BEACON ENVIRONMENTAL

MLA™
Muskoka Lakes Association
Preserving Muskoka for Future Generations

2019
Water Quality Initiative Report

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A. Area Summaries

Update (April 2020)

The MLA wishes to inform all readers that the classification of Bass Lake has been updated to "yellow" based on algae test results that became known to the authors after the report was issued. This specifically changes the summary **Table 8** [page 28] as follows:

Table 8. Summary of 2019 Sites with Yellow and Red Stoplights

Area	Site	*E. coli*	Phosphorus	Harmful Algae Bloom	Stoplight
BAS	BAS-5		Yearly mean TP exceeds spring TP	Harmful Algae Bloom was reported in 2019	Yellow
BOY	BOY-3			Harmful Algae Bloom reported in 2018 near BOY-3	Yellow
BRA	BRA-1			Harmful Algae Bloom was reported in 2019	Red
COX	COX-0		Yearly mean TP exceeds spring TP		Yellow
GUL	GUL-0		Yearly mean TP exceeds spring TP		Yellow
GLW	GLW-0		Yearly mean TP exceeds spring TP		Yellow
MIN	MIN-6 (NS)	E. coli above the 30 cfu/100 ml threshold.			Yellow
MIR	MIR-0		Yearly mean TP exceeds spring TP		Yellow
SKB	SKB-0		Increasing trend in spring TP measurements over last 3 years		Yellow
WAK	WAK-6	*E. coli* above the 30 cfu/100 ml threshold.			Yellow
WIN	WIN-1			Harmful Algae Bloom reported in 2018 near WIN-1	Yellow

The MLA stoplight system red areas are therefore reduced by one (i.e. from 2 to 1), and the number of yellow sites is increased by one (i.e. from 9 to 10). Specific details on the results for Bass Lake can be found on the Area Summary for Bass Lake [BAS] on pages A70-A71.

Executive Summary

The MLA Water Quality Initiative Report presents data collected at 180 locations during the summer of 2019 and compares it to data collected from 2002 to 2018. Based on our analysis of the long-term data acquired to date, the water quality at most of the sampling locations remains good to excellent.

The objectives of the MLA Water Quality Program are:

- To promote and encourage good stewardship of the lakes;
- To monitor the long-term health of the lakes;
- To identify adverse water quality trends at an early stage; and
- To promote causation studies and remediation by the responsible authorities.

There are multiple cases where the data collected by dedicated MLA volunteers has initiated closer inspection of specific sites. The accountability arising from the Water Quality Program contributes to local improvements of septic systems, changes to municipal sewage treatment practices, and, overall, increased vigilance to protect the qualities of our lakes. This report summarizes the efforts of many committed volunteers and staff. Together, we continue to make a difference!

Area Summary Sheets are used to summarize sampling results and traffic light symbology. The traffic lights were established by the MLA to provide a visual indication of the overall water quality at each Area. A green light indicates the water quality remains consistently good and a yellow light indicates that further investigation is recommended to maintain good water quality. A red light indicates remedial action may be necessary to improve water quality.

The spring freshet of 2019 produced historic flooding conditions. The level in Lake Muskoka was the highest ever recorded and the 2019 flood was the second “100-year flood” in 6 years.

The 2019 sampling season started in mid-May, ended in late August and generally included a total of four sampling events at each location. New deep-water stations were established at Foot’s Bay (FTB-4 and FTB-5) to monitor phosphorus and bacteria levels in 2019. The primary change to the monitoring program in 2019 was the use of a new laboratory (ALS) to complete the analyses. The new lab provided a detection limit of 3.0 µg /L and precision to 0.1 µg /L. Sample bottles similar to the pre-treated bottles used in 2018 were used in 2019.

In 2019, of the 55 Areas tested, there were 42 Areas with a green light, 9 Areas with a yellow light and 2 Areas with a red light. It is noted that the green, yellow and red Areas do not add up to the total number of Areas tested as there are 2 sites with only one or two years of data that are not rated yet. This year, 6 Areas changed from a green light to a yellow light, and 5 Areas changed from a yellow light to a green light.

The water quality parameters sampled during the 2019 program consisted of temperature, Secchi depth (clarity), Total Phosphorus (nutrients), *Escherichia coli (E. coli)* and Total Coliform (bacteria count). There was a total of 238 Secchi depth measurements, 446 Phosphorus samples, and 261 bacteria

samples taken. In 2019, 22 of the 46 duplicate phosphorus samples (48%) were deemed to be bad splits.

Secchi depths recorded in 2019 continue to remain consistent with the depths reported historically and continue to generally support the classification of oligotrophic.

Although there was an overall generally increasing trend in most of the deep-water spring phosphorus concentrations in 2017 compared with values in 2016, that trend was not realized in 2018 or 2019. At the deep-water station sites that were sampled for spring phosphorus, 8 (15%) of the 52 sites showed the lowest spring phosphorus concentration recorded to date, compared to 42 % in 2018. All the sites with the lowest recorded spring phosphorus concentrations to date were either Affiliate sites, or sites located within Lake Muskoka

Conversely, in 2019, five of the deep-water sites recorded the highest spring phosphorus concentrations to date, compared to 4 deep-water sites in 2018. All the sites with the highest spring phosphorus concentrations to date were located within Little Lake Joseph, Lake Rosseau, or the Indian River.

An overall generally static trend in most of the nearshore phosphorus concentrations continued in 2019, similar to the results in 2018. At the nearshore station sites, 10% (9 of 86 sites) of the sites showed an increasing trend in the past 3 years. Of those 10 sites, 5 of them had an increasing trend due to a high value obtained in 2019, all of which were analyzed to be outliers. An analysis of the trend over time at each of the nearshore stations, using all data, shows that at 73 % (63 of 86) of the stations there was a decreasing trend in phosphorus.

Of the watercourse sites sampled for spring phosphorus in 2019, MRV-5 showed the lowest spring phosphorus concentration to date, and HMB-8 showed the second lowest spring phosphorus concentration to date. At watercourse station WIN-7, the 2019 spring phosphorus concentration was the lowest ever recorded, and the yearly mean phosphorus concentration was the lowest recorded in the 6 years of data gathered.

Spring phosphorus levels in Lake Joseph, Lake Rosseau and Lake Muskoka in 2019 were generally below 10 µg/L, indicating oligotrophic conditions. Elevated phosphorus concentrations at the nearshore sites were primarily associated with each site location being adjacent to streams flowing into the three lakes. Spring phosphorus levels in the Affiliate lakes and rivers in 2019 were all below 10 µg/L, except for elevated levels at Brandy Lake (BDY-0) and Indian River (IND-7).

For Harmful Algae Bloom analysis in 2019, the MLA has assigned a red light threshold for those locations with a confirmed blue-green algal (cyanobacteria) bloom in 2019, a yellow light threshold for those locations with a blue-green algal bloom confirmed within the last 3 years, or, a bloom in the current year (2019) with the toxic component (microcystins) measured to be <20 µg/L. Finally, the MLA has assigned a green light threshold for those locations that have never had a blue-green algal bloom, or that have had 3 years since the last bloom. In 2018, HAB's were reported near the Windermere WIN-1 site (base of falls below Clark's Pond), and the Boyd Bay BOY-3 site (near Spirit Bay Harbour). In 2019, a blue-green algae bloom was reported in Brandy Lake (September 12), and Bass Lake (October 24).

E. coli levels are measured in colony forming units per millilitre of sample (cfu/ml). *E. coli* levels exceeded 50 cfu/100 ml at 11 (4.6%) of 240 sampling events for *E. coli* in 2019, compared to 9.2%

reported in 2018. The sites that reported elevated *E. coli* levels (>50 cfu/100ml) in 2019 include Bala Bay (BAL-2), Beaumaris (BMR-4), Moon River (MOO-1), Star Lake (STR-3), and Walkers Point (WAK-6). The focus stations at Minett (MIN-1, MIN-6, MIN-7 and MIN-9), also observed elevated *E. coli* levels and all sites required re-testing. From those sites identified for further *E. coli* analysis in 2019, the Minett station (MIN-6) continues to show elevated *E. coli* levels.

Following analysis of the 2019 results, Beacon recommends that the primary Focus Areas for the 2020 sampling season should continue to be Minett (MIN). Additional focus in 2020 should be directed to Bruce Lake (BRU-3), East Bay (EAS-2), and Windermere (WIN-1 and WIN-5) due to the 2019 nearshore TP measurements being substantially higher than the deep-water TP (yellow traffic light threshold), and to Walkers Point (WAK-6) due to the geometric mean *E. coli* level in 2019 being above the MLA yellow traffic light. Attention should also be focussed on the spring sample at Skeleton Bay (SKB-0) due to the increasing trend in spring TP measurements over last 3 years.

Several lake health concerns in the Muskoka watershed, in addition to levels of total phosphorus, water clarity and bacteria, that are the core of MLA's field monitoring program, have been identified. While not directly part of the MLA Water Quality Initiative, the MLA is keeping up to date on these issues through participation in external committees and task forces to augment its guardianship of lake water quality.

It is important that everyone contribute to the goal of improving water quality and aesthetics of their lakes, while raising public awareness about healthy lake systems. Any stewardship activities will benefit the watershed over the long-term and leave a positive legacy for future generations.

1. Introduction

The Muskoka Lakes Association (MLA) is a non-profit organization that was founded in 1894 to represent the interests of lakeshore residents on Lakes Rosseau, Joseph and Muskoka and many smaller surrounding lakes, and is Canada's oldest cottage association. The MLA's mission is to 'promote the responsible use, enjoyment and conservation of the unique Muskoka environment.' **The MLA objectives of monitoring lake water quality to provide data to protect vulnerable areas and promoting stewardship are carried out through the Water Quality Initiative.**

The MLA Environment Committee is a group of volunteers that utilize professional expertise to analyze the yearly water quality data and to provide recommendations and program modification/development options. In 2013, Beacon Environmental Limited (Beacon) was retained as the primary consultant to assist the MLA with these tasks and continues to provide professional expertise through 2019. This Water Quality Report presents the most recent data collected in 2019 and compares it to data collected from 2002 to the present.

Area Summary sheets have been prepared for each of the sampling areas in the 2019 program and these are presented in **Appendix A**. The Summaries provide an analysis of the data collected in 2019 and include historical total phosphorus and Escherichia coli (*E. coli*) results, where sampled. In addition, specific recommendations for the sampling areas are provided to continue to maintain, and where possible, improve the health of the lakes.

The results, summaries and scientific opinion regarding general health presented in the 2019 Water Quality Initiative Report are based on Beacon's analysis of data provided by the MLA. This does not represent the health of the entire lake and only captures information collected at a certain time and location during the sampling year. The reader should take this into consideration when reviewing the 2019 Water Quality Initiative Report and use caution in extrapolating data to a lake or watershed (any surface area from which runoff resulting from rainfall or snow melt is collected and drained or seeps to a common point including a marsh, stream, river, lake or groundwater).

1.1 Water Quality Initiative – Past and Present

The MLA's Water Quality Initiative (WQI) is a citizen-science based water quality monitoring program designed to measure key biological, chemical, and physical indicators of water quality in lakes throughout the District of Muskoka and parts of Parry Sound. The MLA has been collecting water quality samples since the 1970's, with the current WQI program implemented in 2001 and updates and upgrades have continued to improve the program through the years. The program is directed by the MLA Environment Committee, administered by support staff based at the MLA office in Port Carling, and implemented by a dedicated group of more than 100 volunteers. This program continues to be one of the most comprehensive water monitoring programs of any lake association in Canada.

The MLA partners with provincial agencies to monitor lake health in Muskoka. Over the longer term, the Ministry of the Environment, Conservation and Parks (MECP) Lake Partner Program (LPP) has recorded Secchi depth and phosphorus concentrations in the lakes. The LPP Program is a province

wide, volunteer-based, water quality monitoring program in which the MECP monitors more than 600 of the province's inland lakes, dating back more than 20 years. The 2019 LPP data was not available at the time of issuance of this report.

The MLA has adopted a long-term monitoring strategy for phosphorus, calcium, water clarity, and water temperature, and in 2013 introduced a monitoring strategy for DOC. The MLA's WQI continues to follow the detailed sampling protocol of the MECP and goes further with additional sampling for bacterial counts, and in some years for dissolved organic carbon (DOC) and calcium. Bacteria monitoring activities have focused on determining whether chronically elevated conditions exist in targeted nearshore recreation areas. This document provides a comprehensive overview of the monitoring program including sampling and analytical methodologies.

Similar monitoring programs are presently being undertaken by the MECP Lake Partner Program, District of Muskoka, Lake of Bays Association, Township of the Archipelago (partnered with the Georgian Bay Biosphere Reserve) and other lake associations. The MLA WQI complements and expands upon other monitoring programs conducted in the region by government agencies and other volunteer groups.

The MLA WQI program is different than that of the District Municipality of Muskoka (DMM) and the LPP in that it includes additional sampling sites and more frequent sampling. The DMM tests approximately 190 locations covering 164 lakes over a three-year period with approximately 80 locations done annually at deep-water sites in the spring (just after freshet). A total of 43 parameters are tested at each of these 190 locations. This program has ± 30 years of data. The LPP program samples over 600 lakes across the Province. These locations are at deep-water sites and are collected in the spring. LPP samples are tested for phosphorus and calcium. MLA tests at 190 locations four times over the summer in May, June, July & August. The locations include both deep-water and nearshore sites. Samples are tested for phosphorus and bacteria. The LPP and MLA sampling is undertaken by volunteers while the DMM uses hired staff.

Greater collaboration with similar monitoring programs has led to standardization of protocols, methodologies and sampling sites. The MLA continues to review similar monitoring programs to ensure that this program continues to keep up to date on methodologies and sampling parameters. It is important to note that while following established protocols, sampling methodologies and measurement technologies differ, however slightly, in the MLA WQI Methodology.

The WQI has evolved over the years since its initiation as a pilot program in 2001. Changes occur to add analytical power to the existing database. For example, Calcium was sampled for in 2011 and 2012 in response to recent findings that suggested calcium was declining faster than what would be realized under natural processes. The decline of calcium is anticipated to be associated with a longer time frame (decades) and as such, it can be sampled for less frequently.

Another example of change is the addition of sampling for dissolved organic carbon (DOC) which was initiated in 2013 and continued through 2018. DOC is the most abundant dissolved substance entering lakes and rivers in Muskoka/Parry Sound. DOC affects the acid-base chemistry which in turn affects the availability of some forms of nitrogen and phosphorus in lakes and rivers. Waterbodies that have a tea or brown colour tend to be high in DOC. DOC was not sampled for in 2019.

The master list of sampling areas and locations was reviewed early in the spring of 2019. The established list of core deep-water sites remained intact for long-term monitoring through 2019. Yearly sampling at a handful of previously stable sites was reduced to every other year. Monitoring sites were added at locations identified in areas of potential additional loads to the lake, and sampling efforts were increased at select 'Yellow' monitoring sites. In 2019, the MLA tested at 180 locations.

1.2 Harmful Algae Blooms (HAB's)

Harmful Algae Blooms [HAB's] are becoming an increasing concern in the Muskoka Watershed and are recognized in the DMM update to the Official Plan (OPA 47). Since identification of HAB's requires significant expertise, this is not currently part of the MLA WQI program. Current protocol is to have concerned citizens report suspected algae blooms to the MECP Spills Action Line and for MECP personnel to field verify whether the bloom is blue green algae (also known as cyanobacteria). Verified HAB's are sampled and lab tested for harmful components. As a HAB is a human health issue, HAB sites are posted on the Simcoe Muskoka District Health Unit website.

OPA 47 notes the importance of multiple environmental stressors and has included HAB's as one of three key water quality indicators that offer "*insight into measurable and observable changes in recreational water quality on a waterbody-specific basis*". Of the three identified water quality indicators in OPA 47, HAB's are included as "*A blue-green algal (cyanobacteria) bloom confirmed and documented by the Province and/or Health Unit*".

1.3 Monitoring Volunteers

In 2019, volunteers dedicated their time and continued support in collecting water quality samples at 180 different sampling locations including 238 Secchi depth measurements, 446 phosphorus samples (including duplicates), and 261 bacteria samples.

Without the continued dedication and support from the volunteers this sampling program would not be possible. Each Area Summary sheet identifies the volunteer samplers as well as the team leaders (**bolded**).

Each spring, two training workshops are offered to provide the volunteer samplers with an opportunity to review the methodology and understand any updates to the protocol.

2. Water Quality Monitoring Program

The objectives of the MLA Water Quality Program are:

- To promote and encourage good stewardship of the lakes;
- To monitor the long-term health of the lakes;

- To identify adverse water quality trends at an early stage; and
- To promote causation studies and remediation by the responsible authorities.

2.1 Regional Setting

The MLA sampling stations are in the Canadian Shield Physiographic Region (Ontario Geological Survey, 2003). The bedrock throughout this region has extensive outcroppings which are primarily the result of glaciation and post-glacial events. Prominent bedrock knobs and ridges are common and dominate features in some areas. The Precambrian landform expression strongly influences the topographic patterns of the region as well as the local overland drainage characteristics.

The MLA sampling stations are also located in an area of the Province known as “The Land Between”. “The Land Between” is an ecotone, or transition zone, which lies between the Canadian Shield and the St. Lawrence Lowlands, stretching across south-central Ontario.

2.2 Local Watershed Characteristics

The MLA sampling locations (**Figure 1**) are located within the Great Lakes drainage basin in central Ontario and eventually drain into Lake Huron via Georgian Bay. Within the Georgian Bay catchment area, most of the MLA sampling locations are within the Muskoka River watershed which drains an area approximately 4660 km^2 (Muskoka Water Web, 2013). The Muskoka River watershed is further divided into three subwatersheds: North and South Subwatersheds and the Lower Muskoka Subwatershed (Acres, 2006). Most of the sampling locations are within the Lower Muskoka Subwatershed which originates in Algonquin Park (Acres, 2006).

As noted in the District Municipality of Muskoka discussion paper *Dispelling the Myth and Closing the Gap 2019 Update* (February 2019), in August 2018, the MECP announced the Province’s new *Watershed Conservation and Management Initiative* for the Muskoka area. The Watershed Conservation and Management Initiative recognizes that the Muskoka Watershed is one of Ontario’s most distinctive natural environments and is essential for both its ecological services and for the economic benefits it brings to the region - and beyond - as a premier tourism destination.

Approximately 68% of the Muskoka River watershed is covered in forest and other natural vegetation; 15% consists of water (lakes, rivers and ponds), 11% is wetlands, and 2% is rock barrens and outcrops. Settlement areas only make up 2% of the watershed while developed land such as agriculture (cropland, pasture and open fields) and golf courses make up 2% of land cover within the watershed (Muskoka Heritage Foundation, 2007).

Where the bedrock is covered by soils, it is generally very thin and nutrient poor, therefore limiting the amount of nutrients that flow to the adjacent waterbodies.

Lakes with a phosphorus concentration less than 10 µg/L are considered oligotrophic (nutrient poor) (Dillon *et al.* 1986). This generally implies that the lake is very clear and deep with minimal aquatic plants and algal blooms, as well as high levels of dissolved oxygen. Lakes with a phosphorus

concentration between 10 and 20 µg/L are considered mesotrophic (moderately enriched). These lakes have some aquatic vegetation and can support an array of fish species. Lakes with a phosphorus concentration above 20 µg/L are considered eutrophic (nutrient rich). These lakes have large areas of aquatic vegetation and are often subject to algal blooms, thus having lower levels of oxygen. Muskoka naturally has a range of lakes in all three categories, although most lakes are oligotrophic.

Increases in the nutrient content of a lake (primarily phosphorus and nitrogen), can occur as a result of rainfall, overland run-off and percolation of soil-water to the lake. Higher concentrations of these dissolved nutrients can cause the water to become progressively more fertile and productive, stimulating the development of free-floating microscopic plants (algae).

All lakes are subject to nutrient inputs, however, artificial (man-made) enrichment will increase the rate of eutrophication. Eutrophication generally promotes excessive plant growth and decay, favouring simple algae and plankton over other more complicated plants, and causes a severe reduction in water quality.

Lake Muskoka is the largest lake in the Muskoka River watershed based on total surface area and is also the receiving water body for Lake Rosseau and Lake Joseph which are also the third and fourth largest lakes respectively. Lake of Bays is the second largest lake in the Muskoka River watershed.

Water management can typically be broken down into two interrelated components; water quality and quantity. Water quality is directly affected by quantity. For example, flooding and heavy precipitation events can cause several contaminants to enter waterways due to overland flow picking up contaminants on adjacent lands or overflow of sewage treatment systems. Since contaminant loading fluctuates with weather events, it is important to sample continuously through different seasons and years to help understand the fluctuations.

Under normal circumstances, during rainfall events, nutrients (phosphorus and nitrogen) associated with overland flow are generally retained by physical absorption in the lands adjacent to the waterbodies.

Typically, during normal rainfall and snowmelt conditions, water flows across the land picking up contaminants before entering waterways. As well as chemical contaminants and nutrients being flushed into natural water systems, *E. coli* and other bacterial contaminants from flooded or poorly functioning septic systems and warm-blooded animals may also enter waterways in this fashion.

Nutrient loading from a watershed can increase significantly when precipitation rates exceed the average rate. The Muskoka River Water Management Plan (MRWMP) provides for higher spring water levels resulting from the melting snow. The MRWMP states "*High water levels in early spring are natural occurrences which help to recharge groundwater supplies, transfer nutrients and sediments to wetlands and shoreline riparian zones and provides spring spawning fish and amphibians with access to wetlands and shoreline habitats*" (Acres, 2006).

The following three tables (**Table 1**, **Table 2**, and **Table 3**) summarize the rainfall and temperature records from the Beatrice Station from 2014 to 2019.

Table 1. Total & Average Monthly Rainfall recorded at the Beatrice Station[1]

Month	Total Monthly Precipitation (mm) in 2014	Total Monthly Precipitation (mm) in 2015	Total Monthly Precipitation (mm) in 2016	Total Monthly Precipitation (mm) in 2017	Total Monthly Precipitation (mm) in 2018	Total Monthly Precipitation (mm) in 2019	Average Monthly Precipitation (mm) 1981-2010
March	64.9	44.1	182.3	87.5	31.0	62.4	75.2
April	91.6	89.1	64.4	155.6	103.8	133.3	76.8
May	103.6	73.7	56.3	130.2	27.8	100.8	97.9
June	163.1	120.1	41.3	151.6	25.5	101.1	87.7
July	89.8	45.0	72.6	79.6	57.0	23.9	94.3
August	109.9	110.7	195.5	211.2	196.1	75.3	87.7

Table 2. Average Temperatures recorded at the Beatrice Station[1]

Month	Mean Temperature (°C) in 2014	Mean Temperature (°C) in 2015	Mean Temperature (°C) in 2016	Mean Temperature (°C) in 2017	Mean Temperature (°C) in 2018	Mean Temperature (°C) in 2019	Mean Temperature (°C) 1981-2010
March	-8.4	-6.2	-1.5	-5.9	-3.3	-6.2	-3.8
April	3.1	3.8	1.6	6.3	-0.2	3.3	4.4
May	11.1	12.6	11.0	10.1	13.3	9.1	11.0
June	17.0	14.9	15.5	15.4	15.5	14.2	15.8
July	16.2	17.5	18.6	17.9	19.5	19.3	18.2
August	16.8	17.1	19.4	16.4	19.3	16.5	17.3

Table 3. Highest Air Temperatures recorded at the Beatrice Station[2]

Month	Highest Temperature (°C) in 2014	Highest Temperature (°C) in 2015	Highest Temperature (°C) in 2016	Highest Temperature (°C) in 2017	Highest Temperature (°C) in 2018	Highest Temperature (°C) in 2019	Highest Temperature (°C) 1981-2010
March	11.4	8.9	12.7	9.5	8.6	9.9	2.4
April	15.9	21.0	22.4	27.1	17.9	18.9	10.7
May	25.1	29.5	30.0	28.4	30.9	21.4	18.1
June	29.3	24.9	29.6	27.7	30.0	27.7	22.6
July	28.4	31.1	30.0	28.0	33.9	30.6	24.9
August	27.5	28.7	33.3	27.5	30.4	27.9	23.8

Although there was a gradual snow melt for the first few weeks of April, and lake levels in the early spring of 2019 were slightly below the MRWMP management levels in the second week of April, the

[1] *Data obtained online from Government of Canada Environment and Natural Resources webpage notes that some values are based on incomplete data (http://climate.weather.gc.ca/climate_data/daily_data)*

[2] *Data obtained online from Government of Canada Environment and Natural Resources webpage notes that some values are based on incomplete data (http://climate.weather.gc.ca/climate_data/daily_data)*

spring freshet of 2019 produced historic flooding conditions. The levels in the lakes were the highest ever recorded and the 2019 flood was the second "100-year flood" in 6 years. The data presented in the hydrograph in **Figure 2** show the elevation of Lake Muskoka measured at Beaumaris from January 2003 through September 2019. Note the highest recorded level of 10.505 m on May 3, 2019. The second highest recorded level was 10.202 m on April 27, 2013.

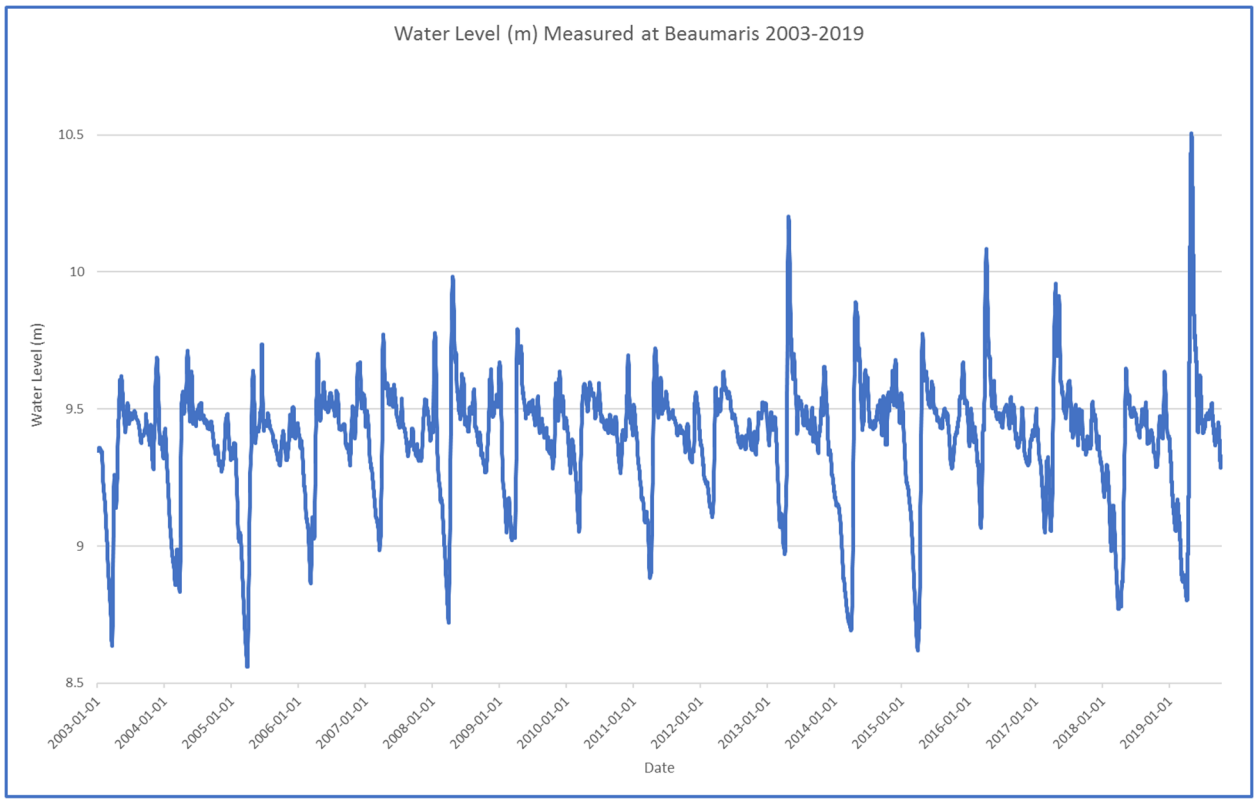

Figure 2. Water Level Recorded on Lake Muskoka at Beaumaris from 2003 to 2019 (Source: Government of Canada https://wateroffice.ec.gc.ca)

The average temperatures recorded in 2019 in May, June and August were generally cooler each month than temperatures recorded in the previous 5 years (**Table 2**), and a high total monthly amount of precipitation was recorded in April (**Table 1**).

A large rainfall event recorded at the Beatrice Weather Station on March 10 (20.9 mm) coupled with warm temperatures on March 14th and 15th (9.9 and 8.2, respectively) melted a large part of the winter snowpack. Precipitation in March, July and August was below the long-term average (**Table 1**). Snow continued through April as temperatures remained well below average for the month (**Table 2**).

Colder temperatures through the winter produced thick ice on the lakes which resulted in the ice staying on the lakes for an extended period in 2019, similar to the conditions in 2018. The earliest recorded ice-out date is March 23, 2012, the latest recorded ice-out date is May 7, 1926, and the average recorded ice-out date is April 19th (http://www.muskokacottageexperts.com/muskoka-ice-out-info). Due to the

colder winter temperatures, as well as the cooler March and April temperatures in 2019, ice-out was delayed until April 27 in 2019.

Large rainfall events recorded at the Beatrice Weather Station in April occurred on the 18th (28.7 mm), 19th (15.0 mm), and 26th (32.9 mm), adding to the melting snow of the freshet, and further adding to the extreme flooding conditions this spring. The only other large rainfall events (>20.0 mm) through the summer occurred on June 13th (22.2 mm) and 15th (30.3 mm).

2.3 General Methods

The WQI study area includes Lakes Muskoka, Rosseau, and Joseph and several smaller affiliate lakes and rivers. The study area is divided into sampling areas representative of lakes, bays, and rivers of interest. Each sampling area consists of one or more sampling sites. Most sampling areas have one reference site established in a central, deep-water location intended to represent "average" water quality conditions.

Details of the sampling protocols are provided in the MLA Water Quality Initiative Methodology Report (http://www.mla.on.ca).

2.4 Water Quality Parameters

Water samples collected for each of the sampling locations are analyzed for a variety of parameters and help to characterize the chemical composition of the waterbody and identify potential issues. The water quality parameters sampled during the 2019 program are provided below in **Table 4** along with a brief description of the parameter and reason for measuring.

Table 4. 2019 Water Quality Parameters

Water Quality Parameter	Description	Reason for Measuring
Total Phosphorus	Total phosphorus measures all forms of phosphorus present in a sample. There are many sources of phosphorus which are both man-made and naturally occurring in the environment. Phosphorus is the principal nutrient causing eutrophication.	Phosphorus is an essential nutrient for all living organisms. However elevated levels of phosphorus can affect aquatic ecosystems, often leading to algal blooms and increased plant growth, therefore decreasing water quality.

Water Quality Parameter	Description	Reason for Measuring
***Escherichia coli* (*E. coli*) and Total Coliforms**	Total coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in soils, plants and in intestines of warm-blooded and cold-blooded animals. Fecal coliforms, particularly *Escherichia coli*, are found exclusively in the intestinal tract of warm-blooded animals.	In abundance, E. coli will indicate contamination from excreta from warm-blooded animals, including humans, and may pose an immediate health risk.
Secchi Depth	The Secchi disk is used to measure water clarity at the deep-water sampling sites.	Clear water allows light to penetrate deeper into lakes which allows for photosynthesis and oxygen production. Secchi depth is one indicator of lake health used in conjunction with nutrient concentrations from the laboratory analyses.
Temperature	The temperature of the water is recorded during each sampling event using a thermometer and recorded in degrees Celsius.	Water temperature affects different physical, biological and chemical characteristics of a lake. Long term records assist in trend analysis.

The 2019 sampling season began in late-May due to the flooding conditions, ending in late August and generally included a total of four sampling events. Components of the program included:

- Total phosphorus (TP) samples were generally collected either once during spring turnover, or on separate occasions throughout the sampling season. All TP samples collected in May at the deep stations are considered spring turnover TP samples. This is because the lakes in this area have not yet stratified, separating the lake into layers. This allows for vertical mixing of the water column and phosphorus concentrations are mixed in the water column. The remaining TP samples in June, July and August were taken from a mix of locations including deep-water, nearshore and watercourse sampling locations.

- Bacteria samples were tested for *E. coli* and total coliforms. These samples were collected from nearshore locations during the second, third and fourth sampling events. Additional sampling was to be implemented weekly if *E. coli* levels were found to be equal to or greater than 50 cfu/100ml. *E. coli* sampling at focus areas established in 2016 at Minett (MIN-1, MIN-6, MIN-7 and MIN-9) was continued through 2019. This included sampling for *E. coli* 8 times through the summer.

- A Secchi disk was used to measure water clarity at the deep-water locations. In general, sampling occurred at each of the deep stations 3 to 4 times in 2019.

- Temperature was measured at each of the sampling stations during each of the sampling events throughout the spring and summer.

This water quality program focuses on phosphorus and *E. coli* sampling on a yearly basis and incorporates additional parameters including DOC and calcium on a rotational basis or when necessary. Algal bloom monitoring and/or sampling is not part of this monitoring program and any recommendations or classifications provided for each area are based on results as per the water quality parameters mentioned above.

2.5 Updates in the 2019 Monitoring Program

Sampling sites are chosen and classified according to their local environment. The three site types are **nearshore, deep-water, and watercourse**. Nearshore sites are located adjacent to land where the water depth is generally between 50 cm and 150 cm as this is the depth at which most recreational use occurs. Deep-water sites are in deeper, open water locales. Watercourse sites are in streams and creeks conveying flow to the larger waterbodies. Sampling methodologies differ based on the type of sampling site (see Water Quality Initiative Methodology Report, Beacon 2019).

Prior to each sampling season, a complete review of the sampling sites is conducted. Sampling sites generally remain consistent from year to year, as the main goal of the program is to discover the sources of phosphorus entering the lakes based on long term trends, while other objectives include providing additional data to support the protection of vulnerable areas, monitor *E. coli*, and promote stewardship. However, site revisions are made as necessary based on analyses of previous data, volunteer availability, new information, and budget. Generally, bacteria monitoring is discontinued at sampling sites exhibiting persistently low bacteria levels (3+ consecutive years with average concentrations below 10 cfu/100ml). In sampling areas where bacteria monitoring is reduced, new nearshore sites are generally established as necessary.

The review of the historical data and planning for the 2019 program resulted in changes in sampling locations and water quality parameters sampled. Changes include:

- Two monitoring sites were added at locations identified in areas of potential additional loads to the lake.
- Five monitoring locations were discontinued in 2019 due to either low *E. coli* levels in the previous years, or because sites are sampled on a rotational basis.
- Phosphorus sampling was increased in 2019 at 15 locations and decreased at 5 locations.
- Leonard Lake and Three Mile Lake did not participate in the 2019 program.

Calcium was again not sampled for during the 2019 program. Testing for calcium is done periodically as levels change slowly over time. The DMM is collecting and reporting on calcium levels.

Finally, the 2019 monitoring program changed to use ALS for laboratory analytical analysis of the phosphorus samples. ALS provided a detection limit of 3.0 µg /L and precision to 0.1 µg /L.

3. 2019 Monitoring Results and Sampling Analysis

Based on the long-term data acquired to date, the water quality in most of the sampling locations remains consistently good to excellent. The results from each sampling area are presented in the Area Summary Sheets (**Appendix A**). Each sheet describes the specific sampling area and provides a summary of the 2019 data, as well as graphical results of phosphorus and *E. coli* results, if sampled for. Each new area description in 2019 is based upon first-hand knowledge, historical and up to date aerial photography, as well as file information from the Ministry of Natural Resources and Forestry and the District Municipality of Muskoka.

The Area Summary Sheets summarize mean Secchi Disk depth, spring turnover phosphorus and yearly mean phosphorus concentrations, and *E. coli* and total coliform yearly geometric means. A visual indication of the overall water quality at each Area is presented by means of a traffic light symbol. The meaning of each symbol is described below:

Green Light
Water quality remains consistently good.

Yellow Light
Further investigation is recommended to maintain good water quality.

Red Light
Remedial action is recommended to improve water quality.

In 2019, thresholds were redeveloped for each of the traffic light symbols to better quantify the data trends for phosphorus based on the District Municipality of Muskoka recently adopted Official Plan amendment (OPA 47). The key water quality indicators are provided in DMM Policy C.2.6.3.2 and identify the water quality indicators as:

i) A long-term statistically significant ($p<0.1$) increasing trend in total phosphorus concentration demonstrated by at least five (5) spring overturn phosphorus measurements obtained through the District of Muskoka water quality sampling program since 2001;

ii) A long-term total phosphorus concentration of greater than 20 µg/L demonstrated by the average of five (5) most recent spring overturn phosphorus measurements obtained through the District of Muskoka water quality sampling program within the last ten (10) years; and/or

iii) A blue-green algal (cyanobacteria) bloom confirmed and documented by the Province and/or Health Unit.

OPA 47 provides schedules, which are an operative part of the Muskoka Official Plan. Schedule E2 provides a list of "Waterbodies Where a Water Quality Indicator has been Confirmed in Accordance with the Policies of Section C2.6 of the Muskoka Official Plan". As defined in Policy C2.6.6.1 (Waterbodies Listed in Schedule E2) in OPA 47:

> *a) A waterbody will be added to Schedule E2 once one or more of the water quality indicators identified in Section C2.6.3.2 a) i) and ii) is confirmed to be present for three consecutive years of monitoring and/or when the water quality indicator identified in Section C2.6.3.2 a) iii) is confirmed to be present.*

For phosphorus analysis this year, the MLA has assigned a yellow light threshold for phosphorus concentrations that are either:

a) >20 µg /L (latest 3-year spring turnover average);
b) show an increasing trend in spring measurements over the last 3 years; OR
c) have an annual average TP that exceeds spring TP;

Similarly, the MLA has assigned a red light threshold for phosphorus concentrations that are either:

a) >20 µg/L (latest 5-year spring turnover average); OR
b) have a statistically increasing trend in spring measurements over the last 5 years (or longer).

For Harmful Algae Bloom analysis in 2019, the MLA has assigned a red light threshold for those locations with a confirmed blue-green algal (cyanobacteria) bloom in 2019, a yellow light threshold for those locations with a blue-green algal bloom confirmed within the last 3 years, or, a bloom in the current year (2019) with the toxic component (microcystins) measured to be <20 µg/L. Finally, the MLA has assigned a green light threshold for those locations that have never had a blue-green algal bloom, or that have had 3 years since the last bloom.

In 2018, following consultation with the MLA Environment Committee, new *E. coli* and phosphorus thresholds were established using Health Canada and the Ministry of Health and Long-Term Care standards. These thresholds continue to be used for 2019.

Regarding *E. coli*, the methodology recommended in the Ministry of Health and Long-Term Care Operational Approaches for Recreational Water Guideline (2018) for recreational water use at public beaches and waterfronts is based on a geometric mean of levels of *E. coli* determined from a minimum of five samples per site collected within a one-month period. If the geometric mean for a series of 5 samples in a month at a given site exceeds 200 colony forming units (cfu) of *E. coli* per 100 milliliters (ml), the site is unsuitable for swimming and bathing. While many watershed managers believe that among bacteria of the coliform group, *E. coli* is the most suitable and useful indicator of fecal coliform, others continue to require testing for total coliform. For this parameter, the guideline for recreational body contact is 1,000 cfu per 100 ml, based on a geometric mean for a series of 5 samples per site per month. The MLA *E. coli* geometric mean is determined over the sampling program duration (1 sample per month over 4 months). If the *E. coli* levels are found to be greater than 50 cfu/100ml, the MLA WQI includes a field protocol that requires volunteers to re-sample the site. Therefore, some sites may have more than one *E. coli* sample per month.

The following table (**Table 5**) describes the thresholds for the 2019 analysis of *E. coli* and phosphorus concentrations.

Table 5. MLA Thresholds for Assigning Traffic Light Limits for Area Summaries

Traffic Light	*E. coli Yearly Geometric Mean (cfu/100 ml)*	Phosphorus Trend Associated with all Sampling Years	Harmful Algae Blooms (HAB's)
	0 – 30	Flat or decreasing visual trend	No bloom ever, or 3 years since last bloom
	31 – 199	a) >20 µg /L (latest 3-year spring turnover average); b) show an increasing trend in spring measurements over last 3 years; OR c) yearly mean TP exceeds spring TP	Bloom within last 3 years, or if available, bloom in current year with toxic component (microcystins) measured <20 µg /L
	>200 geometric mean for a series of 5 samples per site per month	a) >20 µg/L (latest 5-year spring turnover average); OR b) statistically increasing trend in spring measurements over last 5 years (or longer).	Bloom in current year

The traffic light symbols in each Area Summary are based on the category indicating the level of water quality related to *E. coli* and phosphorus levels as defined in **Table 5**.

Traffic light thresholds for phosphorus are reviewed annually with the MLA Environment Committee.

3.1 Mean Secchi Depth Measurements

Secchi depth is a measurement of water clarity, providing water quality information. A decrease in water clarity in these sampling locations is most likely either a result of increased dissolved organic carbon (DOC) levels or increased levels of nutrients from the watershed. DOC inputs originate in wetlands and cause a naturally brown or tea colour in a water body. A decrease in water clarity can also result from increased levels of suspended sediments in turn leading to algal growth, decreasing clarity.

Water clarity can change in the short term because of weather, shoreline development or seasonal changes. A long-term decrease in water clarity is generally an indication of an increase in nutrient (phosphorus and nitrogen) levels and therefore a decrease in water quality. Lakes with a Secchi depth >5 m are considered oligotrophic or unenriched. Lakes with a Secchi depth between 3 and 5 m are considered mesotrophic or moderately enriched. Finally, lakes with a Secchi depth <3 m are considered eutrophic or enriched (Dillon *et al.* 1986).

Secchi depth values are determined by averaging the "up" and "down" measurements recorded by the volunteers using a Secchi disk. The mean Secchi disk value listed in the Area Summaries represents the arithmetic mean of values obtained from individual sampling sites throughout the season. The Area Summary Sheets provide the mean Secchi depth for each deep-water site sampled in 2019. The 2019 sampling program included additional sampling through the year for Secchi values to better understand water clarity through the summer. Because water clarity in most lakes in Muskoka/Parry Sound is affected by dissolved organic carbon (DOC), which results in tea coloured water, and not just by algal concentrations, the Secchi depths alone cannot be considered an indicator of nutrient (phosphorus) status; however, this data remains important for monitoring long-term water quality trends.

That said, generally the Secchi depths recorded in 2019 continue to remain consistent with the depths reported historically, with expected minor variation (up and down) through the years. Overall, shallower yearly average Secchi depths were observed in 2019 compared to 2018. Stations STN-0 and HMB-0 (7.00 m), and FTB-0 and BRU-0 (6.50 m) recorded the deepest mean Secchi readings in 2019. It should be noted that, similar to 2018, the lowest mean Secchi depths recorded in 2019 were from the Brandy Lake sites. Stations BDY-0, BDY-2, BDY-3, BDY-9 and BDY-10 (1.00 m) and BDY- 2,5,6 & 11 (0.90 m) all experienced the lowest mean Secchi readings in 2019.

3.2 Phosphorus

Phosphorus accumulation in upland soils may affect freshwater ecosystems. Production in most lakes depends on phosphorus input (Schindler 1977). Excess phosphorus in aquatic ecosystems leads to decreased water clarity, low dissolved oxygen, dispersal of toxic compounds, and a shift from macrophyte-dominated ecology characterized by diverse biota to an alga dominated system with low biodiversity (Vollenweider 1968; Horne and Goldman 1994). Potential phosphorus accumulation in aquatic ecosystems is thus strongly influenced by watershed land use and the concentration of phosphorus in watershed soils.

3.2.1 Deep-water

Several years of spring-turnover phosphorus data can be analyzed to understand the nutrient status of the lake and understand trends through time which might indicate a change in the nutrient status of the lake.

As noted in the District of Muskoka 2012 Lake System Health Monitoring Program Year End Report:

> "*Phosphorus is the nutrient that controls the growth of algae in most Ontario lakes. For this reason, an increase in phosphorus in a lake increases the potential for algal blooms. Algal blooms detract from recreational water quality and, in some cases, affect the habitat of coldwater fish species such as Lake Trout*."

Duplicate phosphorus samples collected in 2019 were analyzed for the degree of difference between the duplicates according to the District Municipality of Muskoka (DMM) phosphorus data management protocol and the MECP interim protocol for removing what are termed bad splits. The MECP Lakeshore Capacity User Manual (November 2011) states that if duplicate samples that differ by the higher being

30% more than the lower, or >5 mg/L than the lower, then the higher sample should be deemed as a bad split and should be removed from the analysis and the lower value is used. Beacon has analyzed the 2019 data to remove any of the bad splits from the analysis as per the present MECP interim approach. All the raw data will remain in the database should it be required for future consideration if for example the MECP interim protocol for bad splits is revised.

In 2017, a change in the methodology occurred such that one single grab sample (previously two samples) was acquired from which 2 samples (one sample plus a duplicate) were taken for phosphorus analysis. This change decreased the number of "bad-splits" to less than half of those encountered in 2016. In the 2017, 8% (33 of 403 samples) were deemed to be bad splits. In 2018 and 2019, fewer duplicates were acquired and bad splits increased. In 2018, 19 of 47 samples (40%) were deemed to be bad splits, and in 2019, 22 of the 46 duplicate phosphorus samples (48%) were deemed to be bad splits. Of the 22 bad splits in 2019, 7 of those were the same sites with bad splits in 2018 (ALL-0, CLR-0, GUL-0, MUS-3, SPC-0 and STR-0 [twice]).

Following the analysis for bad splits, an outlier analysis was undertaken for all spring turnover data using the DMM protocol. There are various approaches to outlier detection depending on the objective, and the number of observations in the data set. The DMM uses the Grubb's Test for outliers contained in the 2008 Gartner Lee report *Review of Long-Term Water Quality Data for the Lake System Health Program*. The Grubb's Test for outliers (extreme studentized deviates) was used in previous MLA water quality reports and continues to be used to analyze the 2019 data.

Since the outlier detection is dependent on long-term data analysis, all the dataset is used for each sampling location during each sampling analysis. Natural variation in levels of spring phosphorus is realized following the statistical analysis using Grubb's Test. A good example continues to be the May 2011 spring turnover phosphorus concentration at the Foot's Bay deep station (FTB-0). Using the Grubb's Test in 2013, the value obtained in the spring of 2011 (15 µg/L) was an outlier. A value the same as that obtained in the spring of 2011 was recorded in the spring of 2018 (15 µg/L). Analysis of spring phosphorus using Grubb's Test in 2019 resulted in no significant outliers at the FTB-0 site. In 2018, FTB-0 was classified with a yellow stoplight due to the increasing phosphorus trend in the past 3 years. In 2019 the increasing p trend has stopped and FTB-0 is once again classified with a green stoplight.

Following the Grubb's Test analysis of spring phosphorus from 2002-2019, a total of 10 spring phosphorus data points were removed in the 2019 analysis of the data sets, compared to 11 in 2018 and 18 in 2017. The data points, (and corresponding year shown in brackets) removed from the database in 2019 were from GNB-0 (2018), HMB-0 (2011), MBA-0 (2003), MIN-0 (2016), MIR-0 (2014), POR-0 (2018), RMI-0 (2004), STN-0 (2011), TOB-0 (2017) and WLB-0 (2006).

The spring phosphorus data that passed the statistical analysis are plotted and presented in the Area Summary Sheets (**Appendix A**). The reader is reminded that in 2012 the deep-water total phosphorus data were deemed unreliable, were removed from the analysis, and therefore no results are presented in the Area Summary Sheets for phosphorus in 2012.

Spring turnover and yearly mean total phosphorus data have been acquired for most sites monitored in 2019. Current and historical total phosphorus data for deep-water sites within each sampling area are presented in a graph to show long-term trends. Where appropriate, graphs show MLA data in relation

to the previous DMM threshold concentration set by the DMM, and the present water quality indicator threshold (20 µg/L) adopted by the DMM in OPA 47.

On the graphs illustrating long-term phosphorus levels, previous DMM threshold concentrations have been represented by a single grey dashed line. The present water quality indicator threshold (20 µg/L) adopted by the DMM in OPA 47 is shown as a dark blue solid line. **Figure 3** shows the 2019 graph for ELG-0 for illustration purposes. For sampling areas in the DMM, the previous DMM threshold values are those in previous year's reports, provided by the DMM. Sampling areas without previous threshold lines were not previously modelled and are not comparable to other areas as previously confirmed through consultation with the DMM.

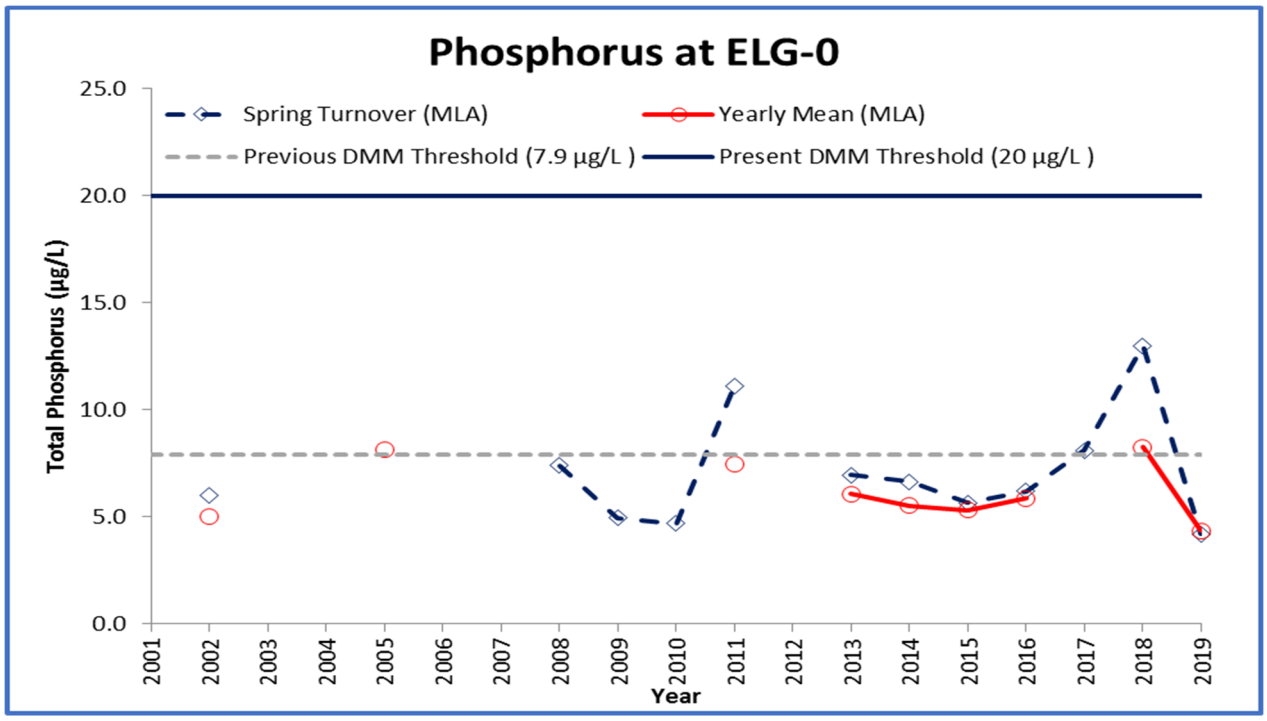

Figure 3. Illustration of ELG-0 Showing Long-term Phosphorus Levels

Figure 3 is provided to explain the phosphorus graphs in the Area Summary sheets, using ELG-0 as an example. Spring turnover and yearly mean total phosphorus measured by the MLA at ELG-0 is shown in µg/L on the y-axis and sampling year is indicated on the x-axis. Spring turnover total phosphorus concentration was calculated as the arithmetic mean of the spring or mid-May duplicate sample measurements, where available for all sites. Historical spring turnover total phosphorus concentrations for the deep-water reference sites have been represented graphically as a blue line with diamonds or as single blue diamonds (**Figure 3**), if consecutive years of data were not available. Note that in previous years, duplicate spring turnover samples were not consistently collected at some sites and for these sites, a single spring turnover sample has been reported. Historical deep-water yearly mean total phosphorus concentrations have been represented graphically in the Area Summaries as a red line with circles or as a single red circle, if consecutive years of data were not available.

Deep-water, nearshore and watercourse yearly mean total phosphorus concentrations in 2019 were calculated as the arithmetic mean of all measurements from an individual sampling site within the sampling season, including duplicate sample measurements, where available.
Although there was an overall generally increasing trend in most of the deep-water spring phosphorus concentrations in 2017 compared with values in 2016, that trend was not realized in 2018 or 2019. At the deep-water station sites (not including the watercourse sites listed in **Table 8**) that were sampled for spring phosphorus, 8 (15%) of the 52 sites showed the lowest spring phosphorus concentration recorded to date, compared to 42 % in 2018. **Table 6** summarizes the 2019 stations with the lowest recorded deep-water spring phosphorus concentrations to date. Additionally, 3 (6%) of those 52 sites that were sampled for spring phosphorus showed the lowest levels of yearly mean phosphorus concentration recorded to date.

Table 6. Lowest Recorded Spring Phosphorus to Date at Deep-water Sites

Lake Joseph	Lake Muskoka	Lake Rosseau	Affiliate Sites
	Arundel (ARN-0)		Gullwing Lake (GLW-0)
	East Bay (EAS-0)		Gull Lake (GUL-0)
	Eileen Gowan (ELG-0)		Silver Lake (SVR-0)
	Dudley Bay (MUS-2)		
	Taylor Island (TAY-0)		

Conversely, in 2019, five of the deep-water sites recorded the highest spring phosphorus concentrations to date, compared to 4 deep-water sites in 2018. Those 5 sites in 2019 were IND-0 (9.4 µg/L), LLJ-0 (10.7 µg/L), MGN-0 (8.0 µg/L), POR-0 (6.5 µg/L) and SKB-0 (9.5 µg/L). The highest value to date for POR-0 (13.0 µg/L) was an outlier in 2018 and 2019.

It is interesting to note that all the sites with the lowest recorded spring phosphorus concentrations to date were either Affiliate sites, or sites located within Lake Muskoka and all the sites with the highest spring phosphorus concentrations to date were located within Little Lake Joseph, Lake Rosseau, or the Indian River.

3.2.2 Nearshore

Two new nearshore stations (FTB-4 and FTB-5) was established in Green's Bay to the west of Foot's Bay to investigate phosphorus concentrations and *E. coli* levels. Beacon recommends that the new stations continue to be sampled through 2020 to analyze for trends.

Nearshore phosphorus concentrations in 2019 remained consistent with results since 2016 showing an overall generally static (neither increasing nor decreasing) trend in most of the nearshore phosphorus concentrations. At the nearshore station sites, 10% (9 of 86 sites) of the sites showed an increasing trend in the past 3 years, similar to the 2018 analysis. Of those 10 sites, 5 of them had an increasing trend due to a high value obtained in 2019, all of which were analyzed to be outliers. An analysis of the trend over time at each of the nearshore stations using all data shows that at 73 % (63 of 86) of the stations there was a decreasing trend in phosphorus, and at 9% there was neither an increasing or decreasing trend. Six of the nearshore sites were not analyzed for trending phosphorus as each of them consisted of 3 or less observations to date.

Table 7 summarizes the 2019 stations with nearshore phosphorus concentrations that were generally elevated from the 2018 and 2017 concentrations.

Table 7. Elevated 2019 Phosphorus Nearshore Sites

Lake Joseph	Lake Muskoka	Lake Rosseau	Indian River	Affiliate Sites
Foot's Bay (FTB-3)	Dudley Bay (DUD-1)	Rosseau Falls (RFL-1)[1]	Indian River (IND-8)[1]	Bass Lake (BAS-7)[1]
Little Lake Joseph (LLJ-2)[1]	Willow Beach (WLB-4)	Skeleton Bay (SKB-1)		Bruce Lake (BRU-6)[1]

[1.] Increasing trend due to one high value obtained in 2019, analyzed to be an outlier.

3.2.3 Watercourse

Of the watercourse sites sampled for spring phosphorus in 2019, MRV-5 showed the lowest spring phosphorus concentration to date, and HMB-8 showed the second lowest spring phosphorus concentration to date. It should be noted that 13 watercourse sites were sampled for spring phosphorus in 2018 and of those, 100% showed a lower phosphorus concentration than in 2017.

The watercourse stations (WIN-7 and WIN-8) established at Windermere in 2014 to assess nutrient inputs from the lakes and ponds upstream of the long-established WIN-1 site continued to be sampled in 2019. The spring phosphorus concentration in 2018 at WIN-7 was the lowest ever recorded and this was repeated in 2019 with an even lower spring phosphorus concentration. The yearly mean phosphorus concentration at WIN-7 was the lowest recorded in the 6 years of data gathered. The phosphorus trend at both WIN-7 and WIN-8 has generally been decreasing for the last 6 years at each of these stations. Continued sampling at all the Windermere stations in 2019 is recommended to assess the scale and trends of the nutrient input from the upstream sources.

3.2.4 Summary

The spring phosphorus levels at each of the nearshore and deep-water stations in Lake Joseph, Lake Rosseau and Lake Muskoka, are shown in **Figure 4**, **Figure 5**, and **Figure 6**, respectively.

As noted previously, lakes with a phosphorus concentration less than 10 µg/L are considered oligotrophic (nutrient poor), lakes with a phosphorus concentration between 10 and 20 µg/L are considered mesotrophic (moderately enriched), and lakes with a phosphorus concentration above 20 µg/L are considered eutrophic (nutrient rich).

Spring phosphorus levels in Lake Joseph in 2019 were generally below 10 µg/L, indicating oligotrophic conditions (**Figure 4**). Although the deep-water site in Little Lake Joseph and one of the nearshore stations (LLJ-7) had high readings in the spring, these higher levels were not realized downstream in any of the Joseph River sites (JOR-0, JOR-1 or JOR-2), or at the Cox Bay sites (COX-0, COX-2, COX-3, COX-6, COX-7, COX-8). Additionally, the phosphorus levels at LLJ-7 in the spring of all other years (2015-2018) have been below 10 µg/L. Although the 32.1µg/L at LLJ-7 in 2019 was evaluated to be an outlier, it is still shown in **Figure 4**.

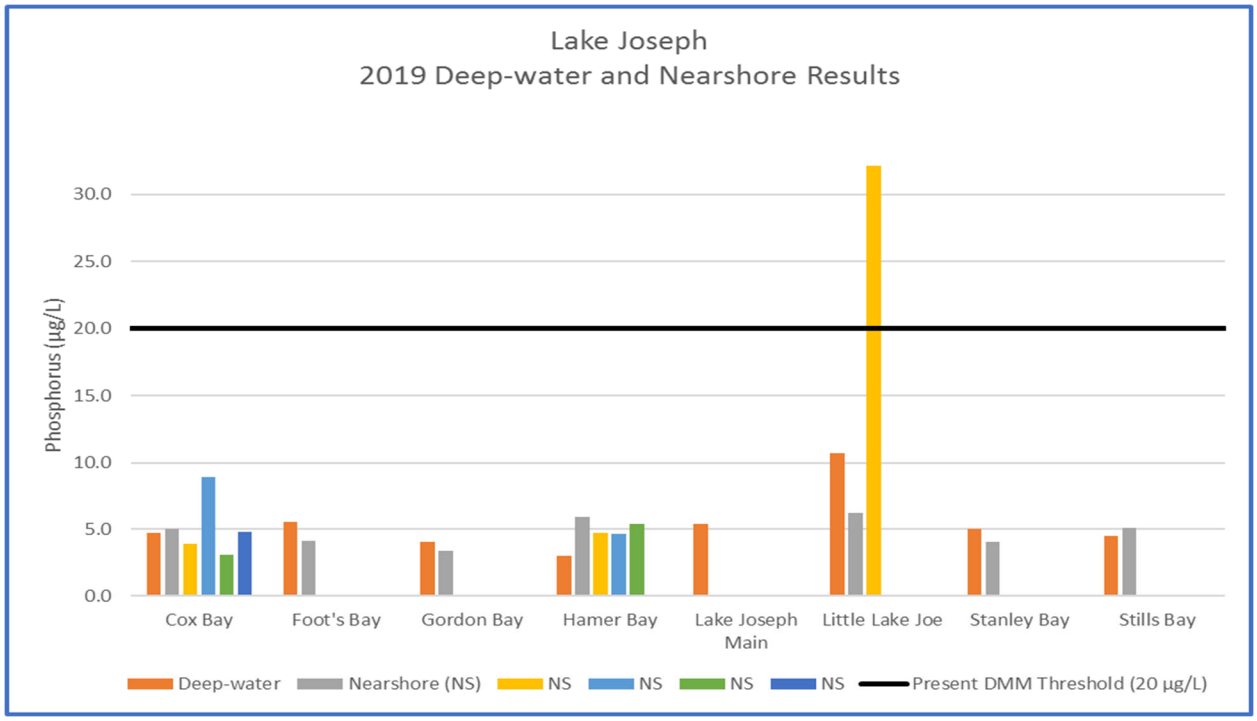

Figure 4. 2019 Spring Phosphorus Levels at Deep-water and Nearshore Stations in Lake Joseph

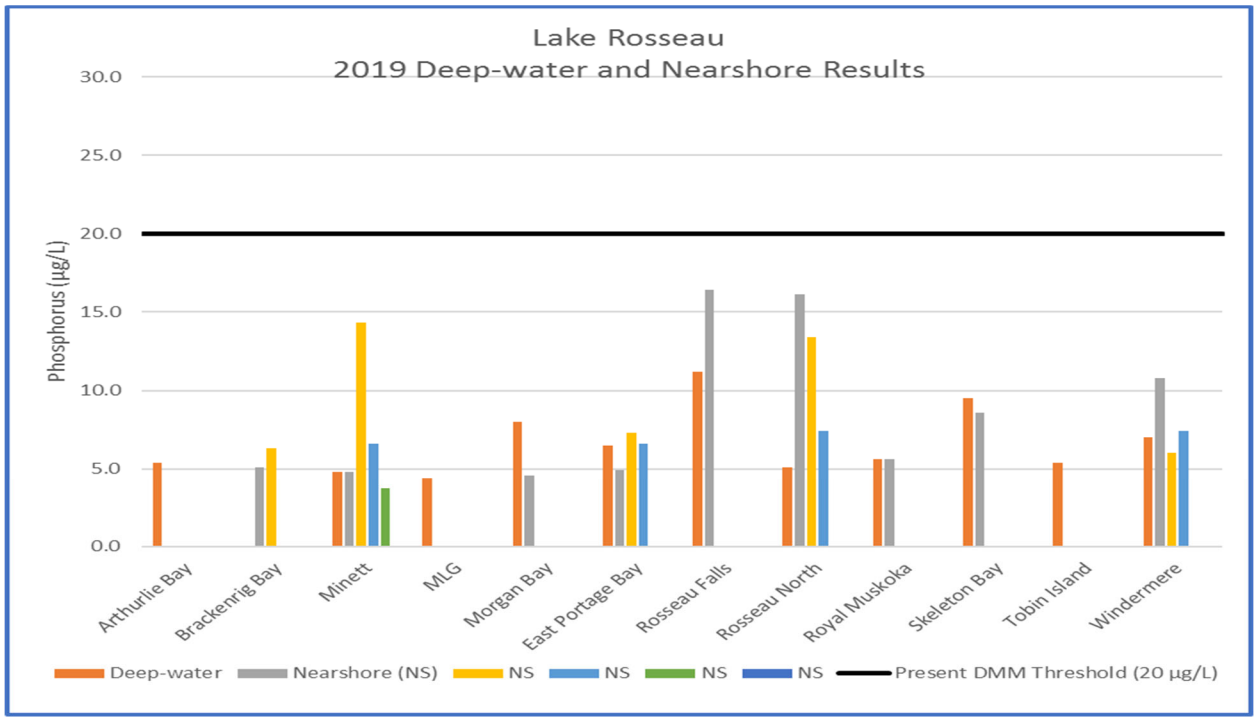

Figure 5. 2019 Spring Phosphorus Levels at Deep-water and Nearshore Stations in Lake Rosseau

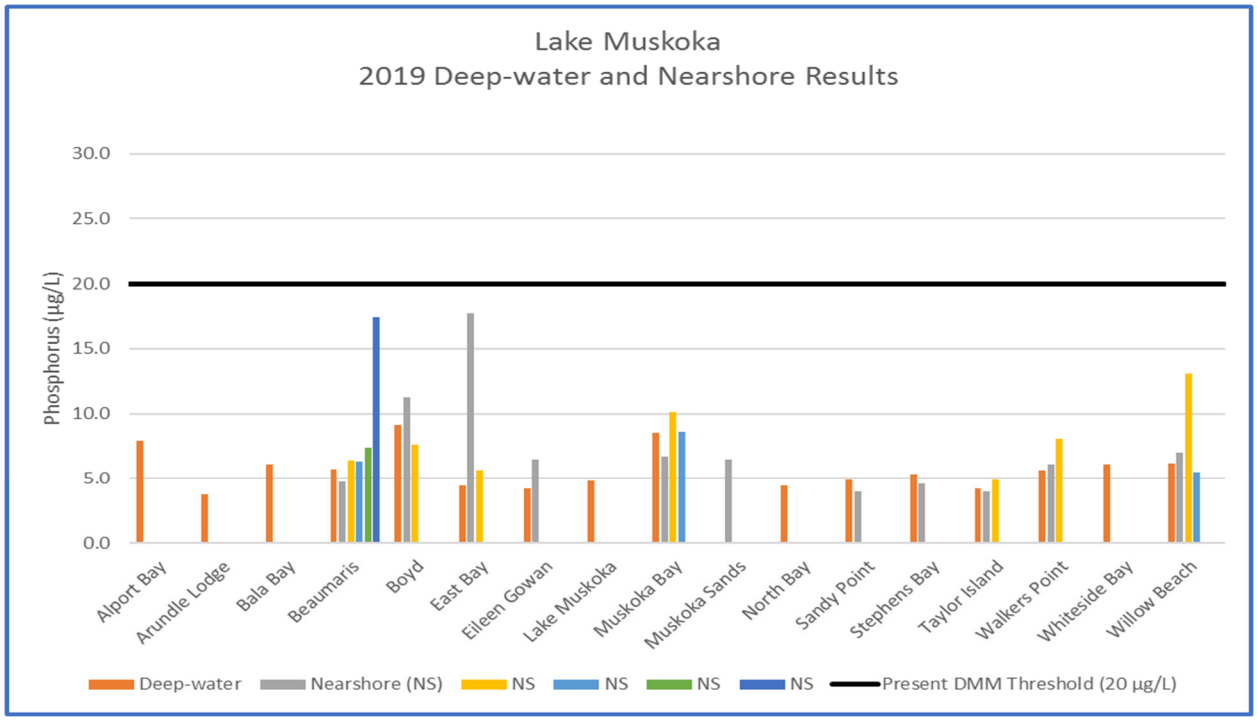

Figure 6. 2019 Spring Phosphorus Levels at Deep-water and Nearshore Stations in Lake Muskoka

Spring phosphorus levels in Lake Rosseau in 2019 (**Figure 5**) were generally below 10 µg/L, with elevated levels at Minett (MIN-6), Rosseau Falls (RFL-0 and RFL-1), Rosseau North (RSH-2 and RSH-4) and Windermere (WIN-1). Phosphorus levels at each of these stations, except for RFL-0 (only 2 years of data), consistently exceed 10 µg/L each spring. Stations MIN-6, RFL-1, RSH-2 and WIN-1 are all located adjacent to streams entering Lake Rosseau. Station RSH-4 is located directly adjacent to the Town of Rosseau public docks in the Town of Rosseau.

Spring phosphorus levels in Lake Muskoka in 2019 (**Figure 6**) were also generally below 10 µg/L, with elevated levels at Boyd Bay (BOY-3), East Bay (EAS-2), Muskoka Bay (MBA-4) and Willow Beach (WLB-3). Each of these stations is located adjacent to streams entering Lake Muskoka.

Spring phosphorus levels at the deep stations in all three lakes (Joseph, Rosseau, and Muskoka) were all below 10 µg/L, except for stations LLJ-0 and RFL-0. Station LLJ-0 has recorded spring phosphorus levels exceeding 10 µg/L in 2 of the 13 years of sampling (2014 and 2019). Otherwise, the average spring phosphorus of the other 11 sampling years at LLJ-0 is 5.3 µg/L. Beacon recommends that LLJ-0 continue to be sampled to analyze for long-term trends in spring phosphorus. Station RFL-0 is at the edge of a small bay associated with RFL-1 and the stream entering Lake Rosseau. Since there are only 2 years of data for RFL-0, Beacon recommends that RFL-0 continue to be sampled to evaluate for long-term trends in spring phosphorus.

The spring phosphorus levels at each of the nearshore and deep-water stations in the Affiliate lakes and rivers are shown in **Figure 7** below.

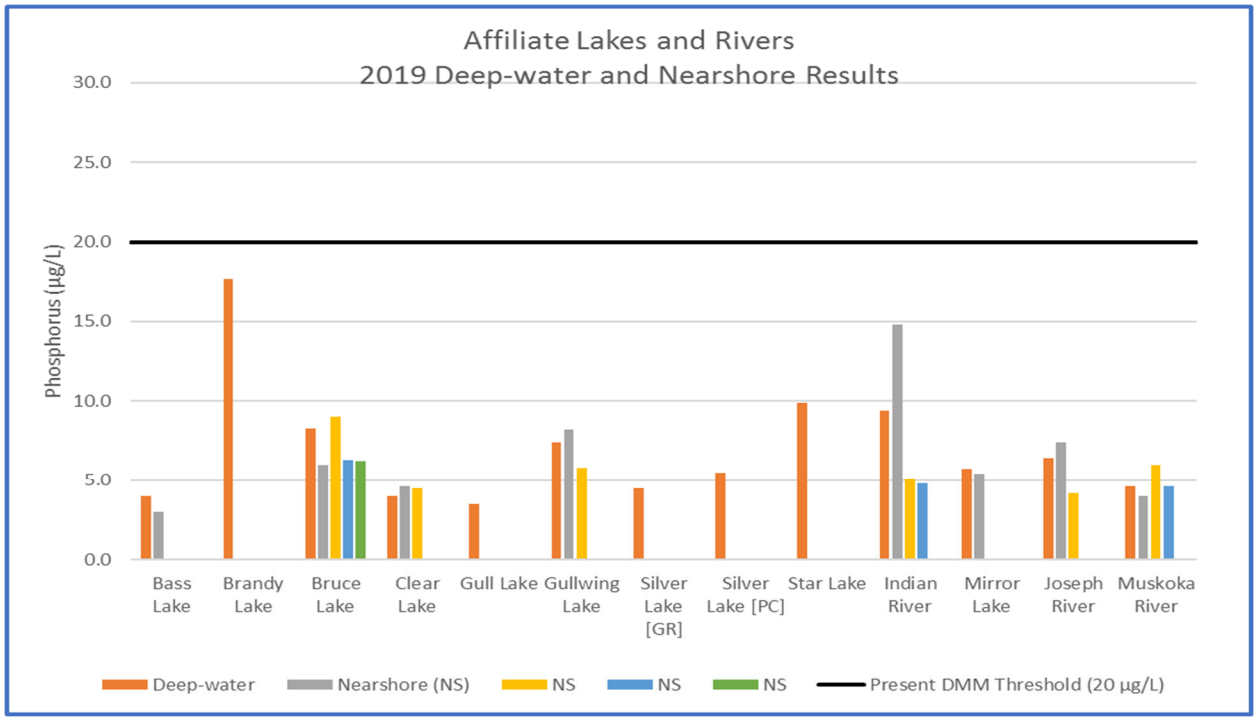

Figure 7. 2019 Spring Phosphorus Levels at Deep-water and Nearshore Stations in Affiliate Lakes and Rivers

Spring phosphorus levels in the Affiliate lakes and rivers in 2019 (**Figure 7**) were all below 10 µg/L, except for elevated levels at Brandy Lake (BDY-0) and Indian River (IND-7). BDY-0 has consistently been at or exceeded 10 µg/L in all 14 years sampled to date and IND-7 exceeded 10 µg/L for the second time in 7 sampling dates.

Water level fluctuations can significantly affect lake water quality. As noted previously, the spring freshet of 2019 produced historic flooding conditions. The levels in the lakes were the highest ever recorded and the 2019 flood was the second “100-year flood” in 6 years. High water levels can increase the concentration of nutrients from runoff and flooded lakeshore soils. Older septic systems, located near lakes, may flood when groundwater levels are high. Yet another consequence of fluctuating water level is shoreline erosion. Each of these scenarios can increase the concentration of phosphorus in a receiving water body.

The average length of time water remains in a lake is called the retention time or flushing rate. The lake’s size, water source, and watershed size primarily determine the retention time. Rapid water exchange rates allow nutrients to be flushed out of the lake quickly, or conversely, nutrients may remain within a waterbody for years.

It was postulated in the 2017 Water Quality Initiative Report that the high-water levels and flooding encountered from the high level of precipitation in the spring of 2016 would have also potentially allowed the addition of nutrients to the waterbodies that may not be apparent for years. Although the lack of spring freshet in 2018 decreased the amount of nutrients being flushed into the watershed, the record setting flooding in the spring of 2019 brought more water and possibly nutrients than ever before. That said, some of the lowest spring phosphorus levels to date were recorded in the waterbody at the

downstream end of the watershed (Lake Muskoka sites ARN-0, EAS-0, ELG-0, MUS-2 and TAY-0), as well as the Affiliate sites Gullwing Lake (GLW-0), Gull Lake (GUL-0) and Silver Lake in Gravenhurst (SVR-0). There were no similar record low spring phosphorus levels in either Lake Joseph or Lake Rosseau.

Following the 2018 analysis, there did not seem to be a defined increase in phosphorus concentrations that might be correlated with the 2016 spring flooding. Beacon will continue to review spring and yearly mean phosphorus levels at all stations to look for continuing potential impacts and trends, including impacts resulting from the flooding conditions of 2019.

3.3 Harmful Algae Blooms (HAB's)

In 2018, HAB's were reported near the Windermere WIN-1 site (base of falls below Clark's Pond), and the Boyd Bay BOY-3 site (near Spirit Bay Harbour). In 2019, a blue-green algae bloom was reported in Brandy Lake (September 12), and Bass Lake (October 24). Algae bloom locations are shown in **Figure 1**.

3.4 Bacteria

Total coliform and *E. coli* data have been summarized in the tables on each Area Summary Sheet for all sites monitored in 2019. Current and historical *E. coli* data continue to be presented graphically. *E. coli* concentrations are reported as the number of colony forming units (cfu) observed in 100 ml of lake water (cfu/100 ml) on the y-axis and sampling sites are indicated on the x-axis. On the *E. coli* graphs, each sampling site is represented as a cluster of bars that represent different sampling seasons (years). Each year is represented by different coloured bars. Each graph also compares *E. coli* levels to the MLA yellow traffic light limit (Section 3), which is represented by a black dotted line at 30 cfu/100ml.

The Ministry of Health and Long-Term Care recently updated their measurement standard for *E. coli* at public beaches in its Long-Term Care Operational Approaches for Recreational Water Guideline (2018). If the geometric mean for a sample series at a given site exceeds 200 cfu of *E. coli* per 100 ml, the site is unsuitable for swimming and bathing. The geometric mean exceeding 200 cfu/100ml is also the new threshold for the MLA red traffic light as described above in section 3. The methodology recommended in the Long-Term Care Operational Approaches for Recreational Water Guideline (2018) at bathing beaches is based on a geometric mean of levels of *E. coli* determined from a minimum of five samples per site collected within a one-month period. It is important to note that the geometric mean reported in the Area Summaries is based on the number of samples collected at each station.

Bacteria, including *E. coli*, may survive for weeks in water and sediment and possibly even in submerged fecal pellets. Cold temperatures generally allow bacteria to survive longer than in warm water where they may be degraded or eaten by other microorganisms. *E. coli* levels at a sampling date provide a snapshot of the concentration of bacteria at one point in time. Sampling through several months in a year can provide evidence of ongoing bacteria issues.

3.4.1 Total Coliforms

Total coliform data is summarized for areas where bacterial monitoring was conducted in 2019. Total coliform concentrations are reported as yearly averages calculated as the geometric mean of all available measurements, including follow-up measurements, for an individual sampling site. Total coliform measurements of <3 cfu/100 ml were assigned a value of 1 cfu/100 ml to calculate means. Geometric means presented in the Area Summaries were rounded to the nearest colony forming unit.

3.4.2 E. coli

E. coli data are summarized for areas where bacterial monitoring was conducted in 2019. *E. coli* levels are presented as yearly averages calculated as the geometric mean of all available measurements, including re-test measurements, for an individual sampling site. Current and historical *E. coli* levels are also illustrated graphically in Area Summaries. *E. coli* measurements of <3 cfu/100 ml were assigned a value of 1 cfu/100 ml for calculating means. For the *E. coli* graphs in the Area Summaries, every site that was sampled has a minimum value of 1 cfu/100 ml; where no bar is shown for a site/year, no data was collected or reported. Geometric means presented in the Area Summaries were rounded to the nearest colony forming unit.

The MLA WQI includes a field protocol that requires volunteers to re-sample a site if *E. coli* levels are found to be greater than 50 cfu/100ml. This cautious approach allows the MLA to monitor sites that demonstrate potential for ongoing concern. Following this protocol, *E. coli* levels exceeded 50 cfu/100 mL at 11 (4.6%) of 240 sampling events for *E. coli* in 2019, not including retests. These results are less than the 9.2% reported in 2018, 8.0% in 2017, and 8.7 % in 2016. Of the 10 samples, re-tests were completed at all but one of the sites.

The sites that reported elevated *E. coli* levels (>50 cfu/100ml) in 2019 include Bala Bay (BAL-2), Beaumaris (BMR-4), Moon River (MOO-13), Star Lake (STR-3), and Walkers Point (WAK-6). The focus stations at Minett (MIN-1, MIN-6 [3 dates], MIN-7 and MIN-9), also observed elevated *E. coli* levels (>50 cfu/100ml) and required re-testing. Elevated *E. coli* levels (>50 cfu/100ml) at BAL-2, STR-3, MIN-1, MIN-6, MIN-7 and MIN-9 were also recorded for these stations in 2018.

In Star Lake in 2018 the sampler noted on the sampling sheets that during the final sampling date at STR-3, a very high water level had submerged an old beaver dam, allowing water to overflow toward STR-3. In 2019, the sampler noted that although the water levels were very high, the top of the old beaver dam was not submerged, therefore holding back water. Beaver impounds are a known source of *E. coli* and the water flowing over a submerged dam may allow bacteria to flow into the lake, increasing the *E. coli* levels. The *E. coli* geometric mean at STR-3 decreased from 17.5 cfu/100ml in 2018 to 10.8 cfu/ml in 2019.

From those sites identified in 2016 through 2018 for further analysis and sampled for in 2019, the Minett station (MIN-6) continues to show elevated *E. coli* levels.

In addition to the sites above that were noted to be in excess of *E. coli* levels >50 cfu/100ml, the following sites were above the MLA yellow traffic light limit (geometric mean >30 cfu/100ml) for *E. coli* in 2019: Minett (MIN-6) and Walkers Point (WAK-6).

Beacon recommends that the sampling sites for total coliform and *E. coli* be reviewed in the early spring of 2019 and continued where appropriate to continue to monitor bacteria levels, particularly at the stations noted above with yearly mean *E. coli* counts above the MLA traffic light limits. Beacon also recommends the continued increased sampling of the Minett focus area in 2019.

3.5 Summary of Monitoring Results

Each of the Areas are assigned a stoplight colour based on the thresholds developed for both phosphorus and *E. coli*. There were no red lights assigned in 2019, which is consistent with previous years. In 2019 a total of 9 Areas were assigned a yellow stoplight, and 2 Areas were assigned a red light (**Table 8**). Of these, five (BAS, BOY, GUL, SKB and WAK) had previously been green in 2016, 2017 and 2018.

Table 8. Summary of 2019 Sites with Yellow and Red Stoplights

Area	Site	*E. coli*	Phosphorus	Harmful Algae Bloom	Stoplight
BAS	BAS-5		Yearly mean TP exceeds spring TP	Harmful Algae Bloom was reported in 2019	Red
BOY	BOY-3			Harmful Algae Bloom reported in 2018 near BOY-3	Yellow
BRA	BRA-1			Harmful Algae Bloom was reported in 2019	Red
COX	COX-0		Yearly mean TP exceeds spring TP		Yellow
GUL	GUL-0		Yearly mean TP exceeds spring TP		Yellow
GLW	GLW-0		Yearly mean TP exceeds spring TP		Yellow
MIN	MIN-6 (NS)	E. coli above the 30 cfu/100 ml threshold.			Yellow
MIR	MIR-0		Yearly mean TP exceeds spring TP		Yellow
SKB	SKB-0		Increasing trend in spring TP measurements over last 3 years		Yellow
WAK	WAK-6	*E. coli* above the 30 cfu/100 ml threshold.			Yellow
WIN	WIN-1			Harmful Algae Bloom reported in 2018 near WIN-1	Yellow

Of the 55 Areas tested in 2019, there was a total of 42 Areas assigned a green light, and of these, 5 had previously been yellow. Nine (9) Areas were assigned a yellow light, including 6 Areas that changed from a green light to a yellow light, and there were two (2) Areas with a red light in 2019. One location (MRV) which had been assigned a yellow stoplight since 2015, was given a green stoplight in 2019. This change from yellow to green is due to the decreased *E. coli* geometric mean and a decreasing trend in phosphorus concentration in 2019.

4. Conclusions

This Water Quality Report presents the most recent data collected in 2019 and compares it to data collected from 2002 to 2018. The 2019 water quality program follows the well-established MLA methodology most recently fine-tuned in the spring of 2017.

Beacon Environmental continues as the primary consultant to assist the MLA with the data analysis. Consultation was undertaken in the spring to review the data from each sampling area and location and to assess each site to decide if continued sampling was necessary, or if sites should be discontinued and new sites added. The changes undertaken in 2019 are detailed in **Section 2.5** and include two monitoring sites added at locations identified in areas of potential additional loads to the lake, five monitoring locations discontinued in 2019 due to either low E. coli levels in the previous years, or because sites are sampled on a rotational basis, and phosphorus sampling increased in 2019 at 15 locations and decreased at 5 locations. Leonard Lake and Three Mile Lake did not participate in the 2019 program.

Secchi depths recorded in 2019 continue to remain consistent with the depths reported historically and continue to generally support the classification of oligotrophic. The 2019 sampling program included additional sampling through the year for Secchi values to better understand water clarity through the summer. Generally, the Secchi depths recorded in 2019 continue to remain consistent with the depths reported historically, with expected minor variation (up and down) through the years. Overall, shallower yearly average Secchi depths were observed in 2019 compared to 2018, likely linked to the flooding conditions in the spring of 2019. Stations STN-0 and HMB-0 (7.00 m), and FTB-0 and BRU-0 (6.50 m) recorded the deepest mean Secchi readings in 2019. Stations GNB-0 and JOS-1 recorded the deepest Secchi readings to date in 2019. The lowest mean Secchi depths recorded in 2019 were from the Brandy Lake sites.

The main change in the 2017 methodology was to obtain one single grab sample to provide a deep-water phosphorus duplicate for analysis. Compared with 2016 data, this methodology change decreased the number of “bad-splits” to less than a half, based on a total of 403 duplicate samples taken in 2017. Revisions to the sampling schedule in 2018 and 2019 included decreasing the number of duplicate phosphorus samples to 47 and 46, respectively. In 2018, 19 of 47 samples (40%) were deemed to be bad splits, and in 2019, 22 of the 46 duplicate phosphorus samples (48%) were deemed to be bad splits. Of the 22 bad splits in 2019, 7 of those were the same sites with bad splits in 2018 (ALL-0, CLR-0, GUL-0, MUS-3, SPC-0 and STR-0 [twice]).

Following the Grubb’s Test analysis of spring phosphorus from 2002-2019, a total of 10 spring phosphorus data points were removed in the 2019 analysis of the data sets, compared to 11 in 2018 and 18 in 2017. The data points, (and corresponding year shown in brackets) removed from the database in 2019 were from GNB-0 (2018), HMB-0 (2011), MBA-0 (2003), MIN-0 (2016), MIR-0 (2014), POR-0 (2018), RMI-0 (2004), STN-0 (2011), TOB-0 (2017) and WLB-0 (2006).

Although there was an overall generally increasing trend in most of the deep-water spring phosphorus concentrations in 2017 compared with values in 2016, that trend was not realized in 2018 or 2019. At the deep-water station sites that were sampled for spring phosphorus, 8 (15%) of the 52 sites showed the lowest spring phosphorus concentration recorded to date, compared to 42 % in 2018. Additionally,

3 (6%) of those 52 sites that were sampled for spring phosphorus showed the lowest levels of yearly mean phosphorus concentration recorded to date.

It is noted that all the deep-water sites with the lowest recorded spring phosphorus concentrations to date were either Affiliate sites, or sites located within Lake Muskoka and all the sites with the highest spring phosphorus concentrations to date were located within Little Lake Joseph, Lake Rosseau, or the Indian River.

Two new nearshore stations (FTB-4 and FTB-5) was established in Green's Bay to the west of Foot's Bay to investigate phosphorus concentrations and *E. coli* levels.

An overall generally static (neither increasing nor decreasing) trend in most of the nearshore phosphorus concentrations continued in 2019, similar to the results in 2018. At the nearshore station sites, 10% (9 of 86 sites) of the sites showed an increasing trend in the past 3 years, similar to the 2018 analysis. Of those 10 sites, 5 of them had an increasing trend due to a high value obtained in 2019, all of which were analyzed to be outliers. An analysis of the trend over time at each of the nearshore stations, using all data, shows that at 73 % (63 of 86) of the stations there was a decreasing trend in phosphorus, and at 9% there was neither an increasing or decreasing trend. Six of the nearshore sites were not analyzed for trending phosphorus as each of them consisted of 3 or less observations to date.

Of the watercourse sites sampled for spring phosphorus in 2019, MRV-5 showed the lowest spring phosphorus concentration to date, and HMB-8 showed the second lowest spring phosphorus concentration to date.

The watercourse stations (WIN-7 and WIN-8) established at Windermere in 2014 to assess nutrient inputs from the lakes and ponds upstream of the long-established WIN-1 site continued to be sampled in 2019. The spring phosphorus concentration in 2018 at WIN-7 was the lowest ever recorded and this was repeated in 2019 with an even lower spring phosphorus concentration. The yearly mean phosphorus concentration at WIN-7 was the lowest recorded in the 6 years of data gathered. The phosphorus trend at both WIN-7 and WIN-8 has generally been decreasing for the last 6 years at each of these stations.

Spring phosphorus levels in Lake Joseph, Lake Rosseau and Lake Muskoka in 2019 were generally below 10 µg/L, indicating oligotrophic conditions. Elevated phosphorus concentrations at the nearshore sites were primarily associated with each site location being adjacent to streams flowing into the three lakes.

Spring phosphorus levels in the Affiliate lakes and rivers in 2019 were all below 10 µg/L, except for elevated levels at Brandy Lake (BDY-0) and Indian River (IND-7). BDY-0 has consistently been at or exceeded 10 µg/L in all 14 years sampled to date and IND-7 exceeded 10 µg/L for the second time in 7 sampling dates.

In 2019 deep-water stations Bass Lake (BAS-5), Cox Bay (COX-0), Gull Lake (GUL-0), Gullwing Lake (GWL-0), and Mirror Lake (MIR-0) exceeded the yellow traffic light limit of yearly mean TP exceeding spring TP. Additionally, nearshore sites at Bruce Lake (BRU-3), East Bay (EAS-2), and Windermere (WIN-1 and WIN-5) exceeded the yellow traffic light limit of nearshore TP measurements being substantially higher than deep-water TP. Finally, deep-water spring phosphorus concentrations at

Skeleton Bay (SKB-0) show an increasing trend over the last 3 years, resulting in a yellow traffic light for this station.

The spring freshet of 2019 produced historic flooding conditions. The levels in the lakes were the highest ever recorded and the 2019 flood was the second "100-year flood" in 6 years. High water levels can increase the concentration of nutrients from runoff and flooded lakeshore soils. The record setting flooding in the spring of 2019 brought more water and possibly nutrients than ever before. That said, some of the lowest spring phosphorus levels to date were recorded in the waterbody at the downstream end of the watershed (Lake Muskoka sites ARN-0, EAS-0, ELG-0, MUS-2 and TAY-0), as well as the Affiliate sites Gullwing Lake (GLW-0), Gull Lake (GUL-0) and Silver Lake in Gravenhurst (SVR-0). There were no similar record low spring phosphorus levels in either Lake Joseph or Lake Rosseau.

Following the 2019 analysis, there did not seem to be a defined increase in phosphorus concentrations that might be correlated with the 2016 or 2019 spring floods. Beacon will continue to review spring and yearly mean phosphorus levels at all stations to look for continuing potential impacts and trends, including impacts resulting from the flooding conditions of 2019.

The MLA WQI includes a field protocol that requires volunteers to re-sample a site if *E. coli* levels are found to be greater than 50 cfu/100ml. This cautious approach allows the MLA to monitor sites that demonstrate potential for ongoing concern. Following this protocol, *E. coli* levels exceeded 50 cfu/100 ml at 11 (4.6%) of 240 sampling events for *E. coli* in 2019. These results are less than the 9.2% reported in 2018, 8.0% in 2017, and 8.7 % in 2016. The sites that reported elevated *E. coli* levels (>50 cfu/100ml) in 2019 include Bala Bay (BAL-2), Beaumaris (BMR-4), Moon River (MOO-1), Star Lake (STR-3), and Walkers Point (WAK-6). The focus stations at Minett (MIN-1, MIN-6, MIN-7 and MIN-9), also observed elevated *E. coli* levels and all sites required re-testing.

From those sites identified for further *E. coli* analysis in 2019, the Minett station (MIN-6) continues to show elevated *E. coli* levels.

In 2019 Minett (MIN-6) and Walkers Point (WAK-6) were above the MLA yellow traffic light limit (geometric mean >30 cfu/100ml) for *E. coli*.

A thorough review of all data acquired since 2002 suggests that the water quality remains consistently good to excellent.

Several lake health concerns in the Muskoka watershed, in addition to levels of total phosphorus, water clarity and bacteria, that are the core of MLA's field monitoring program, have been identified. These include algae blooms (**Section 1.2** above), road salt, calcium and climate change. While not part of the MLA field program, the MLA is keeping up to date on these issues through participation in external committees and task forces to augment its guardianship of lake water quality.

Increased occurrences of harmful algae blooms (cyanobacteria) are a growing concern as nutrients (e.g. phosphorus) appear "under control", however, looking deeper, the professional understanding of algae behavior is incomplete [https://www.muskokawatershed.org/events/msc/2017-mse/]. The release of nutrients from lake bottom sediments triggered by lake warming in shallow locations is high on the list of potential causes. MLA is participating in a pilot study organized by Muskoka Watershed Council

(MWC) to better understand algae in the Muskoka lakes. This is a long-term project and, at the time of writing, conclusions from this year's field work were not available.

Related to the algae issue is the health of lake zooplankton, particularly *Daphnia spp*. These organisms are very important to lake health as they (a) filter lake water several times a season, (b) consume algae, and (c) are the foundation of the lake food chain. Recent research (Brown and Yan, 2015) is showing these aquatic species are under threat from road salt at far lower concentration levels than previously understood. It now appears that salt concentrations over 100 ppm can seriously harm the zooplankton population. Potential consequences from a reduction in Daphnia are increased algae and reduced aquatic life. Data from DMM show Muskoka Bay has salt levels in the mid-teens and Lake Joseph is about 9.5 ppm (Dr. Norman Yan 2019). The MLA is participating in a DMM project to reduce the use of salt in Muskoka for winter road maintenance. It is hoped that reductions can be achieved in time to mitigate existing lake health effects.

Calcium in the local lakes is generally controlled by the amount of available calcium in soils, and ultimately, how quickly it is leached from and replenished in the soils surrounding those lakes. The present level of calcium in the local lakes is declining because Ca input from the local watershed has declined. Calcium reduction is having two effects: (1) reducing the development of bones and exoskeletons in aquatic species, and (2) impacting forest health. In an effort to mitigate these effects, the Friends of the Muskoka Watershed have embarked on a program to collect and distribute fireplace ash in the forest (https://friendsofthemuskokawatershed.org/province-funds-hauling-ash-project/). The MLA is a supporter of this program.

Last year the Province announced a Muskoka Watershed Conservation and Management Initiative, to better identify risks and issues facing the Muskoka River Watershed. The Advisory Group for this Initiative was announced this past August and the MLA has a representative within this nine-member group. It is hoped that this Initiative will boost efforts to address the above issues plus spring flooding.

5. Recommendations

Beacon has had a chance to suggest and implement recommendations since 2013 and has identified areas for review or refinement moving into the 2019 sampling season. Recommendations are provided below.

5.1 Training

Beacon strongly encourages that ALL team leaders continue to attend the annual training session held in the spring prior to the 2020 sampling. Changes to the protocol may be made for 2020 and each person must understand any revisions to the monitoring program for their area. This ensures consistency across the sampling teams and improves data collection through the entire year. Team leaders should actively be encouraging new members to join the sampling team.

It is important for all team leaders to properly train team members on sampling techniques and QA/QC measures for each water quality parameter. All team leaders and samplers must ensure that they understand the techniques and required number of samples for each station for each sampling date.

It is again recommended that training videos be created for use in the 2020 training sessions.

5.2 Methods

The MLA Environment Committee should continue to review sites each winter and understand where sites should be added, restarted, modified or discontinued.

The most important discussion prior to the 2020 sampling season will be to consider the pattern of bad splits in the 2018 and 2019 data. As noted in **Section 3.2**, 22 of the 46 duplicate phosphorus samples (48%) were deemed to be bad splits in 2019. The MLA Environment Committee should consider a review of sampling protocol to better understand the high rate of bad splits and should increase the number of duplicate phosphorus samples in the 2020 program.

Discussions continue to refocus the sampling program moving forward. There are opportunities to reduce sampling at areas that have not shown significant water quality issues (green light) and redirect effort to areas that continuously show concern (yellow or red light). Using the robust data set, Beacon will continue to work with the MLA to identify and classify sampling areas outlined in **Table 9**.

Table 9. Water Quality Sampling Frequency

Category	Sampling Frequency	Criteria
Long-term	Every 2 to 3 years	Sites that have consistently been below any threshold values for at least the past 5 years.
Annual	Continue with annual sampling	
Focus Sites	Increase sampling effort within a predetermined sampling time period (e.g. 5 times per month)	At areas with concentrations consistently over thresholds/limits.

There are also continued opportunities to revise the sampling program to concentrate efforts on High Priority Active Sites such as large urban influenced areas (Gravenhurst Bay, Muskoka River, Indian River, Rosseau and Bala), resort areas and golf course areas.

The Field Coordinator is a great asset to maintain continuity between the MLA Environment Committee and the volunteers. Having the Field Coordinator continue to compile the yearly results will continue to keep the year end data analysis costs lower.

The MLA should continue to rely on the Lake Partner Program data when it is available. It is very important that the MLA confirm with the MECP their intended sampling locations to ensure all sampling locations for the following year are covered by the MECP or the MLA. This discussion should happen early in the year, prior to the early stages of preparation for the coming year.

It is important that if results over 50 cfu/100 ml are encountered for *E. coli* that re-testing is completed. If this is not possible for the regular sampler to complete the re-test, the field coordinator should be made aware so that an alternate arrangement can be made.

5.3 Education

The main water quality issues identified each year are nutrient enrichment and elevated bacteria concentrations. Beacon recommends that the MLA continue promoting stewardship and awareness within the community to improve water quality and understand the important connection between land use, aquatic vegetation and wildlife. At those sites with particularly elevated levels of bacteria (Minett and Windermere) additional emphasis could be placed on providing additional educational resources.

It is important that everyone contribute to the goal of improving water quality and aesthetics of their lakes, while raising public awareness about healthy lake systems. There are a variety of landowner resources available on the MLA website which provide steps landowners can take to reduce their impact.

It was noted that several lake health concerns in the Muskoka watershed have been identified, including algae blooms, road salt, calcium and climate change. It will be important for the MLA to keep up to date on these issues through participation in external committees and task forces and to provide the members with follow-up information to strengthen their stewardship of the watershed.

Any stewardship activities will benefit the watershed over the long-term and leave a positive legacy for future generations.

5.4 Area Specific Recommendations

Area specific recommendations were developed through the analysis of the 2019 water quality data. These recommendations are provided in the Area Summary sheets and summarized below.

1. Following analysis of the 2020 results, Beacon recommends that the primary Focus Areas for the 2020 sampling season should continue to be Minett (MIN).
2. Additional focus in 2020 should be directed to Bruce Lake (BRU-3), East Bay (EAS-2), and Windermere (WIN-1 and WIN-5) due to the 2019 nearshore TP measurements being substantially higher than the deep-water TP.
3. Attention should be focussed on the spring sample at Skeleton Bay (SKB-0) due to the increasing trend in spring TP measurements over last 3 years.
4. Five of the deep-water sites recorded the highest spring phosphorus concentrations to date, compared to 4 deep-water sites in 2018. Those 5 sites in 2019 were Indian River (IND-0), Little Lake Joseph (LLJ-0), Morgan Bay (MGN-0), Portage Bay (POR-0) and Skeleton Bay (SKB-0). Sampling should concentrate on these sites to monitor long-term trends.
5. The sites that reported elevated *E. coli* levels in 2019 include Bala Bay (BAL-2), Beaumaris (BMR-4), Moon River (MOO-1), Star Lake (STR-3), and Walkers Point (WAK-6). The focus stations at Minett (MIN-1, MIN-6, MIN-7 and MIN-9) also observed elevated *E. coli* levels

(>50 cfu/100ml) and required re-testing. The geometric mean *E. coli* level in 2019 at Walkers Point (WAK-6) was above the MLA yellow traffic light, and at the Minett focus area (MIN-6), remained above the MLA yellow traffic light threshold. Sampling should continue in 2019 to monitor long-term trends and additional emphasis could be placed on providing additional educational resources in these Areas.

6. Beacon recommends that the MLA continue to rely on the data from the Lake Partner Program when it is available. The MLA should confirm with the MECP their intended sampling locations to ensure all sampling locations for the following year are covered by the MECP or the MLA. This discussion should happen early in the year, prior to the early stages of preparation for the coming year.

5.5 Overall Study Recommendations:

1. Sampling should continue to build a robust database, to monitor long-term trends and to expand to new Areas or sites where the need is identified.
2. When high nutrient and bacteria results are observed, look at other factors such as the local weather the day of sampling and 72 hours prior. The volunteer field sheets helped in the 2019 analysis and thanks goes to those providing the information.
3. The MLA should include the Lake Partner Program data when it is available.
4. Continued discussions with the MLA are recommended regarding which Areas to focus on for sampling in 2020.

5.6 Next Steps

Beacon believes that there are opportunities to take the WQI program further, and recommends that the MLA Environment Committee:

1. Focus investigations on stations where the MLA can best provide influence in situations of decreasing water quality such as:
    - Larger Urban Areas;
    - Resorts; and
    - Golf Courses.
2. Focus investigations on stations with elevated *E. coli* levels, and at sites with particularly elevated levels of bacteria, additional emphasis could be placed on providing additional educational resources for local stakeholders;
3. Continue to compile up to date photographic records of shoreline use and structures abutting the sampling sites at Focus Areas, particularly at those sites with missing or dated records;
4. Complete the database of GPS coordinates for each station to provide consistency in future sampling;
5. Advocate for causation studies related to blue-green algae blooms for Focus Areas (Bruce Lake, Brandy Lake and Three Mile Lake); and
6. Install monitoring locations where land use change is being contemplated

6. Definitions

Arithmetic mean: This type of average is calculated by adding together a group of numbers and dividing the sum by the sample size.

District Municipality of Muskoka Threshold: The District of Muskoka classifies lakes based on their sensitivity to phosphorus inputs, as an indicator of lake health. Lakes are classified as either low, moderate or highly sensitive to phosphorus. An acceptable threshold for phosphorus has been determined for each lake in Muskoka, which is 50% above the predicted background or undeveloped value. Any existing Threshold values are shown in the Area Summary Sheets.

E. coli: Escherichia coli is one of several types of bacteria that normally inhabit the intestine of humans and animals. *E. coli* is exclusively associated with fecal waste making it a good indicator of fecal contamination. There are many different strains of ***E. coli***; most waterborne strains are themselves not harmful, but some (such as ***E. coli*** O157:H7) can cause serious illness.

Geometric mean: This type of average is calculated by multiplying together a group of *n* numbers and then taking the n^{th} root of the resulting product. The geometric mean is used to indicate the central tendency or typical value of a set of numbers. It is typically used to calculate average bacteria counts because as a living organism, bacteria counts are highly sporadic and inconsistent.

Sampling Area: A geographic location encompassing a group of WQI monitoring sites.

Sampling Site: The discrete and unique location where samples are to be collected and measurements are to be taken.

Secchi Depth: A measure of **water clarity**, measured using a Secchi disk - a small disk attached to a rope. Alternating quarters of the top side of the disk are coloured white and black. The Secchi depth is the depth of water whereby the sampler can no longer distinguish the white and black quarters of the disk.

Spring Turnover Total Phosphorus: A single phosphorus concentration measurement taken in a typically stratified lake during the spring turnover period. This measurement has been shown to adequately represent the overall phosphorus concentration in a lake (Clark, 2010). Spring turnover typically lasts for a few days following ice out when the temperature of the entire water column is consistent (usually 4˚C) allowing the water column to mix. Ontario's Ministry of the Environment experiments have indicated that there is `no appreciable difference in the P means` in long-term data derived using April (true turnover) and May (mixed layer) data. In practice, measurements taken anytime in May are considered to be adequate.

Total Coliform: Coliform includes a variety of bacteria. In practice, detectable coliform are usually enteric, found in the intestinal tracts of humans and other warm-blooded species.

Total Phosphorus: Phosphorus is a chemical element that is essential for all living cells. Total phosphorus is a measure of both inorganic and organic forms of phosphorus. Phosphorus can be

present as dissolved or particulate matter. It is an essential plant nutrient and is often the most limiting nutrient to plant growth in fresh water.

Water Clarity: Water clarity is a measure of how much light penetrates through the water column. The clarity of water is influenced both by suspend particulate matter (sediment and plankton) and by coloured organic matter (tea coloured lakes). Clarity can provide some indication of a lake's overall water quality, especially the amount of algae present.

Yearly Mean Total Phosphorus: The arithmetic mean of phosphorus concentration measurements taken above a stratified water column's thermocline over the ice-free period. Note: yearly mean phosphorus concentration as reported by the WQI is for spring and summer months only.

Note: several of these definitions have been taken from previous years Water Quality Reports, including the WQI Summary Report - Citizens Environment Watch, 2009.

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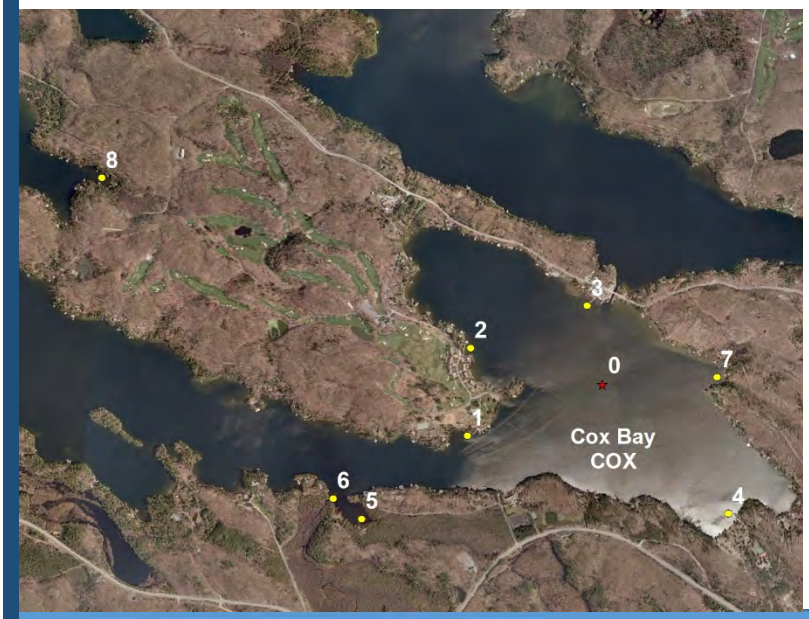
Appendix A

Area Summaries



Area Description:

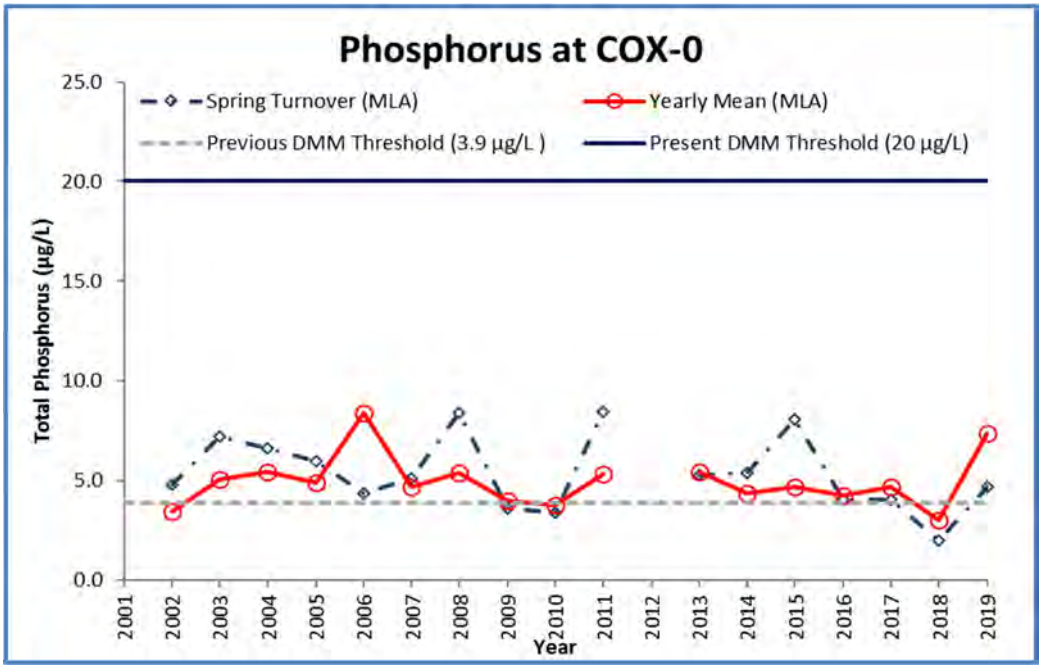
Cox Bay is the southernmost bay of Lake Joseph. The bay is 1.84 km² in area and is up to 12 m in depth. A large resort and golf course are located adjacent to the lake, along with a marina and a canal crossing into Lake Rosseau at Port Sandfield. Most of the shoreline area is developed, but many residences maintain forested cover on their properties. More than 15% of the shoreline is open lawn, pavement or is intensely landscaped. The Cox Bay Stewardship Initiative group has identified ten permanent watercourses that drain into the bay. Cox Bay was historically classified as moderately sensitive and over-threshold by the DMM. Monitoring started in 2002. All stations shown may not be sampled each year.

Volunteer Recognition: **Liz Lundell, Stuart Golvin, Judy Golvin,** and Guy Burry**.**

Cox Bay (COX)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
COX-0	4.5	4.7	7.4			
COX-2		5.0				
COX-3		3.9				
COX-6		8.9	8.3			
COX-7		3.1	4.4			
COX-8		4.8				



Summary and Recommendations:

Yearly mean and spring phosphorus concentrations at the deep station (COX-0) were above the historic DMM threshold of 3.9 µg/L in 2019 and all readings remain well below the present DMM threshold (20 µg/L).The 2019 spring phosphorus concentrations and yearly mean at COX-3, COX-7 and COX-8 are consistent with results to date. The 2019 yearly mean phosphorus average at COX-6 is the highest recorded due to the highest sample result to date in June (17.2 µg/L). That said, the yearly mean phosphorus at COX-0 was substantially higher than the spring turnover concentration, resulting in Cox Bay being classified as yellow in 2019. Secchi measurements vary through sampling years, ranging between 3.35 and 8.25 m (2015). **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

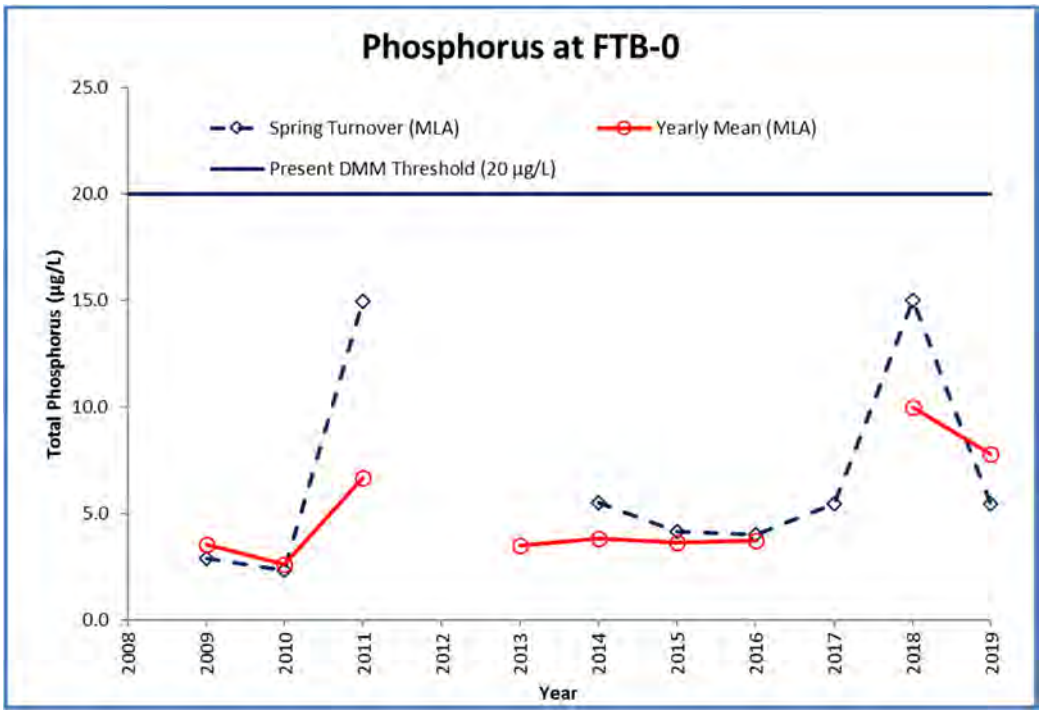
Foot's Bay is in the south-eastern portion of Lake Joseph. Foot's Bay has a higher intensity of development in the southern section, with areas that are adjacent to the highway and a marina. There are still large areas of shoreline with mostly intact forests. The main basin of Lake Joseph was historically classified as highly sensitive by the DMM. Monitoring started in 2009.

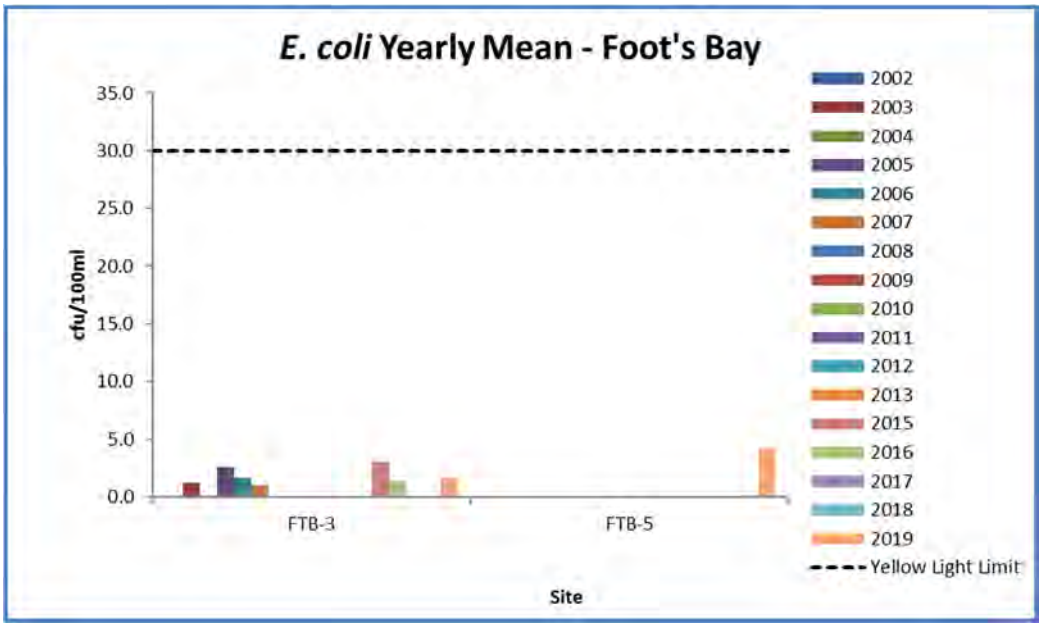
Volunteer Recognition: **Joey Brown, Dave Clark, Andy Benyei, Tom and Sharon Laviolette, Penny Middleton, Andy Benyei** and Joe Quinn.

Foot's Bay (FTB)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

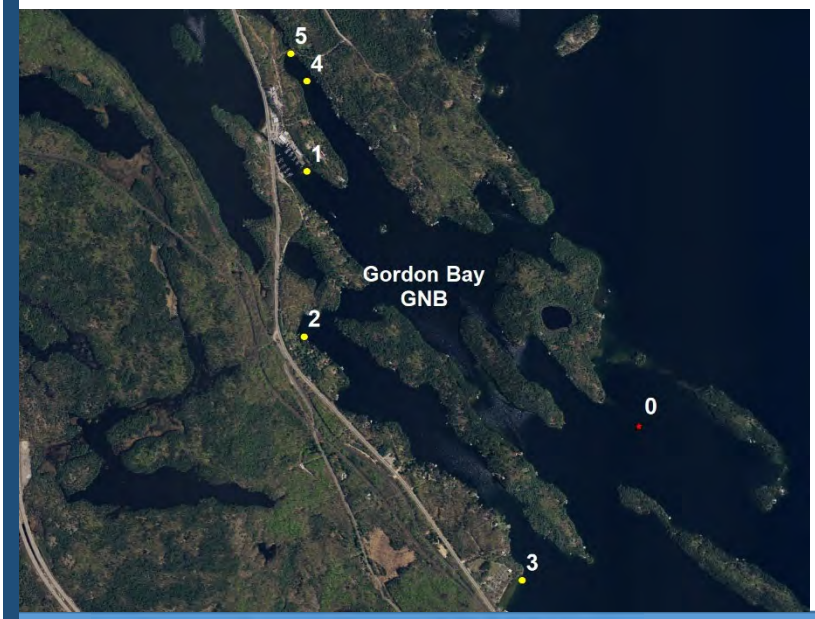
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
FTB-0	5.8	5.5	7.8		
FTB-3		4.1	4.6	1.7	24.7
FTB-4		6.9			
FTB-5		3.9		4.2	76.5





Summary and Recommendations:

The 2019 spring phosphorus concentration at FTB-0 decreased considerably from 2018, and all readings at FTB-0 remain below the present DMM threshold (20 µg/L). The increasing trend of phosphorus levels at FTB-0 has subsided, changing the stoplight from yellow to green. Stations FTB-4 and FTB-5 are new in 2019 and should be continued to be monitored to look for trends. Secchi measurements vary through sampling years, ranging between 2.5 and 7.2 m (2016). **Beacon recommends sampling continue to monitor long-term trends.**



Area Description:

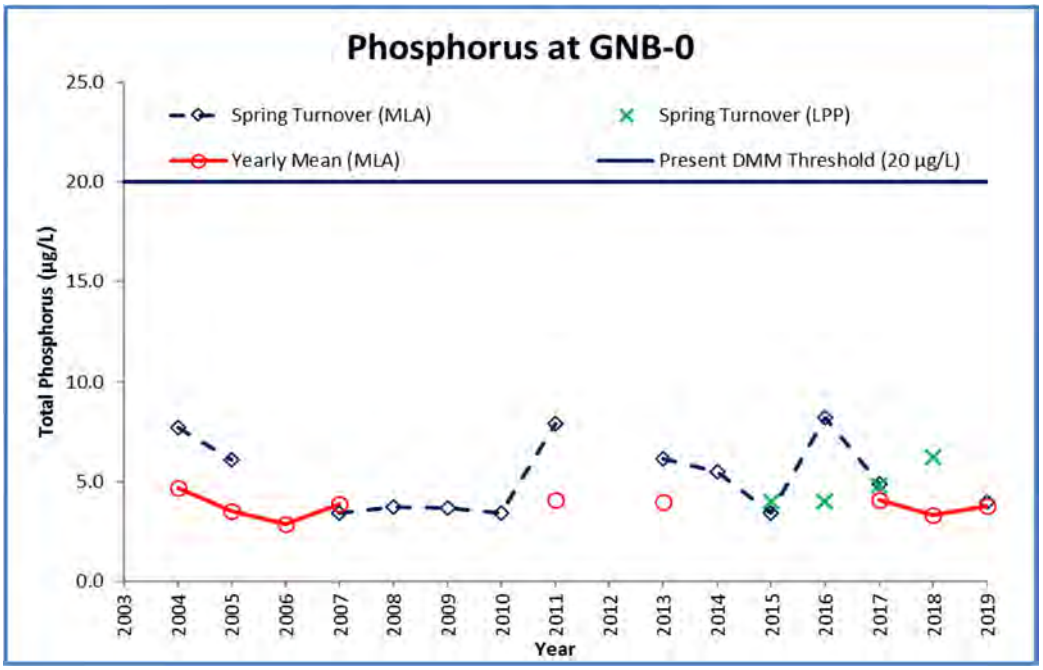
Gordon Bay is in the northwestern part of Lake Joseph. This bay is moderately developed and Highway 169 follows along the shoreline for a large portion of the bay. There is a large marina in the northern part of the bay where one of three creeks discharges into the bay. The main basin of Lake Joseph was historically classified as highly sensitive by the DMM. Monitoring started in 2004. All stations shown may not be sampled each year.

Volunteer Recognition: **Alex Magditsch, Cecil Hayhoe**, **John Offutt**, Juliana Magditsch, Lynda McCarthy, Tom Lundy, Paul Tyers, Barb Butler and the Lake Partnership Program.

Gordon Bay (GNB)

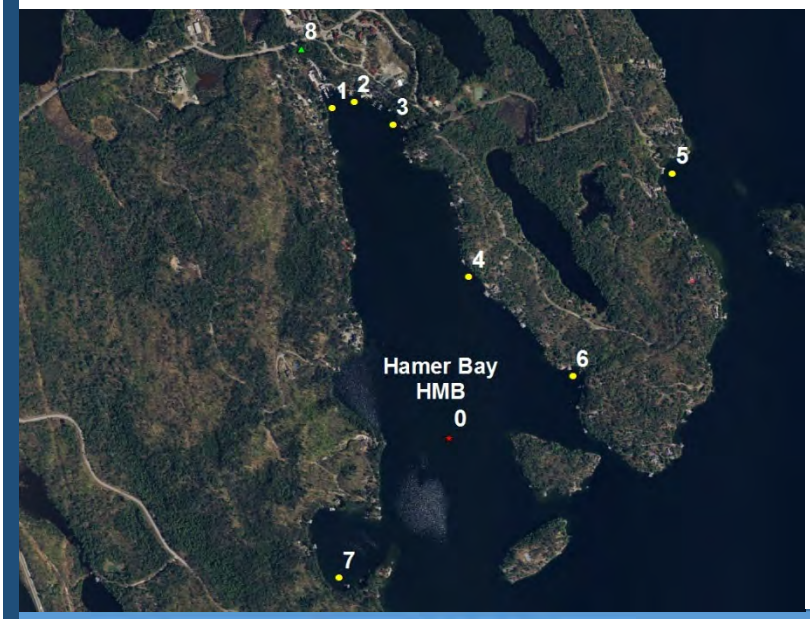
2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
GNB-0	5.5	4.0	3.8		
GNB-4		3.4	4.7		



Summary and Recommendations:

The Grubb's test identified the spring 2018 data for GNB-0 as an outlier and it has again been removed from the data set in 2019. Lake Partner Program spring phosphorus data was available in 2015-2018. Spring phosphorus results remain variable over the sampling years at GNB-0. The MLA spring phosphorus value is lower than 2016 and 2017, and the increasing trend of phosphorus levels at FTB-0 has subsided, changing the stoplight from yellow to green. *E. coli* sampling was discontinued at GNB-4 in 2019. Secchi measurements vary through sampling years, ranging between 3.0 and 7.5 (2013). **Beacon recommends sampling continue to monitor long-term trends.**



Area Description:

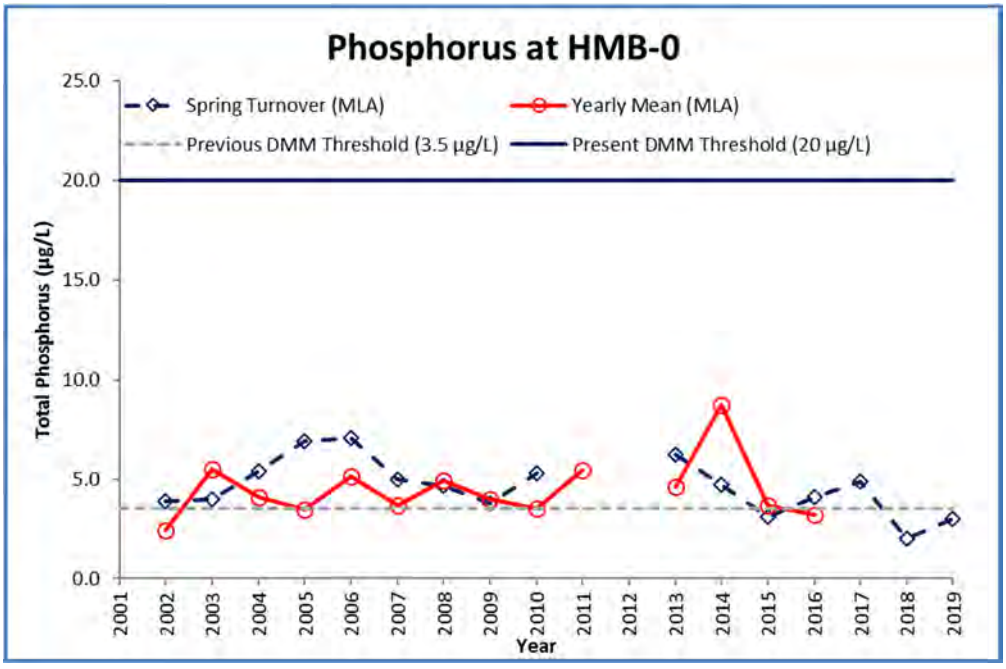
Hamer Bay is a large bay in the northern part of Lake Joseph. This bay receives drainage from a variety of natural and anthropogenic sources. There are three creeks that outlet into the bay, one flows through a large golf course and wetland in the north, and the others through smaller lakes and wetlands. There is a large marina with several parking lots, a resort, and many residential properties along most of the available shoreline. The main basin of Lake Joseph was historically classified as highly sensitive by the DMM. All stations shown may not be sampled each year.

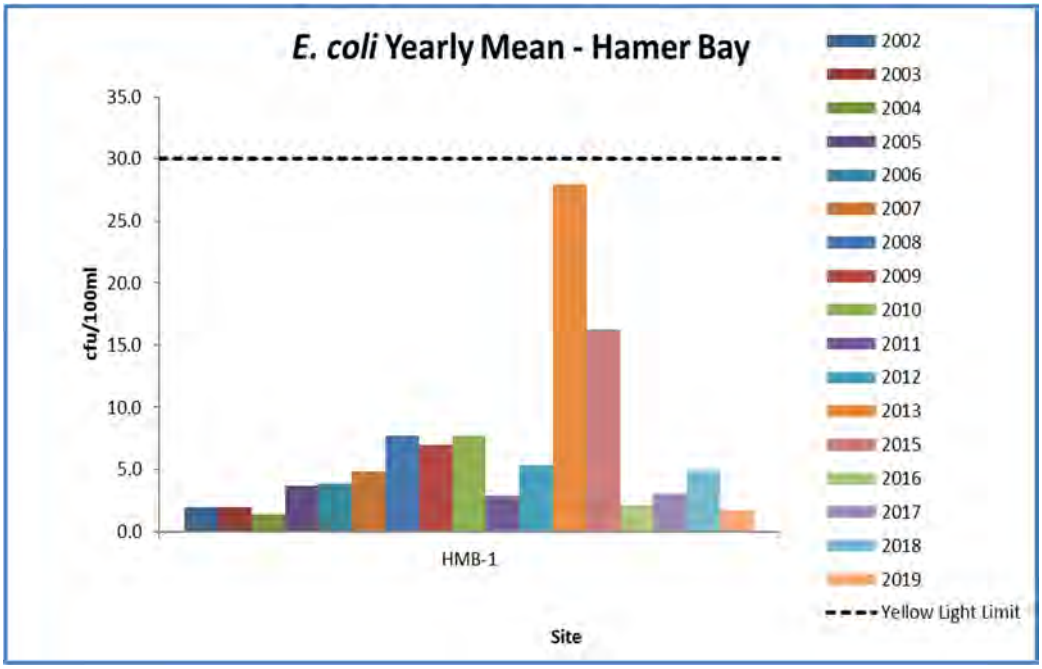
Volunteer Recognition: **Alex Magditsch, Cecil Hayhoe, John Offutt, Paul** Tyers, Tony Lundy Juliana Magditsch, Barb Butler, and Lynda McCarthy.

Hamer Bay (HMB)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
HMB-0	5.2	3.0				
HMB-1		5.9	5.3	1.7	58.8	
HMB-2		4.7	3.6			
HMB-4		4.6	3.4			
HMB-8		5.4	31.9			





Summary and Recommendations:

Spring phosphorus at HMB-0 was again below the historic DMM threshold of 3.5 ug/L (also in 2018), and all readings remain well below the present DMM threshold (20 µg/L). Only one phosphorus sample (spring) was collected in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. The spring phosphorus sample at HMB-0 in 2011 remains removed from the analysis following the Grubb's Test analysis for outliers in 2019. The yearly phosphorus mean at HMB-4 was the lowest recorded to date and the spring phosphorus level at HMB-8 was the second lowest to date. Bacterial counts of *E. coli* at HMB-1 remain well below the MLA stoplight limits (details in report Section 3). Secchi measurements vary through sampling years, ranging between 3.3 and 8.0 (2007). **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

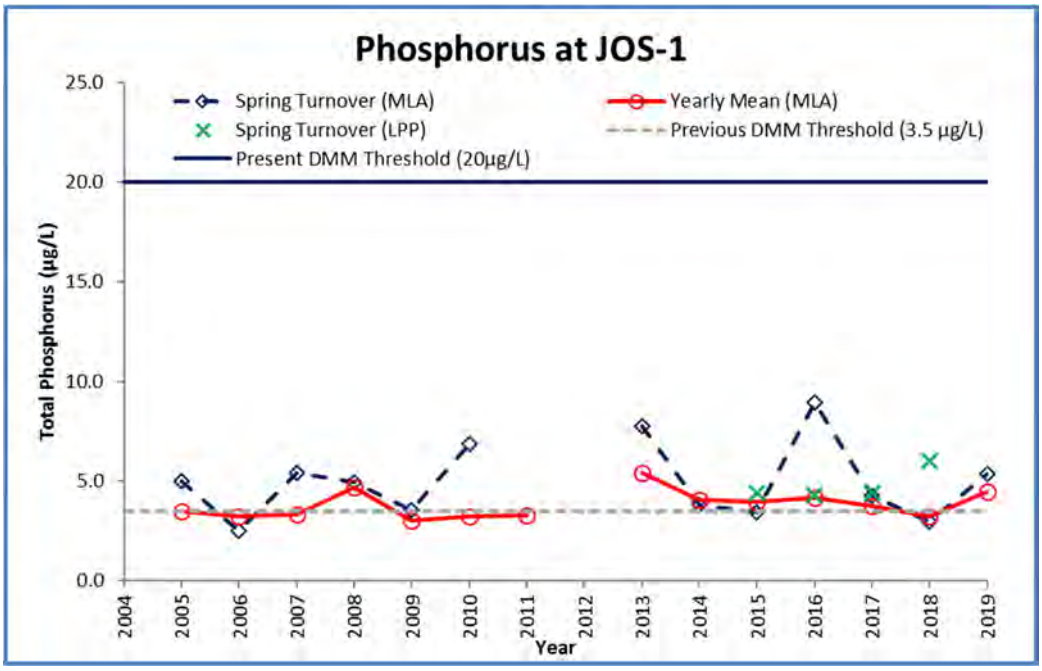
Lake Joseph is a large lake with a surface area of 50.9km² and water depths of up to 94 m. Wetlands account for a small portion of the lake area at about 5%. The lake has various points of inflow and outflow, with drainage from north to south. The Lake Joseph watershed area is 55 km² and has a coldwater fishery. The main basin of the lake was historically classified by the DMM as highly sensitive. Monitoring started in 2005.

Volunteer Recognition: **Alex Magditsch, Cecil Hayhoe, John Offutt**, Juliana Magditsch, Lynda McCarthy, Barb Butler, Paul Tyers and the Lake Partnership Program.

Lake Joseph (JOS)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
JOS-1	5.5	5.4	4.5		



Summary and Recommendations:

The spring phosphorus level at JOS-1 was above the historic DMM threshold of 3.5 ug/L, and all readings remain well below the present DMM threshold (20 µg/L). The yearly phosphorus mean has remained consistent through the sampling years. Lake Partner Program spring phosphorus data was available in 2015-2018. Secchi measurements vary through sampling years between 3 and 7.75 (2008, 2009, 2010). **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

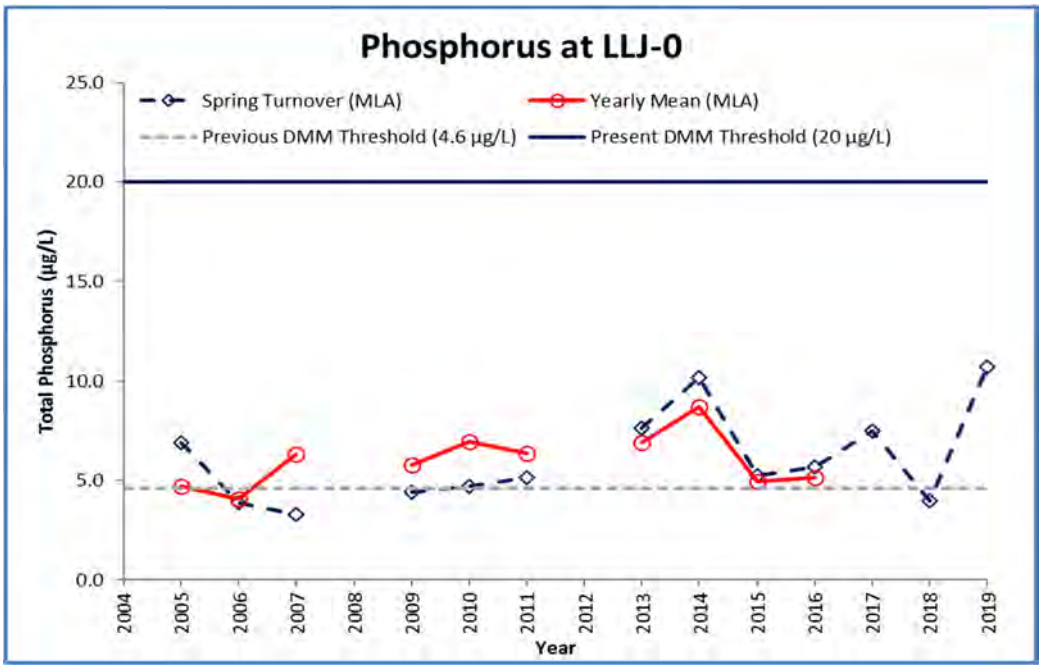
Little Lake Joseph is an isolated arm 2.8 km² in size off the eastern side of Lake Joseph. This is a deep bay with depths of up to 40 m. Most of the shoreline is in a natural state despite many cottages. Three small wetlands outlet into the bay and Little Lake Joseph was historically classified by the DMM as moderately sensitive. Monitoring started in 2005. All stations shown may not be sampled each year.

Volunteer Recognition: **Dirk Soutendijk** and **Westley Begg.**

Little Lake Joseph (LLJ)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
LLJ-0	4.2	10.7			
LLJ-6		6.2	5.7		
LLJ-7		32.1	13.7		



Summary and Recommendations:

The spring phosphorus concentration at LLJ-0 was the highest recorded to date and was above the historic DMM threshold of 4.6 µg/L. That said, and all readings remain well below the present DMM threshold (20 µg/L). Only one spring phosphorus sample was collected at LLJ-0 in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. Interestingly, in the 5 years of data for LLJ-6 and LLJ-7, the spring phosphorus value at LLJ-6 was the lowest recorded to date, and at LLJ-7, was the highest recorded to date. Although high spring phosphorus values were recorded, Little Lake Joseph phosphorus values did not trigger a yellow stop light in 2019. Secchi measurements vary through sampling years, ranging between 2.5 and 6.5 m (2007). **Beacon recommends continued sampling to monitor long-term trends.**

Area Description:

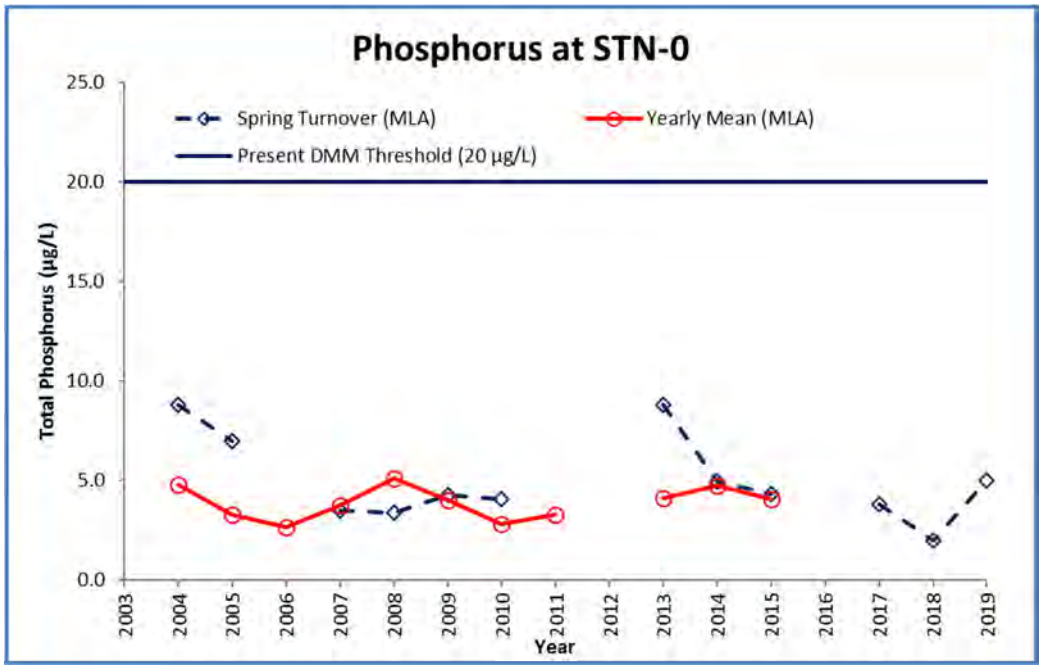
Stanley Bay is located on the north-east side of Lake Joseph. This deepwater bay has evenly distributed development with largely intact forest cover along the shoreline. STN-3 is located in a shallow, sandy area at the end of a small bay where a creek outlets. There are several roads around this bay and a moderate level of residential development, but no marinas, large resorts, commercial development, or agricultural development which could negatively impact water quality. All stations shown may not be sampled each year.

Volunteer Recognition: **Alex Magditsch, Cecil Hayhoe, John Offutt,** Juliana Magditsch, Barb Butler and Lynda McCarthy.

Stanley Bay (STN)

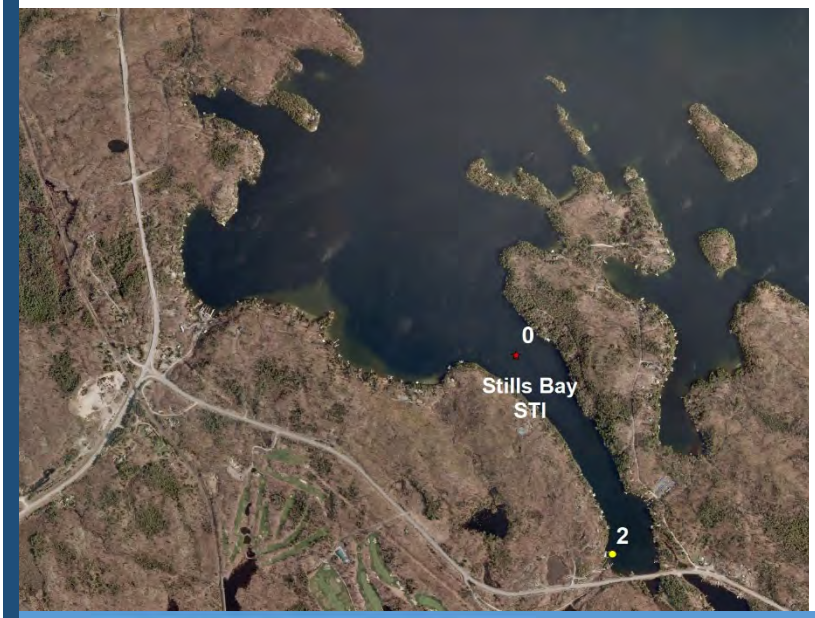
2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
STN-0	5.4	5.0			
STN-2		4.0			



Summary and Recommendations:

Using Grubb's Test for outliers, the spring 2011 phosphorus sample at STN-0 was identified as an outlier in 2013 and remains out of the dataset in 2019. All spring phosphorus and yearly mean phosphorus concentrations at STB-0 are well below the present DMM threshold (20 µg/L). Only one spring phosphorus sample was collected in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. Secchi measurements vary through sampling years, ranging between 3.75 (2009) and 8.0 (2007). **Beacon recommends sampling continue to monitor long-term trends.**



Area Description:

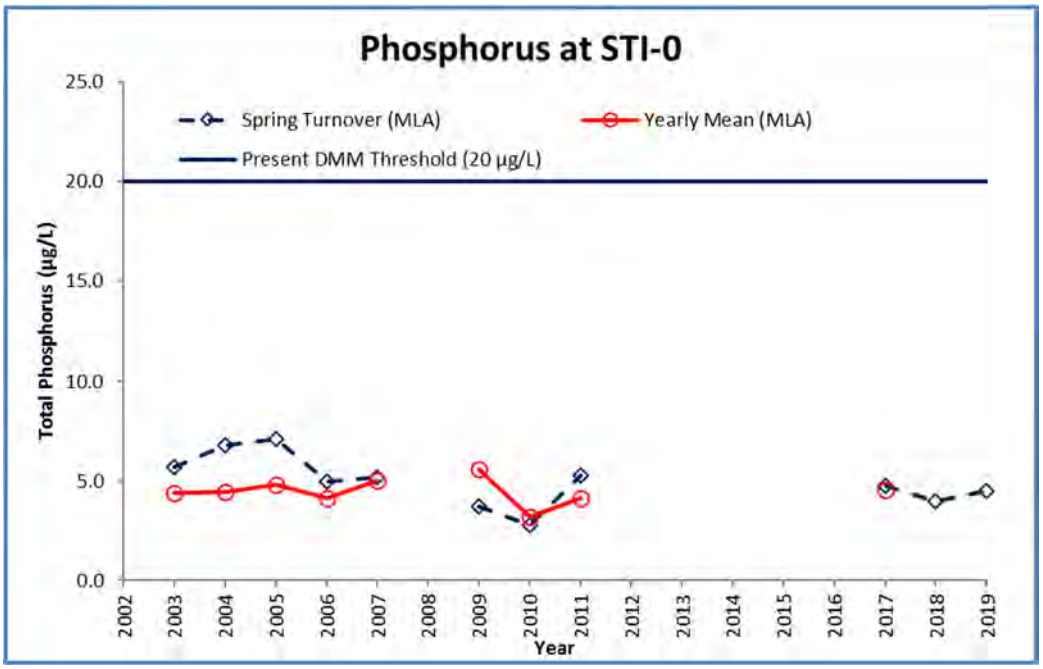
Stills Bay is located in the south-eastern portion of Lake Joseph. Stills Bay is long, narrow, and moderately developed. The southern end of the bay is directly adjacent to highway 169. This bay receives drainage from watercourses that are adjacent to a golf course. There are still large areas of shoreline with mostly intact forests. The main basin of Lake Joseph was historically classified as highly sensitive by the DMM. Monitoring started in 2003. All stations shown may not be sampled each year.

Volunteer Recognition: **Joey Brown, Andy Benyei, Dave Clark, Tom Laviolette, Sharon Laviolette, Penny Middleton** and Joe Quinn.

Stills Bay (STI)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
STI-0		4.5			
STI-2		5.1	3.8		



Summary and Recommendations:

At the deep station (STI-0), spring turnover phosphorus results remain consistent through the years, and all readings remain well below the present DMM threshold (20 µg/L). Only one spring phosphorus sample was collected at STI-0 in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. The spring phosphorous concentration and yearly mean values at STI-2 in 2019 were the lowest recorded to date. Secchi measurements were not taken in 2019. **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

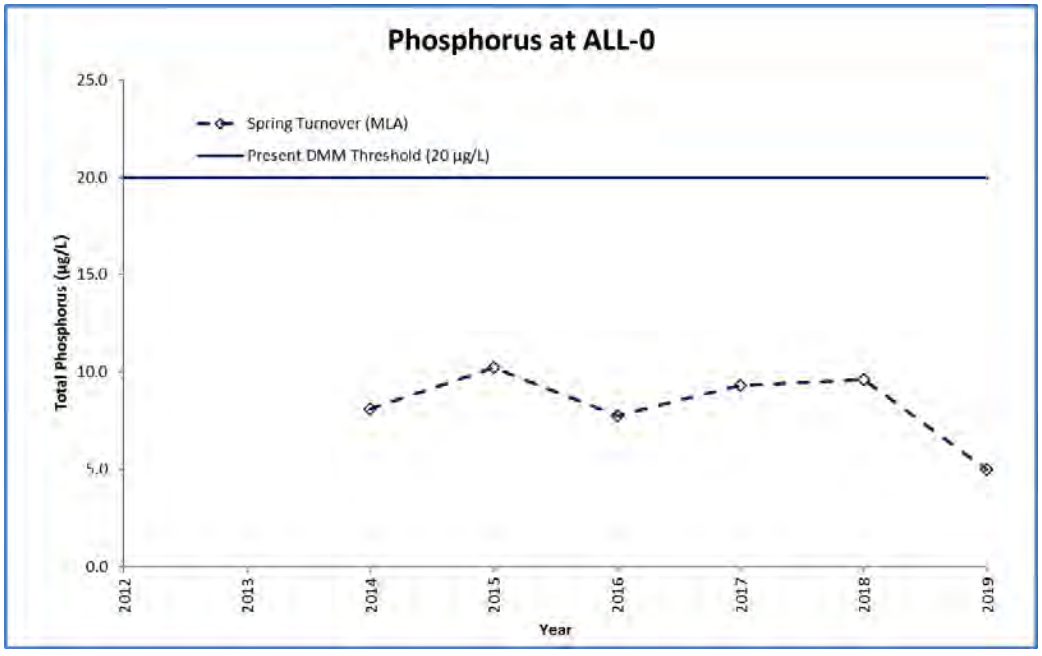
Alport Bay (also known as Alport Lake) is a small bay in the central part of eastern Lake Muskoka, at the mouth of the Muskoka River. The water quality in Alport Bay is influenced by several natural and man-made features, including a marina in the south, a large wetland as well as agriculture in the east, and inflow from the mouth of the Muskoka River. The inflow from the River is highly influenced by a larger portion of the upstream catchment. Much of the shoreline is developed with a high proportion of the residential properties maintaining manicured lawns and minimal vegetation along the shoreline. Monitoring started in 2013.

Volunteer Recognition: **Bill Caughey, Rayma Blaymires,** Jane Caughey, and Chris Blaymires.

Alport Bay (ALL)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
ALL-0	1.6	7.9			



Summary and Recommendations:

After a seventh year of data collection, spring phosphorus in 2019 declined to the lowest recorded level, and all readings remain well below the present DMM threshold (20 µg/L). The 2019 mean Secchi measurement (1.6 m) was shallower than 2018 (2.3 m). **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

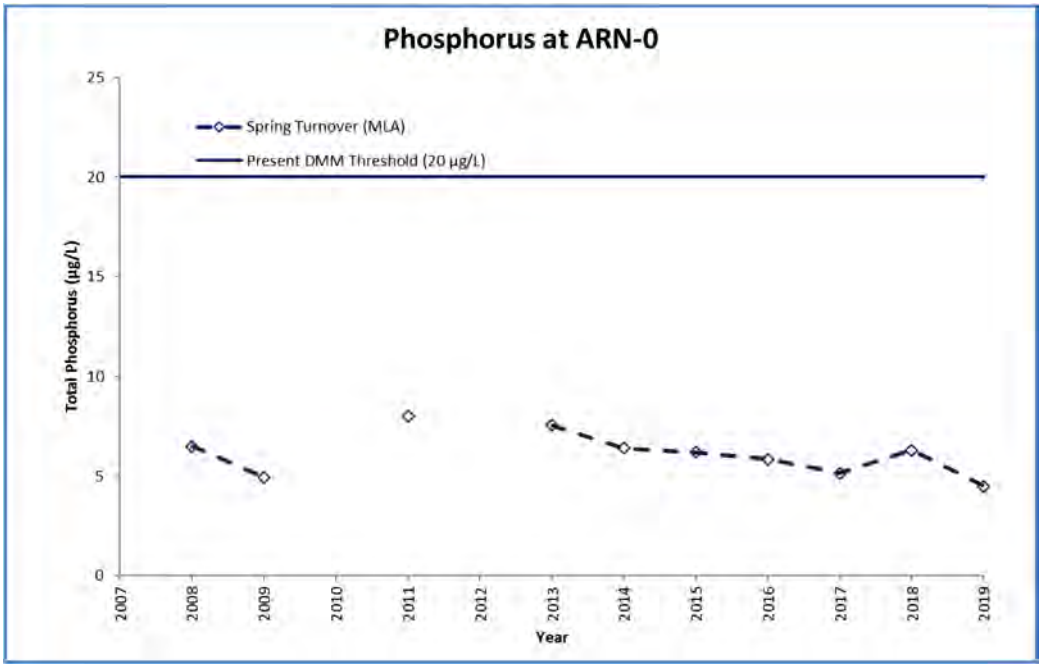
The Arundel Lodge sampling area is in south-central Lake Muskoka, east of Hardy Lake Provincial Park and south of Walker's Point. ARN-0 is located in Skinner Bay, adjacent to Miller Island and Firebrand Island. A creek draining three wetland areas runs along part of Arundle Lodge Rd. and outlets northeast of this site. Monitoring started in 2008.

Volunteer Recognition: **Susan Murphy**, Doug Tate, and Stephen Sims.

Arundel Lodge (ARN)

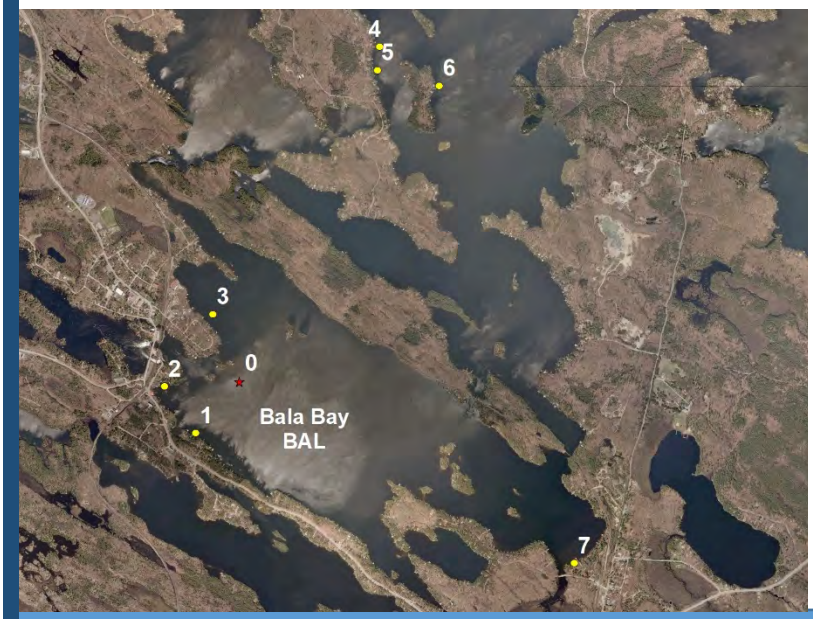
2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
ARN-0	3.5	3.7			



Summary and Recommendations:

Spring phosphorus concentrations remain consistent through the sampling years, and all readings remain well below the present DMM threshold (20 µg/L). The Secchi depth in 2019 (3.5 m) was the deepest recorded to date, and mean Secchi measurements are generally stable through sampling years, varying between 2.4 and 3.5 m. **Beacon recommends continued sampling at this site.**



Area Description:

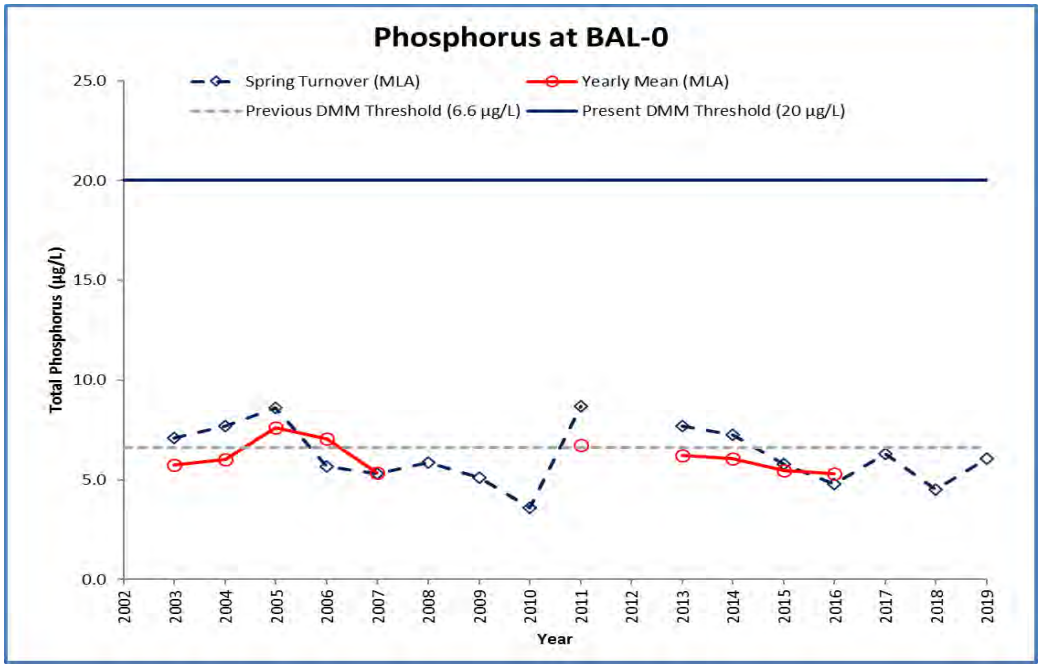
Bala Bay is a large isolated bay in the eastern part of Lake Muskoka. Most of the bay is densely developed but there is intact forest cover along most of the shoreline area. Drainage from the village of Bala does enter the bay along the western shore. The entire Muskoka River Watershed drains through Bala Bay into the Moon River System. There are also two small wetlands that drain into the bay. Monitoring started in 2003. All stations shown may not be sampled each year.

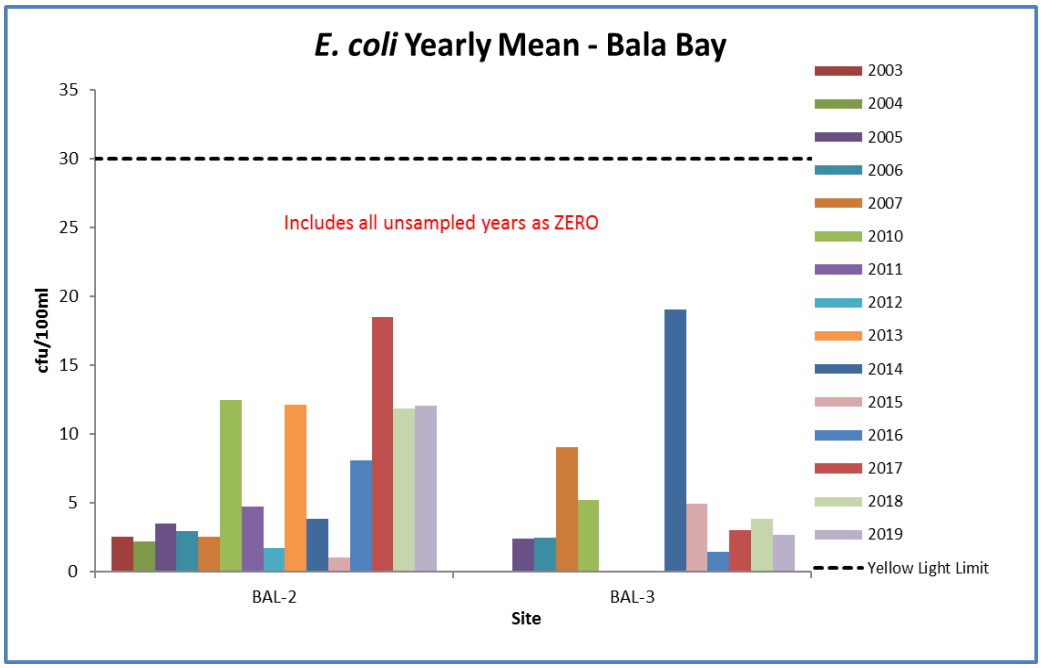
Volunteer Recognition: **Peter Joel** and Alan Hutton.

Bala Bay (BAL)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

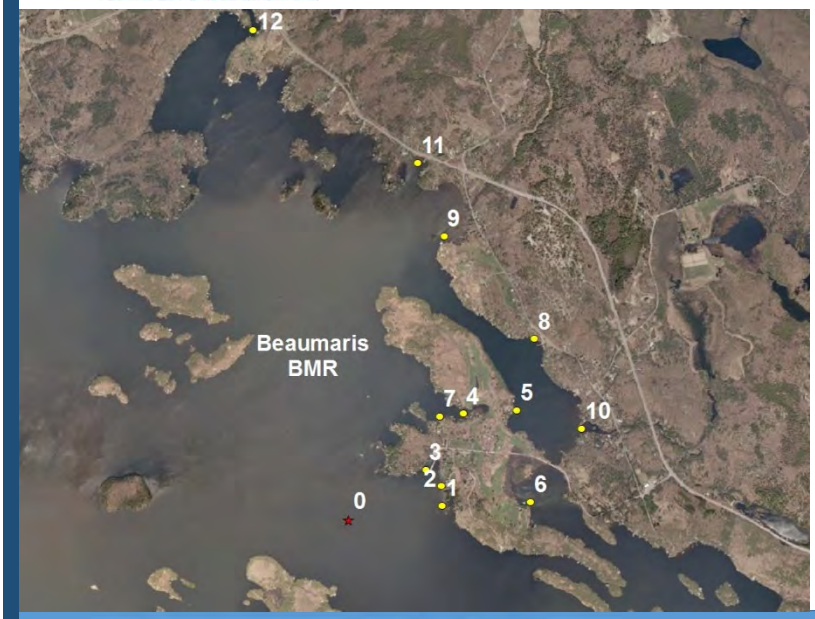
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
BAL-0	3.4	6.1			
BAL-2				12.0	100.2
BAL-3				2.7	38.6





Summary and Recommendations:

Phosphorus results at BAL-0 continue to remain consistent over the sampling years, generally in the range of the historic DMM threshold of 6.6 µg/L, and all readings remain well below the present DMM threshold (20 µg/L). Only one phosphorus sample (spring) was collected at BAL-0 in 2019, therefore no yearly mean could be calculated or reported for 2019. The 2019 *E. coli* results remain well below the MLA limits (details in report Section 3). Re-tests were required at BAL-2. The Secchi depth in 2019 was shallower than 2018 and measurements have ranged through sampling years, varying between 2.46 and 5.25 m (recorded in 2010). **Beacon recommends sampling continue to monitor long-term trends**.



Area Description:

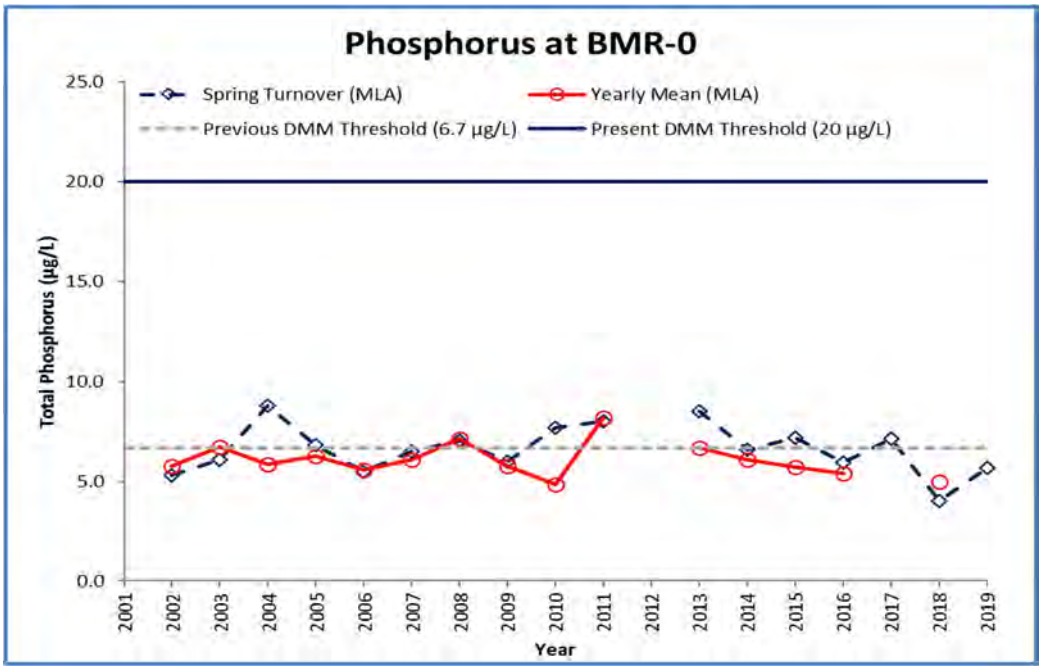
This island is in the Milford Bay area of northeastern Lake Muskoka is approximately 132 ha in size. A golf course takes up much of the island, which is associated with a small private club and marina. Most of the natural shoreline vegetation is intact, but there are many large boathouses in this area. There is a large wetland to the east where the causeway links mainland and the island. Monitoring started in 2002. All stations shown may not be sampled each year.

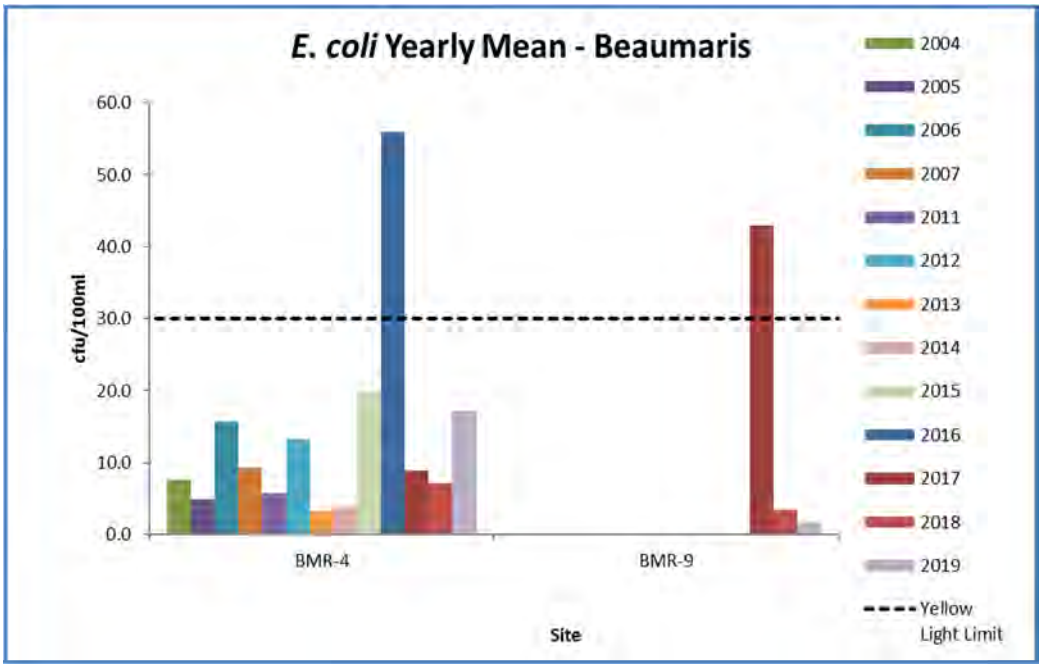
Volunteer Recognition: **Louise Cragg**, Don Furniss, Andree Baillargeon, Eliza Nevin, Chris Cragg, and Allen Flye.

Beaumaris (BMR)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
BMR-0	3.2	5.7				
BMR-4		4.7	4.1	17.2	114.8	
BMR-6		6.4				
BMR-9		6.3		1.7	50.7	
BMR-10		7.4				
BMR-12		17.4				





Summary and Recommendations:

In 2019, only spring phosphorus was sampled for at BMR-0. Results (5.7 µg/L) were higher than the 2018 results (4.0 µg/L). Spring turnover and yearly mean phosphorus concentrations at BMR-4, and BMR-9, and spring turnover phosphorus concentrations at BMR-6 and BMR-10 remain consistent with previous results. Spring phosphorus and yearly mean phosphorus levels at BMR-4 were the second lowest recorded to date. The *E. coli* concentrations at BMR-4 and BMR-9 were well below the yellow light limit set by the MLA (details in report Section 3). The Secchi depth in 2019 is consistent with previous years measurements. Secchi depths have ranged through sampling years, varying between 2.25 and 4.40 m (recorded in 2009 and 2015). BMR was given a green stoplight in 2018 and remains green in 2019. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

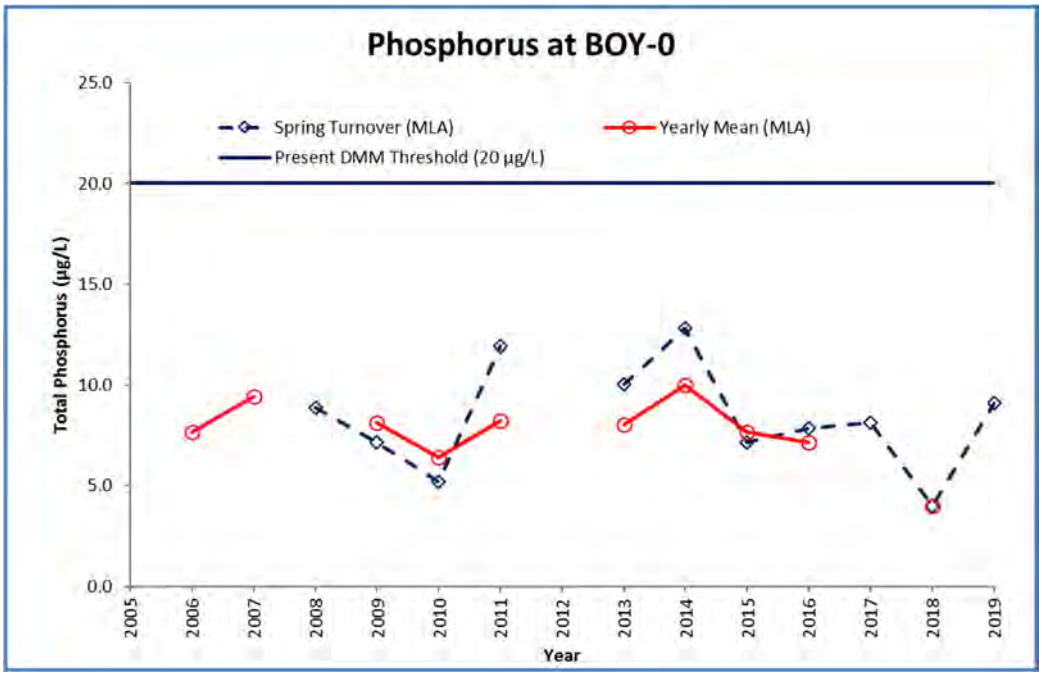
Boyd Bay is a small bay in the central part of eastern Lake Muskoka. The water quality in Boyd Bay is influenced by several natural and man-made features, including a marina in the southeast, a large wetland in the north, Highway 118 to the east and several inflowing creeks. The creeks that drain into the bay are potentially influenced by agricultural areas. Much of the shoreline is developed and many residential properties have manicured lawns along the shoreline. Monitoring started in 2006. All stations shown may not be sampled each year.

Volunteer Recognition: **Bill Caughey, Jane Caughey, Rayma Blaymires**, and **Chris Blaymires.**

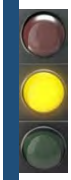
Boyd Bay (BOY)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
BOY-0	1.6	9.1				
BOY-3		11.3	8.4			
BOY-4		7.6	5.9			



Summary and Recommendations:



Only spring phosphorus was sampled for in 2019 at BOY-0, and the concentration (9.1 ug/L) was similar to previous years. The levels of phosphorus at BOY-0 remain well below the present DMM threshold (20 µg/L). The 2019 spring phosphorus concentration at BOY-3 was consistent with previous results, while the 2019 spring and yearly mean phosphorus results at BOY-4 were the lowest recorded to date. Secchi measurements remain stable through the sampling years, varying between 1.07 and 4.45 m (2010). A Harmful Algae Bloom was reported in 2018 near BOY-3 and BOY will remain yellow until a Causation Study concludes that development is not the primary cause of the HAB. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

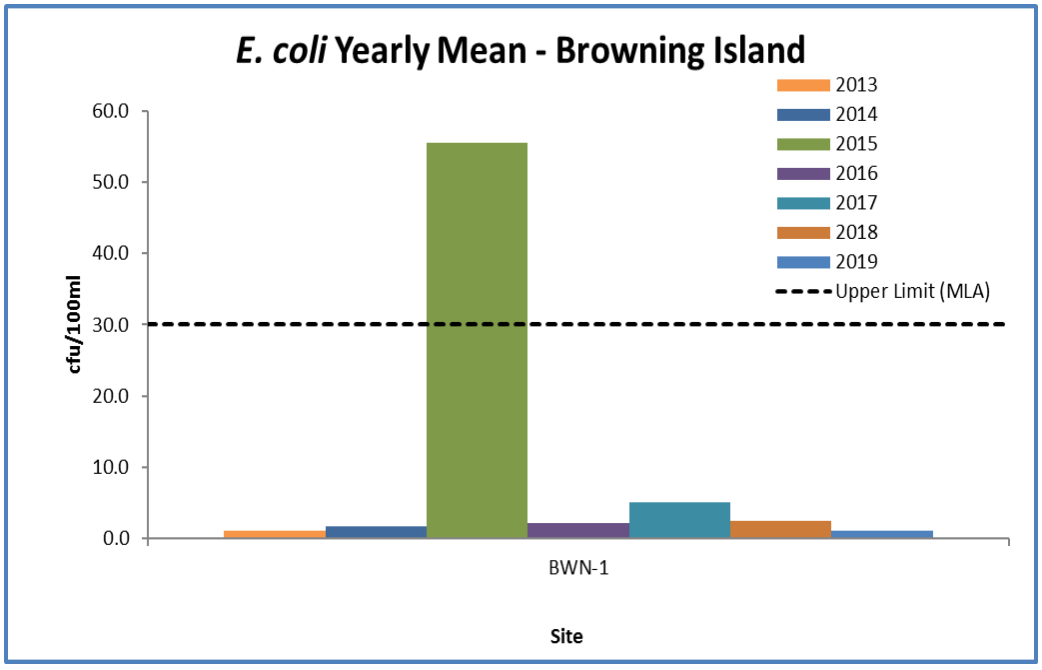
Browning Island is one of the largest islands in the Muskoka Lakes. In the late 1800s the island was stripped of its white pine. Portions of the island were then farmed (cattle, sheep and crops). The central portion of the island remains undeveloped. Through several donations, 338 acres of the island consists of the Browning Island Nature Reserve. Two of the sheltered bays were added to the MLA sampling program in 2013 due to concern that they may be vulnerable areas. All stations shown may not be sampled each year.

Volunteer Recognition: **Kirk Swanson**

Browning Island (BWN)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
BWN-1				1.0	11.5



Summary and Recommendations:

E. coli results continue to be well below the MLA stoplight limits (details in report Section 3) at BWN-1. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

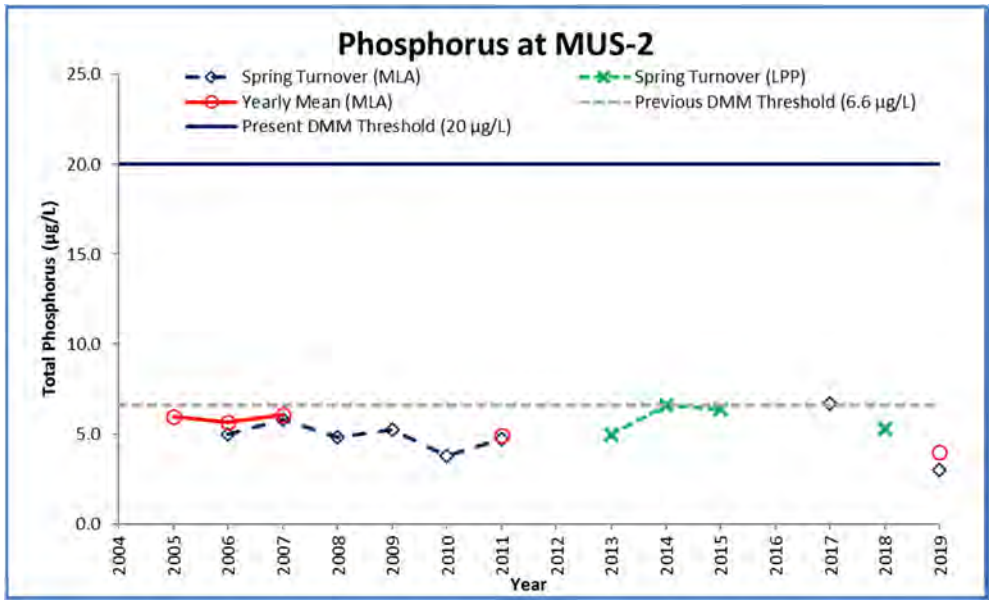
Dudley Bay is located in eastern Lake Muskoka, and is approximately 3.6 km² in size with a maximum depth of 20 m. It is considered moderately developed, with primarily residential properties and several roads, including Highway 169, that are in close proximity to the shoreline. Several creeks and wetlands drain into the bay, including that from the cranberry marsh. Dudley Bay was historically classified as moderately sensitive by the DMM. Monitoring started in 2005.

Volunteer Recognition: **Eleanor Lewis, Kim Seon** and Jim Lewis.

Dudley Bay (DUD-1 & MUS-2)

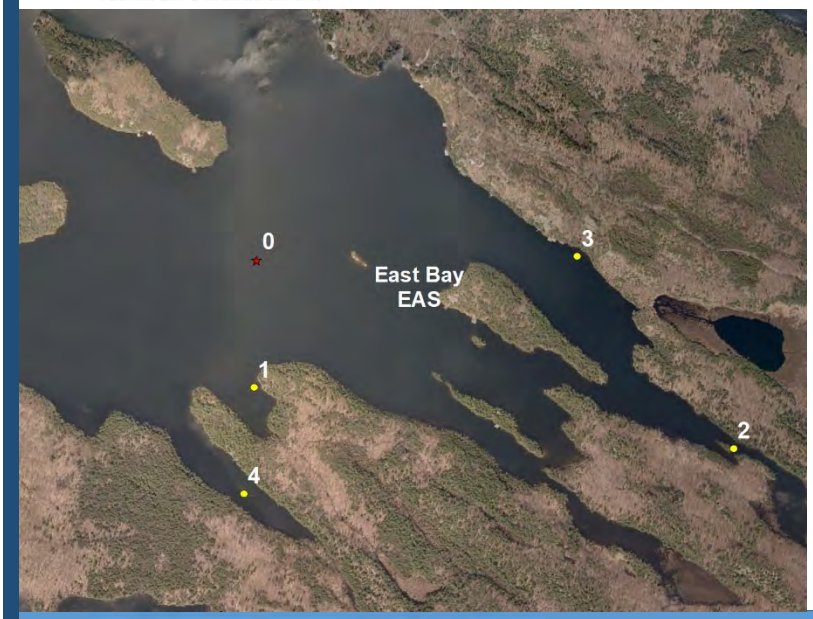
2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
DUD-1		6.6	8.6		
MUS-2	3.0	3.0	4.0		



Summary and Recommendations:

Phosphorus results remain generally below the historic 6.6 µg/L DMM threshold and all readings remain well below the present DMM threshold (20 µg/L). The spring and mean phosphorus results at DUD-1 remain generally consistent through the years. Secchi measurements vary through sampling years, ranging between 2.50 and 4.75 m (2010). **Beacon recommends that the MLA rely on the Lake Partner Program data when it is available, otherwise the MLA should continue to monitor this location to analyse long-term trends.**



Area Description:

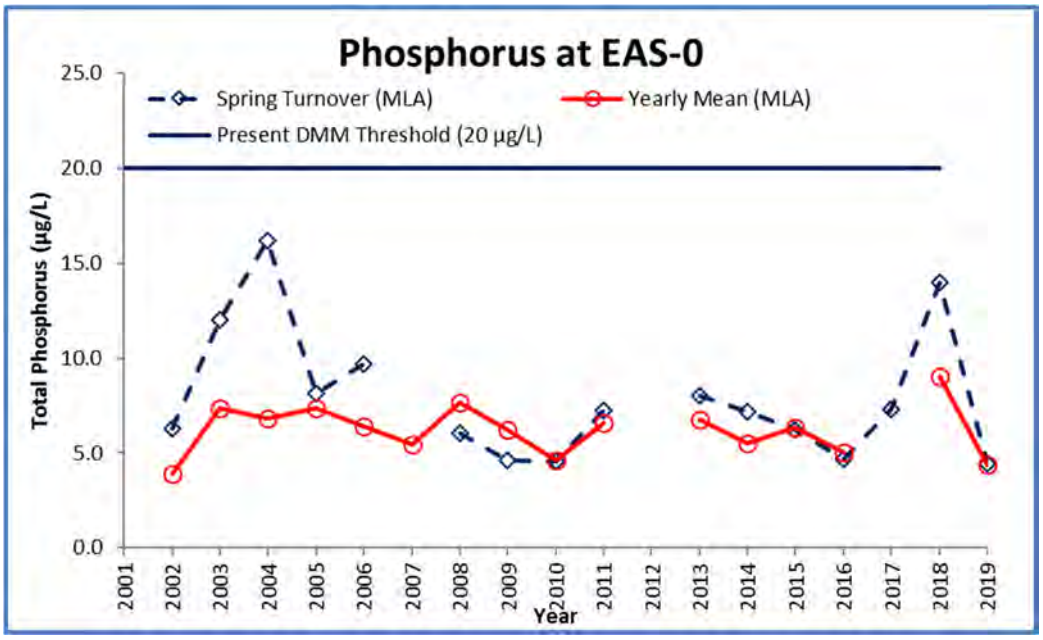
East Bay is in the western portion of Lake Muskoka and is part of Hardy Lake Provincial Park. This is a low development area with very few cottages/residences and few access roads. Several long narrow bays form the drainage area where five creeks outlet into the main bay from the park. These creeks also drain wetland areas into East Bay. Monitoring started in 2002. All stations shown may not be sampled each year.

Volunteer Recognition: **Jan Getson**, **Jeff Hall,** and **Gary Getson**.

East Bay (EAS)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
EAS-0	3.8	4.4	4.4		
EAS-2		17.7	8.9		
EAS-4		5.6	4.4		



Summary and Recommendations:

The spring phosphorus concentration at EAS-0 (4.4 µg/L) was much lower than the previous year, and all readings remain well below the present DMM threshold (20 µg/L). Although the spring phosphorus level at EAS-2 was the highest to date, low concentrations (≤ 7.6 µg/L) in the remainder of 2019 resulted in a yearly phosphorus mean similar to the average of the past 5 years. EAS-4 was a new station in 2017 and should be continued to be monitored to look for trends. The nearshore phosphorus levels at EAS-2 were notably higher than the deep-water levels. Secchi measurements remain stable through sampling years, varying between 2.6 and 5.5 m (2010). **Beacon recommends continued sampling to monitor long-term trends.**

Area Description:

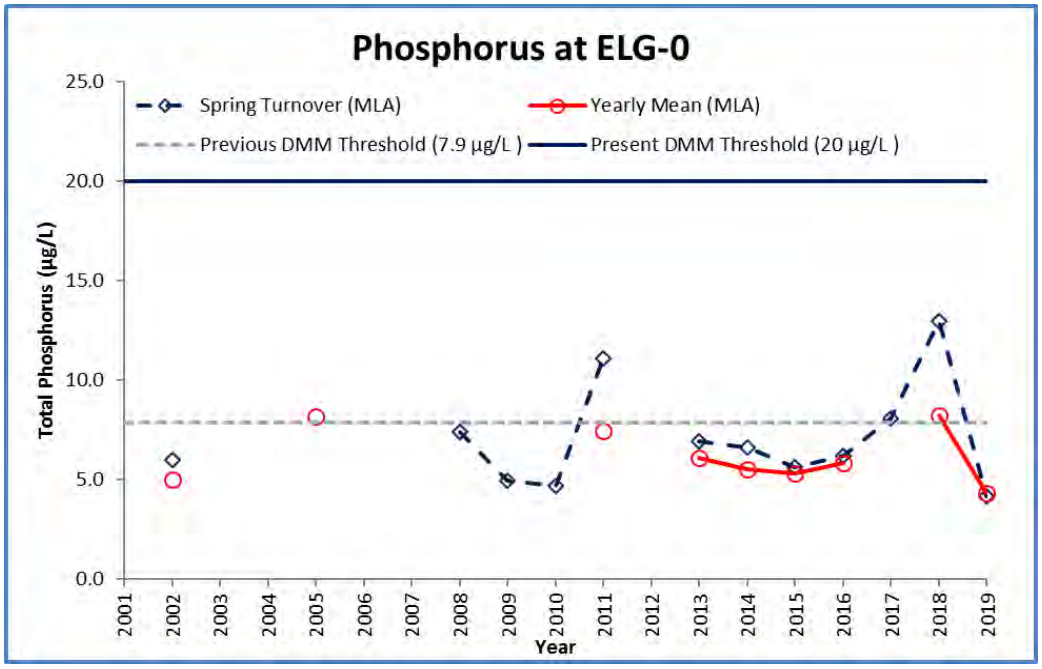
Eilean Gowan Island is in the eastern part of Lake Muskoka and is largely developed with residential cottages. Most of these properties appear to retain a well-vegetated shoreline except for a few lawns and tennis courts directly adjacent to the lake. The interior of this island is completely forested and a small stream outlets from the upland area at sampling site ELG-1. Monitoring started in 2002. All stations shown may not be sampled each year.

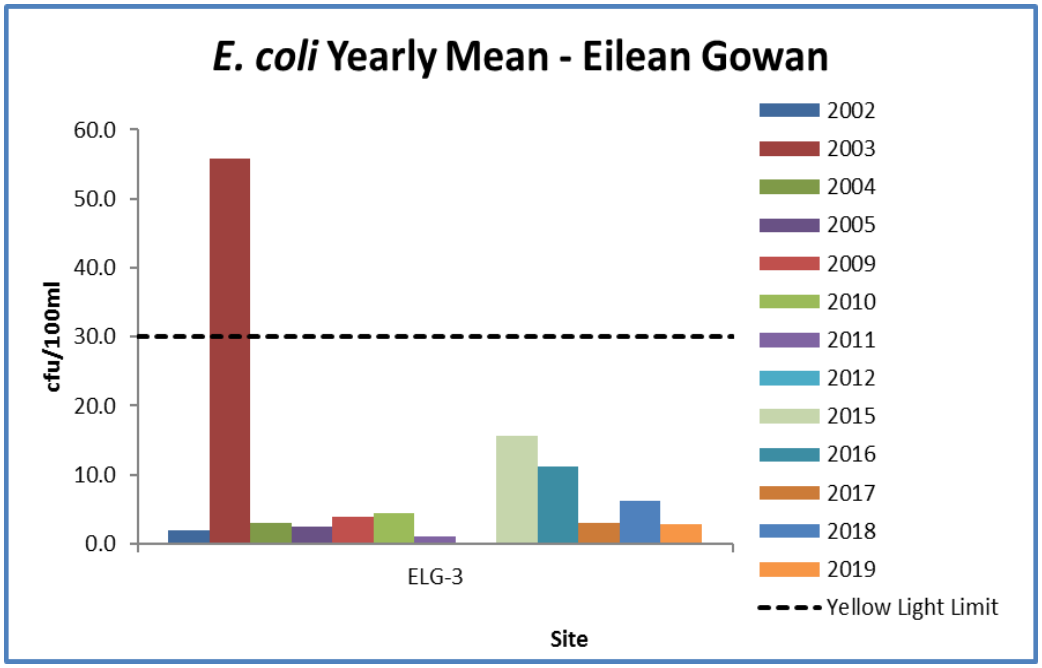
Volunteer Recognition: **Susan Murphy, Doug Tate, Stephen Sims**, Dave Coulson, Sydney Sims, Grayden Coulson, Sam Conley and Beth Tate.

Eilean Gowan Island (ELG)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
ELG-0	3.3	4.2	4.4		
ELG-3				2.9	45.0
ELG-5		6.4			





Summary and Recommendations:

The 2019 spring phosphorus concentration at ELG-0 decreased considerably from 2018, was below the historic DMM threshold of 7.9 µg/L, and all readings at ELG-0 remain well below the present DMM threshold (20 µg/L). Following the test for outliers of the spring phosphorus concentrations, the 2018 remained included and there were no outliers found. The increasing trend of phosphorus levels at ELG-0 has subsided, changing the stoplight from yellow to green. ELG-5 is a new station first established in 2018 and should be continued to be monitored to look for trends. The *E. coli* yearly mean at ELG-3 continued to remain below the MLA stoplight limits (details in report Section 3). Secchi measurements also remain stable through sampling years, varying between 2.0 and 5.25 m (2009). **Beacon recommends continuing sampling to monitor trends.**

Area Description:

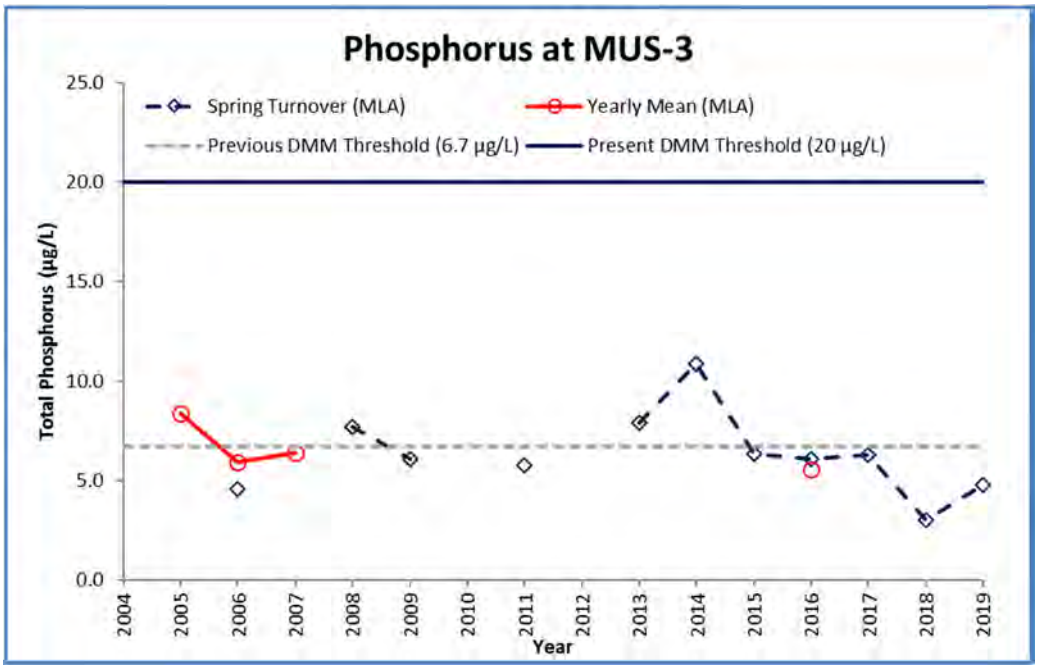
With a surface area of approximately 121 km^2 and water depths of up to 73 m, Lake Muskoka is the largest inland lake within the District of Muskoka. The Lake Muskoka watershed area is 4600 km^2 and approximately 10.5% of the watershed is covered by wetlands. The lake has various points of inflow and outflow, most notably being the outflow into the Moon River. Monitoring started in 2005.

Volunteer Recognition: **Susan Murphy,** Doug Tate, and Stephen Sims.

Lake Muskoka (MUS-3)

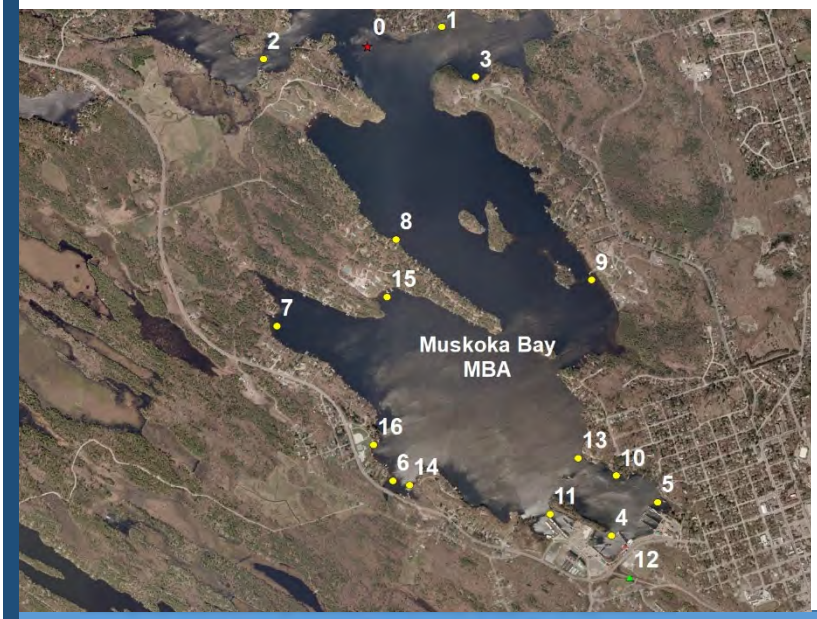
2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
MUS-3	3.3	4.8			



Summary and Recommendations:

The 2019 spring phosphorus concentration at MUS-3 was below the historic DMM threshold (6.7 µg/L) and all readings remain well below the present DMM threshold (20 µg/L). Only one spring phosphorus sample was collected in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. The Secchi depth in 2019 was consistent with previous years and measurements have ranged through sampling years, varying between 2.4 and 3.95 (2016). **Beacon recommends that spring sampling continue to monitor long-term trends.**



Area Description:

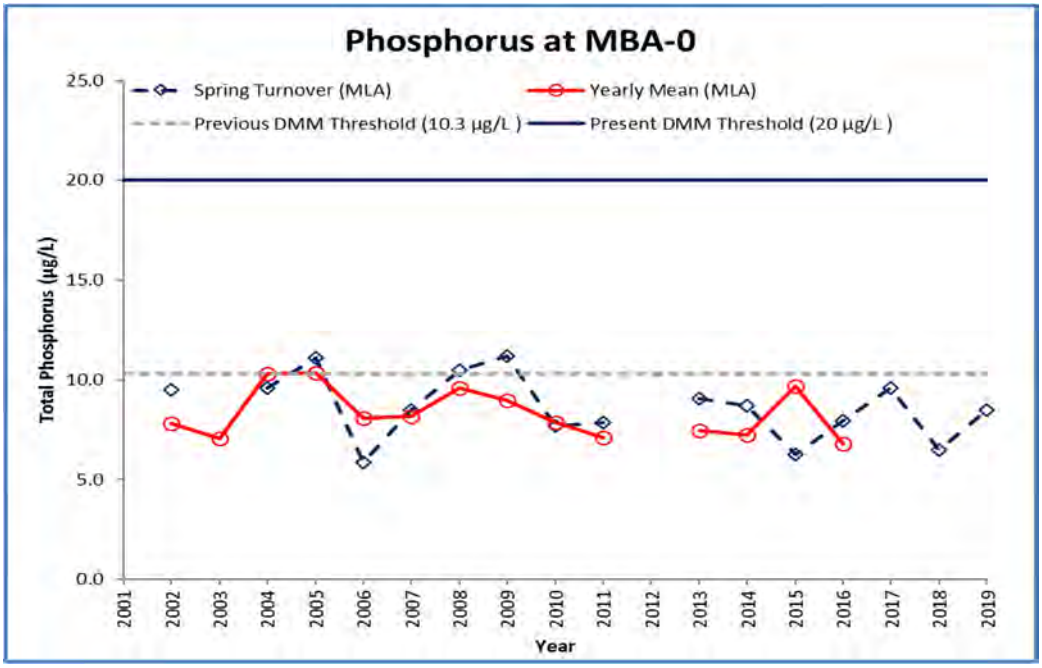
Muskoka Bay is the southernmost bay in Lake Muskoka. The bay has a long history of industrial uses and nutrient issues. Water quality in the bay has improved dramatically since the 1970s. Muskoka Bay was historically classified as moderately sensitive and over threshold by the DMM. Although the bay has a high intensity of development, 80% of the shoreline is presently in a natural state. The southern end of this bay includes a large commercial development and is the receiver of most of Gravenhurst's urban storm water. Several creeks outlet into the bay and wetlands account for 9.4% of the shoreline. Monitoring started in 2002. All stations shown may not be sampled each year.

Volunteer Recognition: **Karen Abells** and Alan Goldenberg.

Muskoka Bay (MBA)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
MBA-0	3.5	8.5				
MBA-2		6.7				
MBA-4		10.1				
MBA-11		8.6				



Summary and Recommendations:

Spring phosphorus concentrations continue to be below the historic DMM threshold level (10.3 µg/L) at the deep station (MBA-0) through the most recent 9 sampling years, and all readings remain well below the present DMM threshold (20 µg/L). Using Grubb's Test for outliers, the spring 2003 phosphorus sample was identified as an outlier in 2013 and remains out of the dataset in 2019. The spring phosphorus concentrations at all sites increased from 2018. Only one spring phosphorus sample was collected at each site in 2019, therefore no yearly means could be calculated, and no values are reported for 2019. *E. coli* was not sampled for in 2019. Secchi measurements vary through the sampling years between 2.15 and 5.9 m (2007, 2019). **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

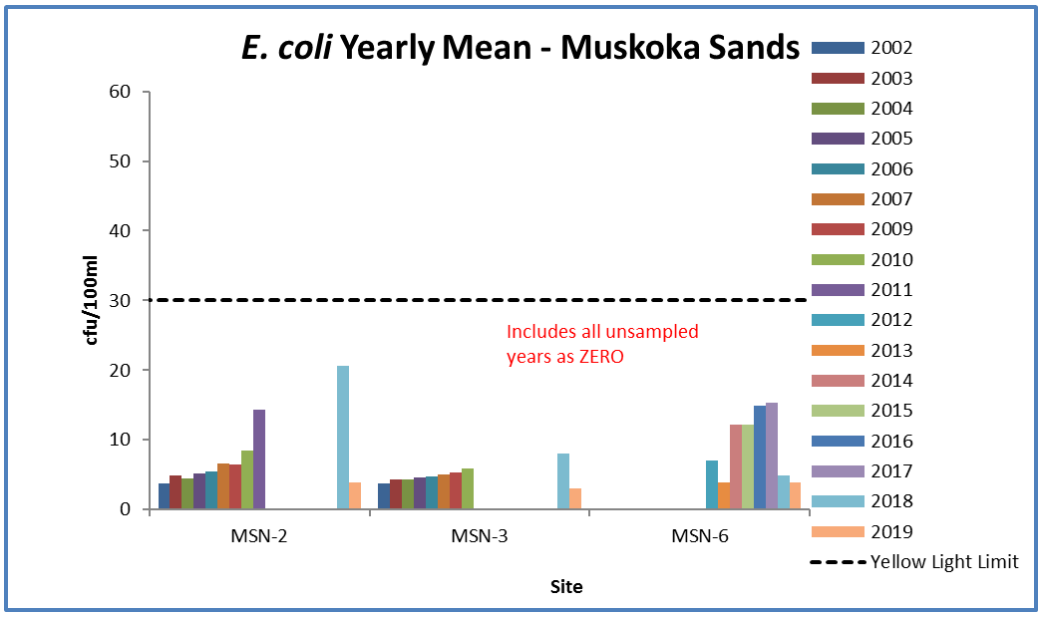
The Muskoka Sands sampling area is located in southeastern Lake Muskoka at the confluence with the Hoc Roc River. This area has a high intensity of development with a large resort and golf course, along with a high density of residential properties and roads adjacent to the lake. The Hoc Roc River flows through agricultural, industrial, residential, and natural wetland areas before it drains into a shallow bay. Dominant northwest winds and a considerable fetch would subject this area to heavy onshore wave action. Monitoring started in 2003. All stations shown may not be sampled each year.

Volunteer Recognition: **Carol Hoskins, Charlotte Hoskins** and Carroll Manol**.**

Muskoka Sands (MSN)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
MSN-0	3.9					
MSN-2				3.9	60.9	
MSN-3				3.0	45.7	
MSN-6				3.9	64.9	
MSN-8		6.5	6.5			



Summary and Recommendations:

Phosphorous samples were not collected at MSN-0 in 2019. MSN-8 is a new station added in 2017 and higher phosphorus results at this station in 2017 and 2018 can be indicative of inputs from the watercourse in this location, however, 2019 spring concentrations were substantially lower than 2018 (20.0 µg/L). *E. coli* results at MSN-2, MSN-3 and MSN-6 in 2019 were all below the MLA limits (details in report Section 3). Secchi measurements vary through the sampling years between 1.0 and 5.25 m (2010). **Beacon recommends that sampling continue to monitor long-term trends, with special attention to Station MSN-8.**

Area Description:

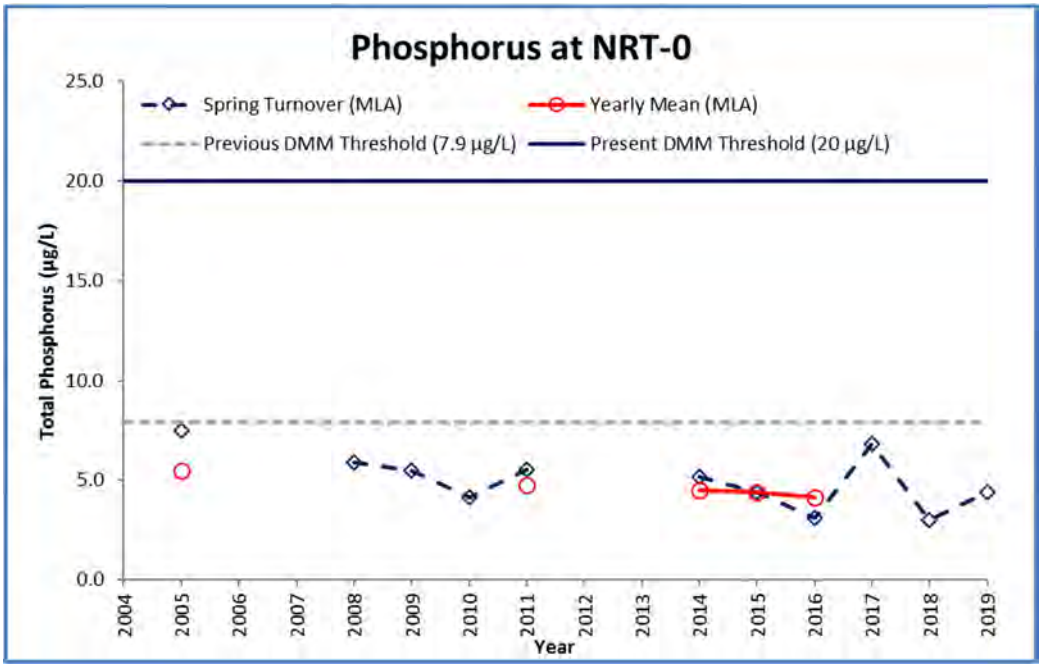
The North Bay sampling area is a large bay in northwestern Lake Muskoka. A total of eight creeks outlet into the bay, several draining wetland areas and one that passes through a District landfill site north of the lake. This is a moderately developed part of the lake, having many residential properties and several roads that are in close proximity to the shoreline. Development is mostly restricted to the areas adjacent to the lake, leaving most of the upland forested areas in a natural state. All stations shown may not be sampled each year.

Volunteer Recognition: **Eleanor Lewis, Kim Seon** and Jim Lewis.

North Bay (NRT)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
NRT-0	3.4	4.4			



Summary and Recommendations:

Spring turnover phosphorus concentrations at NRT-0 have all remained below the historic DMM threshold (7.9 µg/L), and all readings remain well below the present DMM threshold (20 µg/L). Only one spring phosphorus sample was collected in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. Secchi measurements also remain generally stable through sampling years, varying between 2.25 and 4.63 m (2016). **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

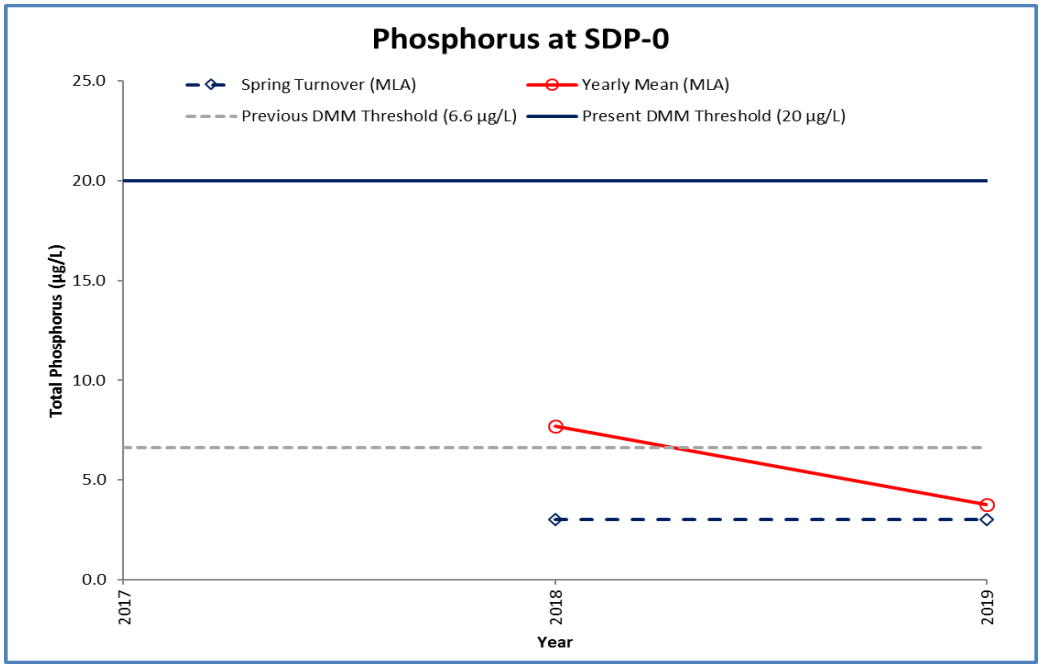
Sandy Point is in the western portion of Lake Muskoka, and directly east of Bala. The Sandy Point stations are at the downstream end of most of the MLA sampling stations in the Lower Muskoka Subwatershed. Lands to the west of these sampling sites contain three active aggregate operations. Monitoring started in 2018. All stations shown may not be sampled each year.

Volunteer Recognition: **Mike Schnarr**

Sandy Point (SDP)

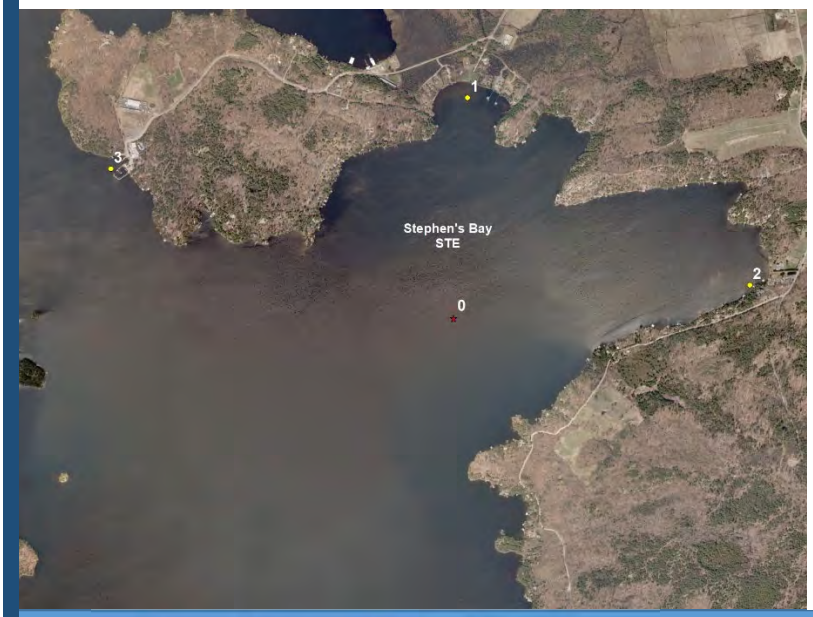
2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
SDP-0	3.2	4.9	3.8		
SDP-1		4.0	3.8		



Summary and Recommendations:

The spring phosphorus concentrations at SDP-0 are below the historic DMM threshold of 6.6 µg/L and are well below the present DMM threshold (20 µg/L). This nearshore station was established in 2018. **Beacon recommends that sampling continue to monitor long-term trends**.



Area Description:

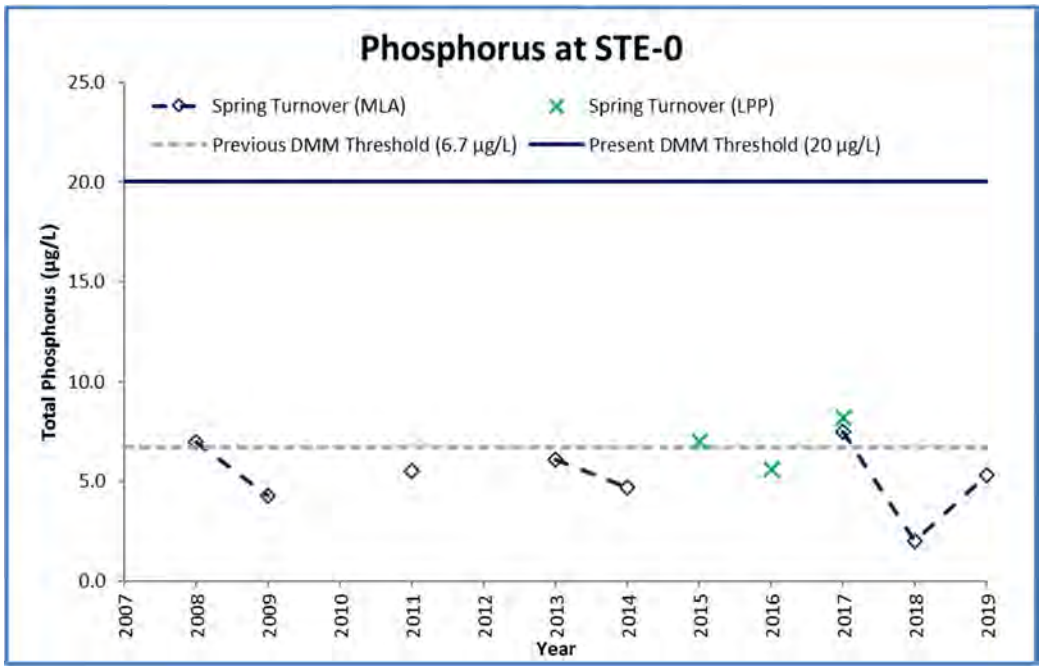
Stephen's Bay is a small bay in the central part of eastern Lake Muskoka, south of the mouth of the Muskoka River. The water quality in Stephen's Bay is influenced by input from adjacent wetlands as well as agriculture in the east, and public beaches (Strawberry Bay and Kirby's). Much of the shoreline is developed. Monitoring started in 2013 due to concern this may be a vulnerable area. All stations shown may not be sampled each year.

Volunteer Recognition: **Bob Kerton,** Louise Cragg, Chris Cragg, Maxwell Kerton, and the Lake Partnership Program.

Stephens Bay (STE)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
STE-0	2.9	5.3			
STE-2		4.6			



Summary and Recommendations:

The spring phosphorus concentration at STE-0 was below the historic DMM threshold of 6.7 µg/L, and all readings remain well below the present DMM threshold (20 µg/L). The spring turnover phosphorus recorded at STE-2 in 2019 is similar to the one other sample taken at STE-2 in 2013 (4.0 µg/L). *E. coli* was not sampled for in 2019. Secchi measurements vary through sampling years, ranging between 2.0 and 4.4 m (2013). **Beacon recommends that the MLA rely on the Lake Partner Program data when it is available, otherwise the MLA should continue to monitor this location to analyse long-term trends.**

Area Description:

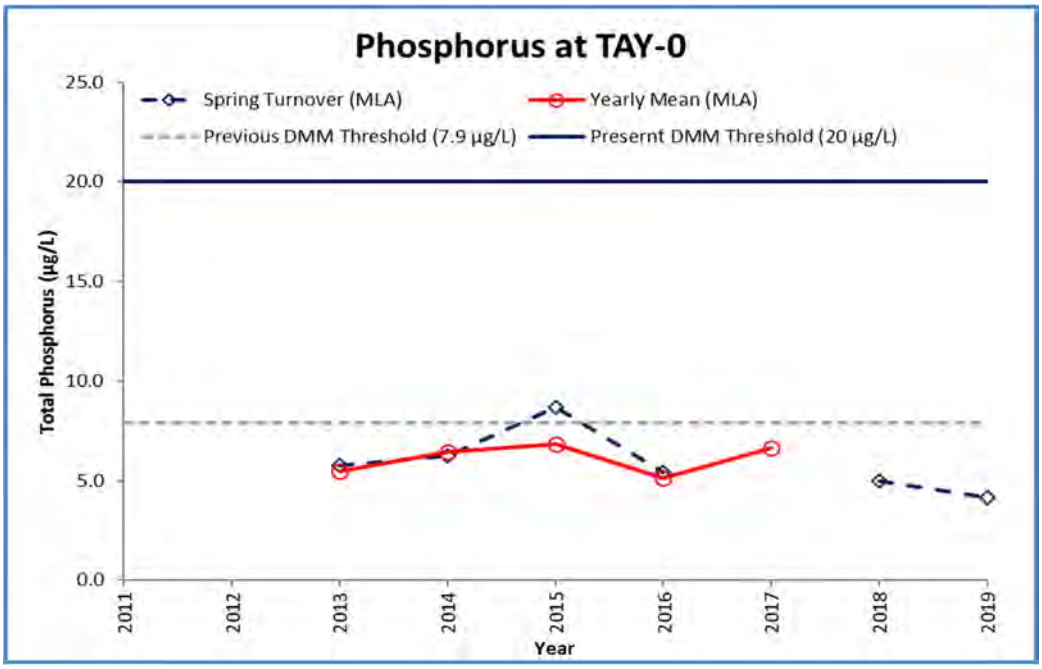
Taylor Island is in the main basin of Lake Muskoka and is approximately 76 ha in size. Development intensity in this area is considered moderate to high; however, most of the natural shoreline vegetation appears to be intact. This area has few lacustrine wetlands. Two streams originating in wetlands, outlet into the lake in this area. TAY-2 is located adjacent to a marina. Monitoring started in 2012. All stations shown may not be sampled each year.

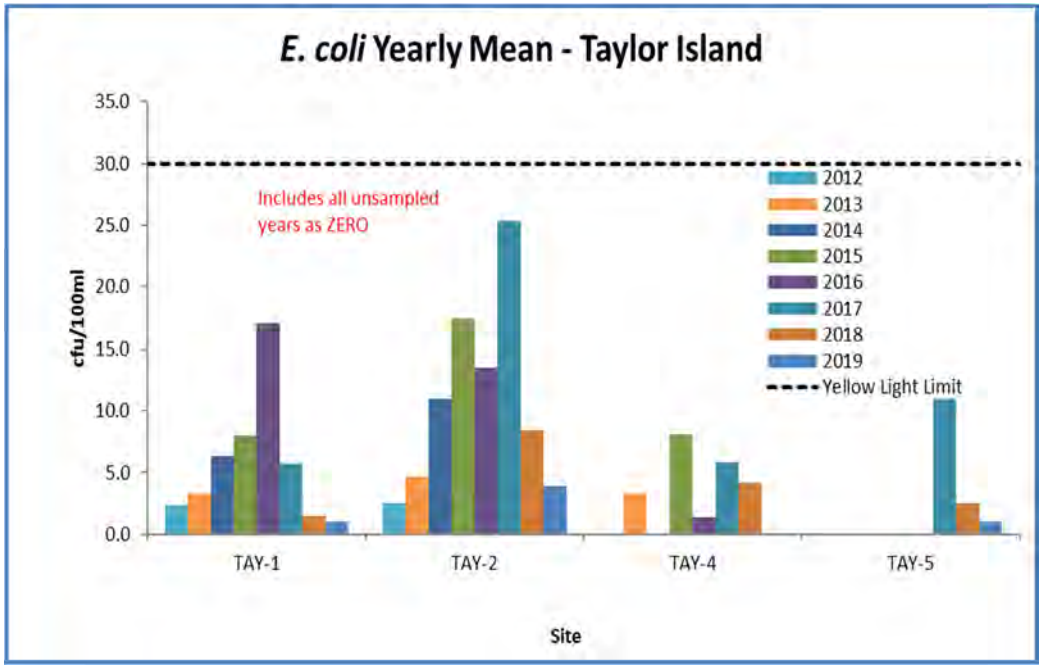
Volunteer Recognition: **Sheila Robinson, George Fallis, Mark Brosch, and** Sandy Brosch.

Taylor Island (TAY)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
TAY-0	3.3	4.2			
TAY-1				1.0	22.7
TAY-2		4.0	4.1	3.9	35.3
TAY-5		4.9		1.0	52.4





Summary and Recommendations:

The 2019 spring phosphorus concentration at the deep station (TAY-0) was below the historic DMM threshold of 7.9 µg/L, and the lowest recorded to date. All phosphorus values remain well below the present DMM threshold (20 µg/L). Only one spring phosphorus sample was collected at TAY-0 in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. The 2019 spring phosphorus and yearly phosphorus mean concentrations at TAY-2 were also the lowest recorded to date. *E. coli* concentrations at TAY-1, TAY-2, and TAY-5 remained below the MLA stoplight limits (details in report Section 3). Secchi measurements remain stable through sampling years, varying between 2.18 and 5.30 m (2016). **Beacon recommends that sampling continue to establish a baseline at TAY-5 and to monitor long-term trends at all stations.**

Area Description:

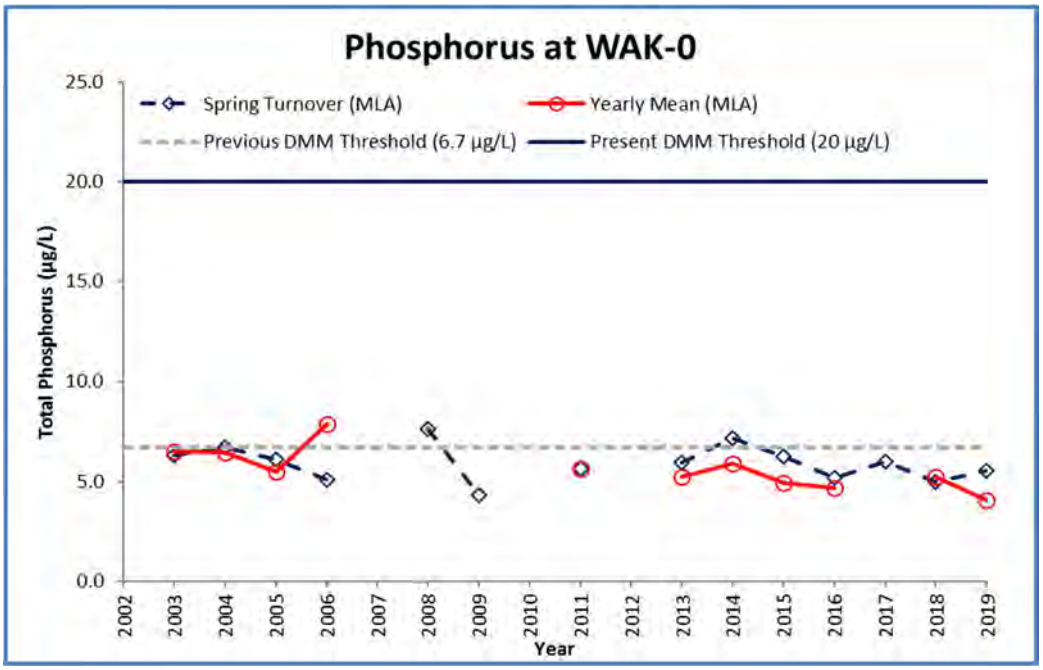
The Walkers Point sampling area is in south-central Lake Muskoka, East of Hardy Lake Provincial Park and west of Browning Island. WAK-0 is located off the tip of Walkers Point, near the mouth of Walkers Bay. A single creek outlets in Walkers Bay. The sampling area includes the bay to the north that contains the outlet of a creek which drain a series of wetlands. All stations shown may not be sampled each year.

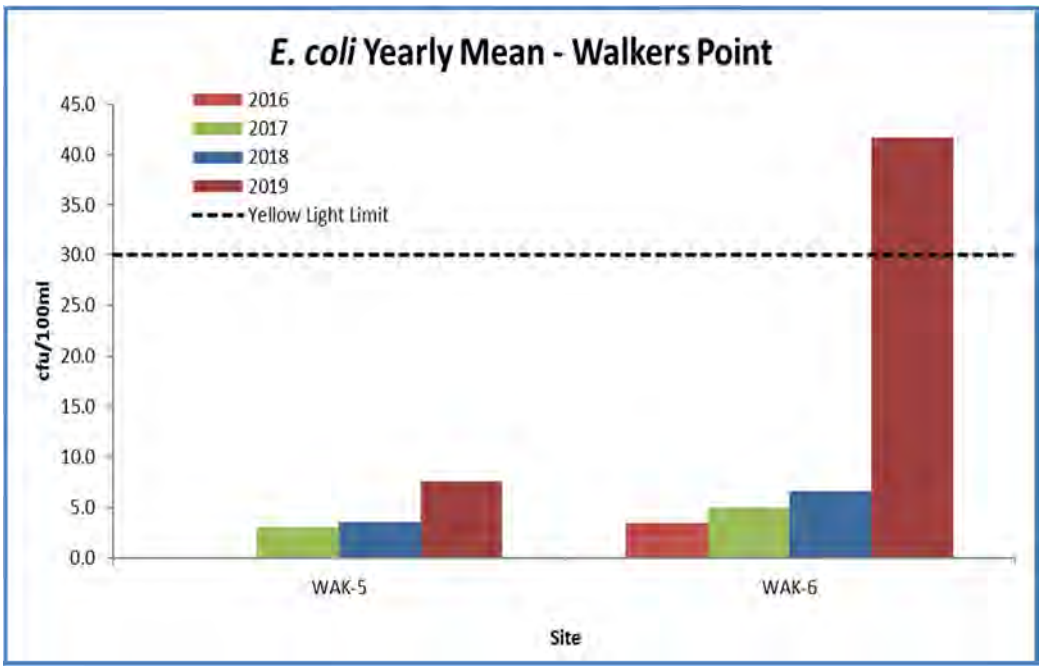
Volunteer Recognition: **Susan Murphy**, Doug Tate, Stephen Sims, Sydney Sims, Grayden Coulson, Dave Coulson, Beth Tate, and Sam Conley.

Walkers Point (WAK)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
WAK-0	3.4	5.6	4.0		
WAK-5		6.1	4.7	7.6	49.5
WAK-6		8.1	5.4	41.7	228.7





Summary and Recommendations:

Phosphorus concentrations at the deep-water station (WAK-0) remain consistent, below the historic DMM threshold of 6.7 µg/L in 2019, and all readings remain well below the present DMM threshold (20 µg/L). Sampling for spring turnover phosphorus concentrations at WAK-5 began in 2017 and data will be analyzed following additional years of gathering samples. Sampling at WAK-6 began in 2015 and phosphorus values have been inconsistent; the two extremes to date (2.0 µg/L and 19.0 µg/L) were recorded in August and June, respectively in 2018. Data will be analyzed for WAK-6 following additional years of gathering samples. *E. coli* testing at WAK-5 continues to show concentrations below the MLA stoplight limits (details in report Section 3), however the WAK-6 geometric mean exceeded this limit in 2019. For this reason, the stoplight has changed from green to yellow in 2019. The Secchi depth measurements have ranged through sampling years, varying between 2.25 and 4.35 (2016). **Beacon recommends that sampling continue to monitor long-term trends.**

Area Description:

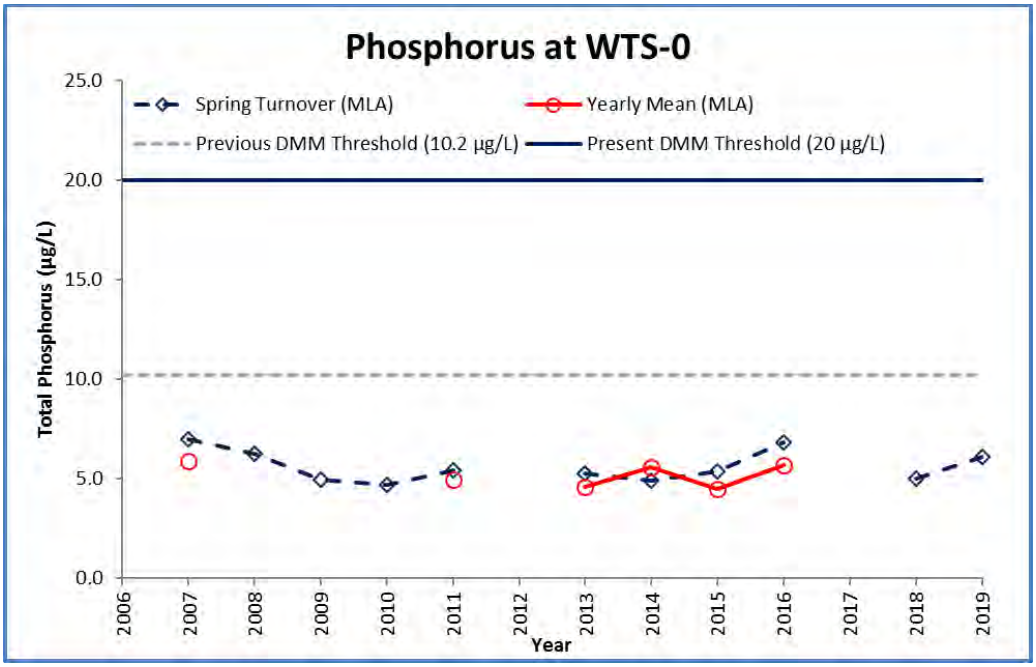
Whiteside Bay is in the northwestern portion of Lake Muskoka and receives a high amount of spring flow from the northwest. It is moderately developed with cottage/residential properties and has roadways that come near the shoreline in several areas. Inflow into the lake comes from two creeks, one of which originates in an extensive wetland complex to the north. Monitoring started in 2007. All stations shown may not be sampled each year.

Volunteer Recognition: **Kim Seon, Eleanor Lewis,** and Jim Lewis.

Whiteside Bay (WTS)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
WTS-0	3.2	6.1			



Summary and Recommendations:

All spring phosphorus concentrations at WTS-0 are below the historic DMM threshold of 10.2 µg/L, and all phosphorus values remain well below the present DMM threshold (20 µg/L). The spring phosphorus levels at WTS-0 are consistent through the sampling years, except for 2017. This sample was determined to be an outlier during the 2017 Grubb's test analysis and continues to be removed in the 2019 analysis. Secchi measurements vary through sampling years, ranging between 2.75 and 4.25 m (2010). **Beacon recommends that sampling continue to monitor long-term trends.**

Area Description:

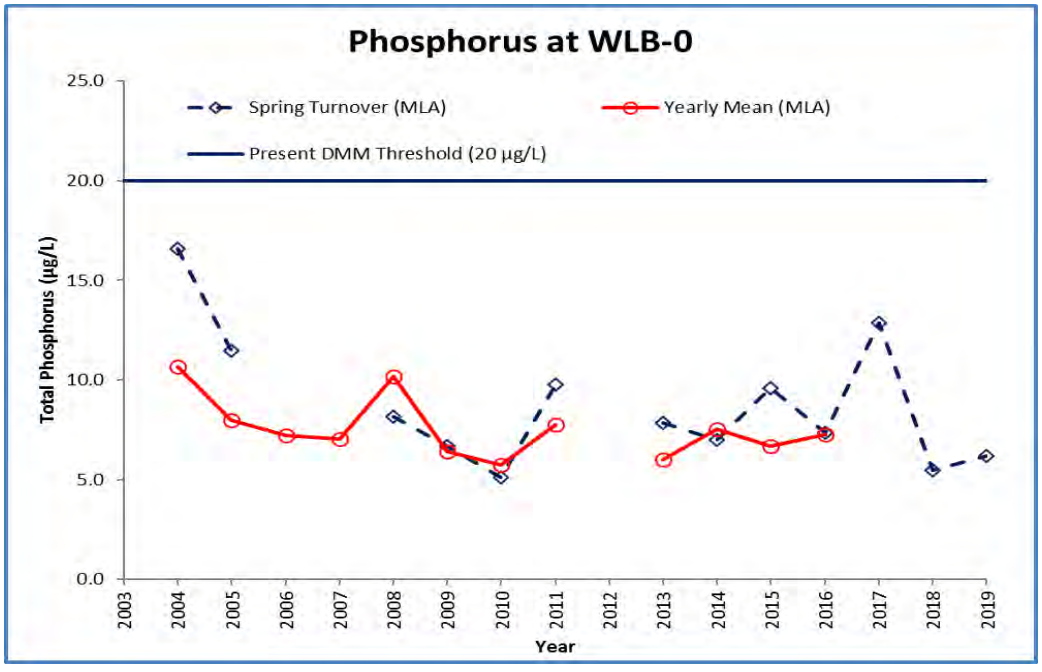
The Willow Beach sampling area encompasses a highly developed section of shoreline. There is a newly re-developed resort complex, a wetland with a creek flowing through a nine-hole golf course and several larger properties with limited retained forest cover. Highway 118 is in close proximity to the shoreline along much of this reach. Monitoring started in 2004. All stations shown may not be sampled each year.

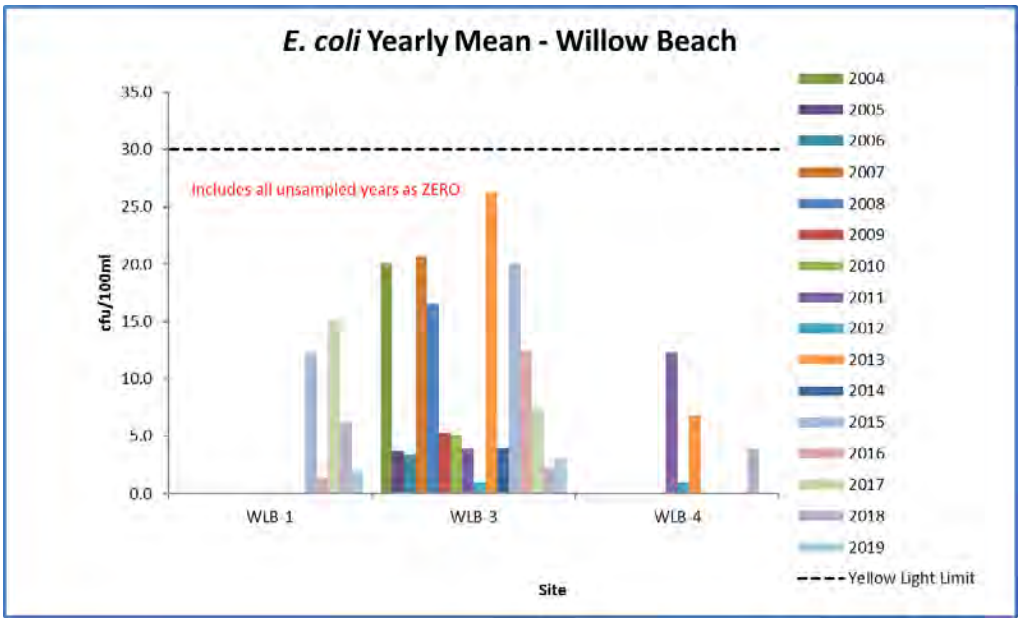
Volunteer Recognition: **Chris Cragg, Murray Walker, Emila Brittain** and Louise Cragg,

Willow Beach (WLB)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
WLB-0	2.7	6.2				
WLB-1		4.9	5.7	2.0	101.9	
WLB-3		13.1	8.1	3.0	104.9	
WLB-4		5.5	5.1			





Summary and Recommendations

All spring phosphorus concentrations at WLB-0 remain well below the present DMM threshold (20 µg/L). Using Grubb's Test for outliers, the spring 2006 phosphorus sample was identified as an outlier and remains out of the dataset in 2019. Only one spring phosphorus sample was collected in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. The 2019 spring turnover and yearly mean phosphorus concentrations at WLB-4 were the lowest recorded to date. The yearly mean phosphorus concentrations at WLB-1 and WLB-3 were also the lowest recorded to date. The *E. coli* levels at WLB-1, WLB-3, and WLB-4 remain well below the MLA stoplight limits (details in report Section 3). Secchi measurements are variable through sampling years, ranging between 0.84 and 6.50 m (2011). **Beacon recommends that sampling continue to monitor long-term trends.**

Area Description:

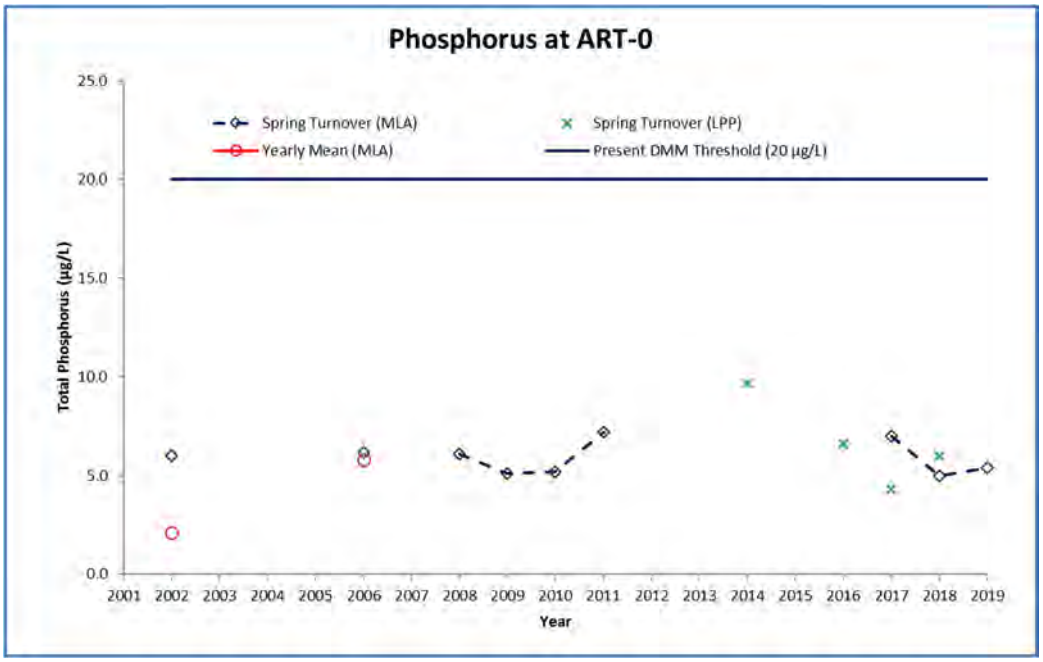
Arthurlie Bay is in the southern basin of Lake Rosseau. The bay is quite shallow in the southern end. Development intensity is considered moderate to high, with some shoreline properties having extensive cleared areas. This bay has several lacustrine wetlands, some of which appear to be partially filled. One creek drains into the bay, flowing through agricultural land prior to entering the lake. Monitoring started in 2002.

Volunteer Recognition: **Katherine Seybold,** and Peter Seybold

Arthurlie Bay (ART)

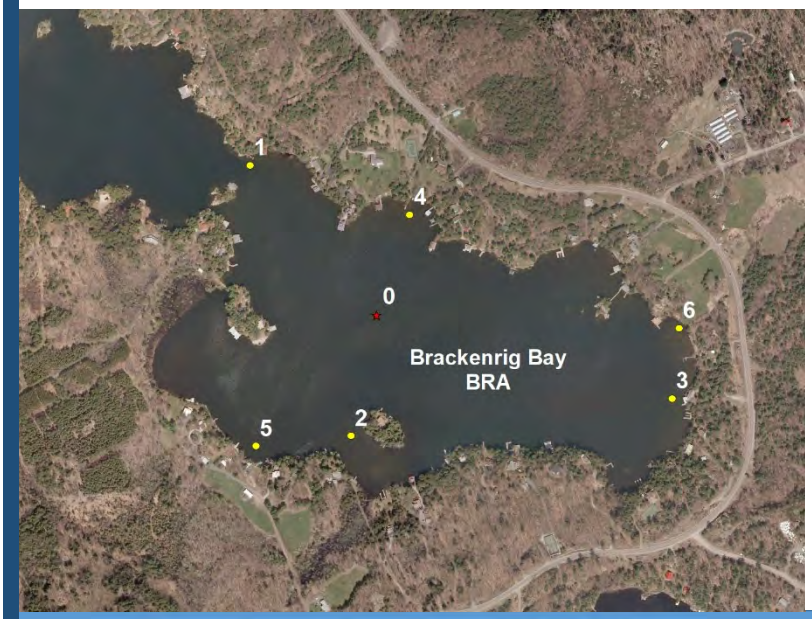
2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
ART-0	3.8	5.4			



Summary and Recommendations:

Phosphorus results remain generally low throughout the sampling years, and all readings remain well below the present DMM threshold (20 µg/L). Lake Partner Program spring phosphorus data was available in 2013, and 2015-2018. Generally, Secchi measurements remain stable through sampling years, varying between 3.0 and 3.9 m (2011). **Beacon continues to recommend that the MLA rely on the Lake Partner Program data when it available, otherwise because of the increasing development pressure in the south end of the bay, the MLA should continue to monitor this location to analyse long-term trends.**



Area Description:

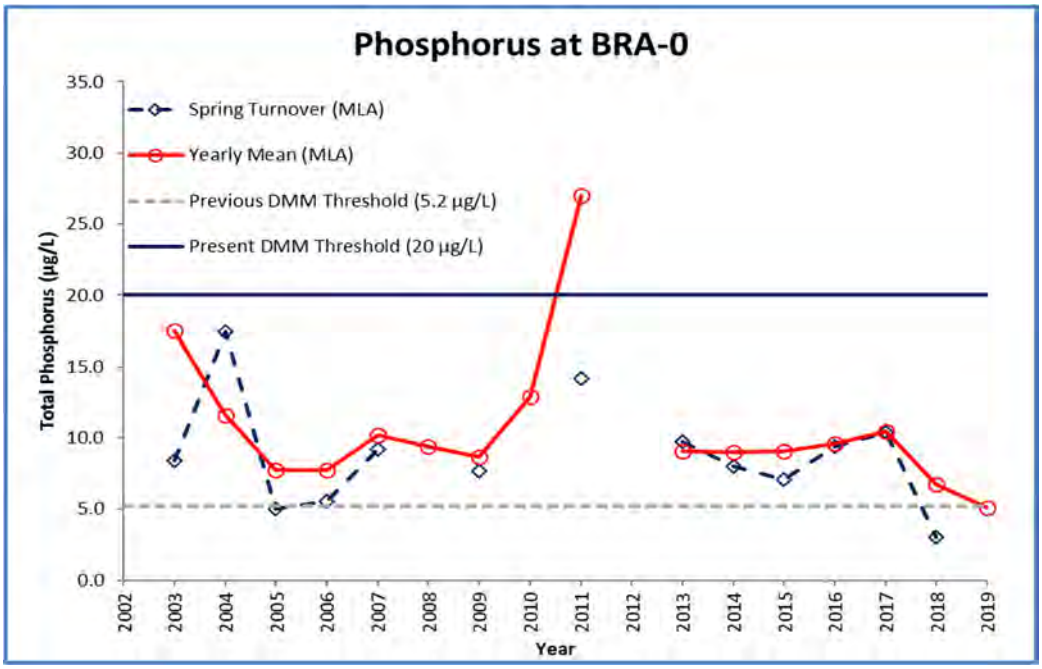
Brackenrig Bay is located in southern Lake Rosseau, is approximately 0.44 km² in area and has a maximum depth of 3 m. This isolated bay is moderately developed with residential properties. Approximately 20% of the immediate shoreline has been altered with over 60% of backlot areas cleared of natural forest. Four creeks drain into the bay, one of which flows through an agricultural area adjacent to a garden center before entering the lake. Brackenrig Road is in close proximity. Brackenrig Bay was formerly classified as moderately sensitive and over-threshold by the DMM. Monitoring started in 2003. All stations shown may not be sampled each year.

Volunteer Recognition: **Judy Stephens-Wells**, Ross Wells and Val Fleck.

Brackenrig Bay (BRA)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
BRA-0	2.4		5.1			
BRA-1		5.1	5.2			
BRA-3			6.4			
BRA-6		6.3	5.6			



Summary and Recommendations:

BRA-0 was sampled in spring 2019, however a spring phosphorous level could not be obtained due to complications in the lab. Spring phosphorus levels at BRA-1 and BRA-6 were higher than 2018 levels. The phosphorus yearly mean at BRA-1 was the lowest recorded to date, and at BRA-6 was the lowest recorded in the last 4 years. *E. coli* sampling at all stations continued to be suspended in 2019. Secchi measurements vary through sampling years, ranging between 1.45 and 3.10 m (2017). BRA was given a green stoplight in 2018 and remains green in 2019. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

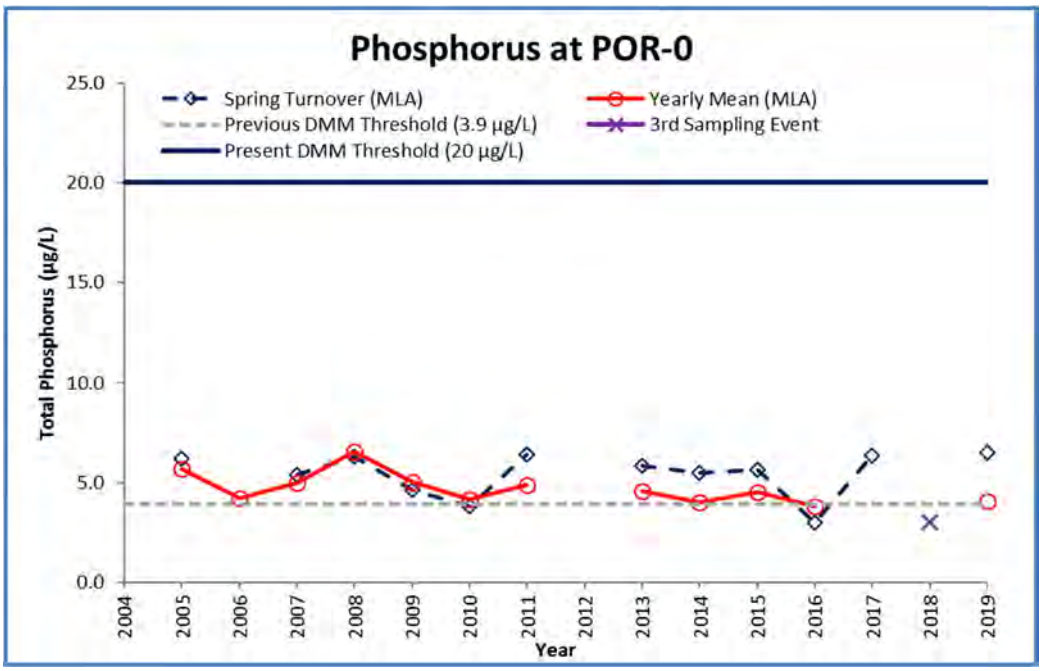
East Portage Bay is located in eastern Lake Rosseau, has an area of approximately 1.33 km², and reaches a maximum depth of 12 m. This moderately developed bay has many roads, with several areas directly adjacent to the shoreline. There is also a large agricultural area adjacent to the northern shoreline of the bay. No creeks outlet into the bay and there are no wetlands draining from the upper watershed. East Portage Bay was historically classified as highly sensitive and over threshold by the DMM. Monitoring started in 2005. All stations shown may not be sampled each year.

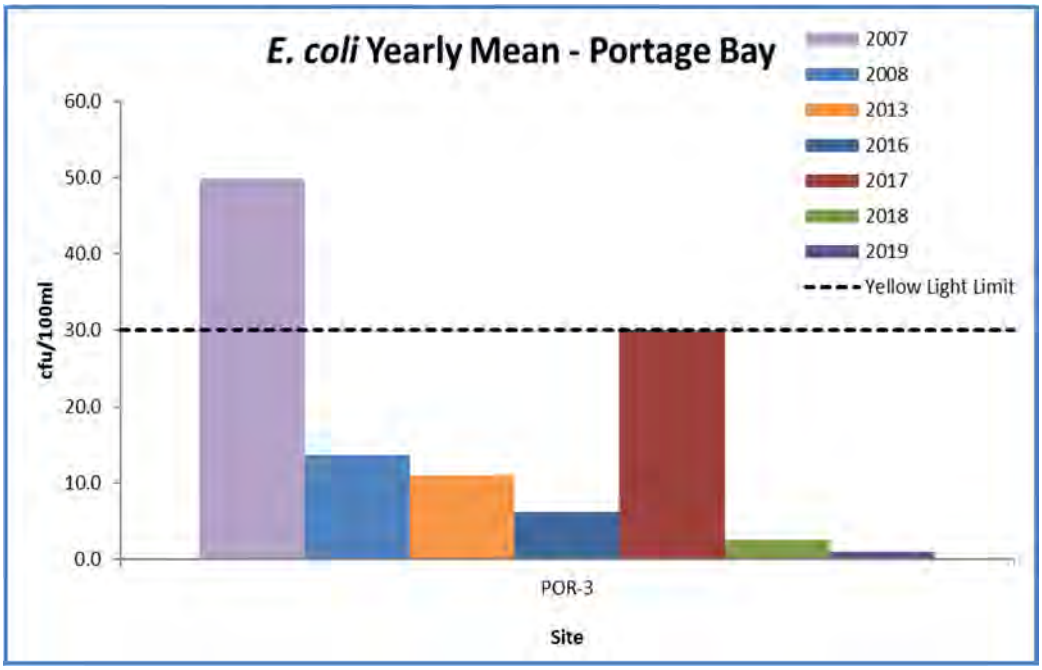
Volunteer Recognition: **Mike Robinson, Jill Robinson, Marje Henke** and Laura Rice.

East Portage Bay (POR)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
POR-0	3.9	6.5	4.1		
POR-1		4.9	3.6		
POR-3		7.3	4.1	1.0	27.0
POR-5		6.6	4.2		





Summary and Recommendations:

The 2018 spring phosphorus concentration (13 µg/L) at the deep station (POR-0) was identified in 2018 and 2019 as an outlier in the Grubb's test and removed from the data sets. The 2019 spring phosphorus concentration at POR-0 was the highest recorded to date. That said, all readings remain well below the present DMM threshold (20 µg/L). The spring phosphorous concentration at POR-1 were the second lowest recorded to date and the yearly mean phosphorus level at POR-3 was the lowest to date. *E. coli* sampling continued at only POR-3 in 2019 and the yearly mean value was well below the MLA stoplight limits (details in report **Section 3**). Secchi measurements vary through sampling years, ranging between 1.45 and 6.5 m (2008). **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

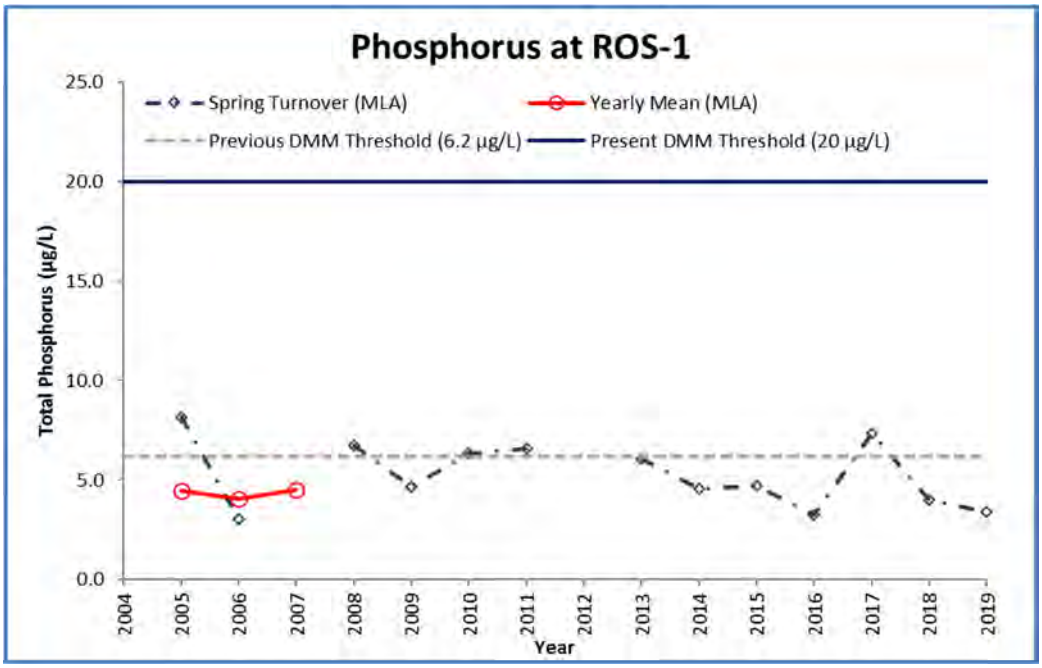
The main basin of Lake Rosseau is approximately 55.5 km² in area with a maximum depth of 90 m. The lake is classified as a coldwater lake and supports a naturally reproducing population of Lake Trout. Wetlands account for 5% of the upper watershed. The Lake Rosseau watershed, excluding the lake itself is 204.5 km². Lake Rosseau was historically classified by the DMM as moderately sensitive. Monitoring started in 2005.

Volunteer Recognition: **Katherine Seybold,** Peter Seybold and B. McCabe.

Lake Rosseau (ROS)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
ROS-1	4.1	3.4			



Summary and Recommendations:

The 2019 spring phosphorus concentration at ROS-1 was below the historic DMM threshold of 6.2 µg/L, and all readings remain well below the present DMM threshold (20 µg/L). Secchi measurements vary through sampling years, ranging between 3.1 and 5.65 m (2014). **Beacon recommends that spring sampling continue to monitor long-term trends.**

Area Description:

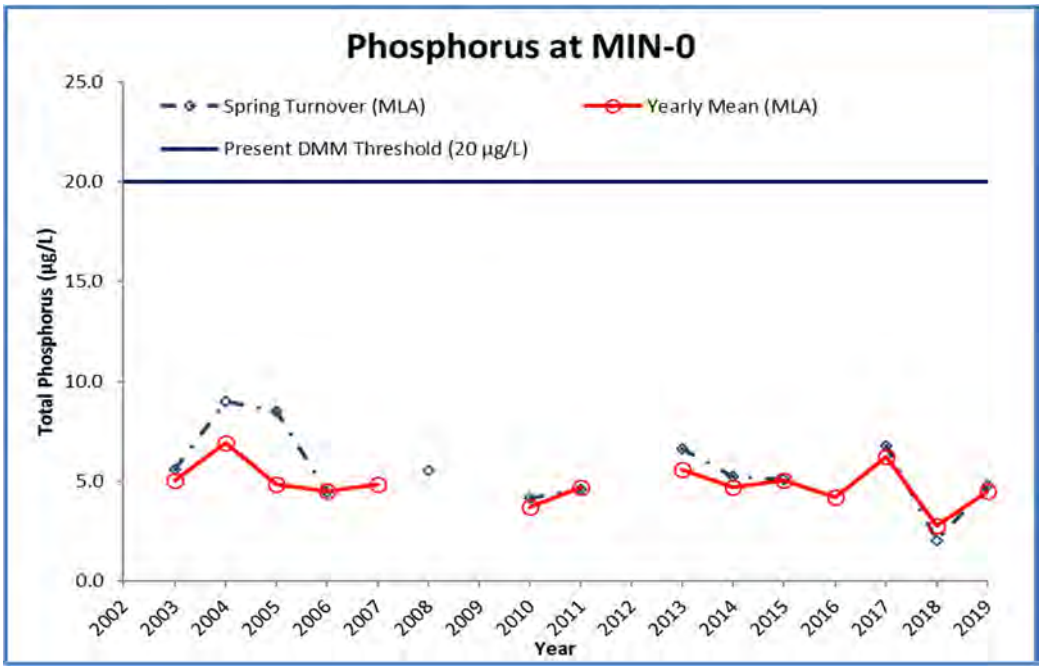
The village of Minett is located in western Lake Rosseau, and has seven sampling sites. Sampling sites were selected with the intention of monitoring the potential effects of high intensity development in this bay. The area contains two large resorts with golf courses, several roads, a marina, and many private residential properties. There is one wetland adjacent to the lake and several other small ones in the area of the bay. Monitoring started with the original program in 2003. All stations shown may not be sampled each year.

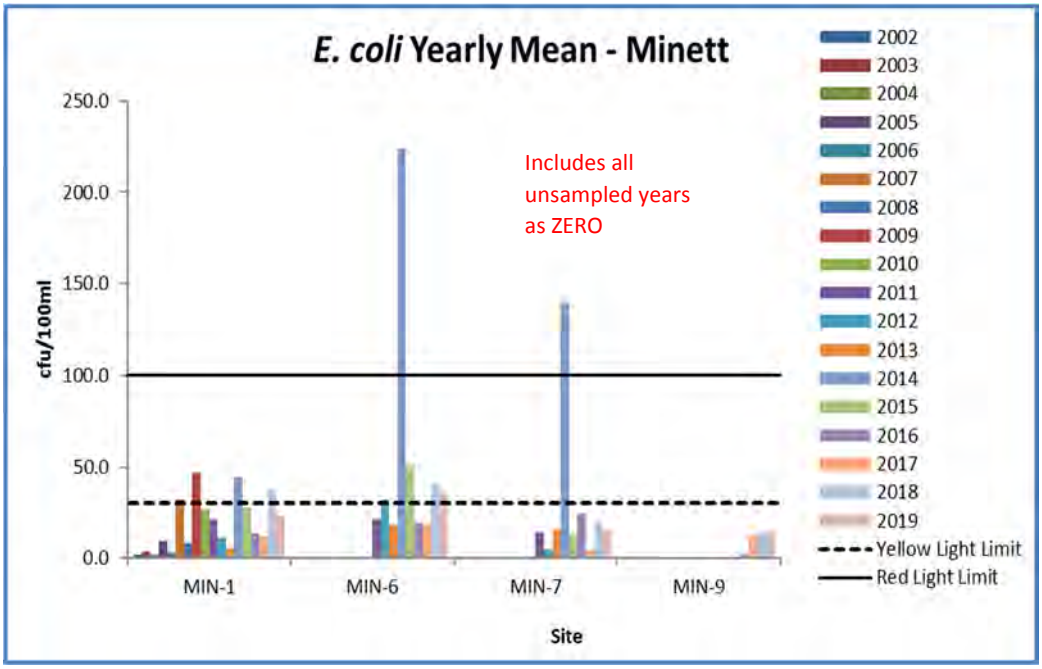
Volunteer Recognition: **Laurie Thomson** and **Greg Thomson.**

Minett (MIN)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

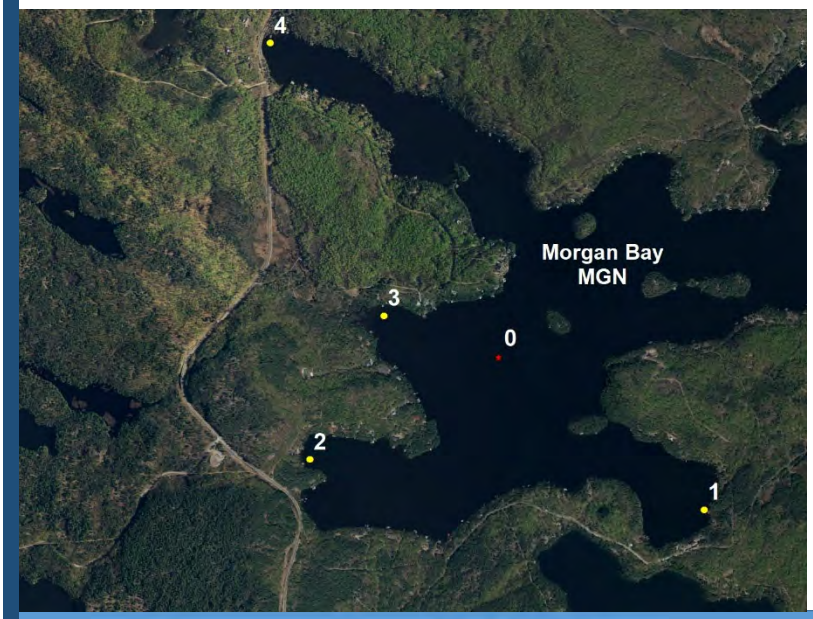
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
MIN-0	4.0	4.8	4.5			
MIN-1		4.8	4.6	23.4	445	
MIN-6		14.3	12.9	35.7	394.6	
MIN-7		6.6	4.8	15.0	237.3	
MIN-9		3.7	4.2	14.8	157.0	





Summary and Recommendations:

The spring phosphorus level at MIN-0 remains consistent, and all readings are well below the present DMM threshold (20 µg/L). The yearly phosphorus mean at MIN-0 has also remained consistent through the sampling years. Using Grubb's Test for outliers, the spring 2016 phosphorus sample at MIN-0 continues to be an outlier in 2019. Phosphorus sampling results at MIN-1 are consistent with previous years. MIN-7 recorded the lowest yearly mean phosphorus level of 8 years of sampling and MIN-9 showed the lowest spring phosphorus and yearly average of the last 4 years. Although MIN-6 had the lowest recorded phosphorus level (5.0 µg/L) at that station to date in August 2019, the threshold of nearshore measurements being substantially higher than the deep-water value was reached, therefore Minett remains classified as yellow in 2019. The yearly mean *E. coli* results at stations MIN-1, MIN-7 and MIN-9 were below the MLA stoplight limits (details in report Section 3), however station MIN-6 was once again above the MLA yellow light limit, maintaining a yellow stop light for Minett. Retesting was required for MIN-1, MIN-6, MIN-7, and MIN-9. Secchi measurements vary through the sampling years between 13.1 and 5.7 m (2017). **Beacon recommends sampling continue to monitor long-term trends.**



Area Description:

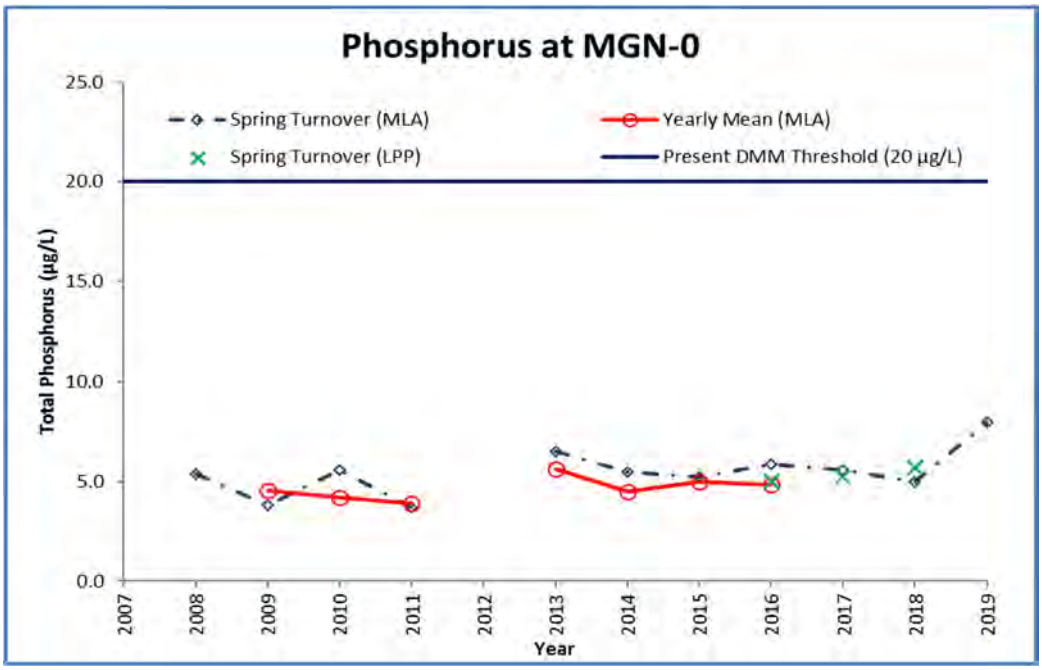
Morgan Bay is in the northernmost part of Lake Rosseau, and a series of small bays make up this large sampling area. Several creeks outlet into this bay close to the nearshore sampling sites and there is a wetland adjacent to the lake at MGN-3. Most of the shoreline area is developed with residential properties, but many retain natural riparian vegetation. Nearly the entire area has road access and several of these roadways come very close to the water. Monitoring started in 2008. All stations shown may not be sampled each year.

Volunteer Recognition: **Sue Wessenger, Carol Ann Ballantyne, Jill Lavine**, John Wessenger, and the Lake Partner Program.

Morgan Bay (MGN)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
MGN-0	1.9	8.0			
MGN-2		4.6	3.8		



Summary and Recommendations:

The spring phosphorus result at MGN-0 in 2019 was the highest recorded to date, and all readings remain well below the present DMM threshold (20 µg/L). Only one phosphorus sample (spring) was collected in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. Lake Partner Program spring phosphorus data was available in 2016, 2017 and 2018, and is included in the graph. Secchi measurements vary through the sampling years between 1.9 (2019) and 5.25 m (2011). **Beacon recommends that the MLA rely on the Lake Partner Program data when it is available, and sampling continue to monitor long-term trends.**

Area Description:

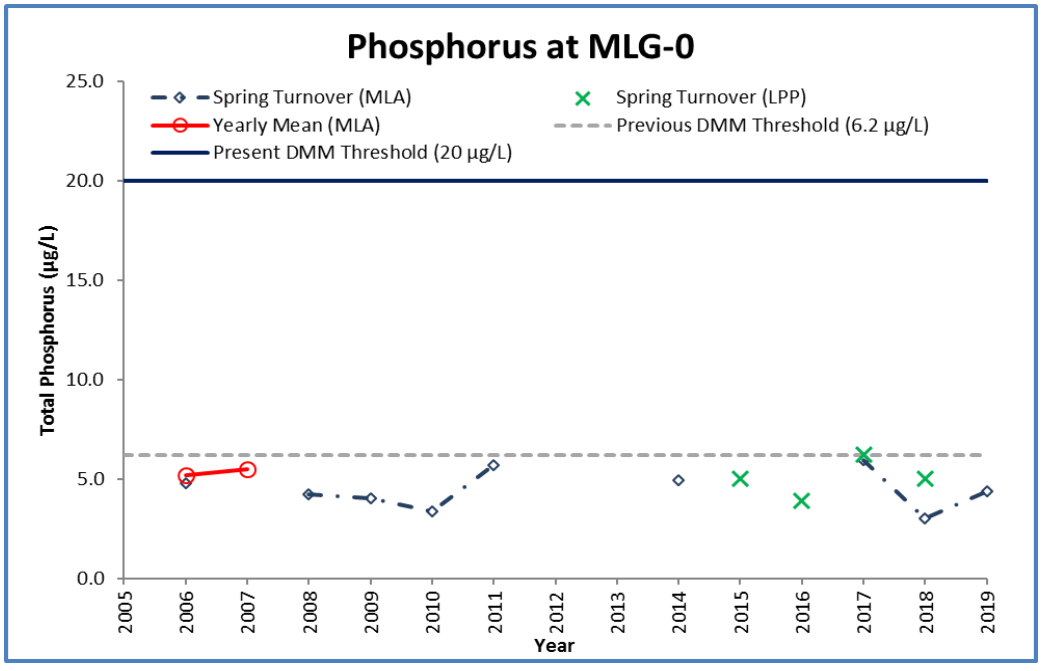
The Muskoka Lakes Golf & Country Club sampling site is located along the southern shore of Lake Rosseau's main basin, near the Town of Port Carling. This bay collects run-off from a golf course area with associated clubhouse and marina. The bay also contains a large wetland that drains into the lake. Dominant northwest winds and a large fetch results in considerable wave action along the southern shoreline of the bay. All stations shown may not be sampled each year.

Volunteer Recognition: **Ian Turnbull, Dianne Turnbull** and the Lake Partner Program.

Muskoka Lakes Golf (MLG)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
MLG-0	3.5	4.4			



Summary and Recommendations:

The spring phosphorus concentration at MLG-0 was below the historic DMM threshold of 6.2 µg/L, and all readings remain well below the present DMM threshold (20 µg/L). Only one phosphorus sample (spring) was collected in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. Lake Partner Program spring phosphorus data was available in 2015, 2016, 2017 and 2018, and is included in the graph. Secchi measurements vary through sampling years, ranging between 3.0 (2019) and 5.5 m (2018). **Beacon recommends that the MLA rely on the Lake Partner Program data when it is available, otherwise the MLA should continue to monitor this location to analyse long-term trends.**

Area Description:

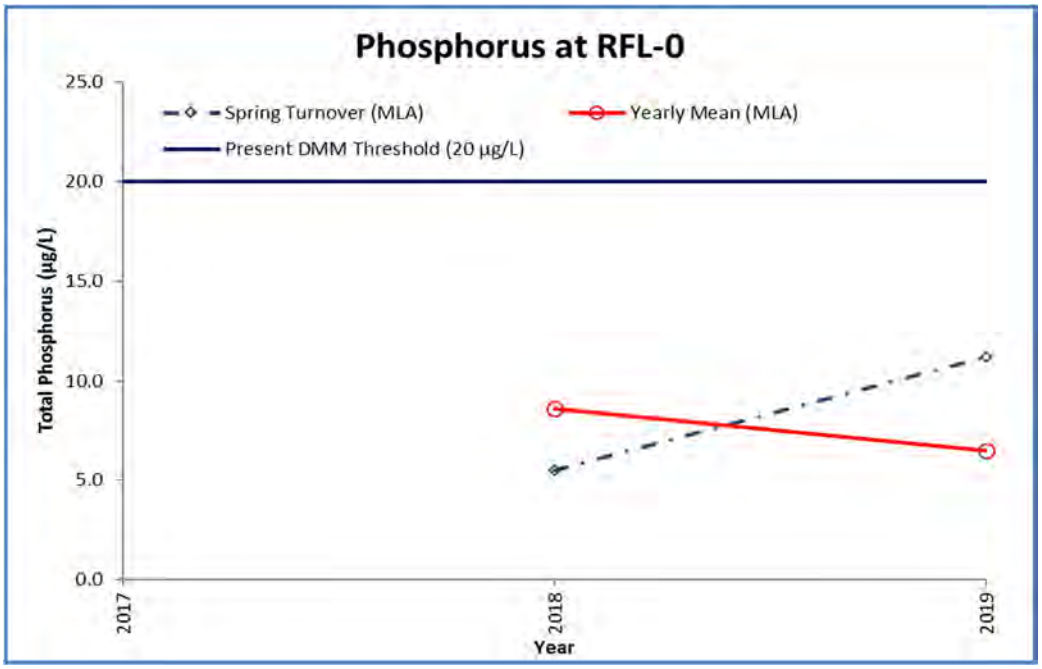
The Rosseau Falls site is located at the point where the Rosseau River enters Rosseau Lake. The Rosseau River Subwatershed flows through the Rosseau River into Lake Rosseau at RFL-1. The Subwatershed is 12,969 hectares in area with 98% identified as natural habitat. Cardwell Lake is the only major water body in the subwatershed and is approximately 2.0 km^2 in size.

Volunteer Recognition: **Sue Wessenger, Jill Lavine, Carol Ann Ballantyne**, and John Wessenger.

Rosseau Falls (RFL)

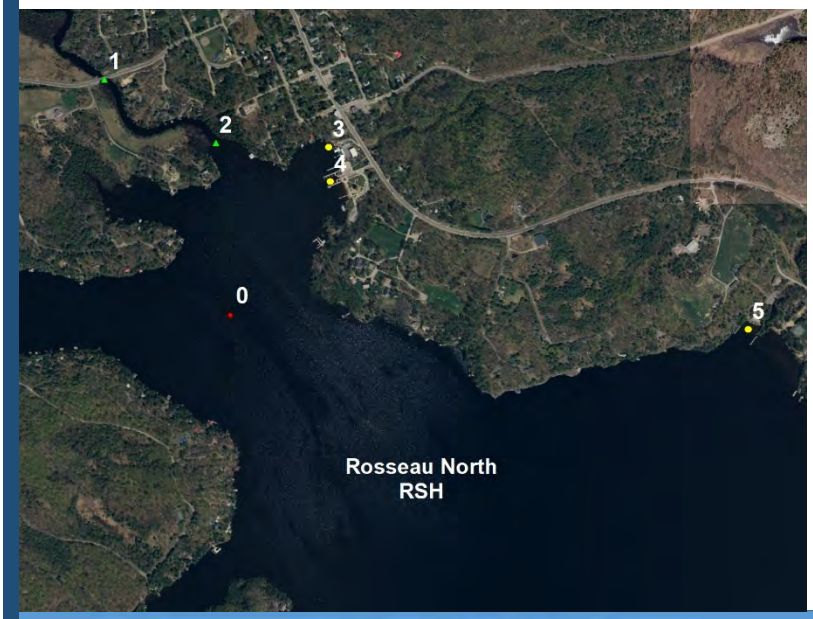
2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
RFL-0	2.9	11.2	6.5		
RFL-1		16.4	82.7		



Summary and Recommendations:

The deep-water station (RFL-0) was established in 2018 and data will be analyzed following additional years of gathering samples. The nearshore station (RFL-1) was established in 2015. The 2019 yearly phosphorus mean concentrations at RFL-1 was the highest recorded to date due to an extremely high sample reading in June; it is very likely that once additional data are complied, that the June value will be an outlier. **Beacon recommends that sampling continue to monitor long-term trends.**



Area Description:

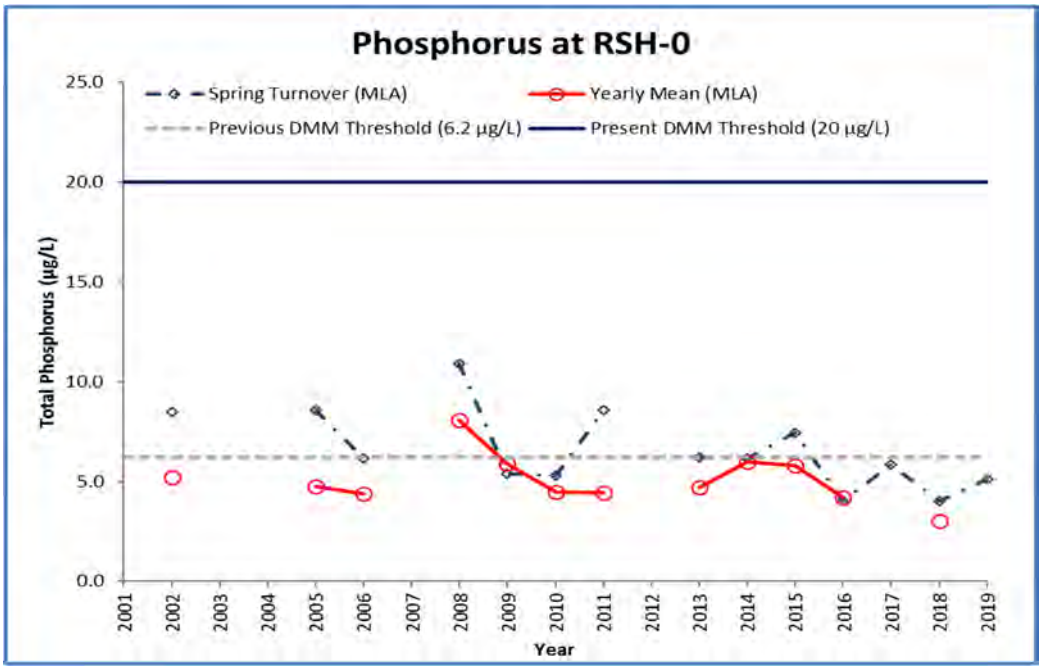
The Rosseau North sampling area is within the limits of the village of Rosseau, at the northern end of Lake Rosseau. Drainage from the village enters the lake at the sampling sites, as well as at the mouth of the Shadow River. Two creeks drain into the bay, one through a lacustrine wetland along the western shoreline and the other near Highway 141 to the east. There is a high level of development not only along the shoreline of the lake and Shadow River, but in much of the watershed area in the form of residential and agricultural properties. Monitoring started in 2002. All stations shown may not be sampled each year.

Volunteer Recognition: **Sue Wessenger, Jill Lavine, Carol Ann Ballantyne**, and John Wessenger.

Rosseau North (RSH)

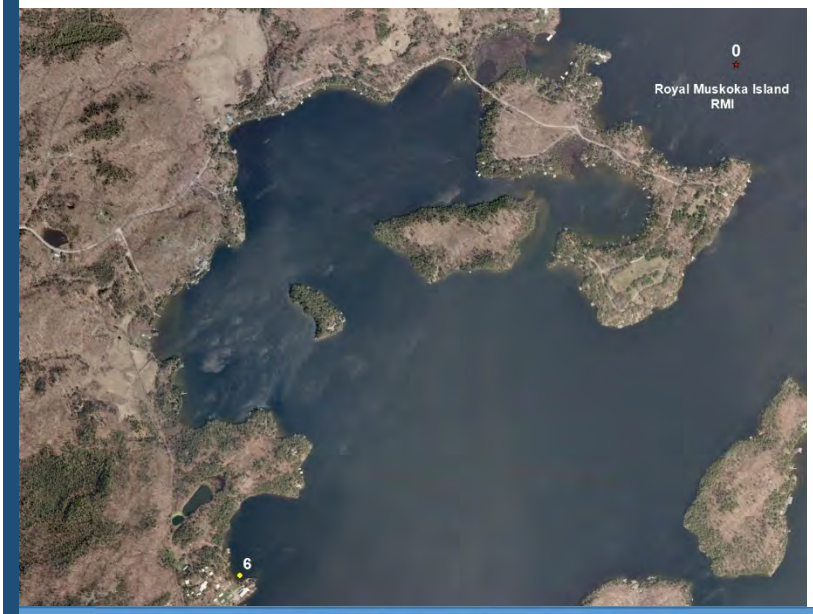
2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
RSH-0	2.6	5.1			
RSH-2		16.1	7.5		
RSH-4		13.4			
RSH-5		7.4			



Summary and Recommendations:

The spring phosphorus concentration at the deep station (RSH-0) was below the historic DMM threshold of 6.2 µg/L in 2019, and all readings remain well below the present DMM threshold (20 µg/L). Only one spring phosphorus sample was collected at RSH-0, RSH-4 and RSH-5 in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. The 2019 spring phosphorus concentration at RSH-4 was the highest recorded to date. *E. coli* sampling was discontinued in 2019 at RSH-5. Secchi measurements vary through the sampling years between 1.9 and 5.1 m (2011). **Beacon recommends that sampling continue to monitor long-term trends.**



Area Description:

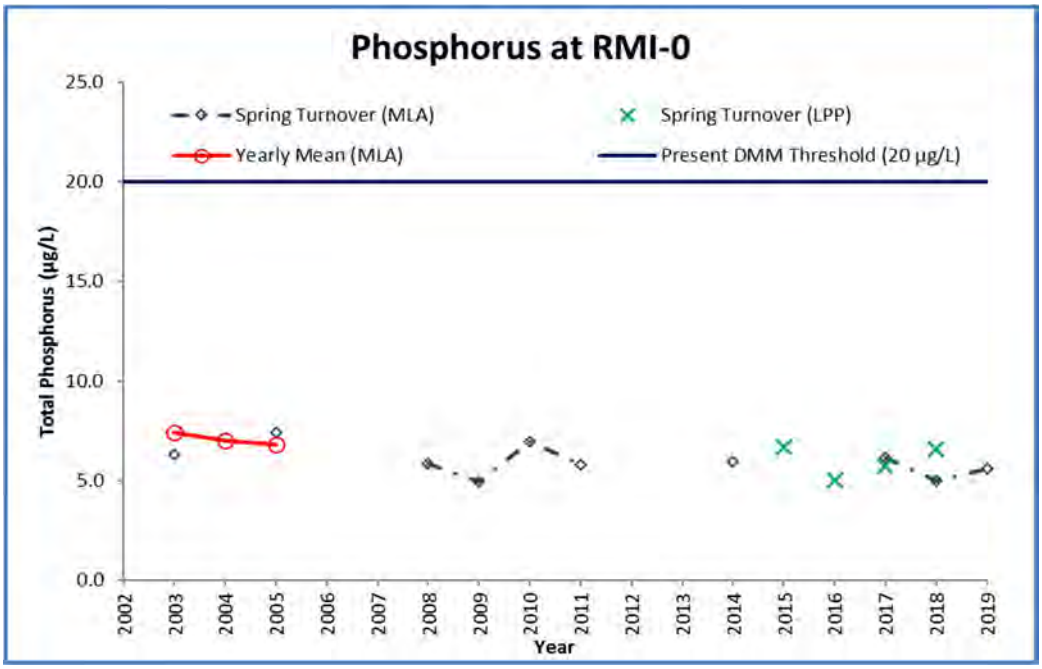
Royal Muskoka Island has one deep-water sampling site located in the central portion of Lake Rosseau. This is a highly developed residential island with many roads and cottages along the shoreline. A large proportion of the interior of the island is cleared or otherwise altered. The eastern shore, opposite RMI-0, is less developed with residences spread out along the shore. Northwest winds and a long fetch would result in significant wave action.

Volunteer Recognition: **Katherine Seybold,** Peter Seybold and B. McCabe.

Royal Muskoka Island (RMI)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
RMI-0	3.3	5.6			
RMI-6		5.6		1.4	5.5



Summary and Recommendations:

Phosphorus results remain generally low throughout the sampling years, and all readings remain well below the present DMM threshold (20 µg/L). Lake Partner Program spring phosphorus data was available in 2013, and 2015-2018. Only one spring phosphorus sample was collected at each of the two stations in 2019, therefore no yearly means could be calculated, and no values are reported for 2019. Generally, Secchi measurements remain stable through sampling years, varying between 2.2 and 4.7 m (2018). **Beacon continues to recommend that the MLA rely on the Lake Partner Program data when it available, otherwise because of the increasing development pressure in the south end of the bay, the MLA should continue to monitor this location to analyse long-term trends.**

Area Description:

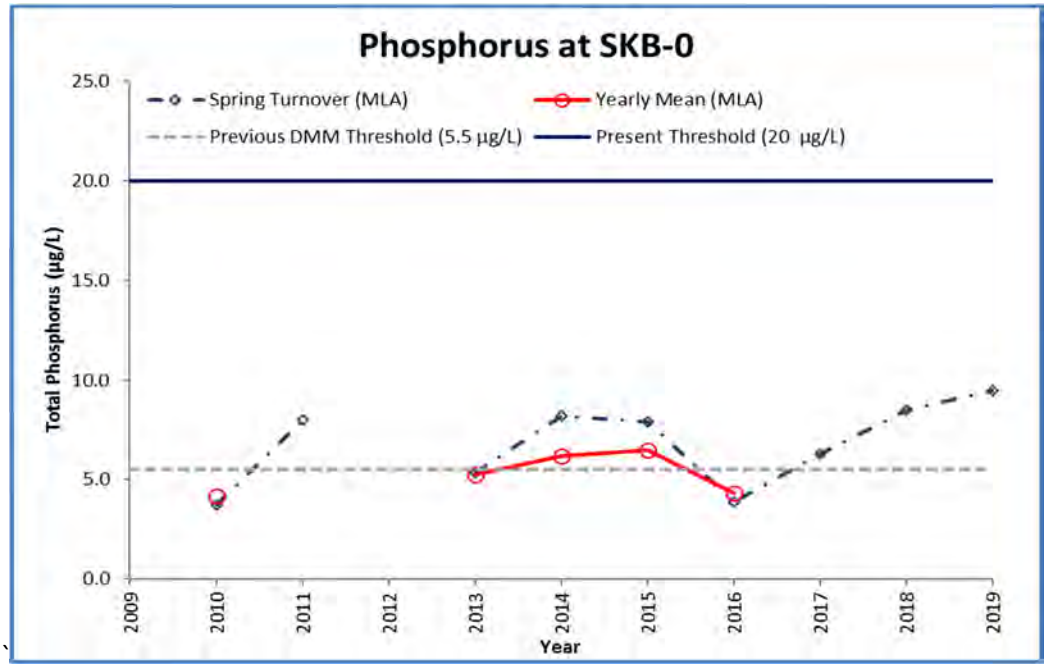
Skeleton Bay is located in the eastern portion of Lake Rosseau's north basin. It is approximately 1.7 km² in size with a maximum depth of 20 m. Highway 141 follows the shoreline in the northeast section of the bay, below a steep, cliffed area. This bay is fed by six watercourses including the Bent River which drains agricultural lands. Skeleton Bay was historically classified as moderately sensitive by the DMM. Monitoring started in 2010. All stations shown may not be sampled each year.

Volunteer Recognition: **Jill Lavine**

Skeleton Bay (SKB)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
SKB-0	3.3	9.5			
SKB-1		8.6	8.3		



Summary and Recommendations:

The spring turnover phosphorus concentration at the deep station (SKB-0) in 2019 was the highest recorded to date, and once again exceeded the historic DMM threshold of 5.5 µg/L. That said, all readings remain well below the present DMM threshold (20 µg/L). Only one spring phosphorus sample was collected at SKB-0 in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. There is a 3-year trend of increasing spring turnover phosphorus at SKB-0, therefore Skeleton Bay changes from a green to a yellow stop light in 2019. Phosphorus concentrations at SKB-1 remain consistent with historic concentrations. Secchi measurements vary greatly through sampling years, ranging between 2.13 and 6.13 m (2010). **Beacon recommends continuing the monitoring program.**

Area Description:

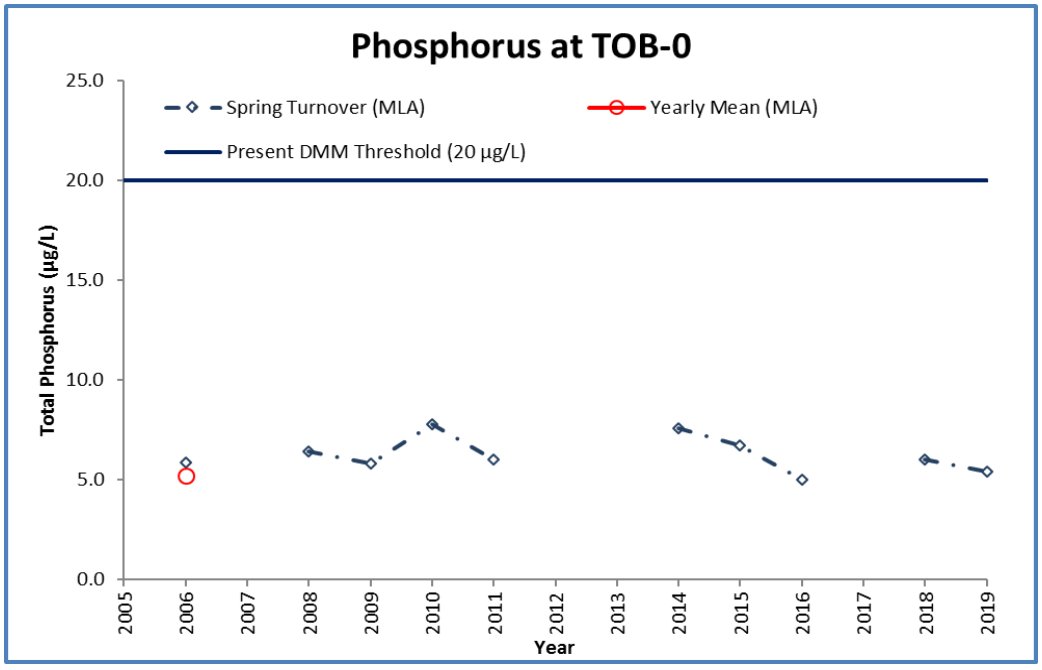
Tobin Island is an open bay area in the central part of Lake Rosseau. The surrounding area is moderately developed with cottage/residential properties along the shoreline and much of the inland forest area remaining in a natural state. Two creeks from adjacent wetland areas drain into the lake within this sampling area.

Volunteer Recognition: **Katherine Seybold** and Peter Seybold.

Tobin Island (TOB)

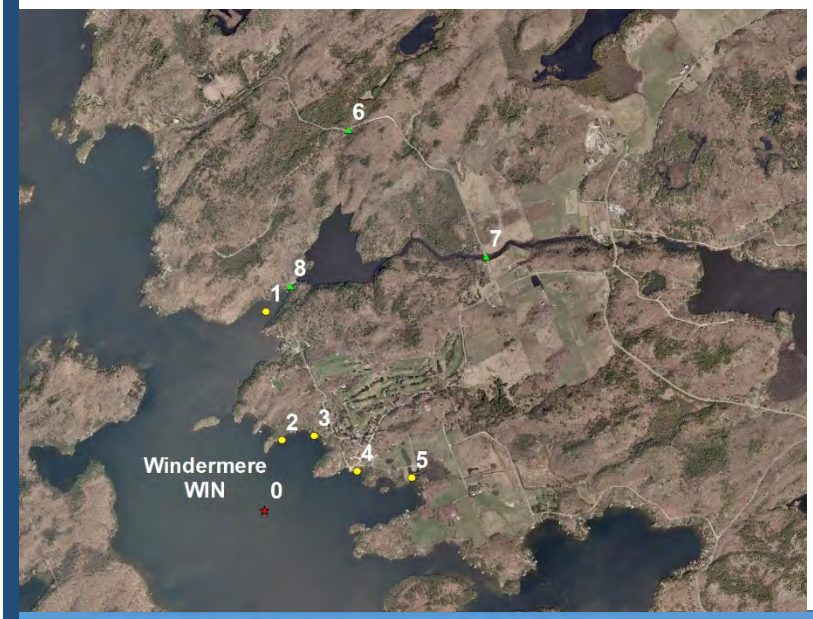
2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
TOB-0	3.6	5.4			



Summary and Recommendations:

The spring turnover phosphorus levels at TOB-0 are consistent through the sampling years, and all phosphorus values remain well below the present DMM threshold (20 µg/L). The 2017 sample was previously determined to be an outlier following the 2019 Grubb's test analysis and remains out of the dataset. Secchi measurements remain stable through sampling years, ranging between 3.0 and 4.3 m (2018). **Beacon recommends that sampling continue to monitor long-term trends.**



Area Description:

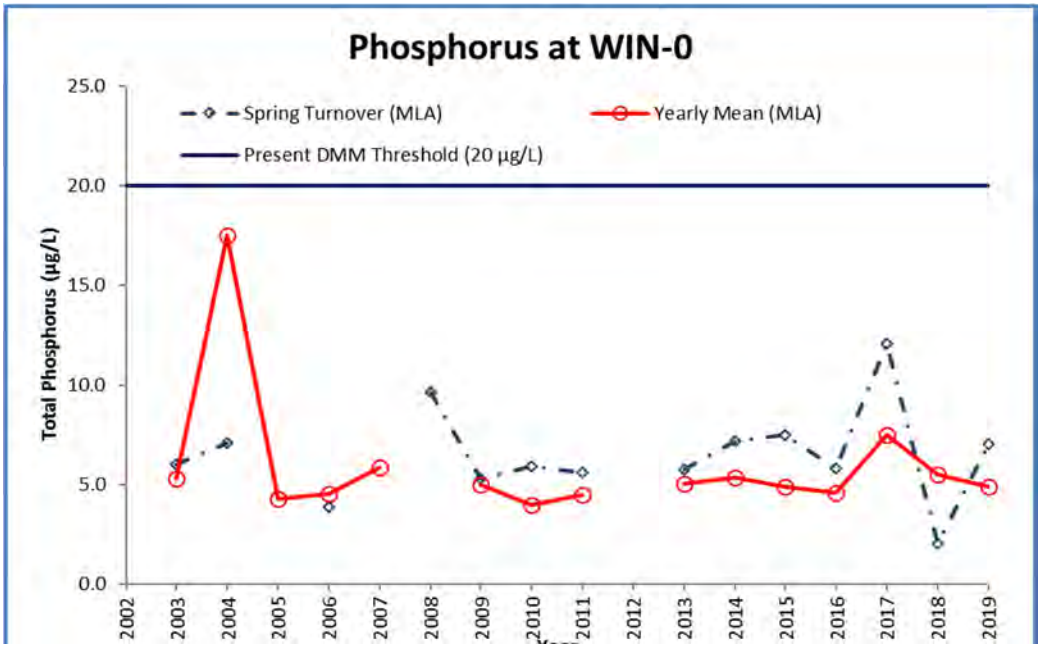
The Windermere village area in northern Lake Rosseau is a highly developed resort and residential area. There is a large resort complex, golf course, marina, and many residential properties. In addition, there is a significant amount of agricultural land nearby. Several creeks outlet into this area, one of which flows through farms fields and wetlands and enters the lake at the marina. Monitoring started with the original program in 2003. All stations shown may not be sampled each year.

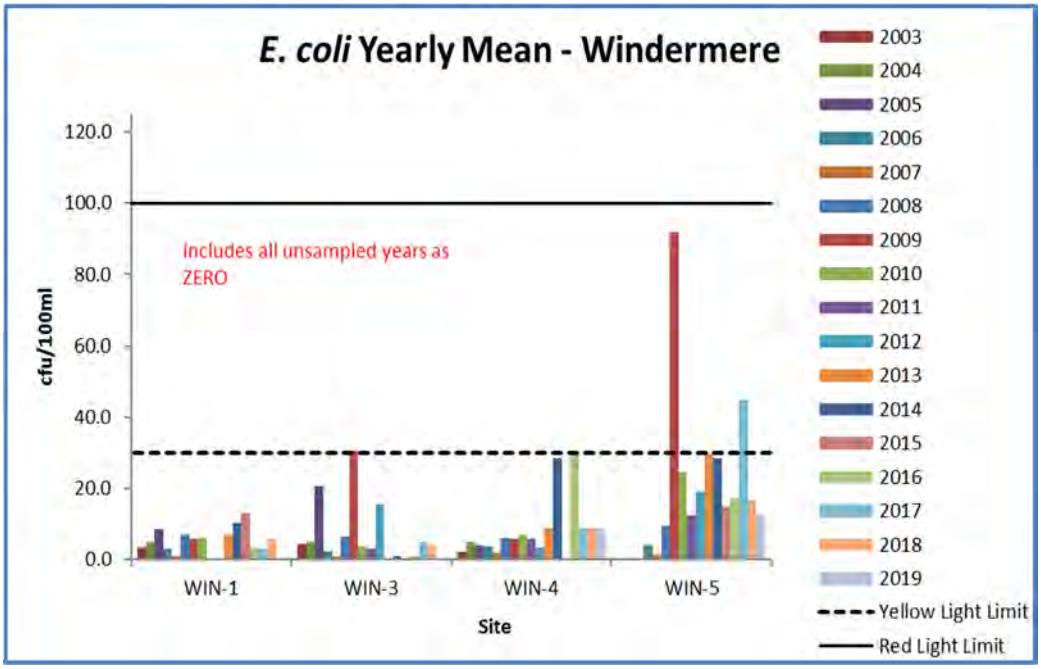
Volunteer Recognition: **Katherine Seybold, Bob McCabe**, Sandy Baptist and Peter Seybold.

Windermere (WIN)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
WIN-0	2.8	7.0	4.9			
WIN-1		10.8	15.2			
WIN-3		6.0	4.7			
WIN-4		7.4	5.6	8.9	50.1	
WIN-5		12.0	11.4	12.3	37.9	
WIN-7		14.1	16.5			
WIN-8		15.6	15.1			





Summary and Recommendations:

All spring phosphorus concentrations at WIN-0 remain well below the present DMM threshold (20 µg/L). The spring turnover phosphorus value at WIN-1 was the second lowest value of 9 years of sampling data. WIN-7 had the lowest spring turnover and yearly mean phosphorus concentrations of 6 years of sampling to date and the yearly mean phosphorus concentration at WIN-8 was tied for the lowest of 6 years of sampling to date. That said, the nearshore phosphorus levels at WIN-1 and WIN-5 were substantially higher than the deep-water levels, resulting in Windermere continuing to be classified as yellow in 2019. Similar to the 2018 results, phosphorus concentrations generally continued to be higher upstream at WIN-7 than downstream at WIN-8. *E. coli* yearly mean counts were below the MLA Yellow Light Limit (details in report Section 3) at all stations in 2019. Secchi measurements vary through sampling years, ranging between 2.5 and 5.7 m (2014). A Harmful Algae Bloom was reported in 2018 near WIN-1 and WIN will remain yellow until a Causation Study concludes that development is not the primary cause of the HAB. **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

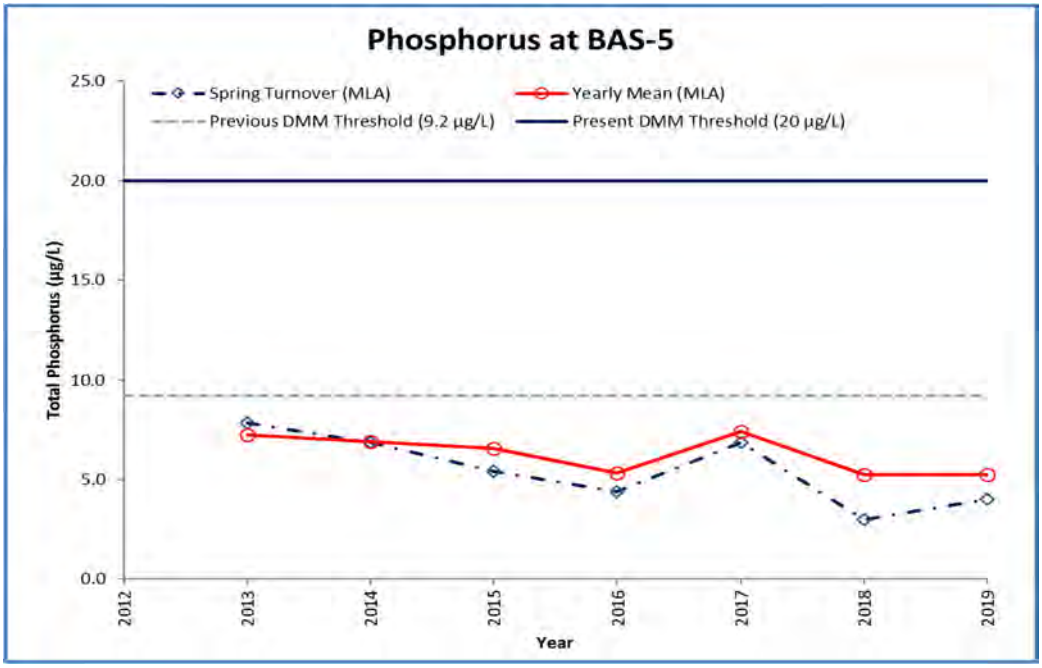
Bass Lake is a small, shallow, moderately developed lake located immediately southwest of Lake Joseph. It is 0.96 km^2 in area with a maximum depth of 8 m. Hwy 169 separates this lake from Lake Joseph at the north end. Bass Lake drains wetlands located to the south and water flows into Stills Bay via Stills Falls. Bass Lake was formerly classified as moderately sensitive by the DMM. Monitoring started in 2005. All stations shown may not be sampled each year.

Volunteer Recognition: **Chris Bodanis**, **Chris Turney**, and **Bev Turney**.

Bass Lake (BAS)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
BAS-2			10.3		
BAS-5	3.1	4.0	5.3		
BAS-7		<3.0	20.9		



Summary and Recommendations:

BAS-5 spring turnover and yearly mean phosphorus concentrations continue to be below the historic DMM threshold of 9.2 µg/L and all readings remain well below the present DMM threshold (20 µg/L). The yearly mean phosphorus concentration at BAS-5 exceeded the spring turnover phosphorus concentration (yellow stoplight). Phosphorus levels at BAS-7 were elevated during mid-summer, causing an elevated mean, similar to the results in 2018. Secchi measurements also remain stable through sampling years, varying between 2.38 m and 3.75 m. A Harmful Algae Bloom was observed in October 2019, with the algae later found to be nontoxic, resulting in a yellow classification for 2019. **Beacon recommends all sampling be continued to monitor long-term trends.**

The classification for Bass Lake has been revised to yellow because a blue-green algae bloom was confirmed on the lake, but subsequent testing confirmed that its toxic components – microcystins- were below levels of concern. This is consistent with the MLA classification methodology on page 15 of the main report. The Bass Lake Association [BLA], which monitors the health of the lake under the MLA WQ program, reported an algae bloom to the Simcoe Muskoka District Health Unit [SMDHU] on October 20, 2019. The reported blue-green algae or cyanobacteria bloom was observed in an isolated area at the north end of the lake near Highway 169 and was short-lived. We are advised by BLA that restrictions on flow exiting the lake by beaver dams are the likely cause. After confirming the bloom, SMDHU issued a routine Public Notice on October 24 and lifted this Notice on November 28 following results of tests by the Ministry of Environment, Conservation and Parks [MECP] which showed that the microcystin component of the cyanobacteria was below the instrument detection limit and well below the Ontario Drinking Water Standard. The BLA Executive has been, and continues to be, very active in monitoring and managing the situation and is taking pro-active steps to ensure all is done to avoid similar occurrences.

Area Description:

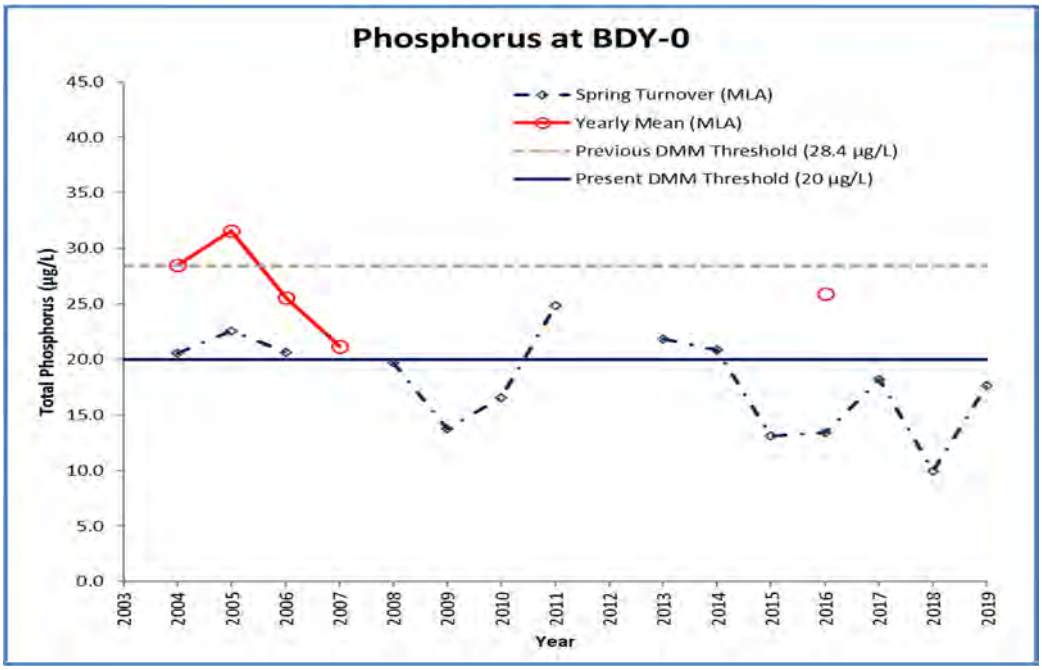
The shoreline of Brandy Lake is moderately developed with many residences and access roads. A large number of the properties maintain a natural shoreline but, there is close to 10% un-buffered lawn. Approximately 40% of the lake shoreline is natural wetland. In the eastern portion of the lake, there is a large wetland with a creek outlet. A second creek is located to the southeast. Brandy Lake is a dystrophic, or "tea-coloured" lake, which is naturally rich in carbon. Monitoring started in 2004. All stations shown may not be sampled each year.

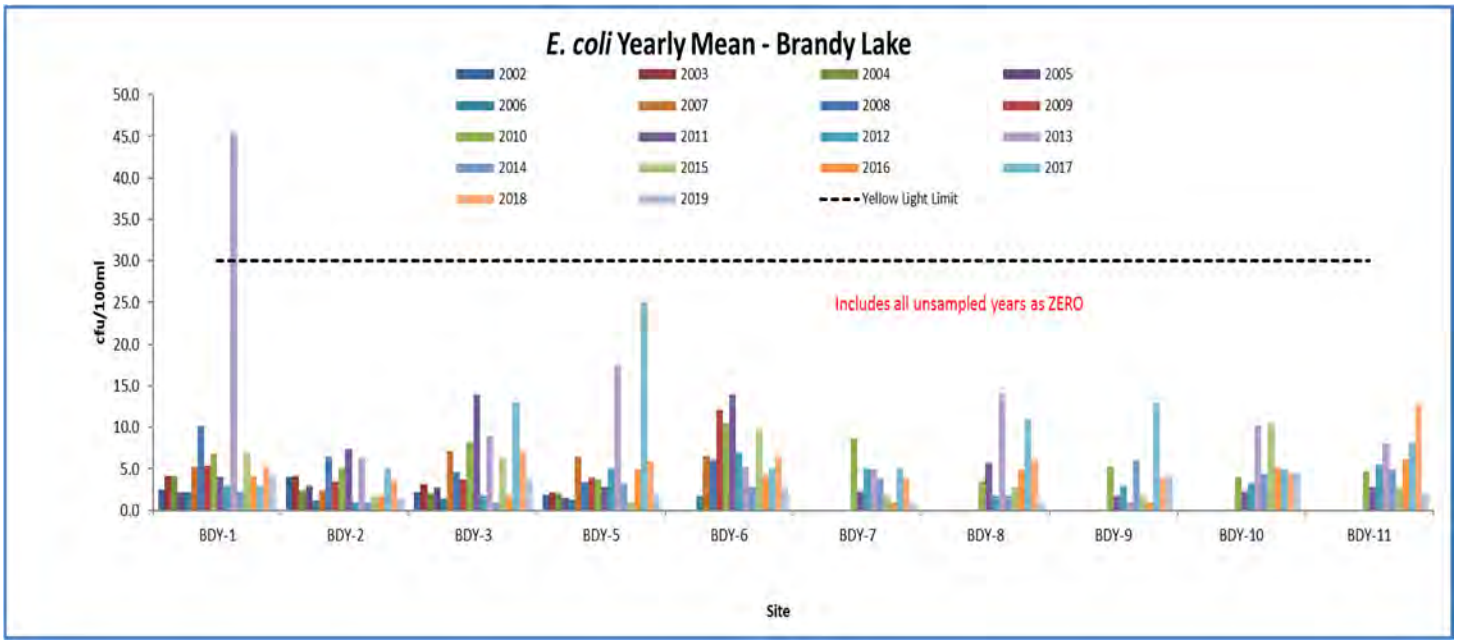
Volunteer Recognition: **Don Burn, Kevin Trimble,** Andy von Bredow, and Jon Deveith.

Brandy Lake (BDY)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
BDY-0	1.0	17.7			
BDY-1	1.0			4.2	10.1
BDY-2	0.9			1.4	21.6
BDY-3	0.8			3.9	8.1
BDY-5	0.9			2	12.4
BDY-6	0.9			2.8	26.9
BDY-7	0.8			1	8.6
BDY-8	1.0			1	6.1
BDY-9	1.0			4.2	17.6
BDY-10	1.0			4.5	16.6
BDY-11	0.9			2.1	13.4





Summary and Recommendations:

Spring phosphorus concentrations continue to remain consistently below the historic DMM threshold of 28.4 µg/L, and for the last 5 years all readings remain well below the present DMM threshold (20 µg/L). Only one phosphorus sample (spring) was collected at BDY-0 in 2019, therefore no yearly mean could be calculated or reported for 2019. All the 2019 *E. coli* yearly means at each of the nearshore stations were below the MLA stoplight limits (details in report Section 3). No retests for any bacterial counts were required in 2019. Secchi measurements remain stable through sampling years, varying between 0.44 and 3.10 m (2007). A Harmful Algae Bloom was reported in September 2019, resulting in the change to a red stoplight in 2019. **Beacon recommends continued sampling to monitor long-term trends.**

Area Description:

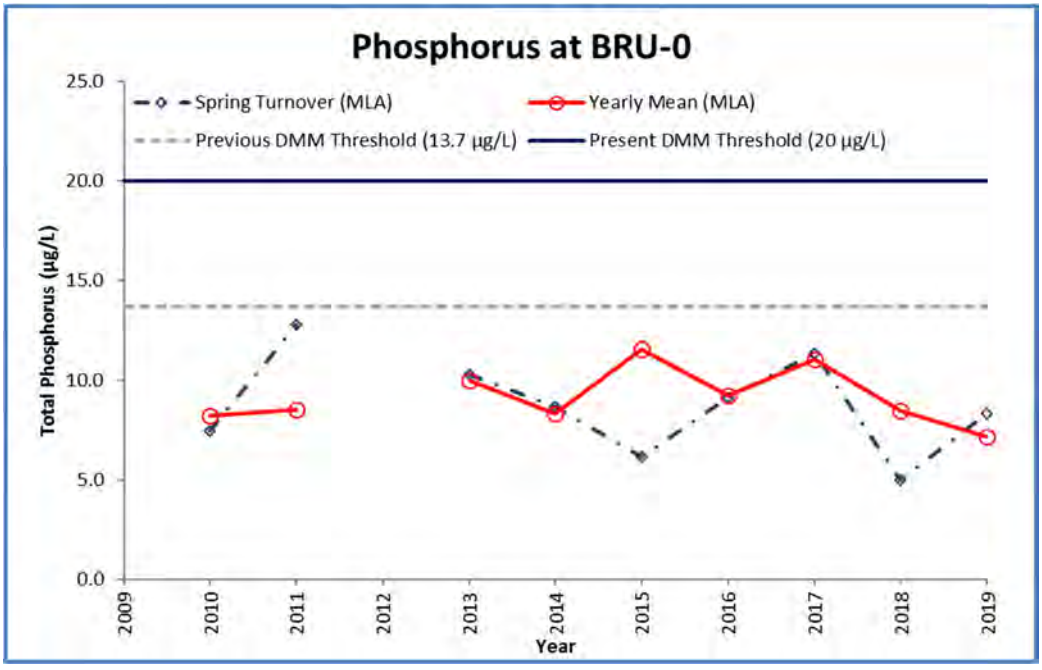
Bruce Lake is located east of Hwy 632, between Lake Joseph and Lake Rosseau. It is relatively small in size at 1.0 km^2 and has a maximum depth of 6 m. Approximately 25% of the catchment area for this lake is made up of wetlands. The lake is moderately developed and there is a golf course located immediately to the south. Bruce Lake was formerly classified as moderately sensitive by the DMM. Monitoring started in 2010. All stations shown may not be sampled each year.

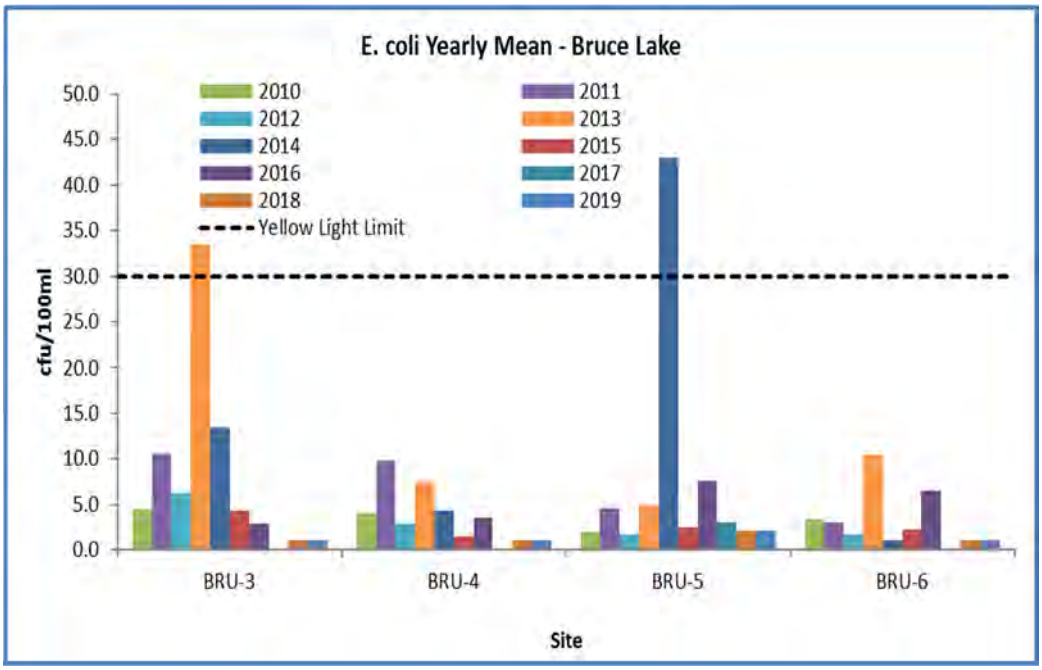
Volunteer Recognition: **Brian Beatty**, and Marlee Brown.

Bruce Lake (BRU)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
BRU-0	5.4	8.3	7.2	1	16
BRU-3		6.0	7.9	1	28.0
BRU-4		9.0	7.1	1	21.1
BRU-5		6.3	7.4	2.1	32.9
BRU-6		6.2	19.2	1	29.0





Summary and Recommendations:

Phosphorus concentrations continue to remain consistently below the historic DMM threshold of 13.7 µg/L, and all readings remain well below the present DMM threshold (20 µg/L). The 2019 spring phosphorus concentrations and yearly means at BRU-5 and BRU-6 were the second lowest recorded in 8 years. The nearshore phosphorus levels at BRU-3 were substantially higher than the deep-water levels. All 2019 *E. coli* yearly means at each of the nearshore stations were well below the MLA stoplight limits (details in report Section 3) and did not exceed 30 cfu/ml. The average Secchi measurement in 2019 was the deepest recorded to date and Secchi measurements remain stable through sampling years, varying between 2.4 and 6.5 m (2019). **Beacon recommends that sampling continue to monitor long-term trends.**

Area Description:

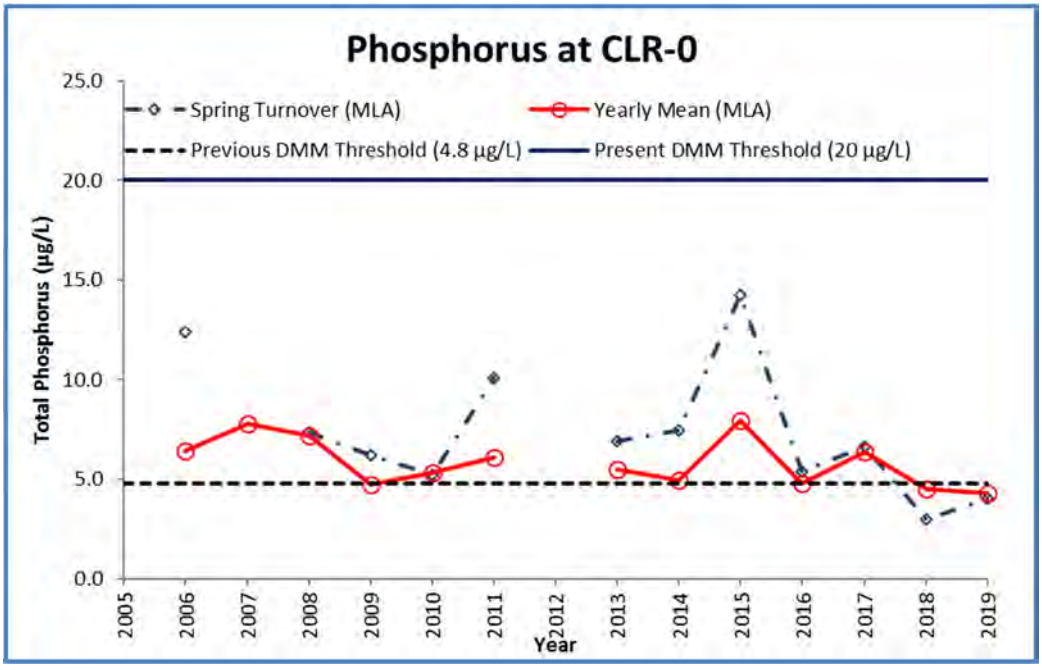
Clear Lake, also called Torrance Lake, is a moderately developed lake with much of the shoreline area converted into residential lots. It is also adjacent to highway 169. This lake is 152 ha in size, has a maximum depth of 16 m and has a very small watershed. There is limited inflow and outflow of water on this lake. Clear Lake was historically classified as moderately sensitive and over threshold by the DMM. Monitoring started in 2006. All stations shown may not be sampled each year.

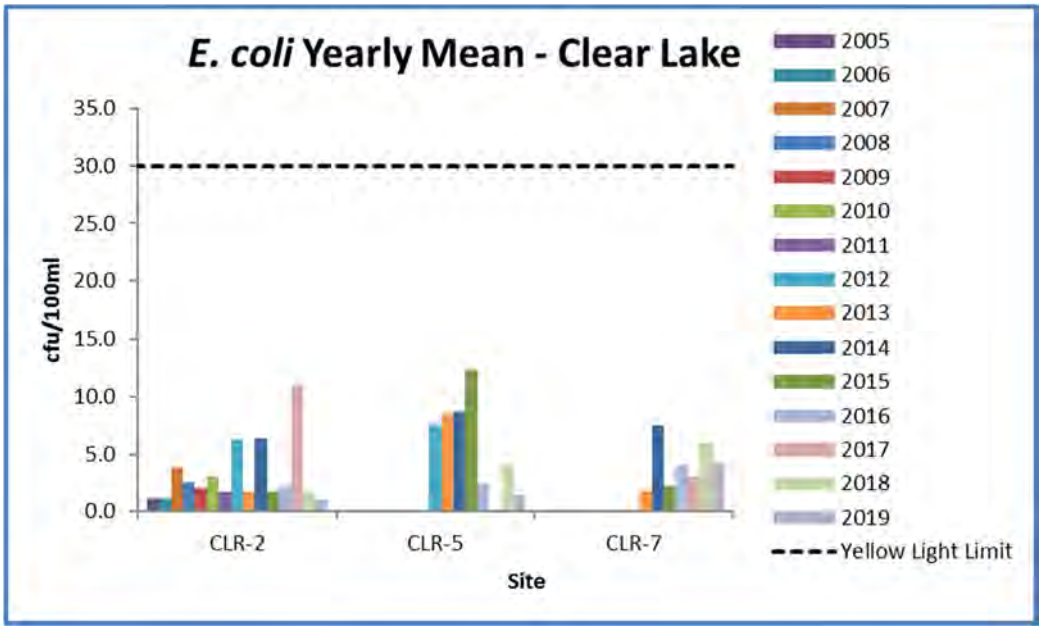
Volunteer Recognition: **Bob** and **Sharon Cleverdon.**

Clear Lake (CLR)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
CLR-0	6.2	4.0	4.3		
CLR-2		4.6	4.7	1.0	46.7
CLR-5		4.5	4.4	1.4	52.9
CLR-7				4.2	46.4





Summary and Recommendations:

Yearly mean and spring phosphorus concentrations at the deep station (CLR-0) were below the historic DMM threshold of 4.8 µg/L for 2019, and all readings remain well below the present DMM threshold (20 µg/L). The spring phosphorus concentration at CLR-2 was the lowest recorded in 10 years of sampling. The *E. coli* levels at the three nearshore sites sampled in 2019 were well below the MLA stoplight limits (details in report Section 3). Secchi measurements vary through sampling years, ranging between 3.63 and 9.30 m (2007). **Beacon recommends that sampling continue to monitor long-term trends.**

Area Description:

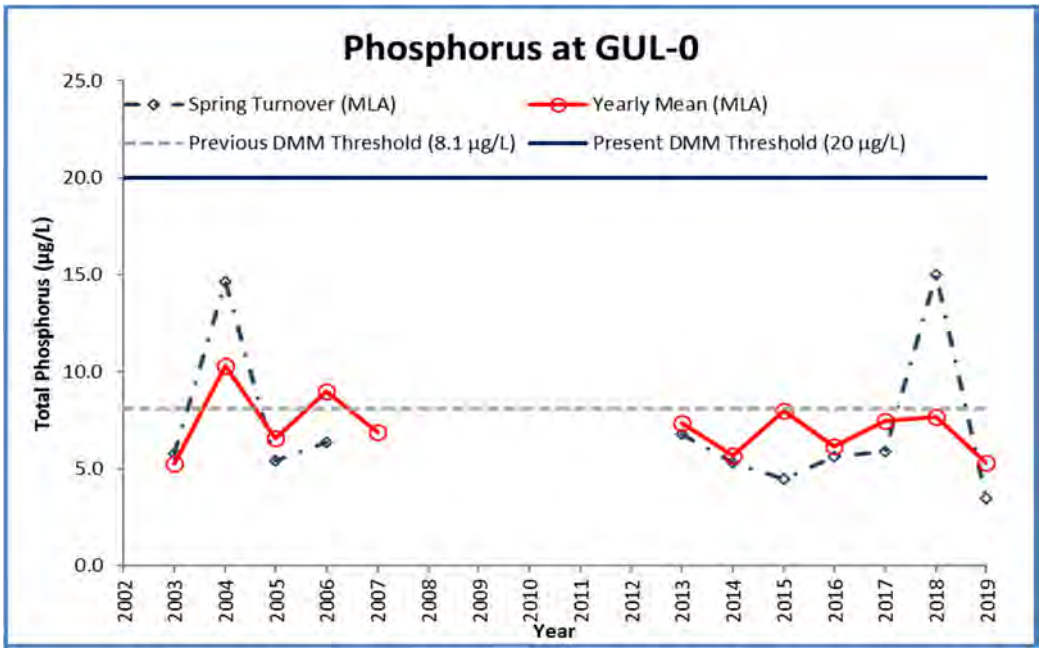
Gull Lake is in the Town of Gravenhurst. Highway 11 crosses Gull Lake at its midpoint. The lake is approximately 1.35 km² in area, with a maximum depth of 7 m. Gull Lake is fed directly from Silver Lake at its south end with an additional nine creeks outletting into the lake. The Gull Lake watershed is approximately 3.6 km² in size. Gull Lake was historically classified as moderately sensitive by the DMM. Monitoring started with the original program in 2003. All stations shown may not be sampled each year.

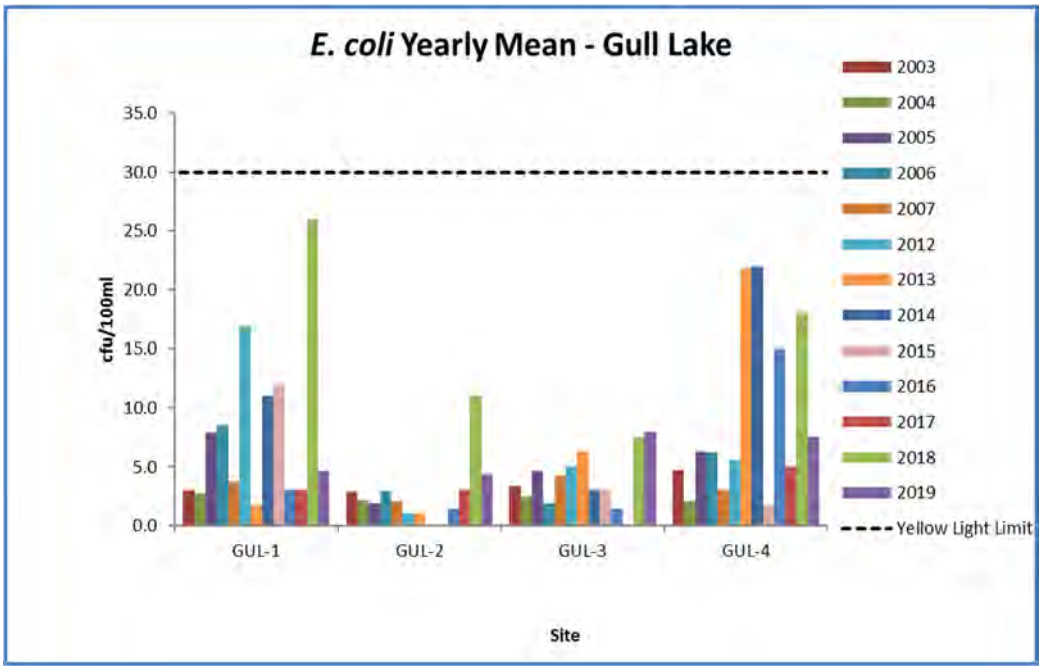
Volunteer Recognition: Bruce Elliott, Dave Stephens, Joanne Smith, Skipper Jim Barwell, and Anne Elliott.

Gull Lake (GUL)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
GUL-0	3.8	3.5	5.3		
GUL-1				4.6	77.4
GUL-2				4.4	134.2
GUL-3				8.0	60.1
GUL-4				7.6	52.6





Summary and Recommendations:

The spring turnover at the deep station (GUL-0) in 2019 was below the historic DMM threshold of 8.1 µg/L and was the lowest recorded to date. All readings at GUL-0 remain below the present DMM threshold (20 µg/L). Although the increasing trend of phosphorus levels at GUL-0 has subsided, the yearly mean phosphorus at GUL-0 was substantially higher than the spring turnover concentration, resulting in Gull Lake being classified as yellow in 2019. *E. coli* counts have continued to be well below the MLA stoplight limits (details in report Section 3), and levels decreased in 2019 from the levels found in 2018 at all four nearshore sites. The Secchi depths remain stable through the years, varying between 2.5 and 4.8 (2016). **Beacon recommends sampling be continued to monitor long-term trends at all sites.**

Area Description:

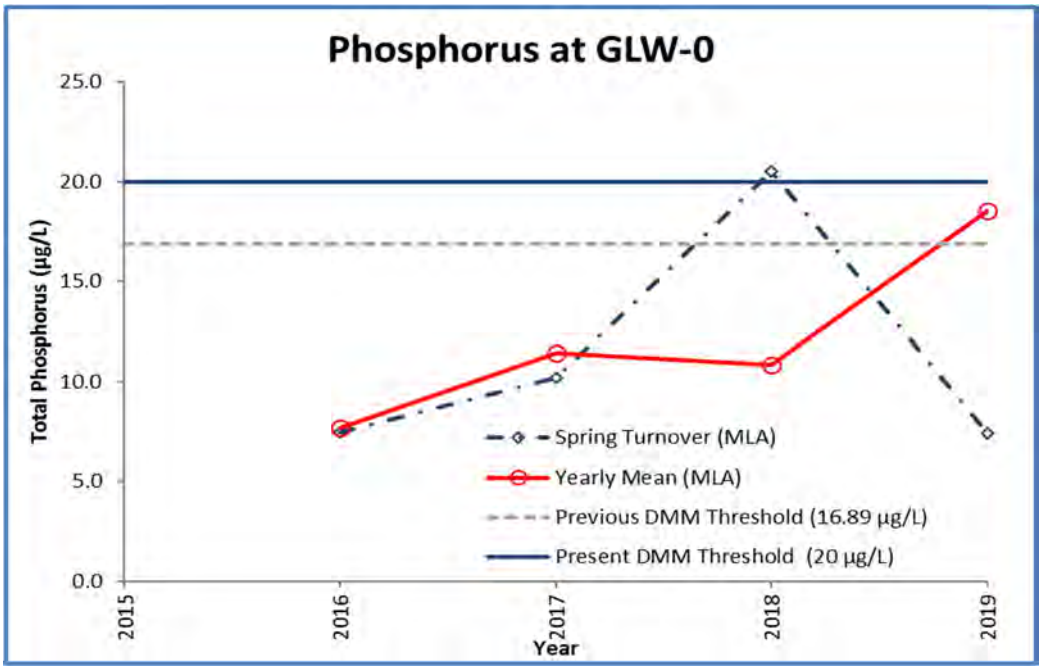
Gullwing Lake is a lake of moderate size (82 hectares) located just south of Torrance. The maximum depth is 9 m and the mean depth is 4 m. The watershed for the lake is 5.71 km^2 and was historically listed as having moderate sensitivity by the District Municipality of Muskoka. Development around the shoreline varies from none on Crown Land (25%) to shoreline residential and a seasonal vacation park located in the most northwestern section. All stations shown may not be sampled each year.

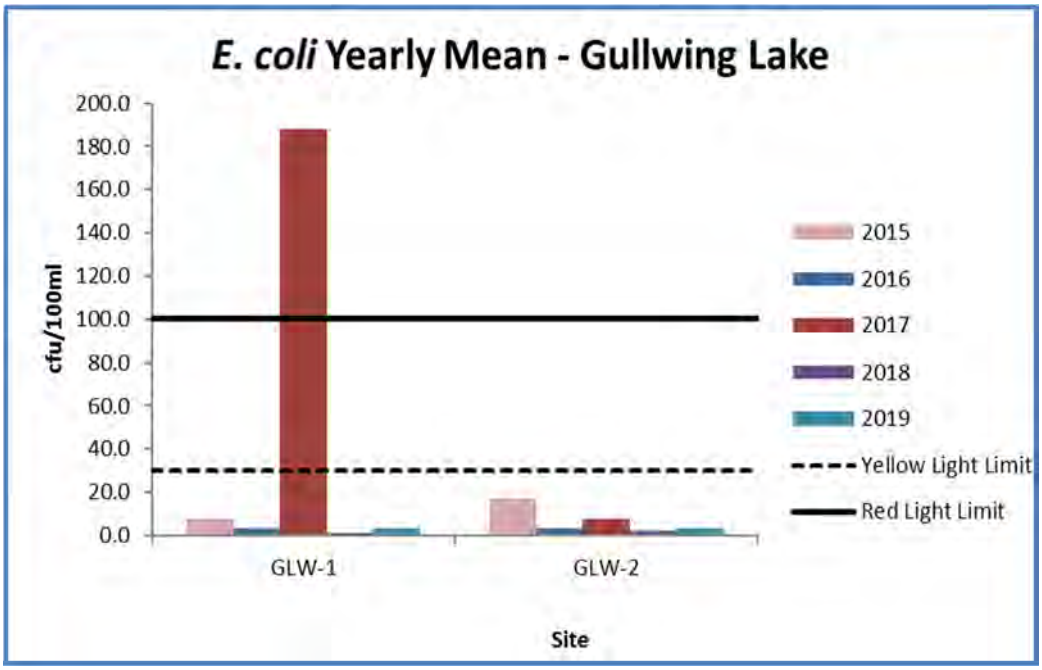
Volunteer Recognition: **Kellie Dobson, Kim Enns,** Donna DiLello, and Jim Dobson.

Gullwing Lake (GLW)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

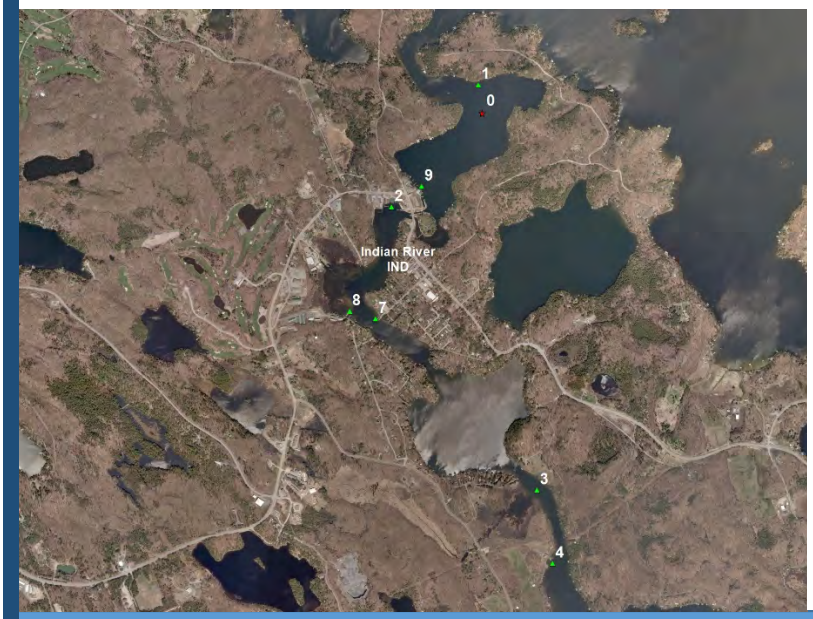
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
GLW-0	2.0	7.4	18.6		
GLW-1		8.2	8.4	3.4	40.8
GLW-2		5.8	8.0	3.2	67.7





Summary and Recommendations:

Although the historic DMM threshold of 16.89 µg/L was exceeded in 2018, the 2016, 2017 and 2019 spring phosphorous levels were below this threshold, and all other readings remain well below the present DMM threshold (20 µg/L). The yearly phosphorus mean at GLW-0 shows an increasing trend. The 2019 yearly mean phosphorus average at GLW-0 is the highest recorded due to the highest sample result to date in August (51.5 µg/L). Additionally, the annual average phosphorus exceeded the spring phosphorus levels at each of the nearshore stations in 2019. Because of the increasing yearly mean phosphorus trend at GLW-0, and the phosphorus levels at the nearshore stations, Gullwing Lake remains classified as yellow in 2019. The *E. coli* yearly mean at GLW-1 and GLW-2 remained below the MLA stoplight limits (details in report Section 3). Secchi measurements vary through the sampling years between 1.5 (2018, 2019) and 3.15 m (2016). **Beacon recommends that sampling continue to monitor long-term trends.**



Area Description:

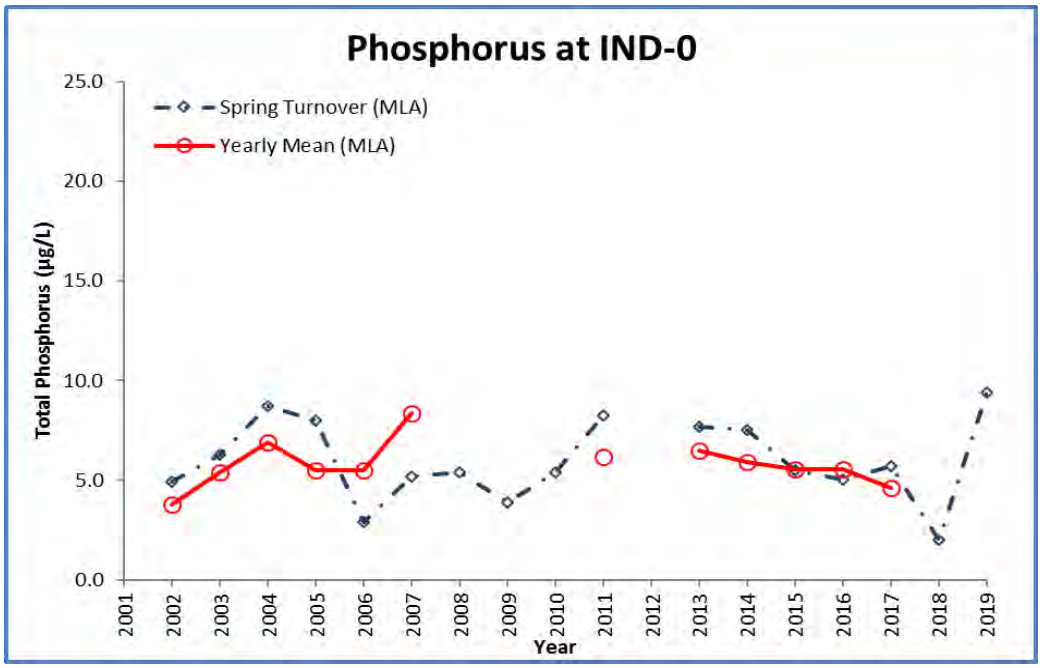
The Indian River flows from Lake Rosseau, through Port Carling and into Mirror Lake and Lake Muskoka. This highly developed area receives stormwater from the Port Carling urban centre. It also has high boat traffic, a locks system, marinas and many commercial and residential properties. A large lacustrine wetland is located adjacent to the river. Monitoring started in 2002. All stations shown may not be sampled each year.

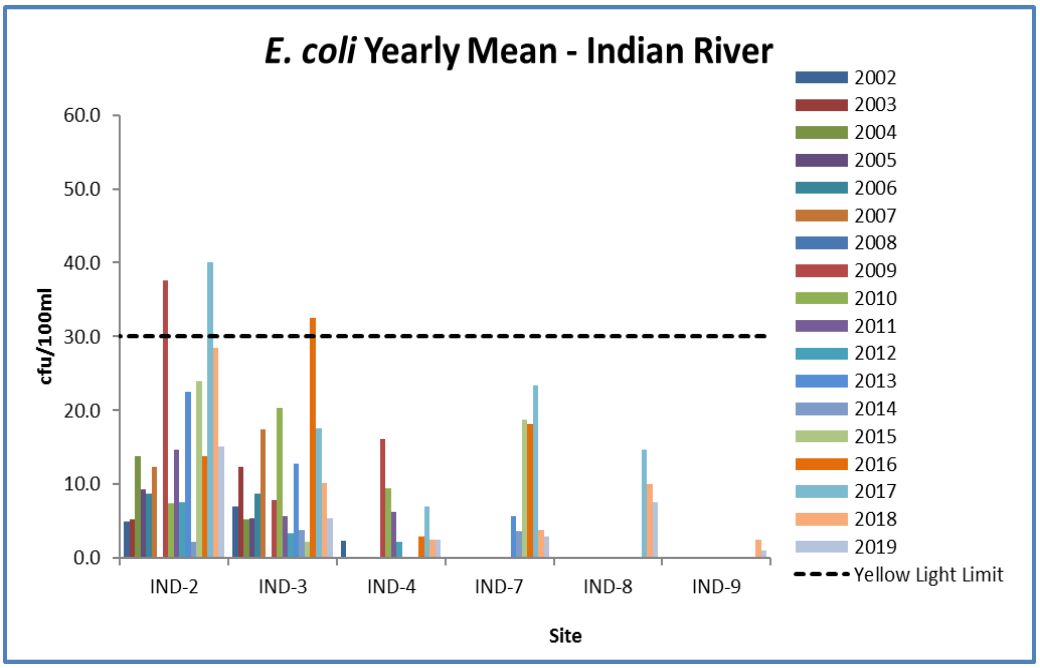
Volunteer Recognition: **Jane Armstrong, Ian Turnbull, Dianne Turnbull** and **Chris Vandergrift.**

Indian River (IND)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

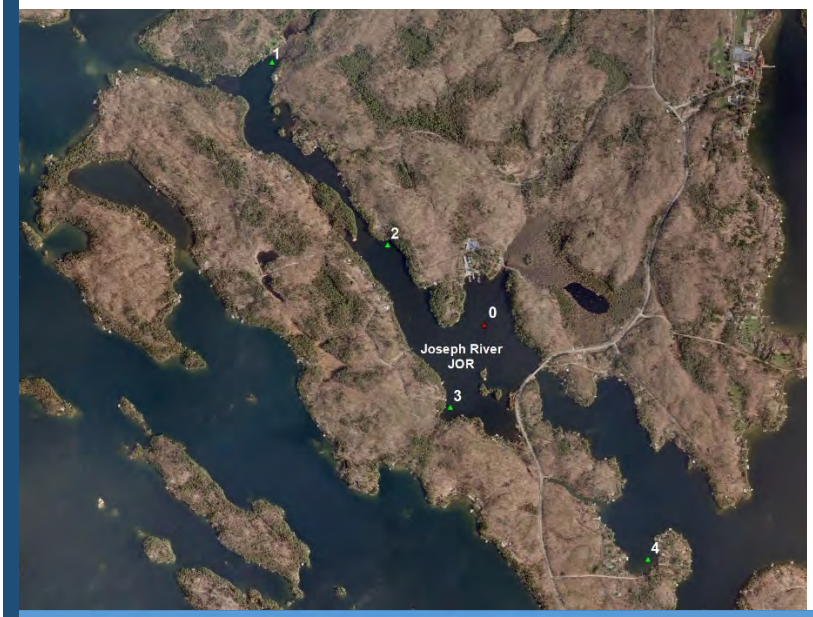
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
IND-0	3.3	9.4				
IND-2				15.1	96.2	
IND-3				5.3	25.1	
IND-4				2.5	26.8	
IND-7		4.6	5.7	3.0	63.7	
IND-8		5.1		7.5	81.2	
IND-9		4.8		1.0	7.8	





Summary and Recommendations:

The 2019 spring phosphorus concentration at IND-0 was the highest recorded to date. Only one spring phosphorus sample was collected at IND-0 in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. Sites IND-8 and IND-9 were new in 2017 and the 2019 spring results remain consistent with low spring phosphorus. *E coli* concentrations observed in 2019 remain below the MLA stoplight limits (details in report Section 3) at all stations. Secchi measurements also remain stable through sampling years, varying between 2.0 and 5.6 (2014). **Beacon recommends that all sampling be continued to monitor long-term trends and *E. coli* levels.**



Area Description:

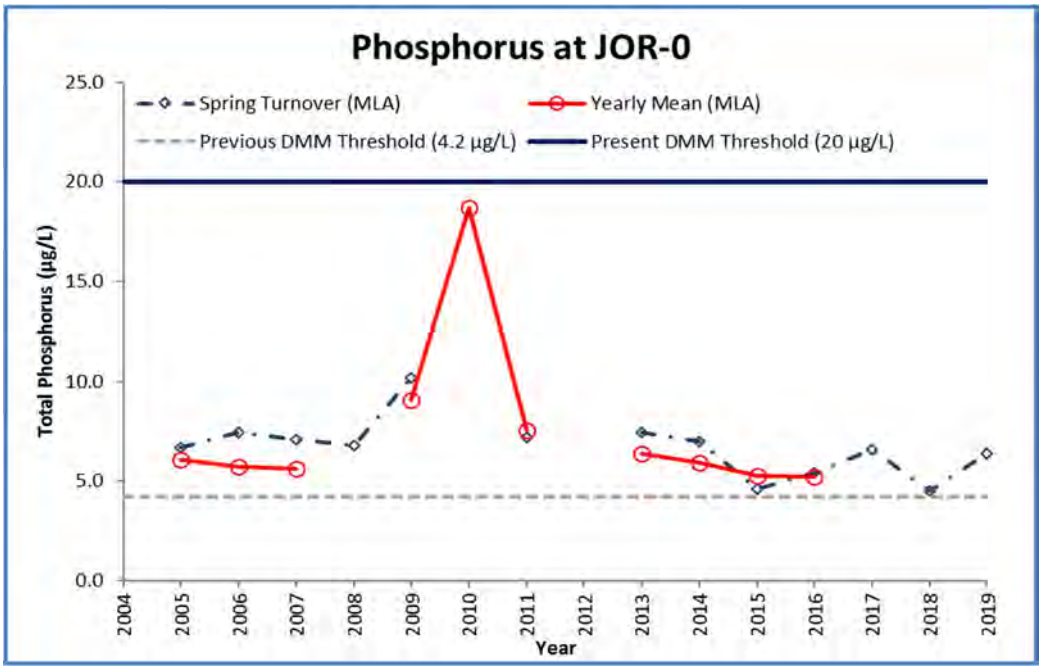
The Joseph River is the water body connecting Lake Joseph and Lake Rosseau. The river is 1.37 km² in size and up to 8 m deep. Direction of flow is from Lake Joseph into Lake Rosseau. A marina, a bridge crossing for Peninsula Road and two wetlands are located adjacent to the channel. This area receives significant boat traffic as the main navigable waterway between the two large lakes. The Joseph River was historically classified as moderately sensitive by the DMM. Monitoring started in 2005. All stations shown may not be sampled each year.

Volunteer Recognition: **Beth Guy, Laurie Leiser** and James Woodruff.

Joseph River (JOR)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
JOR-0	3.2	6.4			
JOR-1		7.4	5.7		
JOR-2		4.2			



Summary and Recommendations:

Phosphorus results at JOR-0 remain consistent over the sampling years, slightly above the historic DMM threshold of 4.2 µg/L, and all readings remain below the present DMM threshold (20 µg/L). Only one spring phosphorus sample was collected at JOR-0 in 2019, therefore no yearly mean could be calculated, and no value is reported for 2019. The spring phosphorus concentration and yearly mean at JOR-1 remains consistent. Only spring phosphorus was acquired at JOR-2 in 2019 and that level also is consistent with historic data. Secchi measurements remain stable through sampling years, varying between 2.4 and 5.38 (2016). **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

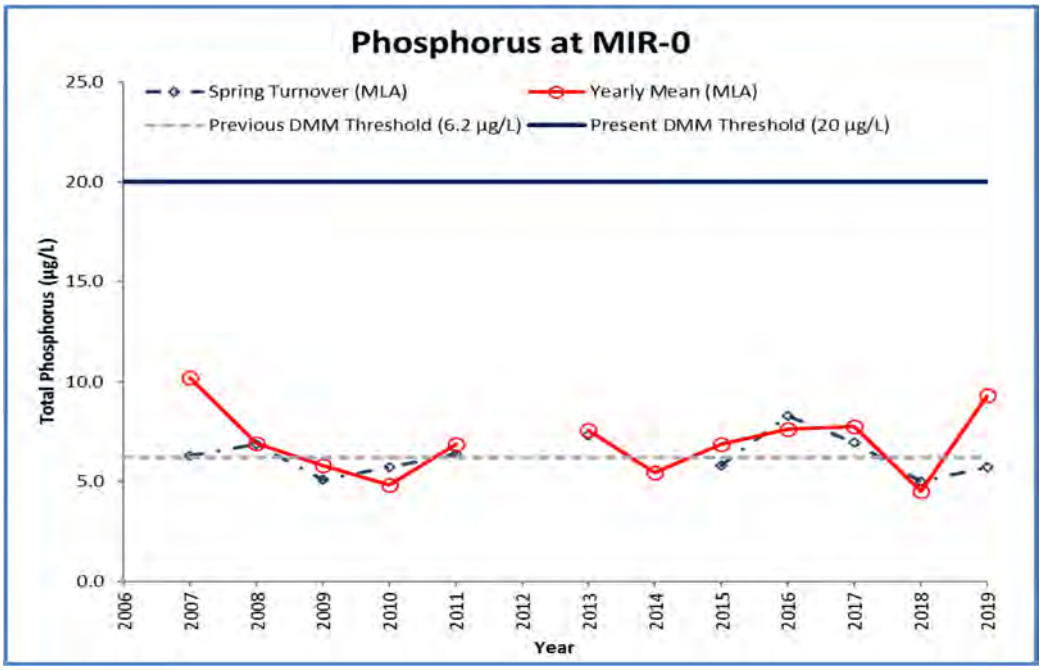
Mirror Lake is essentially a widening of the Indian River as it flows between Lake Rosseau to the north and Lake Muskoka to the south. The lake is approximately 0.46 km² in area, with a maximum depth of 8 m. Two small creeks outlet into the lake near sampling sites MIR-1 and MIR-2. Much of the lake is within the Town of Port Carling and receives drainage from the urban area. Mirror Lake has a small watershed, approximately 0.97 km², and was historically classified as moderately sensitive and over-threshold by the DMM. Monitoring started in 2007. All stations shown may not be sampled each year.

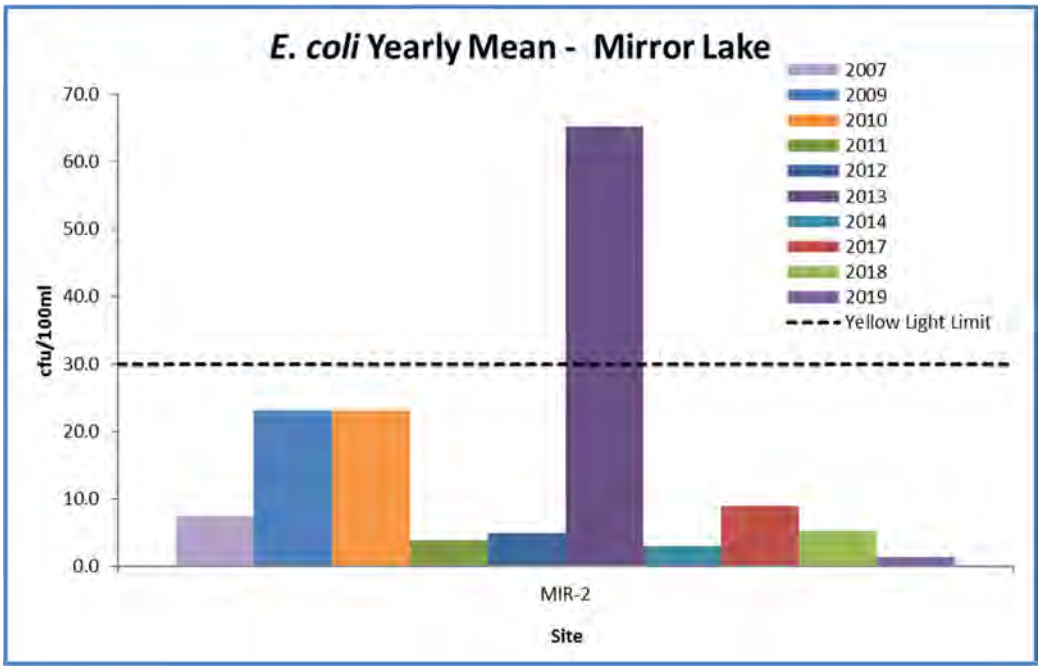
Volunteer Recognition: **Susan Carson, Jane Armstrong and Chris Vandergrift.**

Mirror Lake (MIR)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
MIR-0	3.2	5.7	9.3		
MIR-2		5.4		1.4	40.5





Summary and Recommendations:

The spring phosphorus concentration at the deep station (MIR-0) was below the historic DMM threshold of 6.2 µg/L in 2019, and all readings remain well below the present DMM threshold (20 µg/L). The 2014 spring phosphorus result at MIR-0 remains removed from the analysis following the 2019 Grubb's Test for outliers. The 2019 yearly mean phosphorus average at MIR-0 is the second highest recorded due to the second highest sample result to date in July (22.5 µg/L). The yearly mean phosphorus at MIR-0 was substantially higher than the spring turnover concentration, therefore Mirror Lake changes from a green to a yellow stop light in 2019. The spring phosphorus sample collected at MIR-2 is the lowest recorded to date. *E. coli* counts remain well below the MLA stoplight limits (details in report Section 3) at MIR-2 in 2019. Secchi measurements vary through the sampling years between 1.95 and 4.45 m (2009). **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

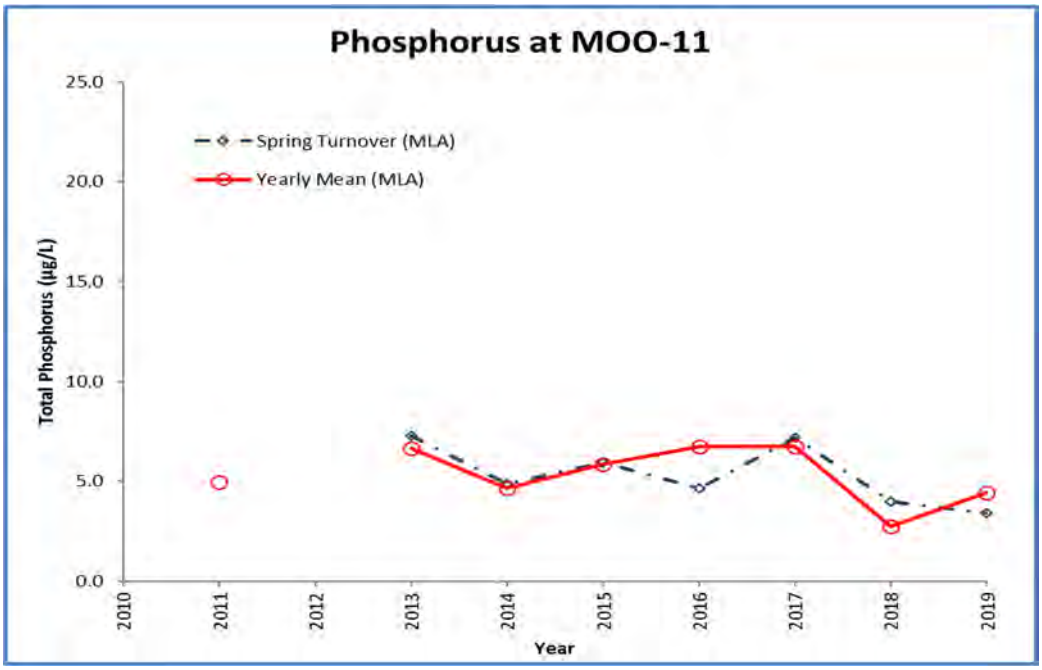
The Moon River is the main outlet of the Muskoka Watershed, flowing from Lake Muskoka to Georgian Bay. The river receives overland drainage from the Town of Bala and its urban area, including many roads and the developed shoreline. Approximately 12 creeks outlet into this sampling area, several of which drain wetlands. All stations shown may not be sampled each year.

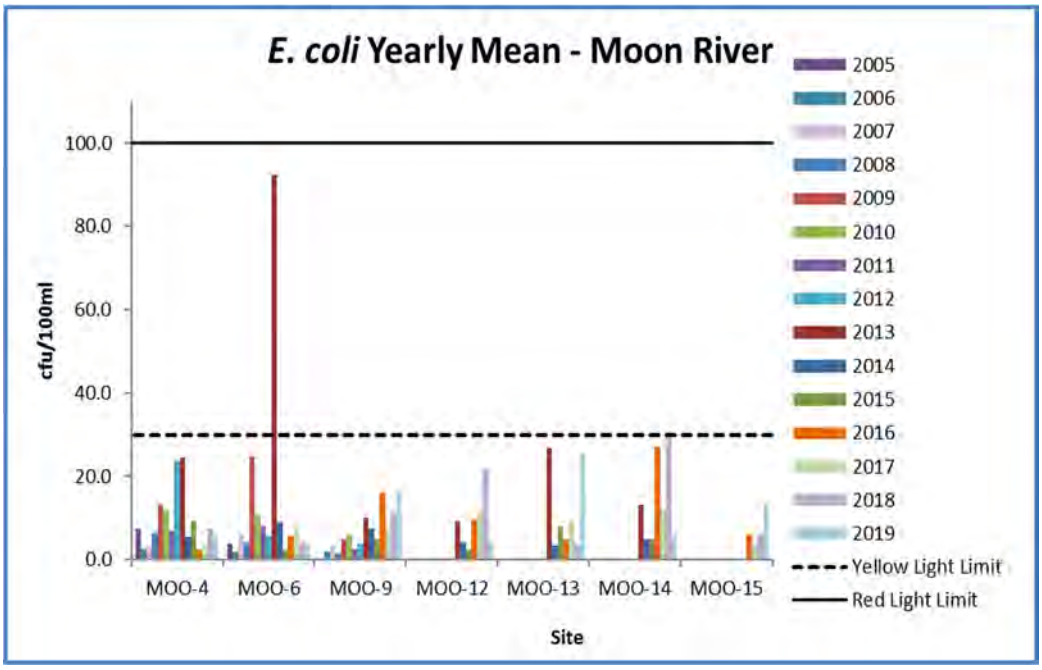
Volunteer Recognition: **Dawson Currie,** Cathy Malcomson, Barrie Fisher, Hannu Ylanko, Cathy Brown, Dave MacIntosh and Mike Adamson.

Moon River (MOO)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
MOO-1		3.3	3.7		
MOO-4		4.2	5.6	5.5	12.7
MOO-6		3.0	3.7	3.6	26.4
MOO-9		3.0	5.3	16.5	31.6
MOO-11	3.8	3.4	4.4		
MOO-12		4.2	5.7	4.0	31.3
MOO-13		4.1	6.0	25.5	54.8
MOO-14		3.3	3.6	5.5	20.8
MOO-15		8.8	6.7	13.4	28.0





Summary and Recommendations:

The spring phosphorus concentration at MOO-11 in 2019 was not obtained due to the severe flooding conditions this year. The yearly mean phosphorus at all of the Moon River stations in 2019 (see table above) are all historically low, but none of the stations recorded a spring phosphorus level, and the values are therefore expected to be lower. *E. coli* levels were all below the MLA stoplight limits (details in report Section 3) in 2019. Without spring phosphorus results, Beacon suggests that the classification of green stoplight be maintained for the Moon River in 2019. Secchi measurements vary through the sampling years between 3.0 and 4.0 m (2017, 2019). **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

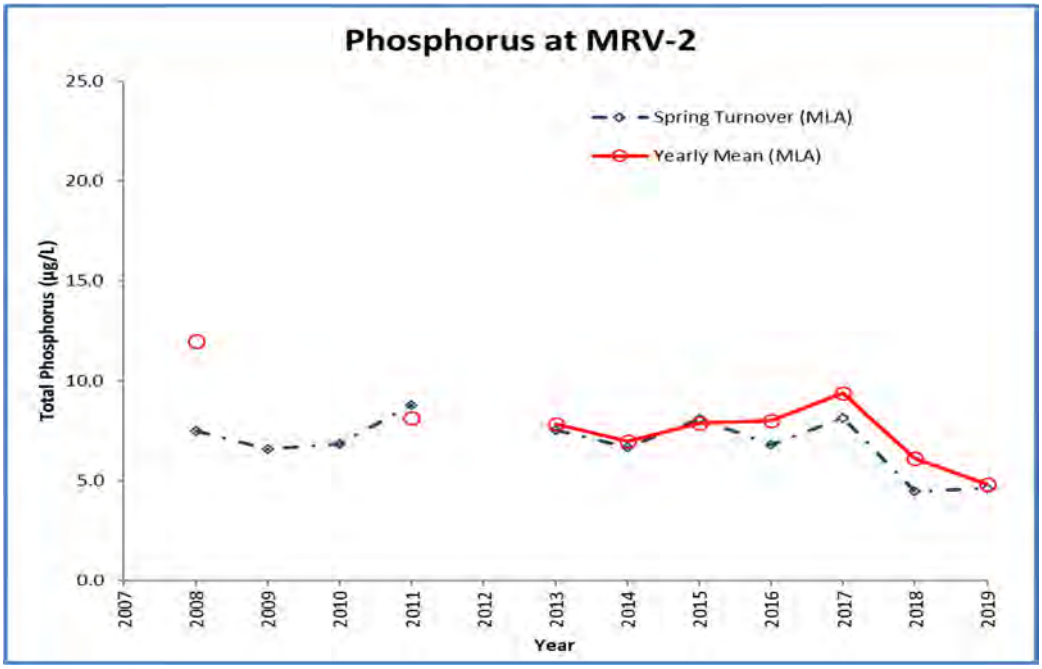
This sample area includes the most downstream reach of the Muskoka River where it flows from the Town of Bracebridge to Alport Bay, Lake Muskoka. This area is highly developed on both banks, and includes the Bracebridge urban area, large agricultural fields, and extensive residential properties along the entire reach of shoreline. Roads are located along both sides of the river for most of the reach length. Several creeks outlet into the river through this reach and there are limited wetland areas adjacent to the river. Monitoring started in 2008. All stations shown may not be sampled each year.

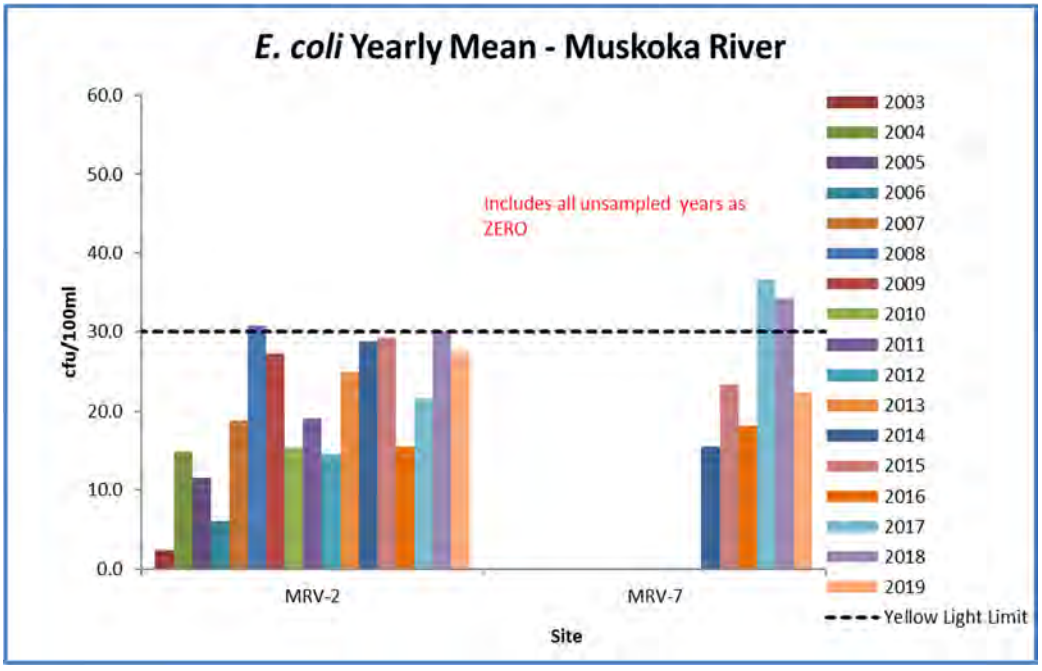
Volunteer Recognition: **Bill Gillbert** and Cathy Gillbert.

Muskoka River (MRV)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
MRV-2	2.4	4.6	4.8	27.5	169.5
MRV-3		4.0			
MRV-4		6.0			
MRV-5		4.6			
MRV-7				22.3	146.3





Summary and Recommendations:

The 2019 spring phosphorus concentration at the deep-water station (MRV-2) was the second lowest recorded to date (2018 was lowest), and the yearly mean phosphorus was lowest to date. The 2019 spring phosphorus concentration at MRV-5 was also the lowest recorded to date. Only one spring phosphorus sample was collected at each of MRV-3, MRV-4, and MRV-5 in 2019, therefore no yearly mean could be calculated, and no values are reported for 2019. *E. coli* levels at MRV-2 and MRV-7 in 2019 were below the MLA yellow stoplight limit (details in report Section 3), The *E Coli* levels at the nearshore stations have subsided, changing the stoplight from yellow to green for the Muskoka River. Secchi measurements vary greatly through sampling years, ranging between 1.22 and 10.25 m (2011). **Beacon recommends that all sampling be continued to monitor long-term trends, with special attention directed to *E. coli* samples in 2019.**

Area Description:

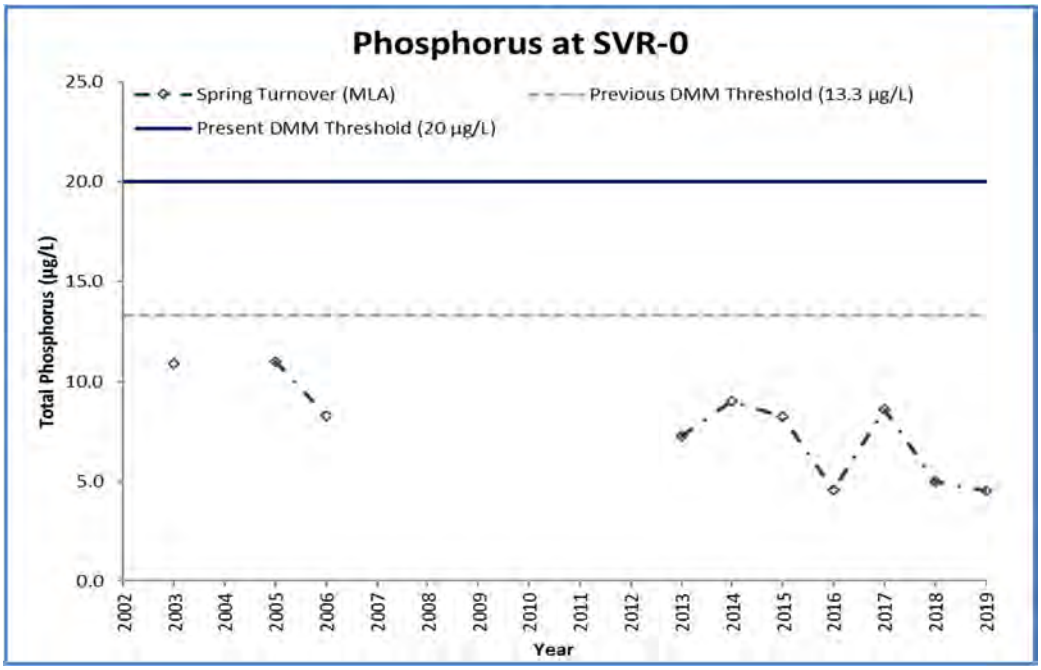
Silver Lake is located at the south end of Gull Lake. The lake is approximately 0.57 km² in area, with a maximum depth of 14 m. No fewer than 13 rivers and streams outlet into the lake. The northwestern portion of Silver Lake contains a navigable outlet into Gull Lake. The Silver Lake watershed is approximately 8 km² in size and contains a number of large lacustrine wetlands. Silver Lake was historically classified as moderately sensitive by the DMM. Monitoring started in 2003. All stations shown may not be sampled each year.

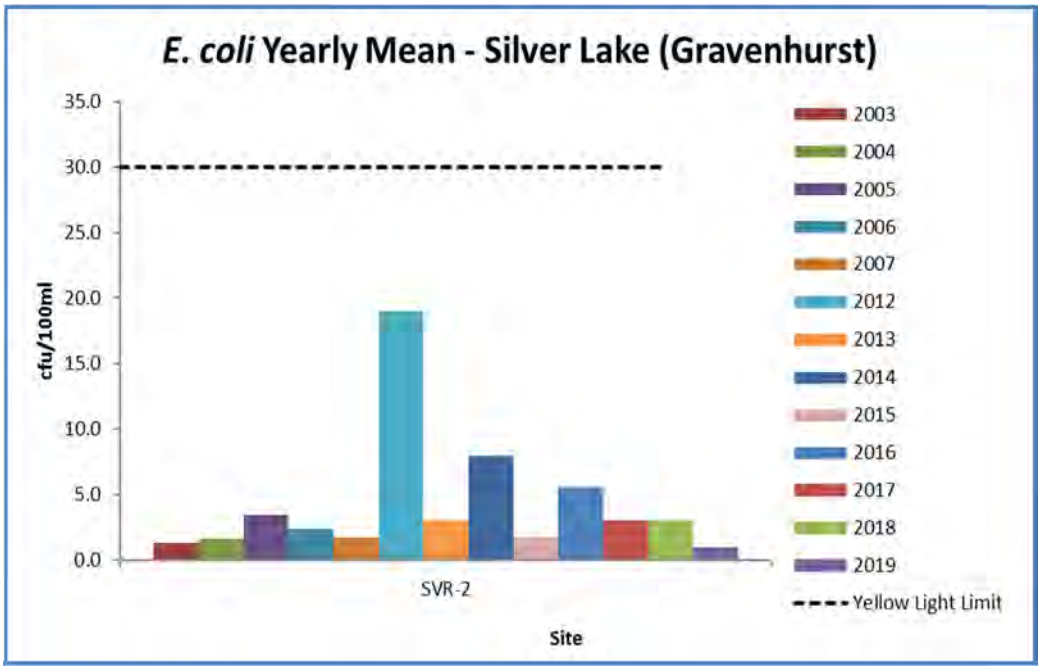
Volunteer Recognition: **Bruce Elliott**

Silver Lake (SVR)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

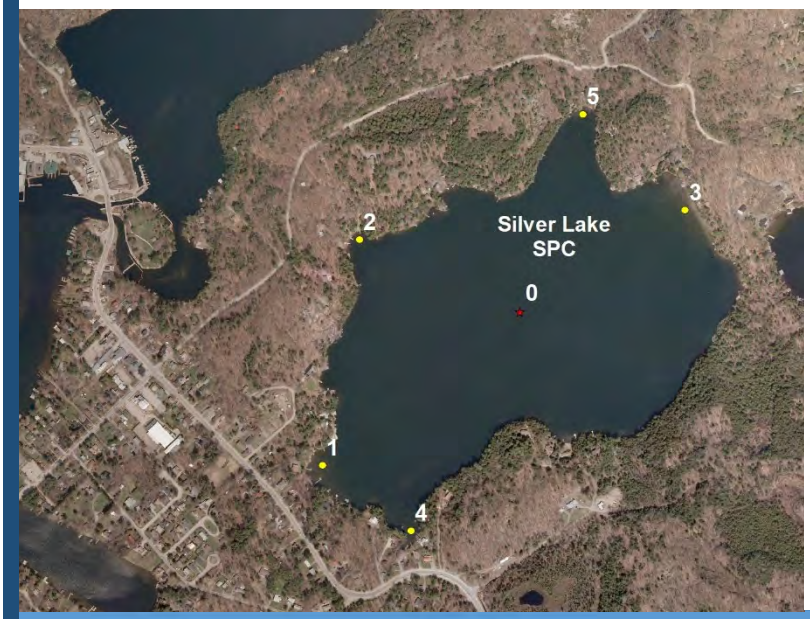
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
SVR-0	2.9	4.5	5.5		
SVR-2				1.0	24.0





Summary and Recommendations:

The spring turnover phosphorus and yearly mean phosphorus concentrations continue to remain well below the historic DMM threshold (13.3 µg/L), and all readings remain well below the present DMM threshold (20 µg/L). The spring phosphorous concentration at SVR-0 was the lowest recorded to date. The *E. coli* yearly mean value for SVR-2 in 2019 remains well below the MLA stoplight limits (details in report Section 3). Secchi measurements vary through the sampling years between 2.0 and 4.5 m (2018). **Beacon recommends sampling continue to monitor long-term trends.**



Area Description:

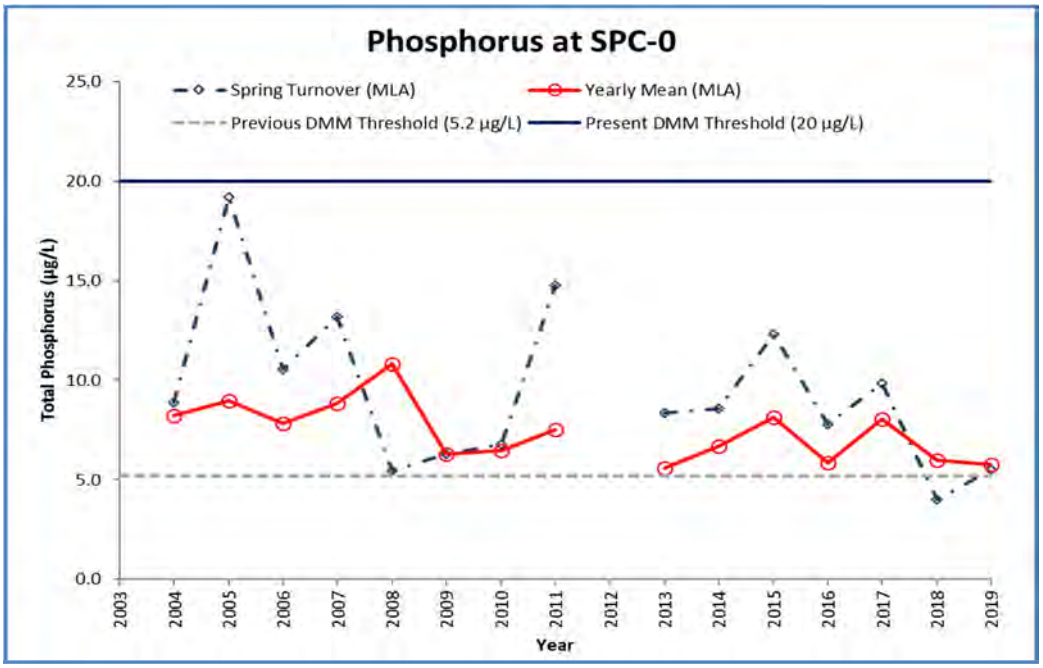
Silver Lake is immediately adjacent to Port Carling, with 0.57 km² in surface area and a maximum depth of 14 m. This lake has a moderate amount of shoreline residential development with alteration in the form of lawns and thinned forest occurring over approximately 50% of the upland area. The riparian area is well buffered with 90% of the immediate shoreline in a natural state. The southwestern portion of this lake receives drainage from part of the Port Carling urban area. There is limited flow into the lake with one identified outlet in the south. Silver Lake was historically classified as moderately sensitive by the DMM. All stations shown may not be sampled each year.

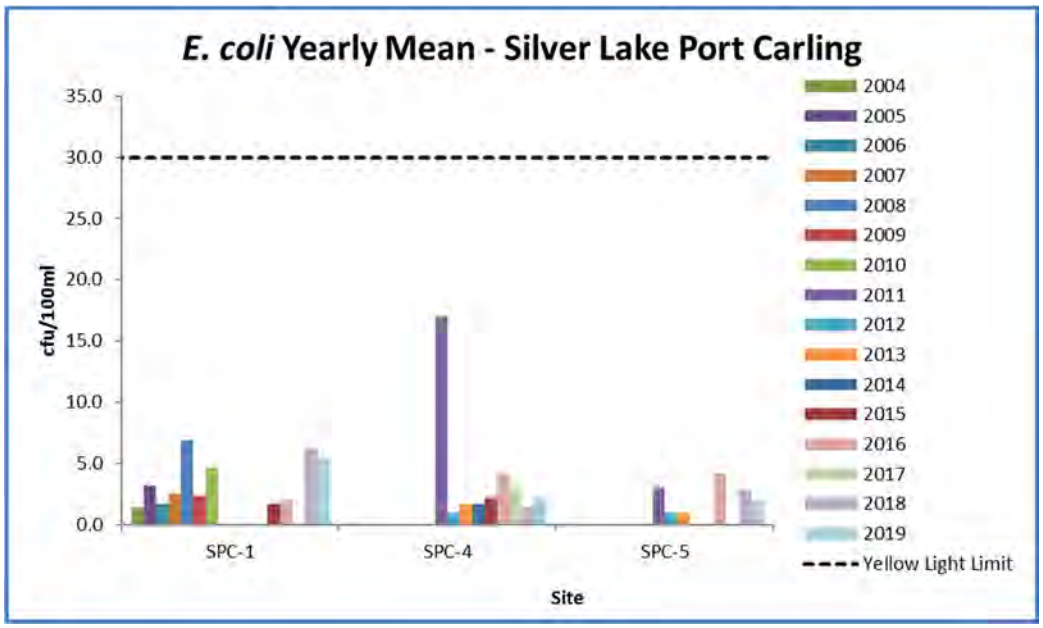
Volunteer Recognition: **Barbara Graydon, Matthew Graydon**, Mike Graydon and Johnathan Graydon.

Silver Lake (SPC)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
SPC-0	4.8	5.5	5.8		
SPC-1				5.5	40.6
SPC-4				2.2	15.7
SPC-5				2.0	23.3





Summary and Recommendations:

Although the 2019 spring phosphorus concentration at the deep station (SPC-0) was above the historic DMM threshold of 5.2 µg/L in 2019, all readings remain well below the present DMM threshold (20 µg/L). *E. coli* counts remain low at all nearshore sampling locations in 2019 and well below the MLA stoplight limits (details in report Section 3). Secchi measurements vary through the sampling years between 2.0 and 7.5 m (2011). **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

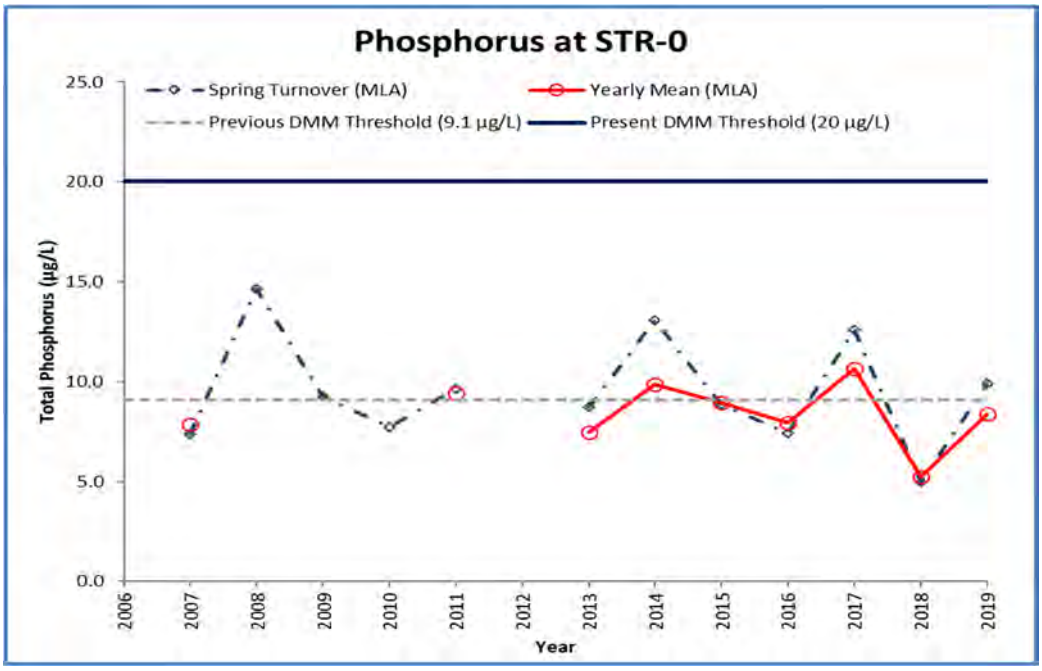
Star Lake is located in the Township of Seguin and is approximately 158 ha in area with a maximum depth of 23 m. This lake has a moderate to high level of shoreline development in the form of residential properties. Many of these properties maintain natural riparian vegetation along their shorelines, but some have extensive clearings and lawns. There is a large agricultural area adjacent to the northwestern shore and several roads located in close proximity to the lake. This lake has several inflow and outflow creeks, with limited wetland areas in the upper watershed. Monitoring started in 2007. All stations shown may not be sampled each year.

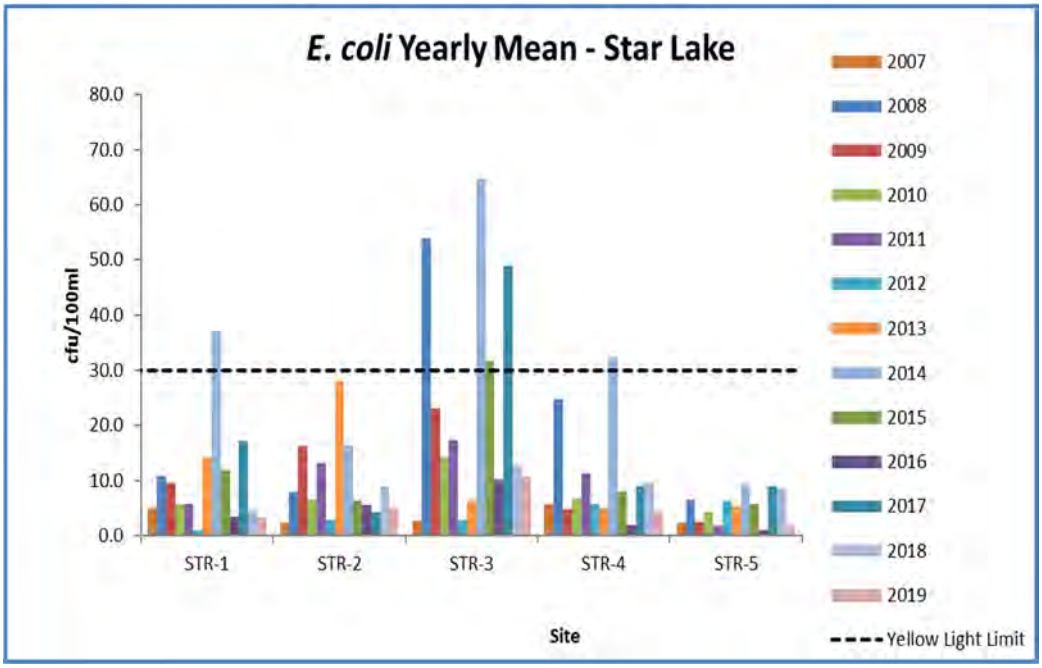
Volunteer Recognition: **Karen Gillies, Melaney Kerley**, and Jim Kerley.

Star Lake (STR)

2019 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2019)

Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
STR-0	2.4	9.9	8.4		
STR-1				3.2	128.2
STR-2				4.9	68.7
STR-3				10.8	175.8
STR-4				4.4	68.2
STR-5				1.7	75.3





Summary and Recommendations:

Although the spring phosphorus concentration at the deep station (STR-0) was above the Seguin threshold of 9.1 µg/L in 2019, all readings to date remain well below the present DMM threshold (20 µg/L). *E coli* mean concentrations in 2019 at all stations were below the MLA stoplight limits (details in report Section 3). *E coli* re-tests were required at STR-3 following the sampling in June. Volunteers noted that water levels were very high at STR-3, however, the old beaver dam was visible during the August 23rd sampling event. Secchi measurements vary through sampling years, ranging between 1.40 and 4.45 m (2007). **Beacon recommends that all sampling be continued to monitor long-term trends.**