

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

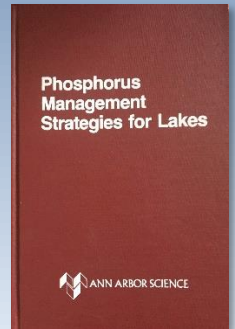
15 µg/L total phosphorus

3.6 µg/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)

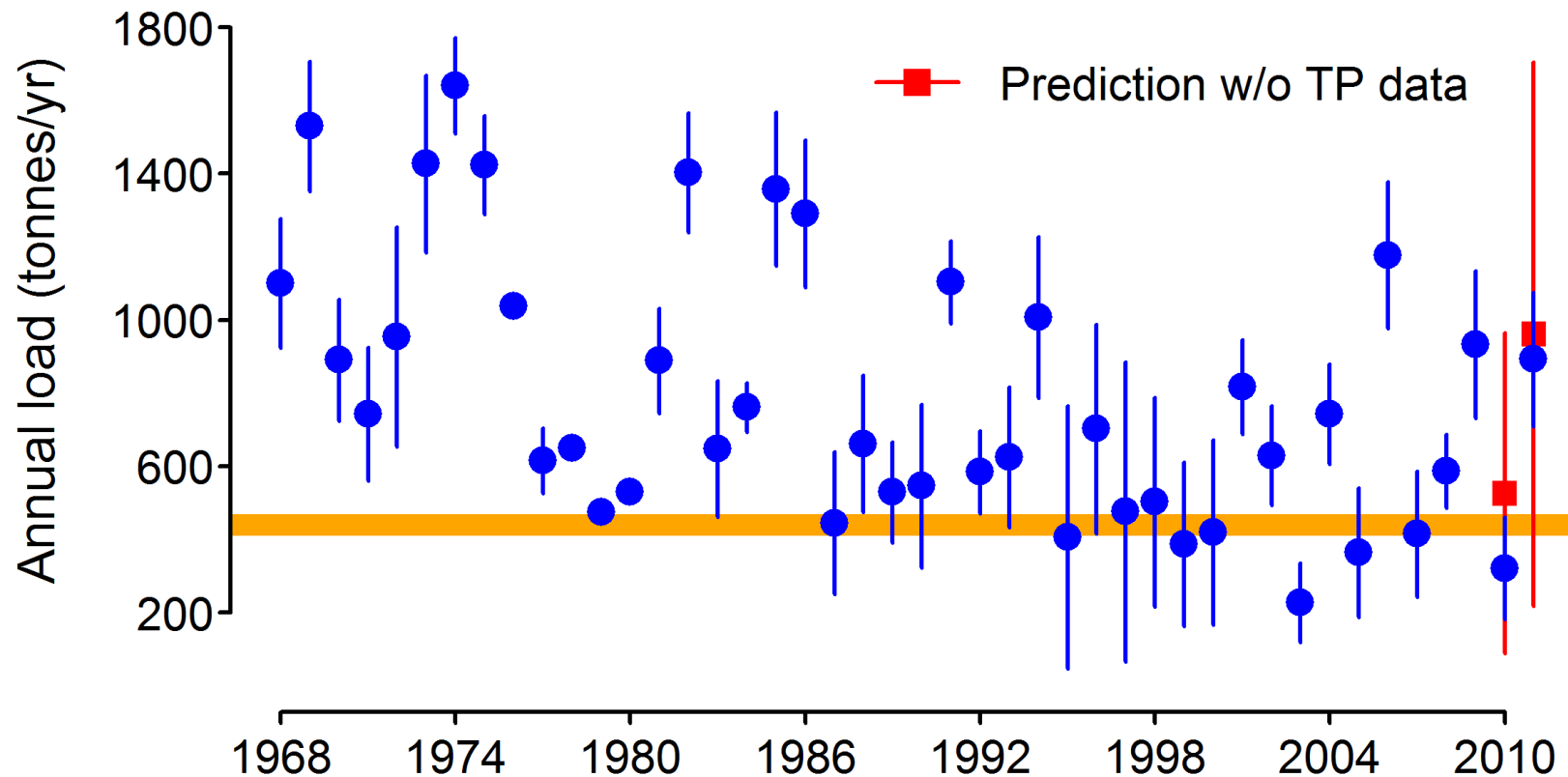
440 metric ton/year Total Phosphorus interim until updated

15 µg/L total phosphorus spring mean - western Lake Erie

5 µg/L total phosphorus spring mean - Lake Huron

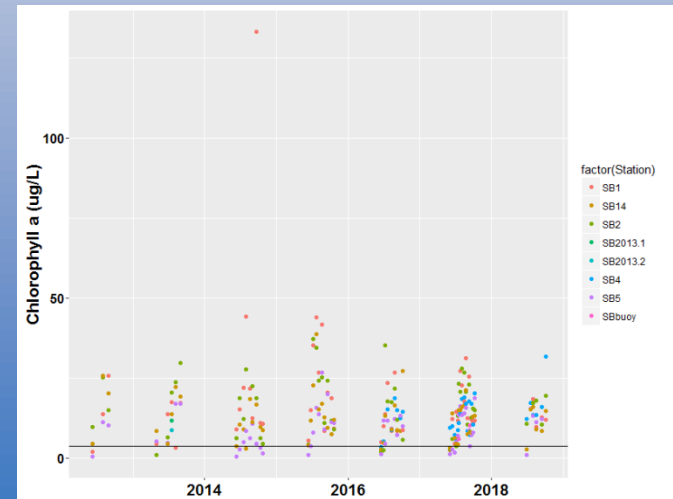
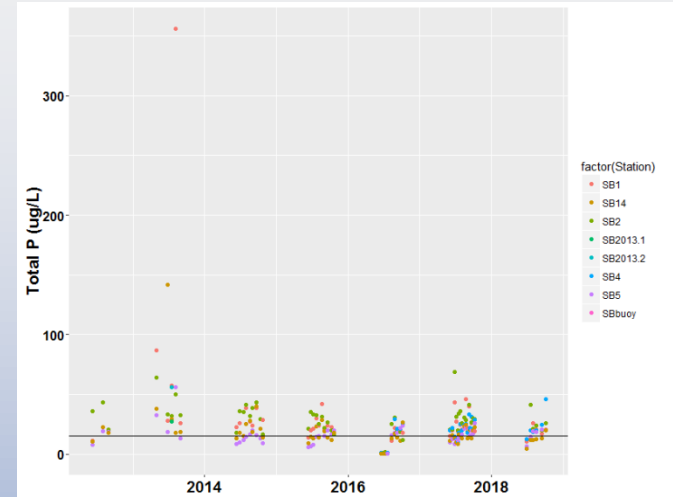
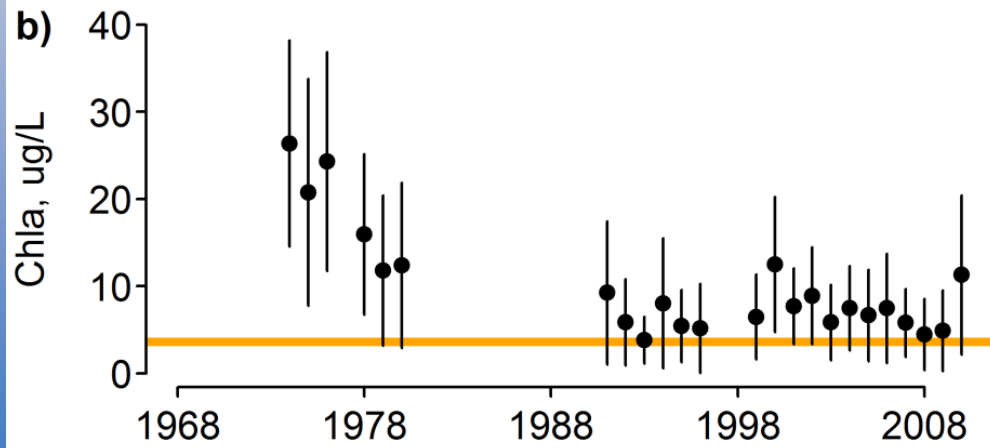
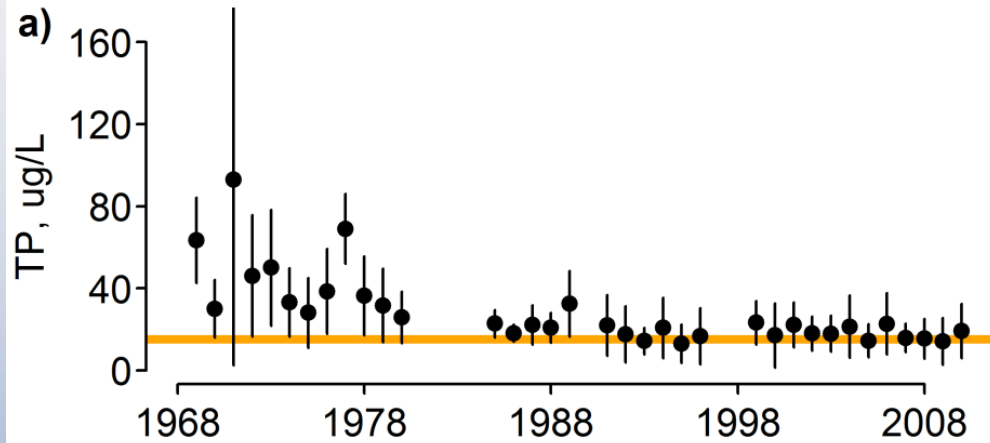
Estimated TP Load vs. Time

(Saginaw River only)

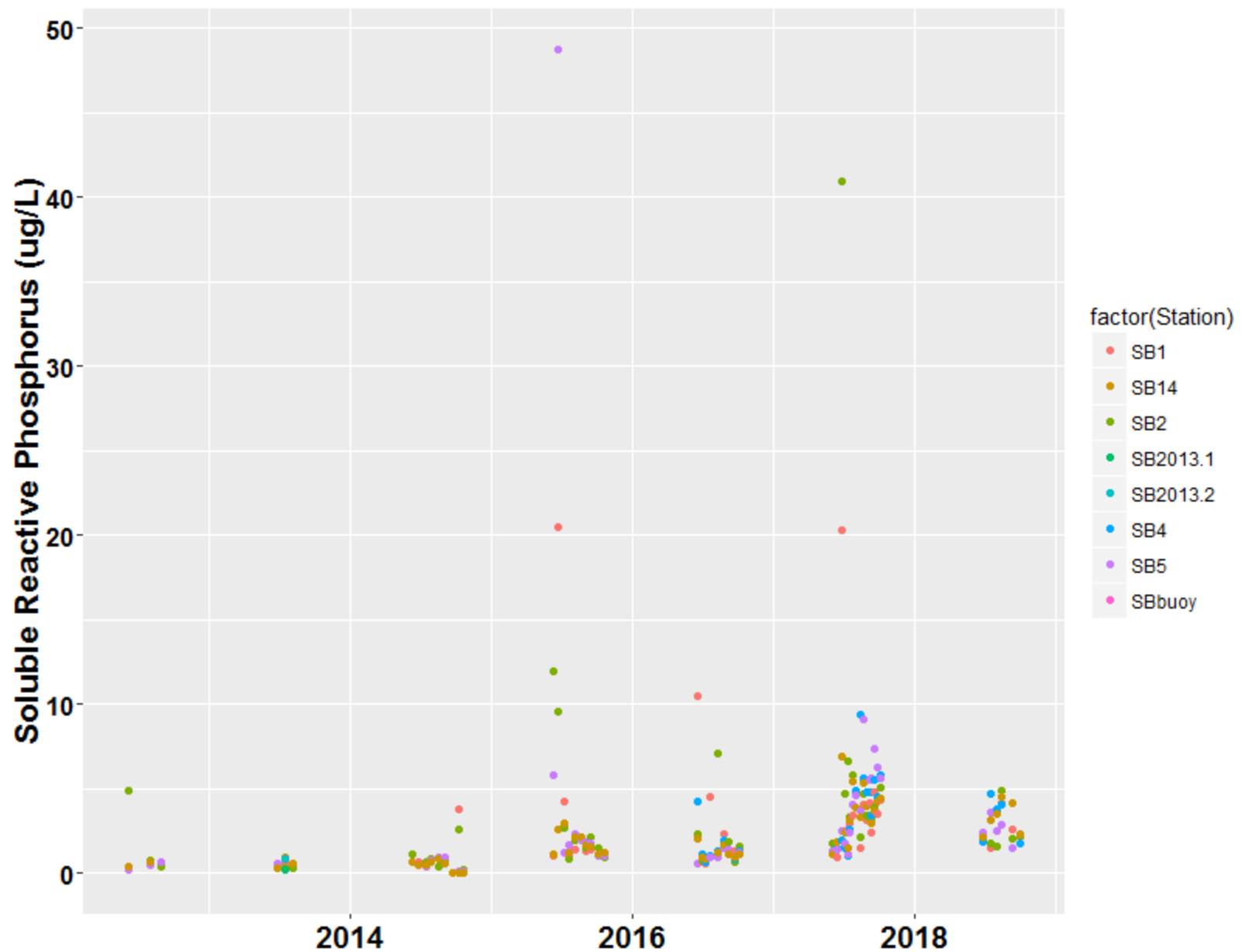


Cha, Y., C.A. Stow, K.H. Reckhow, C. DeMarchi, and T. Johengen. 2010. Phosphorus load estimation in the Saginaw River, MI using a Bayesian hierarchical/multilevel model. *Water Research*, 44: 3270-3282.

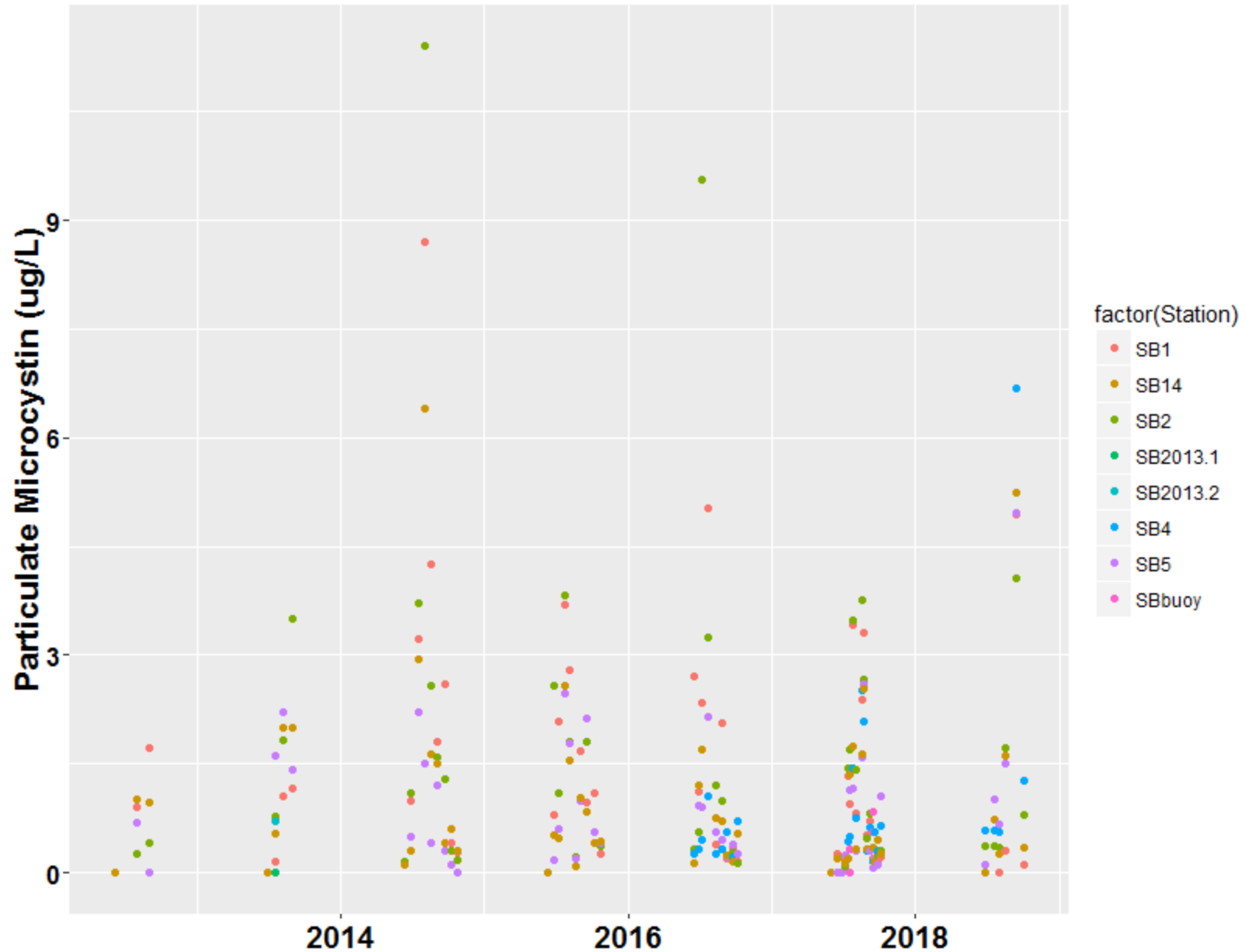
Total Phosphorus and Chlorophyll



Soluble Reactive Phosphorus

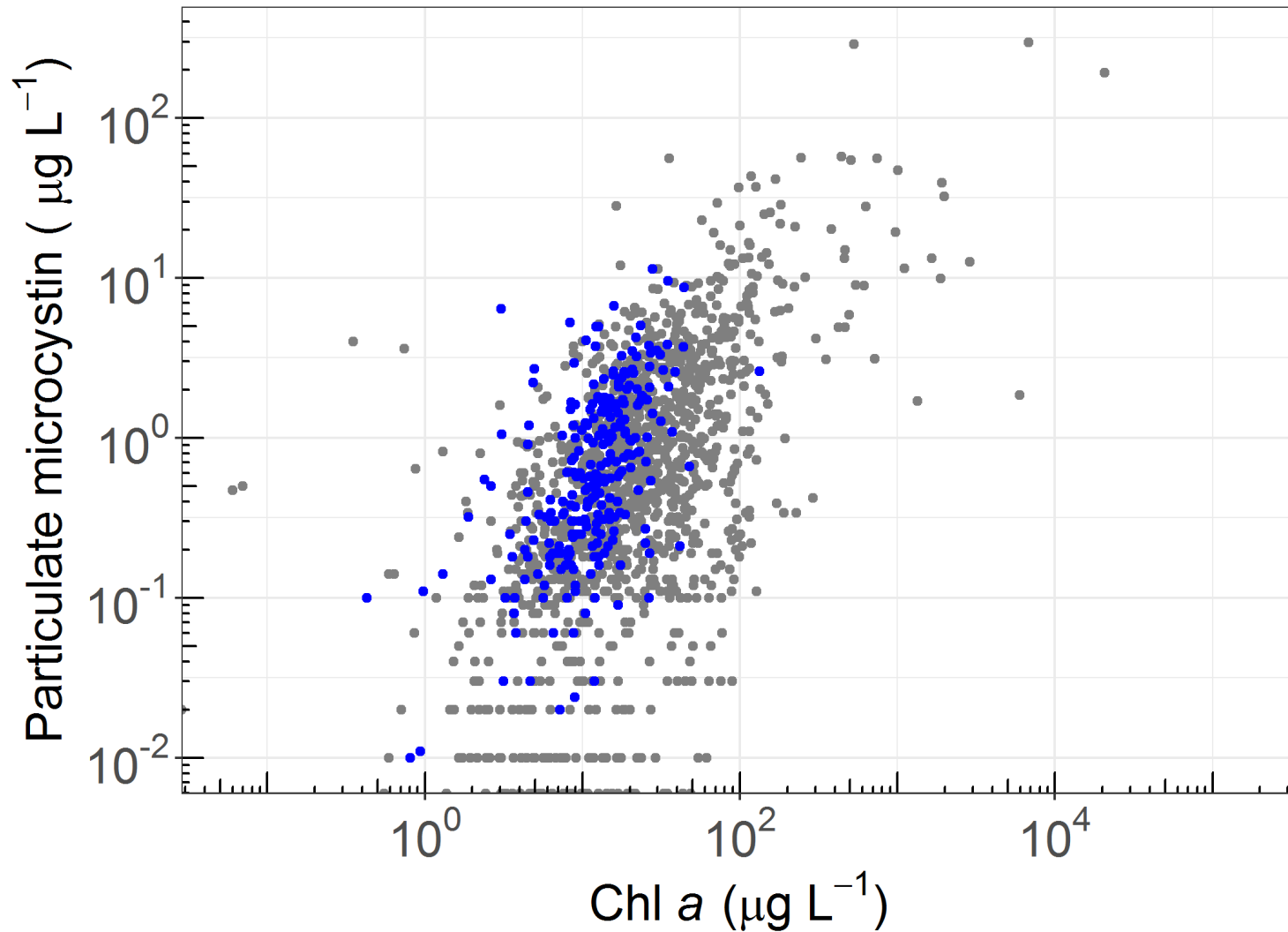


Microcystin



Microcystin vs Chlorophyll a

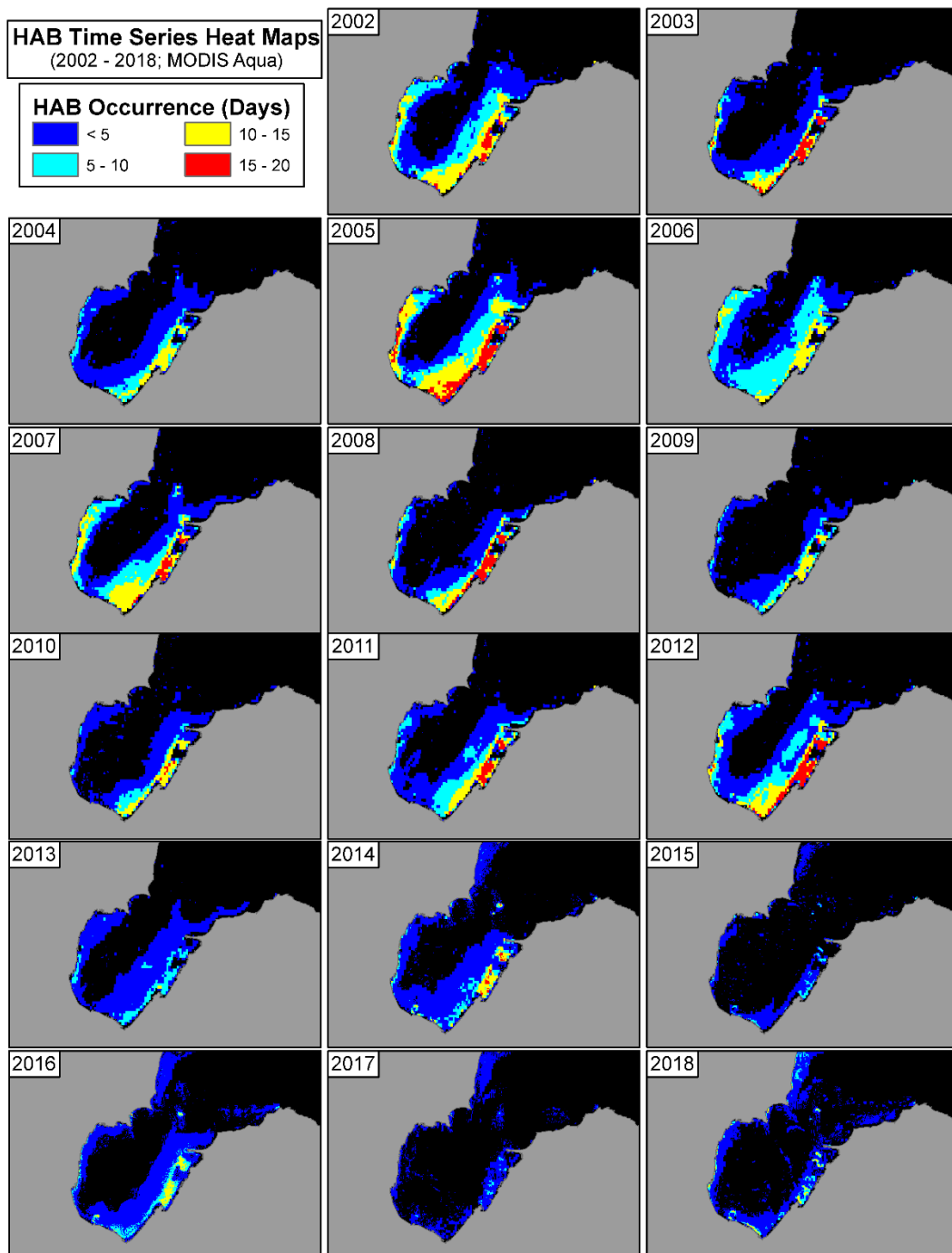
Saginaw Bay – Lake Erie



Courtesy of Dr. Freya Rowland

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

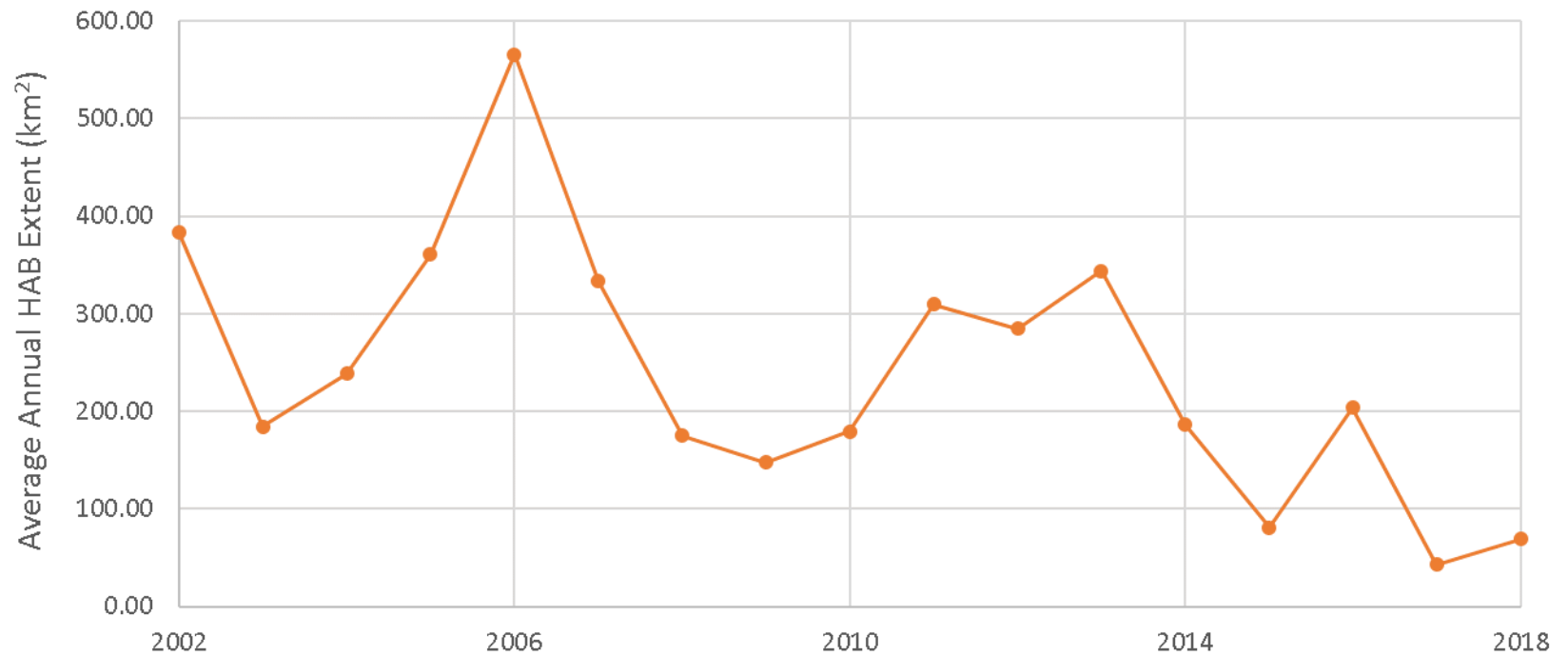
HAB Occurrence (Days)



Courtesy of
Michigan Tech
Research Institute

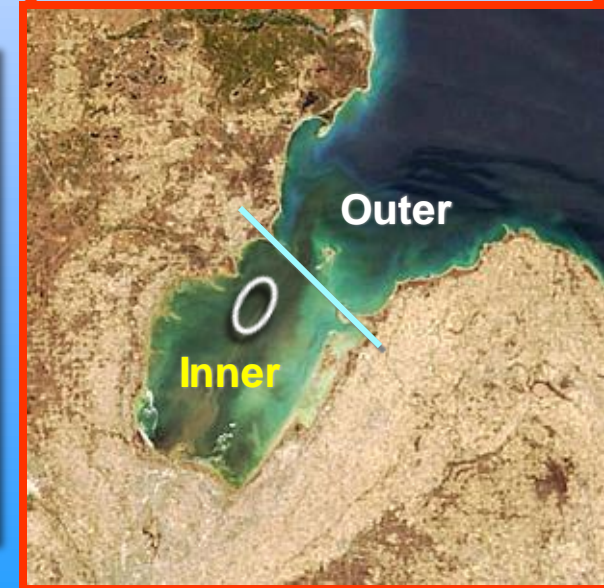
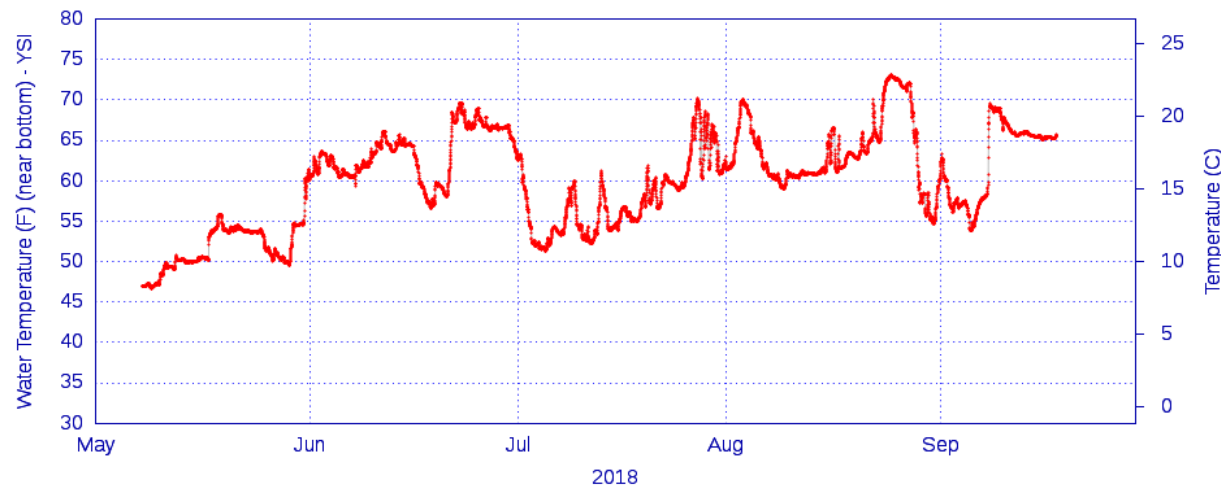
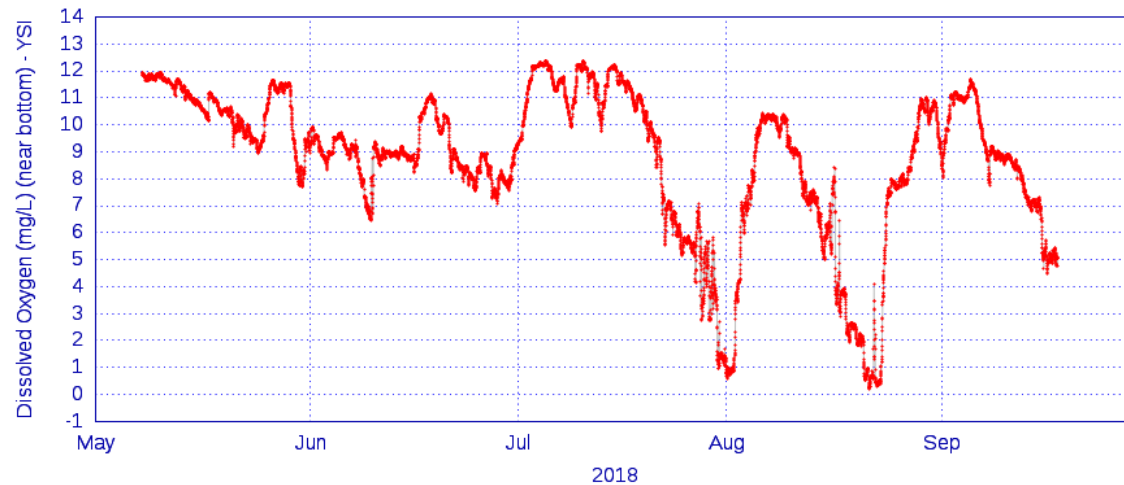
Saginaw Bay

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