



Living Lakes Canada: Tracking Climate Impacts on Alpine Freshwater Systems

Sapphire Lake in
Kokanee Glacier Provincial Park.
Photo: Living Lakes Canada

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Mountains give rise to both torrents and trickles of freshwater. From melting glaciers and snowpacks, rivers and streams cascade down from the alpine, through the mountains, and disperse throughout watersheds. High-elevation headwaters are the lifeblood for people and ecosystems alike. They provide the freshwater that pours through taps, supports the growth of food, and nurtures a diversity of freshwater species, including the iconic Kokanee Salmon. Mountainous rivers and streams also hold cultural, recreational, and intrinsic value. However, these sensitive freshwater systems are changing, and the climate crisis is the catalyst.

High elevation ecosystems are more vulnerable to climate change than lower elevation ecosystems. Consequently, they're expected to experience climate impacts more rapidly.¹ Research suggests that small changes in climate can drive large shifts in alpine freshwater systems.² Shorter winters, an earlier freshet, and increased rainfall will continue to impact the health and function of alpine ecosystems. This will have a ripple effect on the human and biological communities that share these watersheds.

A comprehensive and science-based understanding of these sensitive ecosystems is needed. There is an urgency to start collecting data to help

fill important data gaps, inform water management and decision-making, and support climate change adaptation. Many high elevation areas in Canada have not been actively monitored. It is with this lens that Living Lakes Canada developed its High Elevation (HE) Monitoring Program.

In 2022, the program began surveying two areas nestled among the Selkirk Mountains in the West Kootenays. Located northeast of Nelson B.C., Kokanee Glacier Provincial Park — historically and culturally significant for regional Indigenous communities — is an epicentre for mountaineering, skiing, hiking, and fishing. Sapphire Lake, Lemon Creek, Tanal Lake, and Upper Joker Lake were

selected for monitoring here. Farther west to the opposite side of Slocan Lake, the second monitoring area is located north of the majestic Valhalla Provincial Park, and includes Shannon Lake and Huss Creek. Together, the two monitoring areas and their selected sites represent a mosaic of diverse alpine lakes and streams.

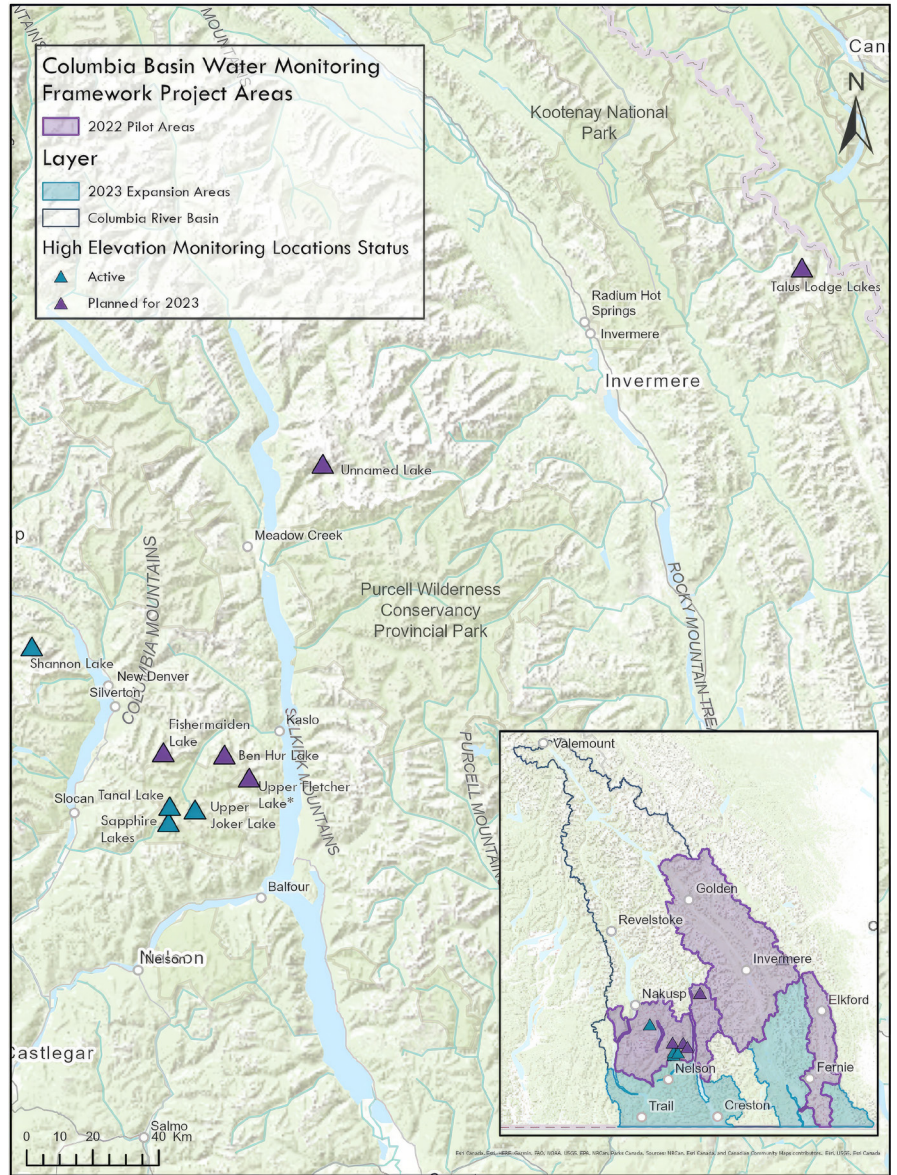
The HE Monitoring Program aims to generate baseline data on alpine ecosystems and establish long-term monitoring to understand how these ecosystems, and the watersheds they are a part of, are responding to climate change. Monitoring field trips to date have included measuring the water's biological, physical, and chemical characteristics, and capturing photographs to track changes on a landscape level. A day of monitoring might include hauling in and pumping up an Alpaca raft to travel the lake's surface in order to map the underwater terrain of an alpine lake — a technique known as bathymetric map surveying. The contours of the lake bottom inform where light and temperature sensors will be installed (two parameters closely linked to aquatic ecosystem function and health). The day might also include collecting samples of benthic macroinvertebrates (small water-dwelling bugs) using a standardized biomonitoring protocol to determine stream health.

Climate, streamflow, snowpack, and glacier mass balance are important alpine features that contribute to the quality and quantity of freshwater systems. The HE Monitoring Program also tracks data related to these features. Climate variability and streamflow parameters are collected through climate and hydrometric stations installed as part of Living Lakes Canada's larger Columbia Basin Water Monitoring Framework project, and in combination with existing climate stations. Snowpack measurements are shared with the program by partnering backcountry lodge owners, and glacier mass balance is collected and published by the World Glacier Monitoring Service.

Monitoring high elevation spaces is only one piece of the puzzle for understanding freshwater systems. The HE Monitoring Program supplies data to the larger, scaled-up monitoring framework developed by Living Lakes Canada. The Columbia Basin Water Monitoring Framework aims to support decision makers in climate change adaptation efforts across the region's watersheds. All the water data collected is housed on a publicly accessible database, known as the Columbia Basin Water Hub. It's here that decision makers, researchers, students, professionals, and the public can access a wide variety of data and information about water. The Water Hub also stores biodiversity observations collected by citizen scientists.

In partnership with the Alpine Club of Canada, the "High Elevation Monitoring Program - Living Lakes Canada" project

2022 High Elevation Monitoring Locations and Proposed 2023 Monitoring Locations



Map of High Elevation Monitoring Locations. Courtesy of Living Lakes Canada

Tarn below Kokanee Glacier in Kokanee Glacier Provincial Park. Photo: Living Lakes Canada





*Kokanee Glacier in
Kokanee Glacier Provincial Park.
Photo: Living Lakes Canada*

launched on the popular citizen science platform, *iNaturalist*. It invites anyone recreating in the program's monitoring locations to help gather information on flora and fauna. Volunteer observations collected in 2022 included Hoary Marmots, American Alpine Lady Fern, and Tiger Swallowtails. By participating in the project, ACC members can learn about mountain biodiversity, while contributing important data to the HE Monitoring Program. The *iNaturalist* project has expanded and new volunteers are always welcome. Information on the locations and how to join can be found on the HE Monitoring Program page, where you'll

*Glacier Monitoring in
Kokanee Glacier Provincial Park.
Photo: Nick Waggoner*

also find an eye-catching report highlighting the program's pilot year.³

In 2023, the HE Monitoring Program moved into five new areas, which includes the addition of six lake monitoring sites and six stream monitoring sites. Short-term data from the program is contributing to our understanding of the current state of these lakes and streams. Long-term data established through continuous multi-year monitoring will help us more accurately model climate trends and impacts, which in turn can inform climate adaptation planning for these fragile mountain ecosystems and the watersheds they support.

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References

- 1 Mountain Research Initiative EDW Working Group, 2015. Elevation-dependent warming in mountain regions of the world. *Nature Climate Change* 5, 424–430. <https://doi.org/10.1038/nclimate2563>
- 2 Preston, D. Caine, N., McKnight D., Williams, M., Hell, K., Miller, M., Hart, S. and Johnson, P. 2016. Climate regulates alpine lake ice cover phenology and aquatic ecosystem structure. *Geophys. Res. Lett.*, 43: 5353–5360.
- 3 For volunteer information, the Pilot Year report, and more, visit: <https://livinglakescanada.ca/project/high-elevation-monitoring-program/>

