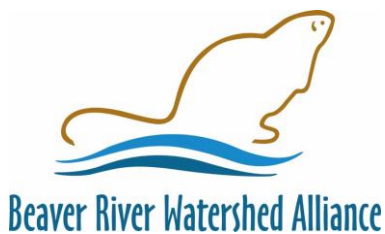




*THE ALBERTA LAKE MANAGEMENT SOCIETY
VOLUNTEER LAKE MONITORING PROGRAM*

2014 Lessard Lake Report

LAKEWATCH IS MADE POSSIBLE WITH SUPPORT FROM:



Ce projet a été réalisé avec l'appui financier de :
This project was undertaken with the financial support of:



Environnement
Canada

Environment
Canada



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.

Acknowledgements

The LakeWatch program is made possible through the dedication of its volunteers. We would like to thank Adrienne and Chuck Miller, Walter Babiy, and Kevin Blomme for their assistance with sampling Lessard Lake in 2014. We would also like to thank Jackson Woren, Brittany Kereliuk, and Kara MacAulay who were summer technicians with ALMS in 2014. Program Coordinator 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 Jackson Woren and Bradley Peter. Alberta Environment, the Beaver River Watershed Alliance (BRWA), the Lakeland Industry and Community Association (LICA), and Environment Canada, were major sponsors of the program.

LESSARD LAKE:

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 forest². 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.



Figure 1 – Lessard Lake. Photo by Jackson Woren.

The lake is small pothole lake with a water surface area of 3.21 km².¹ Average depth of Lessard Lake is 3.9 m and maximum 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 lake¹.

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 Lake³. 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.

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 QUANTITY:

There are many factors influencing water quantity. Some of these factors include the size of the lakes 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 Environment and Sustainable Resource Developments Monitoring and Science division.

Lessard Lake has a very small drainage area which is believed to be only a third the size of the lake¹. Water levels reached a maximum of 700.32 m above sea level (asl) in 1974 when there was above average run-off as well as heavy spring rains (Figure 2). Since 1997, the water level has declined to a historical minimum of 698.382 m asl in 2010. One would expect increased concentration of many water quality parameters due to a loss of water quantity.

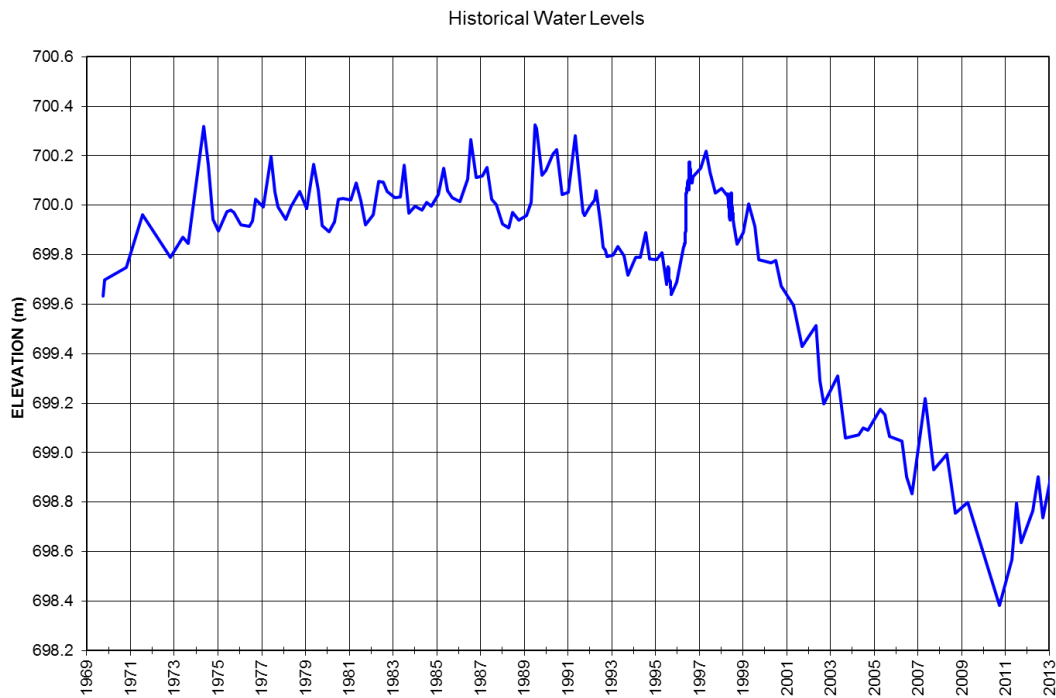


Figure 2 – Water levels measured in meters above sea levels (m asl) from 1970 to 2013. Data obtained from Alberta Environment and Sustainable Resource Development.

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.

Throughout the sampling season, Secchi disk depth did not change dramatically at Lessard Lake (Figure 3). On July 6th, Secchi disk depth measured a seasonal maximum of 2.0 m, while on August 26th and September 23rd Secchi disk depth measured a seasonal minimum of 0.90 m. This decrease in water clarity correlated closely with increases in chlorophyll-*a* concentration, suggesting phytoplankton is the primary factor impeding water clarity at Lessard Lake. On average, Secchi disk depth was measured at 1.25 m throughout the 2014 season.

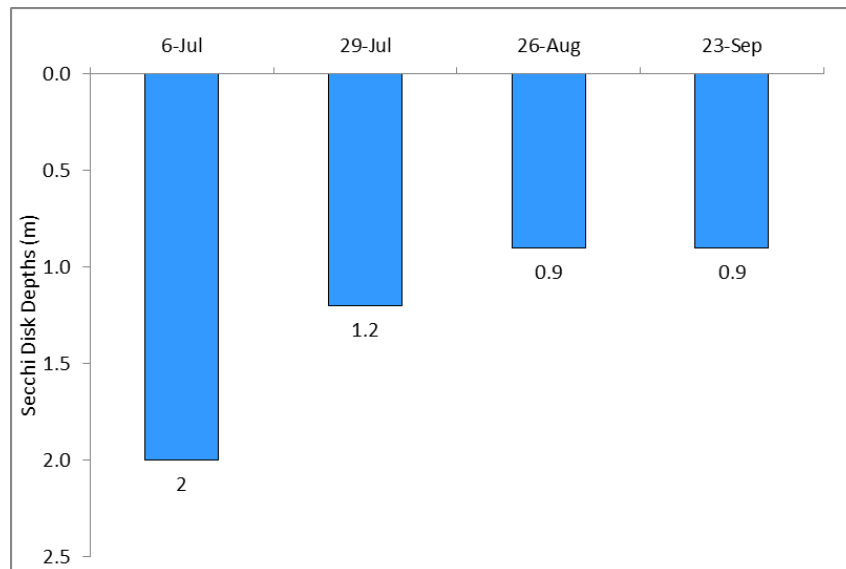


Figure 3 – Secchi disk depths obtained from the profile site on Lessard Lake in 2014.

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.

Surface water temperatures varied greatly throughout the season from a minimum of 14.40°C on September 23rd to a maximum of 22.06°C on July 29th (Figure 4a). Thermal stratification was observed on July 29th starting at 2.0 m. For the remainder of the trips, Lessard Lake was isothermal, which suggests that the lake may stratify on extreme temperature days and breakdown multiple times throughout the season. These lakes are referred to as polymictic lakes, mixing multiple times in a year. The presence/absence of thermal stratification has important implications for nutrient cycling and dissolved oxygen concentrations in Lessard Lake.

On all sampling dates, oxygen concentrations near the surface remained well above the Canadian Council for Ministers of the Environments (CCME) Guidelines for the Protection of Aquatic Life (PAL) of 6.5 mg/L. On July 29th there was an observed seasonal maximum dissolved oxygen concentration of 10.57 mg/L, and on July 6th there was a seasonal minimum of 8.26 mg/L at the surface (Figure 4b). On July 29th, however, dissolved oxygen concentrations dropped dramatically with depth, falling below the CCME PAL guidelines between 2.5 and 3.0 m. Low dissolved oxygen concentrations coupled with warm water temperatures can create a stressful environment for fish. This is common in thermally stratified lakes, as the thermocline creates a density gradient which prevents the mixing of atmospheric oxygen with deeper waters. On each sampling trip, dissolved oxygen concentrations proceeded towards anoxia in close proximity to the sediments. Decomposition occurring on the lakebed is an oxygen-consuming process which further depletes oxygen concentrations.

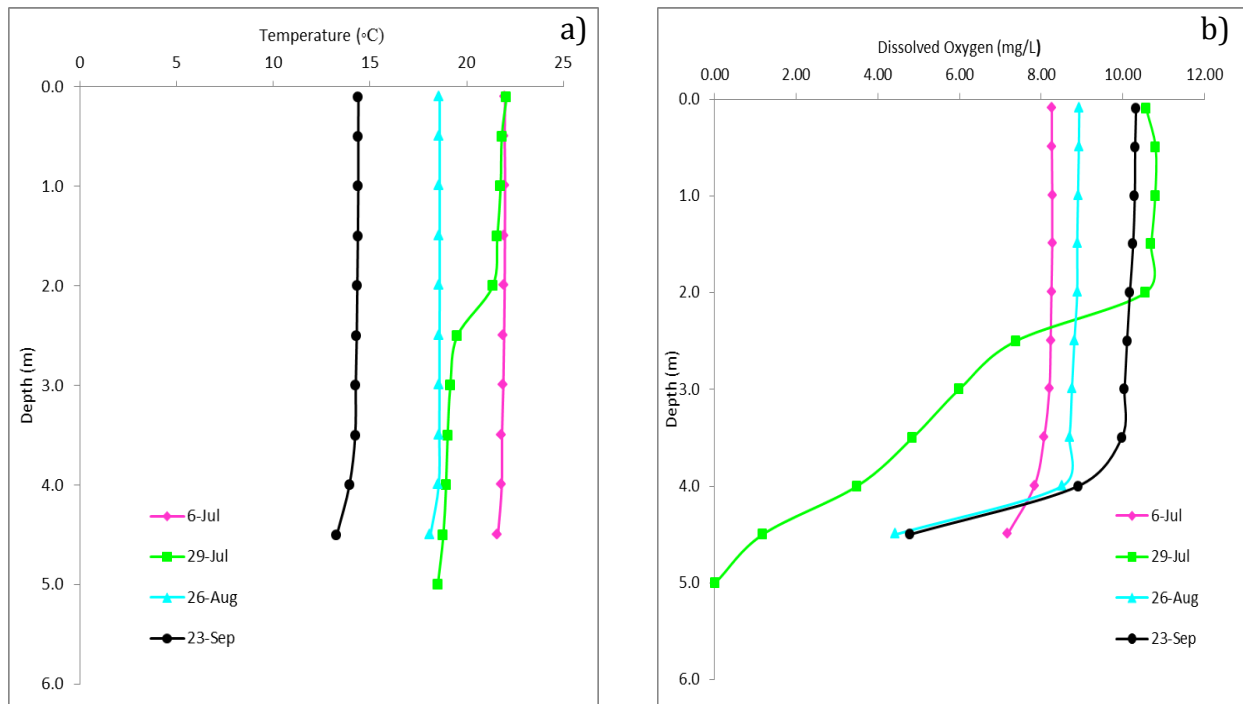


Figure 4 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles from Lessard Lake, 2014.

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.

Average Total Phosphorus (TP) measured 48.5 µg/L in 2014 (Table 1). This value falls into the eutrophic, or nutrient rich, classification. Throughout the summer, TP ranged from a seasonal minimum of 33 µg/L on August 26th to a seasonal maximum of 82 µg/L on September 23rd (Figure 5). Increasing nutrient concentrations throughout the season are typical of a polymictic lake and may be evidence of internal loading from the sediments.

Chlorophyll-*a* concentration measured an average of 17.75 µg/L in 2014 (Table 1). This value falls well into the eutrophic classification. Throughout the summer, chlorophyll-*a* concentration ranged from a minimum of 7 µg/L on July 6th to a maximum of 31 µg/L on September 23rd (Figure 5). More data is required to better understand the relationship between nutrients and chlorophyll-*a* concentration at Lessard Lake.

Finally, total Kjeldahl nitrogen (TKN) measured an average of 1712.5 µg/L in 2014 (Table 1). Unlike total phosphorus and chlorophyll-*a*, average TKN falls into the hypereutrophic classification. Throughout the summer, TKN ranged from a minimum of 1340 µg/L on July 6th to a maximum of 2250 µg/L on September 23rd.

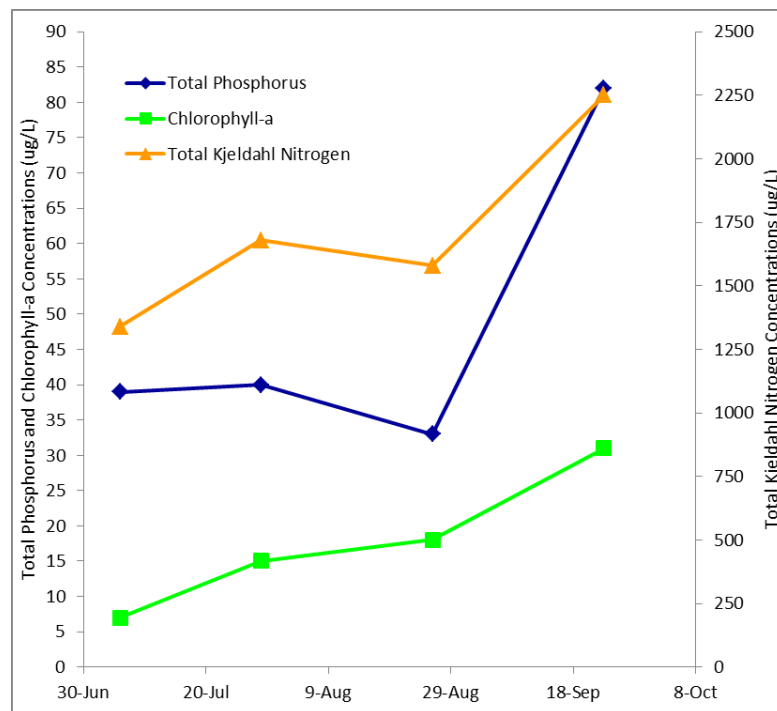


Figure 5 – Total phosphorus (µg/L), chlorophyll-*a* (µg/L), and total Kjeldahl nitrogen (µg/L) concentrations measured four times over the course of the summer of 2014.

Average pH measured 8.38 in 2014 – this value is well above neutral. Lessard Lake has moderate alkalinity (154.25 mg/L CaCO₃) and bicarbonate (188.5 mg/L HCO₃) concentration which will help to buffer the lake against changes to pH (Table 2). Calcium (27.3 mg/L), potassium (16.25 mg/L), and magnesium (13.4 mg/L) are the dominant ions in Lessard Lake, contributing to a conductivity of 311 µS/cm.

Metals were collected twice at Lessard Lake and all concentrations fell within their respective guidelines (Table 2).

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.

In 2014, concentrations of microcystin reached an observed maximum of 0.56 µg/L on August 26th (Table 1). The average concentration in 2014 was 0.27 µg/L. Field notes suggest that *Gloeotrichia spp.*, *Anabaena spp.*, and *Microcystis spp.* were the dominant species throughout the open water season in 2014. It should be noted that there are some species of cyanobacteria that are known to produce microcystin toxins. Caution should always be taken when recreating in waters experiencing cyanobacteria blooms.

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 2014, 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
TP ($\mu\text{g/L}$)	30	48.5
TDP ($\mu\text{g/L}$)	/	14
Chlorophyll- <i>a</i> ($\mu\text{g/L}$)	14.9	17.75
Secchi depth (m)	1.9	1.25
TKN ($\mu\text{g/L}$)	1414	1712.5
NO ₂ and NO ₃ ($\mu\text{g/L}$)	14	0.02
NH ₃ ($\mu\text{g/L}$)	/	32
DOC (mg/L)	/	118.13
Ca (mg/L)	35	27.3
Mg (mg/L)	14	13.4
Na (mg/L)	6	8.09
K (mg/L)	12	16.25
SO ₄ ²⁻ (mg/L)	/	2.65
Cl ⁻ (mg/L)	/	4.35
CO ₃ (mg/L)	0	0.3
HCO ₃ (mg/L)	132	188.5
pH	7.8	8.38
Conductivity ($\mu\text{S/cm}$)	239	311
Hardness (mg/L)	145	123.5
TDS (mg/L)	166	177.5
Microcystin ($\mu\text{g/L}$)	/	0.28
Total Alkalinity (mg/L CaCO ₃)	132	154.25

Note: TP = total phosphorus, TDP = total dissolved phosphorus, Chl-*a* = chlorophyll-*a*, TKN = total Kjeldahl nitrogen. NO₂₊₃ = nitrate+nitrite, NH₃ = ammonia, DOC = dissolved organic carbon, Ca = calcium, Mg = magnesium, Na = sodium, K = potassium, SO₄ = sulphate, Cl = chloride, CO₃ = carbonate, HCO₃ = 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	Guidelines
Aluminum µg/L	31.4	100 ^a
Antimony µg/L	0.031	6 ^e
Arsenic µg/L	0.705	5
Barium µg/L	76.2	1000 ^e
Beryllium µg/L	0.0075	100 ^{d,f}
Bismuth µg/L	0.0005	/
Boron µg/L	61.35	5000 ^{ef}
Cadmium µg/L	0.002	0.085 ^b
Chromium µg/L	0.2415	/
Cobalt µg/L	0.007	1000 ^f
Copper µg/L	0.273	4 ^c
Iron µg/L	46.7	300
Lead µg/L	0.061	7 ^c
Lithium µg/L	11.65	2500 ^g
Manganese µg/L	58.85	200 ^g
Molybdenum µg/L	0.0245	73 ^d
Nickel µg/L	0.004	150 ^c
Selenium µg/L	0.125	1
Silver µg/L	0.001	0.1
Strontium µg/L	151	/
Thallium µg/L	0.000725	0.8
Thorium µg/L	0.002575	/
Tin µg/L	0.046	/
Titanium µg/L	1.785	/
Uranium µg/L	0.028	100 ^e
Vanadium µg/L	0.145	100 ^{f,g}
Zinc µg/L	1.4	30

Values represent means of total recoverable metal concentrations.

^a Based on pH ≥ 6.5; calcium ion concentrations [Ca⁺²] ≥ 4 mg/L; and dissolved organic carbon concentration [DOC] ≥ 2 mg/L.

^b Based on water Hardness of 300 mg/L (as CaCO₃)

^c Based on water hardness > 180mg/L (as CaCO₃)

^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:

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.

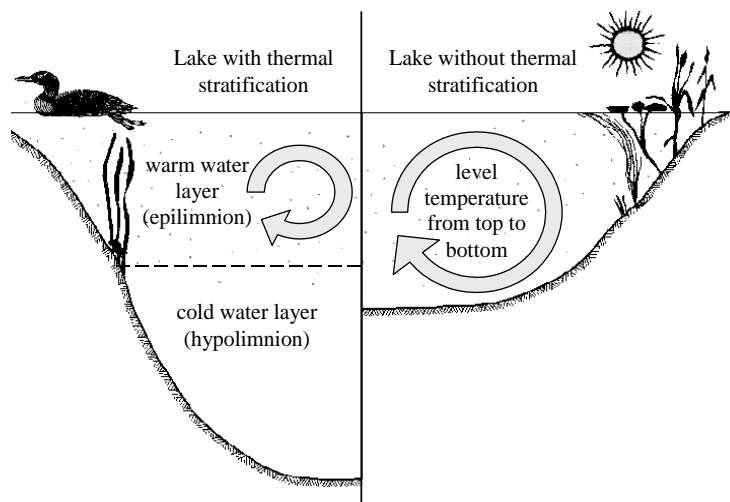


Figure A: Difference in the circulation of the water column depending on thermal stratification.

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•L⁻¹ and should not average less than 6.5 mg•L⁻¹ over a seven-day period. However, the guidelines also require that dissolved oxygen concentrations remain above 9.5 mg•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.

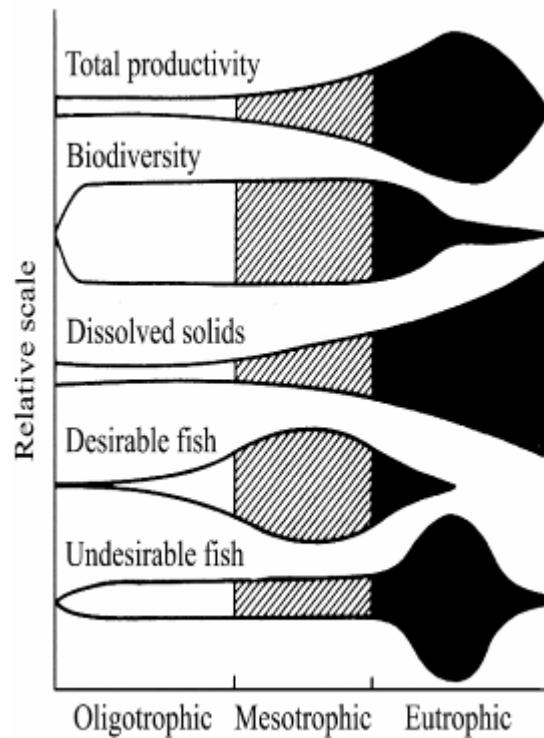


Figure B: Suggested changes in various lake characteristics with eutrophication. From “Ecological Effects of Wastewater”, 1980.

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