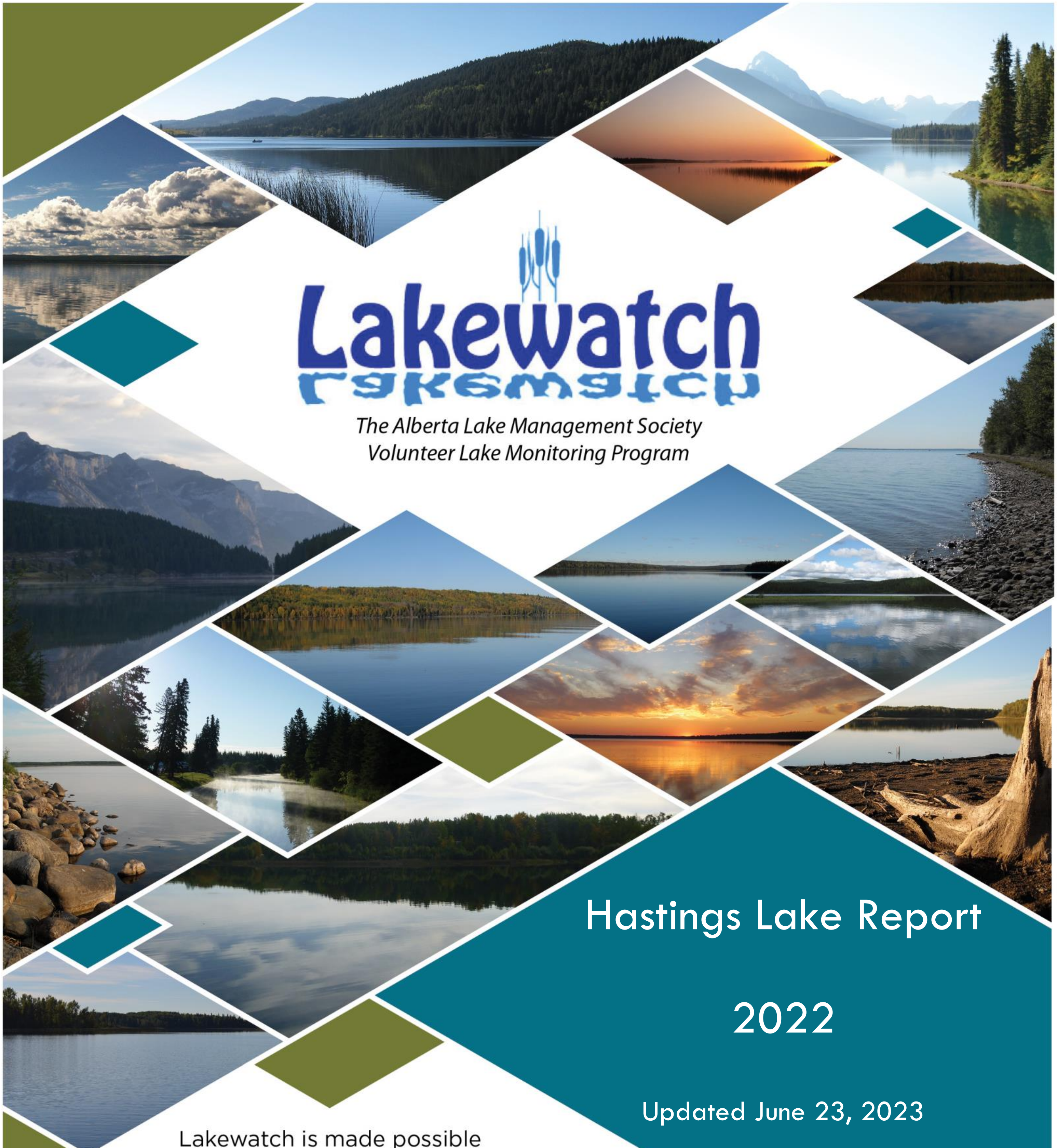

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Hastings Lake Report

2022

Updated June 23, 2023

Lakewatch is made possible with support from:

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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 Ken Quackenbush for his commitment to collecting data at Hastings 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.

HASTINGS LAKE

Hastings Lake, with its natural shoreline and many islands, is a regionally significant nesting, moulting, staging, and migration area for diving ducks, and its islands provide nesting habitat for Canada Geese. The lake is located 40 km east of the city of Edmonton in Strathcona County.

The Cree name for the lake is a-ka-ka-kwa-tikh, which means "the lake that does not freeze".[1] Apparently, springs that flow into the lake bottom prevent parts of the lake from icing over in the winter. In 1884, the lake and its outlet were renamed by J.B. Tyrell for Tom Hastings, a member of Tyrell's geological survey party.

Hastings Lake, photo my Randi Newton, 2012.

Hastings Lake is a shallow, medium-sized water body that consists of two basins separated by a narrow channel. The small, northeast basin is known locally as Little Hastings Lake. The lake has more than 20 islands, mostly located in the main basin; their number and size vary with the water level. When the main basin was surveyed in July 1964, its maximum depth was 7.3 m.

The first settlers at Hastings Lake were Jonas Ward and August Gladue, who arrived sometime during the late 1800's. A Grand Trunk Railway station was built in 1909 at the hamlet of Deville, 2.5 km north of the lake, and a post office was established there soon after. In 1912, the school district of Deville was created, and a school was built in the hamlet. By the late 1890s's, most of the virgin timber had been removed from the area surrounding Hastings Lake, either by fire or by timber cutting. In 1893, Alberta's first forest reserve, the Cooking Lake Forest Reserve, was opened. It included all of Hastings Lake drainage basin as well as land north and south of the drainage basin.

Most of the people who use Hastings Lake are local residents, and recreational facilities for visitors are limited. The only campground is Kawtikh Recreational Retreat on the north shore, a commercially operated facility that opened in 1988. There are 40 rustic campsites, a playground, a picnic area, and a boat launch. The area is used for picnicking, bird watching, and wildlife viewing. Grazing is permitted and the land is fenced, but access to the lakeshore is available and small boats can be launched at the end of the range road. The remainder of the shoreline, with the exception of some reserve land within the hamlet of Hastings Lake, is privately owned. Within the hamlet there is a summer camp operated by the Hastings Lake and Lutheran Bible Camp Association. The most popular recreational activities at Hastings Lake are bird watching and canoeing.

[1] Mitchell, P. and E. Prepas. 1990. Atlas of Alberta Lakes, University of Alberta Press.

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 Hastings Lake was 116 µg/L (Table 2), falling into the hypereutrophic, or very highly productive trophic classification. This value is consistent with the range of observed historical averages (Table 2). TP ranged from a minimum of 96 µg/L on August 19th, to a maximum of 140 µg/L on September 27th (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 during the July 4th sampling event, at 14.0 µg/L, then peaked at 76.7 µg/L on September 27th.

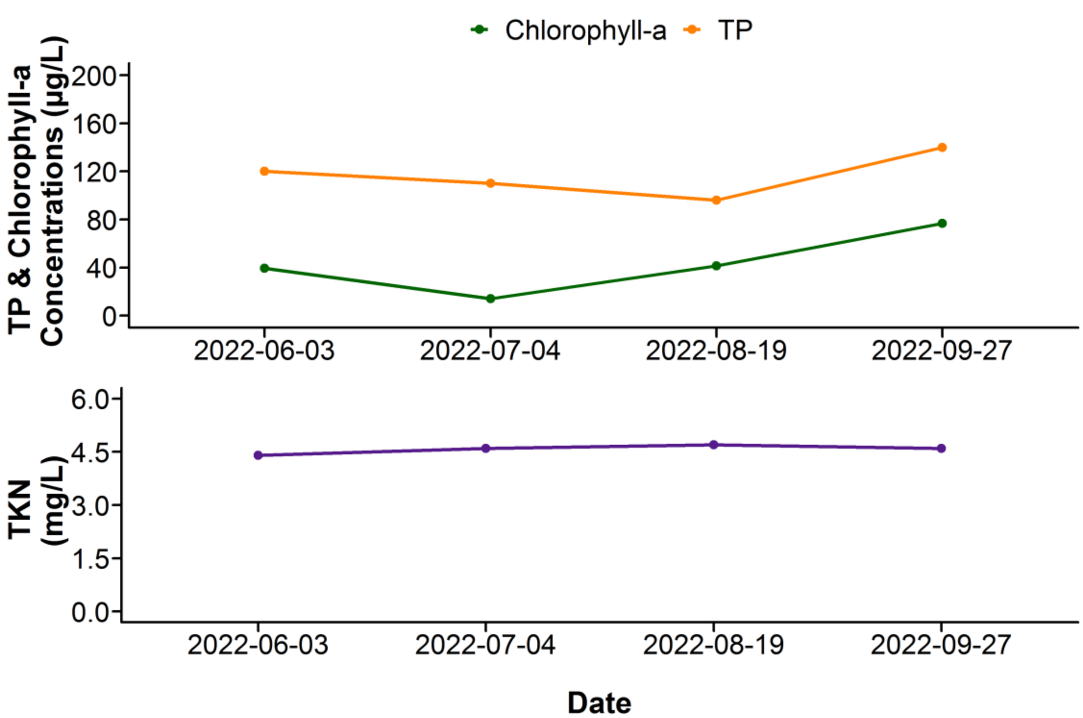

Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Hastings Lake.

The average TKN concentration was 4.6 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 July 4th sampling event, which exceeded the CCME guideline for the protection of aquatic life[2] (Figure 2).

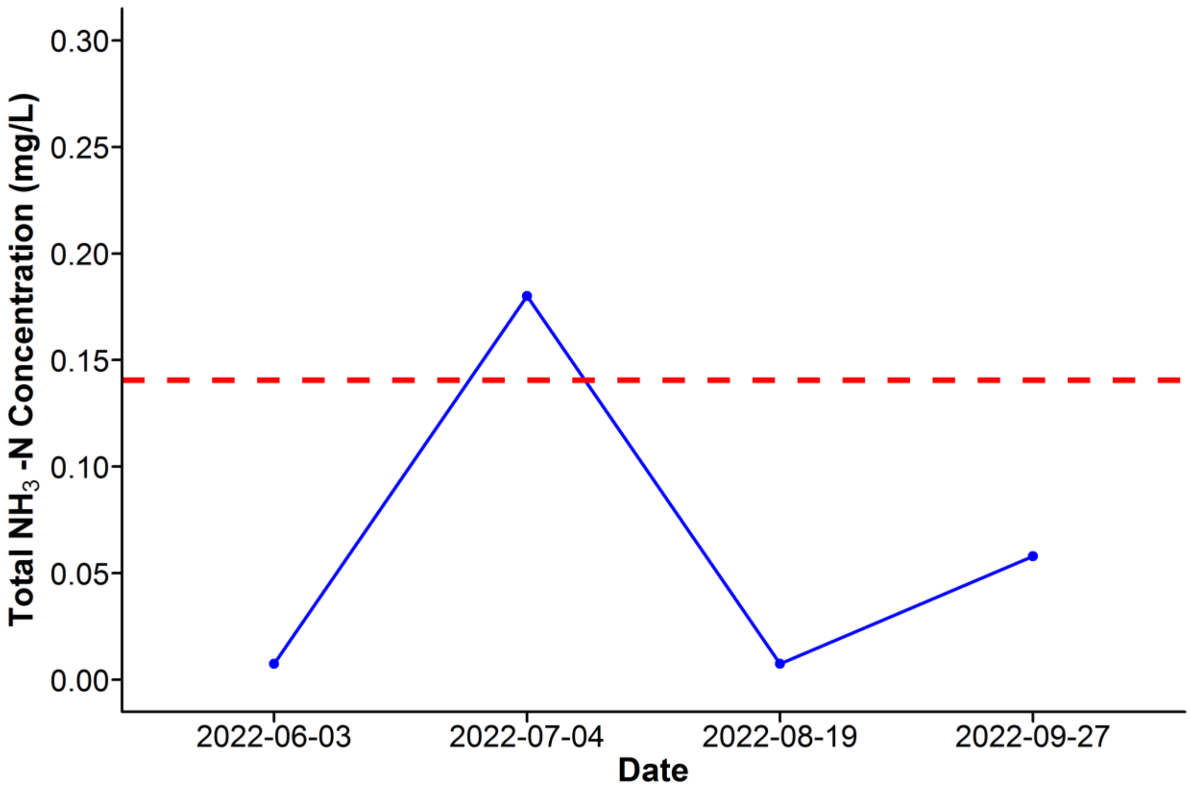

Figure 2. Total ammonia (NH_3-N) concentrations measured four times over the course of the summer at Hastings Lake, along with the CCME guideline for the protection of aquatic life, chronic exposure to Ammonia at pH=8.5, and water temperature at 20°C (0.141 mg/L). Note that the pH and water temperatures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

[2] 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 8.74 in 2022, buffered by high alkalinity (408 mg/L $CaCO_3$) and bicarbonate (415 mg/L HCO_3). Sulphate is the dominant major ion, followed by bicarbonate and sodium, and all ions together contributed to a high conductivity of 1875 µS/cm (Figure 3, top; Table 2). Hastings Lake is on the high range of ion levels compared to other LakeWatch lakes sampled in 2022, and is one of only a few lakes sampled that were sulphate dominated (Figure 3, bottom). Hastings displayed the highest levels of sulphate, and the second highest measured levels of potassium and chloride compared to all other lakes monitored in 2022.

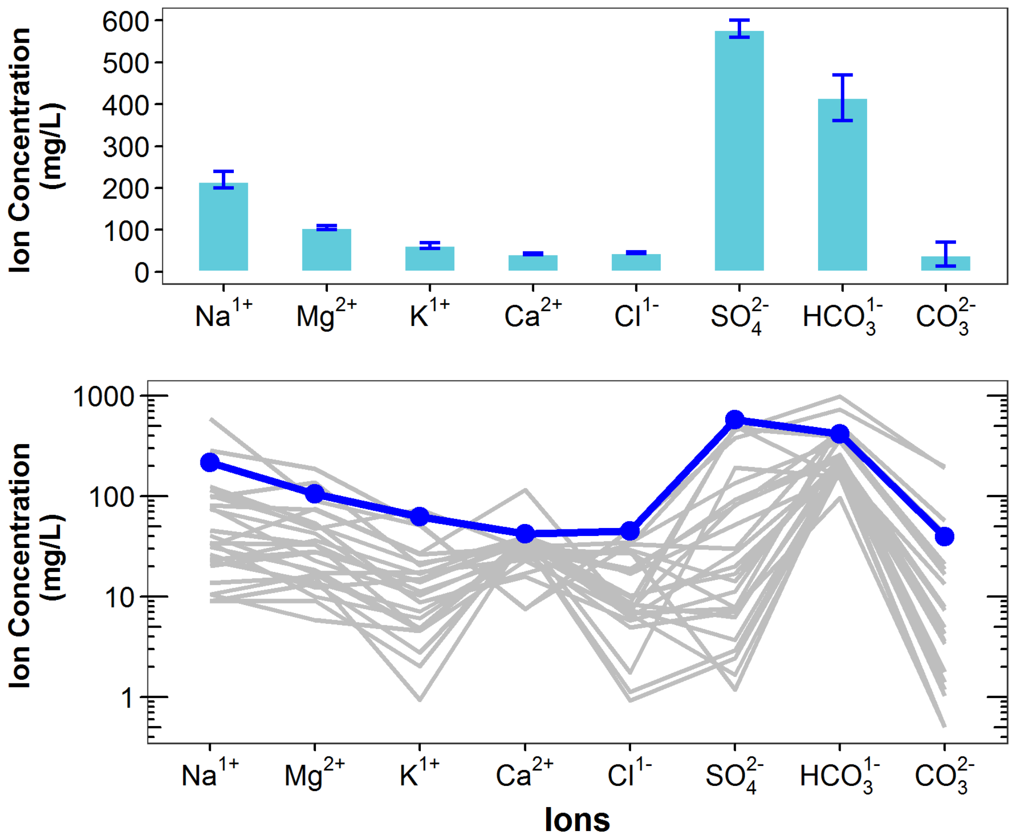

Figure 3. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Hastings Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Hastings 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 Hastings Lake in 2022, but Table 3 lists metal concentrations from 2012.

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 Hastings Lake in 2022 was 1.22 m, corresponding to an average Secchi depth of 0.61 m (Table 2). Euphotic depth varied greatly over the season, ranging from as deep as 1.8 m on July 4th, to as little as 0.9 m on September 27th (Figure 4). The date of best water clarity (July 4th) coincides with lower chlorophyll-a levels, indicating less algae and cyanobacteria, as well as lower dissolved organic carbon levels, which can make water look brownish at higher levels.

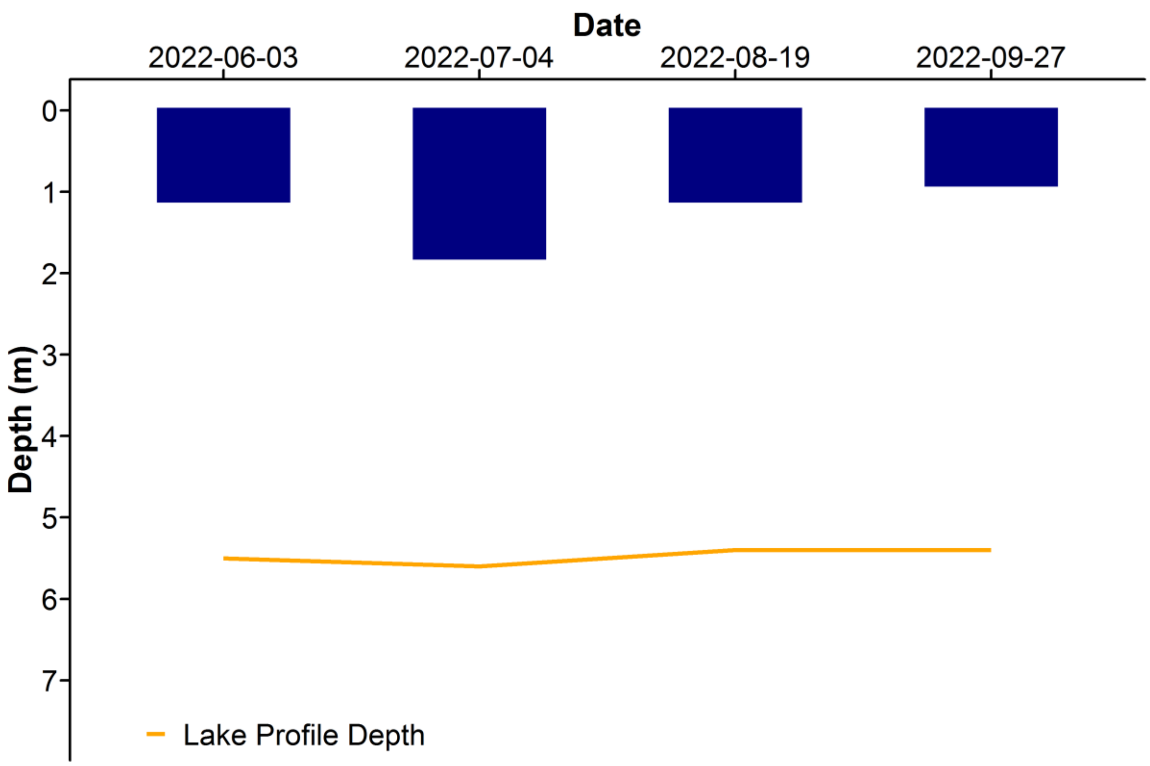

Figure 4. Euphotic depth values measured four times over the course of the summer at Hastings Lake in 2022.

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 Hastings Lake varied throughout the summer, with the August 19th sampling date having the warmest temperatures at 22.8°C (Figure 5a). The lake was mixed during each sampling event, as the water temperatures were consistent from the surface to the bottom of the lake. This is to be expected as the lake is relatively shallow for its large surface area.

Hastings Lake was well oxygenated in the surface waters only during all sampling events measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen, except on July 4th (Figure 5b). During the June and August sampling events, dissolved oxygen levels also were below 6.5 mg/L at depths of 3 m to 5 m, respectively. The lake also displayed anoxic (<1.0mg/L) conditions during the June sampling event, at 5m depth.

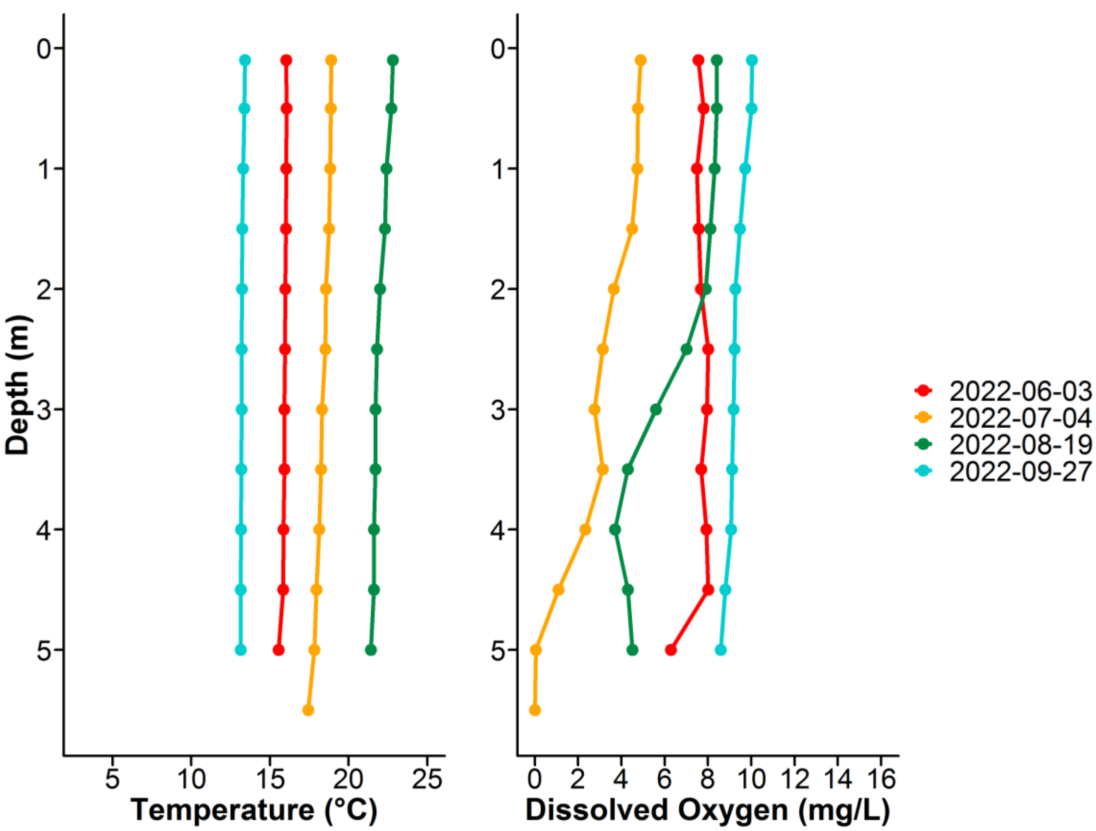

Figure 5. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Hastings Lake measured four times over the course of the summer of 2022.

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 Hastings 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 Hastings Lake in 2022.

Date	Microcystin Concentration (µg/L)
3-Jun-22	0.13
4-Jul-22	0.51
19-Aug-22	1.09
27-Sep-22	2.01
Average	0.93

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 Hastings 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 Hastings 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 Hastings Lake in 2022 were nearly 1m below the historical average (Figure 6). Since the early 2000s, the water levels had been dropping appreciably. Low water levels seen recently at Hastings Lake have been observed before, based on a limited number of measurements in the 1930s and 1940s.

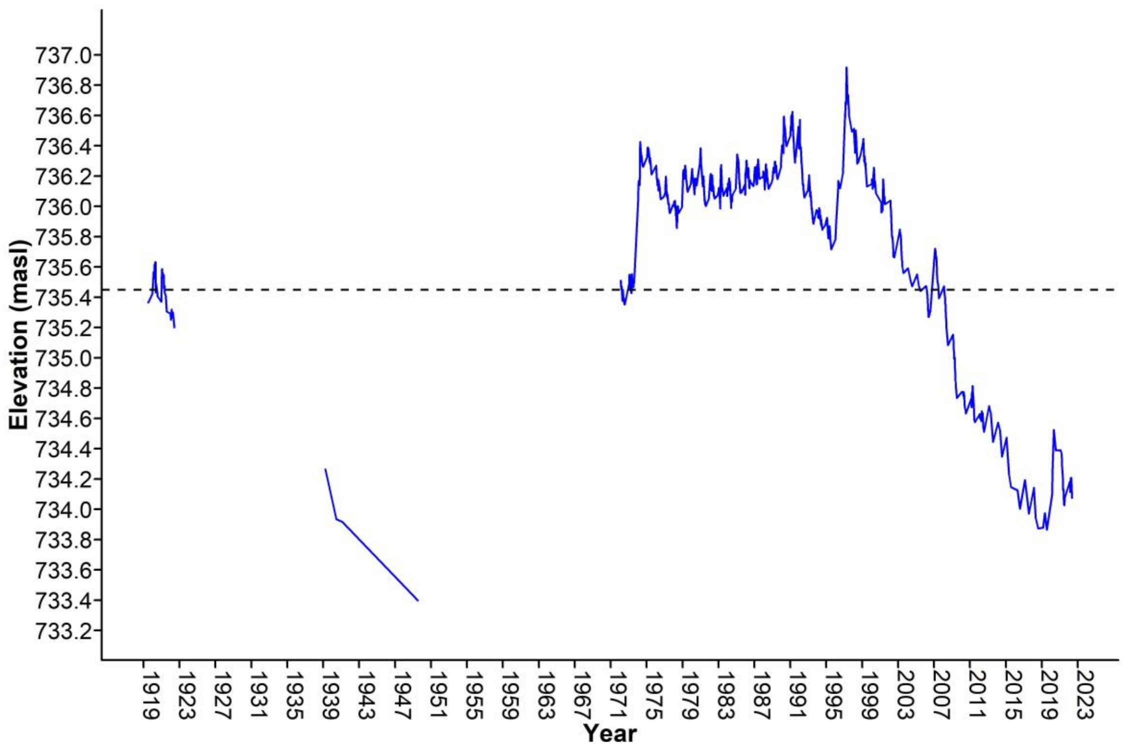

Figure 6. Water levels measured at Hastings Lake in metres above sea level (masl) from 1919-2022. Data retrieved from Alberta Environment and Protected Areas and/or Environment and Climate Change Canada. Black dashed line represents historical yearly average water level.

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.

Hastings Lake experienced a warmer, wetter, and less windy summer than normal (Figure 7). Warm days preceding the August sampling events lead to high water temperatures throughout the whole lake.

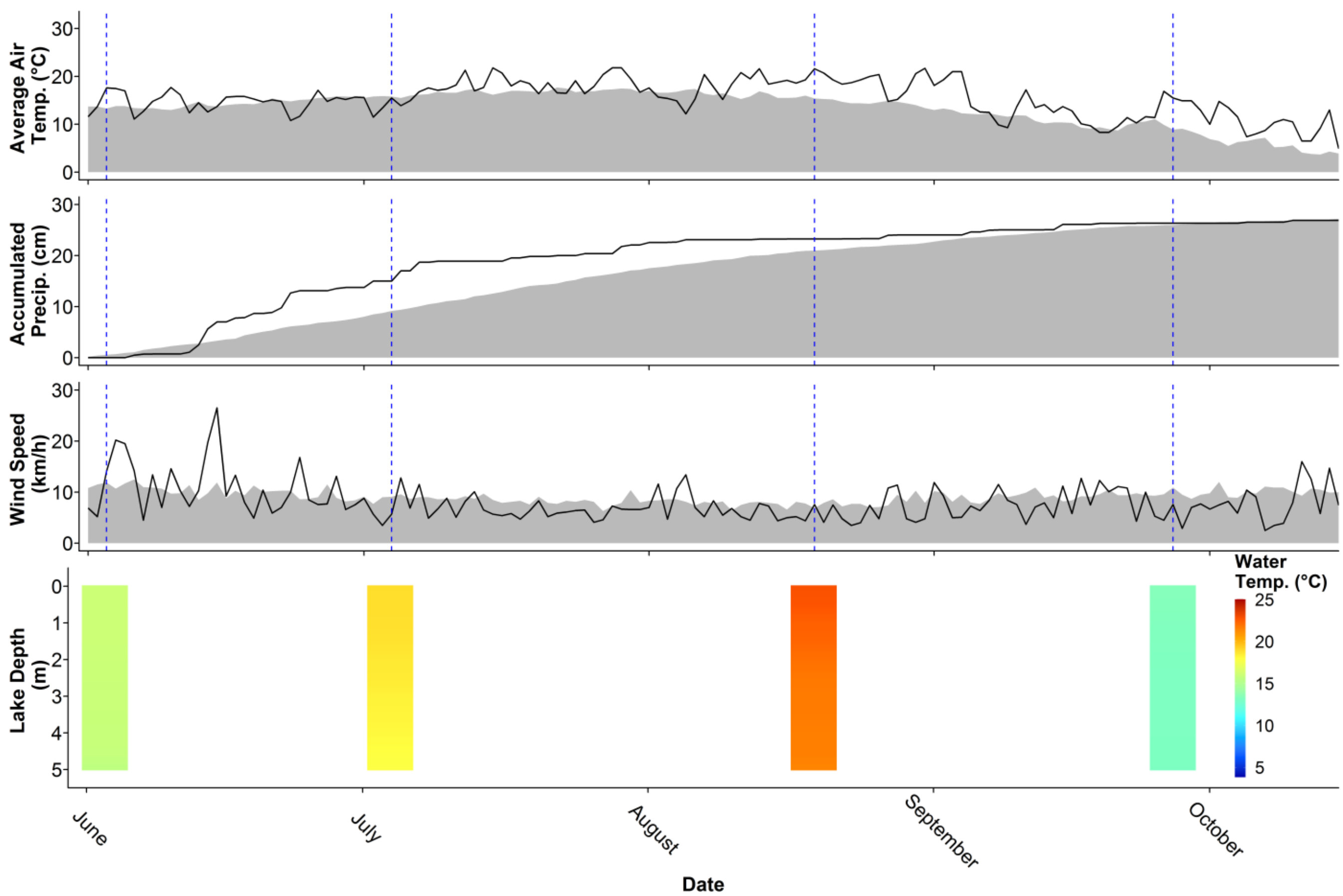

Figure 7. Average air temperature (°C), accumulated precipitation (cm), and wind speed (km/h) measured from 'New Sarepta AGCM,' as well as Hastings Lake temperature profiles, interpolated (°C). Black lines indicate 2022 levels, gray indicates long-term normals, and blue lines indicate sampling dates for Hastings 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 Hastings Lake.

Parameter	1987[a]	1997[b]	2008	2012	2022
TP (µg/L)	114	180	78	88	116
TDP (µg/L)	40	/	20	31	33
Chlorophyll-*a* (µg/L)	72.5	170.4	30.4	32	42.9
Secchi depth (m)	0.9	0.4	0.85	0.59	0.61
TKN (mg/L)	8.4	/	3.6	4.7	4.6
NO_2-N and NO_3-N (µg/L)	12	12	7	2	9
NH_3-N (µg/L)	515	/	43	34	63
DOC (mg/L)	36	/	41	49	49
Ca^{2+} (mg/L)	28	33	29	29	42
Mg^{2+} (mg/L)	46	43	61	72	105
Na^{+} (mg/L)	98	87	139	168	215
K^{+} (mg/L)	28	26	38	45	62
SO_4^{2-} (mg/L)	220	198	274	382	578
Cl^{-} (mg/L)	10	12	22	26	45
CO_3^{2-} (mg/L)	25.8	33	29.5	42.2	39.2
HCO_3^{-} (mg/L)	238	243	324	350	415
pH	9	9.1	8.86	9.07	8.74
Conductivity (µS/cm)	916	747	1165	1424	1875
Hardness (mg/L)	258	259	324	368	542
TDS (mg/L)	573	551	752	937	1325
Microcystin (µg/L)	/	/	0.22	0.59	0.93
Total Alkalinity (mg/L $CaCO_3$)	238	253	315	357	408

[a] Note that data is only from 2 sampling events that took place in July and August.
[b] Note that data is only from 1 sampling event that took place in August.

Table 3. Concentrations of metals measured in Hastings Lake. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	2012	Guidelines
Aluminum µg/L	44.35	100[a]
Antimony µg/L	0.2615	/
Arsenic µg/L	4.12	5
Barium µg/L	63.45	/
Beryllium µg/L	0.01395	100[c,d]
Bismuth µg/L	0.0005	/
Boron µg/L	167.5	1500
Cadmium µg/L	0.0055	0.37[b]
Chromium µg/L	0.529	/
Cobalt µg/L	0.111	50,1000[c,d]
Copper µg/L	1.195	4[b]
Iron µg/L	19.95	300
Lead µg/L	0.0624	7[b]
Lithium µg/L	141	2500[d]
Manganese µg/L	49.4	140[e]
Molybdenum µg/L	0.2315	73
Nickel µg/L	0.14125	150[b]
Selenium µg/L	0.255	1
Silver µg/L	0.00025	0.25
Strontium µg/L	282.5	/
Thallium µg/L	0.00015	0.8
Thorium µg/L	0.00015	/
Tin µg/L	0.015	/
Titanium µg/L	1.4	/
Uranium µg/L	0.684	15
Vanadium µg/L	0.8215	100[c,d]
Zinc µg/L	1.545	30[f]

Values represent means of total recoverable metal concentrations.
[a] Based on pH ≥ 6.5
[b] Based on 2012 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 2012 avg. water hardness (as $CaCO_3$) and avg. pH
[f] Based on 2012 avg. water hardness (as $CaCO_3$), avg. pH, and avg. DOC with CCME equation
A forward slash (/) indicates an absence of data or guideline