PHOSPHORUS AND WATER QUALITY ISSUES IN LAKE ERIE

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What are harmful algae blooms?

Harmful algal blooms (HABs) are so named because they can produce toxins (or poisons) that can cause illness or irritation—sometimes even death—in pets, livestock, and humans. The term "algae" is somewhat misleading since HABs are actually cyanobacteria, which are commonly referred to as "blue-green algae," and are not true algae. These organisms act like many other plant and use photosynthesis to capture sunlight but unlike most plants and algae some can fix their own nitrogen from the atmosphere. Most blooms in Lake Erie and GLSM are types of cyanobacteria that cannot fix nitrogen. At sometimes we do see nitrogen fixing blooms.

Factors that can contribute to HABs include:

- excess nutrients (phosphorus and nitrogen)
- sunlight
- low-water or low-flow conditions
- calm water (low-wind conditions)
- warmer temperatures
- low salinity
- selective grazing (avoiding cyanobacteria)by zooplankton or zebra/quagga mussels

Source: http://www.ohioseagrant.osu.edu/_documents/publications/FS/FS-091-2011%20Harmful%20Algal%20Blooms%20In%20Ohio%20Waters.pdf

How prevalent have HABS have been across Ohio and what have been their impacts?

Ohio EPA has established thresholds and monitors when suspected cyanobacteria are visually present in Ohio's public waters. The warning criterion is noted in Table 1.

Table 1. Warning Criterion used by Ohio EPA in public waters.

Numeric Cyanotoxin Thresholds

All threshold values are reported in ug/L

Type of Advisory	Microcystin *	Anatoxin-a	Cylindrospermopsin	Saxitoxin*
Recreational Public Health Advisory	6	80	5	0.8
Recreational No Contact Advisory**	20	300	20	3
Drinking Water: Do Not Drink Advisory	1	20	1	0.2
Drinking Water: Do Not Use Advisory	20	300	20	3

*Microcystin and Saxitoxin thresholds are intended to be applied to total concentrations of all reported cogeners of those toxins.

**A No Contact Advisory is issued when toxin levels exceed the recommended threshold and there are one or more probable cases of human illness or pet deaths attributable to HABs.

Notes: ppb - parts per billion; **ug/L** - micrograms per liter; Microcystin, Anatoxin-a, Cylindrospermopsin and Saxitoxin are the Cyanotoxins tested for at Ohio state park beaches and at public water systems.

While much attention has been focused on Grand Lake St Mary's and Lake Erie warning and advisories based on the criteria in Table 1 have been posted on 26 different Ohio Lakes in the period 2010-2013. The public can track monitoring at the OEPA site http://wwwapp.epa.ohio.gov/gis/mapportal/hab.html. Ohio Lakes listed in Table 2 had advisories during September, 2014.

Table 2. HAB Warning Status of Ohio Waters' as of 9/10/2014.

Water Body	Number of beaches	Level Microcystin (ppb)	Posted Warning
Buckeye Lake	3	3.4-25	Recreational Public Health Advisory
Grand Lake St Mary's	4	30.4-54.2	Recreational Public Health Advisory
Maumee Bay State Park	1	6.3	Recreational Public Health Advisory
South Bass Island	1	13	Recreational Public Health Advisory

In addition to public health concerns for recreational use, 55% of Ohio's population is served by public water systems that use surface water source water. When measure in gallons delivered, 66% of the water from public systems originates from surface water sources. The World Health Organization has set tolerance of 1 ppb for drinking water. In areas where HAB potential exist, municipal water treatment plants have had to add treatment methods to lower finished drinking water toxin content to below this standard. Increase cost have ranged from $1,000,000 annually for Toledo population 450,000; Celina had capital cost of $7.2 million and yearly operating cost of $500,000 for a population of 11,700 and in 2013-2014 Columbus spent $723,000 treating water from Hoover Reservoir.

In addition the timing of HAB blooms and their proliferation in the recreational waters such as that experienced in 2011 affected boating and fishing. The charter boat industry on Lake Erie accounts for $10 billion of tourism.

The issue of HAB toxins from cyanobacteria is different than the concerns about hypoxia that is often discussed related to algal blooms. Hypoxia results from conditions where algal blooms then die off leaving zones of oxygen depleted water. HAB toxins were documented to have caused 48 human illnesses and 5 animal deaths in 2010. Thus the heightened human health concerns associated with HAB presence in Ohio Watersheds have made the demands to solve the problem more urgent.

Of the factors listed that can contribute to cyanobacteria, two have a direct human foot print phosphorus and invasive species introduction.

What are the Watershed Sources of Phosphorus?

Lake Erie has a longest history of water sampling related to algae and other water quality concerns. Ohio agencies have convened two panels to look at phosphorus in the Lake Erie

Watershed. The Phosphorus Task Force 1 quantified sources of phosphorus in the watershed and potential solutions to lower inflows. Phosphorus Task Force 2 focused on non-point source BMP's and analyzed target loading to improve Lake Erie health. Both reports can be found at http://www.epa.state.oh.us/dsw/lakeerie/index.aspx .

The phosphorus task force 1 report quantified inflows of which are shown in Table 1 below. Figure 6 provide a description of contributing areas defined in Table 1.

Table 1— Approximate distribution of phosphorus entering each component of the Lake Erie system from various external phosphorus sources, 1998 - 2005. (MTA – Metric tonnes/year)

External Phosphorus Source	Connecting Channel MTA	Western Basin MTA	Central/Eastern Basin MTA	Total Loads MTA	Percent of Total
Nonpoint	522	3,987	1,094	5,604	60.8%
Point	1,051	388	469	1,908	20.7%
Upper Lakes	1,080	0	0	1,080	11.7%
Atmospheric		80	548	628	6.8%
Total	2,653	4,455	2,111	9,220	100%
Percent of total	29%	48%	23%	100%	

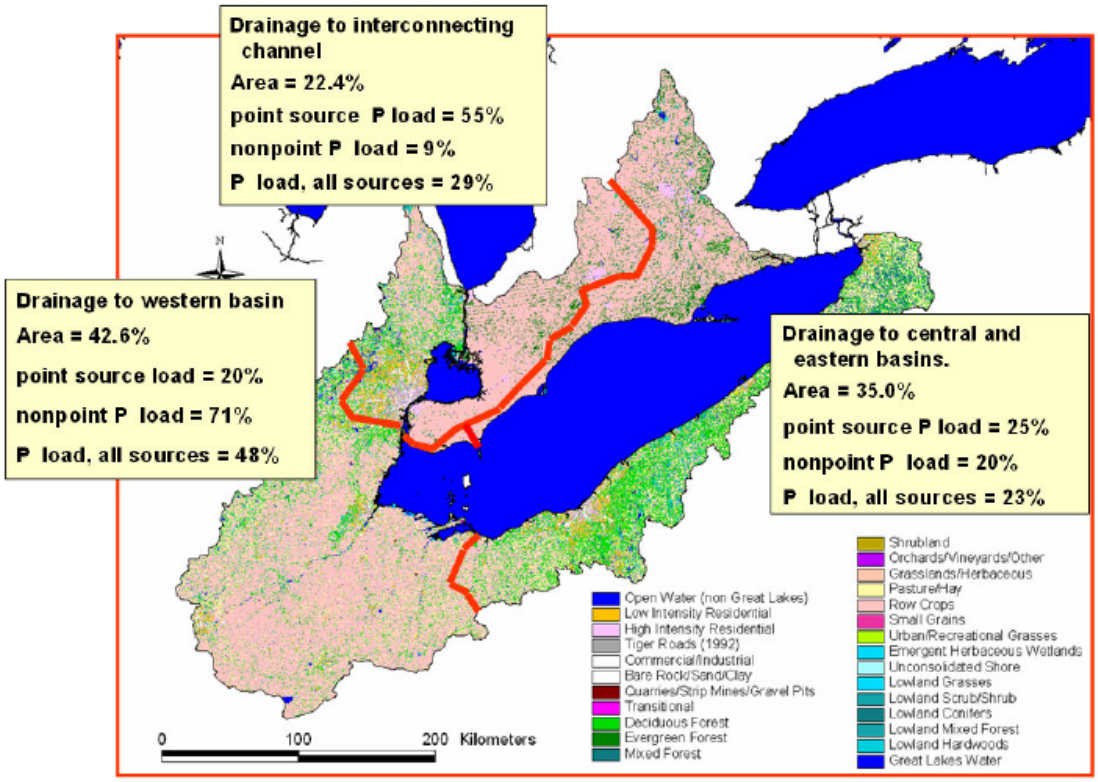

Figure 6— Land areas draining into the three major sub-basins of Lake Erie, along with the corresponding contributions of total phosphorus. (Base map provided by Thomas Hollenhorst, University of Minnesota, Duluth, with phosphorus load allocations calculated by David Baker using data provided by David Dolan, University of Wisconsin, Green Bay and Heidelberg University)

Agriculture is predominate land use in the Western Lake Erie basin account for 4.3 million of the over 5 million acres in the watershed. Even small quantities of P per acre from this large area can be a significant amount of the non-point source P in the basin.

Phosphorus Dissolved Reactive Phosphorus (DRP) compared to Total P Distribution

Another characteristic of today's problem versus what was experience in the 1970's is the phosphorus type distribution. Sediment bound P is determined by filtering a water sample through filter paper with the material maintained on the filter analyzed for bound P. The material passing through the filter is used to determine DRP. Total P is the summation of both the sediment bound quantity of P and soluble quantity of P in the sample. The figure below shows Particulate and DRP. Particulate P is 30% bio available to support algae growth while DRP is 100% bioavailable. The resulting figure shows the increase in Bioavailable P.

The bioavailable phosphorus is a measure of that readily available P in water to support biological growth in this case algae. Smaller quantities of DRP can lead to algae growth due to the higher availability.

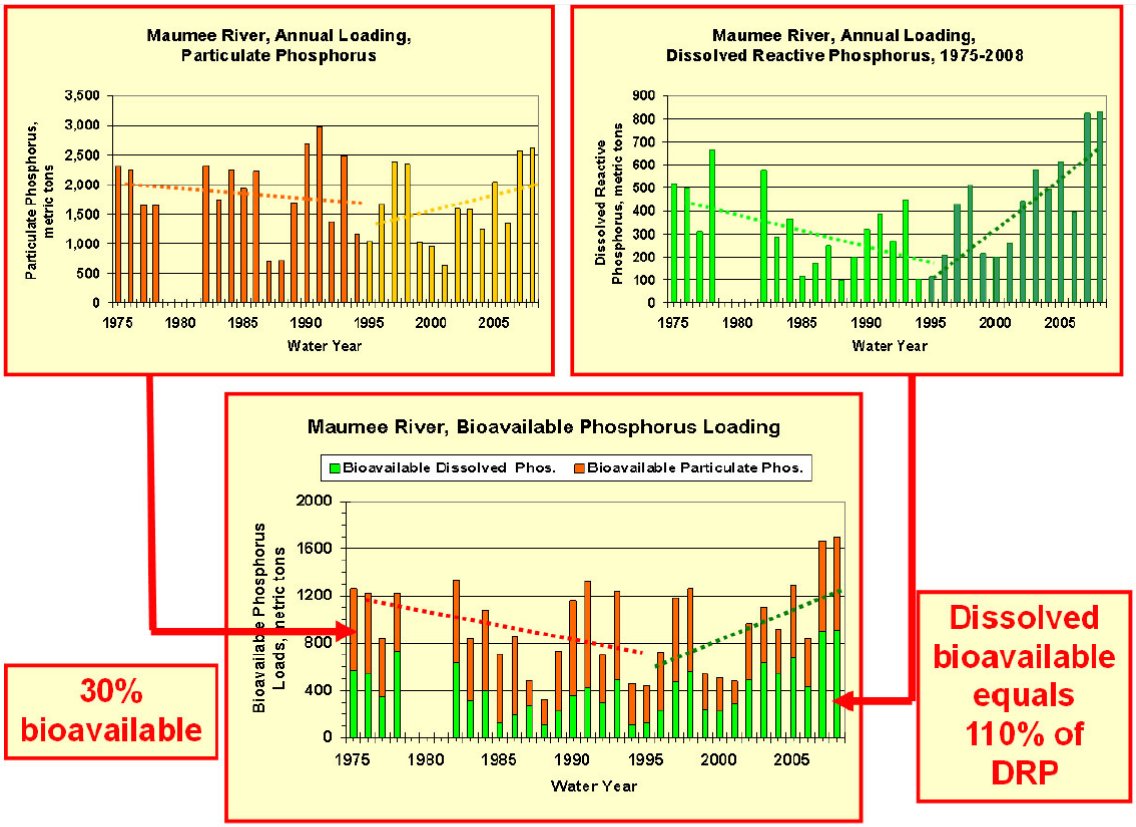

Figure 13 — Estimates of the export of bioavailable phosphorus from the Maumee River at Waterville, 1975-2008. Percentages of bioavailability based on unpublished research by the National Center for Water Quality Research at Heidelberg University (Graphs prepared by David Baker)

Nitrogen has a role

While phosphorus is the primary trigger, nitrogen in water has been shown to play a role in the HAB problem. Recent work has shown that increased levels of nitrogen enhance the reproduction of algae in the presence of phosphorus. Additional nitrogen availability will affect the production of toxins and species that predominate under similar conditions. Excess in nitrogen loading from the watershed will exacerbate the problems associated with HABs.

Nitrogen is one of the larger budget items in the corn enterprise and nitrogen use efficiency while having improved in the past decade still is around 55-60%. According to OSU Extension crop budgets N is 20% of the variable cost of production in the corn enterprise. Gains in NUE can increase profitability and reduce water quality concerns.

Best Management Practices to Keep Phosphorus on the Field

Phosphorous Rate, Application and Timing

Avoid overloading soils. Utilize current soil test (less than 3 years old) and follow tri-state fertilizer recommendation. Where soil test levels are above 40 ppm Bray P1 or 58 ppm Mehlich III-ICP, do not apply additional phosphorus in the corn-soybean rotation. These levels require no additional fertilizer, according to the Tri-State Fertilizer recommendations. Fertilizing soils testing above these levels increases risk of P in runoff and tile drainage.

Avoid winter application. Eliminate surface application of manure or fertilizer to frozen or snow-covered fields. Frozen ground is ground that is frozen to the degree that tillage is not possible. Surface applied manure or fertilizer is subject to runoff events that may occur before the ground thaws and allows nutrients to bind to soil.

Avoid surface application of fertilizer/manure. Surface applications of phosphorus are subject to higher loss if runoff producing rainfall events happen close to application. Placement of nutrient below the surface of the soil reduces loss. If tillage is planned in the crop rotation, P applications should be applied prior to the tillage and till before a rain event. Full width tillage has the potential to increased soil erosion and total phosphorus losses. New placement tools or strategies need to be implemented that place P below the surface with minimal soil and burial of residue. Until these tools become available, use banded application or the minimal amount of tillage to mix nutrient in the soil.

Farm and Field Features

Minimize erosion.

Appropriate conservation practices should be implemented to minimize erosion. Maintain 30% cover as crop residue/cover crop. Filter strips, grassed waterways, water retention, wetlands and water diversion structures are appropriate tools.

Slow the movement of water. Surface water flows from fields directed to tile via standpipes should be converted to blind inlets. As risk loss potential increases for a field consideration should be given for edge of field treatments which control water movement or treat water as it is leaving the site. Drainage water management control structures, in ditch treatments such as two stage ditches and other stream practices can reduce loading.

Know your field's risk. Soil test P, field proximity to water and soil hydrologic class impacts edge of field losses of phosphorus. The NRCS Ohio P Risk index provides a risk of loss index and should be used as part of the development of a Nutrient Management Plan to assess the individual field risk.

Strive to build soil quality. Soil condition is a mitigating factor. Increasing the water infiltration by reducing compaction and improving soil structure increase water retention, nutrient cycling, crop rooting capacity and crop yield. Drainage and soil pH provide a foundation for other practices such as cover crops, drainage, residue management, controlled traffic and soil amendments.

Agricultural Fertilizer Applicator Certification

1) Establishes a Certificate for Fertilizer Application for purpose of agricultural production.
2) Establishes an affirmative defense for a private civil action for claims resulting from application of fertilizer.

1) Certificate for Fertilizer Application

A) Beginning September 30, 2017 a certificate for fertilizer application will be required for application of fertilizer for agricultural production. Agricultural production is defined as "means the cultivation, primarily for sale, of plants or any parts of plants on more than fifty acres. 'Agricultural production' does not include the use of start-up fertilizer applied through a planter."
B) The director of agriculture shall create a fertilizer applicator certification program that educate on time, place, form amount, handling and application of fertilizer, serve as a component of a comprehensive state nutrient reduction program addressing all sources of relevant nutrients, and supports generally practical and economically feasible best management practices.
C) The amount of the fee shall not exceed fees established for pesticide application.
D) Record keeping requirement the date of application of fertilizer, the place of application of fertilizer, the rate of application of fertilizer, an analysis of the fertilizer, and the name of the person applying the fertilizer maintained for 3 years subject to inspection by ODA.
E) Uncertified person can apply fertilizer if under direct supervision of a certified person.
F) Certifications are valid for 3 years. Recertification will be the same as the initial certification procedure.

2) Affirmative Defense (3 requirements, all must be met)

A) The person applying the fertilizer is certified or is applying fertilizer under the instruction and control of a person who is certified.
B) Records have been properly maintained for the application of fertilizer as required
C) The fertilizer has been applied according to and in substantial compliance with a voluntary nutrient management plan. The voluntary nutrient management plan is developed and submit the plan once every five years to the supervisors of the applicable soil and water conservation district or the director for review.

Current status is the bill was signed by the governor on May 22, 2014 and becomes law in 90 days at which time the Ohio Department of Agriculture can submit rules for review through Joint Committee on Agency Rule Review (JCARR) and reviewed by Ohio Legislative Service Commission (LSC).

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