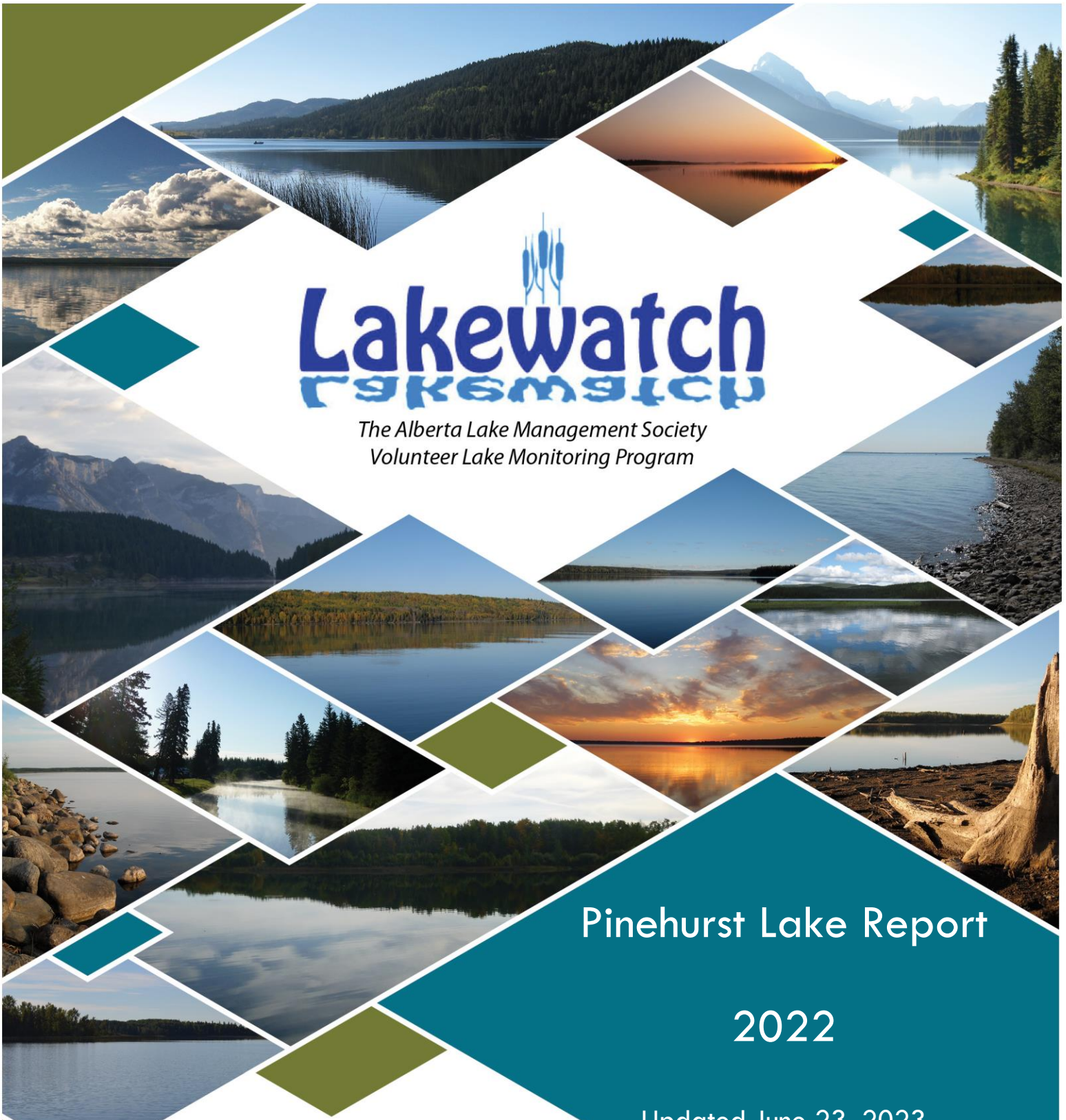

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Pinehurst Lake Report

2022

Updated June 23, 2023

Lakewatch is made possible with support from:

Alberta

Lac La Biche County
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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 Lac La Biche County Staff for their commitment to collecting data at Pinehurst 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.

PINEHURST LAKE

Pinehurst Lake Boat Launch, 2022. Photo by Dominic Wong

Pinehurst Lake is located 20 km south of Lac La Biche and 245 km northeast of Edmonton, in the Lakeland Provincial Recreation Area just east of the Lakeland Provincial Park. The name Pinehurst is derived from the jack pine tree and from the English word "hurst", which means "a wooded hillock". This term refers to the long ridge that runs along the northwest shore of the lake. At one time, jack pine may have grown along the ridge, but forest fires have removed most of this species [1]. Pinehurst Lake has a mean depth of 12 m and a maximum depth of ~21 m. It has a relatively complex shoreline with several bays and two islands just offshore. The bays at the east end of the lake are very shallow (less than 6-m deep) and the bottom of the basin slopes gently. The bay at the north end is somewhat deeper (less than 12-m deep) and its sides slope more steeply. A large area in the center of the basin is quite level, and ranges in depth from 18 m to 21 m.[2] A large permanent stream drains Touchwood into Pinehurst. Pinehurst drains by Punk Creek into the Pinehurst Lake and its watershed area. Sand River, a tributary in the Beaver River basin. The Watershed is almost completely forested and is representative of the central mixed natural subregion with aspen dominant in early seral stages and white spruce increasing with forest age. Black spruce and tamarack on extensive peatlands and sedge bogs are common in this watershed. Recreational development includes an Alberta Provincial Park campsite accessible by road on the western shore and boat-in only, privately owned cabin rentals on the eastern shore.

Pinehurst Lake is a favourite destination for local anglers but restrictive sport fishing regulations have been implemented at the lake to improve the health of the fish populations. Snug Cove (Mud Bay) has been closed to fishing and the remainder of the lake walleye may only be fished with a Special Fish Harvest License. Pike and perch may be fished in limited numbers and sizes.[3] Commercial fishing has not occurred since the seventies.

[1] Chipeniuk, R.C. 1975. Lakes of the Lac la Biche District. R.C. Chipeniuk, Lac La Biche.
[2] University of Alberta. 2005. Atlas of Alberta Lakes. University of Alberta Press. Available at: http://sunsite.ualberta.ca/Projects/Alberta-Lakes/
[3] Government of Alberta. 2013. Guide to Sportfishing Regulations. Available at: http://www.albertaregulations.ca/fishingregs/nb1.html.

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 Pinehurst Lake was 18 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. This value is consistent with observed historical averages (Table 2). TP ranged from a minimum of 13 µg/L on the August 9th sampling, to a maximum of 28 µg/L on June 9th (Figure 1).

Average chlorophyll-*a* concentration in 2022 was 9.1 µg/L (Table 2), falling into the eutrophic, or highly productive trophic classification. Chlorophyll-*a* was lowest at 7.4 µg/L on July 6th and peaked at 10.6 µg/L on June 9th. Chlorophyll-*a* was otherwise quite stable across all four sampling events.

The average TKN concentration was 0.8 mg/L (Table 2). TKN displayed some variation through the season, dropping to a lower level during the July 6th sampling event (Figure 1).

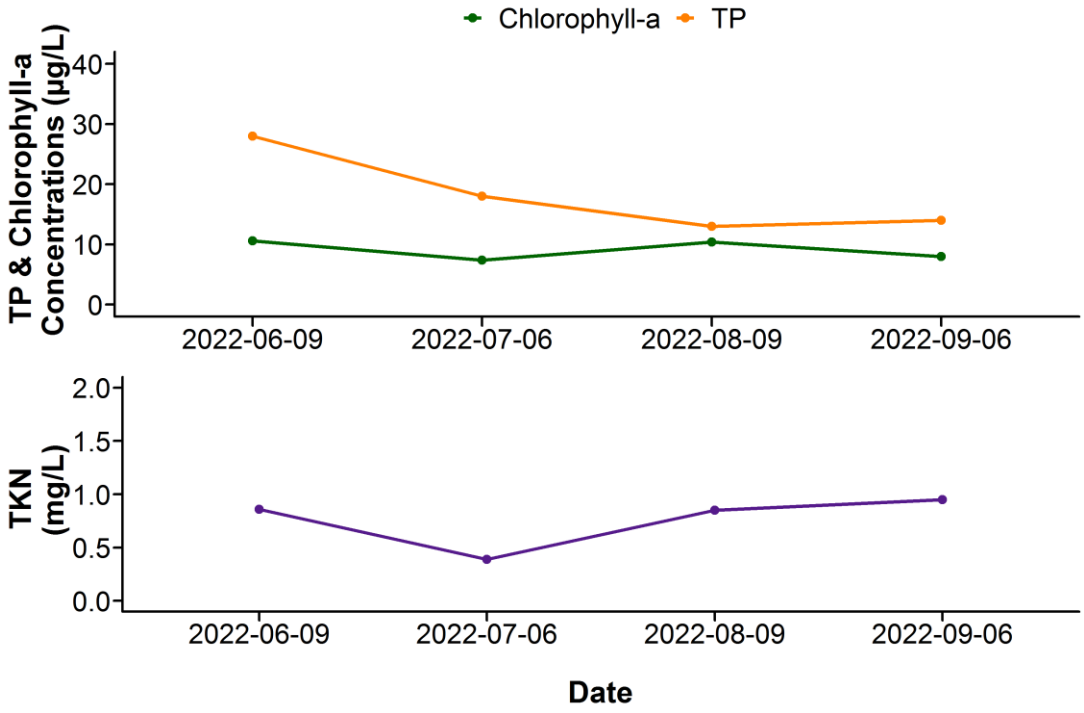

Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Pinehurst Lake.

Average pH was measured as 8.38 in 2022, buffered by moderate alkalinity (160 mg/L $CaCO_3$) and bicarbonate (192 mg/L HCO_3). Aside from bicarbonate, calcium and magnesium were higher than all other major ions, and together contributed to a low conductivity of 298 µS/cm (Figure 2, top; Table 2). Pinehurst Lake is in the low range of ion levels, compared to other LakeWatch lakes sampled in 2022, with the exception of calcium, which is in higher than most other lakes sampled in 2022 (Figure 2, bottom).

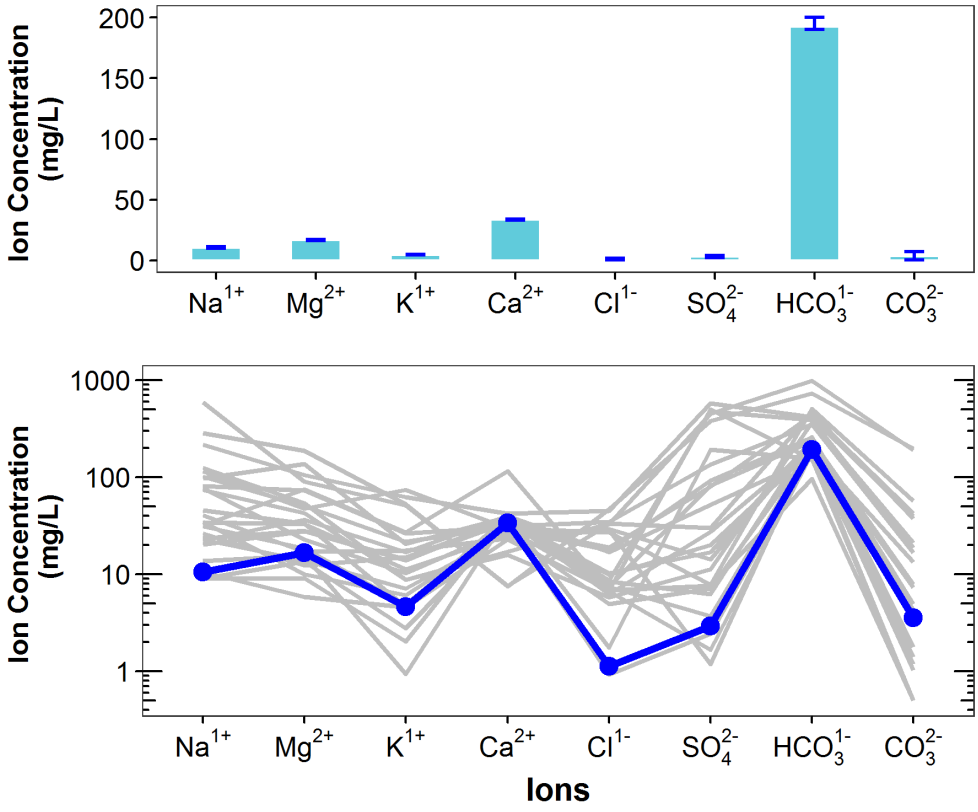

Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Pinehurst Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Pinehurst 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 measured at Pinehurst Lake in 2022, and no metals exceeded the CCME guideline for the protection of aquatic life (Table 3).

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 Pinehurst Lake in 2022 was 6.22 m, corresponding to an average Secchi depth of 3.11 m (Table 2). Euphotic depth varied over the season, ranging from as deep as 9.90 m on July 6th to as shallow as 2.80 m on June 9th (Figure 3).

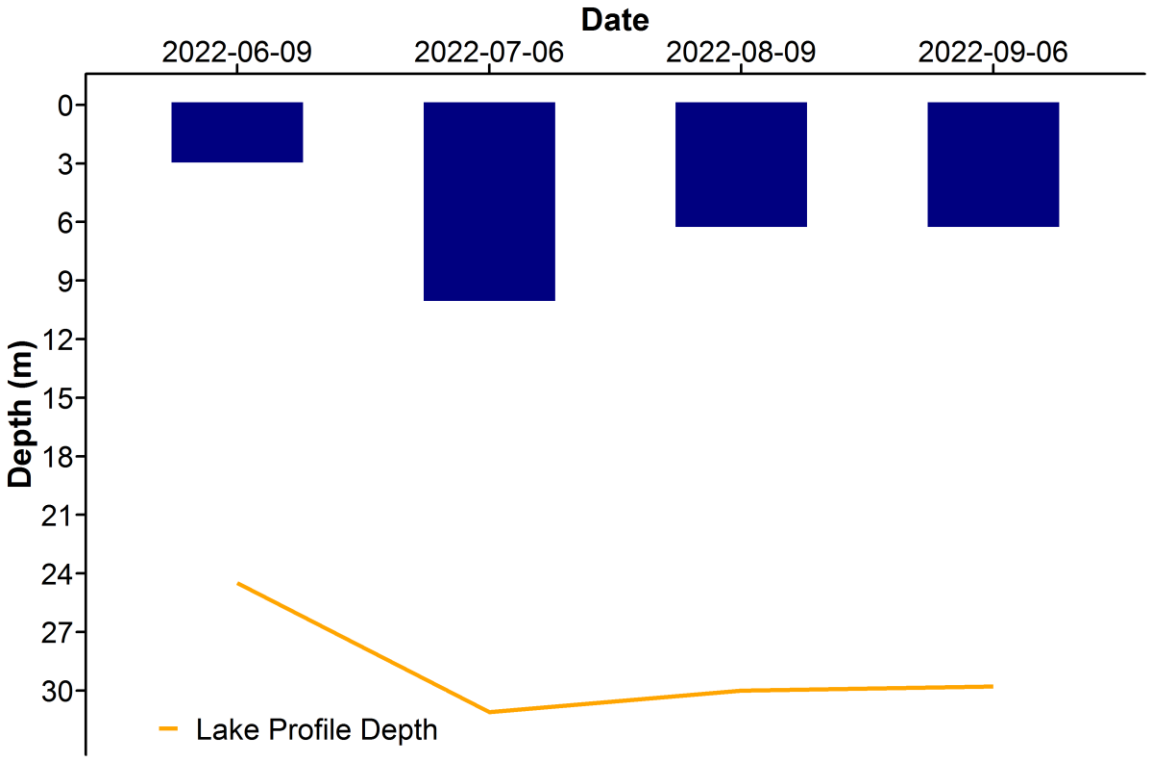

Figure 3. Euphotic depth values measured four times over the course of the summer at Pinehurst Lake in 2022.

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 Pinehurst Lake varied throughout the summer, with the August 11th sampling date having the warmest temperature of 20.2°C (Figure 4a). The lake was stratified during each sampling even, but the strength of stratification varied. In addition, water temperature near the bottom sediments warmed through the season, indicating that lake-wide mixing did occur gradually through the summer.

Pinehurst 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). Interestingly, surface dissolved oxygen abundance decreased through the season. In addition, the bottom waters below the mixing depth (thermocline) became more oxygen depleted through the season. In June, bottom waters had more than 5 mg/L dissolved oxygen, and then below 23 m, 11.5 m and 10.5 m oxygen levels dropped below 1 mg/L during the July, August and September sampling events, respectively.

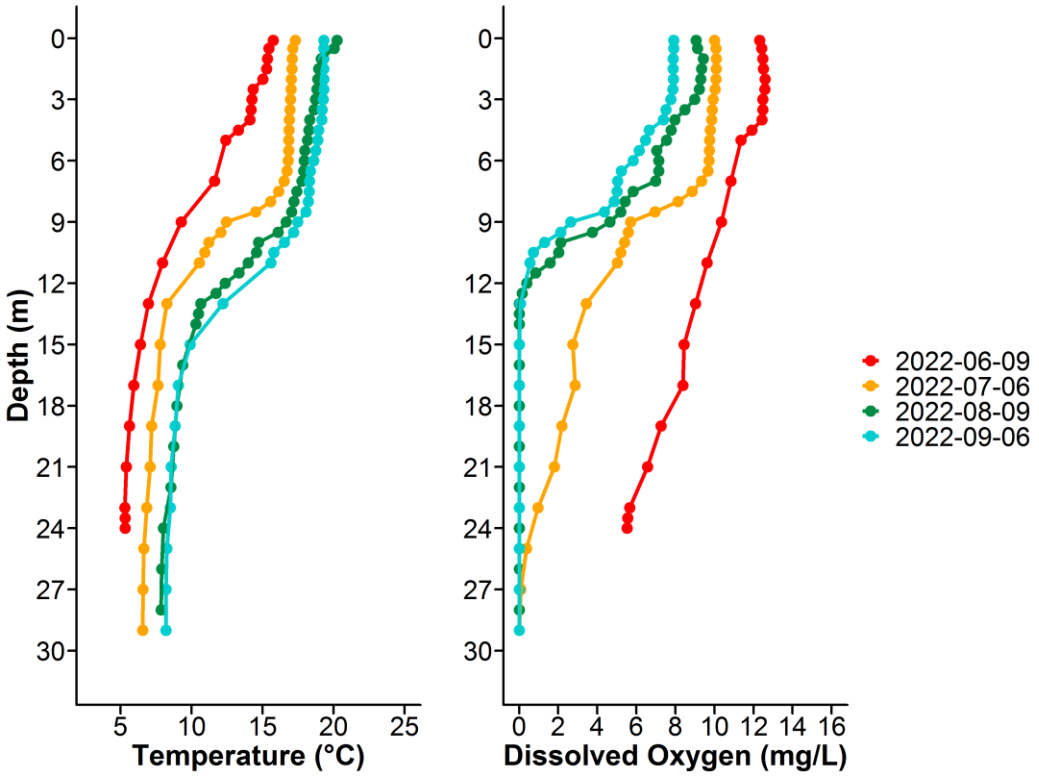

Figure 4. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Pinehurst Lake measured four times over the course of the summer of 2022.

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 Pinehurst Lake fell below the recreational guideline of 10 µg/L during every sampling event in 2022. In addition, microcystin levels from every sampling event were below the laboratory detection limit of 0.10 µg/L. A value of 0.05 µg/L is assigned when a value is below detection, in order to calculate an average. Even though very low levels of microcystin were detected, caution should always be observed when recreating around cyanobacteria.

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

Date	Microcystin Concentration (µg/L)
9-Jun-22	<0.10
6-Jul-22	<0.10
9-Aug-22	<0.10
6-Sep-22	<0.10
Average	0.05

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 Pinehurst 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 watermilfoil specimens were collected from Pinehurst 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 Parks Monitoring and Science division.

Water levels at Pinehurst Lake in 2022 were at or slightly below the historical average (Figure 5). Recent water levels at Pinehurst Lake have generally been above the historical average, following a steep increase in 2005. However, since the mid-2010s, there has been a slight decrease back towards the historical average.

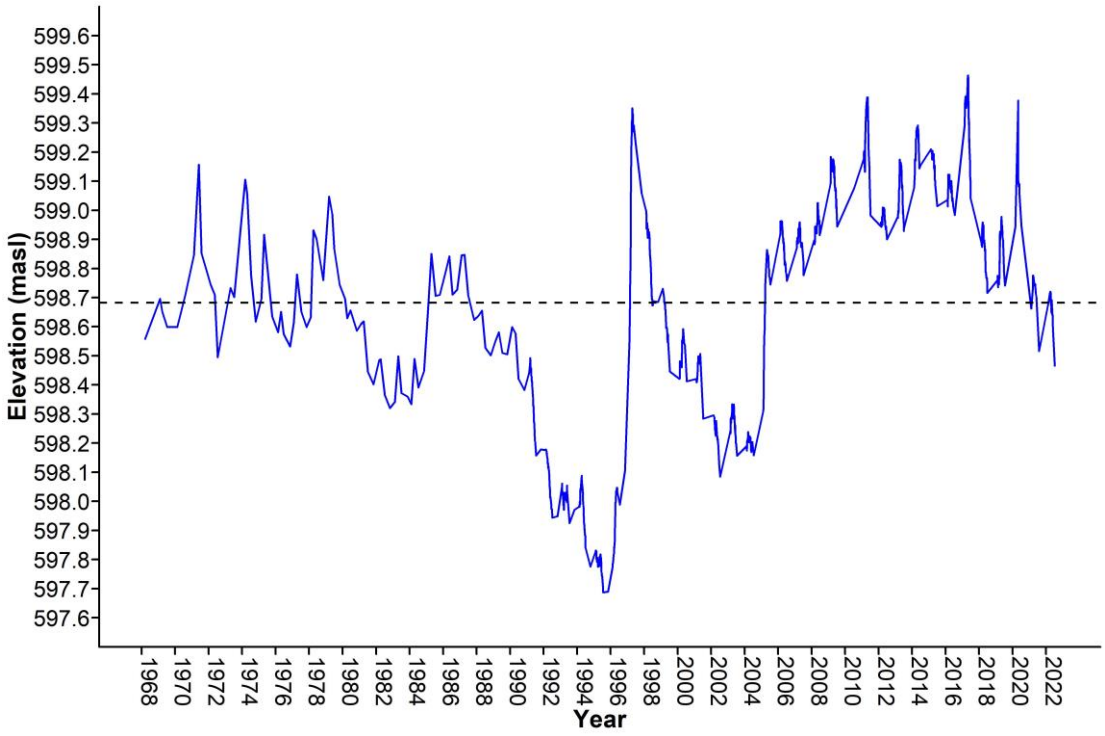

Figure 5. Water levels measured at Pinehurst Lake in metres above sea level (masl) from 1968-2022. Data retrieved from Alberta Environment and Parks and/or Environment and Climate Change Canada. Black dashed line represents historical yearly average water level.

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.

Pinehurst Lake experienced a warmer, slightly drier, and windier summer with slightly less solar radiation than normal (Figure 6). Despite following a period of cooler weather with low solar radiation, the August sampling event still had the warmest surface waters measured the entire summer.

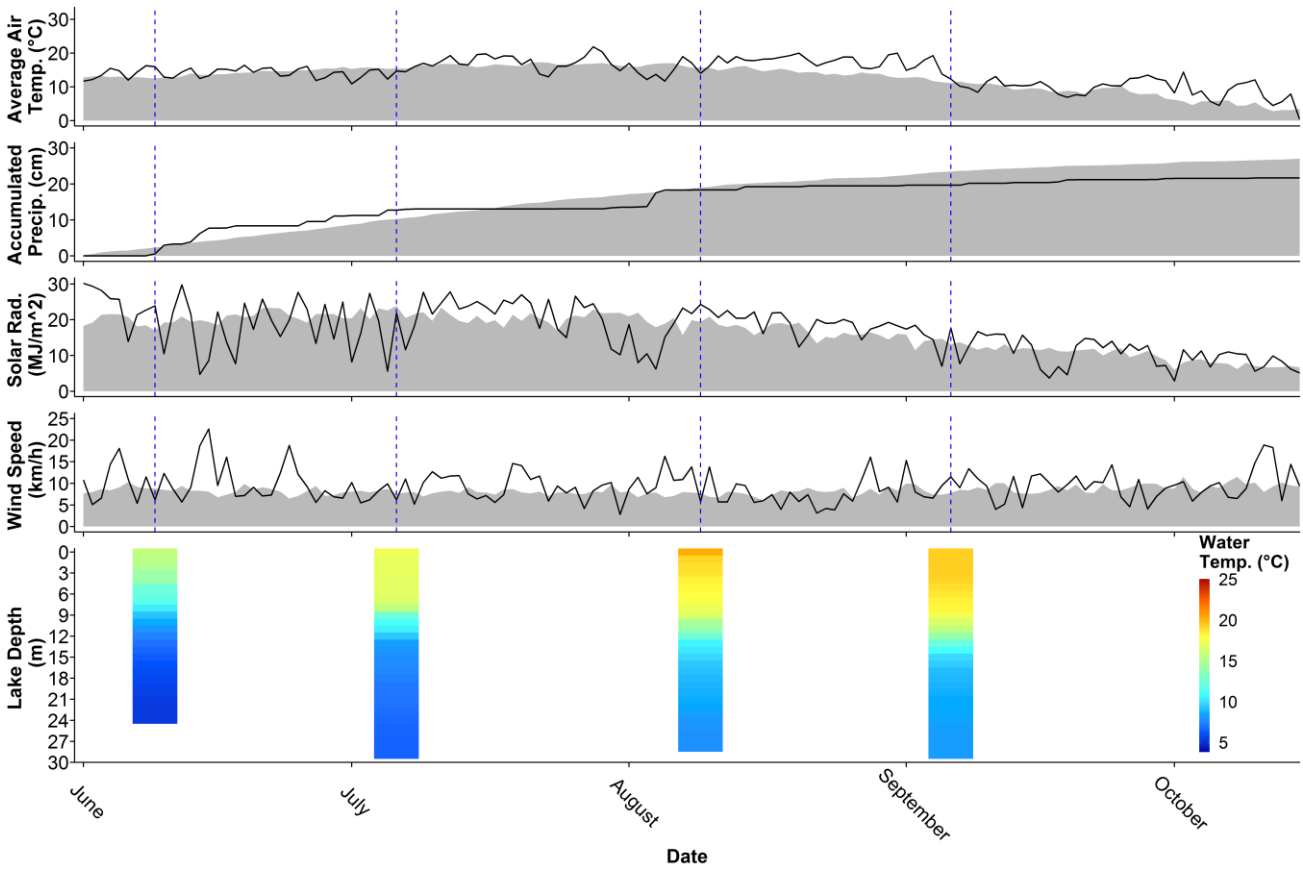

Figure 6. Average air temperature (°C), accumulated precipitation (cm), solar radiation (MJ/m^2), and wind speed (km/h) measured from 'Rich Lake AGDM', as well as Pinehurst Lake temperature profiles, interpolated (°C). Black lines indicate 2022 levels, gray indicates long-term normals, and blue lines indicate sampling dates for Pinehurst 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).

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

Parameter	1986	2013	2015	2016	2022
TP (µg/L)	46	27	16	18	18
TDP (µg/L)	10	14	7	7	6
Chlorophyll-*a* (µg/L)	14.6	5.0	7.2	7.5	9.1
Secchi depth (m)	/	2.68	2.45	3.00	3.11
TKN (mg/L)	1.2	1.0	0.9	0.9	0.8
NO_2-N and NO_3-N (µg/L)	2	3	3	3	5
NH_3-N (µg/L)	16	38	25	25	8
DOC (mg/L)	13	13	13	12	14
Ca (mg/L)	32	32	28	29	34
Mg (mg/L)	13	17	16	17	16
Na (mg/L)	8	11	11	11	10
K (mg/L)	4	4	5	5	5
SO_4^{2-} (mg/L)	3	5	2	2	3
Cl^- (mg/L)	1	1	1	1	1
CO_3 (mg/L)	7	9	7	5	4
HCO_3 (mg/L)	170	179	176	180	192
pH	8.53	8.39	8.59	8.56	8.38
Conductivity (µS/cm)	280	302	286	293	298
Hardness (mg/L)	133	151	136	143	152
TDS (mg/L)	152	166	154	160	168
Microcystin (µg/L)	/	/	0.05	0.05	0.05
Total Alkalinity (mg/L $CaCO_3$)	149	161	154	160	160

*Secchi depth on June 16, 2020 hit lake bottom.

Table 3. Concentrations of metals measured in Pinehurst 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)	2013	2015	2016	2022	Guidelines
Aluminum µg/L	12.65	7.2	8.4	6.9	100[a]
Antimony µg/L	0.01345	0.0195	0.026	0.027	/
Arsenic µg/L	0.6475	0.6055	0.747	0.66	5
Barium µg/L	39.25	38.5	42.8	38.3	/
Beryllium µg/L	0.0057	0.004	0.004	0.0015	100[c,d]
Bismuth µg/L	0.0005	0.005	0.004	0.0015	/
Boron µg/L	43.05	43.35	48.9	43.5	1500
Cadmium µg/L	0.001	0.001	0.005	0.005	0.22[b]
Chromium µg/L	0.293	0.065	0.07	0.05	/
Cobalt µg/L	0.00855	0.0025	0.003	0.024	50,1000[c,d]
Copper µg/L	0.26825	0.23	0.58	0.28	3.39[b]
Iron µg/L	25.6	7.2	25.9	9.7	300
Lead µg/L	0.01735	0.0345	0.2	0.014	5.44[b]
Lithium µg/L	15.05	13.6	15.3	13.1	2500[d]
Manganese µg/L	11.4	20.55	48.4	24.7	260[e]
Molybdenum µg/L	0.01685	0.024	0.418	0.06	73
Nickel µg/L	0.0025	0.004	0.217	0.2	132[b]
Selenium µg/L	0.05	0.05	0.24	0.1	1
Silver µg/L	0.0166	0.001	0.004	0.0005	0.25
Strontium µg/L	139	134.5	140	132	/
Thallium µg/L	0.00015	0.001225	0.0085	0.001	0.8
Thorium µg/L	0.00015	0.010025	0.0085	0.004	/
Tin µg/L	0.05295	0.0215	0.028	0.03	/
Titanium µg/L	0.3165	0.6	0.9	0.16	/
Uranium µg/L	0.0606	0.062	0.058	0.077	15
Vanadium µg/L	0.117	0.095	0.16	0.137	100[c,d]
Zinc µg/L	0.4625	0.35	1	1.6	30[f]

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on 2022 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 2022 avg. water hardness (as CaCO3) and avg. pH

[f] Based on 2022 avg. water hardness (as CaCO3), avg. pH, and avg. DOC with CCME equation

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