The Lake Beat

Volunteer Lake Monitoring Program

Fall/Winter 2015

Topics:

- **Climate Change**
- **HAB Program Update**
- **USEPA HAB Health Advisory Update**

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www.epa.illinois.gov/topics/water-quality/monitoring/vlmp/who-should-volunteer/index

Just Click to follow link.

Climate Change: The Future of Our Lakes is Green

~Diane Tancl

The Illinois Environmental Protection Agency has been monitoring algal toxins in lake and stream samples since 2005. This monitoring has become a permanent Illinois EPA program; the Harmful Algal Bloom Monitoring Program. There is some concern that global climate change and the associated impacts may be triggering harmful algal blooms (HABs). There are many climate related mechanisms that could cause these HABs to become more resilient and more frequent (Carey et al., 2012). Climate change is responsible for global changes in water levels, glaciers shrinking, and oceanic acidity (USEPA, 2012 and USEPA, 2014), but some of the impacts of climate change will be significant to Illinois lakes too.

'Continued on next six pages.'

Adelia (using the Secchi) and Danielle Rush (recording the data) on Lake Carroll, Carroll County.

Here's a couple of pictures to help you look forward to the 2016 season. Start planning now for the time to get the boat, anchor, and Secchi monitoring equipment and hit the lake for lots of fun. Register Now!

Cole Bundren with a four pound bass.

Table 1. 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	Wildfires
Stream Flow	Great Lakes water temps. And levels	Bird Wintering Ranges	Leaf and Bloom Dates	Atmospheric Concentrations greenhouse gases	

The National Oceanic and Atmospheric Administration (NOAA) and the United States Environmental Protection Agency (USEPA) are investigating a number of indicators related to climate change, listed in Table 1 (USEPA, 2012 and USEPA, 2014). One concern over climate change is how it will impact cyanobacteria and HABs (Elliott, 2012).

Figure 1. Harmful Algal Bloom.

The effects of climate change may create conditions that favor some of the physiological and morphological characteristics of cyanobacteria over other algae species (Carey et al., 2012). Increased cyanobacteria can lead to increased HABs, and they are costly to manage and dangerous to human and animal health. Whole lake closures will occur from conditions similar to figure 1. Closures in lakes can have impacts on everything from drinking water to aesthetics. How many lakes would you avoid because they were covered in scum and smelled like an out-house in summer? Is anyone racing to Toledo to sample some of their tap water from Lake Erie? Negative aesthetics can have lasting impacts on the attitudes people have toward a lake or stream.

Did you know?

The World Health Organization concludes that a single guideline value for cyanobacteria or cyanotoxins is not appropriate. Due to the variety of possible exposures through recreational activities (contact, ingestion and inhalation) it is necessary to differentiate between the chiefly irritative symptoms caused by unknown cyanobacterial substances and the more severe health effects due to exposure to high concentrations of known cyanotoxins, particularly microcystins.

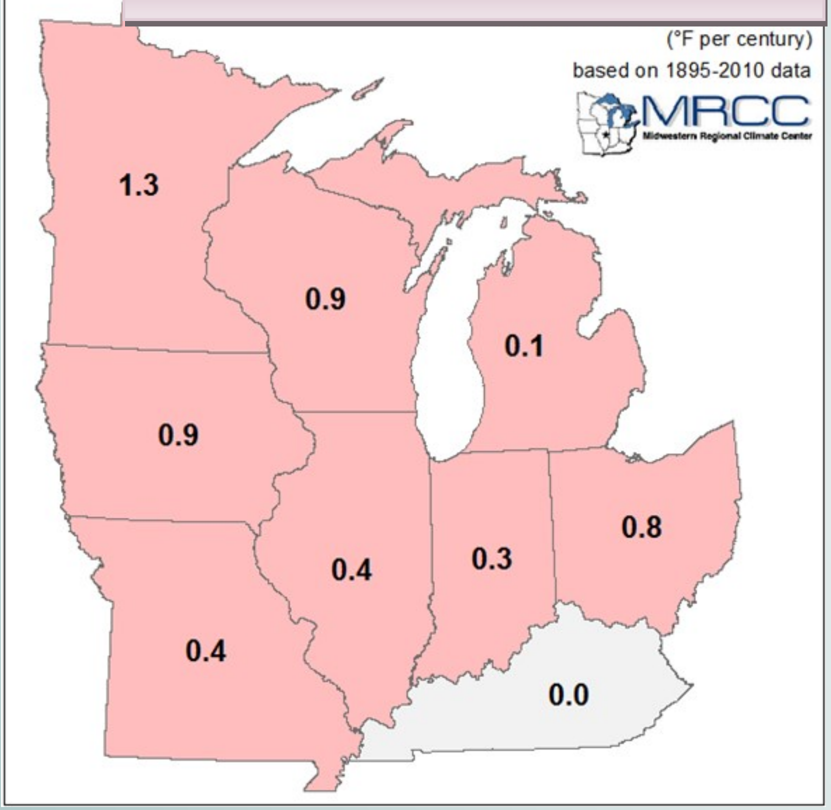
Reference: epa.gov/nutrient-policy-data/guidelines-and-recommendations

World Health Organization recreational risk values for microcystin.

Relative Probability of Acute	Cyanobacteria	Microcystin-LR	Chlorophyll-a
Low	<20,000	<10	<10
Moderate	20,000-	10-20	10-50
High	100,000-	20-2,000	50-5,000
Very High	>10,000,000	>2,000	>5,000

Increases in air and water temperature will play a role in cyanobacteria dominance (Paerl et al., 2012) (Figure 2 uses 115 years of annual statewide temperatures gathered by multiple state and federal partners to develop a trend analysis for each state culminating in the trend values presented and indicating an increase in temperature for most north central states over the last century.) Lake turn-over may come earlier in the spring and occur later in the fall. This longer stratification time can result in a larger, more anoxic hypolimnion stressing out benthic organisms and increasing the biological oxygen demand. An anoxic hypolimnion also creates an environment for nutrient release from the sediment, making more nutrients biologically available following lake mixing. Increased nutrients can be utilized by cyanobacteria to reproduce at rates that form blooms and scums. Cyanobacteria thrive in warmer waters. Lab studies show that they reach their peak growth rates in warmer temperatures, allowing them to gain dominance over other phytoplankton. While diatoms, dinoflagellates, and chlorophytes reproduction rates drops off beyond 25 degrees Celsius, cyanobacteria (blue green algae) are reaching their peak (Paerl et al., 2013). In Illinois, we usually see cyanobacteria peaking in July and August, but if it's hotter sooner, we may see more growth earlier in June or even May. Lakes that may have a problem for a week or two in the summer might evolve to having thick scums for months of the beach and recreation season.

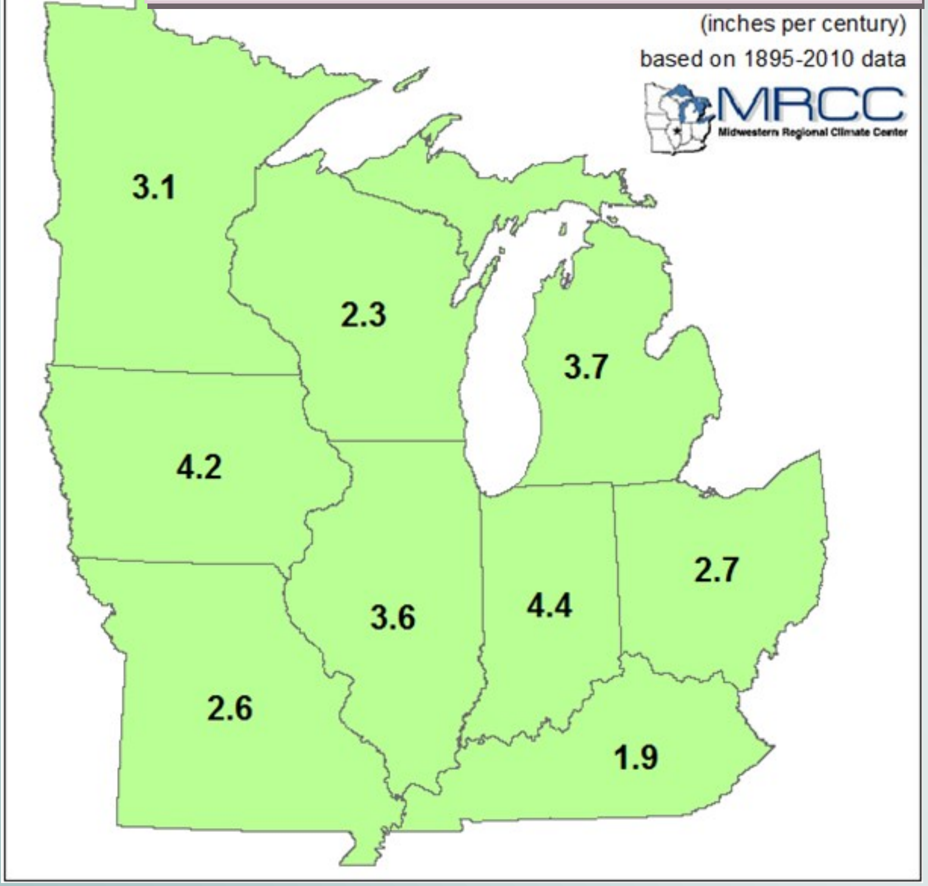
Figure 2. Increase in Annual Temperature (^{0}F) Per Century



Increases in precipitation, and more importantly extreme weather causing flooding, can also be a driver increasing HABs (Reichwaldt et al., 2012). (Figure 3 uses 115 years of annual statewide annual precipitation gathered by multiple state and federal partners to develop a trend analysis for each state culminating in the trend values presented and indicating an increase in annual precipitation for all of the north central states over the last century.) Flooding brings in pollutants, fertilizers, grease and oil which will harm plankton communities. It will increase erosion of unprotected shorelines, and municipalities will have to increase storage in detention ponds by drawing down the water. Drawdowns will also cause destruction of shoreline emergent plants and ruin habitats for fish and other aquatic wildlife. The nitrogen and phosphorus coming into the lake will trigger more cyanobacteria growth and increased turbidity from shoreline erosion will make it harder for plants to grow and compete with phytoplankton for the influx of nutrients. Submersed macrophytes are rooted in the fine sediment and keep it from being resuspended. If submerged macrophytes can no longer get enough light to grow, phytoplankton will gain dominance in the waterbody.

Droughts are another indicator of climate change (USEPA, 2012); increases in droughts, as well as their length and intensity are expected impacts from climate change. Droughts will increase water retention time, cause oxygen depletion and increase water temperature in lakes. Drought conditions favor cyanobacteria because some cyanobacteria are able to produce akinetes. Akinetes are dormant cells that can survive drought conditions for long periods of time. When favorable conditions return, they can germinate (sprout) and generate more plankton colonies (Wetzel, 2001).

Figure 3. Increase in Annual Precipitation (inches) Per Century



Concentrations of greenhouse gases (including carbon dioxide) are increasingly causing climate changes (Holland et al., 2012). Elevated levels in the atmosphere translate to more carbon dioxide being available in aquatic systems. Dissolved inorganic carbon is important for aquatic photosynthesis. In some cases, carbon may be limiting algal growth in eutrophic waters. Cyanobacteria are also poised to benefit from increased levels of carbon dioxide in the atmosphere (Paerl et al., 2012). Thick blooms forming scums of cyanobacteria, in nutrient rich water, have a high demand for carbon dioxide for photosynthesis. Since scums form at or near the surface, they are poised to intercept atmospheric carbon dioxide for photosynthesis, while other algae have to rely on dissolved inorganic carbon lower in the water column. Again, this allows the cyanobacteria to establish dominance. So, what will these increases in cyanobacteria do?

Harmful algal bloom scums shade out other algal species, and plants (Figures 4, 5 and 6). They increase turbidity and reduce aesthetics in lakes and streams. Scums harm industry by causing water shortages when drinking water supplies are shut down. The scums can clog gills on farmed fish. They hurt the recreational economy, because people don't want to swim in green, septic smelling water. The cyanobacteria aren't palatable to a lot of phytoplankton grazers, affecting the foodchain. Photosynthesis increases pH, which can be detrimental to sensitive fish. Increases in biological oxygen demand will cause fish kills and nutrient release from sediments. On top of all of that, there is toxin production. Toxins cause human health effects, such as, dermatitis, liver damage, allergy like symptoms, nerve damage, and in rare cases even death, depending on the dose amount received, type of algal toxin being produced and the type of exposure (inhalation, contact or ingestion) (Figure 7).

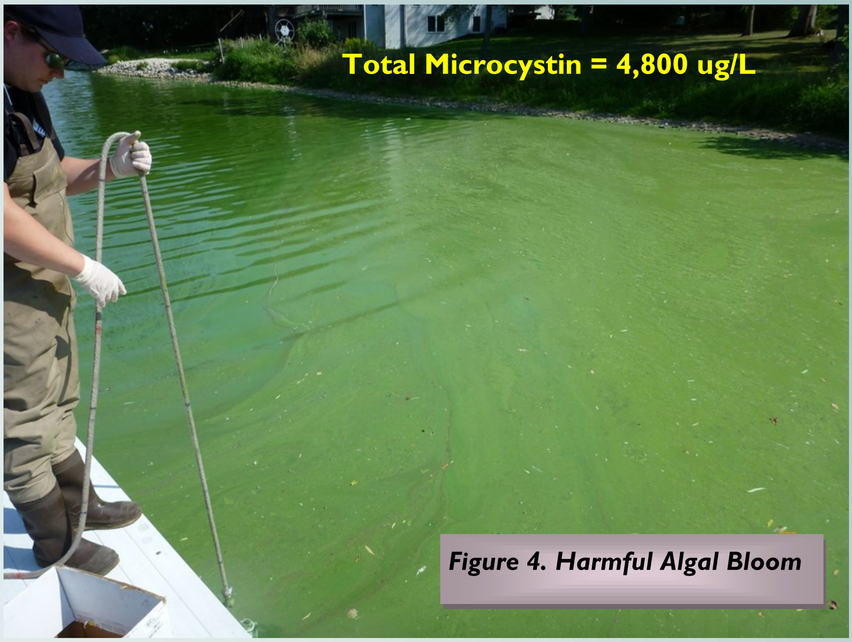


Figure 4. Harmful Algal Bloom

What can we do? Ways to combat climate change can range from protecting pollinators to driving our cars less. Specific to algae, the control starts with nutrient pollution. We need to reduce nitrogen and phosphorus in our lakes' watersheds. A lot of watershed plans in the past assumed that phosphorus would be the most beneficial nutrient to control, since some toxin producing algae can fix atmospheric nitrogen. Recent studies are showing that when blooms are occurring, atmospheric nitrogen isn't enough to sustain a bloom for a combination of reasons (Paerl et al., 2013). There is a high energy requirement to fix nitrogen (have to create heterocysts to support fixing a lot of nitrogen), oxygen concentrations from photosynthesis inhibit the fixation of nitrogen, turbulence and wave action can interrupt it, and some trace metals required for fixation, may be limiting it as well. In waterbodies where nitrogen gas fixation isn't meeting the nitrogen needs for the cyanobacteria, anthropogenic nitrogen will play a big role in supporting and sustaining these HABs. There are some toxin producing algae that don't fix nitrogen, so they require inputs of nitrogen as well.

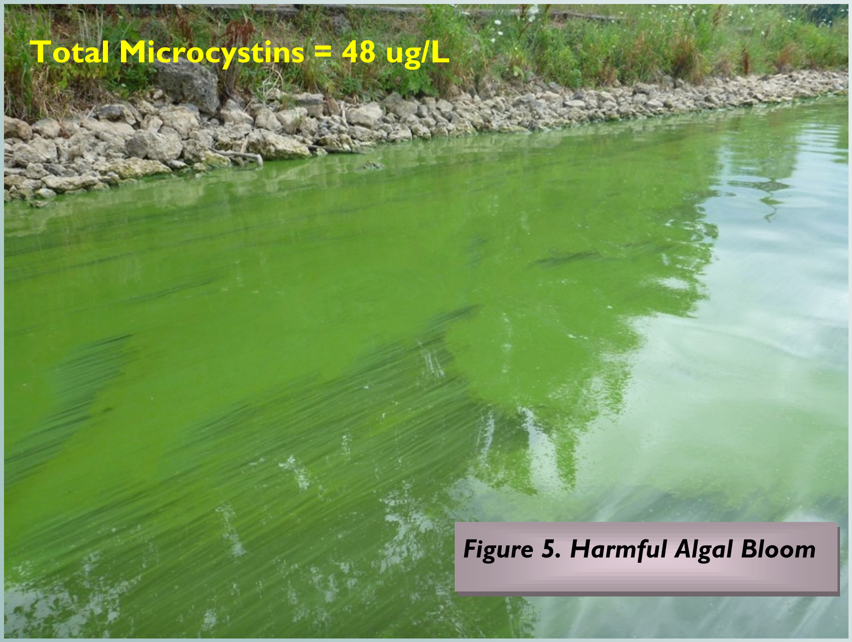


Figure 5. Harmful Algal Bloom

The Illinois Water Resource Center-Illinois Indiana Sea Grant, the Illinois Environmental Protection Agency, the Illinois Department of Agriculture, and representatives of several other groups have formed a policy work group to address nutrient pollution in Illinois. The Illinois Nutrient Loss Reduction Strategy outlines a number of best management practices to keep nutrient pollution out of our lakes and streams. This collaborative effort is one step to reducing the nutrients leaving our agriculture fields and urban landscape from entering our waterways. Illinois EPA will also continue to monitor toxins through the Harmful Algal Bloom program. The monitoring for this program will be a combination of routine sampling for HABs at points of public access to lakes, and response monitoring when blooms and scums are reported to the agency.

Figure 6. Harmful Algal Bloom

One of the main goals of the HAB monitoring program is to protect people from toxic conditions in the water by the use of education and real-time scientific data.

Figure 7. Harmful Algal Bloom

References

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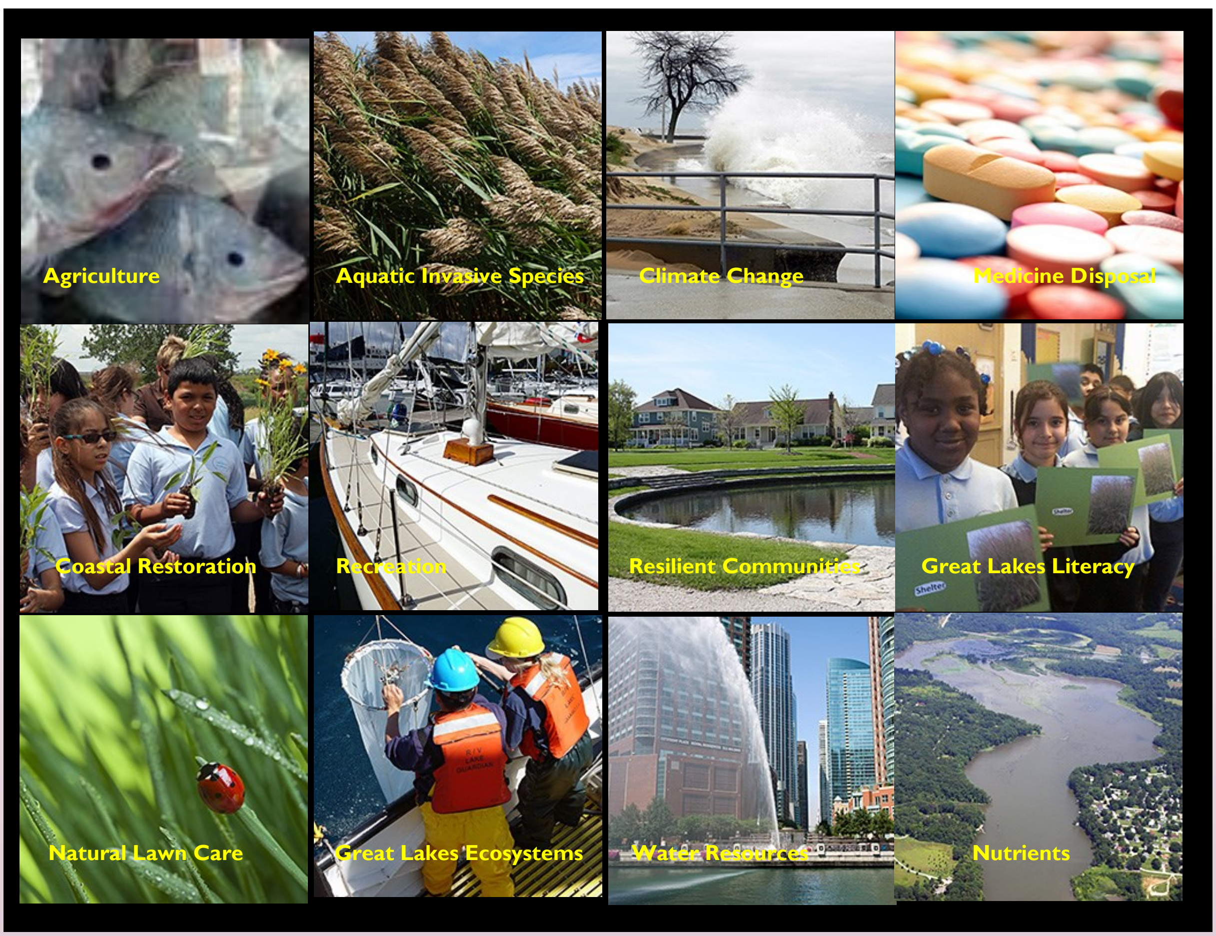
Sea Grant ILLINOIS-INDIANA

Go to iiseagrant.org to check out some of the topics listed below. You'll be glad you did.



HAB Program: What We Did and What We Found in 2015

The Illinois Harmful Algal Bloom (HAB) Program continued into 2015 with some slight modifications from 2014. The HAB Program again consisted of two primary components: a "Routine Monitoring" component and an "Event Response" component. The Routine Monitoring component expanded to target a subset of Illinois inland lake drinking-water intakes and beaches; and a subset of Lake Michigan (LM) drinking-water intakes, harbors, and nearshore stations. The Event Response component focused 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 were sent to the Illinois EPA Division of Laboratories (DOL) for analysis of microcystins by Enzyme-Linked-Immunosorbent Assay (ELISA) methodology.

Routine Monitoring sampling for microcystin occurred at Lake County inland beaches. Samplers were to collect one sample per every two weeks at each of thirty-one Lake County inland-lake beaches from Memorial Day through Labor Day. The public-water-supply (PWS) intake samplers were to collect one sample per month at each of eleven Ambient Lake Monitoring Program (ALMP) PWS intakes, during June through August, and in October, and at the ALMP lake beaches, the samplers were to collect one sample per month at each of approximately ten inland-lake beaches in the central and southern regions, during June through August, and in October. At LM, the samplers were to collect one sample at each at three LM PWS intakes, at each of four LM harbor stations, and at each of five LM nearshore stations, during June through October. The sampling frequency was not fixed and would vary with weather conditions. Finally, in the Fox River, samplers were to collect one sample per every six weeks at each of four Fox River stations, during June through October, as weather and conditions permitted.

Event Response sampling for microcystin occurred at any lake or stream when a cyanobacterial "Bloom" was directly observed by Illinois EPA or Illinois EPA-designated staff. Screening samples for microcystin using an Abraxis-strip test for recreation were taken within 24 hours. If the cyanobacterial bloom was detected at any location within a PWS lake, then within 24 hours, an intake sample was screened using an Abraxis-strip test for source water. In response to a Bloom Report Form submitted to the EPA.HAB email address, when resources allow and pictures suggest the presence of an actual cyanobacterial bloom, screen samples were taken for microcystin using an Abraxis-strip test for recreation within 24 hours.

Table 1 presents a summary of the 2015 proposed field plan and what actually occurred. The PWS Intake overage may be due to the combining of PWS Intake Event Response numbers with the Routine Monitoring numbers.

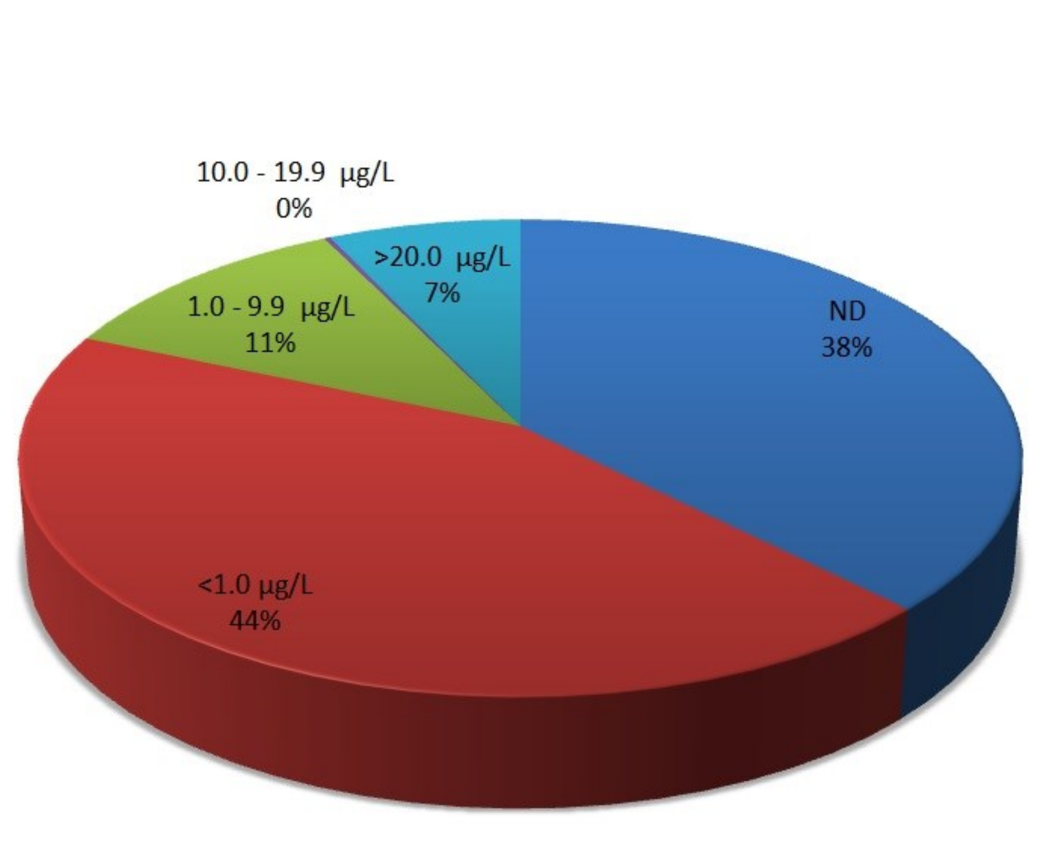
Table 1: 2015 Microcystin Sampling Distribution

Category	Sample Type	Proposed	Actual
Lake County Inland Beaches	Routine	240	237
Public Water Supply Intakes	Routine	44	53
Ambient Lake Monitoring Program Lake Beaches	Routine	40	40
Fox River	Routine	16	13
Lake Michigan	Routine	36	27
Bloom	Response	Unknown (174)	83
n		550	453
Maximum value detected			20,000 ppb

ppb—parts per billion—equivalent to micrograms per liter in the results for this article.

Figure 1 shows a combined breakdown of all the HAB sampling in 2015. Thirty-eight percent of the samples collected did not detect the present of microcystin (non-detect – "ND"). Forty-four percent were less the 1.0 ppb microcystin, eleven percent between 1.0 and 9.9 ppb microcystin, and essentially 0% between 10.0 and 19.9 ppb microcystin. Finally, seven percent were greater than the 20.0 ppb microcystin World Health Organization high risk threshold for primary contact (See the Table 2 at the bottom of page 2 of the first article). Figure 2 compares the actual results distributed between the categories established for the HAB Program in the histogram table.

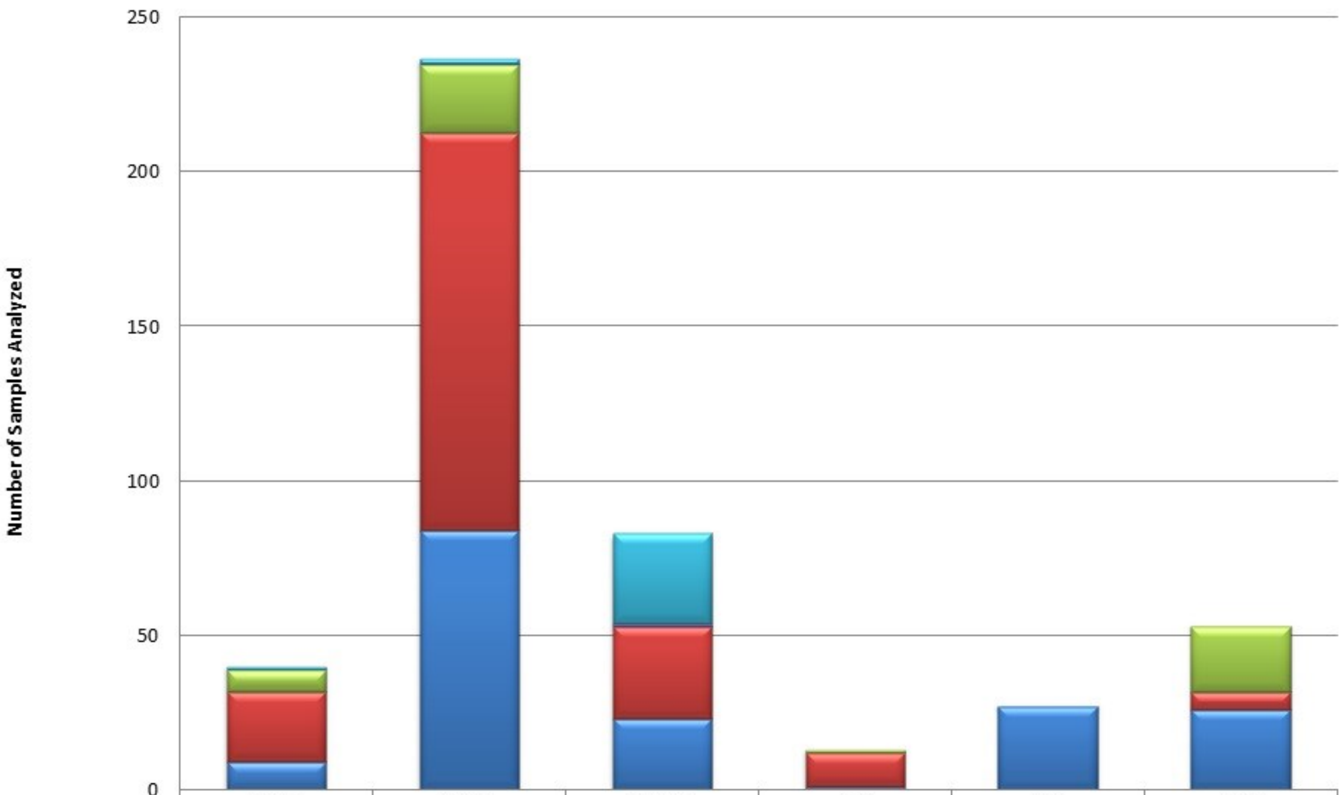
Figure 1: 2015 Microcystin Summary



The Illinois EPA's Harmful Algae Bloom Program continues to adapt as the data from each year is added to the HAB database. The majority of "High Risk" and "Very High Risk" results, 10.0 to 19.9 ppb microcystin and 20.0 ppb microcystin or greater, respectively, were found through the "Event Response" program, at a rate of 90.91% (30 of 33 results). The HAB technical team decided to reduce sampling to only those areas were primary contact to lake uses would most likely occur, boat inlets and beaches, as well as the drinking-water intakes; and a subset of LM drinking-water intakes, harbors, and nearshore stations.

The 2016 sampling plan should look much like the same program; though the technical team is attempting to add to the program by expanding the beach program to include beaches throughout the State of Illinois and not limit it to those in Lake County, LM Program and the ALMP. Another change the team would like to make is to add the use of field testing for cylindrospermopsin, another HAB toxin. These two changes are not confirmed as yet, but will work their way into the program eventually. ~Greg Ratliff

Figure 2: 2015 Microcystin Summary



	ALMP	LCHD	Bloom	Fox	LM	PWS
>20 µg/L	1	2	29	0	0	0
10.0 - 19.9 µg/L	0	0	1	0	0	0
1.0 - 10.0 µg/L	7	22	0	1	0	21
0.15 - 0.99 µg/L	23	129	30	11	0	6
ND	9	84	23	1	27	26

Algal Toxin Health Advisories for Safe Drinking Water

Last summer, the United States Environmental Protection Agency (USEPA) issued health advisory guideline values to protect against elevated levels of algal toxins in drinking water. As the articles in the Lake Beat have mentioned before, algal blooms in rivers, lakes, and ponds sometimes produce harmful toxins. In Illinois, as with many other states, some utilities pull their public water supply from rivers or lake reservoirs; therefore, USEPA has determined algal toxin levels in tap water that are protective of human health based on the best available scientific information.

The health advisory values for algal toxins are 0.3 ppb for microcystin and 0.7 ppb for cylindrospermopsin as levels not to be exceeded in drinking water for children younger than school age. For all other ages, the health advisory values for drinking water are 1.6 ppb for microcystin and 3.0 ppb for cylindrospermopsin. Potential health effects from longer exposure to higher levels of algal toxins in drinking water include gastroenteritis and liver and kidney damage (Table 1).

Table 1.	Drinking Water		
Algal Toxin	Health Advisory Standard	Children Under School Age	Target Tissues
Microcystin	1.6 ppb	0.3 ppb	Liver
Cylindrospermopsin	3.0 ppb	0.7 ppb	Liver, Kidney
ppb - parts per billion—this is equivalent to micrograms per liter throughout this article. Values are based on 10 day exposure.			

While briefly exceeding these advisory levels may not indicate an immediate emergency, USEPA recommends utilities use treatment techniques to lower levels as quickly as possible. Steps that can protect the public from algal toxins in drinking water include: 1) Watching for harmful algal blooms in water bodies used as a source of drinking water, 2) Monitoring source water and drinking water for detections of algal toxins, 3) Treating drinking water as necessary to reduce and remove algal toxins, 4) Notifying the public that younger than school age children should not drink or boil the water if levels are above 0.3 ppb for microcystin and 0.7 ppb for cylindrospermopsin, 4) Notifying the public that no one should drink or boil the water if levels are above 1.6 ppb for microcystin and 3.0 ppb for cylindrospermopsin.

USEPA is currently working on recreational water guideline values. We'll keep you posted. For now, we recommend using the World Health Organization numbers (see microcystin table at bottom of page 2). Stay safe.

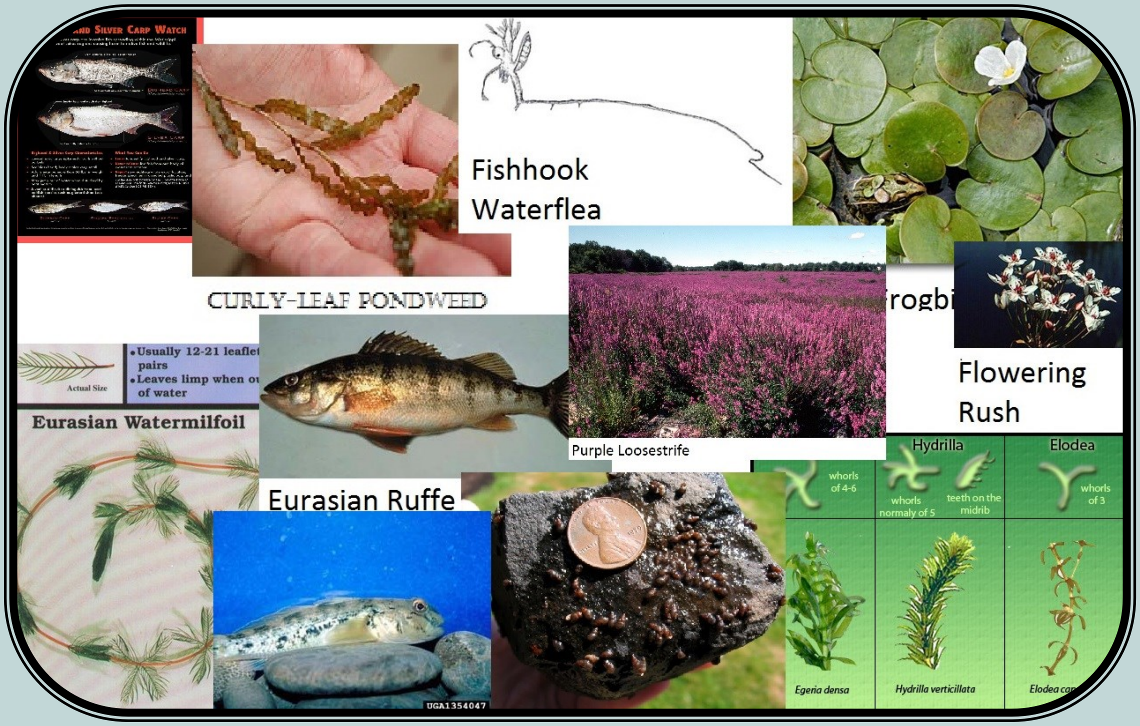
~Greg Ratliff

Stop the Spread!

Follow this checklist to defeat the spread of aquatic exotics:

If you are a boater, angler, water skier, sailor, canoeist or some other type of water enthusiast, there are some important things you can do to help prevent the spread of aquatic exotic species.

- Don't transport water, animals, or plants from one lake or river to another.
- Never dump live fish from one body of water to another.
- Remove plants and animals from your boat, trailer, and accessory equipment (anchors, centerboards, trailer hitch, wheels, rollers, cables, and axles) before leaving the water access area.
- Drain live-wells, bilge water, and transom wells before leaving the water access area.
- Empty bait buckets on land, not in the water. Never dip your bait buckets in one lake if it has water in it from another.
- Wash boats, tackle, downriggers, and trailers with hot water as soon as possible. Flush water through motor's cooling system and any other parts that may have been exposed to lake or river water. If possible, let everything dry for three days (hot water and drying will kill zebra mussel larvae).
- Learn what these organisms look like. Don't purchase exotic species as bait or for ornamental plantings. If you suspect a new infestation of an exotic plant or animal, report it to Illinois EPA's Lakes Unit (217/782-3362), Illinois DNR's Division of Natural Heritage (217/785-8774), Illinois DNR's Natural History Survey at the Havana Field Station (309/543-6000) or the Lake Michigan Biological Station (847/872-6877).
- Consult with the Illinois EPA's Lakes Unit or your local Illinois DNR district fishery biologist for guidance before you try to control or eradicate an exotic "pest." Remember, exotic species thrive on disturbance. Do-it-yourself control treatments often make matters worse and can harm native species!



If you see or suspect a Harmful Algal Bloom (HAB), contact EPA.HAB@illinois.gov and your regional VLMP coordinator

Remember

If you find Hydrilla or any new exotic species in your lake, contact your regional VLMP coordinator.

Regional Coordinators:

VLMP Statewide Contact

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epa.state.il.us/water/conservation/vlmp

Illinois Lake Management Association

The Illinois Lake Management Association (ILMA) is a great resource for lake managers, lake owners and lake homeowner associations, just to name a few. ILMA's mission is to promote understanding and comprehensive management of lake and watershed ecosystems. Check out the web site at www.ilma-lakes.org to see what they can offer you or your homeowner association.

~Greg Ratliff