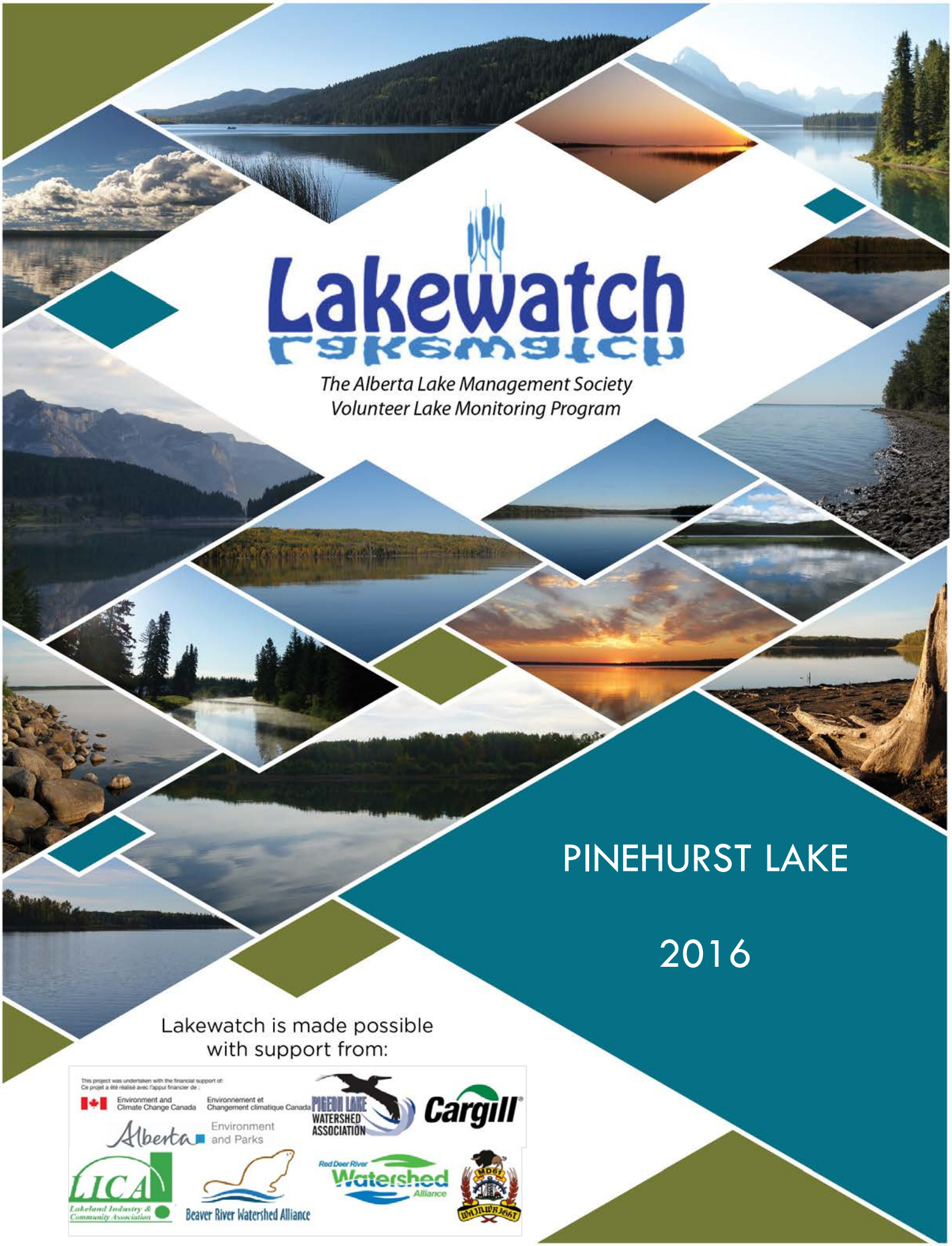

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

PINEHURST LAKE

2016

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Environment and Climate Change Canada
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Cargill
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LICA Lakeland Industry & Community Association
Beaver River Watershed Alliance
Red Deer River Watershed Alliance
MD of Bighorn

ALBERTA LAKE MANAGEMENT SOCIETY'S LAKEWATCH PROGRAM

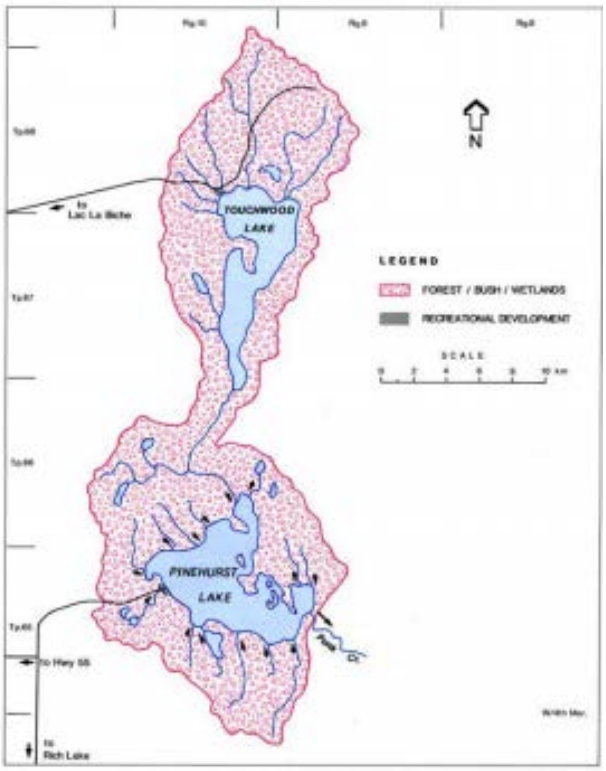
LakeWatch has several important objectives, one of which is to collect and interpret water quality data on Alberta Lakes. Equally important is educating lake users about their aquatic environment, encouraging public involvement in lake management, and facilitating cooperation and partnerships between government, industry, the scientific community and lake users. LakeWatch Reports are designed to summarize basic lake data in understandable terms for a lay 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 people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health of our environment.

ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. We would like to extend a special thanks to Meagan Franchuk from the County of Lac la BIche for arranging sampling of Pinehurst Lake in 2016. We would also like to thank Alicia Kennedy, Ageleky Bouzetos, and Breda Muldoon who were summer technicians in 2016. Executive Director Bradley Peter was instrumental in planning and organizing the field program. Alicia Kennedy was instrumental in report design. This report was prepared by Bradley Peter and Laura Redmond. The Beaver River Watershed, the Lakeland Industry and Community Association, Environment Canada, and Alberta Environment and Parks are major sponsors of the LakeWatch program.

PINEHURST LAKE



Pinehurst Lake and its watershed area.

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 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.

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[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.

The watershed area for Pinehurst Lake is 299.34 km^2 and the lake area is 39.56 km^2. The lake to watershed ratio of Pinehurst Lake is 1:8. A map of the Pinehurst Lake watershed area can be found at http://alms.ca/wp-content/uploads/2016/12/Pinehurst.pdf.

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.

Total phosphorus (TP) in Pinehurst Lake had an average concentration of 18 µg/L in 2016, putting it in the mesotrophic trophic classification (Table 2). TP fluctuated throughout the summer, with the seasonal maximum concentration of 21 µg/L on June 29 (Figure 1).

Chlorophyll-*a* concentrations remained low over the course of the summer, with an average concentration of 7.5 µg/L in 2016 (Table 2). This also puts Pinehurst Lake in the mesotrophic trophic status class. A maximum concentration of 9.2 µg/L was reached on September 29 (Figure 1).

Pinehurst Lake had an average TKN concentration of 0.9 mg/L over four sampling dates in 2016 (Table 2). On August 5 TKN concentrations increased to a seasonal maximum of 0.96 mg/L but declined into September (Figure 1).

Average pH measured as 8.56 in 2016, buffered by moderate alkalinity (160 mg/L $CaCO_3$) and bicarbonate (180 mg/L HCO_3). Calcium and magnesium were the only dominant ions contributing to a relatively low conductivity measure of 293 uS/cm (Table 2).

METALS

Samples were analyzed for metals once throughout the summer (Table 3). In total, 27 metals were sampled for. It should be noted that many metals are naturally present in aquatic environments due to the weathering of rocks and may only become toxic at higher levels.

Metals were measured once at Pinehurst Lake and all measured values fell within their respective guidelines (Table 3).

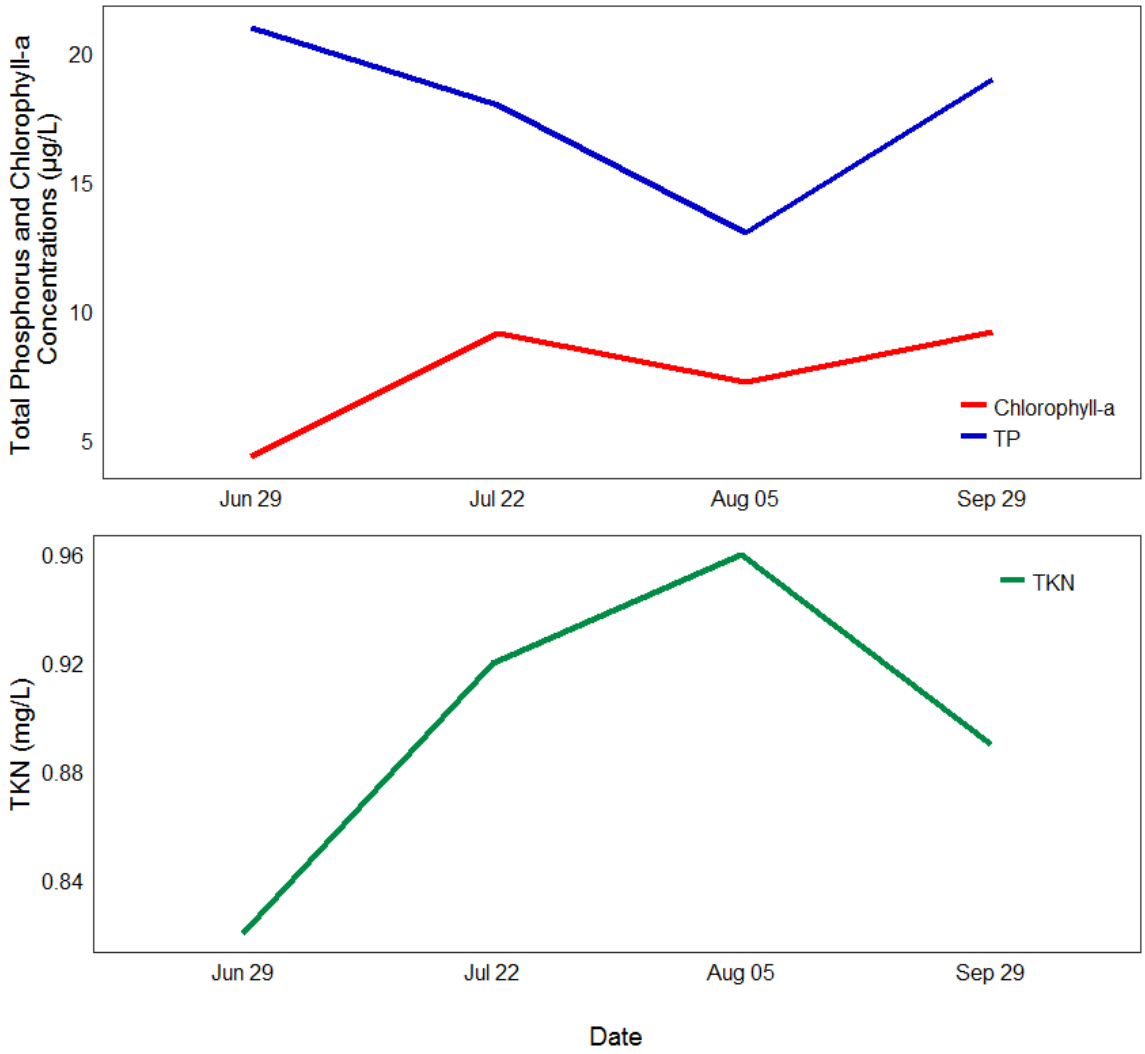

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Pinehurst Lake.

WATER CLARITY AND SECCHI 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 disk depth. Two times the Secchi disk depth equals the euphotic depth – the depth to which there is enough light for photosynthesis.

Average Secchi depth in 2016 was 3 m, classifying Pinehurst Lake as mesotrophic, or moderately productive (Figure 2). A maximum Secchi depth of 3.5 m was recorded on June 29 and September 29, but there were no directional trends in water clarity throughout the sampling season.

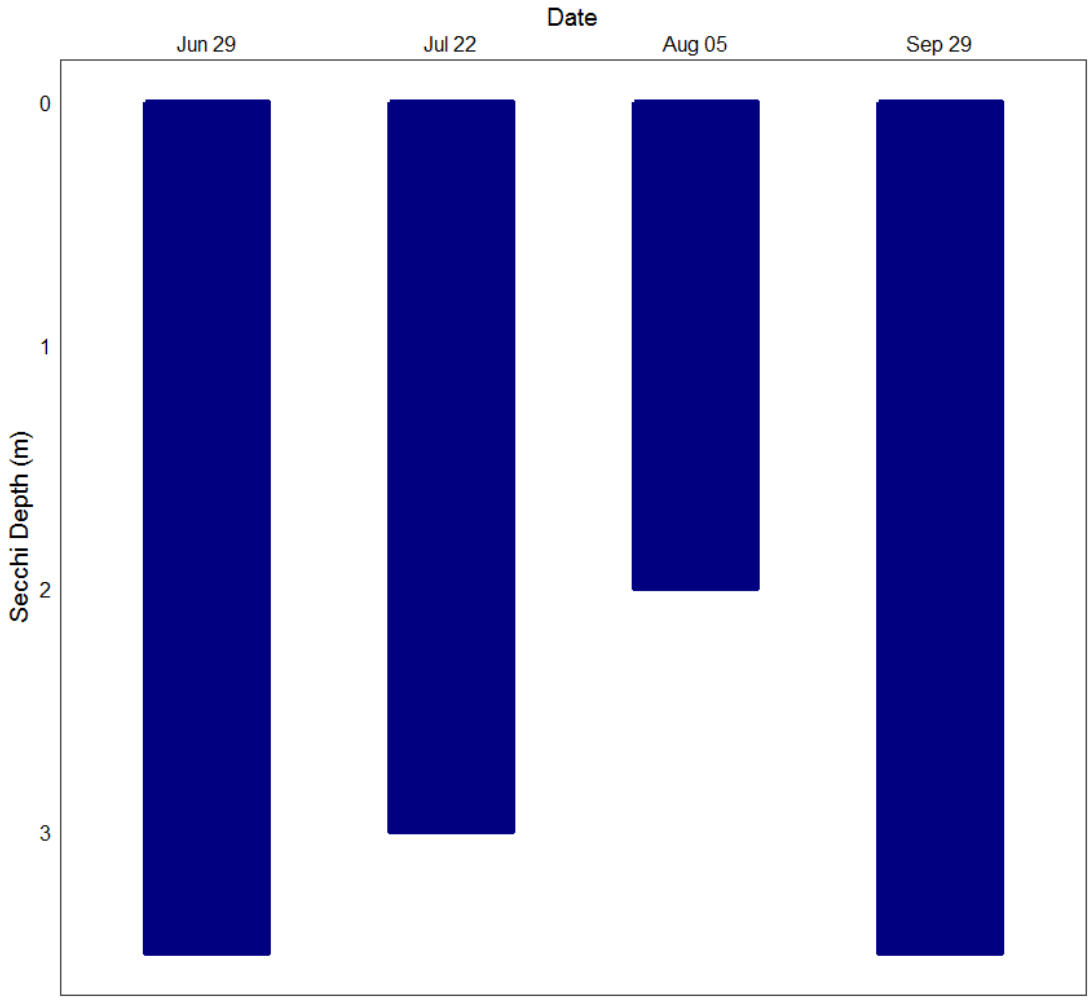

Figure 2 – Secchi depth values measured four times over the course of the summer at Pinehurst Lake in 2016.

WATER TEMPERATURE AND DISSOLVED OXYGEN

Water temperature and dissolved oxygen 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.

Pinehurst Lake water temperatures varied throughout the summer (Figure 3a). A maximum temperature of 21.38°C was observed on August 5. Given that Pinehurst Lake is quite deep, it reached thermal stratification on all sampling visits, with the thermocline at about 10 m, deepening as the surface water warmed over the course of the summer.

Pinehurst Lake remained well oxygenated at the surface throughout the summer, measuring above the Canadian Council for Ministers of the Environment guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). Pinehurst reached near anoxic conditions at the bottom on all sampling dates except July 22. This could be due to the separation of atmospheric oxygen from the surface by way of thermal stratification. It is unclear what caused the lack of DO stratification on July 22, but could be a result of wind during sampling.

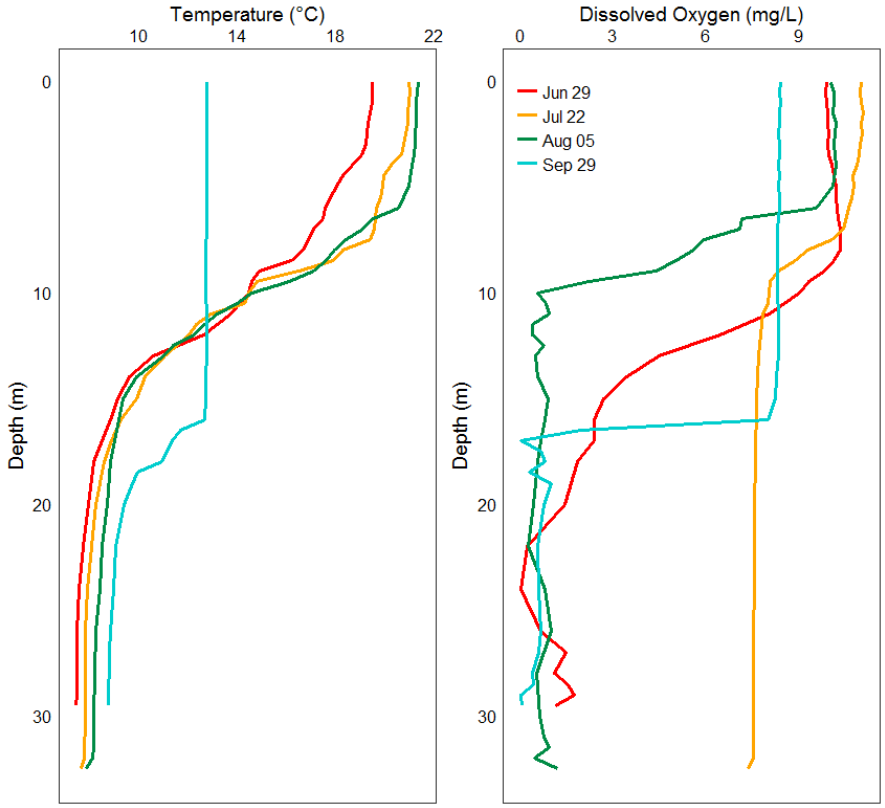

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Pinehurst Lake measured four times over the course of summer 2016.

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 the one of the most common cyanobacteria toxins. In Alberta, recreational guidelines for microcystin are set at 20 µg/L.

Table 1 – Microcystin concentrations measured four times at Pinehurst Lake in 2016. Microcystin levels remained below recommended guidelines on all sampling dates.

Date	Microcystin Concentration (µg/L)
Jun 29	0.05
Jul 22	0.05
Aug 5	0.05
Sep 29	0.05
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 have been linked to creating toxic algae blooms, decreasing the amount of nutrients needed for fish and other native species, and causing millions of dollars in annual costs for repair and maintenance of water-operated infrastructure and facilities.

Monitoring involved two components: monitoring for juvenile mussel veligers using a plankton net and monitoring for attached adult mussels using substrates installed in each lake. In 2016, no invasive mussels were detected in Pinehurst Lake.

WATER LEVELS

There are many factors influencing water quantity. Some of these factors include the size of the lakes 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 in Pinehurst Lake have remained relatively stable since Alberta Environment began monitoring the lake in 1968 (Figure 4). Since 1968, Pinehurst Lake water levels have fluctuated between 597.7 m asl and 599.4 m asl.

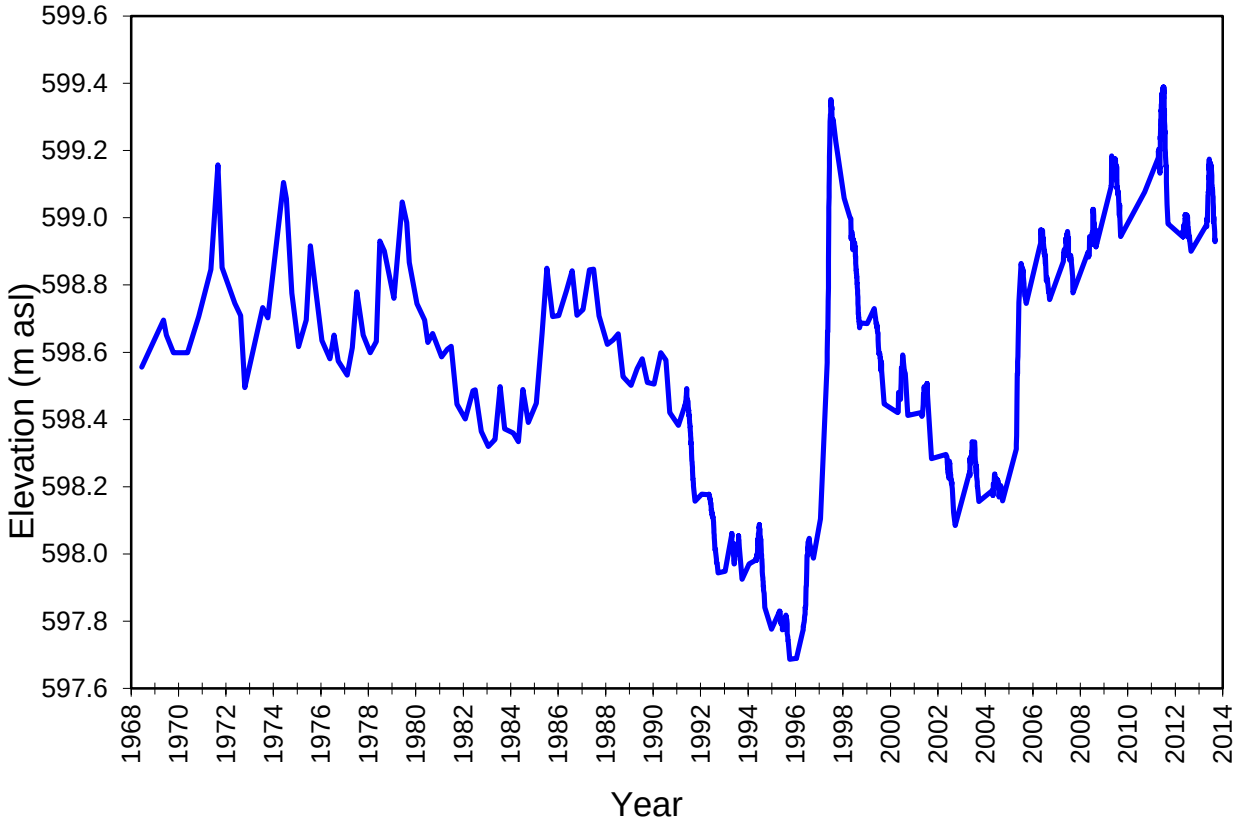

Figure 4- Water levels measured in meters above sea level (m asl) from 1968- 2014. Data retrieved from Alberta Environment.

Table 2: Average Secchi depth and water chemistry values for Pinehurst Lake. Historical values are given for reference.

Parameter	**1986**	**2013**	**2015**	**2016**
TP (µg/L)	45.67	26.6	16	18
TDP (µg/L)	9.83	14.4	7.2	7
Chlorophyll-*a* (µg/L)	14.58	4.968	7.22	7.5
Secchi depth (m)	/	2.68	2.45	3
TKN (mg/L)	1.2	0.95	0.89	0.9
NO_2 and NO_3 (µg/L)	1.58	2.5	2.5	2.5
NH_3 (µg/L)	15.83	37.8	25	25
DOC (mg/L)	13.32	13.46667	13.25	12.275
Ca (mg/L)	32	31.6	28	29.25
Mg (mg/L)	12.83	17.43333	16	17.25
Na (mg/L)	8.17	10.5	11	11
K (mg/L)	3.8	4.466667	4.7	4.975
SO_4^{2-} (mg/L)	2.5	4.5	2.425	2.075
Cl^- (mg/L)	0.5	1.333333	0.5	0.65
CO_3 (mg/L)	6.76	8.7	6.71	5.05
HCO_3 (mg/L)	169.6383	178.8	176	180
pH	8.533333	8.394	8.59	8.56
Conductivity (µS/cm)	280	302.4	286	292.5
Hardness (mg/L)	132.5	150.6667	136	142.5
TDS (mg/L)	152.035	166	154	160
Microcystin (µg/L)	/	/	0.05	0.05
Total Alkalinity (mg/L $CaCO_3$)	148.8333	160.6	154	160

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

Metals (Total Recoverable)	2013	2015	2016	Guidelines
Aluminum µg/L	12.65	7.2	8.4	100[a]
Antimony µg/L	0.01345	0.0195	0.026	6[d]
Arsenic µg/L	0.6475	0.6055	0.747	5
Barium µg/L	39.25	38.5	42.8	1000[d]
Beryllium µg/L	0.0057	0.004	0.004	100[c,e]
Bismuth µg/L	0.0005	0.005	0.004	/
Boron µg/L	43.05	43.35	48.9	1500
Cadmium µg/L	0.001	0.001	0.005	0.26[b]
Chromium µg/L	0.293	0.065	0.07	/
Cobalt µg/L	0.00855	0.0025	0.003	1000[e]
Copper µg/L	0.26825	0.23	0.58	4[b]
Iron µg/L	25.6	7.2	25.9	300
Lead µg/L	0.01735	0.0345	0.2	7[b]
Lithium µg/L	15.05	13.6	15.3	2500[f]
Manganese µg/L	11.4	20.55	48.4	200[f]
Molybdenum µg/L	0.01685	0.024	0.418	73[c]
Nickel µg/L	0.0025	0.004	0.217	150[b]
Selenium µg/L	0.05	0.05	0.24	1
Silver µg/L	0.0166	0.001	0.004	0.25
Strontium µg/L	139	134.5	140	/
Thallium µg/L	0.00015	0.001225	0.0085	0.8
Thorium µg/L	0.00015	0.010025	0.0085	/
Tin µg/L	0.05295	0.0215	0.028	/
Titanium µg/L	0.3165	0.6	0.9	/
Uranium µg/L	0.0606	0.062	0.058	15
Vanadium µg/L	0.117	0.095	0.16	100[e,f]
Zinc µg/L	0.4625	0.35	1	30

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on water hardness > 180mg/L (as CaCO3)

[c] CCME interim value.

[d] Based on Canadian Drinking Water Quality guideline values.

[e] Based on CCME Guidelines for Agricultural use (Livestock Watering).

[f] Based on CCME Guidelines for Agricultural Use (Irrigation).

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