Are Harmful Algal Blooms Possible in Higgins Lake? - Melanie Brown

With all the recent discussion about nutrients and other water quality issues for Higgins Lake, it may be helpful to take a deep dive into harmful algal blooms (HAB) and explore if that is a possibility for Higgins Lake. HABs have occurred in the Midwest U.S. lakes. In particular, severe blooms were observed in the western basin of Lake Erie in several years (shown below), and in 2014 access to drinking water for hundreds of thousands of people was temporarily interrupted due to elevated levels of a toxin associated with the bloom.

A European Space Agency (ESA) Envisat satellite image taken on Oct. 8, 2011, using its MERIS sensor, showing harmful algal bloom in the western basin of Lake Erie. (ESA)

What organisms cause HAB?

The term HAB is a little confusing. HABs are caused by bacteria called cyanobacteria. Cyanobacteria can be found in the water as part of the phytoplankton along with algae. Cyanobacteria are interesting, as like plants, they use green pigment (chlorophyll a) to create energy from light and carbon dioxide through photosynthesis. Even though cyanobacteria are also called “blue-green algae”, they are a bacteria, a less complex lifeform than algae. As a lifeform, Cyanobacteria are estimated to be 2.5 billion to 2.8 billion years old and likely gave rise to algae and plants on the evolutionary tree. A living example of the ancient cyanobacteria are stromatolites in Australia, pictured below. Cyanobacteria are some of the oldest types of lifeforms on the planet.

What conditions may lead to a HAB? Higgins Lake has several conditions that may allow a HAB event. Because of the numerous variables that influence the occurrence, frequency, and duration of HABs, it is impossible to predict with certainty whether a specific water body will develop a bloom. The cyanobacteria that cause HAB need to be present along with the right environmental conditions to support the rapid growth of these cyanobacteria. Based on observations of affected water bodies, HABs often occur in waters with some or all of the following general characteristics: - High phosphorous concentrations (lakes that are eutrophic or hypereutrophic). - Low nitrogen concentrations. - Lakes that are shallow and thermally stratify. The ideal temperature for cyanobacteria is around 25° C (77 degrees F). - Long water residence time, which supports high rates of growth and reproduction. - Low number of algal grazers (e.g., zooplankton). - Stable water conditions that support buoyant, surface-dwelling cyanobacteria. - The presence of zebra/quagga mussels

Higgins Lake has thermal stratification with warm water over shelves in the summer. In addition, the lake has a substantial population of zebra/quagga mussels.

What is the cycle for a HAB?
Under the right conditions, the cyanobacteria multiply rapidly, creating high concentrations of the cyanobacteria on the water surface and within the water column. Once the nutrients are exhausted, the cyanobacteria die and sink in the water column where they decay.

How is a HAB identified?
In general, it is not possible to just look at a bloom and determine if it is cause by cyanobacteria or an algae. Samples of the surface water and water column are looked at under a microscope to identify the types of algae and cyanobacteria that may be present. For a water body as clear as Higgins Lake, a bloom may be noticed if there is discoloration of the water or mats of growth on the surface. To determine if the bloom is harmful in Michigan recreational waters, the

amount of cyanobacteria toxin (microcystin) is measured and compared to the World Health Organization limit of 20 ug/L or to other cyanotoxins at or above appropriate guidelines that have been reviewed by the State.

A bloom should be considered potentially harmful when the chlorophyll a level is greater than 30 µg/L and visible surface accumulations/scum are present, or cells are visible throughout the water column.

What makes the bloom harmful?
HAB can cause a number of harmful effects on the aquatic environment. The bloom at the surface of the water can block light from reaching plants located beneath the bloom, suppressing plant growth and habitat for animals that depend on these plants for cover, food and reproduction. Besides blocking light to plants, the decaying cyanobacteria deplete oxygen in the water, which can affect animals that cannot escape to areas where there is more oxygen. This lack of oxygen can kill fish and other animals.

Another potential harm is the release of toxins in the water. Not all cyanobacteria release toxins but some species release cyanotoxins as they decay. Cyanotoxins are among the most powerful natural poisons known. Some strains of cyanobacteria are capable of producing numerous toxins that can affect liver and brain function. Health symptoms commonly associated with cyanotoxin exposure include nausea, skin rashes, gastrointestinal distress, numbness, and fatigue. There have been reports in recent years throughout the U.S. of human illness and dog and livestock deaths associated with exposure to HABs. Fish and bird mortalities have also been reported in water bodies with persistent cyanobacteria blooms. Unfortunately, there are no remedies to counteract cyanotoxin effects.

The most widespread cyanotoxin in the U.S. is likely microcystin. Microcystin is a potent liver toxin and possible human carcinogen. Microcystis is the most common bloom- forming genus of cyanobacteria, and is almost always toxic. Microcystis blooms resemble a greenish, thick, paint-like (sometimes granular) material that accumulates along shores. Scums that dry on the shores of lakes may contain high concentrations of microcystin for several months, allowing toxins to dissolve in the water even when the cells are no longer alive or after a recently collapsed bloom.

Does Higgins Lake have Cyanobacteria that have been known to cause HAB?
A recent study of water from Higgins Lake included testing for cyanobacteria. (Restorative Lake Sciences Higgins Lake Improvement Study and Management Plan 2020. http://hlpoa.org/wp-content/uploads/2021/07/Higgins-lake-improvement-plan-PPT-July-2021-2.pdf Water samples collected from the deep basins of Higgins Lake included three genera of cyanobacteria: Lyngbya sp., Polycystis sp., and Chroococcus sp. Some strains of Lyngbya sp. are capable of making toxins that can cause skin irritation, liver damage, or gastrointestinal and neurological symptoms. There is no indication that either Polycystis or Chroococcus genera release toxins, and it is not known if the Lyngbya sp. detected in Higgins Lake may release toxins. Nostoc sp. is a cyanobacteria that occurs in shallow waters of Higgins Lake and is not known to release toxin.

They form gelatinous blobs that rest on the shallow sandy bottom and are indicators of nutrient poor environments with extensive freezing. Some Nostoc sp. are used in cancer studies and eaten, but the Nostoc sp. in Higgins Lake has not been identified and should not be eaten. Nostoc sp. are not involved in HAB.

How Does Cyanobacteria get into Higgins Lake?
Studies have shown that Lyngbya sp. cells can be transferred from one water body to another by boat hulls and bilge water, and by many animal species (e.g. birds, turtles, raccoons, insects, etc.) This can involve cells attached to the surface of the organism, or via viable cells in fecal material. Cells can also be transported by wind events such as storms that can transport water droplets or particulate matter over large distances. It is likely that other cyanobacteria may enter Higgins Lake by the same methods. One more reason to thoroughly wash boats and empty bilges before entering the lake.

What is the Relationship Between Mussels and Cyanobacteria?
Research by the Michigan State University identified a relationship between zebra/quagga mussels and cyanobacteria. In lakes not infested with mussels, the cyanobacteria usually need high nutrients to result in a bloom. Mussels filter the water to ingest phytoplankton, which includes cyanobacteria. Lakes colonized by mussels tend to have substantially higher and more variable amounts of cyanobacteria in the water. It is thought that the mussels ingest and spit out cyanobacteria reducing competition with algae for nutrients and increasing the proportion of cyanobacteria in the water compared to other types of phytoplankton. Normally total phosphorus is a positive predictor of cyanobacteria concentrations at the shoreline, but this is only true in lakes that lack mussels. It is possible for Higgins Lake to have the conditions that could support HAB because of our mussel infestation.

How can we prevent a HAB in Higgins Lake? There are only two of the factors listed above that we may be able to control to reduce the risk of a HAB in Higgins Lake. The first factor is to reduce to the extent possible the amount of Total phosphorus in the water. This may be done by reducing phosphorus inputs from individual septic systems, by using no or low phosphorus fertilizers, reducing surface runoff and maintaining green belts. The second factor we can influence is the introduction of invasive species, particularly mussels and cyanobacteria, on recreational equipment and vessels. Boats, floats, skis, and water toys should be cleaned before entering the lake, particularly if they have been used in another lake that has invasive mussels or HABs.

Hopefully, we will never experience a HAB on Higgins Lake but it is good to know more about how they can happen and what to do. For more recommendations regarding HAB, please see the Central Michigan Health Department website on swimming beaches and HAB at https://www.cmdhd.org/swimming-beaches-