



*THE ALBERTA LAKE MANAGEMENT SOCIETY  
VOLUNTEER LAKE MONITORING PROGRAM*

## **2013 Wizard Lake Report**

*COMPLETED WITH SUPPORT FROM:*





## **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 Larry and Cathy McPherson and their grandchildren Anna and Jack for their assistance with sampling in 2013. We would also like to thank Jared Ellenor, Nicole Meyers, and Elynn Murray who were summer technicians with ALMS in 2013. Program Coordinator Bradley Peter was instrumental in planning and organizing the field program. Technologists Chris Ware and Sarah Hustins were involved in the training aspects of the program. Lisa Reinbolt was responsible for data management. This report was prepared by Bradley Peter and Arin Dyer. Alberta Environment and the Beaver River Watershed Alliance (BRWA) were major sponsors of the program.

## WIZARD LAKE:

Wizard Lake (Figure 1, Figure 2) is a long, serpentine, lake lying in a heavily forested, deep glacial meltwater channel 60 km southwest of the city of Edmonton. The valley provides excellent shelter from winds, making this lake very popular for water skiing. The northern shore of the lake is in the county of Leduc and the southern shore of the lake is in the county of Wetaskiwin.



Figure 1 – View of Wizard Lake, 2011. Photo by Jessica Davis.

The First Nations name for the lake was Seksyawas Sakigan, which translates to Lizard Lake, and until the late 1960's the popular name for the lake was Conjuring Lake.<sup>1</sup> First Nations legends said strange noises in the lake came from 'conjuring creatures'; the creek draining the lake, which enters the North Saskatchewan River ~5 km west of Devon, is still called Conjuring Creek<sup>2</sup>.

The year 1904 saw both the first settlers and the opening of a sawmill in the lake area. The sawmill was short-lived, closing in 1905 when the railway was not built across the area as expected. The sawmill was succeeded by the building of an underground coalmine, in operation until the 1940's. Today, the area surrounding the lake includes Wizard Lake Jubilee Park and 110 cottages on the north shore, 61 cottages on the south, and a subdivision.

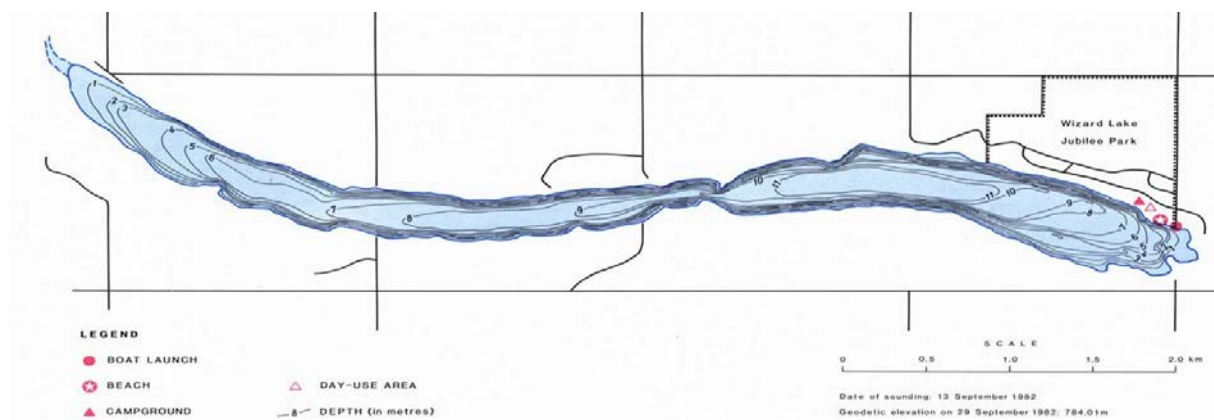


Figure 2 – Bathymetry of Wizard Lake's eastern basin showing contour intervals in meters.

<sup>1</sup> Aubrey, M. K. 2006. Concise place names of Alberta. Retrieved from <http://www.albertasource.ca/placenames/resources/searchcontent.php?book=1>

<sup>2</sup> Aquality Environmental Consulting (2013). Wizard Lake State of the Watershed Report 2012. Retrieved from: [http://www.wizardlake.ca/uploads/1/8/0/3/18037581/state\\_of\\_watershed\\_complete.pdf](http://www.wizardlake.ca/uploads/1/8/0/3/18037581/state_of_watershed_complete.pdf) January 9, 2014.

Wizard Lake is a popular recreation area for water skiing, SCUBA diving, and fishing. Intensive use of the lake, especially on summer weekends, led to conflict between water skiers, high-speed boat operators, canoers, and anglers. A lake management plan was prepared in 1979, which recommended dividing the lake into two zones: the boat speed in the west half of the lake was to be limited to 12 km/hr to facilitate access to anglers, while the boat speed in the east half was to be limited to 65 km/hr to allow water skiing.

Yellow perch and northern pike are the most commonly fished species in the lake. Wizard Lake occupies an area of 2.48 km<sup>2</sup>, with a maximum depth of 11 m and a mean depth of 6.2 m. The length of the lake stretches 11.5 km and has a maximum width of 0.55 km. Wizard Lake lies in the Strawberry Creek sub-basin of the North Saskatchewan River Watershed<sup>2</sup>. The drainage basin is approximately 32.21 km<sup>2</sup>, resulting in a drainage basin:lake ratio of 12:1<sup>2</sup>. It is a eutrophic lake, usually clear, but experiences dense blue-green algae blooms during the summer months that turn the water murky.

For more detailed information on Wizard Lake and its watershed, view the State of the Watershed Report available on the Wizard Lake website at:

[http://www.wizardlake.ca/uploads/1/8/0/3/18037581/state\\_of\\_watershed\\_complete.pdf](http://www.wizardlake.ca/uploads/1/8/0/3/18037581/state_of_watershed_complete.pdf)

#### **WATER LEVELS:**

*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.*

Water levels in Wizard Lake have fluctuated very little since monitoring began in 1968 (Figure 3). Since the 2009 recorded minimum of 783.3 meters above sea level (m asl), water levels have increased to 783.6 m asl. These 2010 levels are almost identical to the initially recorded 783.8 m asl in 1968. With a drainage basin ~10 times the size of the lake (29.8km<sup>2</sup>), Wizard Lake has much input in the form of runoff from the watershed. Two streams on the south side of the lake flow into the lake, while Conjuring Creek drains to the north.

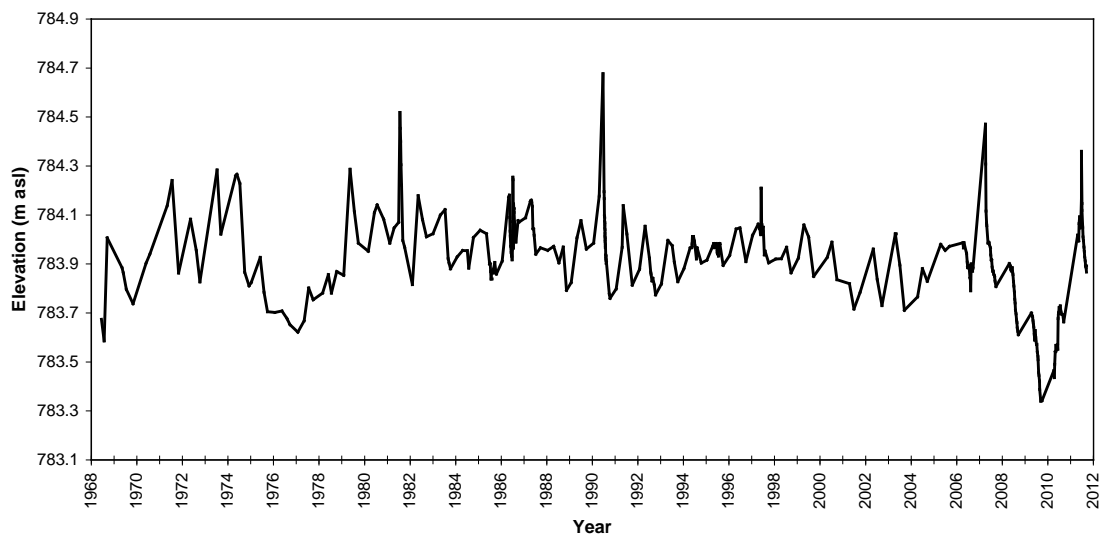


Figure 3 – Water levels in meters above sea level (m asl) from Wizard Lake. Data obtained from Alberta Environment.

## **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.*

Average Secchi disk depth at Wizard lake measured 1.36 m in 2013 (Table 1). An average value of 1.36 m falls on the low end of the historical variation measured at Wizard Lake. Throughout the summer, Secchi disk depth ranged from a minimum of 0.80 m on September 11<sup>th</sup> to a maximum of 2.60 m on June 19<sup>th</sup>. A decrease of Secchi disk depth during mid-summer is common as temperature and nutrient levels become high enough to promote large algae/cyanobacteria blooms. Suspended sediments, due to wind or boating activities, may also act to decrease water clarity.

## **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.*

In 2013 Wizard Lake was thermally stratified on all sampling trips from July through September. Previous sampling years have shown intermittent periods of stratification (meromictic) and it is possible this was the case in 2013 as well. Surface water temperature ranged from a minimum of 15.89 degC on June 27<sup>th</sup> to a maximum of 20.71 degC on August 7<sup>th</sup>. The presence of thermal stratification has important implications for dissolved oxygen concentrations in Wizard Lake.

Dissolved oxygen concentrations fluctuated greatly at Wizard Lake. At the surface, concentrations ranged from oversaturation due to photosynthesis on August 7<sup>th</sup> to reduced concentrations due to water column mixing on September 11<sup>th</sup>. On each trip dissolved oxygen concentration proceeded towards anoxia due in part to thermal stratification which separates surface waters from bottom waters - anoxia was present as early as 6.00 m on July 12<sup>th</sup>. Anoxia below the thermocline is typical at stratified lakes, as decomposition on the lakebed is an oxygen-consuming process. Lack of oxygen near the lakebed may promote the release of phosphorus from the sediment.

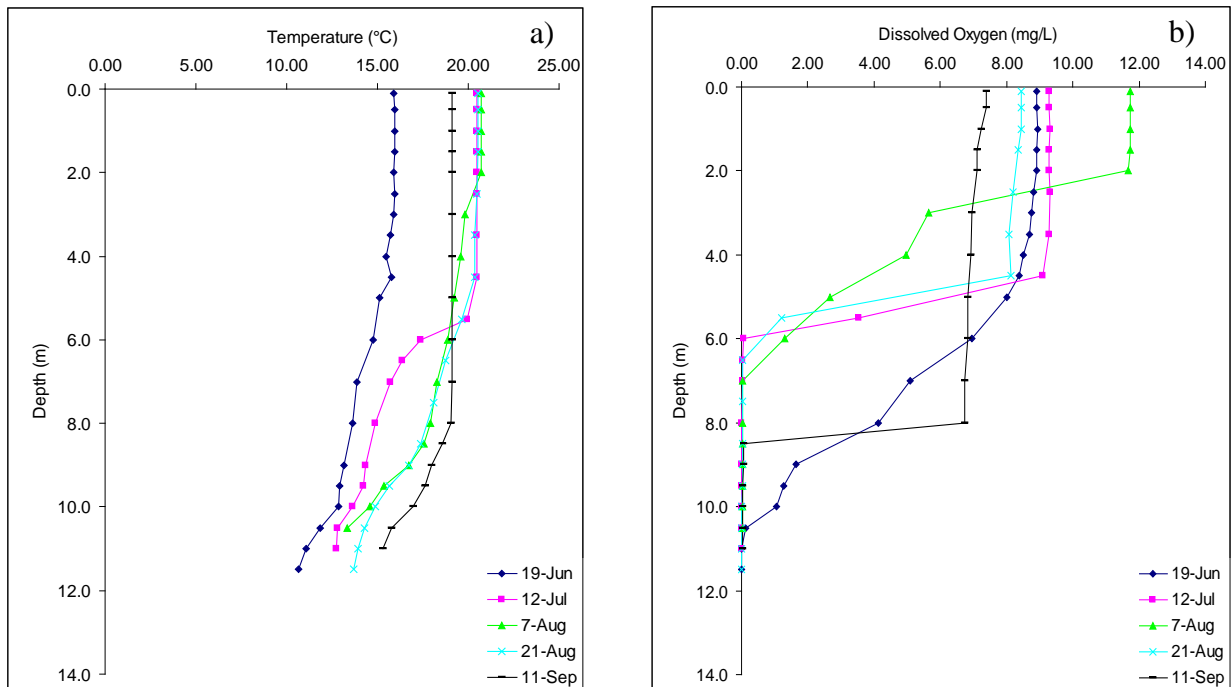


Figure 3 - a) Surface water temperature (°C) and b) dissolved oxygen concentrations (mg/L) measured four times over the course of the summer at Wizard Lake.

#### 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 complete list of parameters.*

Average Total Phosphorus (TP) measured 52.6 ug/L in 2013 – this falls into the eutrophic, or nutrient rich, classification (Table 1). Throughout the summer TP ranged from a minimum of 44 ug/L on June 19<sup>th</sup> to a maximum of 71 ug/L on September 11<sup>th</sup> when the lake began mixing. An average value of 52.6 ug/L falls well within the historical variation observed at Wizard Lake.

Chlorophyll-*a* concentration in 2013 was greatly reduced compared to concentrations measured in 2011 (Table 1). In 2013, average chlorophyll-*a* concentration measured 23.8 ug/L – this value falls into the eutrophic, or nutrient rich, classification. Chlorophyll-*a* concentration generally increased throughout the summer, reaching an observed seasonal maximum of 39.2 ug/L on September 11<sup>th</sup>, this is greatly reduced compared to the seasonal maximum of 62.1 ug/L



Figure 4 – 2011 Cyanobacterial scum on the surface of Wizard Lake.

observed in 2011.

Finally, Total Kjeldahl Nitrogen measured an average of 1246  $\mu\text{g/L}$  in 2013. As with TP and chlorophyll-*a*, this value falls well within the historical variation observed at Wizard Lake.

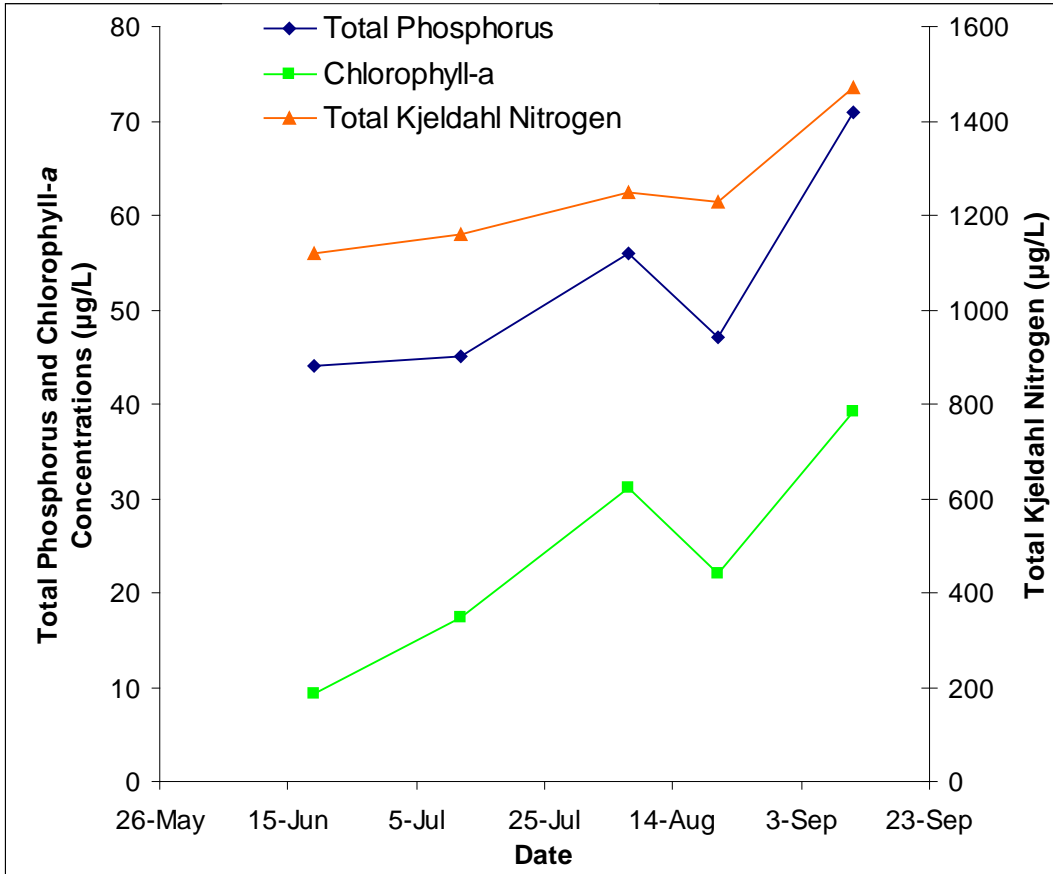


Figure 5 – Total phosphorus ( $\mu\text{g/L}$ ), chlorophyll-*a* ( $\mu\text{g/L}$ ), and total Kjeldahl nitrogen ( $\mu\text{g/L}$ ) concentrations measured five times over the course of the summer of 2013.

Average pH measured 8.472 in 2013, which is well above neutral (Table 1). pH has changed very little compared to historical measurements, and is likely due to the high alkalinity ( $174.2 \text{ mg/L CaCO}_3$ ) and high bicarbonate ( $202.4 \text{ mg/L HCO}_3$ ) concentrations which help to buffer the lake against changes to pH. Concentrations of other ions are quite low, which is reflected in a low conductivity ( $337.2 \mu\text{S/cm}$ ). Microcystin concentrations were low throughout the summer of 2013, never exceeding  $1.0 \mu\text{g/L}$ . On average, microcystin concentration measured  $0.25 \mu\text{g/L}$  which is well below the recreational guidelines of  $20 \mu\text{g/L}$ . Even though a bloom may not be producing large quantities of microcystins, it may produce other cyanotoxins which were not monitored for. Thus, caution should always be used when recreating around waters with cyanobacteria blooms.

Metals were measured twice during the summer of 2013 and all concentrations fell within their respective guidelines (Table 2).

### **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 2013, no zebra or quagga mussels were detected in Wizard Lake.



Figure 6 – Technician Elynne Murray and volunteers Anna and Jack collecting samples to be analyzed for veliger zebra and quagga mussels.



Table 1 – Average Secchi disk depth and water chemistry values for Wizard Lake. Previous years averages are provided for comparison.

Parameter	2006	2008	2009	2010	2011	2013
TP (µg/L)	48.4	50.2	51.5	47.5	75.6	52.6
TDP (µg/L)	13.6	12.4	18	19.5	14.2	18.8
Chlorophyll- <i>a</i> (µg/L)	32.6	23.9	26.8	17.1	39.2	23.8
Secchi depth (m)	1.33	1.43	1.81	2.71	1.15	1.36
TKN (µg/L)	1300	1216	1263	1255	1574	1246
NO <sub>2</sub> and NO <sub>3</sub> (µg/L)	7	2.5	46	19.5	2.5	6.4
NH <sub>3</sub> (µg/L)	31.4	20.6	29	81	19.4	27.6
DOC (mg/L)	/	/	/	12.2	14.5	13.1
Ca (mg/L)	25	27.9	27.8	24.45	27.5	29
Mg (mg/L)	8.5	8.9	9.73	9.09	9.25	9.23
Na (mg/L)	36	34.9	37.5	38	32.3	37.4
K (mg/L)	6	5.8	6	6.15	5.83	6
SO <sub>4</sub> <sup>2-</sup> (mg/L)	3.5	4.5	5	4.25	3	5.83
Cl <sup>-</sup> (mg/L)	4.7	4.5	4.9	5.65	5	5.2
CO <sub>3</sub> (mg/L)	6	10	5.5	/	3.6	5.1
HCO <sub>3</sub> (mg/L)	202	206.3	207.3	215.5	199.8	202.4
pH	8.3	8.3	8.44	8.29	8.45	8.472
Conductivity (µS/cm)	335	337.3	341.3	346	337.2	354
Hardness (mg/L)	97	106	109.4	96	106.9	110.3
TDS (mg/L)	186	191	196	193	185	197.3
Microcystin (µg/L)	/	/	/	0.091	0.25	0.25
Total Alkalinity (mg/L CaCO <sub>3</sub> )	172	175	176	176.5	170	174.2

Note: TP = total phosphorus, TDP = total dissolved phosphorus, Chl-*a* = chlorophyll-*a*, TKN = total Kjeldahl nitrogen. NO<sub>2+3</sub> = nitrate+nitrite, NH<sub>3</sub> = ammonia, Ca = calcium, Mg = magnesium, Na = sodium, K = potassium, SO<sub>4</sub> = sulphate, Cl = chloride, CO<sub>3</sub> = carbonate, HCO<sub>3</sub> = bicarbonate. A forward slash (/) indicates an absence of data.

Table 2 - Concentrations of metals measured in Wizard Lake on August 7<sup>th</sup> and September 11<sup>th</sup> 2013. Values shown for 2013 are an average of those dates. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

<b>Metals (Total Recoverable)</b>	<b>2013</b>	<b>Guidelines</b>
Aluminum µg/L	18	100 <sup>a</sup>
Antimony µg/L	0.06565	6 <sup>e</sup>
Arsenic µg/L	1.205	5
Barium µg/L	60.35	1000 <sup>e</sup>
Beryllium µg/L	0.0015	100 <sup>d,f</sup>
Bismuth µg/L	0.00255	/
Boron µg/L	43.85	5000 <sup>ef</sup>
Cadmium µg/L	0.00225	0.085 <sup>b</sup>
Chromium µg/L	0.3215	/
Cobalt µg/L	0.0312	1000 <sup>f</sup>
Copper µg/L	0.7635	4 <sup>c</sup>
Iron µg/L	52.15	300
Lead µg/L	0.0277	7 <sup>c</sup>
Lithium µg/L	15.5	2500 <sup>g</sup>
Manganese µg/L	74.6	200 <sup>g</sup>
Molybdenum µg/L	0.3795	73 <sup>d</sup>
Nickel µg/L	0.2135	150 <sup>e</sup>
Selenium µg/L	0.095	1
Silver µg/L	0.011475	0.1
Strontium µg/L	230.5	/
Thallium µg/L	0.001175	0.8
Thorium µg/L	0.00015	/
Tin µg/L	0.015	/
Titanium µg/L	0.7815	/
Uranium µg/L	0.328	100 <sup>e</sup>
Vanadium µg/L	0.1915	100 <sup>f,g</sup>
Zinc µg/L	1.914	30

Values represent means of total recoverable metal concentrations.

<sup>a</sup> Based on pH  $\geq$  6.5; calcium ion concentrations  $[Ca^{+2}] \geq$  4 mg/L; and dissolved organic carbon concentration  $[DOC] \geq$  2 mg/L.

<sup>b</sup> Based on water Hardness of 300 mg/L (as CaCO<sub>3</sub>)

<sup>c</sup> Based on water hardness > 180mg/L (as CaCO<sub>3</sub>)

<sup>d</sup> CCME interim value.

<sup>e</sup> Based on Canadian Drinking Water Quality guideline values.

<sup>f</sup> Based on CCME Guidelines for Agricultural use (Livestock Watering).

<sup>g</sup> 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

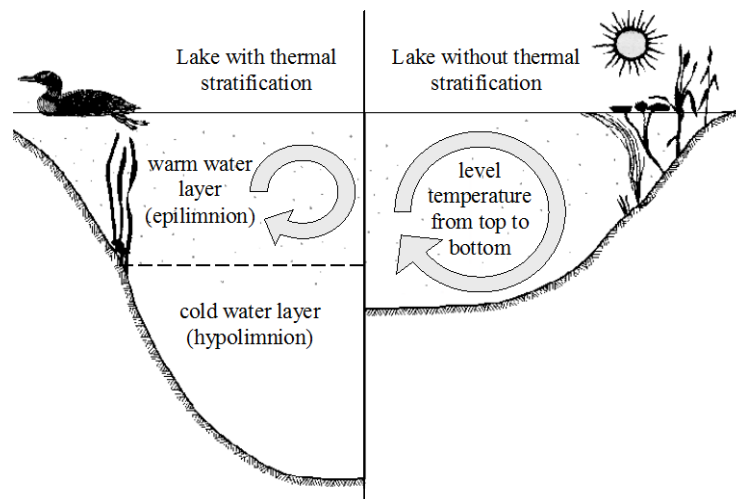


Figure A: Difference in the circulation of the water column depending on thermal stratification.

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

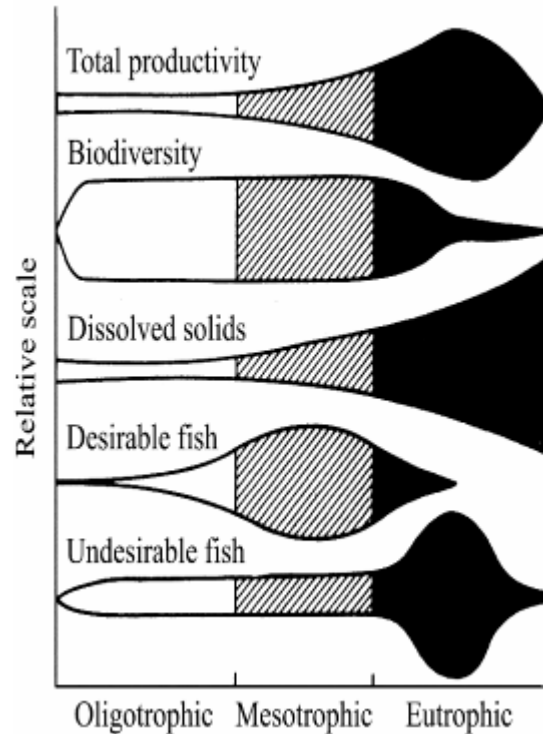


Figure B: Suggested changes in various lake characteristics with eutrophication. From “Ecological Effects of Wastewater”, 1980.

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

Trophic state	Total Phosphorus (µg•L <sup>-1</sup> )	Total Nitrogen (µg•L <sup>-1</sup> )	Chlorophyll a (µg•L <sup>-1</sup> )	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