Lakewatch

THE ALBERTA LAKE MANAGEMENT SOCIETY
VOLUNTEER LAKE MONITORING PROGRAM

2015 Hubbles Lake Report

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Beaver River Watershed Alliance

aemera.org

LICA
Lakeland Industry & Community Association

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LakeWatch has several important objectives, one of which is to collect and interpret water quality data on Alberta Lakes. Equally important is educating lake users about their aquatic environment, encouraging public involvement in lake management, and facilitating cooperation and partnerships between government, industry, the scientific community and lake users. LakeWatch Reports are designed to summarize basic lake data in understandable terms for a lay audience and are not meant to be a complete synopsis of information about specific lakes. Additional information is available for many lakes that have been included in LakeWatch and readers requiring more information are encouraged to seek those sources.

ALMS would like to thank all who express interest in Alberta's aquatic environments and particularly those who have participated in the LakeWatch program. These people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health of our environment.

Data in this report is still in the validation process.

Acknowledgements

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

HUBBLES LAKE:

Hubbles Lake is a small (surface area: 0.4 km^2), lake set in Parkland County in central Alberta. The lake is a 30 minute drive from Edmonton, located just 5 km west of Stony Plain on Highway 16. The lake was named after the founder of a resort which was built on the southeast shore of the lake in the ‘50s.[1]

Figure. 1 – A swimmer makes their way across Hubbles Lakes. Photo by Jackson Woren.

Hubbles Lake is short and narrow, though deep for its size, with a maximum depth of 30 m and an average depth of 10.1 m. Hubbles Lake is thought to have three deep spots, two with a depth of 25 m, and a third with a maximum depth of 30 m; however, the deepest of these spots has been difficult to locate.

Motorized boats are not allowed on Hubbles Lake; therefore, battery powered pontoons are the most popular watercraft. The lake is also used by people who enjoy canoeing, kayaking, and paddle-boarding. Hubbles Lake is known to host the Great White North triathlon every year, and it is not unusual to observe people swimming the length of the lake. Historically, Hubbles Lake was a favourite spot used by SCUBA divers who sunk interesting objects to the bottom of the lake.

Sport fish at Hubbles Lake are limited to Northern Pike (*Esox lucius)* and Yellow Perch (*Perca flavescens*), which were stocked in the late ‘50s. In 1967, a community centennial project placed ~2,000 old tires at the bottom of the lake in effort to create a better fish habitat for the known species.[1] Numerous macrophytes are located in the littoral zone and riparian area of the lake, including species such as the common cattail, sedges, bulrush, arrowheads, and giant bur-reed. Submerged macrophytes include stonewort with low densities of northern water milfoil and sago pondweed.[2] Waterfowl are commonly spotted around the lake and include species such as the mallard duck, Canadian goose, and common loon.

Hubbles Lake has a watershed that is 20 times the surface area of the lake; however, its effective drainage basin is only 1.35 km^2. The lake is located in the boreal mixedwood ecoregion and most of the watershed is open agricultural land with patches of mixed wood and bushes. Hubbles Lake has numerous residential and recreational developments within the watershed and the Hubbles Lake Stewardship Society was recently formed to promote ecological stewardship and sustainable practices around the 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.

The water level at Hubbles Lake has fluctuated ~2.0 m since 1968. In 1971, the water level reached an observed minimum of 727.8 m above sea level (m asl). After this observed minimum, water levels increased in the ‘70s to a maximum of 729.0 m asl in 1981 and 1991 (Figure 2). It is believed that the increase in water levels in the 1970s was attributed to years with above normal snowfalls and heavier than normal spring rains. Hubbles Lake is estimated to have a water residency time of over 100 years as there is no obvious outlet from the lake. Connections between groundwater and surface water are still not fully understood.

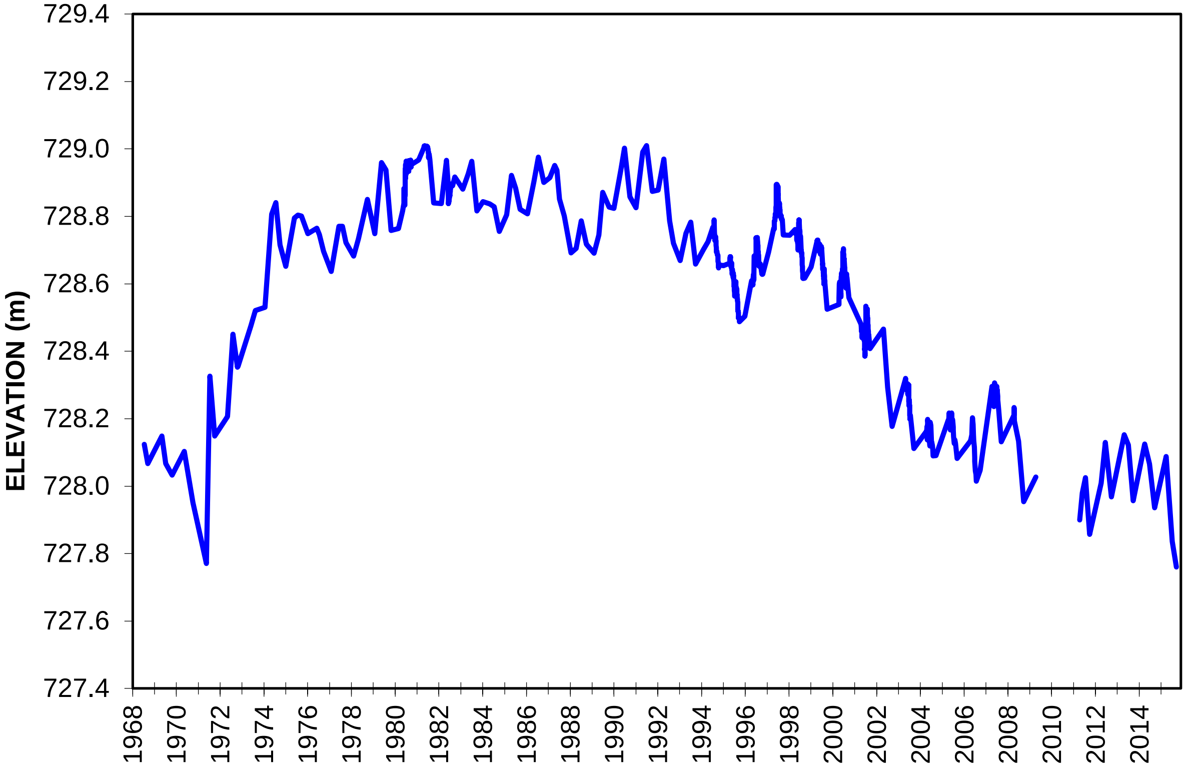

Figure 1 – Water levels in meters above sea level (m asl) measured at Hubbles Lake from 1968 to 2015 by Alberta Environmental and Parks.

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.

Water clarity at Hubbles Lake measured 4.63 m in 2015. This value falls on the low end of the historical variation observed at Hubbles – though more data is required to establish a firm baseline. Throughout the summer, Secchi disk depth measured a maximum of 5.40 m on June 12th and a minimum of 3.75 m on August 14th. There were no significant increases in chlorophyll-*a* concentrations observed on August 14th, suggesting phytoplankton was not responsible for a reduction in water clarity. Thus, reduction in water clarity may be due to environmental factors such as the overcast and slightly windy conditions which were present on August 14th.

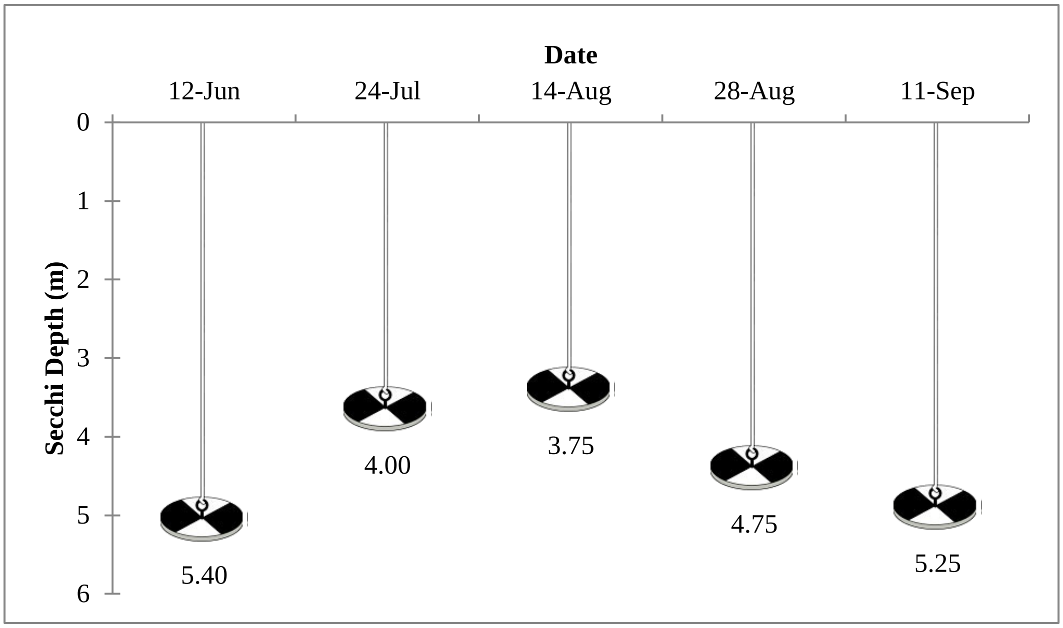

Figure 2 - Secchi depth readings from the profile site at Hubbles Lake during 2015.

WATER TEMPERATURE AND DISSOLVED OXYGEN:

Water temperature and dissolved oxygen profiles in the water column can provide information on water quality and fish habitat. The depth of the thermocline is important in determining the *depth to which dissolved oxygen from the surface can be mixed. Please refer to the end of this report for descriptions of technical terms.*

Temperature in Hubbles Lake remained well stratified throughout 2015. Thermal stratification occurred as early as 4.0 m and as deep as 6.5 m throughout the course of the summer. Maximum surface water temperature measured 22.62 °C on August 14th and minimum surface water temperature measured 16.53 °C on September 11th. Due to the strong thermal stratification present in Hubbles Lake, water temperature near the lake bed consistently measured around 4.50 °C. The small size of the lake, combined with its great depth, lend itself to strong thermal stratification. It is unlikely that Hubbles Lake properly mixes throughout the year, a feature which helps keep nutrient rich bottom waters from mixing with the surface. Hubbles Lake's strong thermal stratificaiton also has important implications for the oxygen dynamics in the lake.

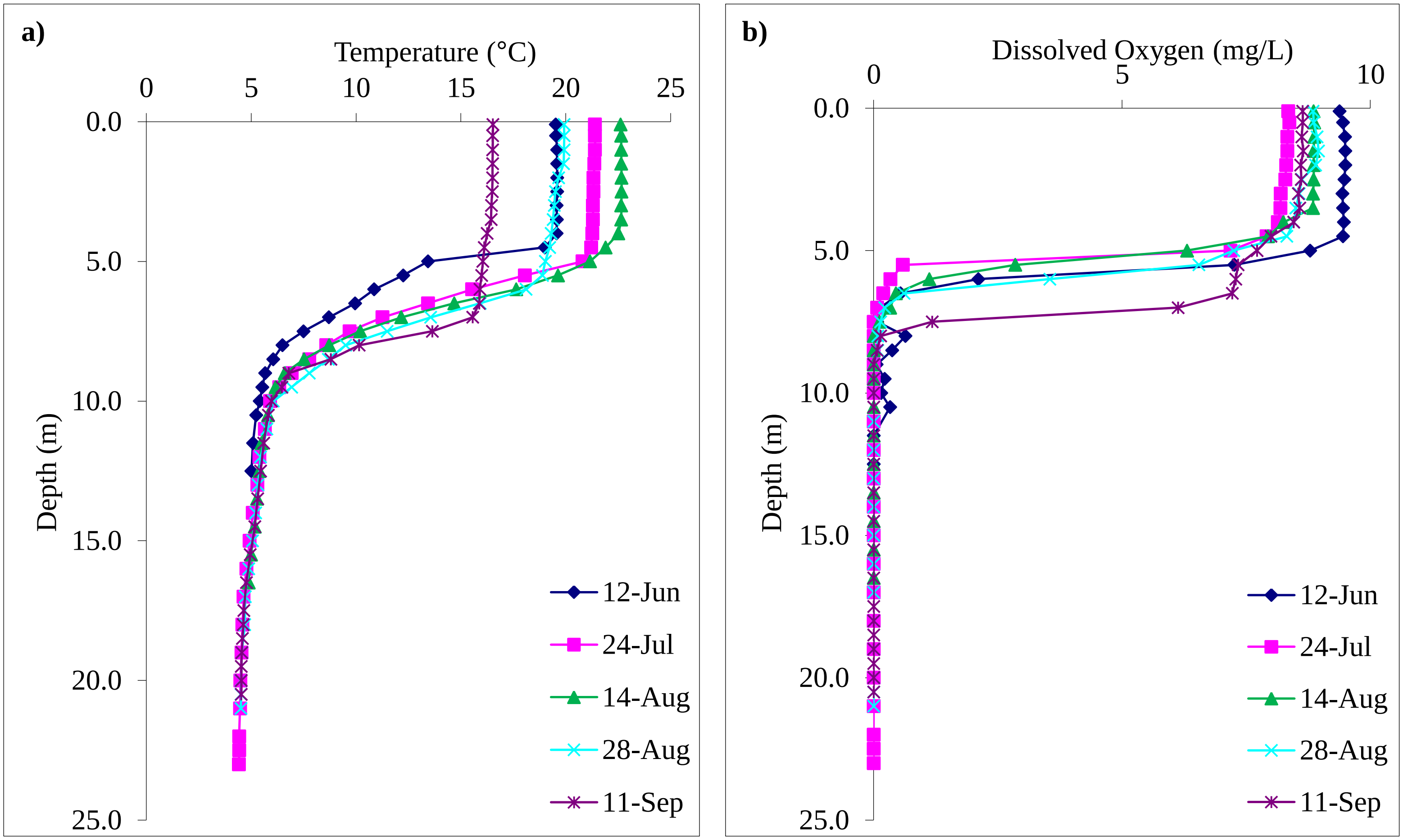

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Hubbles Lake measured five times throughout the course of the summer of 2015.

Dissolved oxygen concentrations behaved very similarly to the temperature profiles measured in Hubbles Lake. Due to thermal stratification, Hubbles Lake showed anoxic conditions as early as 7.5 m on July 24th. Above the thermocline, however, Hubbles Lake was well oxygenated, measuring well above the Canadian Council for Ministers of the Environment guidelines for the

Protection of Aquatic Life of 6.5 mg/L. At the surface, dissolved oxygen concentration varied little throughout the summer, measuring between 8.35-9.38 mg/L.

WATER CHEMISTRY:

ALMS measures a suite of water chemistry parameters. Phosphorus, nitrogen, and chlorophyll-a are important because they are indicators of eutrophication, or excess nutrients, which can lead to harmful algal/cyanobacteria blooms. One direct measure of harmful cyanobacteria blooms are Microcystins, a common group of toxins produced by cyanobacteria. See Table 1 for a more complete list of parameters.

Total Phosphorus (TP) concentration measured an average of 28 µg/L in 2015. As seen in Figure 4, this average was highly influenced by an outlier on July 24th which measured 76 µg/L. An average value of 28 µg/L falls into the mesotrophic, or moderately productive, classification (Table 1). In contrast, in 2014, the highest concentration of phosphorus was observed in June – thus, more data is required to better understand the nutrient dynamics at Hubbles Lake.

In 2015, Total Kjeldahl Nitrogen (TKN) measured an average of 1.3 mg/L (Table 1). Similar to TP, an outlier of 2.7 mg/L measured on September 11th influenced this average. As a result, more nutrient data is required to better understand nitrogen dynamics in Hubbles Lake.

Chlorophyll-*a* concentration in 2015 behaved similarly to that observed in 2014 (Figure 4). An average concentration of 3.64 mg/L was observed in 2015, placing Hubbles Lake into a mesotrophic, or moderately productive, classification (Table 1). An average value of 3.64 falls on the low end of the historical variation observed at Hubbles Lake.

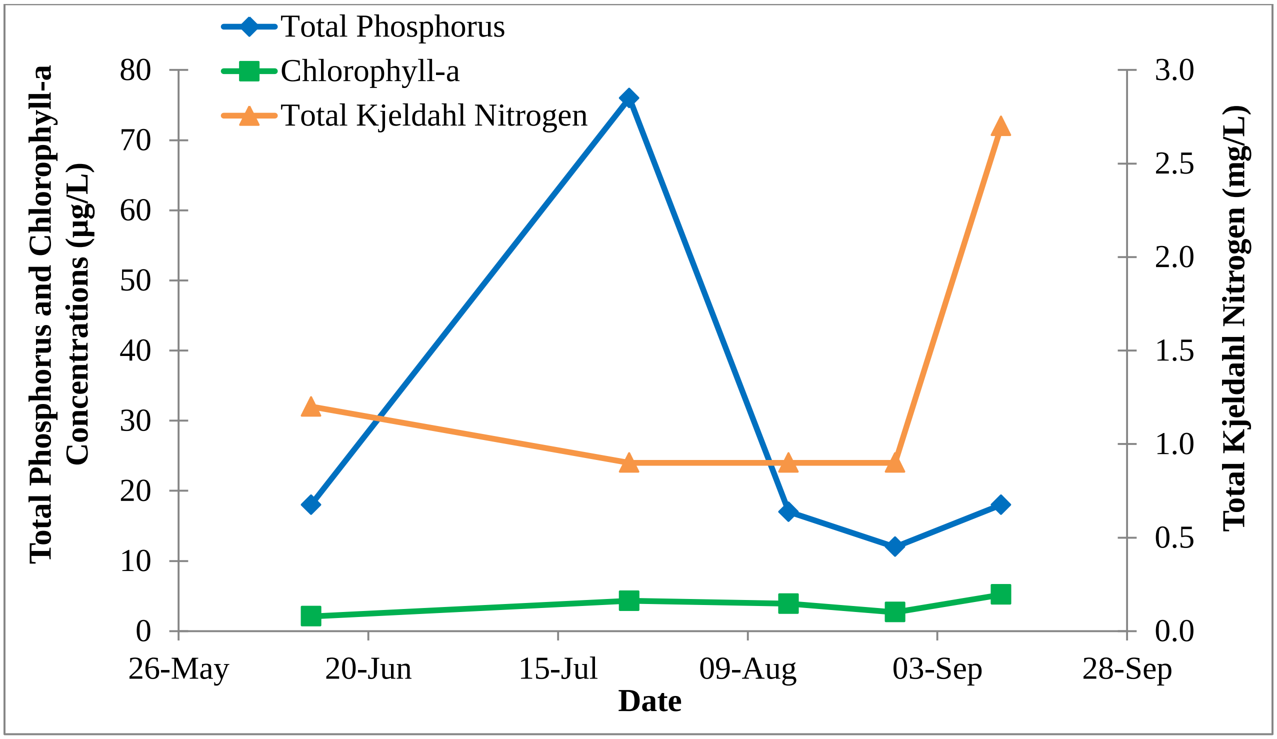

Figure 4 – Total Phosphorus (µg/L), total Kjeldahl nitrogen (TKN), and chlorophyll-*a* (µg/L) concentration measured five times over the course of the summer of 2015 at Hubbles Lake.

Average pH at Hubbles Lake measured 8.06 – while this is slightly lower than many of the lakes in the LakeWatch program, Hubbles Lake is still well buffered against changes to pH due to its alklinity (130 mg/L) and bicarbonate (156 mg/L) concentrations. Hubbles lake has moderate conductivity (612 uS/cm) which is comprised of ions such as sulphate (190 mg/L), calcium (48 mg/L), and magnesium (39 mg/L).

Metals were measured three times in the summer of 2015 – all concentrations fell within their respective guidelines.

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 2015, all microcystin concentrations fell below the laboratory's minimum detection limit of 0.1 μg/L (Table 1).

INVASIVE SPECIES:

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

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

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

Parameter	**1976**	**1980**	**1981**	**1986**	**2014**	**2015**
TP (µg/L)	25	30	24	/	17	28
TDP (µg/L)	/	/	/	9	9	8
Chlorophyll-*a* (µg/L)	/	10.3	7.7	/	1.8	3.6
Secchi depth (m)	/	5.20	3.90	/	6.85	4.63
TKN (mg/L)	1.2	/	1.0	/	0.8	1.3
NO_2 and NO_3 (µg/L)	25.33	/	6	/	28	2.5
NH_3 (µg/L)	100	/	73	/	55	30
DOC (mg/L)	/	/	/	/	8.53	9.22
Ca (mg/L)	/	/	/	47	50	48
Mg (mg/L)	40	/	/	35	35	39
Na (mg/L)	10.67	/	/	9	15	15
K (mg/L)	8.33	/	/	11	11	11
SO_4^{2-} (mg/L)	159	/	/	185	173	190
Cl^- (mg/L)	0.5	/	/	/	3.87	4.24
CO_3 (mg/L)	/	/	2	/	0.10	0.25
HCO_3 (mg/L)	/	/	163	/	158	156
pH	7.87	/	/	7.7	8.14	8.06
Conductivity (µS/cm)	566.67	/	/	418	600	612
Hardness (mg/L)	279.67	/	275	/	269	284
TDS (mg/L)	368	/	/	383	368	382
Microcystin (µg/L)	/	/	/	/	0.12	0.05
Total Alkalinity (mg/L $CaCO_3$)	172.67	/	138	/	129	130

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.

[a] Average value from three samples on July 17th, 1976

[b] Average values from May 4th and August 5th 1981.

[c] Value recorded on March 11th, 1986. N=1

[d] Average of values recorded on March 11, 1986. N=2

[e] Average of values recorded on March 11, 1986. N=3

Table 2 – Concentrations of metals measured in Hubbles Lake on June 12th, August 14th, and September 11th. Values shown for 2015 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)	**2014**	**2015**	**Guidelines**
Aluminum µg/L	10.1	28.5	100[a]
Antimony µg/L	0.045	0.048	6[e]
Arsenic µg/L	1.4	1.42	5
Barium µg/L	80.0	73.0	1000[e]
Beryllium µg/L	0.004	0.004	100[d,f]
Bismuth µg/L	0.0005	0.001	/
Boron µg/L	122	125	5000[ef]
Cadmium µg/L	0.001	0.001	0.085[b]
Chromium µg/L	0.2	0.4	/
Cobalt µg/L	0.032	0.032	1000[f]
Copper µg/L	0.83	0.9	4[c]
Mercury ng/L	/	0.31	26
Mercury ng/L	/	0.93	26
Iron µg/L	17.1	18.2	300
Lead µg/L	0.039	0.037	7[c]
Lithium µg/L	49.7	54.0	2500[g]
Manganese µg/L	37.9	72.9	200[g]
Molybdenum µg/L	0.05865	0.0617	73[d]
Nickel µg/L	0.140	0.033	150[c]
Selenium µg/L	0.08	0.06	1
Silver µg/L	0.001	0.002	0.1
Strontium µg/L	500	541	/
Thallium µg/L	0.0022	0.0014	0.8
Thorium µg/L	0.0005	0.0069	/
Tin µg/L	0.014	0.015	/
Titanium µg/L	0.86	0.70	/
Uranium µg/L	0.187	0.235	100[e]
Vanadium µg/L	0.17	0.20	100[f,g]
Zinc µg/L	1.6	0.8	30

Values represent means of total recoverable metal concentrations.

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

[b] Based on water Hardness of 300 mg/L (as $CaCO_3$)

[c] Based on water hardness > 180mg/L (as $CaCO_3$)

[d] CCME interim value.

[e] Based on Canadian Drinking Water Quality guideline values.

[f] Based on CCME Guidelines for Agricultural use (Livestock Watering).

[g] Based on CCME Guidelines for Agricultural Use (Irrigation).

A forward slash (/) indicates an absence of data or guidelines.

A BRIEF INTRODUCTION TO LIMNOLOGY

INDICATORS OF WATER QUALITY:

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

TEMPERATURE AND MIXING:

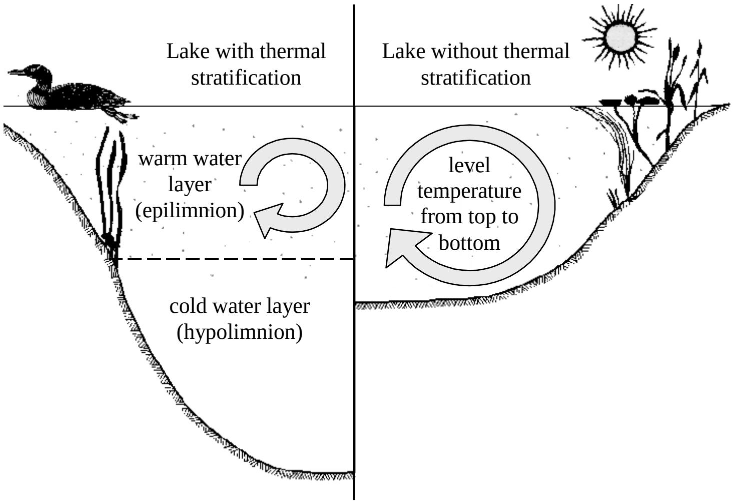

Figure A: Difference in the circulation of the water column depending on thermal stratification.

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

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

DISSOLVED OXYGEN:

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

GENERAL WATER CHEMISTRY:

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

PHOSPHORUS AND NITROGEN:

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

CHLOROPHYLL-*A*:

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

SECCHI DISK TRANSPARENCY:

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

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

TROPHIC STATE:

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

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

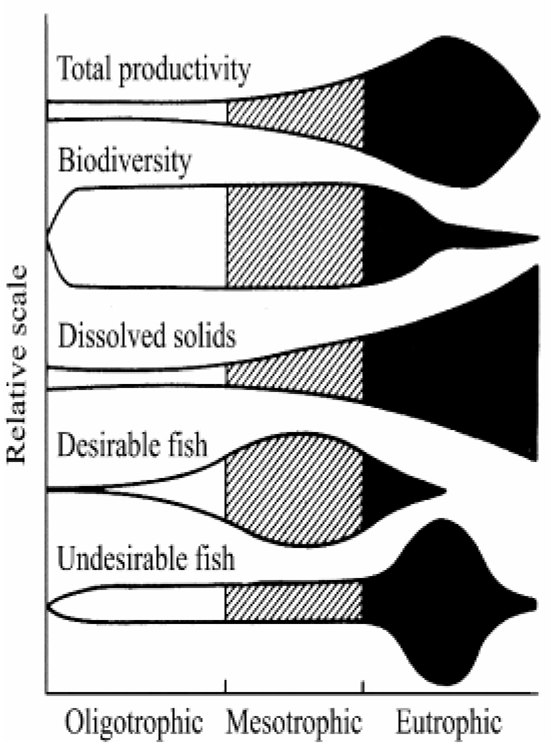

Figure B: Suggested changes in various lake characteristics with eutrophication. From "Ecological Effects of Wastewater", 1980.

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

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