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

## 2015 Michigan Inland Lakes HABs Survey Results

Sarah Holden, Aquatic Biologist
Water Resources Division
Michigan Department of Environmental Quality

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Morrison Lake, 2015

# Overview

- Define HABs
- HABs in Michigan
- 2015 monitoring
  - Status and trend
  - Targeted
  - What we did and results
- What's next?  2016 plans

Lake Macatawa, 2012

# Harmful Algae Blooms

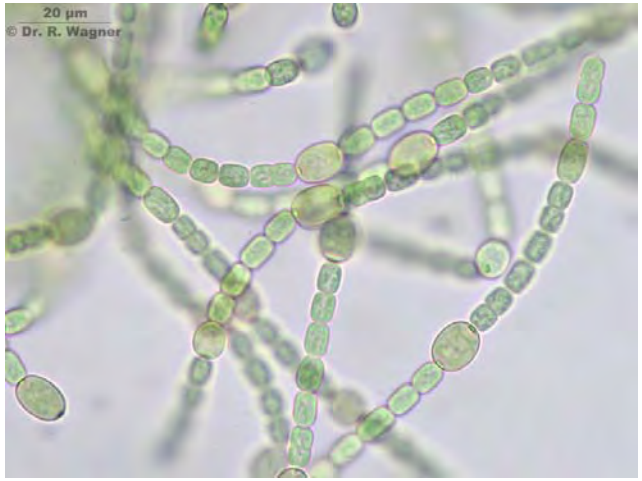
- Algae bloom is a large increase in phytoplankton
- Lake aesthetics – clarity and smell
- 'Harmful' can = aesthetically unappealing, deplete dissolved oxygen, and produce toxins
- MDEQ using harmful = algal toxin production

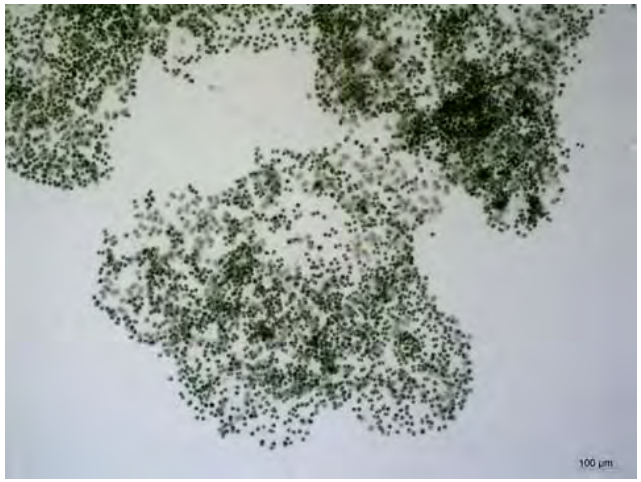

Lake Erie

# Cyanobacteria

- Cyanobacteria/Bluegreen Algae
- Found naturally worldwide in fresh and salt water
- Many fix nitrogen and have resting spores
- Mobile- can harvest nutrients from sediments
- Produce over 80 known toxins
- Types of BGA in Michigan

  microcystis, aphanizomenon, anabaena, cylindrospermopsis, limnothrix, planktothrix



# Cyanotoxins

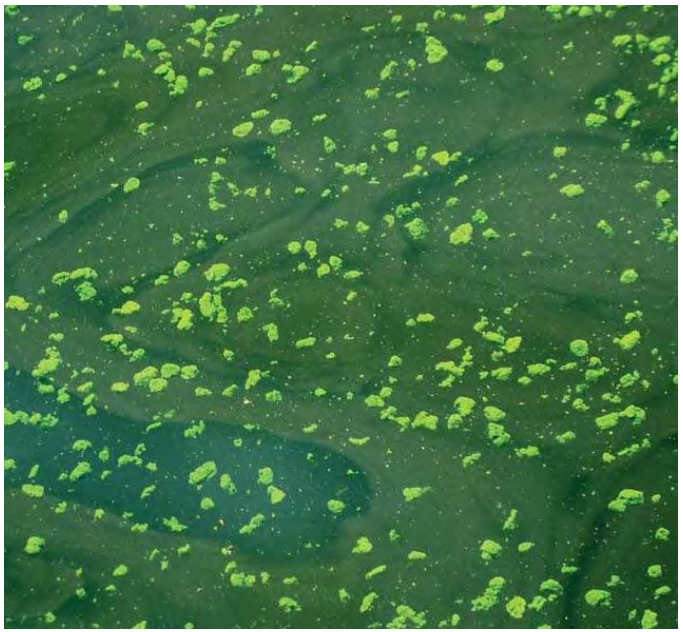
microcystins

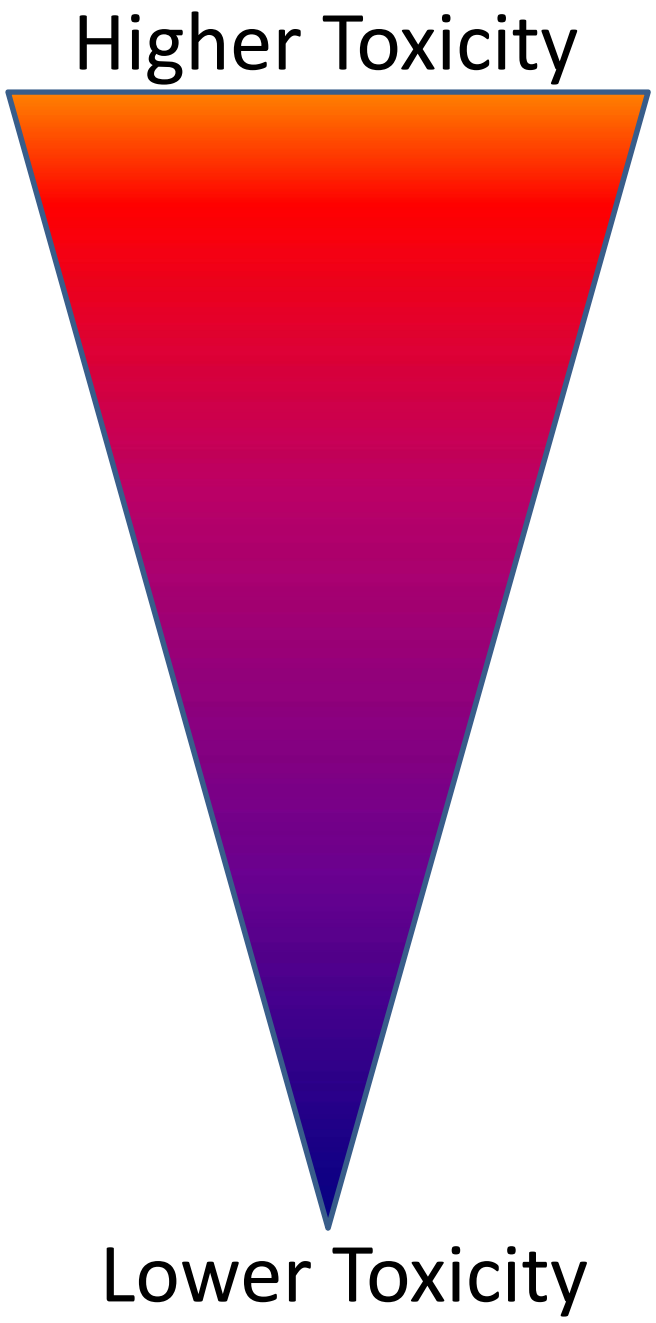
anatoxin

cylindrospermopsin

saxitoxin

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






# Toxin Reference Doses

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)

Cyanide (0.02 mg/kg-d)

Atrazine (0.04 mg/kg-d)

Chlorine (0.1 mg/kg-d)

Ethylene Glycol (2 mg/kg-d)

# Microcystin Risks for Recreation

| | Recreational Use Warnings (µg/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****

# 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 grater than 20 ug/L and visible surface accumulations/scum are present, or cells are visible throughout the water column."

Definition current as of 4/28/2016

# Michigan Inland Lake HABs

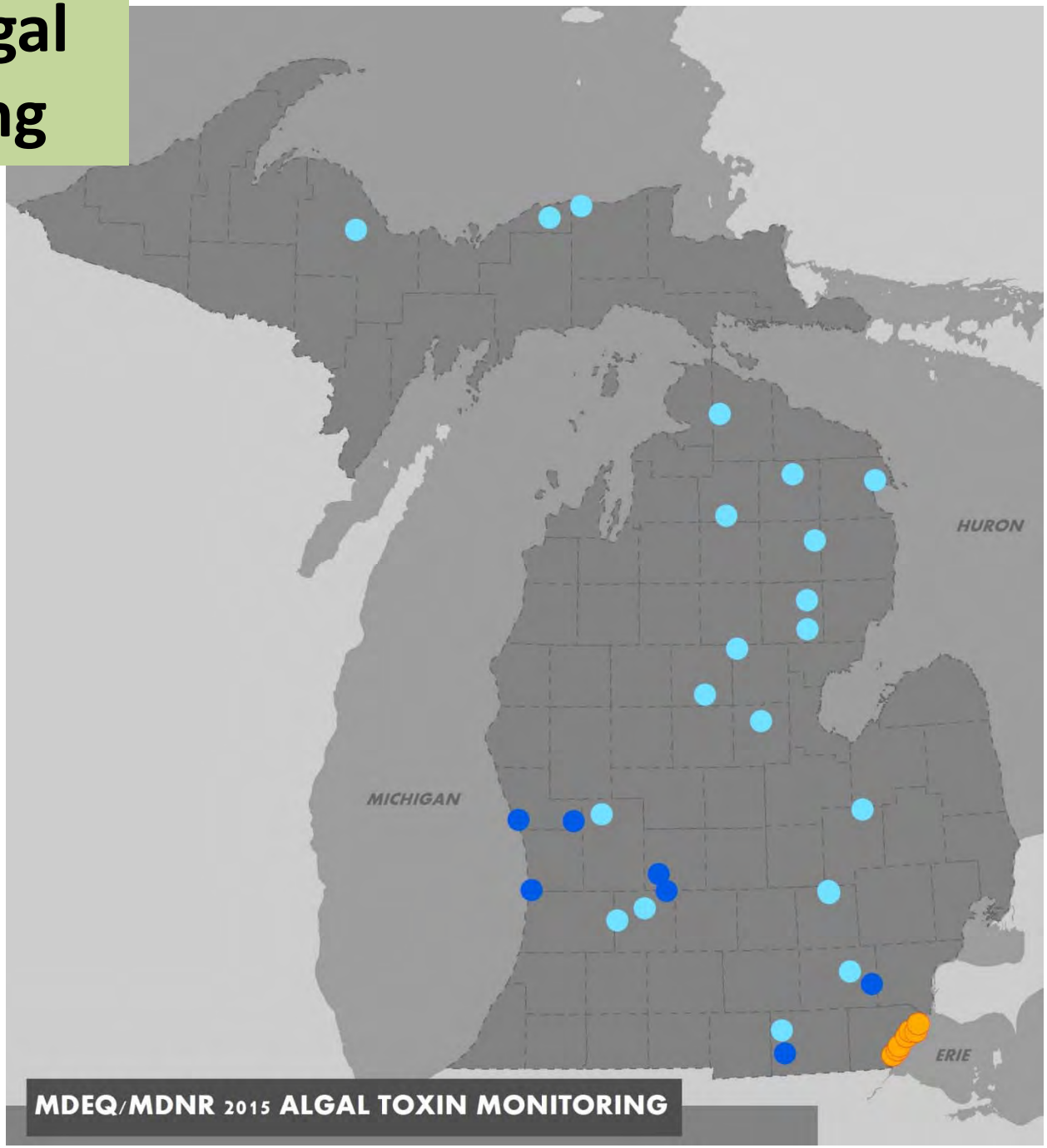
Six studies in MI lakes sampled 232 lakes from 2002 to 2012

| Study | # Lakes | Microcystin Results (µg/) |
|---|---|---|
| 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

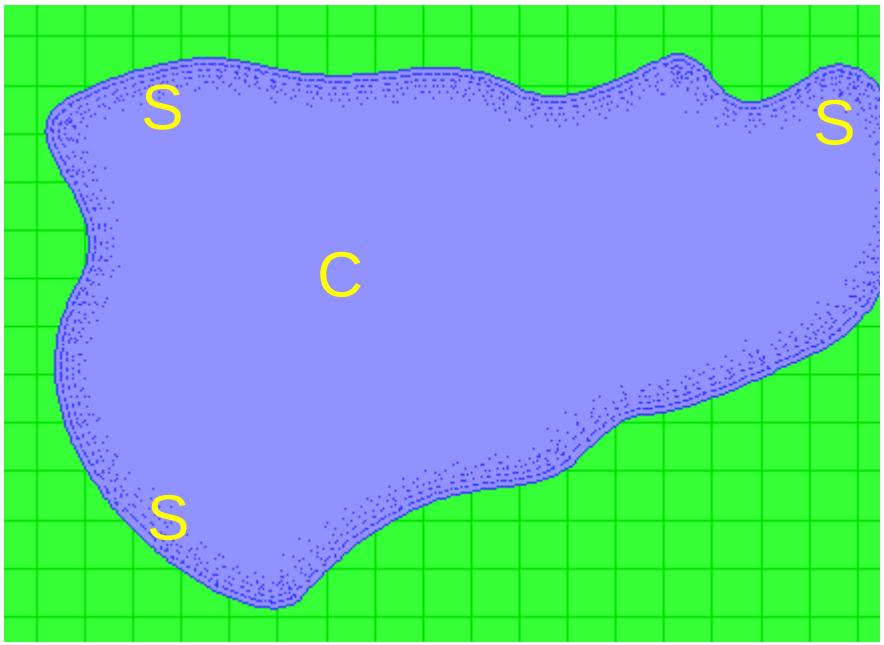
# MI DEQ 2015 Algal Toxin Monitoring

- 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

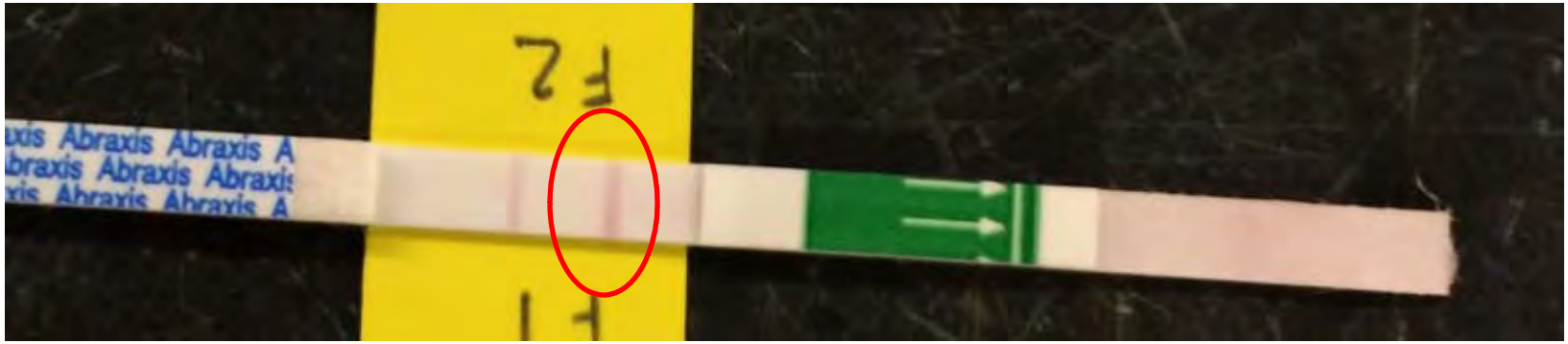



Targeted Lakes Algal Toxin

- 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

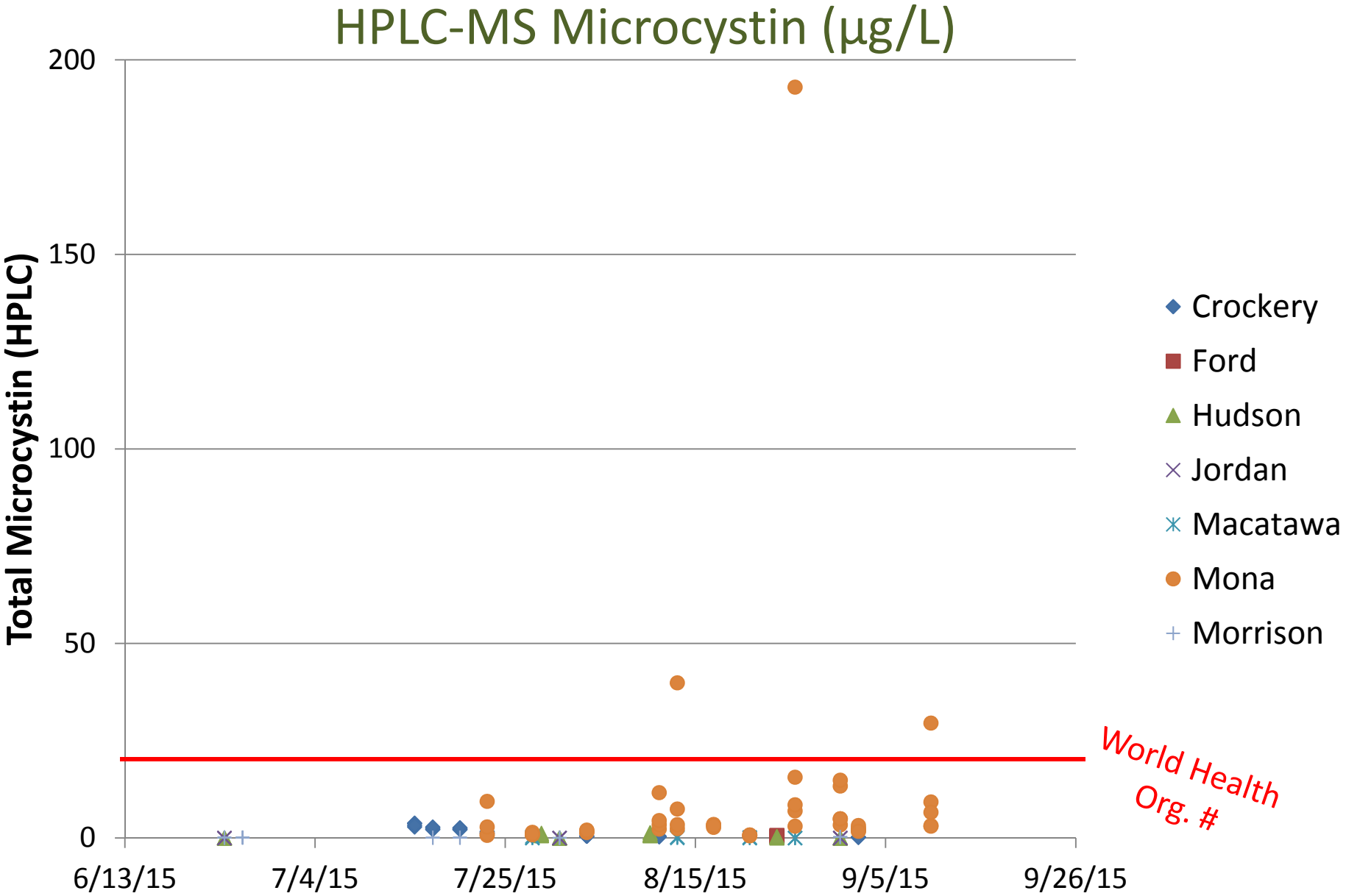


# 2015 Algal Toxin Monitoring - Results

## Microcystin Test Strips (µg/L)

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

# 2015 Algal Toxin Monitoring - Results



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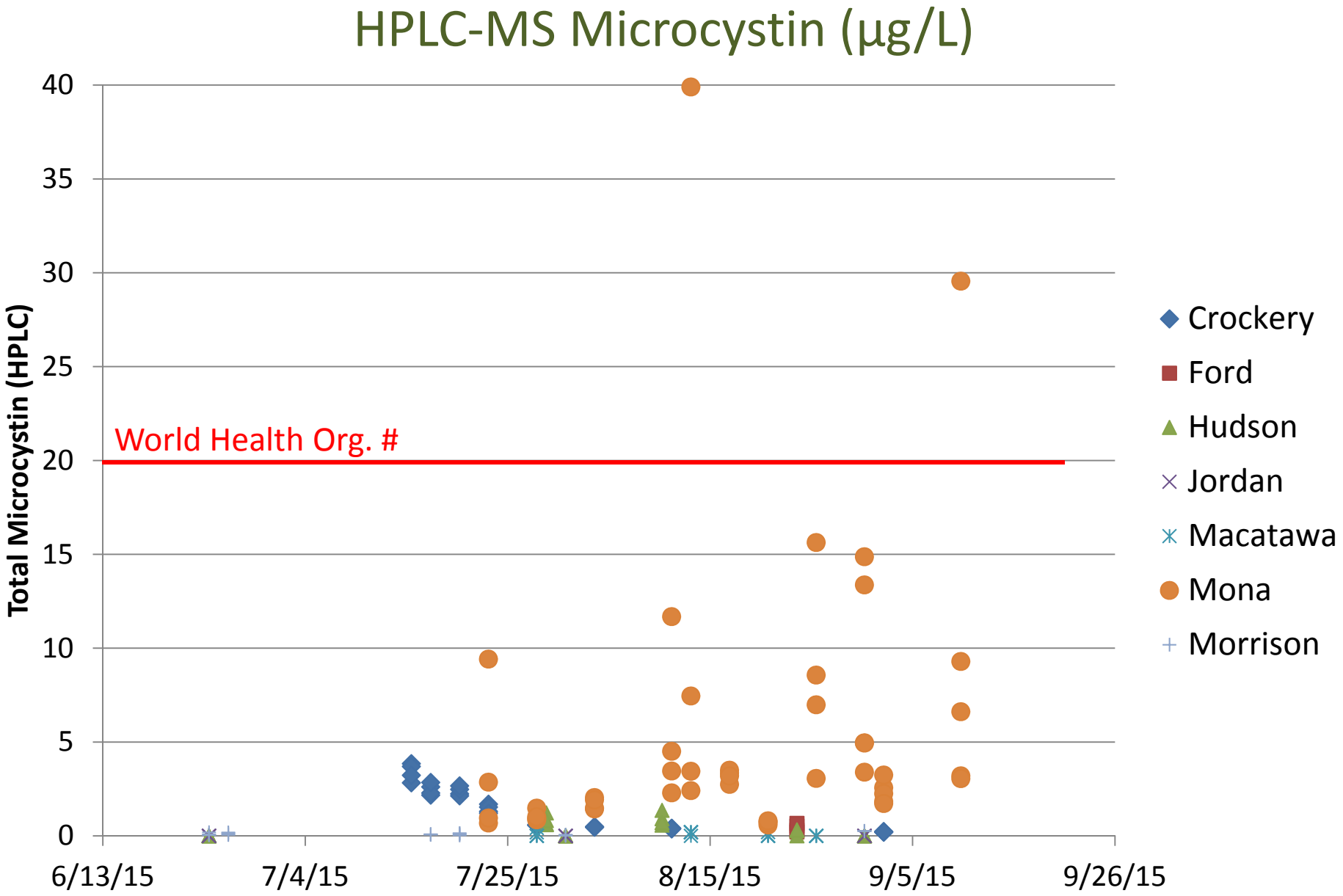
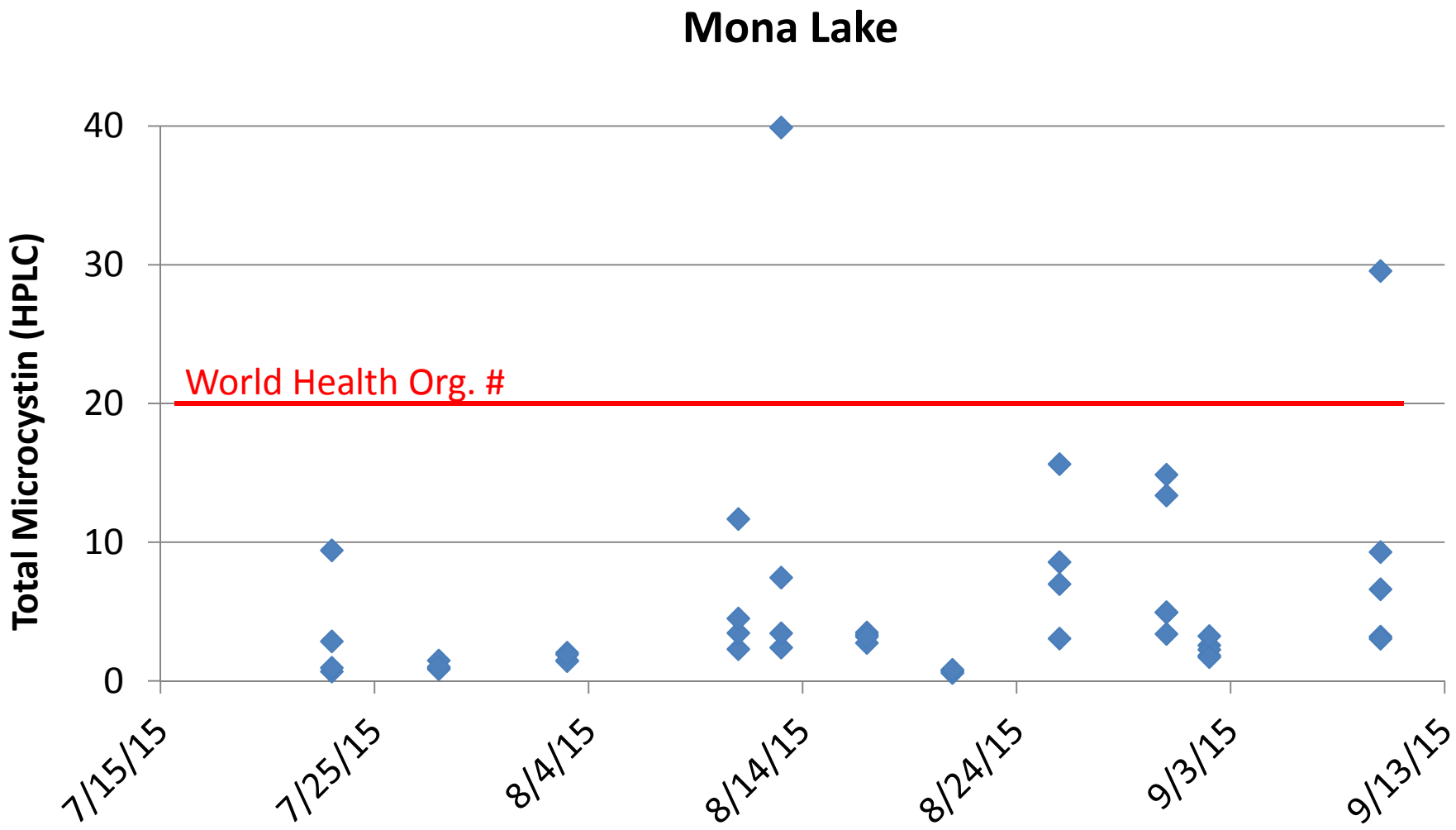


# 2015 Algal Toxin Monitoring - Results

## HPLC-MS Microcystin (µg/L)



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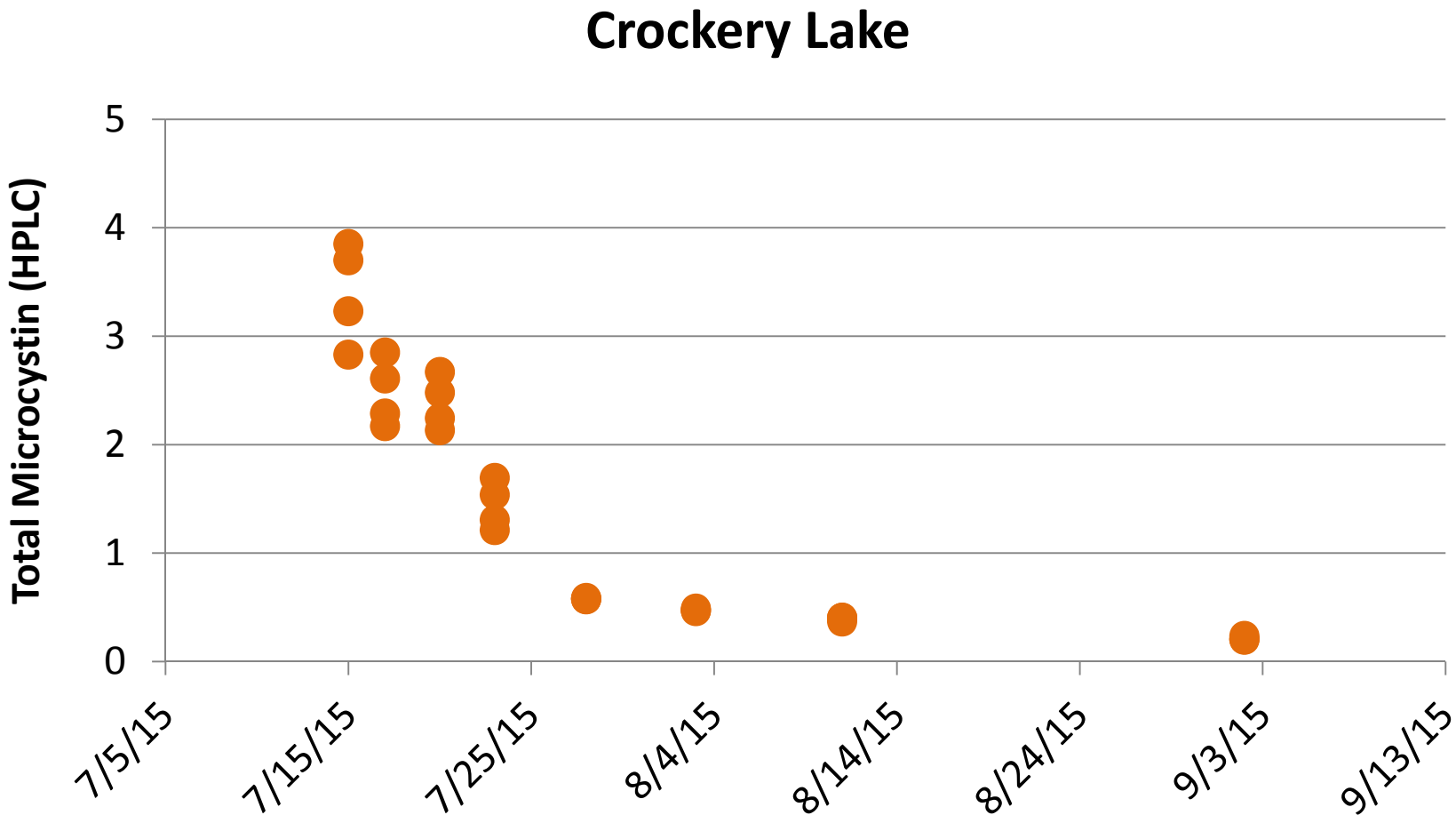
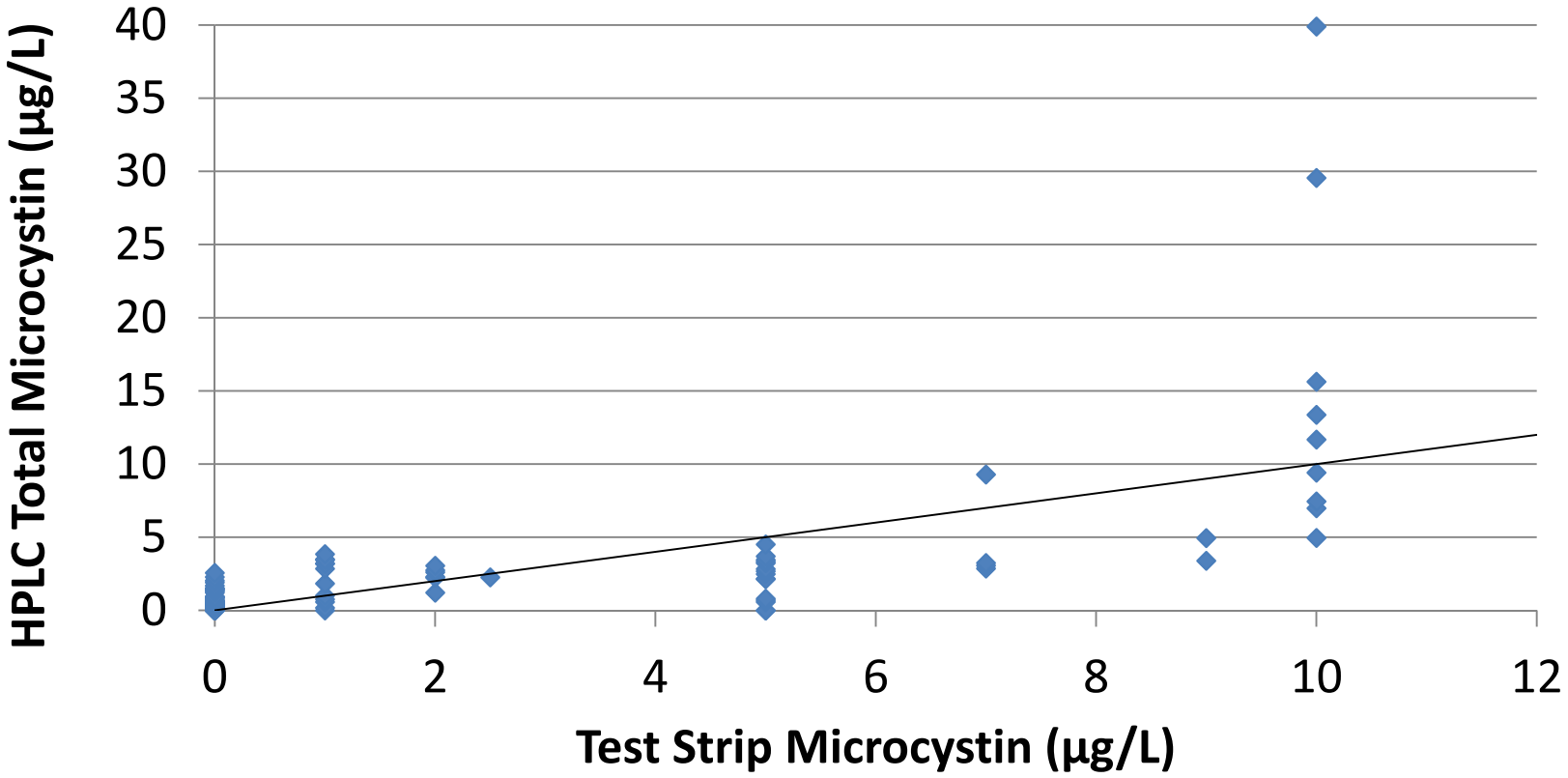


# 2015 Algal Toxin Monitoring - Results

## Field Test Strips vs HPLC-MS Microcystin (µg/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

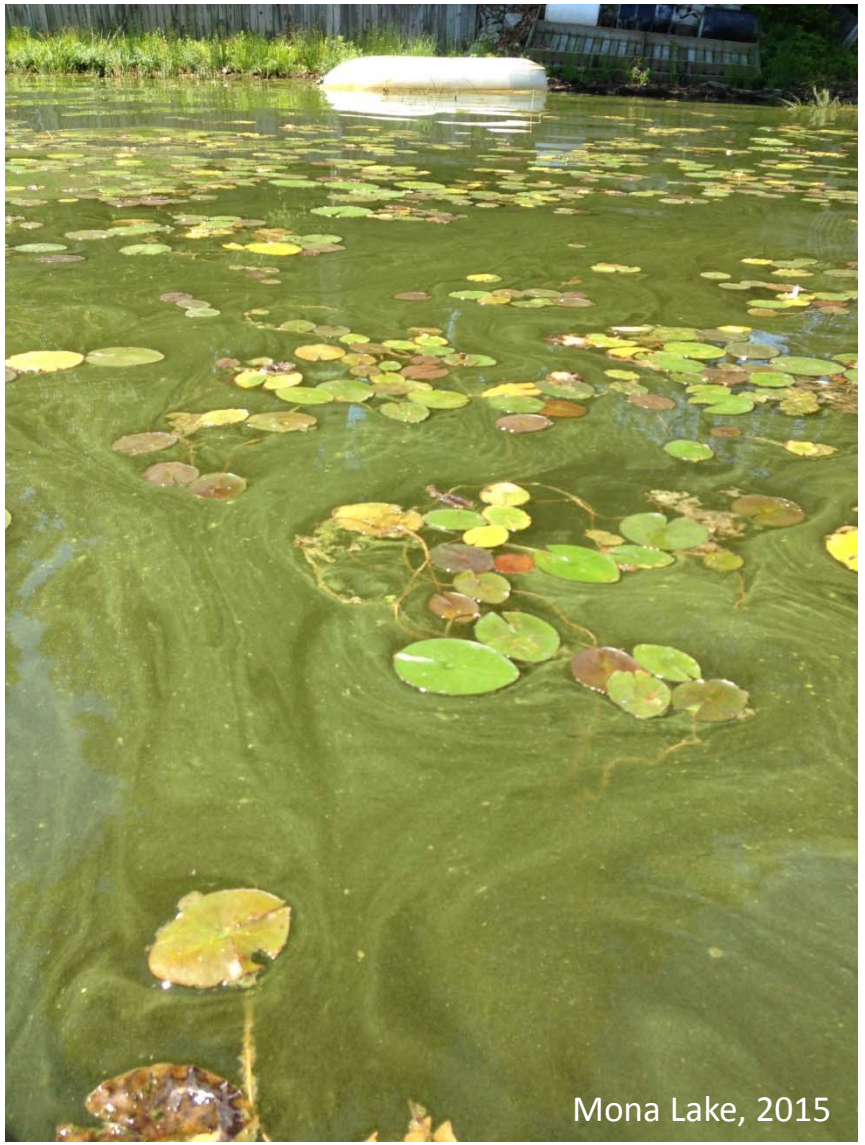
## Anatoxin and Cylindrospermopsin

| Toxin | # Quantified / # Collected | Maximum Result (µg/L) | Recreational Guidance Values (µg/L) |
|---|---|---|---|
| Anatoxin | 75 / 145 | 3.1 | 10 - 300 |
| Cylindrospermopsin | 17 / 145 | 0.1 | 1 - 20 |

Present in Michigan inland lakes at moderate to low rates at 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 ≠ toxic in every water body, BUT when in doubt, stay out.

Mona Lake, 2015

# Examples of ongoing research

- **Ecology**: Develop predictive models to relate nutrient loads, land use/land cover, socioeconomic factors, and climate to the frequency, location, and severity of blooms in lakes
- **Microbiology/Chemistry:** Understand triggers and environmental condiitions that lead to cyanotoxin production
- **Technology:** Develop and improve toxin analytical methods
- **Toxicology**: Clarify cyanotoxin effects on mammalian endpoints and exposure biomarker identification for human health risk assessment
- **Epidemiology**: Characterize cyanotoxin occurrence and nutrient concentrations in US surface waters.
- **Remote Sensing**: Describe water clarity from airborne data and predictions of changes in trophic status

**(modified and expanded upon from USEPA)**

# Additional information

- USEPAhttps://www.epa.gov/nutrientpollution/harmful-algal-blooms
- Other states: ohio**algae**info.com; http://dnr.wi.gov/lakes/bluegreenalgae/
- Upcoming: MDEQ Recreation HABs website
- Laboratories: Lake Superior State University; Phycotech; Dept. Health and Human Services; Michigan State University; Greenwater Lab, and more!
- MDEQ 2015 monitoring results summary paper is available

Sarah Holden, holdens1@michigan.gov