

Are Harmful Algae Blooms (HABs) a Problem in Michigan's Inland Lakes?

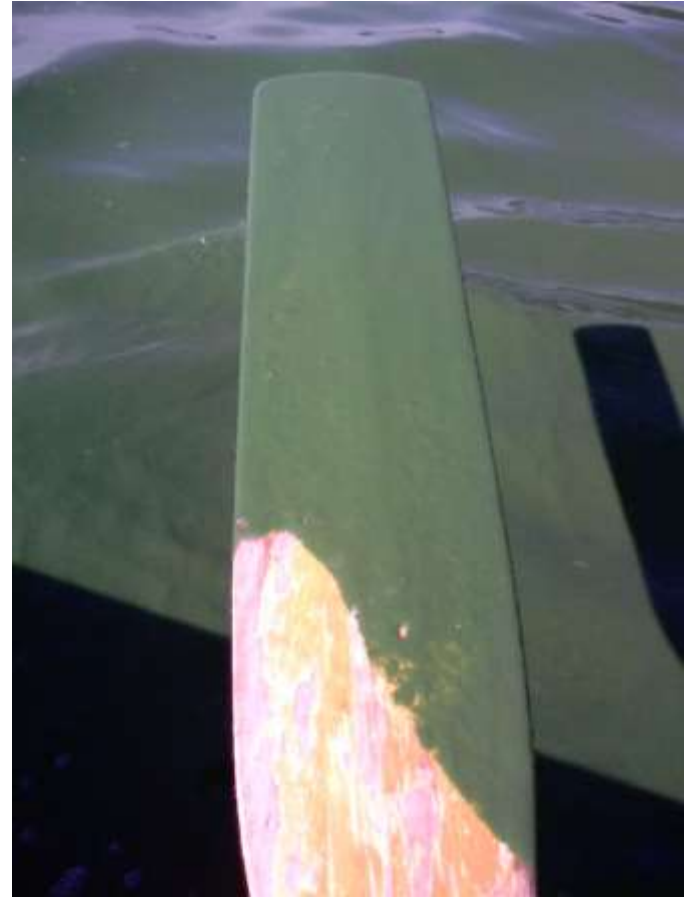
2015 Michigan Inland Lakes HABs Survey Results

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Overview

- Define HABs
- HABs in Michigan
(Lake Erie and Everywhere Else)
- 2015 monitoring
 - Status and trend
 - Targeted
 - What we did and results
- What's next? 2016 plans



Lake Macatawa, 2012

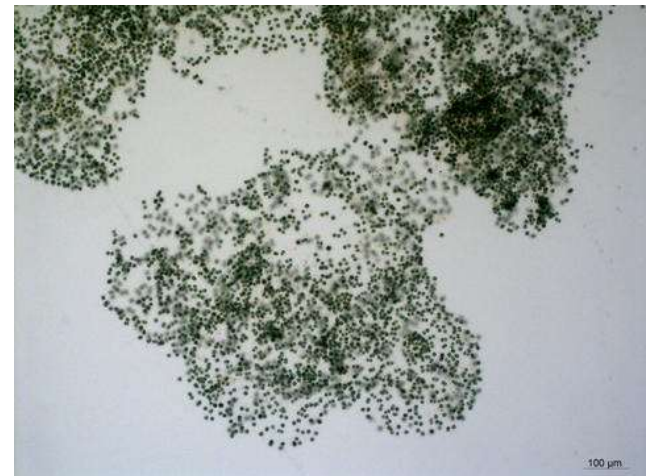
Harmful Algae Blooms

- Algae bloom is a large increase in phytoplankton
 - Cell densities > 20,000 to 100,000 cells/ml (Graham, 2008)
 - Cell densities > 100,000 considered high risk by World Health Organization
- ‘Harmful’ = aesthetically unappealing, deplete dissolved oxygen, and produce toxins
- Cyanobacteria (bluegreen algae) most widespread toxin-producing phytoplankton



Cyanobacteria

- Cyanobacteria/Bluegreen Algae
- Photosynthetic bacteria
- Found naturally worldwide in fresh and salt water
- Produce over 80 known toxins
- Types of BGA in Michigan
 - microcystis, aphanizomenon, anabaena, cylindrospermopsis, limnothrix



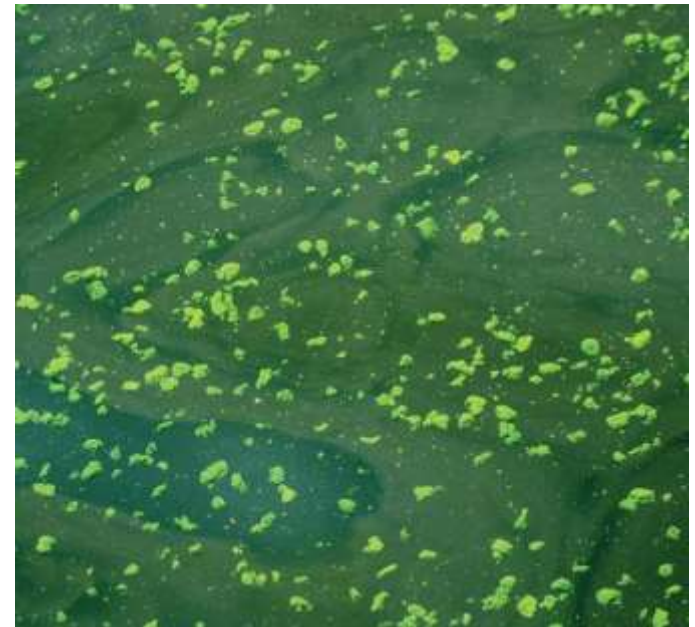
Cyanotoxins

microcystin

anatoxin

cylindrospermopsin

- Human and Animal Health Risks
 - Hepatotoxins
 - Neurotoxins
 - Dermatologic effects
- Water Treatment Costs
- Quality of Life
 - Recreation, property values, tax revenue, employment



Toxin Reference Doses



Higher Toxicity

Lower Toxicity

Dioxin (0.000001 mg/kg-d)

Microcystin LR (0.000003 mg/kg-d)

Saxitoxin (0.000005 mg/kg-d)

PCBs (0.00002 mg/kg-d)

Cylindrospermopsin (0.00003 mg/kg-d)

Methylmercury (0.0001 mg/kg-d)

Anatoxin-A (0.0005 mg/kg-d)

DDT (0.0005 mg/kg-d)

Selenium (0.005 mg/kg-d)

Botulinum toxin A (0.001 mg/kg-d)

Alachlor (0.01 mg/kg-d)

Cyanide (0.02 mg/kg-d)

Atrazine (0.04 mg/kg-d)

Fluoride (0.06 mg/kg-d)

Chlorine (0.1 mg/kg-d)

Aluminum (1 mg/kg-d)

Ethylene Glycol (2 mg/kg-d)

Microcystin Risks for Recreation

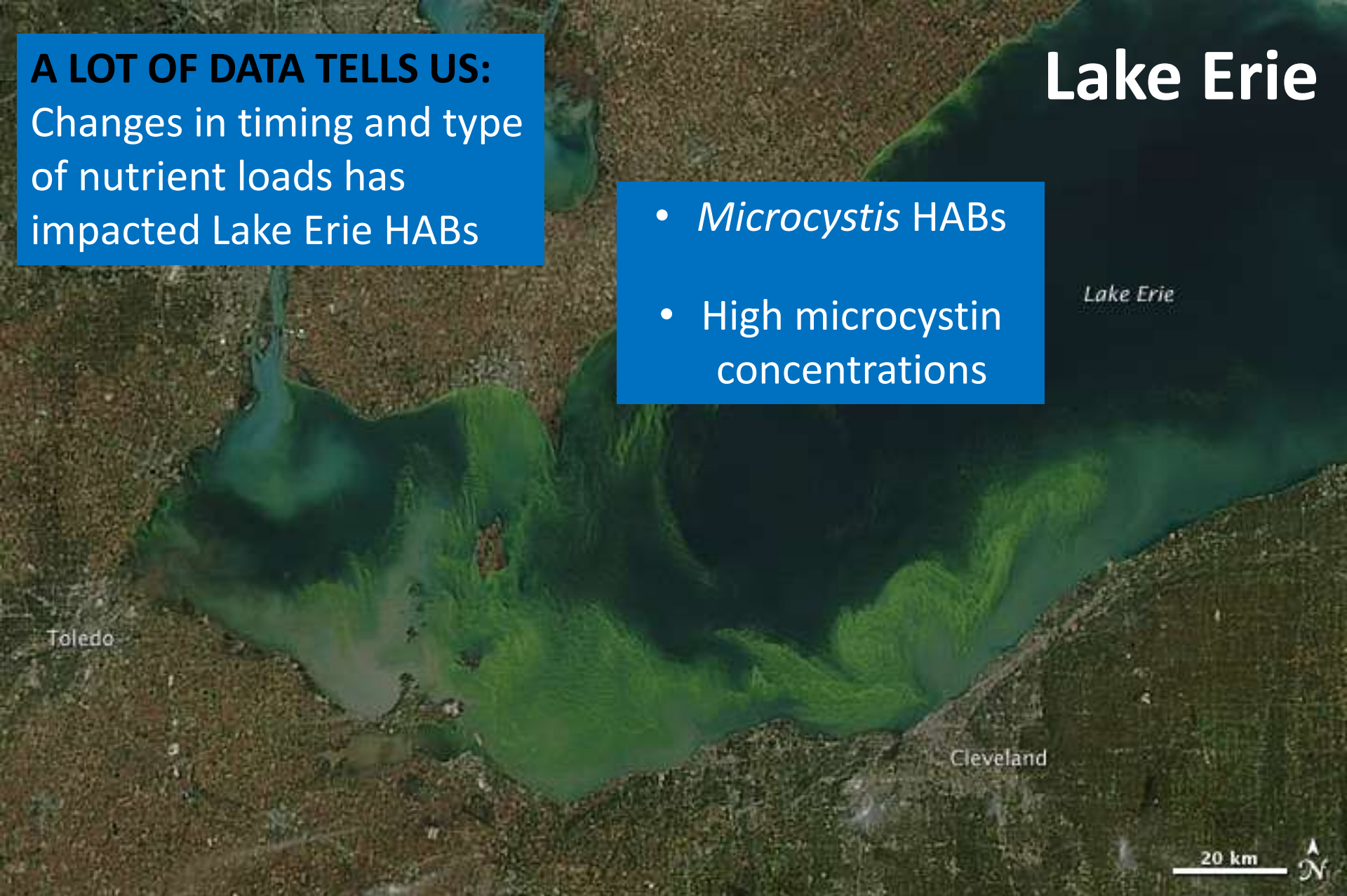
Recreational Use Warnings ($\mu\text{g}/\text{L}$)	
USEPA	In development
MI DEQ	In development
World Health Organization	20
Ohio EPA	20
Illinois EPA	10

****Microcystin Finished Drinking Water Standards are Lower****

A LOT OF DATA TELLS US:
Changes in timing and type
of nutrient loads has
impacted Lake Erie HABs

Lake Erie

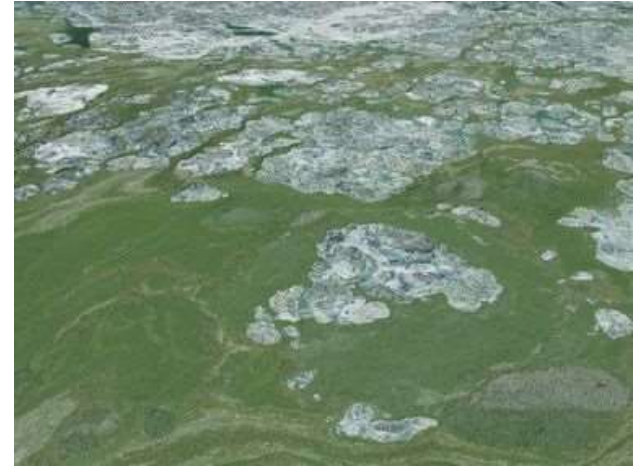
- *Microcystis* HABs
- High microcystin concentrations



NASA October 9, 2011

HABs in the Upper Midwest

- Variable concentrations produced by blooms
- Drinking water sources
- More reports of dog illnesses, dog deaths, and human illnesses associated with HABs (MN, 2015)



Working Michigan HAB Working Definition

“An algal bloom in recreational waters is harmful if microcystin levels are at or above the 20 ug/L WHO non-drinking water guideline, or other algal toxins are at or above appropriate guidelines that have been reviewed by the MDEQ-WRD.”

A bloom should be considered potentially harmful when “the chlorophyll a level is greater than 20 ug/L and visible surface accumulations/scum are present, or cells are visible throughout the water column.”

Michigan Inland Lake HABs

Six studies in MI lakes sampled 232 lakes from 2002 to 2012

Study	# Lakes	Microcystin Results ($\mu\text{g}/\text{l}$)
DEQ – Public Lakes	41	< 1
EPA – NLA (2007, 2012)	103	< 10
CLMP – Volunteers/MSU	77	One sample > 10
GVSU – Muskegon Co.	7	Two samples > 1, all < 20
Leelanau Conservancy	6	One sample > 20, all others < 1

- No evidence of broad scale high concentrations of microcystin
- MDEQ does get reports of and questions about algal blooms - Need to have plans and tools to monitor blooms, assess toxin concentrations, and improve understanding of HABs in MI

MI DEQ 2015 Algal Toxin Monitoring

● Status Inland Lakes

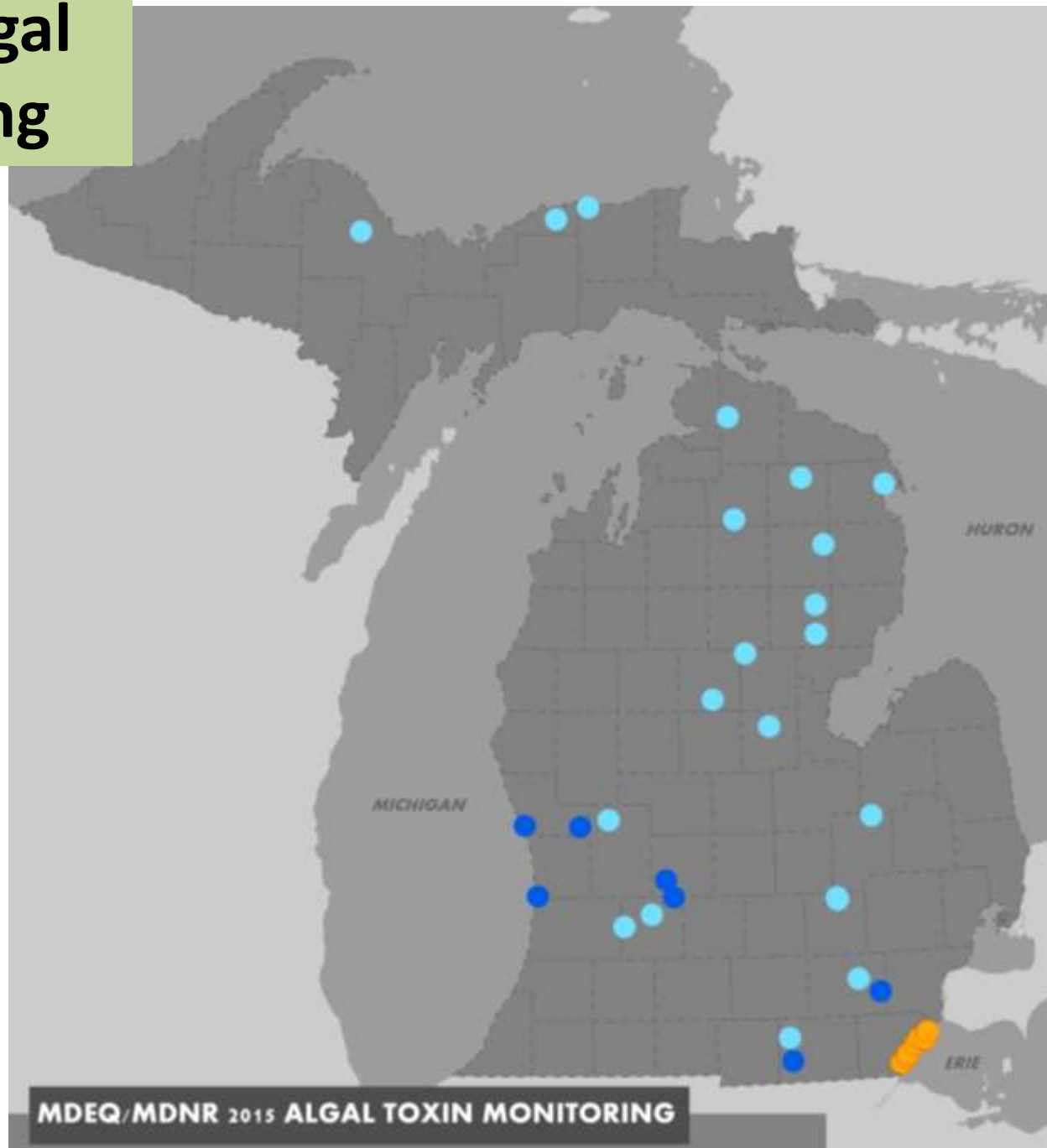
- 22 Lakes
- Microcystin test strips
- 2 sample dates

● Targeted Inland Lakes

- 7 Lakes
- Microcystin test strips
- Quantitative analysis (multiple algal toxins)
- 1 to 11 sample dates

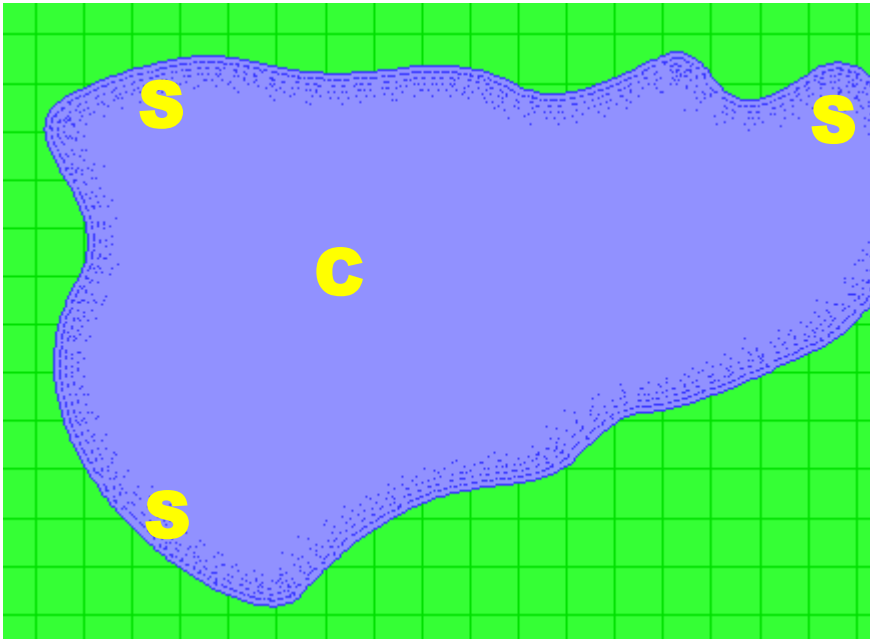
● Lake Erie

- 7 Beaches
- Microcystin test strips
- Quantitative analysis (microcystin)
- ~ 10 sample dates



2015 Algal Toxin Monitoring - Methods

Algal toxins collected as surface grabs at center and 3 shoreline locations



Targeted Lakes Algal Toxin

- Total Microcystin – Test Strip
- HPLC-MS
 - Microcystin- LR, YR, RR, LA
 - Anatoxin-A
 - Homoanatoxin-a
 - Cylindrospermopsin
 - Deoxycylindrospermopsin

2015 Algal Toxin Monitoring - Results

Microcystin Test Strips



2015 Algal Toxin Monitoring - Results

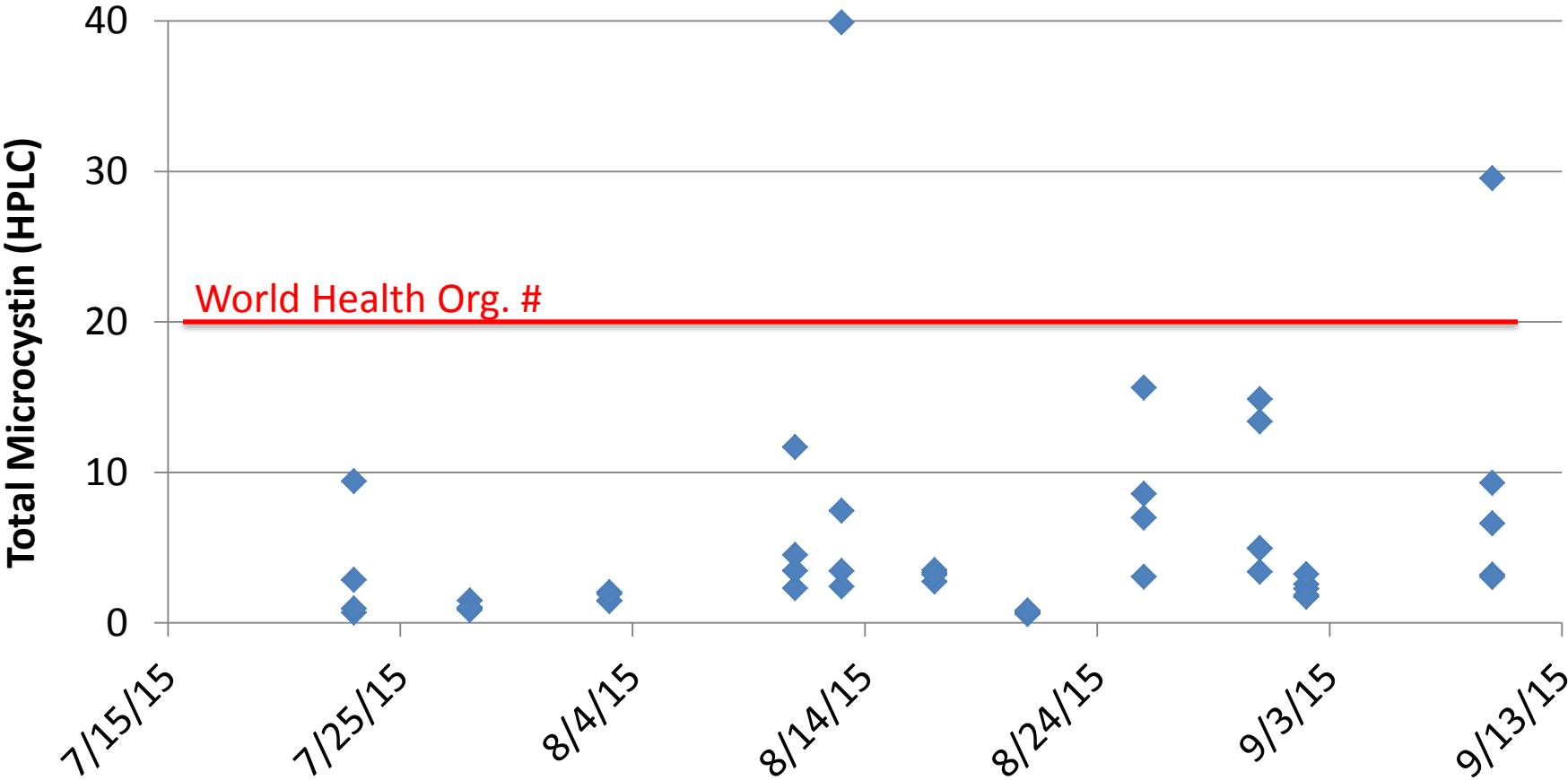
Microcystin Test Strips ($\mu\text{g/L}$)

Lake (# test strips)	< 1	1-10	>10
22 Status and Trend Lakes (168)	164	4 1 lake	0
7 Targeted Lakes (145)	95	39 3 lakes	10 1 lake

2015 Algal Toxin Monitoring - Results

HPLC-MS Microcystin ($\mu\text{g/L}$)

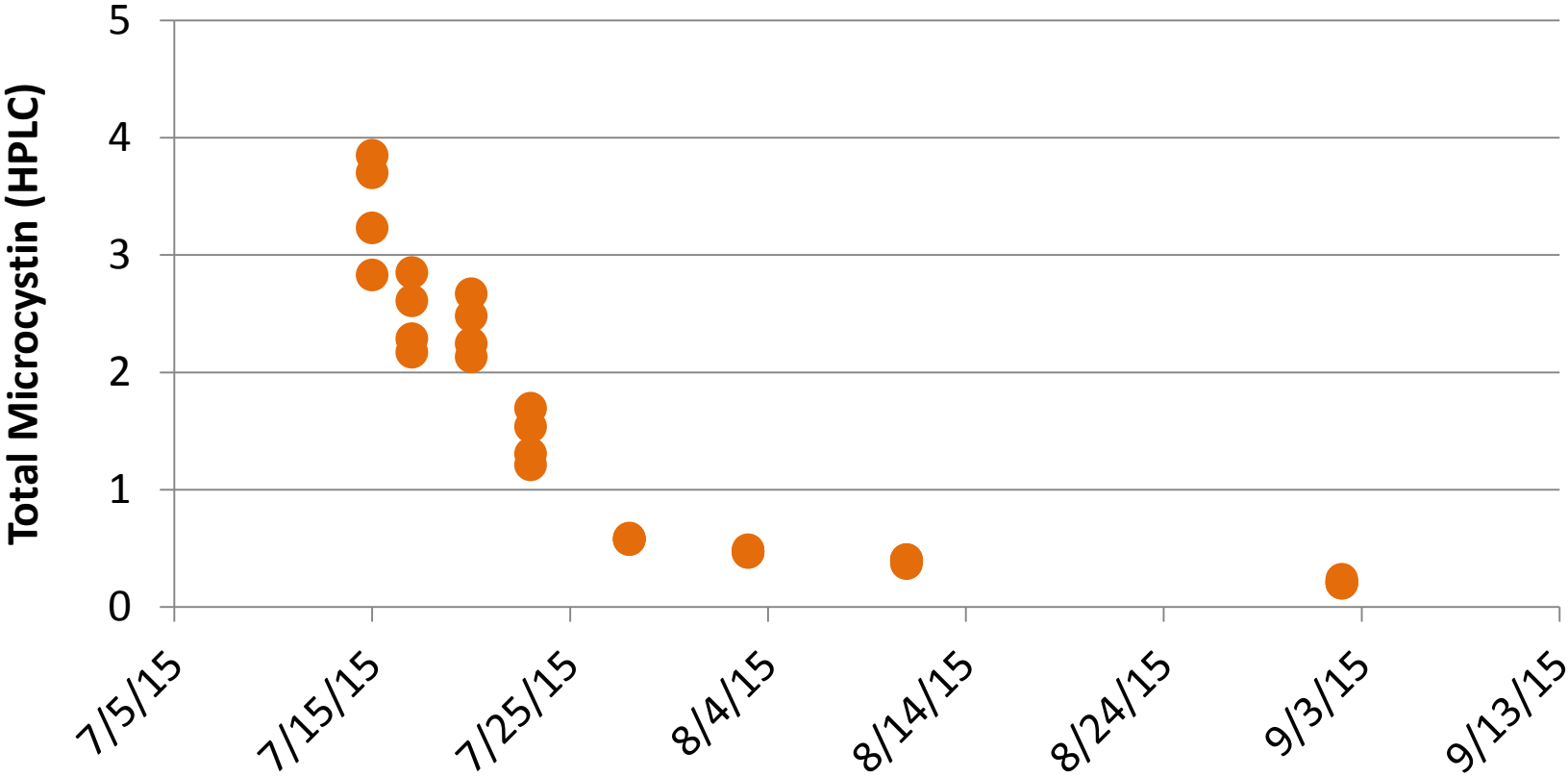
Mona Lake



2015 Algal Toxin Monitoring - Results

HPLC-MS Microcystin ($\mu\text{g/L}$)

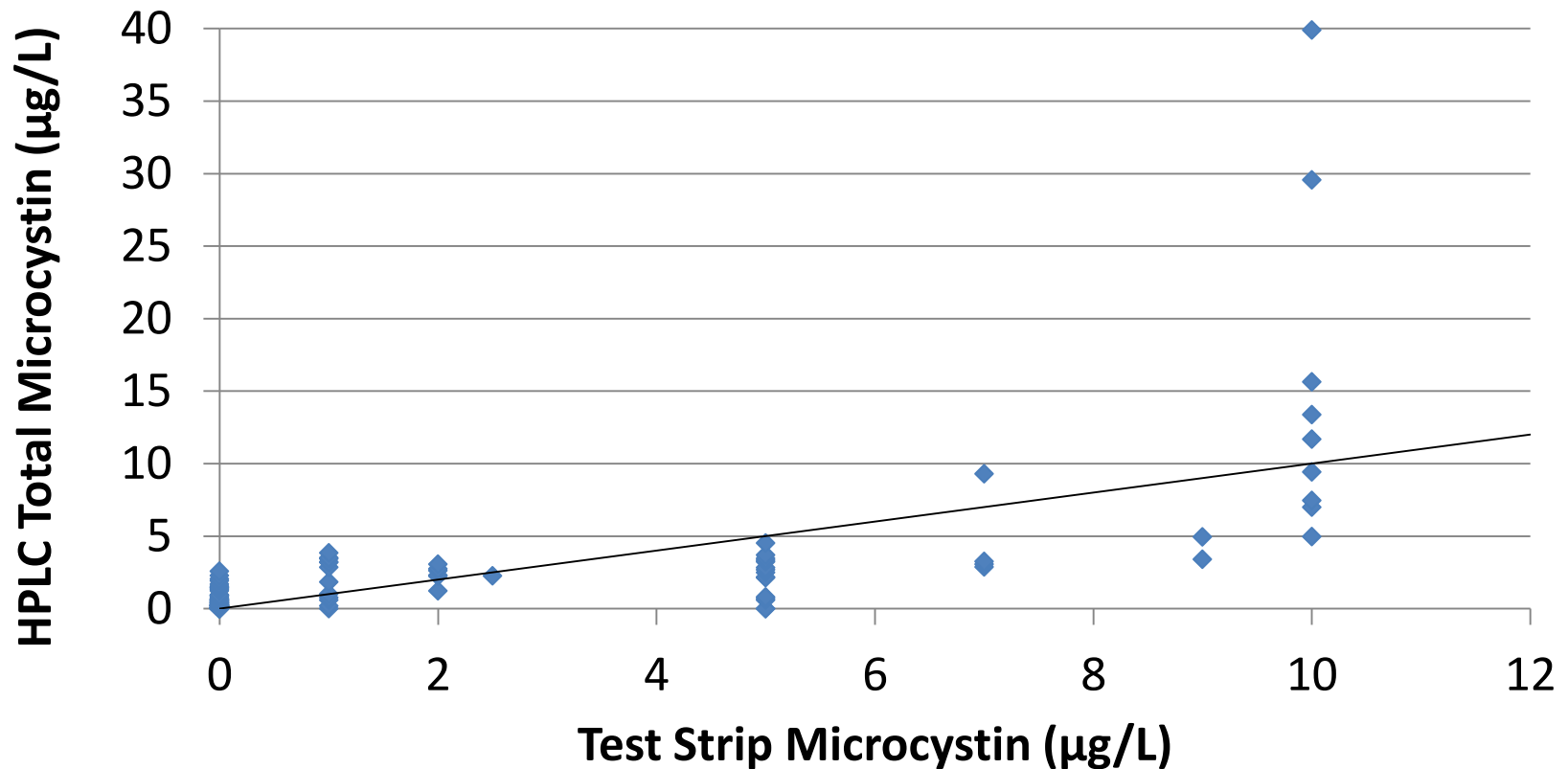
Crockery Lake



2015 Algal Toxin Monitoring - Results

Field Test Strips vs HPLC-MS Microcystin ($\mu\text{g/L}$)

- Misses some low concentrations
- Over estimates some samples in the 0-10 range
- Identifies high samples well



2015 Algal Toxin Monitoring - Results

Microcystin

- Few high concentrations
- Spatial variability
- Temporal variability
- Not well correlated with other water chemistry variables
- Shoreline samples not significantly higher than lake center samples



2015 Algal Toxin Monitoring - Results

Anatoxin and Cylindrospermopsin

Toxin	# Quantified / # Collected	Maximum Result ($\mu\text{g/L}$)	Recreational Guidance Values ($\mu\text{g/L}$)
Anatoxin	75 / 145	3.1	10 - 300
Cylindrospermopsin	17 / 145	0.1	1 - 20

Anatoxin and cylindrospermopsin were present in Michigan inland lakes at moderate to low rates at low concentrations .



2016 Inland Lake Monitoring Plans

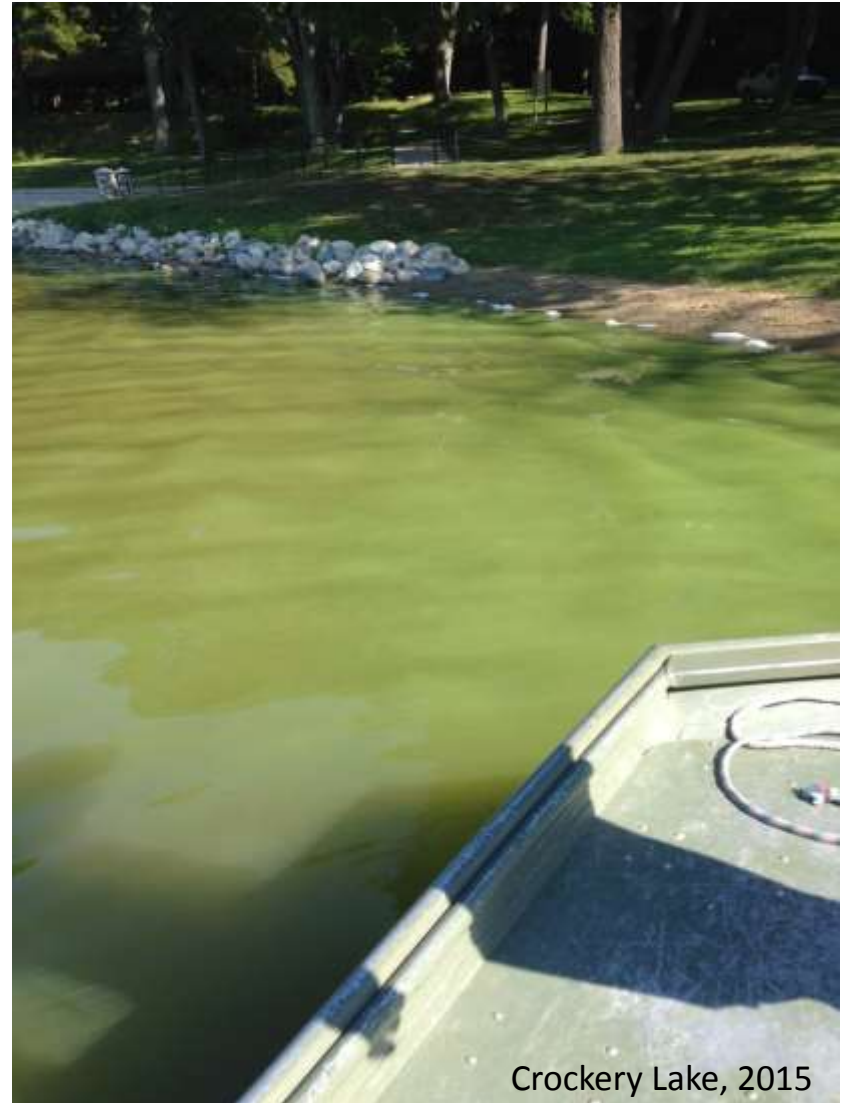
- Status and Trend Program lakes
- Microcystin Test Strips
- Lakes with expected or reported algal blooms
 - TMDL lakes monthly
 - Targeted lakes weekly
 - Response lakes
- Quantitative MS analysis (DHHS)
 - Microcystin (13 congeners)
 - Anatoxin-a
 - Cylindrospermopsin
- Phycocyanin (BGA pigment)
- Algae Identification (dominant taxa)



Mona Lake, 2015

2016 Request For Proposals

- Remote sensing to assess BGA blooms
- Triggers behind cyanotoxin production
- Cyanotoxin sampling methods
- Rapid screening for cyanotoxins



Crockery Lake, 2015

Recreation Concerns and Cyanobacteria

- Working with Monroe County Health Department – test strips
- Expect to have recreational water use standards in 2016
- Increase communication with local health departments
- Green/colored water \neq toxic in every water body, **BUT when in doubt, stay out.**



Questions??

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