Climate Change, HABs, Toxins, Monitoring, and Other Buzz Words to Get You to Come to This Session

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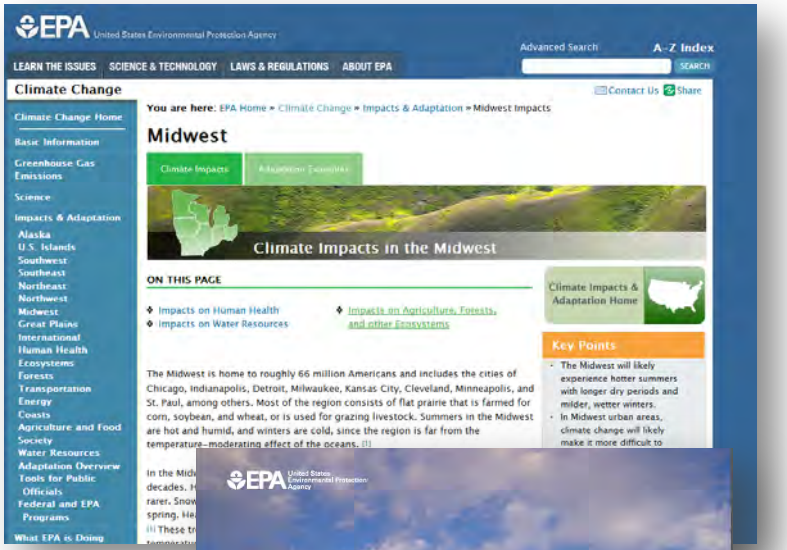
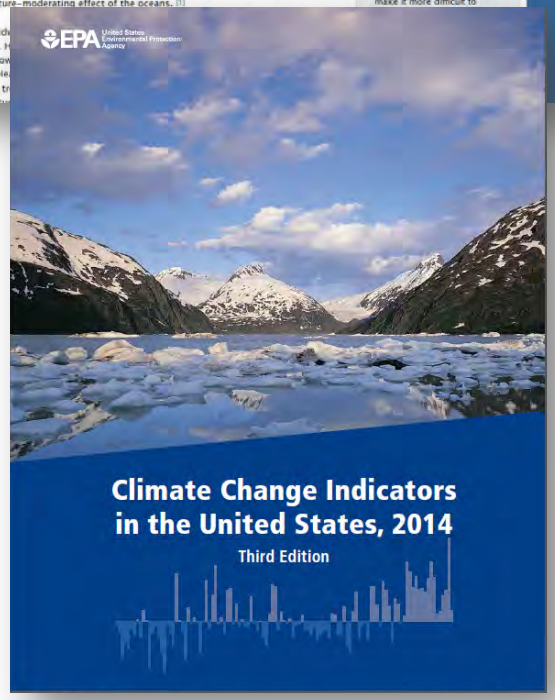
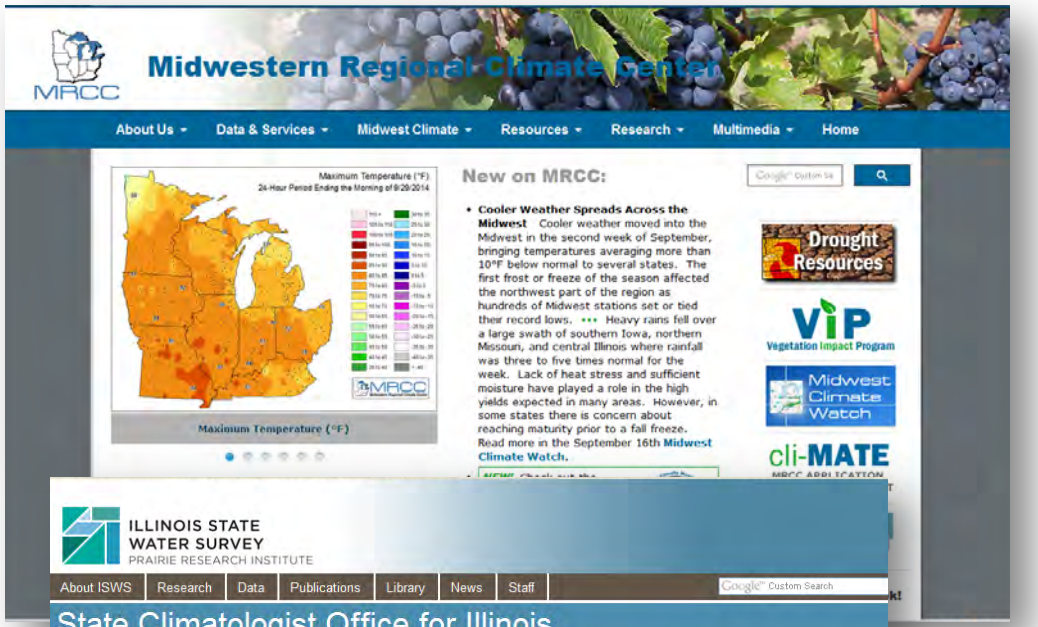
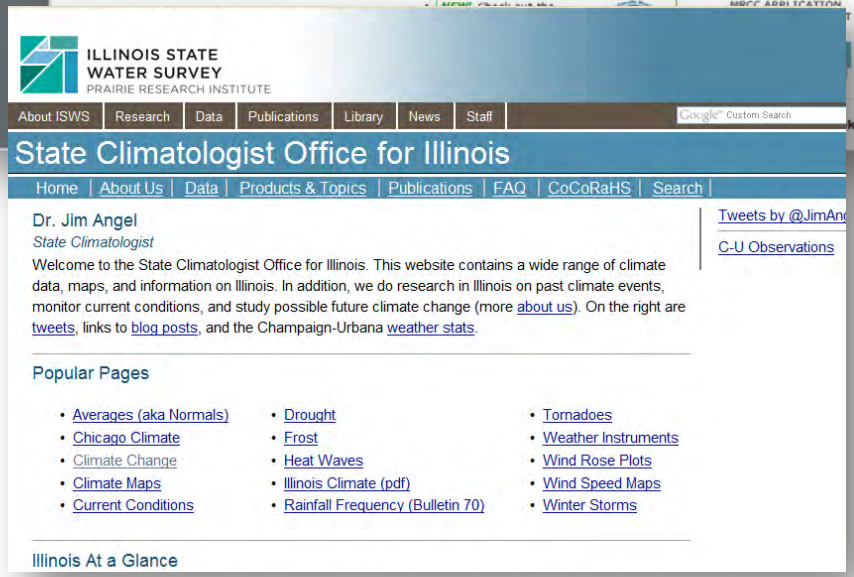
Climate change expectations









Climate Change Indicators

- Green house gas emissions U.S.
- Global greenhouse gas emissions
- Climate forcing
- U.S. and Global temperature
- High and Low temperatures
- U.S. and Global precipitation
- Heavy precipitation
- Drought
- Tropical Cyclone Activity
- Ocean Heat
- Sea Surface Temperature
- Sea Level
- Ocean Acidity
- Arctic Sea Ice
- Glaciers
- Lake Ice
- Snowfall
- Snow Cover
- Snow Pack
- Heating and Cooling Degree Days
- Heat-Related Deaths
- Lyme Disease
- Length of Growing Season
- Ragweed Pollen Season
- Wildfires
- Stream flow
- Great Lakes water temps. and levels
- Bird Wintering Ranges
- Leaf and Bloom Dates
- Atmospheric Concentrations greenhouse gases

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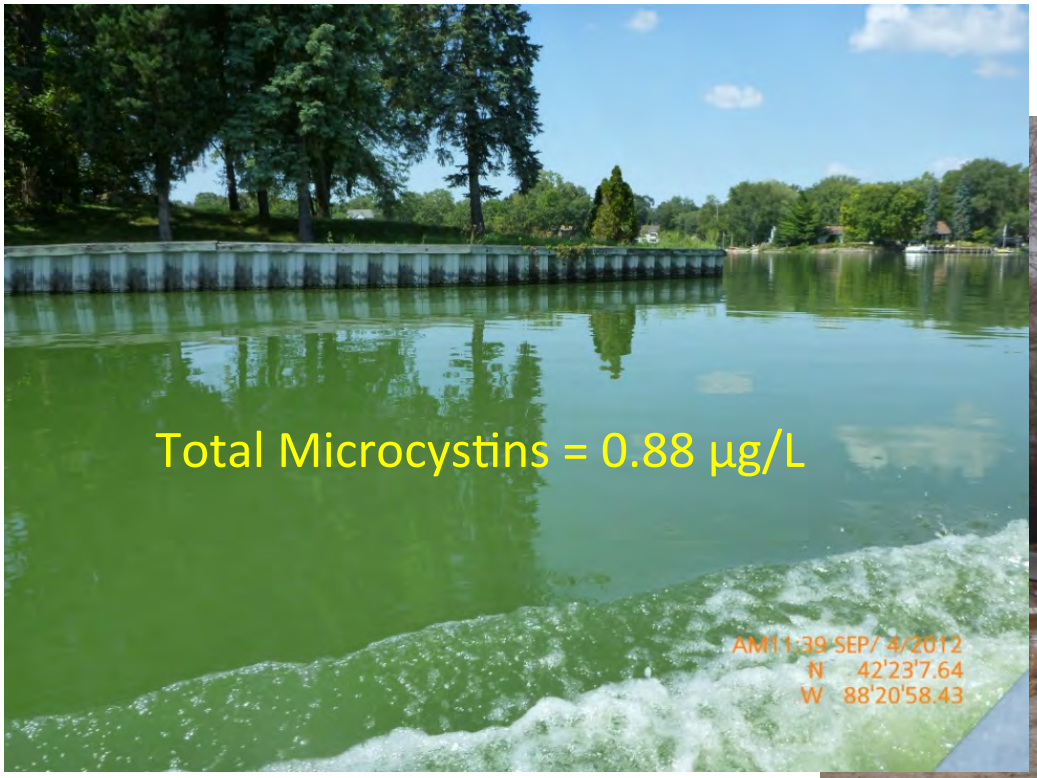
Climate Change and Cyanobacteria

- How does climate change impact cyanobacteria and Harmful Algal Blooms in Illinois lakes?

- "Abundant, good water is essential to continued economic growth and progress. The Congress has found that we have entered a period in which acute water shortages are hampering our industries, our agriculture, our recreation, and our individual health and happiness." (Lyndon B. Johnson, 1964)

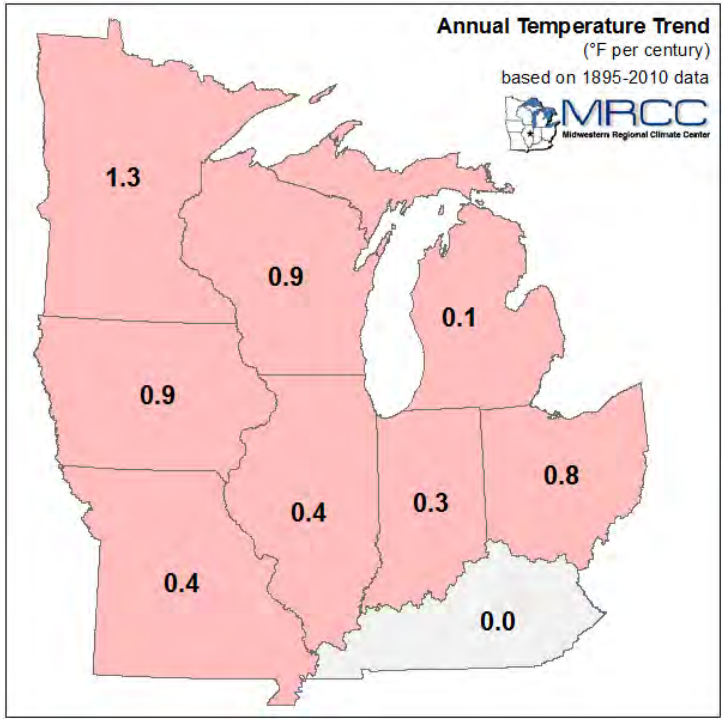
Increased Temperatures

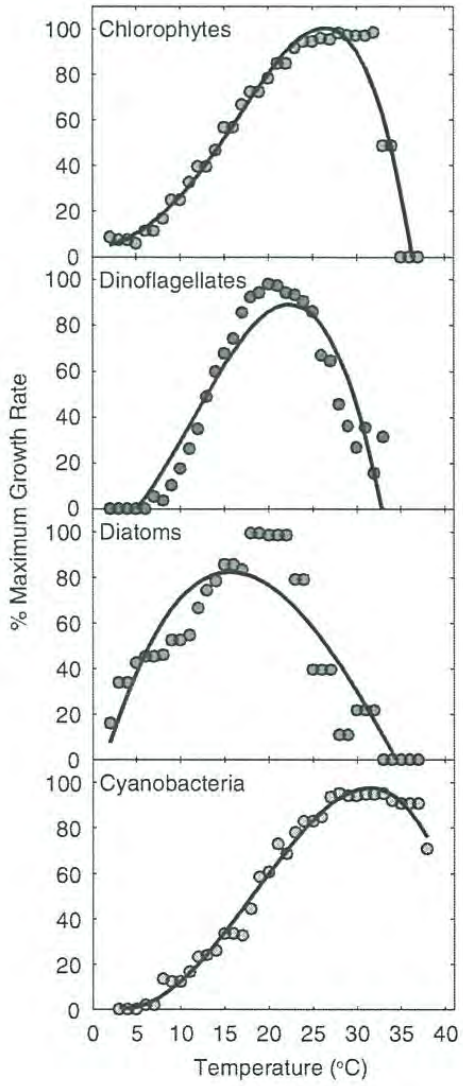
- Average temperatures in the lower 48 states have been increasing, their rate of increase has been faster the past 30 years. (USEPA, 2014)



Increased Temperatures

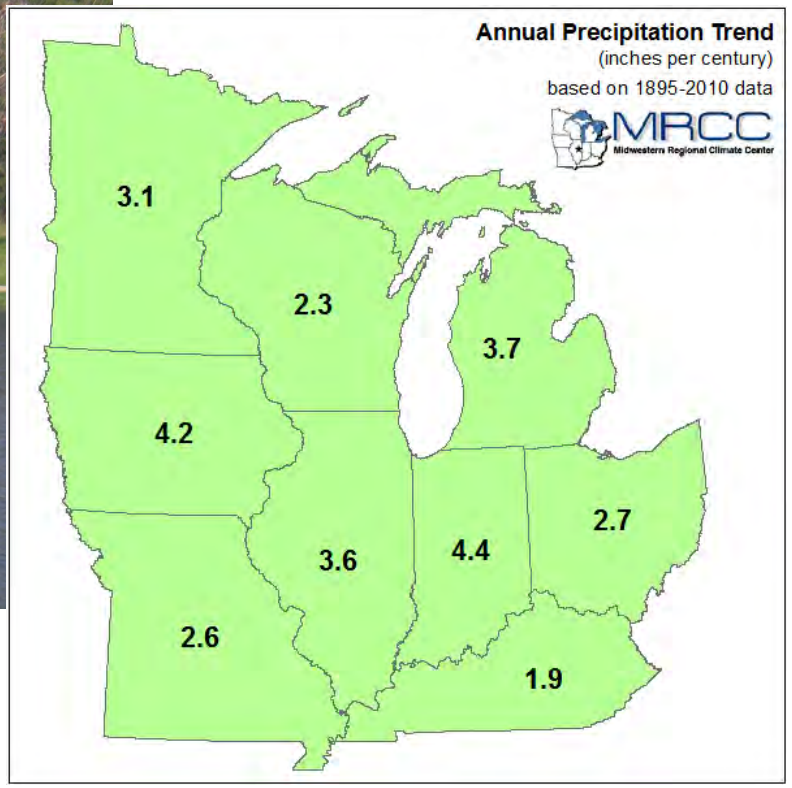
- Cyanobacteria reaches peak growth beyond 30 degrees.
- Spatially, cyanobacteria can also increase water temp locally outcompeting other algae.





http://mrcc.isws.illinois.edu/about/aboutUs.jsp

Increased Flooding



- Increases nutrients
- Increases erosion of unprotected shoreline
- This increases turbidity, leading to more algae blooms

http://mrcc.isws.illinois.edu/about/aboutUs.jsp

Increased Droughts

- Reduced flushing of water
- Oxygen Depletion
- Increases in water temperature
- Reduces habitat

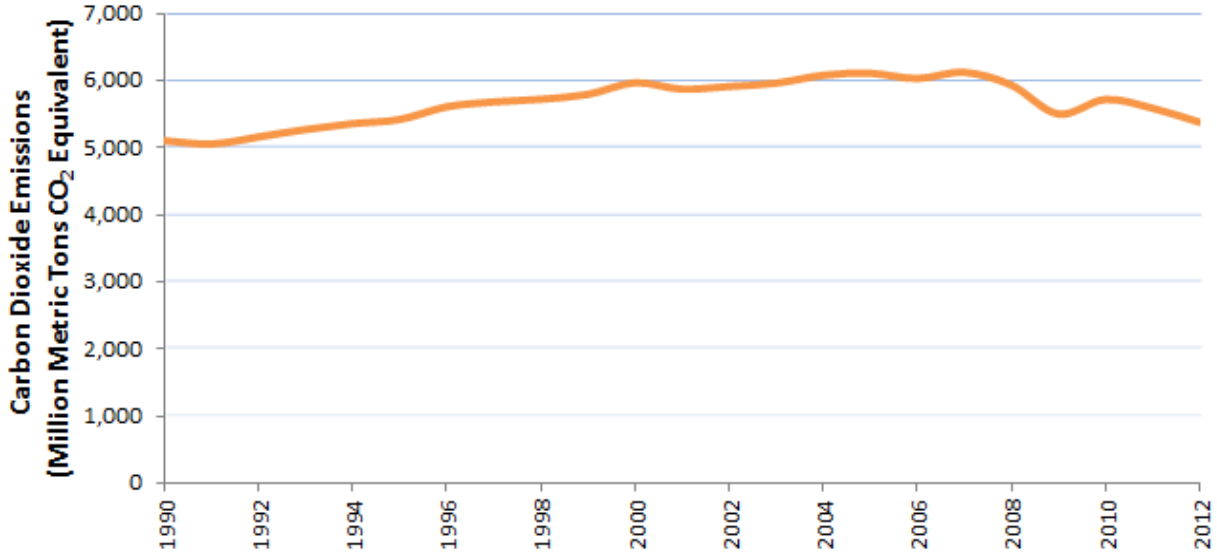
http://www.drought.gov/media/imageserver/NIDIS/DEWS/reports/Central_Region_Quarterly_Climate_Impacts_and_Outlook_Sept2012.pdf

Greenhouse Gases

- “Concentrations of carbon dioxide are currently higher than any levels recorded for hundreds of thousands of years, even after accounting for natural fluctuations.” (USEPA, 2014)

Increased CO_2

- Increased CO_2 can cause acidification in oceans and un productive waterways.
- Opposite effects can occur when CO_2 is limiting algal productivity in eutrophic conditions.
- Increased CO_2 fuels photosynthesis which drives pH up.
- Systems in IL flush with both nitrogen and phosphorus will become increasingly basic.
- Cyanobacteria forms surface scums allowing them to poise by the source of atmospheric CO2 (Climate change: Links to global expansion of harmful cyanobacteria Paerl and Valerie)



Note: All emission estimates from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012.*
http://www.epa.gov/climatechange/ghgemissions/gases/co2.html

Increased Cyanobacteria Leads to Increased CyanoHAB

- What's so harmful about a Harmful Algal Bloom
  - Scums shade out plants
  - Aren't palatable to plankton grazers
  - Increases in pH detrimental to sensitive fish and macroinvertebrates
  - Increased Biological Oxygen Demands
  - Toxin production

Total Microcystins = 0.5µg/L

USEPA Drinking Water

These HAs are not regulations and should not be construed as legally enforceable federal standards. HAs may change as new information becomes available.

Cyanotoxin	Drinking Water Health Advisory (10-day)	
	Bottle-fed infants and pre-school children	School-age children and adults
Microcystins	0.3 µg/L	1.6 µg/L
Cylindrospermopsin	0.7 µg/L	3 µg/L

EPA also developed Health Effect Support Documents (HESD) for microcystins and cylindrospermopsin, and also for anatoxin-a. The HESDs constitute a comprehensive review of the published literature on the chemical and physical properties of these toxins, the toxin synthesis and environmental fate, occurrence and exposure information, and health effects.

USEPA Draft Guidelines

- USEPA issued draft guidelines for microcystins and cylindrospermopsin in December 2016.
- The recommendations are now open for public comment. https://www.epa.gov/wqc/draft-human-health-recreational-ambient-water-quality-criteria-andor-swimming-advisories
- The guidelines are to protect swimming use in lakes and streams.

Table 1. Draft Recreational AWQC for Cyanotoxins

Microcystins	Cylindrospermopsin
4 µg/L [a, b]	8 µg/L [a, b]

a) Swimming Advisory: not to be exceeded on any day

b) Recreational Criteria for Waterbody Impairment: not exceeded more than 10 percent of days per recreational season up to one calendar year.

Fact Sheet: Draft Human Health Recreational Ambient Water Quality Criteria/Swimming Advisories for Microcystins and Cylindrospermopsin

Summary

EPA has issued for public comment draft *Human Health Recreational Ambient Water Quality Criteria (AWQC) and/or Swimming Advisories for Microcystins and Cylindrospermopsin*. These are the draft recommended concentrations of microcystins and cylindrospermopsin in recreational water at or below people will be protected while swimming or participating in other activities on the water.

EPA will accept comments on the 2016 draft criteria document for 60 days. Once final, states can consider adopting these criteria into their water quality standards and using them for Clean Water Act purposes, once the standards are approved by EPA. Alternatively, states can use these same values as the basis of swimming advisories for public notification purposes at beaches.

Background

Cyanobacteria are naturally-occurring photosynthetic bacteria found in many diverse habitats including surface waters and are commonly referred to as blue-green algae. Certain environmental conditions, such as elevated levels of nutrients, warmer temperatures, still water, and plentiful sunlight can promote the growth of cyanobacteria to higher densities, forming what are called harmful algal blooms (HABs). They are called harmful because exposure to these blooms can result in adverse health effects to humans and animals. Cyanotoxins, such as microcystins or cylindrospermopsin, are produced by cyanobacteria. Under HAB conditions, the concentrations of toxins in the water can increase substantially. Elevated cyanotoxin concentrations in surface waters can persist after the bloom fades, so human exposures can occur even after the visible signs of a bloom are gone or have moved downstream.

What are the Health Effects from Exposure to Cyanotoxins in Recreational Waters?

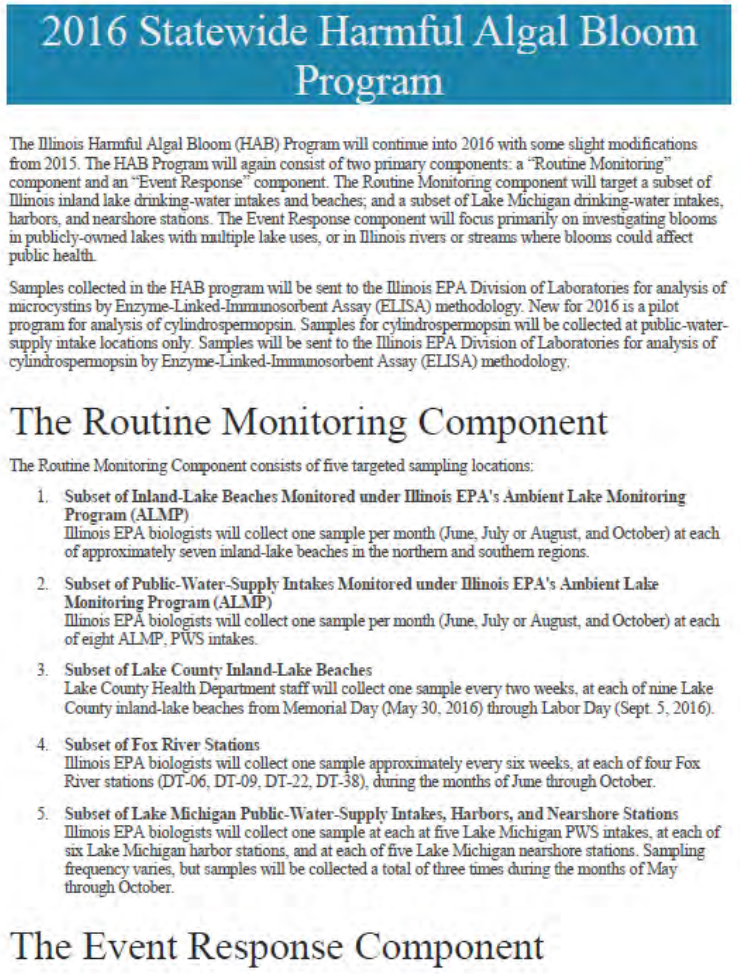
Different cyanotoxins have different health effects associated with exposure. For example, microcystins are primarily associated with liver toxicity, while kidney toxicity is a key health effect for cylindrospermopsin. Other toxins have been shown to affect the skin, gastrointestinal or nervous systems. EPA is including only microcystins and cylindrospermopsin in the draft recreational criteria/swimming advisories.

How Can I Be Exposed to Cyanotoxins?

Cyanotoxins are released into the water as cyanobacteria grow and die. Toxin concentrations can become elevated, particularly during a bloom event, and can persist in the environment after a bloom is over. You can be exposed to elevated levels of cyanotoxins if you swim, play in, or recreate on or in a waterbody where cyanobacteria may reproduce rapidly. Toxins can be ingested, inhaled or absorbed through the skin. The toxins' persistence in the environment can potentially affect downstream users, such as drinking water utilities and recreators, where the bloom may not be directly observed. EPA previously published health advisories for

IL EPA HAB Monitoring Program

- Collect samples for microcystin
- Routine monitoring and event response
- PWS intakes
- Beaches
- Advisory roll
- Online HAB report form
- Protect Human Health
- Expand to add additional toxins



2016 Statewide Harmful Algal Bloom Program

The Illinois Harmful Algal Bloom (HAB) Program will continue into 2016 with some slight modifications from 2015. The HAB Program will again consist of two primary components: a "Routine Monitoring" component and an "Event Response" component. The Routine Monitoring component will target a subset of Illinois inland lake drinking-water intakes and beaches; and a subset of Lake Michigan drinking-water intakes, harbors, and nearshore stations. The Event Response component will focus primarily on investigating blooms in publicly-owned lakes with multiple lake uses, or in Illinois rivers or streams where blooms could affect public health.

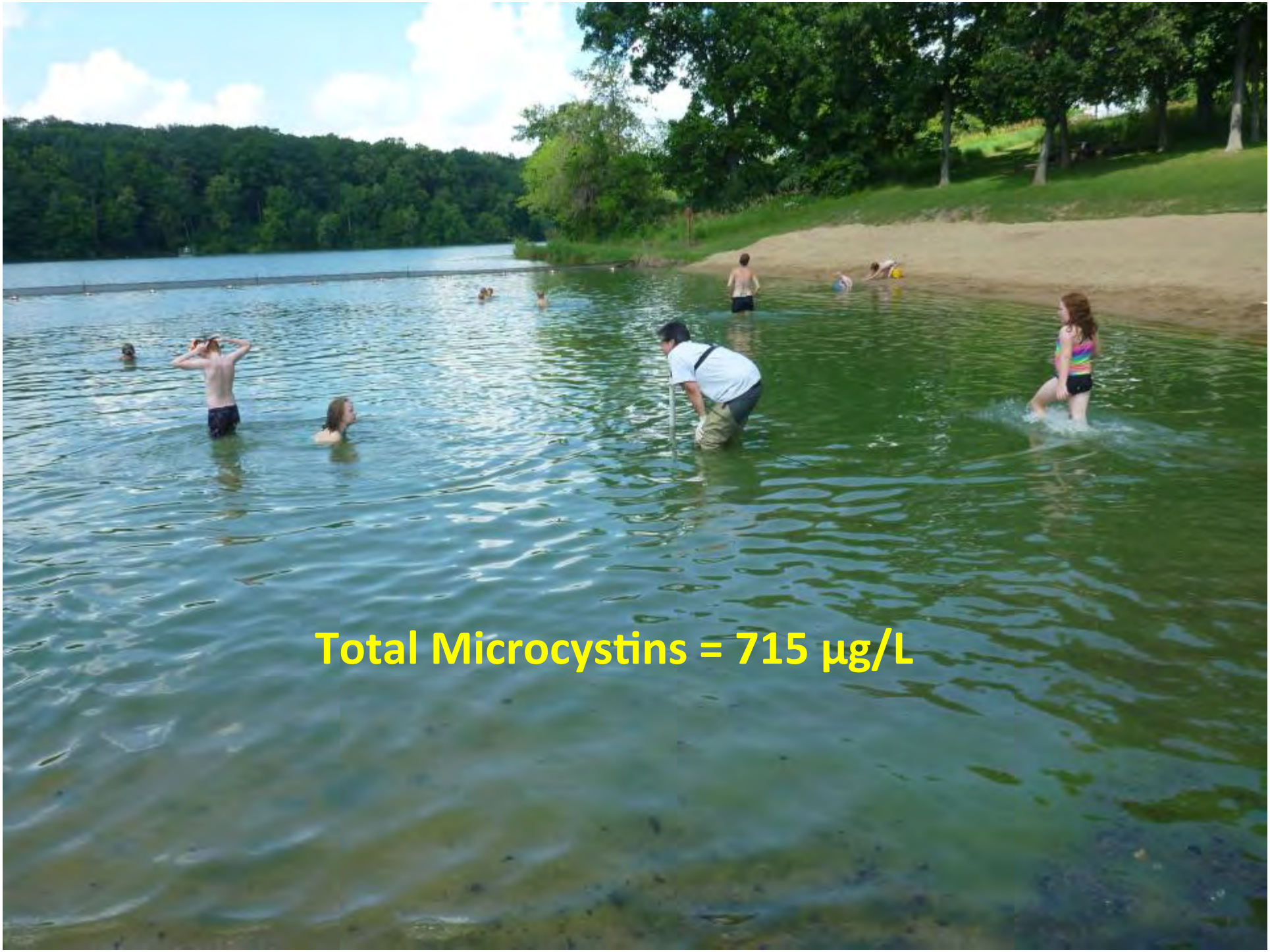
Samples collected in the HAB program will be sent to the Illinois EPA Division of Laboratories for analysis of microcystins by Enzyme-Linked-Immunosorbent Assay (ELISA) methodology. New for 2016 is a pilot program for analysis of cylindrospermopsin. Samples for cylindrospermopsin will be collected at public-water-supply intake locations only. Samples will be sent to the Illinois EPA Division of Laboratories for analysis of cylindrospermopsin by Enzyme-Linked-Immunosorbent Assay (ELISA) methodology.

The Routine Monitoring Component

The Routine Monitoring Component consists of five targeted sampling locations:

1. **Subset of Inland-Lake Beaches Monitored under Illinois EPA's Ambient Lake Monitoring Program (ALMP)**
   Illinois EPA biologists will collect one sample per month (June, July or August, and October) at each of approximately seven inland-lake beaches in the northern and southern regions.
2. **Subset of Public-Water-Supply Intakes Monitored under Illinois EPA's Ambient Lake Monitoring Program (ALMP)**
   Illinois EPA biologists will collect one sample per month (June, July or August, and October) at each of eight ALMP, PWS intakes.
3. **Subset of Lake County Inland-Lake Beaches**
   Lake County Health Department staff will collect one sample every two weeks, at each of nine Lake County inland-lake beaches from Memorial Day (May 30, 2016) through Labor Day (Sept. 5, 2016).
4. **Subset of Fox River Stations**
   Illinois EPA biologists will collect one sample approximately every six weeks, at each of four Fox River stations (DT-06, DT-09, DT-22, DT-38), during the months of June through October.
5. **Subset of Lake Michigan Public-Water-Supply Intakes, Harbors, and Nearshore Stations**
   Illinois EPA biologists will collect one sample at each at five Lake Michigan PWS intakes, at each of six Lake Michigan harbor stations, and at each of five Lake Michigan nearshore stations. Sampling frequency varies, but samples will be collected a total of three times during the months of May through October.

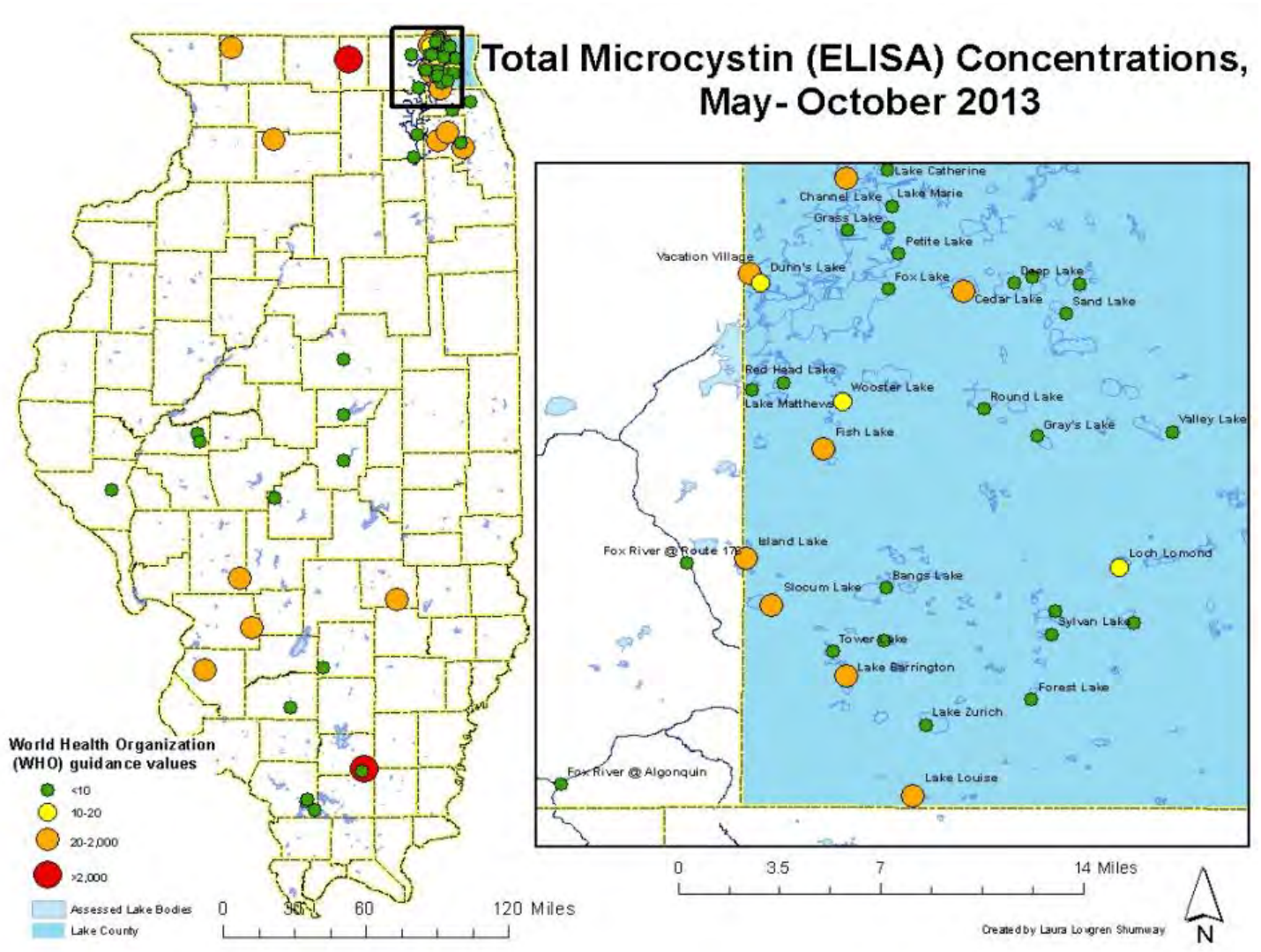
The Event Response Component


Total Microcystins = 715 µg/L


Total Microcystins = 48 µg/L

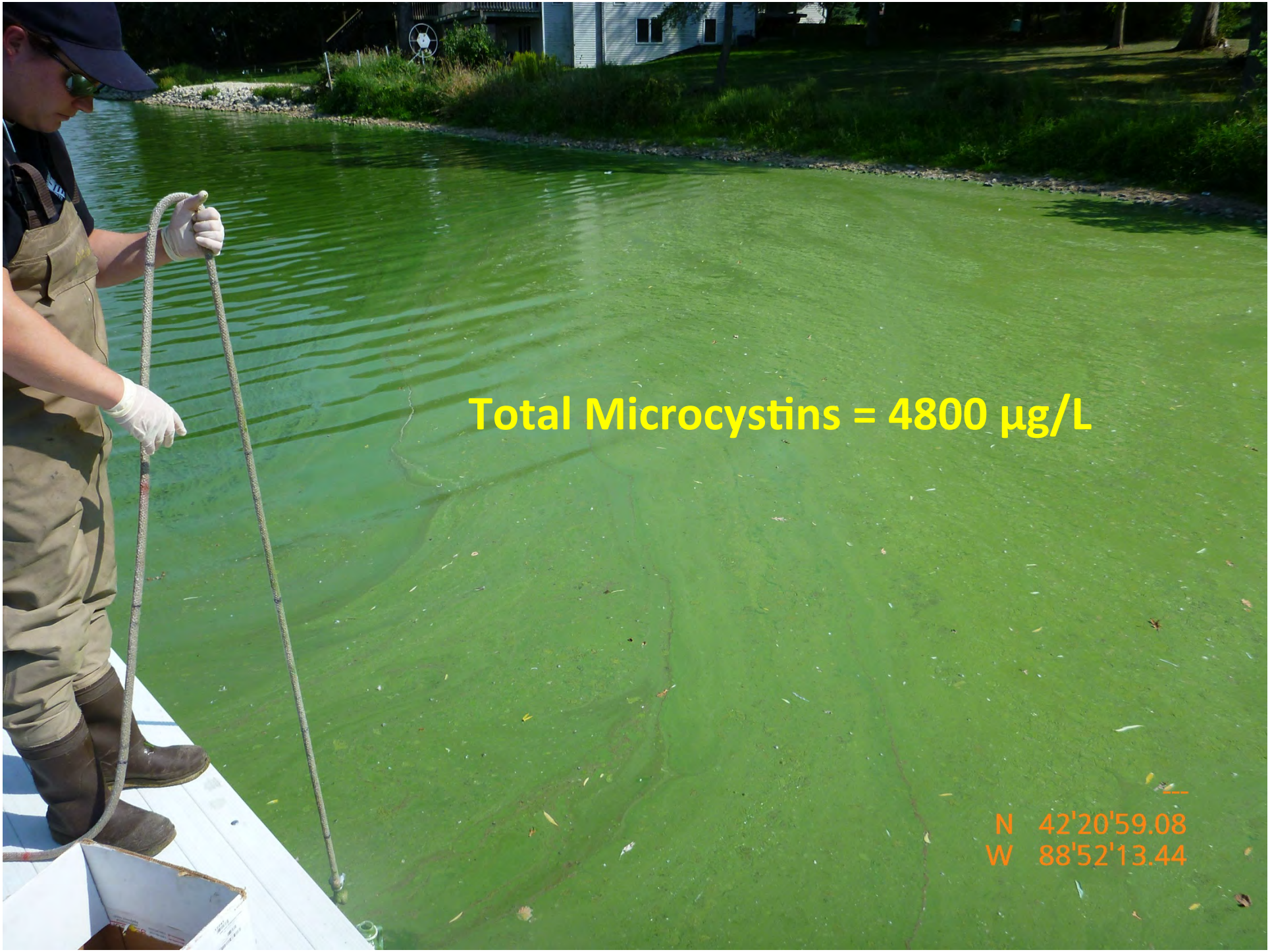
N 42'25'15.73
W 89'49'47.75

IL EPA Monitoring 2013

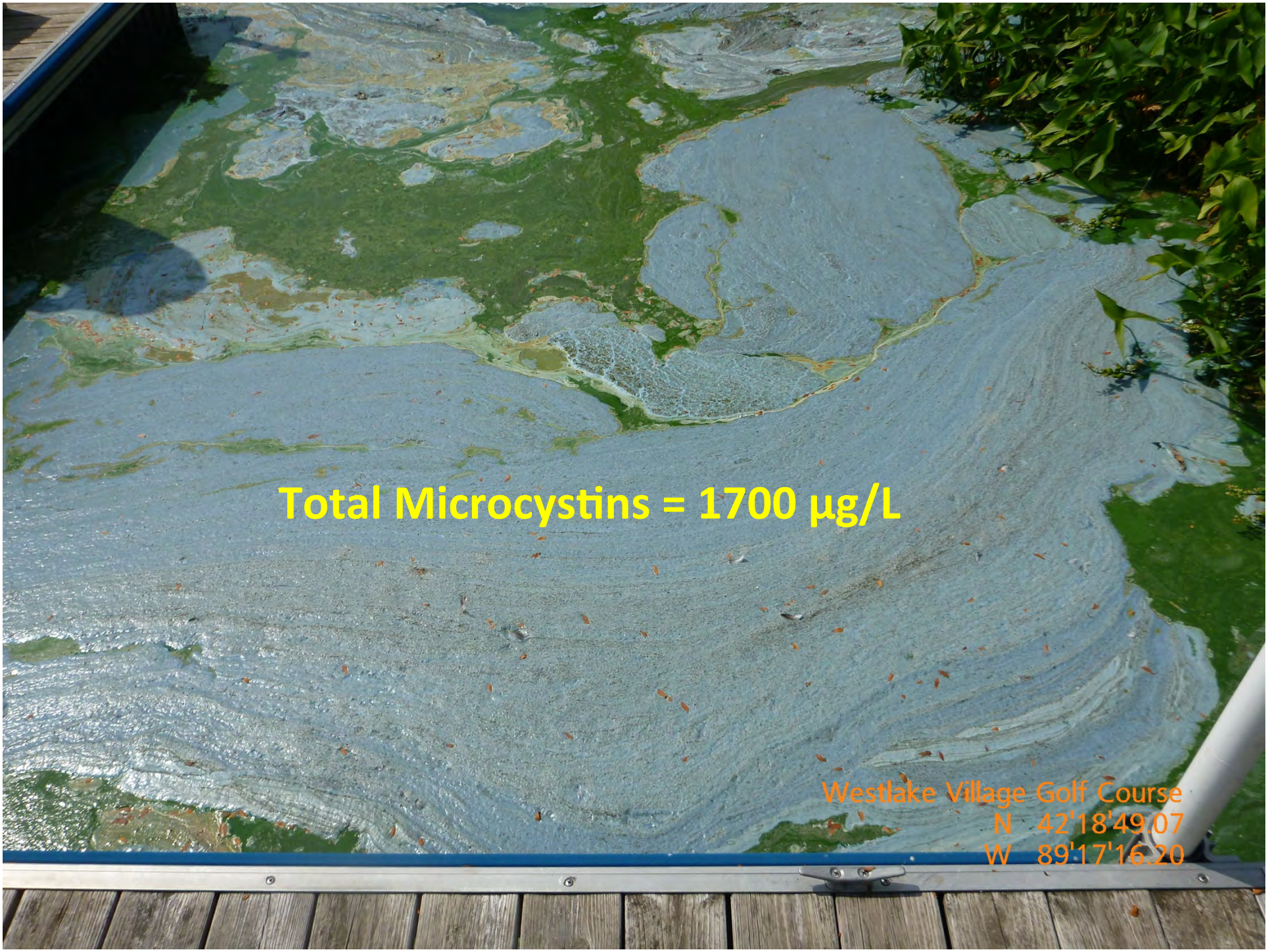


IL EPA

- Nutrient Reduction strategy
  - Need to reduce nitrogen and phosphorus
- Develop water quality standards
- Proactive lake management strategies, especially PWS
- Monitoring and Advisories


Total Microcystins = 4800 µg/L
N 42'20'59.08
W 88'52'13.44

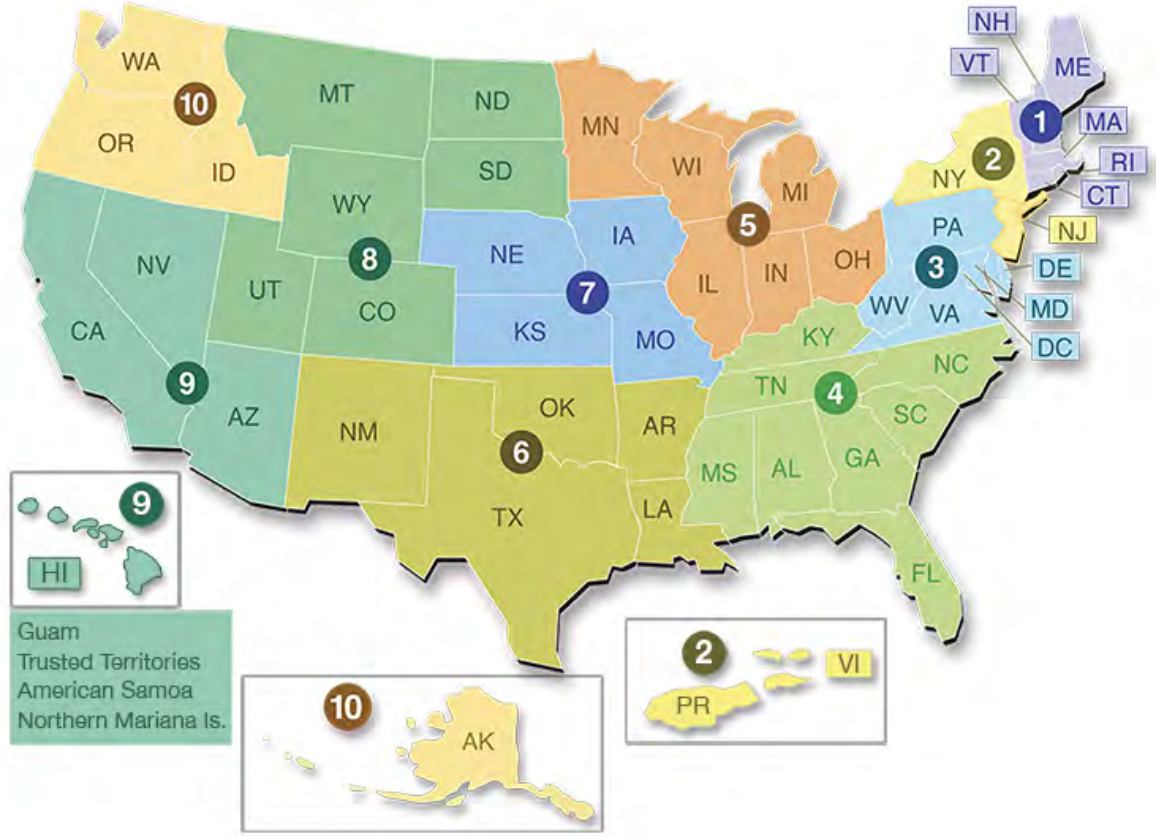

Total Microcystins = Non-detect


Total Microcystins = 1700 µg/L
Westlake Village Golf Course
N 42°18'49.07
W 89°17'16.20

Regional Scale Efforts

- USEPA Region 5 work groups
  - National Lake Assessment
  - Regional Monitoring Networks
  - Regional Biocriteria Development

US EPA REGIONS



National Lake Assessment Survey

- Regional and National scale monitoring
- Statistically valid estimates of lake condition
- Standardize monitoring methods
- Larger pool of reference condition within an ecoregion
- Identify causes of degradation

Indicators Evaluated for the NLA 2012

Biological	Chemical	Physical	Recreational/ Human Health
• Benthic macroinvertebrates • Chlorophyll a • Zooplankton	• Acidification • Atrazine • Dissolved oxygen • Nitrogen • Phosphorus • Sediment mercury	• Drawdown • Human disturbance • Lakeshore habitat • Physical habitat complexity • Shallow water habitat	• Algal toxin (microcystin) • Cyanobacteria

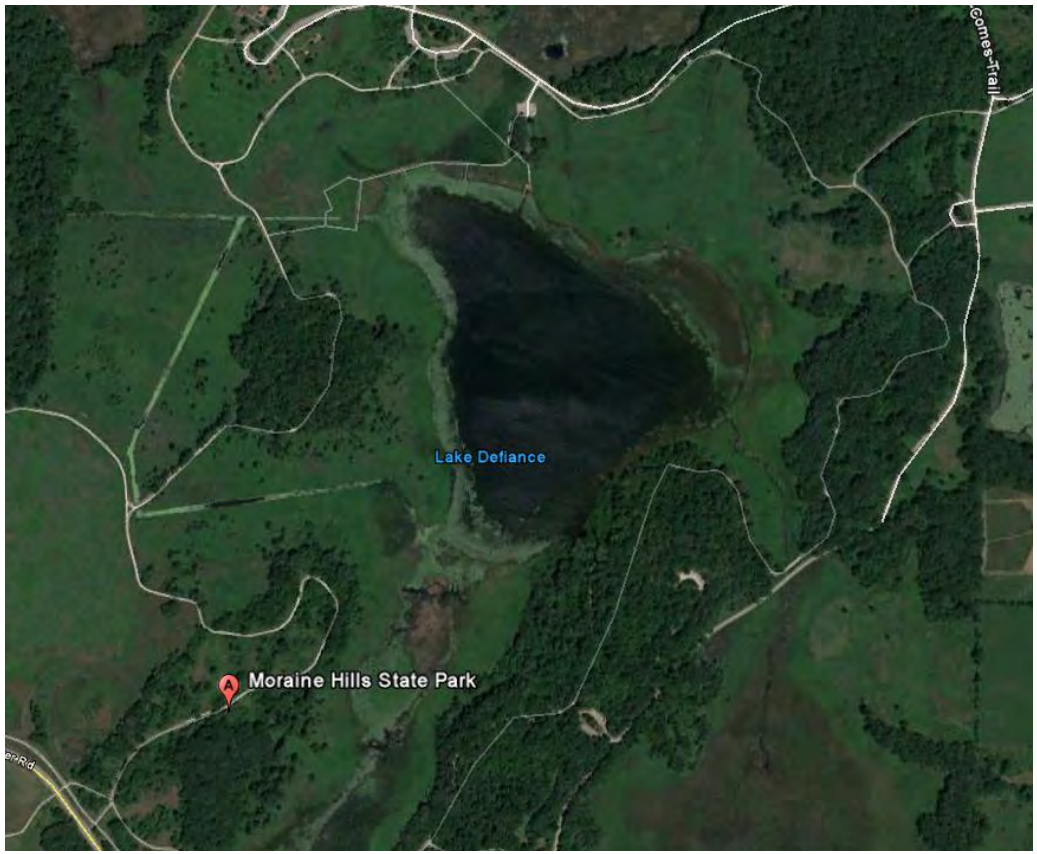
For general descriptions of the indicators used for NLA as well as those used in the coastal survey (NCCA), the rivers and streams survey (NRSA), and the wetlands survey, please visit the Indicators used in the National Aquatic Resource Surveys page.


Total Microcystins = 1250 µg/L


Total Microcystins = 85.9 µg/L

Regional Monitoring Networks

- Long-term monitoring program
- Documents baseline conditions
- Detect long-term changes
- Frequent monitoring (annual)
- Consistent methods
- Pools data from the region for more robust analysis
- Reference condition



Regional Biocriteria Development

- Bioassessment tools
- Use biology to determine water quality
- What organisms to target?
- Who is seeing success?
- How are we monitoring?
- Is there broad range applicability?
- Can we compare our data?

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