



*THE ALBERTA LAKE MANAGEMENT SOCIETY
VOLUNTEER LAKE MONITORING PROGRAM*

2012 Dechaine 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

The LakeWatch program is made possible through the dedication of its volunteers. We would like to thank Colin Gosselin for his assistance with sampling Dechaine Lake in 2012. We would also like to thank Randi Newton and Erin Rodger who were summer technicians with ALMS in 2012. Program Coordinator Bradley Peter was instrumental in planning and organizing the field program. Technologists Trina Ball and Brian Jackson were involved in the training aspects of the program. Lisa Reinbolt was responsible for data management. This report was prepared by Bradley Peter and Arin Dyer. Alberta Environment and the Beaver River Watershed Alliance (BRWA) were major sponsors of the program.

DECHAIINE LAKE:

Dechaine Lake is a small (~1.0 km²), shallow (max depth: ~1.2 m) lake located 4 km northwest of the summer village of Sandy Beach in Lac St. Anne County. Lying in the dry mixedwood natural region of the Sturgeon River Watershed, Dechaine Lake's watershed is primarily developed for agriculture in the form of forage and rangeland.¹ Dechaine Lake has an irregular shoreline (~6.5 km) and a dense littoral zone. The

large amounts of aquatic and semi-aquatic plants make Dechaine Lake an important habitat for birds year round, but especially during migration (pers. comm.).



Figure 1 – Photo of Dechaine Lake by Erin Rodger, 2012.

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.

Currently no long term water quantity data exists for Dechaine Lake.

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 0.62 m during 2012 – this value falls into the hypereutrophic, or extremely productive, classification (Table 1). Throughout the summer, Secchi disk depth fluctuated between a maximum of 1.10 m on June 23rd and a minimum of 0.25 m on September 23rd. It is typical for Secchi disk depth to decrease

¹ City of St. Albert. 2012. Sturgeon River State of the Watershed Report: Technical Report.

throughout the summer as increased temperatures and nutrient concentrations promote algae/cyanobacteria blooms which 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.

Surface water temperature ranged between a minimum of 17.43 °C on September 23rd to a maximum of 25.60 °C on July 22nd (Figure 2a). Despite its shallow depth, water temperature changed quickly from the surface to sediments – on every trip, with the exception of August 11th, water temperature changed more than a degree from the top to the bottom of the water column. Strong

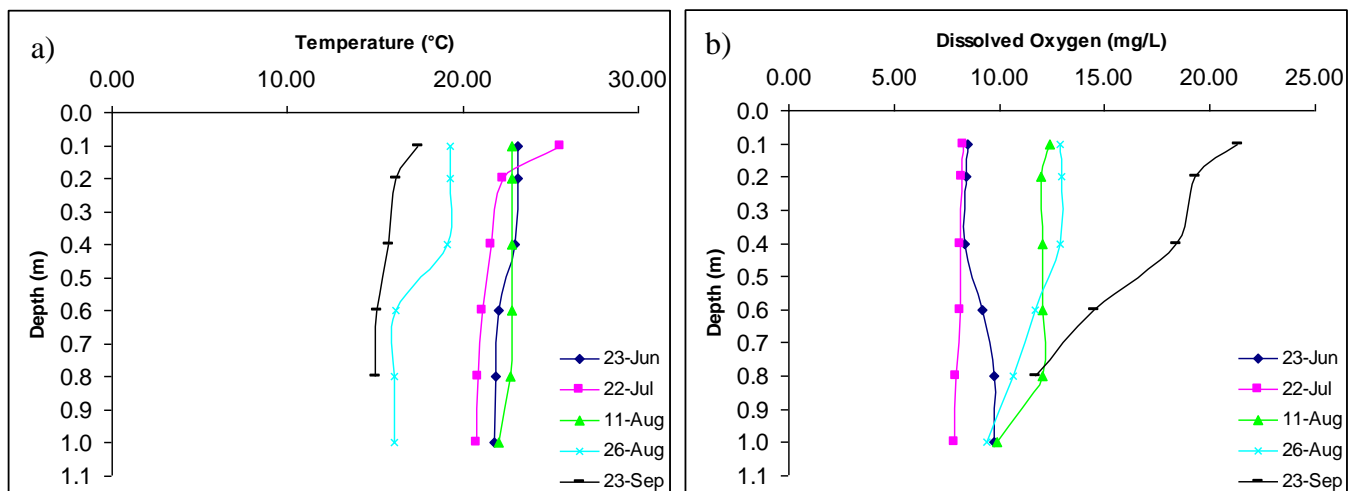


Figure 2 – a) Temperature (°C) and b) dissolved oxygen (mg/L) concentration measured five times over the course of the summer at Dechaine Lake.

Dissolved oxygen concentrations fluctuated greatly throughout the summer of 2012 – despite these fluctuations, concentrations remained well above the Canadian Council for Ministers of the Environment guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 2b). Dissolved oxygen concentrations were highly elevated on September 23rd, measuring 21.31 mg/L at the surface and 11.69 mg/L at the lakebed; photosynthesis by a large algae/cyanobacteria bloom at the time no doubt caused this spike in dissolved oxygen concentrations. High densities of macrophytes in Dechaine Lake may also help raise dissolved oxygen concentrations in Dechaine Lake.

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) concentration measured 478 µg/L in 2012 – this is a very high TP value, and falls into the hypereutrophic classification (Table 1). Throughout the summer TP ranged from a minimum of 353 µg/L on June 23rd to a maximum of 574 µg/L on July 22nd (Figure 3). Large populations of water fowl in the lake may contribute to increased phosphorus concentrations as the lake is small and has little capacity for dilution - phosphorus is the primary nutrient responsible for driving algae/cyanobacterial blooms.²

Average chlorophyll-*a* concentration at Dechaine Lake measured 80.38 µg/L in 2012 – this value falls into the hypereutrophic classification (Table 1). Chlorophyll-*a* concentration increased throughout the summer, measuring 23.9 µg/L on June 23rd and 200 µg/L on September 23rd (Figure 3). The large bloom in September may be related to a redistribution of nutrients due to mixing of the water column or to an increase in the number of waterfowl visiting the lake. Observations by the LakeWatch technician suggested green, filamentous algae was present early in the summer, and cyanobacteria, potentially *Aphanizomenon sp.*, made up the bulk of the phytoplankton population later in the summer.

Concentrations of total Kjeldahl nitrogen (TKN) were high throughout the summer at Dechaine Lake. Average TKN measured 4420 µg/L, with a minimum concentration of 2920 µg/L observed on June 23rd and a maximum concentration of 6590 µg/L observed on September 23rd.

² Fleming, R. and Fraser, H. 2001. The Impact of Waterfowl on Water Quality – Literature Review. University of Guelph.

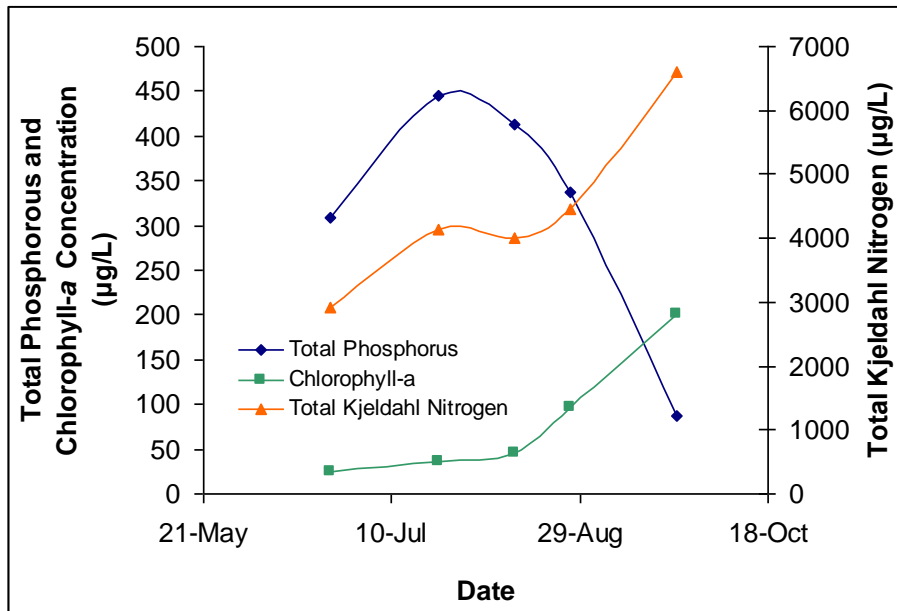


Figure 3 – Total phosphorus, chlorophyll-*a*, and total Kjeldahl nitrogen concentrations ($\mu\text{g/L}$) measured five times over the course of the summer at Dechaine Lake.

Average pH measured 9.302 during 2012 – well above neutral (7.00; Table 1). The Canadian Council for Ministers of the Environment recommended a pH of 6.5 to 9 for the Protection of Aquatic Life, though most surface waters in Alberta have pH between 6.5 and 10. Moderately high bicarbonate concentration (125 mg/L) and alkalinity (129.4 mg/L) likely help to buffer the lake against changes to pH. Conductivity in Dechaine Lake is relatively low, with sodium (37.3 mg/L) and bicarbonate as the dominant ions contributing to conductance. Microcystin, a toxin produced by cyanobacteria, had an average concentration of 0.806 $\mu\text{g/L}$. This value is well below the recreational water quality guidelines of 20 $\mu\text{g/L}$, and only just below the World Health Organizations drinking water quality guidelines of 1.0 $\mu\text{g/L}$. Throughout the summer, this concentration ranged from a minimum of 0.43 $\mu\text{g/L}$ on June 23rd to a maximum of 1.86 $\mu\text{g/L}$ on August 26th.

Metals concentrations were monitored twice throughout the summer, and all concentrations with the exception of iron fell within their respective guidelines. Because Dechaine Lake is so shallow, it is possible that sediment suspended in the water column caused an increase in the concentration of iron in our samples (Table 2).

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

Parameter	2012
TP (µg/L)	478
TDP (µg/L)	318.4
Chlorophyll- <i>a</i> (µg/L)	80.38
Secchi depth (m)	0.62
TKN (µg/L)	4420
NO ₂ and NO ₃ (µg/L)	5.6
NH ₃ (µg/L)	42
DOC (mg/L)	39.6
Ca (mg/L)	12.4
Mg (mg/L)	3.67
Na (mg/L)	37.3
K (mg/L)	11.9
SO ₄ ²⁻ (mg/L)	5.7
Cl ⁻ (mg/L)	5.43
CO ₃ (mg/L)	16
HCO ₃ (mg/L)	125
pH	9.302
Conductivity (µS/cm)	271.6
Hardness (mg/L)	156
TDS (mg/L)	46
TSS	12.7
Microcystin (µg/L)	0.806
Total Alkalinity (mg/L CaCO ₃)	129.4

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

Table 2 - Concentrations of metals measured in Dechaine Lake on August 8th and September 25th 2012. Values shown for 2012 are an average of those dates. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	2012	Guidelines
Aluminum µg/L	27	100 ^a
Antimony µg/L	0.08165	6 ^e
Arsenic µg/L	1.085	5
Barium µg/L	37.7	1000 ^e
Beryllium µg/L	0.01655	100 ^{d,f}
Bismuth µg/L	0.0005	/
Boron µg/L	49.35	5000 ^{ef}
Cadmium µg/L	0.0023	0.085 ^b
Chromium µg/L	0.144	/
Cobalt µg/L	0.0723	1000 ^f
Copper µg/L	0.326	4 ^c
Iron µg/L	386	300
Lead µg/L	0.0716	7 ^c
Lithium µg/L	12.8	2500 ^g
Manganese µg/L	69.5	200 ^g
Molybdenum µg/L	0.2345	73 ^d
Nickel µg/L	0.26	150 ^c
Selenium µg/L	0.076	1
Silver µg/L	0.00025	0.1
Strontium µg/L	83.65	/
Thallium µg/L	0.000225	0.8
Thorium µg/L	0.00015	/
Tin µg/L	0.0352	/
Titanium µg/L	1.67	/
Uranium µg/L	0.147	100 ^e
Vanadium µg/L	0.679	100 ^{f,g}
Zinc µg/L	0.4925	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 CaCO₃)

^c Based on water hardness > 180mg/L (as CaCO₃)

^d CCME interim value.

^e Based on Canadian Drinking Water Quality guideline values.

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

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

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

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

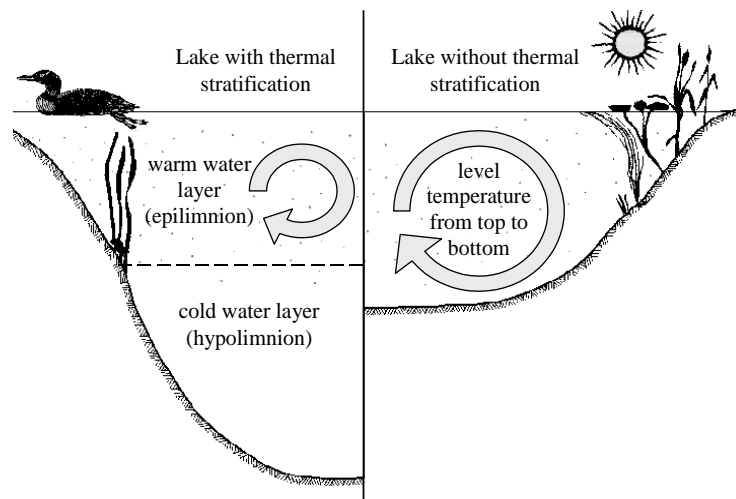


Figure A: Difference in the circulation of the water column depending on thermal stratification.

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•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.

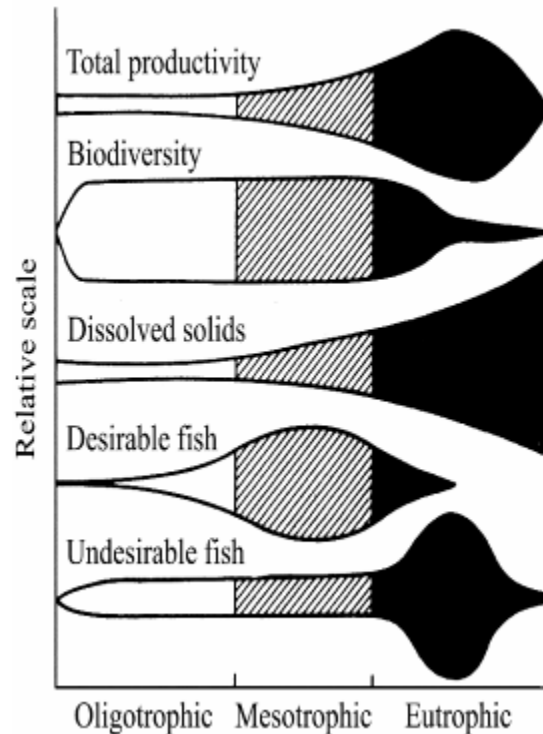


Figure B: Suggested changes in various lake characteristics with eutrophication. From “Ecological Effects of Wastewater”, 1980.

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