OHIO STATE UNIVERSITY EXTENSION

Your Pond Update

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Harmful algal blooms, ponds, and the basics of mitigation and management

Harmful algal blooms (HABs) on Ohio's big public waters—like Grand Lake St. Marys and western Lake Erie—have been grabbing headlines and occasionally the attention of legislators for several years now. Unsightly, odiferous, potentially toxic... Problems related to HABs are a bane to water treatment and private ponds as well. Here, we'll discuss some basics of the responsible organisms, the factors that promote their growth, potentially associated problems, and finally some possible management/mitigation actions.

The culprit

This article will only address HABs of so-called "blue-green algae," the group of organisms technically known as **cyanobacteria** (Braig et al. 2011). They are not true algae, but do behave and appear very similarly to algae and, like algae and plants, contain chlorophyll for photosynthesis. Cyanobacteria rarely have common names, but I promise to keep my use of Latin to a minimum.

Planktonic forms drift in the open water. Those that may appear in Ohio's ponds include *Microcystis, Planktothrix, Aphanizomenon, Anabaena*, and a few others. Of these, *Microcystis* is perhaps most likely to bloom in ponds. Its cells form globular, bright green colonies that can vary their buoyancy. On calm days, *Microcystis* often forms bright green surface scums that can look like a spill of opaque poster paint or even watermeal (Figure 1). Closer inspection will reveal the globby, granular appearance of its colonies. A little wind will often disperse a *Microcystis* bloom throughout the water column, sometimes giving the erroneous impression it has simply disappeared. Again, the colonies can often be observed widely scattered across depths with a closer look.

Benthic forms of cyanobacteria grow attached to bottom sediments, but can break free to float to the surface as mats. While some other benthic species are common to bigger waters, the one that's most likely to grow in Ohio's ponds is *Oscillatoria* (Figure 2) or its close relatives. *Oscillatoria* often does very well in low-light conditions. Benthic species tend to form rather globby mats of fine filaments.

Figure 1. *Microcystis* bloom on Lake Erie near Gibraltar Island (Donna Braig 2011).

Figure 2. *Oscillatoria* bloom in an Ohio pond (Frank Gibbs 2014).

The Ohio Environmental Protection Agency and Departments of Natural Resources and Health jointly manage a website to disseminate HAB info to the public. That site features a nice catalog of HAB photos to aid in identification. Look for it in links posted to ohioalgaeinfo.com.

The causes

The primary cause of HABs in Ohio's waters is excessive nutrient loads, especially phosphorus (P) and nitrogen (N). This is particularly problematic for aquaculture producers because culture ponds are deliberately enriched via feed to maximize productivity. Freshwater productivity—including of HABs—tends to be most directly responsive to soluble P concentrations. Phosphorus can enter ponds from the watershed with spring rains, especially if the surrounding landscape is deliberately fertilized. Soluble P can also be liberated from sediments and become available to fuel a bloom if a pond loses oxygen from deep water with summer stratification. Nitrogen is still important too, and ongoing research is changing our perception of N's role in influencing the species to bloom, toxin production, etc.

The ratio of N to P is a useful metric. Because many HAB-forming species can fix atmospheric nitrogen, HAB problems become more likely as the N:P ratio falls. A ratio of 16:1 is often cited as a threshold for typical lakes and ponds. That threshold can shift in nutrient-rich systems; problems can become evident below 20:1 in sites like aquaculture ponds (William Lynch, Ohio Aquaculture Association, unpublished data).

Summer typically brings reduced rainfall and higher temperatures that promote evaporation. As water evaporates, low water tends to concentrate remaining nutrients. Most HAB-forming organisms also grow better in higher temperatures. Thus, summer often brings together hotter temperatures and concentrations of nutrients that favor HABs.

Related problems

Perhaps the most obvious HAB-related problem is that high biomasses of any photosynthesizing organisms put dissolved oxygen (DO) on a roller-coaster ride of extremes. Under the light of day, net DO production (a byproduct of photosynthesis) is high, but the dark of night (or even an extended period of cloud cover) creates net consumption that can be severe enough to risk an oxygen crash and fish kill.

Harmful algal blooms are so named because many of the associated organisms have the potential to produce toxins (often called cyanotoxins) that can affect the liver, nervous system, or cause skin irritation. Some of those liver and nerve toxins rank highly among the most toxic substances known. Cyanotoxins are often implicated in human illness and pet and livestock deaths. That said, the presence of a HAB-forming organism does not necessarily mean cyanotoxins are being produced. To know, you'd have to have your water tested. Testing can be expensive and should probably be given a much higher priority for sites providing access by the public or used as a domestic water source. (Boiling will not remove cyanotoxins.) Drop me a line if you'd like a current list of contractors testing for the presence of those toxins.

Fortunately, living livers very actively eliminate cyanotoxins, so the toxins tend to not persist for long in fish muscle (Wilson et al. 2008) and do not appear to bioaccumulate up food webs (Ibelings and Chorus 2007). However, even if relatively briefly and even if not likely being further concentrated from prey to predators, those toxins can be present in fish muscle tissue like fillets (Schmidt et al. 2013) and will be much more concentrated in internal organs, especially the liver (Wilson et al. 2008). Consider simply not harvesting fish in the presence of a bloom. At very least, skin fillets and rinse them thoroughly with water from a municipal source.

Cyanobacteria are also well-known for producing other non-toxic chemicals that can impart unpleasant tastes and odors (T&Os). These compounds rapidly accumulate in the fat within fish muscle and are very slow to be eliminated through excretion (Flick 2011). Fattier fishes, like trouts, will hold higher concentrations for longer, but T&O chemicals are also more difficult for humans to detect in fattier tissue. While T&O chemicals occur in lower concentrations and are eliminated more quickly from lean fishes—like Largemouth Bass, Bluegills, or Yellow Perch—their taste and smell are also much more obvious there. If your pond serves as a domestic water supply, these chemicals can impart odor and "off" flavor when concentrations exceed 0.015 ppb (Howgate 2004)—yes, that's about 1/100th of a part per billion! Bleccchhh!

What to do?

Prevention is far more valuable than treatment (you know…1 proverbial g of prevention is of similar value to 1 proverbial kg of cure). Meaning, manage pond and watershed nutrients (especially P) as proactively as possible.

If building a new pond, plan the watershed to minimize nutrient inputs. If possible, select a site that is not likely to receive runoff from agricultural fields or drainage tile. Plan the smallest watershed possible that is likely to keep the pond filled. Austin et al. (1996) recommend 3–5 acres of watershed per acre-foot of pond volume.

For existing ponds, to begin, aerate! An appropriate deep-water aeration program will both minimize available P (by oxygenating bottom sediments and thus limiting dissolution of the nutrient) and mitigate problematic DO fluctuations that can accompany any substantial bloom in warm water. Ideally, position 2–3 diffusers per acre along a pond's deep water and aim for enough circulation to turn over the pond's volume approximately twice each day.

Tolerate the appropriate coverage of submerged vegetation. Depending on your objectives in managing the fishery, that's likely to be perhaps 5–20% of the pond's area; the greater the coverage within that range, the greater the benefit to water quality. Vascular plants both provide a more stable, consistent source of DO than algae and provide beneficial competition for nutrients. Any nutrients that contributed to the growth of aquatic plants are no longer available to fuel the growth of HABs. To provide benefit throughout a growing season, the essence of a good plant assemblage is diversity. I like to see a combination of native pondweeds (*Potamogeton* spp. that grow early in the season, dying back in summer) and native naiads (*Najas* spp. to serve the later season). Be aware that maintaining the coverage of vegetation you'd like is likely to require some active management.

Consider potential consequences very seriously before treating an existing bloom. Any treatment of a large bloom in warm water—the times of year that HABs are most likely—risks an oxygen crash and fish kill, even potentially overwhelming the capability of aeration to mitigate. Cyanobacteria respond to algaecides similarly to true algae, namely to copper-based products: copper sulfate or chelates. Copper formulae are sometimes combined with diquat and a surfactant for tricky benthic blooms. Repeat treatments with sodium carbonate peroxyhydrate are becoming more common when HABs concentrate as surface scums, and sodium carbonate peroxyhydrate formulae are much more benign than copper with less potential for residual side effects. If your source of P is internal recycling from pond sediments, you can remove its availability as a nutrient through alum treatment (buffering with lime if necessary). The chemical effects of an alum treatment will also kill any HAB-forming organisms, still risking an oxygen crash if the bloom is substantial.

Also, be mindful that killing a HAB will not remove any toxins already present. Depending on temperature and other environmental factors, it will take some time for cyanotoxins to degrade to harmless substances. Again, if you really want to know if toxins are present, you'll need to test.

As always, feel free to drop me a line or look to http://ohioline.osu.edu/lines/ennr.html with additional pond-management questions. ...And good luck out there!

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