THE ALBERTA LAKE MANAGEMENT SOCIETY
VOLUNTEER LAKE MONITORING PROGRAM

2015 Lessard Lake Report

LAKEWATCH IS MADE POSSIBLE WITH SUPPORT FROM:

Beaver River Watershed Alliance

aemera.org

LICA Lakeland Industry & Community Association

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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.

Data in this report is still in the validation process.

Acknowledgements

The LakeWatch program is made possible through the dedication of its volunteers. We would like to thank Adrianne and Chuck Miller for volunteering to sample Lessard Lake in 2015. We would also like to thank Laticia McDonald, Ageleky Bouzetos, and Mohamad Youssef who were summer technicians with ALMS in 2015. Executive Director Bradley Peter was instrumental in planning and organizing the field program. Mike Bilyk was involved in the training aspects of the program. Lisa Reinbolt was responsible for data management. This report was prepared by Bradley Peter and Alicia Kennedy. The Beaver River Watershed Alliance (BRWA), the Lakeland Industry and Community Association (LICA), the Alberta Environmental Monitoring Evaluation and Reporting Agency (AEMERA), and Environment Canada, were major sponsors of the program.

LESSARD LAKE:

Figure 1 – Lessard Lake. Photo by Jackson Woren.

Lessard Lake is a small lake located in Lac Ste. Anne County about 20 km away from the town of Gunn on Highway 43. From above, Lessard Lake looks like a hand print with five bays pointing to the east. The lake was thought to be named after Edmund Lessard who was elected into the Alberta Legislature in 1909 and then the senate in 1925. Lessard Lake is found in the Moist Mixedwood subregion of the Boreal Mixedwood ecoregion in Alberta, and much of the land surrounding the lake is covered in forest[2]. There are a few subdivided plots along the north shore, a 161 lot subdivision on the south side of the lake, as well as a public campground with 50 sites which are serviced or basic on the south east bay of the lake. There is an education center located at Lessard Lake which provides an opportunity for large groups of people to enjoy what the lake has to offer.

The lake is small pothole lake with a water surface area of 3.21 km^2.[1] Average depth of Lessard Lake is 3.9 m and maximum depth is approximately 6 m. Lessard Lake has a small drainage basin which is less than 3 times the size of the surface area of the lake. The lake has no clearly defined inlets or outlets and groundwater is believed to be the major contributor of water to the lake[1].

The lake is primarily used for recreational purposes for activities such as swimming, boating, canoeing, kayaking, paddle boarding, and other water sports. Boaters should be cautious while driving around the lake as there is a large mound of rocks that almost completely spans across the two northeast bays of the lake.

Winter kills in 73/74 as well as 74/75 almost completely destroyed the fish populations at Lessard Lake, but through the stocking of pike and perch, the populations rebounded and grew to the point where perch from Lessard Lake were transplanted to stock Nakamun Lake[3]. A brief macrophyte survey in 1975 found that the majority of the shoreline was comprised of bulrush and patches of water lily. A 2014 macrophyte survey at Lessard Lake found: hornwort, flat-stem pondweed, Richardson's pondweed, water lily, arrowhead, sago pondweed, and northern water milfoil.

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[1] University of Alberta. 2005. Atlas of Alberta Lakes. University of Alberta Press. Available at: http://sunsite.ualberta.ca/Projects/Alberta-Lakes/

[2] Strong, W.L. and K.R. Leggat. 198. Ecoregions of Alberta. Alta. En. Nat. Resour., Resour. Eval. Plan. Div., Edmonton.

[3] Clements, G.D. 1975. A preliminary limnological survey of Lessard Lake. Alta. Rec. Parks Wild., Fish Wld. Div., Edmonton.

Two substantial wetlands are located on the west side of the lake and allow for numerous waterfowl species to nest at the lake. Bald eagles are also known to frequent the area and nest at Lessard 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.

Secchi disk depth measured an average of 1.47 m in 2015 – slightly greater than that observed in 2014 (Table 2). Throughout the summer, Secchi disk depth fluctuated from a maximum of 2.50 m on June 29th to a minimum of 0.75 m on August 29th. Secchi disk depth closely tracked the chlorophyll-*a* concentration within Lessard Lake, suggesting phytoplankton biomass is dense enough in late summer to negatively impact water clarity.

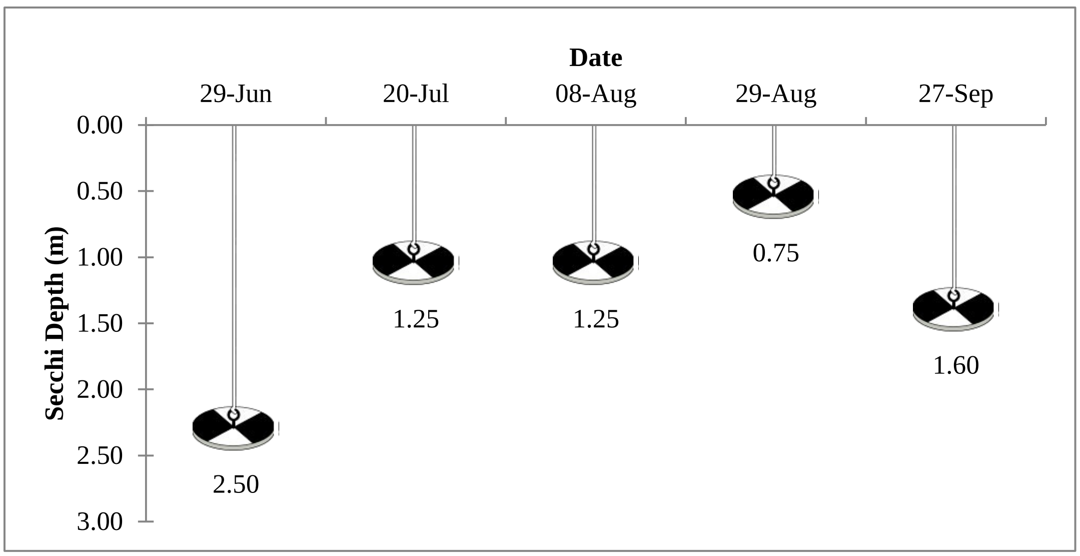

Figure 2 – Secchi disk depth measured five times over the course of the summer at Lessard Lake in 2015.

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.

Thermal stratification was present on June 29th and weak stratification was observed on August 29th when temperature proceeded from 19.41 °C at the surface to 17.08 °C at the lakebed (Figure 3a). Lessard Lake's water column was warm in 2015, measuring a maximum of 24.18 °C at the surface on June 29th and 19.80 °C at the lakebed. By September 27th, the water column became isothermal, measuring ~10.85 °C for the entirety of its length. Lessard Lake is likely polymictic – mixing and stratifying multiple times throughout the summer.

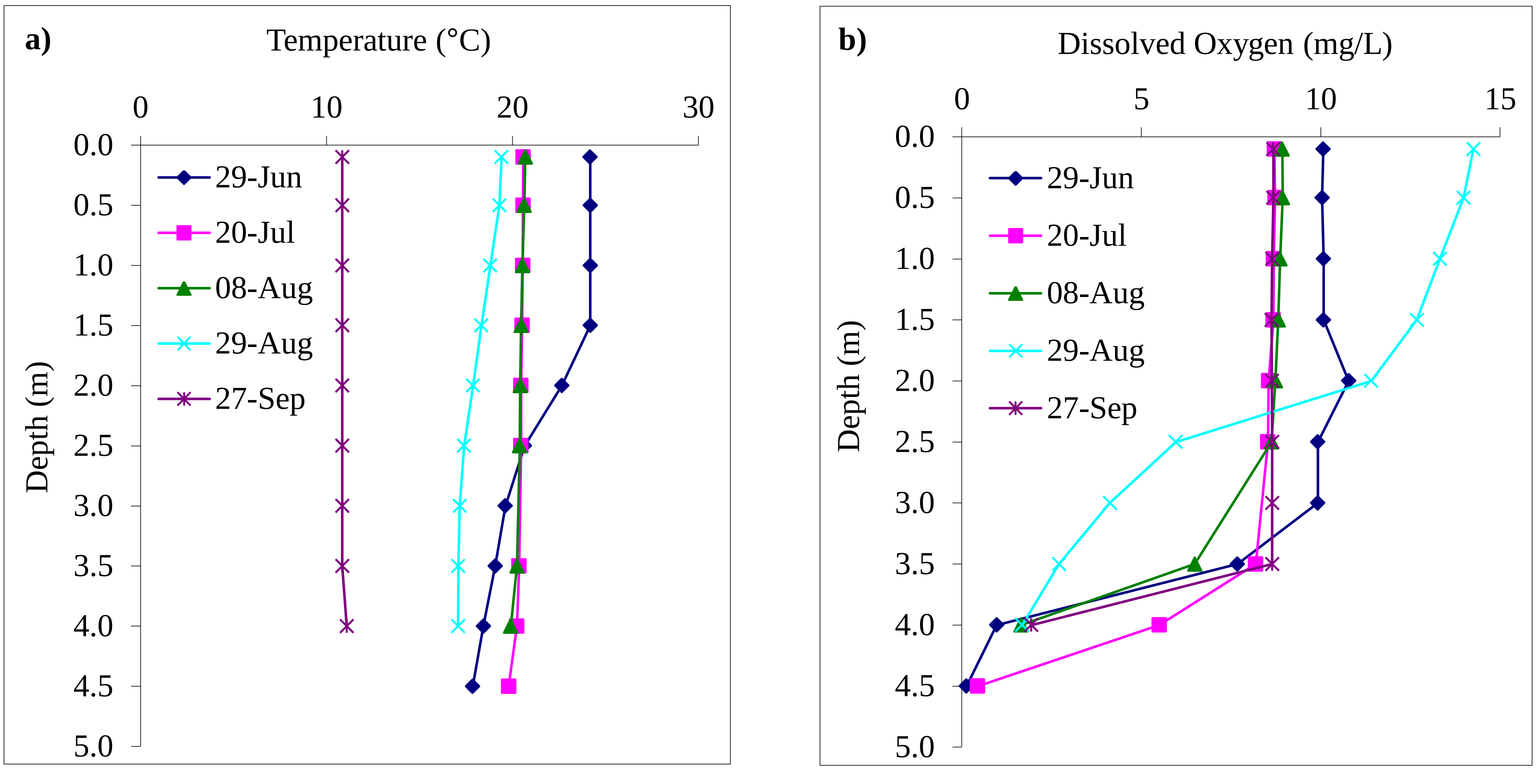

Figure 3 – Temperature (°C) and dissolved oxygen (mg/L) concentrations measured five times over the course of the summer at Lessard Lake in 2015.

Oxygen concentrations at the surface of Lessard Lake remained well above the Canadian Council for Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life (PAL) of 6.5 mg/L. The effects of stratification were evident as oxygen concentrations rapidly declined, measuring below the CCME PAL guidelines as early as 2.5 m (Figure 3b). Even in the absence of thermal stratification, oxygen concentrations regularly proceeded toward hypoxia. The absence of oxygen at the lake-sediment interface may promote the release of phosphorus from the sediments into the above water column. On August 29th, when weak thermal stratification was observed, supersaturation of the surface waters was present due to photosynthetic activity, with oxygen concentration measuring 14.26 mg/L.

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 1 for a more complete list of parameters.*

Total Phosphorus (TP) concentration in Lessard Lake measured an average of 28 µg/L in 2015 (Table 2). This value falls into the mesotrophic, or moderately productive, classification. In 1982 and 2014, Lessard Lake fell into the eutrophic classification with concentrations of 30 µg/L and 49 µg/L, respectively. More data is required to better understand the nutrient dynamics at Lessard Lake. One factor determining phosphorus concentrations in the water column may be the frequency of lake mixing – this is potentially influenced by Lessard Lake's water levels as well as environmental factors such as wind and air temperature. Typical of a polymictic lake, Lessard Lake's TP concentrations increased throughout the summer, measuring a minimum of 17 µg/L on June 29th and a maximum of 41 µg/L on September 27th (Figure 4).

Total Kjeldahl Nitrogen (TKN) concentration measured an average of 1.8 mg/L in 2015 (Table 2). The 2015 value is similar to the TKN averages observed historically and falls into the hypereutrophic classification (Figure 4).

Average chlorophyll-*a* concentration measured 17.76 µg/L in 2015 (Table 2). This average falls into the eutrophic classification and was highly influenced by a large bloom observed on August 29th with a chlorophyll-*a* concentration of 45.7 µg/L (Figure 4).. This bloom resulted in a large decrease in water clarity and coincided with the highest seasonal microcystin concentration.

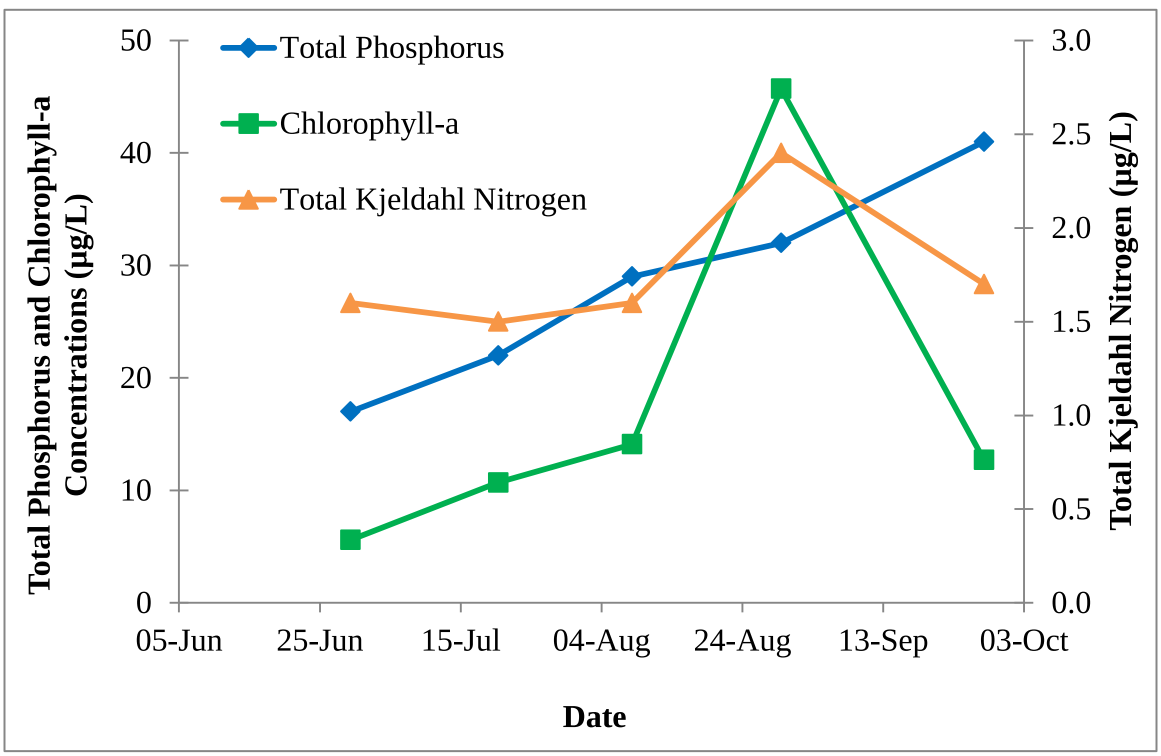

Figure 4 – Total phosphorus (ug/L), total Kjeldahl nitrogen (mg/L), and chlorophyll-*a* concentration (ug/L) measured five times over the course of the summer at Lessard Lake.

Average pH in 2015 measured 8.63 – this value is well above neutral and similar to the 2014 measurement (8.38; Table 2). Lessard Lake has high alkalinity (144 mg/L $CaCO_3$) and bicarbonate (164 mg/L) concentrations which help to buffer the lake against changes to pH. Lessard Lake has low conductivity (290 uS/cm) with dominant contributing ions including calcium (25 mg/L) and potassium (16 mg/L).

Metals were measured three times over the course of the summer at Lessard Lake – all concentrations fell within their respective guidelines (Table 3).

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.

Microcystin was detected on each sampling trip at Lessard Lake – concentrations consistently fell below the recommended recreational guidelines of 20 µg/L (Table 1). Peak microcystin concentration of 3.39 µg/L was observed on August 29th and coincided with the largest observed phytoplankton bloom that season. All cyanobacteria blooms should be treated with caution as you cannot determine the toxicity of a bloom through visual assessment.

Table 1 – Microcystin concentrations measured five time Lessard Lake in 2015.

Date	Microcystin Concentration (µg/L)
29-Jun-15	0.13
20-Jul-15	0.43
08-Aug-15	0.78
29-Aug-15	3.39
27-Sep-15	1.07
Average	**1.16**

INVASIVE SPECIES:

Quagga and Zebra mussels are invasive species which, if introduced to our lakes, will have significant negative ecological, economical, and recreational impacts. ALMS collects water samples which are analyzed for mussel veligers (juveniles) and monitors substrates for adult mussels. In order to prevent the spread of invasive mussels, always clean, drain, and dry your boat between lakes. To report mussel sightings or mussel-fouled boats, call the confidential Alberta hotline at 1-855-336-BOAT.

In 2015, no zebra or quagga mussels were detected in Lessard Lake.

Table 1 – Average Secchi disk depth and water chemistry values for Lessard Lake. Limited data from previous years is provided for comparison.

Parameter	1982	2014	2015
TP (µg/L)	30	48.5	28.2
TDP (µg/L)	/	14	10
Chlorophyll-*a* (µg/L)	14.9	17.75	17.8
Secchi depth (m)	1.9	1.25	1.47
TKN (mg/L)	1.4	1.7	1.8
NO_2 and NO_3 (µg/L)	14	0.02	3.4
NH_3 (µg/L)	/	32	54
DOC (mg/L)	/	118.13	20
Ca (mg/L)	35	27.3	26
Mg (mg/L)	14	13.4	15
Na (mg/L)	6	8.09	8
K (mg/L)	12	16.25	16
SO_4^{2-} (mg/L)	/	2.65	0.7
Cl^- (mg/L)	/	4.35	4.4
CO_3 (mg/L)	0	0.3	6.2
HCO_3 (mg/L)	132	188.5	164
pH	7.8	8.38	8.63
Conductivity (µS/cm)	239	311	290
Hardness (mg/L)	145	123.5	126
TDS (mg/L)	166	177.5	164
Microcystin (µg/L)	/	0.28	1.16
Total Alkalinity (mg/L $CaCO_3$)	132	154.25	144

Note: TP = total phosphorus, TDP = total dissolved phosphorus, Chl-*a* = chlorophyll-*a*, TKN = total Kjeldahl nitrogen. NO_{2+3} = nitrate+nitrite, NH_3 = ammonia, DOC = dissolved organic carbon, Ca = calcium, Mg = magnesium, Na = sodium, K = potassium, SO_4 = sulphate, Cl = chloride, CO_3 = carbonate, HCO_3 = bicarbonate TDS = total dissolved solids. A forward slash (/) indicates an absence of data.

Table 2 - Concentrations of metals measured in Lessard Lake on July 29th and September 23rd, 2014. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	2014	2015	Guidelines
Aluminum μg/L	31.4	11.2	100[a]
Antimony μg/L	0.031	0.024	6[e]
Arsenic μg/L	0.705	0.664	5
Barium μg/L	76.2	62.2	1000[e]
Beryllium μg/L	0.0075	0.004	100[d,f]
Bismuth μg/L	0.0005	0.004	/
Boron μg/L	61.35	68.6	5000[ef]
Cadmium μg/L	0.002	0.001	0.085[b]
Chromium μg/L	0.2415	0.12	/
Cobalt μg/L	0.007	0.016	1000[f]
Copper μg/L	0.273	0.173	4[c]
Iron μg/L	46.7	74.6	300
Lead μg/L	0.061	0.022	7[c]
Lithium μg/L	11.7	14.1	2500[g]
Manganese μg/L	58.9	57.8	200[g]
Molybdenum μg/L	0.0245	0.0367	73[d]
Nickel μg/L	0.004	0.004	150[c]
Selenium μg/L	0.13	0.04	1
Silver μg/L	0.001	0.001	0.1
Strontium μg/L	151	136	/
Thallium μg/L	0.000725	0.00083	0.8
Thorium μg/L	0.00258	0.00118	/
Tin μg/L	0.046	0.013	/
Titanium μg/L	1.79	1.21	/
Uranium μg/L	0.028	0.024	100[e]
Vanadium μg/L	0.15	0.11	100[f,g]
Zinc μg/L	1.4	0.4	30

Values represent means of total recoverable metal concentrations.
[a] Based on pH ≥ 6.5; calcium ion concentrations $[Ca^{+2}] \geq 4$ mg/L; and dissolved organic carbon concentration [DOC] ≥ 2 mg/L.
[b] Based on water Hardness of 300 mg/L (as $CaCO_3$)
[c] Based on water hardness > 180mg/L (as $CaCO_3$)
[d] CCME interim value.
[e] Based on Canadian Drinking Water Quality guideline values.
[f] Based on CCME Guidelines for Agricultural use (Livestock Watering).
[g] Based on CCME Guidelines for Agricultural Use (Irrigation).
A forward slash (/) indicates an absence of data or guidelines.

A BRIEF INTRODUCTION TO LIMNOLOGY

INDICATORS OF WATER QUALITY:

Water samples are collected in LakeWatch to determine the chemical characteristics that characterize general water quality. Though not all encompassing, the variables collected in LakeWatch are sensitive to human activities in watersheds that can cause degraded water quality. For example, nutrients such as phosphorus and nitrogen are important determinants of lake productivity. The concentrations of these nutrients in a lake are impacted (typically elevated) by land use changes such as increased crop production or livestock grazing. Elevated nutrient concentrations can cause increases in undesirable algae blooms resulting in low dissolved oxygen concentrations, degraded habitat for fish and noxious smells. A large increase in nutrients over time may also indicate sewage inputs which in turn may result in other human health concerns associated with bacteria or the protozoan *Cryptosporidium*.

TEMPERATURE AND MIXING:

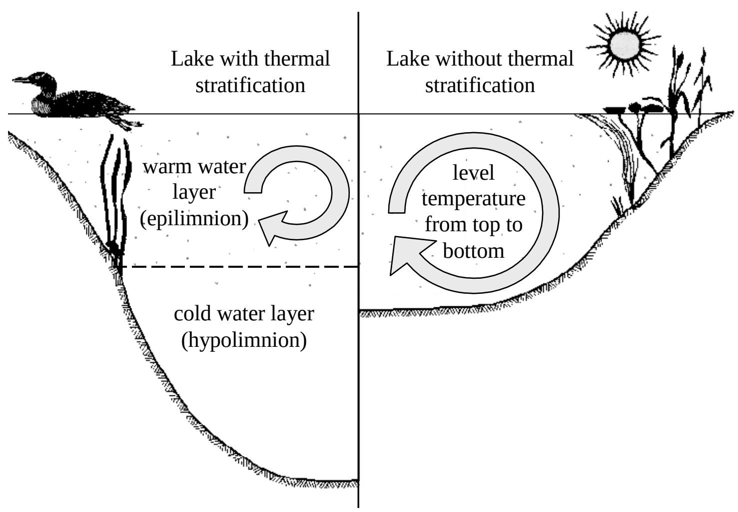

Figure A: Difference in the circulation of the water column depending on thermal stratification.

Water temperature in a lake dictates the behavior of many chemical parameters responsible for water quality. Heat is transferred to a lake at its surface and slowly moves downward depending on water circulation in the lake. Lakes with a large surface area or a small volume tend to have greater mixing due to wind. In deeper lakes, circulation is not strong enough to move warm water to depths typically greater than 4 or 5 m and as a result cooler denser water remains at the bottom of the lake. As the difference in temperature between warm surface and cold deeper water increases, two distinct layers are formed. Limnologists call these layers of water the **epilimnion** at the surface and the **hypolimnion** at the bottom. The layers are separated by a transition layer known as the **metalimnion** which contains the effective wall separating top and bottom waters called a **thermocline**. A thermocline typically occurs when water temperature changes by more than one degree within one meter depth. The hypolimnion and epilimnion do not mix, nor do elements such as oxygen supplied at the surface move downward into the hypolimnion. In the fall, surface waters begin to cool and eventually reach the same temperature as hypolimnetic water. At this point the water mixes from top to bottom in what is often called a **turnover** event. Surface water cools further as ice forms and again a thermocline develops this time with 4° C water at the bottom and near 0° C water on the top.

In spring another turnover event occurs when surface waters warm to 4° C. Lakes with this mixing pattern of two stratification periods and two turnover events are called **dimictic** lakes. In shallower lakes, the water column may mix from top to bottom most of the ice-free season with occasional stratification during periods of calm warm conditions. Lakes that mix frequently are **termed polymictic** lakes. In our cold climate, many shallow lakes are **cold monomictic meaning a thermocline develops every winter, there is one turnover event in spring but the remainder of the ice free season the lake is polymictic.**

DISSOLVED OXYGEN:

Oxygen enters a lake at the lake surface and throughout the water column when produced by photosynthesizing plants, including algae, in the lake. Oxygen is consumed within the lake by respiration of living organisms and decomposition of organic material in the lake sediments. In lakes that stratify (see temperature above), oxygen that dissolves into the lake at the surface cannot mix downward into the hypolimnion. At the same time oxygen is depleted in the hypolimnion by decomposition. The result is that the hypolimnion of a lake can become **anoxic**, meaning it contains little or no dissolved oxygen. When a lake is frozen, the entire water column can become anoxic because the surface is sealed off from the atmosphere. Winter anoxic conditions can result in a fish-kill which is particularly common during harsh winters with extended ice-cover. Alberta Surface Water Quality Guidelines suggest dissolved oxygen concentrations (in the epilimnion) must not decline below 5 $mg \bullet L^{-1}$ and should not average less than 6.5 $mg \bullet L^{-1}$ over a seven-day period. However, the guidelines also require that dissolved oxygen concentrations remain above 9.5 $mg \bullet L^{-1}$ in areas where early life stages of aquatic biota, particularly fish, are present.

GENERAL WATER CHEMISTRY:

Water in lakes always contains substances that have been transported by rain and snow or have entered the lake in groundwater and inflow streams. These substances may be dissolved in the water or suspended as particles. Some of these substances are familiar minerals, such as sodium and chloride, which when combined form table salt, but when dissolved in water separate into the two electrically charged components called **ions**. Most dissolved substances in water are in ionic forms and are held in solution due to the polar nature of the water molecule. **Hydrophobic** (water-fearing) compounds such as oils contain little or no ionic character, are non-polar and for this reason do not readily dissolve in water. Although hydrophobic compounds do not readily dissolve, they can still be transported to lakes by flowing water. Within individual lakes, ion concentrations vary from year to year depending on the amount and mineral content of the water entering the lake. This mineral content can be influenced by the amount of precipitation and other climate variables as well as human activities such as fertilizer and road salt application.

PHOSPHORUS AND NITROGEN:

Phosphorus and nitrogen are important nutrients limiting the growth of algae in Alberta lakes. While nitrogen usually limits agricultural plants, phosphorus is usually in shortest supply in lakes. Even a slight increase of phosphorus in a lake can, given the right conditions, promote algal blooms causing the water to turn green in the summer and impair recreational uses. When pollution originating from livestock manure and human sewage enters lakes not only are the concentrations of phosphorus and nitrogen increased but nitrogen can become a limiting nutrient which is thought to cause blooms of toxic algae belonging to the cyanobacteria. Not all cyanobacteria are toxic, however, the blooms can form decomposing mats that smell and impair dissolved oxygen concentrations in the lake.

CHLOROPHYLL-*A*:

Chlorophyll *a* is a photosynthetic pigment that green plants, including algae, possess enabling them to convert the sun's energy to living material. Chlorophyll *a* can be easily extracted from algae in the laboratory. Consequently, chlorophyll *a* is a good estimate of the amount of algae in the water. Some highly productive lakes are dominated by larger aquatic plants rather than suspended algae. In these lakes, chlorophyll *a* and nutrient values taken from water samples do not include productivity from large aquatic plants. The result, in lakes like Chestermere which are dominated by larger plants known as macrophytes, can be a lower trophic state than if macrophyte biomass was included. Unfortunately, the productivity and nutrient cycling contributions of macrophytes are difficult to sample accurately and are therefore not typically included in trophic state indices.

SECCHI DISK TRANSPARENCY:

Lakes that are clear are more attractive for recreation, whereas those that are turbid or murky are considered by lake users to have poor water quality. A measure of the transparency or clarity of the water is performed with a Secchi disk with an alternating black and white pattern. To measure the clarity of the water, the Secchi disk is lowered down into the water column and the depth where the disk disappears is recorded. The Secchi depth in lakes with a lot of algal growth will be small while the Secchi depth in lakes with little algal growth can be very deep. However, low Secchi depths are not caused by algal growth alone. High concentrations of suspended sediments, particularly fine clays or glacial till, are common in plains or mountain reservoirs of Alberta. Mountain reservoirs may have exceedingly low Secchi depths despite low algal growth and nutrient concentrations.

The euphotic zone or the maximum depth that light can penetrate into the water column for actively growing plants is calculated as twice the Secchi depth. Murky waters, with shallow Secchi depths, can prevent aquatic plants from growing on the lake bottom. Conversely, aquatic plants can ensure lakes have clear water by reducing shoreline erosion and stabilizing lake bottom sediments. In Alberta, many lakes are shallow and bottom sediments contain high concentrations of nutrients. Without aquatic plants, water quality may decline in these lakes due to murky, sediment laden water and excessive algal blooms. Maintaining aquatic plants in certain areas of a lake is often essential for ensuring good water clarity and a healthy lake as many organisms, like aquatic invertebrates and insects, depend on aquatic plants for food and shelter.

TROPHIC STATE:

Trophic state is classification of lakes into four categories of fertility and is a useful index for rating and comparing lakes. From low to high nutrient and algal biomass (as chlorophyll) concentrations, the trophic states are; **oligotrophic**, **mesotrophic**, **eutrophic** and **hypereutrophic (Table 2)**.

A majority of lakes in Alberta contain naturally high levels of chlorophyll *a* (8 to 25 µg/L) due to our deep fertile soils. These lakes are usually considered fertile and are termed eutrophic. The nutrient and algal biomass concentrations that define these categories are shown in the following table, a figure of Alberta lakes compared by trophic state can be found on the ALMS website.

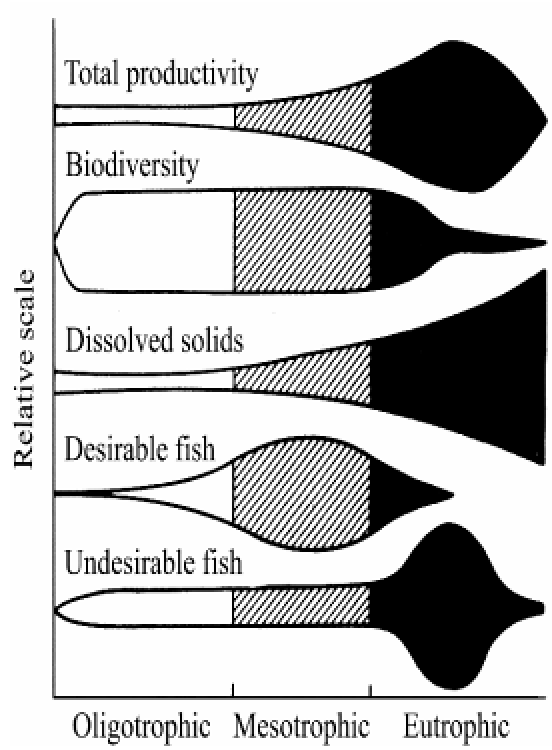

Figure B: Suggested changes in various lake characteristics with eutrophication. From "Ecological Effects of Wastewater", 1980.

Table A - Trophic status classification based on lake water characteristics.

Trophic state	Total Phosphorus (µg•L^{-1})	Total Nitrogen (µg•L^{-1})	Chlorophyll a (µg•L^{-1})	Secchi Depth (m)
Oligotrophic	< 10	< 350	< 3.5	> 4
Mesotrophic	10 – 30	350 - 650	3.5 - 9	4 - 2
Eutrophic	30 – 100	650 - 1200	9 - 25	2 - 1
Hypereutrophic	> 100	> 1200	> 25	< 1