Aquatic Environment Report

Otter Lake & Little Otter Lake

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Prepared For

Otter Lake Ratepayers' Association

GEORGIAN BAY BIOSPHERE
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EXECUTIVE SUMMARY

The Georgian Bay Mnidoo Gamii Biosphere (GBB) has prepared this aquatic environment report for the Otter Lake Ratepayers' Association (OLRA) in order to provide Otter Lake and Little Otter Lake residents with summarized water quality and fish community monitoring data for these lakes. In addition, the report provides a brief summary of a new eDNA project started on Otter Lake, recommendations for further aquatic monitoring, as well as possible stewardship activities. The report is divided into four sections to reflect these objectives – water quality, fish communities, eDNA project, and recommendations.

Water Quality

OLRA participates in the Lake Partner Program (LPP) and conducts benthic monitoring (Figure 1). As part of the LPP, one site on Otter Lake and one site on Little Otter Lake are actively sampled for total phosphorus (TP) concentrations, water clarity, and calcium concentrations. A high-level summary of LPP results is presented in Table 1 (includes Station 4193, Site ID 7 and Station 4196, Site ID 2 which were last sampled in 2018).

Benthic monitoring, following the Ontario Benthos Biomonitoring Network protocol, was initiated in 2019 in three locations (one on Little Otter Lake, two on Otter Lake). The benthic communities of Little Otter Lake and Otter Lake (both impacted and minimally impacted sites) are considered typical of what would be expected for lakes in this region based on the percentage of pollution-sensitive taxa found.

The minimally impacted site on Otter Lake had a slightly higher average percentage of pollution-sensitive taxa (larval mayflies (*Ephemeroptera*), dragonflies and damselflies (*Odonata*), and caddisflies (*Trichoptera*), collectively referred to as %EOT) than the impacted site. Both Otter Lake sites had a higher average %EOT than the Little Otter Lake site, but all sites are considered typical for the region.

No statistically significant differences in %EOT or number of taxonomic groups were identified among sampling years for any of the sampling locations. The benthic communities of Otter Lake and Little Otter Lake should continue to be monitored into the future to note any changes over time that may prompt further investigation.

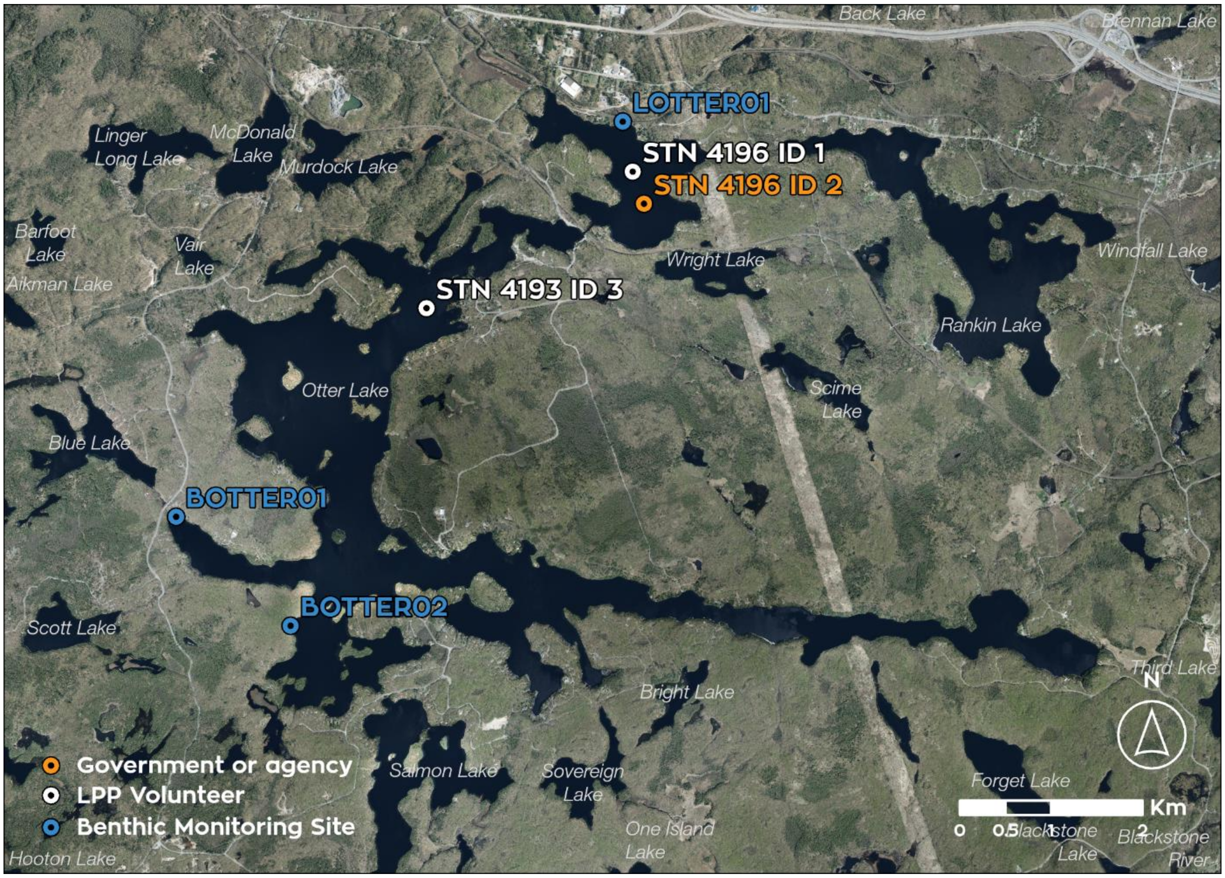

Figure 1. Active and recently active monitoring sites on Otter Lake and Little Otter Lake.

Table 1. Overview of Otter Lake and Little Otter Lake LPP sampling results

	Station 4193, Site ID 3	Station 4193, Site ID 7	Station 4196, Site ID 1	Station 4196, Site ID 2
TP average	n/a	n/a	n/a	7.5 µg/L
TP trend	Increasing	Increasing	Decreasing	n/a
Trophic status	Oligotrophic	Oligotrophic	Oligotrophic	Oligotrophic
Clarity (average)	5.6 m	4.3 m	3.3 m	3.3 m
Calcium (average)	2.3 mg/L	2.3 mg/L	3.5 mg/L	4.1 mg/L

Note: Clarity and calcium are reported as averages. TP is reported as an average for sites with three to five years of data. Trends are reported for sites with more than five years of data. Trophic status is described in terms of three broad categories – oligotrophic, mesotrophic, and eutrophic. TP concentrations below 10 µg/L indicate an oligotrophic or unproductive environment.

Fish Communities

Otter Lake

The major fish species in Otter Lake include lake trout, northern pike, smallmouth bass (introduced), largemouth bass, and black crappie (introduced). Other species in the lake include, but are not limited to, cisco, rainbow smelt (introduced), pumpkinseed, brown bullhead, yellow perch, rock bass, and white sucker.

Otter Lake is designated as a lake trout lake and managed for natural reproduction. Lake trout were previously stocked in the lake but stocking ceased after 1998. The conclusion from a 2013 Spring Profundal Index Netting survey is that the lake trout population is at a moderately low density. However, since stocking was discontinued, the proportion of naturally reproduced fish in the population has increased from a small proportion to about half. The lake appears to have a natural tendency for relatively low lake trout abundance but large average size, regardless of whether stocking is occurring. It is recommended that the lake continue to be managed for a natural population with no supplemental stocking and with the current angling regulations.

A fisheries survey was conducted on Otter Lake in 2023 by the Ministry of Natural Resources and Forestry. Results from this effort are not yet available.

Little Otter Lake

The major fish species in Little Otter Lake include northern pike, largemouth bass, and smallmouth bass. Other species in the lake include, but are not limited to, rock bass, pumpkinseed, cisco, yellow perch, white sucker, and rainbow smelt (introduced).

No stocking has occurred in the lake and no species have been tested for contaminants.

eDNA Project

In 2022, OLRA membership supported initiating a small eDNA project to measure and monitor the biodiversity of aquatic and terrestrial organisms that reside in and around Otter Lake. Of particular interest is the potential detection of species at risk and early detection of invasive species. Six eDNA samples were collected on August 6, 2022. A summary of the results is provided in Table 2. Additional eDNA samples are planned for 2023.

Table 2. Results for six composite eDNA samples taken from locations around Otter Lake

Group	Sampling Locations					
	Broken Link Trib/Sunny Point Bay	Rankin Lake Trib/Little Otter Bay	Link Property Trib/Link Shore	Blue Lake Road Beaver Pond/Sand Bay	Salmon Lake Trib/Salmon Lake Bay	Sovereign Lake Trib/Mud Bay
Invertebrates	132	121	42	76	123	115
Fish	16	13	18	15	11	19
Amphibians	3	2	1	6	3	2
Reptiles	0	0	0	2	0	0
Birds	1	0	0	1	0	1
Mammals	1	0	0	4	2	2
Total # of species	**153**	**136**	**61**	**104**	**139**	**139**

Recommendations

Based on results from water quality sampling, benthic monitoring, and the most recent fish community survey, several recommendations are made in this report.

Water Quality

1. Continue LPP sampling on Otter Lake at Station 4193, Site ID 3 and Little Otter Lake at Station 4196, Site ID 1.
2. Benthic communities should continue to be monitored into the future to note any sudden or gradual changes in the community that could signify changes in water quality and prompt further investigation.

Fish Communities

1. Maintain current angling regulations for lake trout in Otter Lake (40-55 cm protected slot size, winter closure).
2. If there is interest, volunteers could monitor the enhanced lake trout spawning habitat in Otter Lake to determine whether it is being used.
3. Anglers should familiarize themselves with the new regulations for the sale and possession of live bait in Ontario.
4. The app MyCatch by Angler's Atlas can be used by people fishing on the lake to log fishing trips and share fishing data confidentially with biologists.

Stewardship Activities

1. Encourage Otter Lake and Little Otter Lake property owners to maintain and/or restore natural shorelines. For information about choosing native plants for your shoreline, see the Planting for Pollinators guide.
2. Property owners interested in minimizing their ecological footprint can utilize the Georgian Bay Biosphere's Life on the Bay stewardship guide.
3. Get involved in one of the many citizen science programs available for cottagers and residents (e.g., invasive species reporting, IceWatch, FrogWatch, Canadian Lakes Loon Survey) and consider hosting a community Bioblitz. See GBB's Bioblitz guide for more information.

INTRODUCTION

The Georgian Bay Mnidoo Gamii Biosphere (GBB) has prepared this aquatic environment report for the Otter Lake Ratepayers' Association (OLRA) to provide Otter Lake and Little Otter Lake residents with a summary of water quality and fish community monitoring data for these lakes.

Otter Lake is located in Seguin Township (Figure 2) and is part of the Boyne River watershed. Otter Lake is situated within the Williams Treaty of 1923 and the Robinson-Huron Treaty of 1850 (Ministry of Indigenous Affairs, 2022). It is a medium-size lake in the Parry Sound area, measuring 506 hectares in size. The lake has a maximum depth of 44.8 m (147 ft) and a mean depth of 10.8 m (35 ft) (McIntyre, 1999). Lake water level is regulated by a dam at the outlet of Little Otter Lake.

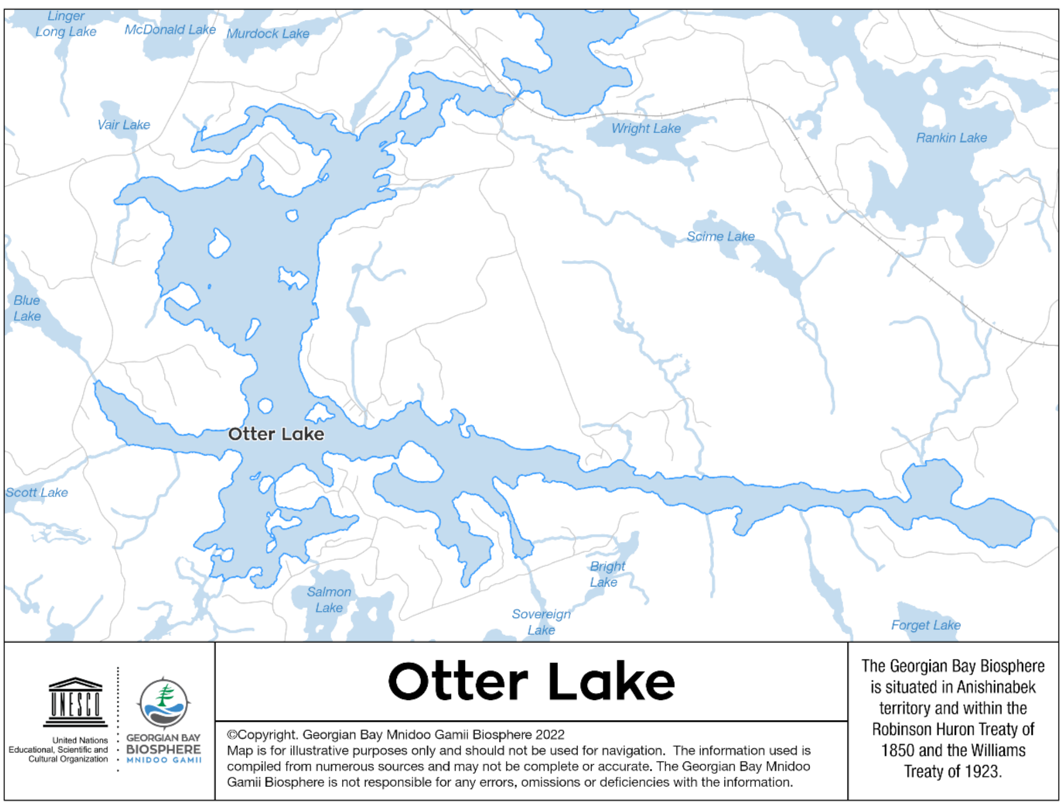

Figure 2. Otter Lake located in Seguin Township.

Otter Lake is readily accessible by road with numerous public access points. Shoreline development on the lake is considered relatively heavy (McIntyre, 1999). Approximately 5% of the shoreline is Treaty/Crown land (MNRF, 2016b). The lake has a varied fish community including a native lake trout population (McIntyre, 1999).

Little Otter Lake (Figure 3) is connected to Otter Lake by a navigable channel but is physically quite different from it. Little Otter Lake is considerably smaller than Otter Lake, measuring 68 hectares in size, and much shallower with a maximum depth of 5.2 m (17 ft) and a mean depth of 2.7 m (9 ft). Compared to Otter Lake, Little Otter Lake has received far less fisheries management attention. The lake supports self-sustaining populations of bass and pike.

Little Otter Lake is accessible by road and public boat launch. Shoreline development on the lake is considered moderate. None of the shoreline is Treaty/Crown land (MNRF, 2016a).

The remainder of this report describes water quality and fisheries monitoring taking place on these lakes, a new eDNA project on Otter Lake, and provides recommendations for future monitoring and stewardship.

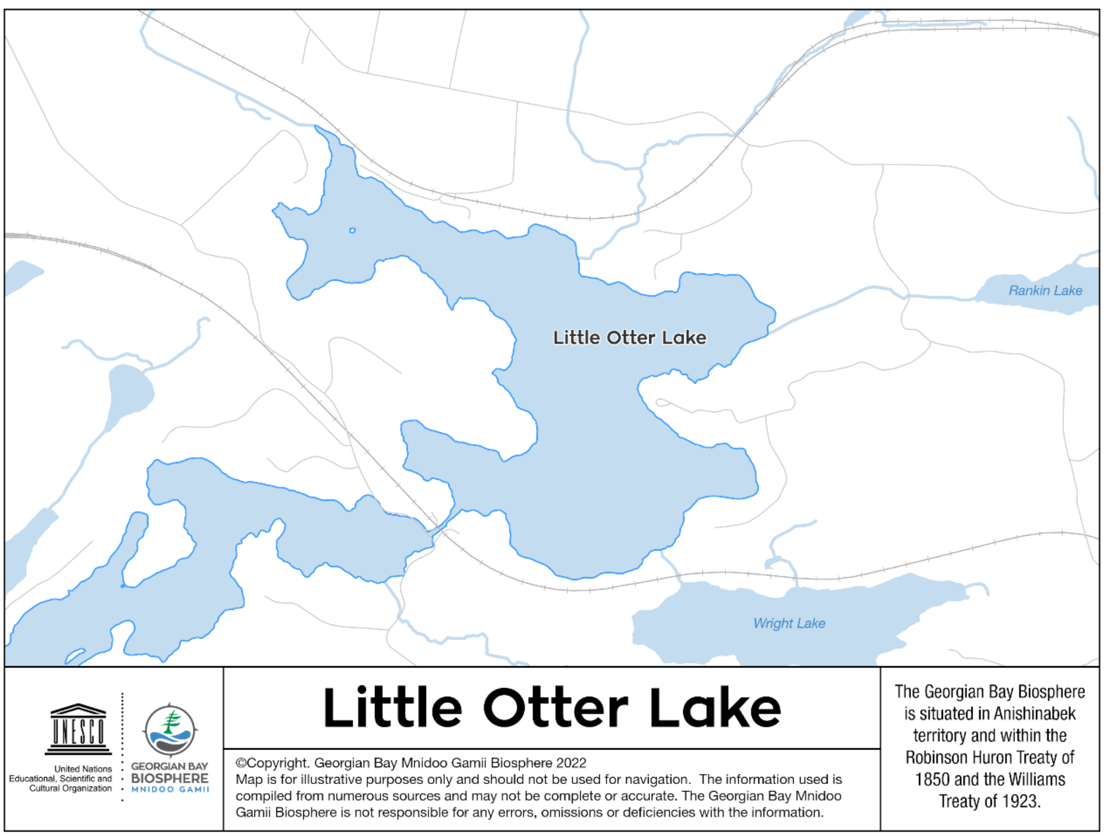

Figure 3. Little Otter Lake located in Seguin Township.

WATER QUALITY

Lake Partner Program

The Lake Partner Program (LPP) is an Ontario-wide, publicly funded, free program that collects data about phosphorus, water clarity, calcium, and chloride from volunteers. The simple tests for total phosphorus (TP) and water clarity provide a strong basis for assessing the health of the ecosystem, and whether TP is too high or too low.

Monitoring TP is very important as phosphorus is the nutrient that controls plant growth (including algae) in lakes. Measuring TP year after year is necessary to detect long-term changes in water quality that may be due to impacts of shoreline development, climate change, and/or other stressors. Inland lakes require TP data to help assess background concentrations relative to present day concentrations. Data collected by volunteers are analyzed by the Dorset Environmental Science Centre (DESC) which makes all data available online.

What is involved in monitoring?

As a general rule, only one representative sampling location is required for each lake even in large convoluted lakes with multiple arms. In the event that there are compelling reasons to believe that water quality in different areas of the lake would be influenced differently by rivers or development, for example, or there are local observed differences or perceived problems, more sites might be recommended. Generally speaking, if the watershed influences are similar across a lake, the water quality will be similar as well.

Spring total phosphorus sampling (following LPP protocols) is sufficient for most locations in the region, as there are few areas that experience fall algal blooms. Additionally, Secchi disc water clarity measurements are taken each month at the same location as the TP samples. The black-and-white Secchi disc is lowered into the water until it is at the absolute limit of being visible. This depth is the Secchi depth of visibility, which is directly related to water clarity and can be used as a simple and effective monitoring tool for determining the effects of human activities on water clarity and, indirectly, on the nutrient content in the water.

The materials needed to take the water samples and conduct water clarity measurements are sent to volunteers by the province. Instructions are included in this package, additionally, training videos are available online. Samples are returned (postage paid) to DESC for analysis and Secchi observation sheets are mailed to DESC in November.

Interpreting Results

Only data collected after the Ministry of Environment, Conservation and Parks (MECP) took over coordination of the LPP (2002 to present) are shown in graphs and labelled on figures. Since 2002, LPP phosphorus samples have been analysed on a low-level phosphorus analyser that has increased the precision of results from +/- 6 µg of phosphorus per litre to +/- 0.7 µg/L. Complete data for all historical and active sampling locations, including data collected prior to 2002, are available in Appendix A (Otter Lake) and Appendix B (Little Otter Lake).

In general, water clarity, as measured by Secchi depth, tends to be higher in open areas with good water circulation. Water clarity tends to diminish (smaller Secchi depth values) in enclosed bays, near wetlands or sources of organic material, and in lakes or areas that have higher nutrient levels either from natural or anthropogenic sources.

Secchi depth values should be compared over several years to assess whether there are water clarity trends for a particular area. Where more than one year of water clarity data exists for a sampling location, Secchi depth in metres is graphed and an average depth is given.

Calcium is a nutrient that is required by all living organisms. Some organisms, including those that are a primary food for many fish, use calcium in the water to form their calcium-rich body coverings. These organisms, like Daphnia, mollusks, clams, amphipods, and crayfish, are very sensitive to declining calcium levels.

Calcium concentrations have been shown to be decreasing in Canadian Shield lakes in response to depleted watershed stores of calcium caused by logging and decades of acid loading associated with acid rain. Combined with lower food availability and warmer temperatures predicted as part of a changing climate, this decrease represents an important stressor for many aquatic species.

Calcium concentrations should be considered over the long term to identify trends. Where more than one year of data exists for a sampling location, calcium concentration in mg/L is graphed.

As phosphorus is the nutrient that controls the growth of plants (e.g., algae) in the aquatic environment, TP concentrations are used to interpret nutrient status. The nutrient status of an aquatic environment is typically described in terms of three broad categories – oligotrophic, mesotrophic, and eutrophic (Figure 4). TP concentrations below 10 µg/L indicate an oligotrophic or unproductive environment. Aquatic environments with TP concentrations ranging between 10 and 20 µg/L are termed mesotrophic and are moderately enriched. Finally, TP concentrations over 20 µg/L indicate a eutrophic aquatic environment in which persistent, nuisance algal blooms are possible.

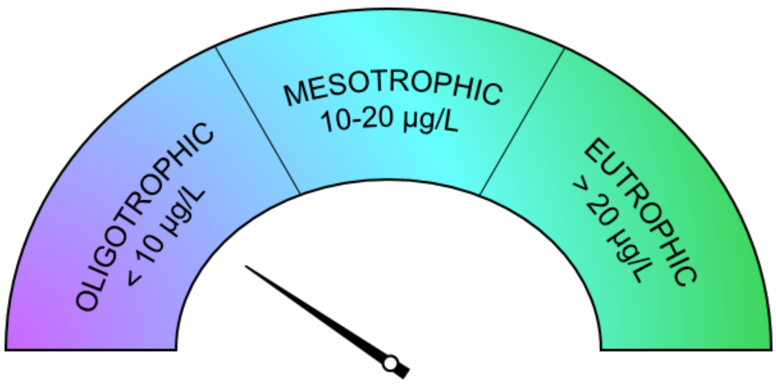

Figure 4. A lake's trophic status is determined by its total phosphorus concentration.

The Interim Provincial Water Quality Objective (PWQO) for TP in inland lakes is 20 µg/L. This measure is intended to serve as a warning for, and to prevent, conditions that could result in the nuisance growth of algae. Results in this report are used to characterize trophic condition and assess any TP trends (e.g., upward, downward). When interpreting data, the MECP cautions that although only three years of data are required to establish a reliable, long-term average to measure current nutrient status, a longer data set is required to examine trends. Some aquatic environments exhibit relatively large differences in TP between years, highlighting the need for long-term data collection to distinguish between natural variation and true anomalies.

Where more than one year of TP data exists for a sampling location, TP in µg/L is graphed. Average TP is calculated for sampling locations with between three and five years of data, as well as locations with five or more years of data for which there is no apparent trend. For sampling locations with five or more years of TP data and for which there is an apparent trend, a trend line is shown on the TP graph and average is not calculated. Visible outliers are removed for the purpose of determining whether a trend exists.

The LPP database (available here) contains TP data from over 1,000 sampling locations across Ontario. Readers may find the database useful in understanding how their lake's TP concentrations compare to other waterbodies across the province.

Otter Lake Results

Figure 5 shows the location of the active LPP sampling site on Otter Lake (Station 4193, site ID 3). Site ID 7 is a recently active site (last sampled in 2018) but is not shown in Figure 5 due to inaccurate coordinates. Results for both of these sites follow.

Complete data for all historical and active Otter Lake sampling locations are available in Appendix A. It is important to note that 2020 and 2021 data are limited as a result of significantly fewer water samples being received and analysed by DESC, due to the Covid-19 pandemic.

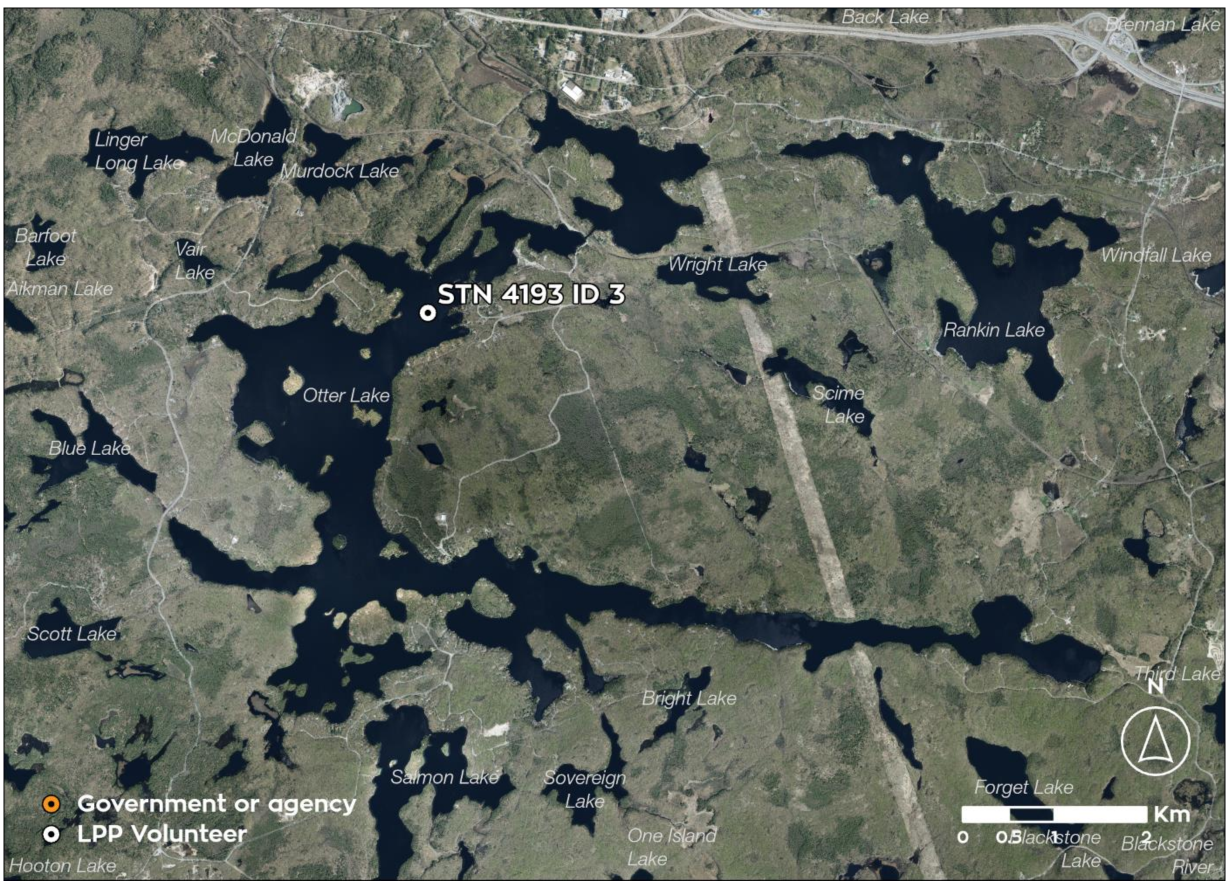

Figure 5. Active Otter Lake LPP sampling location.

Otter Lake	
• Station: 4193	• Trophic status: oligotrophic
• Site ID: 3	• Average TP: n/a
• Description: N end, deep spot	• Trend: decreasing
• Data collector: LPP volunteer	• Average Secchi depth: 5.6 m
• Years sampled: 2002 – 2022	• Visible outliers: None

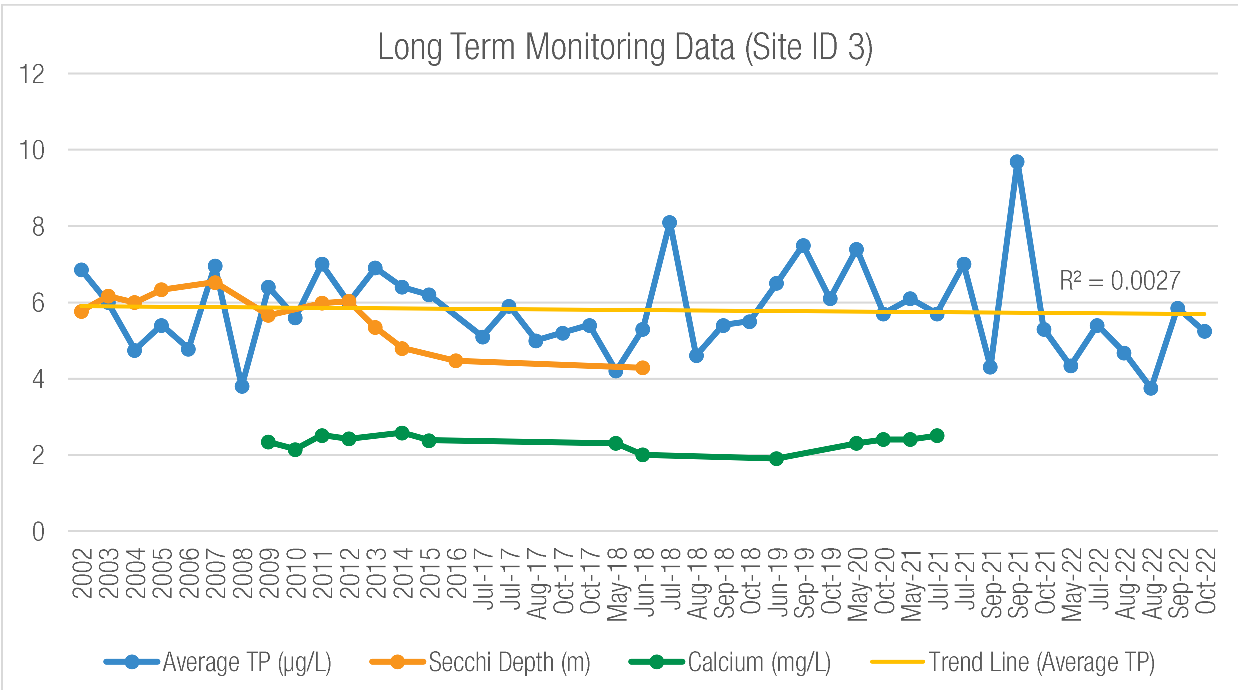

Figure 6. Lake Partner Program data for Station 4193, Site 3 on Otter Lake. *Two data points given in the LPP database for July and October 2017, July and September 2021, and August 2022.

Otter Lake	
• Station: 4193	• Trophic status: oligotrophic
• Site ID: 7	• Average TP: n/a
• Description: Mid lake, deep spot	• Trend: increasing
• Data collector: LPP volunteer	• Average Secchi depth: 4.3 m
• Years sampled: 2012 – 2018	• Visible outliers: None

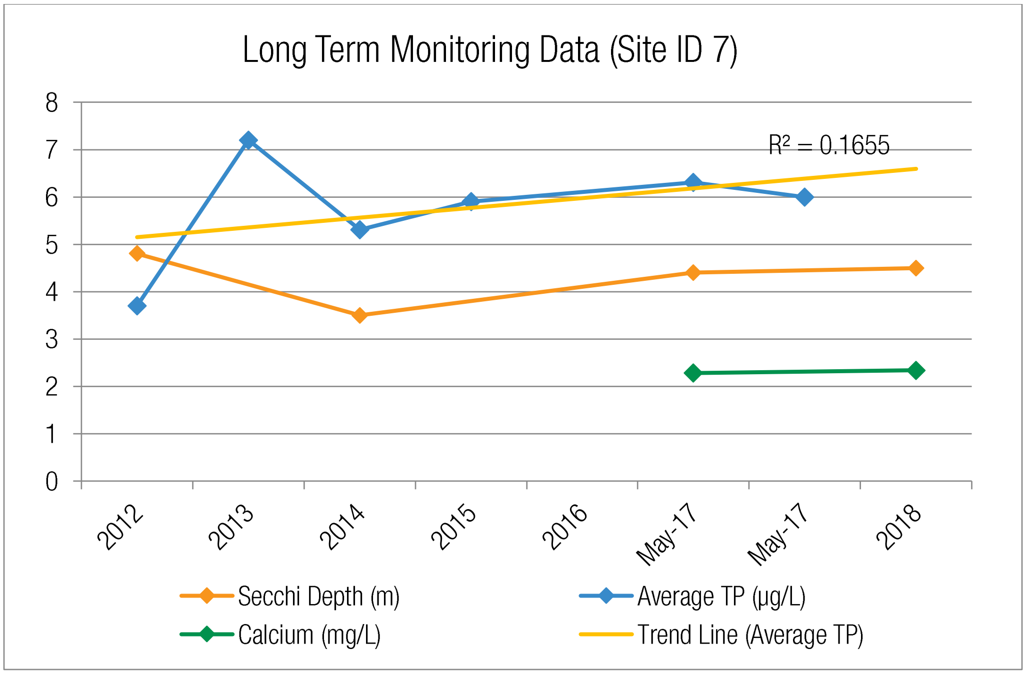

Figure 7. Lake Partner Program data for Station 4193, Site 7 on Otter Lake. *Two data points given in the LPP database for May 2017.

Recommendations

Continue volunteer-led LPP sampling annually. In addition, continue sampling as part of Seguin Township's Lake Water Quality Monitoring Program which monitors approximately 120 lakes across the township on a rotating basis.

Little Otter Lake Results

Figure 8 shows the locations of one active LPP sampling site on Little Otter Lake (Station 4196, site ID 1) and one recently active sampling site (Station 4196, site ID 2). Results for both sites follow.

Complete data for all historical and active Little Otter Lake sampling locations are available in Appendix B. It is important to note that 2020 and 2021 data are limited as a result of significantly fewer water samples being received and analysed by DESC, due to the Covid-19 pandemic.

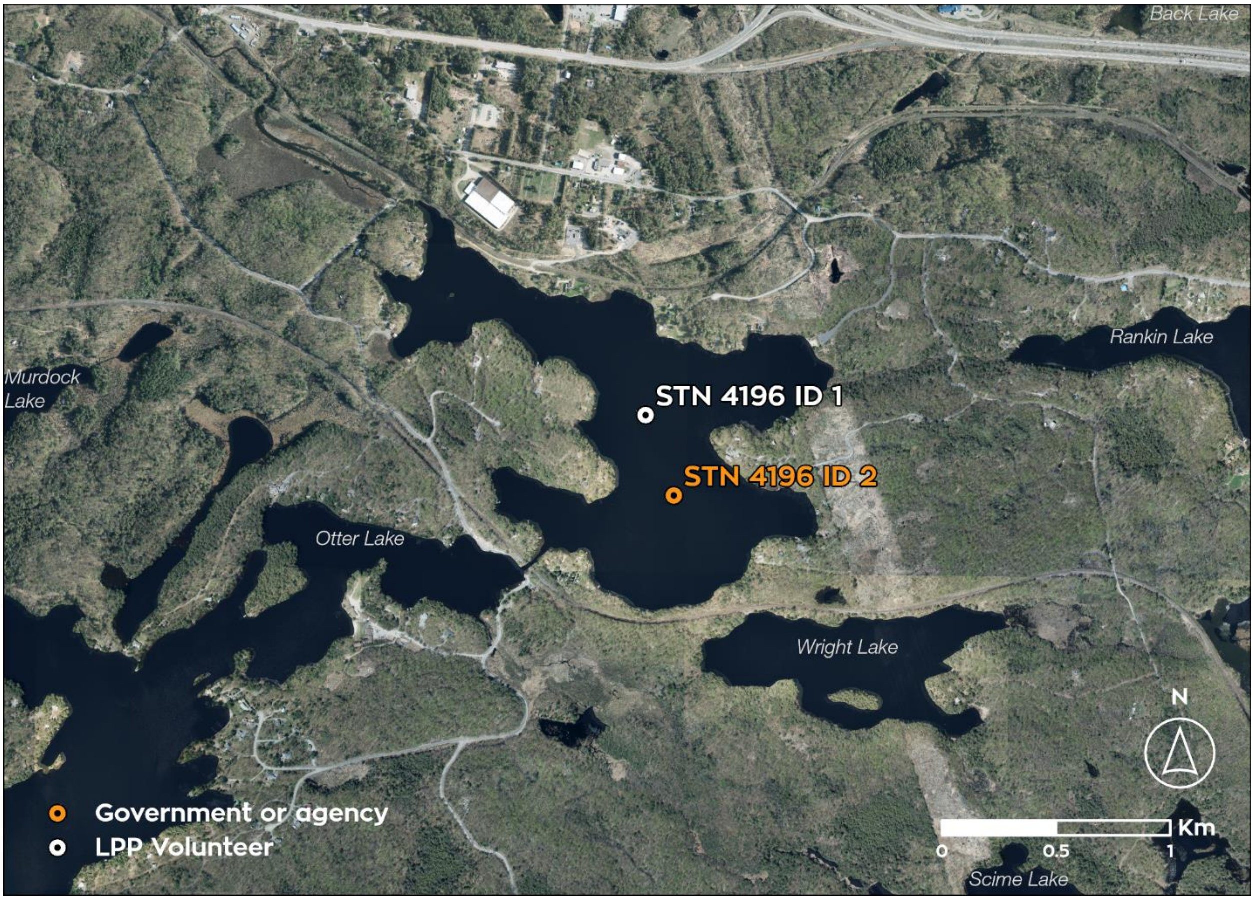

Figure 8. Active and recently active Little Otter Lake LPP sampling locations.

Little Otter Lake	
• Station: 4196	• Trophic status: oligotrophic
• Site ID: 1	• Average TP: n/a
• Description: Mid lake, deep spot	• Trend: decreasing
• Data collector: LPP volunteer	• Average Secchi depth: 3.3 m
• Years Sampled: 2004, 2006, 2017 – 2022	• Visible outliers: TP of 16.8 µg/L in Oct 2020

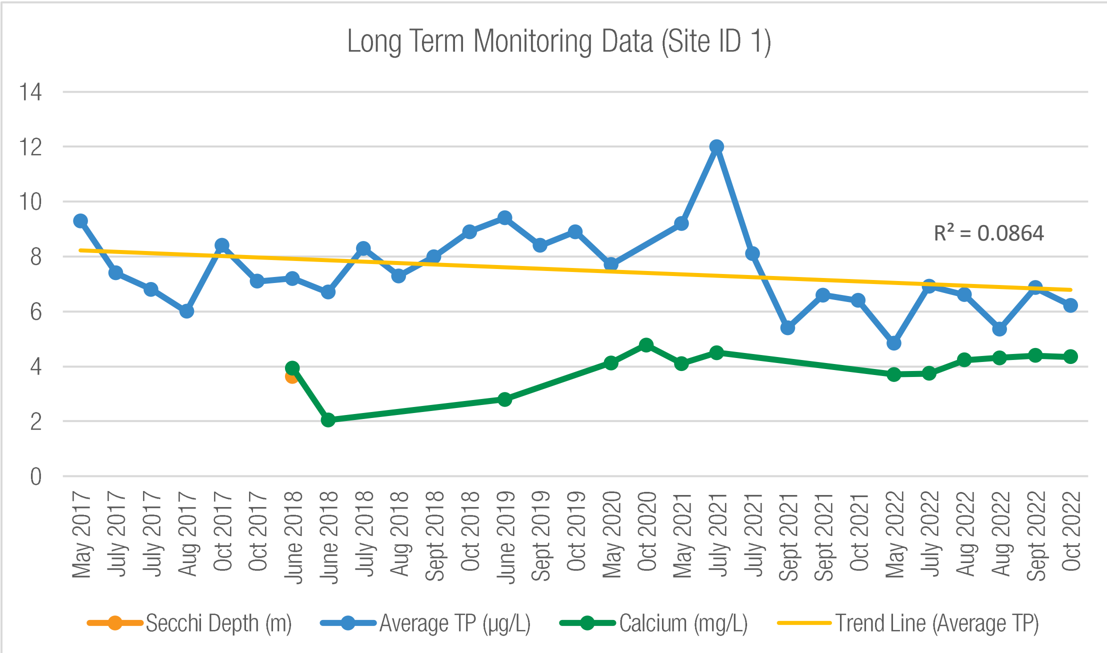

Figure 9. Lake Partner Program data for Station 4196, Site 1 on Little Otter Lake. *Two data points given in the LPP database for July and October 2017, June 2018, July 2021 and September 2021, and August 2022. Site ID 1 was also sampled for TP in 2004 and 2006, these results are presented in

Little Otter Lake	
• Station: 4196	• Trophic status: oligotrophic
• Site ID: 2	• Average TP: 7.5 µg/L
• Description: Mid lake, deep spot	• Trend: n/a
• Data collector: LPP volunteer	• Average Secchi depth: 3.3 m
• Years sampled: 2013, 2014, 2016 – 2018	• Visible outliers: None

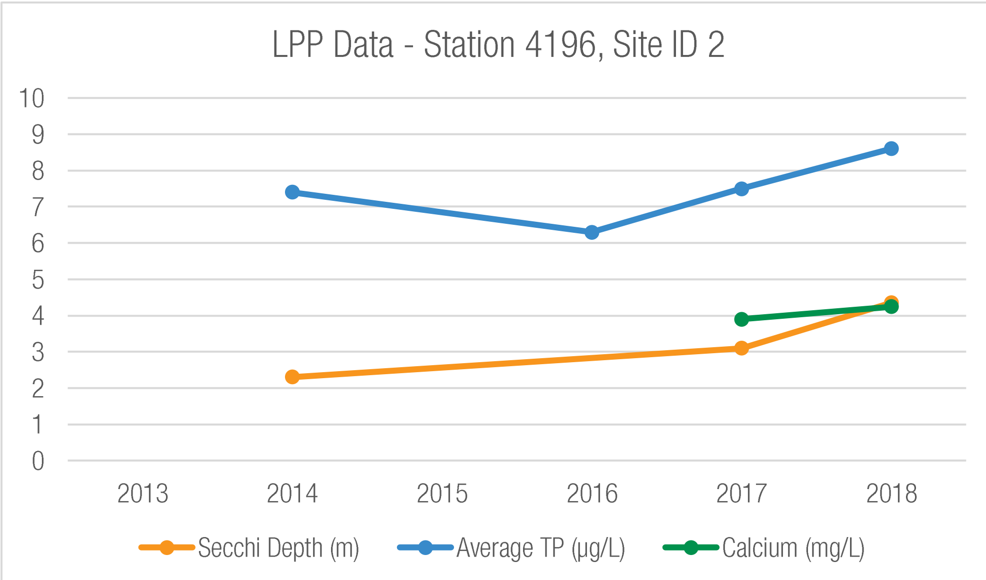

Figure 10. Lake Partner Program data for Station 4196, Site 2 on Little Otter Lake.

Recommendations

Continue volunteer-led LPP sampling annually. In addition, continue sampling as part of Seguin Township's Lake Water Quality Monitoring Program which monitors approximately 120 lakes across the township on a rotating basis.

Benthic Monitoring

Different types of water quality monitoring provide environmental managers with complementary information. Most people are familiar with the idea of looking at water quality from a "stressor-based approach". This includes monitoring water chemistry parameters like pH, dissolved oxygen, total phosphorus, and others. Stressor-based monitoring approaches provide important information about an ecosystem's exposure to stress, but they leave unanswered questions about the significance (or effect) of that stress.

Biological monitoring (e.g., benthic monitoring) uses an "effect-based approach" to provide information about how ecosystems have responded to a stress, for example by looking at fish communities or benthic macroinvertebrates. However, effect-based approaches leave unanswered questions about what stresses are being responded to. Therefore, these approaches (chemical and biological monitoring) are complementary and together provide a more complete picture of aquatic ecosystem health (i.e., the lake's exposure to stress and associated ecological response).

For example, volunteers on Otter Lake and Little Otter Lake monitor phosphorus levels which provide a measure of exposure to stress (e.g., impacts from humans, climate change, invasive species). These measures could be phosphorus levels going up, going down, or staying the same. But what is the impact from these trends on the ecosystem? By adding benthic monitoring, we can start to see if and how the ecosystem is reacting to a stressor.

Over the last three decades, the use of biological monitoring in Ontario has increased dramatically. Researchers, water managers, and the larger scientific community are recognizing the ability of biological monitoring to reflect the impacts of stressors on aquatic ecosystems including the effects of non-point-source and episodic pollution, habitat changes, and the cumulative effects of multiple stressors. Accordingly, the use of biotic changes to evaluate ecosystem condition and water management performance has grown in relevance and legitimacy – to the point that legal and regulatory frameworks in many countries now require information on biological condition. Ontario's Water Resources Act (R.S.O 1990, C. 040) and Environmental Protection Act (R.S.O. 1990, C. E19), for example, define impairment and adverse impact in clearly biological terms.

Benthic macroinvertebrates (or benthos) are small aquatic organisms (including insects, crustaceans, worms, and mollusks). The term benthic macroinvertebrate can be broken down to better understand the nature of these organisms. Benthic macroinvertebrates spend all or part of their life cycle living at the bottom of the lake (benthic), they are quite small but can generally still be seen with the naked eye (macro), and they lack a backbone (invertebrate).

These animals are well suited as indicators of water and sediment quality as they spend most or all of their lives (1-3 years) in constant contact with the benthic environment in a specific area. Furthermore, they are relatively easy and inexpensive to sample, and have varying tolerances to disturbances and pollution (Figure 11). A healthy lake will support high richness (the number of species) and abundance (the number of individuals). If a lake has low species richness and mainly pollution-tolerant species, the lake could be impaired. Changes in the benthic community of a lake (e.g., changes in the types of organisms, abundance) can indicate changes in the lake ecosystem (e.g., improvements in water quality, habitat alteration, introduction of invasive species).

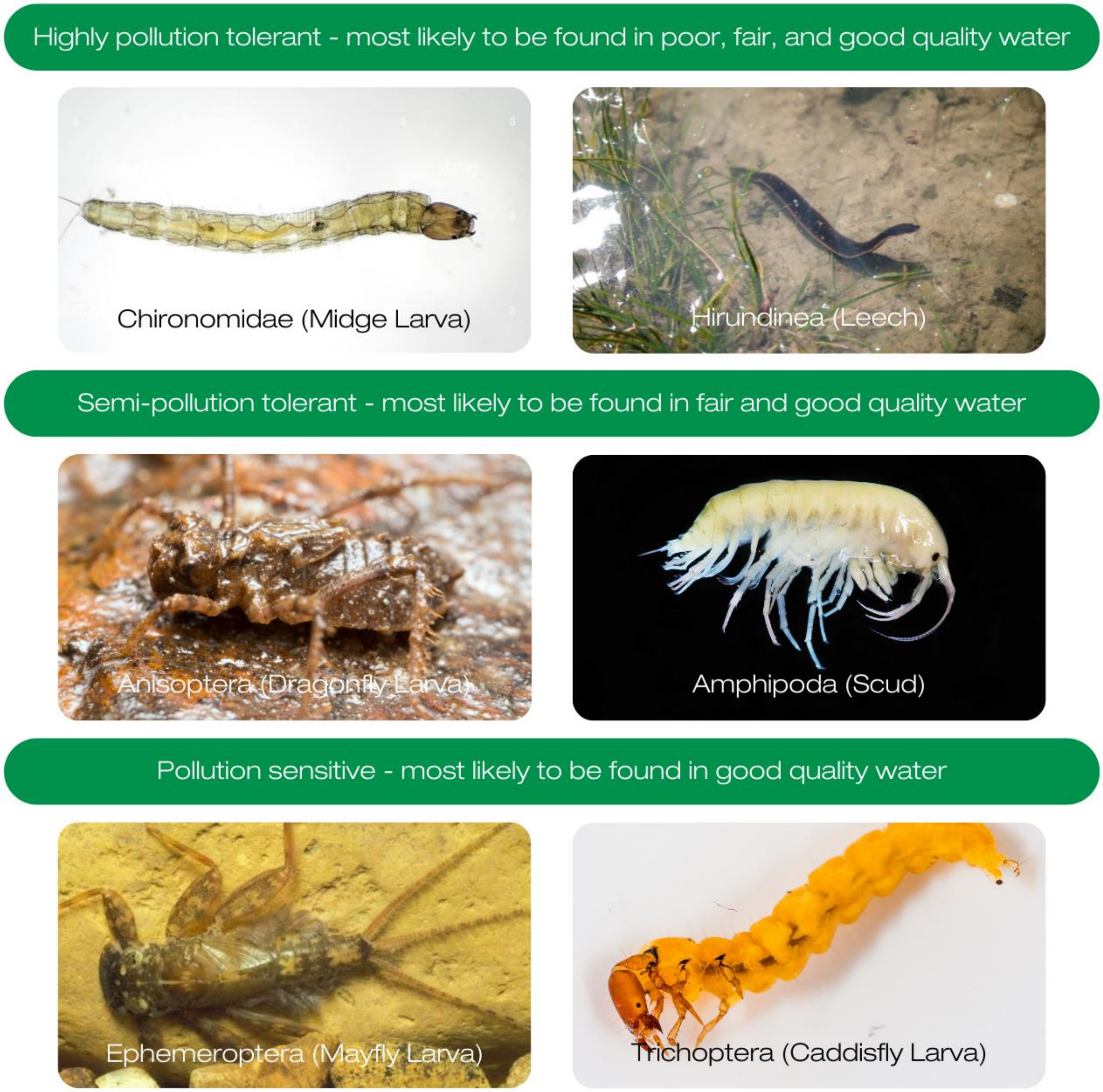

Figure 11. Benthic macroinvertebrates found in Otter Lake and Little Otter Lake and their pollution sensitivities.

Finally, benthic macroinvertebrates are an important part of the food web of a lake. Certain benthic macroinvertebrates are a critical food source for a variety of fish species, while others play a key role in decomposing organic matter.

The objectives of OLRA's benthic monitoring program are to:

- Determine the ecological condition of Otter Lake and Little Otter Lake and monitor over time;

- Compare the lakes to similar lakes in the Parry Sound-Muskoka District; and
- Compare impacted and minimally impacted sites on the lakes.

What is involved in monitoring?

Certified GBB staff oversee benthic macroinvertebrate sampling using the standardized Ontario Benthos Biomonitoring Network (OBBN) protocol for lakes. Three shallow, nearshore areas representative of the lake are selected as test sites (referred to as “lake segments” in the protocol) and sampled each year using the travelling-kick-and-sweep method. The individual doing the sampling disturbs the bottom of the lake in transects from 1m depth to the water’s edge for approximately 10 minutes. Using a net, the dislodged material is collected and placed in a bucket. These samples are then processed to count and identify the different types of benthos in the sample (video available here). There are 27 different groups of benthos that are searched for, ranging in sensitivity to water pollutants and water quality.

Interpreting results

One of the objectives of the benthic monitoring is to characterize the benthic community of each lake and compare them to lakes in the Parry Sound-Muskoka District to determine whether their benthic communities are considered typical of what would be expected for lakes in this region.

The District Municipality of Muskoka has been working with lake associations to conduct benthic monitoring throughout the district since 2004. This rich Muskoka dataset, combined with additional benthic data for lakes in south-central Ontario from the DESC and from Jones et al. (2007), provides the basis needed for regional comparisons among lakes.

As detailed in the 2018 Muskoka Watershed Report Card Background Report, the Muskoka Watershed Council (MWC) reports on lake benthic communities in terms of the percentage of pollution-sensitive taxa found. Specifically, the pollution-sensitive taxa include larval mayflies (*Ephemeroptera*), dragonflies and damselflies (*Odonata*), and caddisflies (*Trichoptera*), collectively referred to as EOT. These taxa are very sensitive to pollution and habitat alterations, meaning that their numbers will be highest in healthy lakes and lowest in unhealthy or disturbed lakes. The average %EOT for a lake is compared to the normal range for %EOT in lakes in the region. In other words, this monitoring seeks to answer the question, does the %EOT for the lake of interest fall within the normal range of what would be expected for a lake in the region?

The normal range for %EOT in lakes in the region was determined by MWC for the Muskoka Watershed Report Card by “randomly selecting one data point from each lake sampled between 2012 and 2017 and characterizing the distribution of values observed among these lakes” (MWC, 2018, p. 46). The resulting range of %EOT values is shown in Figure 12 and is used for analysis in this report.

Following the methodology used by MWC (2018), the average %EOT was calculated for each of the three sampling locations using data collected between 2019 and 2023. The average %EOT for each site was then compared to the normal range (Figure 12) to determine whether the lake is considered typical, atypical, or extremely atypical. These categories are defined by MWC (2018) as follows:

- Typical: %EOT is between the 10th and 90th percentile. These lakes resemble the majority of lakes in the region, and therefore are comprised of typical percentages of EOT species.
- Atypical: %EOT is between either the 5th and 10th percentile or the 90th and 95th percentile. These lakes are outside of the normal range of the majority of lakes in the region. The percentages of EOT species may be slightly higher or lower compared to the majority of lakes in the region.
- Extremely Atypical: %EOT is less than the 5th percentile or greater than the 95th percentile. These lakes do not represent the majority of lakes in the region in terms of the percentages of EOT species. These lakes may have very high or very low percentages of EOT species compared to the majority of lakes in the region.

If a lake is considered atypical or extremely atypical, additional monitoring may be necessary to determine a cause.

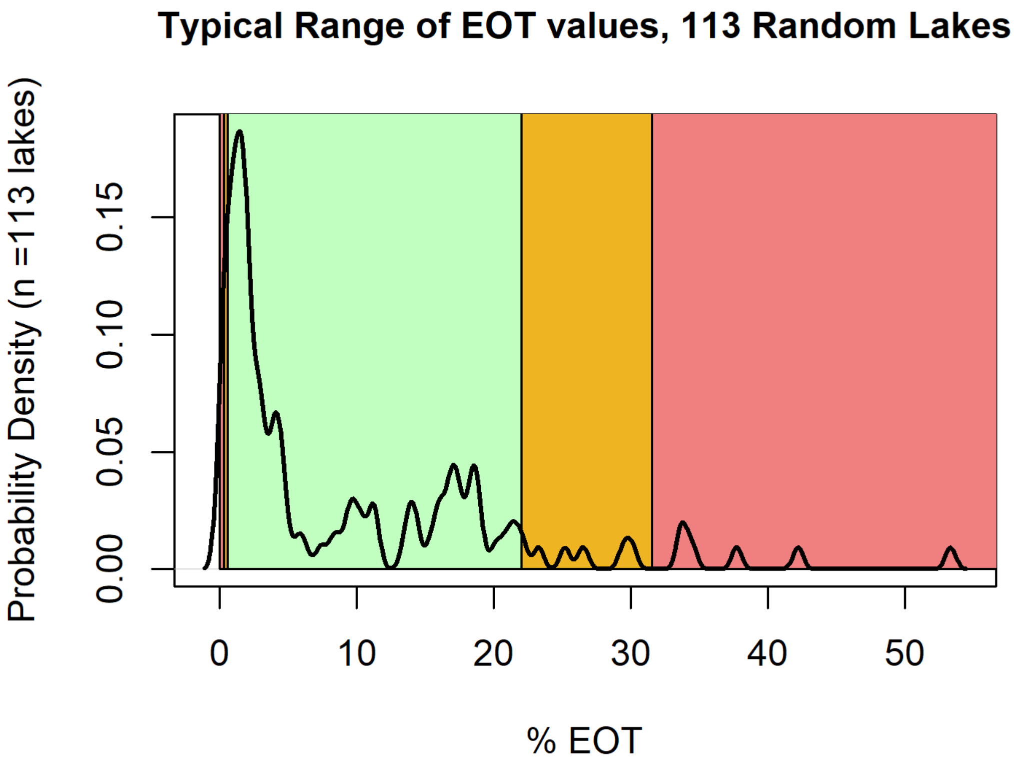

Figure 12. Range of %EOT values of sampled lakes in the region from 2012 to 2017. Typical is shown in green which is between the 10th and 90th percentile (%EOT between 0.55 and 20.99). Atypical is shown in orange which is between the 5th and 10th percentile (%EOT between 0.3 and 0.54) and 90th and 95th percentile (%EOT between 22.1 and 28.01). Extremely atypical is shown in red which is less than the 5th percentile (%EOT less than 0.29) or greater than the 95th percentile (%EOT greater than 31.5).

Otter Lake Results

Two sites (three lake segments each) were sampled on Otter Lake from 2019-2023 – one "impacted" site (BOTTER01) and one "minimally impacted" site (BOTTER02) (Figure 13). Raw data is available upon request. Please contact Katrina Krievins at kkrievins@georgianbaybiosphere.com.

As shown in Figure 14 (BOTTER01) and Figure 15 (BOTTER02), the %EOT for both Otter Lake sites falls within the normal range of what would be expected for a lake in the region.

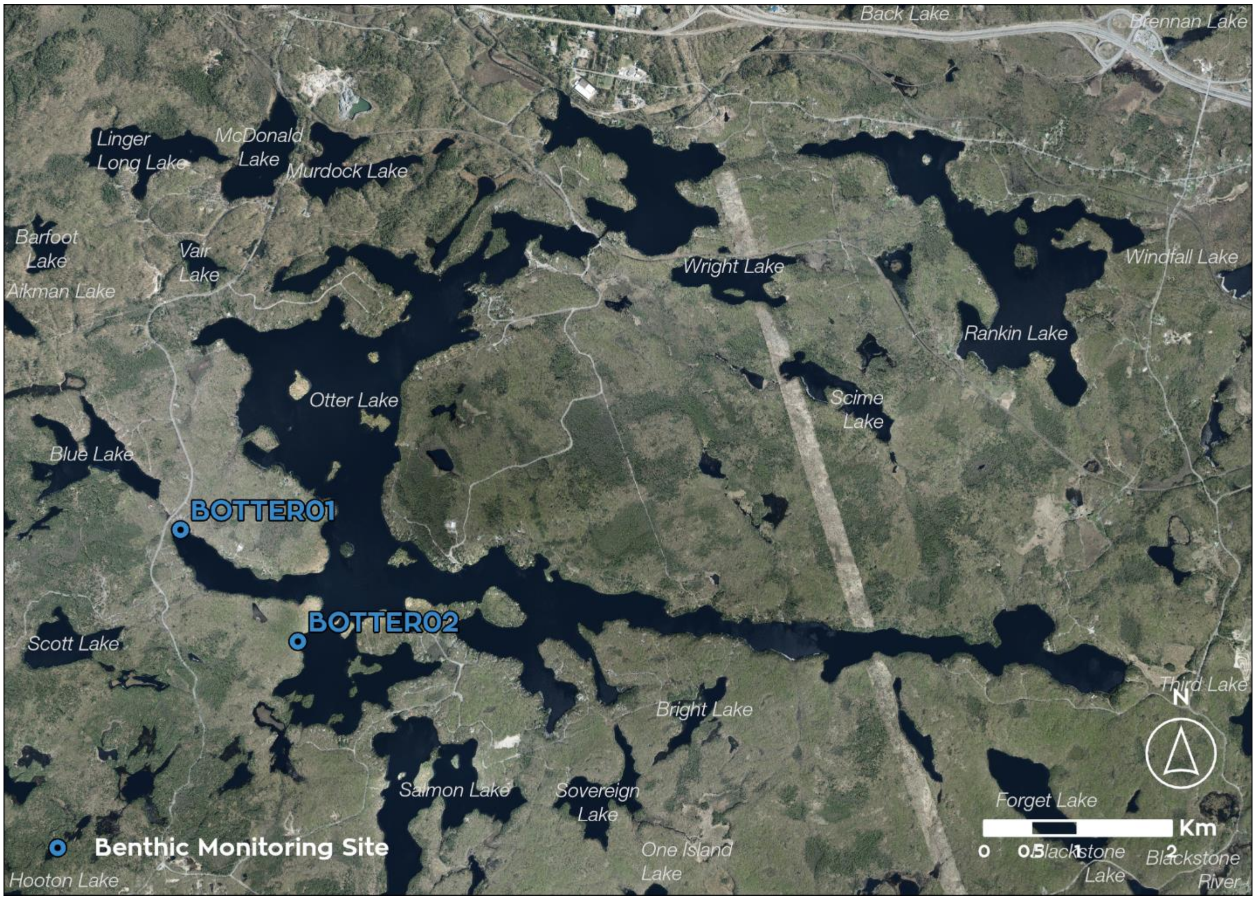

Figure 13. Benthic sampling locations on Otter Lake.

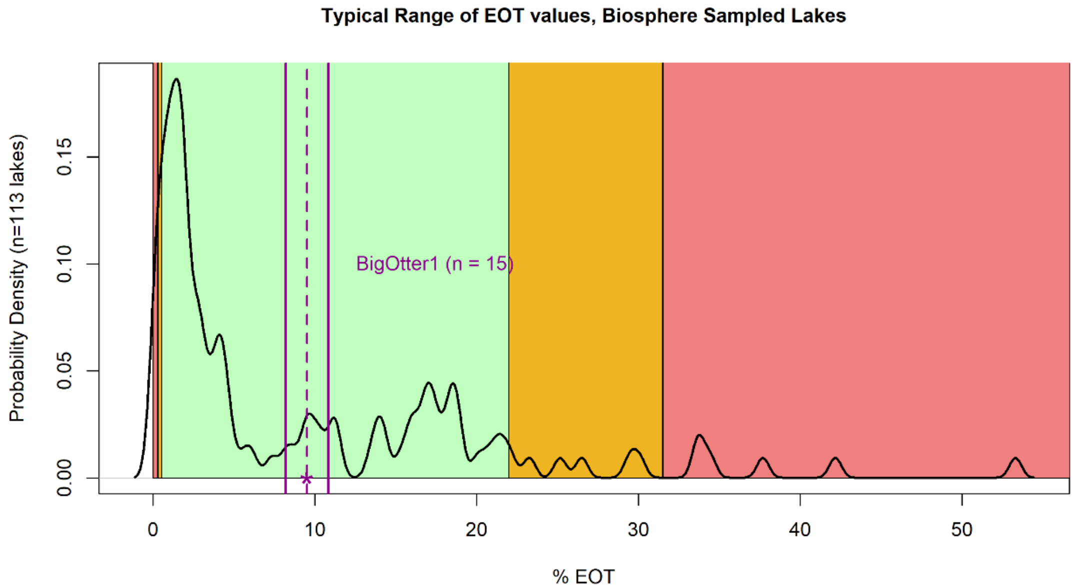

Figure 14. Otter Lake (BOTTER01) average %EOT (dashed purple line) and standard deviation (solid purple line) sampled from 3 lake segments over 5 years (n = 15) fall within the "typical" category (green area) on the typical %EOT range plot (based on 113 sampled lakes). This indicates that the Otter Lake benthic community at site BOTTER01 is typical of what would be expected for a lake in this region.

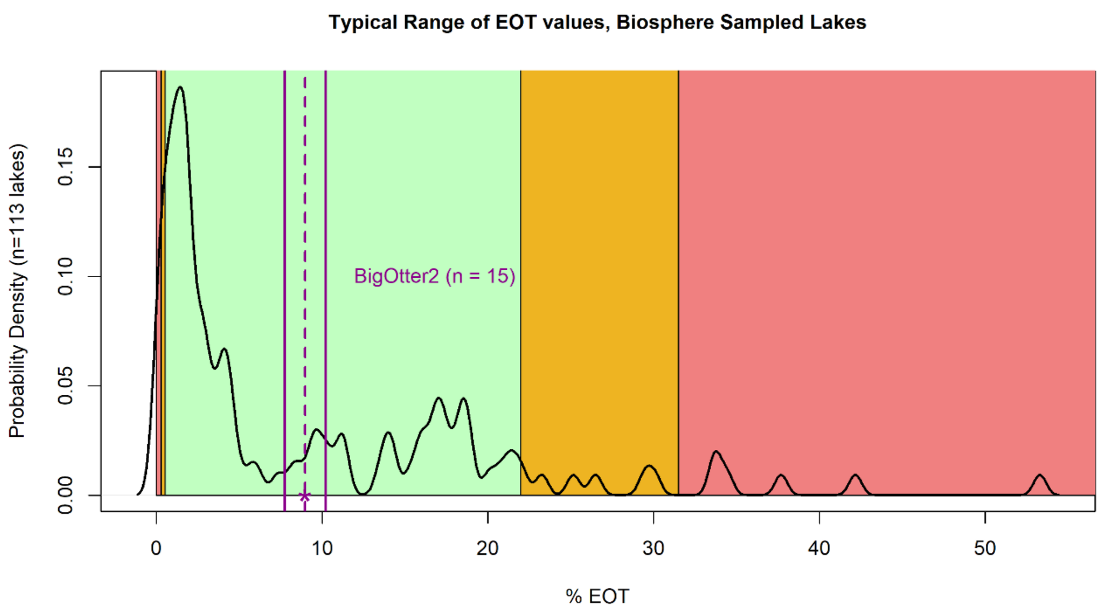

Figure 15. Otter Lake (BOTTER02) average %EOT (dashed purple line) and standard deviation (solid purple line) sampled from 3 lake segments over 5 years (n = 15) fall within the "typical" category (green area) on the typical %EOT range plot (based on 113 sampled lakes). This indicates that the Otter Lake benthic community at site BOTTER02 is typical of what would be expected for a lake in this region.

Recommendations

With lakes in the region facing many threats (e.g., climate change, biodiversity loss, development, pollution), benthic communities act as a barometer of ecological change and impacts. Continuing to monitor the benthic community in Otter Lake will allow OLRA to track trends over time and observe any notable shifts (statistically significant changes) that would be cause for further investigation and potentially require remedial actions.

Little Otter Lake Results

One site (three lake segments) was sampled on Little Otter Lake from 2019-2023 (LOTTER01, Figure 16). Raw data is available upon request. Please contact Katrina Krievins at kkrievins@georgianbaybiosphere.com.

As shown in Figure 17, the %EOT for Little Otter Lake falls within the normal range of what would be expected for a lake in the region.

Figure 16. Benthic sampling location on Little Otter Lake.

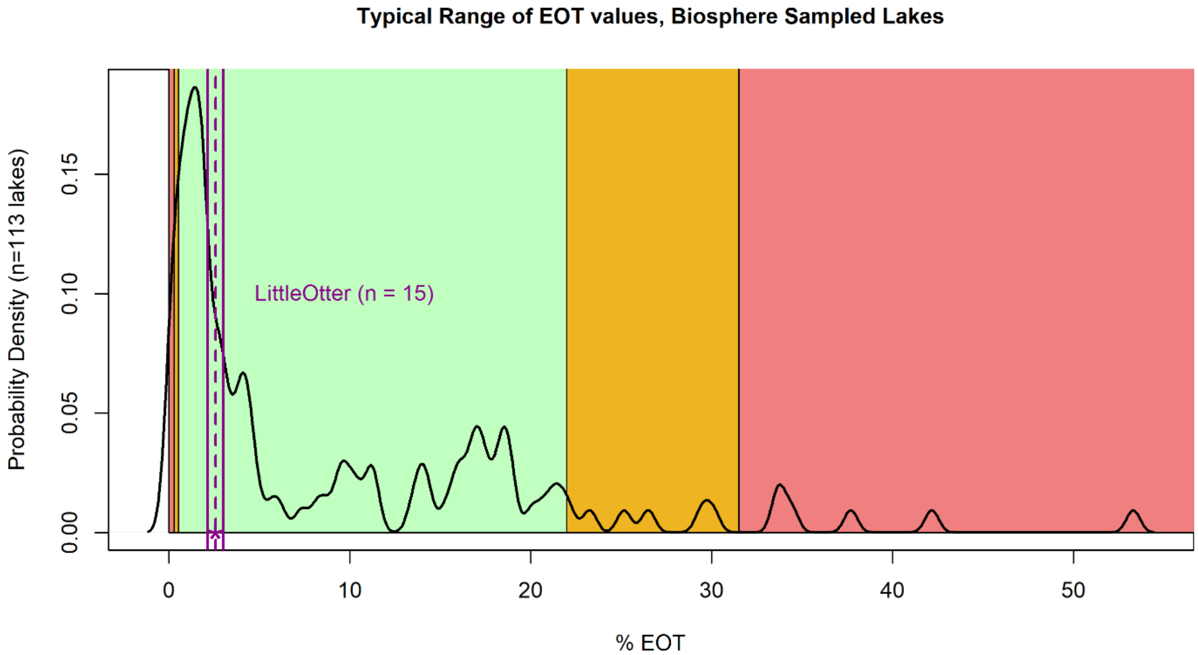

Figure 17. Little Otter Lake average %EOT (dashed purple line) and standard deviation (solid purple line) sampled from 3 lake segments over 5 years (n = 15) fall within the "typical" category (green area) on the typical %EOT range plot (based on 113 sampled lakes). This indicates that the Little Otter Lake benthic community is typical of what would be expected for a lake in this region.

Recommendations

With lakes in the region facing many threats (e.g., climate change, biodiversity loss, development, pollution), benthic communities act as a barometer of ecological change and impacts. Continuing to monitor the benthic community in Little Otter Lake will allow OLRA to track trends over time and observe any notable shifts (statistically significant changes) that would be cause for further investigation and potentially require remedial actions.

Summary of Results

The benthic communities of Otter Lake (both impacted and minimally impacted sites) and Little Otter Lake are considered typical of what would be expected for lakes in this region. The minimally impacted site on Otter Lake had a slightly higher average %EOT than the impacted site. Both Otter Lake sites had a higher average %EOT than the Little Otter Lake site but all sites are considered typical for the region.

No statistically significant differences in %EOT or number of taxonomic groups were identified among sampling years for any of the sampling locations (Appendix C). These communities should continue to be monitored into the future to note any changes over time that may prompt further investigation.

Clark Study of Water Quality on Otter Lake

An embayment water quality monitoring report was prepared in 2017 by Bev Clark, an environmental consultant. The report details the results of monitoring conducted during the open water season in 2017, as well as available historical data collected by the MECP. The conclusions and recommendations from the report are provided in full below (complete report available in Appendix D).

The following conclusions can be drawn from the water quality results derived from this project:

- Conductivity surveys indicate that water throughout Otter Lake has similar watershed origins. The water in Little Otter Lake is slightly different and this may reflect differences in watershed or inflow characteristics.
- Phosphorus concentrations indicate that Otter and Little Otter Lakes are dilute, oligotrophic lakes with excellent water quality and no apparent trends since low-level testing began in 2002. Testing in Little Otter Lake is sparse.
- Phosphorus concentrations in the enclosed embayments that were studied in 2017 are similar in range to those measured over time in the main body of the lake by the Lake Partner Program.
- Bay#2 had elevated P concentrations compared to the other sample sites and higher concentrations approaching 20 µg/L in the late summer which are likely due to internal P loads that are introduced through anoxia in the bottom few meters of water. These conditions are likely natural and related to basin morphometry and watershed characteristics.
- Phosphorus measurements show some variation through time and from location to location but with no trends. There are trends in the long-term, Lake Partner Program water clarity results but the reasons for this are unclear.

Recommendations:

1. Best management practices should be encouraged to minimize the movement of anthropogenic phosphorus into Otter Lake.
2. Volunteers should continue to collect phosphorus and water clarity data at the main basin locations on Otter and Little Otter Lakes. Volunteer dedication is required to collect all samples.

3. If algal blooms occur there should be photographs and water samples taken at the time to assess the extent and species responsible for the bloom.
4. It is not absolutely necessary to establish additional Lake Partner Program sample locations in the enclosed bays because the LPP does not accommodate 1 m off bottom samples.
5. Further test sites could be established if there is evidence of increased development or if typical blue green algal blooms develop in any of the enclosed bays. Water quality measurements do not indicate that this is likely.
6. It would be of some use to conduct annual fall surveys of the enclosed bays to observe temperature oxygen profiles and collect 1 m off bottom samples. This could be accomplished through the Georgian Bay Biosphere enhanced sampling program.

FISH COMMUNITIES

Fish Community Surveys

The Ministry of Natural Resources and Forestry (MNRF) is responsible for gathering data on fish communities in inland lakes. Not all lakes are sampled on a regular basis, nor is the same data collected from every lake. Fish community information presented here represents the most current information publicly available from the MNRF for Otter Lake and Little Otter Lake.

Consumption Advisories

Consumption advisories or restrictions on fish are commonplace across jurisdictions in North America. Fish are exposed to, and absorb, contaminants in the water in a variety of ways (e.g., consuming contaminated food, absorption from the water as it passes over their gills). Contaminants found in fish can come from local sources, as well as sources from thousands of kilometers away (e.g., airborne contaminants that end up in the water via rain or snowfall). Examples of contaminants that are known to be transported long distances include mercury, polychlorinated biphenyls (PCBs), and toxaphene.

Based on species, size, and location, certain fish are more or less suitable to eat than others. Smaller fish tend to be less contaminated than larger fish of the same species. In the Great Lakes, leaner fish (e.g., bass, pike, walleye, perch, panfish) tend to have much lower contaminants than fatty species like trout and salmon. In inland lakes, top-predatory fish such as pike and walleye generally have greater contaminants than panfish or whitefish.

Advisories provide consumption advice for the general population and sensitive populations. The sensitive population includes women of child-bearing age (women who intend to become pregnant or are pregnant) and children younger than 15 years of age. These groups are considered sensitive because pregnant women and nursing mothers can affect the health of their baby through a diet elevated in contaminants, and young children are affected by contaminants at lower levels than the general population.

Otter Lake

Table 3 provides a high-level overview of the fish communities in Otter Lake and their management.

Table 3. Summary of fish communities and their management in Otter Lake (see link)

Major fish species	Lake trout, northern pike, smallmouth bass (introduced; status uncertain), largemouth bass, black crappie (introduced 1999)
Other fish species	Cisco, rainbow smelt (introduced), pumpkinseed, brown bullhead, yellow perch, rock bass, white sucker
Lake trout management	Designated; natural reproduction. Season open from third Saturday in May to September 30, no lake trout between 40-55cm may be kept
Current stocking	None
Historic stocking	Walleye (1939), smallmouth bass (1941-1950), lake trout (1956-1998), rainbow trout (1989-2001)
Contaminants (species tested)	Lake trout (2013)

Population Survey (2013)

Otter Lake was most recently surveyed by the MNRF in 2023, however, results are not yet available. Prior to 2023, a Summer Profundal Index Netting (SPIN) survey was conducted in 2013. SPIN is an adaptable methodology that can be used to assess both small bodied and large bodied lake trout populations in a wide range of lake sizes (Sandstrom & Nester, 2009). A total of 29 net sets were completed over three days of netting (Figure 18).

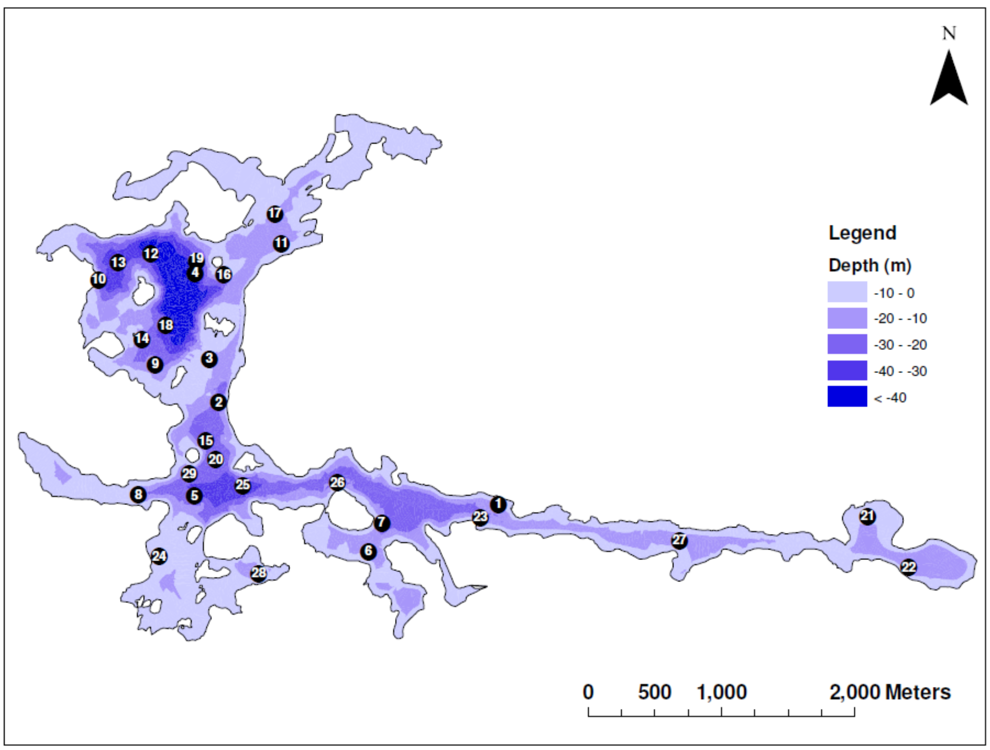

Figure 18. Map of Otter Lake showing bathymetry and net set locations (Scholten, 2014).

During the 2013 survey, nine lake trout, five cisco, two white sucker, and seven smallmouth bass were caught (Table 4). Four of the nine lake trout were large, old (16-20 years) stocked fish. Five were younger (6-9 years) naturally reproduced fish. Based on the survey, the population of catchable (>300 mm) fish is estimated to be in the range of several hundred; a moderately low density. The proportion of naturally reproduced fish in the population has increased from a small proportion to about half, since supplemental stocking was discontinued after 1998. The observation that most natural lake trout were produced after stocking ceased is an encouraging sign of increased reproduction.

Table 4. 2013 Otter Lake SPIN catch summary (Scholten, 2014)

Effort	Depth Stratum	Lake Trout	Cisco	White Sucker	Smallmouth Bass
1	10	1			1
2	20	1			
3	3				1
5	20	1	3		
6	10	1			
7	20		1		
9	10				1
11	10	1			
13	30	1			
14	20	1			
15	20		1		
16	10	1			
20	20	1			
22	10				1
24	3			2	3

Otter Lake appears to have a natural tendency for relatively low lake trout abundance but a large average size, regardless of whether stocking is occurring, due to the natural characteristics of the lake basin and the composition of the fish community.

Lake Trout Habitat

Spawning habitat enhancement was completed on Otter Lake in 2005. Many of the lake trout lakes in the same part of the district have very small areas of good spawning habitat. However, as stated in the 2014 MNRF report, the amount of spawning habitat is probably not the factor that limits population size in Otter Lake (the amount of deep water juvenile habitat is probably more limiting, for instance). Nevertheless, spawning habitat is the one aspect of habitat that can be enhanced and on lakes like Otter Lake where this habitat type is not obviously abundant, shoal enhancement is probably a worthwhile endeavour. At a minimum, it adds resilience to this component of the habitat. Monitoring of shoal use is a relatively low cost, low skill activity that is well suited to volunteers and should be conducted if there is interest from local residents.

Lake Trout Management Recommendations

Otter Lake is currently classified for management of a natural lake trout population. Based on the 2013 assessment, the MNRF believes that this designation should remain. Natural reproduction is occurring and there is some indication that the population is growing as stocked fish decline in abundance. The current management approach should be continued until stocked fish are essentially gone from the population and the natural population has reached its full potential.

The standard regulation for a lake greater than 100 ha with a large bodied population is the 40-55 cm protected slot size (OMNR, 1995). Otter Lake has this protected slot size but also is closed to lake trout fishing in the winter, a regulation normally applied only to lakes less than ~100 ha. Most of the lake trout caught in the 2013 survey were larger than the protected slot size and would have been legal to harvest, suggesting the slot size is not effective at limiting harvest in this population, especially considering that the population abundance is already low. It is recommended that the winter closure be retained in addition to the slot size limit.

In summary, the lake trout population in Otter Lake is currently at a moderately low density. The proportion of naturally reproduced fish in the population has increased from a small proportion to about half, since supplemental stocking was discontinued. The observation that most natural lake trout were produced after stocking ceased is an encouraging sign of increased reproduction. The lake appears to have a natural tendency for relatively low abundance but a large average size, regardless of whether stocking is occurring, due to the natural characteristics of the lake basin and the composition of the fish community. It is recommended that the lake continue to be managed for a natural population with no supplemental stocking and with the current angling regulations (Scholten, 2014).

Consumption Advisories

In terms of advisories for eating fish from Otter Lake, mercury and PCBs are the contaminants of concern (Table 5). Specifically, advisories exist for northern pike and smallmouth bass due to concerns around mercury, and for lake trout, the concern is around PCBs. To learn more about fish consumption advisories and how to reduce the risk from contaminants in fish, please visit the MECP website on eating Ontario fish.

Table 5. Fish consumption advisories for Otter Lake (see link)

Species	General Population	Sensitive Population*
Lake trout [2]	• max 2 meals/month of fish 65-70cm	• no meals of fish 65-70cm
Northern pike [1]	• max 8 meals/month of fish 60-65cm • max 4 meals/month of fish 65-70cm • max 4 meals/month of fish 70-75cm • no meals of fish >75cm	• max 4 meals/month of fish 60-65cm • no meals of fish 65-70cm • no meals of fish 70-75cm • no meals of fish >75cm
Smallmouth bass [1]	• max 16 meals/month of fish 25-30cm • max 12 meals/month of fish 30-35cm • max 8 meals/month of fish 35-40cm • max 4 meals/month of fish 40-45cm	• max 4 meals/month of fish 25-30cm • max 4 meals/month of fish 30-35cm • no meals of fish 35-40cm • no meals of fish 40-45cm

*Women of child-bearing age and children under 15; [1] Mercury; [2] Polychlorinated biphenyls (PCBs)

Little Otter Lake

Table 6 provides a high-level overview of the fish communities in Little Otter Lake. Compared to Otter Lake, Little Otter Lake has received very little fisheries management attention. The fishery is dominated by self-sustaining populations of bass and pike.

Table 6. Summary of fish communities and their management in Litter Otter Lake (see link)

Major fish species	Northern pike, largemouth bass, smallmouth bass
Other fish species	Rock bass, pumpkinseed, longear sunfish (status uncertain), cisco, yellow perch, white sucker, rainbow smelt (introduced)
Lake trout management	Not designated
Current stocking	None
Historic stocking	None
Contaminants (species tested)	No testing done

Consumption Advisories

No fish from Little Otter Lake have been tested for contaminants. Accordingly, there are no consumption advisories specific to Little Otter Lake. Readers are advised to consult advisories for Otter Lake.

eDNA PROJECT

As organisms (e.g., fish, reptiles, invertebrates) move through their environment, they leave behind genetic material such as skin, scales, fur, and feces. Environmental DNA, or eDNA, refers to genetic material collected from an environmental sample (e.g., water, soil, snow, air) rather than directly from an individual organism. eDNA can be used to understand what organisms were recently in an area without actually having to see or capture those organisms. The use of eDNA has been growing in popularity in recent years, particularly for detecting rare or hard to find species, as well as invasive species. In some cases, eDNA has the potential to replace more traditional means of sampling (learn more here).

The OLRA board was approached with a proposal to collect and analyse water samples from Otter Lake. In 2022, OLRA membership supported initiating a small eDNA project to measure and monitor the biodiversity of aquatic and terrestrial organisms that reside in and around Otter Lake. Of particular interest is the potential detection of species at risk and early detection of invasive species. This information can be used to better target future stewardship efforts and complements existing water testing and benthic monitoring supported by OLRA.

Six eDNA composite samples were collected on August 6, 2022. In an effort to maximize sample coverage, each composite sample was comprised of two samples collected from two habitat types (shoreline wetland habitat and tributary stream/wetland habitat) and combined for analysis. Three additional, privately funded eDNA samples were collected in spring 2023 from two vernal pools and a watercourse/wetland habitat on private property. The intent of this effort was to maximize the diversity of habitats sampled to obtain a broad cross section of organisms.

The results show a diversity of invertebrates, fish, and herptiles (frogs, salamanders, snakes, turtles), as well as several mammal and bird species (Table 7). While most fish, herptiles, mammals, and birds could be identified to genus and even species, many invertebrate species could only be identified to family or genus. There were many “unidentified” eDNA sequences in the invertebrate group because the DNA barcoding database for invertebrate species is less extensive compared to the other groups.

Table 7. Results for six composite eDNA samples taken from locations around Otter Lake

Group	Sampling Locations					
	Broken Link Trib/Sunny Point Bay	Rankin Lake Trib/Little Otter Bay	Link Property Trib/Link Shore	Blue Lake Road Beaver Pond/Sand Bay	Salmon Lake Trib/Salmon Lake Bay	Sovereign Lake Trib/Mud Bay
Invertebrates	132	121	42	76	123	115
Fish	16	13	18	15	11	19
Amphibians	3	2	1	6	3	2
Reptiles	0	0	0	2	0	0
Birds	1	0	0	1	0	1
Mammals	1	0	0	4	2	2
Total # of species	**153**	**136**	**61**	**104**	**139**	**139**

Many organisms were common to all sampling locations, while some only occurred at select locations. Collectively, the following organisms were identified (as distinct DNA types):

- 364 invertebrate species
- 32 fish species
- 10 amphibian species
- 7 mammal species
- 2 reptile species
- 2 bird species

The breakdown of these organisms is shown in Table 8.

Table 8. eDNA results by class, order, family, and genus

Sample ID	Class	Order	Family	Genus	Taxa (Species)
Broken Link Trib/Sunny Point Bay	6	12	36	51	132 (34)
Rankin Lake Trib/Little Otter Bay	5	10	23	45	121 (29)
Link Property Trib/Link Shore	2	3	6	14	42 (9)
Blue Lake Road Beaver Pond/Sand Bay	5	9	14	24	76 (15)
Salmon Lake Trib/Salmon Lake Bay	7	12	21	36	123 (27)
Sovereign Lake Trib/Mud Bay	6	8	18	38	116 (20)

Spring samples were somewhat less diverse than summer samples, with fish and turtles not being detected in the spring samples. Invertebrate diversity was similar across seasons.

An additional six samples have been funded by OLRA membership along with three privately funded samples for 2023. Sampling this year will occur in mid September (after lake turnover) and focus more on deep stations and rocky nearshore habitats. When available, these results can be compared to results from the 2023 MNRF fisheries assessment.

SUMMARY OF RECOMMENDATIONS

Water Quality

Continue LPP sampling once per year on Otter Lake (Station 4193, Site ID 3) and Little Otter Lake (Station 4196, Site ID 1). Spring TP sampling is sufficient for most lakes in the region, unless a lake has experienced regular fall algal blooms.

Continue to conduct benthic monitoring annually to track changes over time. While all three sites sampled are currently considered to have 'typical' benthic communities, lakes in the region are experiencing increasing pressures, such as climate change, development, and invasive species. It is important to continue monitoring water quality even in lakes considered to be healthy so that if/when changes start to occur, those changes are noted and appropriate actions can be taken swiftly (e.g., stewardship actions, enhances monitoring or studies). Without long-term, continuous monitoring, changes in the benthic community and water quality more broadly may go unnoticed until there is a significant problem.

Fish Communities

Maintain current angling regulations for lake trout (40-55 cm protected slot size, winter closure). If there is interest, volunteers could monitor the enhanced spawning habitat to determine whether it is being used.

The province of Ontario released new regulations for the sale and possession of live bait in July 2020, anglers should familiarize themselves with these changes to remain in compliance with the new regulations at all times.

The app MyCatch by Angler's Atlas can be used by people fishing on the lake to log fishing trips and share fishing data confidentially with biologists. Use of the app can help supplement fisheries data between MNRF population surveys.

Stewardship Activities

OLRA should encourage Otter Lake and Little Otter Lake property owners to maintain and/or restore natural shorelines. GBB's Planting for Pollinators guide offers property owners assistance in choosing plants for their property that are native to eastern Georgian Bay and that help to enhance the property and conserve important natural habitats.

Property owners interested in decreasing their ecological footprint can also utilize GBB's Life on the Bay stewardship guide (designed to be used by waterfront property owners on inland lakes as well as Georgian Bay). The guide covers a range of topics including how to live with wildlife, how to use landscaping to improve water quality, best practices during construction, how to store chemicals and garbage, and more.

There are many citizen science programs for interested cottagers and residents to get involved in. Examples include invasive species reporting, IceWatch, FrogWatch, Canadian Lakes Loon Survey, and many others. GBB also has a Bioblitz guide available for download to help community groups plan and host their own Bioblitz. This would be a great opportunity to engage and educate the OLRA community.

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APPENDICES

Appendix A. Otter Lake LPP Monitoring Data (Station 4193)

It is important to note that LPP TP data are presented as two samples (TP1 and TP2) plus an average for each sampling date. TP1 and TP2 are duplicate TP concentrations which help to verify confidence in the results and provide a contingency against one sample being lost due to breakage during shipment or laboratory accidents.

If there are major differences between TP1 and TP2, it is likely that one of the two samples was contaminated, for example by zooplankton or other debris. In this case the data will be 'flagged' in yellow. Use caution when interpreting TP data that has been flagged.

Site ID	3
Description	N end, deep spot
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2002	5.77	8.20	5.50	6.85	
2003	6.16	5.20	6.80	6.00	
2004	6.00	5.20	4.29	4.75	
2005	6.33	5.40	5.40	5.40	
2006		5.09	4.46	4.78	
2007	6.53	8.82	5.11	6.97	
2008		3.76	3.84	3.80	
2009	5.66	5.81	6.99	6.40	2.34
2010		4.60	6.60	5.60	2.14
2011	5.98	7.20	6.80	7.00	2.52
2012	6.03	5.80	6.20	6.00	2.42
2013	5.35	6.20	7.60	6.90	
2014	4.79	7.20	5.60	6.40	2.58
2015		7.60	4.80	6.20	2.38
2016	4.47	74.00	7.40	40.70	

Jul 2017		5.20	5.00	5.10	
Jul 2017		6.40	5.40	5.90	
Aug 2017		4.80	5.20	5.00	
Oct 2017		5.20	5.20	5.20	
Oct 2017		5.00	5.80	5.40	
May 2018		4.20	4.20	4.20	2.30
Jun 2018	4.28	5.20	5.40	5.30	2.00
Jul 2018		7.60	8.60	8.10	
Aug 2018		4.60	4.60	4.60	
Sept 2018		5.00	5.80	5.40	
Oct 2018		5.20	5.80	5.50	
Jun 2019		7.40	5.60	6.50	1.90
Sept 2019		8.20	6.80	7.50	
Oct 2019		6.20	6.00	6.10	
May 2020		7.60	7.20	7.40	2.30
Oct 2020		7.00	4.40	5.70	2.40
May 2021		5.6	6.5	6.1	2.4
July 2021		5.5	5.9	5.7	2.5
July 2021		8.3	5.8	7	
Sept 2021		4.6	4	4.3	
Sept 2021		10.3	9.1	9.7	
Oct 2021		4.6	6	5.3	
May 2022		3.65	5.01	4.33	
July 2022		5.57	5.23	5.40	
Aug 2022		4.79	4.56	4.68	
Aug 2022		3.76	3.73	3.75	
Sept 2022		6.17	5.54	5.86	
Oct 2022		5.20	5.28	5.24	

Site ID	7
Description	Mid lake, deep spot
Data Collector	Seguin Township

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2012	4.80	4.00	3.40	3.70	
2013		7.20	7.20	7.20	

2014	3.50	5.20	5.40	5.30	
2015		6.00	5.80	5.90	
2017	4.40	5.80	6.80	6.30	2.28
2017		6.00	6.00	6.00	
2018	4.50				2.34

Year	Site ID	Description	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Data Collector
2016	1	OTO1	5.2	5.2	5.20	MOE Northern Region
2016	2	OTO2	5.6	6.0	5.80	MOE Northern Region
2004	6	N end, NW bay	5.8	5.8	5.80	LPP volunteer

Appendix B. Little Otter Lake LPP Monitoring Data (Station 4196)

It is important to note that LPP TP data are presented as two samples (TP1 and TP2) plus an average for each sampling date. TP1 and TP2 are duplicate TP concentrations which help to verify confidence in the results and provide a contingency against one sample being lost due to breakage during shipment or laboratory accidents.

If there are major differences between TP1 and TP2, it is likely that one of the two samples was contaminated, for example by zooplankton or other debris. In this case the data will be 'flagged' in yellow. Use caution when interpreting TP data that has been flagged.

Site ID	1
Description	Mid lake, deep spot
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2004		7.09	6.70	6.90	
2006		9.99	7.95	8.97	
May 2017		9.80	8.80	9.30	
Jul 2017		7.80	7.00	7.40	
Jul 2017		6.80	6.80	6.80	
Aug 2017		6.00	6.00	6.00	
Oct 2017		8.00	8.80	8.40	
Oct 2017		7.40	6.80	7.10	
Jun 2018	3.63	7.20	7.20	7.20	3.94
Jun 2018		7.00	6.40	6.70	2.04
Jul 2018		9.20	7.40	8.30	
Aug 2018		7.00	7.60	7.30	
Sept 2018		7.60	8.40	8.00	
Oct 2018		7.00	10.80	8.90	
June 2019		10.00	8.80	9.40	2.80
Sept 2019		8.00	8.80	8.40	
Oct 2019		9.00	8.80	8.90	
May 2020		8.20	7.20	7.70	4.12

Oct 2020		21.40	12.20	16.80	4.78
May 2021		9.2	9.1	9.2	4.1
July 2021		11	13	12	4.5
July 2021		7.7	8.4	8.1	
Sept 2021		4.9	6	5.4	
Sept 2021		6.9	6.4	6.6	
Oct 2021		6.6	6.2	6.4	
May 2022		5.04	4.62	4.83	3.71
July 2022		6.70	7.15	6.93	3.74
Aug 2022		6.80	6.42	6.61	4.23
Aug 2022		4.98	5.73	5.36	4.31
Sept 2022		6.19	7.53	6.86	4.39
Oct 2022		6.19	6.25	6.22	4.34

Site ID	2
Description	Mid lake, deep spot
Data Collector	Seguin Township

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2013		3.20	8.60	5.90	
2014	2.30	8.40	6.40	7.40	
2016		6.20	6.40	6.30	
2017	3.10	7.40	7.60	7.50	3.90
2018	4.40	8.40	8.80	8.60	4.24

Appendix C. Annual %EOT and Taxa Results

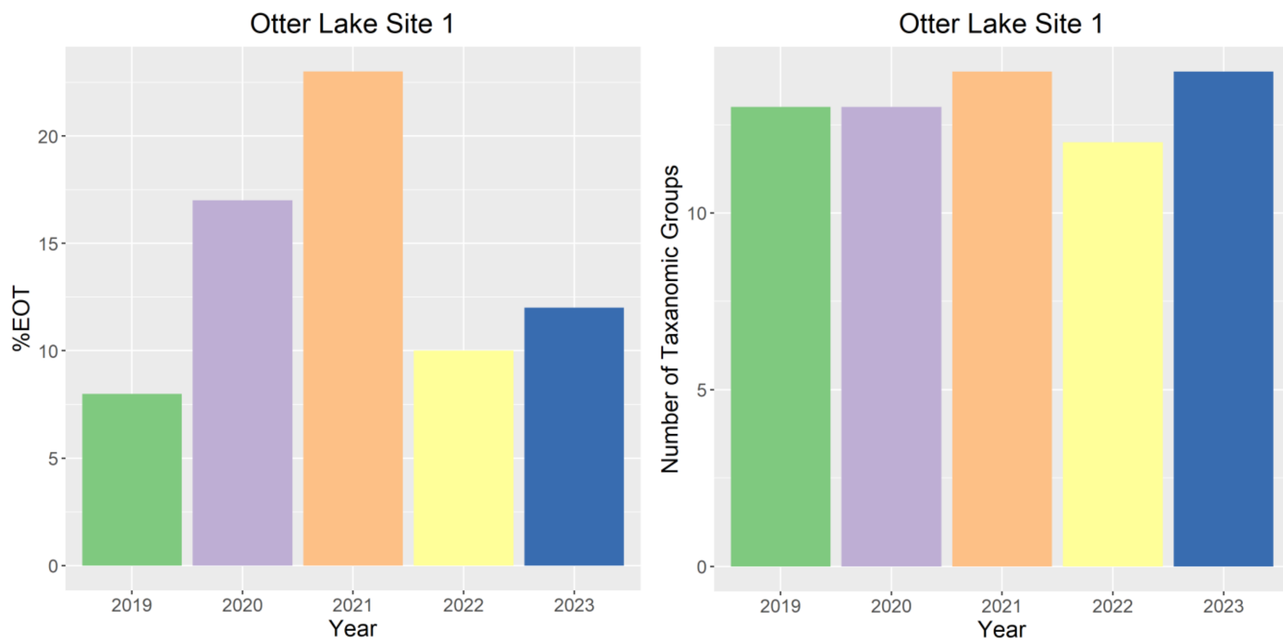


Figure 19. % EOT and the number of taxonomic groups in Otter Lake Site 1 from 2019 to 2023.

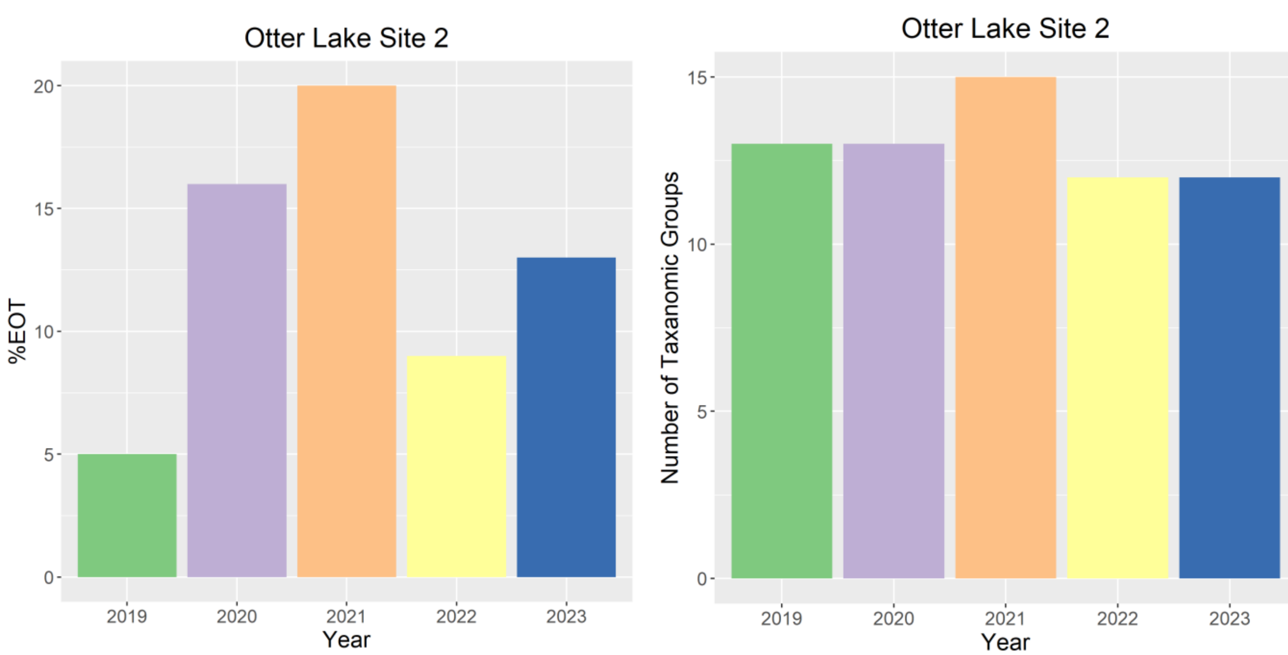


Figure 20. % EOT and the number of taxonomic groups in Otter Lake Site 2 from 2019 to 2023.

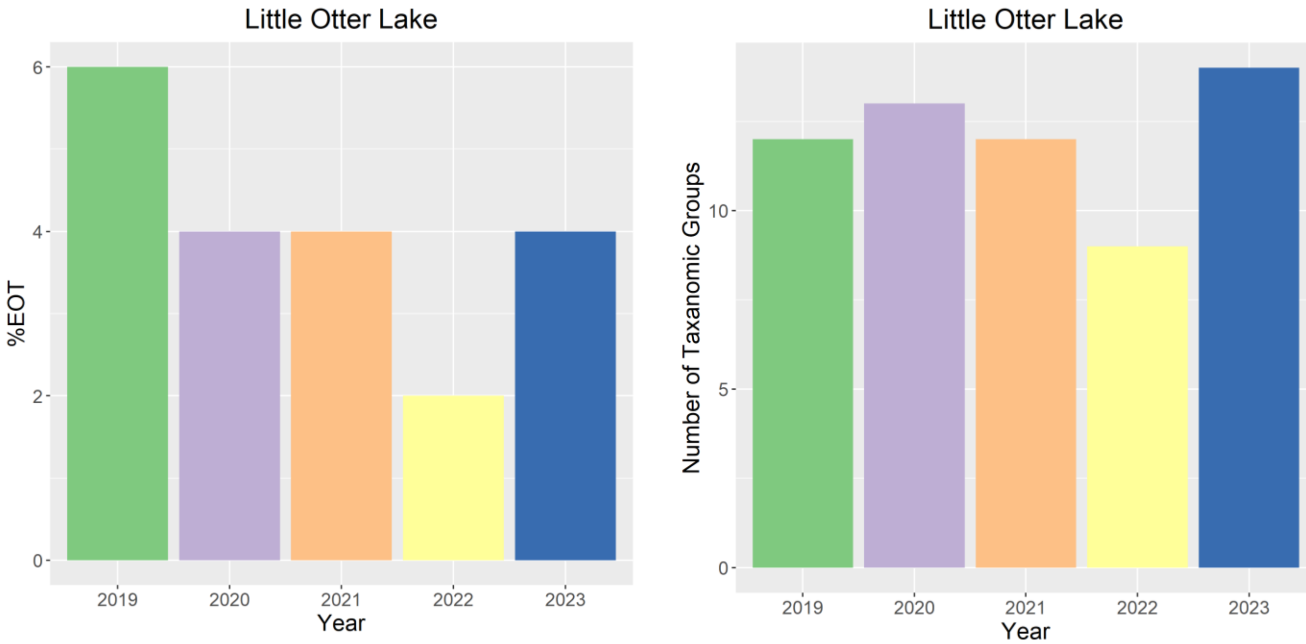


Figure 21. % EOT and the number of taxonomic groups in Little Otter Lake from 2019 to 2023.

Appendix D. Embayment Water Quality Monitoring 2017 and Historical Data Review

Otter Lake, Seguin Twp.

Embayment Water Quality Monitoring 2017 and Historical data Review

Prepared for the Otter Lake Ratepayers' Association

by Bev Clark

November, 2017

Contents

Background

Water Quality was determined to be a priority for members of the Otter Lake Ratepayers' Association. Although the water quality in Otter Lake as determined by the Ministry of the Environment and Climate Change (MOECC), Lake Partner Program (LPP) is excellent, there were concerns that the isolated embayments may have water quality that is degraded when compared to the main open water areas of the lake. This concern was elevated by a recent algal bloom in one of the enclosed embayments.

Otter Lake has been a participant in the MOECC Lake Partner Program for many years, but these observations are made only at the deepest location in the lake and cannot provide information that is transferrable to the enclosed embayments. A more detailed survey of several isolated embayments was therefore planned for the 2017 ice-free season.

In the open water season in 2017, Otter Lake was sampled monthly in 6 enclosed bays (see map). The focus was to see whether there were differences in water quality in these bays compared to the main lake. One additional site was sampled in Little Otter Lake with the samples sent to LPP.

This report contains data collected in the 6 embayments in 2017 together with any available historical data collected by MOECC.

Historical Data Review

Phosphorus and oxygen

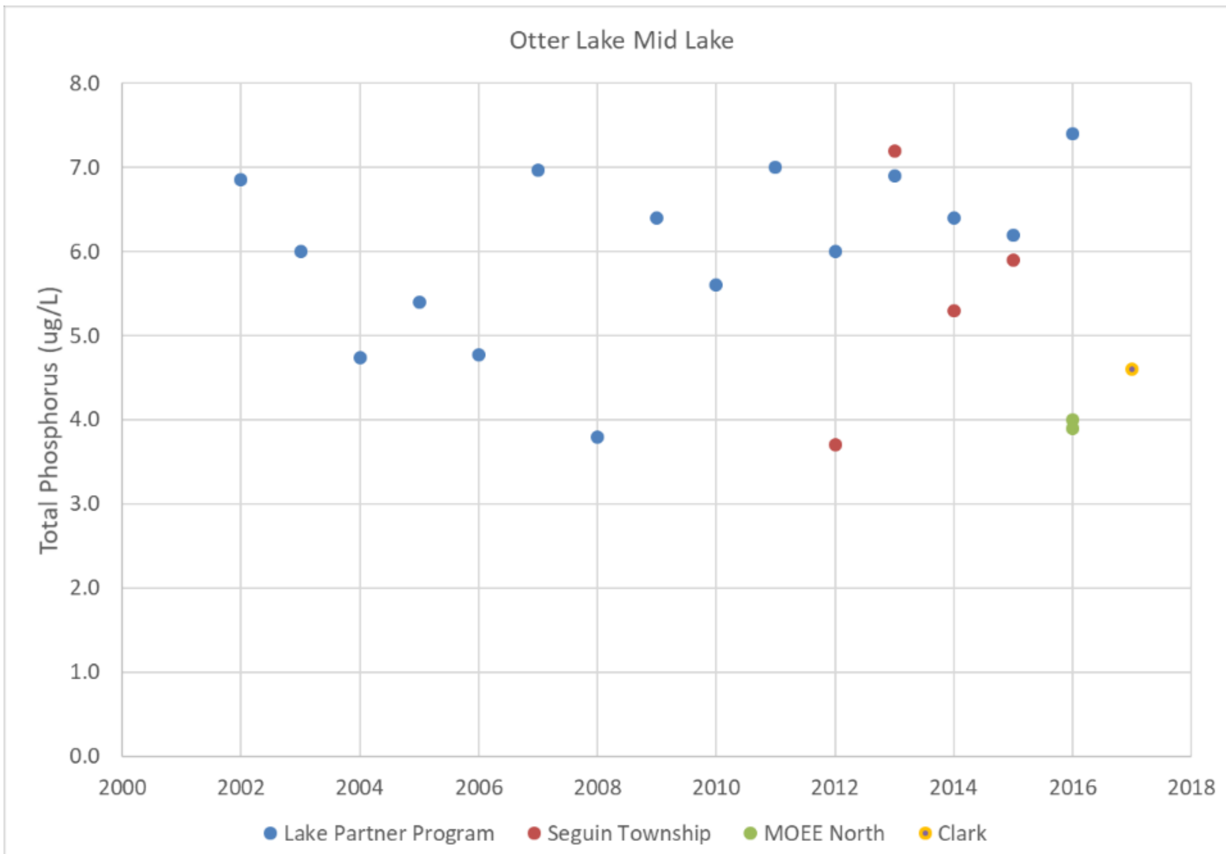
Good historical data has been collected for Otter Lake as it relates to water clarity, phosphorus and dissolved oxygen. Phosphorus data has been collected by multiple agencies because modeled and measured phosphorus concentrations are compared to background concentrations to determine the capacity for development on individual lakes by MOECC and by Seguin Township. Oxygen profile data has been collected by the Ministry of Natural Resources to determine suitability of oxygen habitat for cold water stenotherms. Habitat quality expressed as mean volume weighted hypolimnetic dissolved oxygen(MVWHDO) is used to determine capacity for development on Lake Trout Lakes.

AECOM modeling (2010) determined Otter Lake to be over capacity with both measured and modeled P concentrations above background + 50% (background + 50% for Otter = 4.3 µg/L) and the lake is also assessed to be at capacity with respect to MVWHDO which takes priority for capacity assessment in Lake Tout lakes (lakes must have >7 mg/L MVWHDO). This does not mean that the water quality in Otter Lake is substantially degraded. Lakes with low background phosphorus concentrations like Otter Lake have very low and pristine (oligotrophic) total phosphorus concentrations even when at threshold and the oxygen climate in the lake is only marginally below concentrations that are considered optimal (7mg/L) (See inset).

	Basin	whole lake long-term, mvwhdo	times	hypo %		
Measured	1	7.517	x	0.6076	equals	4.567
Data (above)	2	6.743	x	0.2204	equals	1.486
	3	5.4	x	0.1711	equals	0.923
Whole lake, long-term mvwhdo - measured (observed)						**6.976**
With	1	7.233	x	0.6076	equals	4.394
90 seasonal	2	6.528	x	0.2204	equals	1.438
lots (above)	3	5.242	x	0.1711	equals	0.897
Whole lake, long-term mvwhdo - with 90 seasonal lots added						**6.729**

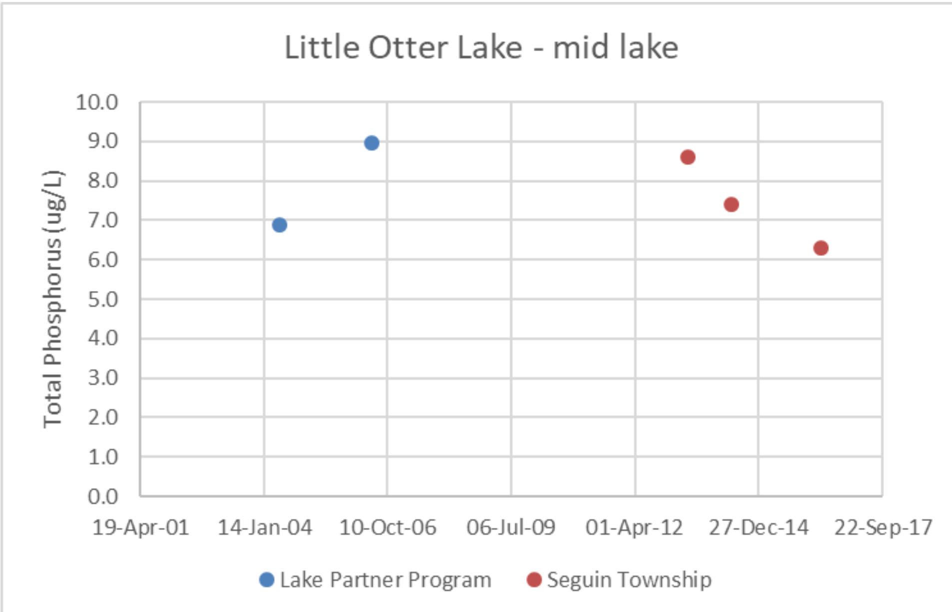
Phosphorus concentrations in Otter Lake have been measured in the spring by volunteers for the MOECC - LPP since 2002 (Figure 1). Although there is no trend during this period there is some variation in the data with values ranging from about 4 to 7 µg/L. This variation is more than would be noticed in some lakes but the range in values is captured by all agencies indicating a natural range in values. The average of all measurements is 5.7 µg/L indicating an oligotrophic lake (P less than 10 µg/L).

Figure 1 – Total phosphorus concentrations at the deepest loaction in Otter Lake (approx. latitude = 45^{0}17'15", longitude = 79^{0}57'48").



Total phosphorus concentrations have also been measured by the same agencies in Little Otter Lake but with less frequency (Figure 2). Average concentration is 7.6 µg/L. Concentrations here may be slightly higher due to the shallow nature of the lake (< 6m) or due to inflows with higher concentrations from Rankin Lake.

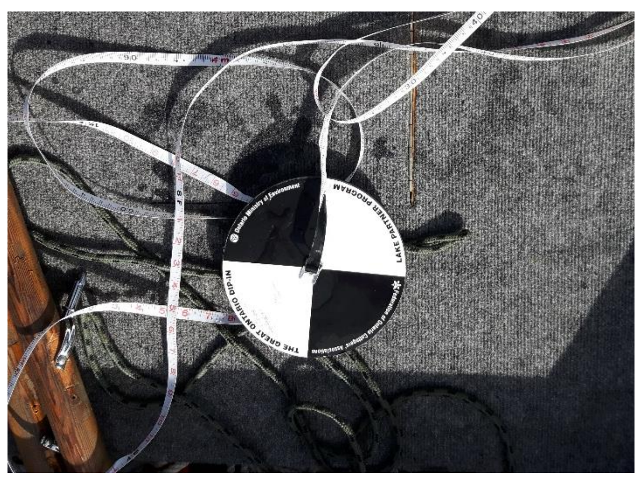
Figure 2 - Total phosphorus concentrations at the centre of Little Otter Lake (approx. latitude = $45^0$17'49", longitude = $79^0$56'35").



Water Clarity

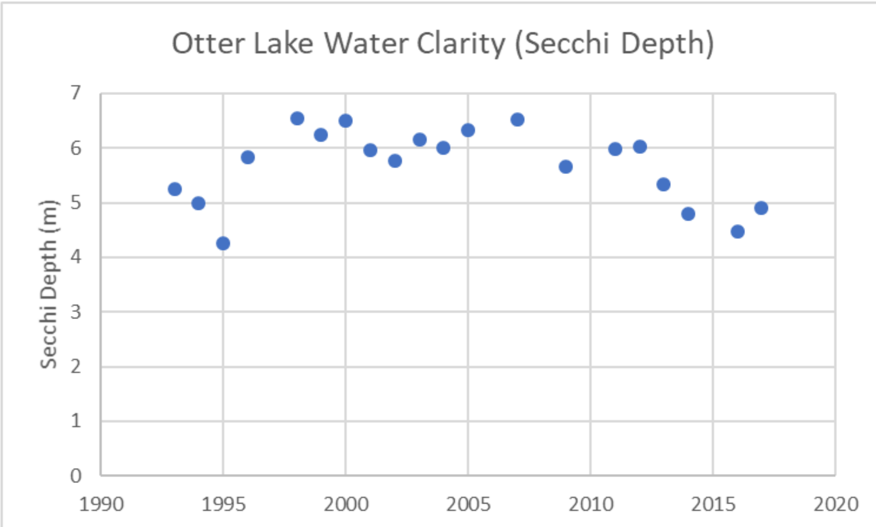
Water clarity observations are made using a Secchi disc on visits to collect water chemistry data. Water clarity can be used as a surrogate for nutrient status, but this relationship is not a good substitute for collecting phosphorus data. As a result, these water clarity observations are seldom used to reflect water chemistry parameters, but they can be useful to track changes that may occur in water clarity which are not linked to general chemistry measurements. This would occur, for example, in cases where zebra mussels have changed the water clarity with no associated change in phosphorus concentrations.

There are trends in the annual mean water clarity observations through time in Otter Lake (Figure 3) but the reasons for this are unclear. The data indicate a loss of water clarity since 2005 to levels that were measured in the 1990s. This may be due to variations in the phosphorus concentrations measured during the same period. In 2017 we observed considerable variation in Secchi depth observations between locations and between visits. It may be that Otter Lake experiences variations in both phosphorus and water clarity measurements that are somewhat higher than expected due to in-lake or watershed processes.



Secchi disc

Figure 3 – Average annual water clarity (Secchi depth in meters) for Otter Lake.



General Water Chemistry

Although there are considerable phosphorus and oxygen data available for Otter Lake there is very little data available for general water chemistry parameters. This is a condition that is shared for the majority of Ontario Lakes. A search of the Dorset Inland Lakes Database shows some measurements (Table 1) from the 1980s for Otter and Little Otter Lakes and these data are typical for what is expected in Lake Trout Lakes on the shield in Ontario, i.e. neutral pH, low alkalinity, low conductivity, low Dissolved Organic Carbon.

There are not enough of these data to draw any conclusions other than to say that the numbers fall into the same range as the observations made in 2017 during this project.

Table 1 – Historic water chemistry data for Otter Lake (MOECC, Dorset).

STN	LAKE_NAME	SDATE	SLOCATION	Secchi	PH	ALK	COND	DOC	CA	MG	NA	K	SO4	TKN	
4197	OTTER LAKE (BIG OTTER)	08-Aug-80	DEEP HOLE		6.42	2.80	32		2.80				7.10		
4196	OTTER LAKE (LITTLE)	07-Aug-80	DEEP HOLE		6.54	6.06	48		4.00				8.85		
4193	OTTER LAKE (BIG OTTER)	14-Jul-81	MID LAKE		6.36	2.36	32	3.40	2.80	0.80	1.10	0.45	8.00		
4193	OTTER LAKE (BIG OTTER)	04-Jun-00	Stn 1, North end	6.5										262	(pre 2002 mean)

Sample Methods

Six sample sites were selected to examine the water quality of enclosed embayments in Otter Lake in 2017 (see map). One additional location was sampled at the mid lake location in Little Otter Lake. The locations and depths for each location are shown in Table 2. Samples were collected once per month between May and October (six visits).

Map - showing the six sample locations.

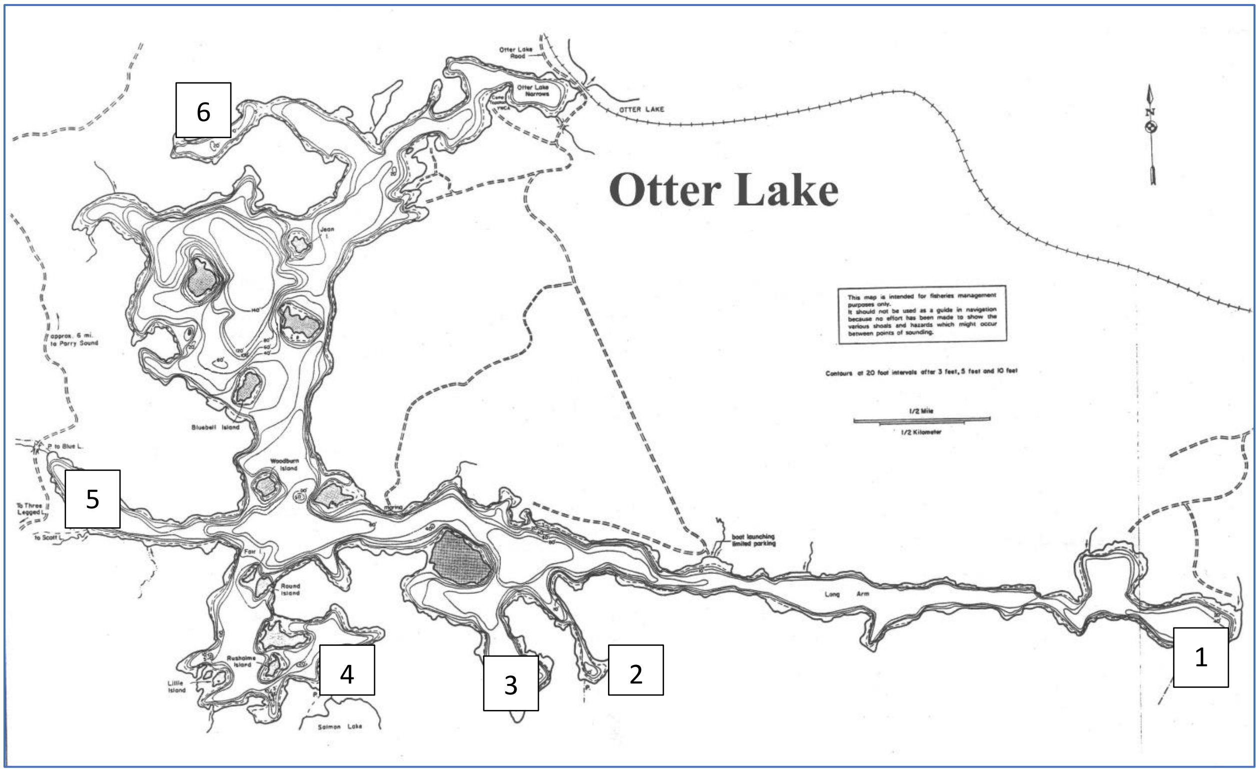


Table 2 – Locations and depths (m) of the 6 sample locations in Otter Lake and the sample location for Little Otter Lake (lol).

Site	Lat	Long	Depth
1	45 15 51.4	79 54 10.2	13
2	45 15 44.4	79 56 50.4	5.6
3	45 15 43.0	79 57 06.0	13
4	45 15 47.7	79 58 04.0	13.5
5	45 16 13.6	79 59 05.6	11
6	45 17 25.1	79 58 28.7	7
lol	45 17 38.8	79 56 36.1	5

On each visit, duplicate samples for total phosphorus were collected from the mixed surface layer for analysis at the Dorset Environmental Science Centre, Trent University Laboratory for low level phosphorus (P) analysis (2 Standard Deviations between duplicates = +/- 0.7 µg/L). At the end of August samples were also collected at 1 meter off bottom to test for internal loads of P from sediments.

On each visit the mixed layer was also tested for pH, conductivity, oxygen, temperature and water clarity (Secchi Depth). At the end of August temperature and oxygen profiles were measured for each meter from surface to bottom to observe mixing depths, potential for anoxia (depleted oxygen in bottom water) and internal loads that can transfer phosphorus from sediments into the water column during anoxia.

On the first visit to the lake a survey was conducted to observe the conductivity at numerous locations throughout the lake. This test generally measures the abundance of elements in the water that can increase electrical conductivity. The test can be used to tell whether the water in different areas of the lake has originated from sources where there are different watershed characteristics and possibly different water chemistry in the inflows. This is valuable in a study such as this where enclosed embayments are being measured. Bays with large inflows from different watersheds might be expected to have different conductivities. Conductivity measurements could be considered as a screening test to explain variations, if any, in the sources of water to the lake or to the nature of the water from place to place in the lake.

Results

Conductivity Survey

Conductivity measurements were made at multiple locations throughout Otter and Little Otter Lakes including the six enclosed embayments selected for this study. The conductivity throughout Otter Lake was similar ranging between 20 and 25 µS/cm. These are low values indicating very dilute water. The narrow range in values indicates that the water in all locations has been supplied from areas with similar watershed characteristics. Otter Lake is not a headwater lake, but it is fed by numerous smaller headwater lakes. The conductivity survey indicates that the watersheds and water chemistry are likely similar throughout this headwater "system".

Conductivity in Little Otter Lake is approximately double the values found elsewhere and this may be due to the shallow nature of the lake or due to inflows from Rankin Lake which is higher in phosphorus.

The conclusions from this survey indicate that water quality conditions should be similar throughout the system since the sources of water to the lake come from watersheds that are similar in their export of ions and anions.

Conductivity at 25 locations throughout Otter and Little Otter lakes is shown in Figure 4.

Figure 4 – Conductivity measurements throughout Otter and Little Otter Lakes on May 28, 2017.

Conductivity values were in a narrow range throughout the open water season in each of the 6 enclosed bays and in Little Otter Lake (Table 3). Values are slightly higher in Bay #6 and about 2 times as high in Little Otter Lake. The conductivity in all cases is low as would be expected for lakes on the Canadian Shield.

Table 3 – Monthly conductivity measurements for the six embayments and for Little Otter Lake (LOL). Values in the right column are measurements from the deep hole in Otter Lake.

	Conductivity							
	1	**2**	**3**	**4**	**5**	**6**	**LOL**	deep
28-May-17	24.1	23.0	21.2	21.4	25.1	27.4	43.4	
02-Jul-17	22.7	20.2	23.4	23.2	22.9	25.0	46.0	
27-Jul-17	24.0	19.0	24.4	24.4	24.0	26.5	51.6	24.4
30-Aug-17	23.7	19.0	23.7	23.6	23.8	25.7	58.6	
02-Oct-17	22.8	19.7	22.3	22.4	22.1	24.1	49.1	22.2
22-Oct-17	21.2	18.8	20.6	20.7	20.6	22.6	44.8	20.8

Total Phosphorus

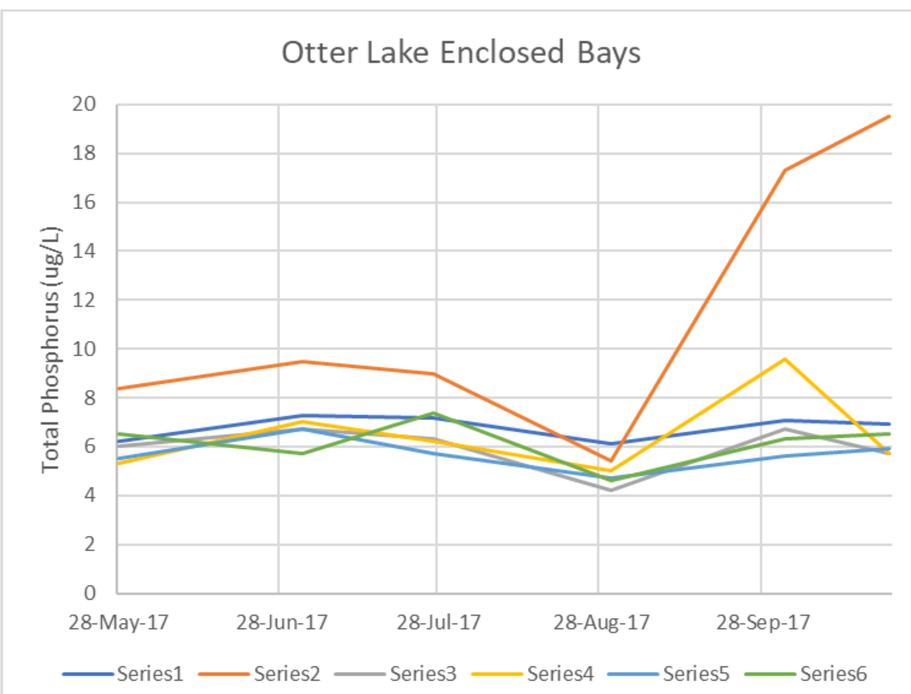
Total phosphorus (P) is the element that controls the growth of algae in most lakes. It is therefore measured to assess nutrient status and the potential for algal blooms. Generally, values below 10 µg/L are considered as having low potential to support algal blooms. These lakes are classed as oligotrophic and include most Lake Trout lakes. Concentrations between 10 and 20 µg/L typify mesotrophic lakes and although algal blooms often occur in these lakes it is generally accepted that avoidance of nuisance algal blooms is possible with P concentrations below 20 µg/L. These are mesotrophic lakes. Lakes with greater than 30 µg/L P are referred to as eutrophic lakes and these often support nuisance blue green algal blooms.

At five of the six sample locations the P concentrations in surface waters were, on each visit, below 10 µg/L (Figure 1). Concentrations ranged from about 4 to 7 µg/L which is the range in values noted for the main areas of the lake through time by the Lake Partner Program (Figure 1).

Notably, the concentrations in Bay#2 are mostly higher than those noted in the other 5 bays and were over 10 µg/L on the last two sample dates. This is due to an internal load and is explained further in the temperature/oxygen section below.

Reports of past blooms in Bay#2 were likely due to small amounts of blue green algae and their toxins that were entrained by filamentous algae. This is not a typical blue green bloom. It is rare to see algal blooms at less then 10 µg/L P but a few species of algae can bloom at these concentrations by taking nutrients from the sediments. It is important to note that conditions favourable to algal blooms can also be amplified by climate change even when there is no increase in nutrients associated with shoreline development.

Figure 5 - Total phosphorus concentrations measured in 6 enclosed bays in Otter Lake in 2017. Concentrations in Bay #2 are higher than in the other 5 bays especially in the fall.



Temperature/Oxygen

Surface measurements

Surface temperature measurements were taken on each visit to see whether any of the locations experiences elevated temperatures. There was very little variation in temperature between locations on each visit (Table 4). The same was true of oxygen measurements at the surface (Table 5).

Table 4 – surface water temperatures at sample locations in 2017.

	Temperature							
	1	**2**	**3**	**4**	**5**	**6**	**LOL**	deep
28-May-17	17.7	18.0	17.7	18.8	16.6	17.1	17.9	
02-Jul-17	21.0	21.3	21.6	21.1	21.0	21.8	21.1	
27-Jul-17	22.8	23.2	23.2	23.0	23.1	23.5	23.4	23.5
30-Aug-17	21.5	21.0	21.3	21.3	21.6	21.2	22.4	
02-Oct-17	18.3	16.8	18.2	18.3	17.9	17.9	18.0	17.9
22-Oct-17	15.3	15.4	14.9	15.0	15.2	14.7	15.1	15.0

Table 5 – Surface oxygen concentrations at sample locations in 2017.

	Dissolved Oxygen							
	1	**2**	**3**	**4**	**5**	**6**	**LOL**	deep
28-May-17	10.5	10.3	10.2	10.1	10.6	10.4	10.1	
02-Jul-17	9.9	9.5	9.9	9.9	10.1	9.5	9.5	
27-Jul-17	9.4	8.3	9.3	9.0	9.4	9.0	9.1	9.5
30-Aug-17	9.6	9.0	9.6	9.7	9.7	9.2	9.0	
Aug 30 1MOB	0.8	0.7	0.8	0.7	0.7	1.0	9.0	
02-Oct-17	9.8	8.6	9.8	9.6	9.9	8.9	9.0	9.9
Oct 02 1MOB	1.3	0.8	1.0	1.0	1.1	1.0	9.0	
22-Oct-17	10.0	9.8	9.7	9.7	9.9	9.6	10.2	10.0

Temperature/Oxygen Profiles

The period of interest for temperature and oxygen profiles is focused on the end of summer when stratified areas of the lake can develop anoxia in the unmixed bottom waters. This happens over the course of the summer with the lowest oxygen in bottom waters occurring in the late summer just before the lake turns over (mixes to the bottom) following the onset of lower temperatures. In most cases where blue green algal blooms occur there is an internal phosphorus load that happens when stratified bottom waters lose their oxygen (anoxia). This does not normally happen in the deep locations of a typical Lake Trout lake but anoxia can be common in shallower areas that stratify. Anoxia allows phosphorus from the sediments to enter the water column and potentially support algal blooms in late summer.

Oxygen and temperature profiles collected on August 30 at the sample sites are shown in Table 6. Stratification is noted at all sites except Little Otter. Thermal stratification is where the bottom waters remain colder and do not mix with the upper layers of warmer water. The upper layer of warm, mixed water is called the Epilimnion (green cells in Table 6). The zone where there is a rapid change in temperature is called the metalimnion (blue cells in table 6). The bottom layer of water which remains cooler and does not mix with upper layers during stratification is called the hypolimnion (yellow cells in Table 6). The hypolimnion can lose its oxygen due to sediment and bacterial consumption and when concentrations go below about 1 µg/L there can be phosphorus released from the sediments. In five of the six bays the oxygen concentrations at the bottom fell below 1.0 µg/L (1.0 at site 6). This is shown by the red numbers in Table 6. The bottom row in Table 6 shows corresponding increases in bottom phosphorus concentrations in 3 of the 6 bays (sites 2, 5 and 6). Although these concentrations are higher they are not high enough to cause concerns.

The bottom line is that these bays do stratify, they do go anoxic, and they do have sediment release of phosphorus in some cases (sites 2, 5 and 6). This indicates that the conditions may be in place to support algal blooms. However, the concentrations of phosphorus in the mixed layer are generally too low to support nuisance blooms and late summer concentrations of P in the mixed layer did not increase (Figure 5) as a result of internal loads except for Bay#2. At Bay#2 the internal load increased the mixed layer phosphorus concentrations so that they approached (but did not exceed) 20 µg/L in late summer (see Figure 5). *Note: It is suggested by the Provincial Water Quality Objectives that P concentrations remain below 20 µg/L to avoid nuisance algal blooms (MOECC, 1994).*

It is important to understand that the oxygen conditions in bottom waters are influenced by basin shape and extent of the stratified season (Molot 1992). In addition, there was a great deal of rain in 2017 which led to high water levels and these conditions may affect stratification and nutrient supply variables making it difficult to determine whether the conditions observed in 2017 at Bay#2 are normal. In addition, the enclosed bay at site 2 is:

- substantially isolated from the remainder of the lake,
- shallow with a large hypolimnetic volume to sediment surface area ratio, and
- bordered by marshy areas.

These characteristics contribute to elevated P in both surface and bottom waters such that the conditions that were observed may occur naturally, i.e. unrelated to shoreline development.

pump to sample bottom waters

Table 6. Temperature, oxygen depth profiles for Aug 30, 2017. Green cells are epilimnion, blue cells are metalimnion and yellow cells are hypolimnion. All sites experience anoxia in the bottom few meters except for Little Otter Lake which remains mixed to the bottom and does not stratify. Bottom row in table shows phosphorus concentrations at 1 m off bottom with increased P at sites 2, 5 and 6 (shown in bold).

	Aug 30 2017													
	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Little Otter	
Depth (m)	Temp	O2	Temp	O2	Temp	O2	Temp	O2	Temp	O2	Temp	O2	Temp	O2
0	21.5	9.6	21.0	9.0	21.3	9.6	21.3	9.7	21.6	9.7	21.2	9.2	22.4	9.0
1	21.1	9.5	20.7	8.9	21.2	9.6	21.2	9.6	21.3	9.6	20.6	9.0	22.0	9.1
2	21.0	9.5	20.4	8.9	20.9	9.5	21.0	9.5	21.1	9.6	20.4	8.7	21.8	9.2
3	20.9	9.5	20.0	8.5	20.7	9.5	20.9	9.5	21.0	9.6	20.2	8.1	21.5	9.1
4	20.9	9.4	18.4	3.8	20.7	9.5	20.8	9.4	20.9	9.6	19.6	6.8	21.1	9.1
5	20.8	9.2	13.5	**0.9**	20.7	9.4	20.7	9.3	20.8	9.5	16.2	1.5	21.0	9.0
6	16.0	8.7	12.9	**0.7**	20.6	9.2	20.6	9.2	20.7	9.4	11.7	1.1		
7	12.3	8.8			16.2	8.5	16.0	5.3	15.3	7.8	11.8	1.0		
8	10.0	7.5			12.2	8.3	12.9	5.0	12.2	4.9				
9	8.5	6.8			10.6	8.2	10.8	4.2	9.9	2.1				
10	7.7	5.6			9.4	7.8	8.6	3.0	8.9	**0.9**				
11	7.2	2.8			8.8	7.1	7.3	1.3	8.5	**0.7**				
12	6.4	1.2			8.0	1.9	6.6	**0.8**						
13	6.2	**0.8**			7.8	**0.8**	6.3	**0.7**						
	total phosphorus 1 meter off bottom (ug/L)													
	8.7		**35.4**		5.7		9.8		**19.2**		**16.6**		NA	
	epi													
	meta													
	hypo													

Otter Lake

Water Clarity

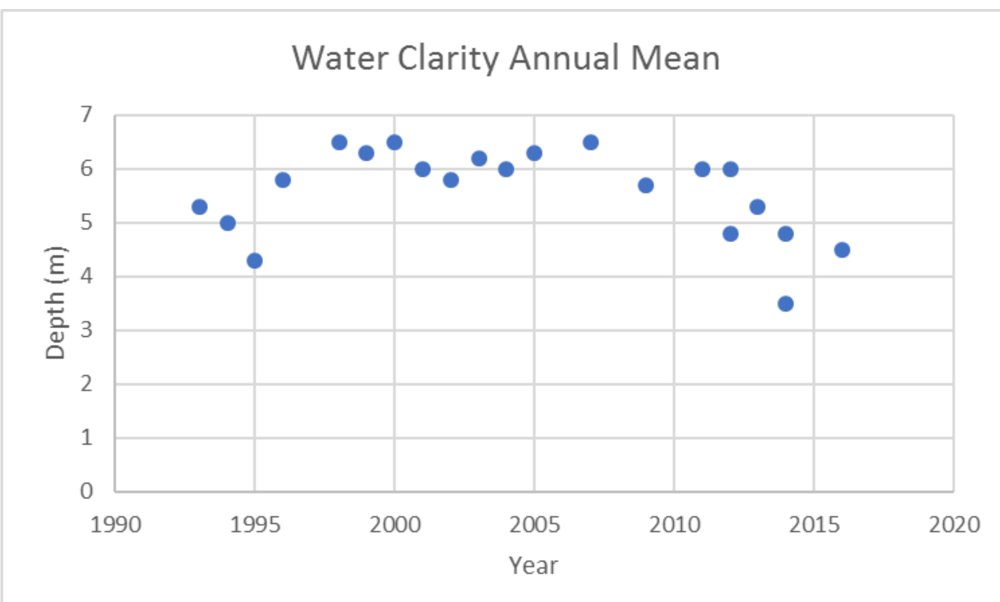
There is a fair amount of variation in water clarity between sites and between visits at the sample locations (Table 7). This is caused by variations in the algal communities at each site and the differences do not appear to be caused by variations in dissolved organic carbon (DOC) which can cause the water to appear "tea stained" and lower the clarity. This is based on field observations; no DOC data was collected.

There is also between-year variation in average water clarity at the deep location in Otter Lake (Figure 6). The factors contributing to these inter-annual changes are unclear.

Table 7 – Water clarity (Secchi depth) observations for the sample sites in 2017.

	Secchi Depth							
	1	**2**	**3**	**4**	**5**	**6**	**LOL**	deep
28-May-17	6.2	3.3	4.1	3.7	4	3.6	3.2	
02-Jul-17	3.3	2.8	3.1	3.5	3.6	4.2	3.4	
27-Jul-17	3.6	2.4	2.8	3.7	2.9	3.3	2.9	3.7
30-Aug-17	3.6	3.6	3.9	4	3.4	3.3	2.7	3.9
02-Oct-17	3.2	3.2	4.2	3.3	4.4	3.4	2.9	5.2
22-Oct-17	4.9	5.2	5.7	4.3	5.3	4.4	4.8	5.9

Figure 6 - Annual mean water clarity observations by Lake Partner Program volunteers between 1993 and 2017.



pH

The pH of surface water was measured at each visit (Table 8). This information is not important within the context of nutrients or algal blooms but is presented here to show that there are some variations between locations which may be linked to CO2 produced by algal communities. There are also some large increases and decreases in pH between sample visits especially at site 6 but we do not have enough data to assess the factors contributing to these changes.

Table 8 – pH measurements in surface water at each sample location in 2017.

	pH							
SITE	**1**	**2**	**3**	**4**	**5**	**6**	**LOL**	deep
28-May-17	6.7	6.5	6.5	6.6	6.7	6.7	6.9	
02-Jul-17	6.4	6.4	6.8	6.7	6.8	6.7	6.8	
27-Jul-17	6.8	5.9	5.8	5.8	5.4	3.5	5.0	5.5
30-Aug-17	6.5	6.6	6.7	7.2	7.3	8.0	7.6	7.1
02-Oct-17	6.6	6.7	6.8	5.9	6.6	7.1	6.9	6.9
22-Oct-17	7.7	7.6	7.6	6.1	6.5	6.4	5.6	6.4

Oxygen, conductivity and pH meters

Conclusions

The following conclusions can be drawn from the water quality results derived from this project.

- Conductivity surveys indicate that water throughout Otter lake has similar watershed origins. The water in Little Otter lake is slightly different and this may reflect differences in watershed or inflow characteristics.
- Phosphorus concentrations indicate that Otter and Little Otter Lakes are dilute, oligotrophic lakes with excellent water quality and no apparent trends since low-level testing began in 2002. Testing in Little Otter Lake is sparse.
- Phosphorus concentrations in the enclosed embayments that were studied in 2017 are similar in range to those measured over time in the main body of the lake by the Lake Partner Program.
- Bay#2 had elevated P concentrations compared to the other sample sites and higher concentrations approaching 20 µg/L in the late summer which are likely due to internal P loads that are introduced through anoxia in the bottom few meters of water. These conditions are likely natural and related to basin morphometry and watershed characteristics.
- Phosphorus measurements show some variation through time and from location to location but with no trends. There are trends in the long-term, Lake Partner Program water clarity results but the reasons for this are unclear.

Lake Partner Program results from Otter and Little Otter Lakes should be available for review in 2018.

Recommendations

1. Best management practices should be encouraged to minimize the movement of anthropogenic phosphorus into Otter Lake.
2. Volunteers should continue to collect phosphorus and water clarity data at the main basin locations on Otter and Little Otter Lakes. Volunteer dedication is required to collect all samples.
3. If algal blooms occur there should be photographs and water samples taken at the time to assess the extent and species responsible for the bloom.
4. It is not absolutely necessary to establish additional Lake Partner Program sample locations in the enclosed bays because the LPP does not accommodate 1 m off bottom samples.
5. Further test sites could be established if there is evidence of increased development or if typical blue green algal blooms develop in any of the enclosed bays. Water quality measurements do not indicate that this is likely.
6. It would be of some use to conduct annual fall surveys of the enclosed bays to observe temperature oxygen profiles and collect 1 m off bottom samples. This could be accomplished through the Georgian Bay Biosphere enhanced sampling program.

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Thank You
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The Georgian Bay Mnidoo Gamii Biosphere (GBB) is an inclusive and dynamic organization that builds capacity for regional sustainability in eastern Georgian Bay.

The GBB is a non-profit registered Canadian charity governed by a Board of Directors.

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