



Hutchinson

Environmental Sciences Ltd.



Muskoka Lakes Association 2022 Water Quality Initiative Report

Prepared for: Muskoka Lakes Association

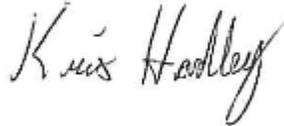
Job #: J210048

December, 2022

Final Report

Signatures

Report Prepared by:



Kristopher R. Hadley, Ph.D.
Senior Aquatic Scientist

Report Reviewed by:



Brent Parsons, M.Sc.
Senior Aquatic Scientist



Executive Summary

The Muskoka Lakes Association (MLA), Canada's oldest lake association, was founded in 1894 to represent the waterfront residents in the Muskoka Region. It has operated "The MLA Water Quality Initiative" (WQI), a monitoring program focussed on Lakes Rosseau, Joseph and Muskoka and including many smaller surrounding lakes, since 2002. The MLA's water quality efforts are concentrated on:

- Protecting and promoting water quality through their monitoring program and
- Promoting responsible land use

The MLA Environment Committee manages over a hundred volunteers to collect annual water quality data and retained Hutchinson Environmental Sciences Limited (HESL) in 2021 to analyze their data and to provide recommendations and program modification/development options. This Water Quality Report presents the most recent data collected in 2022 and compares it to data collected from 2002 to the present.

The MLA and their volunteers monitored 55 areas within 18 lakes and rivers for a total of 700 samples between May and September in 2022. Each sampling area represents a geographic location encompassing a group of WQI monitoring sites, usually focussed on a river, lake or embayment of interest to the MLA. Samples were collected for analysis of total phosphorus (TP) and bacteria (*E. coli* and total coliform), with water and air temperature and Secchi depths recorded at each site.

Changes to the areas and sites monitored by the MLA WQI Program in 2022 were minor. Three additional sites were added near Willow Beach (WLB) in response to the elevated TP concentrations and long-term increasing trend identified during 2021, to investigate potential sources of phosphorus to WLB-3. Ten additional nearshore monitoring sites were also added in 2022, two on Clear Lake (CLR-8 and 9), three on Brandy Lake (BDY-12, 13 and 14), one in Foot's Bay (FTB-6), three in Muskoka Bay (MBA-A, B and C) and one in Skeleton Lake (SKL-6). Additionally, one site on Muskoka Bay (MBA-5) was sampled for the first time since 2014.

Finally, no samples were collected in 2022 at Bass Lake, which has opted out of the MLA WQI Program since 2021. Furthermore, samples were not collected in 2022 at, three stations on Brandy Lake (BDY-3, 5 and 6), all Leonard Lake stations with the exception of LEO-8 (a deep-water stations with limited long-term data), one station on Moon River (MOO-15) and one station on Lake Rosseau (ROS-1).

Detailed summaries of 2022 data for mean Secchi depth, spring and annual average TP and annual geometric mean of *E. coli* and total coliform bacteria counts are included in the Area Reports (Appendix A). Long-term trend analyses for TP concentrations at all monitoring sites were included at sites where more than 5 years of data were available. Significant increasing trends were detected at one site which has been discussed in Section 3.6 and within the area report for Willow Beach. All trend analysis plots have been provided in Appendix B.

Without exception, Secchi depths recorded in 2022 remained within the range of variability of the long-term dataset. We noted that the Secchi depth data analysis methodology currently only includes comparison of the current years data against the long-term range of values collected at a sampling site. Trends in Secchi data were last assessed by HESL in 2017 at a limited number of sampling sites, in 2022 we updated the



assessment of the long-term trends in Secchi data. Although no long-term trends were detected in Secchi depth at any of the stations analyzed we believe the assessment of water clarity data would be a valuable annual addition to the MLA WQI Program.

Deep-water phosphorus concentrations at all sampling areas within the Lake Joseph, Lake Muskoka and Lake Rosseau were below the Ministry of the Environment, Conservation and Parks (MECP) Interim Provincial Water Quality Objectives (PWQO) of 10 and 20 µg/L for inland lakes¹, however nearshore phosphorus concentrations were elevated at sites within several sampling areas following rain events. We noted in 2021 that the majority of cases of elevated nearshore phosphorus were the result of samples collected during “Moderate” or “Heavy” storm events which, in some cases, we found accounted for three or more of the phosphorus samples collected. Storm sampling can be useful to identify sources of phosphorus and therefore should be collected, however HESL recommended that the number of storm events be limited. In 2022, storm event sampling was generally reduced compared to 2021 and we recommend continued training with volunteers to ensure methodological consistency and long-term data compatibility.

Trend assessment of spring phosphorus concentrations found a significant increasing trend at Willow Beach – Lake Muskoka, specifically the WLB-3 station, despite a marked reduction in TP concentration in 2022. Concentrations at this location were the highest recorded to date in 2021 and resulted in additional sampling of the creek that discharges near Willow Beach in 2022. We found substantially elevated total phosphorus concentrations at WLB-6, in a small watercourse adjacent to a horse farm, and recommend sampling at these locations continue in 2023 to gather additional information. Elevated concentrations of phosphorus near agricultural lands suggest that there may be an opportunity to reduce phosphorus export to the watercourse and ultimately to Willow Beach by working with local stakeholders to implement best management practices of fertilizer use and manure management.

Cyanobacterial blooms were recorded in 2022 at Leonard Lake and Three Mile Lake and were reported to the MECP. Based on data recorded by the Simcoe Muskoka District Health Unit (SMDHU), additional blooms in the Muskoka region at lakes and embayment’s not sampled by the MLA WQI program included Bass Lake (Muskoka), Farlain Lake, Mary Lake, Lake St. John, Lake St. George, Penetang Harbour, Smith’s Bay and Muldrew Lakes.

In 2021, *E. coli* counts exceeded 50 cfu/100 mL at 41 sampling events and retests were not completed in 28 of those events in 2021. In 2022, 13 events warranted re-sampling which was performed in all but four of those events. Maintaining sampling protocols was improved in 2022 and continued vigilance is recommended to ensure anomalous data can be confirmed and to maintain consistency, as much as is possible, between current and historical samples.

Sampling areas where *E. coli* counts were elevated (>50 cfu/100ml) in 2022 include Beaumaris (BMR-10), Bruce Lake (BRU-6), Clear Lake (CLR-8), Minett (MIN-1, and 6), Moon River (MOO-6), Muskoka River

¹ To avoid nuisance concentrations of algae in lakes, average total phosphorus concentrations for the ice-free period should not exceed 20 µg/L; A high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 10 µg/L or less. This should apply to all lakes naturally below this value; Excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 30 µg/L.



(MRV-2, and 7), Star Lake (STR-4) and Willow Beach (WLB-1 and 3). The nearshore areas which exceeded a geometric mean of 30 cfu/100mL in 2022 were Beaumaris (BMR-4 and 10), Bruce Lake (BRU-6), Indian River (IND-2), Minett (MIN-1 and 6), Muskoka River (MRV-7) and Willow Beach (WLB-3).

In 2022, 55 areas were sampled, 44 of which were assigned green lights, while ten yellow lights and one red light were assigned based on the MLA criteria. Yellow lights at five of the eleven sampling areas were the result of elevated bacteria concentrations, while five sampling areas (Boyd Bay, Bala Bay, Brandy Lake, Silver Lake (Port Carling) and Leonard Lake) experienced cyanobacterial blooms in 2018 - 2022 for which a causation study has not yet been completed. Blooms documented in 2022 did not exceed the MLA threshold for microcystin of 20 µg/L and were therefore assigned a yellow light. Bruce Lake exceeded yellow light triggers for algae blooms and bacteria concentrations.

A single red light was assigned in 2022 to Willow Beach (WLB-3), where we identified a long-term statistically significant increasing trend in phosphorus concentrations despite a marked reduction in TP concentrations in 2022 relative to the peak value observed in 2021.

HESL has formulated several recommendations which we believe will improve the program moving forward. These include:

1. maintaining consistent sampling at long-term sites whenever possible.
2. continued training with volunteers to ensure methodological consistency and long-term data compatibility.
3. Ongoing analysis of water clarity (Secchi data) as part of future annual monitoring assessments and
4. Focussed sampling at Willow Beach, Minett, Bruce Lake, and Indian River where elevated levels of bacteria and/or phosphorus were identified in 2022.



Table of Contents

Signatures

Executive Summary

1.	Introduction	7
2.	Water Quality Monitoring Program	7
2.1	Regional Setting.....	7
	2.1.1 <i>The Role of Climate</i>	9
2.2	Study Areas and General Methods.....	12
2.3	Water Quality Parameters.....	12
2.4	Updates in the 2022 Program	12
3.	2022 Monitoring Methods and Results	13
3.1	Background	13
3.2	Secchi Disc Depth.....	16
	3.2.1 <i>Quality Control</i>	16
	3.2.2 <i>2022 Secchi Depth Results</i>	17
3.3	Total Phosphorus Concentrations.....	17
	3.3.1 <i>Quality Control</i>	18
	3.3.2 <i>2022 Total Phosphorus Results</i>	18
	3.3.3 <i>Watercourse Stations</i>	19
3.4	Harmful Algal Blooms.....	19
3.5	Bacteria	24
3.6	Summary and Conclusions	26
4.	Recommendations	27
5.	References.....	28

List of Figures

Figure 1. Map of MLA Water Quality Initiative Sampling Sites in 2022.	8
Figure 2. Long-term Trends in Average Annual Air Temperature at the Beatrice Climate Station (6110607).	10
Figure 3. Long-term Records of Total Annual Precipitation at the Beatrice Climate Station (6110607). ...	11
Figure 4. Long-term Water Level at Beaumaris Water Survey of Canada Station (02EB018).....	11
Figure 5. Example of the Presentation of Long-term Phosphorus Monitoring Figures.....	17
Figure 6. Summary of the 2022 Spring Total Phosphorus Results from Lake Joseph Sampling Areas. ...	20
Figure 7. Summary of the 2022 Spring Total Phosphorus Results from Lake Rosseau Sampling Areas..	21
Figure 8. Summary of the 2021 Total Phosphorus Results from Lake Muskoka Sampling Areas.....	22
Figure 9. Summary of the 2021 Spring Total Phosphorus Results from Affiliate Lake and River Sites.....	23
Figure 10. Trends in Long-term Phosphorus Concentrations at WLB-3.....	24
Figure 11. Example of the Presentation of Long-term <i>E. coli</i> Monitoring Figures.	25

List of Tables



Table 1. Average Temperatures Recorded at the Beatrice Climate Station (6110607).	9
Table 2. Total and Average Monthly Rainfall at the Beatrice Climate Station (6110607).....	9
Table 3. Maximum Daily Air Temperatures Recorded at the Beatrice Climate Station (6110607).	10
Table 4. MLA Thresholds for Assigning Traffic Light Limits for Area Summaries.	16
Table 5. Summary of Recent Harmful Algae Blooms in MLA Monitoring Lakes.	19
Table 6. Summary of MLA WQI Threshold Exceedances in 2022.	26

Appendices

Appendix A. Area Reports

Appendix B. Long-term Trend Analyses – Total Phosphorus

Appendix C. Long-term Trend Analyses – Secchi Depth



1. Introduction

There is a need for high quality, long-term data to support effective science-based management of freshwater resources (Smol 2008). This becomes increasingly important as the magnitude and number of environmental stressors grows (e.g., intensification of human land-use, exotic species' invasions and climate change). A region of particular interest in Canada is the lake-rich Muskoka-Haliburton region of south-central Ontario where, despite its relatively remote location, lakes have been influenced by multiple environmental stressors during the past several decades (Hall and Smol 1996, Paterson et al. 2004, DeSellas et al. 2008, Yan et al. 2008). Although distant from major urban and industrial centres, the Muskoka-Haliburton region is a popular destination for recreational activities, and is home to many cottages, resorts and golf courses. As a result, lakes in the region are susceptible to both regional-scale stressors, such as climate change, as well as local, catchment-scale stressors associated with increased shoreline development.

The Muskoka Lakes Association (MLA), Canada's oldest cottage association, was founded in 1894 to represent the waterfront residents in the Muskoka Region and has operated Since 2002, the MLA Water Quality Initiative (WQI), a monitoring program focussed on Lakes Rosseau, Joseph and Muskoka and including many smaller surrounding lakes and rivers. The MLA's water quality efforts are concentrated on:

- Protecting and promoting water quality through their monitoring program and
- Promoting responsible land use

The MLA Environment Committee manages over a hundred volunteers to collect annual water quality data and retained Hutchinson Environmental Sciences Limited (HESL) in 2022 to analyze their data and to provide recommendations and program modification/development options. This Water Quality Report presents the most recent data collected in 2022 and compares it to data collected from 2002 to the present.

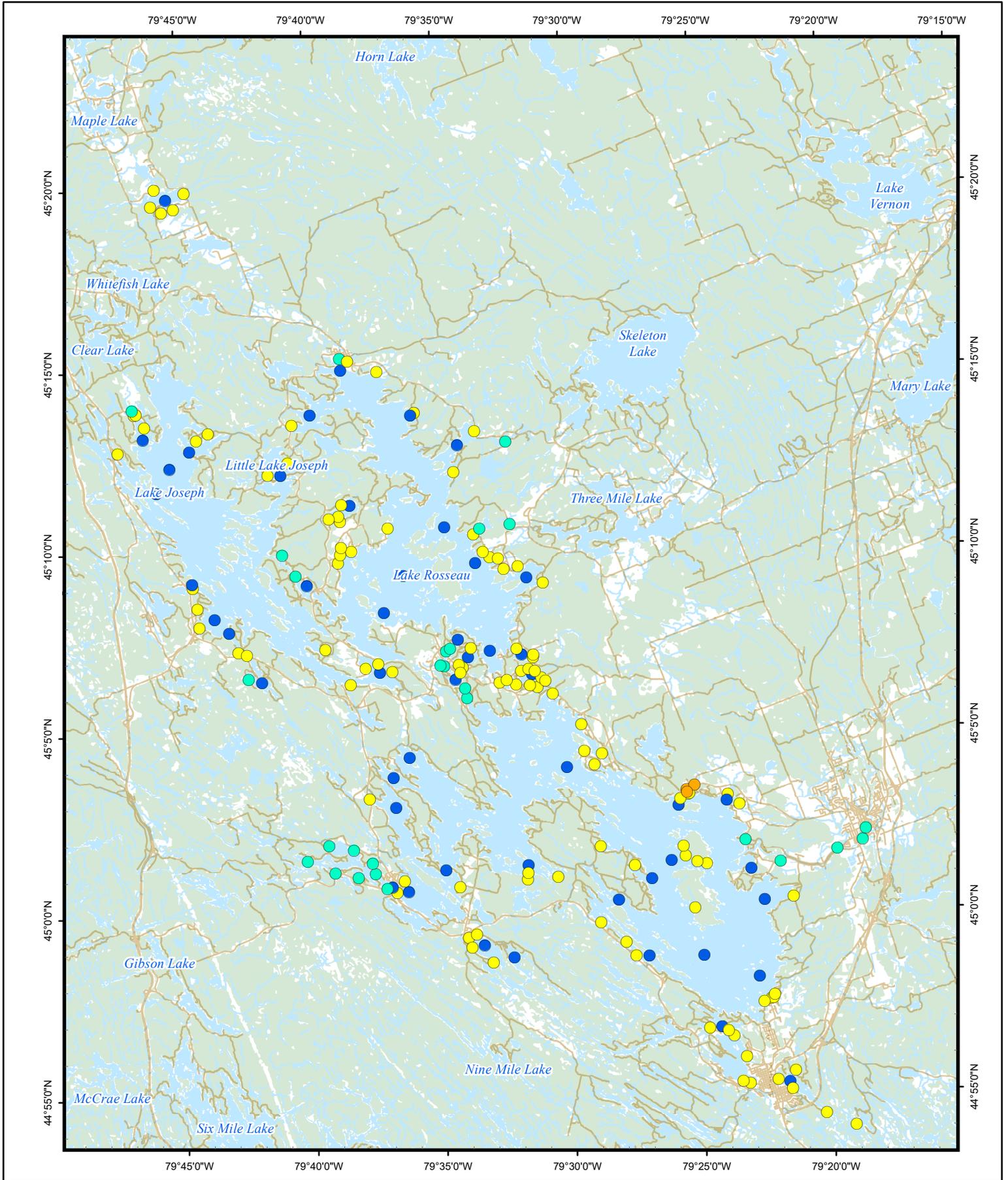
2. Water Quality Monitoring Program

2.1 Regional Setting

The study lakes are located in the Muskoka region of south-central Ontario, Canada, situated on the Precambrian Shield (Figure 1). The Shield is characterized by thin, poorly developed soil with abundant bedrock exposures. Catchments are mainly forested, dominated by sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), yellow birch (*Betula lutea*), red maple (*Acer rubrum*), eastern hemlock (*Tsuga canadensis*), and white and red pine (*Pinus strobus* and *Pinus resinosa*).

A key objective of the MLA program is to determine if the amount, nature and activities associated with shoreline development have altered key water quality indicators: Total Phosphorus (TP), an indicator of lake productivity, water clarity (influenced by algal growth and catchment runoff and measured as Secchi depth) and bacteria as an indicator of potential water borne pathogens (See Section 2.3). Shoreline development varies greatly between and within lakes. Sampling sites have generally been selected based on community concern and are therefore focused on moderately and heavily developed areas which may be influenced by inputs from urban and seasonal recreational (cottages, resorts, golf course, agricultural) activities.





Station Type

- Deep Basin
- Nearshore
- Special Study
- Watercourse

- Roads
- Watercourses
- Waterbodies
- Wooded

00.51 2 3 4 5
 km
Scale = 1:250,000



Project #: 210048 Projection: UTM Zone 17N
 Drafted: K. Hadley Datum: NAD 1983
 Reviewed: B. Parsons Date: Dec 16, 2022

Figure 1
 Sampling Stations

2.1.1 The Role of Climate

The Muskoka region is situated within the boreal ecozone with a temperate climate. Average monthly air temperature from March to August in 2022 varied between -3.1 and 19.2 °C (Table 1) and monthly precipitation was between 44.1 and 130.9 mm (Table 2). Precipitation in March, May, June and July were below the long-term averages and total summer precipitation was lowest it has been in the last 6 years and well below the long-term average. Maximum daily air temperatures in 2022 ranged from 16.0 in March to 32.2 °C in June (Table 3), exceeding the average monthly maxima recorded between 1981 and 2010. Analysis of long-term climate records show a long-term increase in average annual air temperature since the 1980s (Figure 2). Long-term total annual precipitation varied substantially but no significant long-term trend was noted. (Figure 3).

Spring freshet in 2022 was more similar to typical long-term average conditions than the extreme high-water levels that were noted in 2019, however typical summer lows in water level were not recorded in 2022. Peak water levels at the Beaumaris Water Survey of Canada Station (02EB018) in 2022 (9.71 m), was consistent with levels observed in 2020 (9.72 m), when no sampling occurred due to the Covid-19 pandemic, and 2021 (9.67 m). These three years were all well below the 10.5 m recorded in 2019 that produced historic flooding conditions (Figure 4).

Table 1. Average Temperatures Recorded at the Beatrice Climate Station (6110607).

Mean Temperature (°C)								
Month	2016	2017	2018	2019	2020	2021	2022	1981-2010 Average
March	-1.5	-5.9	-3.3	-6.2	-0.9	-1.3	-3.1	-3.8
April	1.6	6.3	-0.2	3.3	2.7	5.9	4.3	4.4
May	11.0	10.1	13.3	9.1	9.9	10.0	13.2	11.0
June	15.5	15.4	15.5	14.2	16.4	17.4	16.5	15.8
July	18.6	17.9	19.5	19.3	20.5	17.6	18.6	18.2
August	19.4	16.4	19.3	16.5	17.3	19.8	19.2	17.3

Table 2. Total and Average Monthly Rainfall at the Beatrice Climate Station (6110607).

Total Monthly Precipitation (mm)								
Month	2016	2017	2018	2019	2020	2021	2022	1981-2010 Average
March	182.3	87.5	31	62.4	98.1	43.4	44.1	75.2
April	64.4	155.6	103.8	133.3	73.6	72.1	84.1	76.8
May	56.3	130.2	27.6	100.8	68.3	14.9	50.2	97.9
June	41.3	151.6	25.5	101.1	100.9	135.9	63.9	87.7
July	72.6	79.6	57	23.9	81.8	136.2	51.6	94.3
August	195.5	211.2	196.1	75.3	129.4	88.2	130.9	87.7
Total	612.4	815.7	441	496.8	552.1	490.7	293.9	519.6



Table 3. Maximum Daily Air Temperatures Recorded at the Beatrice Climate Station (6110607).

Maximum Temperature (°C)								
Month	2016	2017	2018	2019	2020	2021	2022	1981-2010
March	12.7	9.5	8.6	9.9	12.3	18.4	16.0	2.4
April	22.4	27.1	17.9	18.9	15.5	24.4	22.6	10.7
May	30	28.4	30.9	21.4	31.2	29.8	30.4	18.1
June	29.6	27.7	30	27.7	30.3	30.3	32.2	22.6
July	30	28	33.9	30.6	32.4	28	31.8	24.9
August	33.3	27.5	30.4	27.9	29	30.1	31.8	23.8

Figure 2. Long-term Trends in Average Annual Air Temperature at the Beatrice Climate Station (6110607).

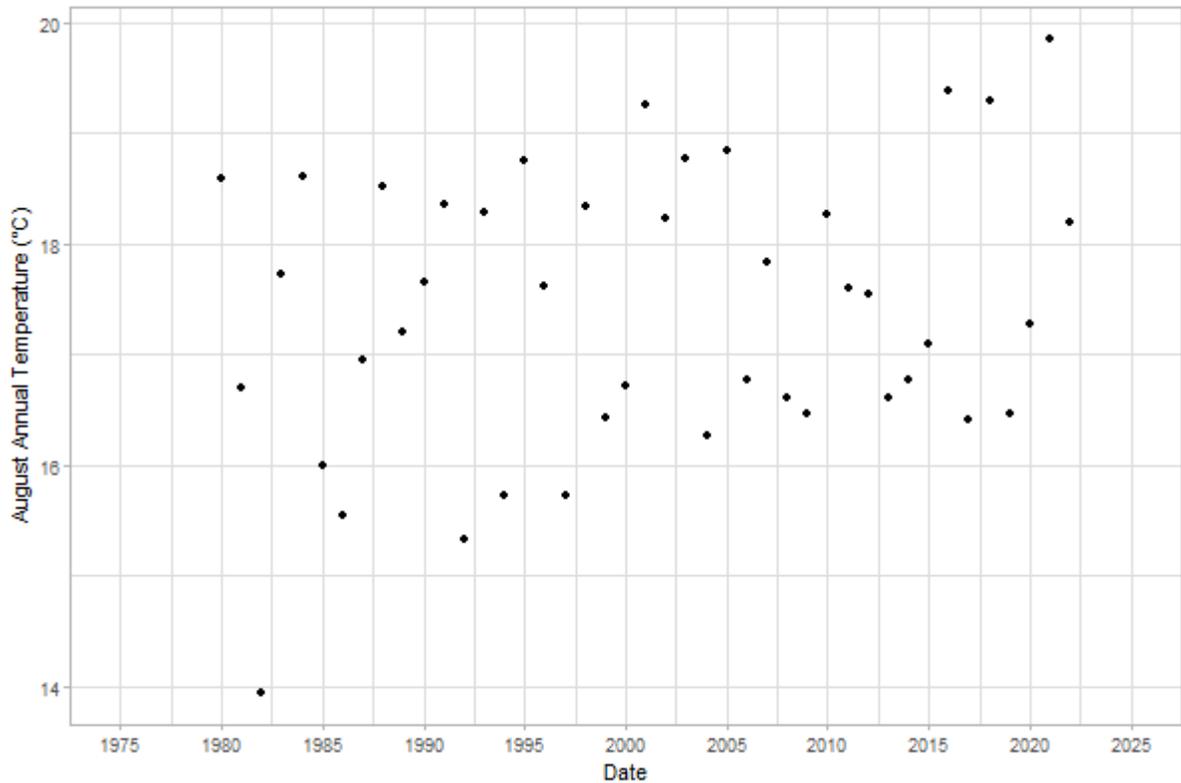


Figure 3. Long-term Records of Total Annual Precipitation at the Beatrice Climate Station (6110607).

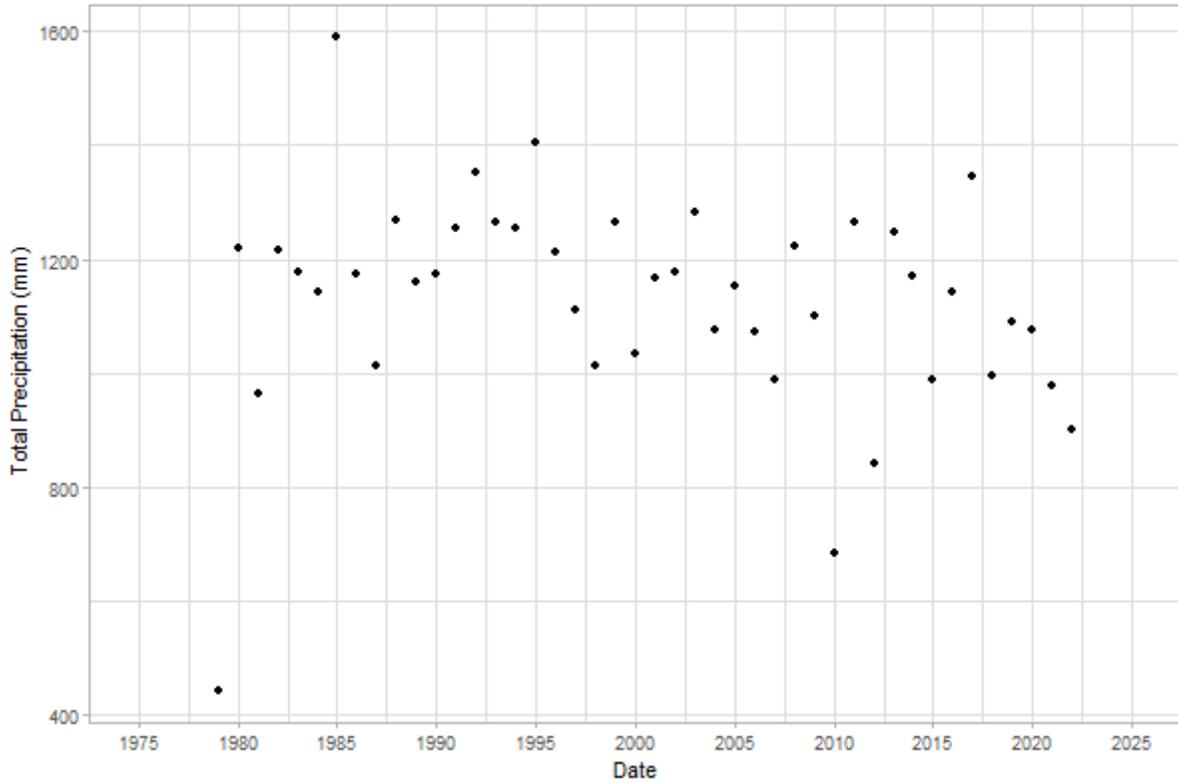
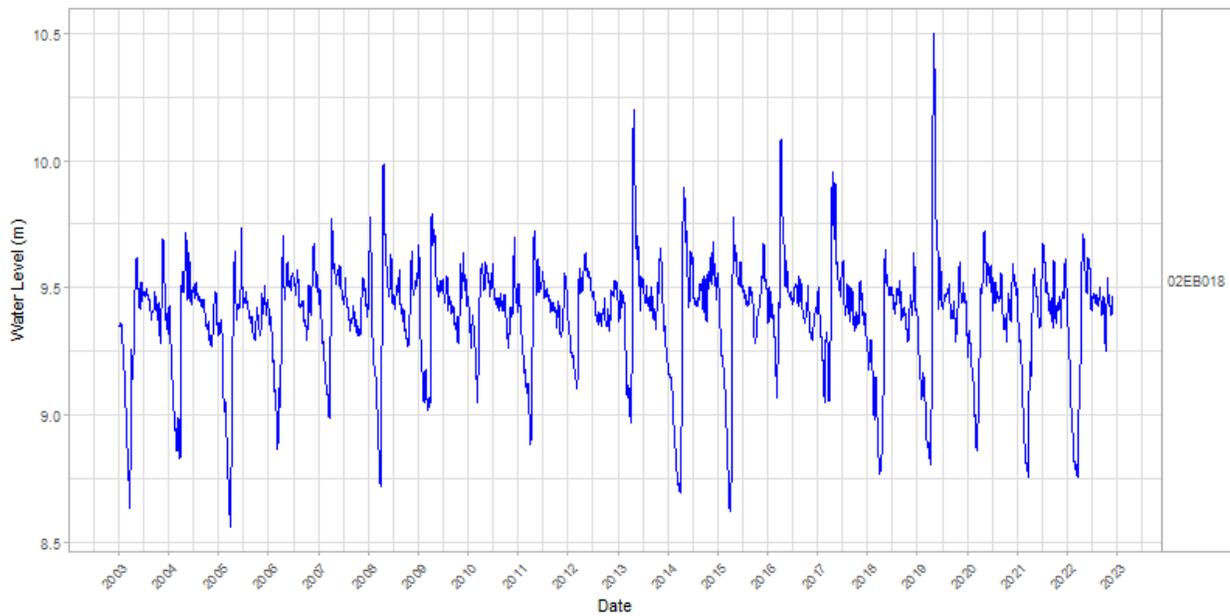


Figure 4. Long-term Water Level at Beaumaris Water Survey of Canada Station (02EB018).



2.2 Study Areas and General Methods

The MLA WQI monitoring program study area includes Lakes Muskoka, Rosseau, and Joseph and several smaller affiliate lakes and rivers in the Muskoka Region. The study area is divided into targeted sampling areas which include lakes, bays, and rivers. Within each sampling area the MLA maintains several sampling stations, normally this includes a deep-water station (to represent average sampling conditions), one or more nearshore sampling stations and, where applicable, watercourse sampling stations.

Details of the sampling protocols are provided in the MLA Water Quality Initiative Methodology Report (<http://www.mla.on.ca>) and these standard protocols were followed in 2022.

2.3 Water Quality Parameters

The MLA WQI is focussed on TP concentrations, Secchi depth measurements and *E. coli* bacteria sampling. For recreational lakes on the Precambrian Shield water quality concerns are most often associated with nutrient enrichment due to increased human phosphorus sources. Phosphorus is often the primary limiting nutrient in freshwaters in support of macrophyte and algal growth. Phosphorus enters lakes via external loading from the watershed, precipitation and, in certain conditions, through internal loading from sediments at the lake bottom. Effluent from sewage treatment systems and stormwater runoff may have particularly high loadings and as a result phosphorus concentrations are commonly used to assess the impacts of development on water quality. Excessive growth of plants and algae and subsequent decomposition can result in lowering of dissolved oxygen concentrations in deep hypolimnetic waters due to the oxygen requirements of bacteria and this may degrade fish habitat and in extreme cases result in “fish kills”, a phenomenon where water temperature near the surface of the lake is too warm and oxygen concentrations of the water near the bottom are too low to support fish resulting in a mass die-off.

Secchi disc depth provides a measure of water clarity which is one indication of the productivity of the lake. For Precambrian Shield lakes, Secchi depth is primarily determined by the amount of dissolved organic carbon (DOC) in the water (Dillon et al. 1986), and this is a function of the amount of wetland in the watershed (Dillon and Molot 1997). High algae growth, however, reduces the penetration of light through the water column and reduces the measured Secchi depth beyond that related to DOC. Decreases in Secchi depth over time may therefore be indicative of increased productivity by, for example shoreline disturbance and development activities that increase total suspended solids or phosphorus loading from the watershed.

E. coli are a species of fecal coliform bacteria that comes from warm-blooded animals, including humans and are a useful indicator of potential pathogens in the water. They are the primary organism used by Health Canada in determining the safety of recreational waters for swimming and bathing.

2.4 Updates in the 2022 Program

Changes to the areas and sites monitored by the MLA WQI Program in 2022 were minor. Additional sites were added near Willow Beach in response to the elevated total phosphorus concentrations and long-term increasing trend identified during 2021, to investigate potential sources of phosphorus to WLB-3. These sites were:



WLB-5 – A wetland on the North side of County Road 118 (@ 45° 03' 15" N, 79° 25' 30" W), where water drains through a large culvert prior to discharging into Lake Muskoka @ WLB-3.

WLB-6 – A small creek entering golf course from East, that drains an adjacent horse farm (@ 45° 03' 27" N, 79° 25' 12" W)

WLB-7 – The outlet of the golf course pond on the upstream side of the sluice gate (@ 45° 03' 20" N, 79° 25' 31" W), which drains to Lake Muskoka

Ten additional nearshore monitoring sites were also added in 2022, two on Clear Lake (CLR-8 and 9; 44.9776103 N, 79.5518035 W; 44.9874229 N, W 79.5522788 W), Three on Brandy Lake (BDY-12, 13 and 14), one in Foot's Bay (FTB-6; 45.1416791 N, 79.7393660 W), three in Muskoka Bay (MBA-A, B and C; 44.94481 N, 79.40096 W; 44.94236 N, 79.39748 W; 44.93264 N, 79.38955 W), one in and one in Skeleton Lake (SKL-6). MBA-5 was sampled for the first time since 2014. Muskoka Bay sites were added at the request of the Muskoka Bay Property Owners Association due to future development concerns, while sites added and/or deleted at Affiliate Lakes by request of the respective Lake/Property Owners Associations.

Finally, no samples were collected in 2022 at Bass Lake (Muskoka), which has opted out of the MLA WQI Program since 2021. Furthermore, samples were not collected in 2022 at:

- Three stations on Brandy Lake (BDY-3, 5 and 6)
- All Leonard Lake stations with the exception of LEO-8 (a deep-water stations with limited long-term data)
- One station on the Moon River (MOO-15)
- One station on Lake Rosseau (ROS-1)

3. 2022 Monitoring Methods and Results

3.1 Background

The MLA and their volunteers monitored 55 areas within 18 lakes and rivers for a total of 700 samples between May and September in 2022. Each sampling area represents a geographic location encompassing a group of WQI monitoring sites, usually focussed on a watercourse, lake or embayment of interest to the MLA.

Detailed summaries of 2022 data for mean Secchi depth, spring and annual average total phosphorus, as well as annual geometric mean of *E. coli* and total coliform bacteria counts are included in the Area Reports (Appendix A). Long-term trend analyses for total phosphorus concentrations at all monitoring sites were included at sites where more than 5 years of data are available. Significant increasing trends were detected at 1 site and discussed within the area report and Section 3.6. All trend analysis plots have been provided in Appendix B. A visual indication of the overall water quality at each Area is presented by means of a traffic light symbol. The meaning of each symbol is described below:





Green Light
Water quality remains consistently good.



Yellow Light
Further investigation is recommended to maintain good water quality.



Red Light
Remedial action is recommended to improve water quality.

In 2019, the MLA developed new thresholds to align monitoring under the WQI Program with the District Municipality of Muskoka's recently adopted Official Plan amendment - OPA 47 (Table 4). The water quality thresholds defined in DMM Policy C.2.6.3.2 are:

- i. A long-term statistically significant ($p < 0.1$) increasing trend in total phosphorus concentration demonstrated by at least five (5) spring overturn phosphorus measurements obtained through the District of Muskoka water quality sampling program since 2001.
- ii. A long-term total phosphorus concentration of greater than 20 $\mu\text{g/L}$ demonstrated by the average of five (5) most recent spring overturn phosphorus measurements obtained through the District of Muskoka water quality sampling program within the last ten (10) years; and/or
- iii. A blue-green algal (cyanobacteria) bloom confirmed and documented by the Province and/or Simcoe-Muskoka District Health Unit.

If conditions (i) or (ii) have been identified in three consecutive monitoring years or condition (iii) has been confirmed to be present, the waterbody is classified as vulnerable and added to Schedule E2. Under the Official Plan, lakes listed under Schedule E2 are subject to a causation study to determine what role, if any, that development has in the measured nutrient enrichment or algae bloom and to recommend management actions.

Beginning in 2019, the MLA has assigned a yellow light threshold for phosphorus concentrations that are either:

- >20 $\mu\text{g/L}$ (latest 3-year spring turnover average);
- show an increasing trend in spring measurements over the last 3 years; or
- have an annual average TP that exceeds spring TP.

A red light threshold for phosphorus concentrations is triggered if:

- concentrations exceed 20 $\mu\text{g/L}$ (latest 5-year spring turnover average); or
- a statistically increasing trend in spring measurements over the last 5 years (or longer).



In addition, a red light occurs for study areas where a confirmed cyanobacterial bloom is detected in the current monitoring year, while a yellow light is assigned if a bloom has been confirmed in the past three years or if microcystin concentrations of a current bloom are below 20 µg/L. A green light for Harmful Algae Blooms is assigned in study areas that have never had a blue-green algal bloom, or that have had 3 years since the last bloom.

E. coli thresholds were established in 2018 using Health Canada and the Ministry of Health and Long-Term Care Operational Approaches for Recreational Water Guideline (2018) for recreational water use at public beaches and waterfronts and are based on a geometric mean of levels of *E. coli*. Health Canada guidelines deem a site unsuitable for swimming and bathing when *E. coli* counts exceed 200 cfu/100mL, based on a minimum of five samples per site collected within a one-month period, which is not currently possible under the MLA WQI program. The MLA has, however, adopted their own, lower, thresholds in recognition of the high water quality in Muskoka's lakes, with the green light established for annual means below 30 cfu/100 ml, yellow for counts between 30 and 199 cfu/100 ml and red where annual means exceed the Health Canada threshold of 200 (Table 4). The MLA *E. coli* geometric mean is calculated annually (ideally, 1 sample per month over 4 months). Individual *E. coli* samples that exceed 50 cfu/100ml require volunteers to re-sample the site weekly. Where additional samples are collected, all data were used to calculate the annual geometric mean.

HESL will review traffic light thresholds with the MLA Environment Committee annually. HESL included the Interim Provincial Water Quality Objectives (PWQO) for TP to our comparisons for each Area Report in 2022. These guidelines are generally applied to ice-free average phosphorus concentrations, however we have assessed both spring and, where available, annual data against the guidelines to provide an additional assessment of current water quality. These additional guideline comparisons are not incorporated into the MLA Stoplight Thresholds.



Table 4. MLA Thresholds for Assigning Traffic Light Limits for Area Summaries.

Traffic Light	<i>E. coli</i> Yearly Geometric Mean (cfu/100 ml)	Phosphorus Trend Associated with all Sampling Years	Harmful Algae Blooms (HAB's)
	0 – 30	Flat or decreasing visual trend	No bloom ever, or 3 years since last bloom
	31 – 199	a) >20 µg /L (latest 3-year spring turnover average); b) show an increasing trend in spring measurements over last 3 years; OR c) yearly mean TP exceeds spring TP	Bloom within last 3 years or, if available, bloom in current year with toxic component (microcystins) measured <20 µg /L
	>200 geometric mean for a series of 5 samples per site per month	a) >20 µg/L (latest 5-year spring turnover average); OR b) statistically increasing trend in spring measurements over last 5 years (or longer).	Bloom in current year with toxic component (microcystins) measured <20 µg /L

3.2 Secchi Disc Depth

Mean Secchi depth measurements at all deep-water stations are provided for each sampling area in the Area Summary Sheets (Appendix A). Without exception, Secchi depths recorded in 2022 remained consistent with the depths reported historically. We noted that the Secchi depth data analysis methodology currently only includes comparison of the current year's data against the long-term range of values collected at a sampling site. We believe water clarity data currently collected by the MLA WQI could include additional analyses to assess long-term change. Trends in Secchi data were last assessed by HESL in 2017 at a limited number of sampling sites. In 2022, we have added long-term analysis of Secchi depth at all stations with sufficient data (> 5 years). Figures for all trend analyses completed in 2022 have been included in Appendix C. When a significant trend is identified, we will include the trend analysis figure and discussion within the Area Report and in the Technical Report discussion (Section 3.3.2). Secchi depth assessments are not incorporated into the MLA Stoplight Thresholds.

3.2.1 Quality Control

Secchi depth measurements are collected as the average of two measurements taken during each field visit. A total of 201 Secchi depth measurements were collected in 2022 across the MLA WQI program sites. Outlier assessment followed methods used for total phosphorus data. Briefly, the Grubb's Test and Dixon Tests were used to identify outliers in Secchi depth data. All outliers, even those identified as potential erroneous measurements, were retained in the long-term data set and will be re-evaluated each year when new data is collected. No samples collected in 2022 were outliers, however QA/QC of past data identified several potentially erroneous values that resulted from data being recorded in feet rather than metres. All such errors were corrected in the database.



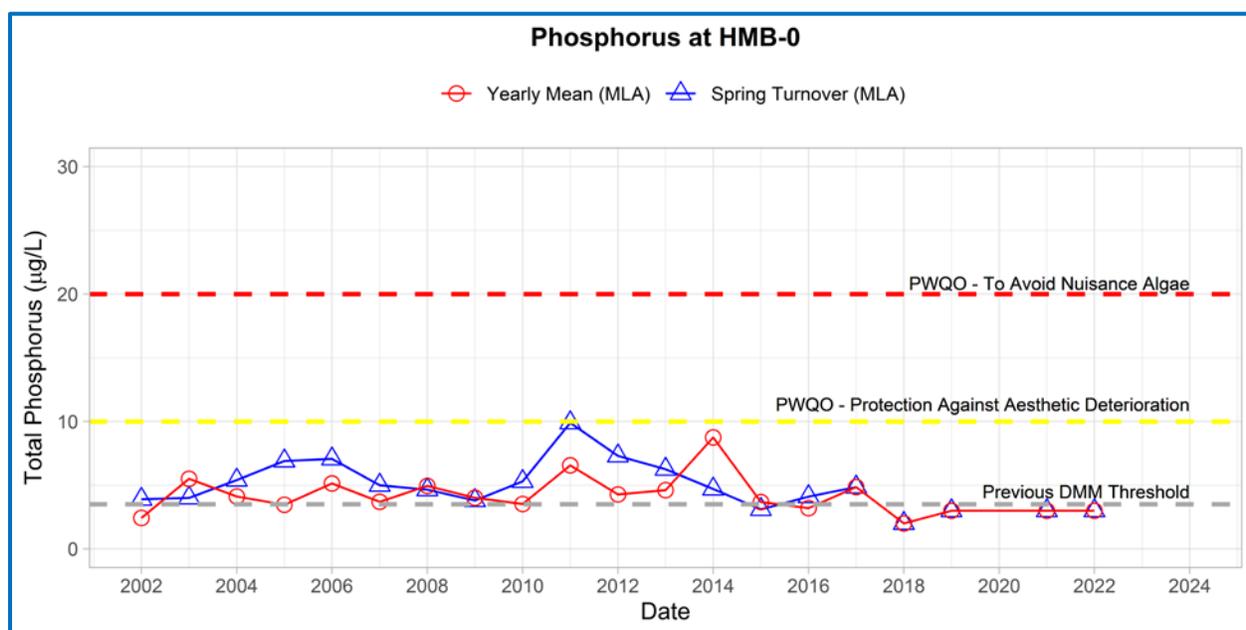
3.2.2 2022 Secchi Depth Results

No significant trends were identified in the Secchi depth data analyzed at any MLA WQI stations in 2022.

3.3 Total Phosphorus Concentrations

Spring total phosphorus concentrations have been collected since monitoring began from the deep-water sampling station within each sampling area and are presented in the Area Summary Reports (Appendix A). In addition, where available, annual average phosphorus data are also presented (e.g. Figure 5). Phosphorus data were compared against the PWQO for Protection Against Aesthetic Deterioration (10 µg/L, Yellow Line) and Prevention Against Nuisance Algal Growth, which coincides with the DMM threshold adopted in OPA 47 (20 µg/L, Red Line), and, where available, previous District of Muskoka Thresholds based on background + 50% (Grey Line). Nearshore phosphorus concentrations were not collected consistently at all nearshore monitoring stations in the MLA WQI Program, in some cases only bacteria were sampled. Where nearshore phosphorus data were collected, we compared spring overturn and annual average nearshore phosphorus concentration against long-term nearshore monitoring data.

Figure 5. Example of the Presentation of Long-term Phosphorus Monitoring Figures.



In 2022, we have continued long-term analysis of total phosphorus concentrations at all deep-water and nearshore stations with sufficient data (> 5 years). Figures for all trend analyses completed in 2022 have been included in Appendix B. When a significant trend is identified, we will include the trend analysis figure and discussion within the Area Report and in the Technical Report discussion (Section 3.3.2). Visual analyses of changes in deep-water and nearshore phosphorus concentrations were also performed to assess the MLA yellow light trigger as described in Section 3.1.

Spring overturn phosphorus concentration from samples collected by the Lake Partner Program and District of Muskoka are available at some sampling stations which are also monitored by the MLA. Based on our



understanding with the Environment Committee, these data will be reviewed by HESL and included as a technical memo or addendum to this report when they become publicly available.

3.3.1 Quality Control

A total of 67 duplicate phosphorus samples were collected in 2022 and 28 bad splits were identified that were either >30% different or had an absolute difference of >5 µg/L. If a bad split was identified, the higher of the two values was discarded. Outlier assessments followed previous methods using the Grubb's Test and Dixon's Test to identify outliers in the spring and annual average total phosphorus data. Unlike previous years, data that were identified as an outlier were retained in the Area summary plots unless it could be clearly identified as contamination. All outliers, even those identified as potential contaminated samples, are retained in the long-term data set, and will be re-evaluated each year when new data is collected. One sample collected in 2022 was identified as an outlier (TAY-5).

3.3.2 2022 Total Phosphorus Results

Deep-water phosphorus concentrations at all sampling areas within Lake Joseph, Lake Muskoka and Lake Rosseau were below PWQO's for inland lakes (Figure 6, 7, 8). Nearshore phosphorus concentrations were elevated at sites within several sampling areas (i.e., BMR, MBA, WIN), following rain events. However, in general phosphorus concentrations were lower in 2022 than 2021, likely as a result of substantial reduced precipitation.

Brandy Lake had spring phosphorus concentrations above the PWQO for Protection Against Aesthetic Deterioration (Figure 9), however, based on long-term data, phosphorus concentrations in Brandy Lake appear naturally elevated and were below the historic District Municipality of Muskoka threshold (28.4 µg/L) in 2022. BMR-10 and 12 were both elevated in spring of 2021, however in 2022 we recorded a substantial reduction in phosphorus concentrations at both nearshore sites (i.e., 58.2 µg/L to 13.9 µg/L at BMR-10 and 33.1 µg/L to 19.3 µg/L at BMR-12) suggesting anomalous values in 2021 may have been the result of sample contamination or a short-term localized runoff event.

In 2022, spring phosphorus concentrations showed a significant increasing trend at Willow Beach on Lake Muskoka, specifically the WLB-3 station (Figure 10). Concentrations at this location declined substantially from the highest concentration recorded to date in 2021, however the significant trend identified in 2021 remains significant in 2022. The magnitude of the long-term increasing trend in total phosphorus concentrations at WLB-3 was approximately 0.98 µg/L/year in 2021 but has declined to 0.77 µg/L/year following 2022 sampling. The WLB-3 station is located in a heavily developed area adjacent to two resorts and near the inflow of a creek which drains a golf course and agricultural lands. Sampling of this creek was performed on May 20th, 2022, by the MLA at three locations (WLB-5, 6 and 7). Phosphorus concentrations at WLB-5 and 7 were elevated (27.6 and 23.5 µg/L, respectively) but below the PWQO for rivers and streams (30 µg/L), however we found substantially elevated total phosphorus concentrations at WLB-6 adjacent to a horse farm (73.6 µg/L). We recommend sampling at these locations continue as the low precipitation in 2022 likely reduced phosphorus export from the watercourse to Willow Beach. Elevated concentrations of phosphorus suggest that there may be an opportunity to reduce phosphorus export to the watercourse and ultimately to Willow Beach by working with local stakeholders to implement best management practices of fertilizer use and manure management.



3.3.3 Watercourse Stations

Watercourse sampling stations do not comprise a significant portion of the MLA WQI Program, however long-term records of water quality have been collected from Muskoka River (MRV), Joseph River (JOR), Indian River (IND), Hamer Bay (HMB-8) and Windermere sampling stations (WIN-7 and WIN-8). Phosphorus concentrations within river stations were frequently elevated (Figure 7, 8 and 10) as seasonal changes in flow impact dissolved organic carbon and suspended sediment loads in the water column and thus impact nutrient concentrations. Phosphorus concentrations at these stations were compared against the PWQO for the Elimination of Excessive Plant Growth in Rivers and Streams (30 µg/L) and, where appropriate, are discussed within the Area Reports.

3.4 Harmful Algal Blooms

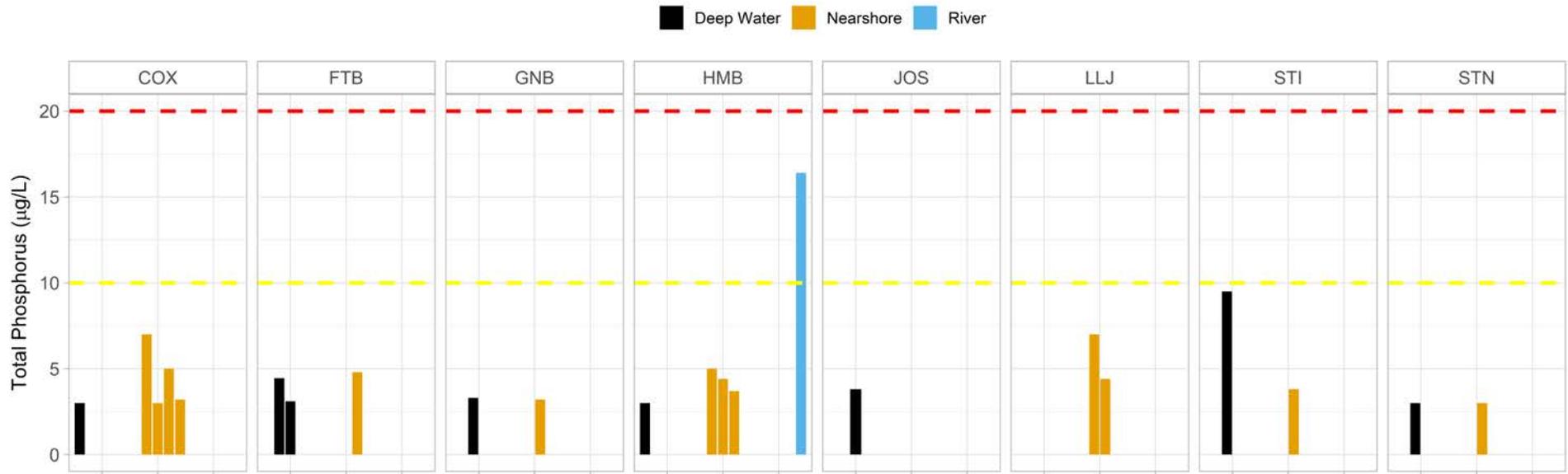
Harmful algae blooms are generally characteristic of nutrient enriched lakes but are being reporting with increased frequency in lakes in the Muskoka region and across Ontario (Winter et al. 2011). In the past decade algae blooms in low nutrient lakes have become significantly more prevalent. In 2020, 2021 and 2022 numerous algae blooms were reported on MLA monitored lakes (Table 5). In the absence of enriched or increasing phosphorus concentrations, the increased blooms are thought to be associated with changes associated with the warming climate (Pick 2015, Reini et al. 2021). Causation of documented algal blooms is addressed under the Lake System Health Program of the District Municipality of Muskoka.

Table 5. Summary of Recent Harmful Algae Blooms in MLA and Muskoka Region Monitoring Lakes.

2020	2021	2022
Leonard Lake Three Mile Lake Bass Lake Bruce Lake Brandy Lake Silver Lake (Port Carling) Muskoka Lake (Weismiller Bay)	Three Mile Lake Leonard Lake Bass Lake	Three Mile Lake Leonard Lake
Outside MLA WQI Program	Outside MLA WQI Program	Outside MLA WQI Program
Georgian Bay (Southeast Shoreline) Little Lake Stewart Lake Paint Lake Lake St. John Kahshe Lake Mary Lake Menominee Lake Fawn Lake	Kahshe Lake Black Lake Cooks Bay (Lake Simcoe) Stewart Lake Little Lake Ril Lake Ten Mile Bay (Lake of Bays) Little Lake Park Lake St. John Sparrow Lake Otter Lake	Bass Lake Farlain Lake Mary Lake Lake St. John Lake St. George Penetang Harbour Smith's Bay Muldrew Lakes



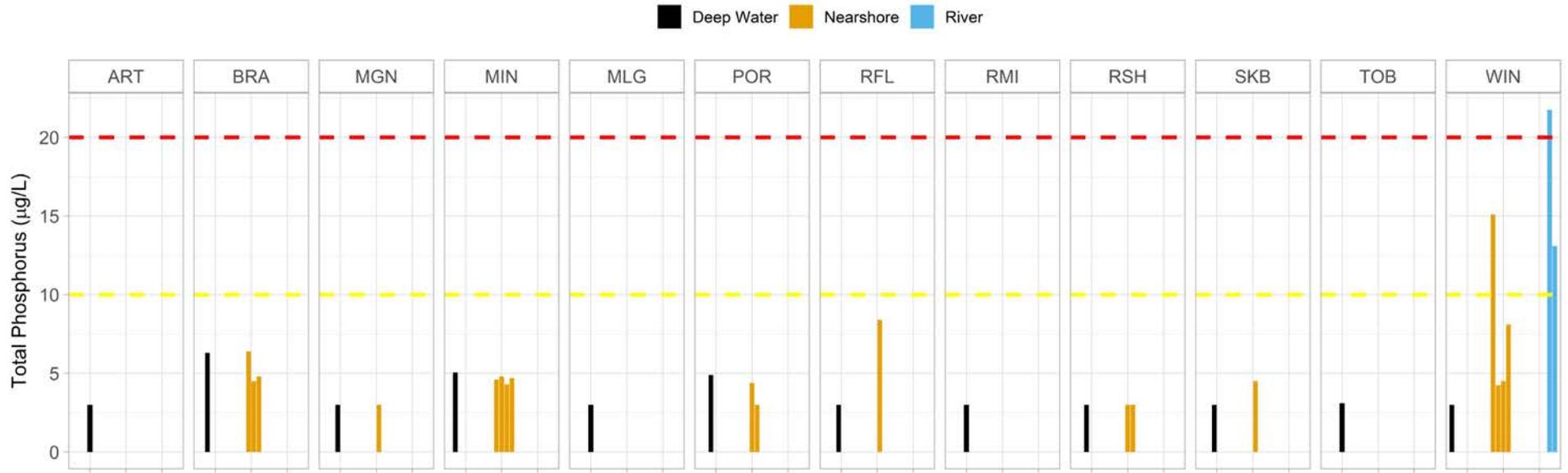
Figure 6. Summary of the 2022 Spring Total Phosphorus Results from Lake Joseph Sampling Areas.



Note: COX = Cox Bay; FTB = Foot's Bay; GNB = Gordon Bay; HMB = Hamer Bay; JOS = Lake Joseph; STI = Stills Bay; STN = Stanley Bay.



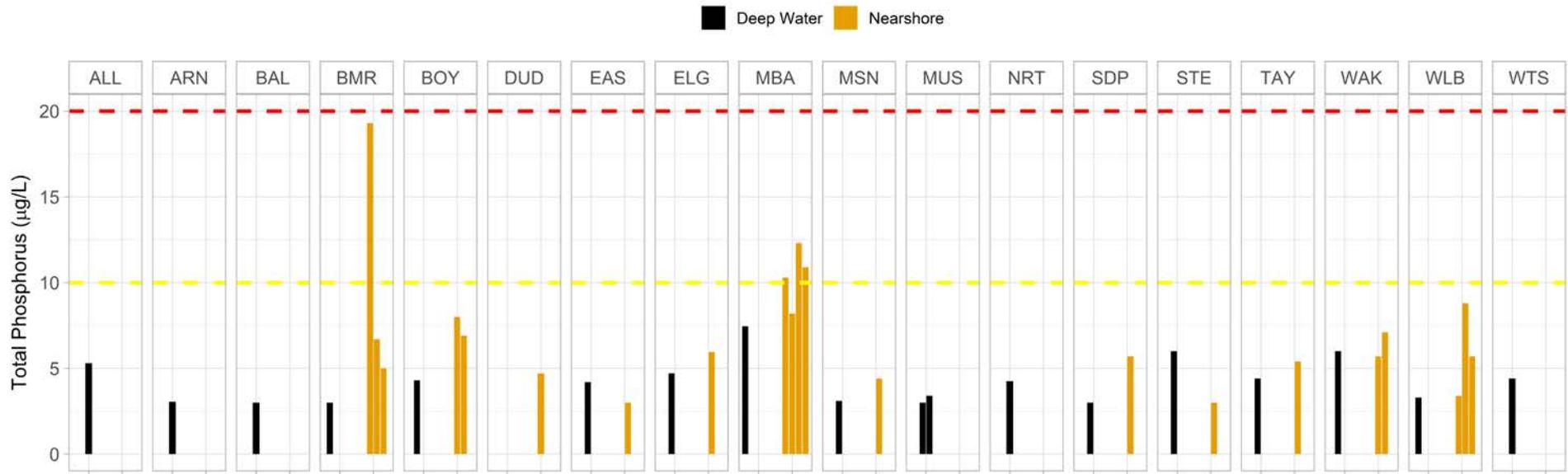
Figure 7. Summary of the 2022 Spring Total Phosphorus Results from Lake Rosseau Sampling Areas.



Note: ART = Arthurlie Bay; BRA = Brackenrig Bay; MGN = Morgan Bay; MIN = Minett; MLG = Muskoka Lakes Golf; POR = East Portage Bay; RFL = Rosseau Falls; RMI = Royal Muskoka Island; ROS = Lake Rosseau; RSH = Rosseau North; SKB = Skeleton Bay; TOB = Tobin Island; WIN = Windermere.



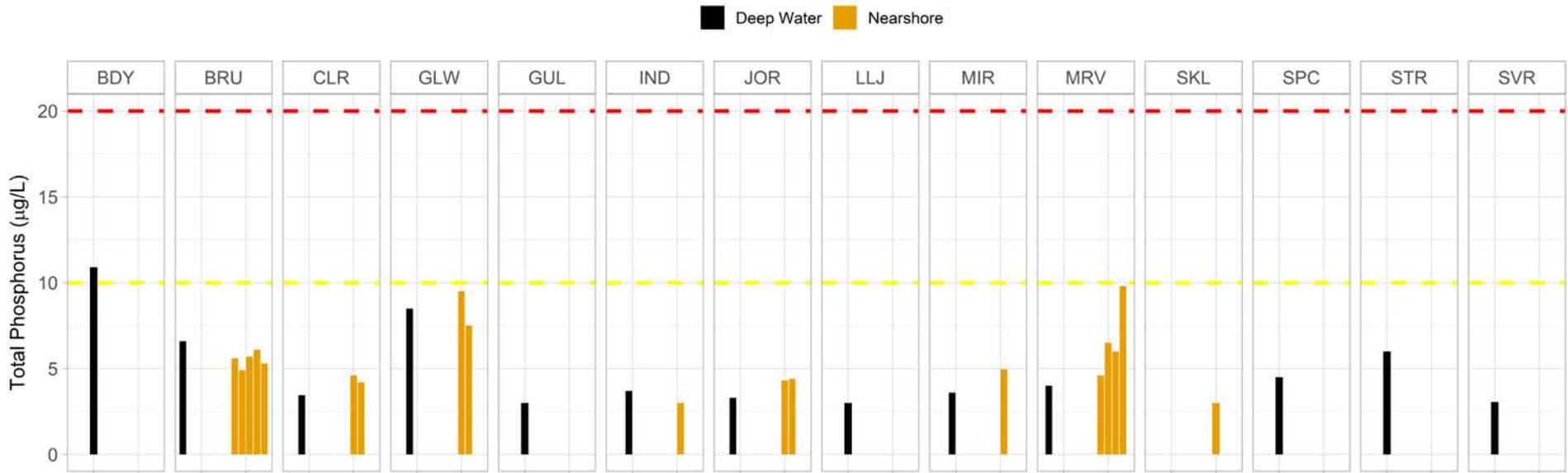
Figure 8. Summary of the 2021 Total Phosphorus Results from Lake Muskoka Sampling Areas.



Note: ALL = Alport Bay; ARN = Arundel Lodge; BAL = Bala Bay; BMR = Beaumaris; BOY = Boyd Bay; DUD = Dudley Bay; EAS = East Bay; ELG = Eilean Gowan Island; MBA = Muskoka Bay; MSN = Muskoka Sands; MUS = Lake Muskoka; NRT = North Bay; SDP = Sandy Point; STE = Stephens Bay; TAY = Taylor Island; WAK = Walkers Point; WLB = Willow Beach; WTS = Whiteside Bay.



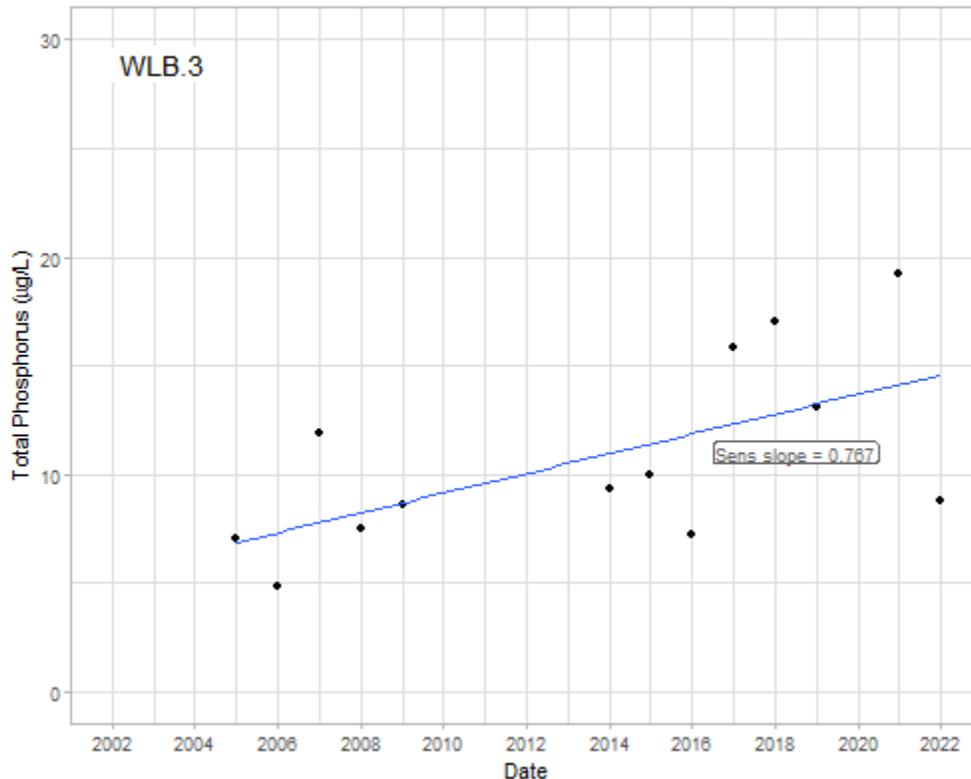
Figure 9. Summary of the 2021 Spring Total Phosphorus Results from Affiliate Lake and River Sites.



Note: BDY = Brandy Lake; BRU = Bruce Lake; CLR = Clear Lake; GLW = Gullwing Lake; IND = Indian River; JOR = Joseph River; LEO = Leonard Lake; LLJ = Little Lake Joseph; MIR = Mirror Lake; MOO = Moon River; MRV = Muskoka River; SKL = Skeleton Lake; SPC = Silver Lake (Port Carling); STR = Star Lake; SVR = Silver Lake (Gravenhurst)



Figure 10. Trends in Long-term Phosphorus Concentrations at WLB-3.



Note: WLB.3 = Willow Beach Nearshore Site #3.

3.5 Bacteria

Under the current MLA WQI Methodology, bacteria (*E. coli* and total coliform) levels were compared to the stop light limits developed by the MLA based on Ministry of Health and Long-Term Care Operational Approaches for Recreational Water Guideline (2018) for recreational water use at public beaches and waterfronts (200 cfu per 100 mL for *E. coli*). In addition, we included the PWQO for *E. coli* is 100 cfu per 100 mL on all Area Report summary figures (e.g., Figure 11).

Total coliform and *E. coli* measurements below the detection limit of 3 cfu/100 mL were assigned a value of 1 cfu/100 mL to calculate geometric means, which were calculated using all available data including any retests.

Total coliform counts from samples collected in 2022 are summarized in the Area Summary Reports. Total coliforms samples collected in 2022 did not exceed the 1000 cfu/100mL guideline at any site, with the exception of WLB-3, which could be indicative of an impact from the upstream agricultural wildlife. Elevated concentrations were frequently associated with precipitation events described by volunteers in their sampling notes.

As noted in Section 3.1, the MLA WQI field protocols require volunteers to re-sample a site if *E. coli* counts are greater than 50 cfu/100mL. *E. coli* counts exceeded 50 cfu/100 mL at 13 (6%) of 205 sampling events



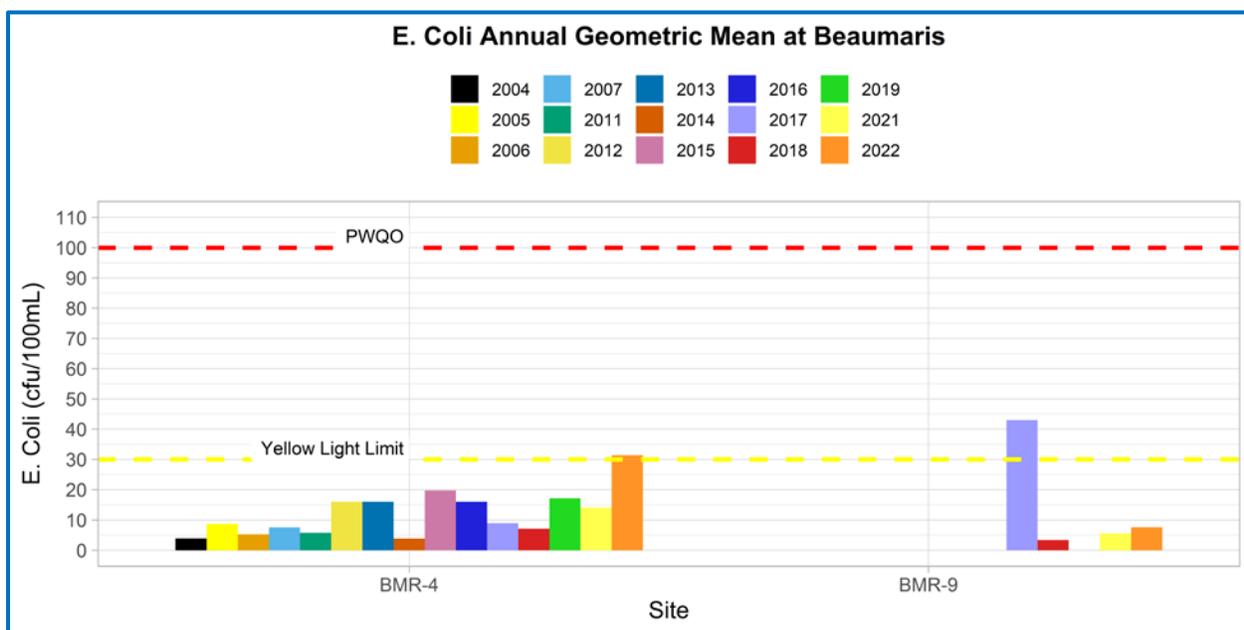
for *E. coli* in 2022. This frequency was lower than recorded in 2021 and consistent with those recorded in recent years (4.6% in 2019, 9.2% in 2018, 8.0% in 2017, and 8.7 % in 2016). Re-tests were not completed in 4 of the 13 sampling events that exceeded the 50 cfu/100mL limit.

Sampling areas where *E. coli* counts were elevated (>50 cfu/100ml) in 2022 include Beaumaris (BMR-10), Bruce Lake (BRU-6), Clear Lake (CLR-8), Minett (MIN-1, and 6), Moon River (MOO-6), Muskoka River (MRV-2, and 7), Star Lake (STR-4) and Willow Beach (WLB-1 and 3). Despite elevated concentrations during some sampling events some of the sites listed did not exceed the yellow light threshold for *E. coli* in 2022. The nearshore areas which exceeded a geometric mean of 30 cfu/100mL in 2022 were Beaumaris (BMR-4 and 10), Bruce Lake (BRU-6), Indian River (IND-2), Minett (MIN-1 and 6), Muskoka River (MRV-7) and Willow Beach (WLB-3).

Bruce Lake was flagged for additional focus in 2019 (Beacon 2020) due to “substantially higher” phosphorus concentrations at BRU-3 (7.9 µg/L in 2019) relative to the deep-water station (BRU-0; 7.2 µg/L), though we suspect that BRU-6 (19.2 µg/L) was the intended site. Spring phosphorus concentrations at Bruce Lake were lower at all sites in 2022 than those recorded in 2021 and 2019, however elevated bacteria concentrations remain a concern at BRU-6 suggesting a continued focus on nearshore sampling at Bruce Lake is warranted.

Indian River has been flagged an area of concern due to the MLA yellow light trigger for *E. coli* bacteria being exceeded at three of the six nearshore sampling stations in 2019. Two of the three bacteria samples collected at IND-2 in 2022 were storm event samples and bacteria counts can vary significantly both in space and over time. As bacteria counts have declined in 2022, we recommend standard sampling continue at Indian River sites in 2023, while attempting to avoid significant rainfall events to maintain consistency with long-term data.

Figure 11. Example of the Presentation of Long-term *E. coli* Monitoring Figures.



3.6 Summary and Conclusions

The MLA Water Quality Initiative Program assigns stoplights to each sample area based on the annual monitoring and long-term data collected as described in Section 3.1. In 2022, 55 areas were sampled, 44 of which were assigned green lights, while ten yellow lights and one red light were assigned based on the MLA criteria (Table 6). Yellow lights at five of the eleven sampling areas were the result of elevated bacteria concentrations, while five sampling areas (Boyd Bay, Bala Bay, Brandy Lake, Silver Lake (Port Carling) and Leonard Lake) experienced cyanobacterial blooms in 2018 - 2022 for which causation studies has not yet been completed, however the Leonard Lake Causation Study is currently underway. Blooms documented in 2022 did not exceed the MLA microcystin threshold of 20 µg/L and were therefore assigned a yellow light. Bruce Lake exceeded yellow light triggers for algae blooms and bacteria concentrations.

A single red light was assigned in 2022 to Willow Beach (WLB-3), where we identified a long-term statistically significant increasing trend in phosphorus concentrations despite a marked reduction in TP concentrations in 2022. Additional sampling and investigation to assess the sources of phosphorus at this location found that phosphorus concentrations were elevated near the agricultural area upstream of Willow Beach and thus best management practices may provide an opportunity to reduce the export of phosphorus to Lake Muskoka at this location. Results in 2022 were similar to those recorded in 2021 when 10 yellow and 1 red light were recorded.

Table 6. Summary of MLA WQI Threshold Exceedances in 2022.

Area	Site	<i>E. coli</i>	Total Phosphorus	Cyanobacteria Bloom	Stoplight
Bala Bay	BAL-0			2020	Yellow
Boyd Bay	BOY-0			2018	Yellow
Brandy Lake	BDY-0			2019, 2020	Yellow
Bruce Lake	BRU-4, BRU-5, BRU-6	>30 cfu /100 mL		2020	Yellow
Beaumaris	BMR-4, BMR-10	>30 cfu / 100mL			Yellow
Indian River	IND-2	>30 cfu/ 100 mL			Yellow
Leonard Lake	LEO-0			2020, 2021	Yellow
Minett	MIN-1, MIN-6	>30 cfu/ 100 mL			Yellow
Muskoka River	MRV-7	>30 cfu/ 100 mL			Yellow
Silver Lake	SPC-0			2020	Yellow
Willow Beach	WLB-3	>30 cfu/ 100 mL	5-year increase		Red

The MLA WQI field protocols require volunteers to re-sample a site if *E. coli* counts are greater than 50 cfu/100mL. Consistency of resampling improved in 2022. *E. coli* counts exceeded 50 cfu/100 mL at 41 sampling events and retests were not completed in 28 of those events in 2021. In 2022, 13 events warranted re-sampling which was performed in all but four of those events. Maintaining sampling protocols was improved in 2022 and continued vigilance is recommended to ensure anomalous data can be confirmed and to maintain consistency, as much as is possible, between current and historical samples.



4. Recommendations

As part of our first year assisting the MLA with their ongoing Water Quality Initiative Monitoring Program, HESL has formulated several recommendations which we believe will improve the program moving forward. These have been discussed within the technical report and are briefly summarized below.

1. Review of the sampling sites by the Environment Committee has been an annual part of the MLA WQI Program and should continue prior to sampling in 2023. We recommend maintaining consistent sampling at long-term sites whenever possible. Trend analyses in 2022 were performed on sites with a minimum of 5 years of data, which represent the absolute minimum number of samples to reasonably draw conclusions on trends over time. Additional data at long-term monitoring stations would increase the number of stations where long-term trend analysis is possible, strengthen the current trend analyses and benefit the program in the future.
2. HESL recommends continue to undertake sampling during dry weather to the extent possible and maintain good notetaking if antecedent rain occurred. Storm-based sampling was reduced in 2022, however continued training with volunteers is recommended to ensure methodological consistency and long-term data compatibility.
3. Retesting of bacteria samples that exceed the MLA Sampling Protocol threshold of 50 cfu/100 mL should be maintained. Sampling protocol compliance in 2022 was improved compared to issues identified during the 2021 Annual Report. Continued training with volunteers is recommended to ensure methodological consistency.
4. Water clarity (i.e., Secchi Disc depth) data that are currently collected under the WQI Program were highly variable. A thorough review of the Secchi data collected by the MLA to date was begun in 2022 to help identify and eliminate anomalous data if present. HESL will continue to screen and improve the long-term data in 2023.
5. An updated analysis of the long-term trends in Secchi depth was completed in 2022 to assess long-term changes in water clarity and, although no significant changes were detected, may be a valuable annual addition to the MLA WQI Program.
6. Willow Beach has been identified as an area of concern based on long-term increasing trends in phosphorus since monitoring began. Continued additional monitoring in 2023 within the watershed (e.g., the creek along Ziska Rd.) may be warranted to assess phosphorus sources and mitigation possibilities.
7. Minett continues to be an area of concern due to historically elevated bacteria counts at MIN-1 and yellow stoplight exceedances at MIN-1 and MIN-6 in 2022. We recommend that additional monitoring of bacteria concentrations continue in the MLA WQI program in 2023.
8. Bruce Lake was flagged for additional focus in 2019 due to “substantially higher” phosphorus concentrations at BRU-3. Phosphorus concentrations at Bruce Lake were lower in 2022 than 2019 and 2021, however elevated bacteria concentrations remain a concern at BRU-6 suggesting a



continued focus on nearshore sampling at Bruce Lake is warranted. We recommend that additional nearshore monitoring in Bruce Lake continue as part of the 2023 WQI program.

9. Indian River has been flagged an area of concern due to the MLA yellow light trigger for *E. coli* bacteria being exceeded at three of the six nearshore sampling stations. In 2022 only a single site at the Indian River exceeded the yellow stoplight trigger. Climate data review showed that precipitation in 2022 was the lowest it has been in the past 6 years, which would reduce overland runoff and thus bacteria in the River. Therefore, we recommend standard sampling continue at Indian River sites in 2023.
10. Windermere has been flagged as an area of concern in 2021. Nearshore phosphorus concentrations and bacteria at WIN-5 near Parker's Marina were substantially reduced in 2022 however low precipitation in 2022 is likely the primary driver of this improvement in water quality. Ongoing additional monitoring of this area is recommended to maintain the long-term record and continue to assess potential water quality issues.

5. References

- Beacon Environmental. 2020. 2019 Water Quality Initiative Report.
- DeSellas, A. Paterson, A.M., Sweetman, J., and Smol, J.P. 2008. Assessing the effects of multiple environmental stressors on zooplankton assemblages in Boreal Shield lakes since pre-industrial times. *Journal of Limnology* (1):41-56
- Dillon, P.J., Nicholls, K.H., Scheider, W.A., Yan, N.D. and Jeffries, D.S. 1986. Lakeshore Capacity Study - Trophic Status. Ontario Ministry of Municipal Affairs, Research and Special Projects Branch. 89 pp.
- Dillon, P. and Molot, L. 1997. Dissolved organic and inorganic carbon mass balances in central Ontario lakes. *Biogeochemistry* 36, pages29–42.
- Hall, R. and Smol, J.P. 1996. Paleolimnological assessment of long-term water-quality changes in south-central Ontario lakes affected by cottage development and acidification. *Canadian Journal of Fisheries and Aquatic Sciences*, 53, 1-17.
- Ministry of Health and Long-Term Care. 2018. Operational Approaches for Recreational Water Guideline.
- Paterson, A.P., Cumming, B.F., Smol, J.P., Hall, R. Marked recent increases of colonial scaled chrysophytes in boreal lakes: implications for the management of taste and odour events. *Freshwater Biology* 49, 199–207.
- Pick, F.R. 2015. Blooming algae: a Canadian perspective on the rise of toxic cyanobacteria. *Can. J. Fish. Aquat. Sci.* 73: 1149-1158.



Reinl, K.L., et al. 2021. Cyanobacterial blooms in oligotrophic lakes: Shifting the high-nutrient paradigm. *Freshwater Biology*, 1-14. DOI : 10.1111/fwb.13791

Smol, J.P. 2008. *Pollution of Lakes and Rivers: A Paleoenvironmental Perspective*, 2nd Edition.

Winter, J.W., A.M. DeSellas, R. Fletcher, L. Heintsch, A. Morley, L. Nakamoto and K. Utsumi. 2011. Algal blooms in Ontario, Canada: Increases in reports since 1994. *Lake and Reservoir Management*. 27:2 107-114.

Yan, N.J., Somers, K.M., Girard, R.E., Paterson, A.M., Keller, W., Ramcharan, C.W., Rusak, J.A., Ingram, R., Morgan, G.E., Gunn, J.M. 2008. Long-term trends in zooplankton of Dorset, Ontario, lakes: the probable interactive effects of changes in pH, total phosphorus, dissolved organic carbon, and predators. *Can. J. Fish. Aquat. Sci.* 65: 862–877.

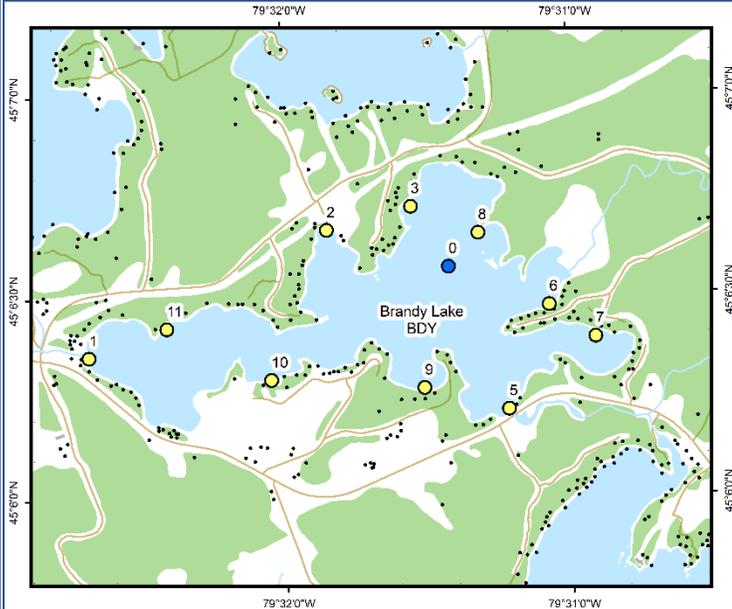


Appendix A. Area Reports





Brandy Lake (BDY)



Area Description:

Brandy Lake is moderately developed with a surface area of 1.15 km² and a maximum depth of 8 m. Many of the residential properties on Brandy Lake maintain a natural shoreline however, ~ 10% of the shoreline area is estimated to be un-buffered lawn. Wetlands comprise ~40% of the shoreline. Brandy Lake is a dystrophic lake, with naturally elevated dissolved organic carbon. MLA monitoring of Brandy Lake began in 2004.

Volunteer Recognition: Kevin Trimble, Andy von Bredow, Derek Stevens.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
BDY-0	-	10.9			
BDY-1	1.2			5	67
BDY-2	1.1			2	50
BDY-7	1.1			2	52
BDY-9	1.1			4	74
BDY-10	1.1			2	44
BDY-11	1.1			3	77
BDY-12	1.0			3	45
BDY-13	1.0			2	29
BDY-14	0.9			3	38

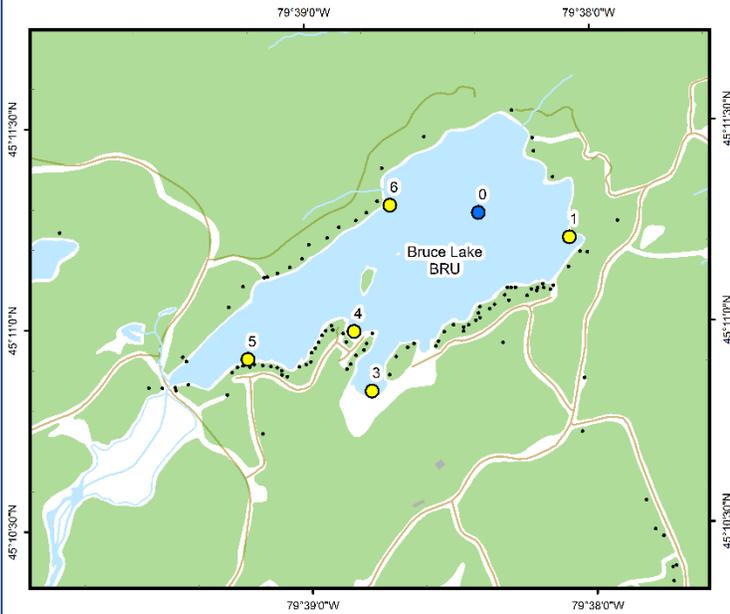


Hutchinson
Environmental Sciences Ltd.



In 2022, the spring phosphorus concentrations at the deep-water station (BDY-0) declined relative to 2021 and was below the historic DMM threshold of 28.4 $\mu\text{g/L}$ and the Provincial Water quality Objective (PWQO) for Nuisance Algal Growth (20 $\mu\text{g/L}$), but above PWQO for Protection Against Aesthetic Deterioration (10 $\mu\text{g/L}$). *E. coli* counts at all nearshore stations were below the yellow light trigger established by the MLA, new stations at BDY-12, 13 and 14 were established in 2022. Average annual Secchi disk depth at BDY-0 was not measured in 2022. A harmful algae bloom was detected in Brandy Lake in September of 2019 resulting in the lake being listed as vulnerable under the Districts Official Plan. Brandy Lake experienced another bloom in 2020 and we have therefore maintained the yellow light in 2022. **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Bruce Lake (BRU)



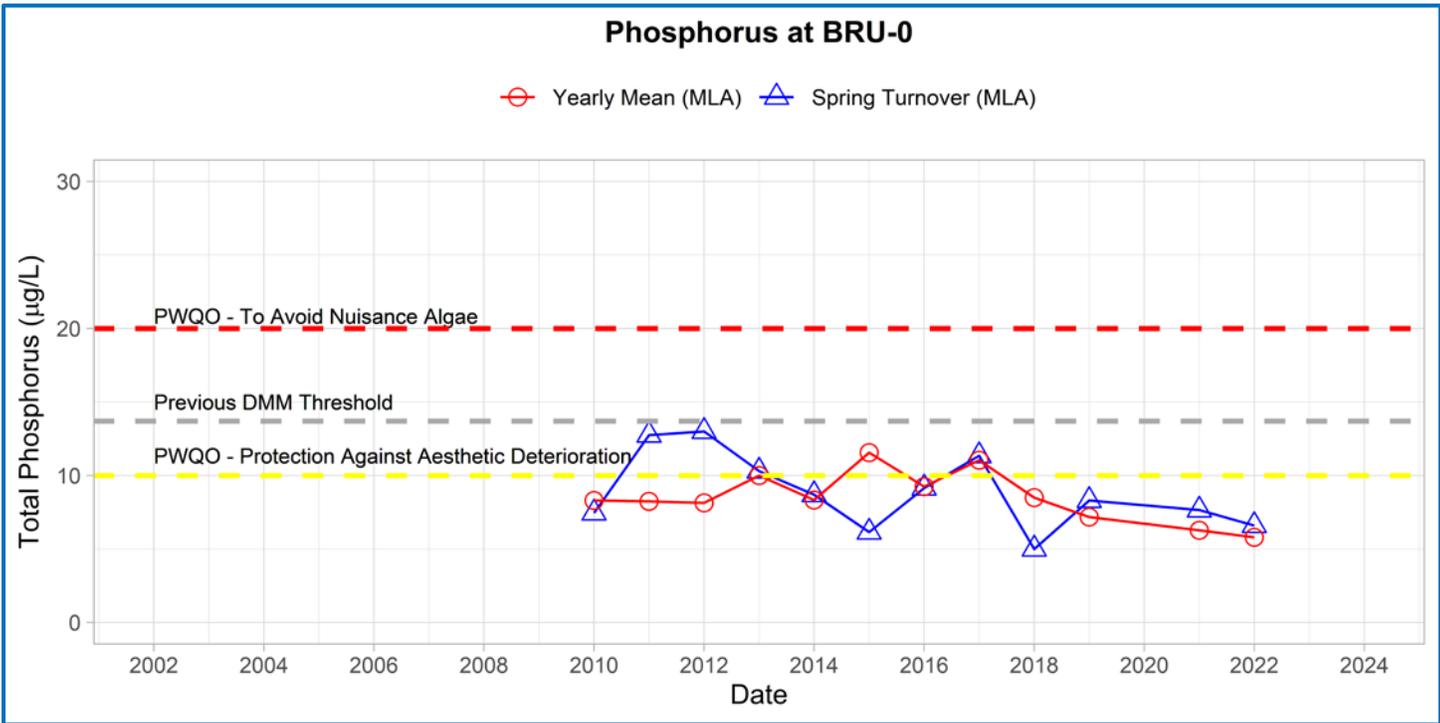
Area Description:

Bruce Lake is a small (surface area = 0.98 km²) lake with a maximum depth of 6 m, located east of Highway 632, between Lake Joseph and Lake Rosseau. Based on DMM data ~7% of the catchment area for this lake is comprised of wetlands. Moderate development on the lake includes a golf course located immediately to the south. Bruce Lake is currently listed as vulnerable by the District of Muskoka following an algae bloom in 2020.

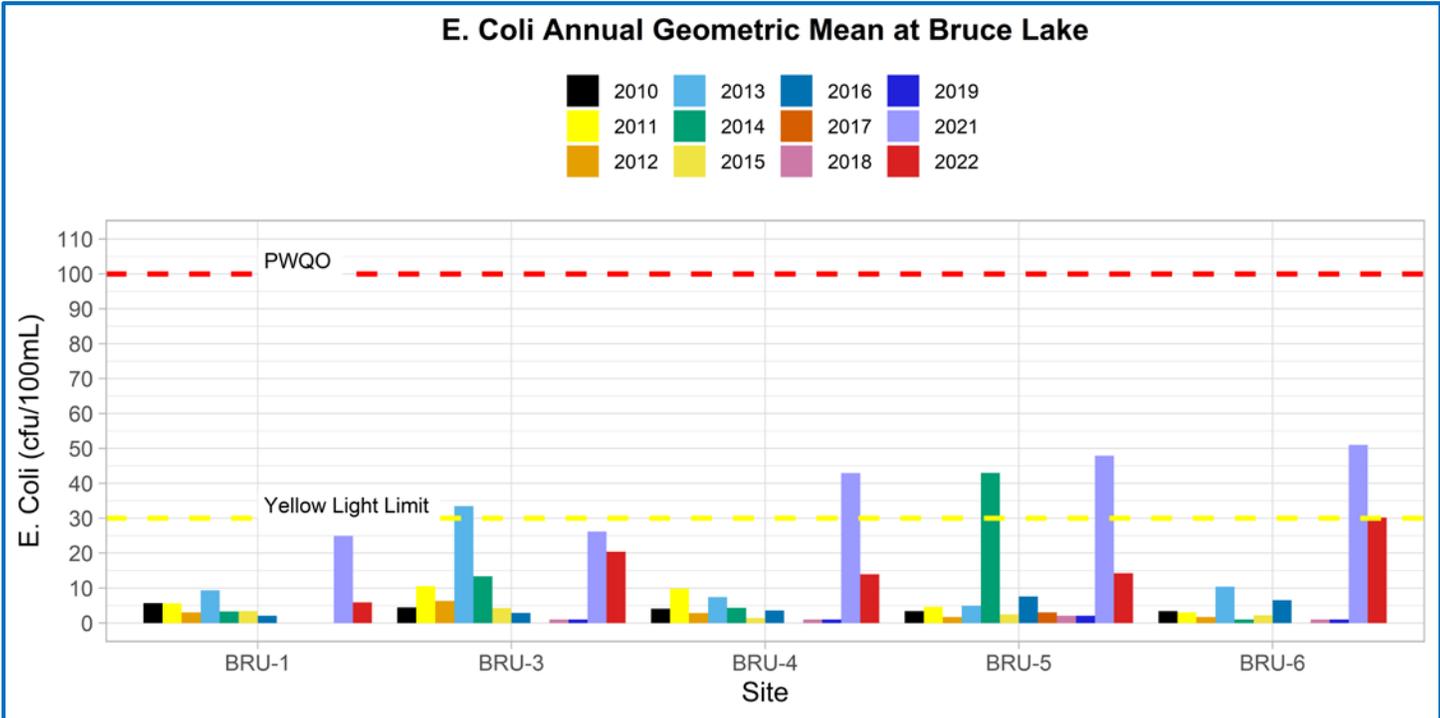
Volunteer Recognition: Andrew Coppola, John Harvey, Paul Hutchinson.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
BRU-0	4.3	6.6	5.8		
BRU-1		5.6	6.9	6	23
BRU-3		4.9	6.5	21	47
BRU-4		5.7	6.1	14	27
BRU-5		6.1	8.1	14	29
BRU-6		5.3	6.8	30	69



Note: Grubbs test indicates data collected in 2012 are considered an outlier

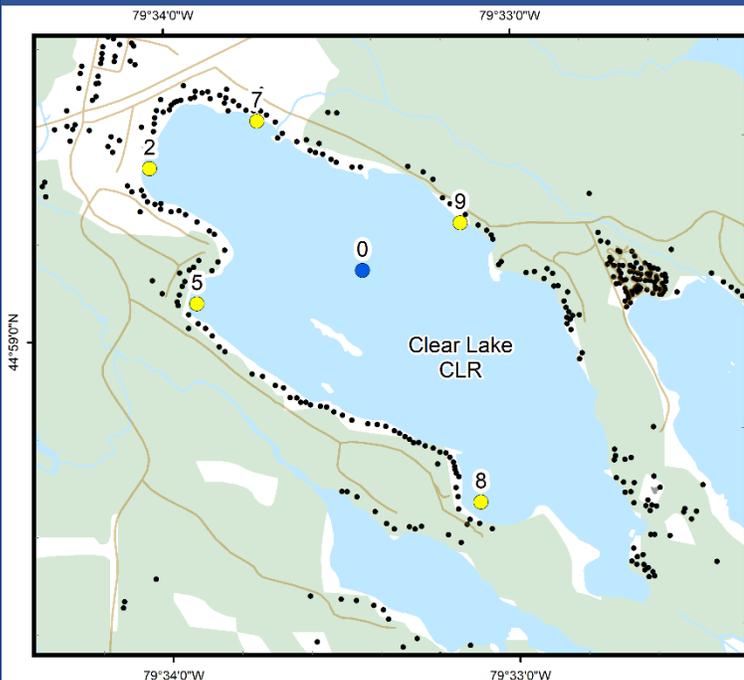


In 2022, annual average and spring phosphorus concentrations at the deep-water station (BRU-0) were below the historic DMM threshold of 13.7 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual and spring phosphorus concentrations at BRU-1, 3, 4, 5 and 6 were within the range of variability of previous monitoring. *E. coli* samples at all stations, except BRU-6 were below the yellow light trigger established by the MLA. Re-tests were not performed for samples over 50 cfu/100mL following the field protocol, follow-up bacteria sampling in 2023 is recommended to inform the 2022 results. Average annual Secchi disk depth (4.3 m) was consistent with previous



monitoring (2.4 and 6.5 m). A harmful algae bloom was reported on Bruce Lake in 2020 resulting in a yellow light being maintained for this lake in 2022. **HESL recommends ongoing sampling to continue to confirm 2022 E. coli results and monitor for long-term trends and emerging issues.**

Clear Lake (CLR)



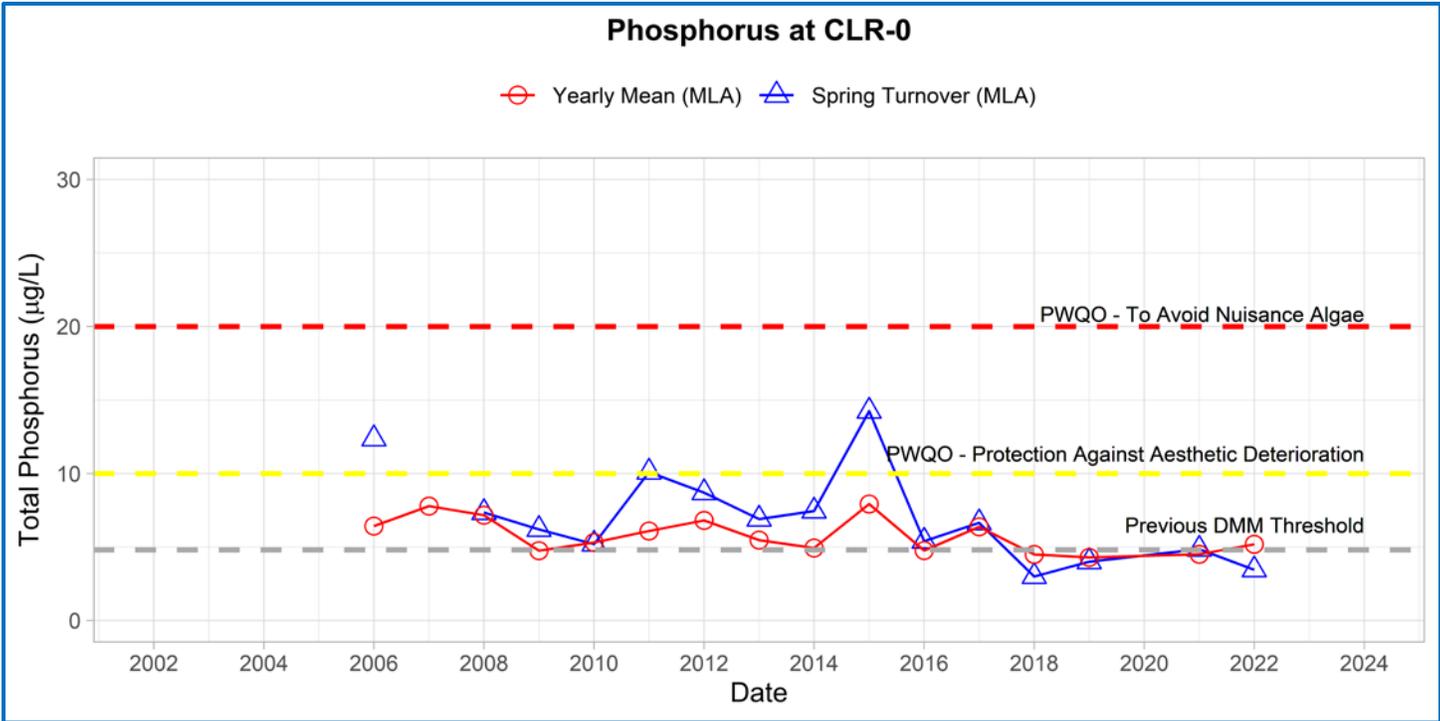
Area Description:

Clear Lake, also called Torrance Lake, is a small (surface area = 1.49 km²) lake with a maximum depth of 16 m. The lake is moderately developed with residential lots and is adjacent to Highway 169. Inflow and outflow of the lake are limited, and surface runoff comes from a small watershed area (0.84 km²). Clear Lake is currently classified as moderately sensitive and over threshold by the DMM. MLA monitoring of Clear Lake began in 2006.

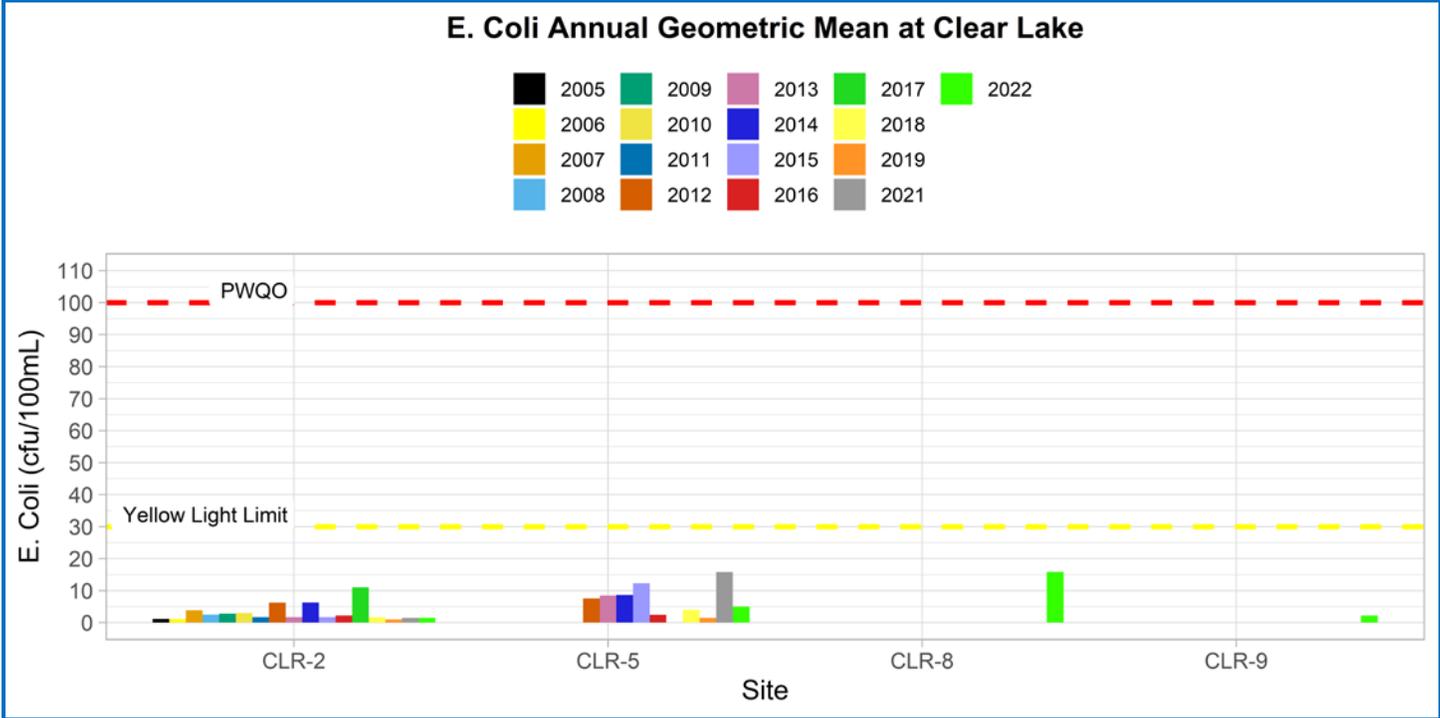
Volunteer Recognition: Bob and Sharon Cleverdon.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
CLR-0	5.5	3.5	5.2		
CLR-2		4.6	3.1	1	66
CLR-5		4.2	3.1	5	137
CLR-8		4.7	5.9	16	104
CLR-9		4.7	3.0	3	39



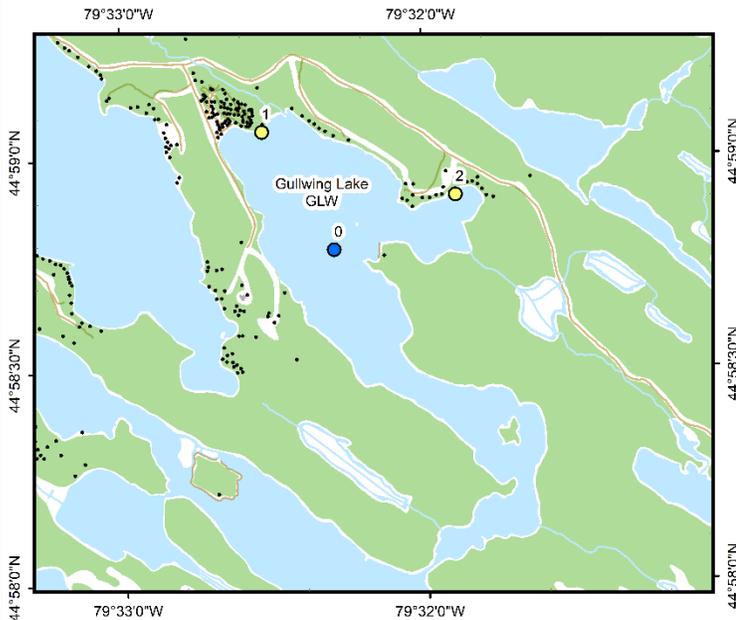
Note: Grubbs test indicates Spring and Annual Total Phosphorus data in 2012 are considered to be outliers.





In 2022, annual average and spring phosphorus concentrations at the deep-water station (CLR-0) were at the historic DMM threshold of 4.8 µg/L but below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual and spring phosphorus concentrations at CLR-2 and 5 were within the range of variability of previous monitoring; 2022 was the first phosphorus sampling year at CLR-8 and 9. *E. coli* counts at all stations were below the yellow light trigger established by the MLA. Average annual Secchi disk depth (5.5 m) was consistent with previous monitoring (3.63 and 9.30 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Gullwing Lake (GLW)



Area Description:

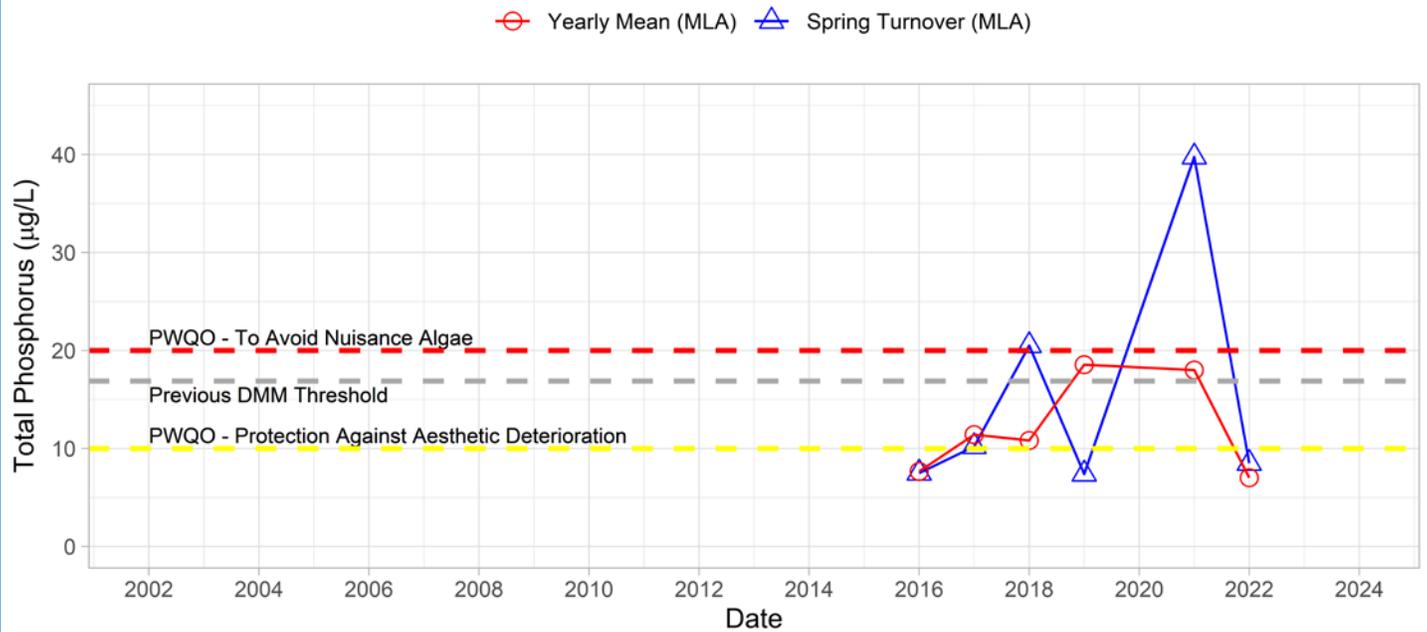
Gullwing Lake is located just south of Torrence and has an area of 0.84km² and a maximum depth of 9 m. The watershed area of Gullwing Lake is 5.71 km² includes Crown Land (25%), shoreline residential and a seasonal vacation park located in the northwest. Gullwing Lake is currently listed as moderate sensitivity by the DMM. MLA monitoring of Gullwing Lake began in 2016.

Volunteer Recognition: **Kellie Dobson, Kim Enns, Donna DiLello, and Jim Dobson.**

2022 Water Quality Results:

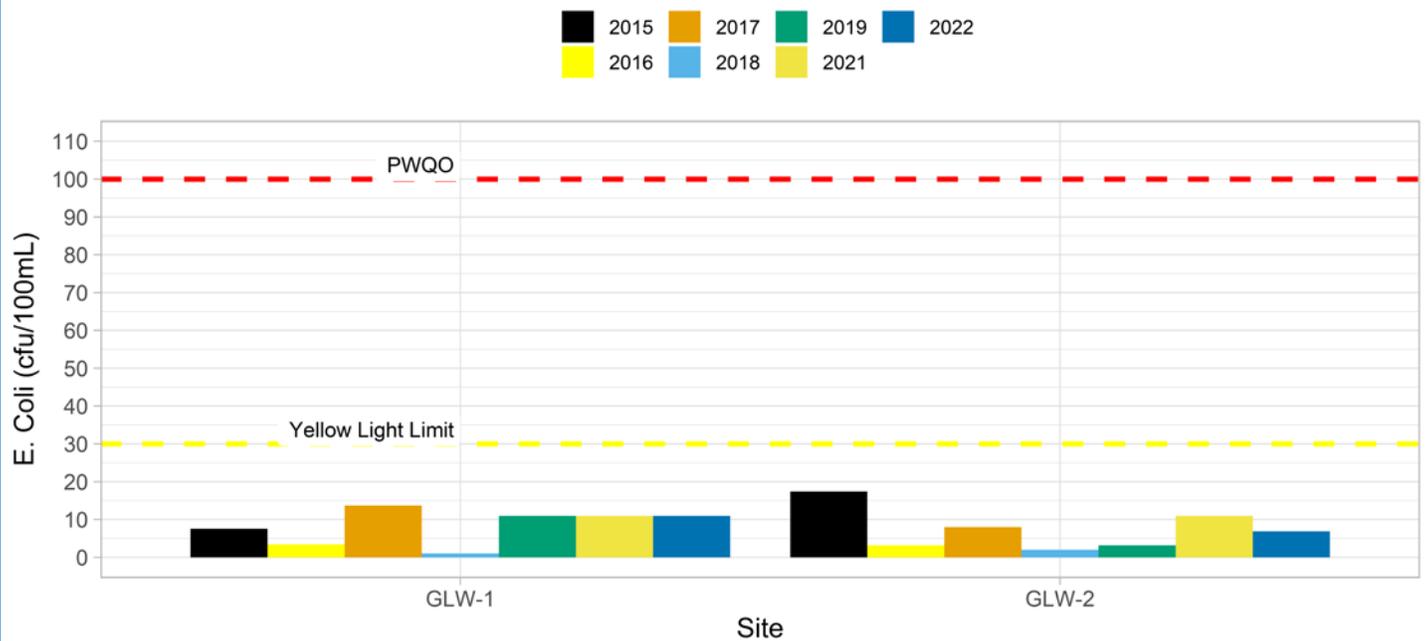
	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
GLW-0	2.4	8.5	7.0		
GLW-1		9.5	7.5	11	66
GLW-2		7.5	7.0	7	60

Phosphorus at GLW-0



Note: Grubbs test indicates no outliers in the spring or annual average phosphorus data.

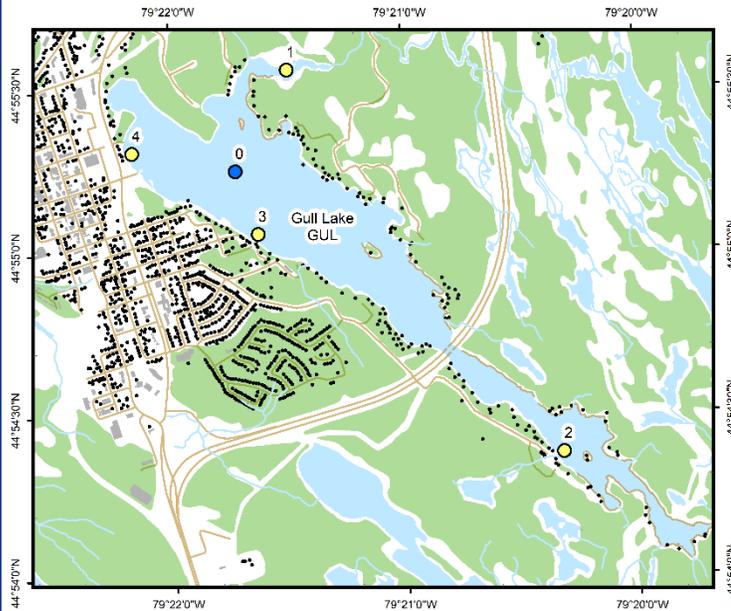
E. Coli Annual Geometric Mean at Gullwing Lake





In 2022, annual average and spring phosphorus concentrations at the deep-water station (GLW-0) were below the historic DMM threshold of 16.89 µg/L, as well as the Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and the guideline for prevention of Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual and spring phosphorus concentrations at GLW-1 and 2 were within the range of variability of previous monitoring. *E. coli* counts at all stations were below the yellow light trigger established by the MLA. Average annual Secchi disk depth (2.4 m) was consistent with previous monitoring (1.5 – 3.15 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and provide additional data to support the anomalous phosphorus value recorded in 2021.**

Gull Lake (GUL)



Area Description:

Gull Lake is a long, narrow lake with a surface area of 1.33 km² and a maximum depth of 7 m in the Town of Gravenhurst. Gull Lake receives inflow from Silver Lake at the south end along with nine creeks and overland runoff from the 3.6 km² watershed. The lake includes significant residential development from the Town of Gravenhurst, particularly in the northwest and Highway 11 crosses the lake at its midpoint. Gull Lake is not currently listed as vulnerable by the DMM. MLA monitoring of Gull Lake began in 2003.

Volunteer Recognition: Bruce & Anne Elliot, Dave & Debbie Stephens, George & Patricia Catleogh.

2022 Water Quality Results:

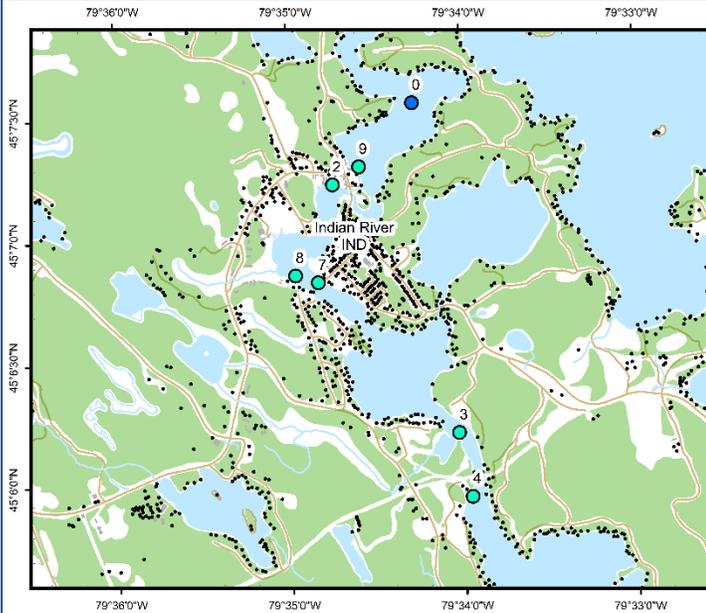
	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
GUL-0	3.55	3.0	6.3		
GUL-1				11	93
GUL-2				3	99
GUL-3				5	43
GUL-4				7	41



The spring phosphorus concentration at the deep-water station (GUL-0) was below the historic DMM threshold of 8.1 $\mu\text{g/L}$ as well as the Provincial Water Quality Monitoring Objectives (PWQO) for Protection Against Aesthetic Deterioration (10 $\mu\text{g/L}$) and the PWQO for Prevention of Nuisance Algal Growth (20 $\mu\text{g/L}$). *E. coli* counts at all stations were below the yellow light trigger established by the MLA. Average annual Secchi disk depth (3.55 m) was consistent with previous monitoring (2.5 – 4.8 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Indian River (IND)



Area Description:

The Indian River connects Lake Rosseau to Mirror Lake and Lake Muskoka. The river flows through and receives stormwater drainage from the urbanized area of Port Carling, which is highly developed. It also has a locks system, several marinas and numerous commercial and residential properties. A large wetland is located adjacent to the river. MLA monitoring of the Indian River began in 2002.

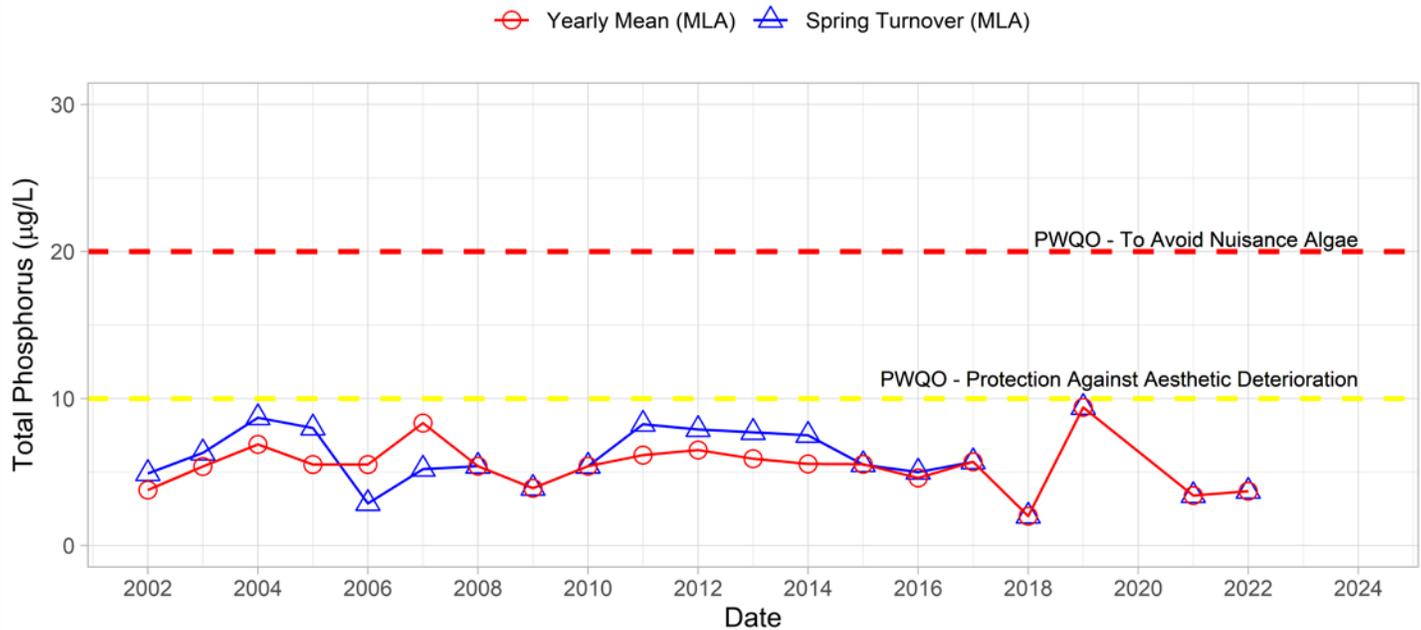
Volunteer Recognition: Jane Armstrong, Susan Carson, Ian Turnbull, Dianne Turnbull, and Chris Vandergrift.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
IND-0	4.0	3.7			
IND-2				28	126
IND-3				4	32
IND-4				15	44
IND-7		3.0	2.9	19	100
IND-8		3.0		15	41
IND-9		3.0		6	87

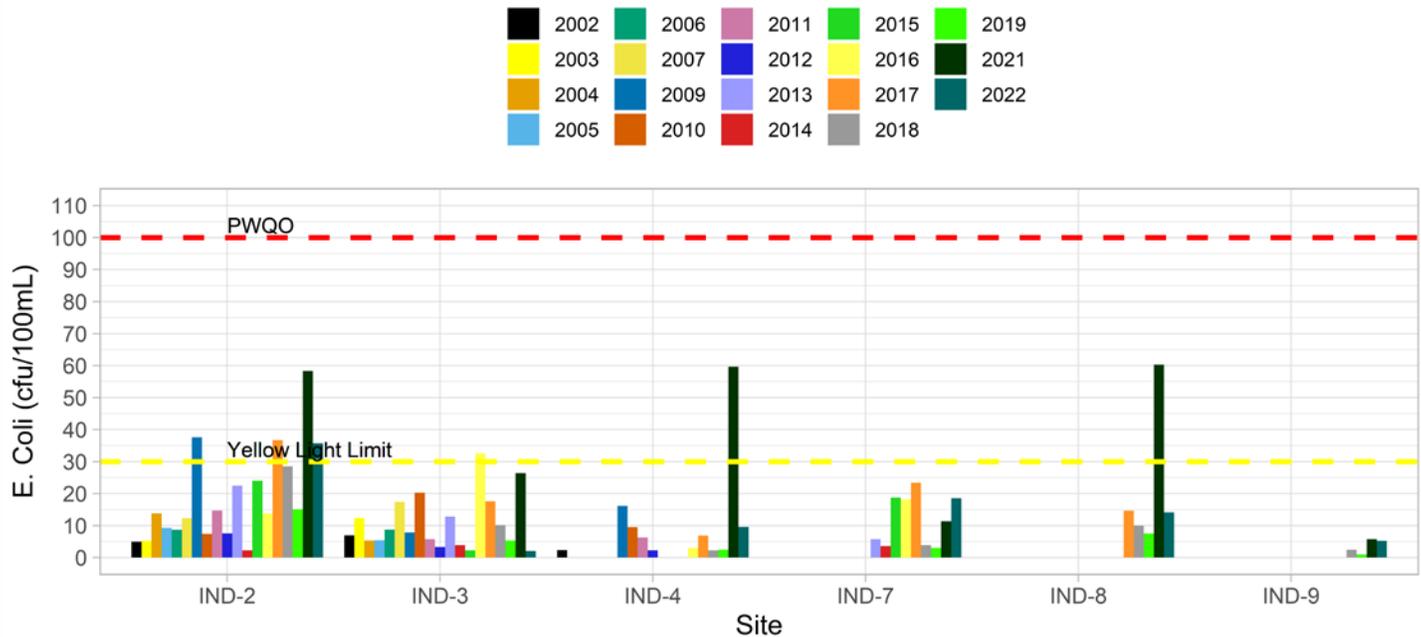


Phosphorus at IND-0



Note: Grubbs test indicates data collected no outliers in the spring or annual average phosphorus data.

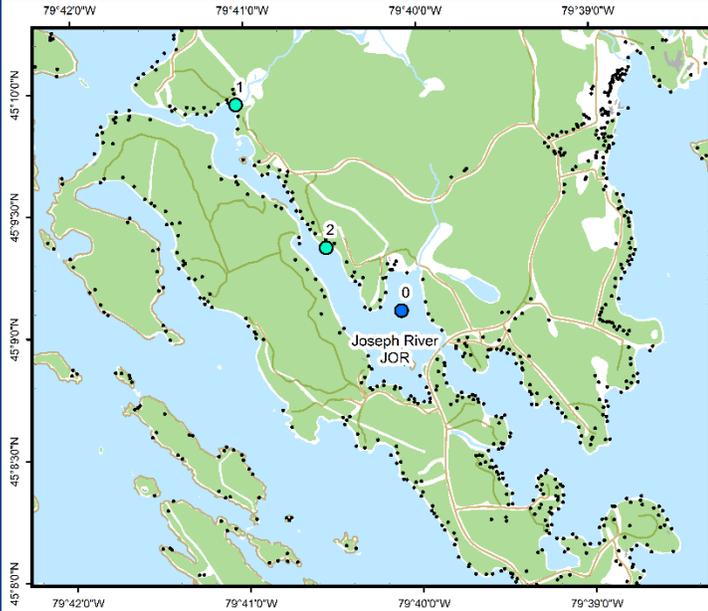
E. Coli Annual Geometric Mean at Indian River



In 2022, annual average and spring phosphorus concentrations at the deep-water station (IND-0) were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and prevention of Nuisance Algal Growth (20 µg/L). Nearshore monitoring of spring phosphorus concentrations at IND-7, 8 and 9 were within the range of variability of previous monitoring. *E. coli* counts at IND-2 were above the yellow light trigger established by the MLA. Average annual Secchi disk depth (4.0 m) was consistent with previous monitoring (2.0 – 5.6 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Joseph River (JOR)



Area Description:

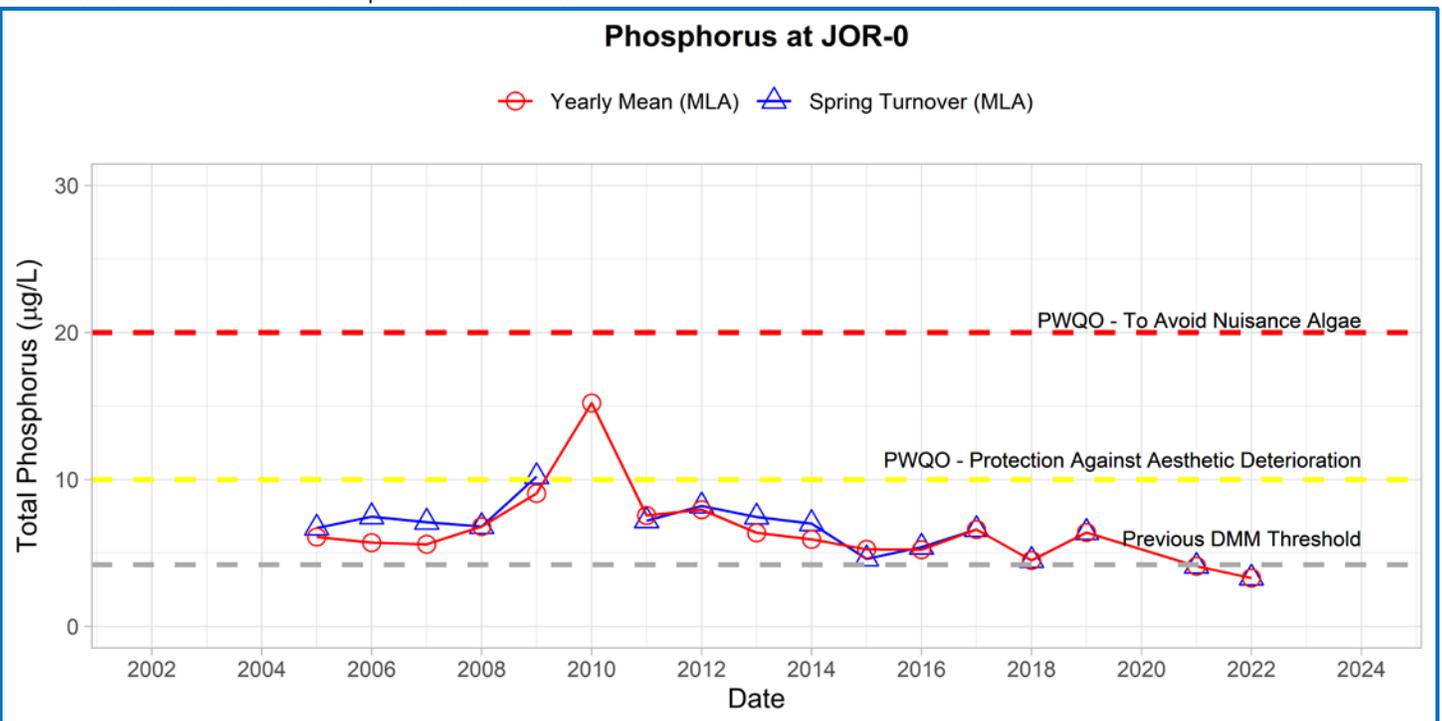
The Joseph River is heavily developed watercourse which flows from Lake Joseph to Lake Rosseau. The river is 1.37 km² in surface area and has a maximum depth of 8 m. Development in the watershed includes a marina, and a bridge crossing for Peninsula Road. The river is the primary waterway between Lake Joseph and Lake Rosseau and therefore receives a high level of boat traffic. The Joseph River was historically classified as moderately sensitive by the DMM. MLA monitoring of the Joseph River began in 2005.

Volunteer Recognition: Beth Guy, Laurie Leiser and James Woodruff.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
JOR-0	3.6	3.3			
JOR-1		4.3	5.3		
JOR-2		4.4			

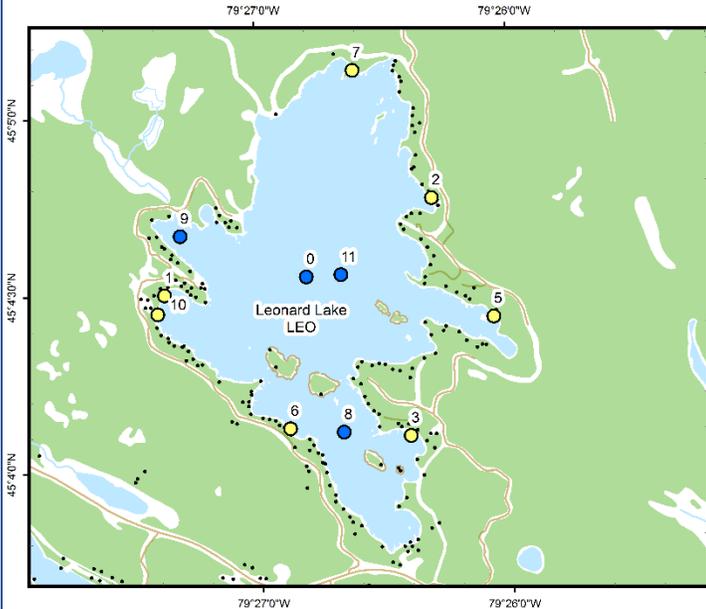
Note: Grubbs test indicated annual average phosphorus data collected in 2010 are considered an outlier as a result of a single measurement which has been removed from the dataset as suspected contamination.





Annual average and spring phosphorus concentrations at the deep-water station (JOR-0) were below the historic DMM threshold of 4.2 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of spring phosphorus concentrations at JOR-1 and 2 were within the range of variability of previous monitoring, as was the annual average phosphorus concentration at JOR-2. Average annual Secchi disk depth (3.6 m) was consistent with previous monitoring (2.4 and 5.38 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Leonard Lake (LEO)



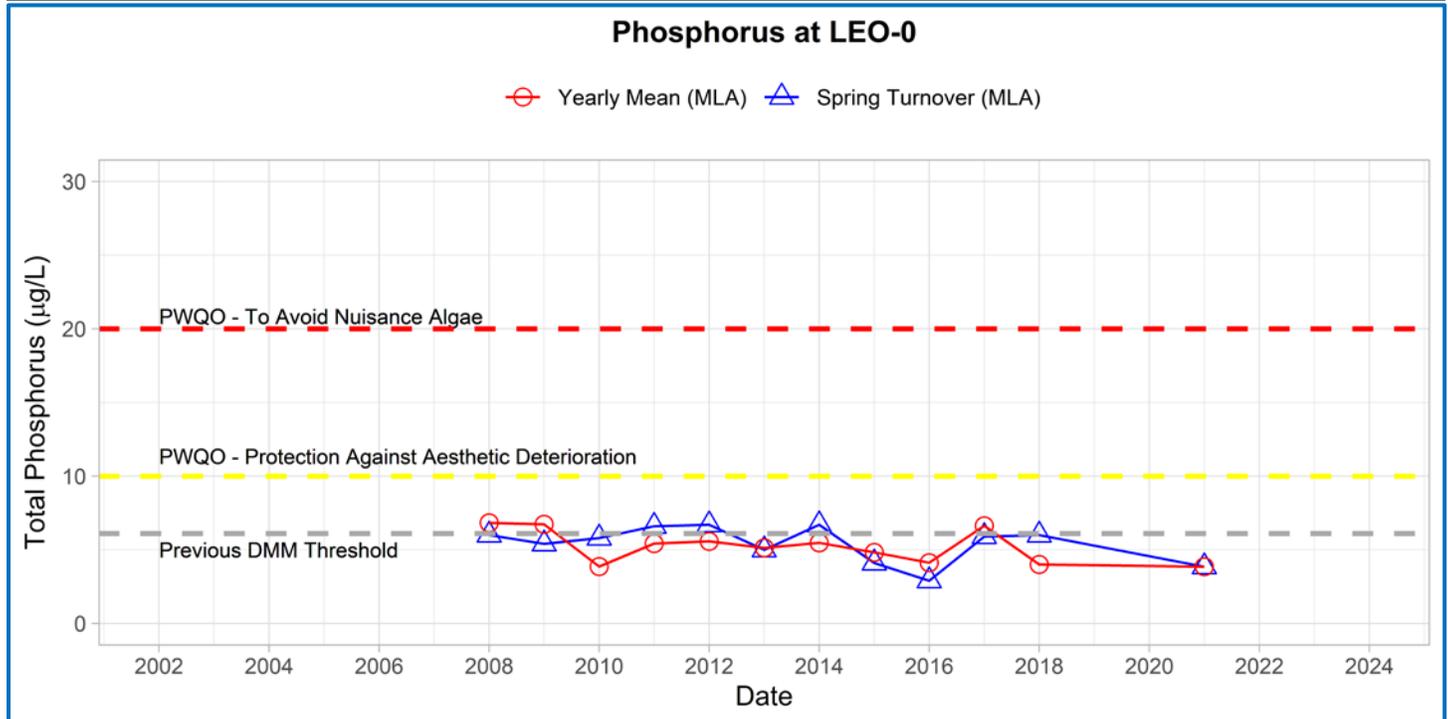
Area Description:

Leonard Lake is a moderately developed lake with a surface area of 1.52 km² and a maximum depth of 16 m. The shoreline of Leonard Lake remains largely unaltered with 93% identified in a natural state, while backlot assessment estimates ~9% altered. There is limited inflow and outflow of water on this lake, and wetlands comprise 9% of the watershed. Leonard Lake is currently listed as vulnerable due to a recent algae bloom, which is currently under investigation by the DMM. MLA monitoring of Leonard Lake began in 2008.

Volunteer Recognition: Betty Isbister, Ester Giesbrecht, and Bruce McNeely

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
LEO-8	3.8	4.4	3.2		



Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.

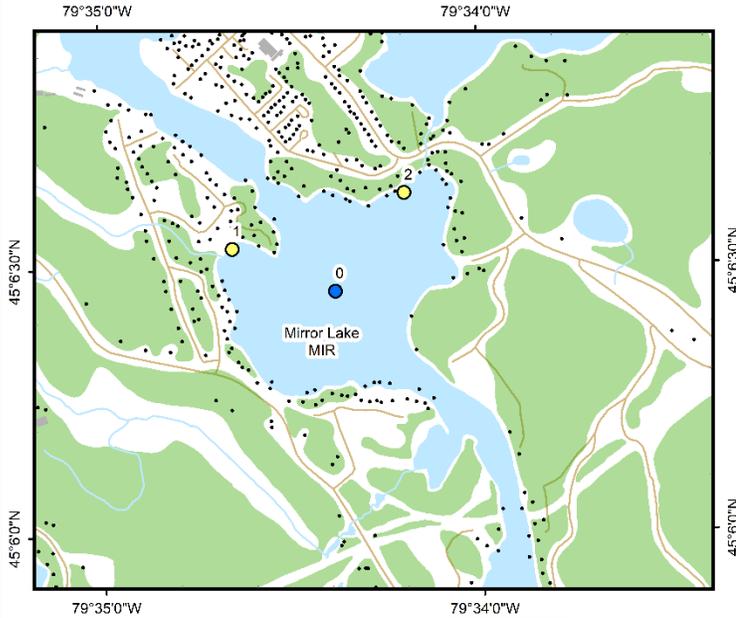


The spring phosphorus concentration at the deep-water station (LEO-0) was not recorded in 2022. The spring phosphorus concentration at LEO-8 was below the historic DMM threshold of 6.1 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). No nearshore monitoring of spring phosphorus concentrations was performed in 2022. The lack of consistent or long-term sampling makes it difficult to assess potential changes in the lake or to potentially connect those changes with activities within the watershed. We would recommend a review of the Leonard Lake sampling strategy by the MLA to focus on fewer sites that are sampled regularly, as is done elsewhere. *E. coli* samples were not collected in 2022. Average annual Secchi disk depth (3.8 m) was measured at LEO-8 and was consistent with previous monitoring in 2018 (4.2 m). Leonard Lake experienced cyanobacterial blooms in 2020 and 2021 with toxin concentrations below 20

µg/L and is listed as yellow pending the completion of a causation study on the impact of development in the area. **HESL recommends a review of the Leonard Lake sampling strategy by the MLA to focus on fewer sites that are sampled regularly beginning in 2023 to monitor for long-term trends and emerging issues.**



Mirror Lake (MIR)



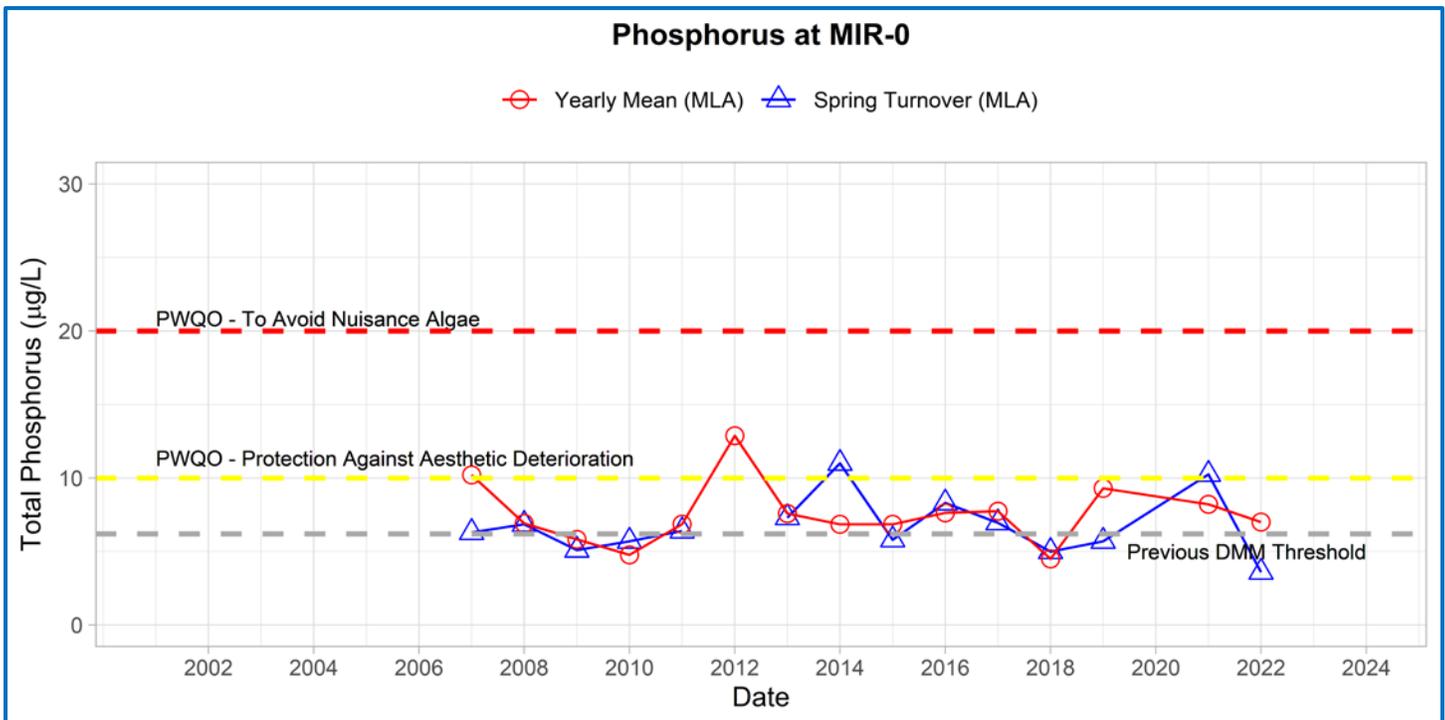
Area Description:

Mirror Lake is a widening of the Indian River south of Port Carling just north of the inflow to Lake Muskoka. The lake has a surface area of 0.46 km² and a maximum depth of 8 m. Two creeks flow into the lake near sampling sites MIR-1 and MIR-2. Development on the lake is high and includes drainage from the urban area of Port Carling. Mirror Lake has a small watershed, approximately 0.97 km², and is currently classified as moderately sensitive and over-threshold by the DMM. MLA monitoring of Mirror Lake began in 2007.

Volunteer Recognition: Susan Carson, Jane Armstrong and Chris Vandergrift

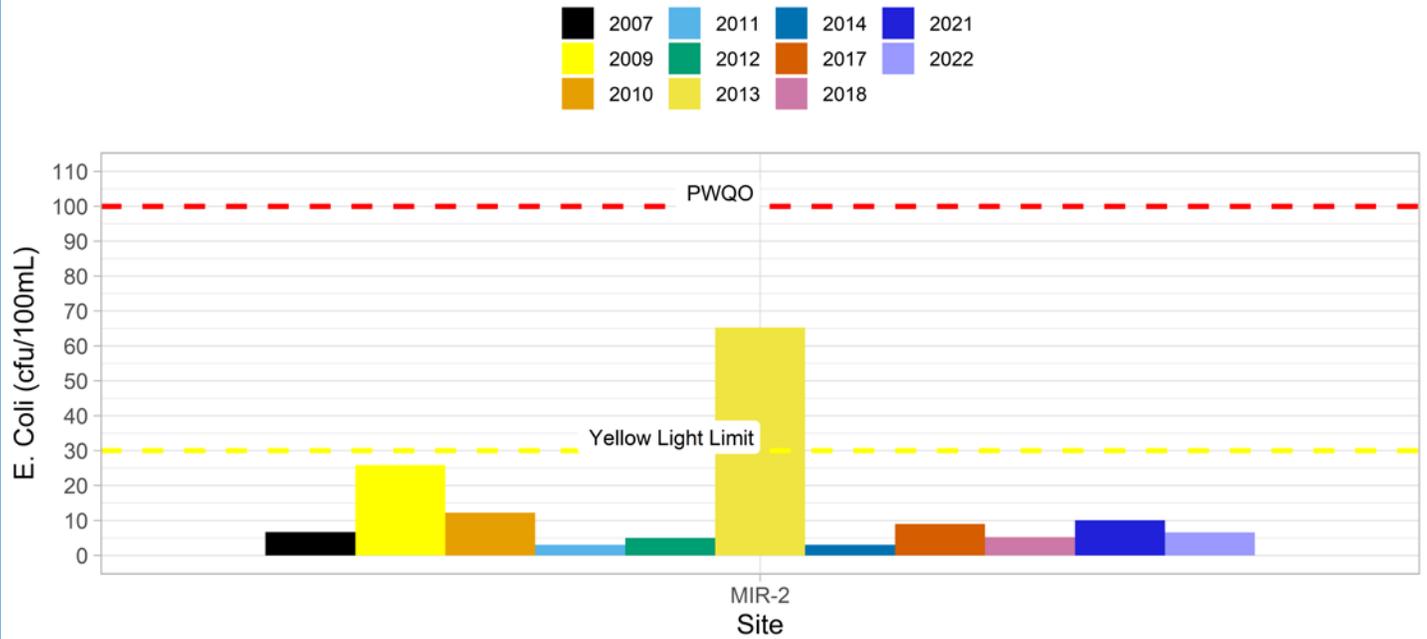
2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
MIR-0	2.7	3.6	7.0		
MIR-2		5.0		7	36



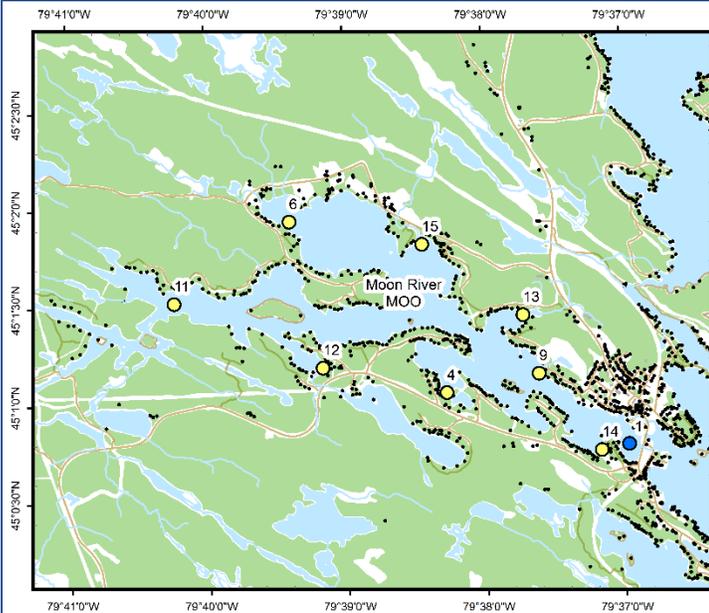
Note: Grubbs test indicates spring phosphorus data collected in 2012 are considered an outlier.

E. Coli Annual Geometric Mean at Mirror Lake



Annual average phosphorus concentrations at the deep-water station (MIR-0) were above the historic DMM threshold of 6.2 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) but below the PWQO for the Prevention of Nuisance Algal Growth (20 µg/L). Spring phosphorus concentrations in 2012 and 2021 were considered outliers from the dataset. Nearshore monitoring of the spring phosphorus concentration at MIR-2 was within the range of variability of previous monitoring. *E. coli* counts were below the MLA stoplight limits at MIR-2 in 2022. Average annual Secchi disk depth (2.7 m) was consistent with previous monitoring (1.95 and 4.45 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Moon River (MOO)



Area Description:

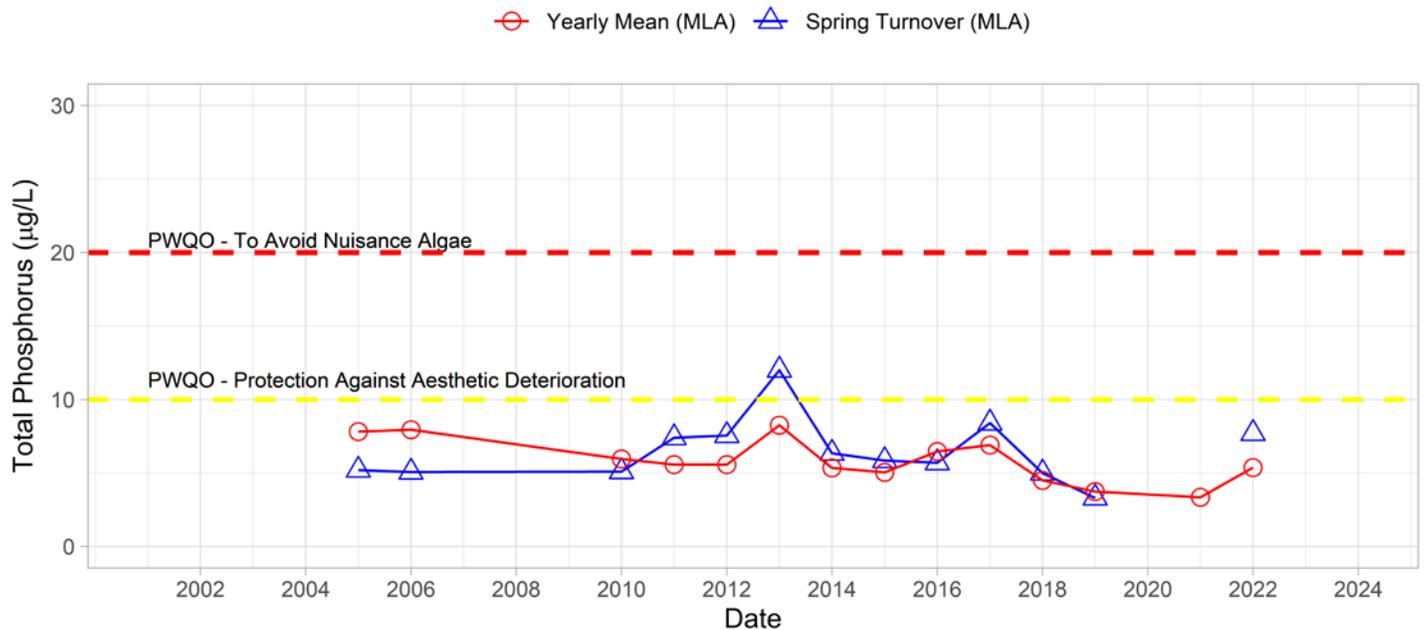
The Moon River is the main outlet of the Muskoka Watershed, flowing from Bala Bay of Lake Muskoka into Georgian Bay. The sampling region is highly developed including the urbanization from the Town of Bala, numerous roads and extensive shoreline development. Numerous small creeks outlet into the sampling area, several of which drain small wetland areas.

Volunteer Recognition: Barry Fisher.

2022 Water Quality Results:

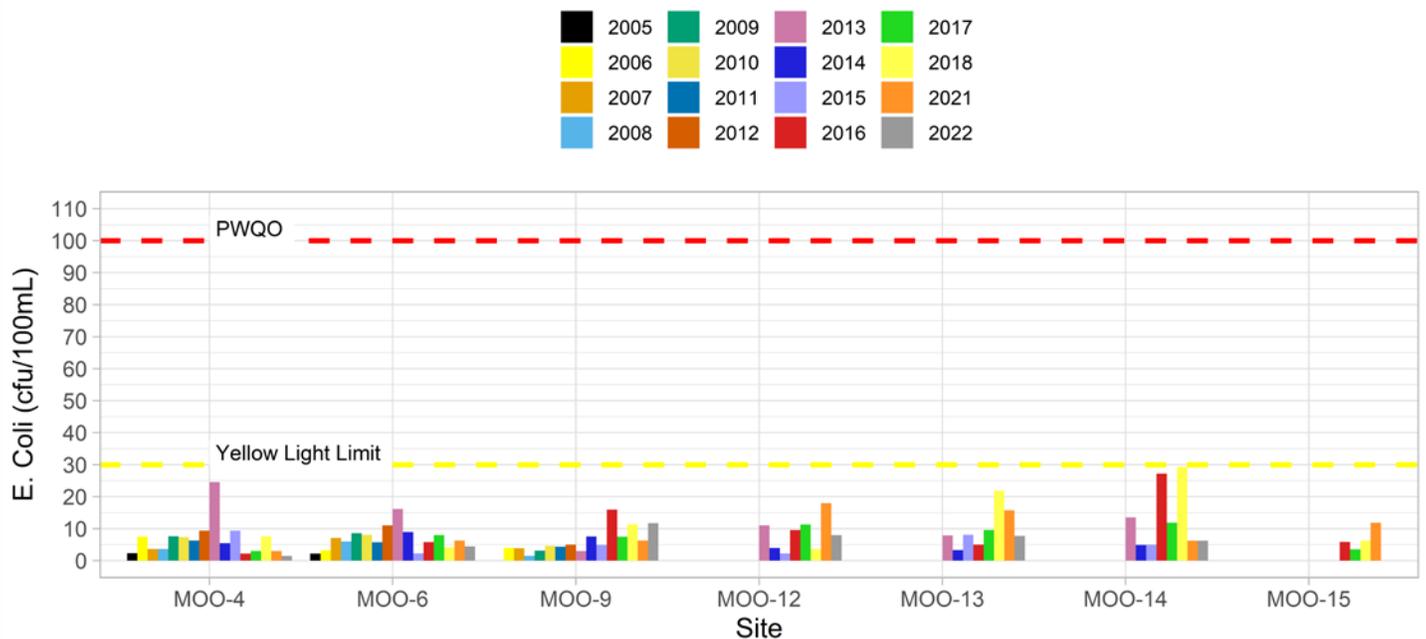
	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
MOO-1		7.7	5.4		
MOO-4		10.9	6.3	2	9
MOO-6		5.9	5.1	5	14
MOO-9		8.7	5.6	12	22
MOO-11	3.1	3.0	2.3		
MOO-12		3.8	2.7	8	29
MOO-13		5.0	6.5	8	21
MOO-14		7.4	4.4	6	18

Phosphorus at MOO-1



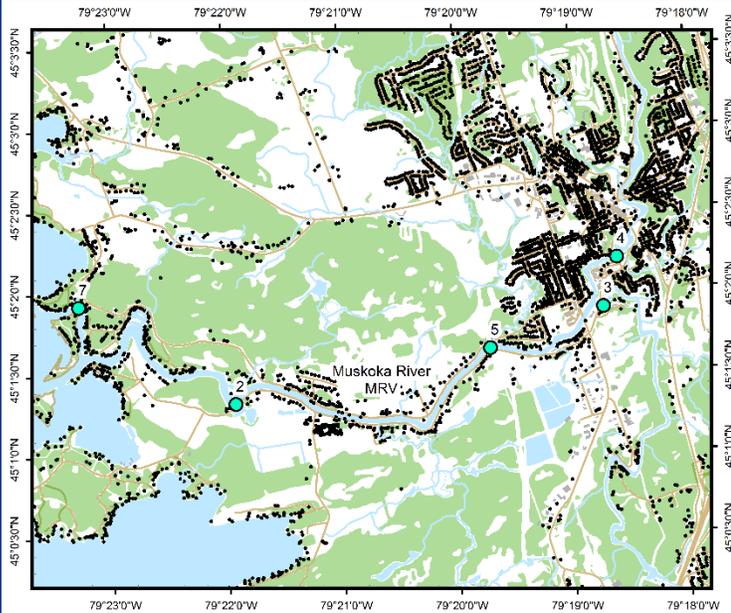
Note: Grubbs test indicates spring phosphorus data collected in 2013 are considered an outlier

E. Coli Annual Geometric Mean at Moon River



Annual average phosphorus concentrations at the deep-water station (MOO-1) were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Spring phosphorus was not collected at MOO-1. Nearshore monitoring of annual average and spring phosphorus concentrations at MOO-4, 6, 9, 11, 12, 13, 14 and 15 were within the range of variability or below values measured during previous monitoring. Average annual Secchi disk depth (3.1 m) was consistent with previous monitoring (3.0 and 4.0 m). *E. coli* counts were below the MLA stoplight trigger at all stations. **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Muskoka River (MRV)



Area Description:

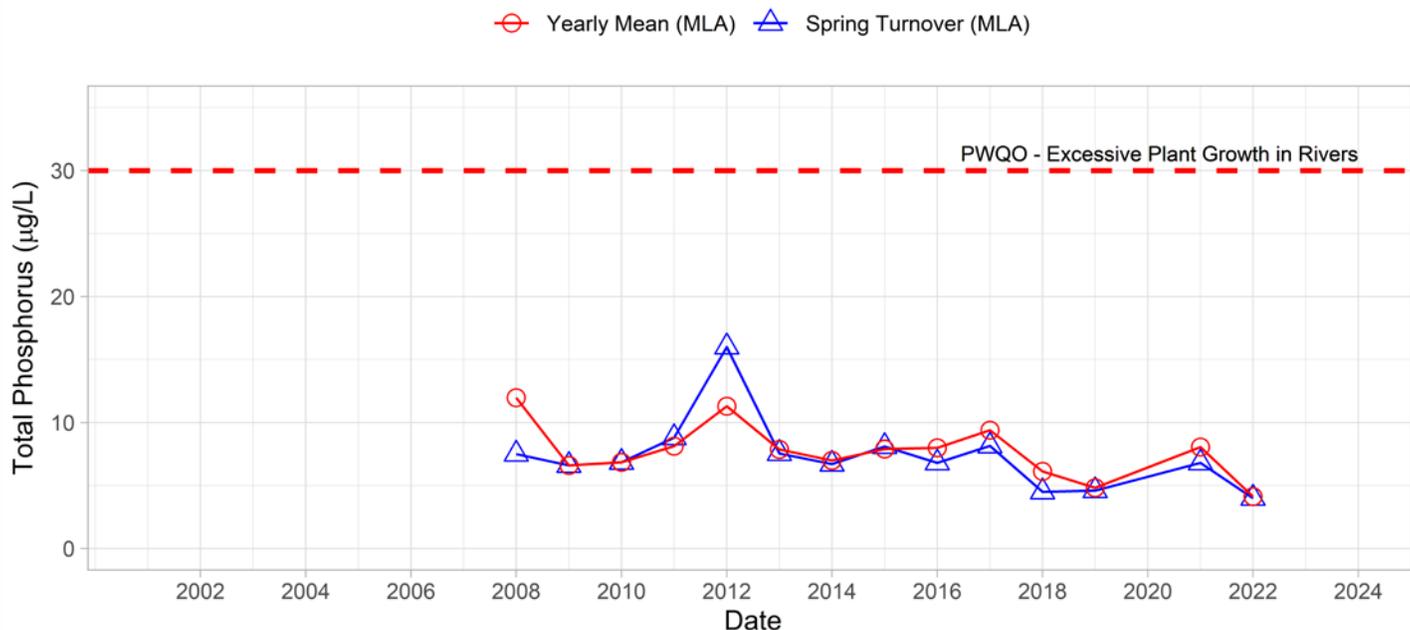
The MLA sample area of the Muskoka River includes the downstream reach from Bracebridge Falls southwest to Alport Bay in Lake Muskoka. The area is highly developed including the urbanized area of Bracebridge, agricultural fields, and extensive residential properties along the entire shoreline. Land clearance and roads are located along both shorelines of the river. MLA monitoring of the Muskoka River began in 2008.

Volunteer Recognition: Mark and Donna Naylor.

2022 Water Quality Results:

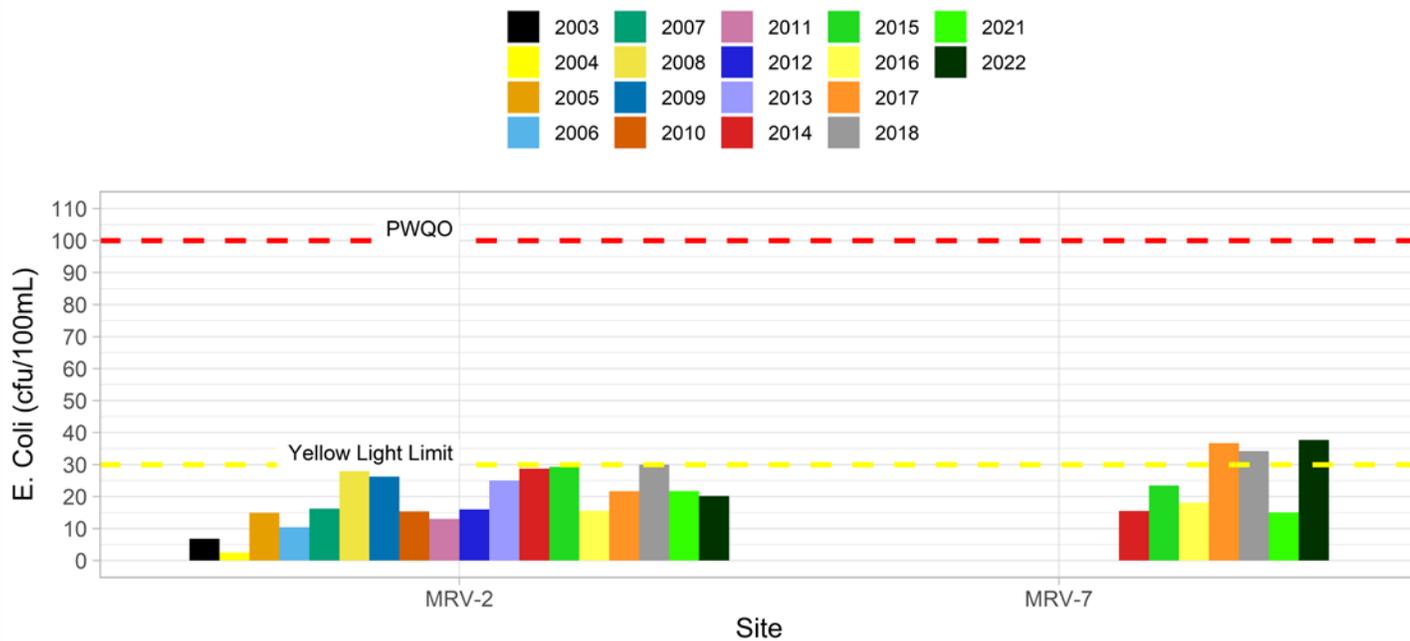
	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
MRV-2	2.7	4.0	4.1	20	299
MRV-3		4.6			
MRV-4		6.5			
MRV-5		6.0			
MRV-7		9.8		38	381

Phosphorus at MRV-2



Note: Grubbs test indicates spring phosphorus data collected in 2012 are considered an outlier.

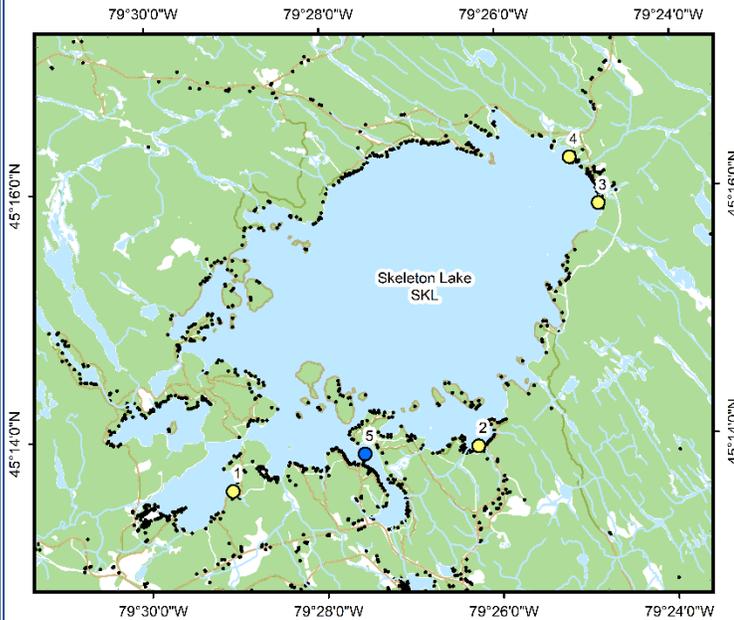
E. Coli Annual Geometric Mean at Muskoka River





Annual average and spring phosphorus concentrations at the downstream station (MRV-2) were below Provincial Water Quality Monitoring Objectives for the Elimination of Excessive Plant Growth in Rivers and Streams (30 µg/L). Nearshore monitoring of spring phosphorus concentrations at MRV-3, 4, 5 and 7 were within the range of variability of previous monitoring years. *E coli* samples collected in 2022 at MRV-7 were above the MLA stoplight limits. Average annual Secchi disk depth (2.7 m) was consistent with previous monitoring (1.22 and 10.25 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Skeleton Lake (SKL)



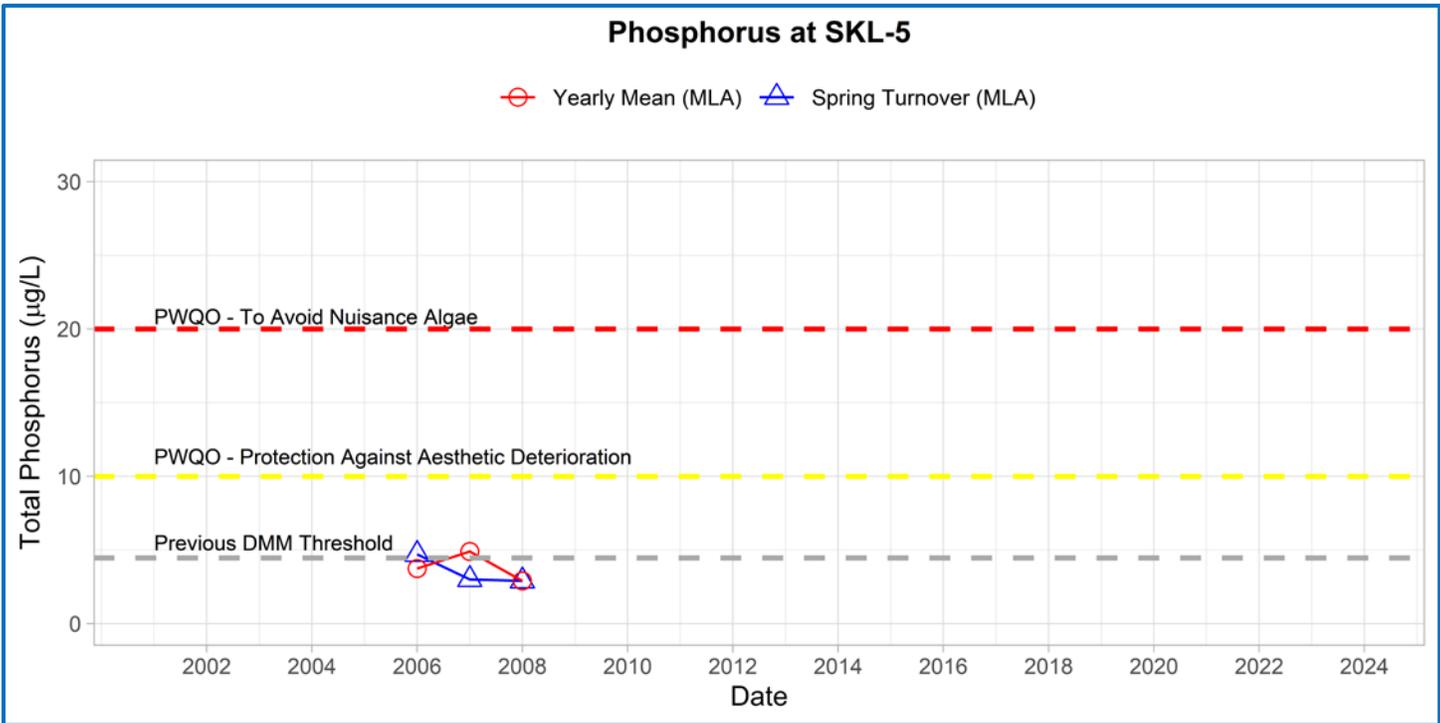
Area Description:

Skeleton Lake is large lake located east of Lake Rosseau and North of Three Mile Lake. It has a surface area of 20.54 km² in area and a maximum depth of 60 m. Skeleton Lake receives drainage from a 46.68 km² watershed. Skeleton Lake is not currently listed as vulnerable by the DMM. MLA monitoring of Skeleton Lake began in 2006 but ended in 2008, sampling resumed in 2021 and is the first sampling event by the MLA since 2008.

Volunteer Recognition: Geoff Ross, Jan Hunter & Tony Shevsky.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
SKL-1	3.5	3.0	3.8		
SKL-2	4.0	3.0	2.5		
SKL-3	6.0	3.0	3.0		
SKL-4	4.0	6.0	3.3		
SKL-6	7.0	3.0	2.5		



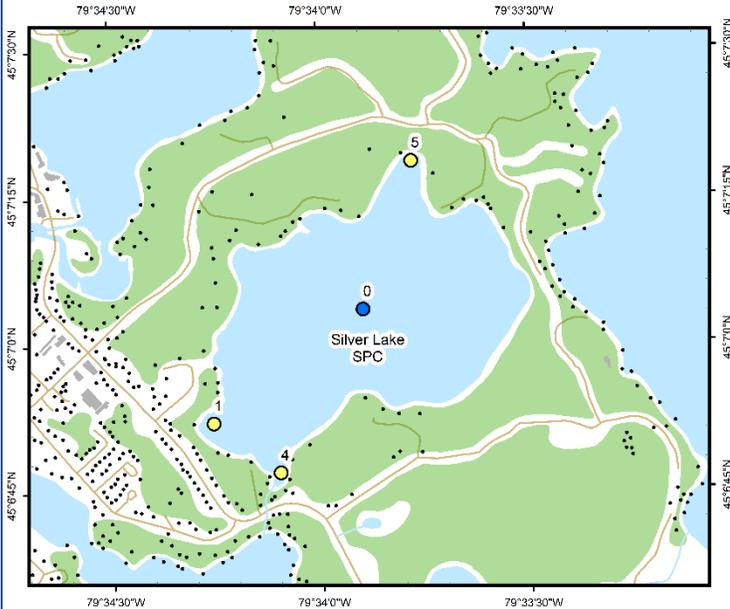
Note: Grubbs test indicates no spring or annual average phosphorus data collected are considered outliers.



Annual average and spring phosphorus concentrations at the deep-water station (SKL-5) was not sampled in 2022. Nearshore monitoring of annual and spring phosphorus concentrations at SKL-1, 2, 3, and 4 was consistent with 2021 results, while a new site at SKL-6 was established in 2022. *E. coli* samples were not collected in 2022 at Skeleton Lake. **HESL recommends ongoing sampling to enable the assessment of long-term trends and emerging issues. If sampling of Skeleton Lake continues monitoring the historical long-term monitoring station (SKL-5), where some previous data are available, is recommended. The MLA WQI from 2008 lists SKL-5 as a deep-water station, however based on the location of SKL-5 it is not a deep-water station, if long-term deep-water monitoring of Skeleton Lake is desired a revised deep-water station could be established by HESL and the Environment Committee.**



Silver Lake (SPC)



Area Description:

Silver Lake is a small lake (surface area = 0.56 km²) with a maximum depth of 14 m just east of Port Carling and west of Arthurlie Bay. The lake has a small watershed area (0.59 km²) and is moderately developed with residential properties. Thinned forest accounts for approximately 50% of the upland area, however 90% of the shoreline is in a natural state. Drainage from Port Carling enters the lake in the southwest and a single outlet drains from the lake in the south. Silver Lake is not currently listed as vulnerable by the DMM.

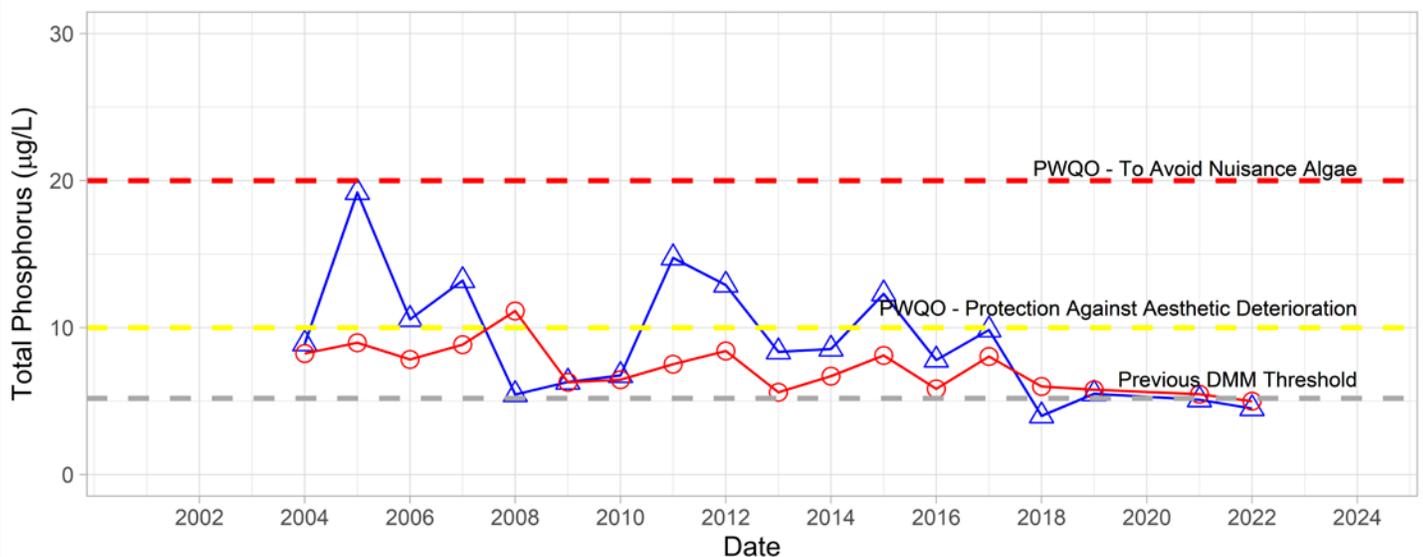
Volunteer Recognition: Barbara Graydon, Matthew Graydon, Mike Graydon and Johnathan Graydon

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
SPC-0	4.4	4.5	5.0		
SPC-1				7	36
SPC-4				3	22
SPC-5				7	58

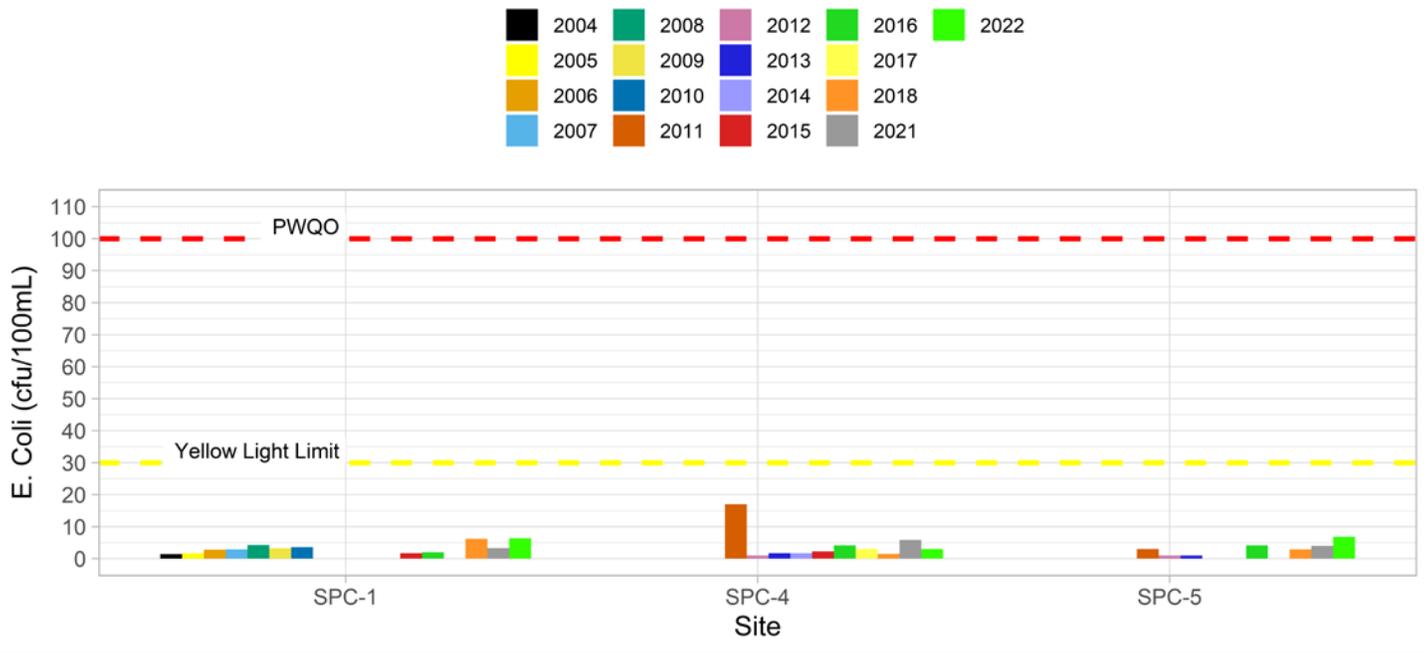
Phosphorus at SPC-0

○ Yearly Mean (MLA) △ Spring Turnover (MLA)



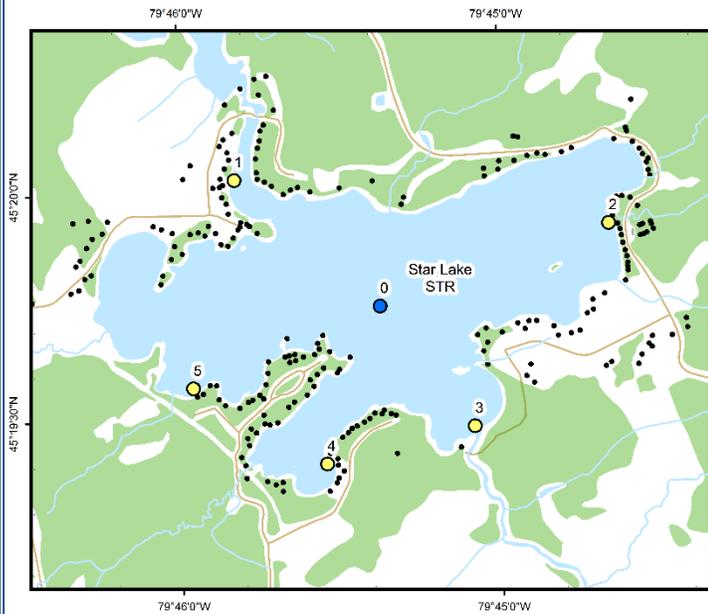
Note: Grubbs test indicates no spring or annual phosphorus data collected are considered outliers.

E. Coli Annual Geometric Mean at Silver Lake (Port Carling)



Annual average and spring phosphorus concentrations at the deep-water station (SPC-0) were below the historic DMM threshold of 5.2 µg/L but below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). *E. coli* counts were below the MLA stoplight limits at all nearshore sites. Average annual Secchi disk depth (4.4 m) was consistent with previous monitoring (2.0 and 7.5 m). Silver Lake experienced a cyanobacterial bloom in 2020 and therefore is still listed as yellow pending the completion of a causation study on the impact of development in the area. **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Star Lake (STR)



Area Description:

Star Lake is a moderately developed lake located within the Township of Seguin. The lake has a surface area of 1.58 km² and a maximum depth of 23 m. Shoreline development on Star Lake includes residential properties some of which have extensive clearings and lawns, particularly in the East. There is also a substantial agricultural development immediately adjacent to the lake in the northwest. This lake has several inflow and outflow creeks including a connection with Mutton Lake to the North. MLA monitoring of Star Lake began in 2007

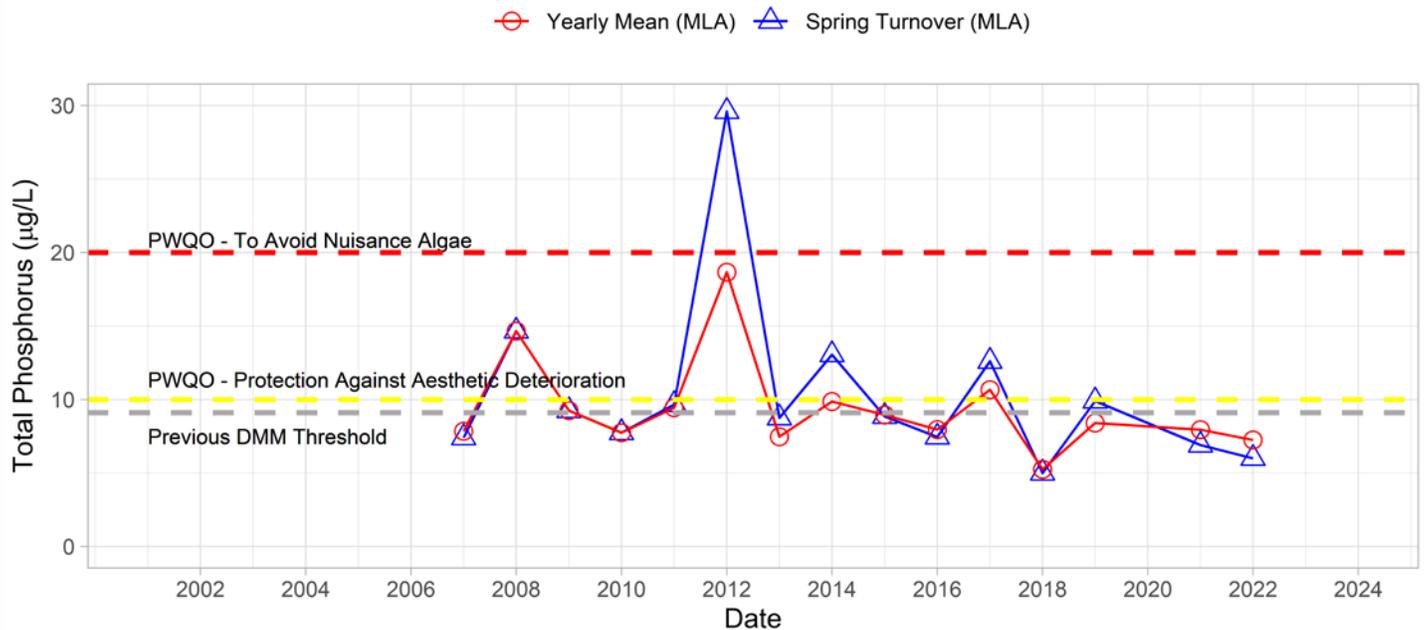
Volunteer Recognition: Karen Gillies, Melaney Kerley, Dawn Sendzik, Kelly Mazza and Jim Kerley.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
STR-0	2.8	6.0	7.3		
STR-1				3	85
STR-2				2	56
STR-3				3	97
STR-4				6	191
STR-5				4	116

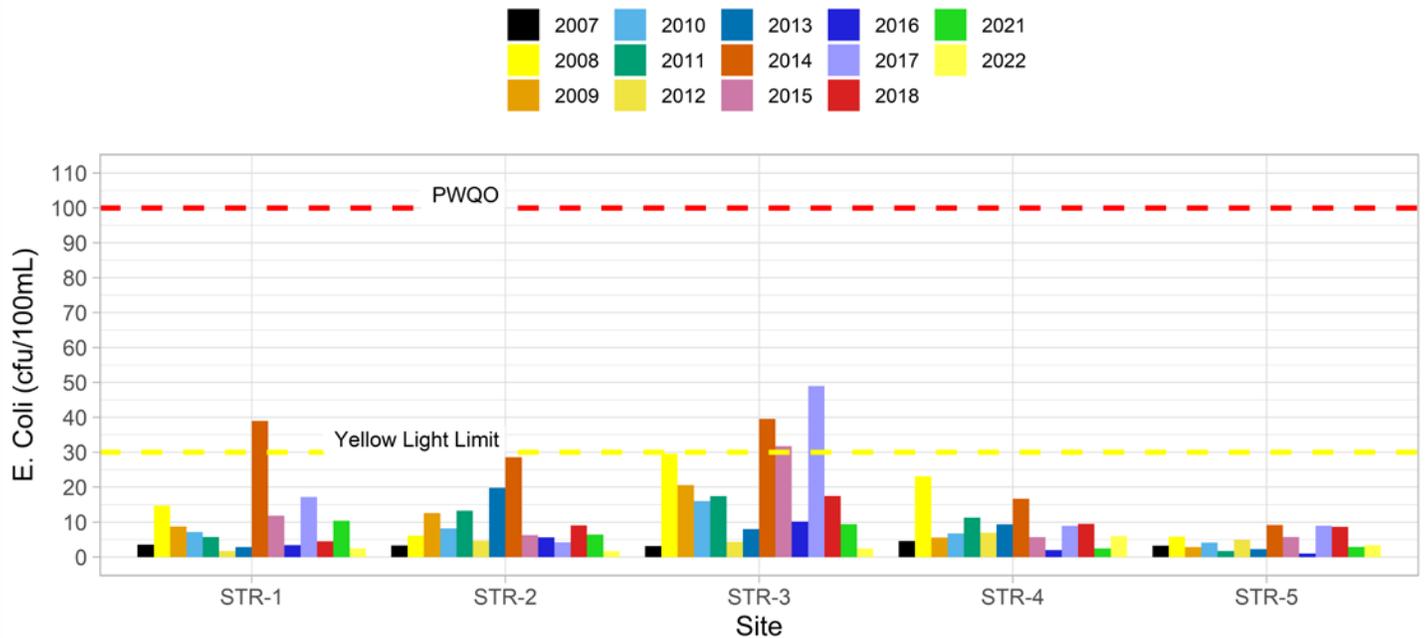


Phosphorus at STR-0



Note: Grubbs test indicates the spring phosphorus concentration collected in 2012 is considered an outlier.

E. Coli Annual Geometric Mean at Star Lake





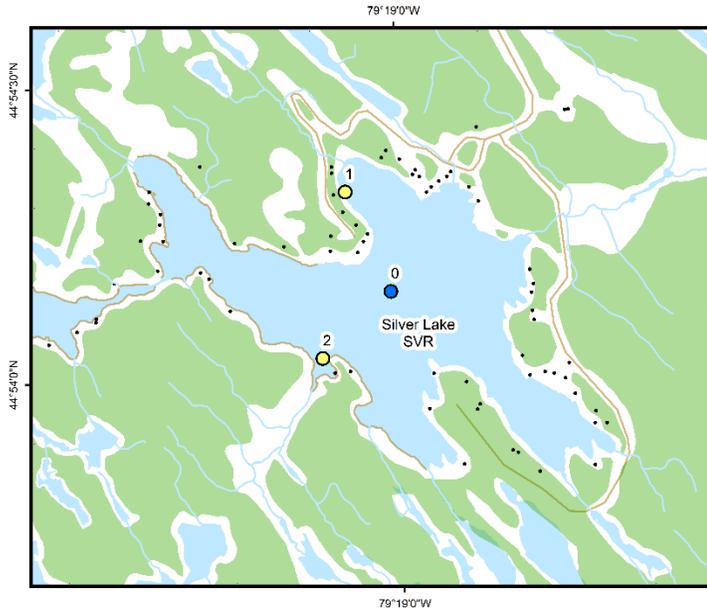
Annual average and spring phosphorus concentrations at the deep-water station (STR-0) were below the historic DMM threshold of 9.1 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). *E coli* samples collected in 2022 at all stations were below the MLA stoplight limits. Average annual Secchi disk depth (2.8 m) was consistent with previous monitoring (1.40 - 4.45 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Silver Lake (SVR)

Area Description:

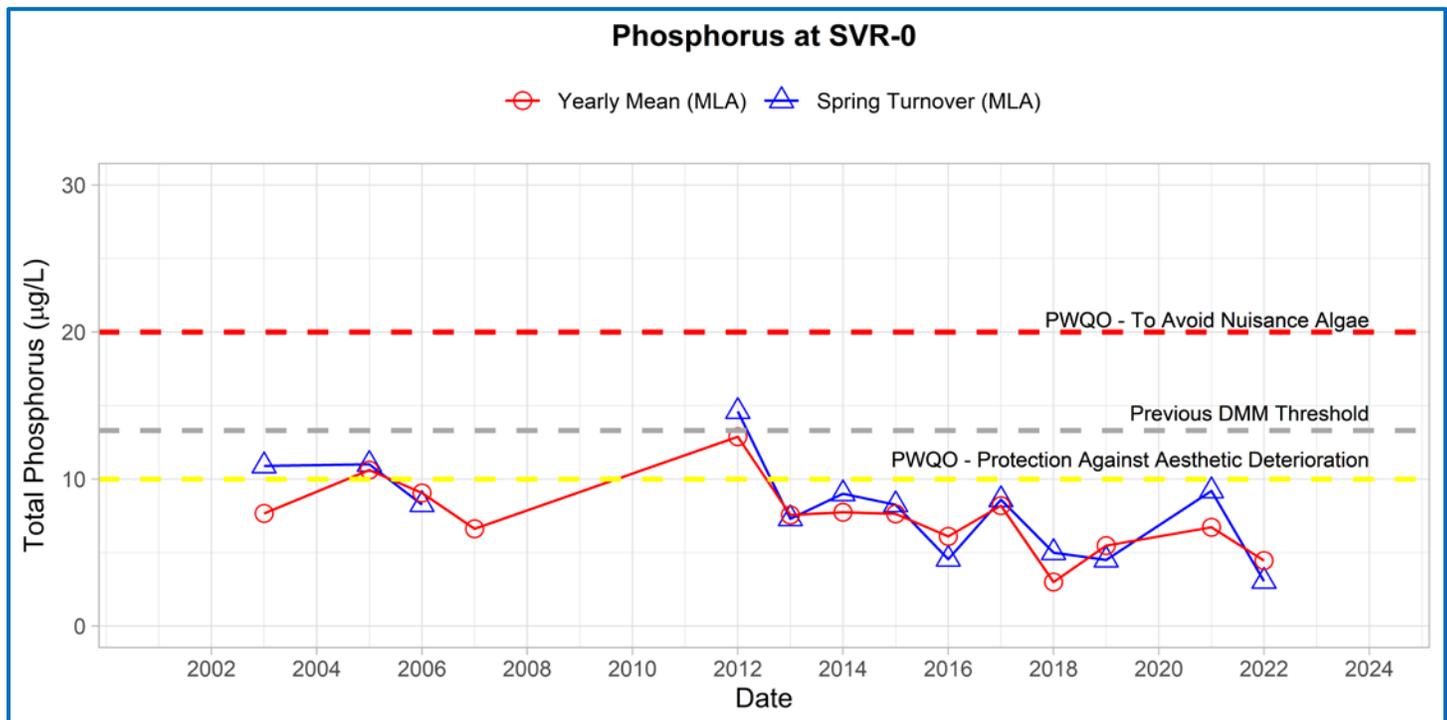
Silver Lake is located at the south end of Gull Lake and has a surface area of 0.58 km² in area and a maximum depth of 14 m. Silver Lake receives drainage from an 8.22 km² watershed via thirteen rivers and streams. The lake is primarily developed on the north and east shorelines and there is a navigable outlet into Gull Lake in the northwest. Silver Lake is not currently listed as vulnerable by the DMM. MLA monitoring of Silver Lake began in 2003.

Volunteer Recognition: Bruce & Anne Elliot, Dave & Debbie Stephens, George & Patricia Catleogh.



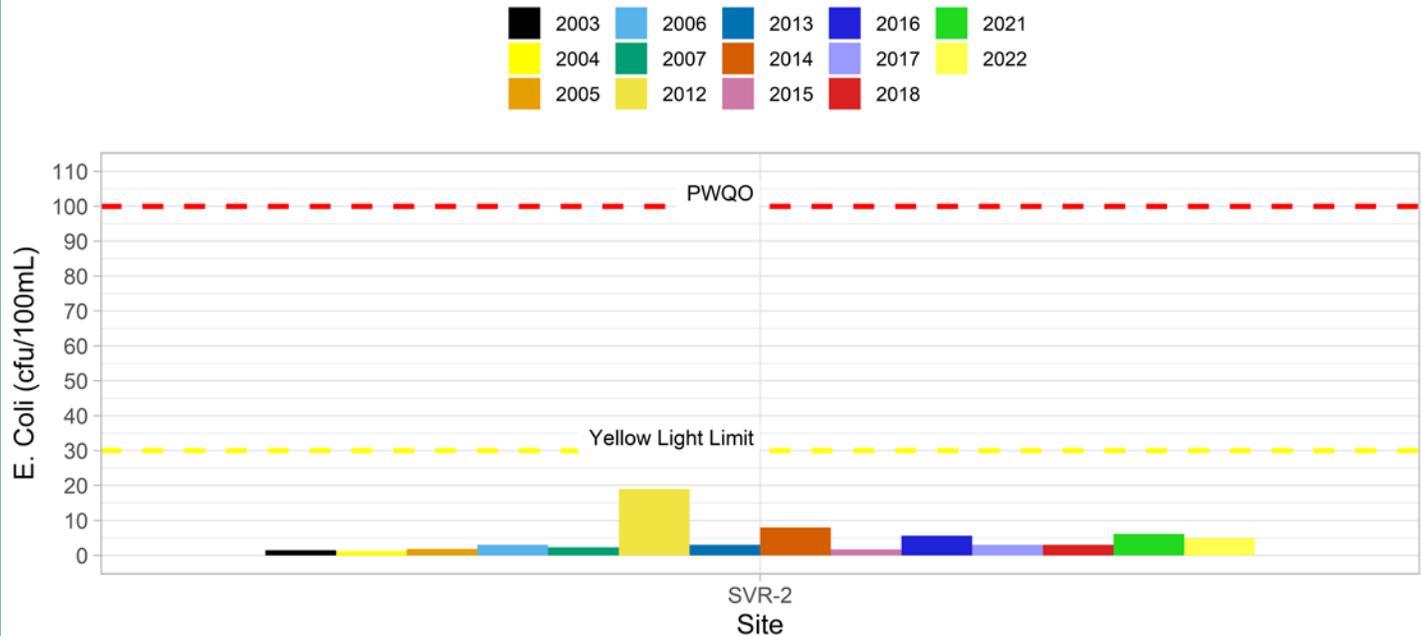
2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
SVR-0	3.1	3.1	4.5		
SVR-2				5	65



Note: Grubbs test indicates no spring or annual average phosphorus data collected are considered outliers.

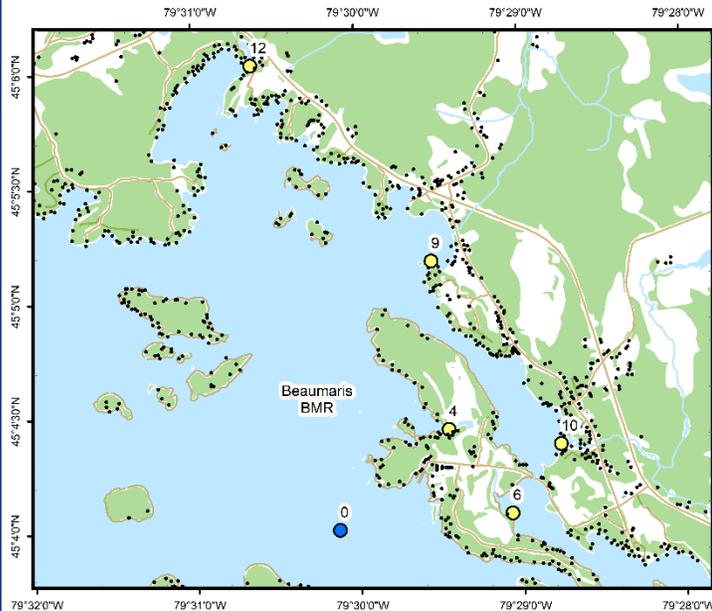
E. Coli Annual Geometric Mean at Silver Lake (Gravenhurst)



Annual average and spring phosphorus concentrations at the deep-water station (SVR-0) were below the historic DMM threshold of 13.3 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). *E. coli* samples collected in 2022 at SVR-2 were below the MLA stoplight limit. Average annual Secchi disk depth (3.1 m) was consistent with previous monitoring (2.0 and 4.5 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Beaumaris (BMR)



Area Description:

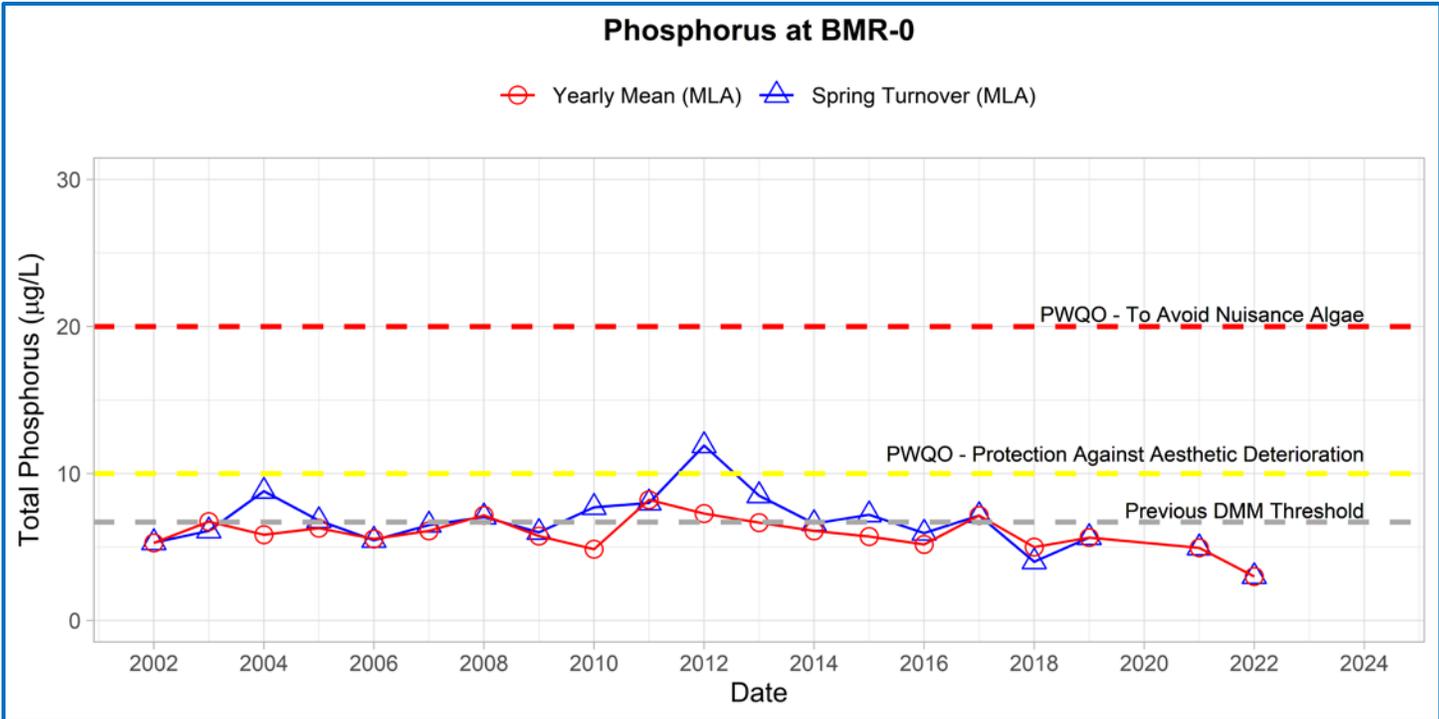
Beaumaris is an island in the Milford Bay region of north-eastern Lake Muskoka and is approximately 132 ha in size. The majority of the island is covered by a golf course with a small private club and marina. Natural shoreline vegetation is largely intact, however large boathouses are common in this area. The watershed includes a wetland to the east where the mainland and the island are linked by a causeway. MLA monitoring at Beaumaris began in 2002.

Volunteer Recognition: Louise Cragg, Don Furniss, Andree Baillargeon, Chris Cragg, Eliza Nevin, Lisa MacLatchy Naprawa, Peter Walsh.

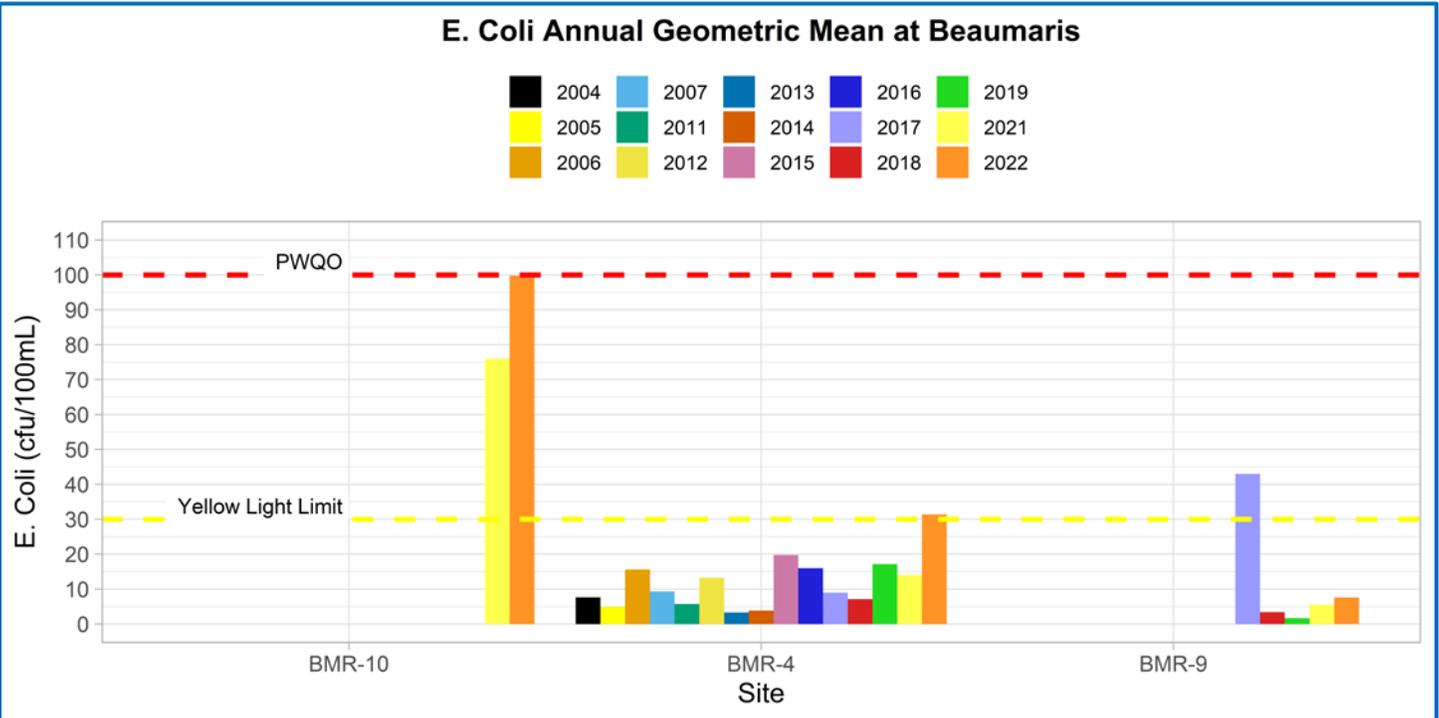
2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
BMR-0	3.8	3.0			
BMR-4		6.7		31	249(28)*
BMR-6		6.0	4.8		
BMR-9		4.3		8	79
BMR-10		13.9	16.8	100	741
BMR-12		19.3	24.4		

Note: Grubbs test indicated that the phosphorus concentration in 2021 at BMR-10 was an outlier. * Total coliforms at BMR-4 recorded a single sample value of 694 cfu/100mL during a storm event, geometric mean has been reported both including and excluding this anomalously high result.



Note: Grubbs test indicates data collected in 2012 are considered an outlier.



Spring phosphorus concentrations at the deep-water station (BMR-0) were below the historic DMM threshold of 6.7 µg/L and the Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L) in 2022. Nearshore monitoring of spring phosphorus concentrations at BMR-4, 6, and 9 were within the range of variability of previous monitoring years, however phosphorus concentrations at BMR-10 and BMR-12 were substantially higher than previous recorded results. 3.1 µg/L, respectively) which were considered an outlier based on the Grubb's test. Ongoing monitoring at these nearshore sites will inform on the elevated concentrations recorded in 2021. Average annual Secchi disk depth (3.8 m) was consistent with previous monitoring (2.25 - 4.40 m). The *E. coli* concentration at BMR-9 was well below the yellow light limit set by the MLA, bacteria collected at BMR-4 and BMR-10 exceeded the yellow light trigger established by the MLA. BMR-10 included numerous

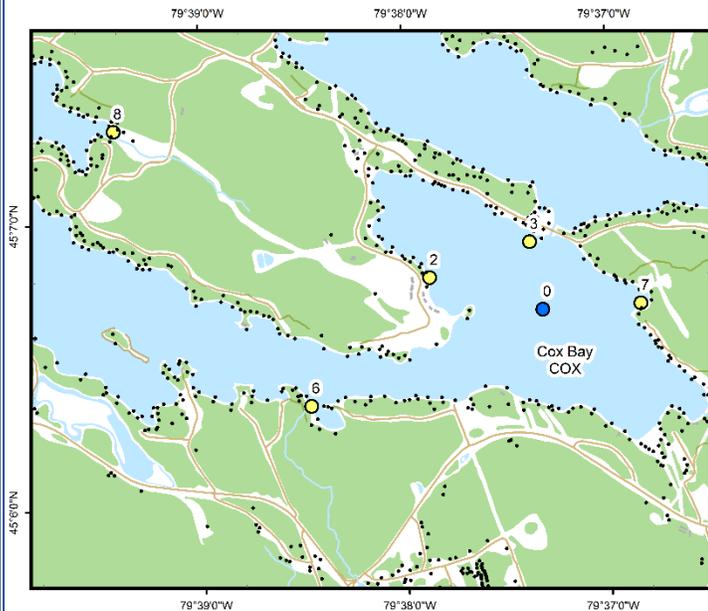


Hutchinson
Environmental Sciences Ltd.



re-tests and storm event samples, however even when removing storm event results *E. coli* concentrations were still above the yellow light trigger. **HESL recommends ongoing sampling to continue to monitor for long-term trends and to further inform on the elevated bacteria concentrations observed at several nearshore sites in 2022.**

Cox Bay (COX)



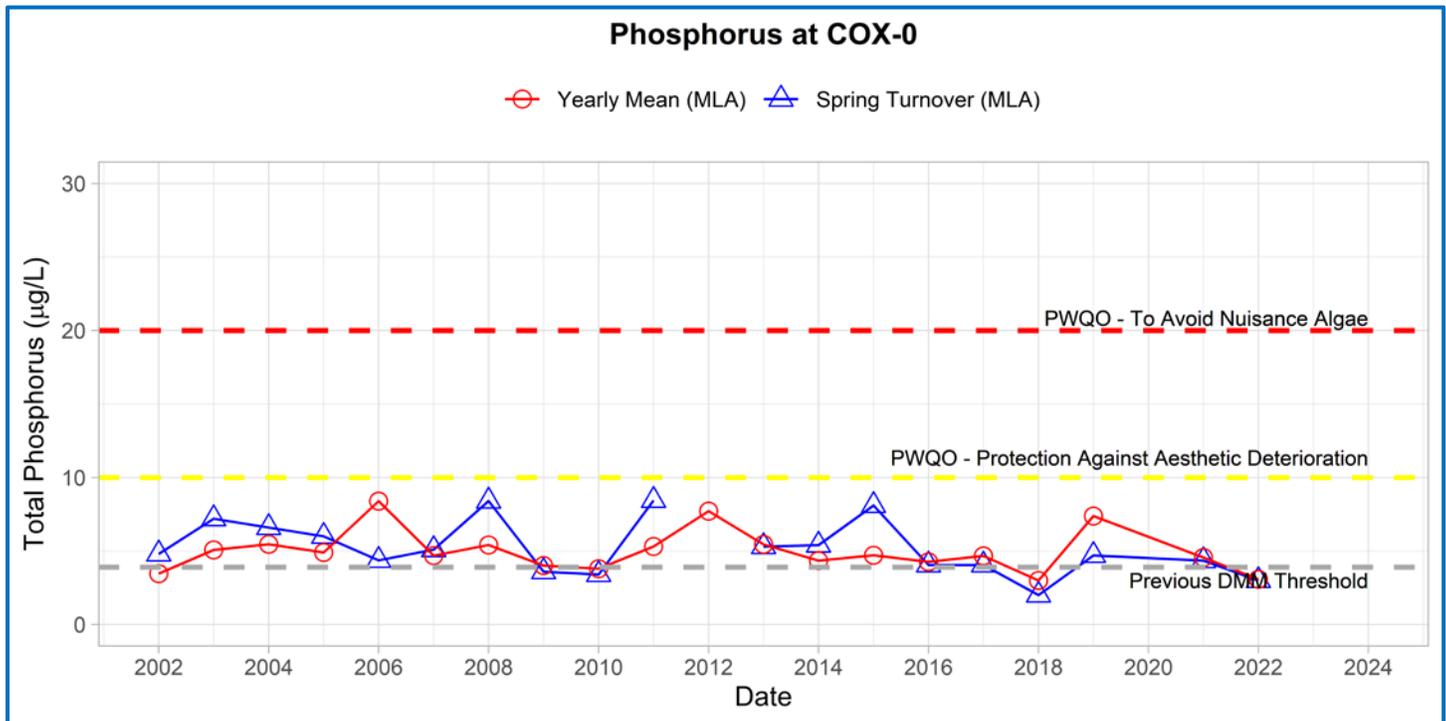
Area Description:

Cox Bay is the southernmost bay of Lake Joseph and is home to a large resort and golf course along with a marina and a canal crossing into Lake Rosseau at Port Sandfield. The bay has an area of 1.84 km² and a maximum depth of 12 m. The bay is highly developed with ~15% of the shoreline being open lawn, pavement or landscaping. The Cox Bay Stewardship Initiative group has identified ten permanent watercourses that drain into the bay. Cox Bay is currently classified as moderately sensitive and over-threshold by the DMM. MLA monitoring in Cox Bay began in 2002.

Volunteer Recognition: Liz Lundell, Stuart Golvin, Judy Golvin, and Guy Burry.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
COX-0	5.1	3.0	3.1		
COX-2		7.0			
COX-3		3.0			
COX-6		5.0	3.1		
COX-7		3.2	3.0		
COX-8		5.5			



Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.



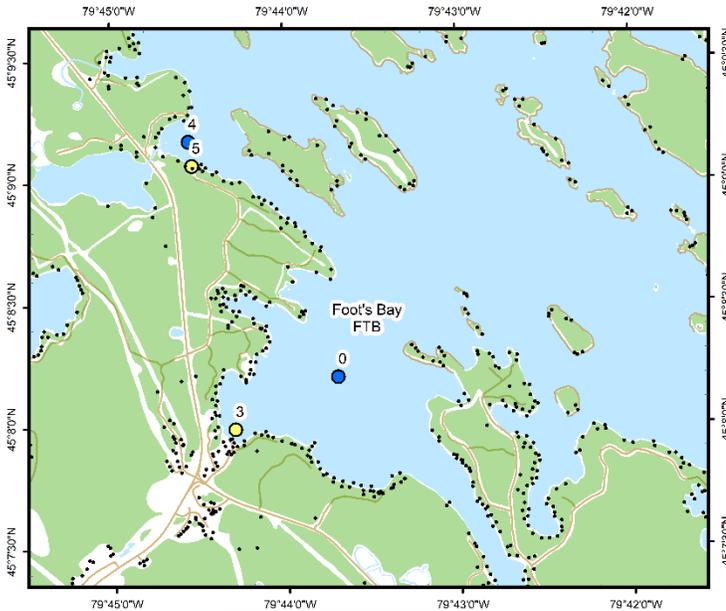
Annual average and spring phosphorus concentrations at the deep-water station (COX-0) were below the historic DMM threshold of 3.9 µg/L and the DMM 10-year average (4.4 µg/L) in 2022. All measured phosphorus concentrations were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of spring phosphorus concentrations at COX-2, 3, 6, 7, and 8 and yearly mean at COX-6 and COX-8 were within the range of variability of previous monitoring years. Average annual Secchi disk depth (5.1 m) was consistent with previous monitoring (3.35 - 8.25 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Foot's Bay (FTB)

Area Description:

Foot's Bay is located in the south-eastern portion of Lake Joseph. The Bay is highly developed along the southern shore near the marina and adjacent to the highway. Several undeveloped shoreline areas, with mostly intact forests, can be found within the Bay. The main basin of Lake Joseph is currently classified as highly sensitive by the DMM while several bays are classified as moderately sensitive. The DMM does not maintain a monitoring station at Foot's Bay. MLA monitoring of Foot's Bay began in 2009.

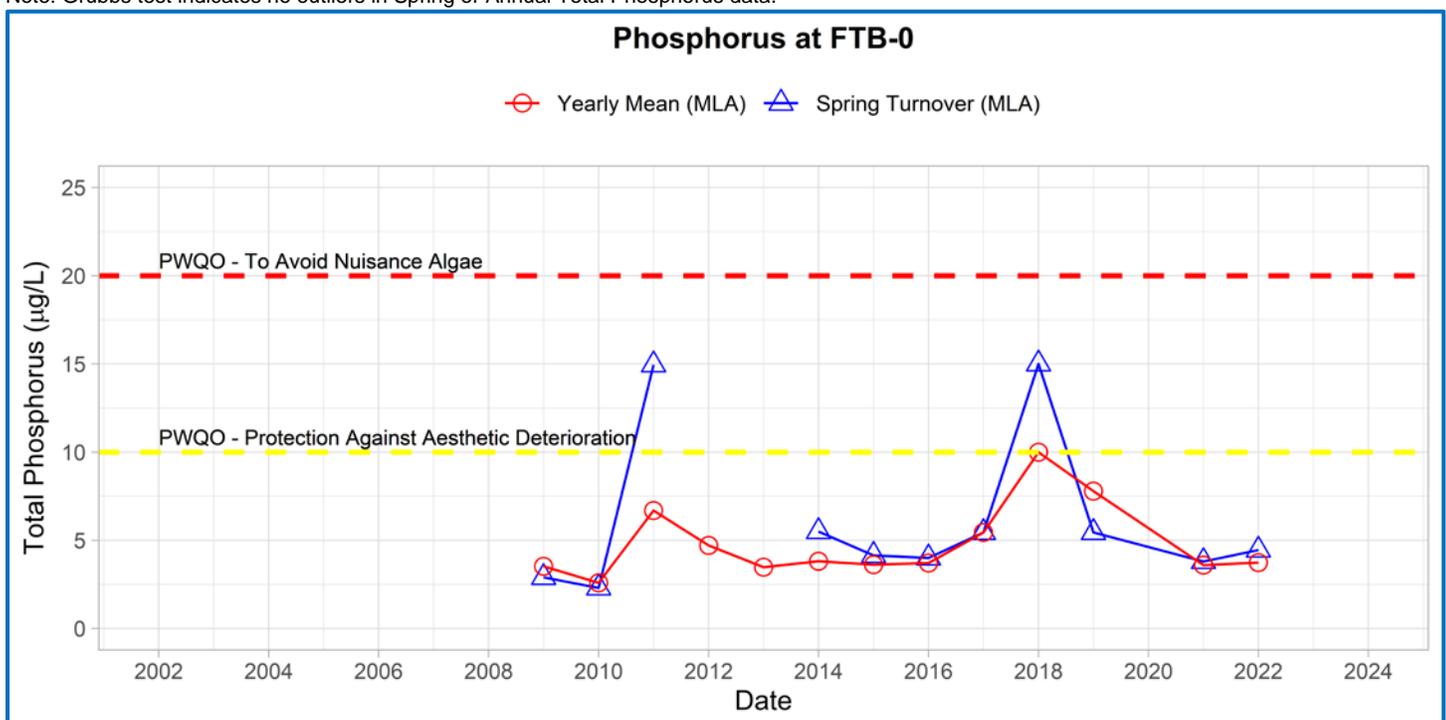
Volunteer Recognition: Dave Clark and Penny Middleton.



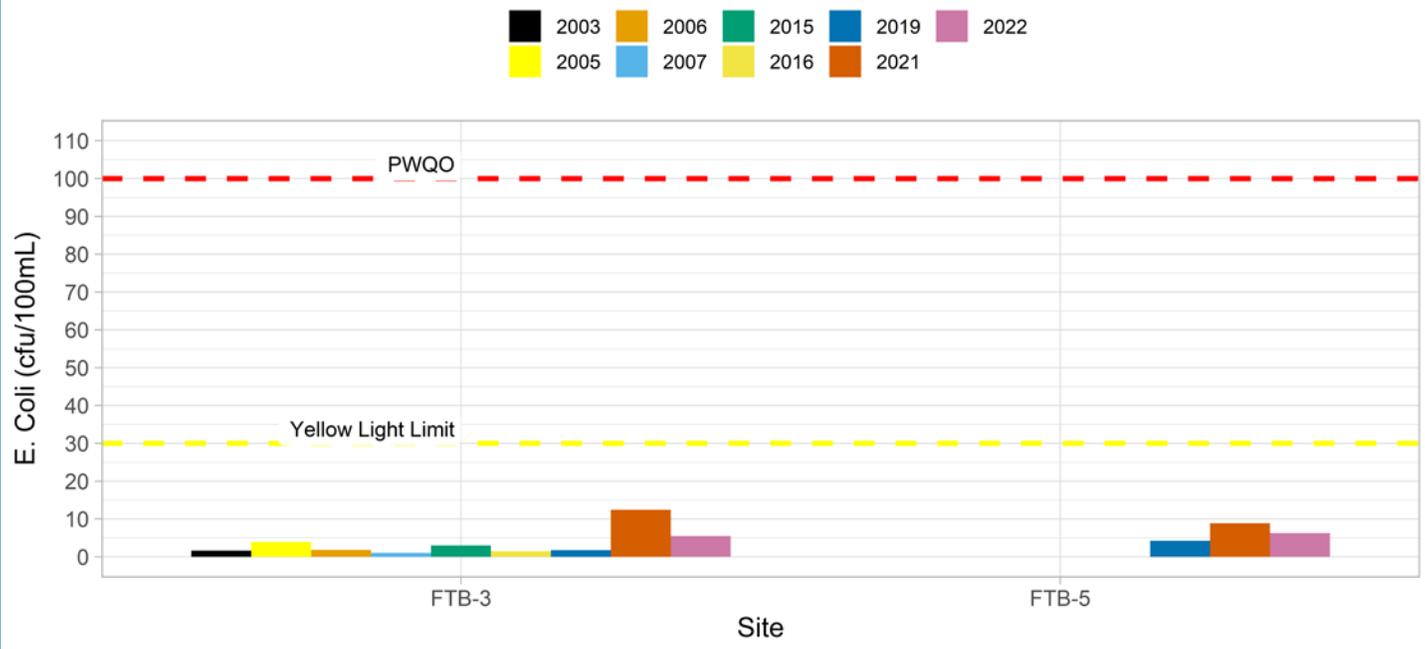
2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
FTB-0	5.7	4.5	3.7		
FTB-3				5.5	30.4
FTB-4		3.1			
FTB-5		4.8		6.24	22.9
FTB-6			3.2		

Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.

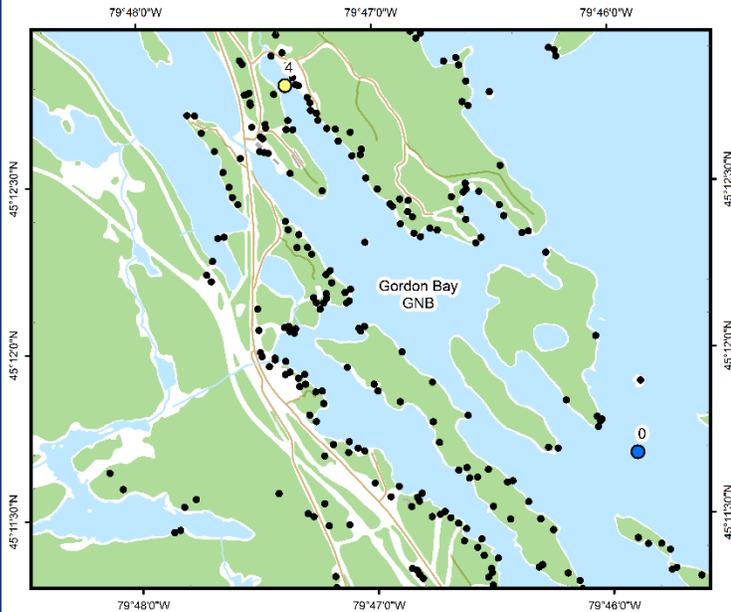


E. Coli Annual Geometric Mean at Foot's Bay



The marked decline in spring total phosphorus concentrations at FTB-0 noted in 2019 and 2021 continued in 2022. Total phosphorus concentrations peaked at 15.0 µg/L in both 2011 and 2018 but decreased considerably in the following monitoring period. In 2022, all measured phosphorus concentrations were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of spring and annual average phosphorus concentrations at FTB-3 were within the range of variability of previous monitoring years, FTB-6 was newly established in 2022 and therefore requires additional data collection. Secchi measurements in 2022 fell within the range of variability measured during the monitoring program (2.5 to 7.2 m). Bacteria concentrations in 2022, based on two collected samples were lower than the peak value observed in 2021. Bacteria concentration still fell below the established MLA trigger limit. **HESL recommends sampling continue in Foot's Bay to monitor long-term trends in nutrients and bacteria.**

Gordon Bay (GNB)



Area Description:

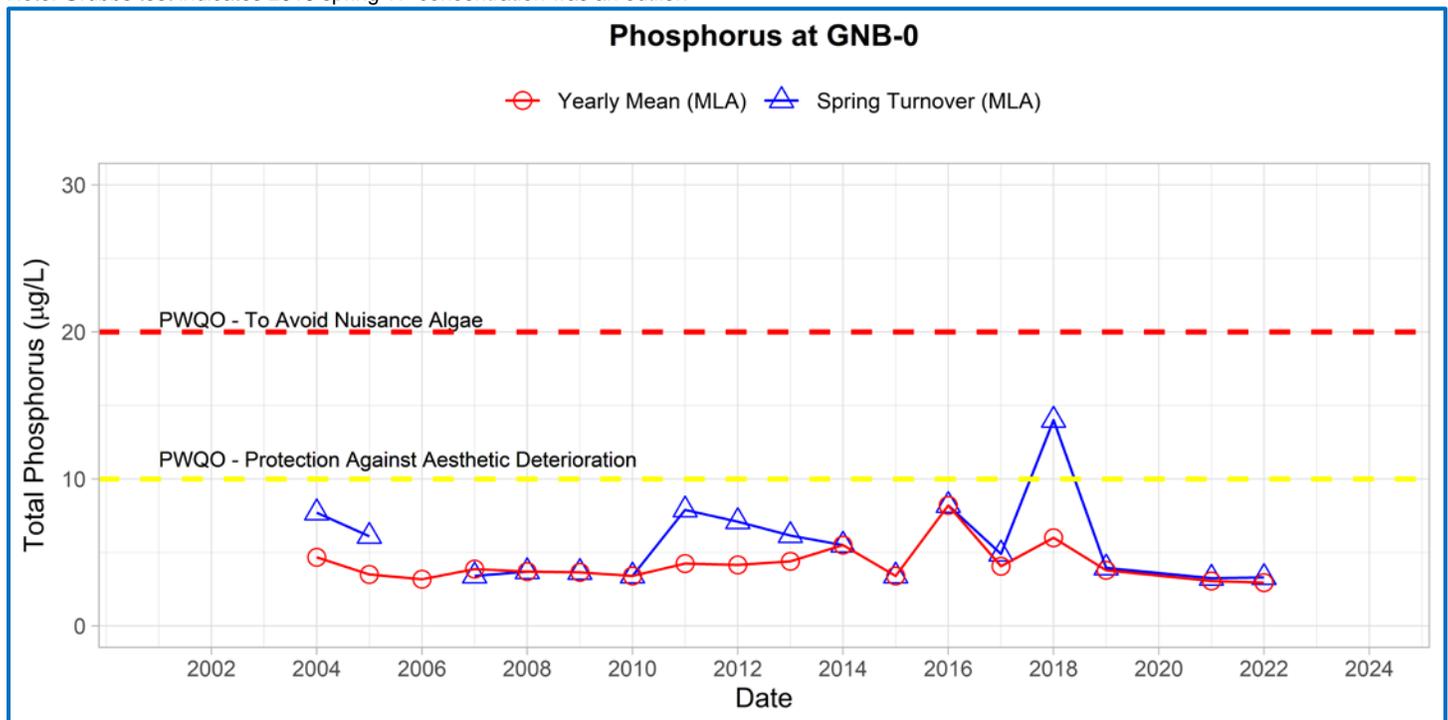
Gordon Bay is a moderately developed region of northwestern Lake Joseph comprised of several smaller bays including Portage Bay, Smith Bay and King Bay. The area includes a large marina in Portage Bay and Lake Joseph Road in the West. MLA monitoring of Gordon Bay began in 2004.

Volunteer Recognition: Alex Magditsch, Cecil Hayhoe.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
GNB-0	5.3	3.3	3.0		
GNB-4		3.2	3.2		

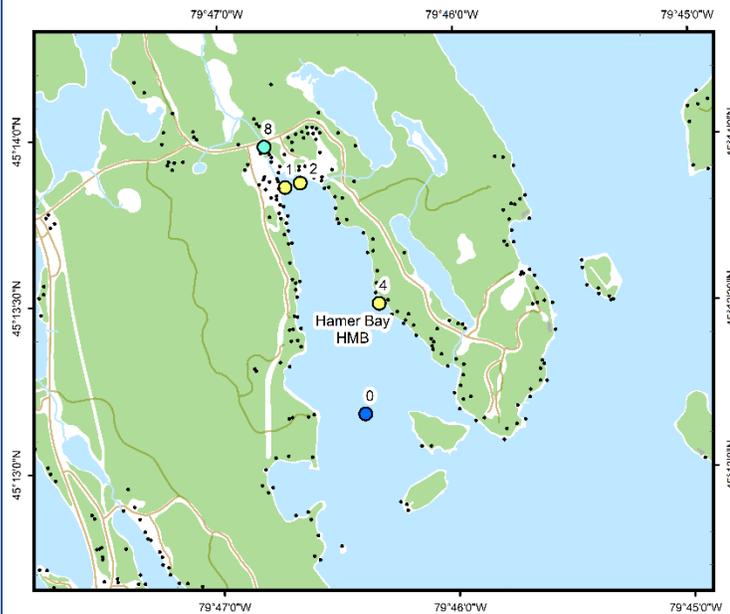
Note: Grubbs test indicates 2018 spring TP concentration was an outlier.





The Grubb's test identified the spring 2018 phosphorus data (14.0 µg/L) for GNB-0 as an outlier, it has again been maintained in the data set but should be interpreted with caution. In 2022, spring total phosphorus concentrations were at or near the detection limit in all samples collected. Nearshore monitoring of spring phosphorus concentrations at GNB-4 was within the range of variability of previous monitoring years. Average annual Secchi disk depth (5.3 m) was consistent with previous monitoring (3.0 - 7.5 m). *E. coli* sampling was discontinued at GNB-4 in 2019. **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Hamer Bay (HMB)



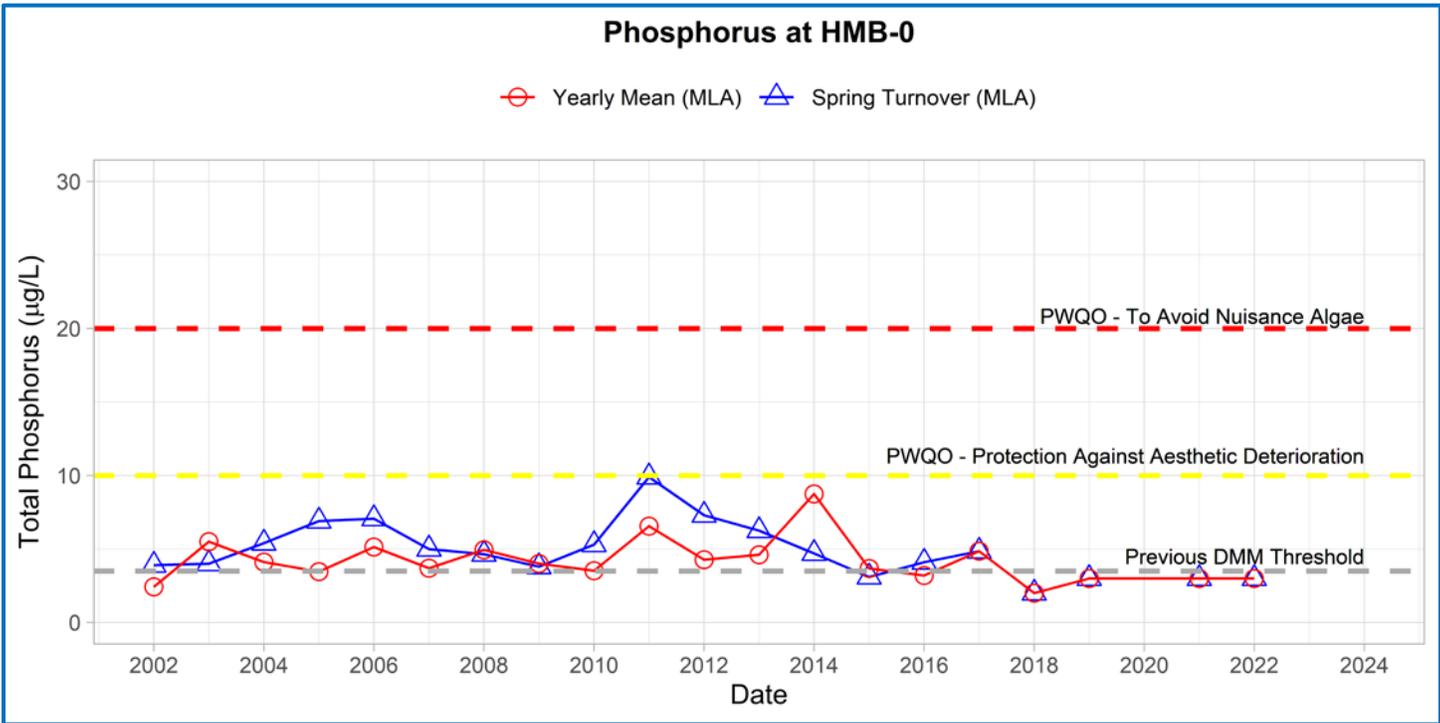
Area Description:

Hamer Bay is in the northern region of Lake Joseph. The bay receives drainage from three creeks, one of which flows through a large golf course and wetland in the north, and the others through smaller lakes and wetlands. Hamer Bay is highly developed including a large marina with several parking lots, a resort, and many residential properties along most of the available shoreline. The main basin of Lake Joseph is currently classified as highly sensitive by the DMM. MLA sampling in Hamer Bay began in 2002.

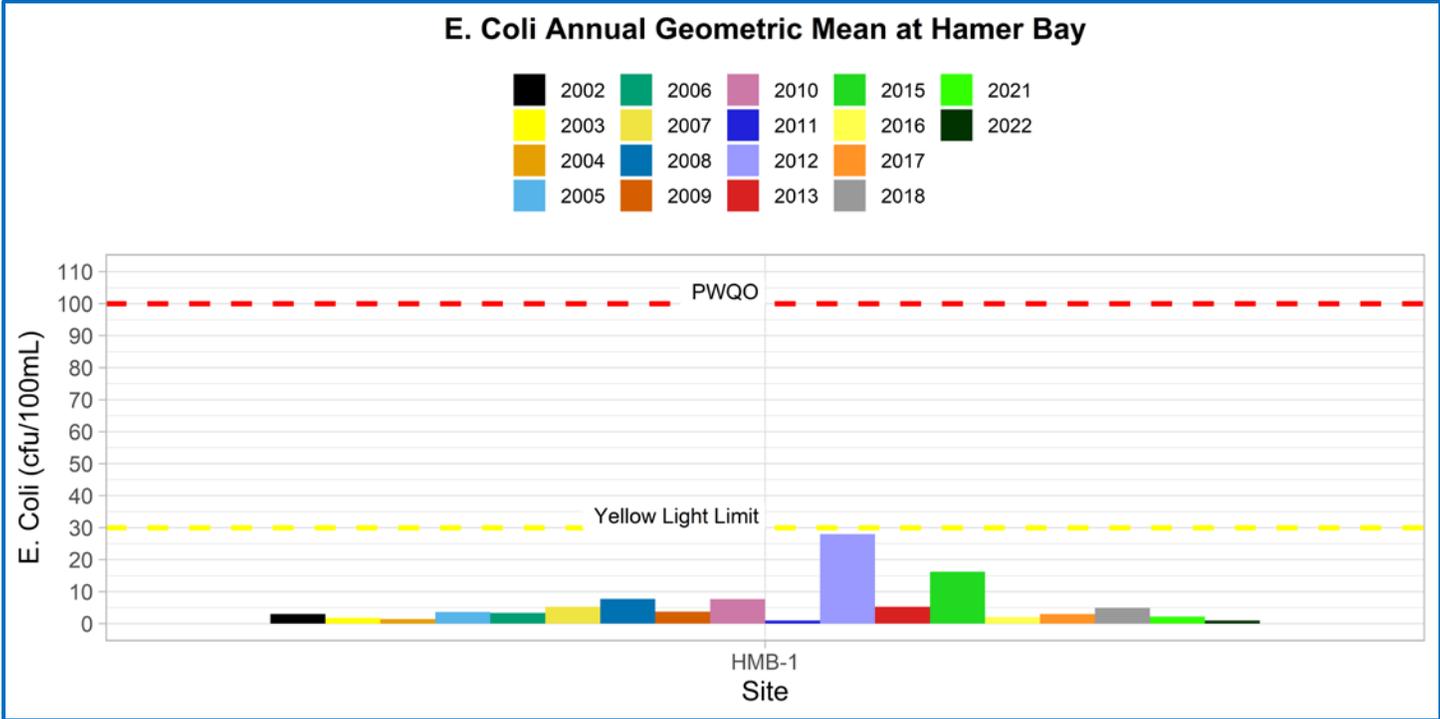
Volunteer Recognition: Alex Magditsch, Cecil Hayhoe.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
HMB-0	-	3.0			
HMB-1		5.0	3.4	1	57
HMB-2		4.4	2.9		
HMB-4		3.7	3.6		
HMB-8		16.4	45.1		



Note: Grubbs test indicates 2014 Annual Total Phosphorus data was an outlier.



In 2022, spring phosphorus at HMB-0 was below the detection limit (3.0 µg/L). All measured phosphorus concentrations were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of spring and annual average phosphorus concentrations at HMB-1, 2 and 4 were within the range of variability of previous monitoring. Phosphorus concentrations at HMB-8 were above the PWQO guideline for controlling excessive plant growth in rivers and streams (30 µg/L) in two of the four samples collected but were consistent with previous monitoring. Bacterial counts of *E. coli* at HMB-1 remain well below the MLA established limits. Elevated total coliforms at HMB-1 in 2022 were heavily influenced by a single sample (182 cfu/100mL)



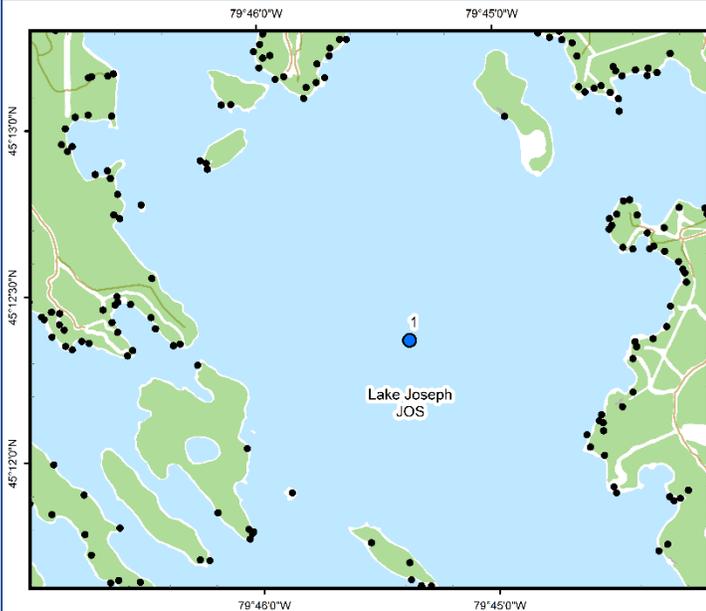
Hutchinson
Environmental Sciences Ltd.



collected during heavy rain. Average annual Secchi disk depth was not recorded in 2022. **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Lake Joseph (JOS)



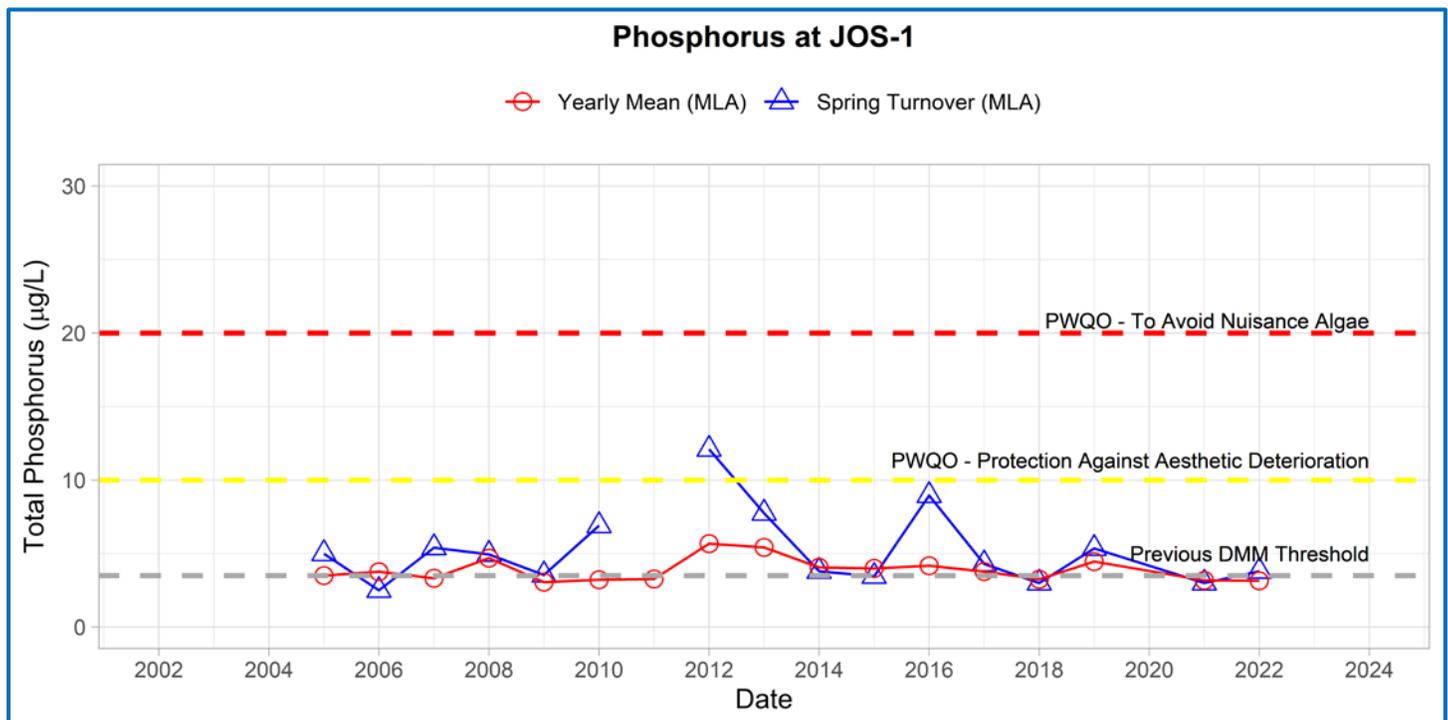
Area Description:

Lake Joseph is a large lake with a surface area of 50.9 km² and a maximum depth of 94 m. The watershed area of Lake Joseph is 55 km² and contains a coldwater fishery. Lake Joseph receives drainage from numerous inflowing streams and rivers and is connected to Lake Rosseau through the narrows at Port Sandfield and the Joseph River. The main basin of the lake is currently classified by the DMM as highly sensitive. MLA monitoring of Lake Joseph's main basin began in 2005.

Volunteer Recognition: Alex Magditsch, Cecil Hayhoe.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
JOS-1	5.3	3.8	3.2		



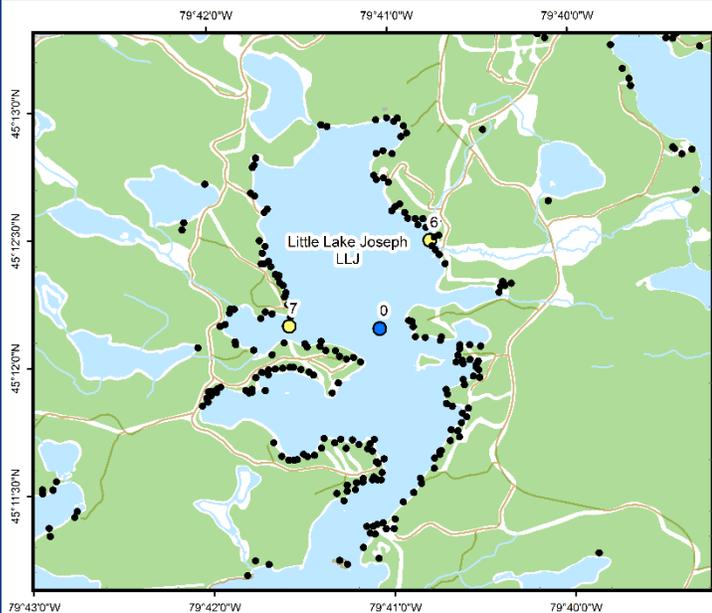
Note: Grubbs test indicates 2012 spring total phosphorus concentrations were an outlier.



In 2022, spring phosphorus concentrations were below the historic DMM threshold of 3.5 µg/L. All measured phosphorus concentrations were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Average annual Secchi disk depth (5.3 m) was consistent with previous monitoring (3.0 – 7.75 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Little Lake Joseph (LLJ)



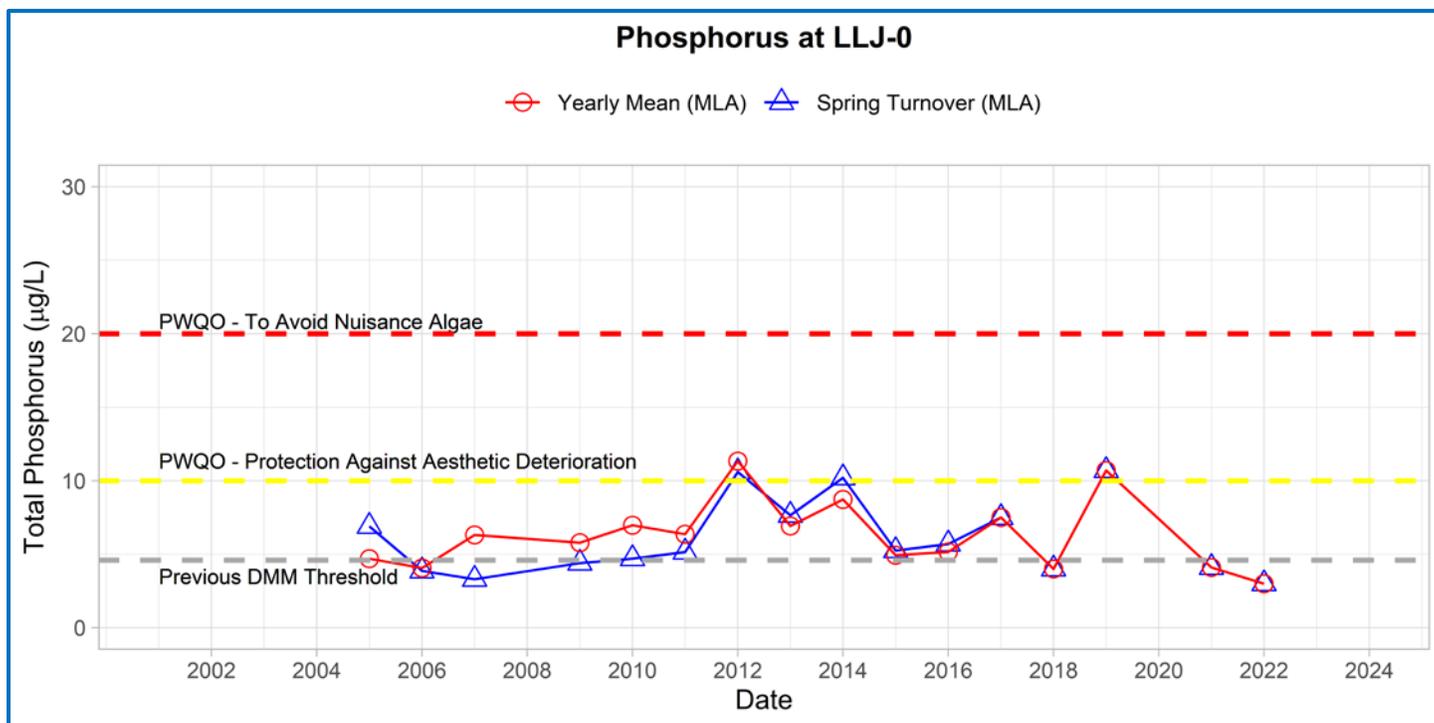
Area Description:

Little Lake Joseph is an isolated embayment of Lake Joseph with an area of 2.8 km² with a maximum depth of 40 m. Despite cottage development the shoreline of Little Lake Joseph remains naturalized. The waterbody receives drainage from three small wetlands. Little Lake Joseph is currently classified by the DMM as moderately sensitive. MLA monitoring of Little Lake Joseph began in 2005.

Volunteer Recognition: Dirk Soutendijk and Westley Begg.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
LLJ-0		3.0			
LLJ-6		7.0	4.3		
LLJ-7		4.4	4.0		



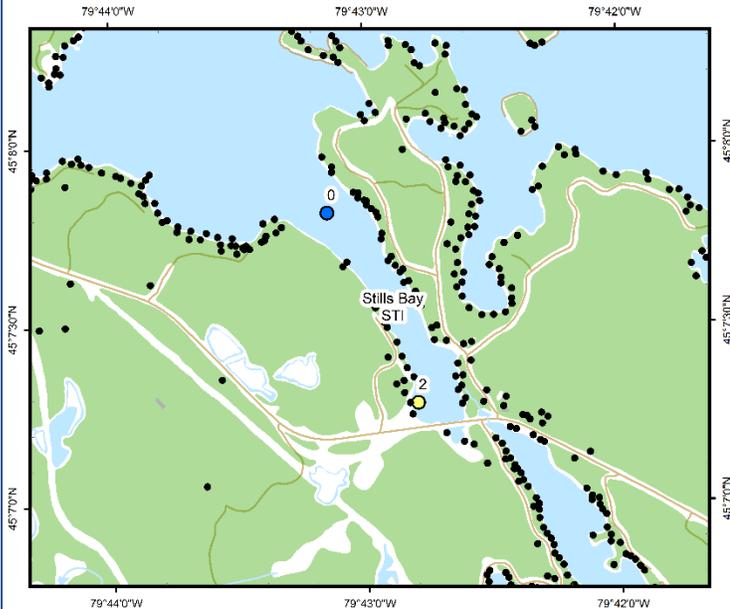
Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.



In 2022, the spring total phosphorus concentration at LLJ-0 was below the historic DMM threshold of 4.6 µg/L. All measured deep-water phosphorus concentrations were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual average phosphorus concentrations at LLJ-6 and 7 were similar, however markedly higher spring phosphorus at LLJ-7 recorded in 2019 and 2021 was no longer detected. This year represents the 7th year with sampling from LLJ-6 and 7, both of which show highly variable spring and annual average phosphorus concentrations and warrant ongoing monitoring. Average annual Secchi disk depth was not recorded in 2022. **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Stills Bay (STI)



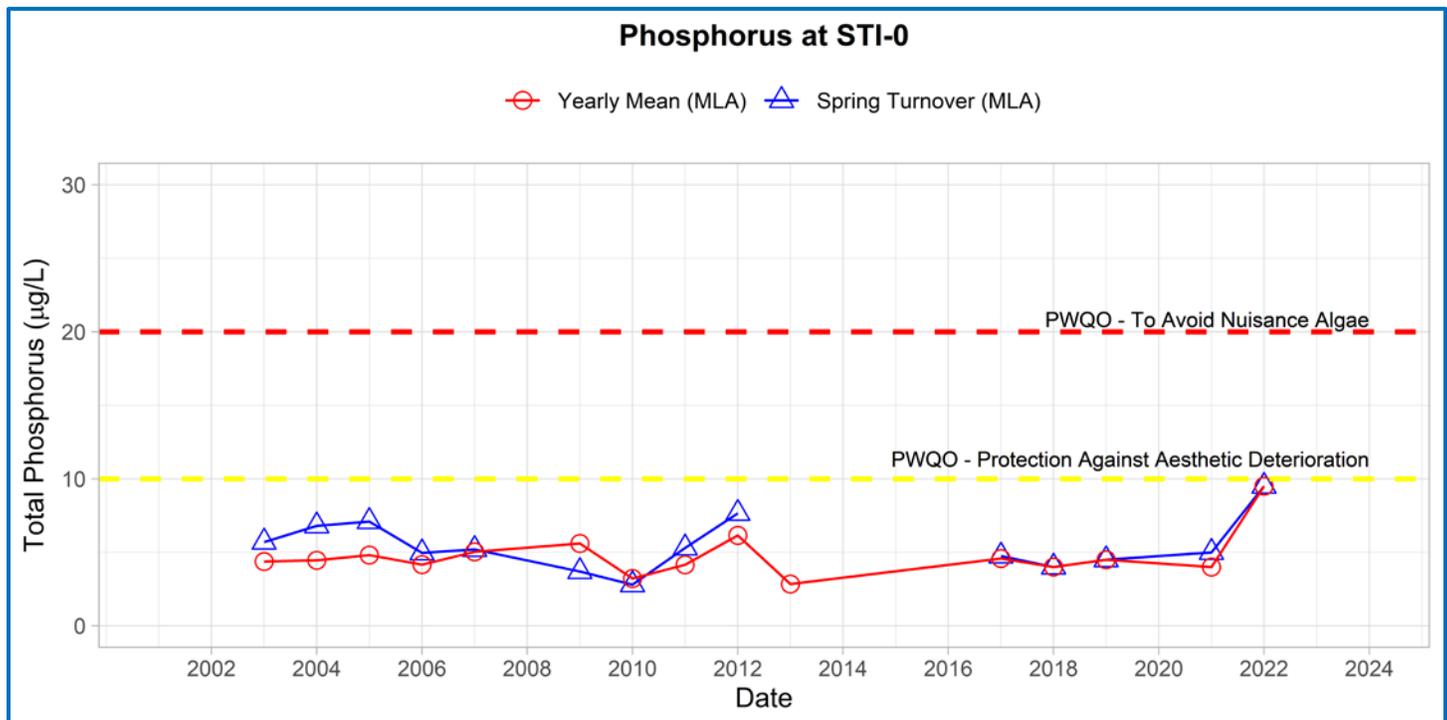
Area Description:

Stills Bay is a long, narrow bay in the south-eastern portion of Lake Joseph. The bay is moderately developed. The southern end of the bay is directly adjacent to Highway 169. Stills Bay receives drainage from several watercourses adjacent to a golf course. Several shoreline areas remain undeveloped with mostly intact forests. The main basin of Lake Joseph is currently classified as highly sensitive by the DMM. MLA monitoring of Stills Bay began in 2003.

Volunteer Recognition: Dave Clark and Penny Middleton.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
STI-0	-	9.5			
STI-2		3.8	3.5		

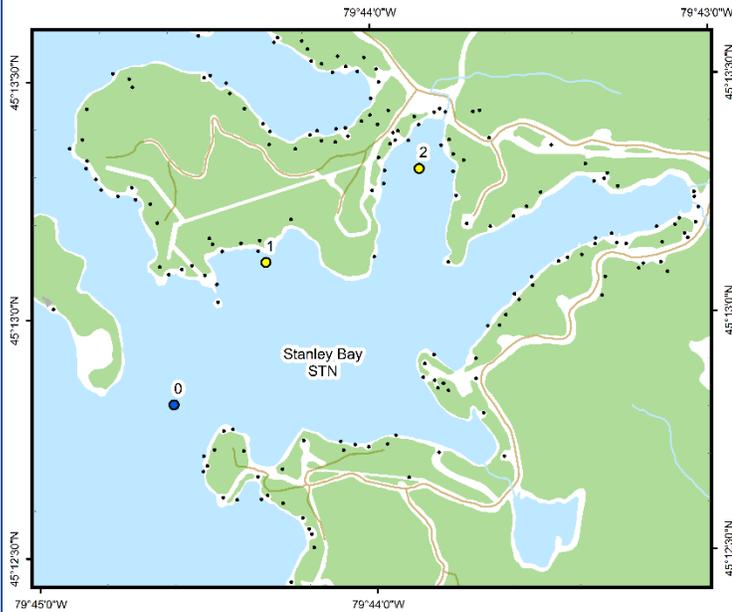


Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.



In 2022, spring turnover phosphorus results were the highest recorded to date, however this sampling event occurred during a storm event and therefore may not be representative of typical monitoring conditions. Nearshore monitoring at STI-2 did not have elevated phosphorus concentrations suggesting the high value recorded at STI-0 may have been the result of sample contamination. All measured phosphorus concentrations were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). The spring phosphorous concentration and yearly mean values at STI-2 in 2022 were declined substantially from the 2021 peak (9.8 µg/L). Average annual Secchi disk depth was not recorded in 2022. **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Stanley Bay (STN)



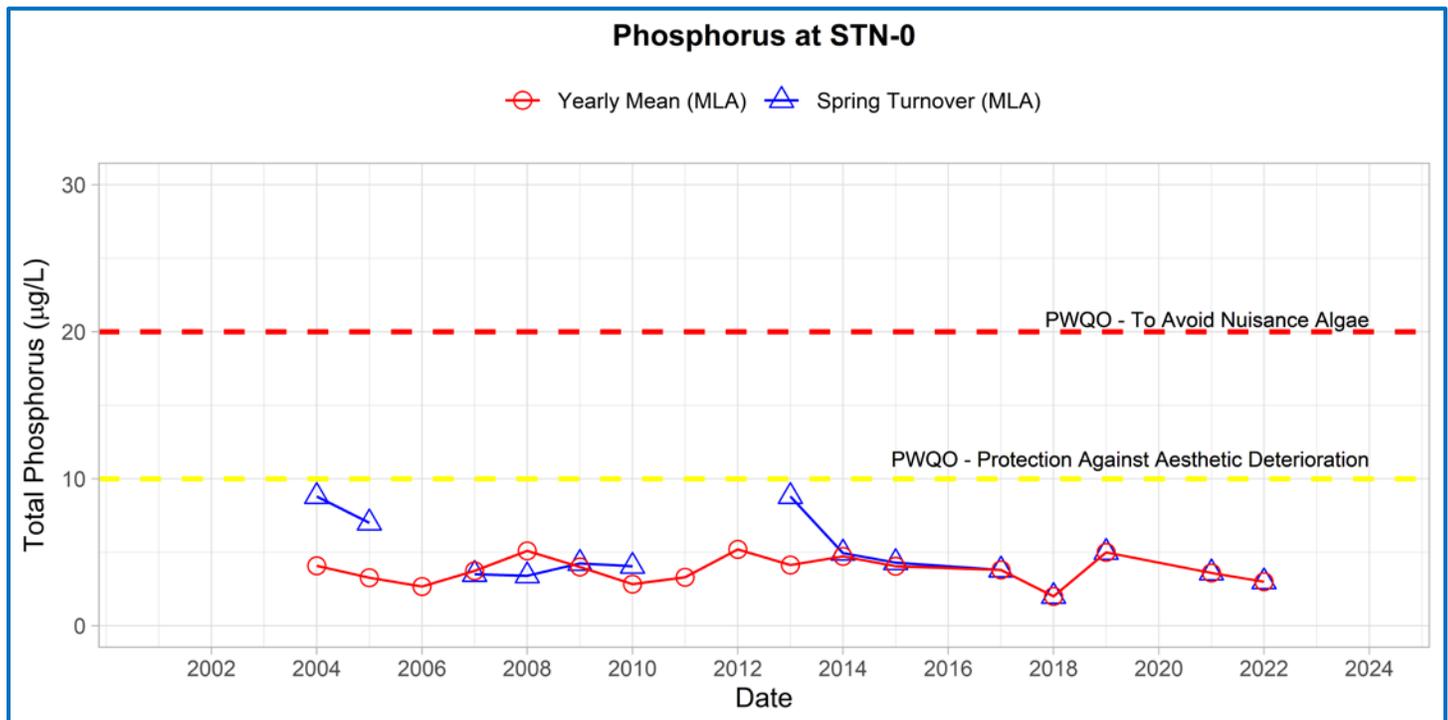
Area Description:

Stanley Bay is a deep-water bay on the north-east side of Lake Joseph. The bay is developed with largely intact forest cover along the shoreline. The bay is surrounded by numerous roads and a moderate level of residential development, and agricultural development which could negatively impact water quality.

Volunteer Recognition: Alex Magditsch, Cecil Hayhoe.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
STN-0	6.4	3.0			
STN-2		3.0			

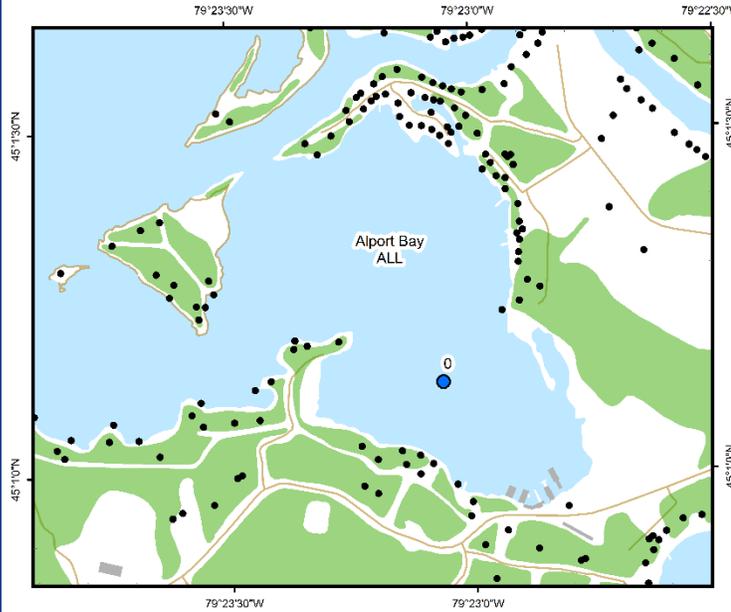


Note: Grubbs test indicates 2011 data for spring total phosphorus was an outlier.



The spring 2011 phosphorus sample at STN-0 was identified as an outlier (29.1 $\mu\text{g/L}$) and was significantly higher than any phosphorus measurement recorded historically at the site. This value is suspected to be a result of sample contamination and therefore has been eliminated from the results in 2021 but retained in the long-term dataset for future consideration as additional data are collected. All measured phosphorus concentrations in 2022 were below the laboratory detection limit as well as the Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 $\mu\text{g/L}$) and Nuisance Algal Growth (20 $\mu\text{g/L}$). Monitoring of spring phosphorus concentrations at STN-2 was within the range of variability of previous monitoring years. Average annual Secchi disk depth (6.4 m) was consistent with previous monitoring (3.75 - 8.0 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Alport Bay (ALL)



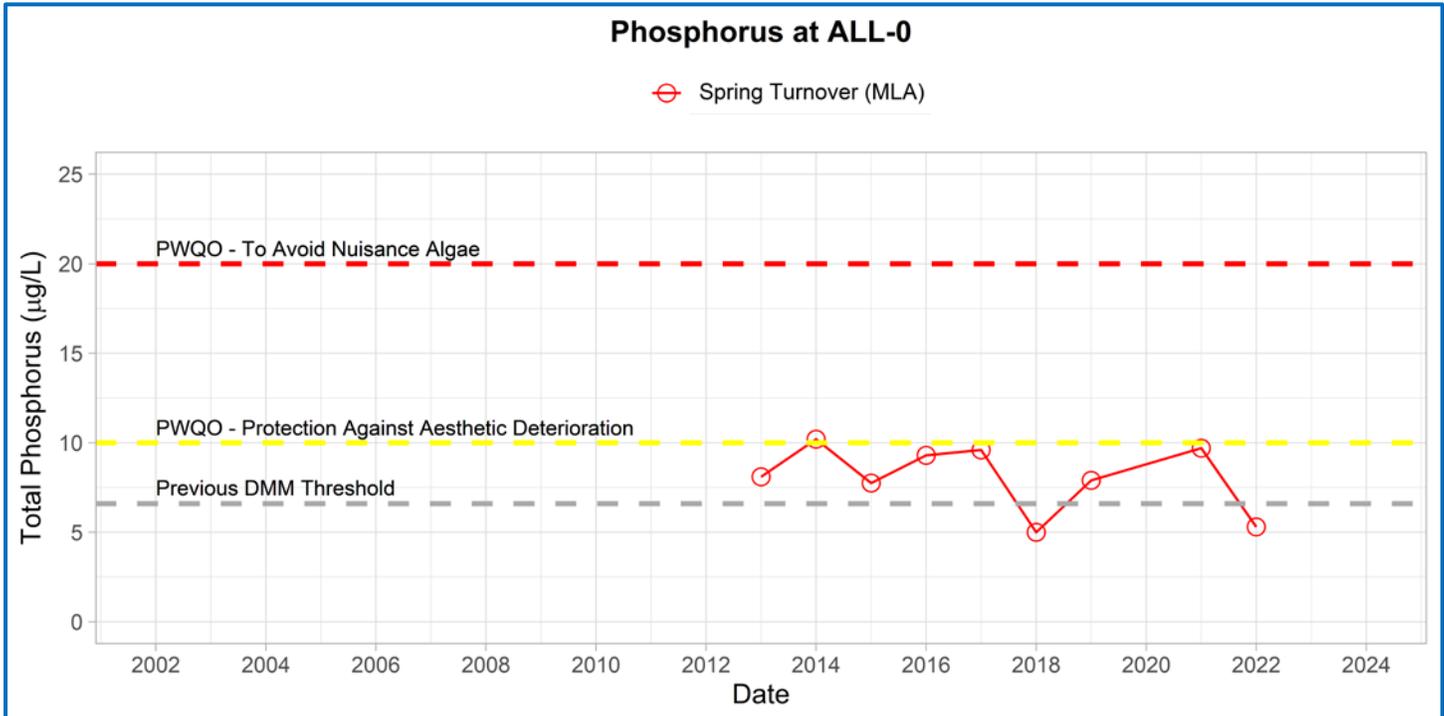
Area Description:

Alport Bay is a small embayment in eastern Lake Muskoka, at the mouth of the Muskoka River. Development in Alport Bay includes a marina in the south and agriculture in the east. Much of the shoreline is developed with a high proportion of the residential properties maintaining manicured lawns and minimal vegetation along the shoreline. MLA monitoring of Alport Bay began in 2013.

Volunteer Recognition: Bill & Jane Caughey, Paul Follis.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
ALL-0	1.9	5.3			

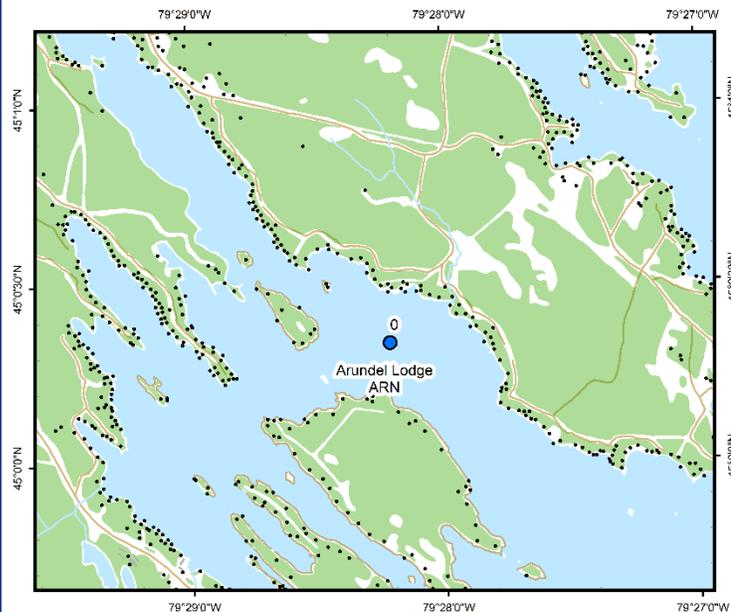


Note: Grubbs test indicates data collected contained no outliers in 2021.



In 2022, spring total phosphorus concentrations were consistent with the range of variability recorded during monitoring since 2013. All measured phosphorus concentrations in 2022 were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Average annual Secchi disk depth (1.9 m) was consistent with previous monitoring in 2019 and 2021 (1.6 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Arundel Lodge (ARN)



Area Description:

The Arundel Lodge sampling area in south-central Lake Muskoka is east of Hardy Lake Provincial Park and south of Walker's Point. The ARN-0 sampling station is located in Skinner Bay, adjacent to Miller and Firebrand Islands. A small creek, which drains three wetland areas outlets northeast of the ARN-0 site. MLA monitoring at Arundel Lodge began in 2008.

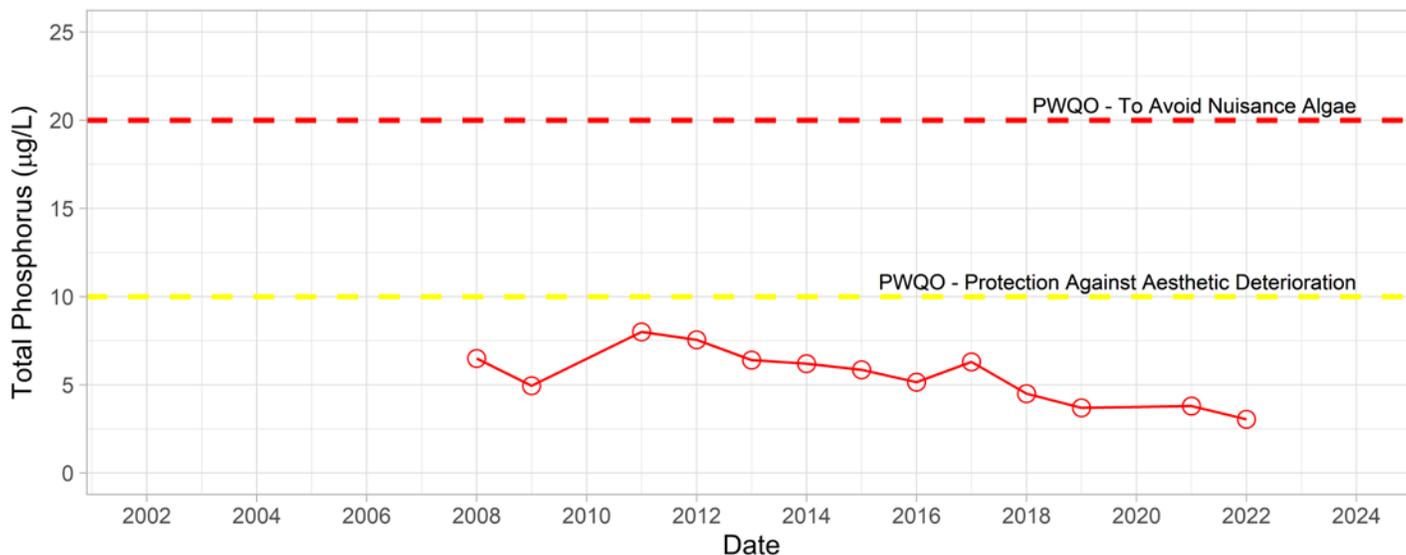
Volunteer Recognition: Carol Hoskins, Sheila Robinson, George Fallis, Stephen Sims, Mark & Sandy Brosch.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
ARN-0	3.4	3.1			

Phosphorus at ARN-0

○ Spring Turnover (MLA)



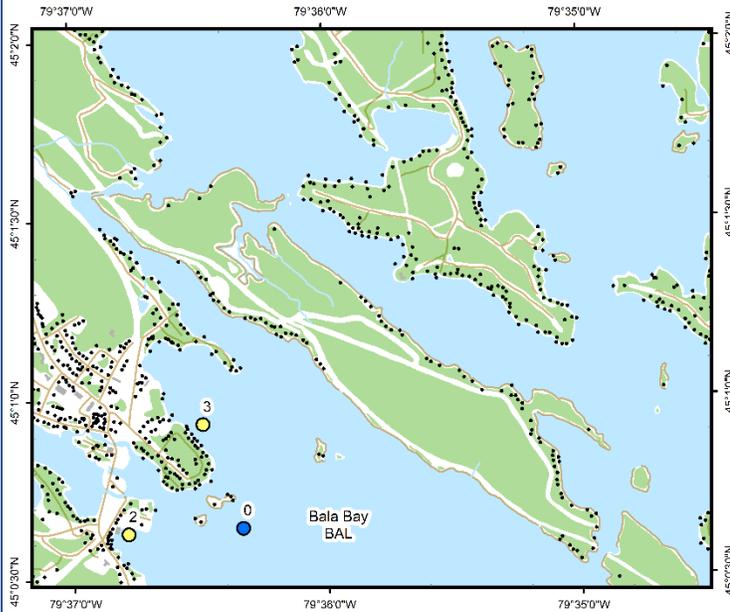
Note: Grubbs test indicates data collected in 2012 are considered an outlier

A vertical traffic light icon with three circular lights. The top light is red, the middle is yellow, and the bottom is green and illuminated.

In 2022, spring total phosphorus concentrations remained consistent with the range of variability measured since the program began in 2008. All measured phosphorus concentrations were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Average annual Secchi disk depth (3.4 m) was consistent with previous monitoring (2.4 – 3.5 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Bala Bay (BAL)



Area Description:

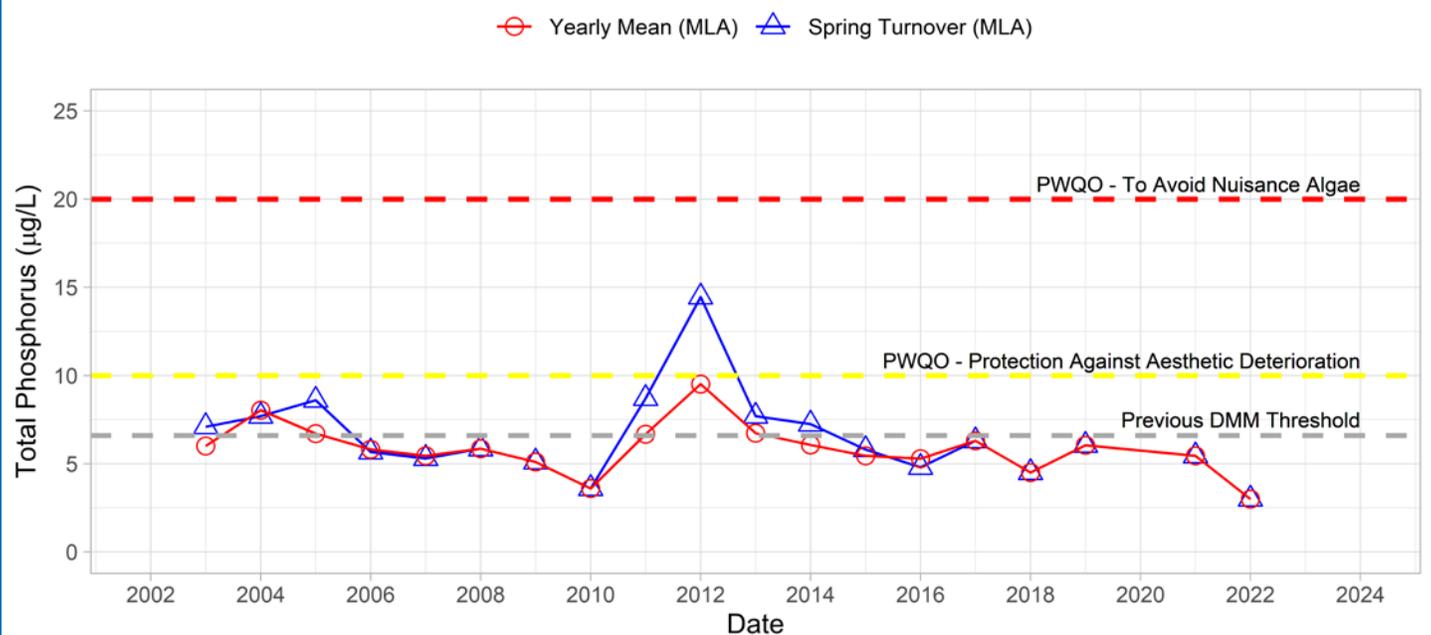
Bala Bay is a large bay in the eastern part of Lake Muskoka, which is largely isolated from the rest of the lake by Wanilah and Bala Park Islands. Much of the bay is densely developed however, forest cover remains intact along most shoreline areas. The Village of Bala is located on the western shore of the bay. Bala Bay is the main outflow point of the Muskoka River Watershed which drains through Bala bay and into the Moon River. There are also two small wetlands that drain into the bay. MLA monitoring of Bala Bay began in 2003.

Volunteer Recognition: Peter Joel and Alan Hutton.

2022 Water Quality Results:

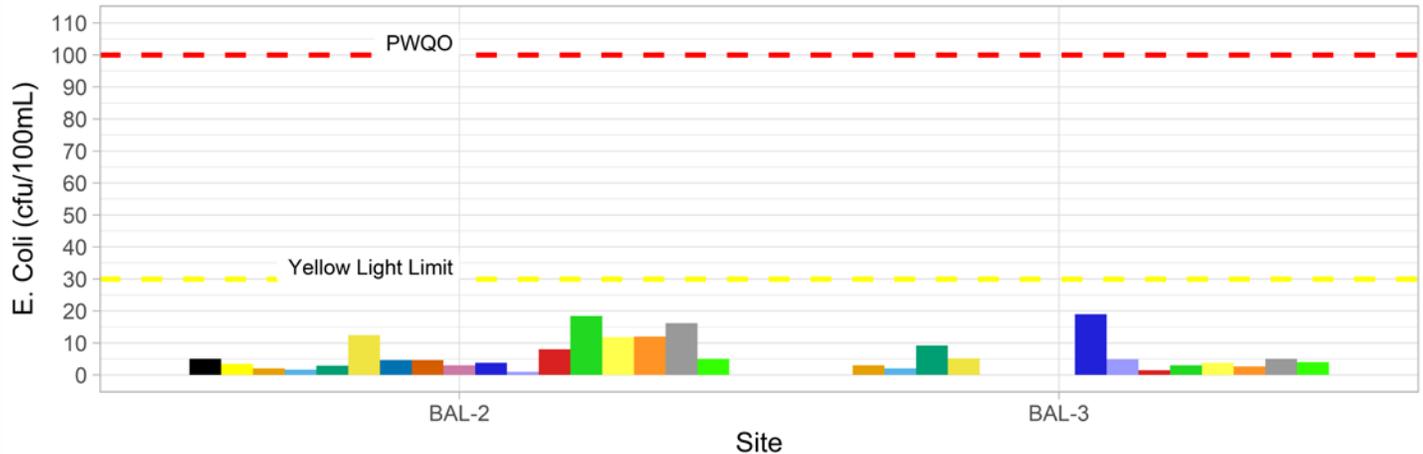
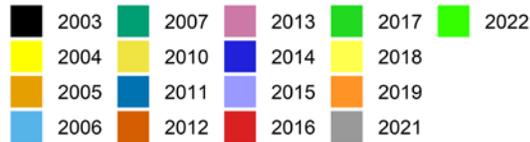
	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
BAL-0	3.2	3.0			
BAL-2				5	91
BAL-3				4	45

Phosphorus at BAL-0



Note: Grubbs test indicates spring total phosphorus data collected in 2012 was considered an outlier.

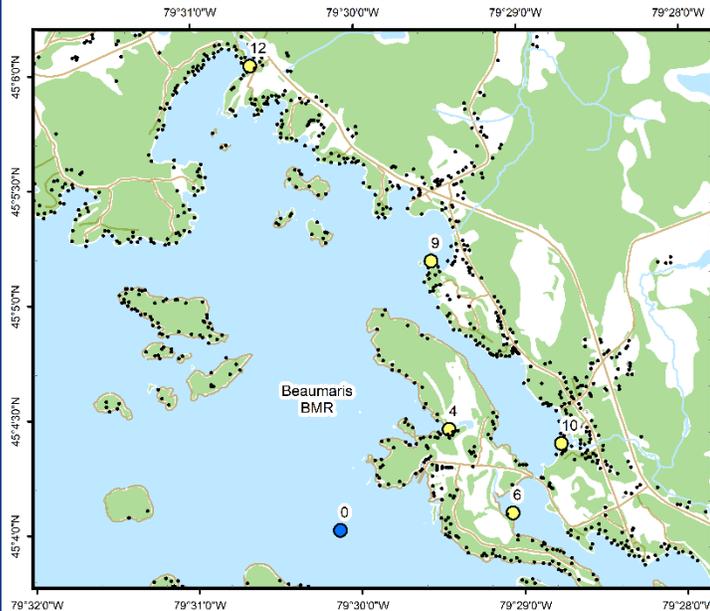
E. Coli Annual Geometric Mean at Bala Bay



In 2022 spring total phosphorus concentrations were within the range of variability recorded during the monitoring period and below the historic DMM threshold of 6.6 µg/L. All measured phosphorus concentrations were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of *E. coli* concentrations at BAL-2 and 3 were within the range of variability of previous monitoring years, and below MLA trigger concentrations. Average annual Secchi disk depth (3.2 m) was consistent with previous monitoring (2.5 – 5.3 m). Simcoe/Muskoka District Health noted a confirmed cyanobacterial bloom in Weismiller Bay in 2020, as a result the area is currently assigned a yellow stoplight. **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Beaumaris (BMR)



Area Description:

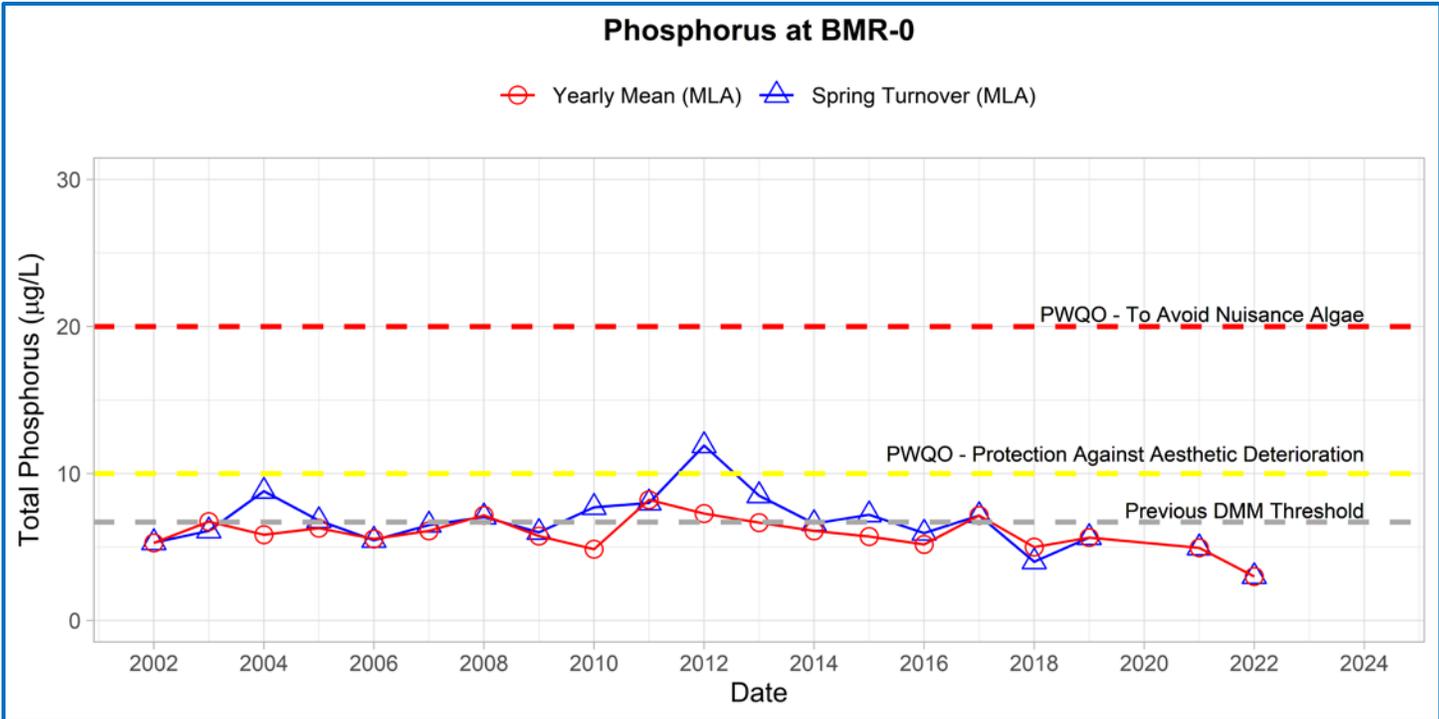
Beaumaris is an island in the Milford Bay region of north-eastern Lake Muskoka and is approximately 132 ha in size. The majority of the island is covered by a golf course with a small private club and marina. Natural shoreline vegetation is largely intact, however large boathouses are common in this area. The watershed includes a wetland to the east where the mainland and the island are linked by a causeway. MLA monitoring at Beaumaris began in 2002.

Volunteer Recognition: Louise Cragg, Don Furniss, Andree Baillargeon, Chris Cragg, Eliza Nevin, Lisa MacLatchy Naprawa, Peter Walsh.

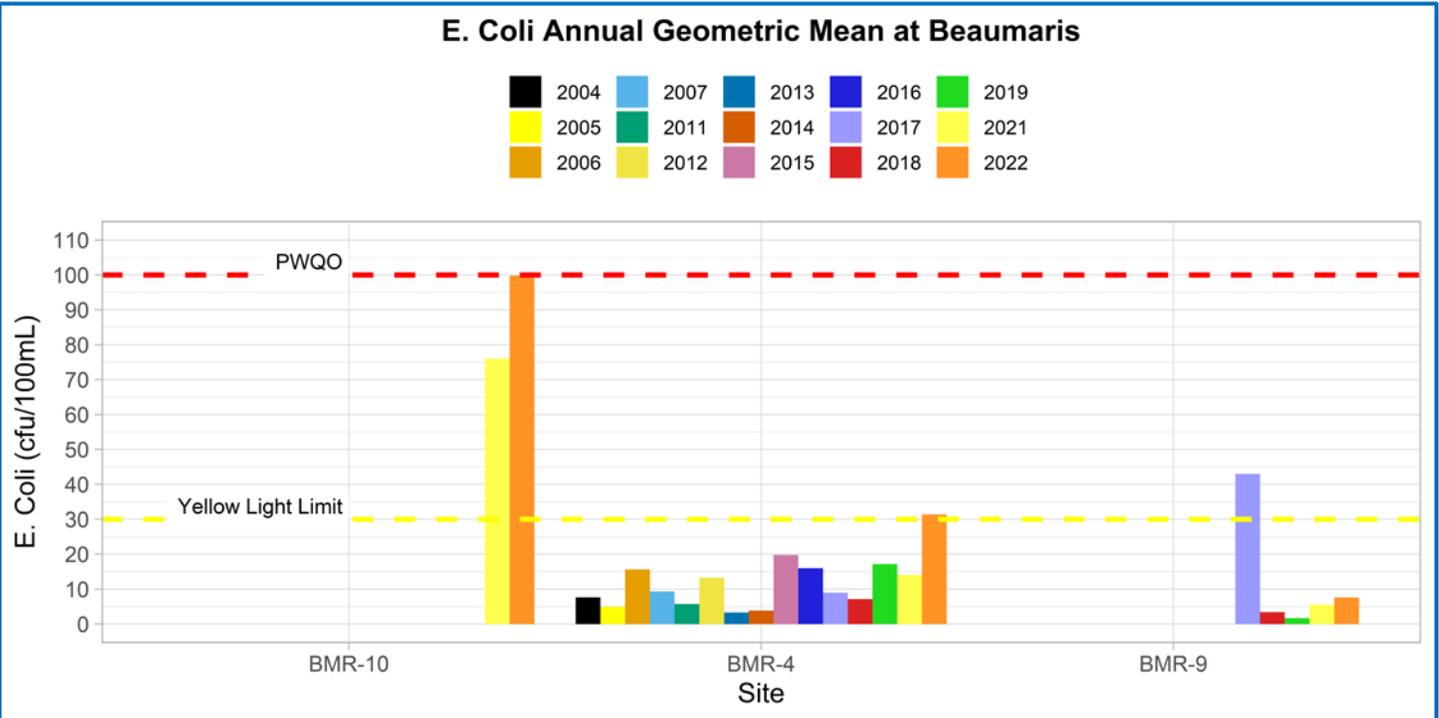
2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
BMR-0	3.8	3.0			
BMR-4		6.7		31	249(28)*
BMR-6		6.0	4.8		
BMR-9		4.3		8	79
BMR-10		13.9	16.8	100	741
BMR-12		19.3	24.4		

Note: Grubbs test indicated that the phosphorus concentration in 2021 at BMR-10 was an outlier. * Total coliforms at BMR-4 recorded a single sample value of 694 cfu/100mL during a storm event, geometric mean has been reported both including and excluding this anomalously high result.



Note: Grubbs test indicates data collected in 2012 are considered an outlier.



Spring phosphorus concentrations at the deep-water station (BMR-0) were below the historic DMM threshold of 6.7 µg/L and the Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L) in 2022. Nearshore monitoring of spring phosphorus concentrations at BMR-4, 6, and 9 were within the range of variability of previous monitoring years, however phosphorus concentrations at BMR-10 and BMR-12 were substantially higher than previous recorded results. 3.1 µg/L, respectively) which were considered an outlier based on the Grubb's test. Ongoing monitoring at these nearshore sites will inform on the elevated concentrations recorded in 2021. Average annual Secchi disk depth (3.8 m) was consistent with previous monitoring (2.25 - 4.40 m). The *E. coli* concentration at BMR-9 was well below the yellow light limit set by the MLA, bacteria collected at BMR-4 and BMR-10 exceeded the yellow light trigger established by the MLA. BMR-10 included numerous

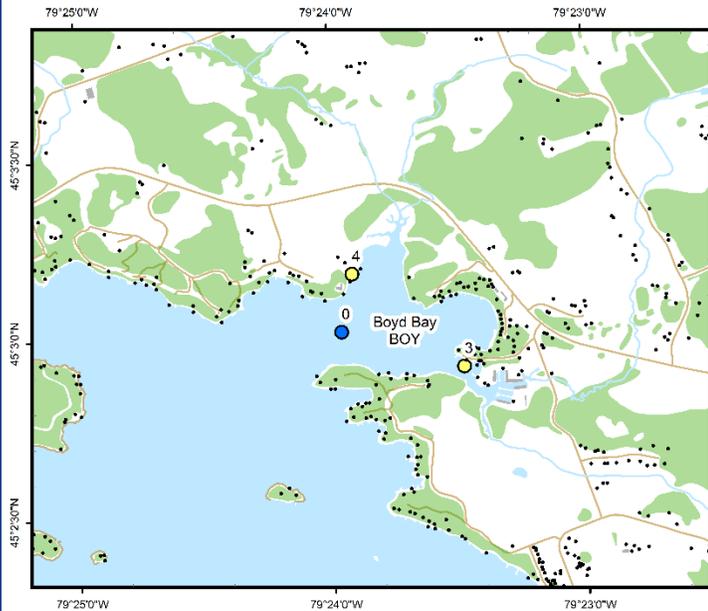


Hutchinson
Environmental Sciences Ltd.



re-tests and storm event samples, however even when removing storm event results *E. coli* concentrations were still above the yellow light trigger. **HESL recommends ongoing sampling to continue to monitor for long-term trends and to further inform on the elevated bacteria concentrations observed at several nearshore sites in 2022.**

Boyd Bay (BOY)



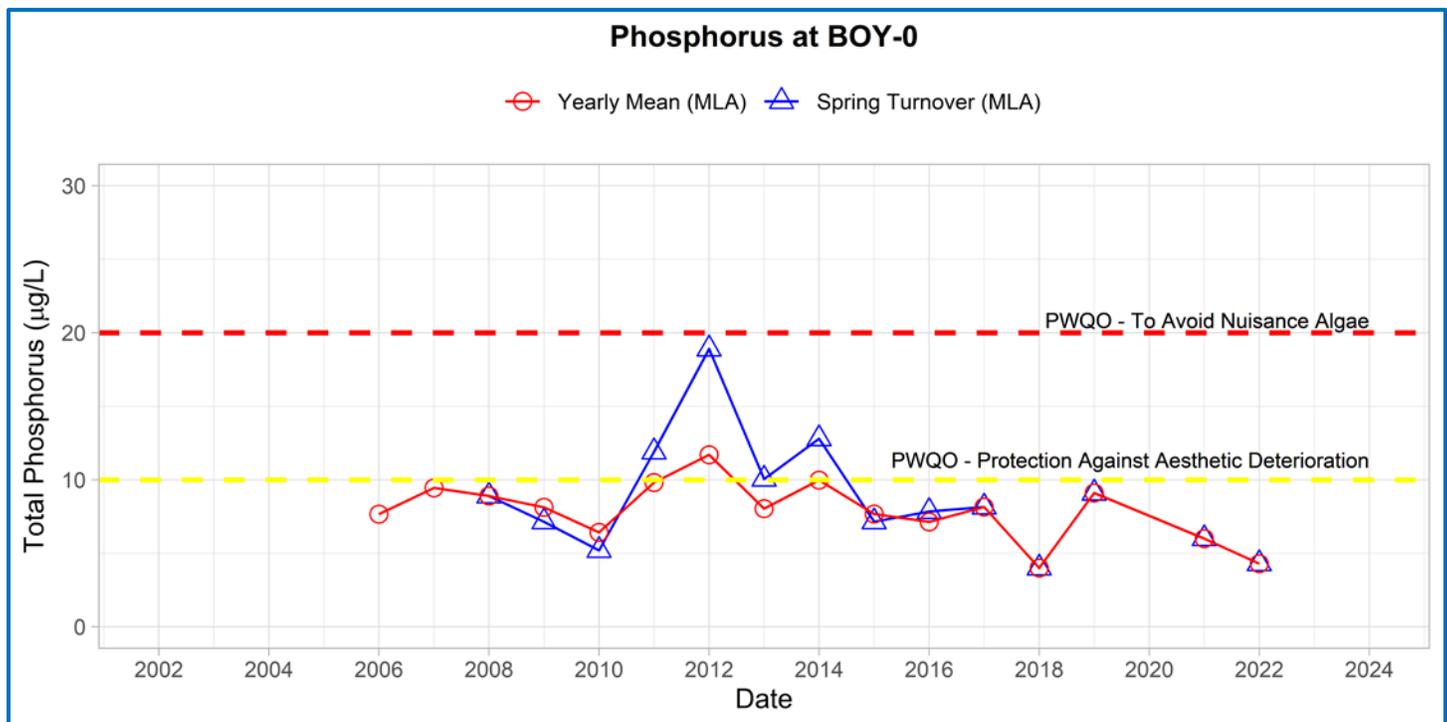
Area Description:

Boyd Bay, in the central part of eastern Lake Muskoka, is a small bay which includes a marina in the southeast, a large wetland in the north, Highway 118 to the east and several inflowing creeks. Inflow from creeks drain agricultural land and therefore may be a source of high nutrient waters. The shoreline of Boyd Bay is highly developed including many residential properties with manicured lawns. MLA monitoring of Boyd Bay began in 2006.

Volunteer Recognition: Bill & Jane Caughey, Paul Follis, Louise Cragg.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L) Spring Turnover	Total Phosphorus (µg/L) Yearly Mean	E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
BOY-0	2.3	4.3			
BOY-3		8.0	6.1		
BOY-4		6.9	5.8		



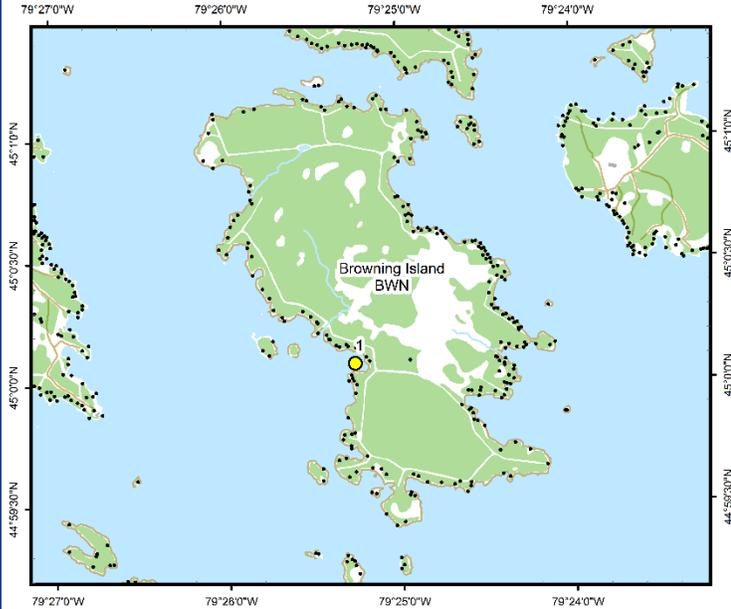
Note: Grubbs test indicates data collected in 2012 are considered an outlier



Spring phosphorus concentrations in 2022 at the deep-water station (BOY-0) were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual average and spring phosphorus concentrations at BOY-3 were within the range of variability of previous monitoring years. Average annual Secchi disk depth (2.3 m) was consistent with previous monitoring (1.07 – 4.45 m). A Harmful Algae Bloom was reported in 2018 near BOY-3 and BOY will remain yellow until a Causation Study has been completed to inform on the likely cause of that bloom.

HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.

Browning Island (BWN)



Area Description:

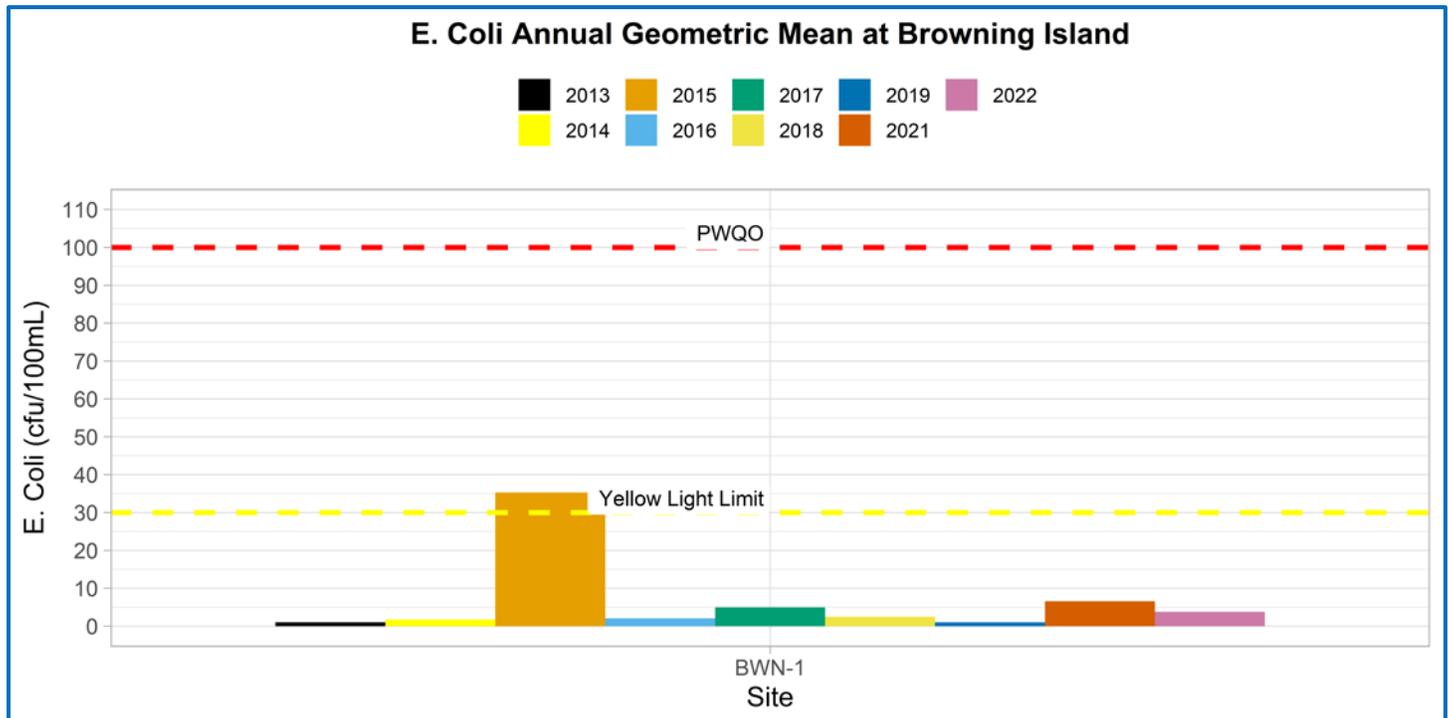
Browning Island is one of the largest islands in the Muskoka Lakes with 1.37 km² of the island consisting of the Browning Island Nature Reserve. Two of the sheltered bays were added to the MLA sampling program in 2013, however only BWN-1 was sampled in 2021. Developed area on the island is limited to residential shoreline cottages and an unpaved landing strip for small aircraft.

Volunteer Recognition: Kirk Swanson



2022 Water Quality Results:

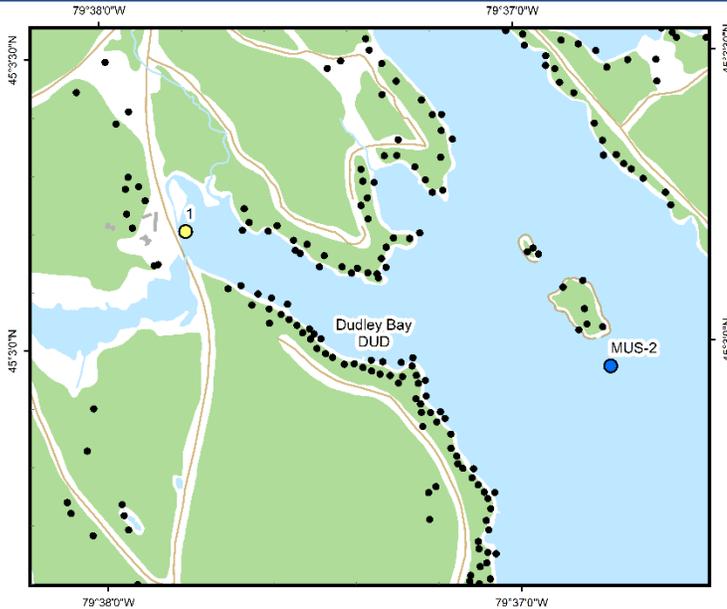
BWN-1	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
				4	36



E. coli results at BWN-1 were below the MLA stoplight limits in 2022. **HESL recommends sampling continue to monitor long-term trends.**



Dudley Bay (DUD-1 and MUS-2)



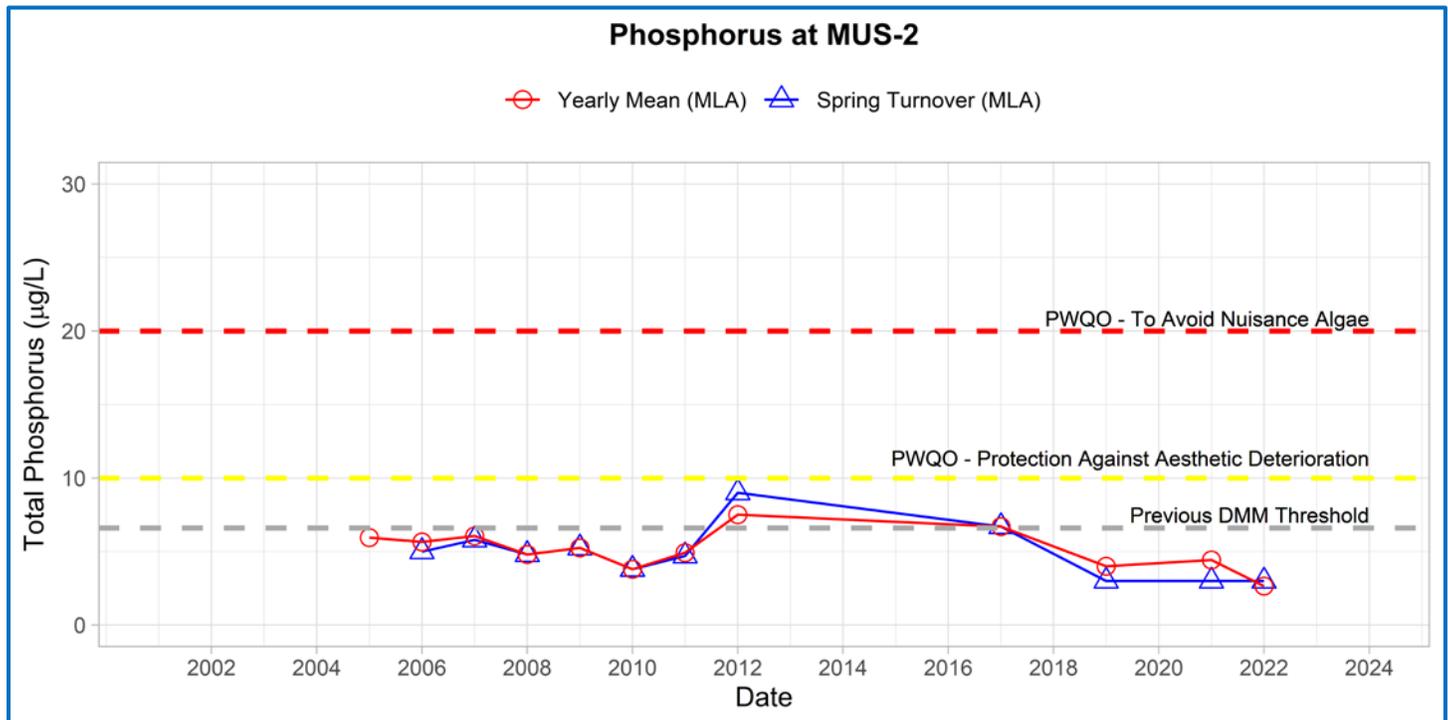
Area Description:

Dudley Bay is a moderately developed area in eastern Lake Muskoka, with a surface area of 3.55 km² and a maximum depth of 20 m. Development in the area includes residential properties, a cranberry farm and Highway 169, which runs in close proximity to the western shoreline. Several creeks and wetlands drain into the bay, including from the cranberry marsh. Dudley Bay was historically classified as moderately sensitive by the DMM. Monitoring started in 2005.

Volunteer Recognition: Eleanor Lewis and Jim Lewis.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
DUD-1		4.7	4.7		
MUS-2	2.9	3.0	2.7		



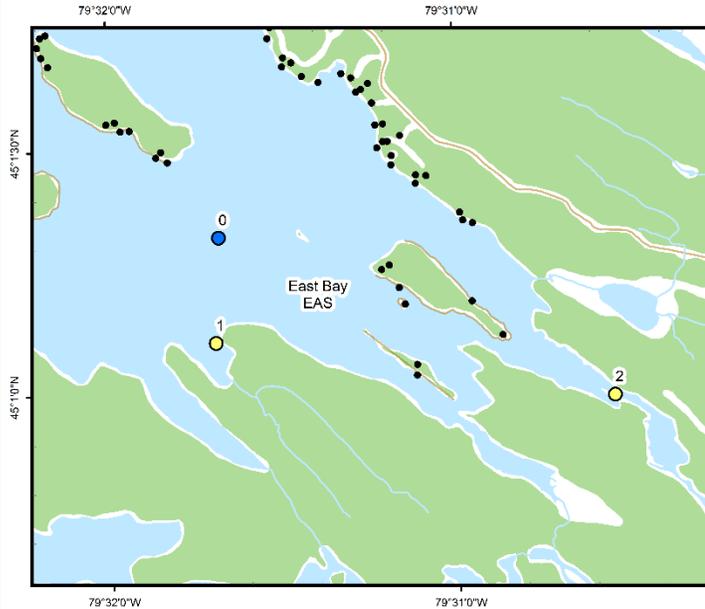
Note: Grubbs test indicates no data collected were considered outliers.



Annual average and spring phosphorus concentrations at the deep-water station (MUS-2) were below the historic DMM threshold of 6.6 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual average and spring phosphorus concentrations at DUD-1 were the lowest recorded since monitoring began in 2012. Average annual Secchi disk depth (2.9 m) was consistent with previous monitoring (2.5 – 4.75 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



East Bay (EAS)



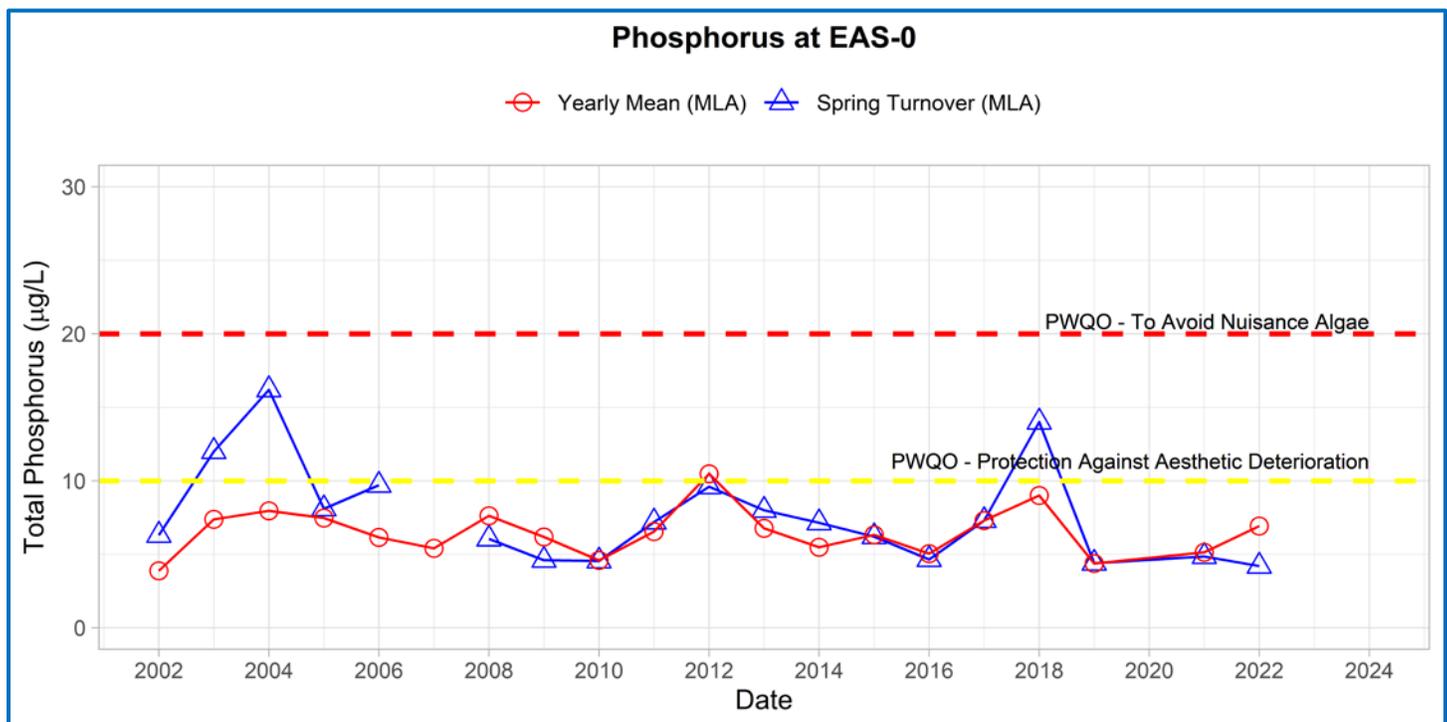
Area Description:

East Bay is part of Hardy Lake Provincial Park located in the western part of Lake Muskoka. Shoreline development in the Bay is low compared to other locations on Lake Muskoka, with few cottages/residences and limited road access. Five creeks flow into the bay through wetland areas of the Provincial Park in the southeast. MLA monitoring of East Bay began in 2002.

Volunteer Recognition: Jan Getson, Jeff Hall, Louise Cragg, Deb Martin-Downs.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
EAS-0	4.0	4.2	6.9		
EAS-2		5.4	5.3		
EAS-4		3.0	3.5		



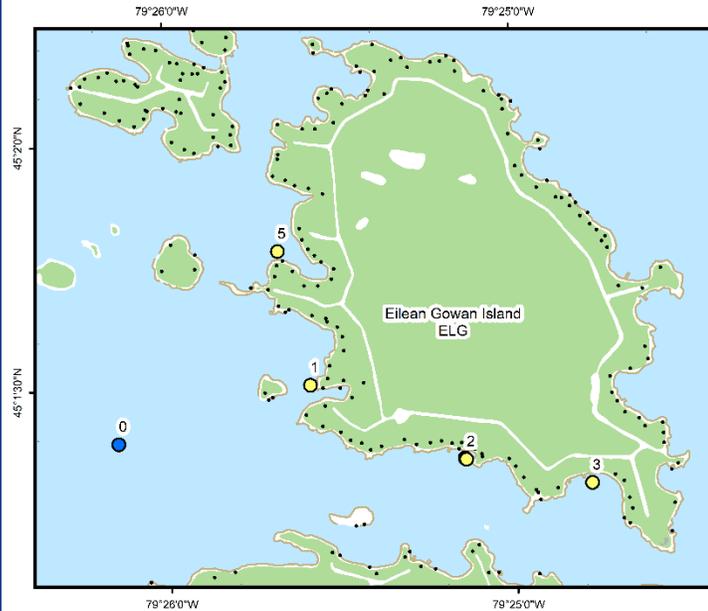
Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.



Annual average and spring phosphorus concentrations at the deep-water station (EAS-0) were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual and spring phosphorus concentrations at EAS-2 and 4 were within the range of variability of previous monitoring years. Average annual Secchi disk depth (4.0 m) was consistent with previous monitoring (2.6 – 5.5 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Eilean Gowan Island (ELG)



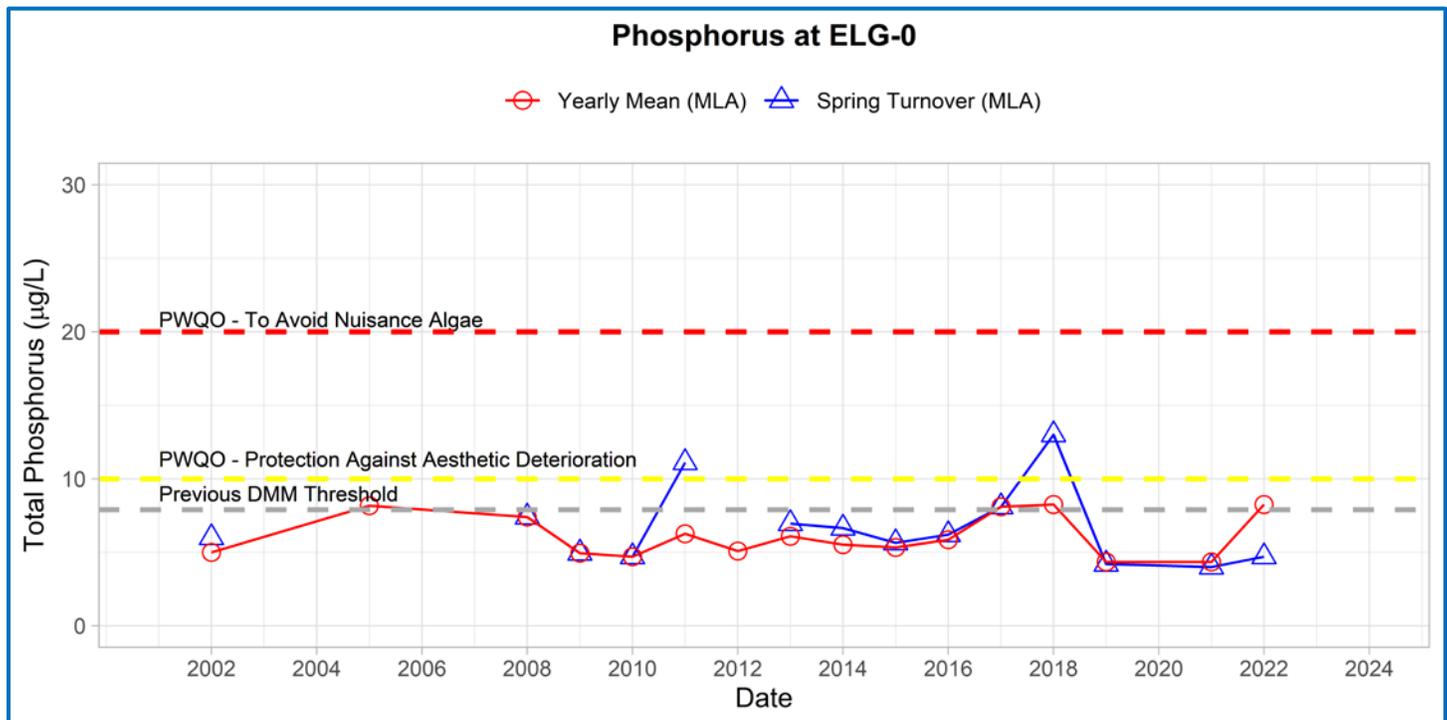
Area Description:

Eilean Gowan Island is located in the eastern part of Lake Muskoka. The island is developed with residential cottages, many of which appear to retain a well-vegetated shoreline. Some manicured lawns and tennis courts are located directly adjacent to the lake. The interior of Eilean Gowan Island is heavily forested and a stream outlets from the upland area to the lake at ELG-1. MLA monitoring of Eilean Gowan Island began in 2002.

Volunteer Recognition: Doug Tate, Beth Tate, Susan Murphy.

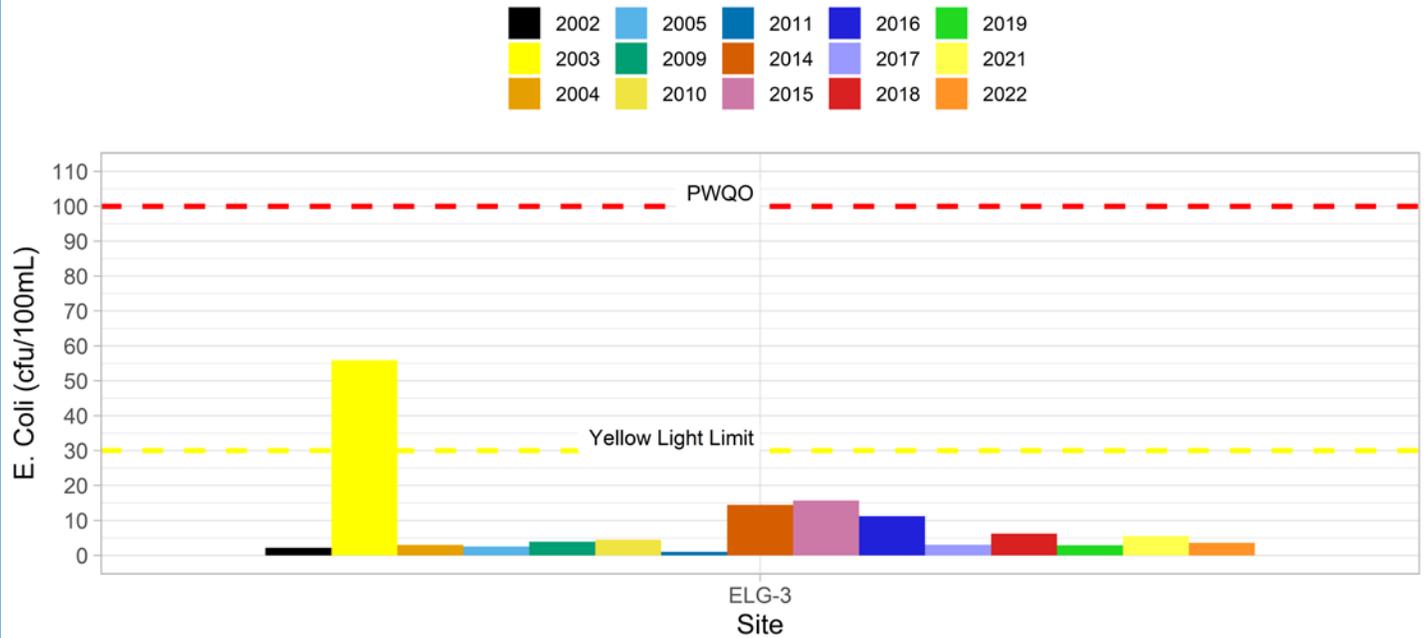
2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
ELG-0	2.6	4.7	8.3		
ELG-3				4	32
ELG-5		6.0			



Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.

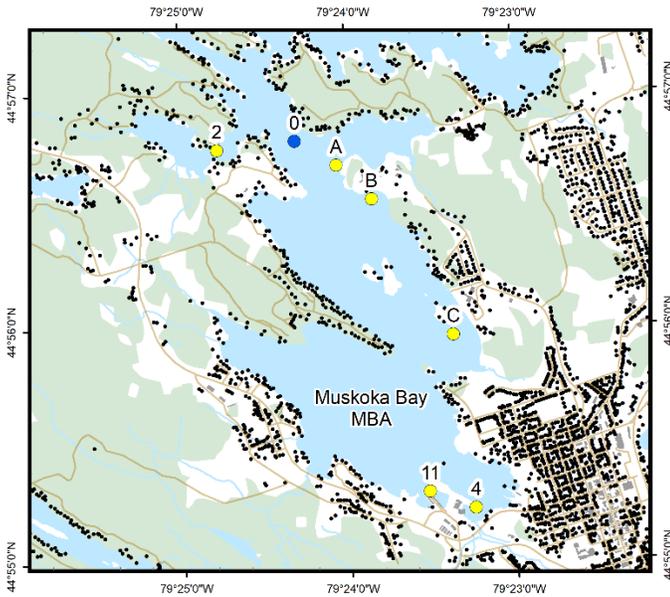
E. Coli Annual Geometric Mean at Eilean Gowan Island



Spring phosphorus concentrations at the deep-water station (ELG-0) were below the historic DMM threshold of 7.9 µg/L. A single measurement in August (21.1 µg/L), the highest recorded at the site since monitoring began in 2002, exceeded the Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L) and increased the average annual TP to 8.3 µg/L. It is unclear if this sample represents an increased phosphorus load at the site or is the result of contamination. Sampling in 2021 will help inform on phosphorus concentrations at ELG-0 in the late summer and determine if this single elevated measurement is a reason for concern. Nearshore monitoring of spring phosphorus concentrations at EAS-5 consistent with previous monitoring at the site. Average annual Secchi disk depth (2.6 m) was consistent with previous monitoring (2.0 – 5.25 m). *E. coli* counts in 2022 were well below the MLA trigger threshold of 30 cfu/100mL at ELG-3. **HESL recommends ongoing sampling to continue to monitor for long-term trends and inform elevated late summer phosphorus recorded in 2022.**



Muskoka Bay (MBA)



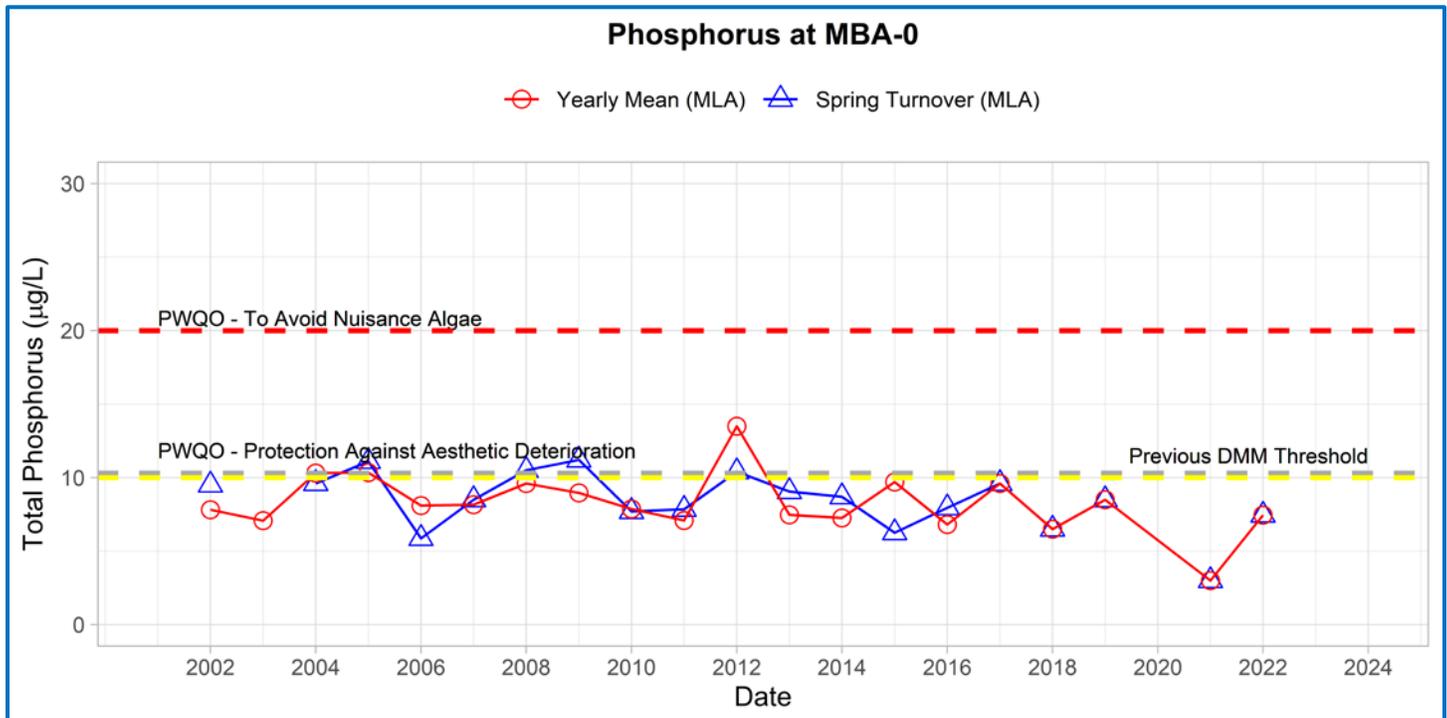
Area Description:

Muskoka Bay is a highly developed bay in southern Lake Muskoka. The highly developed bay has a surface area of 4.03 km² and a maximum depth of 14 m. Development in the area includes a commercial development and marina in the south, the town of Gravenhurst in the East and cottage development along most of the shoreline. The bay also receives urban stormwater from the town of Gravenhurst. Numerous creeks outlet into Muskoka Bay and wetlands account for 13% of the shoreline area. MLA monitoring of Muskoka Bay began in 2002.

Volunteer Recognition: Karen Abells and Alan Goldenberg.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
MBA-0	2.6	7.5			
MBA-2		8.2			
MBA-4		12.3			
MBA-11		10.3			



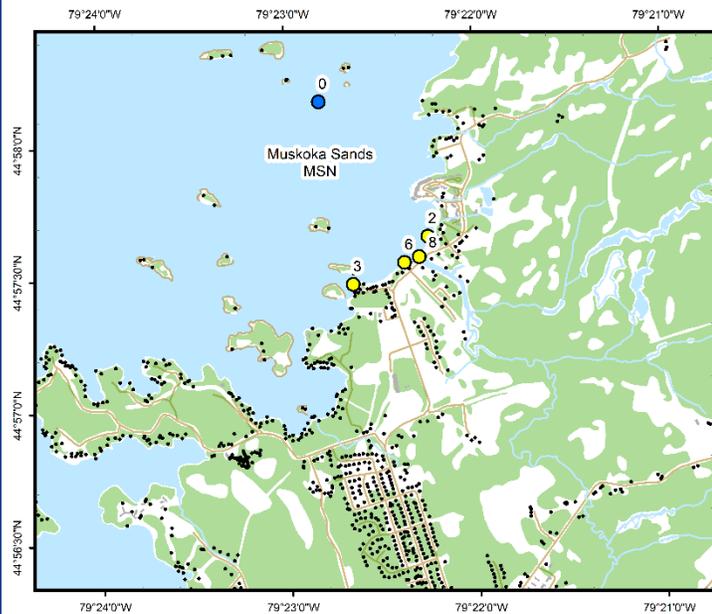


Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.



The spring phosphorus concentration at the deep-water station (MBA-0) was within the range of long-term variability and was below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of spring phosphorus concentrations at MBA-2, 4 and 11 were within the range of variability of previous monitoring years. Average annual Secchi disk depth (2.6 m) was consistent with previous monitoring (2.15 – 5.9 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Muskoka Sands (MSN)



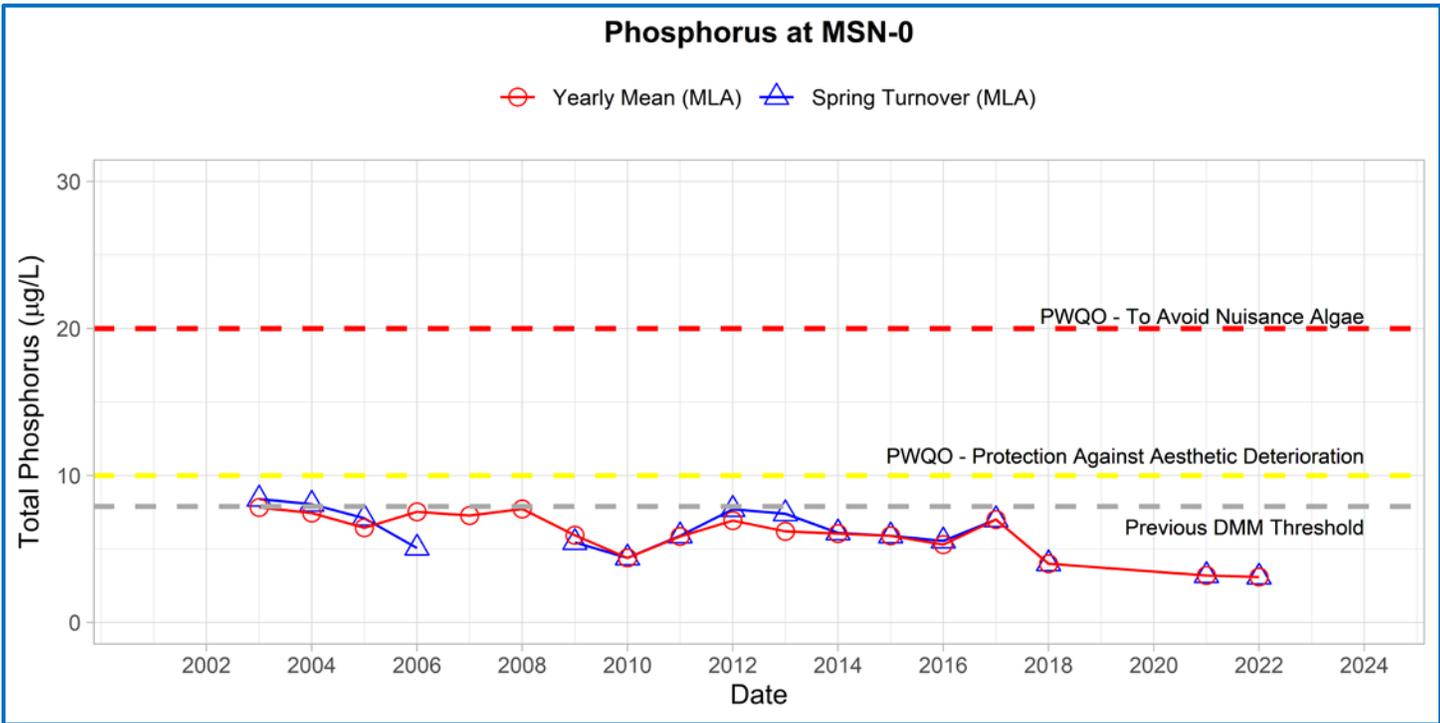
Area Description:

The Muskoka Sands sampling area is a highly developed region in southeastern Lake Muskoka at the inflow of the Hoc Roc River. Development within the area includes a large resort and golf course, a substantial number of residential properties and a large road network adjacent to the lake. Land use in the upstream reaches of the Hoc Roc River includes agricultural, industrial, residential, and natural wetland areas. MLA monitoring at Muskoka Sands began in 2003.

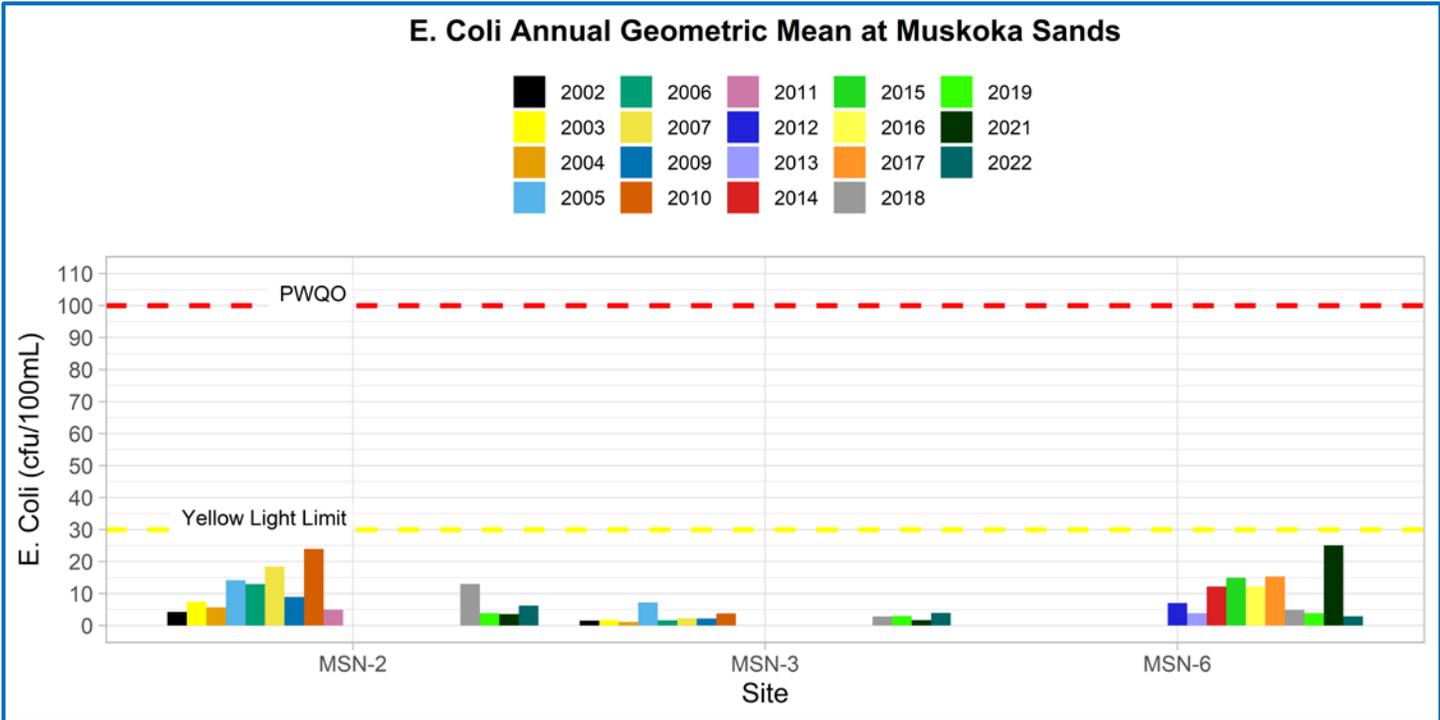
Volunteer Recognition: Sheila Robinson, George Fallis, Stephen Sims.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
MSN-0	3.2	3.1			
MSN-2				6	30
MSN-3				4	80
MSN-6				2	50
MSN-8		4.4	3.3		

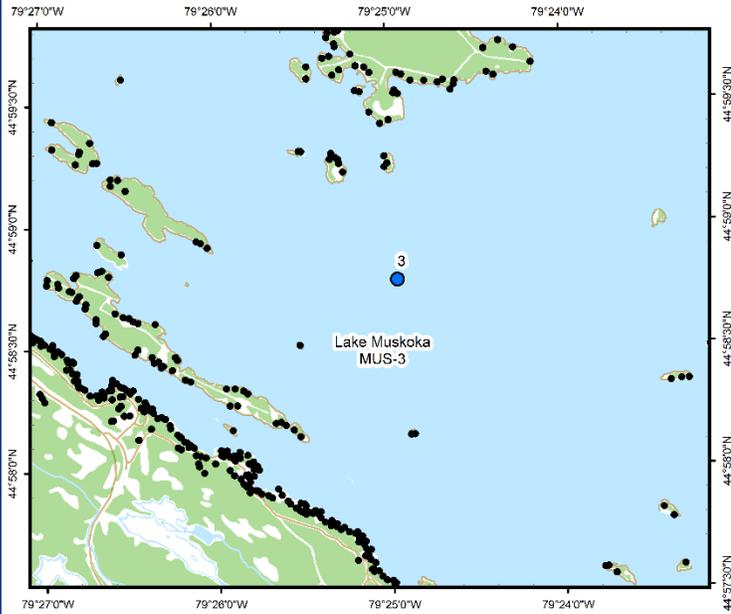


Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.



The spring phosphorus concentration at the deep-water station (MSN-0) was below the historic DMM threshold of 7.9 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of spring phosphorus concentrations at MSN-8 was the lowest on record and all samples collected were below 10 µg/L. Issues with storm sampling identified in 2021 were resolved in 2022 and bacteria counts declined to values typical of the long-term monitoring record. Average annual Secchi disk depth (3.7 m) was consistent with previous monitoring (1.0 - 5.25 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Lake Muskoka (MUS-3)



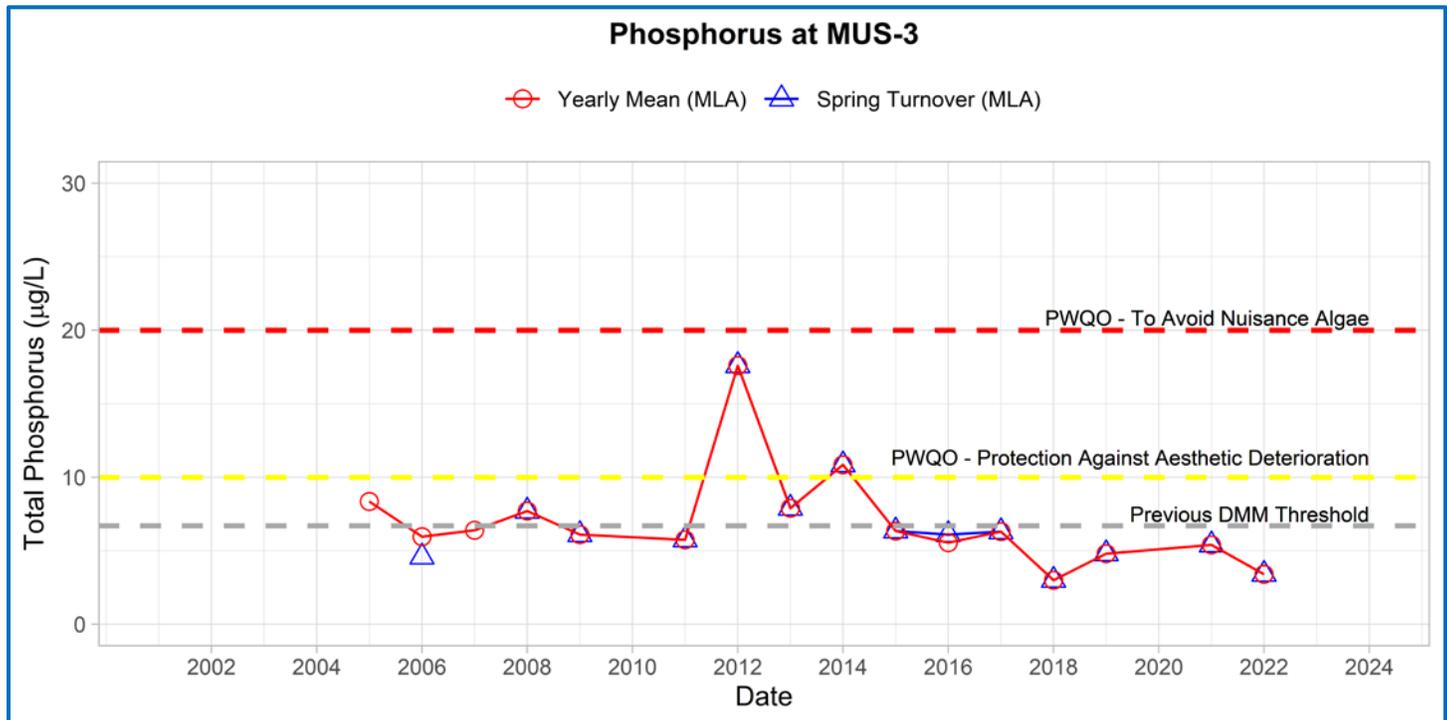
Area Description:

Lake Muskoka is the largest inland lake within the District of Muskoka. The lake has a surface area of 107.55 km² and maximum water depth of 67 m. The main basin of Lake Muskoka has a watershed area of 130.41 km² with approximately 6% of the watershed being covered by wetlands. The lakes main outflow is into the Moon River through Bala Bay. MLA monitoring of Lake Muskoka began in 2005.

Volunteer Recognition: Carol Hoskins, Sheila Robinson, George Fallis, Stephen Sims, Mark & Sandy Brosch.

2022 Water Quality Results:

MUS-3	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
	3.0	3.4			

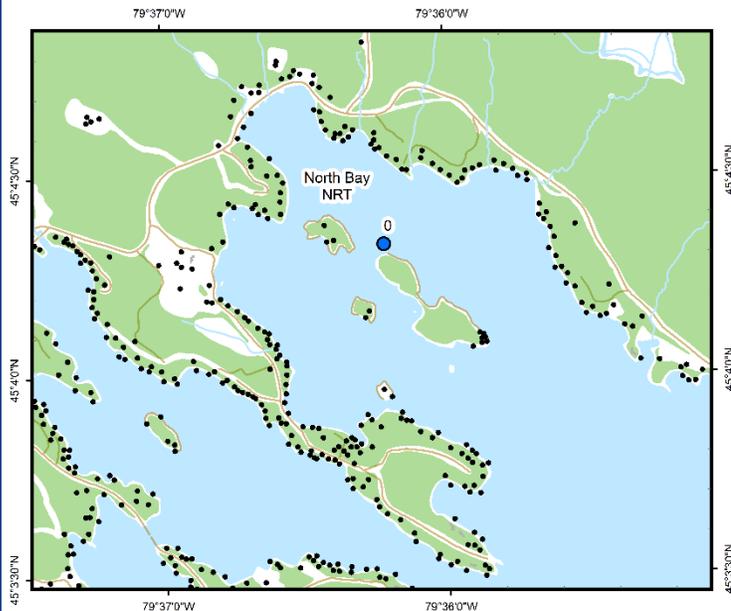


Note: Grubbs test indicates 2012 spring phosphorus data was considered an outlier.



The spring phosphorus concentration at the deep-water station (MUS-3) was below the historic DMM threshold of 6.7 $\mu\text{g/L}$ and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 $\mu\text{g/L}$) and Nuisance Algal Growth (20 $\mu\text{g/L}$). Average annual Secchi disk depth (3.0 m) was consistent with previous monitoring (2.4 – 3.95 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

North Bay (NRT)



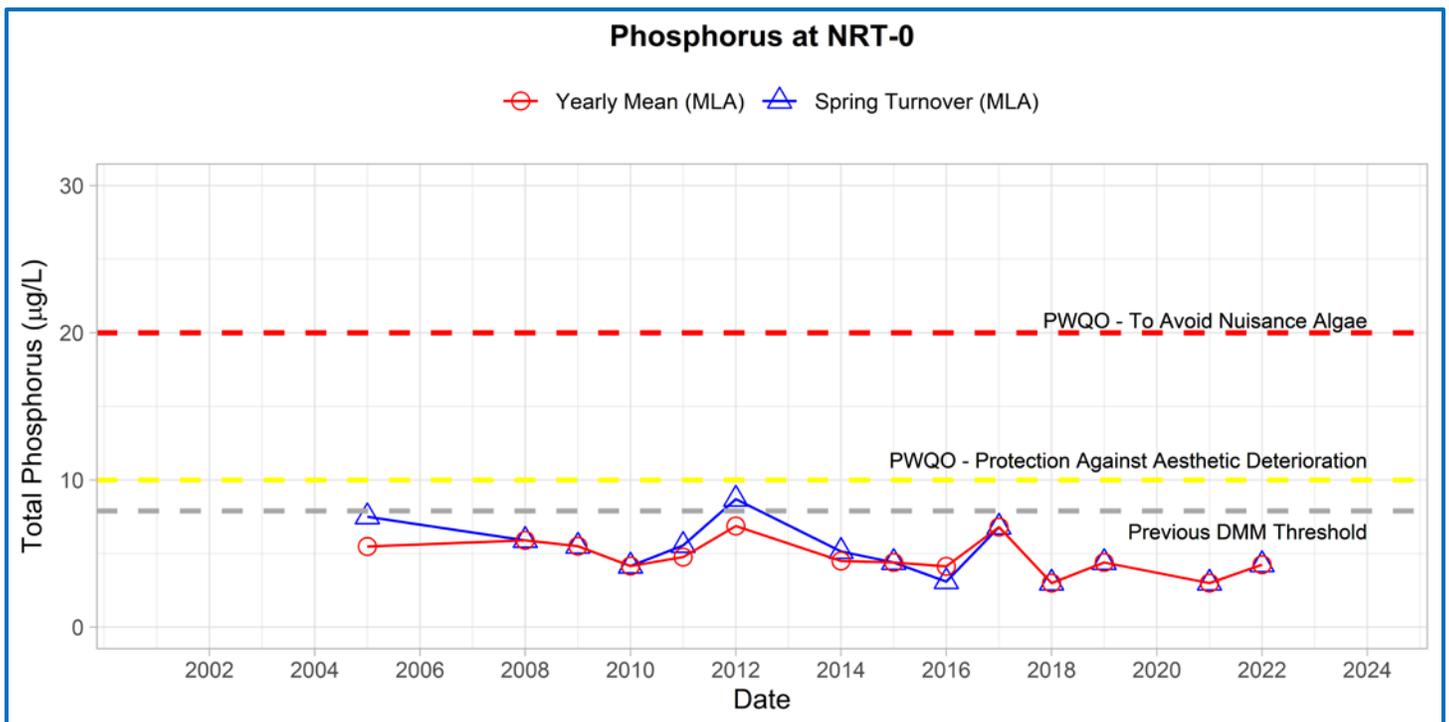
Area Description:

North Bay is a large bay in northwestern Lake Muskoka. Eight creeks outlet into the bay, including one in the North which flows through a District landfill site. North Bay is moderately developed including residential properties and several roads that are in close proximity to the shoreline. Development is focussed on areas adjacent to the lake, and therefore the remainder of the watershed is densely forested

Volunteer Recognition: Eleanor Lewis, Kim Seon and Jim Lewis.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
NRT-0	3.2	4.3			

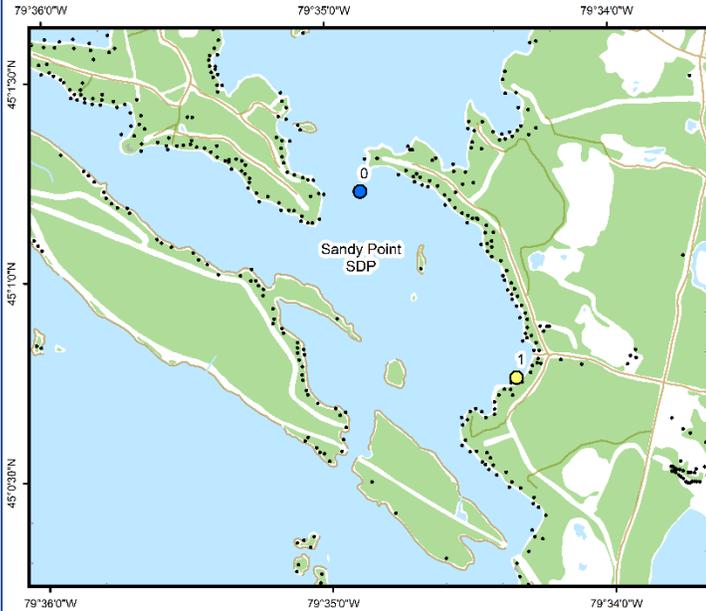


Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.



The spring phosphorus concentration at the deep-water station (NRT-0) was below the historic DMM threshold of 7.9 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Average annual Secchi disk depth (3.2 m) was consistent with previous monitoring (2.25 – 4.63 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Sandy Point (SDP)



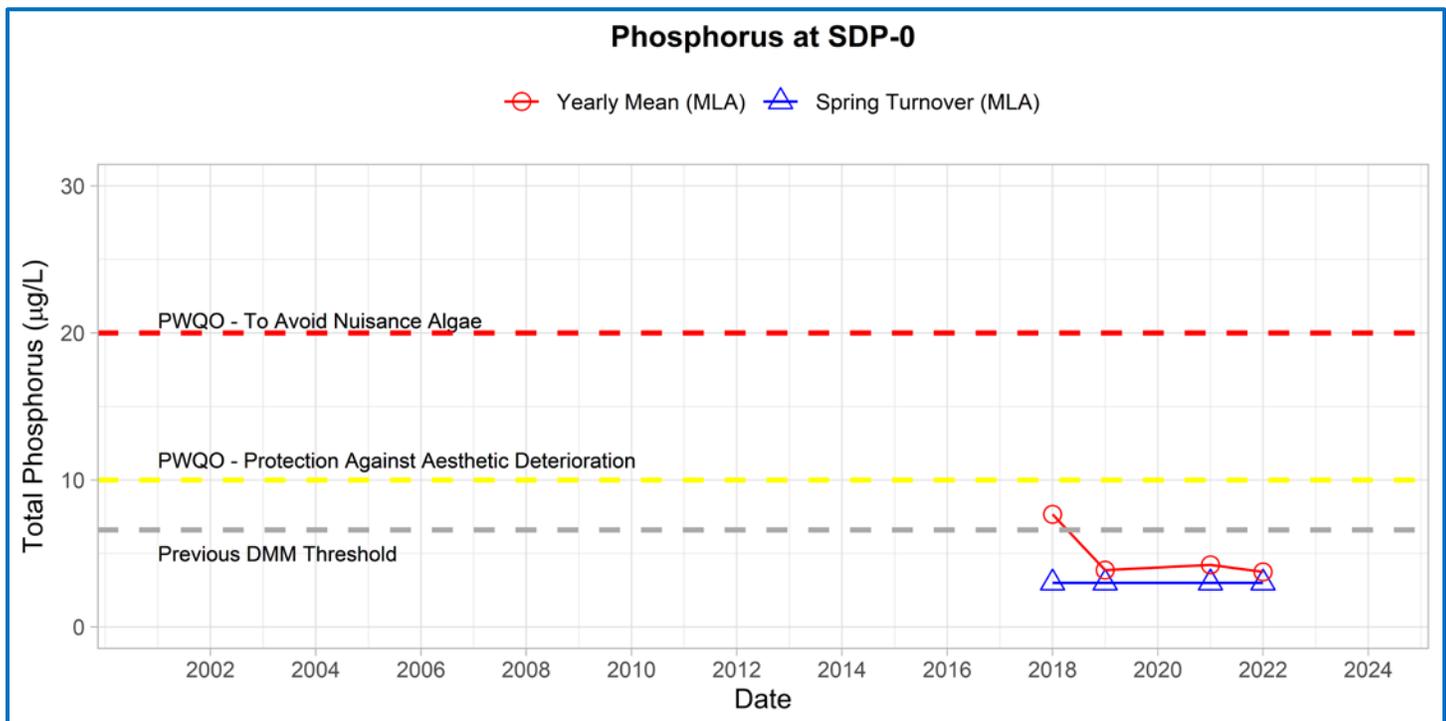
Area Description:

Sandy Point is east of Bala and the Moon River outflow from Lake Muskoka in the western portion of the lake. The Sandy Point stations are northwest of Bala Park Island and Wanilah Island. Three aggregate operations are currently active to the west of the Sandy Point sampling locations. MLA monitoring of Sandy Point began in 2018.

Volunteer Recognition: Mike Schnarr.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
SDP-0	2.7	3.0	3.7		
SDP-1		5.7	4.3		

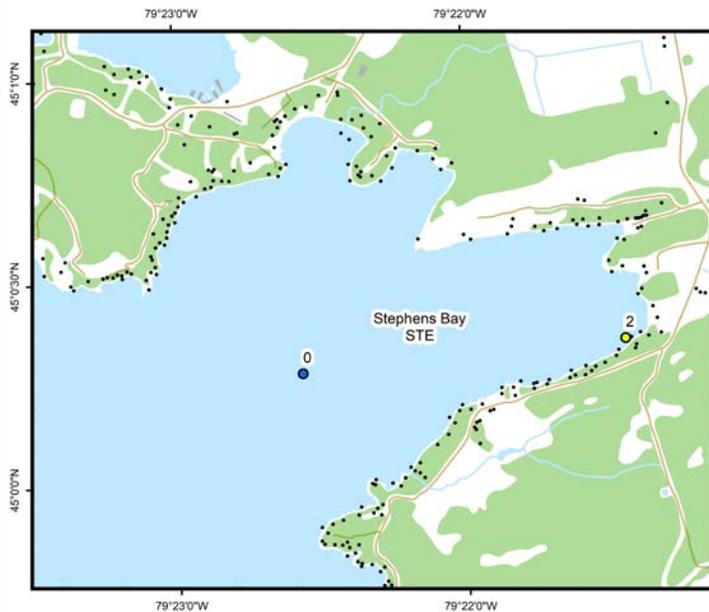


Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.



Annual average and spring phosphorus concentrations at the deep-water station (SDP-0) were below the historic DMM threshold of 6.6 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of spring phosphorus concentrations at SDP-1 were within the range of variability of previous monitoring years, though data at this newly established site (2018) are limited. Average annual Secchi disk depth (2.7 m) was consistent with previous monitoring (3.0 - 3.2 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Stephens Bay (STE)



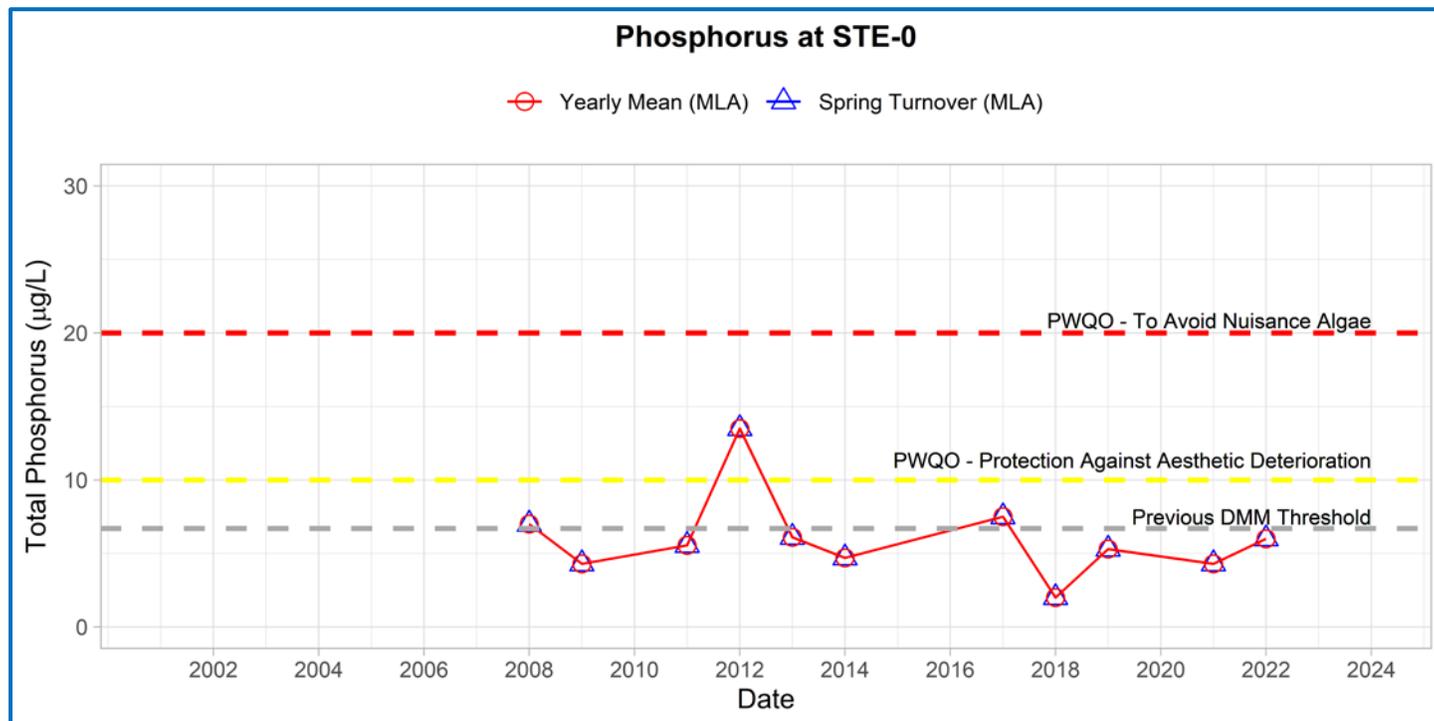
Area Description:

Stephen's Bay is located south of the mouth of the Muskoka River, in the central part of eastern Lake Muskoka. Land use within the watershed area of Stephen's Bay includes input from adjacent wetlands as well as agricultural lands in the east, and two public beaches (Strawberry Bay and Kirby's). Shoreline development in the bay is high. MLA monitoring of Stephen's Bay began in 2013.

Volunteer Recognition: Kirk Swanson

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
STE-0	3.1	6.0			
STE-2		3.0			



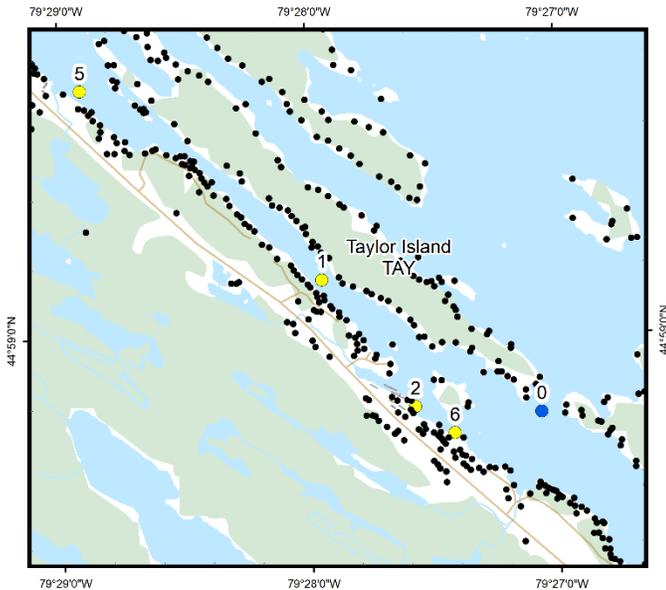
Note: Grubbs test indicates data collected in 2012 are considered an outlier



The spring phosphorus concentration at the deep-water station (STE-0) in 2021 was marginally above the historic DMM threshold of 6.7 $\mu\text{g/L}$ and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 $\mu\text{g/L}$) and Nuisance Algal Growth (20 $\mu\text{g/L}$). Nearshore monitoring of spring phosphorus concentrations at STE-2 began in 2019, phosphorus concentration in 2022 was the lowest on record (3.0 $\mu\text{g/L}$), ongoing monitoring at the STE-2 site will inform of long-term trends in phosphorus concentrations. Average annual Secchi disk depth (3.1 m) was consistent with previous monitoring (2.0 – 4.4 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Taylor Island (TAY)



Area Description:

Taylor Island is a long, narrow, moderate-highly developed island in the main basin of Lake Muskoka. The island is approximately 76 ha in size which despite development retains most of the natural shoreline vegetation. Two wetland streams outlet into Lake Muskoka in this area. Nearshore monitoring station TAY-2 is located adjacent to a marina west of Denison Island. MLA monitoring of Taylor Island began in 2012.

Volunteer Recognition: Carol Hoskins, Sheila Robinson, George Fallis, Stephen Sims, Mark & Sandy Brosch.

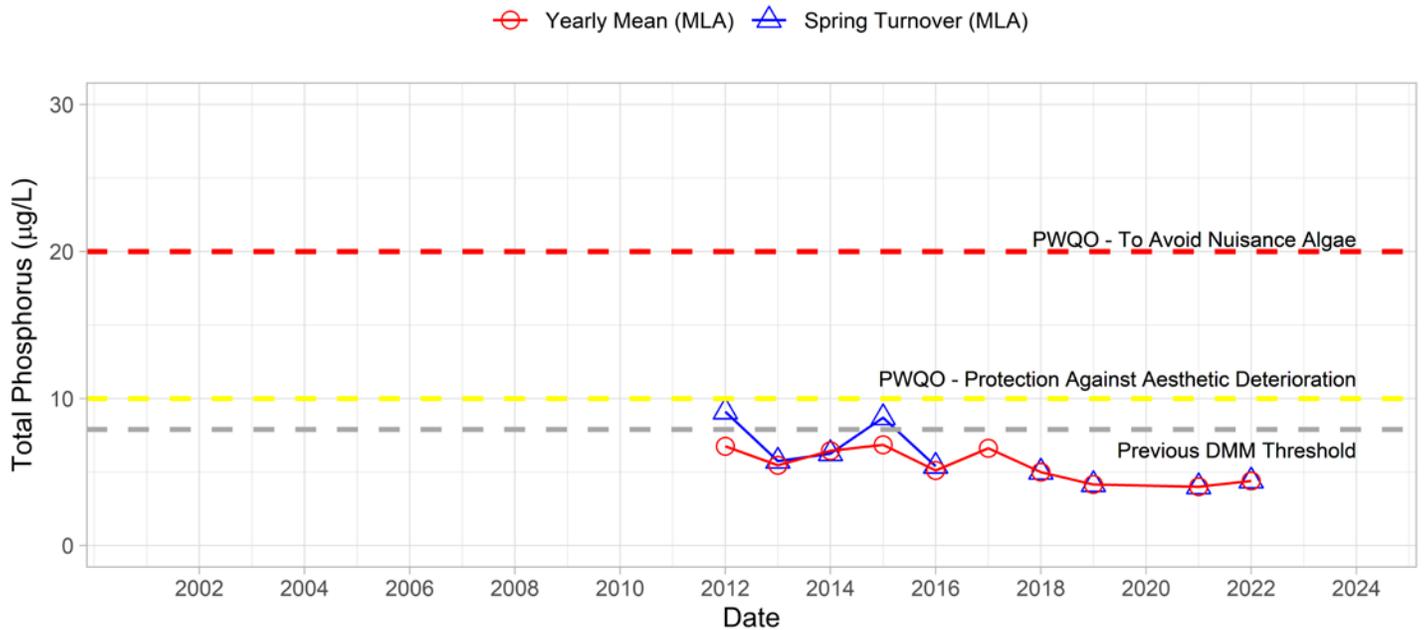
2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
TAY-0	3.4	4.4			
TAY-1				3	26
TAY-2		5.4	5.7	10	83
TAY-5		42.8*		7	75
TAY-6				5	60

Note: *TAY-5 Total phosphorus concentration in 2022 was considered an outlier.

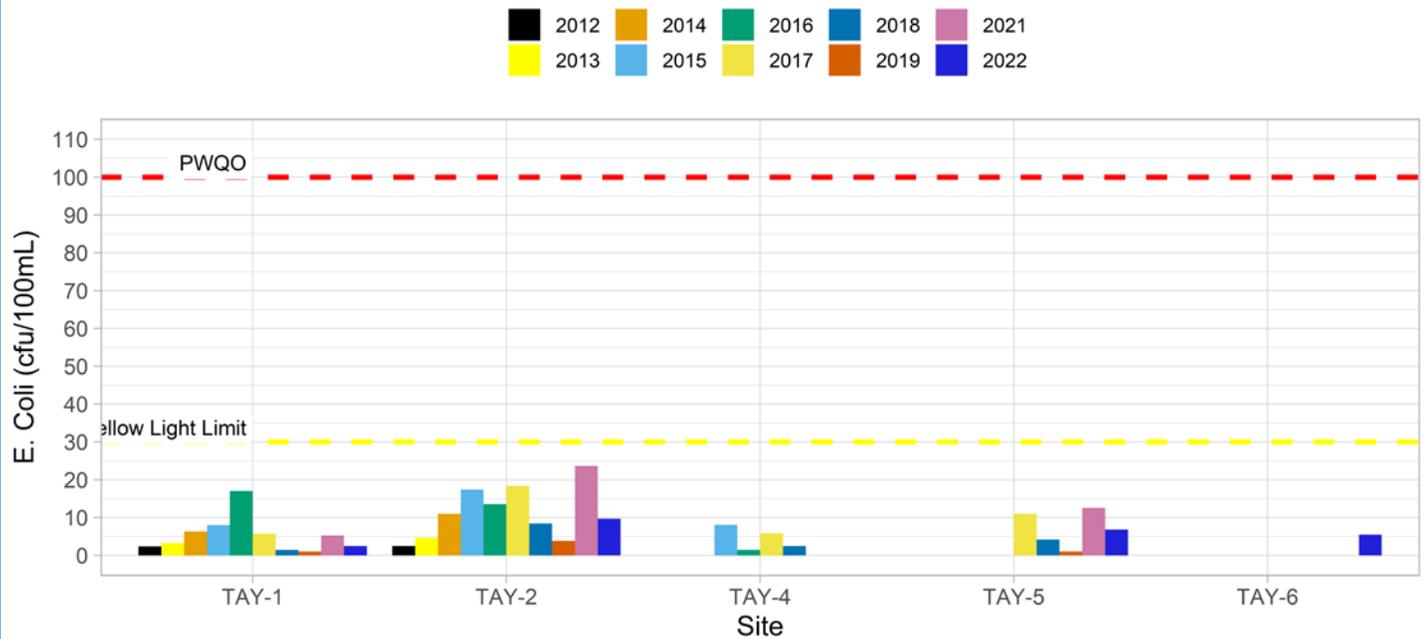


Phosphorus at TAY-0



Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.

E. Coli Annual Geometric Mean at Taylor Island

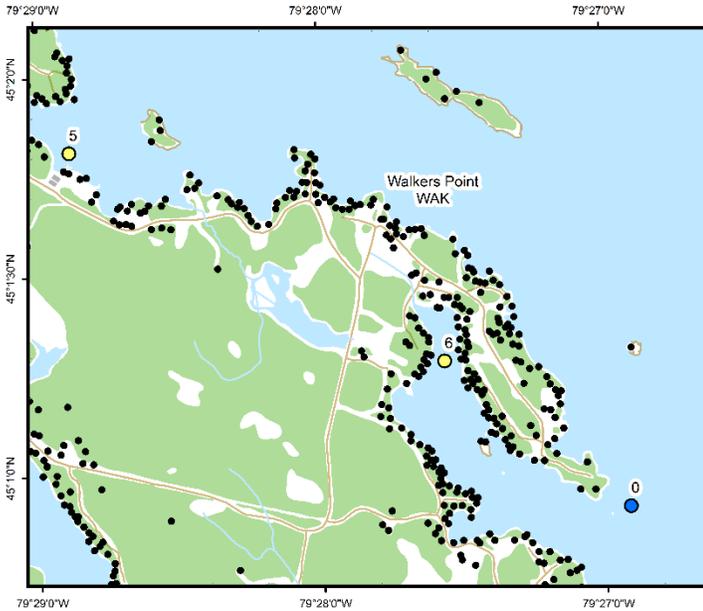




The spring phosphorus concentration at the deep-water station (TAY-0) in 2022 was below the historic DMM threshold of 7.9 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring spring phosphorus concentration at TAY-2 was within the range of variability of previous monitoring years. *E. coli* counts at TAY-1, TAY-2, and TAY-5 and at a newly established site at TAY-6 remained below the MLA stoplight limit. Average annual Secchi disk depth (3.4 m) was consistent with previous monitoring (2.18 – 5.3 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Walkers Point (WAK)



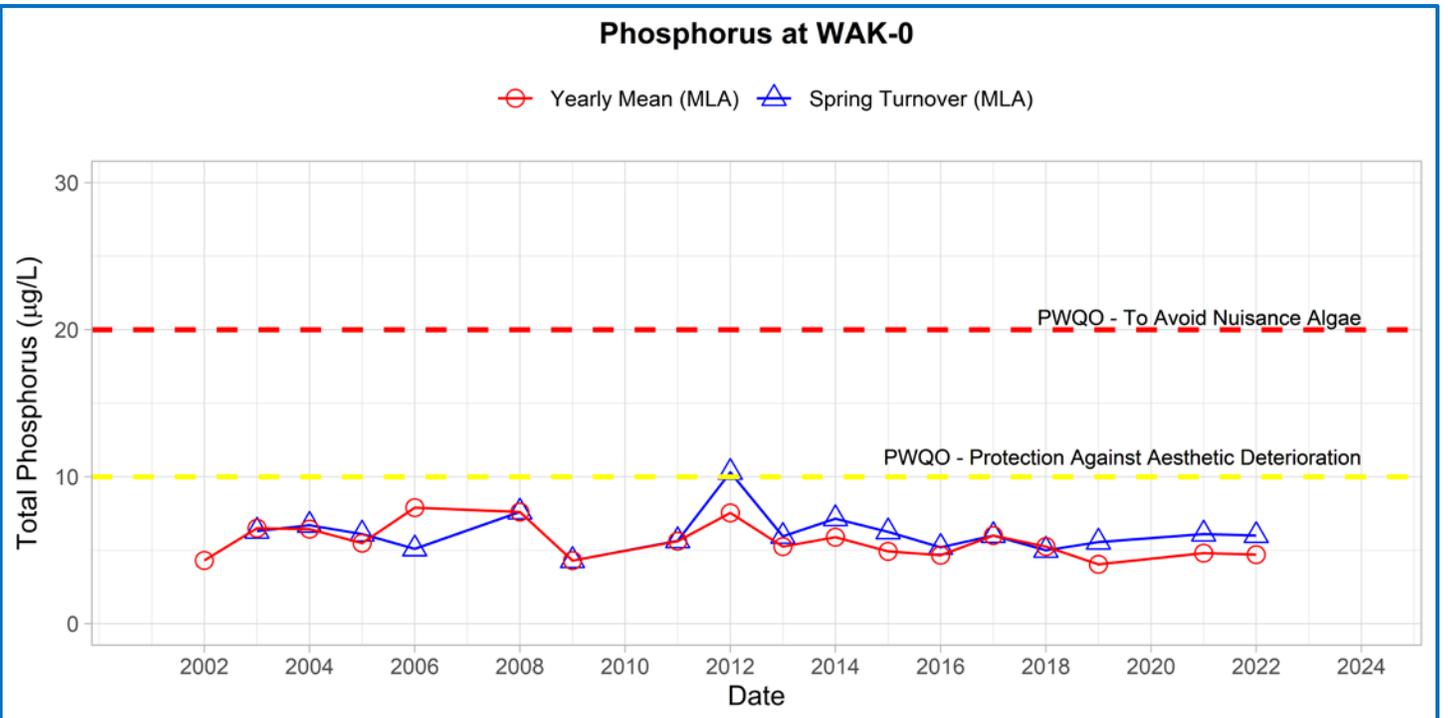
Area Description:

Walkers Point is East of Hardy Lake Provincial Park and west of Browning Island in south-central Lake Muskoka. The deep-water monitoring station (WAK-0) is located off the tip of Walkers Point, near the mouth of Walkers Bay. A single creek flows into Walkers Bay. The sampling area extends northwest to include the outlet of a creek which drain a series of wetlands and is adjacent to a marina. MLA monitoring of Walkers Point began in 2002.

Volunteer Recognition: Susan Murphy, Doug Tate, Beth Tate.

2022 Water Quality Results:

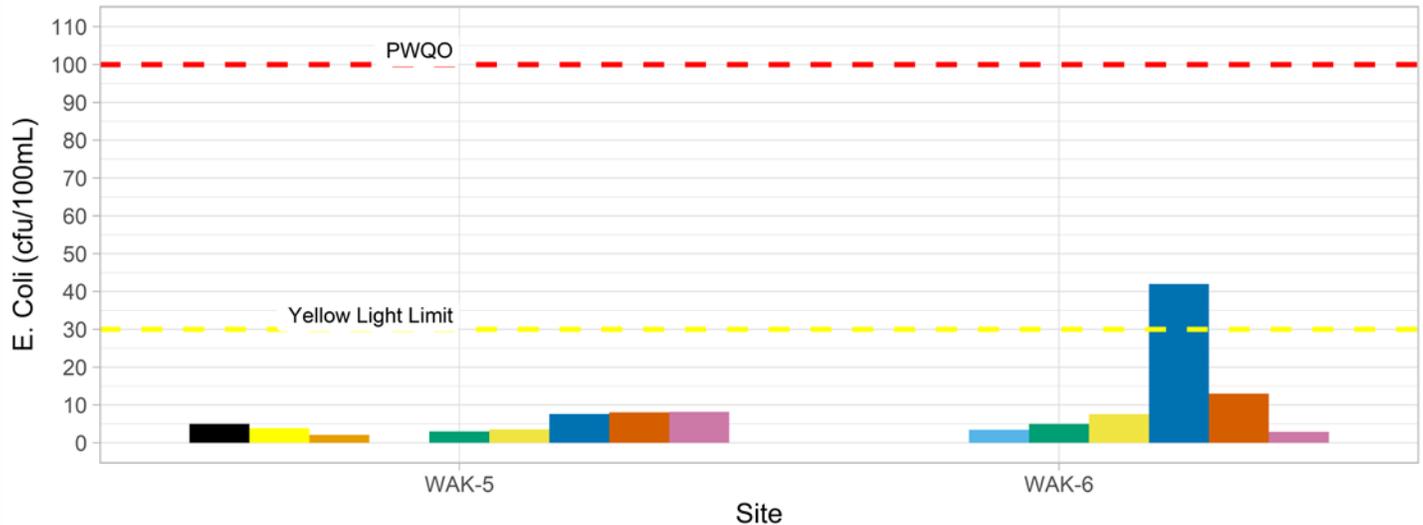
	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
WAK-0	2.7	6.0	4.7		
WAK-5		5.7	4.3	9	32
WAK-6		7.1	5.3	3	67



Note: Grubbs test indicates data collected in 2012 are considered an outlier

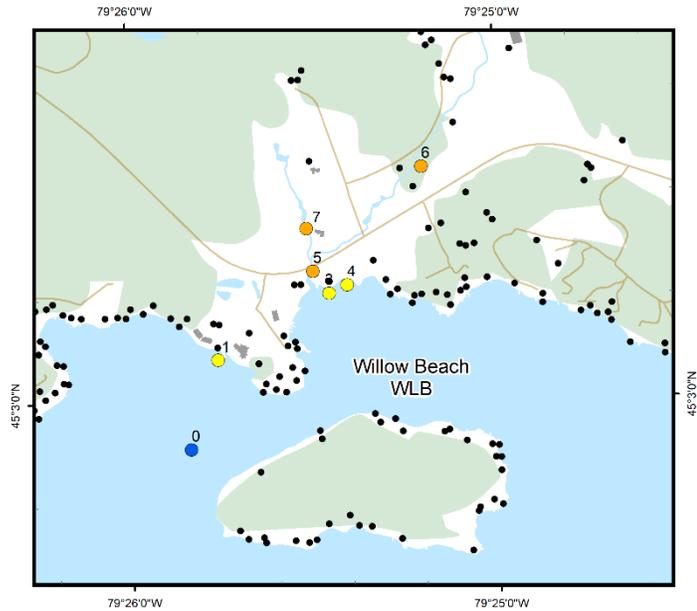


E. Coli Annual Geometric Mean at Walkers Point



Annual average and spring phosphorus concentrations at the deep-water station (WAK-0) in 2022 were below the historic DMM threshold of 6.7 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual average and spring phosphorus concentrations at WAK-5 and 6 were within the range of variability of previous monitoring data collected since 2017 and 2016 respectively. Average annual Secchi disk depth (2.7 m) was consistent with previous monitoring (2.25 - 4.35 m). *E. coli* counts at WAK-5 and 6 were well below the MLA stoplight limits. **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Willow Beach (WLB)



Area Description:

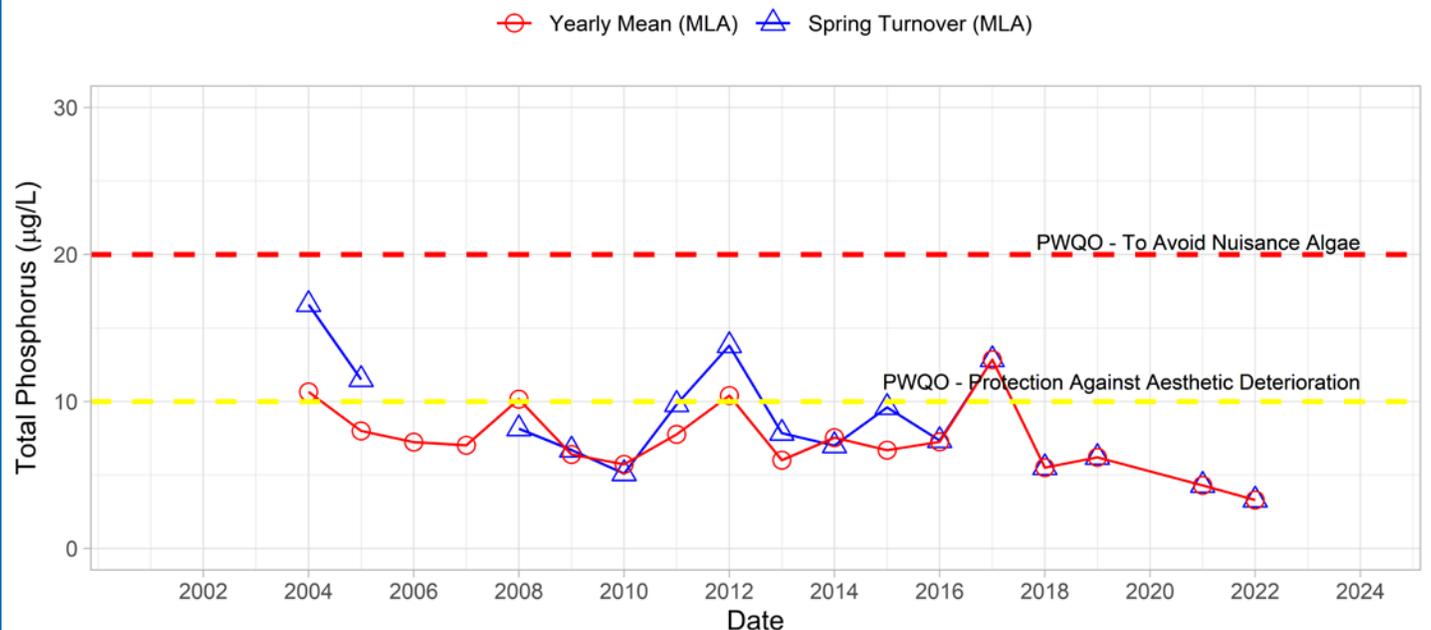
Willow Beach is a highly developed section of shoreline in east central Lake Muskoka, west of Boyd Bay. The Willow Beach shoreline includes a newly redeveloped resort complex, a wetland with a creek flowing through a nine-hole golf course and several larger properties with substantial shoreline alteration and limited retained forest cover. Highway 118 also runs in close proximity to the shoreline along much of the Willow Beach area. MLA monitoring at Willow Beach began in 2004.

Volunteer Recognition: Tom & Pam Poole, Chris Cragg, Louise Cragg.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
WLB-0	2.9	3.3			
WLB-1		3.4	4.0		
WLB-3		8.8	8.0	36	1767
WLB-4		5.7	4.4	2	67

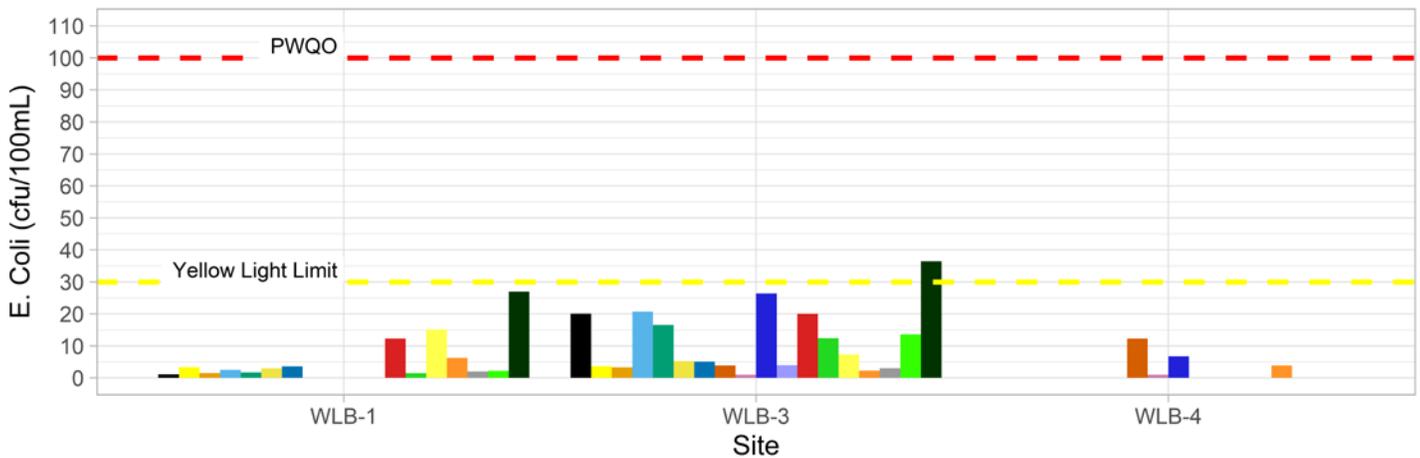
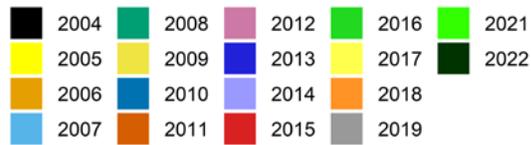
Phosphorus at WLB-0



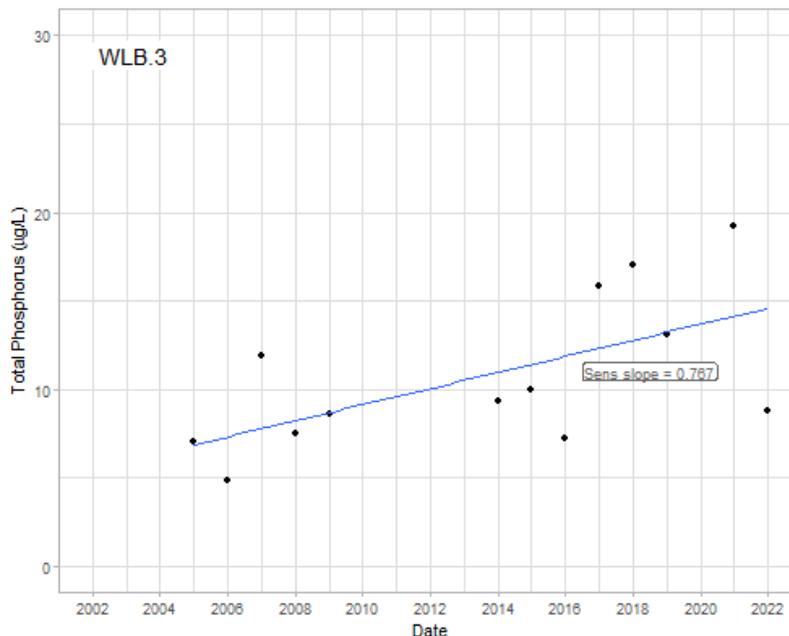
WLB-5		27.6		
WLB-6		73.6		
WLB-7		23.5		

Note: Grubbs test indicates no outliers in Spring or Annual Total Phosphorus data.

E. Coli Annual Geometric Mean at Willow Beach



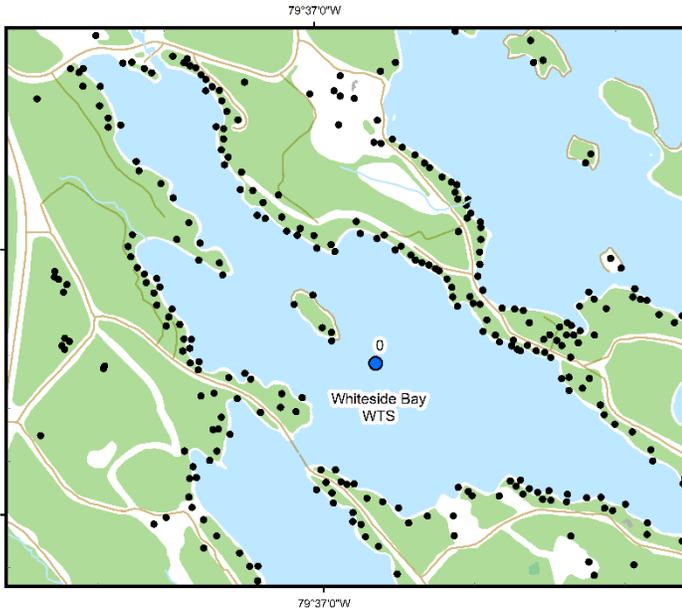
The spring phosphorus concentration at the deep-water station (WLB-0) in 2022 was below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of spring phosphorus concentrations at WLB-1 and 4 were within the range of variability of previous monitoring data collected since 2004 and 2013 respectively. The spring overturn phosphorus concentration at WLB-3 were lower than the peak values observed in 2021. Despite a substantial decline in total phosphorus





concentration in 2022 at WLB-3, assessment of trends in total phosphorus concentrations continues to indicate a significant increasing trend in spring total phosphorus concentrations. The WLB-3 station is located in a heavily developed area adjacent to a resort and near the inflow of a creek which drains a golf course and agricultural lands. Additional sampling was carried out by the MLA as part of recommendation made in the 2021 Annual Report. WLB-5, 6 and 7 were sampled along **Sampling of this creek in the future may provide information on the phosphorus load arriving from the watershed and support discussions with the District on potential mitigation options to reduce the concentrations of phosphorus entering the lake at this site.** Average annual Secchi disk depth (2.48 m) was consistent with previous monitoring (0.84 – 6.5 m). The *E. coli* counts at WLB-3, and WLB-4 were below the MLA stoplight limits in 2021. **HESL recommends ongoing sampling to continue to monitor phosphorus concentrations in the nearshore and update data on long-term trends.**

Whiteside Bay (WTS)



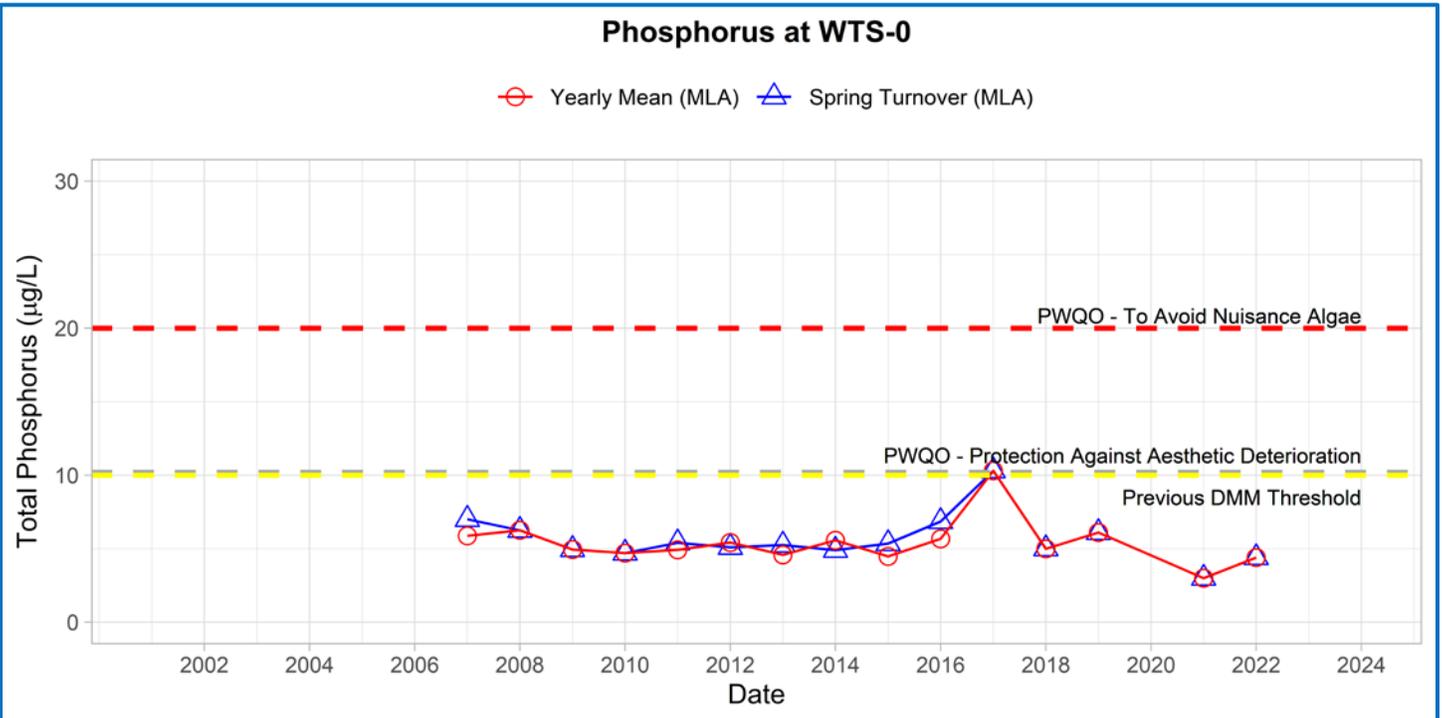
Area Description:

Whiteside Bay is a moderately developed bay in the northwestern portion of Lake Muskoka which receives a high amount of spring flow from the northwest. Development within the Bay includes cottage/residential properties and roadways that approach the shoreline in several areas. Two creeks flow into the bay, including one from the north which originates in a wetland complex. MLA monitoring of Whiteside Bay began in 2007.

Volunteer Recognition: Kim Seon, Eleanor Lewis, and Jim Lewis.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
WTS-0	2.9	4.4			



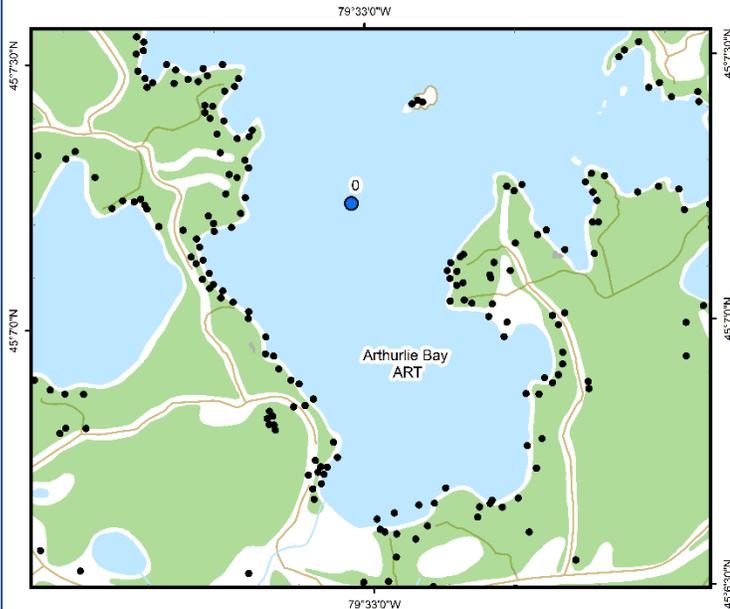
Note: Grubbs test indicates spring total phosphorus data collected in 2017 is an outlier.



The spring phosphorus concentration at the deep-water station (WTS-0) in 2022 was below the historic DMM threshold of 10.2 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of spring phosphorus concentrations has not taken place since 2012. Data collected in 2017 continue to be identified as an outlier, these data have been included in our area assessments but should be interpreted with caution. Average annual Secchi disk depth (2.9 m) was consistent with previous monitoring (2.75 – 4.25 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Arthurlie Bay (ART)



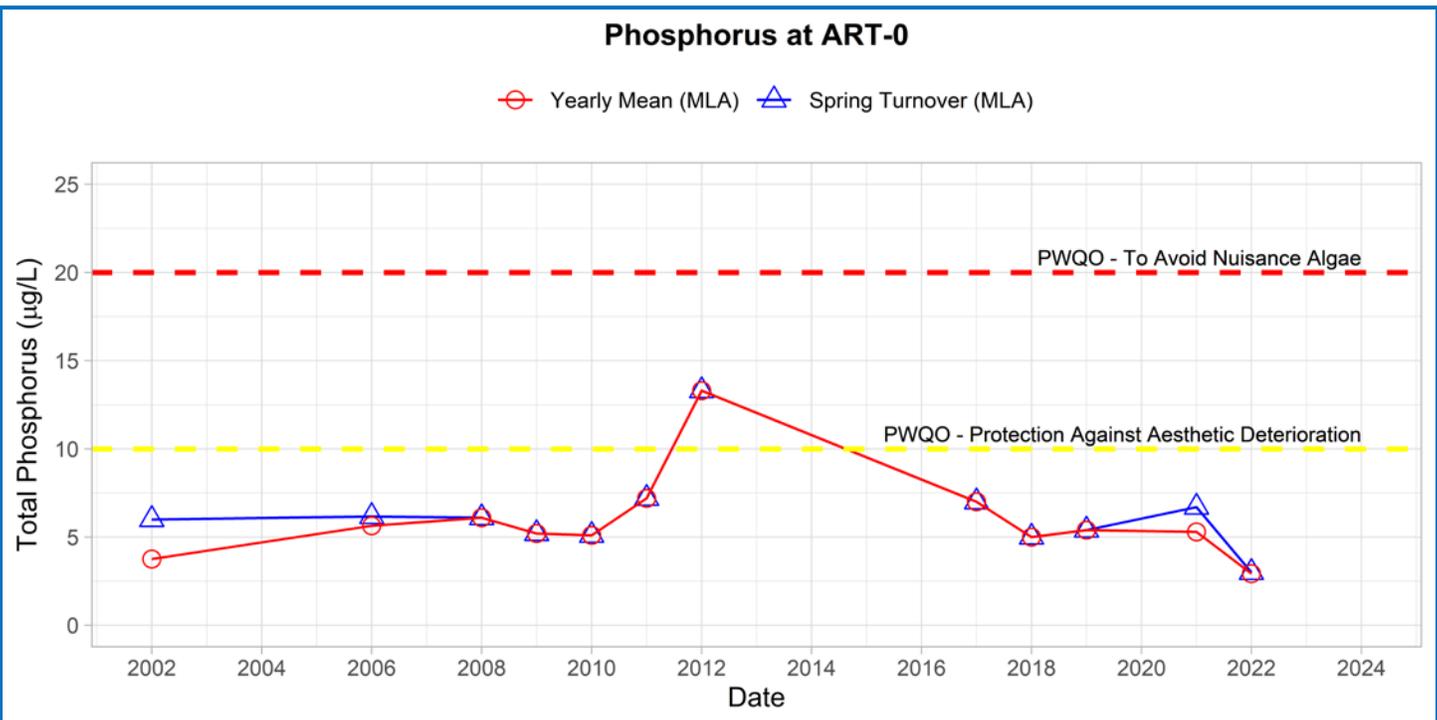
Area Description:

Arthurlie Bay is a shallow bay in the southern basin of Lake Rosseau. Shoreline development is considered moderate to high and includes numerous properties with substantial cleared area. One creek in the south flows through agricultural land prior to entering the southwest corner of the bay. MLA monitoring of Arthurlie Bay began in 2002.

Volunteer Recognition: Mark Tiffin.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
ART-0	3.6	3.0	2.9		

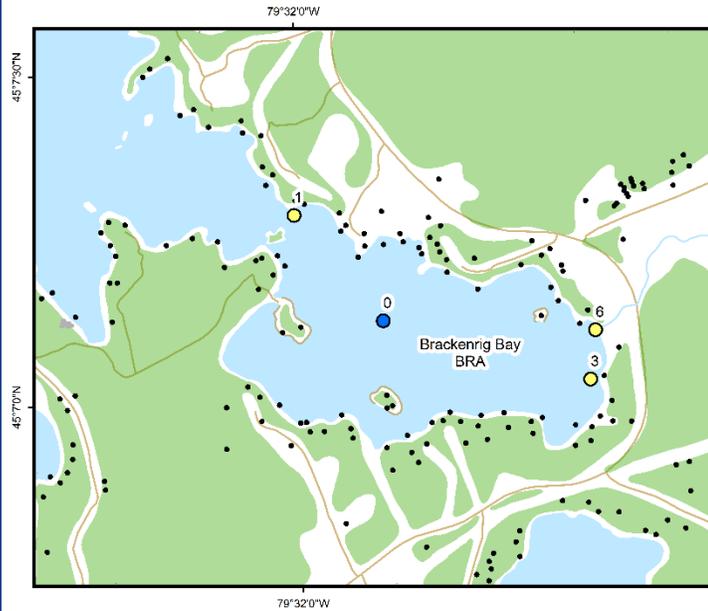


Note: Grubbs test indicates spring phosphorus data collected in 2012 are considered an outlier



Annual average and spring phosphorus concentrations at the deep-water station (ART-0) were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Average annual Secchi disk depth (3.6 m) was consistent with the range of previous measurements (3.7 – 4.4 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Brackenrig Bay (BRA)



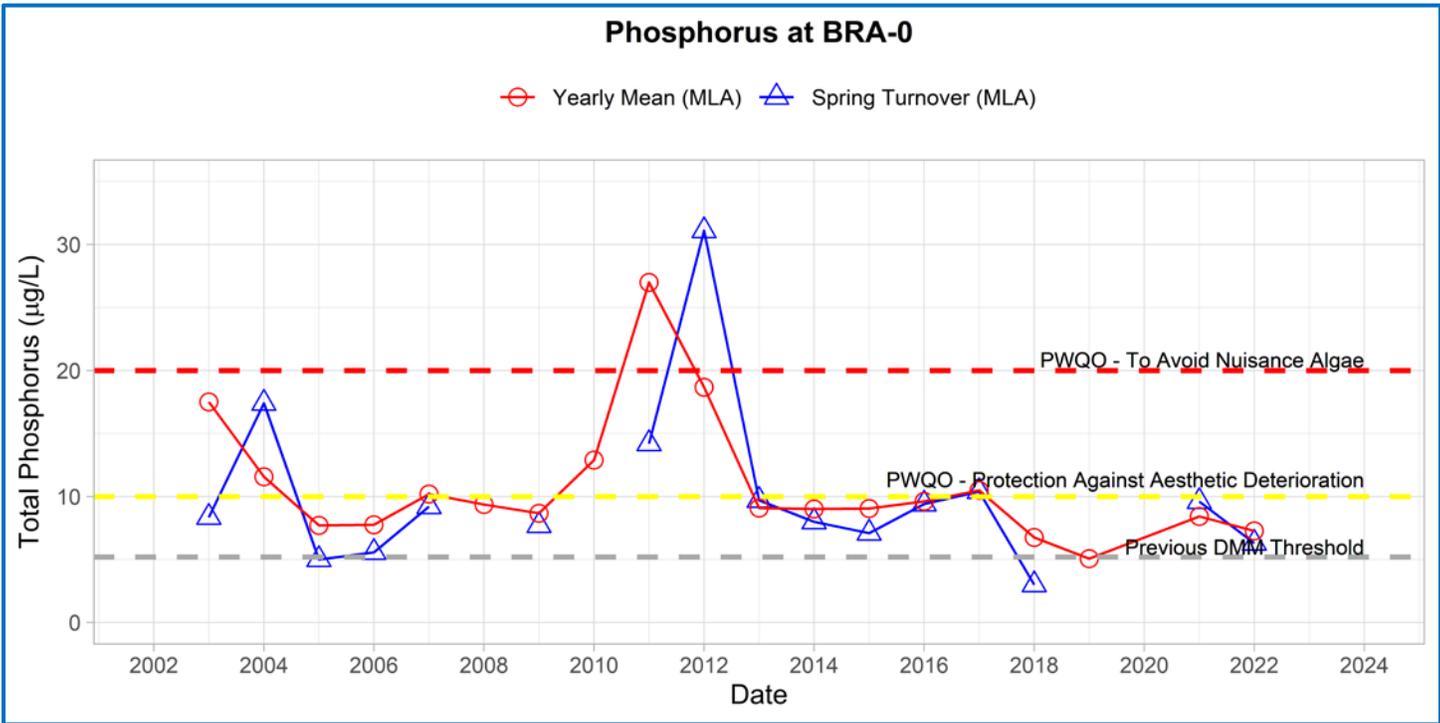
Area Description:

Brackenrig Bay in southern Lake Rosseau, has an area of 0.44 km² and a maximum depth of 3 m. The bay is isolated from Lake Rosseau and is moderately developed with residential properties. Based on District mapping data 18% of the shoreline has been altered with 60% of backlot areas cleared of natural forest. Four creeks drain into the bay, one of which flows through an agricultural area adjacent to a garden center before entering the bay near BRA-6. Brackenrig Bay is not currently listed as sensitive by the DMM. MLA monitoring of Brackenrig Bay began in 2003.

Volunteer Recognition: Judy Stephens-Wells, Ross Wells and Val Fleck.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
BRA-0	2.5	6.3	7.3		
BRA-1		6.4	6.2		
BRA-3		4.5	4.6		
BRA-6		4.8	5.8		

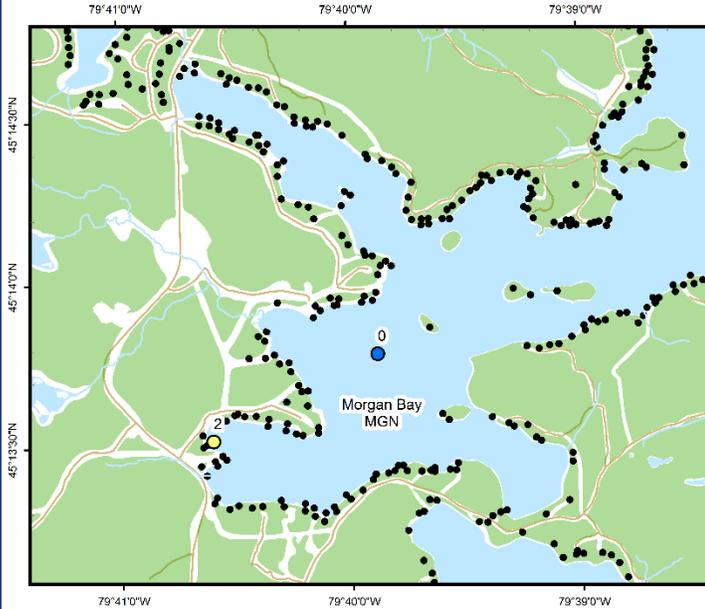


Note: Grubbs test indicates Spring and Annual Total Phosphorus data in 2012 are considered to be outliers.



In 2022, annual average and spring phosphorus concentrations at the deep-water station (BRA-0) were marginally above the historic DMM threshold of 5.2 µg/L but lower than concentrations in 2021 and below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual and spring phosphorus concentrations at BRA-1, 3 and 6 were within the range of variability of previous monitoring. *E. coli* samples at all stations were not collected in 2022. Average annual Secchi disk depth (2.5 m) was consistent with previous monitoring (1.45 – 3.10 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Morgan Bay (MGN)



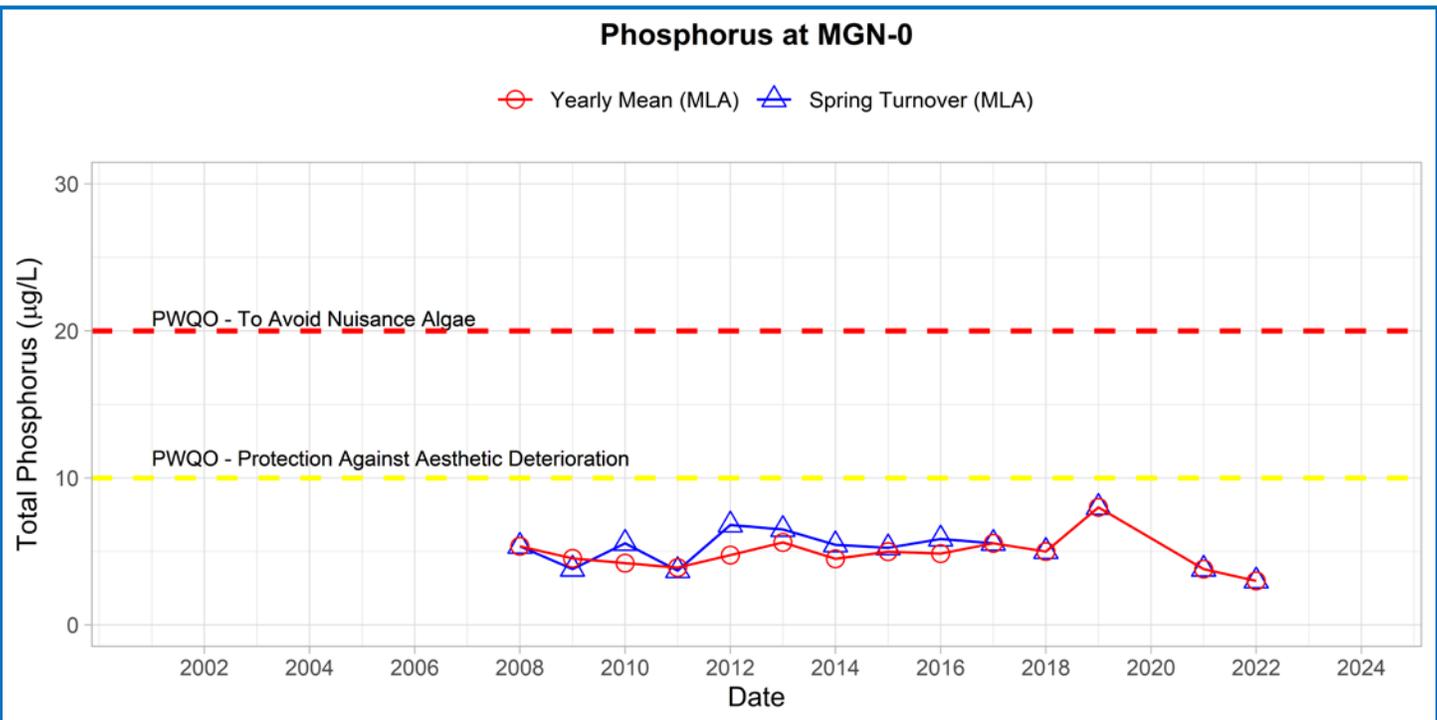
Area Description:

Morgan Bay sampling area is in the northwestern part of Lake Rosseau and includes a series of small bays (i.e., Beechwood Bay, Sucker Bay, Bass Bay). Residential properties have been developed along the majority of the shoreline but many retain natural riparian vegetation. Several creeks flow into Morgan Bay close to the nearshore sampling sites and there is a wetland adjacent to the lake at MGN-3 (last sampled in 2014). Several roads provide access to nearly the entire shoreline area and frequently encroach on the shoreline of the bay. MLA monitoring of Morgan Bay began in 2008.

Volunteer Recognition: Carol Anne Ballantyne.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
MGN-0	3.2	3.0			
MGN-2		3.0	2.5		

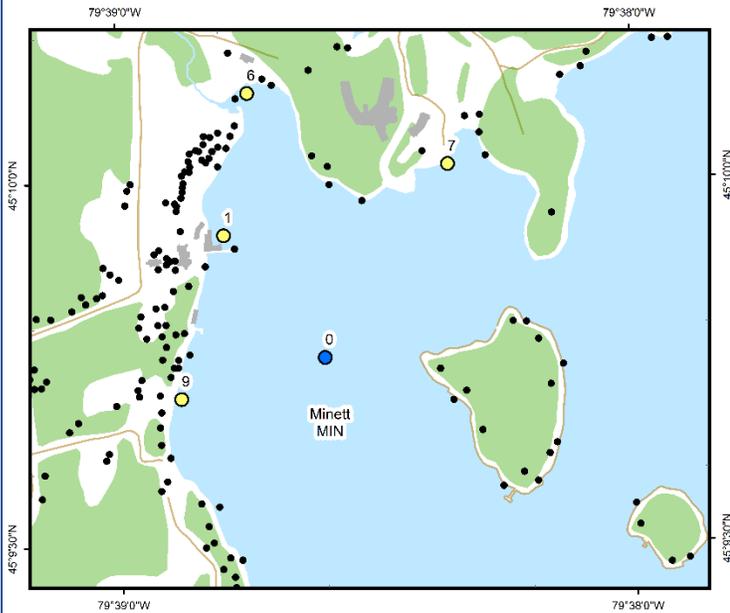


Note: Grubbs test indicates data collected in 2012 are considered an outlier



Spring phosphorus concentration at the deep-water station (MGN-0) was below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual average and spring phosphorus concentration at MGN-2 were within the range of variability of previous monitoring years. Average annual Secchi disk depth (3.2 m) was consistent with previous monitoring (1.9 – 5.25 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Minett (MIN)



Area Description:

The village of Minett is in western Lake Rosseau and includes high intensity development. The sampling area contains two large resorts with golf courses, several roads, a marina, and many private residential properties thus a substantial number of nearshore monitoring locations are included in the MLA sampling program. MLA monitoring in at Minett began with the original program in 2003.

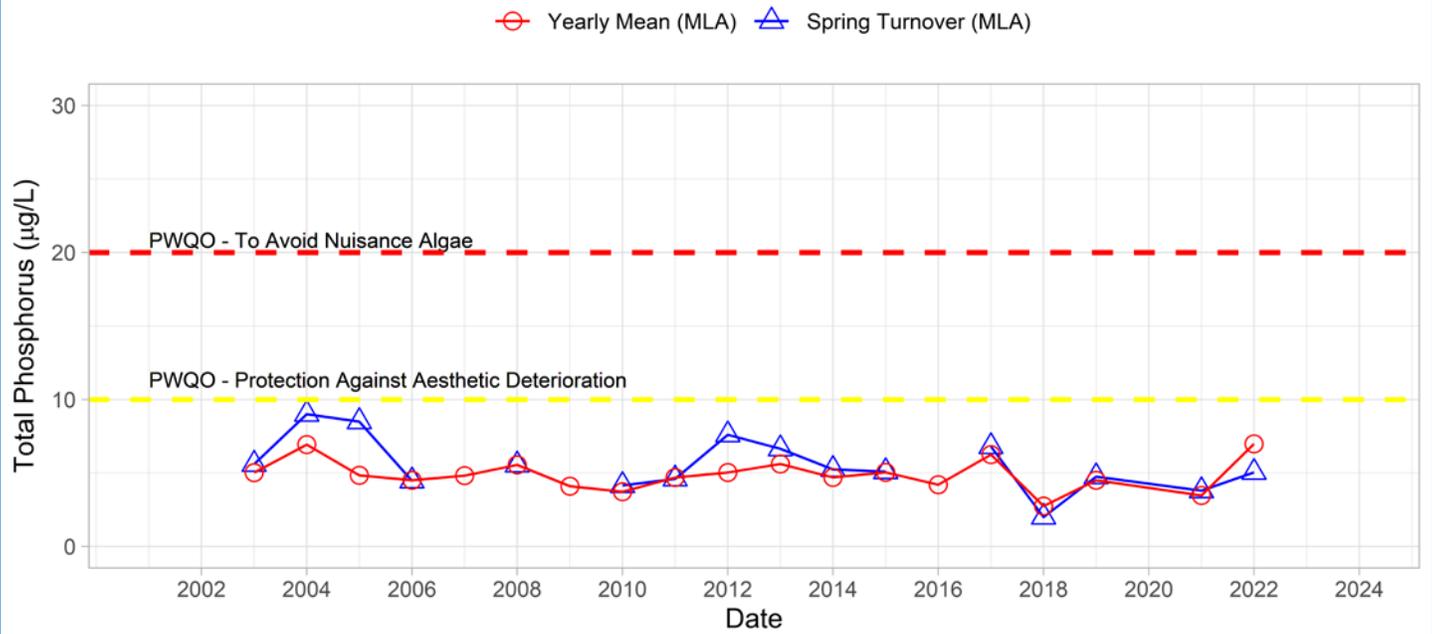
Volunteer Recognition: Laurie Thomson and Greg Thomson.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
MIN-0	4.1	5.1	7.0		
MIN-1		4.5	4.2	36	201
MIN-6		4.8	10.2	30	387
MIN-7		4.3	4.0	9	173
MIN-9		4.7	8.0	8	74



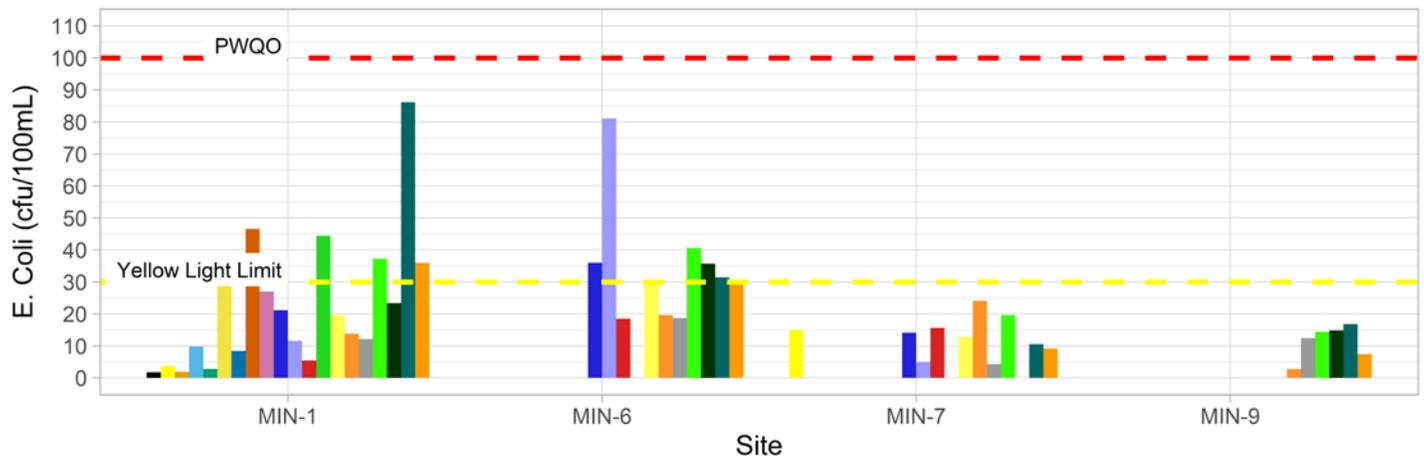
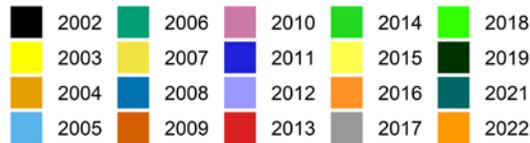
Phosphorus at MIN-0



Note: Grubbs test indicates data collected in 2012 are considered an outlier

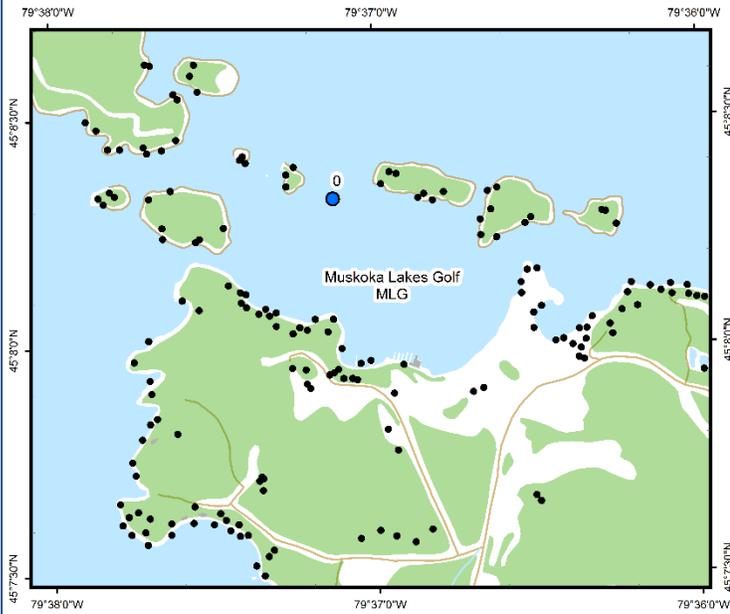


E. Coli Annual Geometric Mean at Minett



Annual average and spring phosphorus concentrations at the deep-water station (MIN-0) were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual average and spring phosphorus concentrations at MIN-1, 7 and 9 were within the range of variability of previous monitoring years. Monitoring at MIN-6 indicated elevated total phosphorus concentrations relative to other nearshore stations detected in 2021 were not detected in 2022. *E. coli* counts at stations MIN-6, MIN-7 and MIN-9 were below the MLA stoplight limits, however MIN-1 was above the MLA yellow light limit, maintaining a yellow stop light for Minett. Average annual Secchi disk depth (4.1 m) was consistent with previous monitoring (1.31 – 5.75 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Muskoka Lakes Golf (MLG)



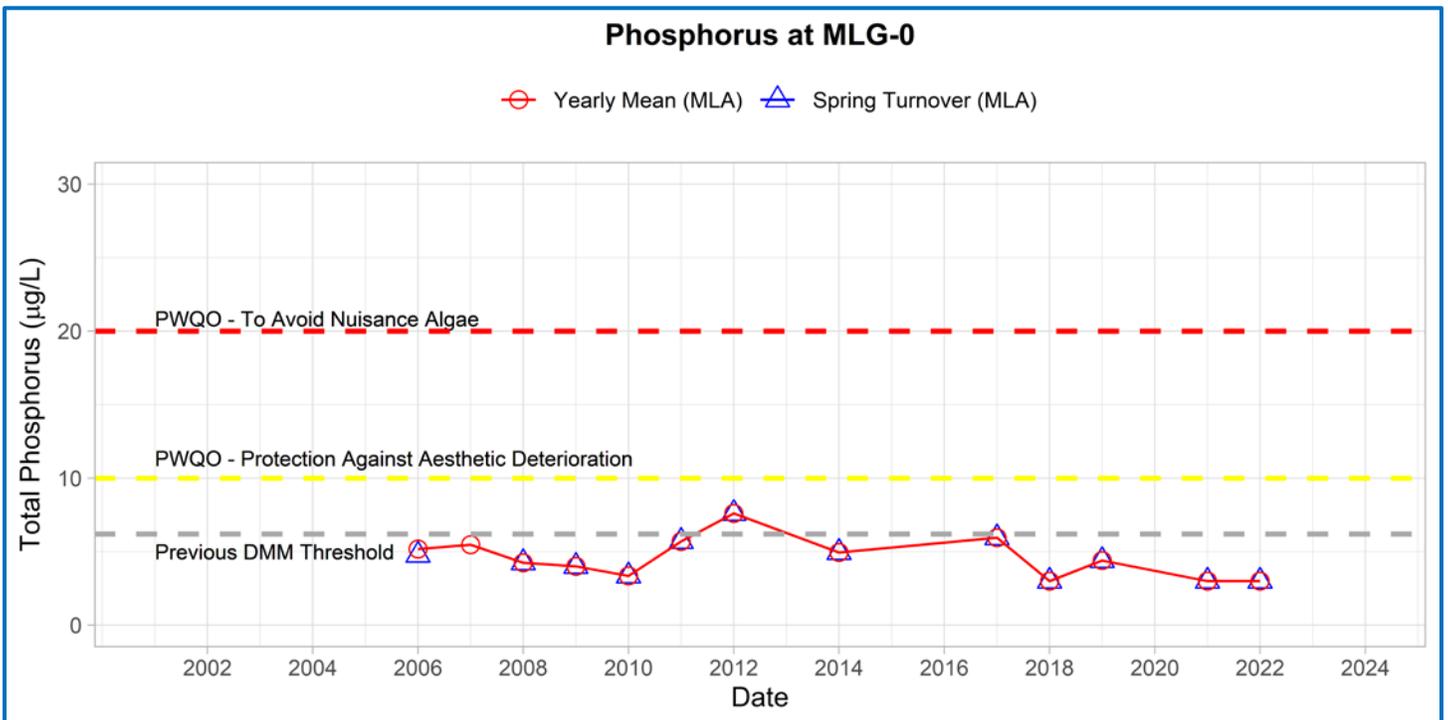
Area Description:

The Muskoka Lakes Golf & Country Club near the Town of Port Carling, along the southern shore of Lake Rosseau's main basin. The bay receives run-off from a golf course area which includes an associated clubhouse and marina. The bay also contains a large wetland that drains into the lake. The northwest winds result in substantial wave action along the southern shoreline of the bay.

Volunteer Recognition: Dianne & Ian Turnbull.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
MLG-0	4.2	3.0			

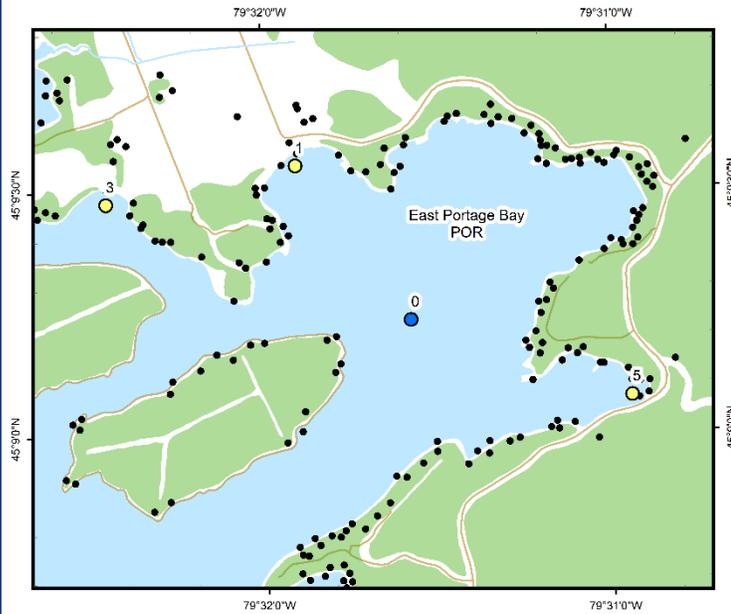


Note: Grubbs test indicates no Spring and Annual Total Phosphorus data were outliers.



In 2022, the spring phosphorus concentrations at the deep-water station (MLG-0) was below the historic DMM threshold of 6.2 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Average annual Secchi disk depth (4.2 m) was consistent with previous monitoring (3.0 – 5.5 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

East Portage Bay (POR)



Area Description:

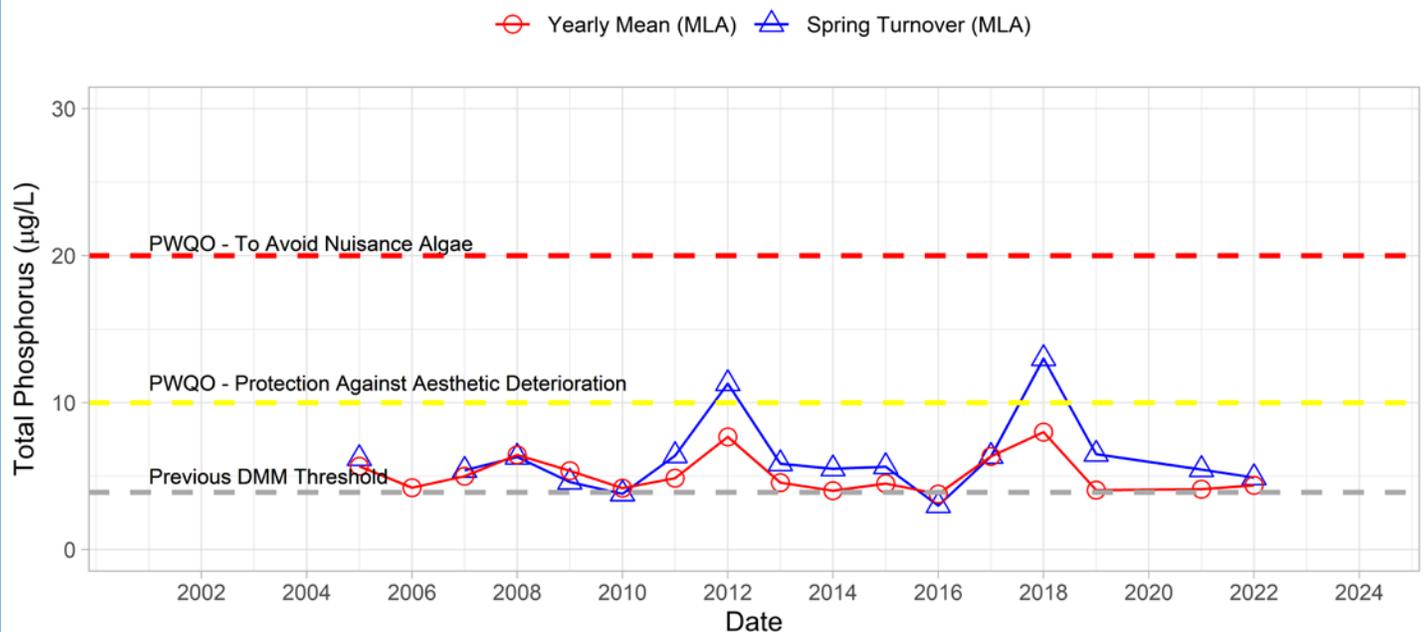
East Portage Bay is a moderately developed bay in eastern Lake Rosseau. The bay has an area of 1.33 km², and a maximum depth of 12 m. Development within the watershed includes several roads which often run directly adjacent to the shoreline and a large agricultural area near the northern shoreline. No watercourses or wetlands drain into the bay. East Portage Bay is not currently classified as vulnerable by the DMM. MLA monitoring of East Portage Bay began in 2005.

Volunteer Recognition: Marge Henke.

2022 Water Quality Results:

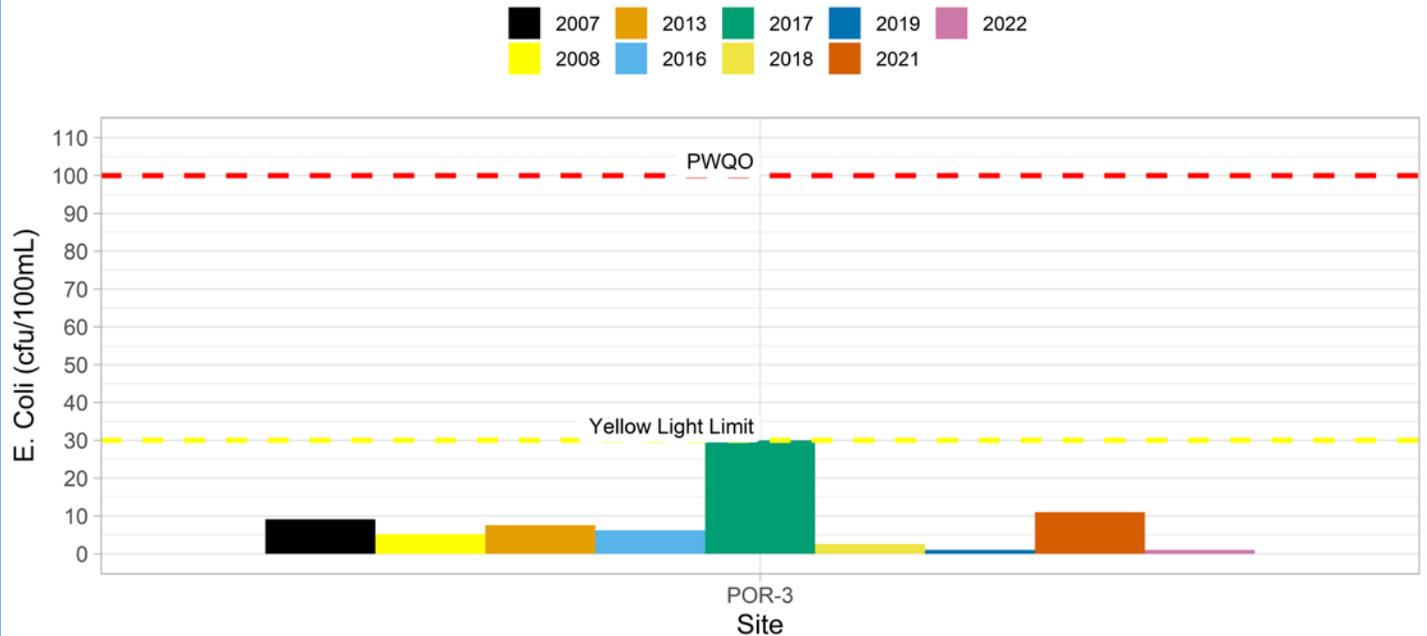
	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
POR-0	4.6	4.9	4.4		
POR-1		4.4	3.8		
POR-3		3.0	3.3	1	21
POR-5		3.0	2.5		

Phosphorus at POR-0



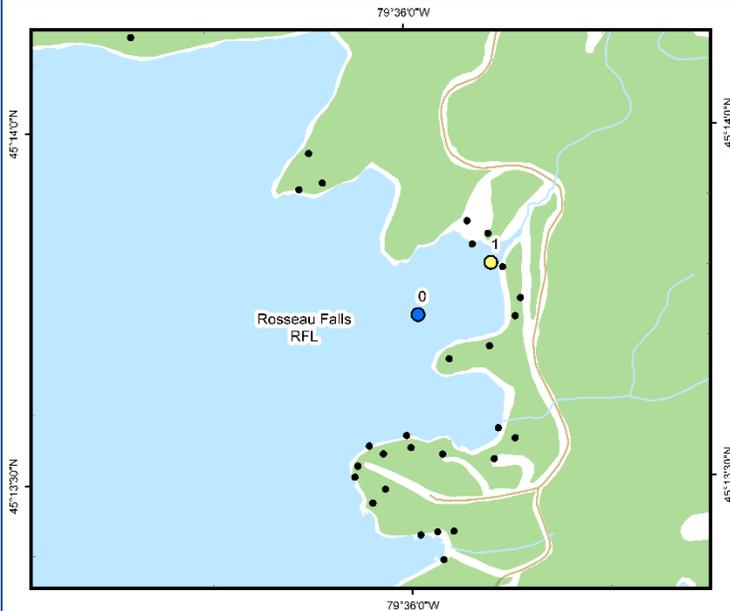
Note: Grubbs test indicates the spring total phosphorus data collected in 2018 are considered an outlier.

E. Coli Annual Geometric Mean at Portage Bay



In 2022, annual average and spring phosphorus concentrations at the deep-water station (POR-0) were marginally above the historic DMM threshold of 3.9 µg/L but below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual and spring phosphorus concentrations at POR-1, 3 and 5 were within the range of variability of previous monitoring. *E. coli* counts at POR-3 were the lowest recorded to date and well below the MLA yellow light trigger value. Average annual Secchi disk depth (4.6 m) was consistent with previous monitoring (1.45 – 6.5 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Rosseau Falls (RFL)



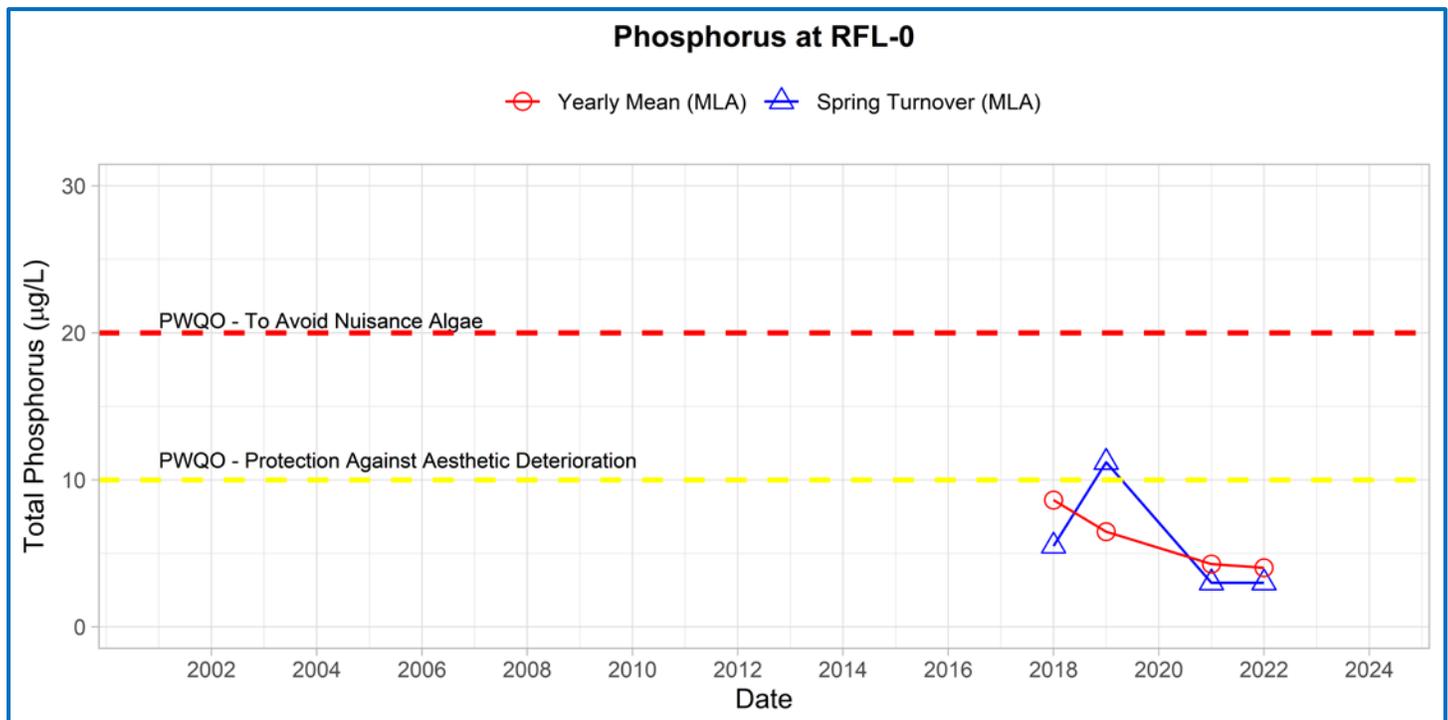
Area Description:

Rosseau Falls is located at the inflow of the Rosseau River to Lake Rosseau. Nearshore sampling at RFL-1 captures inflow from the Rosseau River. The Rosseau River Subwatershed has an area of 130 km², 98% of which is identified as natural. Cardwell Lake is the only major water body in the subwatershed with a surface area of 2.1 km² and a maximum depth of 21 m. MLA monitoring of the Rosseau Falls began in 2018.

Volunteer Recognition: John & Sue Wessenger.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
RFL-0	3.0	3.0	4.0		
RFL-1		8.4	7.5		

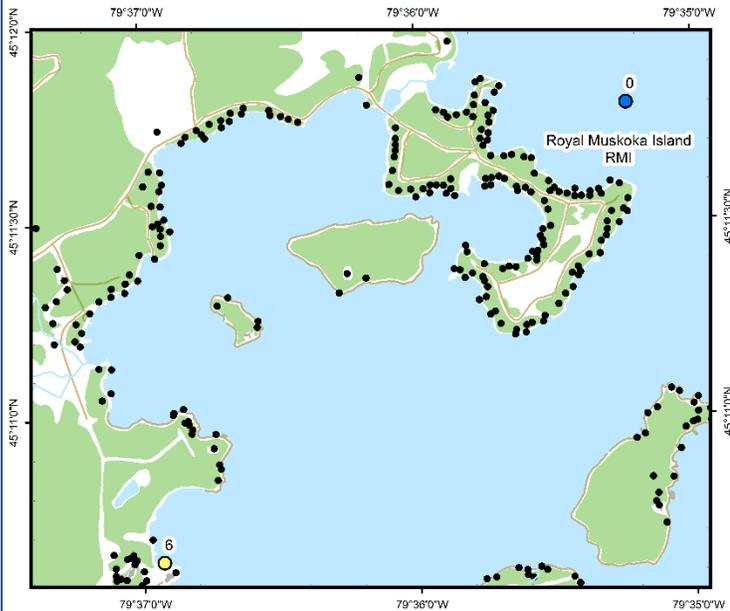


Note: Grubbs test indicates data not collected in are considered outliers.



In 2022, annual average and spring phosphorus concentrations at the deep-water station (RFL-0) were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual and spring phosphorus concentrations at RFL-1 were within the range of variability of previous monitoring. Average annual Secchi disk depth (3.0 m) was consistent with the limited previous monitoring (2.9 – 3.5 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Royal Muskoka Island (RMI)



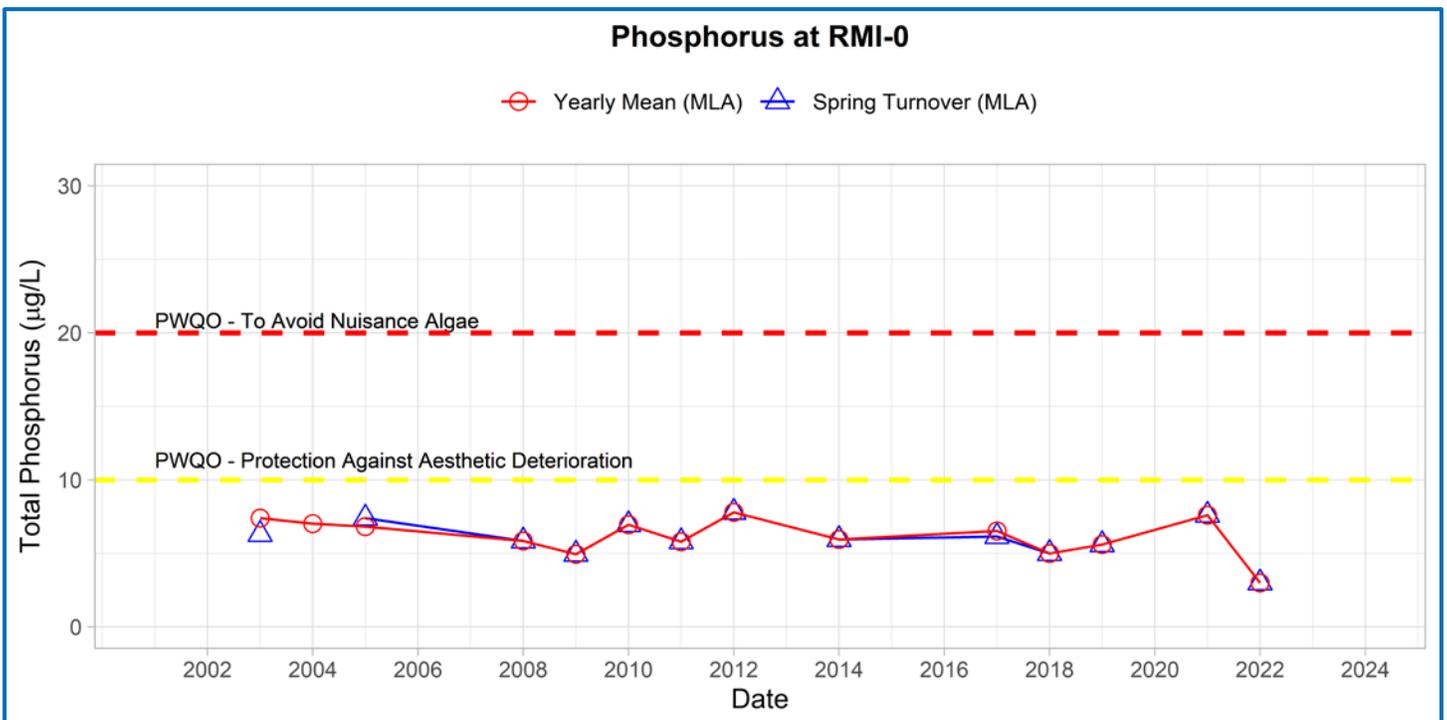
Area Description:

Royal Muskoka Island is a heavily developed residential island in the central portion of Lake Rosseau. A substantial portion of the island's interior has been deforested. Nearshore monitoring extends southwest to include a sampling station adjacent to a summer camp. Northwest winds result in significant wave action near the island. MLA monitoring of Royal Muskoka Island began in 2003.

Volunteer Recognition: Mark Tiffin.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
RMI-0	4.7	3.0			
RMI-6		6.0		2	13



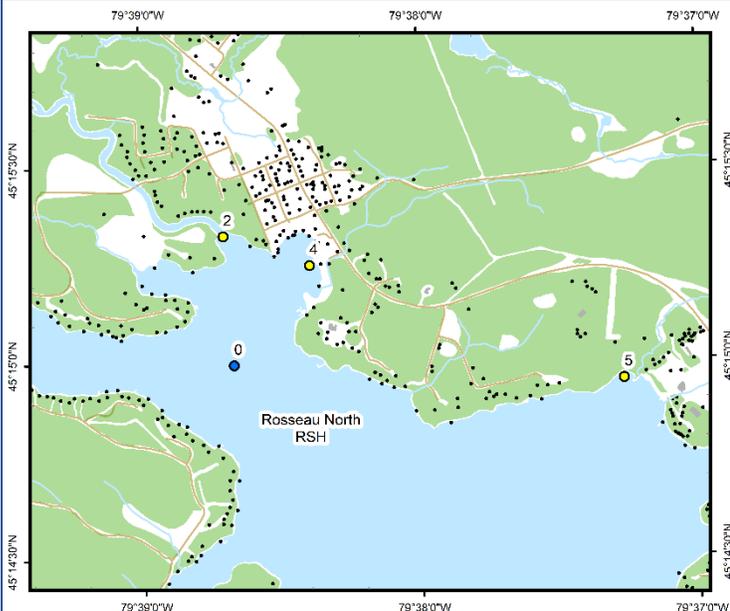
Note: Grubbs test indicates no outliers in spring and annual total phosphorus data.

E. Coli Annual Geometric Mean at Bala Bay



In 2022, the spring phosphorus concentration at the deep-water station (RMI-0) was below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of spring phosphorus concentration at RMI-6 was within the range of the long-term data collected by the MLA. *E. coli* counts in 2022 were well below the MLA trigger value. Average annual Secchi disk depth (4.7 m) was consistent with previous monitoring (2.2 – 4.7 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Rosseau North (RSH)



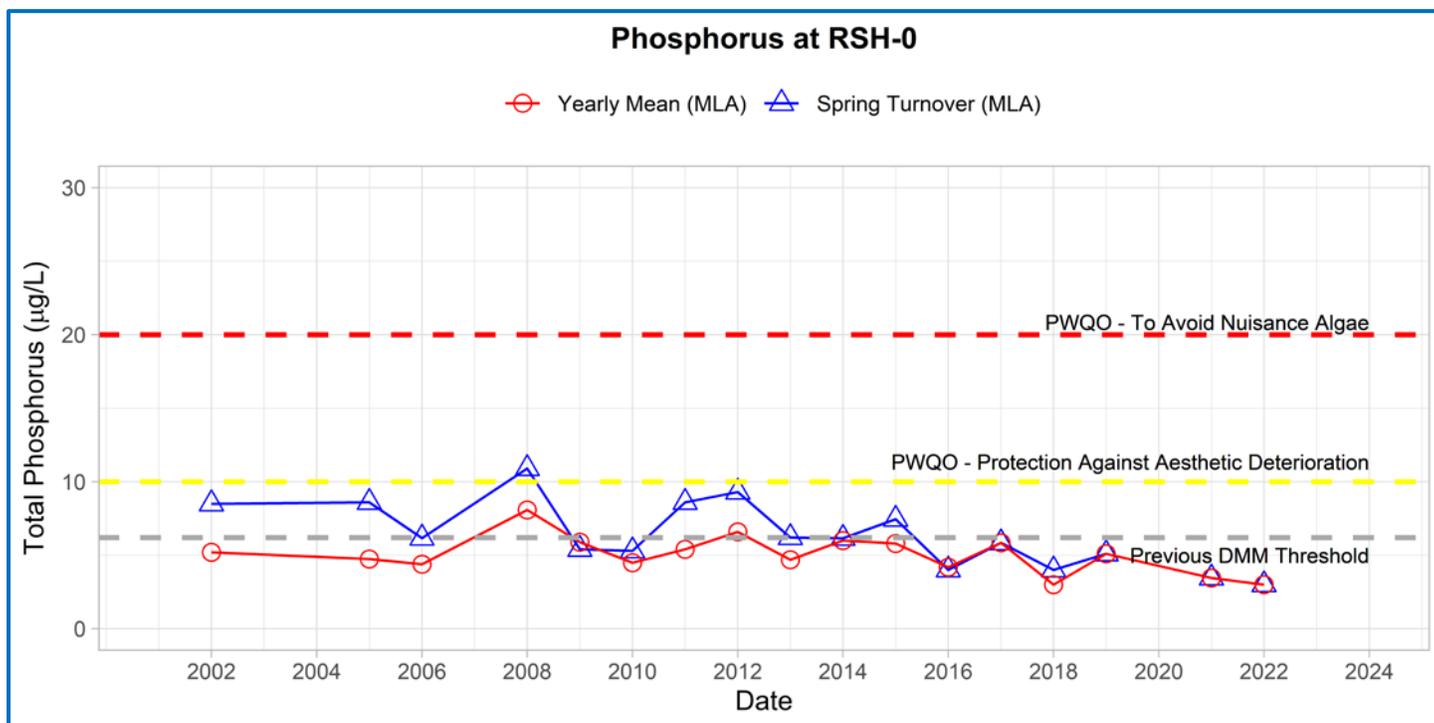
Area Description:

The Rosseau North sampling area includes several small bays (i.e., Rosseau Bay, Beley Bay, and Camerson Bay). The Village of Rosseau at the northern end of Lake Rosseau drains into the lake which also receives drainage from the Shadow River. The watershed is highly developed along the shoreline and upland areas including a marina, residential and agricultural properties. MLA monitoring of Rosseau North began in 2002.

Volunteer Recognition: John & Sue Wessenger.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
RSH-0	4.0	3.0			
RSH-2		3.0	2.8		
RSH-4		3.0			
RSH-5		3.0			



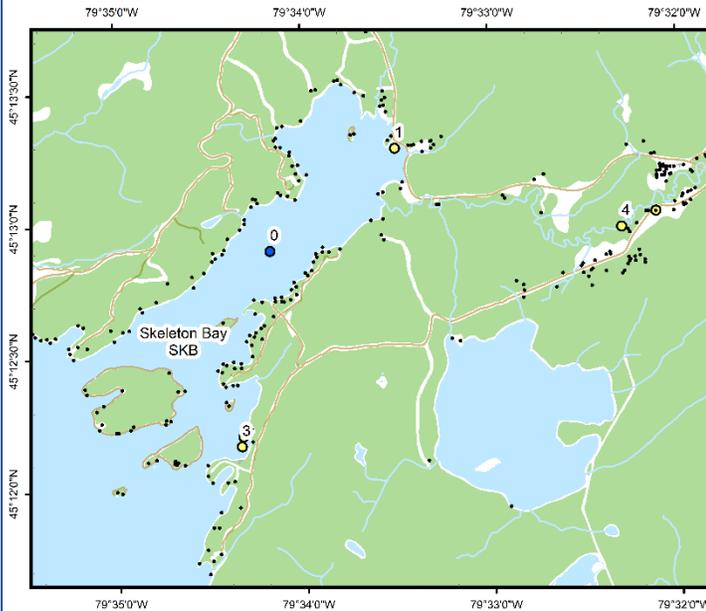
Note: Grubbs test indicates no outliers in spring or annual average total phosphorus data.



In 2022, the spring phosphorus concentrations at the deep-water station (RSH-0) were below the historic DMM threshold of 6.2 µg/L and Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual and spring phosphorus concentrations at RSH-2, 4, and 5 were the lowest recorded to date. *E. coli* samples were not collected in 2022. Average annual Secchi disk depth (4.0 m) was consistent with previous monitoring (1.9 – 5.1 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**



Skeleton Bay (SKB)



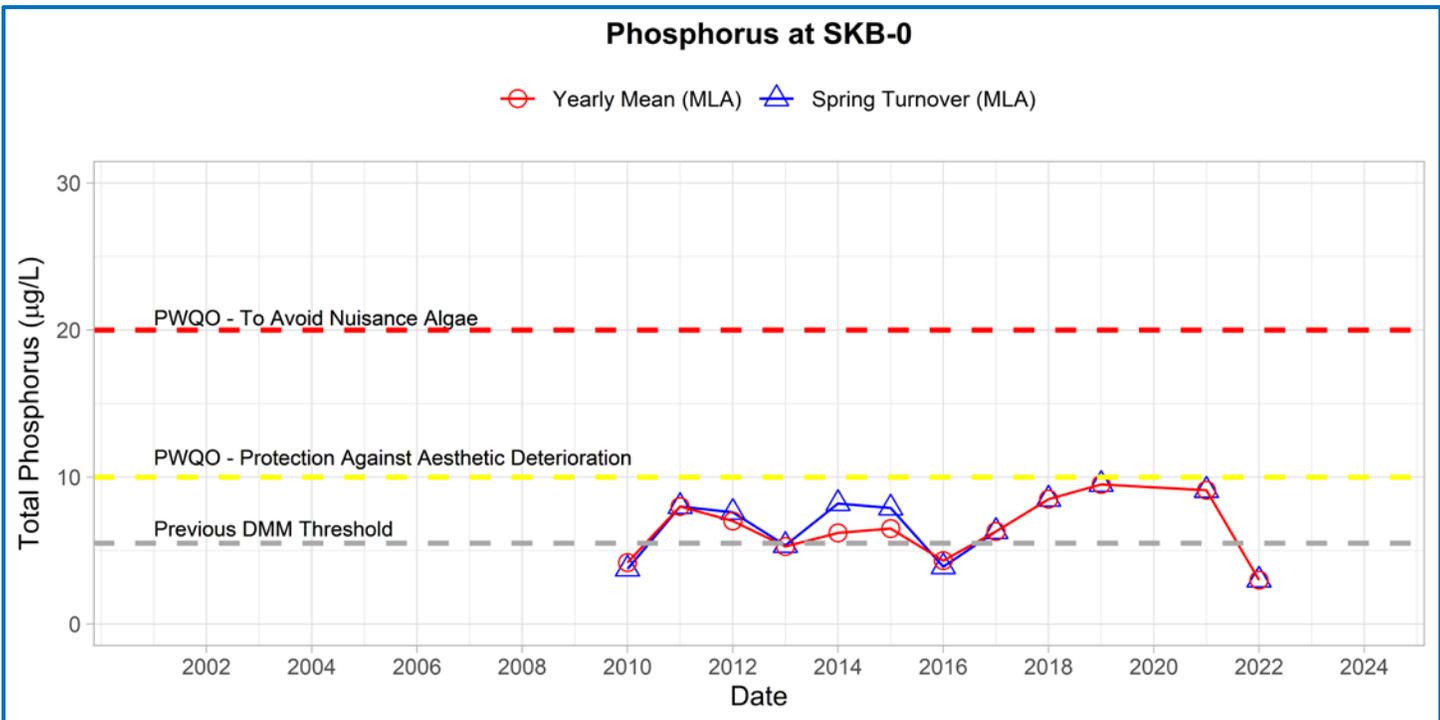
Area Description:

Skeleton Bay is in the eastern portion of Lake Rosseau's north basin. The bay has an area of 1.7 km² and a maximum depth of 20 m. The northeast section of the bay is bordered by Highway 141. This bay receives inflow from six watercourses including the Bent River which drains agricultural lands. Skeleton Bay is not currently listed as vulnerable by the DMM. MLA monitoring of Skeleton Bay began in 2010.

Volunteer Recognition: Jill Levine.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus (µg/L)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
SKB-0	3.1	3.0			
SKB-1		4.5	5.6		

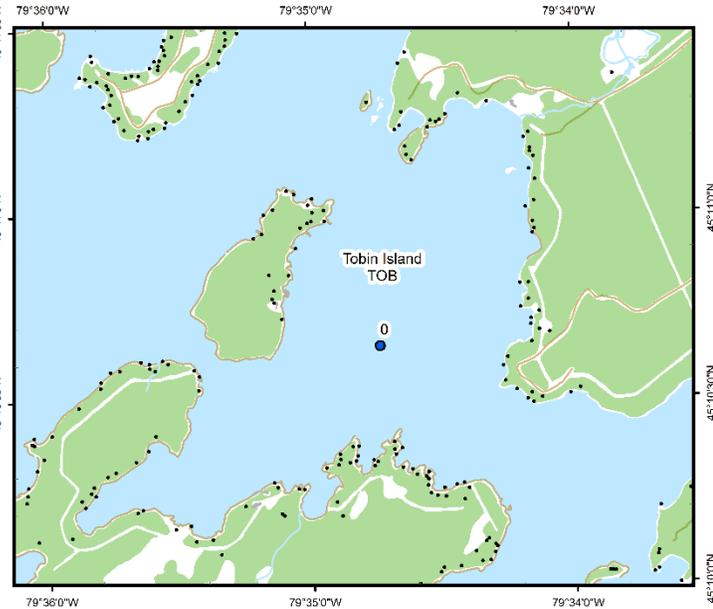


Note: Grubbs test indicates data collected in 2012 are considered an outlier



In 2022, the spring phosphorus concentration at the deep-water station (SKB-0) was the lowest recorded in the MLA dataset and was below the historic DMM threshold of 5.5 µg/L as well as Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Consistent increases in phosphorus concentrations at SKB since 2016 did not continue in 2021. Nearshore monitoring of annual and spring phosphorus concentrations at SKB-1 was within the range of variability of previous monitoring. *E. coli* samples were not collected in 2022. Average annual Secchi disk depth (3.1 m) was consistent with previous monitoring (2.13 – 6.13 m). **HESL recommends ongoing sampling to continue to monitor for changes in long-term trends and emerging issues.**

Tobin Island (TOB)



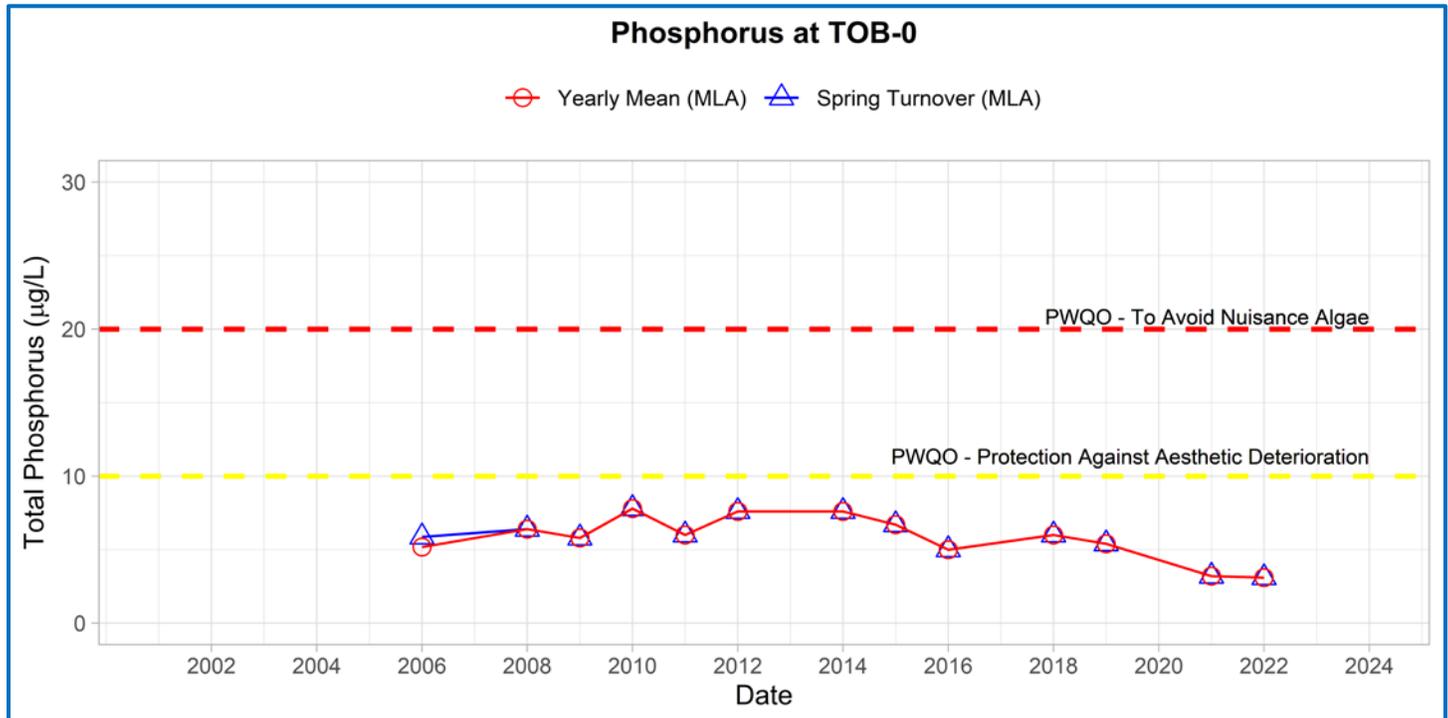
Area Description:

Tobin Island is a moderately developed, open bay in the central part of Lake Rosseau. Development includes cottage/residential properties along the shoreline, however the majority of the inland forest area remains in a natural state. Two creeks from wetland areas flow into the lake within the sampling area. MLA monitoring of Tobin Island began in 2006.

Volunteer Recognition: Mark Tiffin.

2022 Water Quality Results:

	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
TOB-0	4.9	3.1			

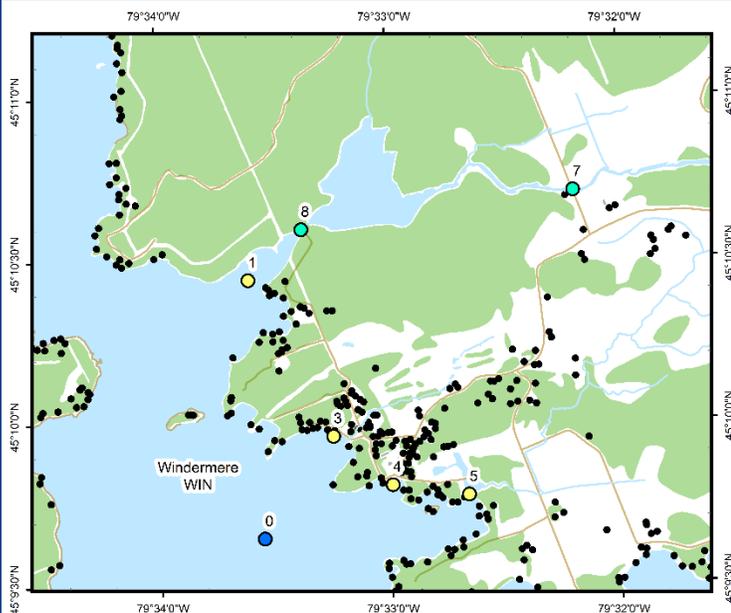


Note: Grubbs test indicates no data collected in are considered outliers.



In 2022, the spring phosphorus concentration at the deep-water station (TOB-0) was below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Average annual Secchi disk depth (4.9 m) was the highest recorded during the long-term monitoring by the MLA WQI Program (range = 3.0 – 4.3 m). **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

Windermere (WIN)



Area Description:

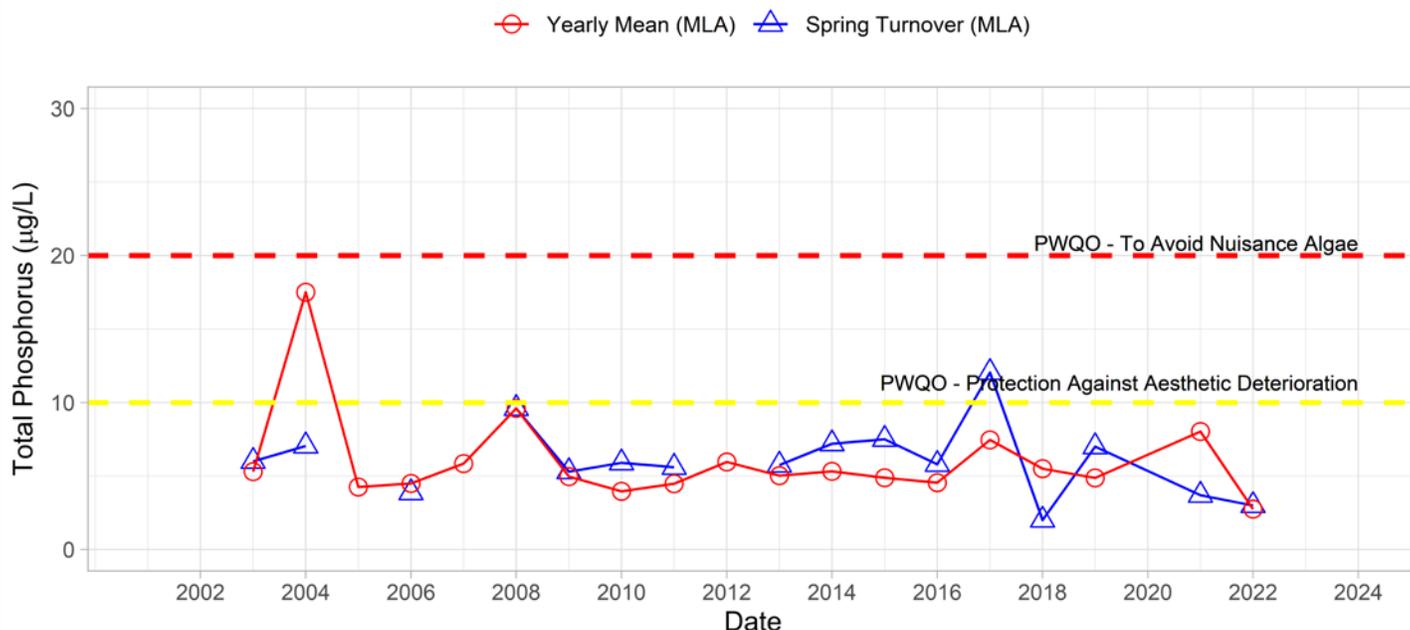
The Village of Windermere is in northern Lake Rosseau. The area is heavily developed including a large resort complex, golf course, marina, and numerous residential properties. In addition, there is a substantial agricultural land use within the watershed. Several creeks outlet into this area, including one which flows through agricultural land before discharging to the lake at the marina. MLA monitoring at Windermere began in 2003.

Volunteer Recognition: Bob McCabe and Karen Terry.

2022 Water Quality Results:

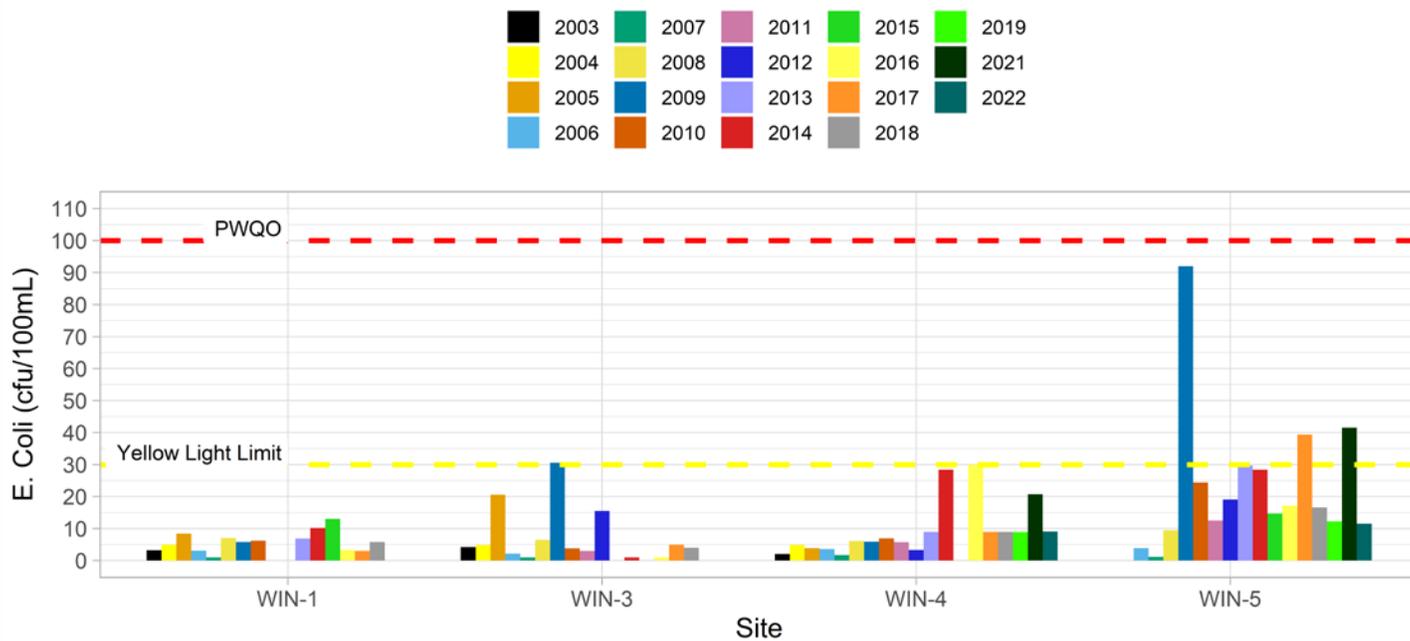
	Mean Secchi Disk (m)	Total Phosphorus ($\mu\text{g/L}$)		E. coli Yearly Geometric Mean (cfu/100mL)	Total Coliforms Yearly Geometric Mean (cfu/100 mL)
		Spring Turnover	Yearly Mean		
WIN-0	3.7	3.0	2.8		
WIN-1		15.1	12.6		
WIN-3		4.3	3.1		
WIN-4		4.5	3.4	9	60
WIN-5		8.1	11.7	12	89
WIN-7		21.8	23.8		
WIN-8		13.1	11.0		

Phosphorus at WIN-0



Note: Grubbs test indicates data collected in 2012 are considered an outlier.

E. Coli Annual Geometric Mean at Windermere



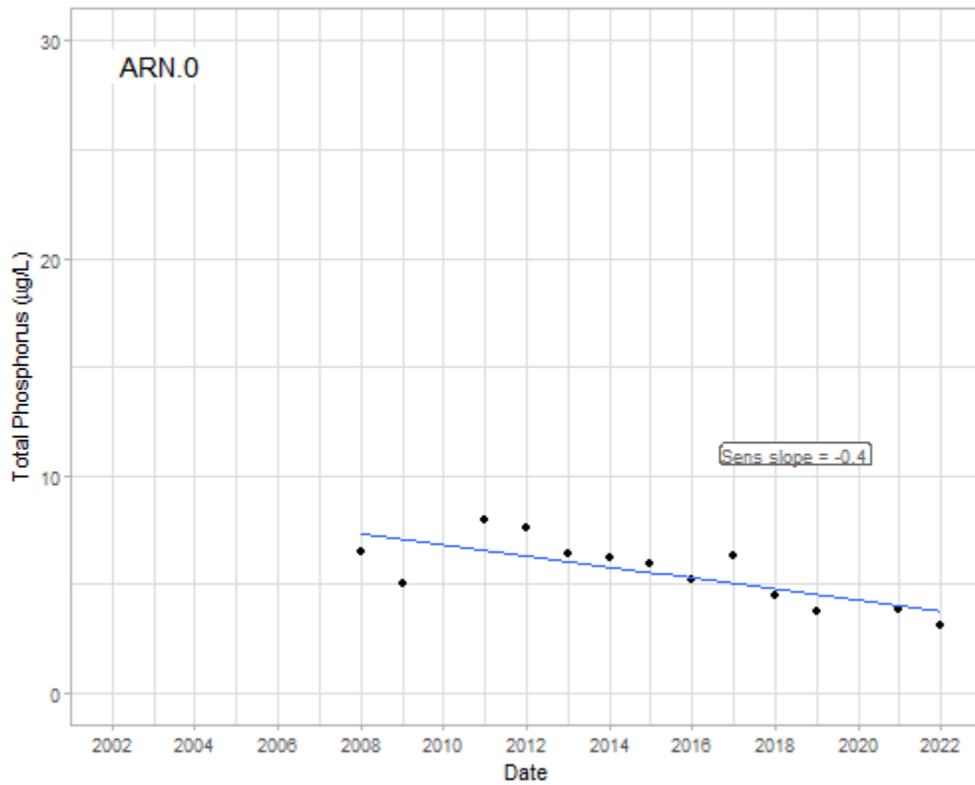
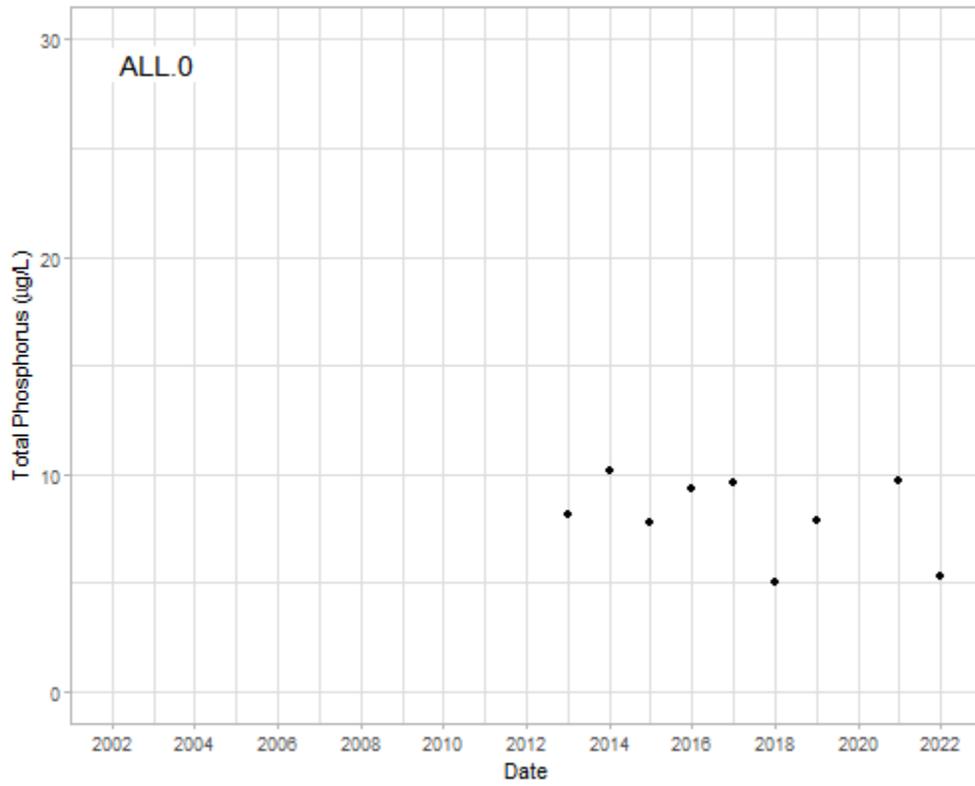


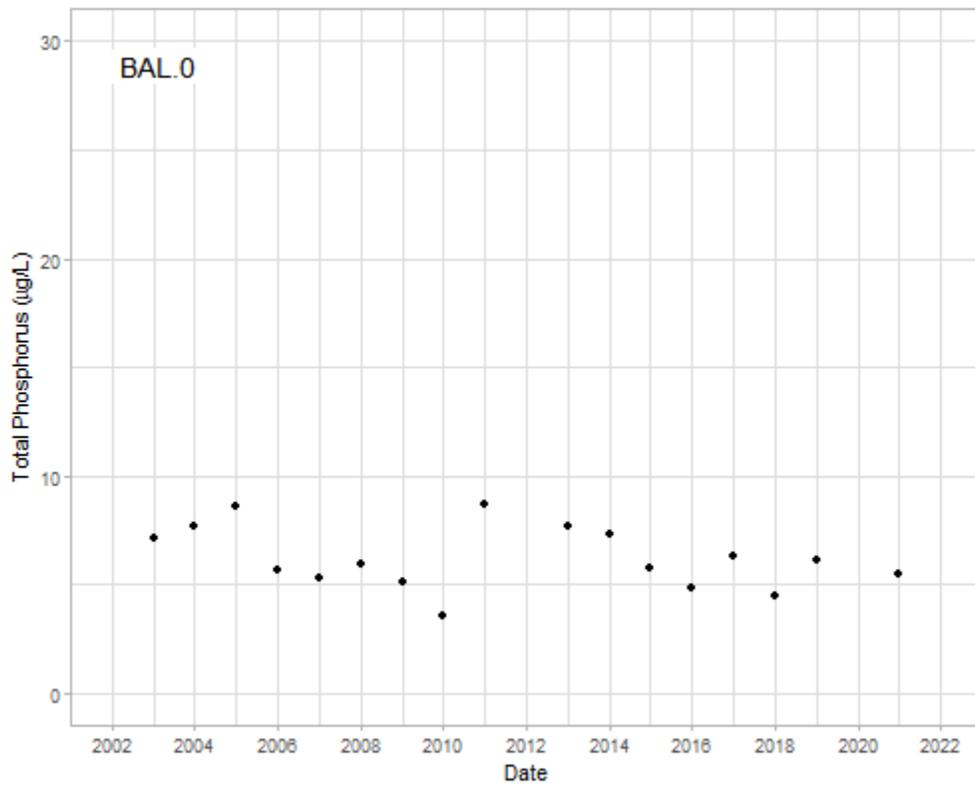
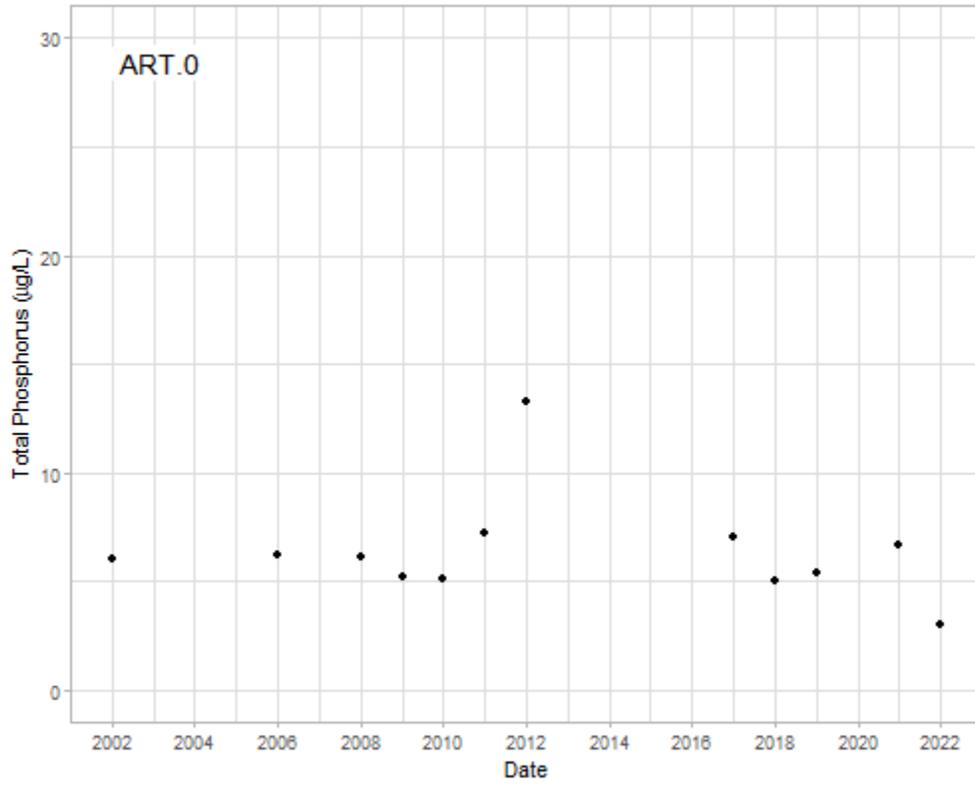
In 2022, annual average and spring phosphorus concentrations at the deep-water station (WIN-0) were below Provincial Water Quality Monitoring Objectives for Protection Against Aesthetic Deterioration (10 µg/L) and Nuisance Algal Growth (20 µg/L). Nearshore monitoring of annual and spring phosphorus concentrations at WIN-1, 3, 4 and 5 were within the range of variability of previous monitoring. At the upstream River station (WIN-7) spring concentrations declined from the peak concentration observed in 2021, while downstream at WIN-8 concentrations were within the range of variability in the long-term record. *E. coli* counts did not exceed the MLA Yellow Light trigger at WIN-5 in 2022. Average annual Secchi disk depth (3.7 m) was consistent with previous monitoring (2.5 and 5.7 m). A recorded algae bloom from 2018 remains unresolved. Pending a causation study exploring the algae bloom. **HESL recommends ongoing sampling to continue to monitor for long-term trends and emerging issues.**

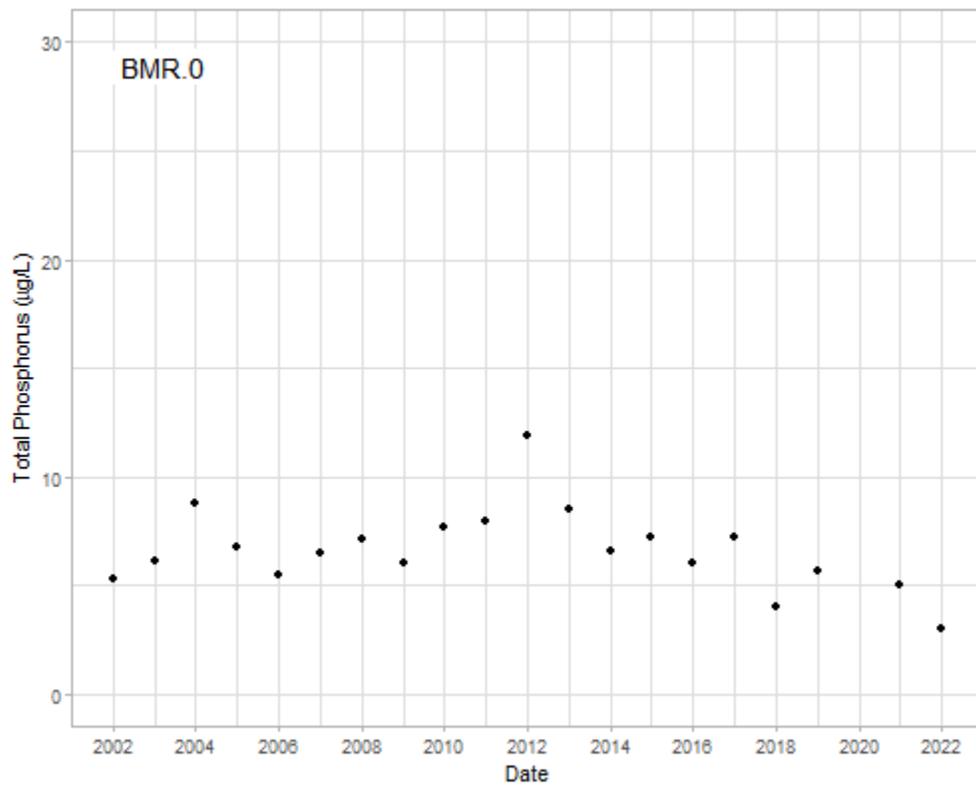
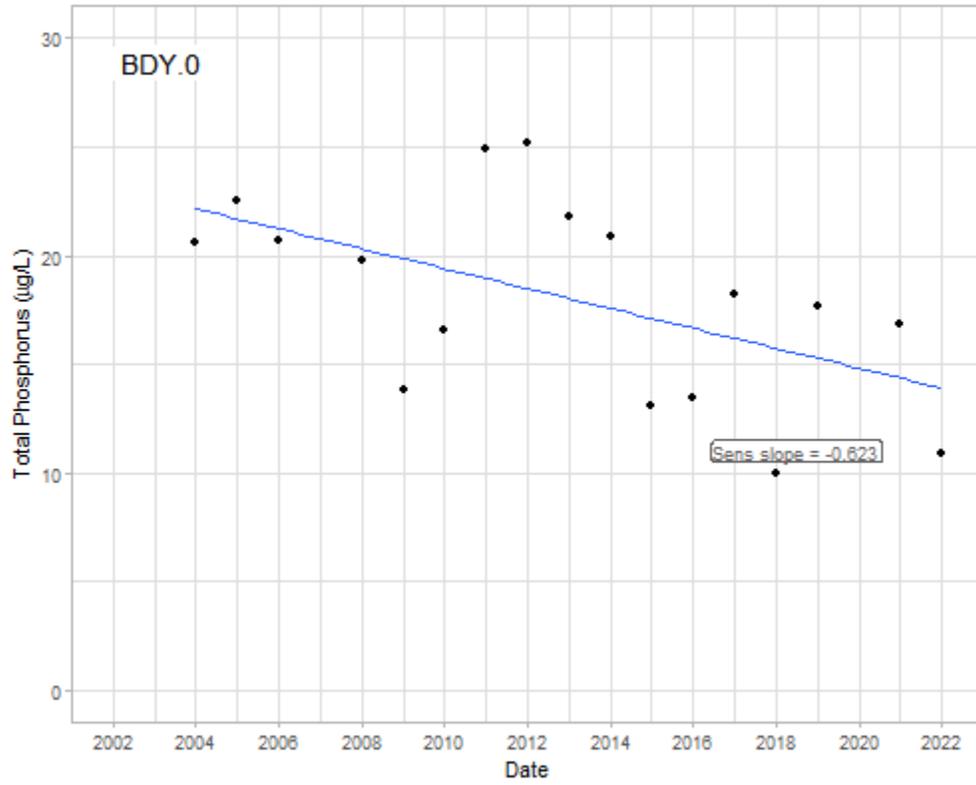
Appendix B. Long-term Trend Analyses – Total Phosphorus

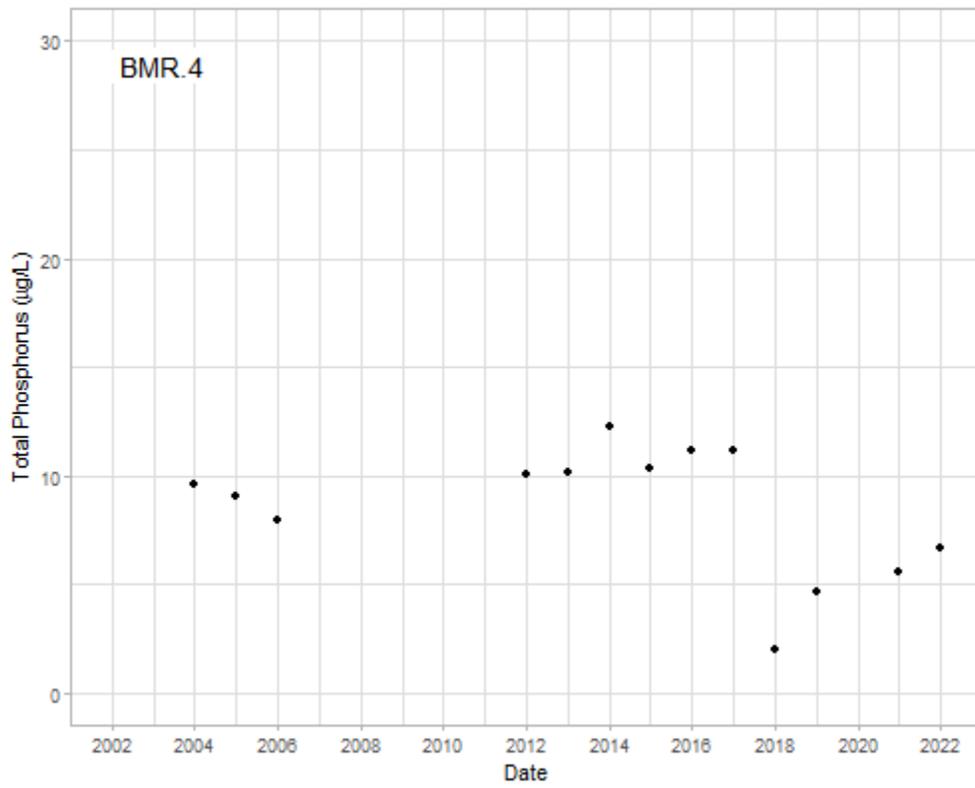
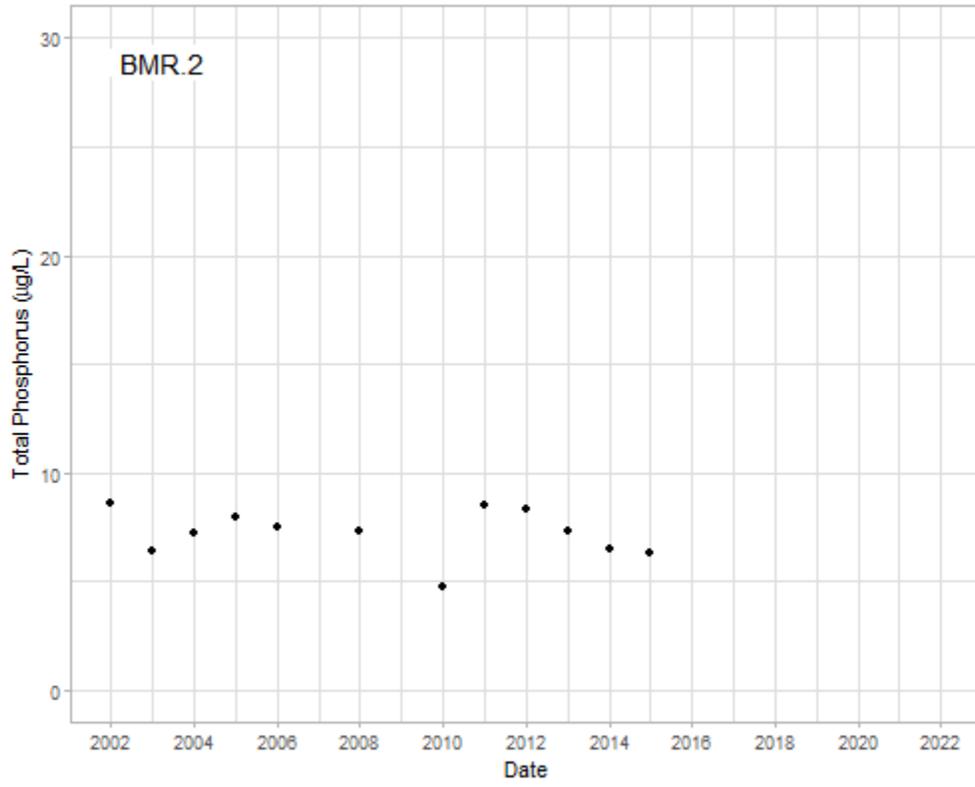


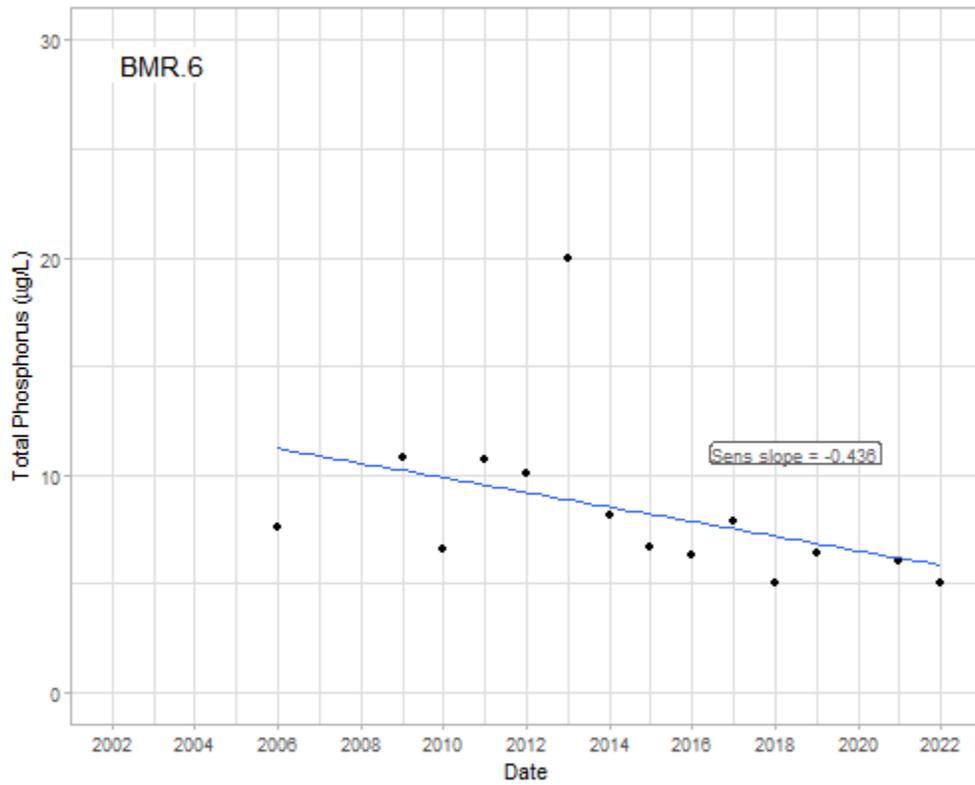
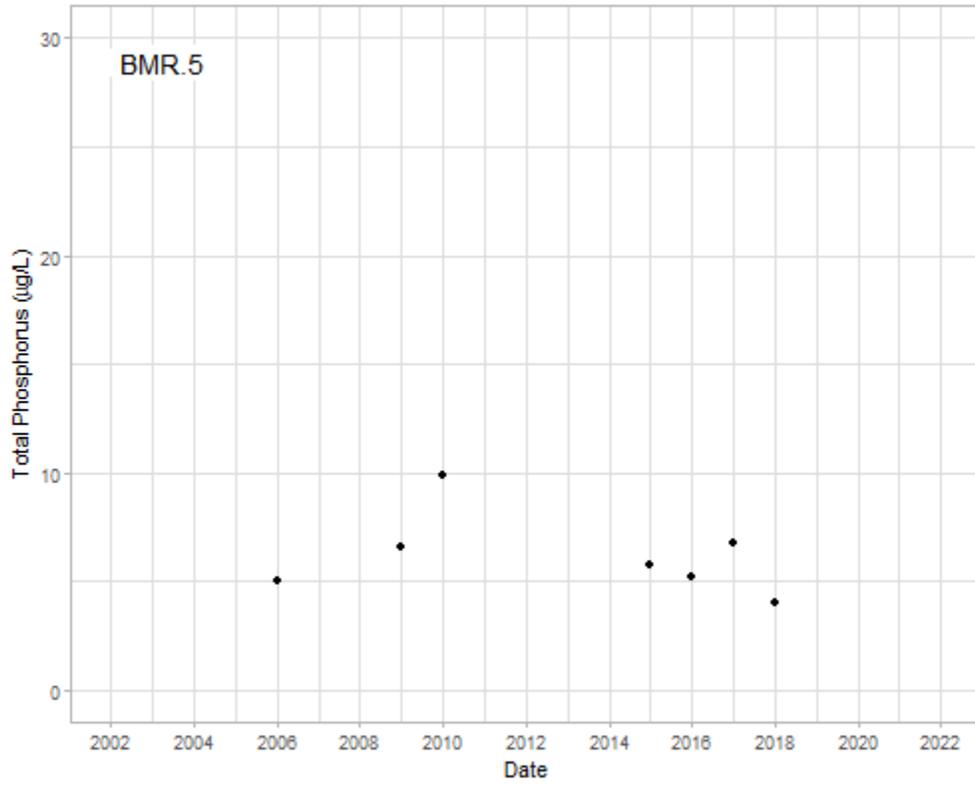
Spring Total Phosphorus Long-term Trends

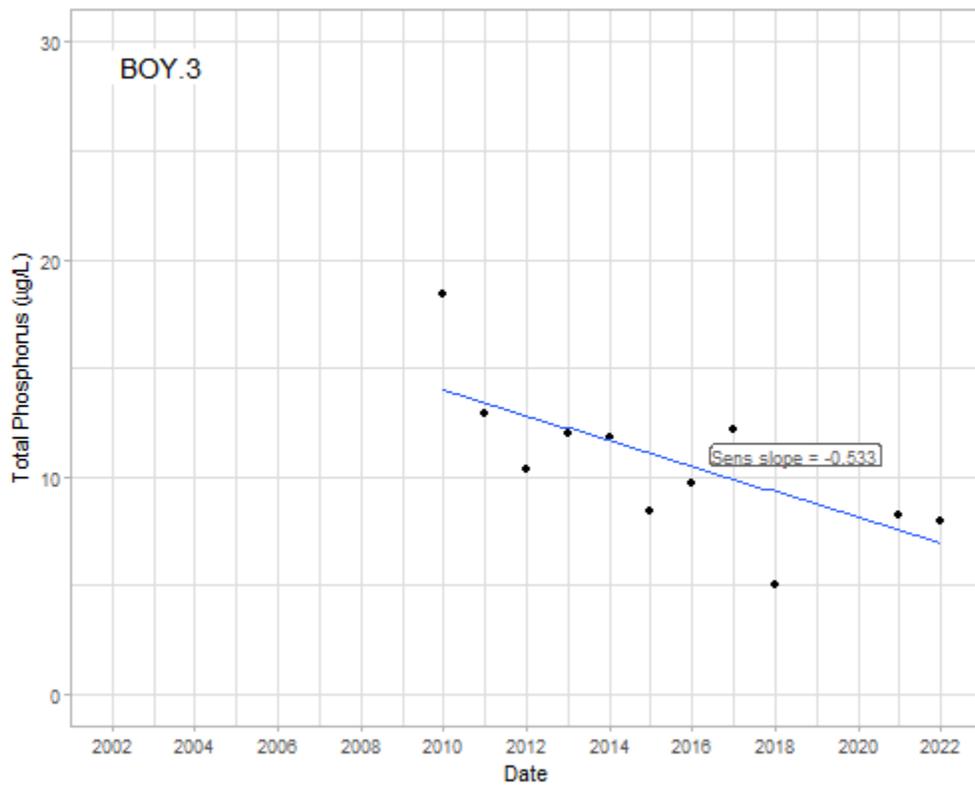
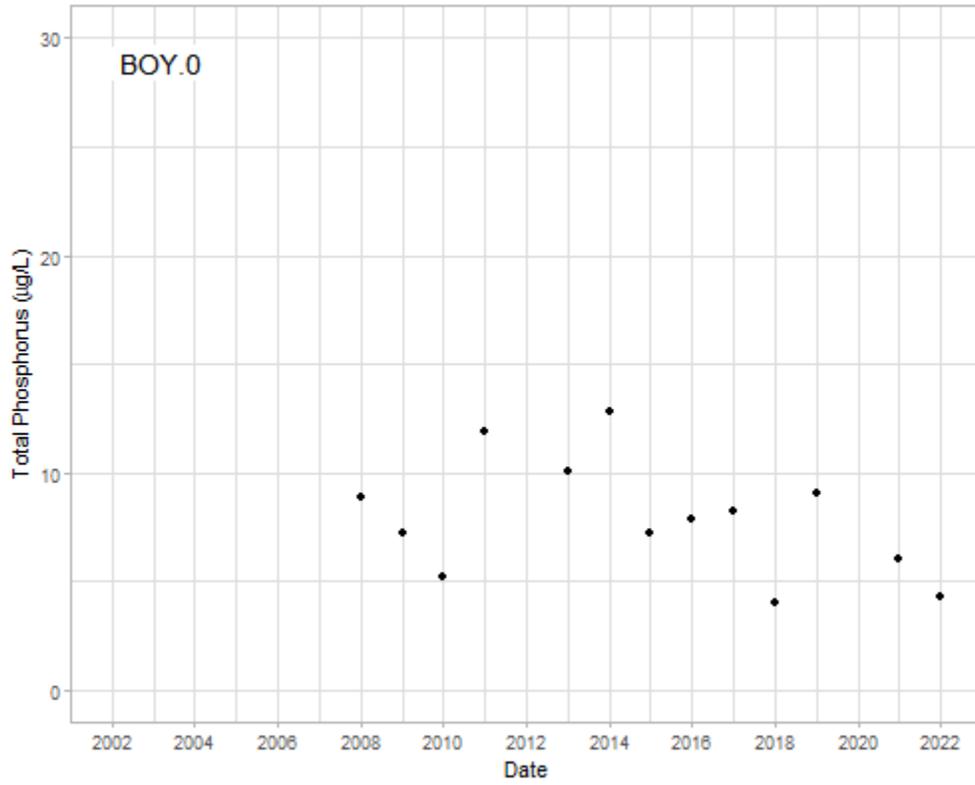


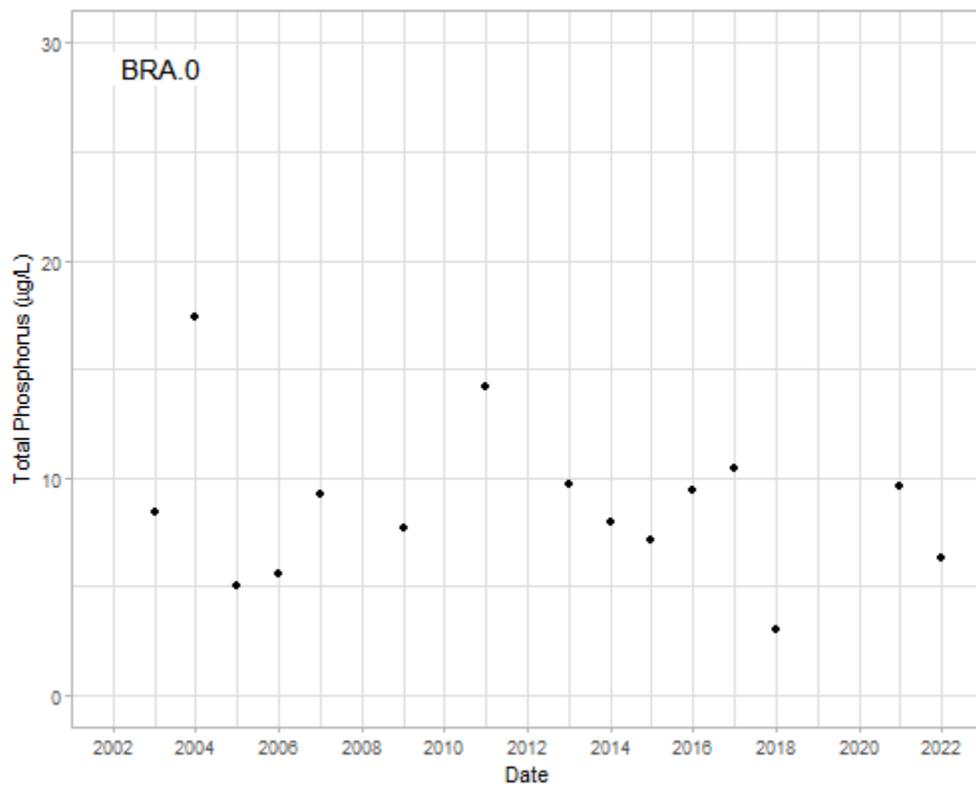
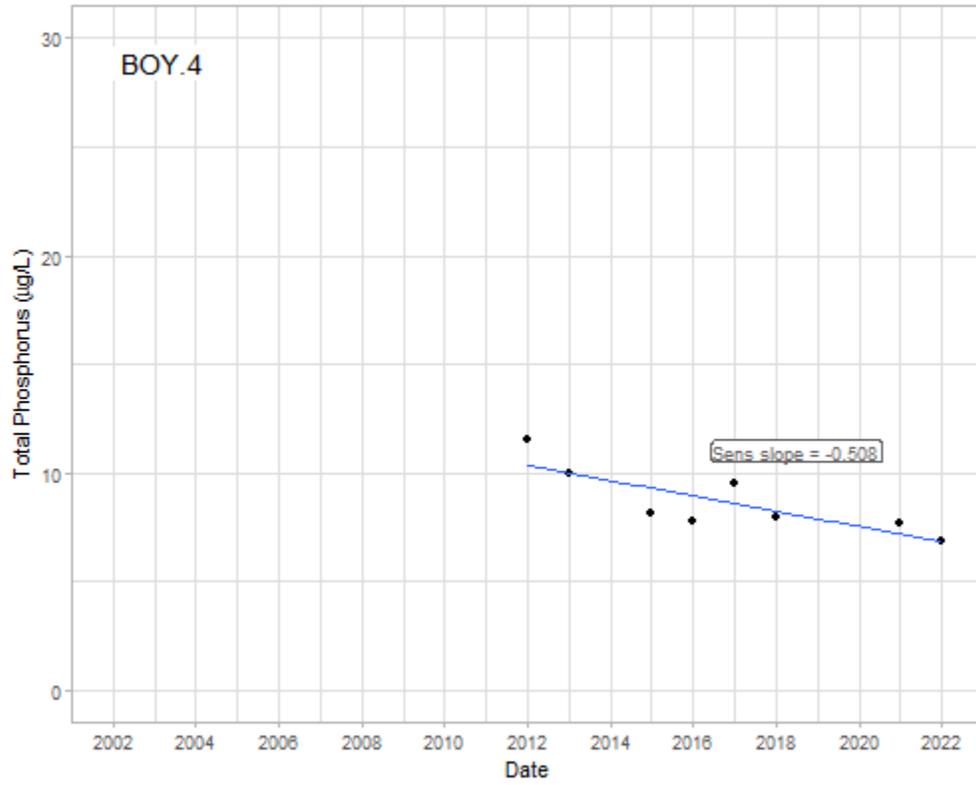


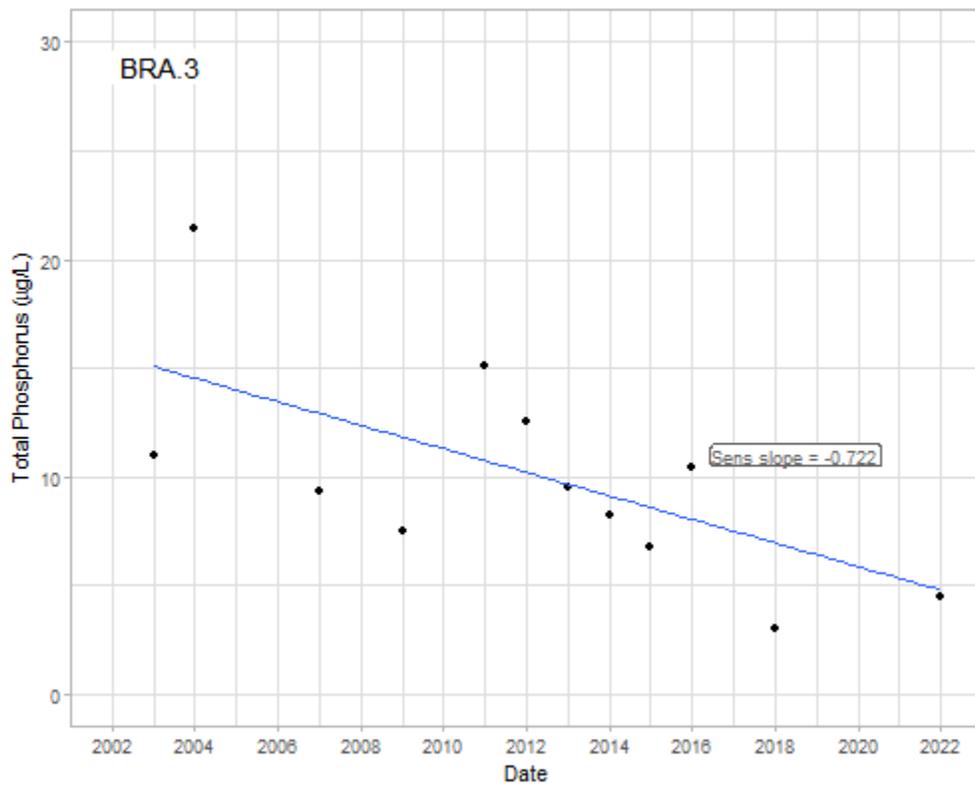
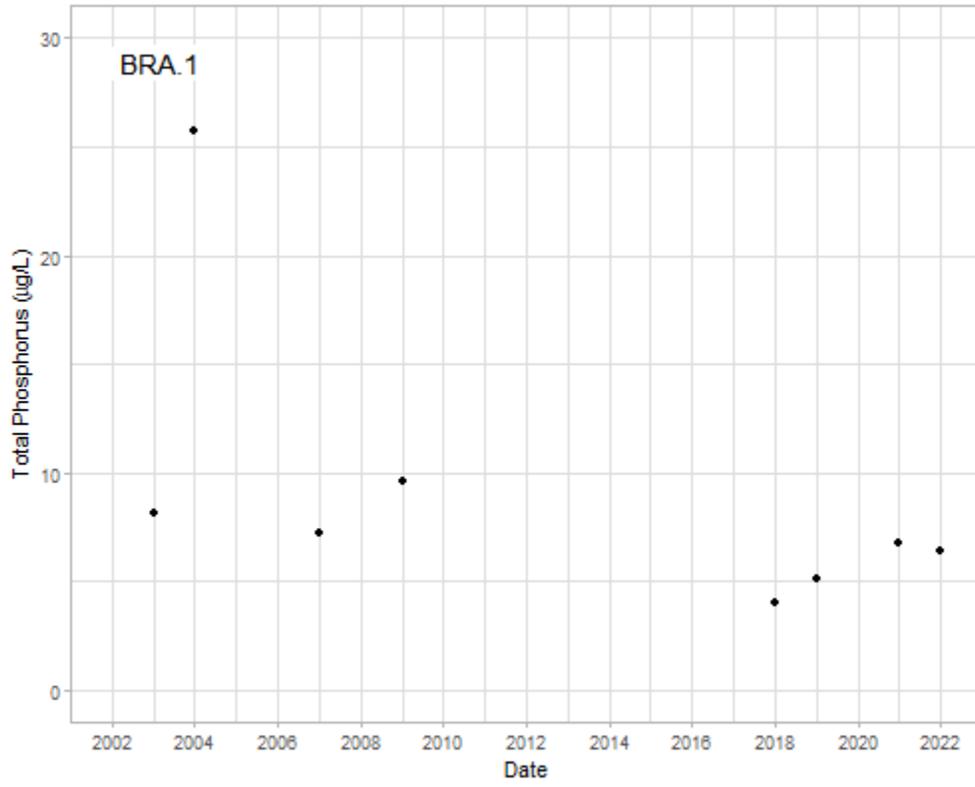


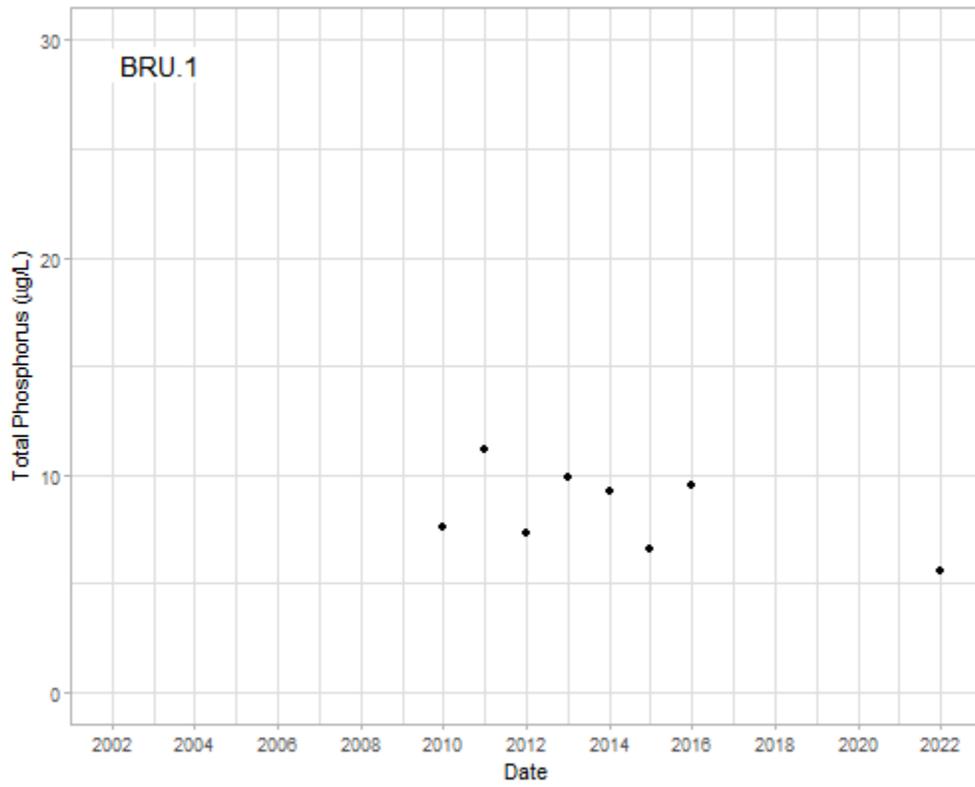
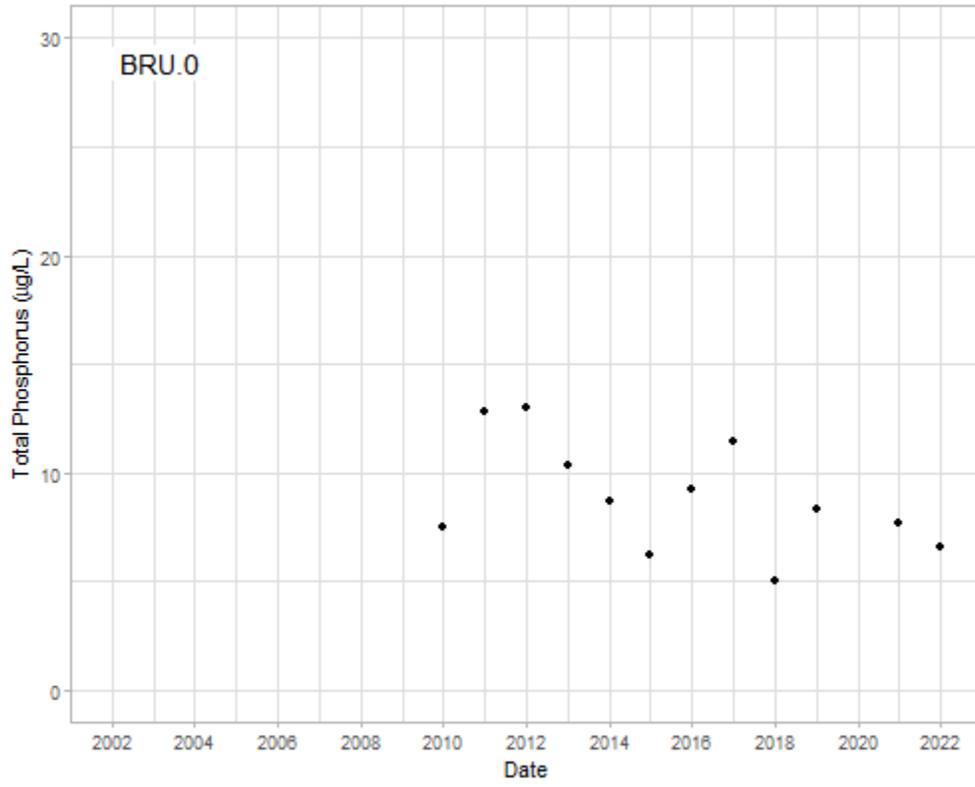


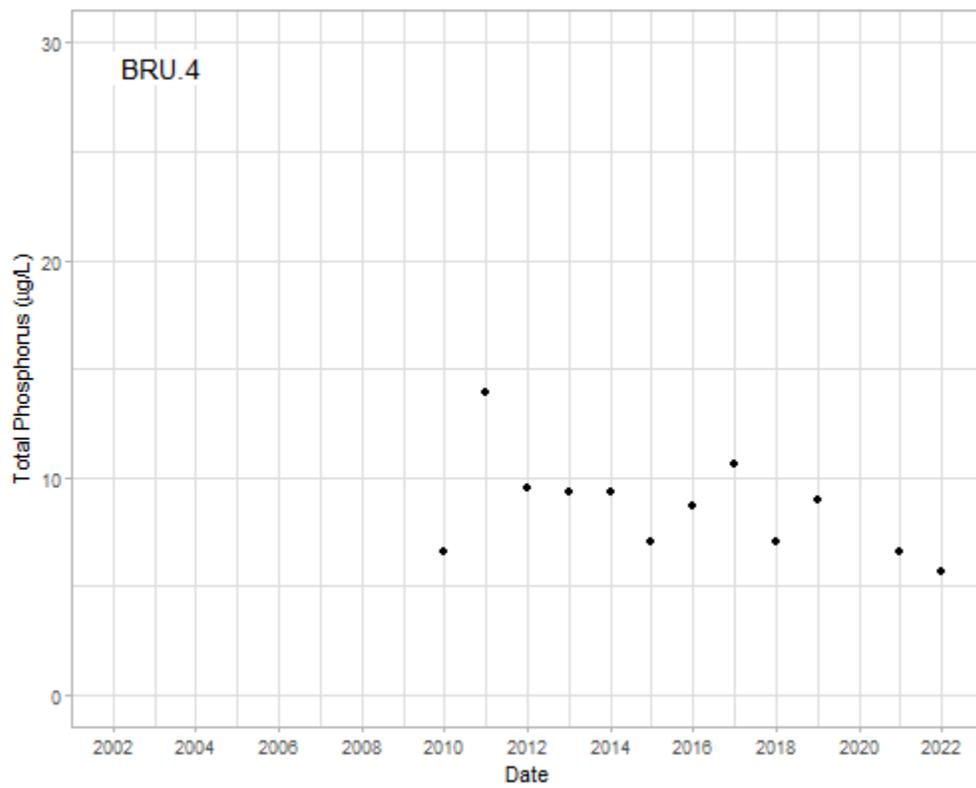
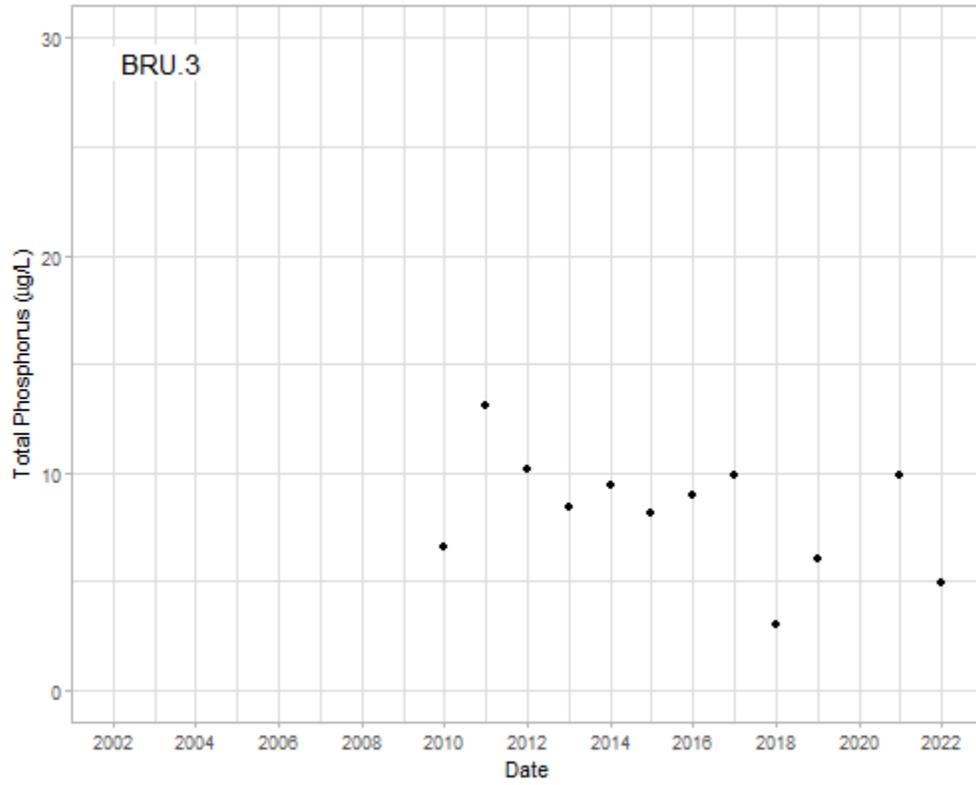


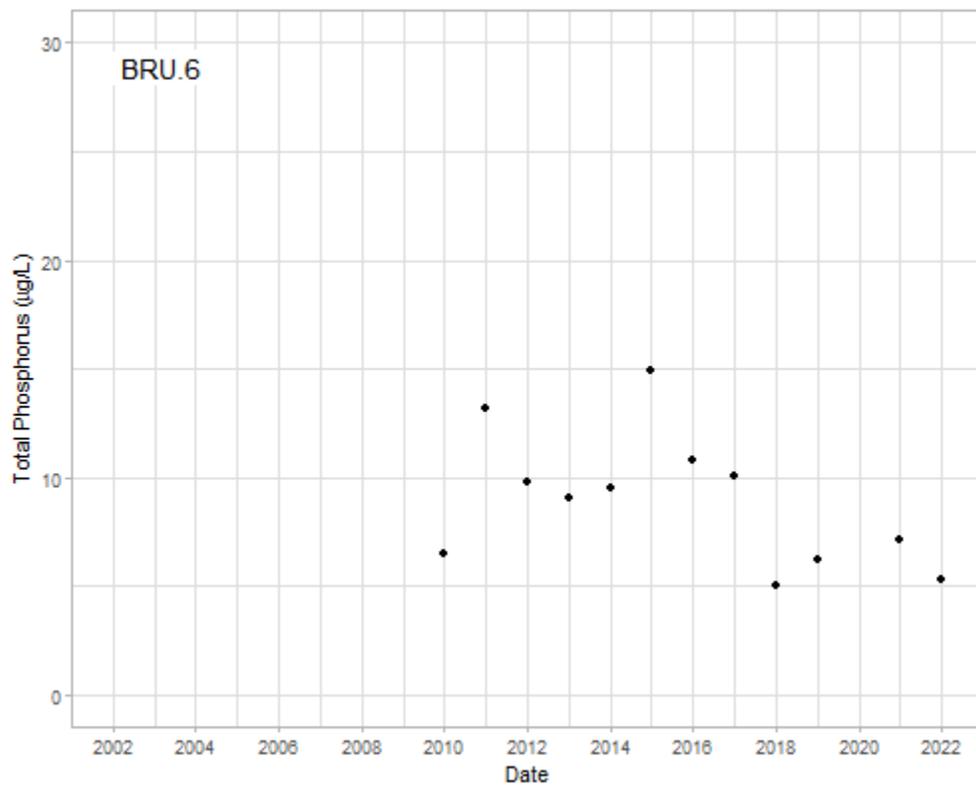
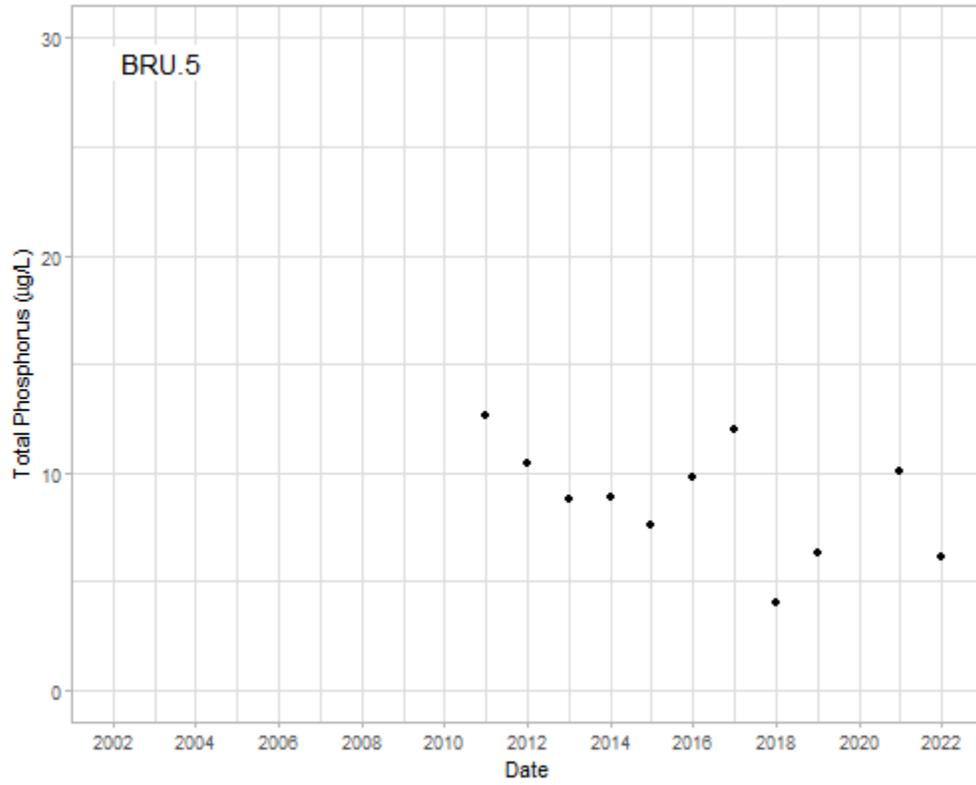


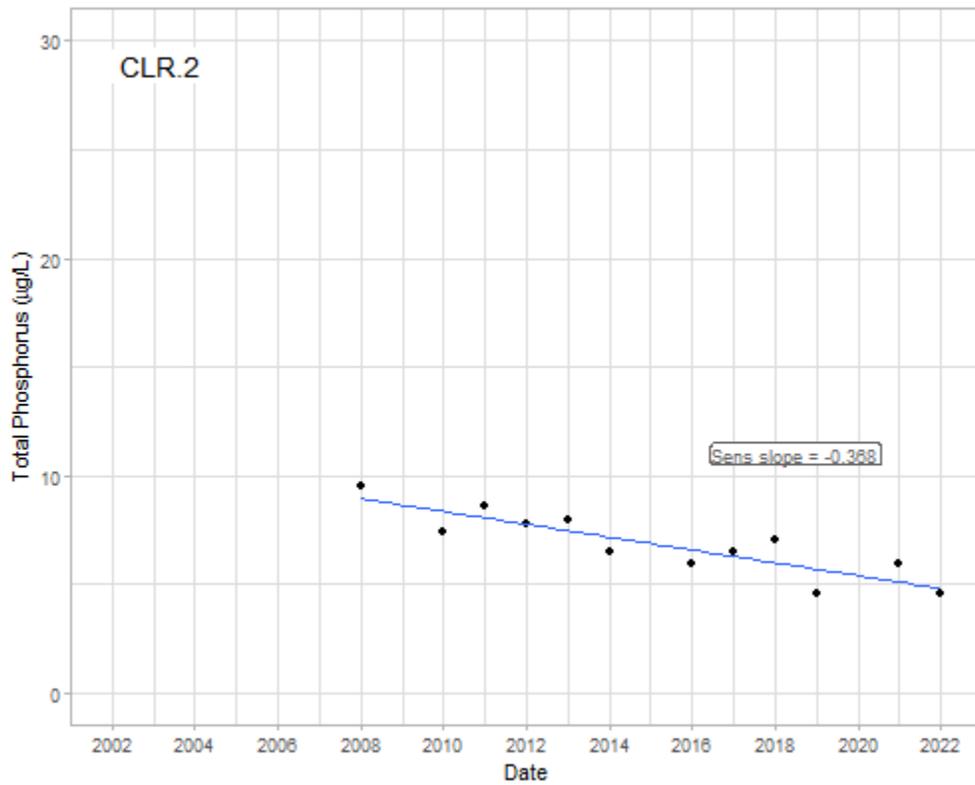
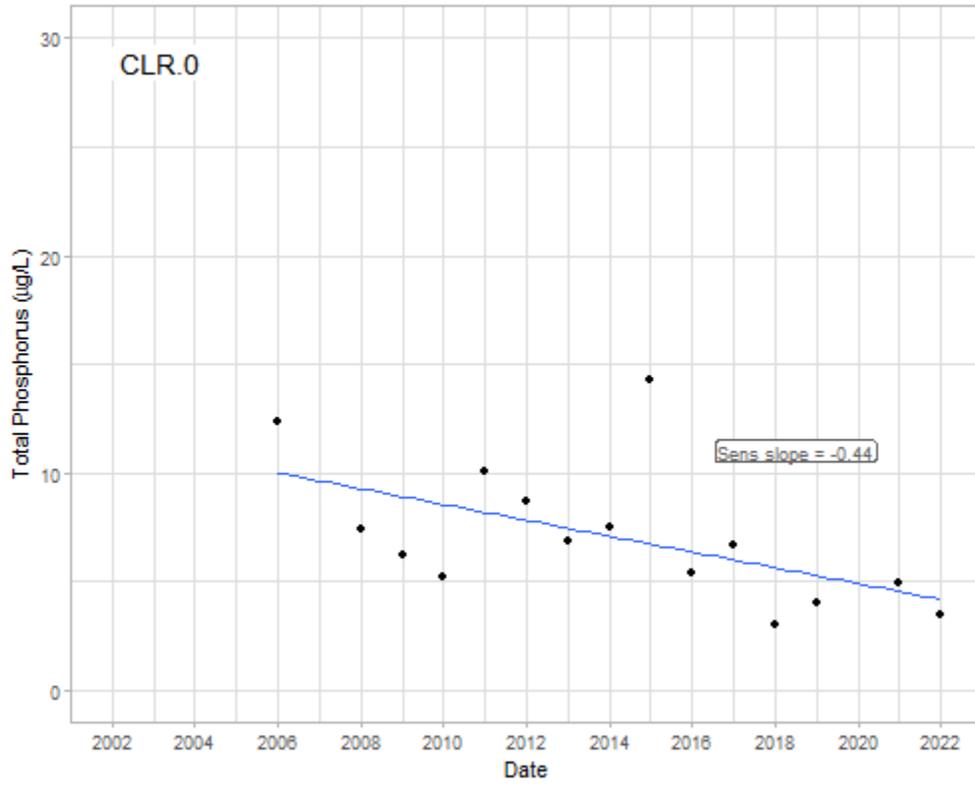


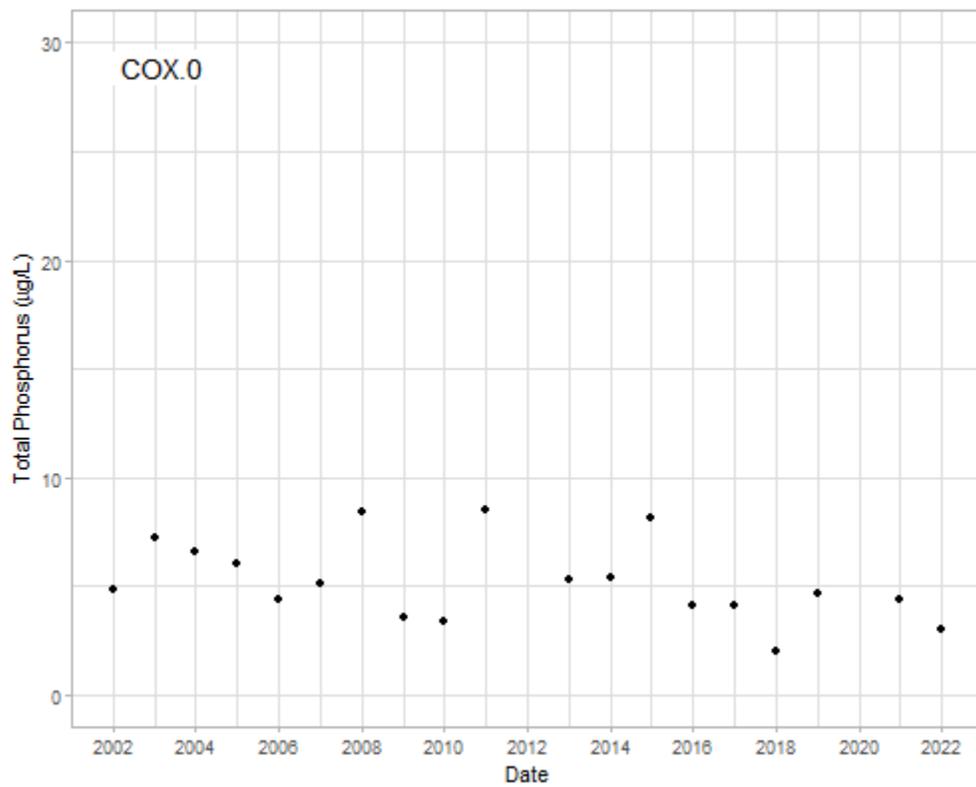
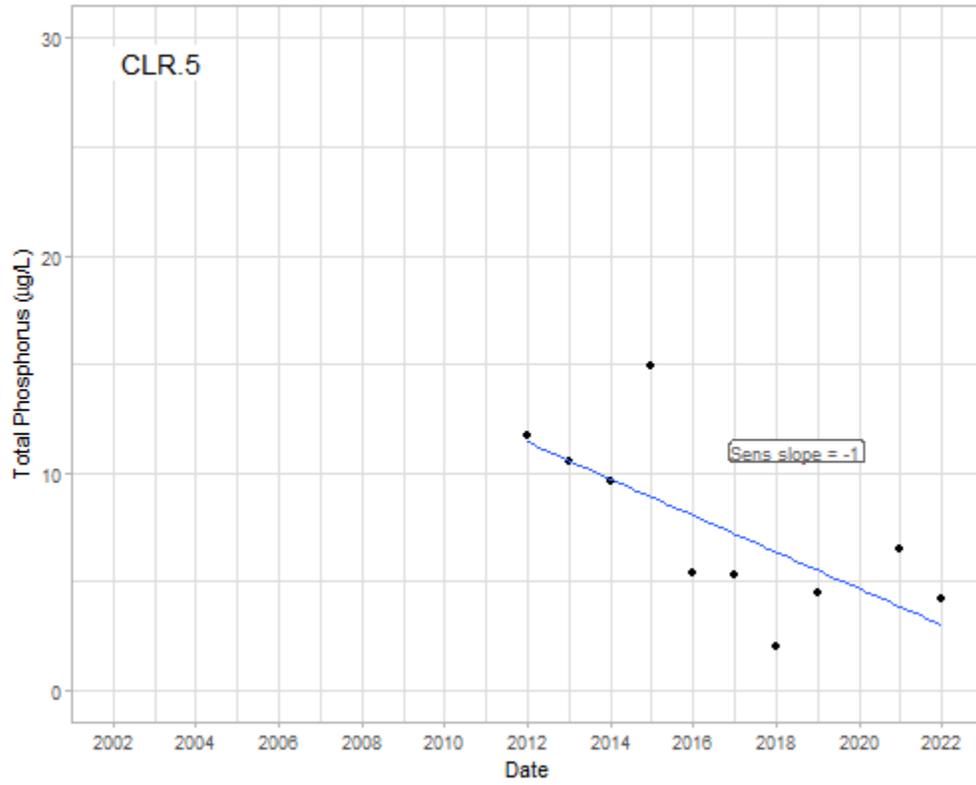


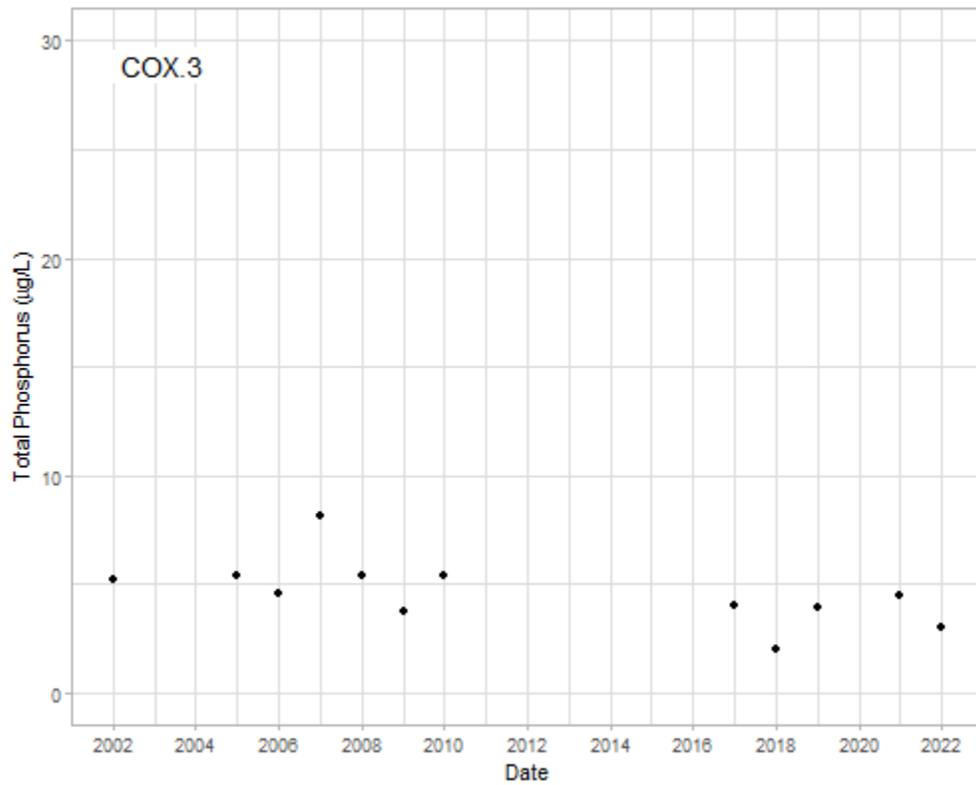
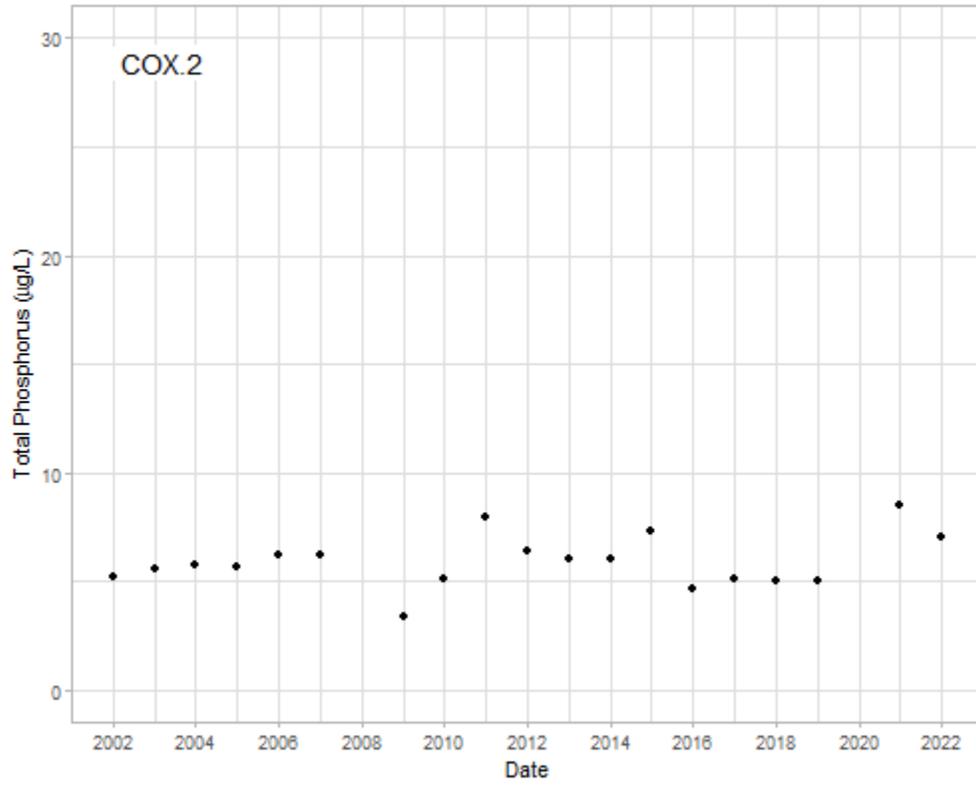


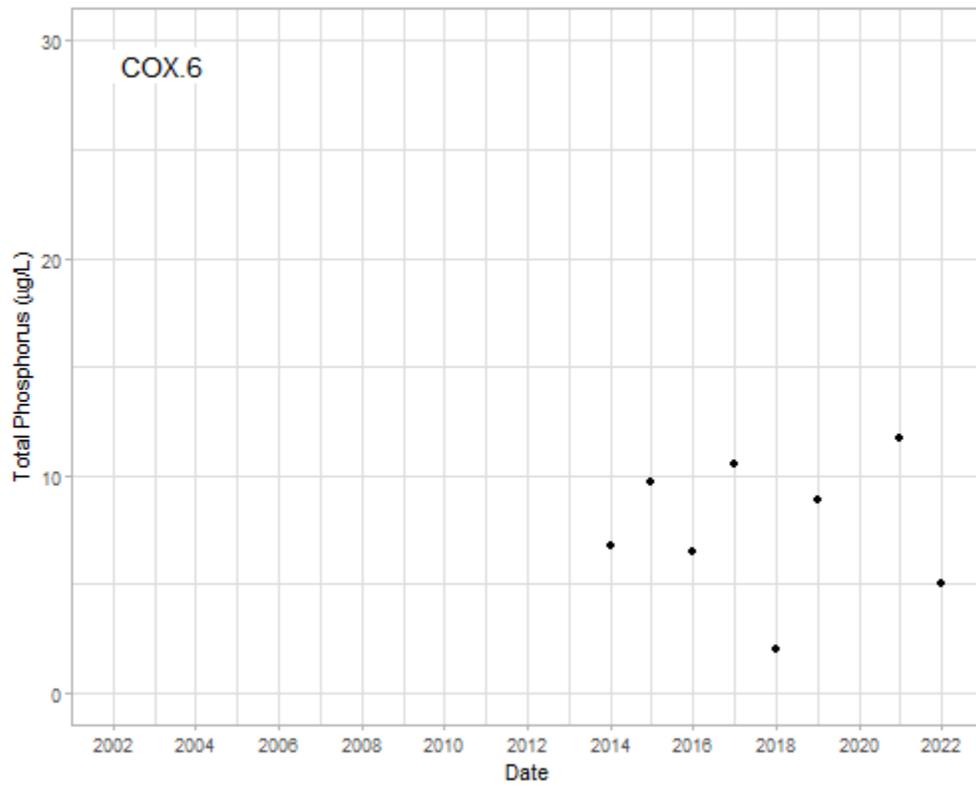
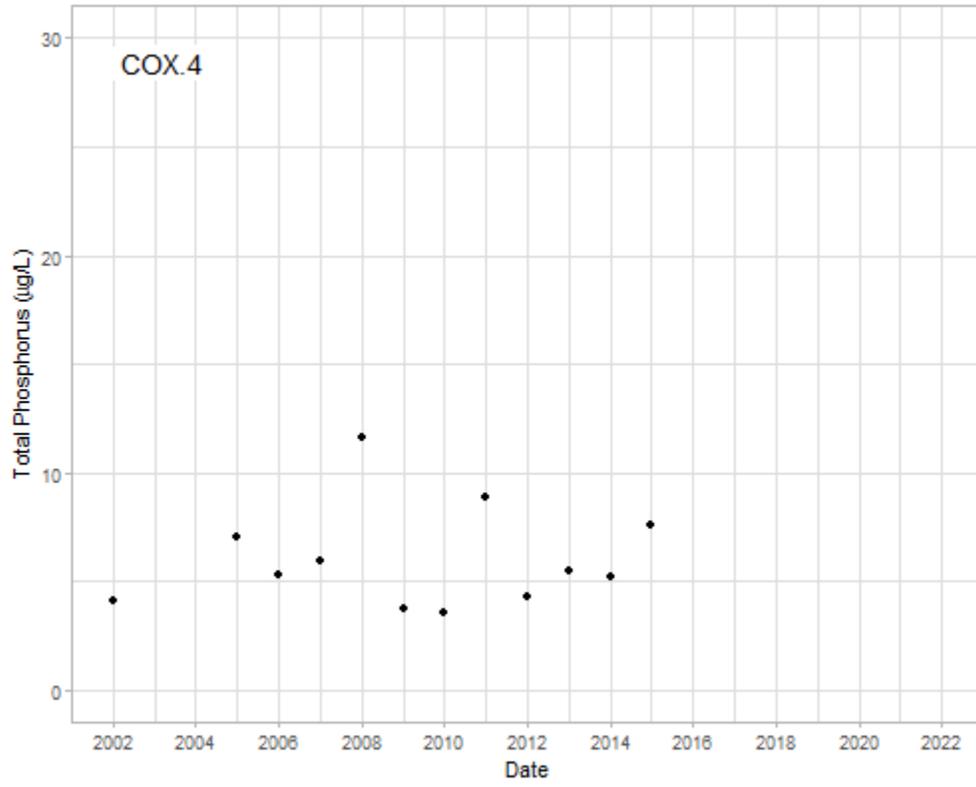


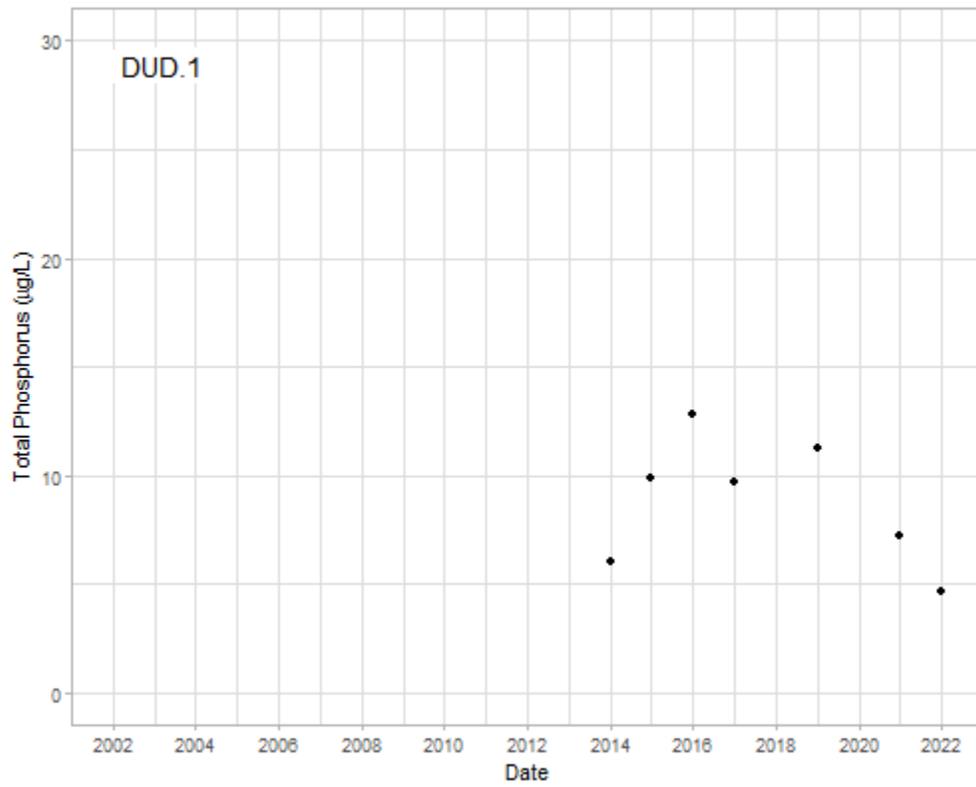
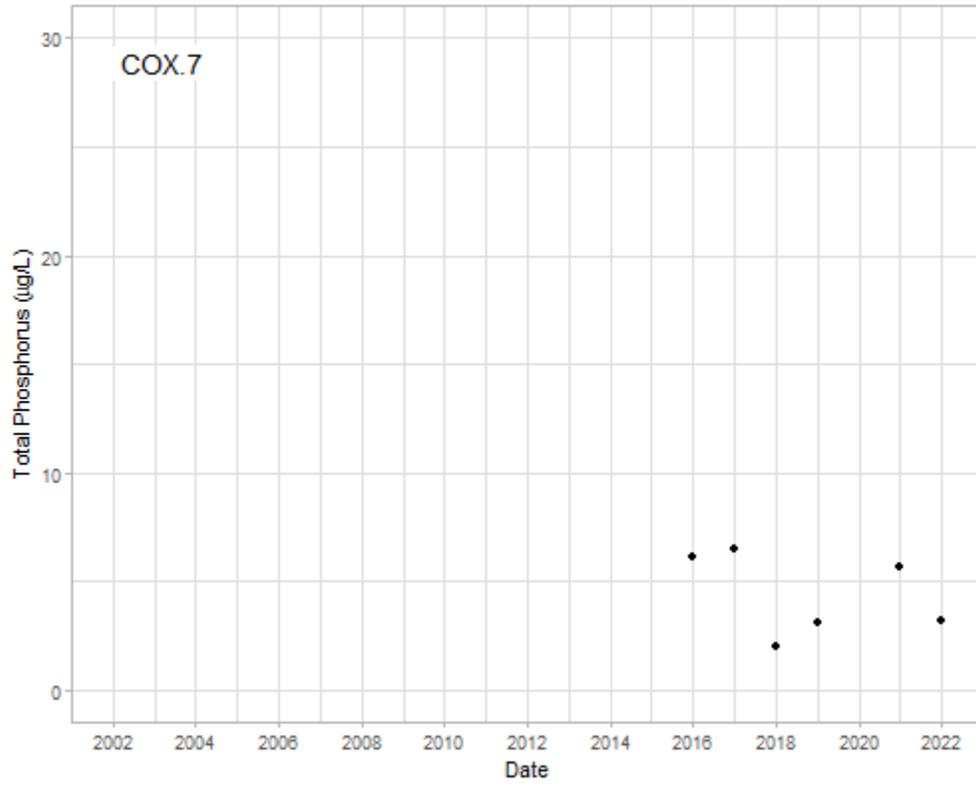


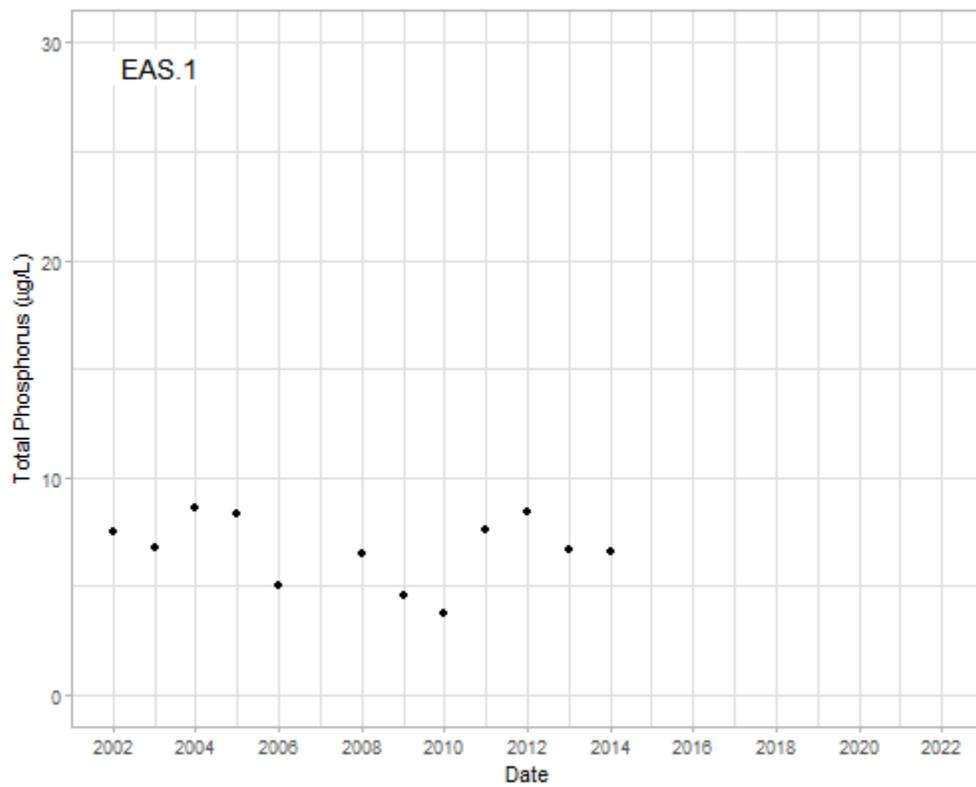
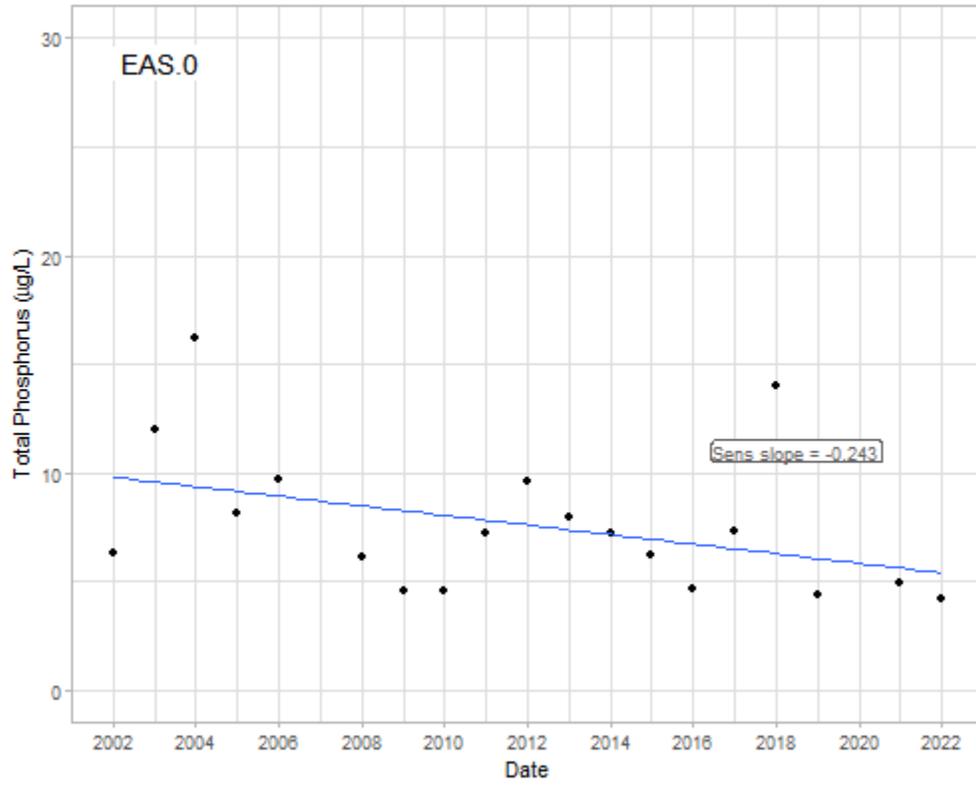


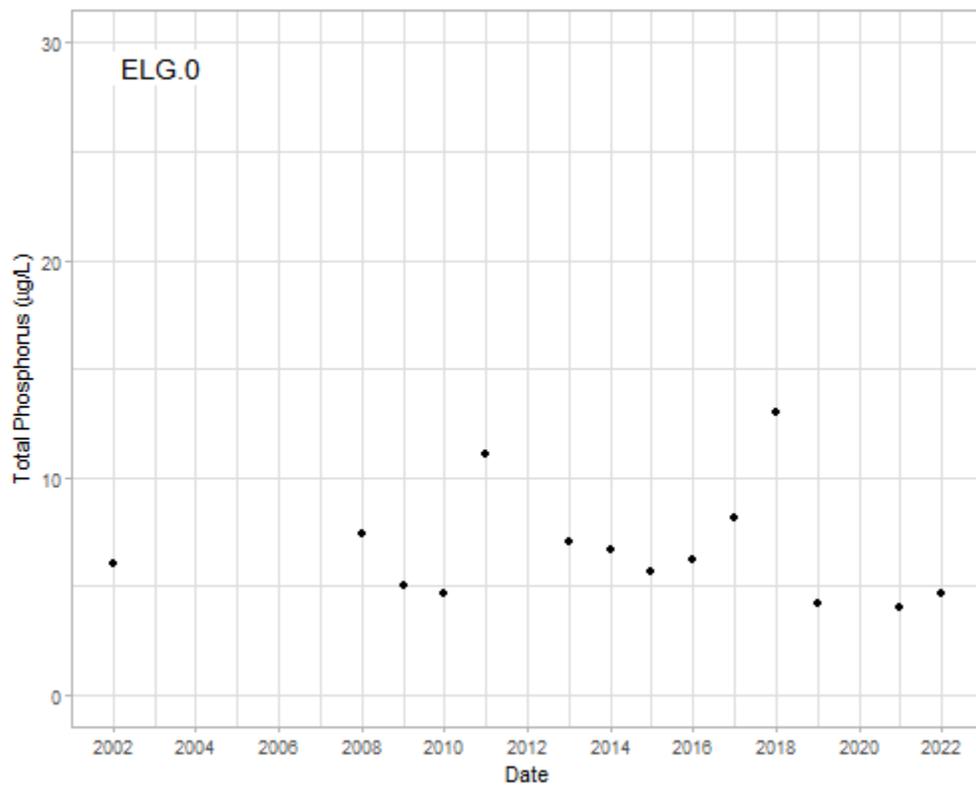
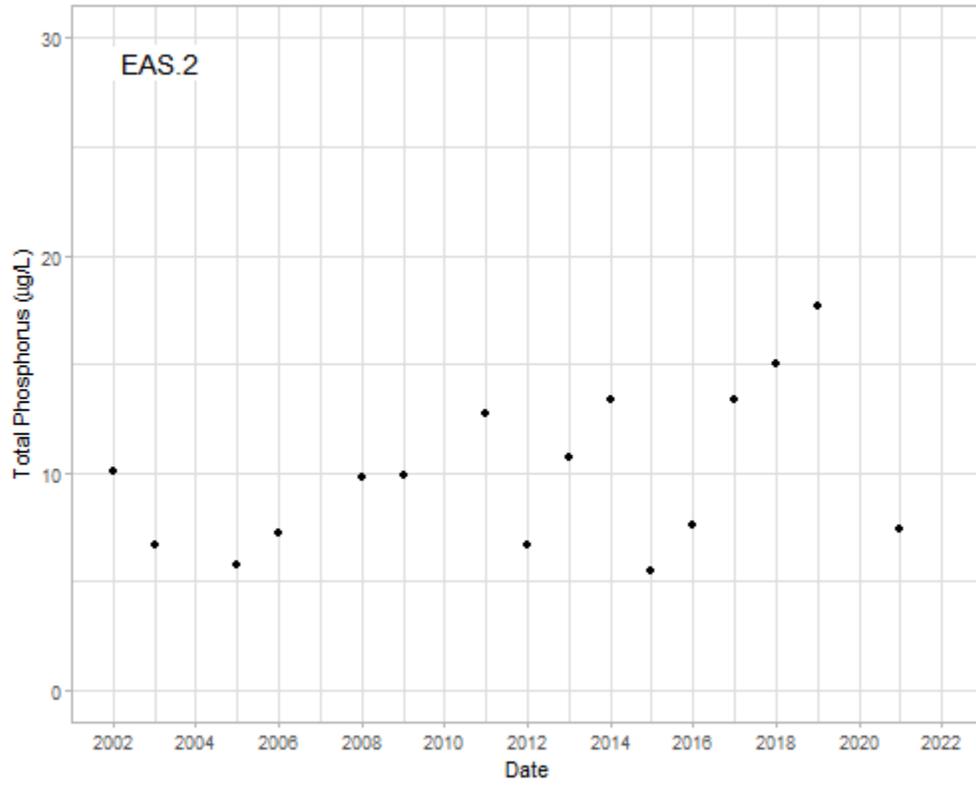


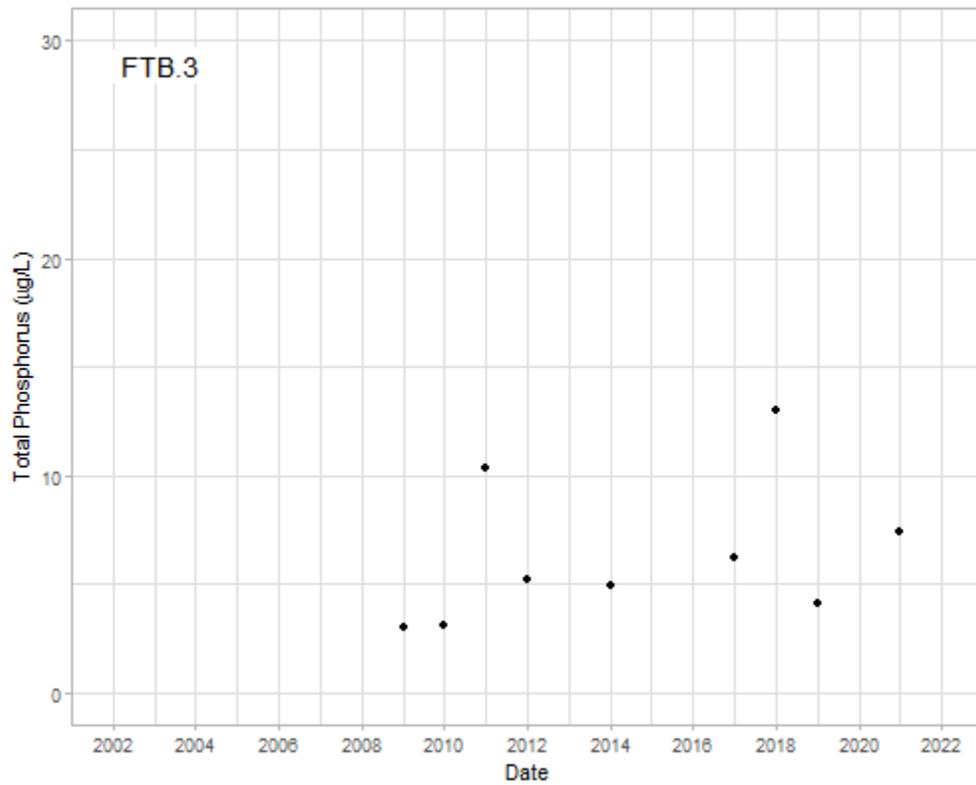
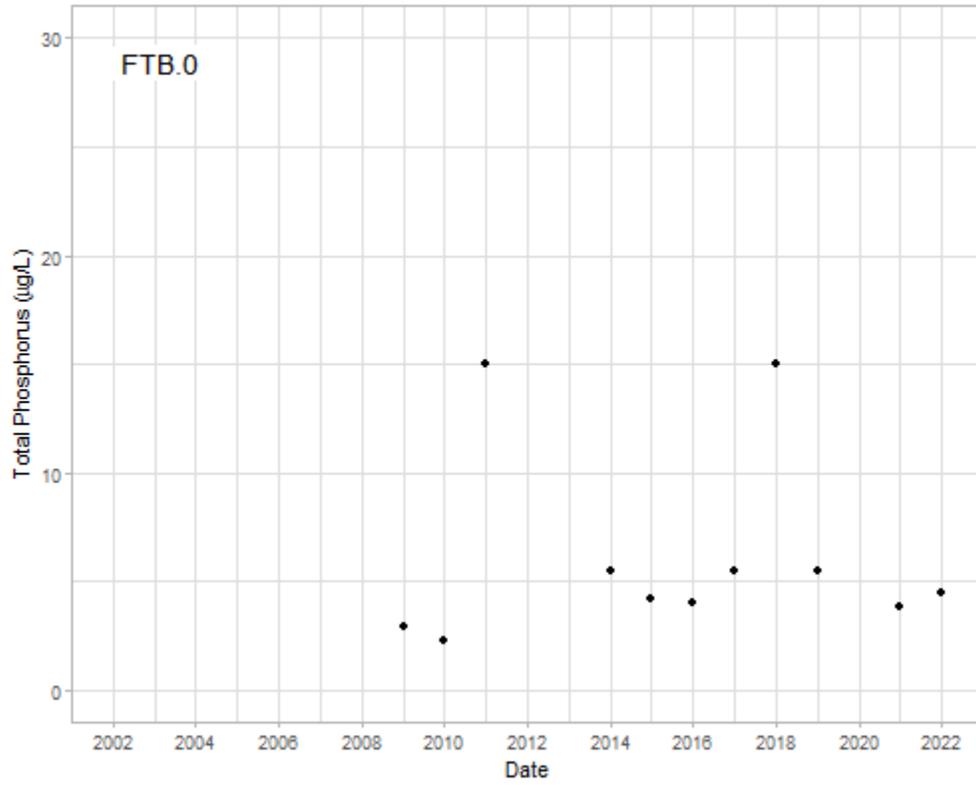


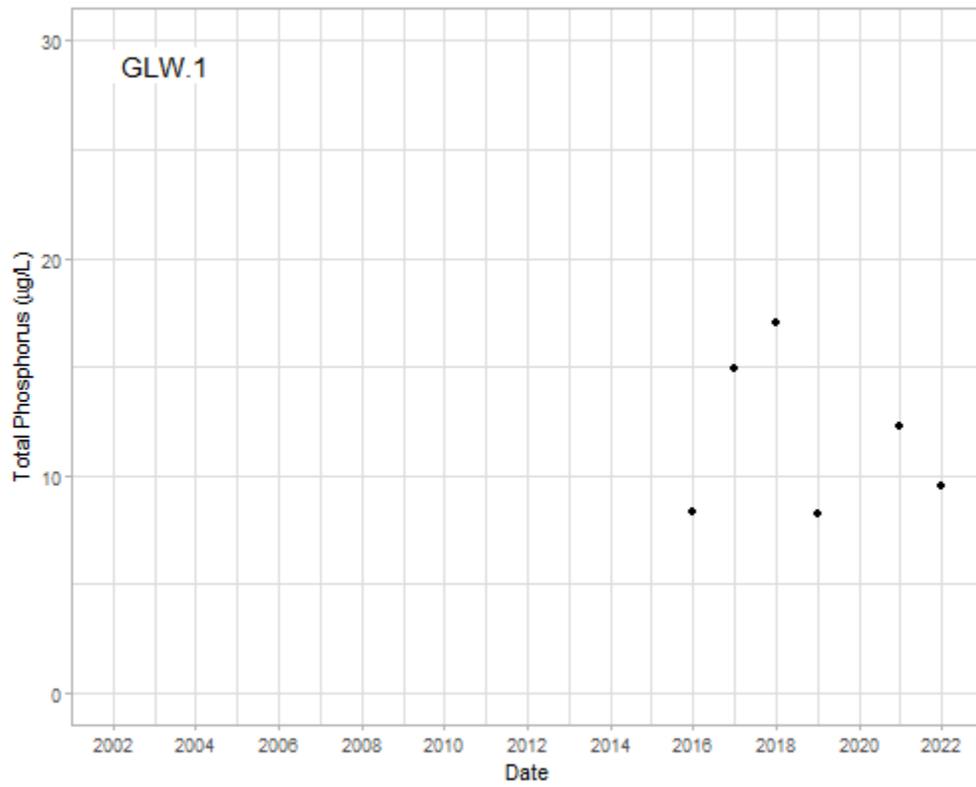
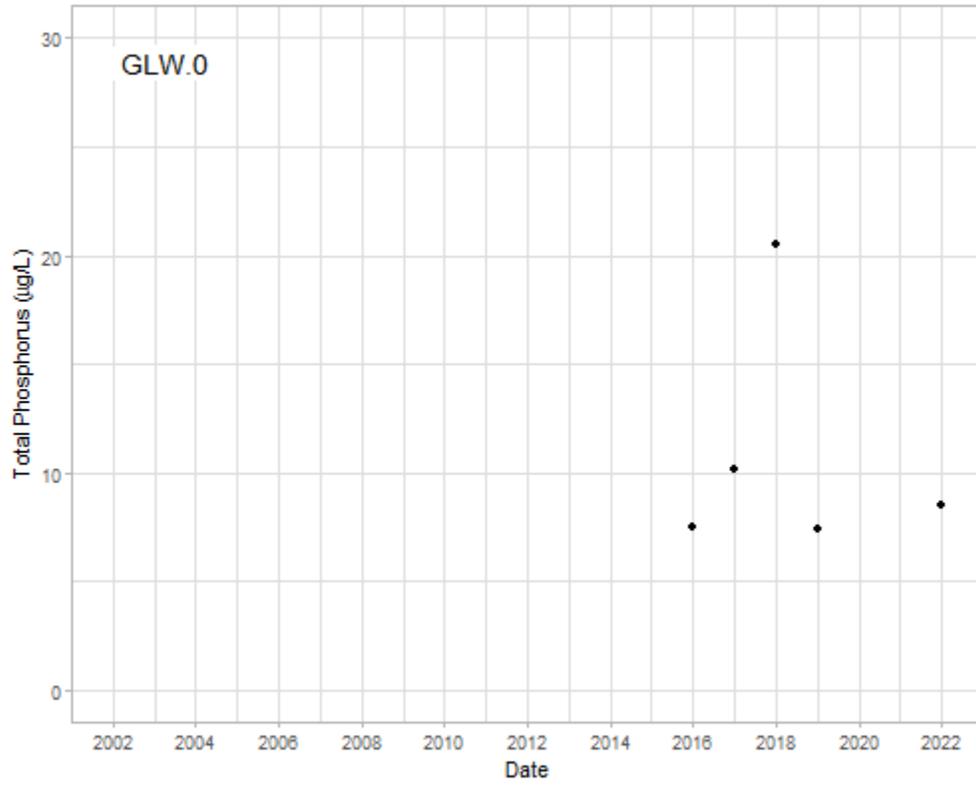


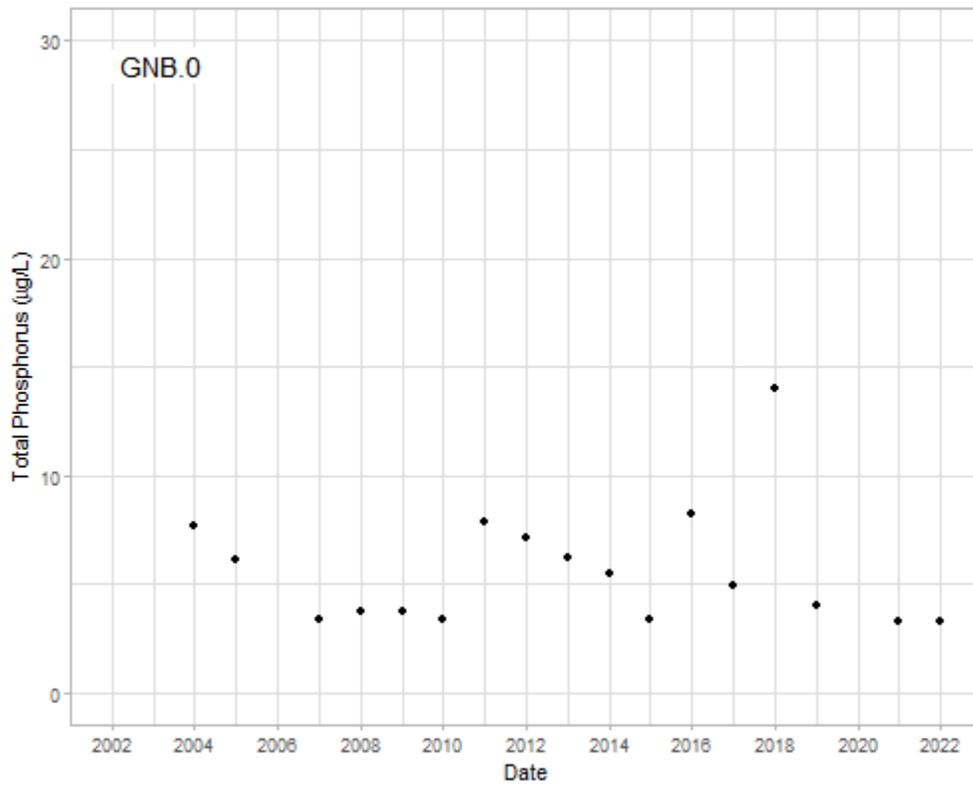
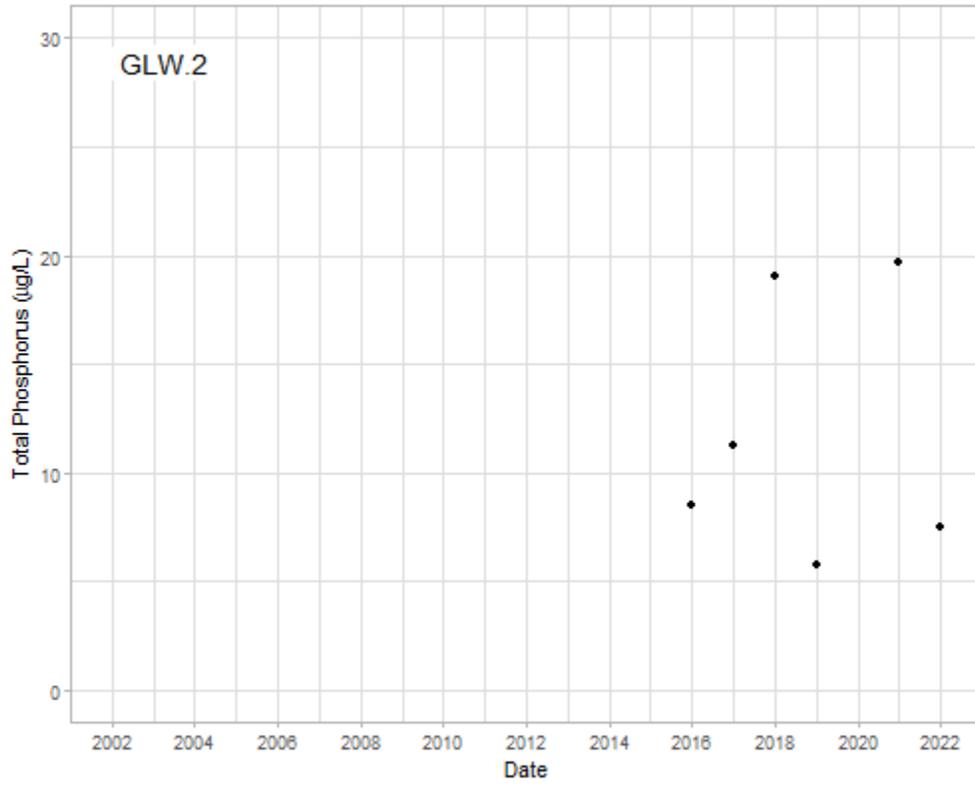


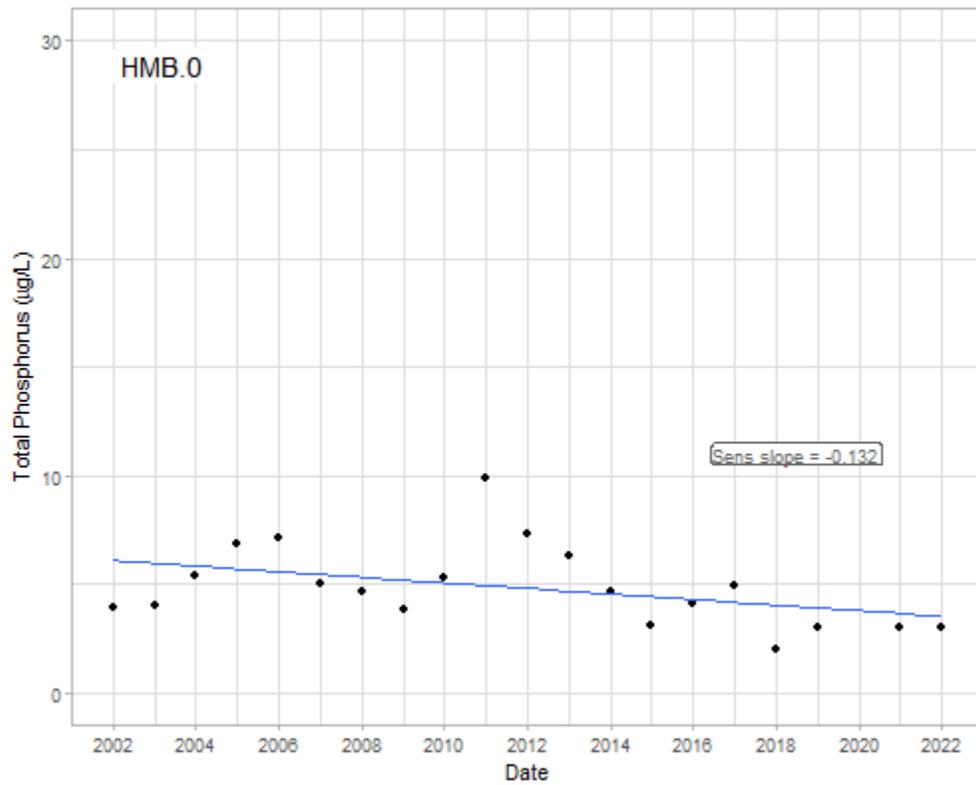
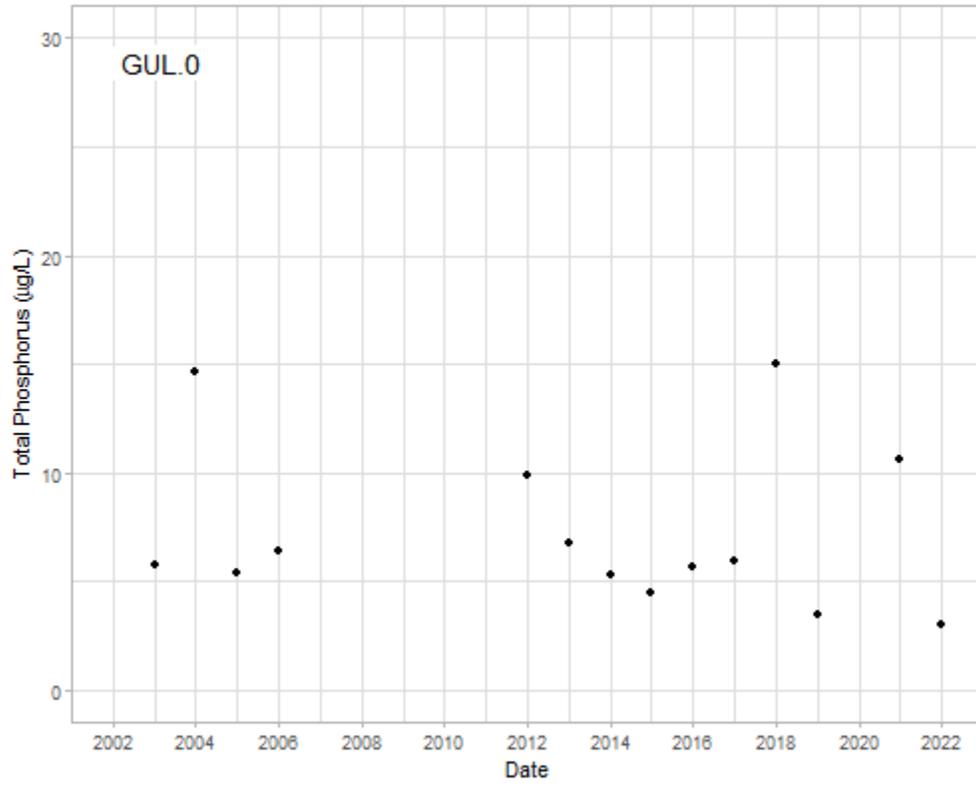


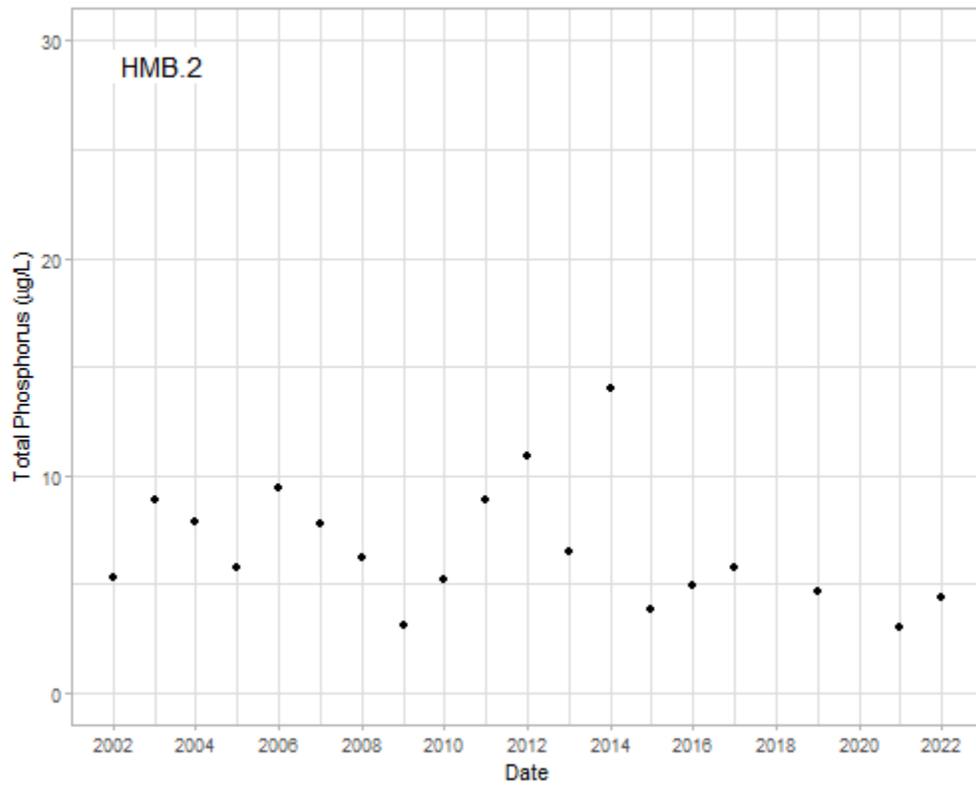
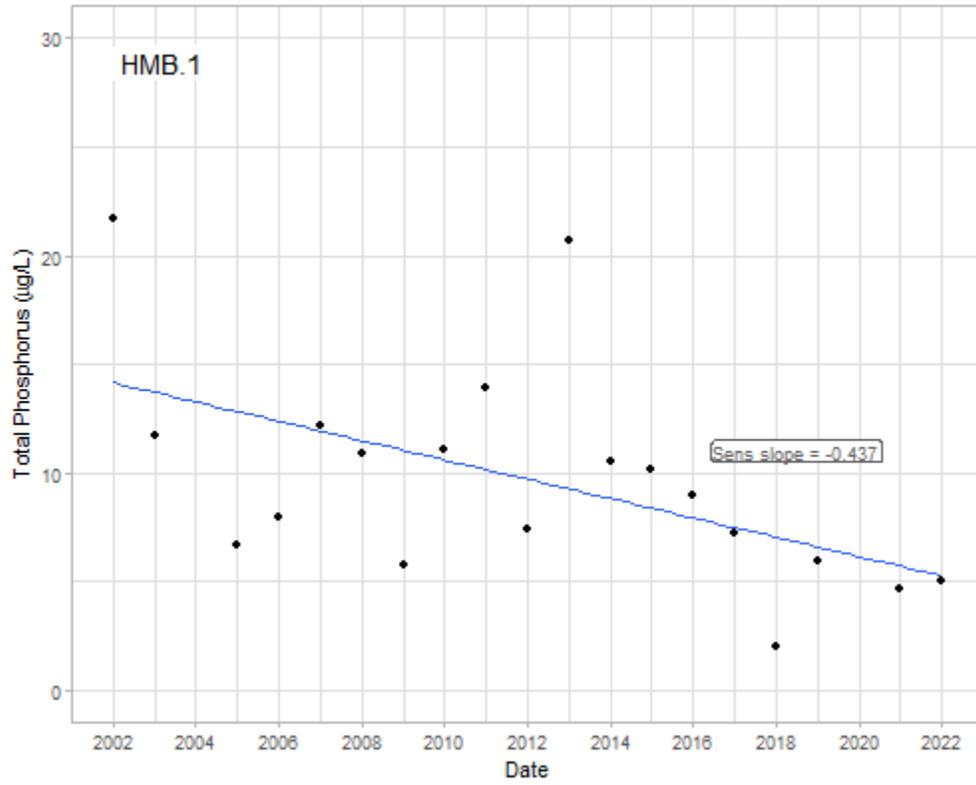


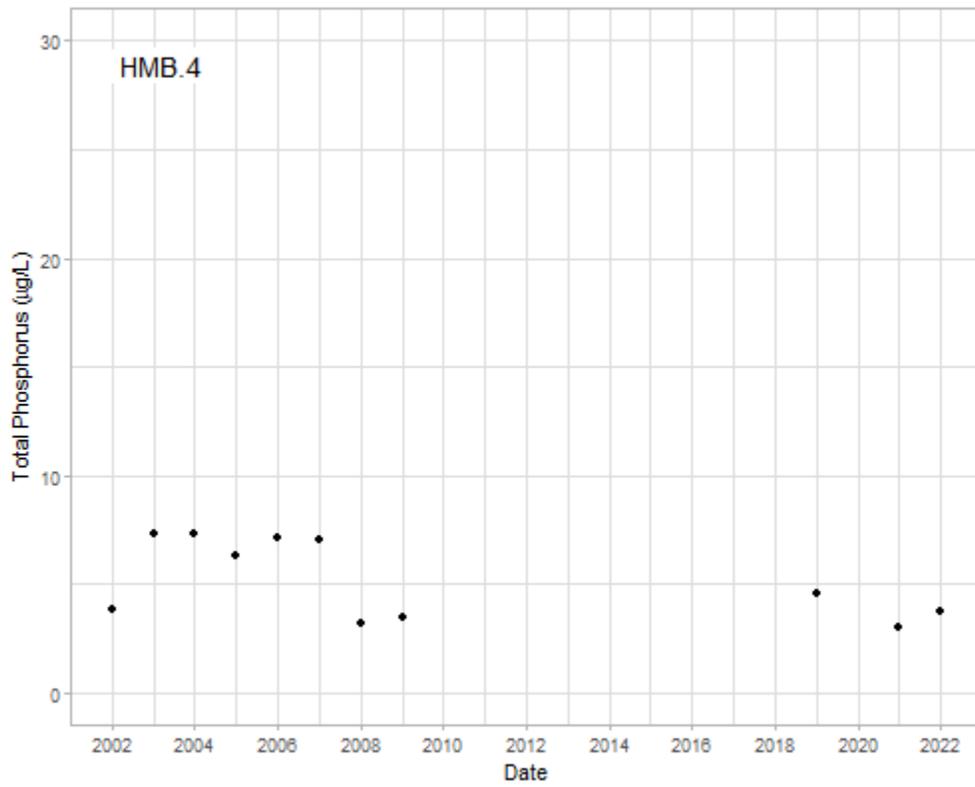
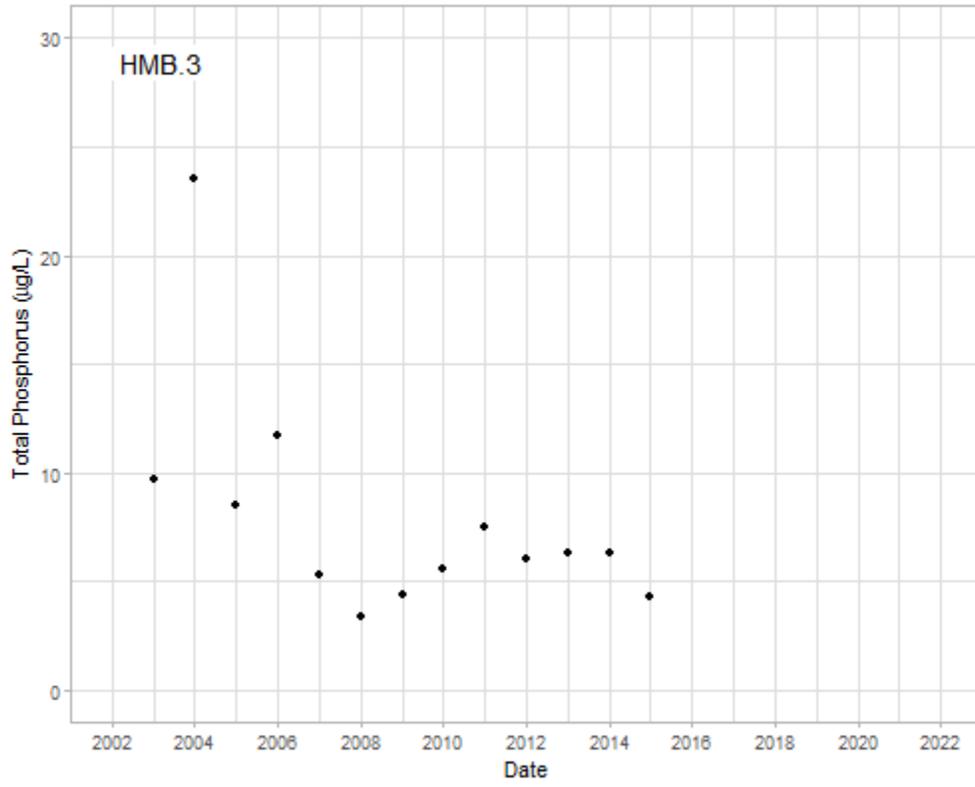


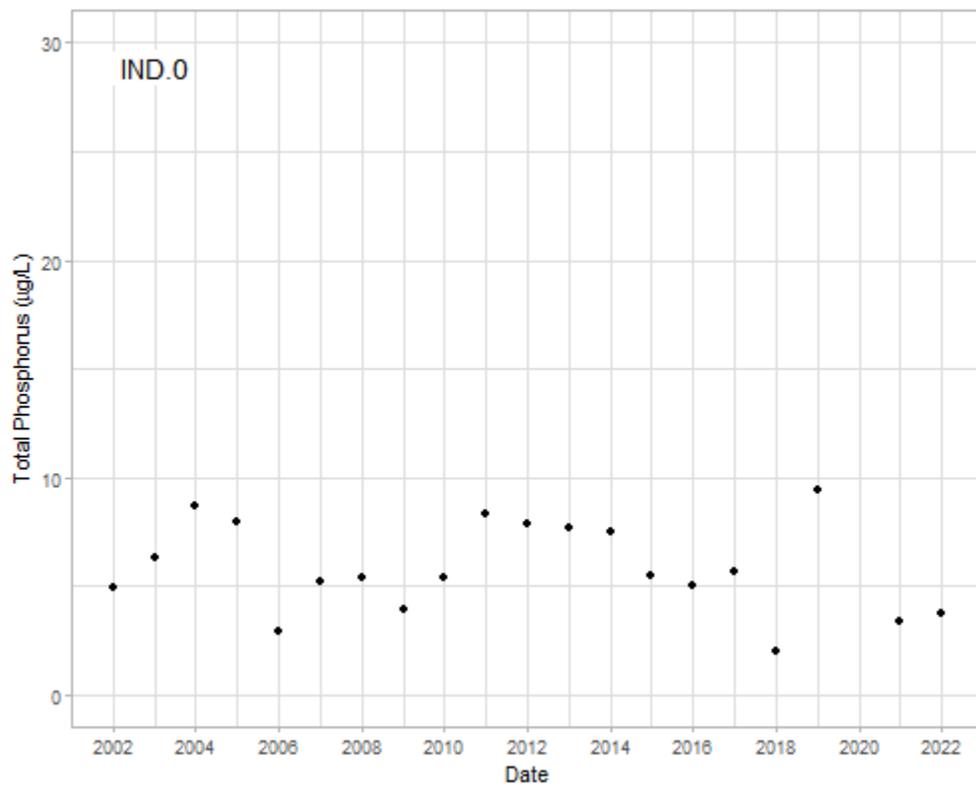
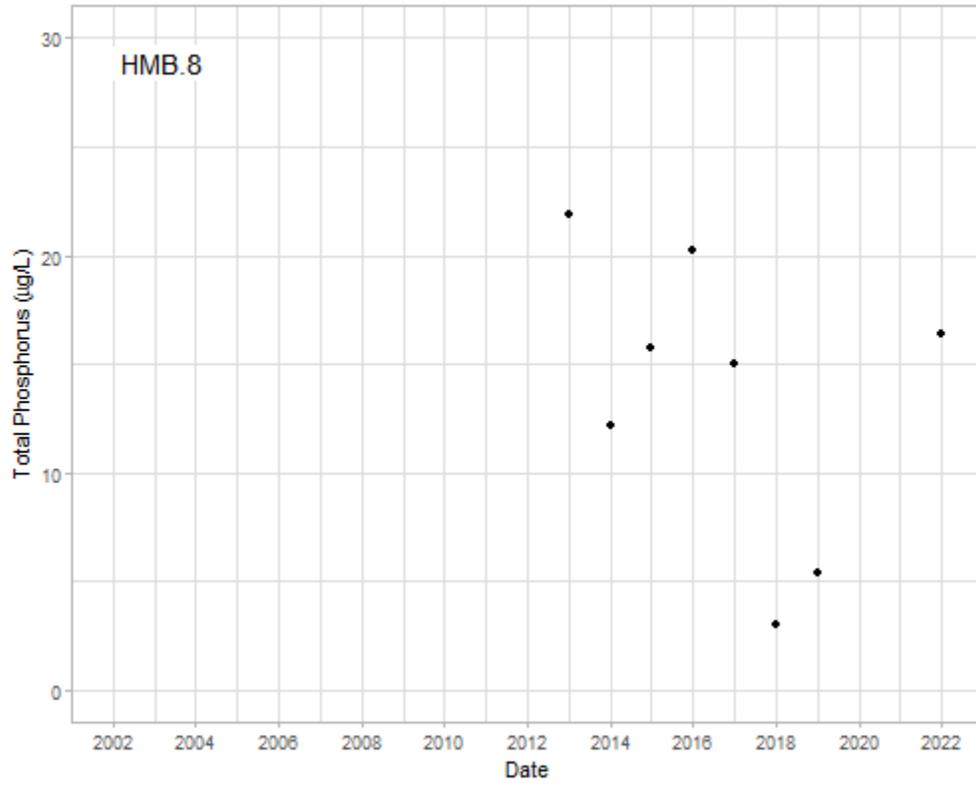


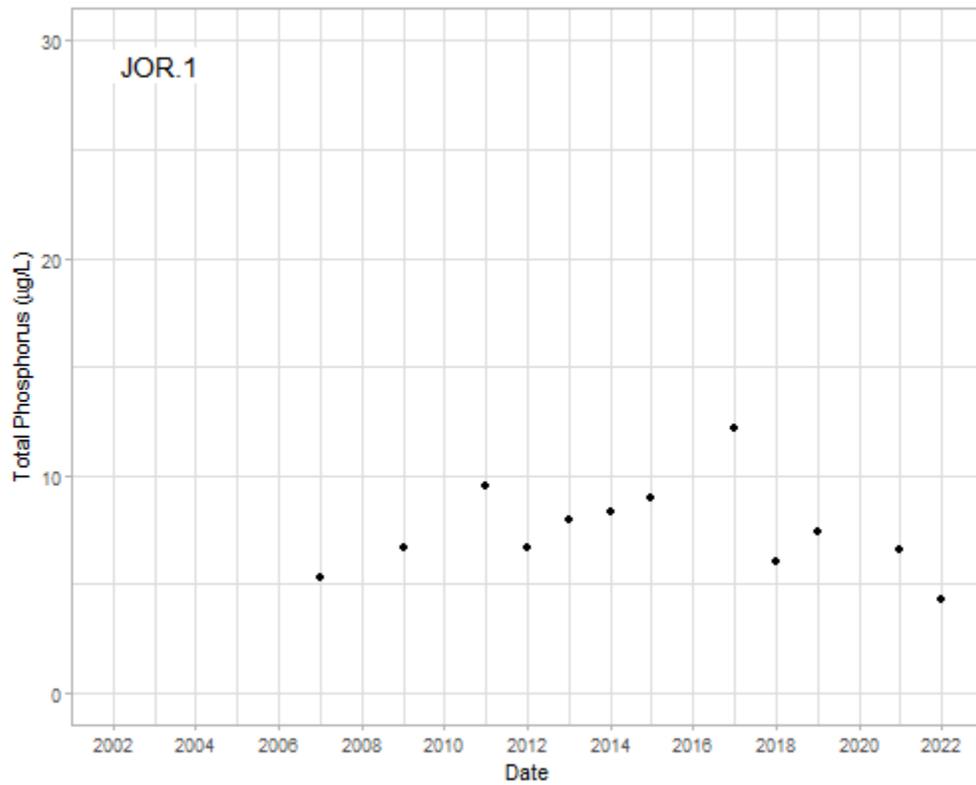
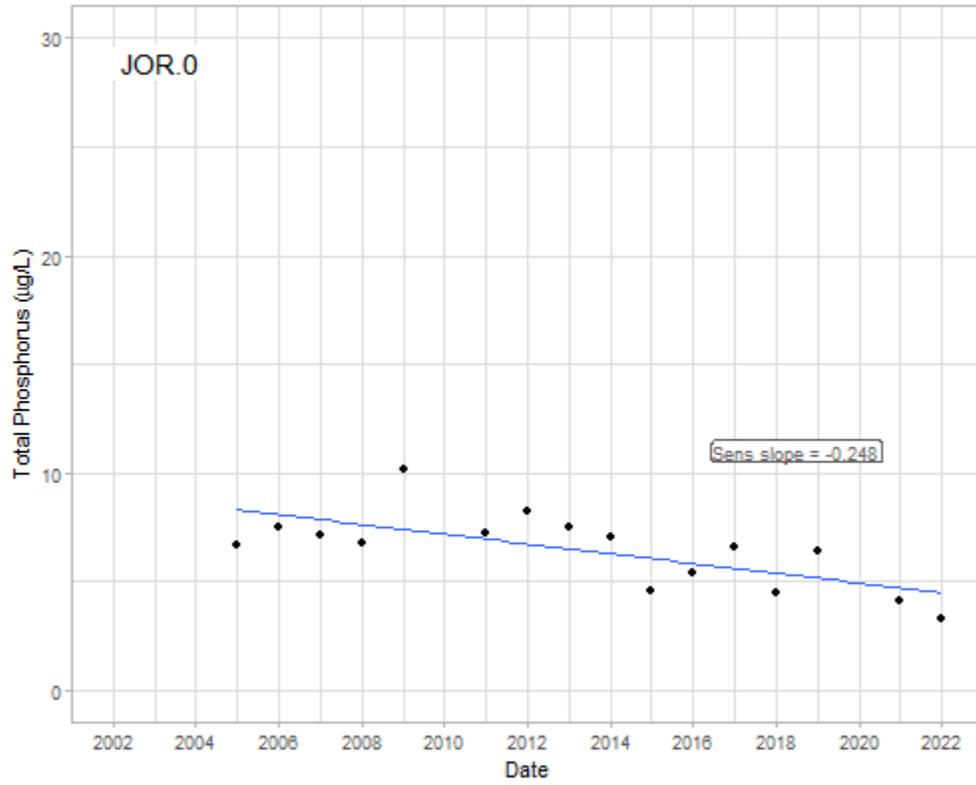


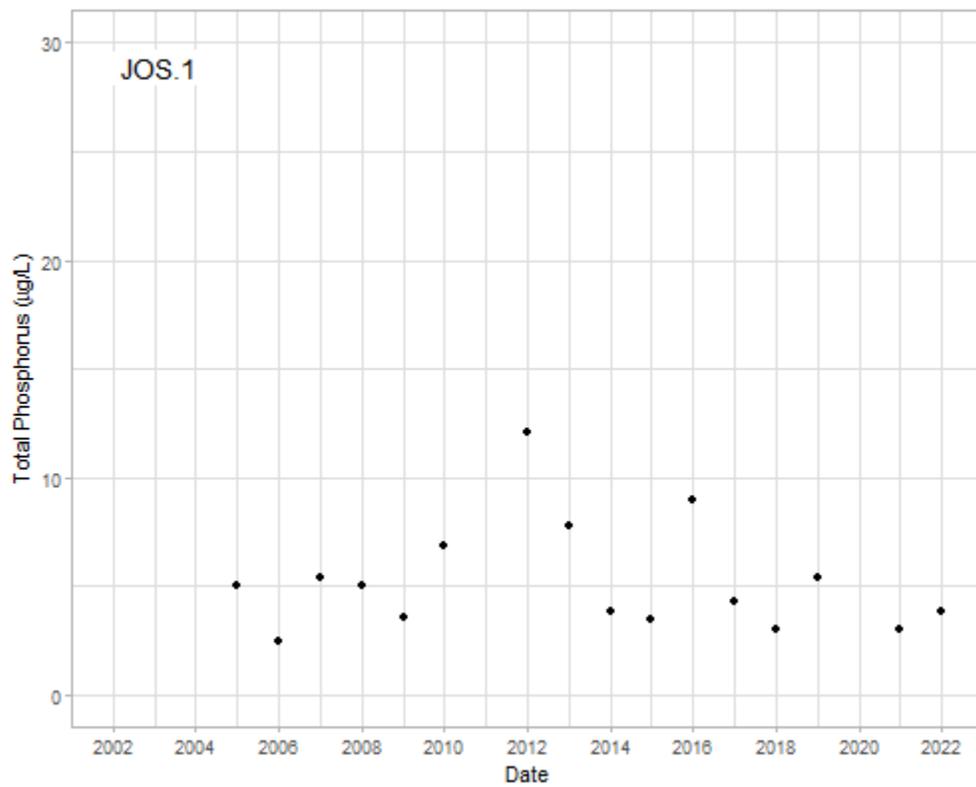
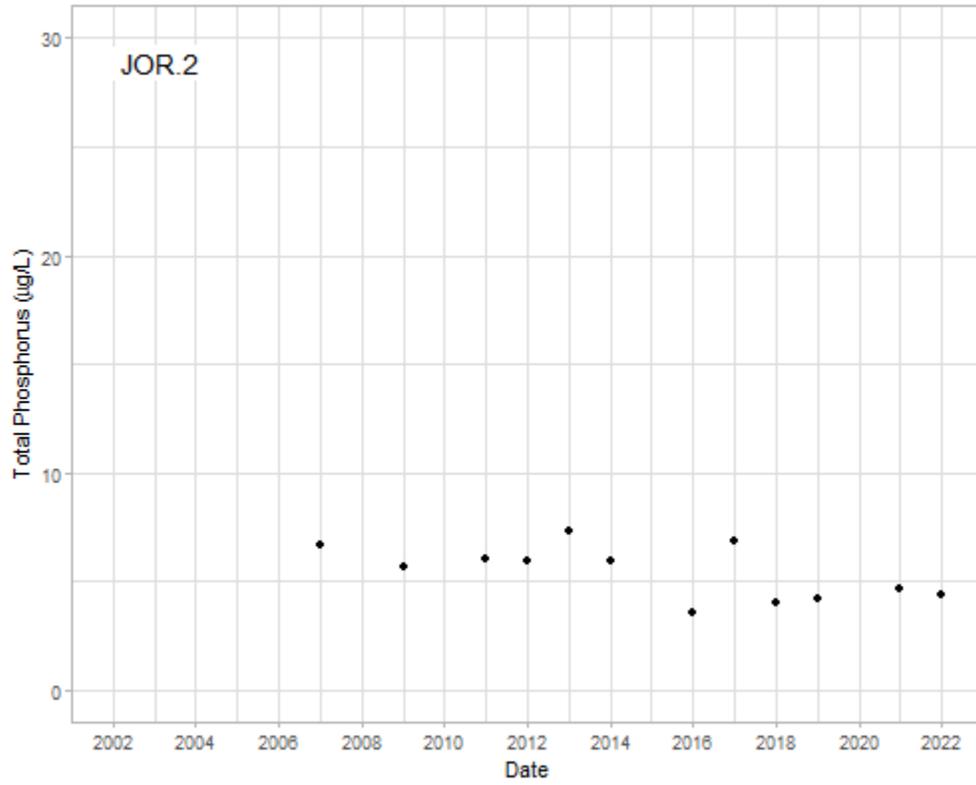


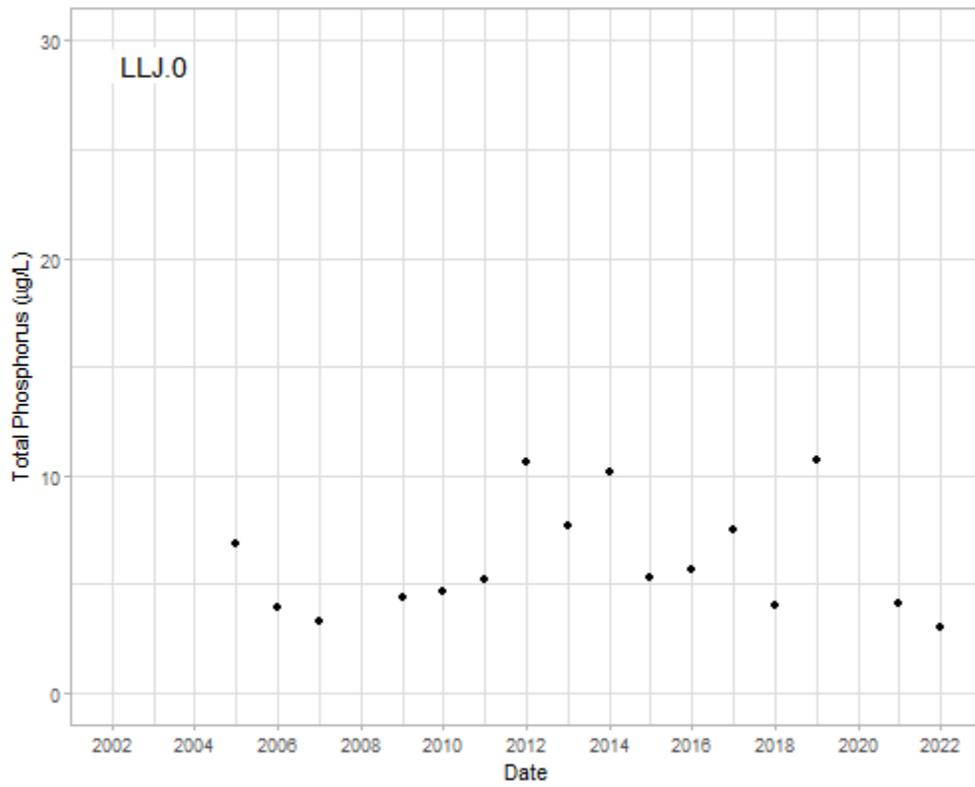
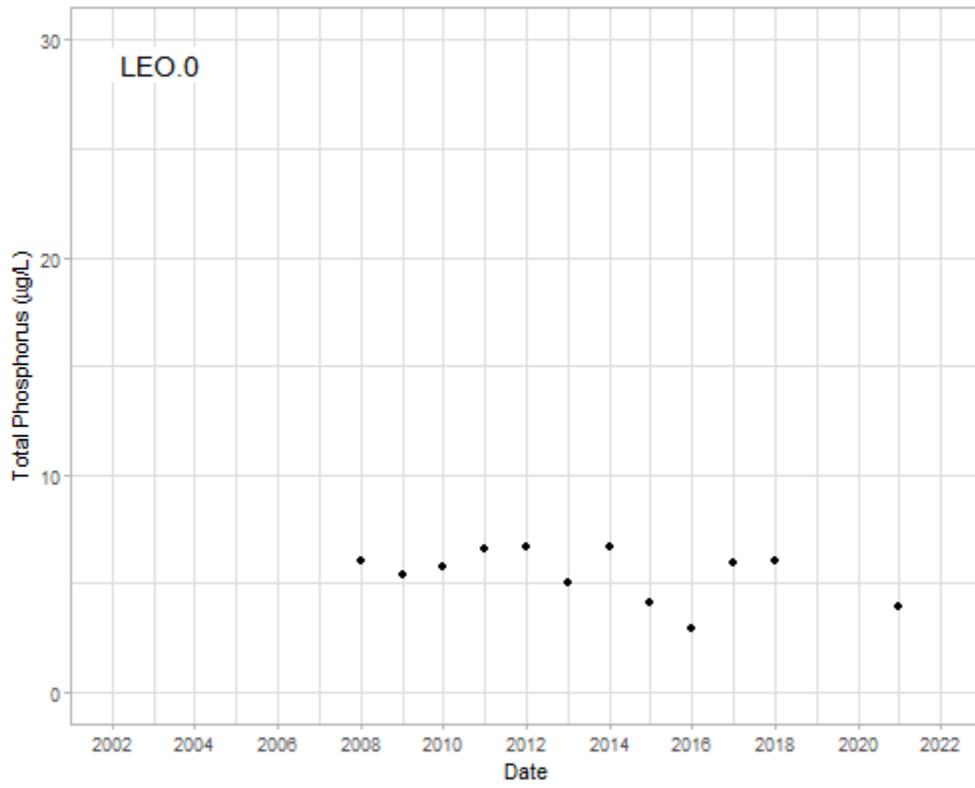


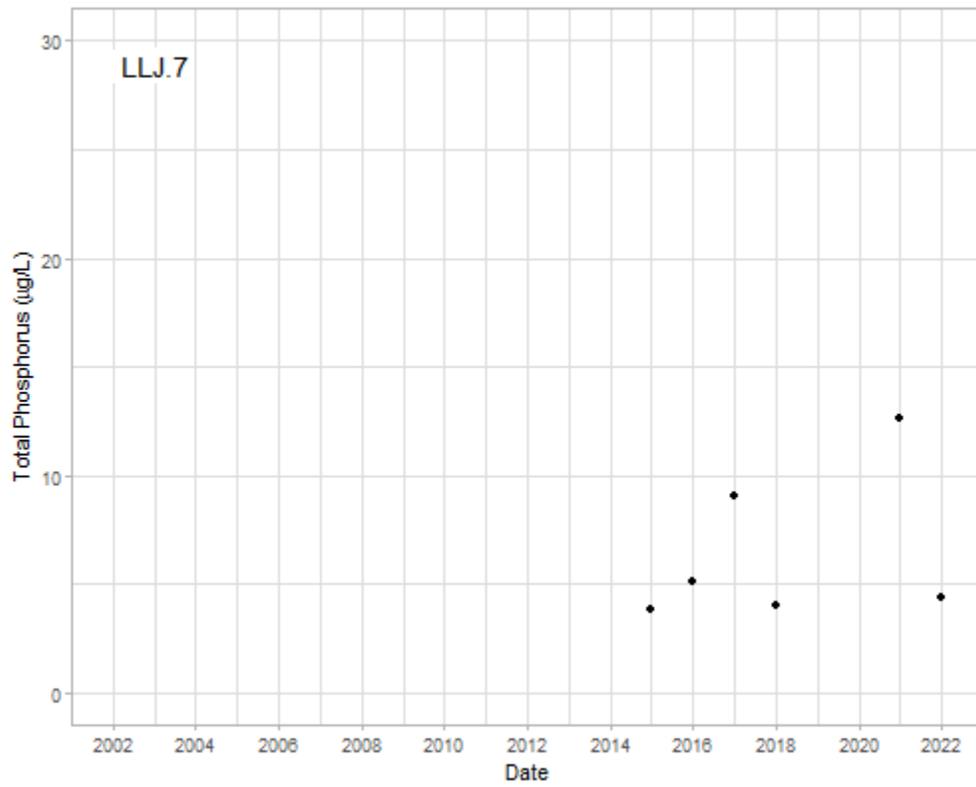
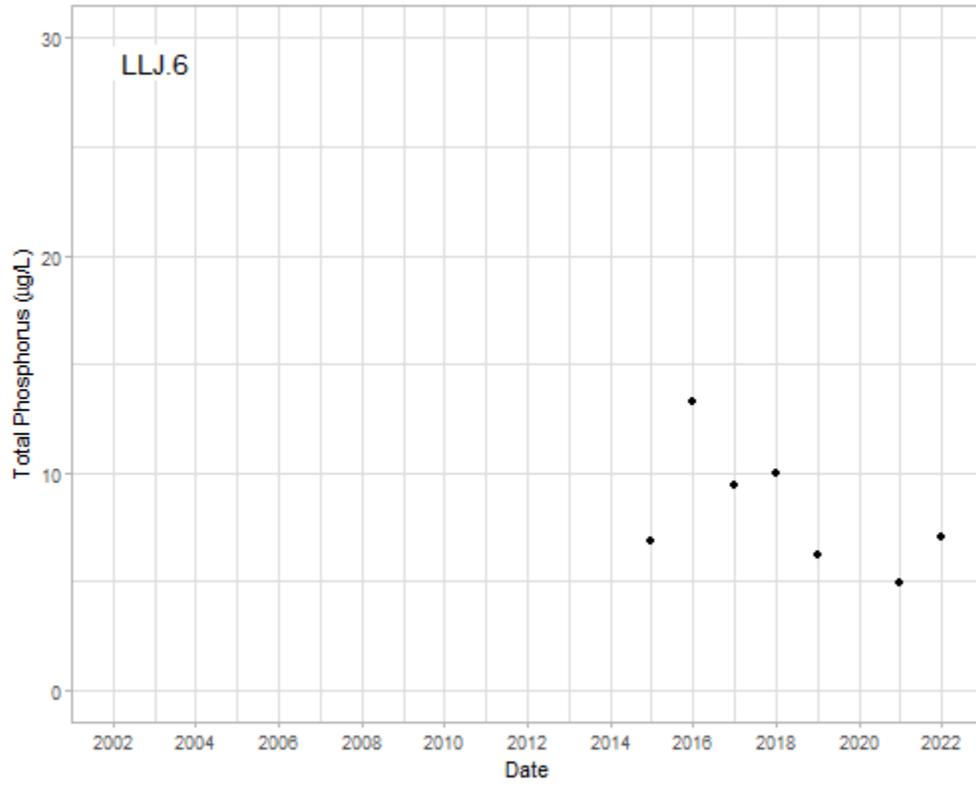


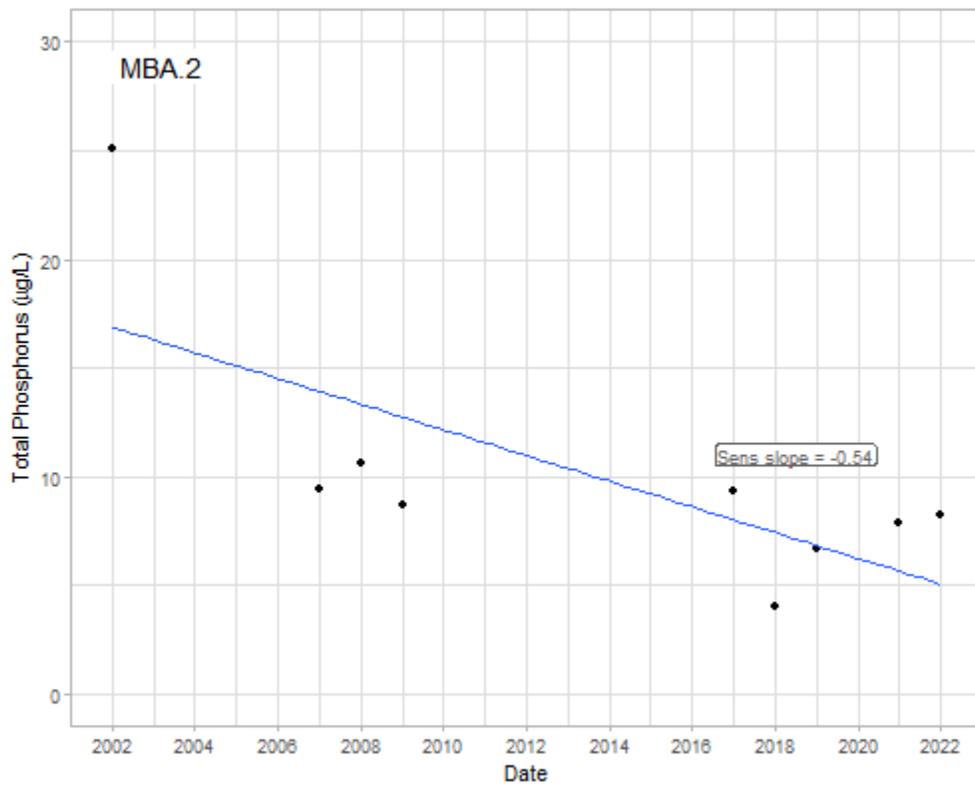
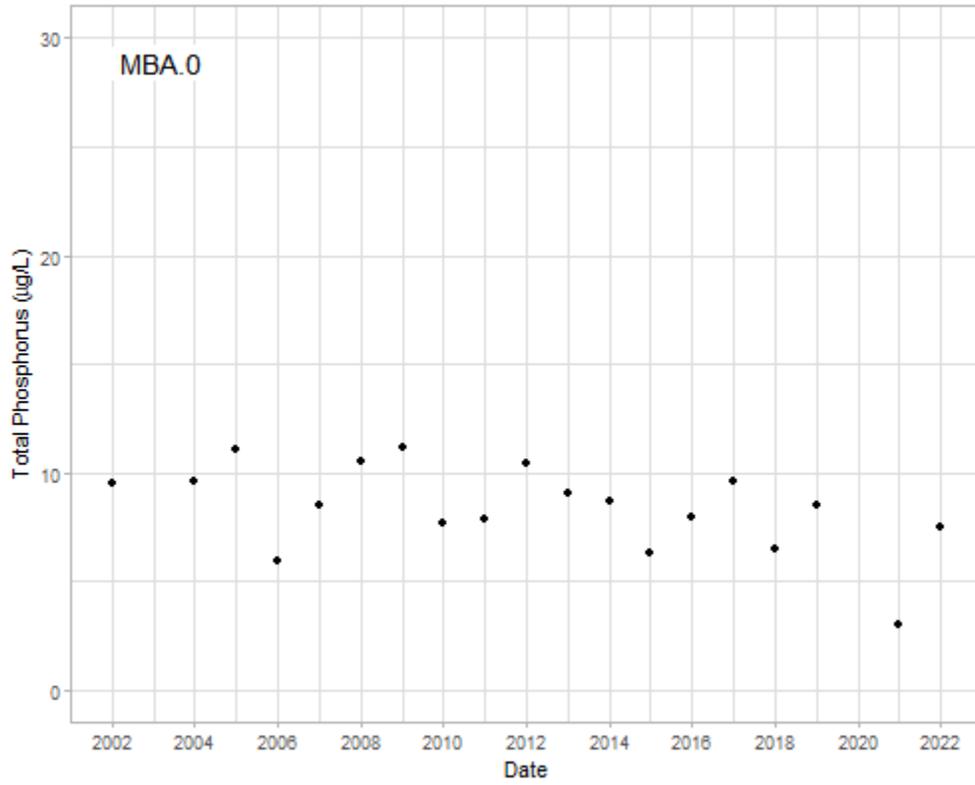


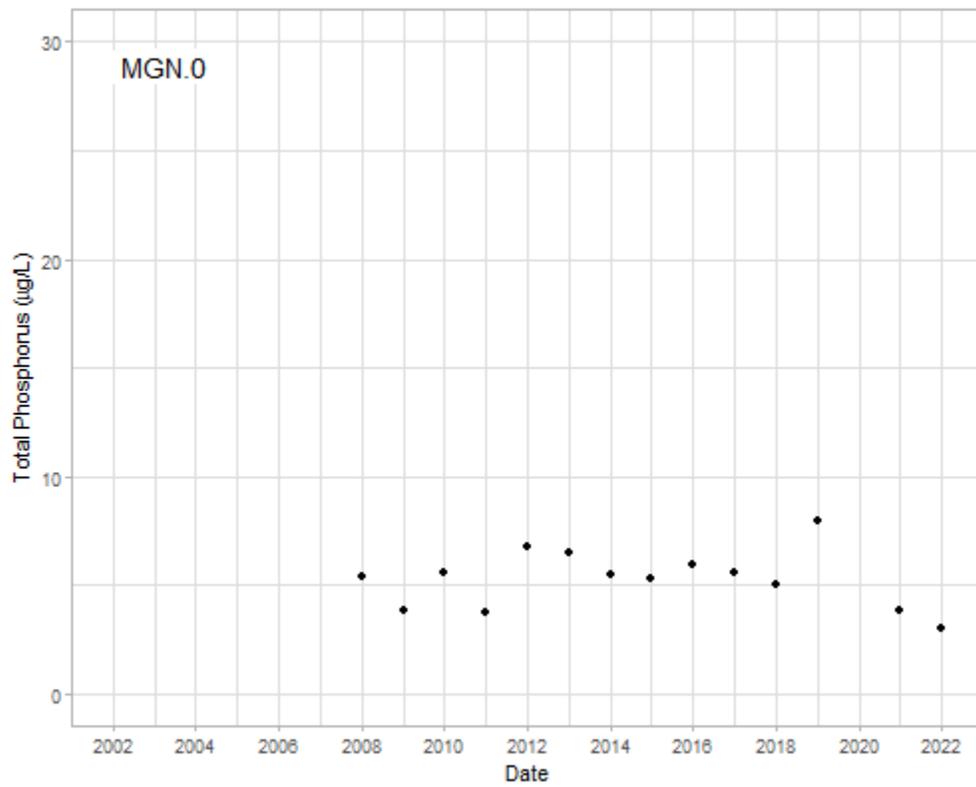
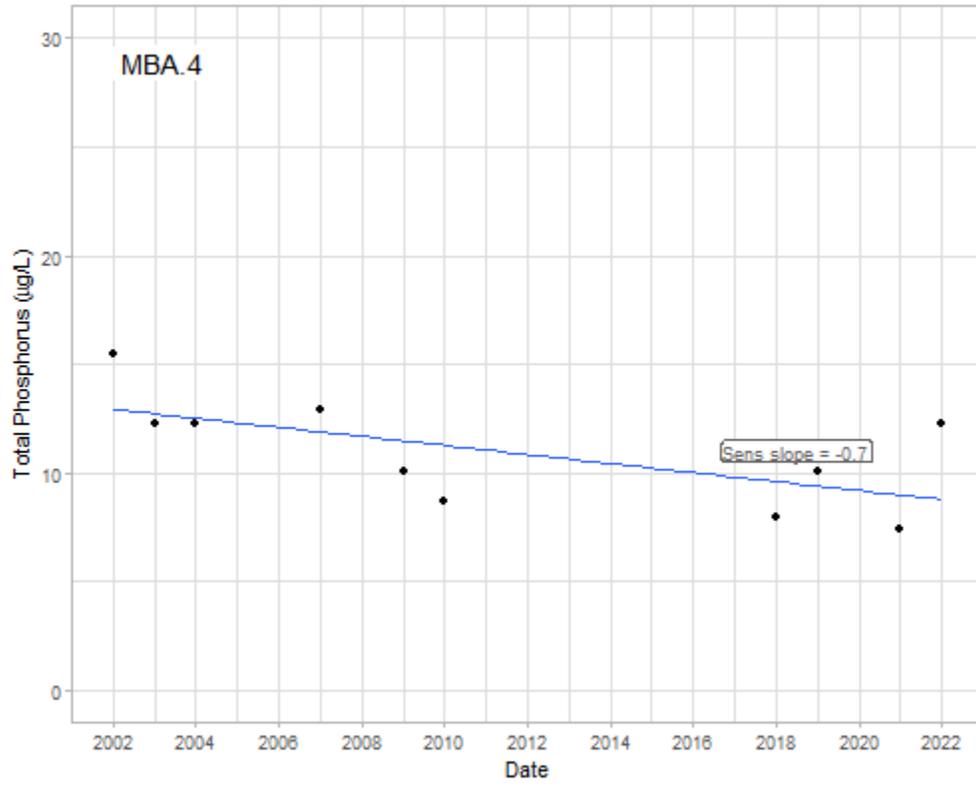


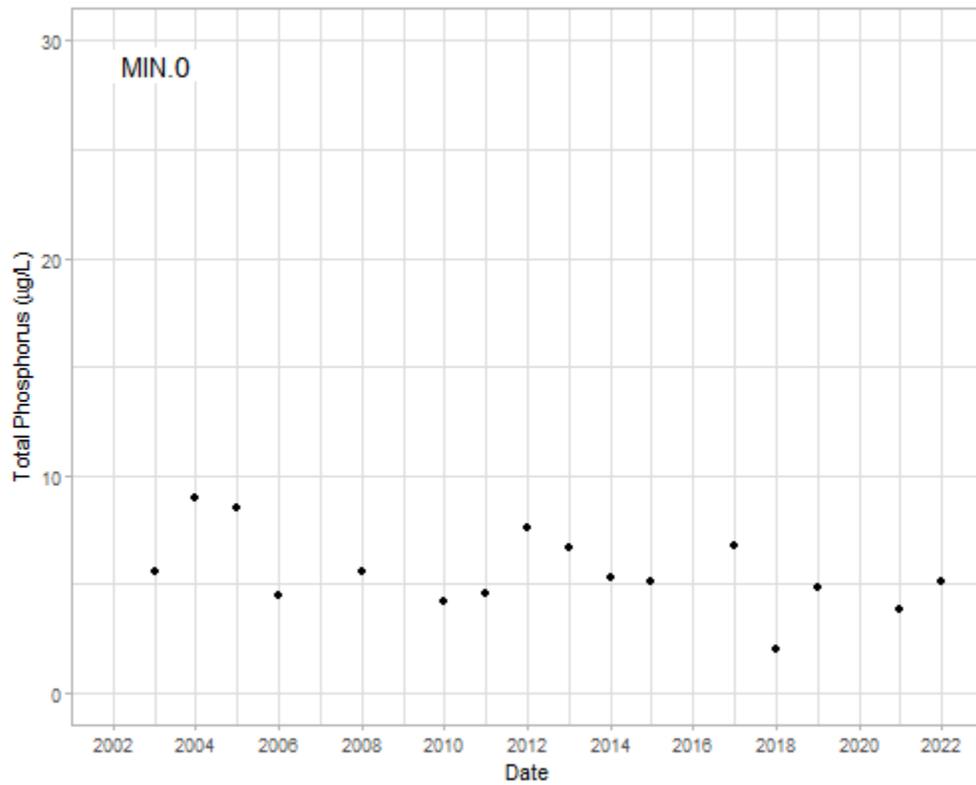
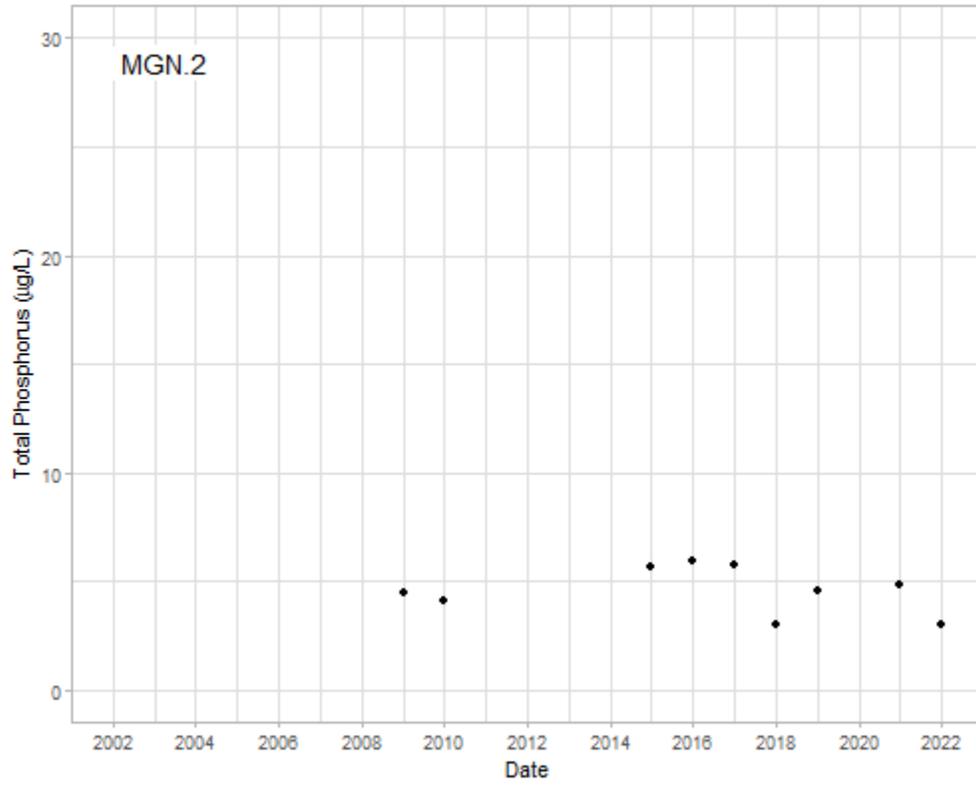


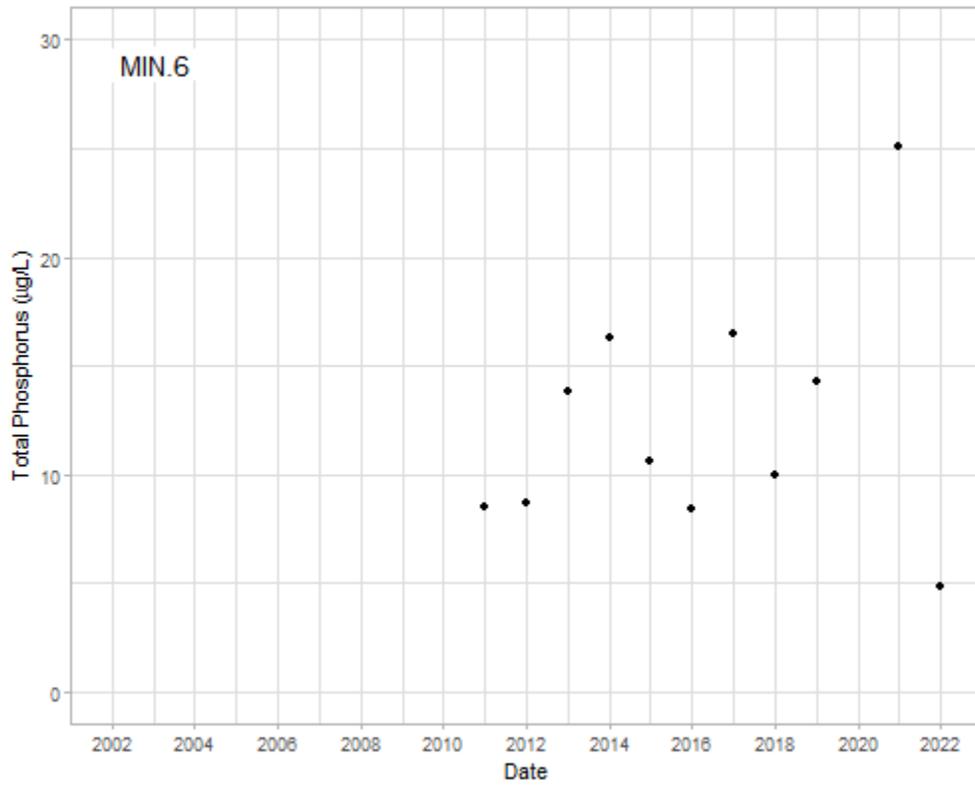
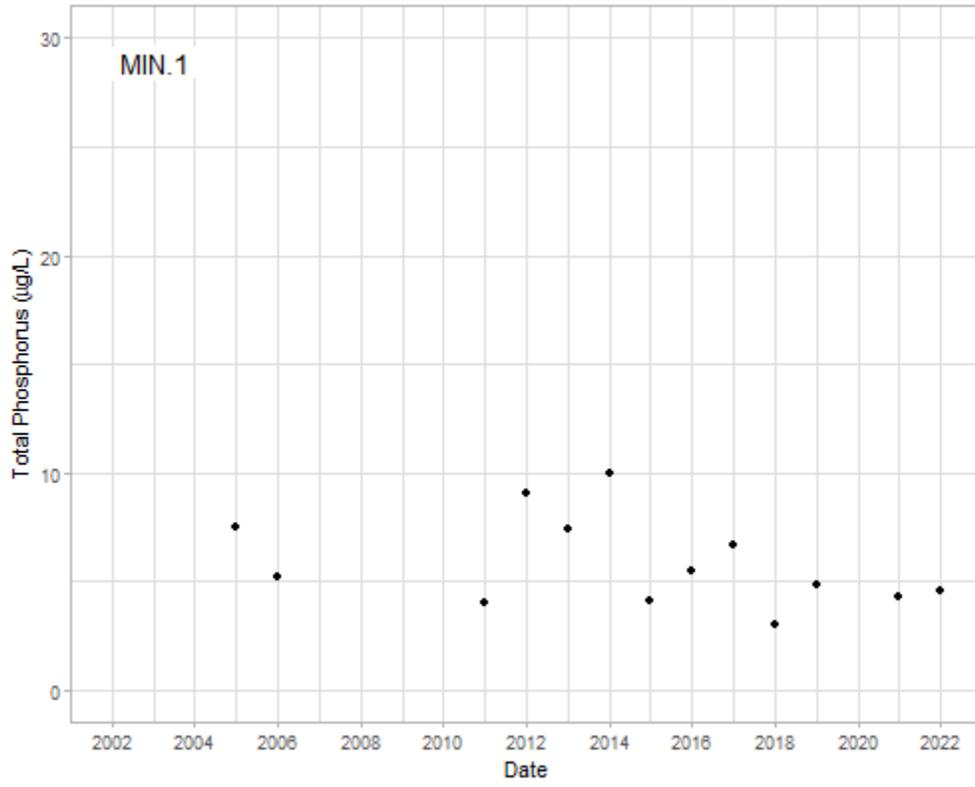


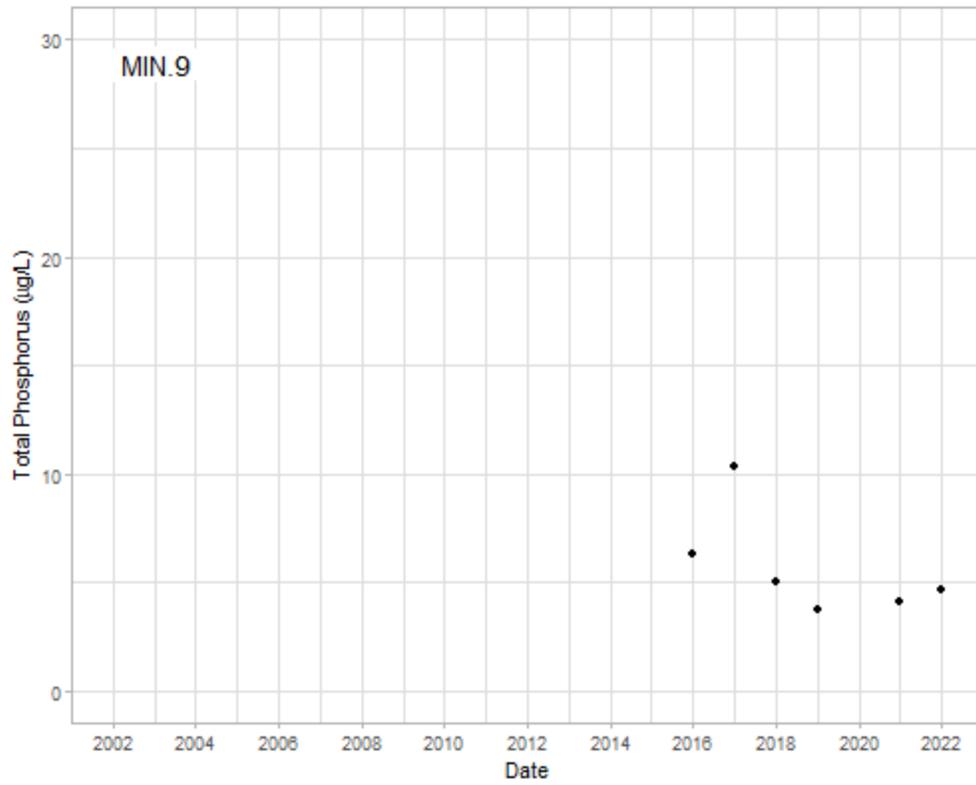
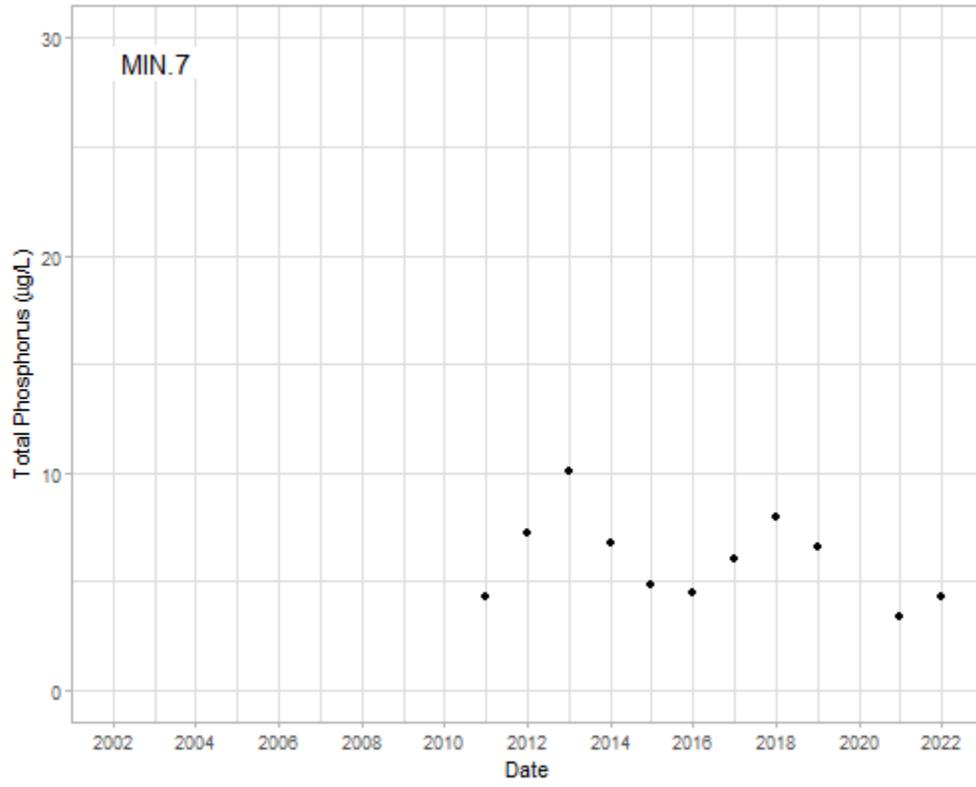


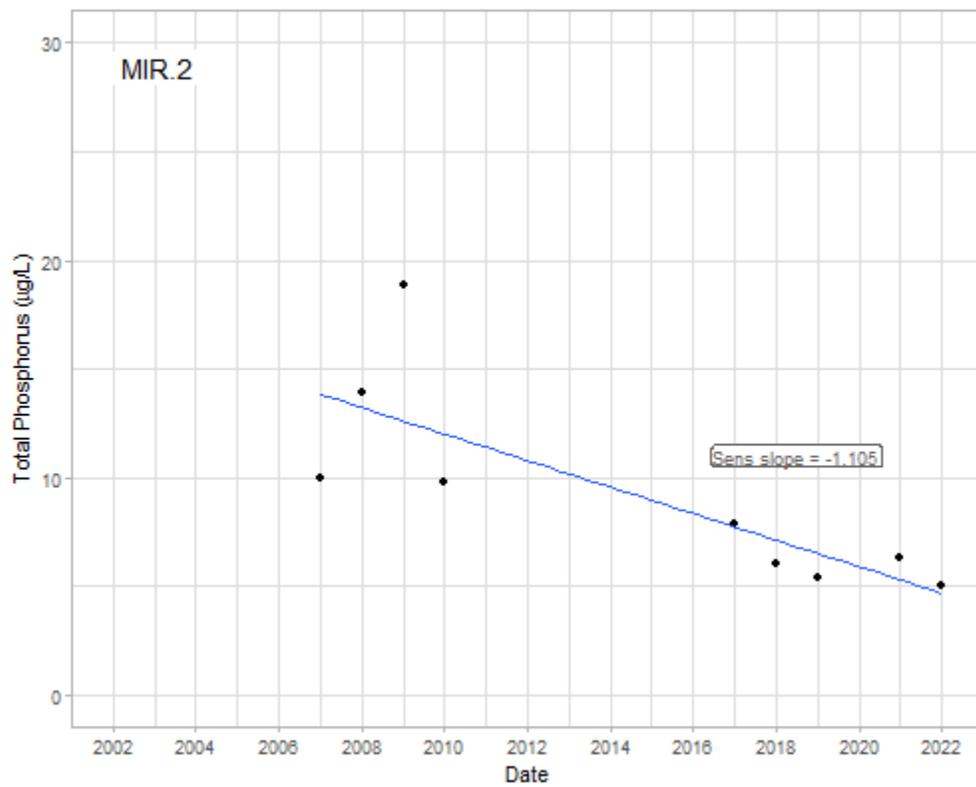
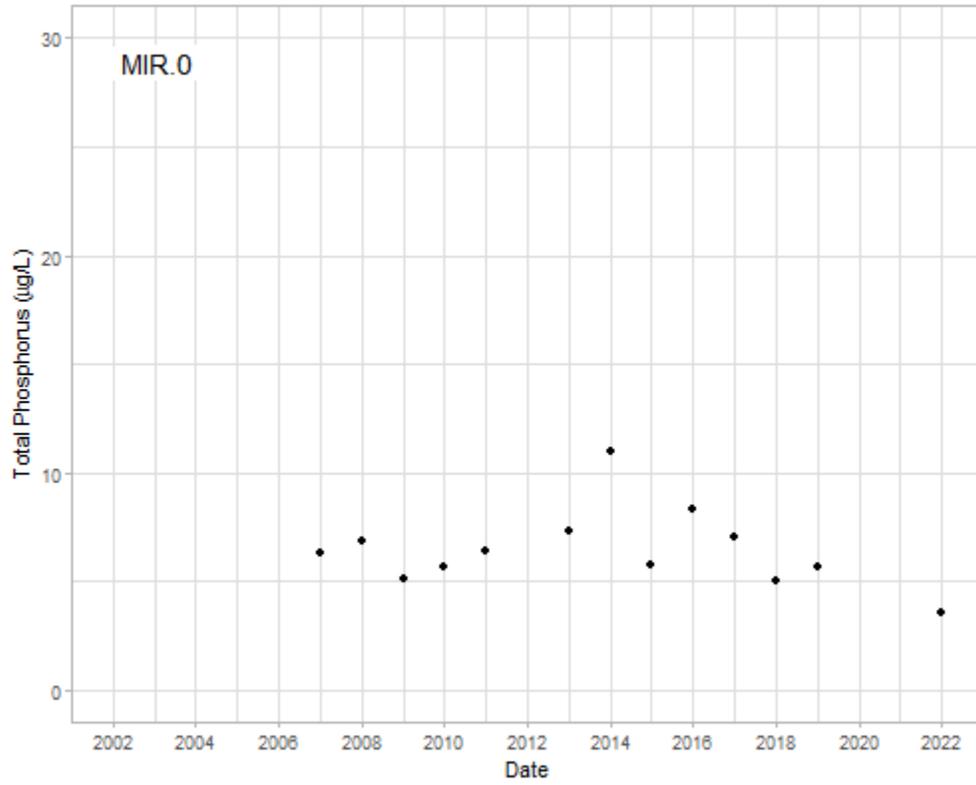


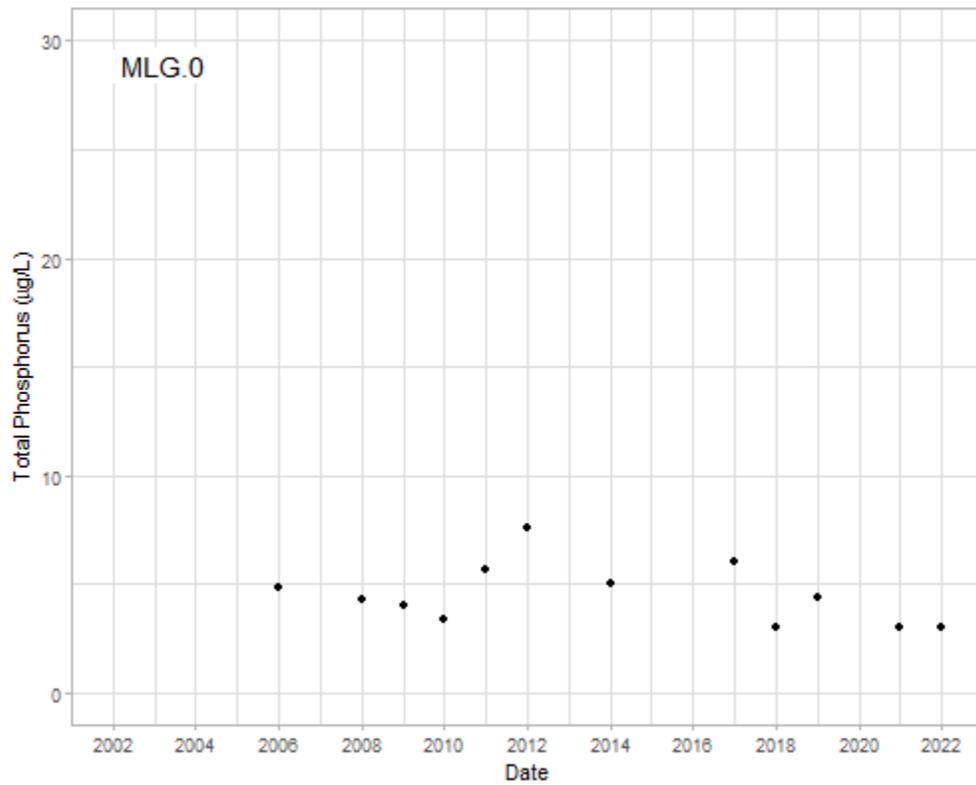
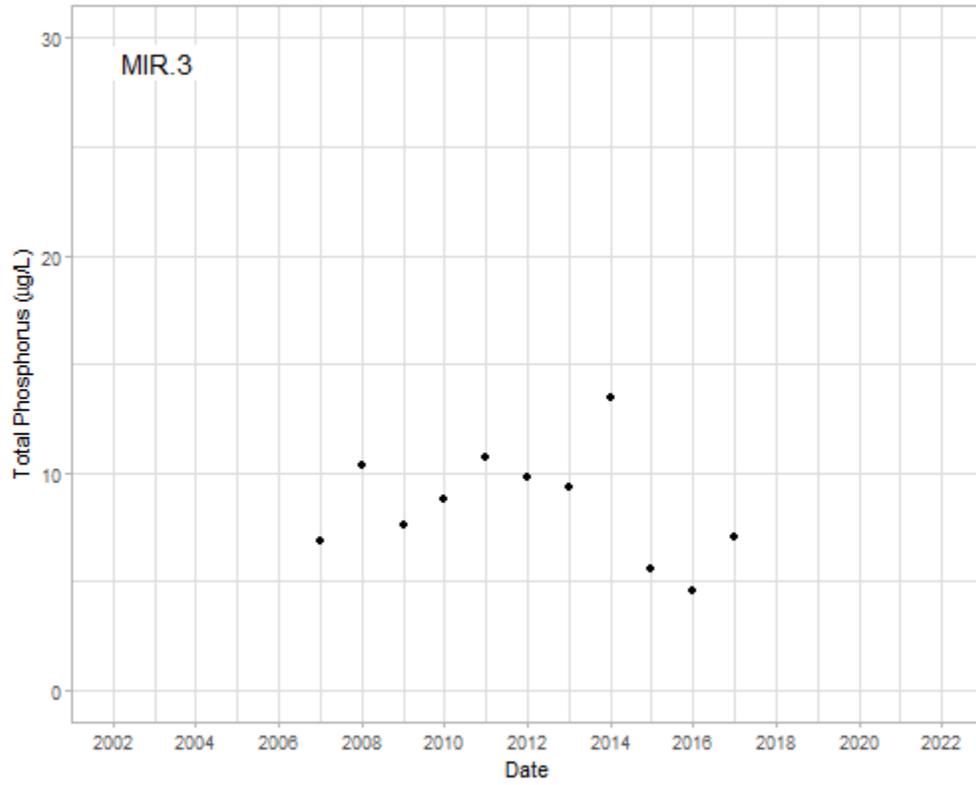


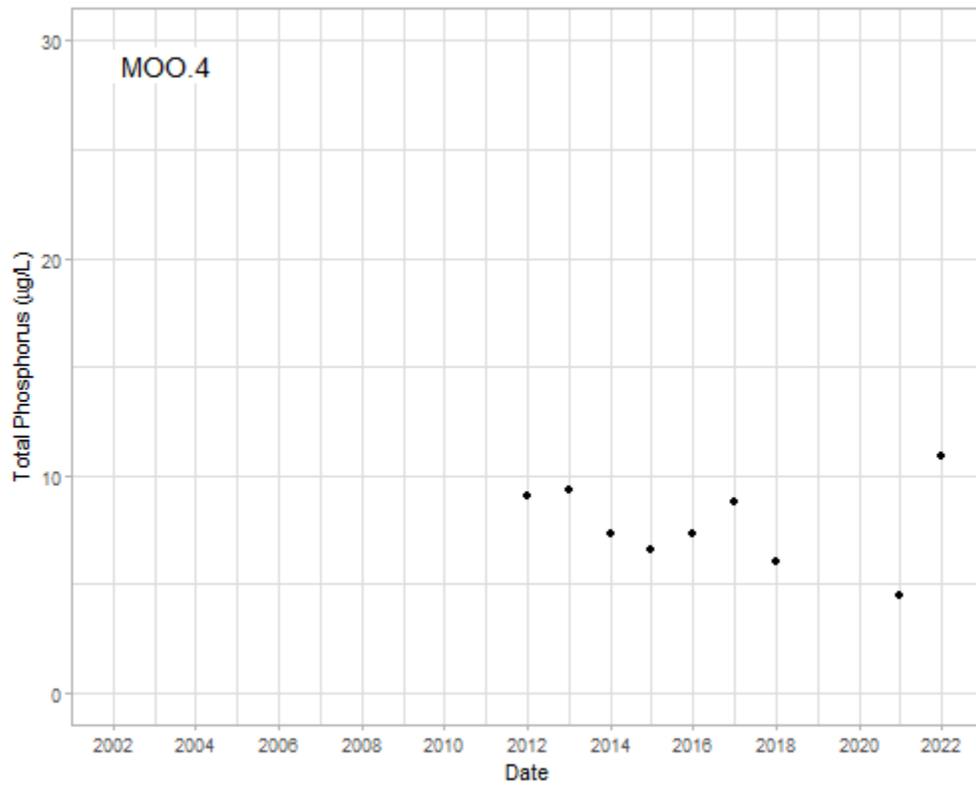
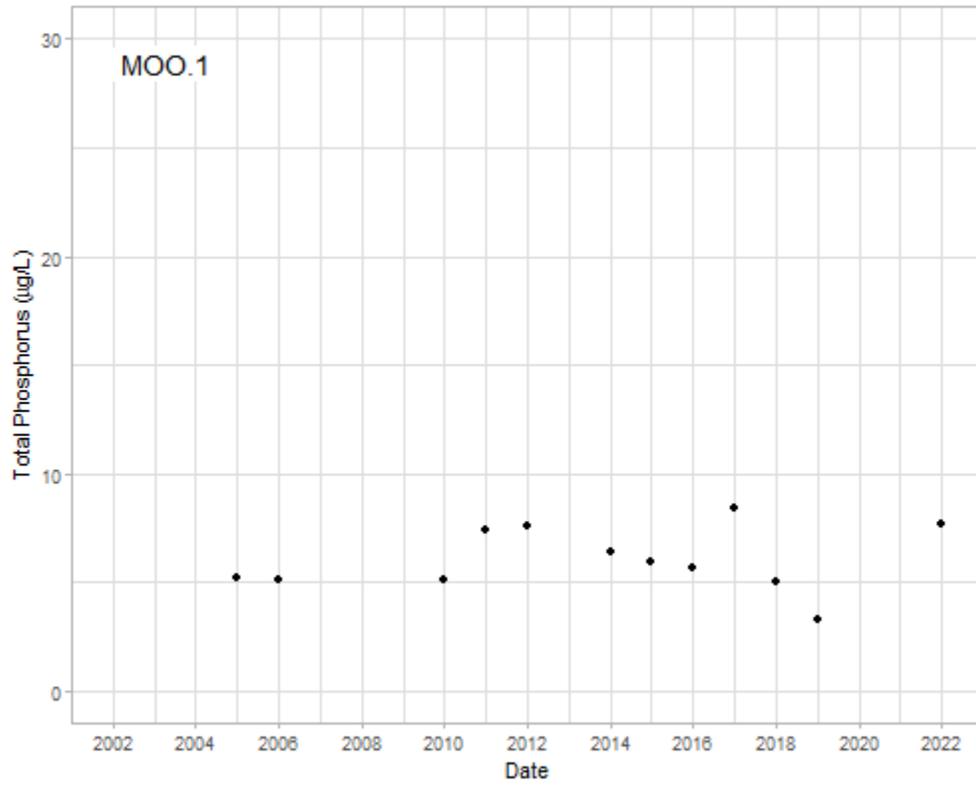


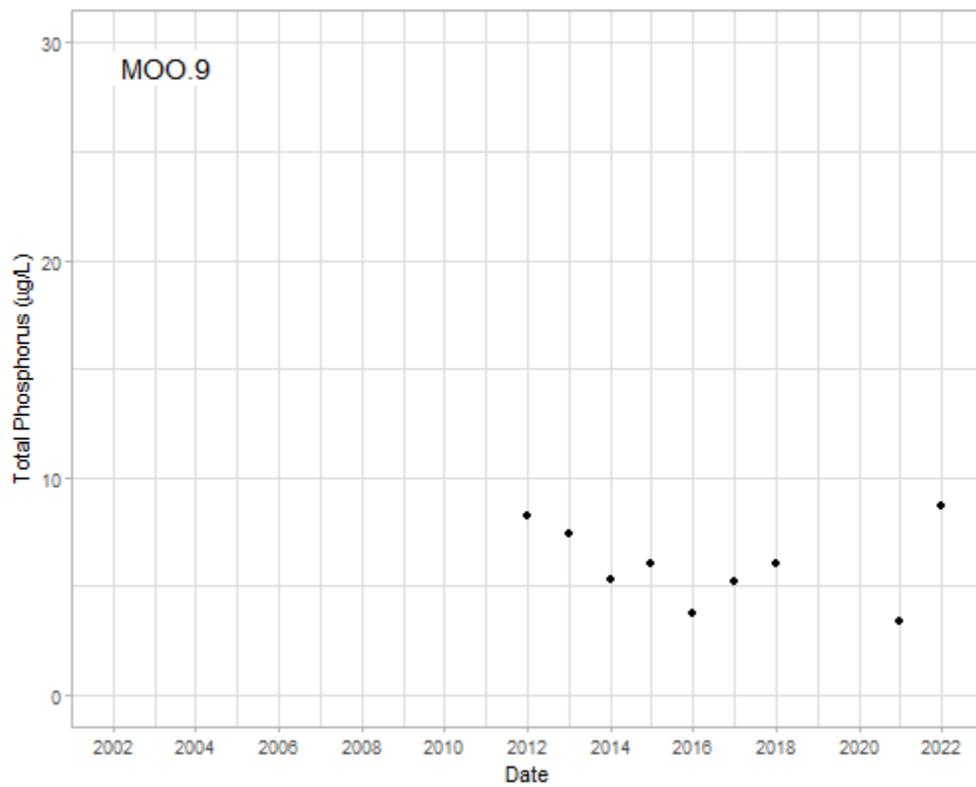
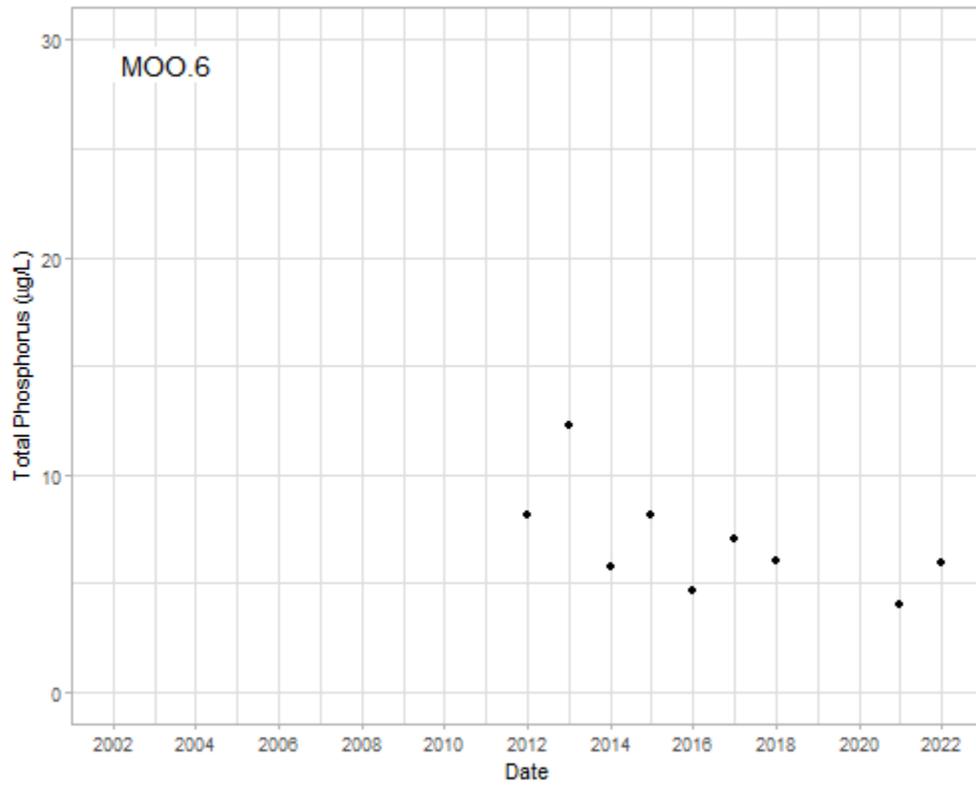


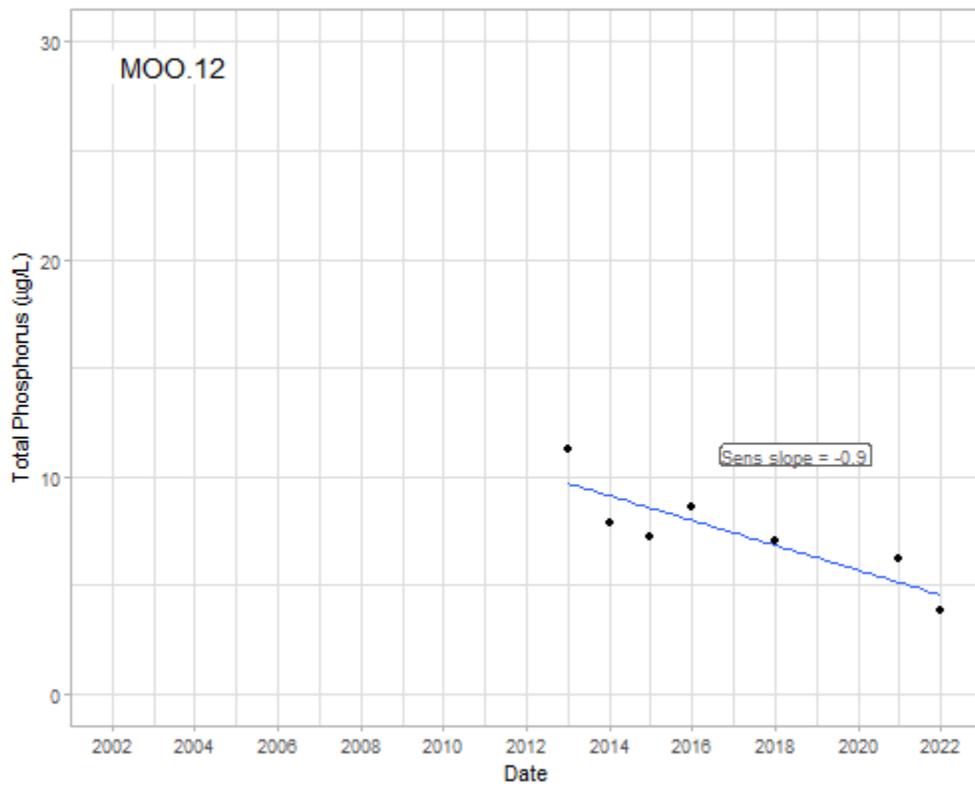
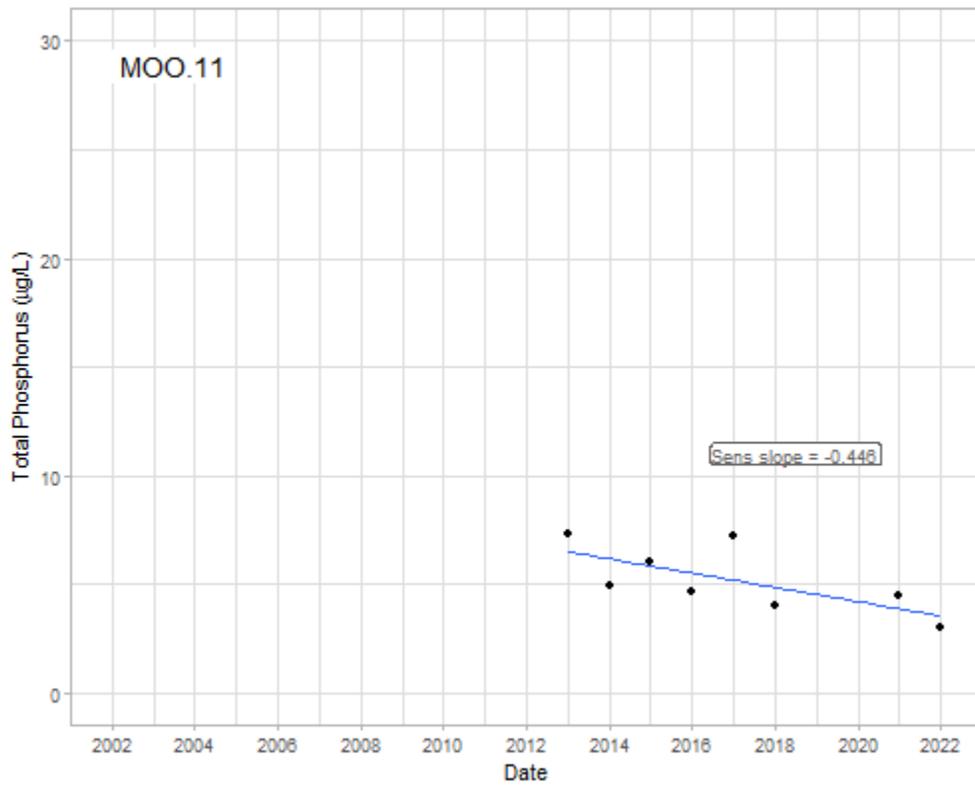


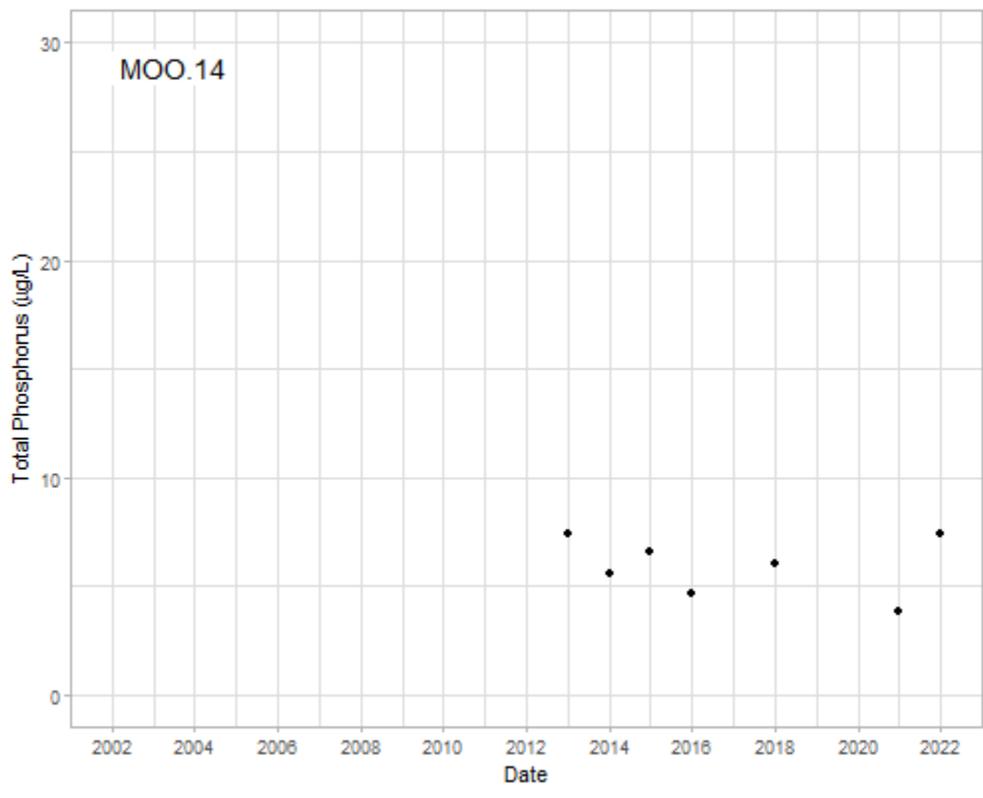
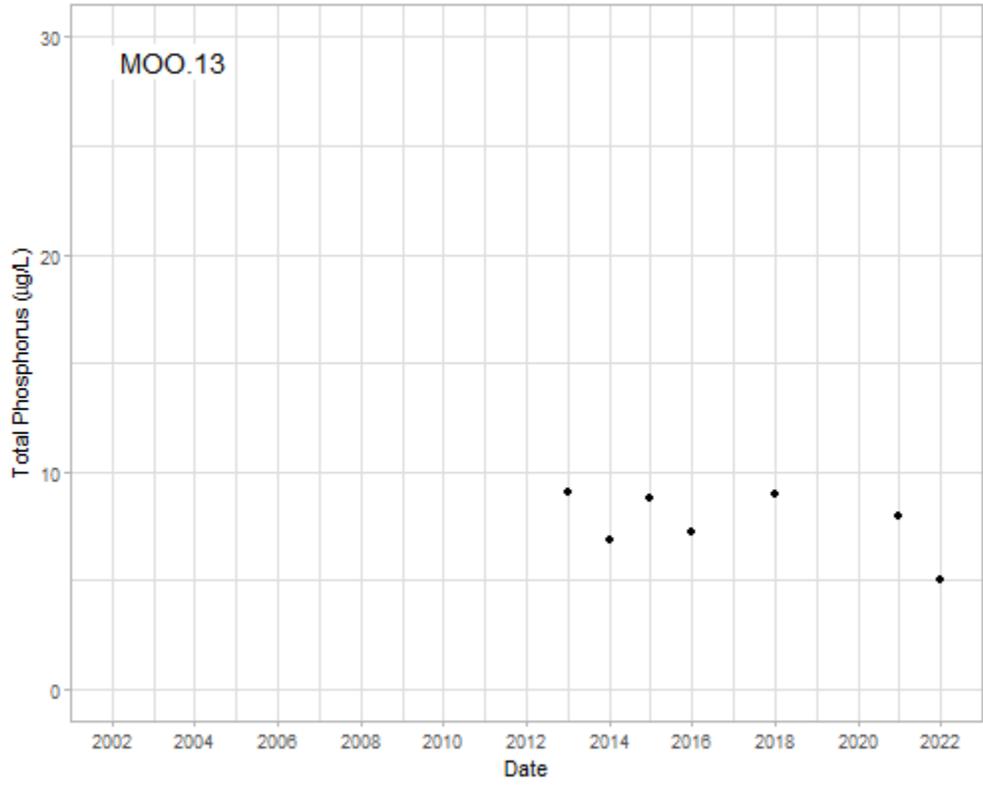


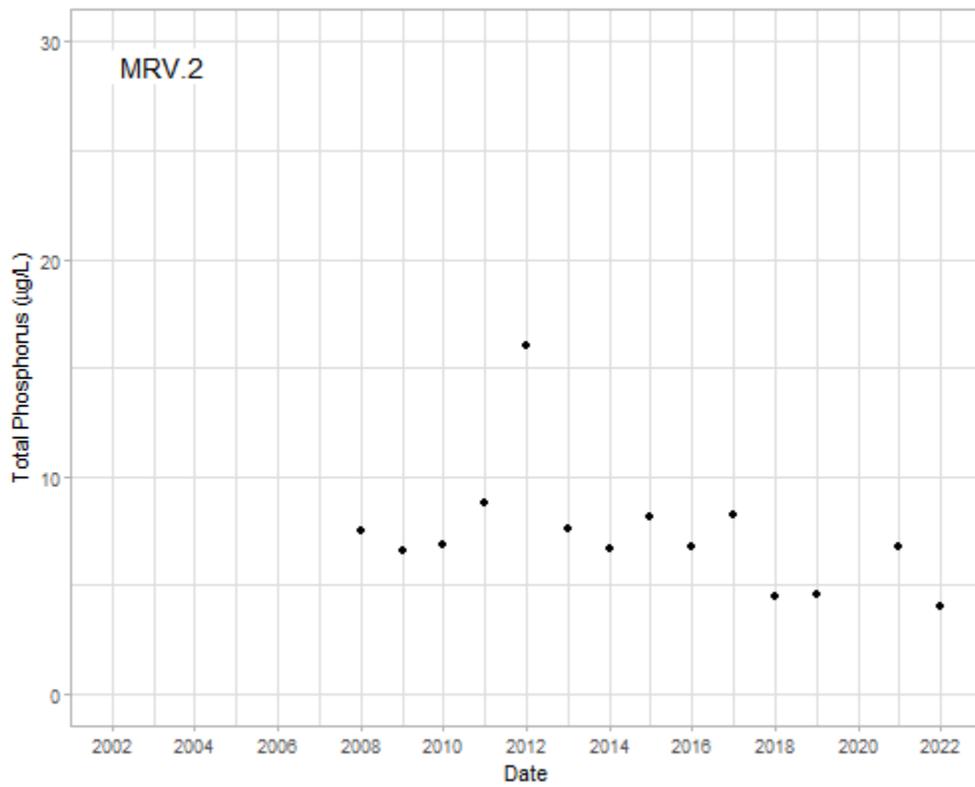
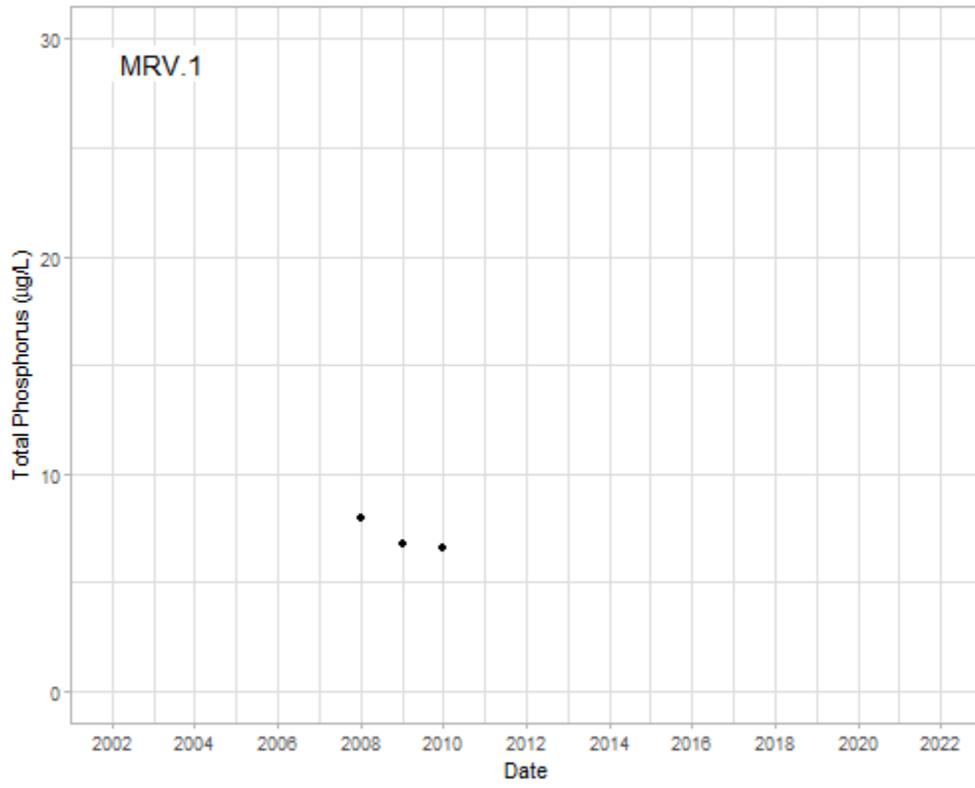


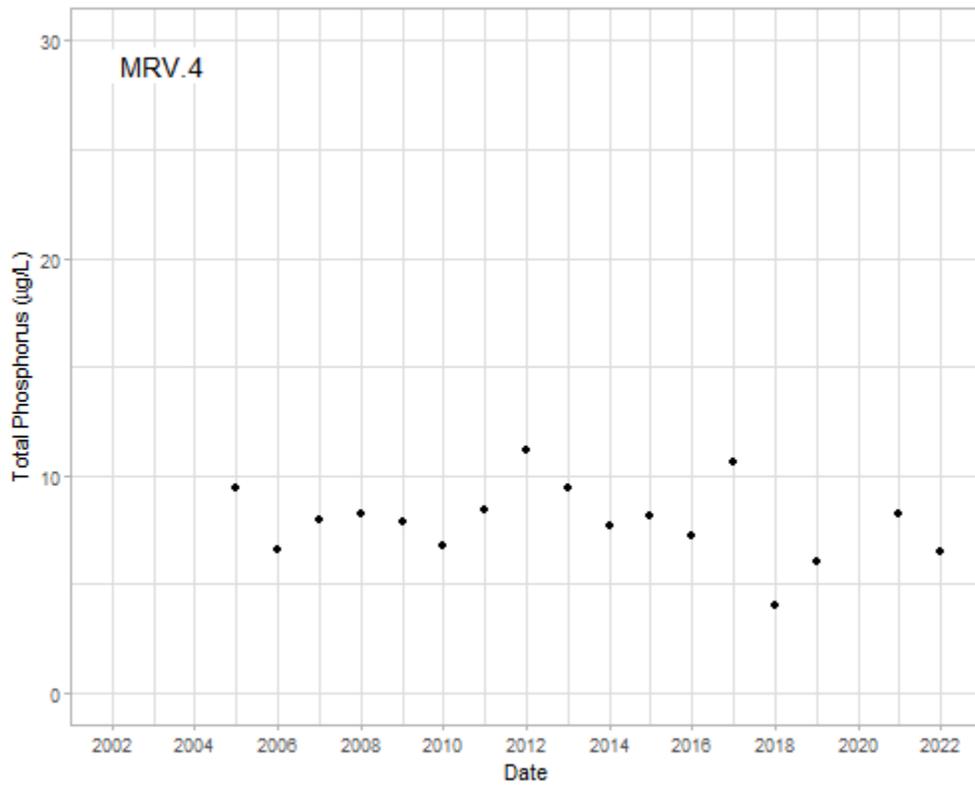
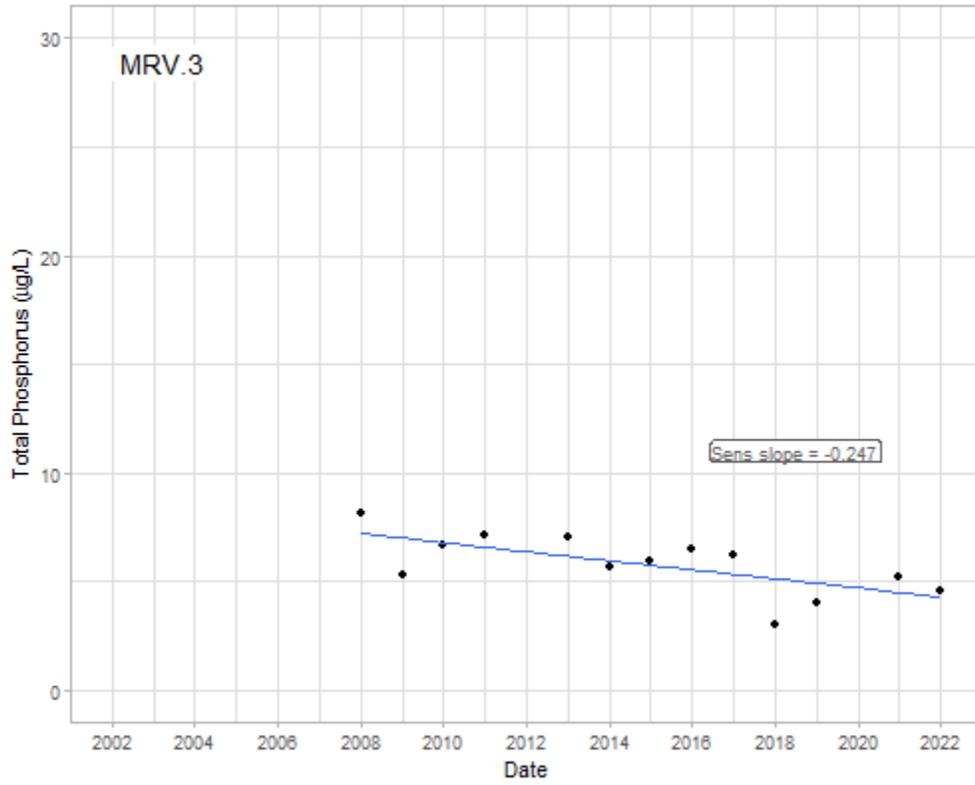


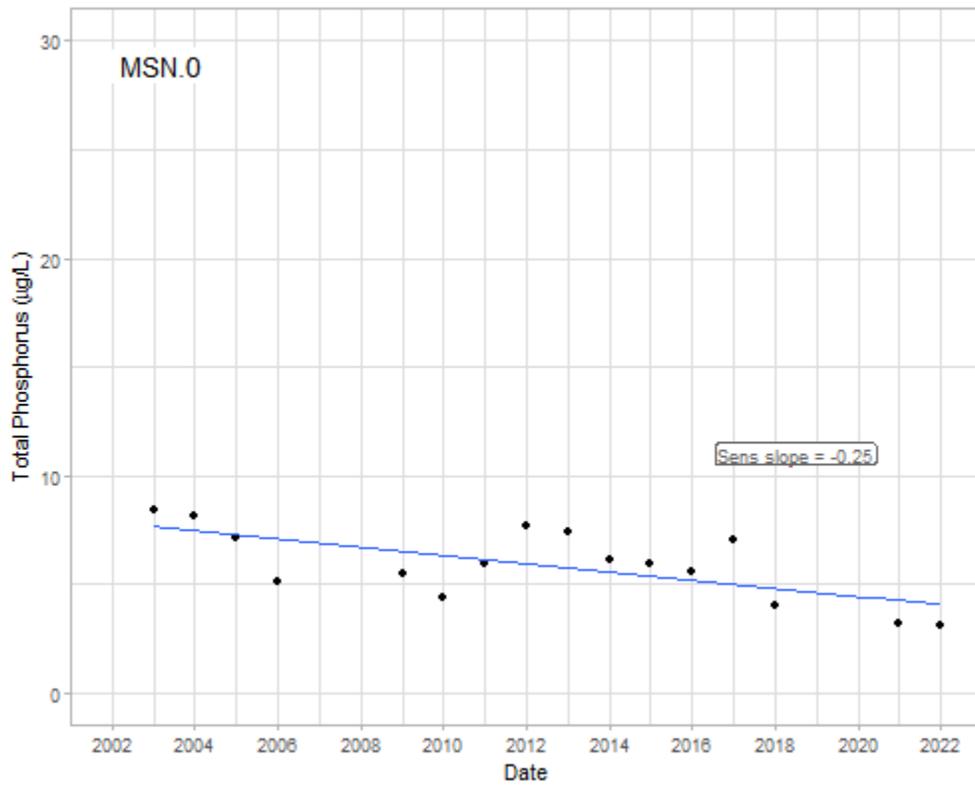
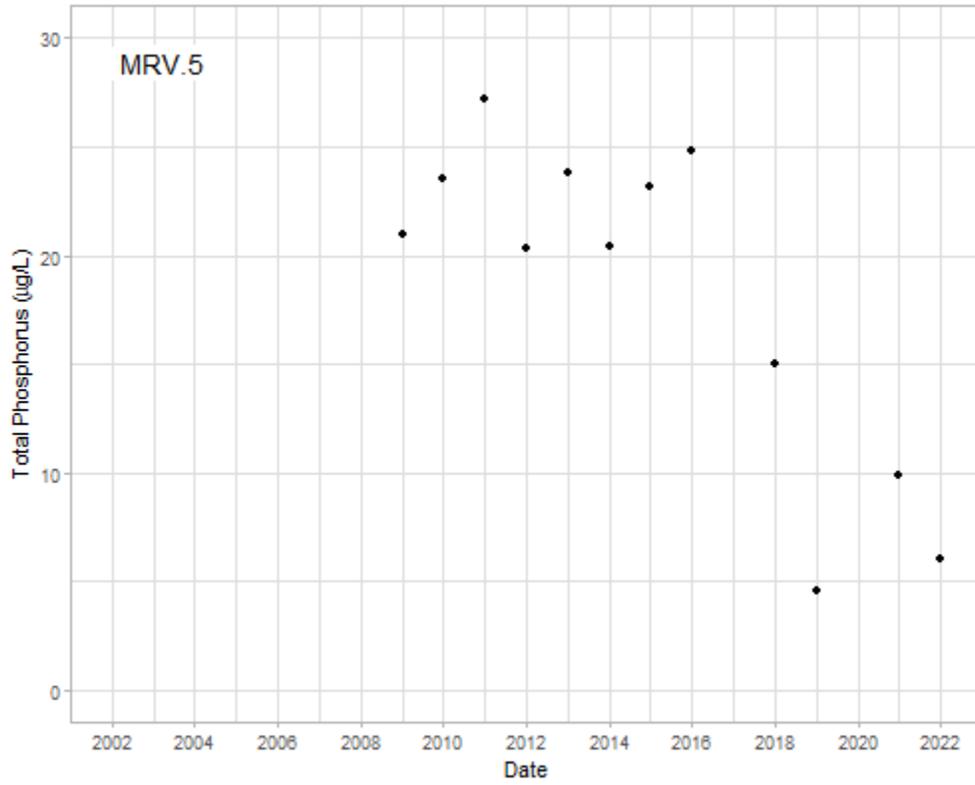


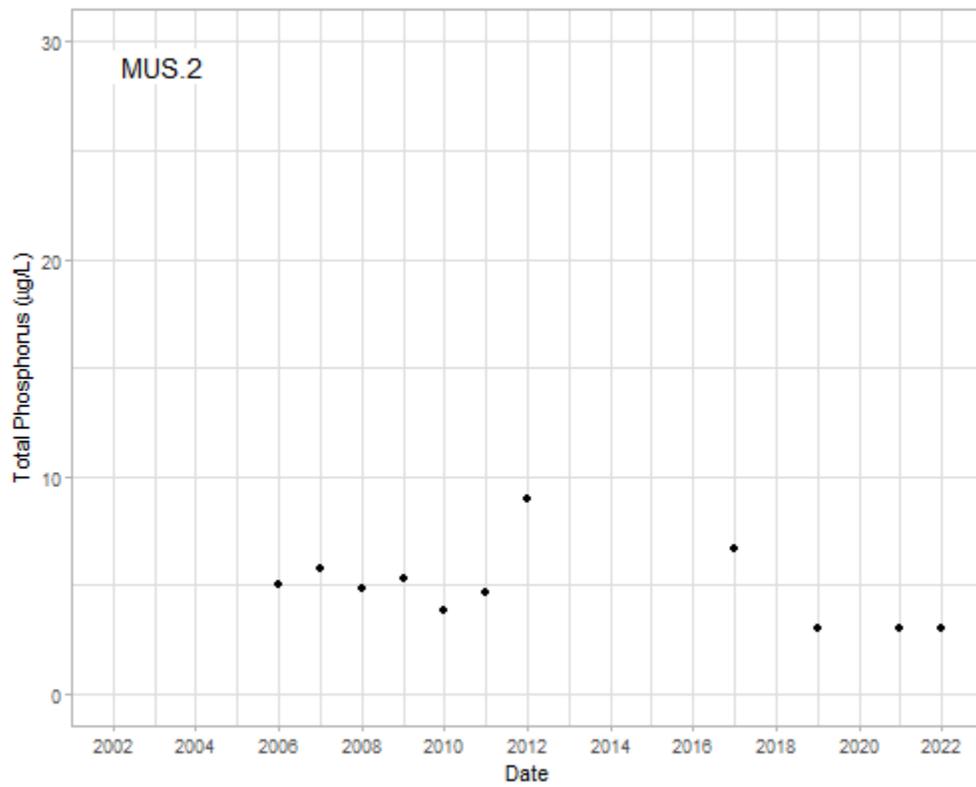
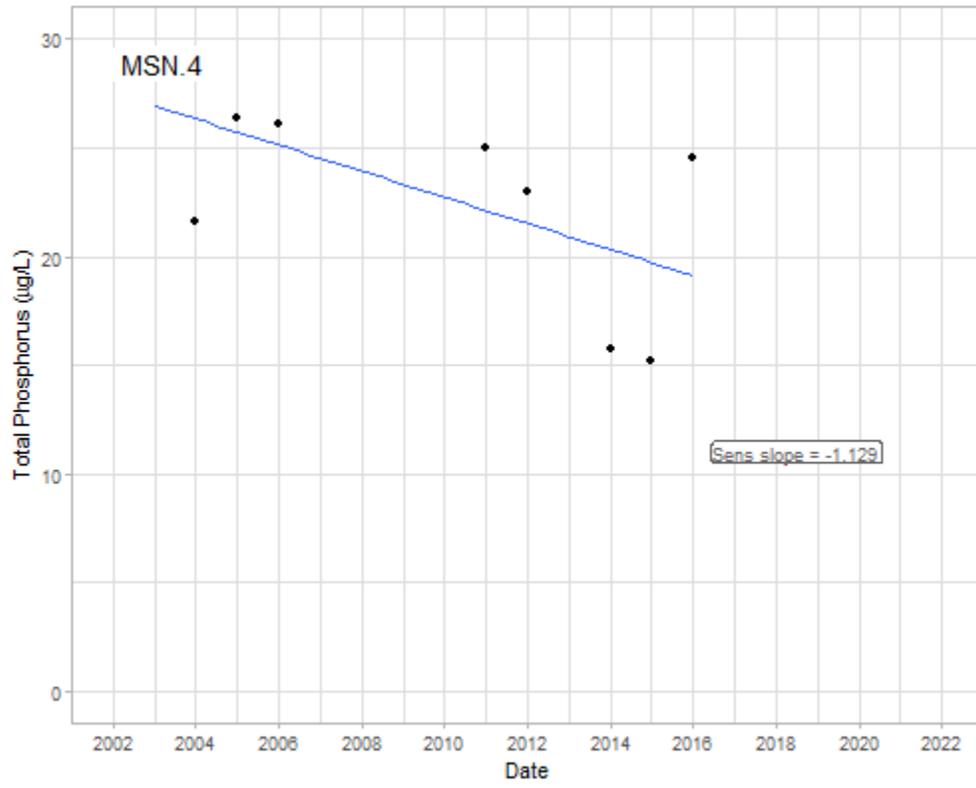


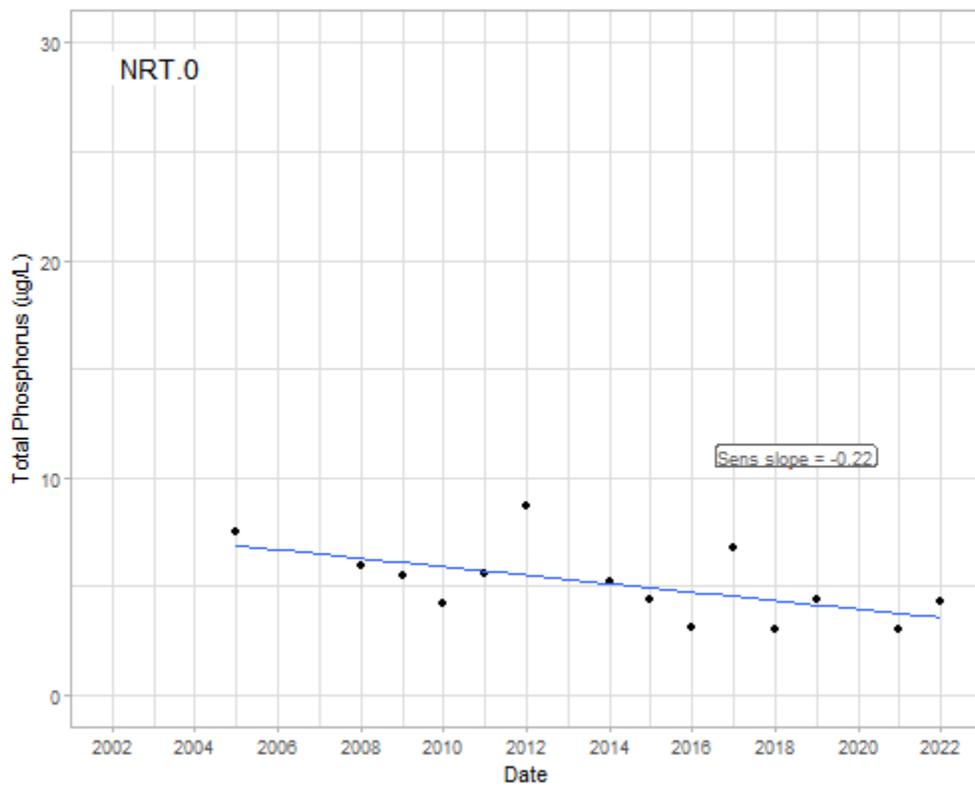
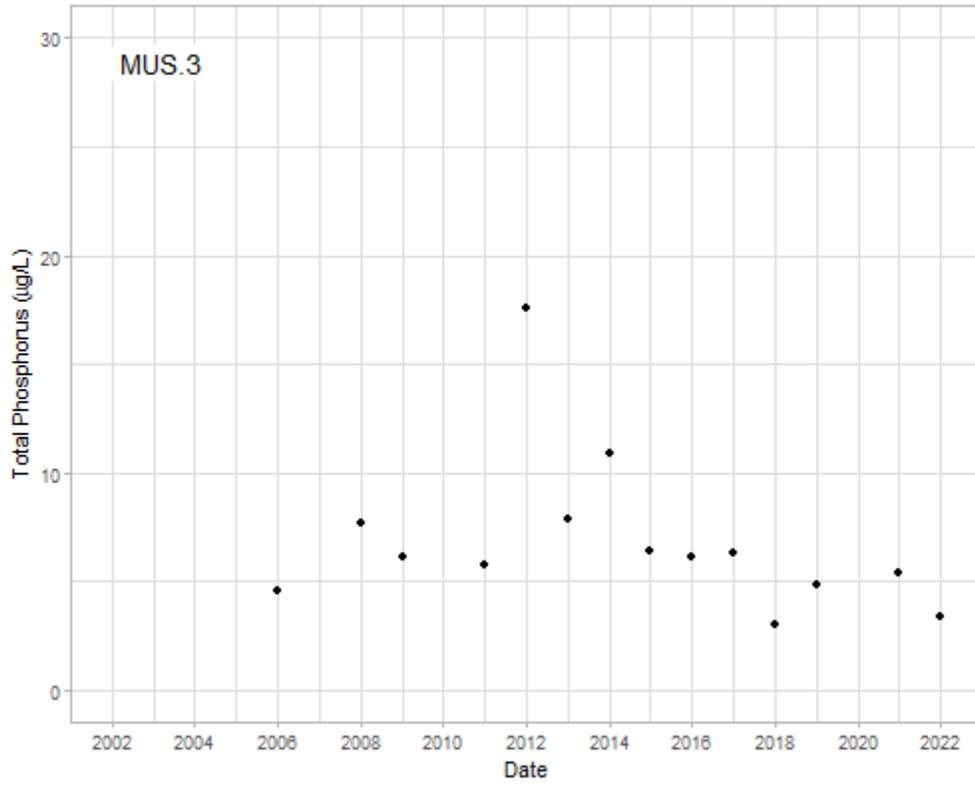


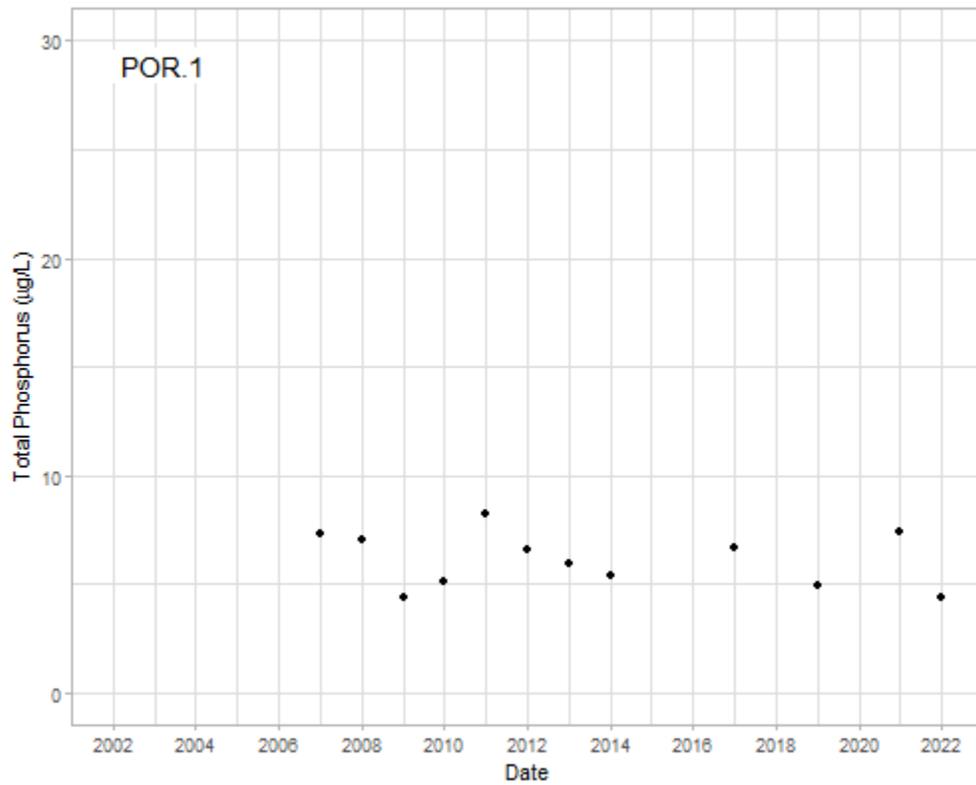
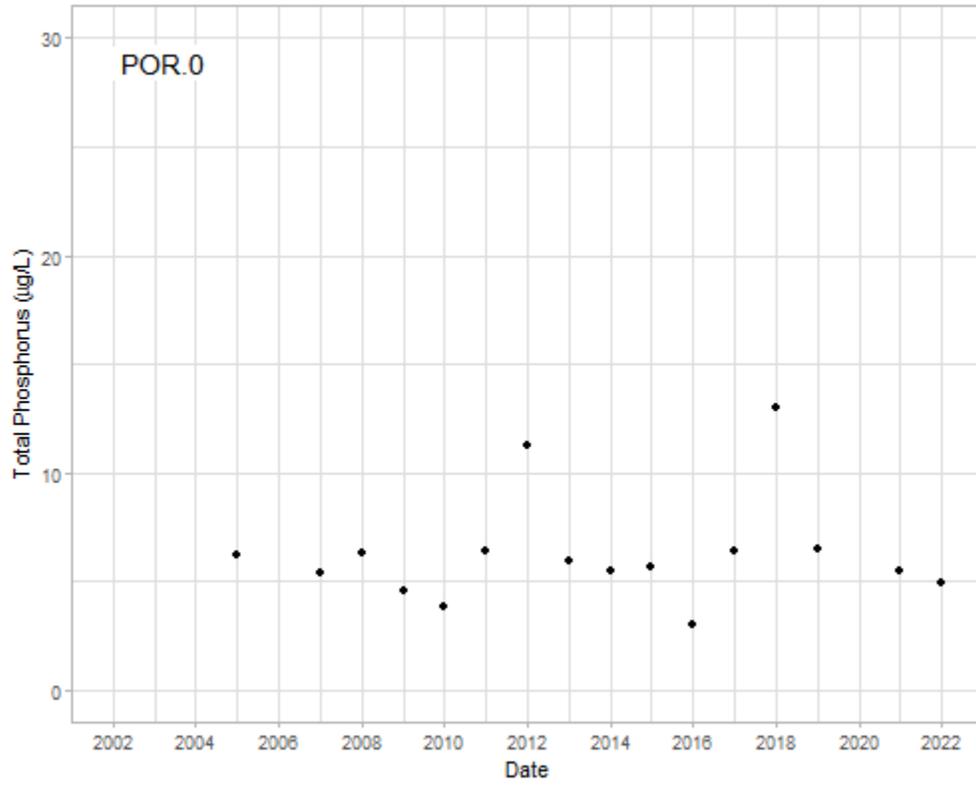


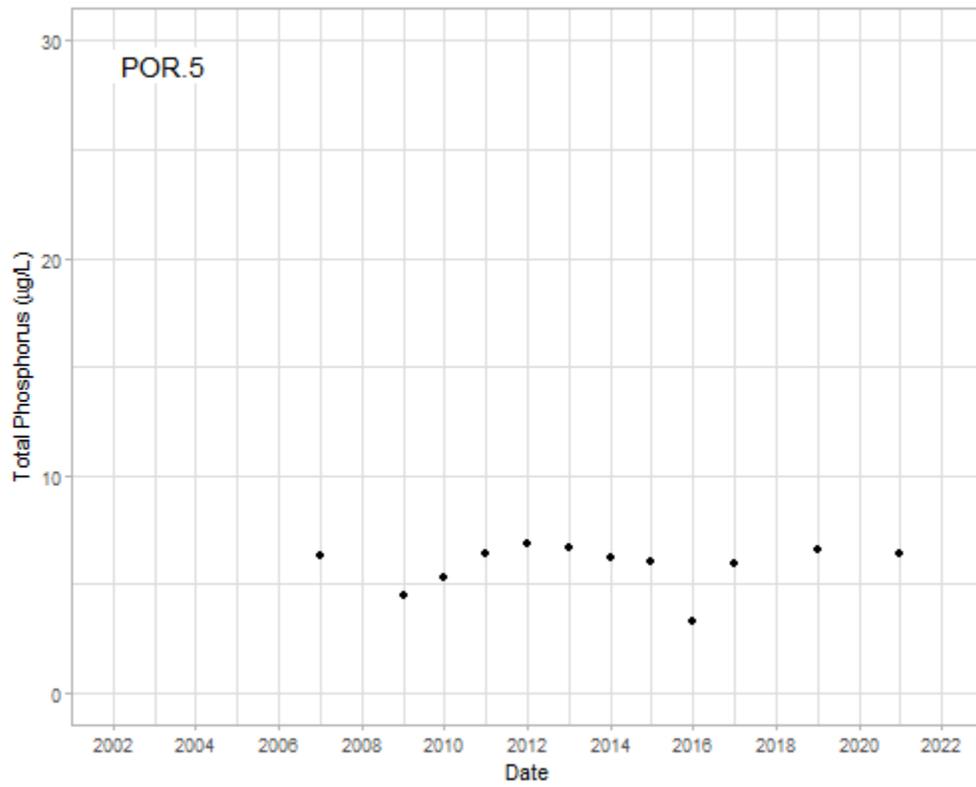
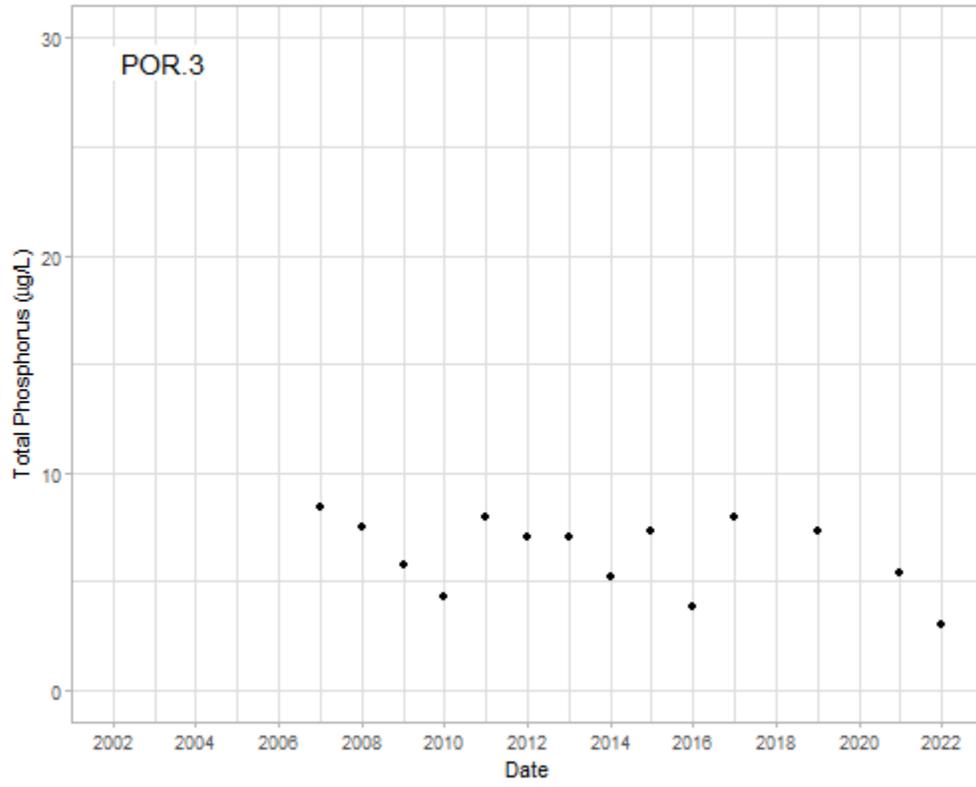


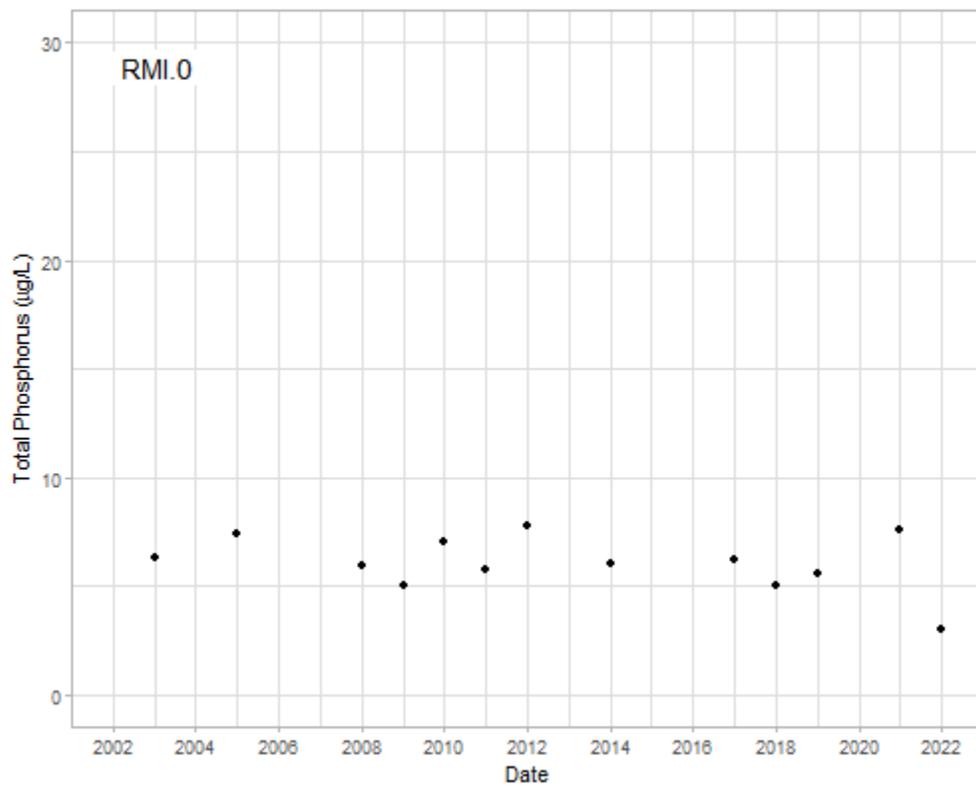
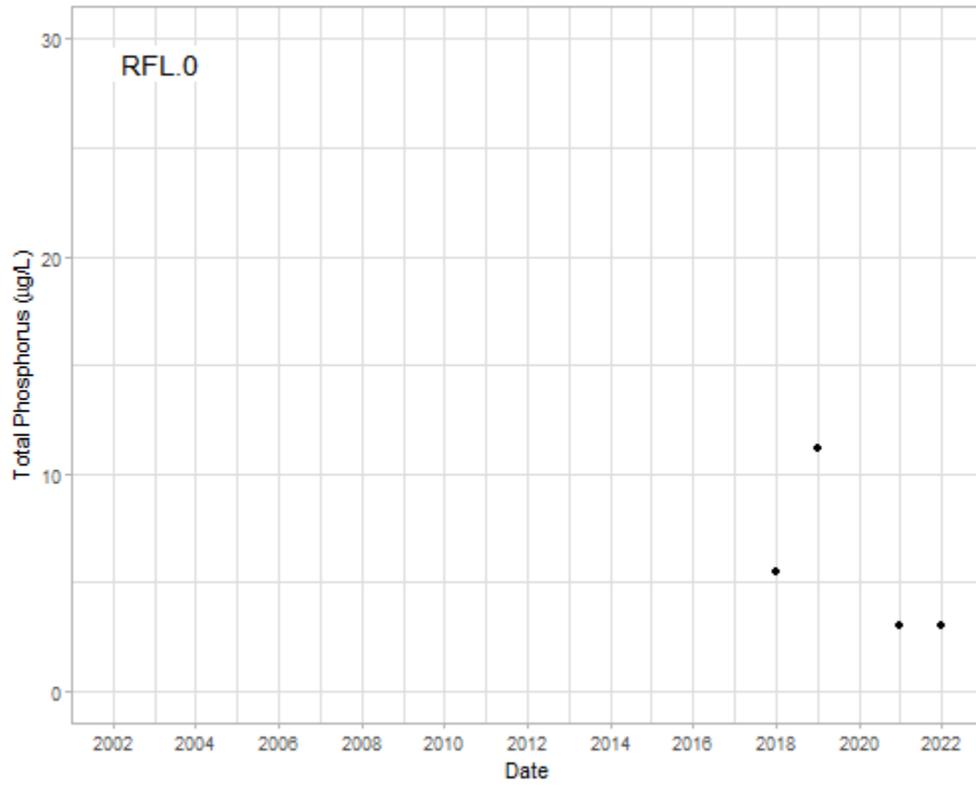


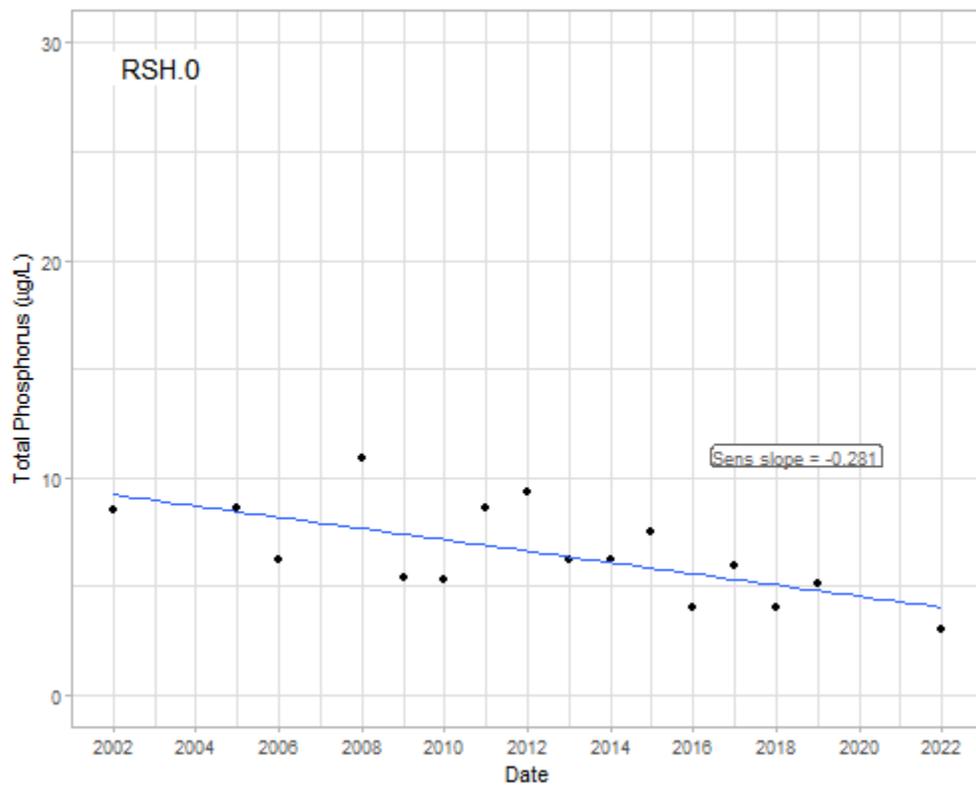
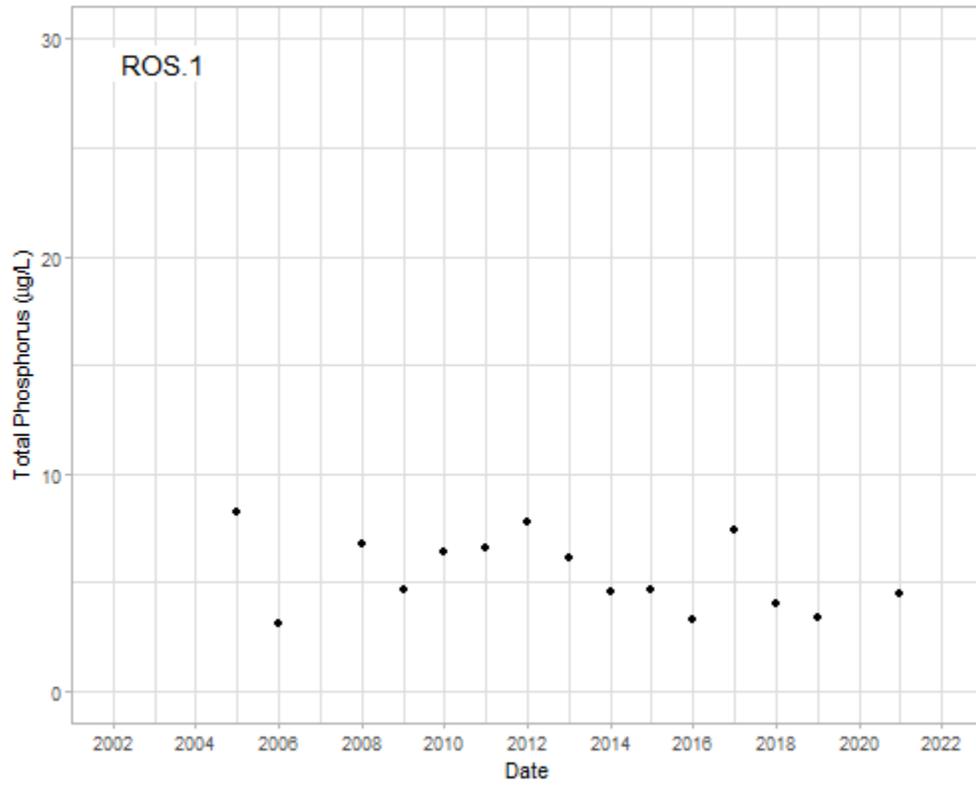


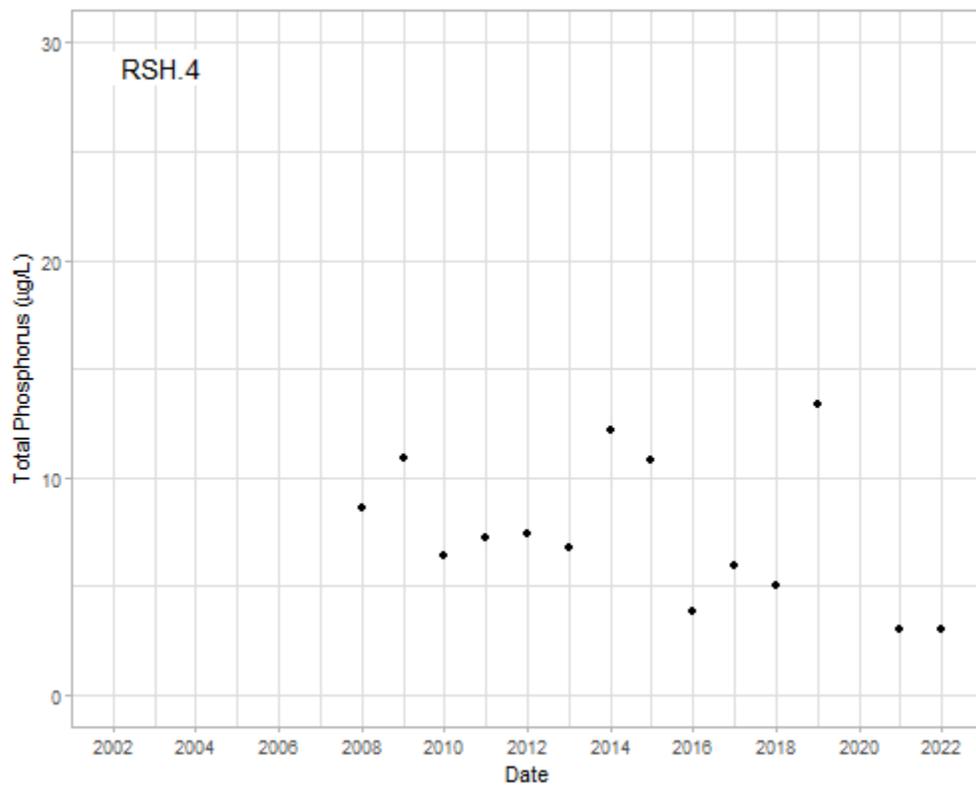
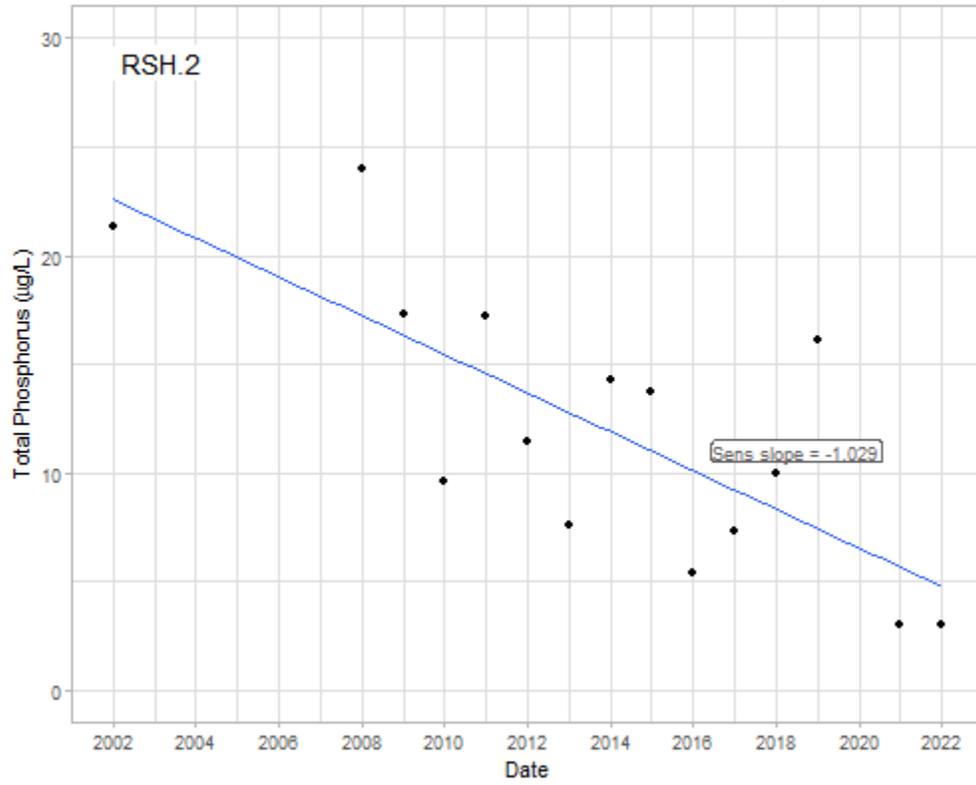


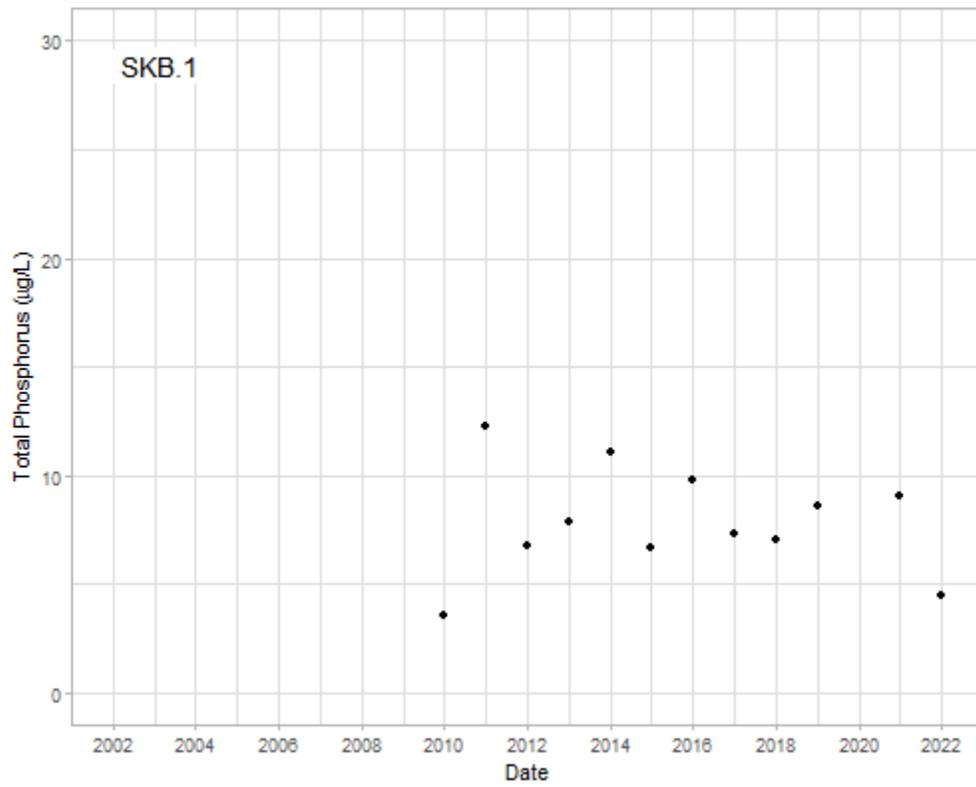
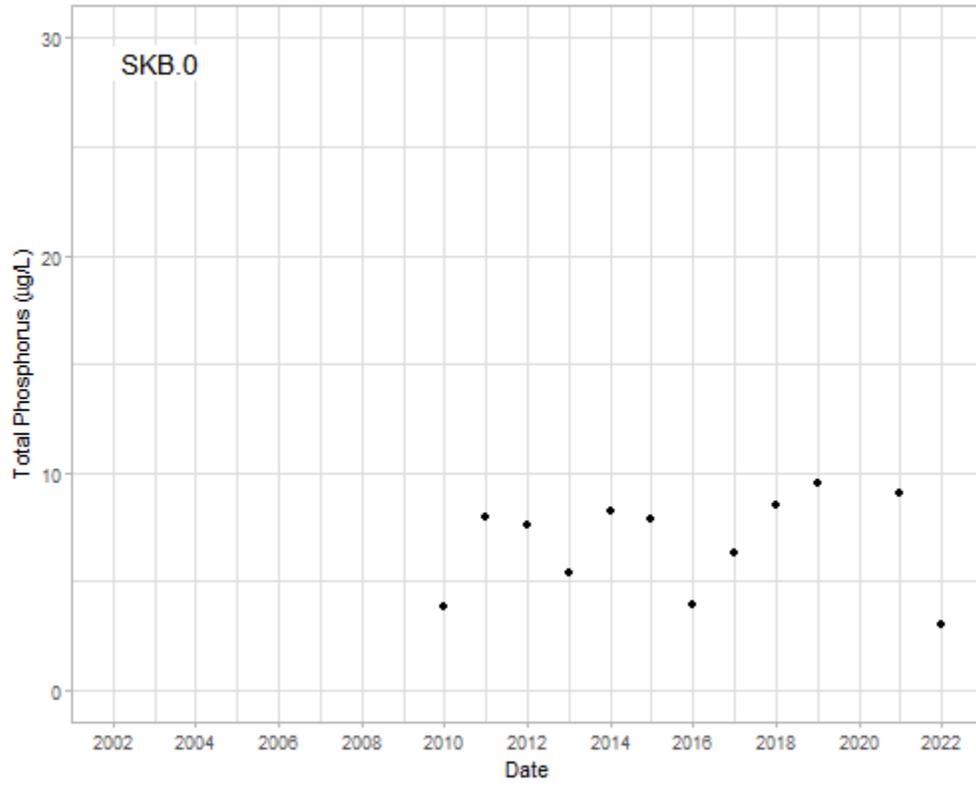


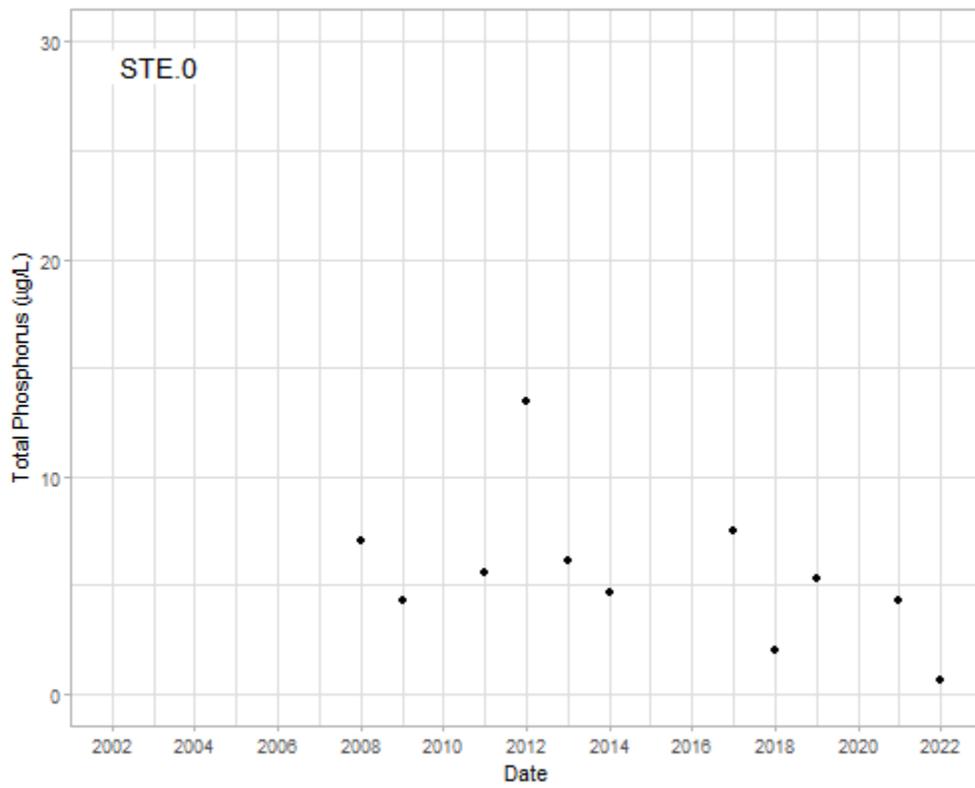
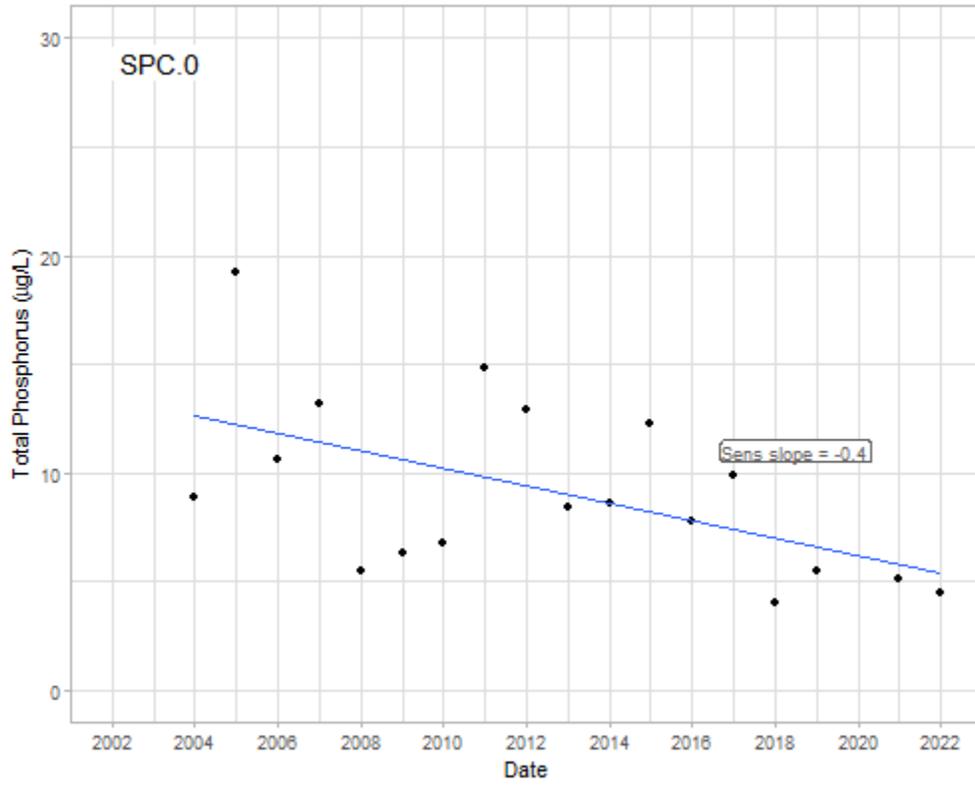


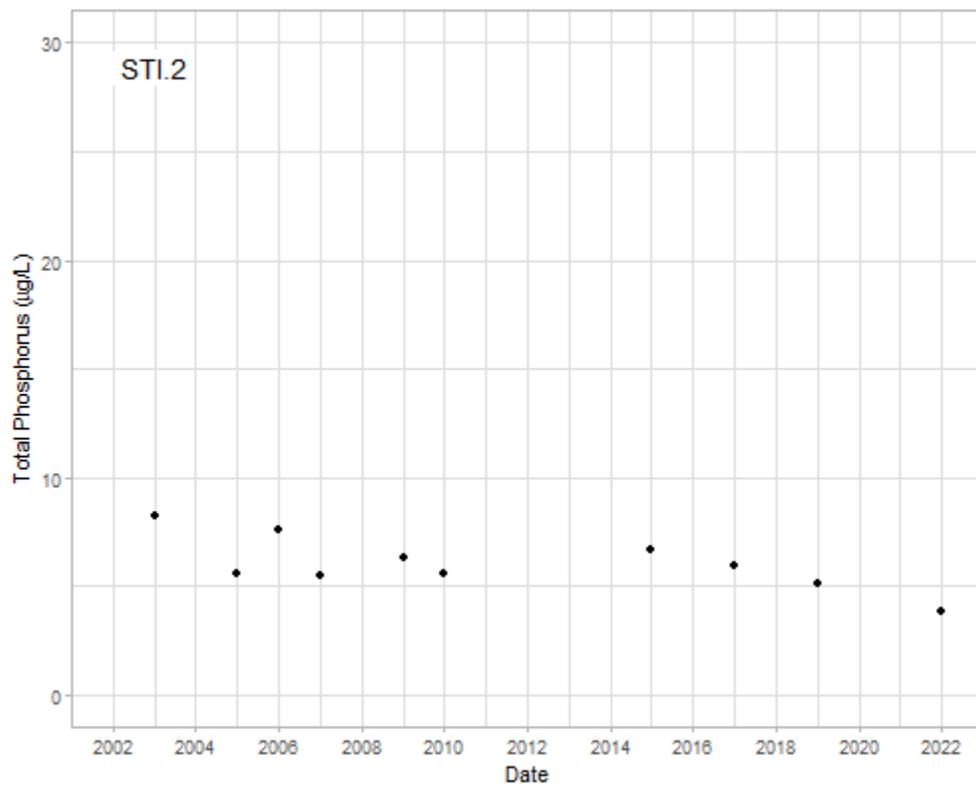
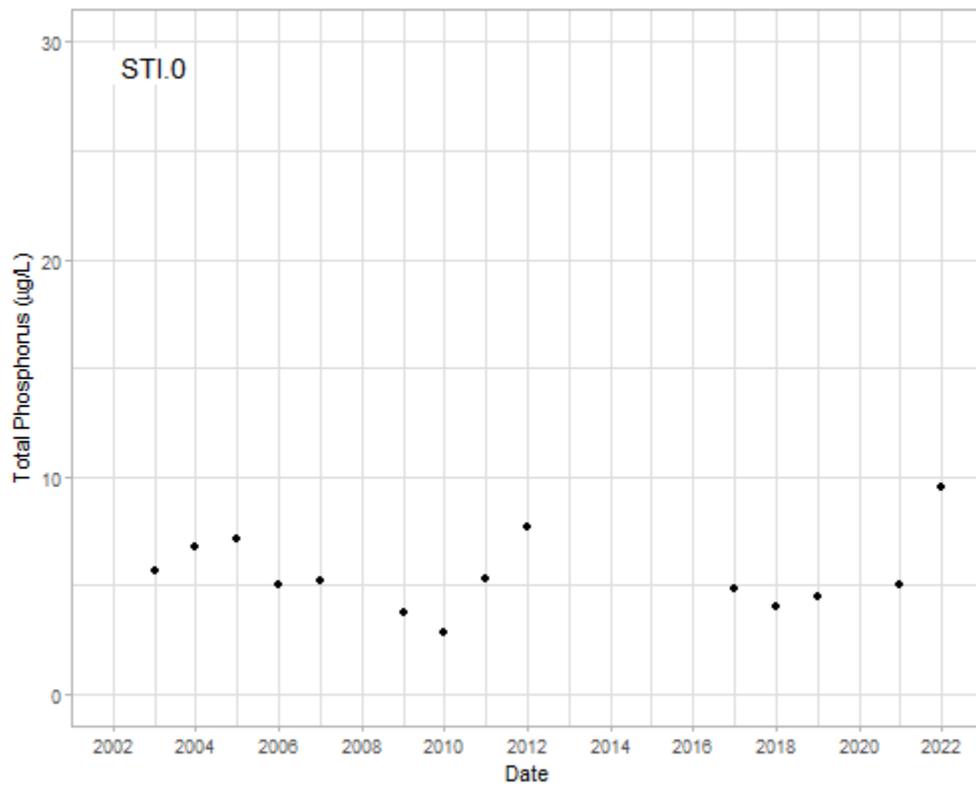


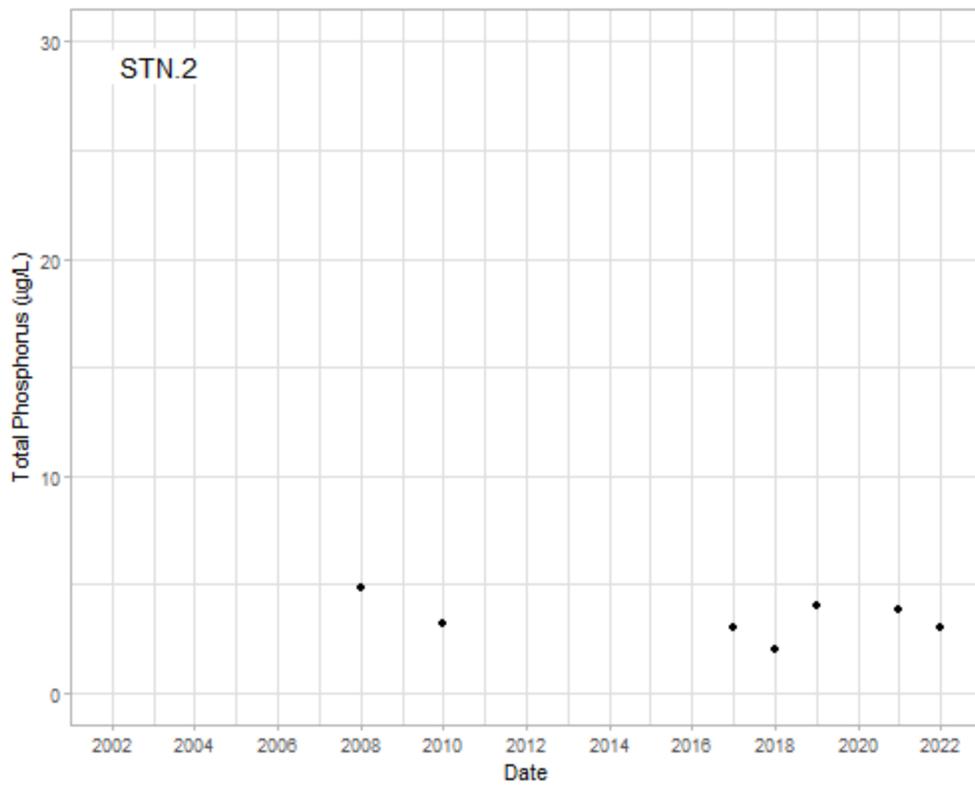
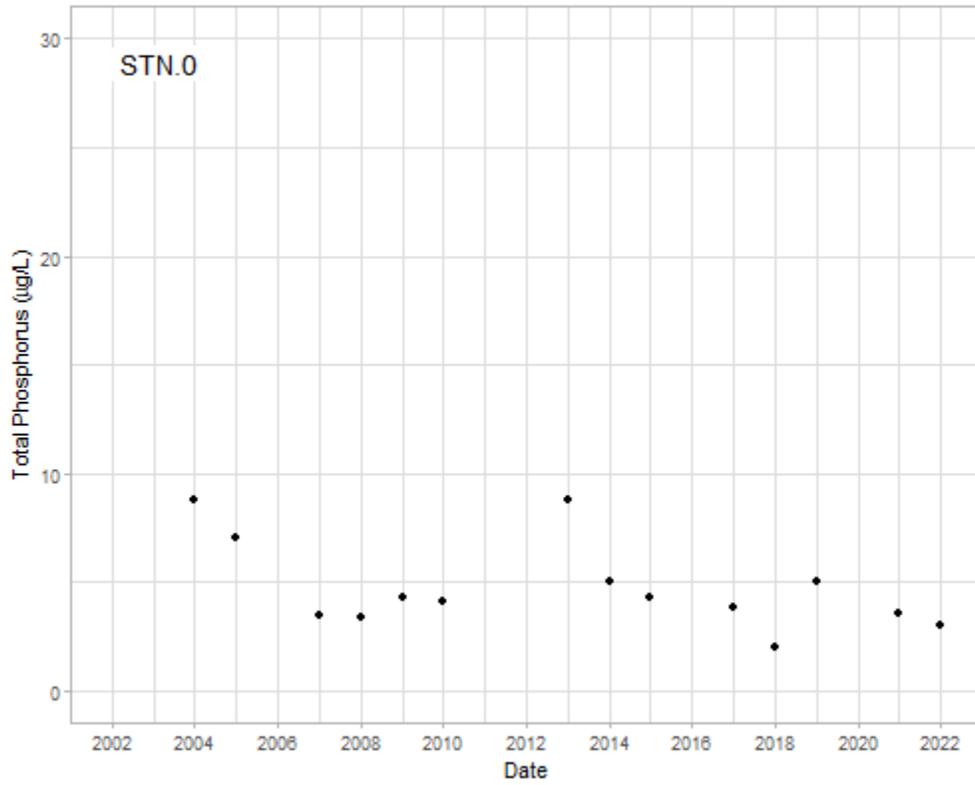


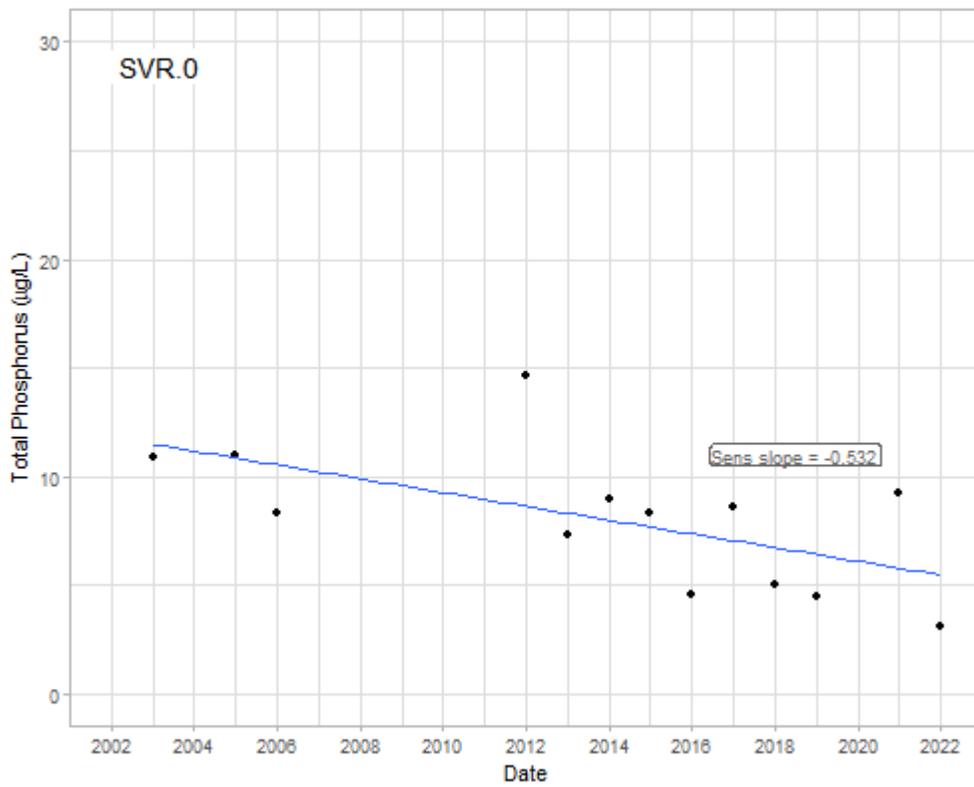
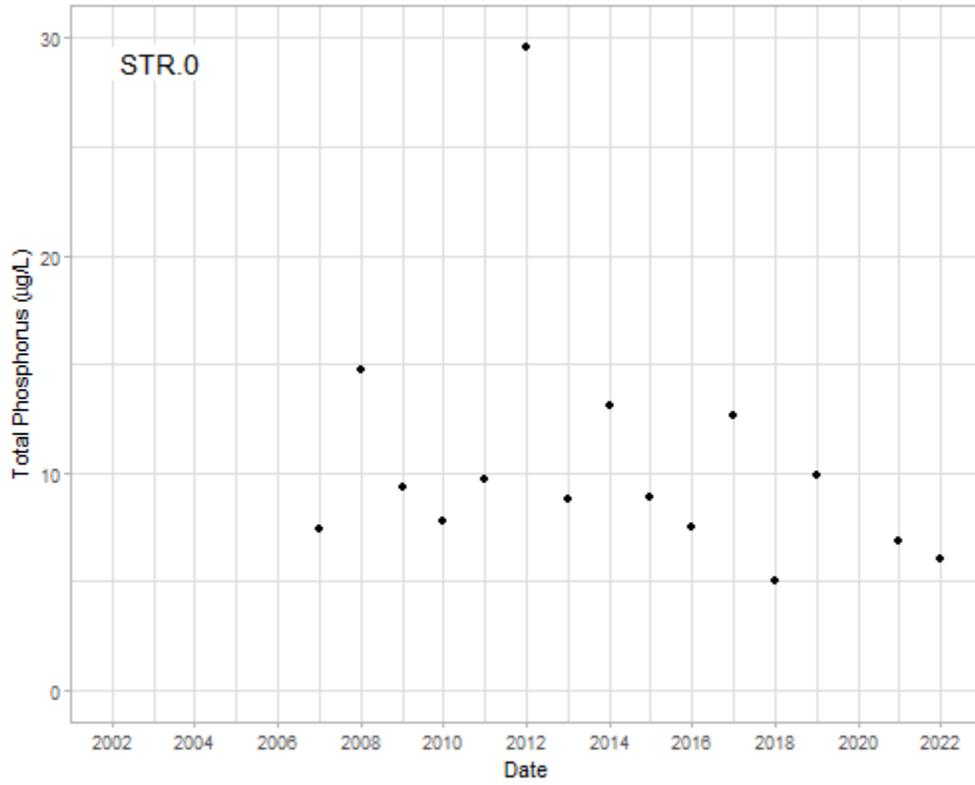


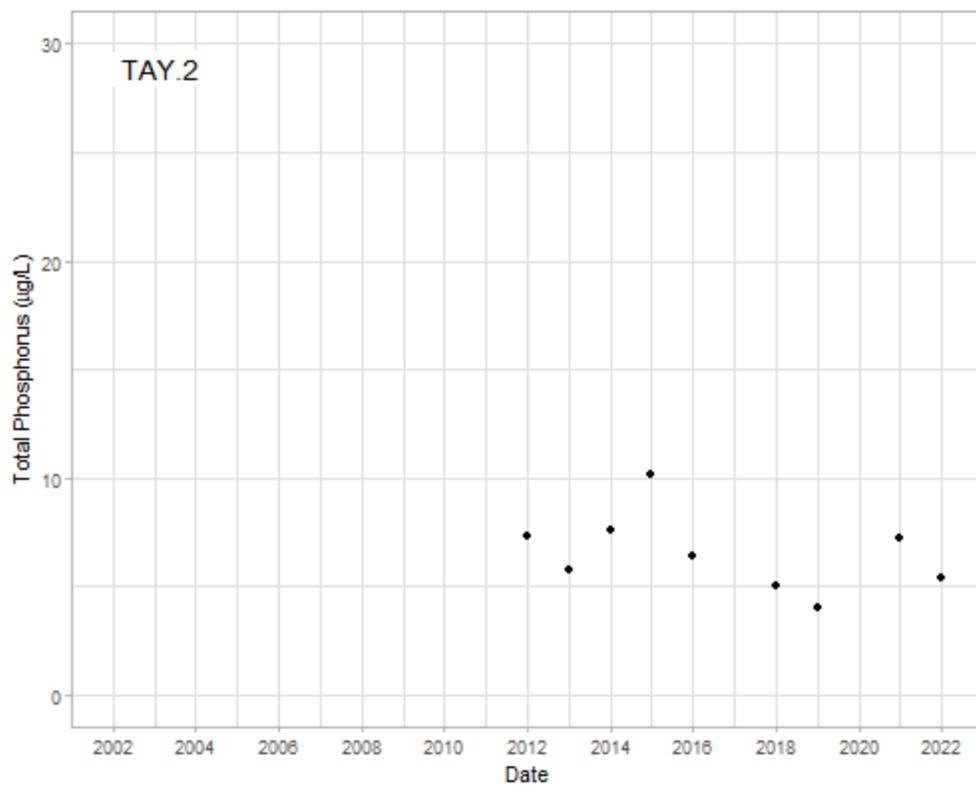
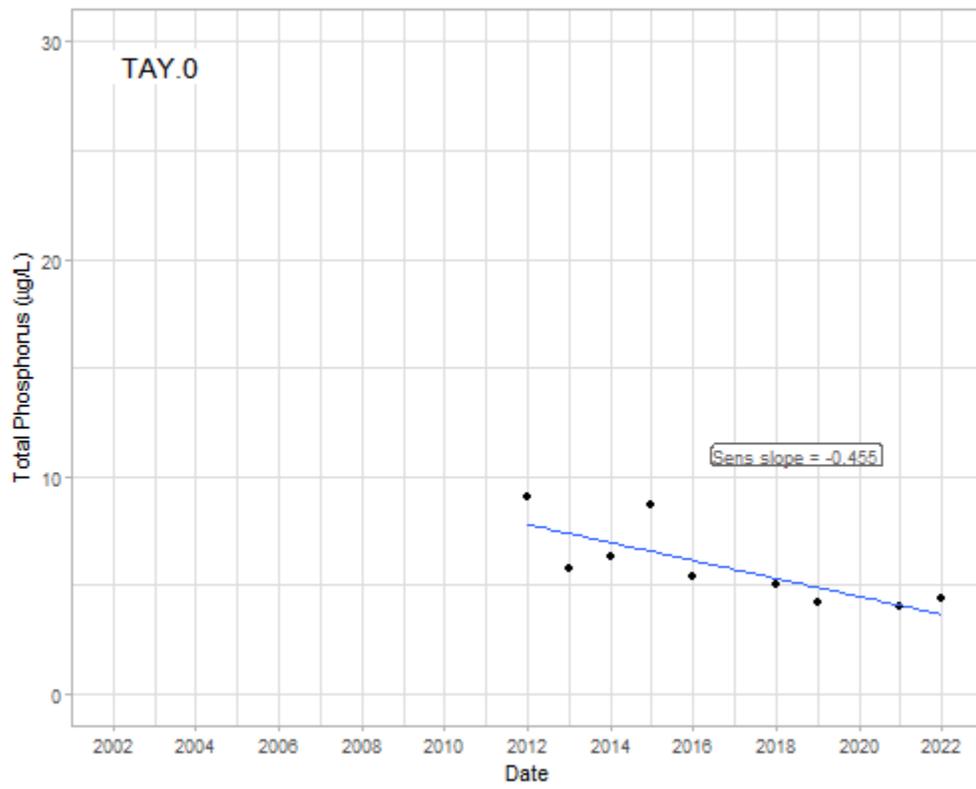


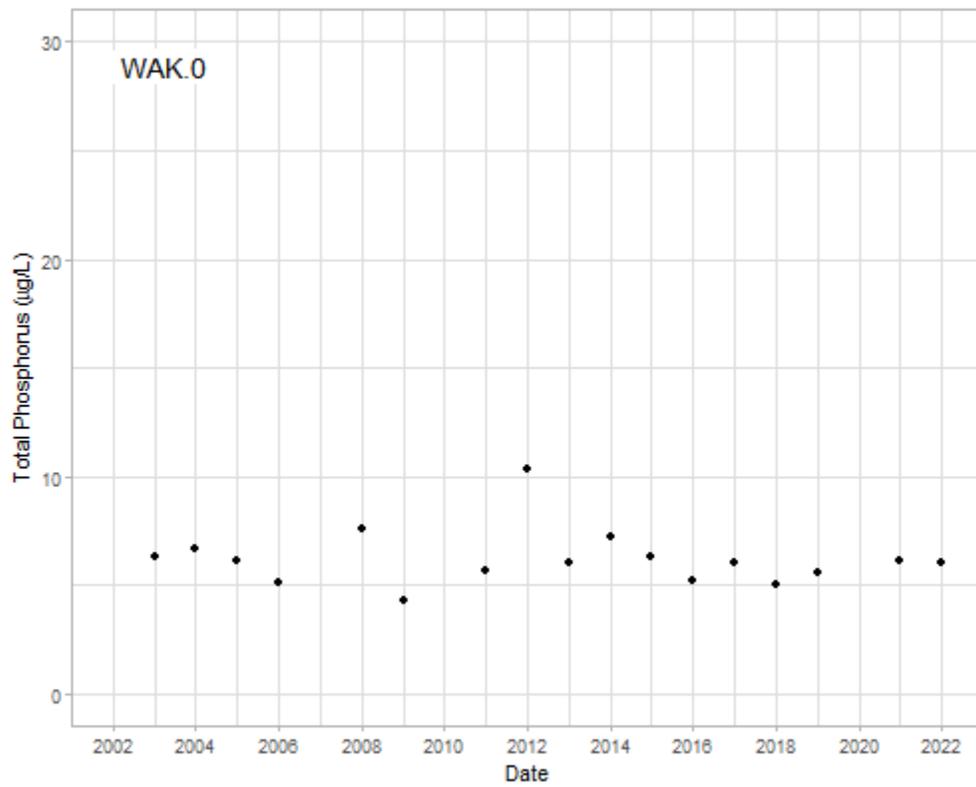
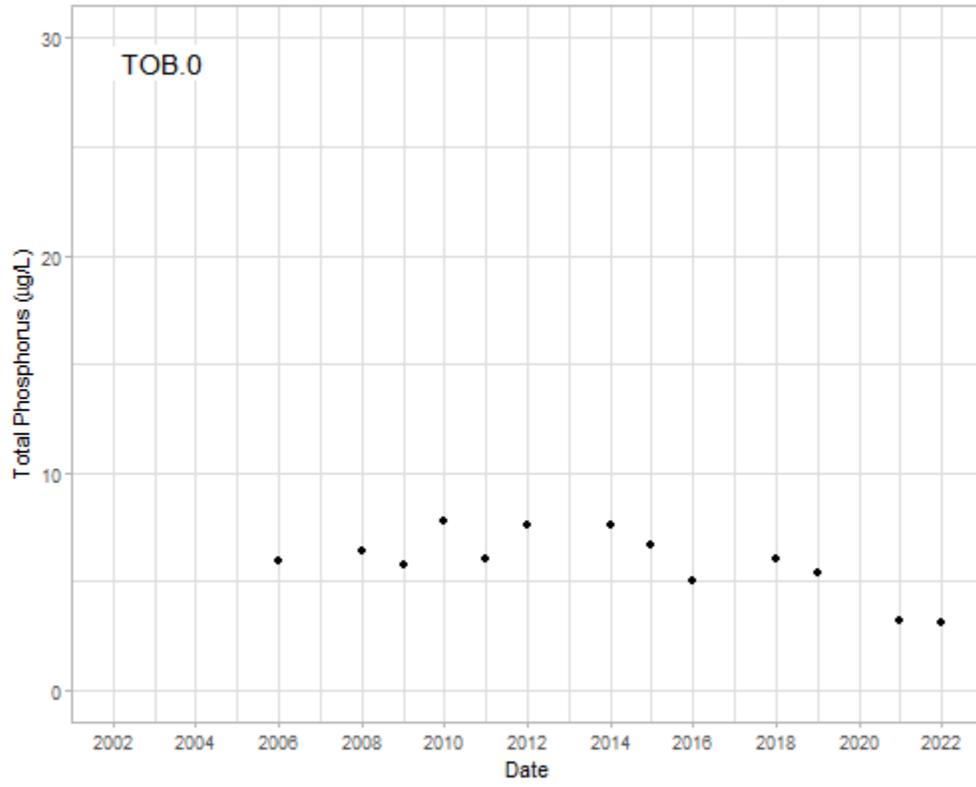


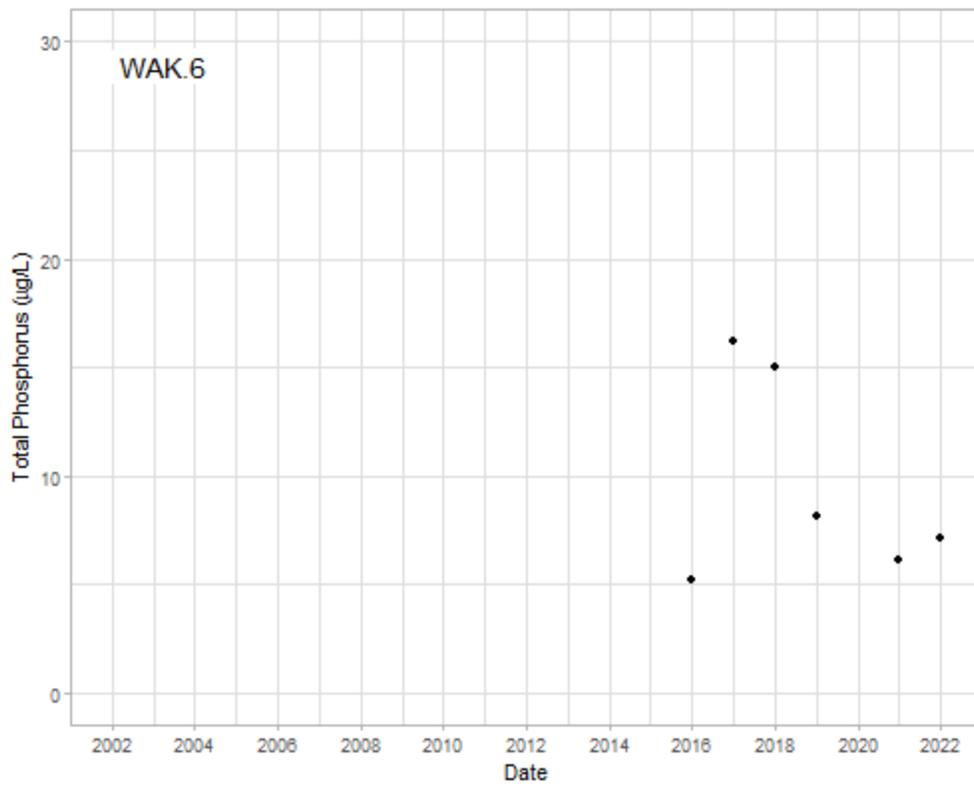
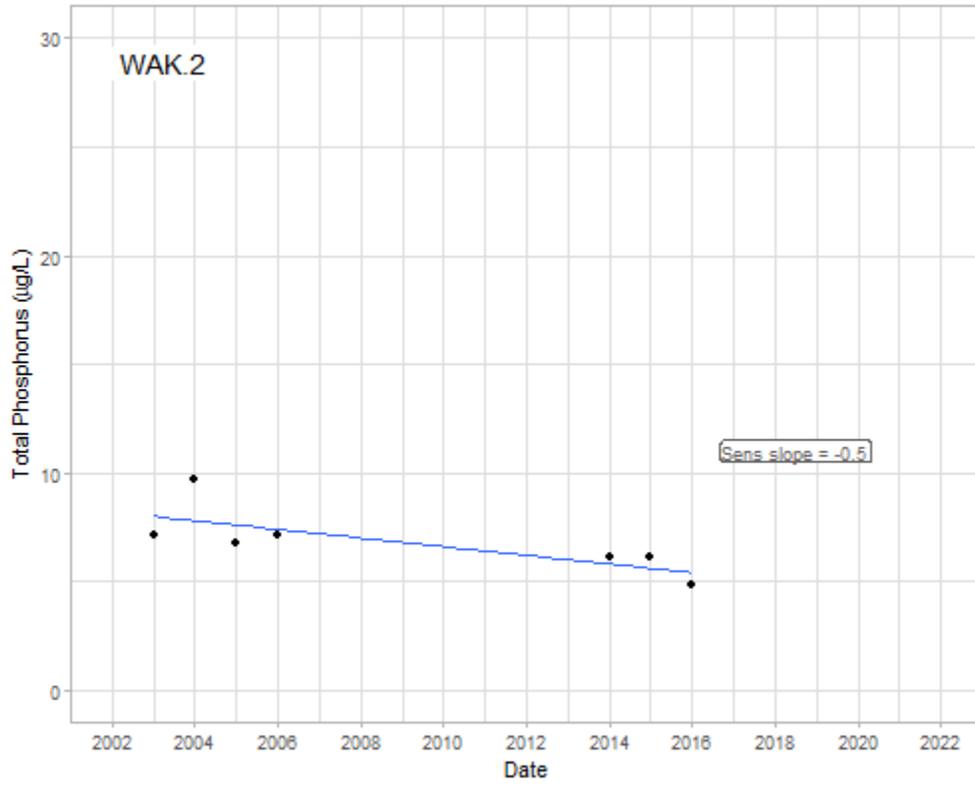


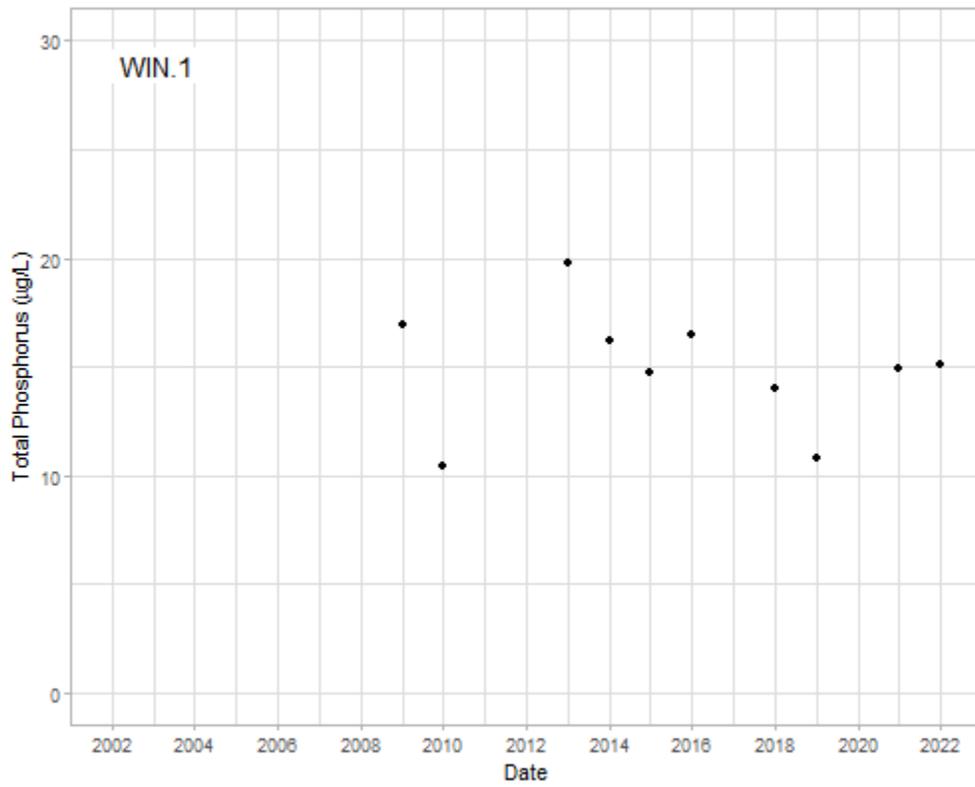
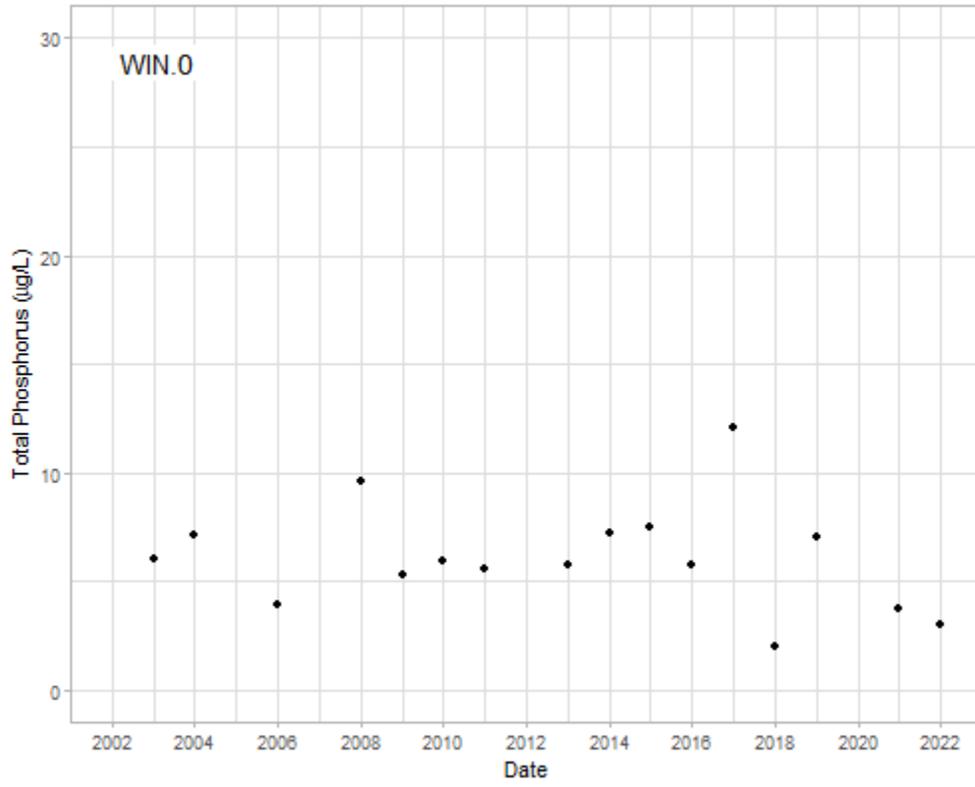


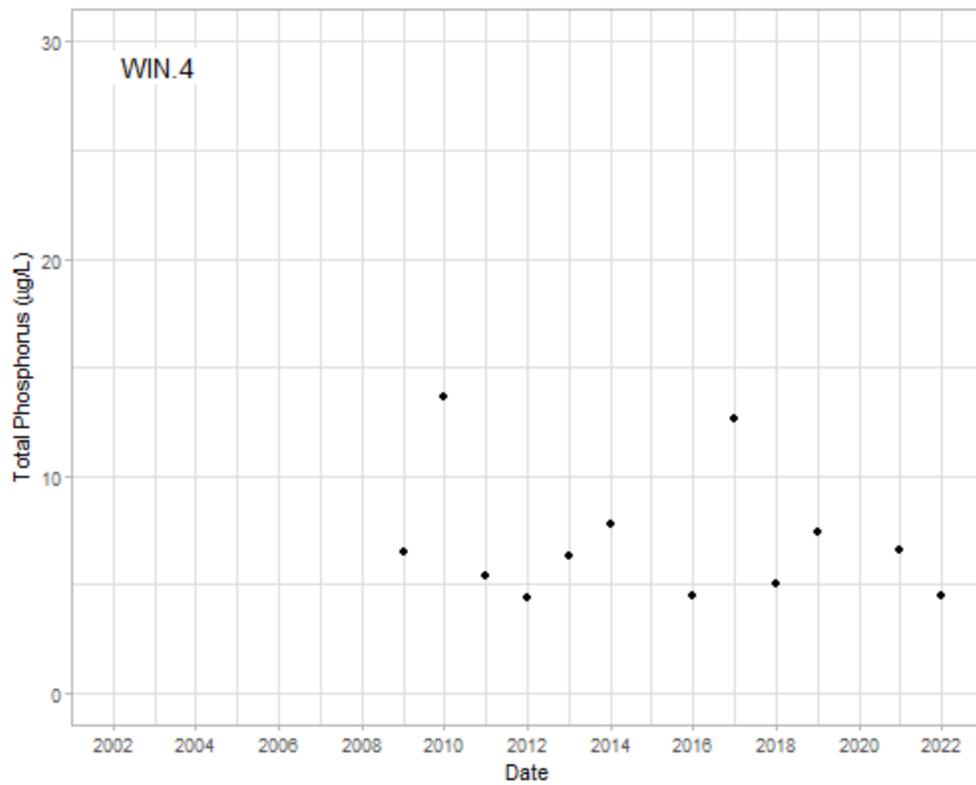
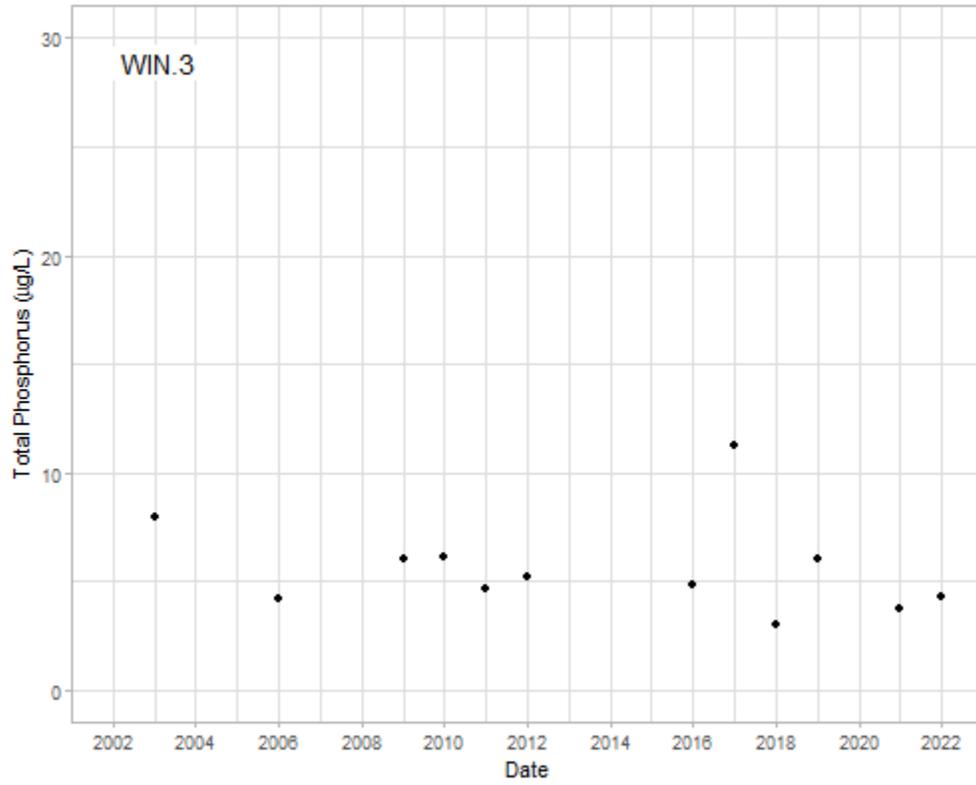


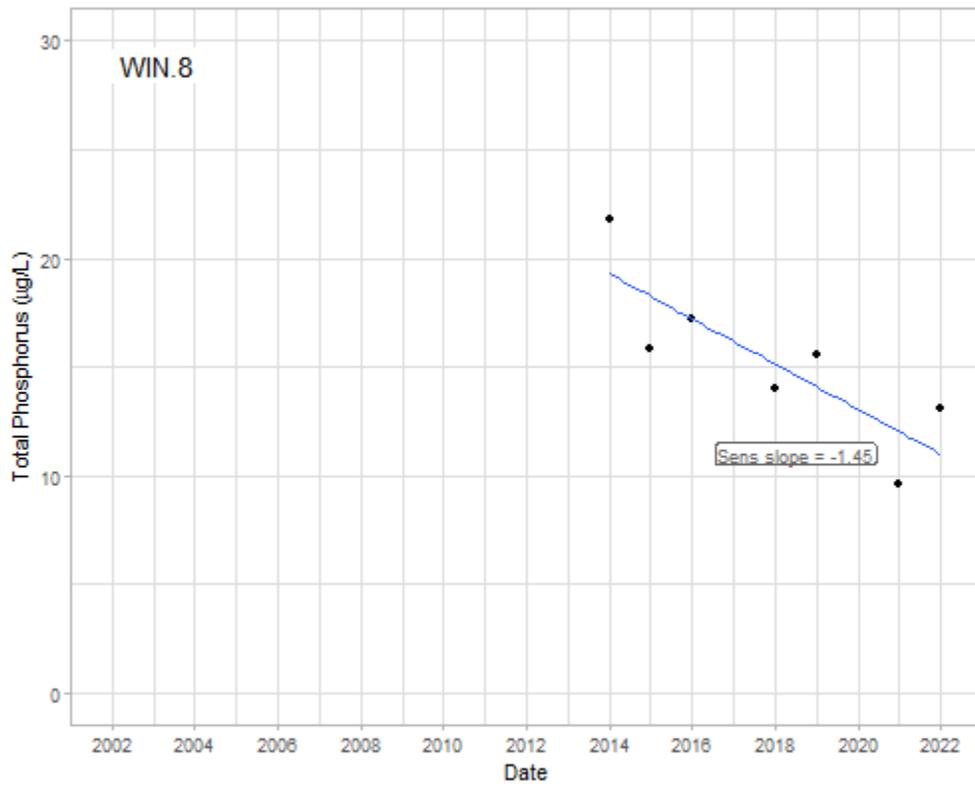
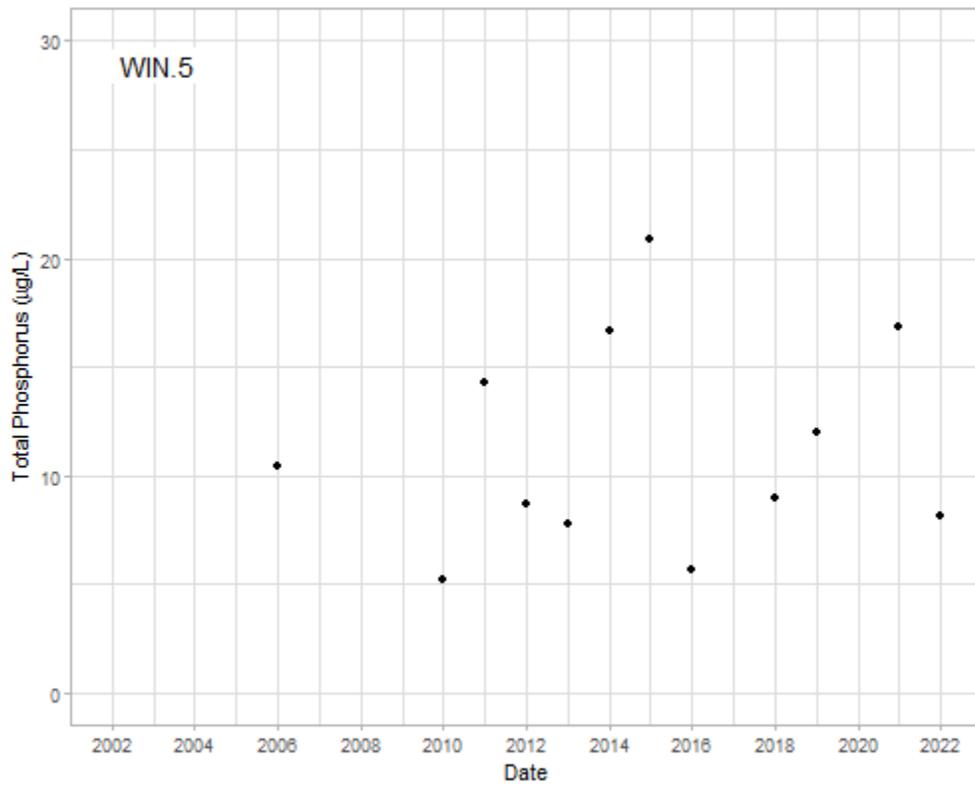


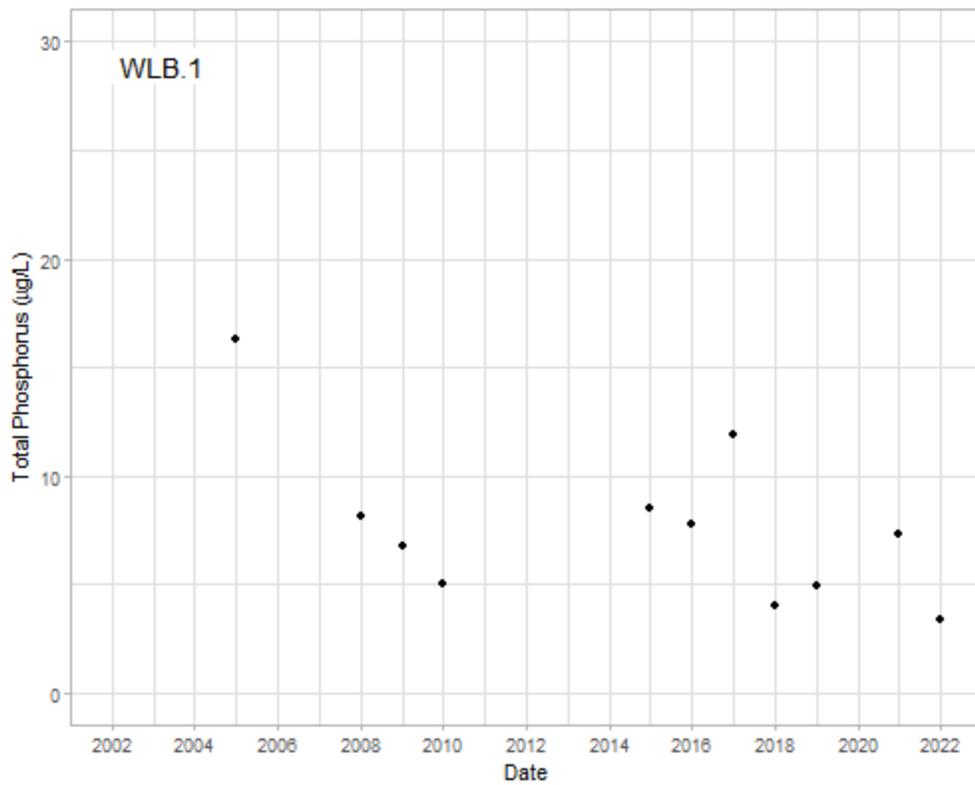
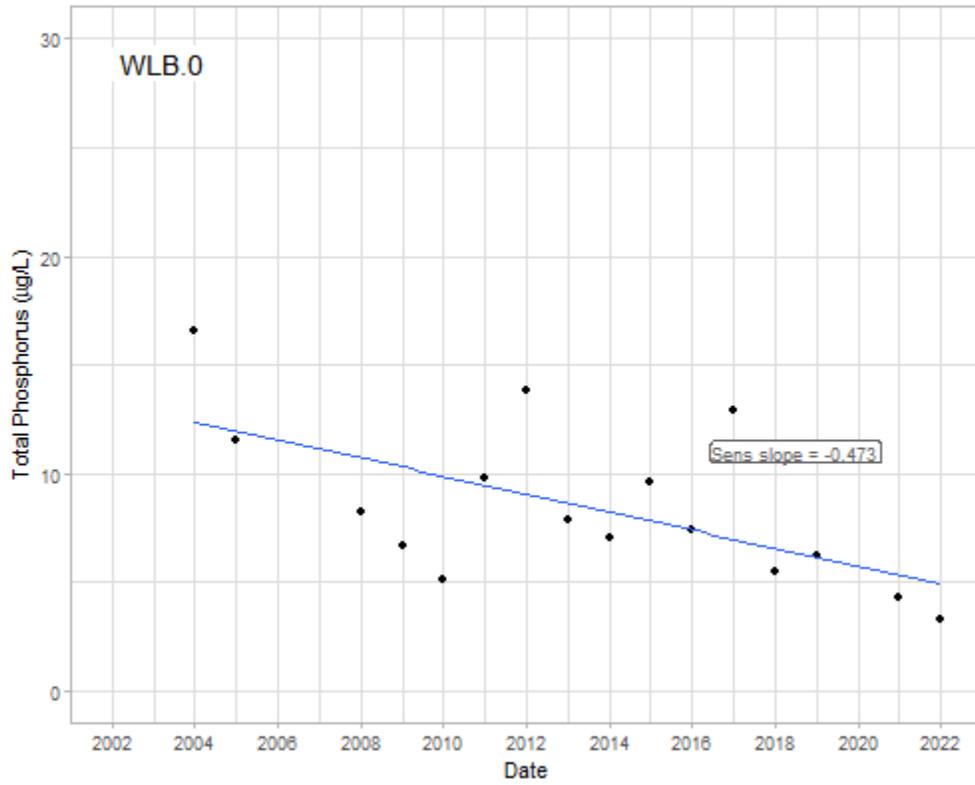


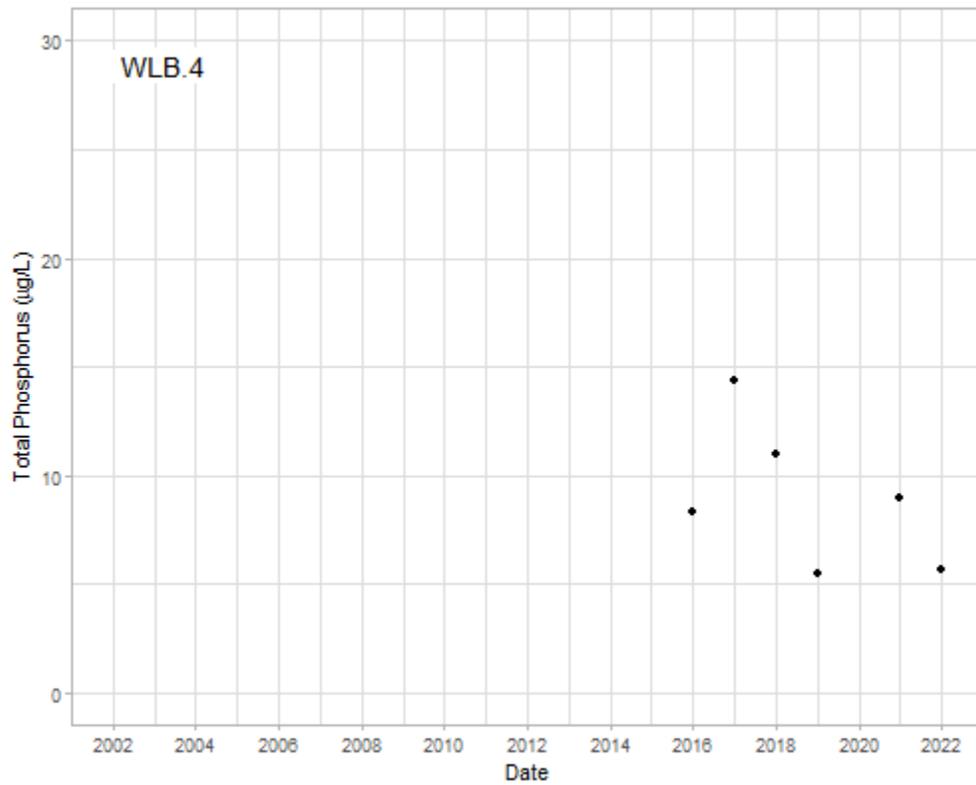
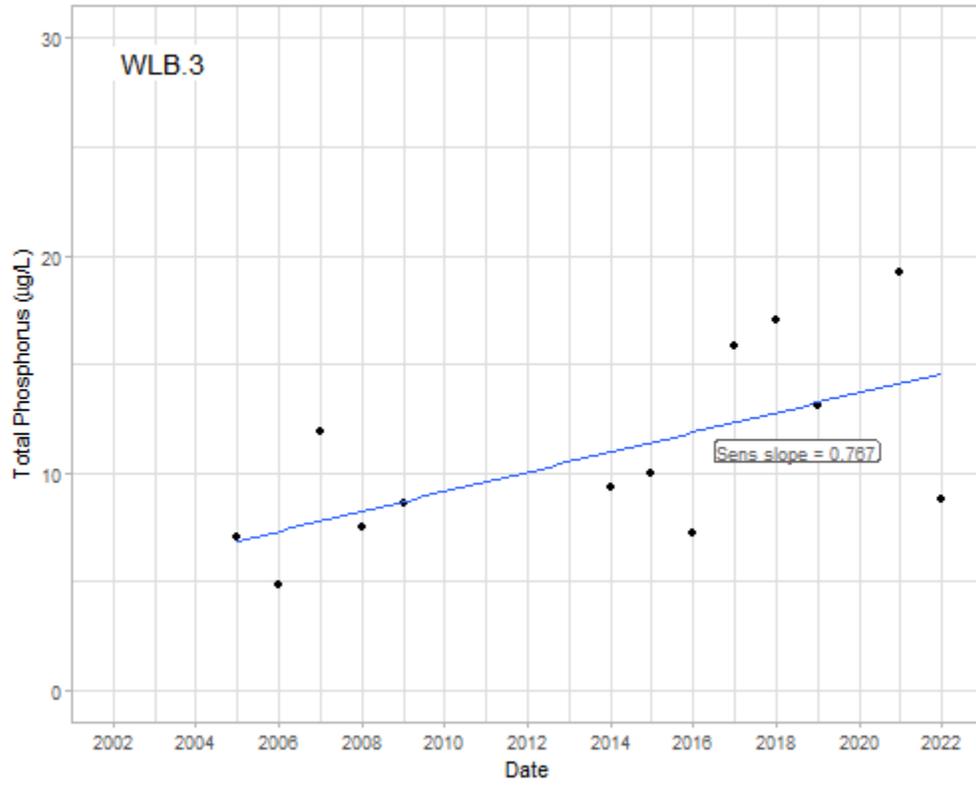


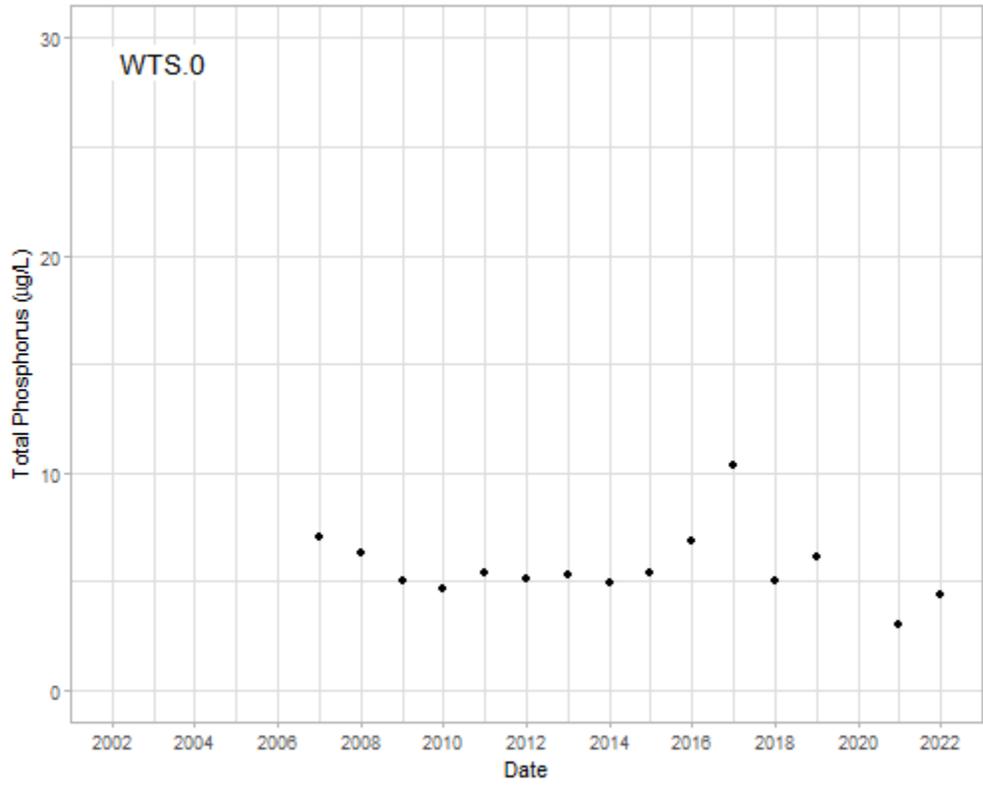












Appendix C. Long-term Trend Analyses – Secchi Depth



Secchi Depth Long-term Trends

