NEW Water's Aquatic Monitoring Program

Sarah Bartlett

May 2019

NEW Water
The brand of the Green Bay Metropolitan Sewerage District

Image c/o CoastWatch
Great Lakes Data Server


May 7, 2018

Green Bay Regional Water Quality Issues

• **PCBs**: **P**oly**C**hlorinated **B**iphenyls
- 13 miles of the lower Fox River
- Sediment dredging 2009-2019
- More than 1 billion dollars for clean-up

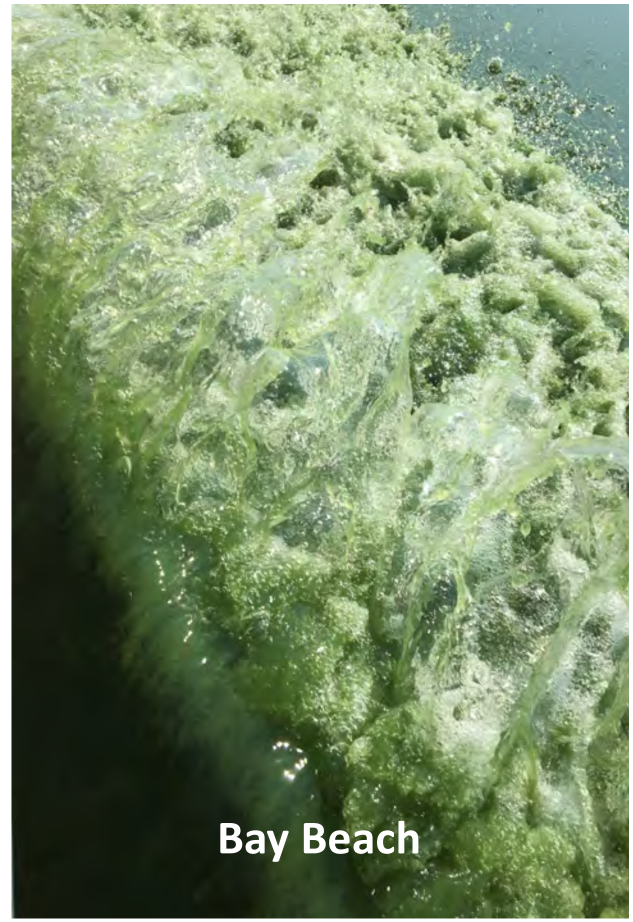
• **EXCESS NUTRIENTS & SEDIMENT RUNOFF**:
- Push to address non-point source inputs

• **DEAD ZONE**:
-Hypoxic and anoxic bottom water
- Highly eutrophic water brings large amount of organic material consumed by benthic organisms that breathe O2 and respire CO2

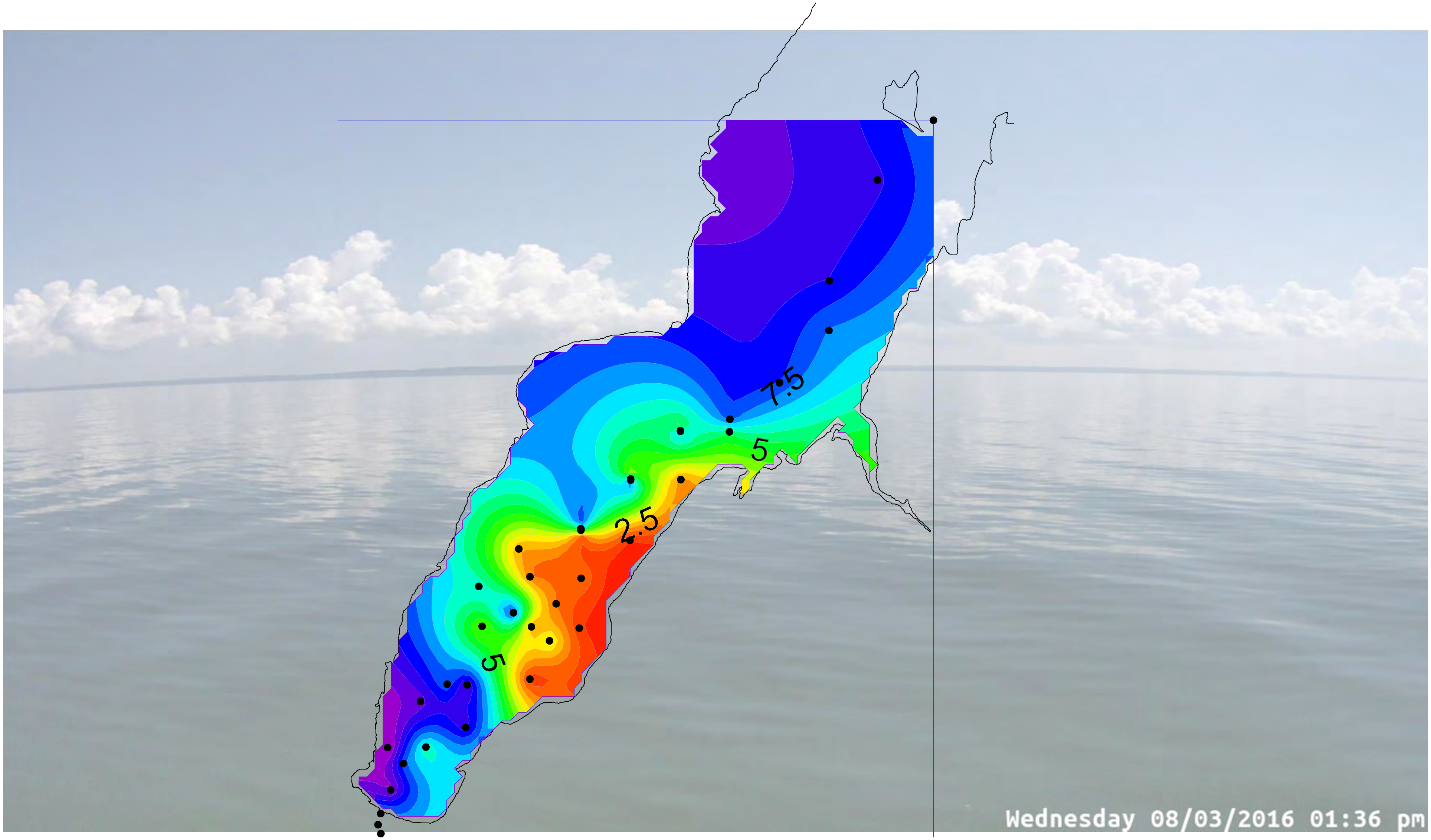
• **HABS**: **H**armful **A**lgal **B**looms
- Cyanobacteria blooms dominate over desired algal species
- Can produce toxins

Spring Runoff

Highly Productive



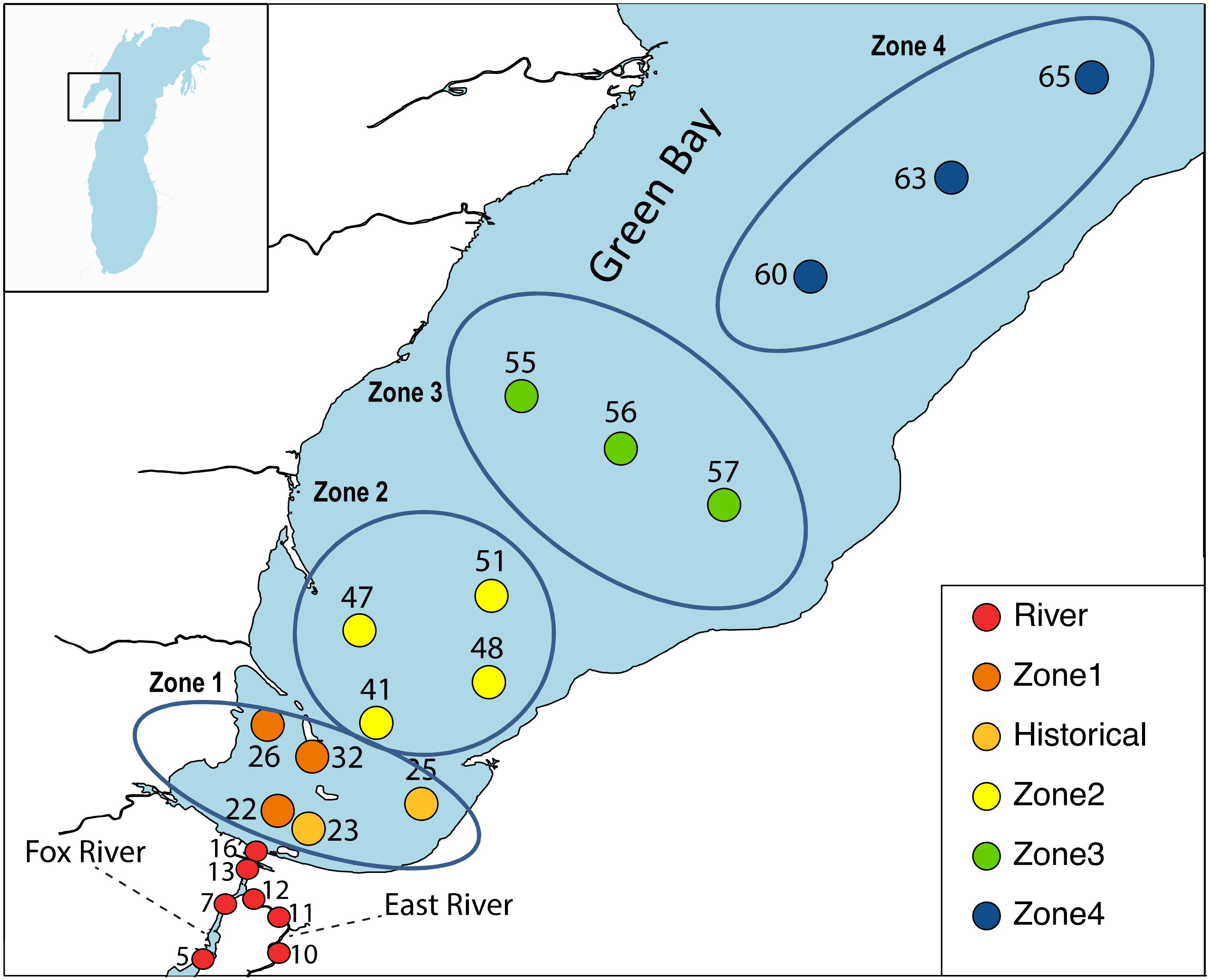
Dead Zone



Aquatic Monitoring Program (AMP)

- Monitoring program began in 1986
- Collect information on:
  - Nutrients
  - Suspended solids
  - Water temperature
  - Dissolved oxygen
  - Water color and clarity
- Weekly samples May → October
  - 23 sites between East River, Fox River, and Green Bay
- Two water quality monitoring stations
  - Mouth of Fox River
  - Entrance Light

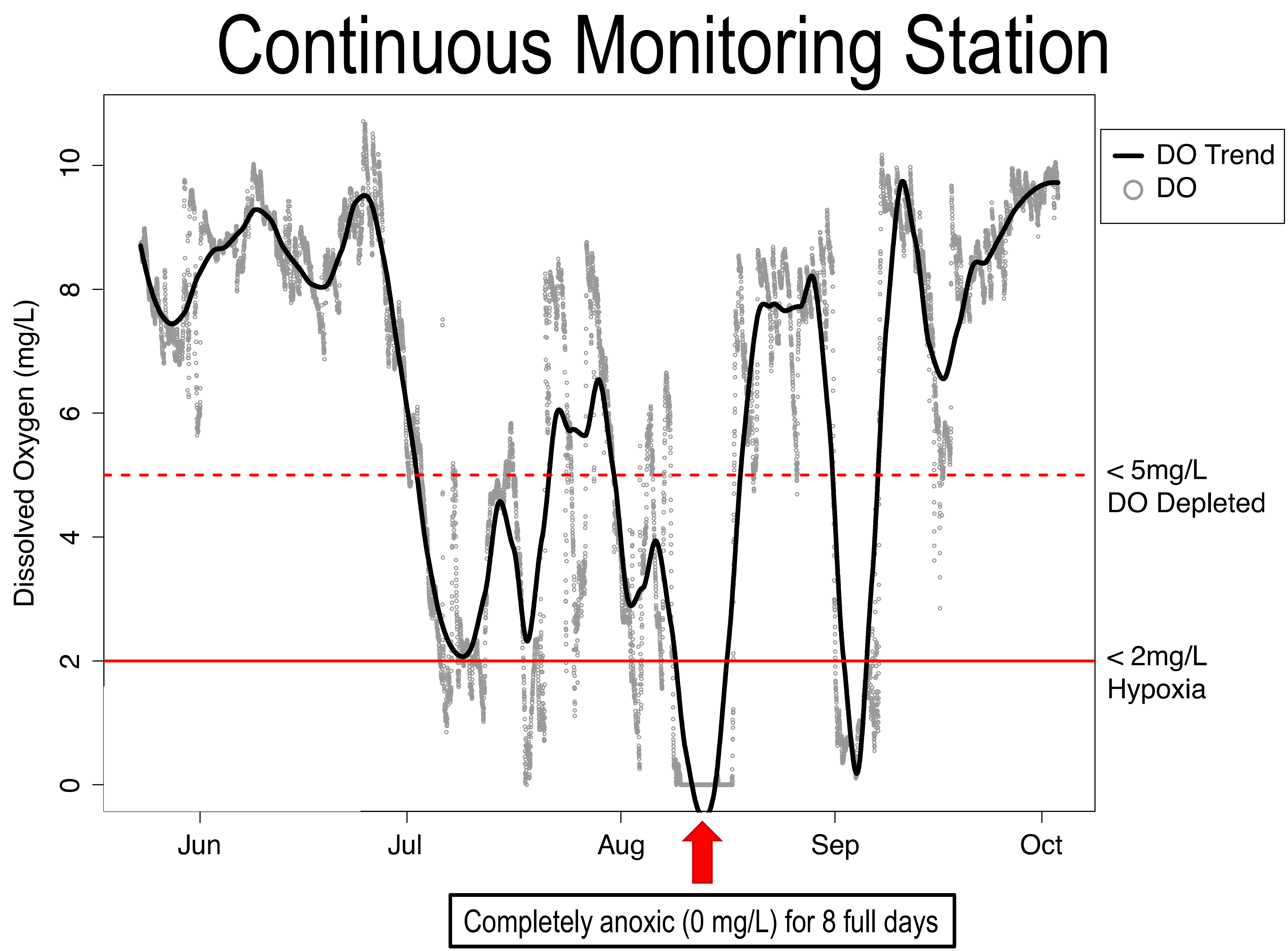
NEW Water Sample Locations




NEW Water
EEN BAY METROPOLITAN SEWAGE DISTRICT
YachtClub
NEW Water

Water Quality Monitoring Stations

- Deployed May – October
- Collect data every 15 min.
- Typical Sensors:
  - Top of Water Column (T)
  - Bottom of Water Column (B)
    - Water Temp (T, B)
    - Conductivity (T, B)
    - pH (T, B)
    - Dissolved Oxygen (T, B)
    - Chlorophyll/Phycocyanin (T)
    - Turbidity (T)



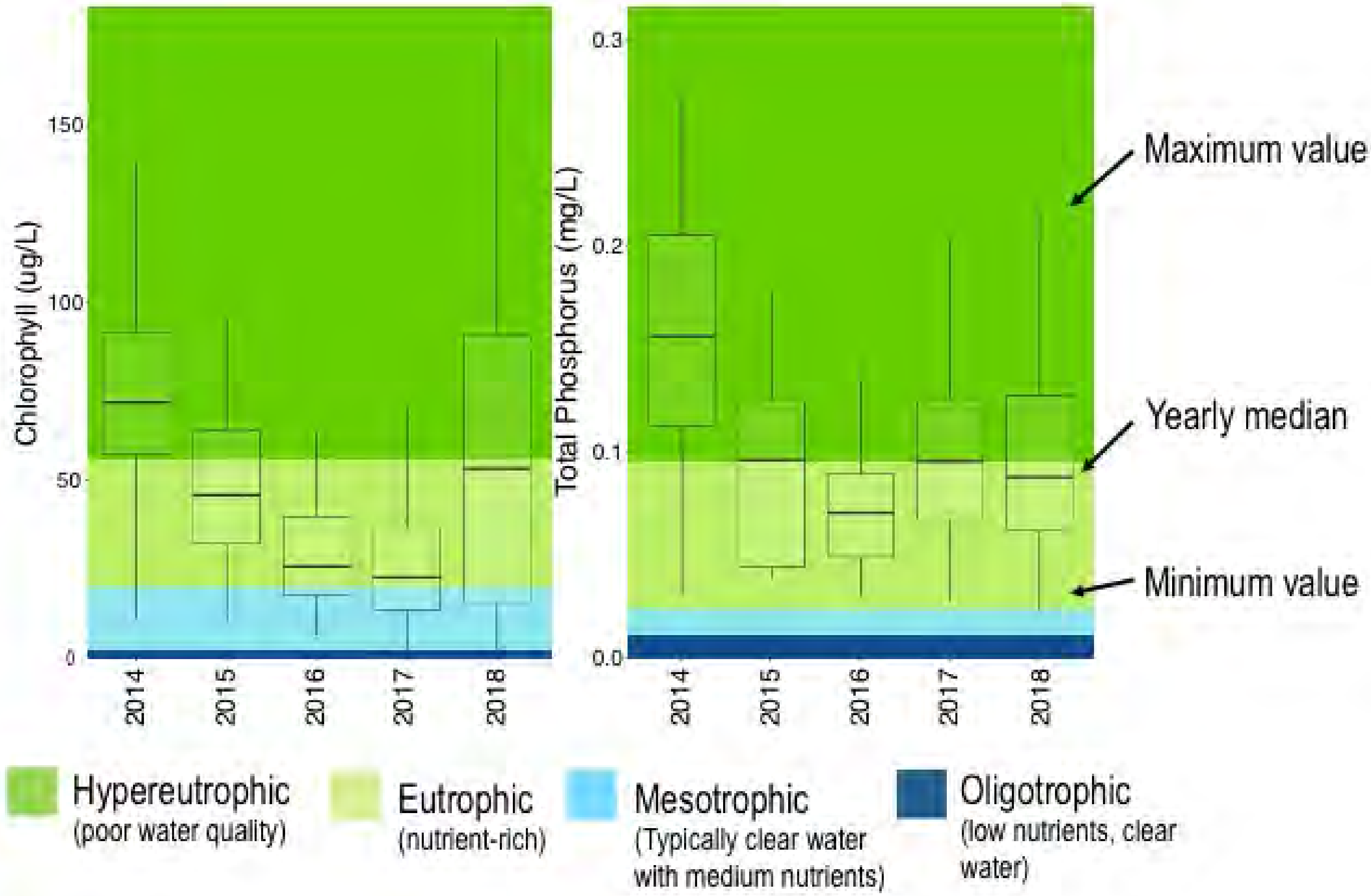
Continuous Monitoring Station
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
Jun
Jul
Aug
Sep
Oct
DO Trend
DO
< 5mg/L
DO Depleted
< 2mg/L
Hypoxia
Completely anoxic (0 mg/L) for 8 full days

Green Bay Area of Concern

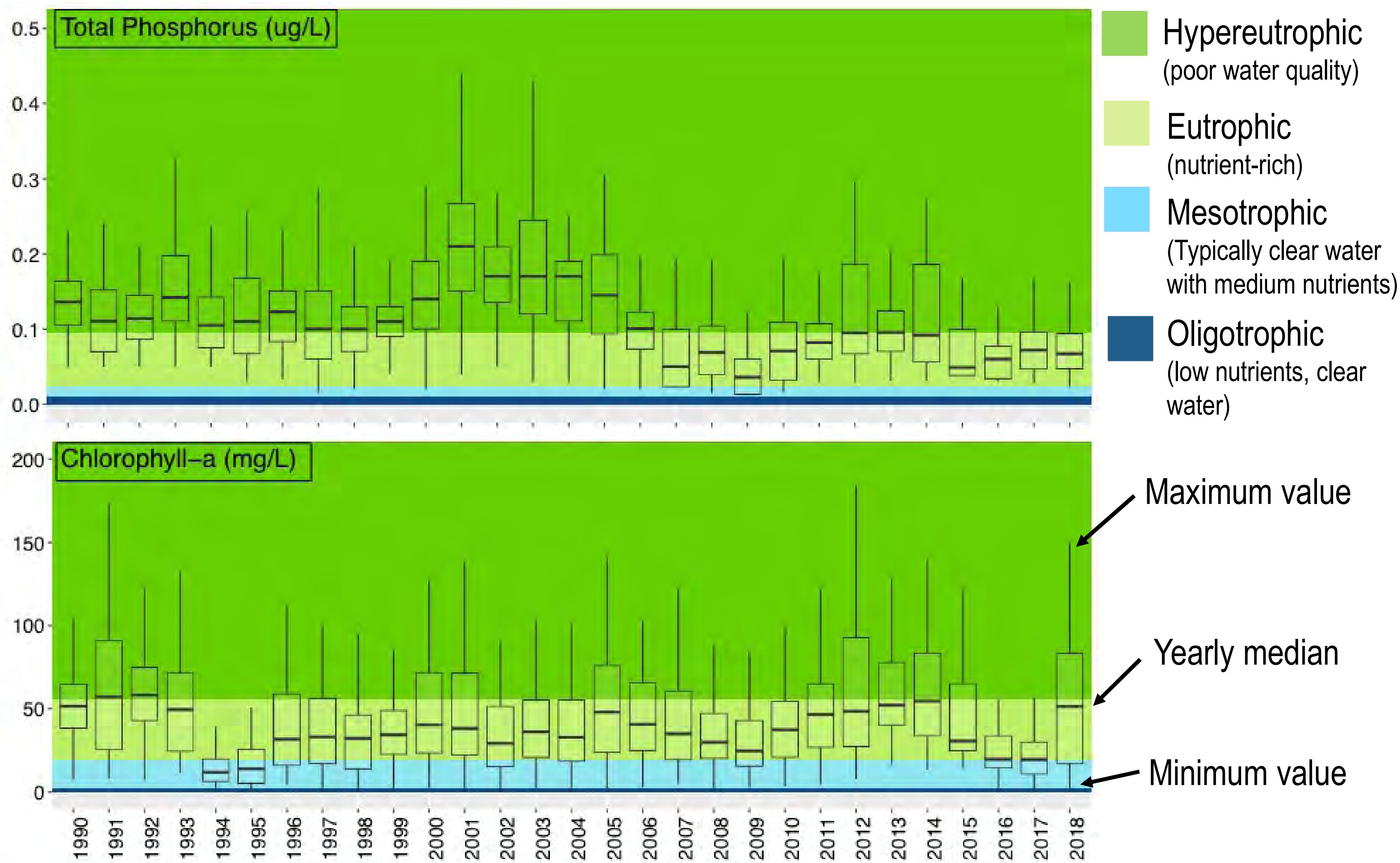
- **AREA OF CONCERN (AOC)**:
  - Lower Green Bay & Fox River
  - By International Joint Commission & US Environmental Protection Agency

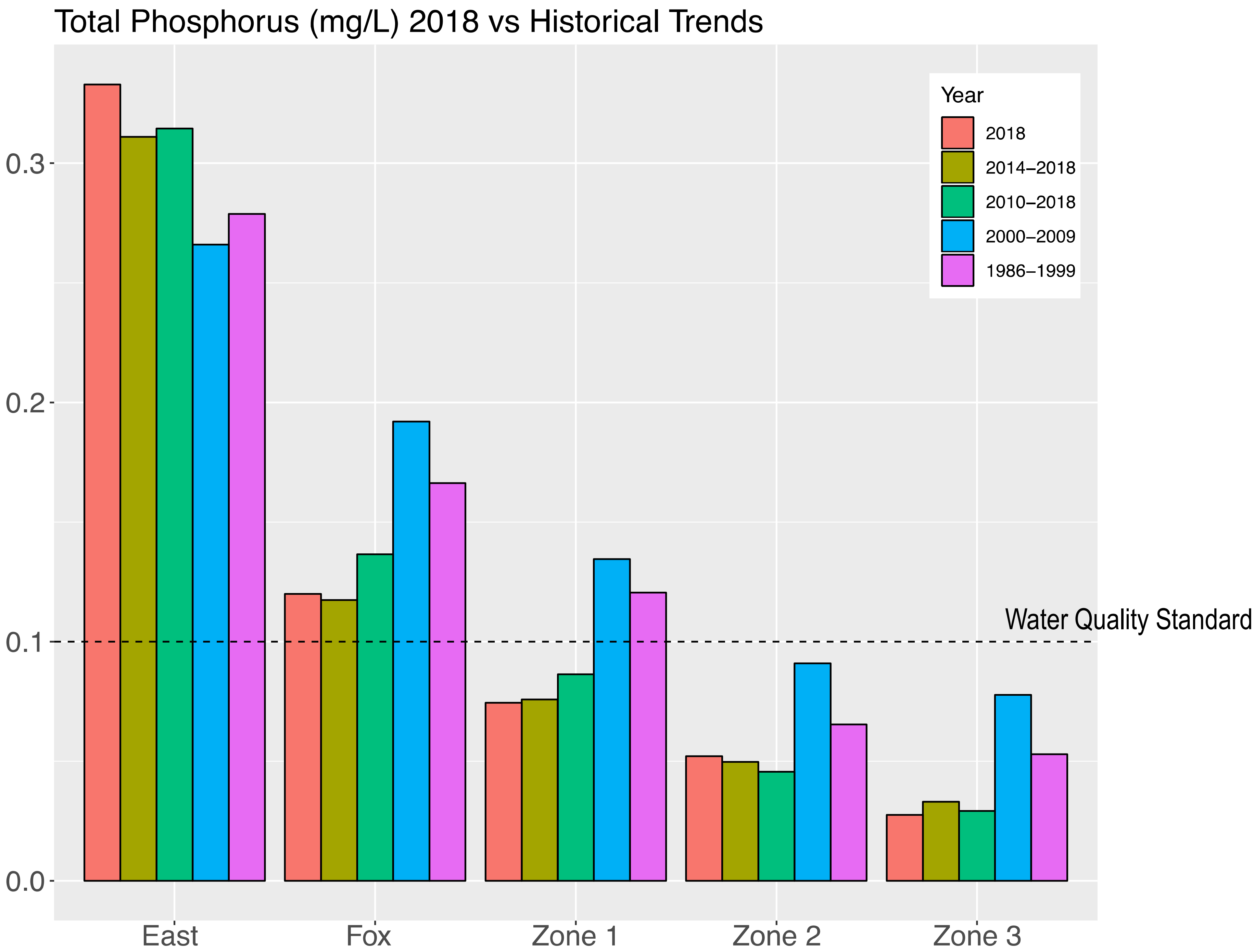
- **TOTAL MAXIMUM DAILY LOAD**:
  - Lower Fox River & Lower Green Bay
  - For Total Phosphorus & Total Suspended Solids
  - By WI Department of Natural Resources & US Environmental Protection Agency

Green Bay AOC Trophic Status

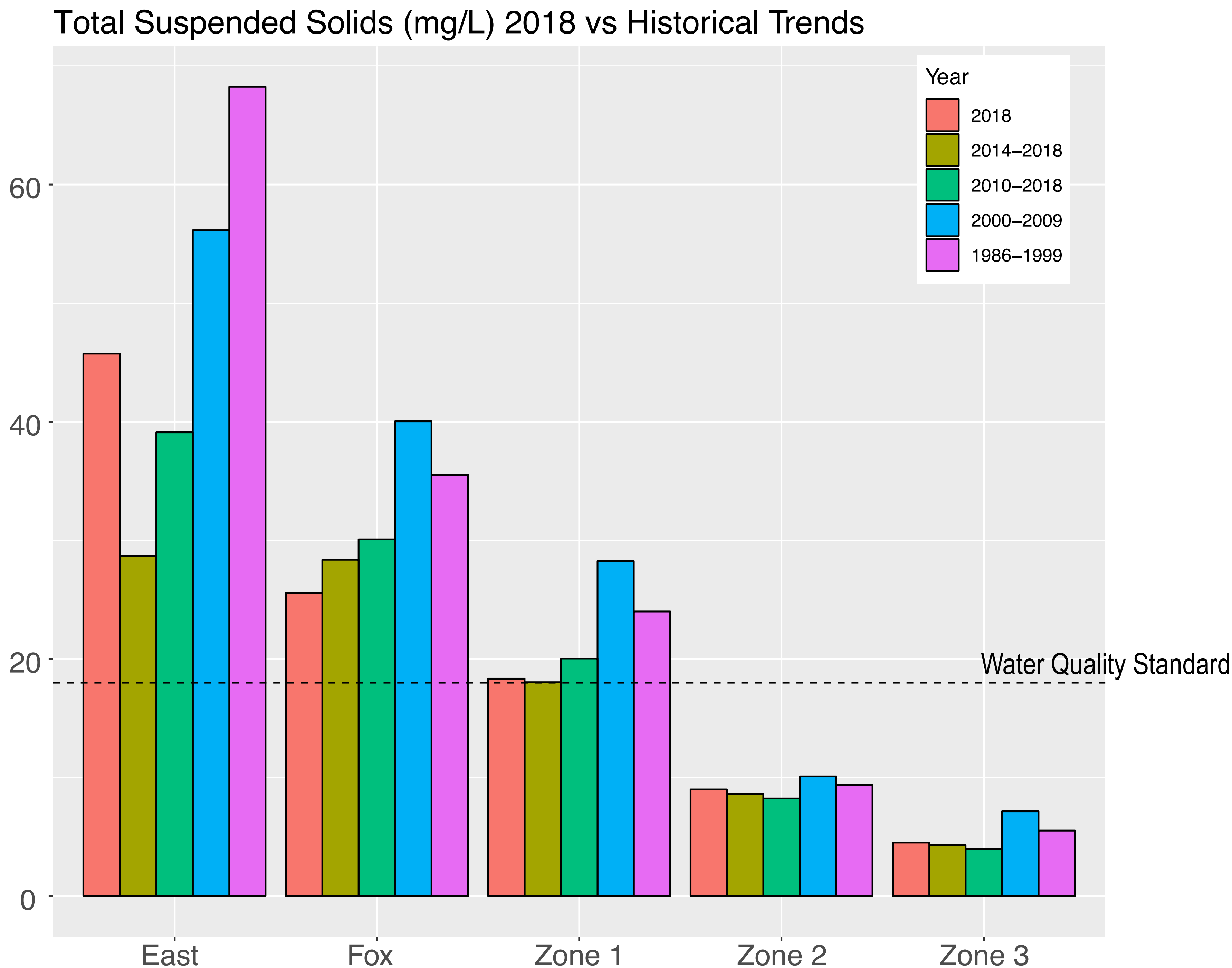


Lower Green Bay Trophic Status

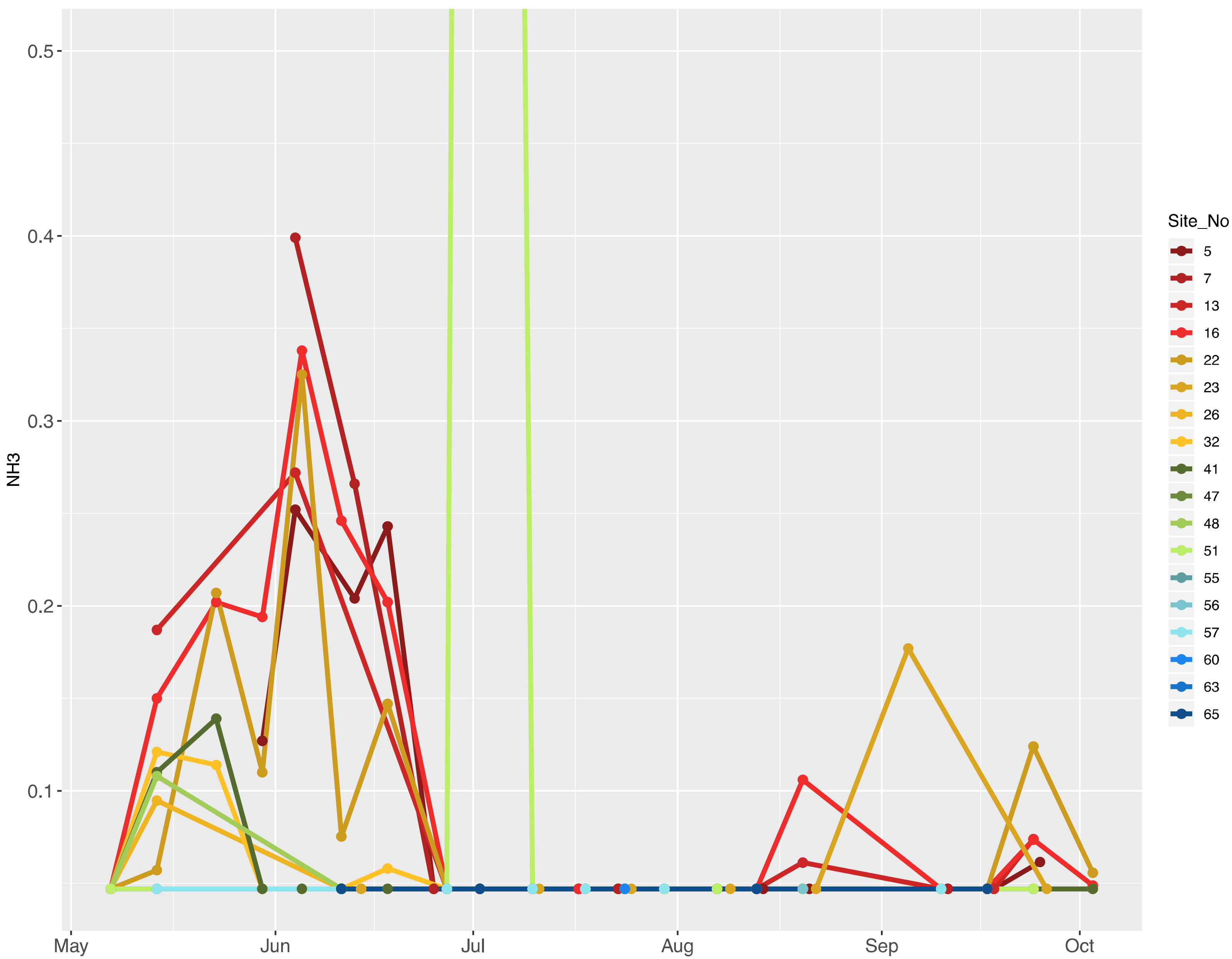




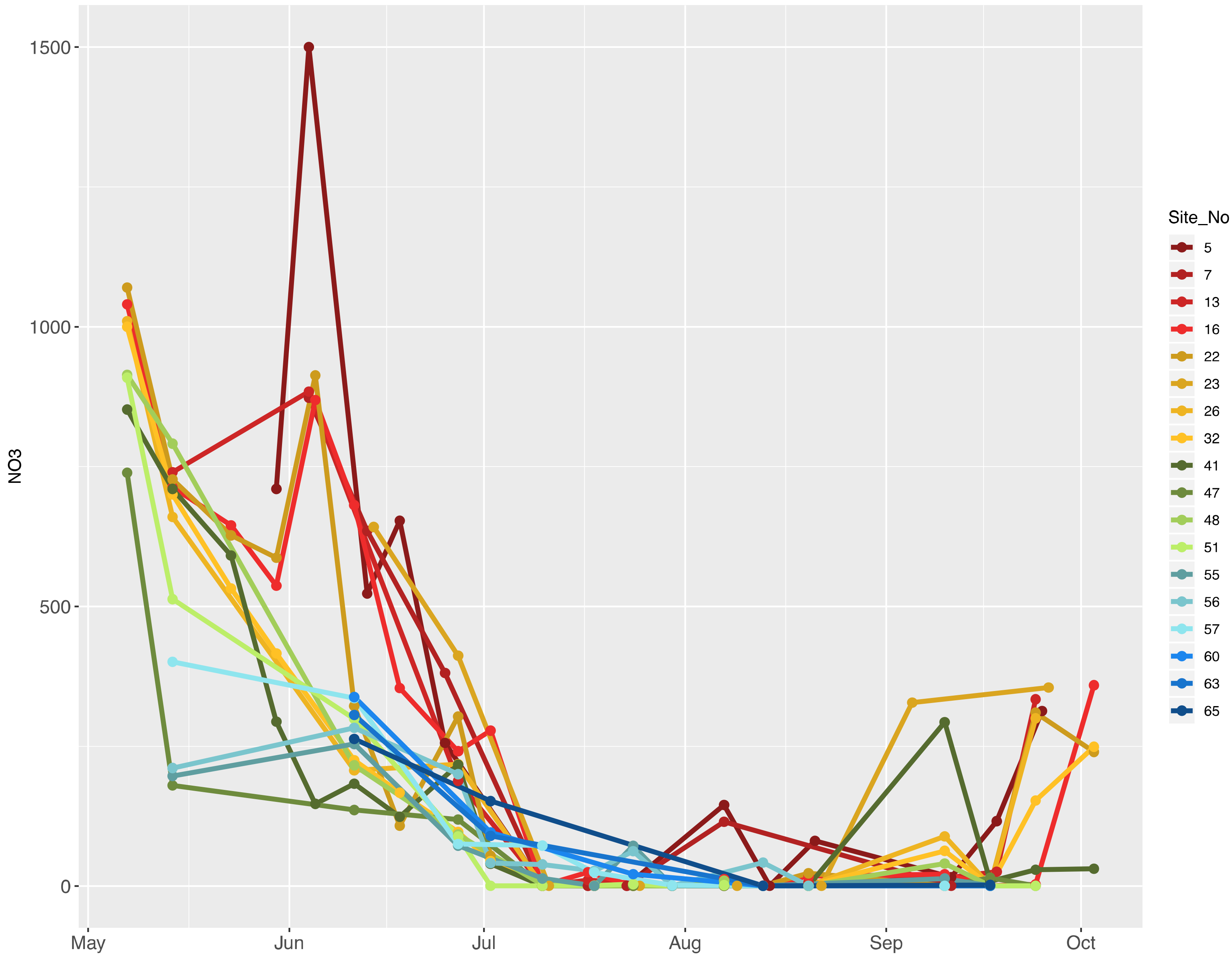
Total Phosphorus (mg/L) 2018 vs Historical Trends
Year
2018
2014–2018
2010–2018
2000–2009
1986–1999
Water Quality Standard
0.3
0.2
0.1
0.0
East
Fox
Zone 1
Zone 2
Zone 3


Total Suspended Solids (mg/L) 2018 vs Historical Trends
Year
2018
2014–2018
2010–2018
2000–2009
1986–1999
60
40
20
0
Water Quality Standard
East
Fox
Zone 1
Zone 2
Zone 3

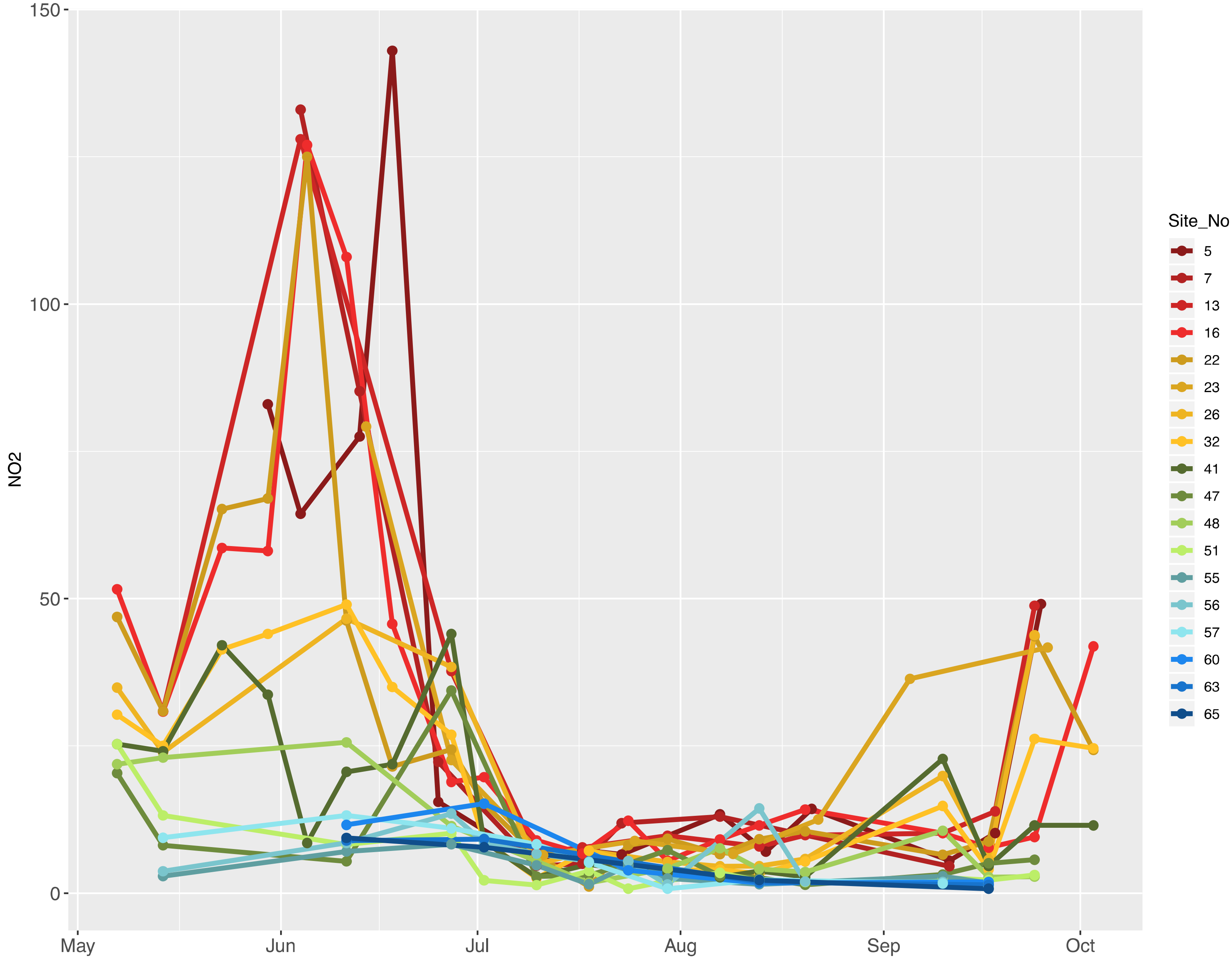
2018 Ammonia



2018 Nitrate



2018 Nitrite

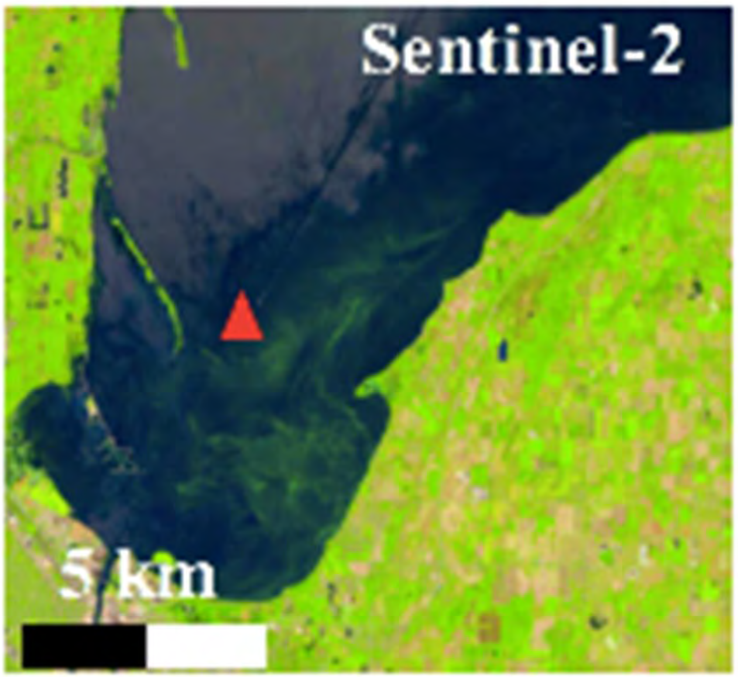


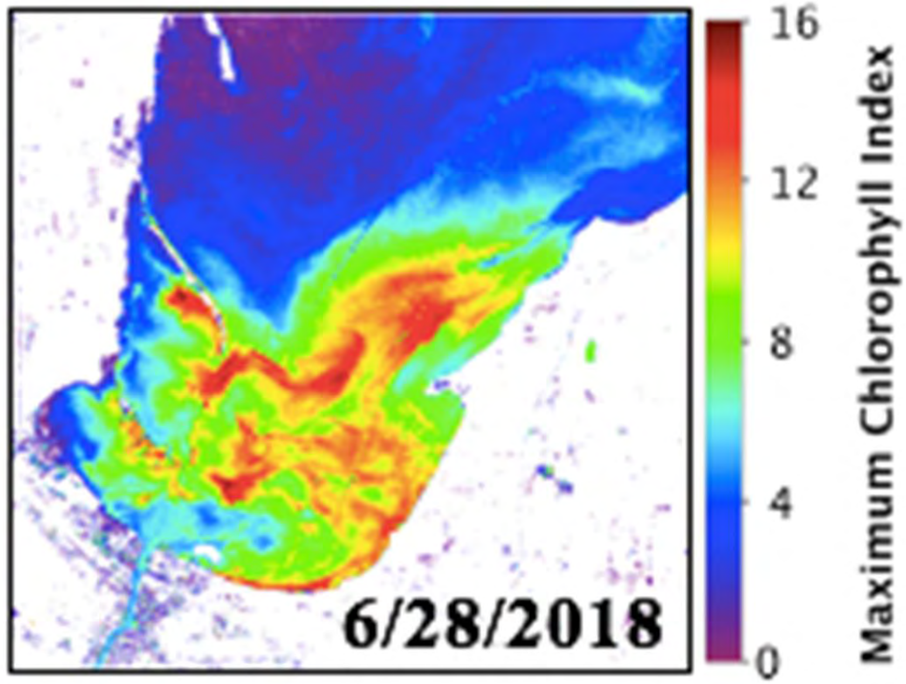
2019 Collaborative Research

- **NASA**: Cyanobacteria monitoring using satellites
- **DNR:** Green Bay nearshore monitoring to support 'Cyanobacteria Assessment Network Collaboration' using remote sensing
- **DNR**: Phase 2 'Assessing cyanobacteria and their toxins in Lower Green Bay'

NASA: SeaPrism Deployment

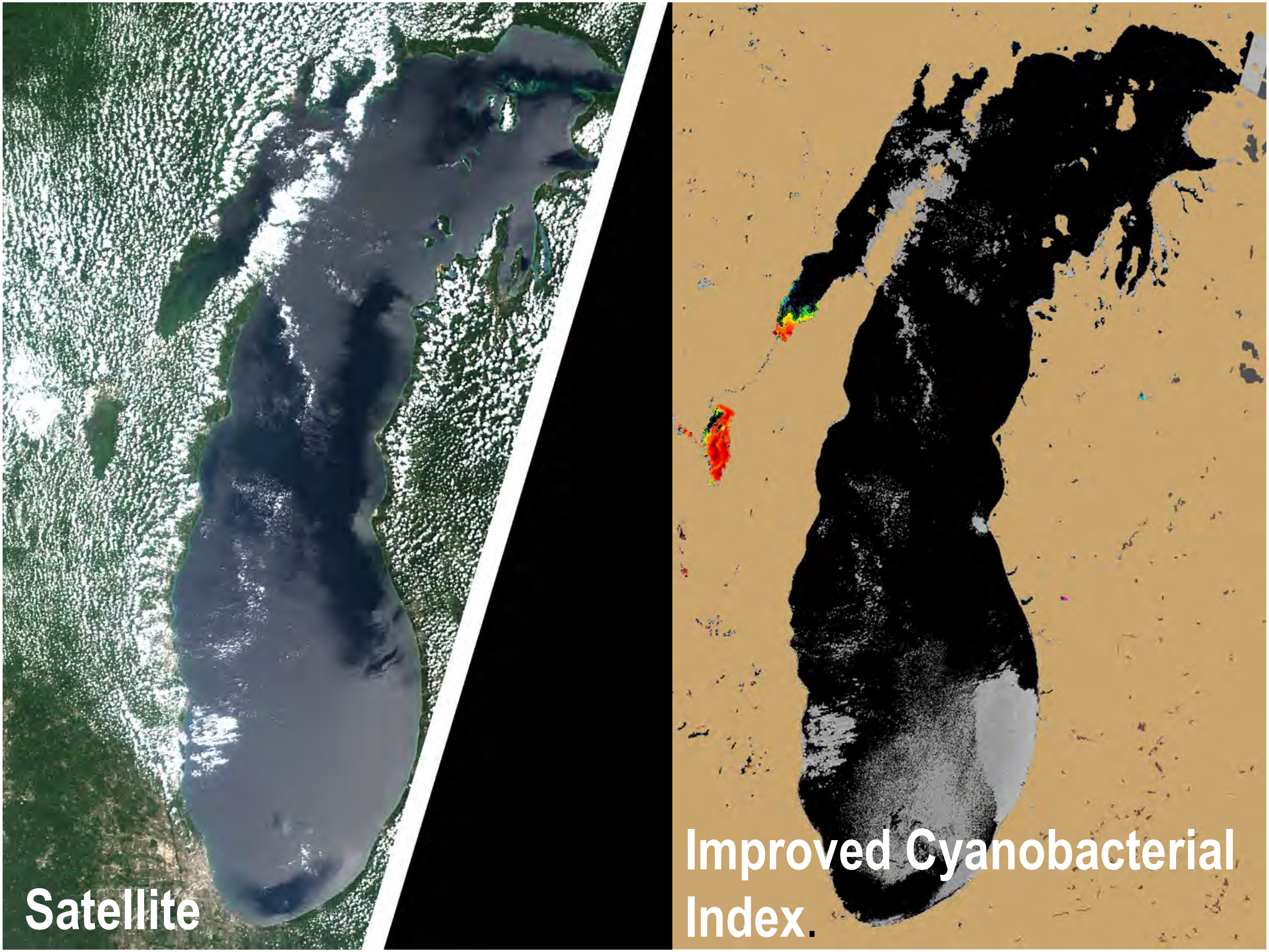
How SeaPrism Works



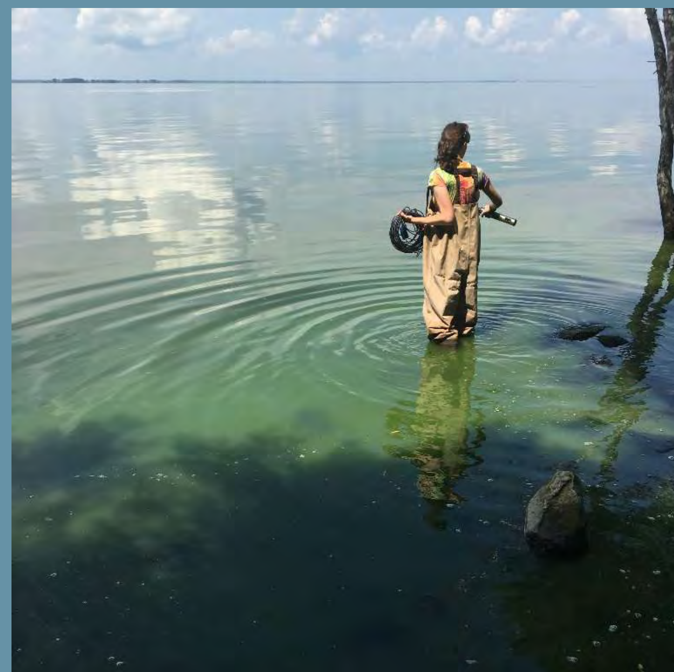


- Image from Sentinel-2 satellite.
- Red triangle is location of SeaPrism.

- Image created using Cyanobacterial Index = satellite data and SeaPrism calibration.


Satellite
Improved Cyanobacterial Index.

Blue-Green Algae Assessment in Lower Green Bay



UWM
UNIVERSITY of WISCONSIN
MILWAUKEE

Cooperative Institute for Great Lakes Research
CIGLR
Great Lakes Science for Society

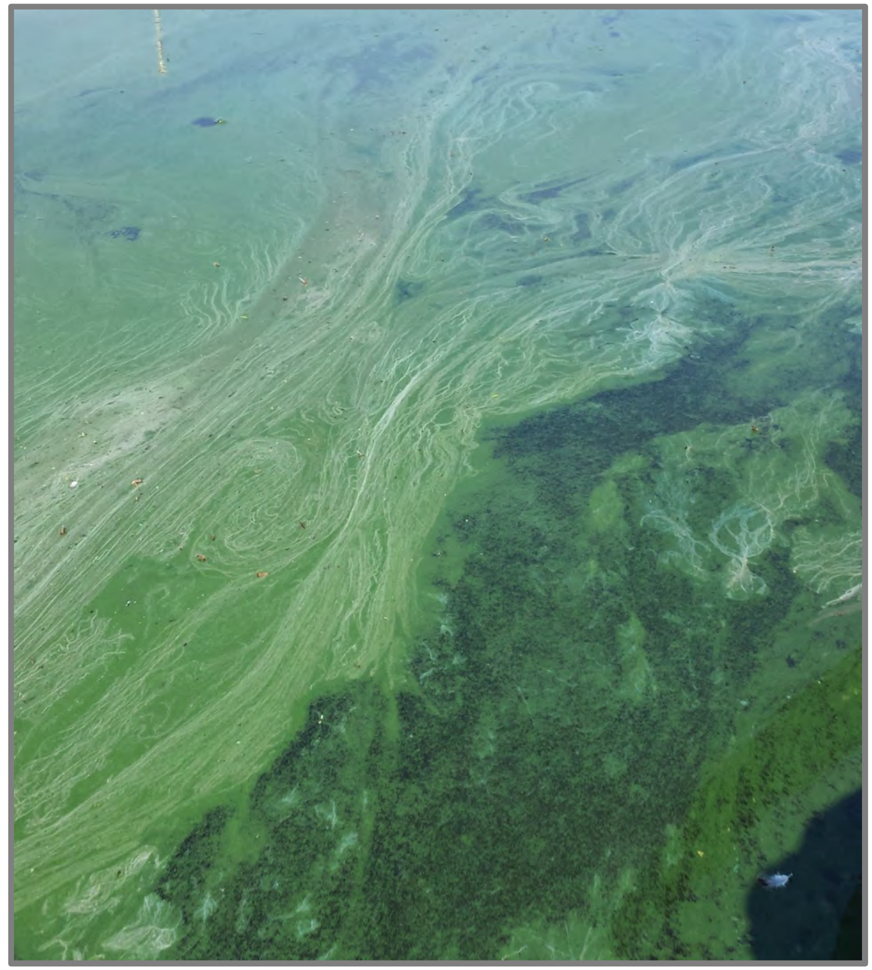
NOAA
U.S. NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

WISCONSIN DEPT. OF NATURAL RESOURCES

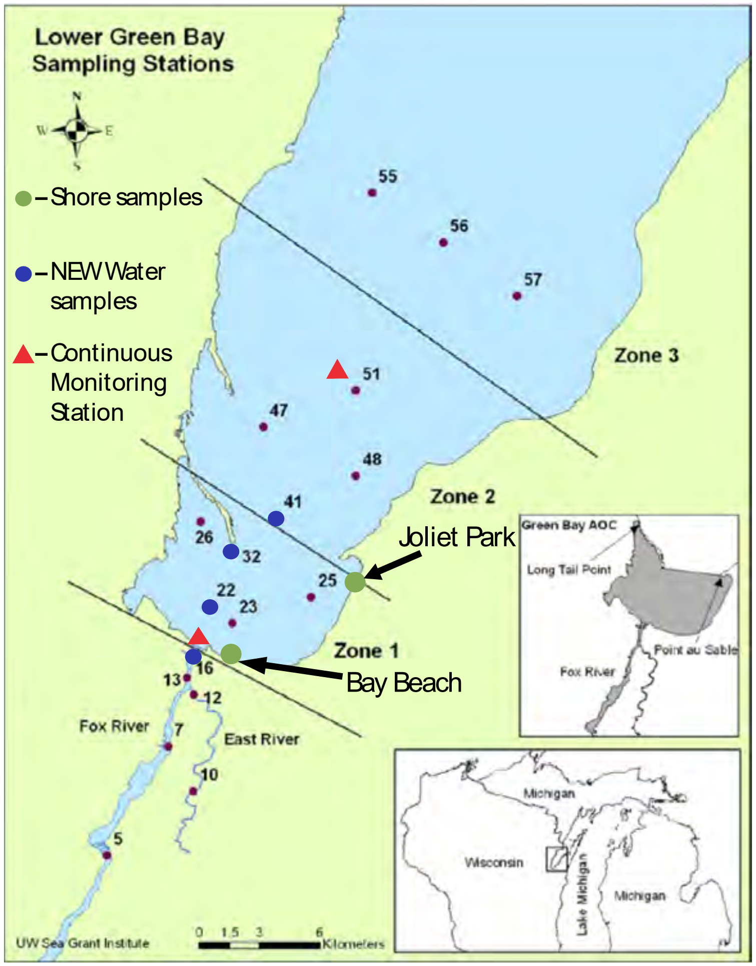
NEW Water
The brand of the Green Bay Metropolitan Sewerage District

Cyanobacteria

- Naturally occurring bacteria (aka ‘Blue Green Algae’)
- Problematic for water quality issues
  - Increase in turbidity
  - Decrease in dissolved oxygen
  - Produce undesirable taste and odor compounds.
- Can produce toxins
- Some taxa produce non-toxic but bioactive compounds potentially of concern

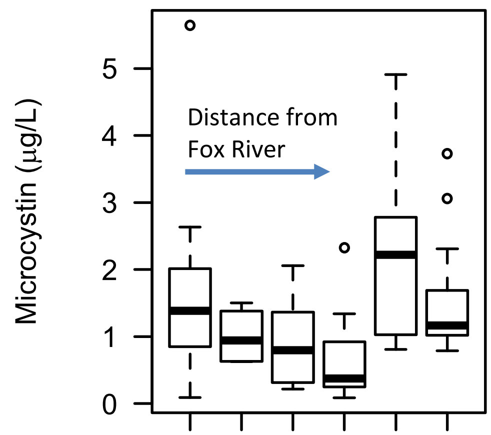


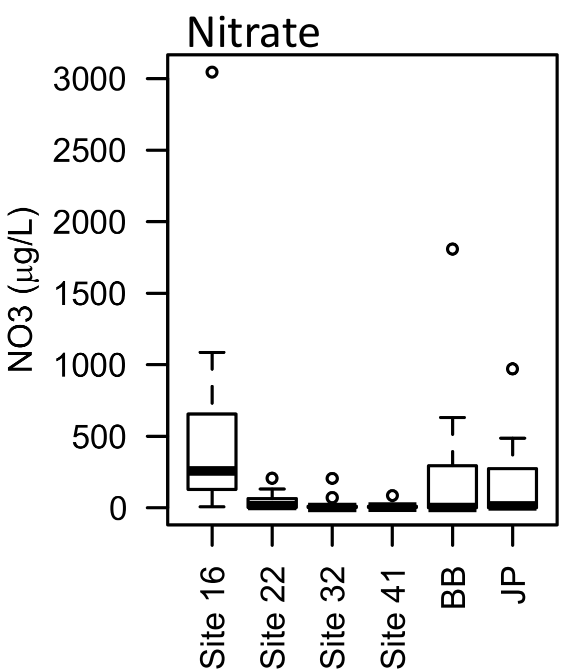
Research Questions

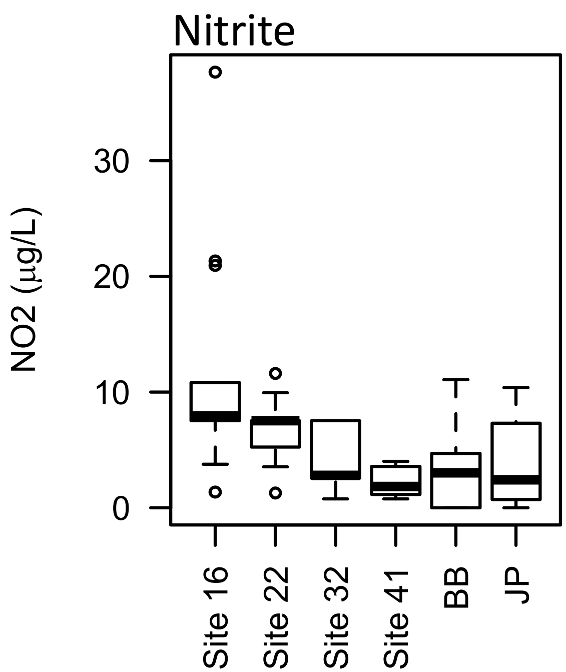


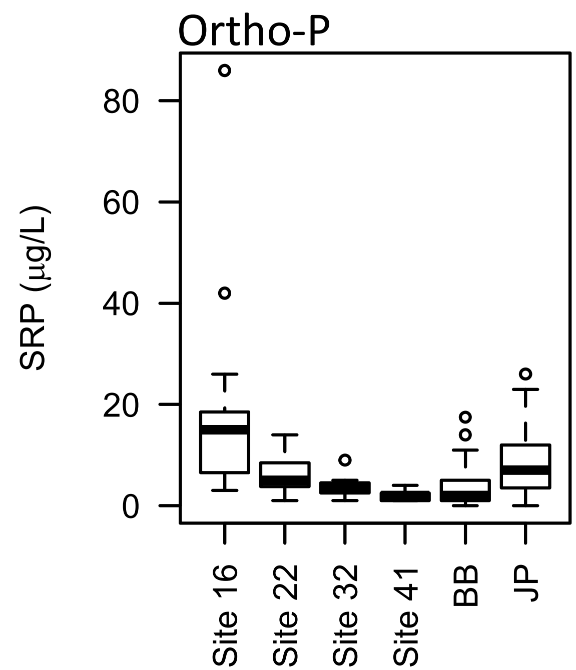
- Diversity and distribution of cyanotoxins in Green Bay
  - Weekly sampling along a transect + Bay Beach and Joliet Park
  - LCMS analysis of cyanotoxins
- Temporal modeling of cyanotoxins in the Bay Beach area
  - Sampling 2-3x per week
  - Physicochemical variables + cyanotoxins
  - Microscopic cell counts
  - Two water quality monitoring buoys
- Who are the microcystin producers in the lower Green Bay and what are drivers of microcystin gene expression?
  - Quantification of toxin + 16S rRNA genes
  - RNA expression analysis of toxin genes

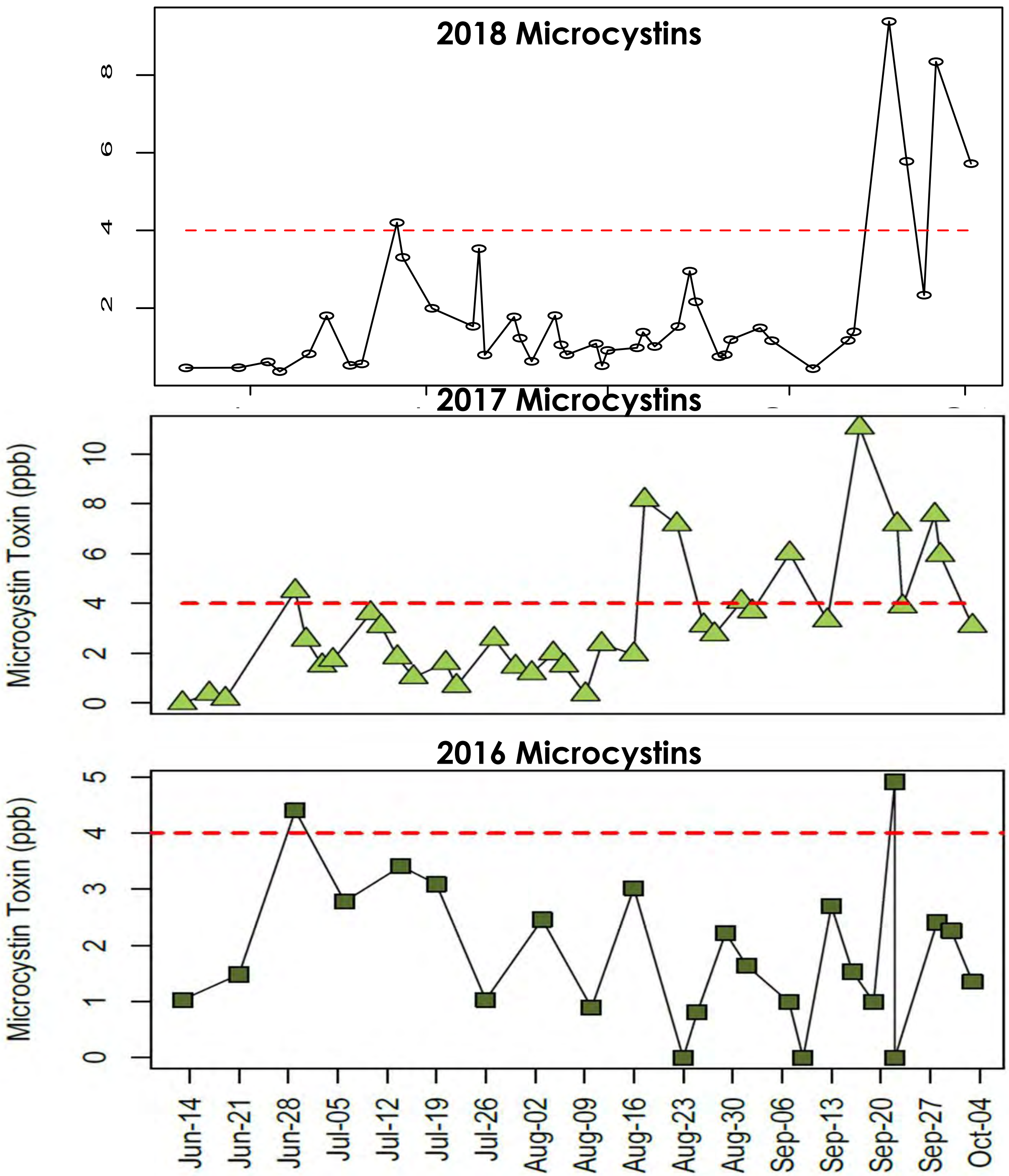
Cyanotoxins and Nutrient Gradient





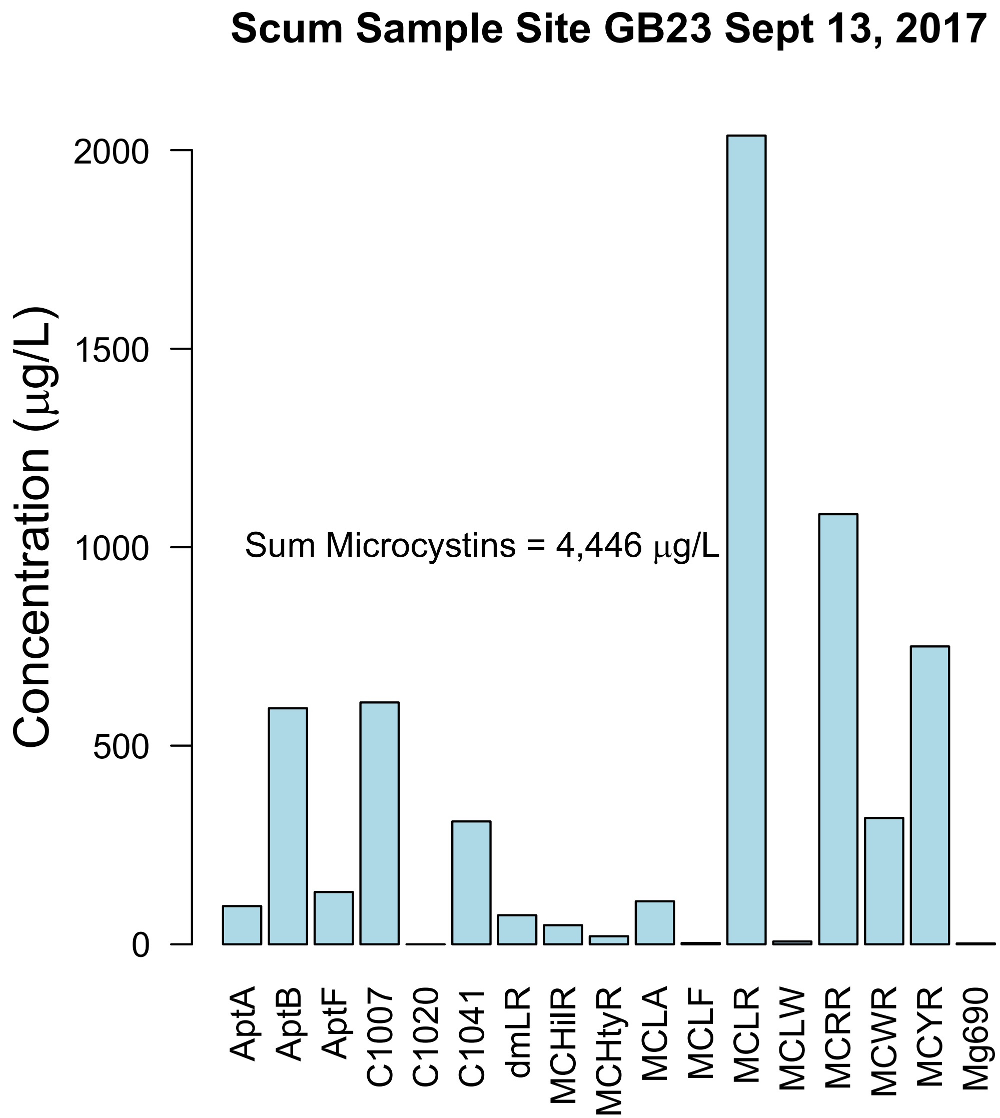






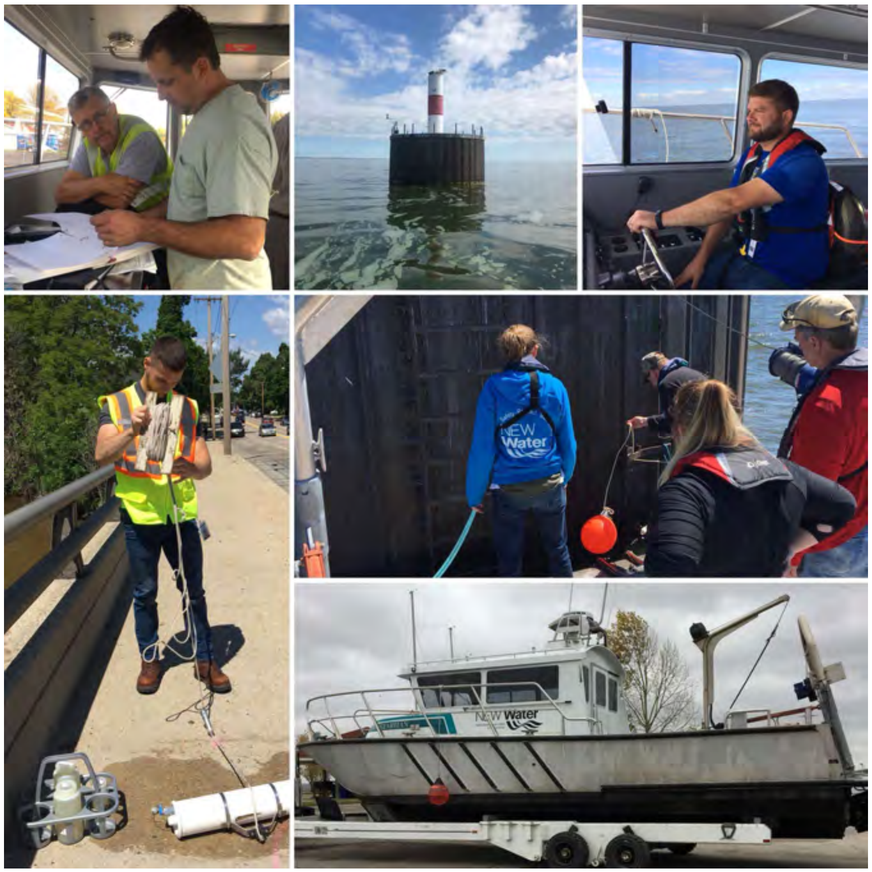
Microcystin Variability

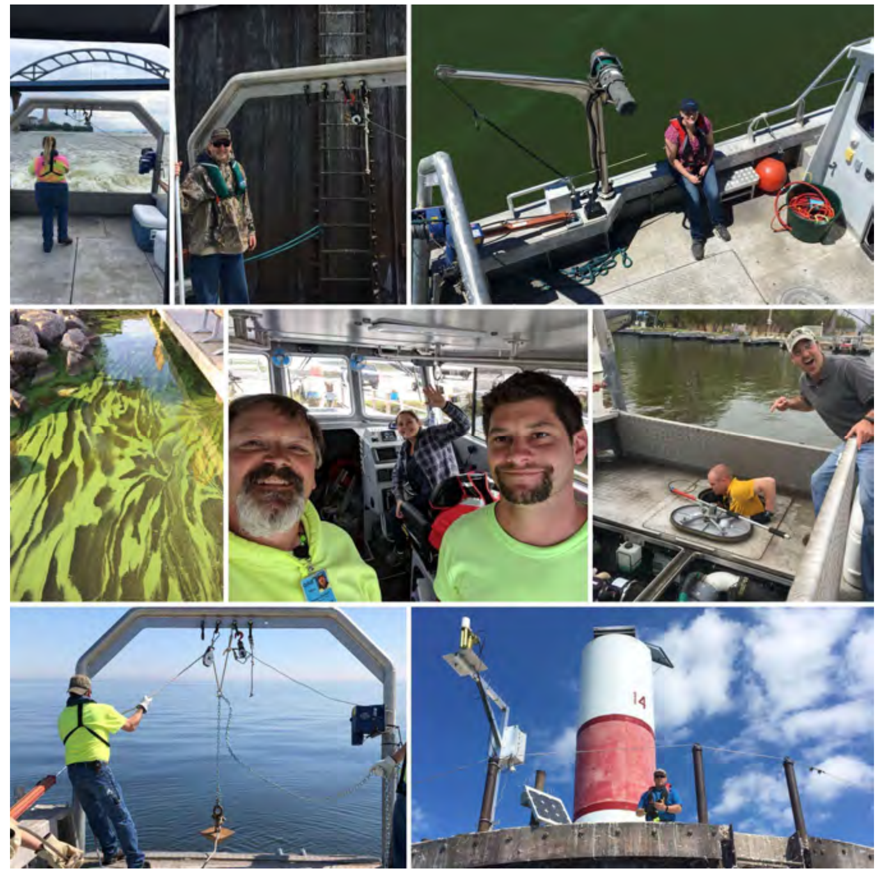
- Cyanotoxins vary within the year but also each year can be very different from the last.
- It is still unclear what environmental drivers in Green Bay cause a 'bad' bloom year.



Scum Sample Site GB23 Sept 13, 2017
Concentration (µg/L)
2000
1500
1000
500
0
Sum Microcystins = 4,446 µg/L
AptA
AptB
AptF
C1007
C1020
C1041
dmLR
MCHilR
MCHtyR
MCLA
MCLF
MCLR
MCLW
MCRR
MCWR
MCYR
Mg690

Thank You





NEW Water
The brand of the Green Bay
Metropolitan Sewerage District