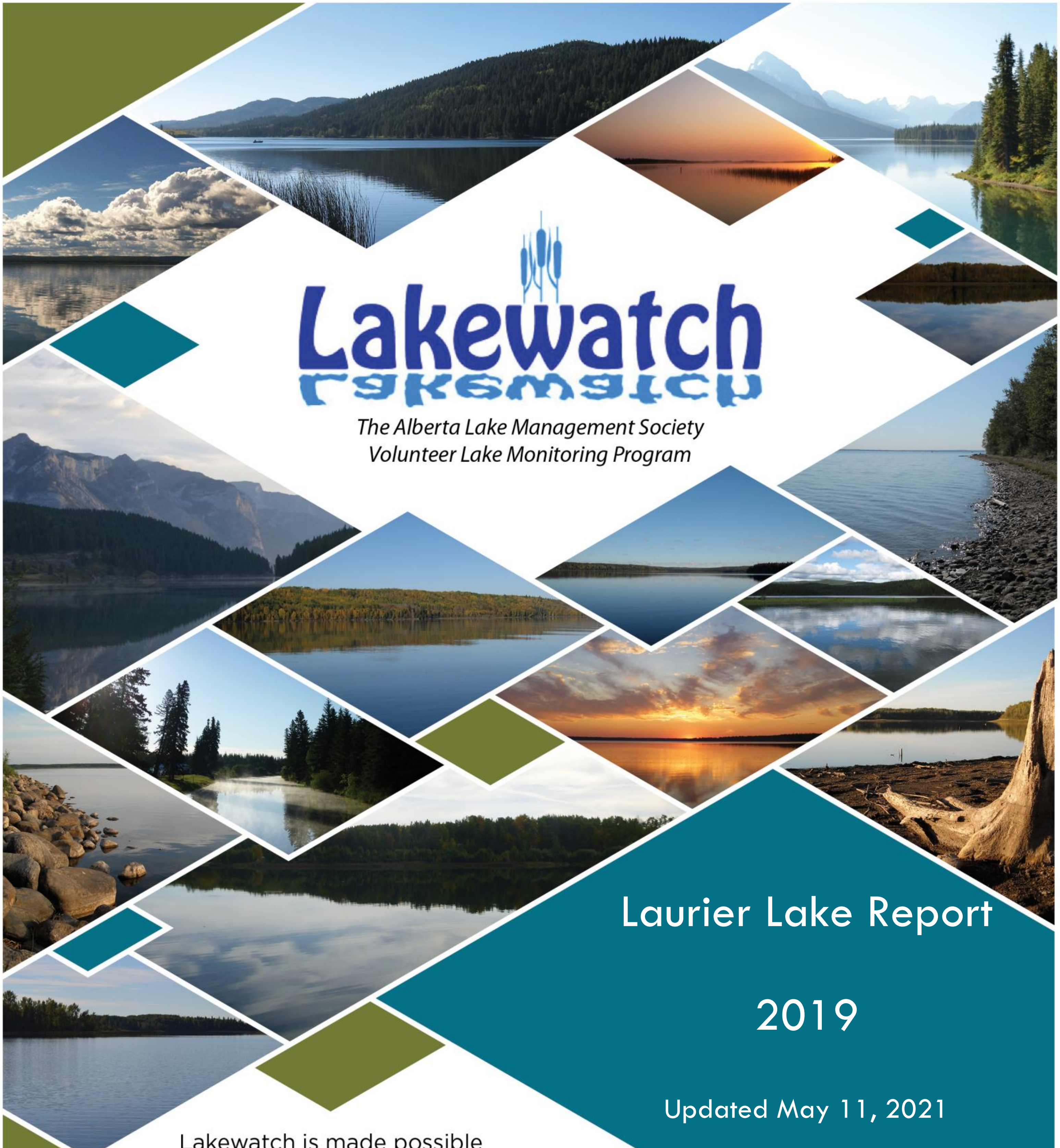


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Laurier Lake Report

2019

Updated May 11, 2021

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.

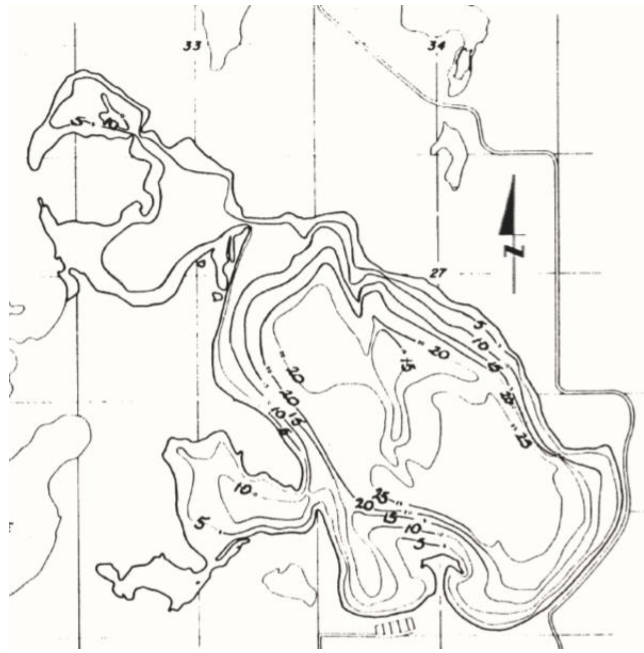
If you require data from this report, please contact ALMS for the raw data files.

ACKNOWLEDGEMENTS

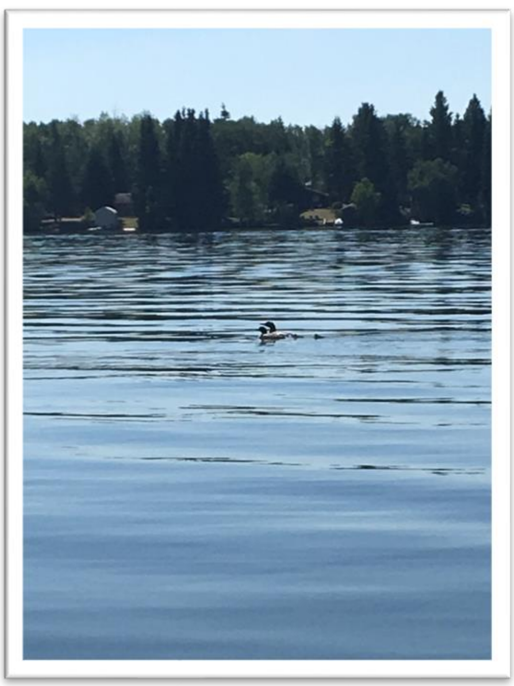
The LakeWatch program is made possible through the dedication of its volunteers. At Laurier Lake, we would like to thank Bev Smith for her years of dedication to LakeWatch. We would also like to thank Sarah Davis Cornet, Caleb Sinn, and Pat Heney, who were summer technicians in 2019. Executive Director 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.

LAURIER LAKE

Laurier Lake is one of four beautiful lakes part of Whitney Lakes Provincial Park 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 circa 1856 (Angler's Atlas).



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

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. 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. For lakes with >10 years of long term data, trend analysis is done with non-parametric methods. The seasonal Kendall test estimates the presence of monotonic (unidirectional) trends across individual seasons (months) and is summed to give an overall trend over time. For lakes that had multiple samplings in a single month, the value closest to the middle of the month was used in analysis.

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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 81 µg/L (Table 2), falling into the eutrophic, or highly productive trophic classification. This value is high relative to the majority of previously detected averages since monitoring began in 2003. Detected TP was lowest in July at 58 µg/L, and peaked at 120 µg/L in September (Figure 1).

Average chlorophyll-*a* concentration in 2019 was 43.5 µg/L (Table 2), falling into the hypereutrophic, or very high productivity trophic classification. Chlorophyll-*a* was lowest in June at 36.4 µg/L and peaked at 51.2 µg/L in mid-July. This rapid increase in chlorophyll-*a* concentrations is characteristic of an algae bloom.

The average TKN concentration was 2.4 mg/L (Table 2) with concentrations peaking in July.

Average pH was measured as 8.85 in 2019, buffered by moderate alkalinity (453 mg/L $CaCO_3$) and bicarbonate (447 mg/L HCO_3). Aside from bicarbonate, sodium and sulphate were the dominant ions contributing to a medium conductivity of 973 µS/cm (Table 2).

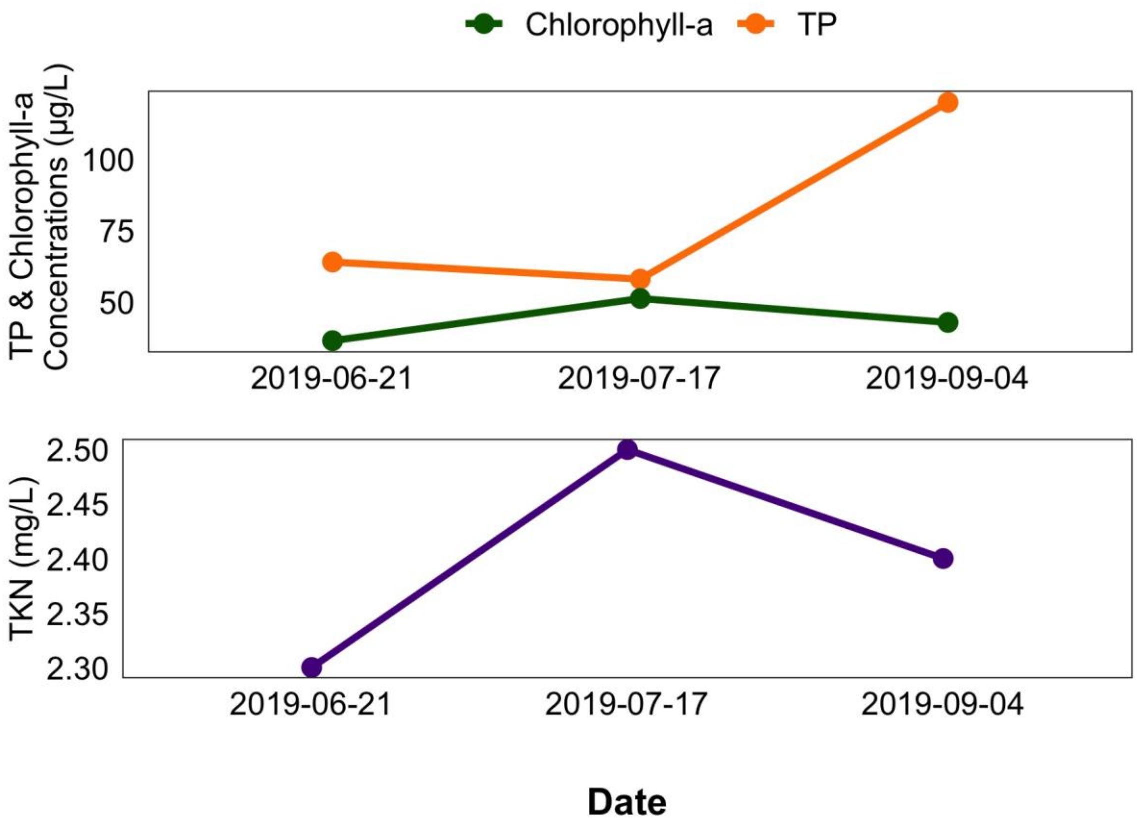


Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured three times over the course of the summer at Laurier Lake.

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 measured once on September 4 at Laurier Lake at the surface, and all measured values fell within their respective guidelines (Table 3).

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 2019 was 1.65 m (Table 2). Secchi depth was lowest in July, and highest early in the season during June sampling event (Figure 2).

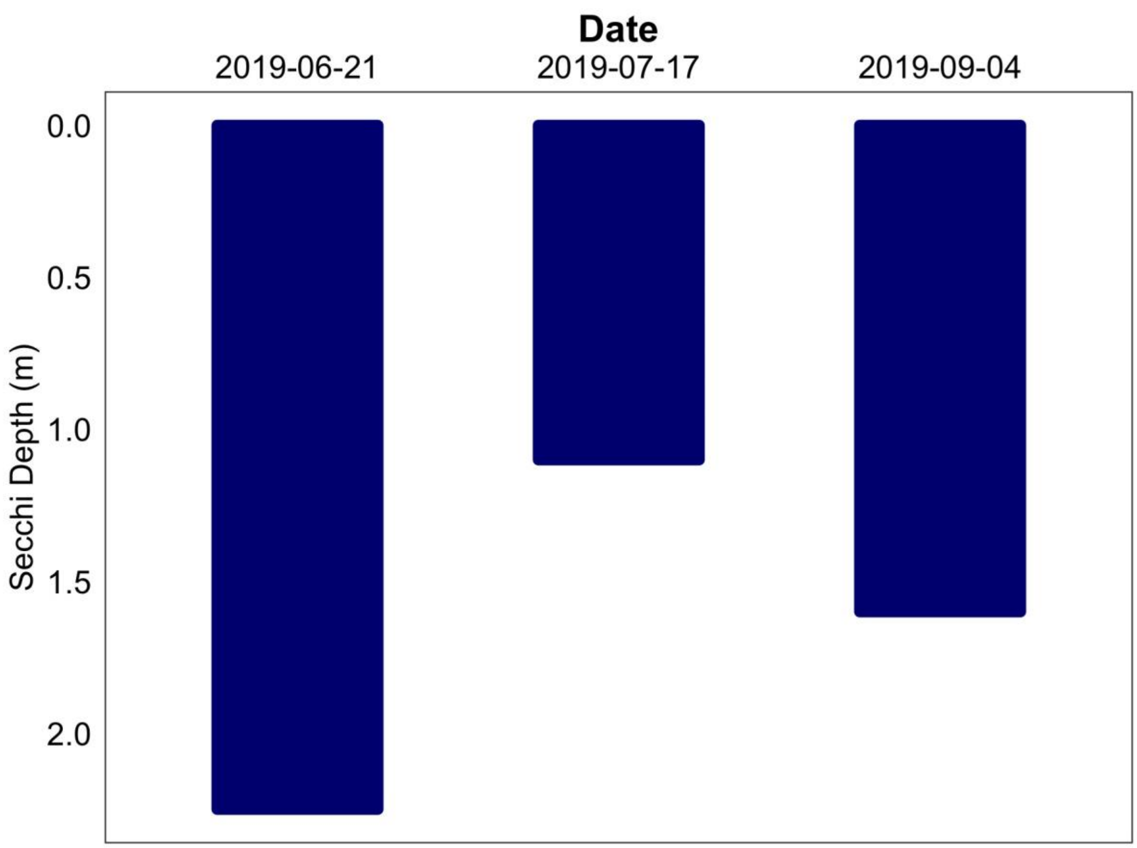


Figure 2. Secchi depth values measured three times over the course of the summer at Laurier Lake in 2019.

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.

Temperatures of Laurier Lake varied throughout the summer, with a maximum temperature of 21.0°C measured at the surface on July 17 (Figure 3a). Other than a slight thermocline at 6 m on June 21, the lake was not stratified during any of the sampling trips, with temperatures fairly constant from top to bottom. This indicates partial or complete mixing throughout the season.

Laurier Lake remained well oxygenated through the top of the water column during most sampling trips, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 3b). The oxygen level fell below this level at around 3-7 meters throughout the season. The lack of oxygen throughout the bottom of the water column at this sampling date may have been due to oxygen consumption from the decomposition organic matter at lake bottom.

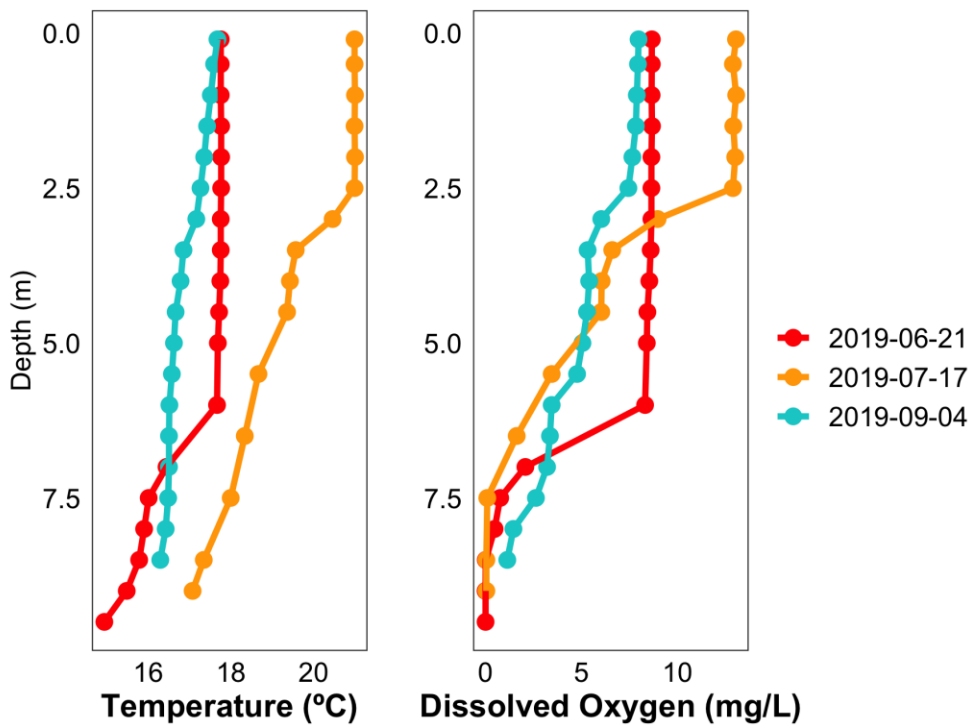


Figure 3. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Laurier Lake measured three times over the course of the summer of 2019.

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 Laurier Lake fell below the recreational guideline of 20 µg/L for at the locations and times sampled in Laurier Lake in 2019. However, an individual grab sample of a cyanobacteria bloom from the centre of the lake had microcystin concentrations measuring 1611 ug/L. This indicates that the bacteria in Laurier Lake are capable of producing high concentrations of cyanobacteria toxin, and caution should be observed when recreating in visible blooms.

Table 1. Composite microcystin concentrations measured three times at Laurier Lake in 2019.

Date	Microcystin Concentration (µg/L)
21-Jun-19	1.09
17-Jul-19	0.95
04-Sep-19	4.6
Average	2.21

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 Laurier 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 Laurier Lake in 2019.

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.

Since water levels were first recorded in 1968, Laurier Lake has fluctuated by 3.2 m (Figure 4). Starting in the early 1980s, lake level slowly decreased until a record low in 2004 at 564 m above sea level (masl). Water levels then began a rapid increase to the record high reached in 2017 at about 567.5 masl.

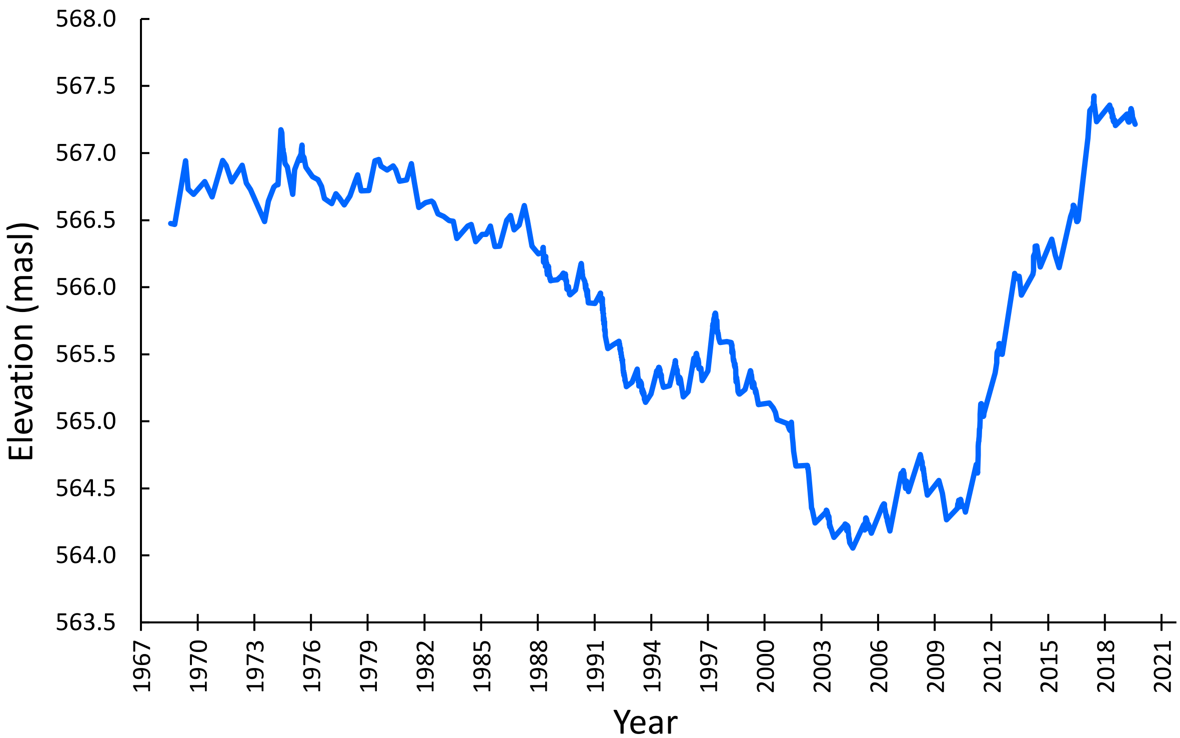


Figure 4. Water levels measured in meters above sea level (masl) from 1968- 2019. Data retrieved from Alberta Environment and Parks.

Table 2. Average historical Secchi depth and water chemistry values for Laurier Lake.

Parameter	2007	2008	2009	2010	2012	2013	2014	2015	2016	2017	2018	2019
TP (µg/L)	42	51	51	38	36	73	48	39	45	53	94	81
TDP (µg/L)	22	19	21	16	19	31	26	13	13	12	17	14
Chlorophyll-*a* (µg/L)	4.3	11.9	9.1	7.0	5.9	14.4	19.6	7.80	36.4	39.6	58.3	43.5
Secchi depth (m)	2.40	1.30	2.00	1.80	3.10	1.72	1.42	2.67	1.94	1.42	1.70	1.65
TKN (mg/L)	2.2	2.7	2.8	2.6	2.2	2.3	2.2	2.2	2.4	2.5	2.9	2.4
NO_2-N and NO_3-N (µg/L)	5	6	6	10	3	3	24	5	5	3	13	18
NH_3-N (µg/L)	46	39	39	33	33	26	33	74	105	66	96	128
DOC (mg/L)	38	38	39	38	32	34	35	33	27	28	30	31
Ca (mg/L)	16	15	12	12	20	23	23	26	25	30	32	30
Mg (mg/L)	98	93	88	99	85	83	72	87	89	77	75	70
Na (mg/L)	123	121	132	136	102	101	108	98	97	87	86	80
K (mg/L)	33	32	38	34	31	35	33	30	32	29	27	25
SO_4^{2-} (mg/L)	112	121	136	149	118	107	103	120	110	91	89	104
Cl^- (mg/L)	20	20	21	23	19	17	18	20	19	17	18	19
CO_3 (mg/L)	86	85	70	85	45	56	64	52	53	42	47	50
HCO_3 (mg/L)	536	544	582	568	547	500	615	536	508	474	470	447
pH	9.11	9.03	9.00	9.10	8.84	8.88	8.90	8.85	8.90	8.86	8.874	8.85
Conductivity (µS/cm)	1163	1197	1247	1257	1144	1099	1100	1100	1100	966	970	973
Hardness (mg/L)	443	419	393	436	399	401	353	422	435	394	390	363
TDS (mg/L)	750	754	784	817	691	669	710	698	683	612	612	603
Microcystin (µg/L)	0.53	0.24	0.39	0.17	0.47	/	3.51	0.49	0.93	2.29	2.68	2.21
Total Alkalinity (mg/L $CaCO_3$)	583	588	594	608	524	503	504	524	505	458	462	453

Table 3a. Concentrations of metals measured in Laurier Lake on in each sampling year since 2007. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference. Values above these guidelines are presented in red.

Metals (Total Recoverable)	2007	2008	2010	2011	2012	2013	**Guidelines**
Aluminum μg/L	29.4	9.69	20.65	17.2	7.61	7.265	100[a]
Antimony μg/L	0.137	0.117	0.131	0.1245	0.115	0.0931	/
Arsenic μg/L	2.6	3	3.185	2.825	2.435	2.35	5
Barium μg/L	20.2	16.95	17.8	19.15	29.6	35.8	/
Beryllium μg/L	<0.003	<0.003	0.002	0.003	0.010	0.002	100[c,d]
Bismuth μg/L	<0.005	0.005	0.002	0.003	0.007	0.001	/
Boron μg/L	175.5	182	188.5	189	221.5	163	1500
Cadmium μg/L	0.008	0.004	0.004	0.003	0.003	0.002	0.26[b]
Chromium μg/L	0.611	0.560	0.441	0.465	0.296	0.526	/
Cobalt μg/L	0.099	0.058	0.071	0.081	0.059	0.048	1000[d]
Copper μg/L	0.61	0.56	0.28	2.90	0.68	0.37	4[b]
Iron μg/L	37.1	15.8	16.855	21.05	9.5	17.15	300
Lead μg/L	0.06	0.02	0.02	0.06	0.02	0.03	7[b]
Lithium μg/L	102.9	100.2	114	114.5	111.5	87.05	2500[e]
Manganese μg/L	5.2	8.0	4.1	8.3	13.0	19.9	5.2
Molybdenum μg/L	0.66	0.59	0.86	0.78	0.59	0.46	73[c]
Nickel μg/L	0.28	0.13	0.13	0.2	0	0.22	150[b]
Selenium μg/L	0.55	0.37	0.42	0.31	0.3	0.24	1
Silver μg/L	<0.003	0.009	0.001	0.043	0.002	0.025	0.25
Strontium μg/L	84.5	62.9	58.85	72.35	114.5	134	/
Thallium μg/L	<0.001	0.002	0.001	0.001	<0.001	<0.001	0.8
Thorium μg/L	<0.01	0.02	0.01	0.04	0.01	0.01	/
Tin μg/L	<0.06	<0.03	0.02	0.02	0.03	0.02	/
Titanium μg/L	1.24	1.36	1.38	0.75	0.69	1.4	/
Uranium μg/L	0.81	0.81	1.09	0.88	0.68	0.68	15
Vanadium μg/L	0.74	0.51	0.81	0.56	0.43	0.33	100[d,e]
Zinc μg/L	1.53	0.92	0.33	1.09	1.03	0.62	30

Table 3b. Continued - Concentrations of metals measured in Laurier Lake on in each sampling year since 2004. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference. Values above these guidelines are presented in red.

Metals (Total Recoverable)	2014	2015	2016	2017	2018	2019	**Guidelines**
Aluminum μg/L	16.05	10.05	3.5	6.8	3.9	28.8	100[a]
Antimony μg/L	0.094	0.1415	0.093	0.074	0.08	0.062	/
Arsenic μg/L	2.165	3.89	1.93	2.56	2.13	2.14	5
Barium μg/L	37.85	23.225	39.9	43.8	53.6	47.2	/
Beryllium μg/L	0.004	0.004	0.004	0.006	<0.001	0.0015	100[c,d]
Bismuth μg/L	0.001	0.015	<0.001	0.006	0	0.0015	/
Boron μg/L	171	280	171	170	140	129	1500
Cadmium μg/L	0.002	0.002	0.001	0.025	0.01	0.005	0.26[b]
Chromium μg/L	0.695	0.185	0.060	0.250	0.1	0.05	/
Cobalt μg/L	0.026	0.071	0.020	0.083	0.06	0.054	1000[d]
Copper μg/L	0.24	1.09	0.78	0.91	0.11	0.15	4[b]
Iron μg/L	13.4	14	8.3	8.3	12	12.1	300
Lead μg/L	0.01	0.04	0.01	0.01	0.01	0.031	7[b]
Lithium μg/L	75.8	149.35	94.3	89.5	75	73.4	2500[e]
Manganese μg/L	20.3	12.6	20.6	13.3	35.3	10.6	5.2
Molybdenum μg/L	0.32	0.78	0.4	0.3	0.33	0.45	73[c]
Nickel μg/L	<0.001	0.16	0.03	1.64	0.22	0.17	150[b]
Selenium μg/L	0.49	0.11	0.57	0.5	0.6	0.4	1
Silver μg/L	0.018	0.002	0.001	0.003	<0.001	0.002	0.25
Strontium μg/L	145	89.2	166	178	210	196	/
Thallium μg/L	0.003	0.022	<0.001	0.005	<0.001	0.001	0.8
Thorium μg/L	<0.01	0.03	0.01	0.014	<0.01	0.012	/
Tin μg/L	0.01	0.02	0.01	0.15	0.06	0.03	/
Titanium μg/L	1.94	2.01	1.4	1.31	1.38	1.64	/
Uranium μg/L	0.55	2.77	0.61	0.5	0.46	0.574	15
Vanadium μg/L	0.44	0.85	0.26	0.31	0.27	0.109	100[d,e]
Zinc μg/L	1.1	1.25	1.1	2.1	1.1	0.8	30

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 for the different parameters in each lake as both line and box-and-whisker plots. Detailed methods are available in the *ALMS Guide to Trend Analysis on Alberta Lakes.*

Table 4. Summary table of trend analysis on Laurier Lake data from 1997 to 2019.

Parameter	Date Range	Direction of Significant Change
Total Phosphorus	1997-2019	Increasing
Chlorophyll-*a*	1997-2019	Increasing
Total Dissolved Solids	1997-2019	Decreasing
Secchi Depth	1997-2019	Decreasing

Definitions:

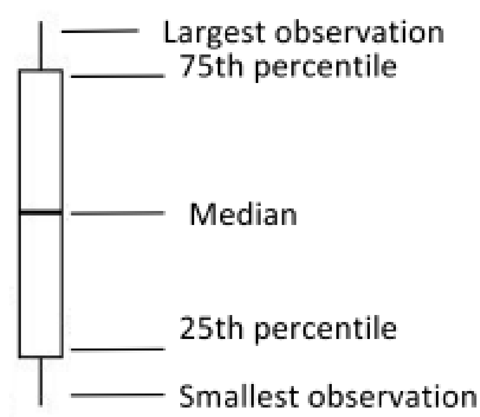
Median: the value in a range of ordered numbers that falls in the middle.

Trend: a general direction in which something is changing.

Monotonic trend: a gradual change in a single direction.

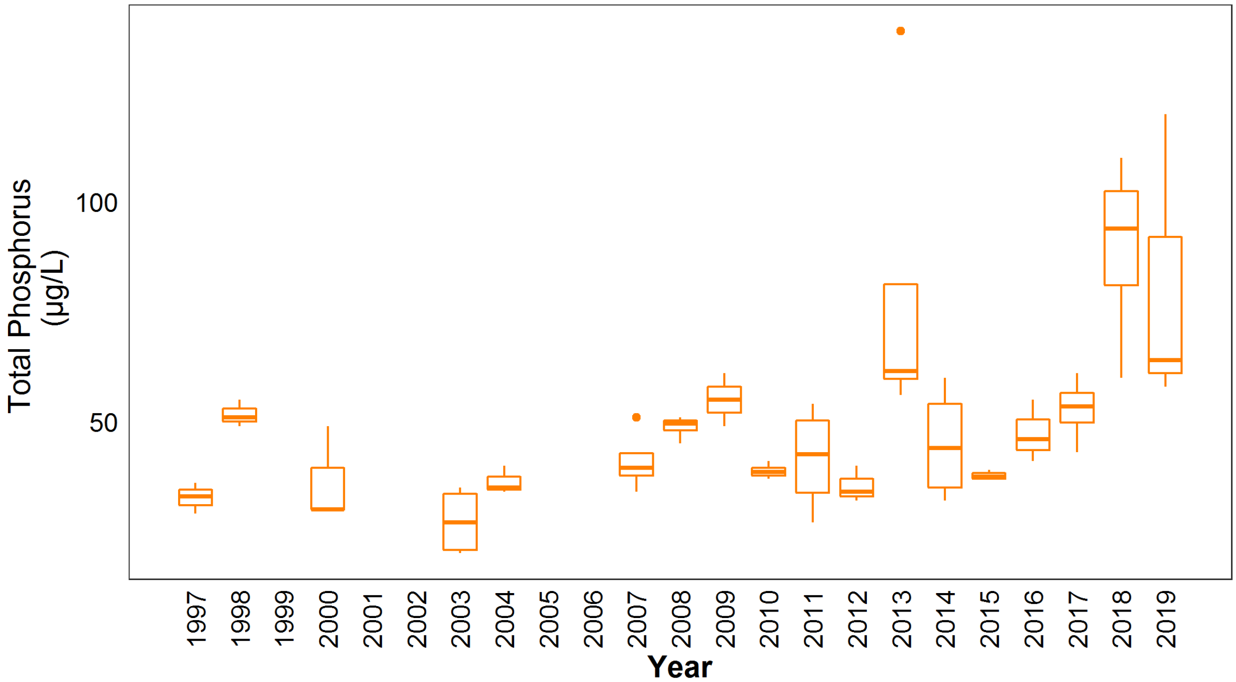
Statistically significant: The likelihood that a relationship between variables is caused by something other than random chance. This is indicated by a p-value of <0.05. Variability: the extent by which data is inconsistent or scattered.

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 = 0.43, $p < 0.001$).



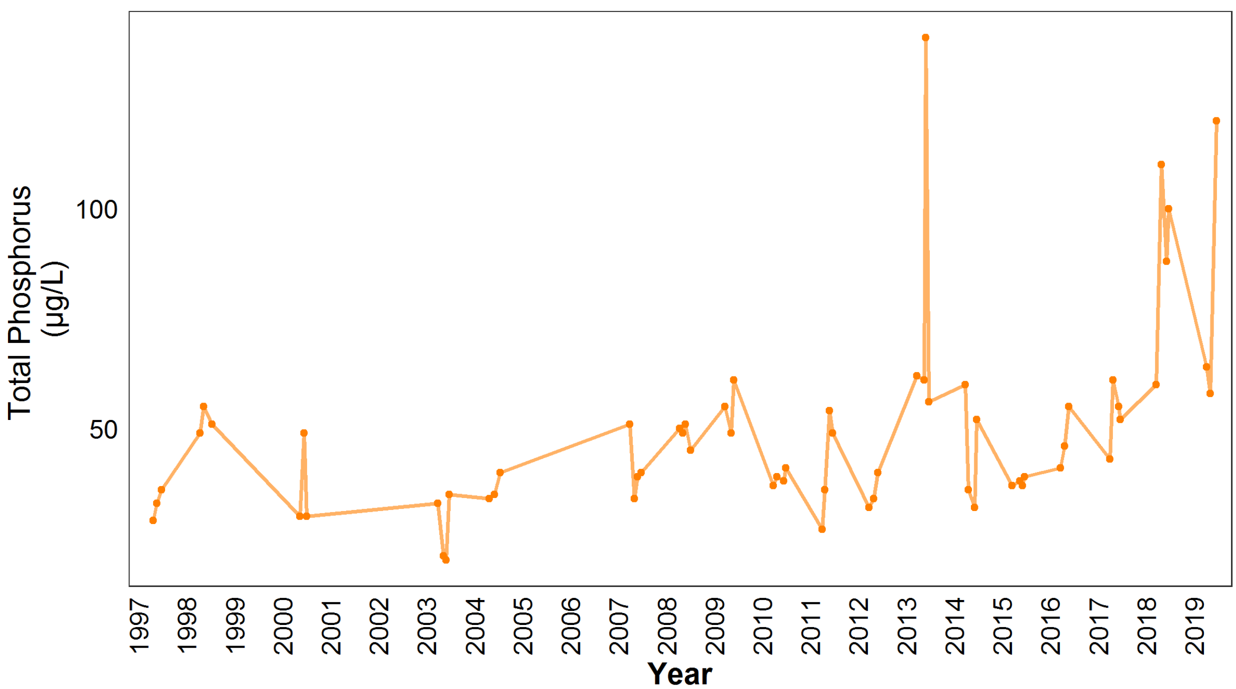
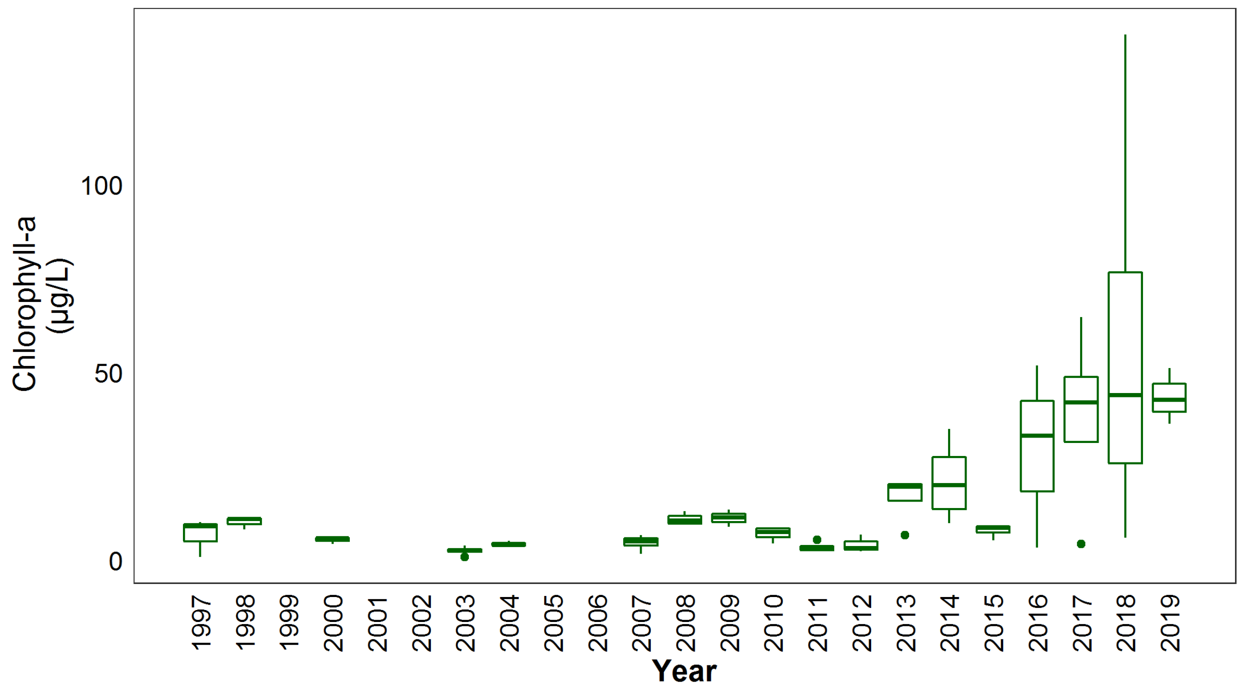


Figure 5. Total phosphorus (TP) concentrations measured between June and September over the long term sampling dates between 1997 and 2019 (n = 64). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

Chlorophyll-*a*

Chlorophyll-*a* has significantly increased over the course of data collection at Laurier Lake (Tau = 0.45, $p <$ 0.001).



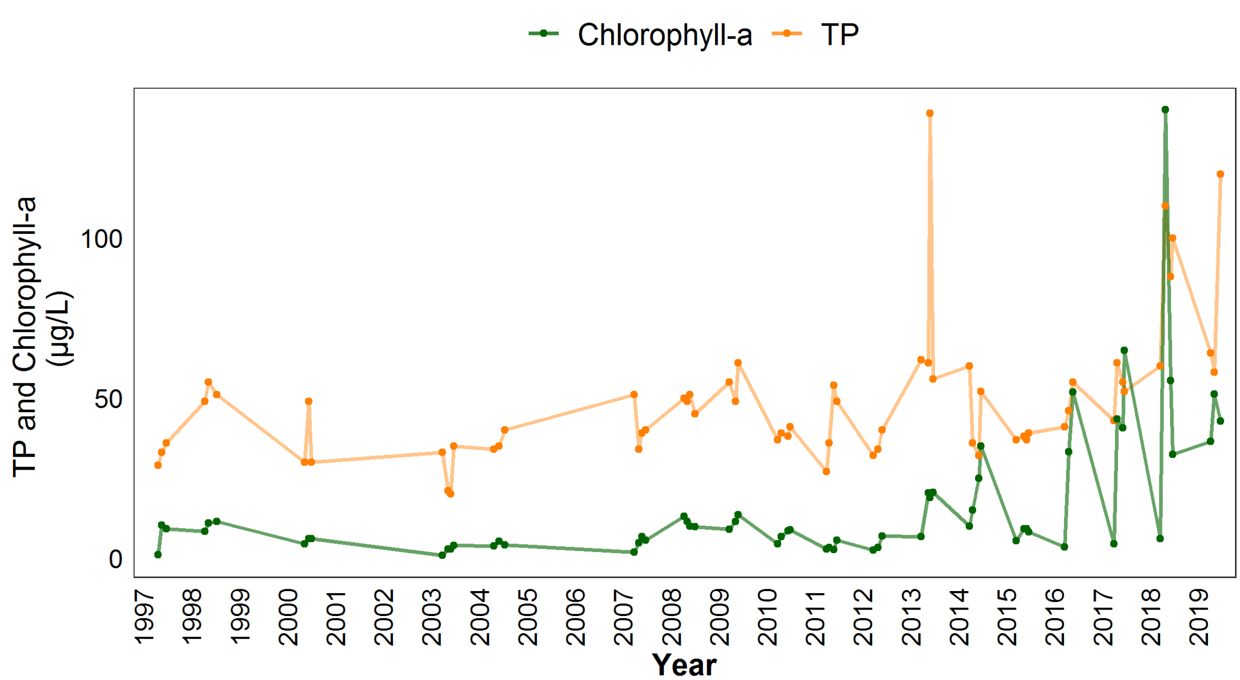
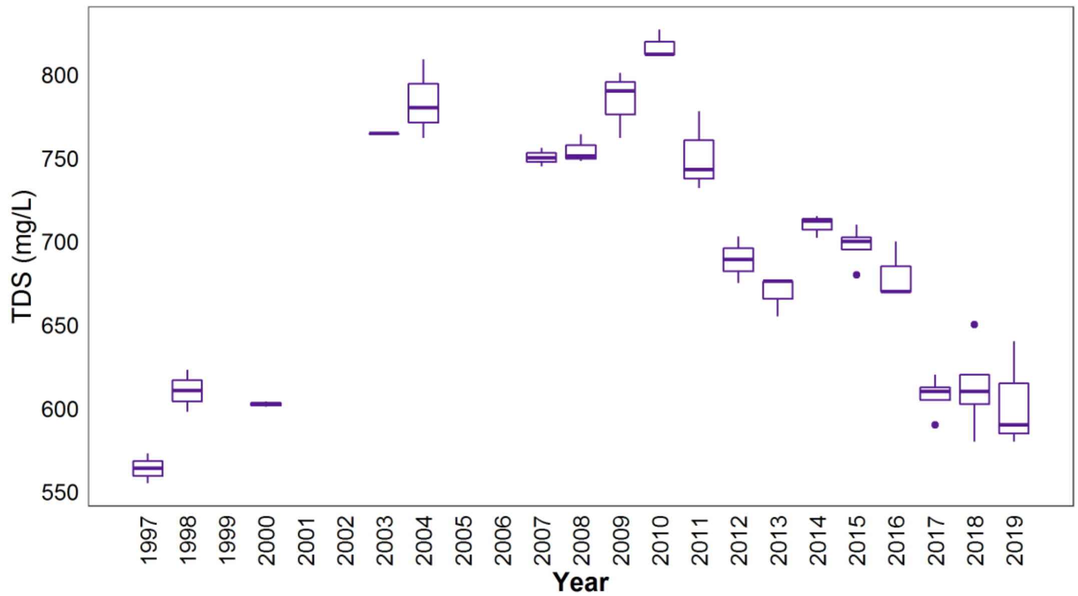


Figure 6. Chlorophyll-*a* concentrations measured between June and September over the long term sampling dates between 1997 and 2019 (n = 64). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

Total Dissolved Solids (TDS)

Trend analysis on TDS shows a significant decrease in TDS over the course of sampling (Tau = -0.36, *p* = 0.003). This is likely attributed to increasing water levels and a dilution effect in Laurier Lake.



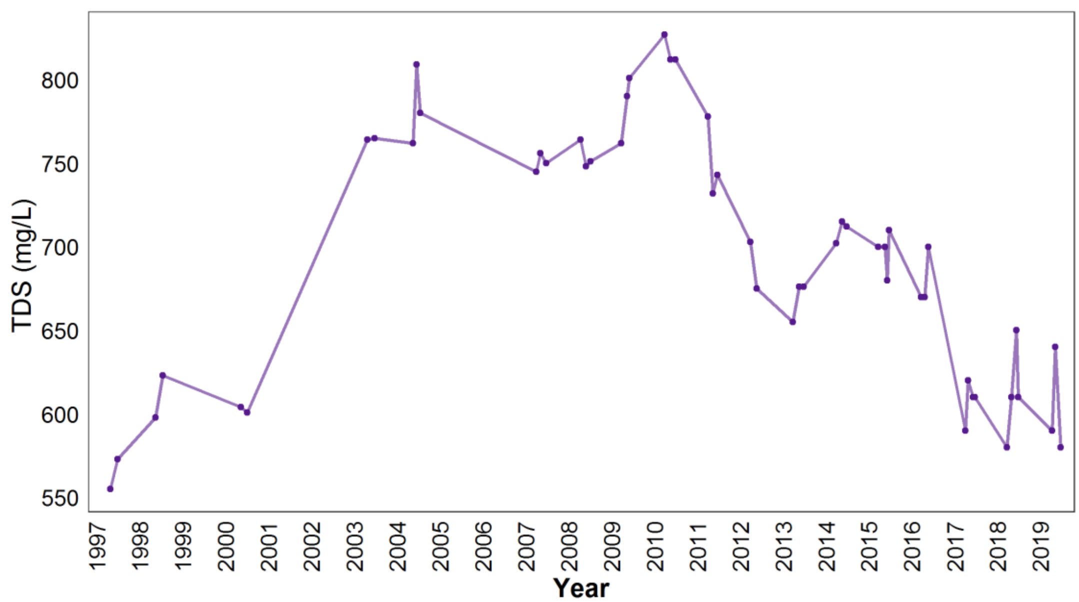
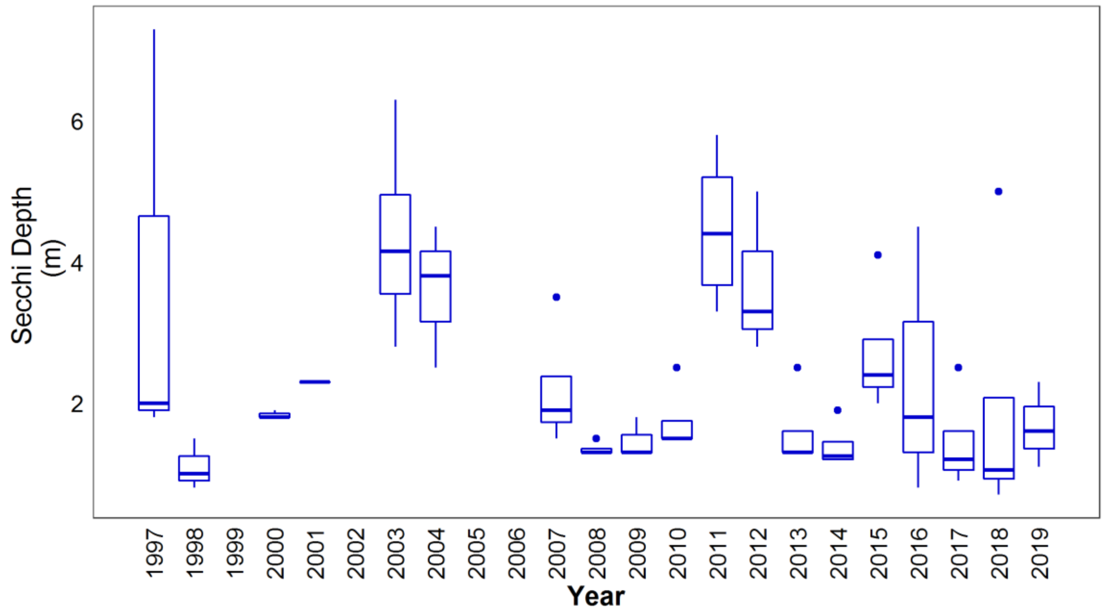


Figure 7. TDS measured between June and September over the long term sampling dates between 2003 and 2019 (n = 52). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

Secchi Depth

Trend analysis found that water clarity measured as Secchi depth has decreased over the sampling period (Tau = -0.25, p = 0.005).



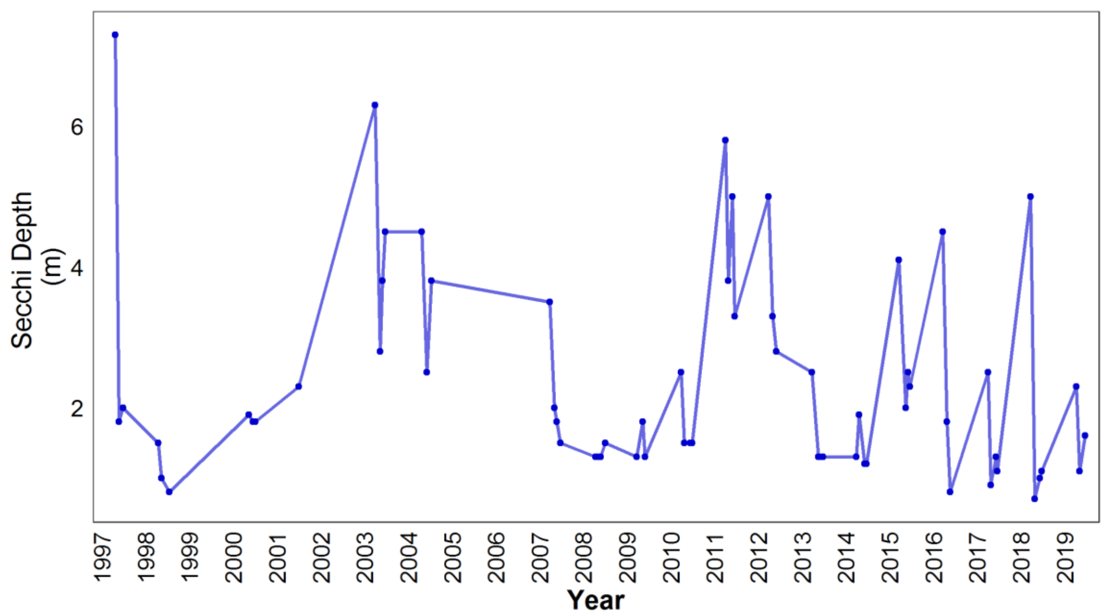


Figure 8. Secchi depth values measured between June and September over the long term sampling dates between 1997 and 2019 (n = 65). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

Table 6. 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	-	Seasonal Kendall	Seasonal Kendall	Seasonal Kendall	Seasonal Kendall
The strength and direction (+ or -) of the trend between -1 and 1	Tau	0.43	0.45	-0.36	-0.25
The extent of the trend	Slope	1.20	1.00	-8.33	-0.04
Number of samples included	n	64	64	52	65
The significance of the trend	*p*	2.59×10^{-6}*	9.98×10^{-7}*	0.0028	0.0048

*$p < 0.05$ is significant within 95%