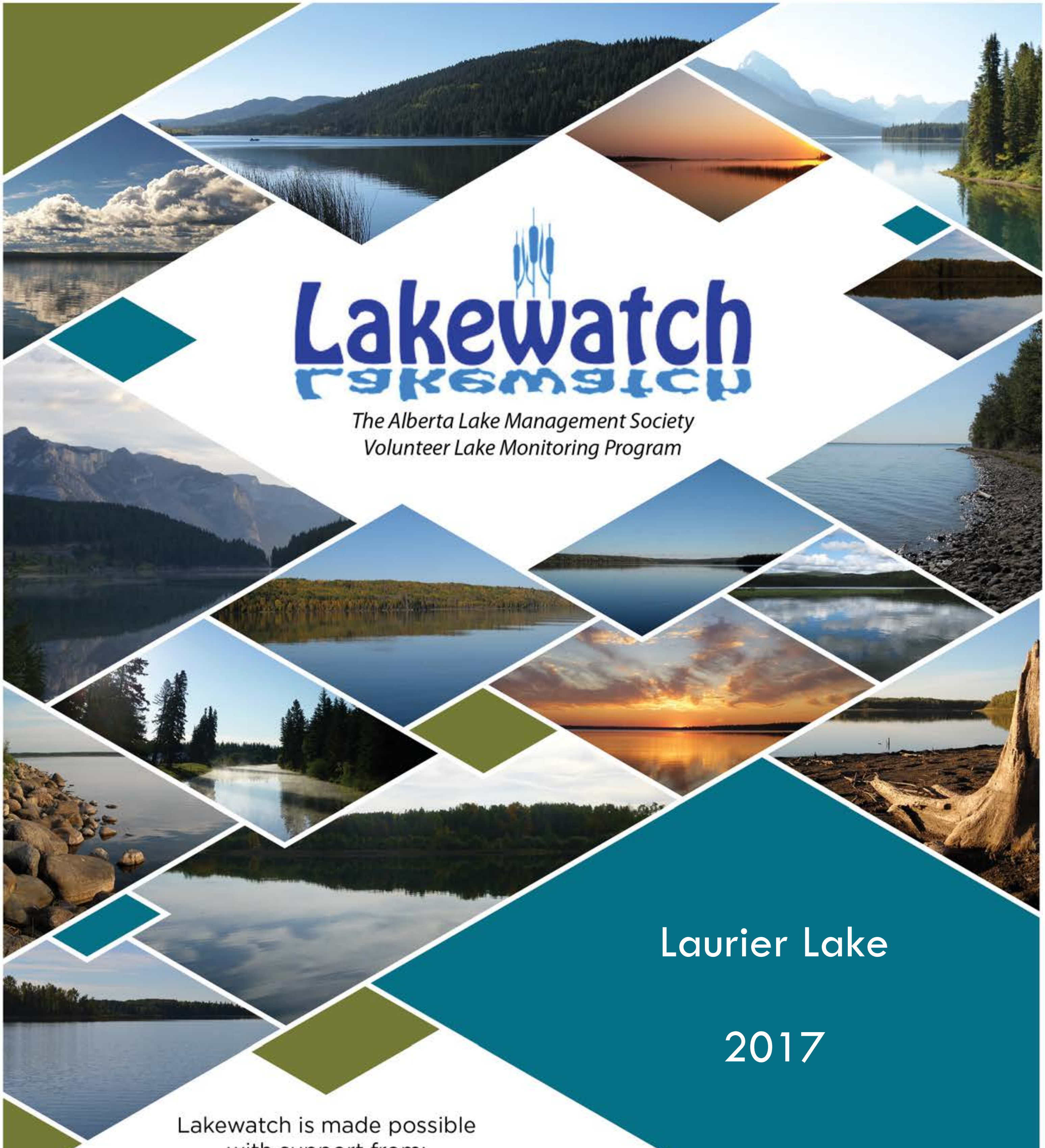


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Laurier Lake

2017

Lakewatch is made possible
with support from:

Cargill Helping the world thrive
Jackfish Lake
Pigeon Lake Watershed Association
LICA Lakeland Industry & Community Association
Red Deer River Watershed Alliance
Beaver River Watershed Alliance
Alberta Environment and Parks

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.

ALMS is happy to discuss the results of this report with our stakeholders. If you would like information or a public presentation, contact us at info@alms.ca.

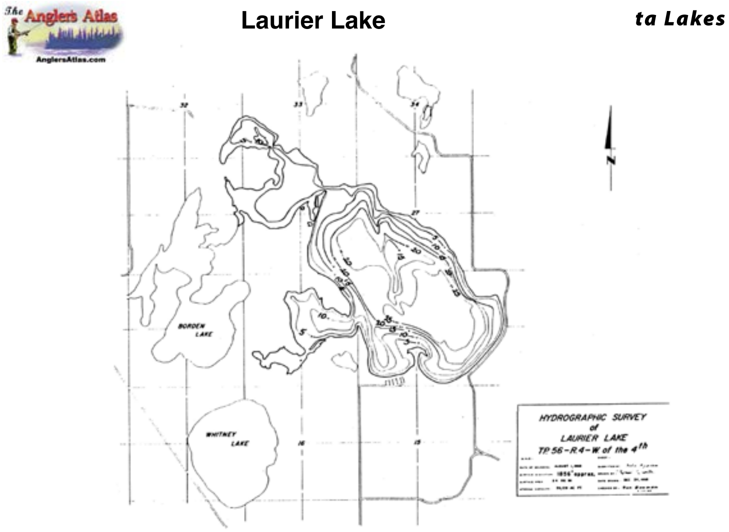
ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. We would like to extend a special thanks to Bev Smith for the time and energy put into sampling Laurier Lake in 2017. We would also like to thank Elashia Young and Melissa Risto who were summer technicians in 2017. Executive Director Bradley Peter and LakeWatch Coordinator Laura Redmond was instrumental in planning and organizing the field program. This report was prepared by Laura Redmond and Bradley Peter. 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.

Loons on Laurier Lake, 2017 (photo by Elashia Young)



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 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.

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 Alberta Innovates Technology Futures (AITF), 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. For lakes with >10 years of long term data, trend analysis is done with non-parametric methods. Mann Kendall tests are used with non-normal data to assess unidirectional trends over time in a dataset (a non-parametric linear regression).

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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 Laurier Lake was 53.2 µg/L (Table 2), falling into the eutrophic, or productive, trophic classification. This average lies well within the range of historical values. TP remained relatively constant over the course of the sampling season (Figure 1).

Average chlorophyll-*a* concentration in 2017 was 39.6 µg/L (Table 2), also putting Laurier Lake into the eutrophic classification. This is the highest chlorophyll-*a* average in historical records. Chlorophyll-*a* concentrations increased throughout the summer, reaching a maximum concentration of 64.8 µg/L on September 1. Chlorophyll-*a* concentrations were significantly correlated with TP concentrations ($r = 0.90$, $p = 0.04$).

Finally, the average TKN concentration was 2.5 mg/L (Table 2), and the maximum concentration was measured on July 7. TKN and chlorophyll-*a* trends were significantly correlated ($r = 0.99$, $p < 0.001$).

Average pH was measured as 8.86 in 2017, buffered by moderate alkalinity (458 mg/L $CaCO_3$) and bicarbonate (474 mg/L HCO_3). Sulphate, sodium and magnesium were the dominant ions contributing to a moderate-high conductivity of 966 µS/cm (Table 2).

METALS

Samples were analyzed for metals (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 on August 18 on Laurier Lake at the surface. In 2017, all measured values fell within their respective guidelines (Table 3).

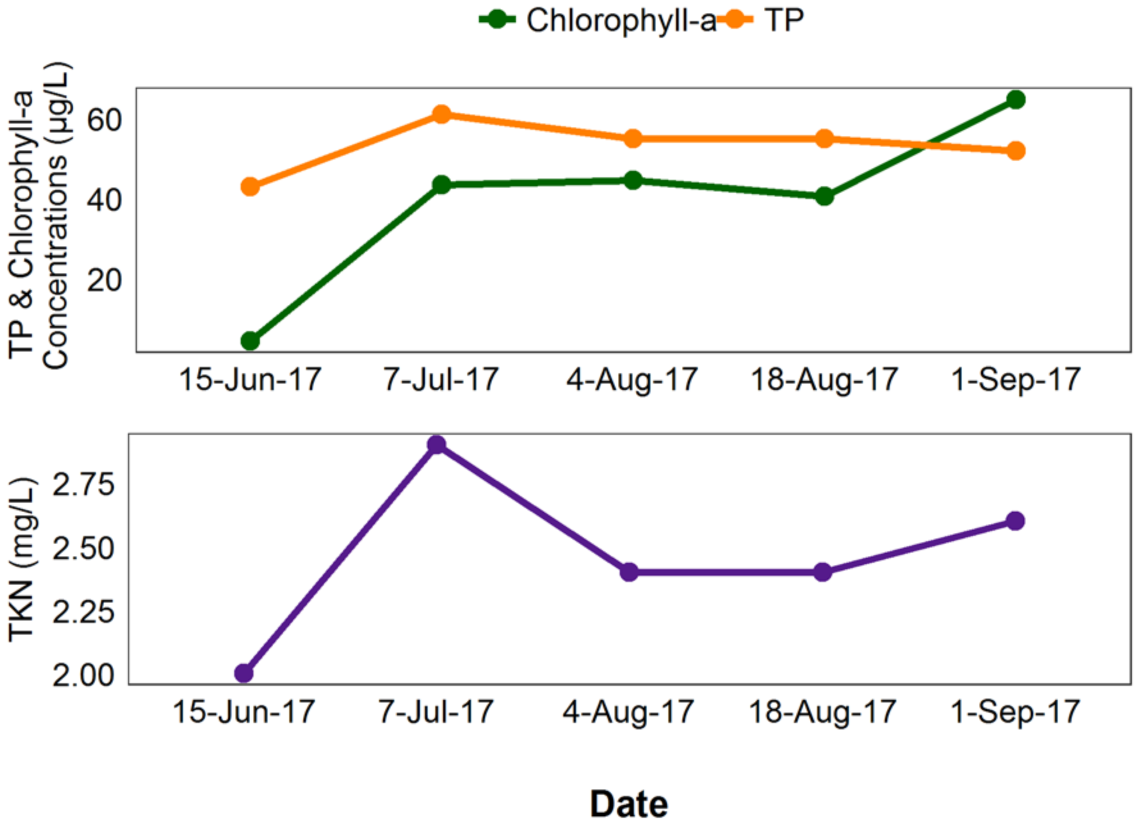


Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured five times over the course of the summer at Laurier Lake.

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 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 Laurier Lake in 2017 was 1.42 m (Table 2). Water clarity measured as Secchi depth was negatively correlated with chlorophyll-*a* concentrations ($r = -0.89$, $p = 0.04$). The decreasing water clarity could be associated with increasing algae biomass in the warmer months of the summer (Figure 2).

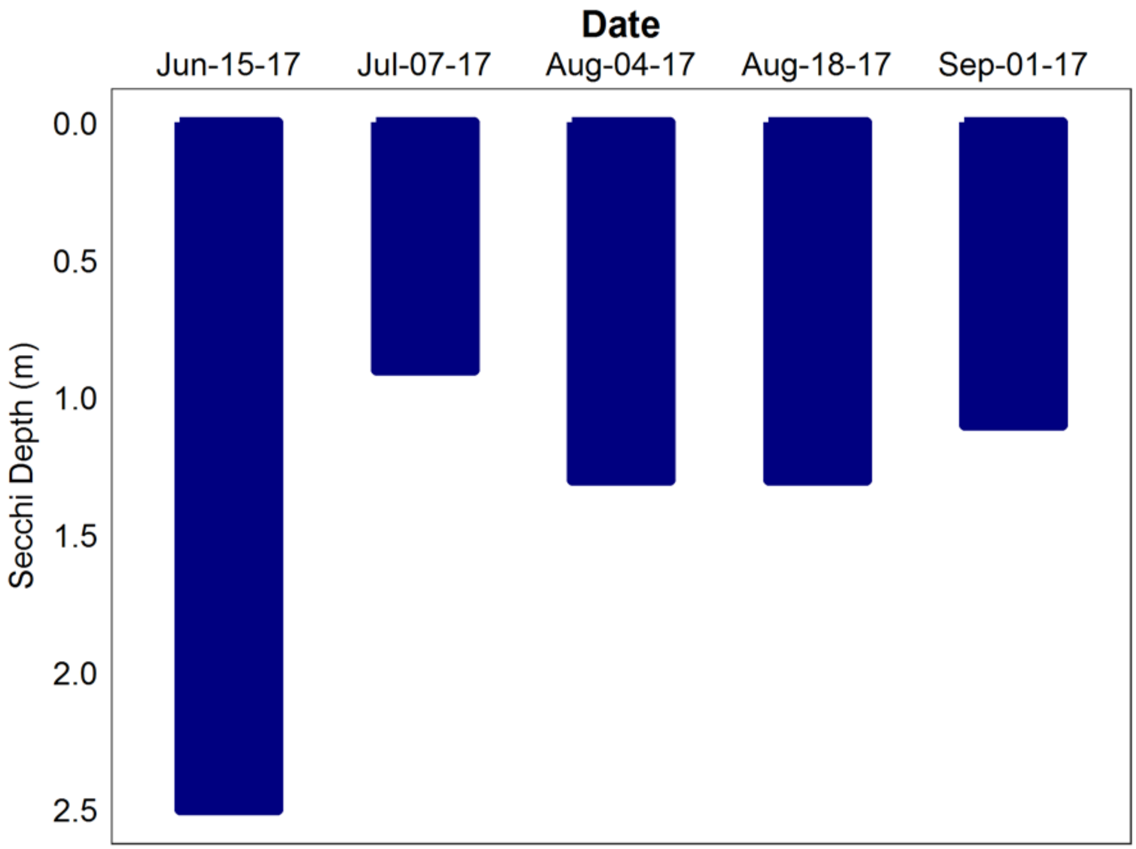


Figure 2 – Secchi depth values measured five times over the course of the summer at Laurier Lake in 2017.

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 Laurier Lake varied throughout the summer, with a maximum temperature of 22.0 °C measured at the surface on July 7 (Figure 3a). Laurier Lake was thermally stratified on June 15, July 7 and August 4.

Laurier Lake remained well oxygenated at the surface on all visits except August 18 when DO fell below the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). During thermal stratification, oxygen levels decreased near the bottom due to separation from atmospheric oxygen that is circulated at the lake’s surface. By September 1, the entire water column was well oxygenated.

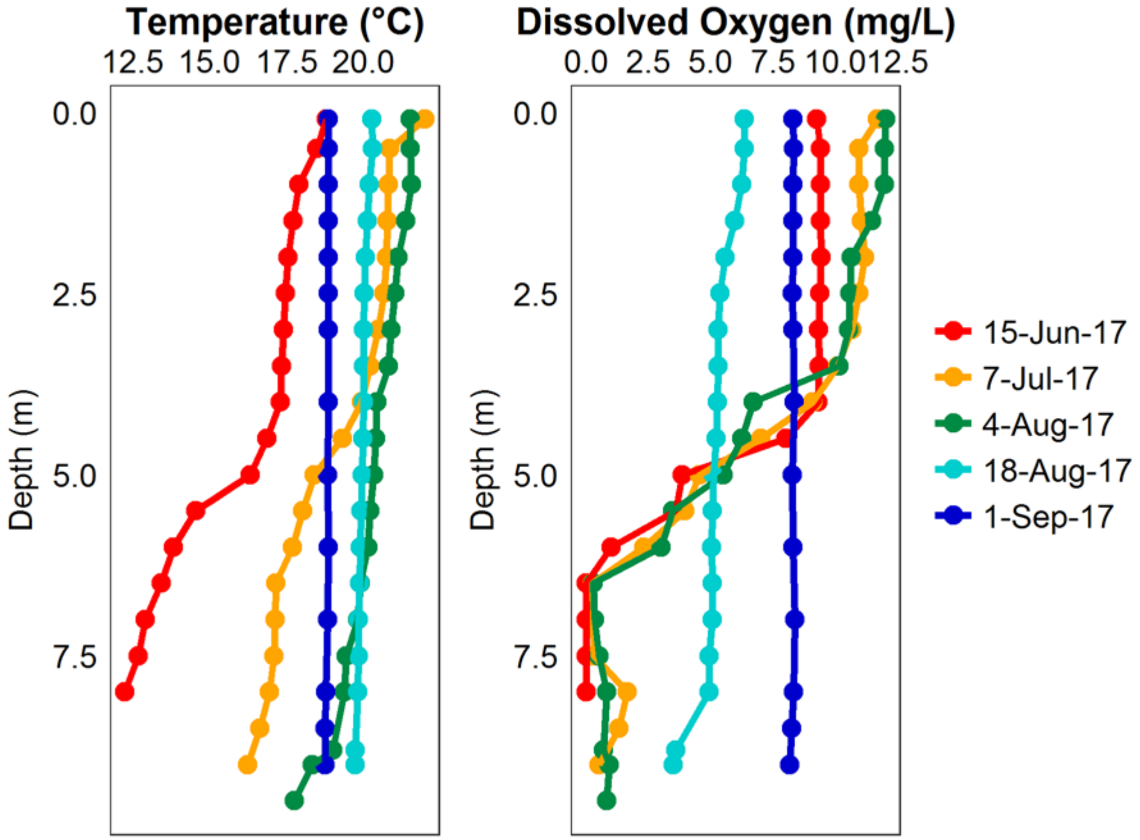


Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Laurier Lake measured five times over the course of the summer of 2017.

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 Laurier Lake fell below the recreational guideline for the entire sampling period of 2017 (Table 1).

Table 1 – Microcystin concentrations measured five times at Laurier Lake in 2017.

Date	Microcystin Concentration (µg/L)
Jun-15-17	0.28
Jul-07-17	1.12
Aug-04-17	2.88
Aug-18-17	2.31
Sep-01-17	4.87
Average	2.29

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. No mussels have been detected in Laurier Lake since invasive species monitoring began in 2013.

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 Laurier Lake have been increasing since the early 2000s (Figure 4). Since 1968, Laurier Lake water levels have fluctuated between 564.1 m asl and 567.35 m asl. In 2017, Laurier Lake reached a historic maximum, increasing by close to 1 m since 2016. Recent increases in water level have resulted in the reconnection of small bays to the main basin of Laurier Lake.

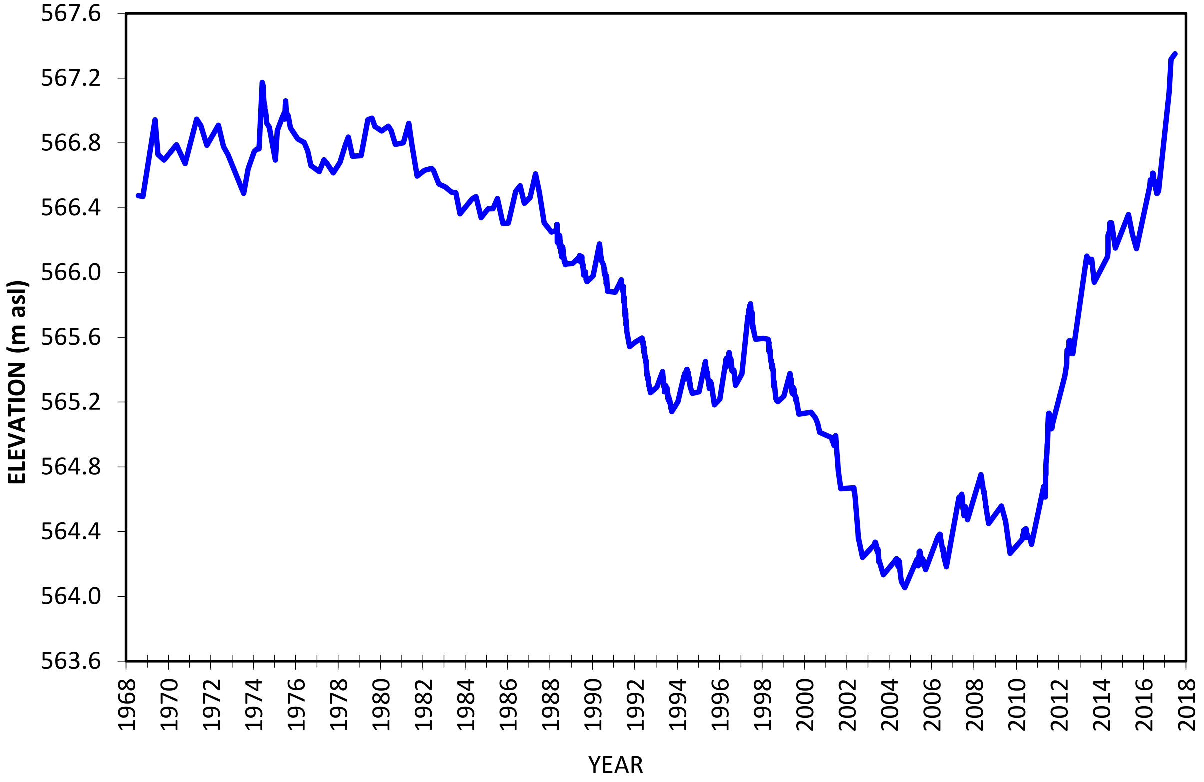


Figure 4- Water levels measured in metres above sea level (m asl) from 1968-2017. Data retrieved from Alberta Environment

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
NO_2-N and NO_3-N (µg/L)	<50	50	<1	/	/	/	3.8	211	6.7
NH_3-N (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
SO_4^{2-} (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
CO_3 (mg/L)	/	/	/	39	62	66	102	112	83.7
HCO_3 (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 $CaCO_3$)	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**	**2017**
TP (µg/L)	41.6	51.2	50.5	37.6	36.4	73.4	48	39.2	45	53.2
TDP (µg/L)	22	18.8	20.5	16.4	19.4	31	26.2	13.4	13	11.8
Chlorophyll-*a* (µg/L)	4.29	11.93	9.13	6.96	5.85	14.37	19.6	7.8	36.4	39.6
Secchi depth (m)	2.40	1.30	2.00	1.80	3.10	1.72	1.42	2.67	1.94	1.42
TKN (mg/L)	2.2	2.7	2.8	2.6	2.2	2.3	2.2	2.2	2.4	2.5
NO_2-N and NO_3-N (µg/L)	5	6	5.75	9.6	3.4	2.5	24	5.4	4.925	2.76
NH_3-N (µg/L)	46.2	39.2	39.3	33.2	33	26.4	32.8	74	105	66.2
DOC (mg/L)	37.9	37.9	39	37.5	32.2	34.1	35.17	33	27	28.4
Ca (mg/L)	16.3	14.5	12.1	12.2	20.2	23.13	23.13	26	25	30
Mg (mg/L)	97.8	92.9	88.1	98.6	84.6	83.3	71.67	87	89	76.8
Na (mg/L)	122.7	120.7	132.3	136	101.9	100.9	108.33	98	97	87.4
K (mg/L)	32.83	31.9	38	34.47	31.3	35.2	32.57	30	31.5	28.8
SO_4^{2-} (mg/L)	111.7	121.3	135.7	148.7	118.3	107.3	102.67	120	110	91.2
Cl^- (mg/L)	19.5	20.2	21.2	22.7	18.7	16.6	18.23	20	19	17.4
CO_3 (mg/L)	86	84.7	70	85	45	55.6	63.66	52	52.5	42.2
HCO_3 (mg/L)	535.7	544.3	582.3	568	546.8	500.2	614.6	536	507.5	474
pH	9.11	9.03	9	9.1	8.84	8.88	8.90	8.85	8.90	8.86
Conductivity (µS/cm)	1163.3	1196.7	1246.7	1257	1143.6	1098.6	1100	1100	1100	966
Hardness (mg/L)	443.3	418.7	392.7	436.3	399	401	353	422	435	394
TDS (mg/L)	750.3	754.3	784.3	817	690.7	669	709.67	698	682.5	612
Microcystin (µg/L)	0.53	0.236	0.39	0.174	0.4692	/	3.514	0.49	0.925	2.29
Total Alkalinity (mg/L $CaCO_3$)	583	588	594	607.7	523.8	503	504	524	505	458

Table 3: Concentrations of metals measured 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**	**2017**	**Guidelines**
Aluminum µg/L	29.4	9.69	20.65	17.2	7.61	7.265	16.05	10.05	3.5	6.8	100[a]
Antimony µg/L	0.137	0.117	0.131	0.1245	0.115	0.0931	0.094	0.1415	0.093	0.074	/
Arsenic µg/L	2.6	3	3.185	2.825	2.435	2.35	2.165	3.89	1.93	2.56	5
Barium µg/L	20.2	16.95	17.8	19.15	29.6	35.8	37.85	23.225	39.9	43.8	/
Beryllium µg/L	<0.003	<0.003	0.0015	0.00275	0.00975	0.0015	0.004	0.004	0.004	0.0055	100[c,d]
Bismuth µg/L	<0.005	0.0051	0.00205	0.0028	0.0067	0.00075	0.0005	0.0145	5.00E-04	0.0055	/
Boron µg/L	175.5	182	188.5	189	221.5	163	171	280	171	170	1500
Cadmium µg/L	0.008	0.0038	0.00425	0.00345	0.00325	0.0019	0.002	0.0015	0.001	0.025	0.26[b]
Chromium µg/L	0.611	0.56	0.441	0.465	0.2955	0.526	0.695	0.185	0.06	0.25	/
Cobalt µg/L	0.099	0.058	0.07075	0.081	0.05905	0.0482	0.0255	0.071	0.02	0.083	1000[d]
Copper µg/L	0.613	0.555	0.278	2.9	0.6815	0.373	0.2425	1.085	0.78	0.91	4[b]
Iron µg/L	37.1	15.8	16.855	21.05	9.5	17.15	13.4	14	8.3	8.3	300
Lead µg/L	0.057	0.023	0.0208	0.05535	0.01625	0.02645	0.00975	0.043	0.005	0.01	7[b]
Lithium µg/L	102.9	100.2	114	114.5	111.5	87.05	75.8	149.35	94.3	89.5	2500[e]
Manganese µg/L	5.15	7.97	4.125	8.335	13	19.9	20.3	12.61	20.6	13.3	200[e]
Molybdenum µg/L	0.661	0.587	0.8645	0.7775	0.5875	0.4565	0.316	0.7825	0.402	0.3	73[c]
Nickel µg/L	0.275	0.127	0.12845	0.199	0.0025	0.2175	0.004	0.164	0.028	1.64	150[b]
Selenium µg/L	0.547	0.372	0.416	0.312	0.302	0.2395	0.49	0.11	0.57	0.5	1
Silver µg/L	<0.003	0.0086	0.001425	0.043125	0.00235	0.02525	0.018	0.0015	0.001	0.0025	0.25
Strontium µg/L	84.5	62.9	58.85	72.35	114.5	134	145	89.2	166	178	/
Thallium µg/L	<0.001	0.0024	0.00115	0.001275	0.000425	0.00015	0.002975	0.02225	0.00045	0.005	0.8
Thorium µg/L	<0.01	0.017	0.01245	0.0379	0.01295	0.0067	0.002225	0.029725	0.007	0.014	/
Tin µg/L	<0.06	<0.03	0.015	0.015	0.0337	0.015	0.01475	0.0215	0.005	0.15	/
Titanium µg/L	1.24	1.36	1.38	0.7535	0.69	1.4	1.935	2.01	1.4	1.31	/
Uranium µg/L	0.811	0.808	1.085	0.875	0.6825	0.677	0.5495	2.77	0.611	0.496	15
Vanadium µg/L	0.742	0.512	0.807	0.563	0.4275	0.3265	0.44	0.845	0.26	0.306	100[d,e]
Zinc µg/L	1.53	0.916	0.326	1.0925	1.031	0.6225	1.1	1.25	1.1	2.1	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 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.

LONG TERM TRENDS

Trend analysis was conducted on the parameters total phosphorus (TP), chlorophyll-*a*, total dissolved solids (TDS) and Secchi depth to look for changes over time in Laurier Lake. In sum, significant increases were observed in chlorophyll-*a* and TP. Significant decreasing trends were observed in TDS and Secchi depth. Secchi depth can be subjective and is sensitive to variation in weather - trend analysis must be interpreted with caution. A decrease in water clarity is likely due to an increase in chlorophyll-*a.* Data is presented below as both a line graph (all data points) and a box-and-whisker plot. Detailed methods are available in the *ALMS Guide to Trend Analysis on Alberta Lakes.*

Table 1: Summary table of trend analysis on Laurier Lake data from 2003 to 2017.

Parameter	Date Range	Trend	Probability
Total Phosphorus	2003-2017	Increasing	Significant
Chlorophyll-*a*	2003-2017	Increasing	Significant
Total Dissolved Solids	2003-2017	Decreasing	Significant
Secchi Depth	2003-2017	Decreasing	Significant

Definitions:

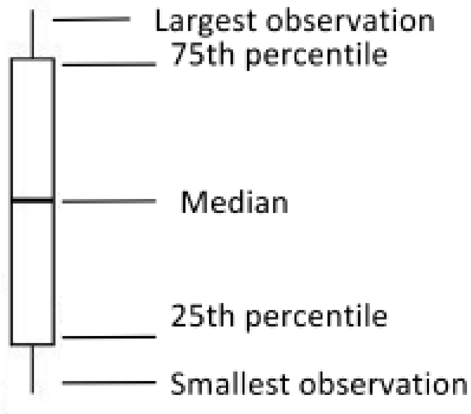
Median: the value in a range of ordered numbers that falls in the middle.

Trend: a general direction in which something is changing.

Monotonic trend: a gradual change in a single direction.

Statistically significant: The likelihood that a relationship between variables is caused by something other than random chance. This is indicated by a p-value of <0.05. Variability: the extent by which data is inconsistent or scattered.

Box and Whisker Plot: a box-and-whisker plot, or boxplot, is a way of displaying all of our annual data. The median splits the data in half. The 75th percentile is the upper quartile of the data, and the 25th percentile is the lower quartile of the data. The top and bottom points are the largest and smallest observations.



Total Phosphorus (TP)

TP has significantly increased over the course of data collection at Laurier Lake (Tau = 0.28, *p* = 0.001).

Figure 1- Total phosphorus (TP) concentrations measured between June and September over the long term sampling dates between 2003 and 2017 (n = 63).

Chlorophyll-*a*

Chlorophyll-*a* has significantly increased over the course of data collection at Laurier Lake (Tau = 0.436, $p <$ 0.001). Chlorophyll-*a* trends follow TP trends with correlation over time (r = 0.30, P= 0.02).

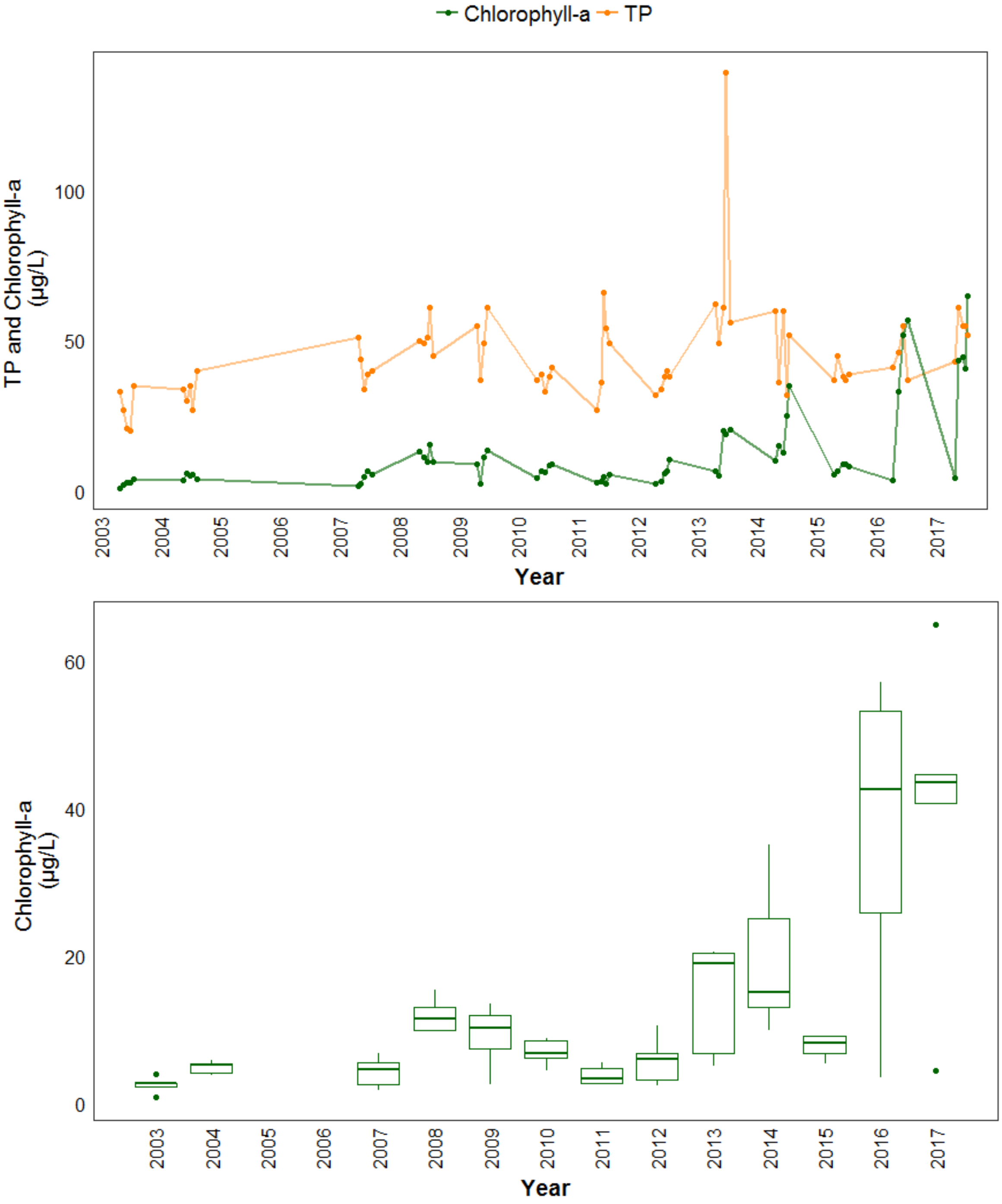


Figure 2-Chlorophyll-*a* concentrations measured between June and September over the long term sampling dates between 2003 and 2017 (n = 63).

Total Dissolved Solids (TDS)

Trend analysis on TDS shows a significant decrease in TDS over the course of sampling (Tau = -0.6, *p* < 0.001). This is likely attributed to increasing water levels and a dilution effect in Laurier Lake.

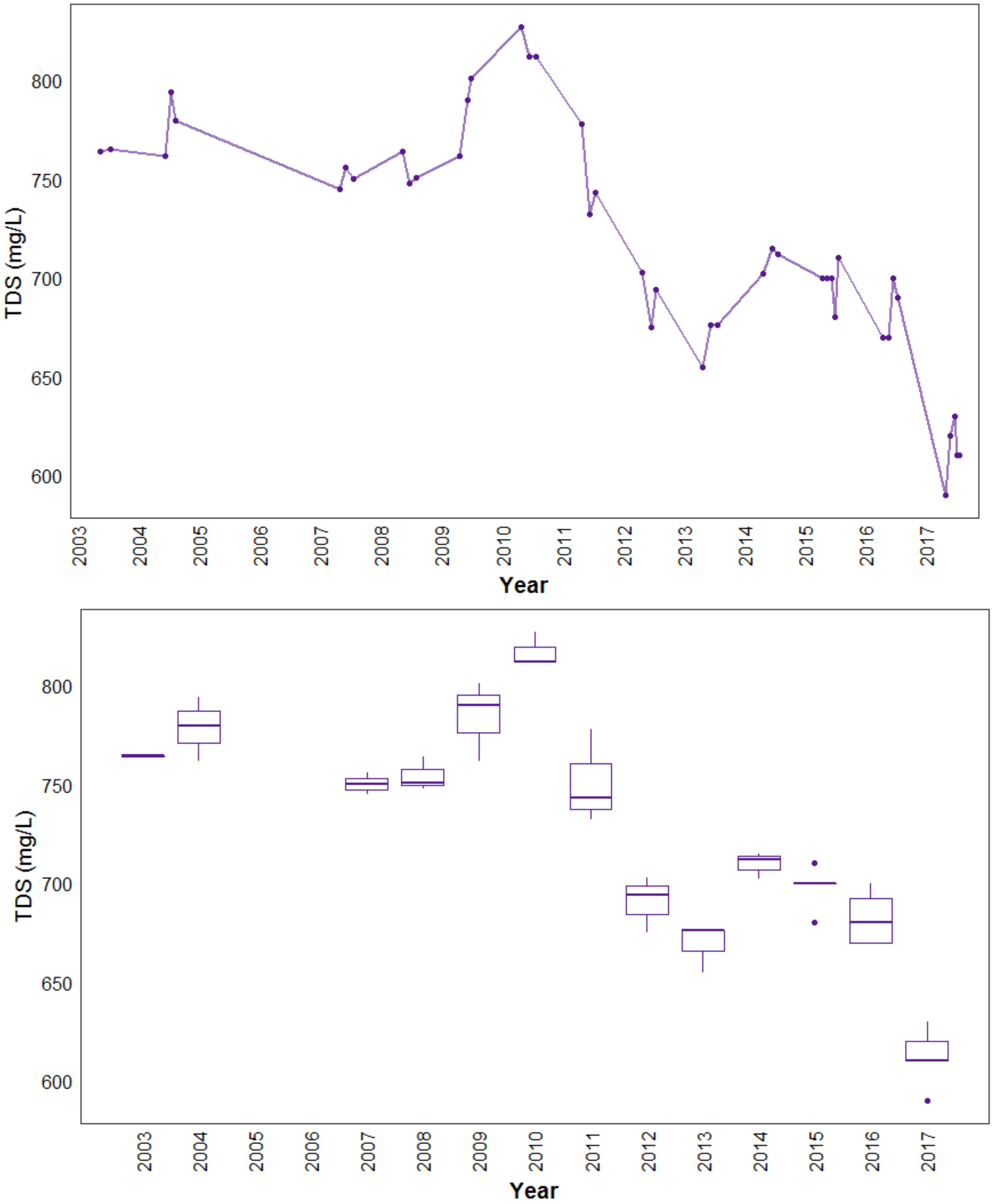


Figure 3- TDS measured between June and September over the long term sampling dates between 2003 and 2017 (n = 43).

Secchi Depth

Trend analysis found that water clarity measured as Secchi depth has decreased over the sampling period (Tau=-0.28, *p* = 0.001).

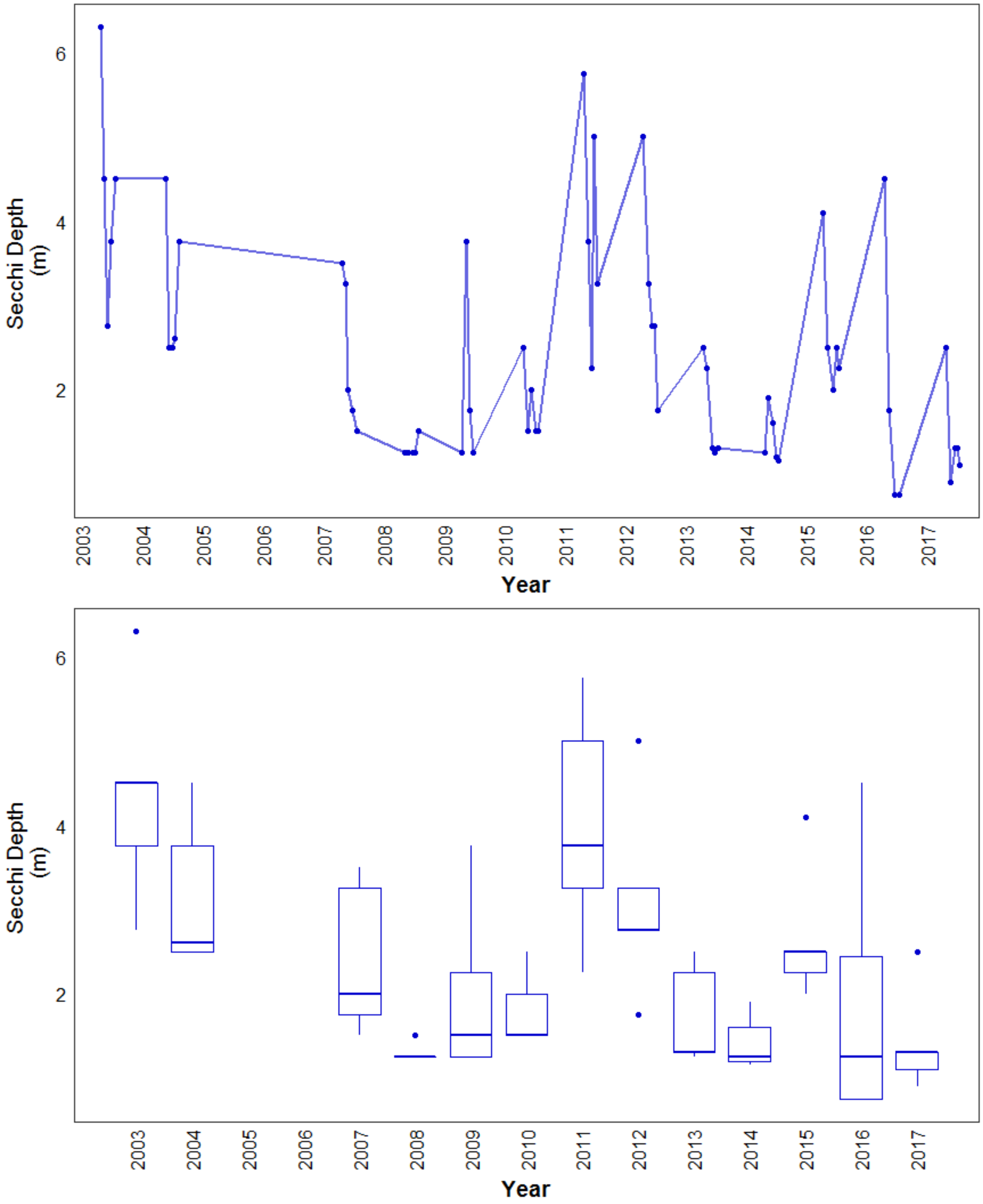


Figure 4- Secchi depth values measured between June and September over the long term sampling dates between 2003 and 2017 (n = 63).

Table 2- Results of Mann-Kendall Trend tests using total phosphorus (TP), chlorophyll-*a*, total dissolved solids (TDS) and Secchi depth data from June to September on Laurier Lake data.

Definition	**Unit**	**Total Phosphorus (TP)**	**Chlorophyll-a**	**Total Dissolved Solids (TDS)**	**Secchi Depth**
Statistical Method	-	Mann Kendall	Mann Kendall	Mann Kendall	Mann Kendall
The strength and direction (+ or -) of the trend between -1 and 1	Tau	0.28	0.44	-0.60	-0.28
The extent of the trend	Slope	0.003	0.003	-0.03	-0.0003
The statistic used to find significance of the trend	Z	3.28	5.05	-5.66	-3.28
Number of samples included	n	63	63	43	63
The significance of the trend	p	0.001*	4.47×10^{-7}*	1.55×10^{-8}*	0.001*

*$p < 0.05$ is significant within 95%