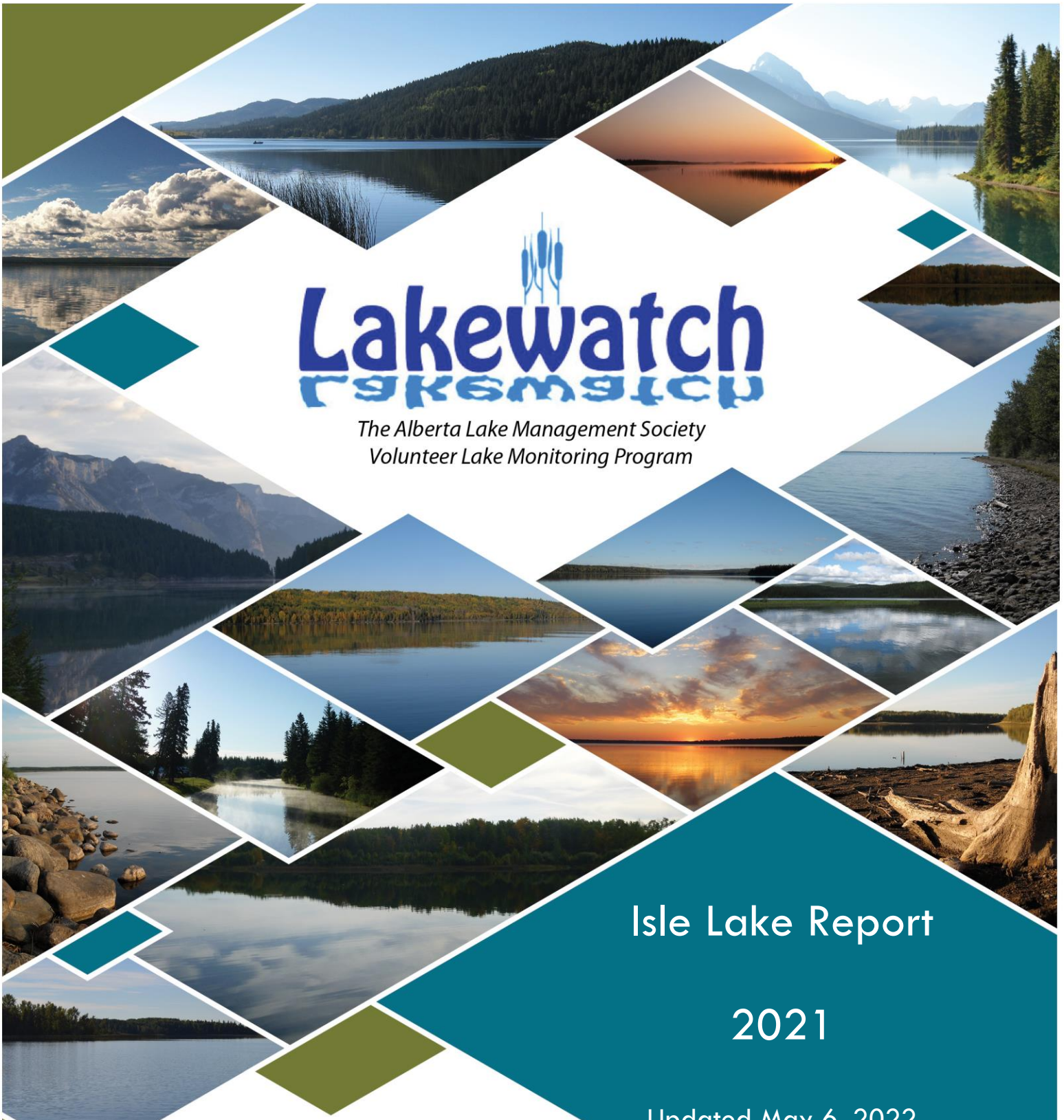

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Isle Lake Report

2021

Updated May 6, 2022

Lakewatch is made possible with support from:

Alberta
LICA Environmental Stewards
Pigeon Lake Watershed Association
MD 61
Alberta ecotrust
Discover Hardisty More than you imagine
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Classification: Protected A

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 Carla Laidlaw for her commitment to collecting data at Isle Lake. We would also like to thank Keri Malanchuk and Brittany Onysyk, who were summer technicians in 2021. Executive Director Bradley Peter and Program Manager Caleb Sinn were instrumental in planning and organizing the field program. This report was prepared by Caleb Sinn and Bradley Peter.

BEFORE READING THIS REPORT, CHECK OUT A BRIEF INTRODUCTION TO LIMNOLOGY AT ALMS.CA/REPORTS

ISLE LAKE

Isle Lake is located in the counties of Lac Ste. Anne and Parkland, 80 km west of the City of Edmonton. The Hamlet of Gainford, established in 1942, is situated on the southwest shore. In 1879, the Hudson Bay Company set up a trading post nearby, at Lac Ste. Anne, and settlers began arriving in 1905 as agricultural lands became available.[1] Today, several subdivisions are registered along the shoreline and the lake is heavily used for recreation. Sport fishing is popular, and species include northern pike, yellow perch, burbot, white suckers, and walleye.[1]

Isle Lake is long and moderately shallow (Figure 1; maximum depth 7.5 m). Isle Lake has experienced many stressors, including high phosphorus content which results in cyanobacteria blooms, and a population of the invasive plant Flowering Rush, which has the potential to reproduce and spread rapidly.

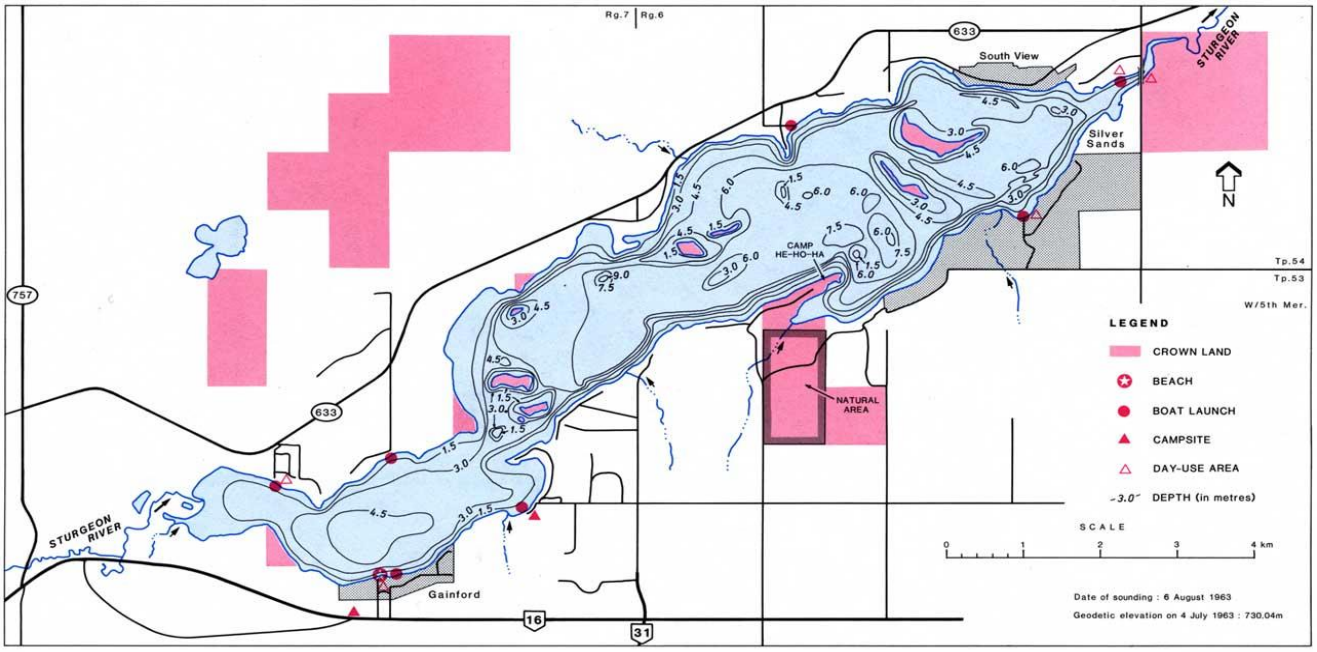


Figure 1 – Bathymetry and shoreline features of Isle Lake.[1]

[1] Mitchell, P. and E. Prepas. 1990. Atlas of Alberta Lakes, University of Alberta Press. Retrieved from http://sunsite.ualberta.ca/projects/alberta-lakes/

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 Isle Lake was 228 µg/L (Table 2), falling into the hypereutrophic, or very highly productive trophic classification. This value is on the higher end of previous historical averages. TP was lowest on the June 13th sampling event at 91 µg/L, and increased steadily through the season to a high of 320 µg/L on September 12th (Figure 1).

Average chlorophyll-*a* concentration in 2021 was 67.7 µg/L (Table 2), falling into the hypereutrophic, or highly productive trophic classification. Chlorophyll-*a* was lowest earliest in the season, at 14.4 µg/L on June 13th and rose through the season to a peak of 101.0 µg/L on September 12th (Figure 1). Chlorophyll-*a* concentrations were significantly positively correlated with TP (r = 0.997, *p* = 0.003).

The average TKN concentration was 2.0 mg/L (Table 2) and varied little through the season, from 2.0 mg/L to 2.3 mg/L (Figure 1). TKN concentrations were significantly positively correlated with TP (r = 0.98, *p* = 0.02), and chlorophyll-a (r = 0.96, *p* = 0.04).

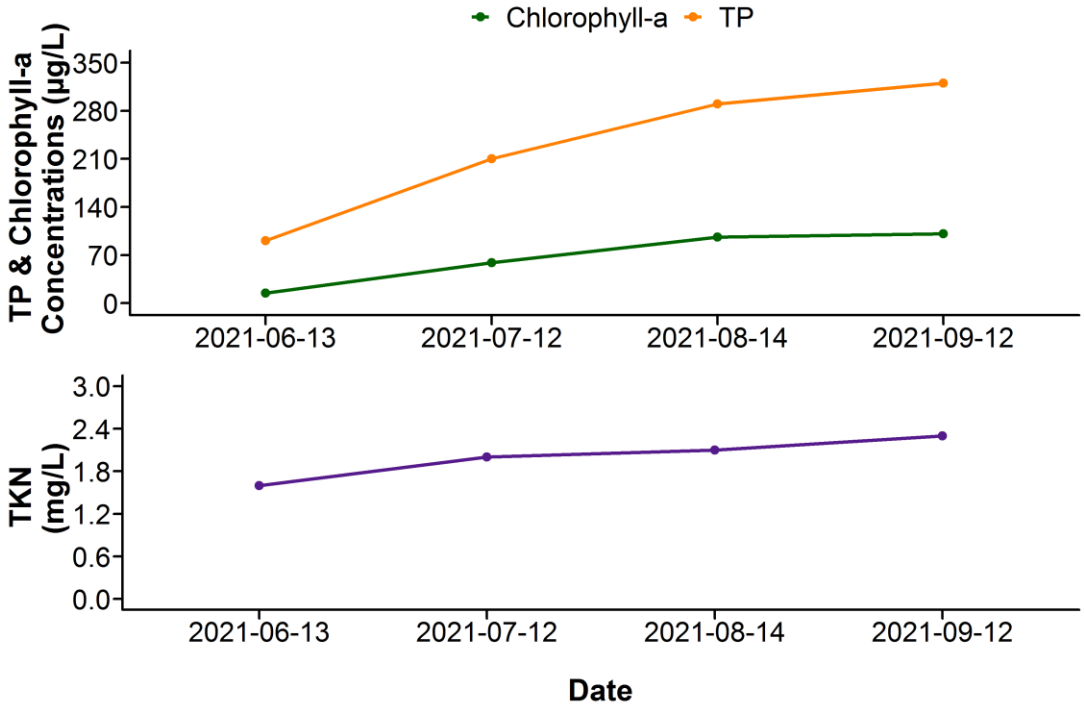


Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Isle Lake.

Average pH was measured as 8.64 in 2021, buffered by low alkalinity (168 mg/L $CaCO_3$) and bicarbonate (188 mg/L HCO_3). Aside from bicarbonate, calcium and sodium were slightly higher than other major ions and together contributed to a low conductivity of 382 µS/cm (Figure 2, top; Table 2). Isle Lake is in the moderate to low range of ion levels compared to other LakeWatch lakes sampled in 2021, with the exception of calcium, where it was higher than most of the other lakes (Figure 2, bottom).

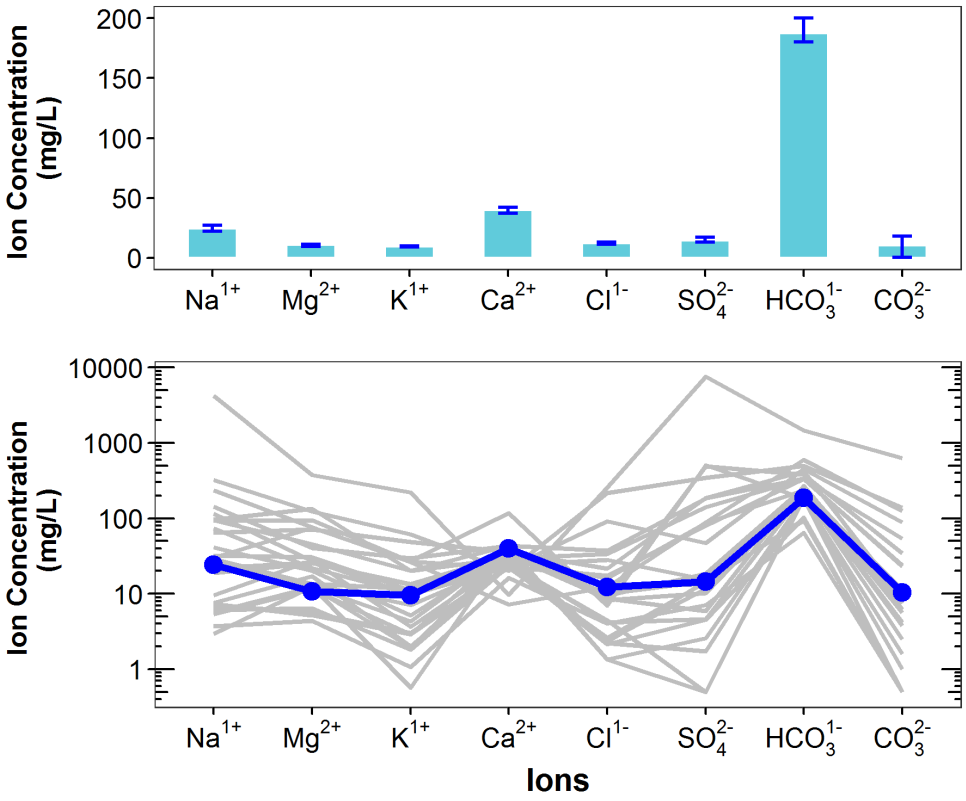


Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Isle Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Isle Lake (blue line) compared to 25 lake basins (gray lines) sampled through the LakeWatch program in 2021 (note $\log_{10}$ 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 not measured at Isle Lake in 2021, but Table 3 displays historical metal concentrations. Historical records show high manganese levels measured in 2015 which exceeded the CCME guideline (2019) for the protection of freshwater life.

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 Isle Lake in 2021 was 2.48 m, corresponding to an average Secchi depth of 1.24 m (Table 2). The euphotic depth was deepest early in the season at 4.5 m on June 13th, and then dropped substantially in July, remaining around 2.0 m for the remainder of the season (Figure 3).

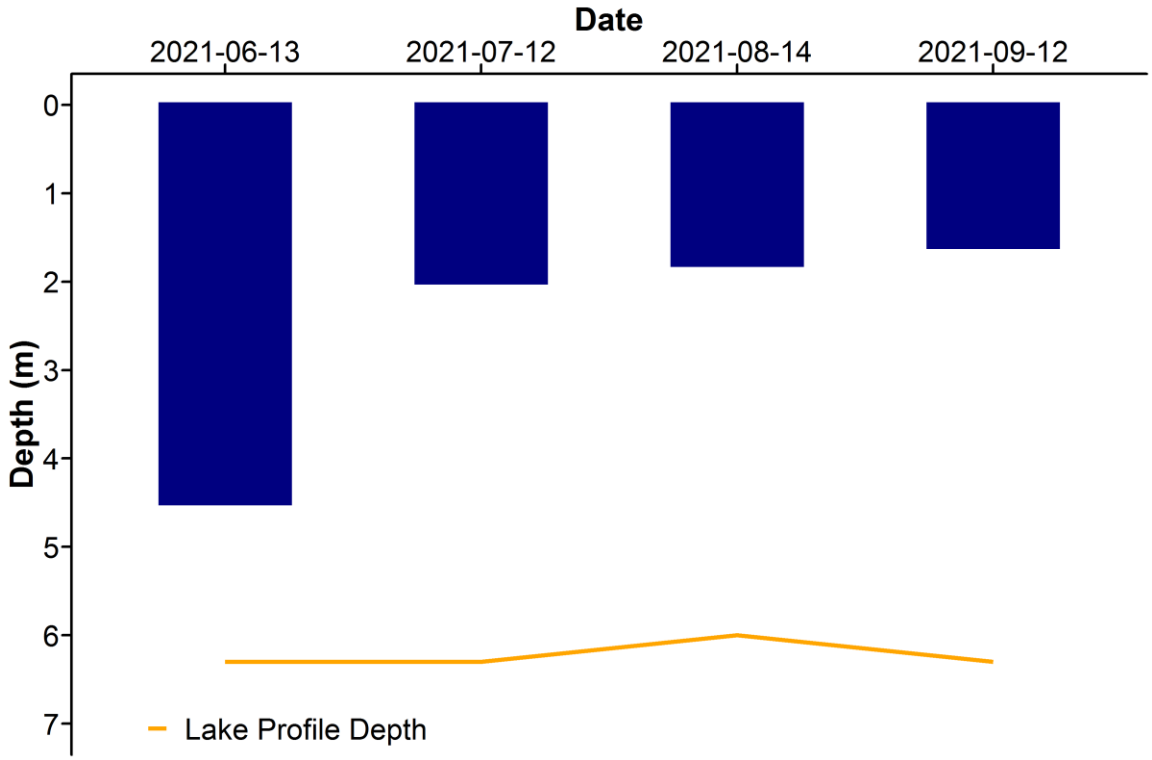


Figure 3. Euphotic depth values measured four times over the course of the summer at Isle Lake in 2021.

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 Isle Lake varied throughout the summer, with the July 12th sampling date having the warmest temperatures at 23.8°C (Figure 4a). With regards to lake temperature, the lake was well mixed during each sampling event.

Isle Lake was well oxygenated in the surface waters on all sampling dates, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 4b). Near the lake-bottom, oxygen levels dropped during the June, July and August sampling events, which is likely due to the effect of high rates of decomposition in the bottom sediments, which would slightly reduce oxygen levels in near bottom waters, despite lake mixing.

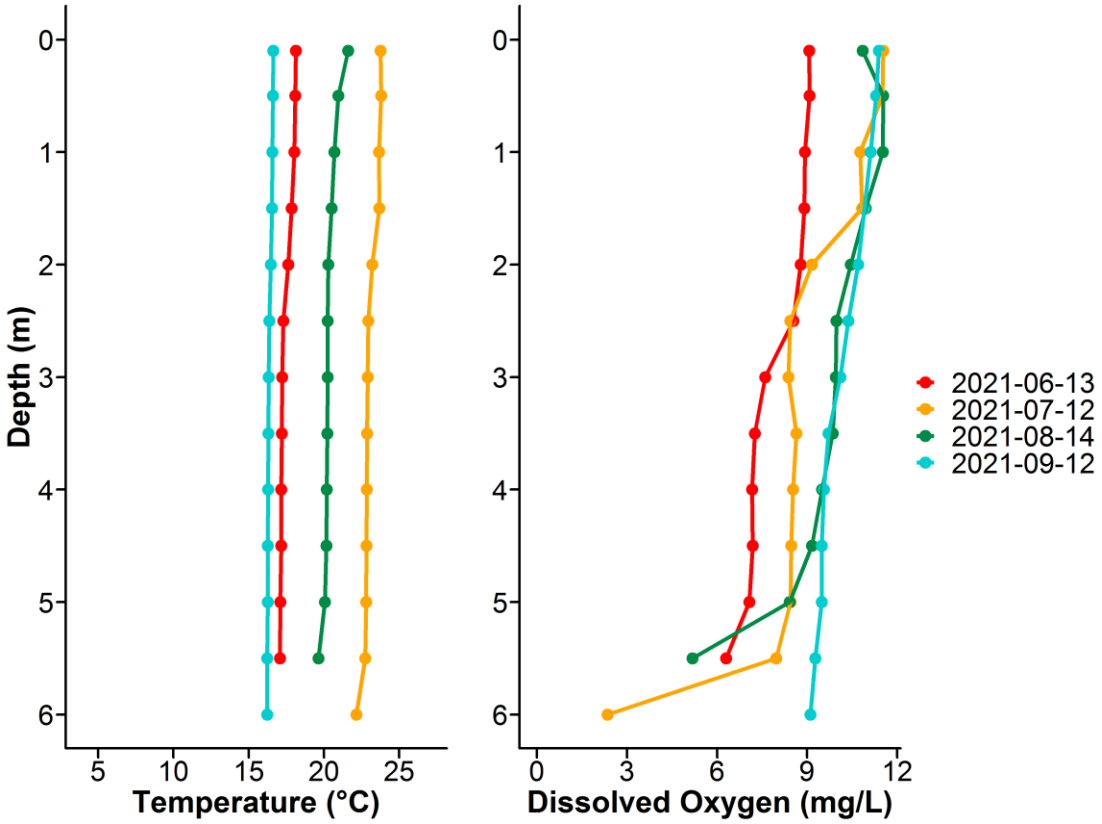


Figure 4. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Isle Lake measured four times over the course of the summer of 2021.

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 Isle Lake fell below the recreational guideline of 10 µg/L during every sampling event in 2021. Microcystin levels in 2021 were within the range historical values (Table 2). Even though levels of microcystin did not exceed the guideline, the levels seen in August and September indicate that certain areas of the lake likely exceeded the guideline – therefore, caution should always be observed when recreating around cyanobacteria.

Table 1. Microcystin concentrations measured four times at Isle Lake in 2021.

Date	Microcystin Concentration (µg/L)
13-Jun-21	0.37
12-Jul-21	3.00
14-Aug-21	7.42
12-Sep-21	6.56
Average	4.34

INVASIVE SPECIES MONITORING

Dreissenid mussels pose a significant concern for Alberta because they impair the function of water conveyance infrastructure and adversely impact the aquatic environment. These invasive mussels 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 involved sampling with a 63 µm plankton net at three sample sites, to look for juvenile mussel veligers and spiny water flea in each lake sampled. In 2021, no mussels or spiny water flea were detected at Isle Lake.

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.

A watermilfoil specimen was collected from Isle Lake on June 8th, and was confirmed to be the native Northern Watermilfoil.

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 Lake Isle in 2021 were slightly below the historical average and dropped appreciably compared to 2020 and 2019 levels (Figure 5).

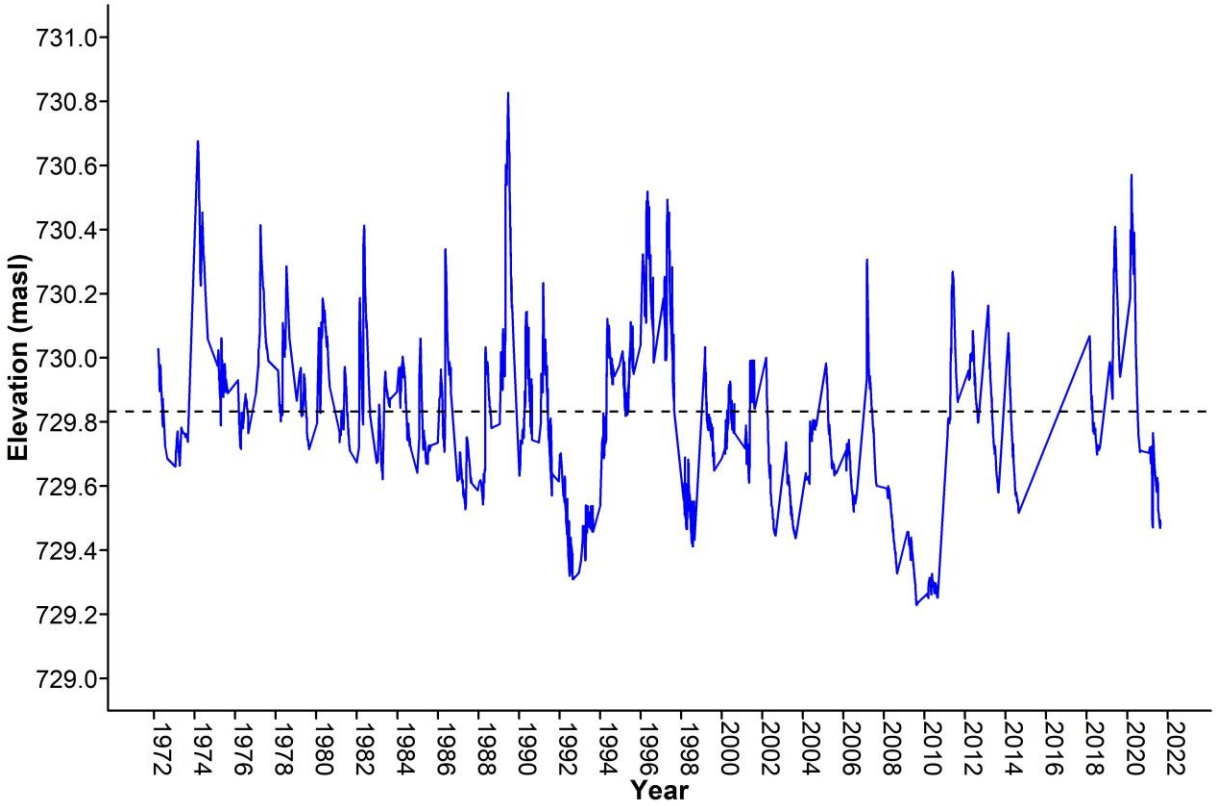


Figure 5. Water levels measured at Isle Lake in metres above sea level (masl) from 1972-2021. Data retrieved from Environment Canada and Alberta Environment and Parks. Black dashed line represents historical yearly average water level. Note that data from November 1 2020 – April 1 2021 removed due to suspect or anomalous values.

WEATHER & 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.

Isle Lake experienced a warmer, drier, slightly windier summer with slightly less solar radiation than compared to normal (Figure 5). A warm spell prior to the July 12th sampling resulted in relatively high near whole-lake temperatures. Windy spells and cooling temperatures ensured that the lake continued to mix through the season, and cool down between the July 12th sampling event and the September 12th sampling event.

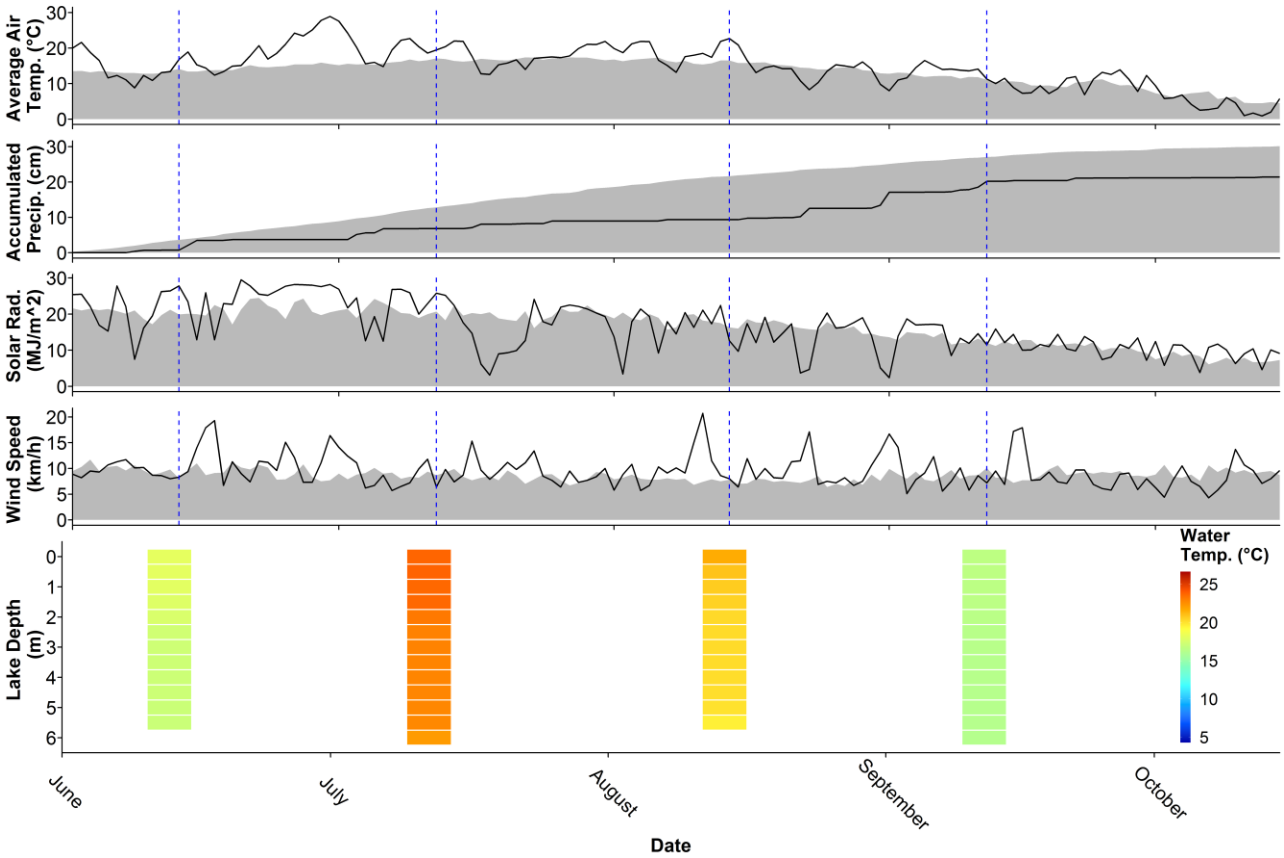


Figure 6. Average air temperature (°C), accumulated precipitation (cm), and wind speed (km/h) measured from Tomahawk AGDM, as well as solar radiation (MJ/m^2) and wind speed (km/h) measured from Evansburg 2 AGCM, with Isle Lake temperature profiles (°C) at the bottom. Black lines indicate 2021 levels, gray indicates long-term normals, and blue lines indicate sampling dates for Isle Lake over the summer. Further information about the weather data provided is available in the LakeWatch 2021 Methods report. Weather data provided by Agriculture, Forestry and Rural Economic Development, Alberta Climate Information Service (ACIS) https://acis.alberta.ca (retrieved April 2022).

Table 2. Average Secchi depth and water chemistry values for Isle Lake. Historical values are given for reference. Number of sample trips are inconsistent between years.

Parameter	1983	1984	1988	1996	1997	1998	2002	2011	2012	2014	2015	2018	2021
TP (µg/L)	93	116	146	74	140	367	95	225	246	252	195	157	228
TDP (µg/L)	46	71	\	32	81	285	43	85	125	163	122	82	158
Chlorophyll-*a* (µg/L)	33.8	43.2	47.5	32.6	45.3	67	13	112.9	117.8	45.4	73.9	63.6	67.7
Secchi depth (m)	2.1	1.86	2.1	3.13	2.43	2.08	2.5	0.7	1.48	1.5	1.48	1.57	1.25
TKN (mg/L)	1.2	1.5	\	1.3	1.3	2	2	2.9	2.9	2.2	2.3	2.2	2
NO_2-N and NO_3-N (µg/L)	13	14	10	31	8	18	3	24	14	36	4	67	9
NH_3-N (µg/L)	156	68	\	126	64	375	2	78	82	207	77	118	52
DOC (mg/L)	12	13	\	14	14	14	\	18	\	20	18	18	18
Ca^{2+} (mg/L)	28	26	31	\	31	32	\	\	\	\	25	34	40
Mg^{2+} (mg/L)	7	7	9	\	8	9	\	\	\	\	11	11	11
Na^{+} (mg/L)	17	18	22	20	18	21	\	33	31	35	34	32	24
K^{+} (mg/L)	6	6	6	\	7	7	\	9	\	10	10	12	10
SO_4^{2-} (mg/L)	8	6	9	10	8	5	\	4	10	6	7	12	14
Cl^{-} (mg/L)	2	3	3	5	5	5	\	10	10	11	12	14	12
CO_3^{2-} (mg/L)	2	12	2	4	7	12	\	3	14	13	14	2	10
HCO_3^{-} (mg/L)	171	154	182	168	159	170	\	203	178	183	170	205	188
pH	8.46	8.72	8.2	8.28	8.67	8.78	\	8.32	8.8	8.65	8.88	8.27	8.64
Conductivity (µS/cm)	286	278	318	308	302	316	\	364	365	370	354	370	382
Hardness (mg/L)	101	95	114	108	112	118	\	108	112	107	108	130	142
TDS (mg/L)	154	154	172	164	151	175	\	196	202	225	202	228	220
Microcystin (µg/L)	\	\	\	\	\	\		0.96	3.26	2.15	6.37	\	4.34
Total Alkalinity (mg/L $CaCO_3$)	142	143	154	142	143	158	\	171	170	171	162	170	168

Table 3. Concentrations of metals measured in Isle 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 (Total Recoverable)	2012	2014	2015	Guidelines
Aluminum µg/L	19.7	10.65	41.83	100[a]
Antimony µg/L	0.06525	0.058	0.058	/
Arsenic µg/L	1.765	1.995	1.650	5
Barium µg/L	78.2	83.6	72.2	/
Beryllium µg/L	0.0078	0.004	0.004	100[c,d]
Bismuth µg/L	0.00665	0.0005	0.0015	/
Boron µg/L	57.45	51.4	64.27	1500
Cadmium µg/L	0.0047	0.0025	0.0013	0.17[b]
Chromium µg/L	0.253	0.385	0.313	/
Cobalt µg/L	0.04645	0.0135	0.0353	50,1000[c,d]
Copper µg/L	0.318	0.44	0.28	2.53[b]
Iron µg/L	36.45	40.1	68.2	300
Lead µg/L	0.05275	0.0695	0.0347	3.51[b]
Lithium µg/L	16.7	14.4	18.2	2500[d]
Manganese µg/L	64.5	153.25[g]	128	120[e]
Mercury @ surface (ng/L)	/	/	0.54	26
Mercury @ bottom (ng/L)	/	/	0.90	26
Molybdenum µg/L	0.5765	0.333	0.316	73
Nickel µg/L	0.1094	0.004	0.2450	101.33[b]
Selenium µg/L	0.078	0.23	0.067	1
Silver µg/L	0.0043	0.001	0.001	0.25
Strontium µg/L	182	210	190	/
Thallium µg/L	0.0026	0.001425	0.000983	0.8
Thorium µg/L	0.024775	0.012125	0.003417	/
Tin µg/L	0.051	0.0135	0.0207	/
Titanium µg/L	1.475	2.565	2.147	/
Uranium µg/L	0.361	0.2475	0.2637	15
Vanadium µg/L	0.5145	0.36	0.39	100[c,d]
Zinc µg/L	1.6215	0.5	0.3833	30[f]

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on 2015 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 2015 avg. water hardness (as CaCO3) and avg. pH

[f] Based on 2015 avg. water hardness (as CaCO3), avg. pH, and avg. DOC with CCME equation

[g] Did not exceed guideline due to effect of relatively lower pH value in 2014 on Manganese variable calculation.

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 Isle Lake. In sum, significant increasing trends were observed in TP and TDS, and no significant trends were detected for chlorophyll-*a* or Secchi depth. Secchi depth can be subjective and is sensitive to variation in weather - 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 Isle Lake data from 1983 to 2021.

Parameter	Date Range	Direction of Significant Trend
Total Phosphorus	1983-2021	Increasing
Chlorophyll-*a*	1983-2021	No Change
Total Dissolved Solids	1983-2021	Increasing
Secchi Depth	1983-2021	No Change

Definitions:

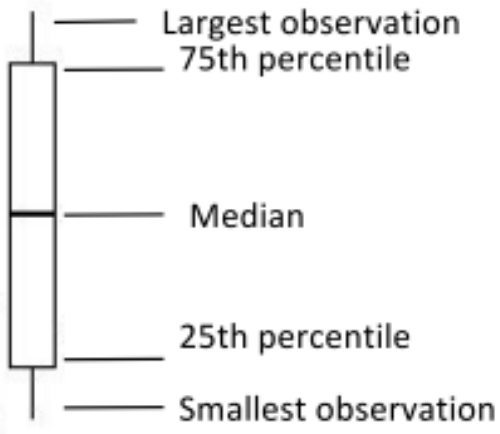
Median: the value in a range of ordered numbers that falls in the middle.

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 showed that it has significantly increased in Isle Lake since 1983 (Tau = 0.28, p = 0.015).

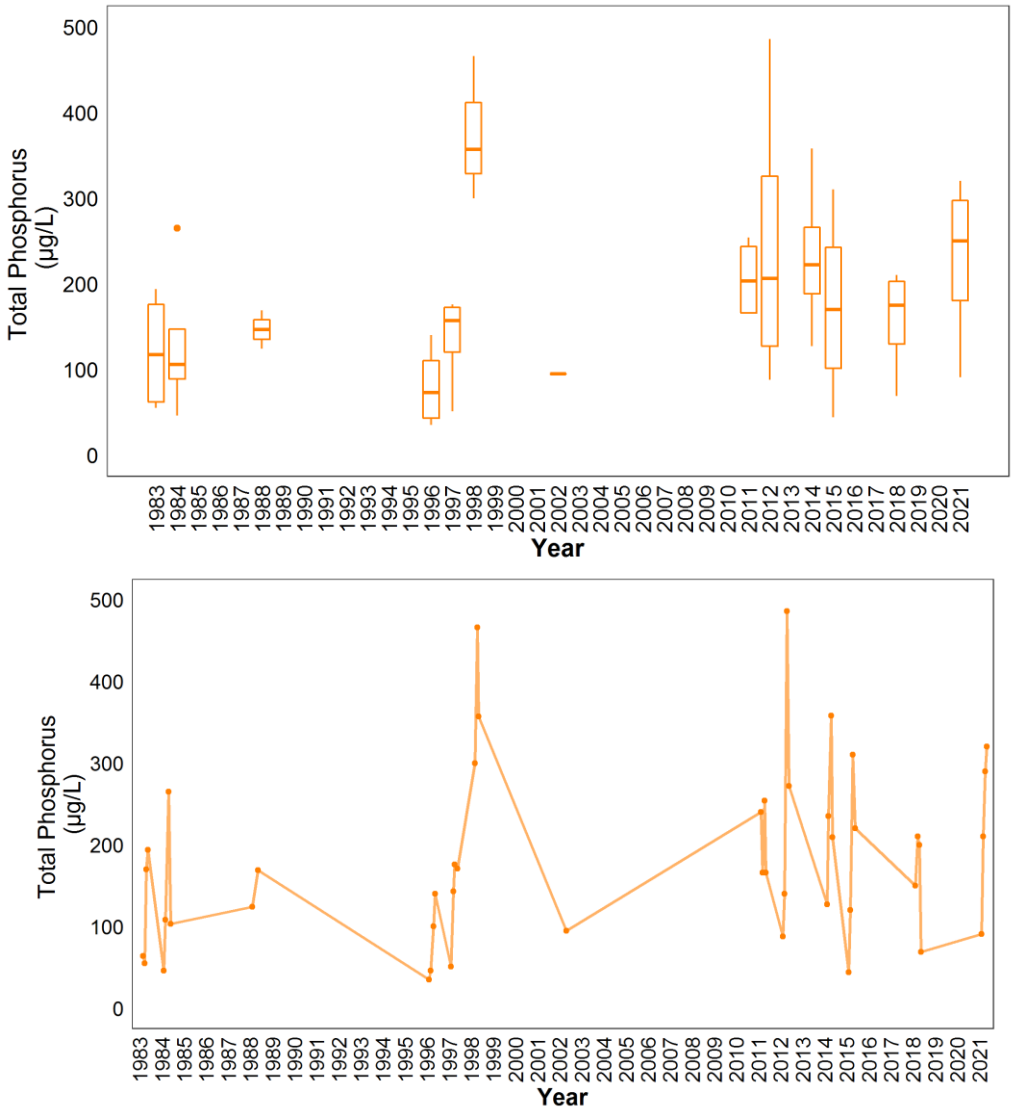


Figure 6. Monthly total phosphorus (TP) concentrations measured between June and September over the long term sampling dates between 1983 and 2021 (n = 46). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

Chlorophyll-*a*

Chlorophyll-*a* concentrations have not significantly changed over time at Isle Lake (Tau = 0.13, $p = 0.29$). Chlorophyll-*a* trends follow TP trends with correlation over time (r = 0.56, $p = 6.90 \times 10^{-5}$).

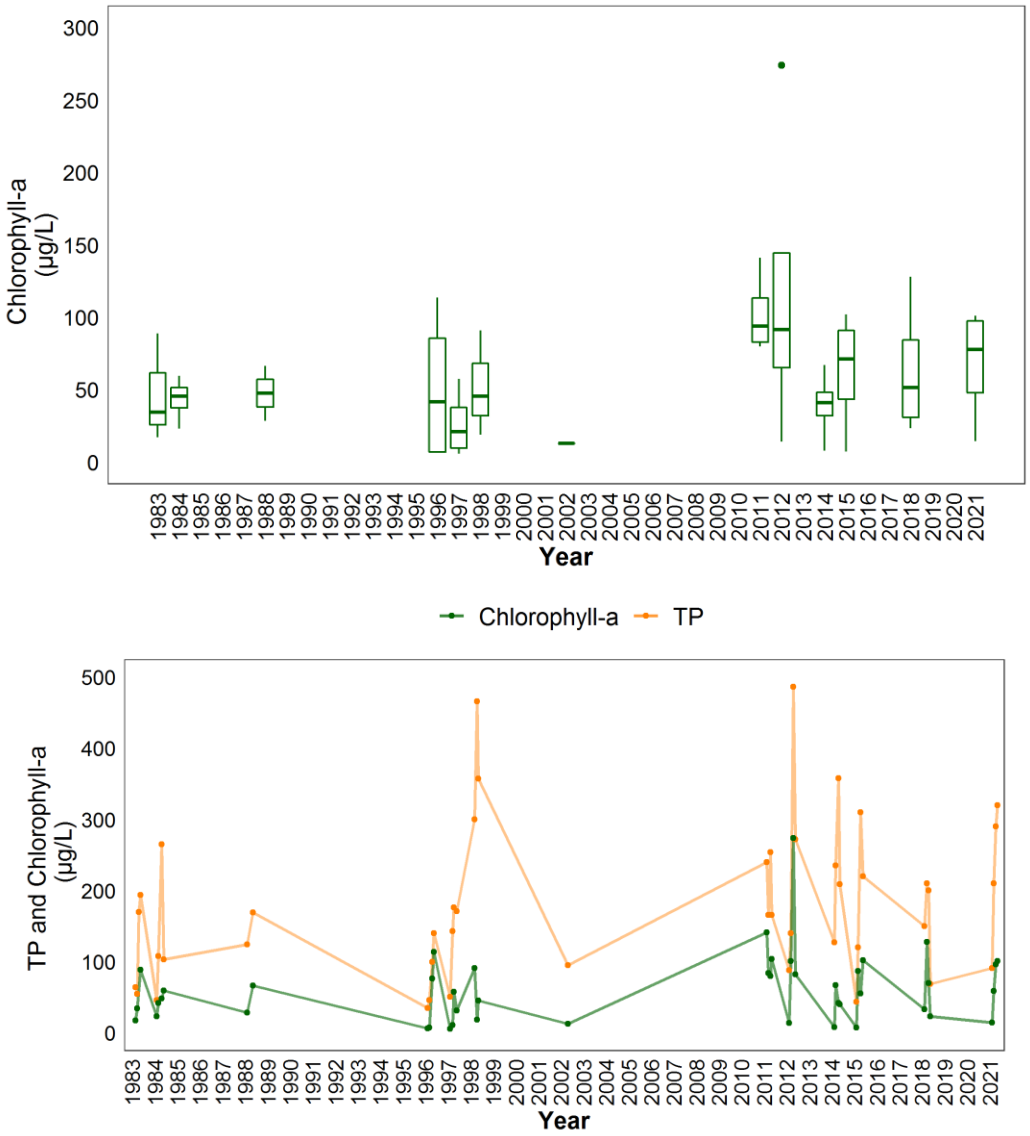


Figure 7. Monthly chlorophyll-*a* concentrations measured between June and September over the long term sampling dates between 1983 and 2021 (n = 45). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples. Line graph is overlain by TP concentrations.

Total Dissolved Solids (TDS)

Trend analysis showed a significant increasing trend in TDS between 1983 and 2021 (Tau = 0.74, p = <0.001) in Isle Lake. TDS levels in Isle Lake have increased by almost 60 mg/L between 1983 and 2021 (Figure 8).

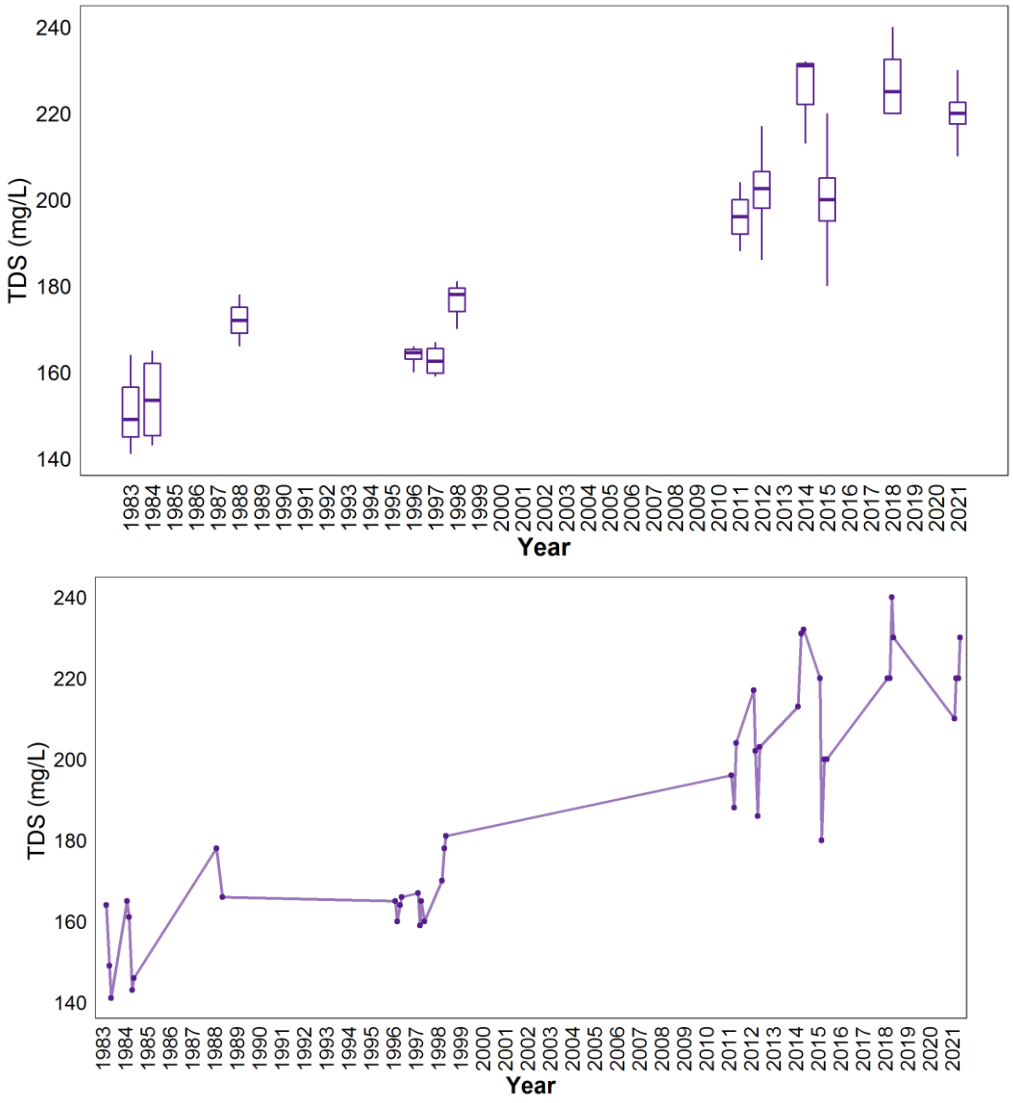


Figure 8. Monthly TDS values measured between June and September over the long term sampling dates between 1983 and 2021 (n = 42). The value closest to the 15th day of the month, was chosen to represent the monthly value in cases with multiple monthly samples.

Due to the significant increasing trend of TDS in Isle Lake, exploring the specific major ions, which may be driving this trend, is important to determine. Trend analysis of the major ions at Isle Lake indicates that alkalinity (bicarbonate, carbonate), sodium and chloride, are likely the key parameters that drove the historical increase in TDS (Figure 9). These three ions and potassium appear to have had a step increase between the first half of the historical record compared to the second half, although alkalinity and sodium appear to have been decreasing in the last 5 years. Chloride and potassium have not decreased to the same degree, in recent years, as much as alkalinity and sodium. Visual trends of magnesium and calcium indicate that these ions may also be increasing over time, but data is insufficient to perform trend analysis.

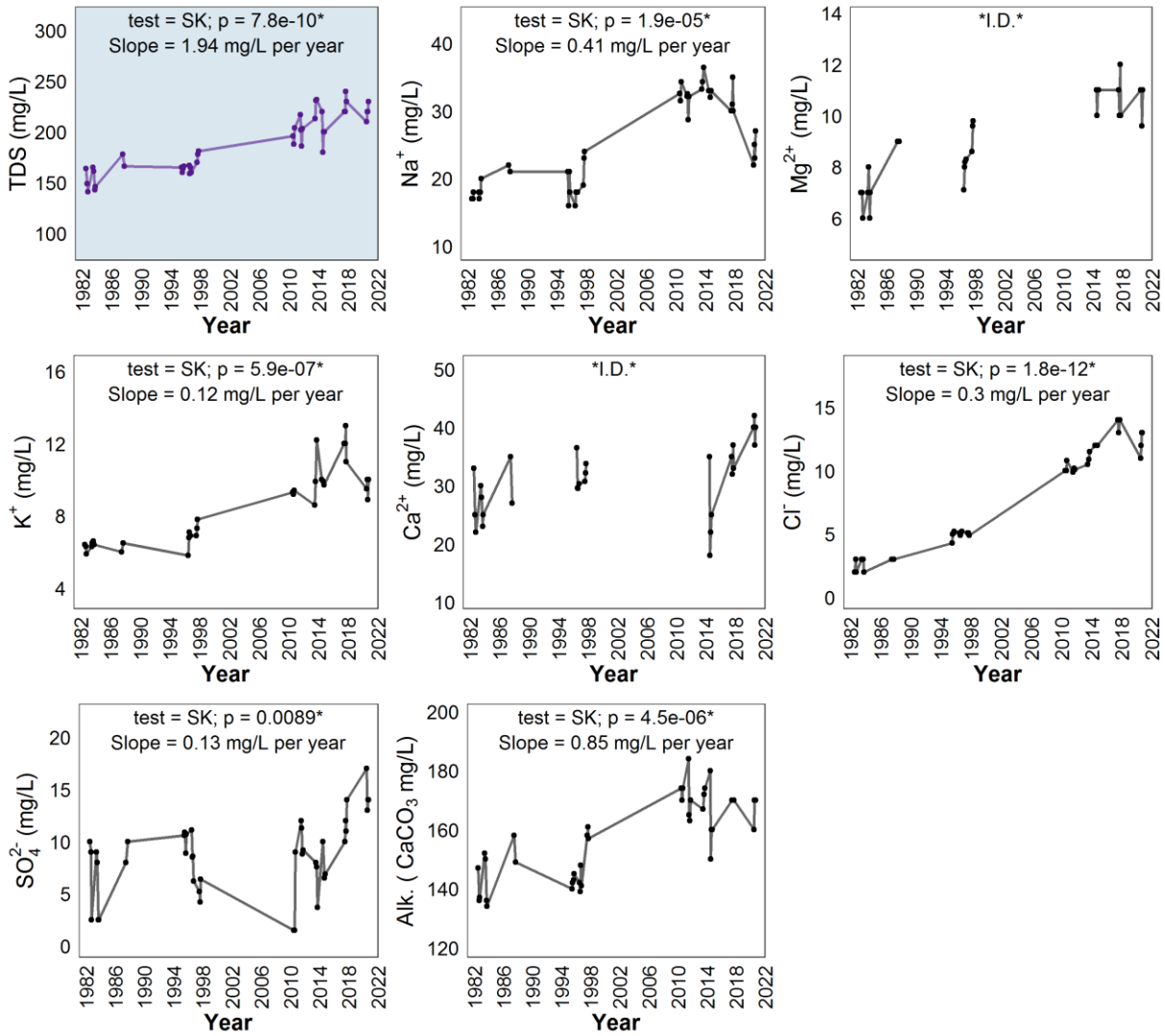


Figure 9. Concentrations of TDS (top left, blue panel), major ions (sodium = Na^+, magnesium = Mg^{2+}, potassium = K^+, calcium = Ca^{2+}, chloride = Cl^-, sulphate = SO_4^{2-}), and total alkalinity (Alk., as mg/L $CaCO_3$) measured monthly between June and September on sampling dates between 1983 and 2021. 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

Secchi depth has not significantly changed in Isle Lake since 1983 (Tau = -0.22, p = 0.069).

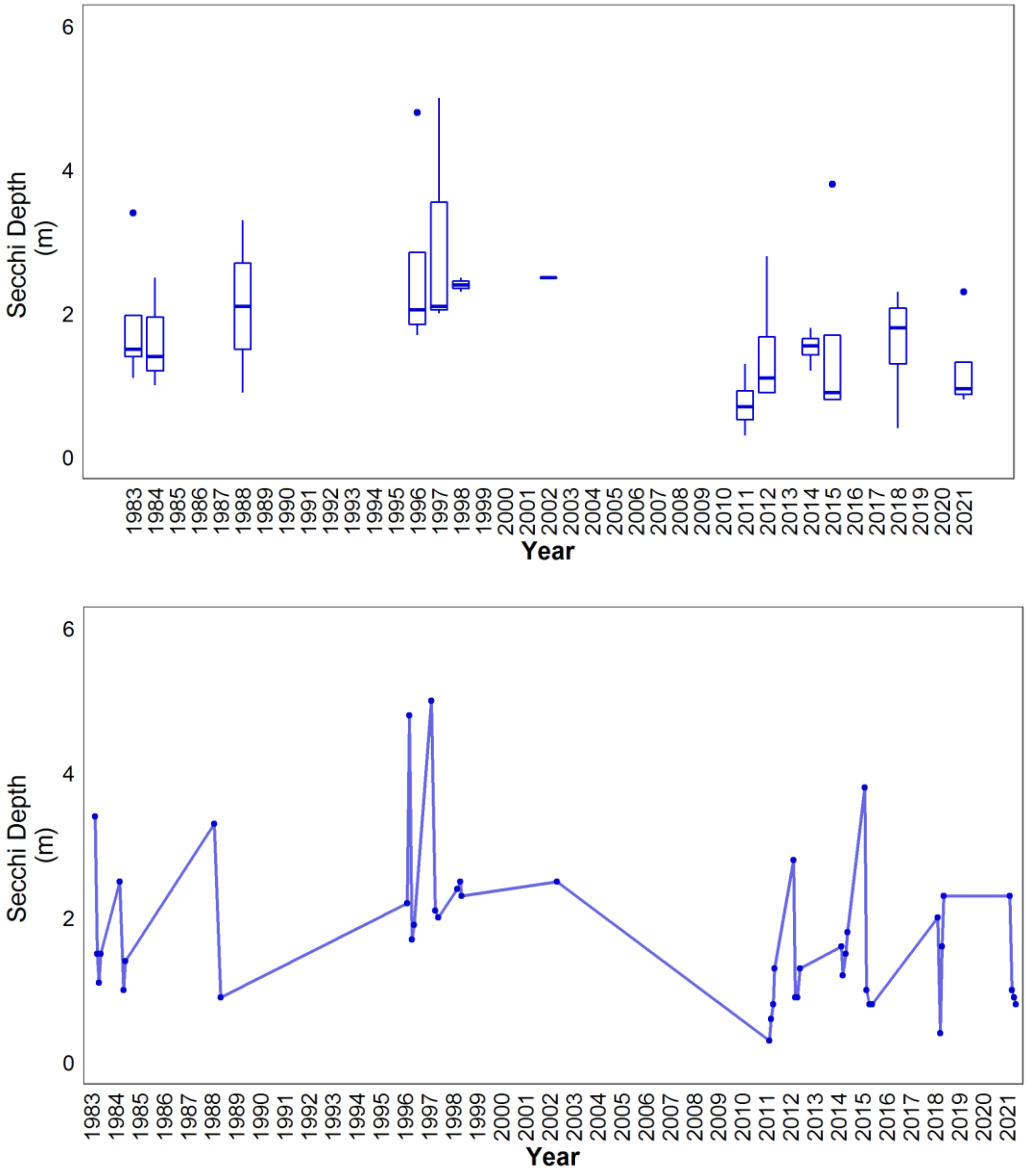


Figure 10. Monthly Secchi depth values measured between June and September over the long term sampling dates between 1983 and 2021 (n = 44). The value closest to the 15th day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

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 1983-2021 on Isle 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	0.28	0.13	0.74	-0.22
The extent of the trend	Slope (units per Year)	2.58	0.45	1.94	-0.01
The statistic used to find significance of the trend	Z	2.44	1.05	6.15	-1.82
Number of samples included	n	46	45	42	44
The significance of the trend	*p*	1.47×10^{-2}*	0.29	7.79×10^{-10}*	6.91×10^{-2}

*$p < 0.05$ is significant within 95%