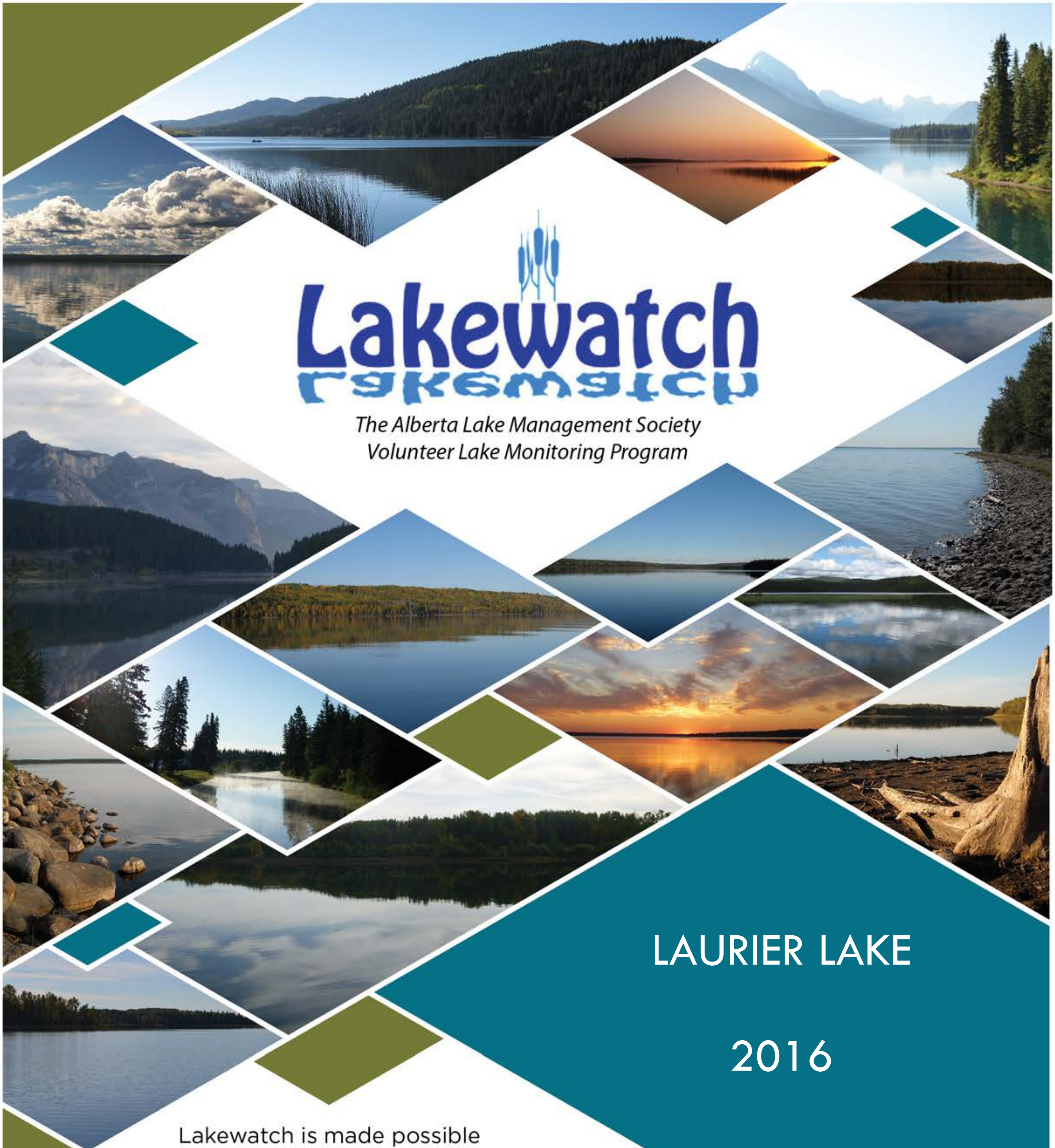

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

LAURIER LAKE

2016

Lakewatch is made possible
with support from:

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Cargill
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LICA Lakeland Industry & Community Association
Beaver River Watershed Alliance
Red Deer River Watershed Alliance
MD61 Wainwright

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.

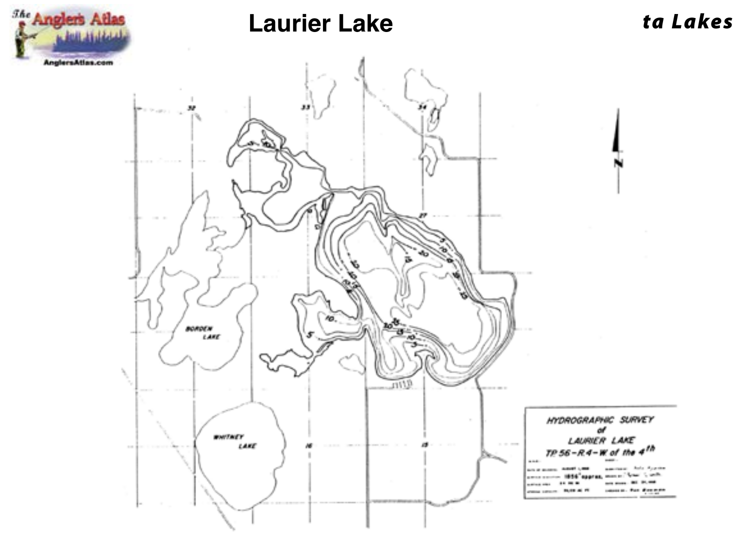
ALMS would like to thank all who express interest in Alberta's aquatic environments and particularly those who have participated in the LakeWatch program. These people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health 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 Bev Smith, Volunteer of the Year Recipient for 2016, for the time and energy put into sampling Laurier 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.

LAURIER LAKE

Laurier Lake is one of four beautiful lakes that were left behind 10,000 years ago when glaciers carved a hummocky terrain of kettles, eskers, and lake basins. Archaeological evidence indicates that the area was inhabited 7000 years ago, with Europeans arriving in 1754 by way of the nearby North Saskatchewan River. The Whitney Lakes Provincial Park adjacent to Laurier Lake was established in 1982. It boasts a diverse setting of jack pine (*Pinus banksiana*) meadows, aspen (*Populus* spp.) groves, willow (*Salix* spp.) thickets, marshes, fens, and mixed wood forests.



Bathymetric map of Laurier Lake (Angler's Atlas).

As many as 148 bird species have been observed in the park with an excellent viewing point on the west side of Laurier Lake. The land surrounding Laurier Lake includes a mixture of recreational cottage development, cleared agricultural land, and natural deciduous forest. Protected Crown Land makes up the north shore of the lake and the remainder is privately owned. The lake is enjoyed through recreational activities including hiking, wildlife viewing, and water-based recreation such as wind surfing, waterskiing, sailing, swimming, and fishing. Yellow perch (*Perca flavescens*) and northern pike (*Esox lucius*) are the sport fish of Laurier Lake. Fish stocking occurred in 1953 with sport and forage fish transferred from Moose Lake to Laurier Lake. The lake has not been managed for commercial or domestic fisheries.

The watershed area for Laurier Lake is 196.00 km^2 and the lake area is 6.57 km^2. The lake to watershed ratio of Laurier Lake is 1:30. A map of the Laurier Lake watershed area can be found at http://alms.ca/wp-content/uploads/2016/12/Laurier.pdf.

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 in Laurier Lake was measured as 45 µg/L (Table 2). This is just above historical levels of TP, and classifies Laurier Lake as eutrophic, or productive. TP increased gradually to a maximum concentration of 55 µg/L on August 3, and then decreased at the end of August (Figure 1).

In 2016, the average chlorophyll-*a* concentration was 36.4 µg/L (Table 2). This value is a historical maximum for Laurier Lake. Chlorophyll-*a* increased steadily over the course of the summer and peaked at 57 µg/L on August 30 (Figure 1). Changes in Laurier Lake's water chemistry is likely related to the increasing water levels at Laurier Lake.

The average TKN concentration was measured as 2.4 mg/L in Laurier Lake (Table 2). TKN concentrations fluctuated throughout the sampling season (Figure 1), potentially due to blue-green algae blooms fixing nitrogen into ammonia (NH_3^-). Average ammonia concentrations were also at a historical maximum of 105 mg/L.

Average pH measured as 8.90 in 2016, buffered by moderate alkalinity (505 mg/L $CaCO_3$) and bicarbonate (507.5 mg/L HCO_3). Magnesium, sulphate and sodium were the dominant ions contributing to a high conductivity measure of 1100 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 Laurier Lake and all measured values fell within their respective guidelines (Table 3).

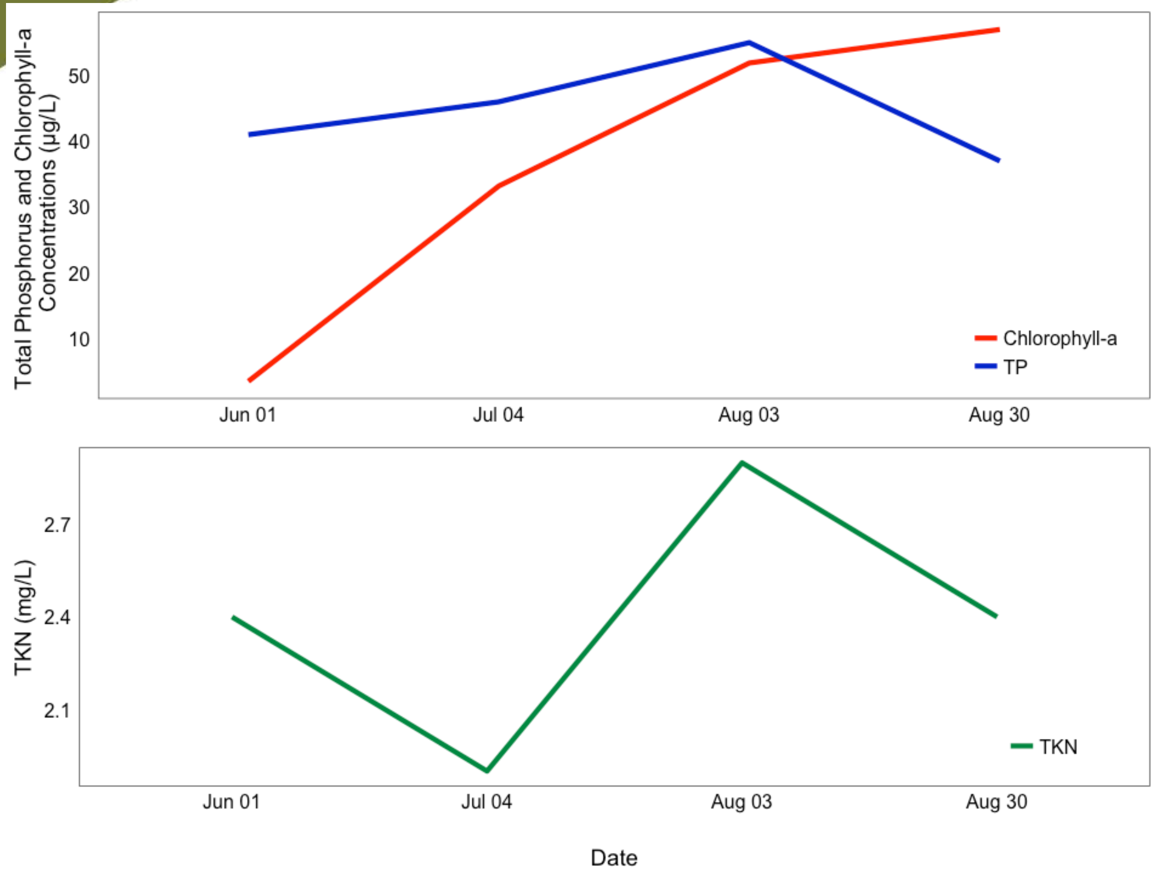


Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Laurier Lake.

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.

Secchi depth decreased over the course of the summer of 2016 (Figure 2). The average Secchi depth observed in Laurier Lake was 1.94 m (Table 2). Secchi depth was negatively correlated with chlorophyll-*a* concentrations (R= -0.98, df= 2, p-value= 0.016), indicating that decreasing water clarity was primarily a result of increasing phytoplankton blooms, which was amplified by warmer water temperatures in August.

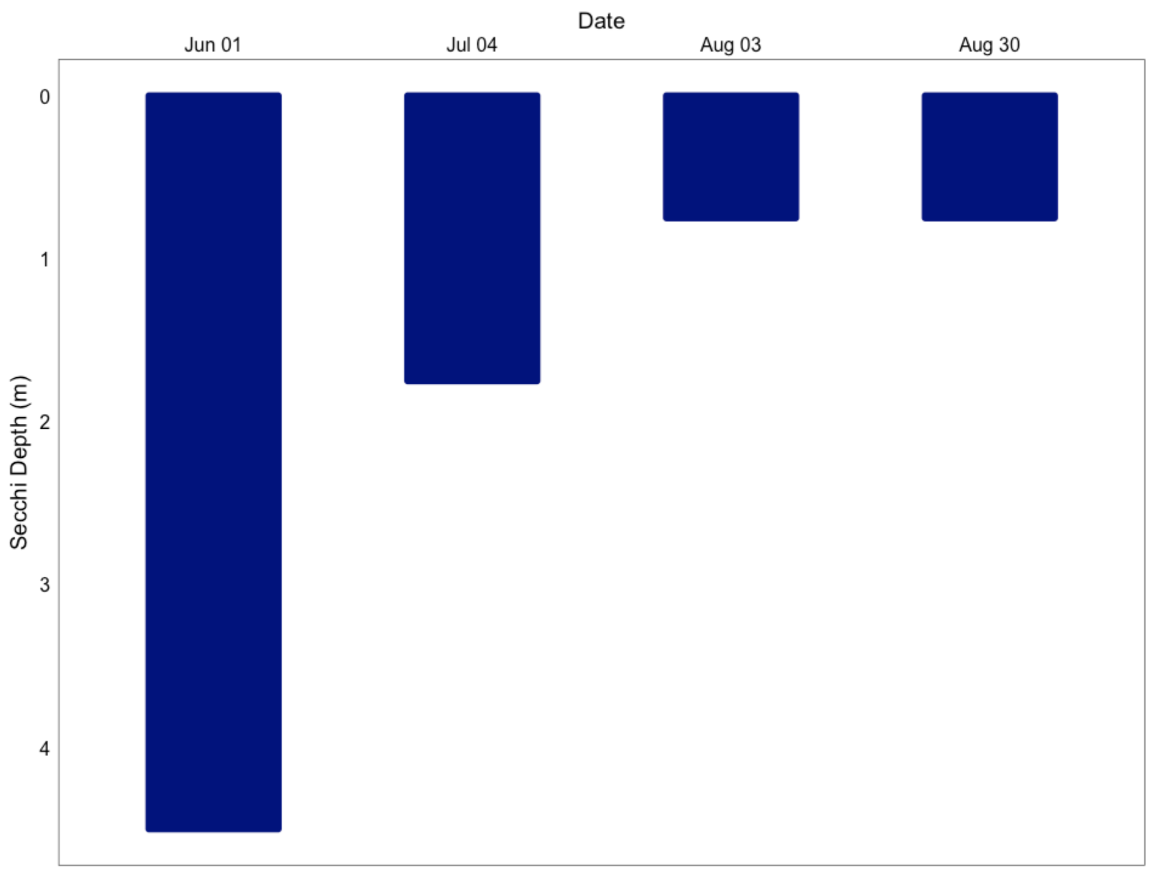


Figure 2 – Secchi depth values measured four times over the course of the summer at Laurier Lake in 2016.

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.

Water temperature in Laurier Lake increased through the summer, and then decreased again at the end of August (Figure 3a). The maximum surface temperature of 21.74 °C was recorded on August 3. Laurier Lake had a very weak thermal stratification in June and July, but was fully mixed through the water column in August.

Laurier 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). Laurier Lake became anoxic as early as 6 m on July 4, but became mixed through the water column on August 30. Thermal stratification at around 6 m on July 4 could play a role in the lack of oxygen below the thermocline.

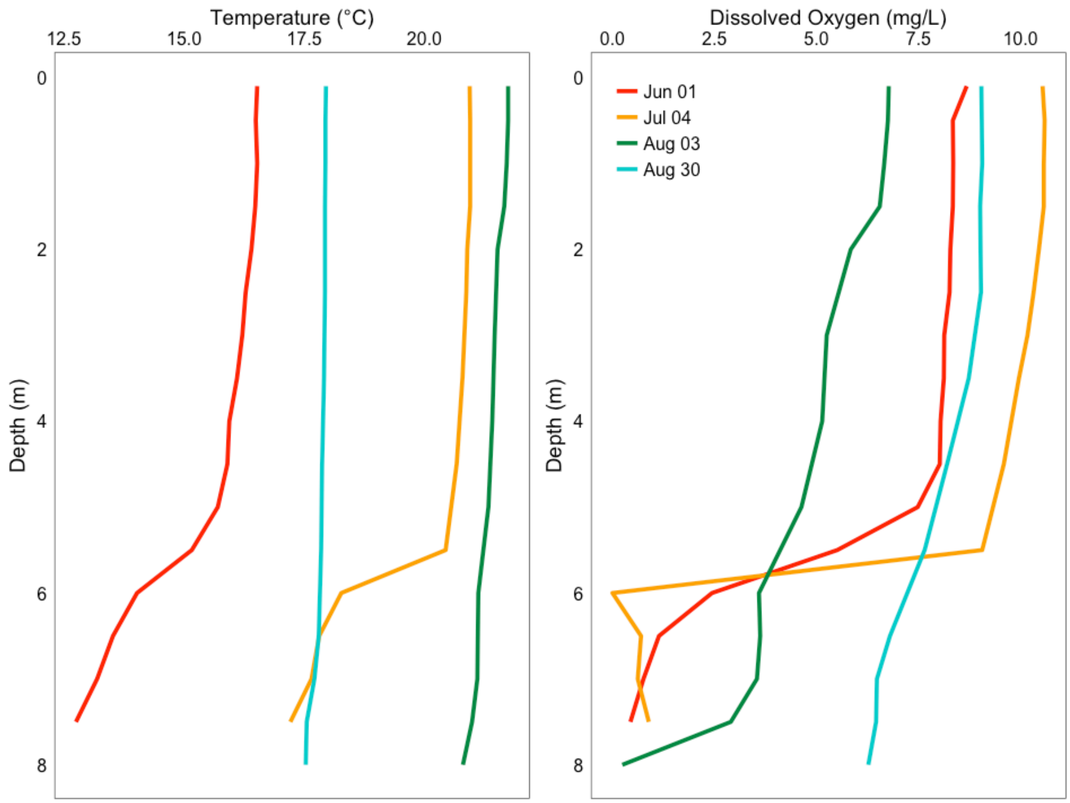


Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Laurier Lake measured four times over the course of the summer of 2016.

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 four times at Laurier Lake in 2016. Microcystin levels remained below the recommended guidelines at all sampling events.

Date	Microcystin Concentration (μg/L)
Jun 1	0.23
Jul 4	0.34
Aug 3	0.84
Aug 30	2.29
Average	0.925

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 Laurier 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 Laurier Lake have remained relatively stable since Alberta Environment began monitoring the lake in 1968 (Figure 4). Since 1968, Laurier Lake water levels have fluctuated between 564.1 m asl and 567.2 m asl. Recent increases in water level have resulted in the reconnection of small bays to the main basin of Laurier Lake.

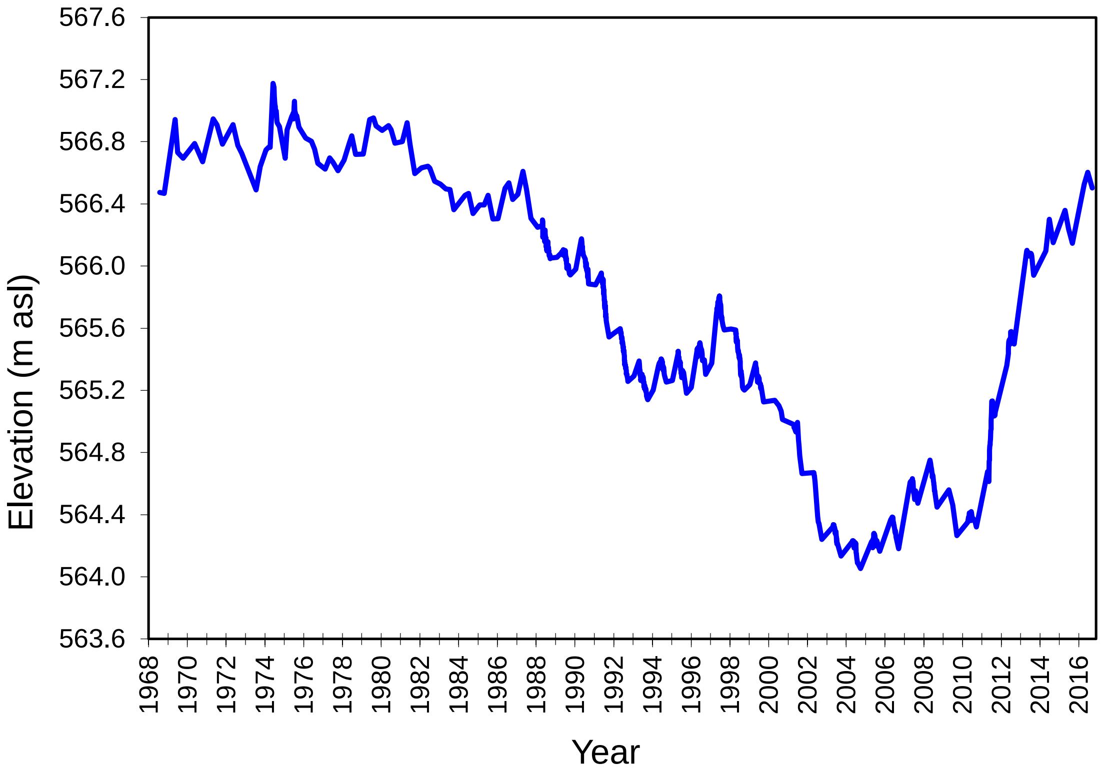


Figure 4- Water levels measured in meters above sea level (m asl) from 1968- 2016. Data retrieved from Alberta Environment.

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

Parameter	1978	1980	1987	1997	1998	2000	2002	2003	2004
TP (µg/L)	/	/	/	32.0	48.0	37.0	36.0	27.2	33.2
TDP (µg/L)	/	/	/	/	/	/	15	15	18
Chlorophyll-a (µg/L)	/	/	/	5.3	8.9	5.5	5.8	2.56	4.9
Secchi depth (m)	/	1.30	1.20	4.60	1.30	1.80	2.50	4.36	3.17
TKN (mg/L)	/	/	/	/	/	/	2.5	2.4	2.6
NO2 and NO3 (µg/L)	<50	50	<1	/	/	/	3.8	211	6.7
NH3 (µg/L)	/	/	/	/	/	/	23	40.8	74.4
DOC (mg/L)	/	/	/	/	/	/	/	/	44.3
Ca (mg/L)	23	27	19	20	21	13	12	10.3	10.6
Mg (mg/L)	48	54	52	73	81	83	99	106	105.1
Na (mg/L)	49	45	59	86	92	98	77	127.5	130.3
K (mg/L)	14	14	17	24	25	25	26	31.25	33.87
SO42- (mg/L)	36	40	41	62	66	73	94	99	103.7
Cl- (mg/L)	5	6	9	12	13	15	12	18.4	20.1
CO3 (mg/L)	/	/	/	39	62	66	102	112	83.7
HCO3 (mg/L)	/	/	/	493	468	469	515	522	601.3
pH	/	/	/	8.8	8.9	8	9.2	9.24	9.06
Conductivity (µS/cm)	/	/	/	/	/	/	/	/	1196.7
Hardness (mg/L)	/	/	/	351	387	376	/	462.5	459
TDS (mg/L)	/	/	/	562	598	602	/	764.5	783.7
Microcystin (µg/L)	/	/	/	/	/	/	/	/	/
Total Alkalinity (mg/L CaCO3)	310	329	360	470	488	493	592	615	633

Table 2: Cont'd- Average Secchi depth and water chemistry values for Laurier Lake. Historical values are presented for reference.

Parameter	2007	2008	2009	2010	2012	2013	2014	2015	2016
TP (µg/L)	41.6	51.2	50.5	37.6	36.4	73.4	48	39.2	45
TDP (µg/L)	22	18.8	20.5	16.4	19.4	31	26.2	13.4	13
Chlorophyll-a (µg/L)	4.29	11.93	9.13	6.96	5.85	14.37	19.6	7.8	36.4
Secchi depth (m)	2.40	1.30	2.00	1.80	3.10	1.72	1.42	2.67	1.94
TKN (mg/L)	2.2	2.7	2.8	2.6	2.2	2.3	2.2	2.2	2.4
NO2 and NO3 (µg/L)	5	6	5.75	9.6	3.4	2.5	24	5.4	4.925
NH3 (µg/L)	46.2	39.2	39.3	33.2	33	26.4	32.8	74	105
DOC (mg/L)	37.9	37.9	39	37.5	32.2	34.1	35.17	33	27
Ca (mg/L)	16.3	14.5	12.1	12.2	20.2	23.13	23.13	26	25
Mg (mg/L)	97.8	92.9	88.1	98.6	84.6	83.3	71.67	87	89
Na (mg/L)	122.7	120.7	132.3	136	101.9	100.9	108.33	98	97
K (mg/L)	32.83	31.9	38	34.47	31.3	35.2	32.57	30	31.5
SO42- (mg/L)	111.7	121.3	135.7	148.7	118.3	107.3	102.67	120	110
Cl- (mg/L)	19.5	20.2	21.2	22.7	18.7	16.6	18.23	20	19
CO3 (mg/L)	86	84.7	70	85	45	55.6	63.66	52	52.5
HCO3 (mg/L)	535.7	544.3	582.3	568	546.8	500.2	614.6	536	507.5
pH	9.11	9.03	9	9.1	8.84	8.88	8.90	8.85	8.90
Conductivity (µS/cm)	1163.3	1196.7	1246.7	1257	1143.6	1098.6	1100	1100	1100
Hardness (mg/L)	443.3	418.7	392.7	436.3	399	401	353	422	435
TDS (mg/L)	750.3	754.3	784.3	817	690.7	669	709.67	698	682.5
Microcystin (µg/L)	0.53	0.236	0.39	0.174	0.4692	/	3.514	0.49	0.925
Total Alkalinity (mg/L CaCO3)	583	588	594	607.7	523.8	503	504	524	505

Table 3: Concentrations of metals measured once in Laurier 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	2011	2012	2013	2014	2015	2016	Guidelines
Aluminum μg/L	29.4	9.69	20.65	17.2	7.61	7.265	16.05	10.05	3.5	100[a]
Antimony μg/L	0.137	0.117	0.131	0.1245	0.115	0.0931	0.094	0.1415	0.093	6[d]
Arsenic μg/L	2.6	3	3.185	2.825	2.435	2.35	2.165	3.89	1.93	5
Barium μg/L	20.2	16.95	17.8	19.15	29.6	35.8	37.85	23.225	39.9	1000[d]
Beryllium μg/L	<0.003	<0.003	0.0015	0.00275	0.00975	0.0015	0.004	0.004	0.004	100[c,e]
Bismuth μg/L	<0.005	0.0051	0.00205	0.0028	0.0067	0.00075	0.0005	0.0145	5.00E-04	/
Boron μg/L	175.5	182	188.5	189	221.5	163	171	280	171	1500
Cadmium μg/L	0.008	0.0038	0.00425	0.00345	0.00325	0.0019	0.002	0.0015	0.001	0.26[b]
Chromium μg/L	0.611	0.56	0.441	0.465	0.2955	0.526	0.695	0.185	0.06	/
Cobalt μg/L	0.099	0.058	0.07075	0.081	0.05905	0.0482	0.0255	0.071	0.02	1000[e]
Copper μg/L	0.613	0.555	0.278	2.9	0.6815	0.373	0.2425	1.085	0.78	4[b]
Iron μg/L	37.1	15.8	16.855	21.05	9.5	17.15	13.4	14	8.3	300
Lead μg/L	0.057	0.023	0.0208	0.05535	0.01625	0.02645	0.00975	0.043	0.005	7[b]
Lithium μg/L	102.9	100.2	114	114.5	111.5	87.05	75.8	149.35	94.3	2500[f]
Manganese μg/L	5.15	7.97	4.125	8.335	13	19.9	20.3	12.61	20.6	200[f]
Molybdenum μg/L	0.661	0.587	0.8645	0.7775	0.5875	0.4565	0.316	0.7825	0.402	73[c]
Nickel μg/L	0.275	0.127	0.12845	0.199	0.0025	0.2175	0.004	0.164	0.028	150[b]
Selenium μg/L	0.547	0.372	0.416	0.312	0.302	0.2395	0.49	0.11	0.57	1
Silver μg/L	<0.003	0.0086	0.001425	0.043125	0.00235	0.02525	0.018	0.0015	0.001	0.25
Strontium μg/L	84.5	62.9	58.85	72.35	114.5	134	145	89.2	166	/
Thallium μg/L	<0.001	0.0024	0.00115	0.001275	0.000425	0.00015	0.002975	0.02225	0.00045	0.8
Thorium μg/L	<0.01	0.017	0.01245	0.0379	0.01295	0.0067	0.002225	0.029725	0.007	/
Tin μg/L	<0.06	<0.03	0.015	0.015	0.0337	0.015	0.01475	0.0215	0.005	/
Titanium μg/L	1.24	1.36	1.38	0.7535	0.69	1.4	1.935	2.01	1.4	/
Uranium μg/L	0.811	0.808	1.085	0.875	0.6825	0.677	0.5495	2.77	0.611	15
Vanadium μg/L	0.742	0.512	0.807	0.563	0.4275	0.3265	0.44	0.845	0.26	100[e,f]
Zinc μg/L	1.53	0.916	0.326	1.0925	1.031	0.6225	1.1	1.25	1.1	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.