Water Quality Objectives Attainment
2024 Shuswap Lake – Sandy Point

Purpose

This report summarizes water quality at Sandy Point located within the Salmon Arm of Shuswap Lake. Water samples collected between April and August 2024 were compared to applicable Water Quality Objectives to determine whether the objectives were met.

Introduction

Shuswap Lake, located in the Southern Interior of British Columbia within Secwepemc territory, is an important waterbody that provides critical fish habitat, serves as a key drinking water source, and supports a thriving recreation and tourism industry. In recognition of the significance of this waterbody, provincial Water Quality Objectives (WQOs) were developed in collaboration with the Pespesellkwe te Secwepemc to protect the most sensitive uses and values of Shuswap Lake (Province of British Columbia and Pespesellkwe te Secwepemc, 2022).

The Shuswap watershed spans 17,478 km^2 within the South Thompson River Basin, which is part of the Fraser River Basin. Shuswap Lake has a surface area of 310 km^2, an elevation of approximately 350 m, and spans several biogeoclimatic zones. The watershed consists of agricultural, residential, and urban areas. Major tributaries to Shuswap Lake are the Salmon and Shuswap Rivers to the south, and the Eagle River to the east. Lake levels naturally fluctuate up to 4 m throughout the year (City of Salmon Arm, 2024). Following a hydraulic residence time[1] of approximately 2-4 years, Shuswap Lake flows into Little Shuswap Lake before becoming the South Thompson River near the Village of Chase.

Shuswap Lake has an atypical “H” shape, with ecologically distinct arms, including the Main Arm, Seymour Arm, Anstey Arm, and Salmon Arm. The Salmon Arm is a shallow, nutrient-rich part of the lake near the outlet of the Salmon River. In recent years, algal blooms in the Salmon Arm Bay have emphasized the need for focused water quality monitoring at this location. The increased frequency

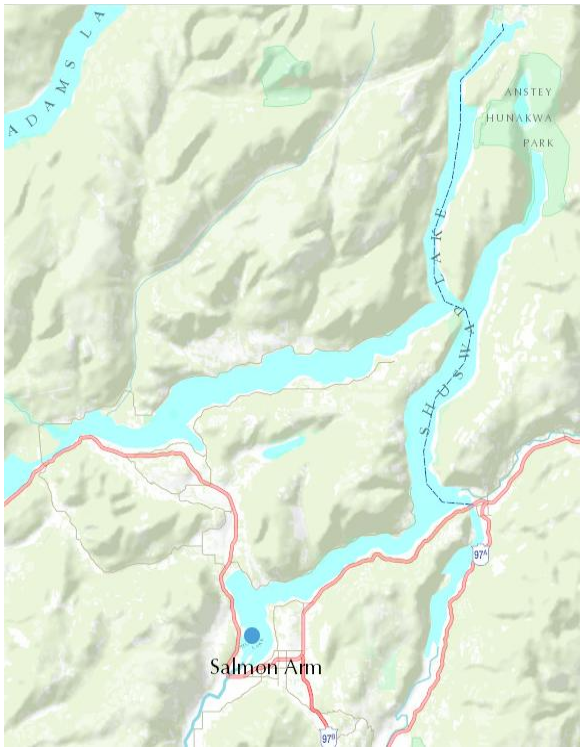

Figure 1. *Water quality monitoring location of Sandy Point (EMS ID 206771; blue dot) in the Salmon Arm Bay of Shuswap Lake, B.C.*

of algal blooms and elevated nutrient concentrations within the Salmon Arm were key drivers for setting the water quality objectives. Meeting WQOs suggests that the uses and values of a waterbody are at low risk of adverse effects with respect to a given parameter.

Water Quality Monitoring Program

The Ministry of Environment and Parks (ENV) conducted water quality monitoring from April to August 2024 within the Salmon Arm at Sandy Point (EMS ID 206771; Figure 1). The intent was to assess attainment of WQOs, understand current conditions, and evaluate seasonal dynamics. Sampling frequency was guided by the recommended monitoring program in the WQOs, which included collecting five samples over 30 days during the spring mixing period (overturn[2]), followed by monthly samples

[1] **Hydraulic residence time** – the average time water remains in a lake before flowing out

[2] **Overturn** – a seasonal event that occurs in the spring when surface water and deeper water equalize in

throughout the growing season (i.e., May to October) when the lake is thermally stratified[3] (Province of British Columbia and Pespesellkwe te Secwepemc, 2022).

Water samples were analyzed in a laboratory for the following parameters:

- **Chlorophyll *a*:** an indicator of algal growth;
- **Nutrients**: ammonia, nitrate, nitrite, total nitrogen, total Kjeldahl nitrogen, dissolved nitrogen, orthophosphate, total phosphorus, and dissolved phosphorus;
- ***Escherichia coli (E. coli)***: a microbiological indicator;
- **Chemical properties:** pH, alkalinity, hardness, total organic carbon, and dissolved organic carbon; and,
- **Physical properties:** true colour, conductivity, total suspended solids, turbidity.

Field measurements were recorded at multiple depths to create a profile of the water column at the sampling site and to provide context for interpretation of the results. Measurements were recorded for:

- Temperature;
- pH;
- Dissolved oxygen;
- Conductivity; and,
- Chlorophyll *a.*

Secchi disk depths were measured during each sampling event to visually assess water transparency.

Of note, the following environmental factors may have influenced the 2024 water quality results:

- High boat traffic around Sandy Point in July and August potentially causing mixing;
- A total solar eclipse on April 8, 2024, which temporarily altered sunlight conditions and may have influenced Secchi depth and chlorophyll *a* readings.

Sampling was not conducted in September or October 2024 as low lake levels impacted boat access.

Water Quality Objective Attainment

The following table is a summary of the evaluation of the 2024 results against WQOs (see table on next page). The 2023 results are included for comparison.

The results of the WQOs attainment monitoring are discussed further below.

Dissolved Oxygen (DO)

Dissolved oxygen (DO) refers to the oxygen in water that is available to aquatic organisms. DO concentrations influence fish species distribution and can alter nutrient availability at low levels.

During the growing season, lakes tend to thermally stratify into distinct layers. The surface layer, or epilimnion, typically has the highest DO concentrations, as oxygen is transferred to the water directly from the air and through wave action. Mixing does not generally occur below the mid-layer, or thermocline. The deeper layer, called the hypolimnion, is isolated from the air and does not readily mix with the more oxygenated epilimnion, generating lower DO conditions. DO concentrations are often lowest near the lake bottom, where decomposition occurs. In 2024, DO concentrations at Sandy Point followed this general profile. All DO concentrations in 2024 were above the WQO (instantaneous minimum ≥ 5 mg/L; Appendix 1, Figure 1).

Secchi Depth (Water Transparency)

Water transparency influences the depth that light can penetrate the water column, also known as the photic zone, which limits aquatic plant and algal growth. In lakes, water transparency is typically measured with a Secchi disk and provides an indication of lake productivity. Generally, lakes with high productivity tend to have low water transparency (i.e., lower Secchi depths) and lakes with low productivity tend to have high water transparency (i.e., higher Secchi depths).

temperature allowing for mixing, which cycles oxygen and nutrients throughout the water column.

[3] **Thermal stratification** – occurs when the water in a lake forms distinct layers due to temperature and density differences. The stratified layers include the epilimnion, thermocline, and hypolimnion.

Table 1. *Comparison of 2024 and 2023 water quality monitoring results from Sandy Point (EMS ID 206771) with Shuswap Lake WQOs; results are highlighted where WQOs were not met.*

Parameter	Shuswap Lake WQO, Sandy Point	2024 Result	2023 Result
Dissolved oxygen (mg/L)[1]	≥ 5	6.63	1.07[a]
Secchi depth (m)[2]	≥ 6	3.74	2.41[b]
Total phosphorus (µg/L)[3]	15	20.5	31.1
Total nitrogen (µg/L)[3]	300	206.9	262.9
Nitrogen: Phosphorus[4]	≥ 20:1	12.6:1	8.45:1
Chlorophyll *a* (µg/L)[5]	7	3.34	1.07
Total Organic Carbon[6]	4	3.16	No data collected in 2023
E. coli (CFU/100 mL)	Primary contact recreation; ≤ 200 (geometric mean[7]) or ≤ 400 (single-sample-maximum)	<1	No data collected in 2023
	Drinking water source: ≤ 10 (90th percentile)		

[1] Instantaneous minimum at any depth.
[2] Annual mean from quarterly measurements.
[3] Average of 5 weekly samples collected over 30 days at 3 depths throughout the water column (surface, mid-depth, and 1 m above the bottom) during spring overturn.
[4] Calculated using average total nitrogen and total phosphorus concentrations at spring overturn.
[5] Calculated from monthly surface water samples collected from May to October.
[6] Maximum from samples collected in the vicinity of intakes with chlorinated drinking water treatment.
[7] Geometric means are calculated from at least 5 weekly samples collected in a 30-day period.
[a] All DO concentrations in 2023 were above the WQO except for June 5 when DO was 4.38-1.07 mg/L between 19-30 m.
[b] In 2024, mean depth was not recorded during the fall or winter (only spring and summer). In 2023, mean depth was not recorded during the winter (only spring, summer, and fall).

Water transparency is typically lowest in the Salmon Arm compared to other arms of Shuswap Lake. The mean Secchi depth of 3.74 m did not meet the WQO (≥ 6 m; Appendix 1, Figure 2). In 2024, Secchi depths were likely influenced by algal growth and suspended sediment.

Total Phosphorus

Phosphorus is an essential nutrient for algal growth. Shuswap Lake has previously been identified as phosphorus-limited and as a result, even minor increases in phosphorus can trigger algal blooms, which in turn can lead to oxygen depletion and water quality impacts (ENV, 2022).

Elevated phosphorus is well-documented in the Salmon Arm and was a driving factor in developing the WQOs. High phosphorus levels are associated with agricultural runoff throughout the Salmon River valley. In 2024, the mean total phosphorus concentration at spring overturn was 20.5 µg/L, which did not meet the WQO (15 µg/L; Appendix 1, Figure 3).

Total Nitrogen

Another key nutrient required by algae is nitrogen. Similar to phosphorus, the Salmon Arm typically has the highest nitrogen concentrations in Shuswap Lake. Sources of nitrogen include atmospheric exchange as well as agricultural and urban runoff.

While phosphorus is often the limiting nutrient for algal growth in Shuswap Lake, excess nitrogen can also impact water quality and contribute to algal blooms. At high concentrations, some types of nitrogen can be harmful to aquatic life. In 2024, the mean total nitrogen concentration at spring overturn was 206.9 µg/L, which was below the WQO (300 µg/L; Appendix 1, Figure 4).

Nitrogen: Phosphorus (N:P) Ratio

The N:P ratio is an indicator of lake productivity and identifies whether a lake is phosphorus- or nitrogen-limited. For Shuswap Lake, N:P ratios tend to decrease with increasing eutrophication[4] (Province of British Columbia and Pespesellkwe te Secwepemc, 2022).

Additionally, the N:P ratio influences algal community composition, as each species thrives at a different N:P ratio. Thus, the N:P ratio is useful for understanding the conditions under which more harmful algal species might be present.

In 2024, the N:P ratio of 12.6:1 at overturn did not meet the WQO (≥ 20:1; Appendix 1, Figure 5). This is linked to high phosphorus concentrations and may contribute to a more productive system, potentially leading to more algal blooms.

Chlorophyll *a*

Chlorophyll *a* is a pigment used by algae and other plants during photosynthesis. In lakes, chlorophyll *a* is measured to determine algal biomass, with more algae present at higher chlorophyll *a* concentrations.

The monthly mean chlorophyll *a* concentration was 3.34 µg/L in 2024, which was below the WQO (≤ 7 µg/L; Appendix 1, Figure 6).

Total Organic Carbon (TOC)

Total organic carbon (TOC) represents the amount of organic content present in a sample. Sources of TOC include living material (e.g., phytoplankton and zooplankton) and organic waste. While TOC itself is not directly harmful to aquatic life or human health, high levels in raw drinking water can lead to the formation of carcinogenic by-products during chlorination (ENV, 2022). Although there are no drinking water intakes in the immediate vicinity of Sandy Point, the water intake for the City of Salmon Arm is located within the Salmon Arm. Therefore, meeting the TOC WQO at this site is important.

In 2024, all TOC concentrations met the WQO (instantaneous maximum ≤ 4 mg/L; Appendix 1, Figure 7).

Escherichia coli (E. coli)

E. coli is a species of bacteria that originates in the intestines of humans and other warm-blooded animals and is a subset of fecal coliform bacteria.

High levels of *E. coli* in waterbodies indicates fecal contamination, which may pose human health risks. WQOs for *E. coli* have been established to protect drinking water, as well as cultural and recreational uses in the Salmon Arm.

In 2024, most *E. coli* results were below the laboratory detection limit (< 1 CFU/100 mL). All

[4] **Eutrophication** – the process in which a waterbody becomes more biologically productive due to an increase in nutrient loading

results met the applicable WQOs (the most stringent WQO is ≤ 10 CFU/100 mL).

Comparison to the 2023 Water Quality Program

In 2023, the following parameters did not meet the WQOs: Secchi depth (2.41 m), total phosphorus (31.1 µg/L), and the N:P ratio (8.45:1). There was one sampling date when DO was below the instantaneous minimum WQO (4.38-1.07 mg/L between 19-30 m).

In 2024, with the exception of DO, WQOs were not met for the same parameters, including Secchi depth (3.74 m), total phosphorus (20.5 µg/L), and the N:P ratio (12.6:1). Comparison of the results indicated that the magnitude of each exceedance was lower in 2024 when compared to 2023. Given that the low lake levels in 2023 likely affected water quality, the 2024 results may be representative of more typical water quality conditions (City of Salmon Arm, 2025).

Summary and Conclusions

The Shuswap Lake WQOs were developed as a set of benchmarks to guide the protection of water quality for the most sensitive uses of Shuswap Lake. For the Salmon Arm, the following results did not meet the WQOs in 2024:

- **Secchi depth** – the mean seasonal depth of 3.74 m did not meet the WQO (≥ 6 m) for the seasons sampled.
- **Total phosphorus** – the mean concentration at spring overturn of 20.5 µg/L did not meet the WQO (15 µg/L).
- **Nitrogen: phosphorus ratio** – the ratio at spring overturn of 12.6:1 did not meet the WQO (≥ 20:1).

The results show that nutrient enrichment remains a concern in the Salmon Arm of Shuswap Lake. Continued monitoring at Sandy Point will contribute to understanding nutrient trends and informing watershed management.

References

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Nordin, R.N. 1985. Water quality criteria for nutrients and algae. B.C. Ministry of Environment, 1985. Victoria, B.C.. Online at: bc_env_nutrients_and_algae_waterqualityguidelines_technical.pdf (gov.bc.ca)

Province of British Columbia and Pespesellkwe te Secwepemc. 2022. Water Quality Objectives for Shuswap Lake. Water Quality Objective Series, WQO-06. Prov. B.C., Victoria B.C.

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Appendix 1

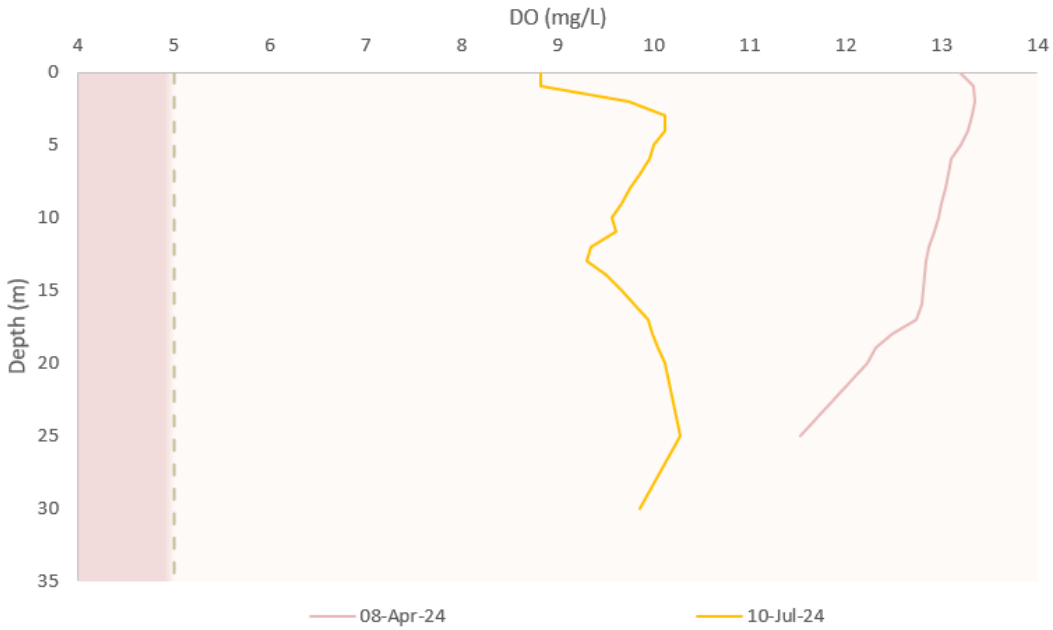

Figure 1. *DO profiles representing typical mixed spring (April) and stratified summer (July) periods. The orange shaded area represents values outside of the 5 mg/L WQO (vertical dashed line).*

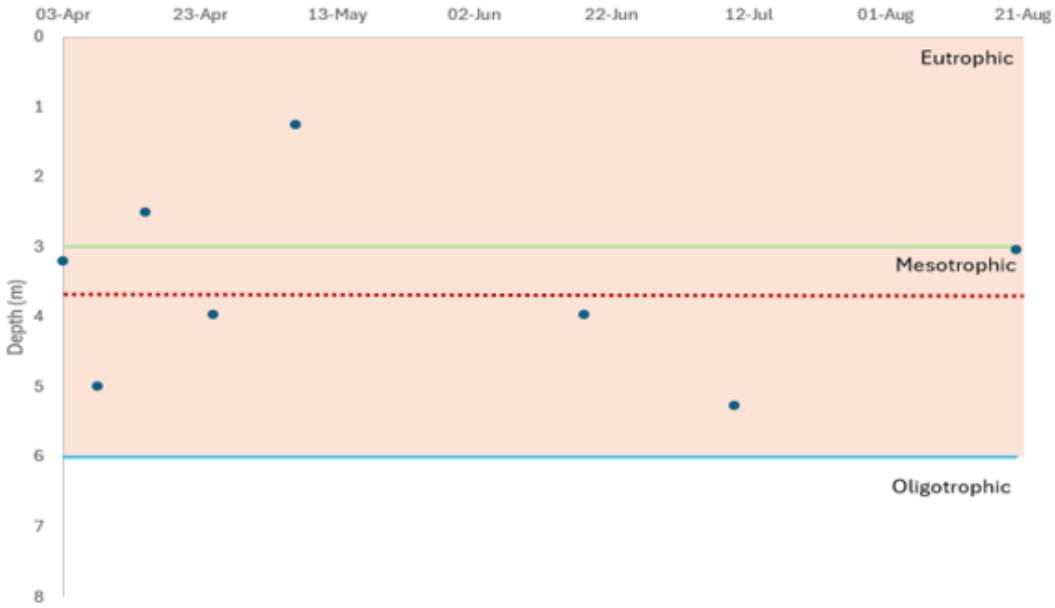

Figure 2. *Secchi depths during the 2024 growing season (mean depth of 3.74 m; dotted line). The orange shaded area represents values outside of the ≥ 6 m WQO, and solid lines indicate lake productivity thresholds (Nordin, 1985).*

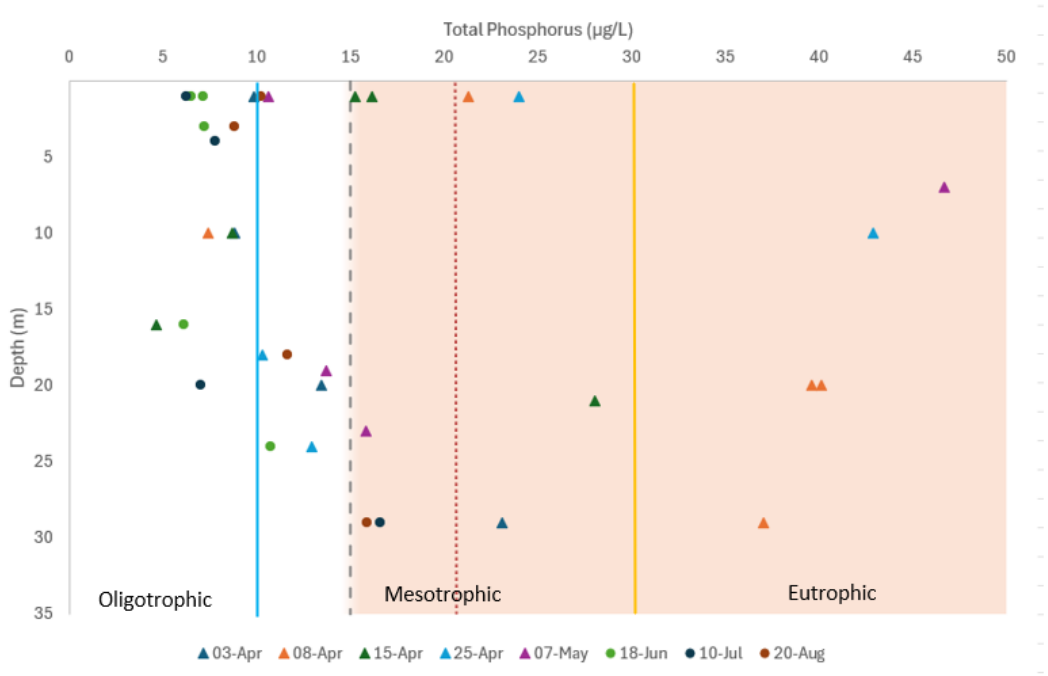

Figure 3. *Mean total phosphorus concentrations during 2024 spring overturn (20.5 µg/L; dotted line). Triangles represent values at spring overturn, with the remainder of the growing season represented by circles. The orange shaded area represents values outside of the ≤ 15 µg/L WQO (dashed line) and solid lines indicate lake productivity thresholds (Nordin, 1985).*

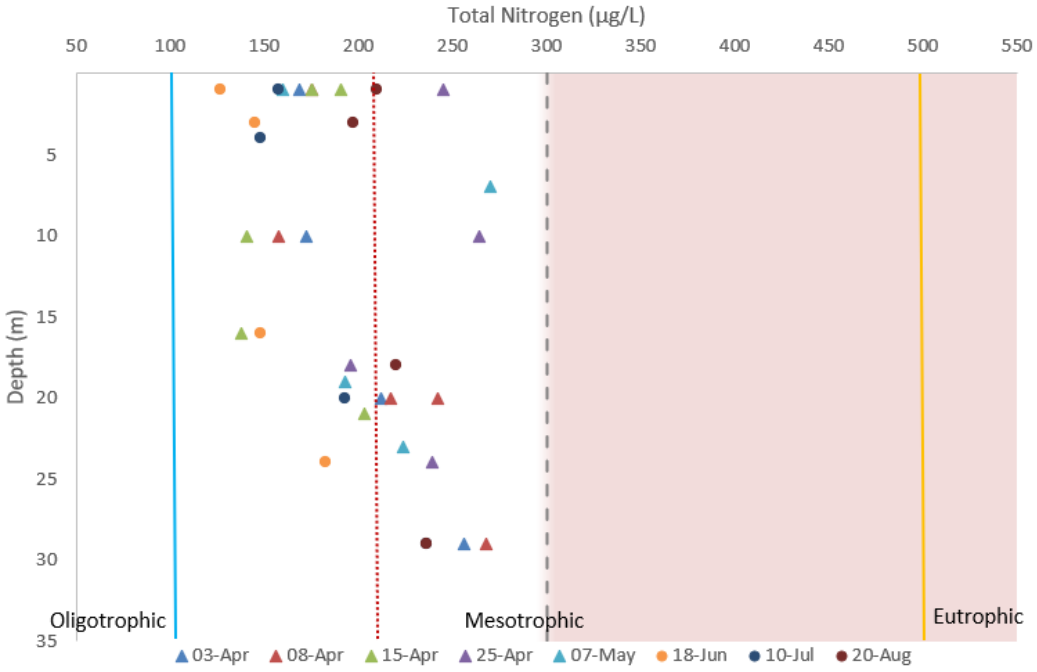

Figure 4. *Mean total nitrogen concentrations during 2024 spring overturn (206.9 µg/L; dotted line). Triangles represent values at spring overturn, with the remainder of the growing season represented by circles. The orange shaded area represents values outside of the ≤ 300 µg/L WQO (dashed line) and solid lines indicate lake productivity thresholds (Nordin, 1985).*

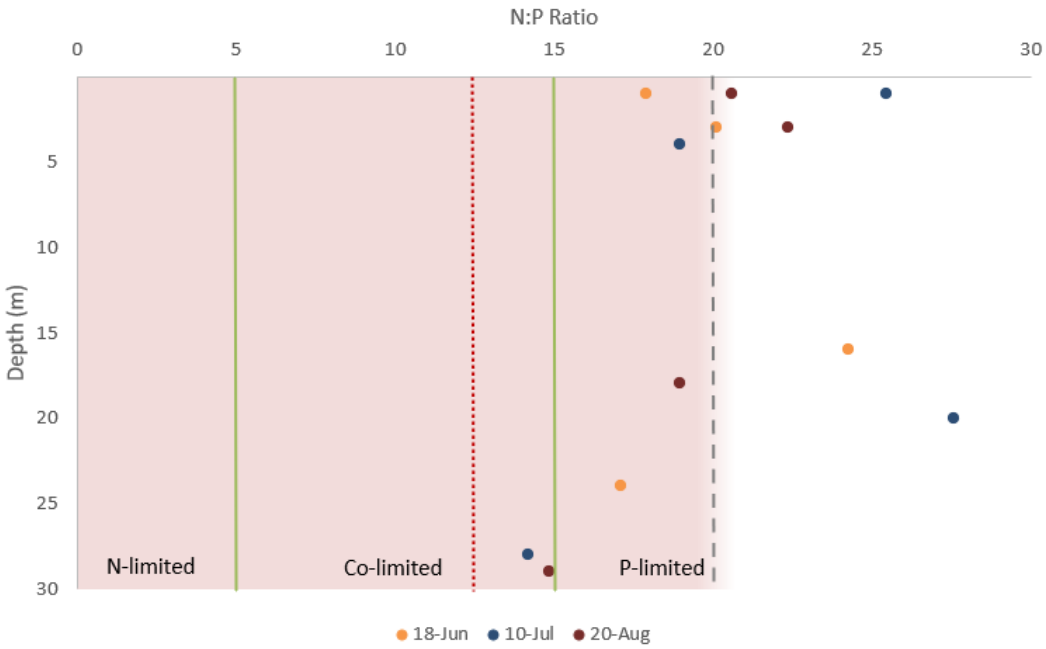

Figure 5. *Mean nitrogen: phosphorus (N:P) ratio during 2024 spring overturn (12.6:1; dotted line), and through the remainder of the growing season (circles). The orange shaded area represents values outside of the ≥ 20:1 WQO (dashed line) and solid vertical lines indicate nutrient limitation thresholds (ENV, 2022).*

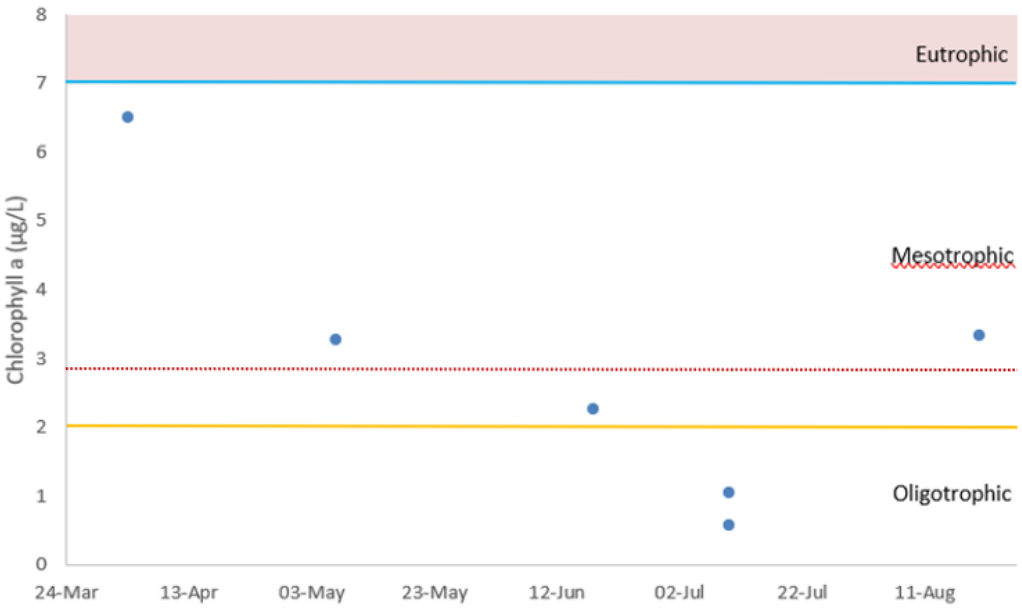

Figure 6. *Chlorophyll-a concentrations during the 2024 growing season (mean concentration of 2.83 µg/L; dotted line). The orange shaded area represents values outside of the ≤ 7 µg/L WQO, and solid horizontal lines indicate lake productivity thresholds (Nordin, 1985).*

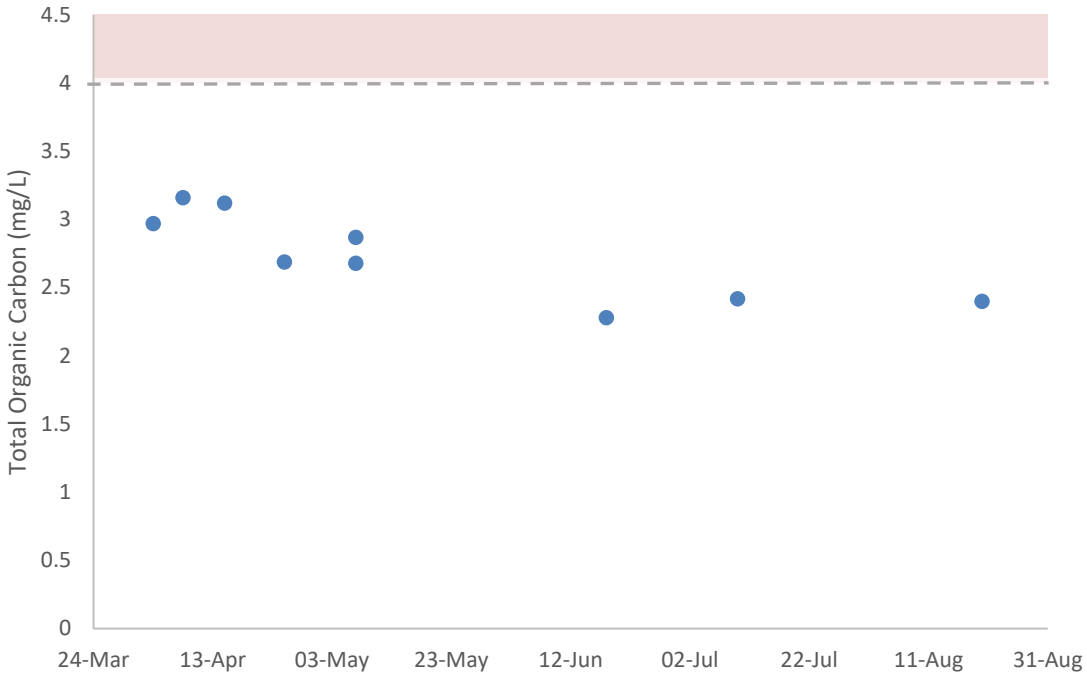

Figure 7. *Total organic carbon concentrations during the 2024 growing season. The orange shaded area represents values outside of the ≤ 4 mg/L instantaneous maximum WQO (dashed line).*