Volunteer Water Quality Monitoring Program Report

2018 Results

Township of The Archipelago
June 2019

Acknowledgements

The water quality monitoring program represents a successful partnership between the Township of The Archipelago, cottager associations, and numerous volunteers in areas along the coast and inland lakes that has lasted since its inception in 1999. The volunteer-based program provides an important avenue for relaying information about our environment to ratepayers and for providing valuable information to the Township.

The Township wishes to thank all of its ratepayers, and in particular the volunteer monitors, for their keen interest and drive to ensure our high quality environment is maintained. The Township is committed to addressing environmental issues and ensuring the maintenance of the environment we all enjoy. This philosophy is integrated into the day to day functioning of the municipality from public works operations to detailed planning analysis.

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Contents

Executive Summary

The Township of The Archipelago's (TOA) water quality monitoring program represents a successful partnership between the TOA, cottager associations, and numerous volunteers in areas along the coast and inland lakes that has lasted since its inception in 1999. The volunteer-based program provides an important avenue for relaying information about the environment to ratepayers, and for providing valuable information to the Township.

In addition, water quality monitoring data collected in the TOA also helps inform the bigger picture story around TP trends in eastern Georgian Bay. Along with data collected by provincial agencies, federal agencies, and other organizations, volunteer collected data (e.g., TOA monitoring data) is used to report on water quality in the 2013 and 2018 *State of the Bay* reports (available here). By bringing all of these sources of data together, a more spatially and temporally complete picture of water quality in eastern Georgian Bay can be achieved. Key among the findings in the 2018 *State of the Bay* report is that there are differences between TP levels in the nearshore and offshore.

Generally, in the offshore, deep waters of Georgian Bay, total phosphorus levels have been naturally low, around 5 micrograms per litre (µg/L). In shallower, protected bays or near wetlands, phosphorus levels can be much higher, this type of nutrient-rich habitat is considered more productive and can support a more diverse food web. However, when nutrients are trapped or concentrated, an algal bloom may result, with TP levels as high as 20 µg/L (to learn more, visit www.stateofthebay.ca).

By continuing to monitor existing Lake Partner Program (LPP) sites, and by initiating monitoring at sites recommended in this report (total of seven recommended locations), volunteers in the TOA provide crucial information and supplement existing data collection by government agencies so that local and regional water quality trends can be tracked over time.

This report presents the results of water quality monitoring efforts in the TOA in 2018. Some of the highlights from 2018 include:

- **15** active LPP sampling locations;
- **9** ratepayer associations monitoring water quality;
- **4** lakes with benthic monitoring conducted; and
- **2** locations with enhanced monitoring conducted.

A third year of enhanced monitoring was conducted in Blackstone Harbour and Sturgeon Bay. Enhanced monitoring consists of taking dissolved oxygen/temperature profiles and fall TP samples at surface and 1 m off bottom. Based on an analysis of three years of data, it was determined that enhanced monitoring is no longer required in Blackstone Harbour. Enhanced monitoring will continue in Sturgeon Bay in 2019 and will begin in Blackstone Lake and Crane Lake.

A high-level summary of the 2018 water quality monitoring results is presented in the table below.

Association / Waterbody	Monitoring Status	Total Phosphorus		Trophic Status	Recommendation
		Average (3-5 yrs)	Trend (>5 yrs)		
Bayfield Nares Islanders' Association	Active (LPP)	n/a	Increasing	Oligotrophic	Continue current monitoring
Blackstone Lake Cottagers' Association	Active (LPP & benthic monitoring)	n/a	Decreasing	Oligotrophic	Continue current monitoring
Cranberry Lake	Inactive (last LPP monitoring in 2017)	n/a	n/a	n/a	Reinitiate standard LPP monitoring
Crane Lake Association	Active (LPP & benthic monitoring)	n/a	Increasing	Oligotrophic	Continue current monitoring
Healey Lake Property Owners' Association	Active (LPP & benthic monitoring)	n/a	n/a	Oligotrophic	Continue current monitoring
Iron City Fishing Club	Inactive (last LPP monitoring in 2016)	n/a	n/a	n/a	Reinitiate standard LPP monitoring
Kapikog Lake Cottagers' Association	Active (LPP & benthic monitoring)	n/a	n/a	n/a	Continue current monitoring
Manitou Association	Inactive (no history of LPP monitoring)	n/a	n/a	n/a	Begin standard LPP monitoring
Naiscoot Lake Association	Inactive (no history of LPP monitoring)	n/a	n/a	n/a	Begin standard LPP monitoring
Pointe au Baril Islanders' Association	Active (LPP)	n/a	Decreasing	Mesotrophic	Continue current monitoring
Rock Island Lake	Inactive (no history of LPP monitoring)	n/a	n/a	n/a	Begin standard LPP monitoring
Sans Souci & Copperhead Association	Inactive (no history of LPP monitoring)	n/a	n/a	n/a	Begin standard LPP monitoring
Skerryvore Ratepayers' Association	Inactive (no history of LPP volunteer monitoring)	n/a	n/a	n/a	Begin standard LPP monitoring
South Channel Association	Active (LPP)	n/a	n/a	n/a	Continue current monitoring
Three Legged Lake Association	Active (LPP)	3 µg/L	n/a	Oligotrophic	Continue current monitoring
Woods Bay Community Association	Active (LPP)	10.3 µg/L	n/a	Mesotrophic	Continue current monitoring

Introduction

In the spring of 2016, the Township of The Archipelago (TOA) recommended changes to its water quality (WQ) monitoring program, with the main recommendation being a shift from bacteria to phosphorus monitoring. These changes came about as a result of a partnership with the Georgian Bay Biosphere Reserve (GBBR). Over three years, as part of their *Coordinated Nutrient Monitoring Program*, GBBR worked with partners to review existing nutrient monitoring efforts along eastern Georgian Bay and develop a new set of guidelines and recommendations to improve effectiveness and efficiency of the collective efforts of volunteers, associations, agencies, and other organizations (click here for further information). Changes to the WQ monitoring program were communicated to ratepayer associations and volunteers in the spring of 2016. Starting in 2018, the TOA also began benthic monitoring on several inland lakes – Kapikog, Healey, Blackstone, and Crane.

Why shift away from regular bacteria monitoring?

The rationale for shifting away from bacteria monitoring is based on a Hutchinson Environmental Sciences report (available here) which concluded that single samples taken at one point in time do not indicate either the spatial or temporal extent of the levels of bacteria observed. This is based on the fact that survival of E. coli in the recreational water environment is dependent on many factors, including temperature, exposure to sunlight, available nutrients, water conditions (e.g., pH, salinity), and competition from, and predation by, other micro-organisms. The new guideline for water quality monitoring recommends that should organizations wish to continue with bacteria testing, 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. For example, recreational sites (e.g., beaches) could be considered for bacteria monitoring as per the province's Beach Management Guidance Document.

Why monitor total phosphorus?

Monitoring total phosphorus (TP) is very important as phosphorus is the nutrient that controls the growth of algae and most living biota in the aquatic environment. Consistently measuring TP creates the potential to detect long-term changes in water quality that may be due to impacts of shoreline development, climate change, and other stressors. The objectives associated with monitoring phosphorus in eastern Georgian Bay are as follows:

1. Mitigating localised water quality issues;
2. Regional characterisation of water quality;
3. Spatial and temporal trend detection; and
4. Identifying the effects of regional drivers and multiple stressors to protect ecosystem function.

GBBR is facilitating the transition from bacteria monitoring to phosphorus monitoring by encouraging ratepayer associations and volunteers to join, or continue with, the Lake Partner Program (LPP). The LPP is an Ontario-wide, publically funded, free program that collects data about phosphorus, water clarity, calcium, and temperature from volunteers. The simple tests for TP and water clarity provide a strong basis for assessing the health of the ecosystem, and whether TP is too high or too low. Advantages of the LPP are that it facilitates comparisons with other organizations monitoring on the Bay, as well as Ontario Ministry of Environment, Conservation and Parks (MECP), and Environment and Climate Change

Canada (ECCC) monitoring programs. Data collected by volunteers are analyzed by the Dorset Environmental Science Centre (DESC) which makes all data available online.

Why monitor benthic macroinvertebrates?

Different monitoring approaches provide water managers with complementary information. "Stressor-based" approaches (e.g., water-chemistry monitoring) provide measures of exposure to stress, but leave unanswered questions about the ecological significance of that stress. Biological approaches (e.g., benthic monitoring) measure biotic responses, but leave unanswered questions about which stressors are impacting the aquatic ecosystem. Therefore, conducting both chemical and biological monitoring provides a complete picture of aquatic ecosystem health (i.e., the lake's exposure to stress and associated ecological response).

Over the last three decades, the use of biological monitoring in Ontario has increased dramatically. The first reason for this is that researchers, water managers, and broader society have acknowledged its ability to reflect the effects of non-point-source and episodic pollution, the effects of habitat changes, and the cumulative effects of multiple stressors. The second reason is that monitoring biodiversity, and using 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 understand what these organisms are like. 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 lake sediments and the water in a specific area. Furthermore, they are relatively easy and inexpensive to sample and they have different tolerances to disturbances and pollution.

Purpose and layout of this report

This report presents the results of the 2018 Water Quality Monitoring Program for the Township of The Archipelago. The main objective of this report is to present water quality data gathered in the 2018 sampling season in order to track trends over time. This type of information will enable ratepayers to examine the long-term trends from their dataset to identify outliers, discern seasonal patterns, and gain a sense of average phosphorus levels for their particular waterbody of concern.

The remainder of this report provides a brief overview of the methods used to collect data and details the results, by ratepayer association, from data gathered in 2018 including an overview of sampling locations, water clarity, total phosphorus concentrations, calcium concentrations, and benthic macroinvertebrates. The final section presents results from enhanced sampling at Sturgeon Bay, Blackstone Harbour, and Bayfield and Nares Inlets.

Methods – Water Chemistry

Sampling locations in the TOA have been recommended for enclosed bays and inland lakes in GBBR's *Enclosed Bays and Inland Lakes Phosphorus Monitoring Guideline*. These sampling locations supplement existing data collection by provincial and federal programs so that local and regional water quality trends can be tracked over time. Whenever possible, volunteers are encouraged to contact GBBR prior to sampling if they have any comments or concerns about the suggested monitoring locations.

Enclosed bays that are connected to Georgian Bay, and have limited exchange of water due to convoluted connections or constricted openings, will have water chemistry characteristics that are mostly subject to influences from the upstream watershed. This will be especially true if there are major inflows or shoreline development within the bay. Even in cases where the bay is considered to be 'natural', there are multiple stressors associated with all ecosystems that occur as a result of climate change, long-range transport of pollutants, and the influx of invading species. Monitoring in these areas will help to understand the impacts of these stressors and support federal and provincial monitoring in similar nearshore areas.

Inland lakes require TP data to help assess background concentrations relative to present day concentrations. Inland lakes should be sampled in all cases where there are no previous data collected. Developed lakes should be sampled before undeveloped lakes in the case where resources are limited. As a general rule, only one representative sampling location is required for each lake even in large convoluted lakes with multiple arms (e.g., Healey Lake). 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 sampling (following LPP protocols) is sufficient for most locations in the TOA, as there are few areas that experience fall algal blooms. However, in some locations 'enhanced' monitoring (beyond LPP) may be required. Generally, the 'trigger' to consider additional monitoring relates to high TP and/or algal blooms. In these scenarios, further water quality parameters can be obtained with only a few additional pieces of equipment, most notably oxygen meters and specialized bottles to collect samples at distinct depths. The following two sections briefly describe the sampling method employed for regular sites and enhanced sites.

Regular monitoring sites

LPP volunteers collect one TP sample in May (during the spring-turnover period) at a deep spot. Additionally, volunteers take Secchi disc water clarity measurements at least once every two weeks throughout the summer. 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 and training videos are available online and additional training is provided by the Georgian Bay Biosphere Reserve. Samples are returned (postage paid) to DESC for analysis and Secchi observation sheets are mailed to DESC in November.

Enhanced monitoring sites

In some cases, further monitoring is required beyond what is recommended by the LPP. Generally, the 'trigger' to consider additional monitoring relates to high TP and/or algal blooms. The collection of additional water quality data should be determined on a case-by-case basis following a review of existing data. GBBR's *Enclosed Bays and Inland Lakes Phosphorus Monitoring Guideline* (available here) includes a decision tree to outline how further monitoring could occur under several different scenarios. It also outlines potential equipment needs and general water chemistry parameters for enhanced monitoring programs. The guideline ensures that information is collected in a standardized way that allows comparison between sites and over time.

Methods – Benthic Monitoring

Certified GBBR staff conduct benthic macroinvertebrate sampling on behalf of the TOA using the standardized Ontario Benthos Biomonitoring Network (OBBN) protocol for lakes. For each lake, three shallow, nearshore areas representative of the lake are selected as test sites (referred to as "lake segments" in the protocol). The same lake segments are sampled each year so segments should ideally be located on Crown land (for continued access). At each lake segment, the travelling-kick-and-sweep sampling method is used. The individual doing the sampling disturbs the bottom of the lake in transects from the water's edge to 1m in depth. Using a net, the dislodged material is collected and placed in a bucket. Sampling is usually done for about 10 minutes. These samples are then processed to count and identify the different types of benthos in the sample (video available here). There are 27 different taxa of benthos that are searched for, each ranging in sensitivity to water pollutants and water quality.

Results – Regular Monitoring Sites

The following section includes a brief discussion on the interpretation of results and the locations of, and results for, each TOA sampling location active in 2018. Please note that only data collected after the MECP took over coordination of the LPP (2002 to present) are shown in graphs and labelled on figures. Since 2002, LPP phosphorus samples have been analysed on a low-level phosphorus analyser that has increased the precision of results from +/- 6 µg of phosphorus per litre to +/- 0.7 µg/L. This low-level analysis is especially important for Georgian Bay TP samples that may have low levels of TP (e.g., 2 µg/L). Complete data for all historical and active sampling locations, including data collected prior to 2002, are available in tables in Appendix A.

Water clarity

In general, water clarity, as measured by Secchi depth, tends to be higher in 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.

When examining the data, it is typical to see a small decline in Secchi depth throughout the year with lowest depths reading near the end of the summer and into September. However, a major decline in the readings should be evaluated more carefully. A multi-year comparison of data is of particular value here to assess the 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, for example Daphnia, which are a primary food for many fish, as well as other aquatic animals such as mollusks, clams, amphipods, and crayfish, use calcium in the water to form their calcium-rich body coverings. These organisms, and many others, are very sensitive to declining calcium levels.

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

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

Total phosphorus

As phosphorus is the nutrient that controls the growth of algae and most living biota 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. 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.

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

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

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 TOA sampling location 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.

Benthic macroinvertebrates

The objective of the TOA's benthic monitoring is to determine the ecological condition of a lake, and compare it to similar lakes in the Parry Sound-Muskoka District. At least two consecutive years of sampling are required to allow results to be compared. Accordingly, results from the first year of benthic monitoring in the TOA are presented in the following sections without additional analysis.

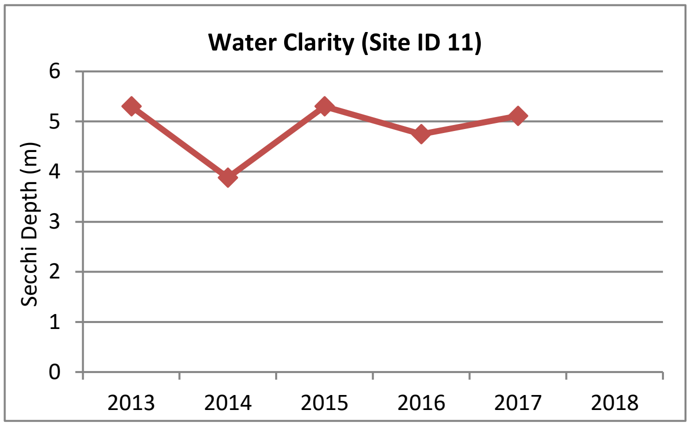
Bayfield Nares Islanders' Association

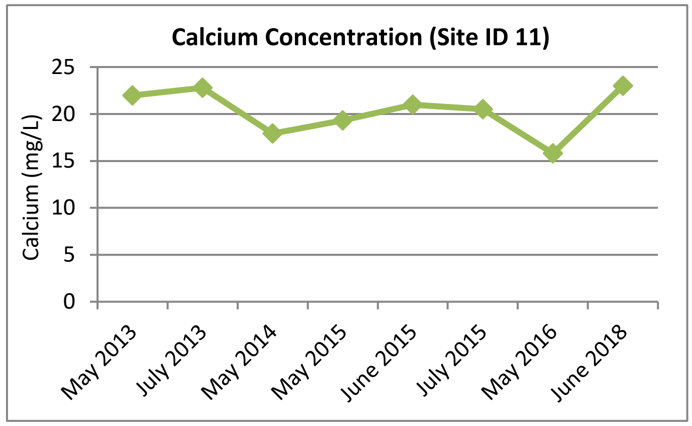
Figure 1. Active LPP sampling location.

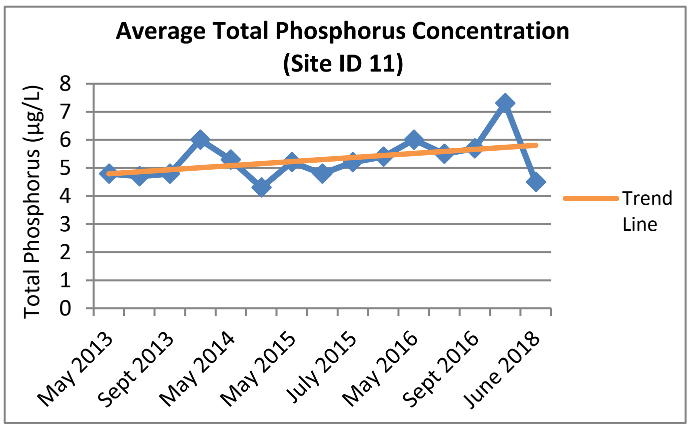
Nares Inlet

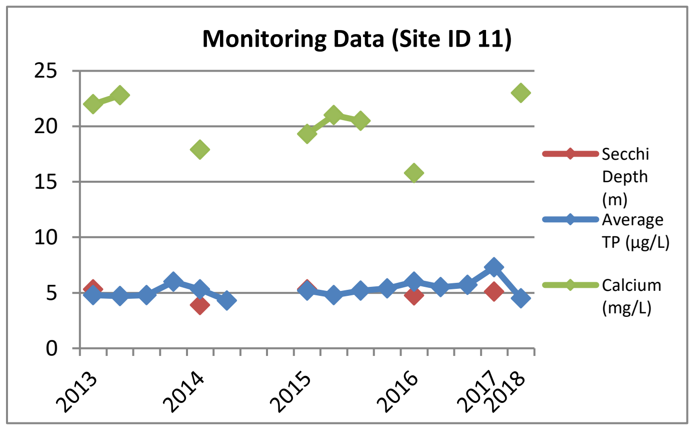
• Station: 7064	• Trophic status: oligotrophic
• Site ID: 11	• Average TP: n/a
• Description: Nares Inlet, deep spot	• Trend (Y/N): Y – increasing
• Data collector: LPP volunteer	• Average Secchi depth: 4.9 m
	• Visible outliers: none

Recommendation: continue with standard LPP monitoring at Site ID 11 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).


Water Clarity (Site ID 11)
Secchi Depth (m)
0
1
2
3
4
5
6
2013
2014
2015
2016
2017
2018


Calcium Concentration (Site ID 11)
Calcium (mg/L)
0
5
10
15
20
25
May 2013
July 2013
May 2014
May 2015
June 2015
July 2015
May 2016
June 2018


Average Total Phosphorus Concentration (Site ID 11)
Total Phosphorus (µg/L)
0
1
2
3
4
5
6
7
8
May 2013
Sept 2013
May 2014
May 2015
July 2015
May 2016
Sept 2016
June 2018
Trend Line


Monitoring Data (Site ID 11)
0
5
10
15
20
25
2013
2014
2015
2016
2017
2018
Secchi Depth (m)
Average TP (µg/L)
Calcium (mg/L)

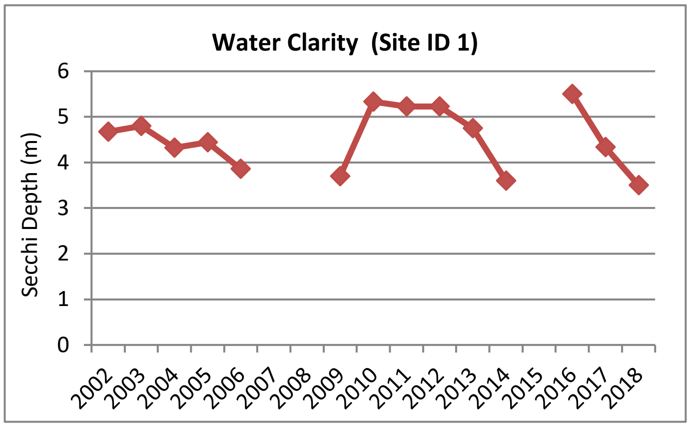
Blackstone Lake Cottagers' Association

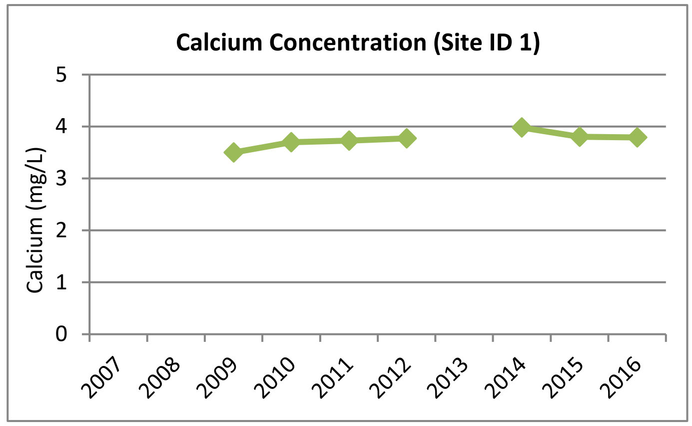
Figure 2. Active and recently active LPP sampling locations. Data collection at locations labelled in white is undertaken by LPP volunteers while data collection at locations labelled in orange is undertaken by the MOE Northern Region.

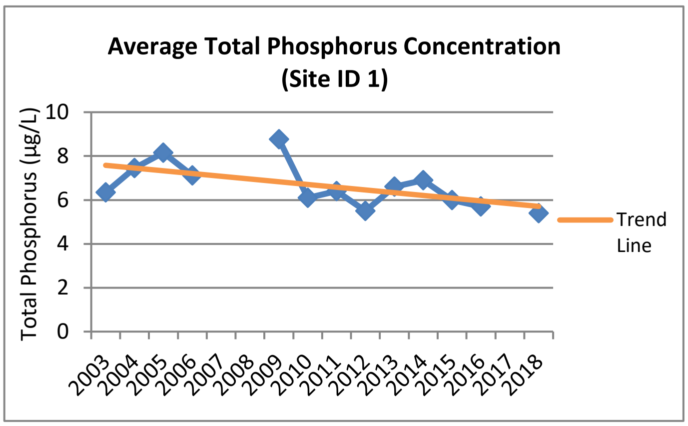
Blackstone Lake

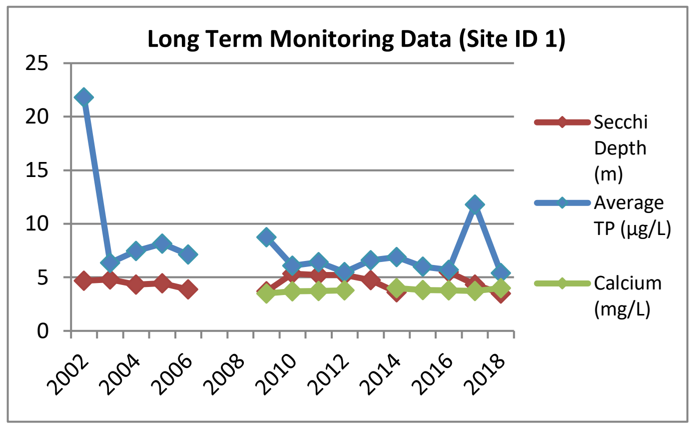
• Station: 461	• Trophic status: oligotrophic
• Site ID: 1	• Average TP: n/a
• Description: mid lake, deep spot	• Trend (Y/N): Y – decreasing
• Data collector: LPP volunteer	• Average Secchi depth: 4.6 m
	• Visible outliers: TP of 22 µg/L in 2002; TP of 12 µg/L in 2017

Recommendation: continue with standard LPP monitoring at Site ID 1 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).









Station	Site ID	Description	2016 Average TP (µg/L)	Data Collector
461	6	BL02	5.30	MOE Northern Region
461	7	BL03	5.30	MOE Northern Region
461	8	BL04	5.00	MOE Northern Region
461	9	BL01	5.80	MOE Northern Region

Blackstone Lake 2018 benthic monitoring results

		Blackstone Lake 2018		
Common Name	Scientific Name	1	2	3
Hydras	Coelenterata			
Flatworms	Turbellaria	1	2	
Roundworms	Nematoda	3		5
Aquatic Earthworms	Oligochaeta	8	10	7
Leeches	Hirudinaea			
Sow bugs	Isopoda	1	28	16
Clams	Pelecypoda	1		
Fairy Shrimp	Amphipoda	7	7	15
Crayfish	Decapoda			
Mites	Hydracarina	16	26	11
Mayflies	Ephemeroptera	14	8	11
Dragonflies	Anisoptera			
Damselflies	Zygoptera			
Stoneflies	Plecoptera			
True Bugs	Hemiptera			
Fishflies and Alderflies	Megaloptera			
Caddisflies	Trichoptera	10	3	6
Aquatic Moths	Lepidoptera			
Beetles	Coleoptera	3	4	4
Snails and Limpets	Gastropoda			
Midges	Chironomidae	16	4	21
Horse and Deer Flies	Tabanidae			
Mosquitos	Culicidae			
No-see-ums	Ceratopogonidae	20	8	11
Craneflies	Tipulidae			
Blackflies	Simuliidae			
Misc. True Flies	Misc. Diptera			
Total Count		100	100	107
Number of Taxa		12	10	10

Cranberry Lake

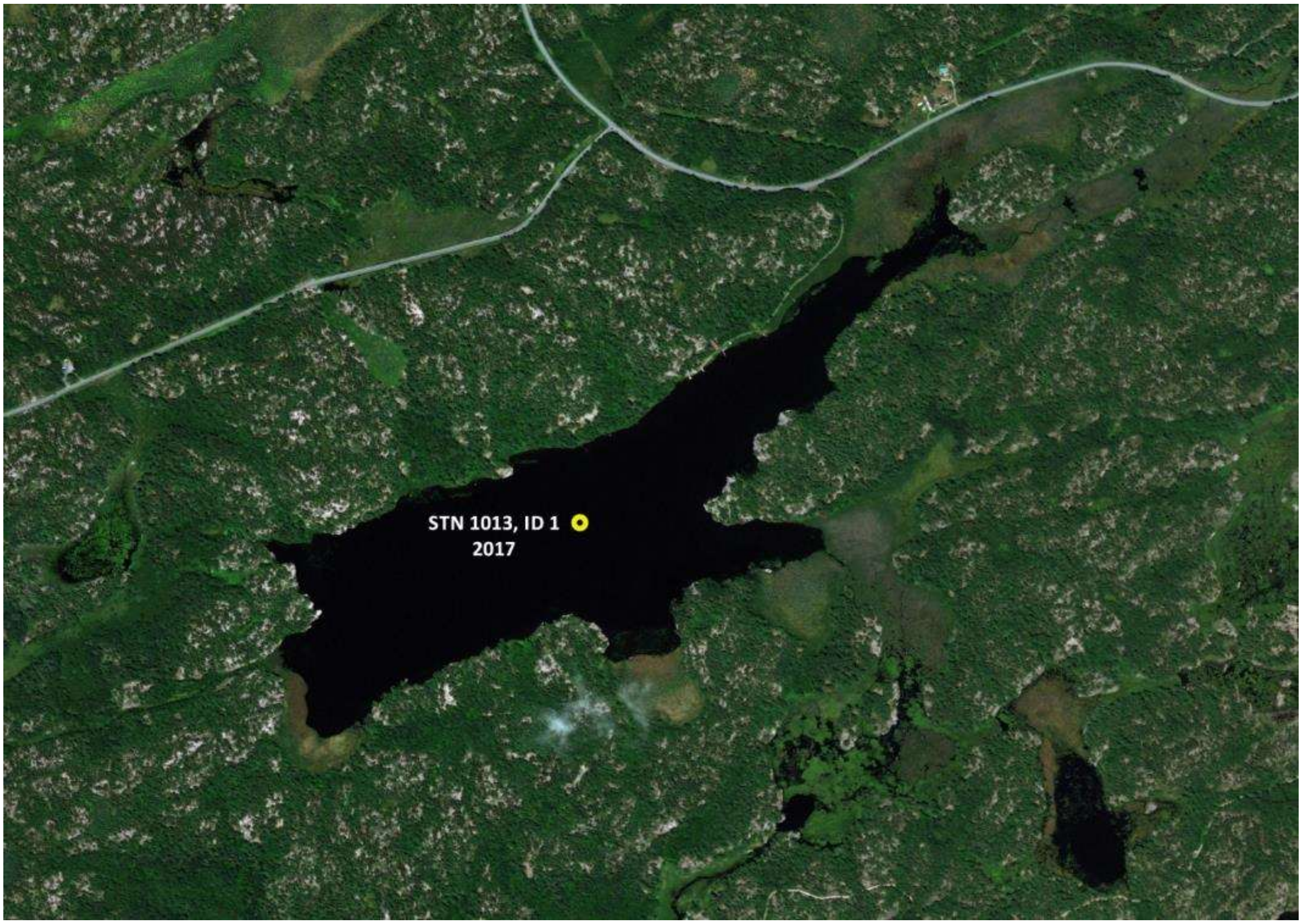


Figure 3. Recently active LPP sampling location.

Cranberry Lake

Station	Site ID	Description	2017 Average TP (µg/L)	Data collector
1013	1	Mid lake, deep spot	12.10	LPP volunteer

Recommendation: reinitiate standard LPP monitoring at Site ID 1 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).

Crane Lake Association

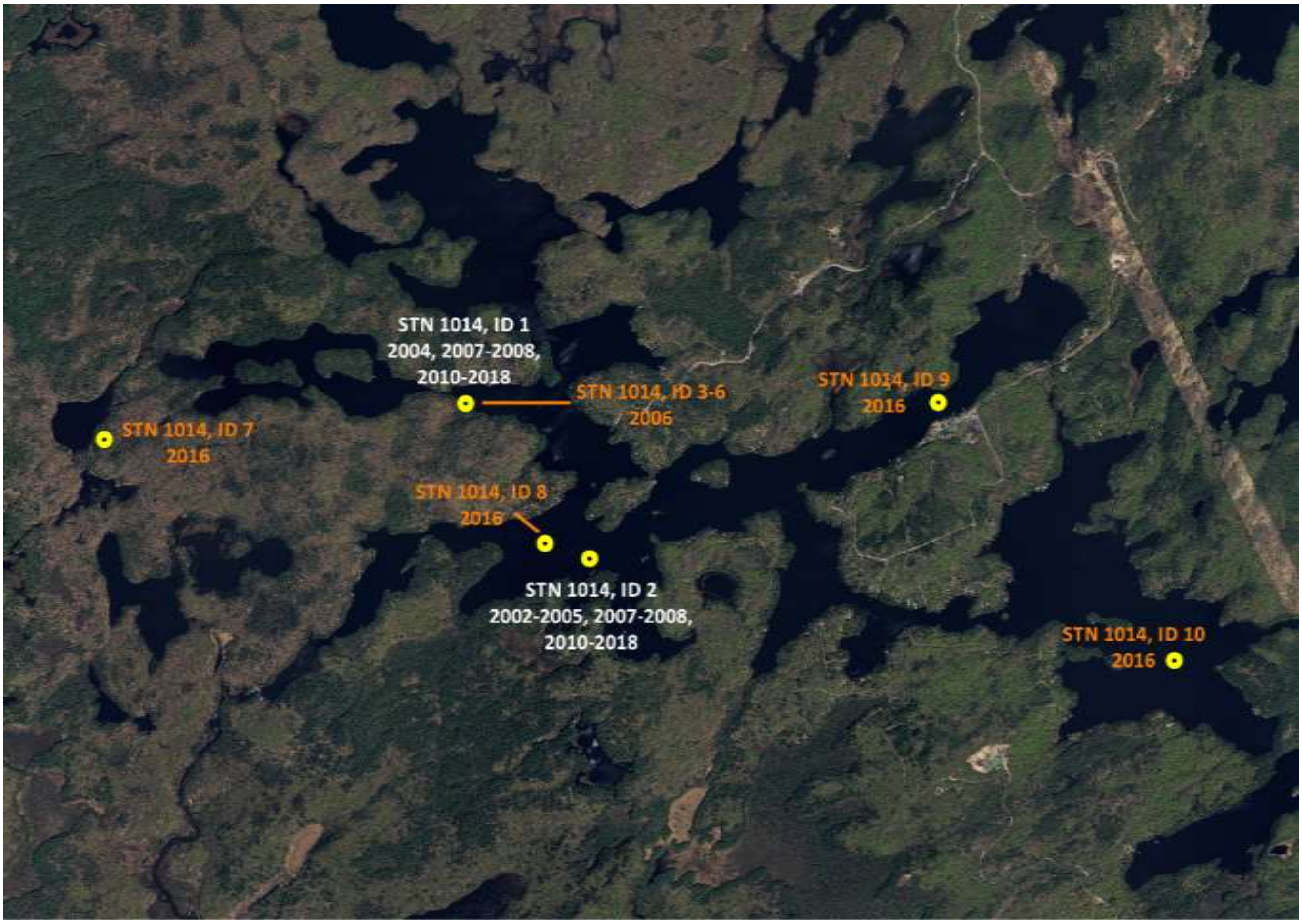
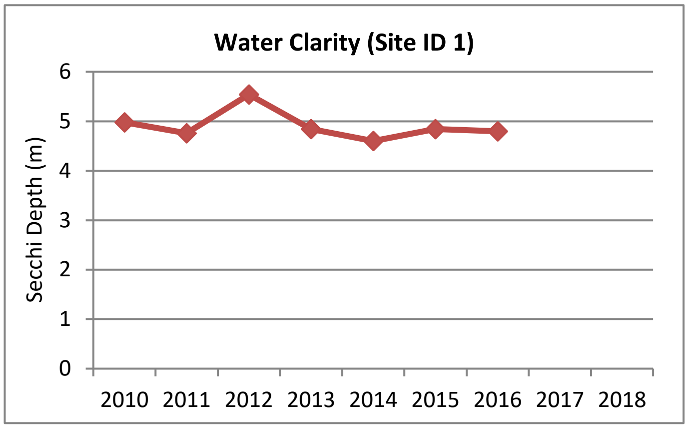


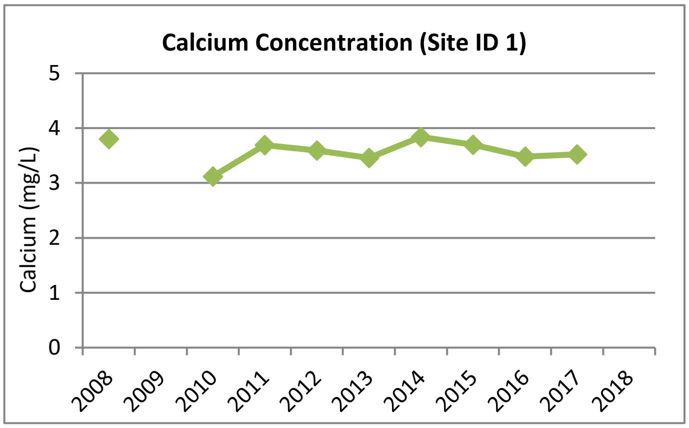
Figure 4. Active and recently active LPP sampling locations. Data collection at locations labelled in white is undertaken by LPP volunteers while data collection at locations labelled in orange is undertaken by the MOE Northern Region.

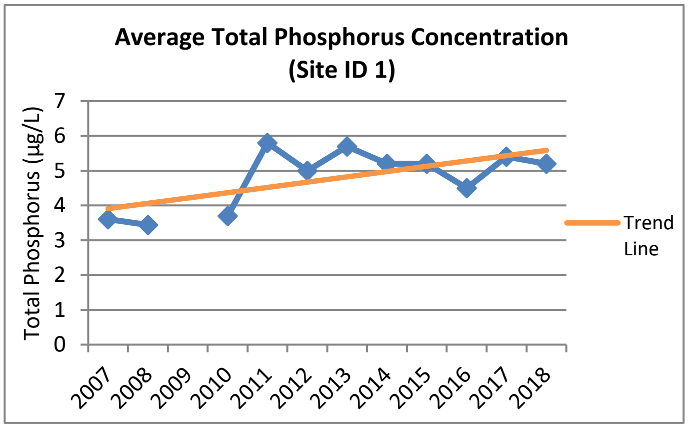
Crane Lake

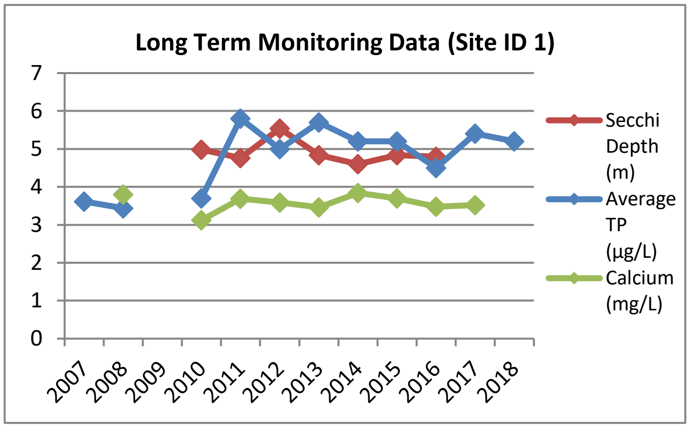
• Station: 1014	• Trophic status: oligotrophic
• Site ID: 1	• Average TP: n/a
• Description: mid-bay, deep spot	• Trend (Y/N): Y – increasing
• Data collector: LPP volunteer	• Average Secchi depth: 4.9 m
	• Visible outliers: none

Recommendation: continue with standard LPP monitoring at Site ID 1 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).


Water Clarity (Site ID 1)
Secchi Depth (m)
0
1
2
3
4
5
6
2010
2011
2012
2013
2014
2015
2016
2017
2018


Calcium Concentration (Site ID 1)
Calcium (mg/L)
0
1
2
3
4
5
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

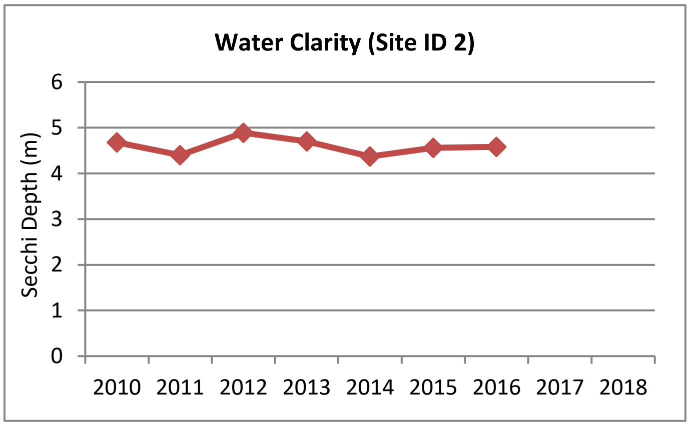

Average Total Phosphorus Concentration (Site ID 1)
Total Phosphorus (µg/L)
0
1
2
3
4
5
6
7
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Trend Line

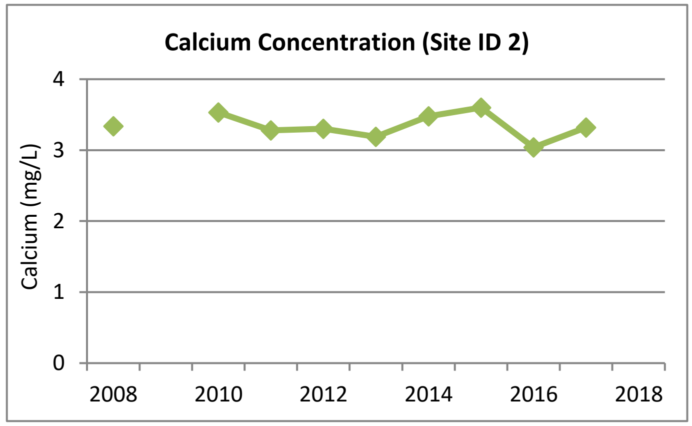

Long Term Monitoring Data (Site ID 1)
0
1
2
3
4
5
6
7
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Secchi Depth (m)
Average TP (µg/L)
Calcium (mg/L)

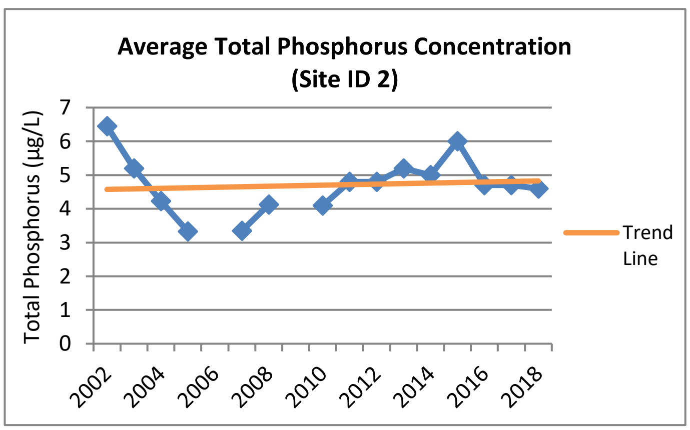
Crane Lake

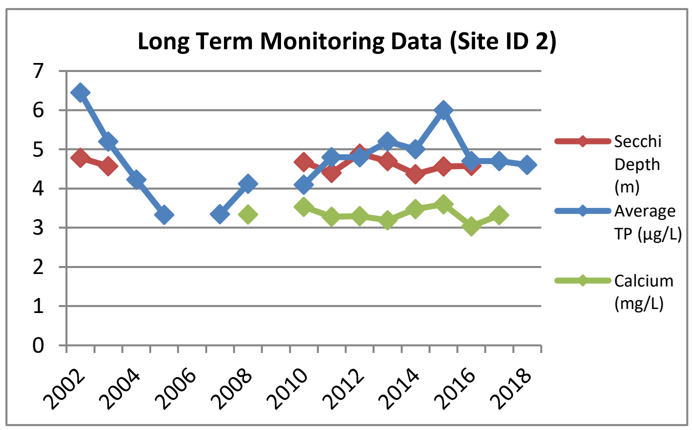
• Station: 1014	• Trophic status: oligotrophic
• Site ID: 2	• Average TP: n/a
• Description: N end, off Marsh Is.	• Trend (Y/N): Y – increasing
• Data collector: LPP volunteer	• Average Secchi depth: 4.6 m
	• Visible outliers: none

Recommendation: continue with standard LPP monitoring at Site ID 2 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).









Station	Site ID	Description	2016 Average TP (µg/L)	Data Collector
1014	7	CR01	3.80	MOE Northern Region
1014	8	CR02	4.30	MOE Northern Region
1014	9	CR03	4.40	MOE Northern Region
1014	10	CR04	4.60	MOE Northern Region

Crane Lake 2018 benthic monitoring results

		Crane Lake 2018		
Common Name	Scientific Name	1	2	3
Hydras	Coelenterata			
Flatworms	Turbellaria		1	4
Roundworms	Nematoda	1		1
Aquatic Earthworms	Oligochaeta	5	2	5
Leeches	Hirudinaea			
Sow bugs	Isopoda		3	4
Clams	Pelecypoda			
Fairy Shrimp	Amphipoda	16	29	6
Crayfish	Decapoda			
Mites	Hydracarina	24	18	31
Mayflies	Ephemeroptera	16	7	3
Dragonflies	Anisoptera	2	1	1
Damselflies	Zygoptera	1	1	
Stoneflies	Plecoptera			
True Bugs	Hemiptera			1
Fishflies and Alderflies	Megaloptera			
Caddisflies	Trichoptera	2		1
Aquatic Moths	Lepidoptera			
Beetles	Coleoptera	2	3	3
Snails and Limpets	Gastropoda	2	1	2
Midges	Chironomidae	19	30	42
Horse and Deer Flies	Tabanidae			
Mosquitos	Culicidae			
No-see-ums	Ceratopogonidae	11	4	5
Craneflies	Tipulidae			
Blackflies	Simuliidae			
Misc. True Flies	Misc. Diptera			
Total Count		101	100	109
Number of Taxa		12	12	14

Healey Lake Property Owners' Association

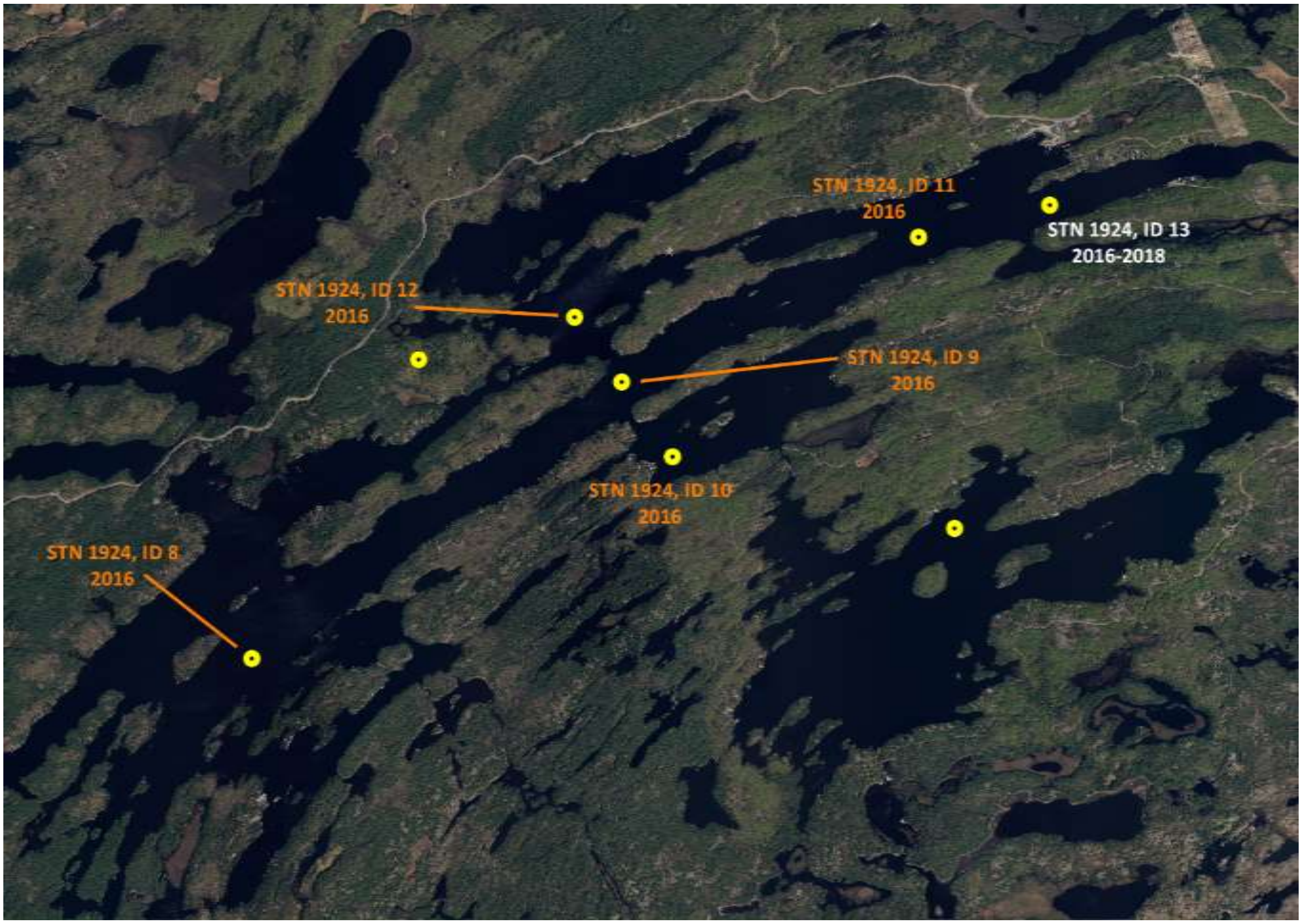
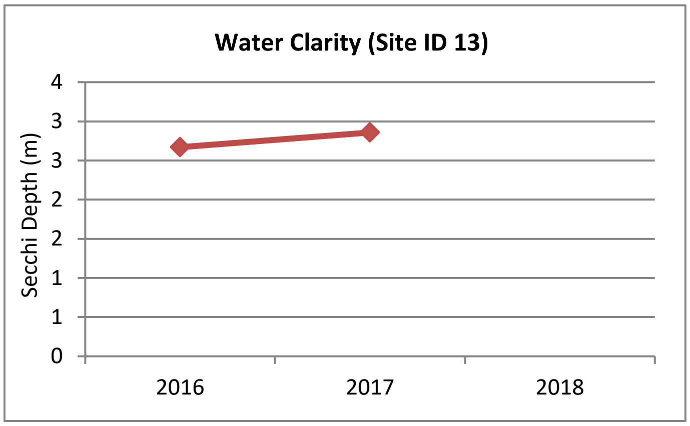


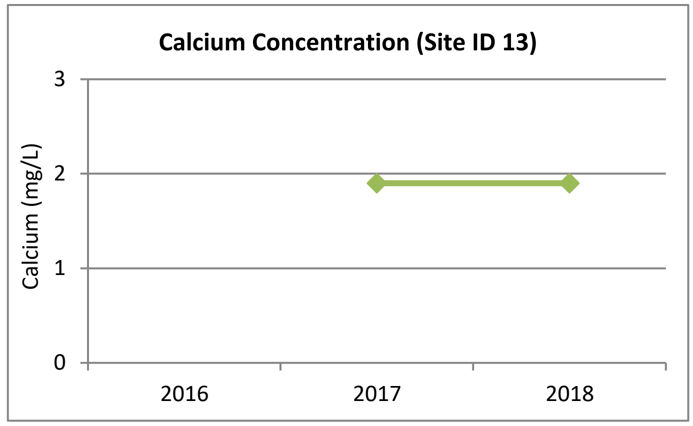
Figure 5. Active and recently active LPP sampling locations. Data collection at locations labelled in white is undertaken by LPP volunteers while data collection at locations labelled in orange is undertaken by the MOE Northern Region.

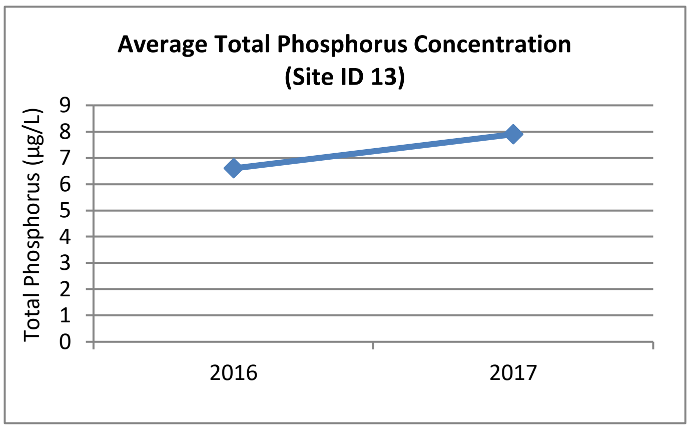
Healey Lake

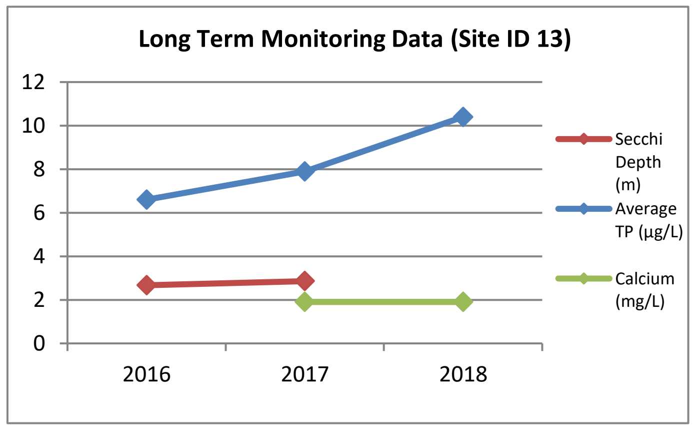
• Station: 1924	• Trophic status: oligotrophic
• Site ID: 13	• Average TP: n/a
• Description: Pinebay, deep spot	• Trend (Y/N): n/a
• Data collector: LPP volunteer	• Average Secchi depth: 2.8 m
	• Visible outliers: none

Recommendation: continue with standard LPP monitoring at Site ID 13 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).









Station	Site ID	Description	2016 Average TP (µg/L)	Data Collector
1924	8	HE01	5.10	MOE Northern Region
1924	9	HE02	5.20	MOE Northern Region
1924	10	HE03	4.70	MOE Northern Region
1924	11	HE04	5.60	MOE Northern Region
1924	12	HE05	5.30	MOE Northern Region

Healey Lake 2018 benthic monitoring results

		Healey Lake 2018		
Common Name	Scientific Name	1	2	3
Hydras	Coelenterata			
Flatworms	Turbellaria	3		1
Roundworms	Nematoda			1
Aquatic Earthworms	Oligochaeta	6	2	
Leeches	Hirudinaea			
Sow bugs	Isopoda	9	70	17
Clams	Pelecypoda			
Fairy Shrimp	Amphipoda	11	15	24
Crayfish	Decapoda			
Mites	Hydracarina	23	7	18
Mayflies	Ephemeroptera	7		5
Dragonflies	Anisoptera		1	2
Damselflies	Zygoptera	2		1
Stoneflies	Plecoptera			
True Bugs	Hemiptera			
Fishflies and Alderflies	Megaloptera			
Caddisflies	Trichoptera			
Aquatic Moths	Lepidoptera			
Beetles	Coleoptera	6		1
Snails and Limpets	Gastropoda	9		3
Midges	Chironomidae	1	2	2
Horse and Deer Flies	Tabanidae			
Mosquitos	Culicidae			
No-see-ums	Ceratopogonidae	22	5	25
Craneflies	Tipulidae			
Blackflies	Simuliidae			
Misc. True Flies	Misc. Diptera	1		
Total Count		100	102	100
Number of Taxa		12	7	12

Iron City Fishing Club

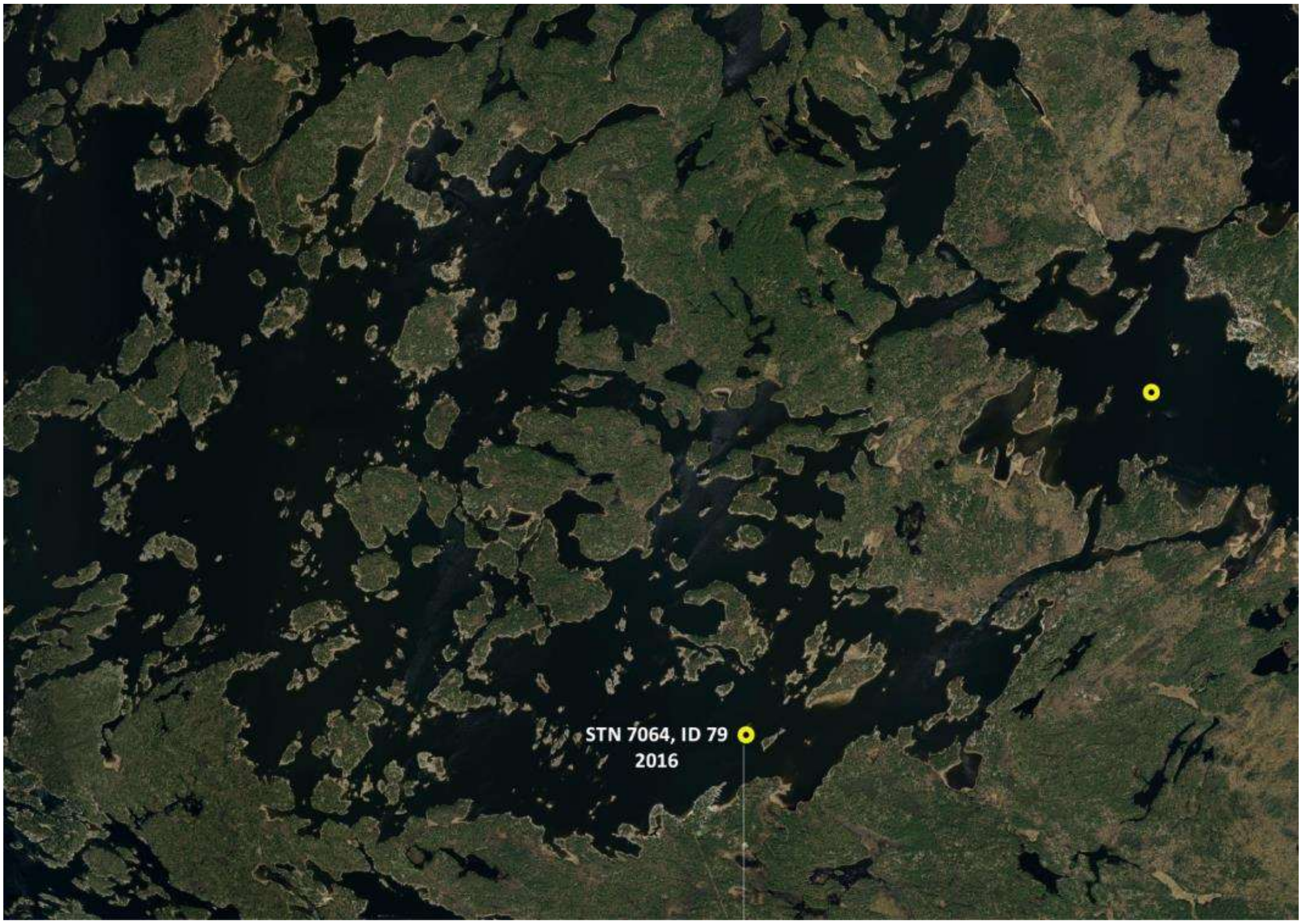


Figure 6. Recently active LPP sampling location.

Iron City Bay

Station	Site ID	Description	2016 Average TP (µg/L)	Data collector
7064	79	Iron City Bay, deep spot	10.30	LPP volunteer

Recommendation: reinitiate standard LPP monitoring at Site ID 79 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).

Kapikog Lake Cottagers' Association

Figure 7. Active and past LPP sampling locations. Data collection at locations labelled in white is undertaken by LPP volunteers while data collection at locations labelled in orange is undertaken by the MOE Northern Region.

Kapikog Lake

Station	Site ID	Description	2018 Average TP (µg/L)	Data collector
2230	2	Stn 2, mid-lake	6.00	LPP volunteer

Recommendation: continue with standard LPP monitoring at Site ID 2 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).

Kapikog Lake 2018 benthic monitoring results

		Kapikog Lake 2018		
Common Name	Scientific Name	1	2	3
Hydras	Coelenterata			
Flatworms	Turbellaria			
Roundworms	Nematoda			
Aquatic Earthworms	Oligochaeta	4	16	3
Leeches	Hirudinaea	1		1
Sow bugs	Isopoda	1	3	1
Clams	Pelecypoda			1
Fairy Shrimp	Amphipoda	40	27	9
Crayfish	Decapoda			
Mites	Hydracarina	5	2	10
Mayflies	Ephemeroptera		3	
Dragonflies	Anisoptera		1	
Damselflies	Zygoptera	1		
Stoneflies	Plecoptera			
True Bugs	Hemiptera			
Fishflies and Alderflies	Megaloptera			
Caddisflies	Trichoptera	5	4	12
Aquatic Moths	Lepidoptera			
Beetles	Coleoptera	2	2	1
Snails and Limpets	Gastropoda		4	3
Midges	Chironomidae	63	21	41
Horse and Deer Flies	Tabanidae			
Mosquitos	Culicidae			
No-see-ums	Ceratopogonidae	8	20	21
Craneflies	Tipulidae			
Blackflies	Simuliidae			
Misc. True Flies	Misc. Diptera			
Total Count		130	103	103
Number of Taxa		10	11	11

Manitou Association

LPP monitoring has not previously been carried out in this area.

Recommendation: refer to the *Enclosed Bays and Inland Lakes Phosphorus Monitoring Guideline* for information on selecting an LPP sampling location and begin standard LPP monitoring (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).

Naiscoot Lake Association

LPP monitoring has not previously been carried out on Naiscoot Lake.

Recommendation: refer to the *Enclosed Bays and Inland Lakes Phosphorus Monitoring Guideline* for information on selecting an LPP sampling location and begin standard LPP monitoring (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).

Pointe au Baril Islanders' Association

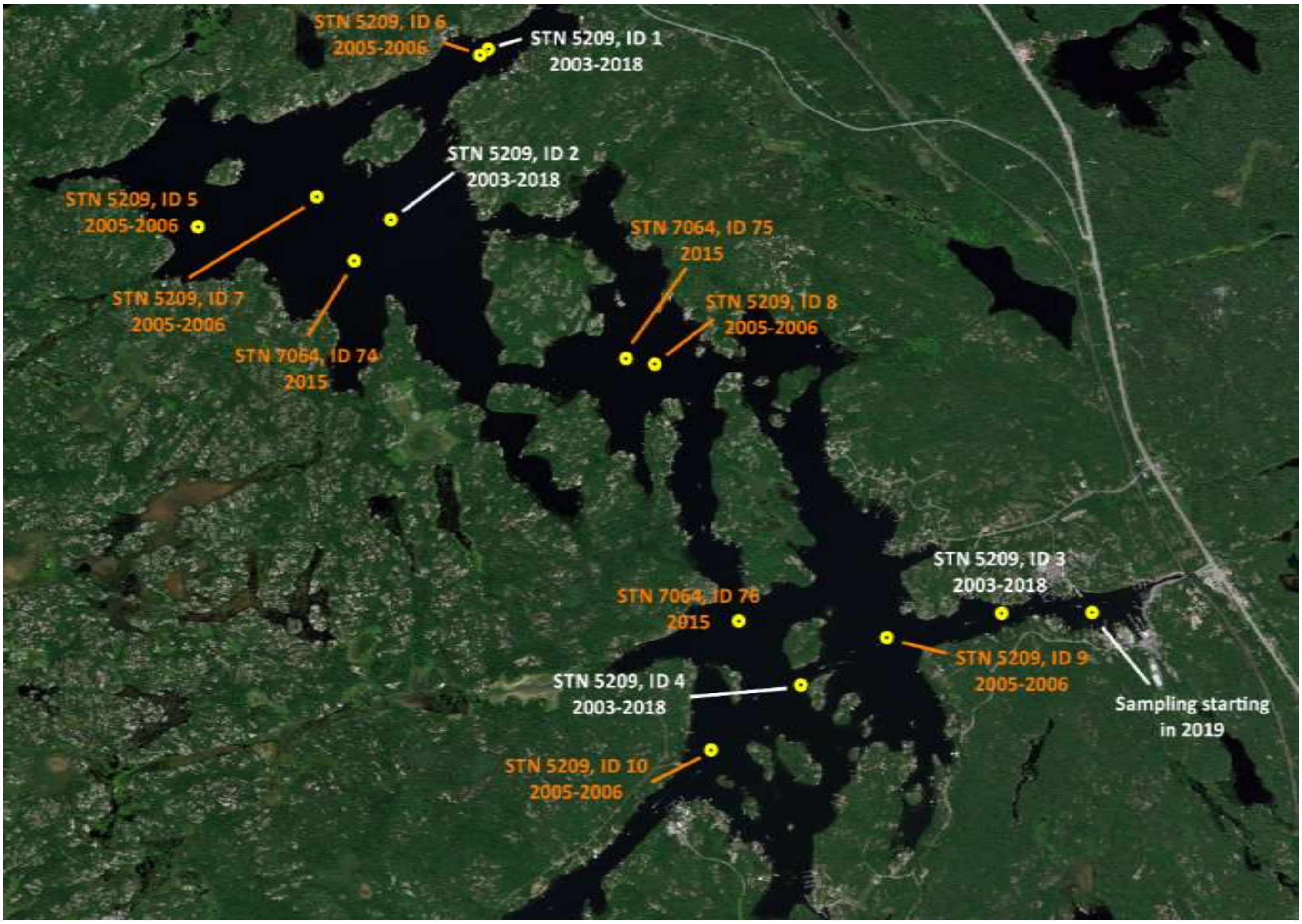
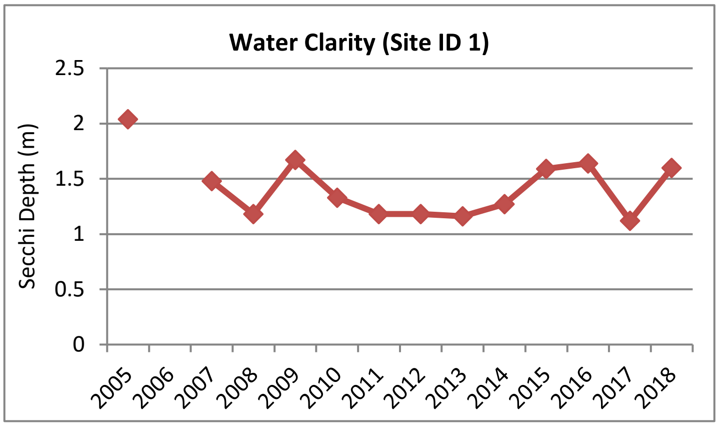


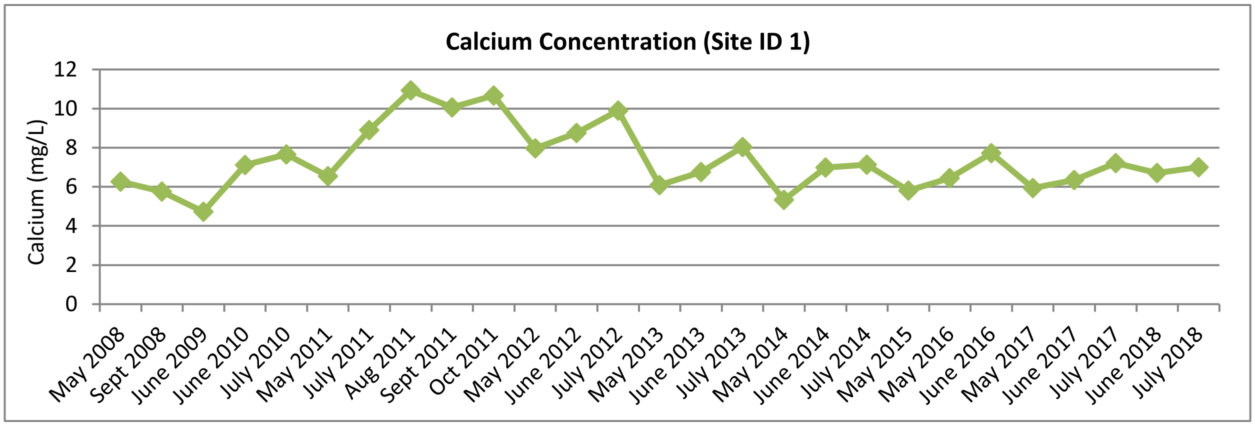
Figure 8. Past and active LPP sampling locations. Data collection at locations labelled in white is undertaken by LPP volunteers while data collection at locations labelled in orange was undertaken by the MOE Northern Region.

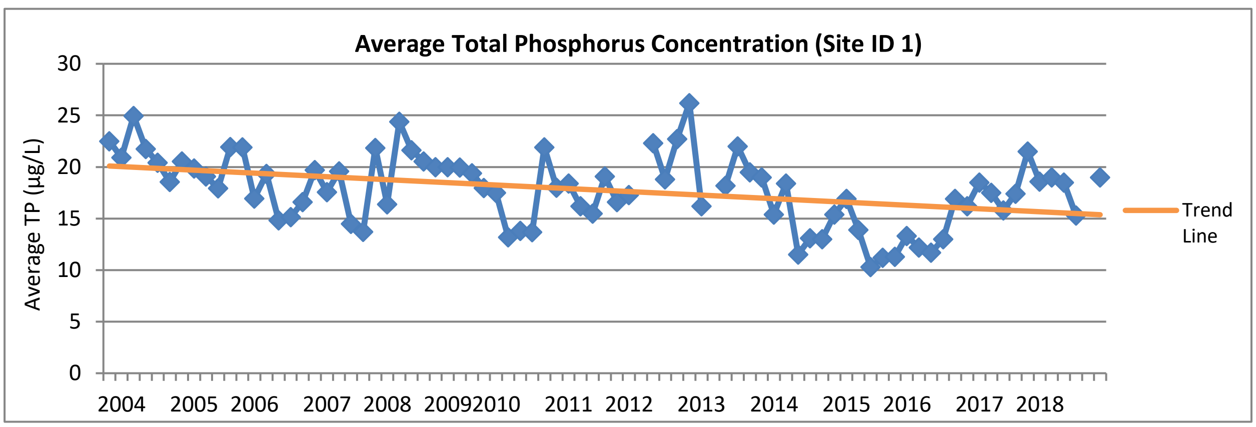
Sturgeon Bay

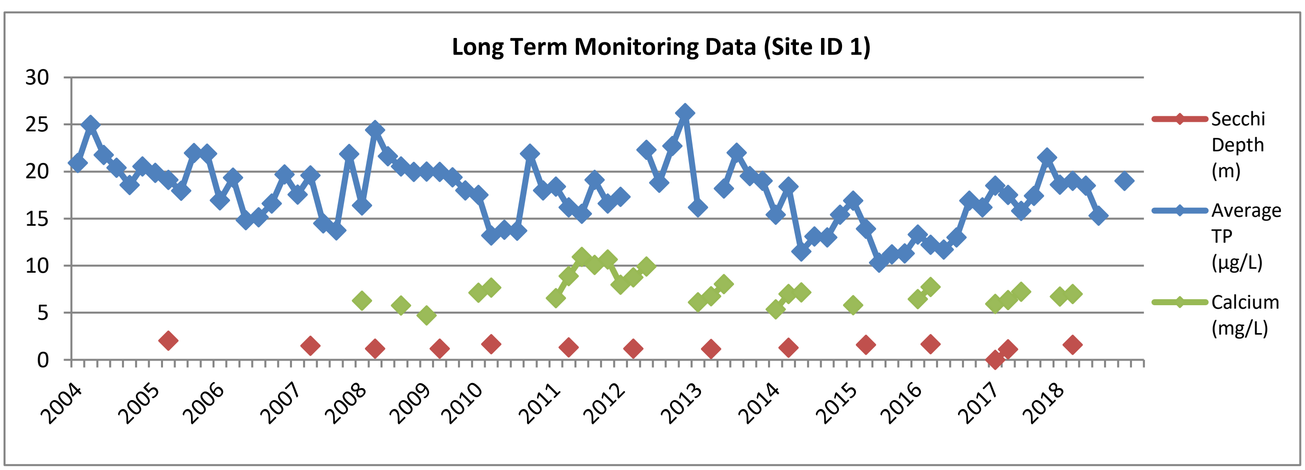
• Station: 5209	• Trophic status: mesotrophic
• Site ID: 1	• Average TP: n/a
• Description: W Sturgeon Bay Prov. Pk	• Trend (Y/N): Y – decreasing
• Data collector: LPP volunteer	• Average Secchi depth: 1.4 m
	• Visible outliers: TP of 58 µg/L in June 2012

Recommendation: continue LPP monitoring at Site ID 1 (i.e., monthly TP and calcium sampling, water clarity measurements at least once every two weeks throughout the summer).


Water Clarity (Site ID 1)
Secchi Depth (m)
2.5
2
1.5
1
0.5
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


Calcium Concentration (Site ID 1)
Calcium (mg/L)
12
10
8
6
4
2
0
May 2008
Sept 2008
June 2009
June 2010
July 2010
May 2011
July 2011
Aug 2011
Sept 2011
Oct 2011
May 2012
June 2012
July 2012
May 2013
June 2013
July 2013
May 2014
June 2014
July 2014
May 2015
May 2016
June 2016
May 2017
June 2017
July 2017
June 2018
July 2018

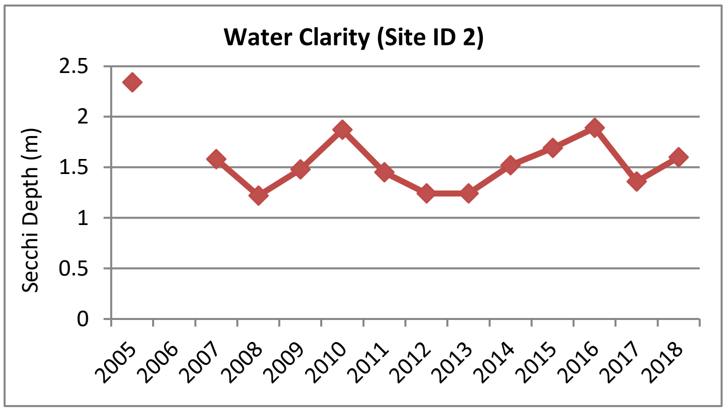

Average Total Phosphorus Concentration (Site ID 1)
Average TP (µg/L)
30
25
20
15
10
5
0
2004
2005
2006
2007
2008
20092010
2011
2012
2013
2014
2015
2016
2017
2018
Trend Line

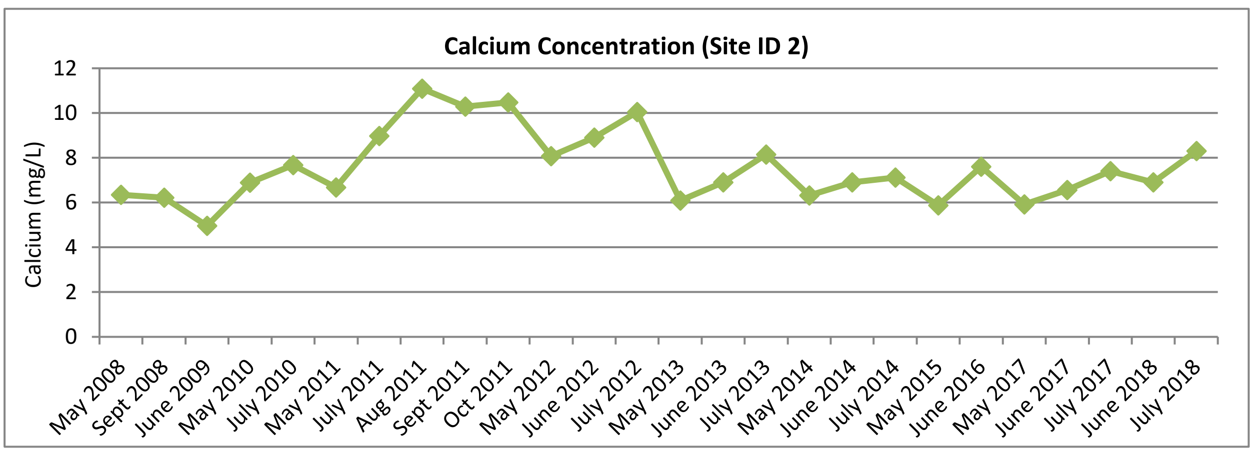

Long Term Monitoring Data (Site ID 1)
30
25
20
15
10
5
0
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Secchi Depth (m)
Average TP (µg/L)
Calcium (mg/L)

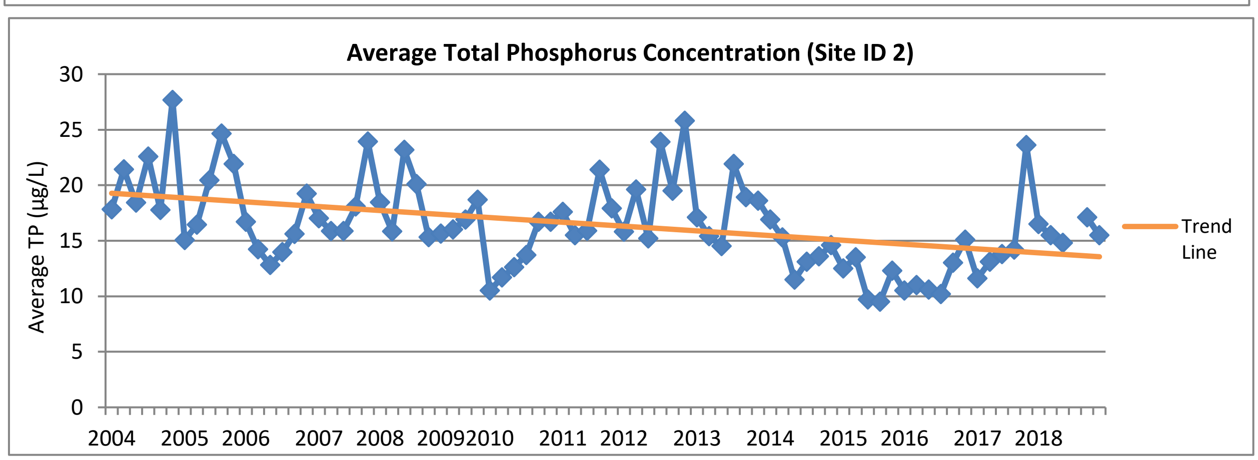
Sturgeon Bay

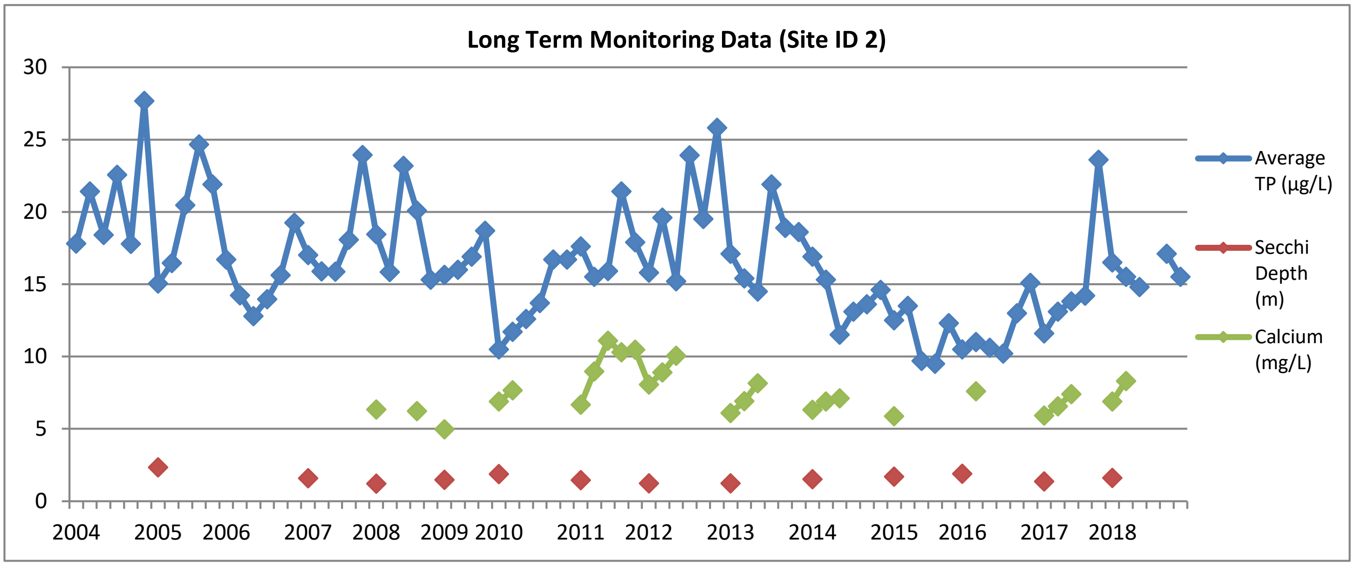
• Station: 5209	• Trophic status: mesotrophic
• Site ID: 2	• Average TP: n/a
• Description: Kenilworth & Skunk I	• Trend (Y/N): Y – decreasing
• Data collector: LPP volunteer	• Average Secchi depth: 1.6 m
	• Visible outliers: none

Recommendation: continue LPP monitoring at Site ID 2 (i.e., monthly TP and calcium sampling, water clarity measurements at least once every two weeks throughout the summer).





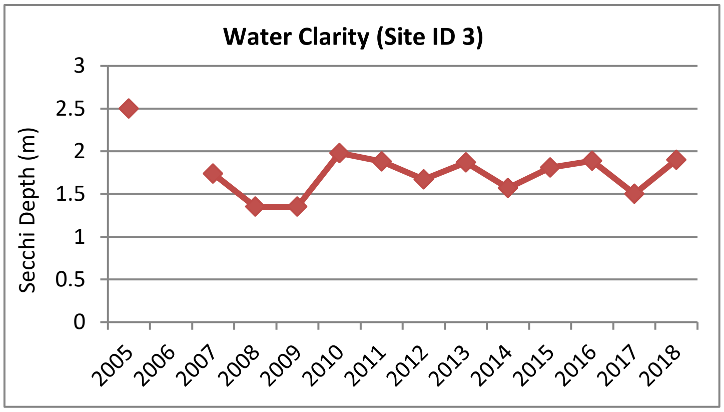


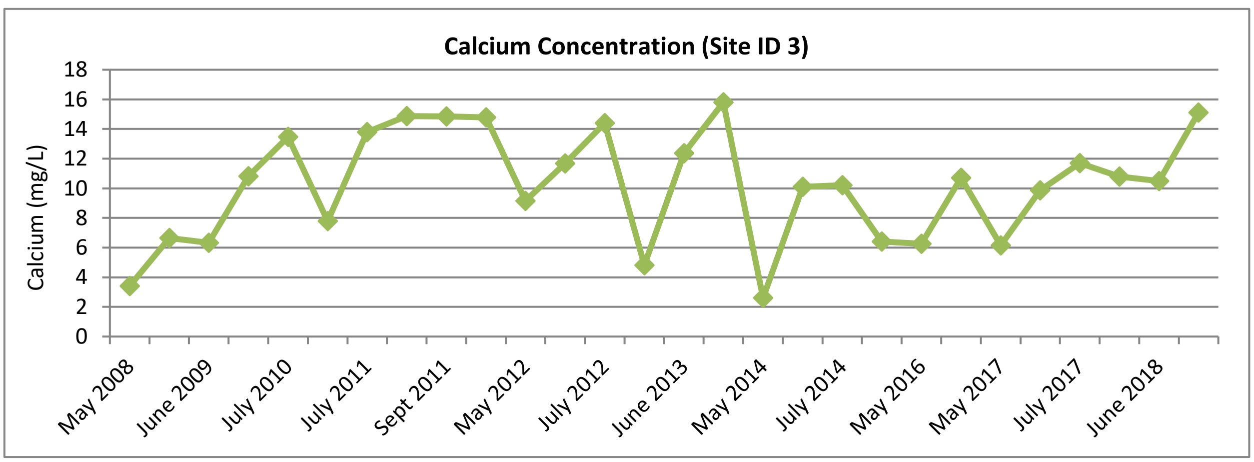

Long Term Monitoring Data (Site ID 2)
30
25
20
15
10
5
0
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Average TP (µg/L)
Secchi Depth (m)
Calcium (mg/L)

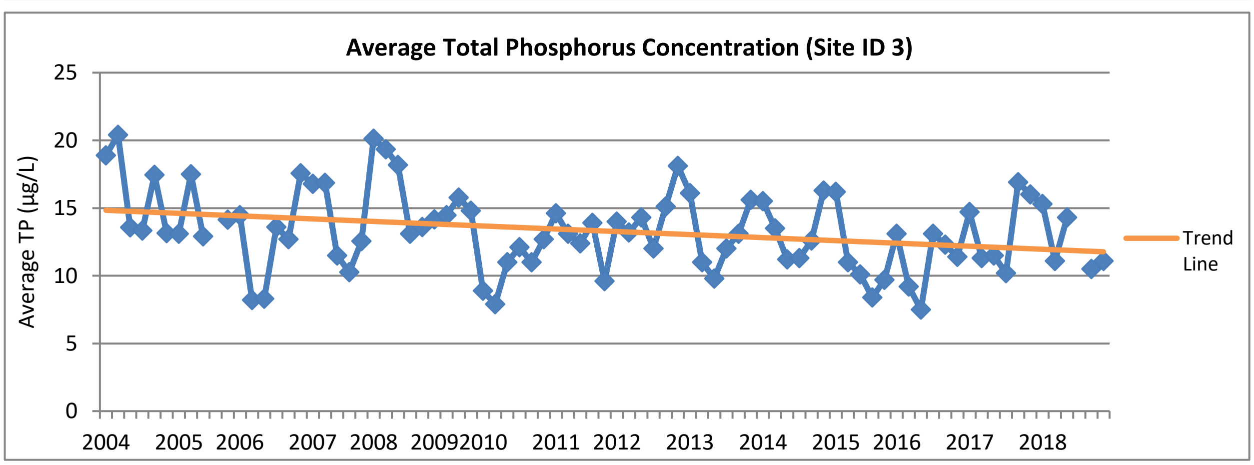
Sturgeon Bay

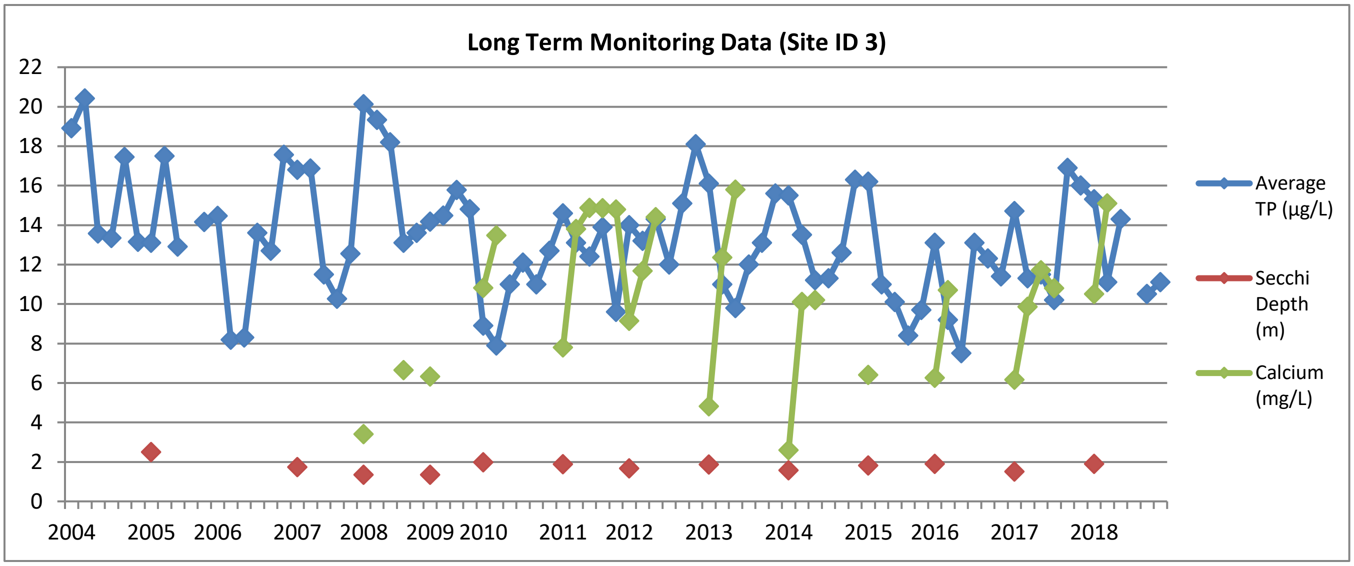
• Station: 5209	• Trophic status: mesotrophic
• Site ID: 3	• Average TP: n/a
• Description: Pointe au Baril chan	• Trend (Y/N): Y – decreasing
• Data collector: LPP volunteer	• Average Secchi depth: 1.8 m
	• Visible outliers: none

Recommendation: continue LPP monitoring at Site ID 3 (i.e., monthly TP and calcium sampling, water clarity measurements at least once every two weeks throughout the summer).





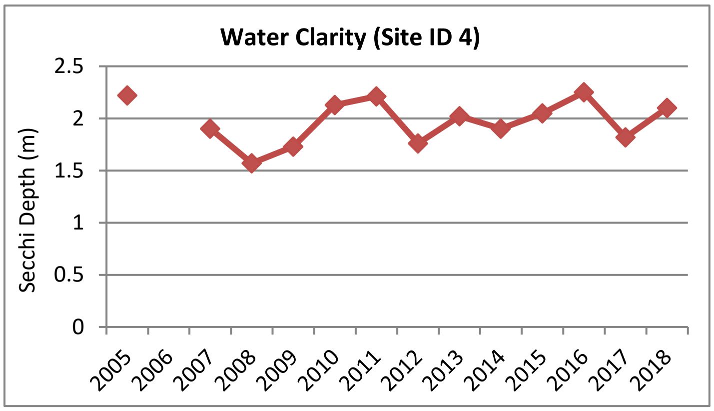


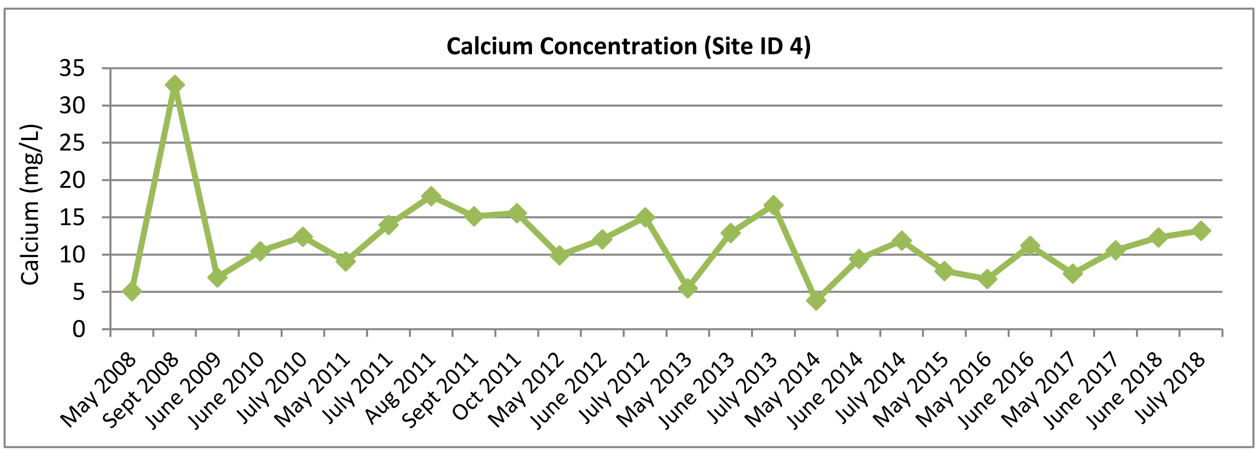

Long Term Monitoring Data (Site ID 3)
22
20
18
16
14
12
10
8
6
4
2
0
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Average TP (µg/L)
Secchi Depth (m)
Calcium (mg/L)

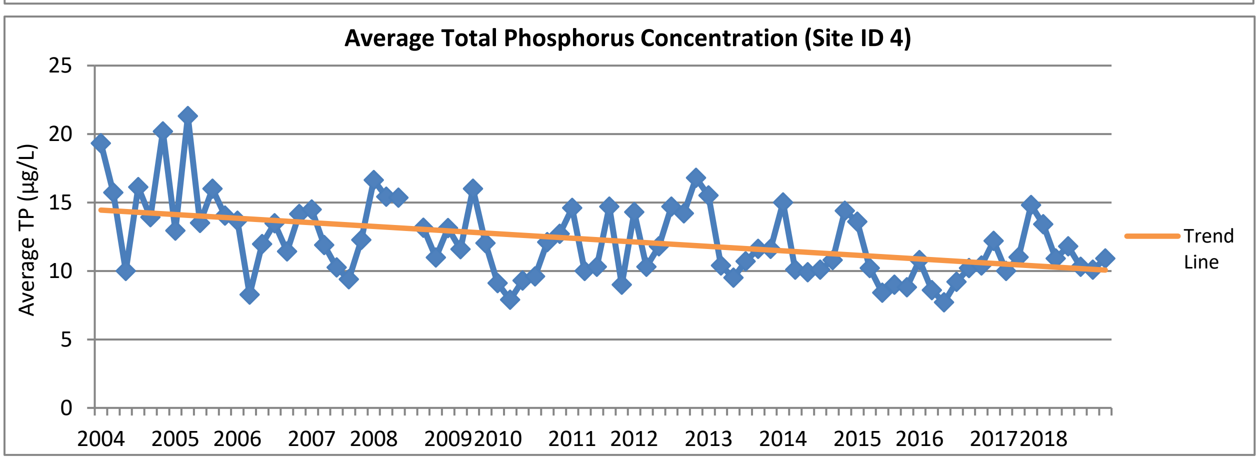
Sturgeon Bay

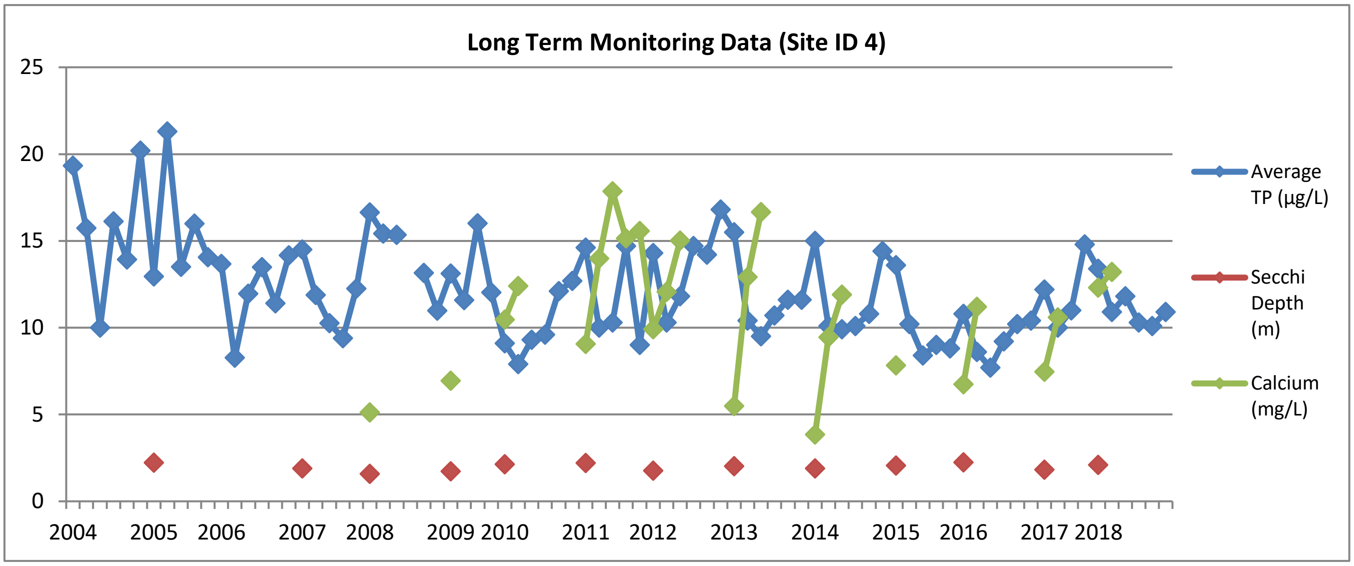
• Station: 5209	• Trophic status: mesotrophic
• Site ID: 4	• Average TP: n/a
• Description: W of School House Is	• Trend (Y/N): Y – decreasing
• Data collector: LPP volunteer	• Average Secchi depth: 2.0 m
	• Visible outliers: calcium concentration of 33 mg/L in September 2008

Recommendation: continue LPP monitoring at Site ID 4 (i.e., monthly TP and calcium sampling, water clarity measurements at least once every two weeks throughout the summer).









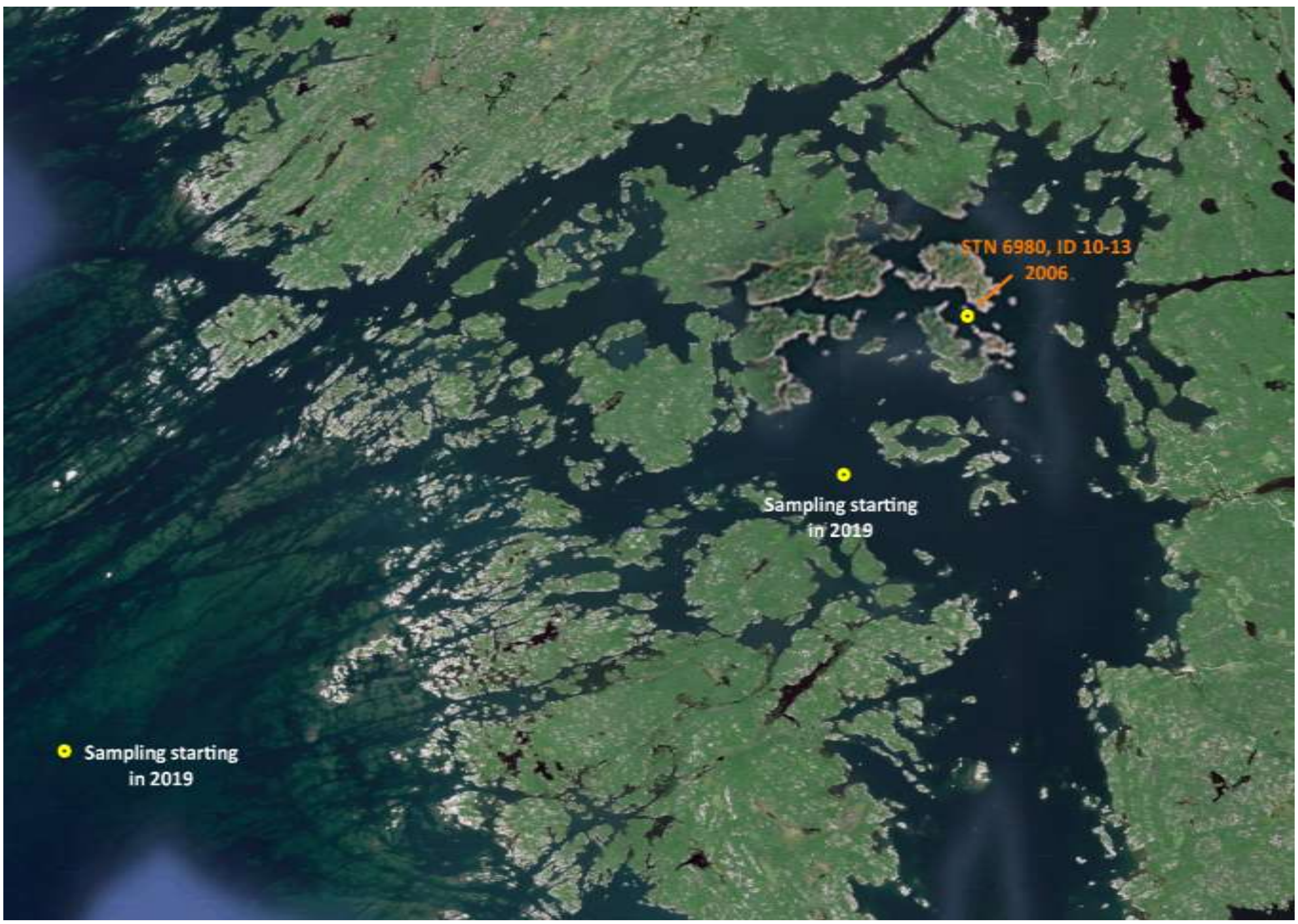


Figure 9. LPP sampling locations starting in 2019.

Rock Island Lake

LPP monitoring has not previously been carried out on Rock Island Lake.

Recommendation: refer to the *Enclosed Bays and Inland Lakes Phosphorus Monitoring Guideline* for information on selecting an LPP sampling location and begin standard LPP monitoring (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).

Sans Souci & Copperhead Association

Figure 10. LPP sampling locations that will be sampled starting in 2019.

Recommendation: begin standard LPP monitoring in 2019 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).

Skerryvore Ratepayers' Association

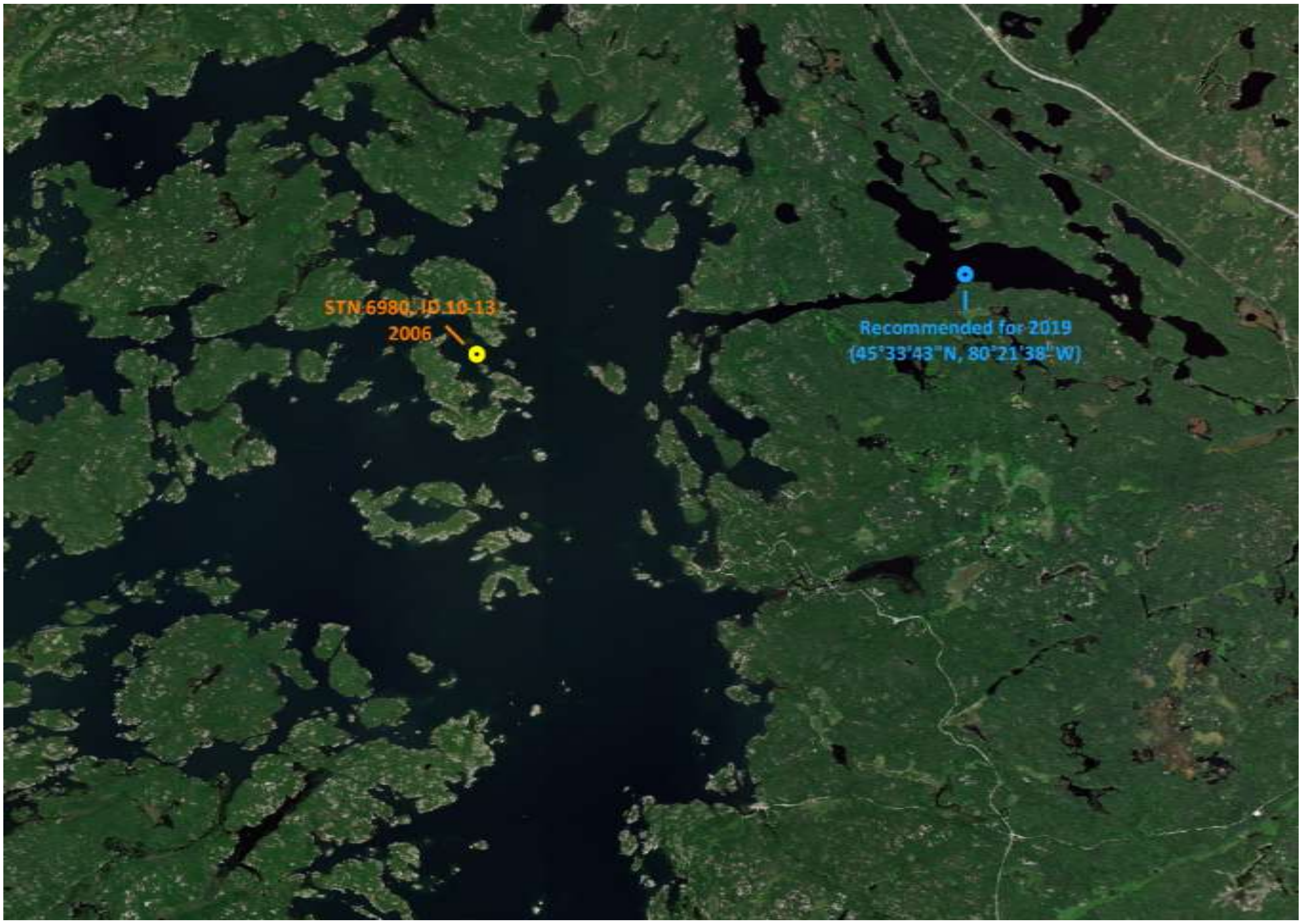


Figure 11. Past LPP sampling location with data collected by the MOE Northern Region and a recommended site for sampling in 2019.

Recommendation: establish an LPP sampling location at the recommended site (site 34 on page 17 of the *Enclosed Bays and Inland Lakes Phosphorus Monitoring Guideline*) and begin standard LPP monitoring at Site ID 10-13 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).

South Channel Association

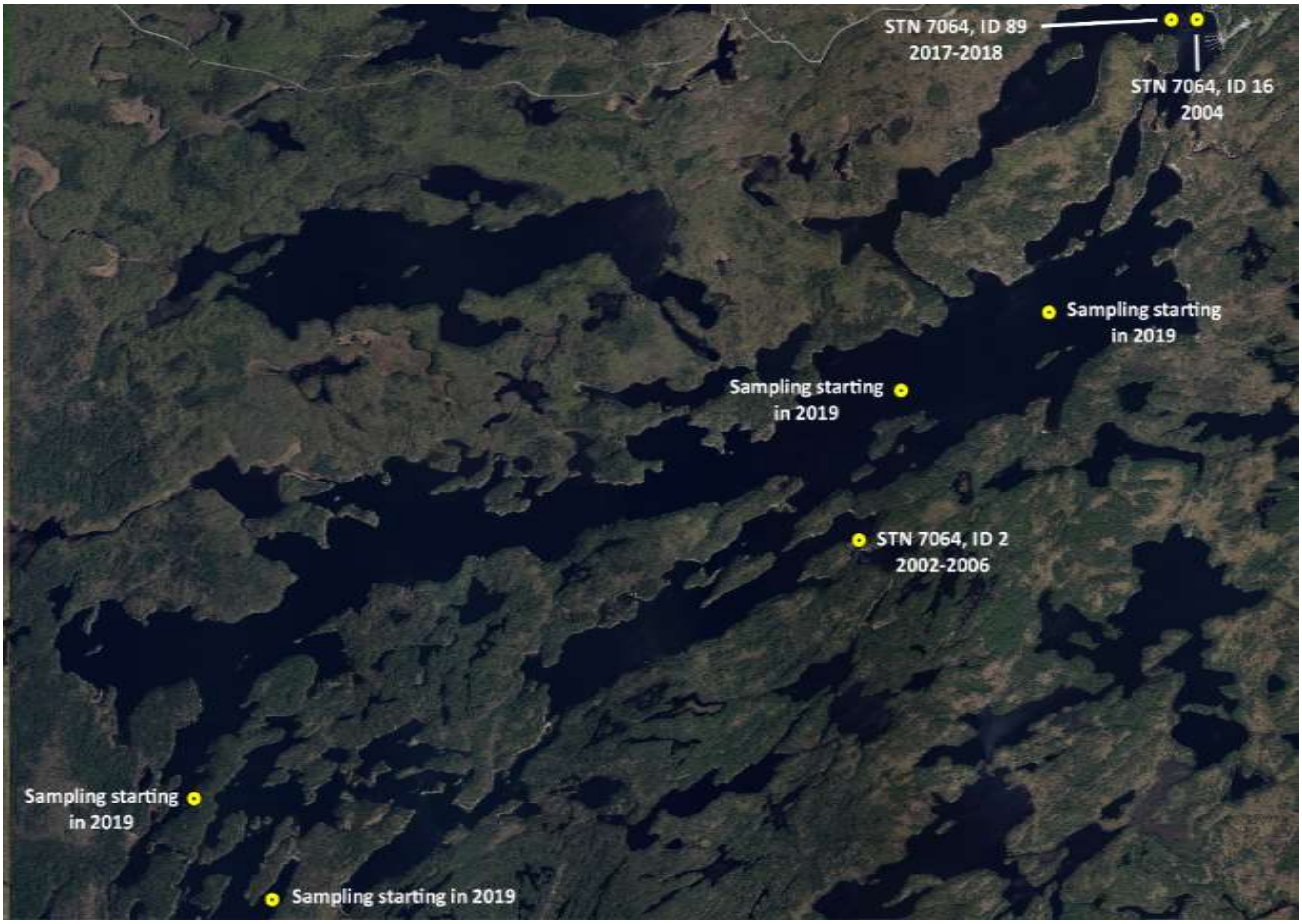


Figure 12. Past and present LPP sampling locations with data collected by LPP volunteers, and locations being sampled starting in 2019.

South Channel

Station	Site ID	Description	2017 Average TP (µg/L)	2018 Average TP (µg/L)	Data collector
7064	89	Channel N of Isabella Island	7.90	7.60	LPP volunteer

Recommendation: continue with standard LPP monitoring at Site ID 89 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer). Prioritize standard LPP sampling at recommended sites (sites 25 and 27 on page 14 of the *Enclosed Bays and Inland Lakes Phosphorus Monitoring Guideline*).

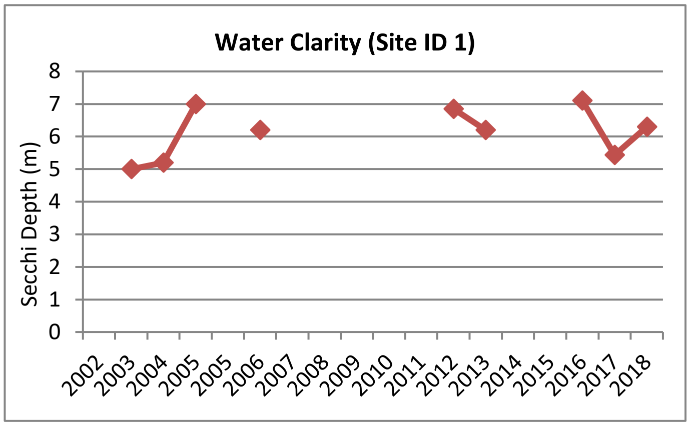
Three Legged Lake Association

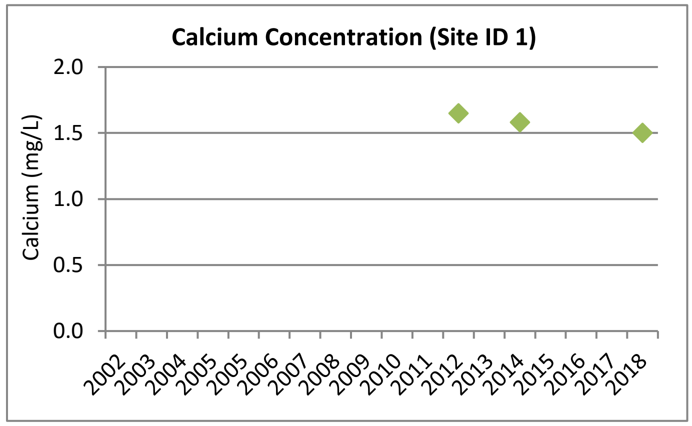
Figure 13. Past and active LPP sampling locations. Data collection at the location labelled in white was undertaken by LPP volunteers while data collection at the location labelled in orange was undertaken by Seguin Township.

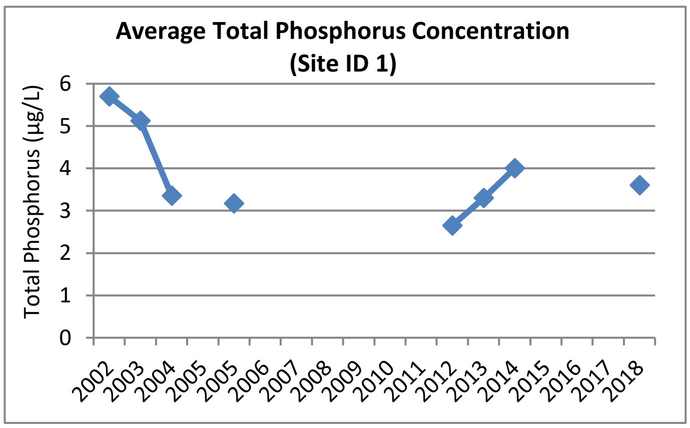
Three Legged Lake

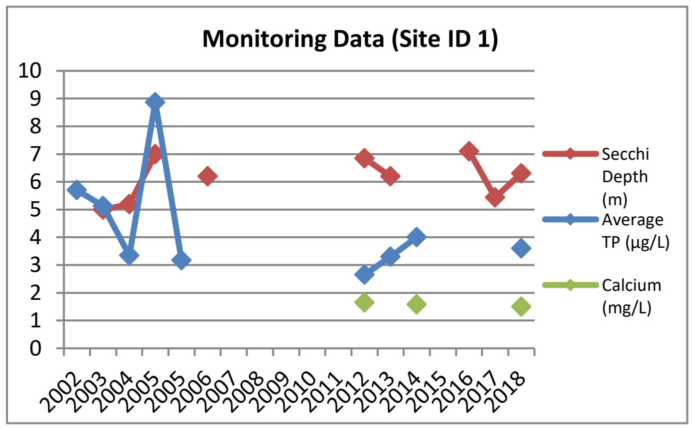
• Station: 5360	• Trophic status: oligotrophic
• Site ID: 1	• Average TP: 3 µg/L
• Description: mid lake, deep spot	• Trend (Y/N): n/a
• Data collector: LPP volunteer	• Average Secchi depth: 6.0 m
	• Visible outliers: TP of 8.9 µg/L in 2005

Recommendation: continue LPP monitoring at Site ID 1 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).


Water Clarity (Site ID 1)
Secchi Depth (m)
0 1 2 3 4 5 6 7 8
2002 2003 2004 2005 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018


Calcium Concentration (Site ID 1)
Calcium (mg/L)
0.0 0.5 1.0 1.5 2.0
2002 2003 2004 2005 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018


Average Total Phosphorus Concentration (Site ID 1)
Total Phosphorus (µg/L)
0 1 2 3 4 5 6
2002 2003 2004 2005 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018


Monitoring Data (Site ID 1)
0 1 2 3 4 5 6 7 8 9 10
2002 2003 2004 2005 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Secchi Depth (m)
Average TP (µg/L)
Calcium (mg/L)

Woods Bay Community Association

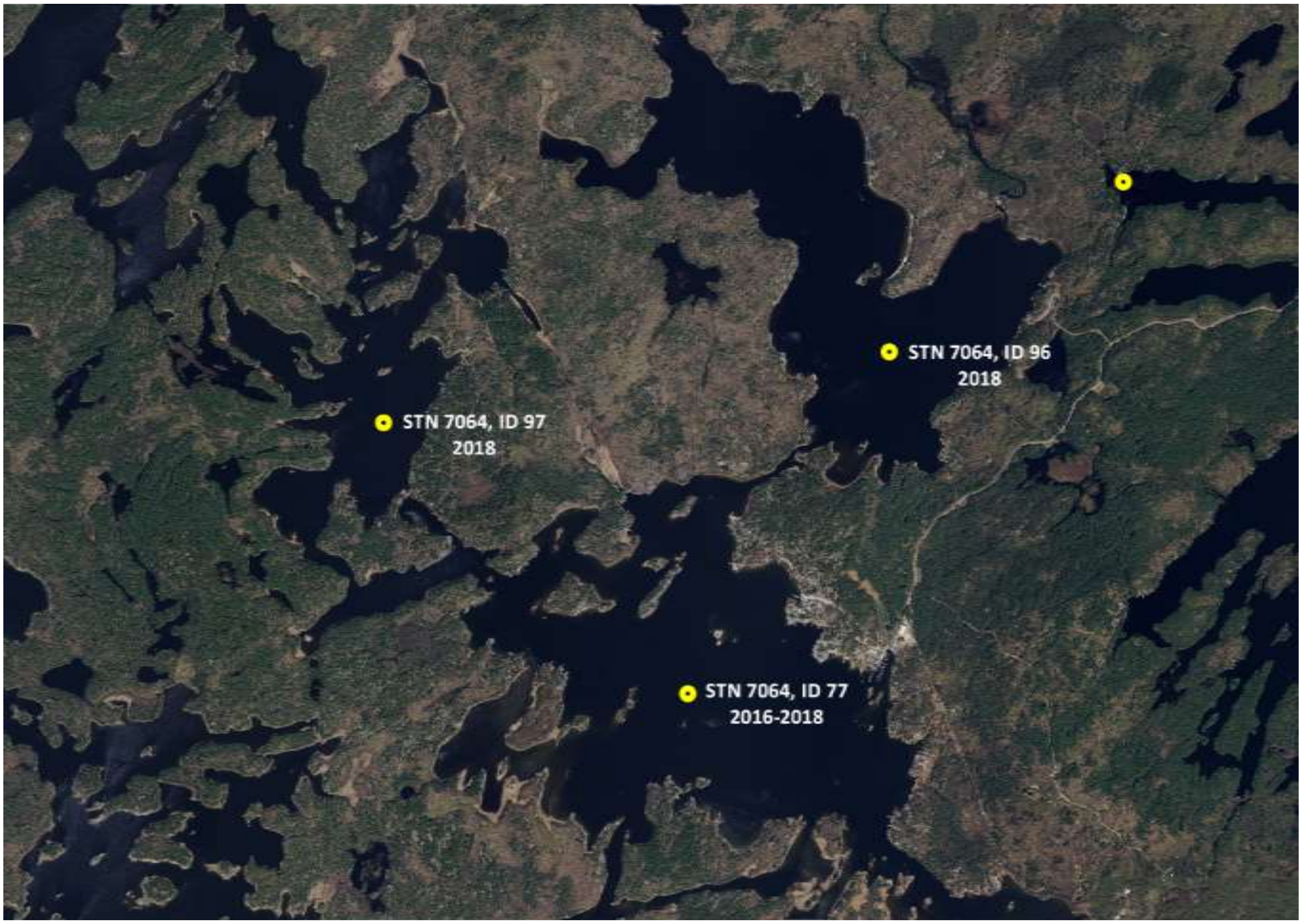
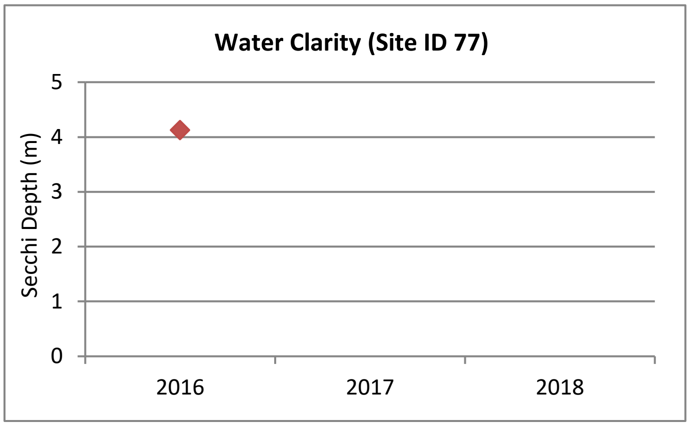


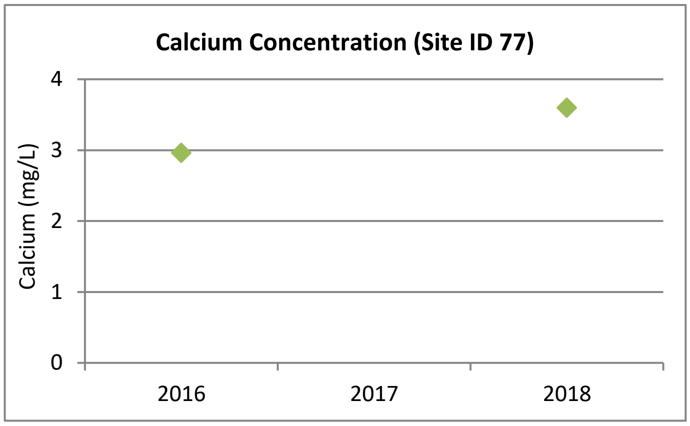
Figure 14. Active LPP sampling locations.

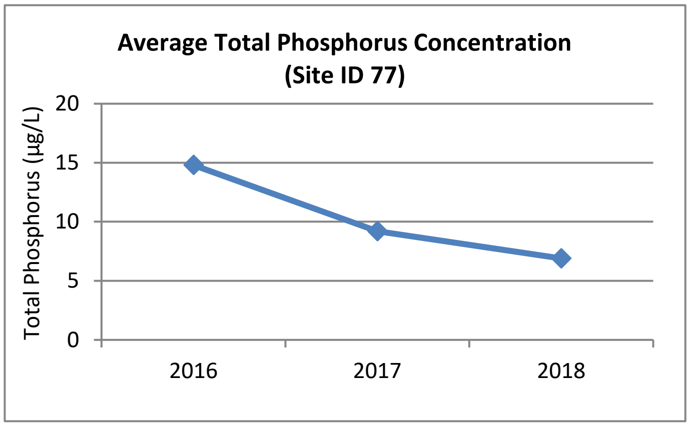
Woods Bay

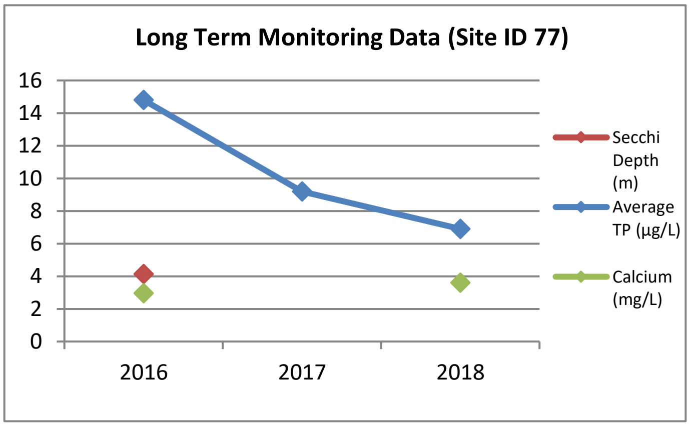
• Station: 7064	• Trophic status: mesotrophic
• Site ID: 77	• Average TP: 10.3 µg/L
• Description: Woods Bay, deep spot	• Trend (Y/N): n/a
• Data collector: LPP volunteer	• Average Secchi depth: 4.1 m
	• Visible outliers: none

Recommendation: continue with standard LPP monitoring at Site IDs 77, 96, and 97 (i.e., TP and calcium sampling once in May, water clarity measurements at least once every two weeks throughout the summer).









Station	Site ID	Description	2018 Average TP (µg/L)	Data collector
7064	96	Blackstone Harbour	7.10	LPP volunteer
7064	97	North Channel	6.30	LPP volunteer

Results – Enhanced Monitoring Sites

Over the past three summers, GBBR and the TOA partnered with the Pointe au Baril Islanders Association (PABIA) and Woods Bay Community Association to conduct enhanced nutrient monitoring in order to better understand nutrient dynamics in Sturgeon Bay and Blackstone Harbour. This partnership involved training and equipment loans (with funding from ECCC). The objectives of enhanced nutrient monitoring are:

1) to identify areas that are thermally stratified;
2) to collect vertical dissolved oxygen and temperature profiles; and
3) to collect late summer total phosphorus samples near the bottom to confirm internal loads.

During summer months, many Ontario Shield lakes (that are deep enough) undergo thermal stratification (see Figure 15) whereby the surface water is mixed by wind down to a depth of ~4-7 m. This mixed layer is called the epilimnion. As the summer progresses the epilimnion will deepen to ~8-10 m. Below the epilimnion there is a zone where temperatures change very rapidly (getting colder) with depth, this is called the metalimnion. The metalimnion is usually several meters thick and the zone within it where temperature changes the most rapidly is called the thermocline. Below the thermocline is the hypolimnion where temperatures are colder and more stable with depth. During stratification these waters do not mix with surface water and cannot, therefore, be replenished if they are depleted of oxygen. If all the oxygen is used up (by bacteria) the hypolimnion is anoxic and these conditions can allow phosphorus from the sediments to enter the hypolimnion. This is called an internal load and these additional nutrients can stimulate late summer algal blooms. Therefore, it is important to assess oxygen and nutrient concentrations in the hypolimnion to help predict the onset of conditions which might lead to algal blooms.

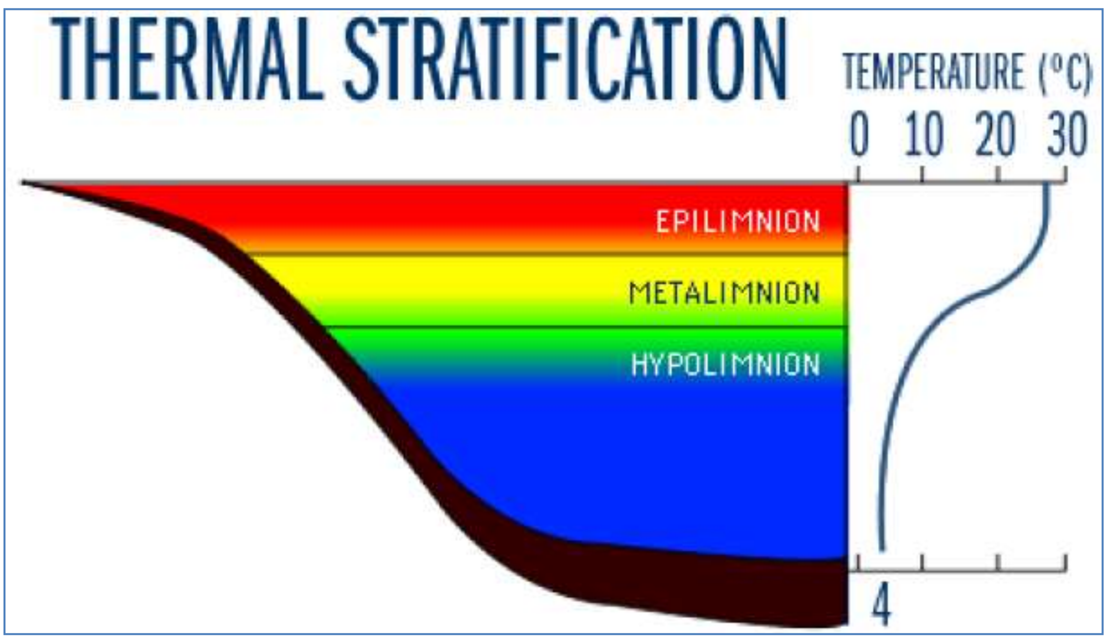


Figure 15. Thermal stratification of a lake into three identifiable layers (source: http://cfpub.epa.gov/watertrain/pdf/limnology.pdf).

Individuals interested in learning more about thermal stratification and how it changes throughout the seasons are encouraged to read the *State of the Bay Background Report* (available here).

Sturgeon Bay

Enhanced monitoring was initiated on Sturgeon Bay in 2016 as part of GBBR's *Coordinated Nutrient Monitoring Program*. Sturgeon Bay suffers from intermittent late summer cyanobacteria blooms and although there have been several in-depth studies conducted in this area, there are no monitoring programs currently in place that regularly measure temperature and dissolved oxygen (DO) profiles. These measurements are necessary to evaluate the extent of hypolimnetic anoxia and the associated potential for the release of phosphorus from lake sediments into the water column (internal loading). PABIA summer staff collected temperature and oxygen profiles over the past three summers at the locations shown in Figure 16.

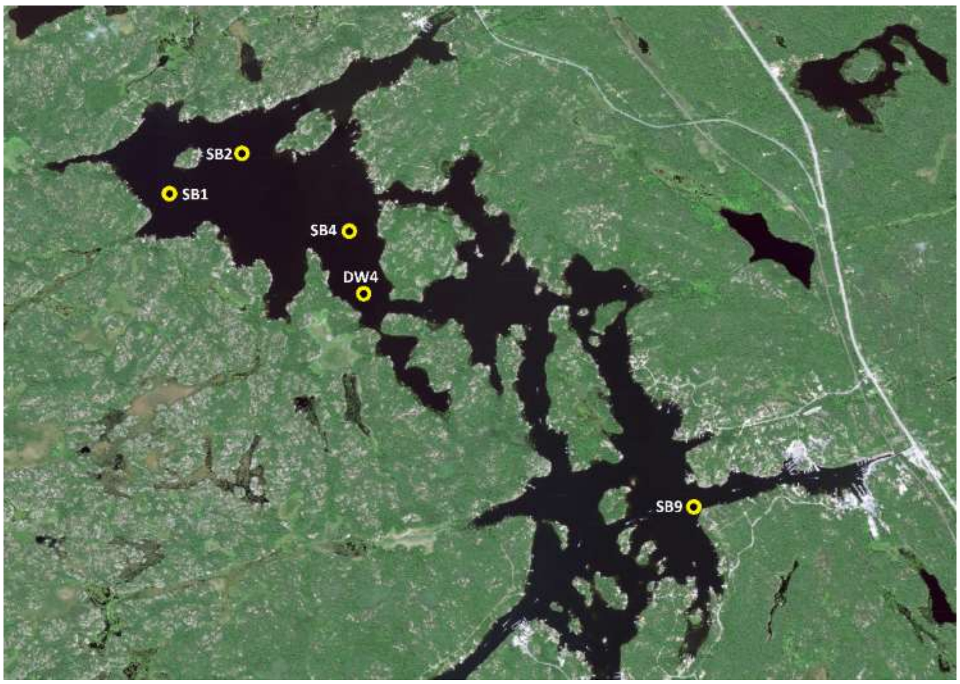


Figure 16. Sturgeon Bay sample locations for temperature and dissolved oxygen from 2016-2018.

GBBR staff sampled TP at 1 m off bottom prior to turnover in the fall of 2016, 2017, and 2018 at the deepest location in Sturgeon Bay (SB2 on Figure 16).

LPP volunteers sampled TP monthly at several locations (as presented above in the section 'Results – Regular Monitoring Sites').

Temperature/dissolved oxygen

PABIA staff collected temperature/DO profiles during routine patrols in the summers of 2016-2018. Results from 2016 and 2017 are summarized in Table 1, complete results (2016-2018) are shown in detail in Appendix B. These data show that Sturgeon Bay is thermally stratified in the deepest locations and that an anoxic hypolimnion develops soon after stratification. It is important to note that Sturgeon Bay's maximum depth is only slightly deeper than the average maximum mixed layer (epilimnion) depths for Shield lakes (9-11 m). Lakes shallower than this will mix to the bottom and will not stratify thermally (i.e., not develop a hypolimnion near the bottom where internal loads can develop).

Sturgeon Bay develops a shallow hypolimnion (several meters deep) in the deepest areas of the lake. Over most of the waterbody's area, the water will mix to the bottom and in some areas, there will be a metalimnion with no stable hypolimnion near the bottom. These areas may still develop internal loads. In those areas that are deep enough to stratify (>9 m), the stratification may be weak or temporary on a seasonal basis. As a result, anoxic sediment with potential to contribute to internal loads may be present in areas of the lake at certain times of year but not at others, making it difficult to assess the extent of areas that can generate internal loads.

A good example of this is shown by the temperature/DO profiles measured at SB1 and SB2 on August 23, 2016. SB1, which is more protected from wind, is mixed on that date to a depth that is 2 m less than at SB2. Anoxic water exists near the bottom at SB1 at depths that are fully oxygenated at SB2. It is therefore not possible to say that on any given date, Sturgeon Bay is anoxic below those depths that are indicated by data collected only at the deepest location. In addition, the extent of anoxic sediments that are overlain by a mixed oxygenated water column is not known. These anoxic sediments may still contribute phosphorus to the mixed water column even without stratification.

Table 1. Summary of temperature/dissolved oxygen profiles collected in Sturgeon Bay in 2016 and 2017.

Site	Latitude	Longitude	Depth (m)	Date	Epi. (m)	Meta. (m)	Hypo. (m)	Anoxic (m)
SB1	45 36.773	80 26.519	8	28-Jul-16	0-7	7-8		At 8
			9	5-Aug-16	0-7	7-8	8-9	8-9
			9	23-Aug-16	0-7	7-9		8-9
			9	7-Aug-17	Weakly mixed			8-9
SB2	45 36.921	80 26.128	11	28-Jul-16	0-7	7-8	8-11	8-11
			12	23-Aug-16	0-9	9-10	10-12	10-12
			14	28-Sep-16	0-11	11-14		13-14
			12	7-Aug-17	Weakly mixed			8-9
SB4	45 36.672	80 25.599	13	13-Aug-16	0-8	8-10	10-13	10-13
			13	7-Aug-17	0-7	7-10	10-14	10-14
			14	26-Aug-17	0-9	9-11	11-14	10-14
			14	1-Sep-17	0-10	10-11	11-14	11-14
SB9	45 35.562	80 23.632	12	23-Aug-16	0-9	9-10	10-12	10-12
			12	26-Aug-17	0-10	10-12		11-12

This aspect of physical limnology is further illustrated by the inclusion of the 2018 data. The three years of profile data are shown together in Figure 17. The profile data are shown for each year by positioning them according to their depth on a generic lake profile. A review of these data indicates a hypolimnion that forms a layer covering more extensive areas of the lake, rather than there being a small cone shaped hypolimnion at the deepest location. This finding is interesting as it indicates that there are larger areas of the lake that stratify than would otherwise be expected (based on data collected at the deep hole).

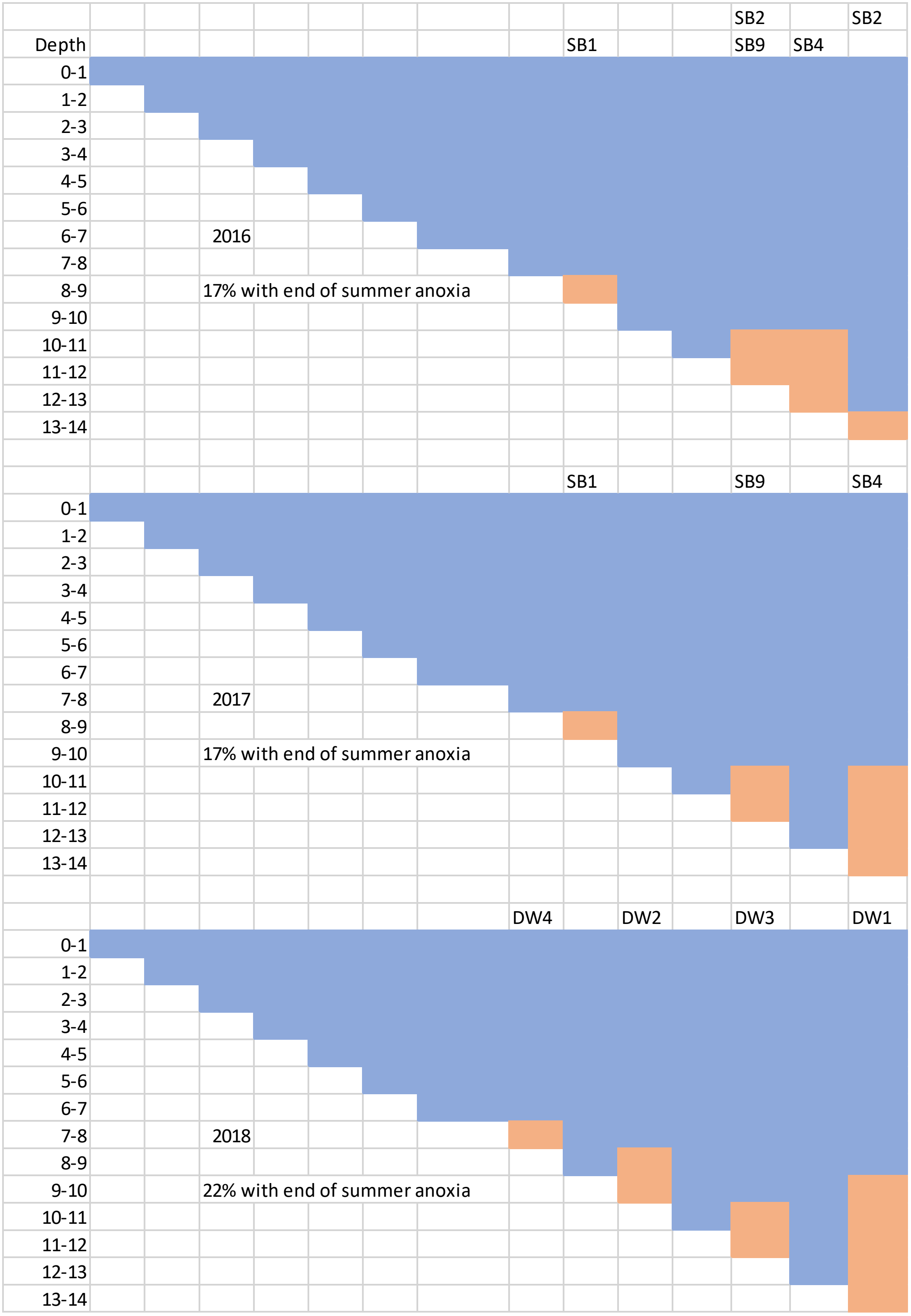


Figure 17. Oxygen profiles for each station on a generic lake depth profile. Anoxic layers are shown in orange. Areas that are 8-9 m are shown to have anoxic hypolimnions while these same depths are not anoxic at the deep hole.

It is interesting to compare these data with the percent of the lake that is represented by any given depth as shown in Table 2. The area of the lake represented by the bottom few meters is only a few percent of the lake area. However, if the extent of anoxia is expanded to 7-9 m, as indicated by profile data, then the area increases to 13-22%.

Table 2. Percent of lake area at 1 m depth intervals

Depth (m)	Lake Area (%)
0	100
1	86.3
2	75.1
3	65.2
4	53
5	40.3
6	30.6
7	22.2
8	17.1
9	13.4
10	10.5
11	7.8
12	5.1
13	1.8
14	0.02

More comprehensive temperature/DO data collected at numerous locations may explain why Sturgeon Bay blooms in some years but not in others. This may not, however, be a compelling question if the nutrient concentrations continue to decline. It would be useful to have some measure of bloom extent in individual years to compare to these oxygen and TP data.

Total phosphorus

GBBR staff collected TP samples at the end of the summer in each year. The results show a deep mixed layer with elevated TP concentrations only in the bottom 1 m. TP concentrations in the anoxic layer were less than 200 µg/L in 2016, which is not indicative of a large internal load, but over 200 µg/L in 2017 (Table 3). The lake was mixed on the last visit in 2018 such that bottom nutrient data collected were not representative of the internal load.

Much of the TP that enters the lake from the sediments (in lakes that have no oxygen in the bottom waters) will enter the water column during the summer months which can result in higher TP concentrations in mid to late summer. This is illustrated by increasing concentrations in the mixed layer at the deep location observed by LPP volunteers in 2016 (Table 4, STN 7064).

Table 3. End of summer TP concentrations at the deepest location in Sturgeon Bay in 2016, 2017, and 2018. TP1 and TP2 represent duplicate analysis of split samples.

Sample Description	Sample Date	TP1(µg/L)	TP2 (µg/L)
Sturgeon Bay 1m	28-Sep-16	20.3	20.7
Sturgeon Bay 13m	28-Sep-16	18.9	21.8
Sturgeon Bay 14m	28-Sep-16	195.3	187.2
Sturgeon Bay 1m off bottom	01-Sep-17	213.3	216.1
Sturgeon Bay 1m	25-Sep-18	20.2	
Sturgeon Bay 1m off bottom	25-Sep-18	29.9	23.3

LPP volunteers have historically sampled several locations in the Sturgeon Bay area (Figure 18). Some of these locations were sampled only once and some have longer term data. These data are summarized on the LPP website. The LPP data collected most recently in Sturgeon Bay are shown in Table 4.

Figure 18. Lake Partner Program sample locations in Sturgeon Bay and Pointe au Baril.

Table 4. Total phosphorus data collected by LPP volunteers in 2018.

STN	Site ID	Lake Name	Site Description	Lat	Long	Date	TP (ug/L)
5209	1	Sturgeon Bay	WSturgeon Bay Prov.Pk	453717	802522	18-Jun-18	18.6
5209	1	Sturgeon Bay	WSturgeon Bay Prov.Pk	453717	802522	17-Jul-18	19.0
5209	1	Sturgeon Bay	WSturgeon Bay Prov.Pk	453717	802522	28-Aug-18	18.5
5209	1	Sturgeon Bay	WSturgeon Bay Prov.Pk	453717	802522	24-Sep-18	15.3
5209	1	Sturgeon Bay	WSturgeon Bay Prov.Pk	453717	802522	24-Oct-18	23.2
5209	1	Sturgeon Bay	WSturgeon Bay Prov.Pk	453717	802522	21-Nov-18	19.0
5209	2	Sturgeon Bay	Kenilworth & Skunk I	453648	802546	18-Jun-18	16.5
5209	2	Sturgeon Bay	Kenilworth & Skunk I	453648	802546	17-Jul-18	15.5
5209	2	Sturgeon Bay	Kenilworth & Skunk I	453648	802546	28-Aug-18	14.8

5209	2	Sturgeon Bay	Kenilworth & Skunk I	453648	802546	24-Sep-18	15.1
5209	2	Sturgeon Bay	Kenilworth & Skunk I	453648	802546	24-Oct-18	17.1
5209	2	Sturgeon Bay	Kenilworth & Skunk I	453648	802546	22-Nov-18	15.5
5209	3	Sturgeon Bay	Pointe au Baril chan	453540	802318	18-Jun-18	15.3
5209	3	Sturgeon Bay	Pointe au Baril chan	453540	802318	17-Jul-18	11.1
5209	3	Sturgeon Bay	Pointe au Baril chan	453540	802318	28-Aug-18	14.3
5209	3	Sturgeon Bay	Pointe au Baril chan	453540	802318	24-Sep-18	15.1
5209	3	Sturgeon Bay	Pointe au Baril chan	453540	802318	24-Oct-18	10.5
5209	3	Sturgeon Bay	Pointe au Baril chan	453540	802318	23-Nov-18	11.1
5209	4	Sturgeon Bay	W of School House Is	453528	802407	18-Jun-18	13.4
5209	4	Sturgeon Bay	W of School House Is	453528	802407	17-Jul-18	10.9
5209	4	Sturgeon Bay	W of School House Is	453528	802407	28-Aug-18	11.8
5209	4	Sturgeon Bay	W of School House Is	453528	802407	24-Sep-18	10.3
5209	4	Sturgeon Bay	W of School House Is	453528	802407	24-Oct-18	10.1
5209	4	Sturgeon Bay	W of School House Is	453528	802407	24-Nov-18	10.9
7064	71	Georgian Bay	Sturgeon Bay, deep spot	444508	794428	21-May-18	12.2
7064	71	Georgian Bay	Sturgeon Bay, deep spot	444508	794428	20-Jun-18	17.0
7064	71	Georgian Bay	Sturgeon Bay, deep spot	444508	794428	15-Jul-18	30.6
7064	71	Georgian Bay	Sturgeon Bay, deep spot	444508	794428	16-Aug-18	24.0
7064	71	Georgian Bay	Sturgeon Bay, deep spot	444508	794428	16-Sep-18	10.9
7064	71	Georgian Bay	Sturgeon Bay, deep spot	444508	794428	15-Oct-18	17.5
7064	71	Georgian Bay	Sturgeon Bay, deep spot	444508	794428	26-Nov-18	30.6

*Data have been 'flagged' in yellow when there are major differences between TP1 and TP2. When there are major differences between TP1 and TP2, it is probable that one of the two samples was contaminated. Contamination can occur when the sample water contains zooplankton or other debris. Use caution when interpreting TP data that has been flagged

Recommendations

Profile and TP data reveal much about the interdependence between oxygen, total phosphorus, and physical limnology in Sturgeon Bay. Although it is recommended to continue to collect these data, the extent to which they are required may be linked to the severity of blooms that occur in the face of declining nutrients in the bay. It would be useful to have some measure of bloom extent in individual years to compare to these oxygen and TP data.

Blackstone Harbour

Blackstone Harbour was identified as an enclosed embayment that thermally stratifies. Although Blackstone Harbour has never been known to have late summer algal blooms, it was selected for enhanced monitoring to investigate areas that stratify to identify potential anoxic conditions in the hypolimnion. An enhanced sampling program was initiated late in the summer of 2016 in time to observe temperature/oxygen profiles and collect TP samples from the mixed layer and 1 m off bottom at the deepest location in Blackstone Harbour (21 m). Samples were taken again in 2017 and 2018. Sample location (Lat 45^{o} 09’ 32”, Long 79^{o} 58’ 56”) is shown in Figure 19.

Figure 19. Sample location in Blackstone Harbour.

Temperature/dissolved oxygen

Blackstone Harbour is relatively deep (21 m) compared to other adjacent embayments (e.g., Woods Bay <10 m) and is well stratified. Late summer anoxia was observed in the bottom 2 m indicating the potential for an internal load. Temperature/DO data collected in 2016, 2017, and 2018 are shown in Table 5.

Table 5. Temperature/dissolved oxygen data for the deepest location in Blackstone Harbour in 2016, 2017, and 2018.

Depth (m)	September 30, 2016		September 13, 2017		September 10, 2018	
	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)
0	17.8	9.6	21.1	9.09	21.6	8.82
1	17.9	9.4	19.8	9.19	21.3	8.82
2	17.9	9.4	19.4	9.18	20.5	8.73
3	17.9	9.3	19	8.88	20.1	8.66
4	17.9	9.2	18.5	8.28	19.9	8.43
5	18	9.2	18.2	7.99	19.7	8.26
6	18	9.2	18	7.74	19.5	8.29
7	18	9.2	17.6	6.97	17.7	3.64
8	18	9.1	16.1	3.77	12	2.85
9	17.7	8	12.4	2.46	10.2	3.92
10	11.1	4.7	10.5	3.94	8.8	5.2
11	9.2	4.4	9.6	4.34	7.9	6.12
12	8.5	4.5	9	4.5	7.4	6.12
13	7.8	4.6	8.5	4.18	7.1	5.88
14	7.2	4.5	8.2	3.84	6.8	5.75
15	6.9	4.1	8	3.37	6.6	5.47
16	6.7	3.6	7.9	2.76	6.4	5.11
17	6.5	2.9	7.6	1.61	6.3	3.9

Depth (m)	September 30, 2016		September 13, 2017		September 10, 2018	
	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)
18	6.4	1.8	7.5	0.85	6.1	2.48
19	6.2	1.2	7.4		6	0.54
20	6.2	0.8	7.3			
21	6.2	0.6				

Temperature/DO data were also collected in Wood's Bay and Coon Gap (North Channel) in 2017 and 2018 and are shown in Table 6.

Table 6. Temperature/dissolved oxygen data for Wood's Bay and Coon Gap in 2017 and 2018.

Depth (m)	Wood's Bay				Coon Gap – North Channel			
	Sept 13, 2018		Sept 10, 2018		Sept 13, 2018		Sept 10, 2018	
	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)
0	20.7	9.12	21.1	8.90	20.5	8.98	21.6	8.31
1	20.6	9.10	20.6	8.91	19.8	8.94	20.9	8.28
2	19.5	9.05	20.4	8.91	19.4	8.75	20.9	8.28
3	19.0	8.93	20.1	8.83	19.2	8.57	20.8	8.27
4	18.8	8.67	19.7	8.63	19.1	8.44	20.6	8.17
5	18.2	7.96	19.7	8.62	19.0	8.32	20.6	8.10
6	18.1	7.78	19.5	8.52	19.0	8.23	20.5	8.05
7	18.0	8.08	19.4	8.44	18.9	8.20	20.4	8.00
8	18.0	8.00	19.4	8.30	18.9	8.13	20.4	8.01
9	17.9	7.89	19.2	8.14	18.9	8.14	20.4	8.01
10	17.9	7.70	19.2	8.05	18.9	8.10	20.4	7.99
11	17.9	7.65	19.2	7.94	18.9	8.07	20.4	7.96
12	17.9	7.60			18.8	8.05	20.4	7.94
13	17.9	7.60			18.8	8.04	20.4	7.94
14					18.8	8.01	20.4	7.94
15					18.8	8.00	20.4	7.90
16					18.8	7.98	20.4	7.89
17					18.8	7.95	20.4	7.83
18					18.8	7.93	20.4	7.80
19					18.8	7.92	20.3	7.80
20					18.8	7.91	20.3	7.79

Total phosphorus

TP was measured at the surface on September 2 and 30, 2016 with similar results on both dates (Table 7). Concentrations ranged from 6.7 µg/L to 8.4 µg/L. More results are needed to establish long-term, mean concentrations but these values represent oligotrophic conditions with excellent water quality as it relates to trophic state. At the end of September there was a slight elevation in TP concentrations at 1 m off bottom (21.5 µg/L) indicating a weak internal load. Similarly, elevated TP concentrations at 1 m off bottom were seen again on September 21, 2017.

Table 7. Total phosphorus concentrations in Blackstone Harbour in 2016, 2017, and 2018. TP1 and TP2 represent duplicate analysis of split samples.

Sample Description	Sample Date	TP1 (µg/L)	TP2 (µg/L)
Blackstone Harbour Top	02-Sep-16	8.8	7.9
Blackstone Harbour Top	30-Sep-16	6.5	6.7
Blackstone Harbour Bottom	30-Sep-16	22.7	20.5
Blackstone Harbour Top	21-Sep-17	7.2	7.0
Blackstone Harbour Bottom	21-Sep-17	22.9	23.8
Blackstone Harbour Top	25-Sep-18	7.5	8.0
Blackstone Harbour Bottom	25-Sep-18	27.6	14.2

Recommendations

Sampling for DO/temperature and TP are no longer required in Blackstone Harbour. Mixed layer TP concentrations indicate excellent water quality. Although there are anoxic conditions and evidence of an internal load, the data do not indicate highly elevated TP concentrations in the hypolimnion at the end of summer.

At present, there is evidence that climate change can enhance the conditions required to support algal blooms. In particular, the blooms may occur in areas where they have not previously been seen and where watershed nutrient loads may not have increased. Participation in the Lake Partner Program should provide enough surveillance to monitor these threats.

Bayfield and Nares Inlets

Bayfield and Nares Inlets are connected to Georgian Bay to the north of Parry Sound and directly west of Pointe au Baril. TP samples were collected from 2014 to 2016 in Bayfield and Nares Inlets as part of a project funded by Environment and Climate Change Canada's Lake Simcoe and South-Eastern Georgian Bay Clean Up Fund. The project goals were to assess the potential for excess TP inputs from anthropogenic sources to these Inlets.

TP samples were collected in Nares Inlet at the south end of the main body of the Inlet and in Bayfield Inlet in the north central area to the east of the inflow from the South Naiscoot River (Figure 20). The Bayfield sample location was moved to the east into deeper water in the third year of the study (2016) to avoid potential effects due to sediment resuspension which may have been contributing to sample variability in 2014-15. Samples were collected approximately twice per month by Bayfield Nares Islanders' Association volunteers to assess seasonal variability in TP concentrations. TP samples were collected at 0-5m composites by lowering a plastic bottle weighted at its base to a depth of 5m. Samples were sent to DESC for analysis.

Both Inlets can be characterized as enclosed embayments with convoluted and complex connections to Georgian Bay. Nares Inlet has relatively few inflows while Bayfield Inlet is likely influenced more by inflows from wetlands considering its higher dissolved organic carbon (DOC) concentration (3.2 mg/L) compared to Nares Inlet (2.4 mg/L). TP concentrations in Bayfield are also higher due to the strong relationship between watershed generated DOC and TP.

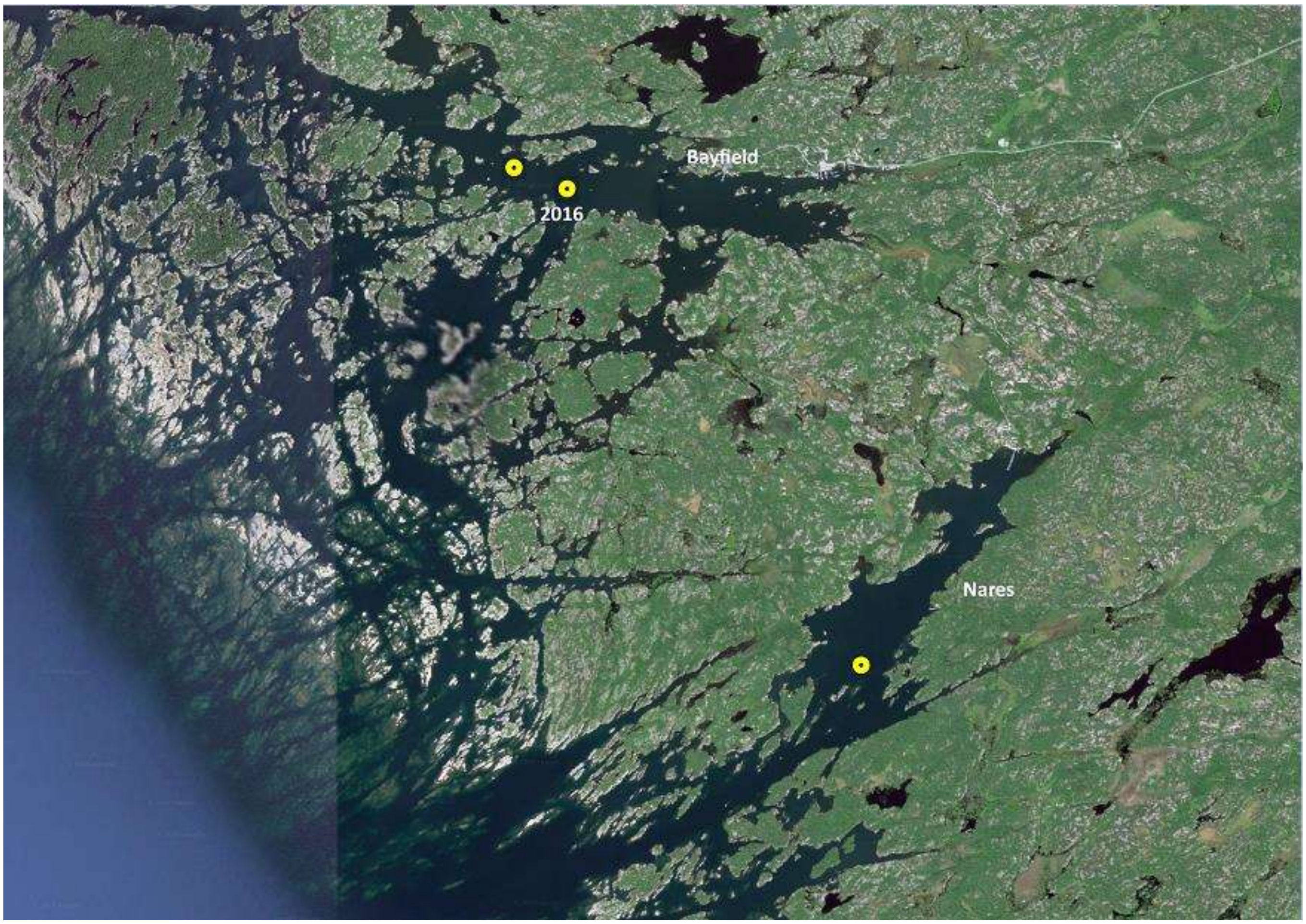


Figure 20. Bayfield Inlet and Nares Inlet sampling locations.

Nares Inlet total phosphorus

Samples for Nares Inlet were collected at the location shown in Figure 20, where the water depth is 7 m. TP concentrations ranged between 4 and 8 µg/L with no distinct seasonal or between-year pattern observed in the three years of the study. Similar annual mean concentrations were found – 2013 = 5.1 µg/L, 2014 = 5.4 µg/L, 2015 = 5.7 µg/L, and 2016 = 6.5 µg/L. Some of this variability (1-2 µg/L) will be due to analytical and sample collection error. It should be noted that in natural inland waters there will be some seasonal variation in the TP concentrations with higher concentrations often in the spring and fall. It is, however, unclear what the normal seasonal variation should be for embayments that are connected to Georgian Bay.

TP concentrations in outer Georgian Bay areas are extremely low, and similar low concentrations have been measured near the entrance to Bayfield Inlet. Any exchange of water with the outer bay will dilute the concentrations of water that has originated from the watershed. However, the differences at these concentrations will be difficult to demonstrate because they fall within the range of analytical and field sample variability (+/- 1-2 µg/L).

These sampling efforts are sufficient to allow the determination of a long-term mean of 5.7 µg/L for Nares Inlet. This indicates very dilute, oligotrophic conditions and generally excellent water quality from a nutrient standpoint.

Bayfield Inlet total phosphorus

Samples were collected in Bayfield Inlet at the two locations shown in Figure 20. Over the three years of this study, observed concentrations in Bayfield Inlet ranged between 5 and 22 µg/L. This range in concentrations is much higher than expected for waters such as these. The sample location was moved to deeper water in 2016 because it was suspected that the seasonal variation measured in 2015 may have been due to sediment resuspension in the relatively shallow sample location (3-4 m). As predicted, the seasonal variability was less in 2016 at the new location (6-12 µg/L).

The range in TP concentrations noted in Bayfield Inlet is several times higher than the range in observed values in the Nares Inlet data. It should be noted that typical seasonal variation is more likely characterized by the 2016 data collected in the deeper location (6-12 µg/L), but it is unclear how much spatial variation exists within the large and complex Inlet. The 2016 data show a decrease in concentrations throughout the open water season with the highest concentrations in the spring. This is a common pattern in many Ontario lakes owing to higher TP concentrations in the melting snowpack followed by lower concentrations resulting from the settling of algae (and the associated TP) to the sediments over the growing season.

Measured concentrations indicate oligotrophic (<10 µg/L) to mesotrophic (10-20 µg/L) conditions at these Bayfield Inlet sample locations. Total phosphorus concentrations of <10 µg/L indicate extremely dilute water which will not usually sustain nuisance algal blooms. There are only a few species of algae (e.g. *Gloeotrichea*, *Aphanothece*) that can bloom at these concentrations and the blooms in these cases are not linked to water column TP concentrations.

Anthropogenic impacts on TP concentrations

Water volumes in these Inlets are large, such that there would need to be considerable anthropogenic, terrestrial, or sediment loads to create measurable increases in the TP concentrations. The higher range in measured concentrations in Bayfield Inlet may be due to watershed influences from inflows from wetlands which are more numerous than those observed for Nares Inlet. This is indicated by the higher dissolved organic carbon (DOC) concentrations in Bayfield Inlet.

A close relationship between measured TP and DOC in eastern Georgian Bay nearshore areas indicate that TP concentrations are the result of natural watershed inputs in almost all areas (TP loads are associated with DOC export from wetlands). It is therefore likely that most TP in these two Inlets originates from natural watershed sources. This, however, does not mean that there are no anthropogenic inputs. It merely means that the human inputs are relatively very small and cannot be demonstrated with these data.

TP concentrations are higher in Bayfield Inlet (6 to 12 µg/L) compared to Nares Inlet (4 to 8 µg/L), this is likely due to higher frequency of wetland inflows to the Inlet. Higher wetland contributions lead to higher measured DOC concentrations. DOC in Bayfield Inlet (3.2 mg/L) is higher than DOC in Nares Inlet (2.4 mg/L). This study shows that there may also be interactions with sediments in the shallower areas of Bayfield Inlet.

Recommendations

Continue with LPP sampling for these two Inlets. There are ongoing sample collection schedules for these Inlets established by the MECP that operate on a 5-year rotation. Continuous annual collection of LPP data would therefore allow the collection of data in the intermediate years between MECP sample visits. Establishment of LPP sample sites at all MECP sites would provide more insight into the spatial variability of TP in these Inlets.

Appendix A – LPP monitoring data for active and historical sampling locations

All Lake Partner Program monitoring data for Township of The Archipelago sampling locations, active and historical, are provided in the tables below, organized by ratepayer association.

Bayfield Nares Islanders' Association

Lake	Georgian Bay
Station	7064
Site ID	11
Description	Nares Inlet, deep spot
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
May 2013	5.30	4.20	5.40	4.80	21.98
July 2013		4.40	5.00	4.70	22.79
Sept 2013		4.80	4.80	4.80	
Oct 2013		6.60	5.40	6.00	
May 2014	3.88	5.80	4.80	5.30	17.90
Aug 2014		4.20	4.40	4.30	
Sept 2014		15.80	6.20	11.00	
Oct 2014		5.20	10.80	8.00	
May 2015	5.30	4.60	5.80	5.20	19.30
June 2015		5.20	4.40	4.80	21.00
July 2015		5.20	5.20	5.20	20.50
Aug 2015		5.20	5.60	5.40	
May 2016	4.75	4.80	7.20	6.00	15.80
Aug 2016		5.20	5.80	5.50	
Sept 2016		6.00	5.40	5.70	
May 2017	5.11	5.60	9.00	7.30	
June 2018		6.00	3.00	4.50	23.00

*Data have been 'flagged' in yellow when there are major differences between TP1 and TP2. When there are major differences between TP1 and TP2, it is probable that one of the two samples was contaminated (usually the higher value). Contamination can occur when the sample water contains zooplankton or other debris. Use caution when interpreting TP data that has been flagged.

Blackstone Lake Cottagers' Association

Lake	Blackstone Lake
Station	461
Site ID	1
Description	Mid lake, deep spot
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2000	6.00				
2001	5.00				
2002	4.67	24.40	19.20	21.80	
2003	4.80	6.40	6.30	6.35	

2004	4.32	7.09	7.81	7.45	
2005	4.44	7.20	9.10	8.15	
2006	3.86	7.35	6.88	7.12	
2009	3.70	7.26	10.26	8.76	3.50
2010	5.33	7.20	5.00	6.10	3.70
2011	5.23	6.20	6.60	6.40	3.73
2012	5.23	5.40	5.60	5.50	3.77
2013	4.75	6.80	6.40	6.60	
2014	3.60	8.40	5.40	6.90	3.98
2015		6.20	5.80	6.00	3.80
2016	5.50	5.00	6.40	5.70	3.79
2017	4.33	12.00	11.60	11.80	3.72
2018	3.50	5.20	5.60	5.40	4.00

Lake	Blackstone Lake
Station	461

Year	Site ID	Description	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Data Collector
2006	2	Driscoll 1	5.0	4.6	4.84	MOE Northern Region
2006	3	Driscoll 2	4.4	4.7	4.54	MOE Northern Region
2006	4	Driscoll 3	4.2	4.9	4.52	MOE Northern Region
2006	5	Driscoll 4	3.3	6.5	4.91	MOE Northern Region
2016	6	BL02	5.2	5.4	5.30	MOE Northern Region
2016	7	BL03	5.2	5.4	5.30	MOE Northern Region
2016	8	BL04	5.2	4.8	5.00	MOE Northern Region
2016	9	BL01	5.8	5.8	5.80	MOE Northern Region

Cranberry Lake

Lake	Georgian Bay
Station	1013
Site ID	1
Description	Mid lake, deep spot
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2017		11.80	12.40	12.10	2.98

Crane Lake Association

Lake	Crane Lake
Station	1014
Site ID	1
Description	Mid-bay, deep spot
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2004	4.67				
2007		3.21	4.02	3.61	

2008		3.40	3.47	3.44	3.80
2009					
2010	4.98	3.60	3.80	3.70	3.12
2011	4.76	6.00	5.60	5.80	3.69
2012	5.54	5.20	4.80	5.00	3.59
2013	4.84	5.60	5.80	5.70	3.46
2014	4.60	5.40	5.00	5.20	3.84
2015	4.84	5.20	5.20	5.20	3.70
2016	4.80	4.60	4.40	4.50	3.48
2017		5.20	5.60	5.40	3.52
2018		5.00	5.40	5.20	

Lake	Crane Lake
Station	1014
Site ID	2
Description	N end, off Marsh Is.
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2002	4.78	6.90	6.00	6.45	
2003	4.57	4.50	5.90	5.20	
2004		3.95	4.50	4.23	
2005		3.06	3.60	3.33	
2006					
2007		3.31	3.38	3.35	
2008		4.00	4.25	4.13	3.34
2009					
2010	4.68	4.20	4.00	4.10	3.53
2011	4.40	4.80	4.80	4.80	3.28
2012	4.89	4.40	5.20	4.80	3.30
2013	4.70	5.00	5.40	5.20	3.19
2014	4.37	5.00	5.00	5.00	3.48
2015	4.56	5.80	6.20	6.00	3.60
2016	4.58	5.40	4.00	4.70	3.04
2017		4.80	4.60	4.70	3.32
2018		4.60	4.60	4.60	

Lake	Crane Lake
Station	1014

Year	Site ID	Description	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Data Collector
2006	3	Driscoll-1	2.80	3.14	2.97	MOE Northern Region
2006	4	Driscoll-2	3.02	2.81	2.92	MOE Northern Region
2006	5	Driscoll-3	6.09		6.09	MOE Northern Region
2006	6	Driscoll-4	2.82	3.94	3.38	MOE Northern Region
2016	7	CR01	3.80	3.80	3.80	MOE Northern Region
2016	8	CR02	4.20	4.40	4.30	MOE Northern Region
2016	9	CR03	4.40	4.40	4.40	MOE Northern Region
2016	10	CR04	4.60	4.60	4.60	MOE Northern Region

Healey Lake Property Owners' Association

Lake	Healey Lake
Station	1924
Site ID	13
Description	Pinebay, Deep spot
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2016	2.67	6.6	6.6	6.60	
2017	2.86	8.20	7.60	7.90	1.90
2018		7.60	13.20	10.40	1.90

*Data have been 'flagged' in yellow when there are major differences between TP1 and TP2. When there are major differences between TP1 and TP2, it is probable that one of the two samples was contaminated (usually the higher value). Contamination can occur when the sample water contains zooplankton or other debris. Use caution when interpreting TP data that has been flagged.

Lake	Healey Lake
Station	1924

Year	Site ID	Description	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Data Collector
2006	4	Driscoll-1		5.85	6.55	6.20	MOE Northern Region
2006	5	Driscoll-2		6.54	7.29	6.92	MOE Northern Region
2006	6	Driscoll-3		10.25	9.50	9.88	MOE Northern Region
2006	7	Driscoll-4		5.62	4.86	5.24	MOE Northern Region
2016	8	HE01		5.2	5.0	5.10	MOE Northern Region
2016	9	HE02		5.2	5.2	5.20	MOE Northern Region
2016	10	HE03		4.8	4.6	4.70	MOE Northern Region
2016	11	HE04		5.6	5.6	5.60	MOE Northern Region
2016	12	HE05		5.4	5.2	5.30	MOE Northern Region

Iron City Fishing Club

Lake	Georgian Bay
Station	7064
Site ID	79
Description	Iron City Bay, deep spot
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2016		10.20	10.40	10.30	

Kapikog Lake Cottagers' Association

Lake	Kapikog Lake
Station	2230
Site ID	1
Description	Stn 1, W end
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
1991	3.45				
1992	4.29				
1993	3.94				
1994	4.31				
1995	4.08				
1996	3.96				

Lake	Kapikog Lake
Station	2230
Site ID	2
Description	Stn 2, mid-lake
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
1991	3.50				
1992	3.96				
1993	3.84				
1994	4.36				
1995	3.88				
1996	4.53				
1997	4.38				
1998	4.38				
1999	4.51				
2000	4.36				
2001	4.25				
2002	4.44	6.61	7.44	7.03	
2003	4.50	4.53	4.86	4.70	
2004	4.00	11.01	7.24	9.13	
2005		5.21	5.48	5.35	
2018	4.70	6.00	6.00	6.00	

Lake	Kapikog Lake
Station	2230
Site ID	3
Description	Stn 3, E end
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
1991	3.44				
1992	3.71				

1993	3.47				
1994	4.04				
1995	3.64				
1996	4.24				

Lake	Kapikog Lake
Station	2230

Year	Site ID	Description	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Data Collector
2006	4	Driscoll-1	4.56	5.53	5.04	MOE Northern Region
2006	5	Driscoll-2	3.94	4.23	4.08	MOE Northern Region
2006	6	Driscoll-3	4.41	4.38	4.39	MOE Northern Region
2006	7	Driscoll-4	4.71	5.18	4.95	MOE Northern Region

Pointe au Baril Islanders' Association

Lake	Sturgeon Bay
Station	5209
Site ID	1
Description	WSturgeonBay Prov.Pk
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
May 2003		23.45	21.65	22.50	
May 2004		19.24	22.59	20.91	
June 2004		25.15	24.74	24.95	
July 2004		22.46	21.03	21.75	
Aug 2004		20.87	19.95	20.41	
Sept 2004		18.46	18.67	18.57	
Oct 2004		20.17	20.92	20.55	
May 2005	2.04	20.00	19.70	19.85	
June 2005		18.80	19.40	19.10	
Aug 2005		17.40	18.50	17.95	
Aug 2005		20.40	23.50	21.95	
Oct 2005		22.40	21.40	21.90	
May 2006		17.10	16.78	16.94	
June 2006		18.77	19.90	19.34	
July 2006		15.31	14.32	14.82	
Aug 2006		15.28	15.02	15.15	
Sept 2006		17.01	16.20	16.61	
Oct 2006		19.60	19.79	19.70	
June 2007	1.48	17.87	17.25	17.56	
July 2007		19.75	19.42	19.59	
July 2007		14.13	14.84	14.48	
Aug 2007		13.71	13.76	13.73	
Oct 2007		20.85	22.87	21.86	
May 2008	1.18	15.86	16.89	16.38	6.26
June 2008		23.19	25.61	24.40	
Aug 2008		21.44	21.79	21.62	

Sept 2008		20.71	20.38	20.55	5.76
Nov 2008		18.93	21.01	19.97	
June 2009	1.18	20.25	19.74	19.99	4.72
July 2009		19.64	20.28	19.96	
Aug 2009		19.47	19.31	19.39	
Sept 2009		16.95	18.99	17.97	
June 2010	1.67	17.80	17.20	17.50	7.11
July 2010		13.40	13.00	13.20	7.65
July 2010		13.60	14.00	13.80	
Aug 2010		13.80	13.60	13.70	
Sept 2010		22.00	21.80	21.90	
Oct 2010		19.00	17.00	18.00	
May 2011	1.33	18.60	18.20	18.40	6.55
July 2011		16.40	16.00	16.20	8.90
Aug 2011		16.00	15.00	15.50	10.92
Sept 2011		19.80	18.40	19.10	10.06
Oct 2011		17.40	15.80	16.60	10.66
May 2012	1.18	17.60	17.00	17.30	7.96
June 2012		63.60	52.80	58.20	8.75
July 2012		22.20	22.40	22.30	9.89
Aug 2012		19.20	18.40	18.80	
Sept 2012		23.40	22.00	22.70	
Oct 2012		25.20	27.20	26.20	
May 2013	1.16	15.80	16.60	16.20	6.09
June 2013		19.80	31.00	25.40	6.75
July 2013		18.80	17.60	18.20	8.04
Aug 2013		20.40	23.60	22.00	
Sept 2013		19.40	19.60	19.50	
Oct 2013		19.20	18.80	19.00	
May 2014	1.27	15.60	15.20	15.40	5.34
June 2014		18.40	18.40	18.40	6.98
July 2014		11.60	11.40	11.50	7.14
Aug 2014		12.60	13.60	13.10	
Sept 2014		12.80	13.20	13.00	
Oct 2014		15.40	15.40	15.40	
May 2015	1.59	17.20	16.60	16.90	5.80
Aug 2015		13.80	14.00	13.90	
Sept 2015		10.20	10.40	10.30	
Sept 2015		11.20	11.20	11.20	
Oct 2015		10.80	11.80	11.30	
May 2016	1.64	13.00	13.60	13.30	6.44
June 2016		11.80	12.60	12.20	7.72
Aug 2016		12.40	11.00	11.70	
Aug 2016		12.80	13.20	13.00	
Sept 2016		17.00	16.80	16.90	
Oct 2016		15.60	16.80	16.20	
May 2017	1.12	19.20	17.80	18.50	5.94
June 2017		16.60	18.40	17.50	6.34
July 2017		15.60	16.00	15.80	7.22

Aug 2017		17.60	17.20	17.40	
Oct 2017		20.80	22.20	21.50	
June 2018	1.60	18.20	19.00	18.60	6.70
July 2018		18.20	19.80	19.00	7.00
Aug 2018		18.60	18.40	18.50	
Sept 2018		15.00	15.60	15.30	
Oct 2018		31.20	15.20	23.20	
Nov 2018		18.20	19.80	19.00	

*Data have been 'flagged' in yellow when there are major differences between TP1 and TP2. When there are major differences between TP1 and TP2, it is probable that one of the two samples was contaminated (usually the higher value). Contamination can occur when the sample water contains zooplankton or other debris. Use caution when interpreting TP data that has been flagged.

Lake	Sturgeon Bay
Station	5209
Site ID	2
Description	Kenilworth & Skunk I
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
May 2003		22.57	26.72	24.65	
May 2004		17.00	18.63	17.82	
June 2004		20.25	22.56	21.41	
July 2004		19.01	17.82	18.42	
Aug 2004		22.22	22.89	22.56	
Sept 2004		17.36	18.19	17.78	
Oct 2004		28.33	26.99	27.66	
May 2005	2.34	15.00	15.10	15.05	
June 2005		16.50	16.40	16.45	
Aug 2005		19.60	21.30	20.45	
Aug 2005		26.00	23.30	24.65	
Oct 2005		21.90		21.90	
May 2006		16.14	17.26	16.70	
June 2006		14.82	13.64	14.23	
July 2006		13.44	12.16	12.80	
Aug 2006		13.64	14.29	13.97	
Sept 2006		15.32	15.90	15.61	
Oct 2006		19.32	19.16	19.24	
June 2007	1.58	15.51	18.52	17.02	
July 2007		15.97	15.78	15.88	
July 2007		15.75	15.97	15.86	
Aug 2007		18.84	17.32	18.08	
Oct 2007		23.23	24.63	23.93	
May 2008	1.22	17.89	19.00	18.45	6.34
June 2008		17.92	13.77	15.85	
Aug 2008		22.43	23.93	23.18	
Sept 2008		19.78	20.40	20.09	6.22
Nov 2008		14.80	15.82	15.31	
June 2009	1.48	15.95	15.33	15.64	4.96

July 2009		16.33	15.68	16.01	
Aug 2009		17.18	16.62	16.90	
Sept 2009		19.92	17.47	18.70	
May 2010	1.87	10.40	10.60	10.50	6.89
July 2010		12.00	11.40	11.70	7.67
July 2010		12.40	12.80	12.60	
Aug 2010		14.20	13.20	13.70	
Sept 2010		17.40	16.00	16.70	
Oct 2010		16.60	16.80	16.70	
May 2011	1.45	17.00	18.20	17.60	6.67
July 2011		15.40	15.60	15.50	8.97
Aug 2011		15.80	16.00	15.90	11.09
Sept 2011		22.40	20.40	21.40	10.29
Oct 2011		18.00	17.80	17.90	10.48
May 2012	1.24	15.40	16.20	15.80	8.07
June 2012		18.00	21.20	19.60	8.90
July 2012		15.60	14.80	15.20	10.04
Aug 2012		23.00	24.80	23.90	
Sept 2012		20.20	18.80	19.50	
Oct 2012		25.40	26.20	25.80	
May 2013	1.24	18.00	16.20	17.10	6.09
June 2013		15.60	15.20	15.40	6.91
July 2013		14.80	14.20	14.50	8.14
Aug 2013		21.60	22.20	21.90	
Sept 2013		18.80	19.00	18.90	
Oct 2013		17.20	20.00	18.60	
May 2014	1.52	16.40	17.40	16.90	6.32
June 2014		15.60	15.00	15.30	6.90
July 2014		11.20	11.80	11.50	7.12
Aug 2014		13.80	12.40	13.10	
Sept 2014		13.20	14.00	13.60	
Oct 2014		14.80	14.40	14.60	
May 2015	1.69	12.40	12.60	12.50	5.88
Aug 2015		13.40	13.60	13.50	
Sept 2015		9.80	9.60	9.70	
Sept 2015		9.60	9.40	9.50	
Oct 2015		12.40	12.20	12.30	
May 2016	1.89	10.60	10.40	10.50	
June 2016		10.80	11.20	11.00	7.60
Aug 2016		10.80	10.40	10.60	
Aug 2016		10.40	10.00	10.20	
Sept 2016		13.40	12.60	13.00	
Oct 2016		15.00	15.20	15.10	
May 2017	1.36	11.60	11.60	11.60	5.92
June 2017		13.60	12.60	13.10	6.56
July 2017		13.40	14.20	13.80	7.40
Aug 2017		14.00	14.40	14.20	
Oct 2017		23.40	23.80	23.60	
June 2018	1.60	16.20	16.80	16.50	6.90

July 2018		13.80	17.20	15.50	8.30
Aug 2018		14.80	14.80	14.80	
Sept 2018		12.40	17.80	15.10	
Oct 2018		17.20	17.00	17.10	
Nov 2018		13.80	17.20	15.50	

*Data have been 'flagged' in yellow when there are major differences between TP1 and TP2. When there are major differences between TP1 and TP2, it is probable that one of the two samples was contaminated (usually the higher value). Contamination can occur when the sample water contains zooplankton or other debris. Use caution when interpreting TP data that has been flagged.

Lake	Sturgeon Bay
Station	5209
Site ID	3
Description	Pointe au Baril chan
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2003		24.40	18.86	21.63	
May 2004		17.61	20.19	18.90	
June 2004		18.02	22.80	20.41	
July 2004		13.74	13.41	13.58	
Aug 2004		13.53	13.16	13.35	
Sept 2004		16.22	18.66	17.44	
Oct 2004		12.91	13.39	13.15	
May 2005	2.5	12.90	13.30	13.10	
June 2005		19.20	15.80	17.50	
Aug 2005		12.30	13.50	12.90	
Aug 2005		13.70	19.20	16.45	
Oct 2005		14.00	14.30	14.15	
May 2006		13.88	15.04	14.46	
June 2006		8.38	8.01	8.20	
July 2006		7.59	9.02	8.31	
Aug 2006		13.30	13.91	13.61	
Sept 2006		12.56	12.82	12.69	
Oct 2006		17.06	18.07	17.57	
June 2007	1.74	16.92	16.66	16.79	
July 2007		16.34	17.38	16.86	
July 2007		12.14	10.86	11.50	
Aug 2007		10.82	9.70	10.26	
Oct 2007		12.58	12.53	12.56	
May 2008	1.35	18.84	21.41	20.13	3.40
June 2008		18.89	19.78	19.34	
Aug 2008		17.14	19.24	18.19	
Sept 2008		13.35	12.85	13.10	6.64
Nov 2008		13.00	14.21	13.61	
June 2009	1.35	14.50	13.84	14.17	6.32
July 2009		15.18	13.78	14.48	
Aug 2009		16.06	15.49	15.78	
Sept 2009		14.98	14.62	14.80	

June 2010	1.98	9.00	8.80	8.90	10.81
July 2010		8.00	7.80	7.90	13.47
July 2010		10.60	11.40	11.00	
Aug 2010		12.00	12.20	12.10	
Sept 2010		11.40	10.60	11.00	
Oct 2010		12.20	13.20	12.70	
May 2011	1.88	14.60	14.60	14.60	7.80
July 2011		14.40	11.80	13.10	13.80
Aug 2011		13.60	11.20	12.40	14.87
Sept 2011		13.40	14.40	13.90	14.86
Oct 2011		10.20	9.00	9.60	14.78
May 2012	1.67	14.20	13.80	14.00	9.15
June 2012		12.60	13.80	13.20	11.67
July 2012		14.60	14.00	14.30	14.40
Aug 2012		11.80	12.20	12.00	
Sept 2012		15.00	15.20	15.10	
Oct 2012		17.80	18.40	18.10	
May 2013	1.87	16.00	16.20	16.10	4.82
June 2013		10.80	11.20	11.00	12.36
July 2013		9.60	10.00	9.80	15.80
Aug 2013		12.20	11.80	12.00	
Sept 2013		13.40	12.80	13.10	
Oct 2013		15.40	15.80	15.60	
May 2014	1.57	15.60	15.40	15.50	2.60
June 2014		13.40	13.60	13.50	10.10
July 2014		11.40	11.00	11.20	10.20
Aug 2014		11.40	11.20	11.30	
Sept 2014		12.60	12.60	12.60	
Oct 2014		15.80	16.80	16.30	
May 2015	1.81	16.20	16.20	16.20	6.40
Aug 2015		11.00	11.00	11.00	
Sept 2015		9.80	10.40	10.10	
Sept 2015		8.40	8.40	8.40	
Oct 2015		10.00	9.40	9.70	
May 2016	1.89	12.80	13.40	13.10	6.26
June 2016		9.00	9.40	9.20	10.70
Aug 2016		7.40	7.60	7.50	
Aug 2016		13.20	13.00	13.10	
Sept 2016		12.40	12.20	12.30	
Oct 2016		11.40	11.40	11.40	
May 2017	1.50	14.60	14.80	14.70	6.16
June 2017		11.20	11.40	11.30	9.86
July 2017		11.80	11.20	11.50	11.70
July 2017		10.20	10.20	10.20	10.80
Aug 2017		17.20	16.60	16.90	
Oct 2017		16.00	16.00	16.00	
June 2018	1.90	16.20	14.40	15.30	10.50
July 2018		10.80	11.40	11.10	15.10
Aug 2018		14.80	13.80	14.30	

Sept 2018		18.40	11.80	15.10	
Oct 2018		10.60	10.40	10.50	
Nov 2018		10.80	11.40	11.10	

*Data have been 'flagged' in yellow when there are major differences between TP1 and TP2. When there are major differences between TP1 and TP2, it is probable that one of the two samples was contaminated (usually the higher value). Contamination can occur when the sample water contains zooplankton or other debris. Use caution when interpreting TP data that has been flagged.

Lake	Sturgeon Bay
Station	5209
Site ID	4
Description	W of School House Is
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
May 2003		21.33	17.90	19.62	
May 2004		20.48	18.17	19.33	
June 2004		16.33	15.13	15.73	
July 2004		10.75	9.24	10.00	
Aug 2004		15.30	16.95	16.13	
Sept 2004		13.96	13.89	13.93	
Oct 2004		21.26	19.12	20.19	
May 2005	2.22	13.00	12.90	12.95	
June 2005		17.10	25.50	21.30	
Aug 2005		14.10	12.90	13.50	
Aug 2005		16.40	15.60	16.00	
Oct 2005		13.40	14.70	14.05	
May 2006		13.32	14.02	13.67	
June 2006		7.80	8.73	8.27	
July 2006		10.88	13.03	11.96	
Aug 2006		12.51	14.46	13.49	
Sept 2006		12.13	10.69	11.41	
Oct 2006		13.86	14.46	14.16	
June 2007	1.9	14.46	14.52	14.49	
July 2007		11.89	11.87	11.88	
July 2007		10.52	10.00	10.26	
Aug 2007		9.69	9.10	9.40	
Oct 2007		11.90	12.61	12.26	
May 2008	1.57	17.09	16.17	16.63	5.12
June 2008		16.39	14.45	15.42	
Aug 2008		14.61	16.08	15.35	
Sept 2008					32.80
Sept 2008		13.38	12.92	13.15	
Nov 2008		11.17	10.79	10.98	
June 2009	1.73	13.05	13.20	13.13	6.94
July 2009		11.62	11.54	11.58	
Aug 2009		16.31	15.71	16.01	
Sept 2009		12.58	11.47	12.03	
June 2010	2.13	9.20	9.00	9.10	10.47

July 2010		8.00	7.80	7.90	12.39
July 2010		9.60	9.00	9.30	
Aug 2010		10.60	8.60	9.60	
Sept 2010		12.00	12.20	12.10	
Oct 2010		12.80	12.60	12.70	
May 2011	2.21	14.20	15.00	14.60	9.07
July 2011		10.00	10.00	10.00	13.98
Aug 2011		10.00	10.60	10.30	17.86
Sept 2011		12.40	17.00	14.70	15.15
Oct 2011		9.40	8.60	9.00	15.56
May 2012	1.76	14.60	14.00	14.30	9.90
June 2012		10.40	10.20	10.30	12.07
July 2012		11.60	12.00	11.80	15.02
Aug 2012		14.20	15.20	14.70	
Sept 2012		14.20	14.20	14.20	
Oct 2012		16.40	17.20	16.80	
May 2013	2.02	14.80	16.20	15.50	5.49
June 2013		10.60	10.20	10.40	12.91
July 2013		9.60	9.40	9.50	16.66
Aug 2013		10.60	10.80	10.70	
Sept 2013		12.20	11.00	11.60	
Oct 2013		12.20	11.00	11.60	
May 2014	1.90	15.20	14.80	15.00	3.84
June 2014		10.20	10.00	10.10	9.44
July 2014		9.60	10.20	9.90	11.90
Aug 2014		10.20	10.00	10.10	
Sept 2014		10.60	11.00	10.80	
Oct 2014		14.20	14.60	14.40	
May 2015	2.05	13.20	14.00	13.60	7.82
Aug 2015		10.20	10.20	10.20	
Sept 2015		8.40	8.40	8.40	
Sept 2015		9.00	9.00	9.00	
Oct 2015		9.00	8.60	8.80	
May 2016	2.25	11.20	10.40	10.80	6.74
June 2016		9.00	8.20	8.60	11.20
Aug 2016		7.60	7.80	7.70	
Aug 2016		9.00	9.40	9.20	
Sept 2016		10.80	9.60	10.20	
Oct 2016		10.20	10.60	10.40	
May 2017	1.82	12.20	12.20	12.20	7.46
June 2017		10.00	10.00	10.00	10.60
Aug 2017		11.20	10.80	11.00	
Oct 2017		15.20	14.40	14.80	
June 2018	2.10	13.60	13.20	13.40	12.30
July 2018		10.60	11.20	10.90	13.20
Aug 2018		11.60	12.00	11.80	
Sept 2018		10.40	10.20	10.30	
Oct 2018		9.80	10.40	10.10	
Nov 2018		10.60	11.20	10.90	

Lake	Sturgeon Bay
Station	5209
Site ID	5
Description	N basin W-Sein/Driscoll 1
Data Collector	MOE Northern Region

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2005	2.20	14.44	13.82	14.13	
2006		11.96	12.61	12.29	

Lake	Sturgeon Bay
Station	5209
Site ID	6
Description	N basin E-Sein/Driscoll 2
Data Collector	MOE Northern Region

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2005	2.30	13.94	14.54	14.24	
2006		13.21	14.44	13.82	

Lake	Sturgeon Bay
Station	5209
Site ID	7
Description	N basin Mid-Sein/Driscoll 3
Data Collector	MOE Northern Region

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2005	2.40	16.22	14.79	15.50	
2006		13.22	13.24	13.23	

Lake	Sturgeon Bay
Station	5209
Site ID	8
Description	Mid bay narrows-Sein/Dris4
Data Collector	MOE Northern Region

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2005	2.20	15.32	15.78	15.55	
2006		13.30	15.93	14.62	

Lake	Sturgeon Bay
Station	5209
Site ID	9
Description	S basin E -Sein/Driscoll 5
Data Collector	MOE Northern Region

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2005	2.10	14.95	14.43	14.69	
2006		13.33	13.99	13.66	

Lake	Sturgeon Bay
Station	5209
Site ID	10
Description	S basin W -Sein/Driscoll 6
Data Collector	MOE Northern Region

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2005	1.60	14.67	13.96	14.32	
2006		11.86	11.80	11.83	

Lake	Georgian Bay
Station	7064

Year	Site ID	Description	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Data Collector
2015	74	Sturgeon Bay SB1	12.40	13.40	12.90	MOE Northern Region
2015	75	Sturgeon Bay SB2	14.20	13.60	13.90	MOE Northern Region
2015	76	Sturgeon Bay SB3	13.20	13.40	13.30	MOE Northern Region

Skerryvore Ratepayers' Association

Lake	Lake Huron
Station	6980

Year	Site ID	Description	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Data Collector
2006	10	Sein-Rathlyn Is	4.69	3.81	4.25	MOE Northern Region
2006	11	Sein-Rathlyn Is	3.76	3.95	3.86	MOE Northern Region
2006	12	Sein-Rathlyn Is	2.77	3.64	3.21	MOE Northern Region
2006	13	Sein-Rathlyn Is	3.44	3.32	3.38	MOE Northern Region

South Channel Association

Lake	Georgian Bay
Station	7064
Site ID	2
Description	South Chan-Nutter Bay
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2002	6.00	6.40	5.40	5.90	
2003	5.20				
2004		6.35	5.92	6.13	
2005		7.66	4.53	6.10	
2006	8.50	6.99	4.60	5.79	

Lake	Georgian Bay
Station	7064
Site ID	16
Description	Rose Pt.-Glen Burnie Mar
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2004		10.61	11.13	10.87	

Lake	Georgian Bay
Station	7064
Site ID	89
Description	Channel N of Isabella Island
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2017		6.80	7.20	7.00	
2017		8.40	9.20	8.80	
2018	3.90	7.40	7.80	7.60	5.20

Three Legged Lake Association

Lake	Three Legged Lake
Station	5360
Site ID	1
Description	Mid lake, deep spot
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2001	5.80				
2002		7.11	4.28	5.70	
2003	5.00	4.67	5.56	5.12	
2004	5.20	3.50	3.20	3.35	
2005	7.00	9.28	8.46	8.87	
2005		3.11	3.22	3.17	
2006	6.20				
2012	6.85	2.70	2.60	2.65	1.65
2013	6.20	3.20	3.40	3.30	
2014		4.00	4.00	4.00	1.58
2016	7.10				
2017	5.44				
2018	6.30	3.60	3.60	3.60	1.50

Lake	Three Legged Lake
Station	5360
Site ID	2
Description	Mid lake, deep spot
Data Collector	Seguin Township

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2013		5.20	3.80	4.50	
2015		3.20	3.00	3.10	
2017	3.80	4.20	4.60	4.40	1.46

Woods Bay Community Association

Lake	Georgian Bay
Station	7064
Site ID	77
Description	Woods Bay, deep spot
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2016	4.13	15.40	14.20	14.80	2.96
2017		9.60	8.80	9.20	
2018		6.80	7.00	6.90	3.60

Lake	Georgian Bay
Station	7064
Site ID	96
Description	Blackstone Harbour
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2018		7.00	7.20	7.10	3.26

Lake	Georgian Bay
Station	7064
Site ID	97
Description	North Channel
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2018		6.20	6.40	6.30	3.58

Other

Lake	Conger Lake (pine)
Station	963
Site ID	1
Description	Mid lake, deep spot
Data Collector	LPP volunteer

Year	Secchi Depth (m)	TP1 (µg/L)	TP2 (µg/L)	Average TP (µg/L)	Calcium (mg/L)
2002		7.63	7.28	7.46	
2003	4.25	5.70	5.70	5.70	
2004	4.30	7.17	5.69	6.43	

Appendix B – Temperature/dissolved oxygen results for Sturgeon Bay

SB1	2016-07-28		2016-08-05		2016-08-23		2017-08-07	
Depth	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)
0	25.6	8.22	25.3	8.2	23.4	7.6	23.7	8.71
1	25.4	8.22	25.3	8.2	23.4	7.6	23.2	8.76
2	25.1	8.17	25.3	8.17	23.4	7.5	22.9	8.72
3	24.9	8.15	24.9	7.78	23.4	7.5	22.2	8.52
4	24.8	8.04	24.4	7.2	23.3	7.6	21.6	7.55
5	24.6	7.93	24.2	6.7	23/1	6.82	20.8	7
6	24.4	7.81	23.5	5	23.1	6.55	20.4	6.58
7	23.3	5.41	22.5	2.18	22.8	4.82	19.6	5.4
8	17.7	0.2	19.3	0.15	21.6	0.58	18.6	3.38
9			16	0.5	20.7	0.2	14.9	0.5

SB2	2016-07-28		2016-08-23		2016-09-28		2017-08-07	
Depth	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)
0	25.6	8.22	23.6	7.83	18.1	9.5	23	8.66
1	25.4	8.22	23.4	7.79	18.1	9.4	23	8.67
2	25.3	8.21	23.4	7.76	18.1	9.4	22.6	8.68
3	24.9	8.17	23.4	7.73	18.1	9.3	22.4	8.26
4	24.7	8.01	23.4	7.71	18.1	9.3	21.7	7.4
5	24.3	7.52	23.4	7.69	18.1	9.2	21	7.02
6	23.2	5.37	23.3	7.69	18.1	9.2	20.6	6.92
7	22.3	3.9	23.3	7.67	18.1	9.2	20	5.78
8	20.9	1.6	23.3	7.65	18.1	9.2	19.3	4.53
9	15.6	0.16	23.2	7.61	18.1	9.2	17.1	2.64
10	13.5	0.11	17.4	0.24	18	9.2	12.7	1.17
11	12.4	0.07	13.5	0.13	18	9.1	11.6	0.66
12			13.6	0.12	17.3	4.3	11.5	0.18
13					15.5	0.8		
14					13.1	0.4		

SB4	2016-08-13		2017-08-07		2017-08-26	
Depth	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)
0	24	8.08	23	8.64	21.7	8.87
1	23.9	8.07	23	8.63	21.6	8.78
2	23.8	8.07	22.9	8.59	21.2	8.45
3	23.8	8.05	22.6	8.34	21.1	7.96
4	23.7	8.04	22.5	8.09	21	7.47
5	23.7	8.02	21.8	6.92	20.9	7.47
6	23.5	7.75	20.6	6.5	20.9	7.23
7	23.4	7.55	19.9	5.73	20.8	7.09
8	23.3	7.05	19.3	4.9	20.8	7.02
9	22.4	4.22	18	3.35	20.6	6.49
10	15.5	0.25	14.2	1.8	17.9	0.46
11	13.5	0.17	12.2	1.15	14	0.26
12	12.5	0.12	11.5	0.63	12.2	0.17
13	12	0.11	11.2	0.28	11.8	0.14
14					11.3	0.12

SB9	2016-08-23		2017-08-26	
Depth	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)
0	24	8.37	21.1	8.55
1	24	8.36	21.2	8.47
2	24	8.35	21.1	8.39
3	24	8.33	21.1	7.99
4	23.9	8.32	21	7.68
5	23.9	8.29	20.9	7.54
6	23.9	8.24	20.7	6.65
7	23.9	8.22	20.5	6.41
8	23.8	8.15	20	6.42
9	23.7	7.86	19.8	5.29
10	17.3	0.22	19.2	1.54
11	16.2	0.17	18.1	0.25
12	16.2	0.14	17.9	0.18

SB1 (45° 36'.774 N, 080° 26'.517 W)

SB1	2018-06-26		2018-07-02		2018-07-27		2018-08-10		2018-08-31	
Depth	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)
0	22.3	8.54	23.7	8.84	24	7.58	24.3	7.68	22.3	8.12
1	21.7	8.59	23.8	8.86	24.1	7.54	24.3	7.62	22.4	8.09
2	21.3	8.51	22.9	8.49	24.2	7.5	24.2	7.51	22.4	8.01
3	20.9	8.03	21.6	6.48	24.1	7.43	24.2	7.43	22.4	7.98
4	20.8	7.78	20.8	6.06	23.9	7.12	24.2	7.41	22.4	7.93
5	20.5	7.01	20	5.02	23.5	4.37	24.1	7.1	22.4	7.89
6	19.8	5.64	19.3	4.33	21.6	2.03	24	6.53	22.3	7.85
7	16.7	2.91	18.5	3.02	20.8	0.58	21.1	0.5	22.3	7.84
8	14.5	3.37	15.2	1.21			16.2	0.29	20.6	2.1
9	12.5	1.19	12.4	0.4			14	0.22	15.4	0.6
10	10.7	0.63					12.6	0.18	12.8	0.41
11	9.9	0.4								

SB2 (45° 36'.921 N, 080° 26'.138 W)

SB1	2018-07-02		2018-07-27		2018-08-10		2018-08-31	
Depth	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)
0	24.3	8.46	24.5	7.53	24.5	7.95	22.1	7.94
1	24.3	8.45	24.4	7.55	24.5	7.8	22.2	7.89
2	24.3	8.43	24.3	7.54	24.3	7.62	22.2	7.86
3	23.6	8.07	24.3	7.54	24.3	7.56	22.2	7.82
4	21.5	6.9	24.2	7.54	24.3	7.53	22.2	7.76
5	20.6	5.74	24.2	7.52	24.2	7.5	22.2	7.72
6	20.1	5.29	22	3.41	23.7	3.84	22.2	7.64
7	18.6	3.49	20.3	0.45	21.2	0.47	22.2	7.59
8	16.5	1.99			18.4	0.32	22.2	7.49
9	15.5	2.48			16.5	0.25	22.1	7.21
10	14.4	1.9			12.5	0.2	14.4	0.55
11	11.8	1.9			11.3	0.17	12.2	0.35
12	11.2	1.74			11	0.14	11.5	0.3

SB4 (45° 36'.675 N, 080° 25'.584 W)

SB1	2018-06-26		2018-07-02		2018-07-27		2018-08-10		2018-08-31	
Depth	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)
0	22.4	8.62	23.6	8.35	24.3	7.79	24.8	8.15	22	8.03
1	22	8.71	23.6	8.33	24.2	7.78	24.7	8.14	22.1	7.97
2	21.9	8.71	23.7	8.35	24.2	7.77	24.6	8.05	22.1	7.93
3	21.7	8.72	23.7	8.32	24.2	7.73	24.6	7.89	22.1	7.86
4	21.5	8.67	23.7	8.33	24.2	7.69	24.5	7.84	22.1	7.82
5	19.5		23.6	8.34	24.2	7.68	24.4	7.66	22.2	7.79
6	18.2	4.28	22.9	8.48	24.2	7.65	23.3	3.4	22.1	7.73
7	17.7	3.98	22.4	8.36	24.1	7.61	21.5	0.48	22	7.61
8	16.3	3.42	21.7	8.47	24.1	7.59	18.3	0.32	21.9	7.59
9	12.2	2.87	19.8	7.82	16.8	1.28	16.5	0.25	17.5	0.86
10	10.7	2.95	19.7	7.1	16.2	0.37	13.2	0.2	14.7	0.3
11	10.5	2.96	18.6	6.3			11.7	0.17	11.6	0.2
12	9.9	2.79	16.9	5.83			10.4	0.15	10.7	0.19
13	8.9	2.41	15.3	5.56			9.9	0.14	10.3	0.18
14							9.7	0.13	9.9	0.16

DW4 (45° 36'.393 N, 080° 25'.497 W)

SB1	2018-07-02		2018-07-27		2018-08-10		2018-08-31	
Depth	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)
0	23.3	8.57	24.5	7.92	24.9	8.1	22	7.89
1	23.5	8.53	24.6	7.86	24.7	8.02	22.1	7.78
2	23.5	8.5	24.4	7.75	24.6	7.68	22.1	7.76
3	23.3	8.41	24.3	7.74	24.6	7.67	22.1	7.71
4	23.2	8.34	24.2	7.6	24.4	7.29	22.1	7.67
5	22.5	7.61	24.2	7.36	24.2	6.53	22.1	7.64
6	20.2	5.5	24.1	7.06	23.8	4.72	22.1	7.64
7	17.9	3.6	24.1	6.97	22.4	2.18	22.1	7.54
8	14.6	2.25	24	6.57	18.1	0.37	21.5	5.53