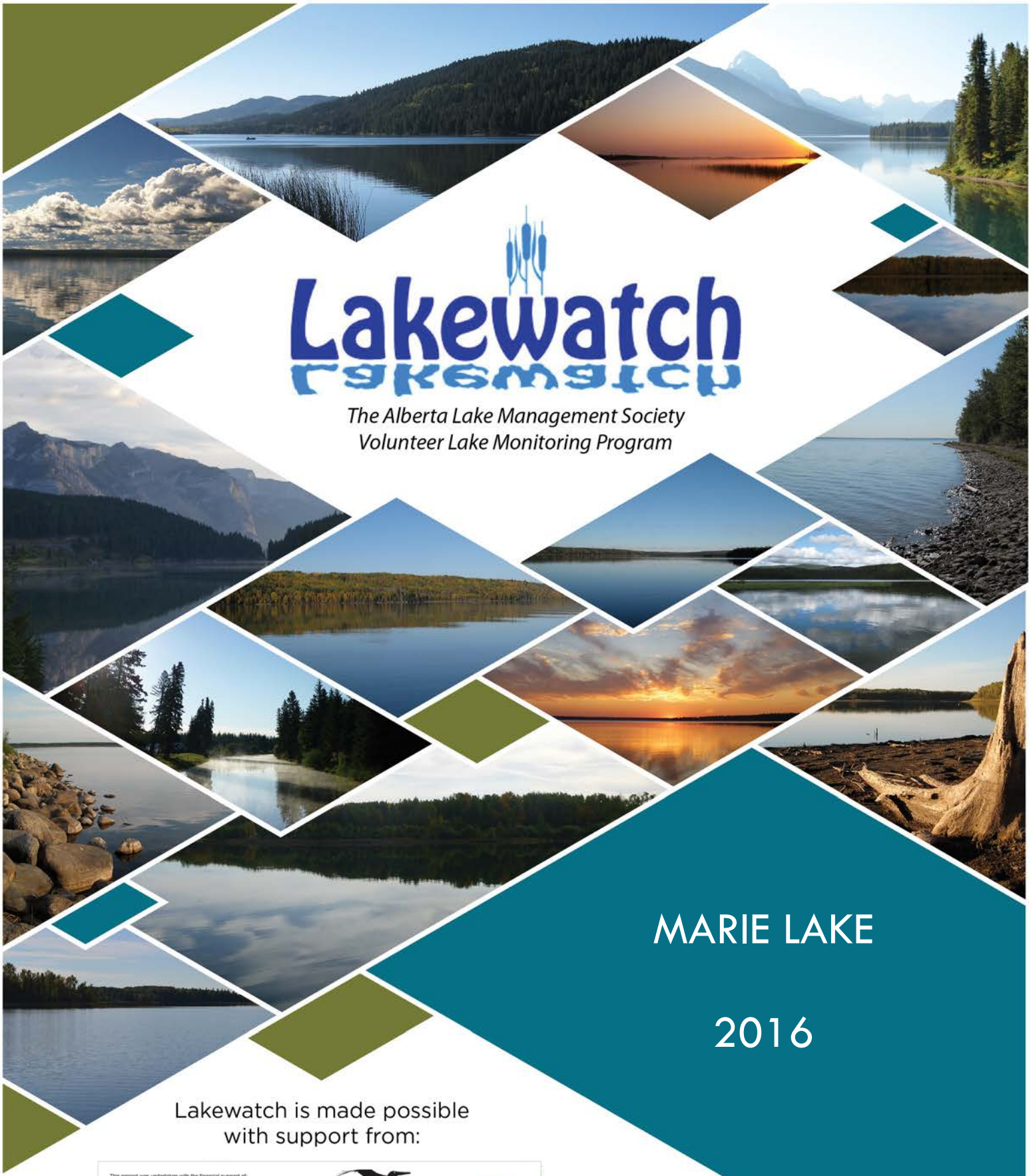

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

MARIE LAKE

2016

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Environment and Climate Change Canada
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LICA Lakeland Industry & Community Association
Beaver River Watershed Alliance
Red Deer River Watershed Alliance

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.

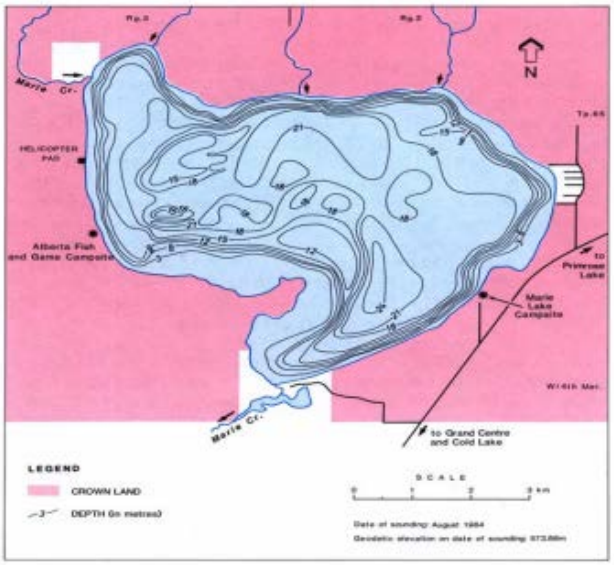
ALMS would like to thank all who express interest in Alberta's aquatic environments and particularly those who have participated in the LakeWatch program. These people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health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

ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. We would like to extend a special thanks to Jim Ross, Lori & Marian Gracia, and Kelvin Plain for the time and energy put into sampling Marie Lake in 2016. We would also like to thank Alicia Kennedy, Ageleky Bouzetos, and Breda Muldoon who were summer technicians in 2016. Executive Director Bradley Peter was instrumental in planning and organizing the field program. Alicia Kennedy was instrumental in report design. This report was prepared by Bradley Peter and Laura Redmond. The Beaver River Watershed, the Lakeland Industry and Community Association, Environment Canada, and Alberta Environment and Parks are major sponsors of the LakeWatch program.

MARIE LAKE

Marie Lake is located in the Beaver River Drainage Basin and lies approximately 26 km northeast of the Town of Cold Lake, in the central mixed wood natural subregion of Alberta.[1] Marie Lake is named after the Cree word Methae or Merai meaning "a fish", and may specifically refer to the burbot (Lota lota) prevalent throughout most of Alberta.[2] The Cree arrived in the late eighteenth century during the growth of the fur trade via a popular trade route from Waterhen, Saskatchewan. Their arrival resulted in the displacement of the Beaver, Blackfoot, and Slavey tribes that were common in the area.[2] Marie Lake is over 26 m deep (Figure 2) with a slow flushing rate (a residence time of 14.5 years). It is mesotrophic and has a small littoral zone for its surface area of 36 km^2 .



Bathymetric map of Marie Lake (Alberta Environment)


Marie Lake- Photo by: Randi Newton 2012

The shoreline is primarily sandy with macrophytes (rooted aquatic plants) limited to a couple areas. A large macrophyte bed is located along the west shore stretching towards the north, and another lies on the western edge of the south bay. Macrophyte beds are dominated by bulrush, pondweed, and northern watermilfoil[1] . The low productivity of the shoreline does not provide suitable habitat for semi-aquatic wildlife; however, the macrophytes beds are very important for maintaining a productive fishery. Sport fish include lake whitefish, walleye, northern pike, yellow perch, and burbot.

The watershed area for Marie Lake is 396.51 km^2 and the lake area is 37.39 km^2. The lake to watershed ratio of Marie Lake is 1:11. A map of the Marie Lake watershed area can be found at http://alms.ca/wp-content/uploads/2016/12/Marie.pdf.

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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] Mitchell, P. and E. Prepas. 1990. Atlas of Alberta Lakes, University of Alberta Press. Retrieved from http://sunsite.ualberta.ca/projects/alberta-lakes/

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.

Total phosphorus (TP) in Marie Lake had an average concentration of 20 µg/L in 2016, putting it in the mesotrophic trophic classification (Table 2). TP was relatively constant throughout the summer, with a spike to the maximum concentration of 59 µg/L on August 13 (Figure 1). It is unclear what caused this input of TP on this date.

Chlorophyll-*a* concentrations remained low over the course of the summer, with an average concentration of 4.0 µg/L in 2016 (Table 2). This puts Marie Lake in the mesotrophic trophic status class. A maximum concentration of 5.9 µg/L was reached on June 8 (Figure 1).

Marie Lake had an average TKN concentration of 0.73 mg/L over five sampling dates in 2016 (Table 2). On June 8 TKN concentrations were at a seasonal maximum of 1.9 mg/L, but declined over the course of the sampling season(Figure 1).

Average pH measured as 8.26 in 2016, buffered by moderate alkalinity (142 mg/L $CaCO_3$) and bicarbonate (170 mg/L HCO_3). Calcium and magnesium were the only dominant ions contributing to a relatively low conductivity measure of 266 uS/cm (Table 2).

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 measured once at Marie Lake and all measured values fell within their respective guidelines (Table 3).

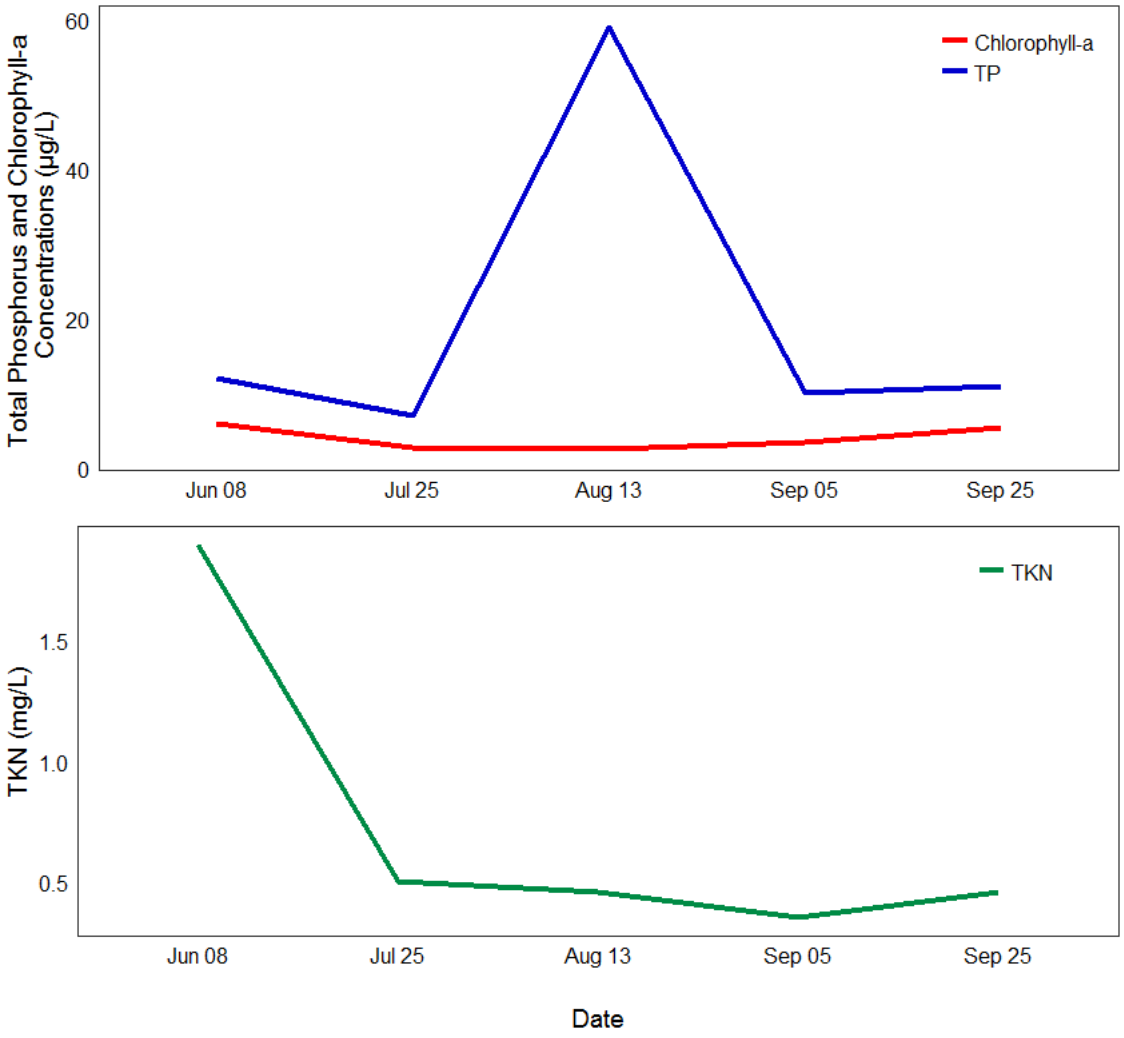

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured five times over the course of the summer at Marie Lake.

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 disk depth. Two times the Secchi disk depth equals the euphotic depth – the depth to which there is enough light for photosynthesis.

Average Secchi depth in 2016 was 3.5 m, classifying Marie lake as mesotrophic, or moderately productive (Figure 2). A maximum Secchi depth of 4 m was recorded on July 25, but Secchi depth remained relatively constant throughout the sampling season.

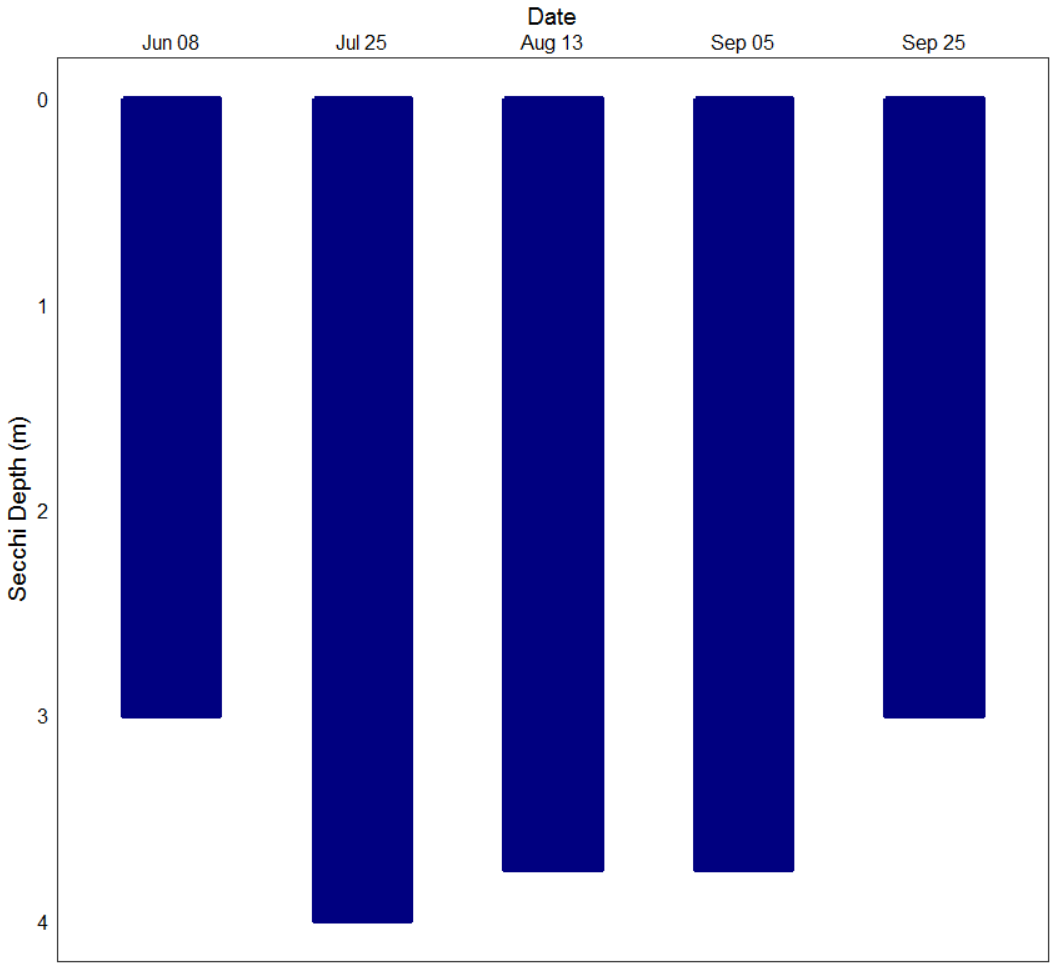

Figure 2 – Secchi depth values measured five times over the course of the summer at Marie Lake in 2016.

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.

Marie Lake water temperatures varied throughout the summer (Figure 3a). A maximum temperature of 20.54 °C was observed on August 13. Given that Marie Lake is quite deep, it reached thermal stratification on all sampling visits, with the thermocline deepening as the surface water warmed over the course of the summer.

Marie Lake remained well oxygenated at the surface throughout the summer, measuring above the Canadian Council for Ministers of the Environment guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). Marie reached anoxic conditions at the bottom on all sampling dates except June 8. This could be due to the separation of atmospheric oxygen from the surface by way of thermal stratification.

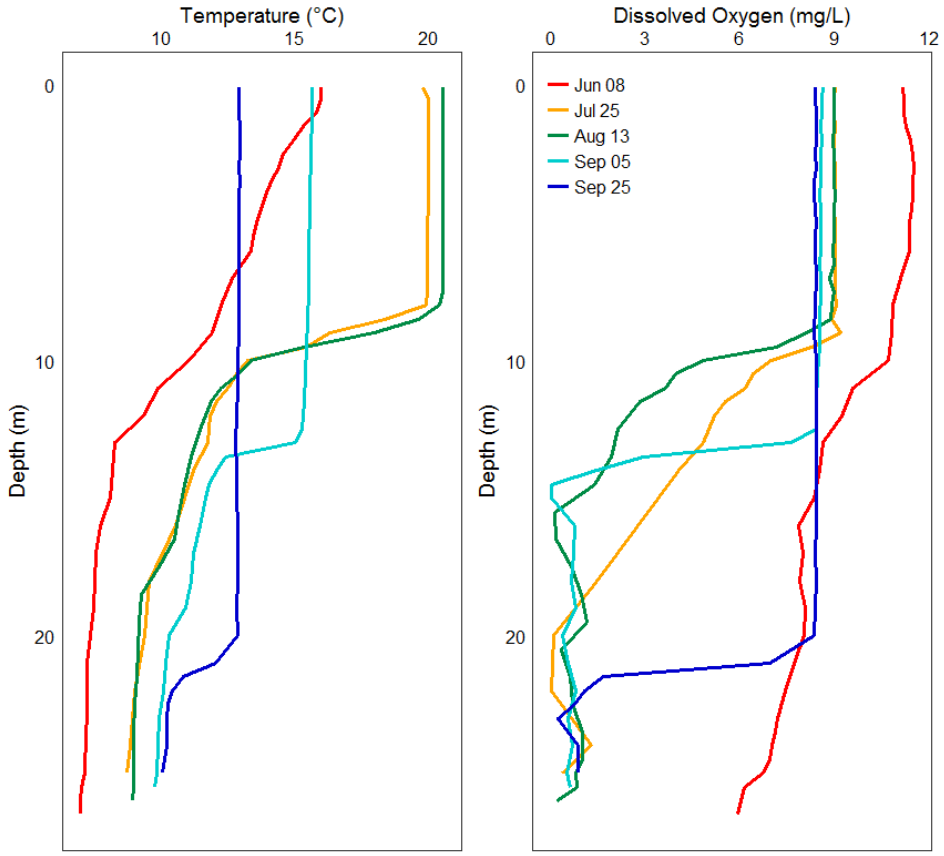

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Marie Lake measured five times over the course of the summer of 2016.

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.

Table 1 – Microcystin concentrations measured five times at Marie Lake in 2016.Concentrations remained below the recommended guidelines for recreational use on all sampling visits.

Date	Microcystin Concentration (µg/L)
Jun 8	0.05
Jul 25	0.05
Aug 13	0.05
Sep 5	0.05
Sep 25	0.05
Average	0.05

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 mussel veligers using a plankton net and monitoring for attached adult mussels using substrates installed in each lake. In 2016, no invasive mussels were detected in Marie Lake.

WATER LEVELS

There are many factors influencing water quantity. Some of these factors include the size of the lakes 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 Marie Lake have remained relatively stable since Environment Canada began monitoring the lake in 1980 (Figure 4). Since 1980, Marie Lake water levels have fluctuated between 573.1 m asl and 574.4 m asl. Data from Environment Canada was only available until 2014.

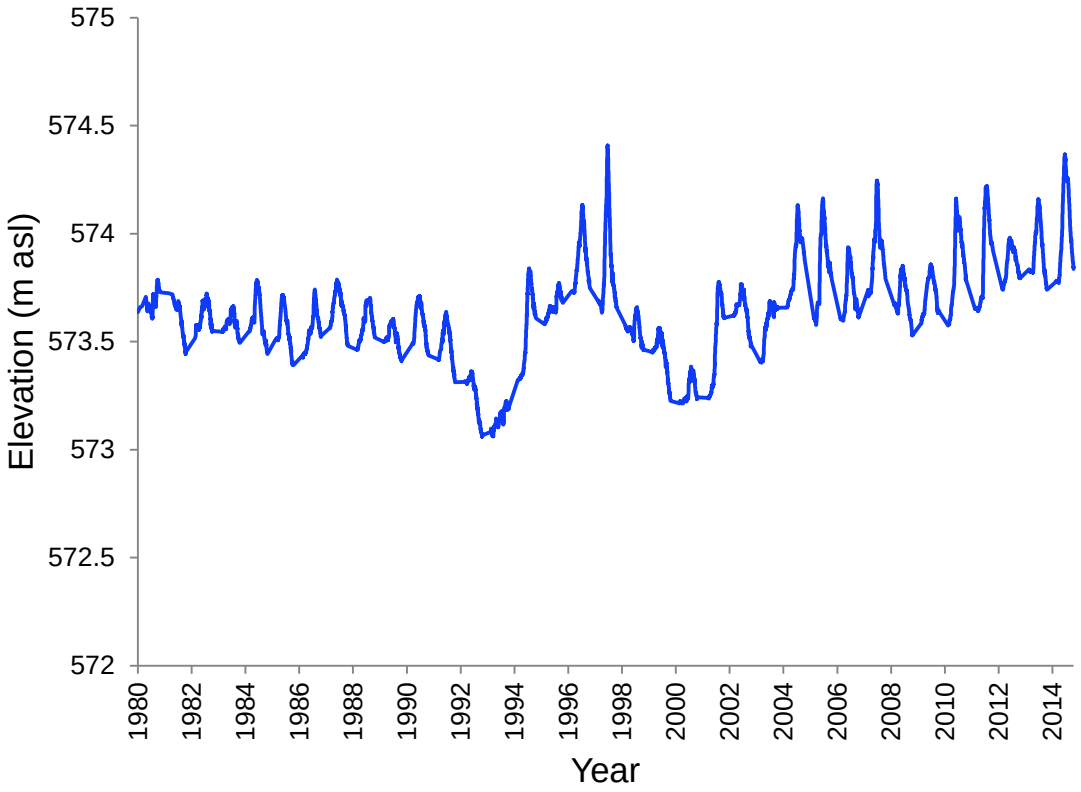

Figure 4- Water levels measured in meters above sea level (m asl) from 1980- 2014. Data retrieved from Environment Canada.

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

Parameter	1980	1981	2002	2003	2004	2007	2008	2009	2010	2012	2014	2016
TP (µg/L)	/	15	13	12.3	14	13.5	17.4	19.8	19.6	12	12.75	20
TDP (µg/L)	/	8	5	4	3.6	4.5	6.6	11.3	5.6	8	6.13	3
Chlorophyll-a (µg/L)	6.5	4.6	2.1	4.03	4.96	2.61	2.71	3.26	3.07	1.45	1.85	4.0
Secchi depth (m)	2.50	3.00	4.60	5.13	3.70	3.57	3.80	3.38	2.95	5.95	5	3.5
TKN (mg/L)	/	/	0.517	0.495	0.554	0.510	0.552	0.617	0.654	0.542	0.515	0.73
NO2 and NO3 (µg/L)	<1	/	1.8	4.75	3.2	2.5	6.5	5	6.2	2.5	20	2.5
NH3 (µg/L)	/	<22	9.3	6.5	7.1	12.25	15.2	16.3	11.2	16.6	13	25
DOC (mg/L)	/	/	/	/	9.67	10.57	11.43	10.43	11.37	10.3	23.05	10
Ca (mg/L)	30	/	35	33.97	33.03	33.5	32.87	31.5	26.95	32.7	32.9	34.2
Mg (mg/L)	12	/	12	14.37	12.25	12.2	12.17	11.7	12.78	12.5	13	13.6
Na (mg/L)	6	/	6	6.23	4.58	7.47	6.4	6.5	6.38	5.8	6.75	6.72
K (mg/L)	2	/	2	2.03	2	1.97	1.93	1.87	1.9	1.63	1.89	2.04
SO42- (mg/L)	<3	/	0.69	6.3	1.5	1.5	2.3	2.67	4.75	1.5	1.5	0.5
Cl- (mg/L)	<1	/	0.56	0.47	0.57	0.77	0.58	0.83	0.8	0.87	0.8	0.5
CO3 (mg/L)	/	/	/	4.33	6.33	7	4	9	0.5	14.7	1.775	1.67
HCO3 (mg/L)	/	/	/	176	171	165.7	173	165.7	174	148.2	173.5	170
pH	/	/	/	8.44	8.44	8.42	8.41	8.51	8.33	8.58	8.39	8.26
Conductivity (µS/cm)	/	/	/	276	273.7	265.7	266.3	263.7	263	267.8	262	266
Hardness (mg/L)	/	/	/	143.7	132.7	134	132.3	127	119.75	142.3	135.5	142
TDS (mg/L)	/	/	/	154.7	144.7	146.3	144.3	143	139	133.3	145	148
Microcystin (µg/L)	/	/	/	/	1.5	/	/	/	/	1.16	/	0.05
Total Alkalinity (mg/L CaCO3)	135	/	147	151.7	150.7	147.3	146.3	145.7	143	145.6	142.25	142

Table 3: Concentrations of metals measured once in Marie Lake. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	2007	2008	2010	2012	2014	2016	Guidelines
Aluminum µg/L	9.1	4.2	12.25	3.705	16.5	7.3	100[a]
Antimony µg/L	0.012	0.024	0.0232	0.0201	0.019	0.077	6[d]
Arsenic µg/L	0.51	0.67	0.6575	0.619	0.635	2.2	5
Barium µg/L	33.3	32.1	32.2	33.6	31.6	10.6	1000[d]
Beryllium µg/L	<0.003	<0.003	0.0062	0.0039	0.004	0.004	100[c,e]
Bismuth µg/L	<0.001	0.0013	0.00195	0.0075	0.0005	5.00E-04	/
Boron µg/L	17.7	23	18.95	38.65	22.2	170	1500
Cadmium µg/L	<0.002	0.0029	0.01085	0.0018	0.002	0.001	0.26[b]
Chromium µg/L	0.08	0.139	0.05285	0.04935	0.09	0.015	/
Cobalt µg/L	<0.001	0.0073	0.0009	0.0005	0.001	0.024	1000[e]
Copper µg/L	0.13	<0.05	0.1555	0.276	0.29	0.84	4[b]
Iron µg/L	39.9	3.28	23.15	2	12.9	7.5	300
Lead µg/L	0.021	0.0674	0.0161	0.003	0.047	0.012	7[b]
Lithium µg/L	4.37	7.25	6.31	6.75	7.01	58.2	2500[f]
Manganese µg/L	21.9	9.07	19.785	11.41	4.3	9.12	200[f]
Molybdenum µg/L	0.154	0.172	0.19	0.173	0.164	0.326	73[c]
Nickel µg/L	<0.005	0.086	0.0025	0.0025	0.004	0.219	150[b]
Selenium µg/L	0.06	<0.1	0.05	0.05	0.03	0.42	1
Silver µg/L	<0.0005	<0.0005	0.00655	0.00025	0.001	0.001	0.25
Strontium µg/L	90.8	91	84.35	88.7	84.7	60.2	/
Thallium µg/L	<0.0003	<0.003	0.002575	0.00015	0.00045	0.0014	0.8
Thorium µg/L	0.007	<0.003	0.00545	0.00015	0.001	0.0021	/
Tin µg/L	0.03	0.0315	0.015	0.015	0.014	0.017	/
Titanium µg/L	1.38	1.03	1.095	0.4205	0.5	0.41	/
Uranium µg/L	0.08	0.0662	0.0676	0.0606	0.051	0.369	15
Vanadium µg/L	0.14	0.112	0.12055	0.08575	0.1	0.2	100[e,f]
Zinc µg/L	0.64	0.175	0.798	0.2915	1.2	1.3	30

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on water hardness > 180mg/L (as CaCO3)

[c] CCME interim value.

[d] Based on Canadian Drinking Water Quality guideline values.

[e] Based on CCME Guidelines for Agricultural use (Livestock Watering).

[f] Based on CCME Guidelines for Agricultural Use (Irrigation).

A forward slash (/) indicates an absence of data or guidelines.