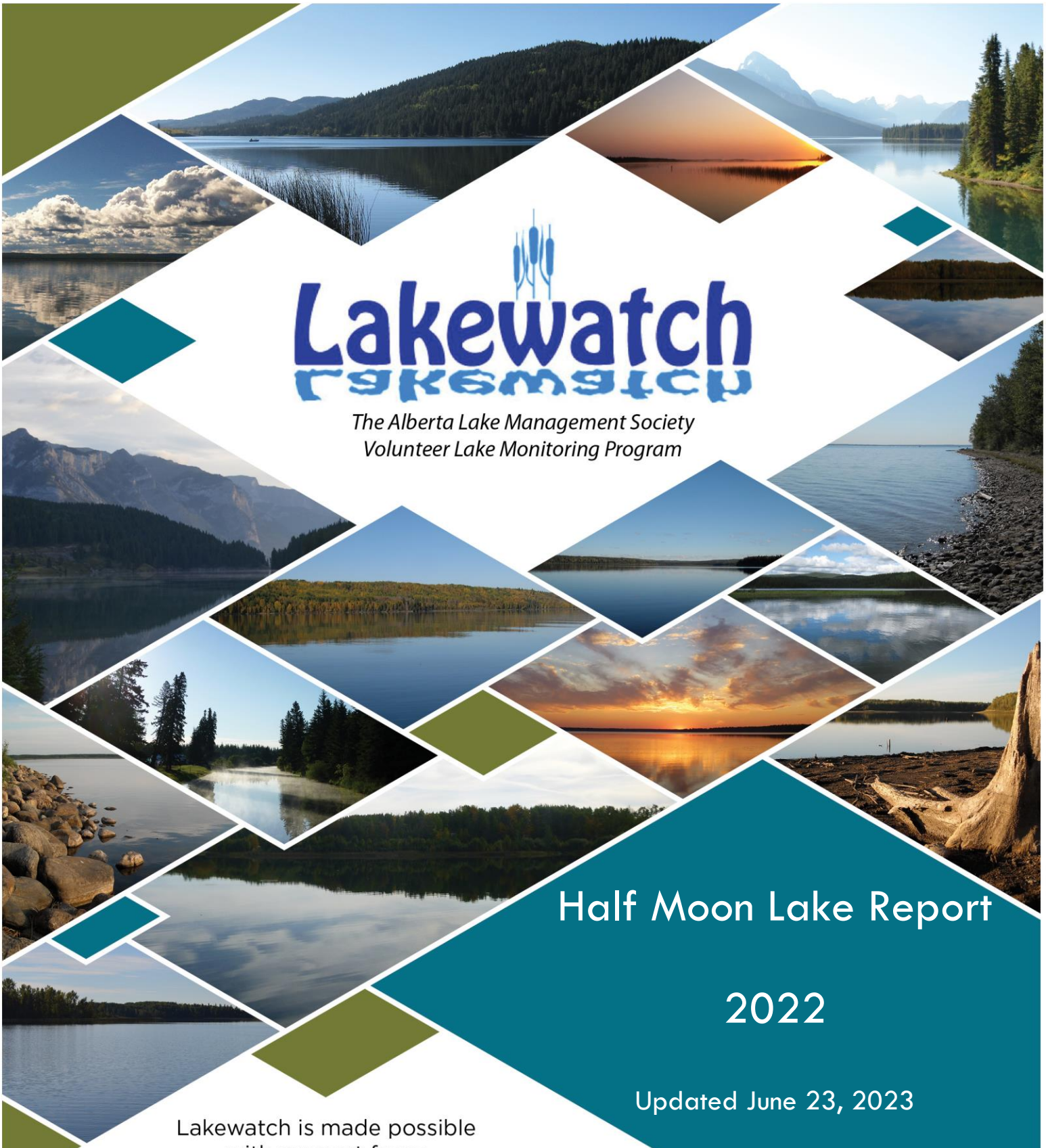

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Half Moon Lake Report

2022

Updated June 23, 2023

Lakewatch is made possible with support from:

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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

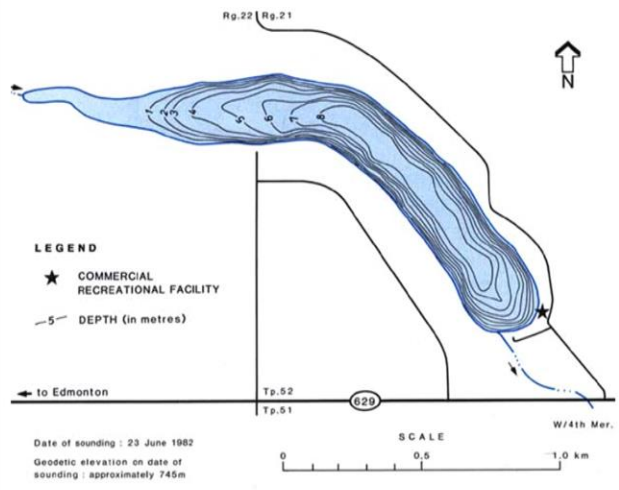
The LakeWatch program is made possible through the dedication of its volunteers. A special thanks to Richard Normandeau for his commitment to collecting data at Half Moon Lake. We would also like to thank Kurstyn Perrin and Dominic Wong, who were summer technicians in 2022. Executive Director Bradley 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.

HALF MOON LAKE

Half Moon Lake is a small lake east of the City of Edmonton in the County of Strathcona. Half Moon Lake lies in the North Saskatchewan River basin, within the Moist Mixedwood Subregion of the Boreal Mixedwood Ecoregion, thus the watershed is dominated by trembling aspen (Populus tremuloides) and balsam poplar (Populus balsamifera)[1].

Half Moon Lake, named for its shape, is small, with a surface area of only 0.41 km^2 and a maximum depth of 8.5 m. The drainage basin is also small, measuring only 2.43 km^2, resulting in a drainage basin to surface area ratio of 6:1. Only one intermittent stream flows into the lake from the north. Development in Half Moon Lake's watershed includes residential units on the East and West shores, and one resort, the Half Moon Lake Resort, on the South shore.

Despite the lakes popularity as a recreational destination, sport fishing is absent. Half Moon Lake has been the subject of several in-lake treatments for the control of nuisance algal/cyanobacterial blooms including herbicides and the addition of lime[2]. In 1989, 58 tonnes of calcium carbonate and 49 tonnes of calcium hydroxide were added to the lake in effort to reduce the amounts of phosphorus and algae/cyanobacteria biomass[3]. In 1989, after positive results from the first additions, an extra 139 tonnes of calcium hydroxide was added to the lake. Results of treating the lake with calcium hydroxide have been mixed and this treatment is likely not a viable way to treat Half Moon Lake. The Residents of Half Moon Lake are considering other treatment options for the lake, subject to better understanding of current and future conditions.



Bathymetry and shoreline features of Half Moon Lake. Source: Babin 1984.

Freshwater invertebrates (bryozoans) found at the bottom of Half Moon Lake—photo by Laura Redmond 2017

[1] Strong, W.L. and K.R. Leggat. (1981). Ecoregions of Alberta. Alta. En. Nat. Resour., Resour. Eval. Plan. Div., Edmonton.
[2] Mitchell, P and E. Prepas. (1990). Atlas of Alberta Lakes, University of Alberta Press. Available at: http://sunsite.ualberta.ca/Projects/Alberta-Lakes/
[3] Prepas, J. and Babin, J. (1990). Final Report on the 1989 Lime Treatment of Halfmoon Lake. Retrieved from: http://environment.gov.ab.ca/info/library/8316.pdf

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

WATER CHEMISTRY

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

The average total phosphorus (TP) concentration for Half Moon Lake was 87 µg/L (Table 2), falling into the eutrophic, or highly productive trophic classification. This value is consistent with the range of observed historical averages (Table 2). TP ranged from a minimum of 54 µg/L on July 20th, to a maximum of 150 µg/L on September 9th (Figure 1).

Average chlorophyll-*a* concentration in 2022 was 52.9 µg/L (Table 2), falling into the hypereutrophic, or very highly productive trophic classification. Chlorophyll-*a* was lowest earliest in the season, at 2.8 µg/L on June 16th and peaked at 90.2 µg/L on September 9th.

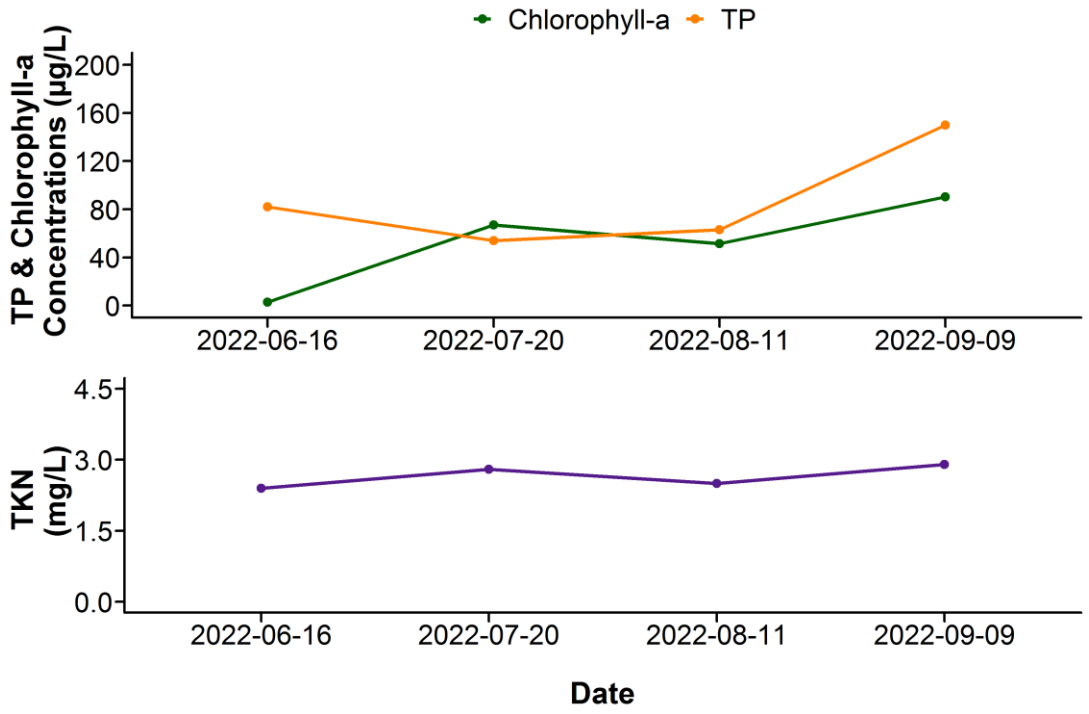


Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Half Moon Lake.

The average TKN concentration was 2.6 mg/L (Table 2). TKN displayed little variation through the season, (Figure 1). Additionally, the lake displayed high levels of ammonia (NH_3) during the June 16th sampling event, which exceeded the CCME guideline for the protection of aquatic life[1] (Figure 2).

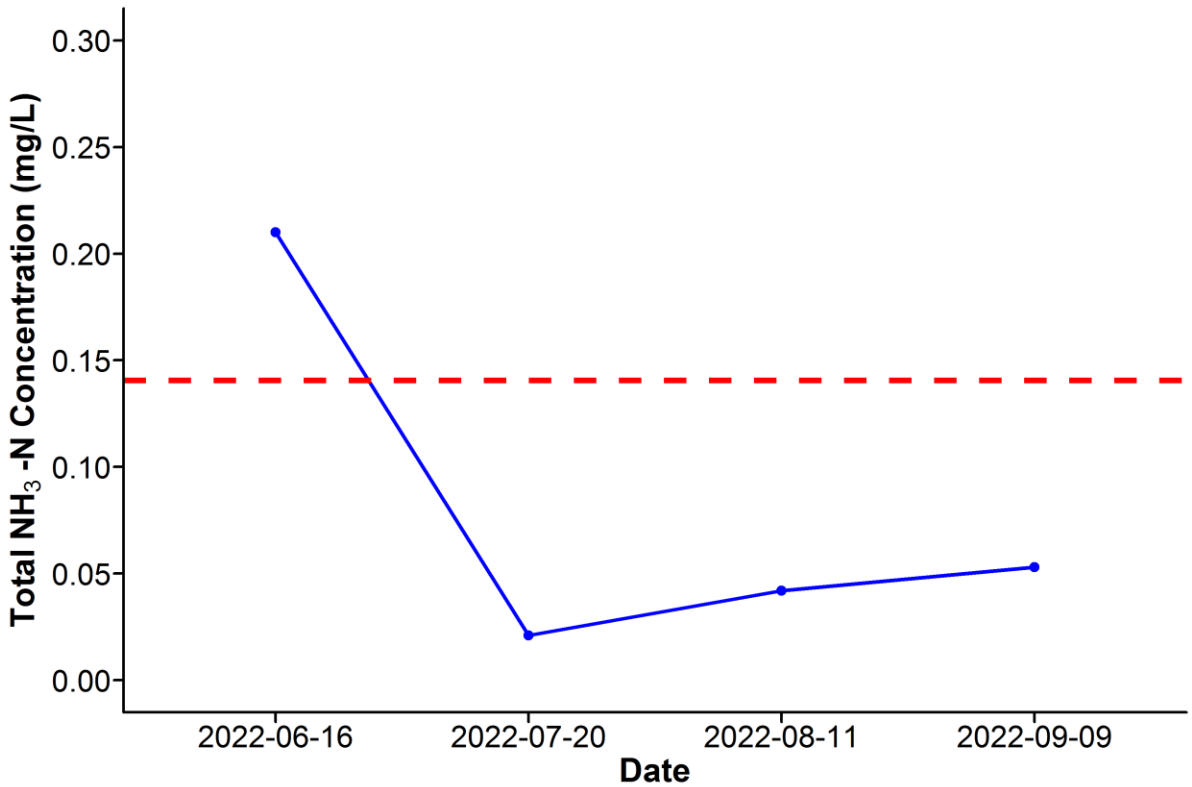


Figure 2. Total ammonia (NH_3-N) concentrations measured four times over the course of the summer at Half Moon Lake, along with the CCME guideline for the protection of aquatic life, chronic exposure to Ammonia at pH=8.5, and water temperature at 20°C (0.141 mg/L). Note that the pH and water temperatures used are based on the average pH and water temperature at Half Moon Lake in 2022. Also note that the guideline is based on NH_3 as N speciation, not NH_3 as NH_3 speciation.

[1] Canadian Council of Ministers of the Environment (CCME). 2010. Canadian water quality guidelines for the protection of aquatic life: Ammonia. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Average pH was measured as 8.39 in 2022, buffered by moderate alkalinity (185 mg/L $CaCO_3$) and bicarbonate (220 mg/L HCO_3). Aside from bicarbonate, all ions with the exception of sulphate and carbonate had similar levels, and together contributed to a low conductivity of 445 µS/cm (Figure 3, top; Table 2). Half Moon Lake is in the average to low end range of ion levels, compared to other LakeWatch lakes sampled in 2022 (Figure 3, bottom). Interestingly Half Moon has the lowest measured level of sulphate compared to all other lakes monitored in 2022 through the LakeWatch program.

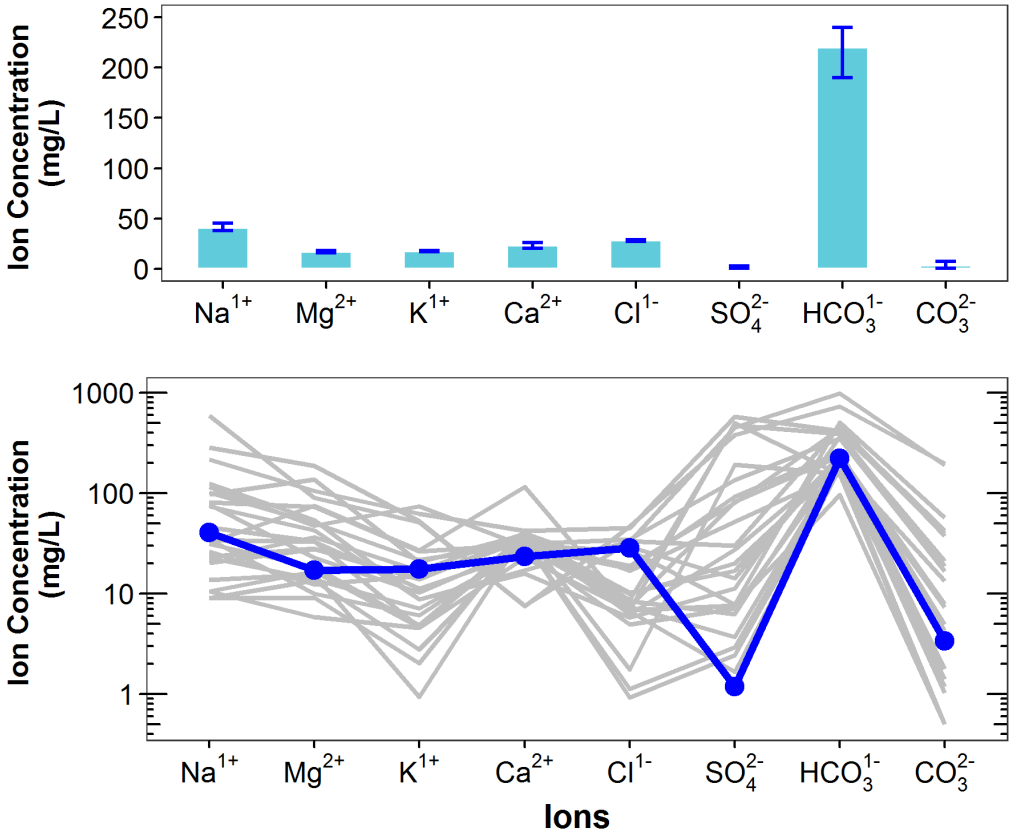


Figure 3. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Half Moon Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Half Moon Lake (blue line) compared to 26 lake basins (gray lines) sampled through the LakeWatch program in 2022 (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 Half Moon Lake in 2022, but Table 3 lists metal concentrations from 2017.

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 Half Moon Lake in 2022 was 3.86 m, corresponding to an average Secchi depth of 1.93 m (Table 2). Euphotic depth varied greatly over the season, ranging from as deep as 8.3 m on June 16th (the measured bottom depth), and then to as little as 1.30 m and 1.50 m on July 20th and September 13th, respectively (Figure 4). Secchi depth was significantly negatively correlated with chlorophyll-*a* ($r = -0.96$, $p = 0.04$), indicating that algae and cyanobacteria abundance was responsible for the changes in water clarity through the summer.

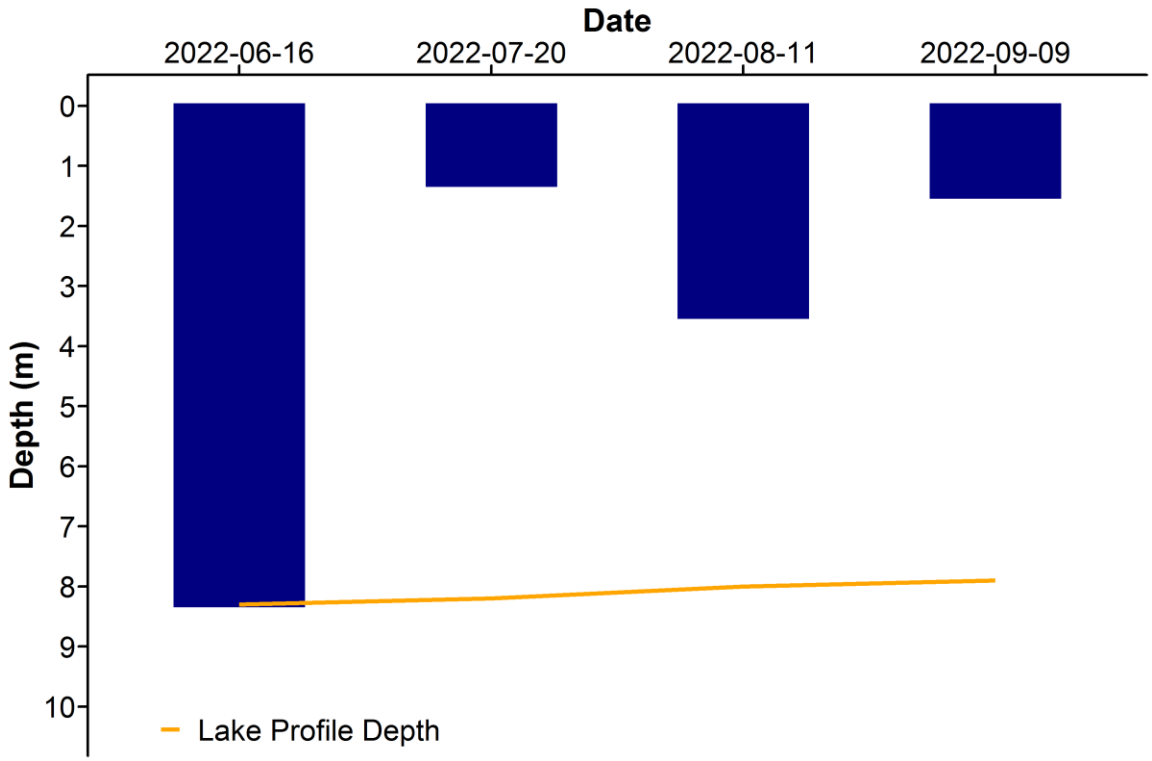


Figure 4. Euphotic depth values measured four times over the course of the summer at Half Moon Lake in 2022.

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, with the July 20th sampling date having the warmest temperatures at 22.9°C (Figure 5a). The lake displayed moderate and weak stratification during all sampling trips, with the exception of September, where the lake was primarily mixed.

Half Moon Lake was well oxygenated in the surface waters only during the July and August sampling events measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 5b). The entire water column was below 6.5 mg/L during the June and September sampling events, and on every date, dissolved oxygen levels eventually became anoxic (<1.0 mg/L), at depths ranging between 4.5 m (July 20th) to 7.0 m (September 9th).

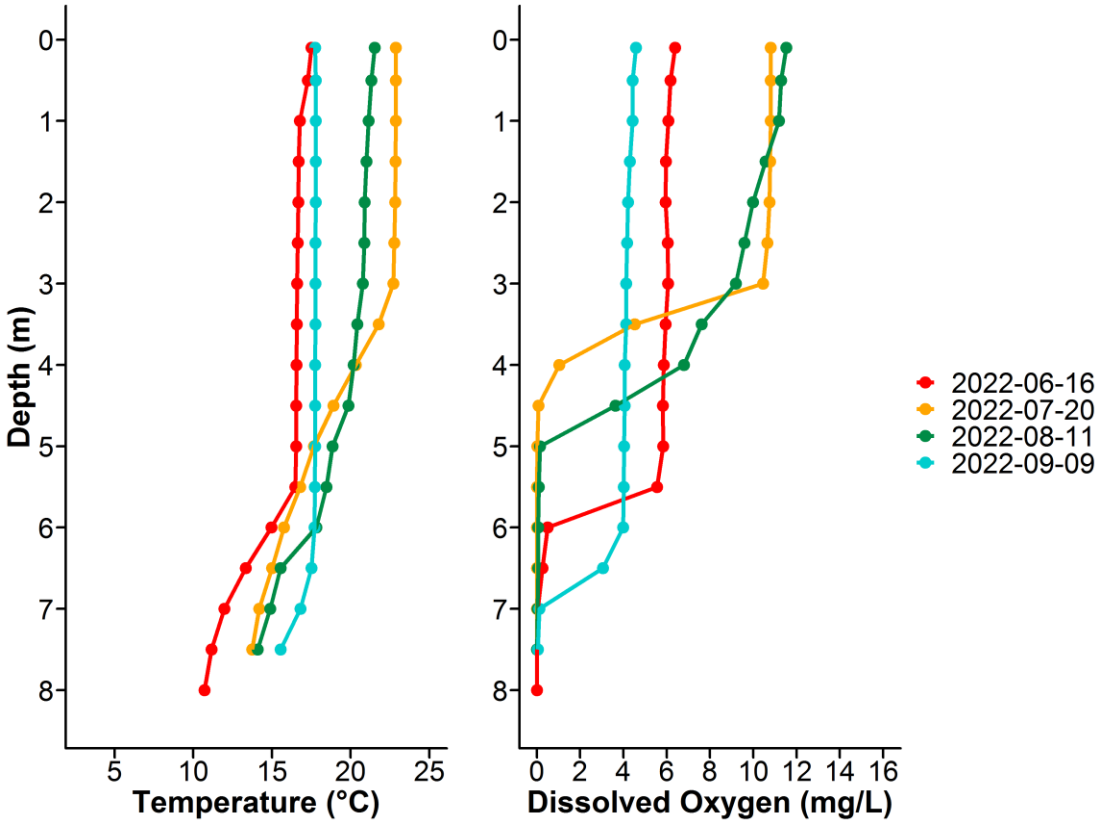


Figure 5. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Half Moon Lake measured four times over the course of the summer of 2022.

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 Half Moon Lake fell below the recreational guideline of 10 µg/L during every sampling event in 2022. Even though low levels of microcystin were detected, caution should always be observed when recreating around cyanobacteria.

Table 1. Microcystin concentrations measured four times at Half Moon Lake in 2022.

Date	Microcystin Concentration (µg/L)
16-Jun-22	0.22
20-Jul-22	1.63
11-Aug-22	5.21
9-Sep-22	3.18
Average	2.56

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 for aquatic invasive species involved sampling with a 63 µm plankton net at three sample sites. This monitoring is designed to detect juvenile Dreissenid mussel veligers and spiny water flea. In 2022, no mussels or spiny water flea were detected at Half Moon 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.

No suspect watermilfoil was observed or collected from Half Moon Lake in 2022.

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 Protected Areas.

Water levels at Half Moon Lake in 2022 were slightly below the historical average (Figure 6). In addition, the recent 4 years of monitoring show similar variation as to what was measured between 1991 – 2002.

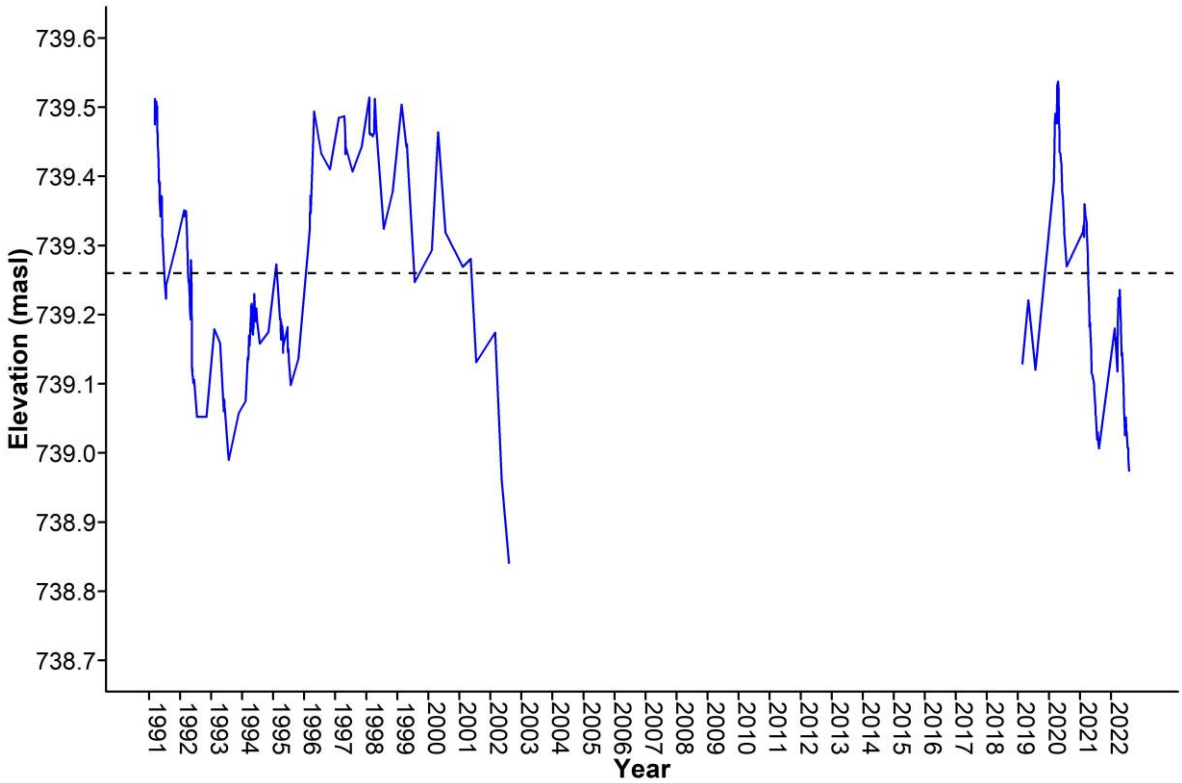


Figure 6. Water levels measured at Half Moon Lake in metres above sea level (masl) from 1991-2022. Data retrieved from Alberta Environment and Protected Areas and/or Environment and Climate Change Canada. Black dashed line represents historical yearly average water level.

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.

Half Moon Lake experienced a warmer, wetter, and less windy summer than normal (Figure 7). Warm days preceding the July and August sampling events lead to higher surface water temperatures. Due to the small size of Half Moon Lake, and the number of calm and warm days, more frequent temperature stratification likely occurred in the lake in 2022.

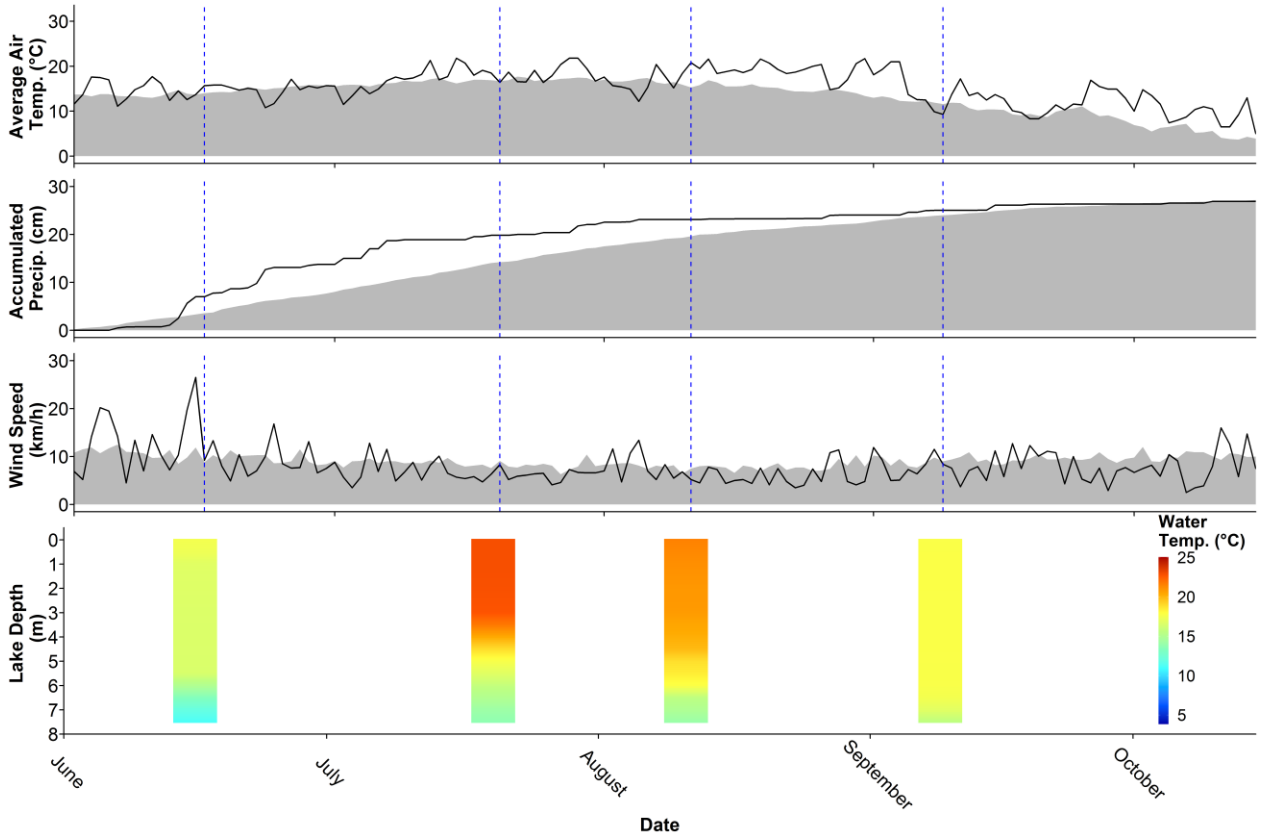


Figure 7. Average air temperature (°C), accumulated precipitation (cm), and wind speed (km/h) measured from 'New Sarepta AGCM,' as well as Half Moon Lake temperature profiles, interpolated (°C). Black lines indicate 2022 levels, gray indicates long-term normals, and blue lines indicate sampling dates for Half Moon Lake over the summer. Further information about the weather data provided is available in the LakeWatch 2022 Methods report. Weather data provided by Agriculture, Forestry and Rural Economic Development, Alberta Climate Information Service (ACIS) https://acis.alberta.ca (retrieved March 2023). Note that solar radiation data is unavailable for 'New Sarepta AGCM.'

Table 2. Average Secchi depth and water chemistry values for Half Moon

Parameter	1982[a]	1987	1988	1989	1990	2011	2017	2018	2019	2020	2022
TP (µg/L)	124	99	135	87	75	111	75	96	80	76	87
TDP (µg/L)	/	27	47	37	26	29	11	9	17	25	24
Chlorophyll-*a* (µg/L)	50.2	63.8	/	44.4	39.5	41.4	51.6	86.3	41.5	27.3	52.9
Secchi depth (m)	1.30	0.80	/	1.48	1.4	1.33	0.66	0.38	1.56	1.27	1.93
TKN (mg/L)	3.1	2.2	2.6	2.0	2.0	2.8	2.7	3.0	2.4	2.1	2.6
NO_2-N and NO_3-N (µg/L)	44	9	15	76	55	4	2	4	25	5	24
NH_3-N (µg/L)	/	/	127	212	65	41	38	81	173	107	82
DOC (mg/L)	/	/	20	19	18	22	22	24	21	19	21
Ca^{2+} (mg/L)	/	19	20	17	19	22	24	23	24	29	23
Mg^{2+} (mg/L)	/	11	14	11	12	17	19	18	17	16	17
Na^{+} (mg/L)	/	18	19	20	20	35	43	41	40	39	40
K^{+} (mg/L)	/	13	13	12	12	15	20	19	18	17	18
SO_4^{2-} (mg/L)	/	<5	<5	4	4	3	3	3	1	3	1
Cl^{-} (mg/L)	/	8	8	9	10	20	26	27	27	27	28
CO_3^{2-} (mg/L)	/	18	7	17	12	9	11	11	4	4	3
HCO_3^{-} (mg/L)	/	133	167	134	156	196	205	208	218	215	220
pH	/	9.05	8.20	8.98	8.67	8.74	8.81	8.71	8.49	8.38	8.39
Conductivity (µS/cm)	/	287	304	291	294	697	430	430	435	443	445
Hardness (mg/L)	/	91	105	90	96	124	135	128	128	143	130
TDS (mg/L)	/	156	165	155	159	224	245	240	238	243	242
Microcystin (µg/L)	/	/	/	/	/	2.07	9.80	6.60	4.84	0.28	2.56
Total Alkalinity (mg/L $CaCO_3$)	/	139	143	136	138	175	188	185	185	183	185

[a] Data from: Mitchell, P and E. Prepas. (1990). Atlas of Alberta Lakes, University of Alberta Press. Available at: http://sunsite.ualberta.ca/Projects/Alberta-Lakes/

Table 3. Concentrations of metals measured in Half Moon 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)	2017 Top	2017 Bottom	Guidelines
Aluminum µg/L	9.6	12	100[a]
Antimony µg/L	0.07	0.07	/
Arsenic µg/L	1.36	1.38	5
Barium µg/L	49.5	53.5	/
Beryllium µg/L	0.0015	0.0015	100[c,d]
Bismuth µg/L	0.0015	0.0015	/
Boron µg/L	75.8	76.6	1500
Cadmium µg/L	0.005	0.005	0.20[b]
Chromium µg/L	0.3	5.3	/
Cobalt µg/L	0.084	0.119	50,1000[c,d]
Copper µg/L	0.23	0.45	3.1[b]
Iron µg/L	27.8	82.9	300
Lead µg/L	0.032	0.114	4.7[b]
Lithium µg/L	27.7	26.7	2500[d]
Manganese µg/L	42.4	104	120[e]
Molybdenum µg/L	0.23	0.16	73
Nickel µg/L	0.36	10.3	120[b]
Selenium µg/L	0.219	0.287	1
Silver µg/L	0.77	2.41	0.25
Strontium µg/L	0.3	0.2	/
Thallium µg/L	5.00E-04	5.00E-04	0.8
Thorium µg/L	118	115	/
Tin µg/L	0.001	0.001	/
Titanium µg/L	0.011	0.008	/
Uranium µg/L	0.03	0.03	15
Vanadium µg/L	0.45	0.66	100[c,d]
Zinc µg/L	0.545	0.536	30[f]

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on 2017 avg. water hardness (as $CaCO_3$) 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 2017 avg. water hardness (as $CaCO_3$) and avg. pH

[f] Based on 2017 avg. water hardness (as $CaCO_3$), avg. pH, and avg. DOC with CCME equation

A forward slash (/) indicates an absence of data or guideline