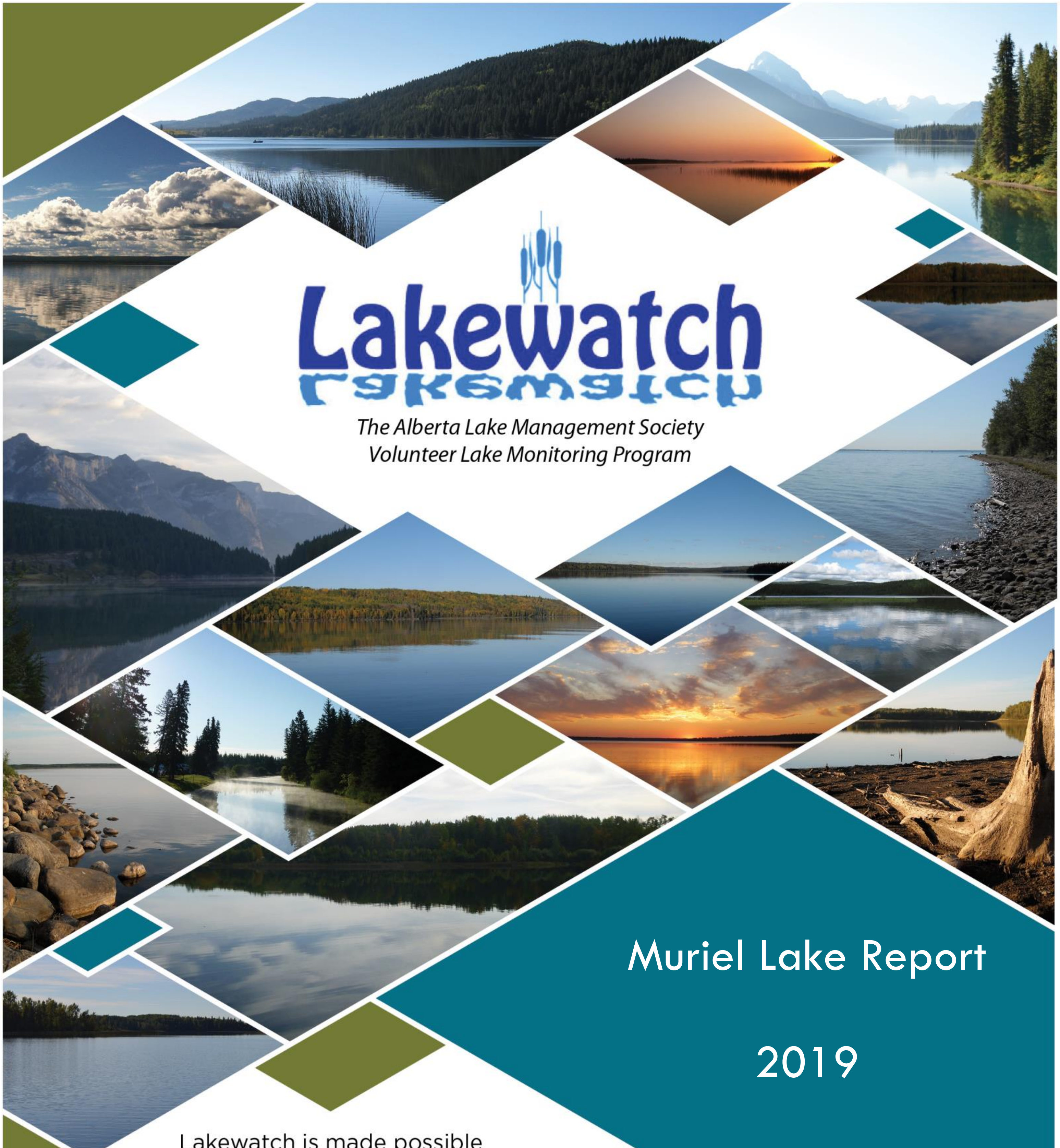

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Muriel Lake Report

2019

Lakewatch is made possible with support from:

Alberta Environment and Parks

Pigeon Lake Watershed Association

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 from Alberta's Lakes. Equally important is educating lake users about aquatic environments, 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 the widest 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.

If you require data from this report, please contact ALMS for the raw data files.

ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. We would like to extend a special thanks to Jeff Hlewka and Richard Bourgeois for the time and energy put into sampling Muriel Lake in 2019. We would also like to thank Sarah Davis Cornet, Caleb Sinn, and Pat Heney, who were summer technicians in 2019. Executive Director Bradley Peter and Program Coordinator Caitlin Mader were instrumental in planning and organizing the field program. This report was prepared by Pat Heney, Bradley Peter, and Caleb Sinn.

MURIEL LAKE

Muriel Lake—photo by Ageleky Bouzetos 2015

Muriel Lake is located 13 km south of the town of Bonnyville and 250 km northeast of Edmonton. The first establishment in the area by non-aboriginal peoples was a fur-trading post in 1781 by the North West Company near the present-day hamlet of Beaver Crossing, about 35 km northeast of Muriel Lake. The first settlers came to the Bonnyville area in 1907 and established an economy based on the timber industry. Two sawmills were located at Muriel Lake, one at the northeastern tip and the other on the large island/peninsula on the eastern shore.

In the 1920's, a large fire forced the economic base to switch to agriculture. There are several subdivisions (391 lots) around the lakeshore, mostly on the south and east sides of the lake. Much of the watershed is occupied by the Kehewin Cree Nation Reserve 123, located on 8200 ha of land southwest of the lake. The largest recreational facility on Muriel Lake is Muriel Lake Park, which is operated by the Municipal District of Bonnyville.

Northern pike, yellow perch, lake whitefish, and walleye were once prevalent in the lake, however these fish are no longer stocked, and a 2012 netting of the lake performed by Environment and Sustainable Resource Development revealed no sport fishes are present in Muriel Lake; only brook stickleback and longnose suckers were captured in 2012 netting[1]. Low winter dissolved oxygen levels (3.0 mg/L) leaves Muriel Lake at a high risk for fish kills.[1] Muriel Lake is a large (64.1 km^2) but shallow water body with a relatively small drainage basin, measuring only 4.8 times the size of the lake area. The shorelines consist primarily of steep rocky slopes, but there are also several attractive sandy beaches. Water levels have been monitored since the late 1960's and since then have dropped by as much as 4.5 m.

[1] Latty, D. (2012). Muriel Lake Fall Walleye Index Netting, 2012. Alberta Environment and Sustainable Resource Development. Retrieved on February 21st, 2012 from: http://srd.alberta.ca/FishWildlife/FisheriesManagement/FallWalleyeIndexNetting/Default.aspx

METHODS

Profiles: Profile data is measured at the deepest spot in the main basin of the lake. At the profile site, temperature, dissolved oxygen, pH, conductivity and redox potential are measured at 0.5 – 1.0 m intervals. Additionally, Secchi depth is measured at the profile site and used to calculate the euphotic zone. For select lakes, metals are collected at the profile site by hand grab from the surface on one visit over the season.

Composite samples: At 10-sites across the lake, water is collected from the euphotic zone and combined across sites into one composite sample. This water is collected for analysis of water chemistry, chlorophyll-a, nutrients and microcystin. Quality control (QC) data for total phosphorus was taken as a duplicate true split on one sampling date. ALMS uses the following accredited labs for analysis: Routine water chemistry and nutrients are analyzed by Maxxam Analytics, chlorophyll-*a* and metals are analyzed by Innotech Alberta, and microcystin is analyzed by the Alberta Centre for Toxicology (ACTF).

Invasive Species: : Invasive mussel monitoring involved sampling with a 63 µm plankton net at three sample sites twice through the summer season to determine the presence of juvenile dreissenid mussel veligers. Technicians also harvested potential Eurasian watermilfoil (*Myriophyllum spicatum)* samples and submitted them for further analysis at the Alberta Plant Health Lab to genetically differentiate whether the sample was the invasive Eurasian watermilfoil or a native watermilfoil. In addition, select lakes were subject to a bioblitz, where a concerted effort to sample the lake's aquatic plant diversity took place.

Data Storage and Analysis: Data is stored in the Water Data System (WDS), a module of the Environmental Management System (EMS) run by Alberta Environment and Parks (AEP). Data goes through a complete validation process by ALMS and AEP. Users should use caution when comparing historical data, as sampling and laboratory techniques have changed over time (e.g. detection limits). For more information on data storage, see AEP Surface Water Quality Data Reports at www.alberta.ca/surface-water-quality-data.aspx.
Data analysis is done using the program R.[1] Data is reconfigured using packages tidyr [2] and dplyr [3] and figures are produced using the package ggplot2 [4]. Trophic status for each lake is classified based on lake water characteristics using values from Nurnberg (1996)[5]. The Canadian Council for Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life are used to compare heavy metals and dissolved oxygen measurements. Pearson's Correlation tests are used to examine relationships between total phosphorus (TP), chlorophyll-*a,* total kjeldahl nitrogen (TKN) and Secchi depth, providing a correlation coefficient (r) to show the strength (0-1) and a p-value to assess significance of the relationship.

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[1] R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.
[2] Wickman, H. and Henry, L. (2017). tidyr: Easily Tidy Data with 'spread ( )' and 'gather ( )' Functions. R package version 0.7.2. https://CRAN.R-project.org/package=tidyr.
[3] Wickman, H., Francois, R., Henry, L. and Muller, K. (2017). dplyr: A Grammar of Data Manipulation. R package version 0.7.4. http://CRAN.R-project.org/package=dplyr.
[4] Wickham, H. (2009). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.
[5]Nurnberg, G.K. (1996). Trophic state of clear and colored, soft- and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish. Lake and Reservoir Management 12: 432-447.

BEFORE READING THIS REPORT, CHECK OUT A BRIEF INTRODUCTION TO LIMNOLOGY AT ALMS.CA/REPORTS

WATER CHEMISTRY

ALMS measures a suite of water chemistry parameters. Phosphorus, nitrogen, 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. See Table 2 for a complete list of parameters.

The average total phosphorus (TP) concentration for Muriel Lake was 58 μg/L (Table 2), falling into the eutrophic, or productive, trophic classification. This average lies within the range of historical values. TP remained relatively constant, peaking in July and decreasing in later months (Figure 1).

Average chlorophyll-*a* concentration in 2019 was 21.7 μg/L (Table 2), also putting Muriel Lake into the eutrophic classification. This chlorophyll-*a* average is high when compared to historical records, although not as high as in 2015. Chlorophyll-*a* concentrations increased throughout the summer, reaching a maximum concentration of 28.6 μg/L on August 6, before falling in September.

Finally, average TKN concentration was 3.4 mg/L (Table 2), and the maximum concentration of 3.5 mg/L was measured on July 3.

Average pH was measured as 9.19 in 2019, buffered by high alkalinity (965 mg/L $CaCO_3$) and bicarbonate (725 mg/L HCO_3). Aside from bicarbonate, sulphate and sodium were the dominant ions contributing to a high conductivity of 2200 μS/cm (Table 2). The high conductivity of Muriel Lake is likely due to decreasing water levels.

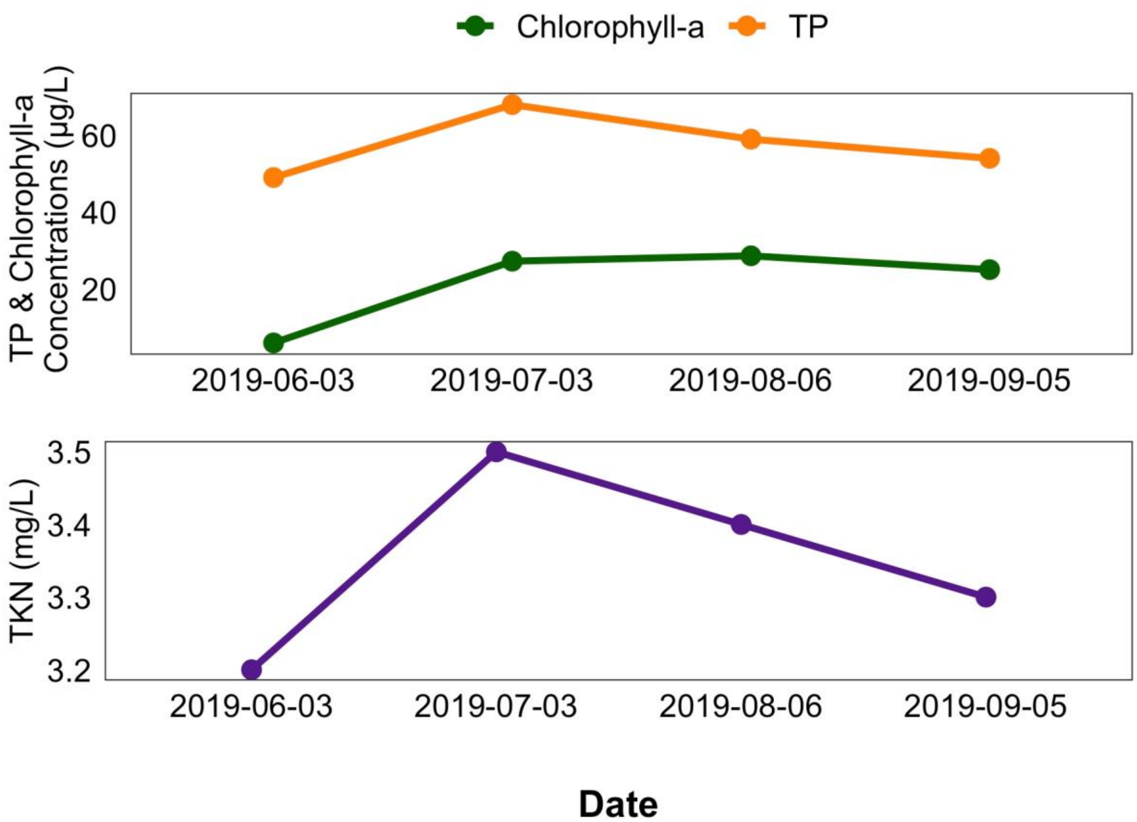

Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Muriel Lake.

METALS

Samples were analyzed for metals once throughout the summer (Table 3). In total, 27 metals were sampled for. 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.

Metals were not measured at Muriel Lake in 2019, but Table 3 displays historical metal concentrations.

WATER CLARITY AND SECCHI 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 but 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 depth. Two times the Secchi depth equals the euphotic depth – the depth to which there is enough light for photosynthesis.

The average Secchi depth of Muriel Lake in 2019 was 1.50 m (Table 2). Aside from a rather deep measurement of 2.80 m on June 3, water clarity measured as Secchi depth remained around 1.00 m in 2019 (Figure 2).

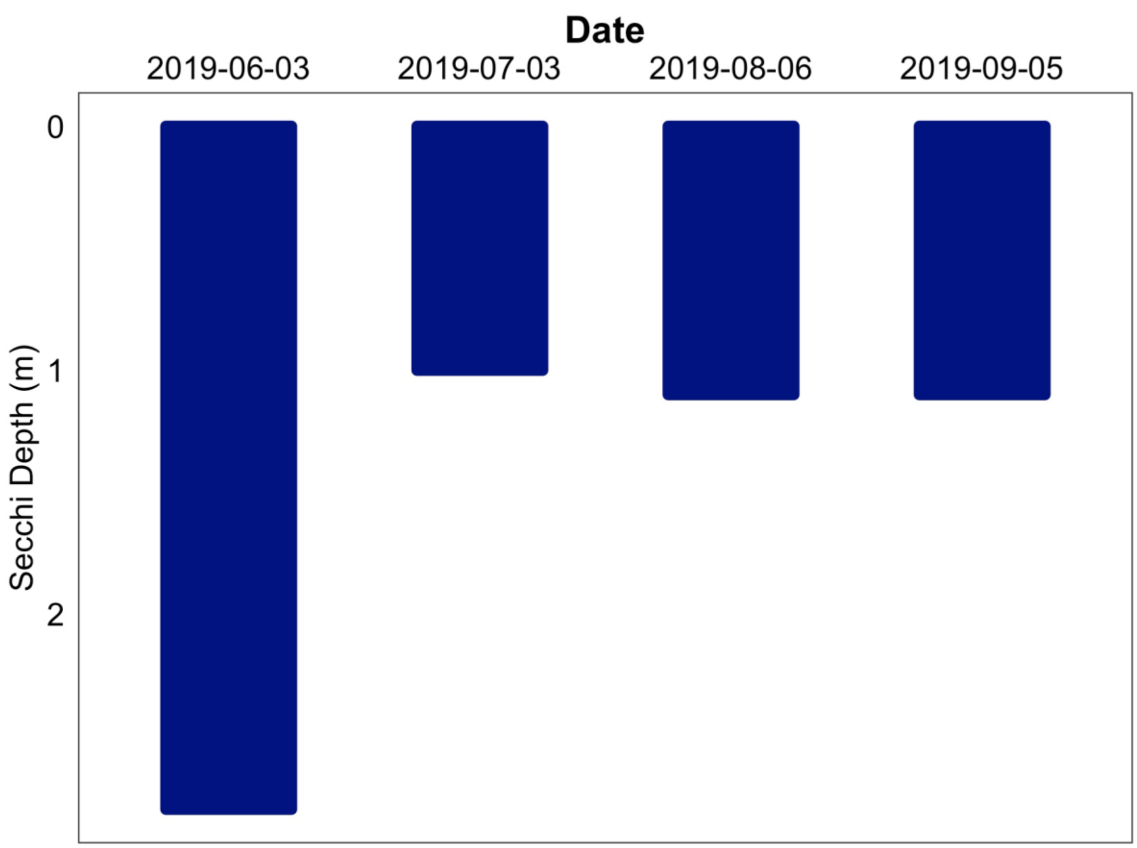

Figure 2. Secchi depth values measured four times over the course of the summer at Muriel Lake in 2019.

WATER TEMPERATURE AND DISSOLVED OXYGEN

Water temperature and dissolved oxygen (DO) profiles in the water column can provide information on water quality and fish habitat. The depth of the thermocline is important in determining the depth to which dissolved oxygen from the surface can be mixed. Please refer to the end of this report for descriptions of technical terms.

Temperatures of Muriel Lake varied throughout the summer, with a maximum temperature of 20.4 °C measured around 1 m on August 6 (Figure 3a). The lake was well mixed throughout the summer as no significant stratification events were observed.

Muriel Lake remained well oxygenated throughout the summer, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 3b). The entire water column was well oxygenated.

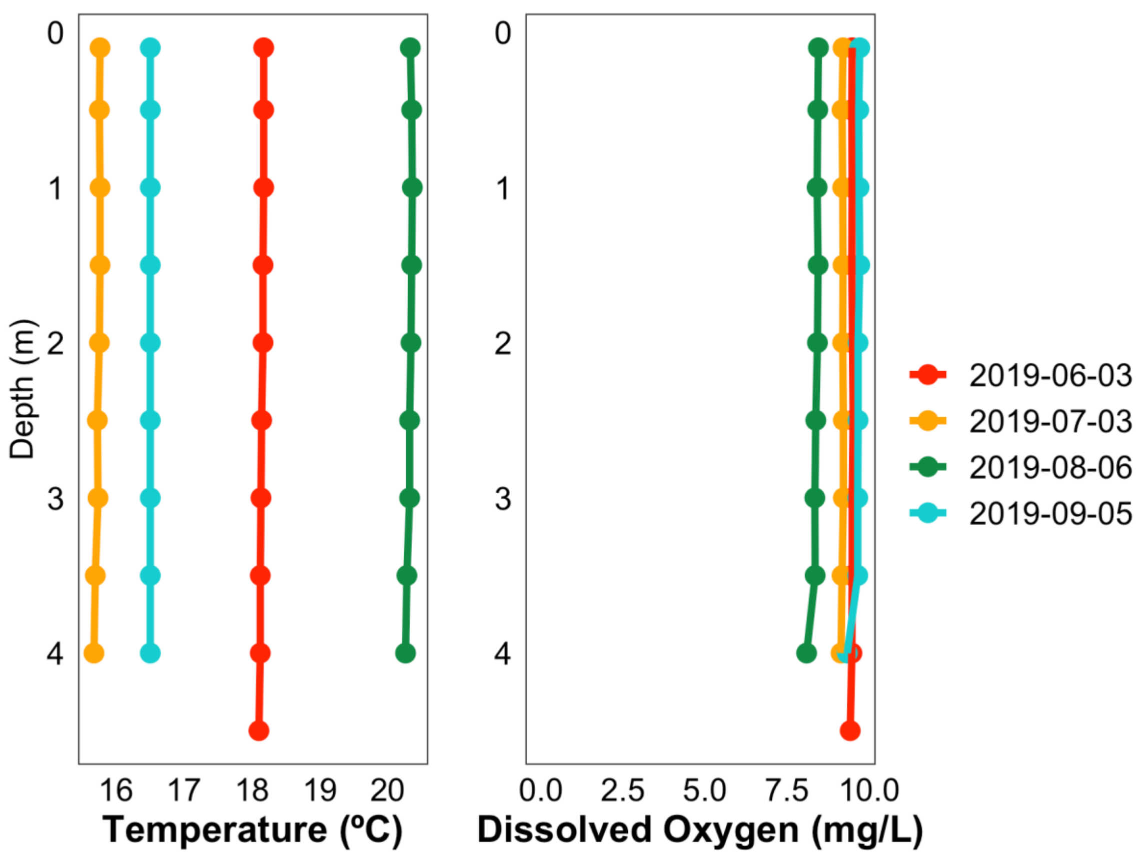

Figure 3. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Muriel Lake measured four times over the course of the summer of 2019.

MICROCYSTIN

Microcystins are toxins produced by cyanobacteria (blue-green algae) which, when ingested, 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 the one of the most common cyanobacteria toxins. In Alberta, recreational guidelines for microcystin are set at 20 μg/L. Blue-green algae advisories are managed by Alberta Health Services. Recreating in algal blooms, even if microcystin concentrations are not above guidelines, is not recommended.

Microcystin levels in Muriel Lake fell below the recreational guideline of 20 μg/L in 2019.

Table 1. Microcystin concentrations measured four times at Muriel Lake in 2019.

Date	Microcystin Concentration (μg/L)
03-Jun-19	0.21
03-Jul-19	0.24
06-Aug-19	0.44
05-Sep-19	0.60
Average	0.37

INVASIVE SPECIES MONITORING

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 have been linked to creating toxic cyanobacteria blooms, decreasing the amount of nutrients needed for fish and other native species, and causing millions of dollars in annual costs for repair and maintenance of water-operated infrastructure and facilities.

Monitoring involved using a 63 μm plankton net at three sample sites to look for juvenile mussel veligers in each lake sampled. No mussels were detected at Muriel Lake in the summer of 2019.

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.

No milfoil, native or Eurasian, was observed at Muriel Lake in 2019.

WATER LEVELS

There are many factors influencing water quantity. Some of these factors include the size of the lake's drainage basin, precipitation, evaporation, water consumption, ground water influences, and the efficiency of the outlet channel structure at removing water from the lake. Requests for water quantity monitoring should go through Alberta Environment and Parks Monitoring and Science division.

Water levels in Muriel Lake have decreased since water level monitoring began in 1968 (Figure 4). Muriel Lake water levels decreased from 559.7 m in 1981 to its historical low of 555.2 m in 2016; 4.5 m down from the steady level of the 1960s and 1970s. Since 2016, levels have gone up slightly, about 0.7m when comparing the low of 2016 to the level in September, 2019.

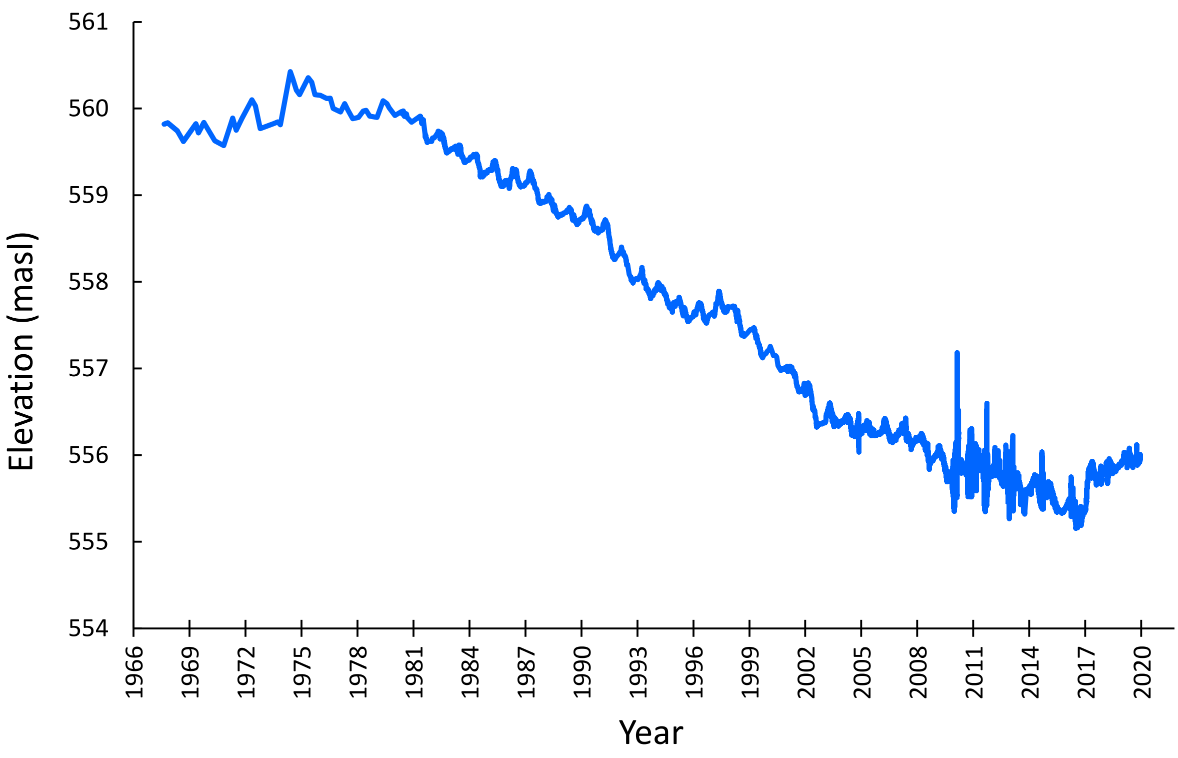

Figure 4. Water levels measured in metres above sea level (masl) from 1968 to February, 2020. Data retrieved from Alberta Environment and Parks.

Table 2. Average Secchi depth and water chemistry values for Muriel Lake. Historical values are given for reference.

Parameter	1988	1993	1997	2003	2006	2009	2012	2015	2017	2019
TP (µg/L)	36	32	41	48	54	64	54	100	48	58
TDP (µg/L)	12	17	16	18	22	29	32	21	16	14
Chlorophyll-*a* (µg/L)	6.7	/	6.7	9.2	8.5	9.6	4.6	31.7	20.9	21.7
Secchi depth (m)	2.16	/	1.86	1.13	1.50	1.08	2.86	0.75	1.03	1.50
TKN (mg/L)	1.5	1.8	2.0	2.5	2.7	3.4	3.1	3.9	3.4	3.4
NO_2-N and NO_3-N (µg/L)	1	1	3	3	3	23	4	3	2	7
NH_3-N (µg/L)	21	111	23	21	45	26	64	56	44	43
DOC (mg/L)	26	33	28	/	45	47	48	62	53	51
Ca (mg/L)	11	7	8	5	6	5	5	4	7	6
Mg (mg/L)	98	115	126	173	164	153	155	210	208	175
Na (mg/L)	118	140	160	238	245	289	283	313	303	278
K (mg/L)	21	27	30	39	41	54	58	56	59	51
SO_4^{2-} (mg/L)	116	143	154	239	257	333	334	398	360	360
Cl^- (mg/L)	17	/	23	34	36	41	41	51	45	48
CO_3 (mg/L)	71	108	115	210	181	213	155	265	213	220
HCO_3 (mg/L)	535	703	620	746	800	858	963	873	783	725
pH	9.03	9.15	9.18	9.28	9.24	9.25	9.19	9.27	9.30	9.19
Conductivity (µS/cm)	1143	1350	1354	/	1925	2157	2212	2475	2200	2200
Hardness (mg/L)	427	491	538	726	688	640	650	875	878	743
TDS (mg/L)	714	853	919	1305	1325	1510	1507	1725	1600	1500
Microcystin (µg/L)	/	/	/	/	0.18	0.22	0.36	16.25	0.30	0.37
Total Alkalinity (mg/L $CaCO_3$)	556	667	696	961	957	1060	1050	1175	998	965

Table 3. Concentrations of metals measured historically in Muriel Lake. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference. Concentrations that exceed these guidelines are displayed in red.

Metals (Total Recoverable)	2003	2006	2009	2012	2015	2017	Guidelines
Aluminum μg/L	34	31.8	20.15	16.485	19.8	85.7	100[a]
Antimony μg/L	0.22	0.183	0.1825	0.2265	0.2435	1.31	/
Arsenic μg/L	7.6	8.54	9.21	8.72	10.7	54.8	5
Barium μg/L	3.9	5.13	3.105	2.88	2.63	15.2	/
Beryllium μg/L	0.07	0.0015	0.0015	0.00625	0.004	0.0055	100[c,d]
Bismuth μg/L	0.013	0.0032	0.0046	0.00245	0.008	0.0055	/
Boron μg/L	319	290	325.5	377.5	441	1760	1500
Cadmium μg/L	0.01	0.0088	0.00365	0.0077	0.006	0.025	0.26[b]
Chromium μg/L	0.63	0.696	0.72	0.6335	0.265	0.25	/
Cobalt μg/L	0.036	0.23	0.0576	0.0489	0.055	0.364	1000[d]
Copper μg/L	1	1.87	1.435	0.995	1.57	3.54	4[b]
Iron μg/L	15	26.3	14.585	23.3	20.3	63.8	300
Lead μg/L	0.115	0.0944	0.04865	0.0444	0.1005	0.174	7[b]
Lithium μg/L	114	132	154	195.5	227.5	819	2500[e]
Manganese μg/L	2.4	4.26	1.665	2.35	2.77	9.57	200[e]
Molybdenum μg/L	1.25	1.49	1.58	1.885	1.995	8.45	73[c]
Nickel μg/L	0.08	0.206	0.1315	0.12535	0.1735	1.33	150[b]
Selenium μg/L	0.7	1.41	0.759	0.466	0.055	12.8	1
Silver μg/L	0.0025	0.0024	0.00575	0.0018	0.0015	0.018	0.25
Strontium μg/L	9.9	11	9.405	9.38	5.535	47.8	/
Thallium μg/L	0.077	0.0098	0.00155	0.000525	0.00045	0.018	0.8
Thorium μg/L	0.015	0.0134	0.00725	0.007825	0.00045	0.043	/
Tin μg/L	0.05	0.015	0.015	0.05495	0.076	0.15	/
Titanium μg/L	2.7	2.58	2.12	1.211	2.13	6.38	/
Uranium μg/L	1.55	1.44	1.595	1.56	1.9	7.23	15
Vanadium μg/L	0.9	0.597	0.703	0.578	0.51	4.55	100[d,e]
Zinc μg/L	2.8	2.46	1.525	1.42	1.7	14.8	30

Values represent means of total recoverable metal concentrations.
[a] Based on pH ≥ 6.5
[b] Based on water hardness > 180mg/L (as $CaCO_3$)
[c] CCME interim value.
[d] Based on CCME Guidelines for Agricultural use (Livestock Watering).
[e] Based on CCME Guidelines for Agricultural Use (Irrigation).
A forward slash (/) indicates an absence of data or guidelines.