WHAT IS CAUSING HARMFUL ALGAE BLOOMS (HABS) IN CANANDAIGUA LAKE AND WHAT CAN WE DO ABOUT IT?

By Kevin Olvany, Watershed Program Manager, Canandaigua Lake Watershed Council

I have been asked this critical two-part question many times over the last few years and especially so this year after experiencing the most substantial lake wide HABs event since we starting seeing HABs in 2015. I hate to disappoint so early in the article- but I am not going to be able to give you an absolute definitive answer to either part of this question! We, in the scientific/watershed management profession have a great deal of answers regarding the major causes of HABs in lakes with substantial amounts of nutrients. However, we are still working on determining the exact cause(s) of HABs in low nutrient lakes across New York State and the Great Lakes region such as Canandaigua, Keuka, Skaneateles and even Lake Superior; that have not had recorded HABs events until the last few years.

When you look at our long term in-lake phosphorus data- there is no discernible upward trend in phosphorus that would point to an easily identified source of phosphorus that is driving HABs in Canandaigua Lake. However, we are in year four of HABs in Canandaigua Lake and the Village of Rushville issued a do not drink advisory because of HABs toxin in the water supply. Each of the four years were somewhat different in HABs intensity, geography and duration. 2015 was our first year and was a substantial HABs event that was similar to 2018 in duration- but only impacted the northern 2/3 of the lake and the bloom intensity did not come close to the levels that we saw in 2018. 2016 was a very light HABs year with only isolated spots in the north half of the lake. We also had a major drought in 2016 that really minimized any watershed-based sources of nutrients entering the lake. 2017 was more intense than 2016, but nowhere near the geographic extent and intensity as 2018. There was a cool/rainy spell in late August of 2017 that may have helped stave off an intense bloom. 2018 was a true lake-wide HABs event that was the most substantial visually, geographically and had the highest concentrations of BGA and the associated toxin.

Aerial image of an algae bloom on September 14th, 2018
Photo by Doug Turnbull

One of the main questions that we are struggling with is- what changed in the watershed and/or Canandaigua Lake in the early part of this decade to trigger HABs to really take off in late August/early September timeframe of the last four years. Over the last 25 years of research on Canandaigua Lake, long time FLCC professor Dr. Bruce Gilman has identified that by late summer we typically see blue green algae (Microcystis) dominate the algal community- but at very low concentrations. We have some good clues as to what has changed to possibly trigger the concentrations of BGA to really explode in lakes like Canandaigua that I will review in this article.

HARMFUL ALGAE BLOOMS IN CANANDAIGUA LAKE, CONTINUED

The Governor's HABs Summits that occurred earlier this year, brought together national, state and local experts to review the explosion of HABs in all types of lakes across NYS. The experts reviewed some of the research to date regarding the general ingredients that are essential to the formation of HABs- sunlight, warm water, calm wind conditions and nutrients- specifically phosphorus and nitrogen. The summits primarily focused on the only factor that we can somewhat control; the nutrient load into lakes from the watershed and/or in-lake sources and what can be done to reduce the amount of nutrients entering the lake.

Based on these summits and the evolving research that is occurring in many places- we are identifying the potential changes in our watershed that could be triggering HABs in Canandaigua Lake. Here is an initial list and review of potential changes in the watershed that we are continuing to refine. I will only be able to briefly review each of these very complex bullet points:

MORE EXTREME STORMS GENERATING HIGHER NUTRIENT LOADS TO THE LAKE

Our field investigations, communications with Highway Superintendents and many residents along with national level research has identified that we have been experiencing extreme storms on a more frequent basis and across a larger portion of the watershed in recent years. These intense storms carry heavy nutrient loads from both natural and human dominated landscapes into the lake. 2015 and 2017 were heavy runoff years and also substantial HABs years whereas 2016 was a major drought year and our lightest HABs year out of the four years. This was leading us to look at the extreme storm issue as a substantial trigger to the HABs that are impacting Canandaigua Lake. However, 2018 was a pretty dry summer and field investigations showed most streams dried up by early summer and stayed dry. I would investigate streams during the rain that we did get and there was very little flow. We did get a little more rain in late August, but we did not get the extreme storms that impacted us in both 2015 and 2017. 2018 was our most intense HABs event, but it was devoid of extreme storms- adding complexity to what is triggering the HABs.

WARMER SUMMER LAKE TEMPERATURES

Dr. Bruce Gilman has documented an increase in the summer lake surface temperatures over the last 25 years, which could be a key ingredient to providing more favorable growing conditions for HABs.

AGRICULTURAL PRACTICES INCREASING NUTRIENT LOADS

Approximately 1/3 of the 109,000-acre Canandaigua Lake watershed is in some form of active agriculture. There does not appear to be any substantial change in the number of acres farmed over the last 10-15 years. Some fields have gone fallow and some fields have been opened up to active agriculture. In addition, there have been millions of state and federal grant dollars along with local farmer money spent on implementing a wide array of water quality practices on watershed farms over the last 20 years through Soil and Water Districts and the US Department of Agriculture that have had tangible water quality improvements. We have gotten numerous questions about manure application and the use of Round Up ready crops as possible causes of HABs. Here is a quick summary regarding these two potential issues:

- Manure application - There have been a couple high profile news articles that have looked at manure applications from large scale farm operations as a driving factor in increasing nutrient loads to the Finger Lakes and thus driving HABs in these lakes. I have been asked about these articles on multiple occasions. We do not have any large-scale Concentrated Animal Feeding Operations (CAFO) operations in the watershed. Many of the other Finger Lakes have several CAFO operations in their watersheds. We have four family run CAFO regulated farm operations that are outside of the watershed area, but do spread manure on some fields in the watershed. These operations must follow plans for manure storage and proper application and are regulated by DEC. We also have some smaller dairy's mostly on the east side of the watershed in the Gorham area. These smaller operations do not have to follow the same regulations as the larger operations. However, when you look at how the overall farming community fertilizes its fields, a substantial portion of the fertilization is not manure based- but from chemical fertilizers. Therefore, we need to look at both forms of fertilizer and from both ag and non-ag land uses. The combination of increased extreme storms with any type of fertilization is an issue that we need to come up with innovative partnership solutions to build water quality resiliency into our landscape.

- Increased use of "Round Up" ready crops - such as genetically modified soybeans and corn that are engineered to tolerate the spraying of "Round-up" during the growing season. This technique is used to knock out weed growth in the field to reduce competition for the crop that is growing on the field. These types of crops have increased over the last decade and thus the use of glyphosate (the active herbicide in Round-up) has potentially increased as well. There is ongoing research in the Lake Erie basin and elsewhere on the impact of glyphosate. The science and chemistry are complex and evolving- but some of the research is suggesting that some BGA are adapted to utilizing the phosphonate portion of glyphosate and as glyphosate breaks down it can also provide a bio-available form of phosphorus. Glyphosate has been around for 50+ years and has been widely used on fields in the watershed when crops are rotated. This is an area that will require much further research by chemists to better understand the complex interactions. This is another area where the combination of increased storm intensity with this potential source of phosphorus is an issue that requires innovative partnership solutions to build water quality resiliency into our landscape.

Agriculture is a critical asset to our community and also needs to be protected and promoted. We will continue to work with our agricultural producers, along with county soil and water and federal agricultural agencies to help build water quality resiliency into our landscapes to reduce the nutrient impact from farming operations even during extreme storm events.

SUBSTANTIAL DEVELOPMENT ON THE WEST SIDE OF THE WATERSHED INCREASING NUTRIENT LOADS

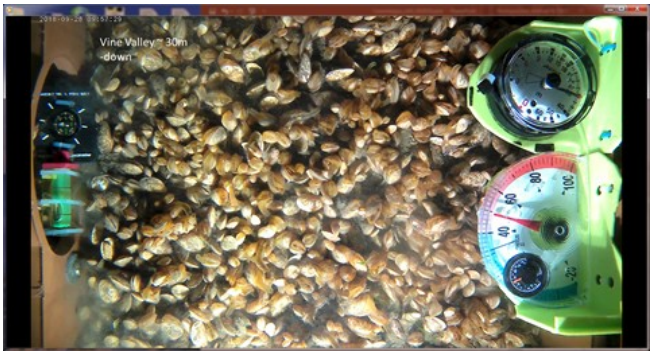
The vast majority of the development and thus population increase in the watershed over the last 10+ years has occurred along the Middle Cheshire Corridor of the Town of Canandaigua. We have had some issues over the years with these developments, but over the last four years they have largely stayed in compliance with stormwater regulations. In addition, for the last decade, the Town and City of Canandaigua have required that any new residential or commercial development must meet enhanced phosphorus regulations, that go beyond the State DEC requirements, in order to reduce the discharge of phosphorus from these areas. In addition to addressing large scale development, there is also a long list of regulations that have been adopted over the last decade by several of the lakeshore towns to reduce the impact of single lot development around the lake. We also have an active septic system inspection program. The new onsite wastewater law will provide further protection from this potential source of pollution. The municipalities understand that more still needs to be done and we are reviewing various options.

VEGETATIVE INVASIVE SPECIES IN THE LAKE

There is ongoing research on certain plant species actually moving phosphorus from the sediments into the water column- thus feeding the algae community. Dr. Bruce Gilman has completed aquatic plant (macrophyte) studies on Canandaigua Lake. Starry stonewort is the new invasive species that has made its way into Canandaigua Lake earlier this decade. Research has indicated that starry stonewort actually utilizes phosphorus from the water column thus potentially reducing phosphorus levels in the lake. Again, there are a lot of complex interactions within the lake ecosystem and further research is warranted.

INVASIVE QUAGGA MUSSELS LARGELY REPLACING INVASIVE ZEBRA MUSSELS

In the mid-1990s, zebra mussels invaded Canandaigua Lake and most other lakes in NYS and the Great Lakes basin. They were the dominant mussel in the lake and had substantial impacts on the ecosystem by filtering/eating the primary producers that formed the base of the food chain. Zebra mussels do not like the taste of BGA and tend to spit them back out. Thus, they tend to shift the ecosystem by the late August timeframe to a more BGA dominated algal community.



Underwater image of mussel density taken off Vine Valley at 30m (~100ft), image taken by Tony Prestigiacomo

Based on Dr. Gilman's and others research on Canandaigua Lake, quagga mussels invaded Canandaigua Lake somewhere in the 2010-2011 timeframe. In very simplistic terms- quagga mussels are like zebra mussels- but on steroids! They tend to do everything better- they can live in deeper water, grow on more substrates, reproduce at a higher rate and filter more good algae. They also spit out BGA because they find the taste unpalatable. Dr. Gilman has done dredge surveys to document densities and that the quagga mussels have largely outcompeted zebra mussels. In September, Tony Prestigiacomo from the DEC Finger Lakes HUB, did some initial underwater camera surveys of the lake bottom and found high densities of mussels at various depths. Quagga mussels also "poop" out feces that contains dissolved phosphorus- which is immediately available to algae.

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HABS ON CANANDAIGUA LAKE, CONTINUED

There is evolving research on other lakes that are documenting the quagga/HABs correlation. To summarize what we think is going on: quagga mussels filter out most of the competition (the good algae) through the growing season, they find BGA unpalatable and thus regurgitate it back into the water column and finally pump out dissolved phosphorus to feed the end of season BGA monopoly. This perfect storm of events seems to be at this point, a substantial contributor to the emergence of HABs as a major issue in Canandaigua Lake and other low phosphorus lakes. The 2018 HABs event on Canandaigua Lake seems to support this possibility.

While we think quagga mussels along with increased water temperatures are key factors for the emergence of HABs on Canandaigua Lake, it does not negate the need for enhanced land-based watershed management. These in-lake factors (that are out of our control) actually increase the need for enhancing our watershed level work because they have made the lake more sensitive to subtle increases in phosphorus.

WHAT CAN WE DO ABOUT REDUCING/ELIMINATING HABS ON CANANDAIGUA LAKE?

Some of the issues identified are largely beyond our control such as: quagga mussels, water temperature and rainfall intensity. Increasing watershed resiliency by managing land-based sources of phosphorus and nitrogen from entering the lake is key- especially with extreme storms becoming more of the new normal. This could be a whole other long article! We have written a watershed plan and comprehensive update of the plan on the various watershed sources of nutrients and how we are working to reduce their impacts. I might be a little biased in saying this - but when you look at each of these sources we can point to many tangible projects, laws and practices that have been implemented across the watershed over the last 20 years that have a net positive impact on the water quality of the lake. However, we obviously need to do a lot more.

Major areas we need to focus on:

- continuing to educate the public on managing their landscapes
- building more wetland and natural stormwater systems throughout the watershed to reduce downstream nutrient loads- we are completing a 3rd system in the Sucker Brook subwatershed, and have funding for large scale projects in multiple locations over the next couple years
- partnering with our farming community and ag related governmental agencies to reduce field-based migration of manure and chemical fertilizer to the road side ditch- nearby stream and ultimately Canandaigua Lake. We have to think outside the box and figure out innovative ways to get many small projects done quickly
- enhance tangible regulations to provide water quality treatment on individual lots in high priority areas
- implementing the onsite wastewater system law throughout the shoreline communities

I have only touched on some of the big potential issues driving HABs in Canandaigua Lake and what we can do about it. There is a lot more research that needs to be completed to better understand the dynamics in our lake and across the Finger Lakes system. It is easy to point to one issue instead of looking at the combination of factors that could be involved. Hopefully this article helps to better understand the clues that we have regarding the dynamics that are driving HABs in Canandaigua Lake. We will have a lot more information coming out over the next few months on how we are going to further research the causes of HABs and the watershed-based strategies to protect Canandaigua Lake.