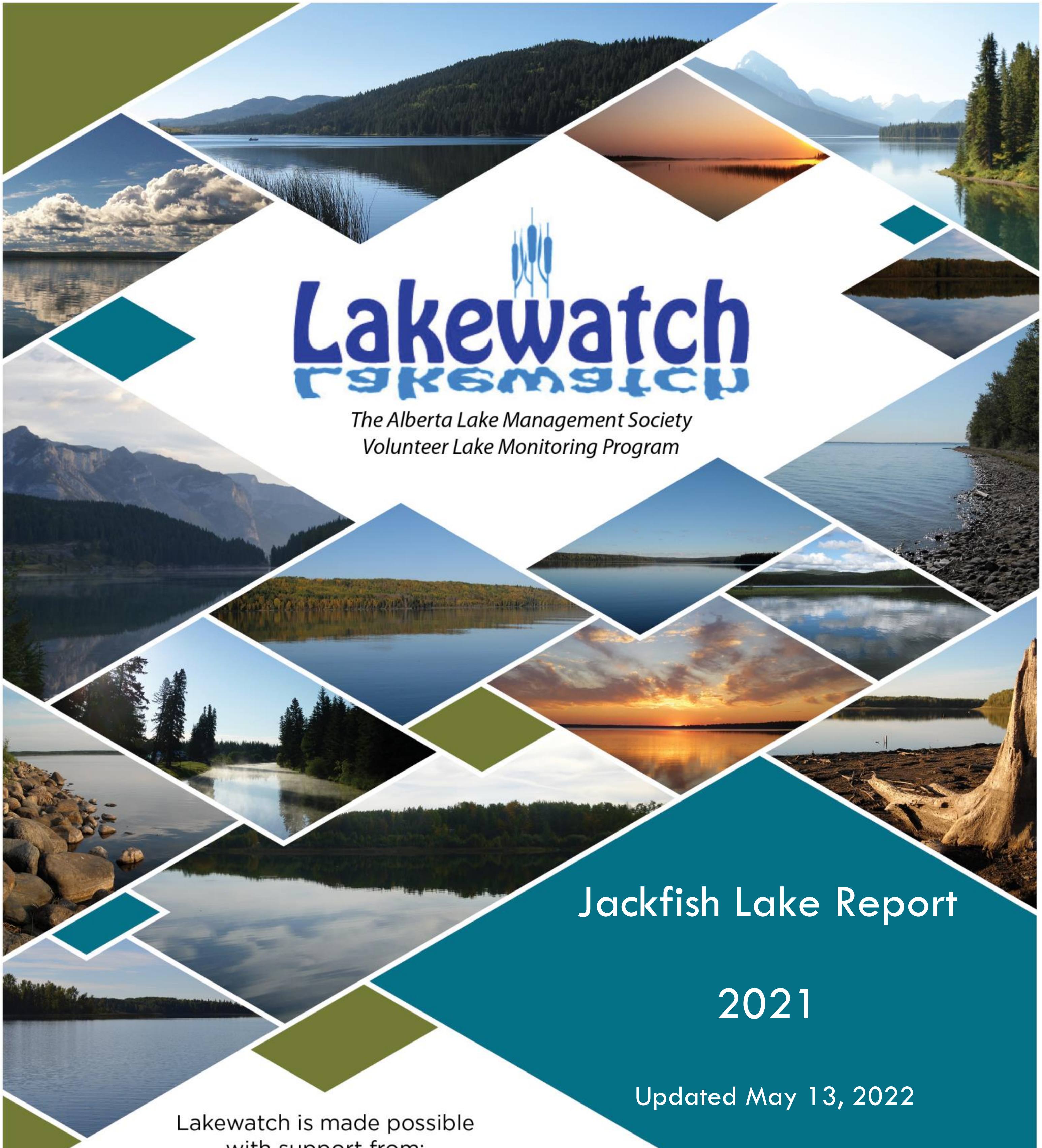


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Jackfish Lake Report

2021

Updated May 13, 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 Keith Tilley for his commitment to collecting data at Jackfish 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.

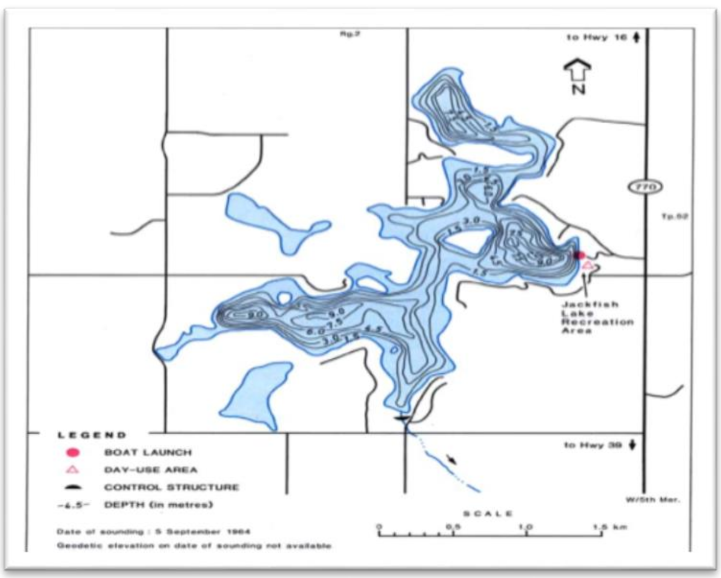
Before reading this report, check out [A Brief Introduction to Limnology] at alms.ca/reports

JACKFISH LAKE

Jackfish Lake, likely named so for the northern pike, which were the target of 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.

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.

Jackfish Lake in 2011 (Photo by: Jessica Davis)



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

[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

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 26 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. This value falls on the lower end of the range of historical averages. TP was lowest on the June 7th sampling event at 18 µg/L, and was highest on September 23rd at 34 µg/L (Figure 1).

Average chlorophyll-*a* concentration in 2021 was 24.1 µg/L (Table 2), falling into the eutrophic, or highly productive trophic classification. Chlorophyll-*a* was lowest earliest in the season, at 4.4 µg/L on June 24th and peaked at 46.1 µg/L on August 27th (Figure 1). Chlorophyll-a was significantly positively correlated with TP (r = 0.97, p = 0.03).

The average TKN concentration was 1.5 mg/L (Table 2) and varied from 1.2 – 1.8 mg/L from June to September (Figure 2).

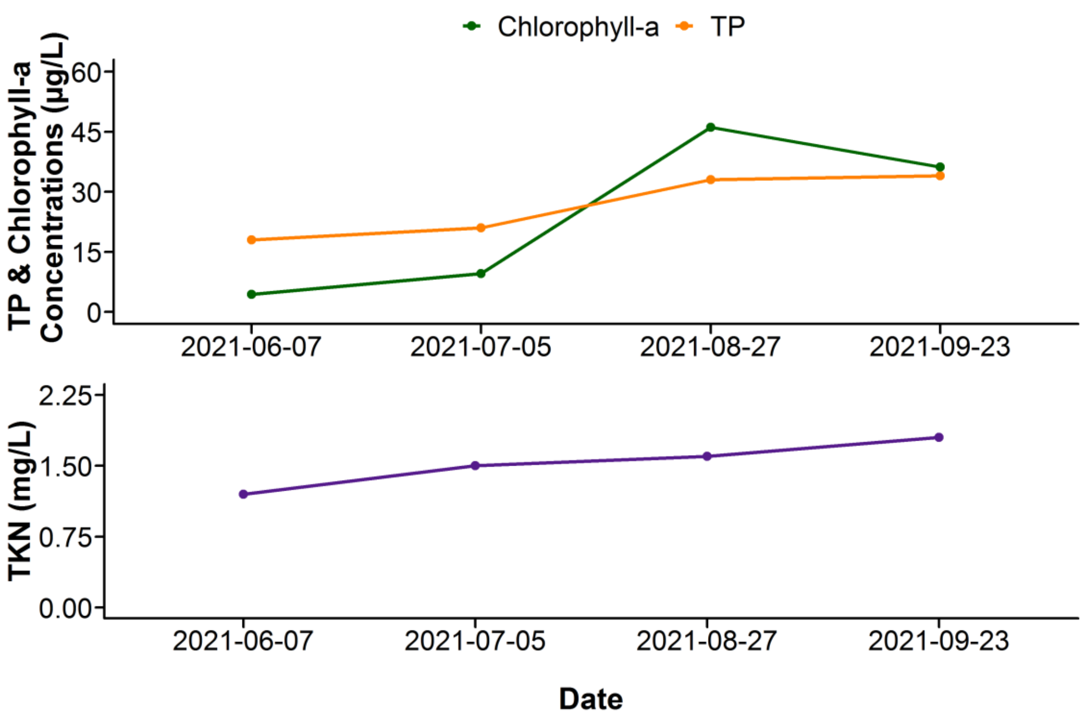


Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Jackfish Lake.

Average pH was measured as 8.06 in 2021, buffered by low alkalinity (148 mg/L $CaCO_3$) and bicarbonate (182 mg/L HCO_3). Sulphate was by far the most abundant ion, followed by bicarbonate, calcium, and magnesium. Together, the ions contributed to a high conductivity of 1200 µS/cm (Figure 2, top; Table 2). Jackfish Lake is in the moderate to high range of most ion levels compared to other LakeWatch lakes sampled in 2021 (Figure 2, bottom). It displayed the highest calcium levels of any lake, but also among the lowest carbonate levels.

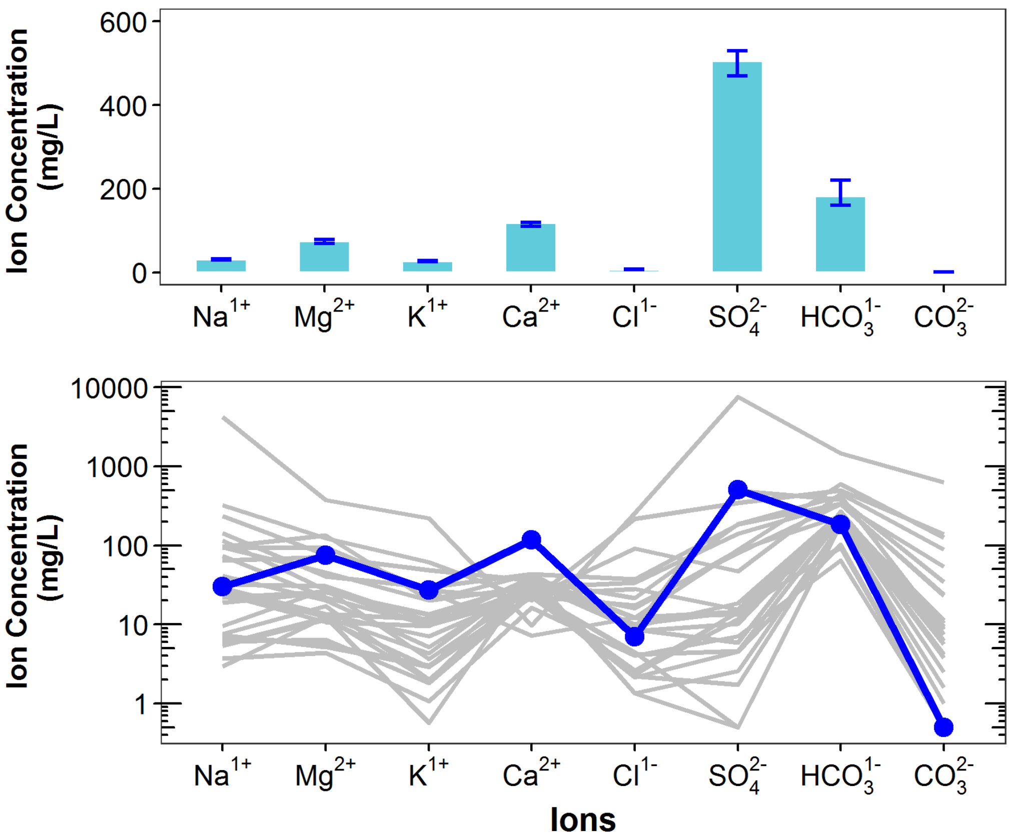


Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Jackfish Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Jackfish 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 Jackfish 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 Jackfish Lake in 2021 was 4.42 m, corresponding to an average Secchi depth of 2.55 m (Table 2). The euphotic depth on June 7th was adjusted to equal the lake's bottom depth, as light was able to reach the bottom of the lake on that day. The euphotic depth continued to decrease through the season, until a minimum of 2.90 m on September 23rd.

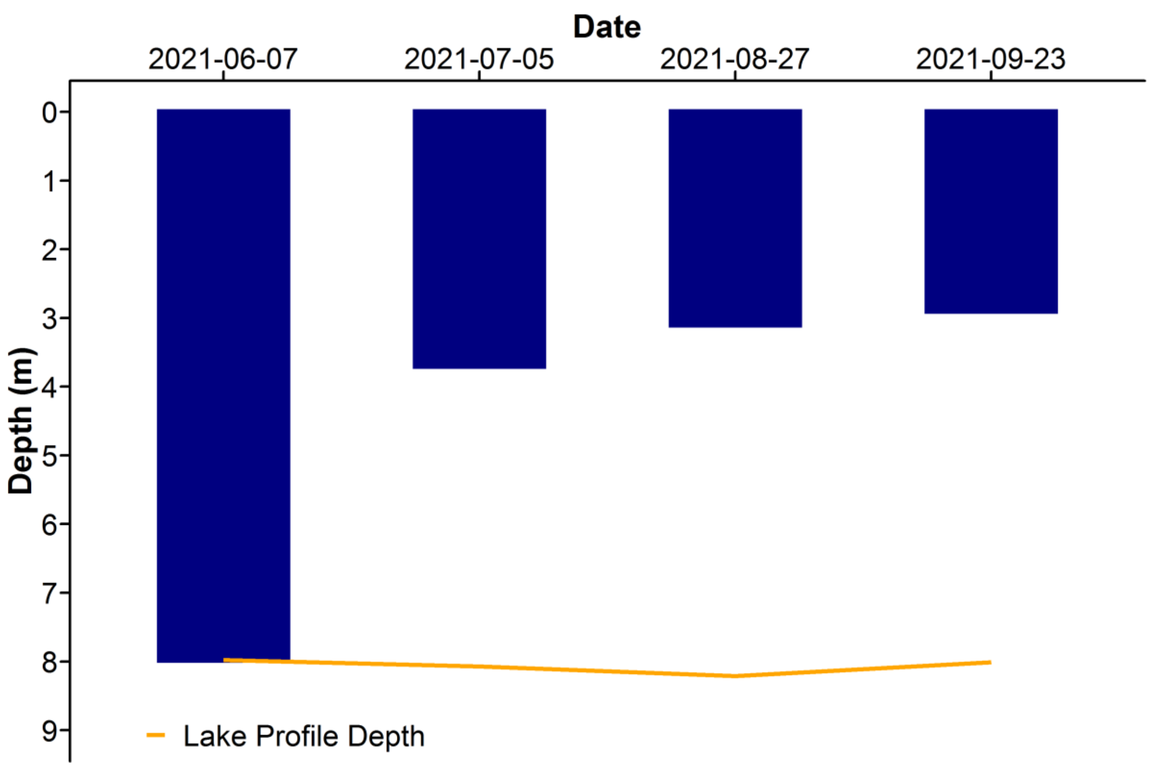


Figure 3. Euphotic depth values measured four times over the course of the summer at Jackfish Lake in 2021.

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 of Jackfish Lake varied throughout the summer, with the July 5th sampling date having the warmest temperatures at 24.2°C (Figure 4a). The lake was slightly stratified during the June and July sampling events, and then was fully mixed during the August and September sampling events.

Jackfish 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 all sampling events, except in September, meaning the slight stratification present in the lake on the June and July sampling dates, was enough to prevent high oxygen surface water from mixing to the bottom. Interestingly, despite the water temperatures indicating that the lake was mixing during the August 27th event, there was also considerable oxygen depletion deep in the water column.

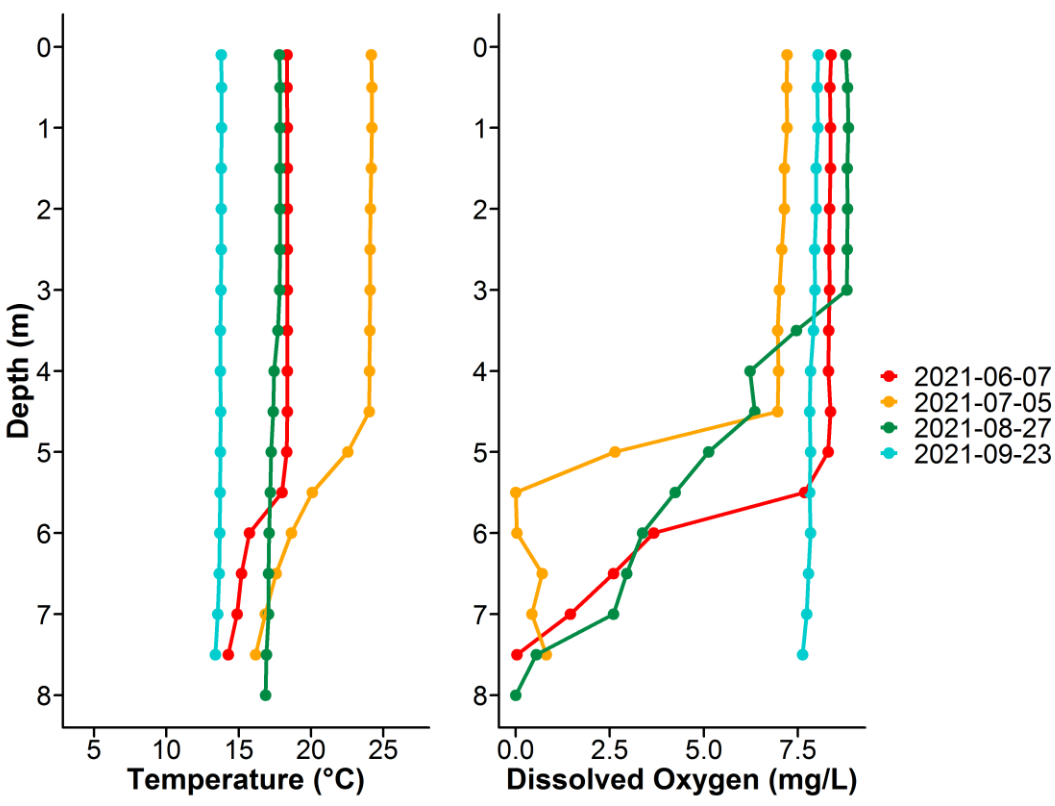


Figure 4. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Jackfish Lake measured four times over the course of the summer of 2021.

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 Jackfish Lake fell below the recreational guideline of 10 μg/L during every sampling event in 2021. Levels on June 7th were below the laboratory detection limit of 0.1 μg/L, and a value of 0.05 μg/L was used to calculate the season average value. 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 Jackfish Lake in 2021.

Date	Microcystin Concentration (μg/L)
7-Jun-21	<0.10
5-Jul-21	0.17
27-Aug-21	0.30
23-Sep-21	0.13
Average	0.16

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 Jackfish 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.

A watermilfoil specimen was collected from Jackfish Lake during the July 5th sampling event, and was confirmed to be the native Northern Watermilfoil.

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 from Jackfish Lake indicates 2021 levels are among the lowest in the historical record, but levels have been relatively stable for the last 15 years (Figure 5).

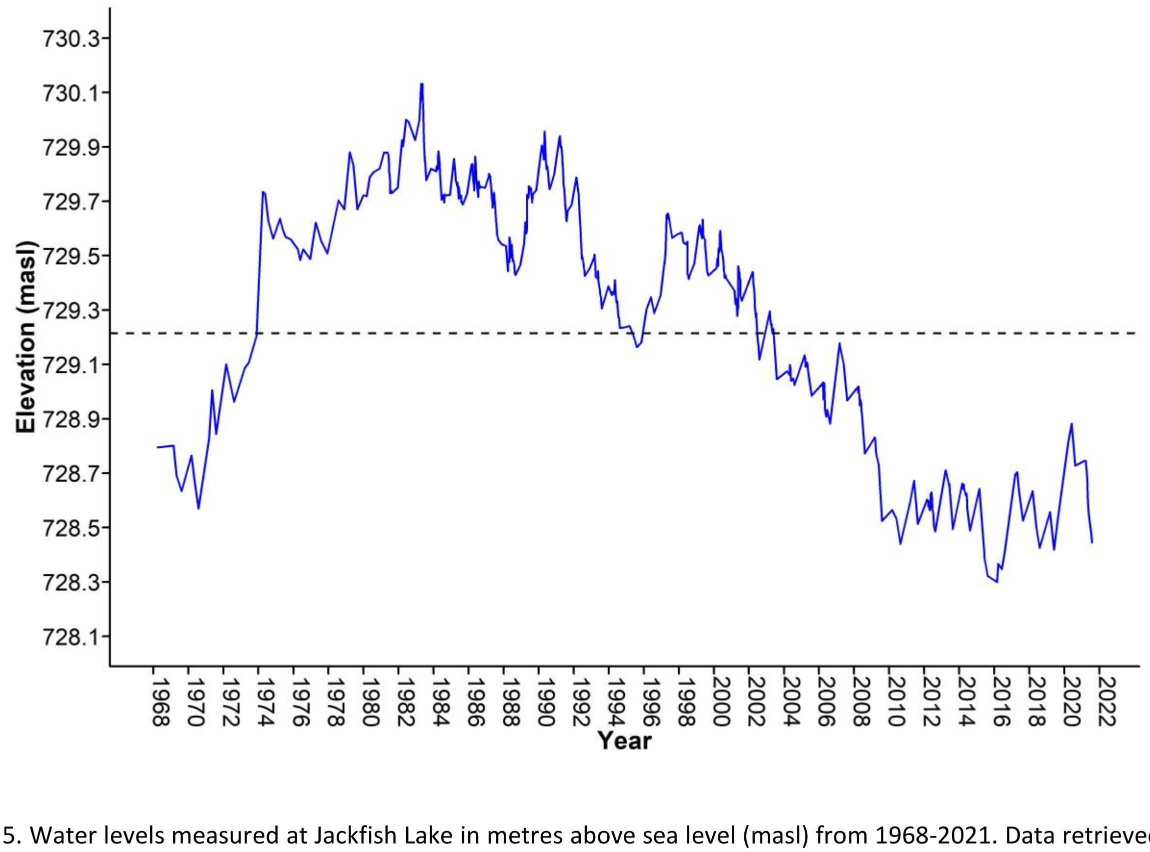


Figure 5. Water levels measured at Jackfish Lake in metres above sea level (masl) from 1968-2021. Data retrieved from Alberta Environment and Parks. Black dashed line represents historical yearly average water level.

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.

Jackfish Lake experienced a warmer, drier, windier summer with slightly more solar radiation compared to normal (Figure 6). A warm spell prior to the July 5th sampling resulted in relatively high water temperatures in the top layer of the lake. At some point between the July and August sampling events, the lake eventually mixed fully due to relatively lower temperatures and wind events. This likely had implications for lake nutrient levels.

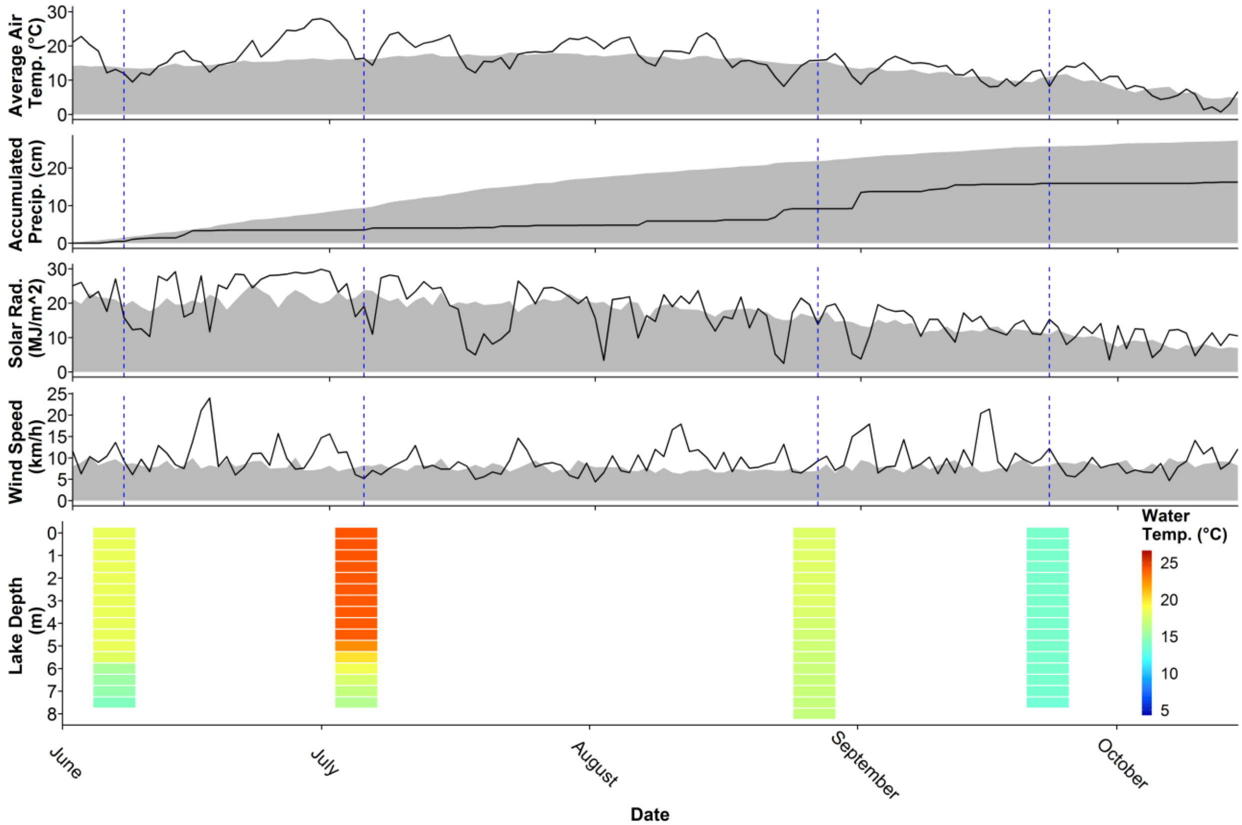


Figure 6. Average air temperature (°C), accumulated precipitation (cm), solar radiation (MJ/m^2) and wind speed (km/h) measured from Edmonton Stony Plain CS, with Jackfish Lake temperature profiles (°C) at the bottom. Black lines indicate 2021 levels, gray indicates long-term normals, and blue lines indicate sampling dates for Jackfish 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 Jackfish Lake. Historical values are given for reference. Number of sample trips are inconsistent between years.

Parameter	1980	1981	1996	2007	2011	2012	2013	2016	2017	2018	2021
TP (µg/L)	\	39	33	22	44	36	34	37	42	21	26
TDP (µg/L)	\	13	11	7	13	15	17	9	9	11	6
Chlorophyll-*a* (µg/L)	12.6	9.2	14.9	12.5	22.9	12.8	7.4	26.5	28.4	11.7	24.1
Secchi depth (m)	3.05	2.58	2.98	1.83	2.18	2.32	2.86	2.52	2.74	1.47	2.6
TKN (mg/L)	1.2	1.1	1.5	1.2	1.4	1.3	1.2	1.5	1.5	1.3	1.5
NO_2-N and NO_3-N (µg/L)	4	5	18	3	4	10	2	10	2	2	5
NH_3-N (µg/L)	40	64	5	21	18	75	19	76	39	29	39
DOC (mg/L)	10	12	\	\	13	13	14	13	14	14	13
Ca^{2+} (mg/L)	76	76	84	94	\	\	\	114	118	120	118
Mg^{2+} (mg/L)	49	48	55	65	\	\	\	78	78	75	74
Na^+ (mg/L)	20	21	25	26	28	27	27	32	32	32	30
K^+ (mg/L)	15	14	20	22	23	24	30	27	27	28	27
SO_4^{2-} (mg/L)	346	336	377	414	432	461	389	492	482	490	505
Cl^- (mg/L)	2	2	4	4	5	5	5	6	6	7	7
CO_3^{2-} (mg/L)	\	\	0.2	2.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5
HCO_3^- (mg/L)	\	\	126	128	131	145	149	150	155	170	182
pH	7.61	7.32	8.02	8.17	8.12	8.12	8.19	8.21	8.18	8.18	8.06
Conductivity (µS/cm)	867	863	944	1009	1099	1106	1127	1200	1175	1200	1200
Hardness (mg/L)	396	403	440	499	530	511	539	612	618	610	608
TDS (mg/L)	566	553	628	688	721	754	697	826	822	837	850
Microcystin (µg/L)	\	\	\	\	0.08	0.09	0.03	0.89	0.19	0.15	0.16
Total Alkalinity (mg/L $CaCO_3$)	97	94	103	105	107	119	123	124	125	140	148

Table 3. Concentrations of metals measured in Jackfish 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)	2012	2013	2015	2016	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	0.0005	0.0055	/
Boron µg/L	159	139	144	673	1500
Cadmium µg/L	0.00275	0.001	0.001	0.025	0.37[b]
Chromium µg/L	0.183	0.2585	0.06	0.25	/
Cobalt µg/L	0.01265	0.0505	0.001	0.196	50,1000[c,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[d]
Manganese µg/L	157.7	73.15	180	236	300[e]
Molybdenum µg/L	0.1375	0.1305	0.175	0.739	73
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[c,d]
Zinc µg/L	1.79	1.615	2.1	13.4	30[f]

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on 2016 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 2016 avg. water hardness (as CaCO3) and avg. pH

[f] Based on 2016 avg. water hardness (as CaCO3), avg. pH, and avg. DOC with CCME equation

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