



*THE ALBERTA LAKE MANAGEMENT SOCIETY
VOLUNTEER LAKE MONITORING PROGRAM*

2014 Isle Lake Report

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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

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ISLE LAKE:

Isle Lake is located in the counties of Lac Ste. Anne and Parkland, 80 km west of the City of Edmonton. The Hamlet of Gainford, established in 1942, is situated on the southwest shore. In 1879, the Hudson Bay Company set up a trading post at nearby Lac Ste. Anne, and settlers began arriving in 1905 as agricultural lands became available.¹ Today, several subdivisions are registered along the shoreline and the lake is heavily used for recreation. Sport fishing is popular, and species include northern pike (*Esox lucius*), yellow perch (*Perca flavescens*), burbot (*Lota lota*), white suckers (*Catostomus commersoni*), and walleye (*Sanders vitreus*).¹

Isle Lake is long and moderately shallow (Fig 1; maximum depth 7.5 m). Dominant phytoplankton in the spring are dinoflagellates (*Peridinium cinctum*) and diatoms (*Stephanodiscus hantzschia* and *Asterionella formosa*). During the summer, cyanobacteria (*Gleotrichia echinulata* and *Aphanizomenon flos-aquae*) are dominant until late fall when again diatoms such as *Stephanodiscus nigrarie* dominate the biomass composition. Emergent aquatic plants such as *Scirpus validus*, *Typha latifolia*, and *Carex* sp. are common. Isle Lake also has a large population of invasive Flowering Rush plants. These plants rapidly fill the lake, making recreation difficult, and reproduce rapidly via fragmentation of the roots.

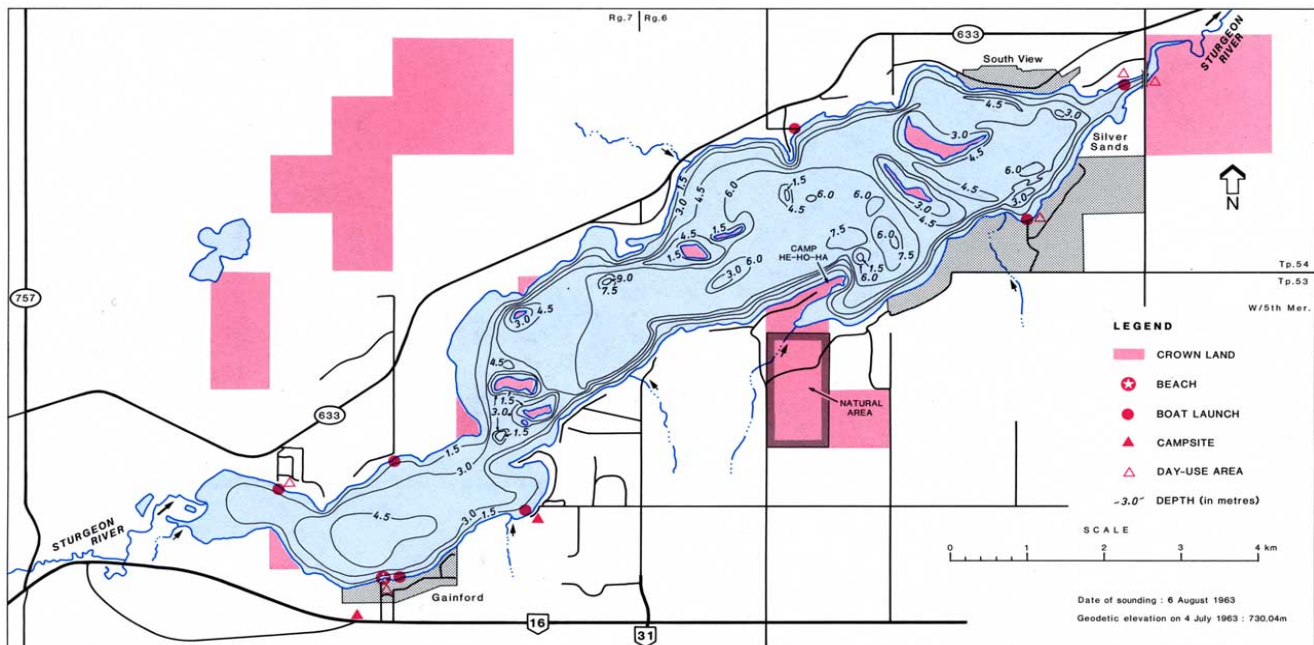


Figure 1 – Bathymetry and shoreline features of Isle Lake.¹

¹ Mitchell, P. and E. Prepas. 1990. Atlas of Alberta Lakes, University of Alberta Press. Retrieved from <http://sunsite.ualberta.ca/projects/alberta-lakes/>

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 at Isle Lake have changed little since monitoring began in 1972 (data available until 2012). Between the historical maximum of 730.5 meters above sea level (m asl) in 1989 and the historical minimum of 729.2 m asl in 2010, water levels have only changed by 1.3 m (Figure 2). With a drainage basin area approximately 11 times the size of the lake, Isle Lake receives large amounts of input in the form of runoff. The Sturgeon River runs into Isle Lake from the West and exits the lake to the East, which then flows into neighbouring Lac St. Anne.

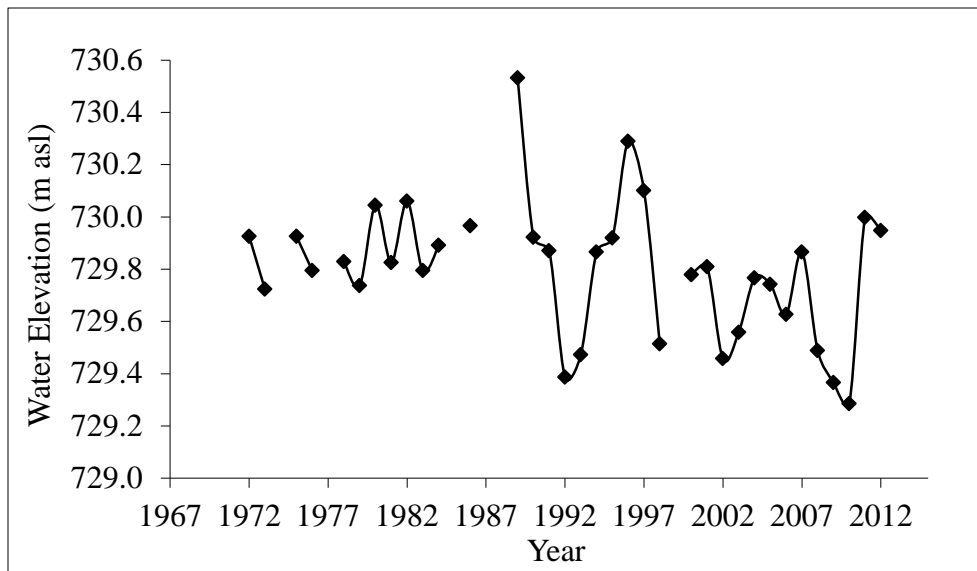


Figure 2 – Water levels at Lake Isle measured in meters above sea level (m asl) from Eureka Beach. Data obtained from Environment Canada.

WATER CLARITY & 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.

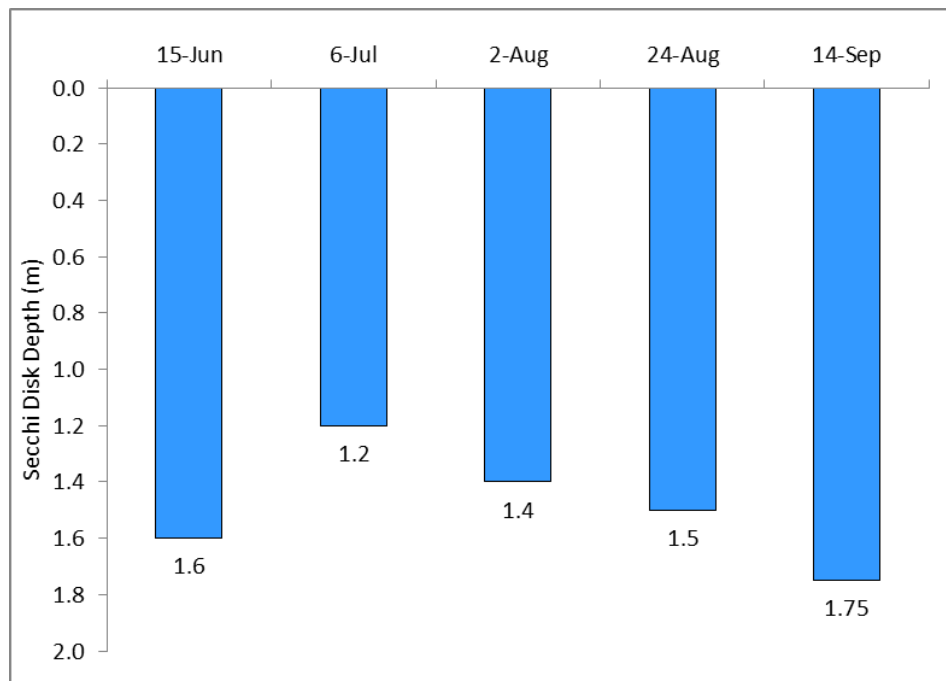


Figure 3 – Secchi disk depths recorded at the profile spot at Lake Isle, 2014.

Average Secchi disk depth at Isle Lake in 2014 was 1.49 m. A value of 1.49 m falls into the eutrophic, or biologically productive, classification. This value also suggests that, on average, no surface light remained for photosynthesis beyond 2.98 m. Decreased water clarity can impair the growth of macrophytes and make foraging difficult for fish. High concentrations of algae/cyanobacteria are likely the biggest impairments to water clarity at Isle Lake. Secchi disk readings showed a seasonal minimum of 1.20 m on July 6th and a seasonal maximum of 1.75 m on September 14th (Figure 3).

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 not observed throughout the summer as the lake remained isothermal throughout the season (Figure 4a). Surface water temperatures varied with a seasonal minimum of 13.14°C on September 14th to a maximum of 21.31°C on July 6th. On extreme temperature days it is possible for Lake Isle to thermally stratify. A lake that mixes and stratifies multiple times throughout the year is referred to a polymictic lake. The presence/absence of thermal stratification has important implications for nutrient cycling and dissolved oxygen concentrations in Lake Isle.

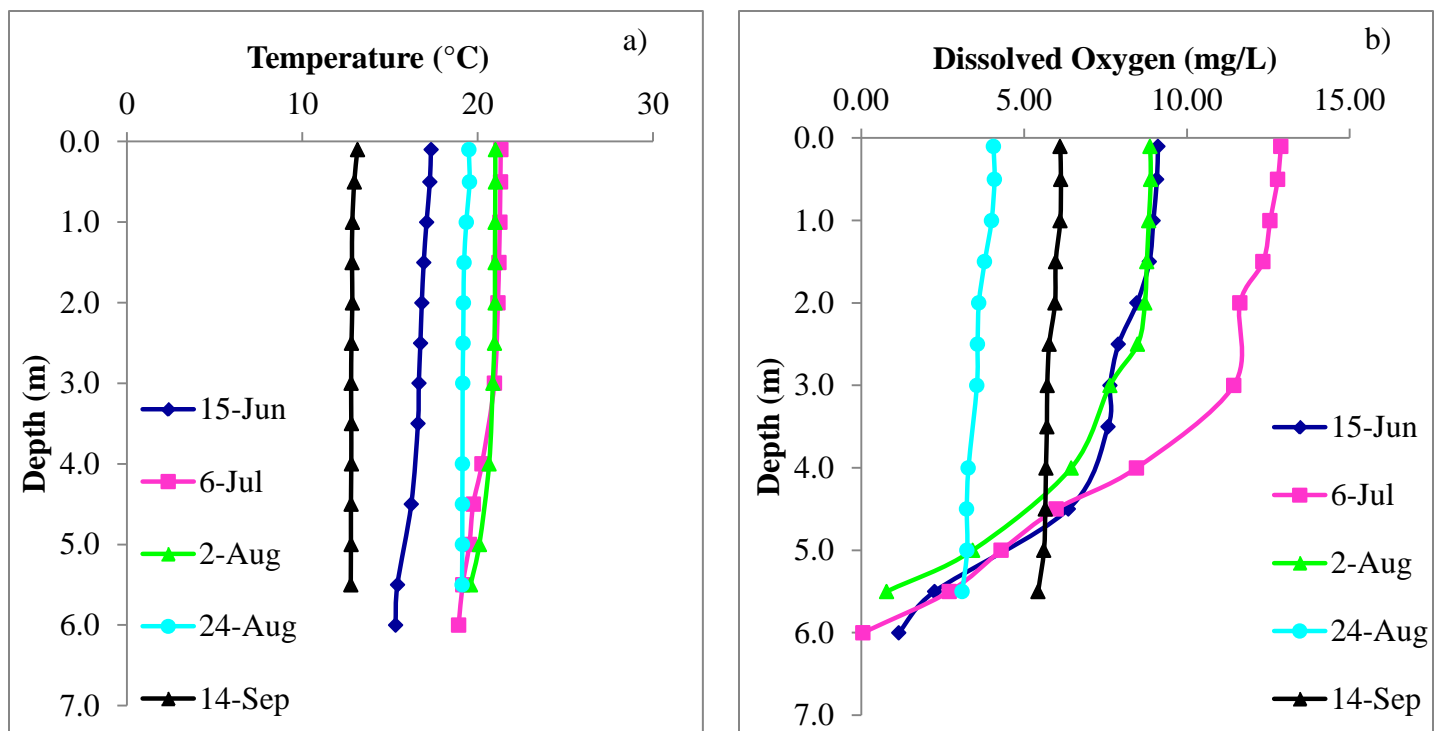


Figure 4 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Lake Isle measured in 2014.

Dissolved oxygen levels at Lake Isle varied greatly in 2014 (Figure 4b). Surface oxygen concentrations ranged from a maximum of 12.89 mg/L on July 6th to a minimum of 4.06 mg/L on August 24th. The Canadian Council for Ministers of the Environment recommends 6.5 mg/L for the Protection of Aquatic Life; on both August 24th and September 14th, the entire water column fell below this guideline. Low oxygen levels are likely a result of the decomposition of algae/cyanobacteria which is an oxygen-consuming process. A combination of high water temperatures and low dissolved oxygen concentrations may lead to summer fish kills, which have been observed at Isle Lake.

WATER CHEMISTRY:

ALMS measures a suite of water chemistry parameters. Phosphorous, 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 Phosphorous (TP) measured during 2014 was 252.4 µg/L, which falls into the hypereutrophic, or extremely productive, classification. Sediment core analysis suggests that Isle Lake has always been nutrient rich, though it is likely becoming more-so due to developments in its watershed². Internal sources contribute large amounts of

² Mitchell, P. 1999. Water Quality Management in Lac St. Anne and Lake Isle: A Diagnostic Study. Retrieved from <http://environment.gov.ab.ca/info/library/5804.pdf>

phosphorous to the lake, and it is likely that internal loading was high in 2014 due to low dissolved oxygen concentrations. In 2014, TP ranged from a minimum of 127 $\mu\text{g/L}$ on June 15th to a maximum of 358 $\mu\text{g/L}$ on August 24th. Mitchell (1999) suggests that the management of septic systems and development in the watershed may result in noticeable improvements in lake water quality.

Average Total Kjeldahl Nitrogen (TKN) also fell into the hypereutrophic classification with a value of 2214 $\mu\text{g/L}$, which is lower than recent years data at Lake Isle. TKN peaked during the middle of summer, with a minimum of 1550 $\mu\text{g/L}$ on June 15th to a maximum of 2950 $\mu\text{g/L}$ on August 2nd.

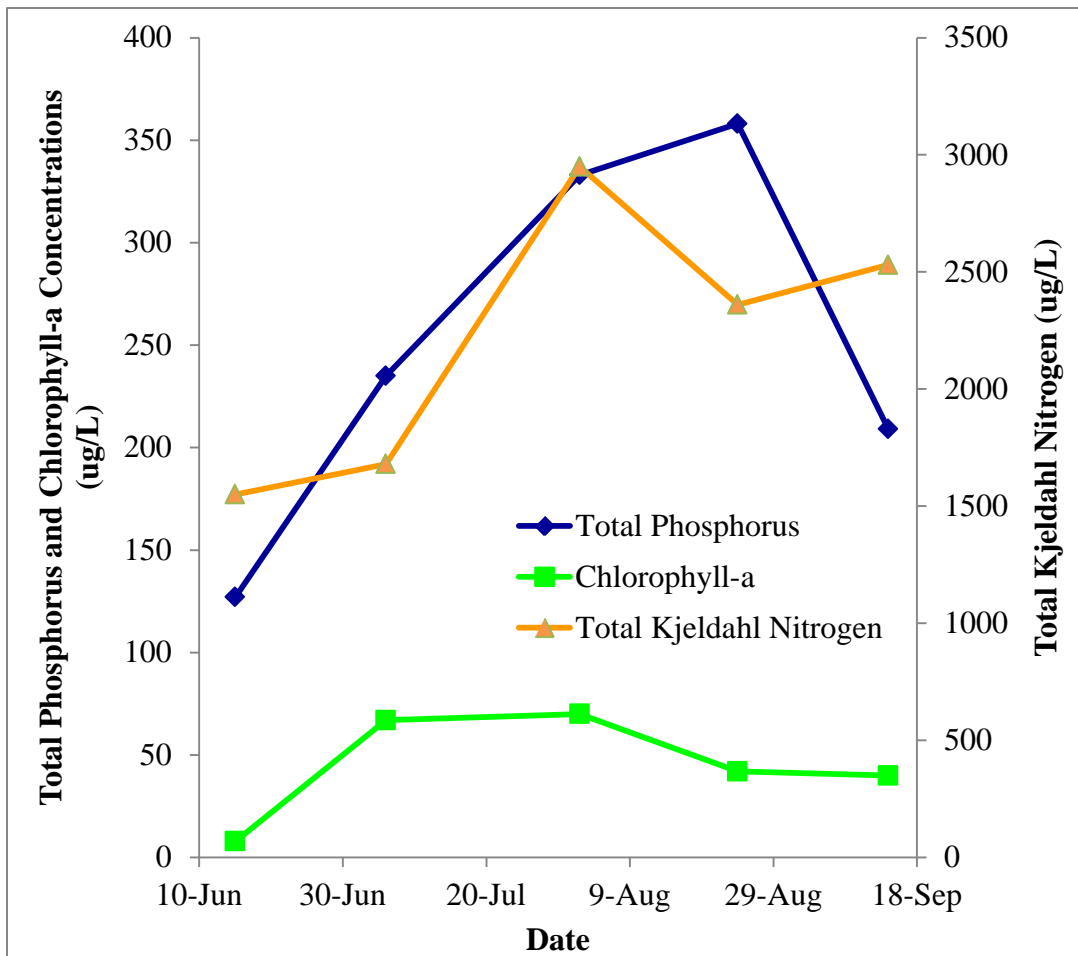


Figure 5 – Total phosphorus ($\mu\text{g/L}$), chlorophyll-*a* ($\mu\text{g/L}$), and total Kjeldahl nitrogen ($\mu\text{g/L}$) concentrations measured five times throughout the summer of 2014.

Finally, average chlorophyll-*a* concentration at Isle Lake measured 45.38 $\mu\text{g/L}$ in 2014. This is the highest value recorded at Lake Isle, and falls into the hypereutrophic classification. The highest concentration of chlorophyll-*a* measured 70 $\mu\text{g/L}$ on August 2nd, while the lowest was recorded on June 15th at 7.9 $\mu\text{g/L}$.

Average pH measured at Isle Lake was 8.64, which is well above neutral. Similar to many other lakes in Alberta, Isle Lake has high bicarbonate concentration (186.2 mg/L HCO_3) and alkalinity (153.04 mg/L CaCO_3) which help to buffer the lake against changes to pH. Concentrations of ions in the lake have not changed appreciably over time, and remain low, as evidenced by Isle Lake's low conductivity (370 $\mu\text{S}/\text{cm}$). Sodium (34.63 mg/L), calcium (27.43 mg/L), and chlorine (10.97 mg/L) are the dominant ions in Isle Lake. The absence of changes to the ion concentration in Isle Lake suggests that there have been few changes to the lake's hydrology.

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 $\mu\text{g}/\text{L}$.

In 2014, microcystin concentrations averaged 2.154 $\mu\text{g}/\text{L}$ – this is well below the recreational guidelines of 20 $\mu\text{g}/\text{L}$; however, this represents an average of ten sites on the lake and caution should always be used when recreating in or near a bloom (Table 2). Average concentrations of microcystin progressed throughout the summer with chlorophyll-a concentrations suggesting the cyanobacteria community at Lake Isle is was likely dominated by microcystin producing species (Table 1). A maximum concentration of 3.03 $\mu\text{g}/\text{L}$ was observed on August 2nd.

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 Lake Isle.

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

Parameter	1983	1984	1996	1997	1998	1996-1998	2002	2011	2012	2014
TP (µg/L)	140	166	94	178	367	/	147	225.2	246.58	252.4
TDP (µg/L)	72	115	37	116	285	/	95	85	124.6	172.6
Chlorophyll- <i>a</i> (µg/L)	64.7	47.5	48.6	65.6	67.1	/	20	113	117.83	45.38
Secchi depth (m)	1.4	1.3	3.1	1.7	2.1	/	2.1	0.66	1.463	1.49
TKN (µg/L)	1798	1838	1288	1675	2130	/	1623	2930	2882.5	2214
NO ₂ and NO ₃ (µg/L)	/	/	/	/	/	/	25	24.5	0.01	36
NH ₃ (µg/L)	/	/	/	/	/	/	52	78.2	81.45	207.4
DOC (mg/L)	/	/	/	/	/	/	/	17.9	/	19.7
Ca (mg/L)	/	/	/	/	/	30.6	30	25.3	28.05	27.43
Mg (mg/L)	/	/	/	/	/	8.6	10	10.8	10.21	9.319
Na (mg/L)	/	/	/	/	/	19	26	32.8	31.36	34.63
K (mg/L)	/	/	/	/	/	7	9	9.3	9.49	10.23
SO ₄ ²⁻ (mg/L)	/	/	/	/	/	30.6	8.9	4	10.34	6.433
Cl ⁻ (mg/L)	/	/	/	/	/	5	6.6	10.3	10.05	10.97
CO ₃ (mg/L)	/	/	/	/	/	7.6	6.2	3.2	14.48	16.05
HCO ₃ (mg/L)	/	/	/	/	/	165	189	203	177.75	186.2
pH	/	/	/	/	/	7.7-9.0	/	8.32	8.81	8.65
Conductivity (µS/cm)	/	/	/	/	/	308	/	364	365.25	370
Hardness (mg/L)	/	/	/	/	/	112	/	108	112.15	106.67
TDS (mg/L)	/	/	/	/	/	166	/	196	202	225.33
Microcystin (µg/L)	/	/	/	/	/	/	/	0.96	3.255	2.154
Total Alkalinity (mg/L CaCO ₃)	/	/	/	/	/	148	153	171	170.5	153.04

Note: TP = total phosphorous, TDP = total dissolved phosphorous, Chl-*a* = chlorophyll-*a*, TKN = total Kjeldahl nitrogen. NO₂₊₃ = nitrate+nitrite, NH₃ = ammonia, Ca = calcium, Mg = magnesium, Na = sodium, K = potassium, SO₄ = sulphate, Cl = chloride, CO₃ = carbonate, HCO₃ = bicarbonate. A forward slash (/) indicates an absence of data.

Table 3 - Concentrations of metals measured in Lake Isle on August 2nd and September 14th 2014. Values shown for 2014 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.

Metals (Total Recoverable)	2012	2014	Guidelines
Aluminum µg/L	19.7	10.65	100 ^a
Antimony µg/L	0.06525	0.058	6 ^e
Arsenic µg/L	1.765	1.995	5
Barium µg/L	78.2	83.6	1000 ^e
Beryllium µg/L	0.0078	0.004	100 ^{d,f}
Bismuth µg/L	0.00665	0.0005	/
Boron µg/L	57.45	51.4	5000 ^{e,f}
Cadmium µg/L	0.0047	0.0025	0.085 ^b
Chromium µg/L	0.253	0.385	/
Cobalt µg/L	0.04645	0.0135	1000 ^f
Copper µg/L	0.318	0.44	4 ^c
Iron µg/L	36.45	40.1	300
Lead µg/L	0.05275	0.0695	7 ^c
Lithium µg/L	16.7	14.4	2500 ^g
Manganese µg/L	64.5	153.25	200 ^g
Molybdenum µg/L	0.5765	0.333	73 ^d
Nickel µg/L	0.1094	0.004	150 ^c
Selenium µg/L	0.078	0.23	1
Silver µg/L	0.0043	0.001	0.1
Strontium µg/L	182	210	/
Thallium µg/L	0.0026	0.001425	0.8
Thorium µg/L	0.024775	0.012125	/
Tin µg/L	0.051	0.0135	/
Titanium µg/L	1.475	2.565	/
Uranium µg/L	0.361	0.2475	100 ^e
Vanadium µg/L	0.5145	0.36	100 ^{f,g}
Zinc µg/L	1.6215	0.5	30

Values represent means of total recoverable metal concentrations.

^a Based on pH ≥ 6.5; calcium ion concentrations [Ca²⁺] ≥ 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.

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.

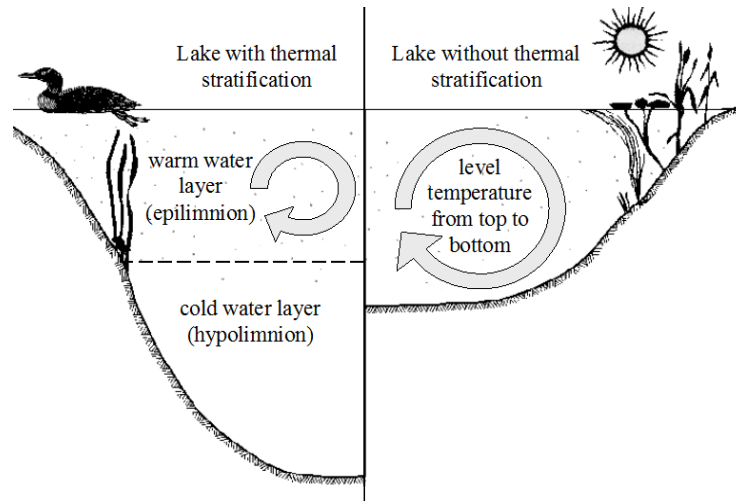


Figure A: Difference in the circulation of the water column depending on thermal stratification.

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.

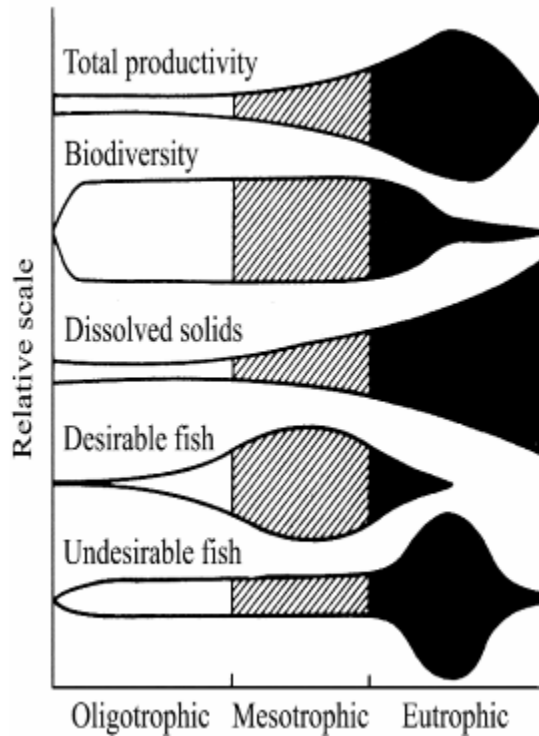


Figure B: Suggested changes in various lake characteristics with eutrophication. From “Ecological Effects of Wastewater”, 1980.

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