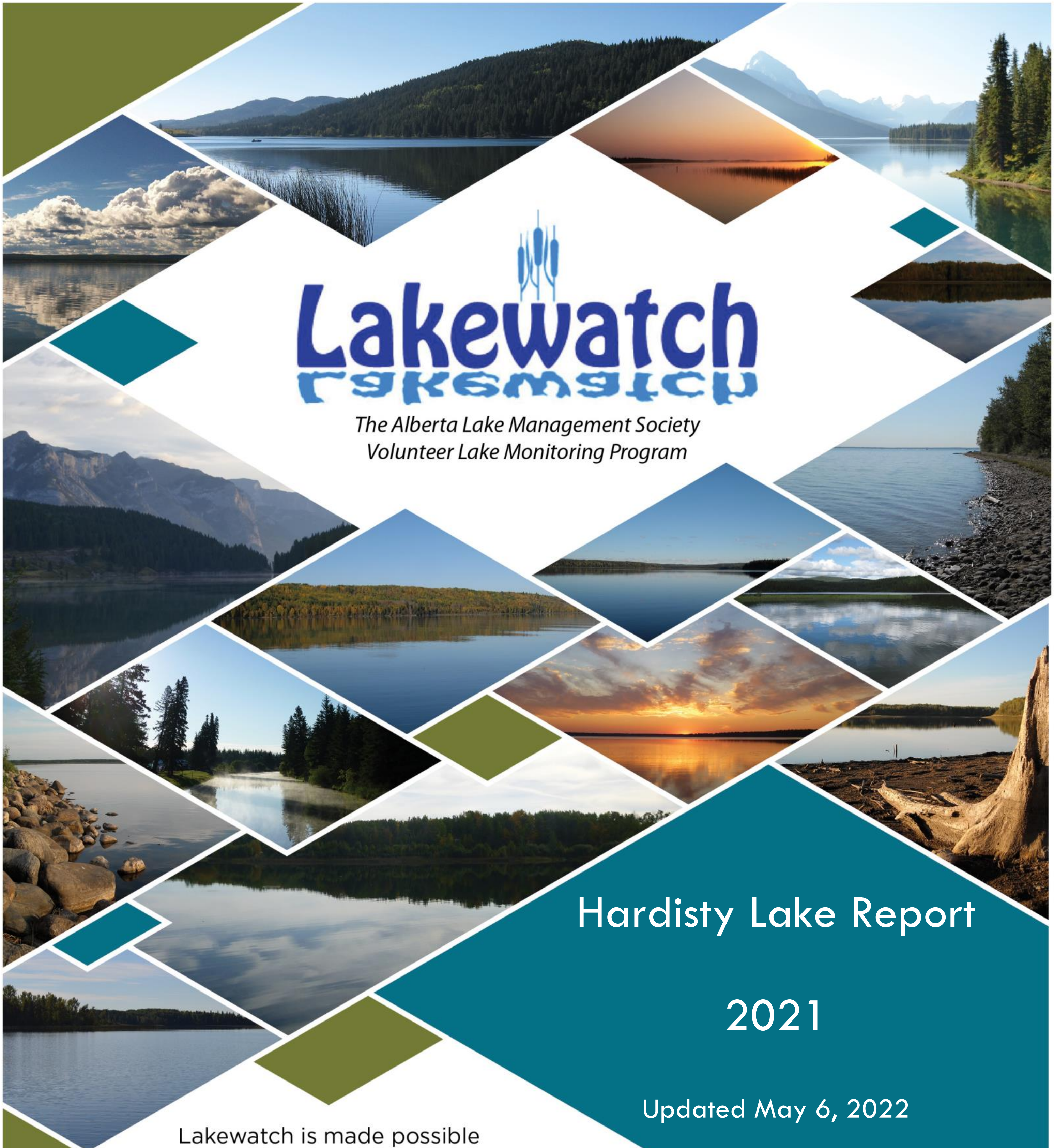

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Hardisty Lake Report

2021

Updated May 6, 2022

Lakewatch is made possible with support from:

Alberta
LICA Environmental Stewards
Pigeon Lake Watershed Association
MD 61 Wainwright
Alberta Ecotrust
Discover Hardisty — More than you imagine
Municipal District Bonnyville No. 87

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 Ivan Lesmeister for his commitment to collecting data at Hardisty 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

HARDISTY LAKE

Aerial view of Hardisty Lake (Google Earth 2011)

This small lake is located within the town limits of, and supplies drinking water to, the town of Hardisty, approximately 200 km southeast of Edmonton in Flagstaff County. Both the town and lake are named after Richard Hardisty, a former member of the Canadian Senate, and last chief trader of the Hudson Bay Company at Fort Edmonton[1]. The lake lies within the Central Parkland natural sub-region, and most of the shoreline borders grassland or private residential properties, which belong to permanent or seasonal occupants. The lake has a teardrop-like shape, with the narrowest point in the northeast, and the larger section to the southwest. The surface area measures 0.26 km^2 , and the maximum depth has been recorded at approximately 5 m. Turbidity is high in Hardisty Lake, causing the lake to appear shades of brown or dark red throughout the year. Hardisty Lake Park, operated by the Hardisty Agricultural Society, is located on the north shore of the lake and provides camping facilities throughout summer months, as well as a sandy beach, large picnic area, and playground. Other facilities in the park include a public golf course, three baseball diamonds, and the rodeo grounds, which hosts the annual Hardisty Rodeo. Boats are banned within the park, however, there is a separate boat launch located on the opposite lakeshore. Motorized boating is permitted on the lake, but there are very specific restrictions, and a boating permit must first be obtained from the town[2]. The lake and its surrounding environment provide habitat for native upland birds, deer, and moose, as well as migrating ducks and geese[2]. No sportfish species are recorded for the lake, and the only fish observed have been small minnow and stickleback species. Northern milfoil (*Myriophyllum sibericum*) and Fries' pondweed (*Potamogeton fresii*) have been observed around the shores of Hardisty Lake. (pers. obs.)

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[1] Place Names of Alberta (2006) Edited by Merrily K Aubrey. Calgary, AB. University of Calg. Press.

[2] Hardisty Lake website – various pages (http://www.hardisty.ca/)

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 Hardisty Lake was 25 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. This value falls below previously historical averages. TP was lowest on the July 14^{th} sampling event at 20 µg/L, and was highest a month later on August 12^{th} at 28 µg/L (Figure 1).

The average chlorophyll-*a* concentration in 2021 was 24.8 µg/L (Table 2), falling into the eutrophic, or highly productive trophic classification. Chlorophyll-*a* was lowest earliest in the season, at 10.8 µg/L on June 24^{th} and peaked at 39.1 µg/L on September 1^{st} (Figure 1).

The average TKN concentration was 2.1 mg/L (Table 2) and varied very little through the season, ranging from 2.0 mg/L to 2.3 mg/L (Figure 1).

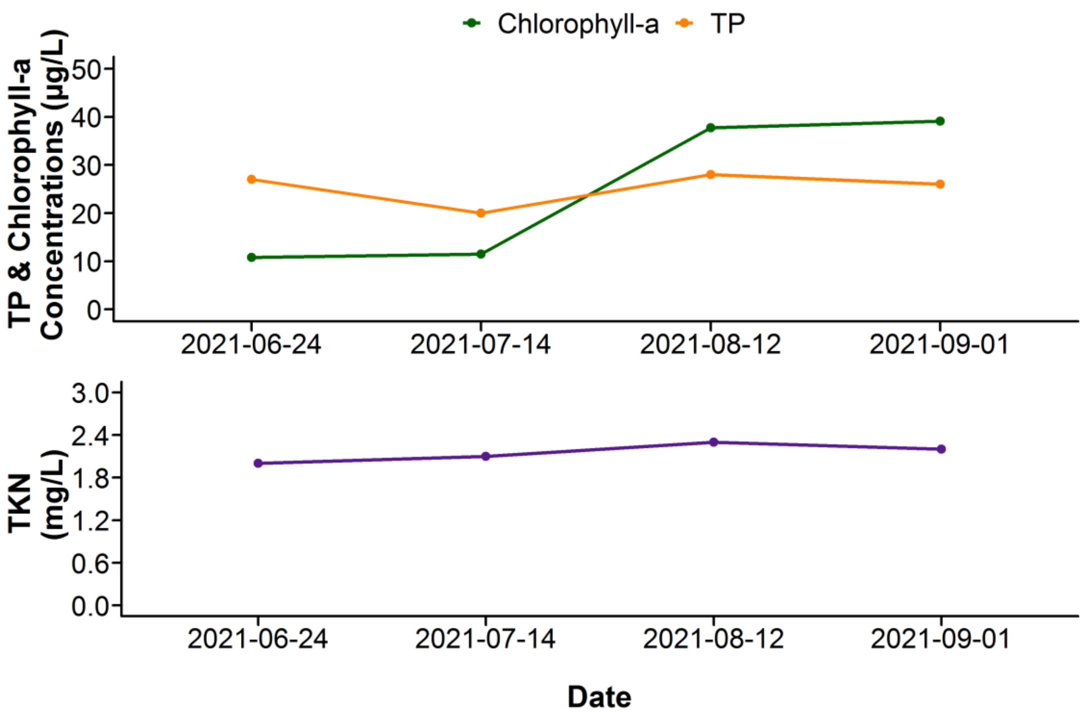

Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Hardisty Lake.

Average pH was measured as 8.95 in 2021, buffered by high alkalinity (518 mg/L $CaCO_3$) and bicarbonate (450 mg/L HCO_3). Bicarbonate was the dominant ion, and potassium, calcium and sulphate were low relative to other ions. Together, the ions contributed to a high conductivity of 1200 µS/cm (Figure 2, top; Table 2). Hardisty Lake is in the high range of ion levels compared to other LakeWatch lakes sampled in 2021 (Figure 2, bottom).

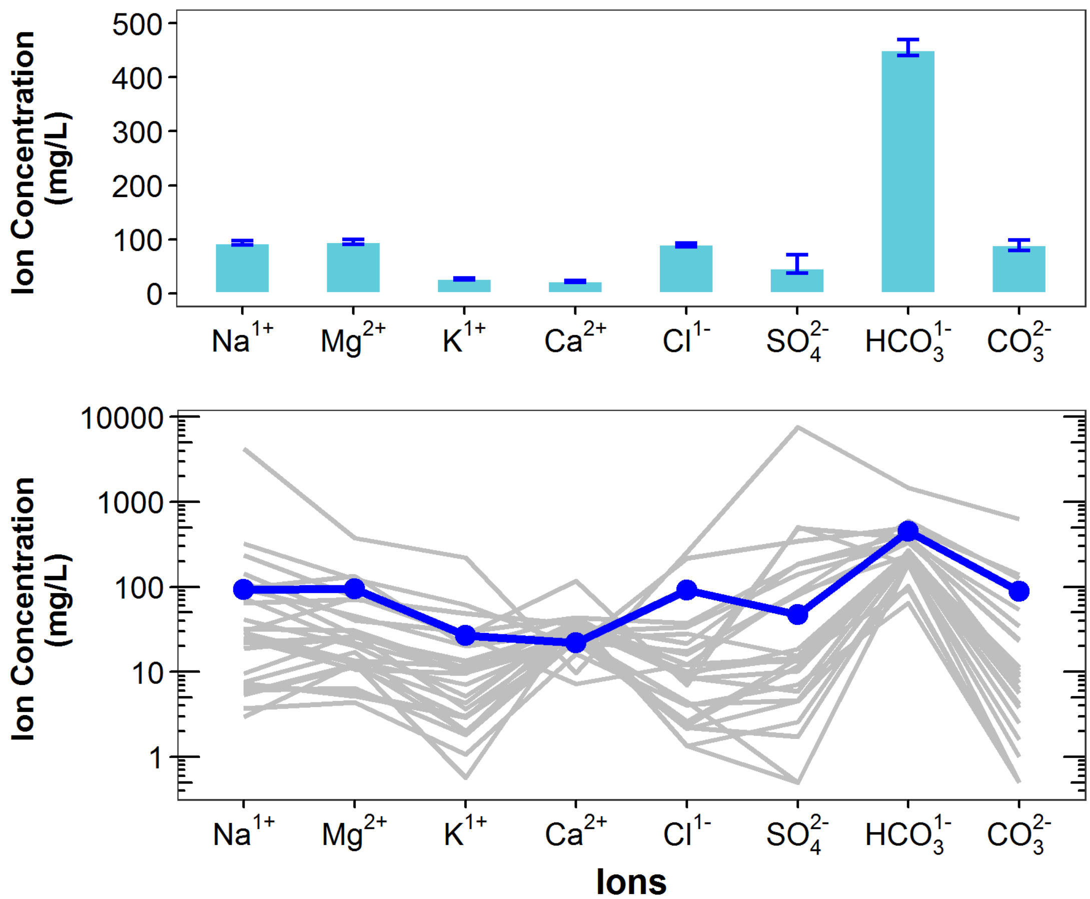

Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Hardisty Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Hardisty 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 Hardisty Lake in 2021, but Table 3 displays historical metal concentrations.

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 Hardisty Lake in 2021 was 2.85 m, corresponding to an average Secchi depth of 1.45 m (Table 2). In June, the euphotic depth was equal to lake bottom at 5.0 m, meaning light was able to reach the bottom of Hardisty Lake. Euphotic depth continued to decrease through the season, until a minimum of 0.9 m on September 1st (Figure 3).

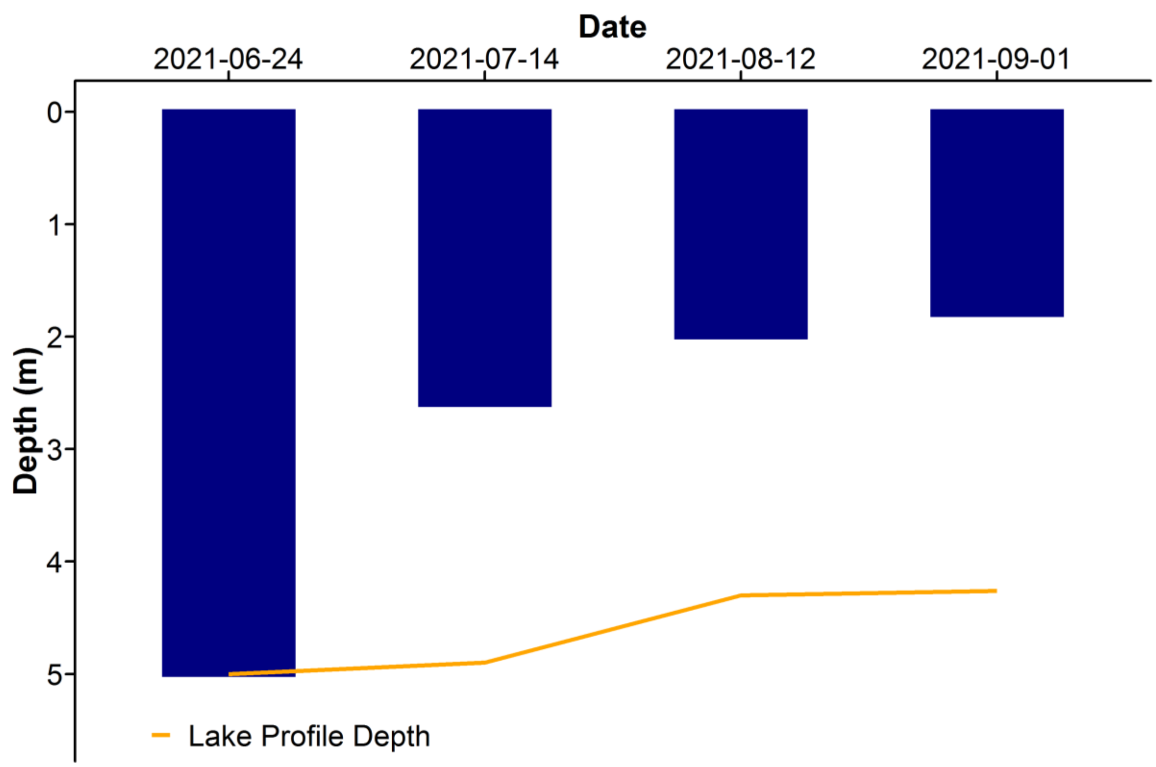

Figure 3. Euphotic depth values measured four times over the course of the summer at Hardisty Lake in 2021.

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 at Hardisty Lake varied throughout the summer, with the July 9th sampling date having the warmest temperatures at 24.6°C (Figure 4a). The lake was mixed during the August and September sampling events, but displayed slight stratification during the June and July sampling events.

Hardisty 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). Deep water oxygen levels dropped during the June and July sampling events, suggesting the slight temperature stratification present in the lake, on those dates, was enough to prevent lake mixing.

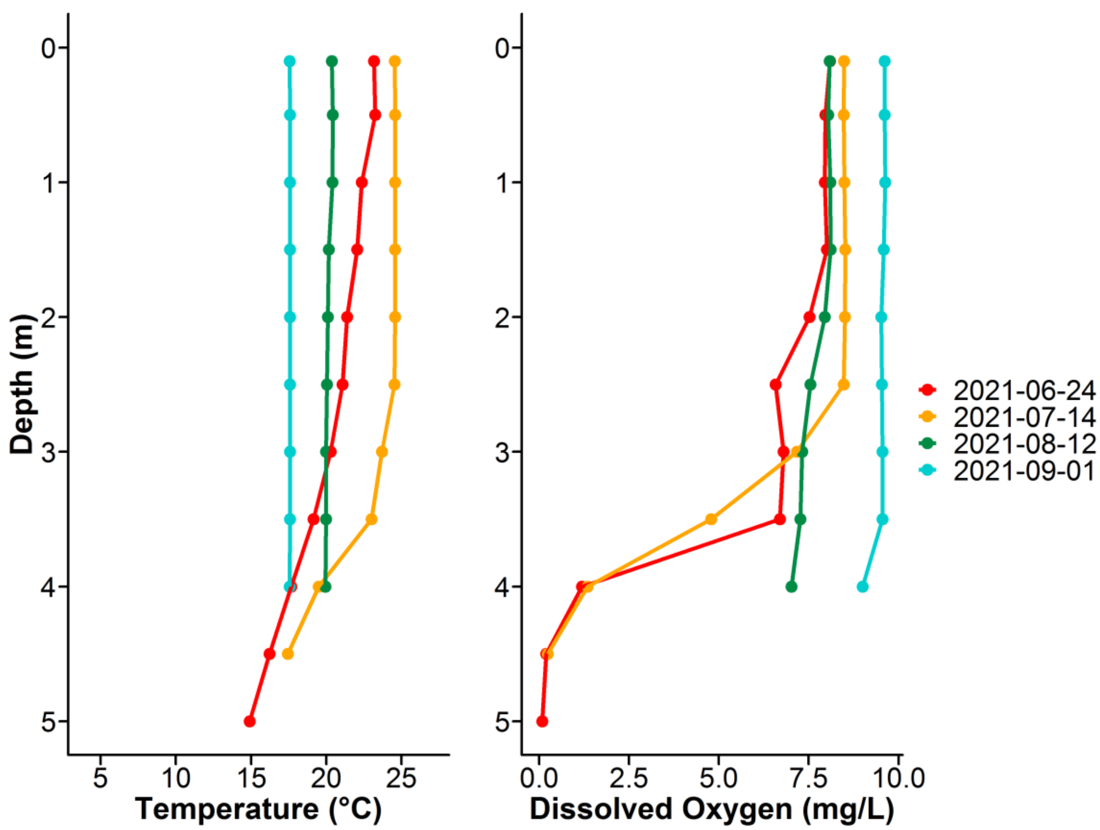

Figure 4. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Hardisty Lake measured four times over the course of the summer of 2021.

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 Hardisty Lake fell below the recreational guideline of 10 μg/L during every sampling event in 2021. Microcystin levels in 2021 were the highest in the historical record for the lake (Table 2). 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 Hardisty Lake in 2021.

Date	Microcystin Concentration (μg/L)
24-Jun-21	0.61
14-Jul-21	0.36
12-Aug-21	2.30
1-Sep-21	2.12
Average	1.35

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 Hardisty 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 Hardisty Lake in 2021.

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 level data for Hardisty Lake is unavailable.

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.

Hardisty Lake experienced a warmer, drier, less windy summer with slightly less solar radiation compared to normal (Figure 5). A warm spell prior to the July 14th sampling resulted in relatively high water temperatures. Windy spells and cooling temperatures likely lead to the change from slight stratification early in the season, to whole lake mixing later in the season.

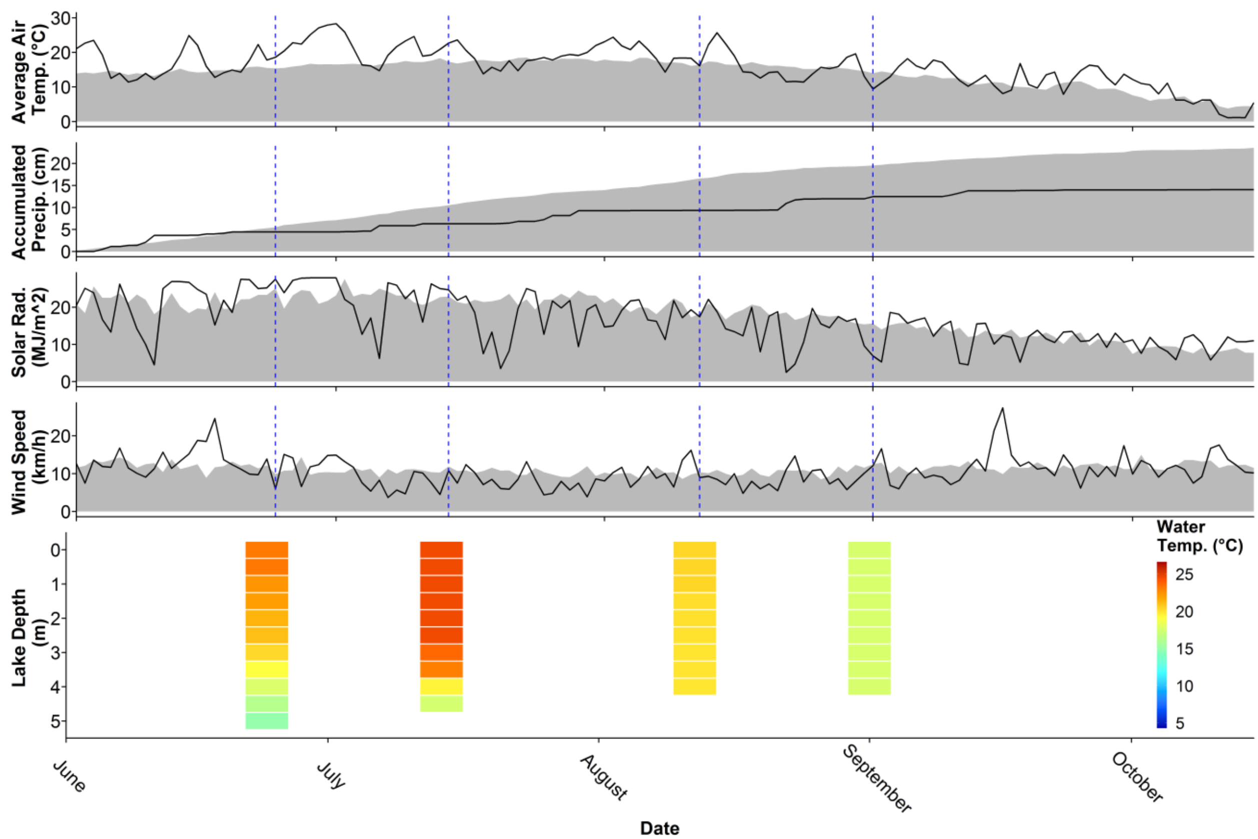

Figure 5. Average air temperature (°C), accumulated precipitation (cm), solar radiation (MJ/m^2) and wind speed (km/h) measured from Bellshill AGCM, with Hardisty Lake temperature profiles (°C) at the bottom. Black lines indicate 2021 levels, gray indicates long-term normals, and blue lines indicate sampling dates for Hardisty 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 Hardisty Lake.

Parameter	1996	2015	2016	2021
TP (µg/L)	32	43	33	25
TDP (µg/L)	13	8	6	5
Chlorophyll-*a* (µg/L)	6.7	44.0	49.3	24.8
Secchi depth (m)	2.58	0.58	0.62	1.45
TKN (mg/L)	4.1	2.6	2.7	2.1
NO_2-N and NO_3-N (µg/L)	2	2	4	4
NH_3-N (µg/L)	930	25	39	22
DOC (mg/L)	33	31	28	26
Ca^{2+} (mg/L)	10	15	20	22
Mg^{2+} (mg/L)	130	99	106	95
Na^{+} (mg/L)	98	97	102	93
K^{+} (mg/L)	36	28	30	27
SO_4^{2-} (mg/L)	26	53	46	47
Cl^{-} (mg/L)	32	68	71	91
CO_3^{2-} (mg/L)	144	89	76	89
HCO_3^{-} (mg/L)	554	495	522	450
pH	9.21	9.09	9.00	8.95
Conductivity (µS/cm)	1188	1175	1200	1200
Hardness (mg/L)	557	445	478	448
TDS (mg/L)	752	698	718	705
Microcystin (µg/L)	\	0.48	0.92	1.35
Total Alkalinity (mg/L $CaCO_3$)	696	555	555	518

Table 3. Concentrations of metals measured in Hardisty 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)	2015	2016	Guidelines
Aluminum µg/L	15.7	7.3	100[a]
Antimony µg/L	0.142	0.12	/
Arsenic µg/L	12.1	10.8	5
Barium µg/L	240	230	/
Beryllium µg/L	0.004	0.004	100[c,d]
Bismuth µg/L	0.012	5.00E-04	/
Boron µg/L	209	201	1500
Cadmium µg/L	0.006	0.001	0.37[b]
Chromium µg/L	0.19	0.04	/
Cobalt µg/L	0.09	0.049	50,1000[c,d]
Copper µg/L	1.17	1.03	4[b]
Iron µg/L	20.4	14.3	300
Lead µg/L	0.063	0.028	7[b]
Lithium µg/L	114	108	2500[d]
Manganese µg/L	18.8	22.5	140[e]
Molybdenum µg/L	2.01	1.64	73
Nickel µg/L	0.488	0.454	150[b]
Selenium µg/L	0.07	0.54	1
Silver µg/L	0.003	0.001	0.25
Strontium µg/L	581	559	/
Thallium µg/L	0.003	0.0015	0.8
Thorium µg/L	0.047	0.005	/
Tin µg/L	0.019	0.019	/
Titanium µg/L	1.63	1.52	/
Uranium µg/L	2.7	2.26	15
Vanadium µg/L	0.47	0.42	100[c,d]
Zinc µg/L	1.2	1.6	30[f]

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on 2012 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 2012 avg. water hardness (as CaCO3) and avg. pH

[f] Based on 2012 avg. water hardness (as CaCO3), avg. pH, and avg. DOC with CCME equation

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