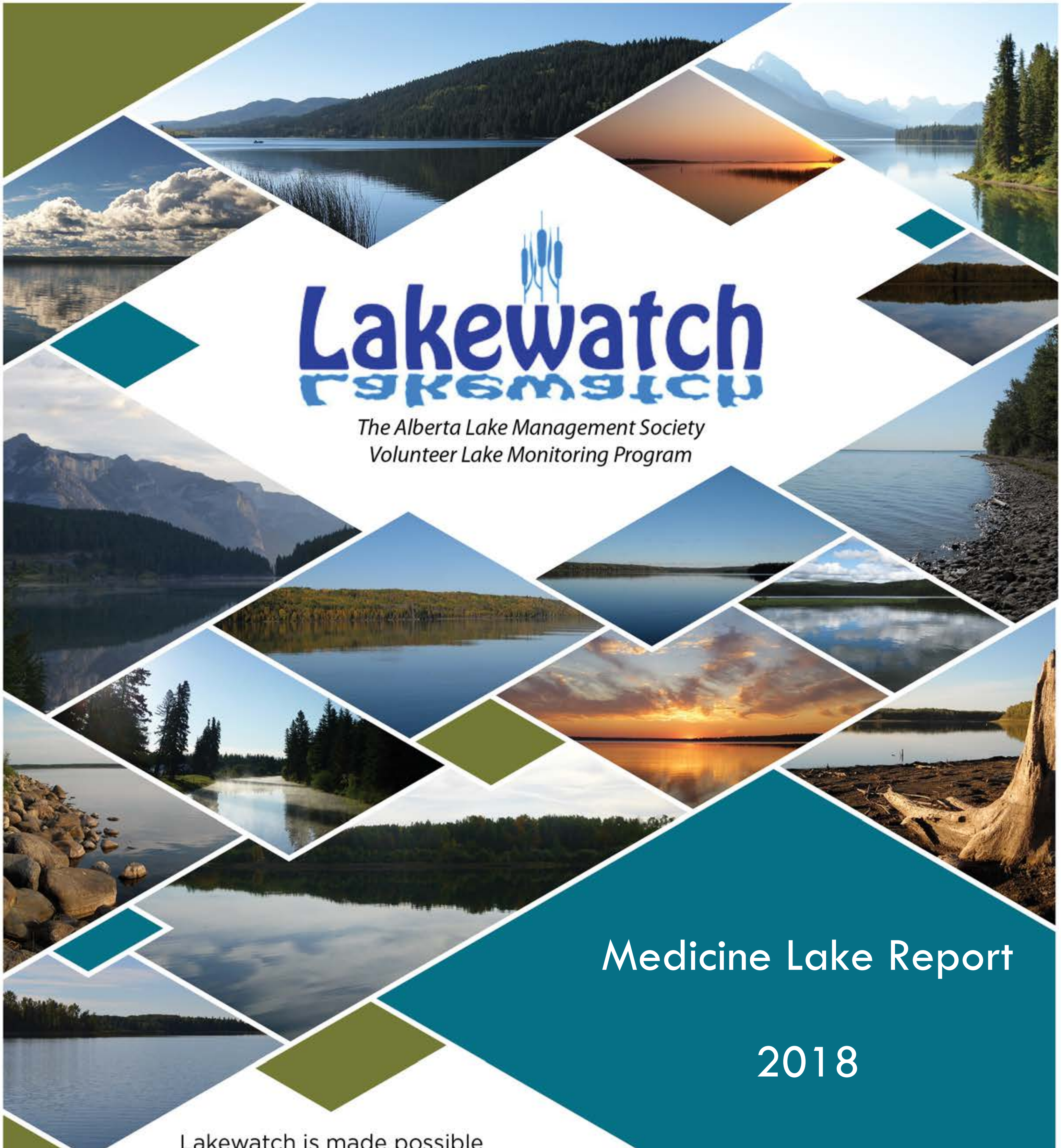


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Medicine Lake Report

2018

Lakewatch is made possible with support from:

Alberta · Pigeon Lake Watershed Association · Jackfish Lake · MD 61 Wainwright · LICA Environmental Stewards · Red Deer River Watershed Alliance · Cargill

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.

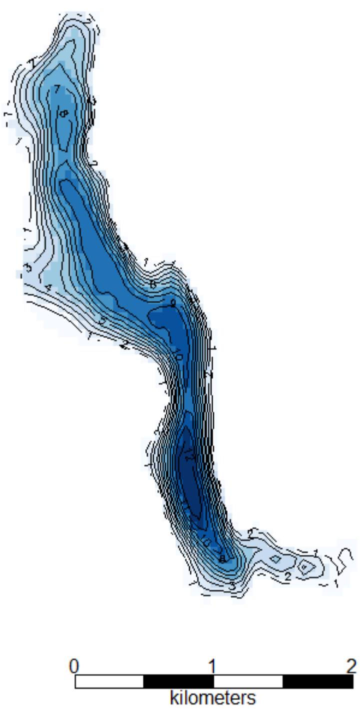
If you require data from this report, please contact ALMS for the raw data files.

ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. A special thanks to Jim Rawlins for his commitment to collecting data at Medicine Lake. We would also like to thank Alanna Robertson, Lindsay Boucher and Shona Derlukewich, who were summer technicians in 2018. Executive Director Bradley Peter and Program Coordinator Laura Redmond were instrumental in planning and organizing the field program. This report was prepared by Caitlin Mader and Bradley Peter.

Medicine Lake

Medicine Lake is a 1.27 km^2 lake located in an eponymous provincial recreation area 47 km north of Rocky Mountain House. This area is at the interface of the lower foothills and central mixedwood natural subregions of Alberta and within the Red Deer River Watershed[1]. Surrounding land uses include oil and gas, but the lake is bordered mostly by in-tact forest and wetlands. The lake is a popular recreational spot for fishing, boating, camping, and other outdoor activities[2].



Approximate bathymetry of Medicine Lake[3,4] (left), and aerial imagery of the lake and its surrounding land[5] (right).

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[1] Nat. Regions Committee. (2006). Nat. Regions and Subregions of AB. Compiled by D.J. Downing and WW Pettapiece. GoA Pub. No. T/852

[2] Alberta Parks. Retrieved 2019/02/01 from https://www.albertaparks.ca/parks/central/medicine-lake-pra/information-facilities/camping/medicine-lake/

[3] Made with Alberta Government Open data, retrieved 2019/02/01 from http://ags.aer.ca/document /DIG/DIG_2008_0467.zip,

[4] Visualized using R core, R Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/. and "raster", Robert J. Hijmans (2018). raster: Geographic Data Analysis an d modeling. R package version 2.8-4. https://CRAN.R-project.org/package=raster

[5] Google earth imagery, retrieved 2019/02/01

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. On one visit per season, metals are collected at the profile site by hand grab from the surface and at some lakes, 1 m off bottom using a Kemmerer.

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). In lakes where mercury samples are taken, they are analyzed by the Biogeochemical Analytical Service Laboratory (BASL).

Invasive Species: Monitoring for invasive quagga and zebra mussels involved two components: monitoring for juvenile mussel veligers using a 63 µm plankton net at three sample sites and monitoring for attached adult mussels using substrates installed at each lake.

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 aep.alberta.ca/water.

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 TP, chlorophyll-*a,* 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 Medicine Lake was 24.6 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. Detected TP was lowest when first sampled in June at 15 µg/L, and rose throughout the season until the final sampling at 34 µg/L in early October (Figure 1).

Average chlorophyll-*a* concentrations in 2018 was 8.4 µg/L (Table 2), falling into the oligotrophic, or low productivity trophic classification. Chlorophyll-*a* ranged from a minimum of 3.5 µg/L in June to a maximum of 12.3 µg/L in late August.

Finally, the average TKN concentration was 0.71 mg/L (Table 2) with concentrations peaking in late August at 0.81 mg/L.

Average pH was measured as 8.17 in 2018, buffered by moderate alkalinity (118 mg/L $CaCO_3$) and bicarbonate (142 mg/L HCO_3). Calcium was the dominant ion contributing to a low conductivity of 228 µS/cm (Table 2).

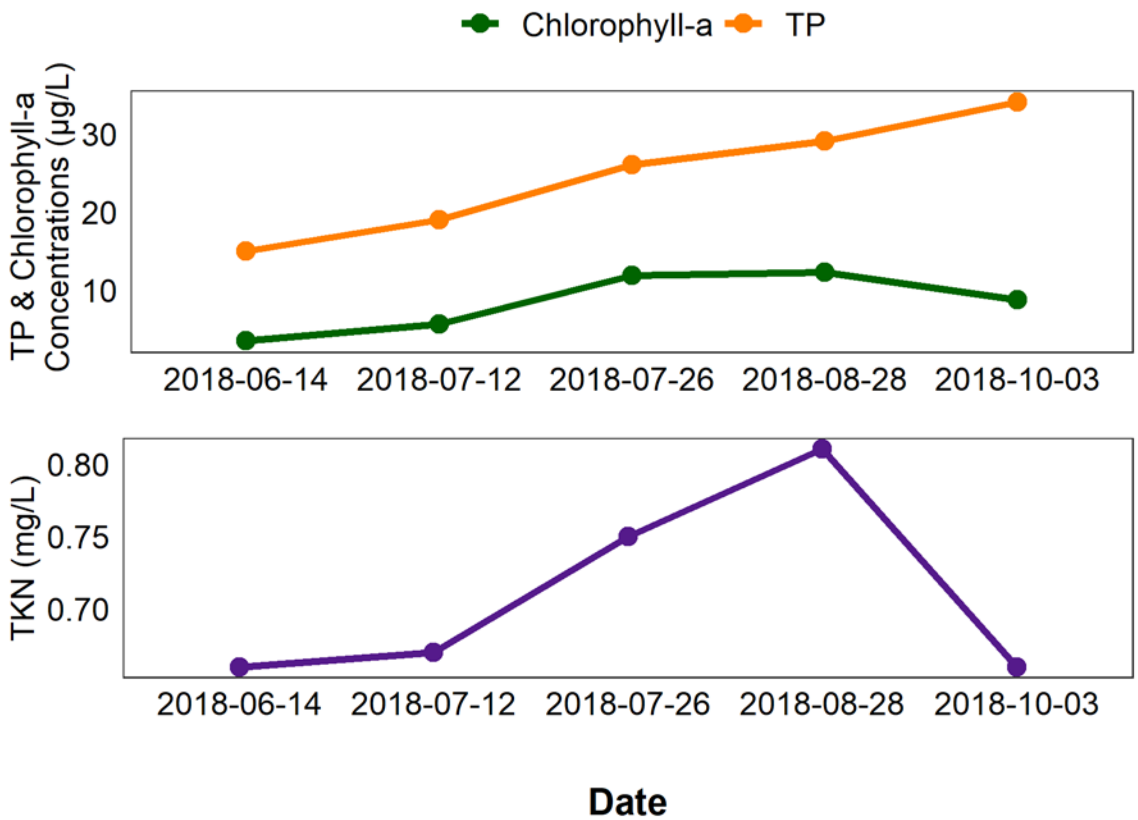

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured five times over the course of the summer at Medicine Lake.

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 Medicine Lake in 2018 was 2.46 m (Table 2). Water clarity lowest on August 28, when a Secchi depth of 1.70 m was measured (Figure 2).

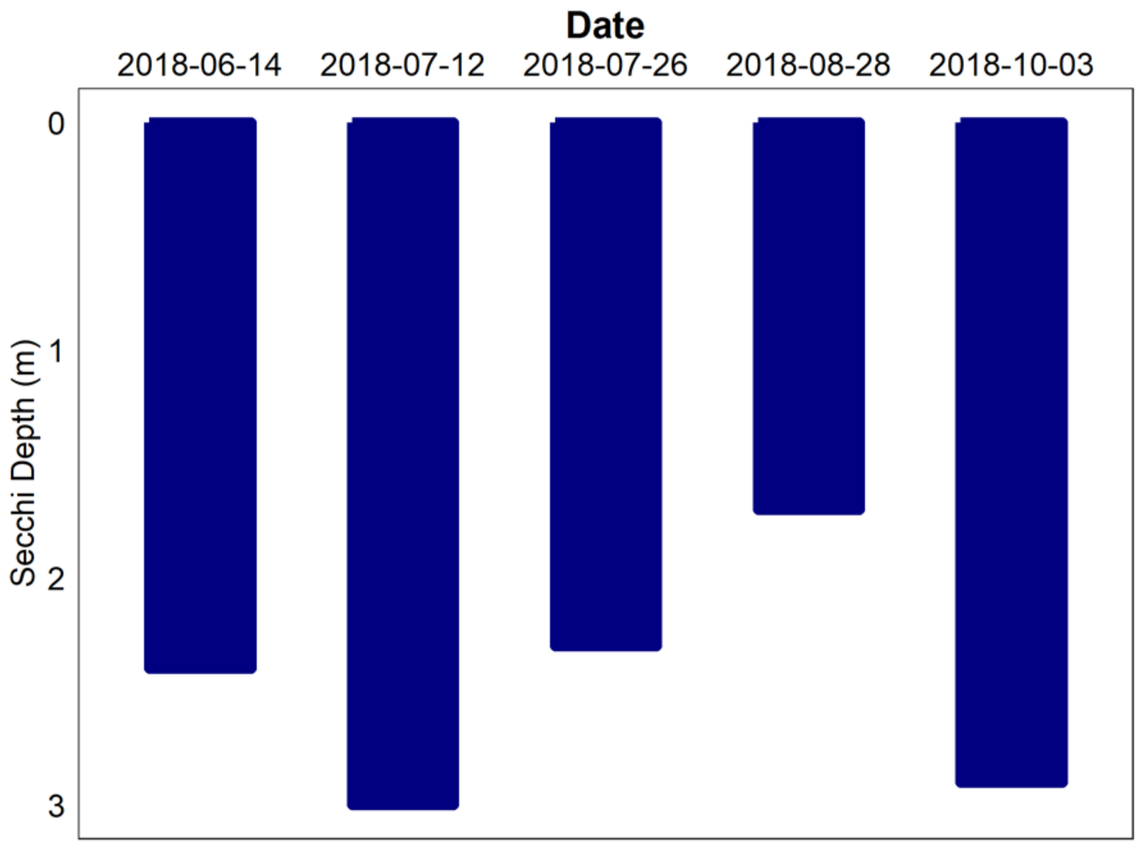

Figure 2 – Secchi depth values measured five times over the course of the summer at Medicine Lake in 2018.

WATER TEMPERATURE AND DISSOLVED OXYGEN

Water temperature and dissolved oxygen 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 Medicine Lake varied throughout the summer, with a maximum temperature of 20.9°C measured at the surface on July 12 (Figure 3a). The lake was not stratified during any of the sampling trips, with temperatures decreasing only within the bottom 1.5 to 3 meters on some sampling trips. This indicates complete or partial mixing throughout the season.

Medicine Lake remained well oxygenated through the upper of the water column most of the summer, measuring above the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). The oxygen level fell below this in the bottom 1.5 to 3 meters on all sampling trips prior to October. This decrease in oxygen levels towards the bottom is likely due to decomposing organic matter on lake bottom, combined with incomplete mixing with surface waters.

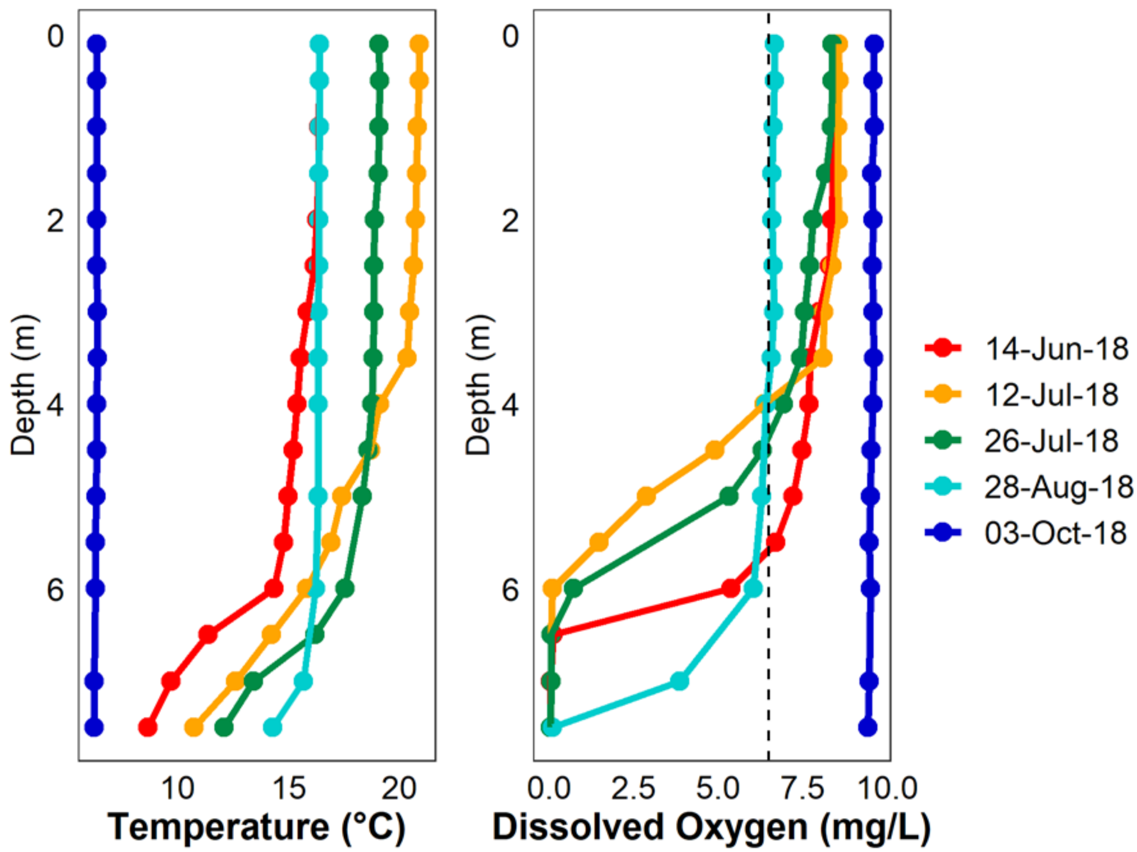

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Medicine Lake measured five times over the course of the summer of 2018.

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 Medicine Lake fell below the recreational guideline of 20 μg/L for 2018.

Table 1 – Microcystin concentrations measured five times at Medicine Lake in 2018.

Date	Microcystin Concentration (μg/L)
14-Jun-18	<0.10
12-Jul-18	0.14
26-Jul-18	0.16
28-Aug-18	0.21
03-Oct-18	0.12
Average	0.15

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 algae 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 two components: monitoring for juvenile mussels (veligers) using a plankton net and monitoring for attached adult mussels using substrates installed in each lake. No mussels have been detected in Medicine Lake.

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.

Records of Medicine Lake water levels date back to 1969 (Figure 4). Water levels naturally fluctuate within and between seasons based on precipitation and evaporation.

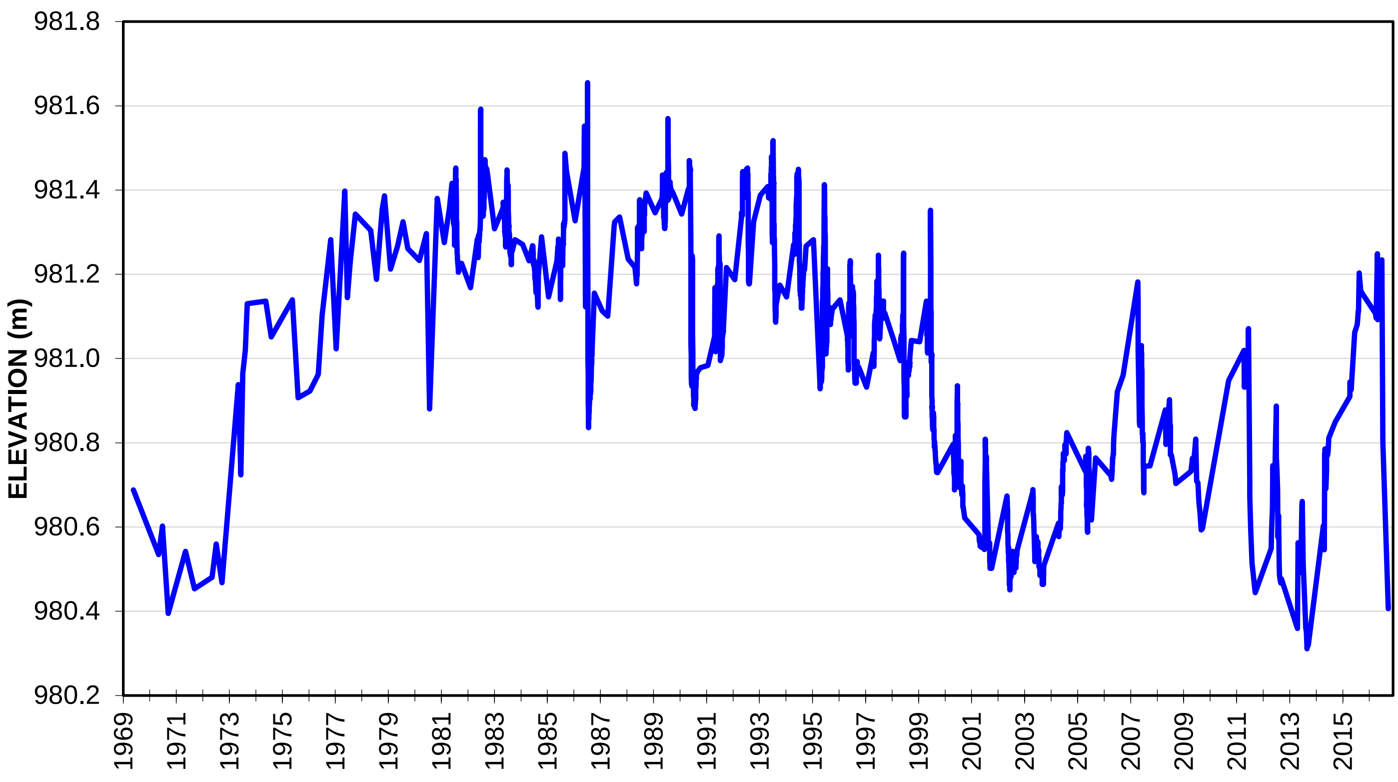

Figure 4: Surface elevation of Medicine Lake, from 1969 to 2016 in meters above sea level. Data retrieved from Alberta Environment and Parks.

Table 2: Average Secchi depth and water chemistry values for Medicine Lake. Historical values are not available for Medicine Lake as 2018 was its first inclusion in the LakeWatch program.

Parameter	**2018**
TP (µg/L)	24.6
TDP (µg/L)	5.9
Chlorophyll-*a* (µg/L)	8.44
Secchi disk depth (m)	2.46
TKN (µg/L)	0.71
$NO_{2,3}$ (µg/L)	5.36
NH_4 (µg/L)	34
Dissolved organic C (mg/L)	14
Ca (mg/L)	26.2
Mg (mg/L)	8.4
Na (mg/L)	14.4
K (mg/L)	1.52
SO_4^{2-} (mg/L)	5.82
Cl^- (mg/L)	1.0
CO_3 (mg/L)	1.0
HCO_3 (mg/L)	142
pH	8.174
Conductivity (µS/cm)	228
Hardness (mg/L)	101.2
TDS (mg/L)	130
Microcystin (µg/L)	0.14
Total Alkalinity (mg/L $CaCO_3$)	118