Blue-green Algae Blooms

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Have you ever gotten a report that someone has spilled green paint in your reservoir, or has your water ever resembled green Kool Aid? If so, your reservoir was likely experiencing an over abundance of cyanobacteria, which is commonly referred to as a blue-green algae bloom. These blooms are most common in waters with high levels of nutrients, such as phosphorus and nitrogen, and they are more frequent later in the summer during calm hot periods. While blue-green algae have been around for billions of years, some scientists think blooms are becoming more common due to increased nutrient runoff and global warming. Blooms are most apparent when they form surface scums that can blow ashore, but these organisms can also be found throughout the water column or concentrated along the thermocline (depth where there is a steep transition in temperature between the warm upper water layer and cold lower layer). Blue-green blooms are often confused with tree pollen (which is also found on land) and filamentous green algae (which looks more like wet moss or fabric than green paint).

Blue-green algae blooms can cause significant water quality problems, particularly for drinking water supplies. First, blooms tend to be ugly and often smell bad, which can undermine public confidence in the water supply. Second, when blooms crash and decay, this can cause a loss of oxygen in deep waters that can lead to fish kills, increased internal nutrient recycling, and iron and manganese problems. Third, these blooms can cause a number of drinking water treatment problems such as: clogged intakes and filters, taste and odor problems, changes in coagulation, and higher chemical costs. Finally, in addition to these water quality and treatment issues, blue-green algae can produce a wide variety of toxins, some of which are very potent.

Unfortunately, it is not known exactly what causes these organisms to produce toxins. Only some strains within a given species have the ability to make toxins, and even these strains do not produce them all the time. Some of the things that are thought to trigger toxin production are changes in temperature, nutrient availability, predation, and competition with other algae. Regardless, it is impossible to determine if toxins are present without testing, so all blue-green algae blooms should be viewed as potentially toxic.

Blue-green algal toxins are a potential danger to other aquatic organisms, wildlife, domestic animals, recreational lake users, and water supplies. Dogs are particularly prone to poisoning, mainly because they will drink and play in bloom waters, with most poisonings resulting from the dogs licking the algae off their fur after they leave the water. Livestock can be protected by limiting their water access on the windblown side of lakes where the blooms accumulate. Aside from illnesses associated with ingestion and inhalation, swimmers can get skin, ear, eye, and nose irritations. Thankfully, reported blue-green algal toxin poisonings associated with potable waters are exceptionally rare, particularly in the US. However, some scientists believe symptoms are often not reported and/or they are confused with other water borne illnesses. Furthermore, there are also health concerns associated with ingested doses low enough to not cause immediate and/or noticeable near-term symptoms.

Microcystin is the most widely studied and distributed toxin in NYS. It is named after the first species from which it was isolated, Microcystis. However, it has since been shown that a large variety of other cyanobacteria also produce this toxin. Microcystin can impact the liver if it is ingested (or breathed via airborne droplets) in sufficient quantities, and symptoms can include: fever, diarrhea, stomach upset and pain, and a yellowing of the skin/eyes. There are also other long-term exposure concerns such as tumor promotion. Other potential health impacts associated with similar exposure to other blue-green algae toxins include damage to the nervous system, contact irritation (itchy skin/eyes) and hay-fever like symptoms.

The first line of defense against the dangers of blue-green algae blooms is to prevent the bloom from ever happening by reducing the amount of phosphorus and nitrogen entering the waterbody. This is best done by controlling the external nutrient loads from the watershed from wastewater, agriculture activities, and stormwater. However, in some cases internal nutrient recycling needs to be halted, particularly when there has been an extended period of heavy nutrient enrichment from the watershed and the water below the themocline becomes depleted of oxygen. This is generally done using a lake wide or deep water alum treatment to bind phosphorus within the lake sediments. Alternatively, dissolved oxygen concentrations can be increased in the lower water column by injecting liquid oxygen or by circulating deep cold water up to the surface to become aerated

and then returned to depth. It is important to stress that these and other lake management techniques described in this article are regulated activities, and it is important to seek and obtain the appropriate permits before beginning this work.

While copper sulfate treatments (and other algaecides) are generally very effective in eliminating blue-green algae blooms, this can be problematic and lead to some undesirable consequences. Blue-green algae toxins are mainly found within the cell membranes, and these toxins are released into the water when the cells are broken apart by an algaeicide or other means. These free toxins are very stable in the environment and rather resistant to conventional drinking water treatment methods. Even boiling is not an effective treatment to eliminate these toxins.

There are some other in-lake treatments that are capable of controlling blue-green algae blooms. Destratfication and lake mixing are two of the more popular methods. The idea here is that since blue-green algae are adapted to life in a stable water column, mixing subjects them to changing hydrostatic pressures that discourage their growth. Destratification involves placing bubblers on the lake bottom to mix the entire water column. It is important to make sure the blubbers are not over or undersized to ensure sediments are not mixed into the water column and/or small pockets of the stratified water are not left in place, because both can lead to increased nutrient recycling. Lake mixing targets just the upper water column above the themocline. Again, sizing is important, and blue-green bloom control is generally not achieved unless the entire upper water column is mixed. While there are case studies to support both of these management techniques, they do not always work, and further scientific investigations are needed. In addition, some people argue that these techniques are somewhat over sold because they seem so "natural". Other newer, more experimental approaches for bloom control include ultrasound, food-web alterations and cyanophages (viruses that attack cyanobacteria).

So, what do you do if your drinking water source has a blue-green algae bloom? First, look for the best water (least algae) possible. This includes using an alternative surface water or well source, drawing water from an alternate intake location or depth, and/or keeping the wind from concentrating the bloom near the intake using a boom or other barrier. Second, remember it is best to keep these cells intact to avoid the release of free toxins. Therefore, do not treat the bloom with copper sulfate or other algaecides, and eliminate or reduce any pre-oxidation at the intake and within the plant. The goal is to coagulate and settle the cells while they are intact, thereby keeping as much of the toxin as possible in cells and associated floc. The addition of powdered activated carbon followed by filtration can also help in controlling toxins, as well as taste and odors associated with blue-green algae blooms. Wood based medium pore carbons are generally considered best for this purpose. Finally, chlorine and various advanced oxidation treatments (such as ozone) can also be effective in removing free toxins following filtration, but pH and applied doses should be optimized for the type and concentrations toxins present.

The NYS Department of Health (DOH) is currently involved in a 5 year cooperative agreement with the Center for Disease Control (CDC) to document Harmful Algae Bloom (HAB) occurrence and any potentially related illnesses (or symptoms), improve the DOH's ability to analyze for algal toxins, and ultimately reduce exposure to HABs. DOH is working closely with the NYS Department of Environmental Concentration (DEC) and the NYS Federation of Lake Associations (FOLA) to collect HAB samples in conjunction with their long-term volunteer based Citizens Statewide Lake Assessment Program (CSLAP) and other DEC monitoring programs. Lake associations were asked to participate if their lake is eutrophic (high in nutrients), has a history of HABs, or is classed as being capable of being a drinking water source. NYS DOH is interested in documenting blue-green algae blooms and reducing the potential for toxin exposures in other waterbodies. Please feel free to contact NYS DOH if you have blue-green algae concerns (518-402-7711; Jim Hyde- jbh01@health.state.ny.us.; Erin DeConno- emd04@health.state.ny.us)

If you would like some general information on blue-green algae exposure check out the DOH website at: http://www.nyhealth.gov/environmental/water/drinking/bluegreenalgae.htm. If you are looking for more technical information this EPA link is a good place to start: http://www.epa.gov/cyano_habs_symposium/monograph.html (see chapter 13 for information on toxin removal)