East Barriere Lake 2021-2023
BC Lake Stewardship and Monitoring Program
Summary Report

The BC Lake Stewardship Society (BCLSS) and the Ministry of Environment and Parks (ENV) partner with local volunteers and stewardship groups to characterize lake water quality through the *BC Lake Stewardship and Monitoring Program* (BCLSMP). The BCLSMP's focus is on understanding water clarity, temperature, oxygen, and nutrients because these factors contribute to the basic understanding of lake processes which influence biological productivity. Concerns about productivity are common, specifically because high productivity can negatively impact recreation, drinking water and aquatic health due to harmful algal blooms. For more information about the BCLSMP please visit www.gov.bc.ca/lakestewardshipmonitoring.

Photo 1. East Barriere Lake – Photo by Richard and Cathy Paul

Background

East Barriere Lake has a surface area of 9.94 sq km, a perimeter of 26.5 km, and an elevation of 635 m. The lake's average depth is 34.9 m, while the deepest spot is 100 m.

East Barriere Lake is located in the Thompson-Nicola region of British Columbia, approximately 25 km from the town of Barrière, BC. The east side of the lake has been heavily logged and has substantial residential development. East Barriere Lake is advertised as an excellent lake for swimming, fishing and other forms of recreation due to its warm temperatures. The lake is becoming increasingly popular with the boating community, especially wake boats (Paul, 2024).

The East Barriere River flows into East Barriere Lake. After exiting the lake, the water joins the main Barriere River. East Barriere Lake has been found to contain rainbow trout, bull trout, kokanee, largescale sucker and northern pikeminnow (B.C. Gov, n.d).

In 1988, the Department of Fisheries and Oceans Canada collected monthly (May-October) limnological information on East Barriere Lake. Some of the findings related to this program include a spring overturn phosphorus concentration of 8.6 µg/L and a 1.49 µg/L average chlorophyll a concentration, placing East Barriere Lake in the oligotrophic category (Shortreed et al., 2001). Other data from the study that may be important for comparison going forward include the lake's average epilimnetic temperature in 1988 of 13.7 °C, and a shallow, stable seasonal thermocline at an average of 6m deep.

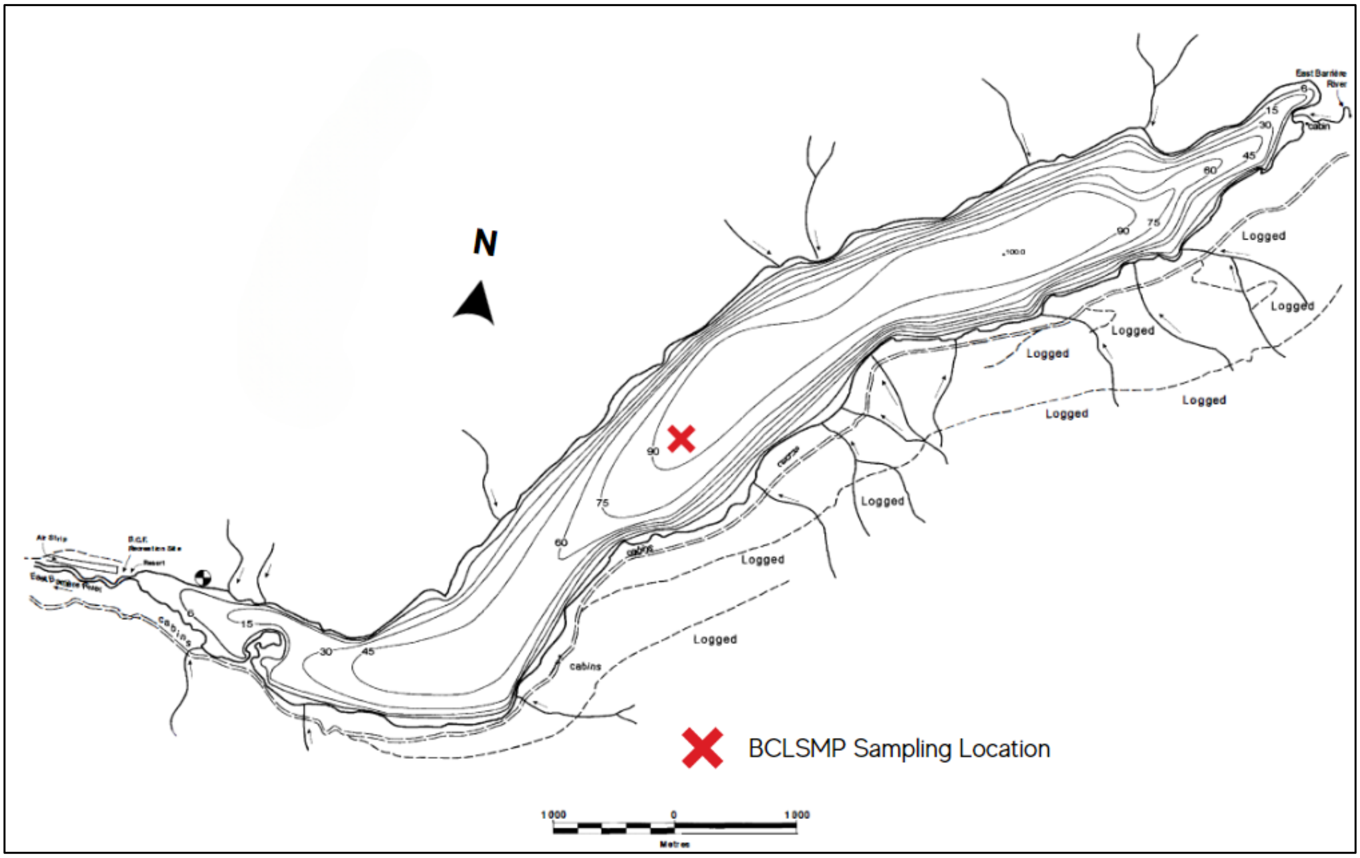
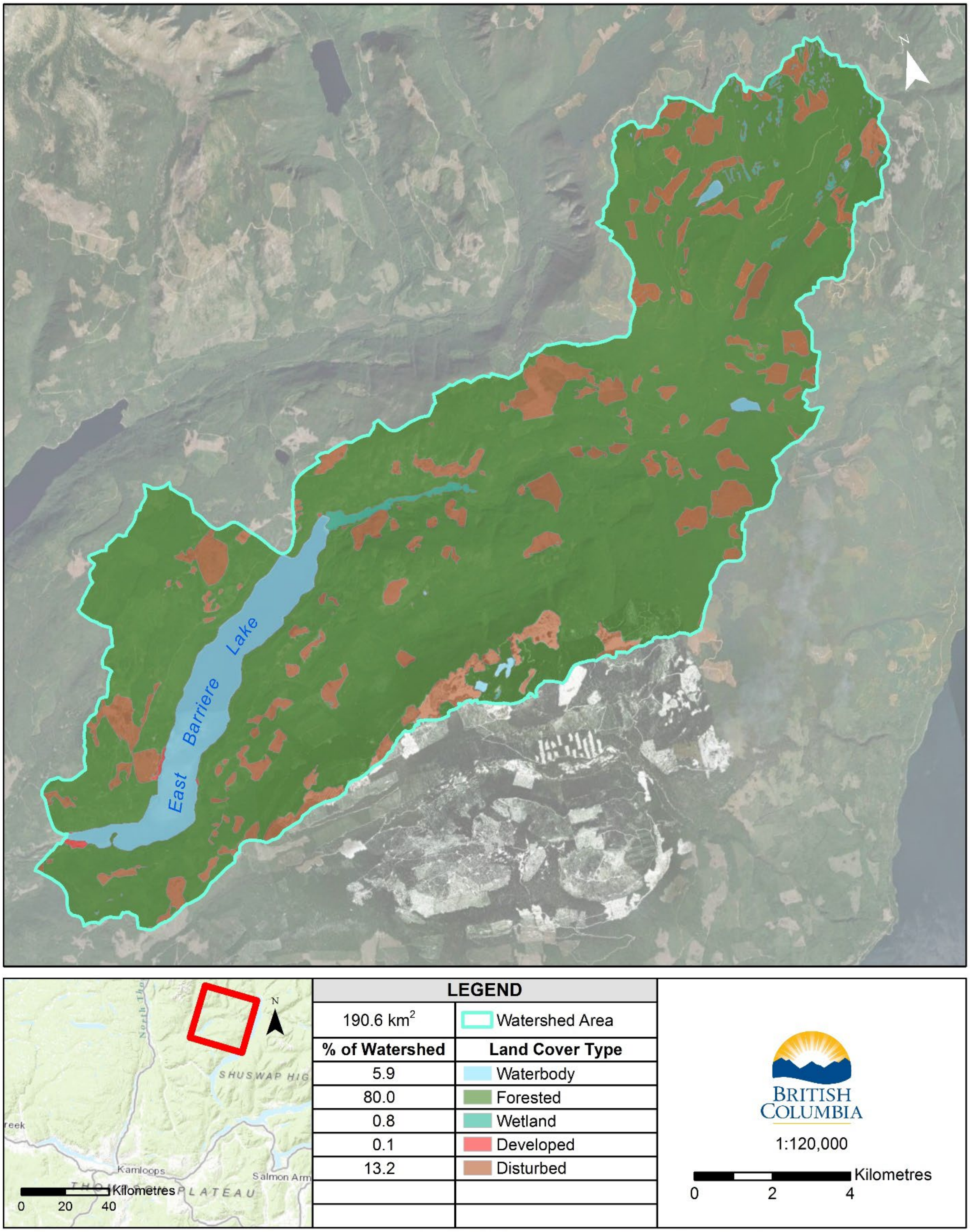


Figure 1. Bathymetric map of East Barriere Lake, including BCLSMP Deep Station sampling site identified by the **red x** (51.2741796, -119.8007499)

Monitoring Approach

This report summarizes Level 1 Study data collected by volunteers from 2021 to 2023. A Level 1 BCLSMP Study collects information from the lake location that best represents the entire lake, such as the centre or deepest point, and includes monitoring surface temperature and water clarity. Information on these parameters is recommended to be collected at least twelve times during the open water season for three consecutive years to characterize the temporal variability typical of lake systems. This data provides valuable baseline and background information that helps us in understanding what is happening in aquatic environments and observe long-term trends.

Level 1 BCLSMP water quality information was collected from East Barriere Lake Deep Station between June and September for sampling events in 2021 and 2023, while data had a wider spread in 2022, spanning from May through September. Twelve sampling events occurred in 2021, 17 in 2022, and 12 in 2023. Surface temperature readings were not recorded for two of the 12 sampling events in 2021.



Map By: B.C. Ministry of Environment and Climate Change Strategy. Land Cover Type based on Sentinel-2 10m land cover time series of the world. Produced by Impact Observatory, Microsoft, and Esri. Land Cover Types are checked against orthophotography (Esri basemaps) but have not been field verified. Date Saved: 2024-07-10 2:56:36 PM Coordinate System: NAD 1983 UTM Zone 11N Datum: Transverse Mercator

Figure 2. East Barriere Lake watershed and associated land uses

Surface Temperature

Surface temperature readings serve as an important ecological indicator. By measuring surface temperature, we can record and compare readings from season to season and year to year. Surface temperature helps to determine much of the seasonal oxygen, phosphorus, and algal conditions. Surface temperature readings were collected by volunteers throughout the 2021-2023 monitoring seasons. The minimum data requirements of 12 readings were met for two of the three years, as two monitoring events did not include surface temperature readings in 2021. However, due to data collection issues, all surface temperature readings before July 1, 2022, are unusable and have been removed from analysis. The spread of the remaining surface temperature data is not evenly distributed from spring through fall, as usable data from 2022 starts in July, and 2023 data spans from the end of June to the end of September. **Figure 3** shows the minimum, mean, and maximum surface temperature readings recorded at the monitoring site and the number of readings each year (n).

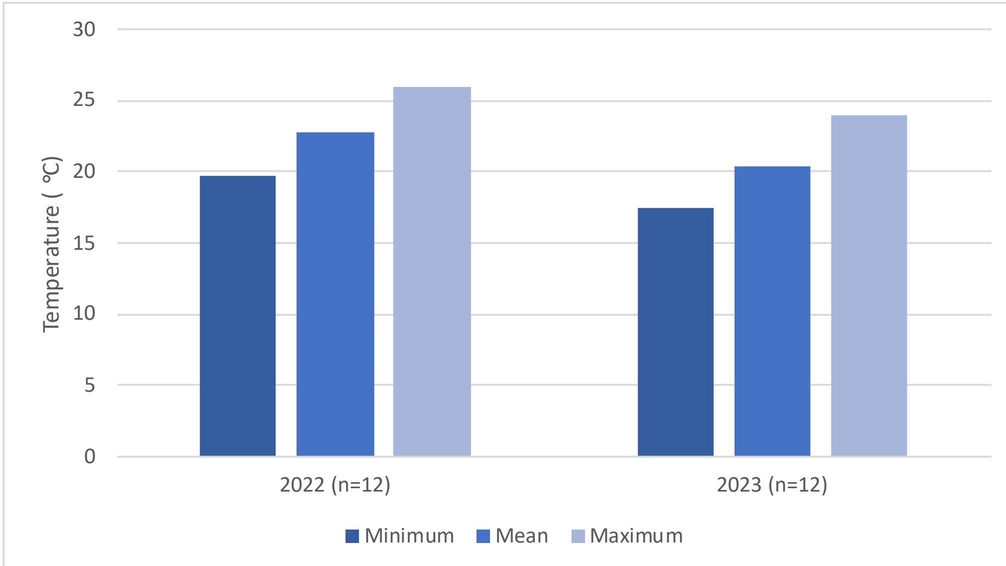


Figure 3 East Barriere Lake surface temperature summary 2022 and 2023

Due to the differing span of data collection each year and limited surface temperature data, conclusions should not be drawn from the data summarized in **Figure 3.** However, this data provides a good starting point for the collection of multiple years of surface temperature that can then be compared to going forward.

It is worth noting that the average surface temperatures for East Barriere Lake for both 2022 and 2023 are above the preferred temperature range for salmonid species. Many fish species, especially salmonids, show signs of stress at temperatures greater than 18ºC or dissolved oxygen levels below 4 mg/L (Truelson,1997). However, with a maximum depth of around 100 meters, most of the water column likely remains within the preferred temperature range for salmonid species.

For subsequent years of data collection, it is recommended that dissolved oxygen and temperature profile (multiple depths through the water column) data be collected from ice-off and continue at least biweekly until turnover is caught in the fall. Temperature and dissolved oxygen profiles can easily be collected using a field meter such as a YSI ProSolo. These profiles would provide valuable information on the current conditions of East Barriere Lake which could then be compared to the historical data available for the lake. Additionally, by taking profiles of a lake it may be possible to detect changes to the depth of the thermocline or changes in the time of lake turnover, which can have marked effects on dissolved oxygen and nutrient cycling. One of the impacts of climate change on lakes in BC is that stronger stratification may occur, and for longer periods, which can have extensive implications on dissolved oxygen levels, nutrient cycling, and habitat availability for salmonid species (Ashley, 2024). Due to the sensitivity of lakes and lake ecosystems to climate change, it is important that proactive measures be taken in order to better predict how lakes throughout BC will respond. The more lakes that provide temperature and DO profiles, the more data points there are for different regions and lake characteristics so that steps can be taken to mitigate impacts or provide information in advance of an extreme shift.

Water Clarity

Water clarity is an indicator of algae, suspended sediments, and other particles in the water. The clarity of the water can be evaluated by using a Secchi disc, a 20 cm diameter black and white disc that measures the depth of light penetration. Natural variations and trends in Secchi depth and temperature occur between years and throughout one season. In general, as temperatures increase during the summer months, Secchi depth typically decreases. This is due to algal growth patterns; as the temperature of the lake increases, so do some species of algae. Due to the increase in algae, the water clarity can decrease. However, there can be other influences on Secchi readings, such as suspended solids from turbid inflowing streams or overland flow.

Water clarity was measured in East Barriere Lake from 2021-2023. The graphs in **Figure 4** show the Secchi readings collected by volunteers from 2021-2023 and the surface temperature readings collected. The minimum data requirement of 12 Secchi readings over the sampling season was met each year. The general trend of increasing surface temperature leading to decreasing Secchi readings is not apparent in the graphs of **Figure 4**.

The graph in **Figure 5** shows the minimum, average, and maximum Secchi depths recorded at the monitoring site and the number of readings each year (n). The deepest Secchi reading obtained between 2021-2023 was 9.15m (2023-08-13), and the minimum reading was 4.3 m (2022-07-07).

The average Secchi depths for each year were 6.1 m (2021), 5.3 m (2022), and 7.9 m (2023). When looking at **Figure 5**, it appears clarity may have improved overall for 2023 compared to previous years (minimum, average, and maximum). However, it should be noted that there was a change in volunteers between years, which could have an impact on the Secchi readings. Also, some variation between years is expected and is the reason for the minimum of 3 years of monitoring.

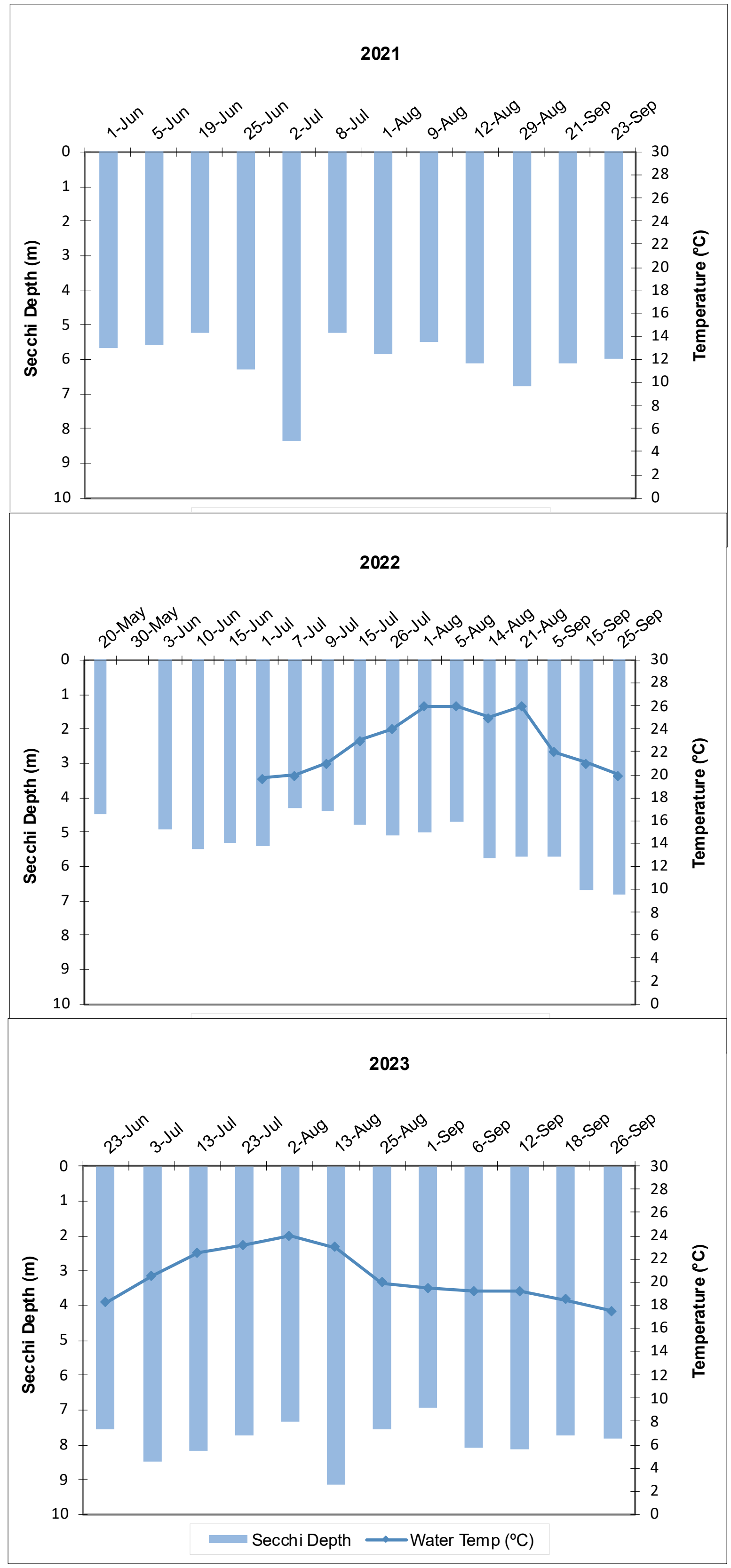


Figure 4 Secchi and surface temperature readings in East Barriere Lake 2021-2023

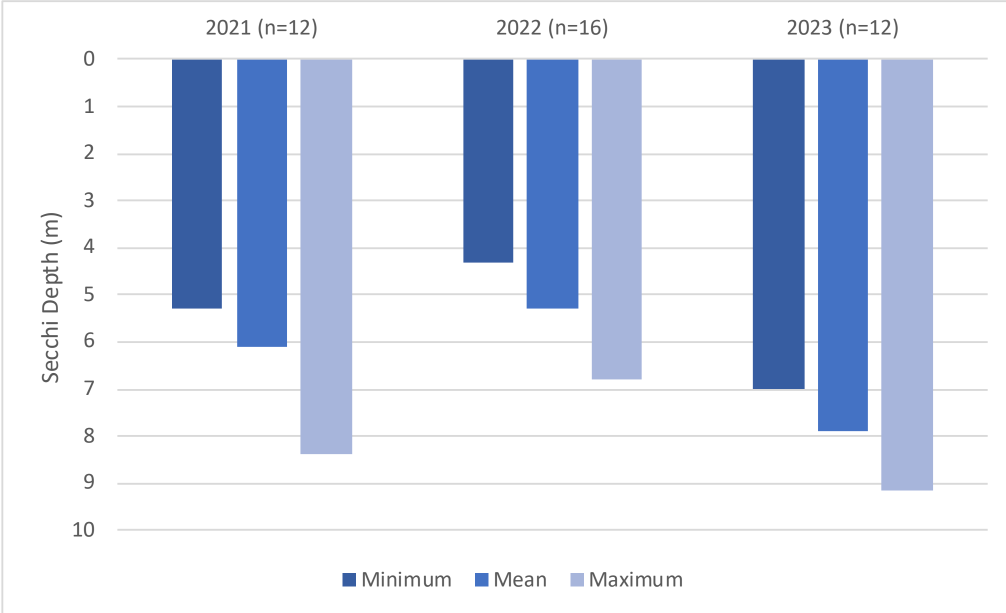


Figure 5 Secchi summary statistics for East Barriere Lake 2021-2023

Trophic Status

Trophic status describes the level of biological productivity within a water body and is measured using Secchi depth, chlorophyll-*a*, and total phosphorus concentrations (Nordin, 1985). Low-productivity lakes are called *oligotrophic* and tend to have clear water and sufficient oxygen for aquatic life throughout the year. Lakes with moderate productivity are called *mesotrophic*. *Eutrophic* lakes have high productivity and often have high densities of aquatic plants and/or algae. Algal blooms may occur in these lakes frequently, reducing recreational opportunities and potentially impacting aquatic habitats.

Based on the average Secchi values obtained between 2021-2023, East Barriere Lake exhibited oligotrophic conditions for 2 of the 3 years, with the 2022 mean falling in the mesotrophic-oligotrophic category. The current Secchi readings that place East Barriere Lake in the oligotrophic category support the historical data collected in 1988 that indicated East Barriere Lake is oligotrophic. Comparing the BCLSMP data to the historical data collected by DFO (1988) supports the suggestion that East Barriere Lake's productivity has not changed significantly in 35 years. However, the 1988 data pointing to the lake being oligotrophic was based on spring overturn phosphorus (8.6 ug/L) and the average chlorophyll a concentration (1.49 ug/L) instead of Secchi depth (Shortreed et al., 2001). Conducting a monitoring program that includes chlorophyll-*a* and phosphorus analysis would provide a better comparison between the 1988 DFO data and the current BCLSMP data and would allow for firmer conclusions on the current productivity of East Barriere Lake.

Table 1. East Barriere Lake trophic indicator results (as per Nordin, 1985).

Parameters	**Trophic Categories**			**East Barriere Lake**	
	Oligotrophic	Mesotrophic	Eutrophic	DFO (1988)	BCLSMP L1 (2021-2023)
Chlorophyll-*a* (µg/L)[3]	0 - 2	2 - 7	>7	1.49	-
Secchi Depth (m)[1]	>6.0	3.0 - 6.0	<3.0	-	6.43
Total Phosphorus (µg/L)[2]	1 - 10	10 - 30	>30	8.6	-

[1] Average of all year's annual average, [2] spring overturn conditions, [3]Average.

Summary

Volunteers have established a great Secchi depth and surface temperature dataset from 2021-2023. Average Secchi depth data in East Barriere Lake from 2021-2023 indicates the lake is experiencing oligotrophic conditions. This data supports the limnological data collected in 1988 by DFO, which also placed the lake in the oligotrophic category. As a result, the data collected from East Barriere Lake indicates that the water quality has remained relatively stable. However, firm conclusions on trophic conditions should not be drawn from Secchi data alone and conducting a monitoring program which includes chlorophyll-*a* and phosphorus analysis would provide a better comparison between the historic and current datasets. This would allow for firmer conclusions to be drawn on the current productivity of East Barriere Lake.

The surface water temperatures recorded in East Barriere Lake from 2022-2023 are very warm, with the average temperatures from all years being above the preferred temperature range for salmonid species. Many fish species, especially salmonids, show signs of stress at temperatures greater than 18°C (Truelson,1997). However, with a maximum depth of around 100 meters, most of the water column likely remains within the preferred temperature range for salmonid species.

Going Forward

Local volunteers could continue to record Secchi and surface temperature readings, with an emphasis on collecting a minimum of 12 evenly spaced readings between ice-off and ice-on. This lake could benefit from additional water chemistry sampling, including phosphorus and chlorophyll-*a* to better compare to the historical data collected in 1988 by DFO. Additionally, because of the high surface water temperatures recorded, obtaining dissolved oxygen and temperature profiles every two weeks from ice-off to ice-on would be valuable data for this lake. There is strong evidence that climate change is exacerbating existing issues in lakes and creating issues where they previously did not exist, whether expected or unexpected. This will make the management of BC's water resources more challenging. One climate change impact already observed in many northern hemisphere lakes is reduced oxygen concentrations and earlier onset and longer periods of stratification, which will make internal nutrient loading more problematic (Woolway et al., 2020). Volunteer-collected data is important for long-term records and can help identify early warning signs should there be a deterioration in water quality from its current state. Local volunteer monitors are also encouraged to continue recording ice-on and ice-off dates for long-term climate change records. These observations can be submitted online through BC Ice Reporting Tool (https://arcg.is/qy1e5).

Tips for Keeping East Barriere Lake Healthy

- The land use pressure within the East Barriere Lake watershed is relatively high due to the logging activity along the lake. Adequate shoreline protections, including healthy riparian buffer zones, can act to mitigate logging and development impacts on water quality and fish habitat (Dosskey et al., 2010). Additionally, intense logging around a lake (even out of the riparian zone) can lead to changes in water quality. Shah et al. (2022) undertook a review of the effects of a range of forestry activities on water quality. They found that studies conducted after forest operations reported a wide array of water quality impacts, including sediment delivery, nutrient losses, carbon transport, metal and base cation releases, and changes to acidity and temperature (Shah et al., 2022). However, there are best management practices that can mitigate or eliminate negative forestry impacts on water quality, such as the use of buffers, low-impact techniques and phased felling (Shah et al., 2022). It is beyond the scope of this report to investigate the forestry practices around East Barriere Lake and compare them to best management practices. However, it is recommended that any forestry follow best management practices to protect the water quality of East Barriere Lake. Additionally, to retain the resilience of the East Barriere Lake watershed, preserving, enhancing, and restoring riparian areas should be a key action.

- East Barriere Lake is becoming very popular with wake boats. Large wake and prop wash from boats can erode shorelines, swamp habitat and nests, and cause habitat disturbance and sediment resuspension in shallow waters. Sediment can be churned up by boats, which can disturb habitat, clog fish gills, smother vegetation, suffocate fish eggs, and release nutrients like phosphorus, which can promote weed growth and algal blooms (BCLSS, 2021). Mercier-Blais and Prairie (2014) found that energy produced by the wake boats they studied dissipated completely if the passage of the boat occurred 300 meters or more from shore. A study by Larratt Aquatic Consulting found that bottom sediments in water as deep as 8 m can be impacted by wake boats (Self, 2019). Wake boats are advised to stay away from shorelines and avoid shallow areas of the lake to protect East Barriere Lake into the future.

Other Tips for Keeping East Barriere Lake Healthy: **See link under Monitoring Resources on:** www.gov.bc.ca/lakestewardshipmonitoring **BCLSS's LakeKeepers Manual:** https://www.bclss.org/programs#lake-keepers-manual

Who to Contact for More Information

The Ministry of Environment and Parks	**The BC Lake Stewardship Society**
3rd Floor, 1011-4th Ave Prince George, BC V2L 3H9 Email: volunteerlakes@gov.bc.ca Website: www.gov.bc.ca/lakestewardshipmonitoring	Box 110, 5505 Jacobson Road, Big Lake Ranch, BC, V0L 1G0 Email: info@bclss.org Website: www.bclss.org

Acknowledgements

Volunteer Monitoring by: Doug and Arlene Pratt, Richard and Cathy Paul, and Linda Hartl
Data Compilation by: Amy Baxter (BCLSS)
Lake Report Production by: Amy Baxter (BCLSS)
Report Review: Norm Zirnhelt (BCLSS) and Kirsten McNeill (ENV)
Land Use Map by: Kim Klaczek (ENV)

References

Ashley, K. 2024. Predicted impacts of climate change on BC Lakes. BCLSS. Retrieved February 11, 2024, from https://www.bclss.org/environmental-issues/predicted-impacts-of-climate-change-on-bc-lakes

B.C Gov. (n.d.). *Fish inventories data queries (FIDQ)*. Fish Inventories Data Queries. Retrieved January 7, 2024, from https://a100.gov.bc.ca/pub/fidq/welcome.do

BC Lake Stewardship Society (BCLSS). 2021. Watch your wake. Retrieved April 14, 2024, from https://www.bclss.org/news/watch-your-wake

Dosskey, M. G., Vidon, P., Gurwick, N. P., Allan, C. J., Duval, T. P., & Lowrance, R. (2010). The role of riparian vegetation in protecting and improving chemical water quality in streams. JAWRA Journal of the American Water Resources Association, 46(2), 261–277. https://doi.org/10.1111/j.1752-1688.2010.00419.x

Mercier-Blais, S., & Prairie, Y. (2014). Project Evaluation of the Impact of Waves Created by Wake Boats on the Shores of the Lakes Memphremagog and Lovering. Retrieved March 10, 2024, from https://lmcd.org/wp-content/uploads/2022/06/Impact-of-Waves-Created-by-Wake-Boats-Canada.pdf

Nordin, R. 1985. Water Quality Criteria for Nutrients and Algae. Water quality Unit, Resource Quality Unit, Resource Quality Section. Ministry of Environment, Lands and Parks. Victoria, BC.

Self, J. 2019. Kalamalka Lake Boat Trials. Retrieved on March 10, 2024, from https://www.bclss.org//wp-content/uploads/2021/08/LARRATT-Wake-Boat-Study.pdf

Shah, N. W., Baillie, B. R., Bishop, K., Ferraz, S., Högbom, L., & Nettles, J. 2022. The effects of forest management on Water Quality. Forest Ecology and Management, 522, 120397. https://doi.org/10.1016/j.foreco.2022.120397

Shortreed, K. S., Morton, K. F., Malange, K., & Hume, J. M. B. 2001. Factors Limiting Juvenile Sockeye Production and Enhancement Potential for Selected B.C. Nursery Lakes. Retrieved on February 17, 2024, https://publications.gc.ca/collections/collection_2015/mpo-dfo/Fs70-5-2001-098-eng.pdf

Truelson, R.L. (1997). Water quality criteria for dissolved oxygen. Prepared for British Columbia's Ministry of Environment, Lands and Parks, Water Management Branch, Victoria

Woolway, R.I., M. Kraemer, J.D. Lenters, C. J. Merchant, C. M. O'Reilly and S. Sharma. (2020). Global lake responses to climate change. Nature Reviews Earth & Environment volume 1, p388–403.