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Recognizing, Understanding and Treating Harmful Algal Blooms (HABs)

John Pennington
Instructor, Water Quality Educator

George Selden
Aquaculture Extension Specialist, UAPB Aquaculture and Fisheries Center

Tate Wentz
Stream Team Coordinator, Arkansas Game and Fish Commission

Brad Austin
Post Doctoral Research Associate

Brian Haggard
Director, Arkansas Water Resources Center

Introduction

Water, sunlight and nutrients combine to promote plant growth in water (Figure 1). A water body, no matter how large or small, will possess aquatic vegetation. This vegetation could be emergent plants, such as cattails or water lily, or submersed plants such as coontail. However, the plants will often be microscopic (Figure 2) and give the pond a green, cloudy appearance. These microscopic plants are collectively called phytoplankton or "a bloom."

Phytoplankton are mostly composed of single-celled plants. Among the most common are green algae, diatoms, dinoflagellates and cyanobacteria (blue-green algae). The last group can be problematic in water bodies, given their ability to produce toxic substances (cyanotoxins). A "bloom" occurs when phytoplankton of any kind become dominant and discolor the water (Figure 3).

What is a Harmful Algal Bloom?

Some phytoplankton, especially cyanobacteria, thrive in nutrient rich water. Often, stimulating a phytoplankton bloom is desired, either to retard the growth of unwanted submersed plants and/or to provide food for larval fish by acting as the base of the pond's food chain. Just because a water body is green doesn't necessarily mean it has phytoplankton capable of producing toxins. When a cloudy green color is not desired, the bloom has become a nuisance algal

Figure 2. *Anabaena* sp. under the microscope. Anabaena in the water column tends to be solitary, with strands of cells taking on the appearance of pearls on a string. (Photo courtesy of Brad Austin.)

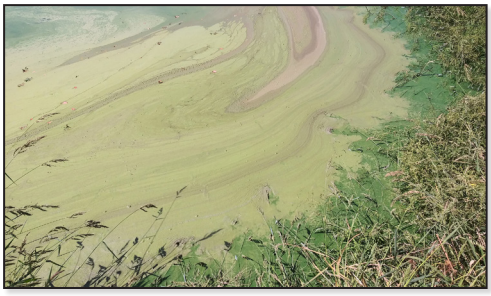

Figure 1. An algal bloom in a pond. (Photo courtesy of George Selden.)

Figure 3. *Cyanobacterial* bloom dominated by *Microcystis* sp. in a small pond in Fayetteville, Ar. (Photo courtesy of Brad Austin.)

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bloom (Figure 4), but it is not easy to tell the difference between a nuisance algal bloom and a harmful algal bloom through visual inspection alone.

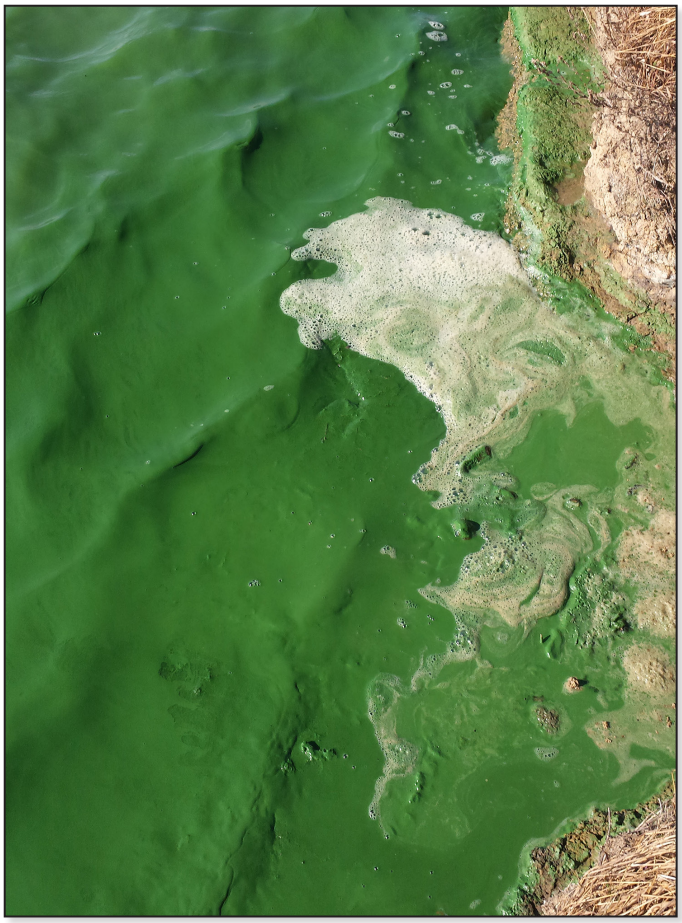

Figure 4. A nuisance algae bloom can look a lot like a harmful algal bloom. (Photo courtesy of George Selden.)

Whether wanted or unwanted, if there is a phytoplankton bloom, the algae species that are dominant will change through the seasons. Cyanobacteria are present year round, but these species usually become dominant in late summer or early fall due to the generally hot, dry, and still weather conditions. Cyanobacteria have an advantage over other algae because they possess gas vacuoles that allow them to maintain an optimal location in the water column.

Cyanobacteria are naturally occurring in surface waters worldwide. More than 50 of the 1,500+ species of cyanobacteria have been shown to produce cyanotoxins that can be harmful to vertebrates. These toxins may cause skin irritation through contact, and may result in illness or death if ingested. If the toxin producing cyanobacteria species become prevalent, and water and climate conditions stimulate the production of toxins, a harmful algal bloom (HABs) can result. It is the production of toxins by the cyanobacteria that create the HAB, not the mere presence or even dominance of cyanobacteria. HABs have the potential to produce a variety of toxic or harmful impacts to public health, recreation, aesthetics, domestic animals, wildlife and the economy. Harmful algal blooms (HABs) can be defined as the excessive growth of microscopic organisms in water that can cause harm to animals, people, or the local ecology.

What Causes Harmful Algal Blooms?

Harmful algal blooms occur naturally due to a combination of nutrients, temperature, sunlight, ecosystem disturbance, hydrology and water chemistry. At present, the exact factors that stimulate algae species to produce toxins are not completely understood. The eutrophication, or nutrient enrichment, of waterbodies is considered a major factor for increasing the occurrence of HABs. The primary nutrients contributing to eutrophication are phosphorus and nitrogen, which can originate from point and nonpoint source inputs from municipal, urban and agricultural activities in a watershed.

Runoff and erosion from fertilized fields and lawns in a watershed, along with erosion from riverbanks, land clearing and land-use change, wastewater treatment discharge, and stormwater runoff are all sources of phosphorus and nitrogen entering waterbodies. In any waterbody, such as a lake or reservoir, nutrients can be deposited in bottom sediments. When dissolved oxygen concentrations are low, or lake-mixing takes place, sediments release phosphorus into the water column. This release of phosphorus can be sufficient to accelerate the growth of algae. For additional information about algal blooms, see fact sheet *FSA9094, Algal Blooms, Scums and Mats in Ponds.*

Recognizing a HAB

While a single cyanobacterium will be invisible to the human eye without a microscope (Figure 5), a bloom will likely become noticeable (Figure 6). The HAB might be blue-green, green, yellow, white, brown, purple or

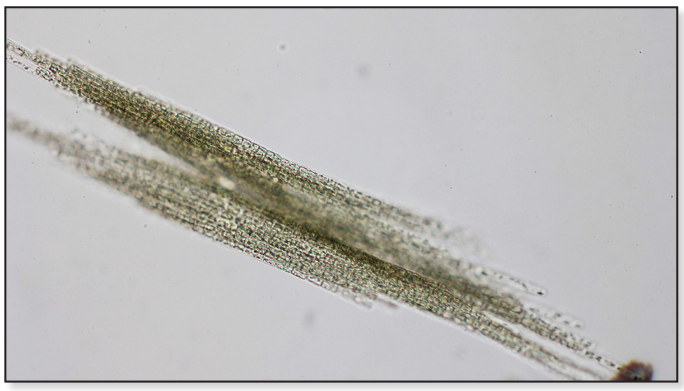

Figure 5. *Aphanizomenon* sp. under the microscope. *Aphanizomenon* trichomes (cells) will group together that can take on the appearance of grass clippings when viewed by the naked eye. (Photo courtesy of Brad Austin.)

Figure 6. Under calm conditions *Aphanizomenon* sp. can form loose clumps at the surface of the water. (Photo courtesy of Brad Austin.)

Figure 7. A foamy, scummy, paint like appearance is an indication to stay away. (Photo courtesy of George Selden.)

red, and might have a paint-like appearance (Figure 7) or look like a foam, mat or a scum. Sometimes a visible surface indicator may not be present and the HAB will look like water that is very green or opaque in appearance. As cyanobacteria in a bloom die and release toxins, the water may taste or smell bad.

Signs of cyanotoxin poisoning depend on the type of toxin, toxin concentration, amount consumed, size of the individual, and exposure route. Most exposures result in no or self-limiting clinical signs, but ingestion of toxins can result in serious illness and presentation for emergency care. Contact with HABs containing the toxins microcystin or cylindrospermopsin may result in symptoms as minor as a skin rash or hives (dermatotoxin), or as major as liver damage, vomiting, diarrhea, anorexia, jaundice, abdominal tenderness, dark urine, and/or death (hepatotoxin). HABs containing the neurotoxins saxitoxin or anatoxin-a, may cause excessive drooling, disorientation, seizures, respiratory failure and death from respiratory paralysis. For more information on the differences between nuisance blooms and HABs see Arkansas Water Resources Center fact sheet *FS-2018-02, Algal Blooms in Arkansas Streams, Ponds, and Lakes* (https://arkansas-water-center.uark.edu/publications/factsheets/FS-2018-02-Algal-blooms-in-Arkansas-streams-ponds-and-lakes-compressed.pdf).

Preventing Harmful Algae Blooms

Most factors that can lead to excessive blue-green algae blooms are known and predictable, and it is possible to take steps that can reduce their occurrence. To reduce HAB occurrence, the best option is to practice watershed protection by limiting or preventing nutrients from entering any water body, including ponds, ditches, streams, bayous, rivers, lakes or oceans. Establishing best management practices, such as basing fertilizer applications on soil test recommendations, properly maintaining septic systems, using vegetative filter strips and erosion management can limit the amount of nutrients that can wash into a water body. Livestock exclusion from water bodies is highly recommended for reduction of nonpoint source pollution and healthier cattle. UofA Extension fact sheet FSA-3128 (https://www.uaex.edu/publications/pdf/FSA-3128.pdf) describes cattle watering systems.

Other options to help prevent algal blooms include using substances that can bind up and inactivate phosphorous. It is thought by some that if the amount of phosphorous available for algae is reduced, algal growth will be decreased. One of these substances is aluminum sulfate (alum). Alum will bind to phospohorous, causing it to precipitate out, rendering it unavailable for plant growth. Adding alum does carry the risk of a fish kill due to changes in pond pH. A fact sheet on using alum can be found here http://agrilife.org/fisheries2/files/2013/09/SRAC-Publication-No.-460-Control-of-Clay-Turbidity-in-Ponds.pdf. There are other commercially available materials that can reduce phosphorous, although some of these products can be quite expensive. It needs to be stressed that these substances don't actually reduce algal populations, but they potentially lead to lower populations by reducing nutrients critical for growth. Promoting circulation by using aeration or destratification equipment can possibly prevent blue-green algae from becoming dominant by denying them their optimum location in the water column. This approach is theoretically practical, but may not always be a realistic alternative for various reasons.

Precautions for Protection

Preventative steps should be taken to protect yourself, other people, pets and livestock by avoiding and limiting contact with water that is discolored (Figure 8), smells bad, or has a foam, mat or scum on the water's surface. Do not drink or allow other

people or pets to drink scummy or very green water. If you, someone else, or your pets or livestock swim, wade, or loaf in water that might contain harmful blue green algae, rinse off immediately with fresh water. Make sure to prevent your pets or livestock from licking their fur if you suspect they have become covered with blue green algae.

If you or your pet swallow water from where there is a harmful algae bloom, call your doctor, poison center or a veterinarian. Call a veterinarian if your animal shows any of the following symptoms of cyanobacteria poisoning: loss of appetite, loss of energy, vomiting, stumbling and falling, foaming at the mouth, diarrhea, convulsions, excessive drooling, tremors and seizure, or any other unexplained sickness after being in contact with water. Symptoms may manifest within one to two hours, but may take days to appear.

Obey any official waterbody closures (Figure 9), and do not eat fish or shellfish from affected areas. Wear protective latex or nitrile gloves if you are taking a sample of what appears to be a HAB.

Treating a HAB

The science of HAB control is still evolving, and

Figure 8. *Microcystis* sp. bloom at Lake Fayetteville, AR. Windy conditions can mix surface waters causing the lake water to take on a pea soup appearance. (Photo courtesy of Brad Austin.)

Figure 9. An example lake closure sign from the Harmful Algal Bloom Response Plan. (Photo courtesy of DEQ.)

treatment approaches will vary by waterbody, and associated water uses. In general, the best way to treat a HAB is to decrease their likelihood by preventing excessive nutrients from entering waterbodies.

Ponds and Streams – There are algaecides commercially available for cyanobacteria control. These can be found in publication MP44 Recommended Chemicals for Weed and Brush Control https://www.uaex.edu/publications/MP-44.aspx). While short-term control of the bloom may be accomplished with the use of an algaecide, this might not be the best course of action. If the cyanobacteria are producing toxins, it is possible that by killing them and causing them to release their toxins, it will actually increase the amount of cyanotoxins present in the water. Once a HAB has been known to occur in a particular waterbody, take additional precautions to increase control of pet, livestock and human contact with the water.

Drinking Water - Cyanobacteria blooms in drinking water sources pose a variety of challenges to water treatment plant managers and operators. The American Water Works Association and the Water Research Foundation have released "*A Water*

Utility Manager's Guide to Cyanotoxins," https://www.awwa.org/portals/0/AWWA/Government/WaterUtilityManagersGuideToCyanotoxins.pdf.This guide provides answers to many common questions utility managers may have, to help them better prepare for cyanotoxins and to respond when cyanotoxins cause water quality problems (AWWA, 2015). Additionally, the EPA released a supporting document titled "*Recommendations for Public Water Systems to prepare for and Respond to Cyanotoxins in Drinking Water*." This document is intended to assist public drinking water systems in managing the risks from cyanotoxins in drinking water. It includes information for evaluating source waters for vulnerability to contamination by cyanotoxins and describes a framework for managing risks associated with cyanotoxins.

How to Test for a HAB

The most definitive test to determine if an algal bloom is harmful is to submit a sample to a qualified lab such as the Arkansas Water Resources Center (AWRC) or the Division of Environmental Quality (DEQ). However, before submitting a sample to a lab there are other methods that might help you make the determination described in AWRC fact sheet *FS-2018-02, "Algal Blooms in Arkansas Streams*, *Ponds, and Lakes*." Additionally, the State of Arkansas Harmful Algal Bloom Management Plan has information on recommended sample collection and submission. Follow the listed safety precautions and submit samples to the Arkansas Water Resources Center https://arkansas-water-center.uark.edu/ or DEQ to be tested for the cyanobacterial toxin known as microcystin.

Steps to Take if you Suspect a HAB

Report suspected harmful algal blooms to your local municipal government, the Arkansas Department of Health (ADH) or DEQ.

Reports of new algae blooms can be relayed to DEQ by email at *habs@adeq.state.ar.us* or by calling 501-682-0744.

Report possible illness to ADH by email *adh.epi.ts@arkansas.gov* or call 501-280-4168.

The DEQ website, www.adeq.state.ar.us, also has an online form and a mobile app, developed as part of a the Arkansas Harmful Algal Bloom Management Plan, to assist individuals in reporting HABs. The online form will request required information, such as location and description, along with voluntary information such as your name and address. If an exact address can't be provided, include information such as the distance from the road and whether the concern is visible from the road. Describe landmarks such as nearby streams, buildings and roads. The complaint submission should include a detailed description of bloom location, color, size, any distinct odors, and should be accompanied with photos. Submissions will provide useful data on tracking bloom occurrence throughout the state.

EPA has issued final recommended recreational ambient water quality criteria or swimming advisories for two cyanotoxins, microcystins and cylindrospermopsin. The Agency has identified recommended concentrations of these cyanotoxins at or below which human health is protected while swimming or participating in other recreational activities in and on the water. States, territories, and authorized tribes can consider adopting these recommended criteria into their water quality standards and using them for Clean Water Act purposes. Alternatively, they can use these same values as the basis of swimming advisories for public notification purposes at recreational waters. The Safe Drinking Water Act provides the authority for EPA to publish health advisories for contaminants not subject to any national primary drinking water regulation. Health advisories describe non-regulatory concentrations of drinking water contaminants at or below which adverse health effects are not anticipated to occur over specific exposure durations.

To protect all age groups, recreational contact limits have been established at 8 micrograms per liter (µg/l) of microcystins, and 15 µg/l of cylindrospermopsin. Drinking water limits have been set as low as 0.7 µg/l of cylindrospermopsin for adults and 0.3 µg/l for infants and bottle-fed children for microcystin in raw drinking water for up to 10 days. Under such circumstances, public notifications are recommended, as well as closing the water body to contact, adjusting water treatment processes or changing water supply. A detailed overview of procedures and advisories to prepare for notifications relating to HABs can be found in the Harmful Algal Bloom Management Plan of the State of Arkansas.

Summary

Cyanobacteria are widespread, present in virtually every waterbody, and are expected to increase over time. They are most likely to become the dominant phytoplankton present during the hottest times of the year, but their presence does not necessarily indicate HAB toxicity. However, if the conditions are right, cyanotoxin production can take place, which could lead to the formation of a HAB. Poisonings are unpredictable and sporadic. Reports of animals dying after ingesting water with dense blue-green algae blooms have been recorded since the 1920s, but they are still relatively rare.

While algae can be controlled using an algaecide, killing algae may not be the best option for the pond manager. Preventing nutrients from entering the water

body is always the best course of action. Consult extension personnel and other knowledgeable sources before taking action.

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JOHN PENNINGTON is an instructor - water quality educator, University of Arkansas System Division of Agriculture, Department of Agriculture and Natural Resources, Little Rock. **GEORGE SELDEN** is aquaculture extension specialist - Department of Aquaculture and Fisheries, Universtiy of Arkansas, Pine Bluff. **TATE WENTZ** is stream team coordinator - Arkansas Game and Fish. **BRAD AUSTIN** is a post doctoral research associate, University of Arkansas. **BRIAN HAGGARD** is director, Arkansas Water Resources Center.

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