Assessing Spatial and Temporal Effects of the Detroit River on Algal Bloom Distribution in Western Lake Erie

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Overview

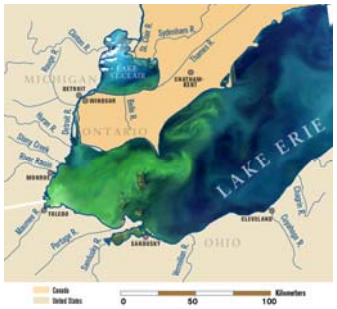

Figure 1. Western Lake Erie on September 3, 2011 (Michalak et al. 2012)[1]

The main cause of harmful algal blooms (HABs) in western Lake Erie is nutrient runoff from the Maumee River. While the Maumee affects bloom intensity, it is not the primary control of flow in the basin. The Detroit River has a larger influence on surface currents as it is 80% of the lake's total inflow. However, its effect on HAB spatial extent and duration remains unknown. Here, we explore the potential role the Detroit River has on influencing summertime algal bloom spatial distribution in western Lake Erie.

Data and Methods

Along with USGS Detroit River discharge measurements, 2 types of classified satellite remote sensing imagery are used:

1. **Optical Water Types (OWT)[2]:** Categorizes different types of water masses based upon how much chlorophyll-*a* and colored dissolved and detrital matter is in the water (Figure 2); 7 classes (2a) have been identified.

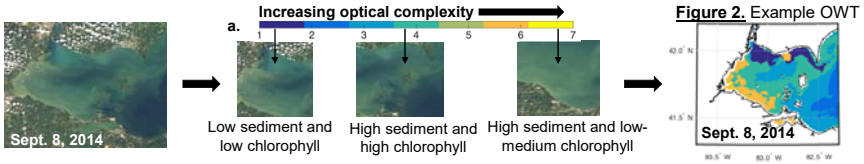

Figure 2. Example OWT

2. **Cyanobacteria Index (CI)[3]:** Identifies presence of HABs in 10-day periods; used to determine bloom presence (Figure 3)

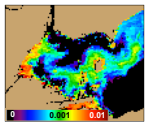

Figure 3. Example CI: September 1-10, 2014

Using these data sources, river and bloom delineations were created and integrated with physical observations to identify river influence:

OWT & CI 10-day composites → OWT & CI Frequencies → River and HAB outlining → Detroit River discharge → Detroit River delineation & influence on HAB characteristics

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Identifying the Detroit River Plume and HABs

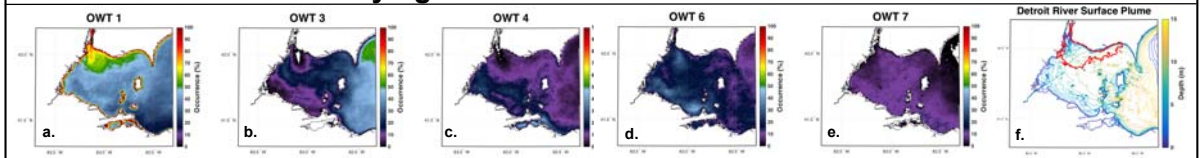

Figure 4. OWT percent frequency, 2002-2014. Frequency is used as a way to classify different water masses. OWT 2 & 5 are not included because they rarely occur in Lake Erie. The Detroit River plume boundary (f) was identified by OWT 1 (a) and 6 (d).

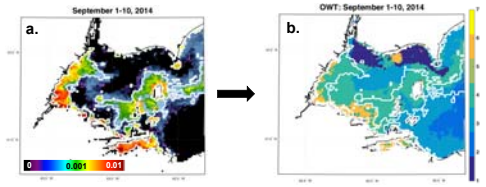

Figure 5. Example of HAB boundary delineation from CI composite imagery (a). CI values greater than 0.001 (considered bloom conditions[3]) were used to determine HAB edge. HABs are a combination of OWTs 4/6/7 (b), indicating high chlorophyll and high colored dissolved and detrital matter.

Detroit River's Impact on HABs

The Detroit River discharge has some influence on HAB intensity (Figure 6), but its influence on HAB surface area varies year to year (Figure 7).

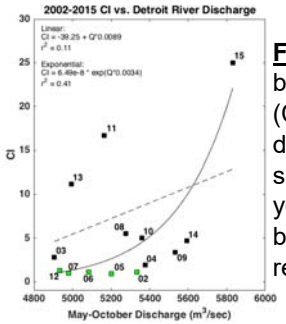

Figure 6. Relationship between HAB intensity (CI) & Detroit River discharge. Black squares represent years with severe blooms, while green represent mild blooms.

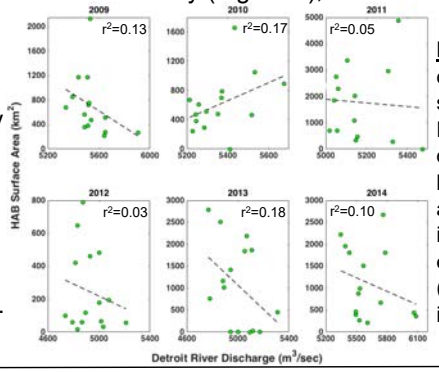

Figure 7. Year by year comparison of HAB surface area to Detroit River discharge. The direct relationship between discharge and area is not strong, indicating that other environmental factors (e.g., wind) need to be included in this study.

Future Analyses:

- Investigate relationship between river discharge and HAB surface area with consideration of wind
- Integrate *in situ* field data to continue identifying HAB presence and distribution in the western basin
- Use statistical analysis to compare surface areas with discharge and other water conditions and determine primary physical drivers of river plume and bloom variability

References: 1. Michalak et al. (2012). Record-setting algal bloom in Lake Erie caused by agricultural and meteorological trends consistent with expected future conditions. *Proceedings of the National Academy of Sciences*, 110(16), 6448-6452. 2. Moore, et al. (2014). An optical water type framework for selecting and blending retrievals from bio-optical algorithms in lakes and coastal waters. *Remote sensing of environment*, 143, 97-111. 3. Stumpf et al. (2016). Forecasting annual cyanobacterial bloom biomass to inform management decisions in Lake Erie. *Journal of Great Lakes Research*, *42*(6), 1174-1183.