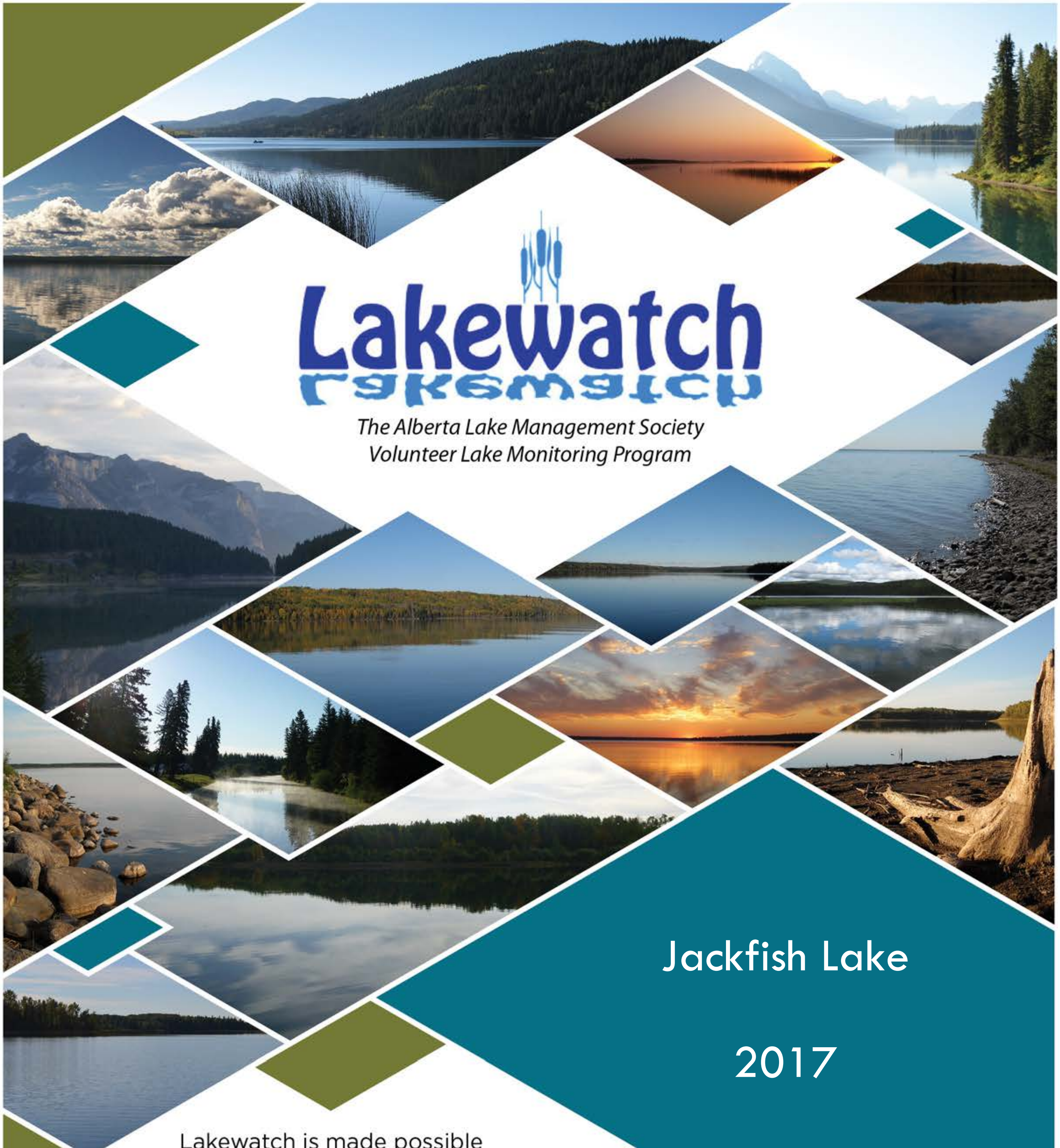


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Jackfish Lake

2017

Lakewatch is made possible with support from:

Cargill Helping the world thrive
Jackfish Lake
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.

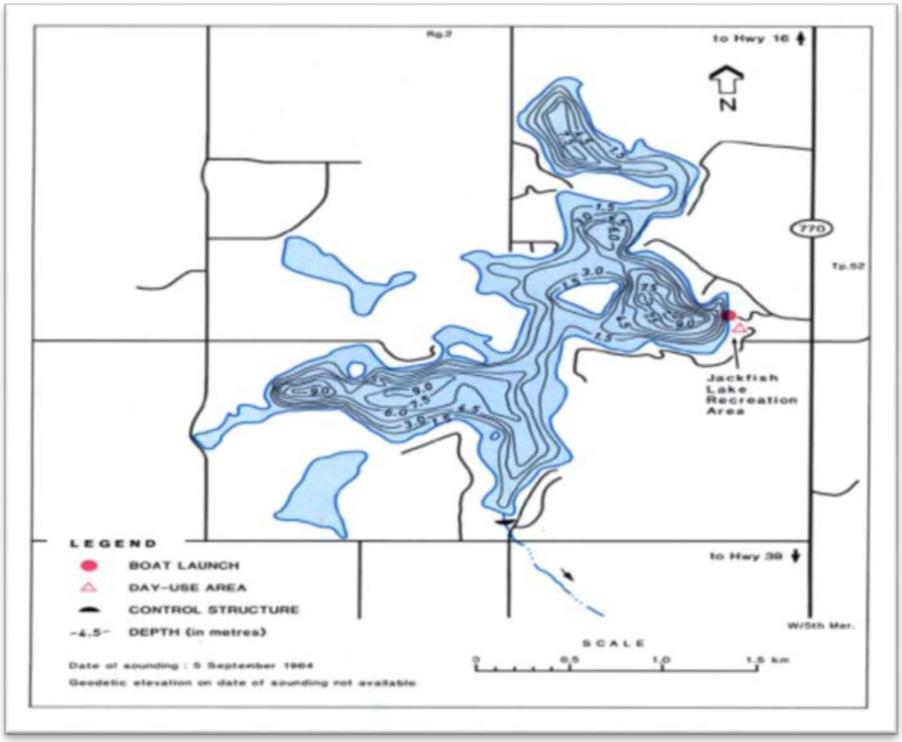
ALMS is happy to discuss the results of this report with our stakeholders. If you would like information or a public presentation, contact us at info@alms.ca.

ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. We would like to extend a special thanks to Jocelyne Pare and Tim Rochemont for the time and energy put into sampling Jackfish 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 was 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.

JACKFISH LAKE

Jackfish Lake, likely named so for northern pike which were the target of a sport fishery, is a popular recreational lake in the North Saskatchewan River Basin in the County of Parkland. [1] Approximately 60 km west of the city of Edmonton, Jackfish Lake is small, with a surface area of only 2.39 km^2, and shallow, with a maximum depth of nine meters.[1] However, due to its irregular shape, the lake has a long, highly developed shoreline of 18.1 km.



Bathymetric map of Jackfish Lake in 1964 (Source: Alberta Environment)

Jackfish Lake in 2011 (Photo by: Jessica Davis)

The drainage basin for Jackfish Lake is small compared to the size of the lake, approximately 12.6 km^2, or four times the size of the lake, and lies in the Moist Mixedwood Subregion of the Boreal Mixedwood Ecoregion [2]. Due to its proximity to both Edmonton and Spruce Grove, Jackfish Lake is heavily used for boating, fishing, and water skiing.

[1] Mitchell, P. and E. Prepas. (1990). Atlas of Alberta Lakes, University of Alberta Press. Retrieved from http://sunsite.ualberta.ca/projects/alberta-lakes/

[2] Nat. Regions Committee. (2006). Nat. Regions and Subregions of AB. Compiled by D.J. Downing and WW Pettapiece. GoA Pub. No. T/852

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 Jackfish Lake was 41.8 µg/L (Table 2), falling into the eutrophic, or productive trophic classification. TP increased over the course of the sampling season, peaking in September (Figure 1).

Average chlorophyll-*a* concentrations in 2017 was 28.4 µg/L (Table 2), putting Jackfish Lake into the hypereutrophic, or very productive classification. Chlorophyll-*a* concentrations also increased over the course of the sampling season, peaking at 48.1 µg/L on August 28. Chlorophyll-*a* was significantly correlated with TP concentrations (r=0.95, p-value=0.05).

Finally, average TKN concentration was 1.525 mg/L (Table 2), and concentrations increased over the course of the summer (Figure 1).

Average pH was measured as 8.18 in 2017, buffered by moderate alkalinity (125 mg/L $CaCO_3$) and bicarbonate (155 mg/L HCO_3). Sulphate and calcium were the dominant ions contributing to a high conductivity of 1175 µS/cm (Table 2).

METALS

Samples were analyzed for metals once (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 on August 28 at Jackfish Lake at the surface. In 2017, Arsenic was measured at 13.2 µg/L, manganese was measured at 236 µg/L and selenium was measured at 3 µg/L, all falling above the CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (Table 3).

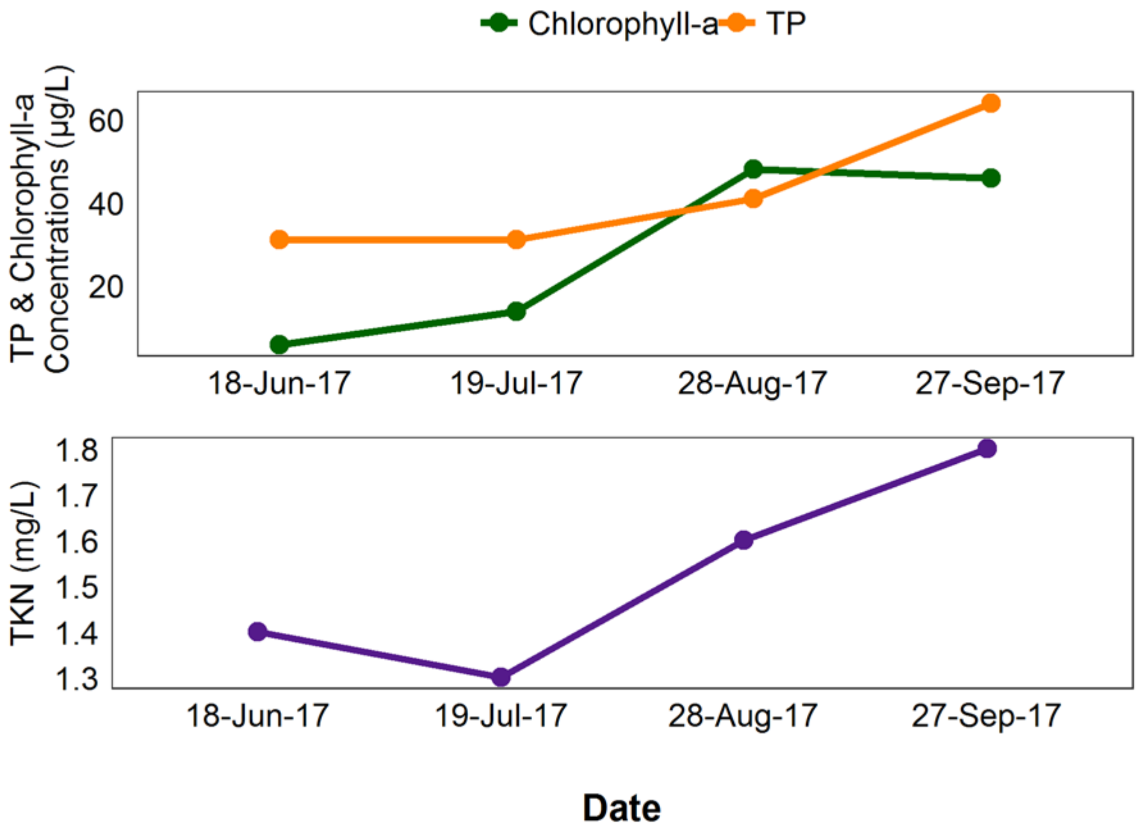

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Jackfish Lake.

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 Jackfish Lake in 2017 was 1.88 m (Table 2). This average does not include the measurement on June 1 as no other water chemistry was collected on that date. Secchi depth decreased over the five sampling visits (Figure 2). The decreasing water clarity could be associated with increasing algae biomass in the warmer months of the summer.

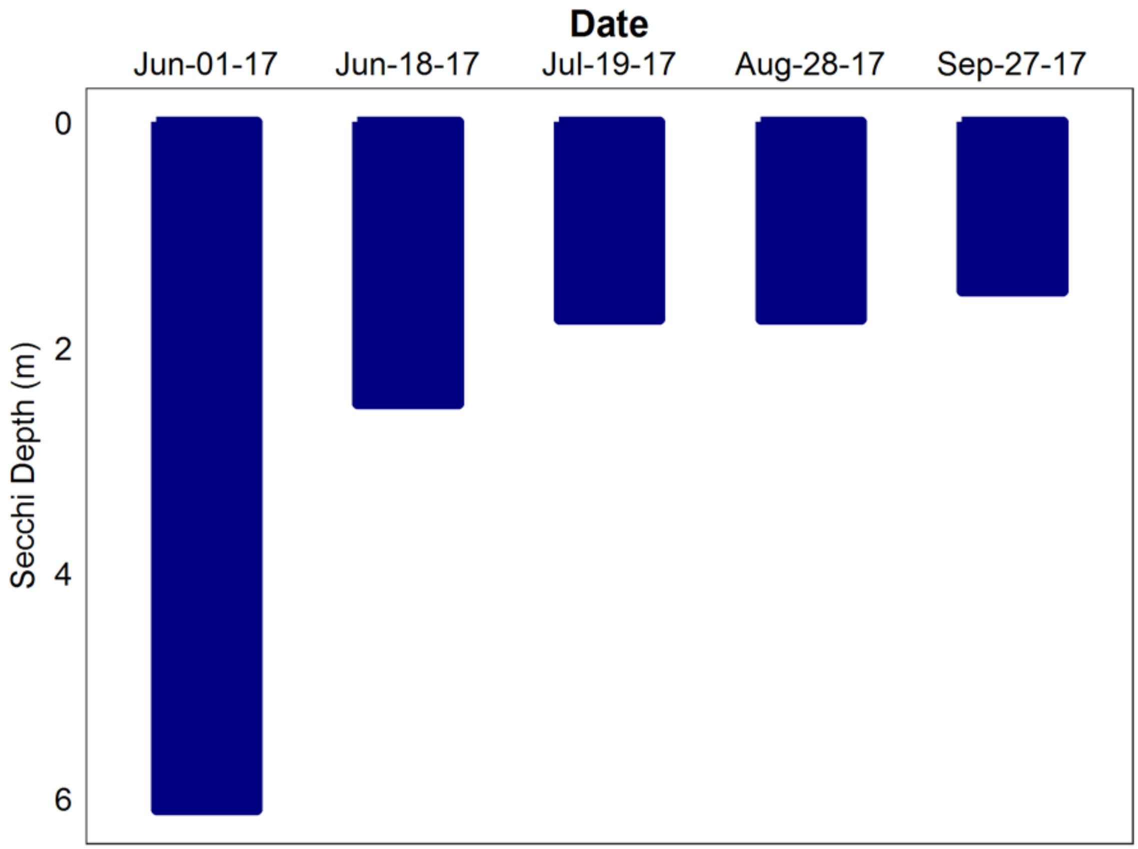

Figure 2 – Secchi depth values measured five times over the course of the summer at Jackfish Lake in 2017.

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.

Jackfish Lake profiles were taken at five sampling visits, the first one being staff training day in June. Temperatures of Jackfish Lake varied throughout the summer, with a maximum temperature of 20.4 °C measured at the surface on July 19 (Figure 3a). The lake was well mixed for most of the summer, with weak stratification occurring in June and July.

Jackfish Lake remained well oxygenated through its water column throughout the summer, measuring above the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). During thermal stratification, oxygen levels decreased near the bottom due to separation from atmospheric oxygen that is circulated at the water surface. On August 28, Jackfish Lake reached anoxia as early as 5 m.

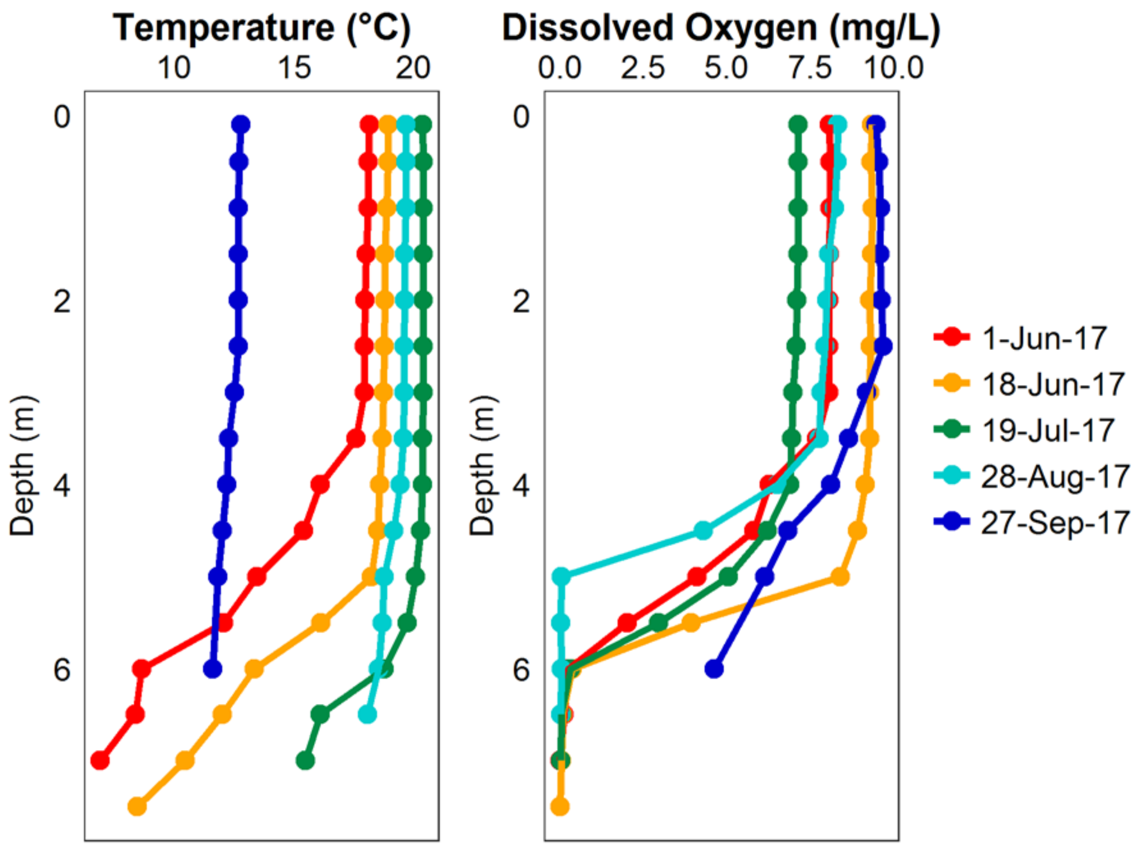

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Jackfish Lake measured five times over the course of the summer of 2017.

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 Jackfish Lake fell below the recreational guideline for the entire sampling period of 2017 (Table 1).

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

Date	Microcystin Concentration (μg/L)
Jun-18-17	0.2
Jul-19-17	0.14
Aug-28-17	0.27
Sep 27-17	0.15
Average	0.19

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 Jackfish 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.

Water levels in Jackfish Lake have been monitored since 1968. Water levels have decreased by more than a metre since the 1990s in Jackfish Lake and in 2016 reached a minimum of 728.3 m.

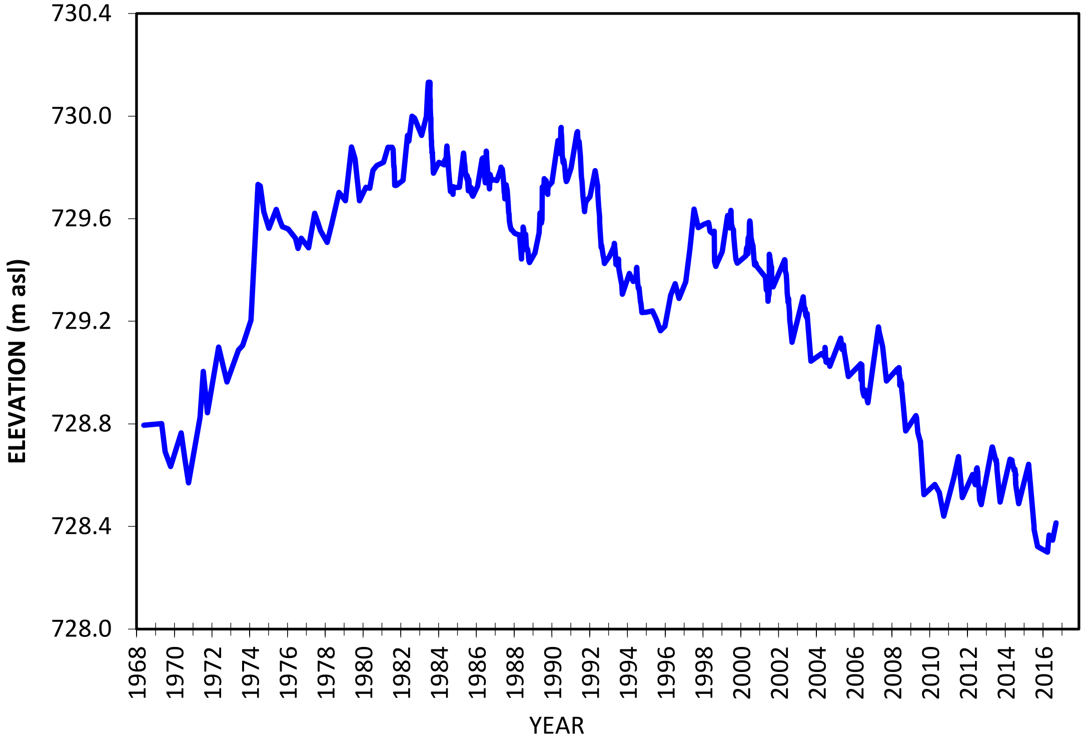

Figure 4- Water levels measured in meters above sea level (m asl) from 1968-2017 at Jackfish Lake. Data retrieved from Alberta Environment and Parks.

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

Parameter	1980	1981	2001	2011	2012	2013	2016	2017
TP (µg/L)	/	39	25	44	36	34.4	37	41.8
TDP (µg/L)	/	/	/	12.6	14.6	17.4	9	9.1
Chlorophyll-*a* (µg/L)	12.6	9.2	12	22.9	12.76	7.39	26.5	28.4
Secchi depth (m)	3	2.4	2.73	2.16	2.3	2.84	2.50	1.88
TKN (mg/L)	1.259	1.174	/	1.442	1.34	1.202	1.48	1.525
NO_2-N and NO_3-N (µg/L)	<5	<3	5	4.2	10.3	2.5	10.44	2.28
NH_3-N (µg/L)	41	64	45	17.8	75.2	19.4	76	39
DOC (mg/L)	/	/	/	12.7	13.1	14.07	13.02	14.25
Ca (mg/L)	76	/	76	102.1	100.5	104.2	114	117.5
Mg (mg/L)	49	/	56	66.8	63.2	67.9	77.8	77.8
Na (mg/L)	/	/	22	28.3	27.2	26.8	31.8	31.5
K (mg/L)	/	/	20	23.3	24.1	30	26.8	27.3
SO_4^{2-} (mg/L)	/	/	392	431.7	461.3	388.7	492	482.5
Cl^- (mg/L)	/	/	4	4.97	5.43	5.2	6.06	5.93
CO_3 (mg/L)	/	/	/	0.5	0.5	0.5	0.58	0.54
HCO_3 (mg/L)	/	/	/	131	145.4	149.2	150	155
pH	/	/	/	8.12	8.12	8.19	8.21	8.18
Conductivity (µS/cm)	/	/	/	1099	1106	1127	1200	1175
Hardness (mg/L)	/	/	/	530	511	539.3	612	617.5
TDS (mg/L)	/	/	/	721	753.7	696.7	826	822.5
Microcystin (µg/L)	/	/	/	0.081	0.089	0.0302	0.894	0.19
Total Alkalinity (mg/L $CaCO_3$)	/	/	77	107.2	119.4	122.6	124	125

Table 3: Concentrations of metals measured in Jackfish Lake on August 28. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	**2012**	**2013**	**2016**	**2017**	**Guidelines**
Aluminum µg/L	16.15	22.7	10.6	53.5	100[a]
Antimony µg/L	0.115	0.1005	0.159	0.626	/
Arsenic µg/L	2.365	1.99	1.93	13.2	5
Barium µg/L	81	74.65	95.4	468	/
Beryllium µg/L	0.0015	0.00905	0.004	0.0055	100[c,d]
Bismuth µg/L	0.00325	0.0005	5.00E-04	0.0055	/
Boron µg/L	159	139	144	673	1500
Cadmium µg/L	0.00275	0.001	0.001	0.025	0.26[b]
Chromium µg/L	0.183	0.2585	0.06	0.25	/
Cobalt µg/L	0.01265	0.0505	0.001	0.196	1000[d]
Copper µg/L	1.4	1.47	1.64	0.63	4[b]
Iron µg/L	24	52.3	26.4	44.7	300
Lead µg/L	0.0436	0.0623	0.025	0.048	7[b]
Lithium µg/L	111	108.3	113	510	2500[e]
Manganese µg/L	157.7	73.15	180	236	200[e]
Molybdenum µg/L	0.1375	0.1305	0.175	0.739	73[c]
Nickel µg/L	0.0025	0.37525	0.004	1.43	150[b]
Selenium µg/L	0.05	0.0845	0.18	3	1
Silver µg/L	0.0023	0.04	0.001	0.024	0.25
Strontium µg/L	892	1090	1110	1050	/
Thallium µg/L	0.000425	0.000475	0.0019	0.01	0.8
Thorium µg/L	0.013525	0.00745	0.0079	0.081	/
Tin µg/L	0.04465	0.015	0.019	0.15	/
Titanium µg/L	0.6135	1.103	0.81	3.76	/
Uranium µg/L	0.455	0.488	0.722	2.98	15
Vanadium µg/L	0.2905	0.2185	0.27	1.19	100[d,e]
Zinc µg/L	1.79	1.615	2.1	13.4	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 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.