Aquatic Environment Report

Manitouwabing Lake

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Prepared For
Township of McKellar &
Manitouwabing Lake
Community Association

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The purpose of this environment report prepared by the Georgian Bay Mnidoo Gamii Biosphere for the Township of McKellar and Manitouwabing Lake Community Association (MLCA) is to provide residents and cottagers with one report summarizing water quality and fish community monitoring data for Manitouwabing Lake. In addition, the report provides recommendations for further monitoring as well as possible stewardship activities. The report is divided into three sections to reflect this purpose – water quality, fish communities, and recommendations.

Water Quality

Volunteers on Manitouwabing Lake participate in the Lake Partner Program (LPP) and the MLCA and McKellar Township recently initiated a benthic monitoring program (Figure 1).

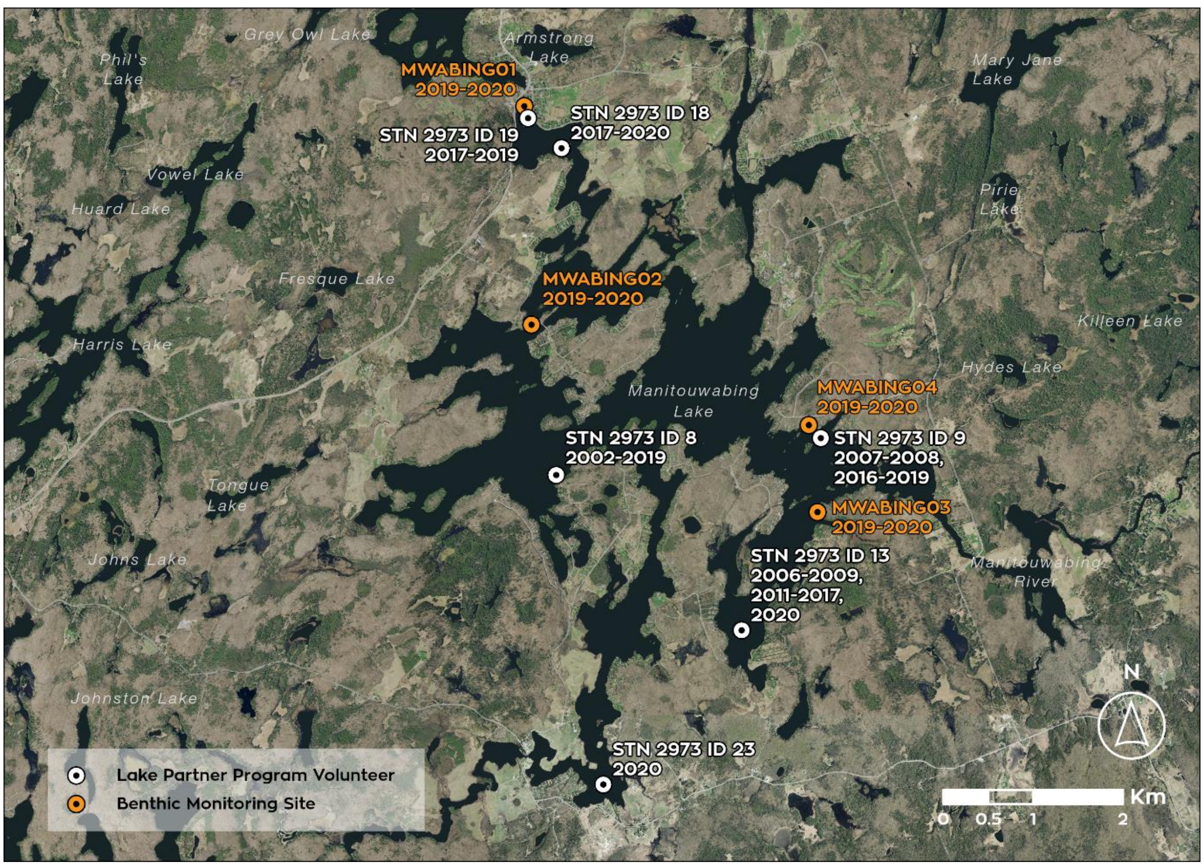

Figure 1. Active and recently active monitoring sites on Manitouwabing Lake.

The LPP collects data about phosphorus, water clarity, and calcium 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 other stressors.

A high-level summary of current Manitouwabing Lake LPP results is presented in Table 1. It is important to note that updates to information gathered through the LPP are limited. Due to the ongoing Covid-19 pandemic, the LPP received and analysed a greatly reduced number of water samples in 2020 and 2021. Updated information for 2020 is presented where it is available, and 2021 data have not yet been released to the public.

Table 1. Overview of Manitouwabing Lake LPP sampling results (Station 2973).

	Site ID 8	Site ID 9	Site ID 13	Site ID 18	Site ID 19	Site ID 23
TP average	n/a	n/a	n/a	n/a	10.9 µg/L	n/a
TP trend	Decreasing	Decreasing	Decreasing	Decreasing	n/a	n/a
Trophic status	Mesotrophic	Mesotrophic	Mesotrophic	Mesotrophic	Mesotrophic	Mesotrophic
Clarity	2.3 m	1.5 m	2.0 m	2.2 m	3.3 m	1.4 m
Calcium	3.6 mg/L	4.2 mg/L	3.0 mg/L	4.1 mg/L	3.0 mg/L	4.2 mg/L

Note: Clarity and calcium are reported as averages. TP is reported as an average for lakes with three to five years of data. Trends are reported for lakes with more than five years of data. Trophic status is described in terms of three broad categories – oligotrophic, mesotrophic, and eutrophic. TP concentrations between 10-20 µg/L indicate a mesotrophic or moderately enriched environment.

Benthic monitoring was initiated in 2020 in four locations throughout the lake following the Ontario Benthos Biomonitoring Network protocol. Benthic macroinvertebrates, or benthos, are small aquatic organisms (e.g., insects, crustaceans, worms) that spend all or part of their lifecycle living at the bottom of the lake. Some benthos can only be found in waterbodies with very good water quality, while others can tolerate poor water quality (Figure 2).

Benthic monitoring is a type of biological monitoring that uses an “effect-based approach” to provide information about how an ecosystem has responded to a stress. This complements water chemistry monitoring (e.g., TP, pH, dissolved oxygen) which looks at water quality from a “stressor-based approach”, providing information about an ecosystem’s exposure to stress. Together these approaches offer a more complete picture of aquatic ecosystem health (i.e., the lake’s exposure to stress and associated ecological response).

Benthic monitoring results for all four sites on Lake Manitouwabing were analyzed, given that there are now three years of data collected. Currently all four sites are considered ‘typical’ when compared to other lakes in the region. This means that the benthic community in the lake is typical for what we would expect to find in this region.

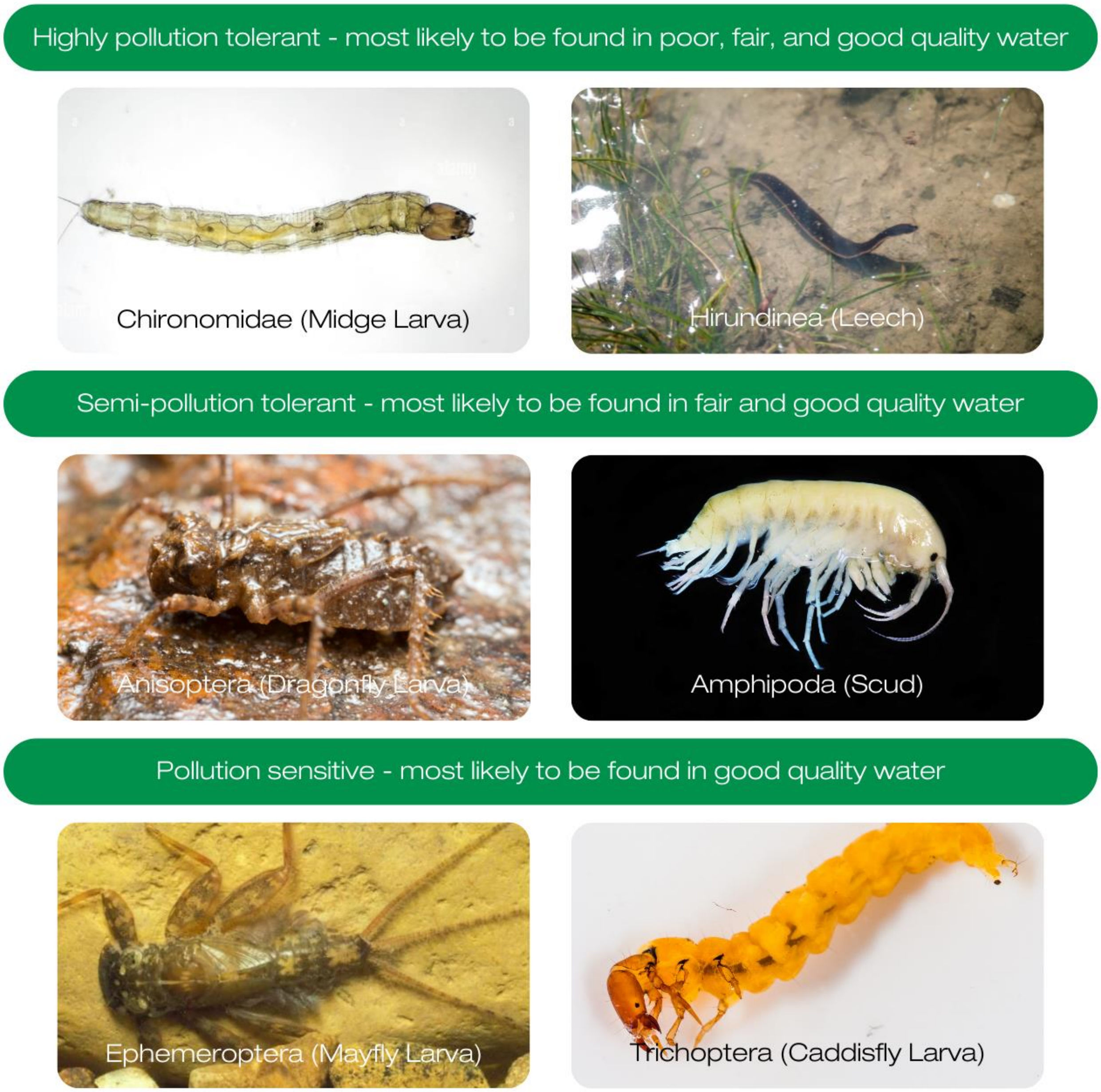

Figure 2. Benthic macroinvertebrates found in Manitouwabing Lake and their pollution sensitivities.

A thorough review of existing water quality data for Manitouwabing Lake was conducted by Bev Clark and published in 2018. The report indicates that TP concentrations throughout the lake are very similar among monitoring sites and between years. There is no clear evidence of increasing TP concentrations over time. The lake is at the lower end of the mesotrophic range (10-20 µg/L), meaning that it will share characteristics more like oligotrophic lakes. In addition, the lake is highly influenced by its watershed. This means that water in the lake will have water quality characteristics similar to the water coming in from the various sources, such as Manitouwabing River.

Fish Communities

Manitouwabing Lake is home to a variety of fish species. Table 2 provides a high-level overview of the fish communities in the lake.

Table 2. Summary of Manitouwabing Lake fish communities and their management (see link)

Major fish species	Largemouth bass (introduced), smallmouth bass (introduced), walleye (introduced), black crappie (introduced), northern pike (introduced)
Other fish species	Lake whitefish, creek chub, brown bullhead, yellow perch, bluntnose minnow, eastern blacknose dace, cisco, pumpkinseed, rock bass, common carp, white sucker
Lake trout management	Not designated
Current stocking	None
Historic stocking	Walleye (1938, 1950-2010), smallmouth bass (1941, 1950-1966)
Contaminants (species tested)	Northern pike, walleye, black crappie

The most recent surveys conducted on Manitouwabing Lake were part of a Nearshore Community Index Netting (NSCIN) project undertaken in 2014 and 2015. Findings from the project suggest that the fish community of Manitouwabing Lake has changed significantly since the next most recent survey in 2004 (Figure 3). Since 2004, black crappie were illegally introduced to the lake and have become a major component of the fish community. Brown bullhead declined in abundance from the peak seen in 2004. Largemouth bass catch rates have increased steadily over the successive surveys although they still comprise a small portion of the catch. Catch rates of the other species did not display any major changes. Based on the 2014-2015 NSCIN project, further walleye stocking is not advised and the lake should instead be managed as a natural walleye lake.

Fish consumption advisories for Manitouwabing Lake are determined by the Ministry of Environment, Conservation and Parks. Fish are exposed to, and absorb, contaminants in the water in a variety of ways (e.g., consuming contaminated food) and pass those contaminants on to humans when consumed. In Manitouwabing Lake, mercury is the contaminant of concern. Table 3 summarizes the Manitouwabing Lake fish consumption advisories.

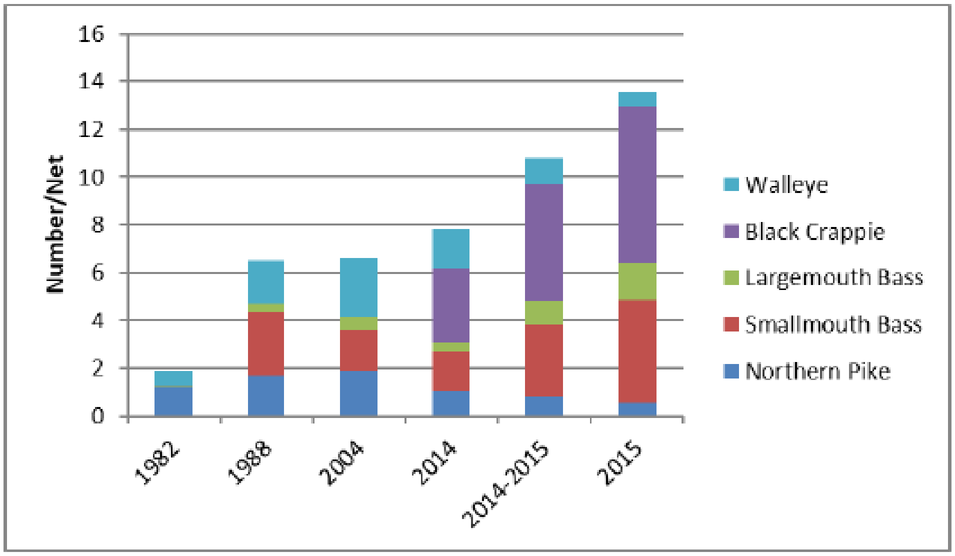

Figure 3. Catch rate (number/net) of major game fish species from 6' trap nets in Manitouwabing Lake, by year (Scholten, 2020).

Table 3. Fish consumption advisories for Manitouwabing Lake (see link).

Species	General Population	Sensitive Population*
Black crappie[1]	• max 32 meals/month of fish 20-25cm • max 12 meals/month of fish 25-30cm	• max 12 meals/month of fish 20-25cm • max 4 meals/month of fish 25-30cm
Northern pike[1]	• max 16 meals/month of fish 30-35cm • max 16 meals/month of fish 35-40cm • max 16 meals/month of fish 40-45cm • max 12 meals/month of fish 45-50cm • max 8 meals/month of fish 50-55cm • max 8 meals/month of fish 55-60cm • max 8 meals/month of fish 60-65cm • max 4 meals/month of fish 65-70cm • max 4 meals/month of fish 70-75cm • max 4 meals/month of fish >75cm	• max 8 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 45-50cm • max 4 meals/month of fish 50-55cm • max 4 meals/month of fish 55-60cm • no meals of fish 60-65cm • no meals of fish 65-70cm • no meals of fish 70-75cm • no meals of fish >75cm
Walleye[1]	• max 8 meals/month of fish 25-30cm • max 8 meals/month of fish 30-35cm • max 4 meals/month of fish 35-40cm • max 4 meals/month of fish 40-45cm • max 4 meals/month of fish 45-50cm • max 2 meals/month of fish 50-55cm • max 2 meals/month of fish 55-60cm • max 2 meals/month of fish 60-65cm • max 0 meals/month of fish 65-70cm	• max 4 meals/month of fish 25-30cm • no meals of fish 30-35cm • no meals of fish 35-40cm • no meals of fish 40-45cm • no meals of fish 45-50cm • no meals of fish 50-55cm • no meals of fish 55-60cm • no meals of fish 60-65cm • no meals of fish 65-70cm

* Women of child-bearing age and children under 15; [1] Mercury

Recommendations

Based on results from LPP sampling, benthic monitoring, Clark's (2018) water quality report, and the most recent fish community survey, several recommendations are made in this report.

Water Quality

1. Continue LPP sampling at several sites. Preference should be given to sites that are spread throughout the lake and that have the longest datasets. Suggested sites are Station 2973, Site IDs 8, 9, 13, and 18.
2. Continue with annual benthic monitoring. 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 Manitouwabing Lake will allow for trends to be tracked over time and the observation of any notable shifts (statistically significant changes) that would be cause for further investigation and potentially require remedial actions.
3. Conduct late summer monitoring of dissolved oxygen in the deepest location and in isolated bays where depths are greater than 7-8m (see map on page 11 of Clark (2018) report).
4. Focus bacteria monitoring on beaches as per the province's Beach Management Guidance Document.
5. Should the MLCA wish to continue with bacteria monitoring elsewhere, it should happen in the framework of a scientific investigation focused on testing specific hypotheses on potential sources of contamination through a focused sampling program.
6. Start keeping long-term records of water temperature.

Fish Communities

1. Anglers should familiarize themselves with the new regulations for the sale and possession of live bait in Ontario. Highlights include:
    - A valid fishing license is required to catch your own live baitfish, leeches, crayfish, and northern leopard frogs.
    - There are specific fish species that can and cannot be used as bait in Ontario.
    - Bait can only be caught in your home Bait Management Zone (BMZ) and cannot leave your BMZ.
    - Baitfish and leeches you catch cannot be sold unless you are a licensed dealer.

- If you fish outside your home BMZ, you must buy your baitfish and leeches locally, keep a receipt, and use or dispose of your bait within two weeks of the purchase date.

2. Anglers should use the app MyCatch by Angler's Atlas to log fishing trips and share fishing data confidentially with biologists.

Stewardship Activities

1. Encourage Manitouwabing Lake property owners to maintain and/or restore natural shorelines. GBB's Life on the Bay Stewardship Guide and Planting for Pollinators guide are helpful resources for property owners interested in native plants and naturalization. Native plants can be sourced from the MLCA Native Plant Seedling Sale and the annual GBB Native Plant Fundraiser (check the GBB events page in the spring).
2. Property owners interested in minimizing their ecological footprint can utilize GBB's Life on the Bay Stewardship Guide.
3. There are many citizen science programs for interested cottagers and residents to get involved in (e.g., invasive species reporting, IceWatch, FrogWatch, Canadian Lakes Loon Survey).

INTRODUCTION

Manitouwabing Lake is situated within the Williams Treaty of 1923 and the Robinson-Huron Treaty of 1850 (Ministry of Indigenous Affairs, 2022) in the traditional territory of Wasauksing First Nation and Shawanaga First Nation (Figure 4).

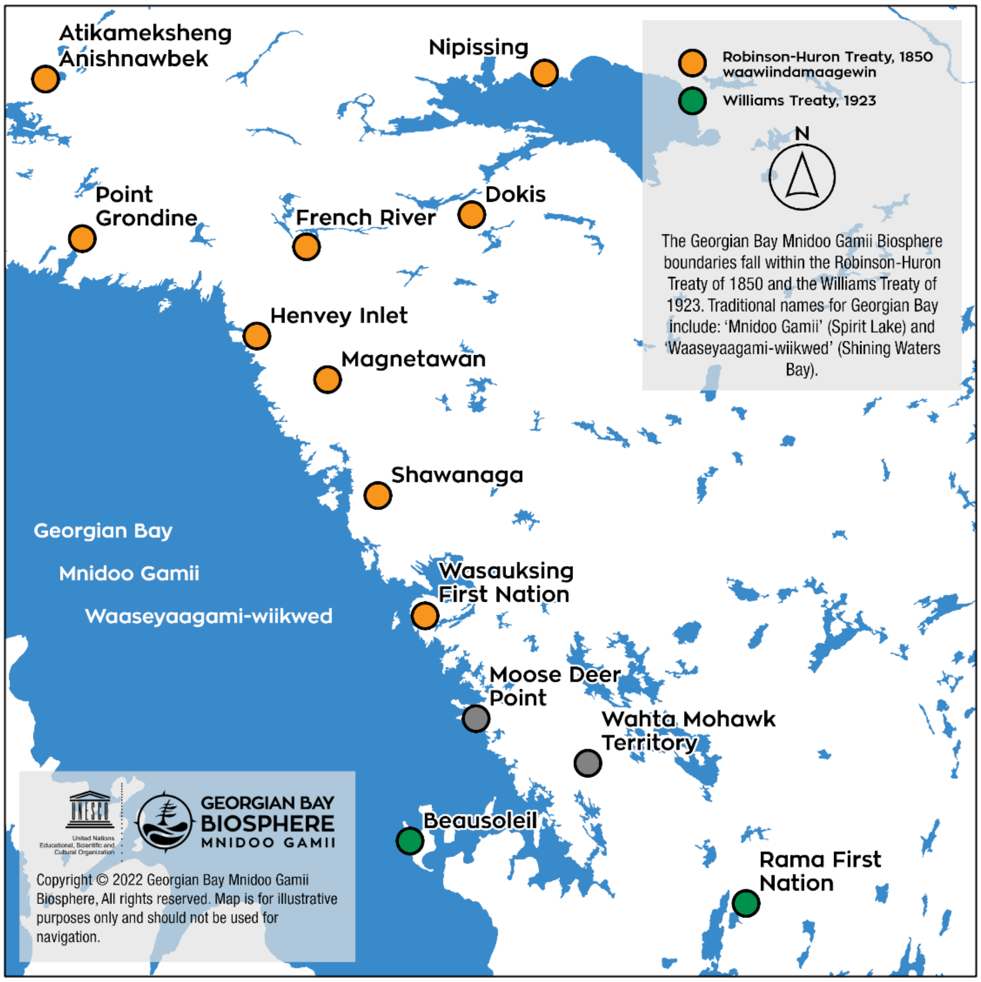

Figure 4. Signatories to the Robinson-Huron Treaty of 1850 and Williams Treaty of 1923.

Manitouwabing Lake is located almost entirely within the geographic and municipal township of McKellar (Figure 5). It is one of the largest lakes in the Parry Sound area, measuring roughly 1,200 hectares in size (Scholten, 2020). The lake collects water from a fairly large watershed through numerous inflows including the Manitouwabing River, and outflows at the south end of the lake (Clark, 2018). Lake water level is regulated by a dam located on the outflow at Hurdville which has raised the water by approximately 2.5m from its natural level (Scholten, 2020). The dam is owned and operated by Parry Sound Generation Corporation for the purpose of hydroelectric power generation downstream at Parry Sound (McIntrye, 2005).

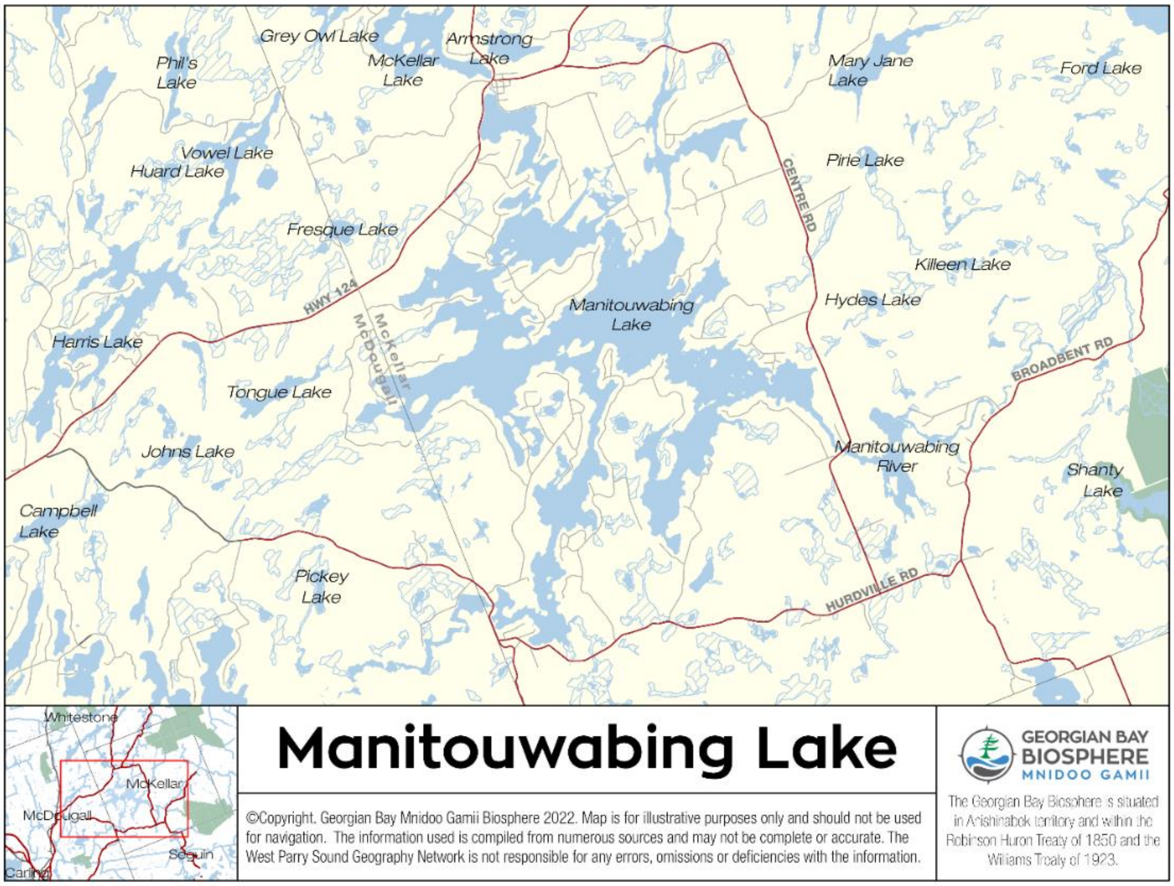

Figure 5. Manitouwabing Lake and surrounding area of McKellar.

The lake has a maximum depth of 33.6m (110ft), a mean depth of 5.6m (18.4ft) (McIntyre, 2005), and a flushing rate of 2.8 times per year (Clark, 2018). A diverse cool/warm water fish community is supported by the lake, dominated by northern pike, smallmouth and largemouth bass, black crappie, and walleye (Scholten, 2020).

Manitouwabing Lake is the site of six resorts and over one thousand private residences (MLCA, 2019). Public access to the lake is possible from several boat launches as well as public docks.

WATER QUALITY

Overview

Volunteers on Manitouwabing Lake participate in the Lake Partner Program (LPP) run by the Ministry of Environment, Conservation and Parks (MECP). Additionally, benthic monitoring is conducted by GBB at four sites on the lake as of 2020 (Figure 6). All past and present LPP data for Manitouwabing Lake can be found in Appendix A.

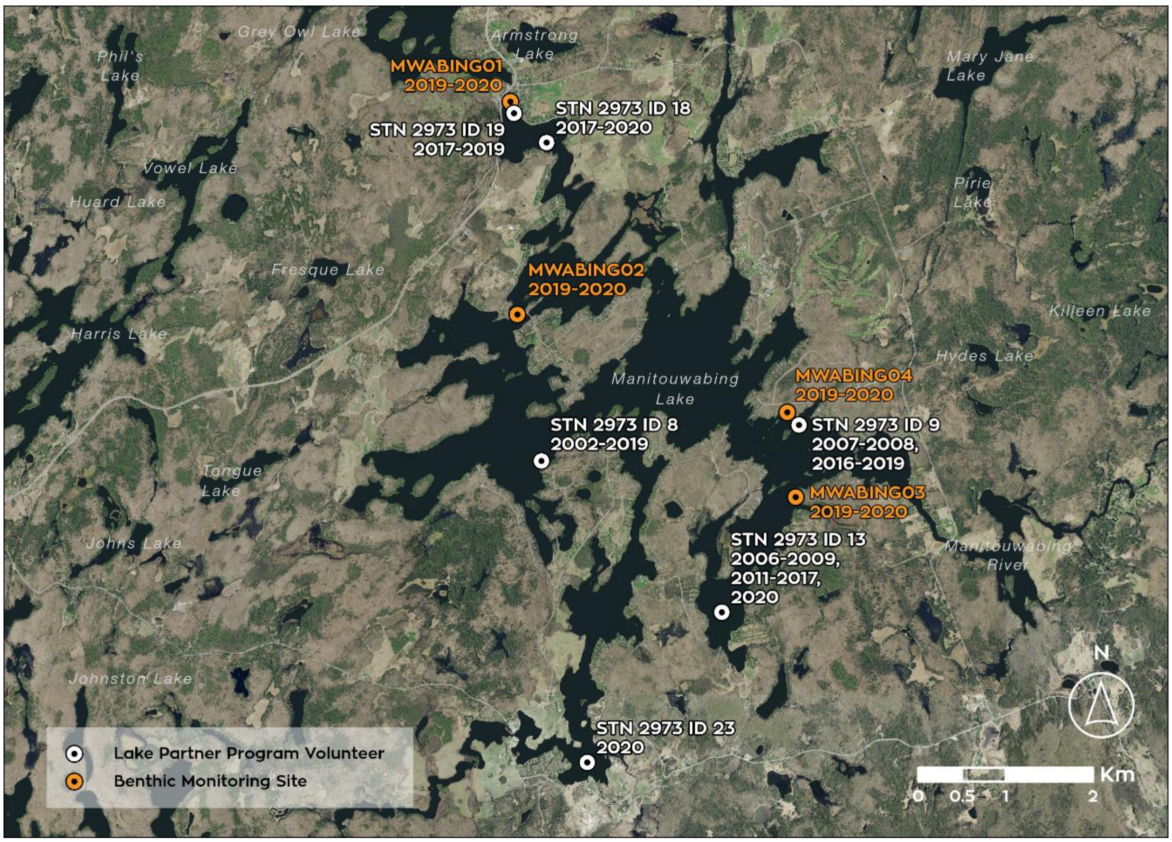

Figure 6. Active and recently active monitoring sites on Manitouwabing Lake. Sampling years are listed under site codes.

Lake Partner Program

The LPP is an Ontario-wide, publicly funded, free program that collects data about phosphorus, water clarity, calcium, and temperature 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 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.

Methods

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

Water Clarity

In general, water clarity, as measured by Secchi depth, tends to be higher in large bodies of water like the open areas of Georgian Bay and in bays 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

Calcium is a nutrient that is required by all living organisms. Some organisms, including those that make up the lower food web, use calcium in the water to form their calcium-rich body coverings. The lower food web forms the foundation of a healthy food web. Prey fish and juvenile predatory fish (piscivores) rely on the lower food web as a main source of food for growth, and predators depend on plentiful prey for their growth – if the lower food web is in poor condition, in time higher levels of the food web will respond and reflect that condition. These organisms of the lower food web, 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.

Total Phosphorus

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 7). 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.

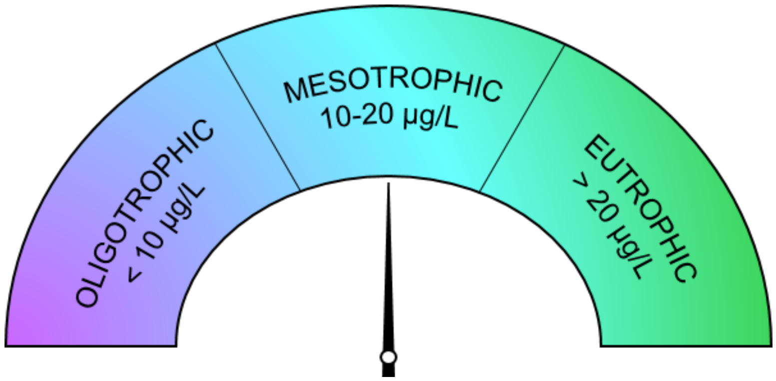

Figure 7. A lake's trophic status is determined by its total phosphorus concentration. Oligotrophic lakes have TP levels less than 10 µg/L; mesotrophic lakes have TP concentrations ranging between 10 and 20 µg/L; and eutrophic lakes have TP concentrations over 20 µg/L.

The Interim Provincial Water Quality Objective (PWQO) for TP in 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 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.

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 one thousand sampling locations across Ontario. Readers may find the database useful in understanding how Manitouwabing Lake TP concentrations compare to other waterbodies across the province.

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 section, only averages are presented and in cases where there is a major difference between TP1 and TP2, averages are not included to avoid erroneous interpretations. TP1, TP2, and average TP are all reported in Appendix A.

Results

All sites sampled on Manitouwabing Lake through the LPP have TP concentrations indicating mesotrophic conditions. This means the lake is moderately enriched with TP concentrations ranging from 10 to 20 µg/L.

Station 2973, Site ID 8	
• Description: West of Maplewood	• Average TP: 11.41 µg/L
• Data collector: LPP volunteer	• Trend: n/a
• Trophic status: mesotrophic	• Average Secchi depth: 2.3 m
	• Visible outliers: none

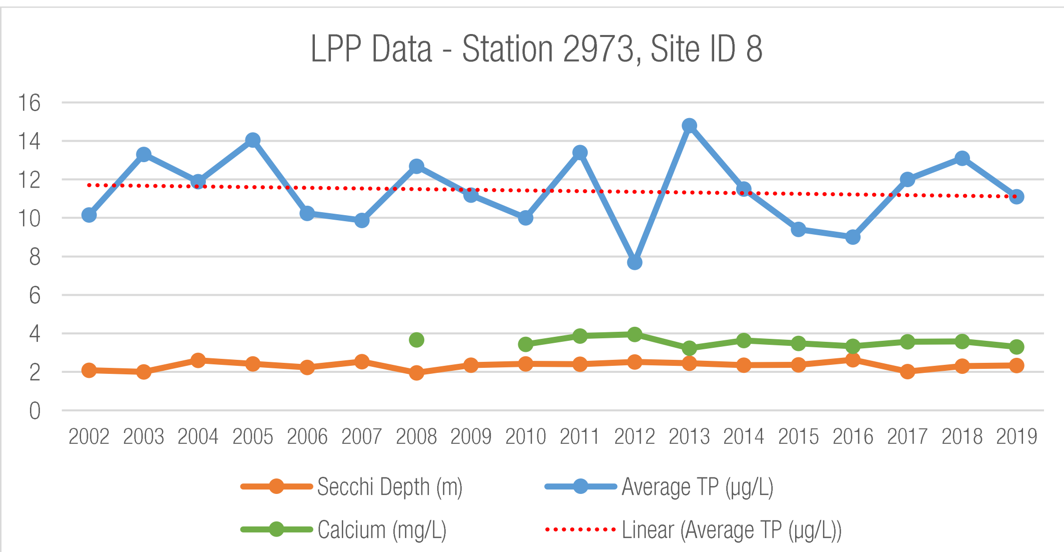

Figure 8. Lake Partner Program data for water clarity, calcium, and total phosphorus at Station 2973, Site 8.

Station 2973, Site ID 9	
• Description: E of Longhorn, Hardle's Cr	• Average TP: n/a
• Data collector: LPP volunteer	• Trend: decreasing
• Trophic status: mesotrophic	• Average Secchi depth: 1.5 m
	• Visible outliers: none

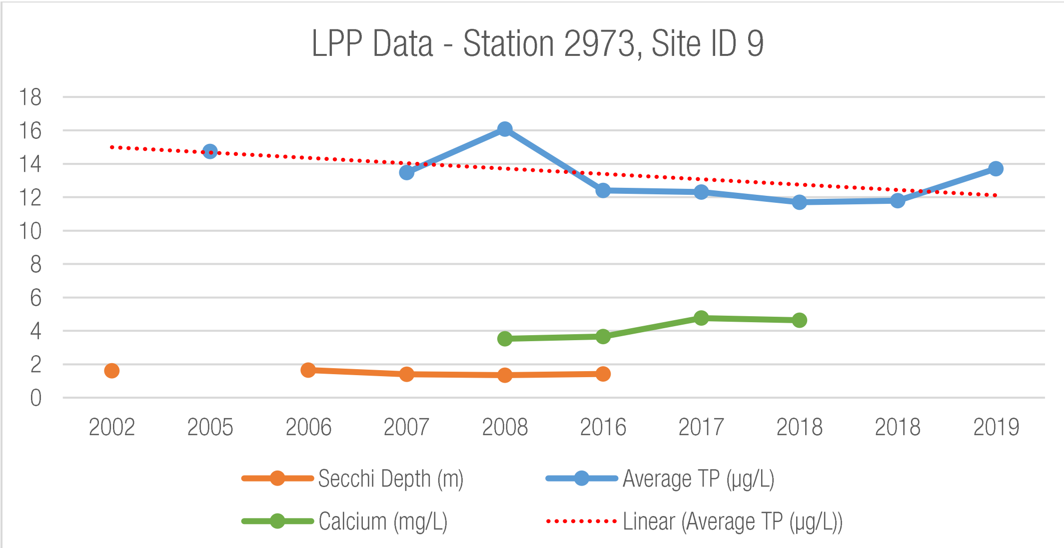

Figure 9. Lake Partner Program data for water clarity, calcium, and total phosphorus at Station 2973, Site 9. Note: two TP data points are given in the LPP database for 2018.

Station 2973, Site ID 13	
• Description: Jones Bay	• Average TP: n/a
• Data collector: LPP volunteer	• Trend: decreasing
• Trophic status: mesotrophic	• Average Secchi depth: 2.0 m
	• Visible outliers: none

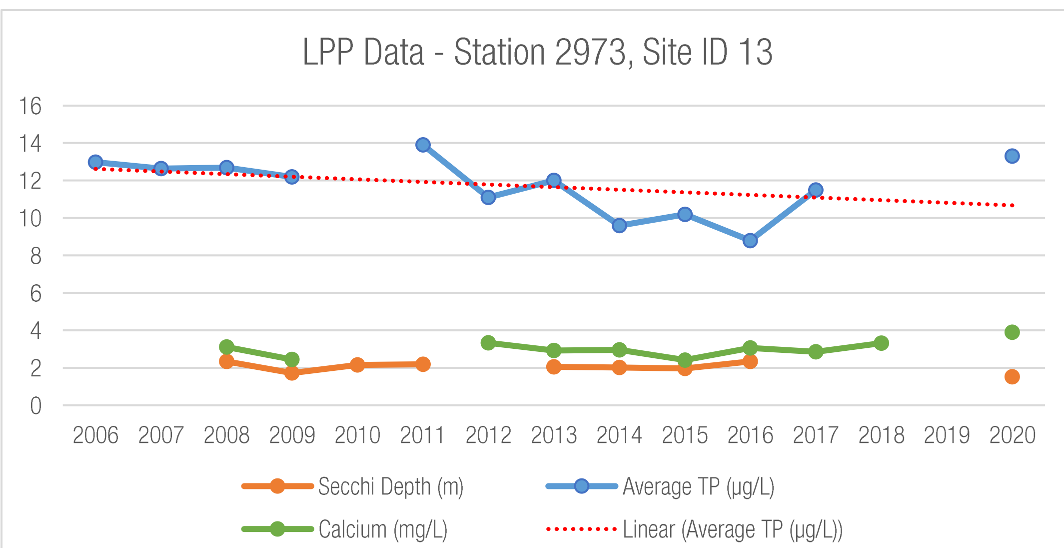

Figure 10. Lake Partner Program data for water clarity, calcium, and total phosphorus at Station 2973, Site 13.

Station 2973, Site ID 18	
• Description: McKellar Bay	• Average TP: n/a
• Data collector: LPP volunteer	• Trend: decreasing
• Trophic status: mesotrophic	• Average Secchi depth: 2.2 m
	• Visible outliers: none

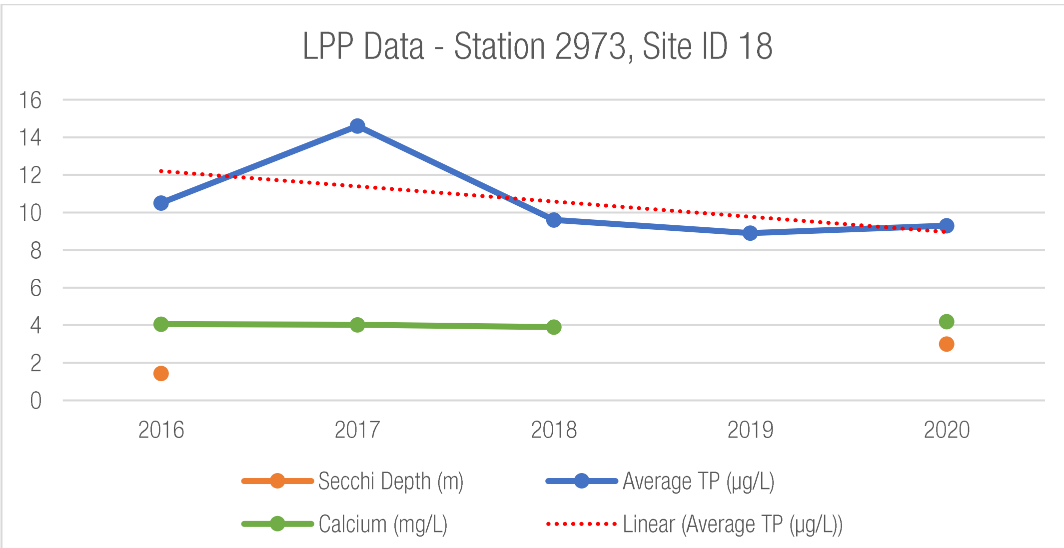

Figure 11. Lake Partner Program data for water clarity, calcium, and total phosphorus at Station 2973, Site 18.

Station 2973, Site ID 19	
• Description: McKellar Bay, near dock	• Average TP: 10.9 µg/L
• Data collector: LPP volunteer	• Trend: n/a
• Trophic status: mesotrophic	• Average Secchi depth: 3.3 m
	• Visible outliers: none

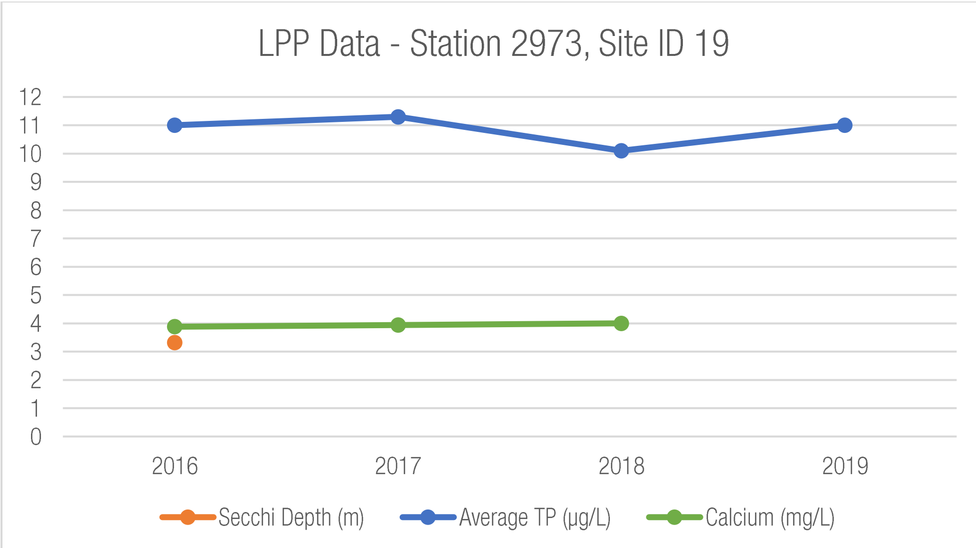

Figure 12. Lake Partner Program data for water clarity, calcium, and total phosphorus at Station 2973, Site 19.

Station	Site ID	Description	Data Collector	2020 Average TP	2020 Secchi depth	2020 Calcium
2973	23	East of Hurdville	LPP volunteer	11.2 µg/L	1.4	4.2

Recommendations

Continue LPP sampling annually. Prioritize locations that have a long, continuous history of sampling or areas with notable water quality concerns. Suggested sites are Station 2973, Site IDs 8, 9, 13, and 18.

Benthic Monitoring

Different types of water quality monitoring provide water 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 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 complete picture of aquatic ecosystem health (i.e., the lake's exposure to stress and associated ecological response).

For example, volunteers on Manitouwabing 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 (as shown by the trend lines on the LPP data charts). 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.

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. Figure 13 highlights common taxa found in lakes throughout the Parry

Sound-Muskoka District, including Manitouwabing Lake, and their varying pollution sensitivities.

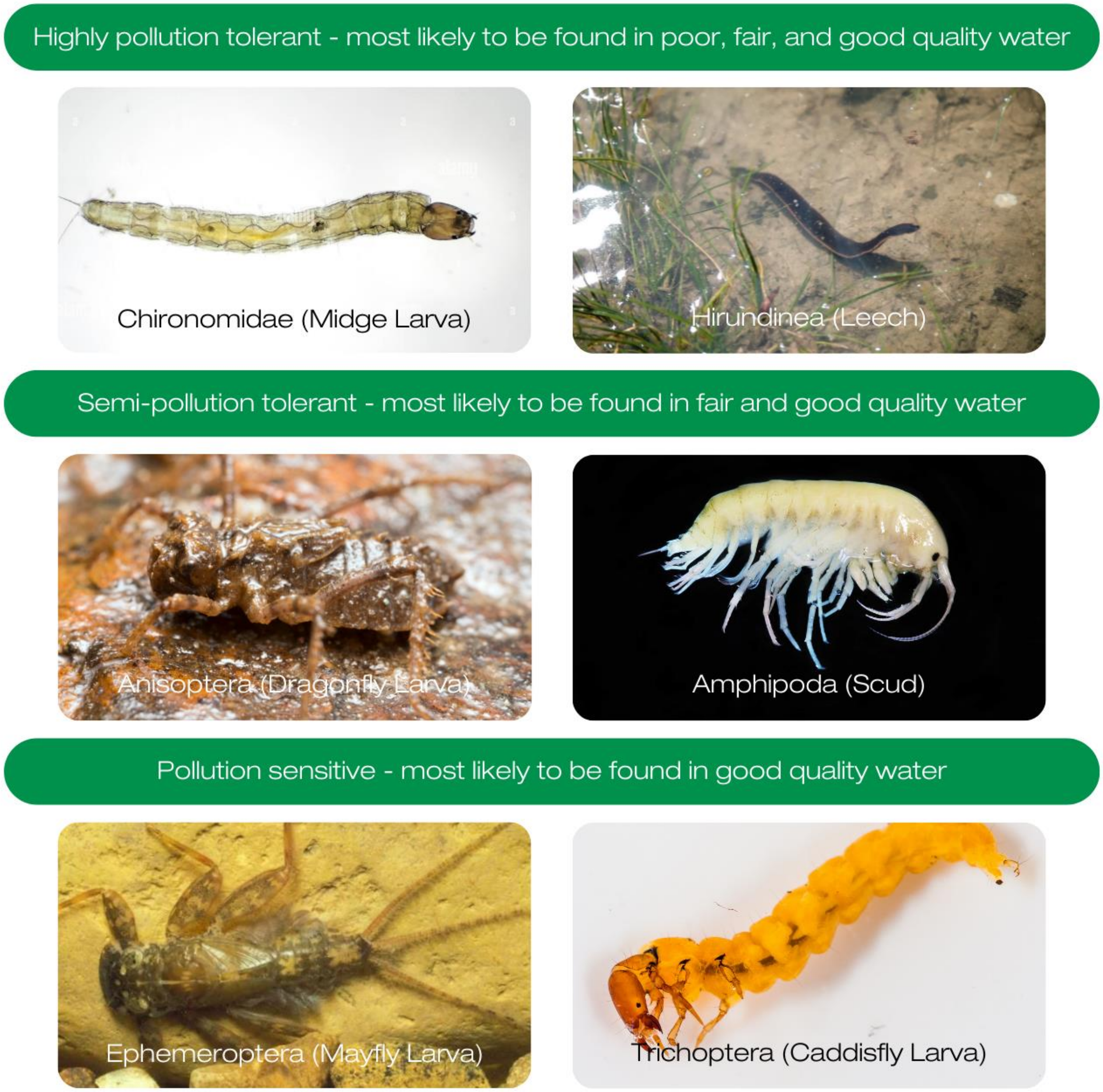

Figure 13. Benthic macroinvertebrates found in Manitouwabing Lake and their pollution sensitivities.

It is important to note that an aquatic ecosystem with pollution tolerant species is not necessarily a cause for concern. If pollution sensitive species are also present in the same area, this indicates that the water quality must be good enough for the pollution sensitive species to thrive, along with those that are less sensitive. When an aquatic ecosystem hosts pollution tolerant species with no evidence of pollution sensitive species, this could indicate a need for further investigation into potential water quality issues.

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).

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

The objectives of the Manitouwabing Lake benthic monitoring program are to:

- Determine the ecological condition of Manitouwabing Lake;
- Compare Manitouwabing Lake to similar lakes in the Parry Sound-Muskoka District; and
- Compare sites within Manitouwabing Lake.

Methods

Certified GBB staff conduct benthic macroinvertebrate sampling on behalf of the Township of McKellar and MLCA using the standardized Ontario Benthos Biomonitoring Network (OBBN) protocol for lakes. For each of the four sites, 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. 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

Manitouwabing Lake has had benthic macroinvertebrate sampling conducted each year since 2020. The objective of the benthic monitoring is to characterize the benthic community of the lake and compare it to lakes in the Parry Sound-Muskoka District to determine whether the benthic community in Manitouwabing Lake is considered typical of what would be expected for a lake 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 Dorset Environmental Science Centre 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 14 and is used for analysis in this report.

Following the methodology used by MWC (2018), the average %EOT was calculated for each of the four sites on Manitouwabing Lake using data collected between 2020 and 2022. The average %EOT for each lake was then compared to the normal range (Figure 14) 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.

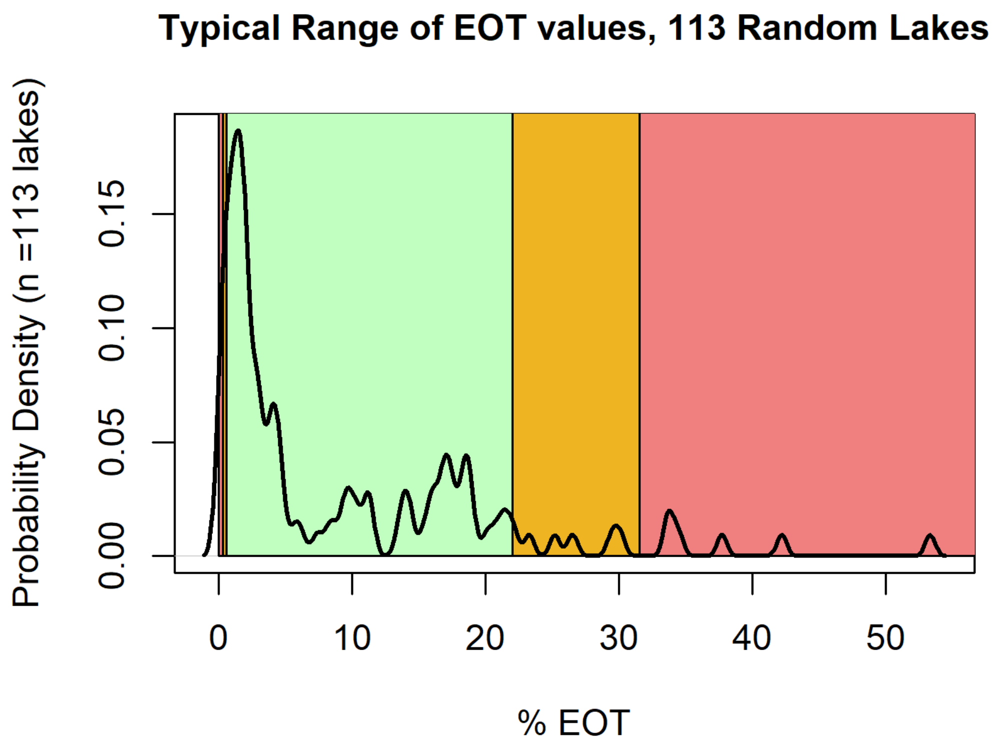

Figure 14. Range of %EOT values of sampled lakes in the region from 2012 to 2017. Typical is shown in green which is between the 10th and 90th percentile (%EOT between 0.55 and 20.99). Atypical is shown in orange which is between the 5th and 10th percentile (%EOT between 0.3 and 0.54) and 90th and 95th 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).

Results

Four sites (three lake segments each) were sampled in Manitouwabing Lake from 2020-2022 (Figure 15). Benthic monitoring data for all sites are available in Appendix B.

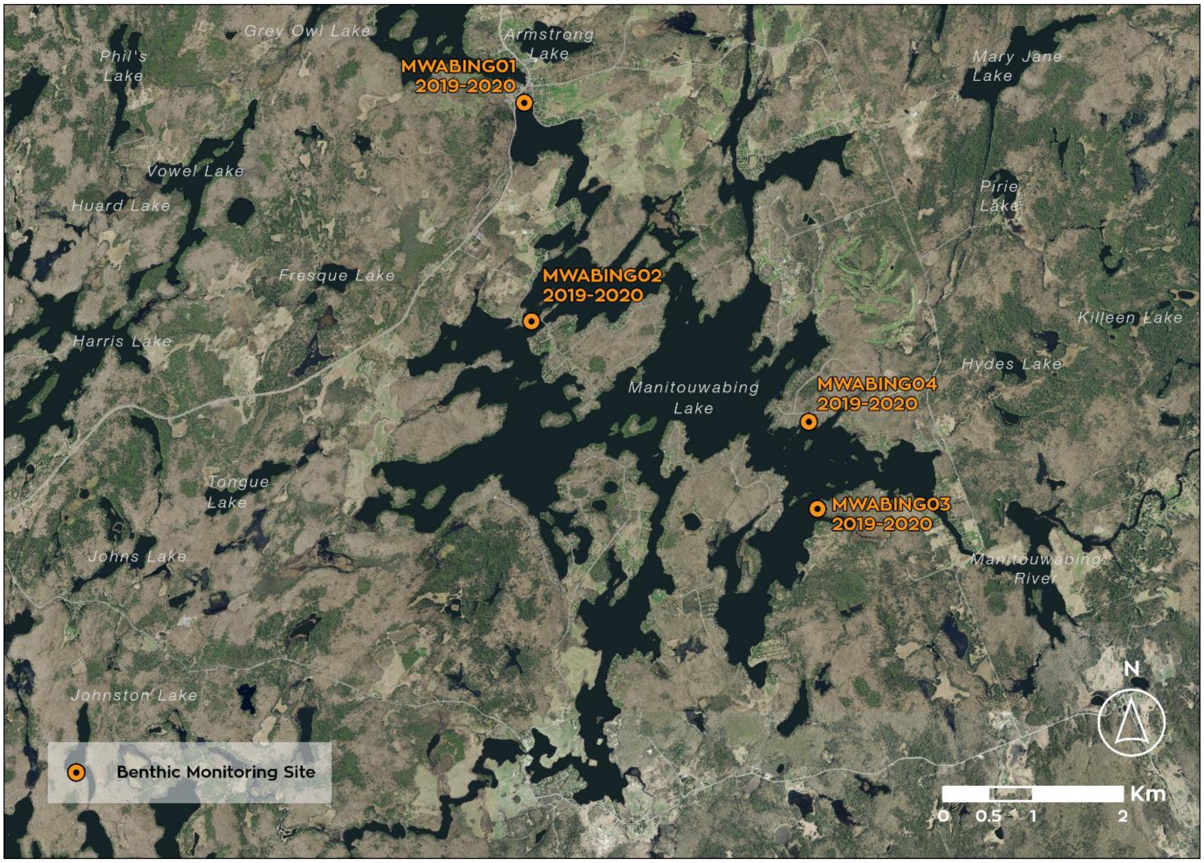

Figure 15. Benthic sampling locations on Manitouwabing Lake.

Site 1 – Manitouwabing Lake

As shown in Figure 16, the %EOT for site 1 on Manitouwabing Lake falls within the normal range of what is expected for lakes in the region.

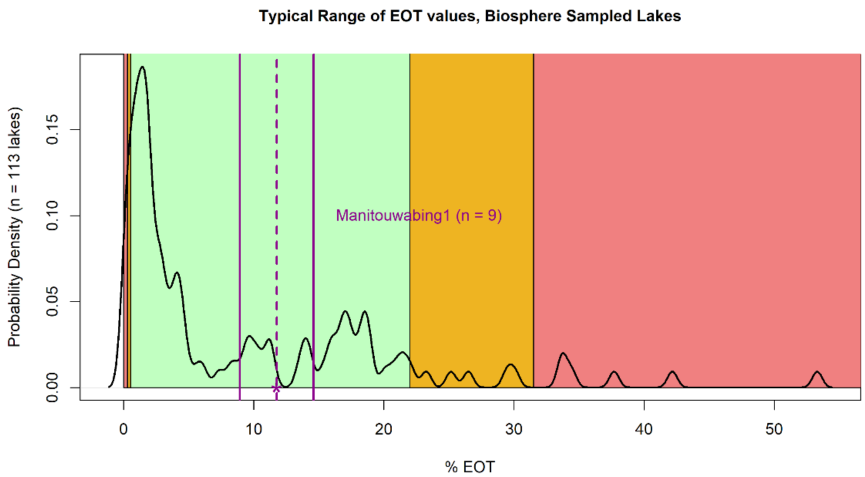

Figure 16. Manitouwabing Lake site 1 average %EOT (dashed purple line) and standard deviation (solid purple line) sampled from 3 lake segments over 3 years (n=9) fall within the "typical" category (green area) on the typical %EOT range plot (based on 113 sampled lakes). This indicates that the benthic community for site 1 is typical of what would be expected for a lake in this region.

Site 2 – Manitouwabing Lake

As shown in Figure 17, the %EOT for site 2 on Manitouwabing Lake falls within the normal range of what is expected for lakes in the region.

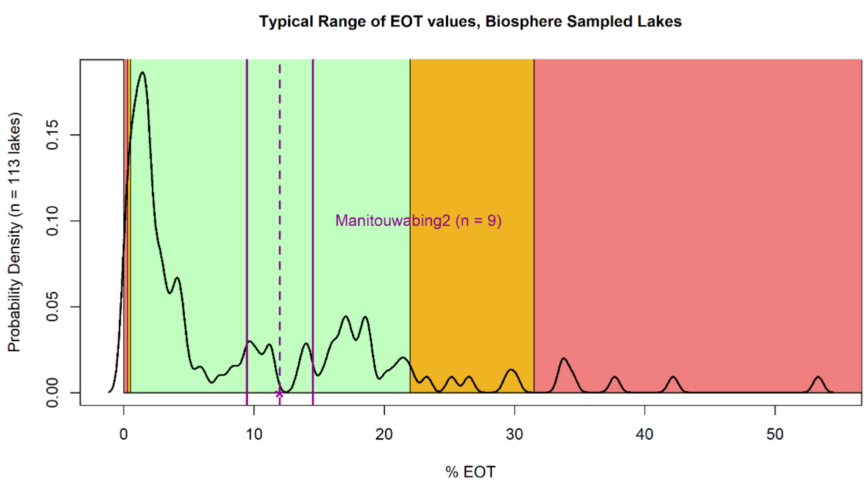

Figure 17. Manitouwabing Lake site 2 average %EOT (dashed purple line) and standard deviation (solid purple line) sampled from 3 lake segments over 3 years (n=9) fall within the "typical" category (green area) on the typical %EOT range plot (based on 113 sampled lakes). This indicates that the benthic community for site 2 is typical of what would be expected for a lake in this region.

Site 3 – Manitouwabing Lake

As shown in Figure 18, the %EOT for site 3 on Manitouwabing Lake falls within the normal range of what is expected for lakes in the region.

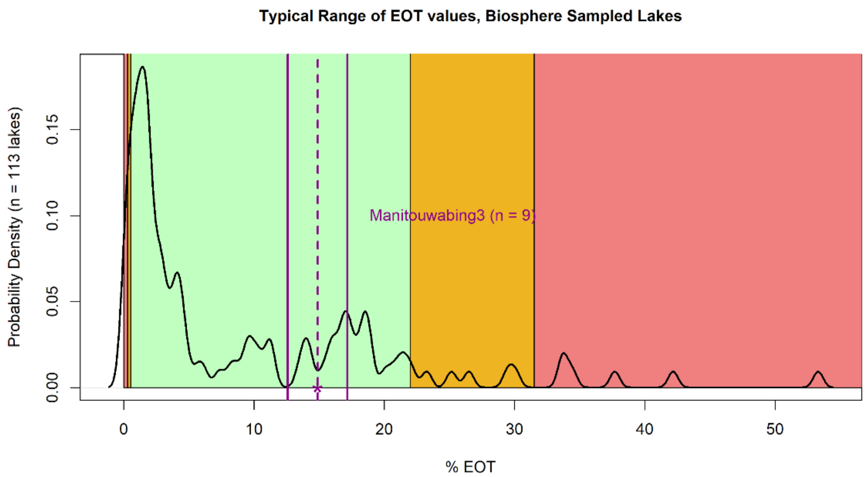

Figure 18. Manitouwabing Lake site 3 average %EOT (dashed purple line) and standard deviation (solid purple line) sampled from 3 lake segments over 3 years (n=9) fall within the "typical" category (green area) on the typical %EOT range plot (based on 113 sampled lakes). This indicates that the benthic community for site 3 is typical of what would be expected for a lake in this region.

Site 4 – Manitouwabing Lake

As shown in Figure 19, the %EOT for site 4 on Manitouwabing Lake falls within the normal range of what is expected for lakes in the region.

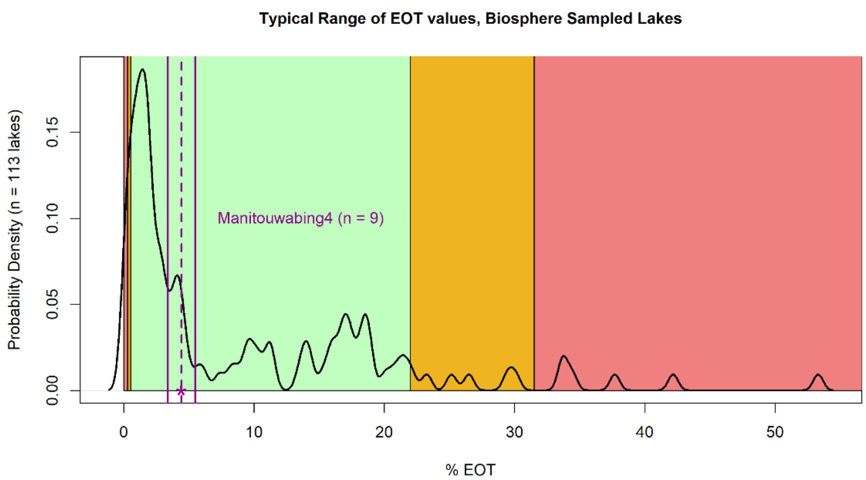

Figure 19. Manitouwabing Lake site 4 average %EOT (dashed purple line) and standard deviation (solid purple line) sampled from 3 lake segments over 3 years (n=9) fall within the "typical" category (green area) on the typical %EOT range plot (based on 113 sampled lakes). This indicates that the benthic community for site 4 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 Manitouwabing Lake will allow for trends to be tracked over time and the observation of any notable shifts (statistically significant changes) that would be cause for further investigation and potentially require remedial actions.

Manitouwabing Lake State of the Basin Review 2018

Bev Clark, Aquatic Scientist, was hired by the MLCA to conduct a thorough review of existing Manitouwabing Lake water quality data and provide recommendations for future water quality monitoring activities. Clark's report was published in 2018 and is available on the MLCA's website. The key conclusion and recommendations from the report are provided in full below (complete report available in Appendix C).

The following conclusions were drawn in Clark's (2018) report:

- The bottom line with respect to phosphorus is that concentrations are similar throughout the lake and consistent between years.
- The phosphorus values indicate a lake that is highly influenced by its watershed with no sign of deterioration in water quality (with respect to phosphorus) over the years.
- Manitouwabing Lake's mesotrophic status is not likely the result of human activity in the watershed but rather the result of export of dissolved organic carbon (DOC) from wetlands. Most of the 11.5 µg/L TP in Manitouwabing Lake has its origins as DOC in the watershed's wetland complexes.
- DOC concentrations throughout the lake are relatively similar (4.2-6.0 mg/L) with slightly more tea stained water in the south east areas of the lake. This relatively narrow range in DOC values throughout the lake indicates similar wetland conditions throughout the different subwatersheds.
- Manitouwabing Lake is not expected to support algal blooms.
- Bacteria data are difficult to interpret. There are conclusions that can be drawn by examination of the data, but there are also many aspects of bacteria in lake water that cannot be deduced from these data. Generally, the Manitouwabing Lake bacteria data show that about 5% of the samples are over 100 counts which is the guideline for recreational use. This indicates that the water is swimmable in most areas 95% of the time.

Recommendations

The following recommendations are made in Clark's (2018) report:

1. Several central locations (LPP Site #11, 1 and 3) and possibly one new location near the outflow be monitored by LPP volunteers with an effort to maintain a long-term monitoring record. Some of these sites may or may not be currently sampled. Long-term monitoring records are important to assess the effect of external drivers on the nutrient status of the lake.
2. The efforts used to collect bacteria data could be directed at other issues such as:
    - Education towards aspects of nearshore (shoreline) management.
    - Useful inventories such as areas where aquatic plants grow to assess whether the extent of plant beds are changing.
    - Long-term records of water levels and/or temperature.
3. Late summer monitoring of dissolved oxygen in the deepest location and in isolated bays where the depths are greater than 7-8m (see page 11 of Clark (2018) report for a map) may provide additional information to address the potential for algal blooms. After areas are identified as having the oxygen depleted at the bottom (with measured oxygen profiles) in year one, there can be samples taken 1 meter from the bottom in subsequent years to assess whether or not there are elevated phosphorus concentrations in the bottom water.
4. All efforts should be made to ensure that invasive species do not enter the watershed. There are many organizations that provide guidance on invading species, e.g. The Federation of Ontario Cottagers' Associations. https://foca.on.ca/aquatic-invasive-species-program/

Additional years of LPP results have become available since Clark's report was published in 2018. These additional data are included in Appendix A along with all historical LPP data for Manitouwabing Lake.

FISH COMMUNITIES

Overview

Table 4 provides a high-level overview of the fish communities in Manitouwabing Lake.

Table 4. Summary of Manitouwabing Lake fish communities and their management (see link)

Major fish species	Largemouth bass (introduced), smallmouth bass (introduced), walleye (introduced), black crappie (introduced), northern pike (introduced)
Other fish species	Lake whitefish, creek chub, brown bullhead, yellow perch, bluntnose minnow, eastern blacknose dace, cisco, pumpkinseed, rock bass, common carp, white sucker
Lake trout management	Not designated
Current stocking	None
Historic stocking	Walleye (1938, 1950-2010), smallmouth bass (1941, 1950-1966)
Contaminants (species tested)	Northern pike, walleye, black crappie

The first documentation of a Ministry-led fish community study on Manitouwabing Lake is from 1959. A cursory survey documented the presence of walleye, smallmouth bass, largemouth bass, yellow perch, lake whitefish, and common carp. Northern pike, however, were not found to be present at that time. A historical note on the Ministry's lake file indicates that northern pike were introduced to the lake via unauthorized introduction in the 1960s. Interestingly, Manitouwabing Lake is the only lake known to contain common carp in the Parry Sound area. Another unreferenced historical note on the Manitouwabing Lake file states that carp were introduced to the lake at the turn of the century (1900) or earlier. Stocking of walleye began in 1938 and in 1941 for smallmouth bass (McIntrye, 2005).

During a 1974 Aquatic Habitat Inventory Survey, northern pike were documented in the lake for the first time. At this time walleye, smallmouth bass, and brown bullhead were all captured in low numbers. On the other hand, northern pike, common white sucker, rock bass, yellow perch, and cisco were captured in high numbers (OMNR, 1974).

In 1982 a trap net and gill net survey was conducted on Manitouwabing Lake to assess the health of the fish population. Results of the survey indicated a well-balanced fish community with good recruitment, although productivity appeared low and there were indications of over-exploitation of game fish (McIntyre, 1983). When this survey was repeated in 1988, the results showed a drastic change to a coarse fish dominated community (i.e., dominated by fish other than game fish) (Sober, 1989). The brown bullhead population saw a dramatic increase between these two surveys. Weight and number of fish caught in 1988 were much higher than in 1982, attributable primarily to the growing brown bullhead population. Walleye, northern pike, and smallmouth bass populations were essentially unchanged.

Intensive creel surveys were conducted in the summer of 1983 and the winter of 1984. Together these surveys revealed high fishing pressure on Manitouwabing Lake and modest harvest of game fish (MacMillan, 1985a; 1985b). Fishing effort exceeded 30 rod hours per hectare with fishing for northern pike described as very good, but only fair for walleye and smallmouth bass. Comparing this information to volunteer creel data pooled from 1973-1979, it appears that fishing quality has not changed much on the lake over time.

In an effort to rebuild walleye stocks and promote natural rehabilitation in Manitouwabing Lake, several habitat enhancement projects were carried out over the decades. Details on some of these efforts are quite sparse. For example, in a note on the lake file in 1985, a walleye spawning bed enhancement project at Broadbent Rapids is mentioned (MNRF, 2010). A separate note added in 1988 states that spawning bed rehabilitation work was completed below the Hurdville Dam (limestone rock placement and sand removal) and spawning bed rubble was cleaned at Squaw Rapids on Middle River (MNRF, 2010). No other details are provided.

In addition to spawning bed enhancement work, lake-specific fishing regulations were changed in 1998. The walleye daily catch limit was reduced to two fish per day and a maximum size catch limit of 35.6 cm (14”) was imposed (this regulation was later revoked in 2008). Furthermore, in 2000, the Manitou-Seguin Game and Fish Club commenced rehabilitative stocking of walleye fry, in partnership with the MNRF. In 2000 and 2001 alone, over 638,000 walleye fry were stocked at various sites in Manitouwabing Lake (McIntyre, 2000; 2001).

An End of Spring Trapnet (ESTN) survey was conducted in 2004, shortly after walleye stocking began. The purpose of the survey was three-fold. First, to assess the status of the nearshore fish community, particularly the walleye population. Second, to evaluate the impact of previous walleye fry stocking, and third, to evaluate the impact of regulations for walleye implemented in 1998. ESTN surveys use live capture, 6’ trap nets set overnight for approximately 24 hours.

A total of 30 net sets were completed from May 17-June 10 resulting in the capture of 2,820 fish weighing over 1,400 kg. As summarized by McIntyre (2005), productivity was found to be exceptionally high, but over 70% of the catch weight was comprised of brown bullhead (Figure 20). Abundance indices for walleye, smallmouth bass, and largemouth bass were somewhat low relative to provincial and Parry Sound area lakes. These figures were similar to those observed on the lake in the 1980s (Figure 21). Northern pike abundance was slightly higher than the provincial and Parry Sound average and similar to abundance measured in the 1980s. Other nearshore species including yellow perch, rock bass, and pumpkinseed were caught in very low abundance.

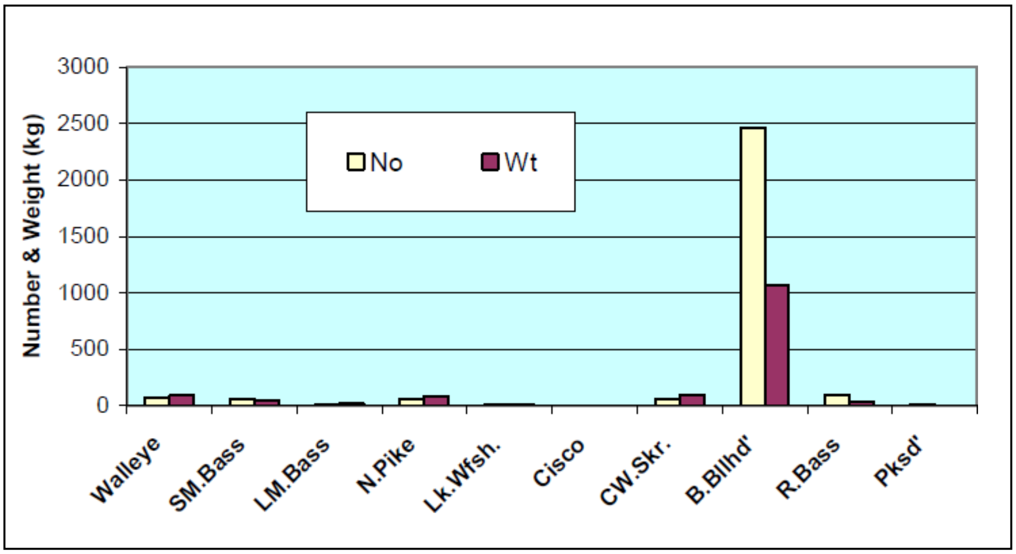

Figure 20. Catch composition for the 2004 ESTN survey on Manitouwabing Lake (McIntyre, 2005).

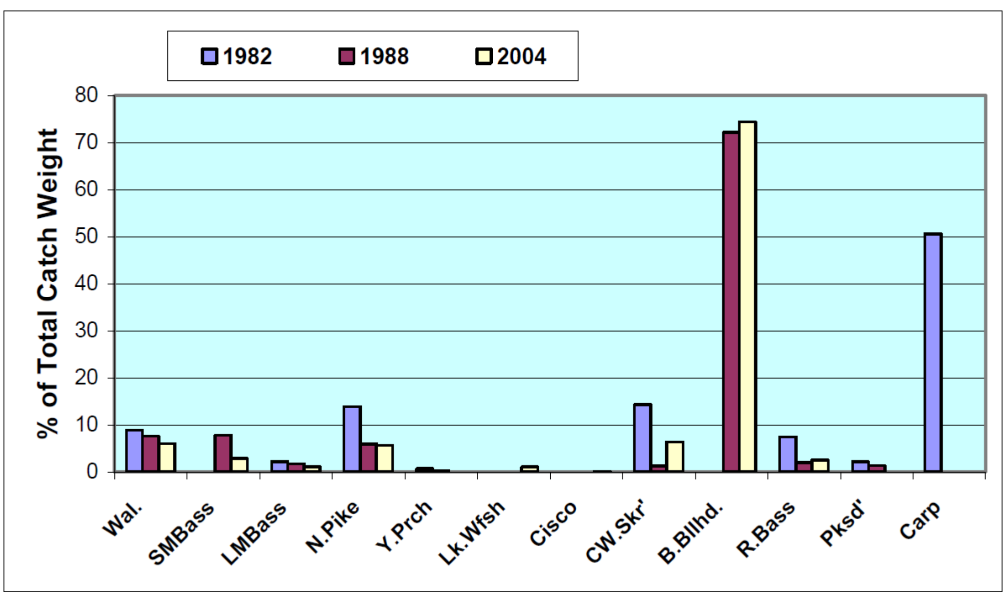

Figure 21. Catch composition by species for the 1982, 1988, and 2004 trapnet surveys on Manitouwabing Lake (McIntyre, 2005).

Nearshore Community Index Netting Project (2004 & 2005)

Manitouwabing Lake was most recently surveyed by the MNRF in 2014 and 2015 Figure 22). A Nearshore Community Index Netting (NSCIN) project was conducted over the two years. The purpose of the survey was to obtain information on the composition of the fish community and the abundance and population of primary game fish species (Scholten, 2020).

NSCIN surveys use live capture, 6' trap nets set overnight for approximately 24 hours. Netting is conducted in late summer from August 1 until the surface temperature cools to 13°C. Net set locations are typically randomly selected, however in this case the same sites used in the 2004 ESTN (McIntyre, 2005) were used again. Captured fish are enumerated by species and major game fish species are sampled in greater detail including length, weight, and the collection of calcified structures for age determination.

A total of 16 net sets were completed from September 8-13, 2014 and 15 net sets completed from September 28-October 2, 2015. Most of the results presented in the NSCIN report are reported by combining results from both years.

By both number and weight, brown bullhead was the most abundant species (average 16.4/net, 7.4kg/net). Of the large game fish, smallmouth bass were the most abundant by number and weight (3.0/net, 2.0kg/net). Northern pike (0.8/net, 1.1kg/net), largemouth bass (1.0/net, 0.8kg/net), and walleye (1.1/net, 1.6kg/net) were all caught at similar rates but varied more in their total weights due to differences in average size of each species. Black crappie were the most numerous game fish overall (4.9/net), but accounted for less weight (1.2kg/net). Finally, white sucker, rock bass, and pumpkinseed made up the remainder of the catch (Figure 23). Table 5 presents a summary of size and age ranges for each game fish species as well as an indication of growth rate.

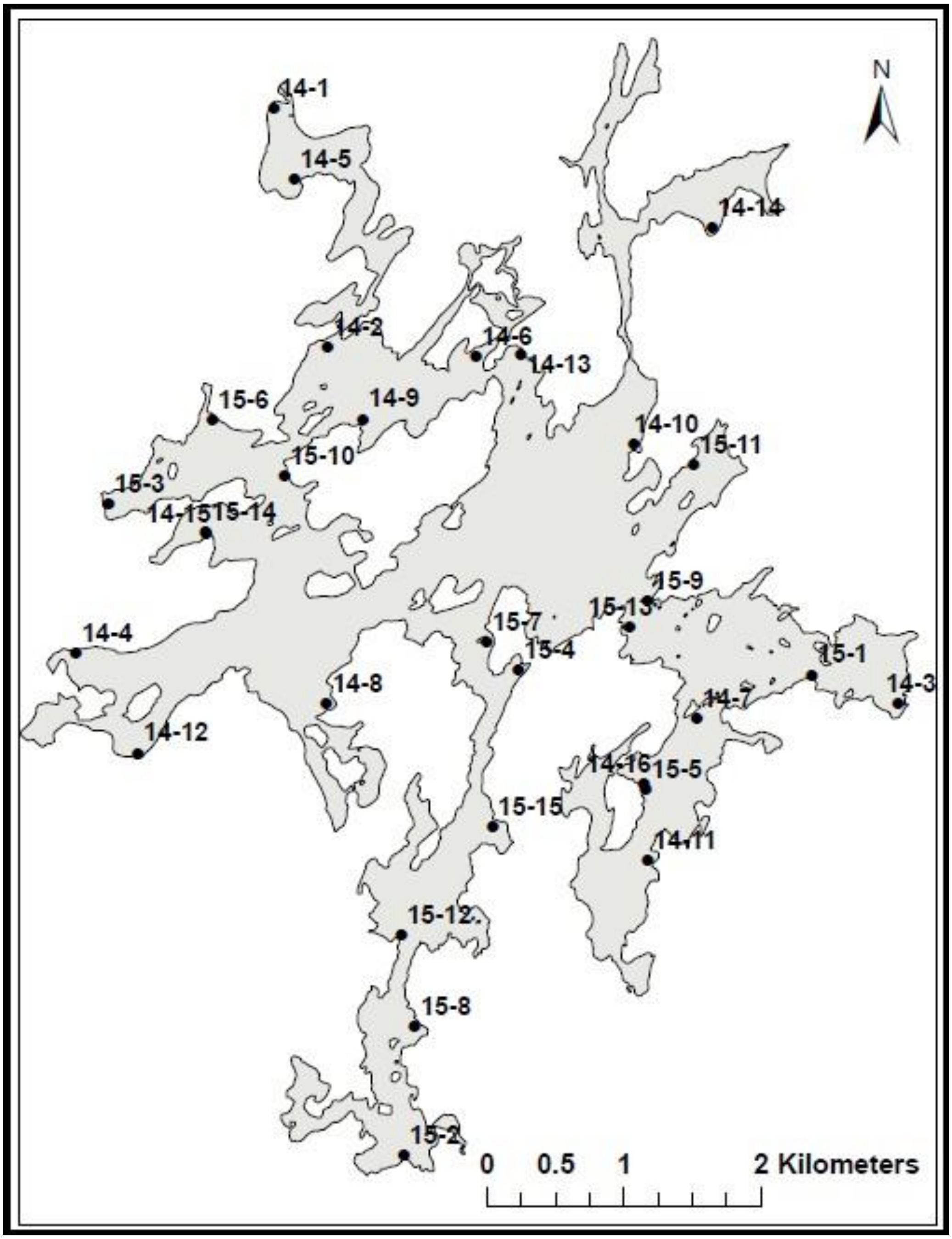

Figure 22. Manitouwabing Lake trap net set locations, NSCIN 2014-2015.

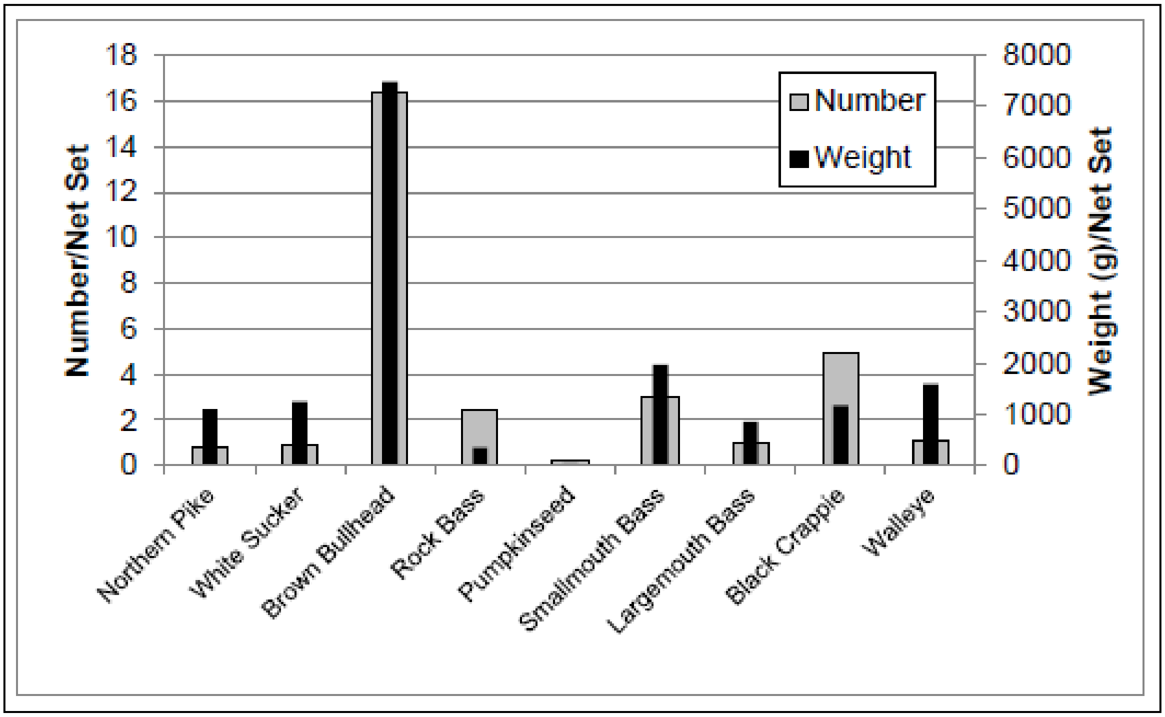

Figure 23. Catch summary by number (wide bars, left vertical axis) and weight (narrow bars, right vertical axis) for Manitouwabing Lake NSCIN 2014-2015 (Scholten, 2020).

Table 5. Summary of game fish species' lengths, ages, and growth rates (Scholten, 2020).

	Walleye	Northern pike	Smallmouth bass	Largemouth bass	Black crappie
Min fork length (mm)	249	337	160	180	115
Max fork length (mm)	672	840	444	431	315
Mean fork length (mm)	487	559	325	347	232
Min age (years)	2	1	1	1	1
Max age (years)	19	8	12	9	5
Mean age (years)	7.7	4.3	6.1	3.1	2.7
Growth rate	Above average	Below average	Above average	Above average*	Above average

* The observed growth rate of largemouth bass was very rapid; above maximum values observed elsewhere in the province.

The 2014-2015 NSCIN report (Scholten, 2020) summarizes that overall, catch composition and abundance of the major game fish species caught were similar to previous surveys, other than the appearance of black crappie (Figure 24). While black crappie had been reported to occur in the lake previously, they did not occur when the last MNRF survey was conducted in 2004. Since being illegally introduced to the lake, back crappie have become a major component of the fish community as evidenced by the fact that they were the second most commonly caught species by number. Several species previously documented were not caught during the 2014-2015 sampling including yellow perch, lake whitefish, cisco, and common carp.

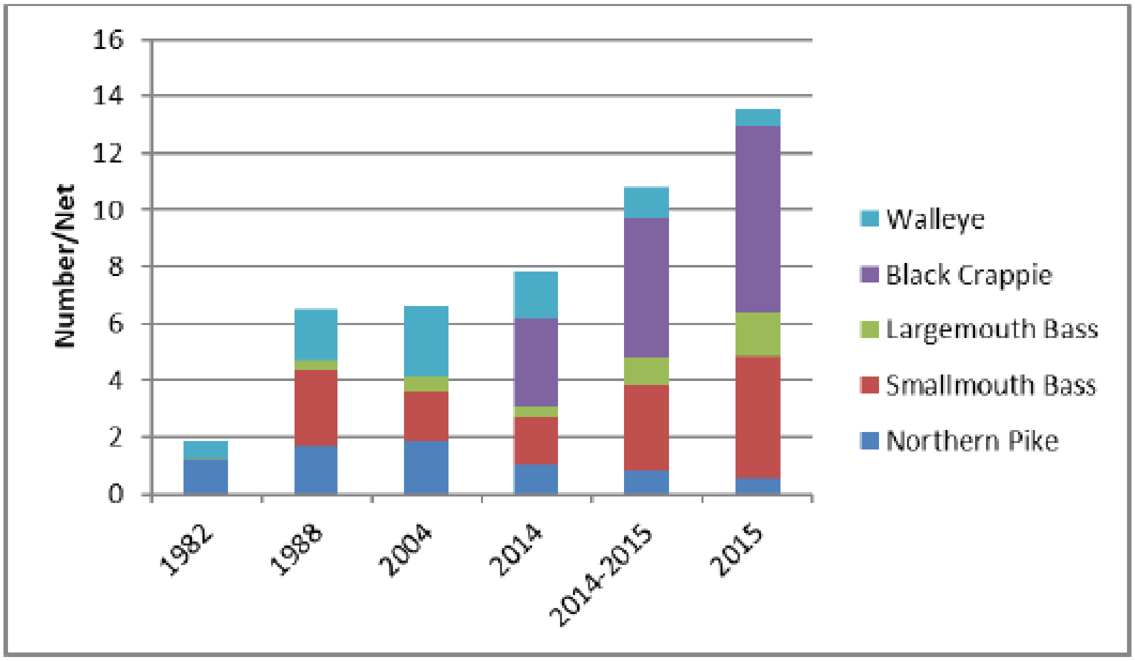

Figure 24. Catch rate (number/net) of major game fish species from 6' trap nets in Manitouwabing Lake, by year (Scholten, 2020).

The overall catch rates of northern pike and walleye in 2014-2015 were somewhat lower than in the past. Smallmouth bass, on the other hand, had a higher catch rate than observed in 1988 and 2004, but not to the point of concluding that a long-term trend has occurred. Largemouth bass catch rate has increased with each successive survey reflecting a real long-term increase in abundance. Brown bullhead catch has shown the greatest variation over surveys; none were caught in 6' trap nets in 1982, extremely large numbers were caught in 1988 and 2004, and a decrease occurred in 2014-2015 (Figure 25). Scholten (2020) states that the implications of changing bullhead abundance on other members of the fish community is unclear but that a real decline in abundance more recently may ease competitive interactions with other species.

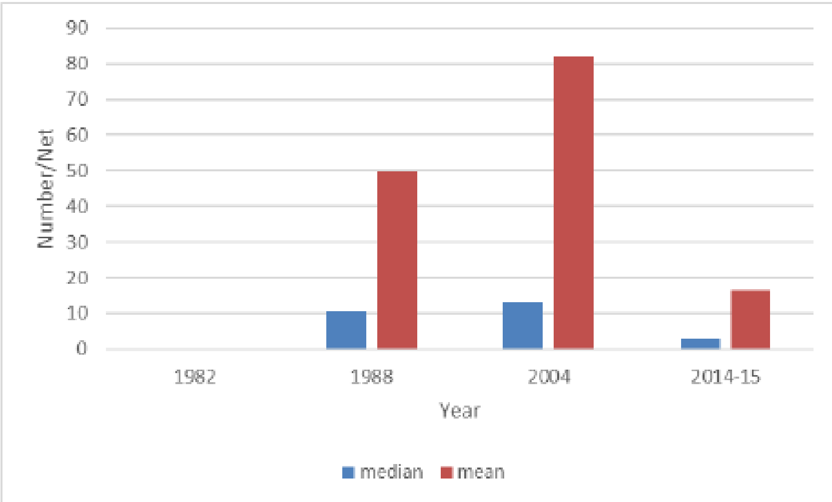

Figure 25. Mean and median catch of brown bullhead from 6' trap nets in Manitouwabing Lake, by year (Scholten, 2020).

Based on the findings from the 2014-2015 NSCIN project, it was determined that Manitouwabing Lake should be "managed as a natural Walleye lake and supplemental stocking should not be done" (Scholten, 2020, p. 15). Provincial guidelines recommend that stocking of a species not occur when a viable self-sustaining population is present (OMNR, 2002). Furthermore, the report recommends that "no lake-specific management actions take place at this time" (Scholten, 2020, p. 15).

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 or their baby through a diet elevated in contaminants, and young children are affected by contaminants at lower levels than the general population.

In terms of advisories for eating fish from Manitouwabing Lake, mercury is the contaminant of concern (Table 6). Specifically, advisories exist for black crappie, northern pike, and walleye due to concerns around mercury. 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 6. Fish consumption advisories for Manitouwabing Lake (see link).

Species	General Population	Sensitive Population*
Black crappie[1]	• max 32 meals/month of fish 20-25cm • max 12 meals/month of fish 25-30cm	• max 12 meals/month of fish 20-25cm • max 4 meals/month of fish 25-30cm
Northern pike[1]	• max 16 meals/month of fish 30-35cm • max 16 meals/month of fish 35-40cm • max 16 meals/month of fish 40-45cm • max 12 meals/month of fish 45-50cm • max 8 meals/month of fish 50-55cm • max 8 meals/month of fish 55-60cm • max 8 meals/month of fish 60-65cm • max 4 meals/month of fish 65-70cm • max 4 meals/month of fish 70-75cm • max 4 meals/month of fish >75cm	• max 8 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 45-50cm • max 4 meals/month of fish 50-55cm • max 4 meals/month of fish 55-60cm • no meals of fish 60-65cm • no meals of fish 65-70cm • no meals of fish 70-75cm • no meals of fish >75cm
Walleye[1]	• max 8 meals/month of fish 25-30cm • max 8 meals/month of fish 30-35cm • max 4 meals/month of fish 35-40cm • max 4 meals/month of fish 40-45cm • max 4 meals/month of fish 45-50cm • max 2 meals/month of fish 50-55cm • max 2 meals/month of fish 55-60cm • max 2 meals/month of fish 60-65cm • max 0 meals/month of fish 65-70cm	• max 4 meals/month of fish 25-30cm • no meals of fish 30-35cm • no meals of fish 35-40cm • no meals of fish 40-45cm • no meals of fish 45-50cm • no meals of fish 50-55cm • no meals of fish 55-60cm • no meals of fish 60-65cm • no meals of fish 65-70cm

* Women of child-bearing age and children under 15; [1] Mercury

SUMMARY OF RECOMMENDATIONS

Water Quality

Continue annual LPP sampling. If capacity is limited, preference should be given to sites that are spread across different areas of the lake and that have the longest datasets. Long-term datasets are important to assess the effect of external drivers on the nutrient status of the lake (Clark, 2018). Suggested sites are Station 2973, Site IDs 8, 9, 13, and 18.

Continue with annual benthic sampling to accurately characterize and track trends in the benthic community in the lake. Lakes in the region are experiencing increasing pressures, such as climate change, invasive species, and development. 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, enhanced 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.

As described by Clark (2018), late summer monitoring of dissolved oxygen in the deepest location and in isolated bays where the depths are greater than 7-8m (see map on page 11 of Clark (2018) report) may provide additional information to address the potential for algal blooms. After areas are identified as having the oxygen depleted at the bottom (with measured oxygen profiles) in year one, samples can be taken 1m from the bottom in subsequent years to assess whether or not there are elevated phosphorus concentrations in the bottom water.

Bacteria monitoring should be focused on beaches as per the province's Beach Management Guidance Document. Should the MLCA wish to continue with bacteria monitoring elsewhere, it should happen in the framework of a scientific investigation focused on testing specific hypotheses on potential sources of contamination through a focused sampling program.

Long-term records of water temperature are easy for a dedicated volunteer or group of volunteers to collect and can provide very useful information.

Fish Communities

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. Highlights include:

- A valid fishing license is required to catch your own live baitfish, leeches, crayfish, and northern leopard frogs.
- There are specific fish species that can and cannot be used as bait in Ontario.
- Bait can only be caught in your home Bait Management Zone (BMZ) and cannot leave your BMZ.
- Baitfish and leeches you catch cannot be sold unless you are a licensed dealer.
- If you fish outside your home BMZ, you must buy your baitfish and leeches locally, keep a receipt, and use or dispose of your bait within two weeks of purchase.

Recreational anglers should use the app MyCatch by Angler's Atlas 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

MLCA should continue to encourage Manitouwabing 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. Native plants can be sourced from the MLCA Native Plant Seedling Sale and the annual GBB Native Plant Fundraiser (check the GBB events page in the spring).

Property owners interested in decreasing their ecological footprint can also utilize GBB's Life on the Bay Stewardship Guide. 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 many more. The Life on the Bay guide is designed to be used by waterfront property owners on Georgian Bay and inland lakes.

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.

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APPENDICES

Appendix A. Active and Historical Lake LPP Sampling Locations

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.

Station: 2973
Site ID: 1
Description: Great Bay
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2002		12.72	13.51	13.12	
2003	2.30	10.21	10.06	10.14	

Station: 2973
Site ID: 3
Description: Longhorn & James Bay
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2002		24.25	36.58	30.42	
2003		12.40	13.52	12.96	

Station: 2973
Site ID: 4
Description: McKellar, near dock
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2002	2.80	51.10	44.80	47.95	
2003	2.37				
2006	3.13	13.96	12.85	13.41	
2007	3.24	11.54	11.72	11.63	
2008	3.55	10.10	10.26	10.18	3.66
2009	3.30	9.51	9.60	9.56	2.34

Station: 2973
Site ID: 6
Description: L Taits Is-Great Bay
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2002	2.09	18.70	13.33	16.02	
2003	2.14	11.40	12.10	11.75	
2004	2.28	9.20	11.23	10.22	
2005	2.33	10.51	10.87	10.69	
2006	2.48	7.12	6.99	7.06	
2007	2.23				
2008	2.17	24.16	21.47	22.82	3.94
2009	2.34	9.38	8.27	8.83	3.00
2011	2.32	11.00	11.20	11.10	3.74
2012	2.28	7.80	8.20	8.00	3.69
2013	2.67	10.00	10.20	10.10	3.21
2014	2.37	13.80	15.20	14.50	3.58
2015	2.24	9.40	9.40	9.40	3.76

Station: 2973
Site ID: 7
Description: N / W Tait's Island
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2006	2.69	10.18	12.27	11.23	
2007	2.73	9.20	9.30	9.25	
2008	2.69	12.63	14.34	13.49	3.88
2009	2.59				

Station: 2973
Site ID: 8
Description: West of Maplewood
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2002	2.08	9.70	10.60	10.15	
2003	2.00	13.20	13.40	13.30	
2004	2.60	12.17	11.61	11.89	
2005	2.42	16.50	11.60	14.05	
2006	2.23	10.03	10.44	10.24	
2007	2.53	10.48	9.26	9.87	
2008	1.96	12.96	12.40	12.68	3.66
2009	2.35	11.63	10.75	11.19	
2010	2.41	9.60	10.40	10.00	3.43
2011	2.39	14.00	12.80	13.40	3.87
2012	2.52	7.80	7.60	7.70	3.95
2013	2.45	13.20	16.40	14.80	3.23
2014	2.35	11.60	11.40	11.50	3.64
2015	2.37	9.20	9.60	9.40	3.48
2016	2.63	9.20	8.80	9.00	3.34
2017	2.02	13.80	10.20	12.00	3.56
2018	2.30	14.20	12.00	13.10	3.58
2019	2.33	10.80	11.40	11.10	3.30

Station: 2973
Site ID: 9
Description: E of Longhorn, Hardie's Cr
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2002	1.61				
2005		14.96	14.53	14.75	
2006	1.65				
2007	1.40	14.21	12.75	13.48	
2008	1.35	16.92	15.22	16.07	3.52
2016	1.42	12.60	12.20	12.40	3.66
2017		13.00	11.60	12.30	4.76
2018		11.20	12.20	11.70	4.64
2018		11.80	11.80	11.80	
2019		14.40	13.00	13.70	

Station: 2973
Site ID: 10
Description: E end, Bailey's
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2002	1.36				

Station: 2973
Site ID: 11
Description: N Tait's Is.
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2006	2.35	9.16	8.53	8.85	
2012	2.63	13.40	12.20	12.80	3.80
2013	2.80	13.20	11.00	12.10	3.30

Station: 2973
Site ID: 12
Description: Manitouwabing (golf cs.) Bay
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2006		9.11	9.70	9.41	
2007	2.25	10.98	10.31	10.65	
2009		9.18	9.81	9.50	2.96

Station: 2973
Site ID: 13
Description: Jones Bay
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2006		13.44	12.52	12.98	
2007		13.06	12.21	12.64	
2008	2.34	13.34	12.06	12.70	3.12
2009	1.73	12.74	11.66	12.20	2.44
2011	2.16	13.00	14.80	13.90	
2012		11.20	11.00	11.10	3.34
2013	2.05	12.00	12.00	12.00	2.92
2014	2.02	9.40	9.80	9.60	2.96
2015	1.98	11.00	9.40	10.20	2.42
2016	2.34	8.80	8.80	8.80	3.06
2017		11.80	11.20	11.50	2.86
2018					3.32
2020	1.52	13.20	13.40	13.30	3.9

Station: 2973
Site ID: 18
Description: McKellar Bay
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2016	1.44	10.40	10.60	10.50	4.06
2017		14.00	15.20	14.60	4.02
2018		9.80	9.40	9.60	3.90
2019		8.80	9.00	8.90	
2020	3	9.60	9.00	9.30	4.20

Station: 2973
Site ID: 19
Description: McKellar, near dock
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2016	3.32	11.20	10.80	11.00	3.88
2017		11.40	11.20	11.30	3.94
2018		9.00	11.20	10.10	4.00
2019		11.80	10.20	11.00	

Station: 2973
Site ID: 20
Description: South of Fire RTE 150 Basin
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2016		7.80	7.60	7.70	3.28

Station: 2973
Site ID: 21
Description: Moffat Basin, Deep spot
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2016		12.60	12.80	12.70	3.76

Station: 2973
Site ID: 22
Description: Basin South of Lakeside Dr.
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2016	2.61	9.20	10.00	9.60	3.76
2017	2.06	12.60	12.80	12.70	23.10

Station: 2973
Site ID: 23
Description: East of Hurdville
Data Collector: LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2020	1.43	11.20	11.20	11.20	4.20

Appendix B. Benthic Sampling Results

Table 7. Manitouwabing Lake Site 1 sampling data (2020-2022).

Common Name	Scientific Name	2020			2021			2022		
		1	2	3	1	2	3	1	2	3
Hydras	Coelenterata	0	0	0	0	0	0	0	0	0
Flatworms	Turbellaria	2	1	10	2	1	7	4	5	2
Roundworms	Nematoda	10	12	7	10	1	12	0	1	7
Aquatic Earthworms	Oligochaeta	2	1	0	6	5	3	1	0	1
Leeches	Hirudinaea	0	0	0	0	0	1	0	1	0
Sow bugs	Isopoda	2	18	15	6	51	32	14	14	12
Clams	Pelcypoda	0	0	0	0	0	0	0	1	0
Scuds	Amphipoda	27	32	36	51	77	44	49	79	47
Crayfish	Decapoda	0	0	0	0	0	0	0	1	0
Mites	Hydracarina	10	10	5	10	5	8	21	24	26
Mayflies	Ephemeroptera	4	4	9	4	1	8	3	6	8
Dragonflies	Anisoptera	11	4	3	2	2	3	0	2	1
Damselflies	Zygoptera	8	1	0	0	2	5	0	6	0
Stoneflies	Plecoptera	0	0	0	0	0	0	0	0	0
True Bugs	Hemiptera	0	0	0	0	1	0	0	0	0
Fishfiles and Alderflies	Megaloptera	0	0	0	0	0	0	0	1	0
Caddisflies	Trichoptera	8	6	4	2	0	2	0	0	1
Aquatic Moths	Lepidoptera	0	0	0	0	0	0	0	0	0
Beetles	Coleoptera	0	0	0	0	0	0	0	1	0
Snails and Limpets	Gastropoda	2	0	4	12	2	3	5	1	1
Midges	Chironomidae	12	10	7	5	10	8	4	3	10
Horse and Deer Flies	Tabanidae	0	0	0	0	0	0	0	0	0
Mosquitos	Culicidae	0	0	0	0	0	0	0	0	0
No-see-ums	Ceratopogonidae	2	2	5	1	4	1	0	1	0
Craneflies	Tipulidae	0	0	0	0	0	0	0	0	0
Blackflies	Simuliidae	0	0	0	0	0	0	0	0	0
Misc. True Flies	Misc. Diptera	0	0	0	0	0	0	0	0	0
Total Count		100	101	105	112	163	137	101	146	116
Number of Taxa		13	12	11	13	14	14	8	15	11
Average % EOT		12%								

Table 8. Manitouwabing Lake Site 2 sampling data (2020-2022).

Common Name	Scientific Name	2020			2021			2022		
		1	2	3	1	2	3	1	2	3
Hydras	Coelenterata	0	0	0	0	0	0	0	0	0
Flatworms	Turbellaria	0	3	0	0	1	2	0	0	1
Roundworms	Nematoda	0	5	7	10	17	10	1	4	2
Aquatic Earthworms	Oligochaeta	0	0	1	0	2	1	1	1	1
Leeches	Hirudinaea	0	0	0	0	1	1	0	0	0
Sow bugs	Isopoda	19	9	42	56	50	21	29	16	21
Clams	Pelcypoda	0	1	0	1	0	1	0	1	1
Scuds	Amphipoda	34	22	21	22	6	42	10	10	28
Crayfish	Decapoda	0	1	0	0	0	0	1	0	0
Mites	Hydracarina	17	13	2	2	24	5	2	26	30
Mayflies	Ephemeroptera	4	20	7	10	1	6	3	8	3
Dragonflies	Anisoptera	2	4	6	5	6	1	1	4	2
Damselflies	Zygoptera	2	5	0	0	0	1	0	0	0
Stoneflies	Plecoptera	0	0	0	0	0	0	0	0	0
True Bugs	Hemiptera	0	1	0	0	0	1	0	0	0
Fishfiles and Alderflies	Megaloptera	0	0	0	0	0	0	0	0	0
Caddisflies	Trichoptera	3	2	2	2	1	3	0	0	1
Aquatic Moths	Lepidoptera	0	0	0	0	0	0	0	0	0
Beetles	Coleoptera	0	0	0	0	0	1	0	1	0
Snails and Limpets	Gastropoda	1	0	2	0	0	1	2	1	3
Midges	Chironomidae	15	14	16	5	6	11	53	29	14
Horse and Deer Flies	Tabanidae	1	0	0	0	0	0	0	0	0
Mosquitos	Culicidae	0	0	0	0	0	0	0	0	0
No-see-ums	Ceratopogonidae	2	3	5	7	0	4	0	0	0
Craneflies	Tipulidae	0	0	0	1	0	0	0	0	0
Blackflies	Simuliidae	0	0	0	0	0	0	0	0	0
Misc. True Flies	Misc. Diptera	0	0	0	0	0	0	0	0	0
Total Count		100	103	111	121	115	112	103	101	107
Number of Taxa		11	14	11	11	11	17	10	11	12
Average % EOT		12%								

Table 9. Manitouwabing Lake Site 3 sampling data (2020-2022).

Common Name	Scientific Name	2020			2021			2022		
		1	2	3	1	2	3	1	2	3
Hydras	Coelenterata	0	0	0	0	0	0	0	0	0
Flatworms	Turbellaria	4	1	1	5	0	13	1	11	14
Roundworms	Nematoda	19	11	26	7	19	50	4	3	10
Aquatic Earthworms	Oligochaeta	5	3	4	2	9	2	2	12	6
Leeches	Hirudinaea	0	1	0	0	0	0	0	0	0
Sow bugs	Isopoda	37	0	2	56	2	8	33	2	5
Clams	Pelcypoda	0	1	2	0	2	1	2	6	4
Scuds	Amphipoda	39	15	36	41	12	21	11	72	8
Crayfish	Decapoda	0	0	0	0	1	0	0	0	0
Mites	Hydracarina	2	3	8	2	5	1	26	16	41
Mayflies	Ephemeroptera	14	14	20	2	13	5	10	32	7
Dragonflies	Anisoptera	7	4	5	3	2	4	0	5	3
Damselflies	Zygoptera	6	0	0	0	0	0	0	0	0
Stoneflies	Plecoptera	0	0	0	0	0	0	0	0	0
True Bugs	Hemiptera	1	0	0	0	0	0	0	0	0
Fishfiles and Alderflies	Megaloptera	0	1	0	0	0	0	0	0	0
Caddisflies	Trichoptera	6	6	22	0	7	8	0	3	5
Aquatic Moths	Lepidoptera	0	0	0	0	0	0	0	1	0
Beetles	Coleoptera	0	0	2	1	0	5	1	3	5
Snails and Limpets	Gastropoda	5	6	2	2	2	1	3	3	2
Midges	Chironomidae	7	57	77	8	27	25	30	85	45
Horse and Deer Flies	Tabanidae	0	0	0	0	0	0	0	0	0
Mosquitos	Culicidae	0	0	0	0	0	0	0	0	0
No-see-ums	Ceratopogonidae	0	0	2	0	2	2	0	2	4
Craneflies	Tipulidae	0	0	0	0	0	0	0	0	0
Blackflies	Simuliidae	0	0	0	0	0	0	0	0	0
Misc. True Flies	Misc. Diptera	0	0	0	0	0	0	0	0	0
Total Count		152	123	209	129	103	146	123	256	159
Number of Taxa		13	13	14	11	13	14	11	15	14
Average % EOT		15%								

Table 10. Manitouwabing Lake Site 4 sampling data (2020-2022).

Common Name	Scientific Name	2020			2021			2022		
		1	2	3	1	2	3	1	2	3
Hydras	Coelenterata	0	0	0	0	0	0	0	0	0
Flatworms	Turbellaria	0	1	5	3	3	3	0	0	0
Roundworms	Nematoda	13	19	17	11	29	39	0	2	0
Aquatic Earthworms	Oligochaeta	1	3	5	1	2	6	0	1	1
Leeches	Hirudinaea	0	0	0	0	0	0	0	0	2
Sow bugs	Isopoda	14	2	12	50	9	9	30	2	33
Clams	Pelcypoda	0	0	0	0	1	0	2	0	2
Scuds	Amphipoda	50	35	145	59	41	80	47	55	30
Crayfish	Decapoda	0	0	0	0	0	0	0	0	0
Mites	Hydracarina	19	17	36	1	4	11	7	17	5
Mayflies	Ephemeroptera	2	5	7	3	2	3	0	1	0
Dragonflies	Anisoptera	0	1	7	3	1	2	3	0	0
Damselflies	Zygoptera	0	0	5	0	0	2	0	0	0
Stoneflies	Plecoptera	0	0	0	0	0	0	0	0	0
True Bugs	Hemiptera	0	0	1	0	0	0	0	0	0
Fishfiles and Alderflies	Megaloptera	0	0	0	1	0	0	0	0	1
Caddisflies	Trichoptera	1	5	4	2	1	0	0	0	1
Aquatic Moths	Lepidoptera	0	1	0	0	1	0	0	0	0
Beetles	Coleoptera	0	0	0	0	1	0	1	0	4
Snails and Limpets	Gastropoda	0	1	0	1	5	2	7	11	7
Midges	Chironomidae	8	18	13	14	5	29	3	11	16
Horse and Deer Flies	Tabanidae	0	0	0	0	0	0	0	0	0
Mosquitos	Culicidae	0	0	0	0	0	0	0	0	0
No-see-ums	Ceratopogonidae	8	2	4	1	2	4	0	1	0
Craneflies	Tipulidae	0	0	0	0	0	0	0	0	0
Blackflies	Simuliidae	0	0	0	0	0	0	0	0	0
Misc. True Flies	Misc. Diptera	0	0	0	0	0	0	0	0	0
Total Count		116	110	261	150	107	190	100	101	102
Number of Taxa		9	13	13	13	15	12	8	9	11
Average % EOT		4%								

Appendix C. Manitouwabing Lake State of the Basin Review 2018

Manitouwabing Lake State of the Basin Review 2018

Killian

Prepared for: Manitouwabing Lake Community

Association By: Clark, October 2018

Contents

Manitouwabing Lake – State of the Basin Review

Overview

Manitouwabing Lake is a large important resource in McKellar Township north west of Parry Sound (Lat, 45.452 Long, 79.904). General Lake characteristics are shown in Table 1.

Table 1 – General characteristics of Manitouwabing Lake. Data from OMNR and MOECP.

Area	1178 ha
Volume	6597 x 10^4 m^3
Max Depth	33 m
Mean depth	5.6 m
Watershed Area	400 km^2
Clarity (Secchi depth)	2.4 m
Runoff	0.464 m
Trophic status	mesotrophic

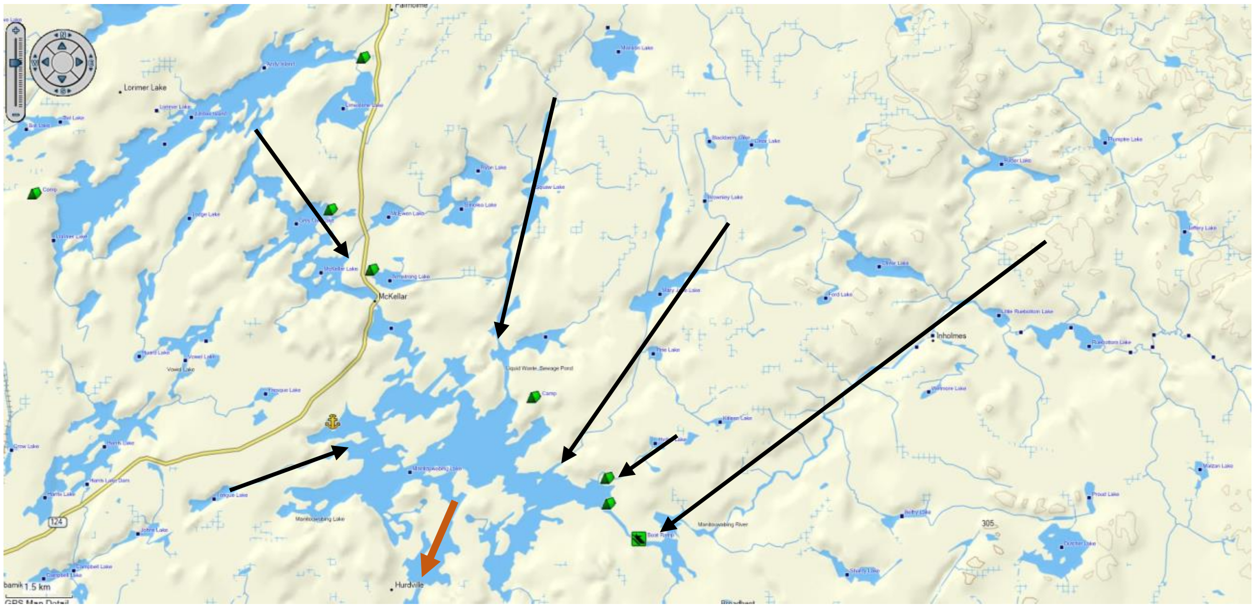
Despite its importance, Manitouwabing Lake and other lakes in the area have not been studied in detail or well characterized with respect to many aspects of water quality. Nevertheless, the data that have been collected to this date allow us to conduct a preliminary assessment of the lake and its watershed and then go forward to make recommendations regarding future steps.

Watershed Influence

Manitouwabing Lake collects water from a large watershed through numerous inflows including the Manitouwabing River (Figure 1). These inflows mix within the lake and exit through the outflow at the south end of the lake. This outflow winds its way to Parry Sound through the Seguin River and ultimately into Georgian Bay.

A large watershed will increase the flushing rate for a lake and give the lake water quality characteristics that are driven by watershed processes more so than by local influences. Using the data in Table 1 we can calculate that the water in the lake is replaced 2.8 times per year or approximately every 4 months. This replacement rate will be, of course, higher during the spring and lower during drier months. Water quality measured in the lake near major inflows will have characteristics similar to those of the inflow and if the watershed characteristics are similar between inflows then this will lead to similar water quality throughout the lake. This is an important consideration because measured water quality is similar for several key parameters throughout Manitouwabing Lake which would indicate similar watershed characteristics for the major inflows to the lake.

Figure 1 – The Manitouwabing watershed showing several major inflows (black arrows) and the outflow to Georgian Bay (brown arrow).



Water Quality

Total Phosphorus

The most revealing characteristic of Manitouwabing Lake (total phosphorus) has been measured by volunteers through the Ministry of the Environment's Lake Partner Program (LPP). Phosphorus is the element that controls the production of algae and, in fact, most of the other organisms that reside in the lake. Lower phosphorus concentrations indicate lower productivity and are generally typical of dilute, gin clear, lake trout lakes. Higher concentrations are found in more productive lakes with more fish, more weeds and more algae. When concentrations of phosphorus are high enough to exacerbate nuisance algal blooms there can be concerns about water quality as a result of toxins that can be produced by bluegreen algae (cyanobacteria). Blooms of this nature are generally rare in Ontario.

Volunteers participating in the LPP have collected total phosphorus data at numerous locations throughout Manitouwabing Lake (Figure 2). The concentrations observed are very similar from place to place in the lake (Table 1 and Figure 3). This indicates that the watershed has a strong influence on the concentration of phosphorus in the lake (through a high flushing rate) which likely obscures any local influences that may occur within the lakes many embayments.

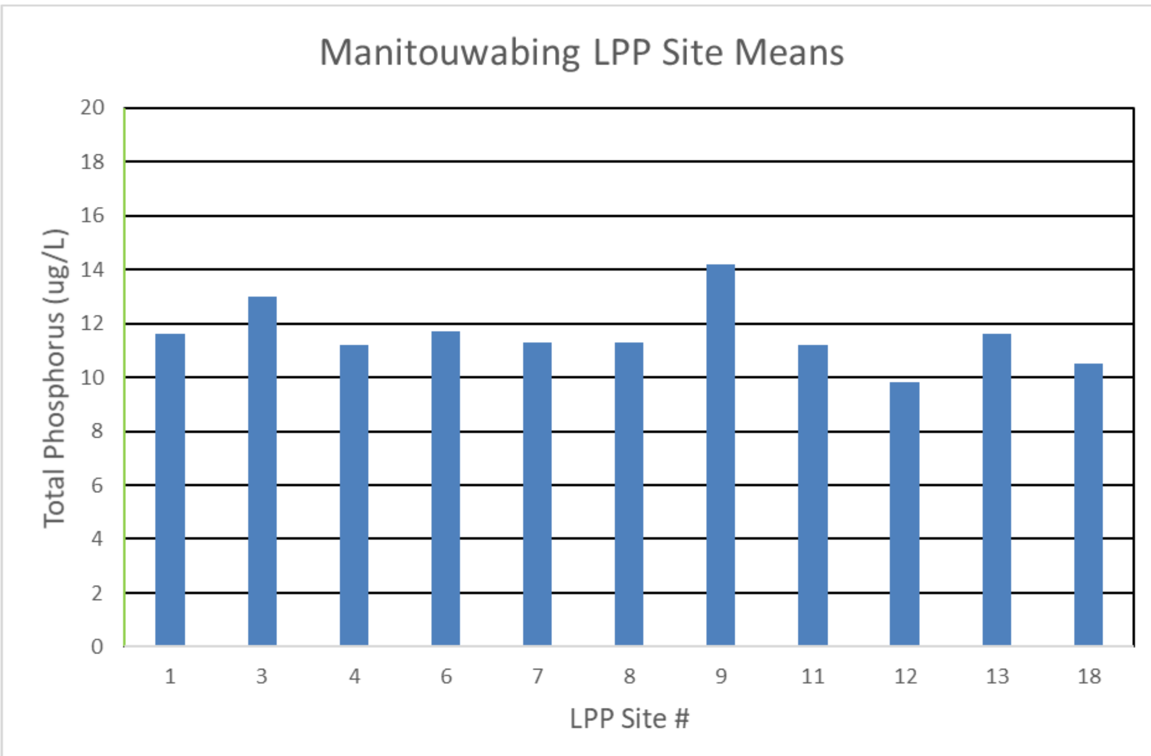
Figure 2 – Lake Partner Program sample sites in Manitouwabing Lake.

Table 1 – Mean total phosphorus concentrations at Lake Partner Program sample sites throughout Manitouwabing Lake.

Site	Lat.	Long.	Mean TP	Status
1	452845	795344	11.6	
3	452748	795302	13	
4	453020	795512	11.2	
6	452837	795413	11.7	current
7	452901	795538	11.3	
8	452810	795500	11.3	current
9	452822	795244	13.8	current
11	452917	795443	11.2	
12	452856	795253	9.8	
13	452713	795326	11.6	current
18	453008	795455	12.6	current
19	453019	795512	11.2	current
20	452901	795538	7.7	current
21	452932	795504	12.7	current
22	452959	795249	11.2	current
		Mean	**11.5**	

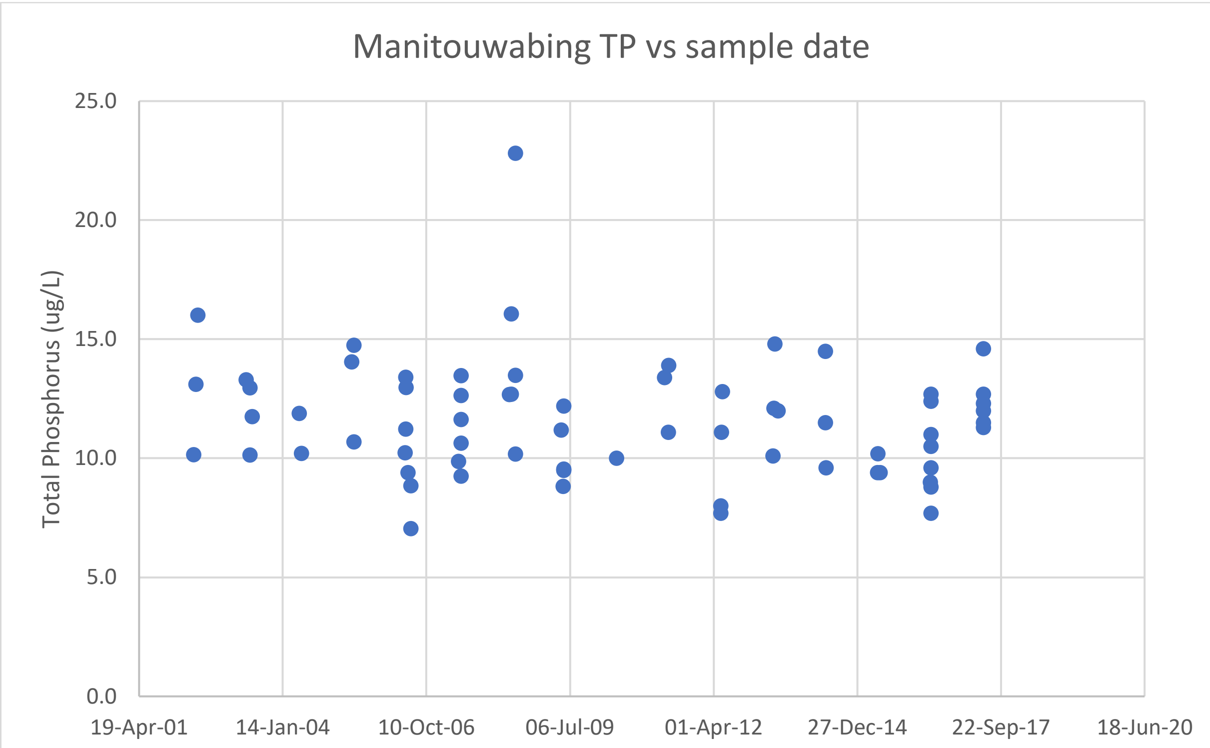
The lakewide mean total phosphorus concentration is 11.5 µg/L. This indicates that Manitouwabing Lake is at the lower end of the mesotrophic range. Lakes that are below 10 µg/L are considered to be oligotrophic (clear dilute and unproductive). Mesotrophic lakes (10-20 µg/L) are in the middle of this trophic classification and these lakes show considerable variation in productivity between the low end of the scale at 10 µg/L and the high end of the scale at 20 ug/L. Lakes over 20 µg/L are considered to be eutrophic with more chance of supporting nuisance algal blooms. Lakes at the lower end of the mesotrophic scale like Manitouwabing will share characteristics more like oligotrophic lakes while lakes at the high end of the scale (closer to 20) will begin to share characteristics of eutrophic lakes.

Figure 3 – Mean total phosphorus concentrations in Manitouwabing Lake at the LPP sample sites



The bottom line with respect to phosphorus is that concentrations are similar throughout the lake and consistent between years (Figure 4). Figure 4 shows that phosphorus concentrations have not increased since 2001 and are similar between sample stations (see Appendix). It is important to note that the range in observed values (approx 10-15 µg/L) is normal for multiple stations over time. These values indicate a lake that is highly influenced by its watershed with no sign of deterioration over the years in water quality with respect to phosphorus.

Figure 4 – Total phosphorus measured by the Lake Partner Program at the locations and dates shown in Appendix 1. Two points considered to be outliers were eliminated. The one datapoint above 20 µg/L is also likely an outlier but duplicate samples were in agreement so the data were retained.



It is important to recognise that human phosphorus inputs to the lake are possible through the operation of failing or inadequate septic systems. It is also possible to add nutrients through the unwise use of shoreline areas that border the lake (riparian areas). Harmful land use practices include the removal of natural shoreline vegetation, proliferation of lawns, use of fertilizers, etc. Education of property owners with respect to these issues can protect the ecosystem integrity of the lake.

Guidance for sustainably living by water is available from many sources.

http://naturecanada.ca/living-by-water/

Dissolved Organic Carbon

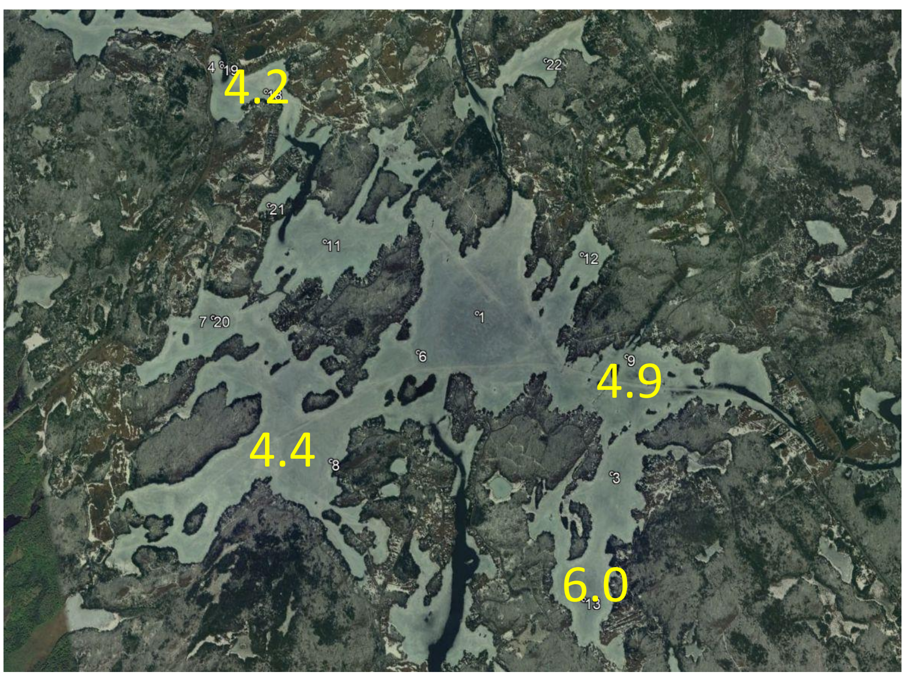
While Manitouwabing Lake is considered to be a mesotrophic lake we can see that much of this phosphorus has its origins in the watershed and is transported to the lake as Dissolved Organic Carbon (DOC) which originates in wetlands. This is the material that causes tea stained water in lakes. In other words it's mesotrophic status is not likely the result of human activity in the watershed but rather the result of export of DOC from wetlands. Concentrations throughout the lake are relatively similar (4.2-6.0 mg/L) with slightly more tea stained water in the south east areas of the lake. This relatively narrow range in DOC values throughout the lake indicates similar wetland conditions throughout the different subwatersheds.

DOC concentrations measured by the LPP are shown in Table 2. Sample Locations are shown in Figure 5.

Table 2 – Dissolved organic carbon concentrations measured by the LPP.

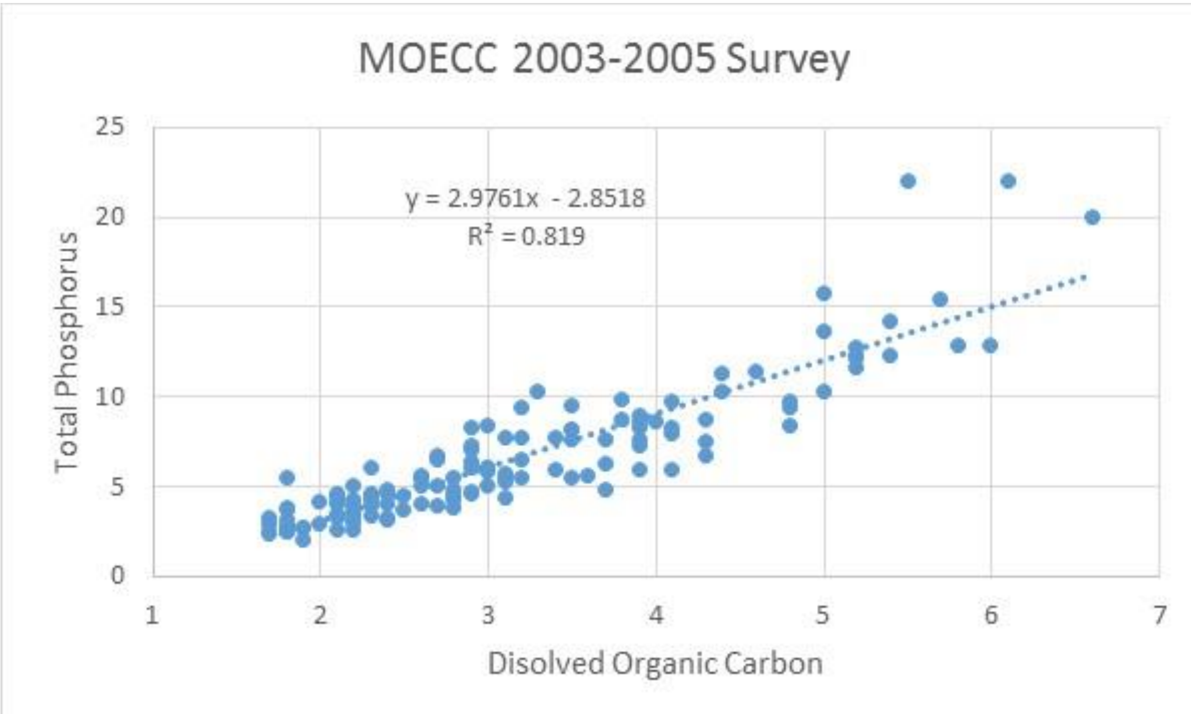
LDESC	LP_STN	SITE	DATE	DOC (mg/L)
MANITOUWABING LAKE-18	2973	18	5/18/2018	4.2
MANITOUWABING LAKE-19	2973	19	5/24/2018	4.1
MANITOUWABING-9	2973	9	5/24/2018	4.9
MANITOUWABING-13	2973	13	5/24/2018	6.0
MANITOUWABING LAKE-8	2973	8	5/20/2018	4.4

Figure 5. DOC concentrations (mg/L) throughout Manitouwabing Lake shown in yellow.



In Figure 6 we can see the relationship between DOC and TP measured by The Ministry of the Environment Conservation and Parks (MOECP) at numerous locations in the nearshore areas of Georgian Bay. The close relationship shows that most of the phosphorus in these areas is associated with DOC. In other words, the phosphorus has its origins in wetlands throughout the watershed.

Figure 6 – The relationship between DOC and phosphorus in nearshore areas of Georgian Bay.



If we consider that Manitouwabing Lake's mean DOC concentration is 4.7 mg/L this corresponds to 11.1 µg/L total phosphorus on the graph in Figure 6. This indicates that most of the 11.5 µg/L TP in Manitouwabing Lake has is origins as DOC in watershed's wetland complexes.

Algal Blooms

Algal blooms can occur for several reasons. Most often they are caused by elevated phosphorus concentrations. Blooms are rare below 10µg/L and become more likely as concentrations approach 20 µg/L. The Provincial Water Quality Objectives recommend maintaining concentrations below 20 µg/L to avoid nuisance algal blooms. Blooms can also be exacerbated by aspects of climate change such that they may now occur in areas where they have previously been absent. Finally, a species of algae called *Gloeotrichia* can bloom in low phosphorus lakes because it derives its nutrients from the sediments rather than from the water.

Manitouwabing Lake is not expected to support algal blooms. It is important to note that if you see a cloudy ball of filamentous algae near the bottom of the lake in a nearshore area – this is not an algal bloom. In addition, sometimes when algae die in the main lake they can be blown by the wind and concentrated into nearshore areas and these occurrences are usually not indicative of algal blooms. Algal blooms are usually indicated by large quantities of bright green cells in the water that cover extensive areas (see photo below).

If you think that an algal bloom is occurring the correct response is to call the MOECP Spills Action Centre.

Spill Reporting 1-800-268-6060

They will then investigate the bloom and call the Ministry of Health if a bloom is confirmed. They will also sample the bloom to confirm the species and will test for the presence of toxins. There is no reason to test for toxins without first following the steps indicated above.

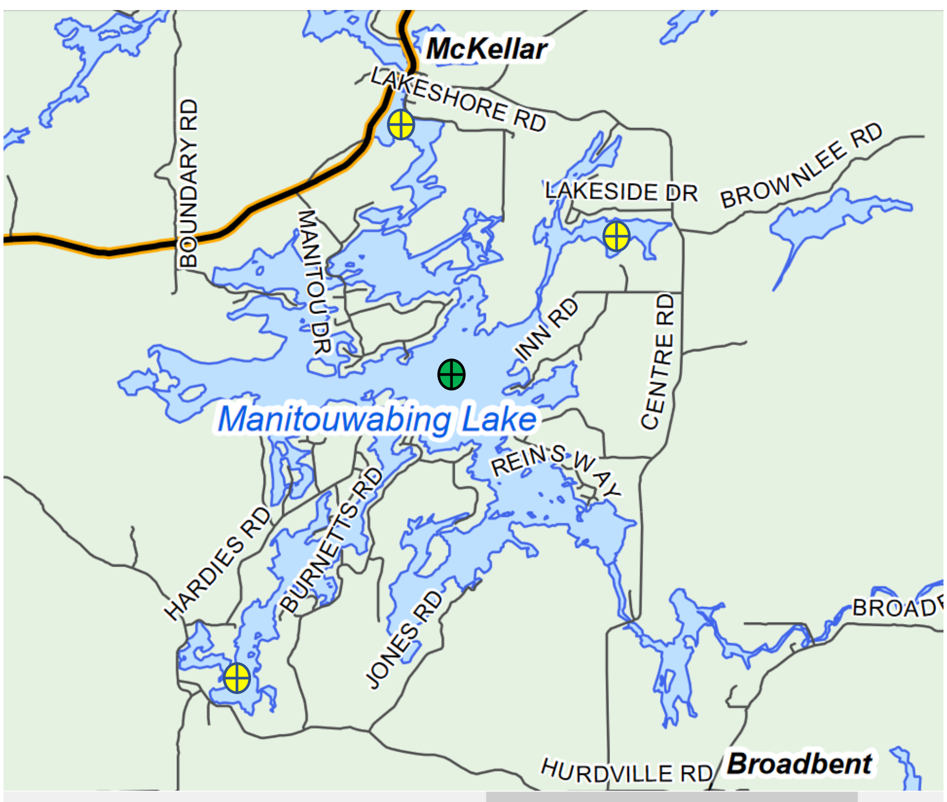
A severe blue green algal bloom.

Dissolved Oxygen

In areas where the bottom waters have their oxygen concentrations reduced to below 1mg/L (this is called anoxia) in late summer there can be phosphorus released from the sediments into the bottom waters. In some cases, this phosphorus can be available to support algal blooms in the mixed, warmer surface water. For this reason, there is merit to measuring dissolved oxygen profiles in the lake for those areas that are deep enough to stratify (the process where warm surface water cannot mix with cold bottom water). In most cases the water needs to be about 7-8 m deep or deeper before this can occur. Shallower areas mix completely to the bottom. In stratified areas, the cold bottom water cannot have its oxygen replenished from the surface such that when oxygen is consumed by bacteria the loss of oxygen cannot be reversed until the lake turns over again in the fall. Under these circumstances there may be phosphorus that enters the cold bottom water from the sediments. If this phosphorus ends up being entrained into the warmer surface water in sufficient quantities, it can help to support algal blooms under the right conditions.

Areas in Manitouwabing where this may occur are shown in yellow on the map below and these areas could be assessed with oxygen/temperature profiles on or 14 days either side of Sept 01. Any additional areas that may stratify could be confirmed in the initial years of monitoring.

Map showing the deepest location (green) and isolated bays that are likely to stratify in yellow (from MLCA).



Bacteria

Volunteers have been collecting bacteria data in many areas throughout Manitouwabing Lake for several years. The data available on the MLCA website has been summarized in Table 3.

Bacteria data are difficult to interpret. There are conclusions that can be drawn by examination of the data in Table 3, but there are also many aspects of bacteria in lake water that cannot be deduced from these data. Generally, these data show that about 5% of the samples are over 100 counts which is the guideline for recreational use. This indicates that the water is swimmable in most areas 95 % of the time. These results are normal for areas where there are no sewage treatment plants or large stormwater discharges.

What these data cannot tell us is:

1. how long the counts were over 100 in a given area,

2. the area or extent to which the >100 count result applies, and most importantly,

3. the source of the bacteria (human or otherwise).

Table 3. Number of samples taken at each site with the number of samples over 100 counts.

							Site								
Sector		1	2	3	4	5	6	7	8	9	10	11	12	Sum	%>100
McKellar/grey Owl	# samples	11	8	15	11	9	11	8	8	11	10	1	1	104	
	# 100 or >	1	0	2	1	1	1	0	0	1	0	0	0	7	7
McKellar	# samples	36	43	30	42	30	4	2	3		12	1	1	204	
	# 100 or >	2	1	0	4	0	4	0	0		3	0	0	14	7
Middle River	# samples	20	35	31	32	33	20	7	4	4	4	0	0	190	
	# 100 or >	0	3	0	1	0	0	0	0	0	0			4	2
Maplewood	# samples	40	28	28	26	23	30	25	31	4	1	0	4	240	
	# 100 or >	5	1	1	0	0	1	0	2	0	0		1	11	5
Tait's Is	# samples	26	30	20	8	3	0	1	21	26	22	25	28	210	
	# 100 or >	2	2	0	1	0		0	0	1	0	0	1	7	3
Manitou Camp	# samples	29	19	23	0	0	0	0	1	0	0	0	0	72	
	# 100 or >	3	0	0					0					3	4
Lona	# samples	28	31	22	26	24	30	42	1	3	0	1	2	210	
	# 100 or >	1	0	1	0	2	1	9	0	0		0	0	14	7
Smith Pine	# samples	22	45	23	27	22	35	28	37	11	12	1	4	267	
	# 100 or >	1	5	0	0	0	4	0	3	1	2	0	0	16	6
Bailey	# samples	33	37	47	31	5	3	5	1	4	2	0	0	168	
	# 100 or >	0	2	4	0	1	0	1	0	0	0			8	5
	Average 5% are 100 or greater														

Invasive Species

The presence of invasive species is not technically a water quality issue but certain invasive species can cause changes in water quality. Mussels, for example, can cause water clarity to increase. In almost every case the invading species will cause changes to the ecosystem's integrity. It is therefore important to avoid the spread of invasive species where possible.

A complete review of the invasive species present or the potential for invasion by numerous species is not possible within the scope of this review. There are, however, many useful resources that can be used to identify invasive species and cautions that can be applied to limit unwanted invasions.

It is important to remember that some invasions of terrestrial vegetation can also have impacts on aquatic ecosystems.

Further Information:

https://foca.on.ca/aquatic-invasive-species-program/

http://www.invadingspecies.com/

https://www.ontarioinvasiveplants.ca/invasive-plants/species/

https://www.ontario.ca/page/stop-spread-invasive-species?_escaped_fragment_=/

Recommendations

1. Several central locations (LPP Site #11, 1 and 3) and possibly one new location near the outflow be monitored by LPP volunteers with an effort to maintain a long-term monitoring record. Some of these sites may or may not be currently sampled (see Table 1). Long-term monitoring records are important to assess the effect of external drivers on the nutrient status of the lake.

2. The efforts used to collect bacteria data could be directed at other issues such as:

- **education towards aspects of nearshore (shoreline) management**.
- **useful inventories such as areas where aquatic plants grow to assess whether the extent of plant beds are changing.**
- **long-term records of water levels and/or temperature.**

3. Late summer monitoring of dissolved oxygen in the deepest location and in isolated bays where the depths are greater than 7-8m may provide additional information to address the potential for algal blooms. After areas are identified as having the oxygen depleted at the bottom (with measured oxygen profiles) in year 1, there can be samples taken 1 meter from the bottom in subsequent years to assess whether or not there are elevated phosphorus concentrations in the bottom water.

4. All efforts should be made to ensure that invasive species do not enter the watershed. There are may organizations that provide guidance on invading species, e.g. The Federation of Ontario Cottagers' Associations. https://foca.on.ca/aquatic-invasive-species-program/

Killian

Appendix

Site	Description	Lat	Long	Date	TP1	TP2	Mean		Site Mean
						(ug/L)			
1	Great Bay	452845	795344	20-May-02	12.7	13.5	13.1		11.6
1	Great Bay	452845	795344	31-May-03	10.2	10.1	10.1		
3	Longhorn & James Bay	452748	795302	20-May-02	24.3	36.6			13
3	Longhorn & James Bay	452748	795302	31-May-03	12.4	13.5	13.0		
4	McKellar, near dock	453020	795512	20-May-02	51.1	44.8			11.2
4	McKellar, near dock	453020	795512	20-May-06	14.0	12.9	13.4		
4	McKellar, near dock	453020	795512	08-Jun-07	11.5	11.7	11.6		
4	McKellar, near dock	453020	795512	22-Jun-08	10.1	10.3	10.2		
4	McKellar, near dock	453020	795512	24-May-09	9.5	9.6	9.6		
6	L Taits Is-Great Bay	452837	795413	02-Jun-02	18.7	13.3	16.0		11.7
6	L Taits Is-Great Bay	452837	795413	15-Jun-03	11.4	12.1	11.8		
6	L Taits Is-Great Bay	452837	795413	23-May-04	9.2	11.2	10.2		
6	L Taits Is-Great Bay	452837	795413	23-May-05	10.5	10.9	10.7		
6	L Taits Is-Great Bay	452837	795413	24-Jun-06	7.1	7.0	7.1		
6	L Taits Is-Great Bay	452837	795413	22-Jun-08	24.2	21.5	22.8		
6	L Taits Is-Great Bay	452837	795413	18-May-09	9.4	8.3	8.8		
6	L Taits Is-Great Bay	452837	795413	22-May-11	11.0	11.2	11.1		
6	L Taits Is-Great Bay	452837	795413	20-May-12	7.8	8.2	8.0		
6	L Taits Is-Great Bay	452837	795413	19-May-13	10.0	10.2	10.1		
6	L Taits Is-Great Bay	452837	795413	19-May-14	13.8	15.2	14.5		
6	L Taits Is-Great Bay	452837	795413	17-May-15	9.4	9.4	9.4		
7	N / W Tait's Island	452901	795538	20-May-06	10.2	12.3	11.2		11.3
7	N / W Tait's Island	452901	795538	08-Jun-07	9.2	9.3	9.3		
7	N / W Tait's Island	452901	795538	22-Jun-08	12.6	14.3	13.5		
8	West of Maplewood	452810	795500	05-May-02	9.7	10.6	10.2		11.3
8	West of Maplewood	452810	795500	04-May-03	13.2	13.4	13.3		
8	West of Maplewood	452810	795500	08-May-04	12.2	11.6	11.9		
8	West of Maplewood	452810	795500	07-May-05	16.5	11.6	14.1		
8	West of Maplewood	452810	795500	14-May-06	10.0	10.4	10.2		
8	West of Maplewood	452810	795500	21-May-07	10.5	9.3	9.9		
8	West of Maplewood	452810	795500	11-May-08	13.0	12.4	12.7		
8	West of Maplewood	452810	795500	05-May-09	11.6	10.8	11.2		
8	West of Maplewood	452810	795500	27-May-10	9.6	10.4	10.0		
8	West of Maplewood	452810	795500	24-Apr-11	14.0	12.8	13.4		
8	West of Maplewood	452810	795500	22-May-12	7.8	7.6	7.7		
8	West of Maplewood	452810	795500	01-Jun-13	13.2	16.4	14.8		
8	West of Maplewood	452810	795500	18-May-14	11.6	11.4	11.5		
8	West of Maplewood	452810	795500	05-Jun-15	9.2	9.6	9.4		
8	West of Maplewood	452810	795500	19-May-16	9.2	8.8	9.0		
8	West of Maplewood	452810	795500	23-May-17	13.8	10.2	12.0		
9	E of Longhorn,Hardie's Cr	452822	795244	24-May-05	15.0	14.5	14.7		13.8
9	E of Longhorn,Hardie's Cr	452822	795244	08-Jun-07	14.2	12.8	13.5		
9	E of Longhorn,Hardie's Cr	452822	795244	23-May-08	16.9	15.2	16.1		
9	E of Longhorn,Hardie's Cr	452822	795244	23-May-16	12.6	12.2	12.4		
9	E of Longhorn,Hardie's Cr	452822	795244	23-May-17	13.0	11.6	12.3		
11	N Tait's Is.	452917	795443	24-Jun-06	9.2	8.5	8.8		11.2
11	N Tait's Is.	452917	795443	31-May-12	13.4	12.2	12.8		
11	N Tait's Is.	452917	795443	26-May-13	13.2	11.0	12.1		
12	Manitouwabing(golf cs.)Bay	452856	795253	04-Jun-06	9.1	9.7	9.4		9.8
12	Manitouwabing(golf cs.)Bay	452856	795253	08-Jun-07	11.0	10.3	10.6		
12	Manitouwabing(golf cs.)Bay	452856	795253	23-May-09	9.2	9.8	9.5		
13	Jones Bay	452713	795326	21-May-06	13.4	12.5	13.0		11.6
13	Jones Bay	452713	795326	08-Jun-07	13.1	12.2	12.6		
13	Jones Bay	452713	795326	23-May-08	13.3	12.1	12.7		
13	Jones Bay	452713	795326	24-May-09	12.7	11.7	12.2		
13	Jones Bay	452713	795326	24-May-11	13.0	14.8	13.9		
13	Jones Bay	452713	795326	26-May-12	11.2	11.0	11.1		
13	Jones Bay	452713	795326	23-Jun-13	12.0	12.0	12.0		
13	Jones Bay	452713	795326	24-May-14	9.4	9.8	9.6		
13	Jones Bay	452713	795326	19-May-15	11.0	9.4	10.2		
13	Jones Bay	452713	795326	23-May-16	8.8	8.8	8.8		
13	Jones Bay	452713	795326	23-May-17	11.8	11.2	11.5		
18	McKellar Bay	453008	795455	24-May-16	10.4	10.6	10.5		12.6
18	McKellar Bay	453008	795455	23-May-17	14.0	15.2	14.6		
19	McKellar, near dock	453019	795512	24-May-16	11.2	10.8	11.0		11.2
19	McKellar, near dock	453019	795512	23-May-17	11.4	11.2	11.3		
20	South of Fire RTE 150 Basin	452901	795538	23-May-16	7.8	7.6	7.7		7.7
21	Moffat Basin, Deep spot	452932	795504	23-May-16	12.6	12.8	12.7		12.7
22	Basin South of Lakeside Dr.	452959	795249	24-May-16	9.2	10.0	9.6		11.2
22	Basin South of Lakeside Dr.	452959	795249	23-May-17	12.6	12.8	12.7		
				Average					**11.5**

Thank You
Miigwech

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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