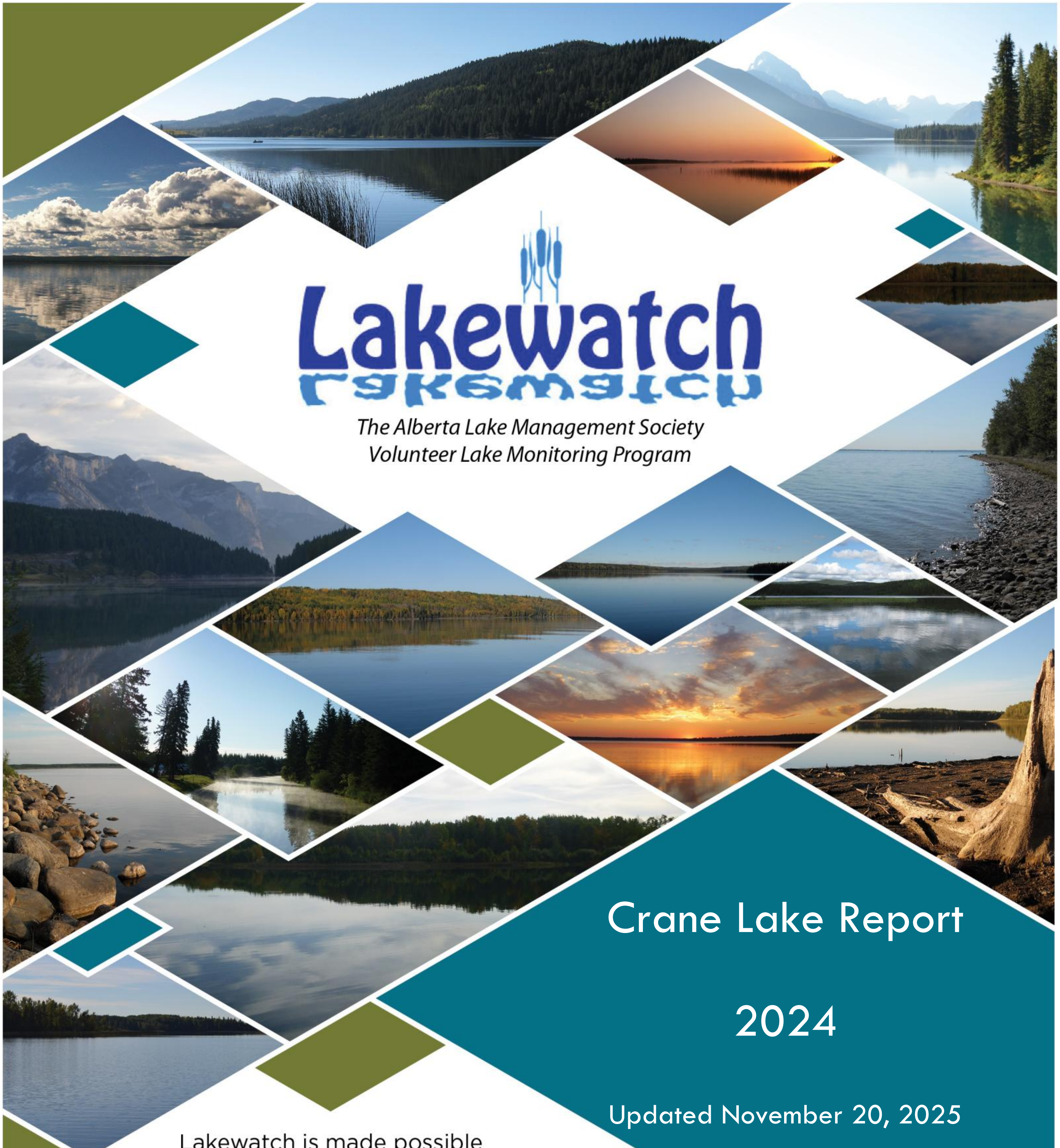

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Crane Lake Report

2024

Updated November 20, 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 Ron Young for their commitment to collecting data at Crane 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**

CRANE LAKE

Crane Lake was originally named Moore Lake, after Dr. Bromley Moore, a former president of the College of Physicians and Surgeons and a friend of the surveyor Marshall Hopkins.[1] Moore Lake is locally referred to as Crane Lake.

Sampling at Crane Lake, August 2024.

Crane Lake is a medium-sized, deep water body located in the Beaver River Watershed, and is about 280 km northeast of Edmonton in the Municipal District of Bonnyville. It has a surface area of 9.28 km^2 with a maximum depth of 26 m in the eastern area of the lake, and an average depth of 8.3 m overall.[2] Crane Lake lies within the central mixedwood subregion of the boreal forest natural region.[3] Most of the shoreline is forested Crown Land. Two former Provincial Areas, Crane Lake East and West, have been disestablished and divested to the Municipal District of Bonnyville. Lakefront property and two commercial resorts occupy the south end of the lake.

Crane Lake has a small drainage basin that is only four times the size of the lake (approximately 40 km^2 to 10 km^2, respectfully). Lakes with smaller drainage basins may be more sensitive to climate variations as there is less area surrounding the lake to drain into it, and a larger area susceptible to water evaporation.[2] Surface water flows to the lake via two minor streams: one on the northeast shore and one on the west shore. An outlet flows from the east shore into nearby Hilda and Ethel Lakes and eventually into the Beaver River, where the water flows to the Athabasca River. Although Crane Lake has a small drainage basin, lake levels have been relatively stable. Groundwater likely plays an important role in maintaining the water level at Crane Lake.[2]

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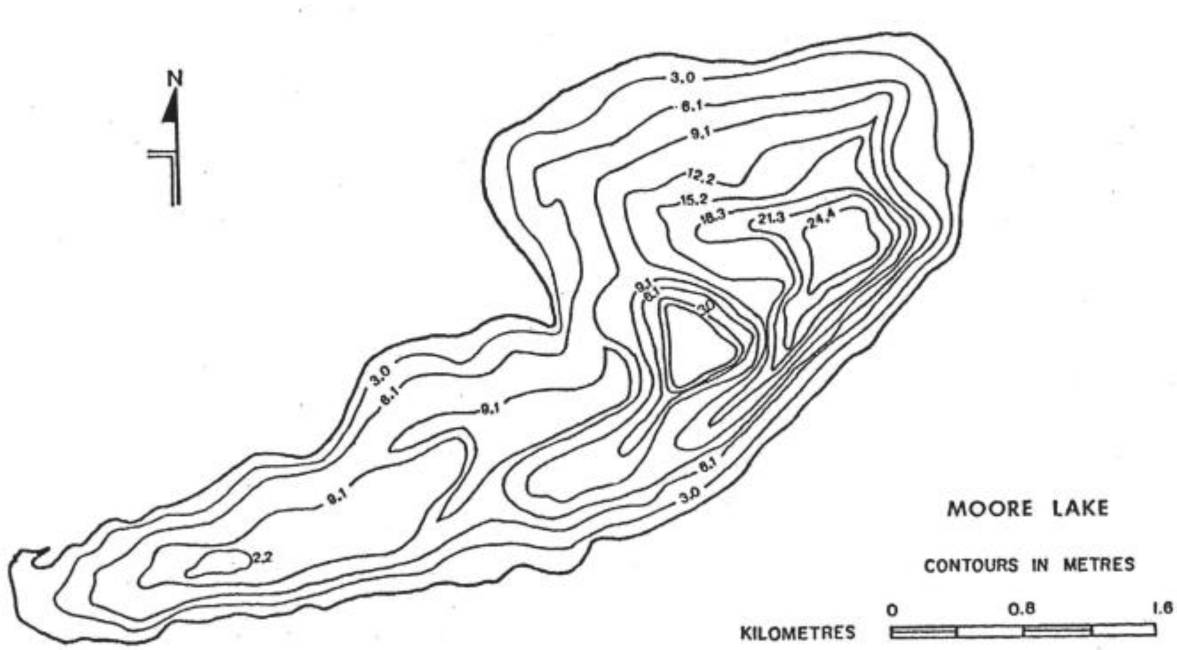
[1] Mitchell, P. and E. Prepas. 1990. Atlas of Alberta Lakes.
[2] Alberta Environment. 2006. Cold Lake-Beaver River Surface Water Quantity and Aquatic Resources State of the Basin Report.
[3] Strong, W.L. and K.R. Leggat. 1981. Ecoregions of Alberta. Alta. En. Nat. Resour., Resour. Eval. Plan. Div., Edmonton.



Bathymetric map of Crane Lake obtained from The Angler's Atlas.

WATER CHEMISTRY

ALMS measures a suite of water chemistry parameters. Phosphorus, nitrogen, and chlorophyll-a are important because they are indicators of eutrophication, or excess nutrients, which can lead to harmful algal/cyanobacteria blooms. One direct measure of harmful cyanobacteria blooms are Microcystins, a common group of toxins produced by cyanobacteria. See Table 2 for a complete list of parameters.

The average total phosphorus (TP) concentration in 2024 for Crane Lake was 13 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. This value falls on the low end of previously observed historical TP averages going back to 1986 (Table 2). TP ranged from a minimum of 7 µg/L on August 14, to a maximum of 27 µg/L on July 17 (Figure 1).

The average chlorophyll-*a* concentration in 2024 was 4.65 µg/L (Table 2), similarly falling into the mesotrophic classification. Chlorophyll-*a* was lowest at 2.8 µg/L on August 14 and peaked at 7.8 µg/L on July 17 (Figure 1). The average chlorophyll-*a* concentration in 2024 falls within the range of chlorophyll-*a* observed historically from 1986 (Table 2).

The average total Kjeldahl nitrogen (TKN) concentration was 0.9 mg/L (Table 2). TKN levels peaked during the July 17 sampling trip, and proceeded to decrease during the August and September sampling events (Figure 1). TKN has been relatively level since lake monitoring began at Crane Lake in 1976 (Table 2).

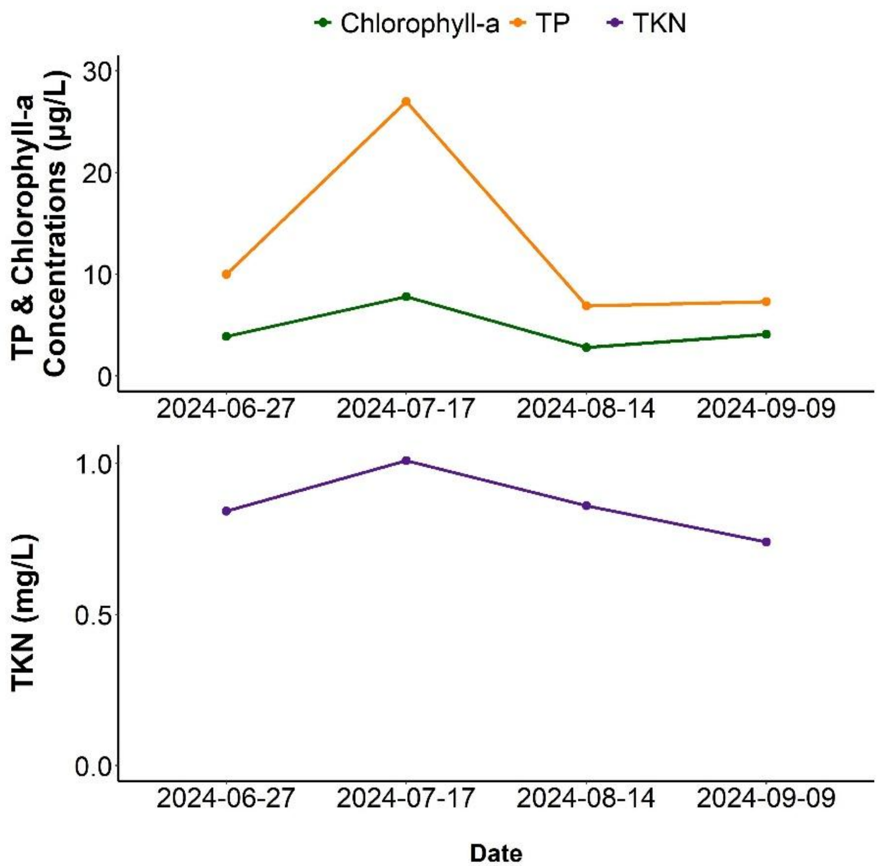


Figure 1. Total Phosphorus, Chlorophyll-a, and Total Kjeldahl Nitrogen concentrations measured over the course of the summer at Crane Lake in 2024.

Average pH was measured as 8.91 in 2024, buffered by moderate alkalinity (462 mg/L $CaCO_3$) and bicarbonate (462 mg/L HCO_3). Aside from bicarbonate, sodium and magnesium were higher than all other major ions, and contributed to a high average conductivity of 932 µS/cm (Figure 2, top; Table 2). Crane Lake falls on the mid-high range of ion concentrations compared to those of other LakeWatch lakes sampled in 2024 (Figure 2, bottom).

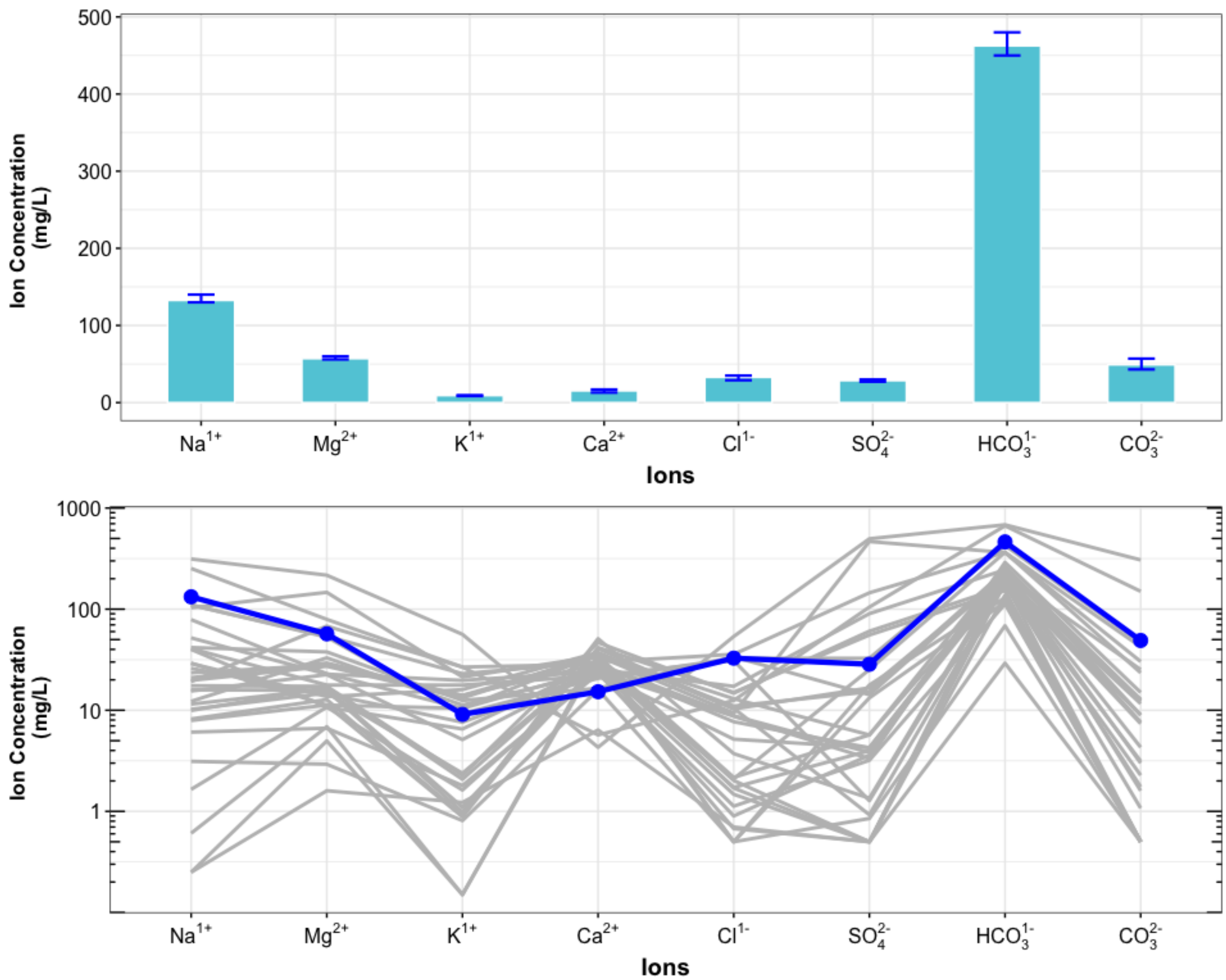


Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from 4 measurements over the course of the summer at Crane Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Crane 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 Crane Lake in 2024 (Table 3). No metals exceeded the CCME chronic guideline for the protection of aquatic life in 2024.[4]

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[4] Canadian Water Quality Guidelines. 2019. Canadian Council of Ministers of the Environment. https://ccme.ca/en/resources#.

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 Crane Lake in 2024 was 6.3 m, corresponding to a Secchi Depth of 3.15 m (Table 2). Euphotic depth showed minimal variation over the season, ranging from as low as 5.6 m on June 17 to as deep as 7 m on September 9 (Figure 3).

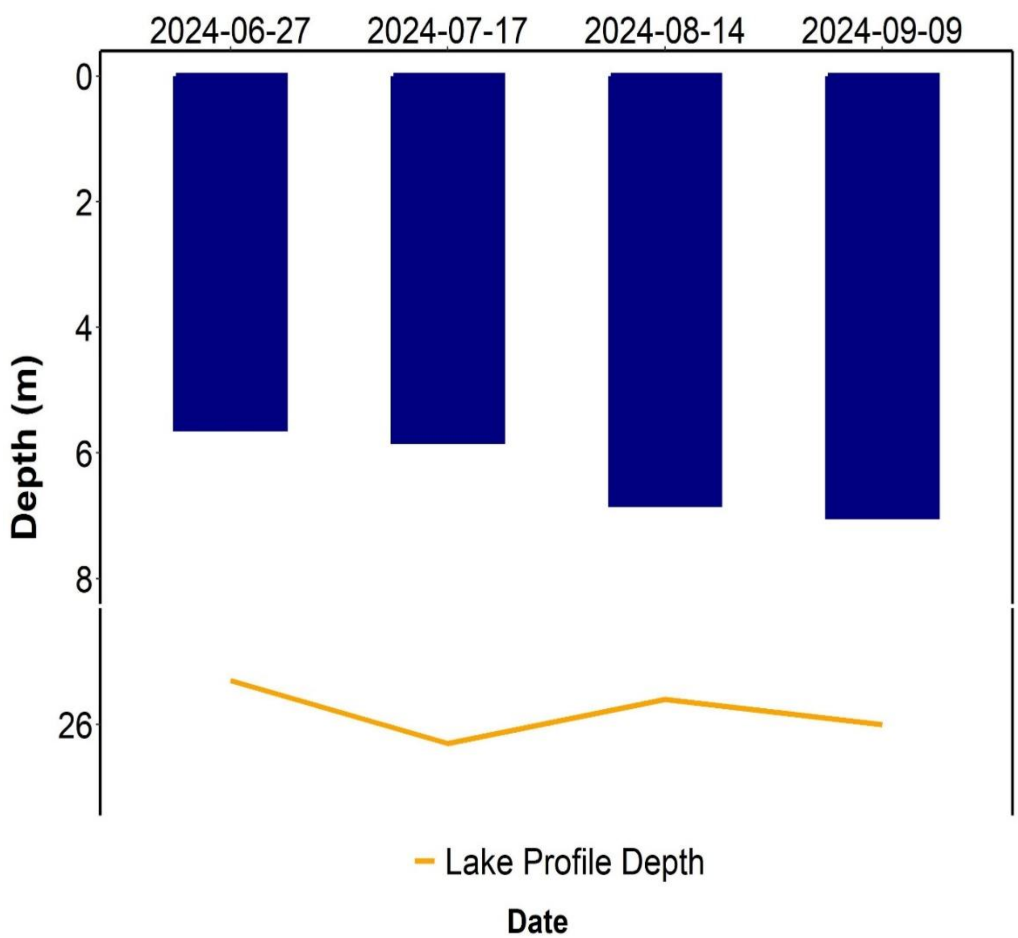

Figure 3. Euphotic depth values measured over the course of the summer at Crane Lake in 2024.

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 Crane Lake varied throughout the summer, with the July 17 sampling having the warmest temperatures at 23.71°C (Figure 4). The lake was strongly stratified during each sampling trip and was especially strong during the August sampling event. During each sampling event, the bottom layer of water (hypolimnion) approached 4°C.

Crane Lake was well oxygenated in the surface waters on all sampling dates, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen[5] (Figure 4b). During all sampling events, dissolved oxygen can be seen decreasing sharply at the thermocline, or mixing depth, at approximately 8 m (Figure 4).

Crane Lake was well stratified during each sampling event, meaning there is a clear differentiation between warm surface water and cooler, denser water near the bottom of the lake. This stratification is likely why TP decreased over the summer (Figure 1). As algae and aquatic plants utilized the phosphorus in the surface water to grow and photosynthesize, the strong stratification of the lake prevented lake mixing, and prevented phosphorus from migrating from the bottom of the lake.

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

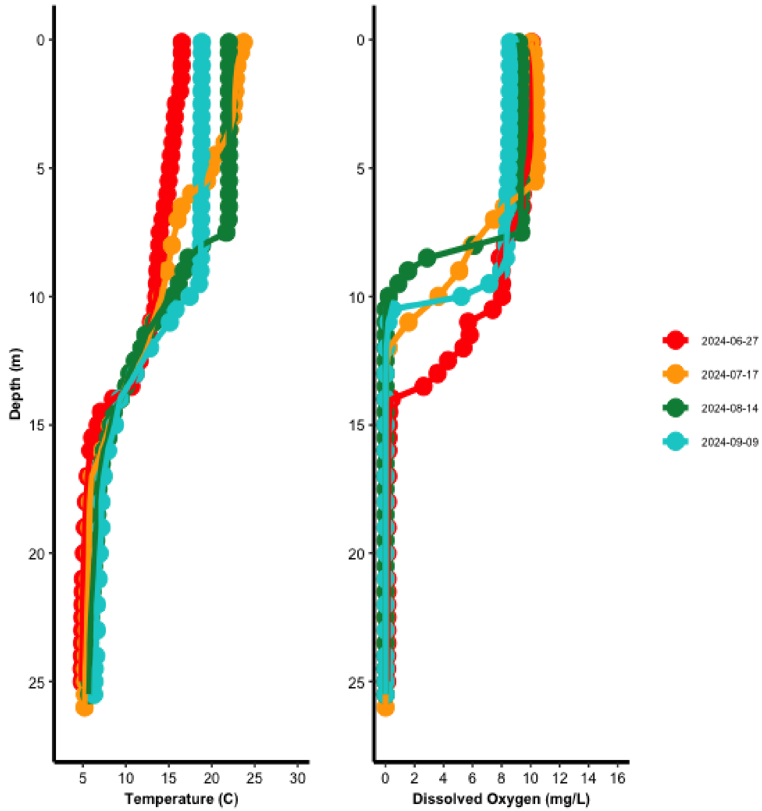


Figure 4. Temperature (°C) and dissolved oxygen (mg/L) profiles for Crane Lake measured four times over the course of the summer of 2024.

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 Crane Lake fell below the recreational guideline of 10 µg/L[6] during every sampling event in 2024. Despite low levels of microcystin detected during sampling events, caution should be observed in areas of the lake where significant cyanobacteria accumulation occurs.

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

Date	Microcystin Concentration (µg/L)
06/27/2024	< 0.1
07/17/2024	< 0.1
08/14/2024	0.12
09/09/2024	0.1
Average	0.08

[6] 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 Crane 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 not collected from Crane Lake in 2024.

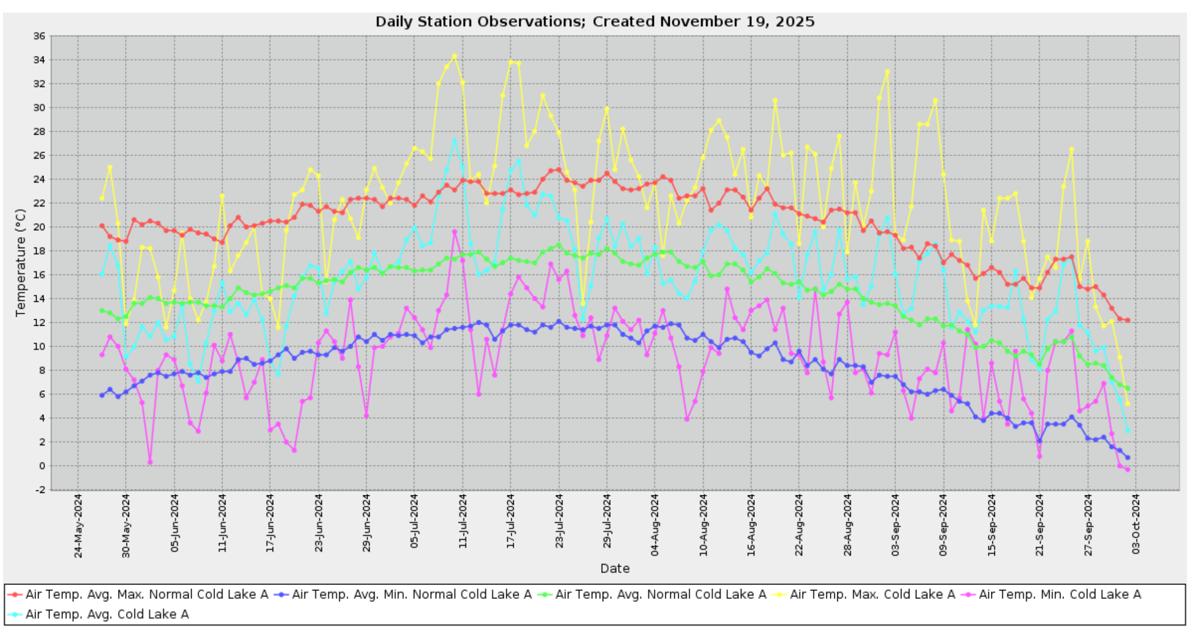
WEATHER AND LAKE STRATIFICATION

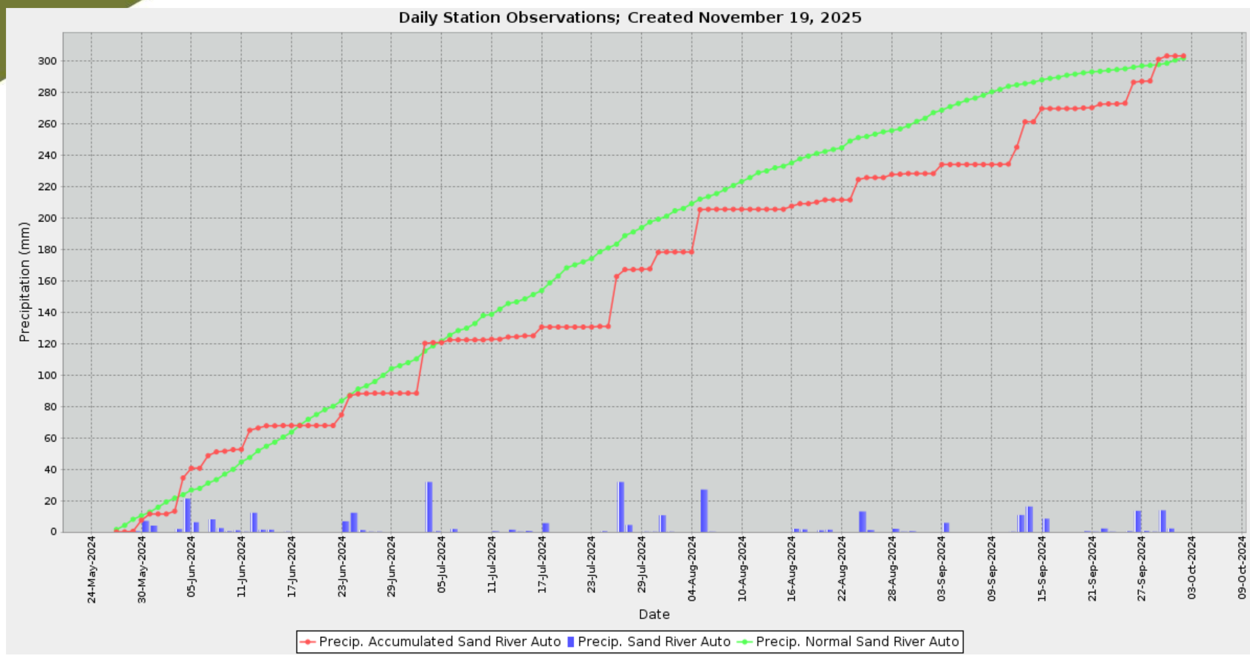
Air temperature will directly impact lake temperatures, and result in different temperature layers (stratification) throughout the lake, depending on its depth. Wind will also impact the degree to which a lake mixes, and how it will stratify. The amount of precipitation that falls within a lake's watershed 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, Crane 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 being cooler than normal, and breaking the record for coldest temperature recorded on both June 2 and 20. The lowest temperature recorded was on June 2 at 0.3°C. July was the warmest month, with the average temperature being 19.9°C. 2024 broke numerous heat records, including the hottest day recorded on July 10 at 34.3°C. September also broke heat records on numerous days.

Crane Lake received about normal precipitation in the summer of 2024 (303 mm total). June was unseasonably wet, with over 67 mm of precipitation falling in the first two weeks of the month. Precipitation fell in short bursts over the remaining summer months, with over 10 mm of precipitation occurring on numerous days over the summer.

Strong winds were also observed throughout the sampling season.





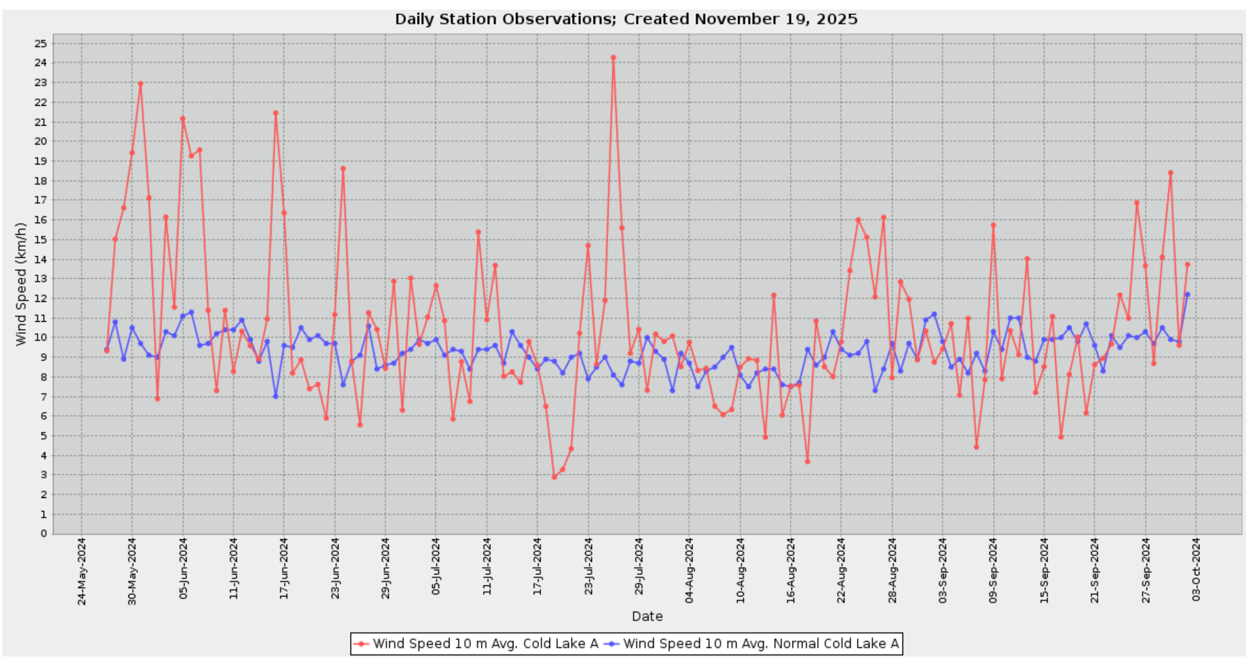


Figure 5. Air temperature (°C) and wind speed (km/h) measured from Cold Lake A weather station southeast of Crane Lake. Precipitation (cm) measured from Sand River weather station northwest of Crane Lake. Weather data provided by Agriculture, Forestry and Rural Economic Development, Alberta Climate Information 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 Crane Lake in 2024 have been relatively stable since 2021 (Figure 7). Lake levels have fluctuated by less than 1 m since the beginning of the historical record (1980) (Figure 8). Stable lake levels observed over time is a good indication that Crane Lake receives substantial inflow from groundwater.[2]

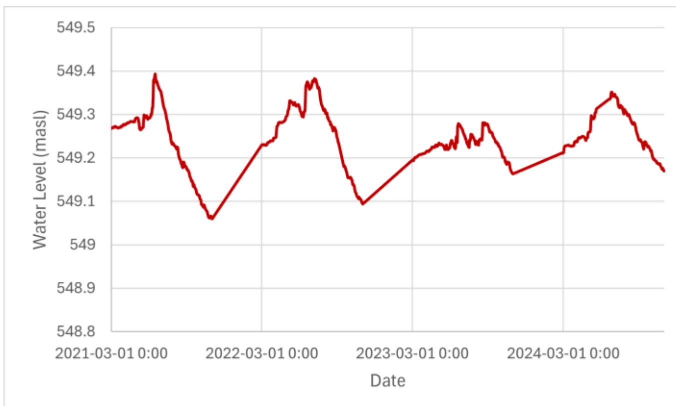


Figure 7. Water levels measured at Crane Lake in metres above sea level (masl) from 2020-2024. Data retrieved from Environment Canada and Alberta Environment and Parks Real-Time Hydrometric Data (https://wateroffice.ec.gc.ca/).

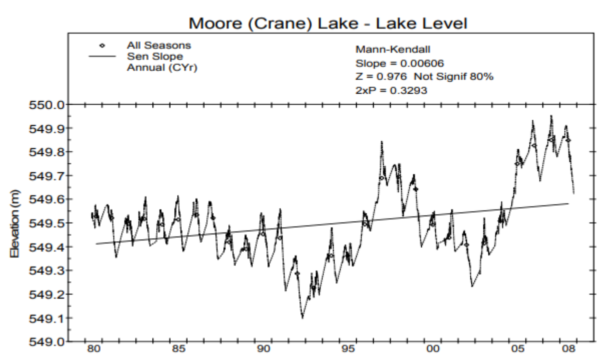


Figure 8. Historical lake levels measured at Crane Lake in metres above sea level from 1980-2008. Graph retrieved from Government of Alberta, Water Quality Conditions and Long-Term Trends in Alberta Lakes.[7]

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[2] Alberta Environment. 2006. Cold Lake-Beaver River Surface Water Quantity and Aquatic Resources State of the Basin Report.
[7] Government of Alberta. 2011. Water Quality Conditions and Long-Term Trends in Alberta Lakes.

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

Parameter	**1986**	**1993**	**1997**	**1998**	**1999**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
TP (µg/L)	22	25	20	34	-	24	23	22	22	19	29	25	21	24	20
TDP (µg/L)	9	10	10	12	-	11	11	10	12	12	11	14	10	12	9
Chlorophyll-a (µg/L)	3.1	-	7	11.6	-	7.1	4.8	3.6	2.4	2.3	2.3	6.3	3.4	3.2	2.5
Secchi depth (m)	-	-	3.45	1.8	2.7	3.22	2.88	3.15	4	3.81	3.75	3.69	3.3	3.55	3.65
TKN (mg/L)	0.8	1.1	1	1	-	1	1	0.9	0.9	0.7	1	1	0.9	1.2	1
NO_2-N and NO_3-N (µg/L)	2	0	8	4	-	6	6	3	2	5	4	5	3	4	22
NH_3-N (µg/L)	-	7	9	24	-	10	-	13	10	-	-	-	9	10	23
DOC (mg/L)	13	14	12	12	-	14	14	14	13	14	13	13	16	19	14
Ca^{2+} (mg/L)	17	12	16	14	-	-	-	-	-	-	-	-	-	-	-
Mg^{2+}(mg/L)	42	48	48	48	-	-	-	-	-	-	-	-	-	-	-
Na^{+} (mg/L)	96	112	116	111	-	125	112	124	124	125	133	121	127	129	135
K^{+} (mg/L)	7	7	8	8	-	8	8	8	8	8	8	6	9	8	8
SO_4^{2-} (mg/L)	20	22	28	15	-	24	28	26	30	35	27	21	28	22	26
Cl^{-} (mg/L)	22	26	26	28	-	29	30	30	30	31	31	30	30	30	31
CO_3^{2-} (mg/L)	-	-	38	34.5	-	41	40.5	43.3	42.7	42.3	37	40.8	34.6	48.4	45.4
HCO_3^{2-} (mg/L)	-	-	411.5	435	-	457.33	459	460.67	468.67	467.33	480	470.5	490.6	463	457
pH	8.9	8.94	8.9	8.89	-	8.92	8.94	8.88	8.89	8.94	8.89	8.95	8.97	8.93	8.8
Conductivity (µS/cm)	770	827	818	841	-	842	873	862	870	867	893	890	916	931	914
Hardness (mg/L)	215	228	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS (mg/L)	430	477	482	488	-	-	-	-	-	-	-	-	-	-	-
Microcystin (µg/L)	-	-	-	-	-	0.16	0.39	0.14	0.1	0.13	0.09	0.09	0.1	0.07	0.08
Total Alkalinity (mg/L CaCO3)	378	416	400	414	-	443	444	450	456	454	456	454	461	461	450

Parameter	2015	2016	2017	2018	2019	2020	2022	2023	2024
TP (µg/L)	12	14	13	13	16	13	9	11	13
TDP (µg/L)	7	6	5	4	6	5	3	4	4
Chlorophyll-a (µg/L)	3.1	4.2	3.7	4.7	5.3	6.8	5	4.5	4.6
Secchi depth (m)	3.65	3.65	3.86	4.02	4.01	3	2.9	3.5	3.15
TKN (mg/L)	1	0.9	0.9	0.9	0.9	1	0.9	0.9	0.9
NO_2-N and NO_3-N (µg/L)	-	2	2	2	2	2	4	16	6
NH_3-N (µg/L)	-	25	16	8	12	25	8	10	8
DOC (mg/L)	13	12	13	13	15	12	13	13	13
Ca^{2+} (mg/L)	12	12	14	15	16	18	17	16	15
Mg^{2+}(mg/L)	55	57	53	54	52	53	54	56	57
Na^{+} (mg/L)	125	136	128	128	122	130	125	130	132
K^{+} (mg/L)	8	9	9	9	8	9	9	9	9
SO_4^{2-} (mg/L)	30	29	30	29	27	28	30	30	28
Cl^{-} (mg/L)	34	34	33	33	36	33	33	34	33
CO_3^{2-} (mg/L)	41.8	47.8	43.2	42	52.8	59.5	37.2	55.8	49
HCO_3^{2-} (mg/L)	480	466	458	468	445	410	460	460	462.5
pH	8.91	8.96	8.93	8.87	8.92	8.84	8.8	8.83	8.91
Conductivity (µS/cm)	916	924	906	900	908	905	898	915	932
Hardness (mg/L)	-	264	254	260	255	265	265	272	270
TDS (mg/L)	540	550	536	544	535	532	535	562	552
Microcystin (µg/L)	0.06	0.14	0.13	0.12	0.12	0.06	0.05	0.05	0.08
Total Alkalinity (mg/L CaCO3)	460	464	446	454	452	438	440	470	462

Table 3. Concentrations of metals measured in Crane 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	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Guidelines
Aluminum (µg/L)	2.14	9.07	5.88	8.86	7.94	4.36	9.06	4.75	14.91	5.45	5.05	100[a]
Antimony (µg/L)	0.03	0.026	0.029	0.042	0.031	0.031	0.027	0.033	0.028	0.03	0.032	/
Arsenic (µg/L)	4.26	3.02	3.31	4.48	3.67	3.06	3.08	3.73	2.91	4.16	4.56	5
Barium (µg/L)	13.4	14.4	14.2	13.8	14	13.2	13.3	13.3	13.2	11.2	9.4	/
Beryllium (µg/L)	0.0027	0.0032	0.0015	0.0015	0.0015	0.0048	0.0015	0.012	0.0065	0.004	0.004	100[c,d]
Bismuth (µg/L)	0.0005	0.0005	0.0014	0.004	0.0019	0.0005	0.0005	0.0005	0.0005	0.0192	0.0005	/
Boron (µg/L)	255	327	266.5	289	310.5	300.5	306.5	324.5	293	307	317	1500
Cadmium (µg/L)	0.007	0.005	0.015	0.013	0.012	0.013	0.006	0.009	0.006	0.006	0.005	0.36[b]
Chromium (µg/L)	0.2435	0.359	0.3285	0.405	0.4715	0.1824	0.197	0.32	0.2815	0.765	0.095	/
Cobalt (µg/L)	0.0109	0.0249	0.01365	0.0153	0.0203	0.0089	0.0015	0.00765	0.0118	0.0075	0.021	500, 1000[c,d]
Copper (µg/L)	0.246	0.38	0.132	1.31	0.294	0.24	0.451	0.448	0.287	0.195	0.355	4[b]
Iron (µg/L)	6.5	34.9	9.4	8.8	19.4	5.18	2.6	2.92	14.01	13.8	7.6	300
Lead (µg/L)	0.052	0.066	0.057	0.034	0.013	0.014	0.021	0.008	0.076	0.007	0.038	7[b]
Lithium (µg/L)	56.7	72.5	60.9	62.1	73.05	66.05	68.35	70.4	66.95	67.7	71.6	[d]
Manganese (µg/L)	1.79	1.7	2.3	1.87	1.31	1.36	1.39	1.48	1.27	1.34	1.9	130[e]
Molybdenum (µg/L)	3.185	3.59	3.175	3.23	3	2.9	2.715	2.79	2.655	2.455	2.525	73
Nickel (µg/L)	0.013	0.092	0.046	0.002	0.13	0.064	0.002	0.002	0.05	0.009	0.012	150[b]
Selenium (µg/L)	0.192	0.515	0.429	0.721	0.432	0.364	0.524	0.294	0.219	0.455	0.03	1
Silver (µg/L)	0.0012	3e-04	3e-04	0.0014	0.0037	0.0004	0.0003	0.0004	0.0073	0.1275	0.002	0.25
Strontium (µg/L)	68.5	75.7	74.2	69	69.9	69.2	67.4	68.4	66.8	56.5	44.5	/
Thallium (µg/L)	0.007	0.0088	0.0011	0.0018	0.003	0.0013	0.0001	0.0001	0.0005	0.0029	0.0019	0.8
Thorium (µg/L)	0.004	0.006	0.01	0.02	0.001	0.005	0.003	0	0.002	0.047	0	/
Tin (µg/L)	0.01	0.01	0.04	0.01	0.01	0.01	0.01	0.03	0.01	0.02	0.02	/
Titanium (µg/L)	0.605	0.785	0.686	0.744	0.574	0.588	0.52	0.504	0.973	0.545	0.595	/
Uranium (µg/L)	0.185	0.214	0.213	0.208	0.178	0.182	0.176	0.178	0.172	0.167	0.164	15
Vanadium (µg/L)	0.151	0.253	0.241	0.235	0.268	0.181	0.186	0.184	0.216	0.355	0.16	100[c,d]
Zinc (µg/L)	2.08	2.5	1.84	0.36	0.33	0.66	0.48	0.47	0.66	0.5	0.9	30[f]

Metals	2016	2017	2018	2019	2020	2022	2023	2024	Guidelines
Aluminum (µg/L)	23	34.2	1.7	3.7	3.4	7	4.4	3.4	100[a]
Antimony (µg/L)	0.035	0.113	0.026	0.024	0.03	0.027	0.031	0.031	/
Arsenic (µg/L)	4.01	21.9	4.08	4.61	4.61	4.27	4.41	4.4	5
Barium (µg/L)	11.4	62.4	13.8	15.4	16.6	15.4	12.2	10.4	/
Beryllium (µg/L)	0.004	0.0075	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	100[c,d]
Bismuth (µg/L)	0.0005	0.0075	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	/
Boron (µg/L)	321	1500	289	288	270	321	304	292	1500
Cadmium (µg/L)	0.141	0.025	0.005	0.005	0.005	0.02	0.005	0.005	0.36[b]
Chromium (µg/L)	1.19	0.25	0.05	0.05	0.05	0.05	0.05	0.05	/
Cobalt (µg/L)	0.014	0.073	0.021	0.021	0.016	0.052	0.017	0.022	500, 1000[c,d]
Copper (µg/L)	1.35	0.76	0.04	0.14	0.04	0.11	0.49	0.1	4[b]
Iron (µg/L)	93.3	40.5	7	8	8.9	7.1	5.8	3.9	300
Lead (µg/L)	0.157	0.122	0.002	0.004	0.008	0.023	0.031	0.005	7[b]
Lithium (µg/L)	76.7	303	67.9	63.9	61.3	66	65.9	67.5	[d]
Manganese (µg/L)	3.63	10.9	1.37	2.42	3.11	3.34	1.68	1.28	130[e]
Molybdenum (µg/L)	2.39	11	2.29	2.16	1.99	1.83	1.81	1.83	73
Nickel (µg/L)	0.301	1.19	0.05	0.07	0.07	0.08	0.17	0.015	150[b]
Selenium (µg/L)	0.55	4.2	0.8	0.4	0.6	0.1	0.8	0.7	1
Silver (µg/L)	0.028	0.008	5e-04	5e-04	5e-04	5e-04	5e-04	5e-04	0.25
Strontium (µg/L)	52	281	70.9	80.4	83.9	72.1	62.2	51.6	/
Thallium (µg/L)	0.0011	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.8
Thorium (µg/L)	0.004	0.04	0.001	0.002	0.001	0.003	0.001	0.003	/
Tin (µg/L)	7.23	0.15	0.03	0.03	0.03	0.03	0.03	0.03	/
Titanium (µg/L)	0.71	2.73	0.36	0.35	0.32	0.18	0.34	0.19	/
Uranium (µg/L)	0.179	0.784	0.166	0.151	0.15	0.136	0.138	0.135	15
Vanadium (µg/L)	0.24	0.726	0.108	0.097	0.637	0.104	0.08	0.077	100[c,d]
Zinc (µg/L)	69.1	5	0.5	0.4	0.7	1.2	2.1	0.5	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 Crane Lake. In sum, a decreasing trend was detected in TP, while an increasing trend was detected in chlorophyll-*a* and TDS. No trend was detected in Secchi disk depth. 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 Crane Lake data from 2005 to 2024.

Parameter	Date Range	Direction of Significant Change
Total Phosphorus	2005-2024	Decreasing
Chlorophyll-*a*	2005-2024	Increasing
Total Dissolved Solids	2005-2024	Increasing
Secchi Depth	2005-2024	No Change

Definitions

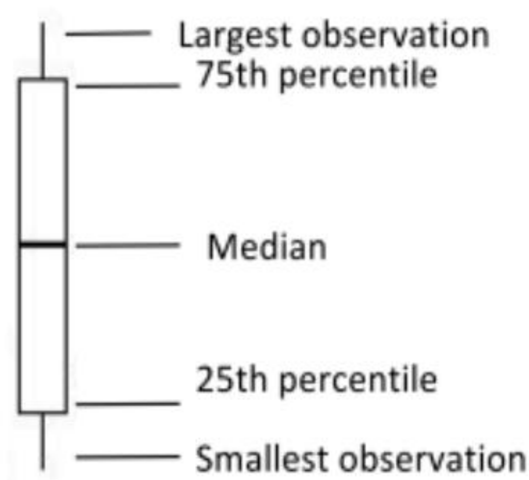
Median: the value in a range of ordered numbers that falls in the middle.

Trend: a general direction in which something is changing.

Monotonic trend: a gradual change in a single direction.

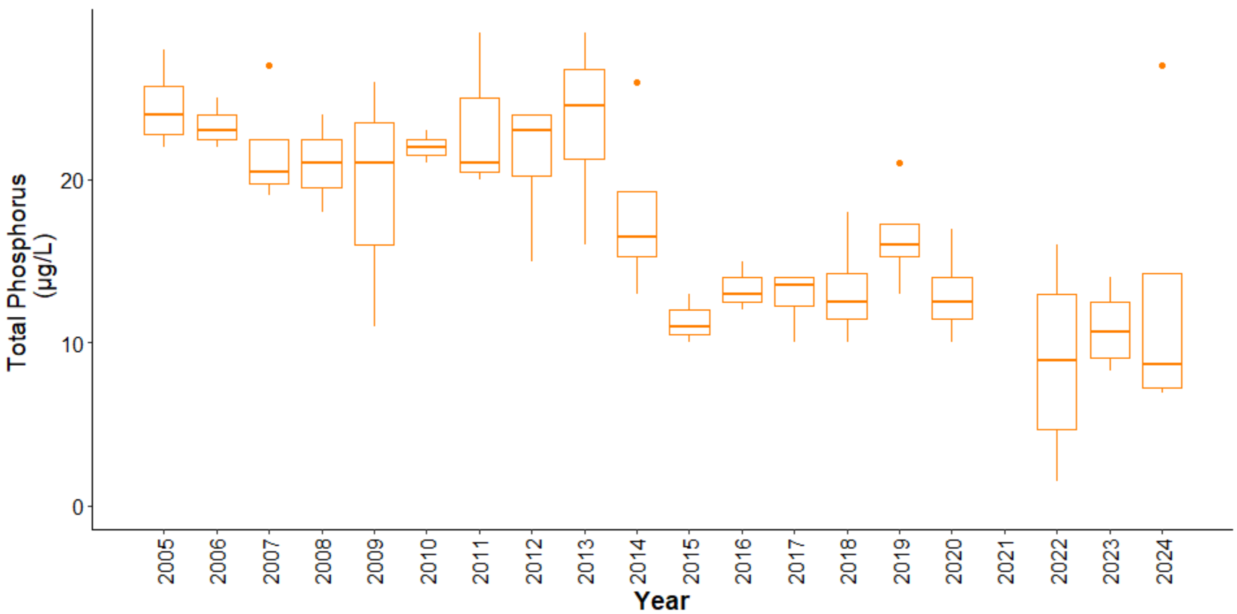
Statistically significant: The likelihood that a relationship between variables is caused by something other than random chance. This is indicated by a p-value of <0.05. Variability: the extent by which data is inconsistent or scattered.

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 suggests TP has significantly decreased in Crane Lake since 2005 (Tau = -0.5585, $p < 0.001$).



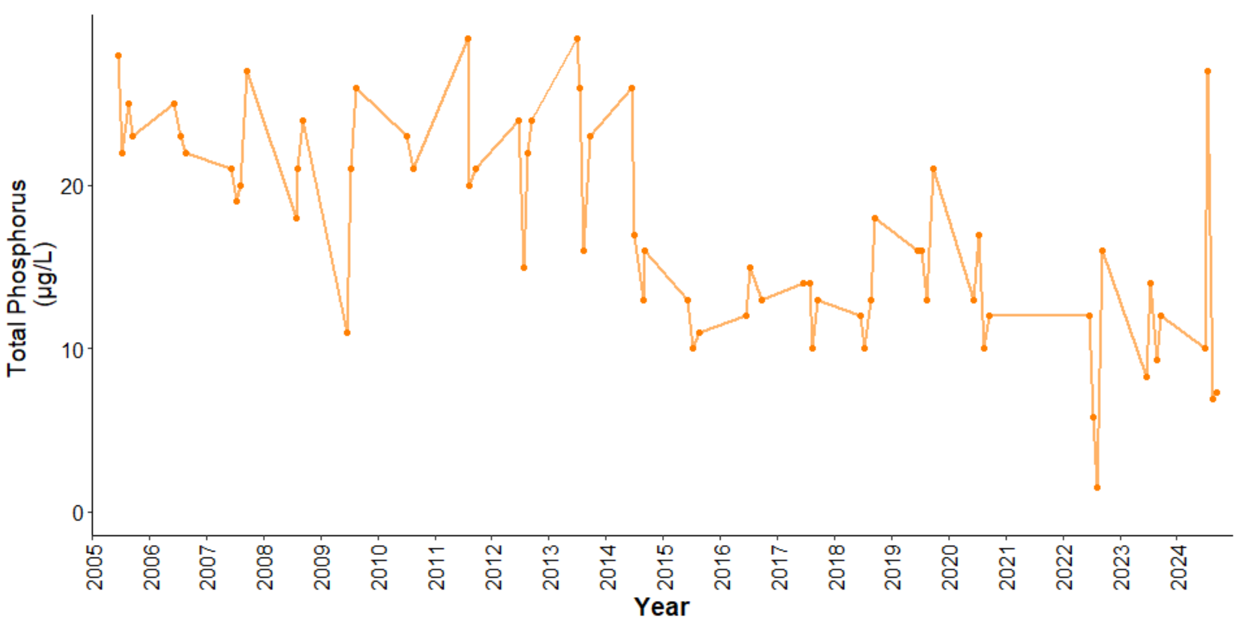
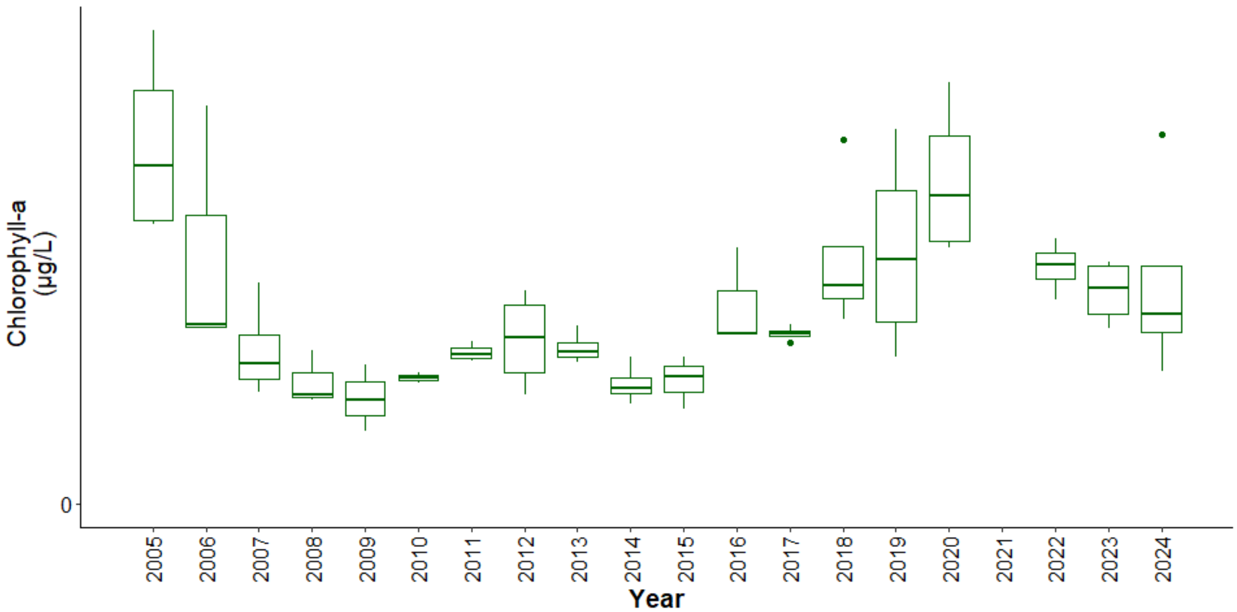


Figure 9. Monthly total phosphorus (TP) concentrations measured between June and September over the long term sampling dates between 2005 and 2024 (n = 68). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

Chlorophyll-*a*

Trend analysis of chlorophyll-*a* suggests it has significantly increased over time at Crane Lake (Tau = 0.2509, $p < 0.005$).



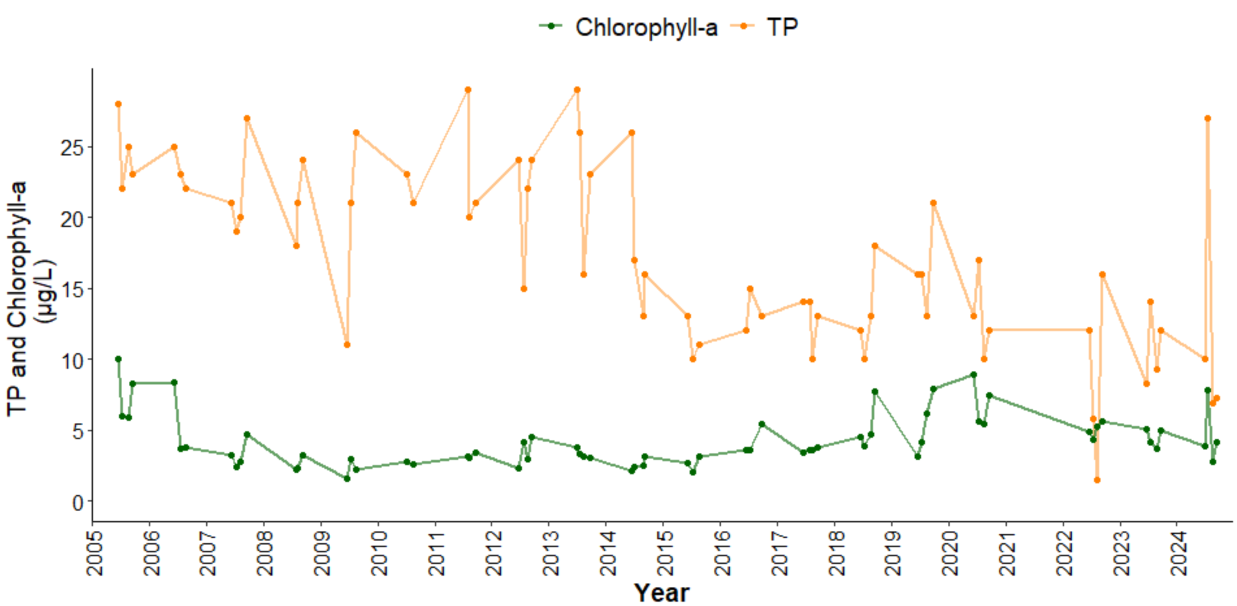
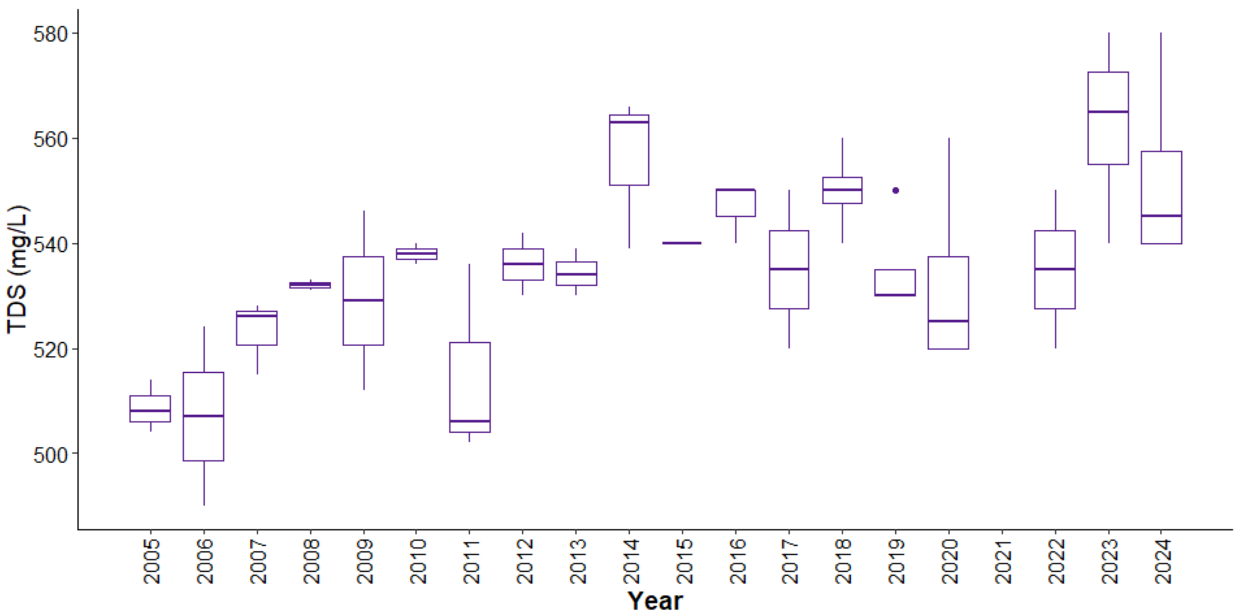


Figure 10. Monthly chlorophyll-*a* concentrations measured between June and September over the long term sampling dates between 2005 and 2024 (n = 68). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples. Line graph is overlain by TP concentrations.

Total Dissolved Solids (TDS)

Trend analysis showed a significantly increasing trend in TDS in Crane Lake since 2005 (Tau = 0.4111, $p < 0.001$).



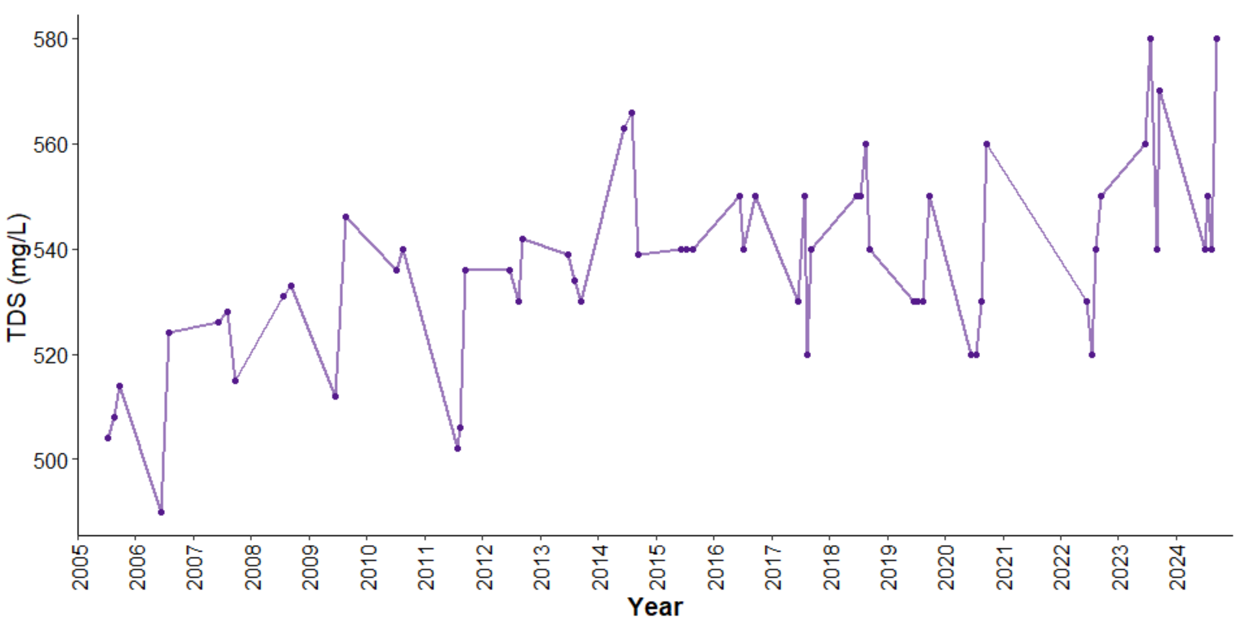


Figure 11. Monthly TDS values measured between June and September over the long term sampling dates between 2005 and 2024 (n = 60). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

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

Trend analysis of major ions at Crane Lake indicates that potassium, calcium, chloride, and sulphate are significantly increasing (Figure 10). No trends were detected in sodium or alkalinity. Magnesium had insufficient data for calculating a trend. As many ions are moving in the same direction, it is likely that evaporative loss is driving the change in total dissolved solids in Crane Lake.

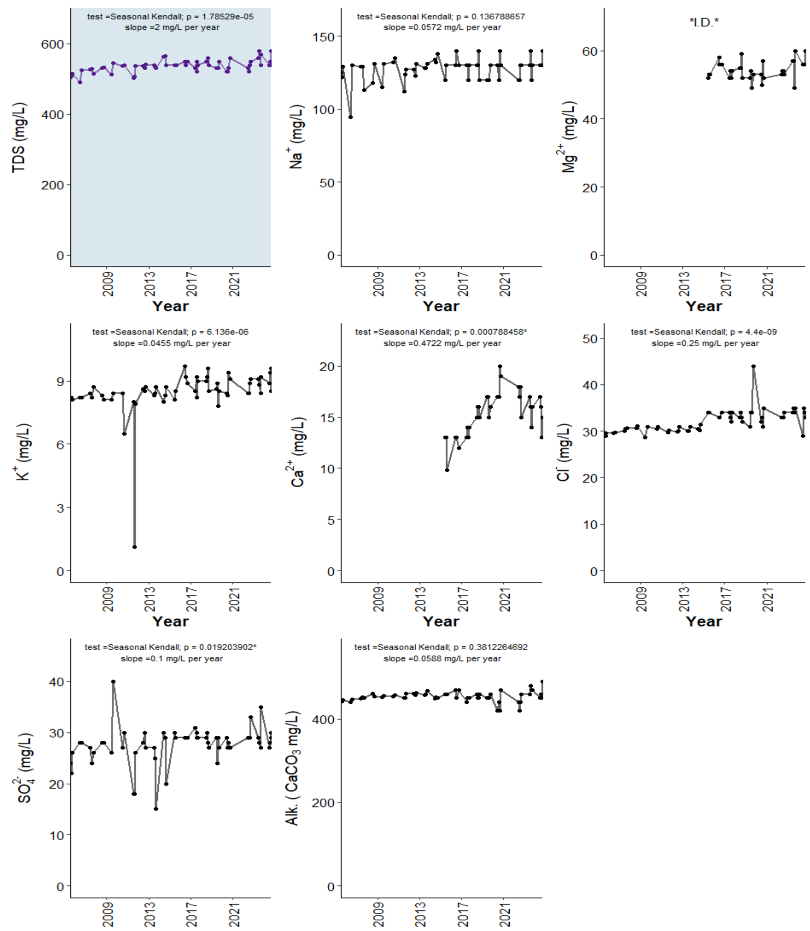
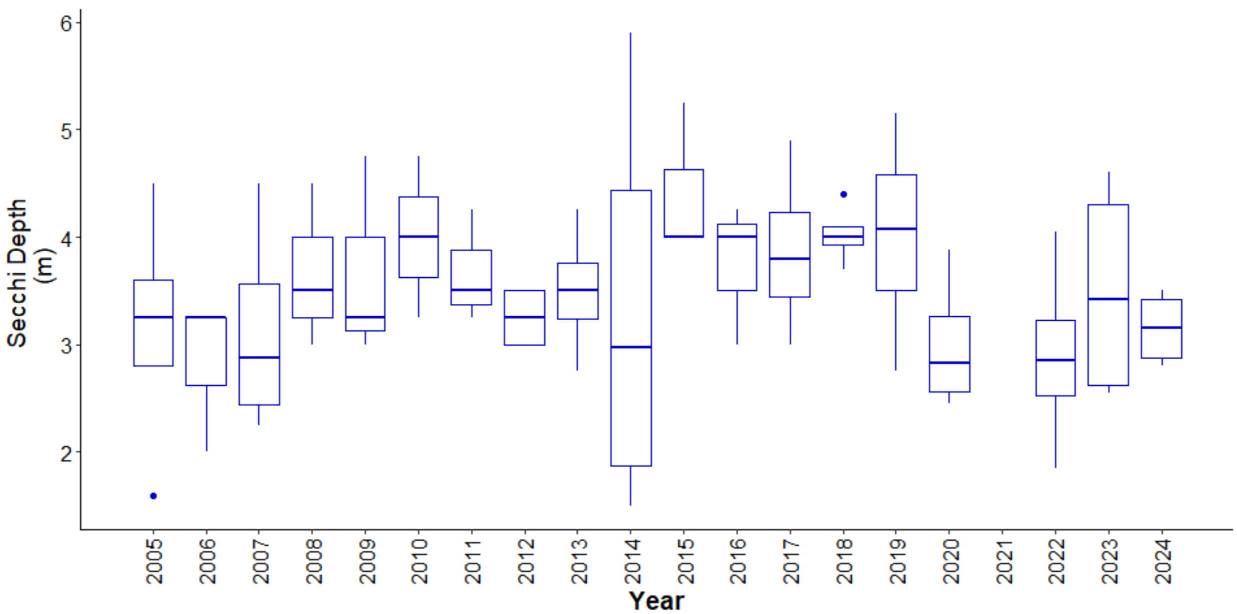


Figure 12. Concentrations of TDS (top left, blue panel), major ions (sodium = Na^+, magnesium = Mg^{2+}, potassium = K^+, calcium = Ca^{2+}, chloride = Cl^-, sulphate = SO_4^{2-}), and total alkalinity (Alk., as mg/L $CaCO_3$) measured monthly between June and September on sampling dates between 2005 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. 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 showed that it has no significant upwards or downwards trend at Crane Lake since 2005 (Tau = 0.056, p = 0.58).



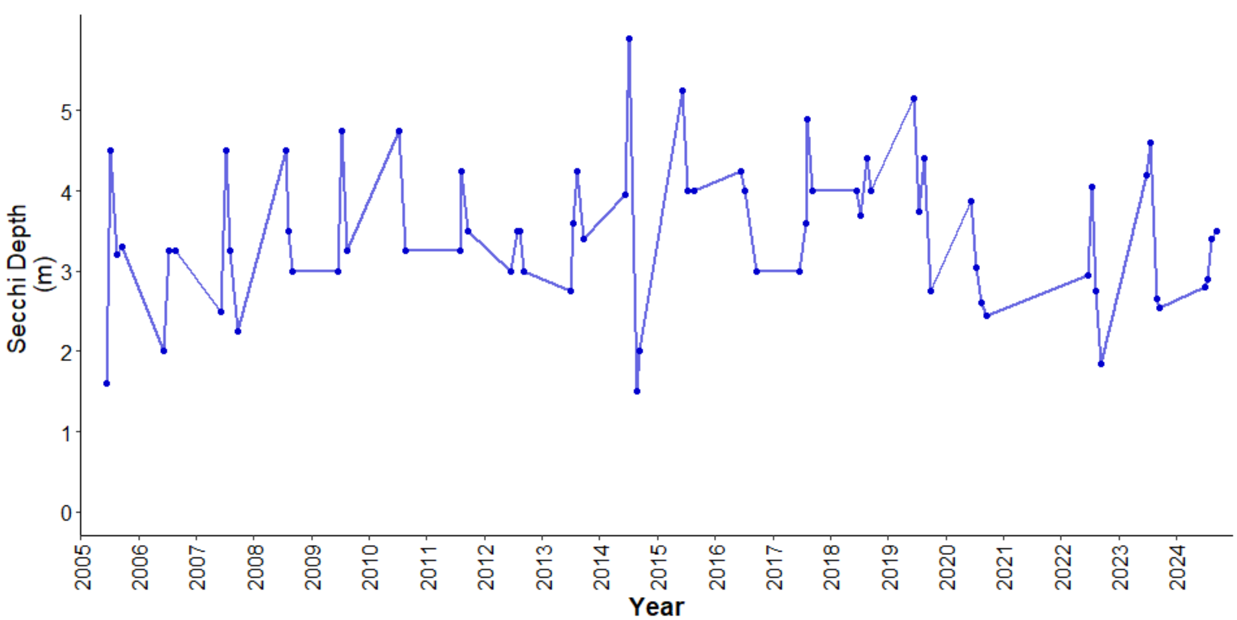


Figure 13. Monthly Secchi depth values measured between June and September over the long term sampling dates between 2005 and 2024 (n = 68). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

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 2005-2024 on Crane 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	-0.5585	0.2509	0.4111	0.056
The extent of the trend	Slope (units per Year)	-0.8333	0.1	2	0.0056
The statistic used to find significance of the trend	Z	-6.1949	2.9107	4.2902	0.5526
Number of samples included	n	68	68	60	68
The signficance of the trend	p	6e-10*	0.004*	1.785e-05*	0.581

*$p < 0.05$ is significant within 95%