Lakewatch

THE ALBERTA LAKE MANAGEMENT SOCIETY
VOLUNTEER LAKE MONITORING PROGRAM

2010 Wizard Lake Report

COMPLETED WITH SUPPORT FROM:

Government of Alberta

Alberta Lake Management Society's Lakewatch Program

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

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

Acknowledgements

The Lakewatch program is made possible through the dedication of its volunteers and Lakewatch Chairs, Al Sosiak and Ron Zurawell. We would like to thank Larry McPherson for his efforts in collecting data in 2010. We would also like to thank Bradley Peter and Emily Port who were summer interns with ALMS in 2010. Project Technical Coordinator Jill Anderson was instrumental in planning and organizing the field program. Technologists Shelley Manchur, Mike Bilyk, Brian Jackson, and John Willis were involved in the training aspects of the program. Doreen LeClair and Chris Rickard were responsible for data management. Jill Anderson (Program Manager) was responsible for program administration and planning. Théo Charette, Ron Zurawell (Limnologist, AENV), Lori Neufeld, and Sarah Lord prepared the original report, which was updated for 2010 by Bradley Peter. Alberta Environment, the Beaver River Watershed Alliance (BRWA), and the Municipal District of Wainwright were major sponsors of the Lakewatch program.

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 - Wizard Lake: Jubilee Park

The First Nations name for the lake was Lizard Lake, and until the late 1960's the popular name for the lake was Conjuring Lake. 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 shore, and a subdivision.

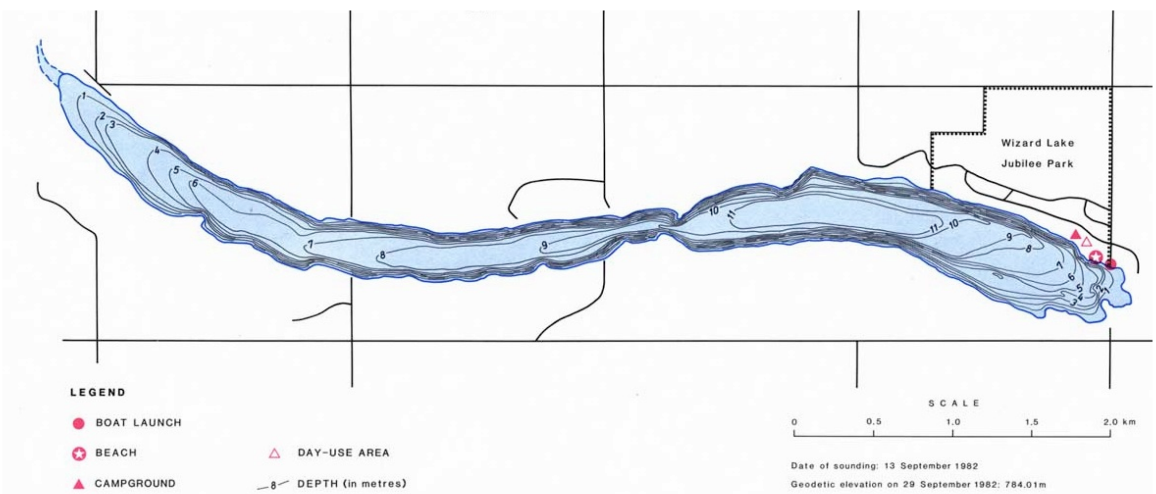

Figure 2 – Bathymetry of Wizard Lake showing contour intervals in meters.

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

Yellow perch and northern pike are the most commonly fished species in the lake. Wizard Lake occupies an area of 2.48 km^2, 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:

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.

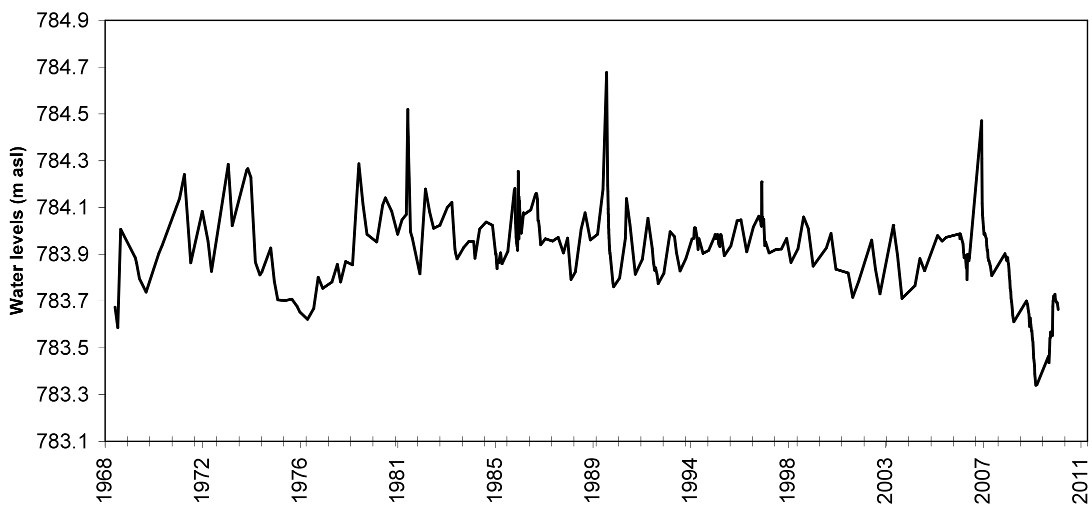

Figure 3 – Historical water levels for Wizard Lake given in meters above sea level. Data retrieved from Alberta Environment.

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.

In 2010, the average secchi disc depth for Wizard Lake was 2.71 meters (Table 1). This is much less turbid than the 2009 (1.84 m), 2008 (1.43 m), and 2006 (1.33 m) secchi depth averages measured by ALMS. The seasonal maximum secchi disc depth for 2010 was 4.1 m on May 25th, which was well before temperatures became high enough to promote large algal blooms. Secchi disc depth decreased in July to 2.75 m and further decreased to a seasonal minimum of 1.5 m in early August. A decrease in secchi disc depth is common throughout the summer as temperatures allow for large algal blooms which significantly decrease water clarity.

WATER TEMPERATURE AND DISSOLVED OXYGEN:

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

In May, water temperature in Wizard Lake was 11.05 °C at the surface and 10.10 °C at the lakebed, showing no thermal stratification (Figure 3a). By July, temperatures had increased to 18.06 °C at the surface and decreased to 12.11 °C at the lakebed, with thermal stratification having developed between 7.0-9.0 m. In August, surface water temperatures had reached a seasonal maximum of 21.36 °C and decreased to 14.81 °C at the lakebed. Thermal stratification was observed between 6.0 m and 7.0 m. Finally, in September, surface temperatures had decreased to those seen in May, measuring 11.93 °C at the surface and 11.15 °C at the lakebed. No thermal stratification was observed in September, as the lake had 'turned-over' or become mixed.

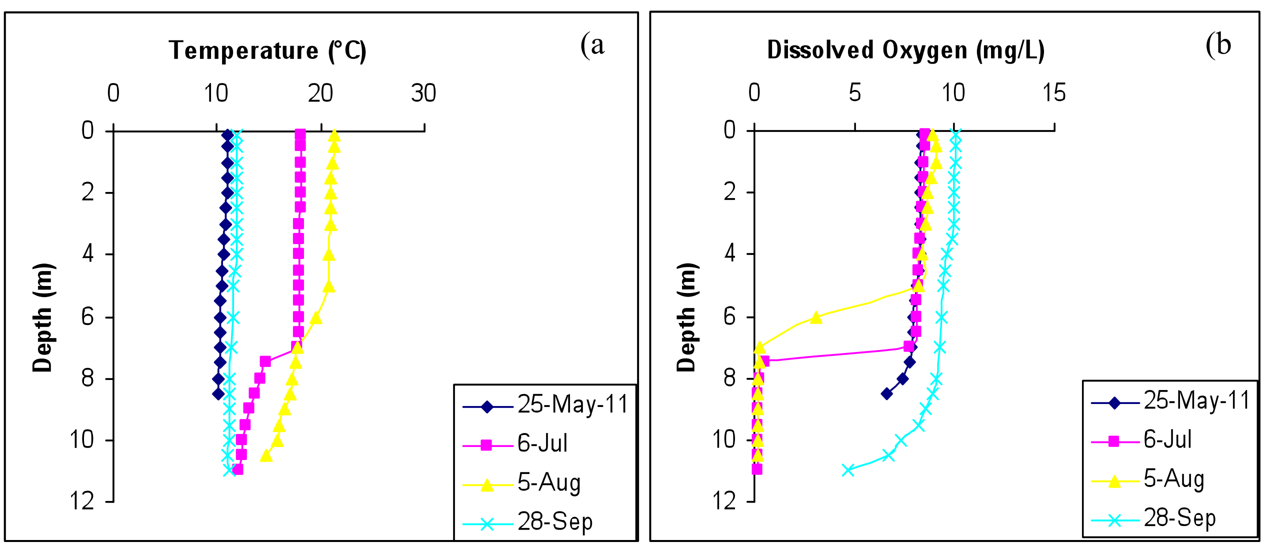

Figure 4 – Profiles of a) temperature (°C) and b) dissolved oxygen (mg/L) measured four times over the course of the summer at Wizard Lake.

In May, dissolved oxygen at the surface of the lake was 8.38 mg/L, decreasing steadily to 6.64 mg/L at the lakebed (Figure 3b). In July, dissolved oxygen at the surface measured

8.57 mg/L though decreased much further than in May to 0.16 mg/L at the lakebed. Anoxia was observed below 7.5 meters, likely due to the decomposition of algae by oxygen-consuming decomposers on the lakebed. Results were similar in August, with surface dissolved oxygen measuring 8.93 mg/L and anoxia being observed below 7.0 meters. In September, dissolved oxygen became more uniform throughout the water column due to the lack of stratification, as dissolved oxygen was 10.05 mg/L at the surface and 4.69 mg/L at the lakebed.

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.

Based on average total phosphorous measured in 2010 (47.5 μg/L), Wizard Lake is considered eutrophic, and has been considered eutrophic since ALMS began measuring the lake in 2006. The 2010 total phosphorous average is lower than that seen in 2009, 2008, and 2006 (Table 1; Figure 6). Total phosphorous in Wizard Lake was at a minimum in May of 32 μg/L, and increased steadily to a maximum of 62 μg/L in September. Total nitrogen in Wizard Lake also increased over the summer from a minimum of 1.18 mg/L in July to a maximum of 1.35 mg/L in September, resulting in an average total nitrogen concentration of 1.255 mg/L. Finally, average chlorophyll-*a* concentration in 2010 was 17.10 mg/L, lower than the 2009, 2008, and 2006 values. Chlorophyll-*a* concentration was at a minimum in May of 4.86 μg/L and a maximum in September of 30.5 μg/L. Due to a mild summer in 2010, smaller-than-normal algal blooms were noticed at many lakes across the province.

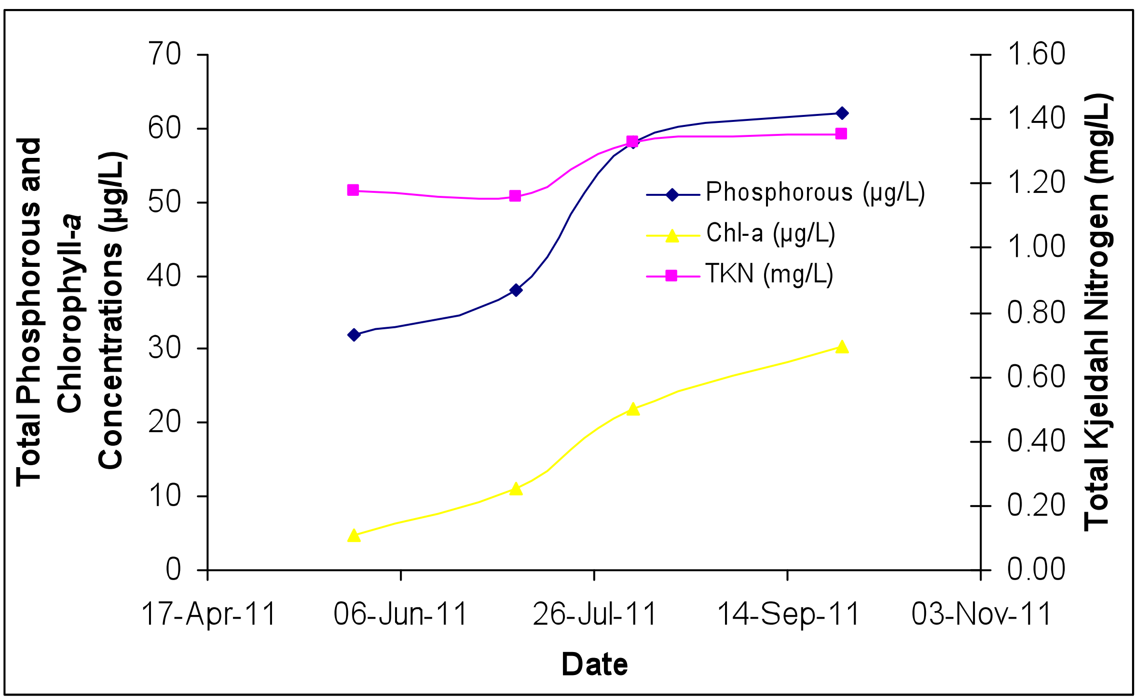

Figure 4 – Total average phosphorous (μg/L), total Kjeldahl nitrogen (mg/L), and chlorophyll-*a* (μg/L) concentration measured four times over the course of the summer at Wizard Lake.

The pH in Wizard Lake has changed very little since ALMS has been taking measurements. In 2010, average pH in Wizard Lake was 8.29. The high alkalinity in Wizard Lake (176.5 mg/L) helps to buffer the lake against changes in pH. Sodium, magnesium, calcium, and bicarbonate all remained dominant ions in 2010

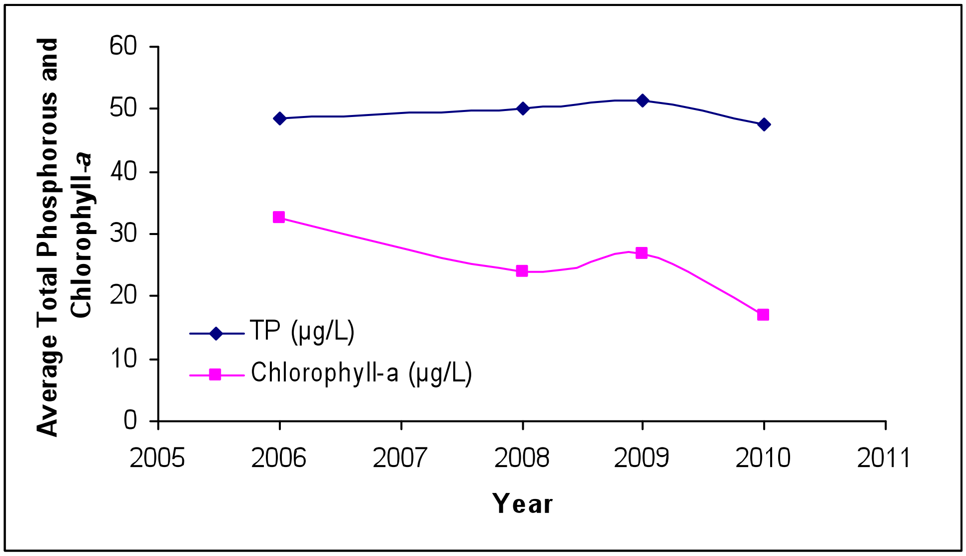

Figure 5 – Average total phosphorous (µg/L) and average chlorophyll-*a* (µg/L) concentration for 2006, 2008, 2009, and 2010 at Wizard Lake.

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Table 1 – Average secchi depth and water chemistry values for Wizard Lake measured in the Lakewatch program for 2006, 2008-2010.

Parameter	**2006**	**2008**	**2009**	**2010**
TP (μg/L)	48.4	50.2	51.5	47.5
TDP (μg/L)	13.6	12.4	18	19.5
Chlorophyll-*a* (μg/L)	32.6	23.9	26.8	17.1
Secchi depth (m)	1.33	1.43	1.81	2.71
TKN (μg/L)	1300	1216	1263	1255
NO_2 and NO_3 (μg/L)	0.007	<0.005	0.046	0.0195
NH_3 (μg/L)	31.4	20.6	29	81
DOC (mg/L)	/	/	/	12.2
Ca (mg/L)	25	27.9	27.8	24.45
Mg (mg/L)	8.5	8.9	9.73	9.09
Na (mg/L)	36	34.9	37.5	38
K (mg/L)	6	5.8	6	6.15
SO_4^{2-} (mg/L)	3.5	4.5	5	4.25
Cl^- (mg/L)	4.7	4.5	4.9	5.65
CO_3 (mg/L)	6	10	5.5	/
HCO_3 (mg/L)	202	206.3	207.3	215.5
pH	8.3	8.3	8.44	8.29
Conductivity (μS/cm)	335	337.3	341.3	346
Hardness (mg/L)	97	106	109.4	96
Microcystin (μg/L)	0.13	0.13	0.16	0.091
TDS (mg/L)	186	191	196	193
Total Alkalinity (mg/L $CaCO_3$)	172	175	176	176.5

Note: TP = total phosphorous, TDP = total dissolved phosphorous, 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.

References

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

Nürnberg, G.K. 1996. Trophic state of clear and colored, soft and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish. Lake and Reservoir Management 12(4):432-447.

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:

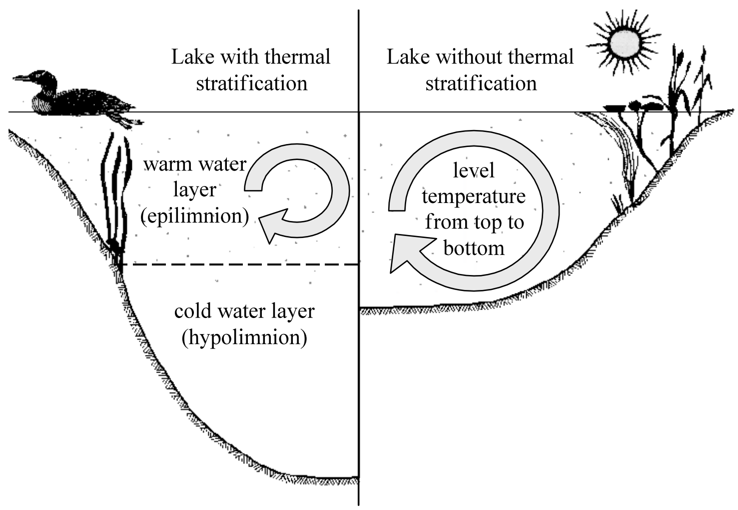

Figure A: Difference in the circulation of the water column depending on thermal stratification.

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.

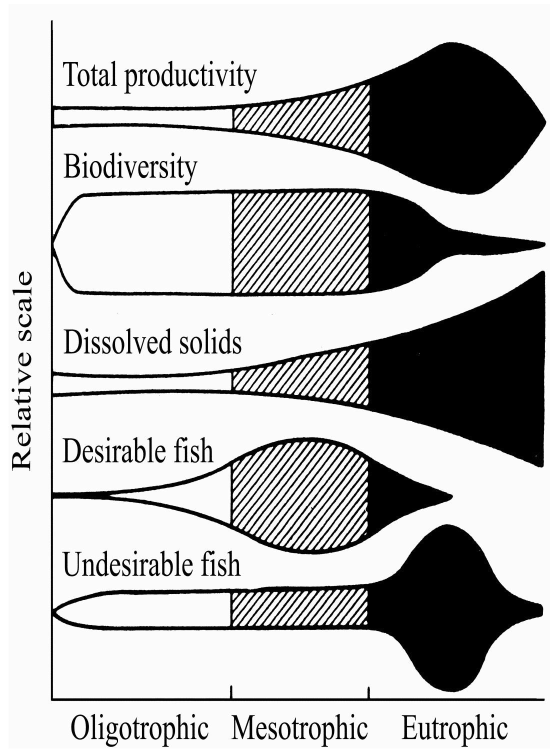

Figure B: Suggested changes in various lake characteristics with eutrophication. From "Ecological Effects of Wastewater", 1980.

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

Note: These values are from a detailed study of global lakes reported in Nurnberg 1996. Alberta Environment uses slightly different values for TP and CHL based on those of the OECD reported by Vollenweider (1982). The AENV and OECD cutoffs for TP are 10, 35 and 100; for CHL are 3, 8 and 25. AENV does not have TN or Secchi depth criteria. The corresponding OECD exists for Secchi depth and the cutoffs are 6, 3 and 1.5 m.