



*THE ALBERTA LAKE MANAGEMENT SOCIETY
VOLUNTEER LAKE MONITORING PROGRAM*

2011 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

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WIZARD LAKE:

Wizard Lake (Figure 1, Figure 2) is a long, serpentine, lake lying in a heavily forested, deep glacial meltwater channel 50 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.¹ First Nations legends said strange noises in the lake came from 'conjuring creatures'; the creek draining the lake is still called Conjuring Creek.

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.

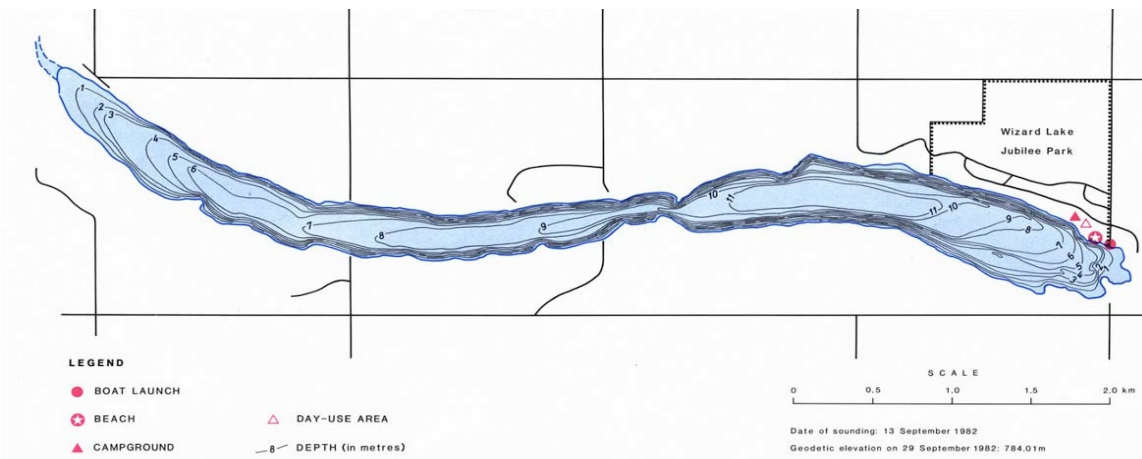


Figure 2 – Bathymetry of Wizard Lake showing contour intervals in meters.

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

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 km², 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. It is a eutrophic lake, usually clear, but experiences dense blue-green algae blooms during the summer months that turn the water murky. The lake basin is made up of approximately 65% forest or bush, 25% agricultural land, 7% lakes or sloughs, and 3% urban development (Mitchell and Prepas 1990).

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 (29.8km²), Wizard Lake has much input in the form of runoff from the watershed. Two intermittent streams on the south side of the lake flow into the lake, while Conjurung Creek drains to the north.

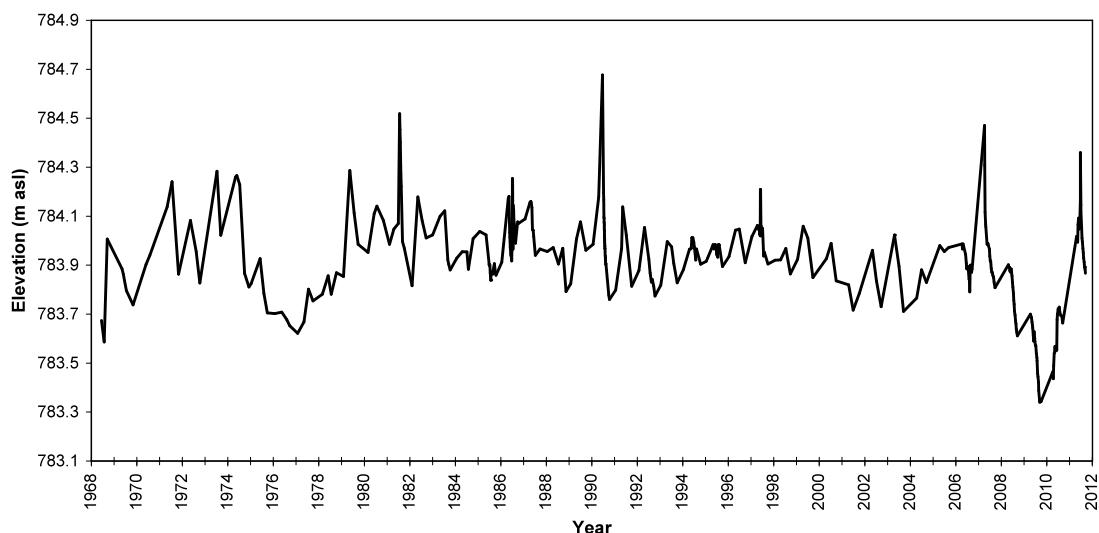


Figure 3 – Water levels in meters above sea level (m asl) from Wizard Lake. Data obtained from Alberta Environment.

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 measured at Wizard lake in 2011 was 1.15 m (Table 1). This value is shallower than measured in previous years, which may be due to the large amounts of runoff received in 2011. Throughout the summer, Secchi disk depth ranged from a minimum of 0.75 m on July 18th and a maximum of 1.75 m on June 27th. 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.

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.

Wizard Lake experienced multiple periods of stratification and mixing throughout the summer of 2011 (meromictic; Figure 4a) On June 27th, Wizard Lake was stratified between 8.5 m and 10.5 m, and was not stratified again until August 18th between 8.0 m and 10.0 m. Surface water temperature ranged from a minimum of 16.98 °C on June 27th and a maximum of 20.18 °C on July 18th. Throughout the water column, water temperatures were high, particularly during periods of mixing.

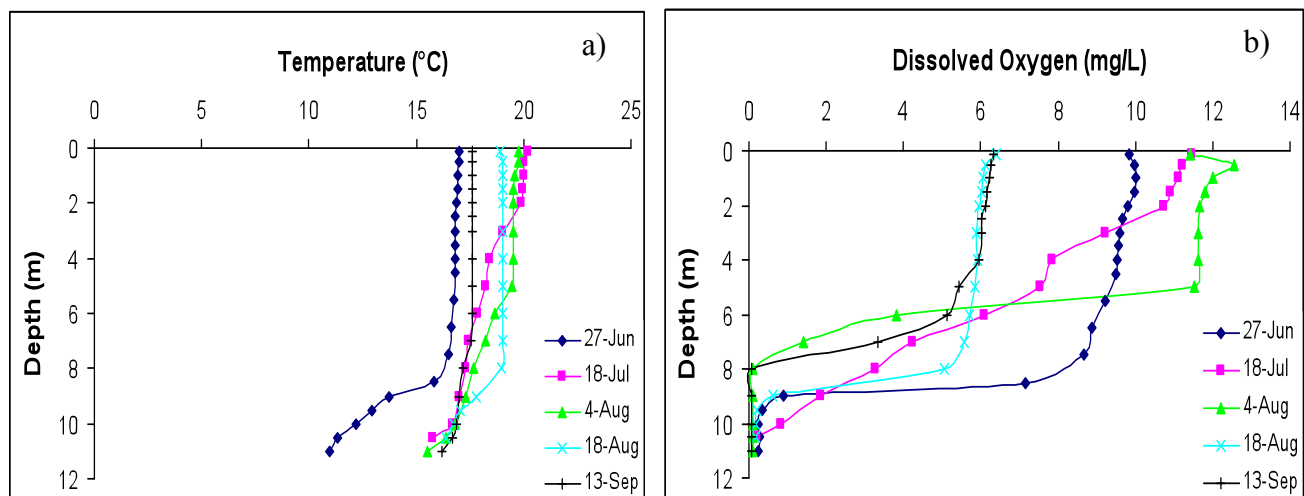


Figure 4 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Wizard Lake measured during the summer of 2011.

Despite the mixing of the water column throughout the summer, dissolved oxygen often proceeded to anoxia at the lakebed on each sampling trip (Figure 4b). Such anoxic conditions were not observed in 2010; the difference likely being higher amount of algae/cyanobacteria in 2011 which consume oxygen when they decompose. Dissolved oxygen at the surface measured a maximum of 11.45 mg/L on July 18th during an algae/cyanobacteria bloom and a minimum of 6.34 mg/L on September 13th after the collapse of the algae/cyanobacteria bloom.

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 at Wizard Lake in 2011 was 75.6 µg/L which falls into the eutrophic, or highly productive, classification (Figure 6). The 2011 average is the highest measured in recent years, and is 24.1 µg/L higher than the previous recorded maximum of 51.5 µg/L in 2009. High amounts of runoff likely contributed to greater amounts of nutrients entering the lake. In addition, anoxic conditions on the lakebed may have promoted increased amounts of phosphorous being released from the sediments.

Similarly, average Total Kjeldahl Nitrogen (TKN) was the highest measured in recent years at 1574 µg/L. This value falls into the hypereutrophic, or extremely productive, classification. TKN remained relatively stable throughout the summer, measuring a minimum of 1350 µg/L on June 27th and a maximum of 1.68 µg/L on July 18th.

Average chlorophyll-*a* was also the highest measured in recent years at 39.2 µg/L. Chlorophyll-*a* concentration changed greatly between June and July, measuring 21.6 and 62.1 µg/L respectively. High levels of chlorophyll-*a* are likely a result of hot summer temperatures and high nutrient levels. Such high levels of cyanobacteria resulted in a Blue-Green Algae Advisory posted by Alberta Health Services on July 28th (Figure 5).



Figure 5 – Surface bloom of cyanobacteria at Wizard Lake during the summer of 2011.

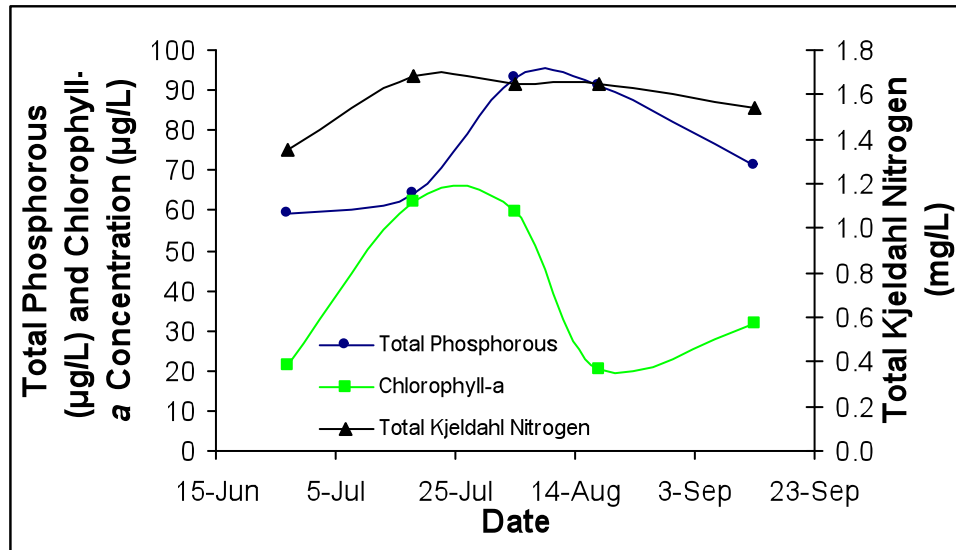


Figure 6 – Total phosphorous (ug/L), total Kjeldahl nitrogen (mg/L), and chlorophyll-*a* (ug/L) measured at Wizard Lake during the summer of 2011.

Average pH measured during 2011 was 8.45, which is well above neutral (Table 1). pH has changed very little compared to historical measurements, and is likely due to the high alkalinity (170 mg/L CaCO₃) and high bicarbonate (199.8 mg/L HCO₃) 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 µS/cm).

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

Parameter	2006	2008	2009	2010	2011
TP (µg/L)	48.4	50.2	51.5	47.5	75.6
TDP (µg/L)	13.6	12.4	18	19.5	14.2
Chlorophyll- <i>a</i> (µg/L)	32.6	23.9	26.8	17.1	39.2
Secchi depth (m)	1.33	1.43	1.81	2.71	1.15
TKN (µg/L)	1300	1216	1263	1255	1574
NO ₂ and NO ₃ (µg/L)	0.007	<0.005	0.046	0.0195	0.0025
NH ₃ (µg/L)	31.4	20.6	29	81	19.4
DOC (mg/L)	/	/	/	12.2	14.5
Ca (mg/L)	25	27.9	27.8	24.45	27.5
Mg (mg/L)	8.5	8.9	9.73	9.09	9.25
Na (mg/L)	36	34.9	37.5	38	32.3
K (mg/L)	6	5.8	6	6.15	5.83
SO ₄ ²⁻ (mg/L)	3.5	4.5	5	4.25	3
Cl ⁻ (mg/L)	4.7	4.5	4.9	5.65	5
CO ₃ (mg/L)	6	10	5.5	/	3.6
HCO ₃ (mg/L)	202	206.3	207.3	215.5	199.8
pH	8.3	8.3	8.44	8.29	8.45
Conductivity (µS/cm)	335	337.3	341.3	346	337.2
Hardness (mg/L)	97	106	109.4	96	106.9
TDS (mg/L)	186	191	196	193	185
Microcystin (µg/L)	/	/	/	0.091	0.25
Total Alkalinity (mg/L CaCO ₃)	172	175	176	176.5	170

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.

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

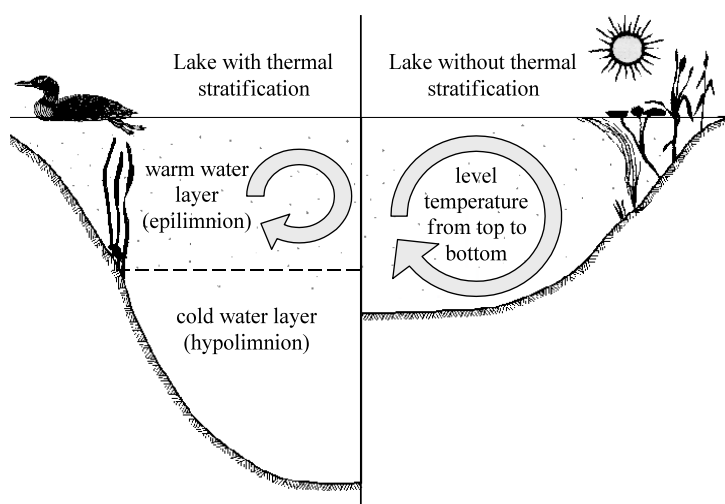


Figure A: Difference in the circulation of the water column depending on thermal stratification.

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⁻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.

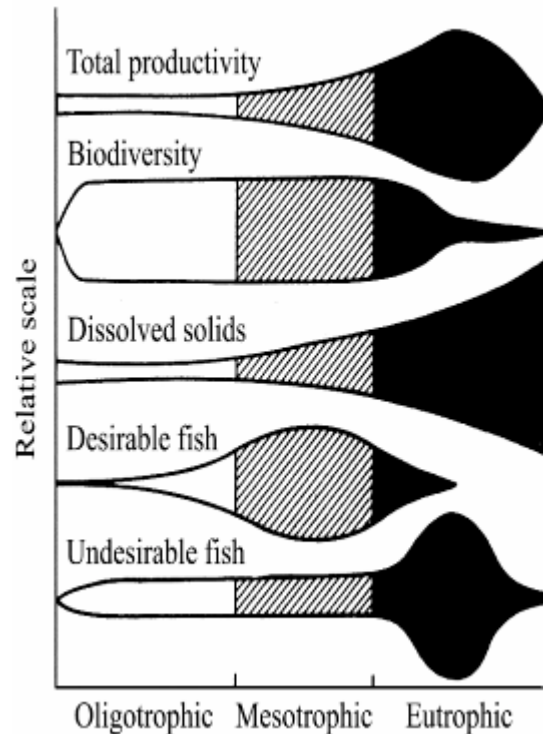


Figure B: Suggested changes in various lake characteristics with eutrophication. From “Ecological Effects of Wastewater”, 1980.

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