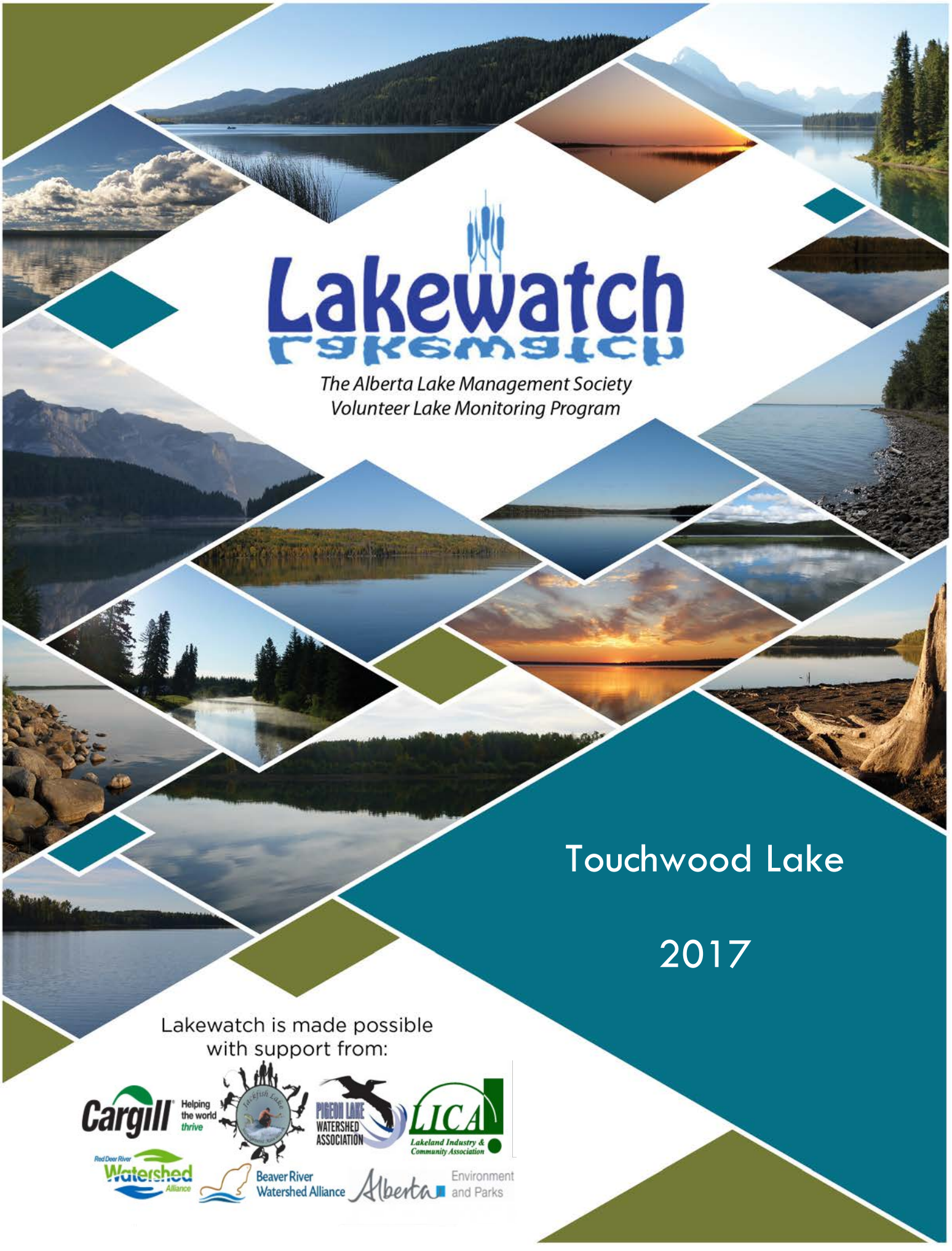

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Touchwood Lake

2017

Lakewatch is made possible with support from:

Cargill Helping the world thrive

Jackfish Lake Management Association

Pigeon Lake Watershed Association

LICA Lakeland Industry & Community Association

Red Deer River Watershed Alliance

Beaver River Watershed Alliance

Alberta Environment and Parks

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.

ALMS is happy to discuss the results of this report with our stakeholders. If you would like information or a public presentation, contact us at info@alms.ca.

ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. We would like to extend a special thanks to Molly Fyten for organizing volunteers and for the time and energy put into sampling Touchwood Lake in 2017. We would also like to thank Elashia Young and Melissa Risto who were summer technicians in 2017. Executive Director Bradley Peter and LakeWatch Coordinator Laura Redmond were instrumental in planning and organizing the field program. This report was prepared by Laura Redmond and Bradley Peter. The Beaver River Watershed, the Lakeland Industry and Community Association, Environment Canada, and Alberta Environment and Parks are major sponsors of the LakeWatch program.

TOUCHWOOD LAKE

Touchwood Lake is a beautiful wilderness lake set in heavily forested, rolling hills. It is located in Lakeland County, 265 km northeast of Edmonton and 45 km east of the town of Lac La Biche, which is the closest large population centre. Touchwood Lake falls within the boundaries of the Lakeland Recreation Area, positioned between the Lakeland Provincial Park to the west and the Cold Lake Air Weapons Range to the east. It is a popular recreational lake for camping, fishing, and boating.

Touchwood Lake 2017—photo by Elashia Young

The word "touchwood" refers to birch punk, which was used to start fires with flint and steel. The Cree called Touchwood Lake Nameygos Sakahegan, which means Trout Lake, in reference to the abundant, large lake trout found there.[1] By the late 1920's, however, the trout population was decimated by the commercial fishery industry. Today, walleye and northern pike are the main species caught by the popular sport fishery. Concentrations of algae in Touchwood Lake are low throughout the open-water period, so the water is clear. The density of aquatic vegetation is sparse to moderate, with many un-vegetated areas along the lakeshore.

Touchwood Lake is one of the largest bodies of water in the Lakeland region (surface area = 29.0 km^2, mean depth = 15.0 m). It is separated into two basins by a large peninsula. The north basin, with a maximum depth of 40.0 m, is the deeper of the two. Touchwood Lake is a headwater lake. It drains quite a large area (111 km^2), but the drainage basin is less than four times the size of the lake. The outlet stream flows to Pinehurst Lake, six km to the south, and eventually to the Beaver River via Punk Creek and Sand River. The drainage basin is part of the Boreal Mixwood Ecoregion[2]. The dominant trees are an association of trembling aspen, balsam poplar, and lodgepole pine on moderately well-drained Gray Luvisols. Other species present are jack pine, white spruce, black spruce, willows, and sedges.

The watershed area for Touchwood Lake is 112.45 km^2 and the lake area is 28.91 km^2. The lake to watershed ratio of Touchwood Lake is 1:4. A map of the Touchwood Lake watershed area can be found at http://alms.ca/wp-content/uploads/2016/12/Touchwood.pdf.

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[1] Chipeniuk, R.C. (1975). Lakes of the Lac La Biche district. R.C. Chipeniuk, Lac La Biche.

[2] Strong, W.L. and K.R. Leggat. (1981). Ecoregions of Alberta. Alberta Energy and Natural Resources, Resource Evaluation and Planning Division. ENR Technical Report T/4. Map at 1:1,500,000.

METHODS

Profiles: Profile data is measured at the deepest spot in the main basin of the lake. At the profile site, temperature, dissolved oxygen, pH, conductivity and redox potential are measured at 0.5- 1.0 m intervals. Additionally, Secchi depth is measured at the profile site and used to calculate the euphotic zone. On one visit per season, metals are collected at the profile site by hand grab from the surface and at some lakes, 1 m off bottom using a Kemmerer.

Composite samples: At 10-sites across the lake, water is collected from the euphotic zone and combined across sites into one composite sample. This water is collected for analysis of water chemistry, chlorophyll-a, nutrients and microcystin. Quality control (QC) data for total phosphorus was taken as a duplicate true split on one sampling date. ALMS uses the following accredited labs for analysis: Routine water chemistry and nutrients are analyzed by Maxxam Analytics, chlorophyll-*a* and metals are analyzed by Alberta Innovates Technology Futures (AITF), and microcystin is analyzed by the Alberta Centre for Toxicology (ACTF). In lakes where mercury samples are taken, they are analyzed by the Biogeochemical Analytical Service Laboratory (BASL).

Invasive Species: Monitoring for invasive quagga and zebra mussels involved two components: monitoring for juvenile mussel veligers using a 63 µm plankton net at three sample sites and monitoring for attached adult mussels using substrates installed at each lake.

Data Storage and Analysis: Data is stored in the Water Data System (WDS), a module of the Environmental Management System (EMS) run by Alberta Environment and Parks (AEP). Data goes through a complete validation process by ALMS and AEP. Users should use caution when comparing historical data, as sampling and laboratory techniques have changed over time (e.g. detection limits). For more information on data storage, see AEP Surface Water Quality Data Reports at aep.alberta.ca/water.

Data analysis is done using the program R.[1] Data is reconfigured using packages tidyr [2] and dplyr [3] and figures are produced using the package ggplot2 [4]. Trophic status for each lake is classified based on lake water characteristics using values from Nurnberg (1996)[5]. The Canadian Council for Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life are used to compare heavy metals and dissolved oxygen measurements. Pearson's Correlation tests are used to examine relationships between TP, chlorophyll-*a,* TKN and Secchi depth, providing a correlation coefficient (r) to show the strength (0-1) and a p-value to assess significance of the relationship.

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[1] R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

[2] Wickman, H. and Henry, L. (2017). tidyr: Easily Tidy Data with 'spread ( )' and 'gather ( )' Functions. R package version 0.7.2. https://CRAN.R-project.org/package=tidyr.

[3] Wickman, H., Francois, R., Henry, L. and Muller, K. (2017). dplyr: A Grammar of Data Manipulation. R package version 0.7.4. http://CRAN.R-project.org/package=dplyr.

[4] Wickham, H. (2009). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.

[5] Nurnberg, G.K. (1996). Trophic state of clear and colored, soft- and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish. Lake and Reservoir Management 12: 432-447.

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 Touchwood Lake was 13.7 µg/L (Table 2), falling into the mesotrophic, or moderately productive, trophic classification. This average falls well within the historical range of TP at Touchwood Lake. TP peaked on July 27 at 19 µg/L, but remained in the mesotrophic classification for the extent of the sampling season.

Average chlorophyll-*a* concentrations in 2017 was 3.5 µg/L (Table 2), putting Touchwood Lake at the edge of the oligotrophic and mesotrophic classifications. Chlorophyll-*a* concentrations were highest on August 17, reaching a maximum concentration of 4.4µg/L, but remained relatively stable over the course of the sampling season.

Finally, average total Kjeldahl nitrogen (TKN) concentration was 0.59 mg/L (Table 2), and the maximum concentration of 0.62 mg/L was measured on September 22, however concentrations remained within a narrow range of change.

Average pH was measured as 8.42 in 2017, buffered by moderate alkalinity (150 mg/L $CaCO_3$) and bicarbonate (175 mg/L HCO_3). Calcium was the dominant ion contributing to a low conductivity of 270 µS/cm (Table 2).

METALS

Samples were analyzed for metals (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 on September 22 at Touchwood Lake at the surface. In 2017, all measured values fell within their respective guidelines (Table 3).

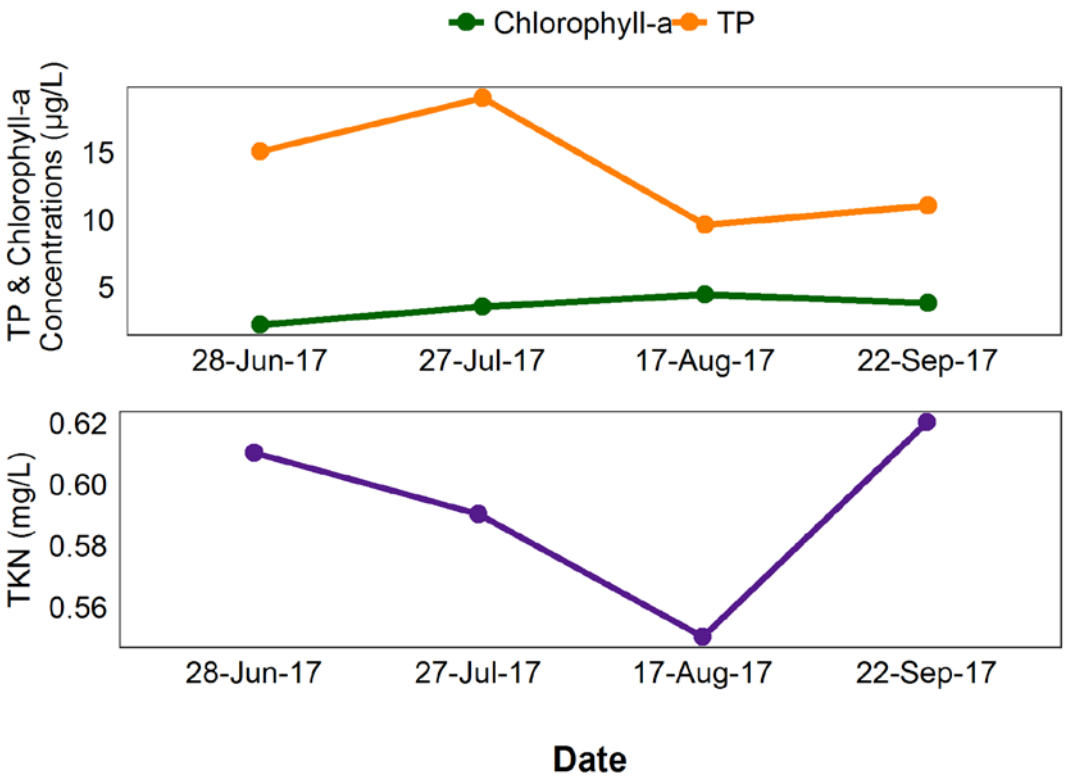

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Touchwood Lake.

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 depth. Two times the Secchi depth equals the euphotic depth – the depth to which there is enough light for photosynthesis.

The average Secchi depth of Touchwood Lake in 2017 was 4.65 m (Table 2). Water clarity measured as Secchi depth remained between 4 and 5 m for the extent of the sampling season. This high water clarity classifies Touchwood Lake as oligotrophic.

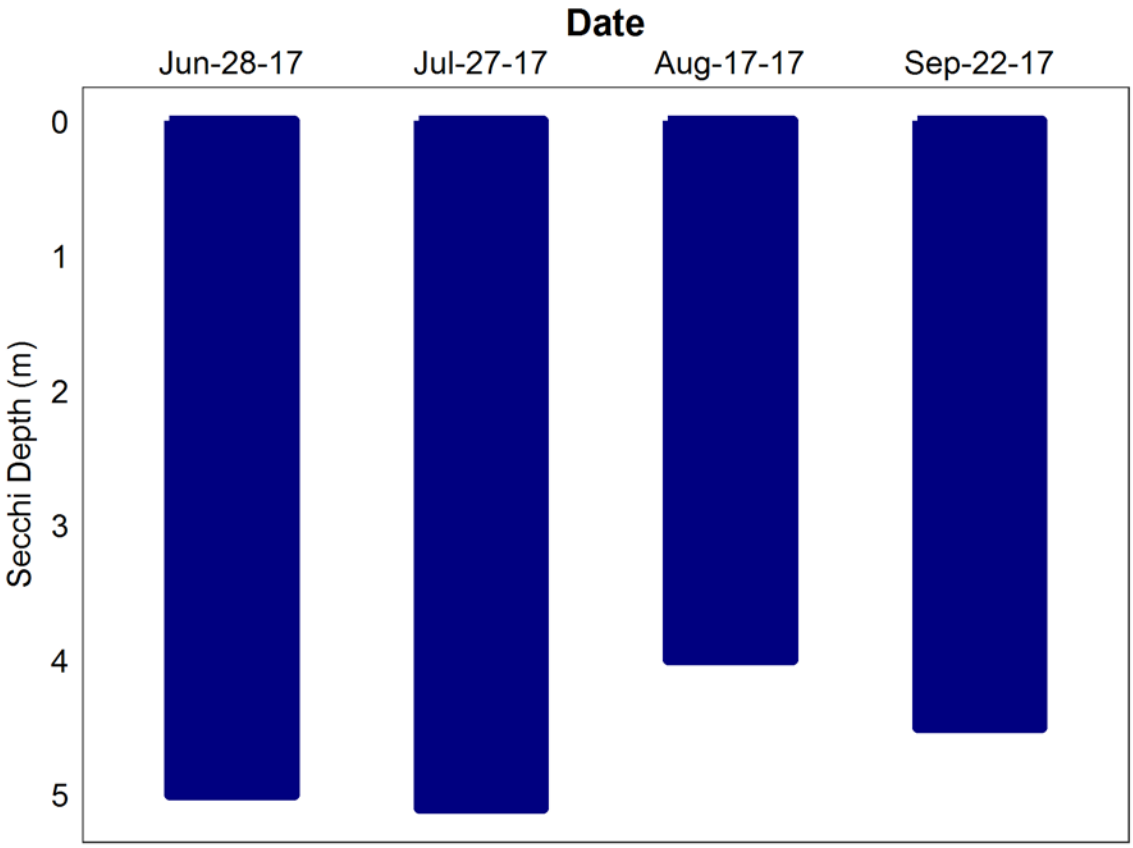

Figure 2 – Secchi depth values measured four times over the course of the summer at Touchwood Lake in 2017.

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.

Temperatures of Touchwood Lake varied throughout the summer, with a maximum temperature of 19.5 °C measured at the surface on July 27 (Figure 3a). Touchwood Lake was stratified for all sampling visits, and the thermocline deepened as the summer progressed.

Touchwood Lake remained well oxygenated at the surface throughout the summer, measuring above the CCME (Figure 3b). Oxygen levels decreased near the bottom in August and September and was likely due to decomposition of organic material and macrophytes. Oxygen remains high to the bottom in June and July due to the high water volume: sediment ratio that limits water to sediment interaction and the use of oxygen.

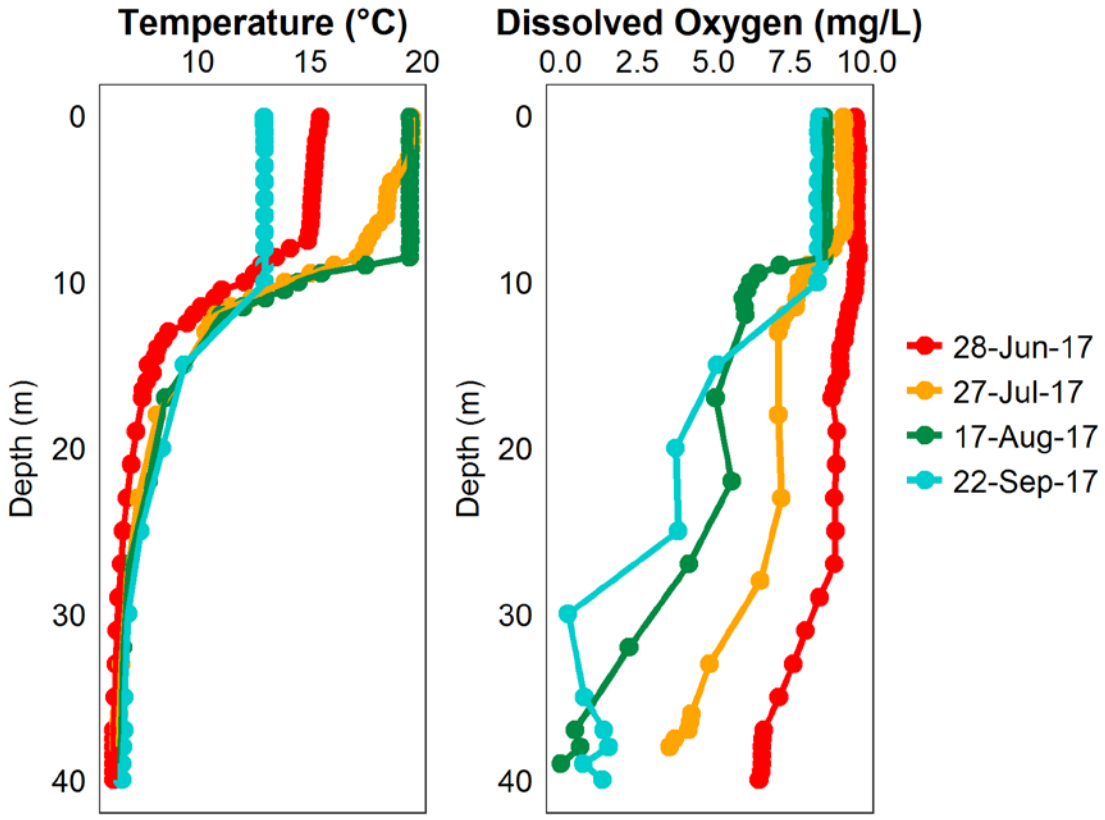

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Touchwood Lake measured four times over the course of the summer of 2017.

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. 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 Touchwood Lake fell below the recreational guideline for the entire sampling period of 2017 and was only detectable on August 17 (Table 1).

Table 1 – Microcystin concentrations measured four times at Touchwood Lake in 2017.

Date	Microcystin Concentration (µg/L)
Jun-28-17	<0.1
Jul-27-17	<0.1
Aug-17-17	0.1
Sep-22-17	<0.1
Average	0.06

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. No mussels have been detected in Touchwood Lake.

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.

Touchwood Lake has been monitored for water levels by Alberta Environment since 1969 (Figure 4). Water levels have increased since the beginning of monitoring and fluctuated in a range of about 2 m. Water level data for 2017 was not available.

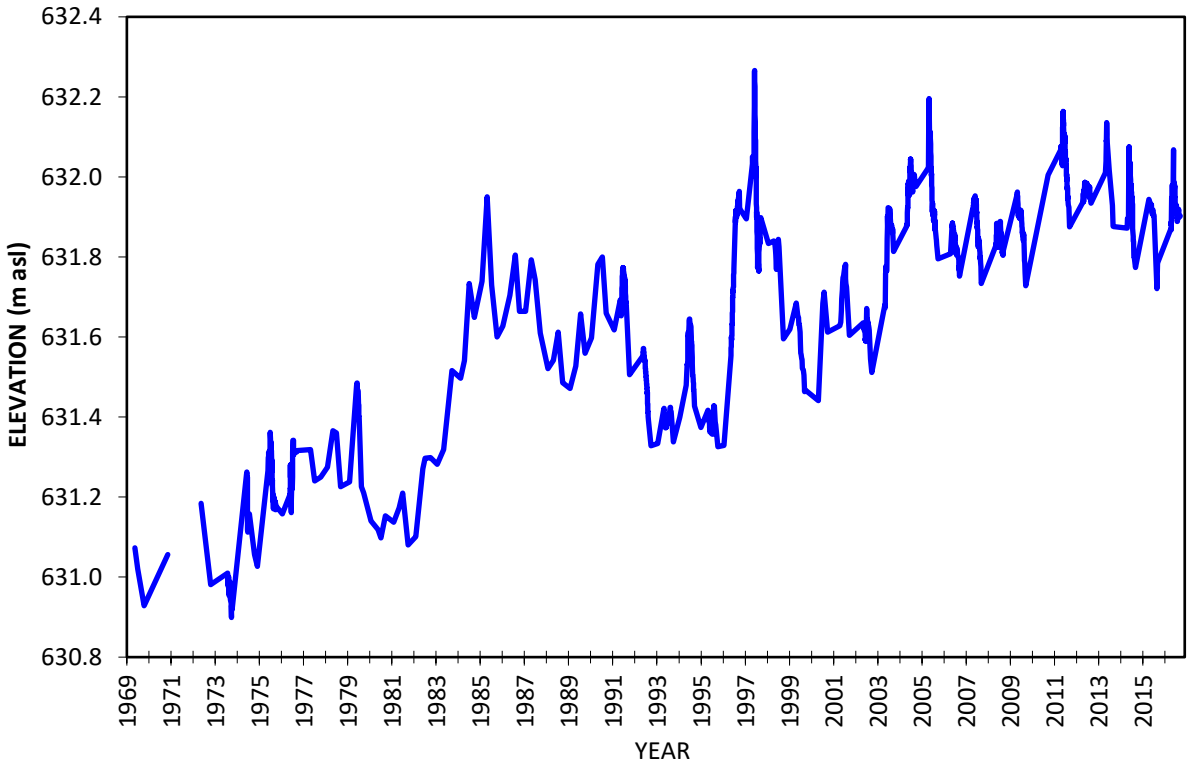

Figure 4- Water levels measured in metres above sea level (m asl) from 1969 to 2016. Data retrieved from Alberta Environment.

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

Parameter	1986	2003	2004	2010	2014	2016	2017
TP (µg/L)	22	15	19	16.8	14.1	11	13.7
TDP (µg/L)	/	9.2	1.5	8	5.9	3	4.5
Chlorophyll-*a* (µg/L)	4.6	3.5	3.7	1.9	1.94	3.40	3.5
Secchi depth (m)	4.9	3.8	4.5	4.65	5.55	4.25	4.65
TKN (mg/L)	0.77	0.59	0.6	0.65	0.59	0.54	0.59
NO_2-N and NO_3-N (µg/L)	10	9.1	3.7	6.5	28	2.5	2.3
NH_3-N (µg/L)	26	16	9.2	14.8	16.8	25	7.9
DOC (mg/L)	11.1	/	10.2	10.8	19.13	9.45	10.3
Ca (mg/L)	33	29	31	27.3	29.63	31.5	33
Mg (mg/L)	11	12	12	13.5	13.13	14.5	15
Na (mg/L)	7.3	8.1	8	8.83	9.58	9.55	9.9
K (mg/L)	2.5	2.7	2.6	2.73	2.59	3.05	3.2
SO_4^{2-} (mg/L)	2.5	3	1.5	6.67	1.5	1.25	1.45
Cl^- (mg/L)	0.5	0.4	0.3	0.7	0.5	0.5	0.5
CO_3 (mg/L)	2.5	5.3	5.5	3	0.1	2.8	2.35
HCO_3 (mg/L)	170	165	166	176	174.6	172.5	175
pH	8.3	8.6	8.4	8.35	8.212	8.49	8.42
Conductivity (µS/cm)	267	/	271	272	269.2	275	270
Hardness (mg/L)	/	122	128	124	128	140	142.5
TDS (mg/L)	/	184	144	148	145.33	150	152.5
Microcystin (µg/L)	/	/	/	/	0.066	0.05	0.06
Total Alkalinity (mg/L $CaCO_3$)	143	144	146	146	142.8	147.5	150

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

Metals (Total Recoverable)	2003	2004	2010	2014	2016	2017	Guidelines
Aluminum µg/L	15	29	21.2	15.05	15.2	3.9	100[a]
Antimony µg/L	0.007	0.029	0.0211	0.0237	0.029	0.025	/
Arsenic µg/L	0.56	0.6	0.644	0.646	0.684	0.63	5
Barium µg/L	33	36	36.05	35.55	34.6	35.4	/
Beryllium µg/L	0.079	0.0015	0.00595	0.004	0.004	0.0015	100[c,d]
Bismuth µg/L	0.004	0.0005	0.00195	0.0005	0.001	0.0015	/
Boron µg/L	32	37	31.45	34	38.7	34.7	1500
Cadmium µg/L	0.01	0.003	0.0033	0.0025	0.003	0.005	0.26[b]
Chromium µg/L	0.28	0.13	0.063	0.196	0.09	0.05	/
Cobalt µg/L	0.021	0.014	0.01065	0.001	0.001	0.018	1000[d]
Copper µg/L	0.59	0.26	0.208	0.364	0.58	0.31	4[b]
Iron µg/L	15	22	21.15	9.75	12.7	12.1	300
Lead µg/L	0.23	0.05	0.0215	0.0274	0.115	0.018	7[b]
Lithium µg/L	9.4	11	9.76	9.53	11.5	11	2500[e]
Manganese µg/L	9.4	12	5.305	5.56	5.16	6.36	200[e]
Molybdenum µg/L	0.11	0.11	0.114	0.08995	0.11	0.13	73[c]
Nickel µg/L	0.03	0.0025	0.0486	0.004	0.294	0.89	150[b]
Selenium µg/L	0.4	0.09	0.05	0.03	0.13	0.1	1
Silver µg/L	0.0025	0.0011	0.00515	0.002	0.001	0.001	0.25
Strontium µg/L	127	130	125.5	130	130	126	/
Thallium µg/L	0.003	0.0014	0.00315	0.00045	0.0011	0.001	0.8
Thorium µg/L	0.004	0.0042	0.00635	0.014805	0.0033	0.009	/
Tin µg/L	0.05	0.037	0.015	0.008225	0.04	0.03	/
Titanium µg/L	0.9	0.74	0.684	0.537	0.63	0.25	/
Uranium µg/L	0.103	0.98	0.1255	0.124	0.134	0.133	15
Vanadium µg/L	0.147	0.16	0.1375	0.126	0.13	0.102	100[d,e]
Zinc µg/L	1.6	1.7	0.2855	0.8585	1.3	1.4	30

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on water hardness > 180mg/L (as $CaCO_3$)

[c] CCME interim value.

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

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

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