THE ALBERTA LAKE MANAGEMENT SOCIETY
VOLUNTEER LAKE MONITORING PROGRAM

2012 Island 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.

Historical data has been re-queried and summarized for the 2012 report.

Acknowledgements

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If you are interested in becoming a volunteer with the LakeWatch program or having your lake monitored, please e-mail us at info@alms.ca or call us at 780-415-9785.

ISLAND LAKE:

Island Lake is topographically interesting, in that it has many islands and bays. The lake is located in the County of Athabasca, about 20 km northwest of the town of Athabasca. The west side is accessible from Highway 2, which passes north through Athabasca from Edmonton then along the west shore of the lake enroute to the town of Slave Lake (Figure 1). Public Access at Island Lake is available at several locations on the west side within the summer villages. Boats may be launched at most sites.

Figure 1 –Island Lake 2012. Photo by Randi Newton, 2012.

Homesteads in the region were first established in about 1908. Seasonal cottage development on Island Lake began with subdivision of land on the west side in 1956; the summer village of Island Lake was incorporated the following year. In 1983, a second summer village, Island Lake South, was incorporated. Almost all residential development around the lake is located on the west shore within the two summer villages.

Island Lake is a medium-sized water body with a surface area of 7.81 km^2 and a drainage basin of 63.2 km^2. The main basin is shallow: the maximum depth is about 12 m, but most of the basin is less than 6 m deep. The deepest part of the lake is in the north basin, which reaches a depth of 18 m. The main basin of Island Lake is fairly shallow. A smaller, deeper northern basin is connected to the main basin by a narrow channel. Shallow areas in the main basin support dense beds of aquatic vegetation. Groundwater inflow was measured by University of Alberta researchers in 1986. Groundwater was estimated to contribute 4% of total water inflow.

Island Lake’s drainage basin is about 8 times the size of the lake. The main inflow drains from Ghost Lake and the northwestern portion of the drainage basin. Several intermittent streams carry runoff to the lake from other portions of the drainage basin. The outflow, Island Creek, flows from the east side of the lake southeast for about 5 km to the Athabasca River. Island Creek is choked with aquatic plants and has limited flow. About 27% of the drainage basin has been cleared, including areas of land around the south and west sides of Island Lake; most of the northern and northwestern regions remain forested. The soils around Island Lake have severe to very severe limitations on agriculture. The most abundant trees are trembling aspen, balsam poplar, white spruce, balsam fir, and white birch. Black spruce grown on poorly drained areas. Mature stands are rare because of past fires and clearing. Mature mixed stands can be found on the large islands and in patches along the north shore of Island Lake. There are extensive areas of Crown Land near the lake, including most of the islands. Several of these areas have been reserved for recreation. Island Lake is a popular destination for the fishing of perch, walleye, pike, and burbot. In fact, the Alberta size record for yellow perch came from Island Lake in 1982, measuring 2 lbs. 15.5 oz.

References:

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

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.

Water levels at Island Lake have been monitored since 1968, and until recently, water levels have been fairly stable over the length of the record; the maximum difference is less than 1.5 m. Water levels increased slightly during early 1970's and were then quite stable until the early 1990's, when they began to decrease. Water levels increased again to reach a historical maximum in 1997, a year with record precipitation. Since then, water levels have decreased to a historical minimum in 2002 and remain low today. Over the period of record the highest water level was recorded in May 1997 at 601.791 m asl.

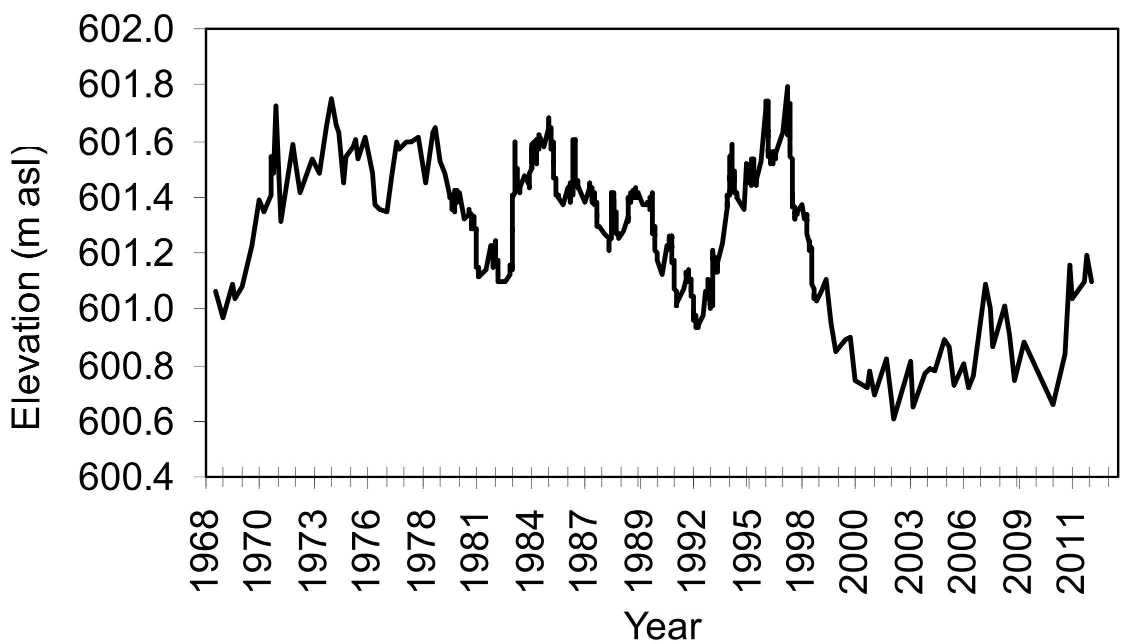

Figure 2 – Water levels in meters above sea level (m asl) for the period 1968-2012. Data obtained from Alberta Environment.

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 measured 3.60 m in 2012 (Table 1). This value is slightly higher than that measured in 2005, and falls into the mesotrophic, or moderately productive, classification. Secchi disk changed little throughout the summer, likely because algae/cyanobacteria levels also fluctuated very little. Secchi disk depth measured a minimum of 3.00 m on September 1st and a maximum of 4.00 m on June 19th. Two factors which might impair water clarity, dissolved organic carbon (DOC) and total suspended solids (TSS), both had low concentrations in 2012 (Table 1).

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.

Lake profiles in 2012 were measured in the deep, northern basin; in the past, profiles have been measured in the shallower main basin (Figure 3a). Strong thermal stratification was present on each sampling trip, beginning as early as 2.0 m on July 9th, and as late as 6.5 m on September 14th. The presence of thermal stratification has important implications for the concentrations of dissolved oxygen in deeper portions of the water column. At the surface, water temperature ranged from a minimum of 15.21 °C and a maximum of 23.07 °C.

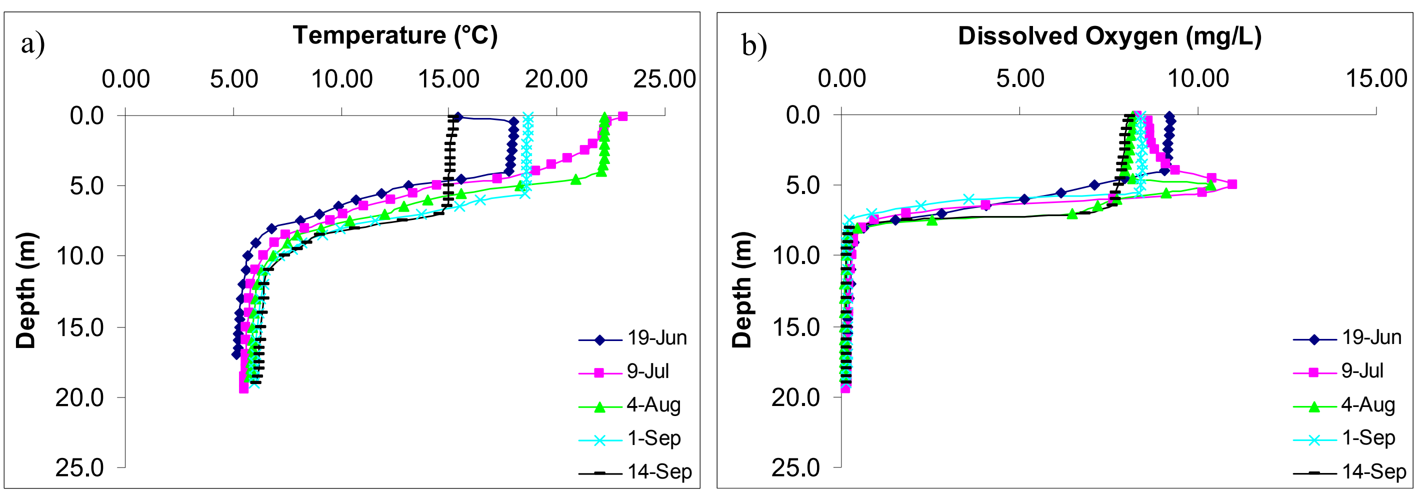

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) concentration profiles measured five times over the course of the summer of 2012 at Island Lake.

Above the thermocline, dissolved oxygen concentrations remained above the Canadian Council for Ministers of the Environment guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). Below the thermocline, dissolved oxygen concentration decreased dramatically, reaching anoxia as early as 7.5 m. Declines in dissolved oxygen concentrations below the thermocline are expected, as the thermocline separates bottom waters from atmospheric oxygen, as well as isolates oxygen-consuming decomposition that occurs on the lakebed. On both July 9th and August 4th, a spike in oxygen was observed in the thermocline – this may be due to a metalimnetic bloom of algae which photosynthesizes at deeper depths than the typical surface blooms.

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 27.8 µg/L – this value falls into the mesotrophic, or moderately productive, classification (Table 1). In contrast, in 2005 average TP measured 34 µg/L, which falls into the eutrophic classification. As the cut-off between mesotrophic and eutrophic is 30 µg/L, it is likely that Island Lake fluctuates between these two classifications. TP is the primary nutrient driving algae/cyanobacteria communities.

Chlorophyll-*a* concentration, an indirect measure of algal/cyanobacterial biomass measured an average of 6.80 µg/L in 2012; this value falls into the mesotrophic classification. Throughout the summer, chlorophyll-*a* concentration ranged from a minimum of 5.39 µg/L on June 19th to a maximum of 8.35 µg/L on September 1st. As with TP, the 2012 chlorophyll-*a* concentration is slightly less than that measured in 2005.

Average total Kjeldahl nitrogen (TKN) measured 1350 µg/L in 2012 – this value falls into the hypereutrophic classification, as it did in 2005. Throughout the summer, TKN ranged from a minimum of 1270 µg/L on July 9th to a maximum of 1440 µg/L on September 14th.

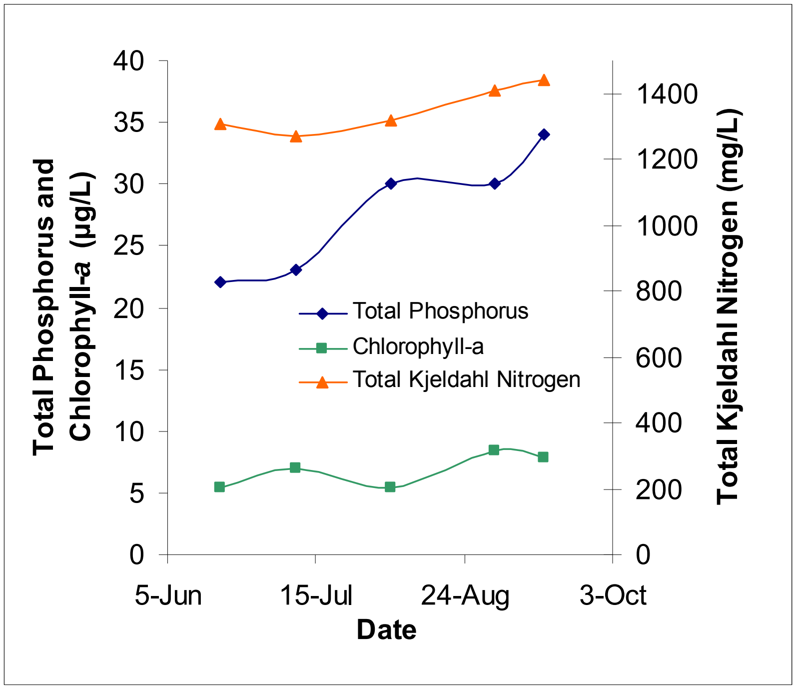

Figure 4 - Total phosphorus (µg/L), chlorophyll-*a* (µg/L), and total Kjeldahl nitrogen (µg/L) measured at Island five times over the course of 2012.

Average pH measured 8.50 during the summer of 2012, well above neutral. Island Lake has a moderately high bicarbonate concentration (271 mg/L HCO_3) and alkalinity (231.8 mg/L $CaCO_3$) which help to buffer the lake against changes to pH. Island Lake has a moderate conductivity, with dominant ions as sodium (47.77 mg/L) and calcium (26.2 mg/L). The concentration of microcystin, a toxin produced by cyanobacteria, measured an average of 0.169 µg/L and reached a maximum of 0.253 µg/L on September 1st, well below the recommended recreational guidelines of 20 µg/L. Metals were measured twice at Island Lake and all values measured fell below their recommended guidelines (Table 2).

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

Parameter	2005	2012
TP (µg/L)	34	27.8
TDP (µg/L)	11.2	12.8
Chlorophyll-*a* (µg/L)	8.37	6.8
Secchi depth (m)	3.13	3.6
TKN (µg/L)	1265	1350
NO_2 and NO_3 (µg/L)	5.4	15.4
NH_3 (µg/L)	30	38
DOC (mg/L)	/	18.7
Ca (mg/L)	21.9	26.2
Mg (mg/L)	20.4	21.03
Na (mg/L)	40.3	47.77
K (mg/L)	9.77	10.47
SO_4^{2-} (mg/L)	6.33	3.5
Cl^- (mg/L)	7.67	10
CO_3 (mg/L)	10.3	5.7
HCO_3 (mg/L)	246.3	271
pH	8.64	8.50
Conductivity (µS/cm)	420	457.6
Hardness (mg/L)	138.7	152
TDS (mg/L)	238	252
TSS	3.67	1.84
Microcystin (µg/L)	0.048	0.169
Total Alkalinity (mg/L $CaCO_3$)	219.3	231.8

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

Table 2 - Concentrations of metals measured in Island Lake on August 4th and September 14th. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	2012	Guidelines
Aluminum µg/L	9.24	100[a]
Antimony µg/L	0.0295	6[e]
Arsenic µg/L	0.707	5
Barium µg/L	59.1	1000[e]
Beryllium µg/L	0.0123	100[d,f]
Bismuth µg/L	0.00375	/
Boron µg/L	142.5	5000[ef]
Cadmium µg/L	0.0032	0.085[b]
Chromium µg/L	0.1715	/
Cobalt µg/L	0.01785	1000[f]
Copper µg/L	0.6765	4[c]
Iron µg/L	18.25	300
Lead µg/L	0.0177	7[c]
Lithium µg/L	29.05	2500[g]
Manganese µg/L	29.7	200[g]
Molybdenum µg/L	0.08485	73[d]
Nickel µg/L	0.0025	150[c]
Selenium µg/L	0.1275	1
Silver µg/L	0.0012	0.1
Strontium µg/L	179.5	/
Thallium µg/L	0.00135	0.8
Thorium µg/L	0.002825	/
Tin µg/L	0.028	/
Titanium µg/L	0.3055	/
Uranium µg/L	0.1195	100[e]
Vanadium µg/L	0.165	100[f,g]
Zinc µg/L	0.6415	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 $CaCO_3$)
[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:

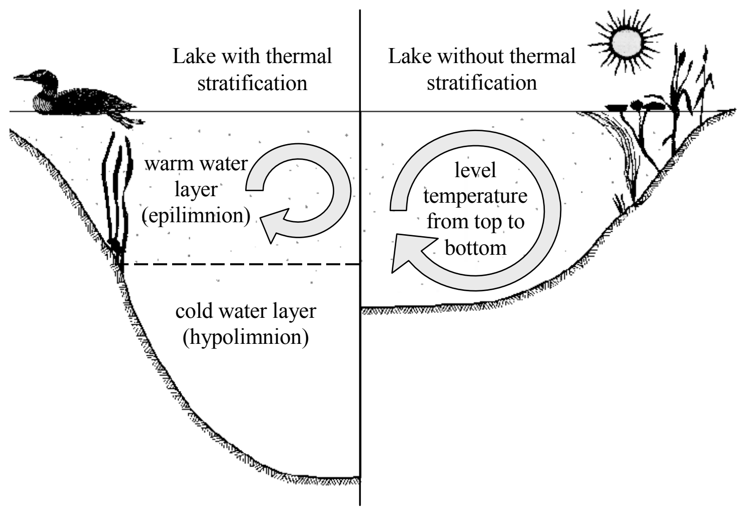

Figure A: Difference in the circulation of the water column depending on thermal stratification.

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.

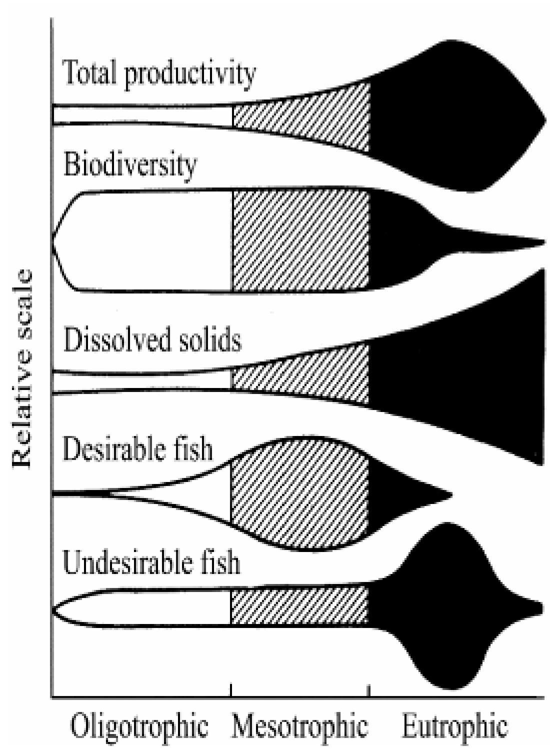

Figure B: Suggested changes in various lake characteristics with eutrophication. From "Ecological Effects of Wastewater", 1980.

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