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WATER QUALITY INITIATIVE
Water Quality Report
2012

RiverStone
ENVIRONMENTAL SOLUTIONS INC.

RIVERSTONE
ENVIRONMENTAL SOLUTIONS INC.

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Mr. Mike Logan
Director, Environment and Water Quality Committee
Muskoka Lakes Association
65 Joseph St., 2nd Floor
Port Carling, ON
P0B 1J0

SUBJECT: Muskoka Lakes Association Water Quality Initiative – 2012 Water Quality Report

Dear Mike:

RiverStone Environmental Solutions Inc. is pleased to provide you with the attached 2012 Water Quality Report.

Please contact us if there are any questions regarding the report, or if further information is required.

Best regards,

RiverStone Environmental Solutions Inc.

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Executive Summary

The Water Quality Initiative's (WQI) overall purpose is "to maintain and improve water quality through water quality monitoring and lake stewardship activities." A major component of meeting the seven detailed objectives of the WQI (see Table 2) is a science-based monitoring program which was established by the Muskoka Lakes Association (MLA) over a decade ago.

In 2012, the WQI and its volunteers monitored water quality indicators at 192 sites in 50 sampling areas located throughout western Muskoka and southern Parry Sound. Volunteers collected 865 total phosphorus samples from 118 sites. Calcium samples and Secchi depth measurement were collected from 50 deep-water reference sites. Volunteers also collected and analyzed 228 bacteria samples from 112 sites.

The 2012 water quality report includes area summaries presenting area specific information including a map and written area description, volunteer recognition, a summary of the 2012 data, comments, and recommendations. Graphs illustrating long-term spring turnover and yearly mean total phosphorus concentrations at deep-water reference sites, and *E. coli* yearly means are also included in each area summary.

Some changes were implemented for the 2012 water quality monitoring program:

- Three new sampling areas (Gull Lake, Silver Lake-Gravenhurst, and Taylor Island) were added to the 2012 WQI based on volunteer input and availability.
- 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 are of particular concern (e.g., beaches, popular swimming sites, etc.).
- The deep-water total phosphorus sampling protocol was modified to allow for sample collection at Secchi depth.

Each year RiverStone provides analysis and/or data review for newly collected information. Some of the key findings and comments noted in the 2012 report include:

- Based on a review of the nearshore total phosphorus, Secchi depth, and *E. coli* data, the monitored lakes have consistently good water quality that is suitable for recreational use.
- The deep-water total phosphorus data for 2012 shows strong evidence of unreliability. Since the reliability of this data is questionable, it was decided by the Committee, in consultation with RiverStone, that this data will be removed from the data set and thus has not been reported this year. It is important to note that, while disappointing, the removal of a single year of deep-water total phosphorus data from the MLA's long-term monitoring data set does not compromise the quality of the overall data set or the integrity of the program. Many of the sites will have been sampled through the DMM and Lake Partner Program in 2012 and should the need arise this data would be available for future use.
- The ***E. coli*** values recorded for the vast majority of the sites sampled are well within the expected range of values that would occur naturally, with most being below the MLA's desired upper limit of 10 cfu/100 ml. New sites added in 2012 also followed this trend. Any sites that showed chronic

elevation or spikes have been identified in the area summaries and would benefit from additional monitoring in 2013. In 2012, the WQI program identified nine **sampling sites** where ***E. coli*** exceeded 50 cfu/100 ml, the MLA limit set as a trigger for re-sampling. Based on the 2012 ***E. coli*** data, there were no sites that had elevated levels requiring contact with appropriate parties as per the MLA's monitoring objective.

- Calcium concentration data collected in 2011-2012 suggests that there is limited year-to-year variation (+/- 0.18 mg/L); however, further data is required to determine overall trends. Calcium levels in most of the lakes monitored remain at or below the threshold levels that are required to maintain stable populations of many key algae consuming species (e.g., crayfish, snails, etc.). An overview of the 2011-2012 calcium data is presented and compared to threshold values in **Figure 1**.

RiverStone has included program recommendations for the 2013 sampling year in this water quality report (see **Section 5.3**). In general, the recommendations include continued use of the Field Co-ordinator and provision of volunteer training, as well a return to the protocols recommended by RiverStone in 2011. Additional recommendations have been included to assist in the early identification of any future errors and to provide a more scientific method for quality control.

In 2012, the MLA was also committed to developing Stewardship Initiatives for focus areas previously identified based on data from its water quality monitoring program. At the request of the MLA, RiverStone prepared individualized letters for five sampling areas: Cox Bay, Hamer Bay, Indian River, Muskoka Bay, and Windermere (**Appendix 1**). These letters include an overview of each area, a detailed review of the available water quality data, and site-specific recommendations for community based stewardship activities.

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LIST OF AREA SUMMARIES

LAKE JOSEPH

LAKE MUSKOKA

1. INTRODUCTION

The Muskoka Lakes Association (MLA) has been conducting a water quality monitoring program since 2001. The intent of the Water Quality Initiative (WQI) is "…to maintain and improve water quality through water quality monitoring and lake stewardship initiatives." The program has evolved over time with last year (2011) being a year of major changes. For the current year, 2012, only minor adjustments were made. A detailed overview of how each Water Quality objective is being met with the current program is included in **Section 5.1.**

In 2012, 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**. Details of these changes are outlined in **Section 2.**

In the current year, the WQI volunteers sampled 192 sites in 50 **sampling areas** throughout western Muskoka and southern Parry Sound. The monitoring program continues to be made possible through the dedicated efforts of its many volunteers. RiverStone Environmental Solutions Inc. (hereafter RiverStone) continues to provide scientific and technical support for program development and throughout the field season, and data analysis and preparation of the annual report. Again, we extend our congratulations to all of those dedicated individuals who contribute to the program; the MLA water quality monitoring program would not be possible without the continued effort of volunteers like you!

To maintain consistency, the 2012 Water Quality Report follows the same format as the 2010 and 2011 reports, providing a general outline of the initiative and summaries for each of the currently monitored **sampling areas**. Throughout the written text of this report, several terms are presented in a bold font. These terms are defined in **Section 6.** For those interested, a detailed description of the WQI program and methods are maintained on the MLA website (www.mla.on.ca).

RiverStone has prepared a two-page summary for each **sampling area** based on data collected in 2012 and has incorporated some of the historical data collected by the MLA. Long-term trends and noteworthy individual water quality measurements were reviewed for each **sampling area** so that comments could be made. Presented again in the 2012 area summaries are calcium data for each area. This is a water quality indicator to watch in the coming years, since decreasing calcium may be one of the key stressors experienced in the lakes of Muskoka. The comments provided in the area summaries are intended to increase awareness of the water quality conditions in "your lake neighbourhood." Ideally, these targeted comments will provide the basis for improving and evolving water quality monitoring of specific areas, while continuing to encourage active involvement in monitoring and stewardship activities.

For those who did not review the 2011 report, we have included again this year the discussion regarding the calcium monitoring component of the MLA program (see **Section 2.4**). In 2011, the MLA expanded its monitoring program to include calcium, which is declining in lakes on the Canadian Shield. Calcium decline is just one of many stressors that may affect recreational water quality; others include global climate change, and increased ice-free periods and water temperatures.

While improved water quality is the major objective of the WQI, it is also important for the WQI, through its volunteers, to promote effective stewardship of land and water amongst all generations and to encourage engagement in good stewardship practices by all members of our lake communities. The most important things that waterfront landowners can do to preserve water quality are: 1) maintain their shoreline in a natural state and 2) ensure that their septic system is functioning properly. In addition to promoting these individual efforts, in 2012 the WQI continued with a neighbourhood based approach in undertaking Stewardship Initiatives in focus areas. At the request of the MLA, RiverStone prepared individualized letters for five focus areas (Cox Bay, Hamer Bay, Indian River, Muskoka Bay, and Windermere; **Appendix 1**). These letters include an overview of each area, a detailed review of the water quality data, and site-specific recommendations for community based stewardship initiatives.

2. PROGRAM CHANGES FOR 2012

For the 2012 year, the MLA water quality monitoring program followed the 2011 protocols with only a few minor changes. The sections below provide a general review of the program changes and rationale.

2.1. Field Protocols

Major changes were made to the MLA protocols in 2011, with the new methods continuing for the 2012 sampling year. A slight modification to the deep-water sampling methodology was developed and implemented in 2012. The change from the 2011 protocol was to allow for the collection of water at **Secchi depth** as opposed to the collection of a composite sample. The modification involved the insertion of a natural cork into the sample collection bottle, prior to lowering it into the water. The cork was removed at the desired depth through the use of a string, allowing the bottle to fill.

2.2. Phosphorus

Phosphorus sampling continues to include a **spring turnover** sample; however seasonal monitoring during the summer months for the calculation of the **yearly mean total phosphorus** was reduced to three events in 2011. **Water clarity** and temperature are monitored during the phosphorus sampling events.

Over the past several years, it was determined that the best application of nearshore phosphorus data was for potentially identifying focus areas, both in the short-term and as part of a long-term monitoring program. The 2012 nearshore program continued at sites that were identified as important in meeting the aforementioned applications. The MLA will continue to assess the need for new sites and annually review the existing sites in focus areas, or potential focus areas, to determine if continued monitoring is required.

2.3. Bacteria

Bacteria are naturally present in freshwater and play an important role in maintaining healthy ecosystems. For the most part, elevated bacteria levels in lakes and rivers are a human health concern

as opposed to a lake health issue. Elevated ***E. coli*** levels in nearshore areas can pose a health risk to swimmers and other recreational users. Local Public Health Units and Ontario Parks routinely monitor bacteria levels at many popular public beaches in our region during the summer; however, there are many high-use areas throughout the Muskoka lakes which are not monitored. As such, the MLA has implemented a bacteria monitoring program to compliment and expand upon existing monitoring activities.

Bacteria levels tend to fluctuate naturally through the seasons, with the highest levels occurring following periods of heavy rainfall and during the hottest months of the summer. To address these key components of bacteria cycles, the MLA adjusted both the location of sampling sites and the frequency and timing of the sampling events in 2011. The same protocol was used in 2012 and new sites were selected based on volunteer input, level of use by people, and/or the intensity of shoreline development. All bacteria sampling was scheduled for the months of July and August. When samples were found to have ***E. coli*** levels of 50 cfu/100 ml or greater, re-sampling was to be completed the following week or as soon as possible thereafter.

2.4. Calcium Monitoring

Calcium monitoring was introduced to the WQI program in 2011 in response to recent scientific findings that suggest calcium concentrations in lakes in Muskoka are declining faster than expected as part of a long-term natural process (Jeziorski et al. 2008). Since calcium monitoring is relatively new to the MLA WQI, some general information regarding the importance of calcium in our lakes is provided below.

Where does the calcium in our water come from?

Calcium makes its way into our lakes and rivers from a number of sources including soil and exposed bedrock. Calcium is released from soil and bedrock and transported into waterways by acid rain. Decomposing vegetation is also a source of calcium, as decomposing vegetation returns calcium to the soil, which in turn is washed into lakes and rivers.

Why is calcium important?

Many aquatic organisms need calcium to develop portions of their body, shells, skeletons, etc. (Watmough et al. 2005). Some of these organisms, such as Daphnia, feed on microscopic aquatic vegetation (e.g., algae) and are important in controlling the growth of species such as algae in lakes and rivers (Edwards et al. 2009). Crayfish, which can play a key role in controlling attached algae and nearshore vegetation (Momot 1995), also require adequate levels of calcium for the development of their shells. Without sufficient calcium in the water, many species are unable to maintain stable populations or survive at all (see **Table 1**). Many of these small organisms aid in nutrient cycling by consuming dead plant and animal matter, feeding on algae and other plants, and acting as a primary food source for many species of fish.

Why are calcium levels declining?

Reduced calcium levels in lakes and rivers have been linked to the amount of calcium in the soil surrounding the waterbody (Jeziorski et al. 2008). Acid rain can cause short-term increases in calcium levels in a waterbody, as the rain dissolves calcium from the top layer of the soil before washing it into lakes and rivers. The calcium that is washed into the waterbody creates a short term increase in the calcium levels within the lake; however, the rate at which calcium is removed from the soil is often faster than the rate at which it can be returned through natural processes (Watmough et al. 2005). Recent declines in acid rain have resulted in lower amounts of calcium being removed from the soil and washed into waterways (Watmough et al. 2005). Unfortunately, at the same time, logging activities have been removing considerable numbers of trees from areas around lakes and rivers. These trees contain considerable amounts of calcium that would normally have been returned to the soil when the trees died (Jeziorski et al. 2008). Over time, the loss of trees in a given area causes the amount of available calcium in the soil to decrease and therefore results in a decrease in the calcium levels in the surrounding lakes and rivers (Jeziorski et al. 2008). The difference in the speed at which calcium is removed from the soil and the speed in which it is returned results in an eventual decline in the amount of calcium in the watercourse.

What does the loss of aquatic calcium mean?

Recent studies have found that when calcium levels drop below 2 mg/L, the lakes population of daphnia and crayfish die off quickly (Carins and Yan 2009). Without daphnia and crayfish, many of the fish in the waterbody will be without food and populations could decline as well. Daphnia have been called the “living lawnmower” as they eat considerable amounts of algae (McCauley et al. 1999). When daphnia populations decline or are lost from a waterbody, algae is able to grow into large blooms that can result in negative impacts to other species and water quality as a whole. Crayfish act as predators of numerous species and are decomposers of much of the dead plant and animal material in a waterbody (Edwards et al. 2009). Loss of crayfish from a waterbody results in a reduced amount of food availability for species at the top of the food chain, as well as a reduction in the cycling of nutrients (e.g., calcium), back into the ecosystem (Edwards et al. 2009).

More simply stated, without sufficient calcium in our lakes, many of the aquatic organisms that presently help control algae would not be able to survive. Without these key species, algae could increase even if phosphorus concentration remained stable.

Table 1. Critical limits of calcium for freshwater organisms.

Species/Group	Ca Critical Limits	Role Within the Ecosystem	Reference
Crayfish	5.0 mg/L for population stability 1.0-2.5 mg/L for individuals to survive	Feed on dead animal and plant tissue to aid in decomposition. Feed on algae communities. Food for larger fish and mammals	Carins and Yan (2009) Holdich and Rogers (2000)
Freshwater Snails	4.0 mg/L for population to thrive 2.0 mg/L for individuals to survive	Freshwater snails graze on algae communities to help keep growth in check Food for larger fish and mammals	Nduko and Harrison (1976)
Mussels and Bivalves	2.5 mg/L for individuals to survive	Filter feed on microscopic plants and animals Food for larger fish and mammals	McMahon (2002)
Zebra Mussels	12.0 mg/L for individuals to survive	Filter feed on microscopic plants and animals Food for larger fish and mammals	Neary and Leach (1991)
Zooplankton (Daphnia, Gammarus)	1.5-2.0 mg/L for populations to survive	Feed on algae communities, keeping algae blooms under control Food for fish	Cairns and Yan (2009)

3. GENERAL METHODS AND WATER QUALITY PARAMETERS

A detailed report describing the methodologies and protocols used in the 2012 WQI program is available on the MLA website (www.mla.on.ca). The following points provide a brief overview of the area summary data that has been included in this report:

- Monitoring schedule – Water quality indicators including, **total phosphorus**, calcium, bacteria, and **Secchi depth** were measured during the sampling season, which began in mid-May and ended in late August. The four scheduled sampling periods in 2012 were as follows: May 11-21, June 29-July 2, July 27-30, and August 24-27.
- Total Phosphorus (spring turnover) – Samples collected from deep-water references sites within or prior to the first sampling period (May 11th to May 21st) are considered **spring turnover total phosphorus** samples, and represent the average phosphorus concentration of a lake. Prior to June 1st, most lakes in our region have not yet stratified (separated into layers); therefore, the concentration of phosphorus in samples taken during this period can be considered the average within the waterbody.
- Total Phosphorus (yearly mean) – In some **sampling areas**, phosphorus samples were collected from deep-water and nearshore **sampling sites** on four separate occasions throughout sampling season. **Yearly mean total phosphorus** concentrations were calculated for sites in these areas.
- Calcium – During the spring turnover sampling period (May 11th to May 21st), calcium samples were collected from one deep-water reference site in each **sampling area**. The concentration of calcium in samples taken during this period can be considered the average within the waterbody.

- Bacteria – **Total coliform** and ***E. coli*** samples were collected from nearshore sites during the second and third sampling periods, when bacterial levels are typically highest. Follow-up sampling for ***E. coli*** was to be conducted when values greater than 50 cfu/100 mL were recorded. Bacteria can be indicators of failing septic systems or other forms of fecal contamination.
- Secchi depth – Secchi discs were used to record depths at deep-water sites in each **sampling area. Secchi depth** provides a general indicator of **water clarity**.

4. UNDERSTANDING THE AREA SUMMARIES

Based on both the historic data and the data collected in 2012, overall water quality conditions in the lakes monitored by the MLA are good to excellent. A detailed analysis of the long-term data was completed in 2009 and supports this conclusion (see the 2009 Technical Report, available on the MLA website).

The area summaries included in this report are designed to describe the various **sampling areas**, summarize the 2012 data, and explain the general long-term water quality trends associated with each **sampling area** and **sampling site**. The area descriptions were developed based on local knowledge, aerial photos, Ontario Base Maps, and information provided by the District Municipality of Muskoka (DMM), including surveyed shoreline land-use maps and historical lake data. The names of volunteers involved in water quality monitoring for each area are listed under "Volunteer Recognition" with team leaders identified in bold.

The data in the area summaries are calculated "averages" that provide a general overview of the water quality at individual **sampling sites** over the sampling season. In 2012, there were a large number of unusually high total phosphorus concentrations documented at deep-water sites, particularly at spring turnover. It is RiverStone's opinion that these values are not accurate reflections of the lakes' true nutrient conditions. Further details regarding the management of the 2012 phosphorus data and analysis are provided below (see **Section 4.2**). Despite the issue identified in the 2012 deep-water phosphorus data, RiverStone is confident based on our review of the 2012 nearshore phosphorus and Secchi depth data that the water quality in the lakes monitored by the MLA is still good to excellent.

4.1. Water Clarity

Secchi depth was used to provide a measure of **water clarity** at deep-water **sampling sites**. **Secchi depth** values are determined by averaging the "up" and "down" measurements recorded by volunteers using a Secchi disc. Depth data listed in the area summaries represent the **arithmetic mean** of values obtained from individual **sampling sites** throughout the sampling season. Because **water clarity** in most lakes in Muskoka 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.

4.2. Phosphorus

Duplicate phosphorus samples collected in 2012 were analyzed for bad splits according to the DMM phosphorus data management protocol. If the two measurements making up the duplicate sample have a variance of greater than 40%, the higher value is removed according to the protocol. Twenty of the 426 samples collected (4.7%) were identified as bad splits. Following the removal of the bad splits, an outlier analysis was also completed for all spring turnover data (50 deep-water sites) using the DMM protocol. In some instances, the DMM outlier protocol could not be applied due to an insufficient number of years of data. The outlier analysis that was performed resulted in the removal of 13 spring turnover deep-water data points from the data set. This outlier test had limitations as prior to 2010 duplicate samples had not been collected consistently for all sites and outlier analysis had not been completed. This has resulted in a highly variable data set prior to 2010 that may not be attributable to natural variation (i.e. could be a result of something as simple as a stray zooplankton ending up in the phosphorus tube).

The 2012 **spring turnover total phosphorus** data that passed the DMM outlier test was plotted and the graphs reviewed. It was evident in the graphs that despite the completion of the outlier analysis, a large proportion of the spring data set was unexpectedly high compared with average historic MLA and DMM values. In an attempt to determine which of the MLA values might accurately reflect actual lake conditions, RiverStone developed additional criteria for identifying possible additional outliers in the 2012 data set. The criteria for this additional test was based on recent science by Clark et al. (2010) which describes:

a) the natural variability of phosphorus concentrations in lakes on the Precambrian Shield (+/-20% or approximately 2 ug/L), and

b) the precision of laboratory testing at the Dorset lab (+/- 0.7 ug/L).

Based on these statistics, it is highly unlikely that the concentration of total phosphorus in a waterbody could increase by more than 3.4 ug/L over the course of a year in the majority of the lakes sampled. The exception could be tea coloured lakes (e.g. Brandy Lake). When the 2012 **spring turnover total phosphorus** data that were not identified as bad splits (37 data points) were compared to the data from recent years when duplicate phosphorus samples were collected (2011 or 2010, if necessary), an additional 13 sites did not pass the RiverStone "test". Gull and Silver Lakes could not be tested using either protocol as the historic dataset was too small and the most recent historic data point was from 2007.

Given the analyses described above regarding data variability, RiverStone is of the opinion that more than 50% of the 2012 spring turnover total phosphorus measurements from deep-water sites do not accurately reflect actual lake conditions. This suggests that 2012 deep-water total phosphorus data are in general unreliable. In order to keep in line with scientific principles and preserve the integrity of the overall MLA data set, it was decided that all 2012 deep-water total phosphorus data points would be removed from the data set. It is important to note that the majority of the total phosphorus data collected by the MLA in 2012 (approximately 60%; from nearshore and watercourse sites) was found to be reliable and representative of actual water quality conditions and was therefore retained.

Fortunately, the intent of the data is for long-term monitoring and there are alternative reliable sources of deep-water total phosphorus data available for local waterbodies (e.g. MOE Lake Partner Program and District of Muskoka).

Determining the source of errors in data can be extremely difficult. RiverStone discussed the possibilities with the MLA administrative and laboratory staff, and the Environment and Water Quality Committee as soon as the first set of laboratory results was provided. Since there were very few bad splits, and the nearshore and watercourse phosphorus data was consistent with the previous year, the source of error is most likely associated with the 2012 change to the deep-water phosphorus sampling protocol.

4.2.1. Data Presentation

In terms of presenting the 2012 data, it was decided that despite errors in the deep-water data, the **yearly mean total phosphorus** data for nearshore and watercourse sites is reliable. The numerical yearly mean data have been provided in the area summaries for nearshore and watercourse sites monitored in 2012. Nearshore and watercourse **yearly mean total phosphorus** concentration in 2012 was calculated as the **arithmetic mean** of all four measurements from an individual **sampling site** within the sampling season, including duplicate sample measurements, where available.

The deep-water total phosphorus data for 2012 have been removed from the 2012 dataset. The area summaries still contain the 2011 and historical total phosphorus data graphs for deep-water reference sites within each sampling area. These are provided from last year's report to show long-term trends. Where applicable, graphs show MLA data in relation to the threshold concentration set by the DMM or Seguin Township.

On the graphs illustrating long-term phosphorus levels, threshold concentrations have been represented by a single black dashed line. For **sampling areas** in the DMM, the threshold values were verified by the DMM. **Sampling areas** without graphed threshold lines have not been modelled and are not comparable to other areas as confirmed through consultation with the DMM. **Spring turnover** and **yearly mean total phosphorus** as measured by the MLA 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. 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, 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 circles, if consecutive years of data were not available.

4.3. Bacteria

Total coliform and ***E. coli*** data have been summarized for all sites monitored in 2012. Current and historical ***E. coli*** data have also been presented graphically. ***E. coli*** concentrations are reported as the number of colony forming units observed in 100 mL of lake water (cfu/100 mL) on the y-axis and **sampling sites** are indicated on the x-axis. For the ***E. coli*** graphs, each **sampling site** is represented as a cluster of bars and different sampling seasons (years) are represented by different coloured bars. Each graph also compares ***E. coli*** levels to the MLA upper limit, which is represented by a grey dotted line. The upper limit value (10 cfu/100 mL) was established as a reasonable limit for maintaining existing water quality in Muskoka for the WQI and is based on advice provided by Dr. Karl Scheifer (2003). It is important to note that a "potential health hazard exists if the fecal coliform **geometric mean** density for a series of water samples exceeds 100 cfu/100 mL" (OMOE 1984).

4.3.1. Total Coliforms

Total coliform data is summarized for areas where bacterial monitoring was conducted in 2012. **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 for the purpose of calculating means. **Geometric means** presented in the area summaries were rounded to the nearest colony forming unit.

4.3.2. *E. coli*

E. coli data is summarized for areas where bacterial monitoring was conducted in 2012. ***E. coli*** levels are presented as yearly averages calculated as the **geometric mean** of all available measurements, including follow-up 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 the purpose of 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 particular site/year, no data was collected. **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 weekly if ***E. coli*** levels were found to be greater than 50 cfu/100 mL. 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 nine of the 112 bacteria **sampling sites** (8.0%) in 2012. Two of the nine sites exhibiting high bacteria levels (MBA-12 and MSN-4) are watercourses sites; follow-up sampling was determined to be unnecessary at these sites as naturally occurring high bacteria levels are expected in these settings.

4.4. Calcium

Separate water samples were collected from the deep-water reference sites during the spring turnover period for the purpose of calcium monitoring. Individual measurements are listed in the area summaries.

Summary of 2012 Calcium Monitoring Results

Results of the 2011-2012 calcium monitoring indicate that nearly all of the sampled lakes appear to be at or below the threshold levels of calcium that are required for populations of many freshwater organisms to exist at stable levels (**Figure 1** and **Table 1**). Some of the lakes and areas sampled are already below threshold levels for survival of several key species. The data relating to calcium collected in 2011-2012 shows only minor variation between the two sampling years (+/- 0.18 mg/L).

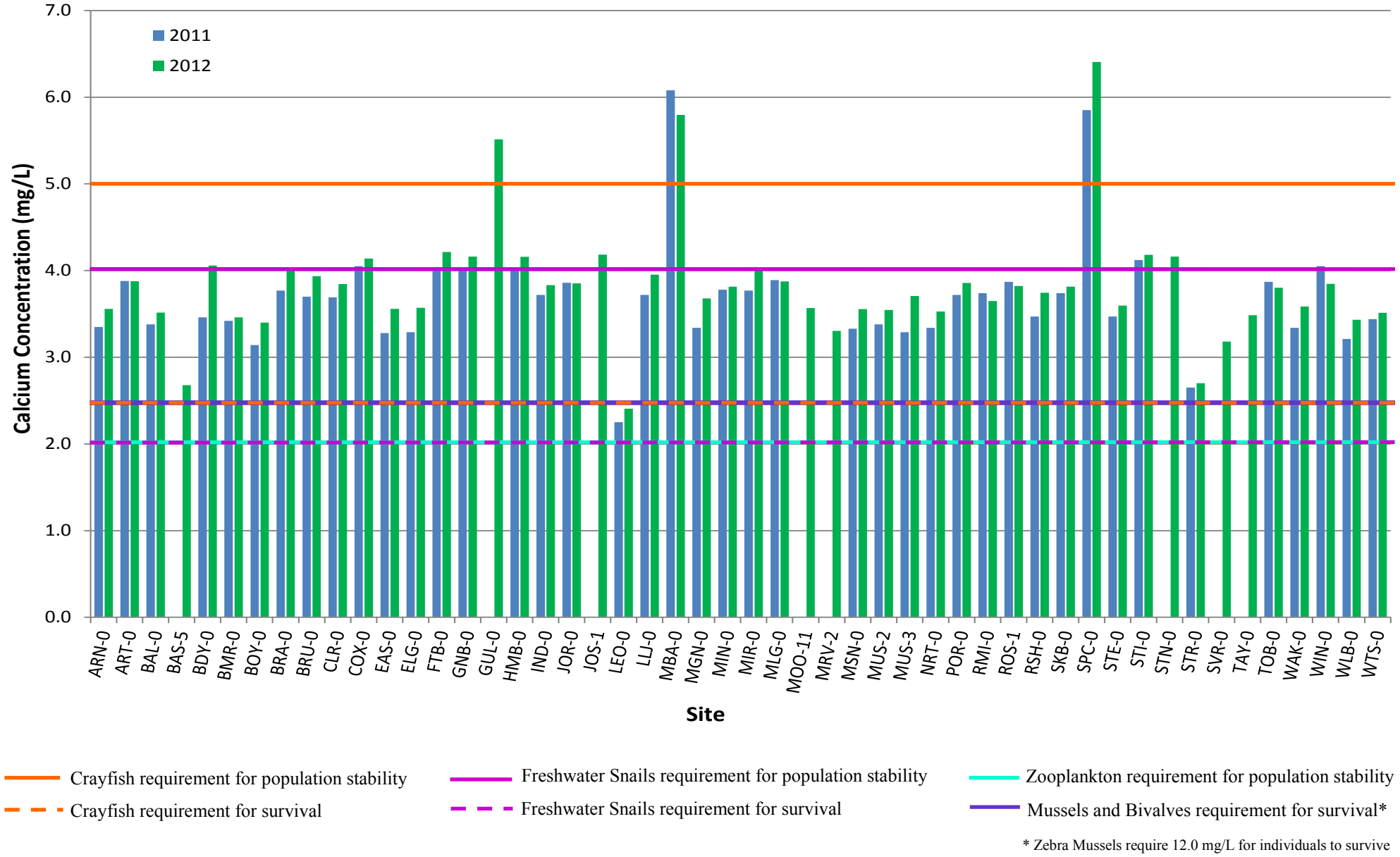

Figure 1. Summary of Spring Turnover Calcium Concentrations at MLA Reference Sites in 2011/2012 compared to threshold values for select freshwater species

4.5. Maps

Updated 2008 aerial photos were extracted from the Muskoka Web Map website and the West Parry Sound Geography Network website and were labelled to show **sampling sites**; these locations were updated for the 2012 season. Site information was compiled using the MLA Water Quality Results map, with information for the new or altered sites provided by MLA staff or directly from volunteers. Yellow dots indicate nearshore sites, red stars represent deep-water sites, and green triangles represent watercourse sites.

5. COMMENTS AND PROGRAM RECOMMENDATIONS FOR 2012

5.1. Comments

The 2012 WQI program followed the same principles as the revised program that was developed in 2011. This program was designed to meet the objectives of the WQI and to allow for the collection of data using methods that are more consistent with government and other volunteer organizations. **Table 2** describes how the program, as implemented in 2012, meets the WQI objectives.

RiverStone has the following general comments regarding the 2012 WQI program and dataset:

1. Monitoring in focus areas continued in 2012. Three new **sampling areas** (Gull Lake, Silver Lake-Gravenhurst, and Taylor Island) were added to the 2012 WQI based on volunteer input and availability.
2. The review of the duplicates collected for all sampling events, resulted in the removal of only 20 bad splits of a possible 426 (5 from the spring turnover period and 15 from the summer). This suggests that volunteer sampling is being completed accurately. The use of filters for the phosphorus samples has reduced the variability and has increased the reliability of each phosphorus data point collected by volunteers.
3. In 2011, the MLA's WQI field methods were updated so that total phosphorus samples were collected from deep-water sites using the same method as the MOE Lake Partner Program. In 2012, a modification was implemented for the deep-water sampling protocol to allow a sample to be collected at Secchi depth. This modification, while well intentioned, is not consistent with the Lake Partner Program method for collection of total phosphorus samples.

   The deep-water total phosphorus data for 2012 shows strong evidence of unreliability. It is RiverStone's opinion this is most likely the result of sample contamination from the used wine corks introduced to the 2012 deep-water sampling protocol. Since the reliability of this data is questionable, this data was removed from the data set.

   It is important to note, that while disappointing, the removal of a single year of deep-water total phosphorus from the MLA long-term monitoring data does not compromise the quality of the overall data set or the integrity of the program. Many of the sites will have been sampled through the DMM and Lake Partner Program in 2012 and should the need arise this data would be available for future use.

4. In 2012, ***E. coli*** sampling was focussed on new sites established in high-use areas and existing sites of concern. Sampling was again limited to the warm weather months when levels could be sufficiently high to cause a human health concern. Follow-up samples were collected for most sites exhibiting high bacteria levels.
5. Calcium concentrations measured in 2011 and 2012 show very little variation, suggesting that if changes are occurring over time, they may be very gradual. While it is not possible to predict trends with two data points, if required for financial reasons it may be appropriate to sample every second year.

Table 2. Muskoka Lakes Association Water Quality Objectives

Water Quality Objective	**Action(s) Taken in 2012**
1. To maintain and improve water quality.	
2. To provide a phosphorus monitoring program for areas of concern which are identified both by the DMM modeling and community members. In those cases where the spring turnover results are either over threshold or trending higher nearshore samples and/or other forms of sampling or testing are taken to determine if the source of phosphorous can be identified.	Volunteers collected 865 phosphorus samples from 118 sites located across western Muskoka and southern Parry Sound. Targeted sampling was conducted in select watercourses to monitor phosphorus inputs. The data set was reviewed for each **sampling area** to identify areas that display unusual trends.
3. To provide additional data to support regulation of vulnerable areas within Muskoka that should be protected. Monitoring will be concentrated in: a) lakes, bays and rivers with areas of concern identified by the DMM, b) lakes, bays and rivers where past MLA data indicates an area of concern, and c) lakes, bays and rivers where the DMM does not monitor.	The MLA continues to monitor waterbodies identified as Over-Threshold by the DMM, areas of concern identified by the MLA based on historical data, and various lakes, bays, and watercourses not monitored by the DMM. Additional supporting data routinely collected as part of the monitoring program includes **water clarity**, water temperature, and adjacent land use. The calcium monitoring program that commenced in 2011 was continued in 2012. This data supports the monitoring of multiple stressors on lake health.
4. To provide a bacteria monitoring program to monitor Coliform and ***E. coli*** and to respond in a timely and appropriate manner in contacting appropriate parties if a concern is identified.	Volunteers collected and analyzed 228 bacteria samples from 112 sites located across western Muskoka and southern Parry Sound. Elevated ***E. coli*** levels were detected at nine **sampling sites** and follow-up samples were collected at six of these sites.
5. To promote effective stewardship of land and water at both the individual and community levels. Provide a Stewardship program as well as financial assistance to those areas where the monitoring data indicate an area of concern. Provide a similar Stewardship program to any interested community that wishes to become more involved recognizing that everybody can impact the health of the watershed regardless of what the monitoring data may indicate.	Stewardship recommendation letters were developed for five focus areas identified by the MLA in 2011 (Cox Bay, Hamer Bay, Indian River, Muskoka Bay, and Windermere). Each letter provided area-specific action items that were implementable by volunteers and would help to achieve overall benefits to recreational water quality.
6. To obtain an annual written report on the data collected that includes an analysis of the data, information on trends and clear and comprehensive recommendations for future activities both for the WQP and the individual communities involved.	The 2012 Water Quality Report provides a comprehensive overview of key water quality indicators for 50 **sampling areas**. The report presents data summaries, identifies trends, and provides area- and program-specific recommendations.
7. To provide clear and appropriate communication about the annual WQI report to all interested parties, appropriate levels of government and the general community.	

5.2. Conclusions/Trends

Some portions of the data collected as a part of the 2012 WQI can be used to draw conclusions, or to postulate general trends in terms of water quality in the lakes in Muskoka. The data and volunteer feedback can also be used to draw conclusions about the program itself. The following conclusions/trends are based on the 2012 data.

1. Based on a review of the nearshore **yearly mean total phosphorus, Secchi depth**, and ***E. coli*** data, the monitored lakes have consistently good water quality that is suitable for recreational use.
2. The total phosphorus data collected from deep-water sites in 2012 is not reflective of current lake conditions and was determined to be unreliable. To ensure the integrity of the MLA's long-term data set these data were removed and should not be used in future years for assessing trends.
3. The ***E. coli*** values recorded for the vast majority of the sites sampled are well within the expected range of values that would occur naturally, with most being below the MLA's desired upper limit of 10 cfu/100 ml. New sites added in 2012 also followed this trend. Any sites that showed chronic elevation or spikes have been identified in the area summaries and would benefit from additional monitoring in 2013. In 2012, the WQI program identified nine **sampling sites** where ***E. coli*** exceeded 50 cfu/100 ml, the MLA limit set as a trigger for re-sampling. Based on the 2012 ***E. coli*** data, there were no sites with elevated levels requiring contact with appropriate parties as per the MLA's monitoring objective.
4. Calcium data from 2011 and in 2012 suggest that calcium concentrations in the majority of the areas sampled are in a range that could limit the success of many organisms that play important roles in lake health. As in 2011, Leonard, Bass, and Star Lake had very low concentrations in 2012. Muskoka Bay, Gull Lake, and Silver Lake (TML) have relatively high concentrations of calcium, compared to the other **sampling areas**.

5.3. Recommendations

Based on the 2012 program and data collected, RiverStone would provide the following recommendations for the various components of the WQI program:

1) Training

- *All team leaders need to attend the annual training sessions and encourage as many team members as possible to attend.*
- *To ensure that **E. coli** sampling is conducted according to the protocol, both the team leader and the field co-ordinator need to carefully review the data immediately following analysis. Any **E. coli** site that exceeds 50 cfu/100 ml needs to be re-sampled the following week or as soon as possible thereafter. Should the second sample exceed 50 cfu/100 ml or any sample exceed 100 cfu/100 ml, a MLA director and the scientific advisor should be consulted to determine the next step.*

2) Methods

- *Continue with protocols recommended by RiverStone in the 2011 program design. Discontinue the use of the cork in the deep-water sampling protocol, as implemented in 2012.The new cork protocol is not consistent with either Lake Partner or DMM protocols and is a possible source of sample*

contamination. The use of a protocol that is consistent with other agencies allows the MLA data to be considered comparable and be used in outside analysis, and increases the data value.

- *To reduce the possibility of equipment contamination in the future data and to allow for an increased ability to identify sources of error, consider the following:*
    - *Review the process through which sampling equipment is prepared and sourced for field kits and discuss in advance with RiverStone.*
    - *Develop a protocol for the insertion of a set of field blanks into the field sampling methods for each sampling date for both deep-water and nearshore samples.*
- *Continue to have a Field Coordinator to support the volunteers, and review and manage data.*
- *Review the volunteer training program and materials, the data review, and communication process undertaken by the Field Coordinator to ensure that when required, **E. coli** follow up samples are collected.*

3) Education and Policy Input

- *In combination with the WQI data, consider using land use indicators such a development density, shoreline development practices, and/or official plan policy to identify Focus Areas.*
- *To promote a more forward thinking approach to stewardship, rebrand the Areas of Concern as "Focus Areas" throughout the program.*
- *Continue to work with and create additional Stewardship Initiative Groups in "Focus Areas" based on available WQI data and other land use indicators.*
- *Continue to monitor the development practices of each municipality. Promote the development of Site Alteration by-laws to assist in education and enforcement of good land stewardship. Sound planning decisions and enforcement are key factors in maintaining and improving water quality.*

4) Program

- *Conduct a complete review of the 2011-12 data sheets to identify specific instances where volunteers are having difficulties with equipment, documentation, and generally following the sampling protocols. Compile a list of the issues to allow specific concerns to be addressed either prior to or during the training session.*
- *If protocol changes are proposed by the Committee or volunteers, the final protocols should be provided to the MLA's scientific advisor for review prior to finalizing the manuals and completing the training sessions.*
- *Based on the recommendations provided for each specific area, team leaders and the field co-ordinator should review the **E. coli sampling sites**. Sites that have measured below the MLA's upper limit for the past three years should be replaced with new **sampling sites in 2013** to allow for increased monitoring, unless a specific site is located in a public swimming area.*
- *Continue to monitor all existing deep-water reference sites for **spring turnover** and **yearly mean total phosphorus** concentrations in 2013. This is very important based on the trend indicated on the 2011 data combined with the unreliable nature of the 2012 data.*

- *Based on the low variability of the 2011/2012 data, it is RiverStone's opinion that it is unlikely that calcium will change rapidly over a span of two years. The MLA could consider changing calcium sampling frequency to every second year if required to free up funds to expand other components of the program. Ideas for expansion include nearshore water sampling and/or crayfish or other indicator species sampling to provide a better understanding of area specific issues and to identify areas of concern based on a second stressor.*
- *Depending on the release date for the updated DMM Lake System Health Program, the existing phosphorus monitoring sites should be reviewed to determine if the addition or removal of sites is warranted in 2013.*
- *Consider more detailed land use studies in the Windermere Area based on the elevated phosphorus concentrations that have been documented in this area in 2012 and historically.*

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.

E. coli*:** Fully known as *Escherichia coli*, it is a subset of **total coliforms**, and is exclusively associated with fecal waste making it a good indicator of faecal 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 disc - a small disc attached to a rope. Alternating quarters of the top side of the disc 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 disc.

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, 1992). Typically the spring turnover lasts for a few days when the temperature of the entire water column is consistent (usually 4˚C) allowing the water column to mix. In practice, measurements taken anytime in May are considered to be adequate by Ontario's Ministry of the Environment.

Total Coliform: Coliform include 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. Amongst other sources, it is found in fertilizers, soaps, and human waste.

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 the WQI Summary Report - Citizens Environment Watch, 2009.

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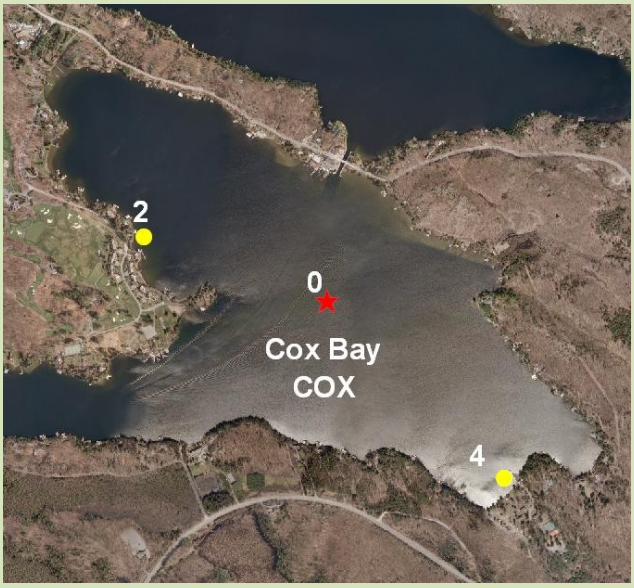
AREA SUMMARIES

COX BAY (COX)



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.

Volunteer Recognition

Cox Bay was monitored in 2012 by **Gord Ross**.

2012 Data

COX-0: Calcium = 4.14 mg/L
Secchi = 5.9 m

COX-2: TP-Yearly mean = 6.7 µg/L

COX-4: TP-Yearly mean = 3.3 µg/L

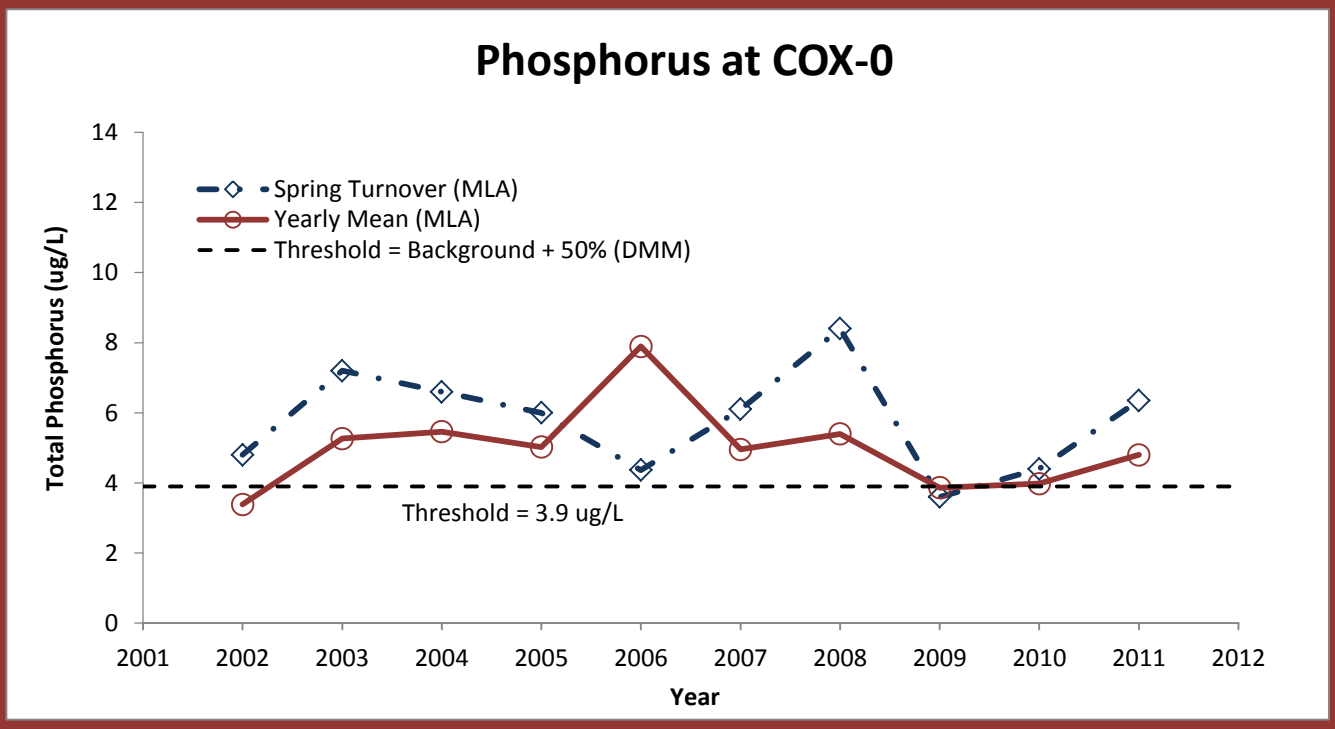
Comments

Monitoring of Cox Bay started in 2002.

Recommendations

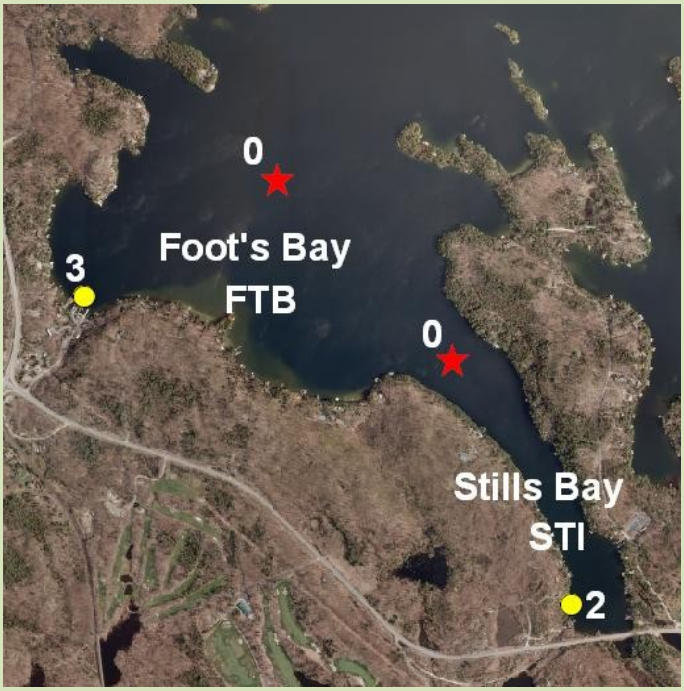
Continue existing sampling protocol to monitor long-term trends.

(COX) COX BAY



Notes:

FOOT'S BAY & STILLS BAY (FTB/STI)



Area Description

Foot's Bay and Stills Bay are connecting bays 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. 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.

Volunteer Recognition

Foot's Bay and Stills Bay were monitored in 2012 by **Joanne Brown**, **Neil Shaw**, Dudley Whitney, and Donald Wilson.

2012 Data

FTB-0: Calcium = 4.21 mg/L
Secchi = 6.5 m

FTB-3: TP-Yearly mean = 3.7 µg/L

STI-0: Calcium = 4.18 mg/L
Secchi = 5.9 m

STI-2: TP-Yearly mean = 5.1 µg/L

Comments

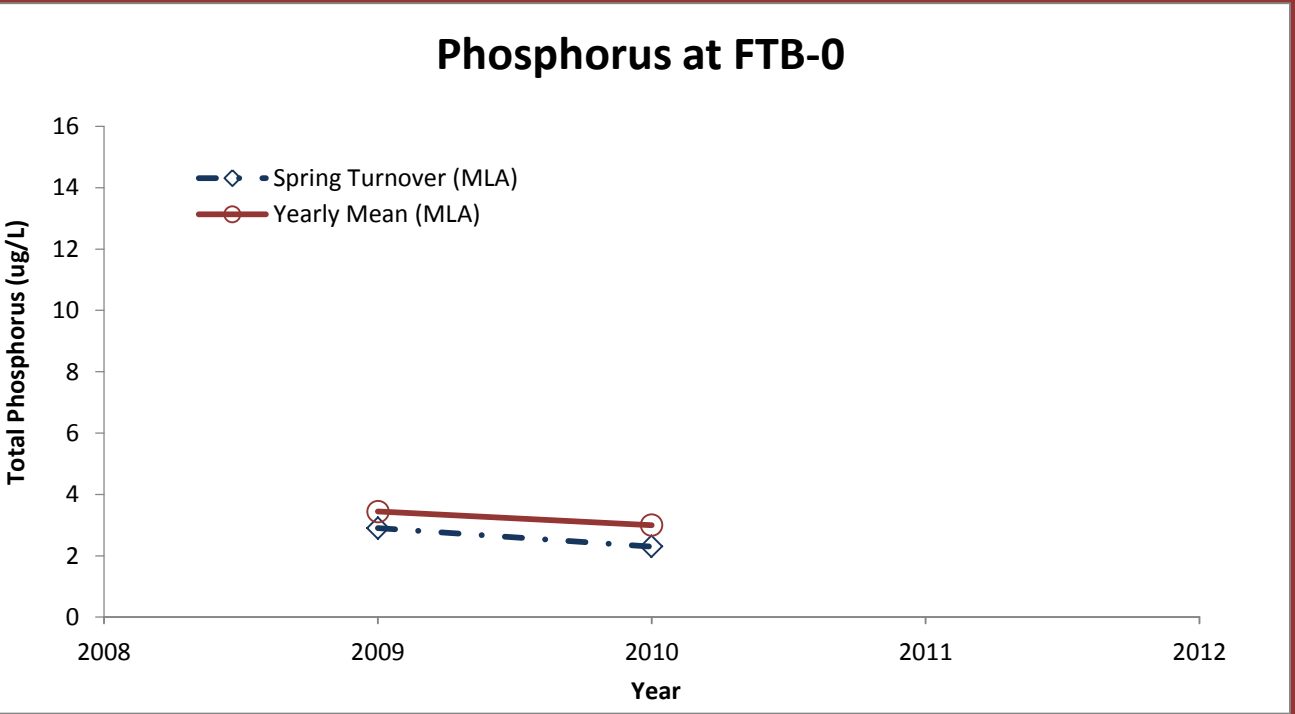
Monitoring of Foot's Bay started in 2009 and monitoring of Stills Bay started in 2003.

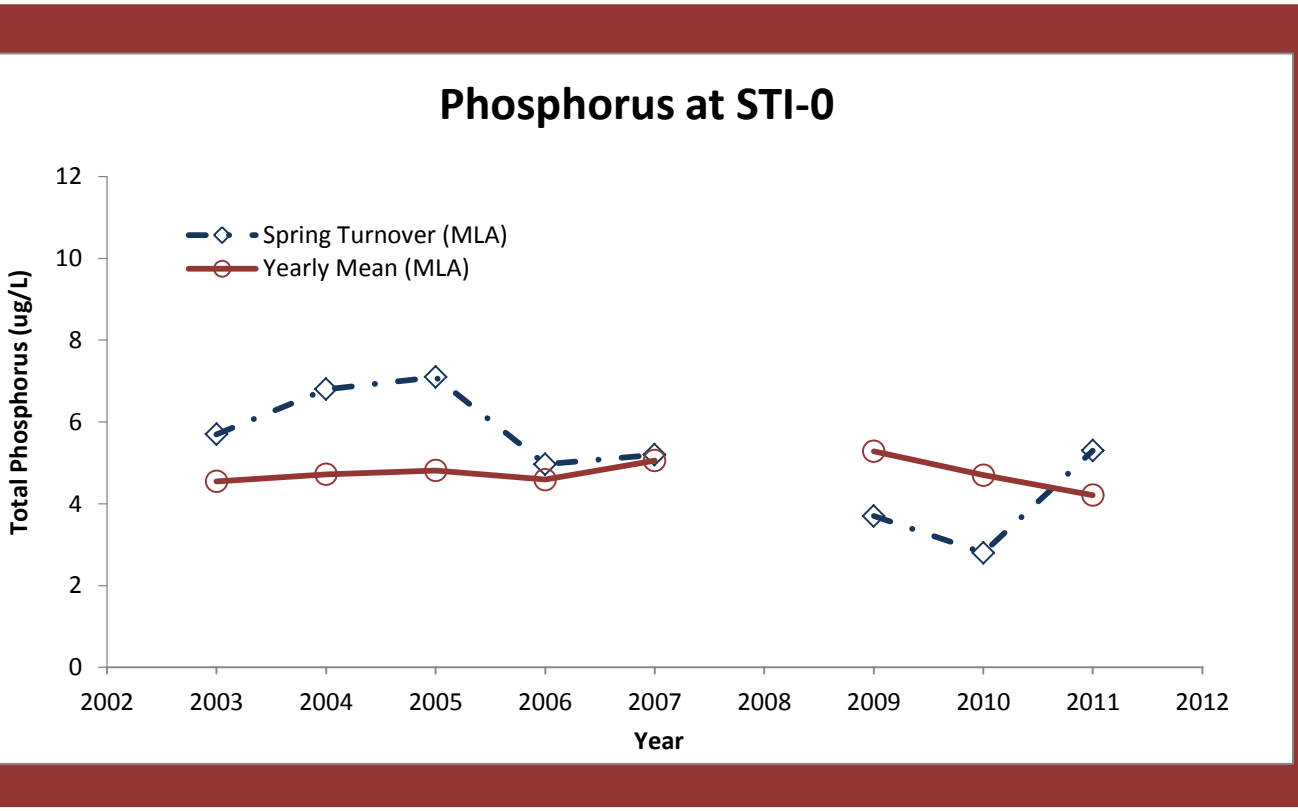
The 2011 spring turnover TP value for FTB-0 (10.5 µg/L) was identified as a potential outlier and removed from the dataset.

Recommendations

Consider collecting triplicate spring turnover TP samples at FTB-0 in 2013.

(FTB/STI) FOOT'S BAY & STILLS BAY





GORDON BAY (GNB)

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.

Volunteer Recognition

Gordon Bay was monitored in 2012 by **Brian Smith**.

2012 Data

GNB-0: Calcium = 4.16 mg/L
Secchi = 6.1 m

GNB-5: TP-Yearly mean = 5.4 µg/L
Total coliforms = 9 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

Comments

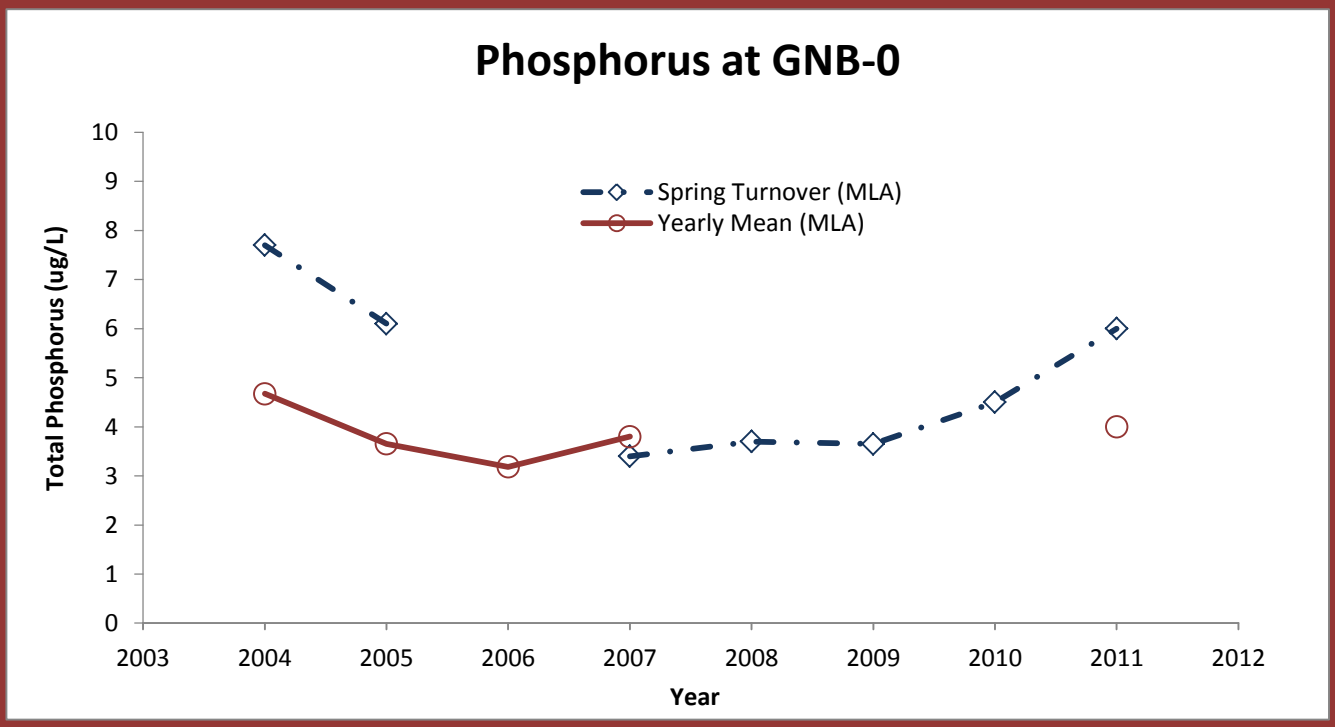
Monitoring of Gordon Bay started in 2004.

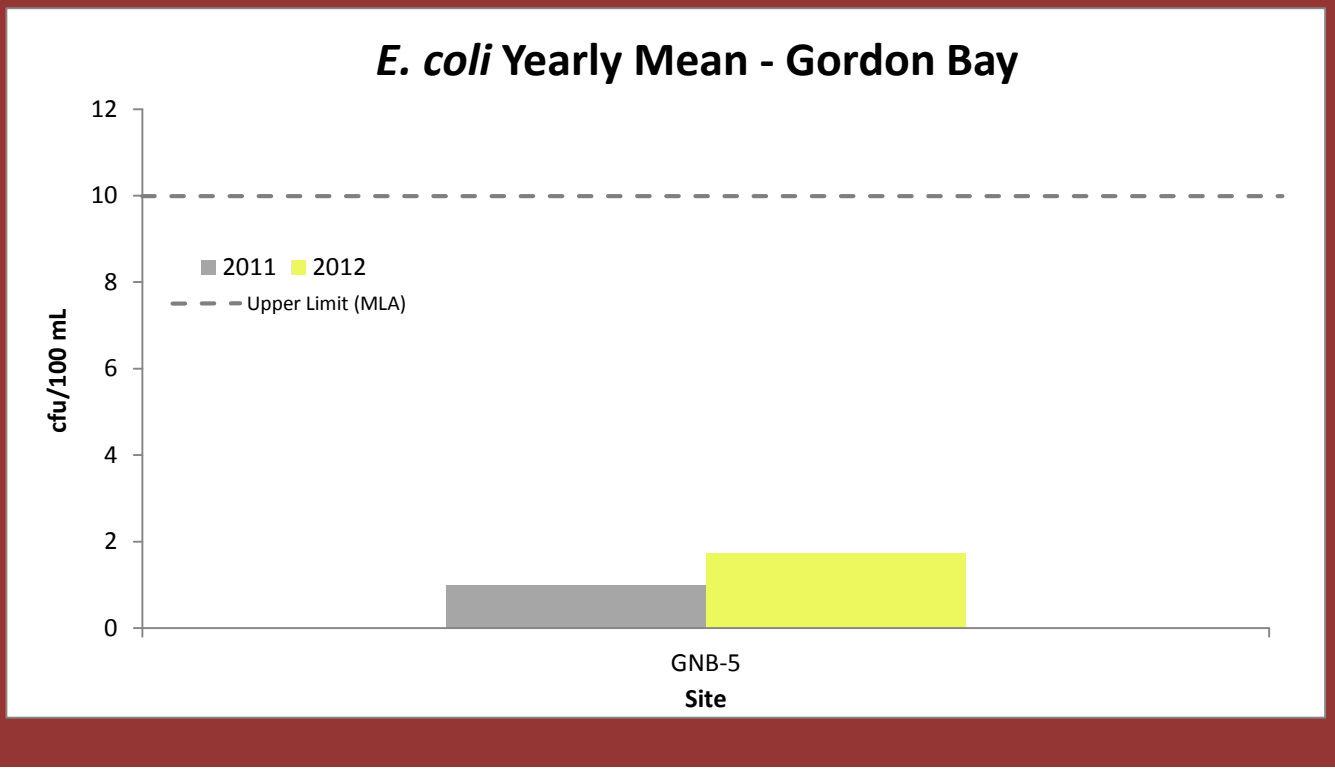
E. coli levels at GNB-5 were below the MLA upper limit in 2012.

Recommendations

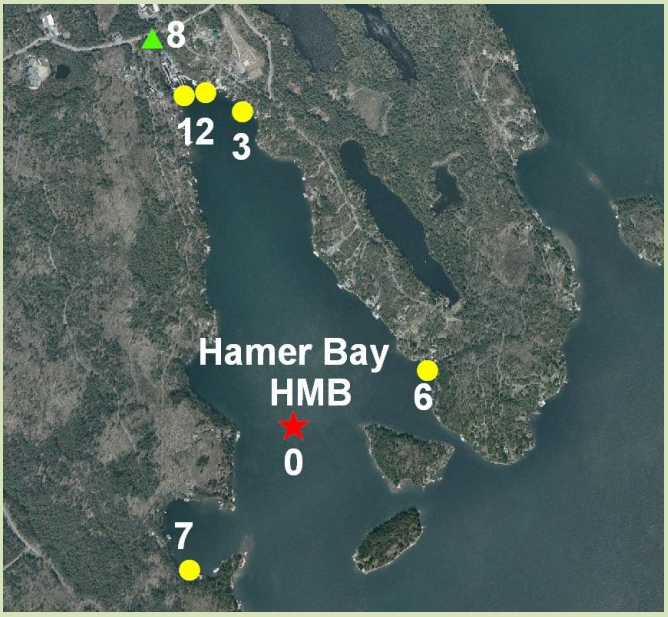
Continue existing sampling protocol to monitor long-term trends.

(GNB) GORDON BAY





HAMER BAY (HMB)



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.

Volunteer Recognition

Hamer Bay was monitored in 2012 by Jim McLellan, **Brian Smith**, and Andrew Watson.

2012 Data

HMB-0: Calcium = 4.16 mg/L
Secchi = 6.6 m

HMB-1: TP-Yearly mean = 6.5 µg/L
Total coliforms = 53 cfu/100 mL
Total *E. coli* = 5 cfu/100 mL

HMB-2: TP-Yearly mean = 5.2 µg/L

HMB-3: TP-Yearly mean = 4.7 µg/L

HMB-6: Total coliforms = 4 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

HMB-7: Total coliforms = 5 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

HMB-8: TP-Yearly mean = 169.2 µg/L*

*Based on 2 sampling events following spring turnover period; one sample contained sediment.

Comments

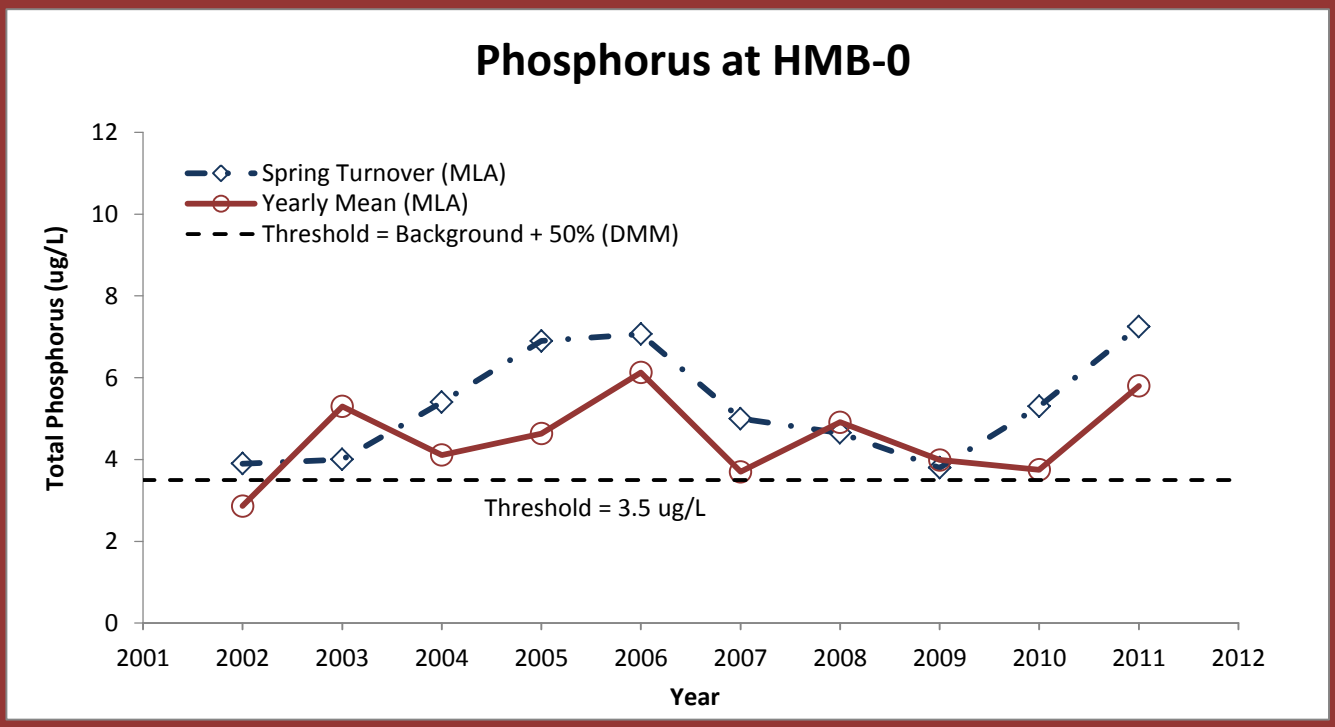
Monitoring of Hamer Bay started in 2002.

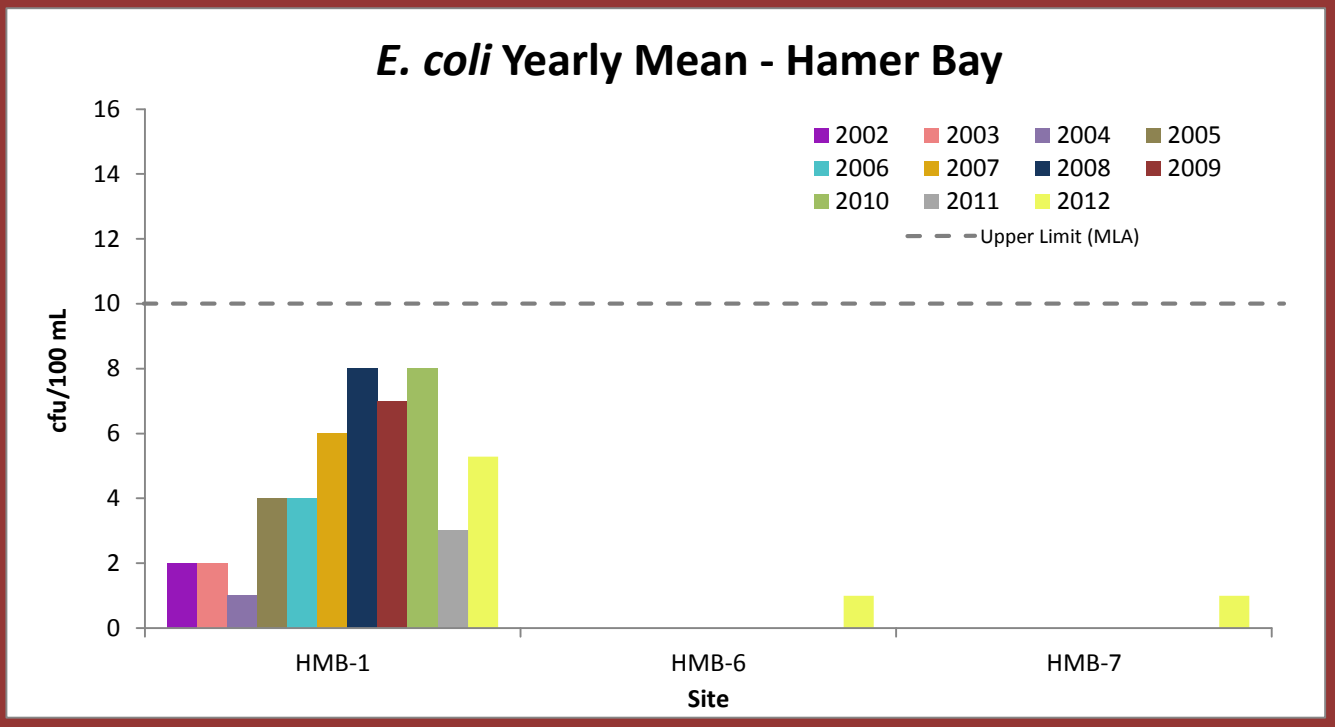
E. coli levels in 2012 were all below the MLA upper limit.

Recommendations

Continue existing sampling protocol to monitor long-term trends.

(HMB) HAMER BAY





LAKE JOSEPH (JOS-1)

Area Description

Lake Joseph is a large lake with a surface area of 50.9 km² and water depths of up to 60 m. Wetlands account for a small portion of the lake area at approximately 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.

Volunteer Recognition

Lake Joseph was monitored in 2012 by Charlie Dalton, Judy Dalton, Spencer Dalton, John Offutt, and **Brian Smith**.

2012 Data

JOS-1: Calcium = 4.18 mg/L
Secchi = 6.4 m

Comments

Monitoring of Lake Joseph started in 2002.

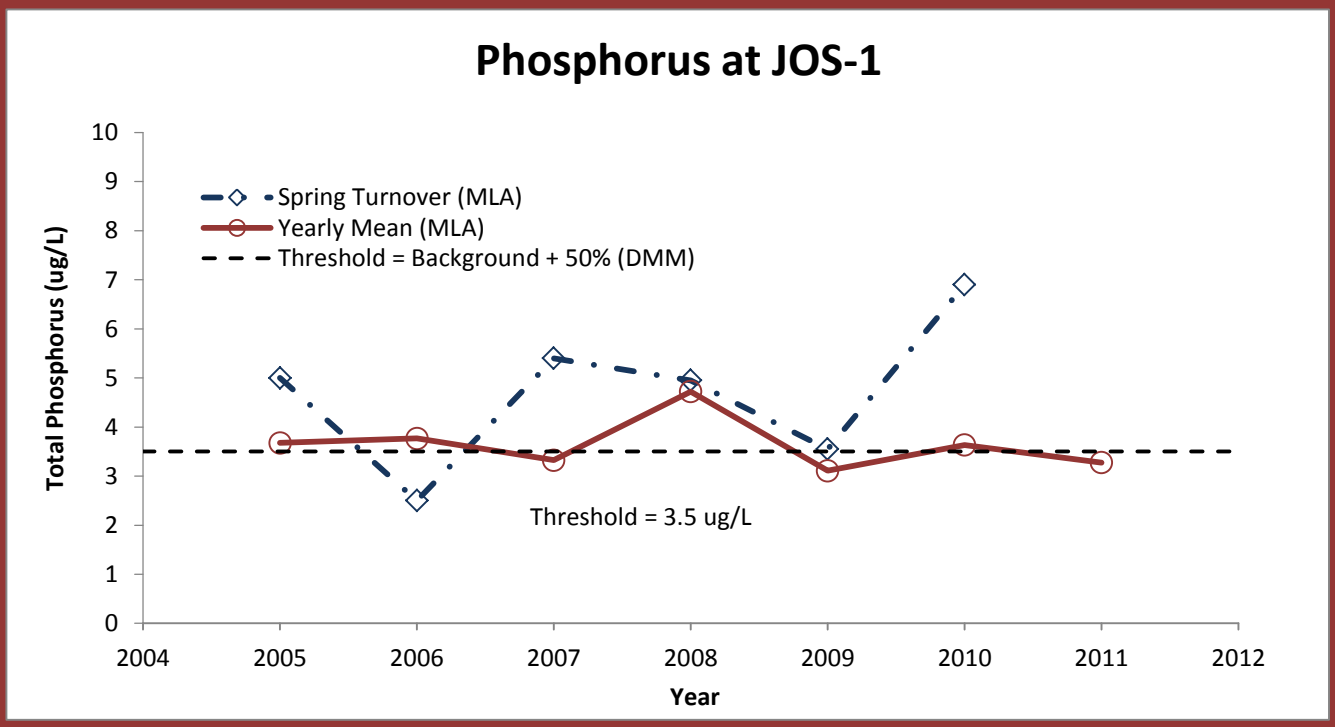
This area has been selected for long-term monitoring.

No spring turnover TP sample was collected from JOS-1 in 2011.

Recommendations

Consider collecting triplicate spring turnover TP samples at JOS-1 in 2013.

(JOS-1) LAKE JOSEPH



Notes:

LITTLE LAKE JOSEPH (LLJ)

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 Joe as moderately sensitive.

Volunteer Recognition

Little Lake Joseph was monitored in 2012 by Karen Brown, Ian Davidson, Denis Jean-Marie, Paul Jean-Marie, John Parker, Daniel Sapalo, **Dirk Soutendijk**, and Tyler Soutendijk

2012 Data

LLJ-0: Calcium = 3.95 mg/L
Secchi = 6.4 m

LLJ-12: Total coliforms = 5 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

LLJ-13: Total coliforms = 6 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

Comments

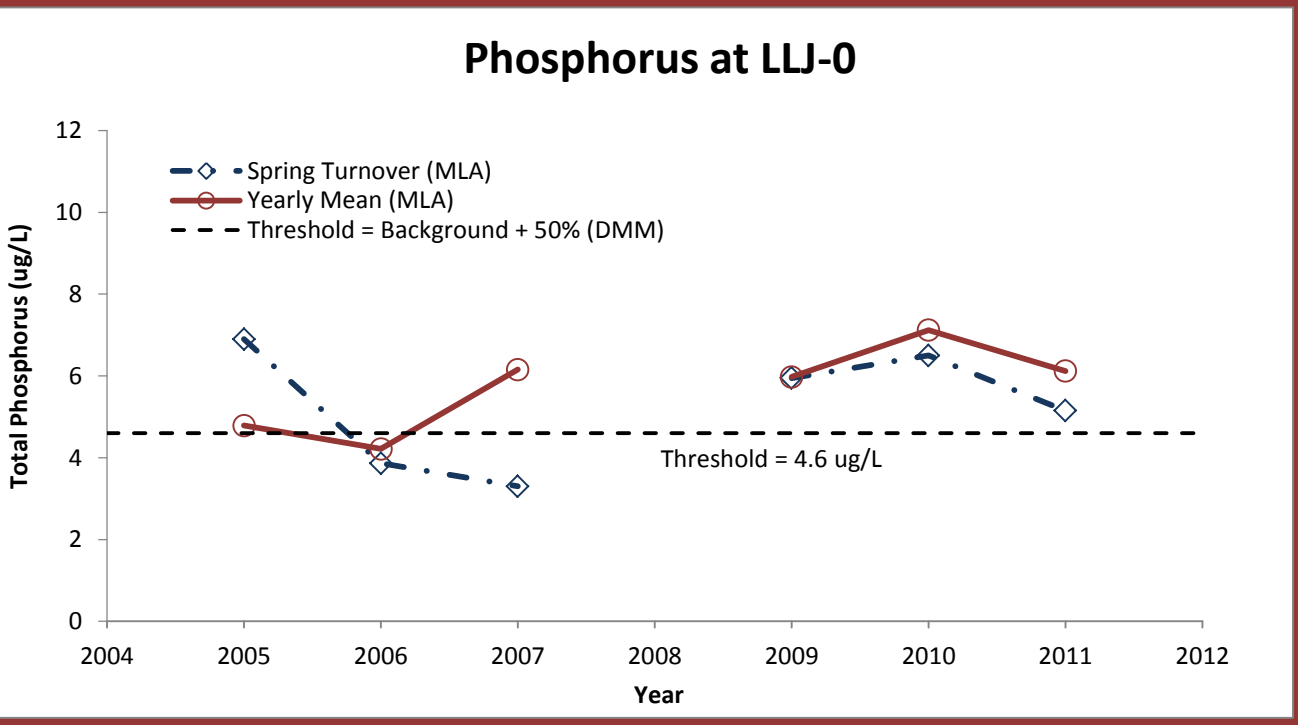
Monitoring of Little Lake Joseph started in 2005.

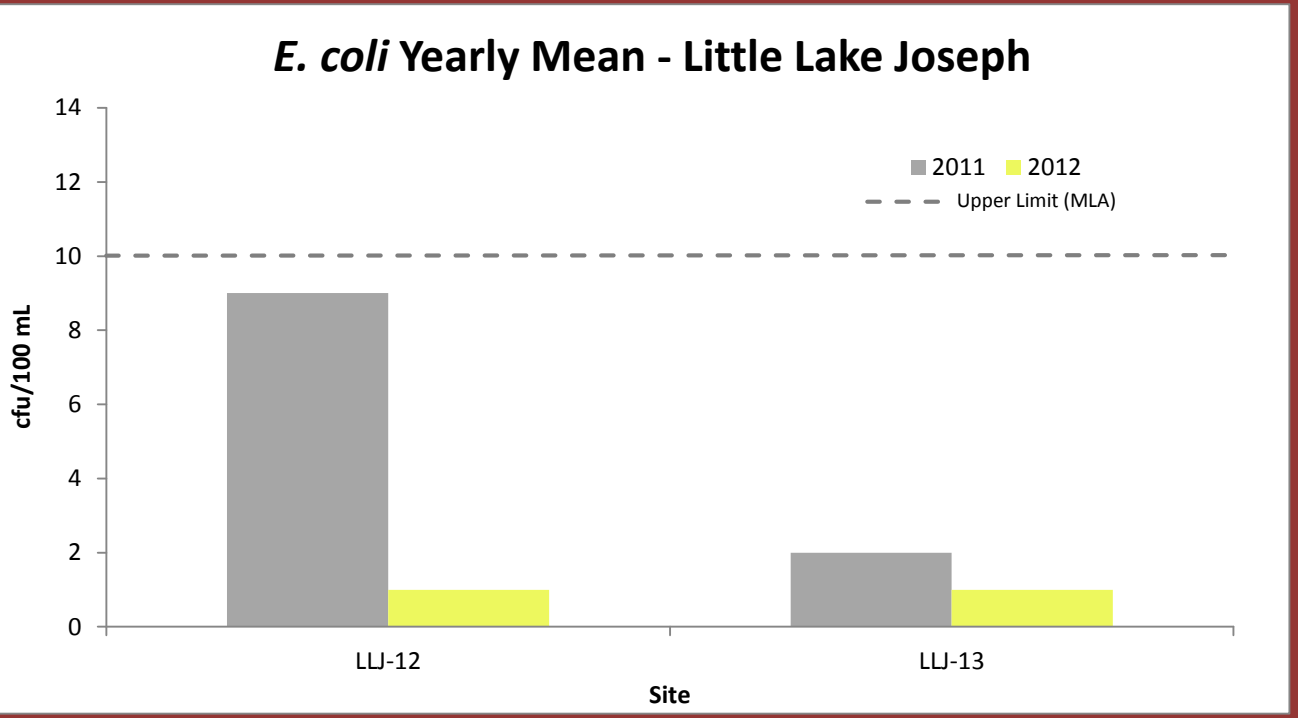
E. coli levels in 2012 were all below the MLA upper limit.

Recommendations

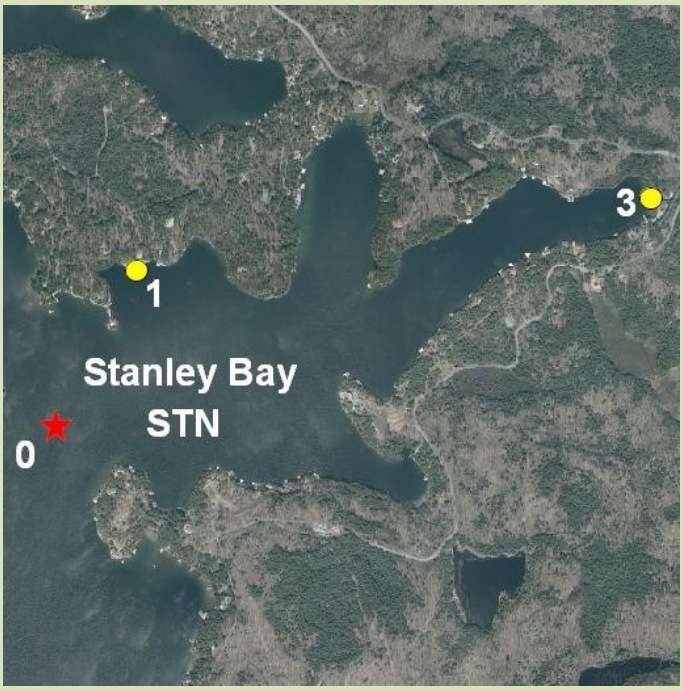
Continue existing sampling protocol in 2012 to monitor long-term trends.

(LLJ) LITTLE LAKE JOSEPH





STANLEY BAY (STN)



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.

Volunteer Recognition

Stanley Bay was monitored in 2012 by Charlie Dalton, Judy Dalton, Spencer Dalton, and **Brian Smith**.

2012 Data

STN-0: Calcium = 4.16 mg/L
Secchi = 6.6 m

STN-1: TP-Yearly mean = 5.8 µg/L*

STN-3: TP-Yearly mean = 4.7 µg/L

*Based on 3 sampling events; 1 set of duplicate samples discarded due to lab error

Comments

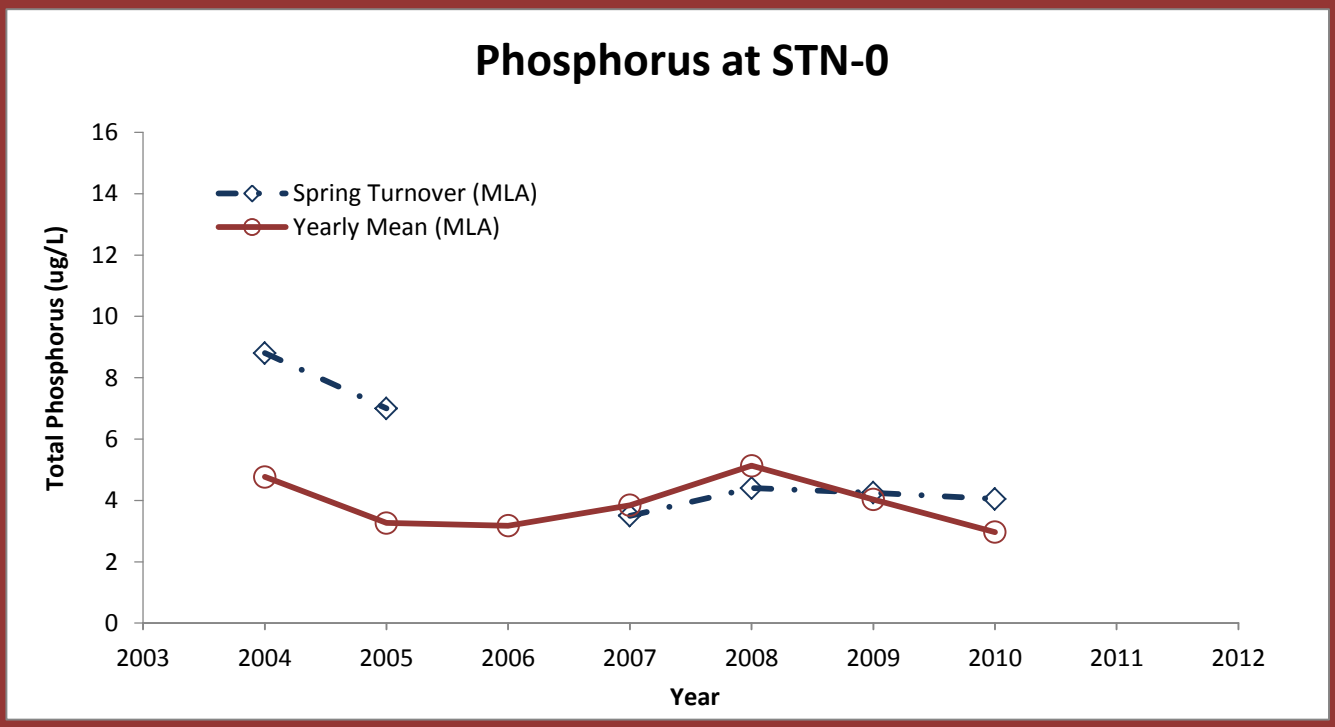
Monitoring of Stanley Bay started in 2004

The 2011 spring turnover TP value for STN-0 (29.1 µg/L) was identified as a potential outlier and removed from the dataset.

Recommendations

Consider collecting triplicate spring turnover TP samples in 2013.

(STN) STANLEY BAY



Notes:

ARUNDLE LODGE (ARN)

Area Description

The Arundle 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.

Volunteer Recognition

Arundle Lodge was monitored in 2012 by **Susan Murphy**, Stephen Sims, Carrie Tate, and Doug Tate.

2012 Data

ARN-0: Calcium = 3.56 mg/L
Secchi = 3.3 m

Comments

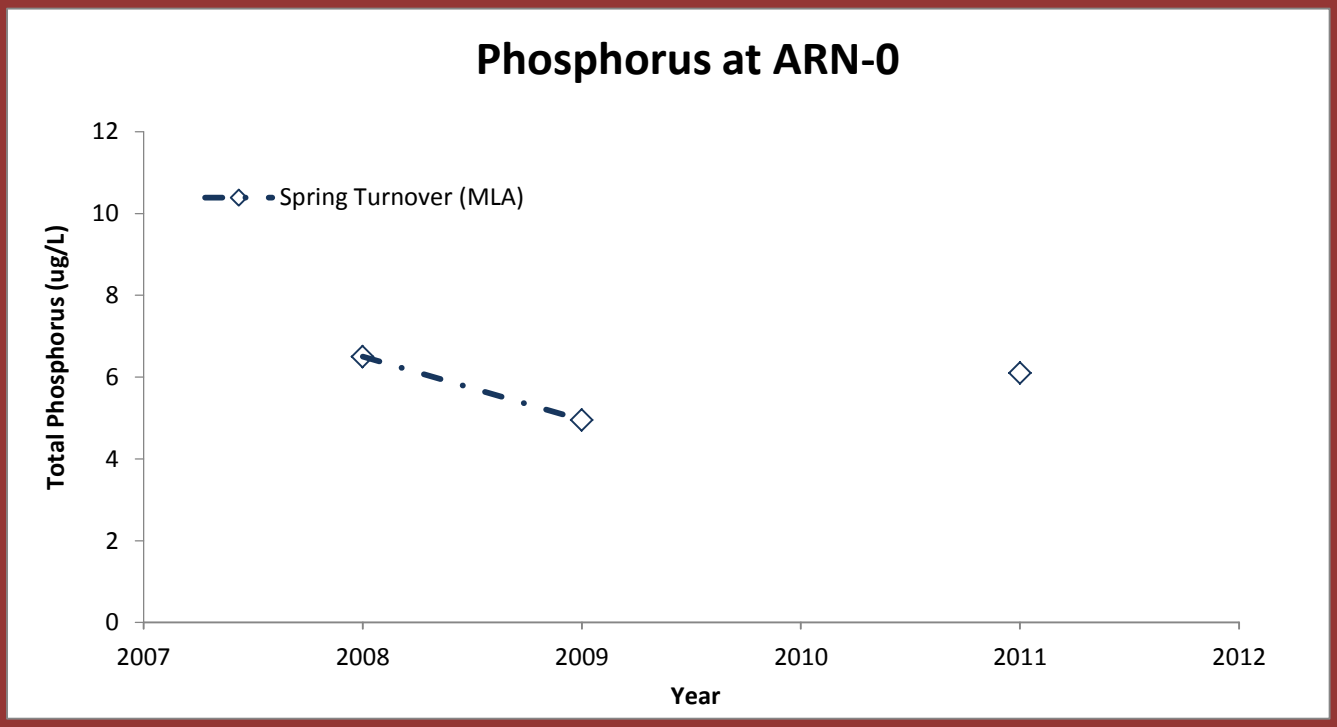
Monitoring of Arundle Lodge started in 2008.

This area has been selected for long-term monitoring.

Recommendations

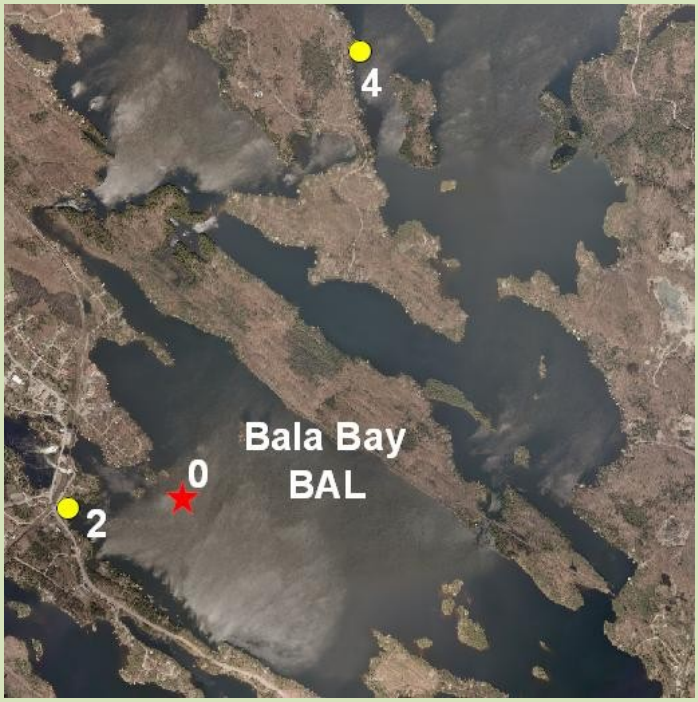
Continue existing sampling protocol to monitor long-term trends.

(ARN) ARUNDLE LODGE



Notes:

BALA BAY (BAL)



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.

Volunteer Recognition

Bala Bay was monitored in 2012 by Alan Hutton, and **Peter Joel**.

2012 Data

BAL-0: Calcium = 3.52 mg/L
Secchi = 4.2 m

BAL-2: Total coliforms = 23 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

BAL-4: Total coliforms = 33 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

Comments

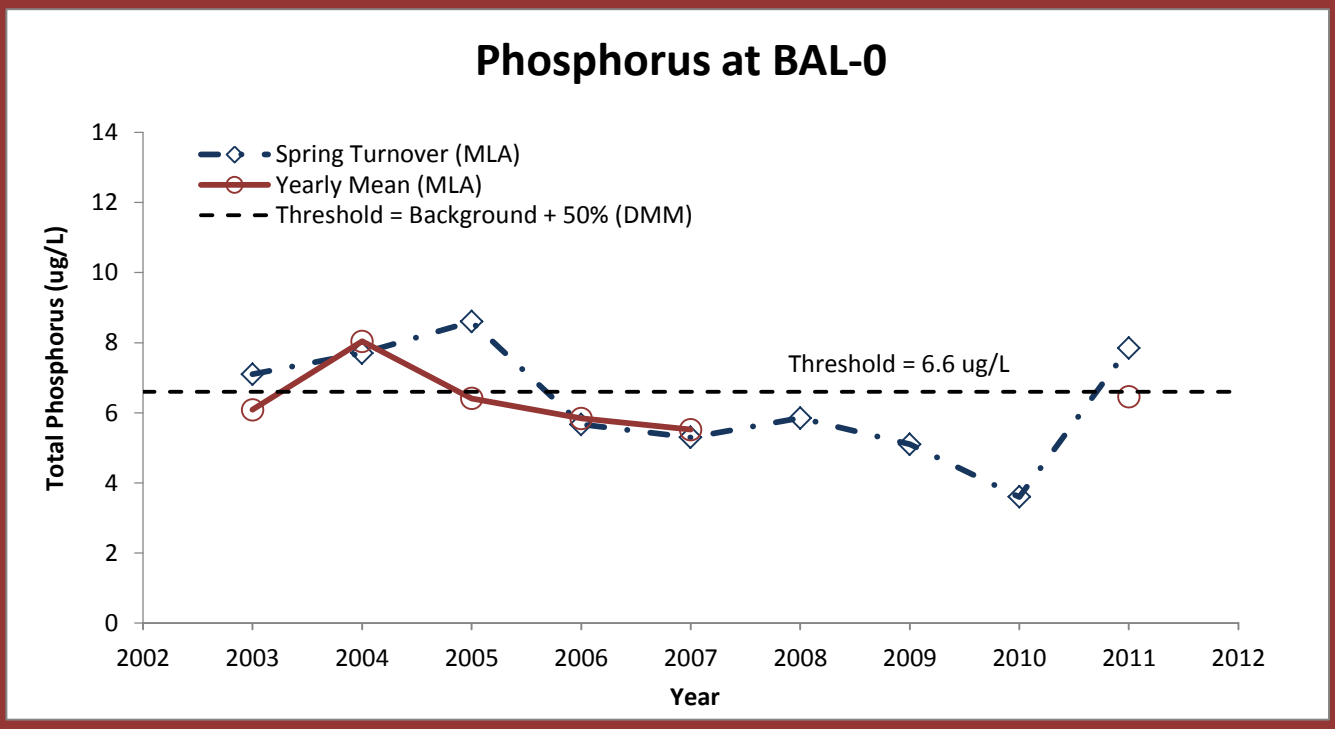
Monitoring of Bala Bay started in 2003.

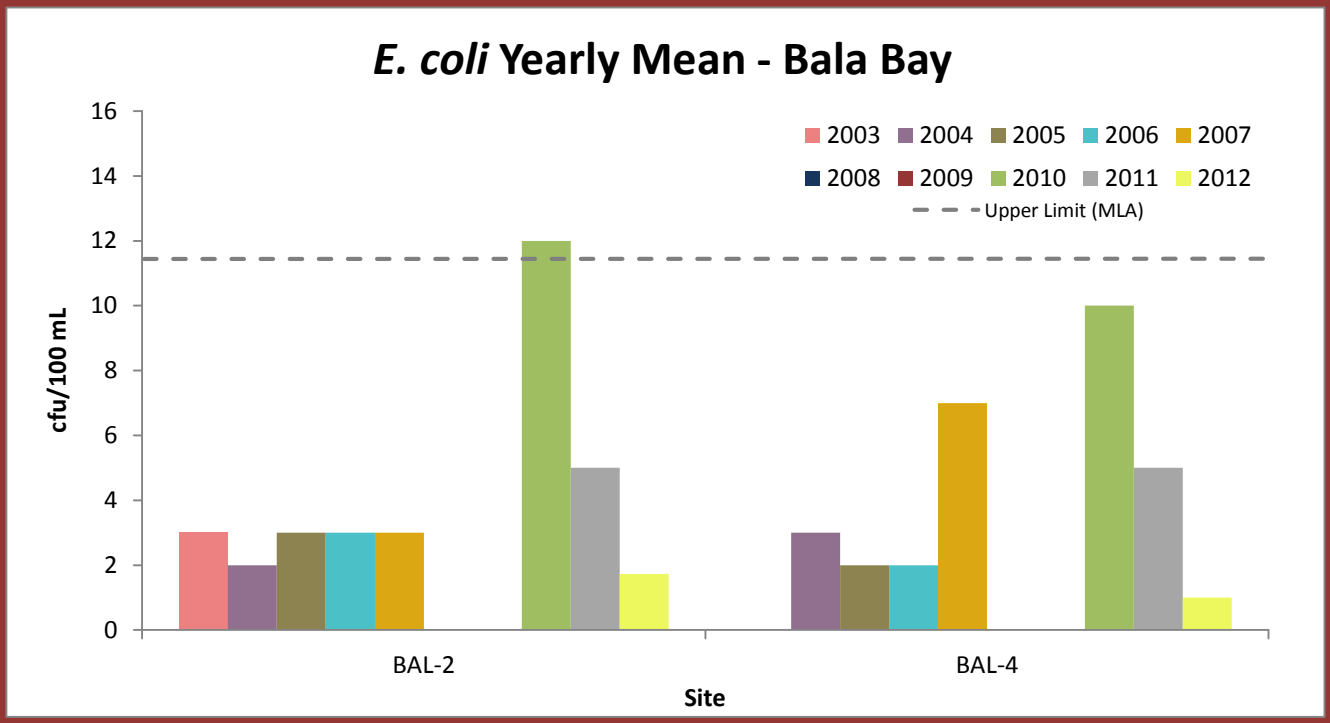
E. coli levels in 2012 were all below the MLA upper limit.

Recommendations

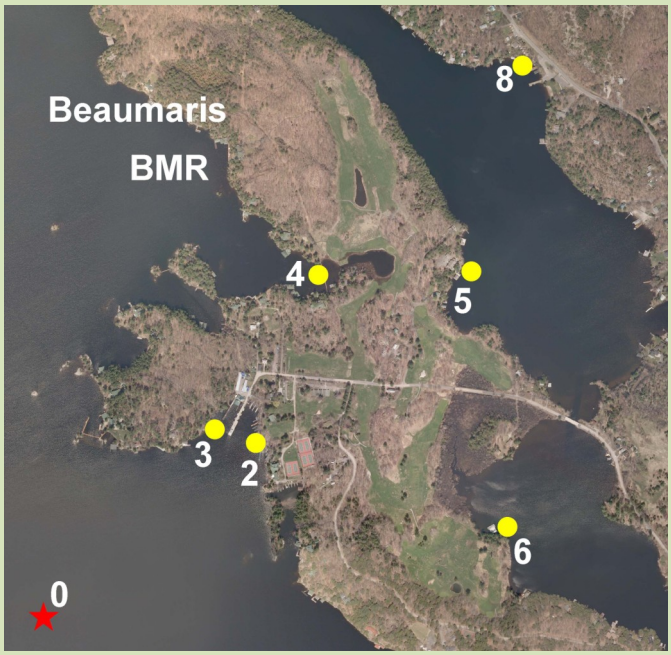
Continue existing sampling protocol to monitor long-term trends.

(BAL) BALA BAY


Phosphorus at BAL-0
Spring Turnover (MLA)
Yearly Mean (MLA)
Threshold = Background + 50% (DMM)
Threshold = 6.6 ug/L
Total Phosphorus (ug/L)
0
2
4
6
8
10
12
14
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year


E. coli Yearly Mean - Bala Bay
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Upper Limit (MLA)
cfu/100 mL
0
2
4
6
8
10
12
14
16
BAL-2
BAL-4
Site

BEAUMARIS (BMR)



Area Description

This island 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. BMR-8 is located near the mainland where Milford Bay Road is in close proximity to Lake Muskoka.

Volunteer Recognition

Beaumaris was monitored in 2012 by Andree Baillargeon, Chris Cragg, **Louise Cragg,** Allen Flye, and Eliza Nevin.

2012 Data

BMR-0: Calcium = 3.46 mg/L
Secchi = 3.8 m

BMR-2: TP-Yearly mean = 5.1 µg/L

BMR-3: Total coliforms = 104 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

BMR-4: TP-Yearly mean = 6.9 µg/L
Total coliforms = 93 cfu/100 mL
Total *E. coli* = 13 cfu/100 mL

BMR-5: Total coliforms = 39 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

BMR-6: TP-Yearly mean = 6.8 µg/L

BMR-8: TP-Yearly mean = 5.2 µg/L

Comments

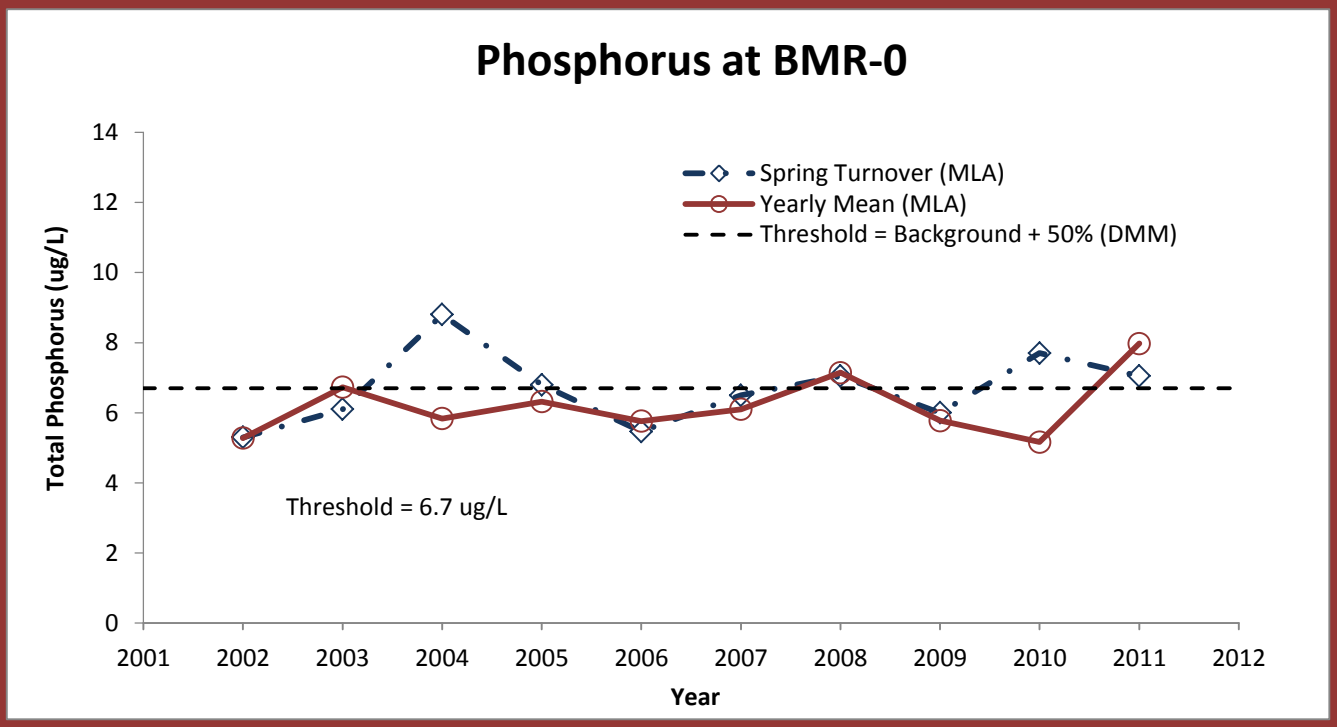
Monitoring of Beaumaris started in 2002.

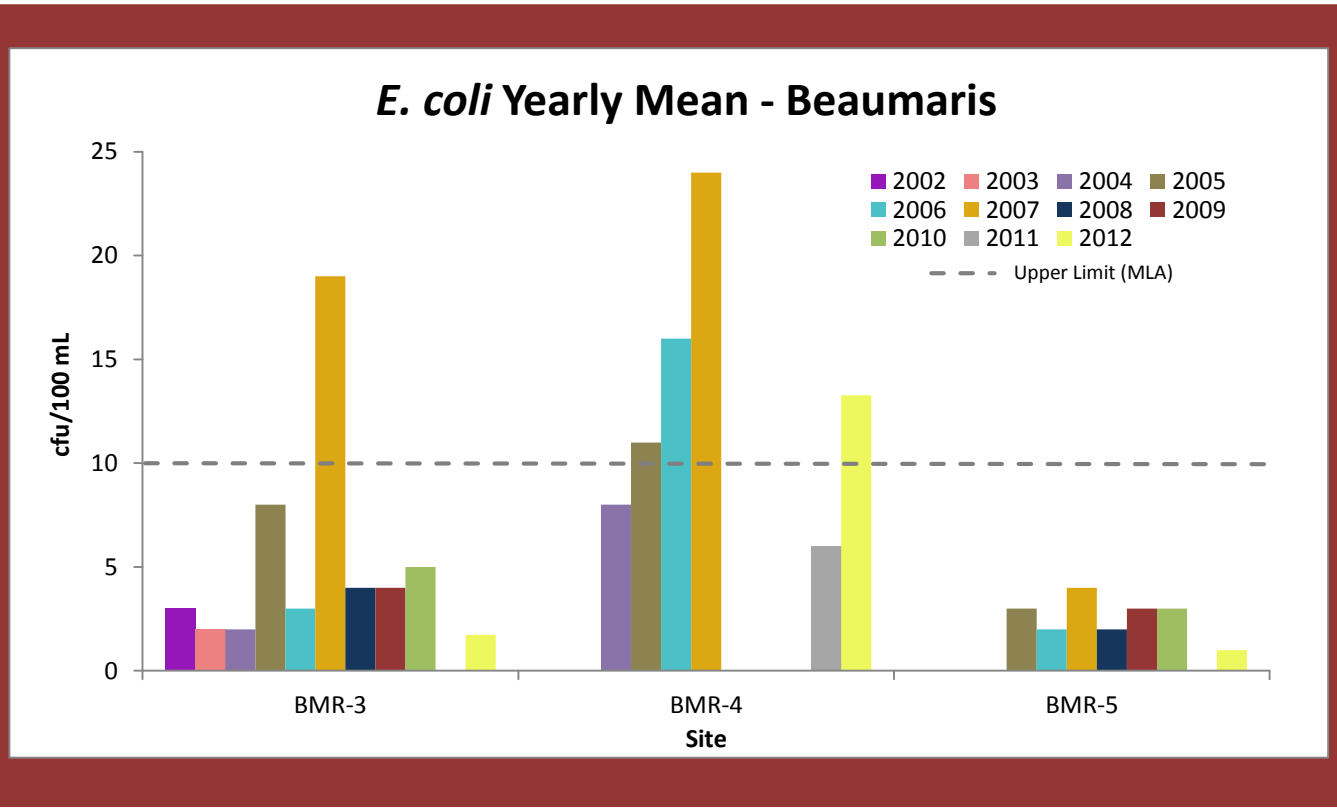
E. coli levels in 2012 were below the MLA upper limit with the exception of BMR-4.

Recommendations

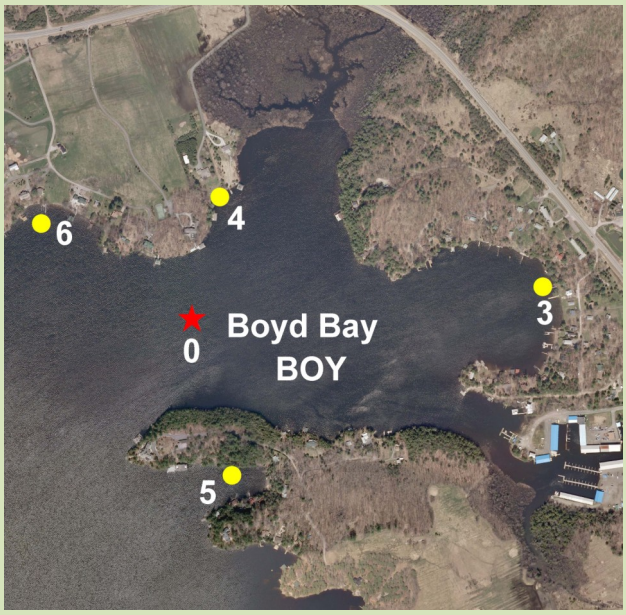
Continue existing sampling protocol to monitor long-term trends.

(BMR) BEAUMARIS





BOYD BAY (BOY)



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.

Volunteer Recognition

Boyd Bay was monitored in 2012 by Chris & Rayma Blaymires, Lynn & Dave Langford, and **John Wood**.

2012 Data

BOY-0: Calcium = 3.40 mg/L
Secchi = 3.7 m

BOY-3: TP-Yearly mean = 8.8 µg/L

BOY-4: TP-Yearly mean = 8.4 µg/L
Total coliforms = 78 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

BOY-5: TP-Yearly mean = 6.7 µg/L
Total coliforms = 46 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

BOY-6: Total coliforms = 36 cfu/100 mL
Total *E. coli* = 4 cfu/100 mL

Comments

Monitoring of Boyd Bay started in 2006.

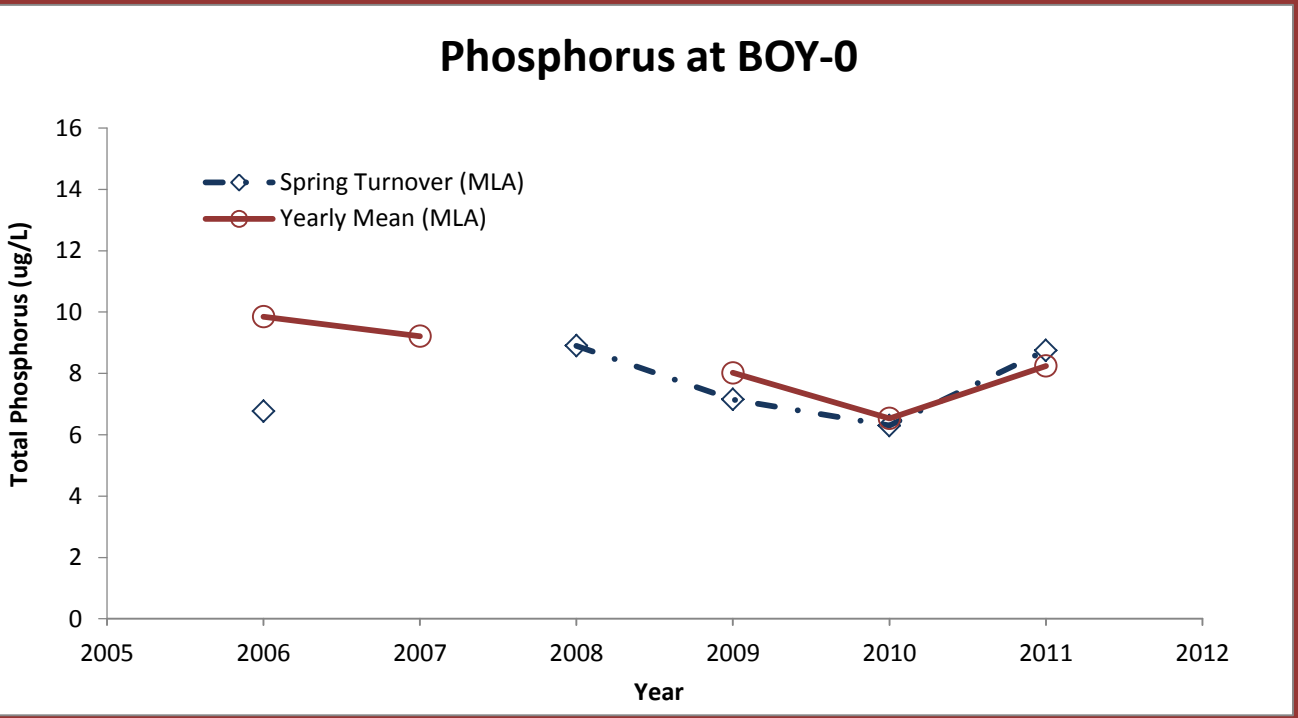
BOY-6 is a newly established site located in a high use area.

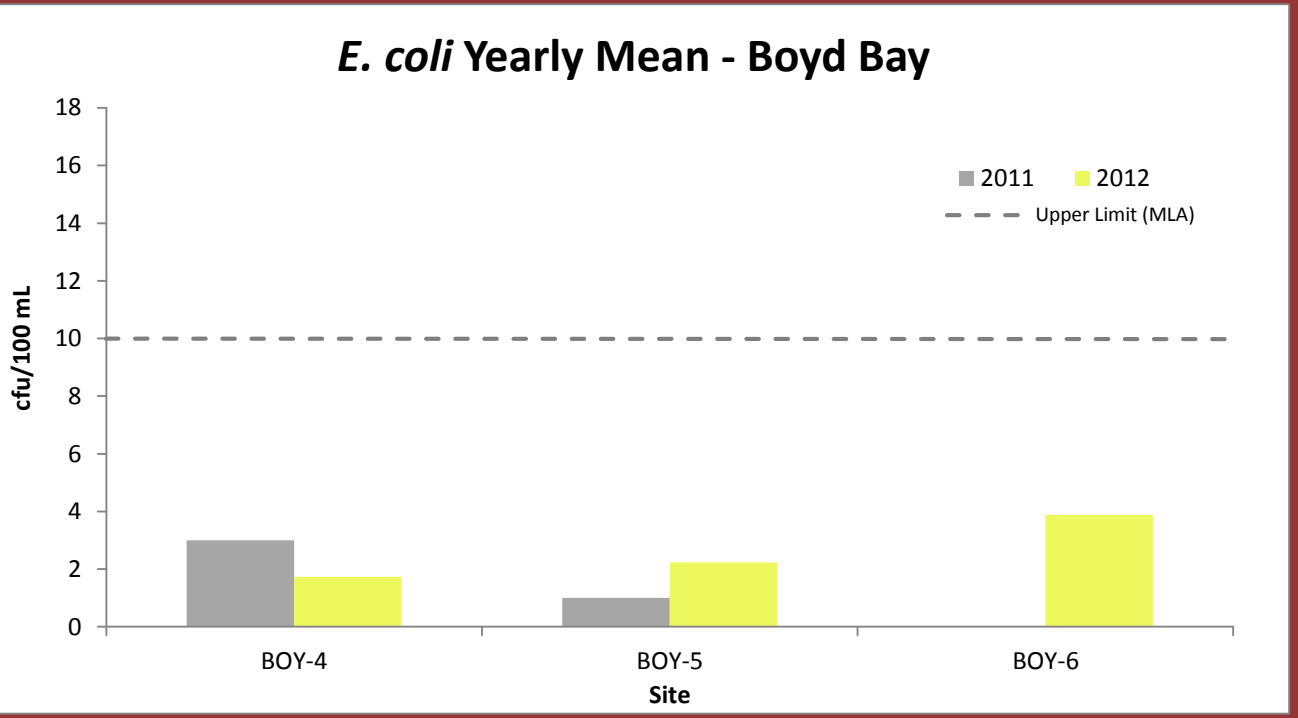
E. coli levels in 2012 at all sites were below the MLA upper limit.

Recommendations

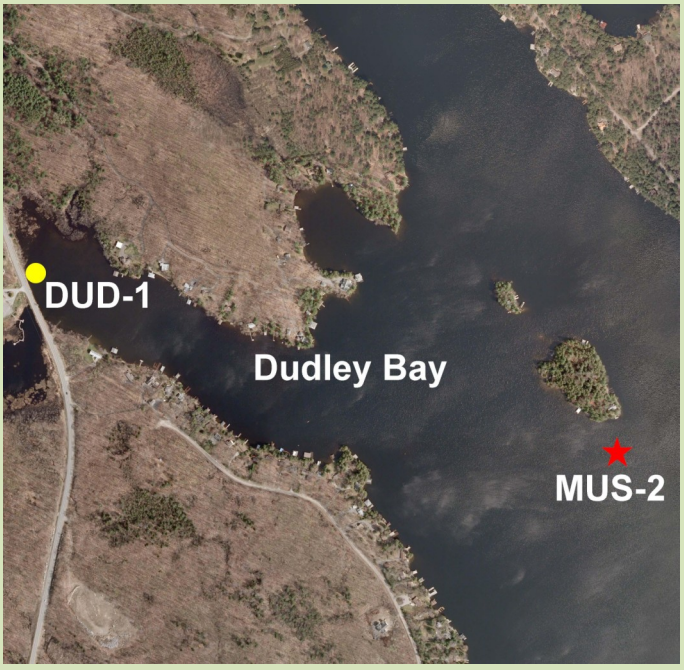
Continue existing sampling protocol in 2012 to monitor long-term trends.

(BOY) BOYD BAY


Phosphorus at BOY-0
Spring Turnover (MLA)
Yearly Mean (MLA)
Total Phosphorus (ug/L)
16
14
12
10
8
6
4
2
0
2005
2006
2007
2008
2009
2010
2011
2012
Year


E. coli Yearly Mean - Boyd Bay
2011
2012
Upper Limit (MLA)
cfu/100 mL
18
16
14
12
10
8
6
4
2
0
BOY-4
BOY-5
BOY-6
Site

DUDLEY BAY (DUD & MUS-2)



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.

Volunteer Recognition

Dudley Bay was monitored in 2012 by Benjamin Bulter, **Eleanor Lewis**, and **Jim Lewis**.

2012 Data

MUS-2: Calcium = 3.55 mg/L
Secchi = 3.5 m

DUD-1 Total coliforms = 31 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

Comments

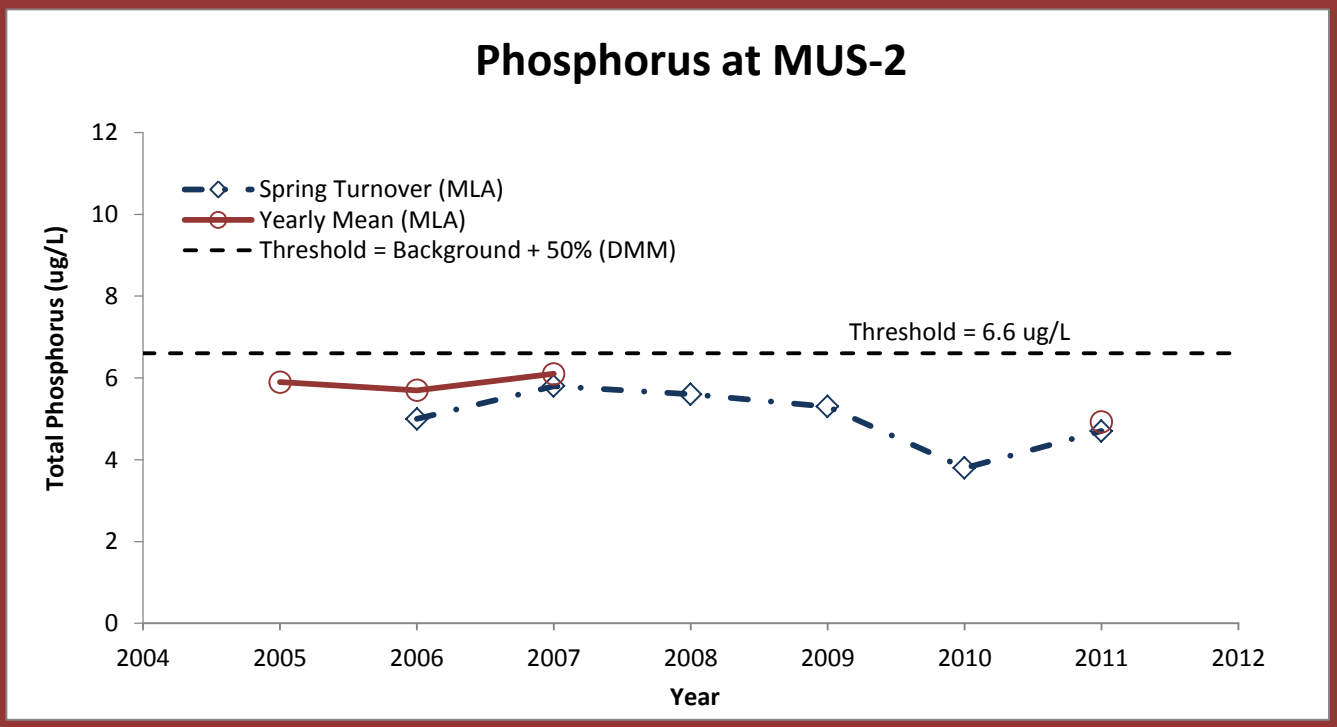
Monitoring of Dudley Bay started in 2005.

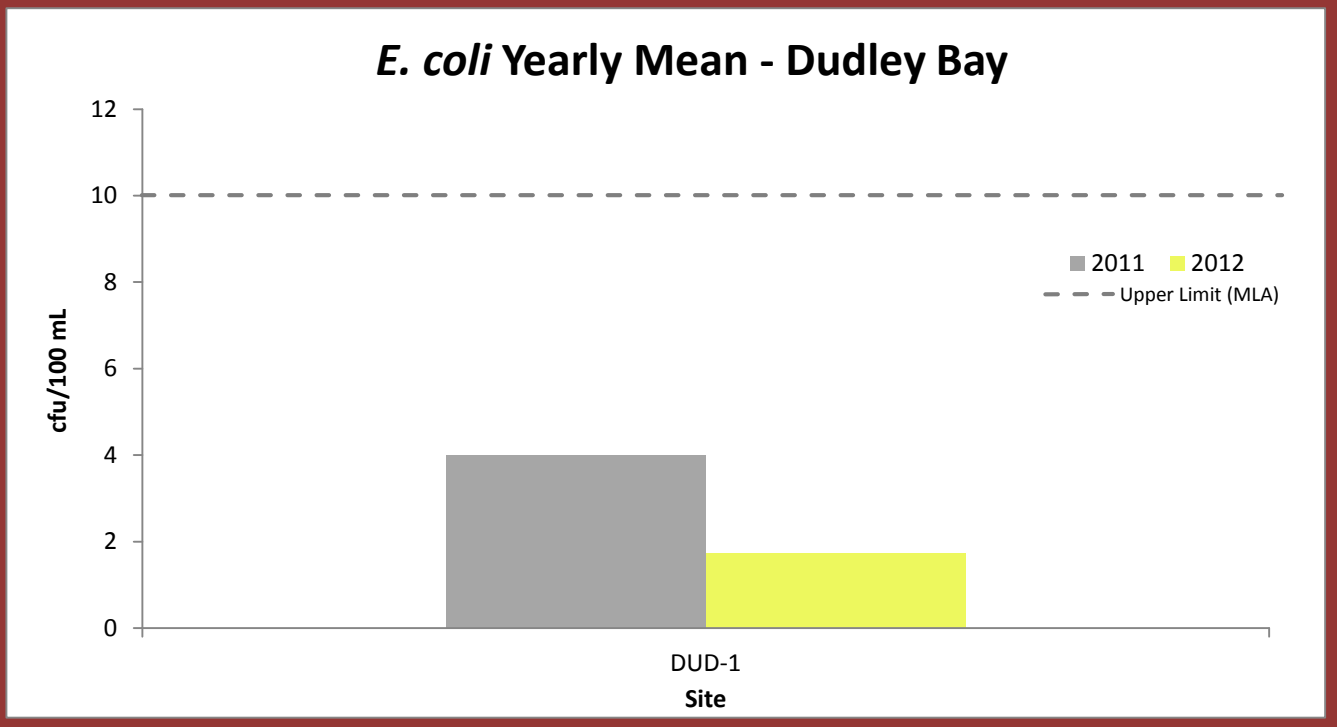
E. coli levels at DUD-1 in 2012 were below the MLA upper limit.

Recommendations

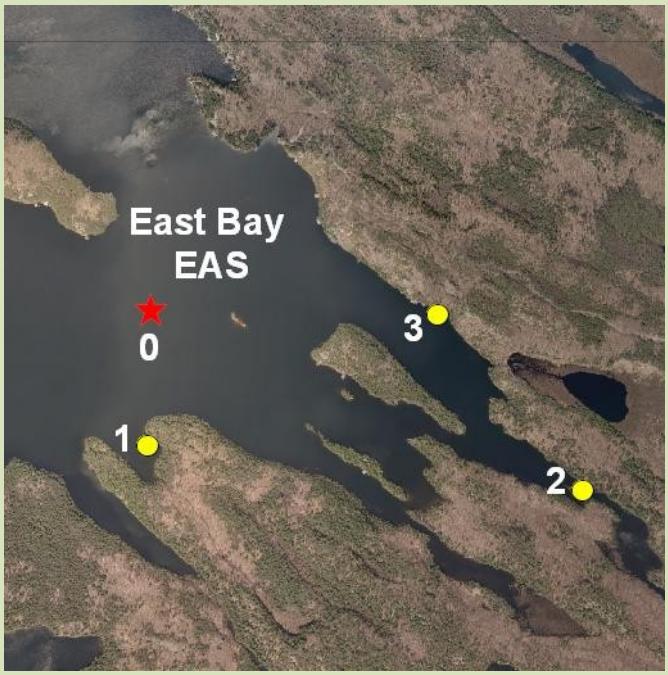
Continue existing sampling protocol to monitor long-term trends.

(DUD & MUS-2) DUDLEY BAY





EAST BAY (EAS)



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 no 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.

Volunteer Recognition

East Bay was monitored in 2012 by **Louise Cragg**, Chloe, Dave, Gary, Janice, & Nolan Getson, and Lloyd Walton.

2012 Data

EAS-0: Calcium = 3.56 mg/L
Secchi = 3.9 m

EAS-1: TP-Yearly mean = 5.2 µg/L

EAS-2: TP-Yearly mean = 8.1 µg/L

EAS-3: TP-Yearly mean = 4.7 µg/L

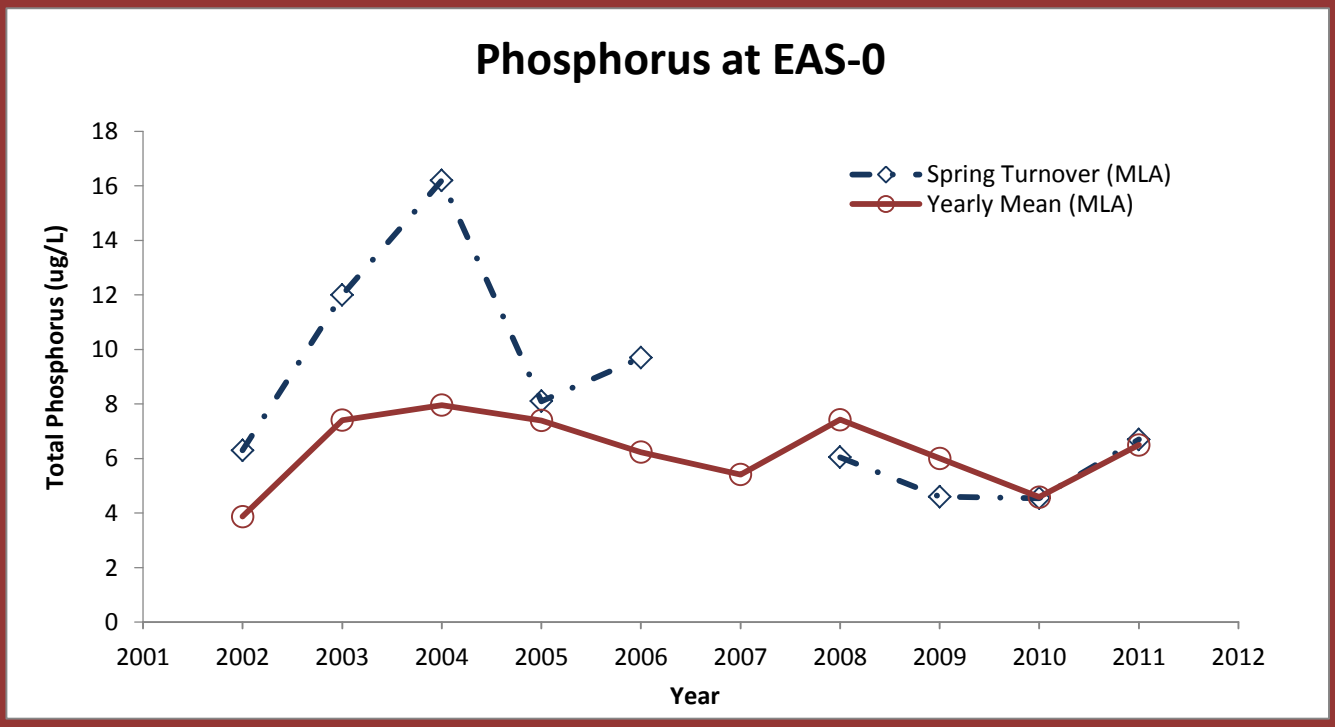
Comments

Monitoring of East Bay started in 2002.

Recommendations

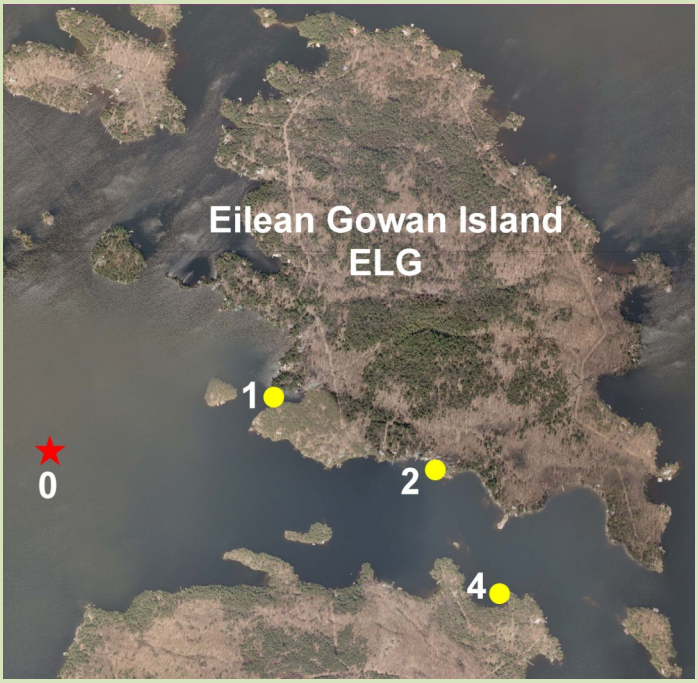
Continue existing sampling protocol to monitor long-term trends.

(EAS) EAST BAY



Notes:

EILEAN GOWAN ISLAND (ELG)



Area Description

Eilean Gowan Island is located 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 with the exception of 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.

Volunteer Recognition

Eilean Gowan Island was monitored in 2012 by **Susan Murphy**, Stephen Sims, Carrie Tate, and Doug Tate.

2012 Data

ELG-0: Calcium = 3.57 mg/L
Secchi = 3.3 m

ELG-1: Total coliforms = 67 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

ELG-2: Total coliforms = 162 cfu/100 mL
Total *E. coli* = 4 cfu/100 mL

ELG-4: Total coliforms = 100 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

Comments

Monitoring of Eilean Gowan Island started in 2002.

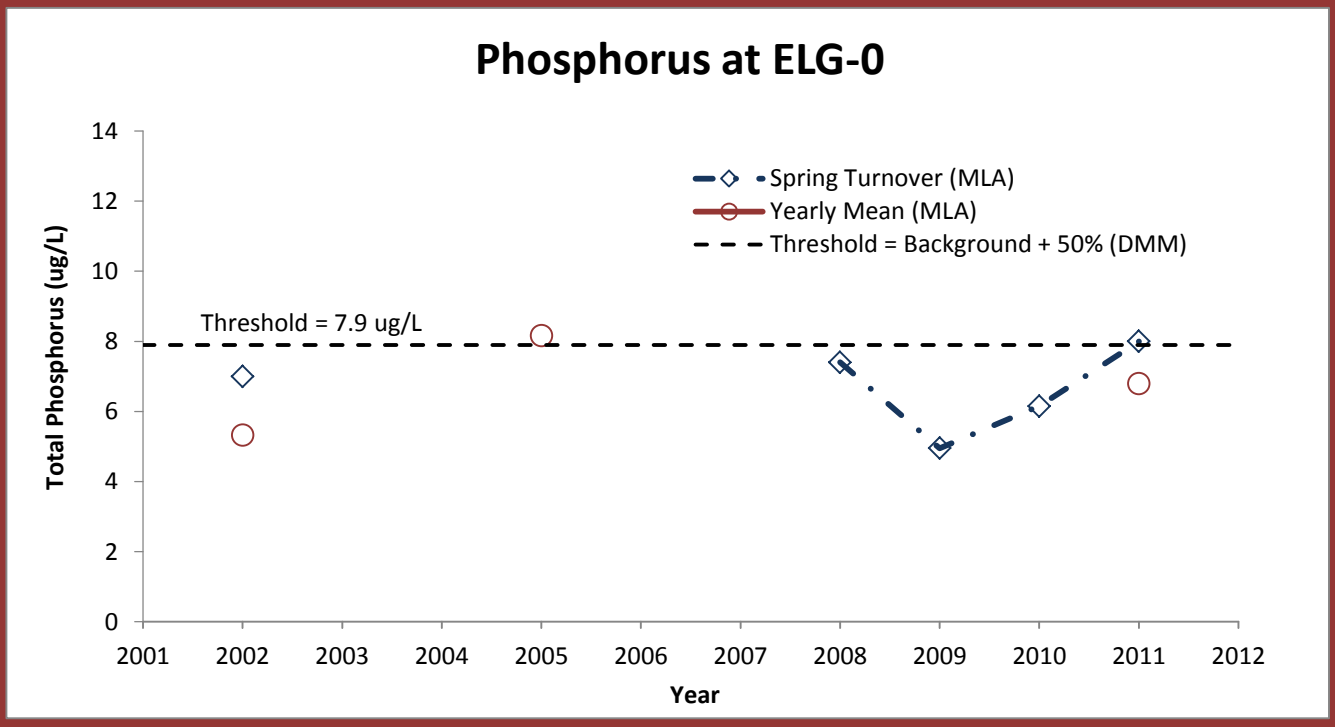
ELG-4 is a newly established site located in a high use area ajdacent to Browning Island.

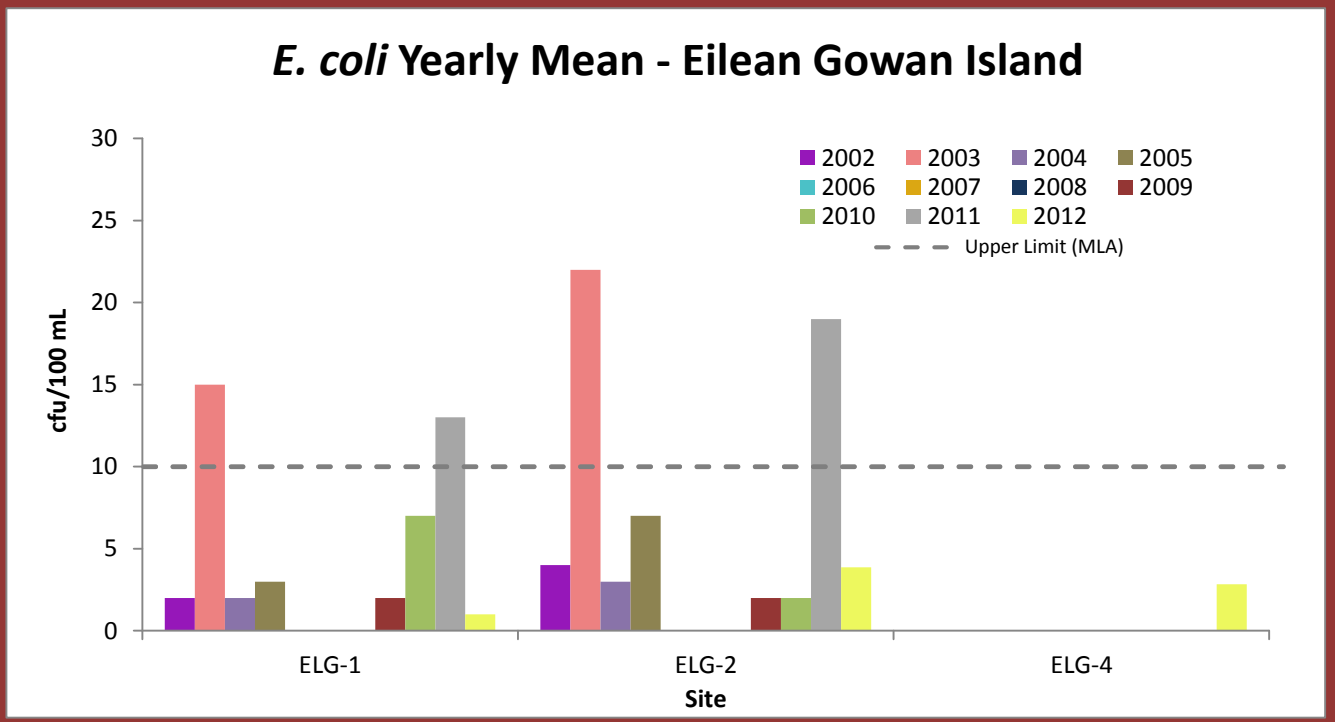
In 2012, *E. coli* levels were below the MLA upper limit at all sites.

Recommendations

Continue existing sampling protocol to monitor long-term trends.

(ELG) EILEAN GOWAN ISLAND





LAKE MUSKOKA (MUS-3)

Area Description

With a surface area of approximately 121 km^2 and with 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.

Volunteer Recognition

Lake Muskoka Main Basin was monitored in 2012 by Chris Blaymire, Rayma Blaymire, and **John Wood**.

2012 Data

MUS-3: Calcium = 3.71 mg/L
Secchi = 4.3 m

Comments

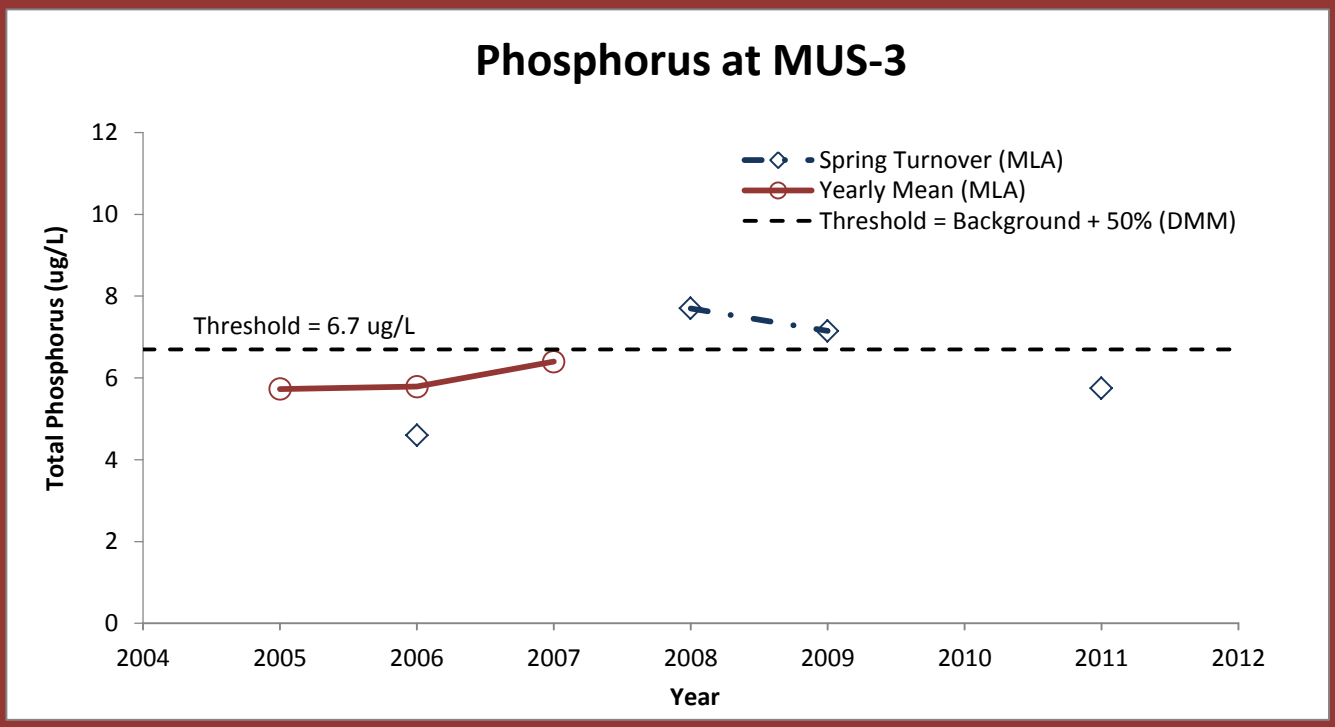
Monitoring of Lake Muskoka Main Basin started in 2005.

This area has been selected for long-term monitoring.

Recommendations

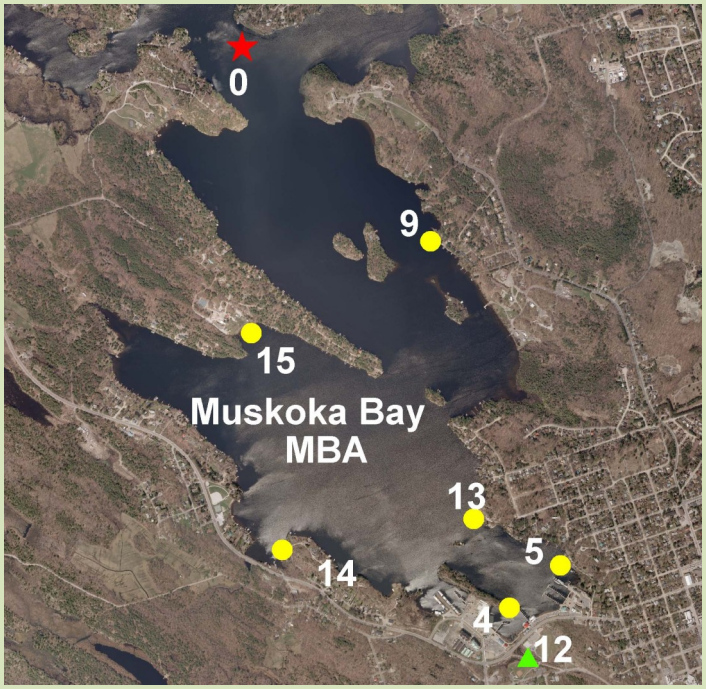
Continue existing sampling protocol to monitor long-term trends.

(MUS-3) LAKE MUSKOKA



Notes:

MUSKOKA BAY (MBA)



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.

Volunteer Recognition

Muskoka Bay was monitored in 2012 by George Genereux, Matthew Mammoliti, **Brian Yeates**, and Diane Yeates.

2012 Data

MBA-0: Calcium = 5.8 mg/L
Secchi = 4.8 m

MBA-4: Total coliforms = 97 cfu/100 mL
Total *E. coli* = 4 cfu/100 mL

MBA-5: Total coliforms = 301 cfu/100 mL
Total *E. coli* = 8 cfu/100 mL

MBA-9: TP-Yearly mean = 6.8 µg/L

MBA-12: TP-Yearly mean = 19.7 µg/L
Total coliforms = 961 cfu/100 mL*
Total *E. coli* = 146 cfu/100 mL*

MBA-13: TP-Yearly mean = 7.3 µg/L
Total coliforms = 195 cfu/100 mL
Total *E. coli* = 14 cfu/100 mL

MBA-14: Total coliforms = 76 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

MBA-15: Total coliforms = 43 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

*Based on 3 sampling events; includes two samples with elevated *E. coli* levels and one follow-up sample

Comments

Monitoring of Muskoka Bay started in 2002.

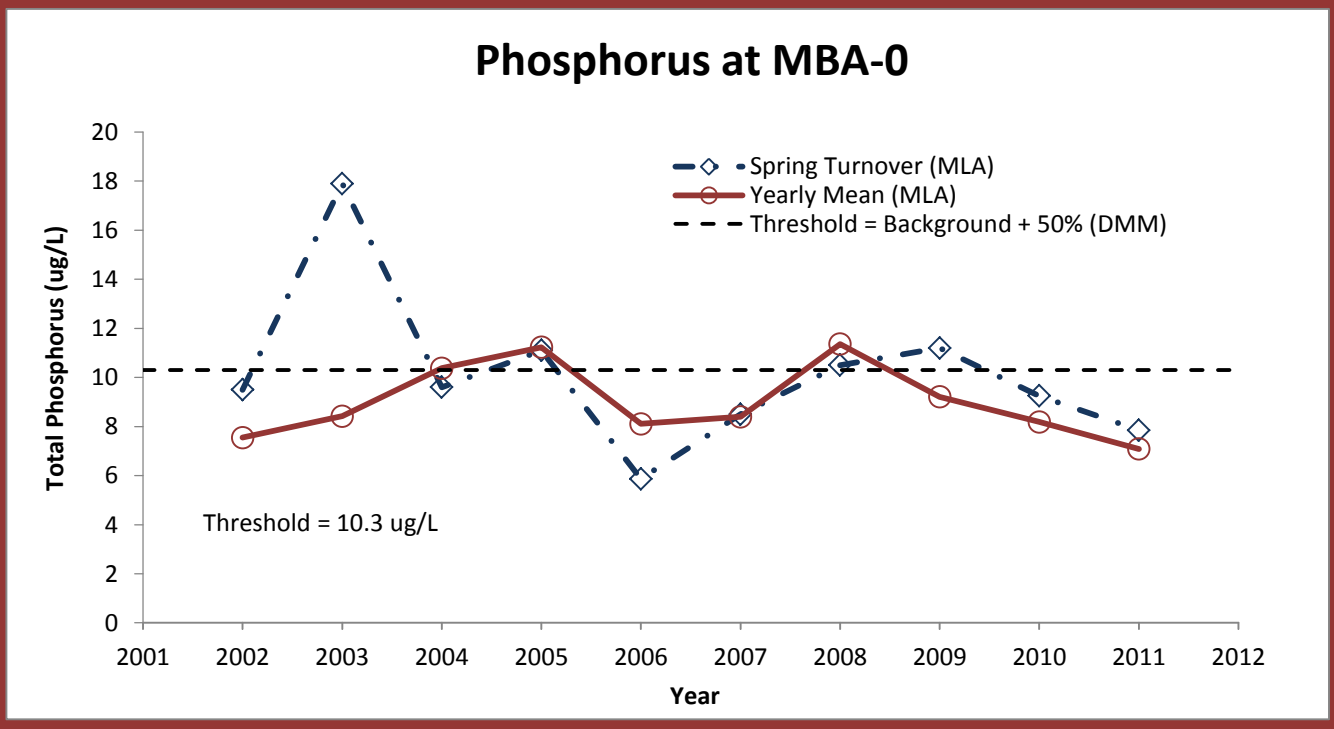
E. coli levels in 2012 were below the MLA upper limit with the exception of MBA-12 and MBA-13.

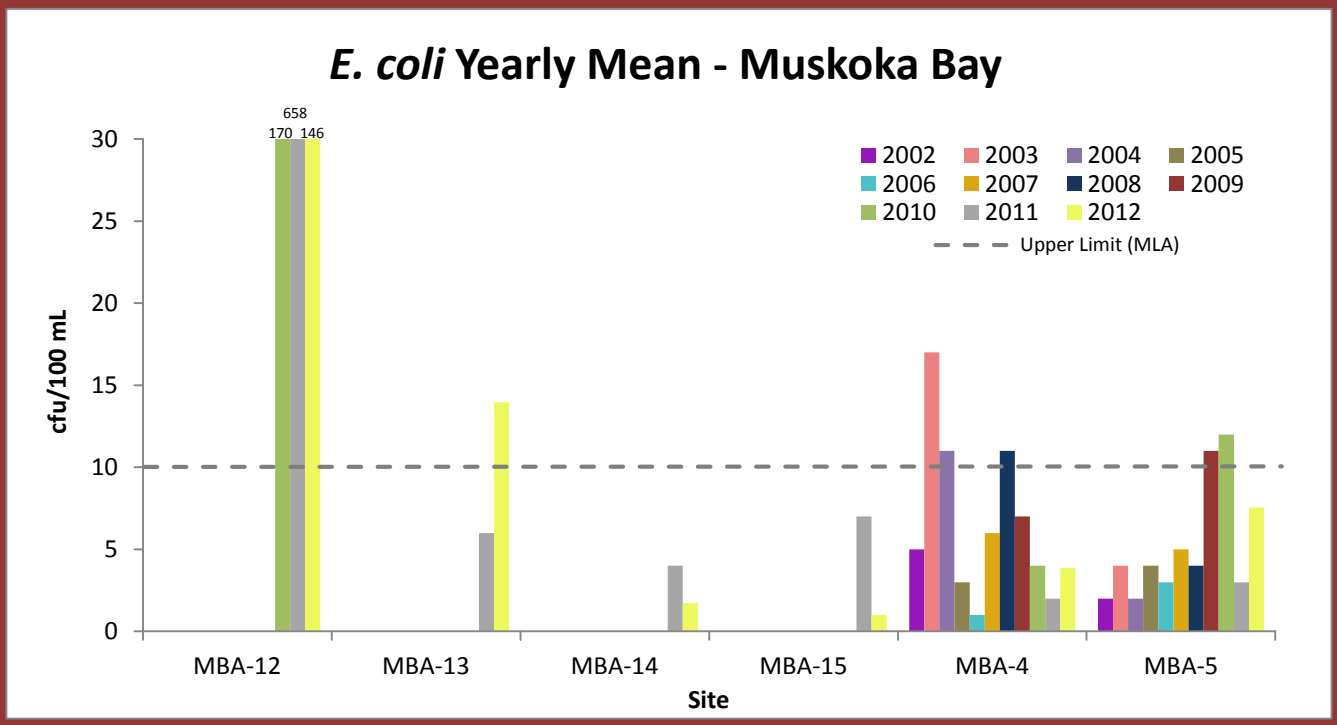
MBA-12 is a watercourse site located within an urban area. Follow-up samples are not always collected from this site as we expect bacteria levels to be naturally elevated.

Recommendations

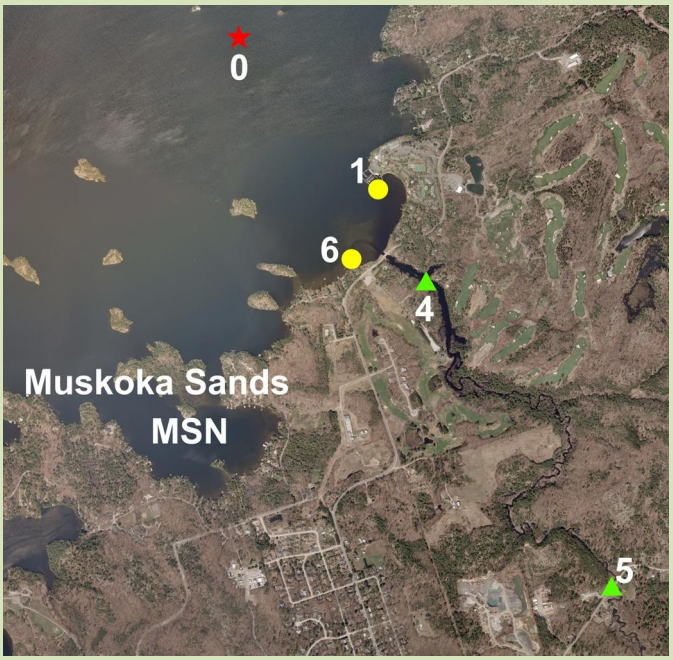
Continue existing sampling protocol to monitor long-term trends.

(MBA) MUSKOKA BAY





MUSKOKA SANDS (MSN)



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.

Volunteer Recognition

Muskoka Sands was monitored in 2012 by **Al Ward** and Carole Ward.

2012 Data

MSN-0: Calicum = 3.56 mg/L
Secchi = 3.7 m

MSN-1: Total coliforms = 61 cfu/100 mL*
Total *E. coli* = 43 cfu/100 mL*

MSN-4: TP-Yearly mean = 24.6 µg/L
Total coliforms = 108 cfu/100 mL*
Total *E. coli* = 55 cfu/100 mL*

MSN-5: TP-Yearly mean = 19.9 µg/L
Total coliforms = 59 cfu/100 mL**
Total *E. coli* = 10 cfu/100 mL**

MSN-6: Total coliforms = 31 cfu/100 mL**
Total *E. coli* = 7 cfu/100 mL**

*Based on 3 sampling events. Includes one or more samples with elevated *E. coli* levels

**Based on 3 sampling events

Comments

Monitoring of Muskoka Sands started in 2003.

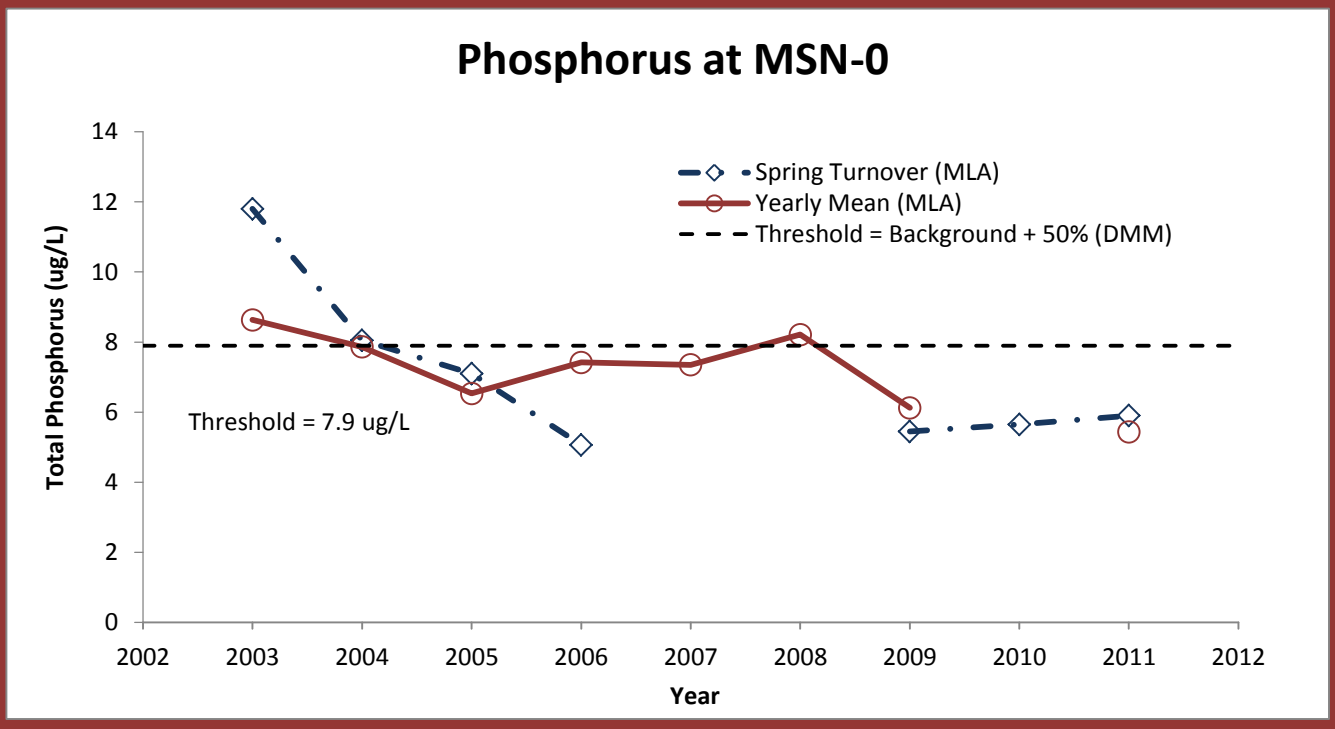
MSN-6 is a newly established site located in a high use area. *E. coli* levels in 2012 were at or below the MLA upper limit with the exception of MSN-1 and MSN-4.

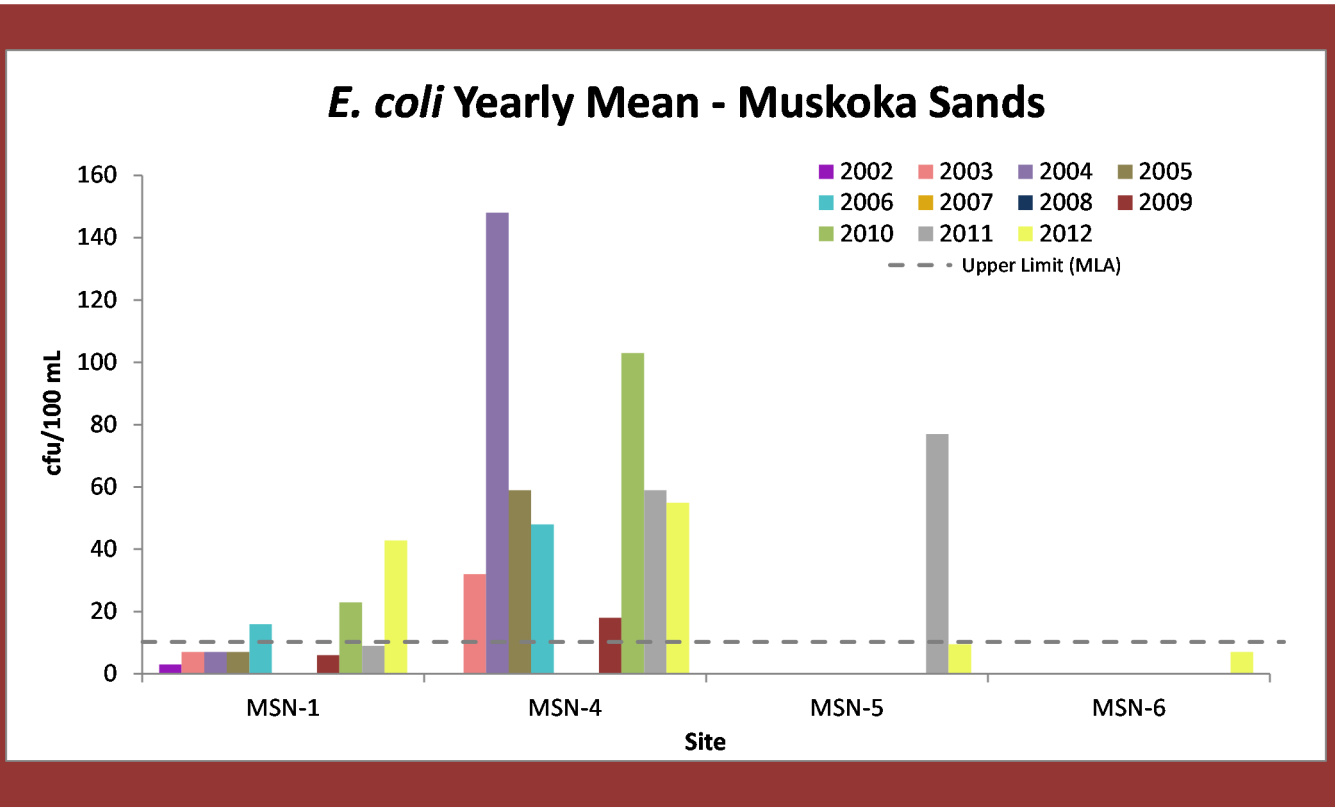
MSN-4 and MSN-5 are watercourse sites located within the Hoc Roc River. Follow-up samples are not always collected from these sites as we expect bacteria levels to be naturally elevated.

Recommendations

Continue existing sampling protocol to monitor long-term trends.

(MSN) MUSKOKA SANDS





NORTH BAY (NRT)

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.

Volunteer Recognition

North Bay was monitored in 2012 by Benjamin Butler, **Eleanor Lewis** and **Jim Lewis**.

2012 Data

NRT-0: Calcium = 3.53 mg/L
Secchi = 3.5 m

NRT-4: Total coliforms = 4 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

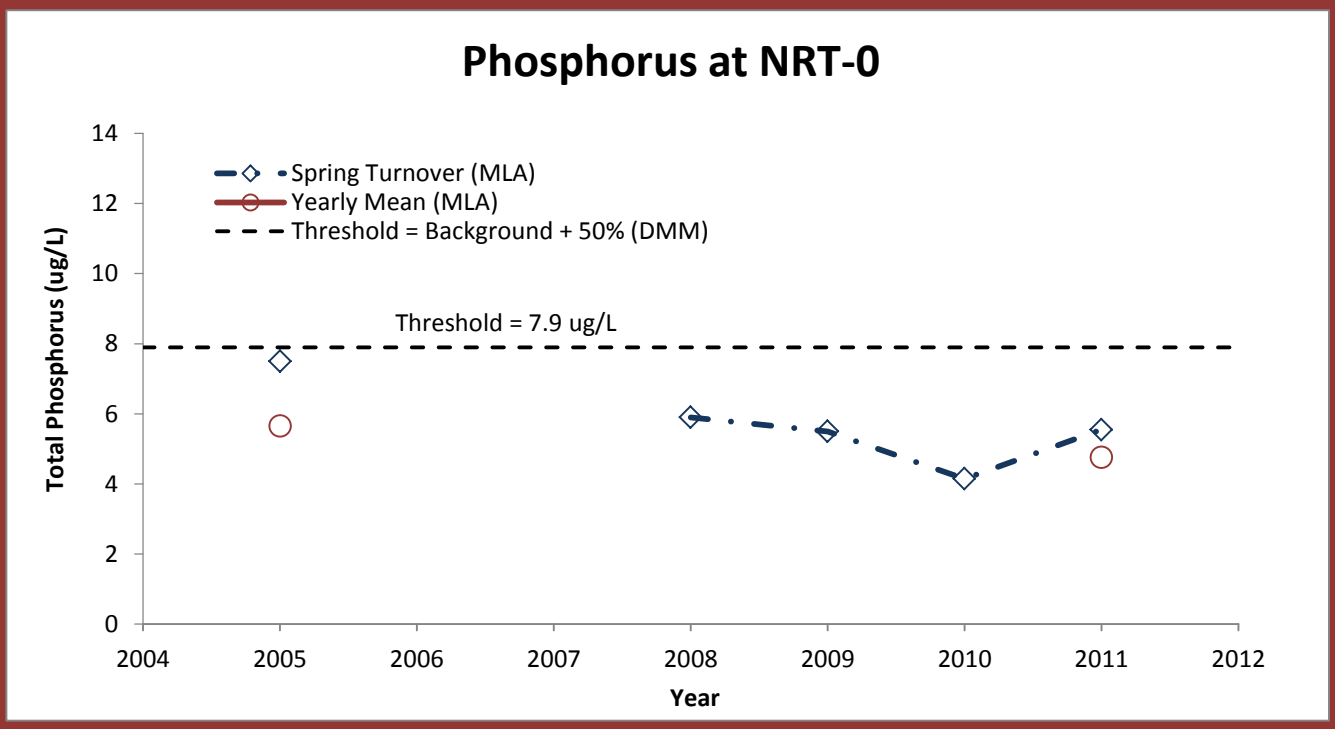
Comments

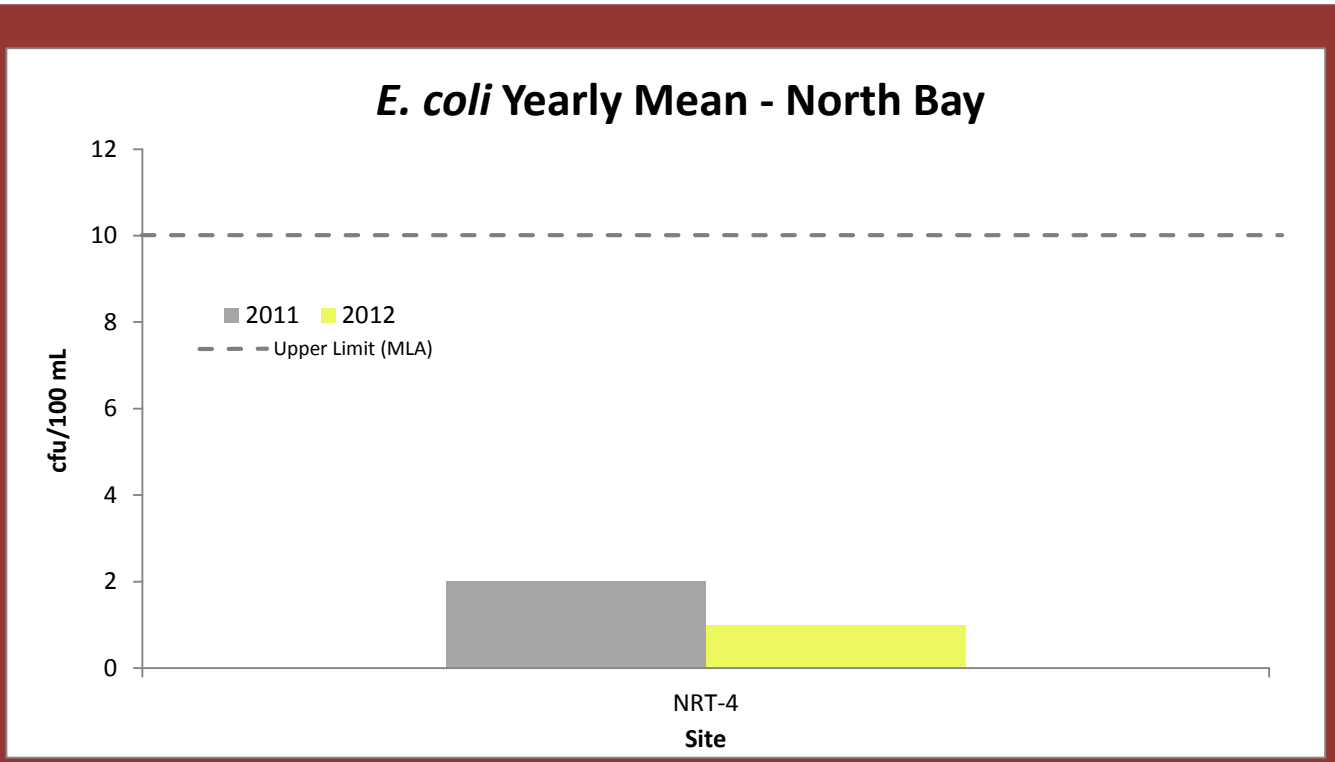
Monitoring of North Bay started in 2005.

E. coli levels at NRT-4 were below the MLA upper limit in 2012.

Recommendations

Continue existing sampling protocol to monitor long-term trends.


Phosphorus at NRT-0
Spring Turnover (MLA)
Yearly Mean (MLA)
Threshold = Background + 50% (DMM)
Threshold = 7.9 ug/L
Total Phosphorus (ug/L)
0
2
4
6
8
10
12
14
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year


E. coli Yearly Mean - North Bay
2011
2012
Upper Limit (MLA)
cfu/100 mL
0
2
4
6
8
10
12
NRT-4
Site

STEPHEN'S BAY (STE)

Area Description

Stephen's Bay is located in the southeastern portion of Lake Muskoka, south of the outlet of the Muskoka River. The bay contains a moderate level of shoreline development with few shoreline properties having extensive cleared areas. There are no creeks draining directly into this bay; however, two creeks outlet into Lake Muskoka, just beyond the mouth of Stephen's Bay.

Volunteer Recognition

Stephen's Bay was monitored in 2012 by Chris Blaymire, Rayma Blaymire, and **John Wood**.

2012 Data

STE-0: Calcium = 3.60 mg/L
Secchi = 4.3 m

Comments

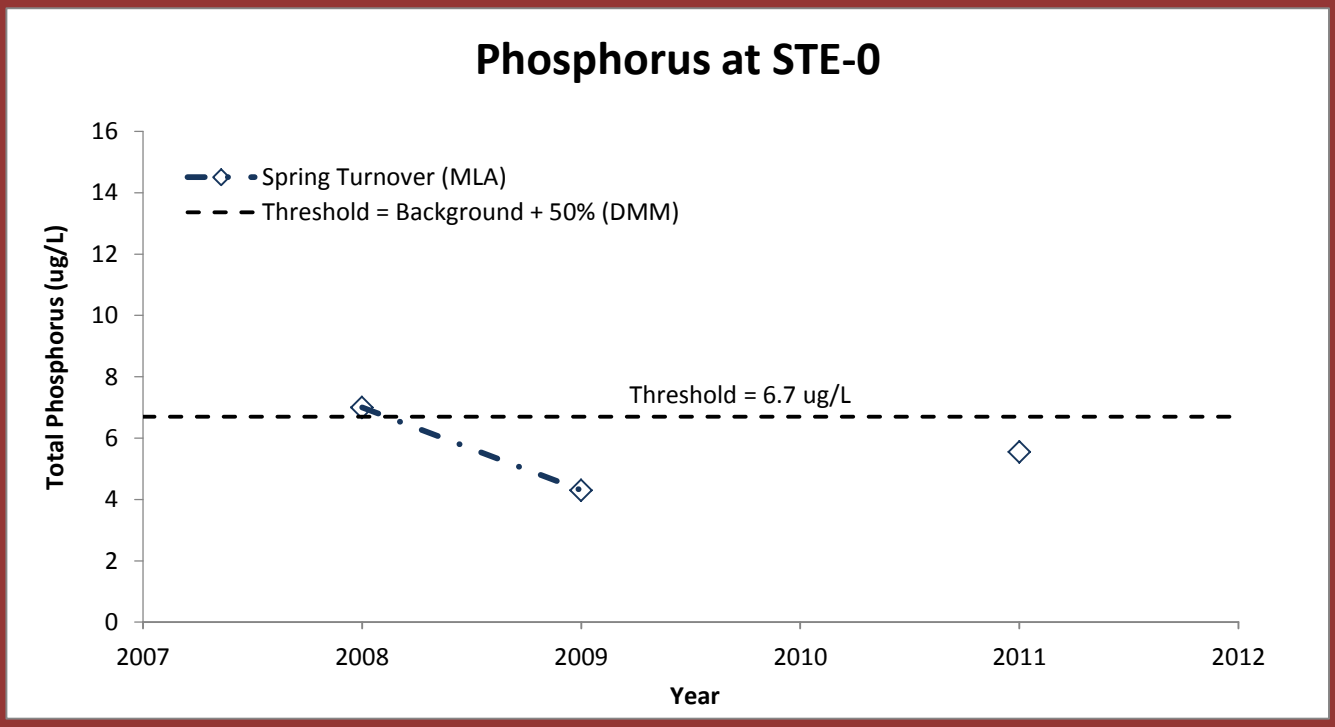
Monitoring of Stephen's Bay started in 2008.

This area has been selected for long-term monitoring.

Recommendations

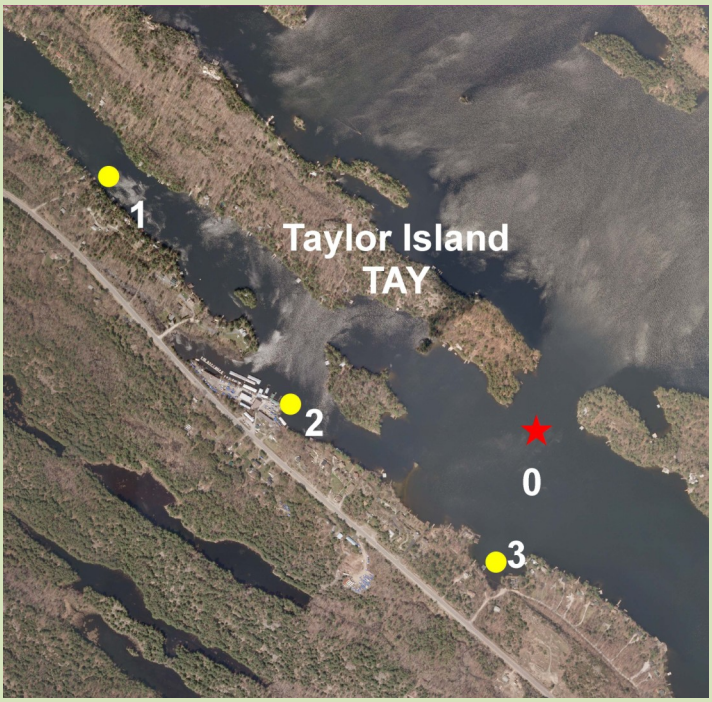
Continue existing sampling protocol to monitor long-term trends.

(STE) STEPHEN'S BAY



Notes:

TAYLOR ISLAND (TAY)



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.

Volunteer Recognition

Taylor Island was monitored in 2012 by Max Niebergall, Brian Ruby, Matt Ruby, and **Al Ward**

2012 Data

TAY-0: Calcium = 3.48 mg/L
Secchi = 3.7 m

TAY-1: Total coliforms = 12 cfu/100 mL*
Total *E. coli* = 2 cfu/100 mL*

TAY-2: TP-Yearly mean = 6.3 µg/L
Total coliforms = 14 cfu/100 mL*
Total *E. coli* = 2 cfu/100 mL*

TAY-3: Total coliforms = 13 cfu/100 mL*
Total *E. coli* = 6 cfu/100 mL*

*Based on 3 sampling events

Comments

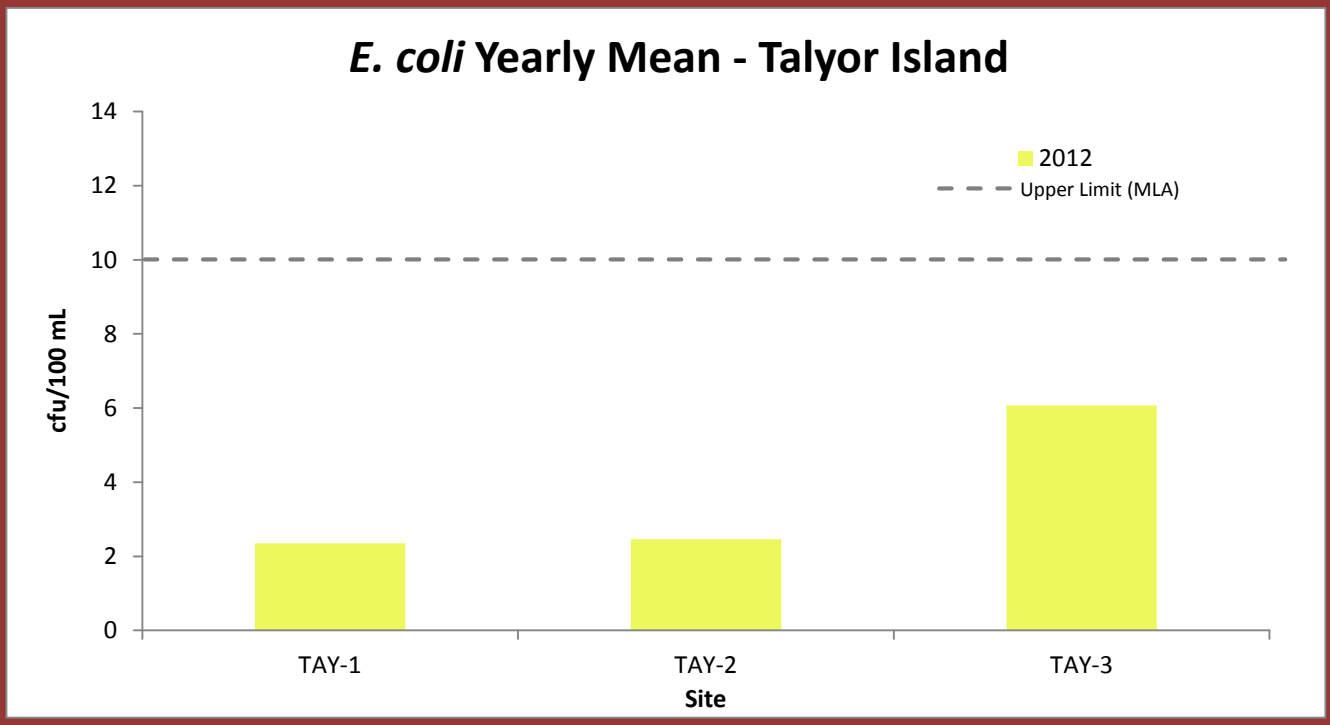
Monitoring of Taylor Island started in 2012.

Three new bacteria monitoring sites (TAY-1, TAY-2, and TAY-3) were established in high use areas. *E. coli* levels were below the MLA upper limit at all sites in 2012.

Recommendations

Continue existing sampling protocol to monitor long-term trends.

(TAY) TAYLOR ISLAND



Notes:

WALKER'S POINT (WAK)

Area Description

The Walker's Point sampling area is in southcentral 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.

Volunteer Recognition

Walker's Point was monitored in 2012 by **Susan Murphy**, Stephen Sims, Carrie Tate, and Doug Tate.

2012 Data

WAK-0: Calcium = 3.58 mg/L
Secchi = 3.1 m

WAK-5 Total coliforms = 31 cfu/100 mL
Total *E. coli* = 4 cfu/100 mL

Comments

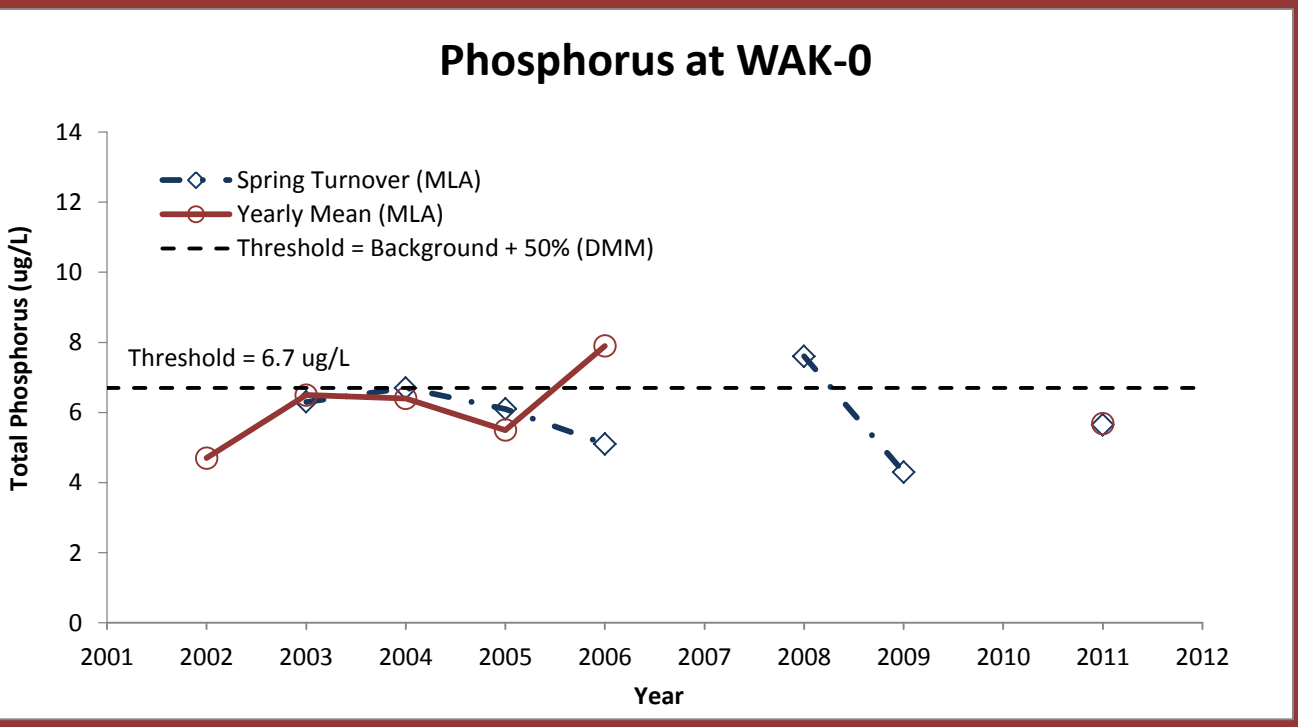
Monitoring at Walker's Point started in 2002.

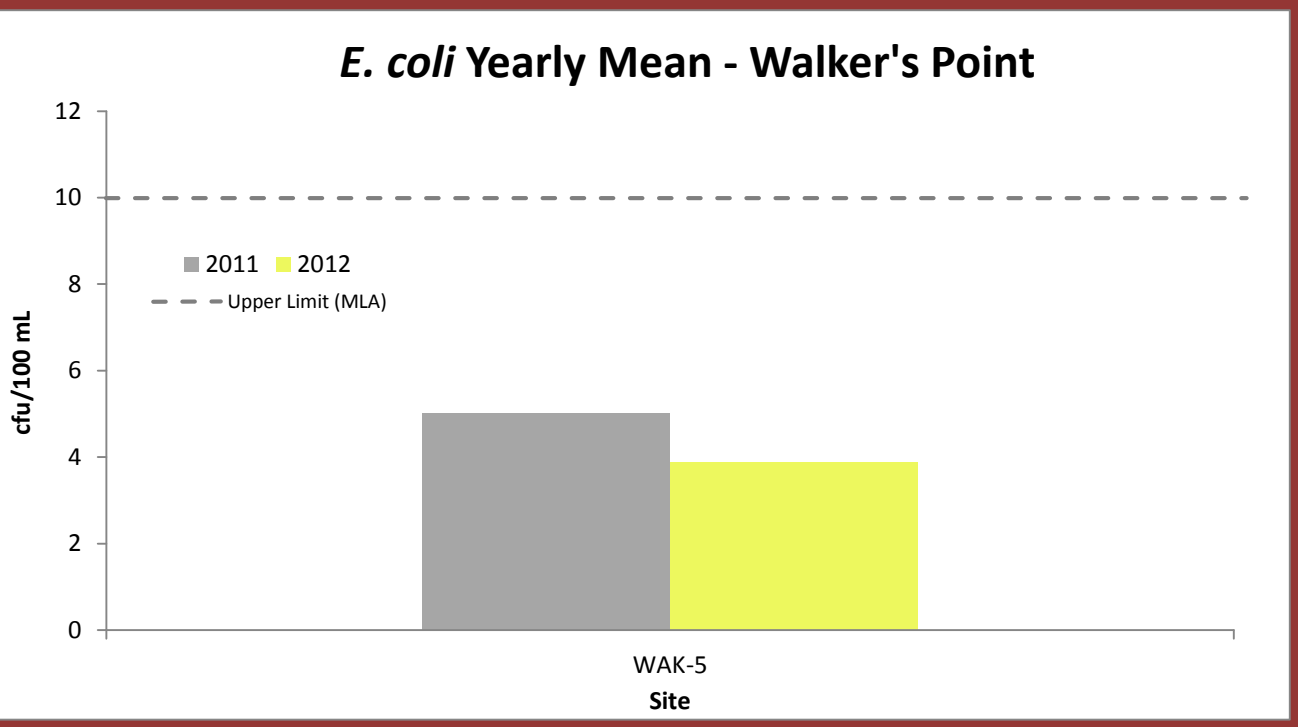
E. coli levels at WAK-5 were below the MLA upper limit.

Recommendations

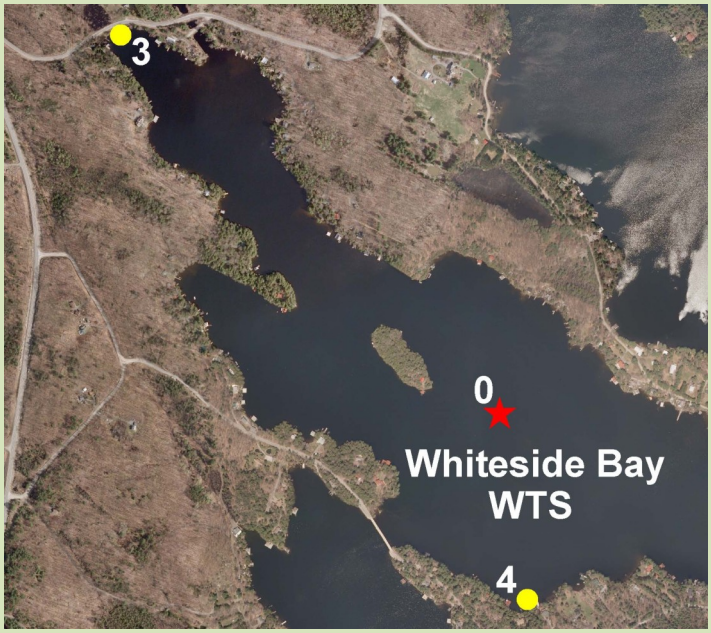
Continue existing sampling protocol to monitor long-term trends.

(WAK) WALKER'S POINT





WHITESIDE BAY (WTS)



Area Description

Whiteside Bay is a partially isolated bay in the northwestern portion of Lake Muskoka. 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.

Volunteer Recognition

Whiteside Bay was monitored in 2012 by Benjamin Butler, **Eleanor Lewis**, and **Jim Lewis**.

2012 Data

WTS-0: Calcium = 3.51 mg/L
Secchi = 3.8 m

WTS-3: Total coliforms = 17 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

WTS-4: Total coliforms = 12 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

Comments

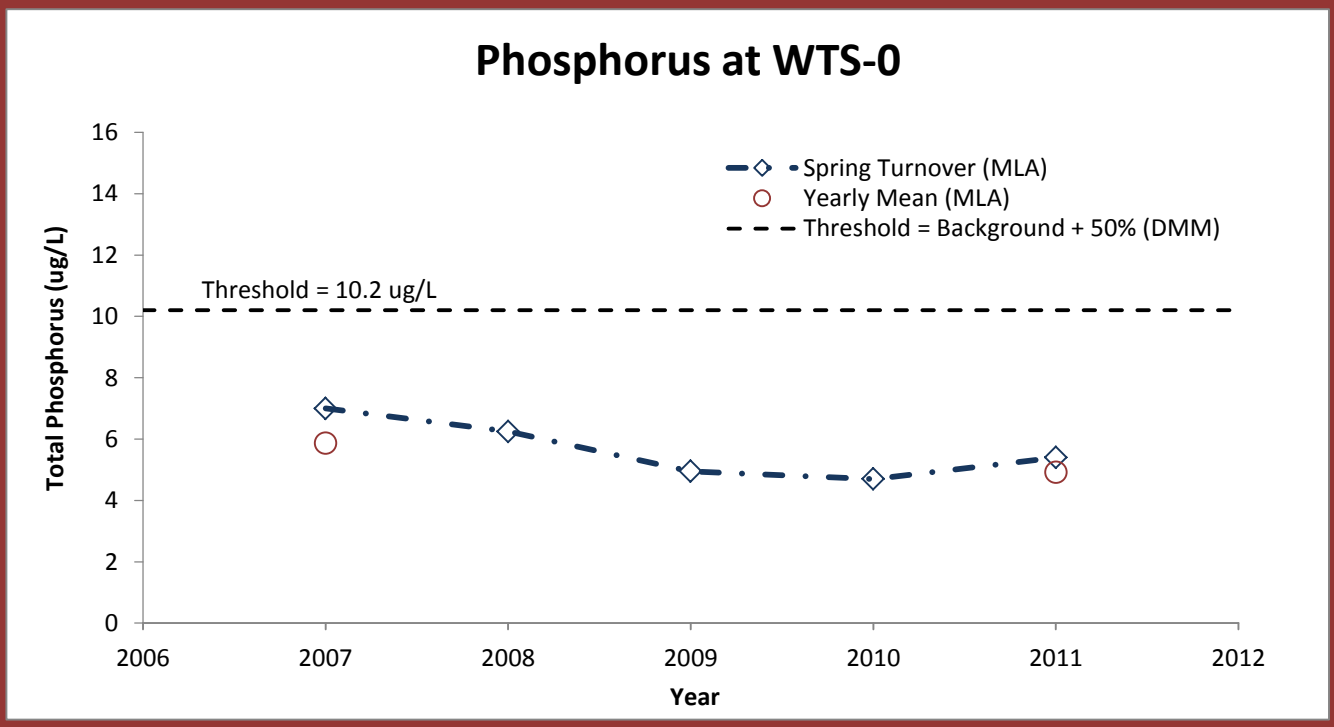
Monitoring of Whiteside Bay started in 2007.

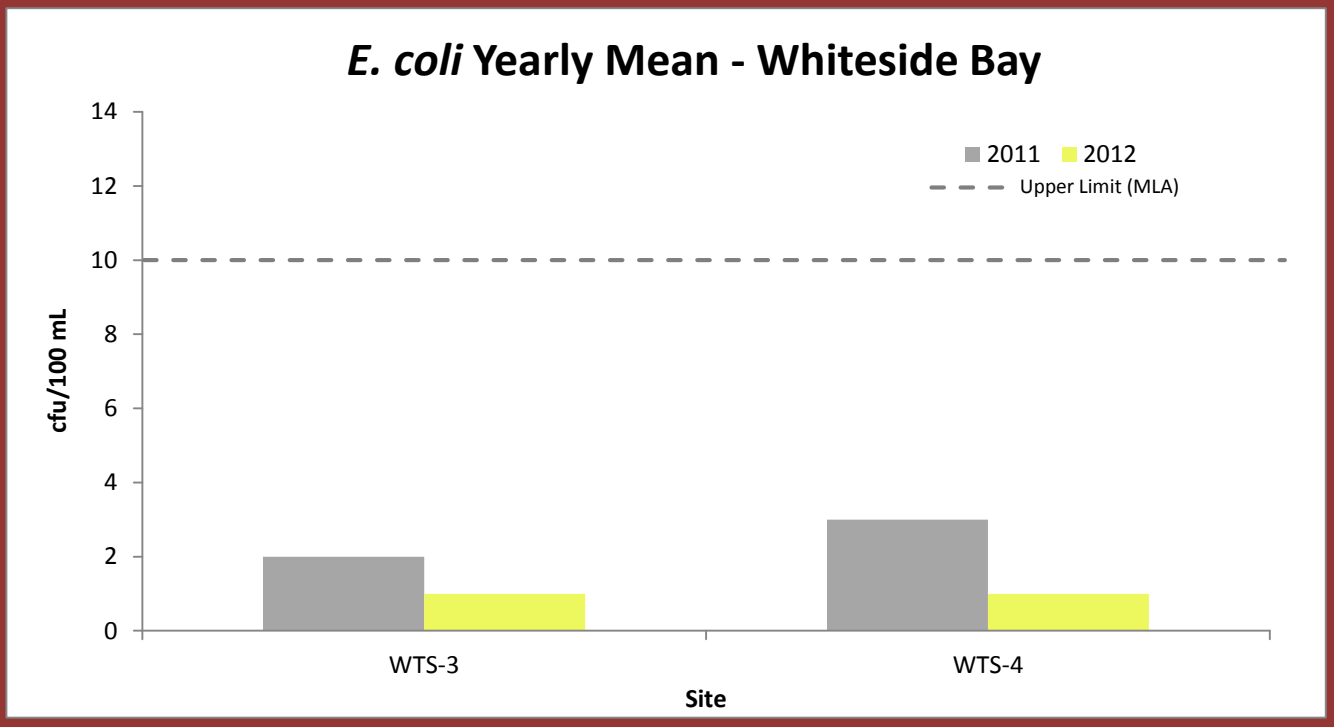
E. coli levels were below the MLA upper limit at all sites in 2012.

Recommendations

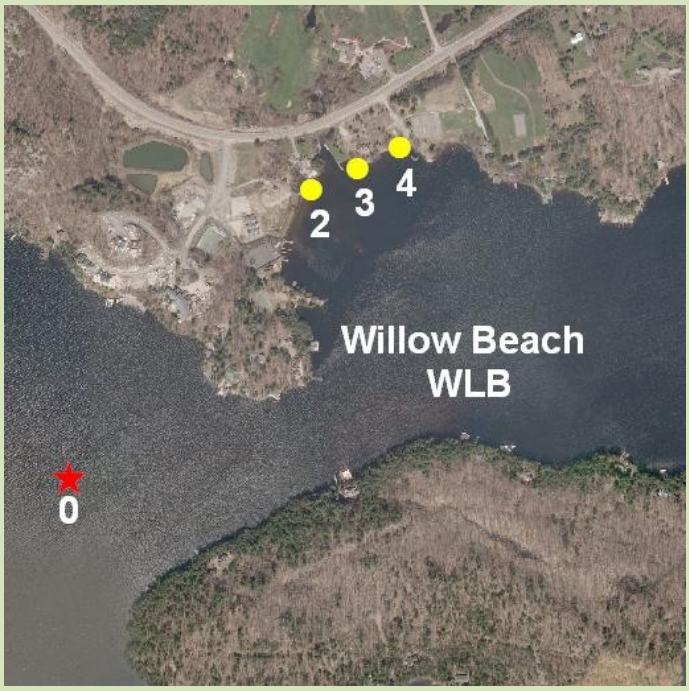
Continue existing sampling protocol to monitor long-term trends.

(WTS) WHITESIDE BAY





WILLOW BEACH (WLB)



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.

Volunteer Recognition

Willow Beach was monitored in 2012 by Dave Langford, Lynn Langford, Chris Sisam, Peter Sisam, Sue Sisam, and **John Wood**.

2012 Data

WLB-0: Calcium = 3.43 mg/L
Secchi = 3.3 m

WLB-2: Total coliforms = 39 cfu/100mL*
Total *E. coli* = 1 cfu/100 mL*

WLB-3: Total coliforms = 69 cfu/100 mL*
Total *E. coli* = 1 cfu/100 mL*

WLB-4: Total coliforms = 36 cfu/100 mL*
Total *E. coli* = 1 cfu/100 mL*

*Based on 1 sampling event

Comments

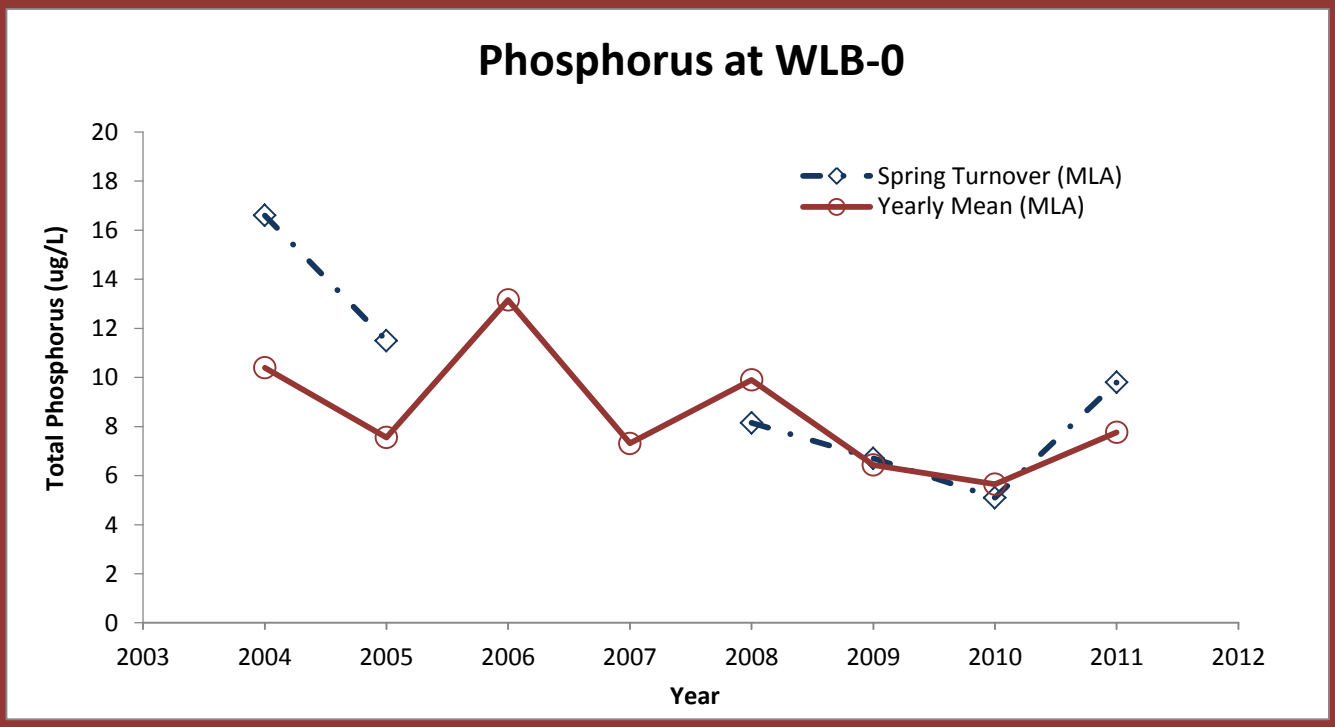
Monitoring of Willow Beach started in 2004.

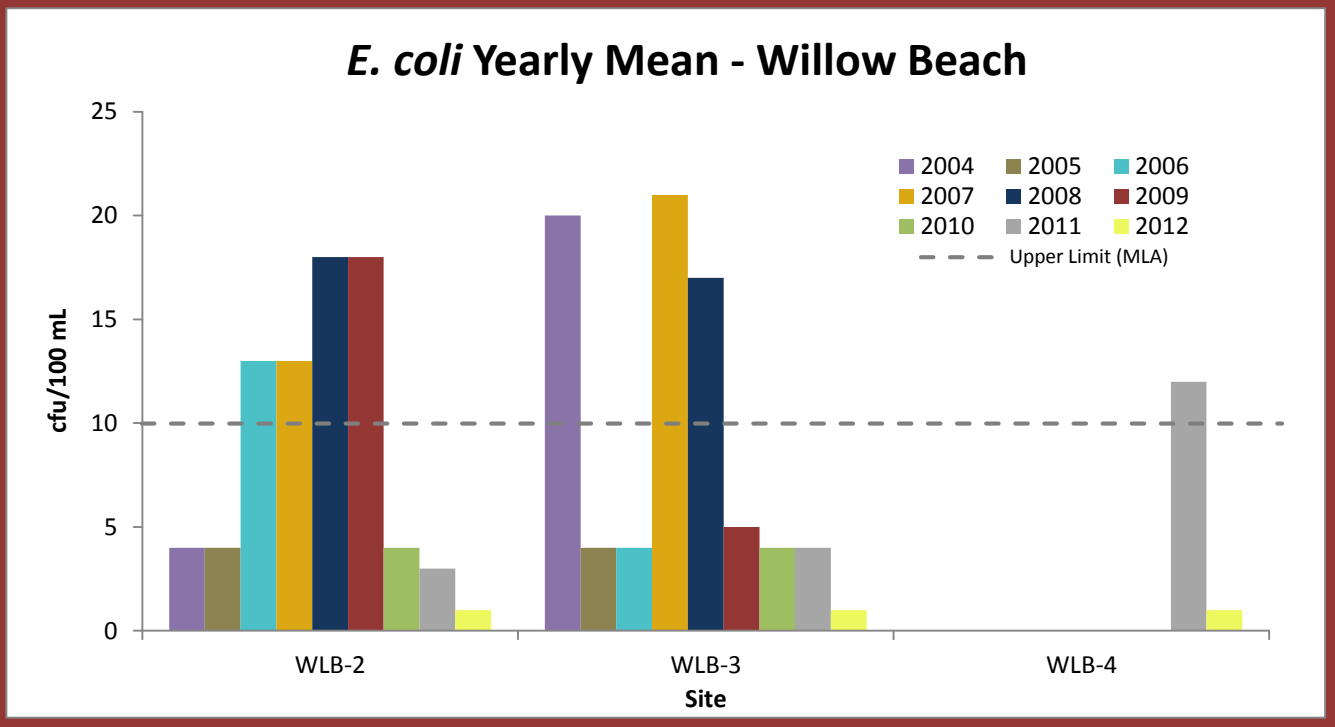
E. coli levels were below the MLA upper limit at all sites in 2012.

Recommendations

Continue existing sampling protocol to monitor long-term trends.

(WLB) WILLOW BEACH





ARTHURLIE BAY (ART)

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.

Volunteer Recognition

Arthurlie Bay was monitored in 2012 by **Katherine Seybold** and Peter Seybold.

2012 Data

ART-0: Calcium = 3.88 mg/L
Secchi = 3.6 m

Comments

Monitoring of Arthurlie Bay started in 2002.

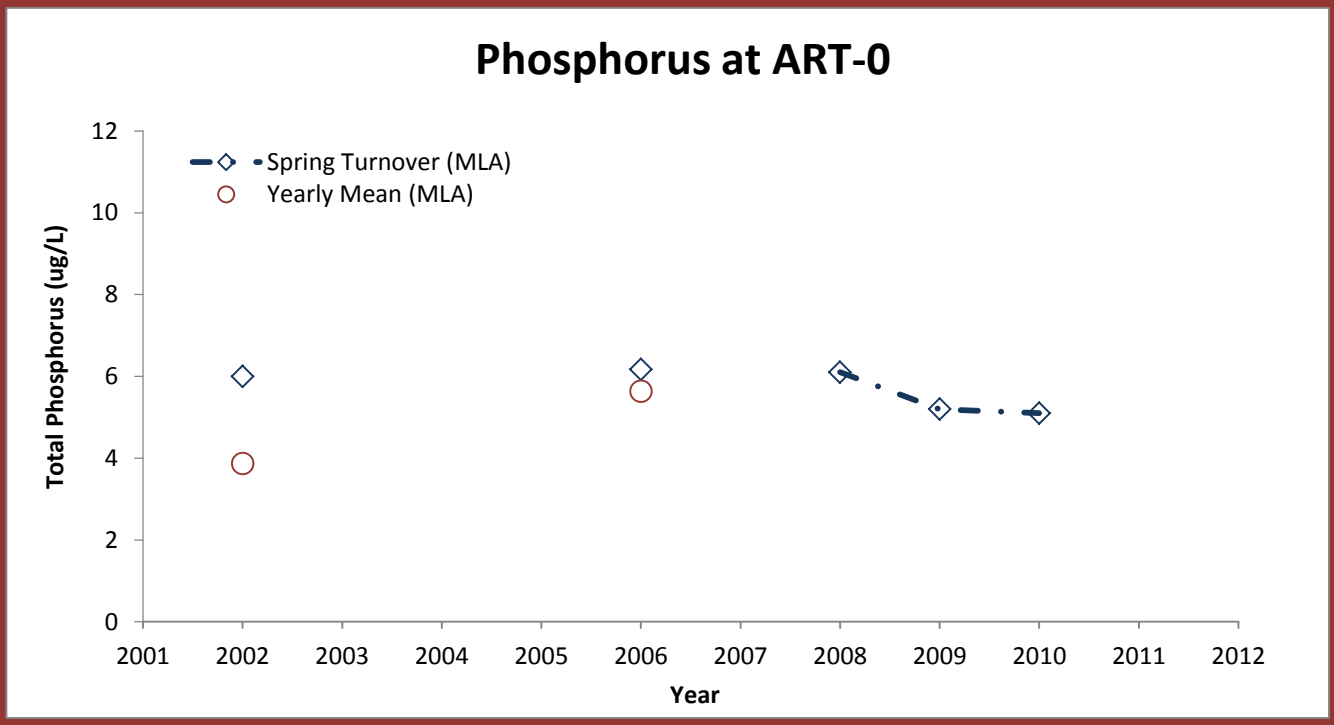
This area has been selected for long-term monitoring.

The 2011 spring turnover TP value for ART-0 (9.4 µg/L) was identified as a potential outlier and was removed from the dataset.

Recommendations

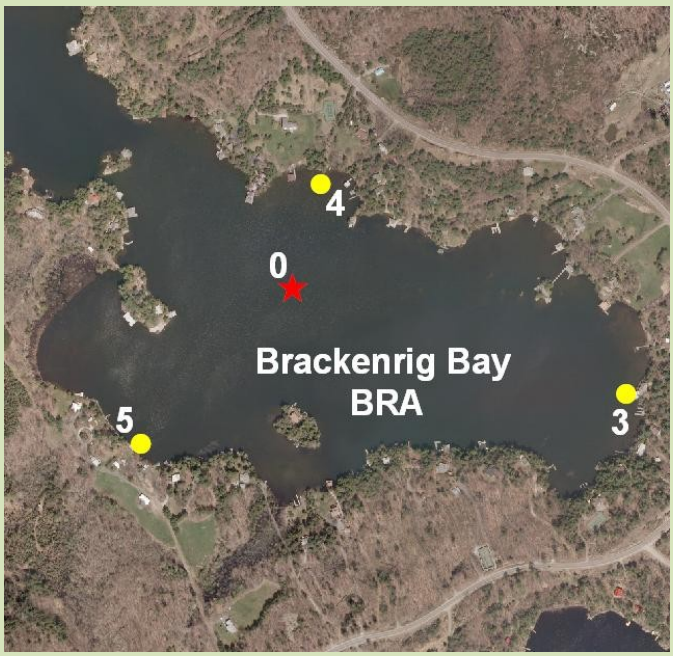
Consider collecting triplicate spring turnover TP samples in 2013.

(ART) ARTHURLIE BAY



Notes:

BRACKENRIG BAY (BRA)



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 comes in close proximity to the lake along the northeast shoreline. Brackenrig Bay has been classified as moderately sensitive and over-threshold by the DMM.

Volunteer Recognition

Brackenrig Bay was monitored in 2012 by John Hylton, **Judith Stephens-Wells**, and Rebecca Stephens-Wells.

2012 Data

BRA-0: Calcium = 4.02 mg/L
Secchi = 2.0 m

BRA-3: TP-Yearly mean = 9.7 µg/L

BRA-4: Total coliforms = 49 cfu/100 mL
Total *E. coli* = 4 cfu/100 mL

BRA-5: Total coliforms = 35 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

Comments

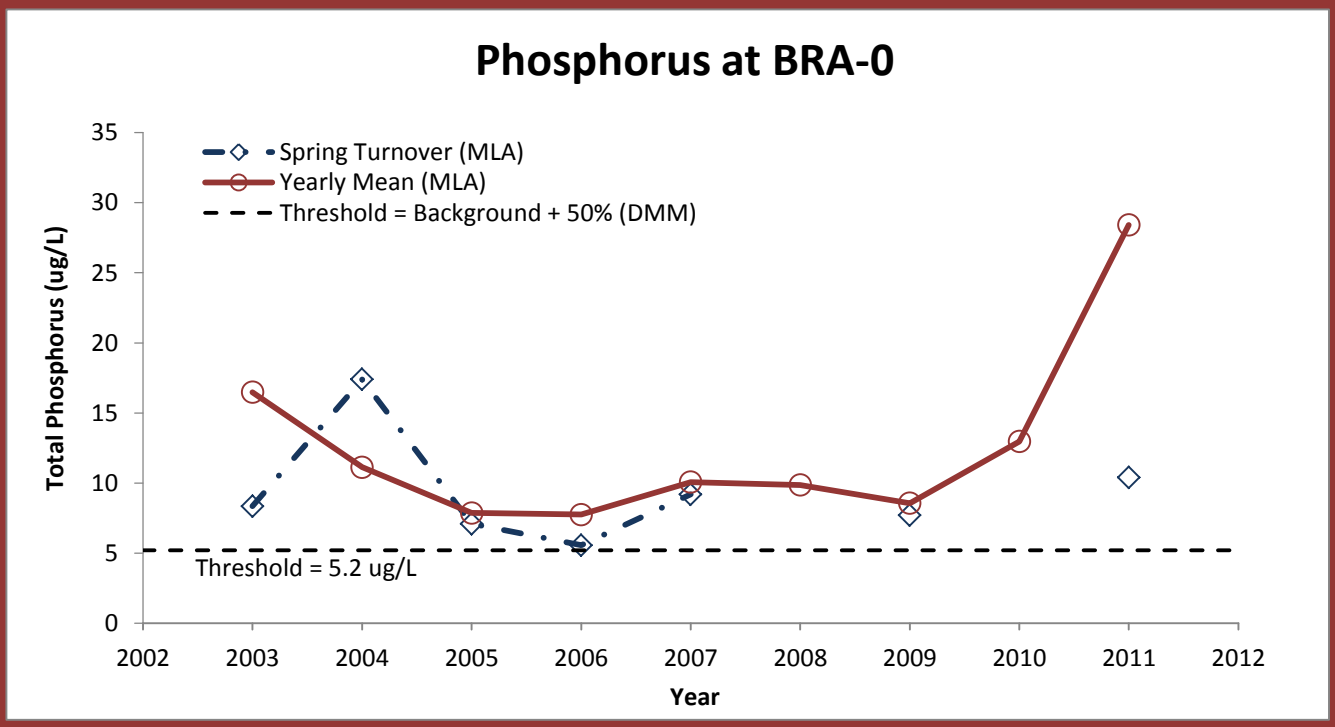
Monitoring of Brackenrig Bay started in 2003.

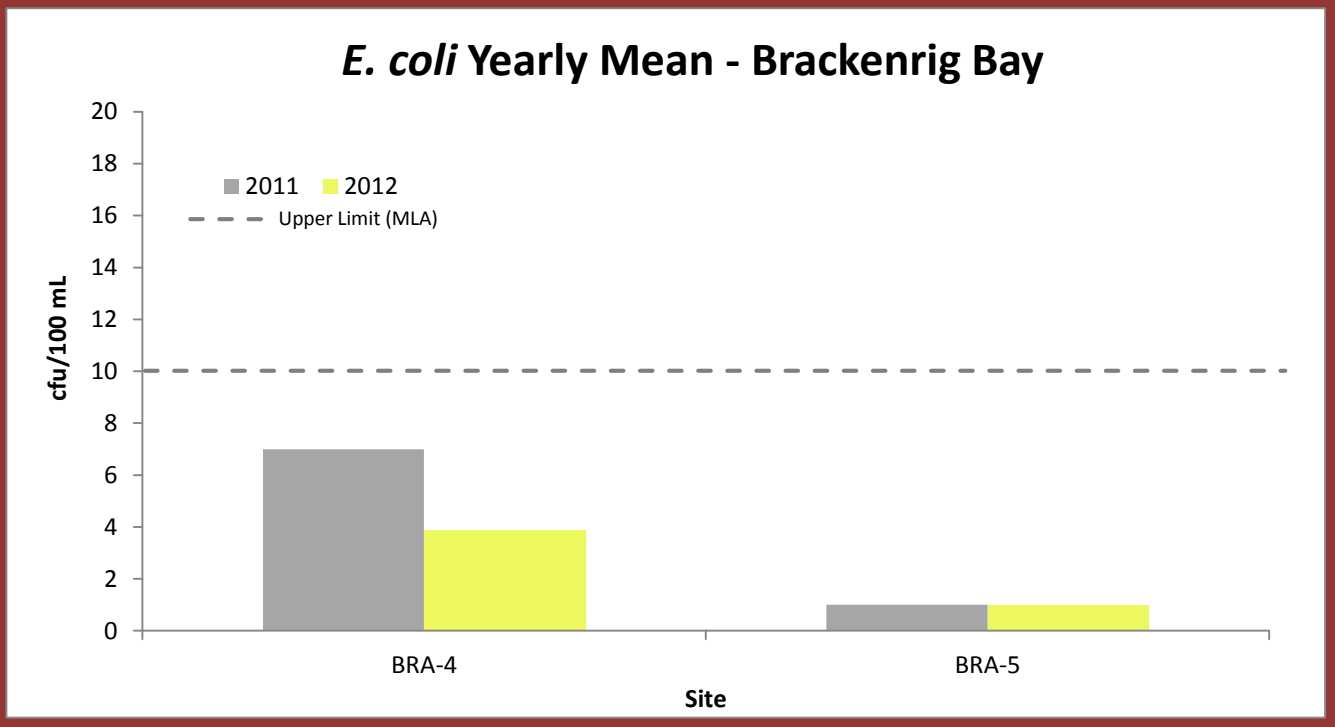
E. coli levels in 2012 were all below the MLA upper limit.

Recommendations

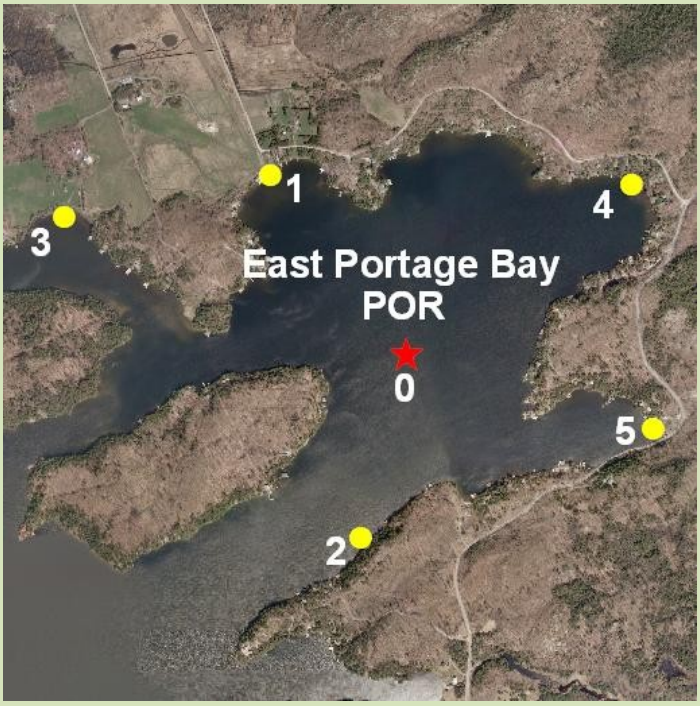
Continue existing sampling protocol to monitor long-term trends.

(BRA) BRACKENRIG BAY





EAST PORTAGE BAY (POR)



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.

Volunteer Recognition

East Portage Bay was monitored in 2012 by Bill Harvey, Andy Henke, Marje Henke, and **Lawton Osler**.

2012 Data

POR-0: Calcium = 3.86 mg/L
Secchi = 5.0 m

POR-1: TP-Yearly mean = 5.2 µg/L

POR-2: TP-Yearly mean = 5.2 µg/L

POR-3: TP-Yearly mean = 5.3 µg/L

POR-4: TP-Yearly mean = 5.2 µg/L

POR-5: TP-Yearly mean = 5.4 µg/L

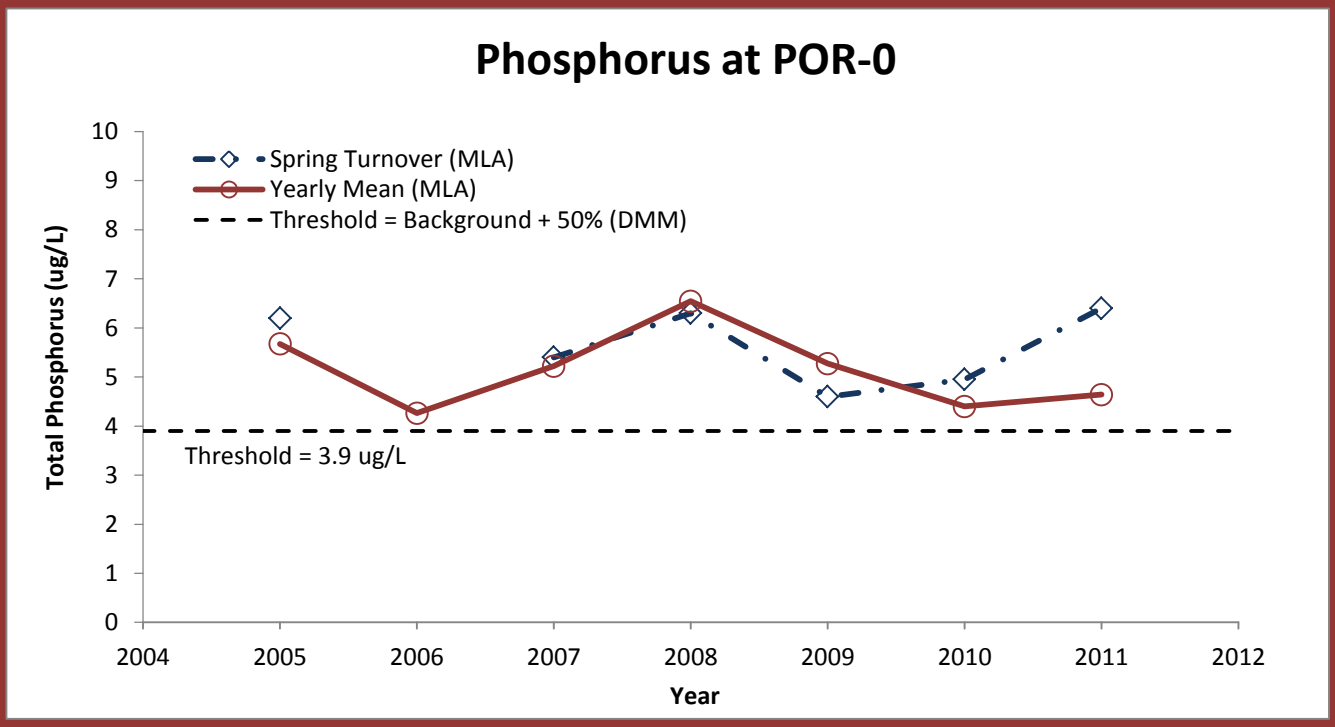
Comments

Monitoring of East Portage Bay started in 2005.

Recommendations

Continue existing sampling protocol to monitor long-term trends.

(POR) EAST PORTAGE BAY



Notes:

LAKE ROSSEAU (ROS-1)

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.

Volunteer Recognition

Lake Rosseau was monitored in 2012 by **Katherine Seybold** and Peter Seybold.

2012 Data

ROS-1: Calcium = 3.82 mg/L
Secchi = 3.5 m

Comments

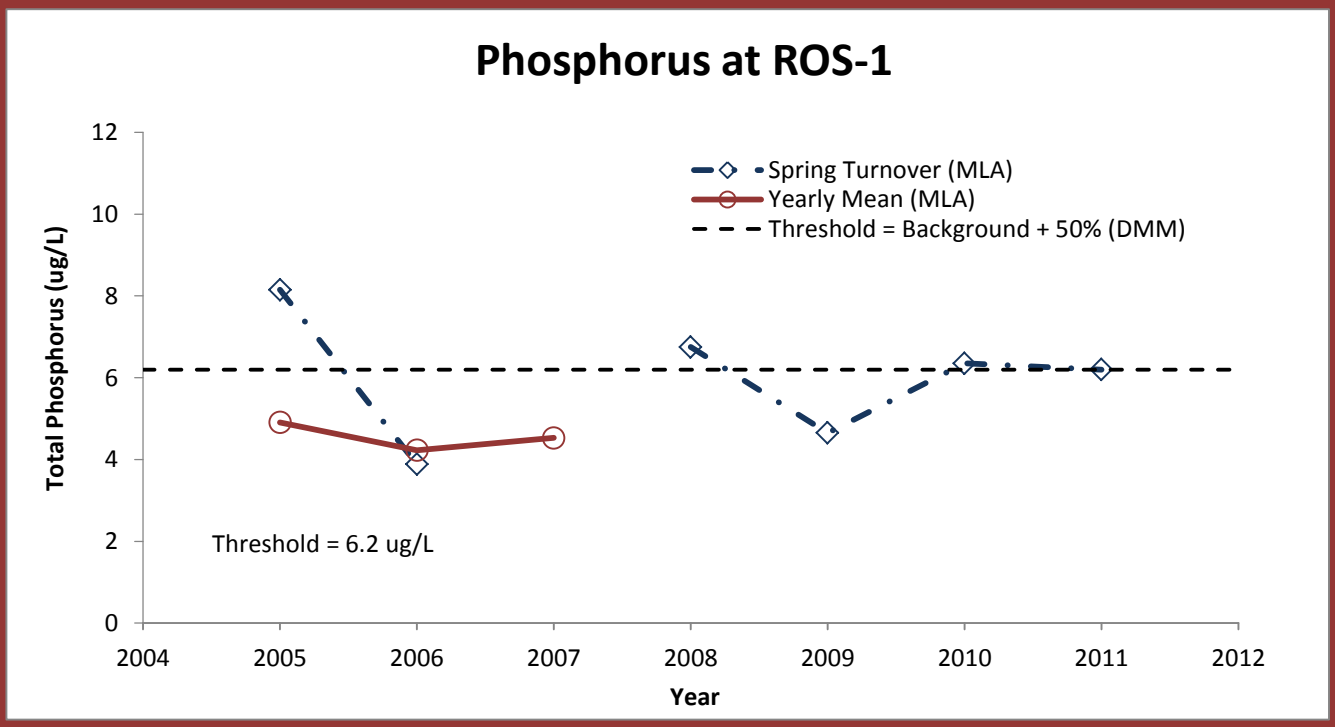
Monitoring of Lake Rosseau Main Basin started in 2005.

This area has been selected for long-term monitoring.

Recommendations

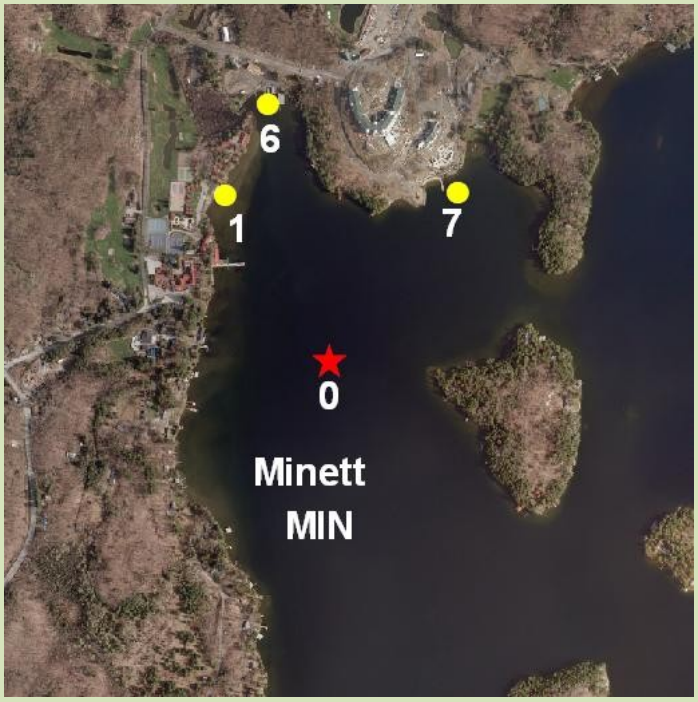
Continue existing sampling protocol to monitor long-term trends.

(ROS-1) LAKE ROSSEAU



Notes:

MINETT (MIN)



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.

Volunteer Recognition

Minett was monitored in 2012 by Lauren Chisholm, **Greg Thomson**, Noah Thomson, **Laurie Thomson**, and Taylor Thomson.

2012 Data

MIN-0: Calcium = 3.81 mg/L
Secchi = 4.8 m

MIN-1: TP-Yearly mean = 6.2 µg/L
Total coliforms = 378 cfu/100 mL*
Total *E. coli* = 12 cfu/100 mL*

MIN-6: TP-Yearly mean = 7.7 µg/L
Total coliforms = 342 cfu/100 mL*
Total *E. coli* = 32 cfu/100 mL*

MIN-7: TP-Yearly mean = 5.3 µg/L
Total coliforms = 158 cfu/100 mL
Total *E. coli* = 5 cfu/100 mL

*Based on 3 sampling events. Includes one sample with elevated *E. coli* levels and one follow-up sample.

Comments

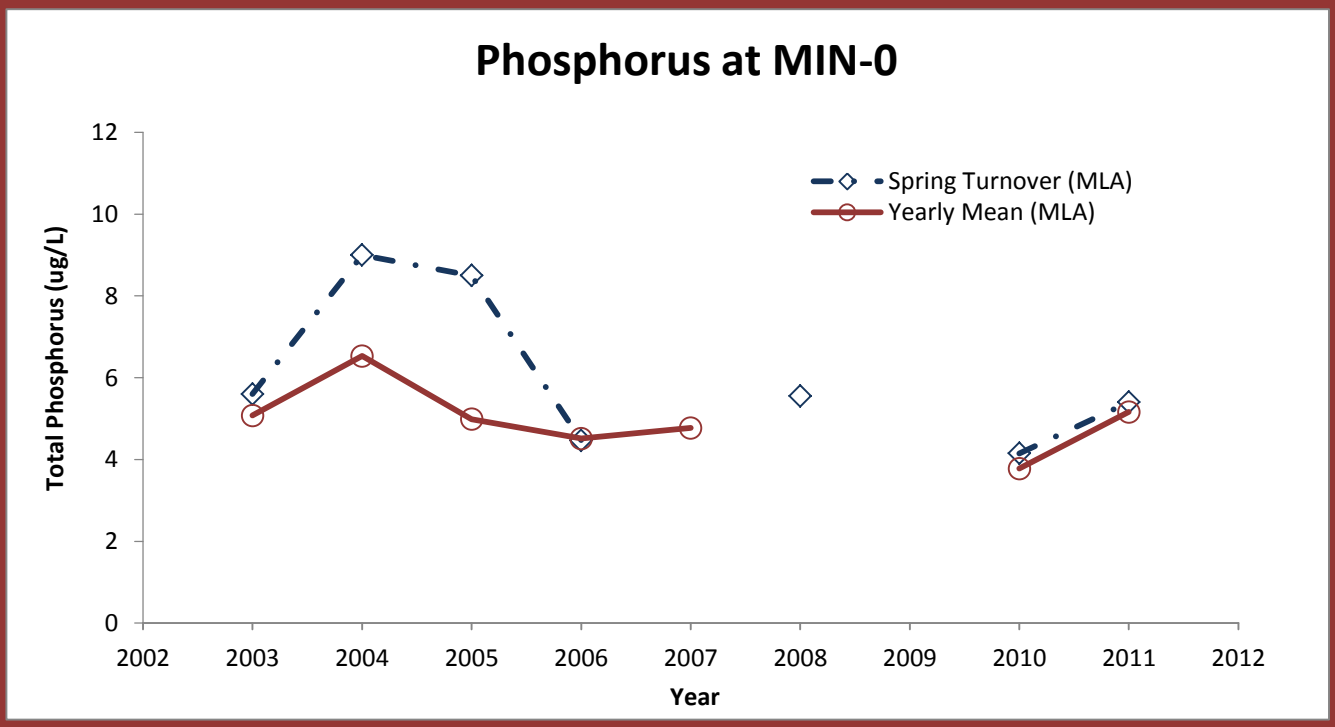
Monitoring of Minett started in 2003.

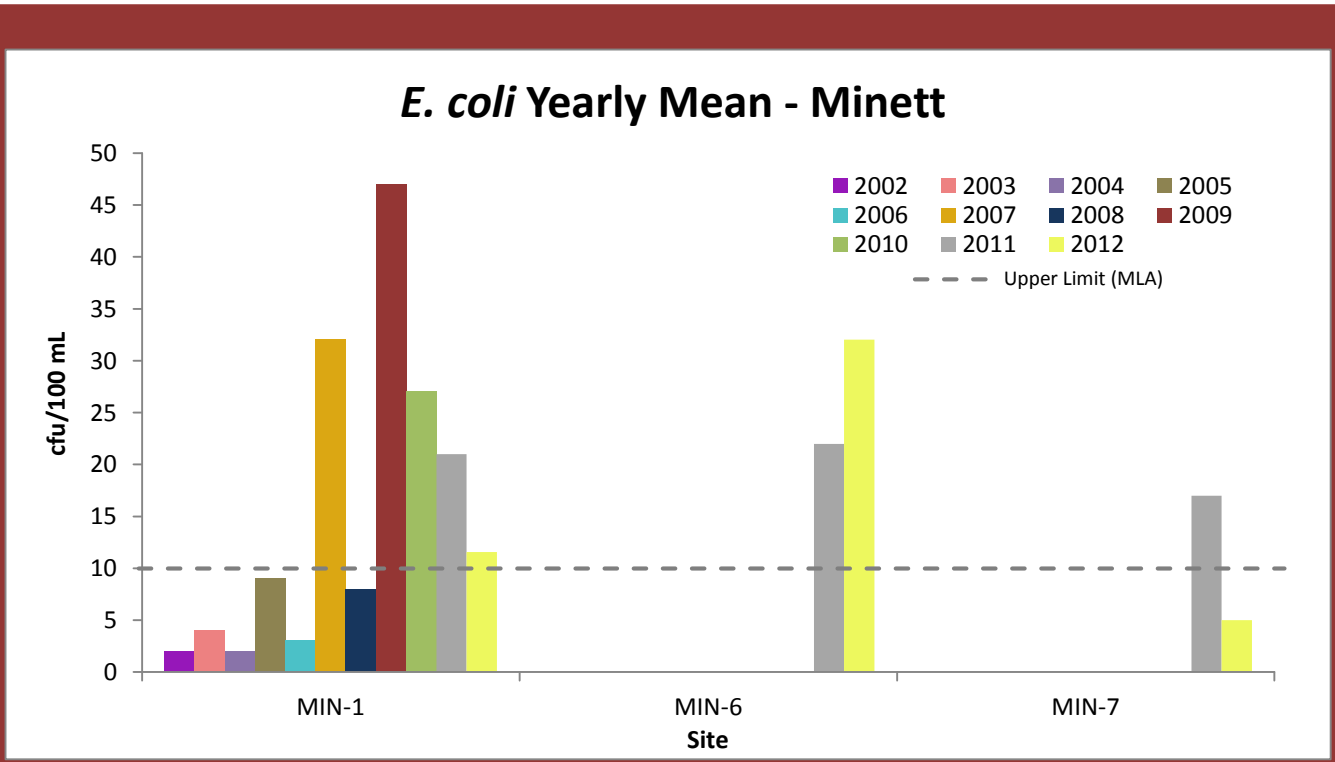
E. coli levels in 2012 were above the MLA upper limit with the exception of MIN-7.

Recommendations

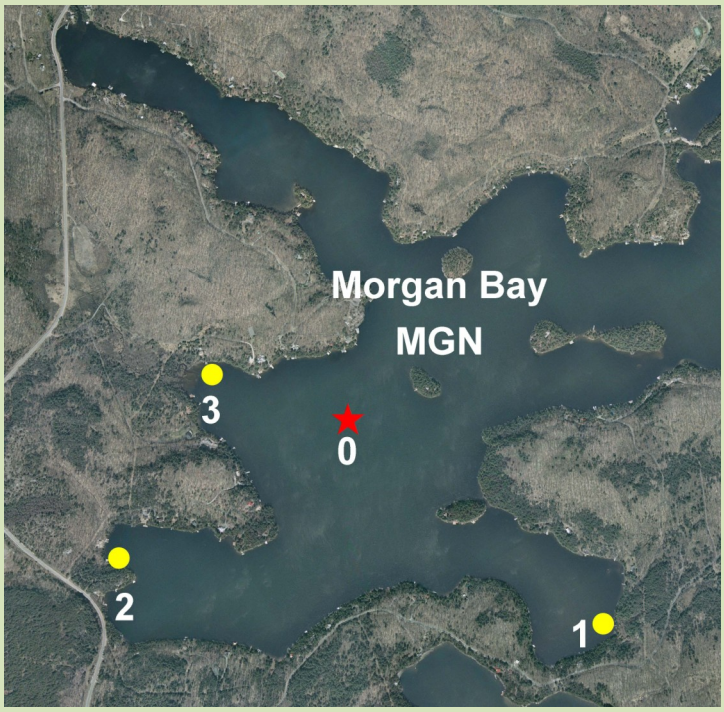
Continue existing sampling protocol to monitor long-term trends.

Ensure that follow-up bacteria samples are collected from sites with elevated *E. coli* levels.


Phosphorus at MIN-0
Total Phosphorus (ug/L)
0
2
4
6
8
10
12
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year
Spring Turnover (MLA)
Yearly Mean (MLA)


E. coli Yearly Mean - Minett
cfu/100 mL
0
5
10
15
20
25
30
35
40
45
50
MIN-1
MIN-6
MIN-7
Site
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Upper Limit (MLA)

MORGAN BAY (MGN)



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.

Volunteer Recognition

Morgan Bay was monitored in 2012 by **David Peacock** and Mary Anne Peacock.

2012 Data

MGN-0: Calcium = 3.68 mg/L
Secchi = 4.1 m*

MGN-1: TP-Yearly mean = 4.3 µg/L

MGN-3: TP-Yearly mean = 5.6 µg/L

*Based on 3 measurements

Note: Bacteria data for MGN-2 discarded due to equipment malfunction

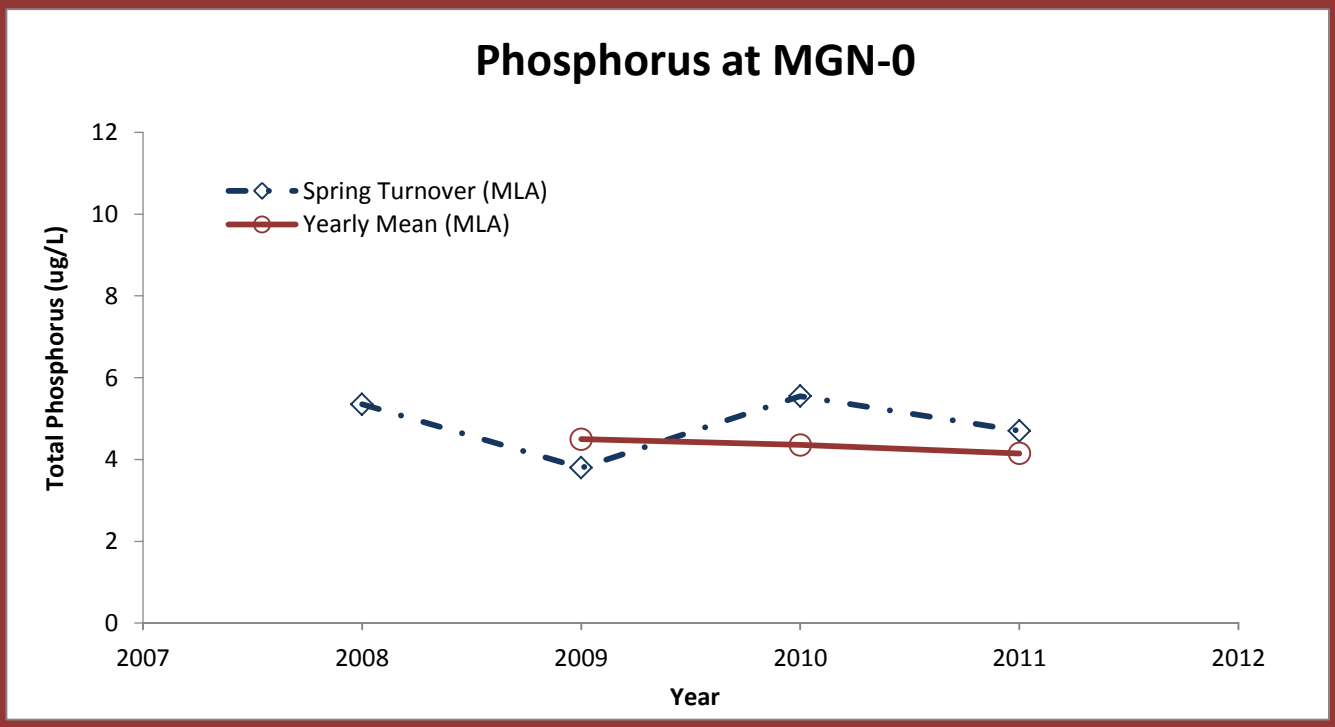
Comments

Monitoring of Morgan Bay started in 2008.

Recommendations

Continue existing sampling protocol to monitor long-term trends.

(MGN) MORGAN BAY



Notes:

MUSKOKA LAKES G&CC (MLG)

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.

Volunteer Recognition

Muskoka Lakes Golf & Country Club was monitored in 2012 by **Katherine Seybold** and Peter Seybold.

2012 Data

MLG-0: Calcium = 3.87 mg/L
Secchi = 3.5 m

Comments

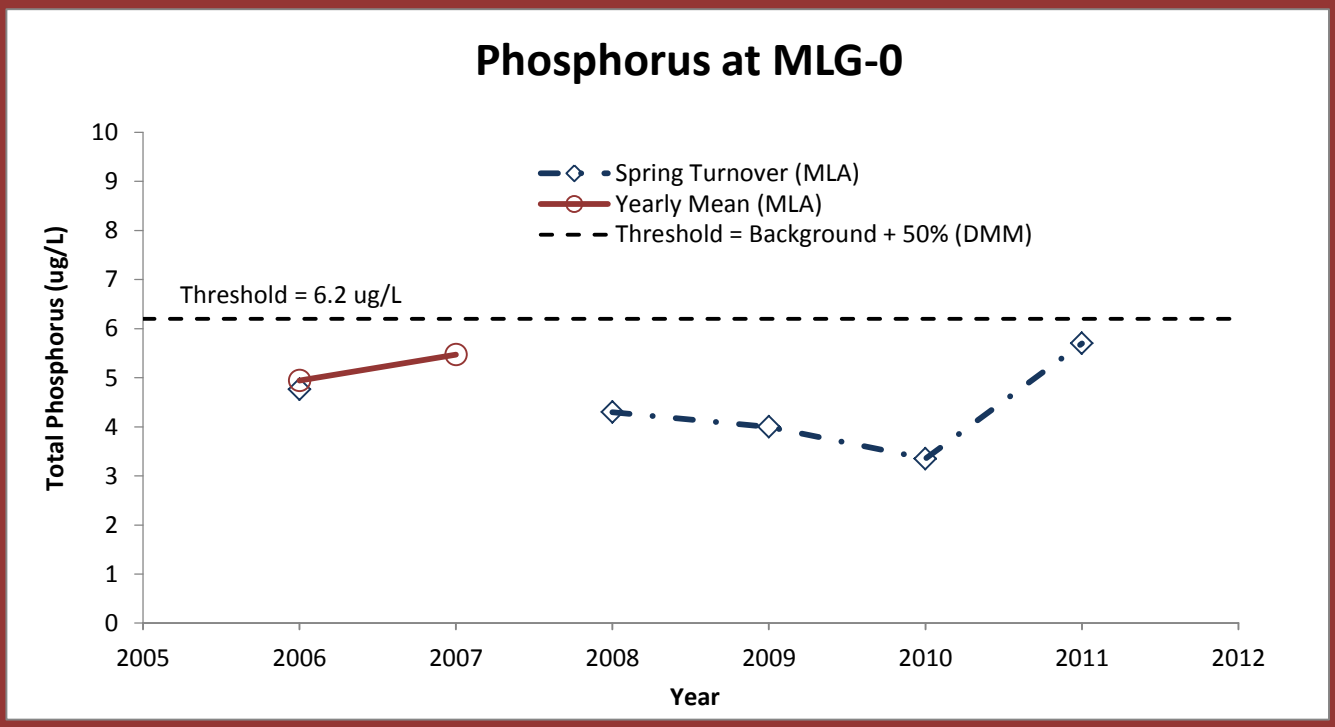
Monitoring of Muskoka Lakes Golf and Country Club started in 2006.

This area has been selected for long-term monitoring.

Recommendations

Continue existing sampling protocol to monitor long-term trends.

(MLG) MUSKOKA LAKES G&CC



Notes:

ROSSEAU NORTH (RSH)

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.

Volunteer Recognition

Rosseau North was monitored in 2012 by **David Peacock** and Mary Anne Peacock.

2012 Data

RSH-0: Calcium = 3.74 mg/L
Secchi = 3.9 m

RSH-2: TP-Yearly mean = 7.8 µg/L
Total coliforms = 8 cfu/100 mL*
Total *E. coli* = 1 cfu/100 mL*

RSH-4: TP-Yearly mean = 5.2 µg/L
Total coliforms = 22 cfu/100 mL*
Total *E. coli* = 1 cfu/100 mL*

RSH-5: Total coliforms = 25 cfu/100 mL*
Total *E. coli* = 1 cfu/100 mL*

*Based on 1 sampling event; data from third sampling period discarded due to equipment malfunciton

Comments

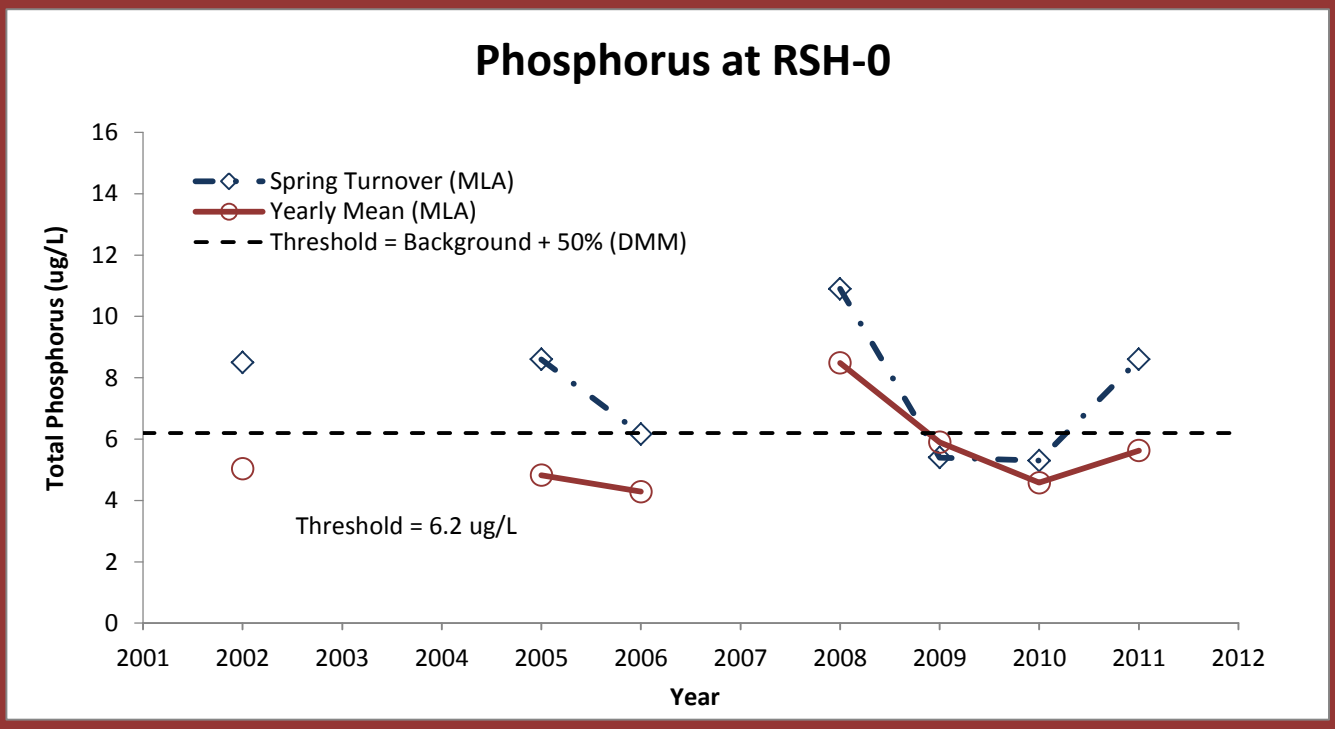
Monitoring of Rosseau North started in 2002.

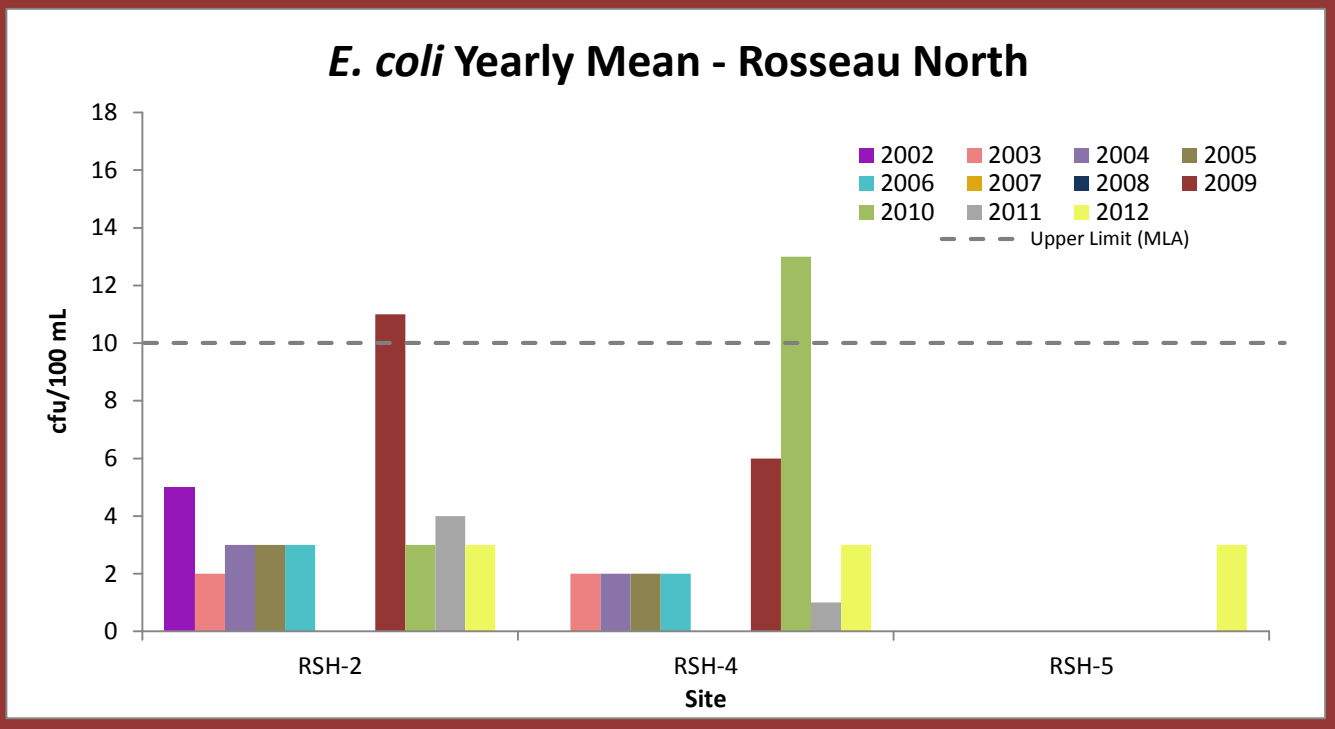
RSH-5 is a newly established site located in a high use area. *E. coli* levels were below the MLA upper limit at all sites in 2012.

Recommendations

E. coli levels at RSH-2 have been equal to or below the MLA upper limit for the past 3 years. Sampling at an alternative location should be considered.

(RSH) ROSSEAU NORTH





ROYAL MUSKOKA ISLAND (RMI)

Area Description

Royal Muskoka Island has one deepwater 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

Royal Muskoka Island was monitored in 2012 by **Katherine Seybold** and Peter Seybold.

2012 Data

RMI-0: Calcium = 3.65 mg/L
Secchi = 3.5 m

Comments

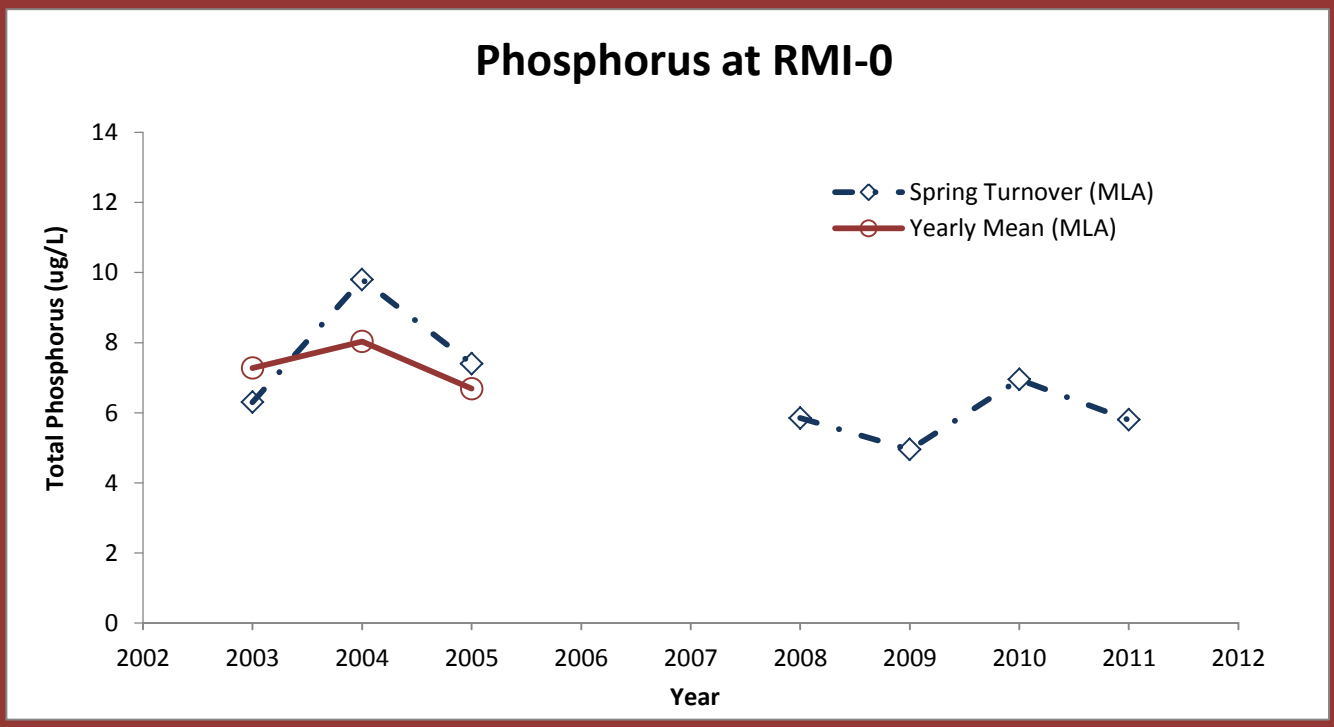
Monitoring of Royal Muskoka Island started in 2003.

This area has been selected for long-term monitoring.

Recommendations

Continue existing sampling protocol to monitor long-term trends.

(RMI) ROYAL MUSKOKA ISLAND



Notes:

SKELETON BAY (SKB)

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.

Volunteer Recognition

Skeleton Bay was monitored in 2012 by David Lavine, Jill Lavine, and **David Peacock**.

2012 Data

SKB-0: Calcium = 3.81 mg/L
Secchi = 3.9 m

SKB-1: TP-Yearly mean = 6.1 µg/L
Total coliforms = 10 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

SKB-3: TP-Yearly mean = 5.2 µg/L
Total coliforms = 10 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

SKB-4: TP-Yearly mean = 11.9 µg/L

Comments

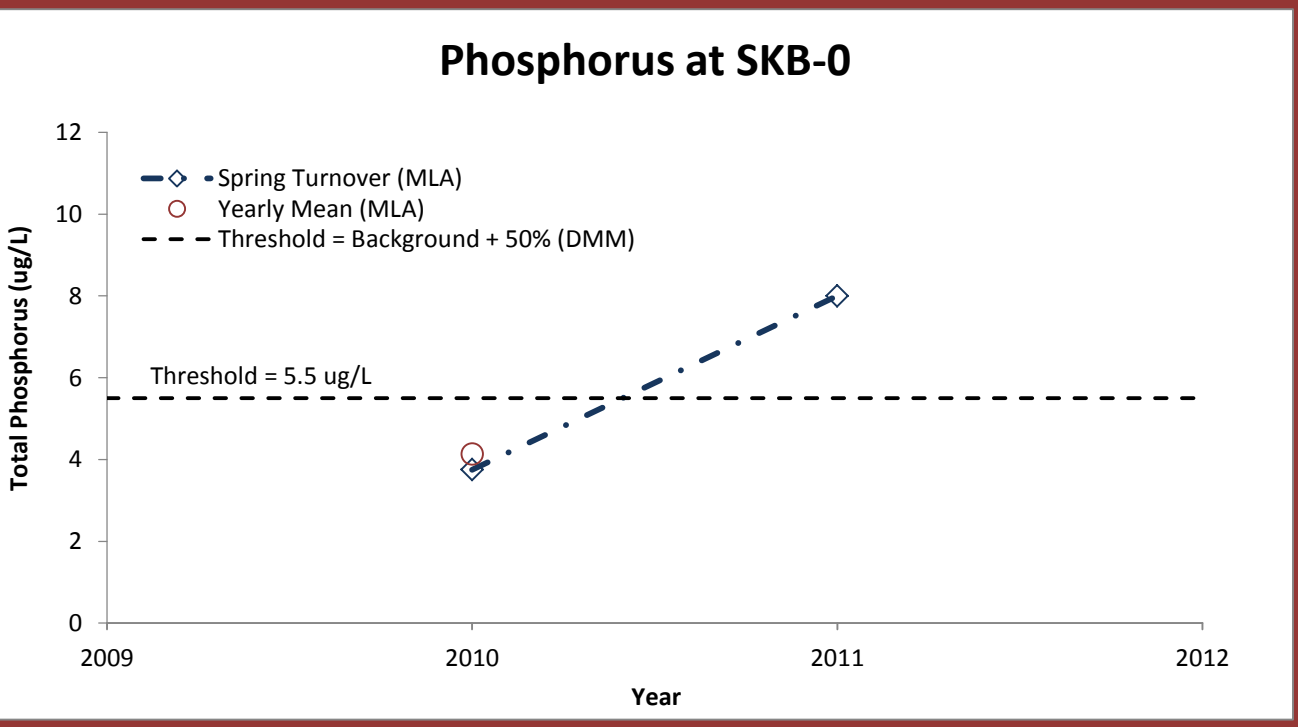
Monitoring of Skeleton Bay started in 2010.

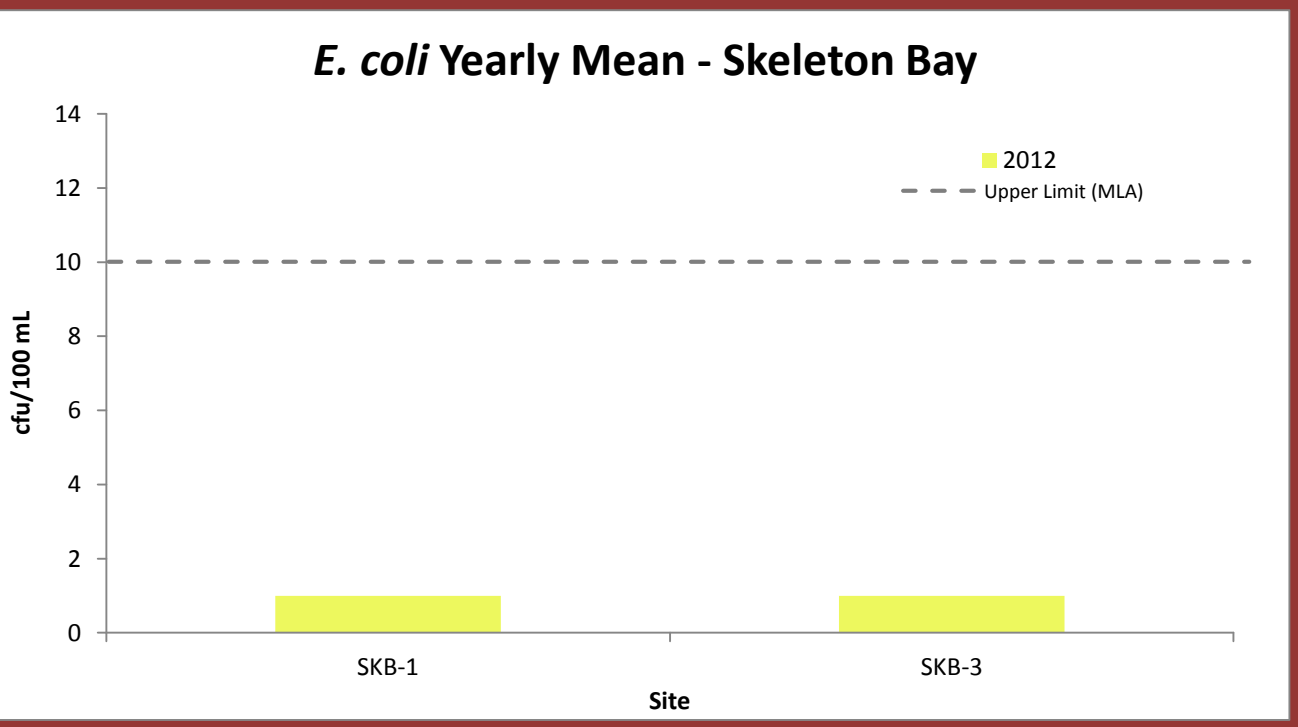
E. coli levels were below the MLA upper limit at all sites in 2012.

Recommendations

Continue existing sampling protocol to monitor long-term trends.

(SKB) SKELETON BAY





TOBIN'S ISLAND (TOB)

Area Description

Tobin's 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

Tobin's Island was monitored in 2012 by **Katherine Seybold** and Peter Seybold.

2012 Data

TOB-0: Calcium = 3.80 mg/L
Secchi = 3.4 m

Comments

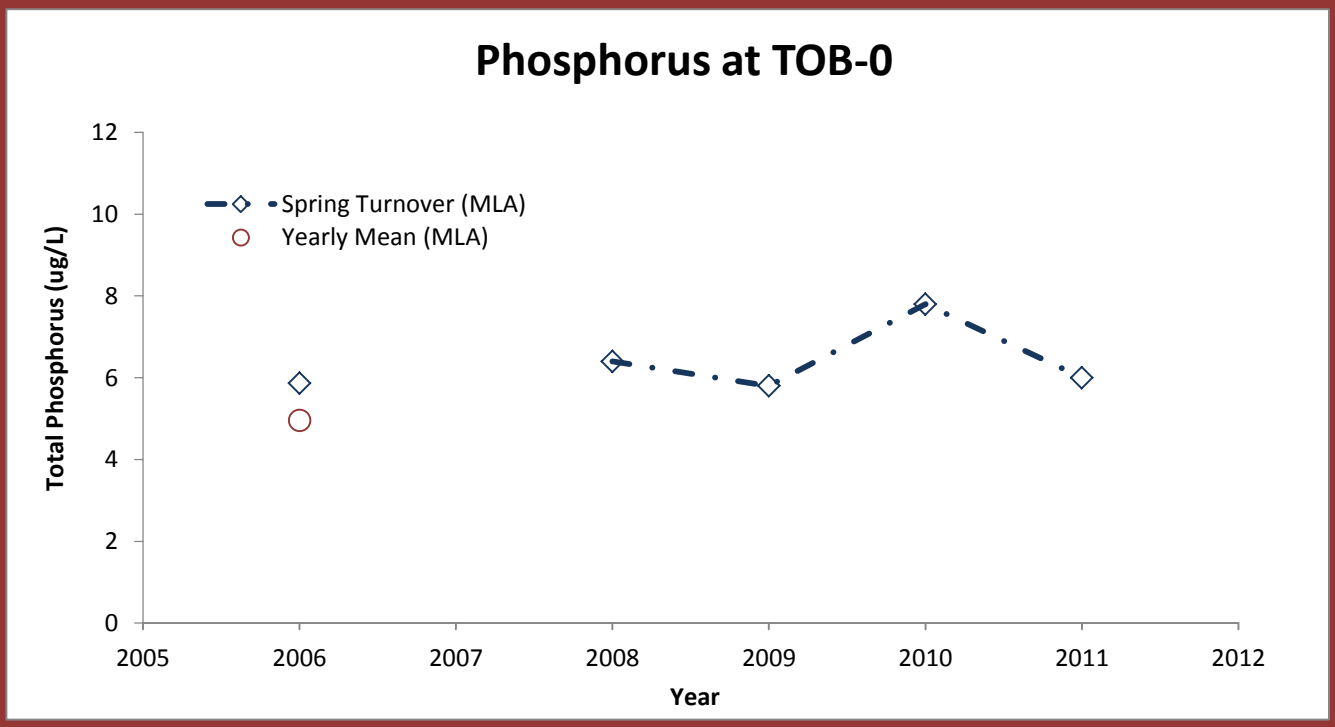
Monitoring of Tobin's Island started in 2006.

This area has been selected for long-term monitoring .

Recommendations

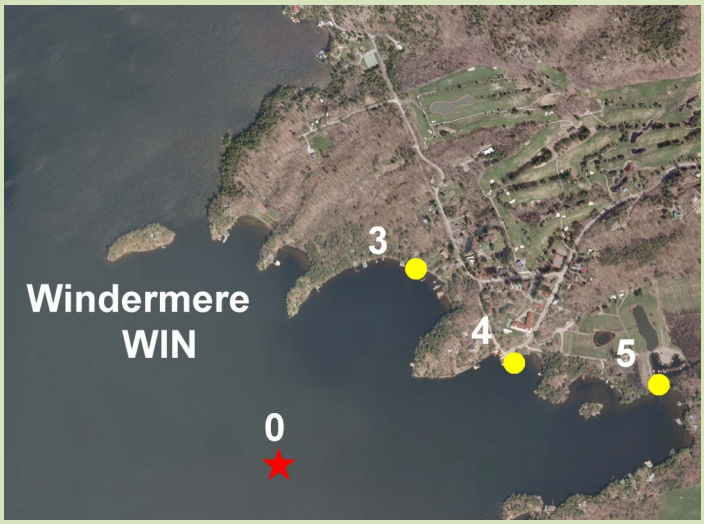
Continue existing sampling protocol to monitor long-term trends.

(TOB) TOBIN'S ISLAND



Notes:

WINDERMERE (WIN)



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 near the sampling area. Several creeks outlet into this area, one of which flows through farms fields and wetlands and enters the lake at the marina.

Volunteer Recognition

Windermere was monitored in 2012 by Cameron Purdy, Drew Purdy, Devon Seybold, **Katherine Seybold**, Luke Seybold, and Peter Seybold.

2012 Data

WIN-0: Calcium = 3.85 mg/L
Secchi = 4.1 m

WIN-3: TP-Yearly mean = 5.2 µg/L
Total coliforms = 177 cfu/100 mL
Total *E. coli* = 15 cfu/100 mL

WIN-4: TP-Yearly mean = 5.3 µg/L
Total coliforms = 83 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

WIN-5: TP-Yearly mean = 11.4 µg/L*
Total coliforms = 65 cfu/100 mL
Total *E. coli* = 19 cfu/100 mL

*Based on 3 sampling events; TP samples were not collected during the third sampling period

Comments

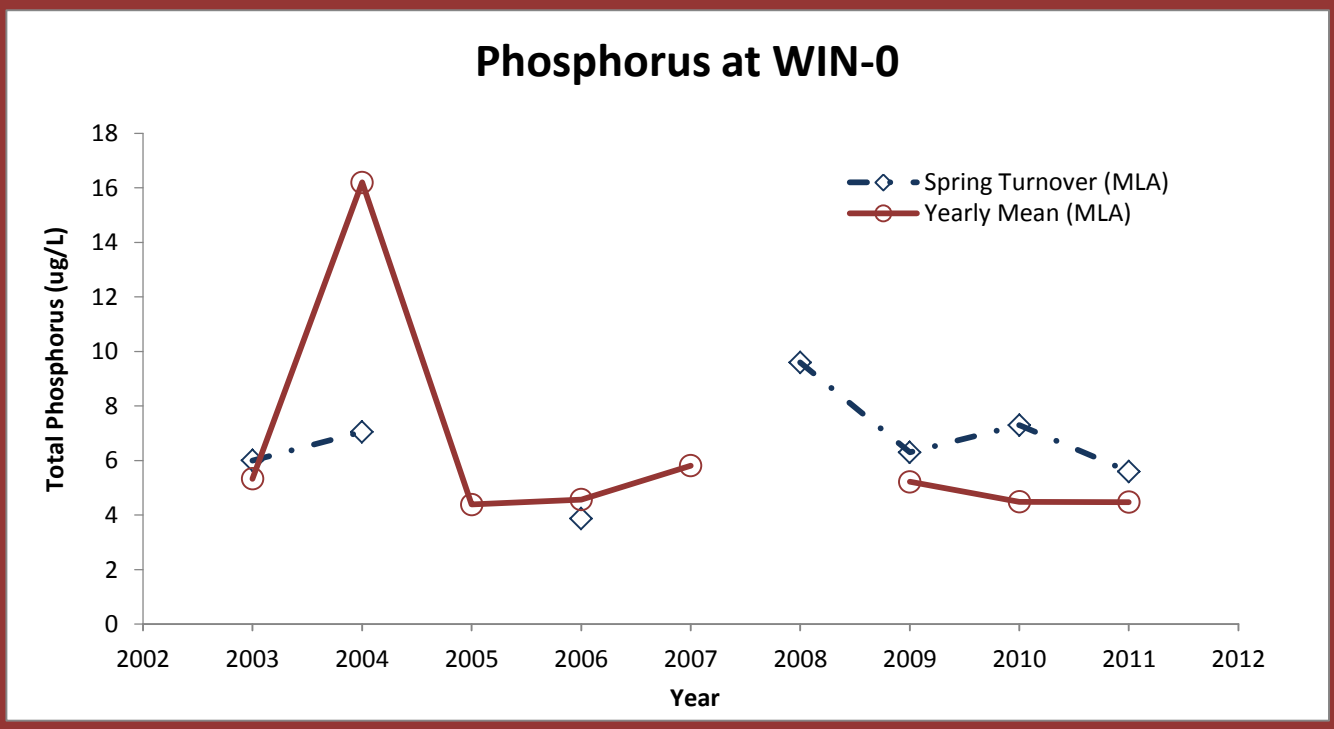
Monitoring of Windermere started in 2003.

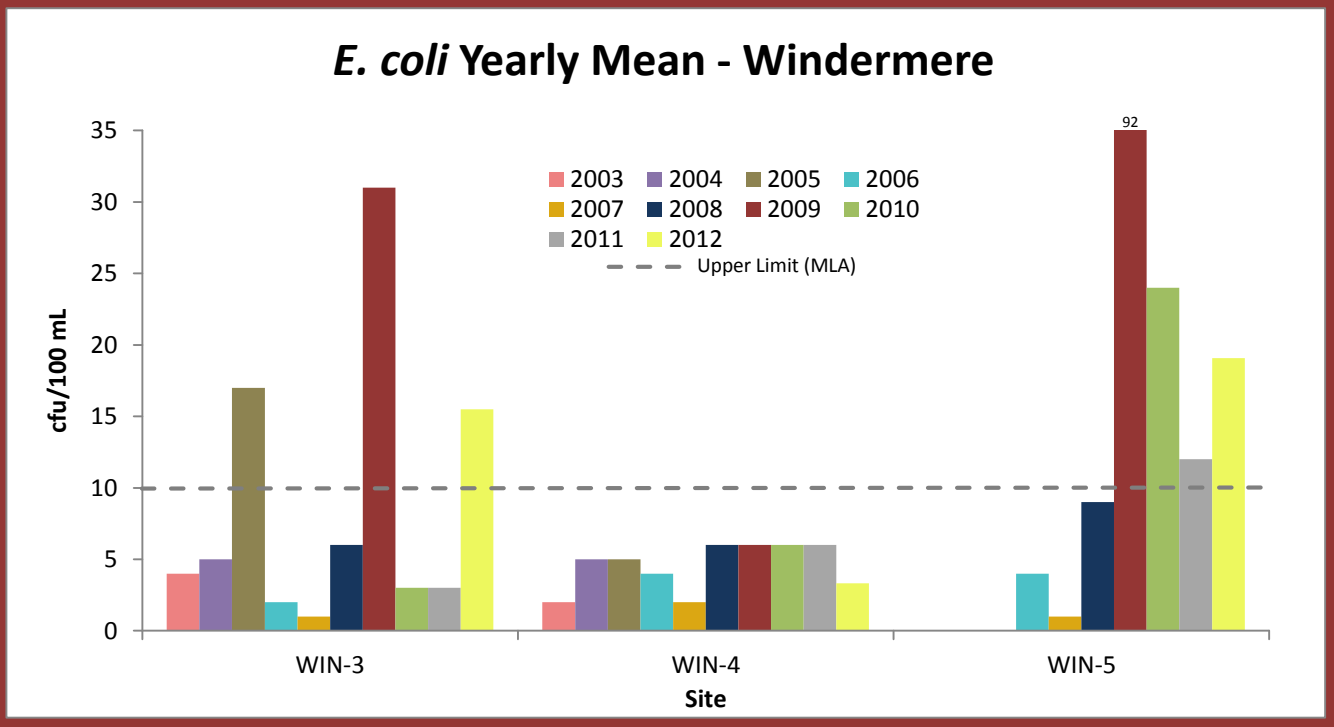
E. coli levels at WIN-3 and WIN-5 were above the MLA upper limit in 2012.

Recommendations

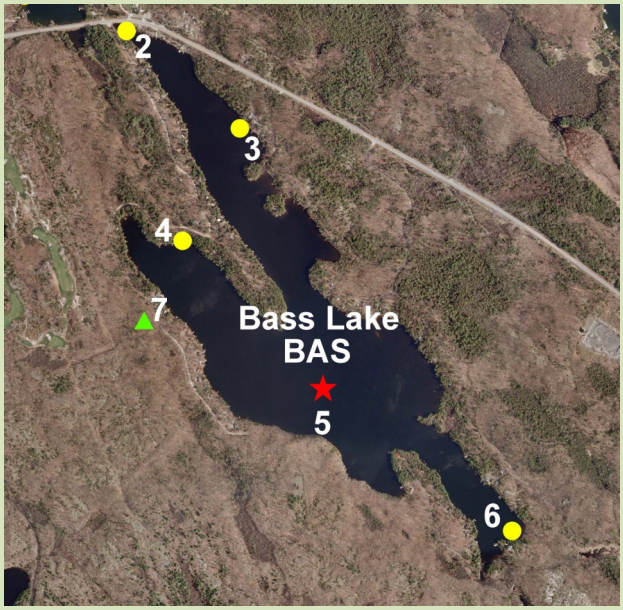
E. coli levels at WIN-4 have been equal to or below the MLA upper limit for the past 3 years. Sampling at an alternative location should be considered.

(WIN) WINDERMERE





BASS LAKE (BAS)



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.

Volunteer Recognition

Bass Lake was monitored in 2012 by **Chris Bodanis**, Andrea Foss, Bev Turney, and Chris Turney.

2012 Data

BAS-5: Calcium = 2.68 mg/L
Secchi = 3.8 m

BAS-2: Total coliforms = 25 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

BAS-3: Total coliforms = 28 cfu/100 mL
Total *E. coli* = 4 cfu/100 mL

BAS-4: Total coliforms = 24 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

BAS-6: Total coliforms = 83 cfu/100 mL*
Total *E. coli* = 3 cfu/100 mL*

BAS-7: TP-Yearly mean = 42.6 µg/L*

*Based on 1 sampling event

Comments

Bass Lake has been monitored from 2005-2007 and 2010-2012.

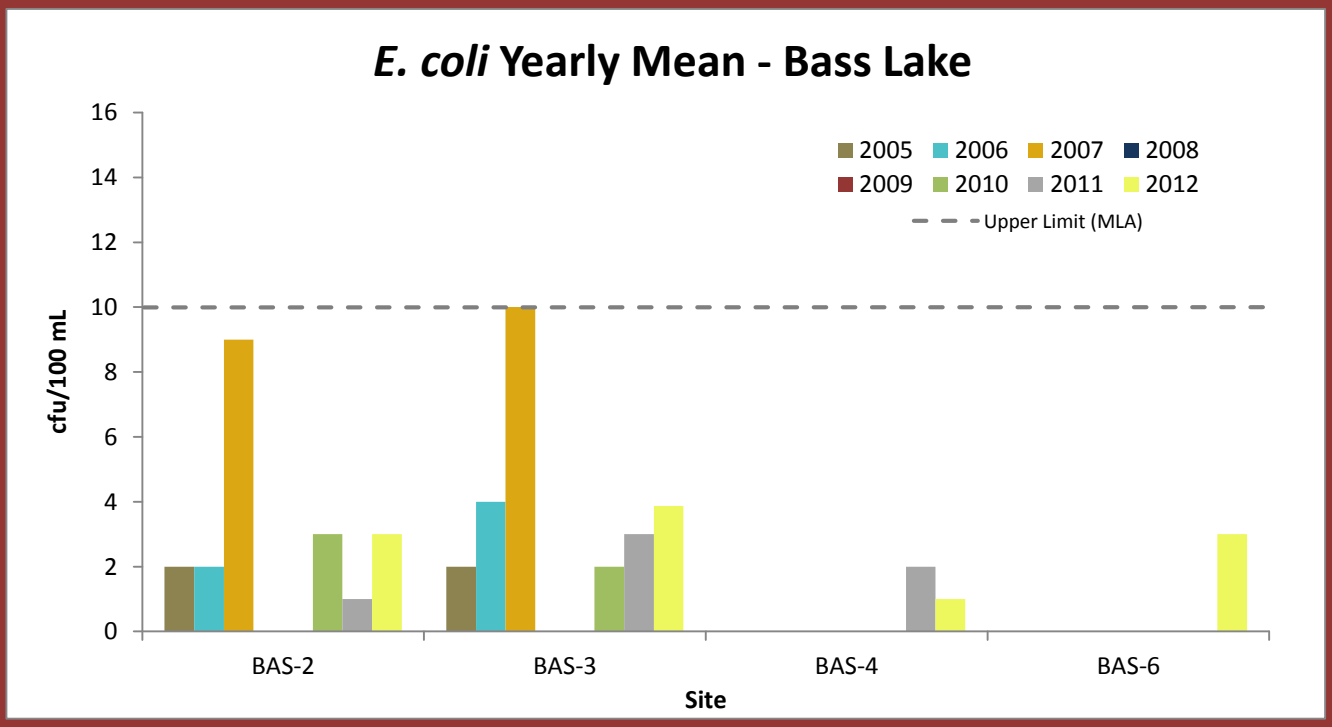
BAS-5 was established as the new deep-water reference site for Bass Lake.

BAS-6 and BAS-7 are newly established sites.

In 2012, *E. coli* levels were below the MLA upper limit at all sites.

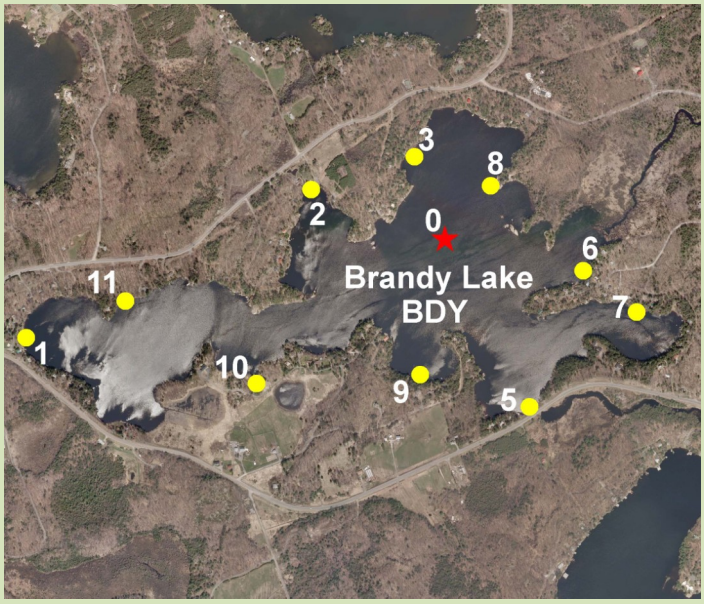
Recommendations

Continue existing sampling protocol to monitor long-term trends.


E. coli Yearly Mean - Bass Lake
16
14
12
10
8
6
4
2
0
cfu/100 mL
2005
2006
2007
2008
2009
2010
2011
2012
Upper Limit (MLA)
BAS-2
BAS-3
BAS-4
BAS-6
Site

Notes:

BRANDY LAKE (BDY)



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.

Volunteer Recognition

Brandy Lake was monitored in 2012 by Bob Hogg, and **Donna & Peter Sale**.

2012 Data

BDY-0: Calcium = 4.06 mg/L
Secchi = 1.4 m

BDY-1: Total coliforms = 57 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

BDY-2: Total coliforms = 18 cfu/100 mL
Total *E. coli* = 7 cfu/100 mL

BDY-3: Total coliforms = 25 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

BDY-5: Total coliforms = 48 cfu/100 mL
Total *E. coli* = 5 cfu/100 mL

BDY-6: Total coliforms = 67 cfu/100 mL
Total *E. coli* = 7 cfu/100 mL

BDY-7: Total coliforms = 44 cfu/100 mL
Total *E. coli* = 5 cfu/100 mL

BDY-8: Total coliforms = 2 cfu/100 mL
Total *E. coli* = 6 cfu/100 mL

BDY-9: Total coliforms = 20 cfu/100 mL
Total *E. coli* = 4 cfu/100 mL

BDY-10: Total coliforms = 15 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

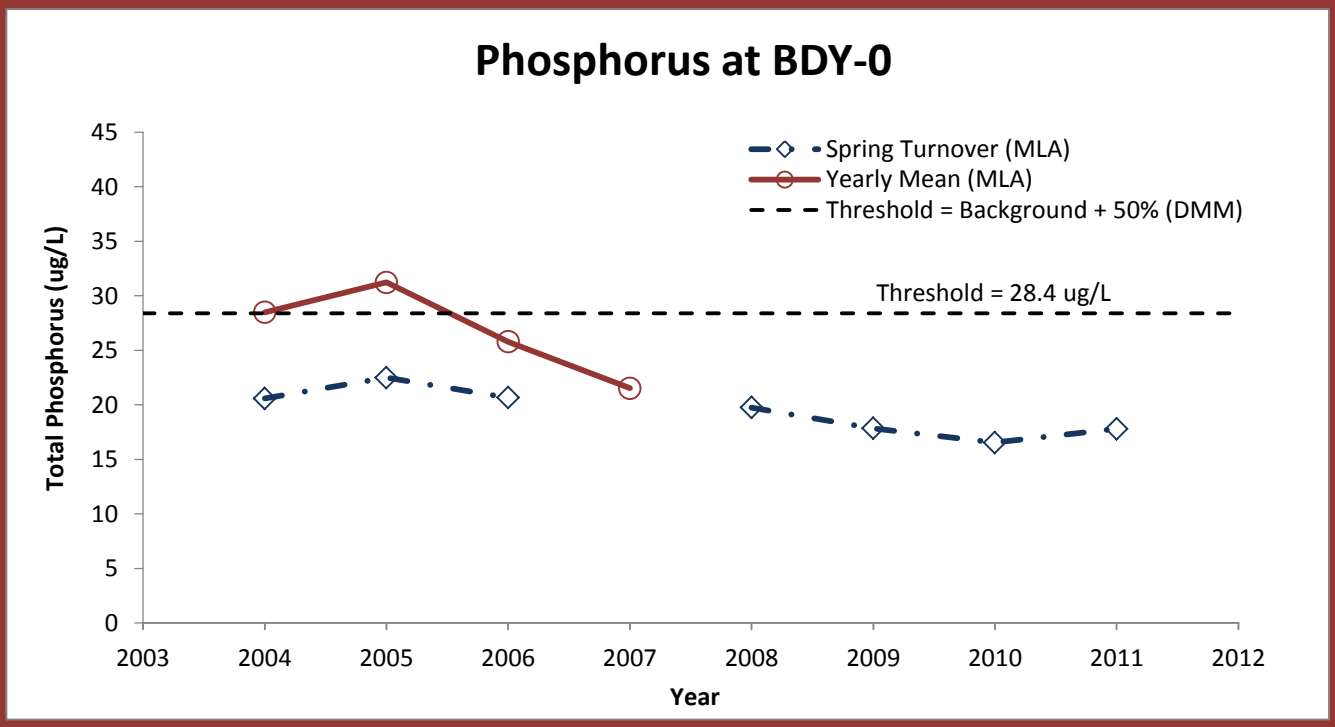
BDY-11: Total coliforms = 59 cfu/100 mL
Total *E. coli* = 5 cfu/100 mL

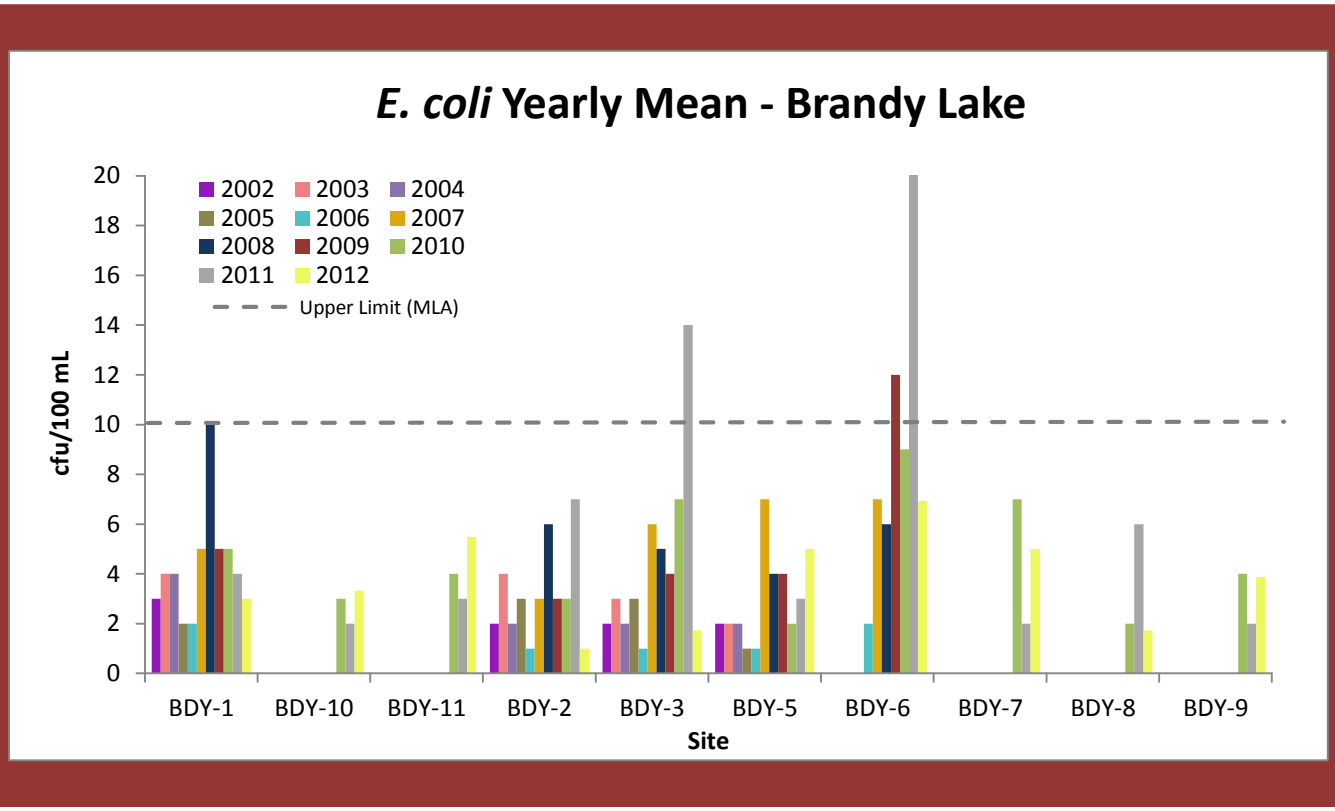
Comments and Recommendations

Monitoring of Brandy Lake started in 2004.

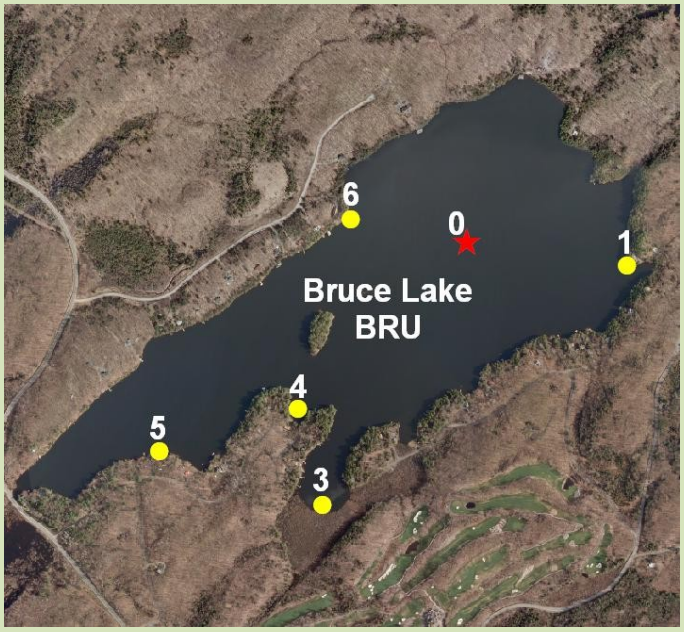
E. coli levels in 2012 were all below the MLA upper limit. *E. coli* levels at all but two sites (BDY-3 and BDY-5) have been equal to or below the MLA upper limit for the past 3 years. Sampling at alternative locations should be considered.

(BDY) BRANDY LAKE





BRUCE LAKE (BRU)



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.

Volunteer Recognition

Bruce Lake was monitored in 2012 by Cam Facer, **Paul Hutchinson**, Pat Ivanyshyn, Milan Kovac, Bob Krieger, and Karen Weber.

2012 Data

BRU-0: Calcium = 3.93 mg/L
Secchi = 4.9 m
Total coliforms = 10 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

BRU-1: TP-Yearly mean = 7.6 µg/L
Total coliforms = 13 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

BRU-3: TP-Yearly mean = 8.1 µg/L
Total coliforms = 24 cfu/100 mL
Total *E. coli* = 6 cfu/100 mL

BRU-4: TP-Yearly mean = 6.9 µg/L
Total coliforms = 14 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

BRU-5: TP-Yearly mean = 7.6 µg/L
Total coliforms = 7 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

BRU-6: TP-Yearly mean = 7.1 µg/L
Total coliforms = 7 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

Comments

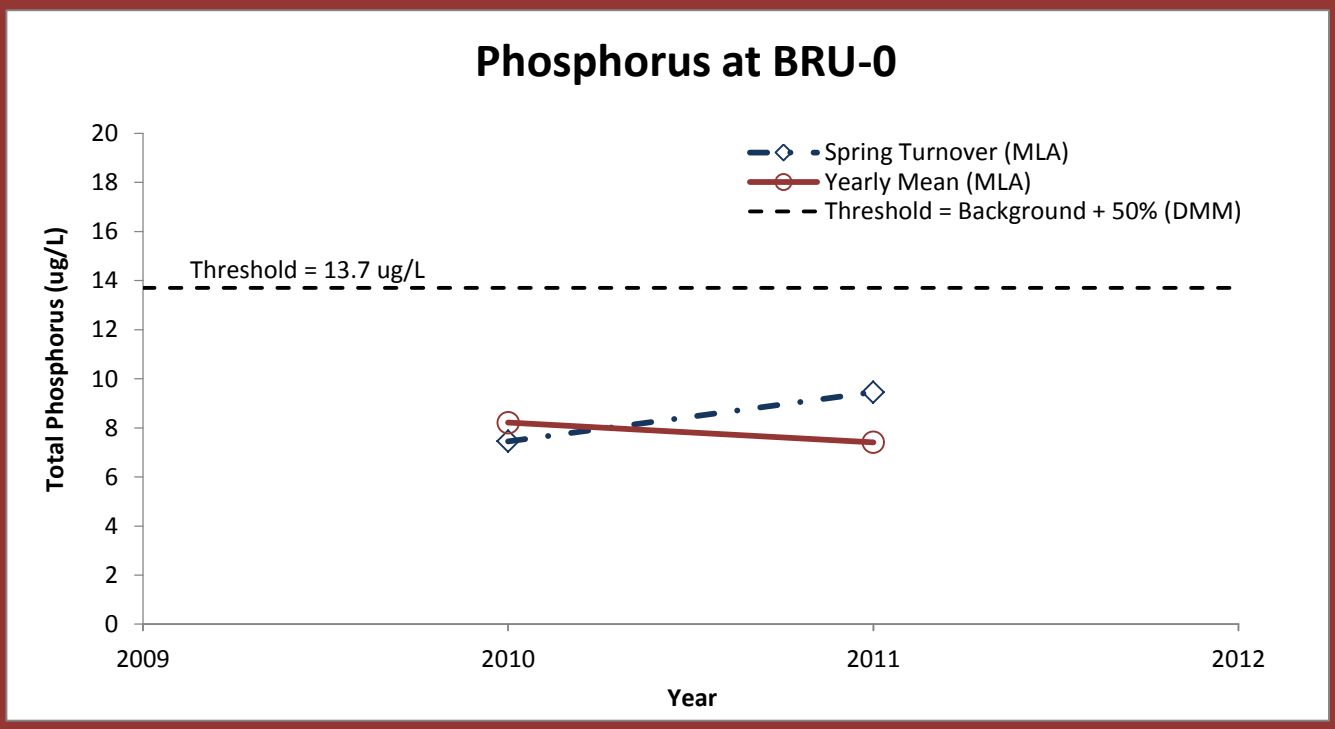
Monitoring of Bruce Lake started in 2010.

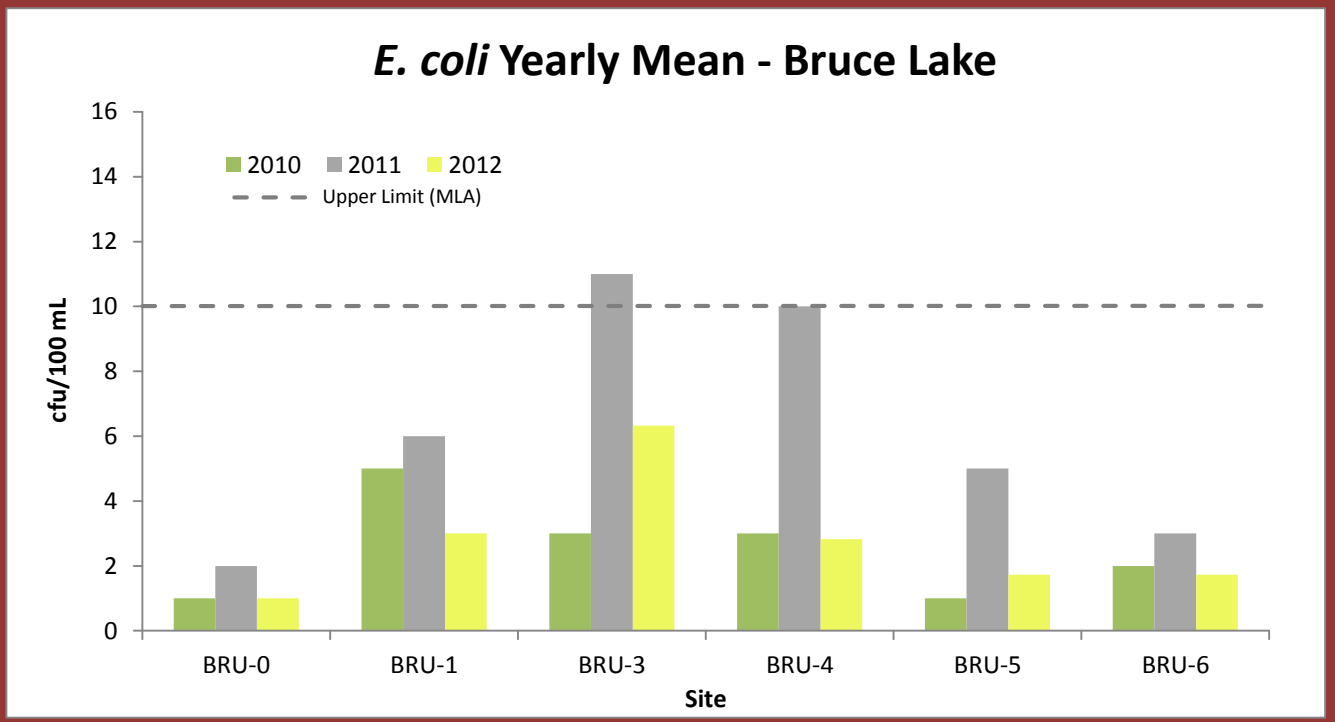
E. coli levels in 2012 were all below the MLA upper limit.

Recommendations

With the exception of BRU-3, *E. coli* levels have been equal to or below the MLA upper limit for the past 3 years. Sampling at alternative locations should be considered.

(BRU) BRUCE LAKE





CLEAR LAKE (CLR)

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.

Volunteer Recognition

Clear Lake was monitored in 2012 by **Bob & Sharon Cleverdon**.

2012 Data

CLR-0: Calcium = 3.85 mg/L
Secchi = 6.1 m

CLR-2: TP-Yearly mean = 6.1 µg/L
Total coliforms = 58 cfu/100 mL
Total *E. coli* = 6 cfu/100 mL

CLR-4: TP-Yearly mean = 5.8 µg/L
Total coliforms = 29 cfu/100 mL
Total *E. coli* = 1 cfu /100 mL

CLR-5: TP-Yearly mean = 7.2 µg/L
Total coliforms = 79 cfu /100 mL
Total *E. coli* = 8 cfu /100 mL

CLR-6: TP-Yearly mean = 5.8 µg/L
Total coliforms = 25 cfu /100 mL
Total *E. coli* = 1 cfu /100 mL

Comments

Monitoring of Clear Lake started in 2006.

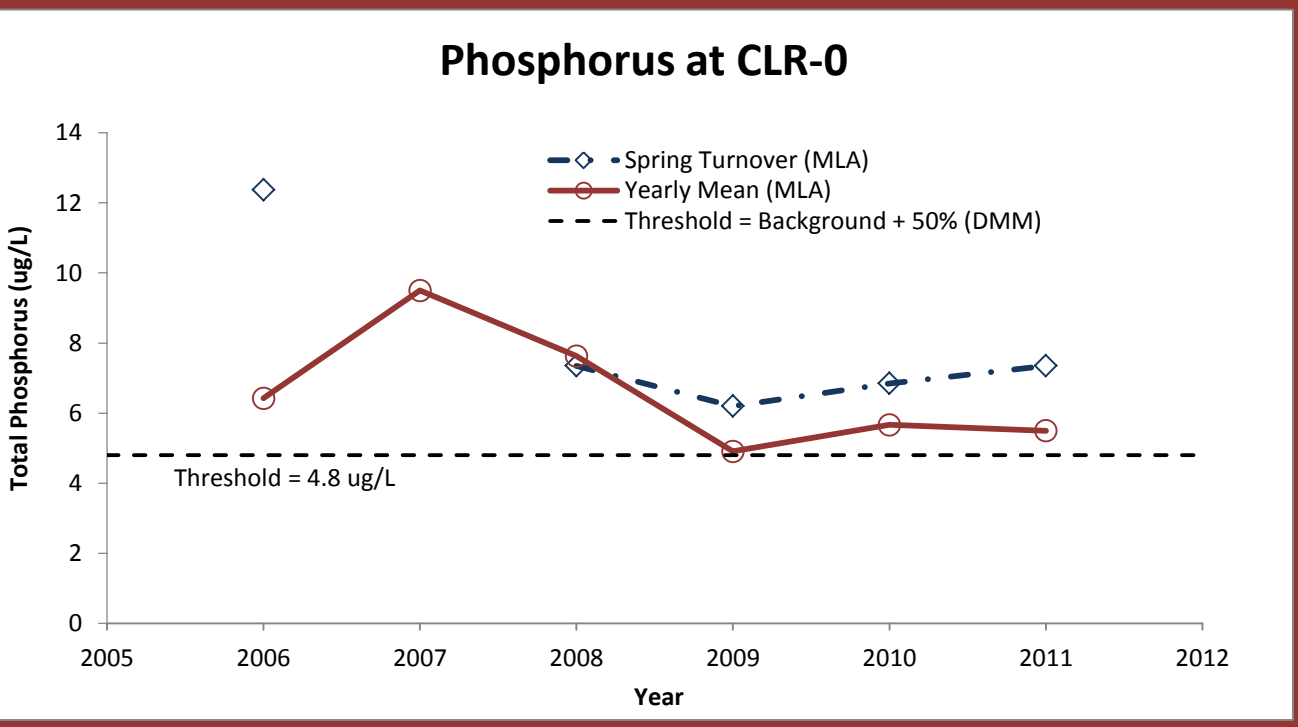
CLR-5 and CLR-6 are newly established sites located in high use areas.

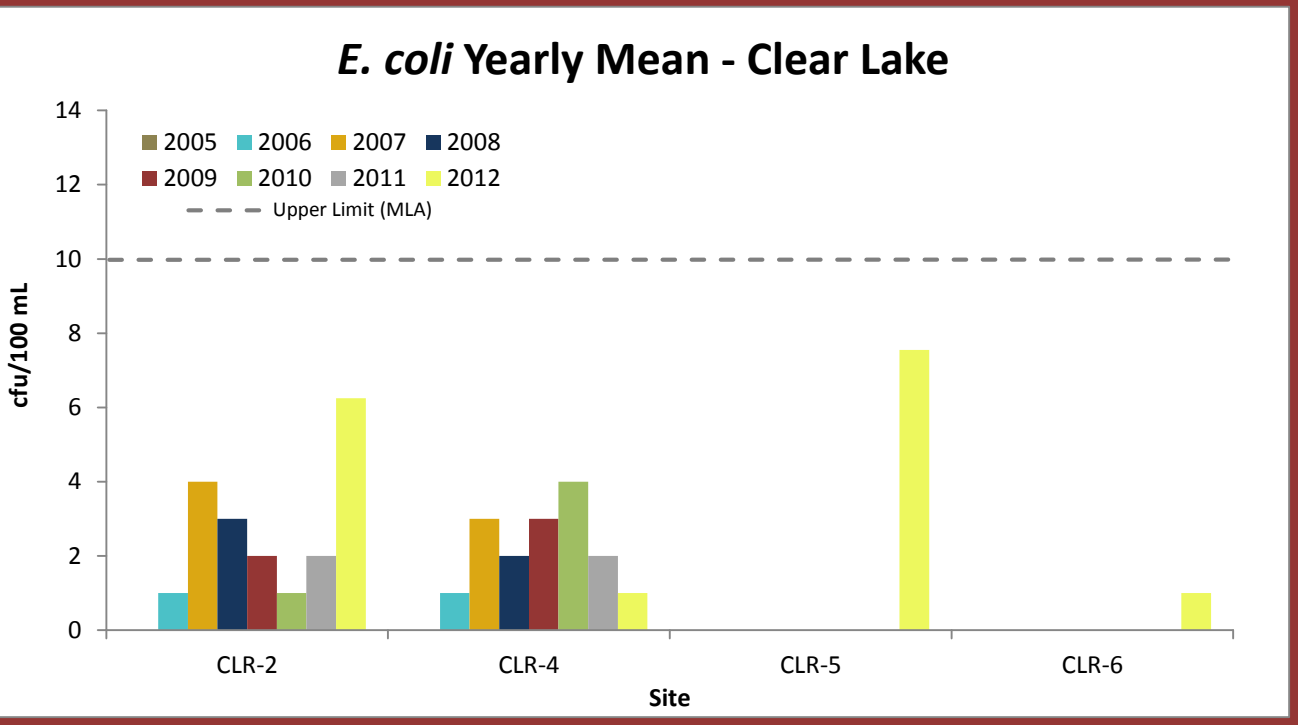
E. coli levels in 2012 were all below the MLA upper limit.

Recommendations

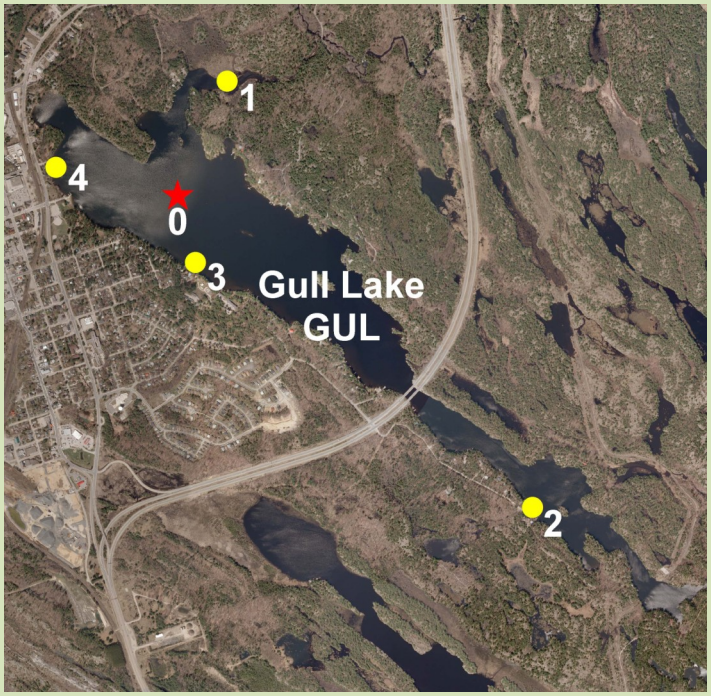
E. coli levels at CLR-2 and CLR-4 have been equal to or below the MLA upper limit for the past 3 years. Sampling at an alternative location should be considered.

(CLR) CLEAR LAKE





GULL LAKE (GUL)



Area Description

Gull Lake is located 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.

Volunteer Recognition

Gull Lake was monitored in 2012 by **Greg Bertrand** and Roger Bertrand.

2012 Data

GUL-0: Calcium = 5.51 mg/L
Secchi = 4.3 m

GUL-1: Total coliforms = 114 cfu/100 mL
Total *E. coli* = 17 cfu/100 mL

GUL-2: Total coliforms = 51 cfu/100 mL
Total *E. coli* = 1 cfu/100 ml

GUL-3: Total coliforms = 51 cfu/100 mL
Total *E. coli* = 5 cfu/100 mL

GUL-4: Total coliforms = 73 cfu/100 mL
Total *E. coli* = 6 cfu/100 mL*

*Based on 3 sampling events. Includes one sample with elevated *E. coli* levels and one follow-up sample.

Comments

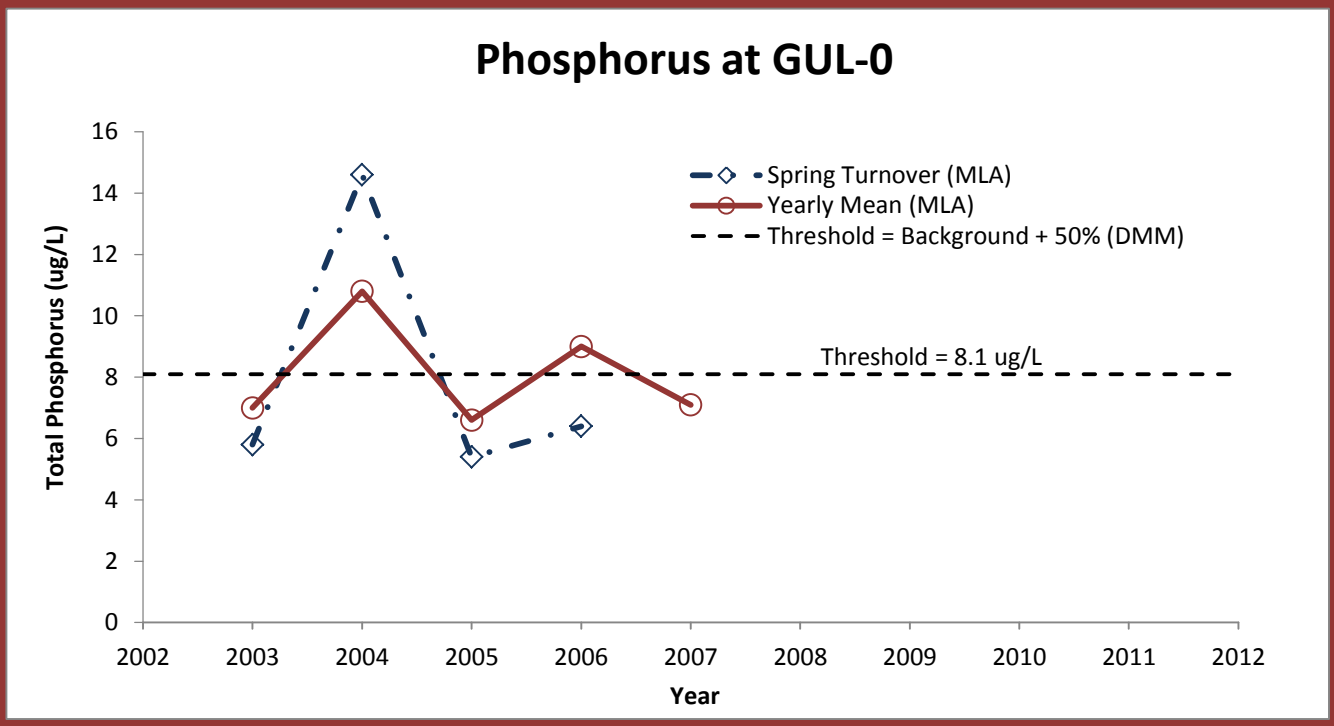
Monitoring of Gull Lake started in 2003.

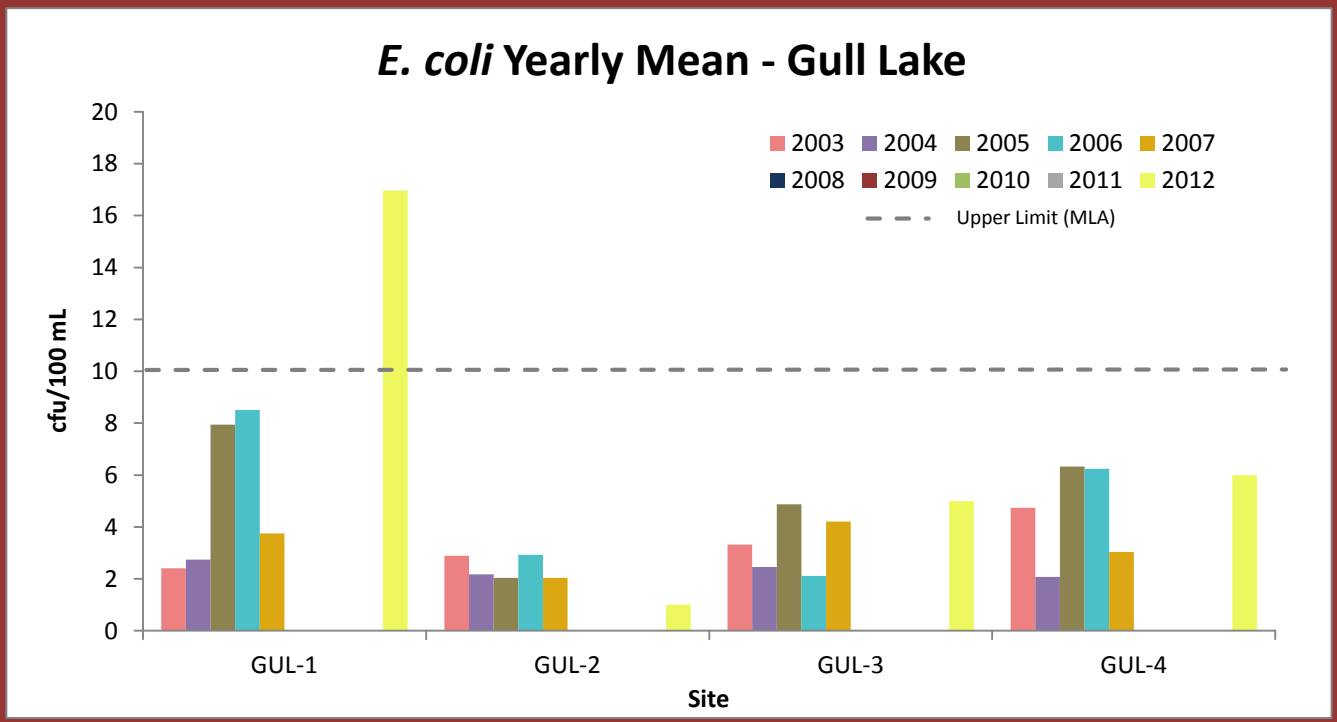
E. coli levels in 2012 were below the MLA upper limit with the exception of GUL-1.

Recommendations

Continue existing protocol to monitor long-term trends.

(GUL) GULL LAKE





INDIAN RIVER (IND)

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.

Volunteer Recognition

Indian River was monitored in 2012 by **Susan Carson**, Jenn Spence, Rick Spence, Sandy Tozer-Spence, Dianne Turnbull, and Ian Turnbull.

2012 Data

IND-0: Calcium = 3.83 mg/L
Secchi = 4.5 m

IND-1: Total coliforms = 17 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

IND-2: Total coliforms = 432 cfu/100 mL
Total *E. coli* = 8 cfu/100 mL

IND-3: Total coliforms = 218 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

IND-4: Total coliforms = 50 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

Comments

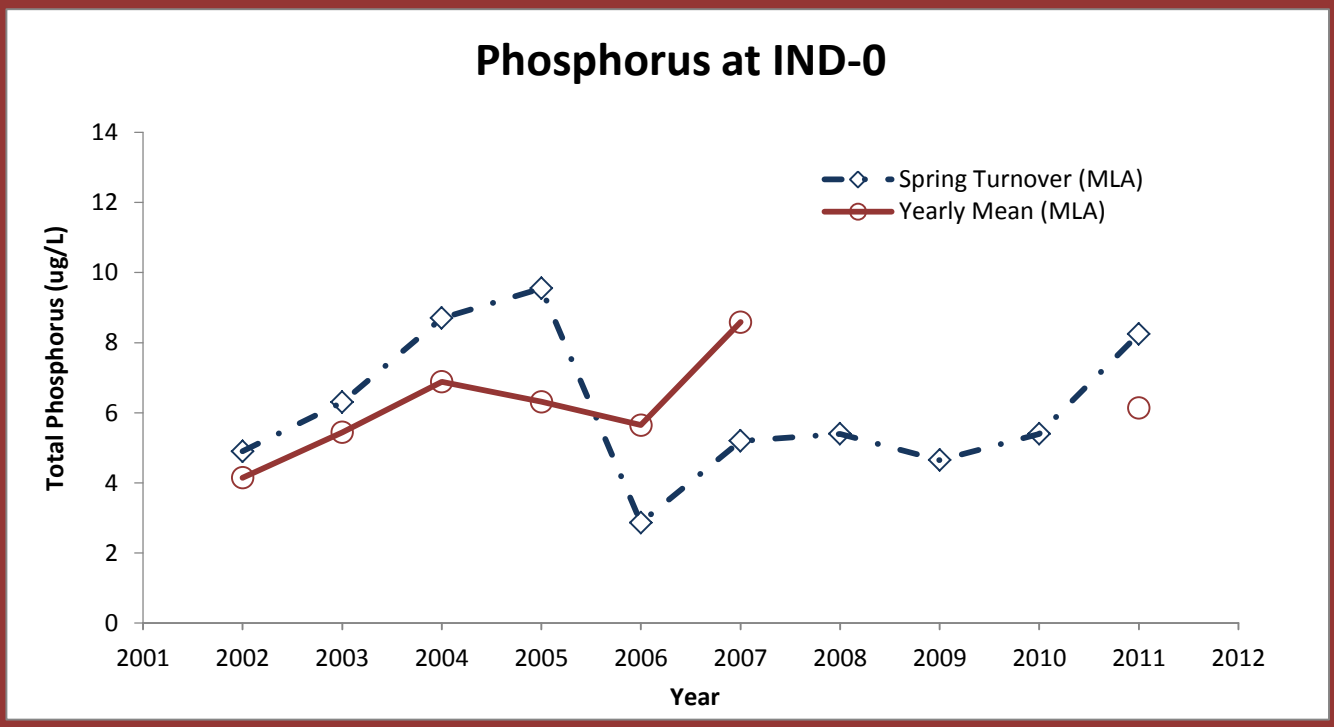
Monitoring of the Indian River started in 2002.

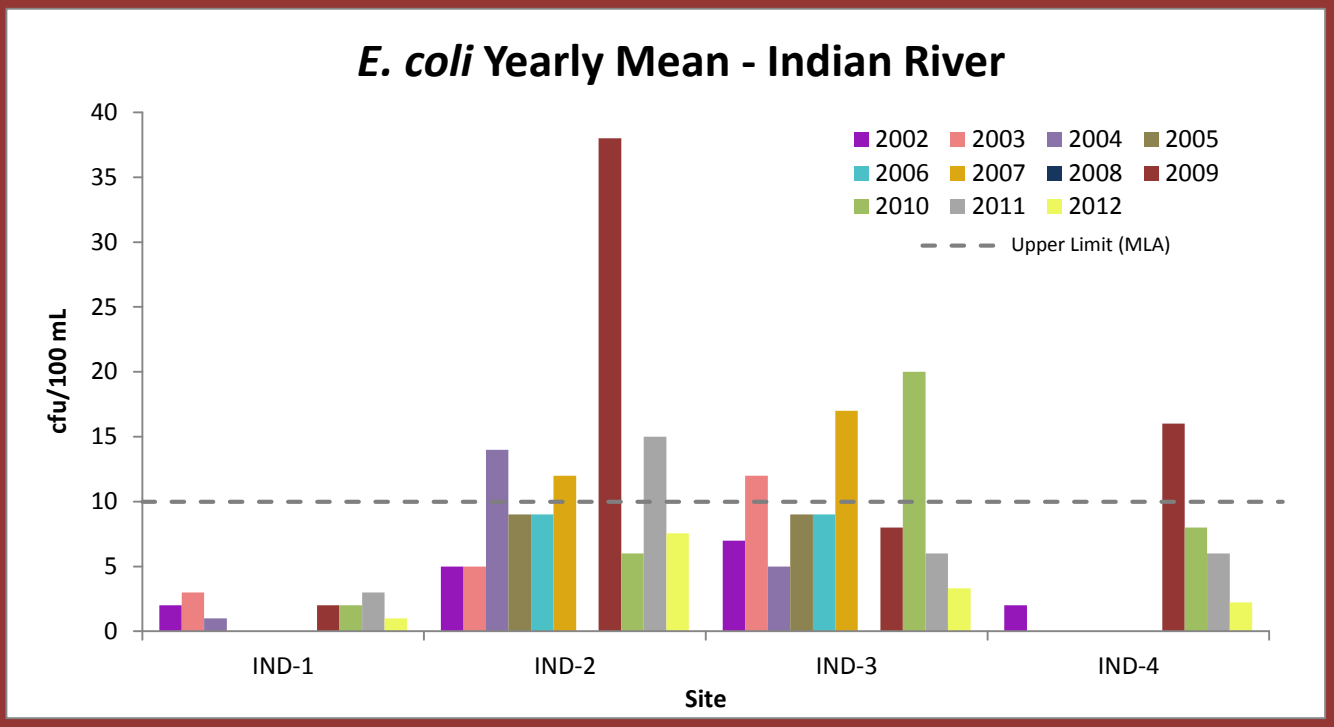
E. coli levels in 2012 were all below the MLA upper limit.

Recommendations

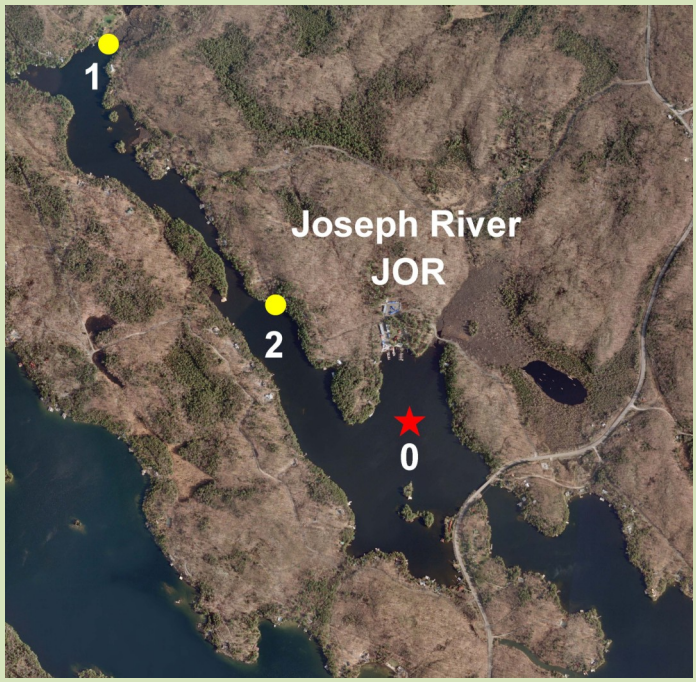
E. coli levels at IND-1 and IND-4 have been equal to or below the MLA upper limit for the past 3 years. Sampling at alternative locations should be considered.

(IND) INDIAN RIVER





JOSEPH RIVER (JOR)



Area Description

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.

Volunteer Recognition

Joseph River was monitored in 2012 by Larry Giles, **Beth Guy**, and Laurie Leiser.

2012 Data

JOR-0: Calcium = 3.85 mg/L
Secchi = 5.0 m

JOR-1: TP-Yearly mean = 5.5 µg/L

JOR-2: TP-Yearly mean = 5.1 µg/L

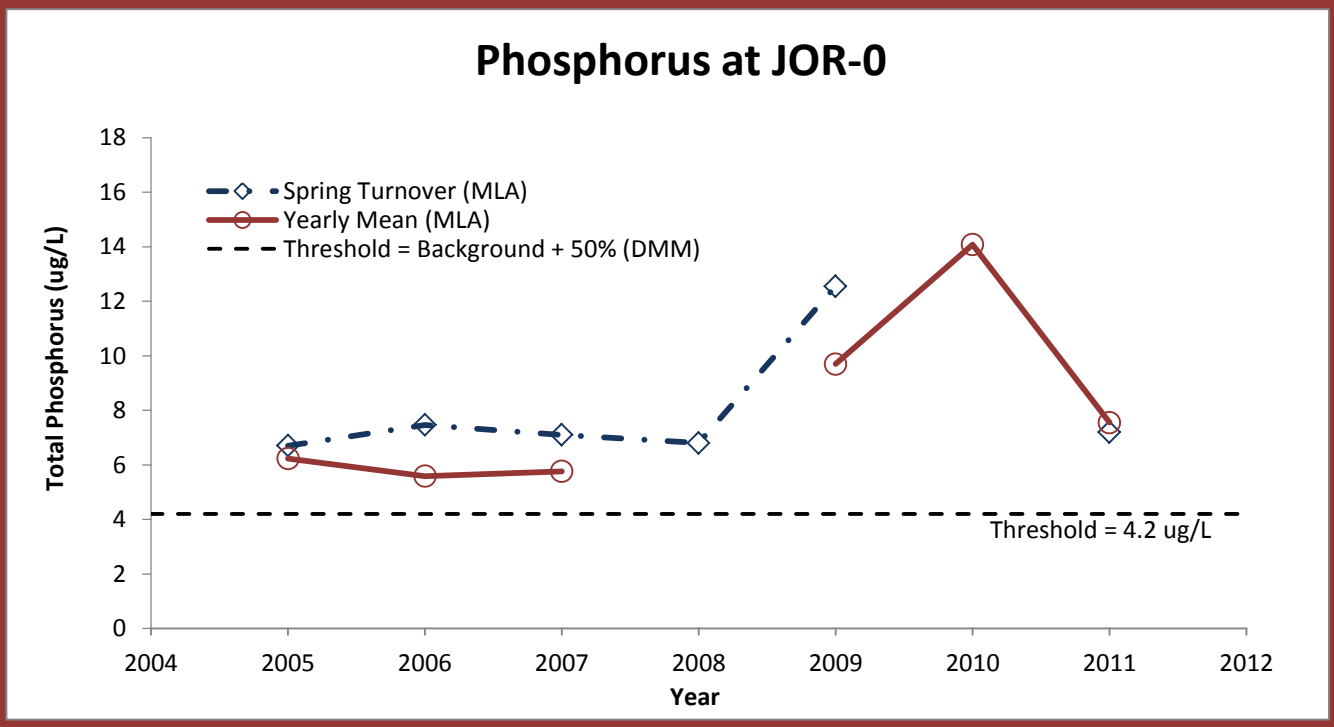
Comments

Monitoring of Joseph River started in 2005.

Recommendations

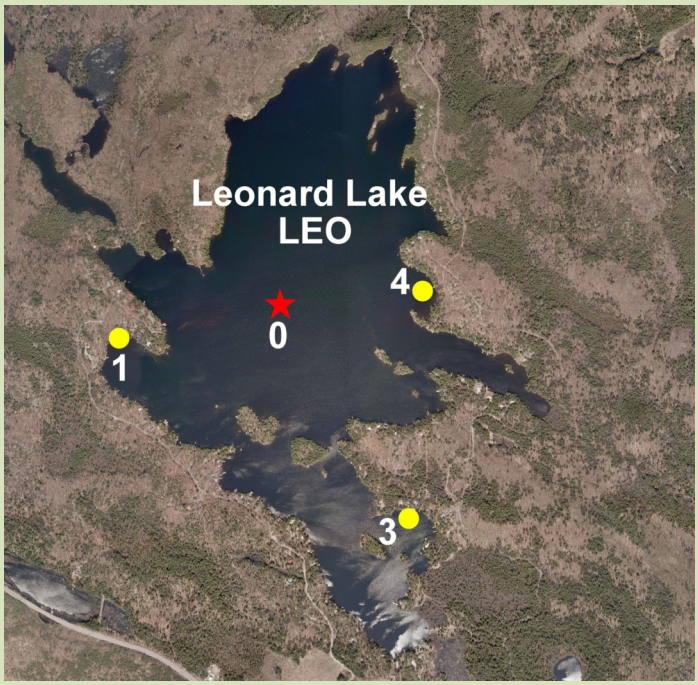
Continue existing sampling protocol to monitor long-term trends.

(JOR) JOSEPH RIVER



Notes:

LEONARD LAKE (LEO)



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.

Volunteer Recognition

Leonard Lake was monitored in 2012 by Mark Greenham, **Betty Isbister**, **Gordon Roberts**, and Doug Wallace.

2012 Data

LEO-0: Calcium = 2.41 mg/L
Secchi = 4.6 m

LEO-1: Total coliforms = 560 cfu/100 mL*
Total *E. coli* = 12 cfu/100 mL*

LEO-3: Total coliforms = 112 cfu/100 mL**
Total *E. coli* = 14 cfu/100 mL**

LEO-4: Total coliforms = 70 cfu/100 mL
Total *E. coli* = 6 cfu/100 mL

*Based on 3 sampling events. Includes one sample with elevated *E. coli* levels; however, no follow-up samples were collected

**Based on 3 sampling events. Includes one sample with elevated *E. coli* levels and one follow-up sample

Comments

Monitoring of Leonard Lake started in 2008.

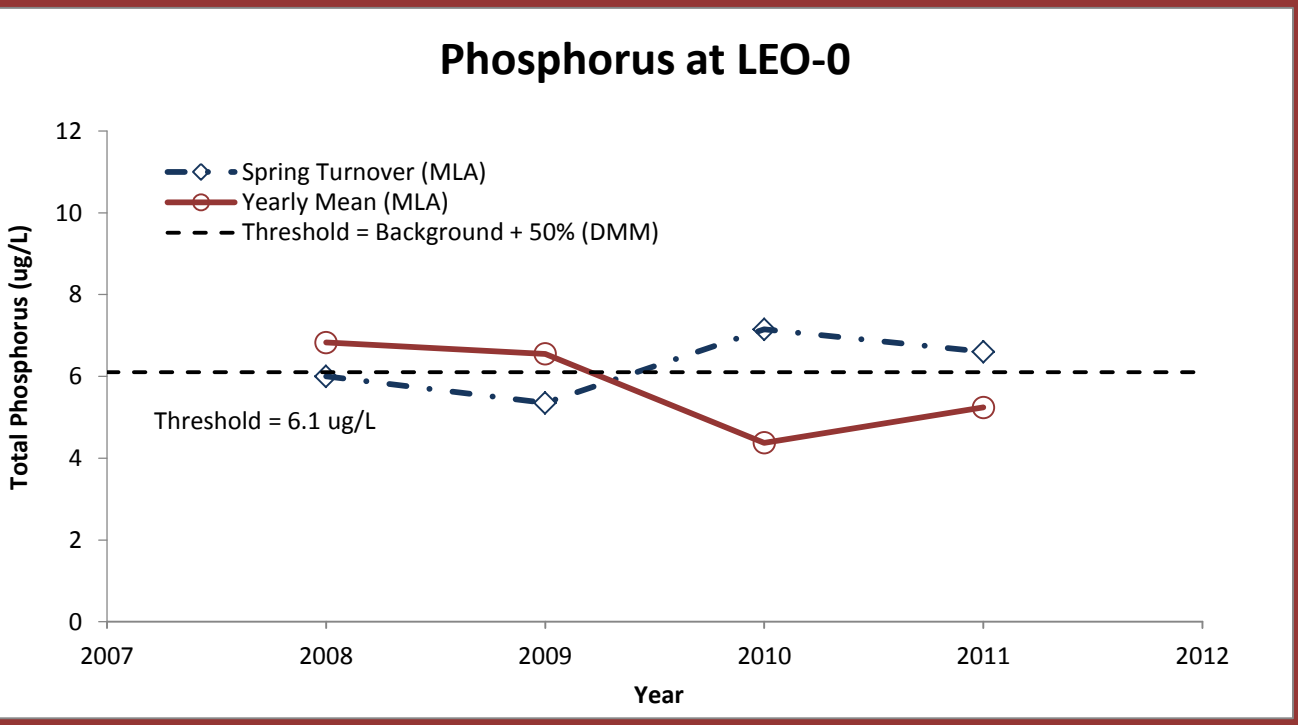
LEO-4 is a newly established site located in a high use area. *E. coli* levels in 2012 were above the MLA upper limit with the exception of LEO-4.

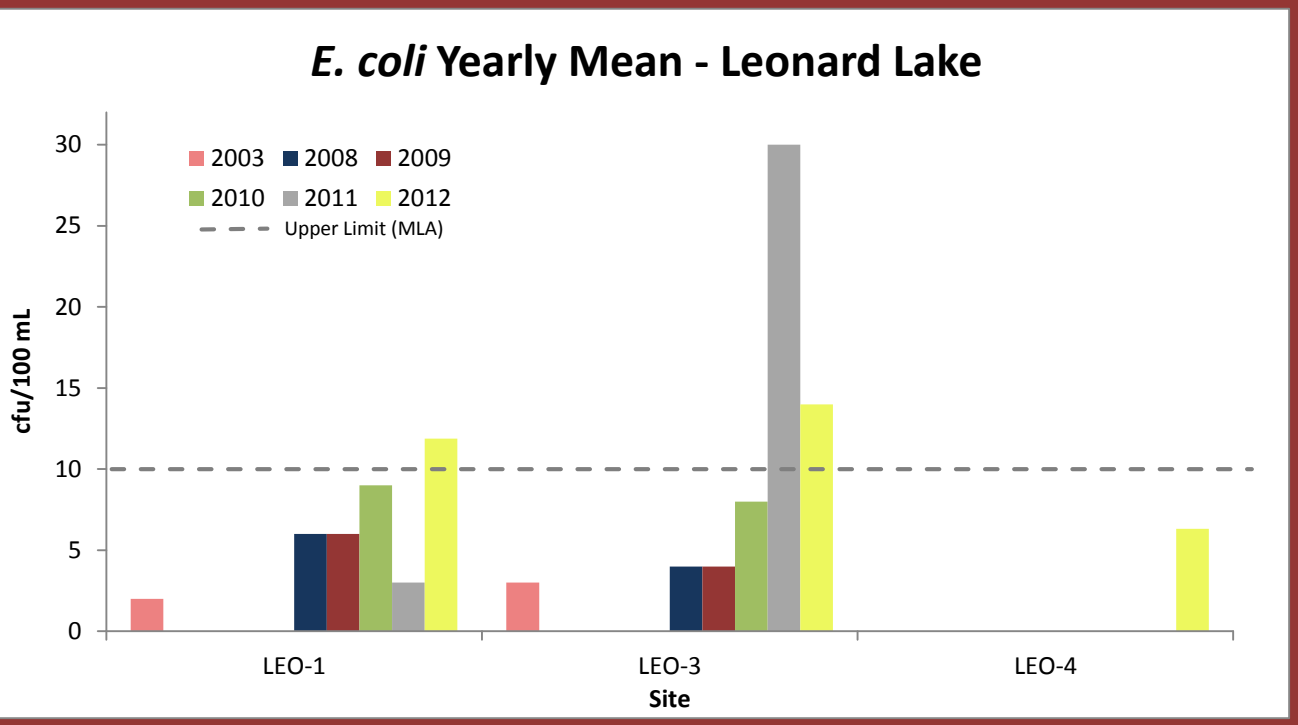
Recommendations

Continue existing sampling protocol to monitor long-term trends.

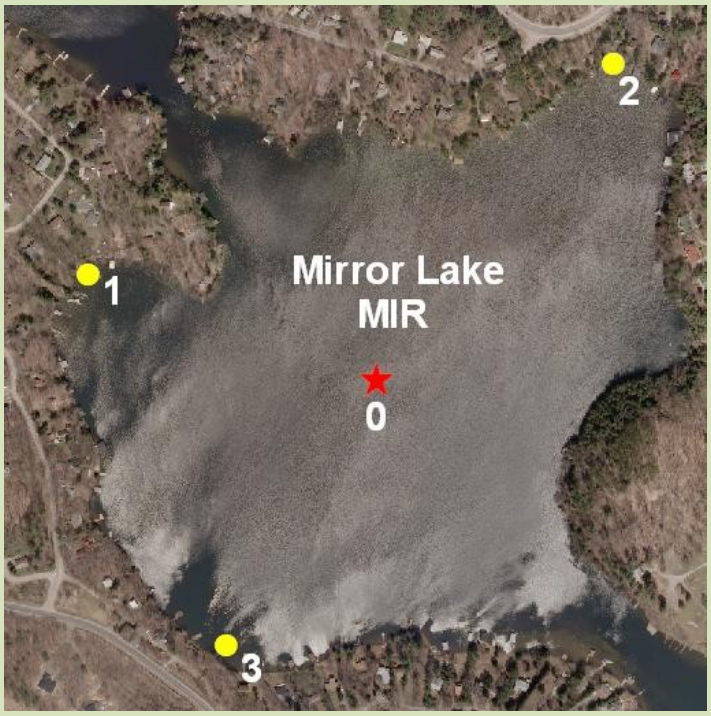
Ensure that elevated *E. coli* results are reported and follow-up bacteria samples are collected in a timely manner.

(LEO) LEONARD LAKE





MIRROR LAKE (MIR)



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.

Volunteer Recognition

Mirror Lake was monitored in 2012 by **Susan Carson**, Jenn Spence, Rick Spence, Sandy Tozer-Spence, and Ian Turnbull.

2012 Data

MIR-0: Calcium = 4.00 mg/L
Secchi = 3.1 m

MIR-1: TP-Yearly mean = 6.7 µg/L
Total coliforms = 70 cfu/100 mL
Total *E. coli* = 12 cfu/100 mL

MIR-2: TP-Yearly mean = 8.6 µg/L
Total coliforms = 58 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

MIR-3: TP-Yearly mean = 8.4 µg/L
Total coliforms = 54 cfu/100 mL
Total *E. coli* = 4 cfu/100 mL

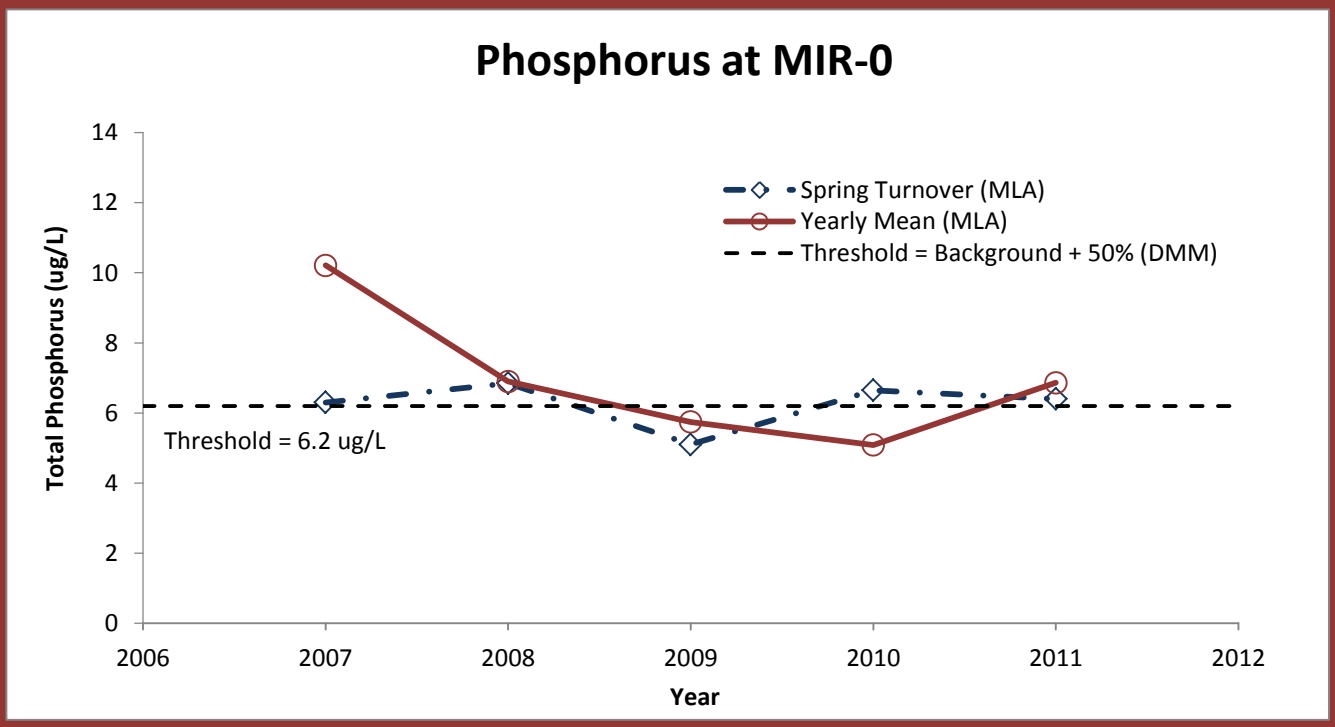
Comments

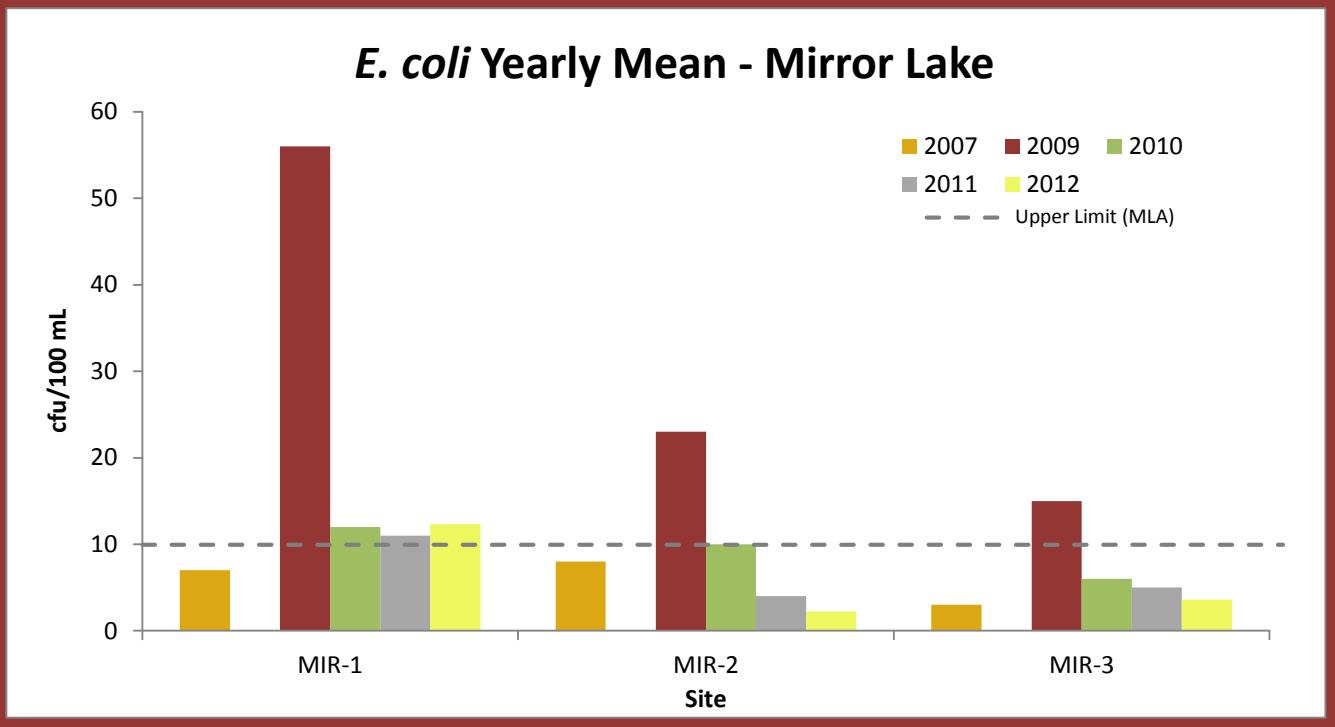
Monitoring of Mirror Lake started in 2007.

E. coli levels in 2012 were below the MLA upper limit with the exception of MIR-1.

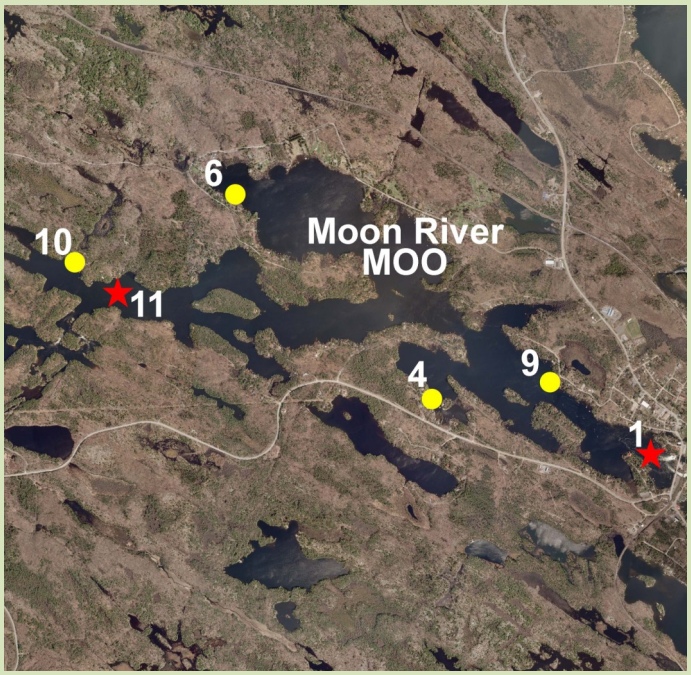
Recommendations

Continue existing sampling protocol to monitor long-term trends.


Phosphorus at MIR-0
Total Phosphorus (ug/L)
14
12
10
8
6
4
2
0
2006
2007
2008
2009
2010
2011
2012
Year
Spring Turnover (MLA)
Yearly Mean (MLA)
Threshold = Background + 50% (DMM)
Threshold = 6.2 ug/L


E. coli Yearly Mean - Mirror Lake
cfu/100 mL
60
50
40
30
20
10
0
MIR-1
MIR-2
MIR-3
Site
2007
2009
2010
2011
2012
Upper Limit (MLA)

MOON RIVER (MOO)



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.

Volunteer Recognition

Moon River was monitored in 2012 by Tara Murphy, Victoria Murphy, Anne Polewski, **Bruno Polewski**, and Bill Purkis.

2012 Data

MOO-11: Calcium = 3.57 mg/L
Secchi = 3.8 m[1]

MOO-1: TP-Yearly mean = 5.6 µg/L

MOO-4: TP-Yearly mean = 7.0 µg/L
Total coliforms = 72 cfu/100 mL[2]
Total *E. coli* = 24 cfu/100 mL[2]

MOO-6: TP-Yearly mean = 5.9 µg/L
Total coliforms = 12 cfu/100 mL
Total *E. coli* = 6 cfu/100 mL

MOO-9: TP-Yearly mean = 7.3 µg/L
Total coliforms = 17 cfu/100 mL
Total *E. coli* = 4 cfu/100 mL

MOO-10: TP-Yearly mean = 5.3 µg/L
Total coliforms = 13 cfu/100mL[3]
Total *E. coli* = 3 cfu/100 mL[3]

[1]Based on 3 measurements following spring turnover period

[2]Based on 3 sampling events; includes one sample with elevated *E. coli* levels and one follow-up sample

[3]Based on 1 sampling event; 1 measurement discarded due to error in bacteria sample analysis

Comments and Recommendations

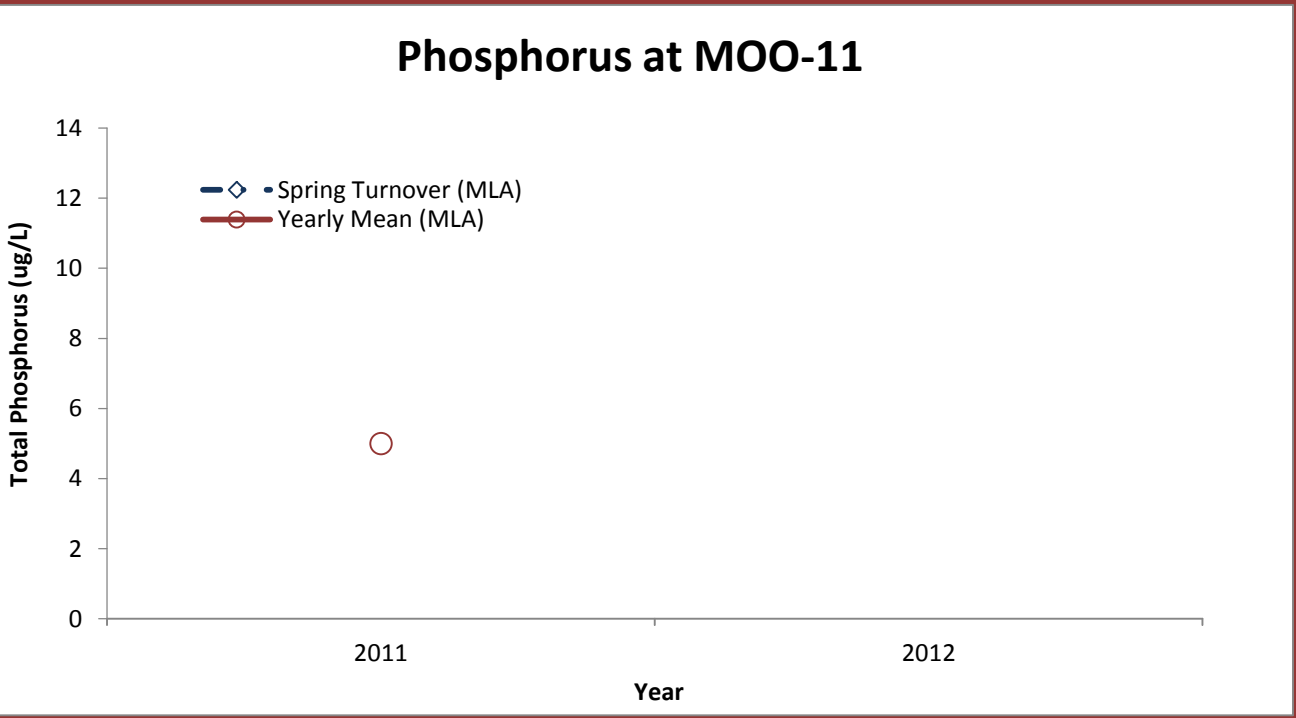
Monitoring of Moon River started in 2005.

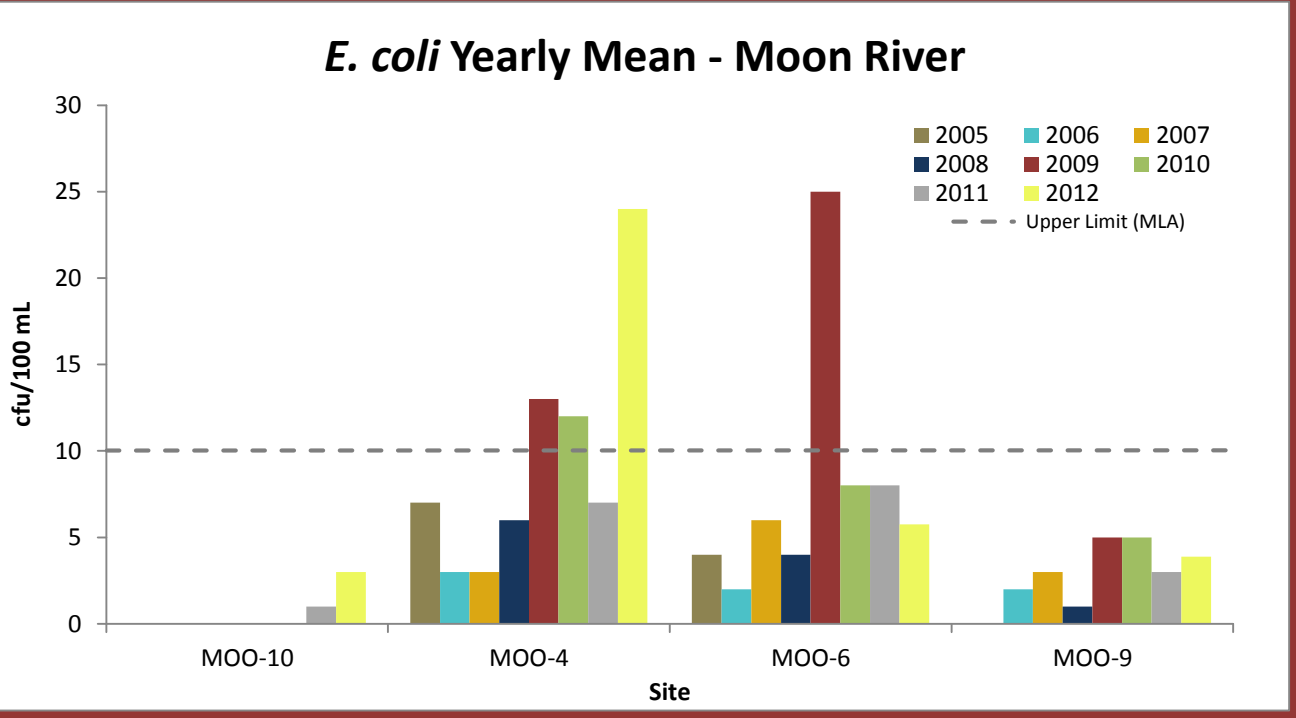
MOO-11 was established as the new deep-water reference site in 2012.

E. coli levels in 2012 were below the MLA upper limit with the exception of MOO-4.

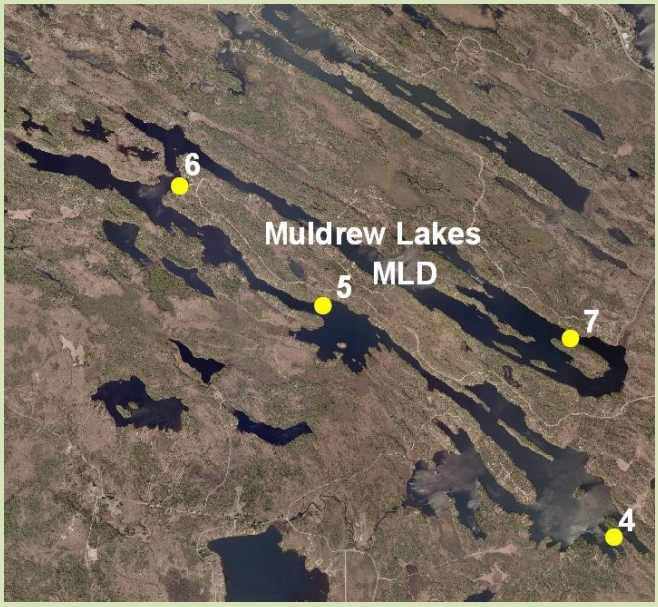
E. coli levels at MOO-6 and MOO-9 have been equal to or below the MLA upper limit for the past 3 years. Sampling at alternative locations should be considered.

(MOO) MOON RIVER





MULDREW LAKES (MLD)



Volunteer Recognition

Muldrew Lakes was monitored in 2012 by **Janet Allen**, Anna & Max McQuang, and Katy, Lily, & Sarah Simpson.

Area Description

North and South Muldrew Lakes are oriented northwest to southeast, formed as a result of glacial retreat. North Muldrew Lake is approximately 1.52 km² in size, a maximum of 16 m deep and is considered moderately sensitive by the DMM. Several creeks and five wetland areas drain into the lake. There is a large resort area along the eastern shoreline and considerable residential development, most retaining a natural shoreline. South Muldrew Lake is approximately 2.7 km² in area, with a maximum depth of 18 m, and is also classified as moderately sensitive. South Muldrew Lake has less shoreline development than North Muldrew Lake, likely due to the extent of adjacent wetlands. Approximately ten wetland areas drain into the eastern portion of South Muldrew Lake.

2012 Data

MLD-4: Total coliforms = 40 cfu/100 mL
Total *E. coli* = 5 cfu/100 mL

MLD-5: Total coliforms = 74 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

MLD-6: Total coliforms = 16 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

MLD-7: Total coliforms = 18 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

Comments

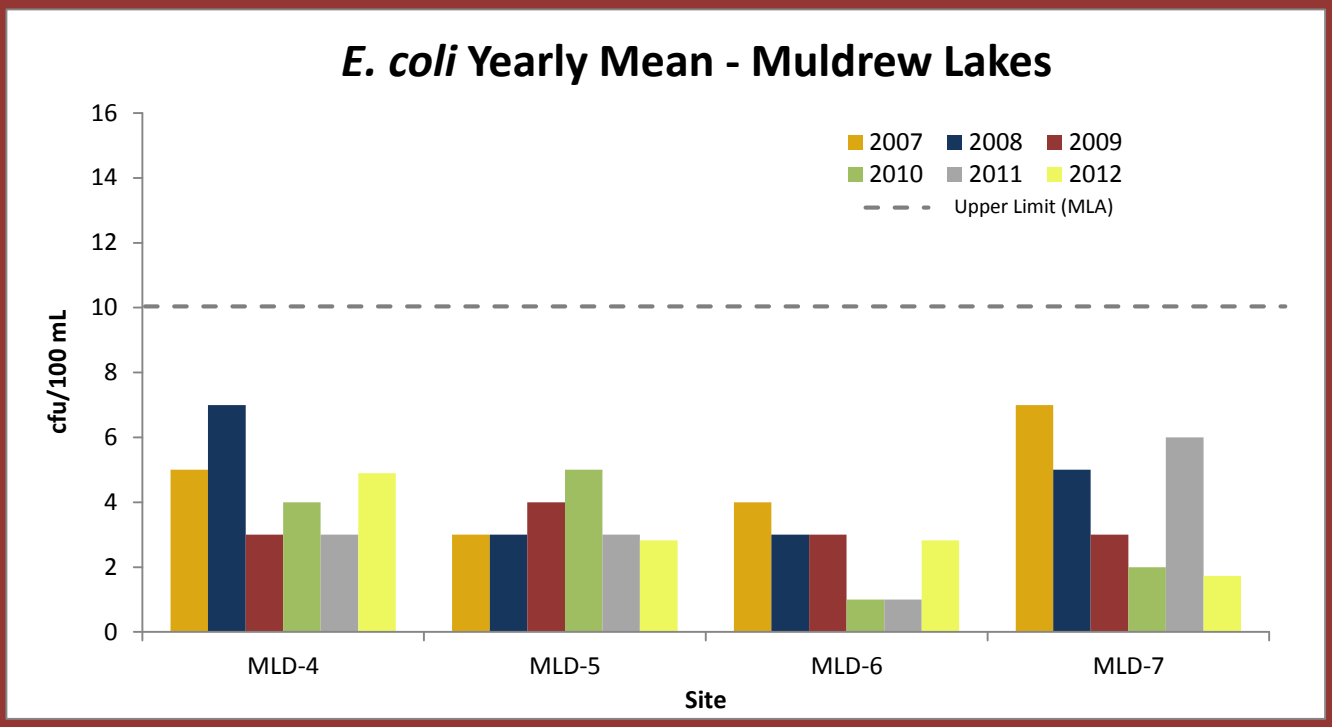
Monitoring of the Muldrew Lakes started in 2006.

E. coli levels were below the MLA upper limit at all sites in 2012.

Recommendations

E. coli levels at all sites have been equal to or below the MLA upper limit for the past 3 years. Sampling at alternative locations should be considered.

(MLD) MULDREW LAKES



Notes:

MUSKOKA RIVER (MRV)

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.

Volunteer Recognition

Muskoka River was monitored in 2012 by Debbie Hastings and **John Wood**.

2012 Data

MRV-2: Calcium = 3.30 mg/L
Secchi = 3.8 m
Total coliforms = 84 cfu/100 mL
Total *E. coli* = 14 cfu/100 mL

MRV-3: Secchi = 4.3 m
Total coliforms = 108 cfu/100 mL
Total *E. coli* = 14 cfu/100 mL

MRV-4: Sechhi = 3.7 m
Total coliforms = 160 cfu/100 mL
Total *E. coli* = 28 cfu/100 mL

MRV-5: TP-Yearly mean = 13.1 µg/L
Total coliforms = 165 cfu/100 mL
Total *E. coli* = 12 cfu/100 mL

MRV-6: TP-Yearly mean = 22.3 µg/L
Total coliforms = 729 cfu/100 mL
Total *E. coli* = 20 cfu/100 mL

Comments

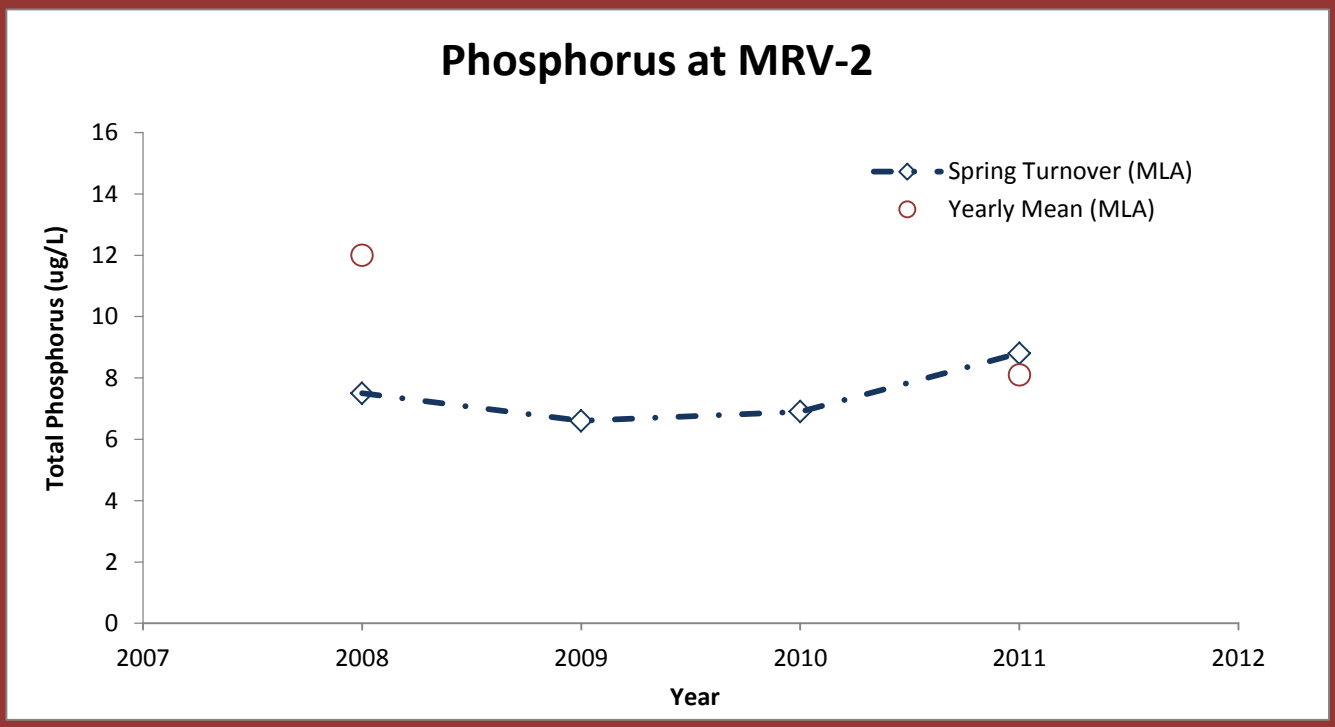
Monitoring of Muskoka River started in 2003.

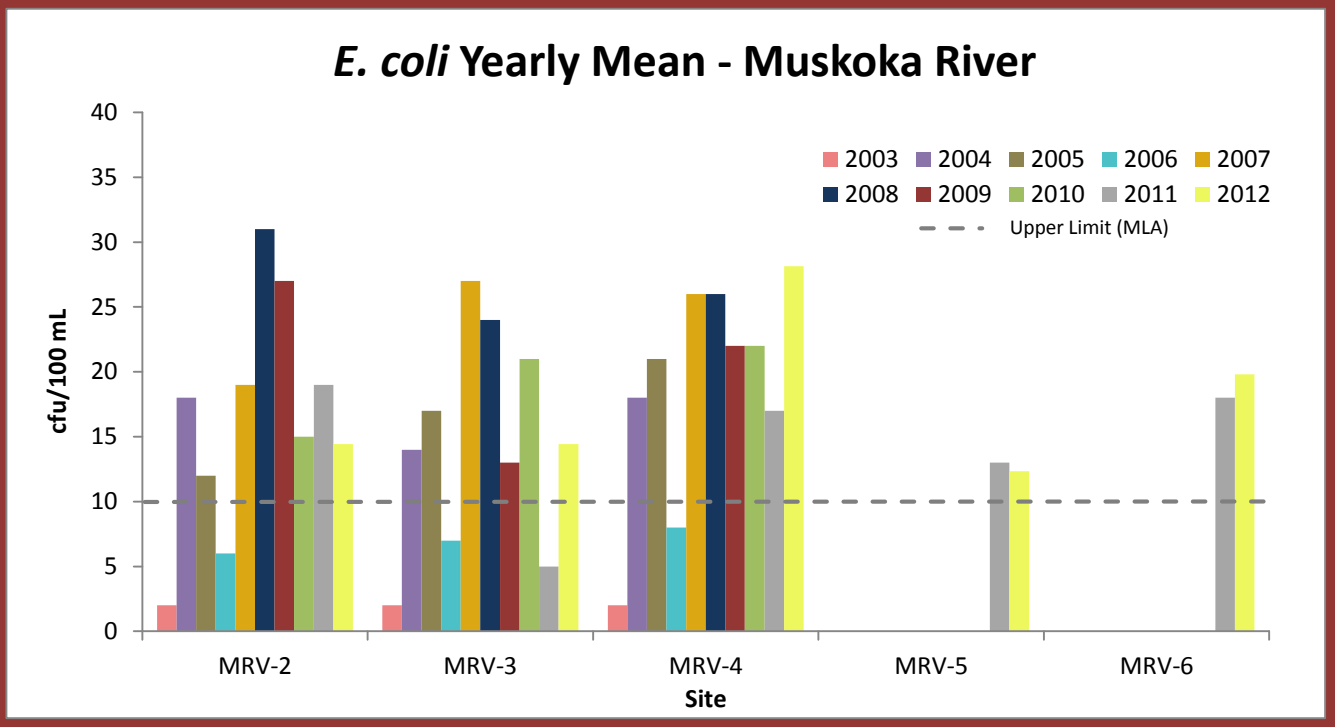
E. coli levels in 2012 were all above the MLA upper limit.

Recommendations

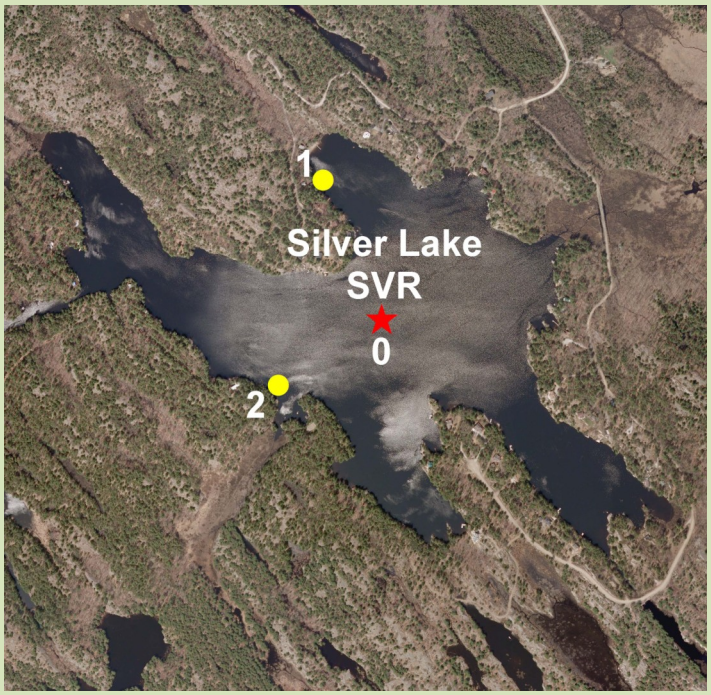
Continue existing sampling protocol to monitor long-term trends.

(MRV) MUSKOKA RIVER





SILVER LAKE—Gravenhurst (SVR)



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 km^2 in size and contains a number of large lacustrine wetlands. Silver Lake is classified as moderately sensitive by the DMM.

Volunteer Recognition

Silver Lake was monitored in 2012 by **Greg Bertrand** and Roger Bertrand.

2012 Data

SVR-0: Calcium = 3.18 mg/L
Secchi = 3.7 m

SVR-1: Total coliforms = 52 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

SVR-2: Total coliforms = 39 cfu/100 mL*
Total *E. coli* = 19 cfu/100 mL*

*Based on 1 sampling event

Comments

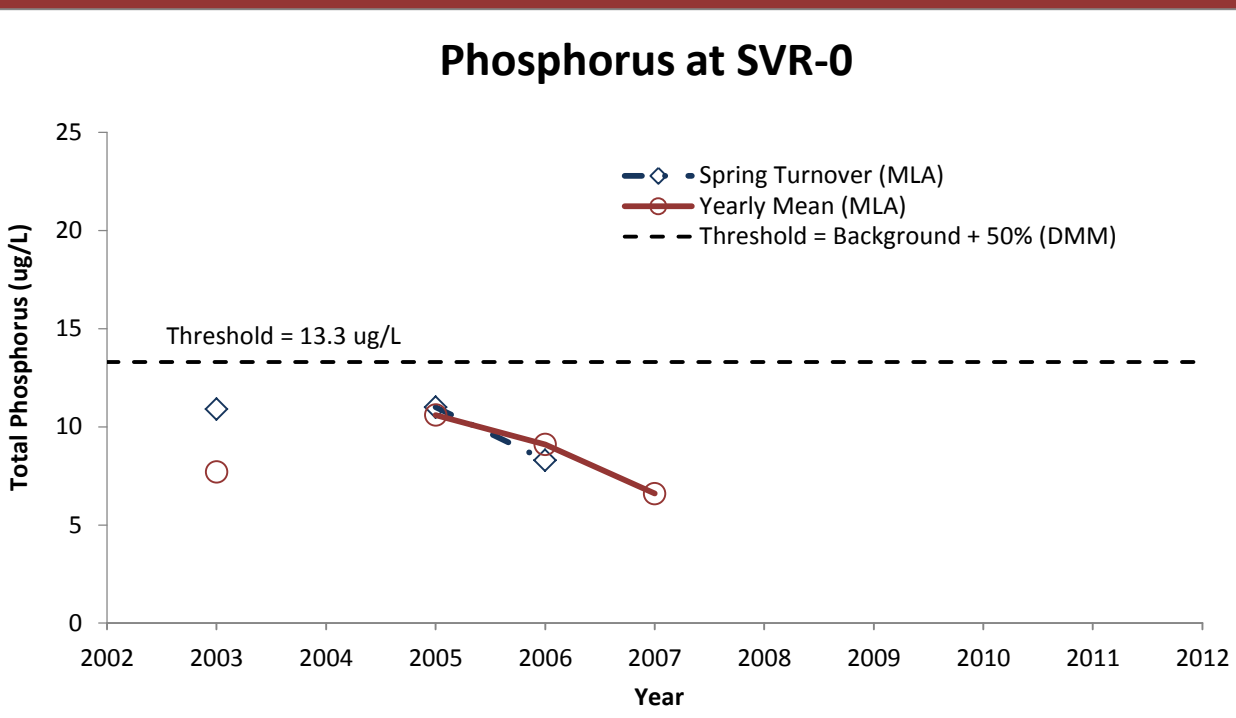
Monitoring of Silver Lake started in 2003

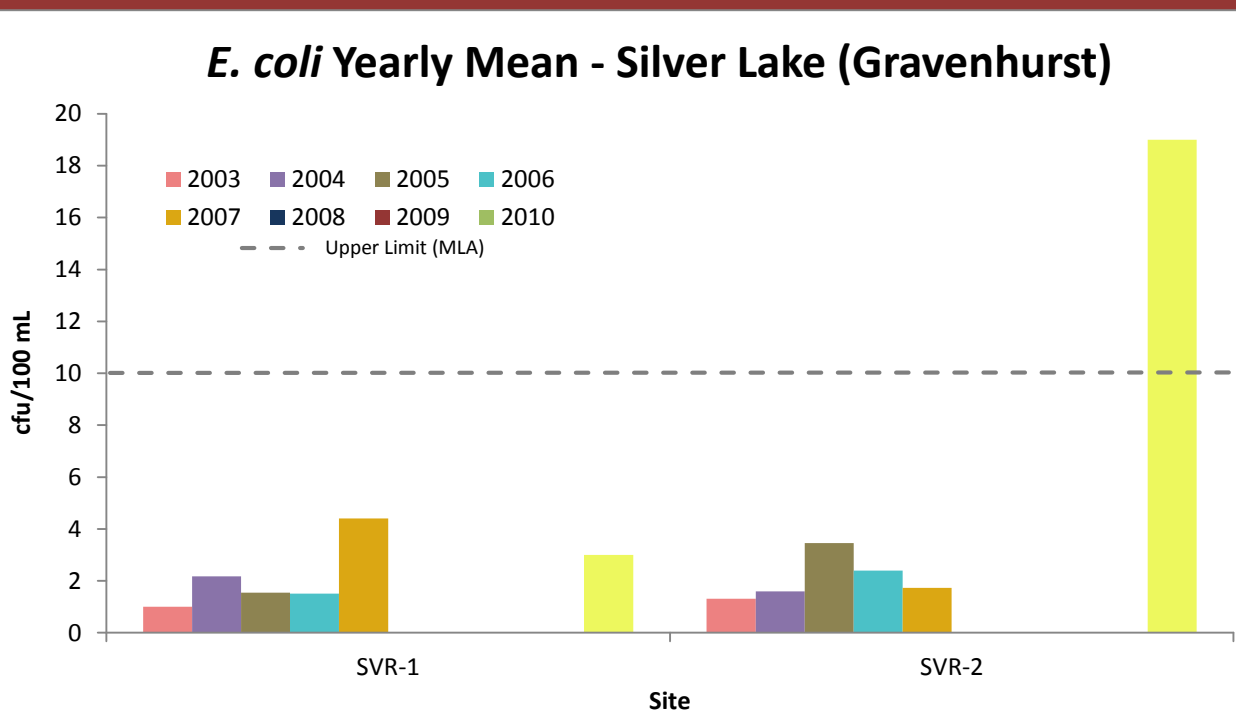
E. coli levels at SVR-1 were below the MLA upper limit while levels at SVR-2 were above the MLA upper limit.

Recommendations

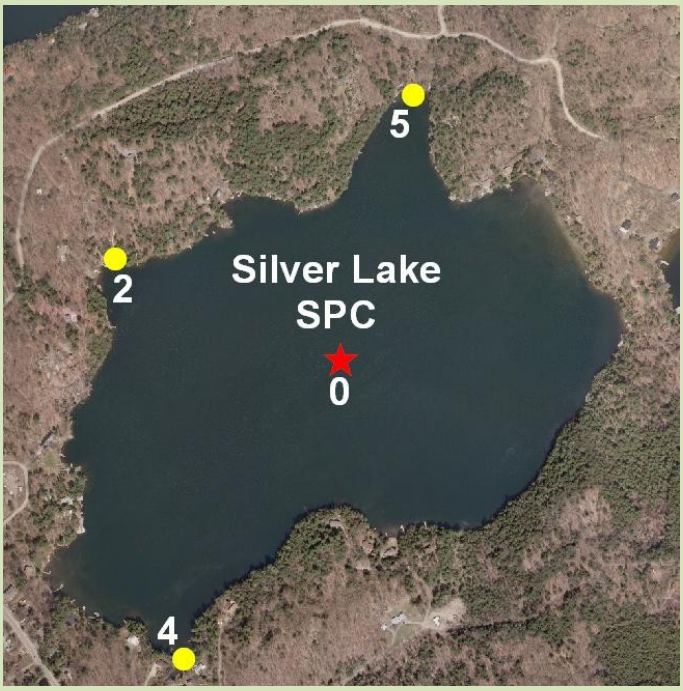
Continue existing sampling protocol to monitor long-term trends.

(SVR) SILVER LAKE—Gravenhurst





SILVER LAKE—TML (SPC)



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.

Volunteer Recognition

Silver Lake was monitored in 2012 by **Perry Bowker** and Jill Ross.

2012 Data

SPC-0: Calcium = 6.41 mg/L
Secchi = 5.2 m

SPC-2: Total coliforms = 9 cfu/100 mL
Total *E. coli* = 2 cfu/100 mL

SPC-4: Total coliforms = 5 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

SPC-5: Total coliforms = 5 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

Comments

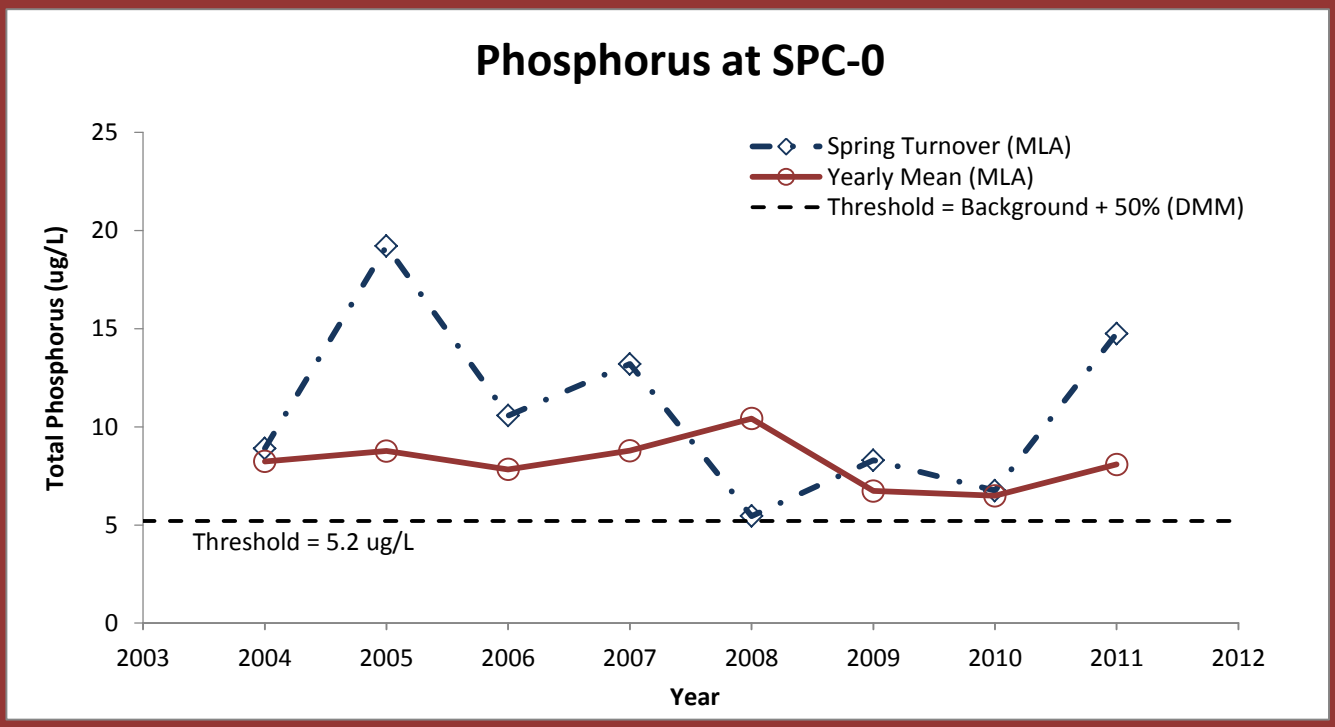
Monitoring of Silver Lake started in 2004.

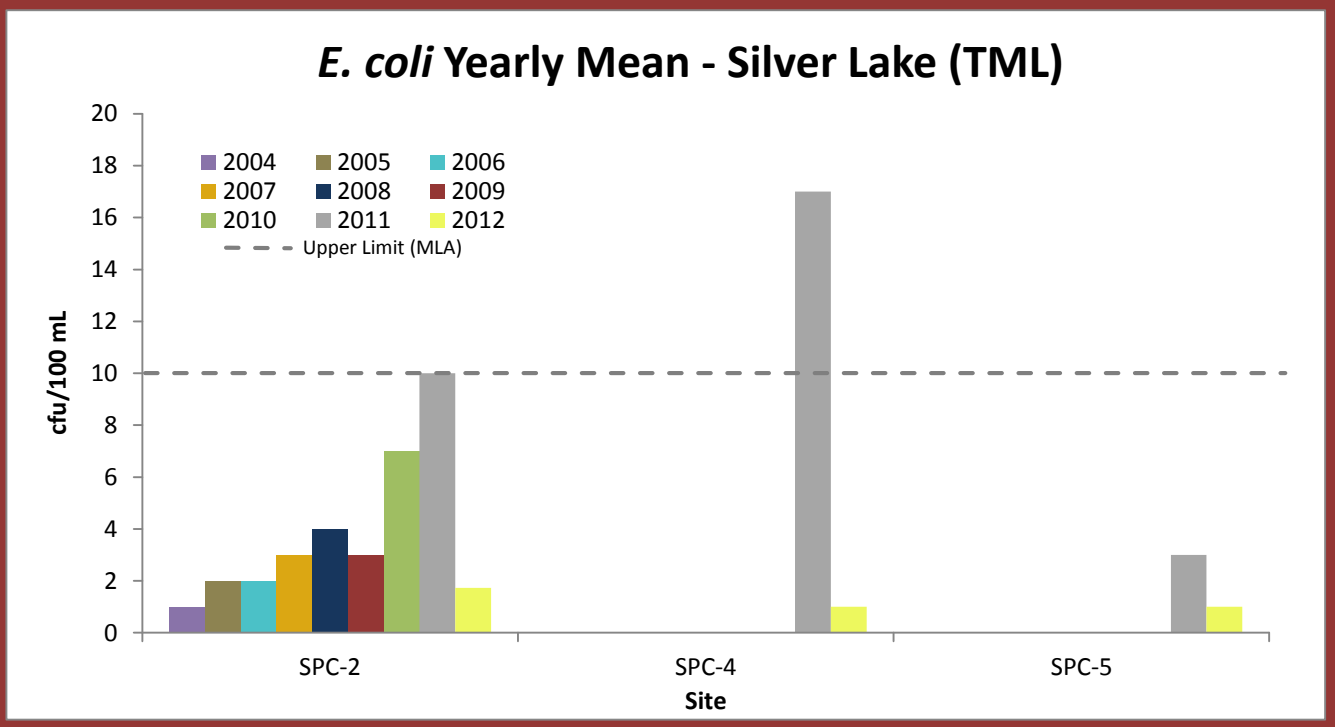
E. coli levels were below the MLA upper limit at all sites in 2012.

Recommendations

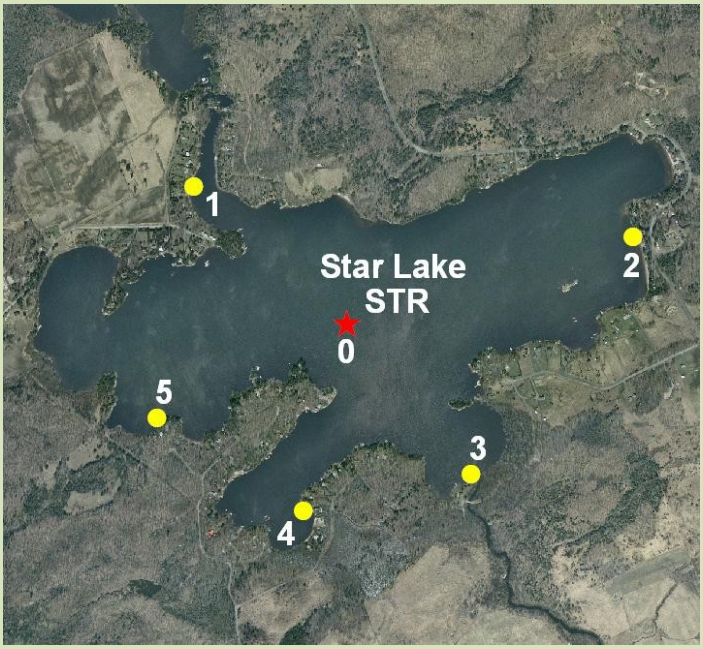
E. coli levels at SPC-2 have been equal to or below the MLA upper limit for the past 3 years. Sampling at an alternative location should be considered.

(SPC) SILVER LAKE—TML





STAR LAKE (STR)



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.

Volunteer Recognition

Star Lake was monitored in 2012 by Esme, Grayson, & Bryce Engleman, **Karen Gillies**, Neil Gillies, and Sara Slater.

2012 Data

STR-0: Calcium = 2.70 mg/L
Secchi = 3.0 m

STR-1: Total coliforms = 139 cfu/100 mL
Total *E. coli* = 1 cfu/100 mL

STR-2: Total coliforms = 49 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

STR-3: Total coliforms = 37 cfu/100 mL
Total *E. coli* = 3 cfu/100 mL

STR-4: Total coliforms = 37 cfu/100 mL
Total *E. coli* = 6 cfu/100 mL

STR-5: Total coliforms = 44 cfu/100 mL
Total *E. coli* = 6 cfu/100 mL

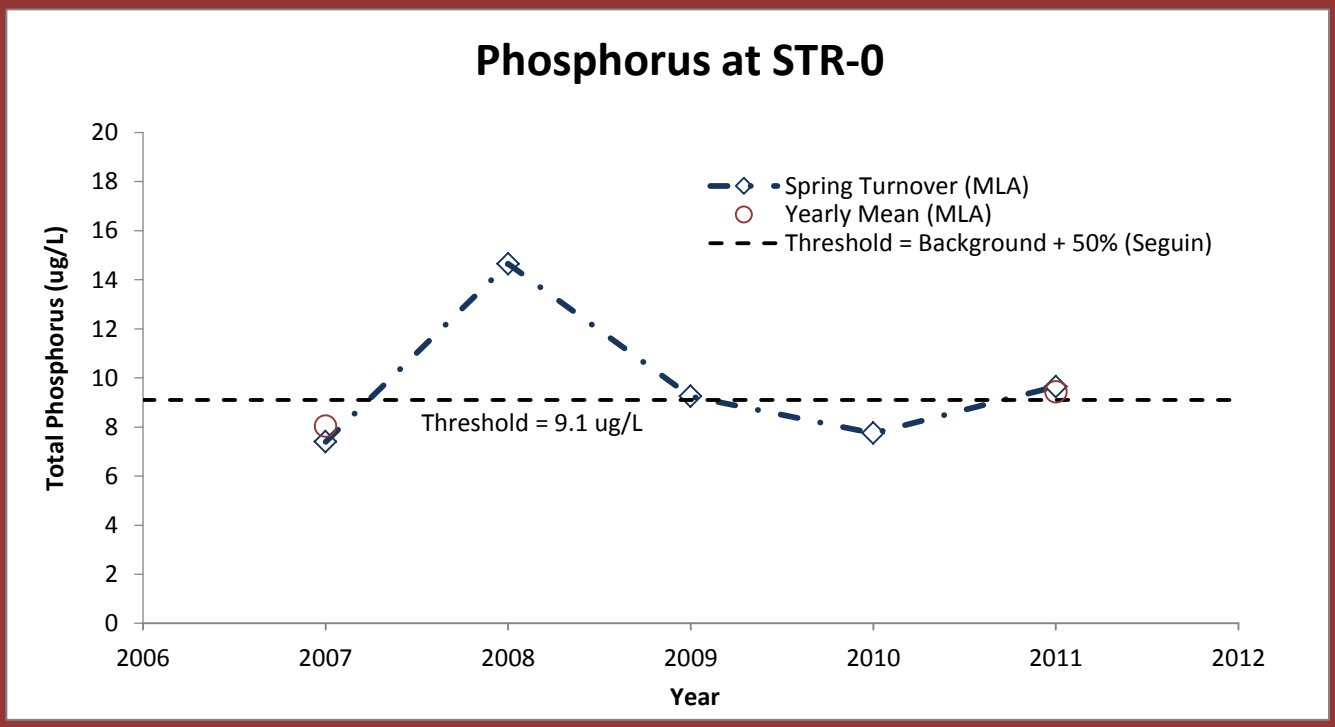
Comments

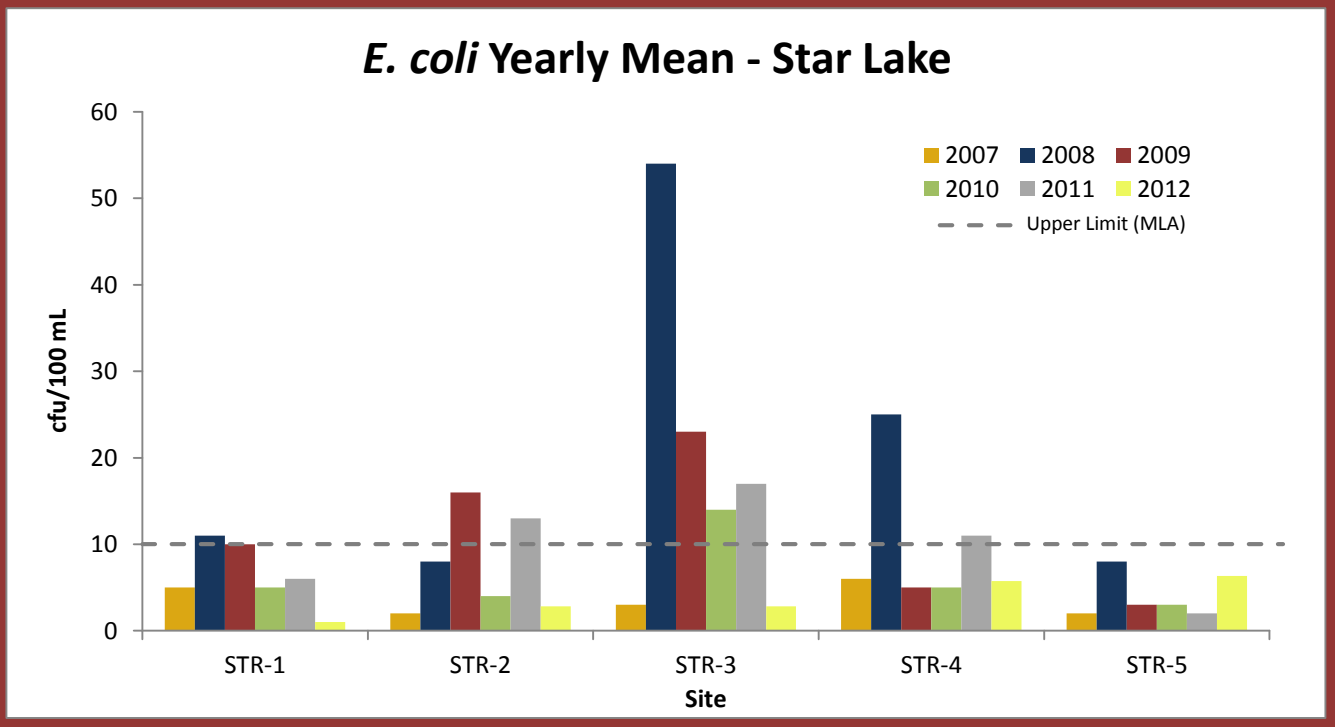
Monitoring of Star Lake started in 2007.

E. coli levels were below the MLA upper limit at all sites in 2012.

Recommendations

E. coli levels at STR-1 and STR-5 have been equal to or below the MLA upper limit for the past 3 years. Sampling at alternative locations should be considered.


Phosphorus at STR-0
Total Phosphorus (ug/L)
20
18
16
14
12
10
8
6
4
2
0
2006
2007
2008
2009
2010
2011
2012
Year
Spring Turnover (MLA)
Yearly Mean (MLA)
Threshold = Background + 50% (Seguin)
Threshold = 9.1 ug/L


E. coli Yearly Mean - Star Lake
cfu/100 mL
60
50
40
30
20
10
0
STR-1
STR-2
STR-3
STR-4
STR-5
Site
2007
2008
2009
2010
2011
2012
Upper Limit (MLA)

Appendix 1. 2012 Stewardship Recommendation Letters for Cox Bay, Hamer Bay, Indian River, Muskoka Bay, and Windermere

RIVERSTONE
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RIVERSTONE
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April 25, 2012
RS#2009-06

Mr. Mike Logan
Muskoka Lakes Association
65 Joseph St. 2nd Floor
Box 298, Port Carling, ON
P0B 1J0

***SUBJECT*: Water Quality Initiative — Focus Area — Cox Bay**

Dear Mike:

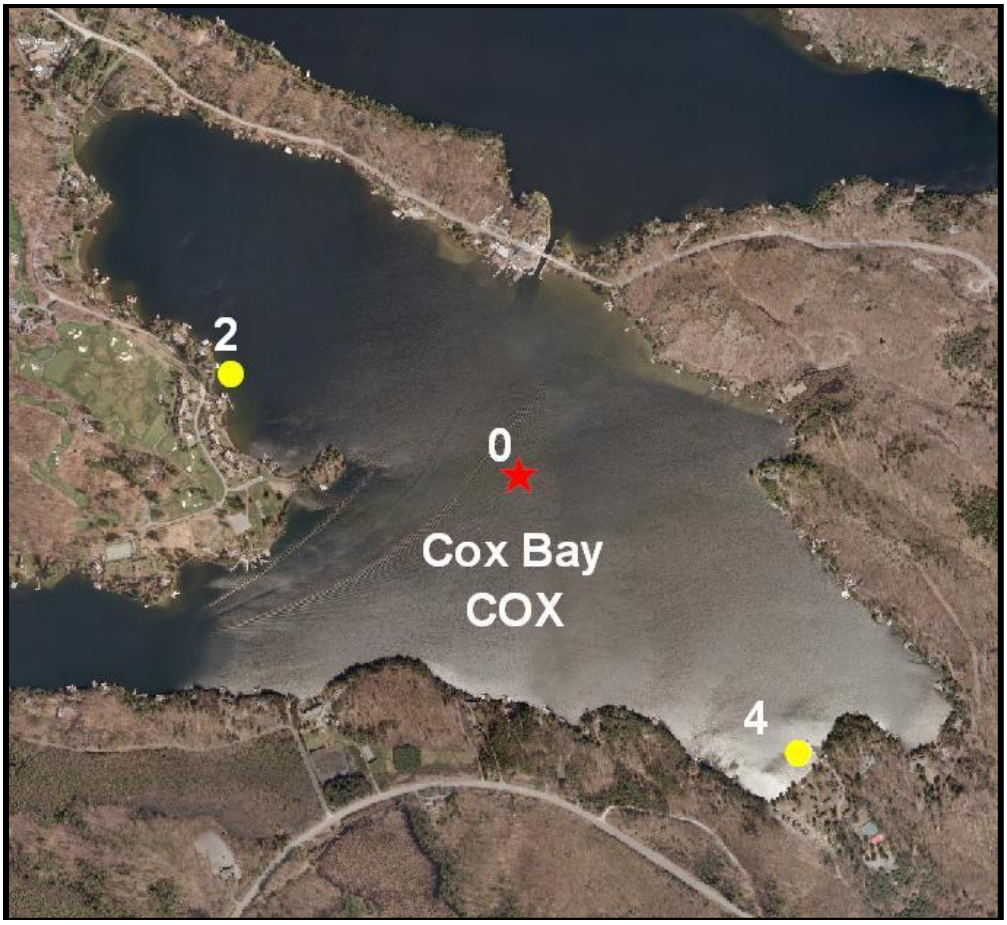
Having completed over a decade of water quality monitoring in numerous lakes, the Muskoka Lakes Association (MLA) is in a position to identify trends in water quality conditions. While the monitoring program is a key part of the MLA objectives, the engagement of local community groups in activities that will maintain and improve the quality of water is also key. With this goal in mind, the MLA retained RiverStone Environmental Solutions Inc. (hereafter RiverStone) to identify areas that could benefit from the development of stewardship initiatives (2011 Water Quality Report); these water bodies have been designated Focus Areas (FA). The stewardship initiatives in FAs would be community based, with some level of support provided by the MLA.

Based on a comprehensive review of all available data, Cox Bay was identified as a FA several years ago. A Community Stewardship Group has been established in Cox Bay and this group has completed a number of additional studies over the past two years. The results of these studies have been reviewed by RiverStone and previous recommendations have been prepared for this area. The following material is relates to the past community based studies, community actions that have been undertaken already, and is prepared specifically so that the Community Group can continue with its Stewardship Initiative. The material includes 1) descriptions of land uses, types of development, and ecological conditions of the drainage basin associated with the FA; 2) an overview of the data considered in the evaluation of the FA designation; and 3) a list of recommendations for community based stewardship initiatives within the watershed that aim to improve the water quality within the FA.

AREA OVERVIEW

Cox Bay is located in the southern portion of Lake Joseph. The drainage area of Cox Bay is 4.2 km^2 in size and contains ten permanent watercourses (**Photograph 1**). Only a small portion of the drainage area (4%) is comprised of wetlands (Lake Data Sheet, DMM 2011). Wetlands can complicate our understanding of how phosphorous moves from terrestrial systems into aquatic systems as they act as a sort of sponge, absorbing phosphorous. The absorptive properties of wetlands are only temporary, as increased concentrations of phosphorous are routinely flushed from the wetlands as part of natural nutrient cycling. Flushing can lead to water with elevated concentrations of phosphorous entering watercourses, resulting in downstream impacts. A large resort, golf course and marina are located adjacent to the lake, and there is a constriction into Lake Rosseau at Port Sandfield. Most of the shoreline area is developed, but many residents have maintained some forest cover on their properties. Approximately 50 % of the drainage area of Cox Bay consists of Commercial and Resort uses, 20 % containing cottages and residences and the remaining 30% is comprised of natural areas (interpreted from DMM Shoreline Land Use Map). Shoreline development of Cox Bay is approximately 15 % commercial/resort, 83 % private cottages and residences, and 2 % road. The Port Carling / Lake Joseph Water Aerodrome is located in Cox Bay. The diversity and nature of land uses within the drainage area, the presence of

wetlands, and the natural shape of the drainage basin result in a complex system in terms of nutrient inputs and the potential impacts on Cox Bay.



Photograph 1. Overview of Cox Bay, Lake Joseph and the MLA sampling sites.

WATER QUALITY DATA REVIEW

As part of our consideration of potential water quality issues associated with Cox Bay, RiverStone reviewed available information from the Lake System Heath (LSH) modelling completed by Gartner Lee (2005), the MLA Water Quality Monitoring data collected from 2002–2011, and the District of Municipality of Muskoka (DMM) water quality sampling data. In 2007, a group of Cox Bay residents started a directed study of the streams discharging to Cox Bay. Water samples were collected from a number of these watercourses in 2007/2008. In 2009/2010, the Cox Bay group targeted a smaller group of stream sites for phosphorus sampling and analysis with the goal of identifying streams that are major contributors to the phosphorus load entering Cox Bay.

The LSH model evaluated the sensitivity of various waterbodies based on their responsiveness to phosphorus inputs and the degree of phosphorus mobility in their respective watersheds. In this case, the responsiveness of the water body is a measure of the change in phosphorus levels in the waterbody after the input of a known amount of nutrient. Finally, LSH measured the amount of phosphorus from human development that would reach the waterbody (Mobility). Cox Bay was modelled as a separate water body from Lake Joseph in the LSH exercise and was found to have a threshold phosphorous level of 3.9 µg/L, a background + 50 % value of 2.6 µg/L and was identified as being "Moderately" sensitive. Monitoring data collected by the DMM indicate that Cox Bay is Over Threshold based on LSH criteria.

MLA and DMM water quality monitoring data indicates that the Total Phosphorous (TP) concentrations in Cox Bay have consistently measured above the LSH threshold over the last 10-years. Based on our review of the MLA's nearshore phosphorus dataset (2010 Water Quality Report), land-based influences on nearshore phosphorus were not detected at COX-1, COX-3, or COX-4. COX-2 is located at the outlet of a stream that drains a large portion of the Lake Joseph Golf Club property and TP measurements have been consistently high. Spring turnover TP measurements at the deep-water reference site (COX-0) have been trending upward over 2009-2011. Since 2003, both the MLA spring turnover and yearly mean phosphorus concentrations in Cox Bay have fluctuated above the LSH threshold value for the bay.

COMMUNITY BASED STEWARDSHIP INITIATIVES

Given that the large data set available for Cox Bay suggests that the bay is consistently over threshold and phosphorus concentrations have been on the rise over the past 3 years, RiverStone recommends the following actions in this Focus Area:

1. **The MLA and Community members should combine efforts to address water quality issues in Cox Bay.**
2. **Community members should maintain their working relationship with ClubLink, the owners and operators of Lake Joseph Golf Club, to discuss ways to improve the water quality in Cox Bay.**
3. **Community members could continue their stream monitoring program, with cooperation from ClubLink, for the stream entering Cox Bay located in the vicinity of 1107 Elgin House Road starting in early spring 2013 through to late fall 2013. The program should include both stream flow and phosphorus concentration measurements.**
4. **The Cox Bay community could publish a Home/Cottage Owner's manual specific for Cox Bay residents and landowners to provide practical ways to manage their home and property in an environmentally sensitive manner and minimize their impacts on the water quality in Cox Bay.**
5. **Continue gathering deep-water phosphorous concentration measurements to monitor ongoing water quality conditions in Cox Bay and to track trends over time in response to stewardship efforts by residents and ClubLink.**

We trust that these recommendations will prove to be useful in working with local stakeholders and stewardship groups. Please contact us if there are any questions.

Best regards,

Bev Wicks, Ph.D.
Senior Aquatic Ecologist

RIVERSTONE
ENVIRONMENTAL SOLUTIONS INC.

April 25, 2012
RS#2009-06

Mr. Mike Logan
Muskoka Lakes Association
65 Joseph St. 2nd Floor
Box 298, Port Carling, ON
P0B 1J0

***SUBJECT*: Water Quality Initiative — Focus Area — Hamer Bay**

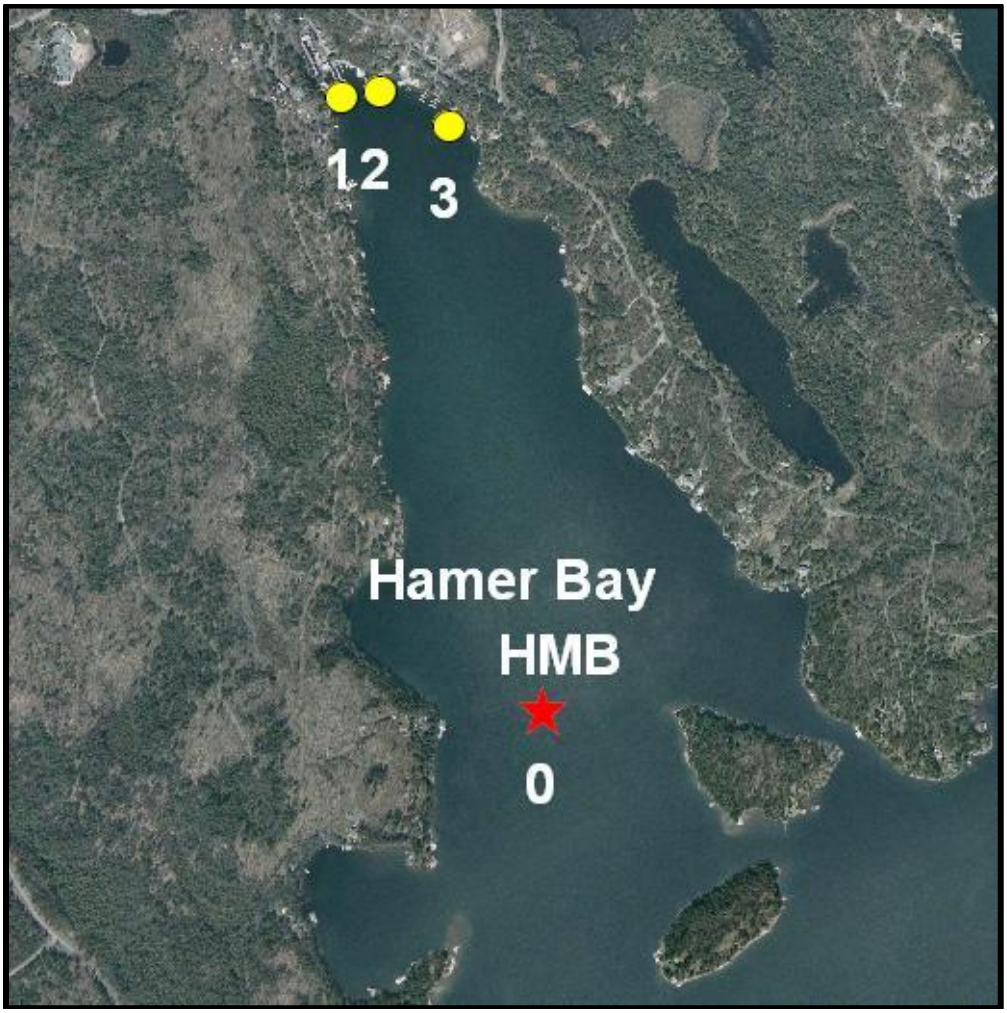
Dear Mike:

Having completed over a decade of water quality monitoring in numerous lakes, the Muskoka Lakes Association (MLA) is in a position to identify trends in water quality conditions. While the monitoring program is a key part of the MLA objectives, the engagement of local community groups in activities that will maintain and improve the quality of water is also key. With this goal in mind, the MLA retained RiverStone Environmental Solutions Inc. (hereafter RiverStone) to identify areas that could benefit from the development of stewardship initiatives (2011 Water Quality Report); these water bodies have been designated Focus Areas (FA). The stewardship initiatives in FAs would be community based, with some level of support provided by the MLA.

Based on a comprehensive review of all available data, RiverStone has identified Hamer Bay as a FA. The following material has been prepared specifically for Hamer Bay and provides 1) descriptions of land uses, types of development, and ecological conditions of the drainage basin associated with the FA; 2) an overview of the data considered in the evaluation of the FA designation; and 3) a list of recommendations for community based stewardship initiatives within the watershed that aim to improve the water quality within the FA.

AREA OVERVIEW

Hamer Bay is located in the northwestern portion of Lake Joseph. Bedrock formations in the area have resulted in a long, narrow, funnel shaped drainage basin for Hamer Bay defined by steep slopes along the most of the shoreline (**Photograph 1**). The total drainage area of Hamer Bay is approximately 3.8 km^2; approximately 5 % of this area is comprised of wetlands (Lake Data Sheet, DMM 2011). Wetlands can complicate our understanding of how phosphorous moves from terrestrial systems into aquatic systems as they act as a sort of sponge, absorbing phosphorous. The absorptive properties of wetlands are only temporary, as increased concentrations of phosphorous are routinely flushed from the wetlands as part of natural nutrient cycling. Flushing can lead to water with elevated concentrations of phosphorous entering watercourses, resulting in downstream impacts. Approximately 80 % of the drainage area of Hamer Bay consists of Commercial or Resort land uses with the remaining 20 % containing cottages and residences (interpreted from DMM Shoreline Land Use Map). In contrast, the shoreline development of Hamer Bay is approximately 10 % commercial, 85 % private cottages and residences, and 5 % undeveloped. The diversity and nature of land uses within the drainage area, the presence of wetlands, and the natural shape of the drainage basin result in a complex system in terms of nutrient inputs and the potential impacts on Hamer Bay.



Photograph 1. Overview of Hamer Bay, Lake Joseph and the MLA sampling locations.

WATER QUALITY DATA REVIEW

As part of our consideration of potential water quality issues associated with Hamer Bay, RiverStone reviewed available information from the Lake System Heath (LSH) modelling completed by Gartner Lee (2005), the MLA Water Quality Monitoring data collected from 2002–2011 and the District of Municipality of Muskoka (DMM) water quality sampling data. In 1999, Clublink redeveloped a golf course on the Rocky Crest property, which comprises the majority of the northern portion of the Hamer Bay drainage basin; golf course operations began in 2001. Considerable water quality data have been gathered by Clublink as part of their Ministry of the Environment Certificate of Approval. Additional monitoring data have been collected by the Lake Joseph North Association (LJNA) to monitor water quality and the potential impacts of surrounding land use activities on water quality in Hamer Bay.

The LSH modelling evaluated of the sensitivity of various waterbodies based on their responsiveness to phosphorus inputs and the degree of phosphorus mobility in their respective watersheds. In this case, the responsiveness of the water body is a measure of the change in phosphorus levels in the waterbody after the input of a known amount of nutrient. Finally, LSH measured the amount of phosphorus from human development that would reach the waterbody (Mobility). Hamer Bay was not modelled as a separate water body from Lake Joseph in the LSH exercise. Therefore, the threshold phosphorous level of 3.5 µg/L, and the "High" sensitivity designation is not specific to Hamer Bay, but is representative of the larger Lake Joseph waterbody.

Note that while the DMM has modelled Lake Joseph and monitors Hamer Bay, Hamer Bay and parts of the lake are located in the Township of Seguin.

MLA water quality monitoring data indicates that the Total Phosphorous (TP) concentrations in Hamer Bay have consistently measured above the LSH threshold for Lake Joseph Main Basin during the monitoring program. Based on our review of the MLA's nearshore phosphorus dataset (2010 Water Quality Report), there are potential land-based influences on nearshore phosphorus at HMB-1. This sampling site is located at the outlet of the stream that drains a large portion of the Hamer Bay drainage area. Spring turnover phosphorus measurements at HMB-0 have been trending upward over 2009-2011. Since 2003, both the MLA spring turnover and yearly mean phosphorus concentrations in Hamer Bay have fluctuated above the LSH threshold value for the main basin of Lake Joseph. Independent data collected by the DMM, Clublink, and LJNA also indicate that TP concentrations in Hamer Bay consistently exceed the LSH threshold level.

COMMUNITY BASED STEWARDSHIP INITIATIVES

Given that the large data set available for Hamer Bay suggests that the bay is potentially responding differently than the main basin of Lake Joseph and phosphorus concentrations in the bay are consistently higher than in the main lake, RiverStone recommends the following actions in this Focus Area:

1. **The MLA and the Community Members should combine efforts to address water quality issues in Hamer Bay.**
2. **Community Members should develop a working relationship with ClubLink, the owners and operators of Rocky Crest Golf Course, to discuss ways to improve the water quality in Hamer Bay.**
3. **Community Members could develop a monitoring program, with cooperation from ClubLink, for the main stream entering Hamer Bay starting in early spring 2013 through to late fall 2013. The program needs to include both stream flow and phosphorus concentration.**
4. **The Hamer Bay community could publish a Home/Cottage Owner's manual specific for Hamer Bay residents and landowners to provide practical ways to manage their home and property in an environmentally sensitive manner and minimize their impacts on the water quality in Hamer Bay.**
5. **Continue gathering deep-water phosphorous concentrations samples to monitor ongoing water quality conditions in Hamer Bay and to track trends over time in response to stewardship efforts by residents and Clublink.**

We trust that these recommendations will prove to be useful in working with local stakeholders and stewardship group. Please contact us if there are any questions.

Best regards,

Bev Wicks, Ph.D.
Senior Aquatic Ecologist

RIVERSTONE
ENVIRONMENTAL SOLUTIONS INC.

April 25, 2012
RS#2009-06

Mr. Mike Logan
Muskoka Lakes Association
65 Joseph St. 2nd Floor
Box 298, Port Carling, ON
P0B 1J0

***SUBJECT*: Water Quality Initiative — Focus Area — Indian River**

Dear Mike:

Having completed over a decade of water quality monitoring in numerous lakes, the Muskoka Lakes Association (MLA) is in a position to identify trends in water quality conditions. While the monitoring program is a key part of the MLA objectives, the engagement of local community groups in activities that will maintain and improve the quality of water is also key. With this goal in mind, the MLA retained RiverStone Environmental Solutions Inc. (hereafter RiverStone) to identify areas that could benefit from the development of stewardship initiatives (2011 Water Quality Report); these water bodies have been designated Focus Areas (FA). The stewardship initiatives in FAs would be community based, with some level of support provided by the MLA.

Based on a comprehensive review of all available data, RiverStone has identified the Indian River as a FA. The following material has been prepared specifically for the Indian River and provides 1) descriptions of land uses, types of development, and ecological conditions of the drainage basin associated with the FA; 2) an overview of the data considered in the evaluation of the FA designation; and 3) a list of recommendations for community based stewardship initiatives within the watershed that aim to improve the water quality within the FA.

AREA OVERVIEW

The Indian River is located between Lake Rosseau and Lake Muskoka with the town of Port Carling being located in the central portion of the river. The drainage area of the Indian River is approximately 3.0 km^2 in size and includes Mirror Lake (**Photograph 1**). In 1997, the northern portion of the Indian River contained approximately 1.5 km^2 of urbanized area with 118 developed lots within 300 m of the shoreline (Gartner Lee 2005). In contrast, the southern portion of the Indian River (south of Mirror Lake) contained no urbanized area and as of 1997, only 34 developed lots (Gartner Lee 2005).

Photograph 1. Overview of the Indian River and the MLA sampling sites.

WATER QUALITY DATA REVIEW

As part of our consideration of potential water quality issues associated with the Indian River, RiverStone reviewed available information from the Lake System Heath (LSH) modelling completed by Gartner Lee (2005) and the MLA Water Quality Monitoring data collected from 2002–2011.

Water quality monitoring data indicates that the yearly mean *E. coli* levels in the Indian River are consistently exceeding the MLA Upper Limit of 10 cfu/100 mL. The highest *E. coli* values are often measured at IND-2 in the heart of Port Carling, and further downstream at IND-3 and IND-4.

COMMUNITY BASED STEWARDSHIP INITIATIVES

Given the data set available for the Indian River indicates that *E. coli* levels routinely exceed the MLA upper limit value and the degree to which activities in the Port Carling area can influence the water quality in the river, RiverStone recommends the following actions in this Focus Area:

1. **The MLA should facilitate the formation of a Community Stewardship Group to address the issue of elevated *E. coli* in the Indian River.**
2. **Community members should focus on the development of a community awareness and education program that could include:**

   a. **a public pet waste bag program for all municipal parks and appropriate signage to encourage pet owners to pick up after their animals;**
   b. **a Citizen Home/Cottage Owner's manual specific to Port Carling, which provides practical ways to manage their home and property in an environmentally sensitive manner and minimize their impacts on the water quality in the Indian River;**
   c. **collaborating with Trout Unlimited Canada to implement the Yellow Fish Road™ initiative in the Port Carling area. The program is a nation-wide environmental education program focused on helping residents understand that storm drains flow directly into the local waterbodies and therefore what goes into the drains can impact water quality.**

3. **Continue gathering *E. coli* samples to monitor ongoing water quality conditions in the Indian River and to track trends over time in response to stewardship efforts by community members.**

We trust that these recommendations will prove to be useful in working with local stakeholders and stewardship groups. Please contact us if there are any questions.

Best regards,

Bev Wicks, Ph.D.
Senior Aquatic Ecologist

RIVERSTONE
ENVIRONMENTAL SOLUTIONS INC.

April 25, 2012
RS#2009-06

Mr. Mike Logan
Muskoka Lakes Association
65 Joseph St. 2nd Floor
Box 298, Port Carling, ON
P0B 1J0

***SUBJECT*: Water Quality Initiative — Focus Area — Muskoka Bay**

Dear Mike:

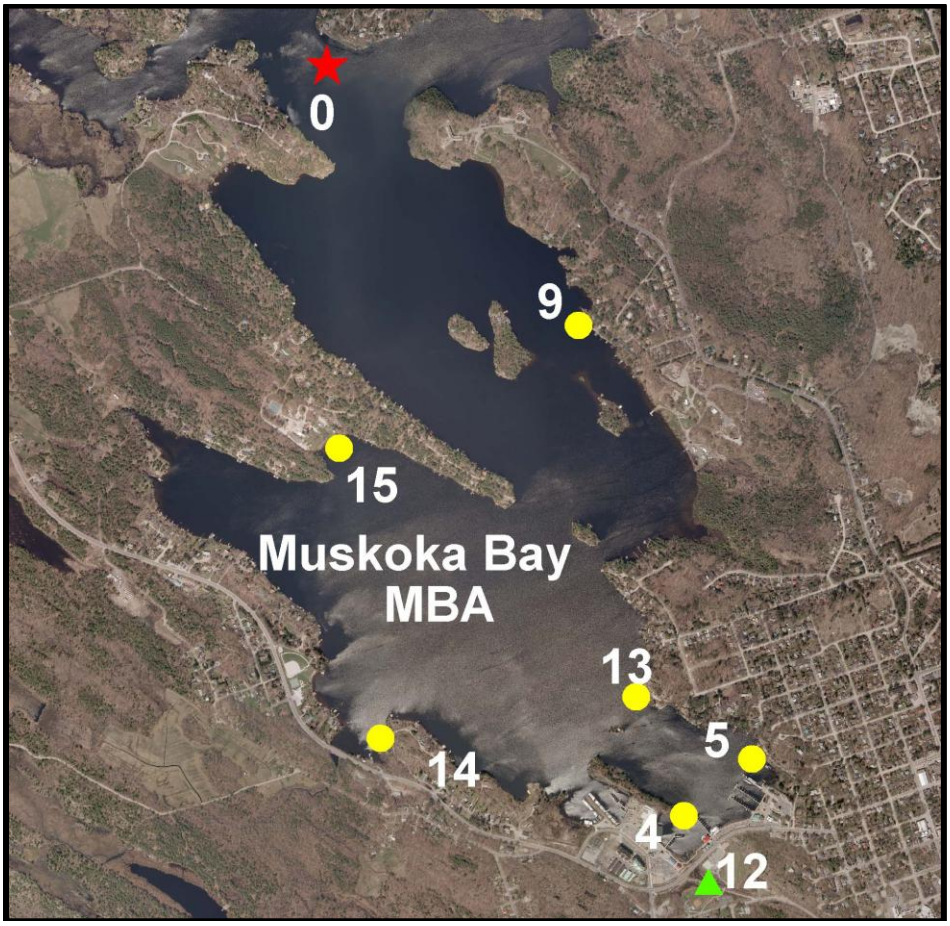
Having completed over a decade of water quality monitoring in numerous lakes, the Muskoka Lakes Association (MLA) is in a position to identify trends in water quality conditions. While the monitoring program is a key part of the MLA objectives, the engagement of local community groups in activities that will maintain and improve the quality of water is also key. With this goal in mind, the MLA retained RiverStone Environmental Solutions Inc. (hereafter RiverStone) to identify areas that could benefit from the development of stewardship initiatives (2011 Water Quality Report); these water bodies have been designated Focus Areas (FA). The stewardship initiatives in FAs would be community based, with some level of support provided by the MLA.

Based on a comprehensive review of all available data, RiverStone has identified Muskoka Bay as a FA. The following material has been prepared specifically for Muskoka Bay and provides 1) descriptions of land uses, types of development, and ecological conditions of the drainage basin associated with the FA; 2) an overview of the data considered in the evaluation of the FA designation; and 3) a list of recommendations for community based stewardship initiatives within the watershed that aim to improve the water quality within the FA.

AREA OVERVIEW

Muskoka Bay is located in the southern portion of Lake Muskoka. The drainage area of Muskoka Bay is 20.4 km^2 in size and contains ten permanent watercourses (**Photograph 1**). The flow patterns of Muskoka Bay are relatively complex as the north end of the bay flushes more frequently than the Gravenhurst Bay end due to the locations of the watercourses. Approximately 9 % of the drainage area is comprised of wetlands (Lake Data Sheet, DMM 2011). Wetlands can complicate our understanding of how phosphorous moves from terrestrial systems into aquatic systems as they act as a sort of sponge, absorbing phosphorous. The absorptive properties of wetlands are only temporary, as increased concentrations of phosphorous are routinely flushed from the wetlands as part of natural nutrient cycling.

Approximately 60 % of the Muskoka Bay shoreline falls within the Town of Gravenhurst city limits. The majority of the shoreline area is developed; however, many residents have maintained forest cover on their properties. Approximately 20 % of the drainage area of Muskoka Bay consists of Commercial and Resort uses, 50 % contains cottages and urban residences and the remaining 30% is comprised of natural areas (interpreted from DMM Shoreline Land Use Map). The shoreline of Muskoka Bay is approximately 10 % commercial/resort, 80 % private cottages and residences, 9 % natural and 1 % road. The high degree of urban influence and the narrow connection to the remainder of Lake Muskoka result in a complex system in terms of nutrient inputs and the potential impacts on Muskoka Bay.



Photograph 1. Overview of Muskoka Bay, Lake Muskoka and the MLA sampling sites.

WATER QUALITY DATA REVIEW

As part of our consideration of potential water quality issues associated with Muskoka Bay, RiverStone reviewed available information from the Lake System Heath (LSH) modelling completed by Gartner Lee (2005), the MLA Water Quality Monitoring data collected from 2002–2011, and the District of Municipality of Muskoka (DMM) water quality sampling data.

The LSH modelling evaluated the sensitivity of various waterbodies based on their responsiveness to phosphorus inputs and the degree of phosphorus mobility in their respective watersheds. In this case, the responsiveness of the water body is a measure of the change in phosphorus levels in the waterbody after the input of a known amount of nutrient. Finally, LSH measured the amount of phosphorus from human development that would reach the waterbody (Mobility). Muskoka Bay was modelled as a separate water body from Lake Muskoka in the LSH exercise and was found to have a threshold phosphorous level of 14.9 µg/L, and a background + 50 % value of 10.25 µg/L. Muskoka Bay was identified as being "Moderately" sensitive and Over Threshold.

MLA and DMM water quality monitoring data indicates that the Total Phosphorous (TP) concentrations in Muskoka Bay have fluctuated above and below the LSH threshold value over the last 10-years. *E. coli* samples collected in urban watercourses and at outfalls of watercourses have shown elevated levels over the past several years of sampling. No other long-term trends can be extracted from the MLA data at this time; however, it is noted that the water quality in Muskoka Bay has been improving since the 1970's when the Town's sewage treatment outflow was relocated.

COMMUNITY BASED STEWARDSHIP INITIATIVES

Given the data set available for Muskoka Bay indicates that phosphorous levels routinely fluctuate around the threshold value, *E. coli* levels are elevated, and the degree to which activities in the Town of Gravenhurst can influence the water quality in the bay, RiverStone recommends the following actions in this Focus Area:

1. **The MLA and Community members should combine efforts to address water quality issues in Muskoka Bay.**
2. **Community members should develop a working relationship with Town Council to discuss concerns with respect to water quality in Muskoka Bay.**
3. **Community members could collaborate with the Town of Gravenhurst to prepare two Homeowner's manuals specific to Muskoka Bay. These manuals could be directed at both waterfront and urban homeowners.**
4. **Community members could collaborate with Trout Unlimited Canada to implement the Yellow Fish Road™ initiative in the Town of Gravenhurst. The program is a nation-wide environmental education program focused on helping residents understand that storm drains flow directly into the local waterbodies and therefore what goes into the drains can impact water quality.**
5. **Community members could collaborate with the Town of Gravenhurst to implement a "pet/animal feces management program". Possible options include poop and scoop signs in parks and trails, kiosks with pet baggies, waterfowl management in parks etc.**
6. **Continue gathering deep-water phosphorous concentrations samples to monitor ongoing water quality conditions in Muskoka Bay and to track trends over time in response to stewardship efforts by community members.**

We trust that these recommendations will prove to be useful in working with local stakeholders and stewardship groups. Please contact us if there are any questions.

Best regards,

Bev Wicks, Ph.D.
Senior Aquatic Ecologist

RIVERSTONE
ENVIRONMENTAL SOLUTIONS INC.

April 25, 2012
RS#2009-06

Mr. Mike Logan
Muskoka Lakes Association
65 Joseph St. 2nd Floor
Box 298, Port Carling, ON
P0B 1J0

***SUBJECT*: Water Quality Initiative — Focus Area — Windermere**

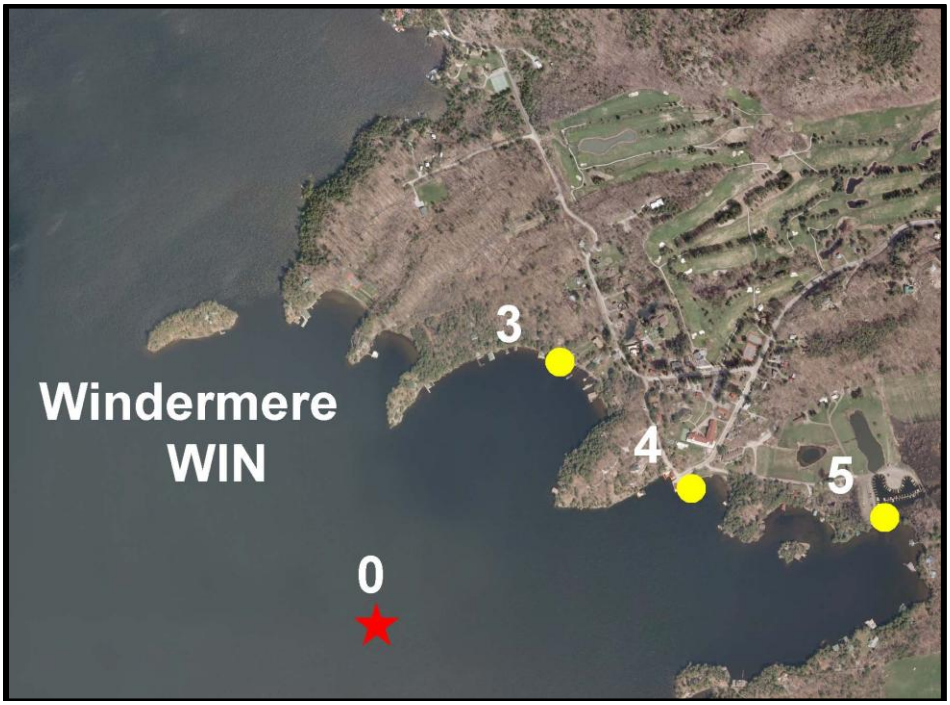
Dear Mike:

Having completed over a decade of water quality monitoring in numerous lakes, the Muskoka Lakes Association (MLA) is in a position to identify trends in water quality conditions. While the monitoring program is a key part of the MLA objectives, the engagement of local community groups in activities that will maintain and improve the quality of water is also key. With this goal in mind, the MLA retained RiverStone Environmental Solutions Inc. (hereafter RiverStone) to identify areas that could benefit from the development of stewardship initiatives (2011 Water Quality Report); these water bodies have been designated Focus Areas (FA). The stewardship initiatives in FAs would be community based, with some level of support provided by the MLA.

Based on a comprehensive review of all available data, RiverStone has identified Windermere as a FA. The following material has been prepared specifically for Windermere and provides 1) descriptions of land uses, types of development, and ecological conditions of the drainage basin associated with the FA; 2) an overview of the data considered in the evaluation of the FA designation; and 3) a list of recommendations for community based stewardship initiatives within the watershed that aim to improve the water quality within the FA.

AREA OVERVIEW

Windermere is located in a highly developed resort and residential area in the central portion of Lake Rosseau. The drainage area of Windermere is approximately 1.7 km^2 in size (**Photograph 1**) and contains Paton Bay in the south, Maple Leaf Bay and two unnamed bays in the north. A portion of the Windermere Airport falls within the Windermere drainage area. The majority of the shoreline area is developed; however, many cottagers and residents have maintained forest cover on their properties. Approximately 70 % of the drainage area of Windermere consists of Commercial and Resort uses, 25 % contains cottages and residences and the remaining 5 % is comprised of natural areas. The shoreline of the Windermere area is approximately 30 % commercial/resort, 60 % private cottages and residences, and 10 % natural. The high degree of resort and commercial development within the drainage area may have resulted in a complex system in terms of nutrient inputs and potential impacts on water quality in the Windermere area.



Photograph 1. Overview of Windermere, Lake Rosseau and the MLA sampling sites.

WATER QUALITY DATA REVIEW

As part of our consideration of potential water quality issues associated with the Windermere area, RiverStone reviewed available information from the Lake System Heath (LSH) modelling completed by Gartner Lee (2005) and the MLA Water Quality Monitoring data collected from 2002–2011. The DMM does not currently monitor water quality within the Windermere area.

The LSH modelling evaluated the sensitivity of various waterbodies based on their responsiveness to phosphorus inputs and the degree of phosphorus mobility in their respective watersheds. In this case, the responsiveness of the water body is a measure of the change in phosphorus levels in the waterbody after the input of a known amount of nutrient. Finally, LSH measured the amount of phosphorus from human development that would reach the waterbody (Mobility). The Windermere area was not modelled as a separate water body from Lake Rosseau in the LSH exercise and as such, threshold values for this location are taken from the main basin of Lake Rosseau. The Lake Rosseau (Main) modeled threshold phosphorous level is 6.91 µg/L, with a modeled background + 50 % value of 6.22 µg/L. Lake Rosseau was identified as being "Moderately" sensitive, but not over threshold.

MLA water quality monitoring data from 2009-2011 indicate that the nearshore Total Phosphorous (TP) concentrations are significantly different from the deep-water reference site. *E. coli* values at site WIN-3 and WIN-5 have been high over the past few years. No other long-term trends can be extracted from the data at this time.

COMMUNITY BASED STEWARDSHIP INITIATIVES

The monitoring data available for the Windermere area raises concerns around both the phosphorous and *E. coli* levels. As very little is currently known about the management of lands in the drainage area and the potential effects of the land uses on the water quality in the Windermere area, RiverStone recommends the following actions in this Focus Area:

1. **The MLA should facilitate the development of a Community Stewardship Group.**

2. **The MLA should assist the Community Stewardship Group in identifying the local stakeholders in the drainage area, focusing on local farm owners, golf courses, resorts, commercial operators and residents.**
3. **The Community Stewardship Group should develop contacts and a working relationship with the commercial operators within the drainage area to discuss water quality concerns based on the provided background information.**
4. **The Community Stewardship Group should gather background information on potential sources of phosphorous and *E. coli* (e.g. Certificates of Approval, Compliance Reports, information on large sewage treatment systems, new development applications, etc.)**
5. **The background information should be reviewed by a qualified professional to assist in the development of a focussed Stewardship Initiative.**
6. **Continue gathering deep-water phosphorous concentrations samples and nearshore *E. coli* samples to monitor ongoing water quality conditions in the Windermere area and to track trends over time.**

We trust that these recommendations will prove to be useful in working with local stakeholders to develop a community based stewardship group. Please contact us if there are any questions.

Best regards,

Bev Wicks, Ph.D.
Senior Aquatic Ecologist