Report to BLA on Water Quality

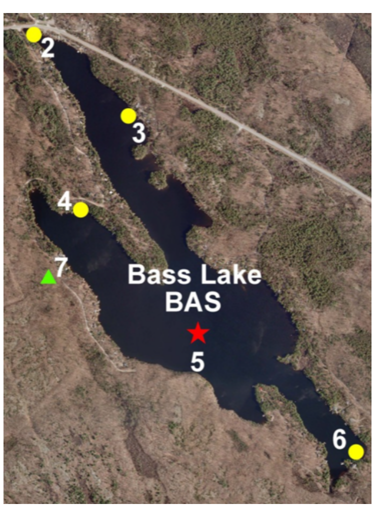
There are two parts to this report. The first is on the water quality of the lake as measured by total phosphorous and secchi depth. This year, the Muskoka Lakes Association suspended their lake monitoring program because of Covid-19. All of the water quality sampling, analysis and interpretation for this year was undertaken by the Bass Lake Association directors. The second part is on the cyanobacteria bloom observed in October/November 2019. The management of information and reporting of the bloom involved considerable effort by the Bass Lake Association directors.

This report is for BLA members information and use only and contains information that has been taken from Muskoka Lakes Association (MLA) reports for previous years as well as from government and other sources. The information is believed to be accurate but has not been independently verified by the BLA Executive and is provided without any liability.

Total Phosphorus and Secchi Depth Measurements

Description:
Bass Lake is a small, shallow, moderately developed lake with an area of 0.96 km^2 in a watershed area of approximately 6.92 km^2. It has a maximum depth of approximately 10 m. Flow from the lake through the culvert under Hwy 169, is controlled by a natural rock weir close to Lake Joseph. During the summer and early fall the water level for Bass Lake is typically below the top of the rock weir resulting in no flow from the lake and the water at the north end and in the outflow channel being stagnant. The duration of this stagnant flow period can be controlled or minimized by placing sandbags on the rock weir. In the past, Ben Roberts has taken care of this responsibility on behalf of the BLA. Ben now advises the BLA on this activity. Bass Lake was formerly classified as moderately sensitive by the District Municipality of Muskoka (DMM). Monitoring with the Muskoka Lakes Association program started in 2005. All stations shown in the lake map were not sampled each year. The sampling includes Total Phosphorus nutrient and Secchi disk measurements. The DMM description and importance of these measurements is described at the end of this section.

Water Sample Collection Team: Chris Bodanis, Chris Turney, and Bev Turney.



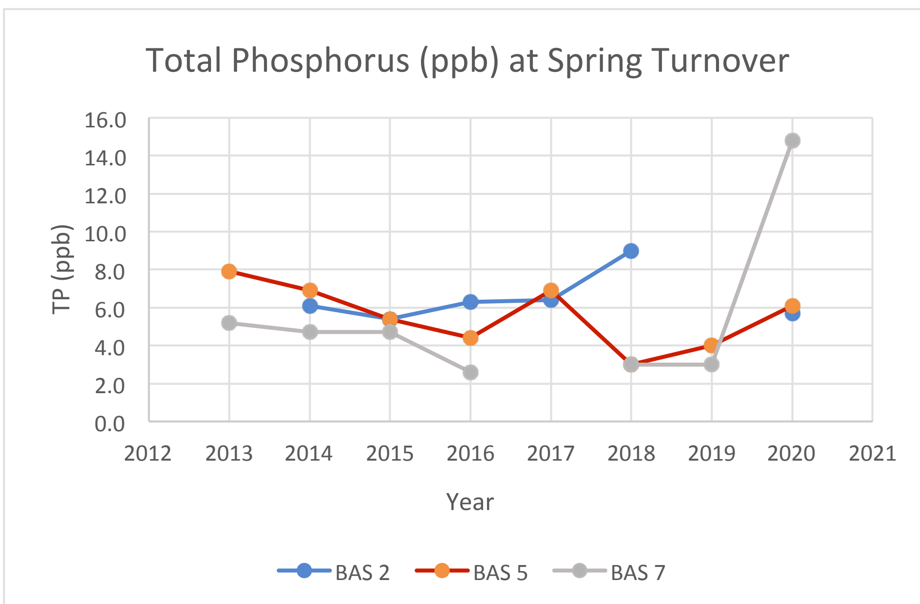
Location of Sample Points

	BAS 2	BAS 5	BAS 7
2013		7.9	5.2
2014	6.1	6.9	4.7
2015	5.4	5.4	4.7
2016	6.3	4.4	2.6
2017	6.4	6.9	
2018	9.0	3.0	3.0
2019		4.0	3.0
2020	5.7	6.1	14.8*

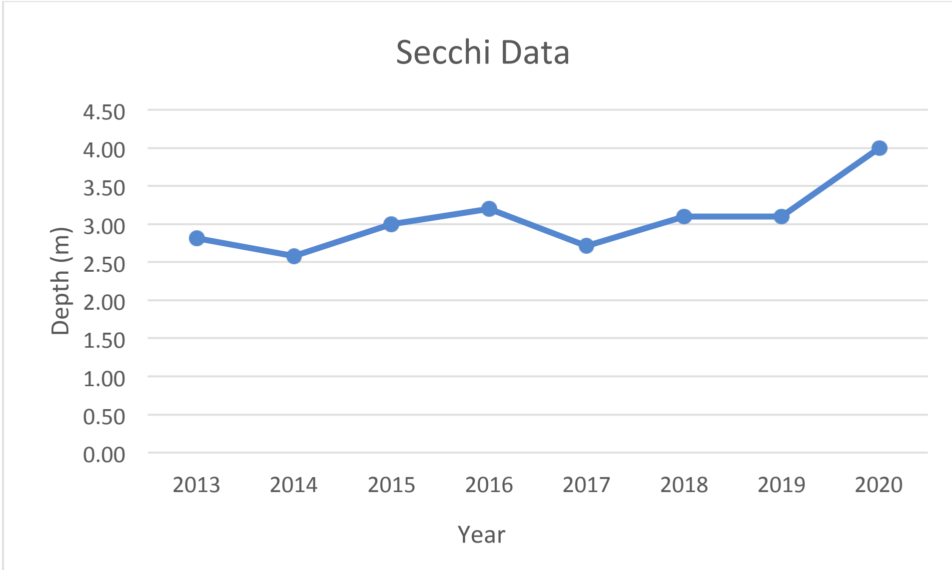
Measured Total Phosphorus (ppb) at Spring Turnover – May

TP Sampling at Other Locations in 2020: BAS 4 6.5 ppb; BAS 6 25.5* ppb

*** Resampling recommended as concentrations appear to be outliers based on historic data. The higher reading at BAS 7 was probably due to concentrations of plant life and debris in the sample.**



Change in TP with Time at BAS 2, BAS 5 and BAS 7



Yearly Change in Secchi Depth

Interpretation of Water Quality Data:

- **The Total Phosphorus in Bass Lake at Bas 5 is typical of that measured in most small lakes in Muskoka**
- **Based on long term Total Phosphorus results, Bass Lake is oligotrophic. The District of Muskoka, based on their 2017 assessment, considers the lake to have moderate sensitivity**

From the District of Muskoka Lake System Health Water Quality Monitoring Program:

1. **Spring phosphorus** Phosphorus is the nutrient that controls the growth of algae in most Ontario lakes. For this reason, any increase in phosphorus in a lake will tend to increase the quantity of algae that can grow. High levels of phosphorus can lead to algal blooms that detract from recreational water quality and in some cases affects the habitat of coldwater fish species such as lake trout. A sensitivity rating is given to each lake in Muskoka based on the lake's responsiveness to phosphorus inputs and the mobility of phosphorus within the lake's watershed. A lake can have either a low, moderate or high sensitivity to phosphorus. Phosphorus samples are collected in the spring during a period called "spring turnover". This is the best time to sample for phosphorus because the lake is completely mixed and a water sample represents the phosphorus concentration throughout the whole lake. By sampling spring phosphorus each year it is possible to detect a change in the nutrient status of a lake. Several years of data must be collected to first observe the normal and between-year differences, before a trend can be identified. Phosphorus enters a lake naturally through sediment and precipitation. Human inputs of phosphorus enter a lake primarily through surface runoff from sources such as septic system seepage, lawn fertilizer runoff,

agricultural runoff and municipal wastewater. Lakes with phosphorus concentrations below 10 micrograms per litre (μg/L) are considered oligotrophic or nutrient-poor. Those with a phosphorus concentration falling between 11 and 20 μg/L are termed mesotrophic or moderately enriched, while lakes with a phosphorus concentration exceeding 20 μg/L are called eutrophic and are considered enriched. Each lake has a threshold concentration, which is equal to the background level of phosphorus plus an additional 50%. If a lake's measured and modelled (value calculated using a water quality model) phosphorus concentrations over a 10-year period are greater than its threshold value, then the lake is considered "over threshold" and more restrictive development policy will apply. Associations will also be encouraged to develop remedial action plans for their lake. A complete list of lakes classified as Over Threshold is available in Appendix K of the Muskoka Official Plan. A review of the Recreational Water Quality Model has been completed. This review addressed recent changes in the existing provincial approach and the related scientific background to the model since its last update was completed in 2005. The results of the review have led to proposed changes to planning policy. Learn more about these proposed changes at http://www.muskoka.on.ca/en/work-and-invest/Water-QualityModel-and-Policy-Review.aspx. 2017 Lake System Health Water Quality Monitoring Program Data Report 8

2. **Secchi depth measurements** Secchi depth is a measurement of water clarity. In Muskoka, the major determinant of water clarity may be either natural colour or an increase in nutrient input from the surrounding watershed. A lake may naturally be a brown colour due to high levels of dissolved organic carbon (DOC) that comes from the wetlands in a watershed. DOC colours lakes brown and reduces water clarity, but is not an indication of nutrient enrichment. Examples of lakes with naturally high DOC content include Brandy Lake and Tea Lake. Water clarity can also decrease as nutrients from the surrounding watershed enter and enrich the lake, resulting in high levels of suspended sediments or algal growth. Water clarity can change weekly or yearly as a result of weather, length of winter ice cover, shoreline development, natural seasonal trends or other impacts. However, when the primary determinant of water clarity is a function of nutrient enrichment, a long-term trend that indicates a reduction in water clarity is an indication of reduced water quality. In general, where a lake is not coloured by DOC, the higher the Secchi depth reading, the clearer the lake and the less nutrients it contains. Lakes with Secchi depth measurements over five metres are considered oligotrophic or nutrient-poor. Those with a Secchi depth measurement falling between three and five metres are termed mesotrophic or moderately enriched, while lakes with a Secchi depth measurement below three metres are called eutrophic and are considered enriched.

Cyanobacteria (Blue-Green Algae)

In October 2019, Blue-Green Algae was observed in the outflow channel between Bass Lake and Stills Bay in Lake Joseph. Specifically, the bloom was between the Culvert under Hwy 169 and a beaver dam under the old bridge just north of the culvert. The observation was reported to the Simcoe Muskoka District Health Unit (SMDHU). They asked Kim Pietz of the Barrie District Office of the Ministry of the

Environment, Conservation and Parks (MECP) to confirm that the observation was cyanobacteria. Kim collected two water samples from Bass Lake on October 21, 2019 and her report was as follows:

1. **Sample site just off Hwy 169:** Analysis of the sample was indicative of a bloom of blue-green algae (specifically: Anabaena (aka Dolichospermum)). Observations included particles that were not identified as algae: debris, Protozoa, zooplankton.

2. **Sample site on Kendon Road:** Small amounts of the following types of algae were observed in the sample, at levelsconsidered too low to contribute to a bloom: blue-green algae (specifically filamentous blue-green algae, Aphanocapsa, Anabaena (aka Dolichospermum)) diatoms (specifically Asterionella, Tabellaria, Navicula) golden-brown algae (specifically Synura, Chrysosphaerella, Dinobryon) green algae (specifically Scenedesmus). Observations included particles that were not identified as algae: Protozoa, debris, pine pollen.

Based on this report, The SMDHU issued a cyanobacteria advisory notice for Bass Lake on October 24, 2019. The BLA directors then immediately went into action and investigated the cyanobacteria problem contacting the MECP, the SMDHU and the Township of Muskoka Lakes. In two rounds of water sampling of Bass Lake by the MECP in October/November 2019, there was no evidence of Microcystin LR, the toxin of concern in cyanobacteria, above the drinking water standard or maximum acceptable concentration (mac) of 1.5 ppb. Most measurements were below the detection limit of equipment. As a result, the SMDHU lifted their advisory for Bass Lake on November 28, 2019. The details of the observed cyanobacteria are presented in the following question/answer format.

What conditions in a lake are associated with cyanobacteria blooms?

Cyanobacteria flourishes in shallow, stagnant water and requires the nutrients phosphorus and nitrogen for their growth. Phosphorus occurs naturally in Bass Lake with the source being plant matter, sediments and septic system effluent. In most of our lakes the nitrogen is often in the form of nitrates with the source being septic systems. Nitrification and denitrification are important processes that occur in the septic system tile bed and result in the change of ammonia in waste to nitrogen. Nitrification is an aerobic process that changes ammonia to nitrate while the denitrification is anaerobic with bacteria reducing the nitrates to nitrogen gas. From the literature: “Nitrogen removal rates for conventional septic tank systems may vary from 0% to 35%”. Hence much of the nitrate will migrate to the lake unattenuated. This is particularly true in our shield setting where the overburden is relatively permeable as is the underlying weathered rock zone; transit times to the lake are relatively quick. Worsening the problem is that some of the septic systems on our lake are undersized or are too close to surface discharge points. The denitrification process where nitrates are reduced to nitrogen in the septic system tile beds does not occur before the nitrates make it to the lake. How do cyanobacteria react to the levels of nitrogen and phosphorus in the water? When there is a deficiency of nitrogen in water relative to the level of phosphorus, cyanobacteria have the ability to produce microcystin to “store” nitrogen. The toxic microcystin is only released when the cyanobacteria die. Research in Canada indicates that the formation of the toxin microcystin by cyanobacteria requires an N:P ratio less than 20 with 95% of instances with microcystin above 1 ppb (the drinking water standard) having P > 26 ppb (eutrophication level) and N > 658. Bass Lake’s last P measurement by DMM was 5.5 ppb while N was about 261 ppb yielding an N:P of slightly more than 40. Typically then, the production of microcystin LR by cyanobacteria occurs in eutrophic lakes and ponds and not the lakes of Muskoka where the nitrogen and phosphorus levels at times are sufficient for the flourishing of the bacteria but not at levels where they need to produce microcystin. Note that the SMDHU advisories are based on the observation of cyanobacteria. The water sampling that follows the observation is to determine whether the cells are producing the toxic microcystin.

Where was the location of the cyanobacteria bloom that triggered the drinking water warning by Simcoe Muskoka District Health?

The cyanobacteria bloom was on the northeast side of Hwy 169 in the outflow channel from Bass Lake to Stills Bay; flow from Bass Lake to the channel is through a recently upgraded culvert under Hwy 169. The cyanobacteria were trapped behind a beaver dam under the old bridge. The beaver dam was cleared soon after the SMDH notice. Normal Fall flow from Bass Lake then flushed the cyanobacteria from the channel with the result that it was transported to Stills Bay, quickly clearing the channel. Any microcystin LR that might be released by the cyanobacteria would impact Stills Bay and not Bass Lake. The cyanobacteria from this bloom would have absolutely no impact on Bass Lake. The possibility of a reoccurrence of a bloom in the channel in following years can be reduced by the following:

- ensuring that flow is not interrupted by a beaver dam;
- as much as possible regulate the flow in the channel by reducing the Spring outflow by placing sand bags on the natural rock weir at Stills Falls; stored water can be slowly released throughout the Summer and early Fall providing a flushing of the channel;
- ensure that nitrate release is minimized from septic system tile beds

Was cyanobacteria observed at any locations in Bass Lake?

Yes. After SMDH issued their cyanobacteria notice for the north end of Bass Lake in late October, following good lake stewardship, a complete and thorough inspection of the lakes shoreline was completed with the lead being Enid Wray; very small concentrations of cyanobacteria were observed in several shore areas with stagnant water. The area of these blooms were less than several square meters. Cyanobacteria occurs naturally in water bodies from the equator to the poles. It is thought to be responsible for the first generation of atmospheric oxygen more than 2.5 billion years ago. Without question, if the shoreline of <u>all</u> lakes in Muskoka were inspected in the same manner that Bass Lake was, cyanobacteria blooms would be discovered in some shore areas of <u>every</u> lake. Exceptional lake stewardship such as that exercised on Bass Lake is our practice. However, careful assessment of the risk of any identified water quality deficiency is required. Characterizations based on either no or minimal data are not appropriate.

What is the risk associated with a cyanobacteria bloom?

Not all cyanobacteria are associated with a negative health end point. Some cultures have used it as a protein source. However, cyanobacteria have the ability to produce microcystin which is associated with some cancers. The microcystin is bound in the cyanobacteria and is only released to the aquatic environment when the cells burst and die. The half-life for the microcystin in water is approximately 10 weeks. The maximum acceptable concentration (mac) of microcystin LR in drinking water is 1.5 ppb (parts per billion). This limit is usually associated with the probability of 1 excess cancer in a million people having lifetime consumption. The mac for microcystin in water used for recreation is 20 ppb. Whether cyanobacteria produce the toxin microcystin and the conditions for its production is the subject of much research. However, research investigating a large data base for cyanobacteria and microcystin concentrations in Canadian surface waters indicates that microcystin levels above 1.5 ppb are more commonly found in lakes/ponds fed by agricultural fertilizers such as phosphates and nitrogen. Levels of microcystin above the drinking water mac were rarely, if ever, measured in non-agricultural areas such as the Canadian Shield. Beyond the data base of the citable Canadian study, contacts at the SMDH and Ontario Ministry of Environment Conservation and Parks (MECP) have indicated that to date they have not measured microcystin LR levels above the drinking water standard of 1.5 ppb in the lakes of Muskoka even though cyanobacteria blooms have been observed; commonly the levels of microcystin were below the instrument detection limit of 0.1 ppb. In addition, no concentrations of Microcystin LR at or greater than the recreational standard of 20 ppb have been measured in the lakes of Muskoka. It is important to recognize that notices released by SMDH are based solely on the observation of cyanobacteria blooms; the notices are not based on microcystin levels. Based on the available data, the likelihood that an observed cyanobacteria bloom will produce microcystin in our lake is low.

Does the SMDH and MECP monitor all Muskoka Lakes for Cyanobacteria?

SMDH and MECP only monitor lakes where cyanobacteria have been reported to them. The BLA is not aware of a program for the monitoring of all lakes and shorelines of Muskoka. The filing of notices is thus somewhat ad hoc. A notice for cyanobacteria will be filed based on observation methods. Subsequent to the detection of cyanobacteria, microcystin LR concentrations will be measured at the location of the bloom with 2 rounds of water sampling usually taken. If access permits, the 2nd round of sampling is taken before the development of winter ice, otherwise the 2nd round occurs in the spring.

Is the SMDH notice of a cyanobacteria bloom on their website sufficient?

The notice of a cyanobacteria bloom on Bass Lake and other Muskoka lakes was posted on the SMDH website. Advising residents of the lake relied solely on “passing the word”. No written notice was given to property owners.

What practices should the residents of Bass Lake follow if the SMDH again files a cyanobacteria bloom notice in the same manner as the one filed this past Fall?

Post Walkerton, the SMDH and other associated agencies are very risk averse. However, for our use of the lake, common sense should be the rule. When a notice is filed and until its status changes by the measurement of microcystin concentrations below the drinking water standard of 1.5 ppb, residents should use bottled water for their consumption. Note that boiling water will not destroy the toxins, and home treatment systems should not be relied upon. While algae clumps may not be observed, dispersed Cyanobacteria may still be in the water column. Because microcystin levels above the 20 ppb recreational standard have never been measured in Muskoka and because there are no morbidity statistics for this level (reference Steve Rebellato of SMDH) residents should be able to continue their recreational use of our lake; but common sense is to not swim in an area with obvious cyanobacteria.

Other Reading:

https://www.ontario.ca/page/blue-green-algae#:~:text=They%20thrive%20in%20areas%20where,may%20form%20solid%2Dlooking%20clumps.

http://www.simcoemuskokahealth.org/Topics/SafeWater/bluegreenalgae_copy1.aspx