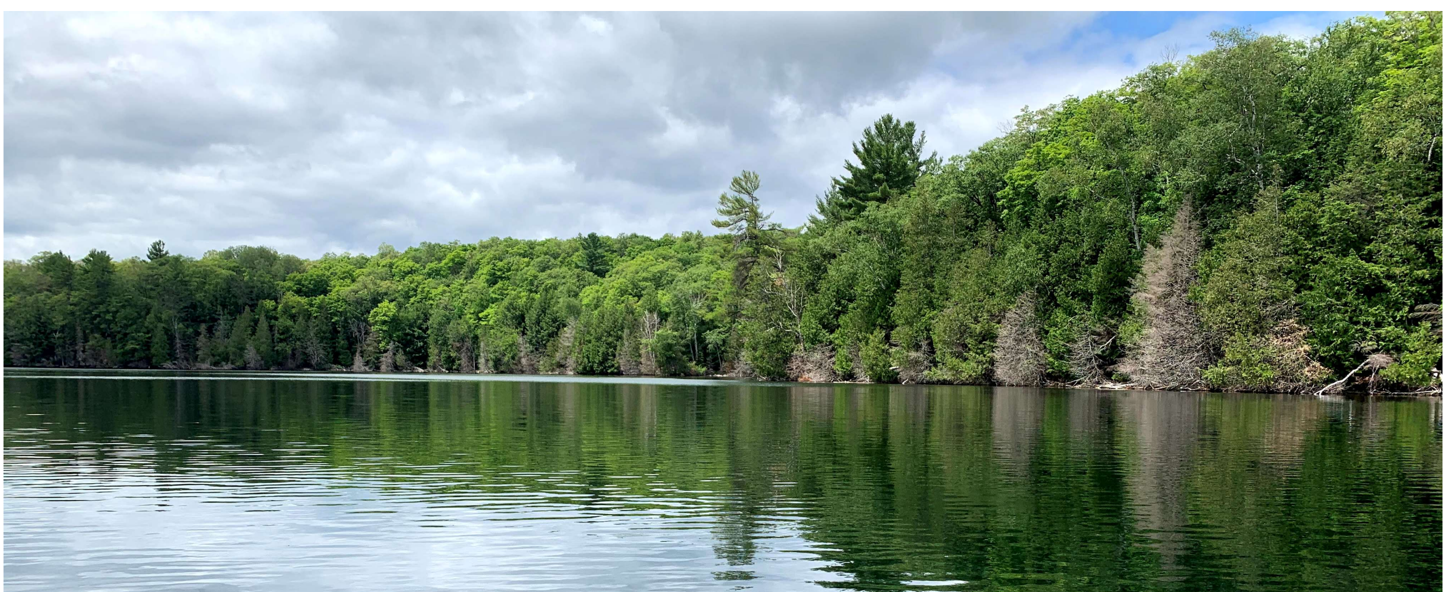
Integrated Monitoring Report 2020 Season

Buckshot Creek Subwatershed

Mississippi Valley Conservation Authority



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Cover photos
Top: Buckshot Lake, July 2020.
Bottom: Grindstone Lake, July 2020.

Executive Summary

The purpose of this integrated monitoring report is to present an overview of the environmental monitoring that Mississippi Valley Conservation Authority (MVCA) undertook during the 2020 season. The emphasis of this report is on results of the lake monitoring program but also includes water levels and flow, snow pack, and stream monitoring data. MVCA samples each of its 10 subwatersheds on a 5-year rotation. The Buckshot Creek watershed was the primary focus for 2020.

The most significant factor affecting the lakes and streams in the summer of 2020 was the reduced snow melt event resulting in average spring flows. The average spring was followed by summer season drought conditions. MVCA issued a Level 1 Low Water Condition Statement on July 13th which was in place until September 1st.

The Covid-19 pandemic forced the cancellation of all spring sampling, while MVCA developed and implemented health and safety protocols that met the provincial and federal health and safety guidance. Once health and safety protocols were implemented, a revised lake sampling schedule was developed that consisted of a reduced number of sample sites and a reduced number of visits to those sites. Provincial restrictions remained in place for the remainder of 2020 which limited MVCA's ability to conduct in-stream sampling, such as electro-fishing.

The lakes were not sampled in May due to the ongoing COVID-19 pandemic. Six of the ten originally intended lakes were sampled in both July and September of 2020, and minimal in-stream work was carried out. Three lakes were sampled within the Buckshot Creek subwatershed (Buckshot, Grindstone, and Mississagagon) and three lakes were sampled along the main path of the Mississippi River (Kashwakamak, Dalhousie and Mississippi Lakes). The sampled lakes maintained their typical nutrient profile characteristics as well as typical dissolved oxygen and temperature profiles for the seasons that were sampled.

Through the stream monitoring program, 11 sites were selected for thermal habitat assessment in 2020. Four of these sites were found to support cold water fish habitat.

This report emphasizes the value of the combined monitoring conducted through MVCA's Water Management, Lake Monitoring, and Stream Monitoring programs. The information gathered through these efforts supports MVCA's stewardship program as well as the planning and regulations department.

Filtering a lake surface water sample

Introduction

The Lake Monitoring Program (formally known as Watershed Watch) was initiated at the Mississippi Valley Conservation Authority (MVCA) in 1998 in partnership with the Mississippi Valley Lake Stewardship Network. The goal of the program is to accumulate reliable environmental data on the lakes within the watershed. Despite various adjustments to the protocol throughout the years, the program has remained a fundamental part of MVCA's environmental monitoring program. It continues to provide valuable baseline data while promoting stewardship of these important features.

The main goal of the lake monitoring program is to collect water quality data and monitor the lakes for changing trends. Due to the large number of lakes monitored within the MVCA area (45 lakes monitored out of over 300 lakes in total), a rotational sampling program is undertaken with the goal to collect baseline data and to monitor general trends. MVCA collects relatively simple data on parameters that are easy to repeat and are important indicators in water quality assessments. Many of the lakes not sampled on a regular basis by MVCA are sampled/monitored through other programs such as the Ministry of Environment, Conservation and Parks' Lake Partner Program (LPP). If lake stewards are interested in more detailed yearly assessments of their lake, they should consider the LPP which is coordinated through the Dorset Environmental Science Centre. Relying on volunteer effort, this program provides equipment and an excellent framework for yearly data collection. It is also an excellent means to promote awareness and ownership of lake health to the lake communities.

Accompanying the lake monitoring program is MVCA's Stream Monitoring program. This program collects valuable information on stream temperature, as well as fish and benthic communities of the watershed's many tributaries. It follows the Ontario Stream Assessment Protocol (OSAP) methods to conduct stream site identifications, electrofishing, benthic surveys, and temperature monitoring at various sites throughout the year. Due to Covid-19 restrictions, MVCA was only able to perform temperature monitoring with the Mississippi River subwatersheds, as many other stream assessment protocols required close physical contact.

The goal of MVCA's fish data collection is largely to determine the presence or absence of cold or cool water species. These species are indicators of the thermal regime of a stream as they require very specific conditions to thrive. Fish sampling was not carried out in the summer of 2020 but MVCA was able to monitor the water temperature at select sites throughout the watershed to confirm the potential thermal habitat available for fish populations. The results are also used for tracking thermal trends between years for longer-term climate analysis.

An example of the crew electrofishing Bolton Creek in 2019

Water Quantity Monitoring

Summary

Three types of water quantity monitoring occurred in the Buckshot Creek subwatershed in 2020; snow pack, water levels, and water flow. Figure 1 shows the locations of the various gauges used to collect water level and flow data, the locations of snow courses where snow pack water content is measured, and the lakes monitored in 2020.

There is one water level gauge station which is equipped with a rain gauge in the Buckshot Creek subwatershed; on Highway 509 east of Plevna. There is also a snow course within the Buckshot Creek Subwatershed, and the Ardoch snow course is immediately south of the watershed.

The watershed did not experience a significant spring freshet/thaw in 2020. The freshet was early and had an average peak flow on the main system. Buckshot Creek's flow peaked on April 5th at 11.6 cm/s, which is close to average. There was below average rainfall for both April and May that, coupled with the early less predominant spring melt, resulted in below average flows as the season moved into June. Rainfall for June and July was again below average. The hot dry weather resulted in a significant drop in flows going into July. MVCA issued a Level 1 Low Water Condition Statement on July 13th which was in place until the beginning of September when late summer rains came. September and October were both wet months allowing levels and flows to return to normal before the winter months.

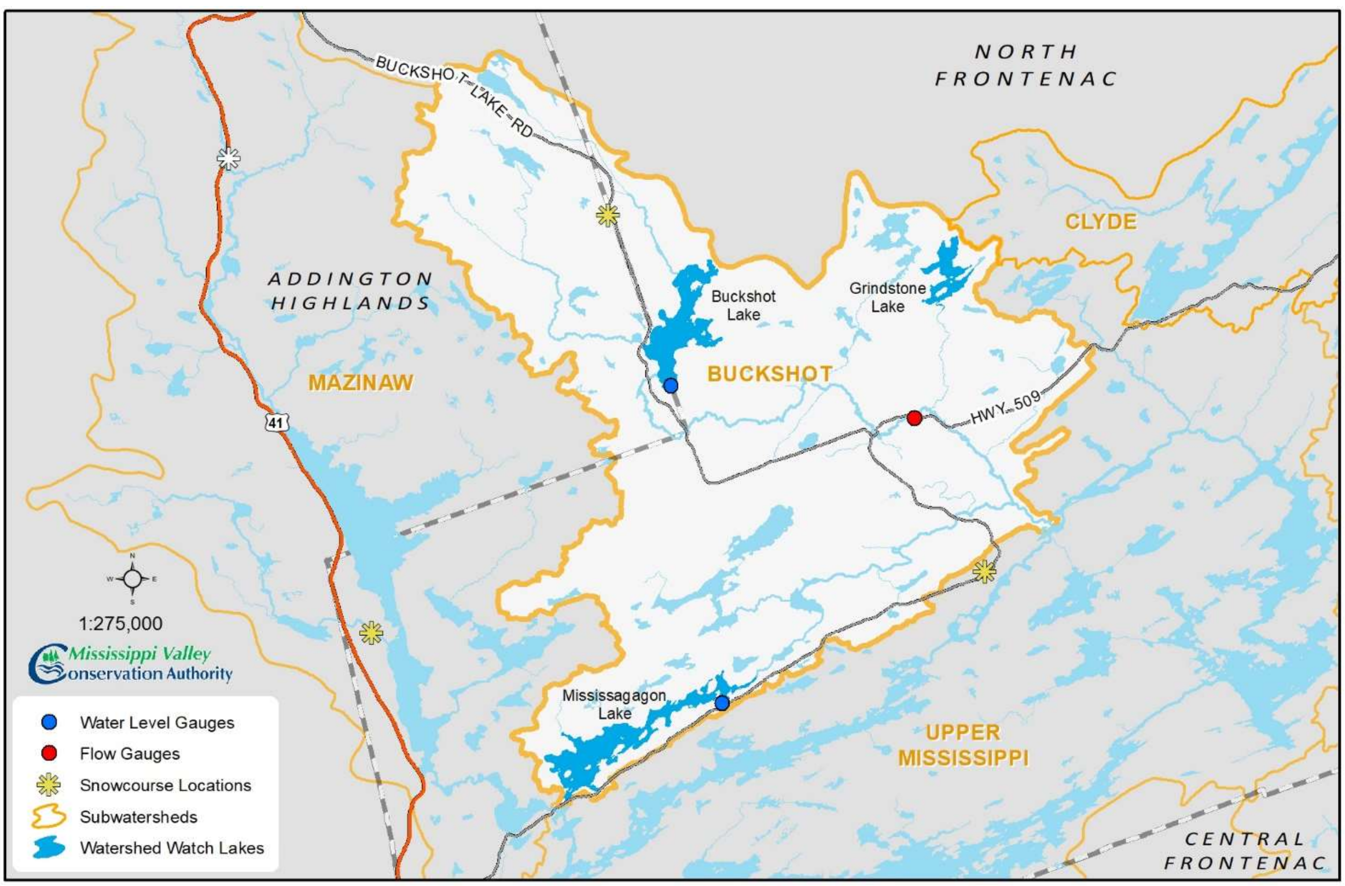


Figure 1: The various water quantity monitoring sites in the Buckshot Creek subwatershed, plus the Buckshot watershed lakes monitored in 2020.

Snow Pack

Snow pack is measured at 16 sites within the MVCA's jurisdiction. This program provides MVCA with information on the expected spring runoff for that year. This assists in decisions related to dam operations and flood forecasting. These water management efforts are critical to minimizing flood damage, maintaining flows and water levels for fish and wildlife, and meeting the target levels for summer recreational activities. There is one snow course within the Buckshot Creek Subwatershed. Another snow course, Ardoch, is nearby to the south-west. The snow pack results for 2020 can be seen in Figure 2.

Measuring snow depth and equivalent water content

It is evident that most of the Buckshot Creek subwatershed was above average for snow water content in 2020. The area was then clear of snow by early April. The snow courses in the rest of the Mississippi Valley showed a similar trend. Rather than melting, infiltrating and flowing into creeks and tributaries, the above average snow pack sublimated into the air in early March accounting for the drop in snow levels shown in Figure 2 while contributing little melt water to the waterways.

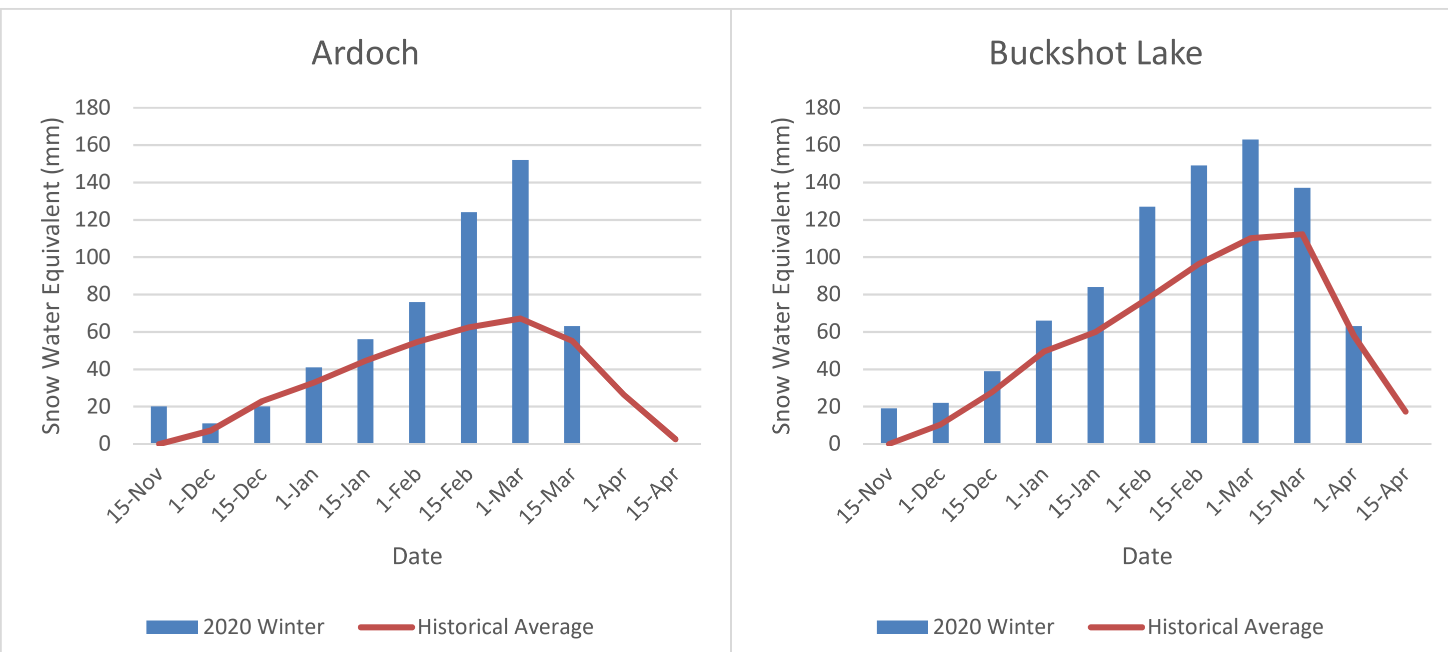


Figure 2: 2020 snow water equivalent levels vs. historical averages sampled at the Ardoch and Buckshot Lake snow course stations.

Stream Flow and Precipitation

Precipitation gauges are located with streamflow gauge stations across the watershed. These gauges inform us of the weather events OR climactic conditions which influence water levels on the Mississippi River. This report will focus on 2020 data from the stream flow and rain gauge station at Buckshot Creek east of Plevna. The daily total precipitation and the daily mean flows at this station can be seen below in Figure 3.

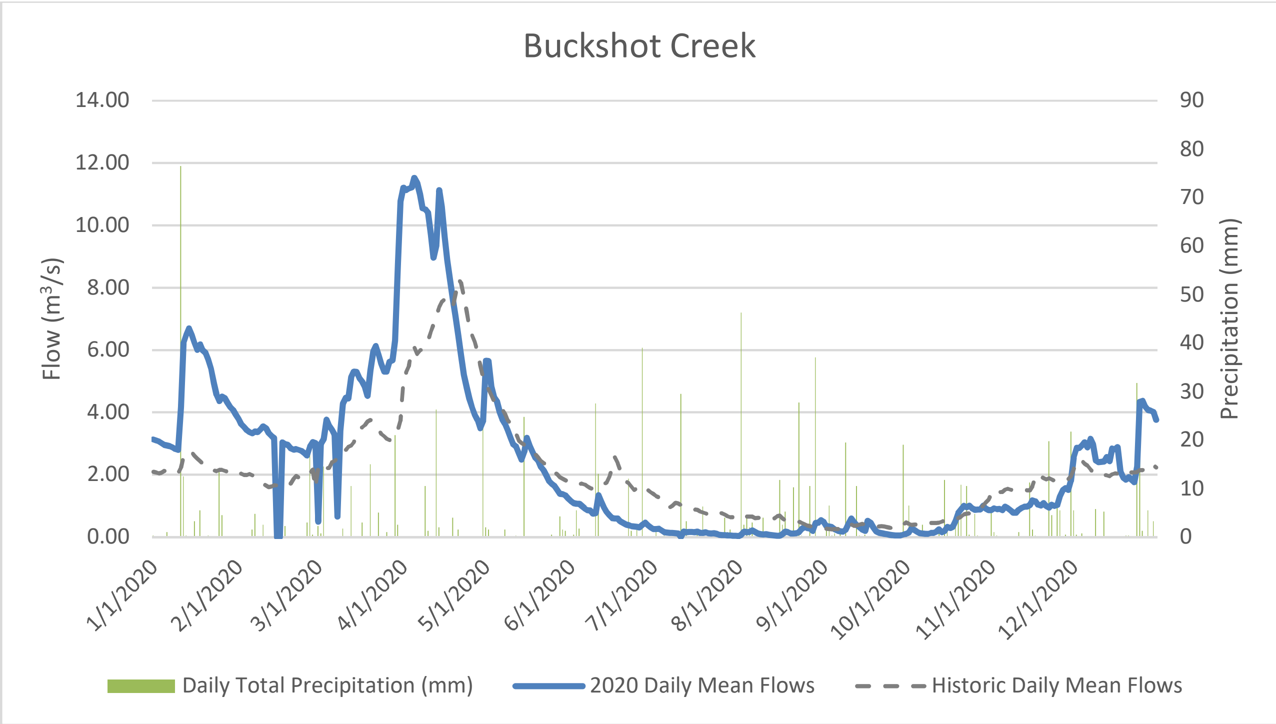


Figure 3: Daily total precipitation and daily mean water flows at the Buckshot Creek gauge station for 2020 compared to the historic daily mean flows for the site.

Figure 3 shows peak flows occurred on April 5th and 6th during a close to average spring freshet. In July MVCA issued a Level 1 Low Water Condition Statement which was in place until fall rains came in September and October.

Figure 3 illustrates the precipitation events that occurred throughout the year. The Buckshot Creek station recorded precipitation on 129 days. Of these, 95 days (74%) contributed 10 mm or less rain to the area. The largest precipitation event occurred on January 11, 2020 and contributed 76.5 mm to the Buckshot Creek area. Due to the hot dry summer season experienced in 2020, the majority of the rain that did fall during these months likely infiltrated in to the soil leaving little surface runoff to contribute to the stream water levels or flows.

The stream flow and rain gauge station on Buckshot Creek near Plevna.

Lake Water Levels

MVCA operates 18 dams throughout the watershed. Water levels are measured from gauges installed at many dams and gauge stations around the watershed. Water levels in three of the lakes monitored in 2020 are managed by dams (Mississagagon Lake, Kashwakamak Lake and Mississippi Lake). In the Buckshot Creek subwatershed there is a water level gauge on the dam at the outlet of Mississagagon Lake (Figure 4). There is also a gauge on Kashwakamak Lake (Figure 5) which is south of Mississagagon Lake and the Buckshot Creek subwatershed.

Due to the dry to average spring, the lakes started the season with near average water levels. Although there was a Level 1 drought that lasted through the summer, the lakes with control structures were able to be operated to near target levels throughout the season.

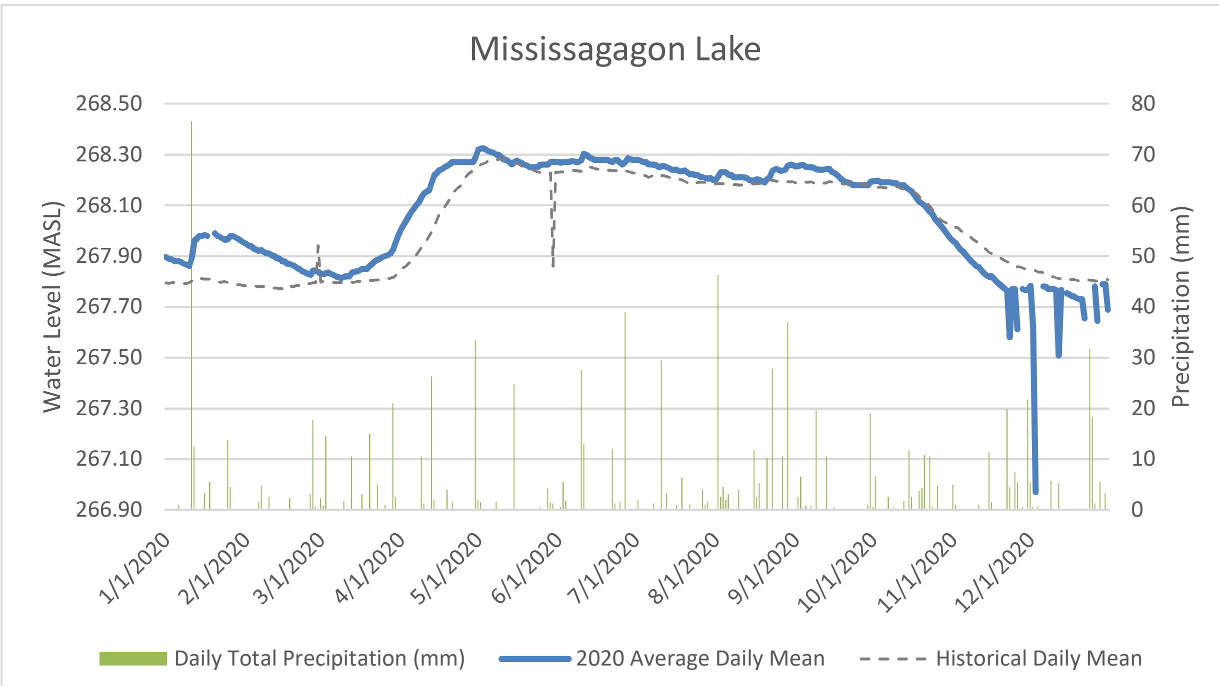


Figure 4: 2020 and historic daily mean water levels (meters above sea level - MASL) at the Mississagagon Lake dam compared to the 2020 daily total precipitation at the Buckshot Creek gauge.

The dam and gauge at the outlet of Mississagagon Lake

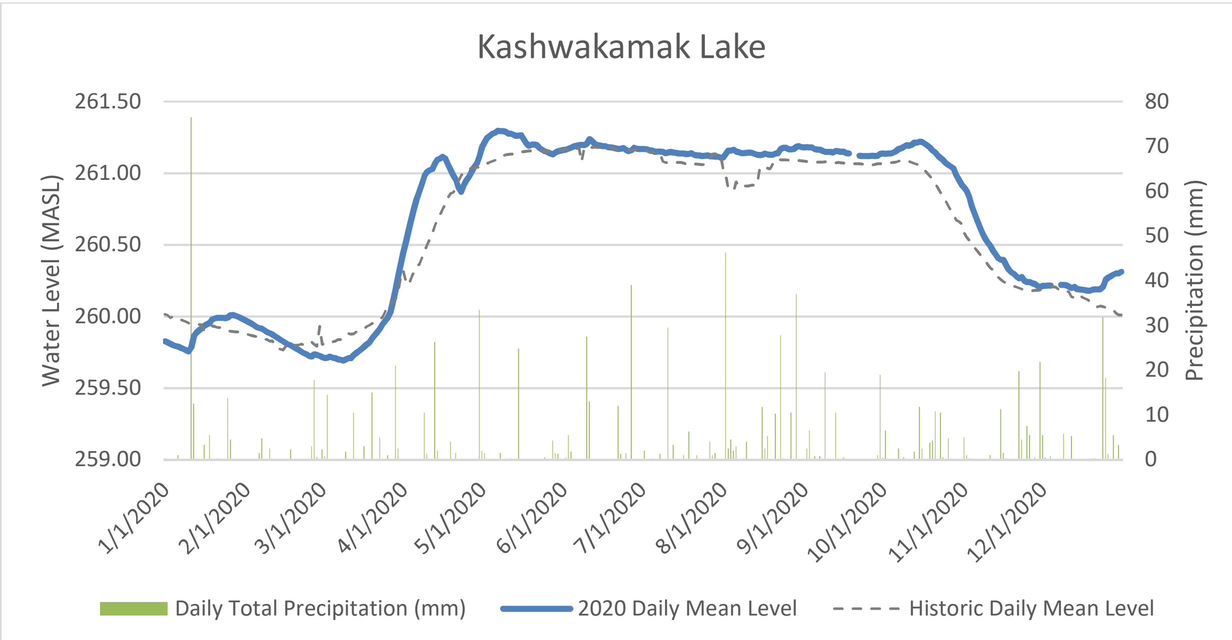


Figure 5: 2020 and historic daily mean water levels (meters above sea level - MASL) at the Kashwakamak Lake dam compared to the 2020 daily total precipitation at the Buckshot Creek gauge.

The dam and gauge station at the outlet of Kashwakamak Lake

Lake Monitoring Program

In 2020, the sampling focus was on the Buckshot Creek subwatershed. Located in the north west portion of the watershed, Buckshot Creek flows from north of Plevna to the Mississippi River downstream (east) of Ardoch. The Buckshot Creek subwatershed is 36.9 km long and has a watershed area of 292 km^2. Three lakes were sampled in the Buckshot Creek subwatershed and three lakes were sampled to represent the main Mississippi River for a total of six lakes sampled in 2020. Table 1 lists the lakes sampled by subwatershed in order from upstream to downstream. Figure 6 highlights the lake sites where sampling occurred in 2020.

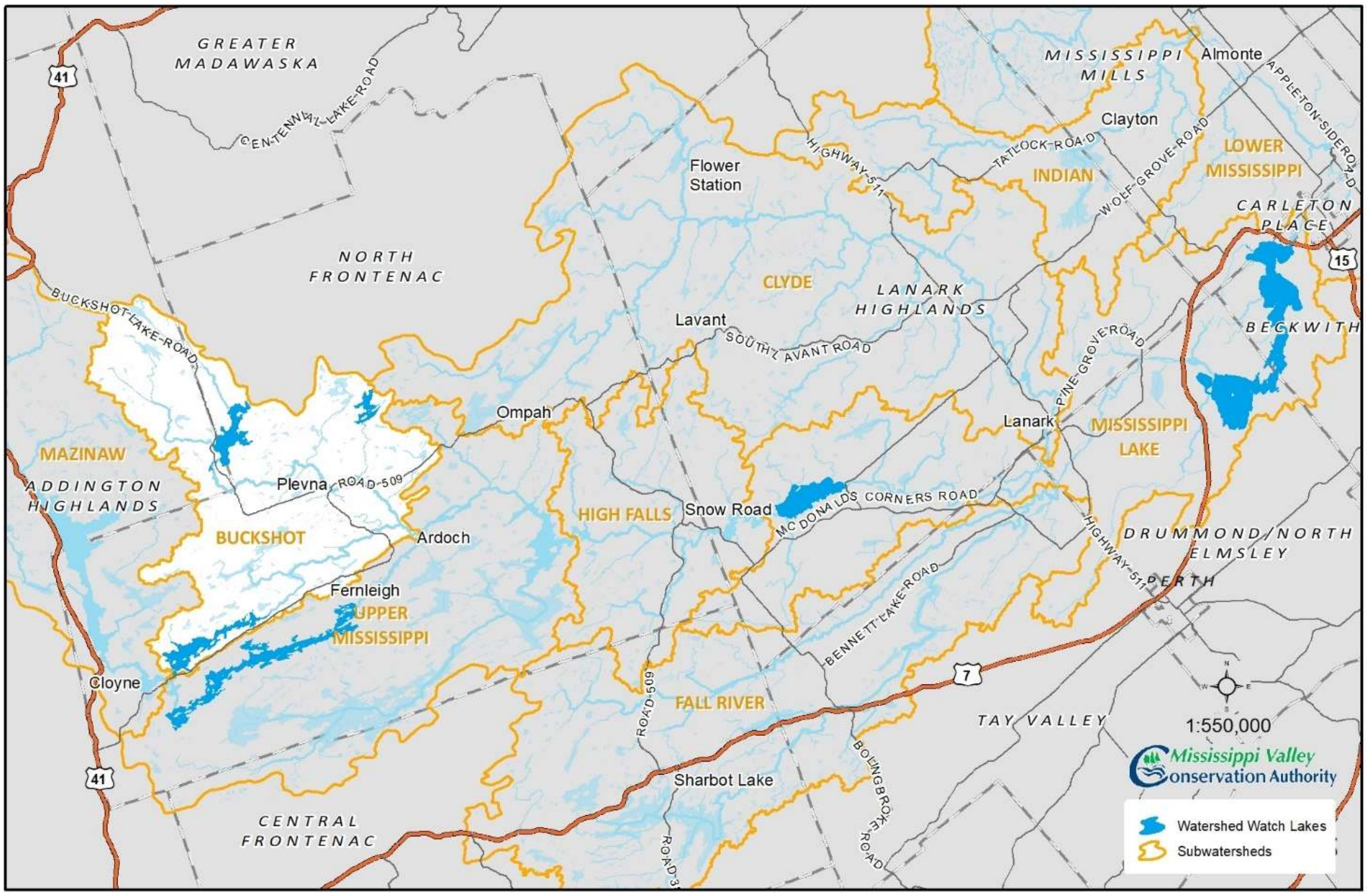


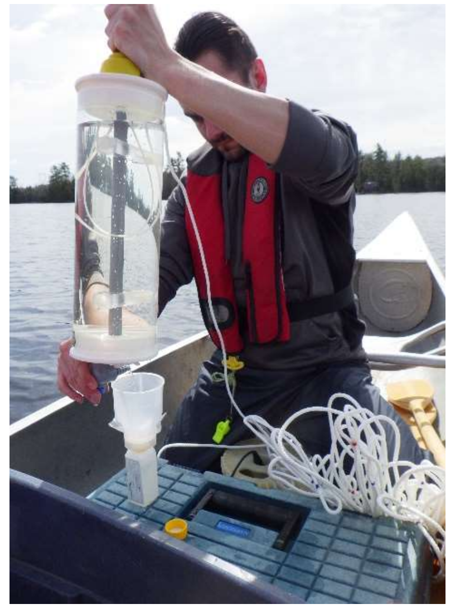
Figure 6: The lakes shown in darker blue are the 6 lakes monitored in 2020. The Buckshot subwatershed is shown in white.

Table 1: Lakes sampled in 2020.

Mississippi Main Stem	Clyde River Subwatershed
Kashwakamak Lake	Buckshot Lake
Dalhousie Lake	Mississagagon Lake
Mississippi Lake	Grindstone Lake

Results Summary

Due to the Covid-19 pandemic all sampling was delayed in 2020 until a sampling plan could be developed that would ensure the safety of staff and watershed residents. In June it was decided to proceed with a reduced sampling schedule of two visits to only six lakes.



Filtering a bottom sample

Overall, the lakes sampled in 2020 were consistent with historic trends for Total Phosphorus (TP) levels, Secchi depth and trophic status. The lakes will continue to be sampled as part of the regular rotation to further support the establishment of a long-term data set characterizing the condition of watershed lakes.

To help interpret and display the results of the lake monitoring program, a box and whisker plot has been used. This type of chart is used to highlight the middle 50% of the data set. In other words, 50% of all data points lie within the box and the additional 50% is shown by the lines (whiskers) extending from the top and bottom of the box, 25% respectively. The median value of the data set is shown with a line indicating the middle of the data set. Outliers are any data points that fall outside of the reach of the box and whisker area. This type of graph shows if any results are considered outliers from the data set as dots above/below the whiskers. As seen in the examples below (Figure 9 and 10). MVCA has chosen to use Box and Whisker plots in order to help interpret the TP results seen in 2020 against the full data set for each of the sampling locations. If a result is between the minimum and maximum values, it could would tend to indicate that the value was a part of the natural variance in the lake. When a TP result is determined to be beyond the minimum or maximum values, it is classified an outlier, indicating that the result could be attributed to sampling error or contamination. The lakes will continue to be monitored as part of the regular sampling rotation which enhances the robustness of MVCA's long-term data set and improves understanding of yearly results.

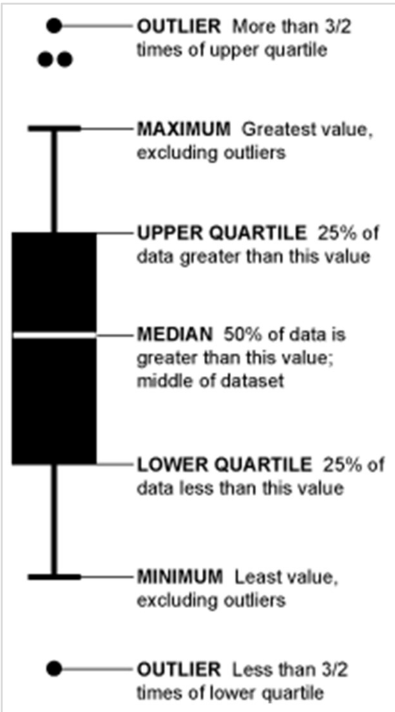


Figure 7: How to interpret a Box and Whisker Plot.

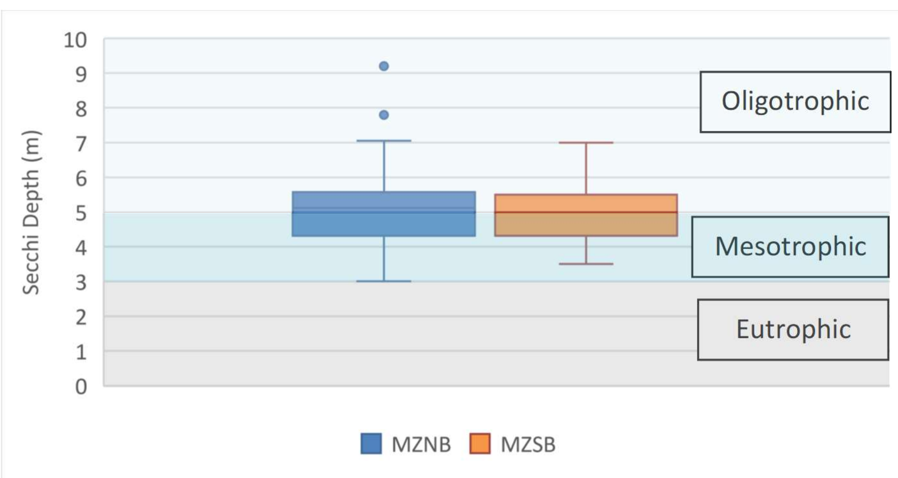


Figure 8: An example of a box and whisker plot from Mazinaw Lake's 2019 Secchi depth results compared to trophic statuses.

Lake Monitoring Indicators and Methodology

The Lake Monitoring Program tests for six water quality parameters. These parameters are selected for their relative simplicity of collection, reproducibility, and ability to determine trophic status. These parameters are further described below.

Calcium

Calcium in lakes is a measure of the levels of calcium (Ca^{2+}), magnesium (Mg^{2+}) and bicarbonate (HCO_3^-) ions in the water. Higher levels of these ions classify the water as 'hard' water, and lower levels 'soft' water. This can be measured various ways but is usually done either as the concentration of free calcium ions (Ca^{2+}) (mg/L) or, calcium hardness because most hard water ions stem from calcium carbonate ($CaCO_3$ in mg/L). For this program, MVCA measures calcium hardness in the field then the result is multiplied by 0.4 to determine the concentration of calcium freely available in the water. Calcium in freshwater usually falls within the range of 4 to 100 mg/L.

Calcium enters a lake largely through the mineral weathering of rocks (especially marbles and limestones). It is then either used by aquatic organisms for bones or shells or as a component in the cell walls of aquatic plants, and eventually deposits into the sediment of the lake. Because of its importance in shell/body coverings, calcium has been shown to influence zooplankton (small planktonic invertebrates) communities, which are an important food source for many baitfish species. Higher calcium levels are also required for zebra mussels to thrive.

Calcium sampling only occurs as part of the spring sampling protocol. Due to the lake monitoring program being on hold during May, Calcium levels were not monitored in 2020.

Secchi Depth

Secchi depth is a measure of water clarity and is collected using a Secchi disc. The Secchi disc is a black and white disc that is lowered into the water on the shady side of the boat to the point where it can no longer be seen. The greater the Secchi depth, the clearer the lake is. The Secchi depth also helps determine the euphotic zone (the depth of water through which light is able to penetrate). Secchi depth can be influenced by the concentration of algae or the presence of other suspended materials in the water. The presence of zebra mussels can also influence Secchi depth as they filter the water and feed on the algae and zooplankton, making the water clearer and possibly increasing Secchi depths. Often a decrease in Secchi depth occurs in unison with an increase in phosphorus. The following guideline shown in Table 3 is used to determine your lake's nutrient status according to Secchi depth.

Secchi disc

Table 3: Interpreting Secchi disc results.

Secchi Depth	Lake Nutrient Status
> 5 meters	Oligotrophic – unenriched, few nutrients
3.0 – 4.9 meters	Mesotrophic – moderately enriched, some nutrients
< 3.0 meters	Eutrophic – enriched, higher levels of nutrients

Total Phosphorus

Phosphorus is an essential nutrient for all living organisms as it plays a role in numerous aspects of biological metabolism. It is also the limiting nutrient in biological activity and therefore when phosphorus levels get too high there tend to be adverse effects such as algae blooms. Phosphorus can be found naturally in the environment, as well as in many man-made products such as soaps, detergents, fertilizers and septic waste. Total phosphorus (TP) is measured in micrograms per liter (µg/L).

Kemmerer Bottle

As part of the Lake Monitoring program, two types of total phosphorus levels are measured at each sampling location: euphotic zone phosphorus (TPA) and bottom phosphorus (TPB). All TP samples are filtered through an 80-micron mesh to remove zooplankton which could skew results. The euphotic zone is defined as twice the Secchi depth and is the depth to which light can reach and influence plant growth.

The bottom phosphorus sample is collected at sites that have a depth greater than the euphotic zone, using a device called a Kemmerer Bottle. The bottle is sent down to the appropriate depth, approximately 1 meter off the bottom of the lake, with both ends open. A weight on the rope is then dropped, causing both ends to close when the weight hits the bottle, sealing the sample water in the bottle, providing a discrete volume of water from the appropriate depth.

Total phosphorus levels provide an accepted standard to characterize a lake's trophic status following the general guidelines seen in Table 2. It should be noted that while these numbers provide an idea of a lake's current trophic status, lakes naturally progress over time from oligotrophic to eutrophic, so an 'ideal' trophic status does not exist. Furthermore, natural variation can cause a great deal of change from year to year and even within years, so it is important to look at larger trends rather than one or two exceptional years.

Table 2: Interpreting total phosphorus results.

Total Phosphorus Level	Lake Trophic Status
< 10 µg/L	Oligotrophic – unenriched, few nutrients
10.1 – 19.9 µg/L	Mesotrophic – moderately enriched, some nutrients
> 20 µg/L	Eutrophic – enriched, higher levels of nutrients

The Provincial Water Quality Objective (PWQO) for phosphorus in lakes is 20 µg/L (*Water Management, Policies and Guidelines, Provincial Water Quality Objectives of the Ministry of the Environment and Energy. MOE. 1994*). The goal is to keep phosphorus below this level in order to maintain aquatic health and the recreational value of watershed lakes.

pH

The pH scale is a logarithmic measure of the concentration of hydrogen ions in solution. It is a measure of the acidity of a solution and ranges from 0 to 14. A pH of 7 is considered neutral, values above 7 are basic, and values below 7 are acidic. The logarithmic scale means that a change from pH 7 to pH 8 is a ten-fold decrease in the concentration of hydrogen ions in solution.

The acidity of a water body affects all chemical reactions within the water. Even small changes in pH can have a large influence on the solubility of some nutrients, including phosphorus, which in turn can influence plant growth. The PWQO for pH in lakes is 6.5 – 8.5, which ensures optimal conditions for most aquatic species.

Dissolved Oxygen and Water Temperature

Dissolved oxygen (D.O.) is essential to all aquatic life, including fish, invertebrates and bacteria. Many factors can influence dissolved oxygen concentrations in a lake but two key factors are lake stratification (water temperature) and the amount of phytoplankton (microscopic algae) produced in the lake.

Lake stratification is the separation of the lake into three layers: the epilimnion (top layer), metalimnion (middle layer) and the hypolimnion (bottom layer). Stratification is caused by changes in water temperature with depth, and occurs from late spring to early fall.

Optical Dissolved Oxygen Probe

Deeper water D.O. is at its lowest during the late summer and early fall. This is when the water in the hypolimnion cannot recharge its oxygen concentrations because it is isolated from the atmosphere by the epilimnion and the thermocline (the steep temperature gradient between the warm sunlight epilimnion water and the cooler hypolimnion water below). Also, during the fall the phytoplankton that have been active during the summer months begin to die and settle to the bottom of the lake. The bacteria that decompose the phytoplankton consume large amounts of dissolved oxygen, further depleting stores in the hypolimnion. The low levels of D.O. in the bottom depths of a lake decrease the amount of critical habitat available for cool water fish species to thrive as they can also be stressed by the warmer temperatures in the oxygen rich epilimnion.

Dissolved oxygen and water temperature are measured using an Optical Dissolved Oxygen Probe. This instrument, pictured above, is lowered through the water at one-meter intervals, where it takes both water temperature and D.O. readings. This creates a dissolved oxygen profile where changes in temperature and D.O. can be recorded as depth increases. Table 4 shows the optimal temperature/D.O. combinations for cold, cool, and warm water fish habitat. Results from the D.O. and water temperature profiles for each of the 2020 lake monitoring sites are available in Appendix A.

Table 4: Optimal conditions for different fish habitat.

	Dissolved Oxygen		Water Temperature
Cold Optimal	>6 mg/L	AND	<10 °C
Cool Optimal	>4 mg/L	AND	<15.5 °C
Warm Optimal	>4 mg/L	AND	<25 °C

Source: Coker, G.A., Portt, C.B., & Minns, C.K.(2001). Morphological and Ecological Characteristics of Canadian Freshwater Fishes. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2554.

Main Mississippi River Lakes

Kashwakamak Lake

Kashwakamak Lake is a deep cold-water Canadian Shield lake along the main Mississippi River. It is 25 meters deep and supports cold-water fish species such as Lake Herring, Lake Whitefish and Brook Trout. Warmer water fish such as northern pike, walleye, yellow perch, small and large mouth bass can also be found here.

Based on Secchi depth and surface water total phosphorus results in 2020 (Table 5, Figure 9) the lake maintains its oligotrophic status.

The water temperature and dissolved oxygen profile from the 2020 sampling events are available in Appendix A.

Table 5: 2020 sampling summary for Kashwakamak Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L)
East Basin	July 8, 2020	5.5	10	9
East Basin	Sept 23, 2020	4.5	8	9
West Basin	July 8, 2020	4	6	13
West Basin	Sept 23, 2020	4	9	14

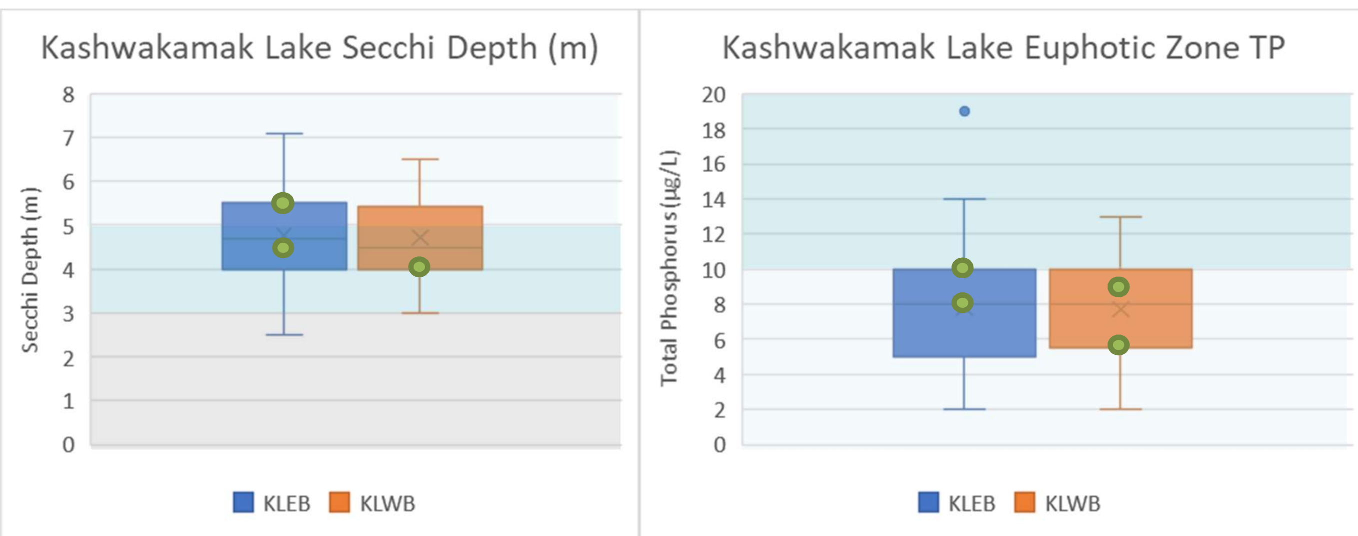


Figure 9: Secchi Depth and Euphotic Zone Total Phosphorus results from six sampling years for both basins of Kashwakamak Lake, compared to the 2020 results shown with a green dot, as compared to the trophic level classifications.

Dalhousie Lake

Dalhousie Lake is the last main river lake before the Clyde and Fall Rivers join the Mississippi River near Lanark and is located at the transition between the Canadian Shield and the St. Lawrence lowlands geologic zones. It is a wide and shallow lake with the deepest area, at 17 meters, located in the western portion of the lake. The lake provides warm water habitat to northern pike, small and large mouth bass, walleye and other fish species.

A summary of the 2020 sampling results are shown in Table 6 and are compared to past years results in Figure 10. Dalhousie lake has maintained a mesotrophic status throughout the eight ice-free seasons that it has been sampled by MVCA. The 2020 sample results further support this classification.

In 2020 Dalhousie Lake experienced very low (< 2 mg/L) levels of dissolved oxygen in the bottom 3 m of the water column during both the July and September sampling events. At certain times of year Dalhousie Lake can have a high flushing rate due to the high riverine flows passing through this part of the watershed. However, during the summer months when river flows are reduced, the mixing and flushing of the bottom lake water may also be reduced. As seen in Table 6, bottom sample total phosphorus results for Dalhousie Lake in 2020 are very high. In 2017, 2018, and 2019 high bottom sample values also occurred. It is possible that these high TP values are linked to a chemical process that dissolved phosphorus from the sediment back into the water column under low dissolved oxygen conditions. As a large main river lake, Dalhousie will continue to be monitored frequently to track the lake's condition, in particular the high total phosphorus in the bottom waters.

The water temperature and dissolved oxygen profile data from the 2020 sampling events are available in Appendix A.

Table 6: 2020 sampling summary for Dalhousie Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L)
Main Basin	July 7, 2020	4.5	17	45
Main Basin	Sept 8, 2020	3	7	99

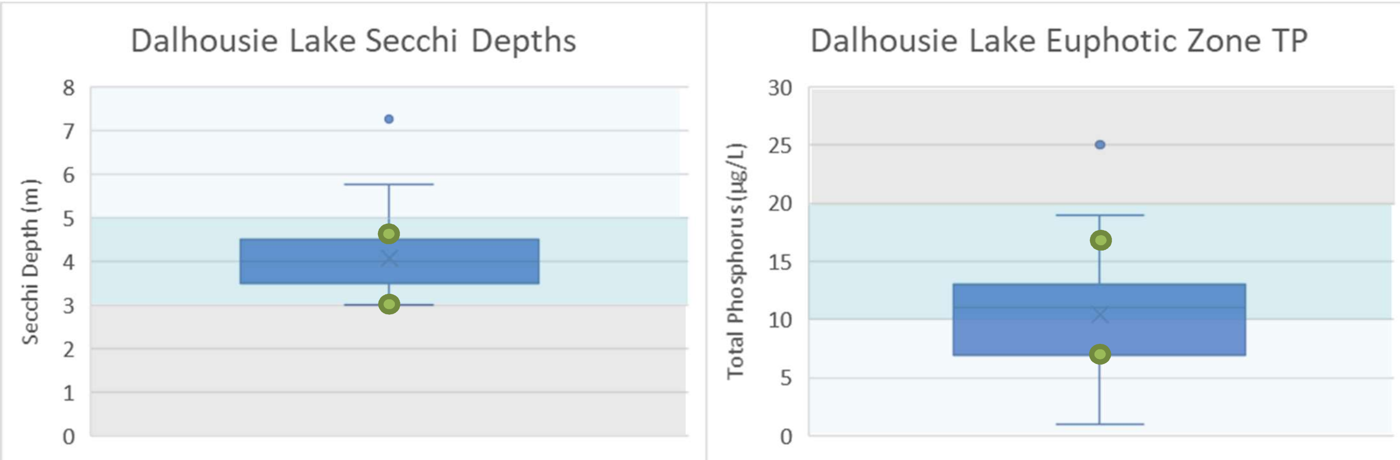


Figure 10: Secchi Depth and Euphotic Zone Total Phosphorus results from eight sampling years for the main basin of Dalhousie Lake, compared to the 2020 results shown with a green dot, as compared to the trophic level classifications.

Mississippi Lake

Mississippi Lake is a large and shallow warm water lake in Lanark County. It is the most downstream lake on the main stem of the Mississippi River system and its outlet is at the town of Carleton Place. It has a maximum depth of 10 meters. MVCA has now monitored it through 16 ice-free seasons. A summary of the results from the 2020 survey are presented in Table 7.

Figure 11 illustrates how this year's results for Secchi depth and euphotic zone total phosphorus samples compare with the overall data set for each of the four sampling locations on the lake. Figure 11 shows all historical Secchi depth and euphotic zone TP data for Mississippi Lake. When the whole dataset is compared it is clear that the 2020 data is within the normal range. The overall historical trend for both Secchi depth results and TP show the lake is predominantly within the mesotrophic classification and the 2020 results further support this classification.

Water temperature and dissolved oxygen profile data from the 2020 sampling events are available in Appendix A.

Table 7: 2020 sampling summary for Mississippi Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L) *
Inlet (MLI)	July 9, 2020	4	9	18
Inlet	Sept 18, 2020	3.5	8	9
Burnt Island (MLB)	July 9, 2020	3.5	10	19
Burnt Island	Sept 18, 2020	3	11	10
Pretties Island (MLP)	July 9, 2020	3.2	13	-
Pretties Island	Sept 18, 2020	3	10	-
Outlet (MLO)	July 9, 2020	2	11	-
Outlet	Sept 18, 2020	2	11	-

*Total Phosphorus samples are only taken from 1 m off the bottom of the lake if the euphotic zone does not extend to the bottom.

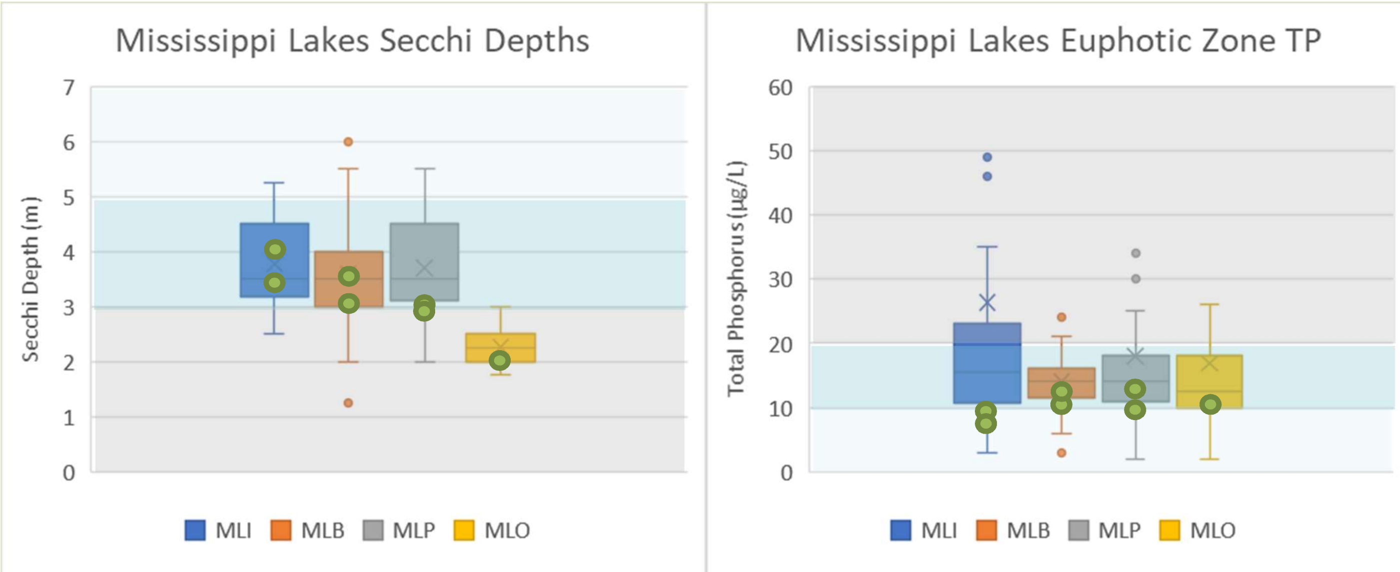
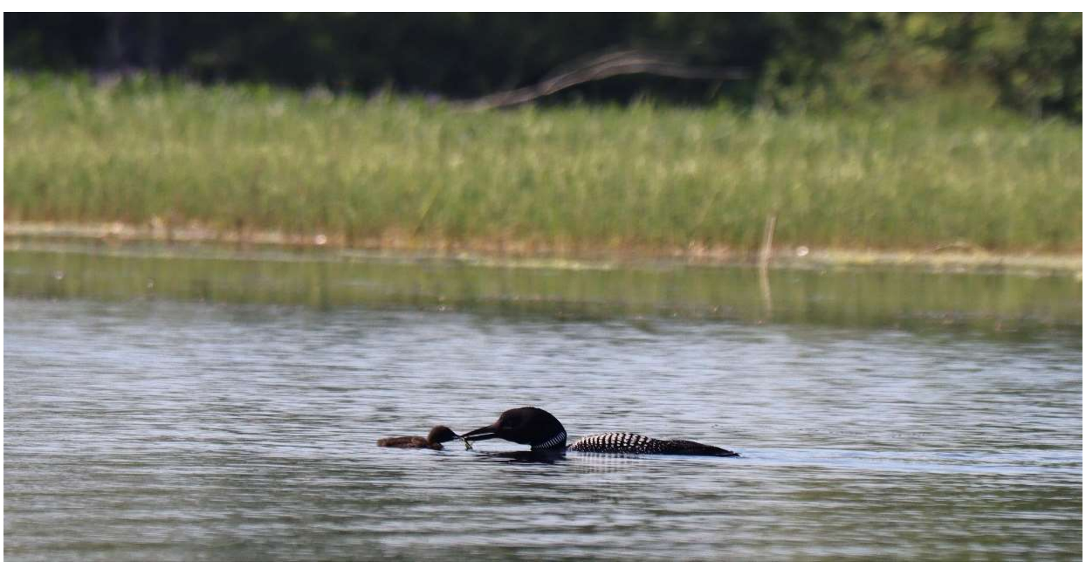


Figure 11: Secchi Depth and Euphotic Zone Total Phosphorus results from 16 sampling years for all four sites, compared to the 2020 results shown with a green dot, as compared to the trophic level classifications. Note: the maximum Secchi depth possible at the outlet site (MLO) is limited by the water depth (3 m) and by a thick bed of aquatic plants inhabiting the area.



Buckshot Creek Subwatershed Lakes

Buckshot Lake

Buckshot Lake is a deep cold-water Canadian Shield lake in the northern headwaters of the Buckshot Creek subwatershed. It is 34 meters deep and supports cold-water fish species such as Lake Trout and Brook Trout. Warmer water fish such as walleye, yellow perch, small and large mouth bass can also be found here.

Data from the 2020 sampling events can be found in Table 8 and Figure 12. As can be seen in in the box and whisker plots, both Secchi depth and TP values align with the data collected in previous years. Historically (4 sampling years) the lake has typically maintained an oligotrophic status, sampling results from 2020 (green points in Fig 11) further support this classification. Based on Secchi depth and surface water total phosphorus results in 2020 (Table 8, Figure 12) the lake maintains an oligotrophic status.

The water temperature and dissolved oxygen profile data from the 2020 sampling events are available in Appendix A.

Table 8: 2020 sampling summary for Buckshot Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L)
Main Basin	July 14, 2020	6	5	9
Main Basin	Sept 11, 2020	4	9	8

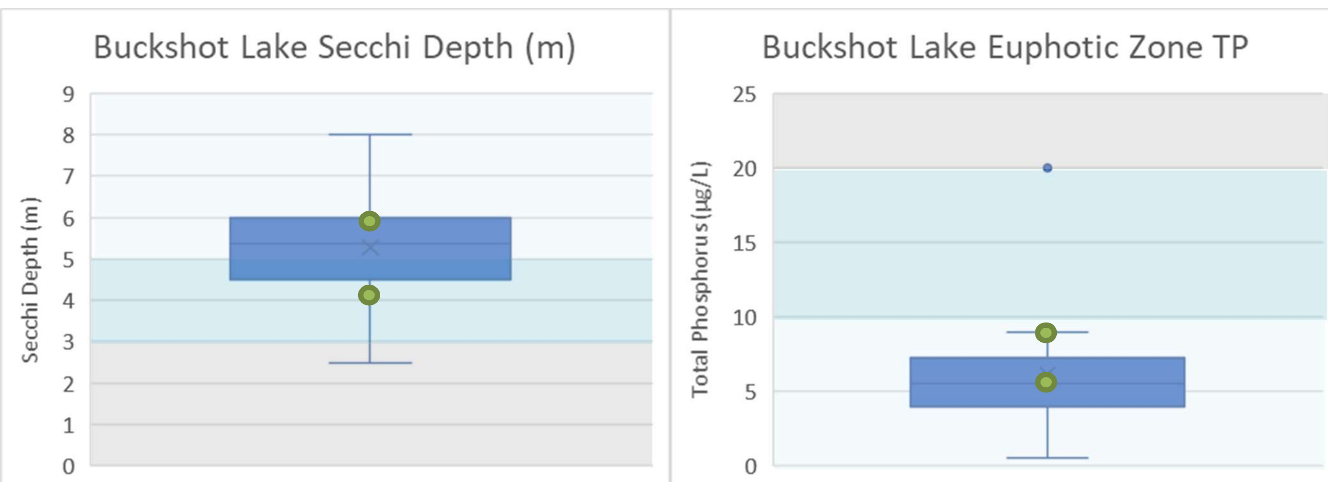


Figure 12: Secchi Depth and Euphotic Zone Total Phosphorus results from five sampling years for Buckshot Lake, compared to the 2020 results shown with a green dot, as compared to the trophic level classifications.

Mississagagon Lake

Mississagagon Lake is a large cold-water Canadian Shield lake in the western headwaters of Buckshot Creek, west of Ardoch. It is 23 m deep and is known to support warm-water fish such as northern pike, yellow perch, small and largemouth bass and walleye. It also supports cold-water fish like lake herring. The Secchi and TP results from the 2020 season are shown in Table 9 and results from both basins are compared to past years in Figure 13.

Figure 13 clearly shows the 2020 sample values (green points) generally fall within the normal distribution of sampling point for Mississagagon Lake. Based on the data collected in 2020 the lake is classified as oligotrophic, this is in line with historical values for Mississagagon Lake. Based on Secchi depth and surface water total phosphorus results from the 2020 season, the lake maintains its oligotrophic classification.

The water temperature and dissolved oxygen profile data from the 2020 sampling events are available in Appendix A.

Table 9: 2020 sampling summary for Mississagagon Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L)
East Basin	July 15, 2020	5	6	4
East Basin	Sept 22, 2020	6.5	10	10
West Basin	July 15, 2020	6.5	4	3
West Basin	Sept 22, 2020	6.5	9	12

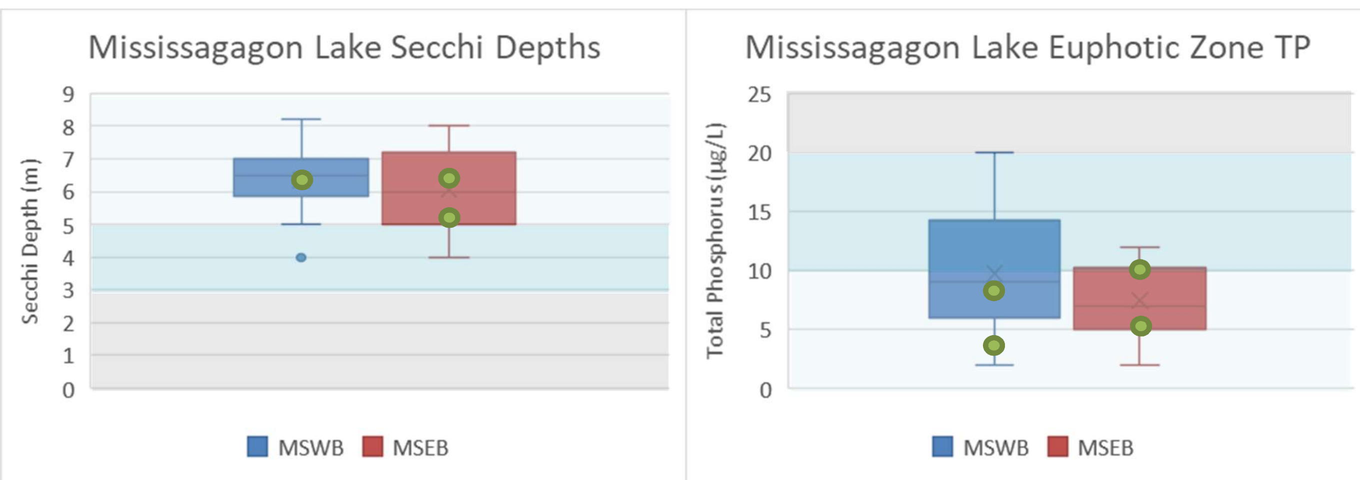


Figure 13: Secchi Depth and Euphotic Zone Total Phosphorus results from five sampling years for both basins in Mississagagon Lake, compared to the 2020 results shown with a green dot, as compared to the trophic level classifications.

Grindstone Lake

Grindstone Lake is a cold-water Canadian Shield lake in the eastern headwaters of Buckshot Creek, east of Plevna. It is 31 m deep lake and supports cold water fish species such as lake trout, brook trout, rainbow trout, splake and lake herring.

The results from the 2020 season are shown in Table 10 and are compared to past years results in Figure 14. Based on Secchi depths and average euphotic zone total phosphorus results from five sampling seasons the lake is classified as meso-oligotrophic.

The water temperature and dissolved oxygen profile data from the 2020 sampling events are available in Appendix A.

Table 10: 2020 sampling summary for Grindstone Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L)
North Basin	July 21, 2020	6	7	-
North Basin	Sept 15, 2020	8	7	8
South Basin	July 21, 2020	6	12	-
South Basin	Sept 15, 2020	5	3	-

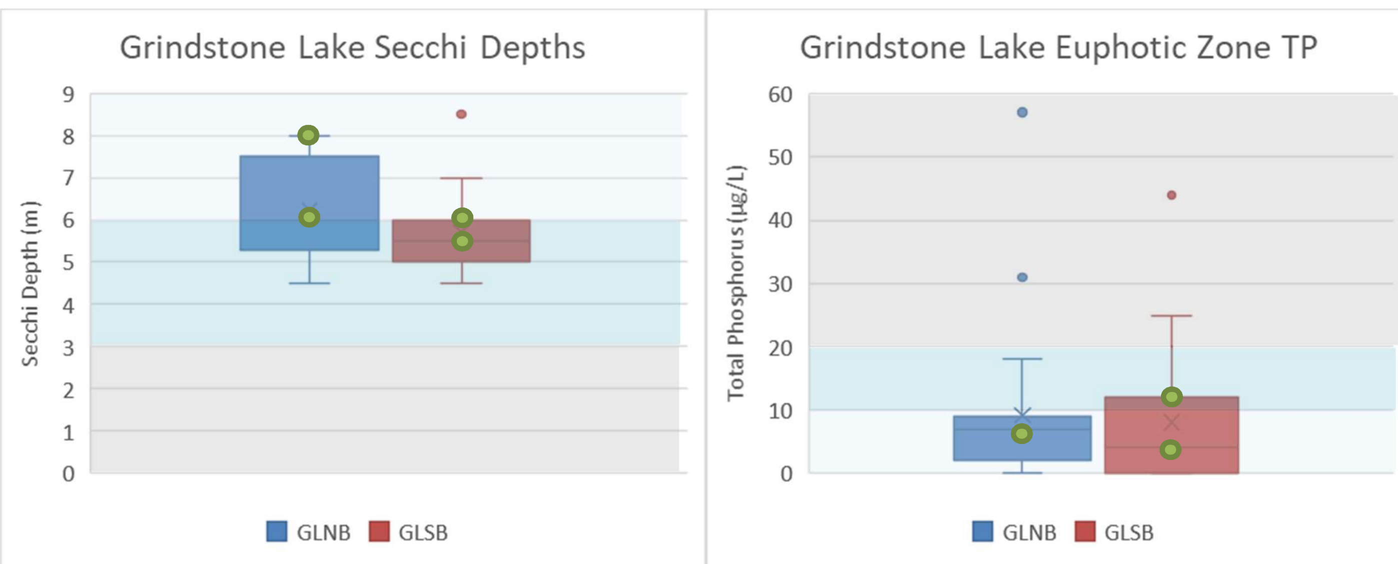


Figure 14: Secchi Depth and Euphotic Zone Total Phosphorus results from five sampling years for the main basin of Grindstone Lake, compared to the 2020 results shown with a green dot, as compared to the trophic level classifications.

Stream Monitoring Program

Summary

While the monitoring program focusses efforts on particular subwatershed(s) each year on a rotational basis, stream sampling is conducted at select additional sites throughout the Mississippi River watershed to help expand MVCA's knowledge of these smaller systems. Due to the Covid-19 pandemic only temperature monitoring data was collected. Figure 15 illustrates the locations of these sites across the Mississippi River watershed and Table 11 summarizes the stream site thermal results for 2020.

Brook Trout

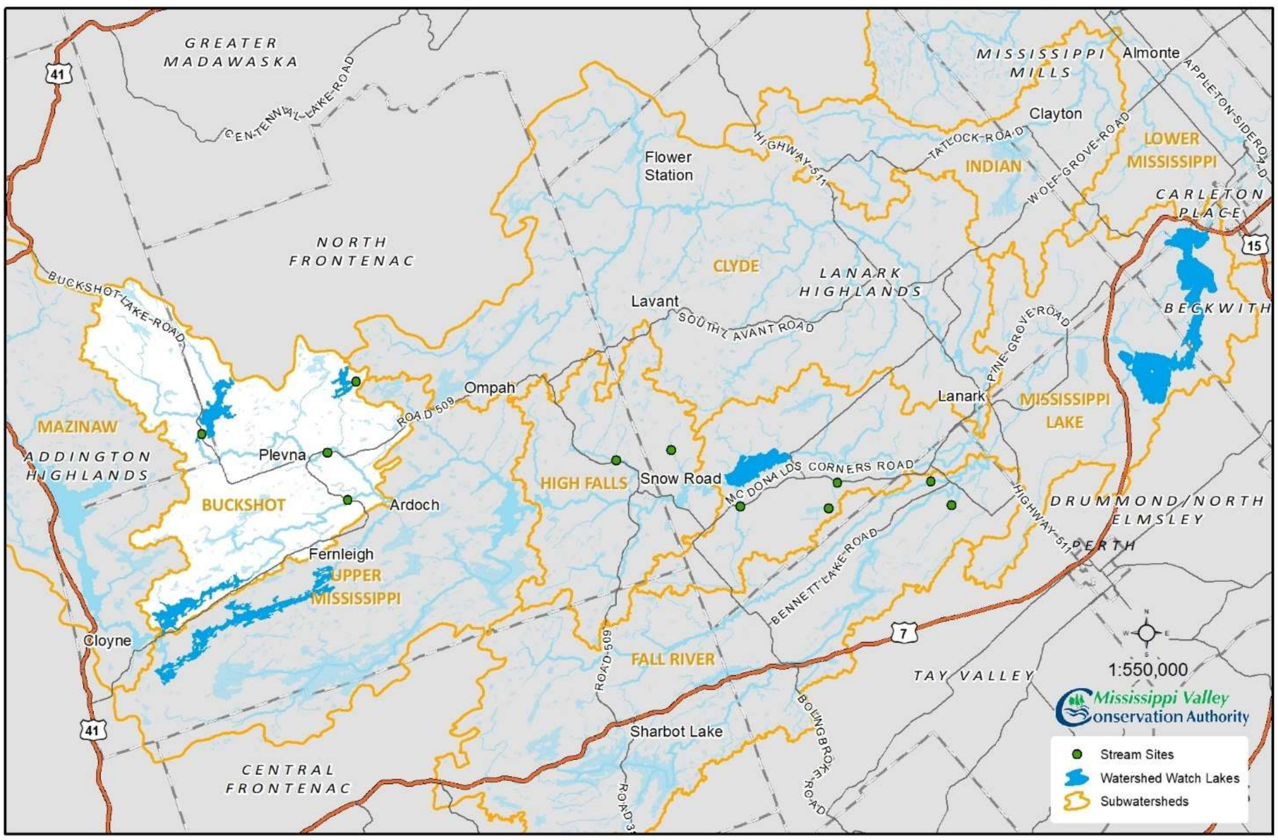


Figure 15: 2020 stream sampling site locations.

Temperature Monitoring

Many factors can influence fluctuations in stream temperature, including springs, tributaries, precipitation runoff, discharge pipes and stream shading from riparian vegetation. The natural year to year variations of water temperatures can be influenced by many factors, (duration and frequency of rain events, flow rates from springs, changes in stream shading, etc.) and can have many impacts on the stress levels and success rates of the cold to cool water fish species that are found in the creek. Water temperature is used along with the maximum air temperature (using the revised Stoneman and Jones method by Cindy Chu *et al, 2009*) to classify a watercourse as either cold, cold-cool, cool, cool-warm, or warm water. Refer to Table 11 for a summary of the thermal classification results from the 2020 season.


Deploying a temperature logger

Temperature loggers were launched at 11 stream sites in the Mississippi River watershed to investigate thermal habitat availability and to continue monitoring known cold to cool water streams for potential variations due to changes in annual climate. For example, Burbot, a cold-water fish, continues to be caught in Bolton Creek however analysis of the data from the temperature loggers have classified that reach as warm water habitat in 2018, 2019 and 2020.

Table 11: A summary of the Mississippi River watershed stream sites sampled in 2020 with their thermal classification results.

Subwatershed	Stream Name	2020 Thermal Classification
Buckshot Creek	Buckshot Creek (Downstream)	Warm
Buckshot Creek	Buckshot Creek (Upstream)	Warm
Buckshot Creek	Swamp Creek - at Hwy 506	Not Available
Buckshot Creek	The outlet creek from Grindstone Lake- at Grindstone lk rd	Warm
Fall River	Bolton Creek	Warm
Fall River	Limekiln Creek	Cool
High Falls	Antoine Creek	Cool
High Falls	Mosquito Creek	Cool
Mississippi Lake	Long Sault Creek (Downstream)	Cool
Mississippi Lake	Long Sault Creek (Upstream)	Warm
Mississippi Lake	Paul’s Creek	Cool-Warm

The 2020 season started with an average melt event. Then the summer was hot and dry and a drought condition was classified from July 15th to September 1st.

Analysis of the temperature logger data indicates that the warm, dry conditions influenced the in-stream water temperatures, and resulted in some loggers not collecting information as they were in dry conditions. There is a need for continued monitoring at these stations to determine if the observed thermal fluctuations are an ongoing trend or a temporary condition due to the hot dry conditions experienced in the last few summers.

Water temperature in Paul's Creek has now been monitored for four consecutive ice-free seasons. In 2017 the creek was classified as cool, however in 2018 the system was classified as a cool-warm system and has stayed within that range since then. Bolton Creek had a similar warming between a cool-warm classification in 2017 and a warm classification in 2018. In 2019 and 2020 Bolton Creek has remained classified as warm. Cold water fish are still found in both systems indicating that there are sufficient cool water refuges near the study sites to maintain these populations.

Mosquito Creek has been monitored for three years now and has been classified as a cool water to cold-cool water system over that time.

Lastly, in contrast to the observed warming discussed above, Long Sault Creek became cooler after 2017 it has remained within a cool water classification.

Shoreline Stewardship

MVCA's Tree Planting Programs

Shoreline tree planting is an effective way to protect water quality, combat erosion, clean the water, and create healthy habitat for fish, birds, pollinators and other wildlife. To help with this, MVCA has two programs that distribute native species of trees and shrubs to waterfront properties within the watershed.

MVCA administers a small-scale shoreline planting program where MVCA staff conduct a site visit then work with the property owners to design a shoreline planting plan that will suit their property's needs. MVCA then orders, delivers and installs the plants according to the agreed upon plan. In 2020, this program resulted in 330 trees and shrubs being planted across 8 properties.

For the past three years, MVCA has been working with a select number of lake associations on a rotational basis to pilot a free tree event, where property owners are offered up to 15 shoreline plant species per property. In 2020, MVCA partnered with the Mississagagon Lake Association and the Shabomeka Lake Association to distribute 425 plants to 26 properties. Due to the continued success of this program within the lake community, MVCA will be working with Sharbot Lake and Dalhousie Lake in 2021.

Lake Planning

2020 Activity Summary

MVCA has a mandated role to address natural hazard issues, such as flooding and erosion in the review of planning applications under the Planning Act. Additionally, in an advisory role, applications are reviewed within the context of Natural Heritage values such as wetlands, wildlife and fish habitat; as well as water quality and quantity. MVCA also administers Ontario Regulation 153/06. The purpose of this regulation is to prevent loss of life and property due to flooding and erosion, and to conserve and enhance natural resources. In MVCA regulated areas (floodplains, shorelines and wetlands), permission is required from MVCA for development, interference with wetlands, and alterations to shorelines and watercourses.

In 2020, MVCA planning and regulations staff reviewed 34 permit applications on the lakes monitored in 2020. This represents 19% of the total permits issued in 2020.

Having reliable information about the health of a lake is essential for providing appropriate and effective recommendations on development applications. Data from the lake monitoring program assists MVCA in providing recommendations that mitigate impacts of shoreline development. It also serves to encourage and assist shoreline residents, both seasonal and permanent, to become stewards of their lake by taking an active role in restoring and enhancing their shoreline. Stewardship initiatives that protect and enhance water quality include temporarily storing water (eg. rain barrels), directing runoff away from the lake (e.g. installing properly working eavestroughs), creating or enhancing surfaces to allow more water to infiltrate rather than run off along the surface (e.g. rain gardens), and planting trees and shrubs along the shoreline.

Appendix A: Water Temperature and Dissolved Oxygen Profile Details

The results from the 2020 temperature and dissolved oxygen profiles from all the lake sampling events are presented below in alphabetical order. For the lakes with appropriate cool to cold water conditions, a colour code has been applied to the table representing optimal cold-water habitat conditions (in blue) and the fringe vital conditions for survival (in pink) as defined in Table A-1. Some of the warm water lakes may be shown to have these conditions periodically but they do not last throughout the season and thus they only support a warm water fishery.

Table A-2 summarizes the thermal classifications for the lakes sampled in 2020. Some of the cold-water lakes may no longer support certain cold-water fish species (such as lake trout) due to historical stocking activities or water level management efforts.

Table A-1: Optimal and vital habitat conditions for cold water fish species such as trout.

(blue)	Optimal Habitat for Cold Water Fisheries (Trout) = DO > 6 mg/L at < 10°C
(orange)	Vital Habitat for Cold Water Fisheries (Trout) = DO > 4 mg/L at < 15.5°C

Table A-2: List of cold water and warm water lakes monitored in 2020.

Cold Water Lakes	Warm Water Lakes
Kashwakamak Lake	Dalhousie Lake
Missagagon Lake	Mississippi Lake
Buckshot Lake	
Grindstone Lake	

Buckshot Lake

	June 14 2020		September 11 2020	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	26.1	7.91	17.6	9.98
1	26.1	7.9	17.7	9.88
2	25.8	7.92	17.7	9.86
3	25.7	7.92	17.7	9.81
4	25.7	7.87	17.7	9.79
5	19.7	8.51	17.7	9.77
6	14.7	8.24	17.7	9.74
7	11.7	8.34	17.7	9.71
8	10.2	8.4	13.9	6.74
9	9.5	8.46	11.3	6.78
10	8.9	8.47	9.9	7.14
11	8.5	8.47	9.1	7.25
12	8.3	8.61	8.7	7.38
13	8	8.71	8.4	7.53
14	7.8	8.75	8	7.77
15	7.5	8.8	7.8	7.99
16	7.3	8.85	7.6	8.08
17	7.2	8.85	7.4	8.1
18	7.1	8.89	7.2	8.14
19	7	8.73	7	7.81
20	6.9	8.67	6.9	7.83
21	6.8	8.7	6.8	7.84
22	6.7	8.53	6.7	7.6
23	6.6	8.33	6.7	7.18
24	6.6	8.12	6.6	6.55
25	6.6	8.11	6.5	5.28
26			6.5	5.2
27			6.4	3.55

Dalhousie Lake

Main Basin

	June 7 2020		September 8 2020	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	26.7	9.14	20	9.27
1	26.7	9.14	20	9.24
2	26.4	9.1	20	9.18
3	25.7	9.32	20	9.15
4	24.2	8.79	20	9.11
5	22.6	7.93	20	9.07
6	20.1	6.88	20	9.86
7	15.5	5.81	20	8.89
8	13.6	5.21	18.8	4.28
9	12.1	4.08	15.1	1.18
10	11	2.44	12.3	0.68
11	10.4	1.8	11.3	0.63
12	10.2	1.36		
13	10.1	1.14		
14	10	0.43		

Grindstone Lake

North Basin

	June 21 2020		Sept 15 2020	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	24.7	8.34	17.4	9.71
1	24.9	8.3	17.4	9.67
2	24.8	8.32	17.4	9.66
3	24.8	8.29	17.4	9.65
4	24.7	8.26	17.4	9.64
5	22.2	10.79	17.4	9.63
6	16.9	11.66	17.4	9.59
7	13.2	10.83	17.4	9.55
8	11.7	10.35	17.3	9.54
9	11	9.6	12.9	5.63
10	9.8	5.72	11.4	1.00

South Basin

	June 21 2020		Sept 15 2020	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	25	8.3	17.3	9.8
1	24.9	8.31	17.4	9.77
2	24.8	8.23	17.4	9.73
3	24.7	8.19	17.3	9.74
4	24.6	8.18	17.3	9.81
5	21.9	10.57		

Kashwakamak Lake

East Basin

	June 8 2020		September 23 2020	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	27.3	8.03	17.0	10.35
1	27	8.06	17.0	10.34
2	26.8	8.11	16.9	10.34
3	26.4	8.14	16.9	10.32
4	25.6	8.22	106.9	10.29
5	23.6	8.45	16.9	10.26
6	20.5	8.79	16.8	10.24
7	16.4	9.98	16.8	10.21
8	11.8	11.22	16.8	10.12
9	10.6	11.02	15.8	9.65
10	9.5	10.13	10.7	8.00
11	9.2	9.52	9.9	7.82
12	9	9.11	9.5	5.80
13	8.8	8.96	9.3	6.10
14	8.6	8.8	9.1	6.15
15	8.5	8.68	9.0	5.66
16	8.4	8.64	8.8	5.73
17	8.3	8.46	8.7	5.22
18	8.2	7.95	8.5	4.47
19	8	6.89	8.3	4.07
20	7.8	5.77	8.2	3.24
21	7.8	5.17		

West Basin

	June 8 2020		September 23 2020	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	26.9	8.06	17.3	10.15
1	26.7	8.09	17.1	10.19
2	26.5	8.1	16.9	10.17
3	25	8.45	16.8	10.20
4	23.8	8.65	16.8	10.19
5	21.8	8.85	16.8	10.16
6	19.9	8.95	16.7	10.14
7	16.3	9.85	16.7	10.05
8	12.5	10.88	16.6	9.94
9	10.5	10.4	16.4	9.82
10	9.6	9	13.0	7.20
11	9.1	7.96	10.5	4.96
12	8.8	6.32	9.8	4.01
13			9.5	3.25
14			9.2	1.65

Mississagagon Lake

East Basin

	June 15 2020		September - 2020	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	26.5	8.26	16.6	10.60
1	26.5	8.29	16.8	10.51
2	26.3	8.48	16.8	10.49
3	26	9.12	16.8	10.46
4	24.3	10.33	16.8	10.43
5	22.3	10.58	16.8	10.37
6	19.6	11.02	16.8	10.18
7	16	11.84	16.8	10.13
8	12.5	11.52	16.7	10.34
9	10.6	10.72	16.1	10.06
10	9.9	10.27	12.7	9.64
11	9.5	9.99	10.7	9.22
12	9.3	9.71	10.0	8.21
13	9	9.02	9.7	7.59
14	8.8	8.28	9.5	6.37
15	8.6	5.91	9.4	5.66

West Basin

	June 15 2020		September - 2020	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	26.3	8.13	17.1	10.48
1	26.2	8.15	17.0	10.47
2	26.2	8.13	16.9	10.47
3	26	8.09	16.9	10.46
4	26	8.13	16.8	10.48
5	25.9	8.12	16.8	10.46
6	21.3	11.05	16.8	10.43
7	17.3	12.44	16.8	10.40
8	13.7	12.38	16.8	10.36
9	11.3	11.58	16.2	10.38
10	10.2	11.14	12.9	10.98
11	9.8	10.99	11.1	10.87
12	9.4	10.01	10.4	10.00
13	9	9.09	9.8	9.33
14	8.8	9.72	9.5	8.96
15	8.6	9.21	9.4	8.07
16	8.7	9.07	9.0	7.93
17	8	9.02	8.5	7.48
18	7.8	8.24	8.1	6.25
19	7.6	7.36	7.7	4.65
20	7.3	5.69	7.2	3.73
21			6.9	2.35
22			6.4	0.99
23			6.4	0.75
24			6.4	0.69

Mississippi Lake

Inlet

	June 9 2020		September 16 2020	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	29.2	7.85	16.8	9.74
1	28.8	7.93	16.8	9.7
2	28.6	7.75	16.8	9.68
3	27.4	7.86	16.8	9.62
4	24	7.09	16.8	9.56
5	21	3.25	16.8	9.45
6	18.5	1.4	16.7	9.39
7	17.1	0.48	16.7	9.28
8	16.1	0.42		
9	15.6	0.4		

Burnt Island

	June 9 2020		September 18 2020	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	28.3	8.38	16.6	10.35
1	27.8	8.46	16.7	10.28
2	27.4	8.41	16.8	10.14
3	27.2	8.32	16.8	10.12
4	25.1	6.1	16.8	10.11
5	23.1	3.21	16.9	10.05
6	21.5	1.43	16.9	10.00
7	21.2	0.88	16.8	9.97
8	20.9	0.59	16.8	9.88
9	20.8	0.53		
10	20.6	0.41		

Pretties Island

	June 9 2020		September 18 2020	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	28.6	8.35	16.8	10.21
1	28.0	8.44	16.9	10.19
2	27.4	8.46	17.0	10.15
3	27.0	7.96	17.0	10.14
4	26.5	7.67	16.9	10.16
5	23.8	2.43	16.9	10.12
6	23.3	1.69		

Outlet

	June 9 2020		September 18 2020	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	29.3	8.55	15.7	11.14
1	28.7	8.69	15.7	11.16
2	28.2	10.41		