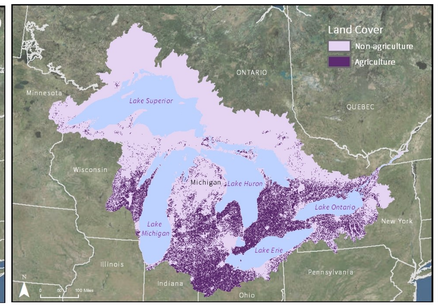
Tempera-Turn It Down

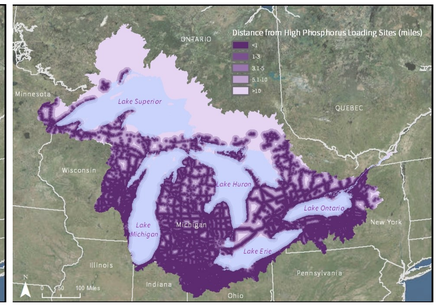
Factor	1 Extremely Low Risk	2 Low Risk	3 Average Risk	4 High Risk	5 Extremely High Risk
Distance from Roads	>1mile	>.5miles	>.2miles	>.1-1mile	≤.1mile
Land Cover	Non-agriculture	Non-agriculture	Non-agriculture	Agriculture	Agriculture
Distance from High Phosphorus Loading Sites	>10miles	5-10miles	3-5miles	1-3miles	<1mile
Change in Mean Annual Surface Temperature	-1.5- -0.15°C	-0.15-0.3°C	0.3-0.75°C	0.75-1.25°C	1.25-3.8°C
Zebra Mussel Infestation (Density)	<0.00005	0.00005-0.0001	0.0001-0.0003	0.0003-0.0005	0.0005-0.0045

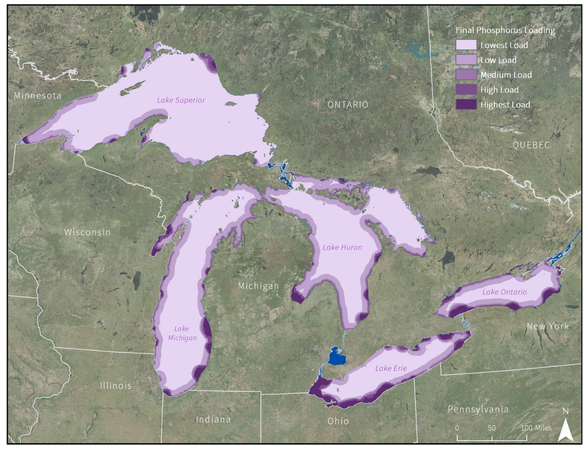
Cladophora grows best in temperatures between 50° and 77° Fahrenheit. The Great Lakes have been experiencing higher average surface temperatures in recent decades. As the Great Lakes warm, they become more suitable habitat for *Cladophora*. The average surface water temperature was acquired from the Great Lakes Aquatic Habitat Framework. The average surface temperature in 1995 was subtracted from the average surface temperature in 2013 using the Raster Calculator in order to find the change in average surface temperature from 1995 to 2013. As global temperatures continue to rise, it is likely that the average surface temperature of the Great Lakes has also risen from 2013 to present day. The current average surface temperature of each lake ranges from 60° to 70°F, with Lake Erie and Lake Ontario as the warmest lakes each year.











Phosphor-uh-oh!

Cladophora growth is limited to phosphorus rich areas. The recommended phosphorus level is below 2 µg/L. The main sources of phosphorus loading are agricultural lands, major roads, and other runoff from rivers. Because only the watersheds in the Great Lakes basin drain into the Great Lakes, that was the perimeter set for this analysis. The land cover in the basin was classified as either 'agriculture' or 'non-agriculture'. The Euclidean distance from major roads was calculated, and then the two layers were added to find the areas of highest phosphorus loading. The distance from those areas was calculated, and that was added to phosphorus runoff from rivers to find the final amount of phosphorus loading into the Great Lakes.

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DATA SOURCES

ESRI Data | Great Lakes Aquatic Habitat Framework | US Census Bureau | US Geologic Survey | Allan et al. 2013 PNAS | Statistics Canada | Ministry of Natural Resources and Forestry

Projection: NAD 1983 Great Lakes Basin Albers

IMAGE SOURCES

Emily Haines original images |

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