CHAPTER 6 – HAZARDOUS ALGAL BLOOMS

Author: Geoff Ross

Algae are a diverse group of microscopic, single-celled or colonial, photosynthesizing organisms that occur in all moist or aquatic habitats. The mid-water algae or phytoplankton, are vital basal links in every lake food web. Through photosynthesis, they use solar energy, carbon dioxide, and water to build organic molecules that allow for their own growth and provide food to aquatic zooplankton, and ultimately to fish and other animals. In the process of photosynthesis, they generate significant amounts of oxygen that is released to the atmosphere. Every second breath you take provides you with oxygen originally placed into the atmosphere by phytoplankton in lakes and oceans. Phytoplankton belong to several distinct divisions or phyla such as the diatoms, the golden algae, and the green algae. Also included in the phytoplankton, but very different to other algae are the blue-green algae or cyanobacteria.

Unfortunately, on occasion, conditions can be particularly favorable for algal growth and reproduction. At these times, algal populations of any species can become quite large, resulting in a visible scum or *bloom* on the lake surface. These blooms can develop over just a few days and can disappear just as fast, as algal cells die and decompose. Severe blooms can deplete a lake of oxygen leading to fish kills and other serious disruptions to the lake ecosystem. They can also prove noxious, in appearance as well as odor, degrading our enjoyment of our lakes. In rare instances, cyanobacterial or blue-green algal species produce toxins that can cause serious health risks to people and animals drinking or bathing in the water. In Ontario, cyanobacterial blooms are considered Harmful Algal Blooms (HABs). These blooms often make the water look blue-green or olive-green, or like green pea soup or turquoise paint.

Not all cyanobacteria blooms produce harmful toxins, but their presence indicates the potential for the water to be dangerous for people and for animals. When a suspected algal bloom is reported, samples are taken for taxonomic analysis and subsequent testing for toxins by the Ontario Ministry of Environment Conservation and Parks (MECP). If a bloom is confirmed as resulting from cyanobacteria, the Simcoe Muskoka District Health Unit (SMDHU) will issue a Public Notice of a HAB, advising people and animals to avoid contact with the water. This is done as a precaution in advance of results confirming the presence of toxins actually being released.

The fact that HABs have been identified as cyanobacteria blooms via testing and analysis by scientists, and the fact that HABs can have serious implications, makes them useful as indicators of watershed health.

Typically, the root cause of HABs has been viewed as excessive nutrient concentrations, notably phosphorus, in the water. This creates the ideal conditions for various types of algae and cyanobacteria to bloom. Until quite recently, HABs in Ontario have been observed to be associated with high phosphorus concentrations in lakes and have been quite rare in the Muskoka watersheds.

As discussed in Chapter 2, phosphorus concentrations as measured by springtime surface water samples, are generally low in the Muskoka watersheds, and in many lakes, concentrations have been decreasing. There was little reason to expect that HABs might become more common here. And yet, HAB advisories have been increasing in Muskoka. Figure 16 below indicates the total number of HAB advisories issued for the District Municipality of Muskoka (DMM), by year, from 2009 to 2022. These were in all cases issued for cyanobacterial blooms.

The data in Figure 16, and the fact that increases in cyanobacterial HABs are occurring without observed increases in springtime phosphorus, is consistent with other data reported for Muskoka, Canada, and other countries (Favot et al., 2023).

The data in Figure 16 present total HABs for all lakes in DMM. None of these lakes has a reported HAB every year. The 11 HABs reported in 2021 came from 11 different lakes, many of which had no previous reports of HABs.

Clearly, something is changing in Muskoka. But what change is driving increased HABs, what are the implications, and how should we respond? The HAB advisories reported in Figure 16 depend entirely on reporting by the public. This initiates the sampling and analysis by MECP leading to the advisory issued by SMDHU. Perhaps the increase in advisories is solely due to increased concern and awareness by the public?

Favot et al. (2023) discuss this possibility using the wider province-wide dataset and conclude that increased awareness could be at most a contributing factor. A real increase in cyanobacterial HABs is occurring in oligotrophic lakes on the Canadian shield. And HABs sometimes occur on remote lakes with little human influence, such as Dickson Lake in Algonquin Park, which experienced a blue-green bloom in 2014. While something real is happening, scientists have not yet determined the precise mechanism driving the more frequent blue-green blooms. Several possibilities are being investigated, and all likely have links to climate change.

Given that increases in water temperature will generally cause increases in the growth of most kinds of algae, it appears possible that the increased frequency of HABs in Muskoka is a result of increased water temperatures resulting from climate change. However, the impacts of climate change go beyond just increased water temperature, including for example changes in wind speed that impact lake stratification, and changes in precipitation patterns that may impact phosphorus loadings via increased shoreline erosion. The latter could be introducing phosphorus that is not presently accounted for by current monitoring protocols. A longer season during which a lake is stratified can lead to reduced oxygen levels, and even anoxia, in the deeper part of the lake. Under anoxic conditions phosphorus and other nutrients trapped in the sediments at the bottom of a lake can be remobilized, becoming available for organisms living in the water column. Such a longer season has in fact been documented in Chapter 13, as the trend to a longer ice-free period due to climate change. Other possible drivers of increased HABs may or may not be linked to climate change. These include changes in food web structure and invasive species (Favot et al., 2023).

At the current time, we do not know enough about the causes of increased HABs to say with certainty why they are occurring, or how we should respond. The main conclusions to be drawn are;

- More research is required to determine the causes of the increase in HABs. The knowledge gained will be of key importance to determining how we should respond.
- Of particular concern, climate change is likely creating a range of new conditions under which our current practices for protecting the environment, from HABs and other threats, are no longer adequate. Further research is an essential tool for determining where and why this is happening, and what changes are needed.
- Such research might include, among other things, assessing the degree to which climate change is responsible for greater shoreline erosion, thus impacting phosphorus input to lakes in a manner that is not being identified through current monitoring protocols. This could indicate needed changes in phosphorus monitoring protocols and more stringent shoreline protection standards.

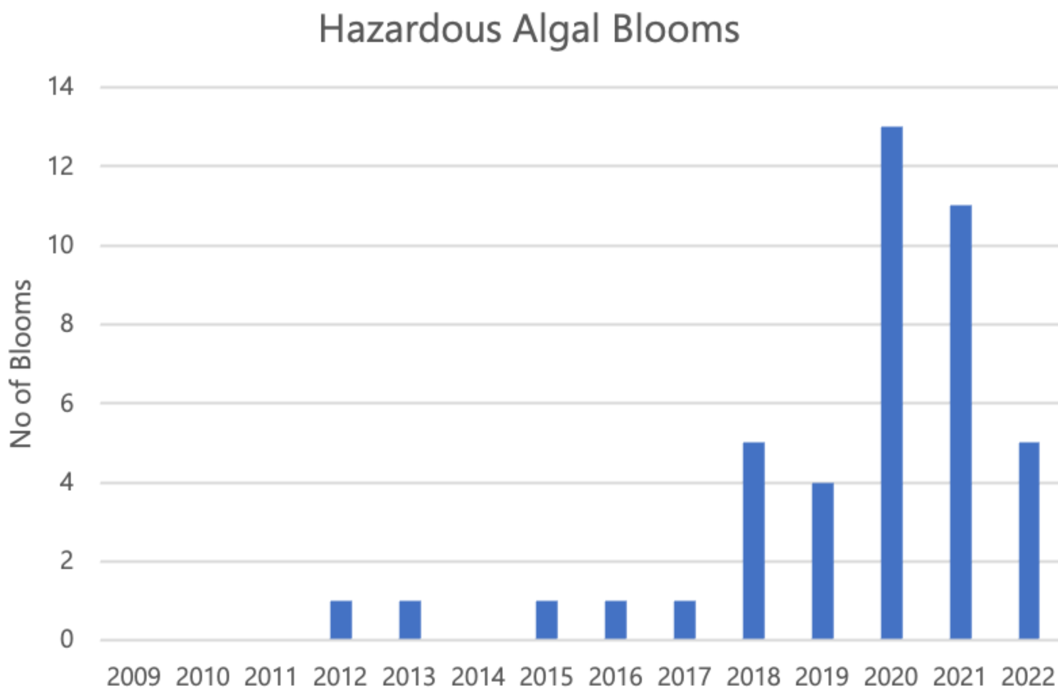

Figure 16. History of HAB advisories issued by Simcoe Muskoka District Health Unit (SMDHU) for waterbodies within the District of Muskoka (SMDHU, personal communication). No data available prior to 2009.