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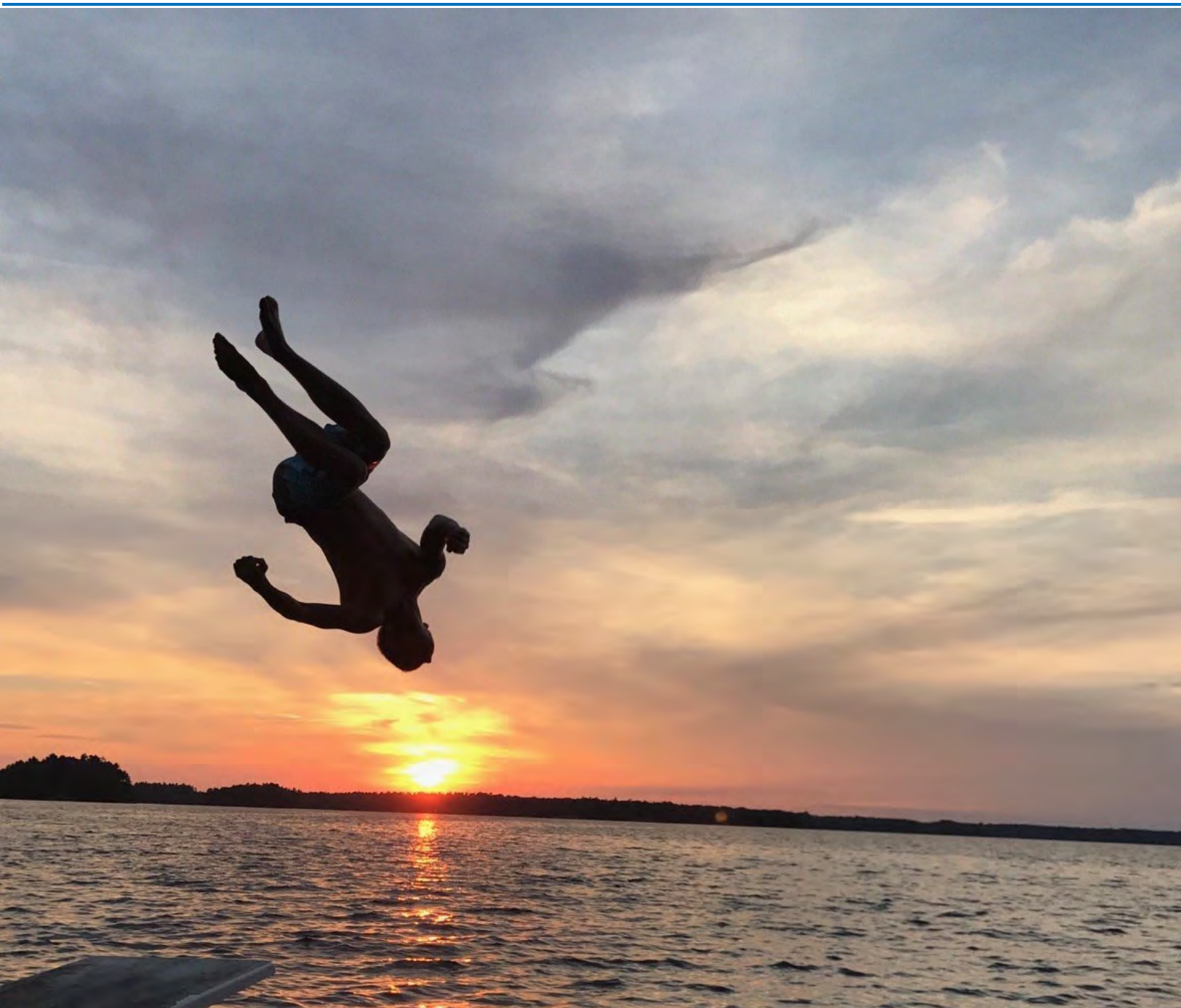
MLA™ Muskoka Lakes Association
Preserving Muskoka for Future Generations

2018
Water Quality Initiative Report



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Executive Summary

The MLA Water Quality Initiative Report presents data collected at 196 locations during the summer of 2018 and compares it to data collected from 2002 to 2017. 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 passionate 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 are making a difference!

Area Summary Sheets are used to summarize sampling results, and traffic light symbology, established by the MLA, provides a visual indication of the overall water quality at each Area as follows:

- Green light indicates the water quality remains consistently good;
- Yellow light indicates that further investigation is recommended to maintain good water quality, and
- Red light indicates remedial action may be necessary to improve water quality.

In 2018, of the 56 Areas tested, there were 45 Areas with a green light, 9 Areas with a yellow light and 0 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 a few new sites or sites with only one or two years of data that are not rated yet. This year, 4 Areas changed from a green light to a yellow light, 8 Areas changed from a yellow light to a green light, and 2 Areas (RFL-0 and SDP-0) were sampled for the first time in 2018 and will receive a traffic light classification in 2019.

Changes to the monitoring program in 2018 included the method of obtaining the phosphorus samples and a new laboratory used to complete the analyses. The phosphorous samples were formerly sent to Trent University labs at Dorset (part of the Dorset Environmental Science Centre, DESC) which provided a low method detection limit (<0.7 µg/L). When they closed suddenly in late March 2018 the best replacement solution was a major Toronto lab who was competitively priced but less accurate (higher method detection limit of 2.0 µg /L and accuracy +/- 20% at 8.0 µg /L). Other high accuracy labs at DESC had no capacity to accommodate the MLA work. Changing from Trent to the new lab also required a change from glass test tube sample containers to plastic, pre-treated bottles. Although the glass test tubes were to be rinsed prior to obtaining samples, the pre-treated bottles used in 2018 were not rinsed.

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 2018 sampling season started in mid-May, ended in late August and generally included a total of four sampling events at each location. The water quality parameters sampled during the 2018 program are the same as those sampled in 2017 and consisted of temperature, Secchi depth (clarity), Dissolved Organic Carbon (DOC), Total Phosphorus (nutrients), *Escherichia coli (E. coli)* and Total Coliform (bacteria count). There was a total of 233 Secchi depth measurements, 441 Phosphorus samples, 16 DOC and 284 *E. coli* samples taken.

Although there was an overall general increase in most of the deep-water spring phosphorus concentrations in 2017 compared with values in 2016, that was not realized in 2018. At the deep-water station sites that were sampled for spring phosphorus, 20 (42 %) of the 48 sites showed the lowest spring phosphorus concentration recorded to date. In 2018, four of the deep-water sites recorded the highest spring phosphorus concentrations to date at those sites. In general, the phosphorus concentrations were lower than in previous years.

Of the 13 watercourse sites sampled for spring phosphorus, 100% showed a lower phosphorus concentration than in 2017 and 100% of those sites with a measured yearly phosphorus mean also showed lower yearly mean concentrations compared with results from 2017.

New deep-water stations were established at Rosseau Falls (RFL-0), Sandy Point (SDP-0) and Leonard Lake (LEO-8 and LEO-11) in 2018 to investigate phosphorus concentrations. Additionally, new nearshore stations were established at Eilean Gowan (ELG-5), Sandy Point (SDP-1) and Leonard Lake (LEO-9 and LEO-10) to monitor phosphorus and bacteria levels in 2018.

Phosphorus concentrations at near shore sites, including watercourse sites, generally showed a decline from previous years. 52% of the sites showed a decrease in phosphorus concentrations compared to the 2017 levels, with most of those dropping even below 2016 levels. In contrast, 9% of the sites showed an increase over previous years. These sites are of interest and will be followed more closely in future. Finally, 39% of the nearshore phosphorus concentrations in 2018 showed a trend of decreasing phosphorus concentration compared to the values at those stations in 2016 and 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 2018. The spring phosphorus concentrations in 2018 at WIN-7 and WIN-8 were both the lowest ever recorded at each of the sites. The yearly mean phosphorus concentrations at both sites were the second lowest recorded in the 5 years of data gathered, which was a result of the low concentrations recorded in the first 2 of 4 sampling events in 2018.

DOC was sampled at 4 of the MLA sites in Three Mile Lake in 2018. An analysis of the total phosphorus concentration versus DOC concentration was undertaken this year, based on 3 full years of data collection in 2016 through 2018. The results of the DOC sampling in Three Mile Lake show indications of higher concentrations of DOC associated with lower levels of phosphorus. Although the correlation of DOC vs TP is difficult to assess on an individual site basis, it would be prudent for the MLA to continue to assess the long-term levels of DOC in Three Mile Lake.

E. coli levels, measured in colony forming units (cfu), exceeded 50 cfu/100 mL at 29 (9.2%) of 316 sampling events for *E. coli* in 2018. These results are similar to the 8% reported in 2017, and 8.7 % in 2016. Sixteen (16) sites reported elevated *E. coli* levels (>50 cfu/100mL) in 2018 compared with 12

sites in 2017. It should be noted that there were 316 samples in 2018, while there were only 282 samples in 2017, potentially contributing to the increased number of sites reporting elevated levels. The sites that reported elevated *E. coli* levels in 2018 include Bala Bay (BAL-2), Gull Lake (GUL-1), Moon River (MOO-14), Muskoka River (MRV-2 and MRV-7), Muskoka Sands (MSN-3), Star Lake (STR-1, STR-2, STR-3, STR-4, and STR5), and Windermere (WIN-5). The focus stations at Minett (MIN-1, MIN-6, MIN-7 and MIN-9), observed elevated *E. coli* levels (>50 cfu/100mL) and required re-testing as well.

From those sites identified in 2016 and 2017 for further analysis and sampled for in 2018, the Minett station (MIN-6) continued 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 (30 cfu/100ml) for *E. coli* within the past three years: , Beaumaris (BMR-4 and BMR-9), Gullwing Lake (GLW-1), Moon River (MOO-14), Muskoka Bay (MBA-13), Windermere (WIN-4 and WIN-5), Indian River (IND-2, and IND-3), and Muskoka River (MRV-2 and MRV-7).

Following analysis of the 2018 results, Beacon recommends that the primary Focus Areas for the 2019 sampling season should continue to be Minett (MIN) as well as East Portage Bay (POR).

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 Water Quality & 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 2018. This Water Quality Report presents the most recent data collected in 2018 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 2018 program and these are presented in **Appendix A**. The Summaries provide an analysis of the data collected in 2018 and include historical total phosphorus and *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 2018 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 2018 Water Quality Initiative Report and use caution in extrapolating data to a lake or watershed.

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 Water Quality & 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 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. In 2018, six (6) of the deep-water sampling stations spring phosphorus data was obtained from the LPP.

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. Additionally, 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 also 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 programs are accomplished with volunteers while 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.

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 less frequently.

Another example of change is the addition of sampling for dissolved organic carbon (DOC) which was initiated in 2013 and continued through 2017. Three Mile Lake is the only area that continues to be sampled for DOC in 2018. Research has indicated that natural levels of total phosphorus from Precambrian Shield watersheds can most likely be correlated with levels of DOC. By having background data, unnatural (human influenced) increases in phosphorus can be more easily realized. DOC can also be sampled for in intermittent years to analyze for long term trends.

Some of the more notable changes that have helped shape the WQI are presented below:

2001 The program was initiated in the summer of 2001 to gather preliminary information on innovative means of water quality determination in the Muskoka lakes. The first year's programme focussed on developing protocols for the collection of replicable data.

2002 The program established that water quality programs should focus on nearshore areas and not just on open water areas as they have done in the past. Results showed that nutrient and bacterial levels were higher in nearshore areas than in open water and that there were areas of concern.

2003 In 2003 the Board of Directors made a long-term commitment to the initiative and raised funds to pay the operating expenses. Phosphorus samples started to be filtered and the Program was extended to "affiliate" partner associations.

2004 The program was focused on the residential land use activities and their effect on water quality. Monitoring efforts grew to 136 sites monitored by an all-time high number of volunteers. The program discontinued filtering the phosphorus samples because the filters appeared to significantly alter the data collected.

2005 The focus of research in 2005 was to develop a correlation between MLA total phosphorus concentration data with the data that has been collected by both the District of Muskoka and the MOECC.

2006 Statistical analysis conducted on the water quality data collected from 2002-2006 indicated that the WQI program did not have the capacity to consider highly complex relationships.

2007 Additional monitoring efforts were directed towards specific lakes and bays classified as "over-threshold" by the District of Muskoka. The MLA's attention was refocused in 2007 following recommendations of the 2006 Annual Report and the introduction of the District Municipality of Muskoka's Lake System Health Program which classifies lakes and parts of lakes based on estimated human impact on trophic status. The resources of the WQI were directed to specific sampling areas where concerns about water quality had come to light and focussed on determining the sources of phosphorus loading and other contaminants in these areas.

2008 Monitoring efforts scaled back very slightly to fewer sites monitored by over 110 volunteers. Turbidity measurements were discontinued in favour of the Secchi depth protocol that was added in 2007 to enable volunteers in the field to complete more of the program.

2009 The WQI monitoring program data showed decreasing concentrations of phosphorus in Lakes Rosseau, Muskoka and Joseph.

2010 Through the support of the WQI, Stream Monitoring Action Plans were implemented for Muskoka Bay and Cox Bay. Both areas had historically been identified as areas of concern through the WQI. Data analysis revealed that land-based influences on nearshore phosphorus were only detectable at sites located near creek outlets. The Summary Report and Technical Reports were condensed into one report.

2011 Several changes occurred in 2011 to standardize the methodology to allow comparison with other sampling programs. The changes included:

- Re introduction of filtering phosphorus samples, collection of samples at Secchi disk depth, and collection of duplicate samples;
- Sampling frequency was reduced from eight sampling events to four;
- Calcium sampling was undertaken in correlation with spring turnover phosphorus to increase the analytical ability of the WQI program; and
- Twenty-three sampling areas were added to the 2011 WQI, based on volunteer input and areas identified with the potential for concern during the 2010 review.

2012 Bacteria monitoring was discontinued at selected sites that were exhibiting chronically low average bacteria levels (three or more years below the MLA upper limit of 10 cfu/100 mL). New bacteria sampling sites were established in high-use areas where potential risks to health and recreational water quality were of concern (e.g., beaches, popular swimming sites, etc.). Calcium concentration data collected in 2011-2012 suggested that there was limited year-to -year variation (+/- 0.18 mg/L); however, it was determined that further data was required to determine overall trends. Changes to the program were limited to modifications of the deep-water phosphorus sampling methodology, revisions to bacteria sampling sites, and the addition of new sampling areas. The deep-water sampling methodology was changed for 2012 and results suggested that 2012 deep-water total phosphorus data were in general unreliable and were not included in the report.

2013 Consultation was undertaken in the spring to look at 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 2013 included 15 sites being removed, 8 sites being added, and 4 sites being modified. Additionally, Dissolved Organic Carbon was added to the parameter suite in six locations to better understand potential sources of natural phosphorus versus human impact.

2014 Each sampling area and location was reassessed at the beginning of the year to understand requirements for the sampling season. A total of 13 sites were discontinued, 8 sites were added, 8 sites restarted, 24 sites modified and sampling for DOC was continued. Elevated *E. coli* concentrations were recorded at several sites including at MIN-6 in Wallace Bay. Discussion with the MLA Water Quality & Environment Committee resulted in a proposal to proceed with a second stage monitoring program for 2015.

2015 The 2014 Area Summaries were reviewed to assess each site and modifications were undertaken to restart or temporarily discontinue particular sites. The most important revision in 2015 was the initiation of a Second Stage Water Quality Assessment (SSWQA) in Wallace Bay of Lake Rosseau. The SSWQA was designed to assist in determining whether remedial action was required where elevated levels of *E. coli* had been identified at MIN-6. Compared with the total coliform and *E. coli* levels encountered at MIN-6 in 2014, those recorded in 2015 show a marked decrease.

2016 All of the sampling areas and locations were reassessed at the beginning of the year to understand requirements for the 2016 sampling season. A total of 15 sites were discontinued,

8 sites were added, 10 sites restarted, 11 sites modified and sampling for DOC was continued. *E. coli* samples were collected 3 times versus 2 times previously at routine sampling sites. Increased sampling of 8 times per summer was started at the Minett focus site. New thresholds for the 2016 analysis of *E. coli* concentrations were implemented and discussed in Table 11.

2017 The master list of sampling areas and locations was reviewed early in the year. A list of core deep-water sites was identified for long-term monitoring as they are representative of the main lake embayments. Sampling at 24 previously stable sites was reduced to spring phosphorus only. Monitoring sites were added at locations identified in areas of potential additional loads to the lake, and included creek drainage from 'Yellow' sites, resorts, marinas and public beaches. 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. Several sampling sites for *E. coli* were suspended if they had concentrations < 10 cfu/100 ml for 3 years. The correlation between DOC and total phosphorus was analysed at 22 stations.

2018 Each of the sampling areas was reviewed in the early spring to revise the number of sampling sites, where necessary. The changes undertaken in 2018 included 11 sites being suspended for 2018, 8 sites being added, 6 sites being restarted, 84 being modified. Most of the modifications included increasing the number of Secchi measurements through the summer. Additionally, dissolved organic carbon sampling was suspended at all stations, except for stations in Three Mile Lake.

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.

1.3 Monitoring Volunteers

In 2018, volunteers dedicated their time and continued support in collecting water quality samples at 196 different sampling locations including 233 Secchi depth measurements, 441 phosphorus samples, 16 DOC samples and 284 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.

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).

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.

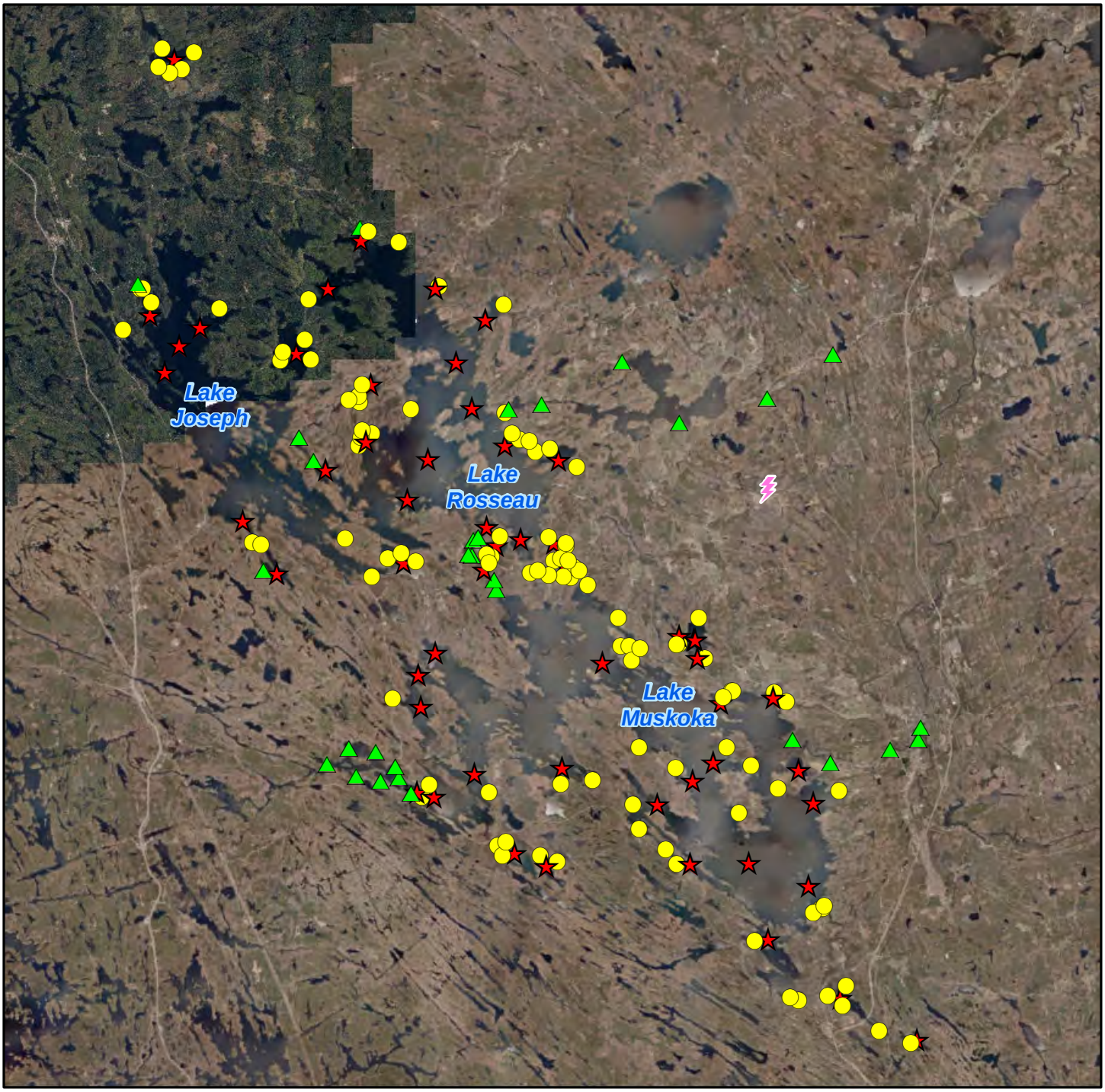
Water management can typically be broken down into two interrelated components; water quality and quantity. Water quality is directly affected by quantity. For example, flooding and heavy precipitation events can cause several contaminants to enter waterways due to overland flow picking up contaminants 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 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 increases 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 2013 to 2018.



Legend

Beatrice Weather Station

Station Type

Deep

Nearshore

Watercourse

Ontario Base Map Vector Base
First Base Solutions Web Mapping
District of Muskoka 2008 and West
Parry Sound Geography Network 2013

2018 Station Locations

Figure 1

Muskoka Lakes Association

UTM Zone 17 N, NAD 83

N
W E
S

0 2.5 5 10 Kilometers

1:275,000

BEACON ENVIRONMENTAL

Project 213090
December 2018

The spring freshet of 2018 did not produce flooding conditions as generally cooler temperatures (**Table 1**) and lower than average precipitation (**Table 2**) were recorded. A large rainfall event on Family Day (February 19) melted a large part of the winter snow pack. Precipitation in March and May was well below the long-term average (**Table 1**), although, lake levels were within the MRWMP normal range in March, April and into mid-May. Little amounts of snow continued through April as temperatures remained well below average for the month (**Table 2**).

Colder temperatures in April resulted in the ice staying on the lakes for an extended period 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 temperatures, ice-out was delayed until the last day in April in 2018.

In contrast to the summer conditions in 2017 which included cooler than average temperatures and higher than average rainfall amounts, the summer of 2018 saw significantly less rainfall through March to August and most notably in May and June. The summer of 2018 was on average the warmest observed in the last 6 years. Large rainfall events were sporadic and occurred on April 5th (22.8 mm), August 17th (30.2 mm), 21st (63.7 mm), 25th (26.9 mm) and 27th (44.7 mm).

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

Month	Total Monthly Precipitation (mm) in 2013	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	Average Monthly Precipitation (mm) 1981-2010
March	55.0	64.9	44.1	182.3	87.5	31.0	75.2
April	174.6	91.6	89.1	64.4	155.6	103.8	76.8
May	122.9	103.6	73.7	56.3	130.2	27.8	97.9
June	95.5	163.1	120.1	41.3	151.6	25.5	87.7
July	59.8	89.8	45.0	72.6	79.6	57.0	94.3
August	98.2	109.9	110.7	195.5	211.2	196.1	87.7

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

Month	Mean Temperature (°C) in 2013	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) 1981-2010
March	-3.0	-8.4	-6.2	-1.5	-5.9	-3.3	-3.8
April	3.3	3.1	3.8	1.6	6.3	-0.2	4.4
May	12.4	11.1	12.6	11.0	10.1	13.3	11.0
June	15.4	17.0	14.9	15.5	15.4	15.5	15.8
July	18.7	16.2	17.5	18.6	17.9	19.5	18.2
August	16.6	16.8	17.1	19.4	16.4	19.3	17.3

[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)*

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

Month	Highest Temperature (°C) in 2013	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) 1981-2010
March	10.4	11.4	8.9	12.7	9.5	8.6	2.4
April	22.8	15.9	21.0	22.4	27.1	17.9	10.7
May	29.9	25.1	29.5	30.0	28.4	30.9	18.1
June	29.5	29.3	24.9	29.6	27.7	30.0	22.6
July	31.1	28.4	31.1	30.0	28.0	33.9	24.9
August	28.6	27.5	28.7	33.3	27.5	30.4	23.8

The Spring condition of the lakes this year had some notable changes from prior years. There was no flooding associated with freshet. Water levels gradually rose from their drawdown state to normal spring operating levels. Ice out at April 30 was later than most years so first sampling was closer to ice out than normal. DMM recommends allowing two weeks after ice out for turnover to occur. MLA met this criterion. The 2018 spring condition is believed to have resulted in clearer water and lower phosphorus concentrations (as a result of less sediment from flooding).

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 exhibit “average” water quality conditions.

The duplicate phosphorus sampling method initiated during the 2017 sampling program changed from the method in the previous 4 years and continued to be used in 2018. The change in 2017 brought the sampling methods in line with the methods employed by the District of Muskoka. Further details 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 2018 program are provided below in **Table 4** along with a brief description of the parameter and reason for measuring.

[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)*

Table 4. 2018 Water Quality Parameters

Water Quality Parameter	Description	Reason for Measuring
Dissolved Organic Carbon (DOC)	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 is an important component in the carbon cycle and a primary food source for aquatic webs. Research has indicated that natural levels of total phosphorus from Precambrian Shield watersheds can most likely be correlated with levels of DOC.
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.
***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 2018 sampling season began in mid-May, ended 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 2018. This included sampling for *E. coli* 8 times during the summer.

- A Secchi disk was used to measure water clarity at the deep-water locations. The amount of Secchi sampling was increased in 2018 at most of the deep-water locations. In general, sampling increased from once in May in 2017 to occurring at each of the deep stations 3 to 4 times in 2018.

- Dissolved organic carbon was sampled at 4 locations during the 4 sampling events in 2018. DOC was collected at Three Mile Lake (TML-1, TML-2, TML-3 and TML-4). Each of these nearshore sites was selected based on their proximity to potential sources of external phosphorus.

- Water clarity in the lakes in Muskoka Parry Sound region is partially determined by DOC that imparts a tea colour in the water. DOC compounds in Precambrian Shield waters are formed by the decomposition of organic plant matter primarily in wetland areas and concentrations in lake waters have been determined by the amount of wetland in the catchment of a lake (Hutchinson 2002). The influence of DOC is entirely natural and cannot be managed to improve water clarity (Secchi depth). DOC is closely related to total phosphorus concentrations in Muskoka lakes and has been declining over the past 25 years (Hutchinson Environmental Sciences Ltd. 2016).

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.

A summary of the 2018 sampling program for each location is provided below in **Tables 5** through **9**, outlining which areas or affiliate lakes were included in the program, their sampling location and water quality parameters sampled for each. **Figure 1** illustrates the sampling areas in 2018.

Table 5. Summary of the Lake Joseph 2018 Monitoring Program

Sampling Area	Sampling Location	Water Quality Parameters Collected in 2018			
		Secchi Disk	TP	DOC	Bacteria
Cox Bay	COX-0	✓	✓		
	COX-2		✓		
	COX-3		✓		
	COX-6		✓		
	COX-7		✓		
	COX-8		✓		
Foot's Bay	FTB-0	✓	✓		
	FTB-3		✓		
Gordon Bay	GNB-0	✓	✓		
	GNB-4		✓		✓
Hamer Bay	HMB-0	✓	✓		
	HMB-1		✓		✓
	HMB-2		✓		
	HMB-4		✓		
	HMB-8		✓		
Little Lake Joseph	LLJ-0	✓	✓		
	LLJ-6		✓		
	LLJ-7		✓		
	LLJ-12				✓
	LLJ-13				✓
Main Basin	JOS-1	✓	✓		
Stanley Bay	STN-0	✓	✓		
	STN-2		✓		
Stills Bay	STI-0		✓		
	STI-2		✓		

Table 6. Summary of the Lake Muskoka 2018 Monitoring Program

Sampling Area	Sampling Location	Water Quality Parameters Collected in 2018			
		Secchi Disk	TP	DOC	Bacteria
Alport Bay	ALL-0	✓	✓		
Arundle Lodge	ARN-0	✓	✓		
Bala Bay	BAL-0	✓	✓		
	BAL-2				✓
	BAL-3				✓
Beaumaris	BMR-0	✓	✓		
	BMR-4		✓		✓
	BMR-5		✓		
	BMR-6		✓		
	BMR-9		✓		✓
	BMR-10		✓		
	BMR-12		✓		

Sampling Area	Sampling Location	Water Quality Parameters Collected in 2018			
		Secchi Disk	TP	DOC	Bacteria
Boyd Bay	BOY-0	✓	✓		
	BOY-3		✓		
	BOY-4		✓		
Browning Island	BWN-1				✓
Dudley Bay	DUD-1		✓		
	MUS-2	✓			
East Bay	EAS-0	✓	✓		
	EAS-2		✓		
	EAS-4		✓		✓
Eilean Gowan	ELG-0	✓	✓		
	ELG-3				✓
	ELG-5		✓		
Main Basin	MUS-3	✓	✓		
Muskoka Bay	MBA-0	✓	✓		
	MBA-2		✓		
	MBA-4		✓		
	MBA-11		✓		
Muskoka Sands	MSN-0	✓	✓		
	MSN-2				✓
	MSN-3				✓
	MSN-6				✓
	MSN-8	✓	✓		
North Bay	NRT-0	✓	✓		
Sandy Point	SDP-0	✓	✓		
	SDP-1	✓	✓		
Stephen's Bay	STE-0	✓	✓		
	STE-2				✓
	STE-3	✓	✓		✓
Taylor Island	TAY-0	✓	✓		
	TAY-1				✓
	TAY-2		✓		✓
	TAY-4				✓
	TAY-5				✓
Walkers Point	WAK-0	✓	✓		
	WAK-5		✓		✓
	WAK-6		✓		✓
Whiteside Bay	WTS-0	✓	✓		
Willow Beach	WLB-0	✓	✓		
	WLB-1		✓		✓
	WLB-3		✓		✓
	WLB-4		✓		

Table 7. Summary of the Lake Rosseau 2018 Monitoring Program

Sampling Area	Sampling Location	Water Quality Parameters Collected in 2018			
		Secchi Disk	TP	DOC	Bacteria
Arthurlie Bay	ART-0	✓	✓		
Brackenrig Bay	BRA-0	✓	✓		
	BRA-1		✓		
	BRA-3		✓		
	BRA-6		✓		
East Portage Bay	POR-0	✓	✓		
	POR-1		✓		
	POR-3		✓		✓
	POR-5		✓		
Main Basin	ROS-1	✓	✓		
Minett	MIN-0	✓	✓		
	MIN-1		✓		✓
	MIN-6		✓		✓
	MIN-7		✓		✓
	MIN-9		✓		✓
Morgan Bay	MGN-0	✓	✓		
	MGN-2		✓		
Muskoka Lakes G&CC	MLG-0	✓	✓		
Rosseau Falls	RFL-0	✓	✓		
	RFL-1		✓		
Rosseau North	RSH-0	✓	✓		
	RSH-2	✓	✓		
	RSH-4	✓	✓		
	RSH-5	✓	✓		✓
Royal Muskoka Island	RMI-0	✓	✓		
	RMI-6		✓		✓
Skeleton Bay	SKB-0	✓	✓		
	SKB-1		✓		
Tobin Island	TOB-0	✓	✓		
Windermere	WIN-0	✓	✓		
	WIN-1		✓		✓
	WIN-3		✓		✓
	WIN-4		✓		✓
	WIN-5		✓		✓
	WIN-7		✓		
	WIN-8		✓		

Table 8. Summary of the Watercourse 2018 Monitoring Program

Sampling Area	Sampling Location	Water Quality Parameters Collected in 2018			
		Secchi Disk	TP	DOC	Bacteria
Indian River	IND-0	✓	✓		
	IND-2				✓
	IND-3				✓
	IND-4		✓		✓
	IND-7		✓		✓
	IND-8		✓		✓
	IND-9		✓		✓
Joseph River	JOR-0	✓	✓		
	JOR-1		✓		
	JOR-2		✓		
Mirror Lake	MIR-0	✓	✓		
	MIR-2		✓		✓
Muskoka River	MRV-2	✓	✓		✓
	MRV-3		✓		
	MRV-4		✓		
	MRV-5		✓		
	MRV-7	✓			✓

Table 9. Summary of the Affiliate 2018 Monitoring Program

Sampling Area	Sampling Location	Water Quality Parameters Collected in 2018			
		Secchi Disk	TP	DOC	Bacteria
Bass Lake	BAS-2		✓		
	BAS-5	✓	✓		
	BAS-7		✓		
Brandy Lake	BDY-0	✓	✓		
	BDY-1	✓			✓
	BDY-2	✓			✓
	BDY-3	✓			✓
	BDY-5	✓			✓
	BDY-6	✓			✓
	BDY-7	✓			✓
	BDY-8	✓			✓
	BDY-9	✓			✓
	BDY-10	✓			✓
	BDY-11	✓			✓
Bruce Lake	BRU-0	✓	✓		
	BRU-3		✓		✓
	BRU-4		✓		✓
	BRU-5		✓		✓
	BRU-6		✓		✓

Sampling Area	Sampling Location	Water Quality Parameters Collected in 2018			
		Secchi Disk	TP	DOC	Bacteria
Clear Lake	CLR-0	✓	✓		
	CLR-2		✓		✓
	CLR-5		✓		✓
	CLR-7				✓
Gull Lake	GUL-0	✓	✓		
	GUL-1				✓
	GUL-2				✓
	GUL-3				✓
	GUL-4				✓
Gullwing Lake	GLW-0	✓	✓		
	GLW-1		✓		✓
	GLW-2		✓		✓
Leonard Lake	LEO-0	✓	✓		
	LEO-1		✓		✓
	LEO-3		✓		✓
	LEO-7		✓		✓
	LEO-8	✓	✓		
	LEO-9	✓	✓		
	LEO-10	✓	✓		✓
	LEO-11	✓	✓		
Moon River	MOO-1		✓		
	MOO-4		✓		✓
	MOO-6		✓		✓
	MOO-9		✓		✓
	MOO-11	✓	✓		
	MOO-12		✓		✓
	MOO-13		✓		✓
	MOO-14		✓		✓
	MOO-15		✓		✓
Silver Lake (GH)	SVR-0	✓	✓		
	SVR-2				✓
Silver Lake (TML)	SPC-0	✓	✓		
	SPC-1				✓
	SPC-4				✓
	SPC-5				✓
Star Lake	STR-0	✓	✓		
	STR-1				✓
	STR-2				✓
	STR-3				✓
	STR-4				✓
	STR-5				✓
Three Mile Lake	TML-1		✓	✓	
	TML-2		✓	✓	
	TML-3		✓	✓	
	TML-4		✓	✓	

2.5 Updates in the 2018 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 2017).

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 chronically 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 2018 program resulted in changes in sampling locations and water quality parameters sampled. Parameters changed include:

- Monitoring sites were added at locations identified in areas of potential additional loads to the lake and included creek drainage associated with 'Yellow' sites, and other areas of concern.
- Sampling for phosphorus in 2018 remained consistent with the 2017 program, except for a few (1 to 3) additional phosphorus samples taken at 12 monitoring sites, as well as one less sample taken from 6 sites, and 3 less samples taken from one site.

Calcium was again not sampled for during the 2018 program. Testing for calcium is done periodically as levels change slowly over time. The DMM is collecting and reporting on calcium levels.

Several sampling locations were added, removed, restarted or modified from the 2018 program (**Tables 5** through **9**). These changes are summarized in **Table 10** below. The changes undertaken include 11 sites being suspended for 2018, 8 sites being added, 6 sites being restarted, 84 being modified and 6 sites making use of the Lake Partner Program spring phosphorus data.

Changes to the monitoring program in 2018 included the method of obtaining the phosphorus samples and a new laboratory used to complete the analyses. The sample collection was modified in 2017 to obtaining one single grab sample (previously two samples) from which 2 samples (one sample plus a duplicate) were taken for phosphorus analysis.

Changes to the monitoring program in 2018 included the method of obtaining the phosphorus samples and a new laboratory used to complete the analyses. The phosphorous samples were formerly sent to Trent University labs at Dorset (part of the Dorset Environmental Science Centre, DESC) which provided a low method detection limit (<0.7 µg/L). When they closed suddenly in late March 2018 the

best replacement solution was a major Toronto lab competitively priced but less accurate (higher method detection limit of 2.0 µg /L and accuracy +/- 20% at 8.0 µg /L). Other high accuracy labs at DESC had no capacity to accommodate the MLA work. Changing from Trent to the new lab also required a change from glass test tube sample containers to plastic, pre-treated bottles. Although the glass test tubes were to be rinsed prior to obtaining samples, the pre-treated bottles used in 2018 were not rinsed.

Table 10. Summary of the 2018 Monitoring Program Revisions

Waterbody Name	Sampling Area	Sampling Location	Site Added	Site Restarted	Site Removed	Site Modified
Lake Joseph	Cox Bay	COX-6				No DOC sample was taken
	Cox Bay	COX-9			✓	
	Foot's Bay	FTB-0				Secchi sampling increased to 4 dates, phosphorus sampling increased to 2 dates
	Foot's Bay	FTB-3				Phosphorus sampling increased to 2 dates, bacteria stopped
	Gordon Bay	GNB-0				Secchi sampling reduced to 3 dates
	Hamer Bay	HMB-0				Secchi sampling increased to 4 dates
	Hamer Bay	HMB-4		✓		
	Hamer Bay	HMB-8				No DOC sample was taken
	Little Lake Joseph	LLJ-0				Secchi sampling increased to 3 dates
	Little Lake Joseph	LLJ-12		✓		
	Little Lake Joseph	LLJ-13		✓		
	Joseph Main	JOS-1				Secchi sampling reduced to 3 dates
	Stanley Bay	STN-0				Secchi sampling increased to 3 dates
	Stills Bay	STI-0				No Secchi sampling
	Stills Bay	STI-2				Phosphorus sampling reduced to 3 dates
Lake Muskoka	Alport Bay	ALL-0				Secchi sampling increased to 2 dates
	Arundle Lodge	ARN-0				Secchi sampling increased to 4 dates
	Bala Bay	BAL-0				Secchi sampling increased to 4 dates
	Bala Bay	BAL-4			✓	
	Bala Bay	BAL-6			✓	
	Beaumaris	BMR-0				Secchi sampling increased to 4 dates, phosphorus sampling increased to 2 dates
	Beaumaris	BMR-4				No DOC sample was taken
	Beaumaris	BMR-6				No DOC sample was taken
	Beaumaris	BMR-9				Bacteria sampling added on 3 dates
	Beaumaris	BMR-11			✓	
	Boyd Bay	BOY-0				Secchi sampling increased to 4 dates, phosphorus sampling increased to 2 dates
	Boyd Bay	BOY-4				No DOC sample was taken

Waterbody Name	Sampling Area	Sampling Location	Site Added	Site Restarted	Site Removed	Site Modified
	Dudley Bay	MUS-2				Secchi sampling increased to 3 dates, phosphorus sampling replaced by Lake Partner Program
	East Bay	EAS-0				Secchi sampling increased to 2 dates, phosphorus sampling increased to 4 dates
	East Bay	EAS-3			✓	
	East Bay	EAS-4				Bacteria sampling added on 1 date
	Eilean Gowan	ELG-0				Secchi sampling increased to 2 dates, phosphorus sampling increased to 2 dates
	Eilean Gowan	ELG-5	✓			
	Muskoka Main	MUS-3				Secchi sampling increased to 4 dates
	Muskoka Bay	MBA-0				Secchi sampling increased to 4 dates
	Muskoka Bay	MBA-4				Phosphorus sampling increased to 1 date, bacteria stopped
	Muskoka Bay	MBA-16			✓	
	Muskoka Sands	MSN-0				Secchi sampling increased to 4 dates
	Muskoka Sands	MSN-1			✓	
	Muskoka Sands	MSN-2		✓		
	Muskoka Sands	MSN-3		✓		
	Muskoka Sands	MSN-8				Secchi sampling added on 1 date
	North Bay	NRT-0				Secchi sampling increased to 4 dates
	Sandy Point	SDP-0	✓			
	Sandy Point	SDP-1	✓			
	Stephen's Bay	STE-0				Secchi sampling added on 1 date
	Stephen's Bay	STE-3				Secchi sampling added on 3 dates
	Taylor Island	TAY-0				Secchi sampling increased to 4 dates
	Taylor Island	TAY-5				Phosphorus sampling suspended
	Walkers Point	WAK-0				Secchi sampling increased to 4 dates, phosphorus sampling increased to 4 dates
	Walkers Point	WAK-5				Phosphorus sampling increased to 4 dates
	Walkers Point	WAK-6				Phosphorus sampling increased to 4 dates
	Whiteside bay	WTS-0				Secchi sampling increased to 4 dates
	Willow Beach	WLB-0				Secchi sampling increased to 4 dates
	Willow Beach	WLB-1				Bacteria sampling decreased to 2 dates

Waterbody Name	Sampling Area	Sampling Location	Site Added	Site Restarted	Site Removed	Site Modified
	Willow Beach	WLB-3				No DOC sample was taken, bacteria sampling decreased to 2 dates
Lake Rosseau Lake Rosseau	Arthurlie Bay	ART-0				Secchi sampling increased to 3 dates
	Brackenrig Bay	BRA-1		✓		
	Brackenrig Bay	BRA-3				No DOC sample was taken
	East Portage Bay	POR-0				Secchi sampling increased to 4 dates
	East Portage Bay	POR-1				Phosphorus sampling added on 1 date
	Rosseau Main	ROS-1				Secchi sampling increased to 2 dates
	Minett	MIN-6				No DOC sample was taken
	Morgan Bay	MGN-0				Secchi sampling increased to 3 dates
	Muskoka Lakes G&CC	MLG-0				Secchi sampling increased to 3 dates
	Muskoka Lakes G&CC	MLG-1			✓	
	Muskoka Lakes G&CC	MLG-2			✓	
	Rosseau Falls	RFL-0	✓			
	Rosseau North	RSH-0				Secchi sampling increased to 3 dates, phosphorus sampling increased to 2 dates
	Rosseau North	RSH-2				Secchi sampling added on 1 date
	Rosseau North	RSH-4				Secchi sampling added on 1 date
	Rosseau North	RSH-5				Secchi sampling added on 1 date, bacteria sampling reduced to 2 dates
	Royal Muskoka	RMI-0				Secchi sampling increased to 3 dates
	Skeleton Bay	SKB-0				Secchi sampling increased to 3 dates
	Tobin Island	TOB-0				Secchi sampling increased to 4 dates
	Windermere	WIN-1				No DOC sample was taken
	Windermere	WIN-7				No DOC sample was taken
Indian River	Indian River	IND-0				Secchi sampling increased to 4 dates
	Indian River	IND-4				Bacteria sampling reduced to 2 dates
	Indian River	IND-7				No DOC sample was taken

Waterbody Name	Sampling Area	Sampling Location	Site Added	Site Restarted	Site Removed	Site Modified
Joseph River	JOR-0					Secchi sampling increased to 4 dates
Muskoka River	Muskoka River	MRV-7				Secchi sampling added on 4 dates, bacteria sampling increased to 5 dates
Affiliates	Brandy Lake	BDY-1				Secchi sampling added on 2 dates, bacteria sampling increased to 4 dates
	Brandy Lake	BDY-2				Secchi sampling added on 2 dates, bacteria sampling increased to 4 dates
	Brandy Lake	BDY-3				Secchi sampling added on 3 dates, bacteria sampling increased to 4 dates
	Brandy Lake	BDY-5				Secchi sampling added on 3 dates, bacteria sampling increased to 4 dates
	Brandy Lake	BDY-6				Secchi sampling added on 3 dates, bacteria sampling increased to 4 dates
	Brandy Lake	BDY-7				Secchi sampling added on 3 dates, bacteria sampling increased to 4 dates
	Brandy Lake	BDY-8				Secchi sampling added on 3 dates, bacteria sampling increased to 4 dates
	Brandy Lake	BDY-9				Secchi sampling added on 3 dates, bacteria sampling increased to 4 dates
	Brandy Lake	BDY-10				Secchi sampling added on 3 dates, bacteria sampling increased to 4 dates
	Brandy Lake	BDY-11				Secchi sampling added on 3 dates, bacteria sampling increased to 4 dates
	Gull Lake	GUL-0				Secchi sampling reduced to 3 dates
	Gull Lake	GUL-1				Bacteria sampling reduced to 2 dates
	Gull Lake	GUL-2				Bacteria sampling reduced to 2 dates
	Gull Lake	GUL-3				Bacteria sampling reduced to 2 dates
	Gull Lake	GUL-4				Bacteria sampling reduced to 2 dates
	Gullwing Lake	GLW-0				Secchi sampling added on 4 dates
	Leonard Lake	LEO-1				Phosphorus sampling decreased to 3 dates
	Leonard Lake	LEO-6			✓	
	Leonard Lake	LEO-7				Phosphorus sampling decreased to 1 date

Waterbody Name	Sampling Area	Sampling Location	Site Added	Site Restarted	Site Removed	Site Modified
	Leonard Lake	LEO-8	✓			
	Leonard Lake	LEO-9	✓			
	Leonard Lake	LEO-10	✓			
	Leonard Lake	LEO-11	✓			
	Moon River	MOO-11				Secchi sampling reduced to 3 dates
	Silver Lake (GH)	SVR-0				Secchi sampling increased to 3 dates, phosphorus sampling increased to 3 dates
	Silver Lake (GH)	SVR-2				Bacteria sampling reduced to 2 dates
	Three Mile Lake	TML-5			✓	
TOTALS			**8**	**6**	**11**	**84**

3. 2018 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 2018 data, as well as graphical results of phosphorus and *E. coli* results, if sampled for. Each new area description in 2018 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. In 2013, Beacon introduced a visual indication of the overall water quality at each Area by means of a traffic light symbol. This method was well received within the MLA membership and continues to be used in this report with updated thresholds. 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 2016, thresholds were redeveloped for each of the traffic light symbols to better quantify the data trends for *E. coli*. In 2018, following consultation with the MLA Water Quality & Environment Committee, new *E. coli* and phosphorus thresholds were established. Health Canada and the Ministry of Health and Long-Term Care recently updated their measurement standard for *E. coli* at public beaches from 100 cfu/100ml to 200 cfu/100ml. As a result of this update, the Simcoe Muskoka District Health Unit has adopted this limit as well.

In addition, the District Municipality of Muskoka (DMM) has recently adopted an amendment to their Official Plan (OPA 47) redefining phosphorus acceptance limits. The DMM will be using the following triggers for phosphorus that will lead to a causation study being undertaken:

- If there is a statistically increasing trend in phosphorus from 2001 to current date;
- If the average phosphorus concentration of most recent 10 years is >20 µg/L; and
- If there is a documented algae bloom.

For phosphorus analysis this year, the MLA has assigned a yellow light threshold for phosphorus concentrations that are either >20 µg /L or show an increasing trend over the previous three years.

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 11**) describes the thresholds for the 2018 analysis of *E. coli* and phosphorus concentrations.

Table 11. 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
	0 - 30	Flat or decreasing visual trend
	31 - 199	>20 µg/L (3 year average) OR increasing trend over 3 years
	>200 geometric mean for a series of 5 samples per site per month	>20 µg/L (5 year average) OR statistically increasing trend over 5 years (or longer)

The traffic light symbols in each Area Summary are based on the category of symbol indicating the level of water quality related to *E. coli* and phosphorus levels as defined in **Table 11**.

As noted above, traffic light thresholds for phosphorus are reviewed annually with the MLA Water Quality & 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 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 2018. 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 2018 continue to remain consistent with the depths reported historically with expected minor variation (up and down) through the years. Overall, in 2018 deeper Secchi depths were observed compared to previous years. Stations ART-0 (4.75 m), BAL-0 (4.21 m), MOO-11 (3.55 m), RMI-0 (4.20 m) and SVR-0 (3.83 m) recorded the deepest Secchi readings to date in 2018. It should also be noted that at 3 of the deep-water sites, the Secchi depth was the lowest recorded to date. Stations GLW-0 (2.13 m), MIN-0 (3.91 m), and STR-0 (1.99 m) all experienced the lowest Secchi reading to date in 2018. Each of these three stations was sampled during all four sampling events.

3.2 Phosphorus

Several years of spring-turnover phosphorus data can be analysed 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 2018 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 >5mg/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 2018 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 the 2018 phosphorus sampling dataset, 19 of 437 samples (4%) were deemed to be bad splits. In the 2017, 8% were deemed to be bad splits, 18% in 2016, and 19% in 2015. Modifying the phosphorus sampling protocol in 2017 has led to a decrease in the number of bad splits.

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 2018 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 2018 resulted in no significant outliers at the FTB-0 site. The phosphorus exceeded the previous DMM threshold of 7.9 and in 2018 FTB-0 classified with a yellow stoplight due to the increasing phosphorus trend in the past 3 years.

Following the analysis of spring phosphorus from 2002-2018, a total of 11 spring phosphorus data points were removed in the 2018 analysis of the data sets, compared to 18 in 2017. The 2018 data points removed from database were from Gordon Bay (GNB-0) and East Portage Bay (POR-0).

The spring phosphorus data that passed the statistical analysis are plotted and presented in the Area Summary Sheets. 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 2018. 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 threshold concentration previously set by the DMM or Seguin Township.

On the graphs illustrating long-term phosphorus levels, historic threshold concentrations have been represented by a single black dashed line. **Figure 2** shows the 2018 graph for ELG-0 for illustration purposes. For sampling areas in the DMM, the threshold values are those in previous year's reports, provided by the DMM. Sampling areas without graphed threshold lines have not been modelled and are not comparable to other areas as previously confirmed through consultation with the DMM.

Figure 2 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 2**), 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 single red circle, if consecutive years of data were not available.

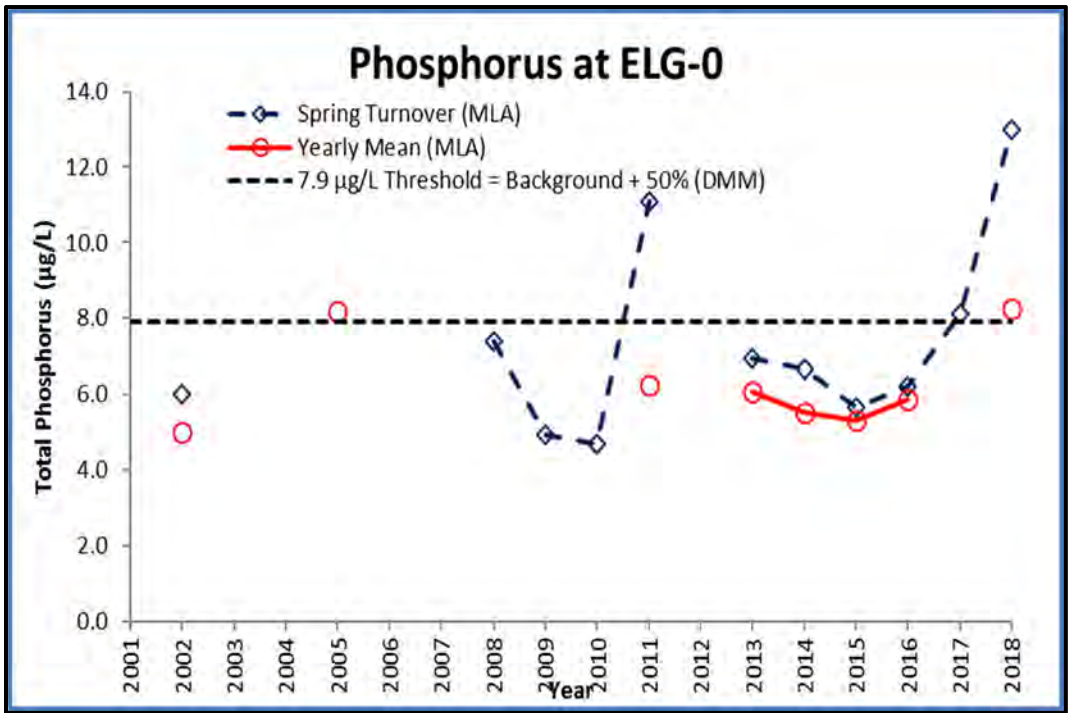


Figure 2. Illustration of ELG-0 showing long-term phosphorus levels

Deep-water, nearshore and watercourse yearly mean total phosphorus concentrations in 2018 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. At the deep-water station sites (not including the watercourse sites listed in **Table 8**) that were sampled for spring phosphorus, 20 (42 %) of the 48 sites showed the lowest spring phosphorus concentration recorded to date. In 2018, four of the deep-water sites recorded the highest spring phosphorus concentrations to date. Those 4 sites were FTB-0 (15.0 µg/L in 2018, 5.5 µg/L in 2017), ELG-0 (13.0 µg/L, in 2018, 8.1 µg/L in 2017), POR-0 (13.0 µg/L, in 2018, 6.4 µg/L in 2017), and GUL-0 (15.0 µg/L, in 2018, 5.9 µg/L in 2017). It is noted that the data for POR-0 was an outlier in 2018.

Table 12 summarizes the 2018 stations with the lowest recorded deep-water spring phosphorus concentrations to date.

Table 12. Lowest Recorded Spring Phosphorus to Date at Deep-water Sites

Lake Joseph	Lake Muskoka	Lake Rosseau	Affiliate Sites
Cox Bay (COX-0)	Boyd Bay (BOY-0)	Brackenrig Bay (BRA-0)	Bass Lake (BAS-5)
Hamer Bay (HMB-0)	Lake Muskoka Main Basin (MUS-3)	Minett (MIN-0)	Brandy Lake (BDY-0)
	Muskoka Sands (MSN-0)	Muskoka Lakes Golf &CC (MLG-0)	Bruce Lake (BRU-0)
	North Bay (NRT-0)	Rosseau North (RSH-0)	Clear Lake (CLR-0)
	Stephen's Bay (STE-0)	Windermere (WIN-0)	Moon River (MOO-11)
	Taylor Island (TAY-0)		Silver Lake (SPC-0)
			Star Lake (STR-0)

Of the 13 watercourse sites sampled for spring phosphorus in 2018, 100% showed a lower phosphorus concentration than in 2017 and 100% of those sites with a measured yearly phosphorus mean also showed lower yearly mean concentrations compared with results from 2017.

New nearshore stations were established at Rosseau Falls (RFL-0), Sandy Point (SDP-0) and Leonard Lake (LEO-8 and LEO-11) in 2018 to investigate phosphorus concentrations. Additionally, new nearshore stations were established at Eilean Gowan (ELG-5), Sandy Point (SDP-1) and Leonard Lake (LEO-9 and LEO-10) to monitor phosphorus and bacteria levels in 2018. Beacon recommends that the new stations continue to be sampled through 2019 to analyse for trends.

There is also an overall generally static (neither increasing or decreasing) trend in most of the nearshore phosphorus concentrations in 2018 compared with values in 2016 and 2017. At the nearshore station sites, including the watercourse sites listed in **Table 8**, 52% of the sites, although having an increasing trend in 2017 compared to 2016, generally showed a decrease from the 2017 results, more consistent with the 2016 concentrations, resulting in a static state. 9% of the nearshore stations in 2018 showed a trend of increasing phosphorus concentration compared to the values at those stations in 2016 and 2017. Finally, 39% of the nearshore phosphorus concentrations in 2018 showed a trend of decreasing phosphorus concentration compared to the values at those stations in 2016 and 2017. This decreasing trend in 2018 may have been a direct result in the low rainfall observed in the spring, causing less input into the lakes.

Table 13 summarizes the 2018 stations with nearshore phosphorus concentrations that were generally elevated from the 2017 and 2016 concentrations.

Table 13. Elevated 2018 Phosphorus Nearshore Sites

Lake Joseph	Lake Muskoka	Lake Rosseau	Affiliate Sites
Foot's Bay (FTB-3)	Dudley Bay (DUD-1)	East Portage Bay (POR-1 and POR-3)	
Hamer Bay (HMB-2)	Willow Beach (WLB-3 and WLB-4)		

From those sites identified in **Table 13**, the two stations that saw the highest increase in spring and yearly means phosphorus concentrations were at the Hamer Bay site (HMB-2) and the Dudley Bay site (DUD-1).

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 2018. The spring phosphorus concentrations in 2018 at WIN-7 and WIN-8 were both the lowest ever recorded at each of the sites. The yearly mean phosphorus concentrations at both sites were the second lowest recorded in the 5 years of data gathered, which was a result of the low concentrations recorded in the first 2 of 4 sampling events in 2018. Continued sampling at all these Windermere stations in 2019 is recommended to assess the scale and trends of the nutrient input from the upstream sources.

Water level fluctuations can significantly affect lake water quality. High water levels such as those experienced in the three big lakes during the spring of 2013 and 2016 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 levels 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. 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. Additionally, the lack of spring freshet in 2018 decreased the amount of nutrients being flushed into the watershed, and the historically low phosphorus concentrations realized in the spring of 2018 is likely a direct result of the lack of flooding during freshet.

Beacon will continue to review spring and yearly mean phosphorus levels at all stations to look for continuing potential impacts and trends.

3.3 Dissolved Organic Carbon

The Lakeshore Capacity Model is a variant of the original MECP Lakeshore Capacity Study Trophic Status Model (Dillon *et al.* 1986), which has been substantially reworked and updated over the years to reflect improved scientific understanding of phosphorus loads to lakes and lake responses to those loads (Hutchinson 2002; Paterson *et al*. 2006). The model is a steady-state mass balance model that estimates hydrologic and phosphorus loading from natural (watershed runoff and atmospheric deposition) and human (septic systems and land disturbance) sources for all lakes within a watershed, and links them together considering lake dynamics to predict phosphorus concentrations in lakes.

Most recently, Hutchinson Environmental Sciences Ltd. (HESL) produced a Revised Water Quality Model and Lake System Health Program Report (HESL 2016) in which they developed recommendations to revise the original program based on an initial review in 2013, followed by another review in 2015. Changes to the Lake System Health Program (LSHP) were provided by HESL, and these changes are detailed in the proposed Official Plan Amendment 47 (OPA 47) currently accepted by the District Municipality of Muskoka (DMM), and under review by the Province.

The levels of Dissolved Organic Carbon (DOC) in lakes are becoming recognized as a useful measure of lake health, complementing data on phosphorus levels. This is because DOC levels give insight to help distinguish the origin of the phosphorus, as described above. For that reason, MLA testing now includes sampling for DOC. Dillon and Molot (1997) stated that wetlands are a rich source of DOC and TP and that annual TP export is probably a function of DOC and iron export. Work undertaken by Hutchinson (2002) noted that research on total phosphorus concentrations in Precambrian Shield lakes was significantly related to the amount of wetland in the lake's catchment. Research by Gartner Lee Ltd. (2005) showed evidence of a statistically significant relationship between DOC and TP in the lakes in the DMM. HESL's most recent report (HESL 2016) concluded that DOC is closely related to TP concentrations, and work undertaken by Palmer et al. (2011) concluded that DOC has been increasing in the Muskoka Lakes over the last 25 years. **Figure 3** illustrates the HESL (2016) work showing increasing total phosphorus is correlated with increasing concentrations of DOC.

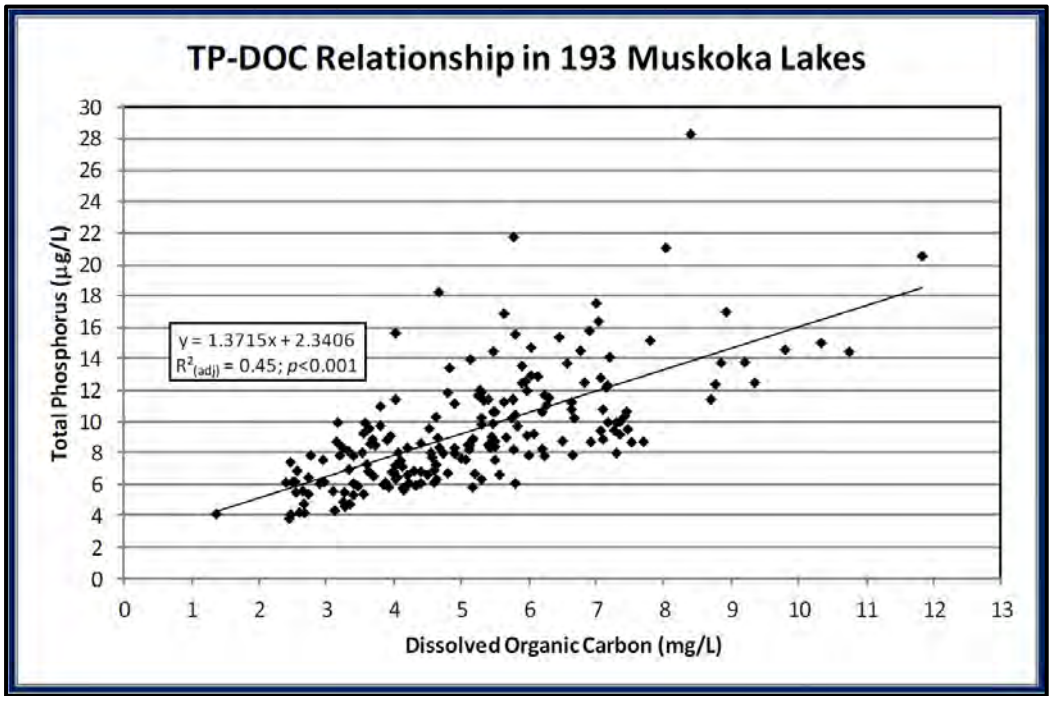


Figure 3. Reproduced from HESL (2016) showing the influence of Dissolved Organic Carbon on average long-term phosphorus concentrations in Muskoka lakes.

The DOC and total phosphorus (TP) points displayed in **Figure 3** represent concentrations in individual lakes, and generally, the points are spread around the trend line with approximately half of the points above the line and half below. The linear trend line indicates a predicted concentration in TP dependant on the concentration of DOC.

DOC was sampled at 4 of the MLA sites in Three Mile Lake in 2018. An analysis of the total phosphorus concentration versus DOC concentration was undertaken this year, based on 3 full years of data collection in 2016 through 2018.

The data was reviewed on an individual site basis, and on a whole lake basis. When TP was plotted against DOC for individual sites (**Figure 4**), results varied and none of the four trends were like that obtained by HESL (2016). When TP was plotted against DOC for the lake as a whole using all the data (**Figure 5**), results varied although the trendline was more similar to that obtained by HESL (2016).

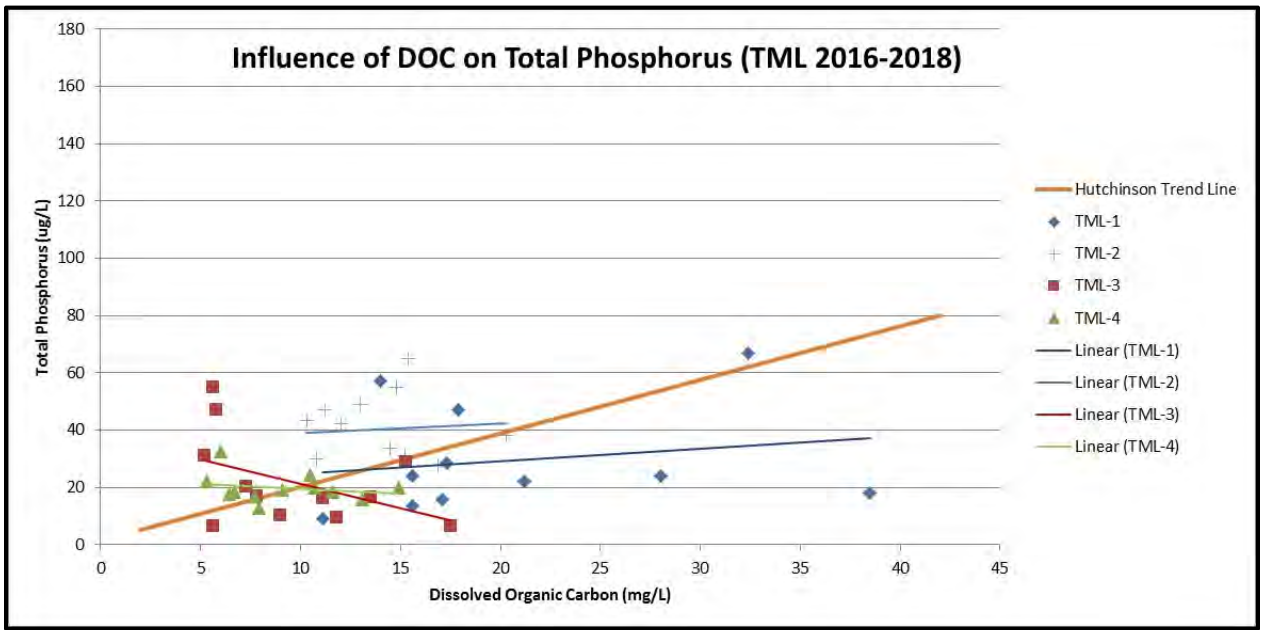


Figure 4. Linear Regression analysis of TP vs DOC in four TML sites, compared to the Hutchinson Trend Line (HESL 2016).

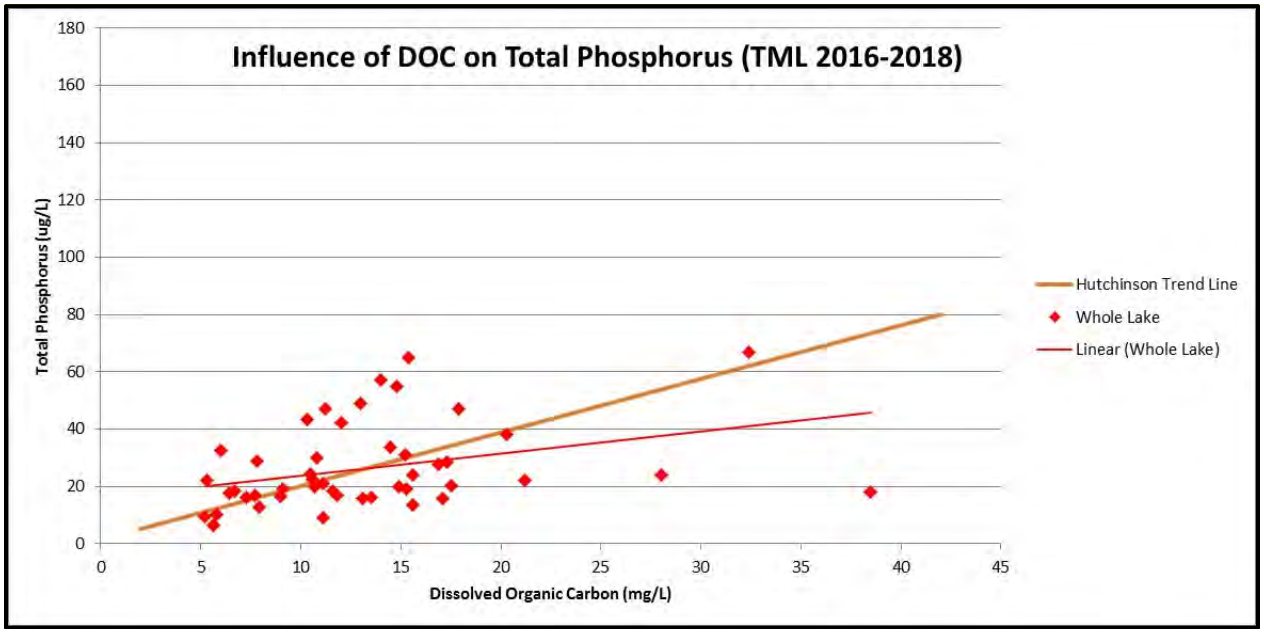


Figure 5. Linear Regression analysis of TP vs DOC in all Three Mile Lake sites, compared to the Hutchinson Trend Line (HESL 2016).

Theoretically, if the DOC input to a site remains consistent, and phosphorus inputs are added from other sources (man-made), it would be expected that the linear trend line would be raised with a similar slope to that of the HESL (2016) trend line. This pattern was not seen following analysis at any of the four individual TML sites shown in **Figure 4**.

As noted previously, the HESL (2016) work looked at comparisons at a lake level. Even when the individual sites were grouped together as a whole lake sample, the sites did not visually show a similar pattern to that obtained in the HESL (2016) results (**Figure 5**). The lines for the individual sites are not indicative of a correlation of a natural source of DOC and phosphorus from nearby wetlands.

In other recent research into water quality changes in south-central Ontario lakes, Palmer et al (2011) noted changes in the lakes, including the lakes in Muskoka, which showed decreasing phosphorus levels and increasing DOC. The Palmer et. al. (2011) work has provided evidence that climate change has impacted water quality parameters including additional DOC which is being transported to adjacent lakes during rainfall events since the increased air temperatures are providing for conditions which enhance the decomposition and release of DOC from soils.

Additionally, the Palmer et al (2011) research indicated that phosphorus levels were decreasing in the lakes and they pointed out that Eimers et al (2009) had found that TP had decreased despite increased development.

The results of the DOC sampling in Three Mile Lake show indications of higher concentrations of DOC associated with lower levels of phosphorus, similar to the results found by Palmer et al (2011).

Although the correlation of DOC vs TP is difficult to assess on an individual site basis, it would be prudent for the MLA to continue to assess the long-term levels of DOC in Three Mile Lake. Beacon recommends that future DOC sampling should be undertaken once every 3 years at each of the four TML sites to monitor trends on a long-term basis.

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 2018. 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 considered to be 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. In 2018, the MLA collected 5 samples in a one-month period at STR-3. 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 2018. 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 2018. *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 29 (9.2%) of 316 sampling events for *E. coli* in 2018. These results are similar to the 8% reported in 2017, and 8.7 % in 2016. Of the 29 samples, re-tests were not completed at three sites (BAL-2, GUL-1 and WIN-5).

Sixteen (16) sites reported elevated *E. coli* levels (>50 cfu/100mL) in 2018 compared with 12 sites in 2017. It should be noted that there were 316 samples in 2018, while there were only 282 samples in 2017, potentially contributing to the increased number of sites reporting elevated levels. The sites that reported elevated *E. coli* levels in 2018 include Bala Bay (BAL-2), Gull Lake (GUL-1), Moon River (MOO-14), Muskoka River (MRV-2 and MRV-7), Muskoka Sands (MSN-3), Star Lake (STR-1, STR-2, STR-3, STR-4, and STR-5), and Windermere (WIN-5). 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.

It was noted in the sampling field sheets for Star Lake that during the final sampling date at STR-3, following a large rainfall event a few days before, the sampler noted very high water levels and that an old beaver dam was submerged, allowing water to overflow toward STR-3. Beaver impounds are a known source of *E. coli* and the water flowing over the submerged dam may have allowed bacteria to flow into the lake, increasing the *E. coli* levels.

From those sites identified in 2016 and 2017 for further analysis and sampled for in 2018, the Minett station (MIN-6) continued 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 (30 cfu/100ml) for *E. coli* within the past three years: , Beaumaris (BMR-4 and BMR-9), Gullwing Lake (GLW-1), Moon River (MOO-14), Muskoka Bay (MBA-13), Windermere (WIN-4 and WIN-5), Indian River (IND-2, and IND-3), and Muskoka River (MRV-2 and MRV-7).

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 2018, which is consistent with previous years. In 2018 a total of 9 Areas were assigned a yellow stoplight (**Table 14**). Of these, two (ELG and FTB) had previously been green since 2015. Further discussion of the stoplight colour for each Area is provided below.

Table 14. Summary of Sites with Yellow Stoplights

Area	Site	*E. coli*	Phosphorus
DUD	DUD-1		Phosphorus above 20 µg/L threshold
ELG	ELG-0 (DW)		Increasing trend over 3 years
FTB	FTB-0 (DW)		Increasing trend over 3 years
GNB	LPP		Increasing trend over 3 years
GLW	GLW-0 (NS)		Phosphorus above 20 µg/L threshold
MIN	MIN-1 (NS) MIN-6 (NS)	*E. coli* above the 30 cfu/100 ml threshold.	
MRV	MRV-2 (DW) MRV-7 (WC)	*E. coli* above the 30 cfu/100 ml threshold.	
TML	TML-1 (WC) TML-2 (WC) TML-3 (WC) TML-4 (WC)		Phosphorus above 20 µg/L threshold
WIN	WIN-1 (NS) WIN-3 (NS) WIN-7 (NS) WIN-8 (NS)		Phosphorus above 20 µg/L threshold

There was a total of 45 sites assigned a green light in 2018, of these, 8 had previously been yellow. Nine Areas were assigned a yellow light, including 4 Areas that changed from a green light to a yellow light, and there were no Areas with a red light in 2018. Four locations (BRA, IND, MIR, and STR) which have been assigned a yellow stoplight since 2015, were given a green stoplight in 2018. This change from yellow to green is due in part to the new thresholds and a decreasing trend in phosphorus concentrations.

4. Conclusions

This Water Quality Report presents the most recent data collected in 2018 and compares it to data collected from 2002 to 2017. The 2018 water quality program follows the well-established MLA methodology most recently fine-tuned in the spring of 2017. The main change in the 2017 methodology was to obtain one single grab sample to provide a deep-water duplicate for analysis. Compared with 2016 data, this methodology change decreased the number of “bad-splits” to less than a half in 2017, and less than one quarter in 2018.

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 2018 are detailed in **Table 10** and include 11 sites being suspended for 2018, 8 sites being added, 6 sites being restarted, and 84 being modified. Most of the modifications included increasing the number of Secchi measurements through the summer. Additionally, dissolved organic carbon sampling was suspended at all stations, except for stations in Three Mile Lake.

Secchi depths recorded in 2018 continue to remain consistent with the depths reported historically and continue to generally support the classification of oligotrophic. Overall, deeper Secchi depths were observed compared to previous years. Stations ART-0, BAL-0, MOO-11, RMI-0 and SVR-0 recorded the deepest Secchi readings to date in 2018. On the opposite end, stations GLW-0, MIN-0 and STR-0 all experienced the lowest Secchi reading to date in 2018. The deeper Secchi readings coupled with historically low phosphorus readings may be correlated with the lack of spring freshet and lack of flooding conditions. Of the 57 Areas sampled in the monitoring program, 32 Areas had sampling sites with the lowest spring phosphorus recorded to date.

Duplicate phosphorus samples collected in 2018 were analyzed for bad splits according to the DMM phosphorus data management protocol. In the 2018 phosphorus sampling dataset, 19 of 437 samples (4%) were deemed to be bad splits. In the 2017, 8% were deemed to be bad splits, 18% in 2016, and 19% in 2015. Modifying the phosphorus sampling protocol in 2017 has led to a decrease in the number of bad splits.

Following the analysis of spring phosphorus from 2002-2018, a total of 11 spring phosphorus data points were removed in the 2018 analysis of the data sets, compared to 18 in 2017. The data points removed from 2018 data set were those from Gordon Bay (GNB-0) and East Portage Bay (POR-0).

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. At the deep-water station sites (not including the watercourse sites) that were sampled for spring phosphorus, 20 (42%) of the 48 sites showed the lowest spring phosphorus concentration recorded to date. Conversely, in 2018, four of the deep-water sites recorded the highest spring phosphorus concentrations to date at those sites.

There is an overall generally static (neither increasing or decreasing) trend in most of the nearshore phosphorus concentrations in 2018 compared with values in 2016 and 2017. At the nearshore station sites, including the watercourse sites, 52% of the sites, although having an increasing trend in 2017 compared to 2016, generally showed a decrease from the 2017 results, more consistent with the 2016 concentrations, resulting in a static state. Nine (9)% of the nearshore phosphorus concentrations in 2018 showed a trend of increasing phosphorus concentration compared to the values at those stations in 2016 and 2017. Finally, 39% of the nearshore phosphorus concentrations in 2018 showed a trend of decreasing phosphorus concentration compared to the values at those stations in 2016 and 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 2018. The spring phosphorus concentrations in 2018 at WIN-7 and WIN-8 were both the lowest ever recorded at each of the sites. The yearly mean phosphorus concentrations at both sites were the second lowest recorded in the 5 years of data gathered, which was a result of the low concentrations recorded in the first 2 of 4 sampling events in 2018.

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. Additionally, the lack of flooding during spring freshet in 2018 decreased the amount of nutrients being flushed into the watershed, and the historically low phosphorus concentrations realized in the spring of 2018 is likely a direct result of the lack of flooding during freshet.

DOC was sampled at 4 of the MLA sites in Three Mile Lake in 2018. The results of the analysis were not indicative of a correlation of a natural source of DOC and phosphorus from nearby wetlands and results of the DOC sampling in Three Mile Lake showed indications of higher concentrations of DOC associated with lower levels of phosphorus, similar to the results found by Palmer et al (2011).

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 29 (9.2%) of 316 sampling events for *E. coli* in 2018. These results are similar to the 8% reported in 2017, and 8.7 % in 2016.

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

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 2019 sampling. Changes to the protocol may be made for 2019 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 2019 training sessions.

5.2 Methods

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

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 15**.

Table 15. 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 (ex. 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.

Additionally, the District Municipality of Muskoka has reviewed their Lake System Health program and approved Official Plan Amendment 47 (OPA 47), although it has not yet received endorsement from the Province. It is anticipated that the DMM will be using the following triggers for phosphorus that will lead to a causation study being undertaken:

- If there is a statistically increasing trend in phosphorus from 2001 to current date;
- If the average phosphorus concentration of most recent 10 years is >20 µg/L; and
- If there is a documented algae bloom.

It is recommended that changes to the MLA thresholds in 2019 should consider the DMM final phosphorus triggers approved by the Province regarding their traffic light limits for the deep-water stations. Consideration for changes to the traffic light system for phosphorus triggers for 2019 should incorporate:

- The Districts triggers for deep-water stations;
- Consideration for distance to nearby wetlands, streams and documented wildlife; and
- Rate of increasing phosphorus levels.

The Field Coordinator is a great asset to maintain continuity between the Water Quality Initiative 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 to work with the District in coordinating the location of the sampling sites. It is anticipated that the MLA will work continue to work towards creating a geodatabase of sampling locations using the District GPS coordinates.

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 waterfowl. 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 provides steps landowners can take to reduce their impact.

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 2018 water quality data. These recommendations are provided in the Area Summary sheets and summarized below.

1. Following analysis of the 2018 results, Beacon recommends that the primary Focus Areas for the 2019 sampling season should continue to be Minett (MIN) as well as East Portage Bay (POR).
2. Three Mile Lake was added to the 2016 program and sampling should continue in 2019.
3. Elevated 2018 deep-water spring phosphorus concentrations in comparison to 2017 were recorded at Gordon Bay (GNB-0), East Bay (EAS-0), Eilean Gowan (ELG-0), Foot's Bay (FTB-0), Gull Lake (GUL-0), Gullwing Lake (GLW-0), Skeleton Bay (SKB-0), and Tobin's Island (TOB-0). The 2018 spring phosphorus value for East Portage Bay (POR-0) was an outlier according to the Grubb's Test. Of these sampling locations, elevated levels of mean yearly phosphorus in 2018 compared with 2017 were also recorded at East Bay (EAS-0), Eilean Gowan (ELG-0), Foot's Bay (FTB-0), and Gull Lake (GUL-0). Sampling should concentrate on these sites to more closely monitor long-term trends.
4. The sites that reported elevated *E. coli* levels in 2018 include Bala Bay (BAL-2), Gull Lake (GUL-1), Moon River (MOO-14), Muskoka River (MRV-2 and MRV-7), Muskoka Sands (MSN-3), Star Lake (STR-1, STR-2, STR-3, STR-4, and STR5), and Windermere (WIN-5).

The focus stations at Minett (MIN-1, MIN-6, MIN-7 and MIN-9), observed elevated *E. coli* levels (>50 cfu/100mL) and required re-testing. *E. coli* levels at the Minett focus area (MIN-1 and MIN-6) in 2018 were above the MLA yellow traffic light similar to previous years (with the exception of station MIN-9). Sampling should continue in 2019 to monitor long-term trends and additional emphasis could be placed on providing additional educational resources.

5. 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 2017 analysis and thanks goes to those providing the information.
3. The MLA can rely on the Lake Partner Program data when it is available. Presently Lake Partner Program data from Gordon Bay, Lake Joseph Main, Dudley Bay, Muskoka Lakes Golf and Country Club, Morgan Bay and Royal Muskoka Island and are included in this 2018 report.
4. Continued discussions with the MLA are recommended to refocus the sampling program regarding traffic light thresholds and areas to focus on for sampling in 2019.

5.6 Next Steps

Beacon believes that there are opportunities to take the WQI program further, and recommends that the Water Quality and 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 for Focus Areas (Minett, Windermere and Three Mile Lake);

6. Install monitoring locations where landuse change is being contemplated; and
7. Undertake additional analysis in 2019 to statistically look at long term phosphorus trends at nearshore sites.

6. Definitions

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

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.

7. References

Acres International Limited. 2006.
Muskoka River Water Management Plan. Available at: http://www.muskokawaterweb.ca/water-101/water-quantity/mrwmp

Dillon, P.J., K.H. Nicholls, W.A. Scheider, N.D. Yan and D.S. Jefferies. 1986.
Lakeshore Capacity Study - Trophic Status. Ontario Ministry of Municipal Affairs, Res. and Spec. Proj. Branch. 89 p.

Dillon, P.J and L.A. Molot. 1997.
Effect of landscape form on export of dissolved organic carbon, iron and phosphorus from forested stream catchments. Water Resour. Res. 33:2591-2600.

Hutchinson, N.J., 2002.
Limnology, Plumbing and Planning: Evaluation of Nutrient-Based Limits to Shoreline Development in Precambrian Shield Watersheds. Ch. II.17 in: R. France, (ed). Handbook of Water Sensitive Ecological Planning and Design, CRC Press. Boca Raton Fla

Hutchinson Environmental Sciences Ltd. 2016
Revised Water Quality Model and Lake System Health Program. Prepared for the District Municipality of Muskoka

Ministry of Health and Long-Term Care. 2018.
Operational Approaches for Recreational Water Guideline, 2018.

Ontario Geological Survey. 2003.
Surficial geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128.

Ontario Ministry of the Environment. 1984.
Microorganisms in Recreational Waters. Scientific Criteria Document for Standard Development No. 1-84.

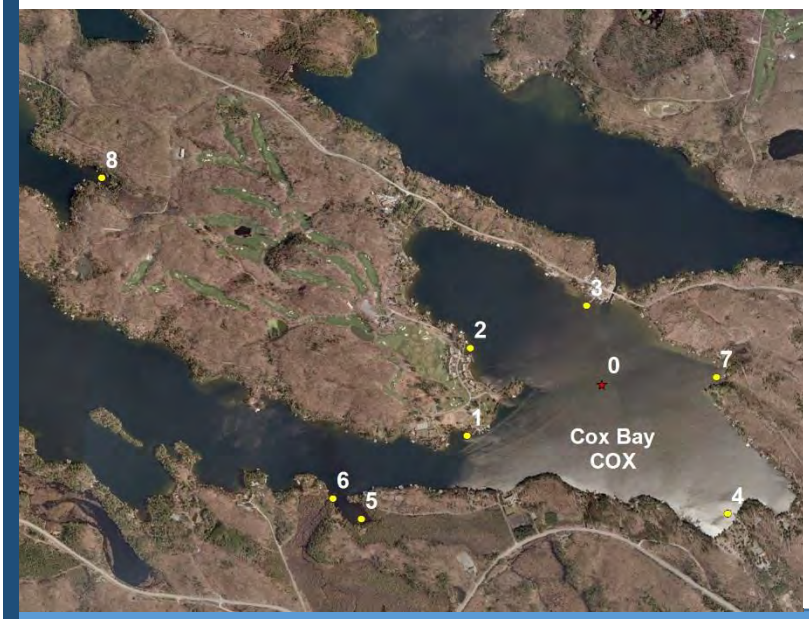
Palmer, M.E., N.D. Yan, A.M. Paterson and R.E. Girard. 2011.
Water quality changes in south-central Ontario lakes and the role of local factors in regulating lake response to regional stressors. Can. J. Fish. Aquat. Sci. 68: 1038-1049.

Paterson, A.M., P.J. Dillon, N.J. Hutchinson, M.N. Futter, B.J. Clark, R.B. Mills, R.A. Reid and W.A. Scheider. 2006.
A review of the components, coefficients, and technical assumptions Ontario's Lakeshore Capacity Model. Lake and Reserv. Manage. Vol. 22(1):7-18.

The Muskoka Heritage Foundation. 2007.
The Muskoka River Watershed Inventory Project – Final Report.

Appendix A

Area Summaries



Area Description:

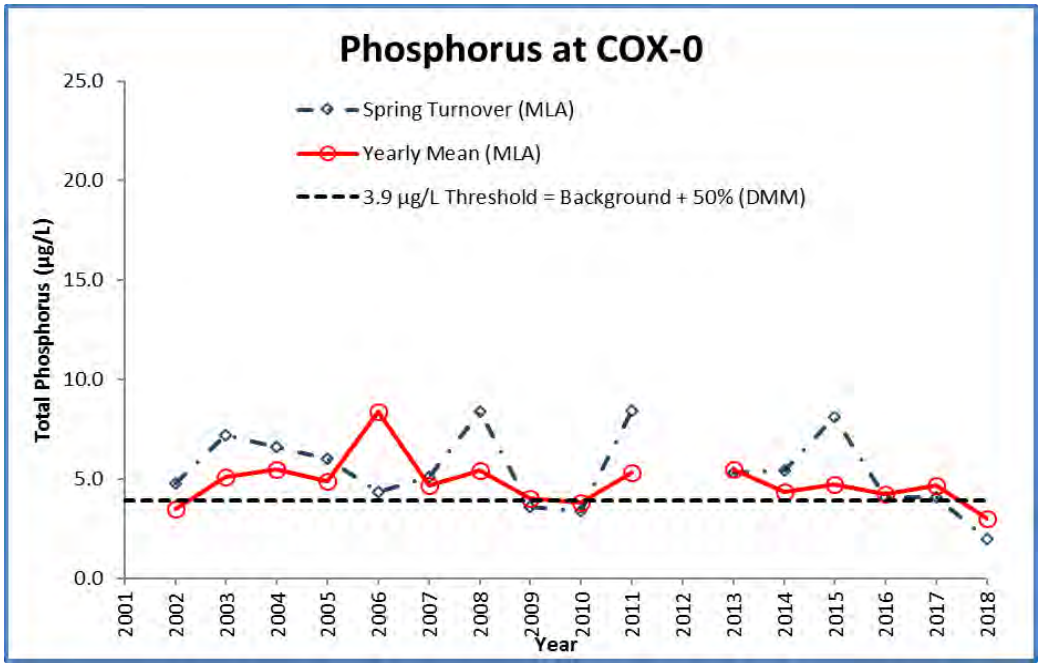
Cox Bay is the southernmost bay of Lake Joseph. The bay is 1.84 km² in area and is up to 12 m in depth. A large resort and golf course are located adjacent to the lake, along with a marina and a canal crossing into Lake Rosseau at Port Sandfield. Most of the shoreline area is developed, but many residences 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 is 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,** Judy Golvin, Guy Burry and Stuart Golvin.

Cox Bay (COX)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	5.2	2.0	3.0			
COX-2		5.0				
COX-3		2.0				
COX-6		2.0	2.0			
COX-7		2.0	2.5			
COX-8		2.0				



Summary and Recommendations:

Yearly mean and spring phosphorus concentrations at the deep station (COX-0) were below the historic DMM threshold of 3.9 µg/L in 2018, and the lowest recorded to date. The 2018 spring phosphorus concentrations at COX-3, COX-6, COX-7 and COX-8 (only 2 years of data) were the lowest recorded to date. As well, the yearly phosphorus means at COX-6 and COX-7 were the lowest recorded at those stations to date. Secchi measurements vary through sampling years, ranging between 3.35 and 8.25. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

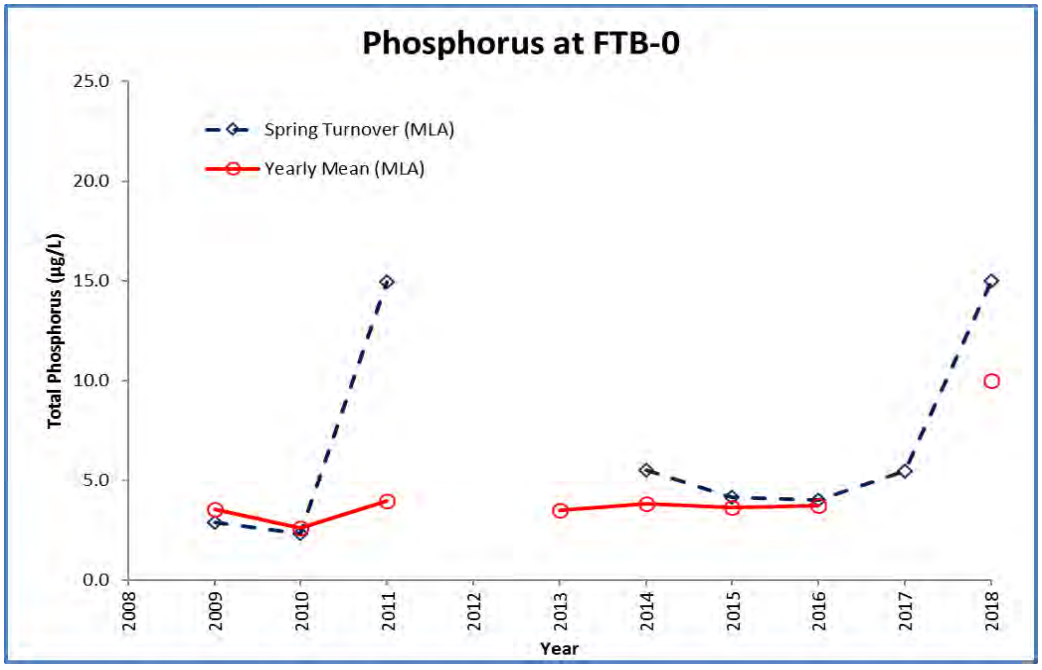
Foot's Bay is located in the south-eastern portion of Lake Joseph. Foot's Bay has a higher intensity of development in the southern section, with areas that are adjacent to the highway and a marina. There are still large areas of shoreline with mostly intact forests. The main basin of Lake Joseph is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

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

Foot's Bay (FTB)

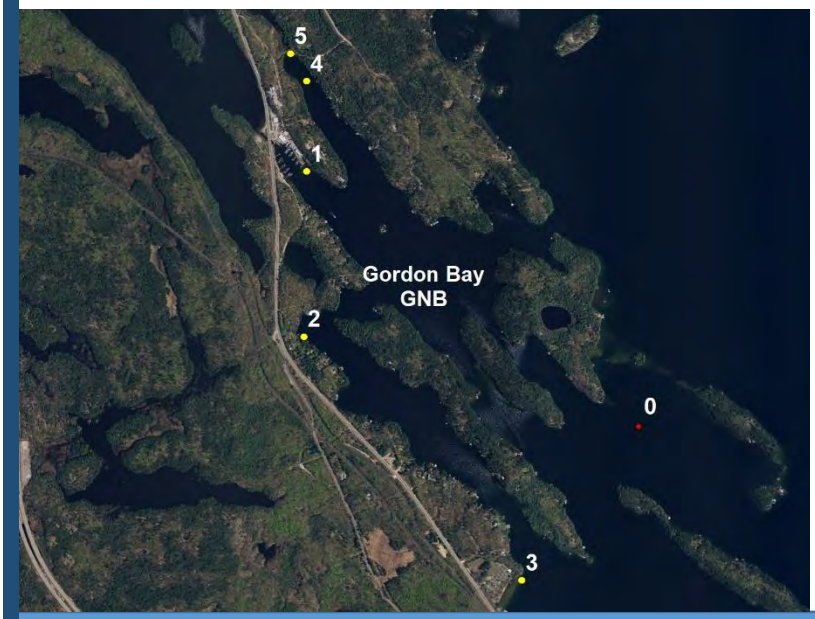
2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	6.4	15.0	10.0		
FTB-3		13.0	7.5		



Summary and Recommendations:

The 2018 spring phosphorus concentration at FTB-0 exceeded the historic DMM threshold of 7.9 µg/L and was tied with 2010 for highest recorded level to date. The Grubb's Test for outliers at FTB-0 did not identify the 2011 spring phosphorus level as an outlier in 2018 due to the high spring phosphorus level observed in 2018. The 2018 yearly phosphorus mean value at FTB -0 was also the highest recorded to date. Phosphorus levels show an increasing trend in the last 3 years, changing the stoplight from green to yellow. The spring phosphorus value at FTB-3 is the highest recorded of 7 sampling years dating back to 2009. Secchi measurements vary through sampling years, ranging between 2.5 and 7.2. **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 is classified as highly sensitive by the DMM. Monitoring started in 2004. All stations shown may not be sampled each year.

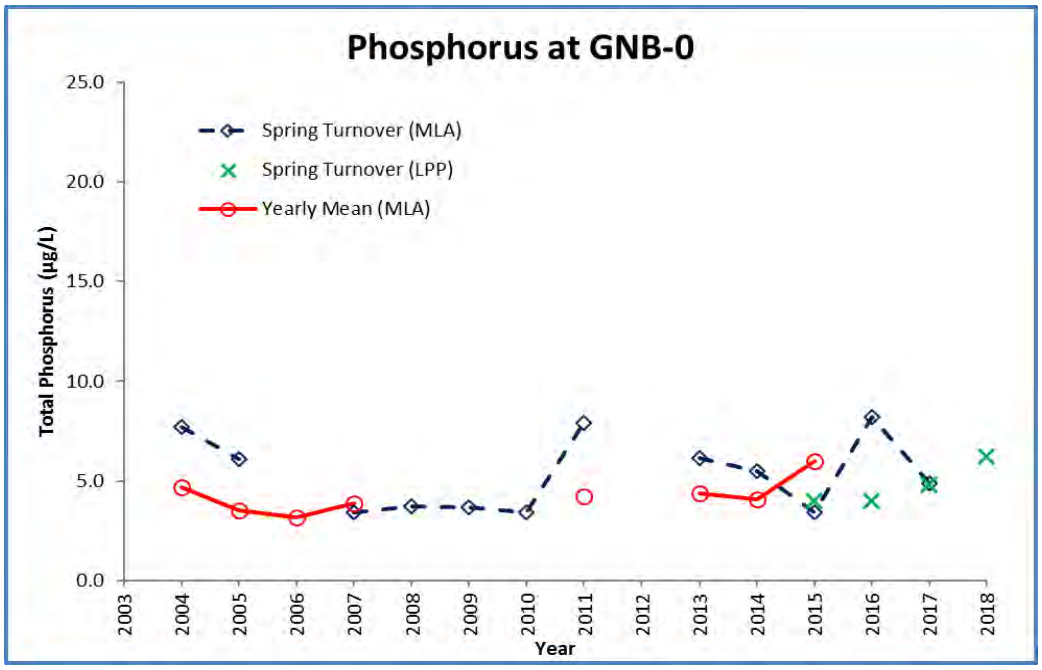
Volunteer Recognition: **Alex Magditsch, Cecil Hayhoe**, **John Offutt**, Juliana Magditsch, Lynda McCarthy and the Lake Partnership Program.

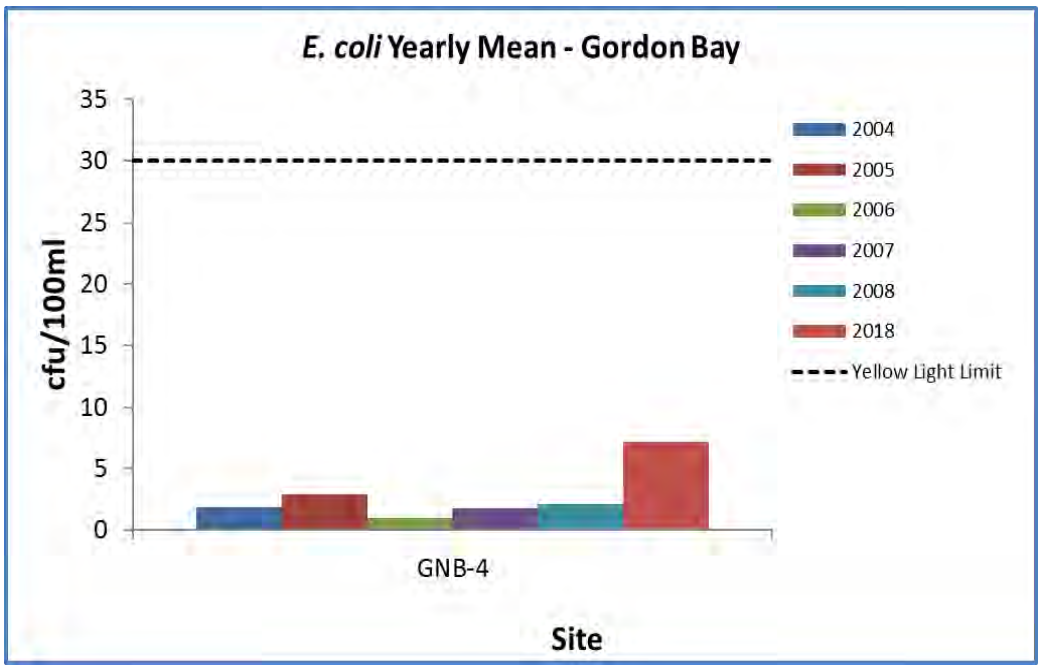
Gordon Bay (GNB)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	6.3	14.0*	6.0		
GNB-4		11.0		7.2	30.2

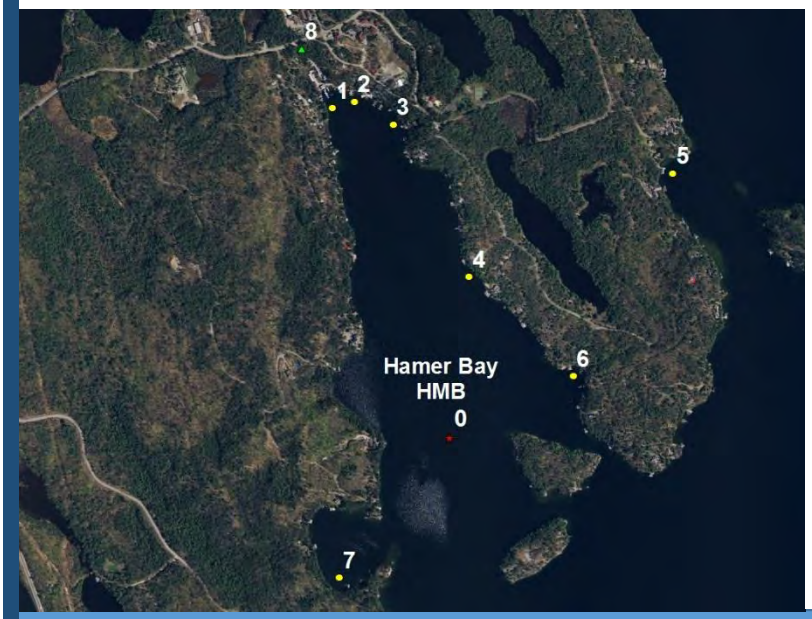
*outlier in 2018 data





Summary and Recommendations:

The Grubb's test identified the spring 2018 data for GNB-0 as an outlier and it has therefore been removed from the data set. Lake Partner Program spring phosphorus data for GNB-0 was available in 2018 and is included in the graph. Although spring phosphorus results remain variable over the sampling years at GNB-0, there is an increasing trend, changing the stoplight colour from green to yellow in 2018. Only one spring phosphorus sample was collected at GNB-4 in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. *E. coli* sampling was restarted at GNB-4 in 2018 and the concentrations in 2018 continued to be well below the MLA stoplight limits (details in report Section 3). Secchi measurements vary through sampling years, ranging between 3.0 and 7.5. **Beacon recommends sampling continue to monitor long-term trends.**



Area Description:

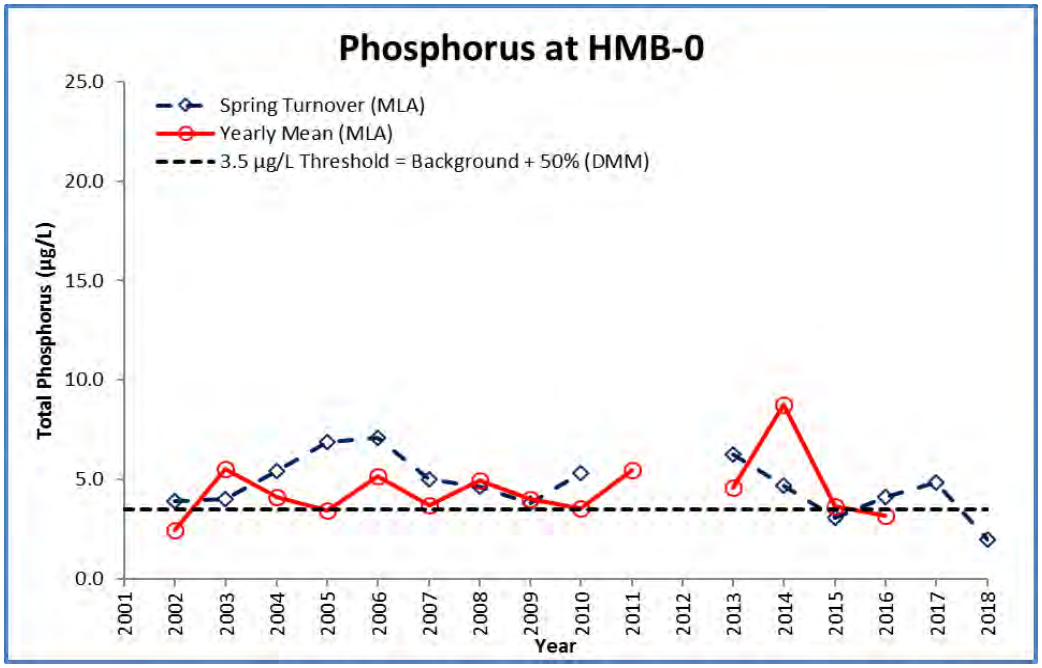
Hamer Bay is a large bay in the northern part of Lake Joseph. This bay receives drainage from a variety of natural and anthropogenic sources. There are three creeks that outlet into the bay, one flows through a large golf course and wetland in the north, and the others through smaller lakes and wetlands. 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 is classified as highly sensitive by the DMM. All stations shown may not be sampled each year.

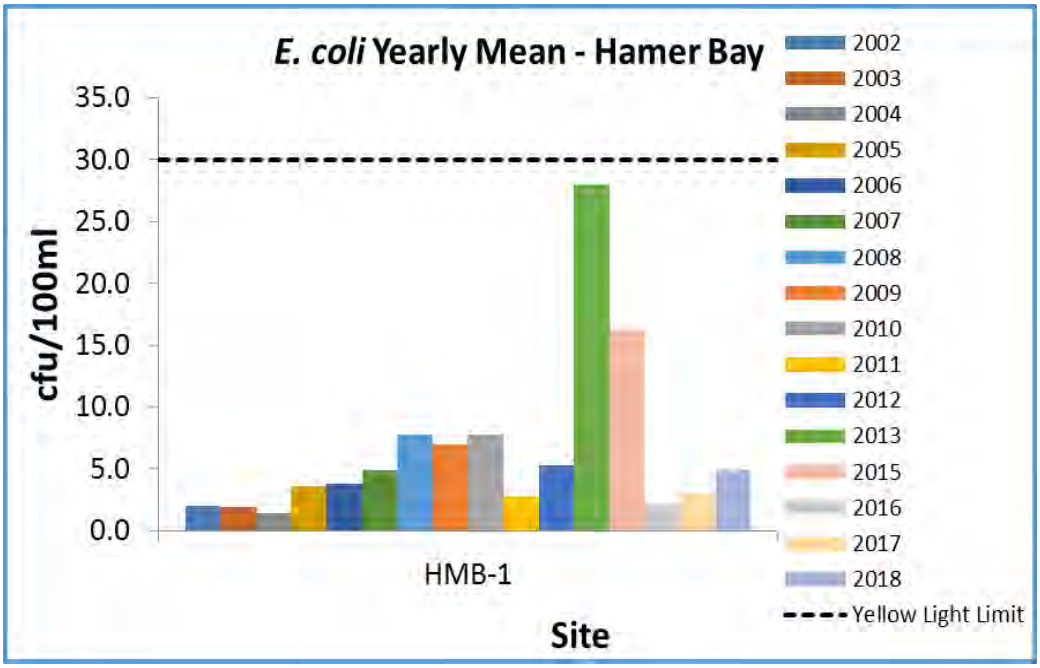
Volunteer Recognition: **Alex Magditsch, Cecil Hayhoe, John Offutt,** Juliana Magditsch, and Lynda McCarthy.

Hamer Bay (HMB)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in in 2018)

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	6.4	2.0				
HMB-1		2.0	2.8	4.9	34.6	
HMB-2		24.0	8.5			
HMB-4			4.6	2.3	9.2	
HMB-8		3.0	21.0			





Summary and Recommendations:

Spring phosphorus at HMB-0 in 2018 was well below the historic DMM threshold of 3.5 ug/L, and the lowest recorded to date. Only one phosphorus sample (spring) was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. The spring phosphorus sample at HMB-0 in 2011 remains removed from the analysis following the Grubb's Test analysis for outliers in 2018. The 2018 spring phosphorus concentrations at HMB-1 and HMB-8 were the lowest recorded to date. As well, the yearly phosphorus mean at HMB-1 was the lowest recorded and at HMB-8 was the second lowest recorded to date. On the contrary, HMB-2 had the highest recorded spring phosphorus and yearly phosphorus mean values 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. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

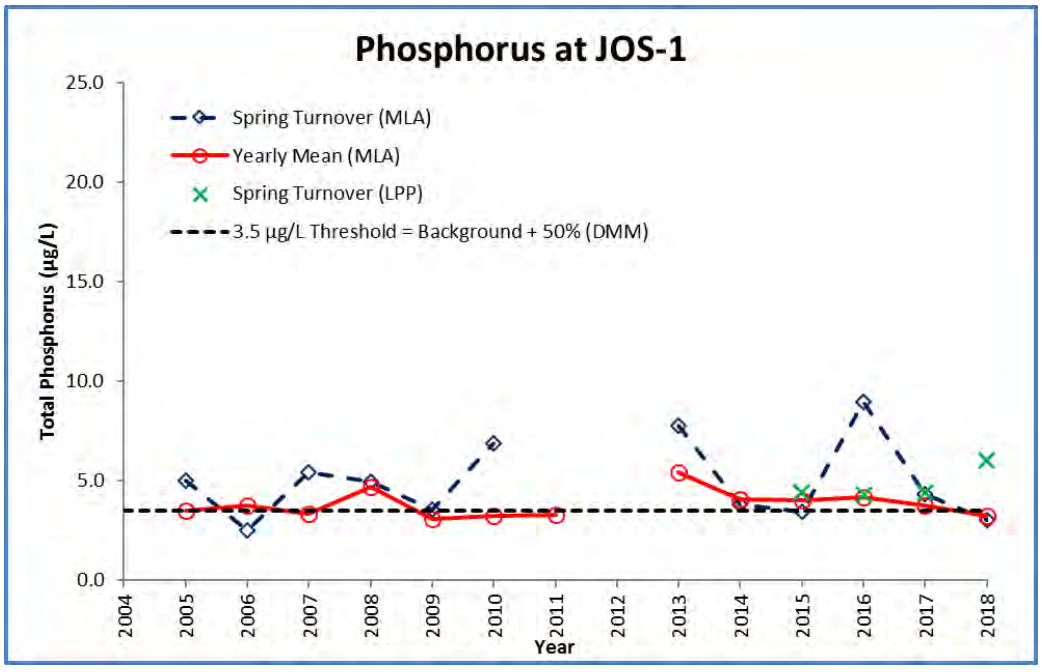
Lake Joseph is a large lake with a surface area of 50.9km² and water depths of up to 60 m. Wetlands account for a small portion of the lake area at about 5%. The lake has various points of inflow and outflow, with drainage from north to south. The Lake Joseph watershed area is 55 km² and has a coldwater fishery. The DMM has classified the main basin of the lake as highly sensitive. Monitoring started in 2005.

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

Lake Joseph (JOS)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	6.1	3.0	3.3		



Summary and Recommendations:

The spring phosphorus level at JOS-1 was slightly below the historic DMM threshold of 3.5 ug/L, was the second lowest recorded to date, and the yearly phosphorus mean generally has remained consistent through the sampling years. The 2018 Lake Partner Program spring phosphorus data also remains consistent through the past 4 years. Phosphorus levels are generally stable in the last 3 years, changing the stoplight from yellow to green. Secchi measurements remain stable through sampling years, varying between 3 and 7.75. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

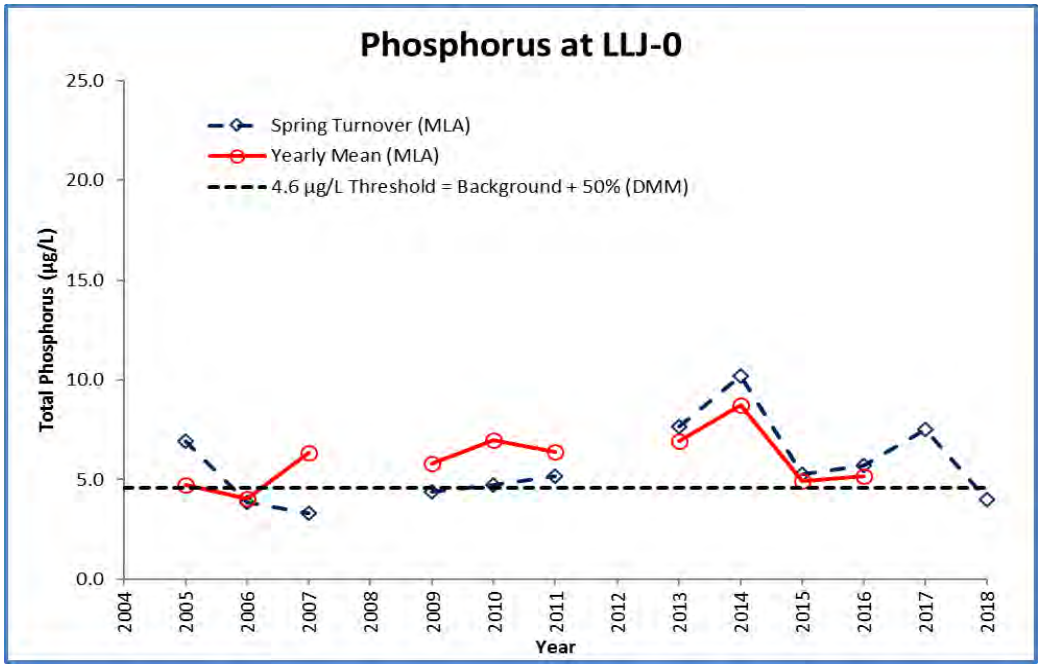
Little Lake Joseph is an isolated arm 2.8 km² in size off the eastern side of Lake Joseph. This is a deep bay with depths of up to 40 m. Most of the shoreline is in a natural state despite many cottages. Three small wetlands outlet into the bay and the DMM has classified Little Lake Joseph as moderately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

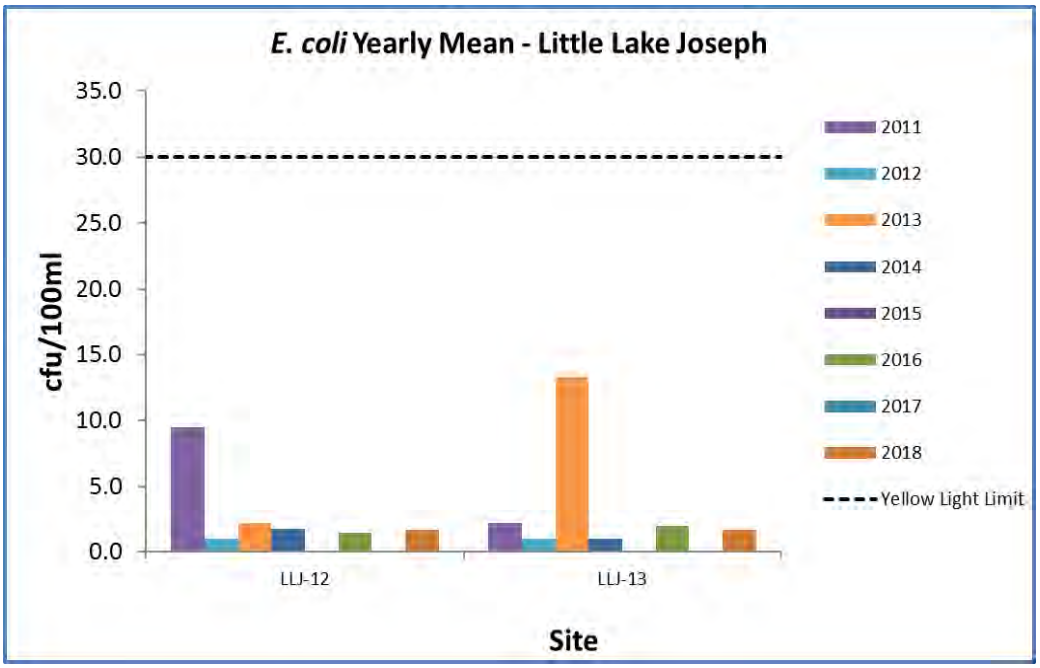
Volunteer Recognition: **Dirk Soutendijk** and **Westley Begg.**

Little Lake Joseph (LLJ)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	5.5	4.0			
LLJ-6		10.0	4.3		
LLJ-7		4.0	2.5		
LLJ-12				1.7	41.6
LLJ-13				1.7	36.2





Summary and Recommendations:

The spring phosphorus concentration at LLJ-0 was the third lowest recorded to date and was below the historic DMM threshold of 4.6 µg/L. Only one spring phosphorus sample was collected at LLJ-0 in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. The yearly phosphorus mean values at LLJ-6 and LLJ-7 were the lowest recorded to date. The *E. coli* yearly mean at LLJ-12 and LLJ-13 remained below the MLA stoplight limits. The mean Secchi depth in 2018 was the 2nd deepest to date and measurements have varied between 2.5 and 6.5 (recorded in 2007). LLJ was given a green stoplight in 2018, changed from a yellow stoplight in 2017. **Beacon recommends continued sampling to monitor long-term trends.**

Area Description:

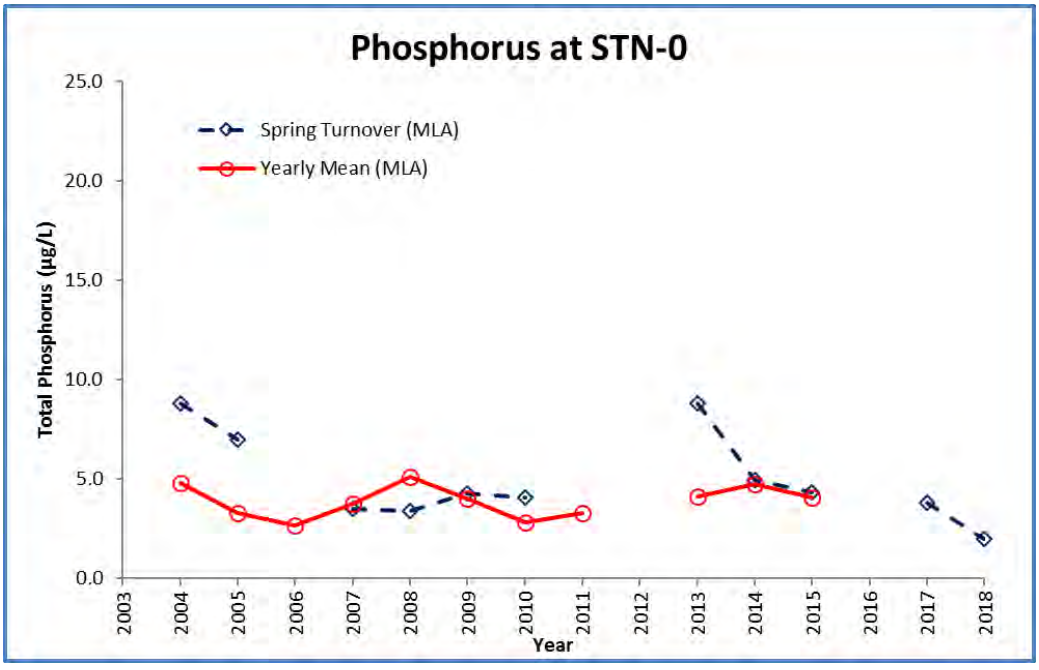
Stanley Bay is located on the north-east side of Lake Joseph. This deepwater bay has evenly distributed development with largely intact forest cover along the shoreline. STN-3 is located in a shallow, sandy area at the end of a small bay where a creek outlets. There are several roads around this bay 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 and Lynda McCarthy.

Stanley Bay (STN)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in in 2018)

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	6.4	2.0			
STN-2		2.0			



Summary and Recommendations:

The 2018 spring phosphorus concentration at STN-0 was the lowest to date. Using Grubb's Test for outliers, the spring 2011 phosphorus sample was identified as an outlier in 2013 and remains out of the dataset in 2018. Only one spring phosphorus sample was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. The spring phosphorus value at STN-2 was also the lowest recorded to date. Secchi measurements vary through sampling years, ranging between 3.75 to 8. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

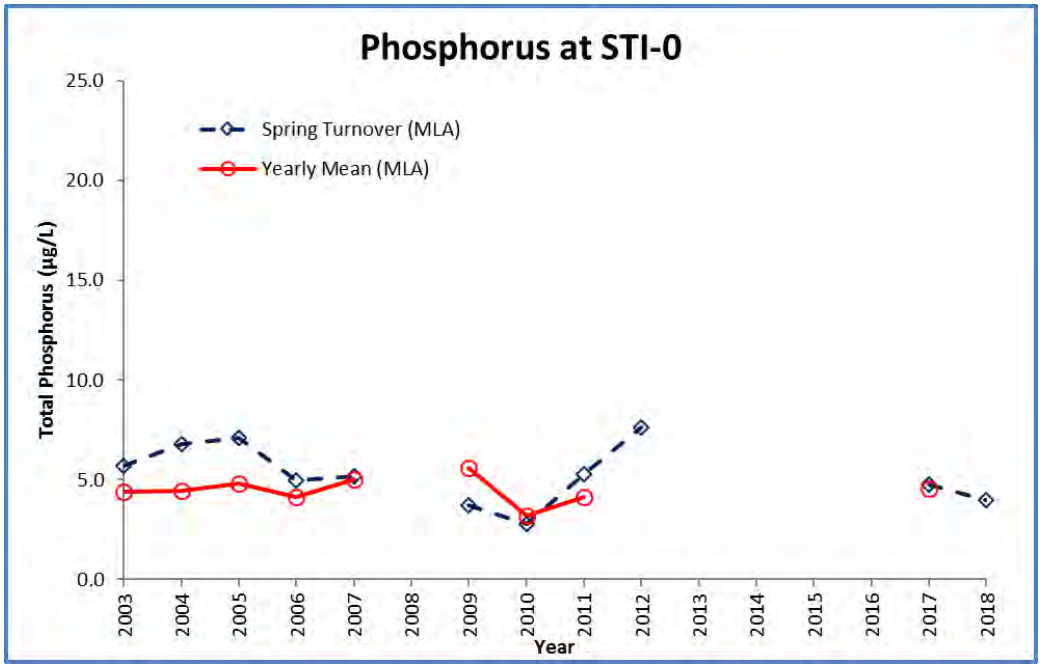
Stills Bay is located in the south-eastern portion of Lake Joseph. Stills Bay is long, narrow, and moderately developed. The southern end of the bay is directly adjacent to highway 169. This bay receives drainage from watercourses that are adjacent to a golf course. There are still large areas of shoreline with mostly intact forests. The main basin of Lake Joseph is 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, and Sharon Laviolette.

Stills Bay (STI)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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		4.0			
STI-2			6.7		



Summary and Recommendations:

At the deep station (STI-0), spring turnover phosphorus results remain consistent through the years. Only one spring phosphorus sample was collected at STI-0 in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. The yearly phosphorus mean value at STI-2 in 2018 remains consistent with historic values. Secchi measurements vary through sampling years, ranging between 2.0 and 6.8. **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

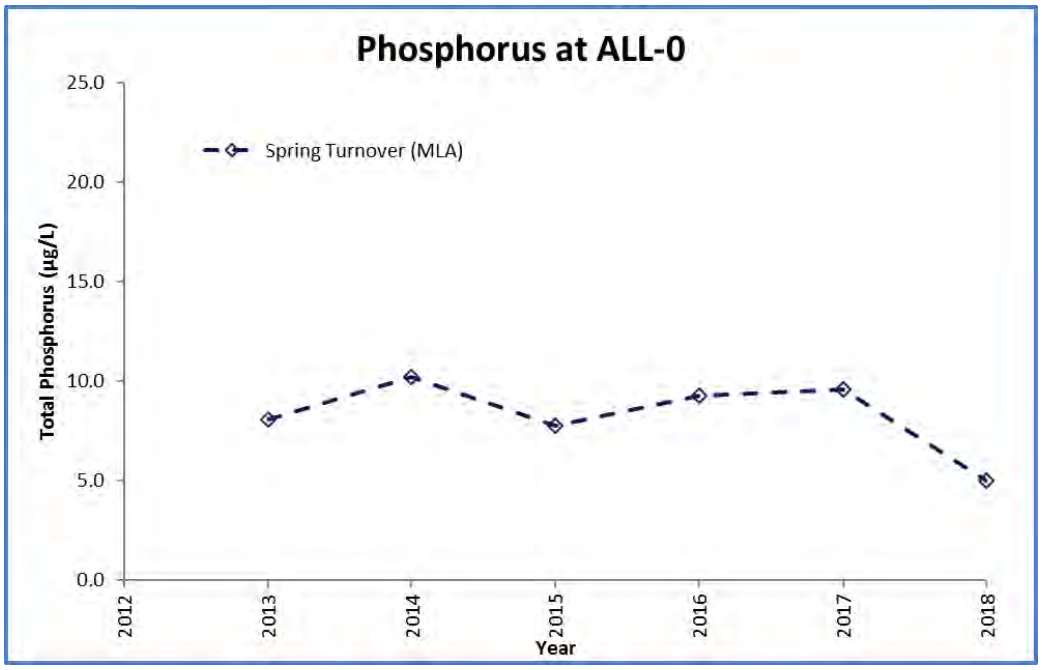
Alport Bay (also known as Alport Lake) is a small bay in the central part of eastern Lake Muskoka, at the mouth of the Muskoka River. The water quality in Alport Bay is influenced by several natural and man-made features, including a marina in the south, a large wetland as well as agriculture in the 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: **Rayma Blaymires Chris Cragg,** L. Cragg and Chris Blaymires.

Alport Bay (ALL)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	2.3	5.0			



Summary and Recommendations:

After a sixth year of data collection, spring phosphorus in 2018 declined to the lowest level recorded. The 2018 Secchi measurement was the 2nd deepest Secchi recorded to date with a depth of 2.3 m. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

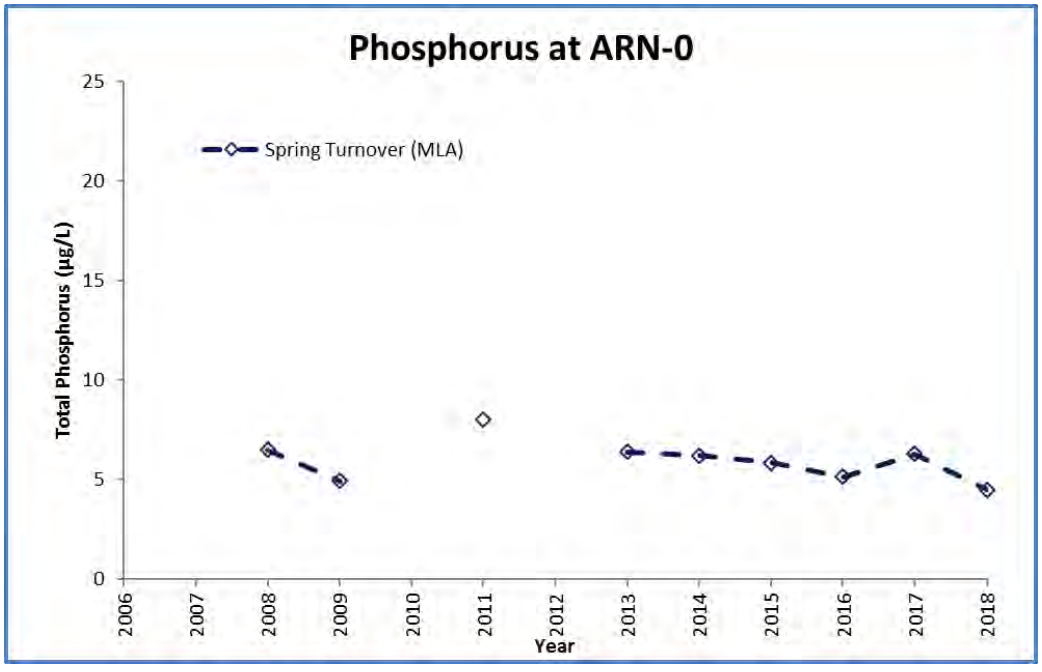
The Arundel Lodge sampling area is in south-central Lake Muskoka, east of Hardy Lake Provincial Park and south of Walker's Point. ARN-0 is located in Skinner Bay, adjacent to Miller Island and Firebrand Island. A creek draining three wetland areas runs along part of Arundle Lodge Rd. and outlets northeast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

Volunteer Recognition: **Susan Murphy** Doug Tate, Stephen Sims, Sheila Robinson, Beth Wilson and George Fallis.

Arundel Lodge (ARN)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.0	4.5			



Summary and Recommendations:

Spring phosphorus concentrations remain consistent through the sampling years. The Secchi depth in 2018 was deeper than 2017, while mean Secchi measurements are generally stable through sampling years, varying between 2.4 and 3.45 (recorded in 2011). **Beacon recommends continued sampling at this site.**

Area Description:

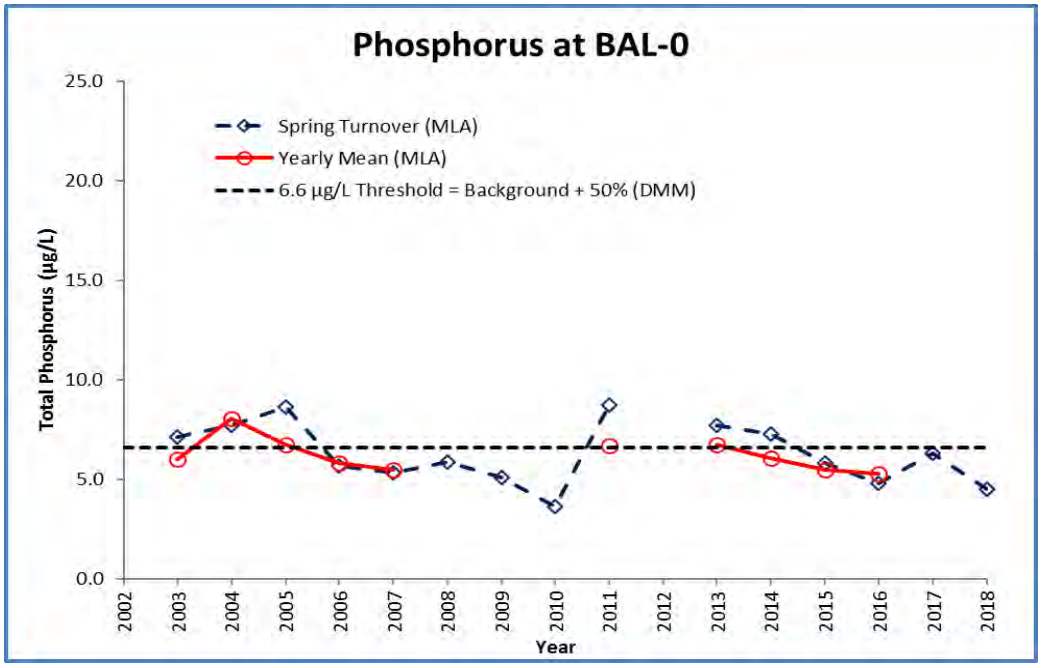
Bala Bay is a large isolated bay in the eastern part of Lake Muskoka. Most of the bay is densely developed but there is intact forest cover along most of the shoreline area. Drainage from the village of Bala does enter the bay along the western shore. The entire Muskoka River Watershed drains through 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.

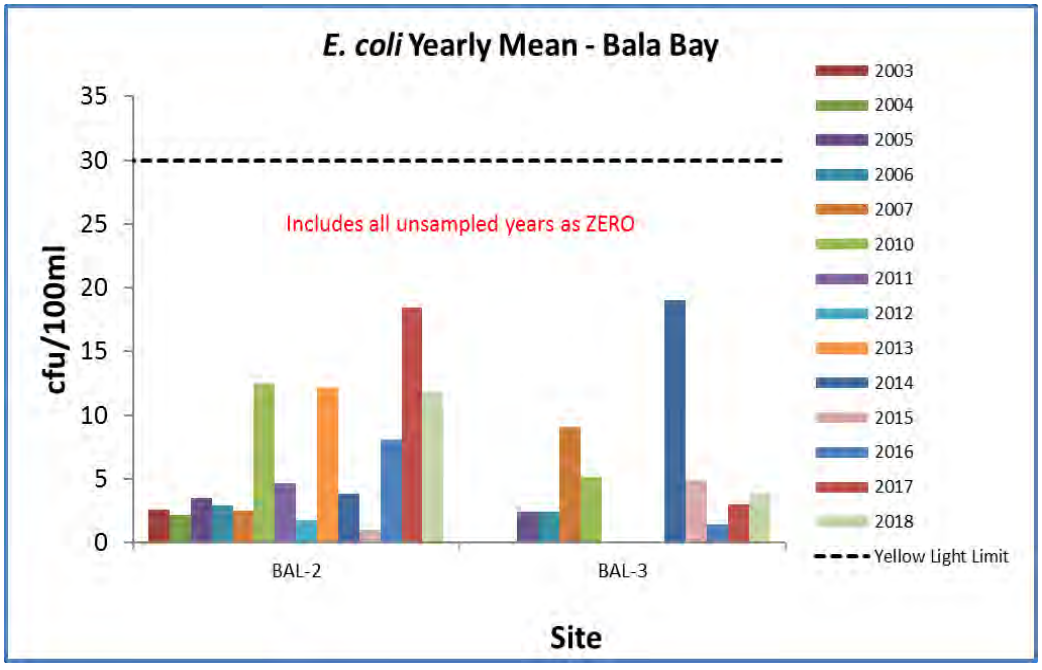
Volunteer Recognition: **Peter Joel** and Alan Hutton.

Bala Bay (BAL)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

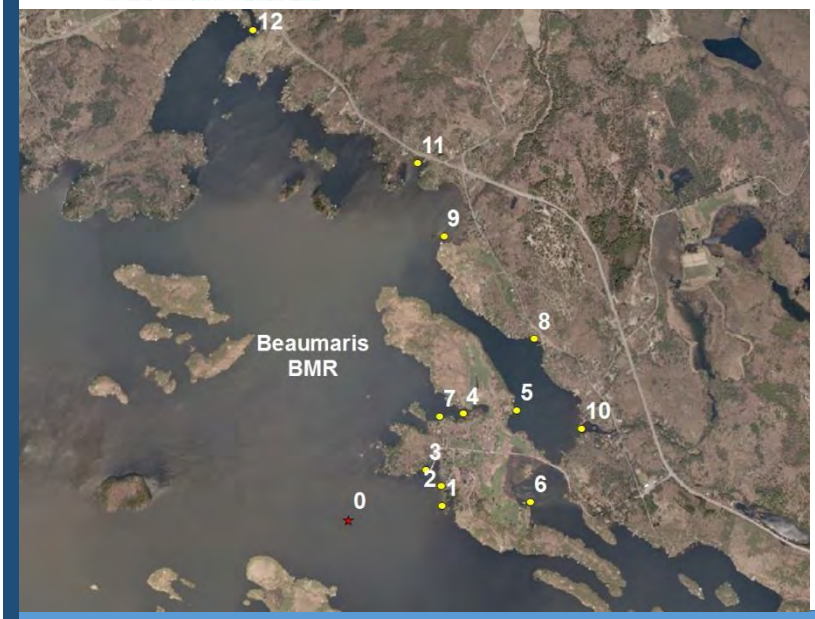
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
BAL-0	4.2	4.5			
BAL-2				11.8	43.1
BAL-3				3.8	54.6





Summary and Recommendations:

Phosphorus results at BAL-0 continue to remain consistent over the sampling years and generally in the range of the historic DMM threshold of 6.6 µg/L. Only one spring phosphorus sample was collected at BAL-0 in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. The 2018 *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 2018 was the deepest to date and measurements have ranged through sampling years, varying between 2.46 and 5.25 (recorded in 2010). **Beacon recommends sampling continue to monitor long-term trends**.



Area Description:

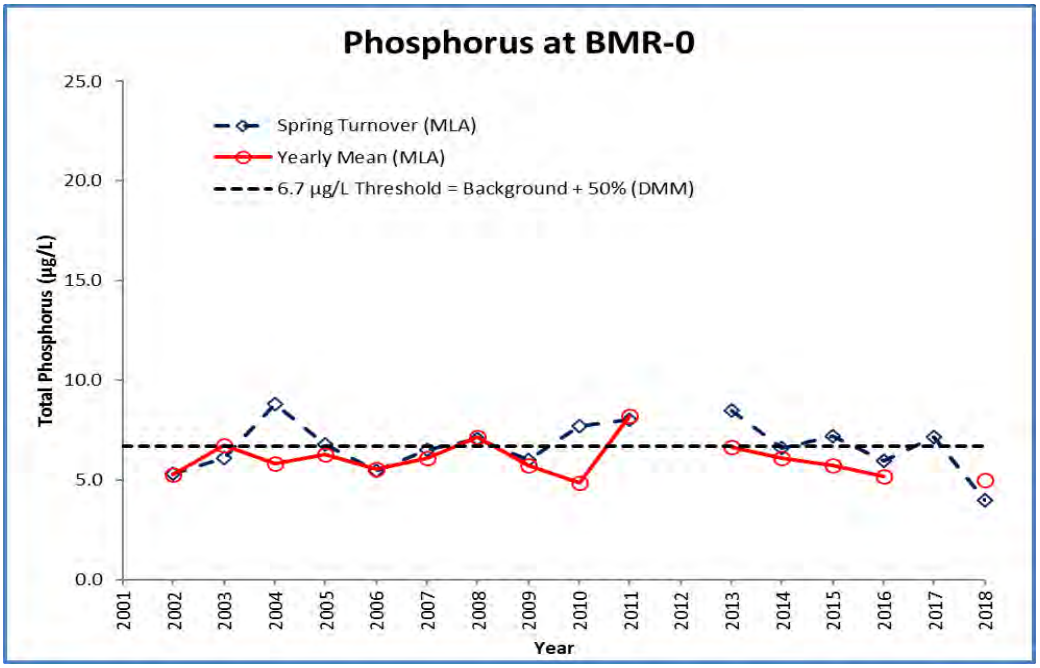
This island is in the Milford Bay area of northeastern Lake Muskoka is approximately 132 ha in size. A golf course takes up much of the island, which is associated with a small private club and marina. Most of the natural shoreline vegetation is intact, but there are many large boathouses in this area. 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.

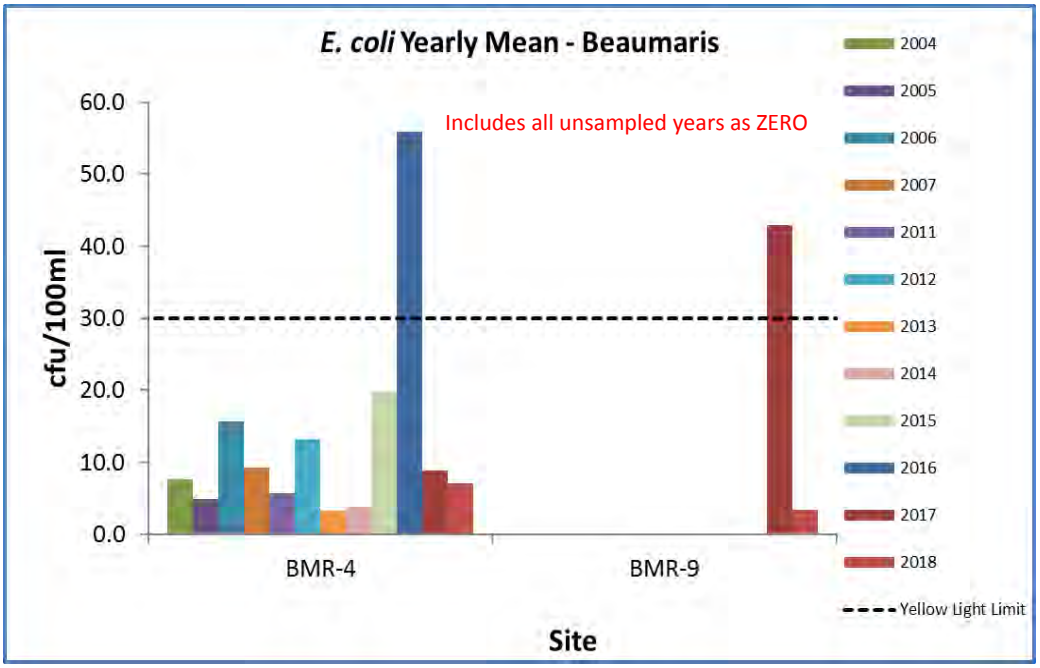
Volunteer Recognition: **Louise Cragg**, **Don Furniss**, **Lloyd Walton, Eliza Nevin,** Chris Cragg, Andree Baillargeon and Allen Flye.

Beaumaris (BMR)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.3	4.0	5.0			
BMR-4		2.0	4.3	7.1	105.1	
BMR-5		4.0				
BMR-6		5.0	6.3			
BMR-9		5.0		3.4	59.0	
BMR-10		10				
BMR-12		12				





Summary and Recommendations:

Phosphorus was sampled for at the first 2 dates at BMR-0 in 2018, and spring phosphorus results were the lowest recorded to date (4.0 µg/L). Spring turnover and yearly mean phosphorus concentrations at BMR-5, BMR-6, and BMR-9 remain consistent with previous results while spring phosphorus at BMR-4 was the lowest recorded to date and overall, BMR-4 showed lower that average phosphorus through the year. Spring phosphorus at BMR-10 decreased from 2017 and spring phosphorus decreased substantially at BMR-12 from the level in 2017. 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 2018 was consistent with previous years measurements prior to 2017. Depths have ranged through sampling years, varying between 2.25 and 4.40 (recorded in 2009 and 2015). BMR was given a green stoplight in 2018, changed from a yellow stoplight in 2017. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

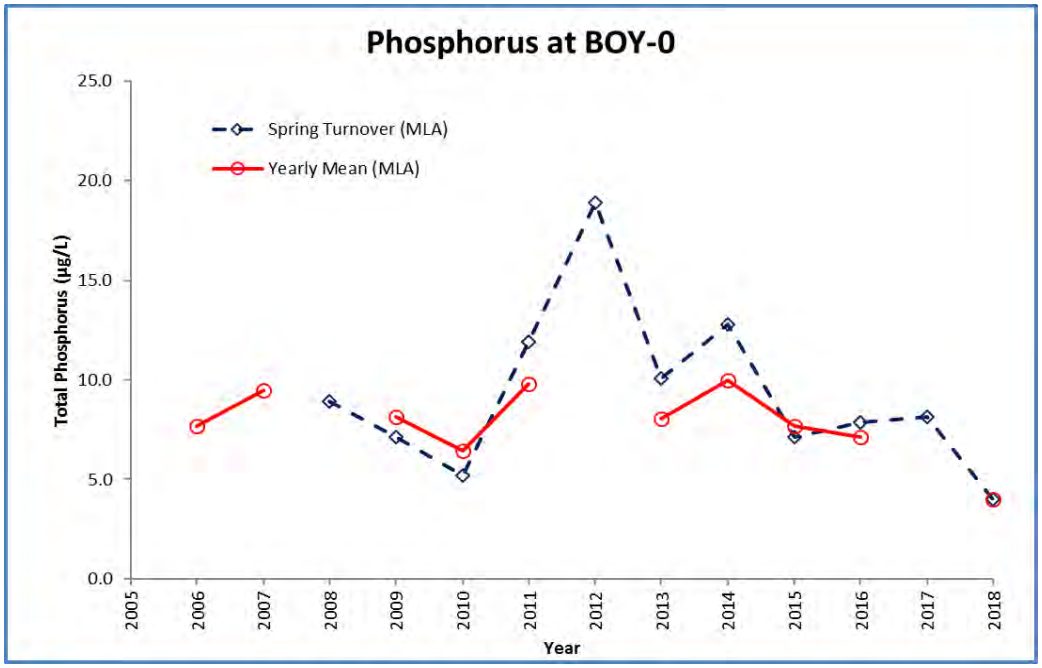
Boyd Bay is a small bay in the central part of eastern Lake Muskoka. The water quality in Boyd Bay is influenced by several natural and man-made features, including a marina in the southeast, a large wetland in the north, Highway 118 to the east and several inflowing creeks. The creeks that drain into 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: **Chris Cragg, Rayma Blaymires, Lynn Langford**, Chris Blaymires and Dave Langford.

Boyd Bay (BOY)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	2.9	4.0	4.0			
BOY-3		5	6.5			
BOY-4		8	7.3			



Summary and Recommendations:

Phosphorus was sampled for at the first 2 dates at BOY-0 in 2018 and concentrations were lower than any previous years with a spring and mean value of 4.0 ug/L. The spring phosphorus concentrations at BOY-3 was the lowest recorded value to date while the spring phosphorus at BOY-4 was consistent with the previous 3 years. The phosphorus yearly mean at both BOY-3 and BOY-4 were the lowest recorded in the last 4 years at each station. Secchi measurements remain stable through the sampling years, varying between 1.07 and 4.45. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

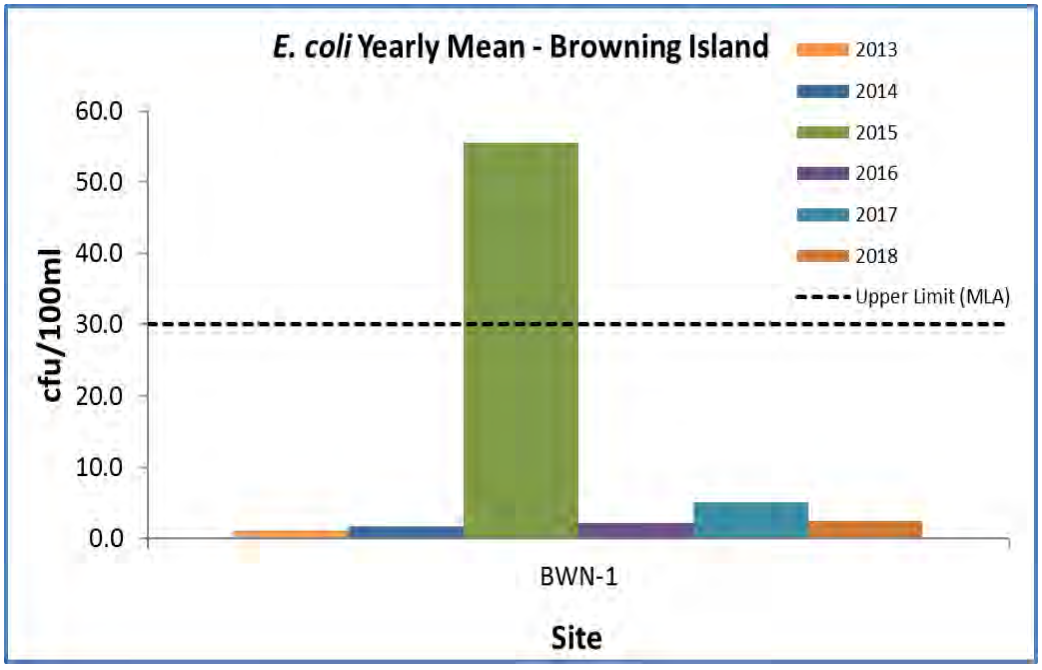
Browning Island is one of the largest islands in the Muskoka Lakes. In the late 1800s the island was stripped of its white pine. Portions of the island were then farmed (cattle, sheep and crops). The central portion of the island remains undeveloped. Through several donations, 338 acres of the island 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** and Janessa Swanson.

Browning Island (BWN)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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				2.5	55.2



Summary and Recommendations:

E. coli results continued 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:

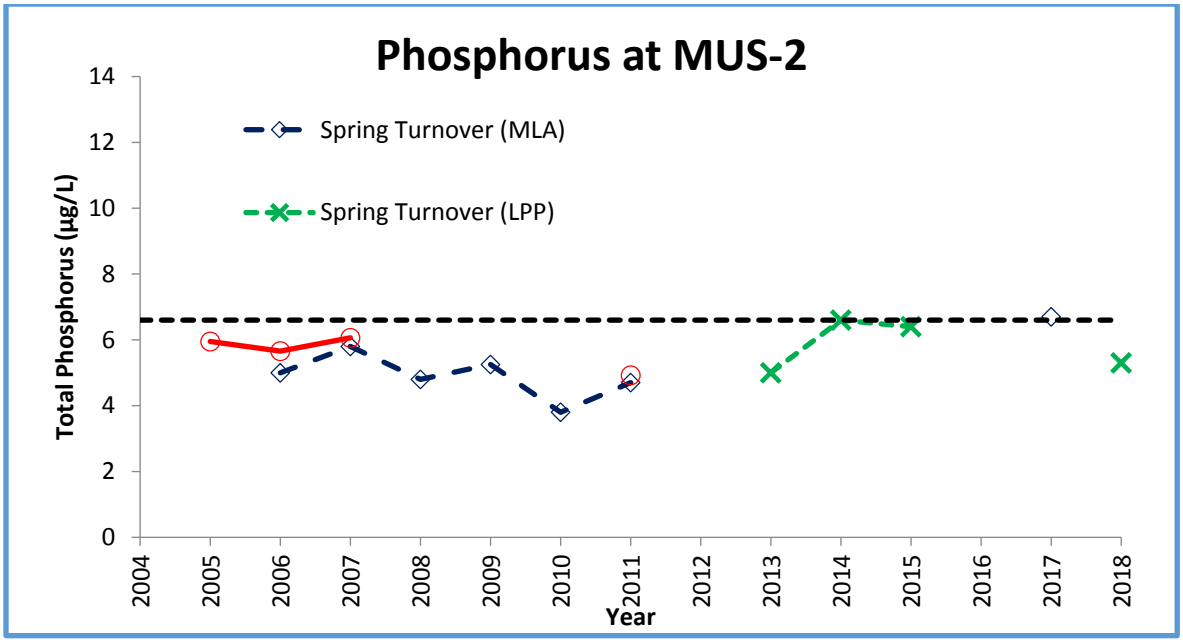
Dudley Bay is located in eastern Lake Muskoka, and is approximately 3.6 km² in size with a maximum depth of 20 m. It is considered moderately developed, with primarily residential properties and several roads, including Highway 169, that are in close proximity to the shoreline. Several creeks and wetlands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

Volunteer Recognition: **Eleanor Lewis, Kim Seon** and Jake Seon

Dudley Bay (DUD-1 & MUS-2)

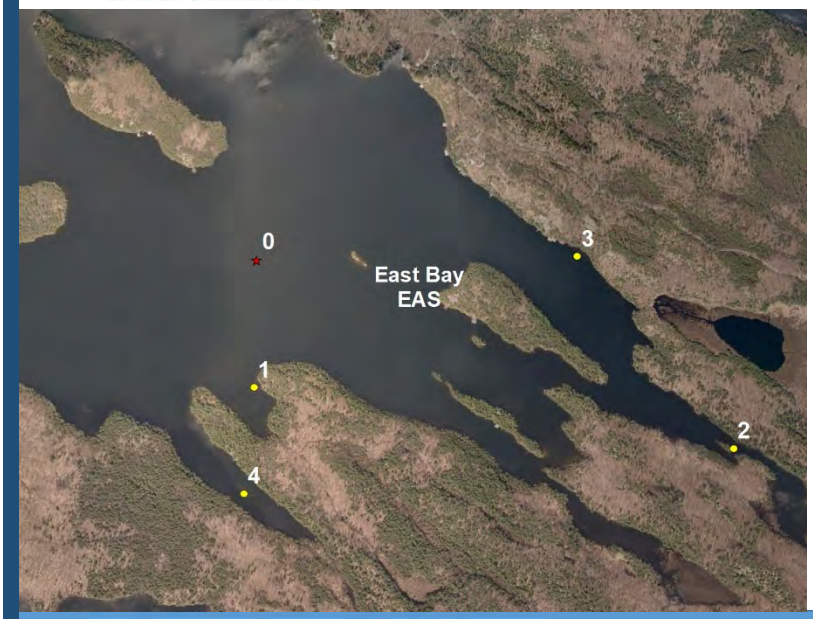
2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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		22.0	10.5		
MUS-2	3.2				



Summary and Recommendations:

Phosphorus results remain generally below the 6.6 µg/L DMM threshold. The spring phosphorus at DUD-1 was >20µg/L, causing it to be classified as yellow in 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:

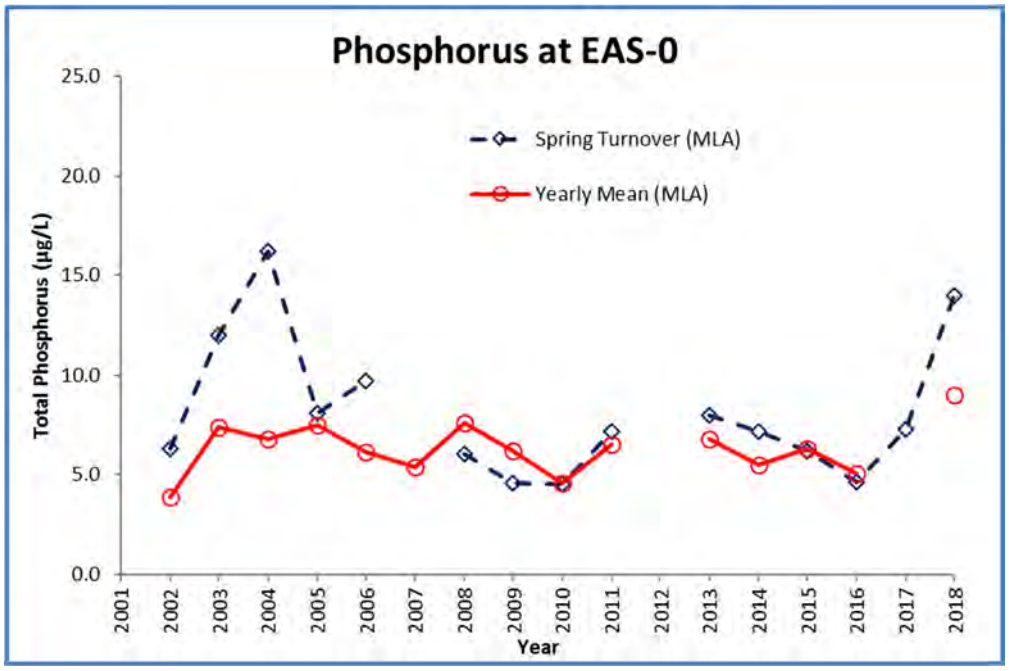
East Bay is in the western portion of Lake Muskoka and is part of Hardy Lake Provincial Park. This is a low development area with very few cottages/residences and few access roads. Several long narrow bays form the drainage area where five creeks outlet into the main bay from the park. These creeks also 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)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	4.0	14.0	9.0		
EAS-2		15.0	6.8		
EAS-4		14.0		5	87



Summary and Recommendations:

Spring phosphorus concentrations at EAS-0 (14.0 μg/L) showed an increase in 2018, however it remained below the 2004 high concentration of 16.2 μg/L. The yearly phosphorus mean at EAS-0 also increased because of the high spring phosphorus. Phosphorus levels show an increasing trend in the last 3 years, changing the stoplight from green to yellow. Although the spring phosphorus level at EAS-2 was also the highest to date, low concentrations (≤ 5.0 μg/L) in the remainder of 2018 produced the lowest yearly phosphorus mean in the last 5 years for this same station. EAS-4 was a new station in 2017 and the 2018 spring phosphorus measurement was well above that of 2017 (6.0 μg/L). Secchi measurements remain stable through sampling years, varying between 2.6 and 5.5. **Beacon recommends continued sampling to monitor long-term trends.**

Area Description:

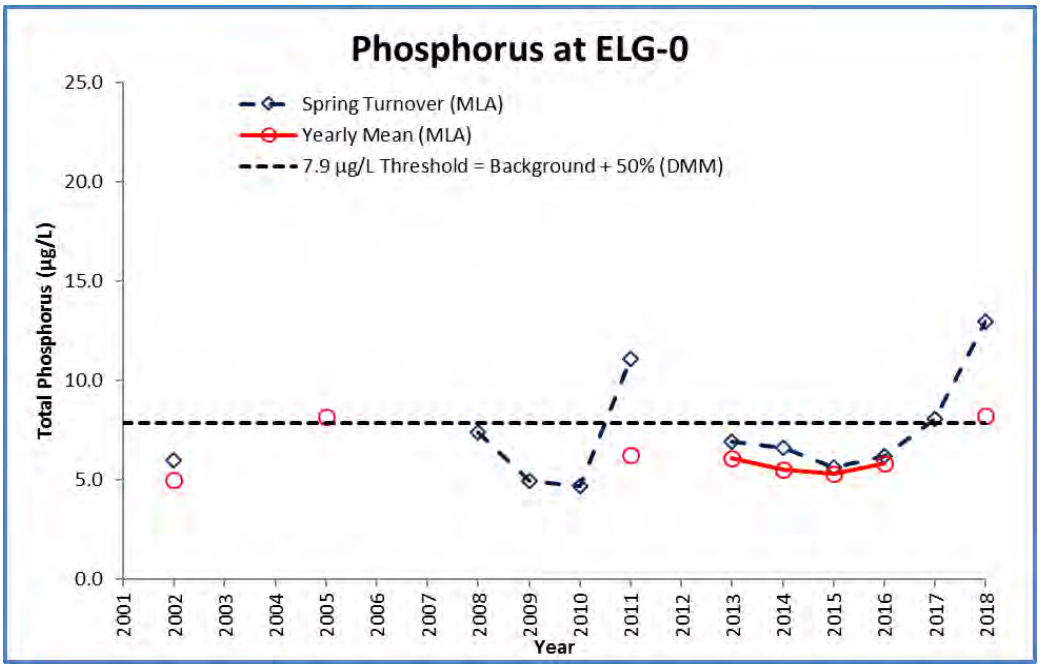
Eilean Gowan Island is in the eastern part of Lake Muskoka and is largely developed with residential cottages. Most of these properties appear to retain a well-vegetated shoreline except for a few lawns and tennis courts directly adjacent to the lake. The interior of this island is completely forested 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.

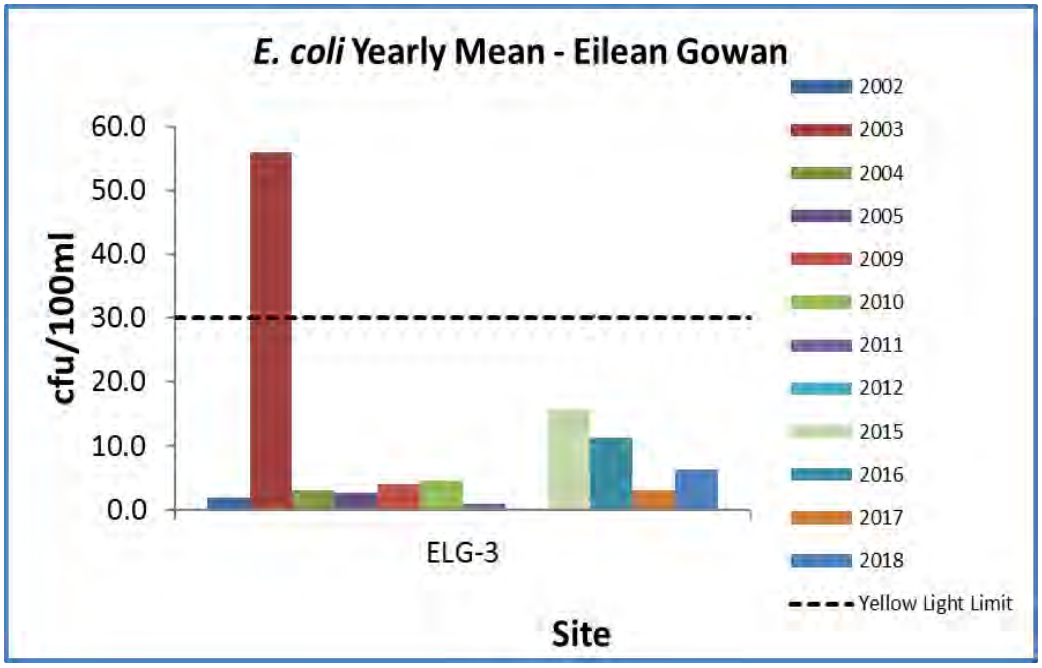
Volunteer Recognition: **Susan Murphy**, Doug Tate, Stephen Sims, Sheila Robinson and Beth Wilson.

Eilean Gowan Island (ELG)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	2.6	13.0	8.3		
ELG-3				6.2	43.5
ELG-5		14.0			





Summary and Recommendations:

The 2018 spring phosphorus concentration at ELG-0 exceeded the historic DMM threshold of 7.9 µg/L and was highest recorded level to date. Following the test for outliers of the spring phosphorus concentrations, the 2011 spring phosphorus data was again included in the analysis given the higher 2018 concentration. The 2018 yearly phosphorus mean value at ELG-0 was also the highest recorded to date. Phosphorus levels show an increasing trend in the last 3 years, changing the stoplight from green to yellow. ELG-5 is a new station first established in 2018 and had a spring phosphorus value similar to that recorded at ELG-0. 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 5.3. **Beacon recommends continuing sampling to monitor trends.**

Area Description:

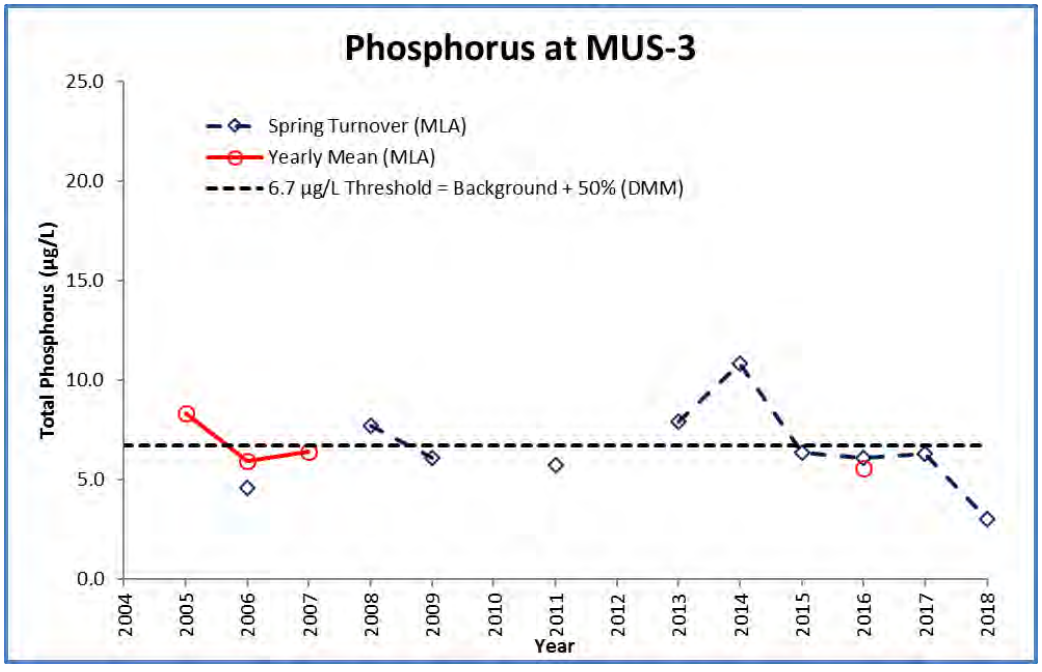
With a surface area of approximately 121 km^2 and water depths of up to 73 m, Lake Muskoka is the largest inland lake within the District of Muskoka. The Lake Muskoka watershed area is 4600 km^2 and approximately 10.5% of the watershed is covered by wetlands. The lake has various points of inflow and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

Volunteer Recognition: **Sheila Robinson**, Doug Tate, Stephen Sims, Susan Murphy and George Fallis.

Lake Muskoka (MUS-3)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	2.9	3.0			



Summary and Recommendations:

The spring phosphorus concentration at MUS-3 was the lowest recorded to date and well below the historic DMM threshold (6.7 µg/L). Only one spring phosphorus sample was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. Using Grubb's Test for outliers, the spring 2014 phosphorus sample (10.9 µg/L) at MUS-3 was no longer identified as an outlier in 2018 and was included in the dataset. The Secchi depth in 2018 was consistent with previous years and measurements have ranged through sampling years, varying between 2.4 and 3.95 (recorded in 2016). **Beacon recommends that spring sampling continue to monitor long-term trends.**

Area Description:

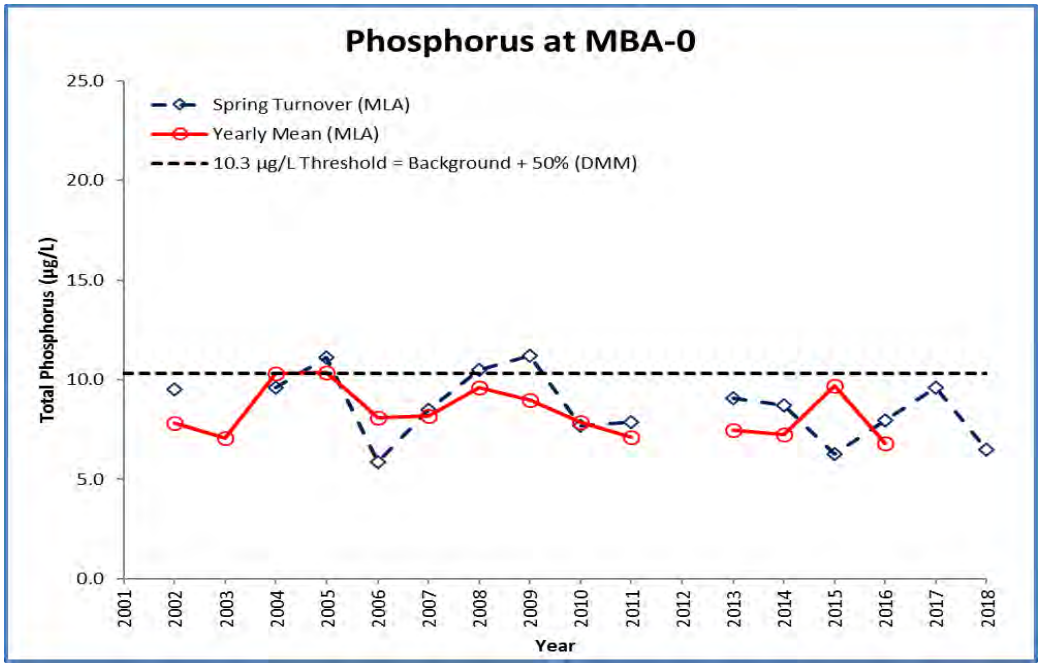
Muskoka Bay is the southernmost bay in Lake Muskoka. The bay has a long history of industrial uses and nutrient issues. While water quality in the bay has improved dramatically since the 1970s, it is still classified as moderately sensitive and over threshold by the DMM. Although the bay has a high intensity 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)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	6.5				
MBA-2		4.0				
MBA-4		8.0				
MBA-11		7.0				



Summary and Recommendations:

Spring turnover phosphorus concentrations continue to remain below or at the historic DMM threshold level (10.3 µg/L) at the deep station (MBA-0) through the most recent 8 sampling years. 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 2018. The spring phosphorus concentrations at MBA-2, MBA-4 and MBA-11 were the lowest recorded to date. Only one spring phosphorus sample was collected at each site in 2018, therefore no yearly means could be calculated, and no values are reported for 2018. *E. coli* was not sampled for in 2018. Secchi measurements vary somewhat through sampling years, ranging between 2.15 to 5.90. **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

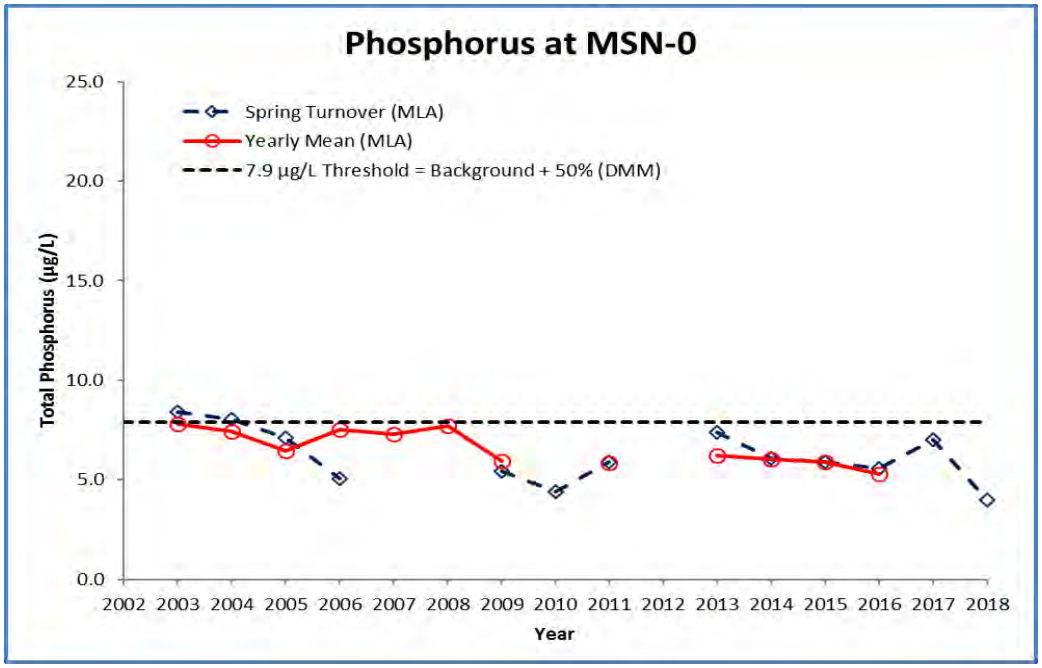
The Muskoka Sands sampling area is located in southeastern Lake Muskoka at the confluence with the Hoc Roc River. This area has a high intensity of development with a large resort and golf course, along with a high density of residential properties and roads adjacent to the lake. The Hoc Roc River flows 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.

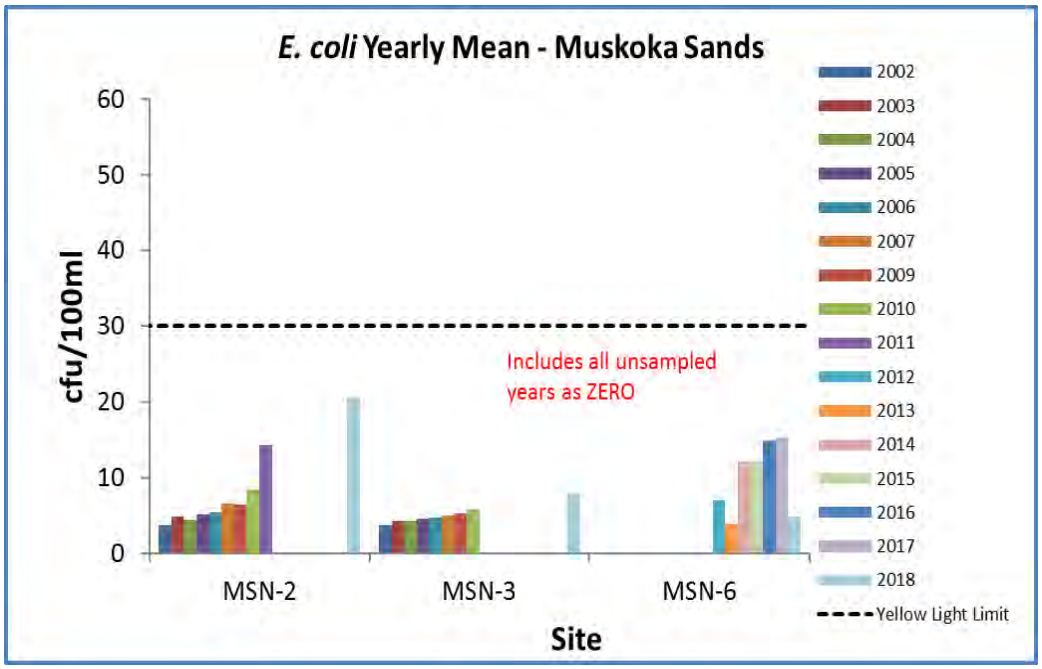
Volunteer Recognition: **Carol Hoskins** and Carroll Manol

Muskoka Sands (MSN)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.7	4.0				
MSN-2				5.5	102.9	
MSN-3				3.7	38.9	
MSN-6				4.9	69.2	
MSN-8	0.5	20.0	12.8			





Summary and Recommendations:

The spring phosphorus concentration at the deep station (MSN-0) remains below the historic DMM threshold of 7.9 µg/L in 2018 and is the lowest recorded to date. Only one spring phosphorus sample was collected at MSN-0 in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. MSN-8 is a new station added in 2017; higher phosphorus results in 2017 and 2018 are indicative of inputs from the watercourse in this location. *E. coli* results at MSN-2, MSN-3 and MSN-6 in 2018 were all below the MLA limits (details in report Section 3). Re-tests were required at MSN-3. Secchi measurements remain stable through sampling years at station MSN-0, varying between 2.7 and 5.25. Secchi measurements were taken for the first time in 2017 at Station MSN-8. **Beacon recommends that sampling continue to monitor long-term trends, with special attention to Station MSN-8.**

Area Description:

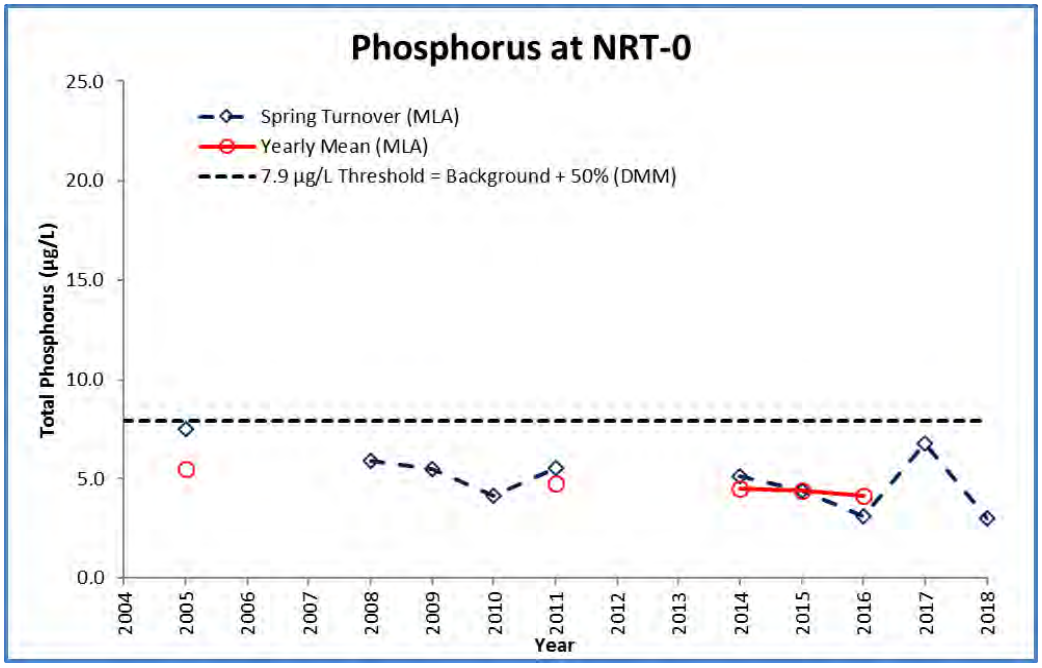
The North Bay sampling area is a large bay in northwestern Lake Muskoka. A total of eight creeks outlet into the bay, several draining wetland areas and one that passes through a District landfill site north of the lake. This is a moderately developed part of the lake, having many residential properties 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 Jake Seon.

North Bay (NRT)

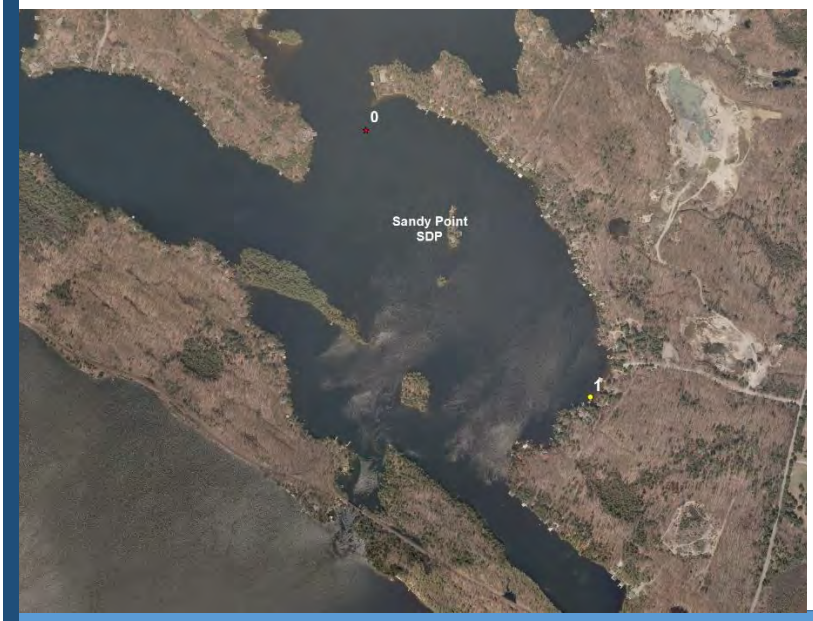
2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.0			



Summary and Recommendations:

Spring turnover phosphorus concentrations at NRT-0 have all remained below the historic DMM threshold, with the lowest spring phosphorus value recorded in 2018. Only one spring phosphorus sample was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. Secchi measurements also remain generally stable through sampling years, varying between 2.25 and 4.63. **Beacon recommends sampling continue to monitor long-term trends.**



Area Description:

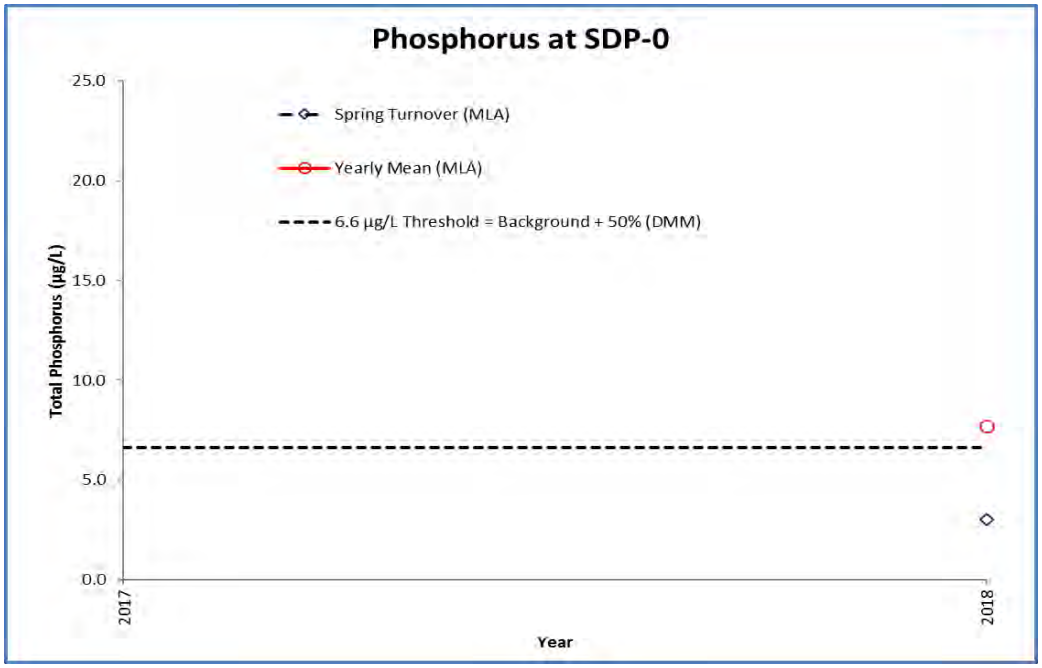
Sandy Point is in the western portion of Lake Muskoka, and directly east of Bala. The Sandy Point stations are at the downstream end of most of the MLA sampling stations in the Lower Muskoka Subwatershed. Lands to the west of these sampling sites contain three active aggregate operations. Monitoring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

Volunteer Recognition: **Mike Schnarr,** and Eleanor Lewis

Sandy Point (SDP)

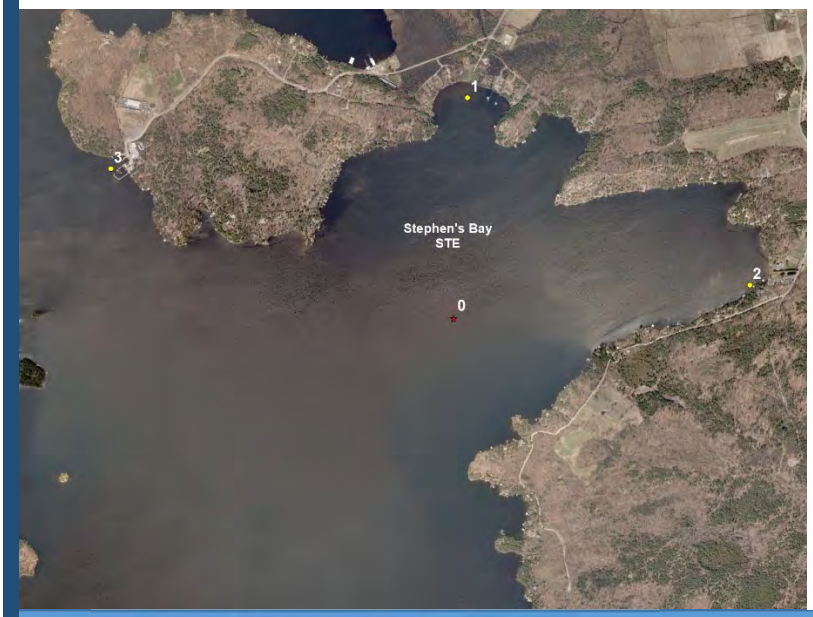
2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	2.9	3.0	7.7		
SDP-1	3.0	2.0	6.3		



Summary and Recommendations:

This nearshore station was established in 2018. **Beacon recommends that sampling continue to monitor long-term trends**.



Area Description:

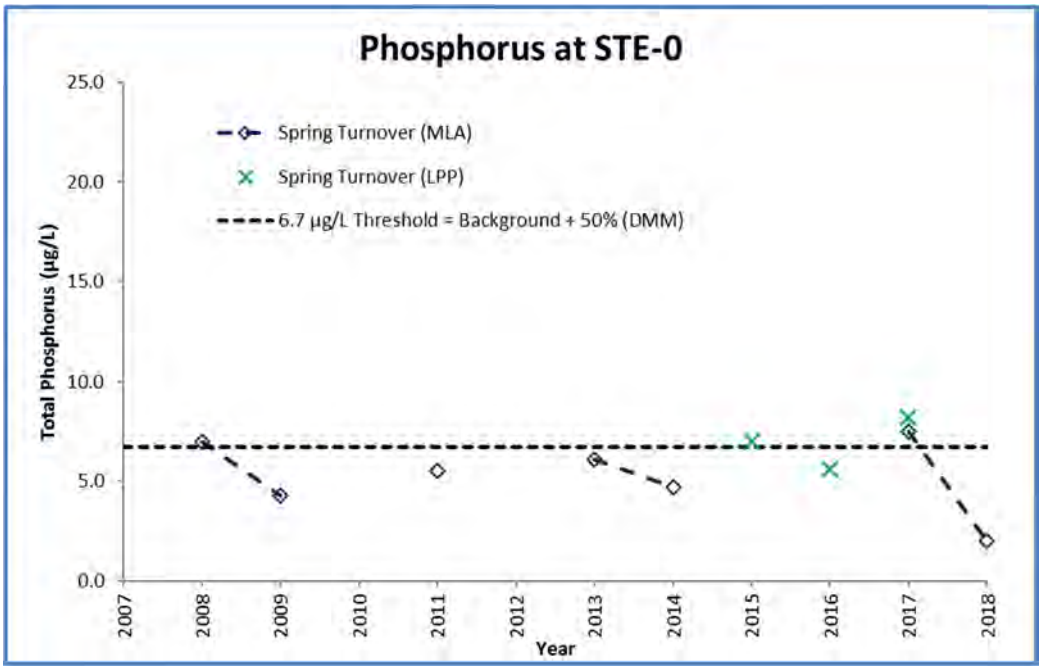
Stephen's Bay is a small bay in the central part of eastern Lake Muskoka, south of the mouth of the Muskoka River. The water quality in Stephen's Bay is influenced by input from adjacent wetlands as well as agriculture in the east, and public beaches (Strawberry Bay and Kirby's). Much of the shoreline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

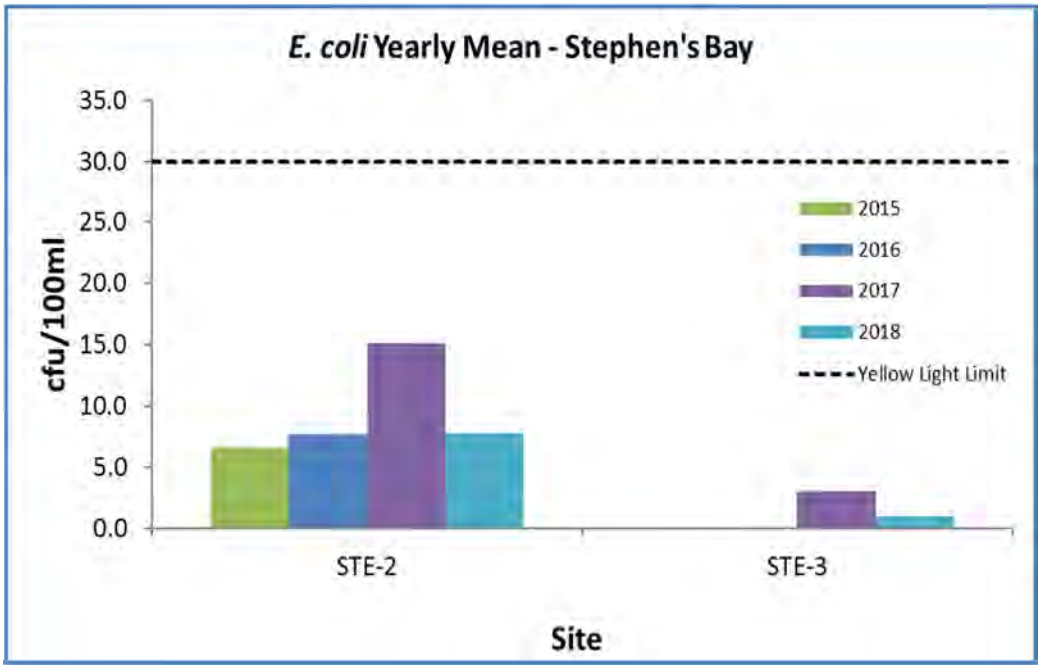
Volunteer Recognition: **L. Cragg, Bob Kerton,** Chloe Kerton, C. Cragg, Bari Kerton, and the Lake Partnership Program.

Stephens Bay (STE)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	2.0			
STE-2				7.8	87.7
STE-3	2.9	5.0		1.0	56.0





Summary and Recommendations:

The 2018 spring phosphorus concentration at the deep station (STE-0) was below the historic DMM threshold of 6.7 µg/L in 2018, and the lowest recorded to date. Spring turnover phosphorus was sampled for at STE-3 in 2018 for the second time and data will be analyzed following additional years of gathering samples. *E. coli* concentrations at STE-2 and STE-3 in 2018 remained below the MLA stoplight limits (details in report Section 3). The Secchi depths have ranged through sampling years, varying between 2.0 and 4.4 (recorded in 2013). Secchi measurements were taken for the first time in 2017 at STE-3. **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:

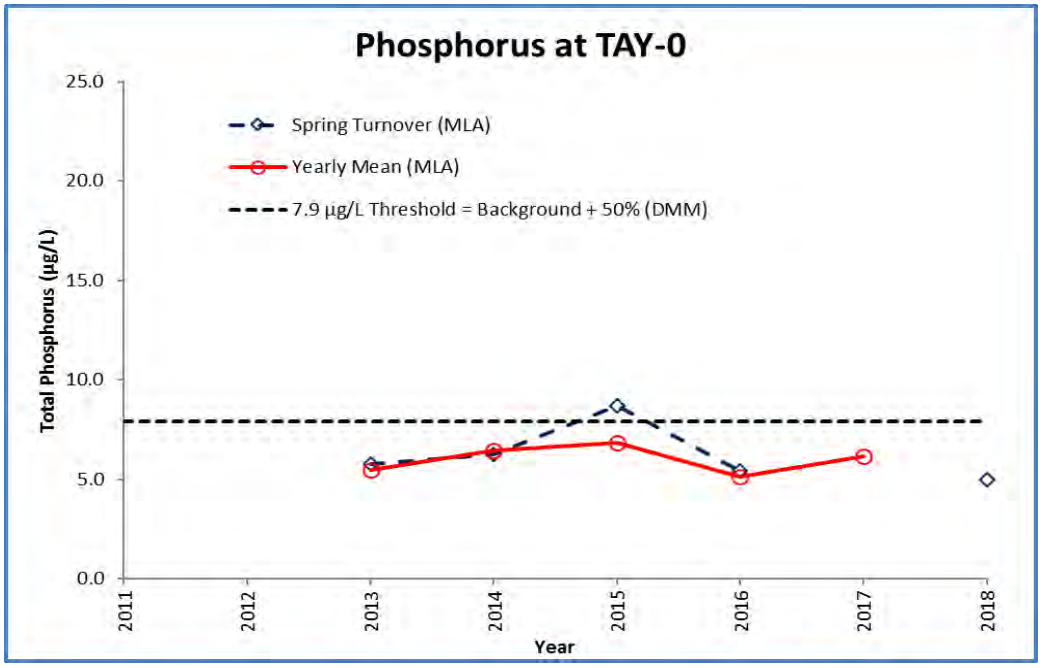
Taylor Island is in the main basin of Lake Muskoka and is approximately 76 ha in size. Development intensity in this area is considered moderate to high; however, most of the natural shoreline vegetation appears to be intact. This area has few lacustrine wetlands. Two streams originating in wetlands, 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.

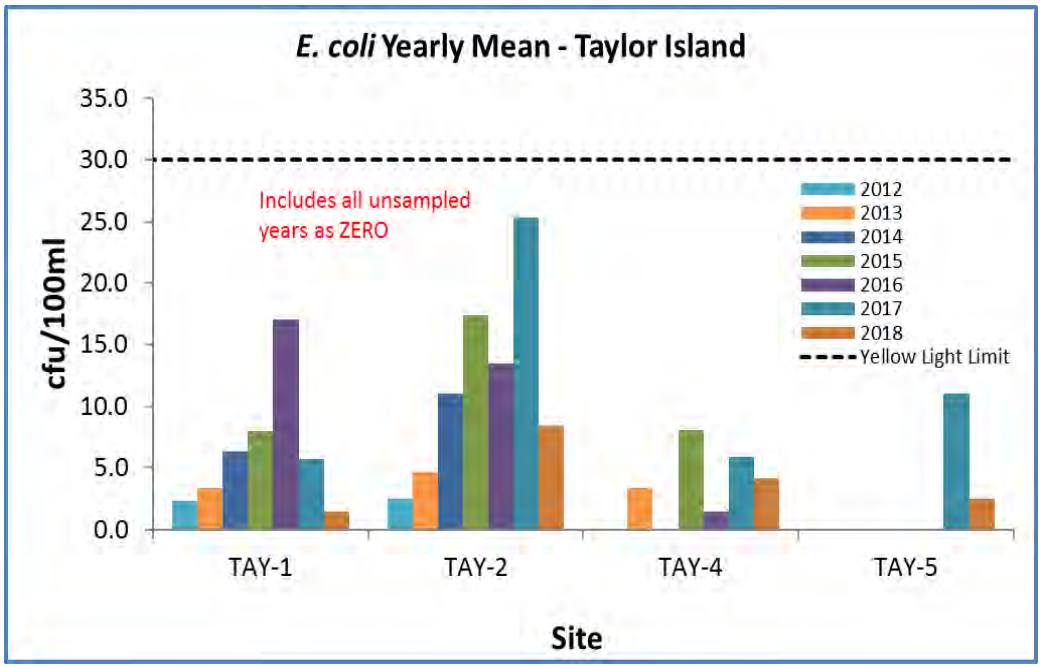
Volunteer Recognition: **Caroll Manol, Carol Hoskins, Mark Brosch**, Sandy Brosch, Doug Tate, Mike Mynhior, and Stephen Sims.

Taylor Island (TAY)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

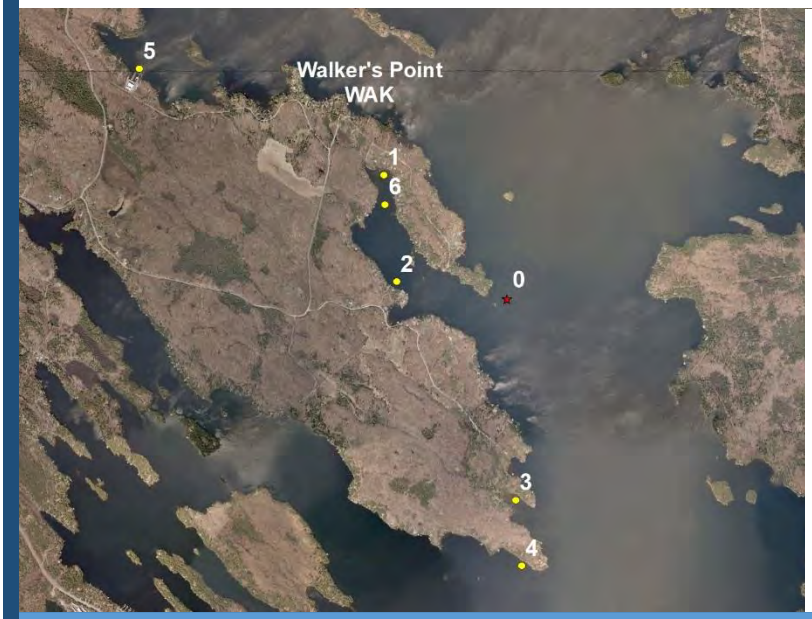
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
TAY-0	3.7	5.0			
TAY-1				1.4	62.5
TAY-2		5.0	3.5	8.4	61.9
TAY-4				2.5	66.6
TAY-5				4.2	52.7





Summary and Recommendations:

The 2018 spring phosphorus concentration at the deep station (TAY-0) was below the historic DMM threshold of 7.9 µg/L in 2018, and the lowest recorded to date. Only one spring phosphorus sample was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. The 2018 spring phosphorus and yearly phosphorus mean concentrations at TAY-2 also the lowest recorded to date. *E. coli* concentrations at TAY-1, TAY-2, TAY-4 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. **Beacon recommends that sampling continue to establish a baseline at TAY-5 and to monitor long-term trends at all stations.**



Area Description:

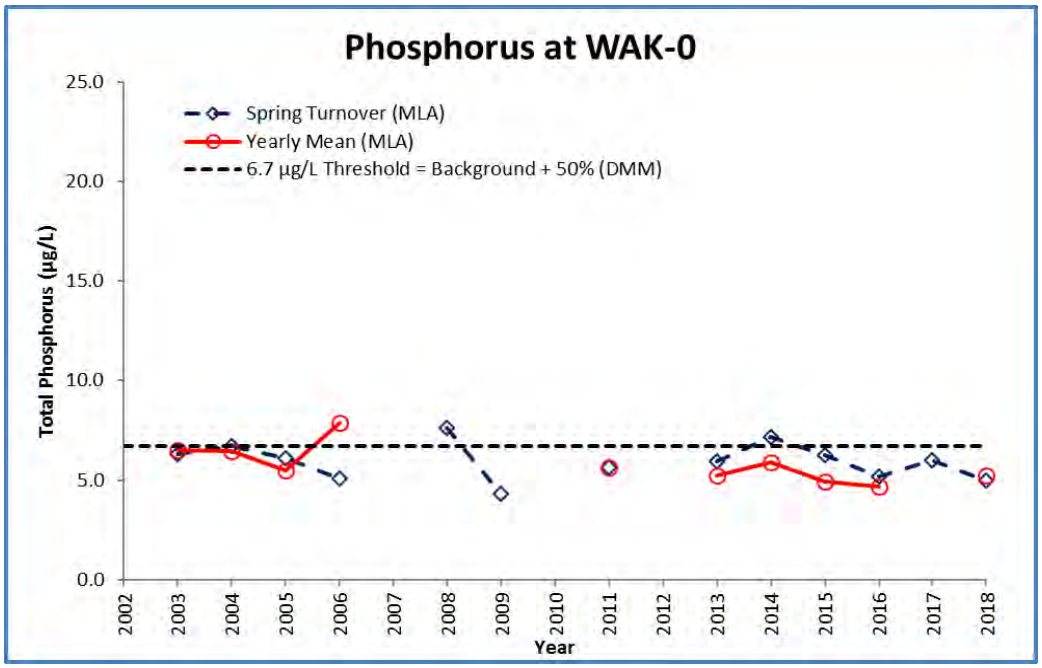
The Walkers Point sampling area is in south-central Lake Muskoka, East of Hardy Lake Provincial Park and west of Browning Island. WAK-0 is located off the tip of Walkers Point, near the mouth of Walkers Bay. A single creek outlets in Walkers Bay. The sampling area includes the bay to the north that contains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

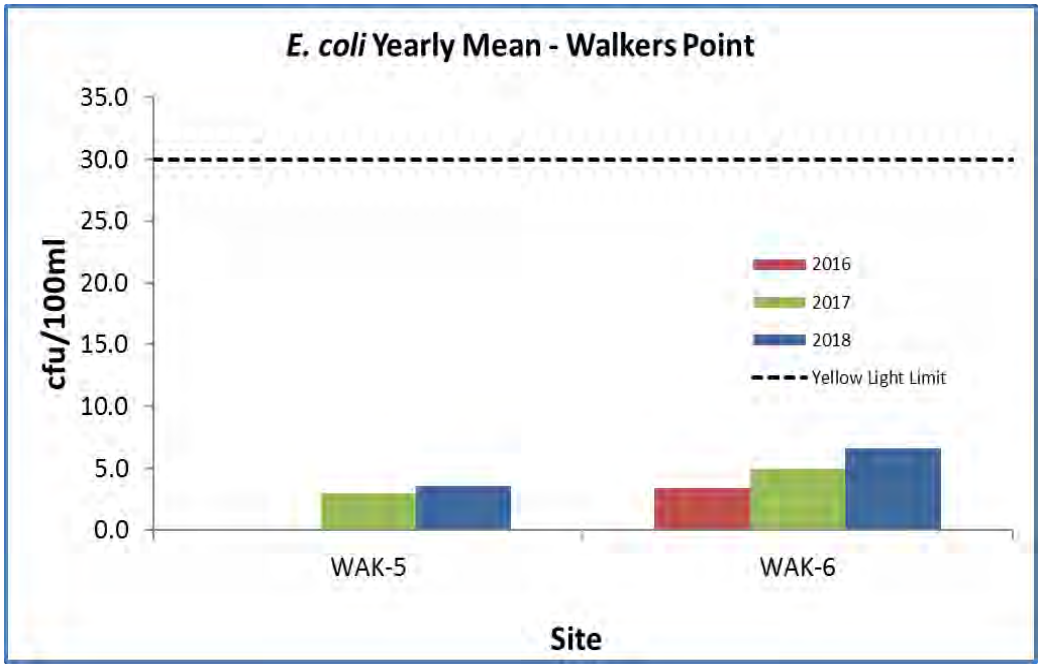
Volunteer Recognition: **Susan Murphy**, Stephen Sims, Sheila Robinson, Beth Wilson, and Doug Tate.

Walkers Point (WAK)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

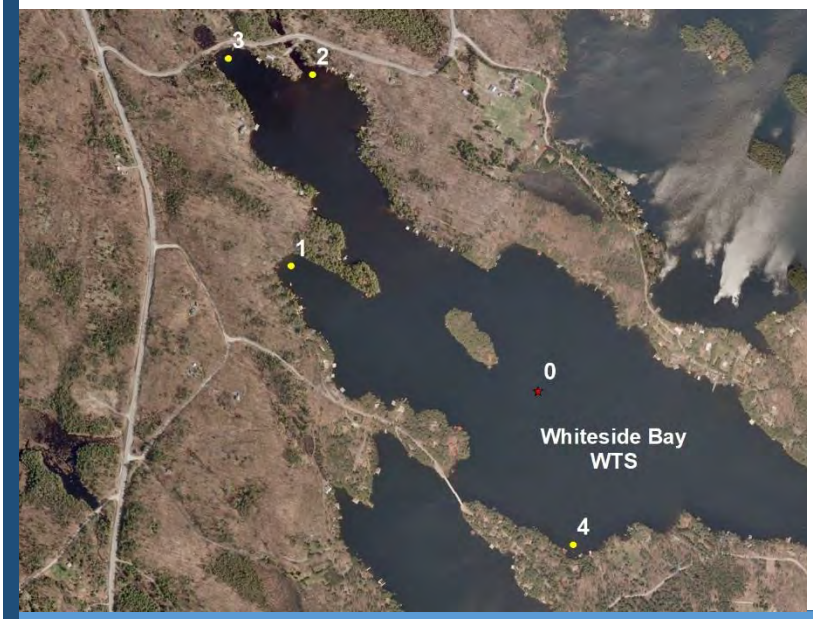
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
WAK-0	3.2	5.0	5.3		
WAK-5		6.0	9.3	3.6	70.1
WAK-6		15.0	10.0	6.6	73.2





Summary and Recommendations:

Phosphorus concentrations at the deep-water station (WAK-0) continue to remain consistent and below the historic DMM threshold of 6.7 µg/L in 2018. 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 and WAK-6 continues to show concentrations below the MLA stoplight limits (details in report Section 3). The Secchi depth measurements have ranged through sampling years, varying between 2.25 and 4.35 (recorded in 2016). **Beacon recommends that sampling continue to monitor long-term trends.**



Area Description:

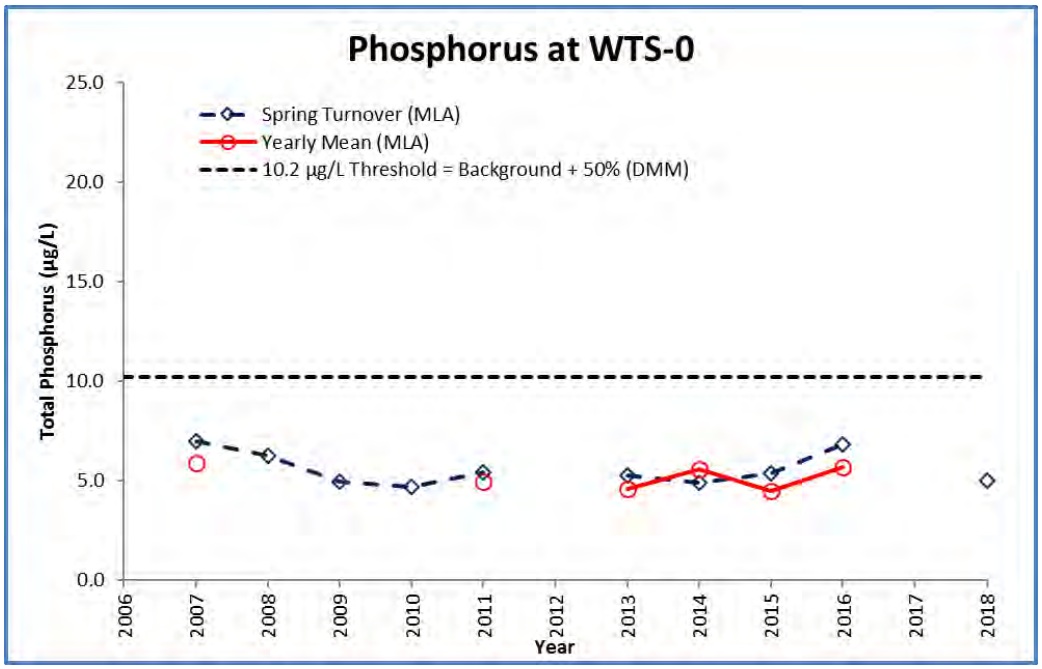
Whiteside Bay is located in the northwestern portion of Lake Muskoka and receives a high amount of spring flow from the northwest. It is moderately developed with cottage/residential properties and has roadways that come in close proximity to the shoreline in several areas. Inflow into the lake comes 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 Jake Seon

Whiteside Bay (WTS)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.3	5.0			



Summary and Recommendations:

The spring turnover phosphorus levels at the deep station (WTS-0) are consistent through the sampling years, except for the results from 2017. This sample was determined to be an outlier during the Grubb's test analysis and was removed from the dataset. Only one spring phosphorus sample was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. Secchi measurements vary through sampling years, ranging between 2.75 and 4.25. **Beacon recommends that sampling continue to monitor long-term trends.**

Area Description:

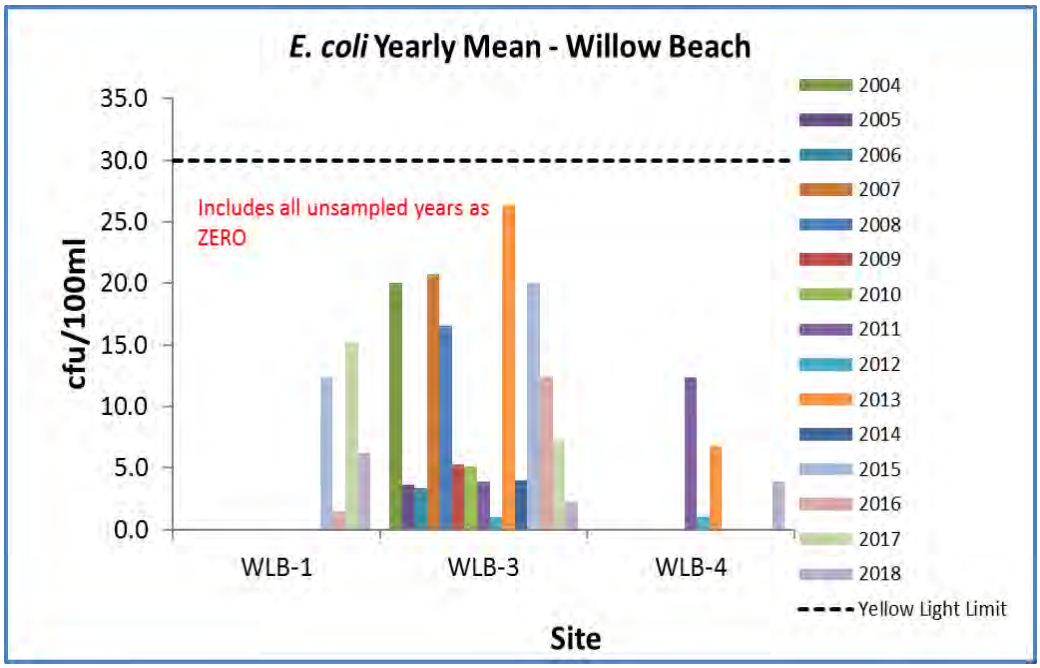
The Willow Beach sampling area encompasses a highly developed section of shoreline. There is a newly re-developed resort complex, a wetland with a creek flowing through a nine-hole golf course and several larger properties with limited retained forest cover. Highway 118 is in close proximity to the shoreline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

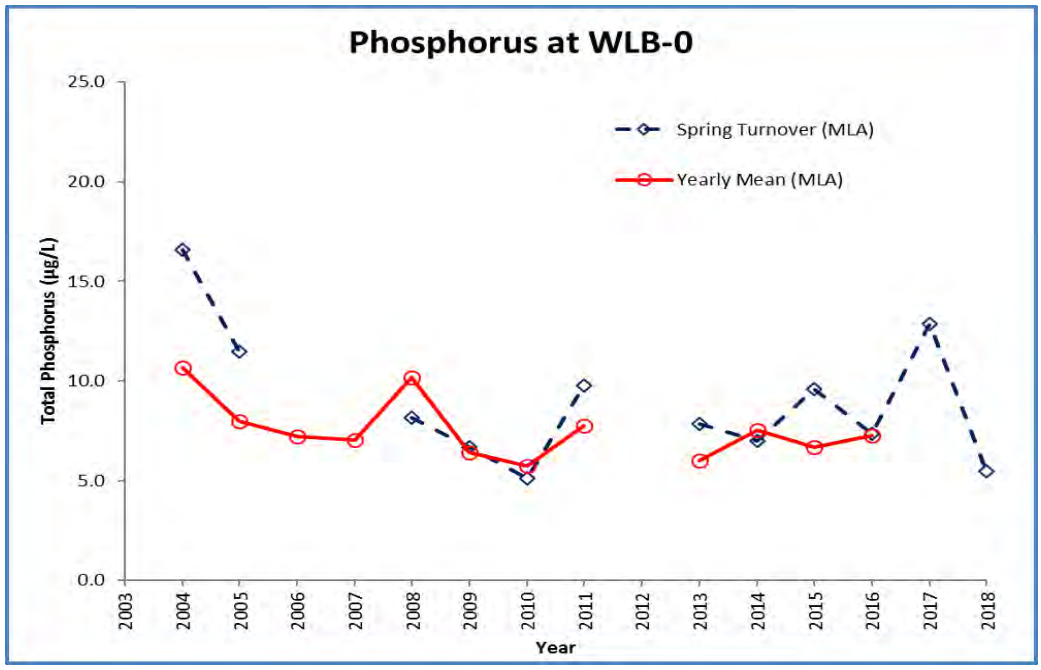
Volunteer Recognition: **Chris Cragg**, **Murray Walker,** Louise Cragg, and Emila Brittain.

Willow Beach (WLB)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.2	5.5				
WLB-1		4.0	6.5	6.2	58.7	
WLB-3		17.0	14.3	2.2	31.5	
WLB-4		11.0	18.5	3.9	108.8	





Summary and Recommendations

The spring turnover phosphorus level at the deep station (WLB-0) has been variable through the sampling years, and in 2018, was the second lowest concentration to date. Using Grubb's Test for outliers, the spring 2006 phosphorus sample was identified as an outlier and remains out of the dataset in 2018. Only one spring phosphorus sample was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. The 2018 spring phosphorus concentrations at WLB-1 and WLB-3 were the lowest recorded to date. Additionally, the yearly phosphorus mean at WLB-4 was the highest recorded to date, resulting from high concentrations in June and July. The *E. coli* levels at WLB-1 and WLB-3 remain well below the MLA stoplight limits (details in report Section 3). Secchi measurements are considerably variable through sampling years, ranging between 0.84 and 6.50. **Beacon recommends that sampling continue to monitor long-term trends, particularly at WLB-4.**

Area Description:

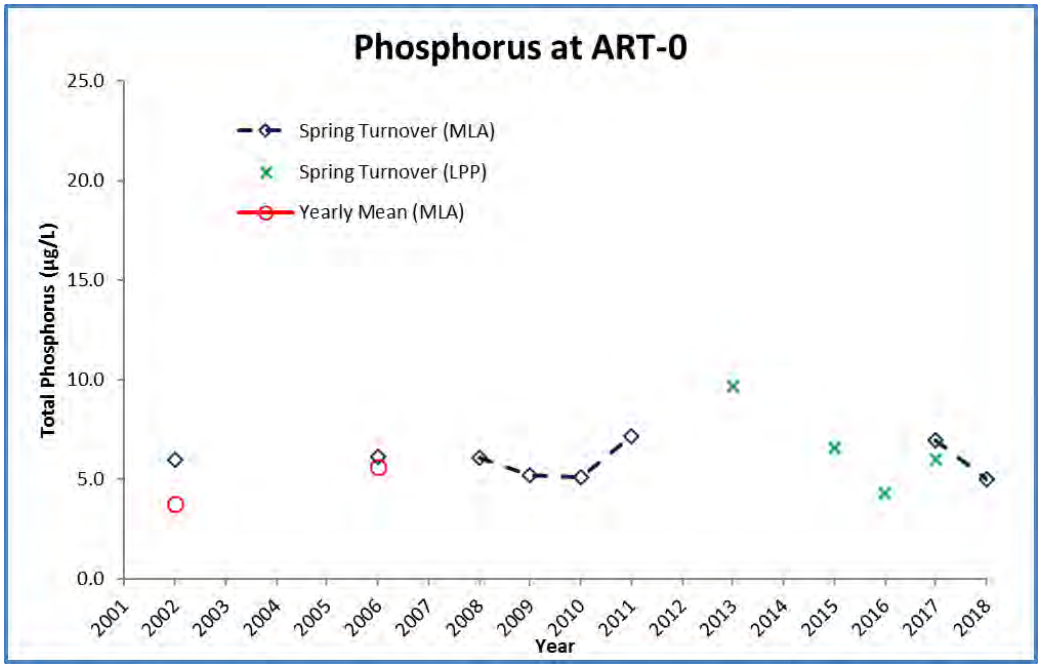
Arthurlie Bay is in the southern basin of Lake Rosseau. The bay is quite shallow in the southern end. Development intensity is considered moderate to high, with some shoreline properties having extensive cleared areas. This bay has several lacustrine wetlands, some of which appear to be partially filled.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

Volunteer Recognition: **Katherine Seybold,** Peter Seybold and the Lake Partnership Program.

Arthurlie Bay (ART)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	4.8	5.0			



Summary and Recommendations:

Phosphorus results remain generally low throughout the sampling years. Lake Partner Program spring phosphorus data was available in 2013, 2015 2016 and 2017. The 2018 Secchi measurement was the deepest Secchi recorded to date at 4.8 m. Generally, Secchi measurements remain stable through sampling years, varying between 3.0 and 3.9. **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 bay, the MLA should continue to monitor this location to analyse long-term trends.**

Area Description:

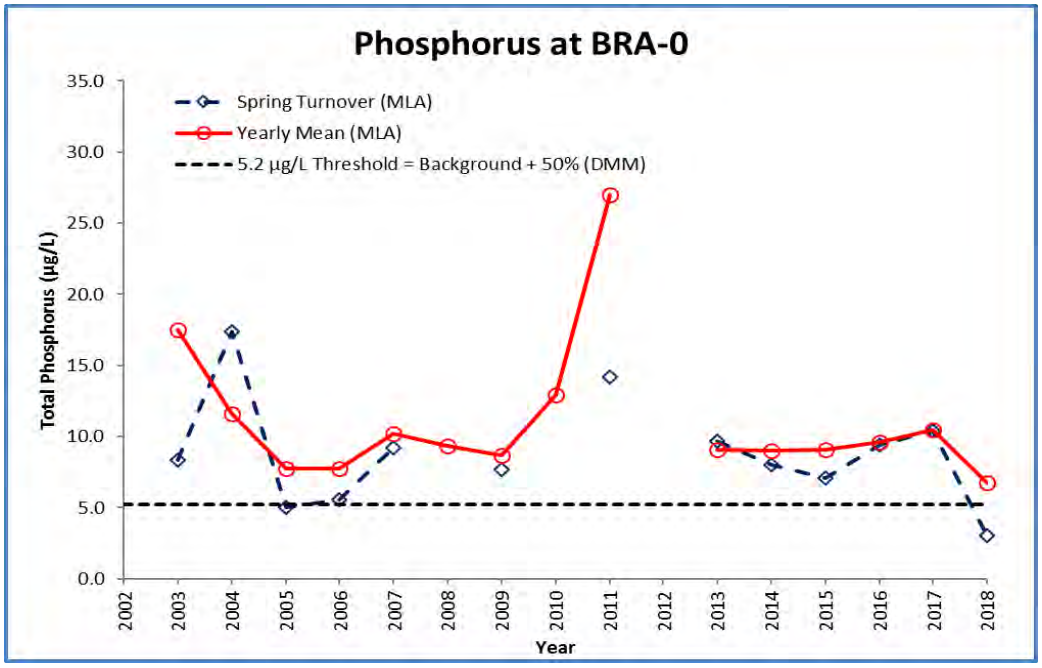
Brackenrig Bay is located in southern Lake Rosseau, is approximately 0.44 km² in area and has a maximum depth of 3 m. This isolated bay is moderately developed with residential properties. Approximately 20% of the immediate shoreline has been altered with over 60% of backlot areas cleared of natural 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 has been 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)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	2.3	3.0	6.8			
BRA-1		4.0	7.5			
BRA-3		3.0	8.3			
BRA-6		4.0	7.0			



Summary and Recommendations:

The 2018 spring phosphorus was below the historic DMM threshold of 5.2 µg/L and the lowest recorded to date. Similarly, the yearly mean phosphorus result is 2018 was also the lowest to date. Spring phosphorus levels at each of BRA-1 (last sampled in 2010), BRA-3 and BRA-6 were the lowest recorded to date. The phosphorus yearly mean at both BRA-3 and BRA-6 were the lowest recorded in the last 3 years at each station. *E. coli* sampling at all stations continued to be suspended in 2018. Secchi measurements vary through sampling years, ranging between 1.45 and 3.10. BRA was given a green stoplight in 2018, changed from a yellow stoplight in 2017. **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 has been classified as highly sensitive and over threshold by the DMM. Monitoring started in 2005. All stations shown may not be sampled each year.

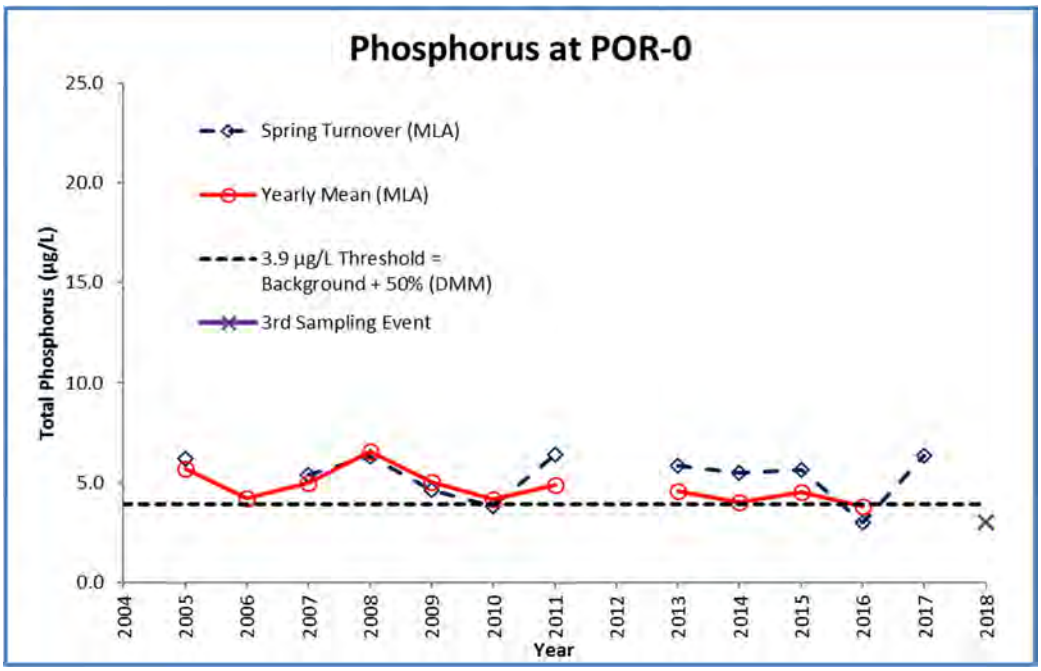
Volunteer Recognition: **Marje Henke, Catherine LeBoeuf, Mike Robinson**, Jill Robinson and Andy Henke.

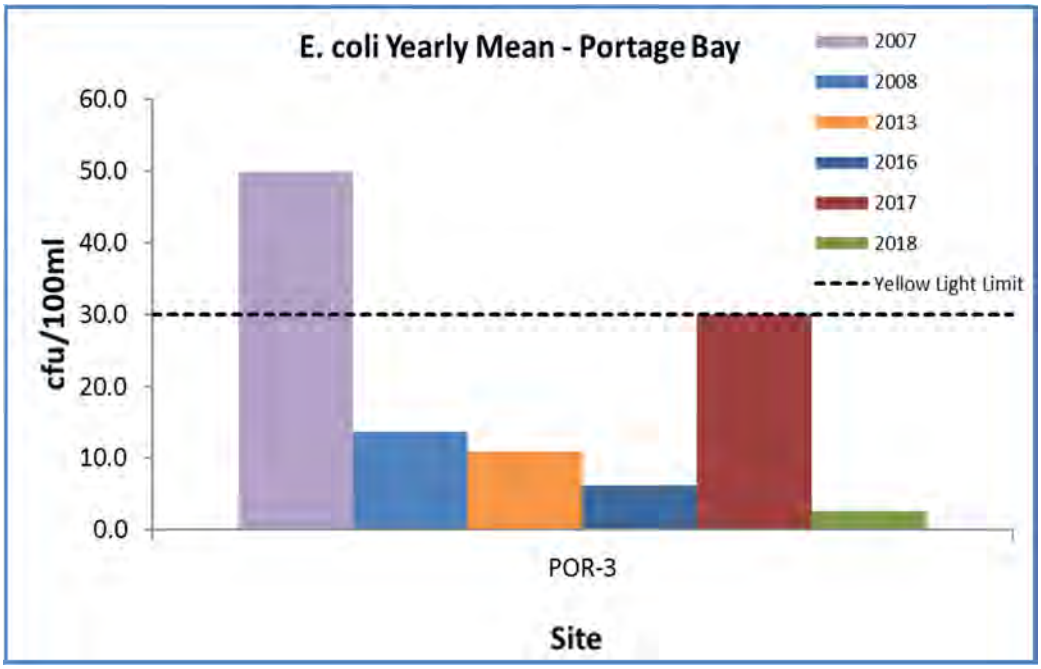
East Portage Bay (POR)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	4.7	*	8.0		
POR-1		13.0	8.5		
POR-3		15.0	6.8	2.6	122.7
POR-5		14.0	5.8		

Notes – *the 2018 spring phosphorus at POR-0 was an outlier and removed from the data set





Summary and Recommendations:

The 2018 spring turnover phosphorus concentration (13 µg/L) at the deep station (POR-0) was identified as an outlier in the Grubb's test and therefore it was removed from the data set in 2018. Similarly, the 2018 spring phosphorus concentrations at POR-1 and POR-3 were the highest recorded to date, and the second highest at POR-5. As well, the yearly phosphorus means at POR-1 and POR-3 were the highest recorded at those stations to date and phosphorus concentrations have been generally increasing over the last three years. *E. coli* sampling was continued at only POR-3 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. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

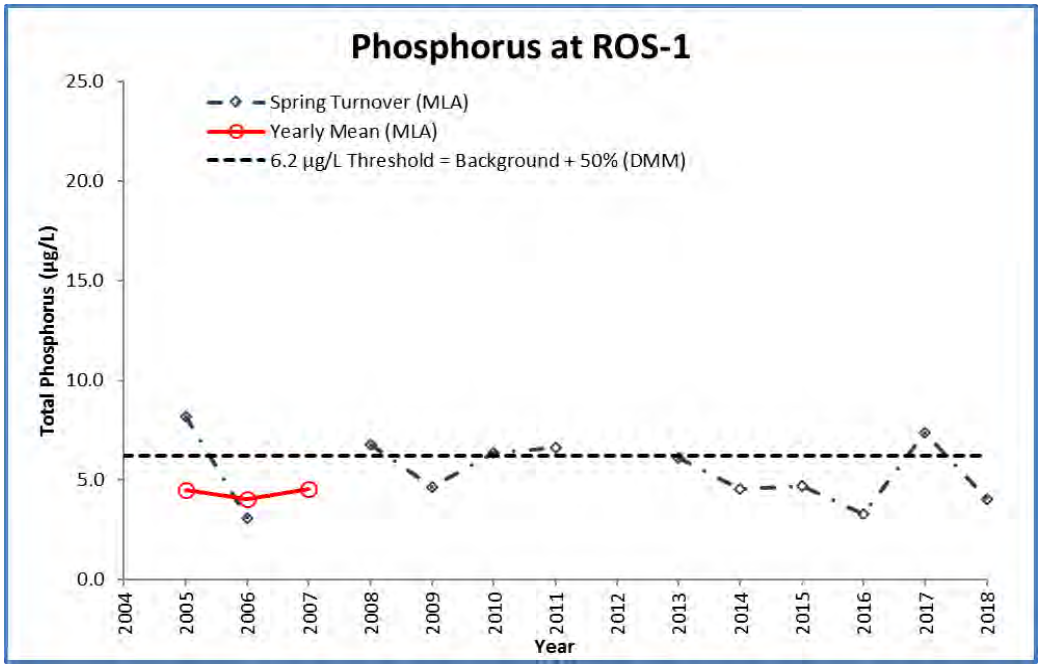
The main basin of Lake Rosseau is approximately 55.5 km² in area with a maximum depth of 60 m. The lake is classified as a coldwater lake and supports a naturally reproducing population of Lake Trout. Wetlands account for 5% of the upper watershed. The Lake Rosseau watershed, excluding the lake itself is 204.5 km². The DMM has classified the lake as moderately sensitive. Monitoring started in 2005.

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

Lake Rosseau (ROS)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	4.7	4.0			



Summary and Recommendations:

The 2018 spring phosphorus concentration at ROS-1 was below the historic DMM threshold of 6.2 µg/L. Only one spring phosphorus sample was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. The mean Secchi measurement in 2018 (averaged from 2 sample dates) was the 2nd deepest recorded to date. **Beacon recommends that spring sampling continue to monitor long-term trends.**

Area Description:

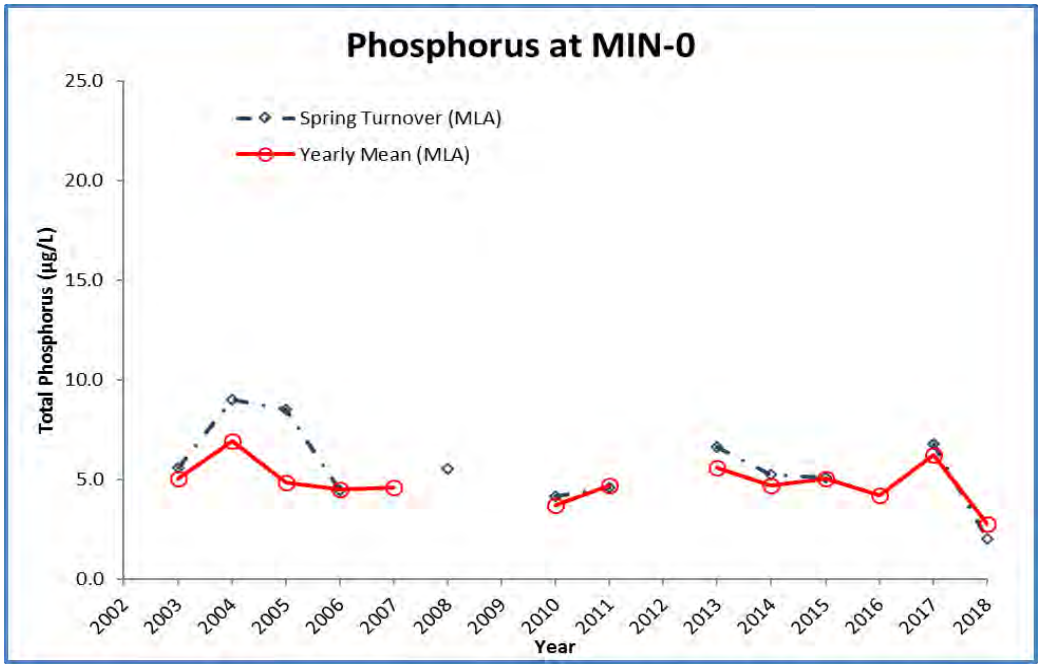
The village of Minett is located in western Lake Rosseau, and has four sampling sites. Sampling sites were selected with the intention of monitoring the potential effects of high intensity development in this bay. The area contains two large resorts with golf courses, several roads, a marina, and many 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.

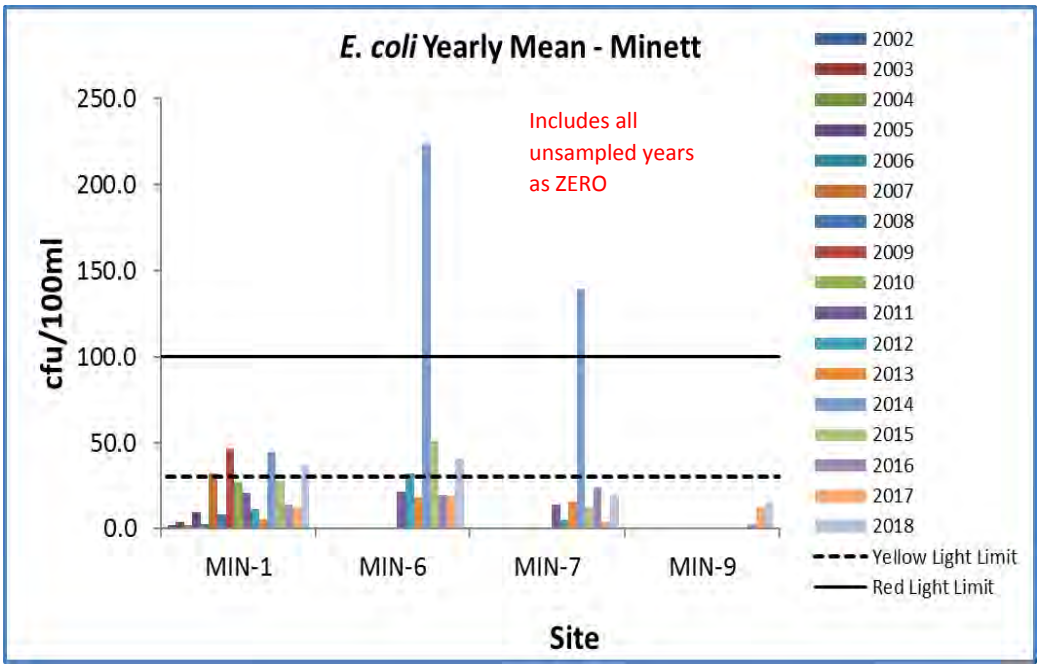
Volunteer Recognition: **Laurie Thomson, Greg Thomson,** Esper Thomson and Taylor Thomson.

Minett (MIN)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

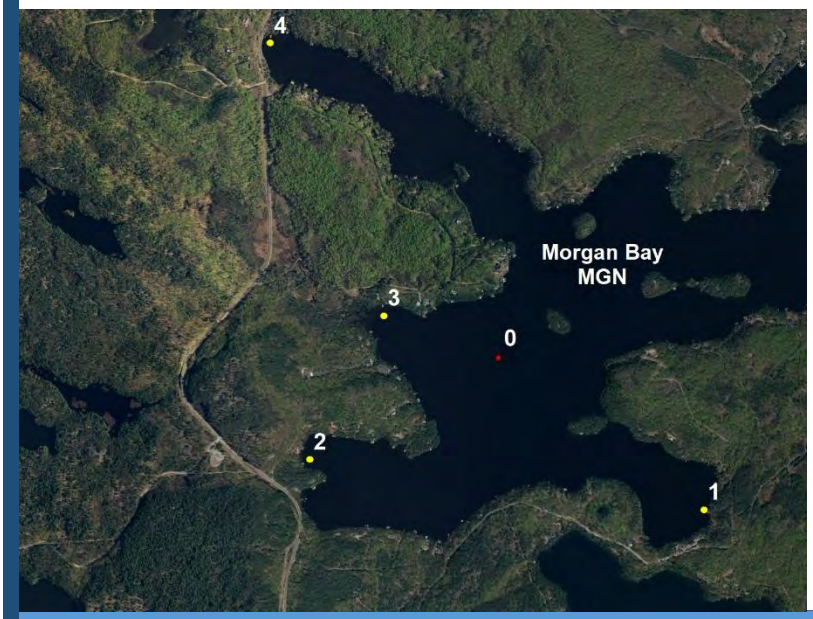
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
MIN-0	3.9	2.0	2.8			
MIN-1		3.0	3.0	37.2	169.0	
MIN-6		10.0	11.5	40.7	223.5	
MIN-7		8.0	6.8	19.6	163.2	
MIN-9		5.0	5.0	14.4	184.1	





Summary and Recommendations:

Yearly mean and spring phosphorus concentrations at the deep station (MIN-0) were the lowest recorded to date. Using Grubb's Test for outliers, the spring 2016 phosphorus sample at MIN-0 was identified as an outlier and was removed from the graph and yearly average for 2018. The 2018 spring phosphorus concentration as well as the yearly phosphorus means at MIN-1 and MIN-6 were the lowest recorded to date. The yearly phosphorus means at MIN-7 was the highest of 8 years recorded to date, resulting from a high recording (15.0 µg/L) in June 2018. The yearly mean *E. coli* results at stations MIN-7 and MIN-9 were below the MLA stoplight limits (details in report Section 3), however at stations MIN-1 and MIN-6 they were slightly above the MLA yellow light limit. Retesting was required for MIN-1, MIN-6, MIN-7, and MIN-9. The 2018 mean Secchi measurement was the lowest measured to date at 3.9 m. **Beacon recommends sampling continue to monitor long-term trends.**



Area Description:

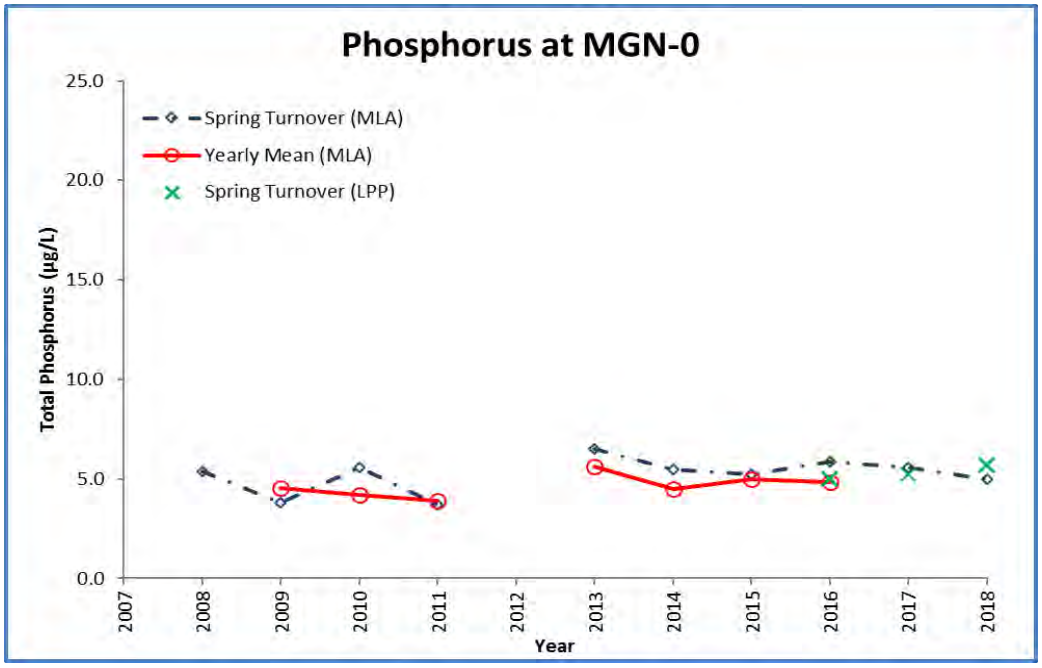
Morgan Bay is in the northernmost part of Lake Rosseau, and a series of small bays make up this large sampling area. Several creeks outlet into this bay close to the nearshore sampling sites and there is a wetland adjacent to the lake at MGN-3. Most of the shoreline area is developed with residential 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: **David Peacock,** Barry Matthews, Nancy Matthews, Heather Cockburn, Andy Cockburn, Mary Anne Peacock and the Lake Partner Program.

Morgan Bay (MGN)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.7	5.0			
MGN-2		3.0	2.8		



Summary and Recommendations:

All spring phosphorus results remain consistent over the sampling years. Only one spring phosphorus sample was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. Lake Partner Program spring phosphorus data was available in 2016, 2017 and 2018, and is included in the graph. Secchi measurements vary through these years, ranging between 2.6 and 5.25. **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:

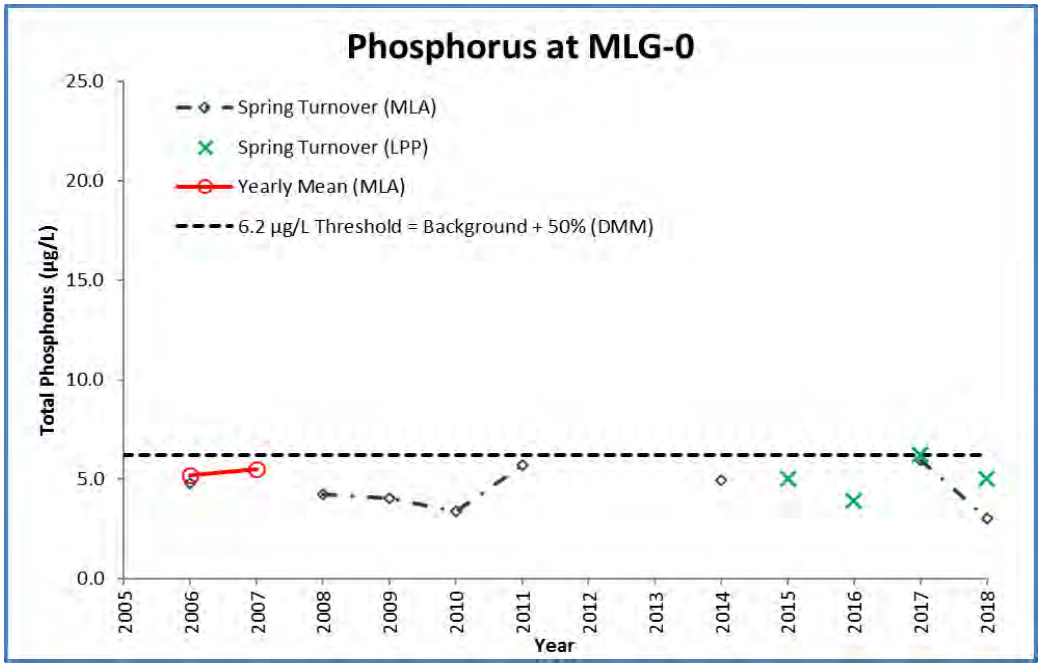
The Muskoka Lakes Golf & Country Club sampling site is located along the southern shore of Lake Rosseau's main basin, near the Town of Port Carling. This bay collects run-off from a golf course area with associated clubhouse and marina. The bay also contains a large wetland that drains into the lake. 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, Susan Carson,** Randy Carson and the Lake Partner Program.

Muskoka Lakes Golf (MLG)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	5.2	3.0			



Summary and Recommendations:

The spring phosphorus concentration at MLG-0 was the lowest recorded to date and was below the historic DMM threshold of 6.2 µg/L. Only one spring phosphorus sample was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. 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 3.2 and 5.35. **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:

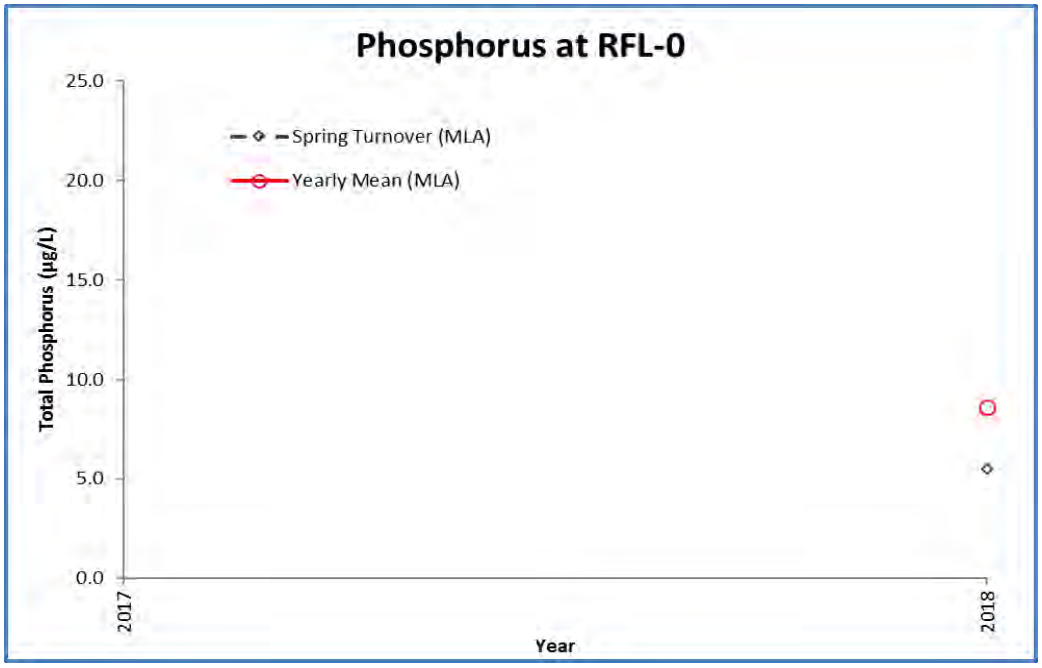
The Rosseau Falls site is located at the point where the Rosseau River enters Rosseau Lake. The Rosseau River Subwatershed flows through the Rosseau River into Lake Rosseau at RFL-1. The Subwatershed is 12,969 hectares in area with 98% identified as natural habitat. Cardwell Lake is the only major water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

Volunteer Recognition: **Sue Wessenger** , John Wessenger, and Jill Levine.

Rosseau Falls (RFL)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.5	5.5	8.6		
RFL-1		21.0	12.5		



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 2018 spring phosphorus as well as the yearly phosphorus mean concentrations at RFL-1 were the highest recorded to date. **Beacon recommends that sampling continue to monitor long-term trends.**

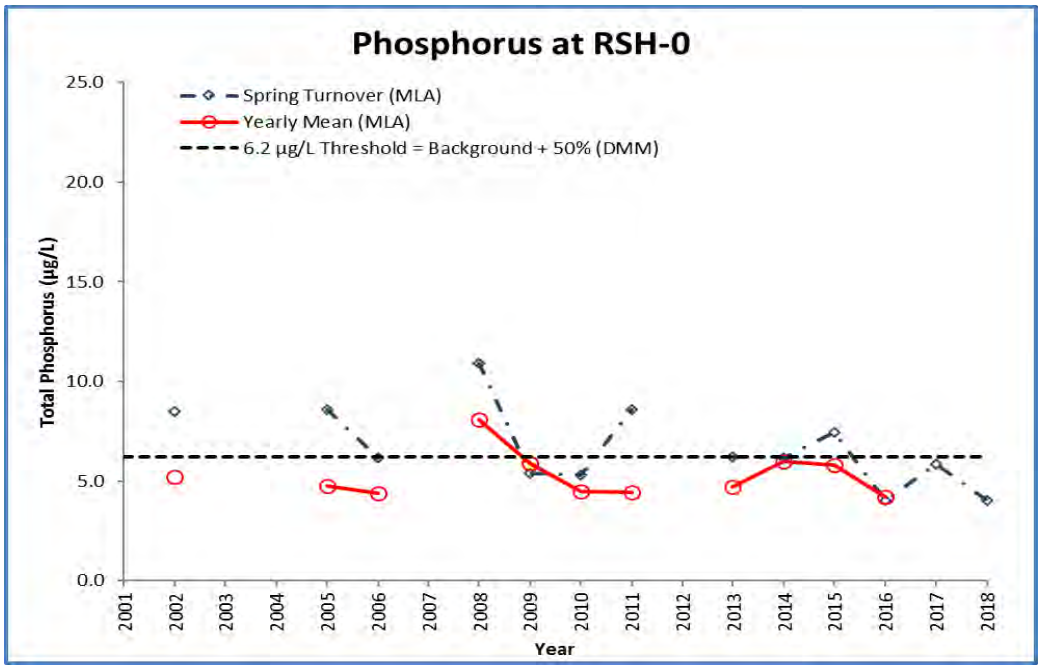
Area Description:

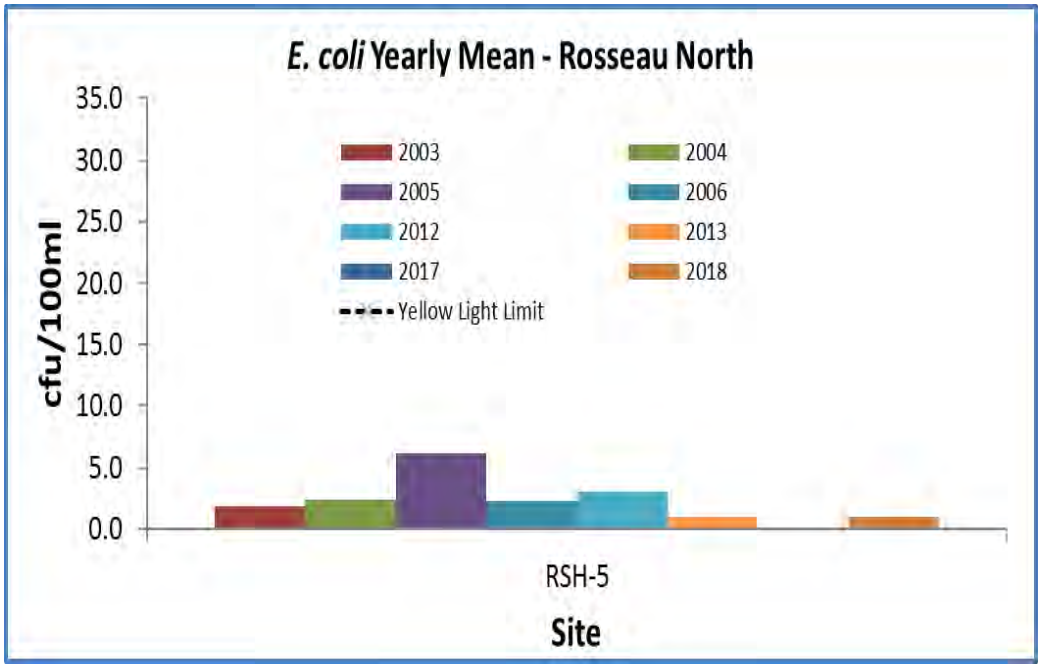
The Rosseau North sampling area is within the limits of the village of Rosseau, at the northern end of Lake Rosseau. Drainage from the village enters the lake at the sampling sites, as well as at the mouth of the Shadow River. Two creeks drain into the bay, one through a lacustrine wetland along the 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: **David Peacock,** Mary Anne Peacock, Barry Matthews, Nancy Matthews, Andy Cockburn and Heather Cockburn

Rosseau North (RSH)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.5	4.0	3.0		
RSH-2	3.3	10.0	5.8		
RSH-4	4.3	5.0	3.0		
RSH-5	3.8	8.0		1	15.6





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 2018, and the lowest recorded to date. Only one spring phosphorus sample was collected at RSH-5 in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. The yearly phosphorus mean at RSH-4 was the lowest recorded to date. *E. coli* sampling restarted in 2018 at RSH-5 and values were well below the MLA stoplight limits (details in report **Section 3**). Secchi measurements somewhat remain stable through sampling years, varying between 2.25 and 5.10. **Beacon recommends that sampling continue to monitor long-term trends.**

Area Description:

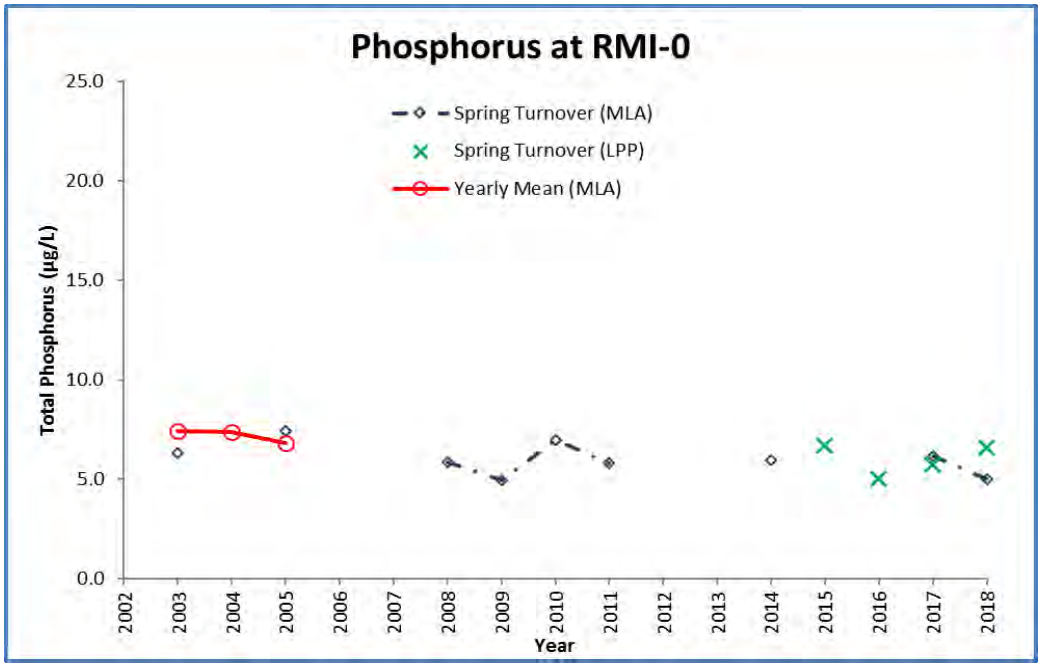
Royal Muskoka Island has one deep-water sampling site located in the central portion of Lake Rosseau. This is a highly developed residential island with many roads and cottages along the shoreline. A large proportion of the interior of the island is cleared or otherwise altered. The eastern shore, opposite 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: **Jayne Schipper**, Jeremy Schipper, Stuart Schipper, and the Lake Partnership Program.

Royal Muskoka Island (RMI)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	4.2	5.0			
RMI-6		8.0		1.4	29.4



Summary and Recommendations:

The spring phosphorus concentration at the deep station (RMI-0) was the lowest recorded to date. The 2018Grubb's Test for outliers identified the 2004 spring phosphorus (9.8 µg/L) as an outlier, and it was removed from the analysis. Lake Partner Program spring phosphorus data was available in 2015, 2016, 2017 and 2018, and is included in the graph. Only one spring phosphorus sample was collected at each of the two stations in 2018, therefore no yearly means could be calculated, and no values are reported for 2018. The RMI-6 site was added in 2017 and data will be analyzed following additional years of gathering samples. The Secchi depth in 2018 was the deepest measured to date and depths have ranged through sampling years, varying between 2.20 and 3.70 (recorded in 2011). **Beacon recommends that the MLA rely on the Lake Partner Program data when it is available, and the MLA should continue to monitor this location to analyse long-term trends.**

Area Description:

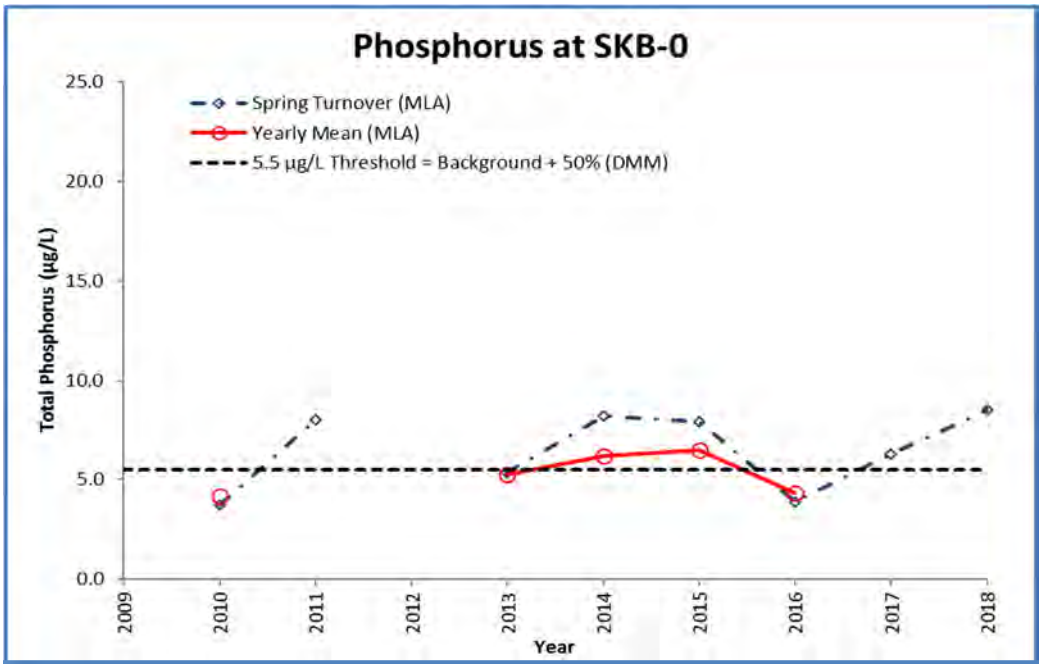
Skeleton Bay is located in the eastern portion of Lake Rosseau's north basin. It is approximately 1.7 km² in size with a maximum depth of 20 m. Highway 141 follows the shoreline in the northeast section of the bay, below a steep, cliffed area. This bay is fed by six watercourses including the Bent River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

Volunteer Recognition: **Jill Lavine** and Jordan Lavine.

Skeleton Bay (SKB)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.5	8.5			
SKB-1		7.0	6.3		



Summary and Recommendations:

As indicated in the graph, the spring turnover phosphorus concentration at the deep station (SKB-0) in 2018 once again exceeded the DMM threshold of 5.5 µg/L, and was the highest recorded to date. Spring phosphorus levels show an increasing trend in the last 3 years, changing the stoplight from green to yellow. Only one spring phosphorus sample was collected at SKB-0 in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. Phosphorus concentrations at SKB-1 remain consistent with historic concentrations. Secchi measurements vary greatly through sampling years, ranging between 2.13 and 9.50. **Beacon recommends continuing the monitoring program.**

Area Description:

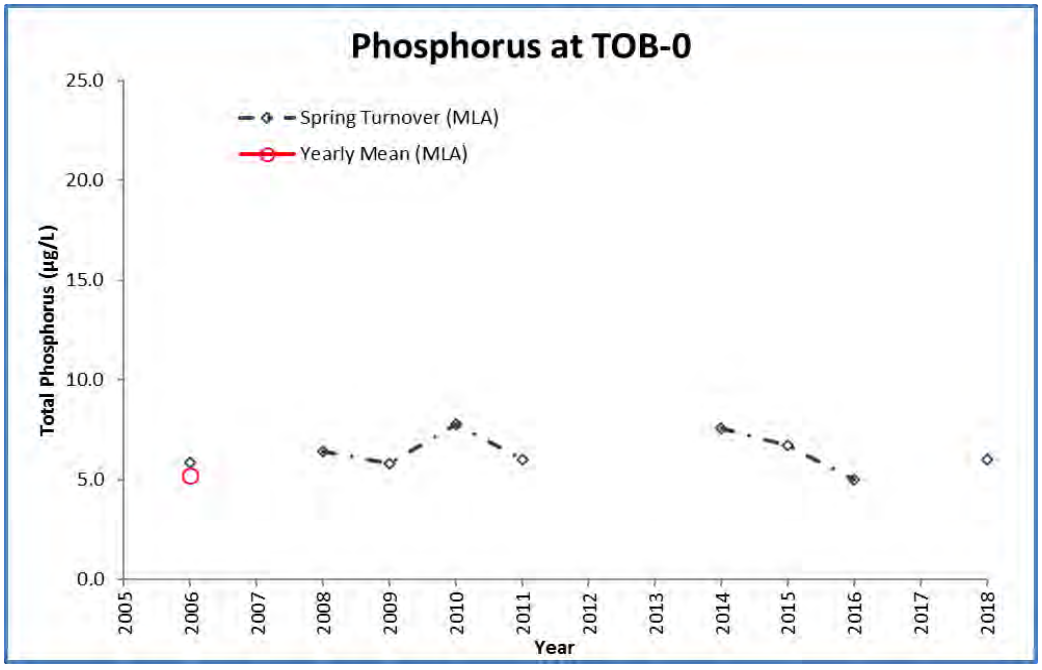
Tobin Island is an open bay area in the central part of Lake Rosseau. The surrounding area is moderately developed with cottage/residential properties along the shoreline and much of the inland forest area remaining in a natural state. Two creeks from adjacent wetland areas drain into the lake within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

Volunteer Recognition: **Jayne Schipper,** Jeremy Schipper, and Stuart Schipper

Tobin Island (TOB)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.8	6.0			



Summary and Recommendations:

The spring turnover phosphorus levels at the deep station are consistent through the sampling years, except for the results from 2017. The 2017 sample was determined to be an outlier following the 2018 Grubb's test analysis and was removed from the dataset. Only one spring phosphorus sample was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. Secchi measurements remain stable through sampling years, ranging between 3.1 and 3.9. **Beacon recommends that sampling continue to monitor long-term trends.**

Area Description:

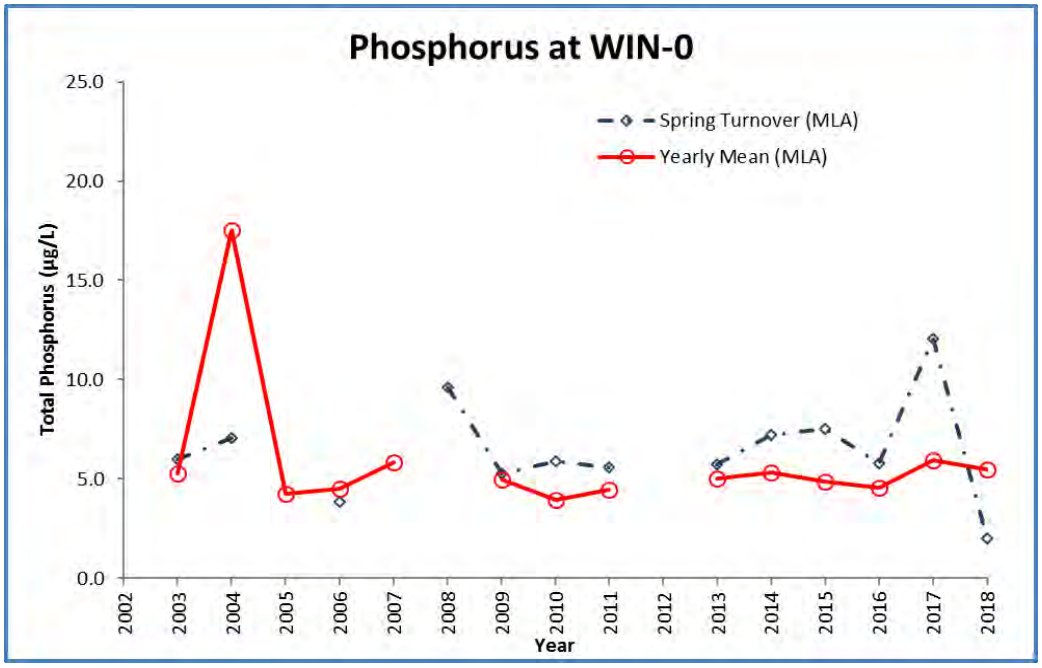
The Windermere village area in northern Lake Rosseau is a highly developed resort and residential area. There is a large resort complex, golf course, marina, and many residential properties. In addition, there is a significant amount of agricultural land nearby. Several creeks outlet into this area, 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.

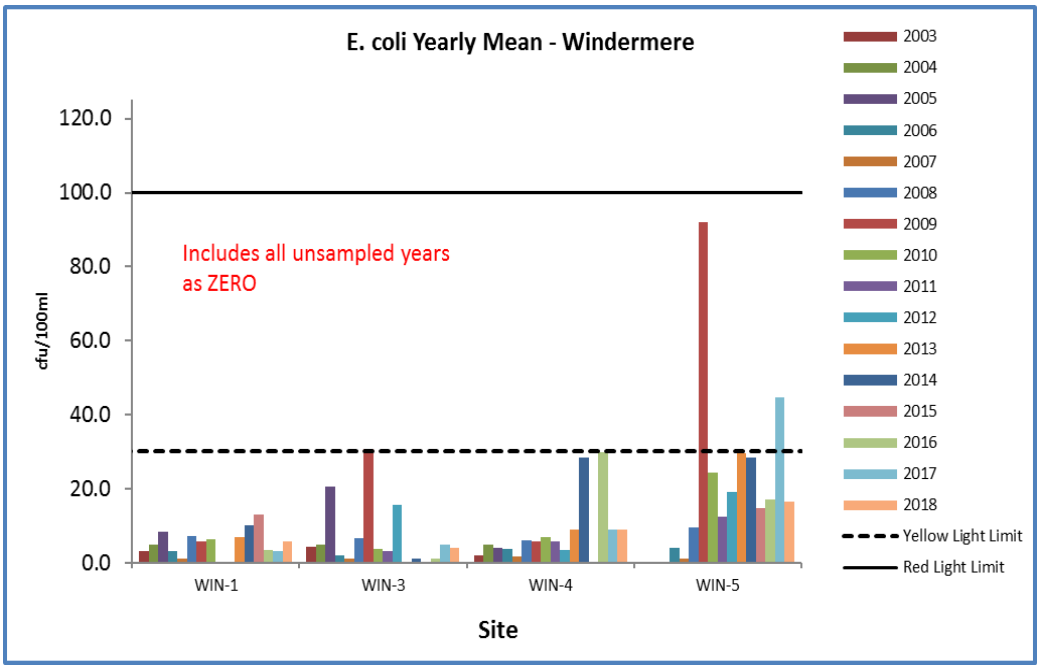
Volunteer Recognition: **Katherine Seybold, Jayne Schipper**, Jeremy Schipper, Stuart Schipper and Peter Seybold.

Windermere (WIN)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	4.2	2.0	5.5			
WIN-1		14.0	18.3	5.8	276.7	
WIN-3		3.0	10.5	4.0	81.2	
WIN-4		5.0	4.0	8.9	172.2	
WIN-5		9.0	12.0	16.6	173.3	
WIN-7		19.0	31.3			
WIN-8		14.0	20.5			





Summary and Recommendations:

The 2018 spring phosphorus concentration at the deep station (WIN-0) was the lowest recorded to date. The 2018 spring phosphorus concentrations at WIN-3, WIN-7 and WIN-8 were the lowest recorded to date. In 2018, elevated phosphorus concentrations were recorded at WIN-7 in July (42.0 µg/L) and August (37.0 µg/L). Values recorded on the same dates at WIN-8, which is downstream of WIN-7 were much lower in July (22.0 µg/L) and August (26.0 µg/L). The phosphorus concentrations >20µg/L cause WIN to be classified as yellow in 2018. *E. coli* yearly mean counts were below the MLA Yellow Light Limit (details in report Section 3) at all stations in 2018. A re-test was required at WIN-5, however the sample was not collected. Secchi measurements vary through sampling years, ranging between 2.75 and 5.70. **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

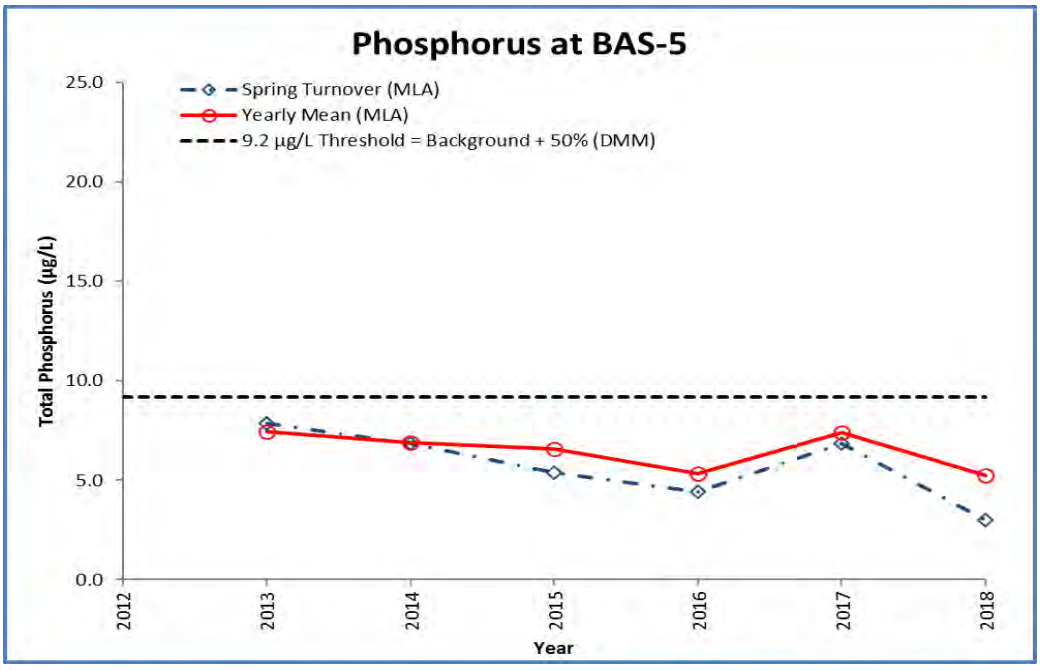
Bass Lake is a small, shallow, moderately developed lake located immediately southwest of Lake Joseph. It is 0.96 km^2 in area with a maximum depth of 8 m. Hwy 169 separates this lake from Lake Joseph at the north end. Bass Lake drains wetlands located to the south and water flows into Stills Bay via Stills Falls. Bass Lake has been 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**, **Bev Turney** and Sam Bodanis.

Bass Lake (BAS)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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		9.0	5.5		
BAS-5	3.1	3	5.3		
BAS-7		3.0	8.5		



Summary and Recommendations:

BAS-5 spring turnover and yearly mean phosphorus concentrations were the lowest values recorded and continue to be below the historic DMM threshold of 9.2 µg/L. The spring phosphorus sample at BAS-5 in 2012 remains removed from the analysis following the Grubb's Test analysis for outliers in 2018. Phosphorus levels at BAS-7 were elevated during mid-summer, causing an elevated mean. Secchi measurements also remain stable through sampling years, varying between 2.38 and 3.75. **Beacon recommends all sampling be continued to monitor long-term trends.**

Area Description:

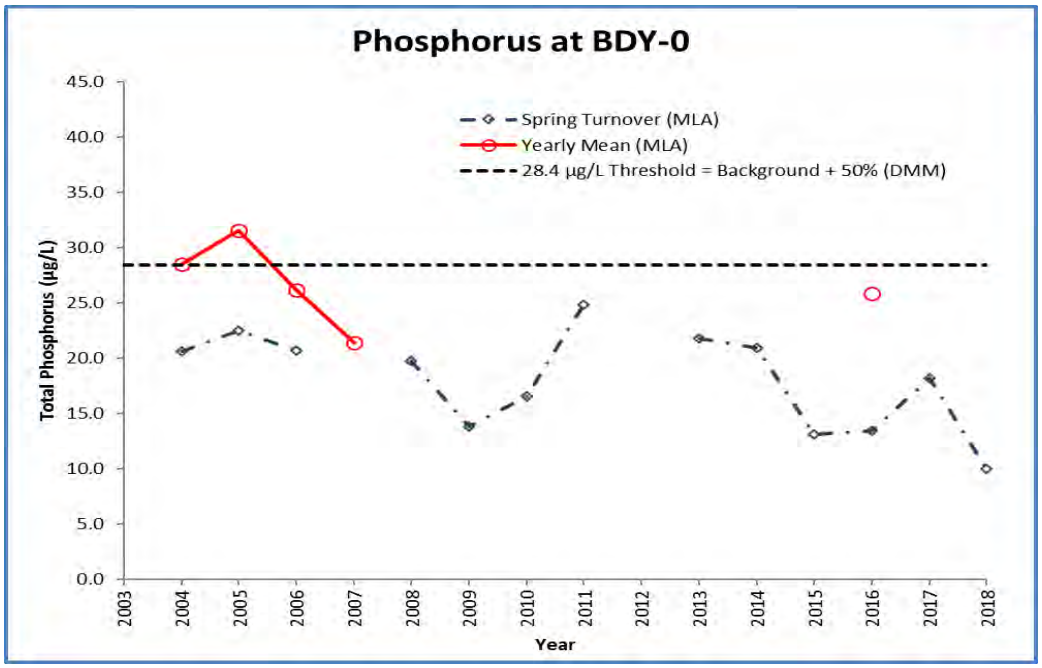
The shoreline of Brandy Lake is moderately developed with many residences and access roads. A large number of the properties maintain a natural shoreline but, there is close to 10% un-buffered lawn. Approximately 40% of the lake shoreline is natural wetland. In the eastern portion of the lake, there 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.

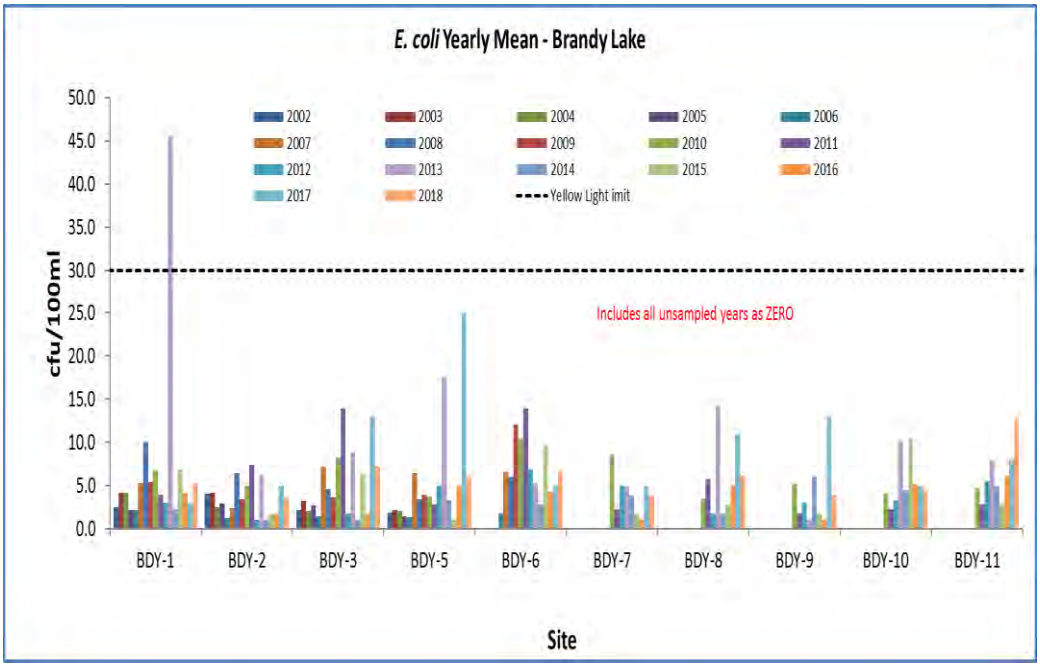
Volunteer Recognition: **Kevin Trimble,** D.Burn, A. von Bredow and Moreen Miller.

Brandy Lake (BDY)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	1.2	10.0			
BDY-1	1.3			5.4	26.6
BDY-2	1.2			3.6	20.0
BDY-3	1.2			7.1	29.6
BDY-5	1.2			5.9	19.1
BDY-6	1.2			6.6	41.7
BDY-7	1.2			3.9	53.1
BDY-8	1.2			6.2	22.2
BDY-9	1.4			4.0	34.7
BDY-10	1.3			4.4	37.9
BDY-11	1.3			12.8	58.5





Summary and Recommendations:

Spring phosphorus concentrations continue to remain consistently below the historic DMM threshold of 28.4 µg/L, with the lowest phosphorus value observed in 2018 of 10.0 ug/L. Only one spring phosphorus sample was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. All the 2018 *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 2018. Secchi measurements remain stable through sampling years, varying between 0.44 and 3.1. **Beacon recommends continued sampling to monitor long-term trends.**

Area Description:

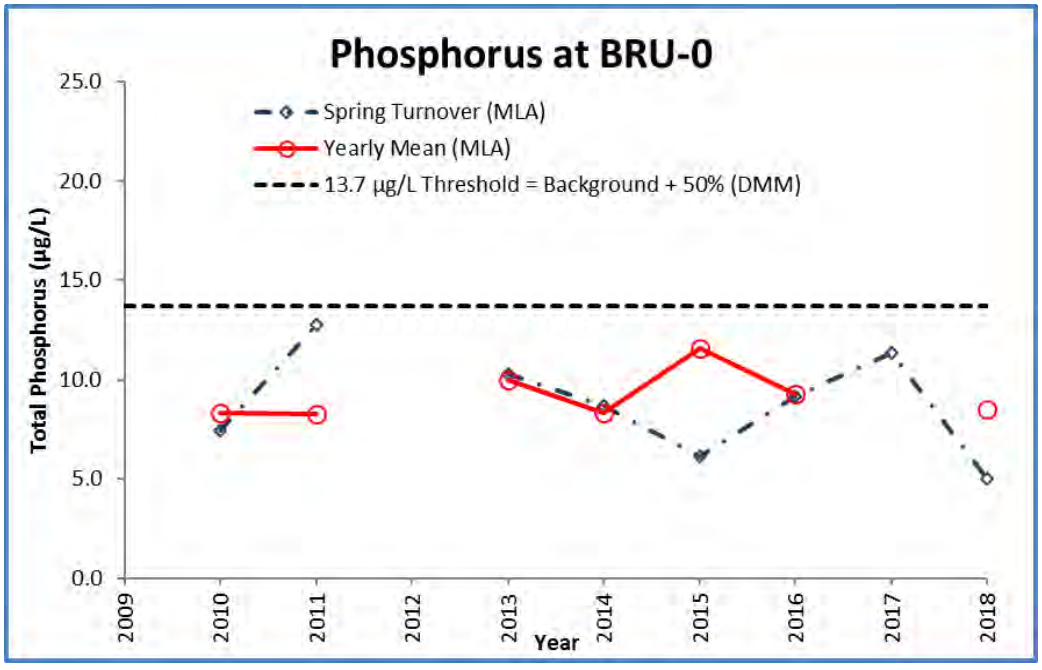
Bruce Lake is located east of Hwy 632, between Lake Joseph and Lake Rosseau. It is relatively small in size at 1.0 km^2 and has a maximum depth of 6 m. Approximately 25% of the catchment area for this lake is made up of wetlands. The lake is moderately developed and there is a golf course located immediately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

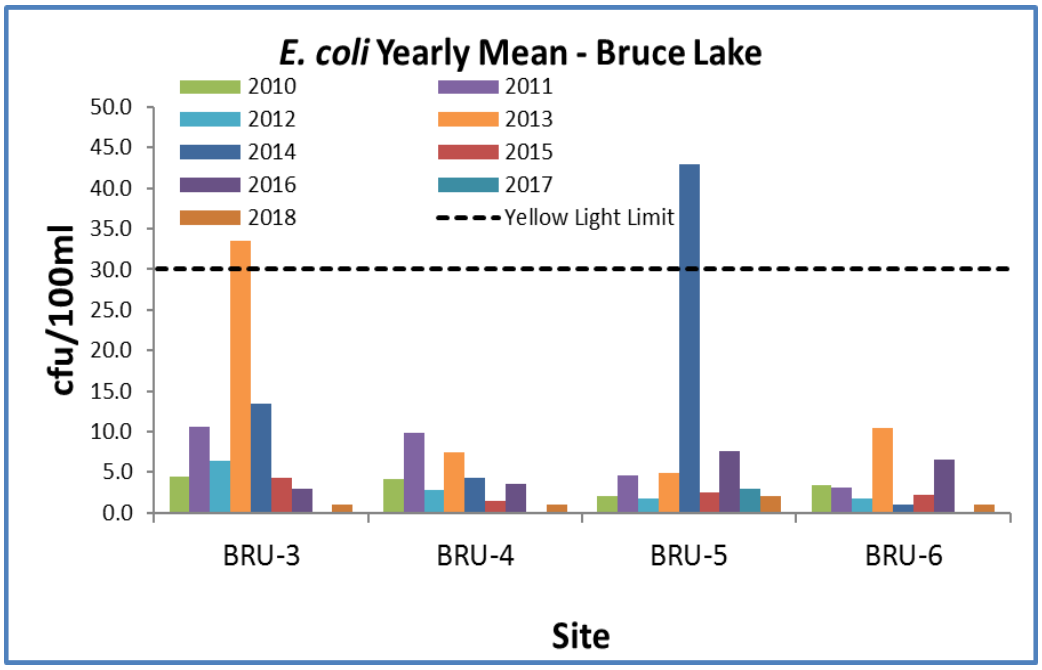
Volunteer Recognition: **Brian Beatty, Richard Eaves and Joanna Eaves.**

Bruce Lake (BRU)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.5	5.0	8.5		
BRU-3		3.0	5.0	1	33.5
BRU-4		7.0	4.8	1	21.8
BRU-5		4.0	4.3	2.1	45.4
BRU-6		5.0	5.0	1	28.7





Summary and Recommendations:

Phosphorus concentrations continue to remain consistently below the historic DMM threshold of 13.7 µg/L through all sampling years at BRU-0, with the lowest phosphorus concentration to date (5.0 µg/L) observed in 2018. The 2018 spring phosphorus concentrations at BRU-3, BRU-5 and BRU-6 were the lowest recorded to date. As well, the yearly phosphorus means at BRU-3, BRU-4, BRU-5 and BRU-6 were the lowest recorded at those stations to date. All the 2018 *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. Secchi measurements also remain stable through sampling years, varying between 2.4 and 4.75. **Beacon recommends that sampling continue to monitor long-term trends.**

Area Description:

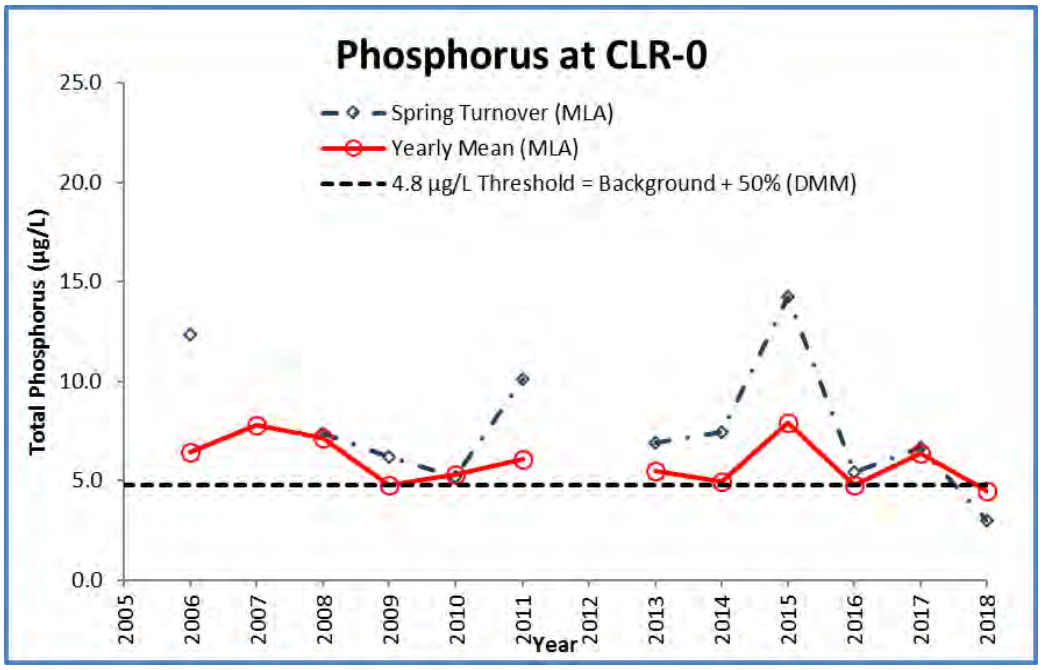
Clear Lake, also called Torrance Lake, is a moderately developed lake with much of the shoreline area converted into residential lots. It is also adjacent to highway 169. This lake is 152 ha in size, has a maximum depth of 16 m and has a very small watershed. There is limited inflow and outflow of water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

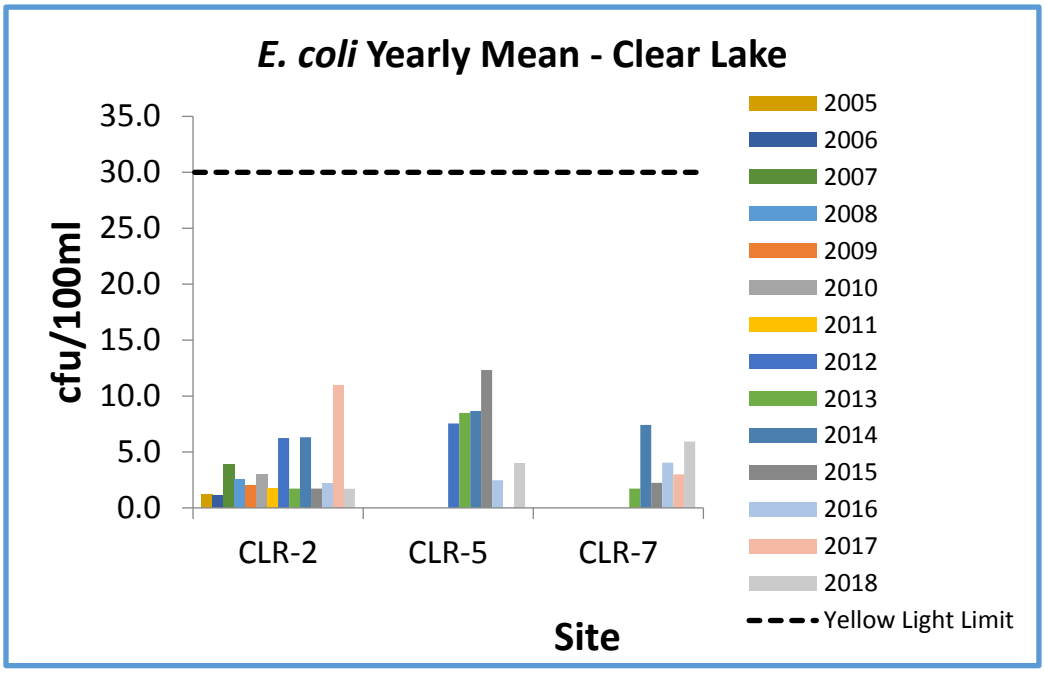
Volunteer Recognition: **Bob** and **Sharon Cleverdon.**

Clear Lake (CLR)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	6.4	3.0	4.5		
CLR-2		7.0	3.8	1.7	21.4
CLR-5		2.0	2.3	4.0	37.3
CLR-7				5.9	23.8





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 2018, and the lowest recorded to date. The spring phosphorus concentration at CLR-5 and the phosphorus yearly mean at both CLR-2 and CLR-5 were the lowest recorded in the last 5 years at each station. The *E. coli* levels at the three nearshore sites sampled in 2018 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. **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 km^2 in size. Gull Lake is classified as moderately sensitive by the DMM. Monitoring started with the original program in 2003. All stations shown may not be sampled each year.

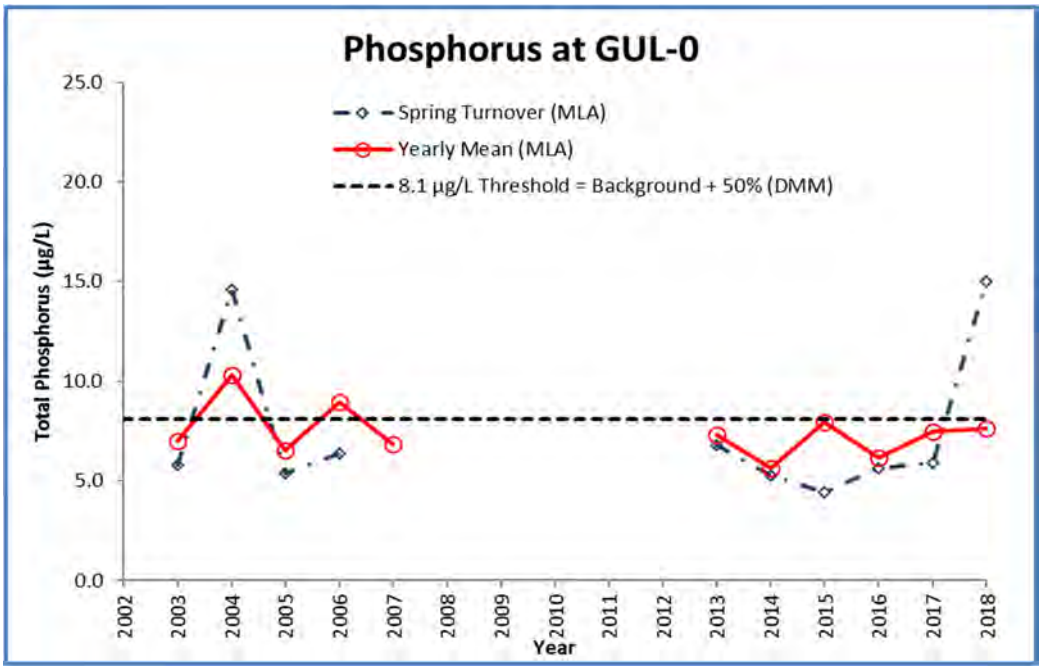
Volunteer Recognition: Bruce Elliott,

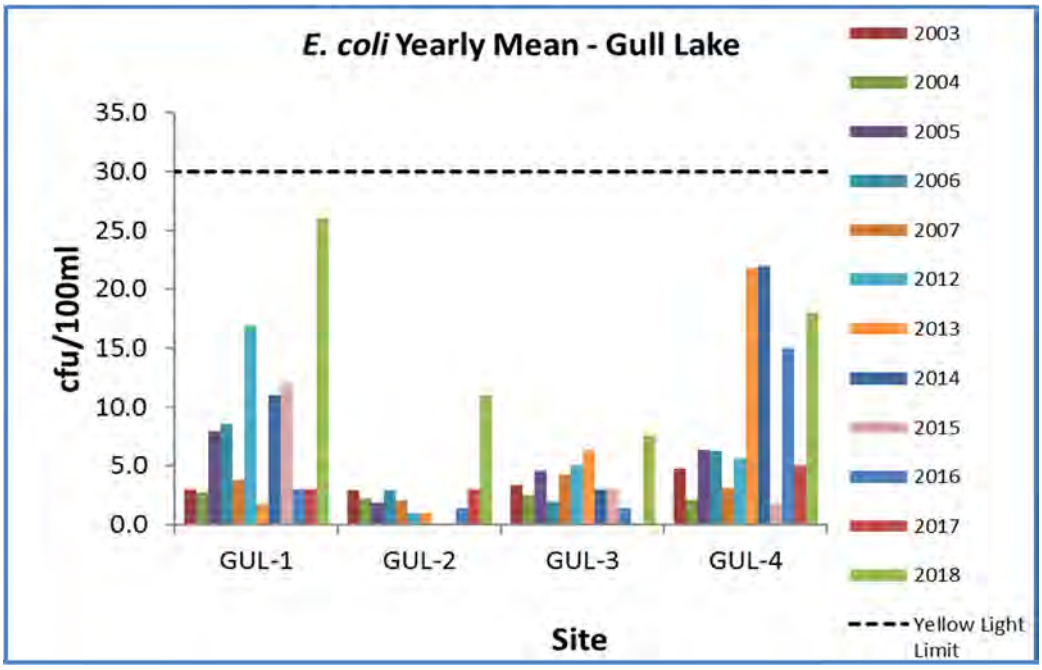
Peter Elliott, Ross Elliott and Anne Elliott.

Gull Lake (GUL)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.7	15.0	7.7		
GUL-1				26	100.4
GUL-2				11	71.7
GUL-3				7.5	65.1
GUL-4				18.0	74.0





Summary and Recommendations:

The spring turnover at the deep station (GUL-0) in 2018 was above the historic DMM threshold of 8.1 µg/L and was the highest recorded to date. Phosphorus levels show an increasing trend in the last 3 years, changing the stoplight from green to yellow. Using Grubb's Test for outliers, the spring 2004 phosphorus sample at GUL-0 was no longer an outlier in 2018. The yearly phosphorus mean was consistent with values recorded through the years at GUL-0. *E. coli* counts have continued to be well below the MLA stoplight limits, however levels increased in 2018 (details in report Section 3) at all four nearshore sites. Re-tests were required at GUL-1, however these were not completed. The Secchi depths remain stable through the years and measurements have ranged through sampling years, varying between 2.5 and 4.8 (recorded in 2016). **Beacon recommends sampling be continued to monitor long-term trends at all sites.**

Area Description:

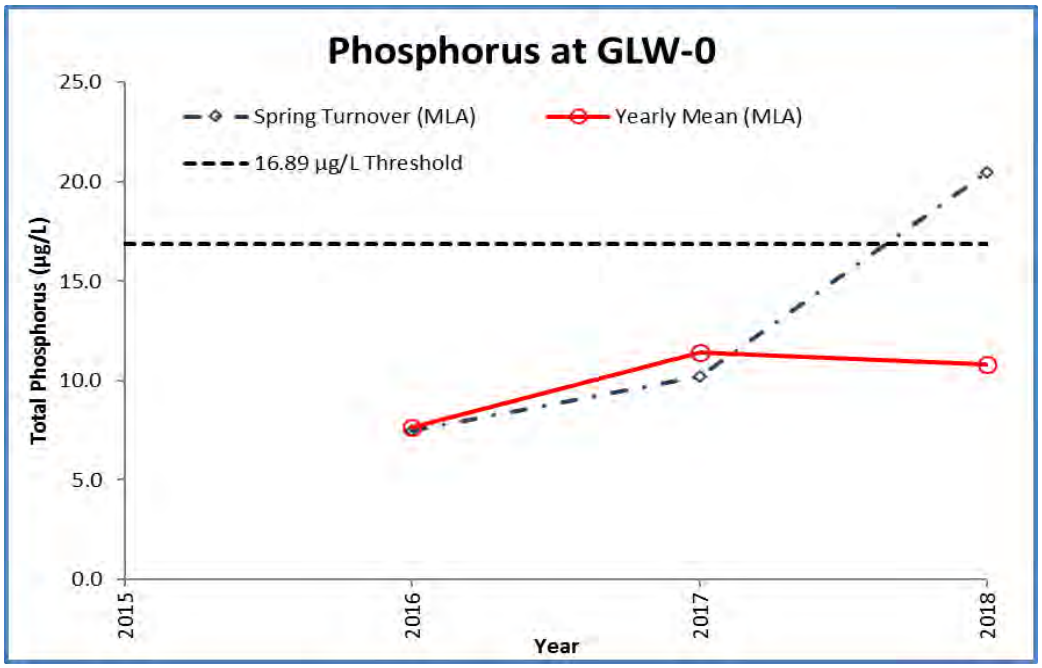
Gullwing Lake is a lake of moderate size (82 hectares) located just south of Torrance. The maximum depth is 9 m and the mean depth is 4m. The watershed for the lake is 5.71 km^2 and is listed as having moderate sensitivity by the District Municipality of Muskoka. Development around the shoreline varies 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.

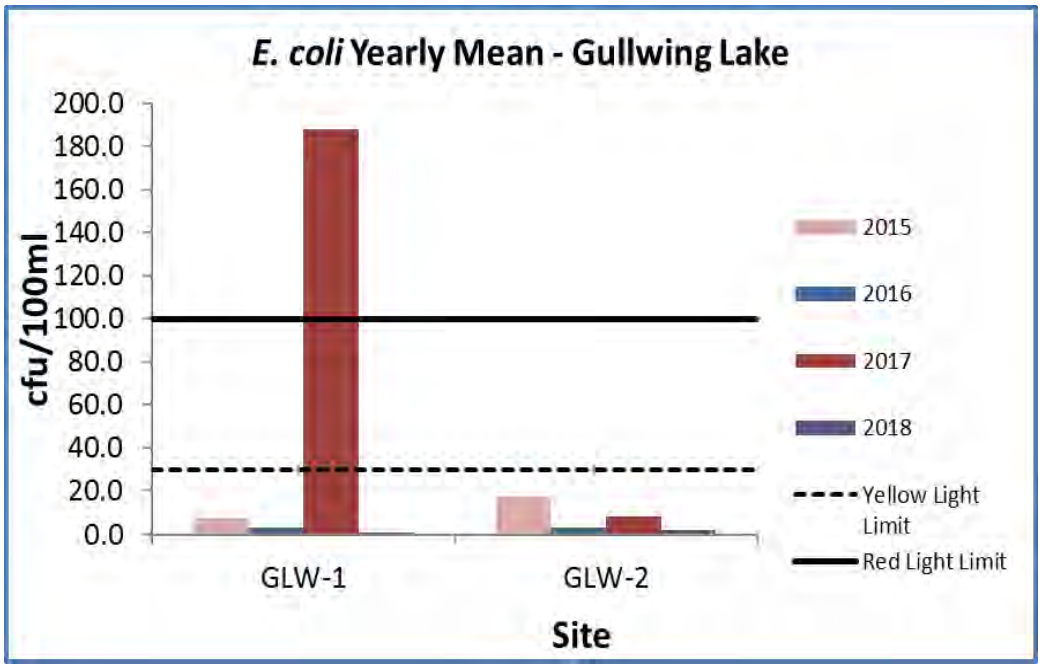
Volunteer Recognition: **Kellie Dobson, Kim Enns and Donna Di Lello.**

Gullwing Lake (GLW)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

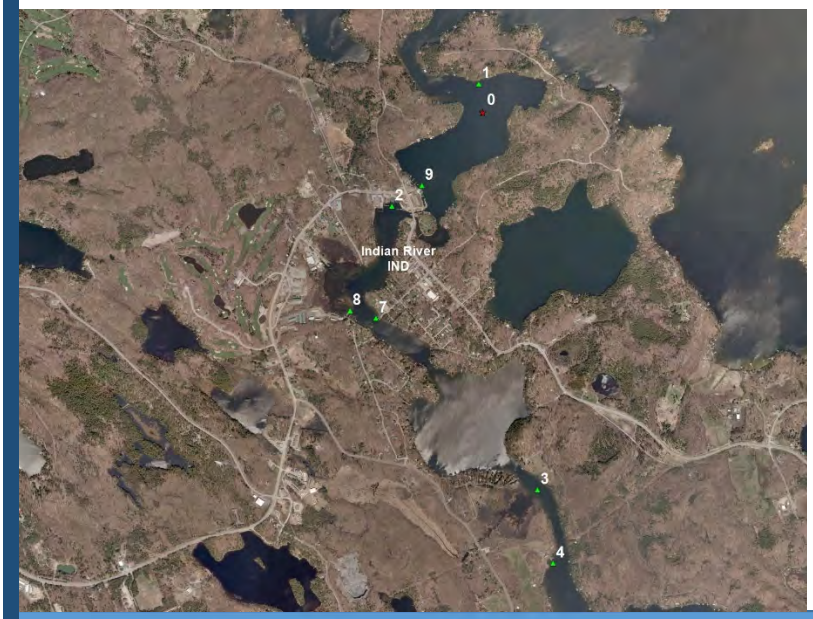
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
GLW-0	2.1	20.5	10.8		
GLW-1		17.0	10.5	1.0	143.1
GLW-2		19.0	9.8	2.0	130.2





Summary and Recommendations:

The GLW-0 sampling station was established in 2016 and phosphorus concentrations remained below the historic DMM threshold of 16.89 µg/L through 2016 and 2017 but exceeded it in 2018. The yearly phosphorus mean at GLW-0 shows an increasing trend in the last 2 years. The spring phosphorus at GLW-0 was >20µg/L, causing it to be classified as yellow in 2018. Although the spring phosphorus concentrations at GLW-1 and GLW-2 were the highest of the three years sampled, the yearly phosphorus means at these stations were the second lowest to date, resulting from low phosphorus levels at the last 2 sampling dates. The 2018 *E. coli* yearly mean for both GLW-1 and GLW-2 were well below the yellow light limit. The Secchi measurement was the lowest value measured to date. **Beacon recommends that sampling continue to monitor long-term trends.**



Area Description:

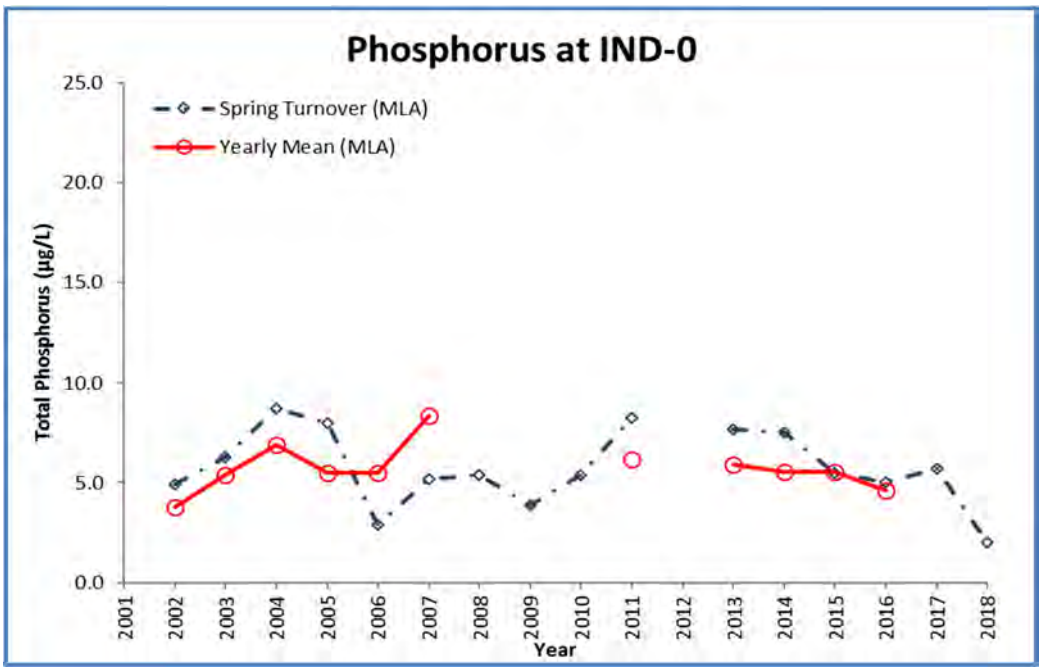
The Indian River flows from Lake Rosseau, through Port Carling and into Mirror Lake and Lake Muskoka. This highly developed area receives stormwater from the Port Carling urban centre. It also has high boat traffic, a locks system, marinas and many commercial and residential properties. A large lacustrine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

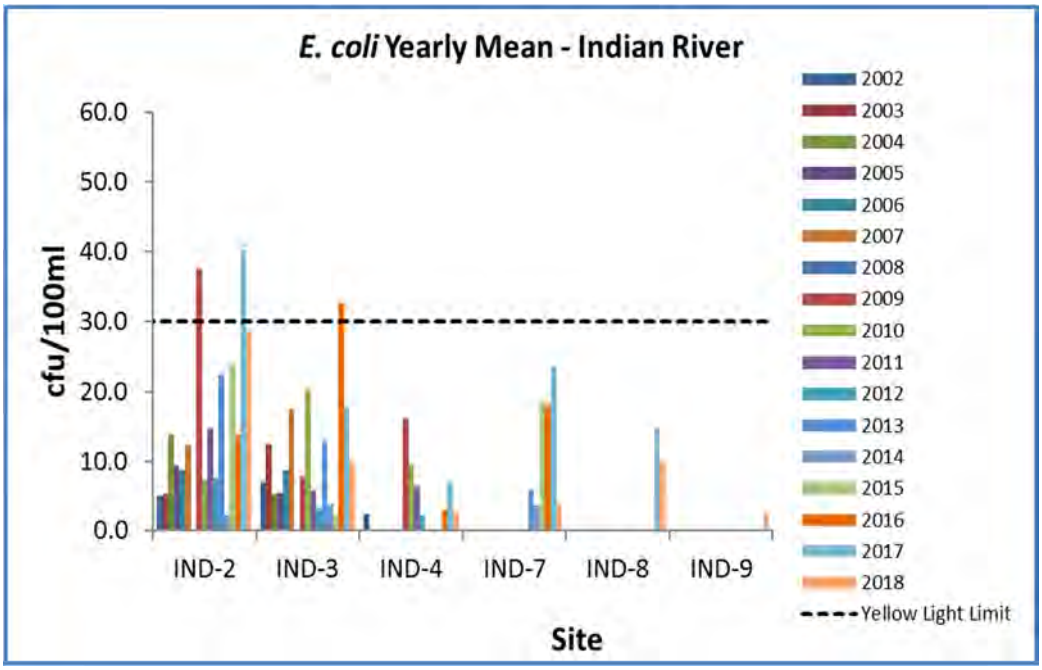
Volunteer Recognition: **Susan Carson, Ian Turnbull, Dianne Turnbull** and **Randy Carson.**

Indian River (IND)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

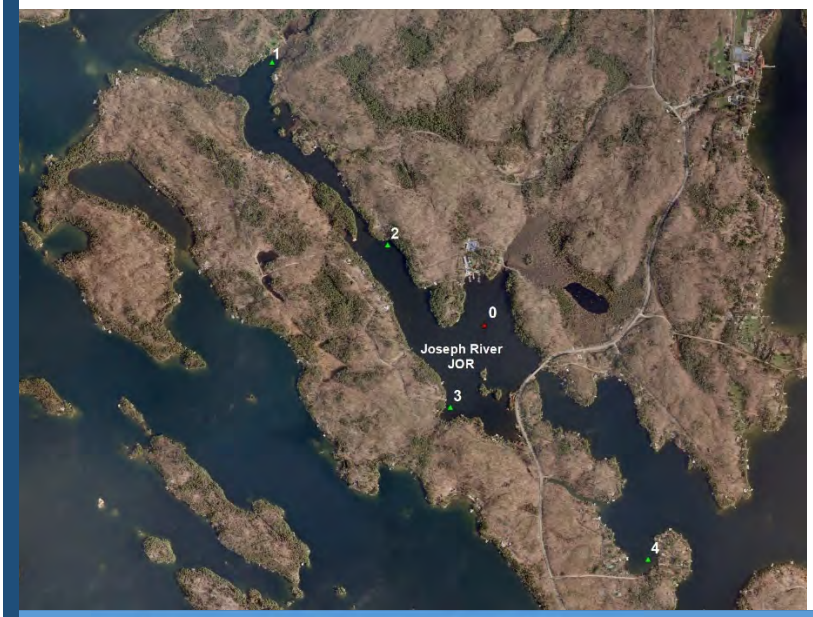
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)	DOC Yearly Mean
		Spring Turnover	Yearly Mean			
IND-0	4.2	2.0				
IND-2				28.5	269.3	
IND-3				10.1	293.1	
IND-4				2.4	37.0	
IND-7		2.0	3.8	3.9	262.1	
IND-8		4.0		10	166.4	
IND-9		2.0		2.5	47.0	





Summary and Recommendations:

The 2018 spring phosphorus concentration at IND-0 was the lowest recorded to date. Spring phosphorus results at IND-0 have generally been decreasing in the last 5 years. Only one spring phosphorus sample was collected in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. Spring phosphorus and yearly phosphorus mean values at IND-7 were the lowest recorded to date. Sites IND-8 and IND-9 were new in 2017 and show results consistent with the other sites in 2018 with low spring phosphorus. *E coli* concentrations observed in 2018 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. IND was given a green stoplight in 2018, changed from a yellow stoplight in 2017. **Beacon recommends that all sampling be continued to monitor long-term trends and *E. coli* levels.**



Area Description:

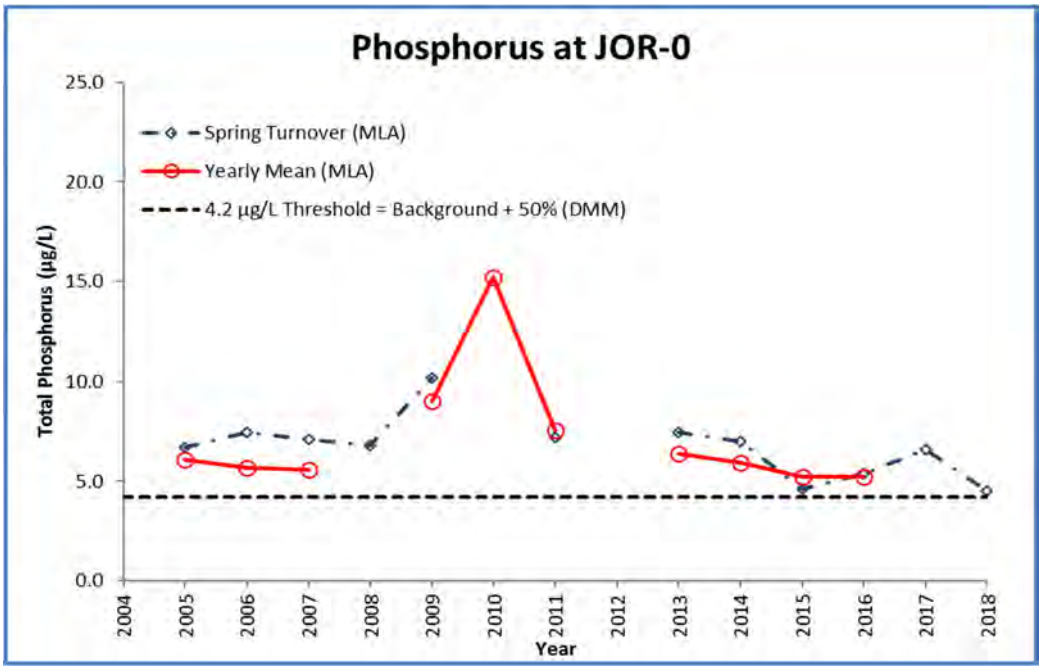
The Joseph River is the water body connecting Lake Joseph and Lake Rosseau. The river is 1.37 km² in size and up to 8 m deep. Direction of flow is from Lake Joseph into Lake Rosseau. A marina, a bridge crossing for Peninsula Road and two wetlands are located adjacent to the channel. This area receives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

Volunteer Recognition: **Beth Guy**

Joseph River (JOR)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.6	4.5			
JOR-1		6.0	3.8		
JOR-2		4.0			



Summary and Recommendations:

Phosphorus results at JOR-0 remain consistent over the sampling years, and slightly above the historic DMM threshold of 4.2 µg/L. Only one spring phosphorus sample was collected at JOR-0 in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. The spring phosphorus concentration at JOR-1 was the second lowest to date and the yearly phosphorus mean concentration was the lowest to date. Only spring phosphorus was acquired at JOR-2 in 2018 and that result was the second lowest spring phosphorus concentration to date. Secchi measurements also remain stable through sampling years, varying between 2.5 and 5.38. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

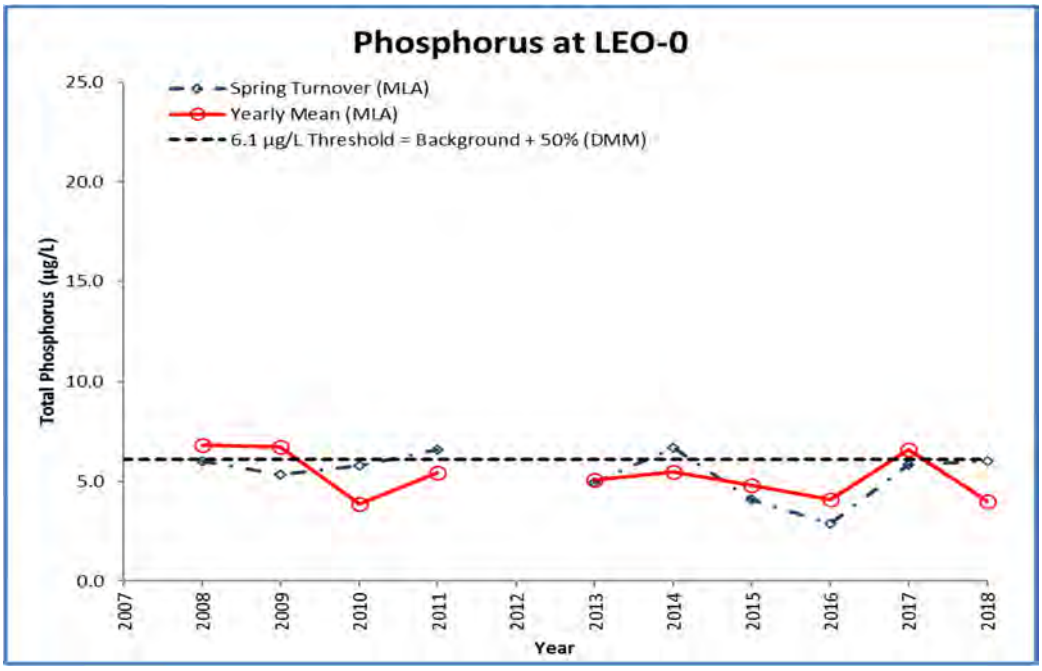
Leonard Lake is a medium sized lake at 1.52 km² in size and has a maximum depth of 16 m. This lake is moderately developed with primarily residential properties. Immediate shoreline alteration is limited to 9% but backlot clearing and forest thinning is found in 77% of properties. There is limited inflow and outflow of water on this lake, and few wetlands in the vicinity. Leonard Lake is classified as moderately sensitive and over-threshold by the DMM. Monitoring started in 2008. All stations shown may not be sampled each year.

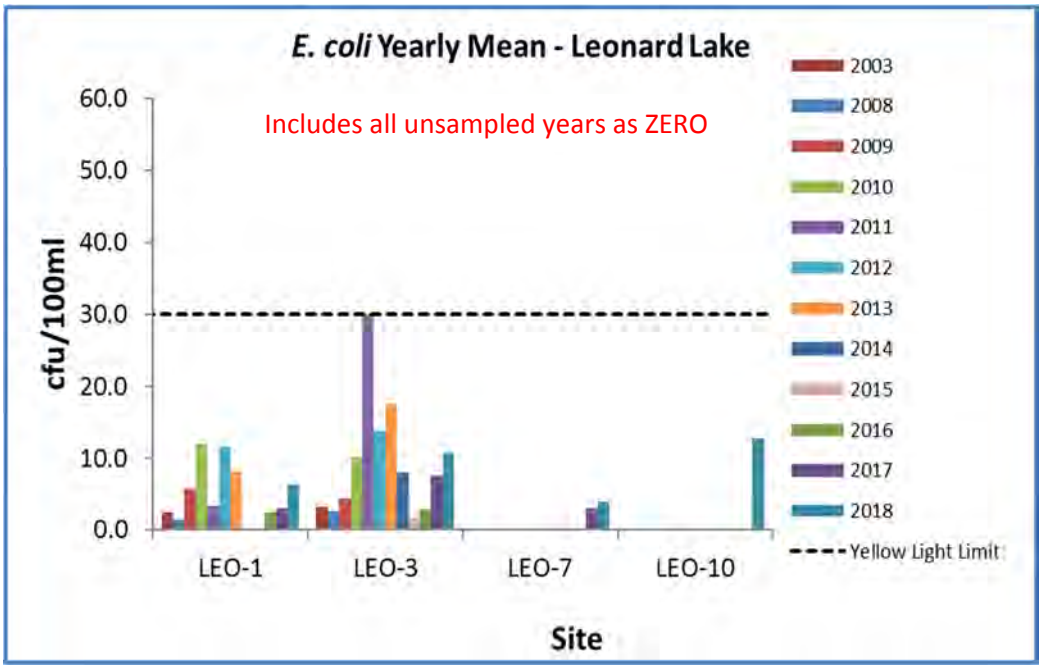
Volunteer Recognition: **Gordon Roberts, Betty Isbister, Ester Giesbrecht,** and Bruce McNeely**.**

Leonard Lake (LEO)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

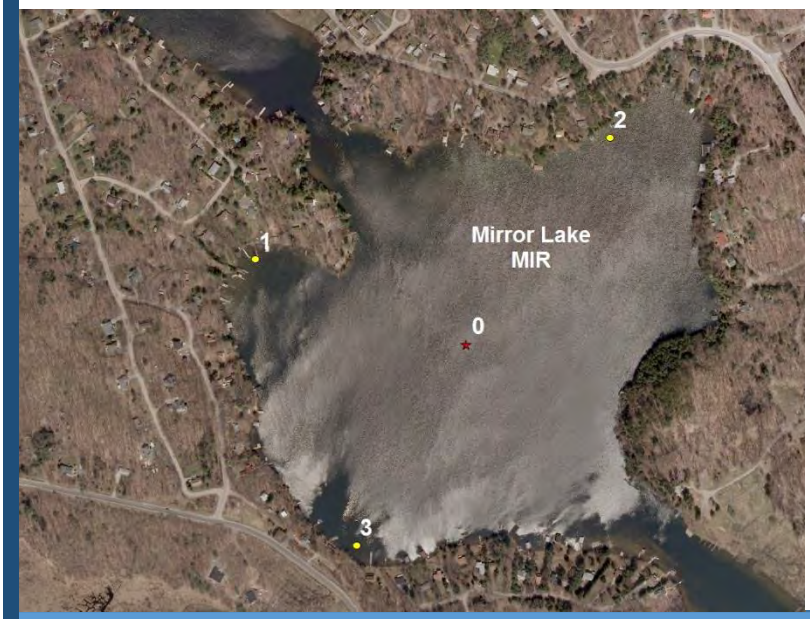
Station	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		*E. coli* Yearly Geometric Mean (cfu/100 ml)	Total Coliform Yearly Geometric Mean (cfu/100 ml)
		Spring Turnover	Yearly Mean		
LEO-0	4.3	6.0	4.0		
LEO-1			4.7	6.4	176.9
LEO-3		6.0	5.8	10.6	141.6
LEO-7		3.0		4.0	96.4
LEO-8	4.2	3.0	3.3		
LEO-9	4.1	2.0	3.0		
LEO-10			2.3	12.7	97.6
LEO-11	4.3	5.0	5.3		





Summary and Recommendations:

Two new nearshore stations were established at LEO-8 and LEO-11 to investigate phosphorus concentrations. The spring phosphorus concentration in 2018 remained below the historic DMM threshold of 6.1 µg/L. The yearly phosphorus mean at LEO-0 was the second lowest recorded to date (3.9 µg/L in 2010). Spring phosphorus levels were not recorded at LEO-1, and those recorded at LEO-3 and LEO-7 are consistent with values obtained previously. Yearly phosphorus means at LEO-1 and LEO-3 are also consistent with data obtained previously, and since only spring phosphorus was obtained at LEO-7, there is no yearly phosphorus mean value to compare with the only other year of sampling (2017). This was the first year for spring phosphorus sampling at LEO-8, LEO-9, LEO-10 and LEO-11. *E. coli* counts were slightly higher than values observed in 2017 and all yearly *E. coli* means at each of the nearshore stations were well below the MLA stoplight limits. Secchi measurements remain stable through sampling years, varying between 3.25 and 6.0. **Beacon recommends that all sampling be continued to monitor long-term trends.**



Area Description:

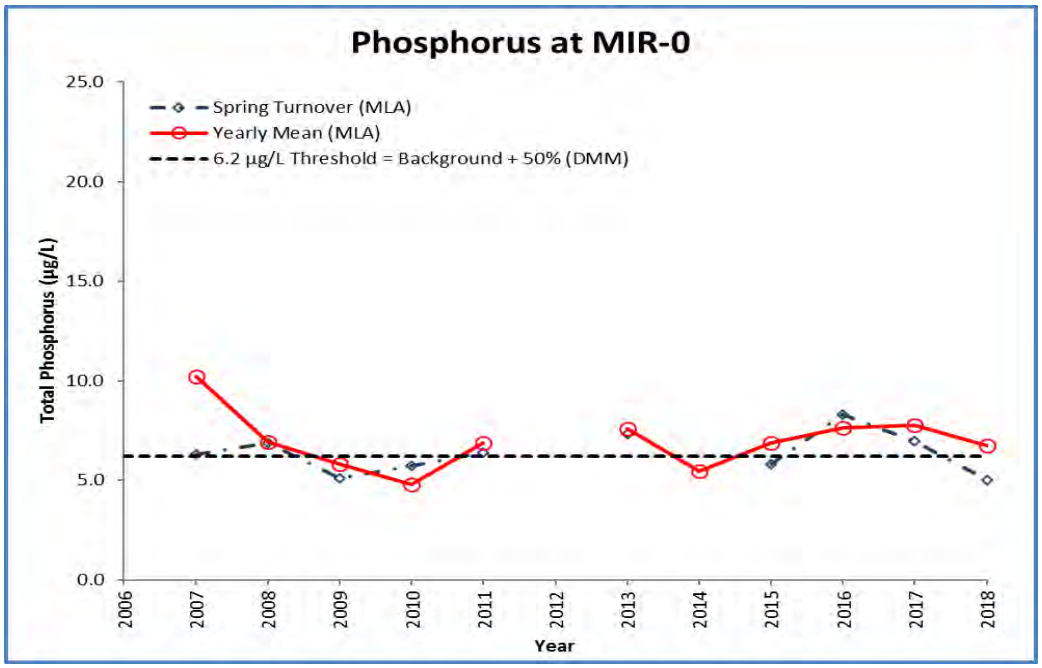
Mirror Lake is essentially a widening of the Indian River as it flows between Lake Rosseau to the north and Lake Muskoka to the south. The lake is approximately 0.46 km² in area, with a maximum depth of 8 m. Two small creeks outlet into the lake near sampling sites MIR-1 and MIR-2. Much of the lake is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

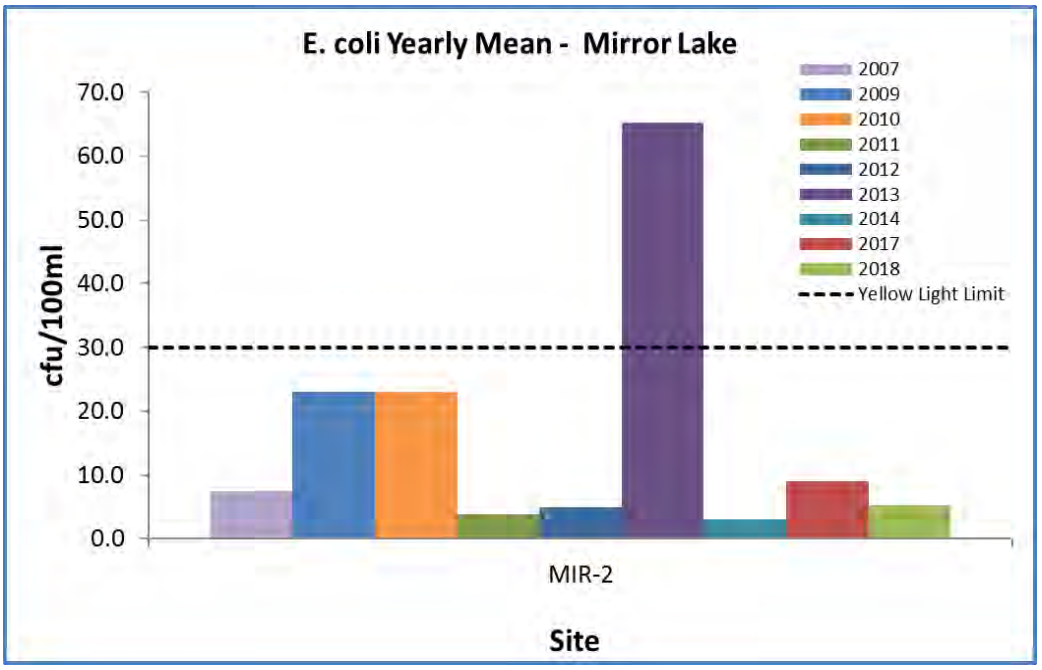
Volunteer Recognition: **Susan Carson, Ian Turnbull, Dianne Turnbull** and Randy Carson.

Mirror Lake (MIR)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.3	5.0	6.7		
MIR-2		6.0		5.2	142.8





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 2018, and the lowest recorded to date. The 2014 spring turnover phosphorus result at MIR-0 remains removed from the analysis following the 2018 Grubb's Test for outliers. Only one spring phosphorus sample was collected at MIR-2 in 2018, therefore no yearly mean could be calculated, and no value is reported for 2018. The spring sample collected at MIR-2 was the lowest recorded spring phosphorus to date at that site. *E. coli* counts remain well below the MLA stoplight limits (details in report Section 3) at MIR-2 in 2018. Mean Secchi measurements also remain stable through sampling years, varying between 1.95 and 4.45. MIR was given a green stoplight in 2018, changed from a yellow stoplight in 2017. **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

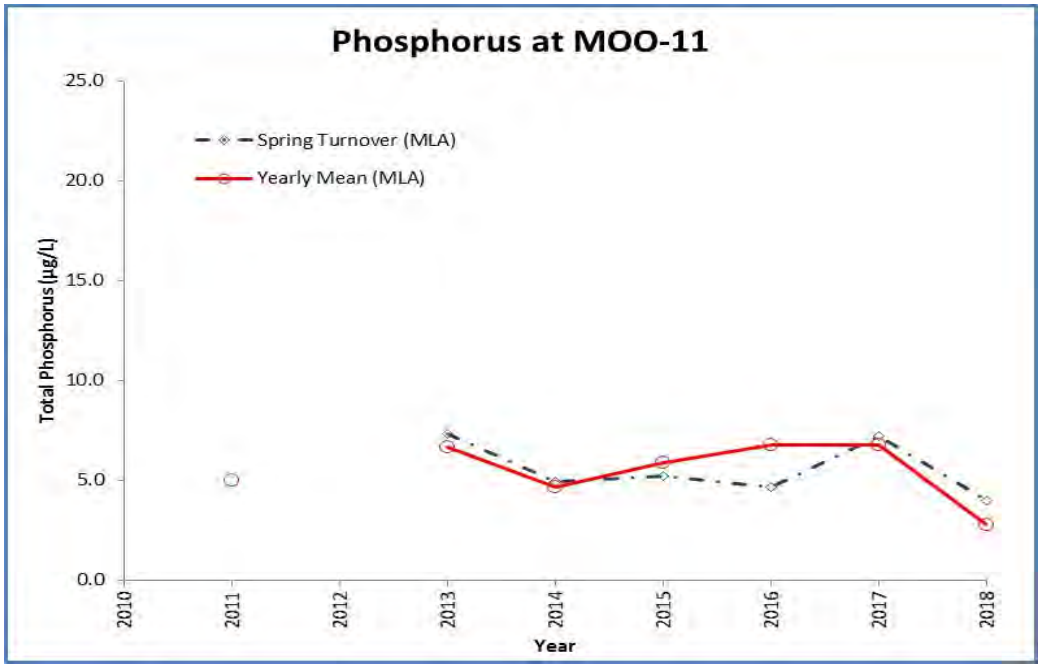
The Moon River is the main outlet of the Muskoka Watershed, flowing from Lake Muskoka to Georgian Bay. The river receives overland drainage from the Town of Bala and its urban area, including many roads and the developed shoreline. Approximately 12 creeks outlet into this sampling area, several of which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

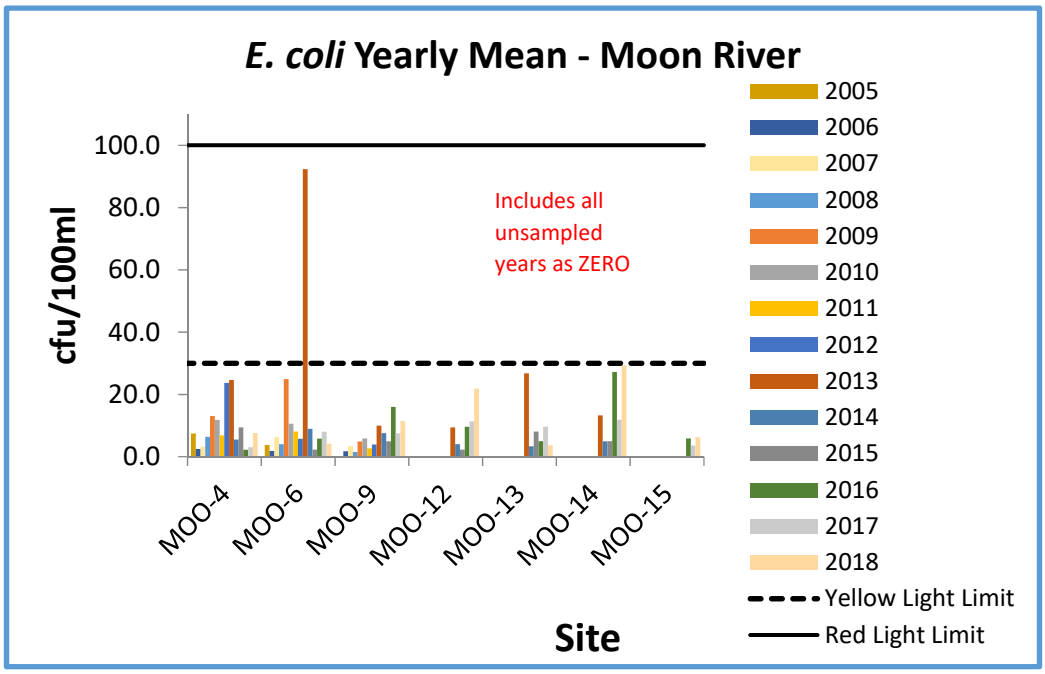
Volunteer Recognition: **Barry Fisher, Hayley Masson, Jessica Ylanko, Cathy Malcomson, Cathy Brown, Dave Macintosh**, Mike Malone, Hannu Ylanko, and Barbara Macintosh.

Moon River (MOO)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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		5.0	4.5		
MOO-4		6.0	5.5	7.6	41.0
MOO-6		6.0	6.0	4.2	26.6
MOO-9		6.0	6.0	11.4	29.7
MOO-11	3.6	4.0	2.8		
MOO-12		7.0	4.8	3.6	51.1
MOO-13		9.0	7.8	21.9	100.3
MOO-14		6.0	4.5	29.3	81.7
MOO-15		9.0	7.0	6.3	38.7





Summary and Recommendations:

The spring phosphorus and yearly mean phosphorus concentrations at MOO-11 in 2018 were the lowest recorded to date. The 2018 spring phosphorus and yearly phosphorus mean concentrations at MOO-1, MOO-4 and MOO-12 were the lowest recorded to date. All other sites remained consistent with phosphorus levels encountered historically. *E. coli* levels were all below the MLA stoplight limits (details in report Section 3) in 2018. The 2018 mean Secchi measurement was the deepest recorded to date. **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

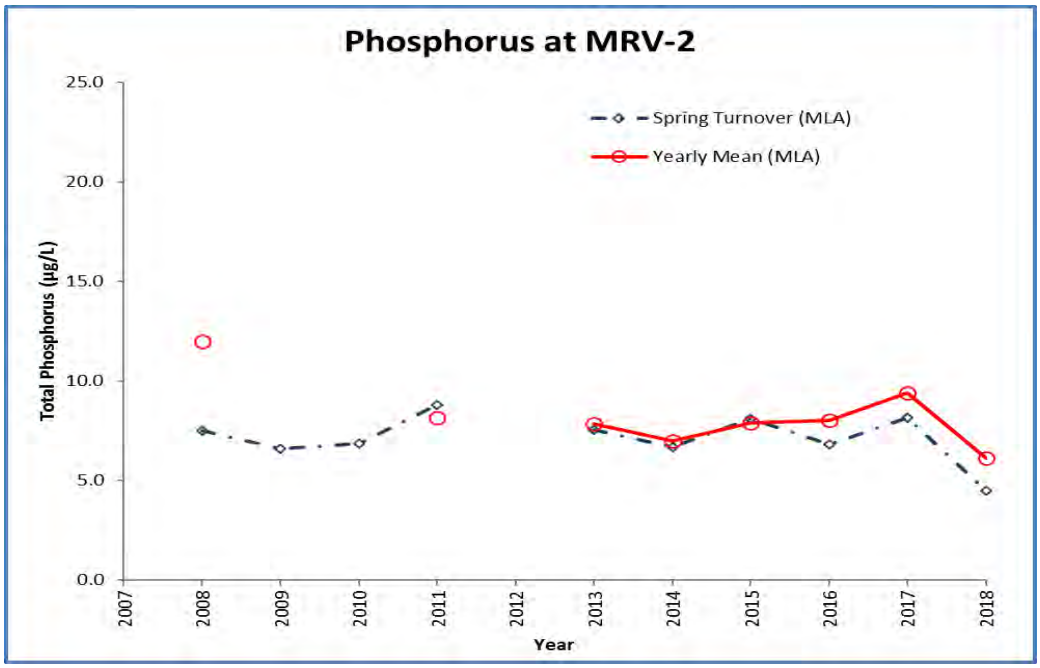
This sample area includes the most downstream reach of the Muskoka River where it flows from the Town of Bracebridge to Alport Bay, Lake Muskoka. This area is highly developed on both banks, and includes the Bracebridge urban area, large agricultural fields, and extensive residential properties along 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.

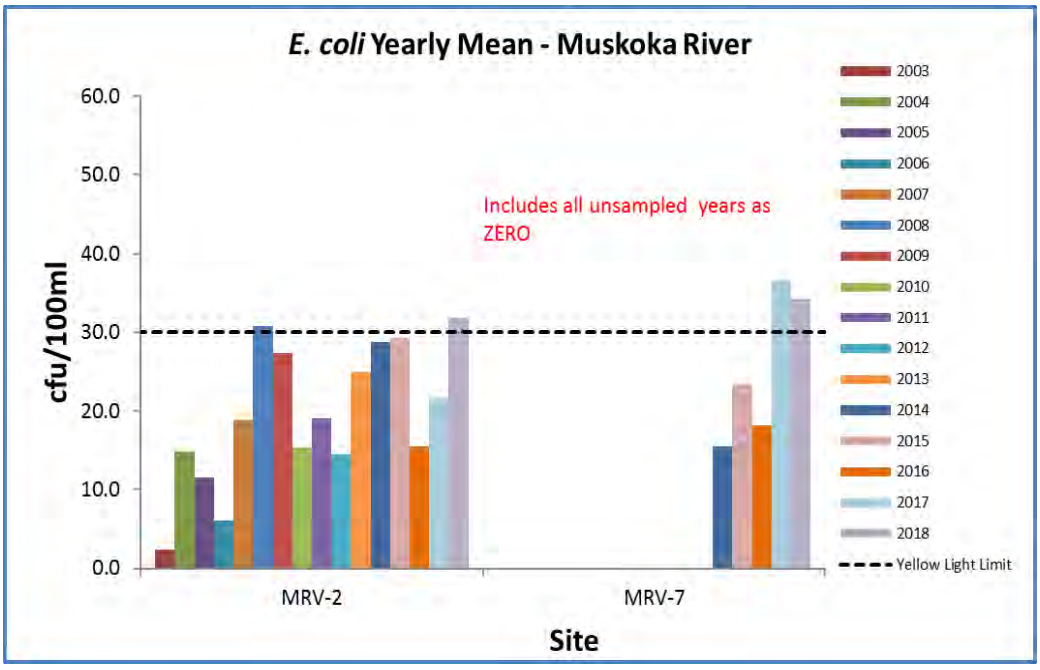
Volunteer Recognition: **Chris Cragg**, **Bill Gilbert, Debbie Hastings**, L.Cragg, and Cathy Gilbert

Muskoka River (MRV)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	2.3	4.5	6.1	31.8	175.1
MRV-3		3.0			
MRV-4		4.0			
MRV-5		15.0			
MRV-7	2.0			34.2	167.0





Summary and Recommendations:

Yearly mean and spring phosphorus concentrations at the deep station (MRV-2) were the lowest recorded to date. The 2018 spring phosphorus concentration at MRV-3, MRV-4, and 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 2018, therefore no yearly mean could be calculated, and no values are reported for 2018. *E. coli* levels at MRV-2 and MRV-7 in 2018 exceeded the MLA yellow stoplight limit (details in report Section 3). Two retests were required for MRV-2 and MRV-7. Secchi measurements varied greatly through sampling years, ranging between 1.22 and 10.25. **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 is classified as moderately sensitive by the DMM. Monitoring started in 2003. All stations shown may not be sampled each year.

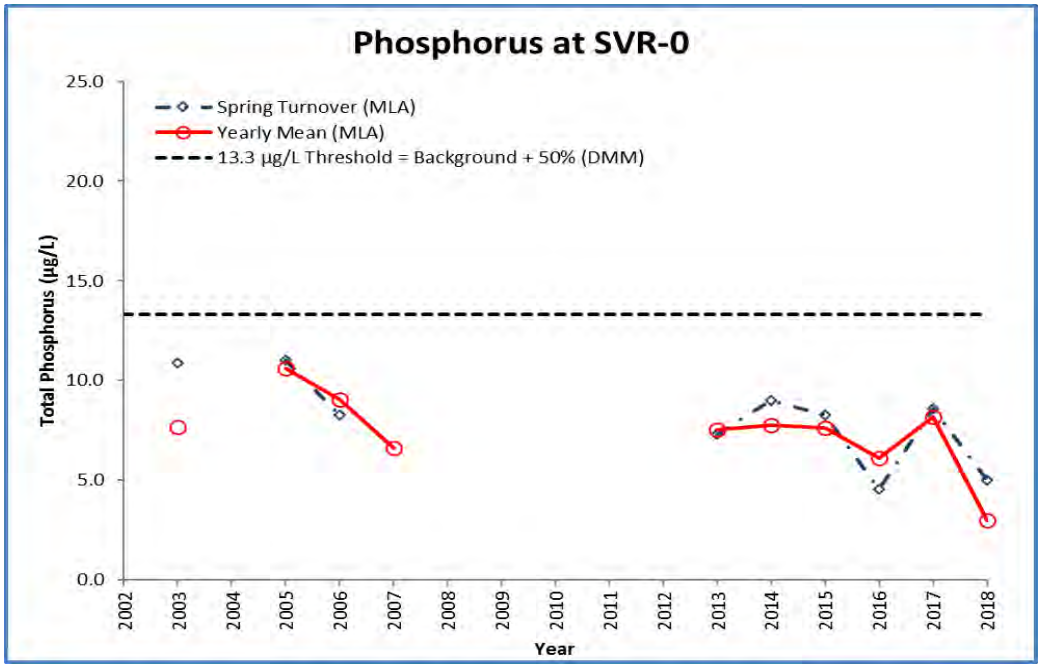
Volunteer Recognition: **Bruce Elliott,**

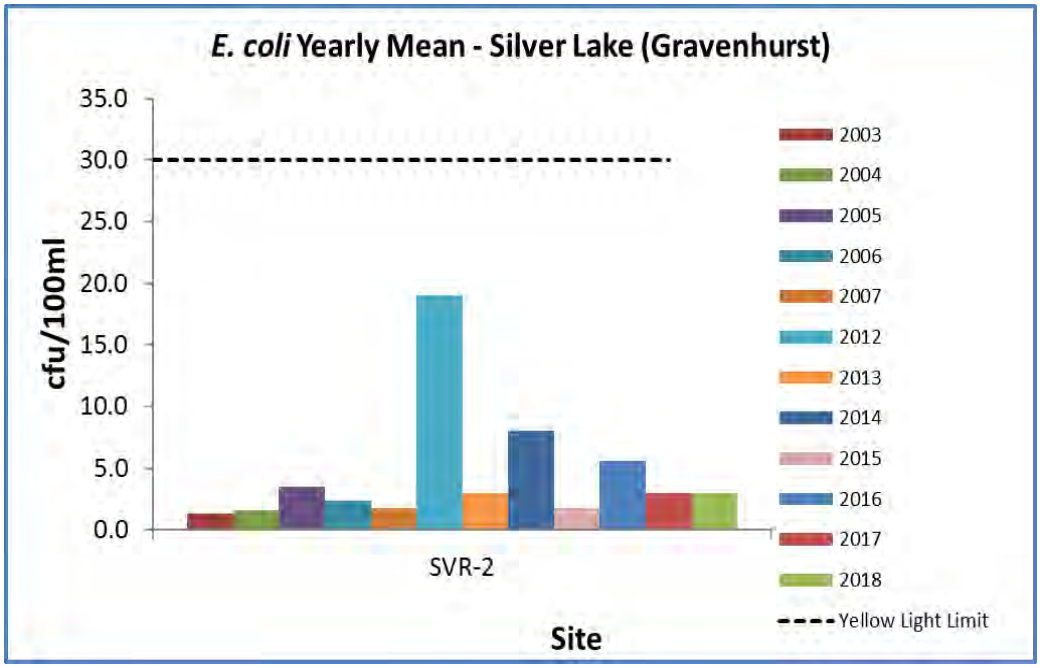
Anne Elliott, Peter Elliott, and Ross Elliott.

Silver Lake (SVR)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	3.8	5.0	3.0		
SVR-2				3.0	90.2





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). The yearly phosphorus mean at SVR-0 was the lowest recorded to date. The *E. coli* yearly mean value for SVR-2 in 2018 remains well below the MLA stoplight limits (details in report Section 3). The 2018 mean Secchi measurement is the deepest reading recorded to date. **Beacon recommends sampling continue to monitor long-term trends.**

Area Description:

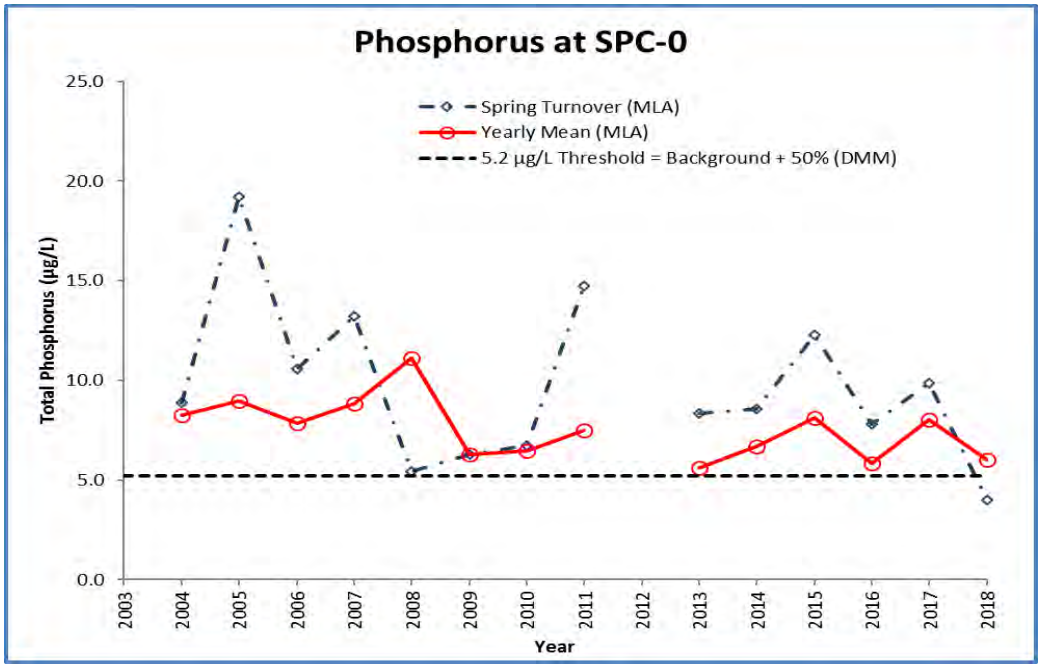
Silver Lake is immediately adjacent to Port Carling, with 0.57 km² in surface area and a maximum depth of 14 m. This lake has a moderate amount of shoreline residential development with alteration in the form of lawns and thinned forest occurring over approximately 50% of the upland area. The riparian 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 is classified as moderately sensitive by the DMM. All stations shown may not be sampled each year.

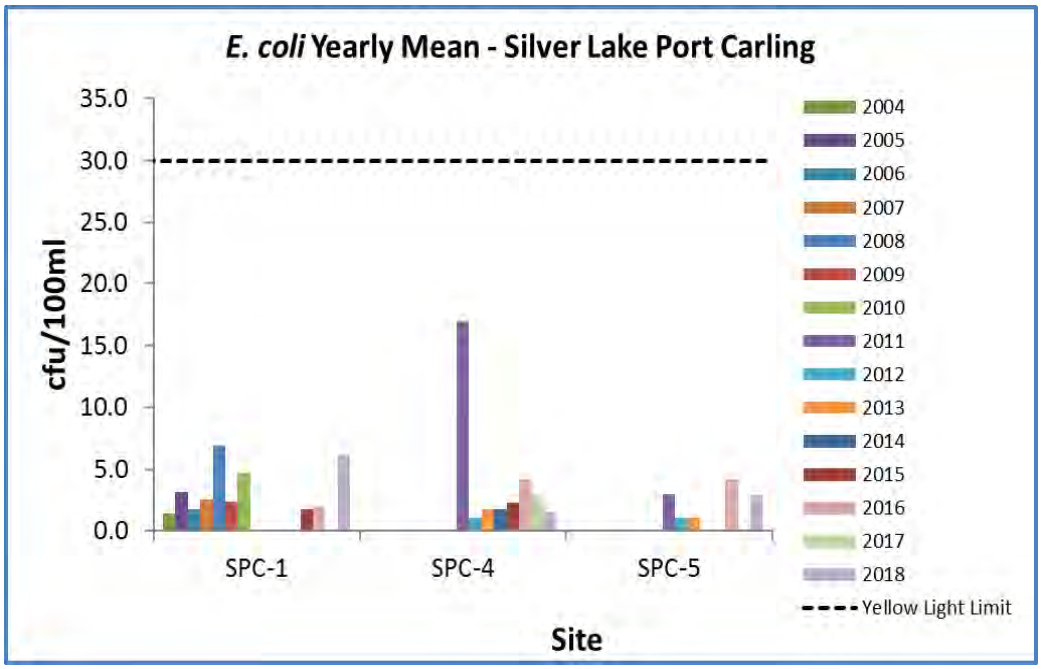
Volunteer Recognition: **Barbara Graydon, Matthew Graydon**, and Johnathan Graydon.

Silver Lake (SPC)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	5.1	4.0	6.0		
SPC-1				6.2	39.2
SPC-4				1.4	42.3
SPC-5				2.9	26.9





Summary and Recommendations:

The 2018 spring phosphorus concentration at the deep station (SPC-0) was below the historic DMM threshold of 5.2 µg/L in 2018, and the lowest recorded to date. The yearly phosphorus mean at SPC-0 remains consistent with previous sampling years. *E. coli* counts remain low at all nearshore sampling locations in 2018 and well below the MLA stoplight limits (details in report Section 3). Secchi depth measurements continue to vary across the sampling years. Volunteers notes significant aquatic vegetation during all the 2018 sampling events. **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

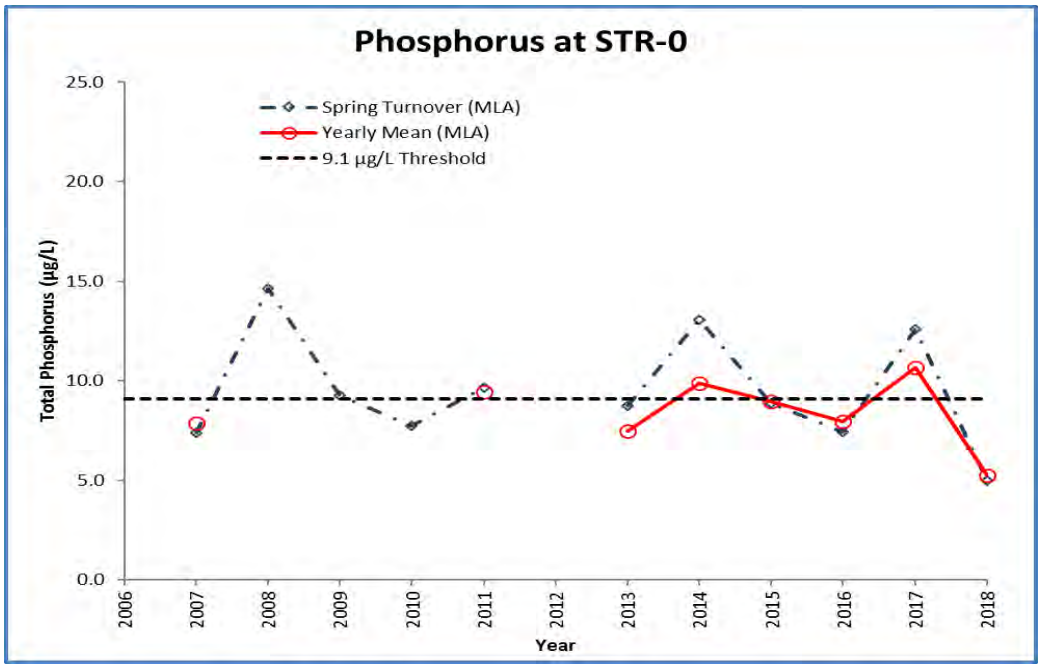
Star Lake is located in the Township of Seguin and is approximately 158 ha in area with a maximum depth of 23 m. This lake has a moderate to high level of shoreline development in the form of residential properties. Many of these properties maintain natural riparian vegetation along their shorelines, 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.

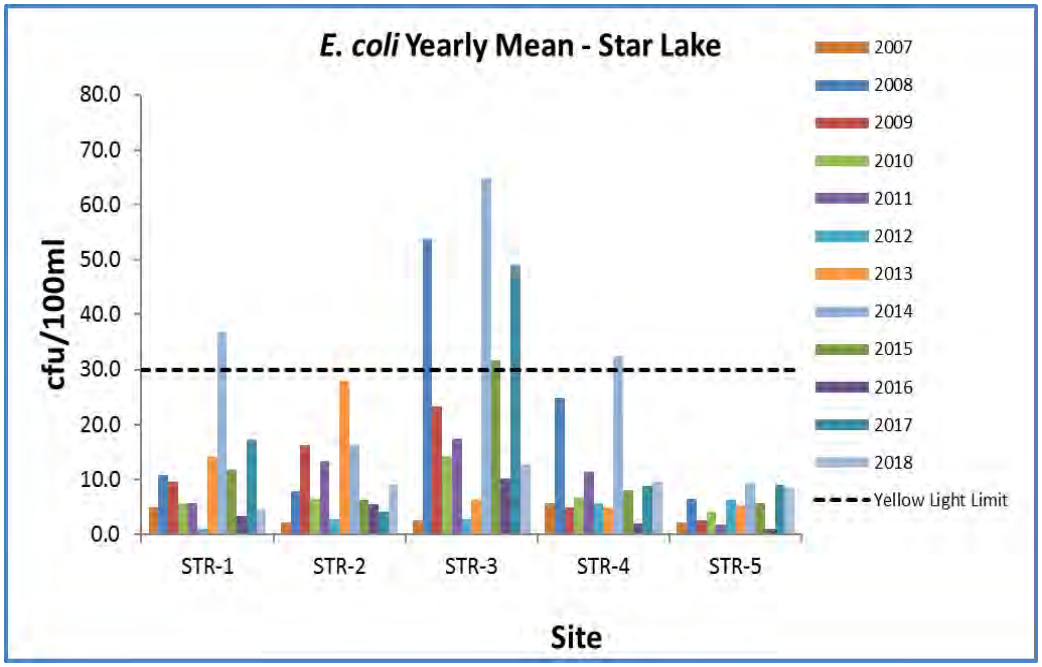
Volunteer Recognition: **Karen Gillies, Sara Slater**, Melaney Kerley, Jim Kerley, Neil Gillies, and Harold Slater.

Star Lake (STR)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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	2.0	5.0	5.3		
STR-1				4.5	137.4
STR-2				9.0	113.7
STR-3				12.8	198.4
STR-4				9.5	215.7
STR-5				8.6	198.4





Summary and Recommendations:

Yearly mean and spring phosphorus concentrations at the deep station (STR-0) were below the DMM threshold of 9.1 µg/L in 2018, and the lowest recorded to date. *E. coli* mean concentrations in 2018 at all stations were below the MLA stoplight limits (details in report Section 3). Re-tests were required at STR-1, STR-3, STR-4 and STR-5 following the final sampling in August. Volunteers noted that during the August 24th sampling event at STR-3, the old beaver dam was submerged due to the high water levels. STR was given a green stoplight in 2018, changed from a yellow stoplight in 2017. Secchi depth measurements vary across the sampling years. **Beacon recommends that all sampling be continued to monitor long-term trends.**

Area Description:

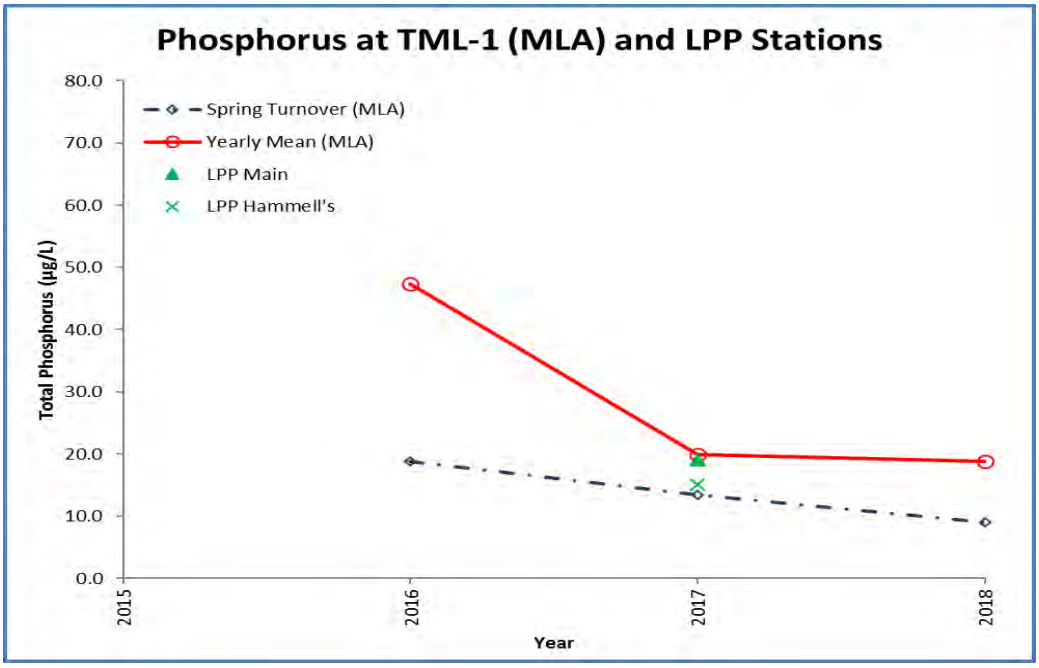
Three Mile Lake is a mesotrophic lake. The Three Mile Lake Watershed covers approximately 14,600 ha and includes portions of the Township of Muskoka Lakes, Town of Huntsville, and Town of Bracebridge. The Three Mile Lake Watershed is 3% Crown land and 97% privately owned and is atypical within the Muskoka region as it supports a comparatively large agricultural community (8% of the watershed area). Three Mile Lake consists of a shallow main basin and a deeper bay (Hammel's Bay). Monitoring started in 2016. All stations shown may not be sampled each year.

Volunteer Recognition: **Rob Fullerton**, **Paul Voulgaris**, Lesley Mellship, and Al Holley.

Three Mile Lake (TML)

2018 Water Quality Results: (**Note**: Hatched cell signifies not tested for in 2018)

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			
TML-1		9.0	18.8			23.3
TML-2		30.0	40.8			13.0
TML-3		29.0	21.3			10.4
TML-4		17.0	17.5			10.3



Summary and Recommendations:

The 2018 spring phosphorus concentration as well as the yearly phosphorus means at TML-1 and TML-4 were the lowest recorded to date (3 years of data). The 2018 spring phosphorus and yearly phosphorus mean at TML-3 were the highest recorded to date, resulting from the high spring recording (29.0 µg/L) in May 2018. The spring phosphorus at both TML-2 and TML-3 was >20µg/L, causing TML to be classified as yellow in 2018. DOC was sampled for at TML-1, TML-2, TML-3 and TML-4 and is discussed in Section 3.3. **Beacon recommends that sampling continue to monitor long-term trends.**