HARMFUL ALGAL BLOOMS (HABS): AN INTRODUCTION

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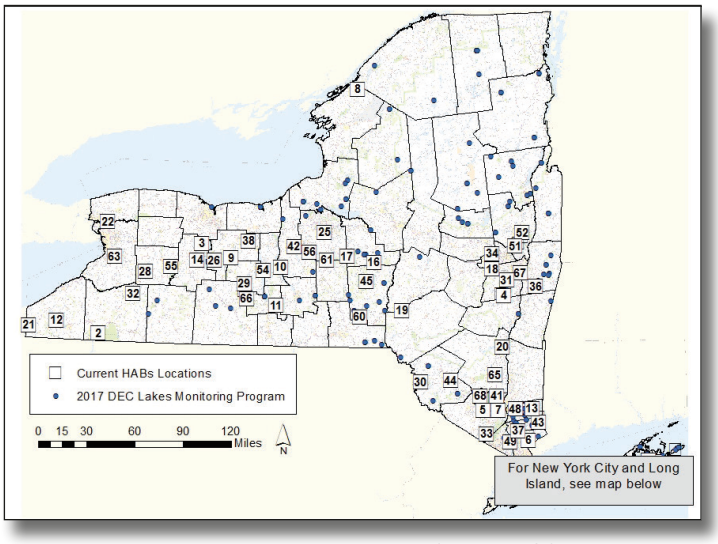
This past summer, officials at the NYSDEC and NYSDOH as well as many county agencies were kept very busy monitoring Harmful Algal Blooms (HABs) across New York State. In this article, I will help define HABs, explain what causes them, how to try to prevent them, and what water systems can do in response to them.

Honestly, I first became fully aware of the issue of Harmful Algal Blooms in the context of drinking water in the summer of 2014. During this period, you may remember that the city of Toledo, Ohio (a city supplying a population of 500,000 in northwestern Ohio) had to issue a do not drink advisory for parts of three days. This was due to toxins found in the city's water supply source: Lake Erie. HABs are now impacting some surface waters supplying drinking water to communities in New York. Figure 1 is a map from the NYSDEC website that shows waterbodies in upstate New York with HABs notifications as of early October 2017. Note that this map shows all HABs notifications, including non-drinking water sources.



HABs Locations as of early October 2017 (From NYSDEC website)

BACKGROUND

An algal bloom is a rapid increase or accumulation in the population of algae typically resulting in a discoloration of the water. The most common types of HABs are made up of cyanobacteria (also known as blue-green algae). Cyanobacteria are similar to bloom producing algae in that they possess chlorophyll and are capable of photosynthesis. They similarly can produce dense, foul-smelling mats and can discolor the water to shades ranging from green, blue-green, yellow, brown, and even red, or white (see Figure 2). However, unlike green algal blooms, cyanobacteria produce toxins (hence the word harmful). According to EPA, microcystins are the most widespread of the cyanotoxins. EPA recommends a drinking water health advisory level for microcystins of at or below 0.3 micrograms per liter for children pre-school age and younger (less than six years old). For school-age children through adults, the recommended health advisory level for microcystins in drinking water is at or below 1.6 micrograms per liter. Short-term exposure to cyanotoxins in drinking water reportedly include gastroenteritis, and liver and kidney damage.

Appearance of HABs (from NYSDEC HABs Brochure).

I would like to stress again that there is a difference between green algal blooms that many surface waters experience and harmful algal blooms that are mainly the result of cyanobacteria (blue-green algae). It takes results from laboratory analysis of a sampled bloom to determine if it is indeed a HAB event or not.

CAUSE AND OCCURRENCE

The cause of algal blooms and HAB formation is the excess enrichment of water with nutrients: nitrogen and phosphorus. Nutrient sources include runoff from agricultural land, stormwater, and wastewater discharges. Conditions that favor HAB formation are: warm weather, calm weather, and periods of rainfall followed by prolonged periods of sunnier and dry conditions. Water temperatures of 77°F or greater generally favor the growth of cyanobacteria. Warmer weather beginning in September 2017 saw a dramatic rise in HABs in New York. HABs plagued a variety of waterbodies, from small ponds to large lakes used for drinking water such as Chautauqua Lake and several of New York's ▶▶▶

Finger Lakes. One lake that has been particularly prone to HABs is Owasco Lake, the source of water for the City of Auburn and other communities.

PREVENTING AND MITIGATING HABS

Ultimately, watershed management efforts to reduce the amount of phosphorus and nitrogen to waterbodies is the solution to prevent HABs. Efforts to reduce non-point source pollution can include best management practices and other measures for agriculture, stormwater management, and wastewater disposal.

Prevention of HABs through watershed management should be considered the longer-term solution. However it has a timeline of potential success that exceeds a single bloom season. There are shorter-term, in-lake measures that can be effective for controlling algal blooms. Some physical, chemical, or biological strategies include: floating treatment wetlands, algaecides (if applied very early in the algal bloom), coagulation and flocculation chemicals, aeration, mechanical circulation, surface skimming, ultrasound, hexagonal tile covers placed on the surface of the water, and barley straw.

HABS AND WATER TREATMENT

To discuss HABs and drinking water treatment, it is important to understand that cyanotoxins can be located within the intact cyanobacteria cell (intracellular) or outside the cell within the water (extracellular). If monitoring indicates a significant fraction of toxins in intracellular form, conventional surface water treatment (flocculation, coagulation, sedimentation, and filtration) is generally effective at removing the cyanobacteria and any cyanotoxins. EPA guidelines indicate that treatment systems with mostly intracellular cyanobacteria cells should stop or limit any pre-oxidation and limit algaecide application during blooms, and optimize coagulation, clarification, and filtration processes.

If a significant fraction of cyanotoxins are within the water (extracellular), conventional surface water treatment is generally not effective. In these cases, carbon adsorption can be used to remove organic compounds such as microcystins. Carbon can be in the form of powdered activated carbon (PAC) or granular activated carbon (GAC). PAC can be fed at the raw water intake, at the rapid mix prior to coagulation, or in clarifiers. GAC can be incorporated into the sand bed or as separate columns after the sand filters. In addressing the Owasco Lake issue, the City of Auburn has installed a system that injects PAC into pipes carrying the raw lake water to the water treatment plant. The Town of Owasco also obtains its drinking water from Owasco Lake. They have installed GAC filters that receive water after conventional treatment.

It is interesting to note that some research has shown that oxidation of microcystins by chlorine can be effective at some concentrations, temperatures, pH ranges, and organic content of the water. However, chlorine is not effective against all cyanotoxins.

CONCLUSIONS

HABs is an issue that is not likely to go away. It will require surface water systems to be attentive to source water protection efforts and monitoring at multiple locations. This includes monitoring of the source water itself, and at various locations throughout the treatment process. In addition, some systems will have to undergo some additional plant optimization.