ABOUT HARMFUL ALGAL BLOOMS (HABs)

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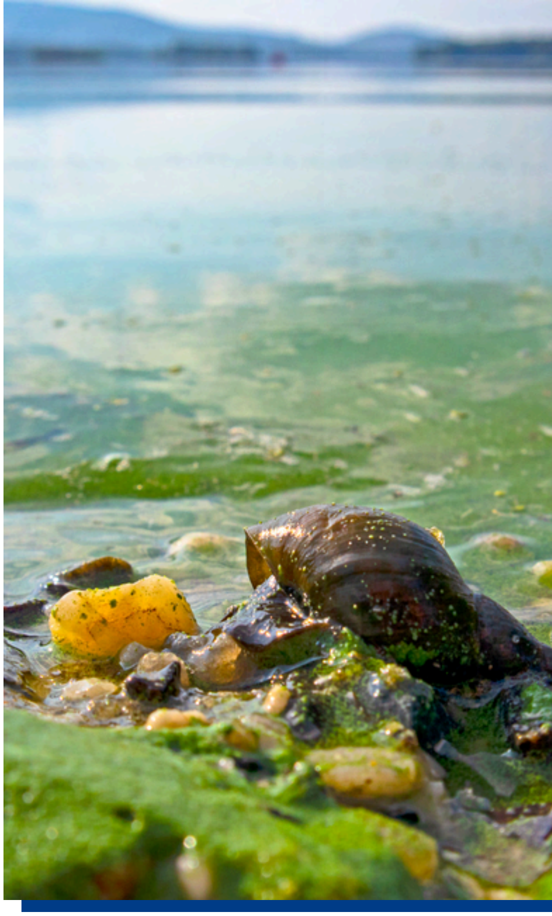


BACKGROUND

Harmful algal blooms (HABs) are visually dense accumulations of algae or cyanobacteria that can interfere with intended uses of water resources. Most often, the term "HAB" is used to refer to growths of toxin-producing cyanobacteria, also known as "blue-green algae". As time goes on, states across the country are experiencing more severe, frequent, and longer-lasting HABs in freshwater bodies. Unfortunately, the rate of occurrence of HABs appears to exceed the rate at which education is provided to the public, leading to uncertainty and lack of information for individuals to know how to protect themselves, their families, and their pets and livestock. This article has been prepared to provide some fundamental information on HABs, the potential associated risks, how to avoid risks, and some general information regarding management solutions.

WHAT ARE CYANOBACTERIA?

Cyanobacteria, commonly referred to as "blue-green algae", are microscopic single-celled organisms that are in the same taxonomic kingdom as bacteria but can conduct photosynthesis like plants and true algae. These organisms can grow in ponds, lakes, reservoirs, streams, canals, and estuaries, but thrive in shallow, stagnant, and warm waters such as small lakes and ponds. Cyanobacteria have unique and competitive traits compared to true algae. These include the ability to regulate their buoyancy in the water column to access sunlight and nutrients, higher tolerances to salinity and warm water temperatures, ability to acclimate to nutrient-limited conditions, and the ability to take up excess nutrients and store them (namely phosphorus), known as luxury consumption. Cyanobacteria are naturally present in freshwater bodies at relatively low densities and are a normal part of aquatic ecosystems. However, when aquatic systems become imbalanced, cyanobacteria have the potential to dominate and form densities that become visible to the human eye, which is often referred to as a "bloom", thus giving way to the term, harmful algal bloom (HAB). Symptoms of climate change as well as increased human population and activity appear to correlate with increased severity, frequency, and duration of HABs in freshwaters throughout the US. These may include warmer water temperatures, more intense precipitation events leading to increased runoff containing nutrients, lesser duration of ice cover during winter, more land being used for agricultural, residential, and commercial purposes, and less land containing vegetation or forest that could serve as "buffer zones" for trapping nutrients from runoff. Within a water body, cyanobacteria may be planktonic (free-floating in water column), benthic (growing on rocks, sunken detritus, and sediments), and/or filamentous mat-forming species that cover the sediments or float to the surface of the water column. Cyanobacteria are not evenly distributed in water bodies. Accumulations of planktonic cells are often driven to shoreline areas due to wind and wave action, creating visible blue-green surface scums. Given the inherently competitive and adaptable characteristics of cyanobacteria, paired with the environmental changes taking place that favor cyanobacterial growth, it is anticipated that HABs will only become more frequent (spatially and temporally), more intense, and longer-lasting in our freshwater resources. Therefore, it is important to understand the risks and what the options are for risk management.

WHY ARE CYANOBACTERIA HARMFUL?

Many species of cyanobacteria can produce toxins that have known adverse effects in people, animals, and plants. Three common toxins produced by freshwater cyanobacteria include microcystins and cylindrospermopsins, which are primarily liver and kidney toxins, and anatoxin-a, a potent neurotoxin. There are many other toxins that can be produced by cyanobacteria that are still being discovered and further studied. If, when, and to what extent toxins are produced in a bloom vary from site to site, but may be influenced by water characteristics, ambient conditions, and general time of year, among other variables. For this reason, it is not appropriate to assume toxins are being produced each time a bloom is visually observed. The only way to confirm whether toxins are being produced is to have a water sample collected and tested by a laboratory with those capabilities. Further, it is important to note that a positive toxin detection one day does not guarantee toxins will be detectable the following day, or even within the same day. This is largely due to the fluctuating nature of cyanobacterial growth as well as internal (within a water body) or external (to the water body) characteristics that may be influencing actual toxin production within cells.

To understand how we can get exposed to cyanobacterial toxins, we must first understand how toxin production occurs in water. Within a surface scum of cyanobacteria, there could be billions or trillions (and higher) of individual cells present. Assuming toxins have been detected, each individual cell is producing toxin. Certain toxins, like microcystins, are retained within cells until cell death for the most part. Other toxins may be actively released from cells into the surrounding water as they are produced. Therefore, the total toxin concentration in a body of water is the sum of the toxins within cells and outside of cells (dissolved in water). In a shoreline scum where cells are extremely dense, it is logical that toxin levels would be relatively higher, compared to open water areas that do not contain such high densities of cells. It is important to note that it does not matter whether toxins are in or out of cells from a health risk perspective in recreational settings. We can get exposed regardless of what form the toxins are in, since the water is ultimately the carrier and contains both cells and dissolved toxins.

CYANOTOXIN EXPOSURE ROUTES FOR PEOPLE

INGESTION OF:

- CONTAMINATED DRINKING WATER
- FRUITS, VEGETABLES, AND GRAINS IRRIGATED WITH CONTAMINATED WATER
- CONTAMINATED WATER DURING RECREATION AND SWIMMING
- FISH AND SHELLFISH HARVESTED FROM CONTAMINATED WATER
- SUPPLEMENTS AND DRINKS CONTAINING BLUE-GREEN ALGAE (E.G. GREEN SMOOTHIES, ALGAE POWDERS AND CAPSULES)

INHALATION OF:

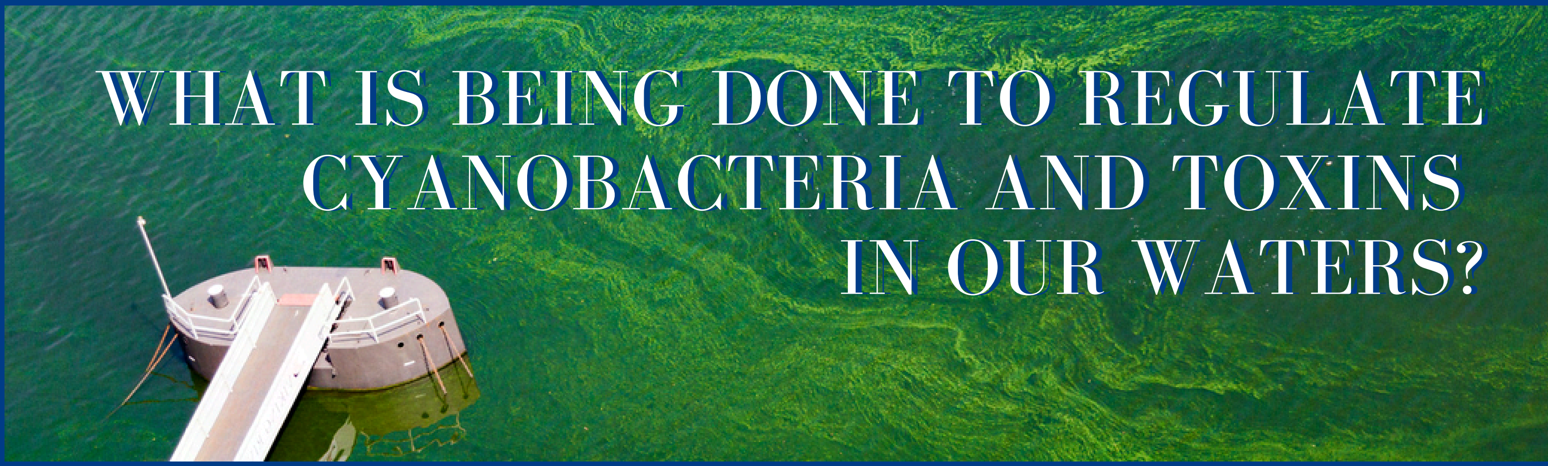
- AEROSOLIZED WATER DROPLETS (WATER MIST) WHEN LIVING NEAR OR RECREATING AT CONTAMINATED WATER BODY

WHY ARE CYANOBACTERIA HARMFUL? (CONT.)

The primary ways that people and animals can get exposed to cyanobacterial toxins are through ingestion and inhalation of contaminated water and ingestion of contaminated foods. Exposures leading to severe illness and death in people, pets, and livestock are most likely from ingestion directly from a contaminated body of water, since relatively high concentrations are necessary to elicit acute toxicity in mammals. Contrary to popular belief, people are just as susceptible as pets in terms of health impacts from toxin exposures. Dog deaths are likely more frequent since they may indiscriminately drink from shorelines with dense accumulations of cyanobacteria cells, and lick their fur after swimming, resulting in high concentrations of cells being ingested. Of course, most people and even children, will not be quick to swim in or drink green water. Thus, the probability of exposure will be lowered for people who are using good judgement. One other risk-related concern is long-term exposure to sub-lethal levels of toxins via inhalation by people who live or work near contaminated water. Prior scientific studies have shown that microcystins may further promote tumor formation when there are other cancer-causing agents present in the body, but data are limited or lacking to support whether they are inherently carcinogenic on their own. Symptoms of acute exposure to microcystins or cylindrospermopsins may include (but are not limited to) abdominal pain, nausea, vomiting, diarrhea, skin rashes, eye and ear irritation, and asthma and nasal irritation. Symptoms of exposure to anatoxin-a may include dizziness, drowsiness, lack of coordination and balance, incoherent speech, tingling, and respiratory paralysis.

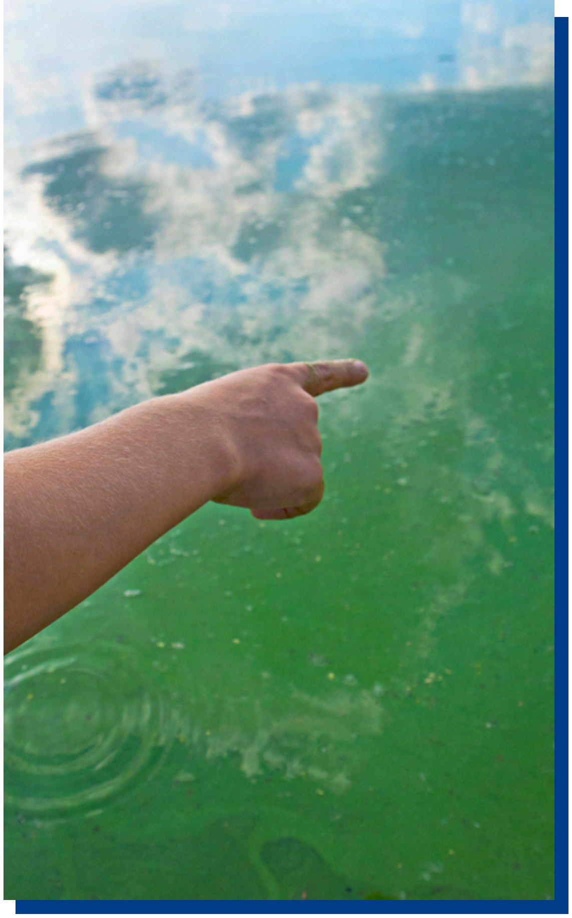
Aside from known health effects, cyanobacteria can also be harmful from an economic perspective. Property values and revenues from tourism and recreation can be severely impacted when HABs frequent our critical freshwater resources. Local economies suffer severely when beaches and lakes are closed for recreation due to HAB issues. Higher-profile examples including the Lake Okeechobee Waterway in Florida and Lake Erie in Ohio have shown losses of millions of dollars in tourism revenue each year. Similarly, financial losses can be incurred with death of livestock that drank from contaminated waters or lower crop yields from contaminated irrigation water. These types of impacts have been documented in scientific journals to some extent but are likely happening much more frequently than what is reported.

WHAT IS BEING DONE TO REGULATE CYANOBACTERIA AND TOXINS IN OUR WATERS?



Currently, there are no federally regulated water quality standards for safe levels of cyanobacterial toxins in drinking or recreational waters, or in foods. At best, there are health advisory guidelines provided by the US Environmental Protection Agency (EPA) for drinking waters and for recreation. States have the right to adopt those guidelines, or not, since they are not law. Select states (e.g. Ohio and California) require all public water supply systems above a certain size to monitor for and report on microcystin levels. Most other states do not have any framework in place for monitoring in drinking waters. Within each state, there may be drinking water treatment plants that are independently monitoring and managing for cyanobacterial toxins, but this is at the discretion of each utility.

Many states have begun to implement monitoring and advisory frameworks for large public lakes for recreational risks, but this still leaves private lakes and pond owners to navigate potential risks on their own. Each state may have a different agency in charge of HAB education and monitoring, but typically these agencies include the EPA, Department of Natural Resources (DNR), or Department of Environmental Protection (DEP). In Indiana, the Department of Environmental Monitoring (IDEM), the DNR, the Indiana Department of Health, and the U.S. Army Corps of Engineers have partnered on sampling and monitoring at many state beaches. Closings and advisories are posted on IDNR's State Parks Advisories and Closings webpage.



HOW CAN YOU SPOT HABs?

Dense blooms of planktonic (free-floating) cyanobacteria are often in the form of blue-green or green scums on the surface of the water. Scums may resemble dried paint, green lumps, hair-like green strands, or even just a thin film. You may also notice a green tint to the water. It is important to remember that absence of a dense surface scum does not confirm absence of cyanobacteria at a given site. Lower cell densities could be present and not detectable to the human eye. If you observe any signs of cyanobacteria growth, it is advisable for people and pets to avoid the water entirely, since this is when risks are greater.

To confirm presence or absence of potential toxin-producing cyanobacteria in your water, samples can be collected and submitted to a laboratory for identification of species present and toxin screening. It is important to note that non-detectable levels of HAB species at a given point in time are not conclusive for all other times of the year. Cyanobacteria can develop dense blooms in a matter of days, so it is important to remain observant of the water throughout the warmer seasons of the year (especially late Summer). Some pond owners and lake managers may prefer to establish a routine monitoring program for their water to more accurately track conditions and make informed decisions about if/how to use the water, and also to help them decide when management actions are necessary.

WHAT CAN BE DONE TO CONTROL OR MITIGATE HABs?

Since cyanobacteria are not invasive species and are a normal part of aquatic ecosystems, total eradication is not a reasonable or viable management goal. Certain actions can be taken with the goal of rebalancing nutrient levels and decreasing frequency or severity of HABs in the future (preventative measures), while other tactics are intended to mitigate growths as problems arise, so that immediate risks can be minimized (proactive and reactive measures).

Nutrient management within a pond or lake is one method of altering conditions such that cyanobacteria may not be as successful in dominating the system. Since excess phosphorus is commonly hypothesized to correlate with HABs, certain products are available to decrease bioavailable concentrations of phosphorus to cyanobacteria. Alum (aluminum sulfate) and Phoslock® (modified clay product) are two products that can be used to precipitate phosphorus from the water column to the sediments. Phoslock® can also bind with phosphorus in sediments, so that these nutrients cannot be resuspended into the water column. These products are typically applied in the fall and early spring (when no HABs are present) to sequester phosphorus before it is taken up by cells. Preliminary analysis of water characteristics and nutrient levels is strongly recommended prior to applying these products, so that the correct amount of product can be applied.

USEPA-registered algaecides are products applied to water to mitigate existing growths of cyanobacteria and can be used as a maintenance tactic to control growth as needed. The active ingredients in these algaecides include copper, hydrogen peroxide, or endothall in various formulations. These products can be applied by you, if you own the pond or lake and have the proper equipment, or by licensed and certified aquatic applicators. When used according to legal label application instructions, these algaecides should not pose risks to fish and other aquatic life. In scenarios where the algal growth is extremely dense, there are risks to fish from performing an algaecide application, due to rapid oxygen depletion following treatment (from decaying algal cells). These situations are better handled by licensed applicators who can help you decide if treating would be safe at that time. It is also possible to avoid those scenarios by proactively monitoring your water and beginning treatments early in the growing season (rather than waiting until late Summer). There are other potential mitigation tactics available for managing HABs, but many of these approaches are lacking in performance data or are still in the early development stages, and thus it is unknown whether these tactics will provide reliable and cost-effective results at this time. It is also important to acknowledge that “no action”, or not implementing any sort of management plan carries its own set of risks (health and financially related) which must be carefully assessed.

SUMMARY

Harmful algal blooms (HABs) are increasingly inhabiting our freshwater resources, especially ponds, lakes, and reservoirs. The human population relies heavily on freshwater for a wide array of critical uses including but not limited to drinking water, recreation, fish and wildlife propagation, navigation, agriculture, aquaculture, irrigation, and industry. When HABs dominate a water body, many of these uses can be limited or lost entirely, and we are also faced with potential for severe risks to people and animals. Currently, there are no laws in place to protect human health or other animals from possible exposures to cyanotoxins. So, it will become even more important for the public to gain information about HABs and associated risks so that they can do their best to protect themselves and their families. Importantly, there are preventative and rapid management solutions available to help suppress and minimize HABs that are environmentally sound and cost-effective.

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