Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Thunder Lake Report

2019

Lakewatch is made possible with support from:

Alberta Environment and Parks

Pigeon Lake Watershed Association

Lacombe County

LICA Environmental Stewards

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

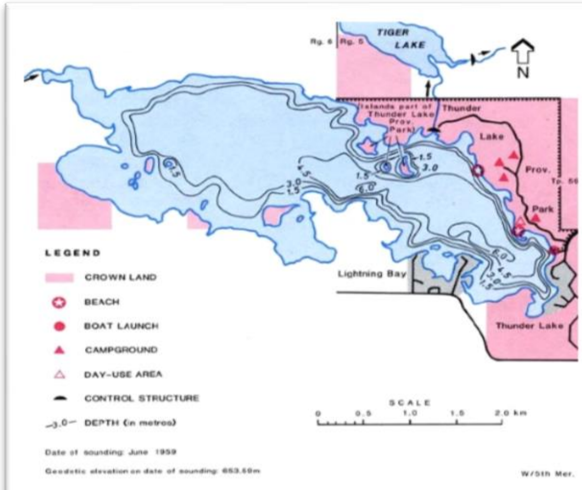
The LakeWatch program is made possible through the dedication of its volunteers. A special thank you to Mike and Walter Zaminer, and Kent Hooey for their time sampling Thunder Lake. We would also like to thank Sarah Davis Cornet, Caleb Sinn, and Pat Heney, who were summer technicians in 2019. Executive Director Bradley Peter and Program Coordinator Caitlin Mader were instrumental in planning and organizing the field program. This report was prepared by Pat Heney, Bradley Peter, and Caleb Sinn.

THUNDER LAKE

Sunset at Thunder Lake in 2007.

Thunder Lake is an attractive recreational lake located in the County of Barrhead. It is situated approximately 22 km west of the town of Barrhead and 130 km northwest of the city of Edmonton. Thunder Lake Provincial Park is on the northeast side of the lake, and can be reached by Highway 18 from Barrhead. The lake's name is a translation of an Indian word that described the loud thundering sound made by the lake's ice cracking in winter[1].

Thunder Lake is a medium-sized water body, approximately 6 km long with a maximum width of 2.4 km. The western half of the lake slopes gently to a maximum depth of approximately 4.5 m, while the eastern half slopes more steeply to a maximum depth of 6.1 m. There are several islands in the lake; three of them are part of the provincial park. Historically, local residents used the lake recreationally for many years and in 1951 they petitioned the provincial government for a park. That same year, the Barrhead Kinsmen cleared a beach at the lake, and in 1958 the province established Thunder Lake Provincial Park. There are three camping loops with a total of 127 sites, a group camping area, a sewage disposal facility, tap water, playgrounds, a change house, a concession, picnic shelters, two swimming areas and beaches, two boat mooring areas, a boat launch and several walking trails. There are no boating restrictions over most of the lake, but in posted areas such as designated swimming areas, all boats are prohibited. In other posted areas, power boats are restricted to a maximum speed of 12 km/hour.



Bathymetry of Thunder Lake, AB. Contour intervals are 3 m.

Algae turn the water in Thunder Lake green during summer and aquatic vegetation grows around much of the shoreline. During winter, levels of dissolved oxygen frequently become critical for the fish population, and winterkills have occurred several times since the late 1960s. The lake has been stocked with northern pike and yellow perch, and the presence of these species provide a popular sport fishery.

[1] Holmgren, E.J. and P.M. Holmgren. 1976. Over 2000 place names of Alberta. 3rd ed. West. Producer Prairie Books, Saskatoon.

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. For select lakes, metals are collected at the profile site by hand grab from the surface on one visit over the season.

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 Innotech Alberta, and microcystin is analyzed by the Alberta Centre for Toxicology (ACTF).

Invasive Species: : Invasive mussel monitoring involved sampling with a 63 µm plankton net at three sample sites twice through the summer season to determine the presence of juvenile dreissenid mussel veligers. Technicians also harvested potential Eurasian watermilfoil (*Myriophyllum spicatum)* samples and submitted them for further analysis at the Alberta Plant Health Lab to genetically differentiate whether the sample was the invasive Eurasian watermilfoil or a native watermilfoil. In addition, select lakes were subject to a bioblitz, where a concerted effort to sample the lake's aquatic plant diversity took place.

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 www.alberta.ca/surface-water-quality-data.aspx.

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 total phosphorus (TP), chlorophyll-*a,* total kjeldahl nitrogen (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.

[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 Thunder Lake was 45 µg/L (Table 2), falling into the category of eutrophic, or highly productive trophic classification. Detected TP was fairly consistent throughout the season, ranging from a minimum of 42 µg/L in both June and July to a maximum of 52 µg/L on August 14 (Figure 1).

Average chlorophyll-*a* concentration in 2019 was 41.6 µg/L (Table 2), falling into the hypereutrophic, or very high productivity trophic classification. Chlorophyll-*a* was lowest earliest in the season, at 21.4 µg/L on June 11 and peaked at 64.8 µg/L on August 14.

Finally, the average TKN concentration was 2.0 mg/L (Table 2) with the highest concentration observed on August 14 at 2.2 mg/L, and lowest on the final sampling period September 12 at 2.1 mg/L.

Average pH was measured as 8.55 in 2019, buffered by moderate alkalinity (243 mg/L $CaCO_3$) and bicarbonate (283 mg/L HCO_3). Calcium and sodium were the dominant ions contributing to a low conductivity of 473 µS/cm (Table 2).

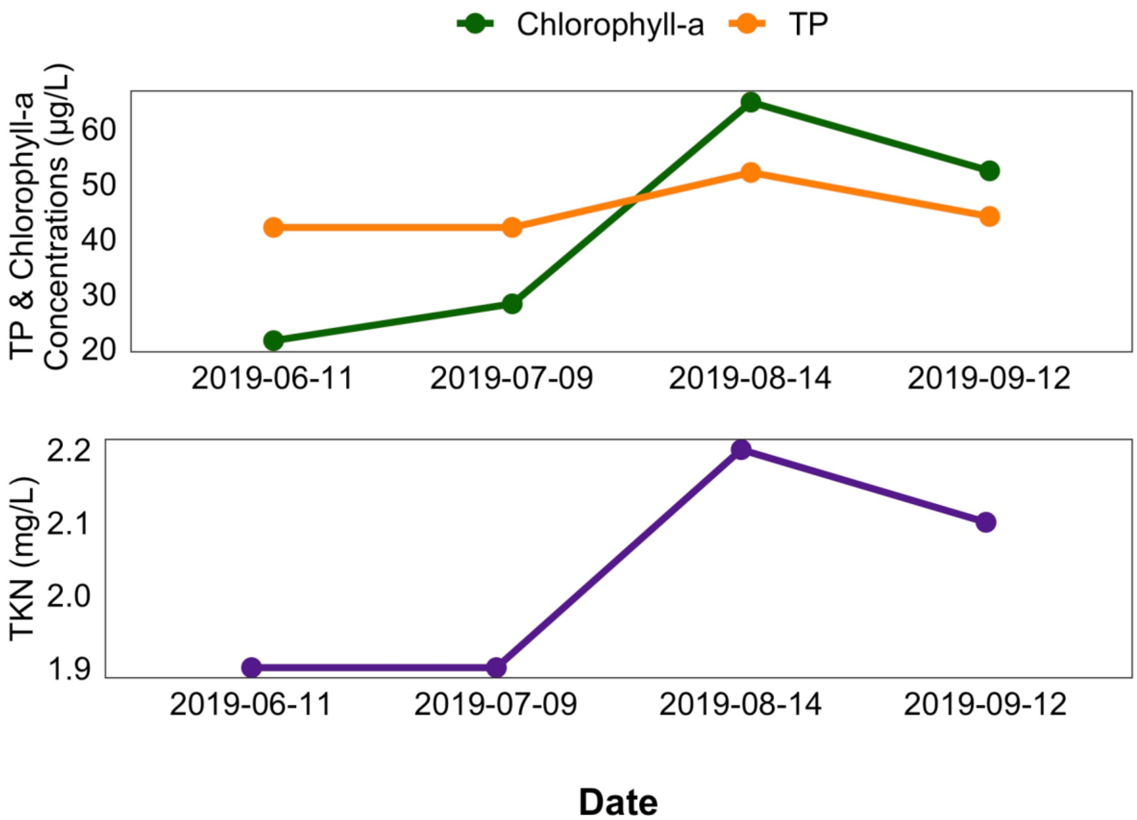


Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Thunder Lake.

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 not measured at Thunder Lake in 2019.

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 Thunder Lake in 2019 was 0.9 m (Table 2). Secchi depth varied little over the season, from a maximum of 1.15 m in both June and July, to a minimum of 0.6 m on August 14 (Figure 2).

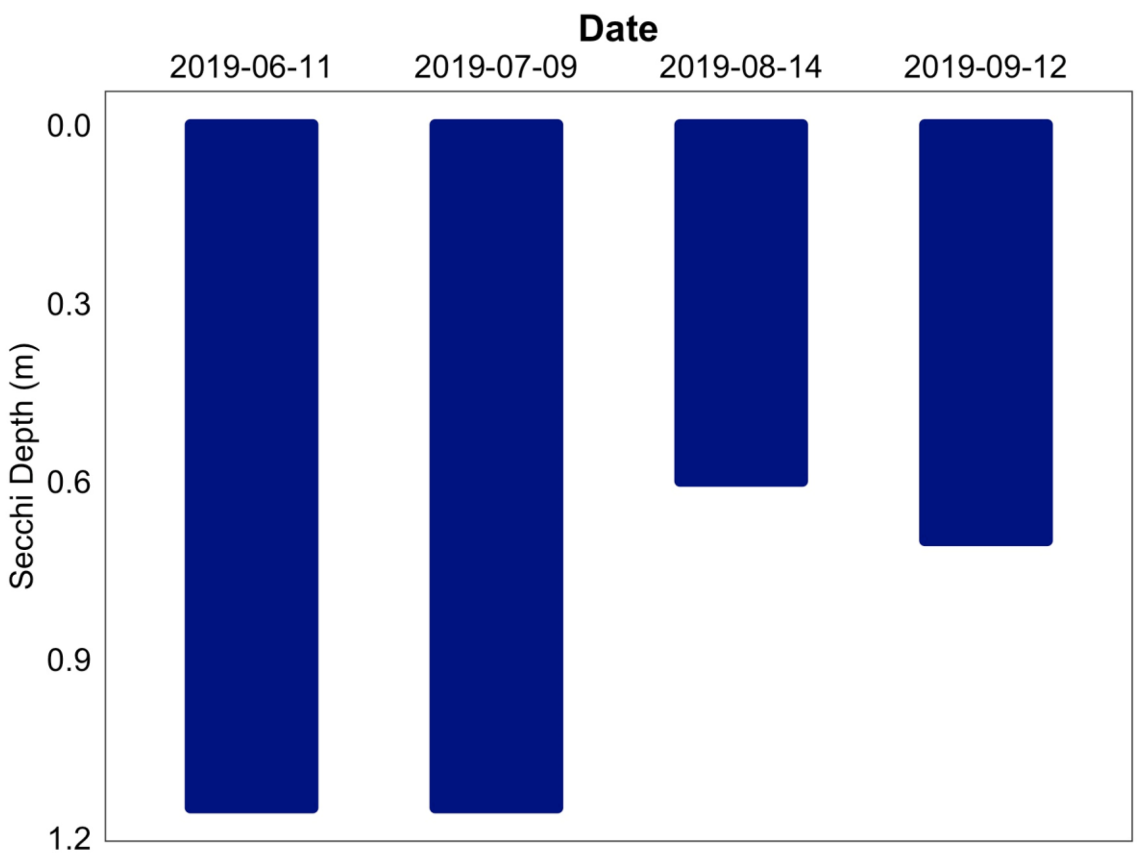


Figure 2. Secchi depth values measured four times over the course of the summer at Thunder Lake in 2019.

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.

Temperatures of Thunder Lake varied throughout the summer, with a minimum temperature of 14.1 °C at 5.5 m on September 12, and a maximum temperature of 19.5°C measured at the surface on August 14 (Figure 3a). The lake was not stratified during any of the sampling trips, with temperatures fairly constant from top to bottom, which indicates complete mixing throughout the season. This is typical of shallow lakes.

The surface of Thunder Lake was well oxygenated on all sampling dates, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 3b). These higher concentrations is likely due to cyanobacteria blooms photosynthesizing at the lake's surface. Throughout the summer, the lake displayed low oxygen levels around 3.5 - 5 meters, likely due to decomposition of dead cyanobacteria and organic matter on the lake bottom.

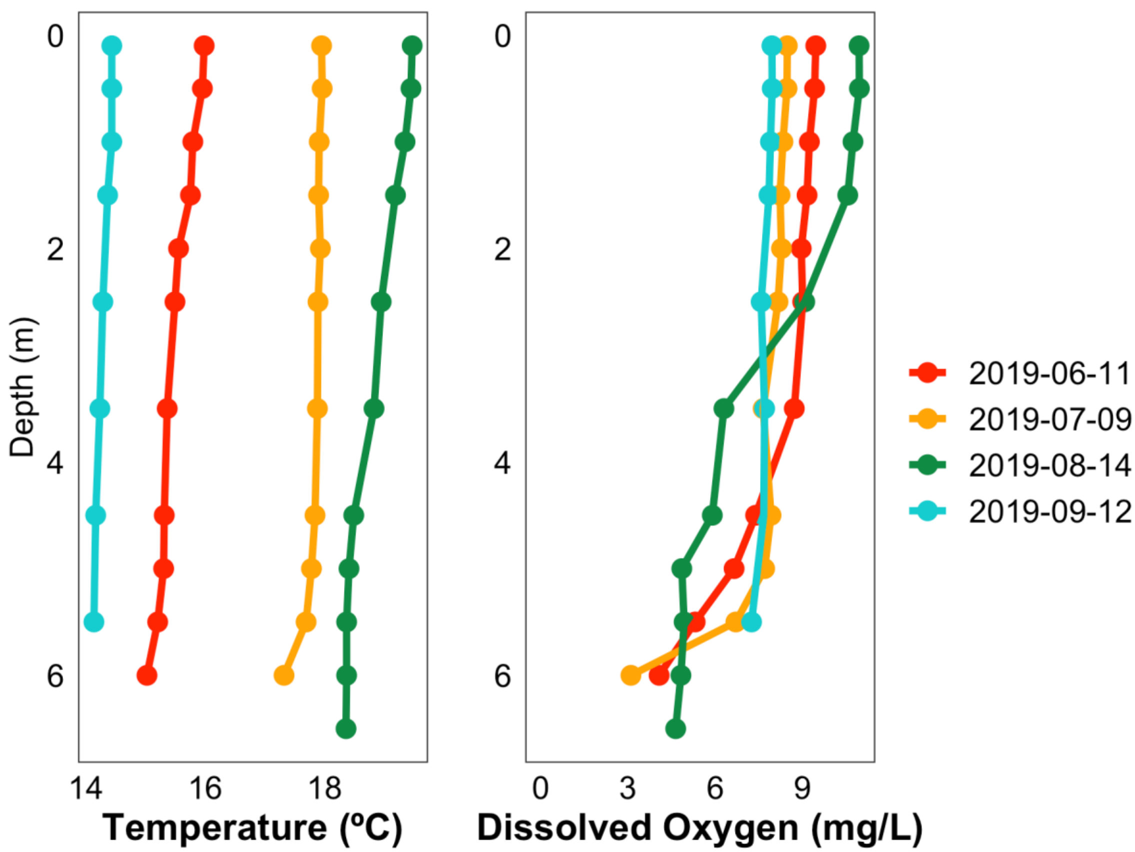


Figure 3. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Thunder Lake measured four times over the course of the summer of 2019.

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 Thunder Lake fell below the recreational guideline of 20 μg/L in 2019. However, August and September concentrations of microcystin suggest areas of the lake may contain levels which could be harmful to human health. Recreating in or near cyanobacteria blooms should be avoided.

Table 1. Microcystin concentrations measured four times at Thunder Lake in 2019.

Date	Microcystin Concentration (μg/L)
11-Jun-19	0.77
09-Jul-19	1.28
14-Aug-19	4.14
12-Sep-19	3.96
Average	2.54

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 cyanobacteria 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 using a 63 μm plankton net at three sample sites to look for juvenile mussel veligers in each lake sampled. No mussels were detected at Thunder Lake in the summer of 2019.

Eurasian watermilfoil is 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.

No watermilfoil, native or the invasive Eurasian Watermilfoil, was observed at Thunder Lake in summer, 2019.

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.

Thunder Lake had no well-defined outlet prior to 1963, and land near the lake flooded when water levels were high. To control lake levels, Ducks Unlimited (Canada) and the provincial government constructed a weir and canal on the north shore in 1963. Water flows north from Thunder Lake to nearby Tiger Lake via this canal, then to the Paddle River via Little Paddle Creek. Water levels in Thunder Lake were first recorded in 1960 and 1961, and have been monitored regularly since 1964 (Figure 4). During a drought in 1967, the town of Barrhead used Thunder Lake, via the Paddle River, as an emergency water supply. That year the water level dropped 0.47 m, and by September of 1968, the lake level had declined to the historic minimum of 653.1 m asl. The elevation rose considerably during 1971, which was a year of high precipitation levels, and continued to rise until May 1972, when the historic maximum elevation of 654.2 m asl was reached. From 1980 to 1999 water level fluctuated over a range of about 0.5 m, which would result in only a small change in lake area. Water levels at Thunder Lake then declined significantly from 1999 until it reached a historic minimum of 653.1 m asl in October of 2010. This reduction in water level impaired the operation of the boat launch in the provincial park. Between 2010 and 2019, levels have recovered quickly to the higher end of the historical range.

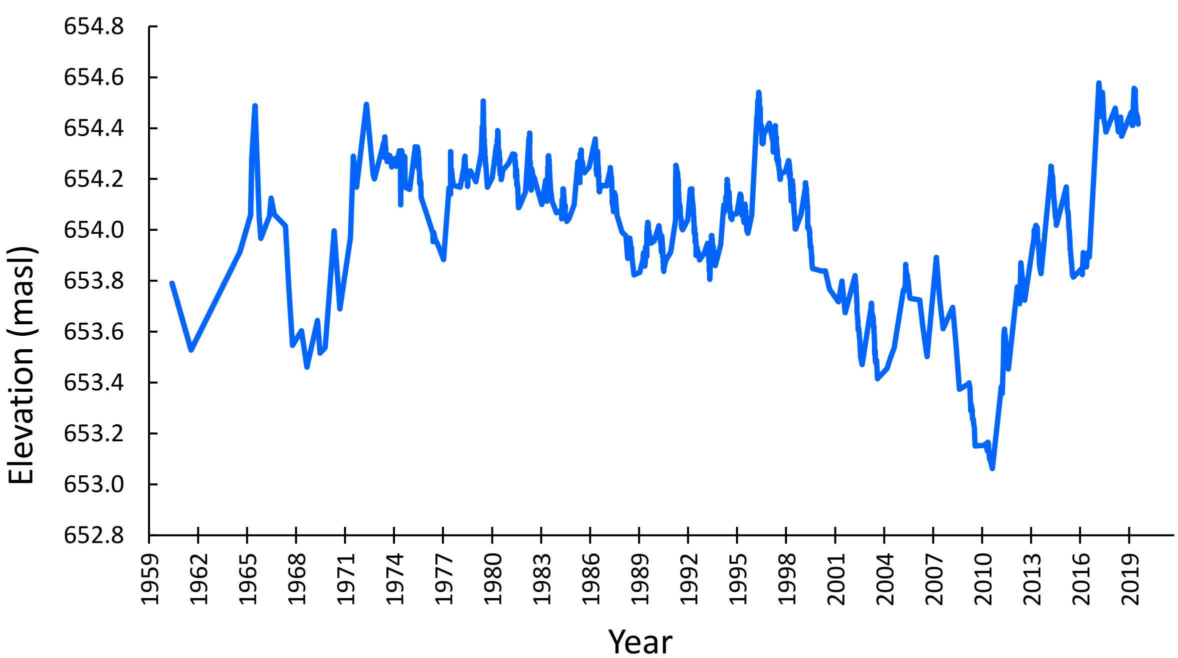


Figure 4. Water levels measured in metres above sea level (masl) from 1960 to 2019. Data retrieved from Alberta Environment and Parks.

Table 2. Average Secchi depth and water chemistry values for Thunder Lake.

Parameter	2009	2019
TP (µg/L)	112	45
TDP (µg/L)	44	7
Chlorophyll-*a* (µg/L)	39.9	41.7
Secchi depth (m)	0.65	0.90
TKN (mg/L)	3.7	2.0
NO_2-N and NO_3-N (µg/L)	3	7
NH_3-N (µg/L)	/	22
DOC (mg/L)	39	27
Ca (mg/L)	18	28
Mg (mg/L)	25	19
Na (mg/L)	68	45
K (mg/L)	20	17
SO_4^{2-} (mg/L)	14	5
Cl^- (mg/L)	6	8
CO_3 (mg/L)	/	7
HCO_3 (mg/L)	/	283
pH	9.10	8.55
Conductivity (µS/cm)	525	473
Hardness (mg/L)	148	150
TDS (mg/L)	329	273
Microcystin (µg/L)	/	2.54
Total Alkalinity (mg/L $CaCO_3$)	299	243