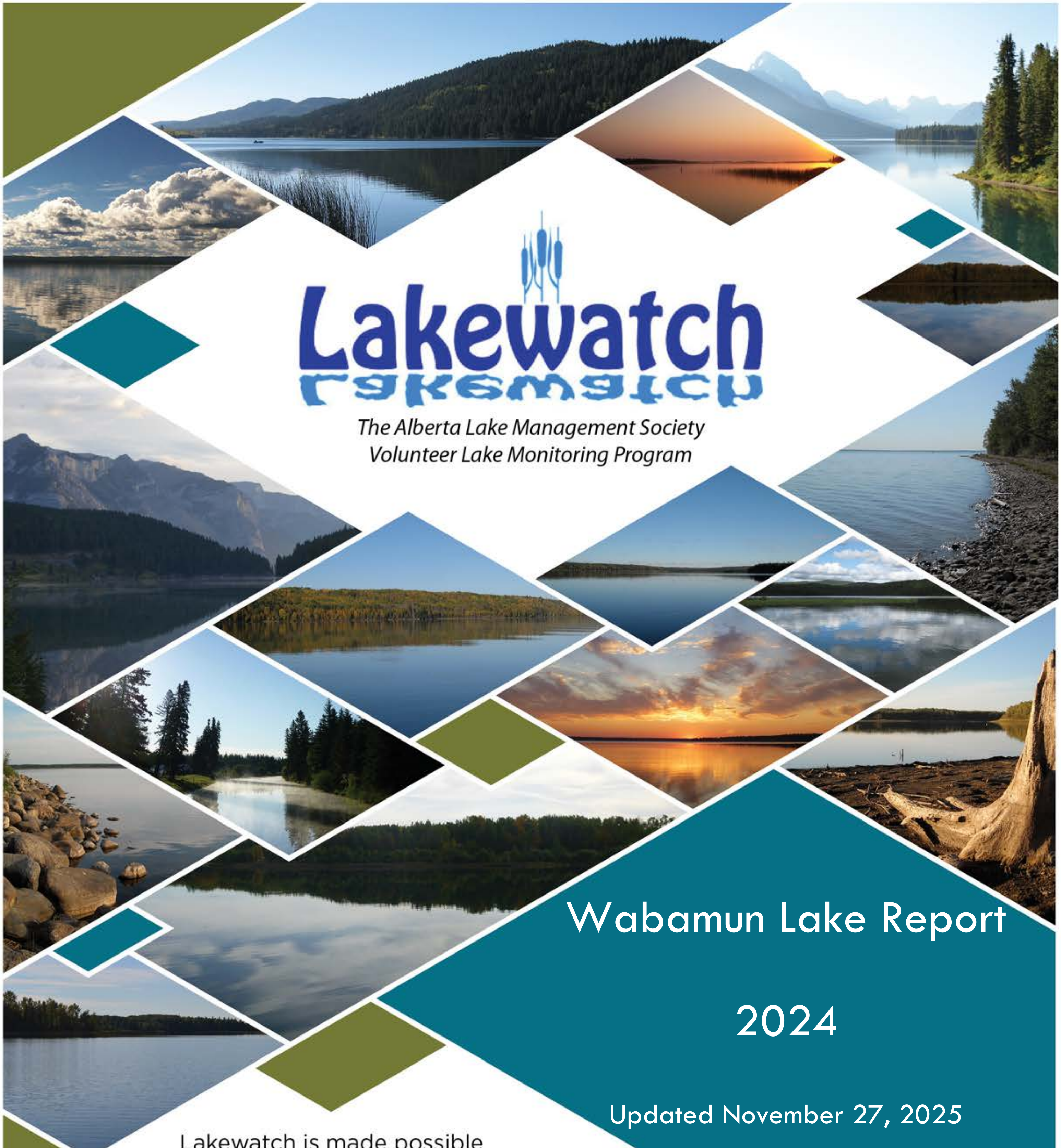


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Wabamun Lake Report

2024

Updated November 27, 2025

Lakewatch is made possible
with support from:

Alberta

LICA ENVIRONMENTAL STEWARDS

PIGEON LAKE WATERSHED ASSOCIATION

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.

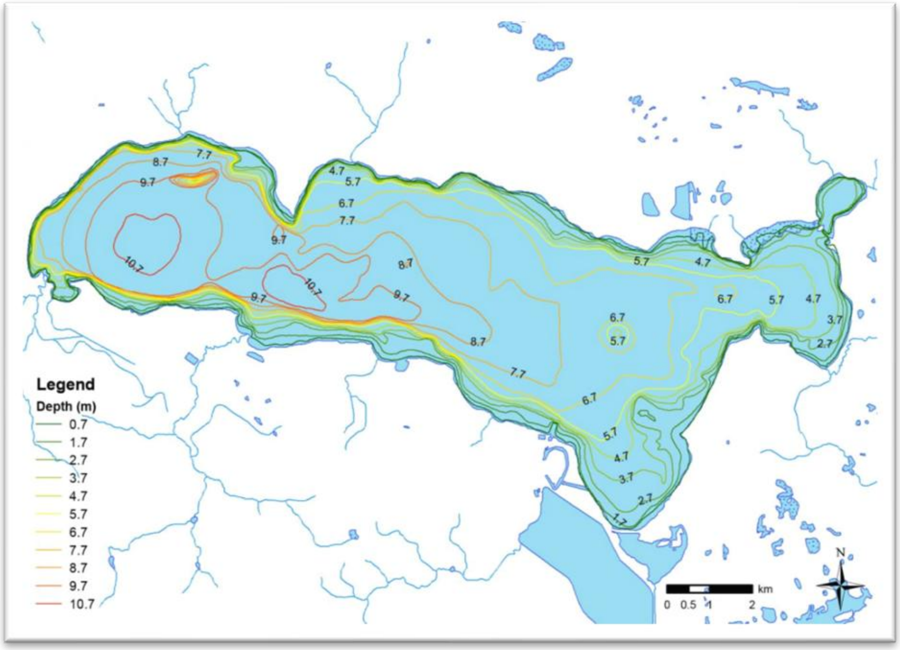
ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. A special thanks to Niel Fleming and Sue Styles for their commitment to collecting data at Wabamun Lake. We would also like to thank Katherine Cundict and Jordyn Lajeunesse, who were summer technicians in 2024. Executive Director Bradley Peter and Program Manager Brittany Onysyk were instrumental in planning and organizing the field program. This report was prepared by Brittany Onysyk and Bradley Peter.

BEFORE READING THIS REPORT, CHECK OUT [A BRIEF INTRODUCTION TO LIMNOLOGY]

WABUMAN LAKE

Wabamun Lake is a very popular, large lake situated 60 km west of Edmonton in the North Saskatchewan watershed. The lake's watershed is approximately 351 km^2, and the lake itself has a surface area of 79 km^2, a mean depth of 5.1 m and the deepest spot being approximately 11 m deep.[1] "Wabamun" is Cree for "mirror". Wabamun Lake was also called "White Whale Lake" for most of the 1800s, due to the size of large whitefish harvested from the lake at that time.[2]



Bathymetric map of Wabamun Lake (Alberta Geological Survey 2008).[1]

The Wabamun Paul First Nations Reserve is situated on the eastern edge of the lake, and many other communities line Wabamun's shore. Of them, the Village of Wabamun was established in 1912, and the summer villages of Lakeview and Kapasiwin were some of the first summer villages to be established in Alberta.[1] Other communities across the lake include Fallis, Seba Beach, Betula Beach, and Point Allison, to name just a few. Wabamun Lake Provincial Park is located on the northeast part of the lake and protects much of the shoreline of Moonlight Bay.

Wabamun Lake lies within both the dry mixedwood and central mixedwood subregions.[3] The North Saskatchewan watershed is highly developed by human footprint, and there is much industrial activity throughout the watershed as well as adjacent to the lake.

Historically, two coal-fired power plants and one surface coal mine located south of Wabamun Lake were in operation, owned by TransAlta. The Sundance power plant near the southeast shore within the watershed was the largest coal-fired electrical generation plant in Western Canada.[4] Five of the six coal-fired generating units at Sundance have been retired, the remainder currently temporarily shut down.[4] The Keephills power plant is still in operation, and was converted to natural gas in 2021.[5] While the Keephills plant is located outside of the Wabamun watershed, both the Keephills and Sundance cooling ponds drained into the lake after treatment by the Wabamun Water Treatment Plant.[6] SunHills Mining, a subsidiary of TransAlta, operated the Highvale Mine from the 1970s until its decommission in 2021.[1,7] The Highvale Mine is considered

Canada's largest strip coalmine.[1] The Highvale Mine is in the process of reclamation, and is located on the south shore of the lake, stretching southeast to the North Saskatchewan River. TransAlta also operated the Wabamun Power Plant and Whitewood Mine on the northeast shore from 1962 - 2010.[1] Historically, water was removed from the lake for operations. As of 2005, no water was diverted for any mine/plant operations or facilities.[1]

A train derailment also occurred at Wabamun Lake in the summer of 2005. 46 Canadian National Railway (CN) cars derailed 7.5 km west of the Village of Wabamun, resulting in the release of Bunker 'C' oil and Pole-Treating oil. The spill was cleaned up and monitored over the next few years. [1]

The data in this report will only reflect conditions sampled from the Main Basin of Wabamun Lake (Station Code: AB05DE0650).

Sampling at Wabamun Lake on June 11, 2024.

[1] Aquality Environmental Consulting. 2013. Wabamun Lake State of the Watershed Report.
[2] Mitchell, P. and E. Prepas. 1990. Atlas of Alberta Lakes.
[3] Strong, W.L. and K.R. Leggat. 1981. Ecoregions of Alberta.
[4] TransAlta Corporation. 2025. Sundance. https://transalta.com/about-us/our-operations/facilities/sundance/
[5] TransAlta Corporation. 2025. Keephills. https://transalta.com/about-us/our-operations/facilities/keephills/
[6] Associated Environmental. 2018. Water Quality Status and Trends in Wabamun Lake.
[7] TransAlta Corporation. 2022. Highvale Mine Decommissioning and Reclamation Plan.

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 Wabamun Lake was 34 µg/L (Table 2), falling into the eutrophic, or highly productive trophic classification. This value is in the mid-range of historical averages (Table 2). TP was lowest at the beginning of the season at 25 µg/L on June 11 sampling event and was highest at 48 µg/L during the August 19 sampling event (Figure 1). A water budget conducted on Wabamun Lake suggests that about 50% of the total phosphorus in the lake is released from sediments.[1]

The average chlorophyll-*a* concentration in 2024 was 12.9 µg/L (Table 2), similarly falling into the eutrophic classification. Chlorophyll-*a* was lowest at 8.2 µg/L on June 11 and peaked at 17.1 µg/L on August 19 (Figure 1).

The average Total Kjeldahl Nitrogen (TKN) concentration was 0.9 mg/L (Table 2). TKN increased slightly over the season (Figure 1).

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[1] Aquality Environmental Consulting. 2013. Wabamun Lake State of the Watershed Report.

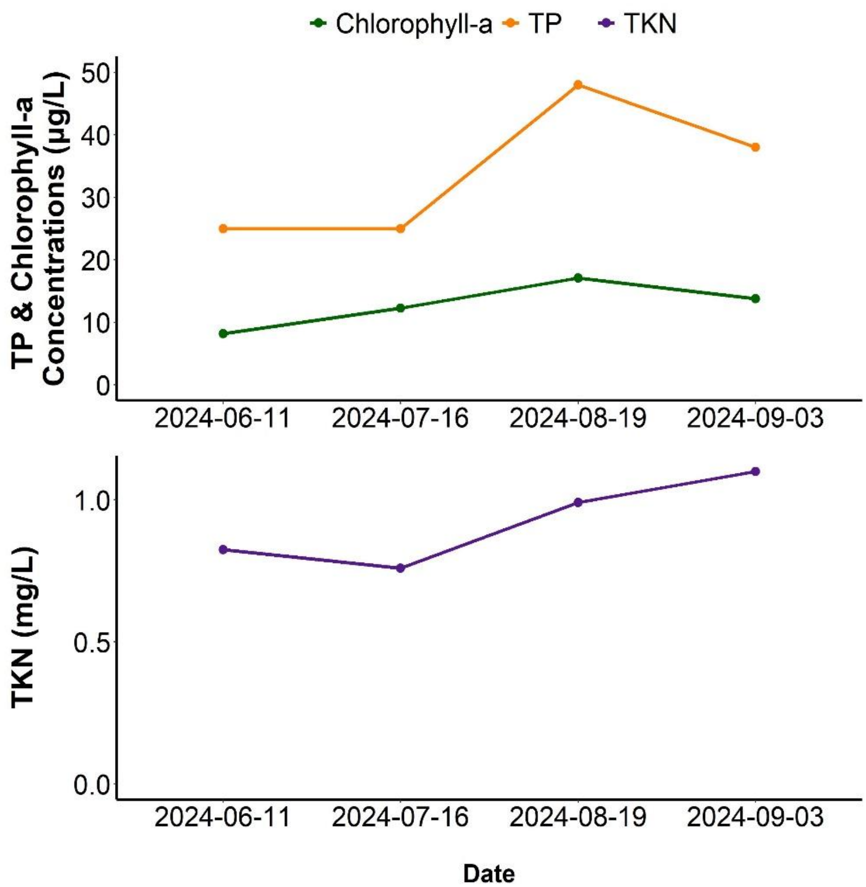

Figure 1. Total Phosphorus, Chlorophyll-*a*, and Total Kjeldahl Nitrogen concentrations measured over the course of the summer at Wabuman Lake in 2024.

Average pH was measured as 8.55 in 2024, buffered by a moderate alkalinity (220 mg/L $CaCO_3$) and bicarbonate (245 mg/L HCO_3). Aside from bicarbonate, sulphate and sodium were higher than all other major ions, and contributed to a moderate conductivity of 648 µS/cm (Figure 2, top; Table 2). Wabamun Lake is in the moderate range of ion levels compared to other LakeWatch lakes sampled in 2024 (Figure 2, bottom).

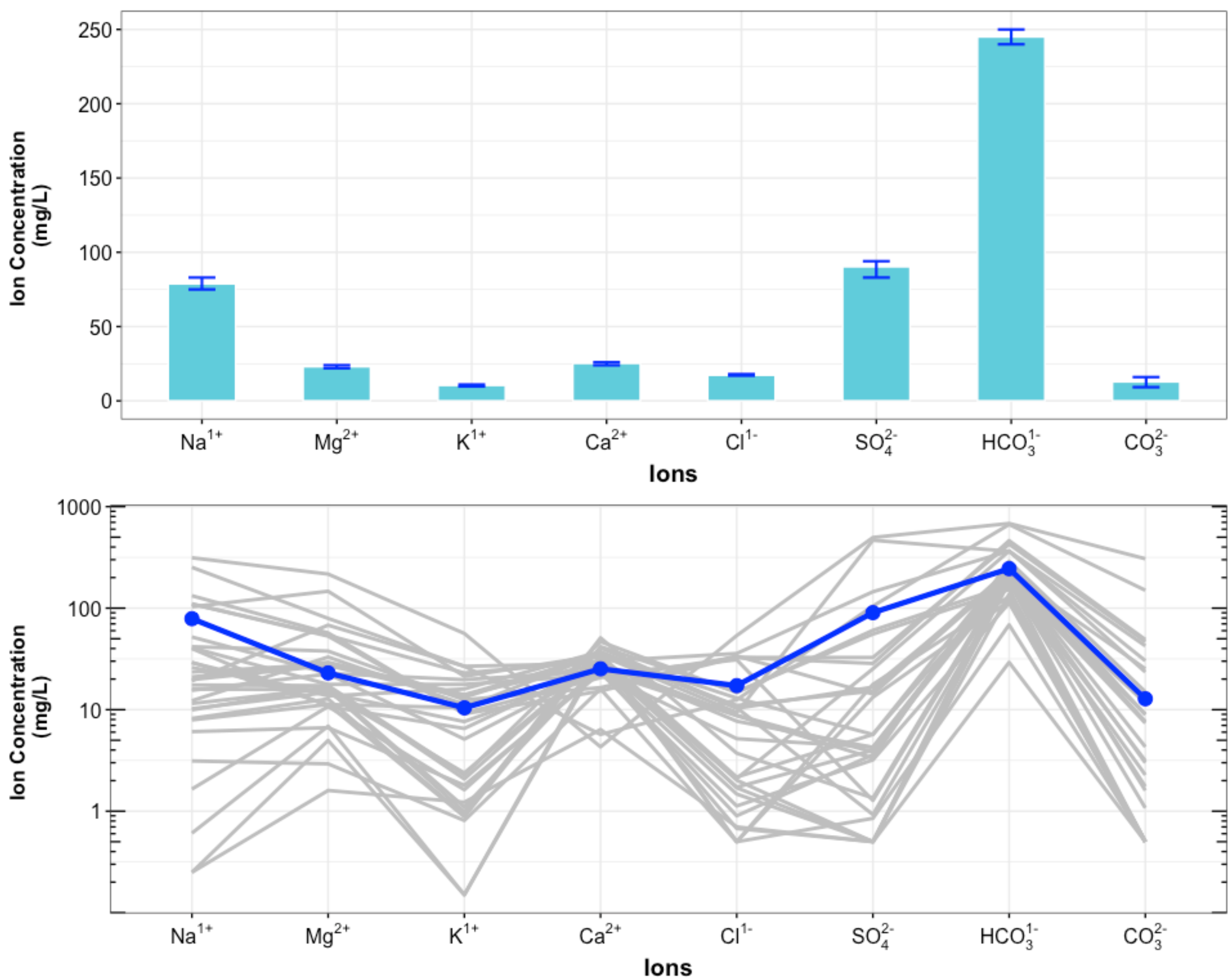

Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from 4 measurements over the course of the summer at Wabuman Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Wabuman Lake (blue line) compared to 26 lake basins (gray lines) sampled through the LakeWatch program in 2024 (note log10 scale on y-axis of bottom figure).

Metals

Metals will naturally be present in aquatic environments due to in-lake processes or the erosion of rocks, or introduced to the environment from human activities such as urban, agricultural, or industrial developments. Many metals have a unique guideline as they may become toxic at higher concentrations. Where current metal data are not available, historical concentrations for 27 metals have been provided (Table 3).

Metals were measured at Wabamun Lake in 2024 (Table 3). No metals exceeded the CCME chronic guideline for the protection of aquatic life in 2024.[8]

[8] Canadian Water Quality Guidelines. 2019. Canadian Council of Ministers of the Environment.

WATER CLARITY AND EUPHOTIC 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 euphotic depth of Wabuman Lake in 2024 was 4.9 m, corresponding to a Sechi depth of 2.45 (Table 2). Euphotic depth varied slightly over the season, ranging from as shallow as 3.8 m on August 19 to as deep as 6.4 m on June 11 (Figure 3).

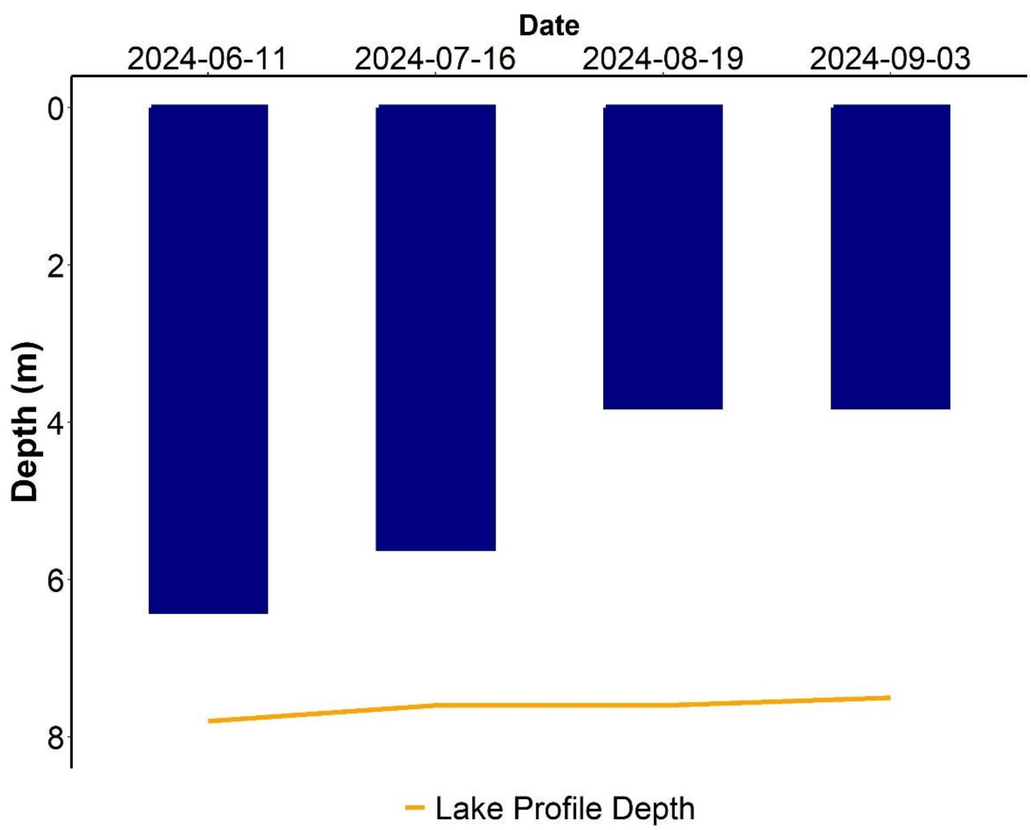

Figure 3. Euphotic depth values measured over the course of the summer at Wabuman Lake in 2024.

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. Please refer to the end of this report for descriptions of technical terms.

Surface temperatures of Wabamun Lake varied throughout the summer, with the July 16 sampling having the warmest temperatures at 21.79 °C (Figure 4). The lake was well mixed during each sampling date. The lake was the coldest during the June sampling event, warmed up through July and August, then cooled down slightly in September, but was still approximately 3°C warmer than during the June sampling event.

Wabamun Lake was well oxygenated in the surface waters on all sampling dates, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen[9] (Figure 4). A sharp decrease in oxygen was detected towards the bottom of the lake (6.5 m) during the July 16 and September 3 sampling events where oxygen levels approached 2 mg/L.

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[9] Canadian Council of Ministers of the Environment. 1999. Canadian water quality guidelines for the protection of aquatic life: Dissolved oxygen (freshwater).

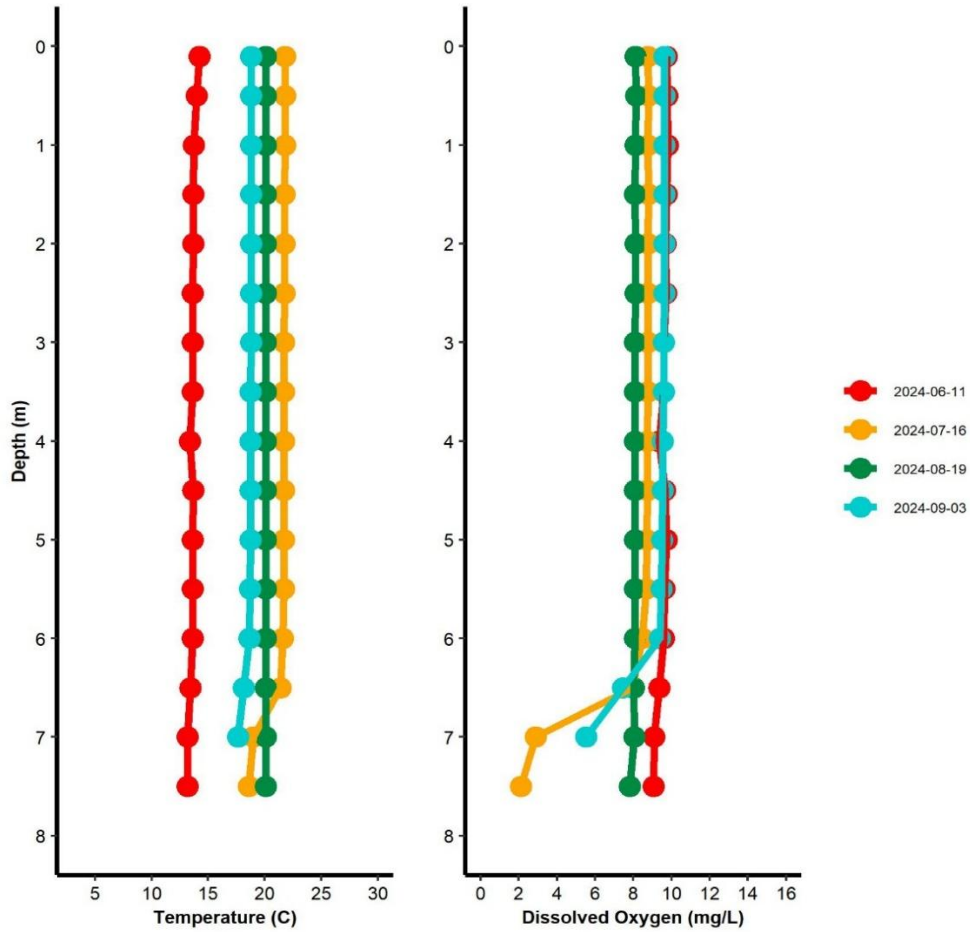


Figure 4. Temperature (°C) and dissolved oxygen (mg/L) profiles for Wabuman Lake measured over the course of the summer of 2024.

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 one of the most common cyanobacteria toxins. In Alberta, recreational guidelines for microcystin are set at 10 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 Wabuman Lake fell below the recreational guideline of 10 µg/L[10] during every sampling event in 2024. Despite low levels of microcystin detected during the sampling events, caution should be observed in areas of the lake where significant cyanobacteria accumulation occurs.

Table 1. Microcystin concentrations measured four times at Wabuman Lake in 2024.

Date	Microcystin Concentration (µg/L)
06/11/2024	< 0.1
07/16/2024	< 0.1
08/19/2024	0.36
09/03/2024	0.74
Average	**0.3**

[10] Health Canada. 2022. Guidelines for Canadian Recreational Water Quality.

INVASIVE SPECIES

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 can change lake conditions which can then lead to toxic cyanobacteria blooms, decrease the amount of nutrients needed for fish and other native species, and cause millions of dollars in annual costs for repair and maintenance of water-operated infrastructure and facilities. Spiny water flea pose a concern for Alberta because they alter the abundance and diversity of native zooplankton, as they are aggressive zooplankton predators. Through over-predation, they will impact higher trophic levels such as fish. They also disrupt fishing equipment by attaching in large numbers to fishing lines.

Monitoring for aquatic invasive species involved sampling with a 63 µm plankton net. This monitoring is designed to detect juvenile Dreissenid mussel veligers and spiny water flea. No mussels or spiny water flea were detected in Wabuman Lake in 2024.

Eurasian watermilfoil is a 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. Eurasian watermilfoil can look similar to the native Northern watermilfoil, thus genetic analysis is ideal for suspect watermilfoil species identification.

Watermilfoil was collected from Wabamun Lake on July 16, 2024. The specimen was confirmed to be Northern Watermilfoil (*Myriophyllum sibiricum*).

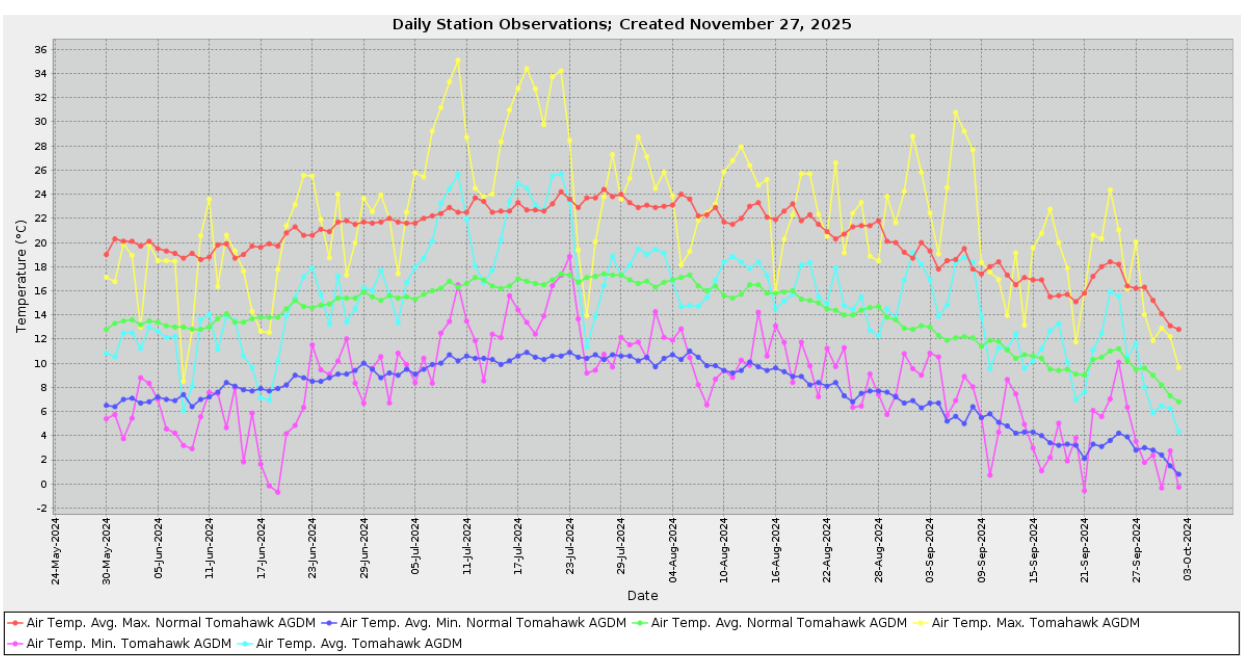
WEATHER AND LAKE STRATIFICATION

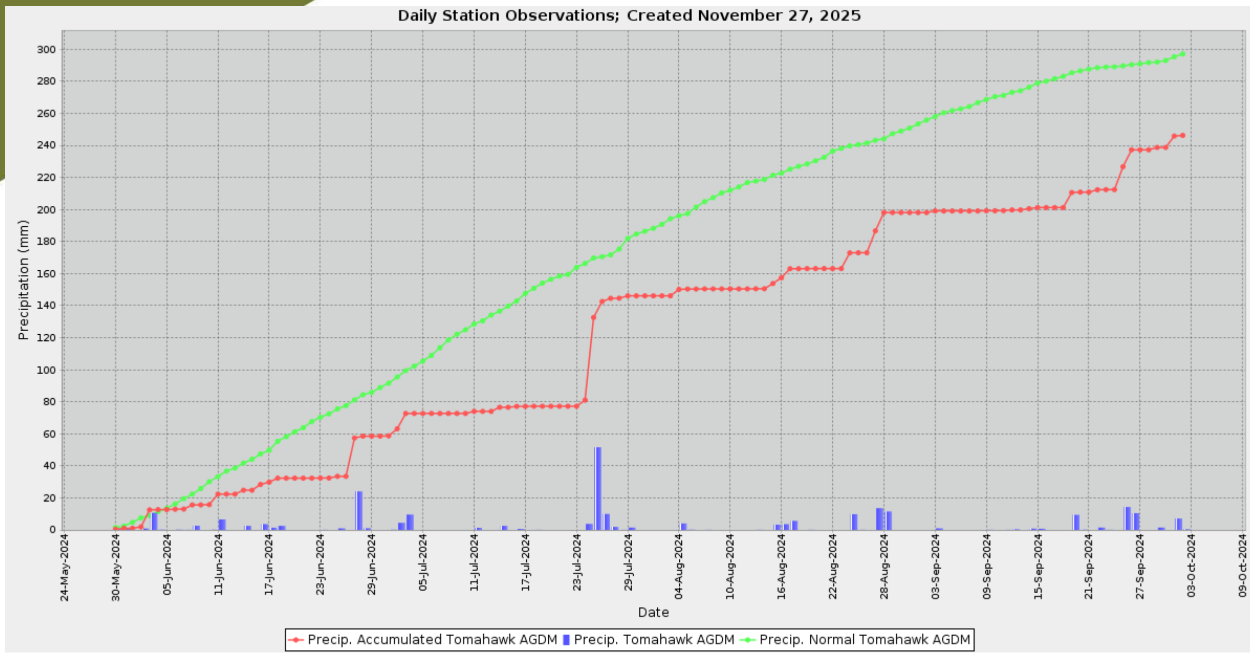
Air temperature will directly impact lake temperatures, and result in different temperature layers (stratification) throughout the lake, depending on its depth. Wind will also impact the degree to which a lake mixes, and how it will stratify. The amount of precipitation that falls within a lake's watershed will have important implications, depending on the context of the watershed and the amount of precipitation that has fallen. Solar radiation represents the amount of energy that reaches the earth's surface, and has implications for lake temperature & productivity.

In 2024, Wabamun Lake experienced a warmer and windier summer compared to normal, with less than normal accumulated precipitation (Figure 5). Although it was warmer overall, the beginning of the sampling season was unseasonably cold and wet, with the month of June falling below average temperatures and breaking the lowest temperature record on June 19 at -0.7°C. July was the warmest month, with the average temperature being 19.7°C. 2024 also broke heat records on numerous days in July and September, including the hottest day recorded on July 10 at 35.1°C. September was also a warmer than average month, with the average temperature being 12.5°C.

Wabamun Lake received less than normal precipitation in the summer of 2024 (246 mm total). Precipitation was sporadic over the summer months, and generally fell a bit at a time, with the exception of July 25 when over 50 mm of precipitation fell (Figure 5).

Strong winds were also observed throughout the sampling season.





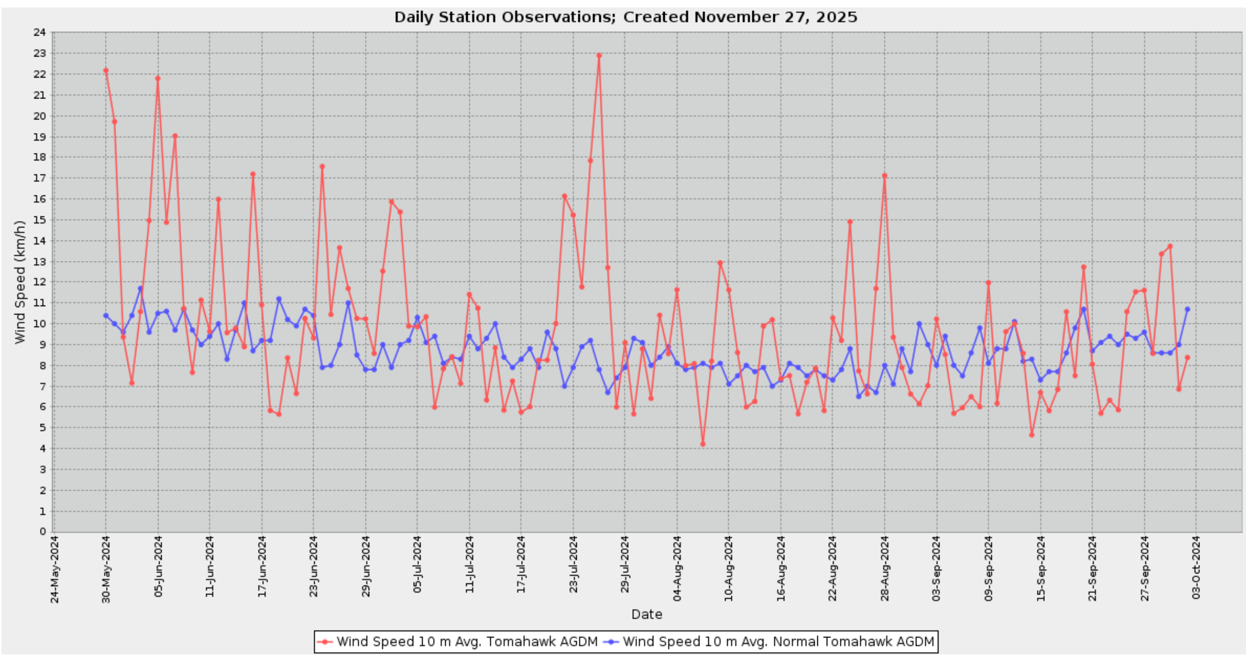


Figure 5. Air temperature (°C), wind speed (km/h), and precipitation (mm) measured from Tomahawk weather station southwest of Wabamun Lake. Weather data provided by Agriculture, Forestry and Rural Economic Development, Alberta Climate Information Service (ACIS) https://acis.alberta.ca.

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 at Wabamun Lake have fluctuated between 723.7 masl and 725.2 masl (Figure 6). In 2024, water levels were at about 724.0 masl (Figure 7), which falls within the historical average (Figure 6). A weir has controlled the water level of Wabamun Lake for nearly a century.[1] The weir level has been set at to 724.55 masl, above which depth water would flow out of the weir. Any industrial displacement of water from the lake was also required to be replaced.[1]

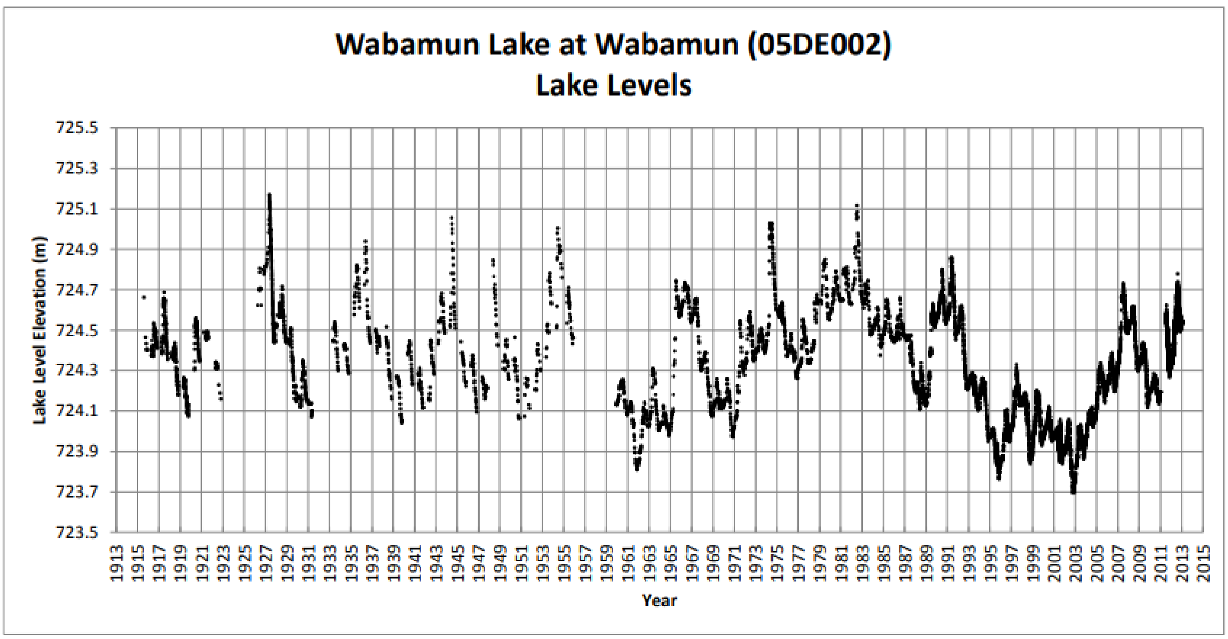


Figure 6. Historical water levels measured at Wabamun Lake in metres above sea level (masl) from 1913-2015. Obtained from 2013 Wabamun Lake State of the Watershed Report (Aquality Environmental Consulting).[1]

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[1] Aquality Environmental Consulting. 2013. Wabamun Lake State of the Watershed Report.

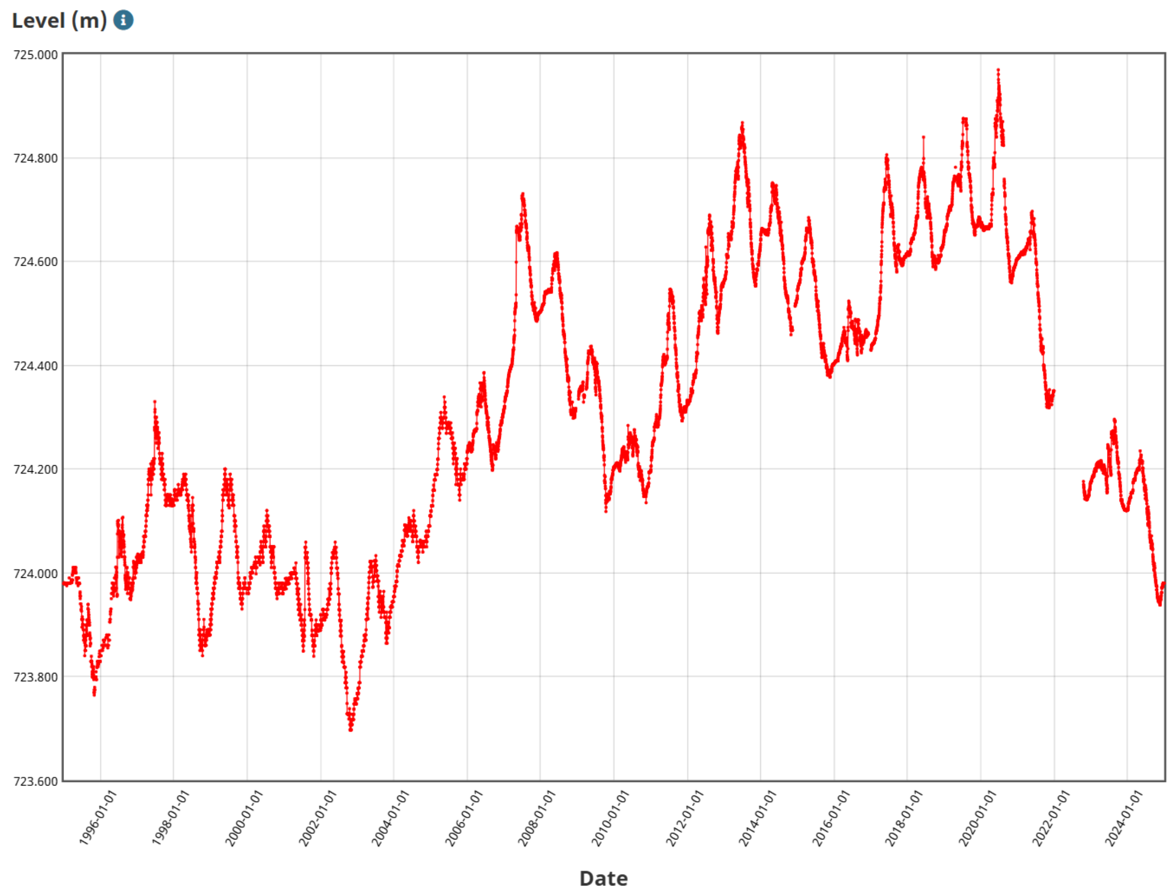


Figure 7. Water levels measured at Wabamun Lake at the Sundance Power Station in metres above sea level (masl) from 1990-2024. Obtained from Environment Canada and Alberta Environment and Parks Real-Time Hydrometric Data (https://wateroffice.ec.gc.ca/).

Table 2. Average Secchi depth and water chemistry values for Wabuman Lake for the Main Basin only. Sampling events from only the East or West Basin have been excluded from this table.

Parameter	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
TP (µg/L)	35	31	18	33	37	35	34	35	34	33	32	34	33
TDP (µg/L)	19	13	6	10	11	12	12	13	13	11	12	11	10
Chlorophyll-a (µg/L)	10.4	10.9	10.6	10.3	12.5	12.0	11.2	17.2	11.1	12.7	11.6	12.3	11.3
Secchi depth (m)	2.29	1.90	2.44	2.58	2.74	2.82	2.70	2.63	2.13	2.07	2.09	2.04	2.05
TKN (mg/L)	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.9	0.9	1.0	1.0	1.0
NO_2-N and NO_3-N (µg/L)	5	12	3	2	7	2	2	3	1	2	4	5	3
NH_3-N (µg/L)	17	21	9	17	19	15	-	16	-	8	13	-	10
DOC (mg/L)	11	11	14	11	11	12	13	12	11	12	12	13	12
Ca^{2+} (mg/L)	24	23	25	26	26	25	24	25	24	25	22	23	23
Mg^{2+}(mg/L)	12	12	13	13	13	15	14	15	15	15	15	15	16
Na^{+} (mg/L)	45	47	46	47	47	51	49	49	46	51	52	54	56
K^{+} (mg/L)	7	8	8	8	8	8	8	8	8	8	8	9	9
SO_4^{2-} (mg/L)	28	26	25	27	30	28	27	29	28	31	28	28	30
Cl^{-} (mg/L)	3	3	3	4	4	4	5	4	4	5	5	5	6
CO~$_3^{2-}$ (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
HCO_3^{2-} (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	8.52	8.63	8.56	8.67	8.57	8.67	8.43	8.61	8.62	8.66	8.71	8.61	8.62
Conductivity (µS/cm)	412	416	421	421	430	439	428	432	434	447	444	452	459
Hardness (mg/L)	108	108	115	117	119	124	118	123	123	123	116	120	123
TDS (mg/L)	233	236	235	241	247	252	247	249	245	256	253	258	268
Microcystin (µg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Alkalinity (mg/L CaCO3)	190	195	193	195	198	203	197	199	200	203	203	206	212

Parameter	1996	1997	1998	2010	2011	2012	2013	2019	2020	2021	2022	2023	2024
TP (µg/L)	34	36	36	34	40	33	36	27	44	26	24	18	34
TDP (µg/L)	11	11	11	13	9	14	14	7	6	7	6	7	8
Chlorophyll-a (µg/L)	11.2	14.1	13.3	7.9	11.5	11.0	8.8	11.1	11.7	12.0	9.1	9.4	12.9
Secchi depth (m)	2.06	2.28	2.00	1.93	1.47	1.99	1.79	2.69	2.42	2.70	3.19	3.65	2.45
TKN (mg/L)	0.8	0.8	0.9	1.1	1.1	1.0	1.0	0.9	1.0	1.0	0.9	0.9	0.9
NO_2-N and NO_3-N (µg/L)	4	5	4	7	2	3	2	2	2	3	6	4	3
NH_3-N (µg/L)	-	-	-	12	12	17	11	15	24	15	13	16	19
DOC (mg/L)	13	12	-	12	-	11	-	10	10	10	11	10	11
Ca^{2+} (mg/L)	24	24	22	-	-	-	-	28	29	29	29	27	25
Mg^{2+}(mg/L)	15	16	15	-	-	-	-	22	22	22	23	23	23
Na^{+} (mg/L)	57	57	58	77	73	72	73	75	74	74	76	72	79
K^{+} (mg/L)	9	9	9	10	10	10	9	10	10	10	10	9	10
SO_4^{2-} (mg/L)	33	31	31	86	80	85	83	88	87	86	92	73	90
Cl^{-} (mg/L)	6	9	6	13	13	13	12	16	16	16	18	16	17
$CO{\sim}_3^{2-}$ (mg/L)	8.5	10.3	11.5	8.4	9.3	6.9	10.1	6.5	7	11.1	3.6	11.1	12.8
HCO_3^{2-} (mg/L)	234.25	238.25	235	242.57	233.33	244.57	239.25	255	230	237.5	255	267.5	245
pH	8.47	8.51	8.51	8.62	8.65	8.50	8.36	8.59	8.54	8.62	8.40	8.55	8.55
Conductivity (µS/cm)	466	470	479	592	583	602	608	612	598	630	630	582	648
Hardness (mg/L)	124	-	-	-	-	-	-	158	162	162	168	162	158
TDS (mg/L)	270	274	271	356	343	353	353	370	360	365	380	365	382
Microcystin (µg/L)	-	-	-	0.1	0.17	0.17	0.11	0.12	0.24	0.08	0.15	0.12	0.3
Total Alkalinity (mg/L CaCO3)	207	213	212	213	207	212	213	220	198	212	212	235	220

Table 3. Concentrations of metals measured in Wabuman Lake. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference. Note that metal sample collection method changed in 2016 from composite to single surface grab at the profile location.

Metals	2013	2016	2017	2020	2024	Guidelines
Aluminum (µg/L)	30.55	16.2	48.2	15.1	13.4	100[a]
Antimony (µg/L)	0.178	0.162	0.262	0.145	0.176	/
Arsenic (µg/L)	2.77	3.07	3.31	3.2	3.23	5
Barium (µg/L)	130.5	124.6	177.3	128	116	/
Beryllium (µg/L)	0.0074	0.004	0.004	0.003	0.0015	100[c,d]
Bismuth (µg/L)	5e-04	6e-04	0.001	0.0015	0.0015	/
Boron (µg/L)	920.5	913.8	1773.3	791	822	1500
Cadmium (µg/L)	0.011	0.007	0.016	0.005	0.005	0.36[b]
Chromium (µg/L)	0.493	0.087	0.12	0.05	0.05	/
Cobalt (µg/L)	0.0283	0.046	0.001	0.016	0.043	500, 1000[c,d]
Copper (µg/L)	0.642	1.064	1.473	0.46	0.5	4[b]
Iron (µg/L)	18.96	16.52	13.5	13	11.7	300
Lead (µg/L)	0.062	0.037	0.025	0.045	0.024	7[b]
Lithium (µg/L)	39.65	45.32	70.57	38	40	2500[d]
Manganese (µg/L)	37.55	42.82	6.56	24	84.3	130[e]
Molybdenum (µg/L)	4.625	5.274	8.343	5.14	5.33	73
Nickel (µg/L)	0.182	0.48	0.45	0.42	0.31	150[b]
Selenium (µg/L)	0.148	0.304	0.293	0.3	0.4	1
Silver (µg/L)	0.0185	0.0016	0.001	5e-04	5e-04	0.25
Strontium (µg/L)	401.5	349.2	540	367	356	/
Thallium (µg/L)	8e-04	0.0025	8e-04	0.001	0.001	0.8
Thorium (µg/L)	0.005	0.012	0.002	0.012	0.004	/
Tin (µg/L)	0.04	0.02	0.02	0.03	0.03	/
Titanium (µg/L)	1.2	0.686	0.707	0.48	0.61	/
Uranium (µg/L)	0.456	0.442	0.755	0.419	0.498	15
Vanadium (µg/L)	0.827	0.89	1.03	0.873	0.924	100[c,d]
Zinc (µg/L)	1.06	1.56	3.47	1.7	08	30[f]

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on 2016 avg. water hardness (as CaCO3) with CCME equation

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

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

[e] Based on CCME Manganese variable calculation (https://ccme.ca/en/chemical/129#_aql_fresh_concentration) using 2016 avg. water hardness (as CaCO3) and avg. pH

[f] Based on 2016 avg. water hardness (as CaCO3), avg. pH, and avg. DOC with CCME equation

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 Wabamun Lake. In order to evaluate trends, years where the East Basin and West Basin were sampled separately have been combined to create a whole lake average. In years where parameters have been analyzed via two separate analytical methods (separate valid method variable codes), the average of those two tests was averaged to create a useable value. In sum, TP and chlorophyll-*a* were found to have a significant decreasing trend. TDS and Secchi depth had a significantly increasing trend. Secchi depth can be subjective and is sensitive to variation in weather; therefore, trend analysis must be interpreted with caution. Data is presented below 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 Wabamun Lake data from 1983 to 2024.

Parameter	Date Range	Direction of Significant Change
Total Phosphorus	1983-2024	Decreasing
Chlorophyll-*a*	1983-2024	Decreasing
Total Dissolved Solids	1983-2024	Increasing
Secchi Depth	1983-2024	Increasing

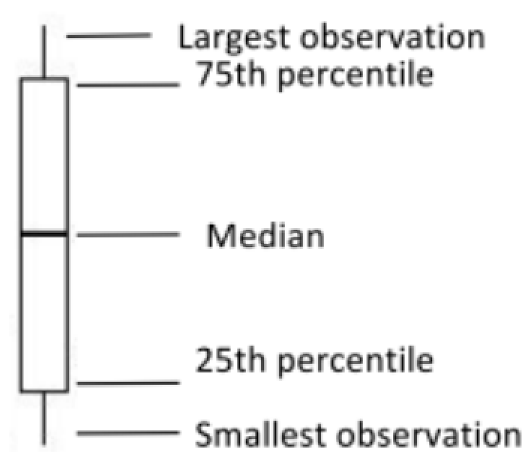
Definitions

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.

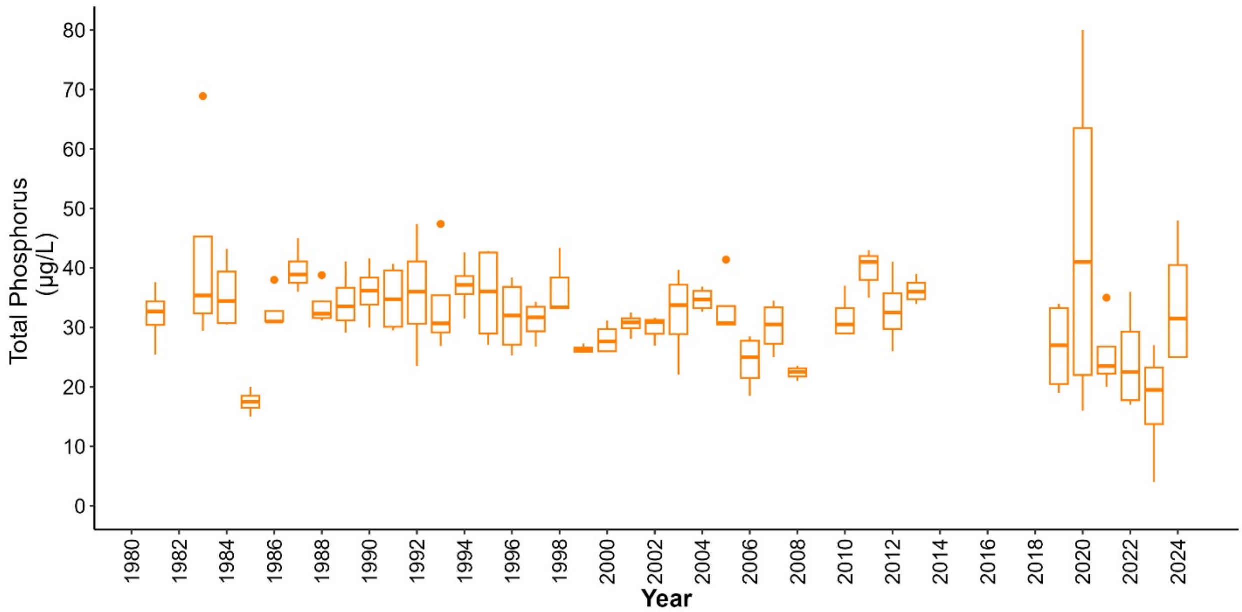
Statistically significant: The likelihood that a relationship between variables is caused by something other than random chance. This is indicated by a p-value of <0.05.
Variability: the extent by which data is inconsistent or scattered.



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)

Trend analysis of TP over time showed a significant decreasing trend in Wabamun Lake since 1983 (Tau = -0.177, p = 0.003).



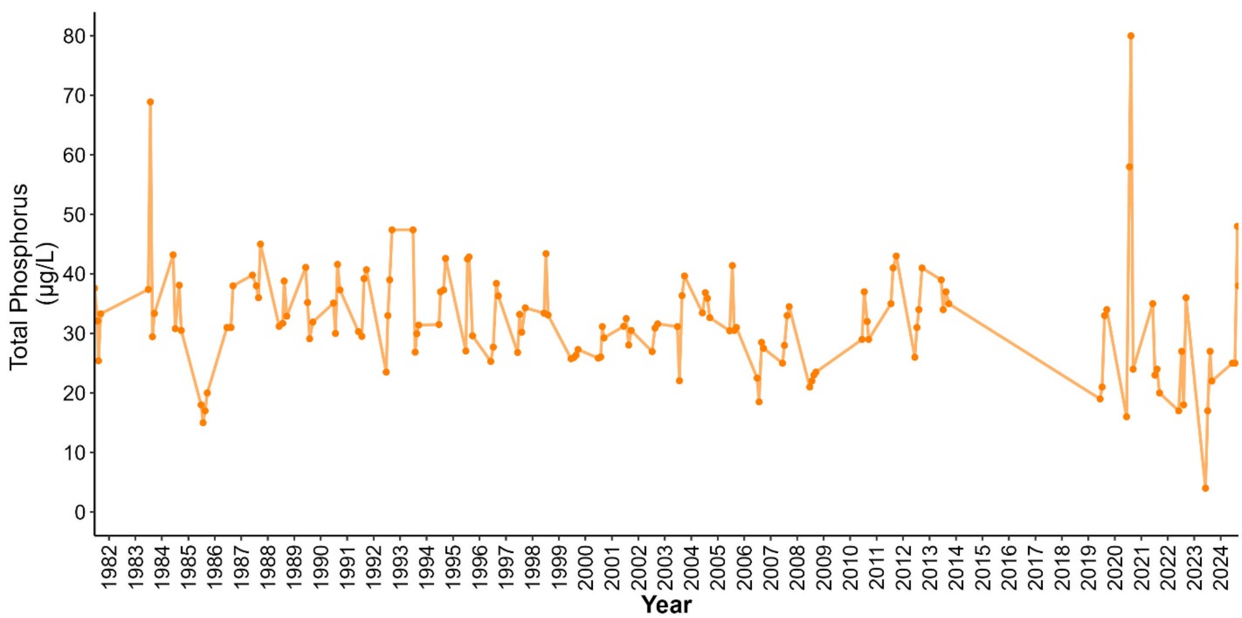
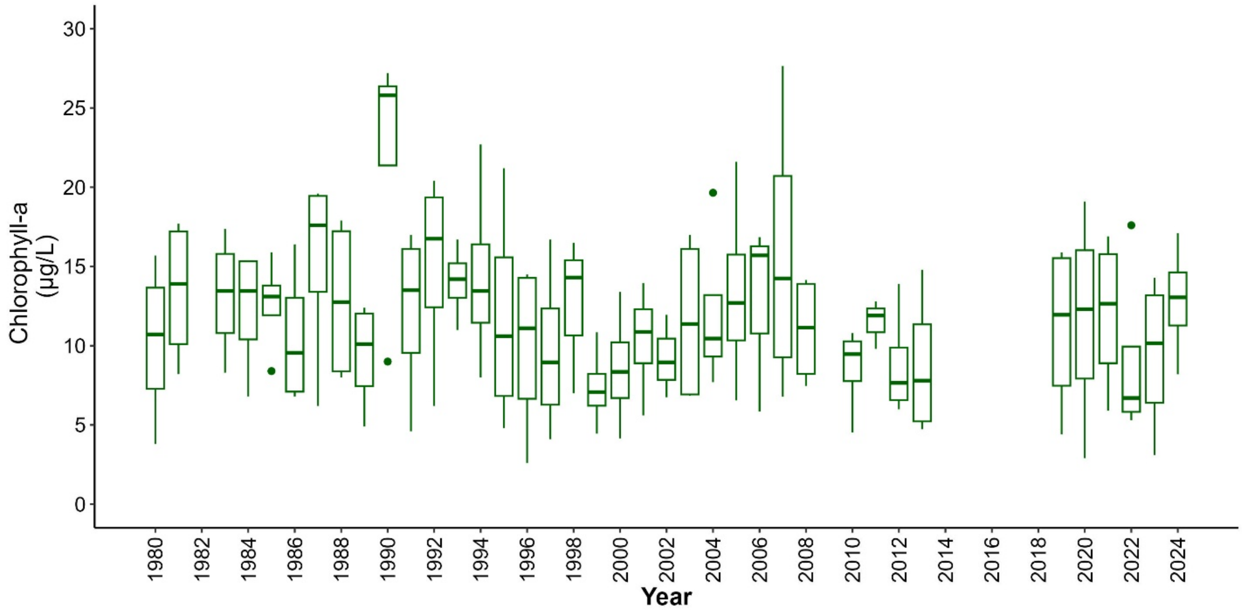


Figure 8. Monthly total phosphorus (TP) concentrations measured between June and September over the long term sampling dates between 1983 and 2024 (n = 110). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

Chlorophyll-*a*

Trend analysis of chlorophyll-*a* showed it has significantly decreased over time at Wabamun Lake from 1983 to 2024 (Tau = -0.148, p = 0.011).



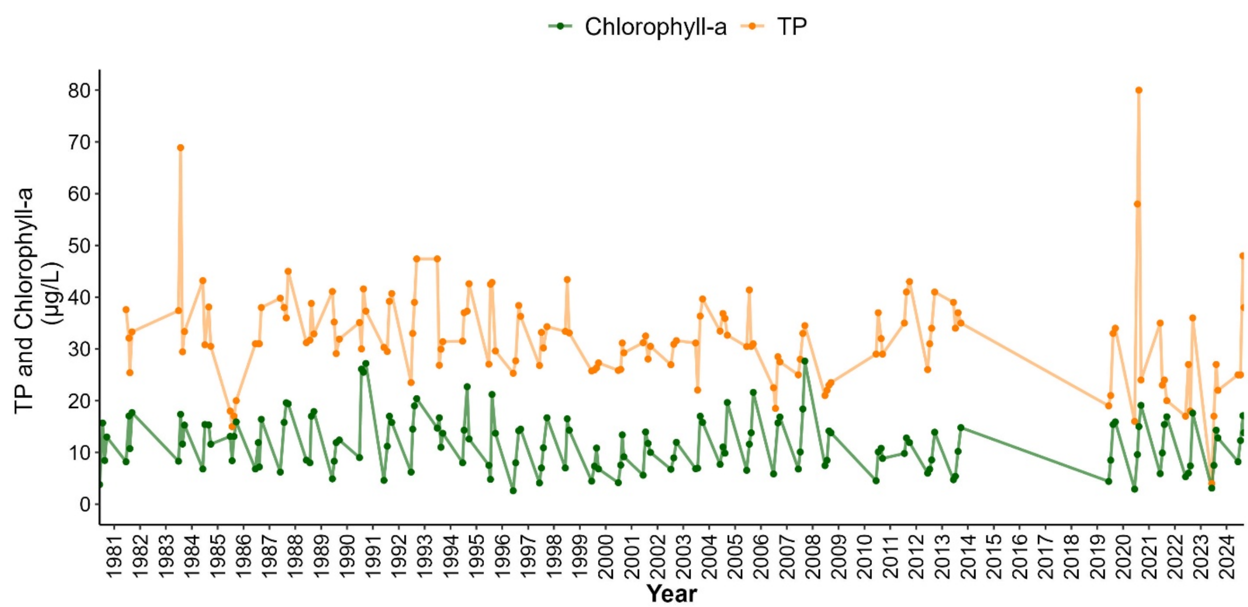
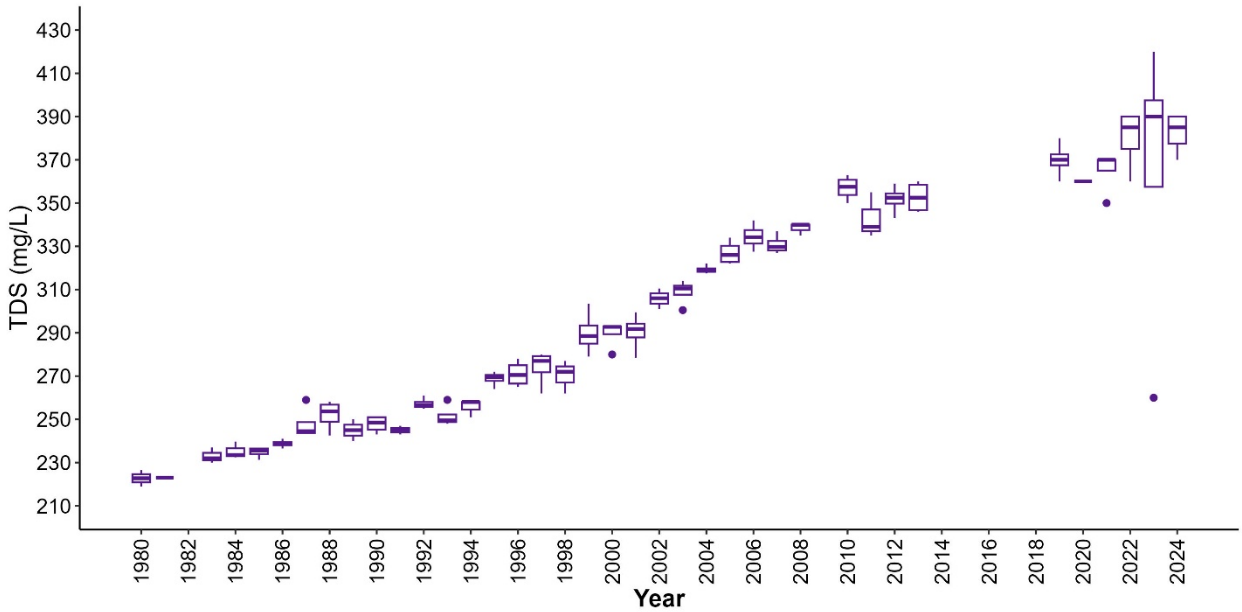


Figure 9. Monthly chlorophyll-*a* concentrations measured between June and September over the long term sampling dates between 1983 and 2024 (n = 110). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples. Line graph is overlain by TP concentrations.

Total Dissolved Solids (TDS)

Trend analysis showed a significant increasing trend in TDS in Wabamun Lake since 1983 (Tau = 0.907, $p < 0.001$).



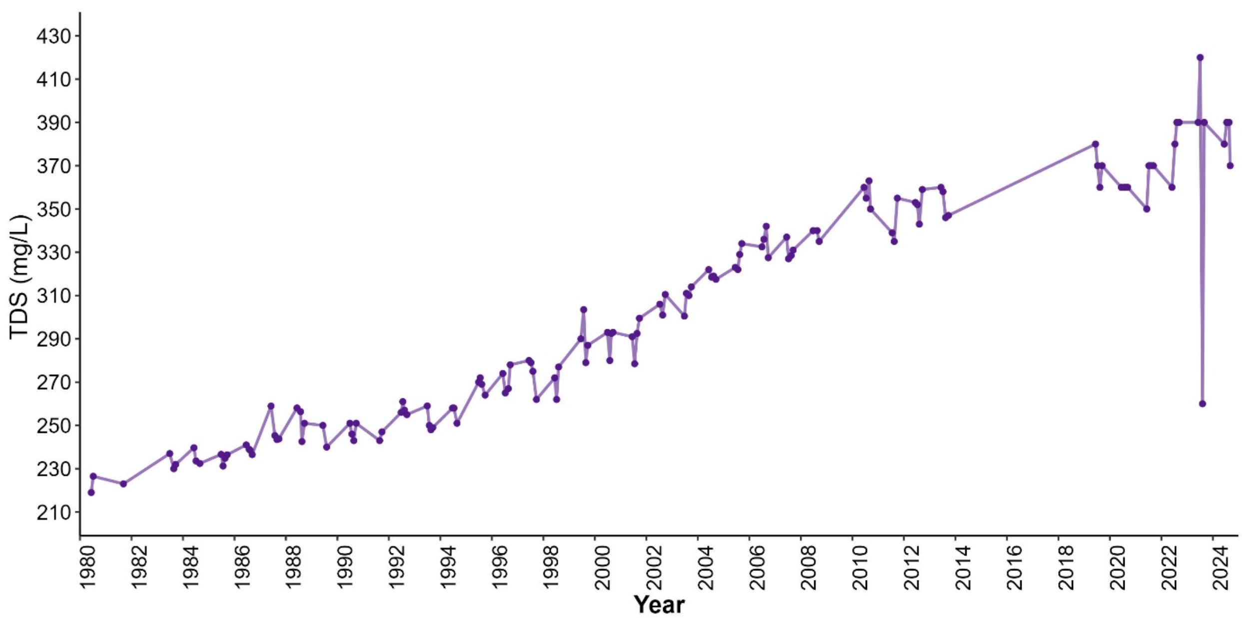


Figure 10. Monthly TDS values measured between June and September over the long term sampling dates between 1983 and 2024 (n = 92). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

Due to the significant increasing trend of TDS in Wabamun Lake, exploring the specific major ions which may be driving this trend is important to determine.

Trend analysis of major ions at Wabamun Lake indicates that sodium, potassium, chloride, and alkalinity are significantly increasing (Figure 11). Sodium and alkalinity (bicarbonate and carbonate) display the greatest magnitude of change over time, increasing at 0.24 mg/L and 0.48 mg/L per year, respectively. No trends were detected in calcium or sulphate. Magnesium had insufficient data for calculating a trend.

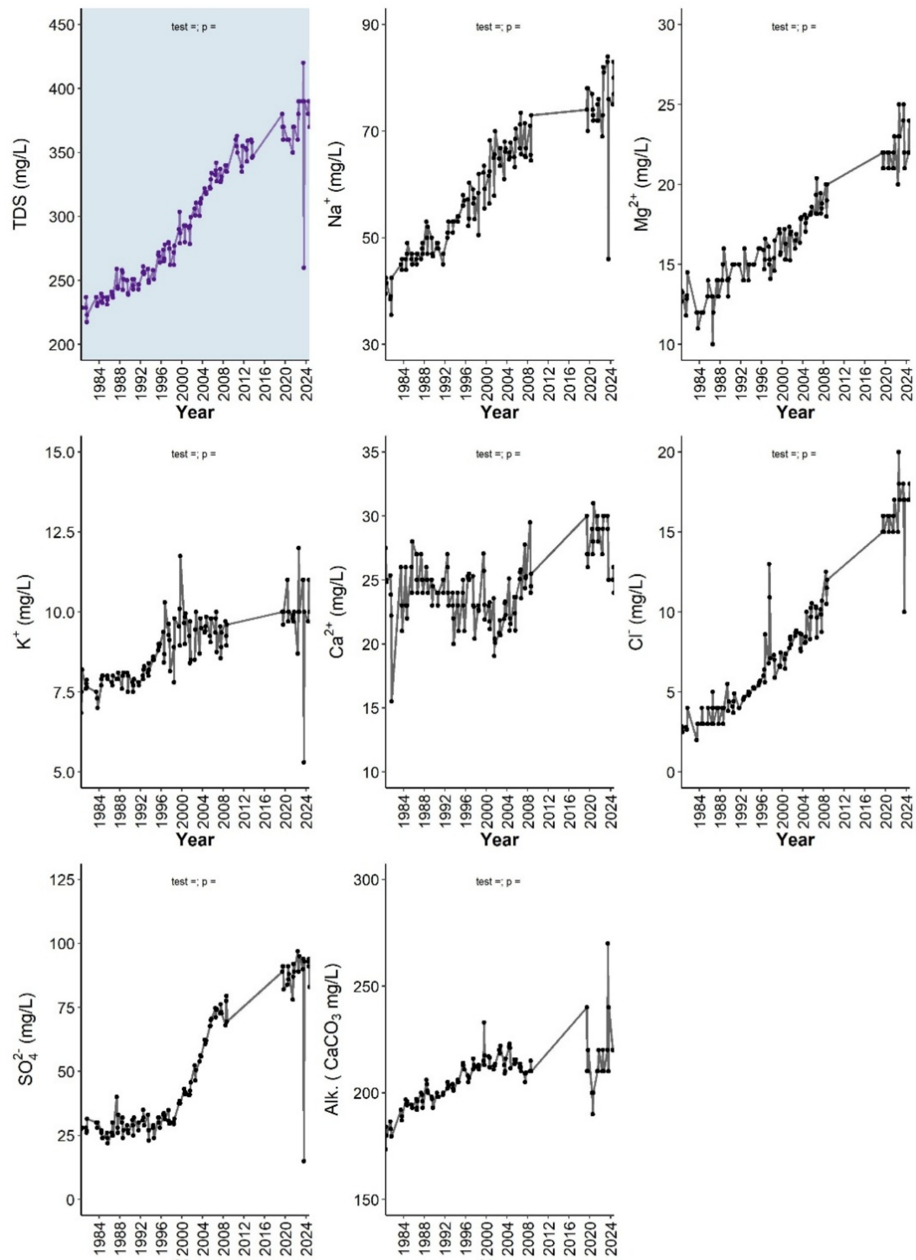
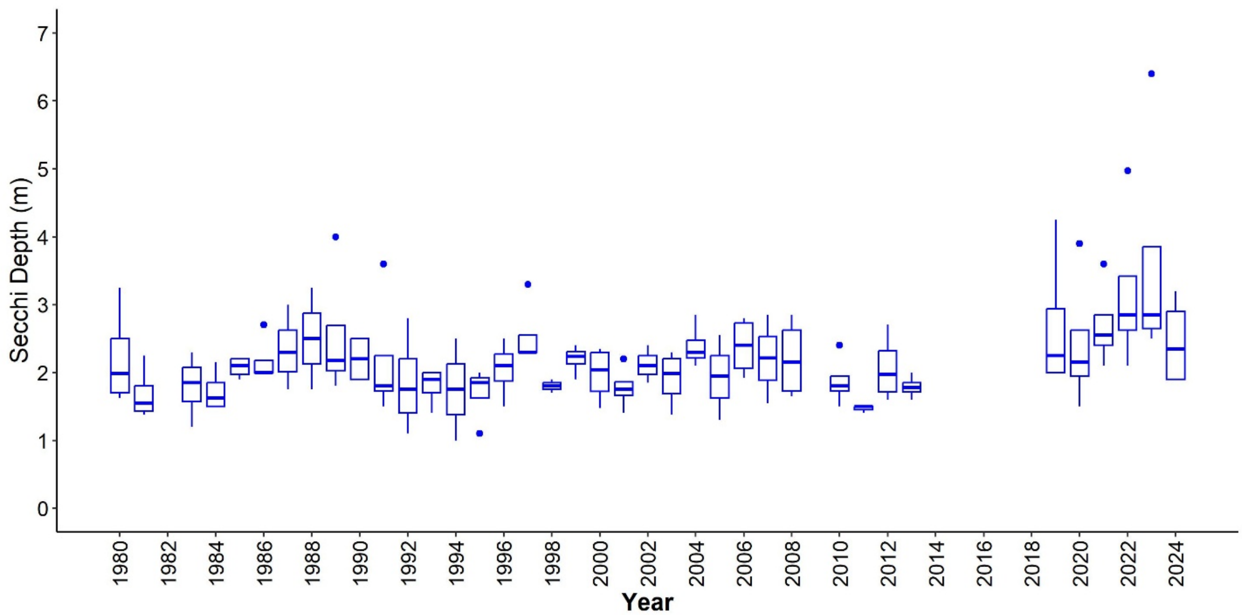


Figure 11. Concentrations of TDS (top left, blue panel), major ions (sodium = Na^{+}, magnesium = Mg^{2+}, potassium = K^{+}, calcium = Ca^{2+}, chloride = Cl^{-}, sulphate = SO_4^{2-}), and total alkalinity (Alk., as mg/L $CaCO_3$) measured monthly between June and September on sampling dates between 1983 and 2024. Also represented is the monotonic trend results for each parameter; test used (MK = Mann Kendall, SK = Seasonal Kendall), significance of test (p; assessed as significance when $p < 0.05$) and the slope of the trend. A p-value of 0* indicates an extremely low p-value. Test selection follows method outline in the ALMS Guide to Trend Analysis on Alberta Lakes. Note that some ions had insufficient data (I.D.) therefore trends were not calculated. 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 of Secchi depth over time showed that it has significantly increased (the lake has become more clear) in Wabamun Lake since 1983 (Tau = 0.199, $p < 0.001$).



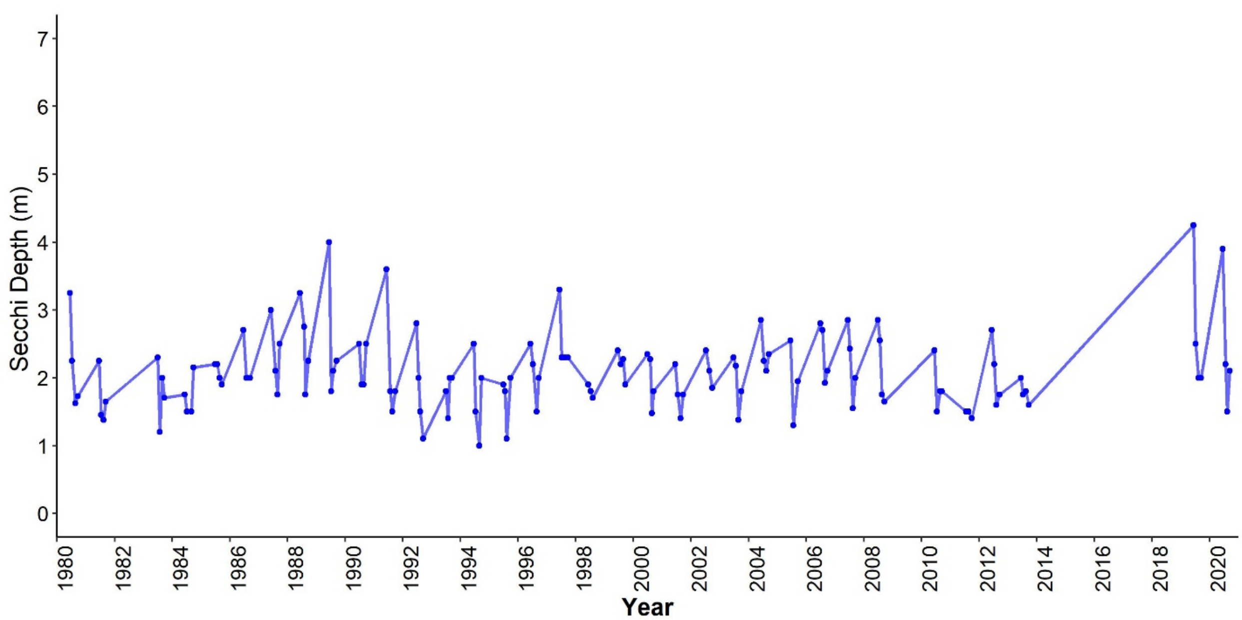


Figure 12. Monthly Secchi depth values measured between June and September over the long term sampling dates between 1983 and 2024 (n = 111). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

Table 5. Results of trend tests using total phosphorus, chlorophyll-*a*, total dissolved solids, and Secchi depth data from June to September for sampled years from 1983-2024 on Wabamun 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	-0.177	-0.148	0.907	0.199
The extent of the trend	Slope (units per Year)	-0.182	-0.06	4.07	0.010
The statistic used to find significance of the trend	Z	-3.005	-2.5497	15.07	3.508
Number of samples included	n	145	148	136	149
The significance of the trend	*p*	0.003*	0.011*	<0.001*	<0.001*

*$p < 0.05$ is significant within 95%