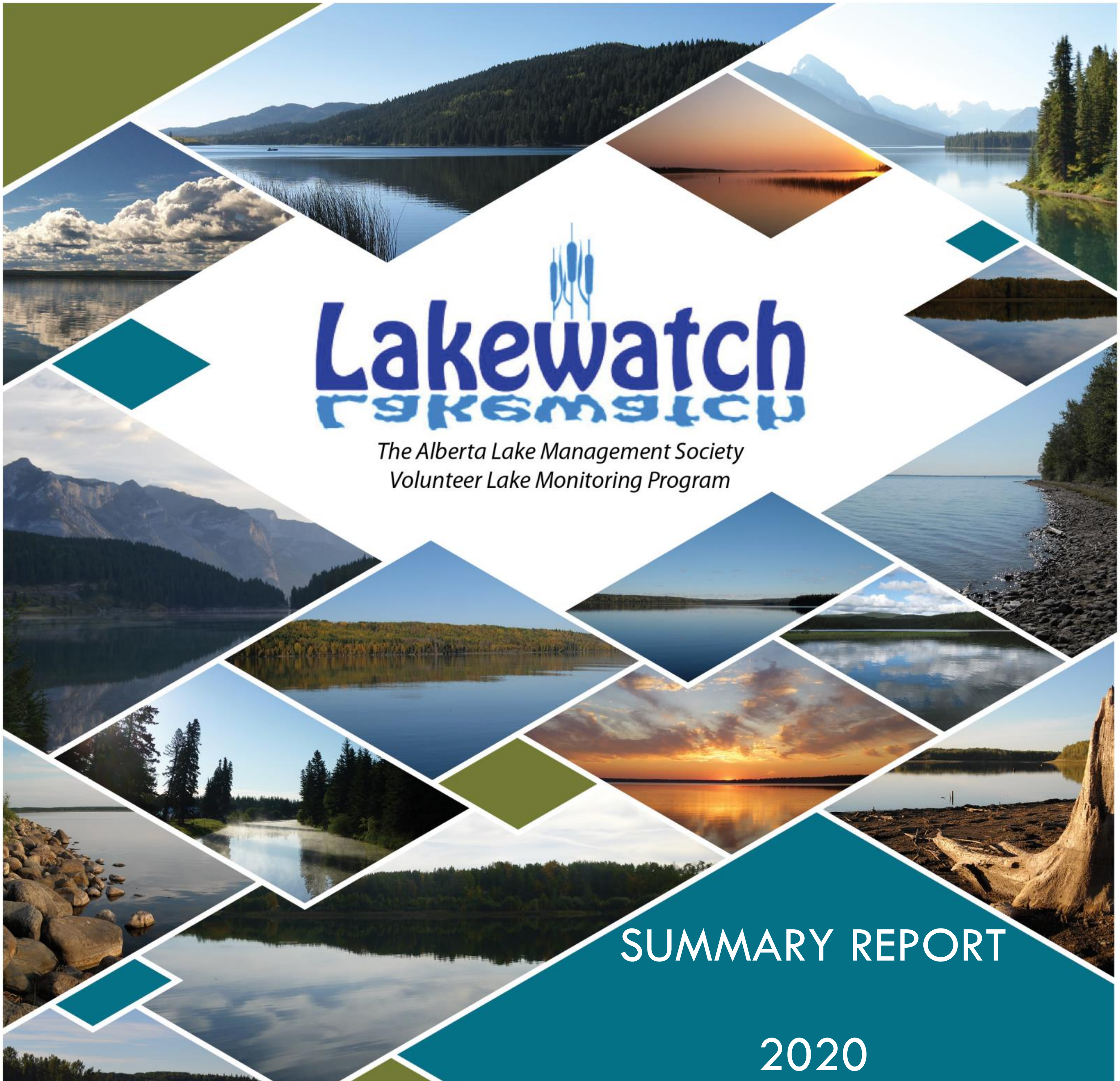


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

SUMMARY REPORT

2020

Updated April 29, 2021

Lakewatch is made possible with support from:

Alberta Environment and Parks
Pigeon Lake Watershed Association
Moose Lake Watershed Society
Lacombe County
LICA Environmental Stewards

ALBERTA LAKE MANAGEMENT SOCIETY'S LAKEWATCH PROGRAM

LakeWatch has several important objectives, one of which is to collect and interpret water quality data on Alberta Lakes. Equally important is educating lake users about their aquatic environment, encouraging public involvement in lake management, and facilitating cooperation and partnerships between government, industry, the scientific community and lake users. LakeWatch Reports are designed to summarize basic lake data in understandable terms for a lay audience and are not meant to be a complete synopsis of information about specific lakes. Additional information is available for many lakes that have been included in LakeWatch and readers requiring more information are encouraged to seek those sources.

ALMS would like to thank all who express interest in Alberta's aquatic environments and particularly those who have participated in the LakeWatch program. These leaders in stewardship give us hope that our water resources will not be the limiting factor in the health of our environment.

ACKNOWLEDGEMENTS

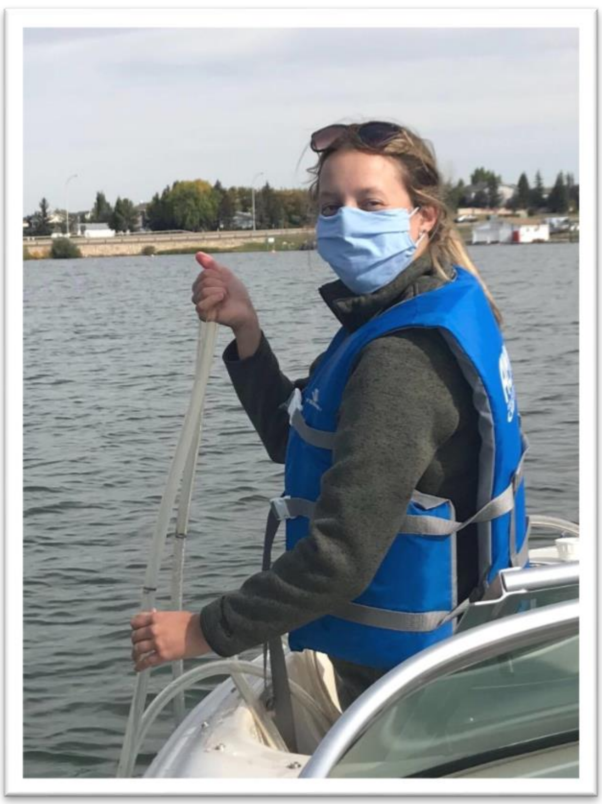
The LakeWatch program is made possible through the dedication of its volunteers. We would also like to thank Kyra Ford and Ryan Turner, who were summer technicians in 2020. Executive Director Bradley Peter and Program Manager Caleb Sinn were instrumental in planning and organizing the field program. This report was prepared by Caleb Sinn and Bradley Peter.

INTRODUCTION

In 2020, ALMS received funding from the Lakeland Industry and Community Association (LICA), the Pigeon Lake Watershed Association, Lacombe County, the Moose Lake Watershed Society, and Alberta Environment and Parks, to conduct LakeWatch, a volunteer participatory water quality monitoring program.

SAMPLE RECORD

Two summer field technicians (Kyra Ford, and Ryan Turner) were hired in May of 2020 to conduct water quality sampling. ALMS completed a provincial park monitoring program at 5 lakes and a standard monitoring program at 20 lakes. From June to September 2020, lakes were visited a maximum of four times each. In 2020, 101 of 101 scheduled trips were completed. This resulted in a completion rate of 100% (Table 1). It is rare to have a LakeWatch season with no missed trips – the weather, volunteer commitment, slightly lower number of lakes, requirement of four sampling events (down from five in past seasons), and the scheduling capability of the field technicians all cooperated to achieve a perfect sampling season.



The 2020 LakeWatch Technicians Kyra Ford (left), and Ryan Turner (right).

Table 1. The LakeWatch sample completion record for 2020. Note that Unnamed Lake (PL1) had a spring trip before the sampling season start, on May 20th.

Program	Lakes	Trip 1	Trip 2	Trip 3	Trip 4
Base Lakes	Alix	3-Jul	28-Jul	17-Aug	22-Sep
	Antler	23-Jun	24-Jul	18-Aug	17-Sep
	Chestermere	24-Jun	29-Jul	25-Aug	23-Sep
	Half Moon	4-Jun	6-Jul	4-Aug	3-Sep
	Lac La Nonne	30-Jun	17-Jul	19-Aug	4-Sep
	Lac Sante	22-Jun	27-Jul	20-Aug	11-Sep
	Lacombe	16-Jun	13-Jul	10-Aug	9-Sep
	Mayatan Lake East	18-Jun	16-Jul	13-Aug	11-Sep
	Mayatan Lake West	18-Jun	16-Jul	13-Aug	11-Sep
	Pigeon	10-Jun	9-Jul	4-Aug	3-Sep
	Shiningbank	18-Jun	9-Jul	12-Aug	2-Sep
	Unnamed Lake (PL1)	23-Jun	29-Jul	27-Aug	17-Sep
	Wabamun	12-Jun	22-Jul	11-Aug	10-Sep
	Wizard	4-Jun	7-Jul	5-Aug	4-Sep
LICA	Crane	10-Jun	16-Jul	17-Aug	18-Sep
	Jessie	10-Jun	20-Jul	9-Sep	22-Sep
	Moose	16-Jun	21-Jul	21-Aug	10-Sep
	Muriel	19-Jun	20-Jul	17-Aug	9-Sep
	Skeleton Lake North	29-Jun	23-Jul	23-Aug	14-Sep
	Skeleton Lake South	29-Jun	23-Jul	23-Aug	5-Sep
Parks	Beauvais	22-Jun	23-Jul	19-Aug	15-Sep
	Gregg	23-Jun	22-Jul	25-Aug	24-Sep
	Jarvis	23-Jun	22-Jul	26-Aug	24-Sep
	Lower Kananaskis	25-Jun	21-Jul	20-Aug	14-Sep
	Upper Kananaskis	25-Jun	21-Jul	20-Aug	14-Sep

VOLUNTEERS

In 2020, ALMS worked with 39 unique volunteers for a total of 407 volunteer hours spent sampling lakes. Volunteers also provided invaluable local knowledge about their lake that is used to contextualize lake conditions and inform safe lake sampling. Each year, ALMS volunteers show outstanding dedication and commitment to the LakeWatch program, and in 2020 deserve particular appreciation for their support during the COVID-19 pandemic. Each year, ALMS recognizes one volunteer or watershed stewardship group who has shown outstanding dedication and commitment to an ALMS program. This year, Richard Normandeau from Half Moon Lake was presented with the ALMS Volunteer of the Year Award.

ALMS Volunteer of the Year (2020) recipient Richard Normandeau during a sampling trip on Half Moon Lake.

RESULTS

While ALMS collects a large suite of water chemistry parameters, this report will highlight the variability which exists between lakes across only a few of our major parameters: Euphotic Depth, Total Phosphorus, Chlorophyll-a, and Microcystin. Please note that variation within these parameters does not necessarily reflect a degree of lake management, for many factors outside of human control also impact lake water quality. The depth of the lake, the size of the drainage basin, lake order (indicative or groundwater influx and position in hydrological network), and the composition of bedrock and sediment are just some of the factors which affect lake water quality and should be taken into consideration when reading these results. Results are also presented as seasonal averages for comparability – seasonal trends (and in some cases, historical trends where enough data for a trend analysis is available) for the parameters presented below are available in each lake's individual 2020 LakeWatch reports. Results are categorized into trophic status, or degree of lake productivity. More on trophic status, along with class criteria, can be found in 'A Brief Introduction to Limnology' on the ALMS website.

The 2020 LakeWatch season captured a wider range of lake types throughout the province relative to most seasons. This is mainly due to the provincial park lakes that were sampled, as they were foothill lakes (Gregg, Jarvis, Beauvais Lakes) or montane reservoirs (Upper Kananaskis and Lower Kananaskis Lakes) which will have among the lowest nutrient and productivity levels across the province.

The 2020 season also included two lake systems (Mayatan and Skeleton Lakes) which have morphologically distinct basins that were sampled separately. This allows for the opportunity to investigate the differences between basins which are unique from each other in morphology (depth, surface area). Interestingly, the basins of Mayatan Lake appear more similar to each other during to the 2020 season, while the basins of Skeleton Lake diverged primarily in water clarity and microcystin levels, indicating that the basins algal and cyanobacteria communities differ.

Another unique aspect of the 2020 season is the inclusion of Unnamed Lake (PL1). This lake is situated in the Carvel Pitted Delta within Parkland County, is surrounded by private property, and is extremely small (less than 5 hectares). Despite its small size, it is relatively deep, having the 11^{th} deepest profile depth (12.2 m) of the 25 lakes sampled (Figure 1). PL1 was first observed in 2019 to have low productivity, and was subsequently included in the 2020 season to learn more about its seasonal function, and additional water quality parameters. While PL1 was sampled with the same method as LakeWatch lakes, the funding of the lake's sampling through ALMS' LakeKeepers program limited the number of parameters included in laboratory analysis, including lake ion chemistry (Figure 5). To learn more about PL1, and other unnamed lakes sampled in in the Carvel Pitted Delta in summer 2020, view the 2020 Summer LakeKeepers Report, available on the ALMS website.

In the appendix below, a table is presented which integrates comparable parameters (Secchi depth, total phosphorus (TP), and total kjeldahl nitrogen (TKN)) between the LakeWatch 2020 season with the lake sampling completed by Lac La Biche County at Fork, Elinor, Lac La Biche, and Beaver Lakes.

WATER CLARITY AND EUPHOTIC DEPTH

Water clarity is influenced by suspended materials both living and dead, as well as dissolved colored compounds in the water column. During the melting of snow and ice in spring, lake water can become turbid (cloudy) from silt transported into the lake. Lake water usually clears in late spring, then becomes more turbid with increased algal growth as the summer progresses. The easiest and most widely used measure of lake water clarity is the Secchi disk depth – the depth to which a checkered disk disappears. Two times the Secchi disk depth equals the euphotic depth – the depth to which there is enough light for photosynthesis.

Average euphotic depths in 2020 ranged from a minimum of 0.66 m at Antler Lake to a maximum of 13.35 m at Upper Kananaskis Lake (Figure 1). Water clarity at Antler, Muriel, Jessie, and Skeleton North Lakes appears to be negatively impacted by algal blooms as euphotic depth averages were significantly negatively correlated with average chlorophyll-*a* concentrations across lakes (Kendalls' Tau-b, $\tau_b = -0.57$, *p-value* < 0.001). Euphotic depth was nearest lake profile depth at Jessie, Alix, Lacombe, Mayatan East and Beauvais Lakes, meaning that light was reaching the bottom sediments across all depths of the lake for the majority of the summer, likely having a large influence on the lake's aquatic plant distribution, and benthic (lake bottom) algae and cyanobacteria communities.

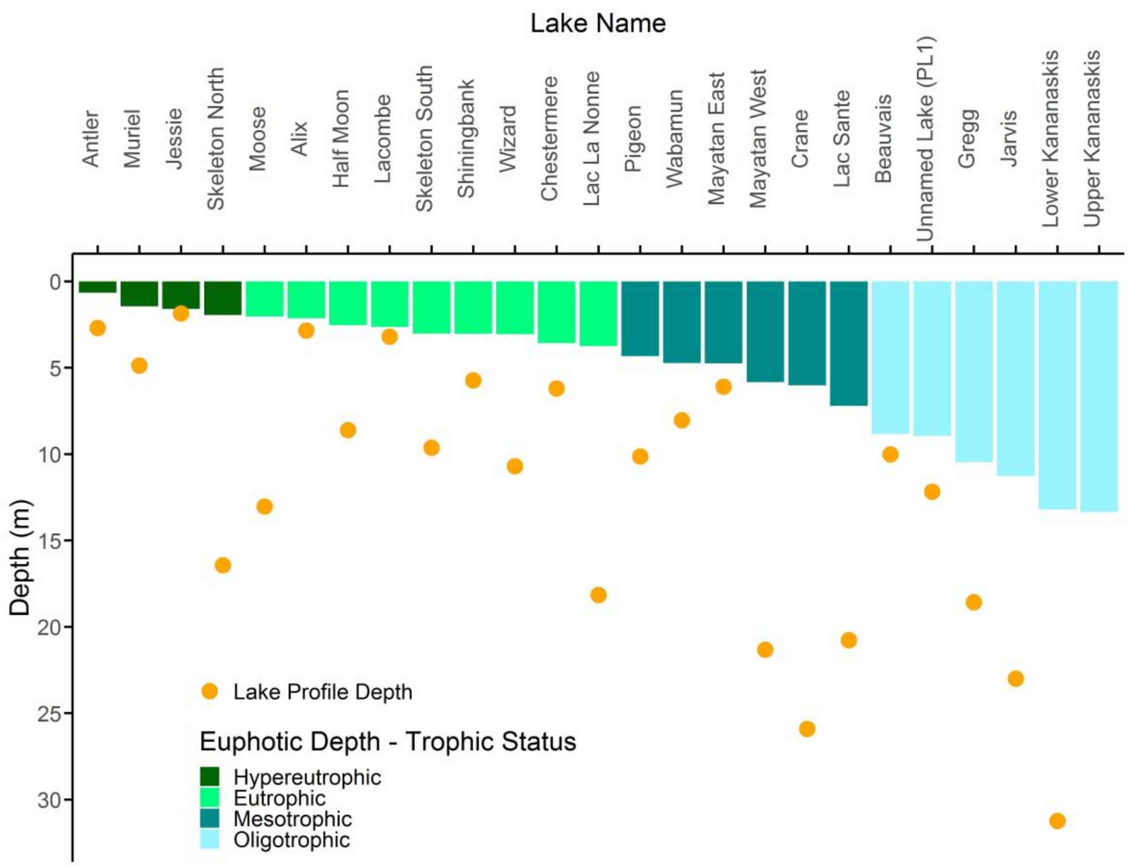


Figure 1. Average euphotic depth (m) values and lake profile depth measured at 25 lakes sampled as part of the LakeWatch program during the summer of 2020. Upper Kananaskis lake profile depth (100.25 m) not included in figure.

WATER CHEMISTRY – Total Phosphorus

ALMS measures a suite of water chemistry parameters. Phosphorus and chlorophyll-a are important because they are indicators of eutrophication, or excess nutrients, which can lead to harmful algal/cyanobacteria blooms. One direct measure of harmful cyanobacteria blooms are microcystins, a common group of toxins produced by cyanobacteria. Some lakes in Alberta have naturally high levels of phosphorus due to nutrient-rich geology, while others experience eutrophication resulting from human-related activities. High levels of phosphorus promote cyanobacteria growth, which is measured by assessing chlorophyll-a concentrations. Absolute values of phosphorus and chlorophyll-a alone do not point to human-caused eutrophication or naturally elevated nutrients, however the trajectory of those parameters over time, coupled with other lake information, may indicate whether the nutrient and chlorophyll-a levels are natural, or human-caused.

Average total phosphorus concentrations ranged from a minimum of 1.5 μg/L at Upper Kananaskis Lake to a maximum of 470 μg/L at Antler Lake (Figure 2).

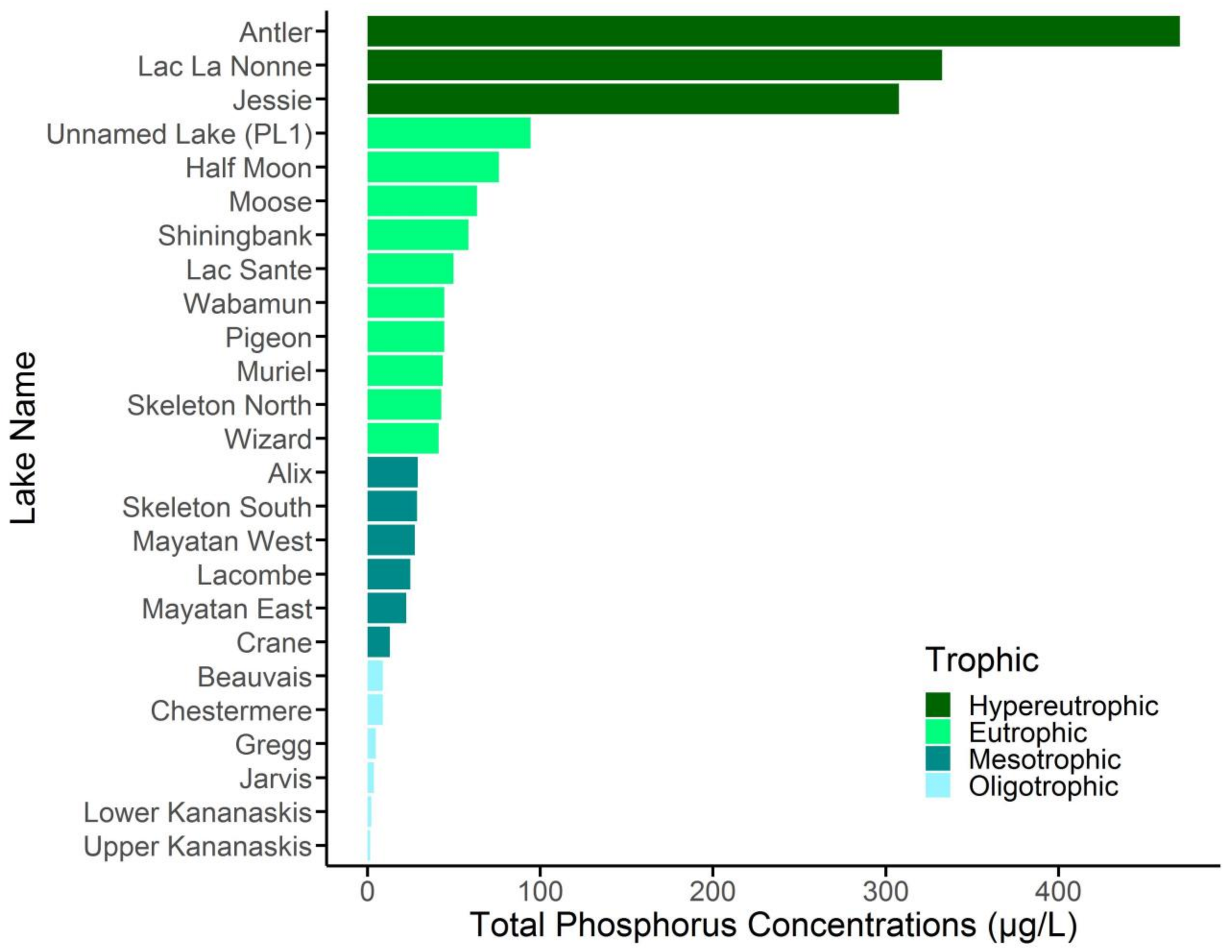


Figure 2. Average total phosphorus (TP) concentrations measured at 25 lakes sampled as part of the LakeWatch program during the summer of 2020.

WATER CHEMISTRY – Chlorophyll-a

Chlorophyll-a is the green pigment found in plants, algae, and cyanobacteria that allows them to photosynthesize. Measuring the concentration of chlorophyll-a is a proxy for how much algae and cyanobacteria is present in lake water, because all algae and cyanobacteria will produce chlorophyll-a to support photosynthesis.

Average chlorophyll-*a* concentrations ranged from a minimum of 1.33 μg/L at Upper Kananaskis Lake to a maximum of 204 μg/L at Antler Lake (Figure 3). Chlorophyll-*a* and TP averages were significantly correlated across lakes (Kendalls' Tau, $\tau = 0.67$, *p-value* < 0.001).

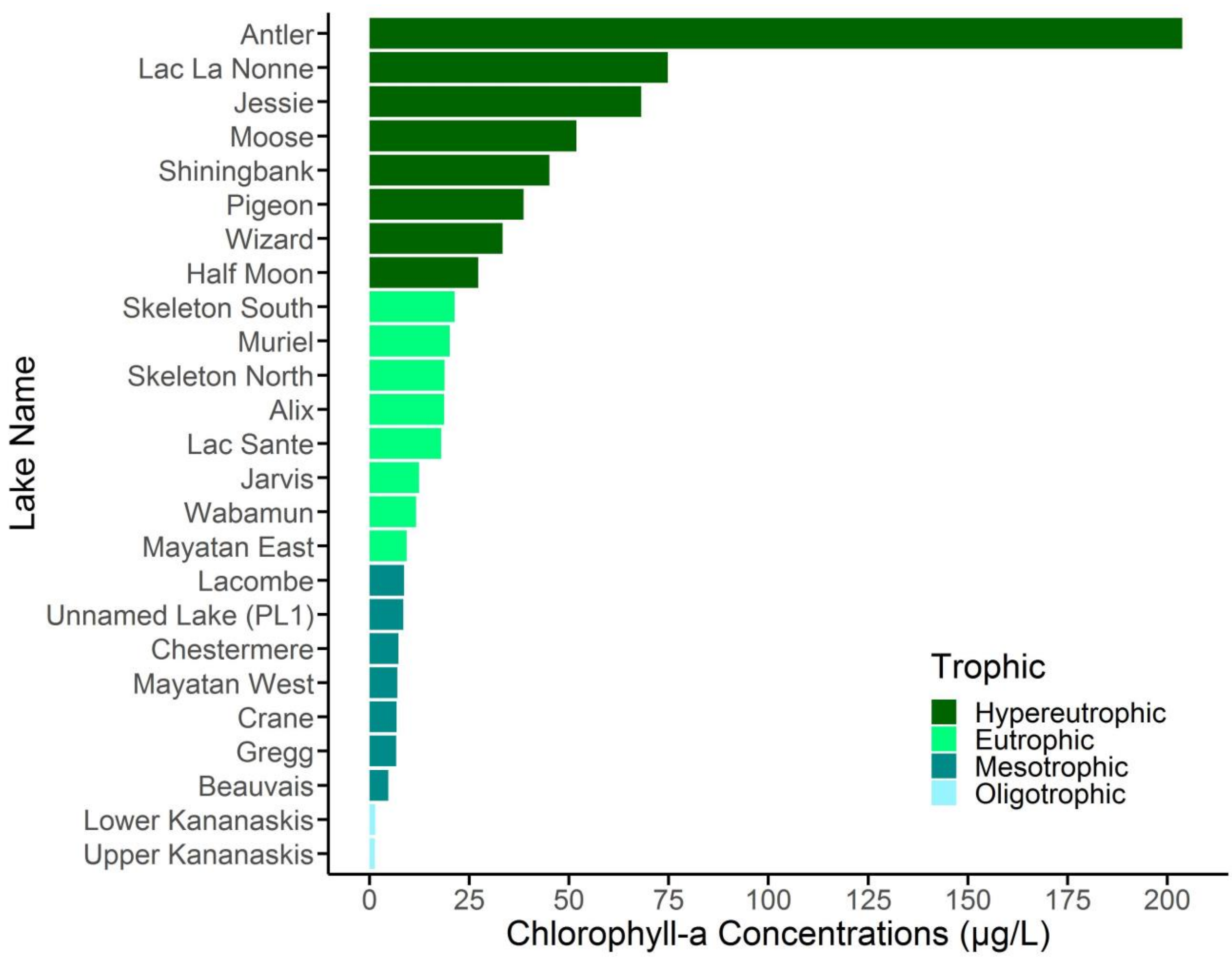


Figure 3. Average chlorophyll-*a* values measured at 25 lakes sampled as part of the LakeWatch program during the summer of 2020.

WATER CHEMISTRY – Microcystin

Microcystins are toxins produced by cyanobacteria (blue-green algae) which, when ingested by mammals, can cause severe liver damage. Microcystins are produced by many species of cyanobacteria which are common to Alberta's Lakes, and are thought to be one of the most common cyanobacteria toxins. In Alberta, recreational guidelines for microcystin are set at 20 µg/L, and as of 2020, the laboratory detection limit (the lowest level to which microcystin can be confidently detected by the analysis technique) is 0.1 µg/L.

Average microcystin concentrations fell below the minimum detection limit of 0.1 µg/L at Beauvais, Chestermere, Gregg, Jarvis, Lower Kananaskis, Upper Kananaskis, Mayatan East, Mayatan West, and Unnamed (PL1) Lakes (Figure 4). Microcystin was detected at every other lake, with the highest average concentration observed at Antler Lake, measuring 13.52 µg /L. Antler Lake was the only lake sampled in 2020 to measure higher than the recreational guideline of 20 µg /L, with a concentrations of 27.44 µg /L and 23.09 µg /L measured during the August and July sampling events, respectively. Samples from discrete locations such as a surface grab sample from a thick bloom, or from a beach, may have toxin concentrations higher than the recreational guidelines, and caution should be observed when recreating in or around cyanobacteria blooms.

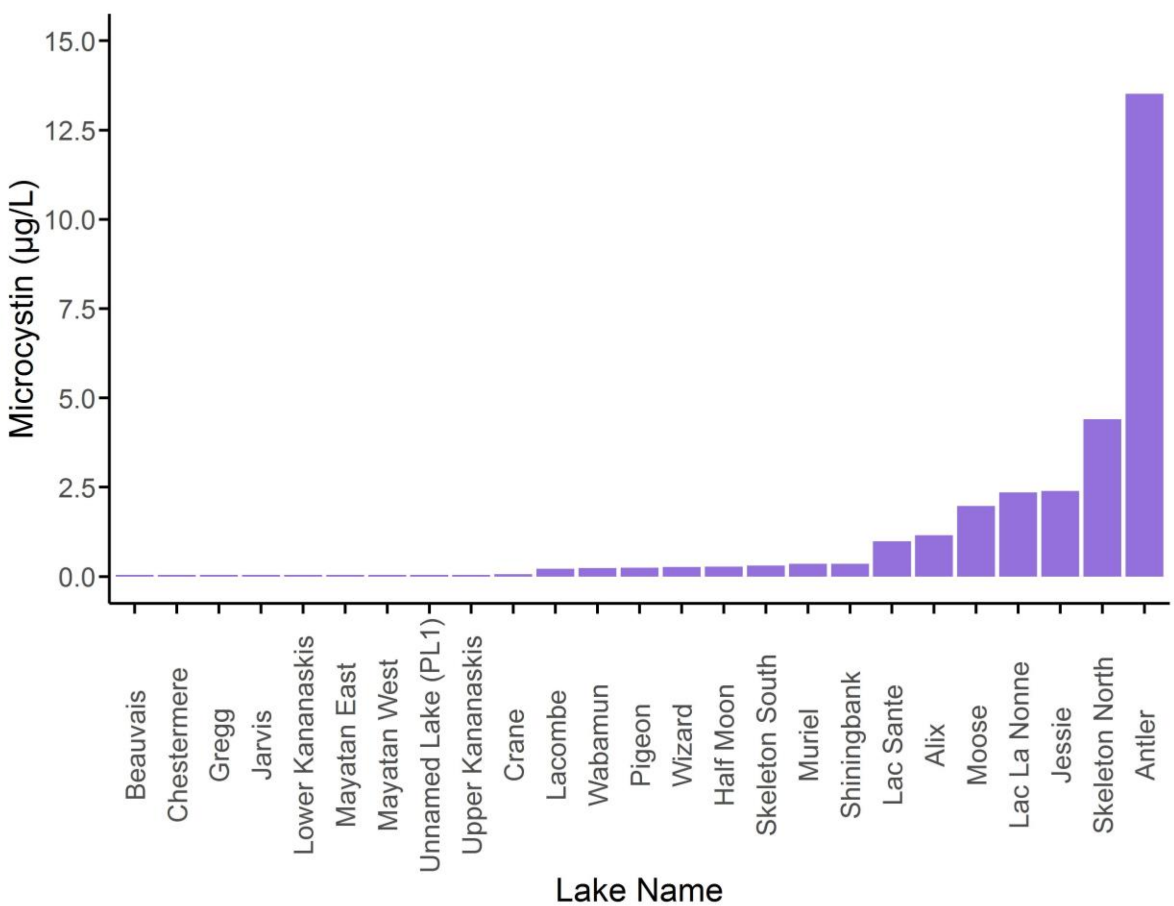


Figure 4. Average microcystin concentrations measured at 25 lakes sampled as part of the LakeWatch program during the summer of 2020. Note that microcystin was only measured at Unnamed Lake (PL1) during May and July sampling events.

WATER CHEMISTRY – Total Kjeldahl Nitrogen

As with phosphorus, nitrogen is a nutrient that primary producers require in order to grow. Some lakes in Alberta have naturally high levels of nitrogen due to nutrient-rich geology, while others experience eutrophication resulting from human-related activities. High levels of nitrogen may promote excessive cyanobacteria growth, although generally only if phosphorus levels are not limiting. Total Kjeldahl nitrogen represents the sum of organic forms of nitrogen, along with ammonia and ammonium.

Average total Kjeldahl nitrogen (TKN) concentrations ranged from a minimum of 0.07 mg/L at Lower Kananaskis Lake to a maximum of 5.88 mg/L at Antler Lake (Figure 5). Chlorophyll-*a* and TKN averages were significantly correlated across lakes (Kendalls' Tau, $\tau = 0.51$, *p-value* < 0.001), and TP and TKN averages were also significantly correlated across lakes (Kendalls' Tau, $\tau = 0.64$, *p-value* < 0.001).

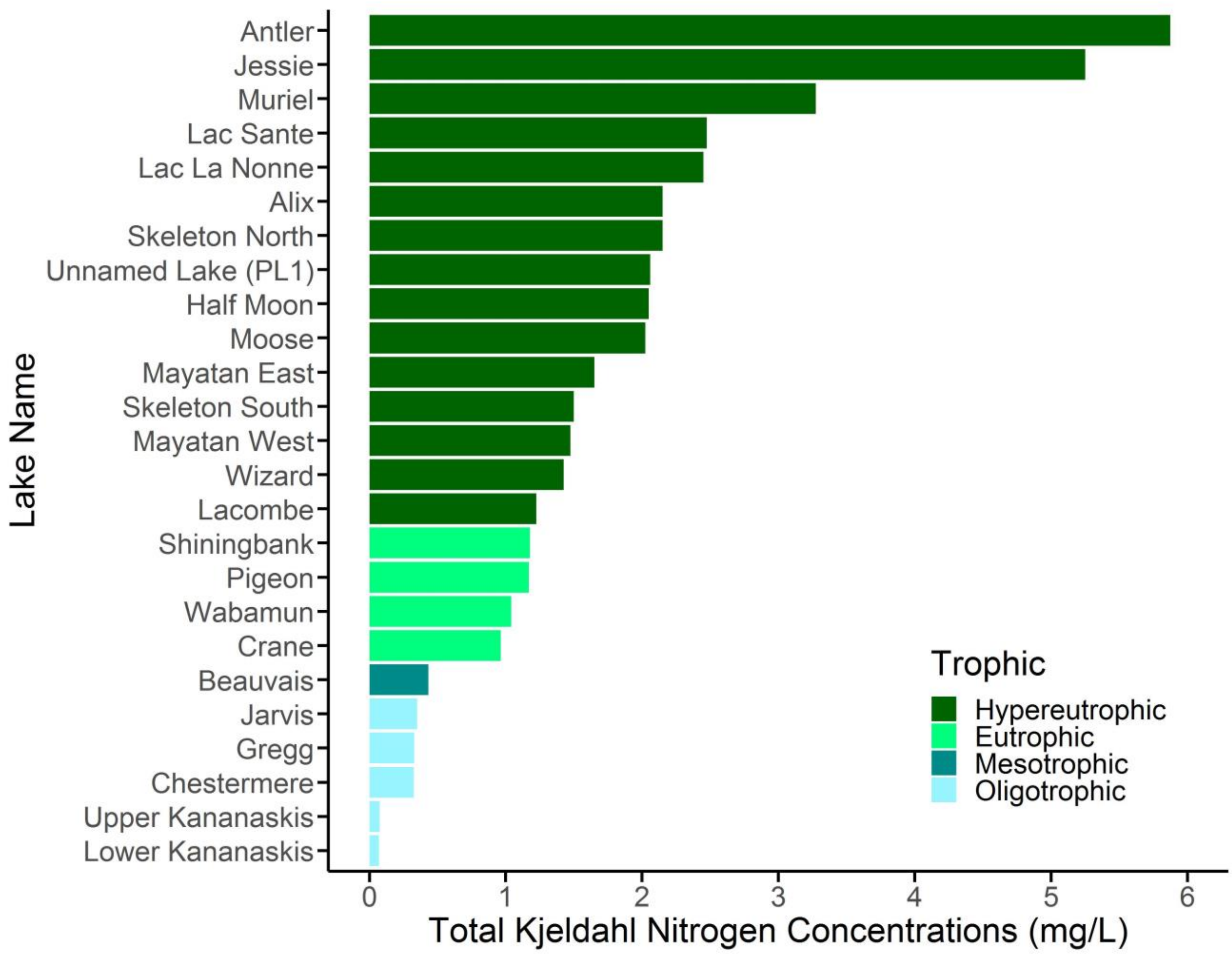


Figure 5. Average total Kjeldahl nitrogen (TKN) concentrations measured at 25 lakes sampled as part of the LakeWatch program during the summer of 2020.

WATER CHEMISTRY – Ion Chemistry

Measuring specific ion abundances helps to better understand the nuances between lakes in terms of their water chemistry. Differences in the levels of these ions, or salts, may indicate a relatively high groundwater contribution, run-off of surrounding geology or road salts applications, or if levels are low, that surrounding geology contributes little salts, and instead dilutes levels present in the lake. Levels may also increase in times of low rainfall, and evaporation of lake water then results in a concentration of ions. Ion levels are important to monitor as certain organisms will have tolerances to specific ions, and high levels of certain ions may aid to identify the source, whether natural or human-caused.

Average levels of different ions varied between the lakes sampled as part of the 2020 LakeWatch season (Figure 6). Low variability in calcium and bicarbonate was observed across 2020 lakes. Lakes sampled within the Bow, Athabasca and Oldman River watersheds generally had lower ion levels, as these lakes were situated in foothills and montane ecoregions. Lakes sampled within the Beaver River watershed had higher levels, and certain lakes in the North Saskatchewan watershed also had higher levels of magnesium and sulphate.

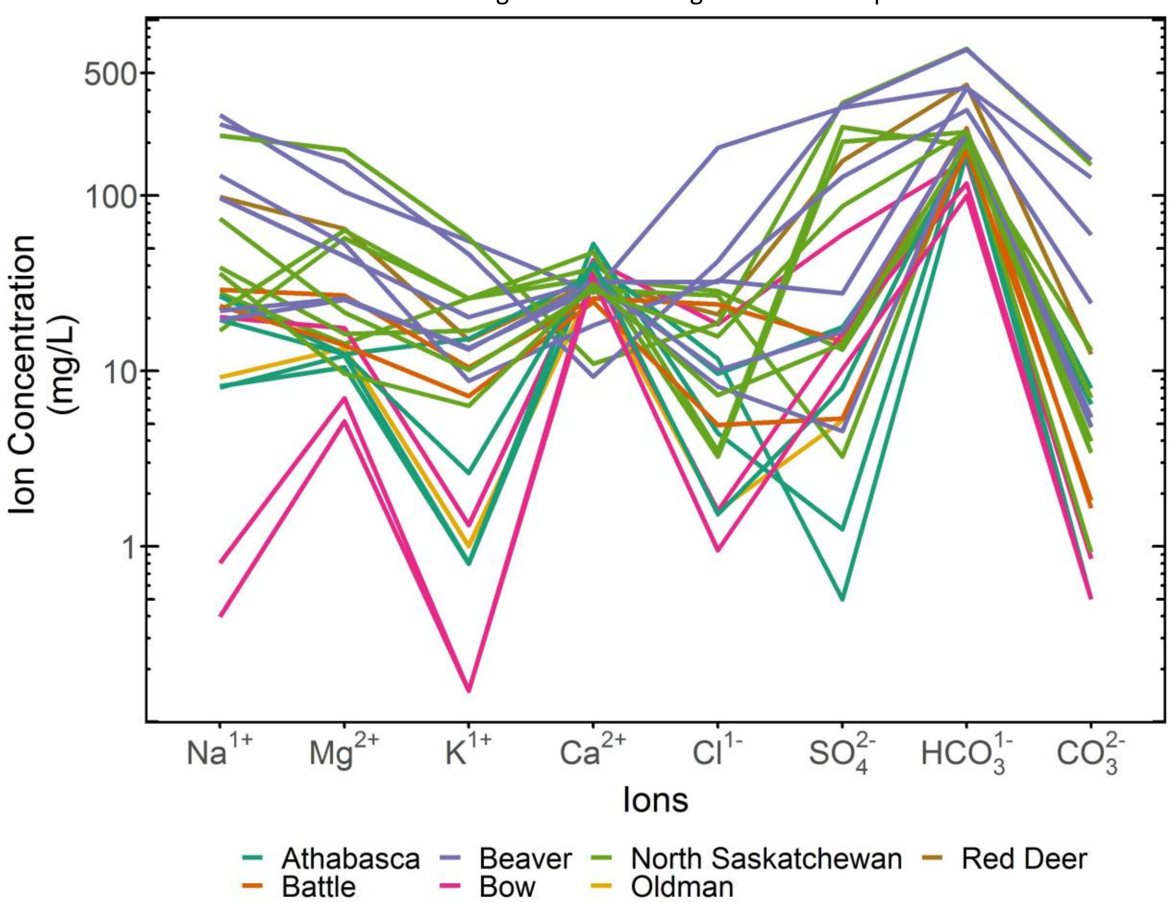


Figure 6. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer in lakes sampled through the LakeWatch program in 2020 (note log_{10} scale on y-axis).

APPENDIX

The table and figure in this appendix compare and contrast data collected through Lac la Biche County's (LLBC) lake sampling program with samples collected through the LakeWatch program. Incorporating data from LLBC into this report will help to bring awareness to this program as well as support the County with their environmental reporting efforts. One figure and table were produced in order to assist with contextualizing data collected through Lac La Biche County's (LLBC) lake monitoring program with data collected in the LakeWatch program. Similar to LakeWatch, LLBC collects Secchi depth at the profile site, and total phosphorus and total Kjeldahl nitrogen were measured from euphotic-spatial composite. Seasonal sampling frequency differed from the LakeWatch season – all five lakes (Beaver, Fork, Elinor, Lac La Biche East, and Lac La Biche West) were sampled twice in early summer (either May or June), then once in August. Lac La Biche West had an additional sampling event in July. Therefore, the averages presented in Table 2 should be interpreted within that context. The comparison of sampling frequency can be viewed in Figure 7.

Data from LLBC's lake water quality monitoring program is publicly available through the Gordon Foundation's DataStream (https://gordonfoundation.ca/initiatives/datastream/). The total phosphorus data selected was quantified using the APHA 4500 method, and total Kjeldahl nitrogen was quantified using the method from J. ENVIRON. MONIT., 2005,7,37-42,RSC. For more information about LLBC's lake water quality data, contact: green@laclabichecounty.com.

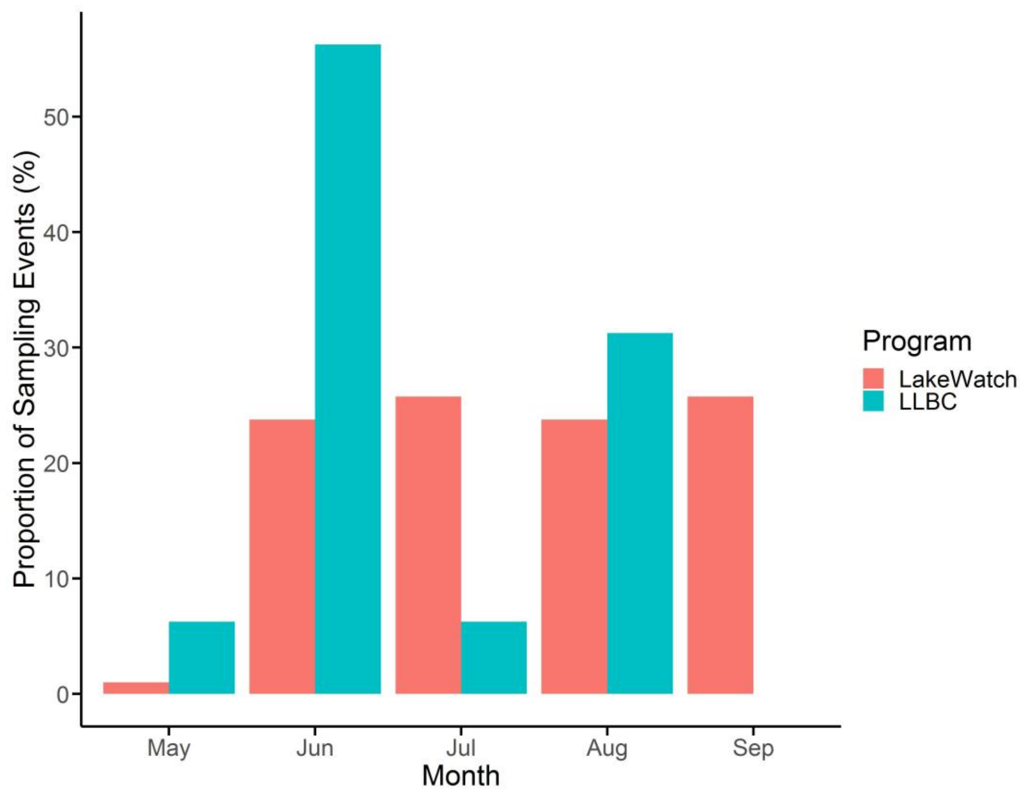


Figure 7. Proportion of sampling events completed each month during the summer of 2020 for each of Lac La Biche County's (LLBC) and the Alberta Lake Management Society's LakeWatch lake water quality sampling programs.

Table 2. Average seasonal total phosphorus, total Kjeldahl nitrogen and Secchi depth from the summer of 2020 for Lac La Biche County's (LLBC) and the Alberta Lake Management Society's LakeWatch lake water quality sampling programs. Sample count has been included for reference, and table is organized in descending order based on average total phosphorus.

Lake	Program	Total Phosphorus (µg/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Depth (m)	Sample Count
Antler	LakeWatch	470	5.88	0.33	4
Lac La Nonne	LakeWatch	333	2.45	1.87	4
Jessie Lake	LakeWatch	308	5.25	1.35	4
Unnamed Lake (PL1)	LakeWatch	94	2.06	4.47	5
Lac La Biche East	LLBC	92	1.33	1.42	3
Half Moon	LakeWatch	76	2.05	1.27	4
Fork	LLBC	67	2.13	1.42	3
Moose	LakeWatch	64	2.03	1.01	4
Shiningbank	LakeWatch	59	1.18	1.52	4
Lac La Biche West	LLBC	50	0.87	1.94	4
Lac Sante	LakeWatch	50	2.48	3.61	4
Pigeon	LakeWatch	45	1.17	2.16	4
Wabamun	LakeWatch	45	1.04	2.43	4
Muriel	LakeWatch	44	3.28	0.72	4
Skeleton North	LakeWatch	43	2.15	0.98	4
Wizard	LakeWatch	41	1.43	1.53	4
Elinor	LLBC	36	1.40	2.50	3
Alix	LakeWatch	29	2.15	1.06	4
Beaver	LLBC	29	1.59	3.25*	3
Skeleton South	LakeWatch	29	1.50	1.51	4
Mayatan West	LakeWatch	28	1.48	2.91	4
Lacombe	LakeWatch	25	1.23	1.71	4
Mayatan East	LakeWatch	23	1.65	2.38	4
Crane	LakeWatch	13	0.96	3.00	4
Beauvais	LakeWatch	9	0.43	4.45	4
Chestermere	LakeWatch	9	0.33	1.79	4
Gregg	LakeWatch	5	0.33	5.29	4
Jarvis	LakeWatch	4	0.35	5.64	4
Lower Kananaskis	LakeWatch	2	0.07	6.60	4
Upper Kananaskis	LakeWatch	2	0.08	6.68	4

*Beaver Lake Secchi depth average from only two sampling events – June 2nd and June 18th.