

# Saginaw Bay Harmful Algal Blooms: Nutrient Status



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with a lot of help from friends and colleagues



**5 year study 2008-2013**  
**NOAA Center for Sponsored Coastal Ocean Research**

**Also a study from 1991-1996**

# Water Quality History - context

1974 Report - many problems, minimal data

1978 Great Lakes Water Quality Agreement

440 metric ton/year Total Phosphorus target

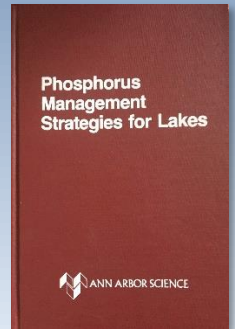
15  $\mu\text{g}/\text{L}$  total phosphorus

3.6  $\mu\text{g}/\text{L}$  chlorophyll a

3.9 m secchi depth

mesotrophic state

} goals in supporting documentation



early phosphorus reduction efforts – targeted point sources

mid-1980s success “declared” - emphasis shifted to toxic contaminants

2012 Great Lakes Water Quality Agreement

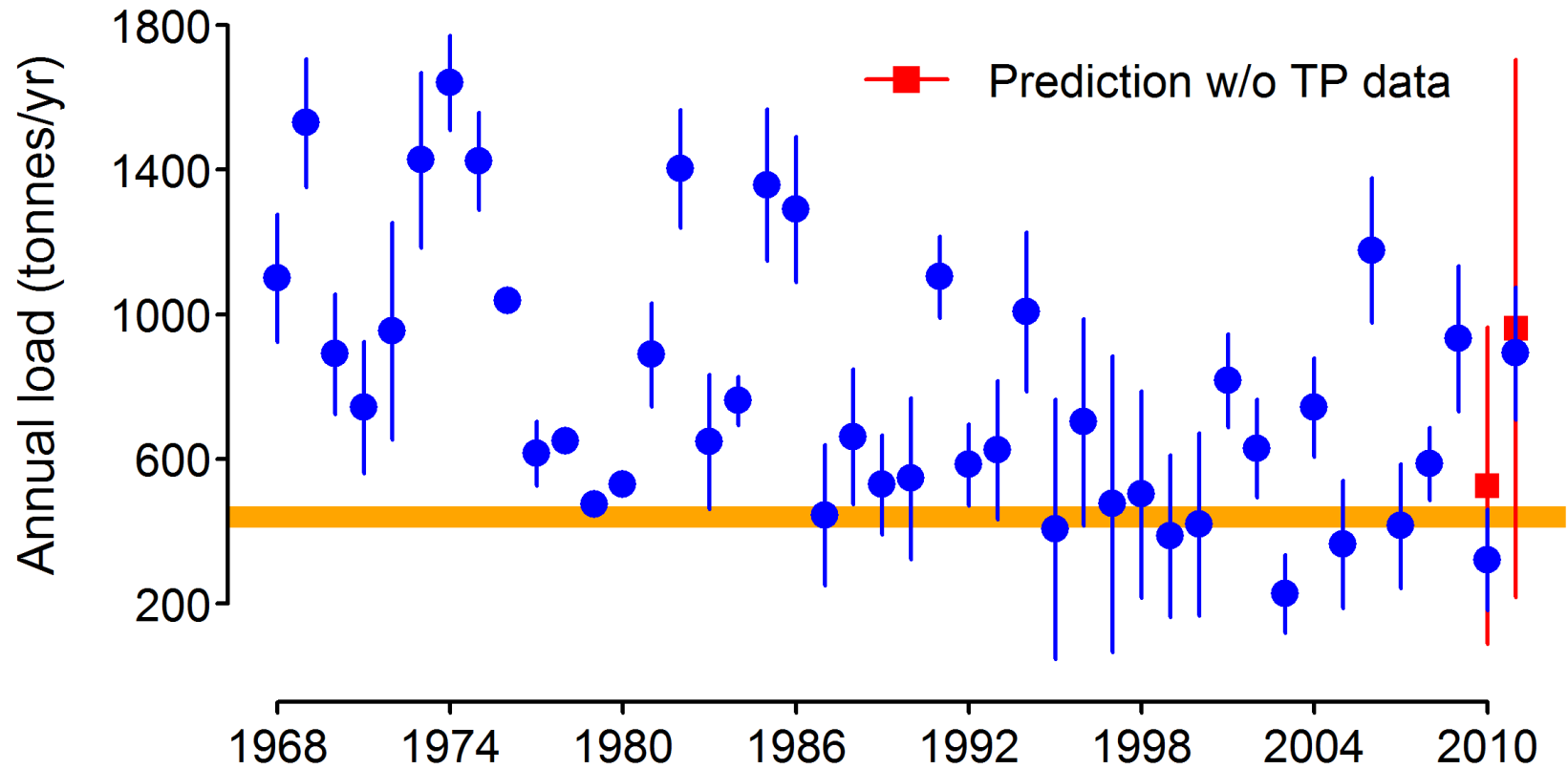
charge to review/update existing targets (3 years for Lake Erie)

440 metric ton/year Total Phosphorus interim until updated

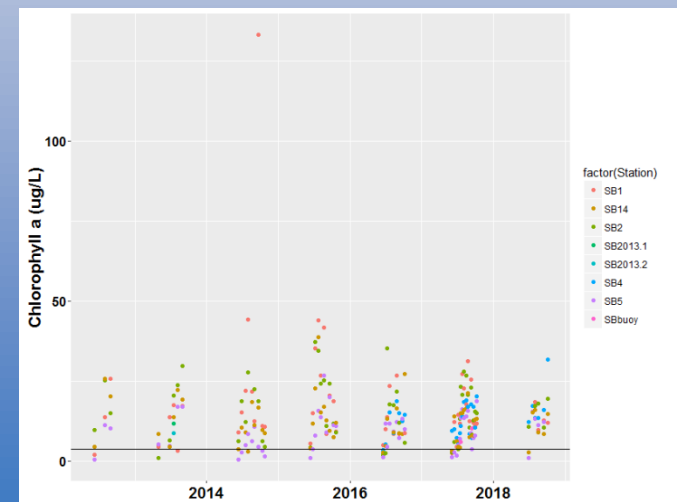
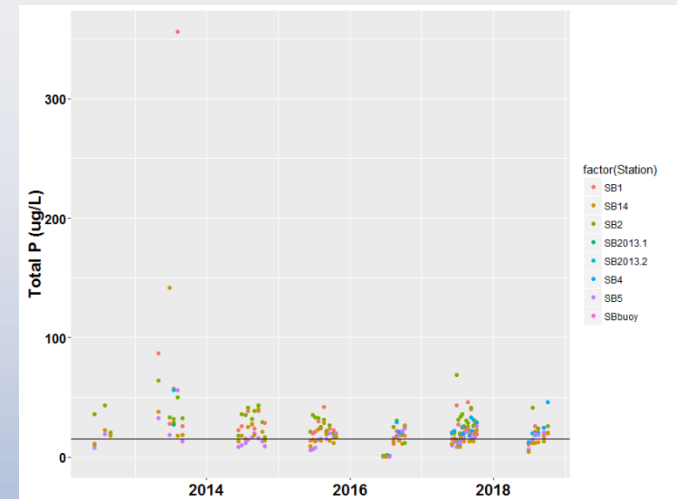
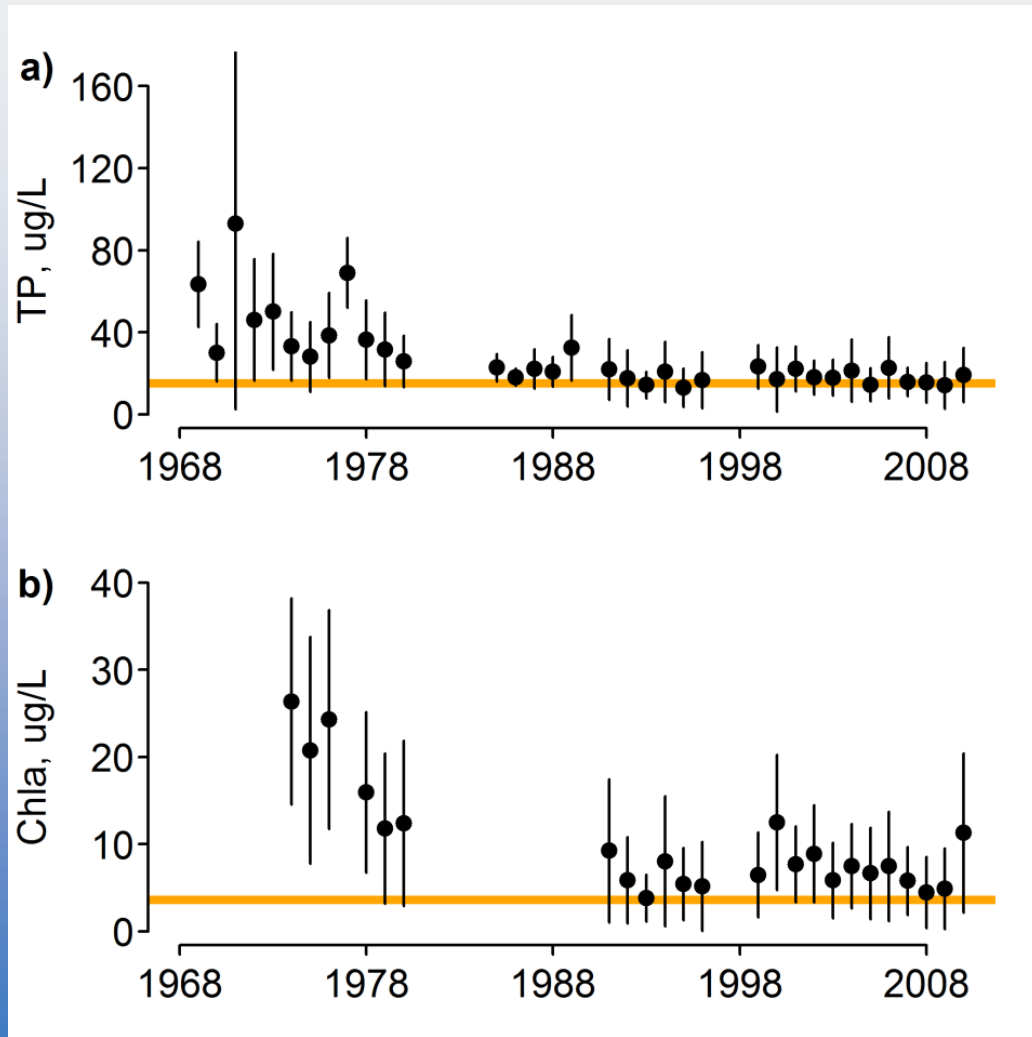
15  $\mu\text{g}/\text{L}$  total phosphorus spring mean - western Lake Erie

5  $\mu\text{g}/\text{L}$  total phosphorus spring mean - Lake Huron

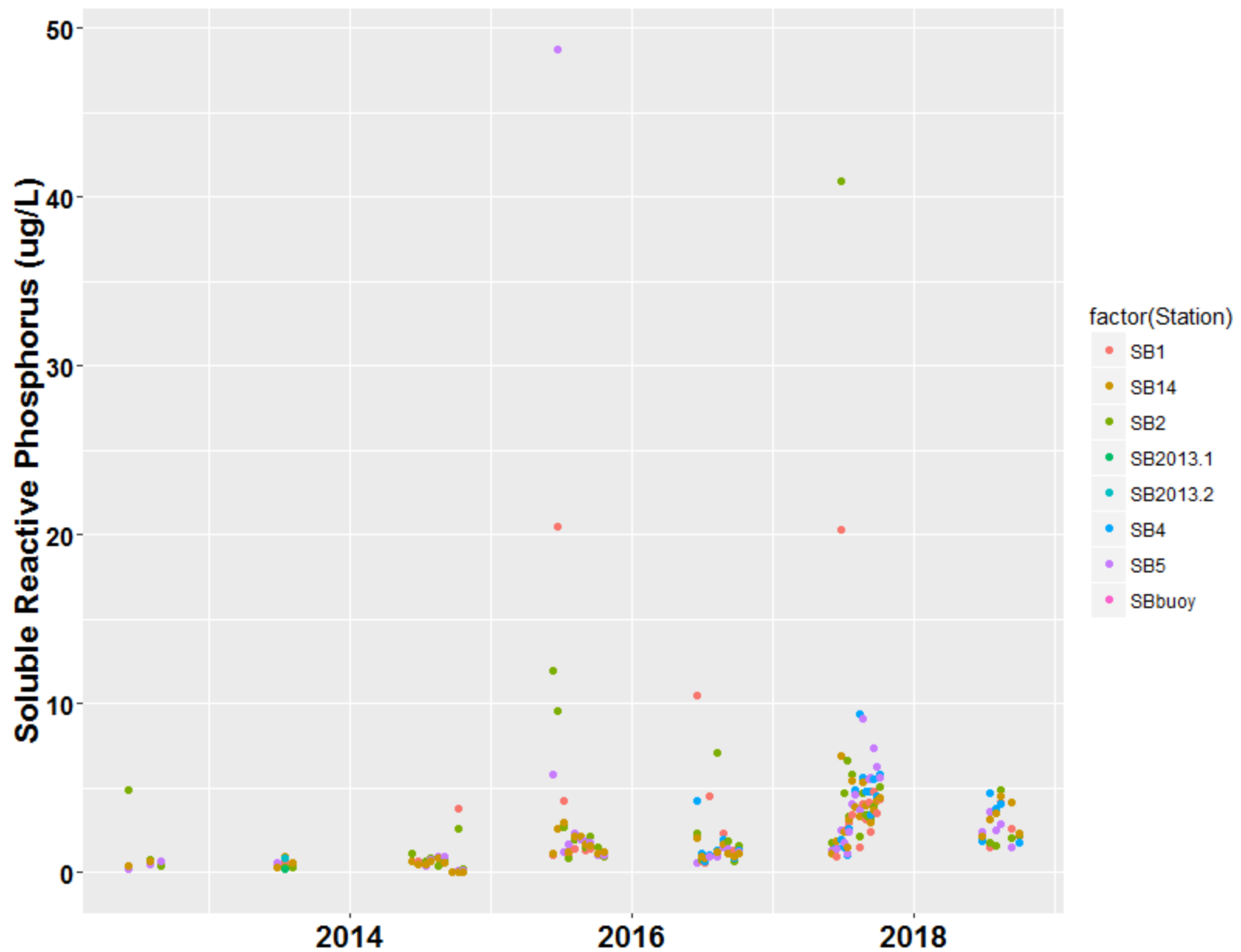
# Estimated TP Load vs. Time (Saginaw River only)



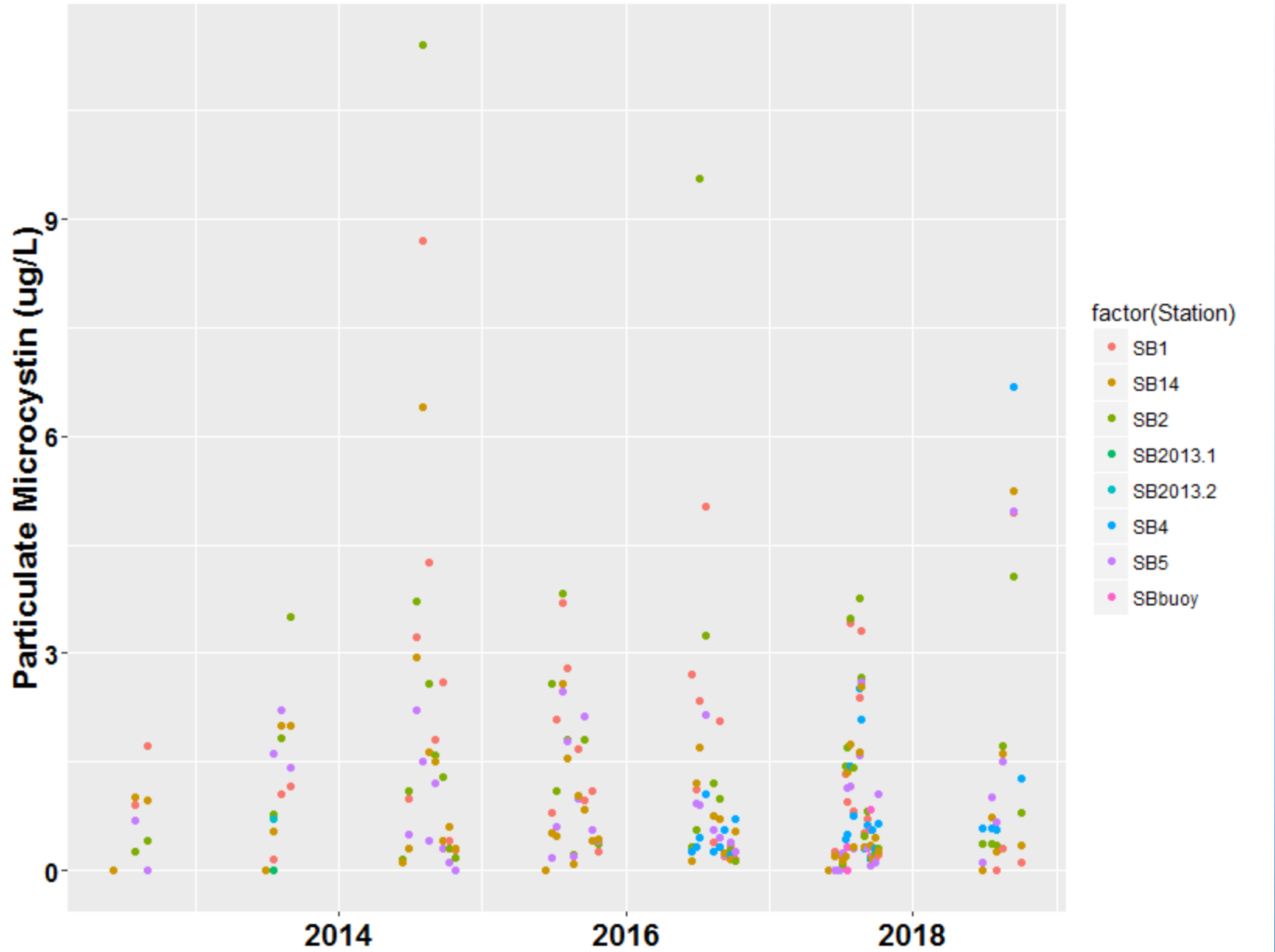
# Total Phosphorus and Chlorophyll



# Soluble Reactive Phosphorus

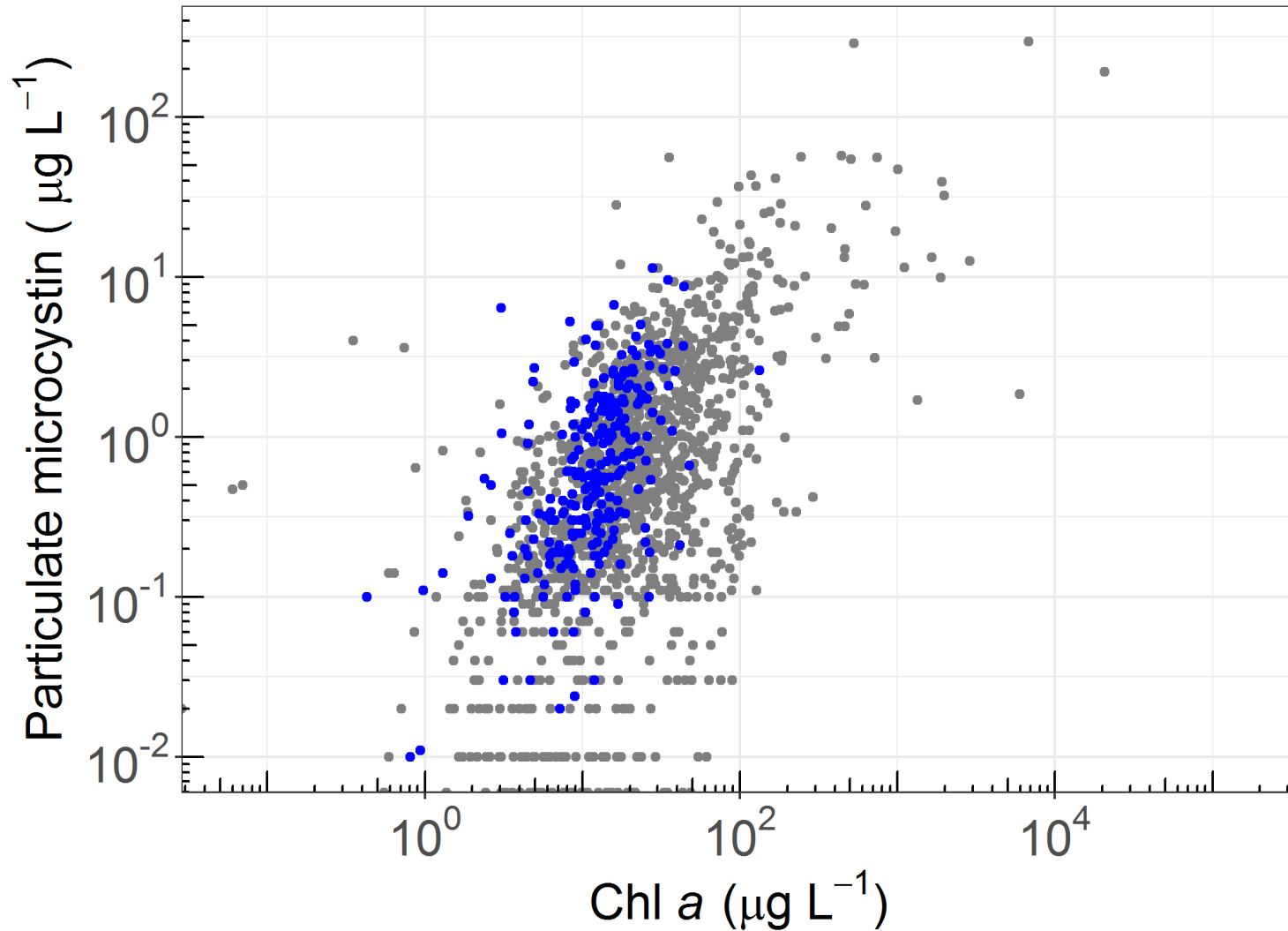


# Microcystin



# Microcystin vs Chlorophyll a

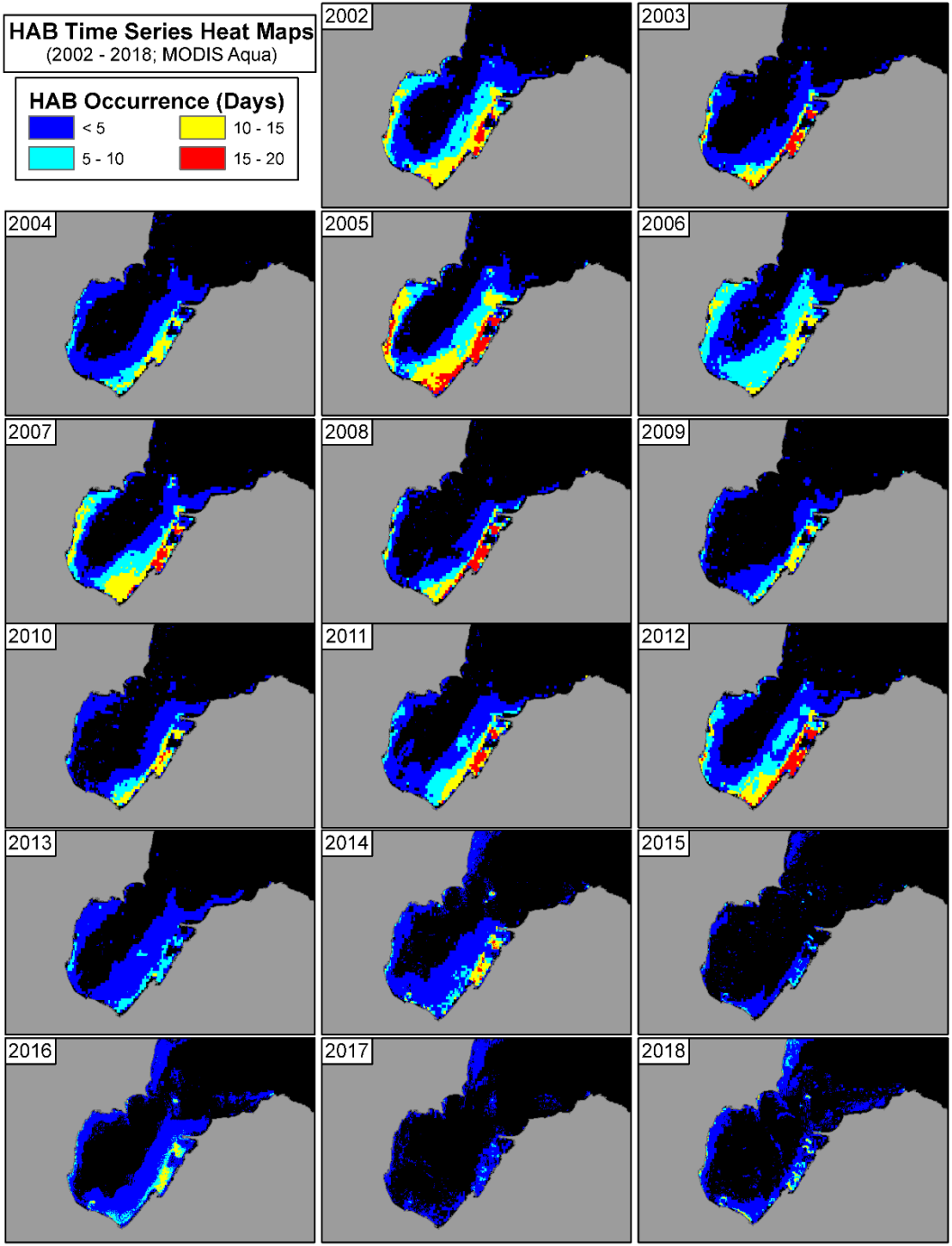
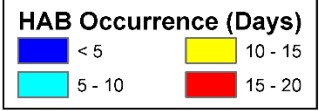
Saginaw Bay – Lake Erie



Courtesy of Dr. Freya Rowland

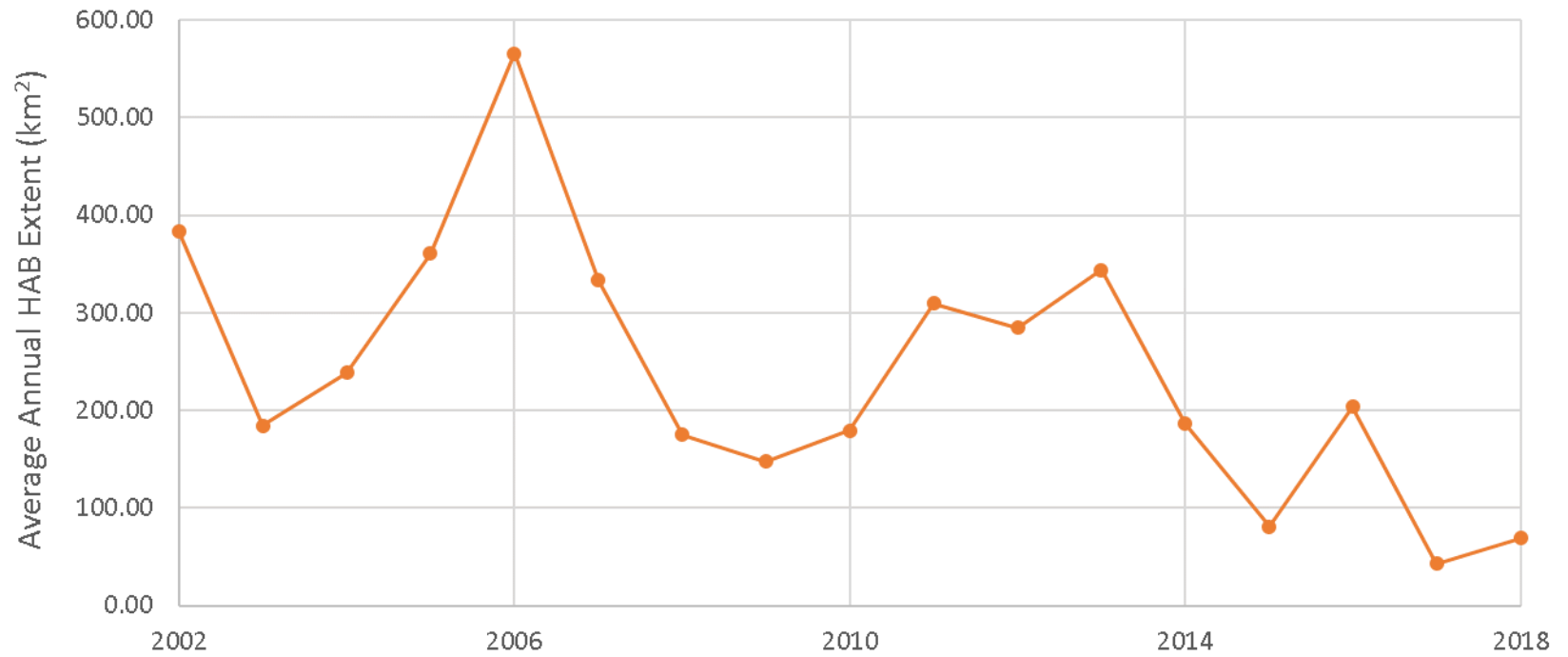


**HAB Time Series Heat Maps**  
(2002 - 2018; MODIS Aqua)



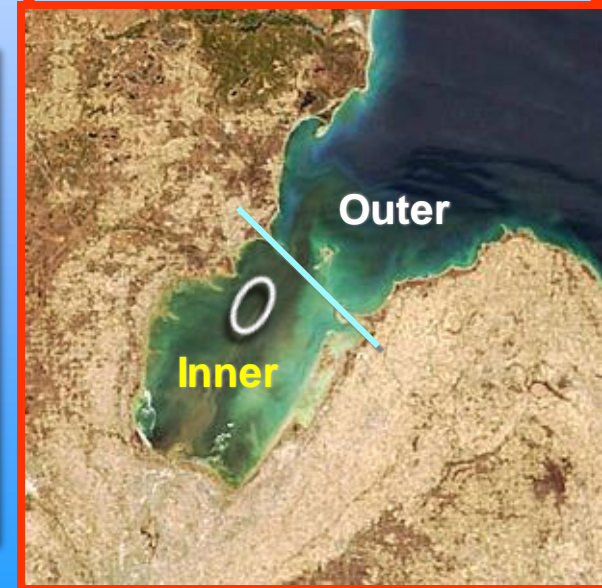
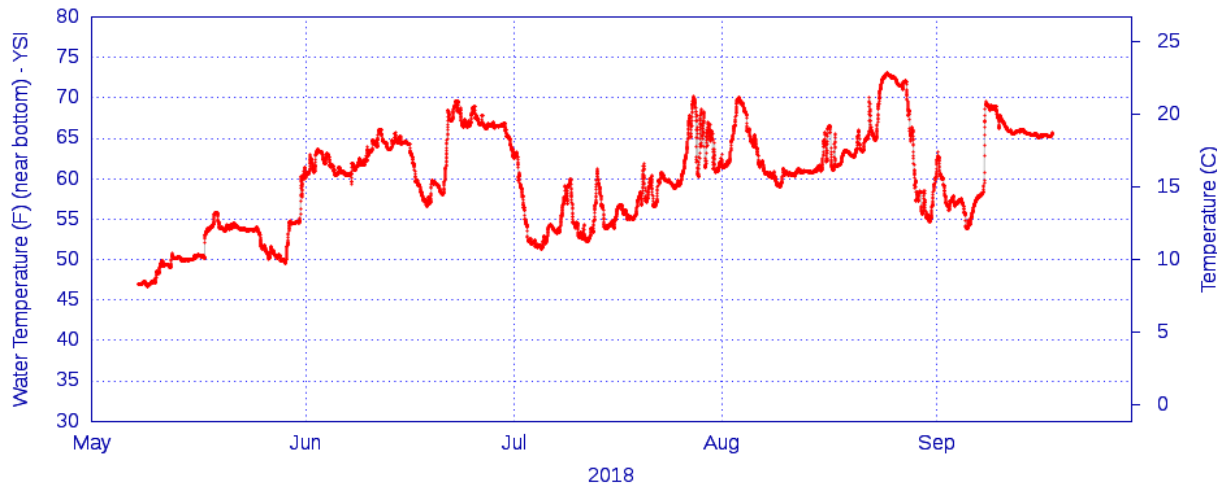
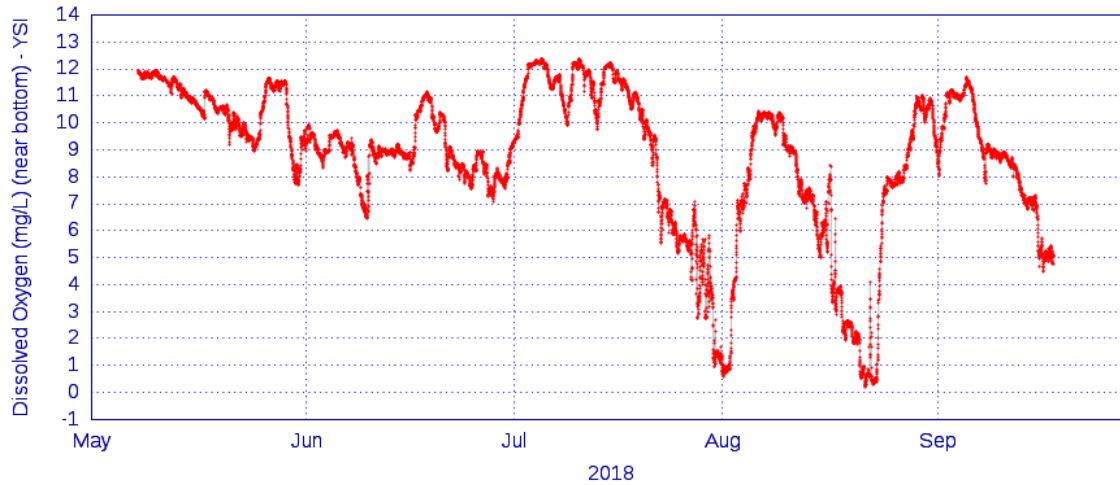
Courtesy of  
Michigan Tech  
Research Institute

## Saginaw Bay Average Bloom Extent



Courtesy of  
Michigan Tech  
Research Institute

# Summertime Oxygen Depletion



Great Lakes  
Water Quality  
Agreement

Protocol Amending the Agreement Between Canada and the United States of America  
on Great Lakes Water Quality, 1978, as Amended on October 16, 1983,  
and on November 18, 1987  
Signed September 7, 2012



Canada

# 2012 – New GLWQA

effective February 2013

## 10 Annexes

### Annex 4 - Nutrients

#### Six Lake Ecosystem Objectives

- 1) minimize hypoxic zones
- 2) algal biomass below nuisance levels (*Cladophora*)
- 3) algal species consistent with healthy ecosystems nearshore
- 4) cyanobacteria at levels that do not pose toxin risk
- 5) oligotrophic state in open waters
- 6) mesotrophic conditions western, central Erie

#### Update Phosphorus Load Targets

(Do this for Lake Erie within 3 years - February 2016)

# Summary

- TP load target not met as of 2011 – current status unclear  
need data (all tributaries)
- Original TP, chlorophyll a, secchi objectives not met
- Microcystin present  
moderate concentrations
- Evidence for periodic, short-term hypoxia  
important...?
- HABS concentrated around perimeter  
declining extent?
- Decisions pursuant to Annex 4 2012 GLWQA pending