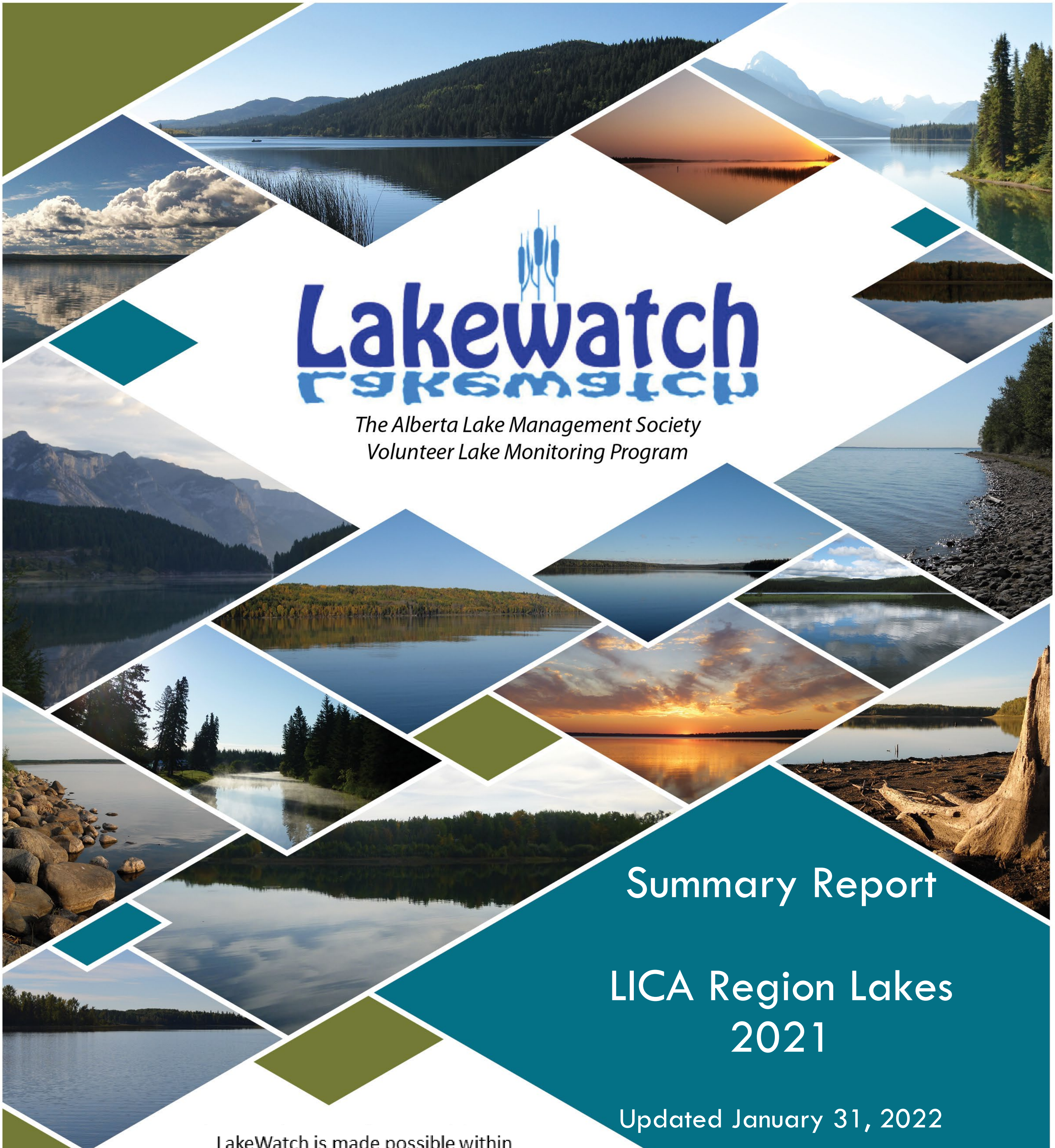


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Summary Report

LICA Region Lakes 2021

Updated January 31, 2022

LakeWatch is made possible within the LICA region with support from:

LICA ENVIRONMENTAL STEWARDS

MUNICIPAL DISTRICT BONNYVILLE NO. 87

Alberta

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 Keri Malanchuk and Brittany Onysyk who were summer technicians in 2021. 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 2021, ALMS received funding from the Lakeland Industry and Community Association (LICA), the Municipal District of Bonnyville No. 87, and Alberta Environment and Parks to conduct LakeWatch, a participatory water quality monitoring program, for select lakes in the LICA region. This report presents a concise summary of key parameters from seven lakes which were sampled within the LICA region in the summer of 2021, and the figures presented below are simply meant to contextualize lakes in the LICA region, and are not necessarily comparisons of lake health. More comprehensive water quality reports are available for each individual lake from data collected in the 2021 season, and can be accessed on the ALMS website (https://alms.ca/reports/), along with historical reports for those lakes. These individual LakeWatch reports may also present trend analysis results, where enough historical data exists, which is the best approach for evaluating lake water quality and health over time.

SAMPLE RECORD

From June through September 2021, each of the 7 lakes in the LICA region were sampled four times, with the exception of Skeleton South which was sampled five times (Table 1). This sampling record represents a 100% completion rate.

Table 1- The LICA region lakes LakeWatch sample completion record for 2021.

Lake	Trip 1	Trip 2	Trip 3	Trip 4	Bonus Trip
Jessie	24-Jun	15-Jul	9-Aug	14-Sep	
Marie	15-Jun	26-Jul	24-Aug	21-Sep	
Minnie	3-Jun	15-Jul	13-Aug	14-Sep	
Moose	25-Jun	14-Jul	13-Aug	10-Sep	
Skeleton North	9-Jun	7-Jul	19-Aug	22-Sep	
Skeleton South	14-Jun	19-Jul	5-Aug	28-Aug	22-Sep
Upper Mann	24-Jun	25-Jul	14-Aug	11-Sep	

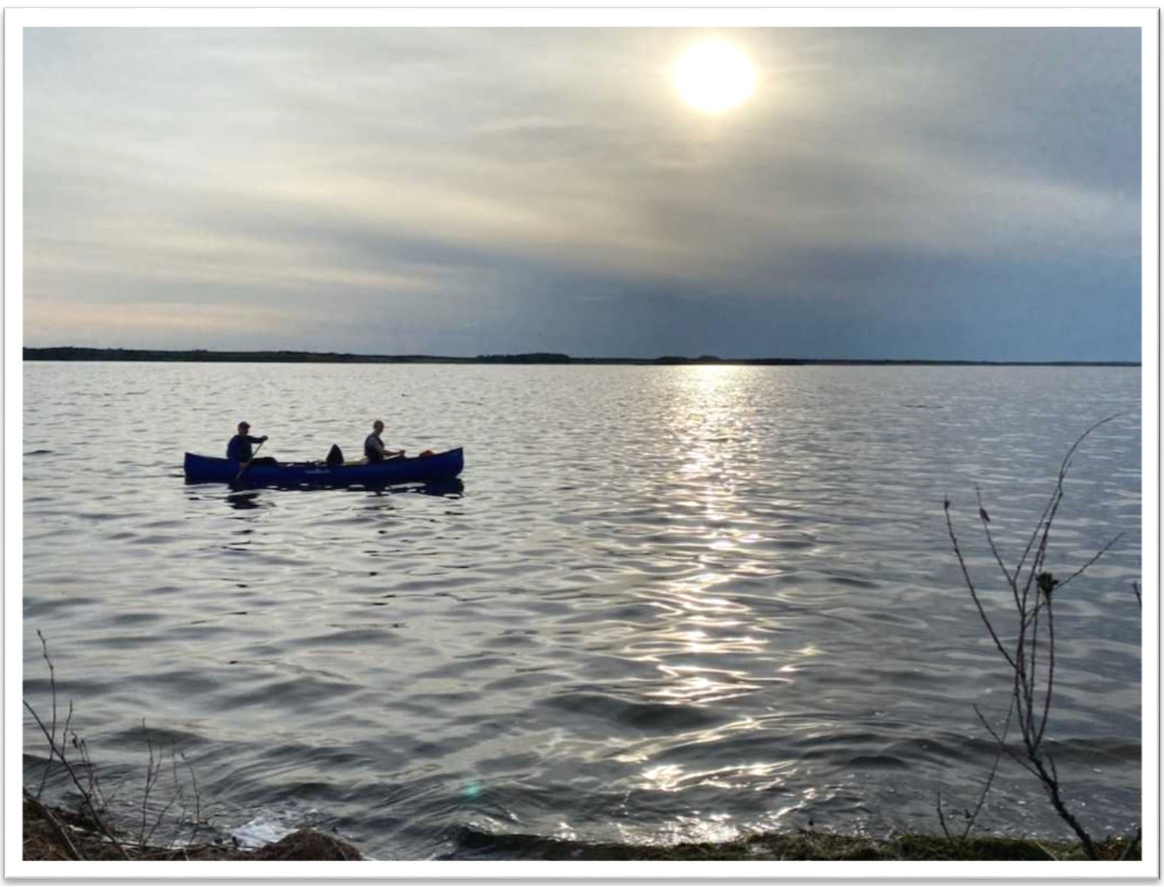
STAFF AND VOLUNTEERS

Two LakeWatch technicians were hired in May 2021 to conduct water quality sampling, and Keri Malanchuk was assigned the LICA region lakes. ALMS worked with 11 volunteers in the LICA region for a total of 93 volunteer hours spent lake sampling. Volunteers provided boats used for sampling, operated the boats, and assisted the LakeWatch technician with sampling procedures. Volunteers provided invaluable local knowledge about their lake that was used to contextualize lake conditions and improve lake sampling safety. Each year ALMS volunteers show outstanding dedication and commitment to the LakeWatch program, and in 2021 deserve particular appreciation for their support during the COVID-19 pandemic.

LakeWatch Technician Keri sampling with volunteer Charity at Upper Mann Lake, 2021

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 major parameters: Euphotic Depth, Total Phosphorus, Chlorophyll-a, Microcystin, and major ions. 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 interpreting 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 some of the parameters presented below are available in each lake's individual 2021 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.



LakeWatch sampling of Jessie Lake by canoe, 2021

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 within the LICA region in 2021 ranged from a minimum of 1.45 m at Skeleton Lake North to a maximum of 8.15 m at Marie Lake (Figure 1). Lake profile depth, or the depth of the location where the Secchi depth measurement was taken, is also presented for context. Euphotic depth averages were significantly correlated with average chlorophyll-*a* concentrations across the lakes (Kendalls' Tau-b, τ_b= -0.71, *p-value* = 0.03). This means that water turbidity appeared to be primarily associated with elevated growth of cyanobacteria and algae. Jessie Lake and Upper Mann Lake also displayed average euphotic depths that were almost as deep as the average lake profile depth (Figure 1). This means that light was likely reaching the bottom sediments across the majority of depths of the lake through the summer, likely having a large influence on the lake's aquatic plant distribution, and benthic (lake bottom) algae and cyanobacteria communities.

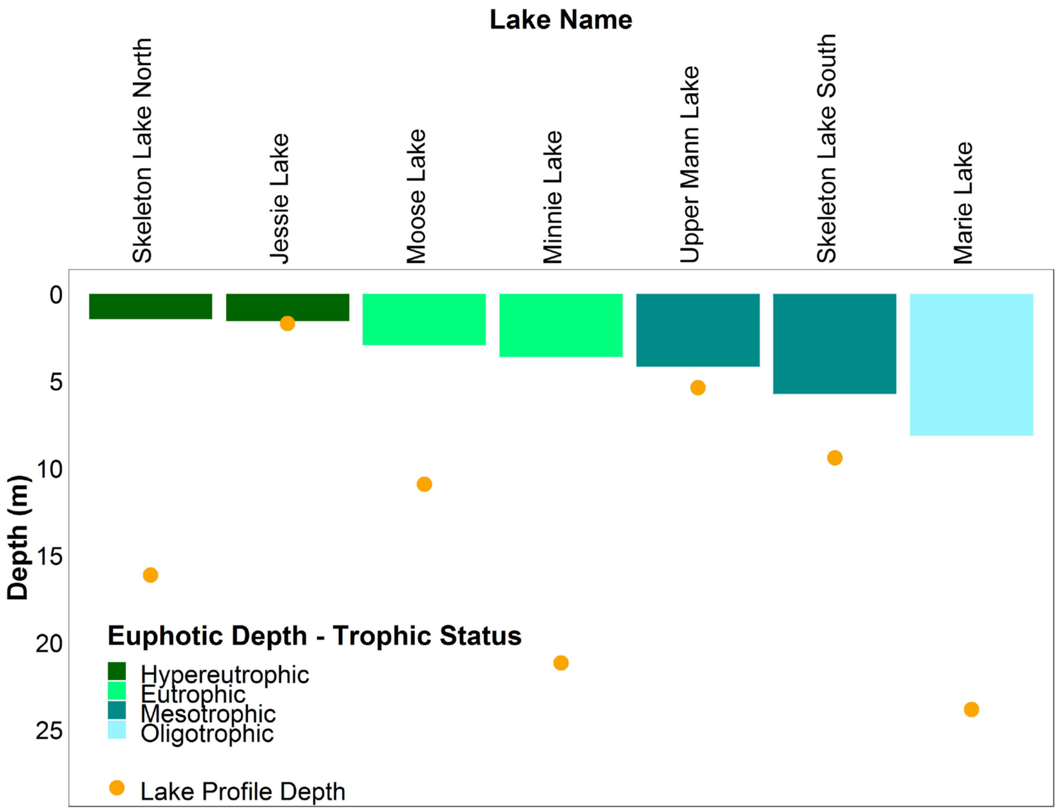


Figure 1. Average euphotic depth (m) and lake profile depth (m) values from 7 LICA region lakes sampled through the LakeWatch program during the summer of 2021.

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 7.1 μg/L at Marie Lake to a maximum of 265 μg/L at Upper Mann Lake (Figure 2, Table 3). Total phosphorus and total Kjeldahl nitrogen averages were significantly positively correlated across lakes (Kendalls' Tau, τ= 0.81, *p-value* = 0.01), meaning that for lakes sampled in the LICA region in 2021, increased levels of phosphorus were proportional to increased nitrogen levels.

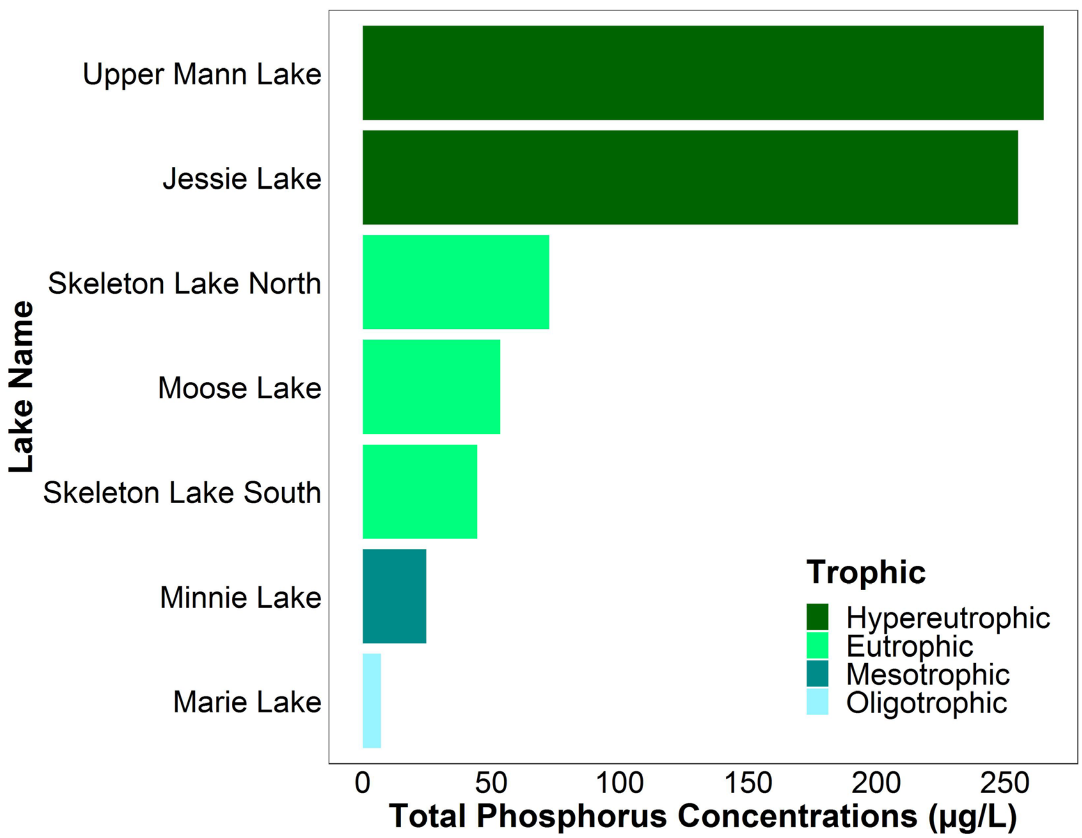


Figure 2. Average total phosphorus (TP) concentrations from 7 LICA region lakes sampled through the LakeWatch program during the summer of 2021.

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 concentrations ranged from a minimum of 0.55 mg/L at Marie Lake to a maximum of 5.68 mg/L at Jessie Lake (Figure 3, Table 3). Chlorophyll-*a* and total Kjeldahl nitrogen averages were significantly positively correlated across lakes (Kendalls' Tau, τ= 0.71, *p-value* = 0.03), meaning that for lakes sampled in the LICA region in 2021, high levels of nitrogen were correlated with high levels of cyanobacteria and algae.

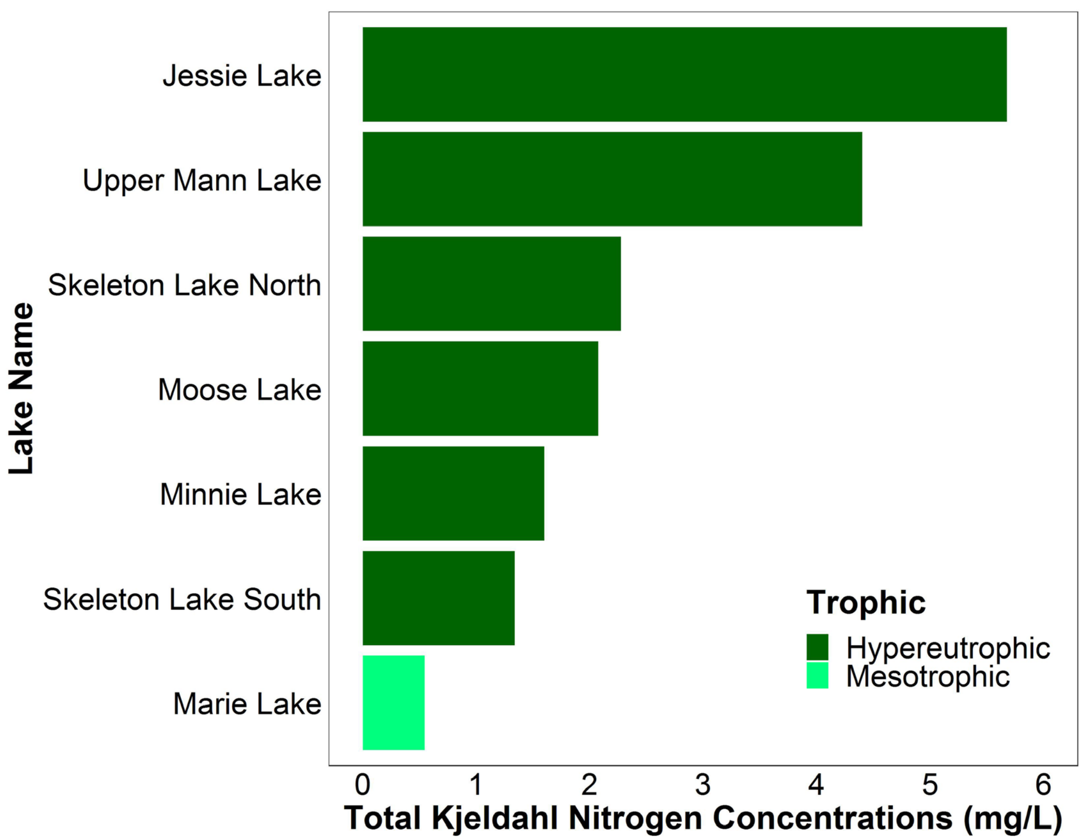


Figure 3. Average total Kjeldahl nitrogen concentrations from 7 LICA region lakes sampled through the LakeWatch program during the summer of 2021.

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 4.28 μg/L at Marie Lake to a maximum of 77.20 μg /L at Jessie Lake (Figure 4, Table 3). Chlorophyll-*a* and total phosphorus averages were significantly positively correlated across lakes (Kendalls' Tau, $\tau = 0.71$, *p-value* = 0.03), meaning that for lakes sampled in the LICA region in 2021, high levels of phosphorus were correlated with high levels of cyanobacteria and algae.

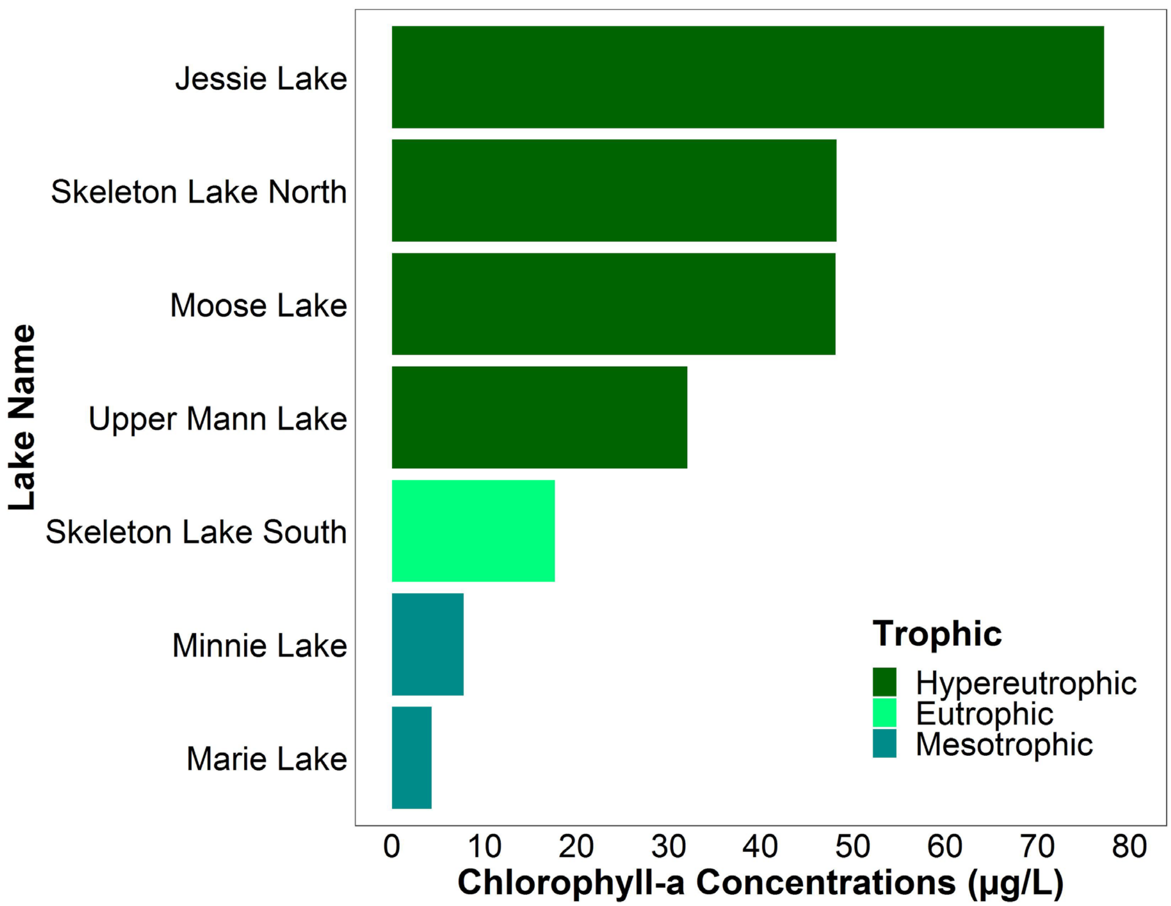


Figure 4. Average chlorophyll-*a* values from 7 LICA region lakes sampled through the LakeWatch program during the summer of 2021.

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 2021, 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 ranged from <0.1 µg/L at Marie Lake to 9.30 µg /L at Skeleton Lake North (Figure 5, Table 3). None of the lakes measured higher than the recreational guideline of 20 µg /L during any single sampling event throughout the summer of 2020. However, individual locations not sampled by ALMS at each lake may display toxin concentrations higher than the recreational guidelines, and caution should be observed when recreating in or around cyanobacteria. For more information about recreating in lakes with cyanobacteria, refer to this document produced by Alberta Health Services about frequently asked questions regarding cyanobacteria.

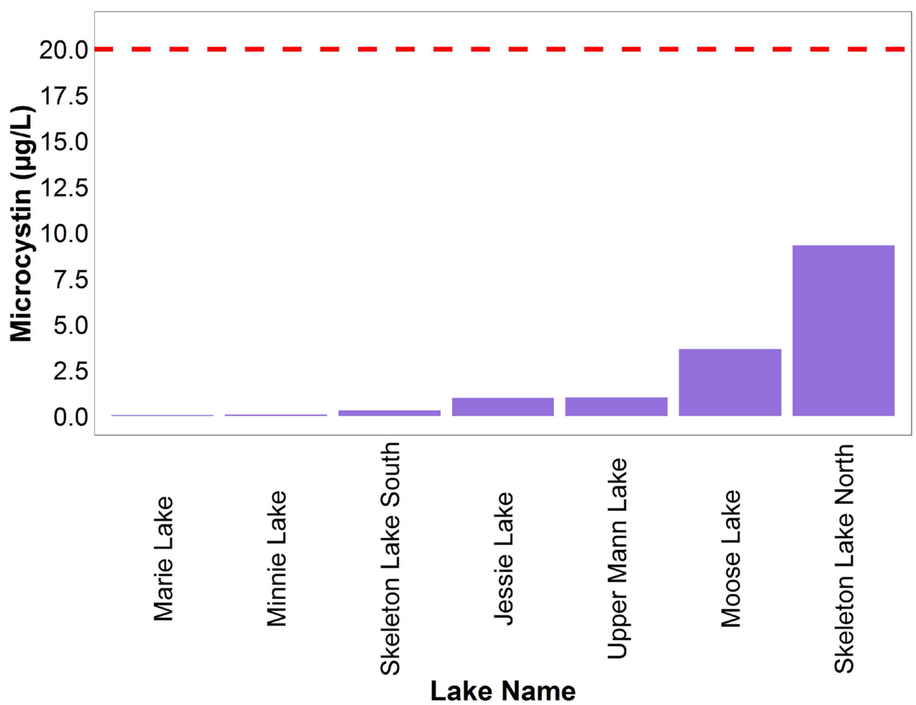


Figure 5. Average microcystin concentrations from 7 LICA region lakes sampled through the LakeWatch program during the summer of 2021. Note that Alberta's recreational guideline of 20 µg/L is indicated by the red horizontal dashed line.

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 sensitivities 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 in the LICA region as part of the 2021 LakeWatch season (Figure 6). Low variability in calcium and bicarbonate was observed across the lakes. Marie Lake had the lowest levels of all ions, with the exception of calcium, where Jessie Lake had the lowest levels. Jessie Lake, Upper Mann Lake, and Minnie Lake generally displayed the highest levels of all other ions. Interestingly, ion levels were very comparable for both Skeleton Lake North and South, except for sulphate, where Skeleton Lake North had levels three times as high.

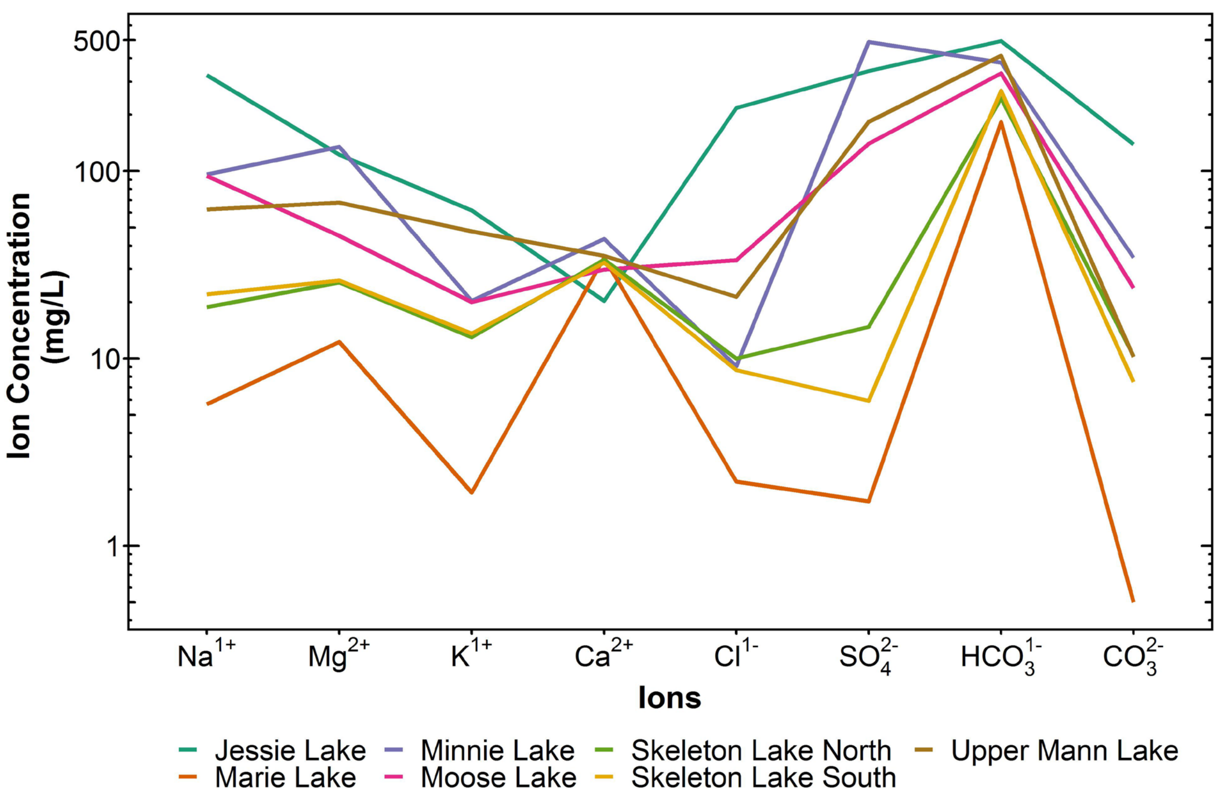


Figure 6. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from 7 LICA region lakes sampled through the LakeWatch program during the summer of 2021 (note log_{10} scale on y-axis).

SUMMARIZED PARAMETERS

Table 3. Average water chemistry (nutrients, chlorophyll-a, and microcystin), euphotic depth, and lake profile depth summaries for LICA region lakes sampled through the LakeWatch program during the summer of 2021.

Lake Name	Total Phosphorus (µg/L)	Total Kjeldahl Nitrogen (mg/L)	Chlorophyll-a (µg/L)	Microcystin (µg/L)	Euphotic depth (m)	Lake Profile Depth (m)
Jessie	255	5.68	77.20	0.99	1.56	1.7
Marie	7.1	0.55	4.28	<0.10	8.15	23.8
Minnie	24.8	1.60	7.78	0.08	3.62	21.2
Moose	53.5	2.08	48.10	3.64	2.95	10.9
Skeleton North	72.5	2.28	48.23	9.30	1.45	16.1
Skeleton South	44.6	1.34	17.66	0.30	5.75	9.4
Upper Mann	265	4.40	32.03	1.02	4.18	5.4

INVASIVE SPECIES

Dreissenid mussels pose a significant concern for Alberta because they impair the function of water conveyance infrastructure and adversely impact the aquatic environment. These invasive mussels can change lake conditions which can then lead to toxic cyanobacteria blooms, decrease the amount of nutrients needed for fish and other native species, and cause millions of dollars in annual costs for repair and maintenance of water-operated infrastructure and facilities. Spiny water flea pose a concern for Alberta because they alter the abundance and diversity of native zooplankton as they are aggressive zooplankton predators. Through over-predation, they will impact higher trophic levels such as fish. They also disrupt fishing equipment by attaching in large numbers to fishing lines.

Monitoring involved sampling with a 63 µm plankton net at three sample sites to look for juvenile mussel veligers and spiny water flea in each lake sampled. In 2021, no mussels or spiny water flea were detected in the 7 LICA region lakes sampled.

Eurasian watermilfoil is non-native aquatic plant that poses a threat to aquatic habitats in Alberta because it grows in dense mats preventing light penetration through the water column, reduces oxygen levels when the dense mats decompose, and outcompetes native aquatic plants. Eurasian watermilfoil can look similar to the native Northern watermilfoil, thus genetic analysis is ideal for watermilfoil species identification.

Suspect watermilfoil specimens were collected from all LICA region lakes sampled through the LakeWatch program in 2021, except Jessie Lake, were no watermilfoil was observed. Through ALMS' aquatic plant monitoring initiatives, suspect watermilfoil specimens were collected at 8 other lakes in the LICA region; Floatingstone Lake, Beaver Lake, Fork Lake, Long Lake, Stoney Lake, Steele Lake, Lac Bellevue, and Lottie Lake. All specimens collected were confirmed to be the native Northern watermilfoil (*Myriophyllum sibiricum)* upon genetic confirmation by the Alberta Plant Health Laboratory.

METALS

A surface sample was collected once at each lake in August to be used for metal analysis. In total, the abundance of 27 metals were investigated. It should be noted that many metals are naturally present in aquatic environments due to the weathering of rocks and may only become toxic at higher levels. In this report we highlight the results of arsenic, boron, aluminum and selenium as they have fallen above their recommended Canadian Council for Ministers of the Environment (CCME) guidelines in the LICA region in previous years. Individual LakeWatch reports will present the complete suite of metal results. In wet years, metals may be elevated as a result due to groundwater recharge and the weathering of rocks and sediments.

Even though aluminum can be found in water naturally, examples of anthropogenic (human caused) sources of aluminum include dust produced from agriculture, mining, and coal combustion. In 2021, none of the sampled lakes were in exceedance of the aluminum CCME guidelines for the Protection of Aquatic Life (100 µg/L; Table 4).

Arsenic is naturally elevated in the Beaver River Watershed and can be introduced into the aquatic environment through industrial or municipal discharges or from the combustion of fossil fuels. In 2021, arsenic levels in Jessie Lake and Minnie Lake exceeded the CCME guidelines for the Protection of Aquatic Life (5 µg/L; Table 4).

Boron is naturally occurring in many minerals, particularly in clay-rich sediments, and natural weathering often releases boron into the environment at rates comparable to or greater than anthropogenic sources, such as municipal wastewater, coal power plants, irrigation, copper smelters and other industries that use boron. In 2021, none of the sampled LICA region lakes exceeded the CCME guidelines for Boron concentrations (1500 µg/L; Table 4).

Selenium can be found in water from both natural and anthropogenic sources. Examples of anthropogenic sources of selenium are the burning of coal and oil, and from agriculture. In 2021, Jessie Lake was in exceedance of the selenium CCME guidelines for the Protection of Aquatic Life (1 µg/L; Table 4).

Table 4. Values of select metals for LICA region lakes sampled through the LakeWatch program during August 2021. Also provided are the Canadian Council for Ministers of the Environment (CCME) recommended guidelines for the Protection of Aquatic Life.

Lake	Aluminum (µg/L)	Arsenic (µg/L)	Boron (µg/L)	Selenium (µg/L)
CCME PAL Guideline	100	5	1500	1
Jessie	20.1	5.47	339	2.3
Marie	8.4	0.56	19.6	<0.2
Minnie	9.4	7.58	179	0.4
Moose	5.9	2.00	154	0.5
Skeleton North	9.1	0.92	97.7	0.3
Skeleton South	4.4	1.18	93.0	0.2
Upper Mann	18.8	3.42	117	0.4