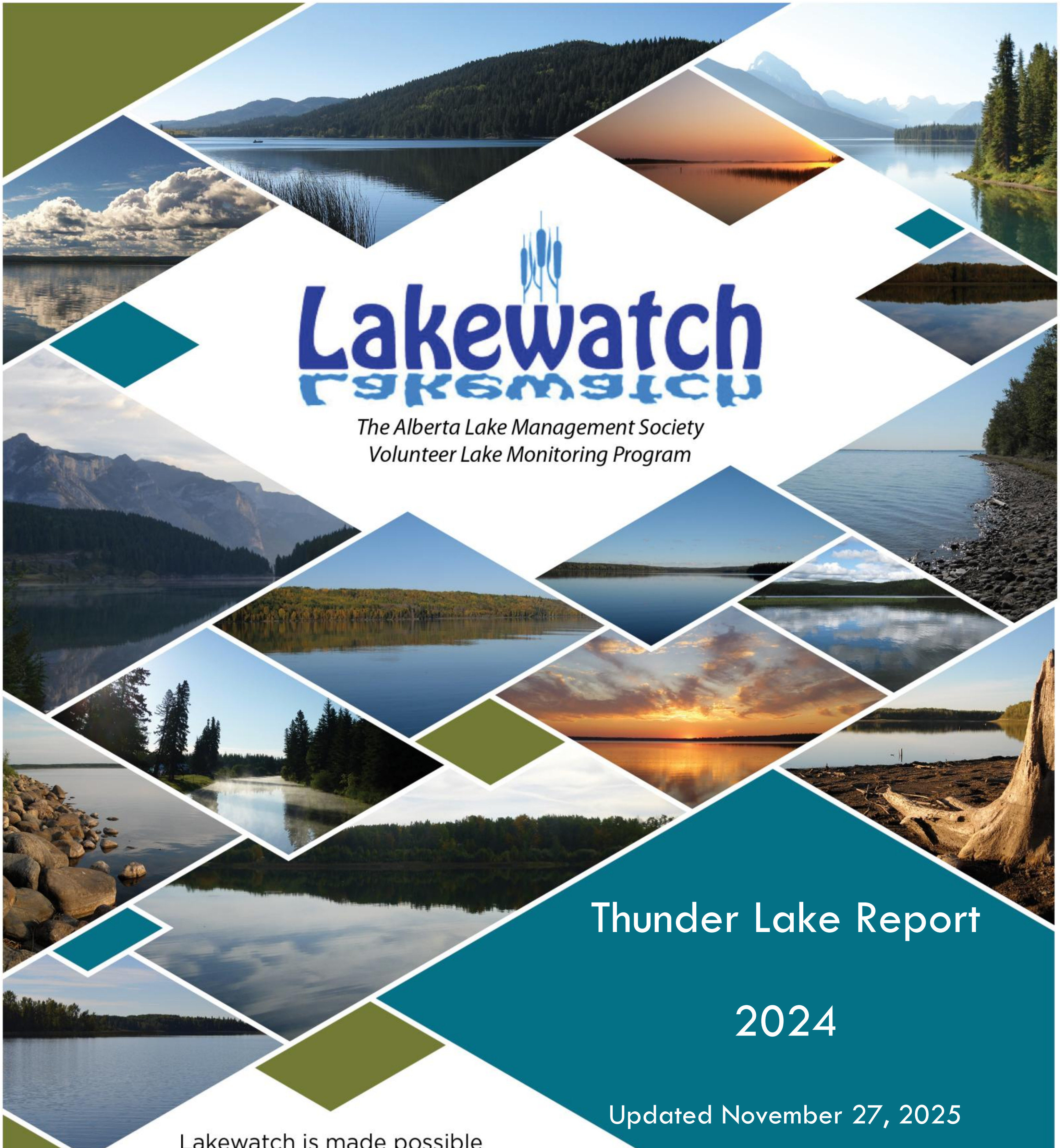


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Thunder 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.

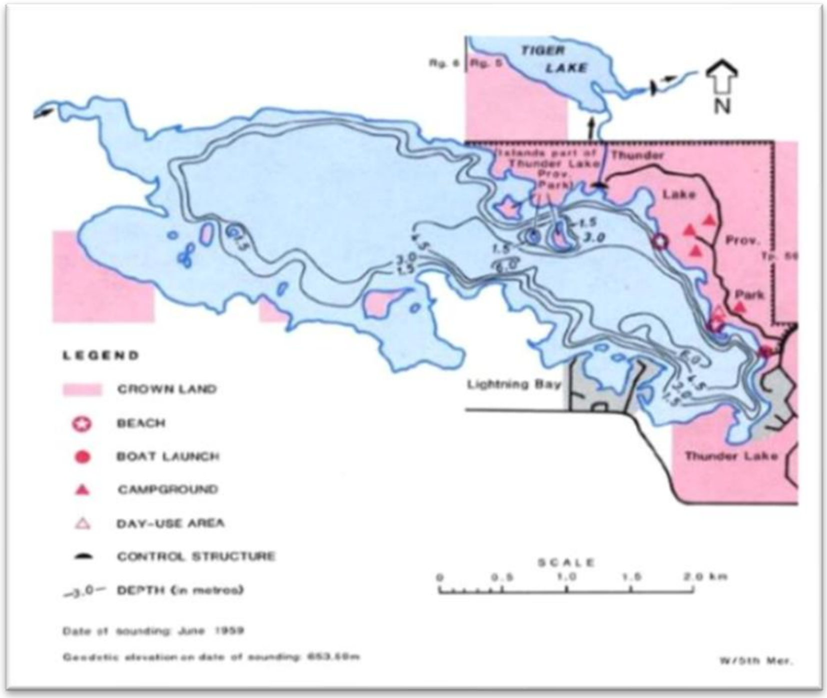
ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. A special thanks to the Zaminer family, particularly Michael & Walter, for their commitment to collecting data at Thunder 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**

THUNDER LAKE

Thunder Lake is an attractive recreational lake located in the County of Barrhead. It is situated approximately 22 km west of the Town of Barrhead and 130 km northwest of the City of Edmonton. The lake's name is rumoured to be a translation of an Indigenous saying that described the loud thundering sound made by the lake's ice cracking in winter.[1]



Bathymetric map of Thunder Lake obtained from the Atlas of Alberta Lakes.

Thunder Lake is a medium-sized water body, occupying an area of 7.03 km^2, with a maximum depth of 6.1 m and a mean depth of 3 m.[1] Thunder Lake is part of the Athabasca River watershed.[2] The watershed area is approximately 21 km^2, resulting in a watershed to lake ratio of 3:1.[1]

Thunder Lake lies within the Dry Mixedwood ecoregion of the Boreal Forest.[3] Most of the watershed is developed as agricultural land. There is minimal housing development on the lake shore, with the only communities located on arms in the southeast basin of the lake. Thunder Lake Provincial Park is on the east side of the lake. Cropland is located directly adjacent to the shoreline along the north of the lake.

Algae regularly turn the water in Thunder Lake green during summer. During winter, levels of dissolved oxygen frequently become critical for the fish population, and winterkills have occurred several times since the late 1960s.[1] The lake has been stocked with northern pike and yellow perch, and the presence of these species historically provide a popular sport fishery.

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[1] Mitchell, P. and E. Prepas. 1990. Atlas of Alberta Lakes.
[2] Athabasca Watershed Council. 2025. The Athabasca Watershed.
[3] Strong, W.L. and K.R. Leggat. 1981. Ecoregions of Alberta.

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 Thunder Lake was 59 µg/L (Table 2), falling into the category of eutrophic, or highly productive trophic classification. Detected TP was fairly consistent throughout the season, ranging from a minimum of 47 µg/L on July 15 to a maximum of 67 µg/L on September 16 (Figure 1).

Average chlorophyll-*a* concentration in 2024 was 49.9 µg/L (Table 2), falling into the hypereutrophic, or very high productivity trophic classification. Chlorophyll-*a* increased as the season went on, ranging from 20.3 µg/L on June 20 and peaking at 81 µg/L on September 16 (Figure 1).

The average Total Kjeldahl Nitrogen (TKN) concentration in 2024 was 2.1 mg/L (Table 2) with the highest concentration observed on August 12 at 2.6 mg/L (Figure 1).

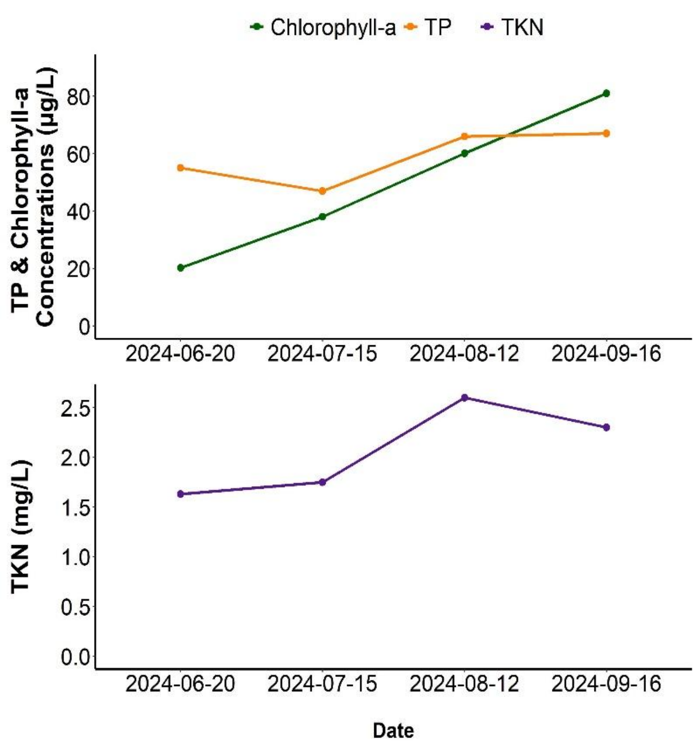

Figure 1. Total Phosphorus (TP), Chlorophyll-*a*, and Total Kjeldahl Nitrogen concentrations measured over the course of the summer at Thunder Lake in 2024.

Average pH was measured as 8.69 in 2024, buffered by moderate alkalinity (262 mg/L $CaCO_3$) and bicarbonate (290 mg/L HCO_3). Aside from bicarbonate, sodium, magnesium, and potassium were higher than the other major ions, contributing to a moderate conductivity of 502 µS/cm (Figure 2, top; Table 2). Thunder Lake is in the middle of the range of ion levels when compared to other LakeWatch lakes sampled in 2024 (Figure 2, bottom).

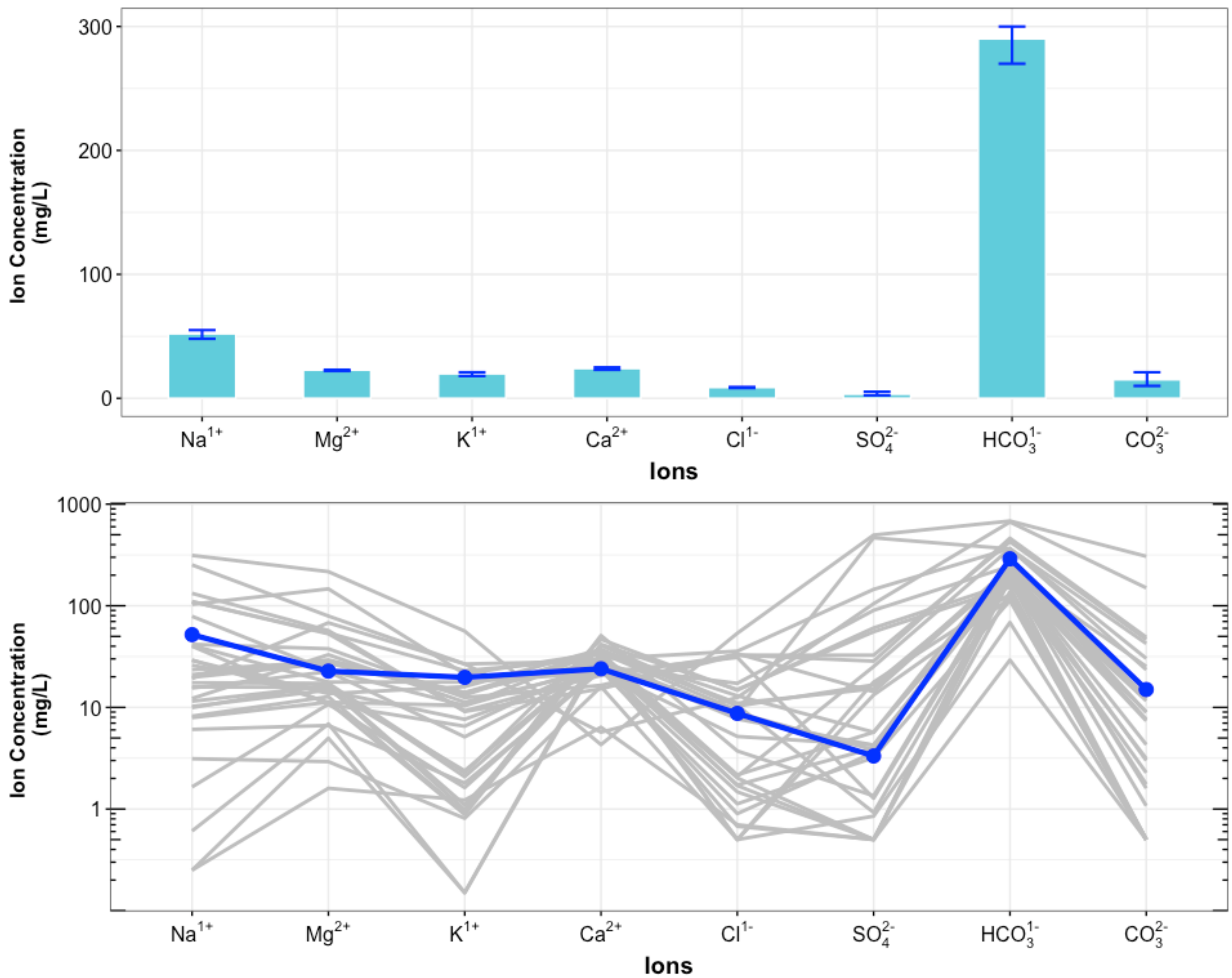

Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from 4 measurements over the course of the summer at Thunder Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Thunder 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).

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 Thunder Lake in 2024 was 1.3 m, corresponding to an average Secchi depth of 0.65 m (Table 2). Euphotic depth showed little variation over the season, fluctuating by about 0.5 m throughout the summer (Figure 3). Euphotic depth was likely influenced by algal growth later in the summer during the August and September sampling trips, as TP and chlorophyll-*a* both increased during these months (Figure 1), indicating that algae and cyanobacteria abundance was responsible for the changes in water clarity through the summer.

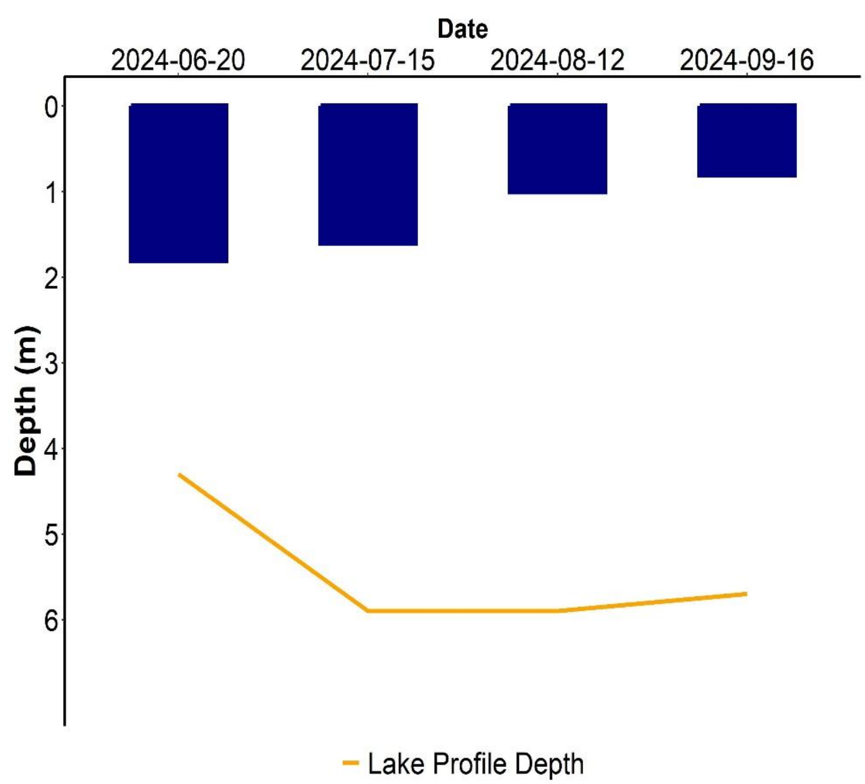

Figure 3. Euphotic depth values measured over the course of the summer at Thunder Lake in 2024.

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 Half Moon Lake varied throughout the summer. July and August were warmer than June and September sampling, with the July 15 sampling event having the warmest temperatures at 22.59 °C (Figure 4). The lake did not experience thermal stratification throughout the summer, and remained mixed during all sampling trips.

Thunder Lake was well oxygenated in the surface waters during all sampling events, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen[5] (Figure 4). Dissolved oxygen levels fell to anoxia (<1.0 mg/L) during the July and August sampling events, with anoxic levels being recorded at about 4.5 m (Figure 4).

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

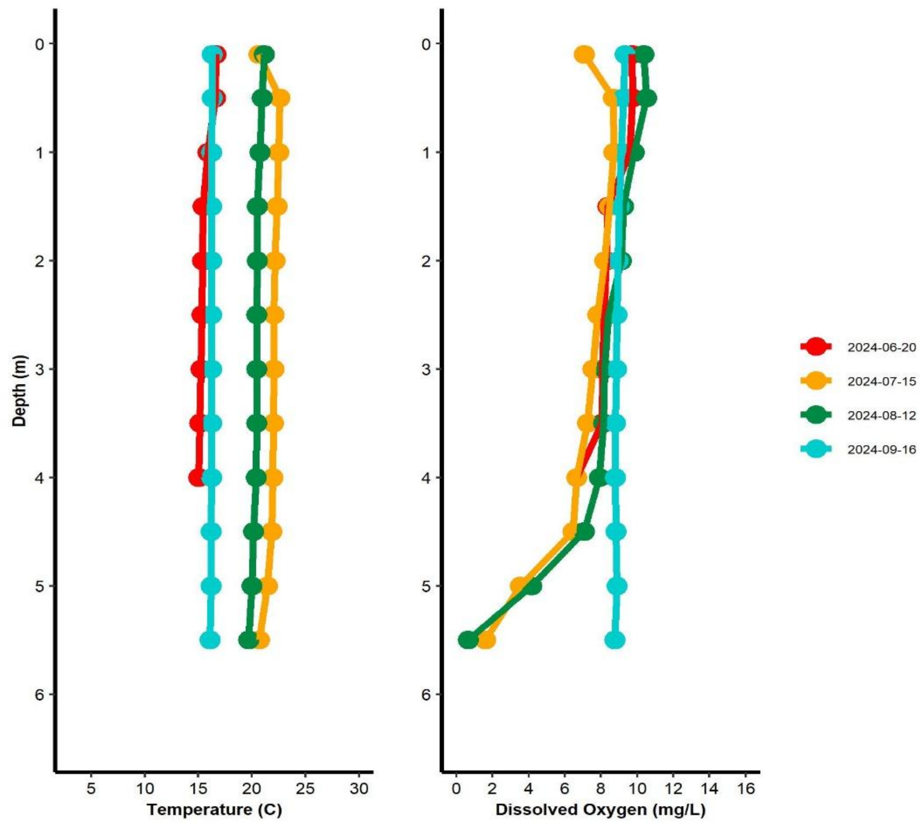


Figure 4. Temperature (°C) and dissolved oxygen (mg/L) profiles for Thunder Lake measured over the course of the summer of 2024. Note: June profiles are only recorded to 4 m due to technicians not locating the deep spot on the lake.

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 Thunder Lake fell below the recreational guideline of 10 µg/L[5] during every sampling event in 2024. However, levels throughout the summer are elevated compared to many lakes and suggest that areas of the lake may contain microcystin levels which could be harmful to human health. Recreating in or near cyanobacteria blooms should be avoided.

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

Date	Microcystin Concentration (µg/L)
06/20/2024	5.39
07/15/2024	7.36
08/12/2024	6.95
09/16/2024	6.02
Average	**6.43**

[5] 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 at Thunder 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 Thunder Lake on June 20. The specimen was confirmed to be Northern Watermilfoil (*Myriophyllum sibiricum*).

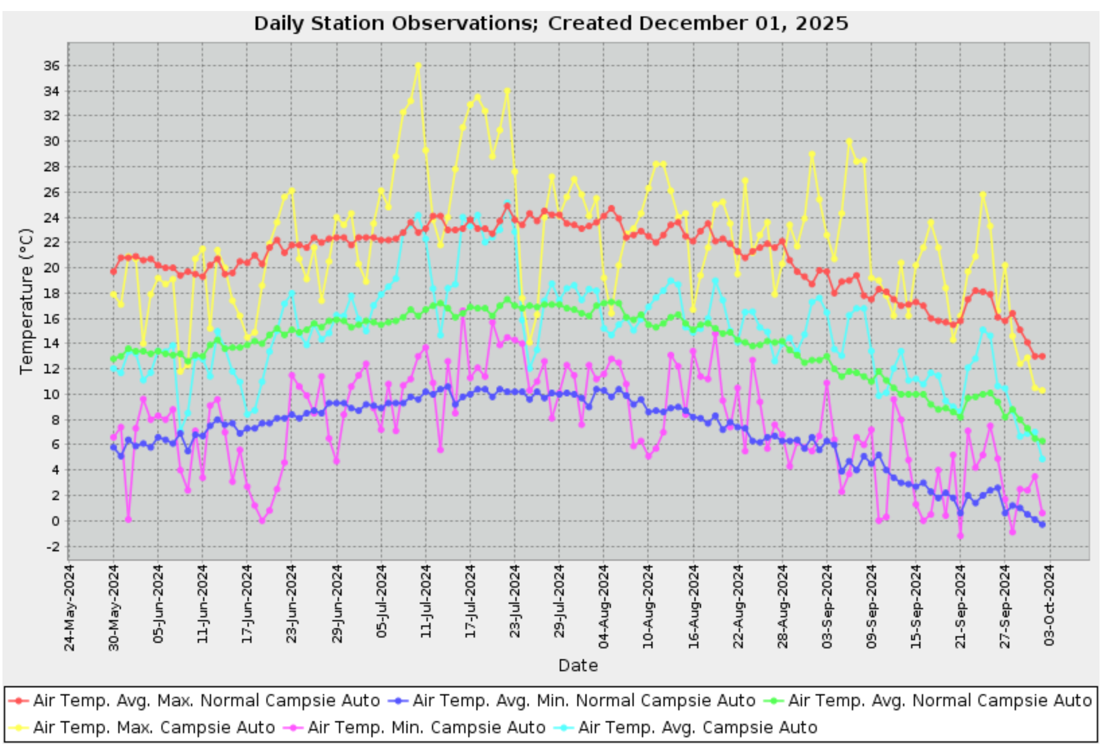
WEATHER AND LAKE STRATIFICATION

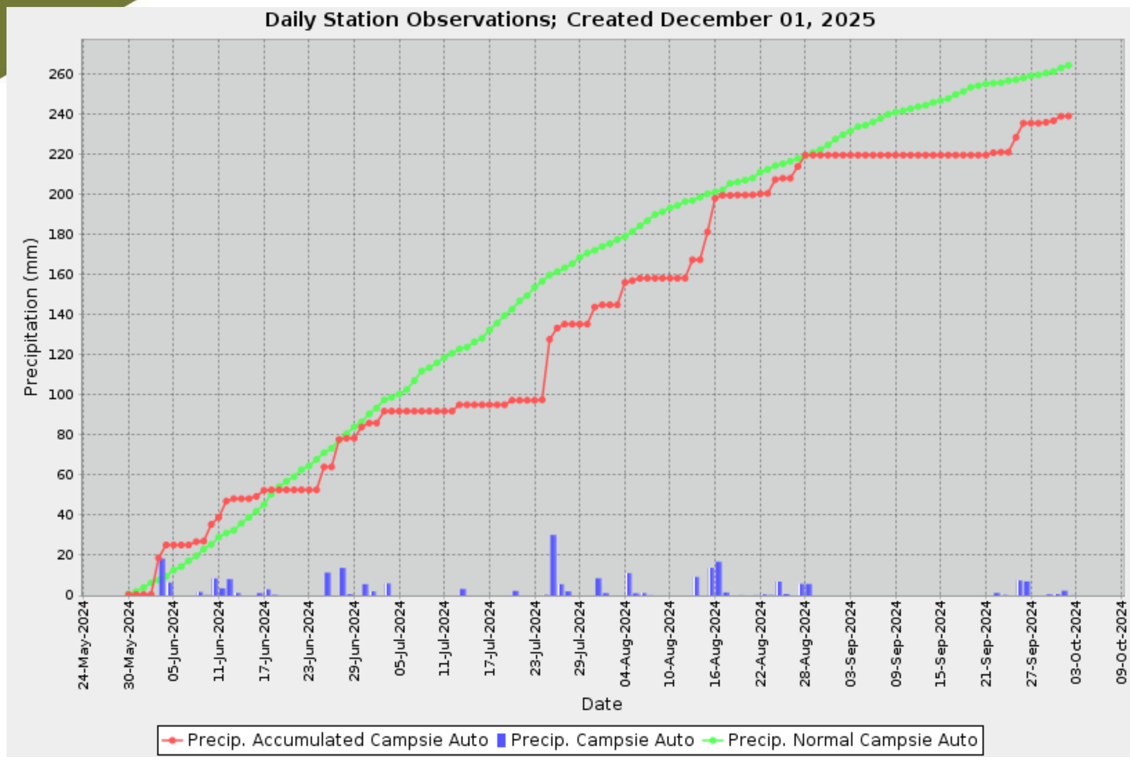
Air temperature will directly impact lake temperatures, and result in different temperature layers (stratification) throughout the lake, depending on its depth. Wind will also impact the degree to which a lake mixes, and how it will stratify. The amount of precipitation that falls within a lake's watershed 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, Thunder 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 cool, with the month of June falling below average temperatures, with the average temperature being 13.05°C. July was the warmest month, with the average temperature being 19.45°C. 2024 also broke heat records on numerous days in July and September, including the hottest day recorded on July 10 at 36°C. August and September were warmer than average months, with the average temperature being 16°C and 12.3°C, respectfully.

Thunder Lake received less precipitation than it normally receives throughout the summer months. The actual precipitation in 2024 was 238 mm total, versus a normal amount of 260 mm (Figure 5).

Strong winds were also observed throughout the sampling season.





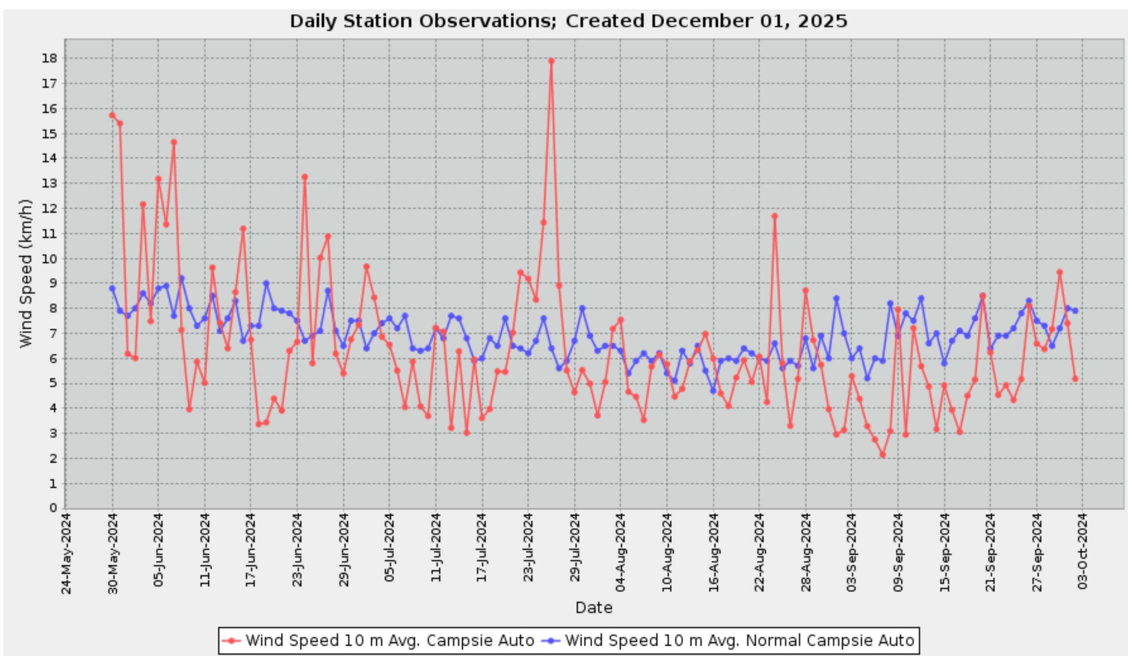


Figure 5. Air temperature (°C), wind speed (km/h), and precipitation (mm) measured from Campsie Auto weather station west of Thunder Lake. Weather data provided by Agriculture, Forestry and Rural Economic Development, Alberta Climate Information Service (ACIS) https://acis.alberta.ca.

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 Thunder Lake fell in the mid-range of the historical record in 2024 (approximately 653.9 masl; Figure 6). Although levels were within the mid-range, levels in 2024 were lower than has been observed at Thunder Lake in nearly a decade (summer 2015 at 653.8 masl; Figure 6).

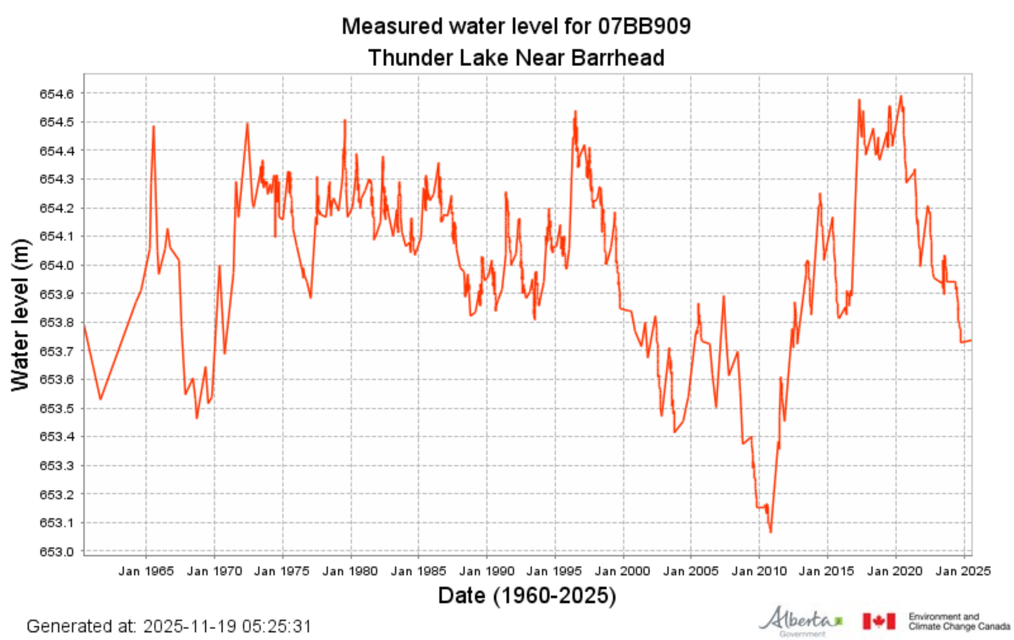


Figure 6. Water levels measured at Thunder Lake in metres above sea level (masl) from 1960-2025. Obtained from Environment Canada and Alberta Environment and Parks Real-Time Hydrometric Data (https://wateroffice.ec.gc.ca/).

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

Parameter	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
TP (µg/L)	41	48	27	35	38	49	67	70	91	122	138
TDP (µg/L)	-	-	-	-	-	-	-	-	-	28	32
Chlorophyll-a (µg/L)	13.6	19.7	12.0	8.2	9.2	17.1	23.9	29.1	40.4	62.7	70.7
Secchi depth (m)	1.54	1.32	1.96	2.21	2.31	2.46	1.76	1.87	1.62	0.92	0.72
TKN (mg/L)	-	-	1.7	-	-	-	-	-	-	2.5	3
NO_2-N and NO_3-N (µg/L)	25	25	107	25	10	10	8	37	5	10	2
NH_3-N (µg/L)	-	-	-	-	-	-	-	-	-	-	-
DOC (mg/L)	-	-	-	-	-	-	-	-	-	28	31
Ca^{2+} (mg/L)	28	26	25	25	24	25	22	19	21	20	22
Mg^{2+}(mg/L)	16	18	20	18	17	20	19	21	20	20	20
Na^+ (mg/L)	38	40	41	38	38	44	45	46	42	47	49
K^+ (mg/L)	10	11	12	11	11	12	12	12	12	14	13
SO_4^{2-} (mg/L)	4	7	5	8	6	4	4	4	2	2	3
Cl^- (mg/L)	2	1	2	1	2	2	2	2	2	3	3
CO~$_3^{2-}$ (mg/L)	-	-	-	-	-	-	-	-	-	-	-
HCO_3^{2-} (mg/L)	-	-	-	-	-	-	-	-	-	-	-
pH	8.50	8.40	8.40	8.55	8.60	8.47	8.73	8.79	9.00	8.75	8.86
Conductivity (µS/cm)	437	443	444	408	414	442	434	433	420	444	460
Hardness (mg/L)	136	140	142	134	132	144	132	135	136	134	140
TDS (mg/L)	238	248	246	231	232	252	244	246	238	250	262
Microcystin (µg/L)	-	-	-	-	-	-	-	-	-	-	-
Total Alkalinity (mg/L CaCO3)	229	239	234	216	221	239	234	235	230	239	252

Parameter	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2002**	**2007**	**2009**	**2019**	**2024**
TP (µg/L)	79	44	46	96	56	25	48	34	233	112	45	59
TDP (µg/L)	28	-	-	-	-	-	-	-	24	45	7	8
Chlorophyll-a (µg/L)	40.6	12.3	16.6	72.8	32.5	3.5	9.2	6.4	73.2	39.9	41.6	49.9
Secchi depth (m)	1.12	1.70	2.15	1.25	0.82	3.50	1.65	2.75	0.83	0.65	0.90	0.65
TKN (mg/L)	2.7	-	-	-	-	-	-	-	3.1	3.7	2	2.1
NO_2-N and NO_3-N (µg/L)	6	7	-	-	-	-	50	3	5	18	7	3
NH_3-N (µg/L)	-	-	-	-	-	-	-	-	-	-	22	22
DOC (mg/L)	35	-	-	-	-	-	-	-	-	39	27	24
Ca^{2+} (mg/L)	22	25	27	28	23	27	22	18	23	-	28	24
Mg^{2+}(mg/L)	21	21	20	19	20	18	20	21	23	-	19	23
Na^{+} (mg/L)	47	48	46	42	44	47	52	57	57	68	45	52
K^{+} (mg/L)	14	15	15	13	14	15	14	18	18	20	17	20
SO_4^{2-} (mg/L)	2	2	3	4	3	6	8	6	7	13	5	3
Cl^{-} (mg/L)	3	3	3	3	3	4	3	2	5	6	8	9
$CO{\sim}_3^{2-}$ (mg/L)	-	-	-	12.6	16.1	0.2	2.5	16	17	34	6.6	15
HCO_3^{2-} (mg/L)	-	-	-	260.33	244	300	286	276	306	296	282.5	290
pH	8.70	8.68	8.31	8.63	8.62	8.27	8.40	8.60	8.70	9.11	8.55	8.69
Conductivity (µS/cm)	456	473	458	429	425	433	476	470	517	525	472	502
Hardness (mg/L)	140	149	149	-	-	-	-	-	-	-	150	155
TDS (mg/L)	258	270	-	251	244	264	264	274	300	329	272	292
Microcystin (µg/L)	-	-	-	-	-	-	-	-	7.86	7	2.54	6.43
Total Alkalinity (mg/L CaCO3)	247	260	241	234	226	246	242	252	279	299	242	262

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 Thunder. In sum, significant increasing trends were detected in total phosphorus, chlorophyll-a, and total dissolved solids. A significant decreasing trend was detected in Secchi disc depth. Large data gaps in Thunder Lake may influence the trend analysis, and results should 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 Thunder Lake data from 1983 to 2024.

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

Definitions

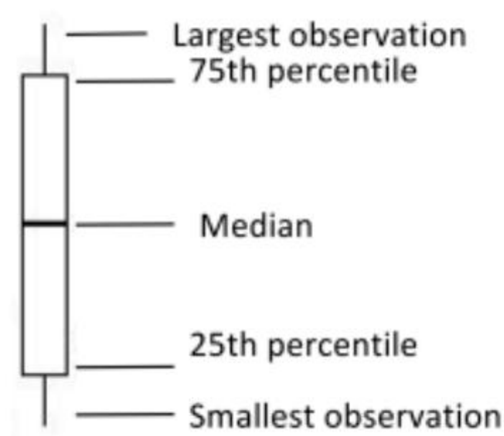
Median: the value in a range of ordered numbers that falls in the middle.

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.



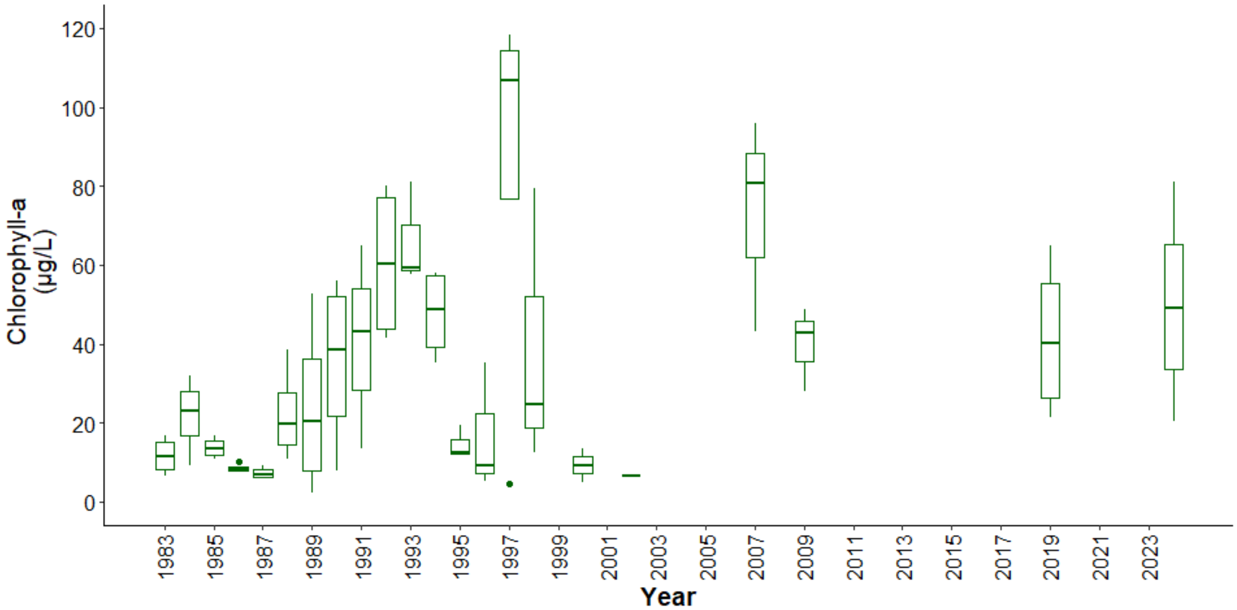
Total Phosphorus (TP)

Trend analysis of TP showed a significantly increasing trend in Thunder since 1983 (Tau = 0.2711, $p = 0.0032$).

Figure 7. Monthly total phosphorus (TP) concentrations measured between June and September over the long term sampling dates between 1983 and 2024 (n = 73). 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 a significantly increasing trend at Thunder Lake (Tau = 0.3293, $p < 0.001$).



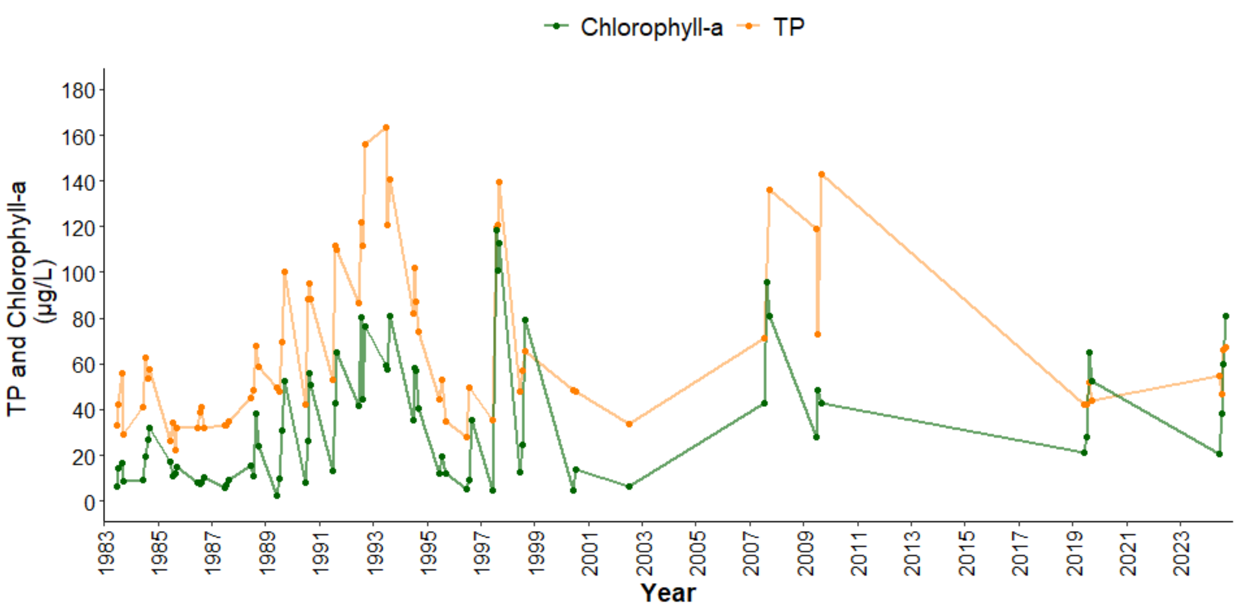


Figure 8. Monthly chlorophyll-*a* concentrations measured between June and September over the long term sampling dates between 1983 and 2024 (n = 75). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples. Line graph is overlain by TP concentrations.

Total Dissolved Solids (TDS)

Trend analysis showed a significantly increasing trend in TDS in Thunder Lake since 1983 (Tau = 0.7224, $p < 0.001$).

Figure 9. Monthly TDS values measured between June and September over the long term sampling dates between 1983 and 2024 (n = 50). 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 Thunder Lake, exploring the specific major ions which may be driving this trend is important to determine.

Trend analysis of major ions at Thunder Lake indicates that sodium, magnesium, potassium, chloride, and alkalinity ($CaCO_3$) are significantly increasing (Figure 10). No trends were detected in calcium or sulphate. These broad changes to the ion composition of Thunder Lake may be driven by hydrological processes, such as evaporative loss.

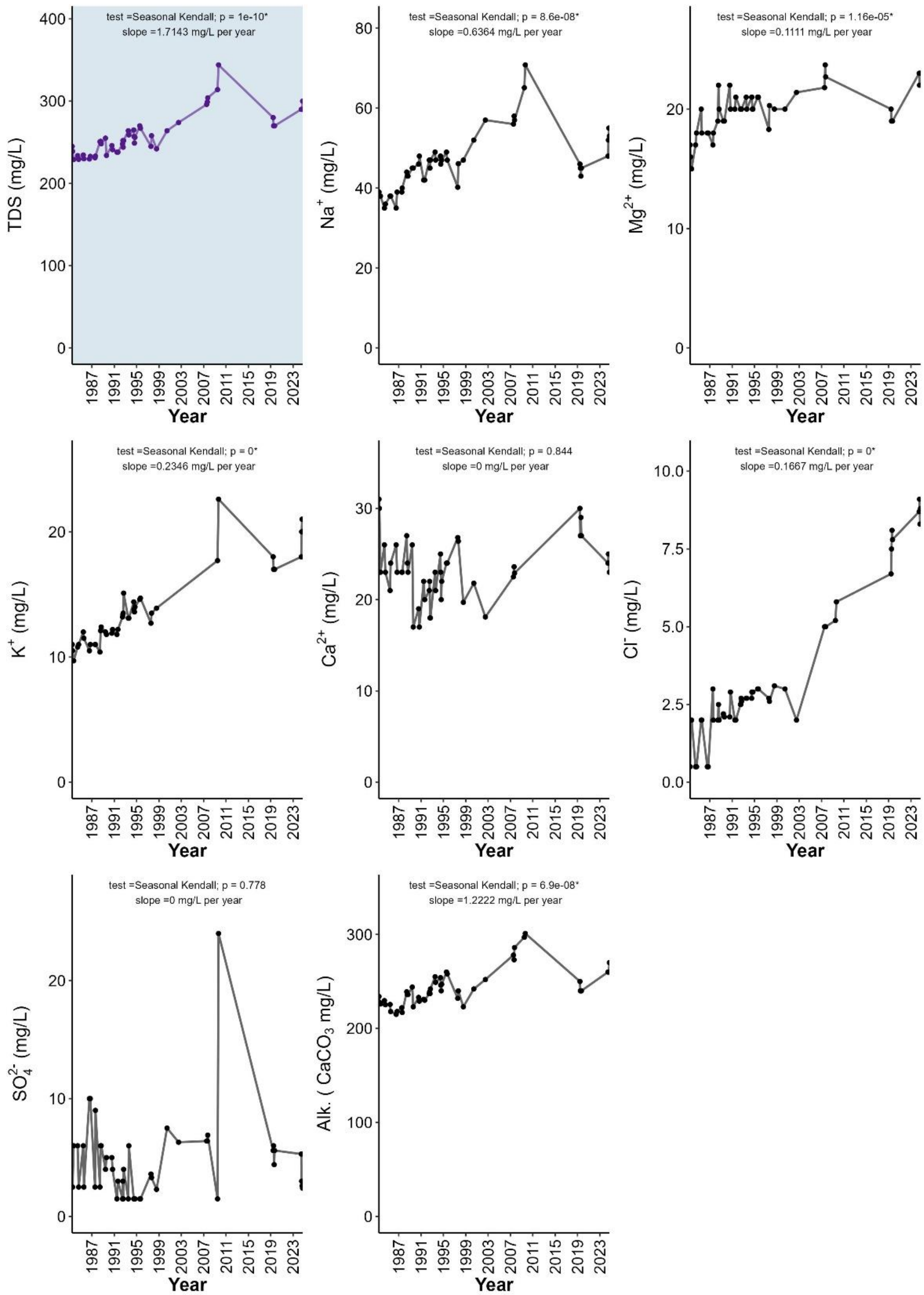


Figure 10. Concentrations of TDS (top left, blue panel), major ions (sodium = Na^+, magnesium = Mg^{2+}, potassium = K^+, calcium = Ca^{2+}, chloride = Cl^-, sulphate = SO_4^{2-}), and total alkalinity (Alk., as mg/L $CaCO_3$) measured monthly between June and September on sampling dates between 1983 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 $p < 0.05$, marked with '*' if significant), and the slope of the trend. P values recorded as 0* indicate extremely low p-values. 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 decreased (the lake has become less clear) in Thunder Lake since 1983 (Tau = -0.4018, $p < 0.001$).

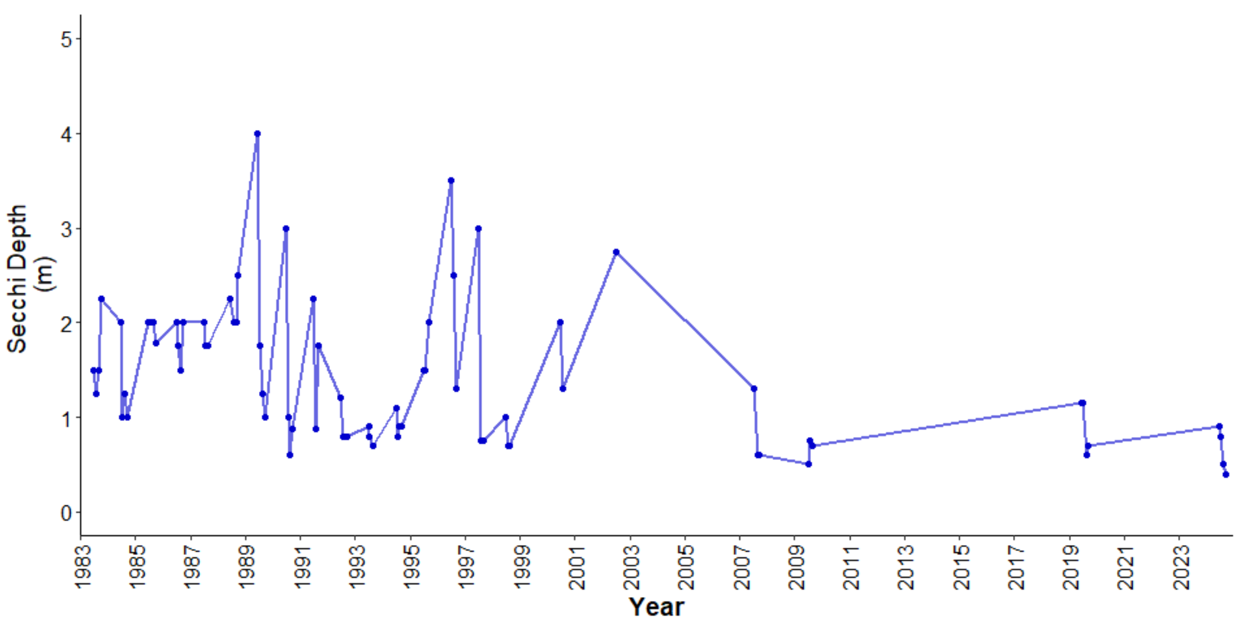


Figure 11. Monthly Secchi depth values measured between June and September over the long term sampling dates between 1983 and 2024 (n = 75). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

Table 5. Results of trend tests using total phosphorus (TP), chlorophyll-*a*, total dissolved solids (TDS), and Secchi depth data from June to September for sampled years from 1983-2024 on Thunder 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	0.2711	0.3293	0.7224	-0.4018
The extent of the trend	Slope (units per Year)	0.9258	0.8026	1.7143	-0.025
The statistic used to find significance of the trend	Z	2.9504	3.6588	6.5035	-4.5205
Number of samples included	n	73	75	50	75
The significance of the trend	*p*	0.0032*	< 0.001*	< 0.001*	< 0.001*

*$p < 0.05$ is significant within 95%