KOOTENAY JOE CREEK © LLC PHOTO

WATERSHED BULLETIN Volume 2, Issue 1: June 2025

COLUMBIA BASIN WATER MONITORING FRAMEWORK

NOT ALL WATERSHEDS ARE EQUAL: RETHINKING WATERSHED MANAGEMENT IN A CHANGING CLIMATE

Living Lakes Canada prioritizes Reconciliation with Indigenous Peoples. We commit to respecting the rights of Indigenous Peoples by aligning our work with the goals of local Indigenous groups. We recognize the role and responsibility that Indigenous Peoples have to all land and the water that flows through it, and we honour that relationship by uplifting Indigenous voices in water stewardship.

As the climate warms, longer, drier, and hotter summer seasons are expected throughout the Canadian Columbia Basin region. These conditions increase wildfire risk and jeopardize historically-reliable water supplies. Watershed basins of various sizes are essential for supplying water for domestic use, fish habitat, and other ecosystem services. In some communities, these watersheds are also a lifeline for **fighting wildfire**[1]. By monitoring watersheds, we can collect data to improve our understanding of hydrologic changes taking place. This information helps guide local resilience efforts to address water security as climate impacts progress.

This *Watershed Bulletin* focuses on the Mid-Columbia Kootenay and Lower Columbia-Kootenay Hydrologic Regions in the Canadian Columbia Basin (see Figure A1 in Appendix), where a high proportion of domestic water consumption is dependent on smaller watersheds. To better prepare for drought, it's important to understand how these smaller watersheds function, and what role they play within larger watershed dynamics, particularly in light of the rapidly changing climate.

Each year, snowpack accumulation, and how quickly it melts in the spring, affects the flow of our rivers and streams. In the West Kootenay, where the Mid-Columbia Kootenay and Lower Columbia-Kootenay Hydrologic Regions are situated, snowmelt historically provided a reliable supply of water into late summer — but that's no longer the case. Communities are increasingly running low on water in the summer because spring heat is starting earlier, less rain is falling during the summer, and heat waves are lasting longer.


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Government agencies usually collect streamflow data from larger streams, with monitoring stations operating for decades. These readings reflect flow patterns from large areas, often spanning hundreds or even thousands of square kilometres. By monitoring only larger streams — watercourses which combine flows from smaller watersheds — the diverse and informative flow responses among small stream systems are ignored.

1 Wildfire Suppression in Rural BC Fuelled by Proactive Water Mapping. *Watershed Bulletin* Volume 1, Issue 2: September 2024. Living Lakes Canada.

In contrast, the Columbia Basin Water Monitoring Framework (CBWMF) network focuses on smaller streams, giving us a closer look at local conditions within the small watersheds, which many communities rely on for water supply.

TRENDS FOR LARGER WEST KOOTENAY RIVERS

First, let's look at some government data from larger watersheds. Environment and Climate Change Canada (ECCC) monitors river discharge across the Canadian Columbia Basin, including major unregulated rivers of the West Kootenay region.

ECCC data for the Kaslo River (Water Survey of Canada station number 08NH005 with a contributing area of 442 square kilometres) shows a declining trend during June through October, with the strongest decline in August and September (Figure 1). In recent years, the data shows reduced variability in the summer months, potentially indicating consistently lower water levels due to prolonged extreme summer conditions.

In contrast, average monthly flow is increasing during November through March, with the strongest increases evident in December and January (Figure 2). These patterns are consistent with projections of global climate models that indicate warmer, wetter winters (more precipitation; snow shifting to rain) and hotter, drier summers for this region. These changes are contributing to an earlier spring, a longer and more intense dry period, and lower low flows in the late summer and fall, undermining the dependability of water supplies.

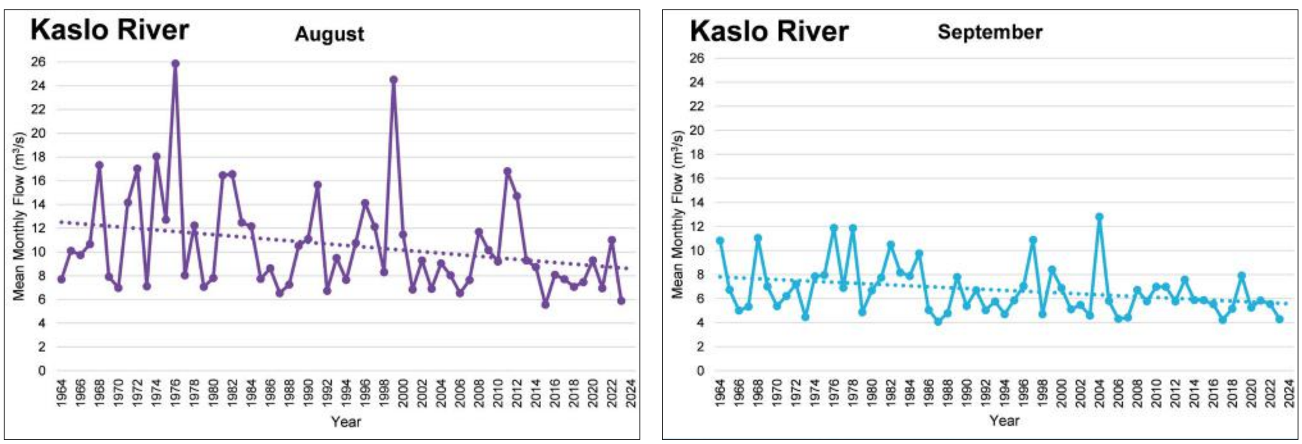


Figure 1. Mean monthly flow of Kaslo River in (a) August and (b) September, showing a decreasing trend throughout the monitoring period; [ECCC data](#).

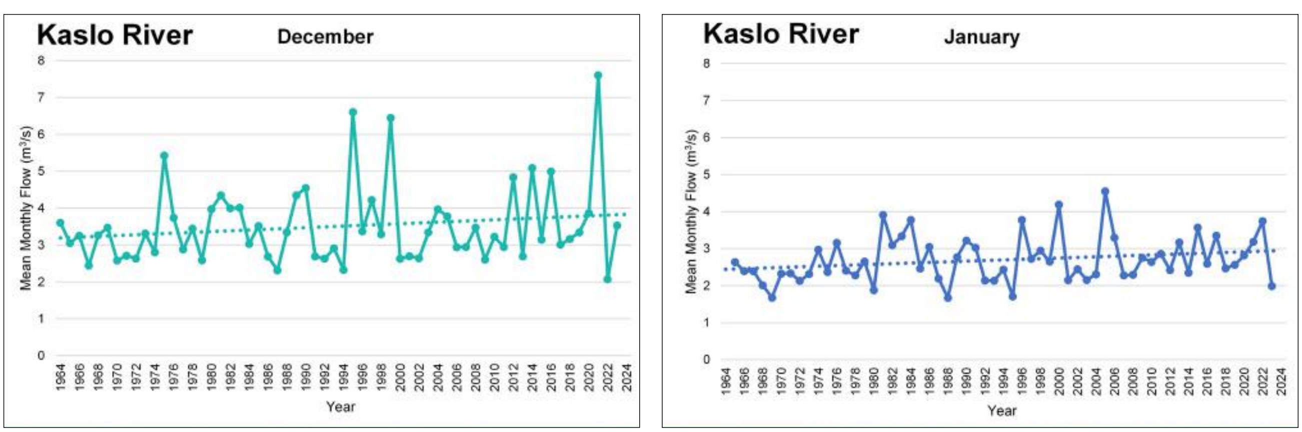


Figure 2. Mean monthly flow of Kaslo River in (a) December and (b) January, showing an increasing trend throughout the monitoring period; [ECCC data](#).

Average monthly flows in the Slocan River date back to 1925 (Water Survey of Canada station number 08NJ013 with a contributing area of 3,330 square kilometres), providing a longer continuous period of record. The declining trend from June through October is again evident in this much larger basin, with the strongest decline in August and September (Figure 3). The longer Slocan data record also suggests that the current trend is a reversal of a previously increasing trend from earlier in the 1900s.

As with the Kaslo River basin, the recent decline in monthly flows reflects the hotter, drier summers being experienced and that are projected to further intensify in the coming years.

In contrast with the summer behaviour, the Slocan River's winter monthly flows are more consistent during the monitoring record. As indicated in Figure 4 for December and January, they show an increasing trend similar to that of the Kaslo River, again suggesting a gradual increasing trend in winter precipitation and temperature.

The ECCC monitoring data from these two larger watersheds suggests an overall decline in fall low flows and an increase in the duration of the low-flow season, leading to increased water supply uncertainty. However, the runoff patterns of these large basins are actually net responses of the interacting dynamics of the many smaller watersheds which compose them. As a result, patterns observed for larger basins may not reflect the individual behaviours of the smaller watersheds within them.

This is where CBWMF data fills a critical gap.

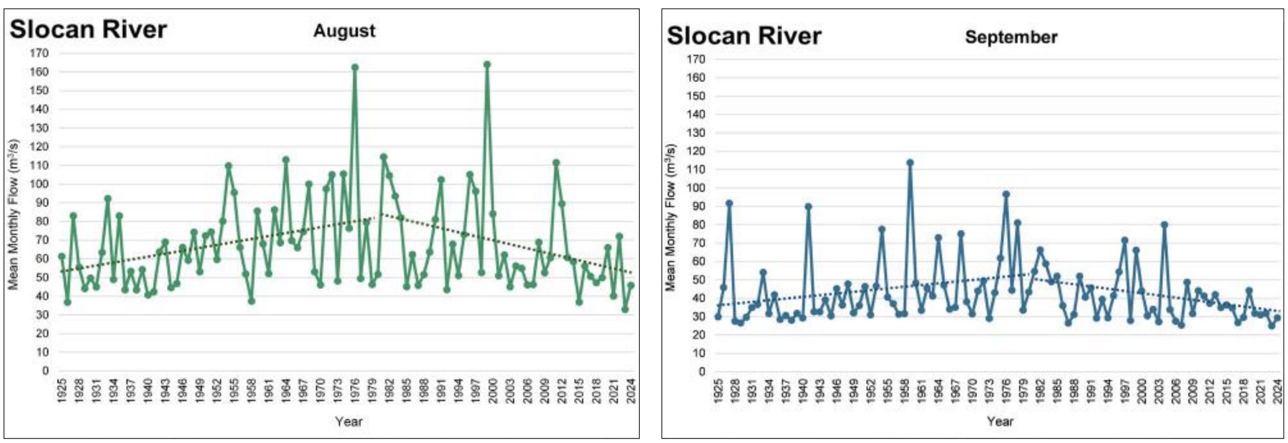


Figure 3. Mean monthly flow of Slocan River in (a) August and (b) September, showing an increasing trend followed by a decreasing trend since about 1980; [ECCC data](#).

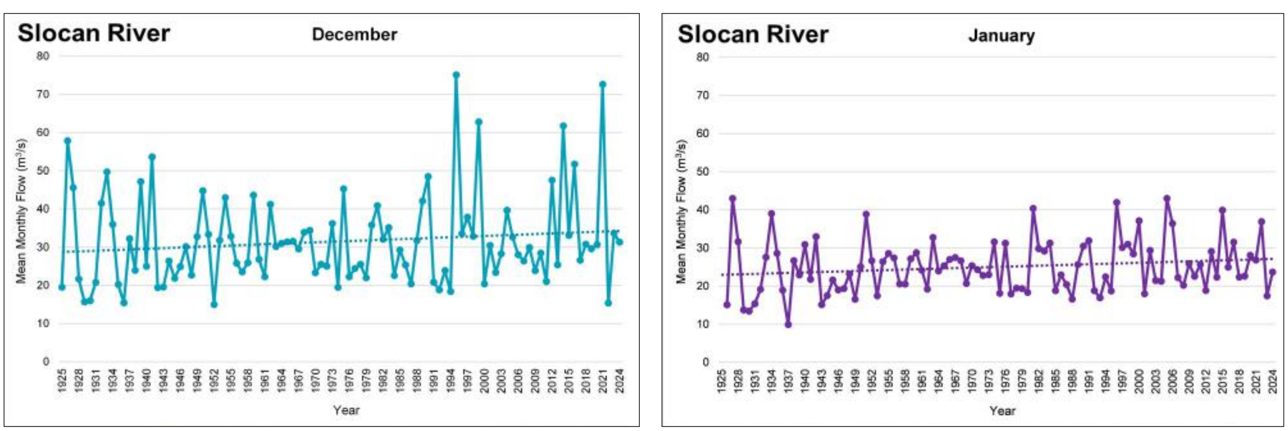


Figure 4. Mean monthly flow of Slocan River in (a) December and (b) January, showing an increasing trend throughout the monitoring period; [ECCC data](#).

CUMULATIVE RUNOFF CURVES USING CBWMF DATA

Across the snow-dominated watersheds of the Columbia Basin, differences in elevation, sun exposure, and size strongly influence how and when water is released each year. For example, lower elevation watersheds with warm, sun-facing slopes tend to release their snowpack earlier and over a shorter period, making them more vulnerable to rapid heating and water shortages later in the season.

In Columbia Basin watersheds, a significant portion of the annual flow is runoff from rainwater and snowmelt. Cumulative runoff curves show the timing of water flowing out of a watershed over the course of a year. Understanding these water dynamics in small basins can improve the potential for proactive management and climate-change preparedness.

Figure 5 shows 2023 and 2024 cumulative runoff curves for seven small watersheds in the West Kootenay: Carlyle, Davis, Dumont, Harrop, Kootenay Joe, Procter, and Upper Glacier. These small watersheds range in size from 4.1 to 63.6 square kilometres. In this region, watersheds of these sizes typically deliver 80% of their annual water output over 5-7 months, largely within April to September. See Table A1 and Figure A2 in the Appendix for more details on the characteristics and locations of these watersheds.

The highest curve in the 2023 graph represents the Dumont watershed, which is the hottest (low elevation; warm aspects), while the lowest curve is from a high location within the Upper Glacier watershed, which is the coolest (high elevation; cool aspects). Dumont watershed is also very small in area (just 4.1 square kilometres) with a narrow range in elevation, giving it added vulnerability to rapid heating. This is demonstrated by its 2023 cumulative runoff curve, which shows that the Dumont watershed released 80% of its annual runoff over only a five-week period.

In contrast, higher elevation watersheds with cooler, shaded slopes (like Upper Glacier and Carlyle) release water more slowly and steadily over a longer period. The variation in water-release timing between these watersheds highlights

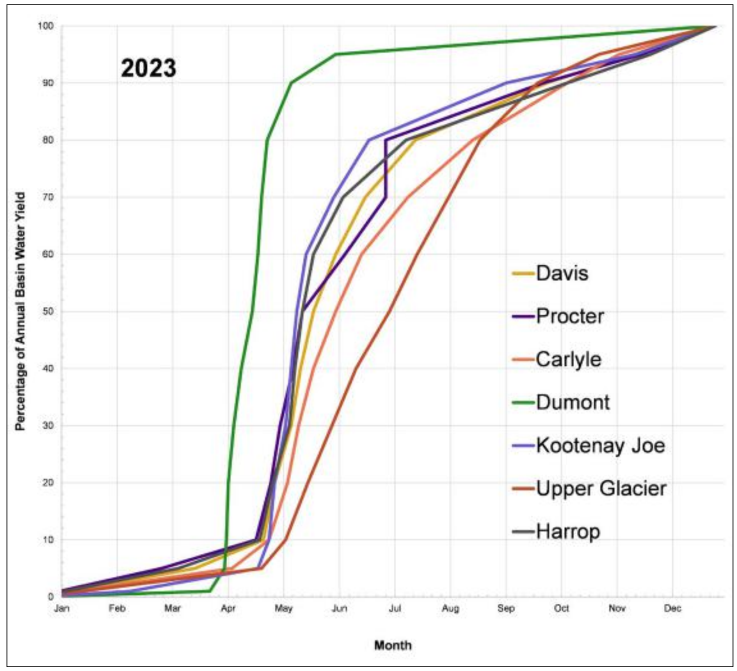
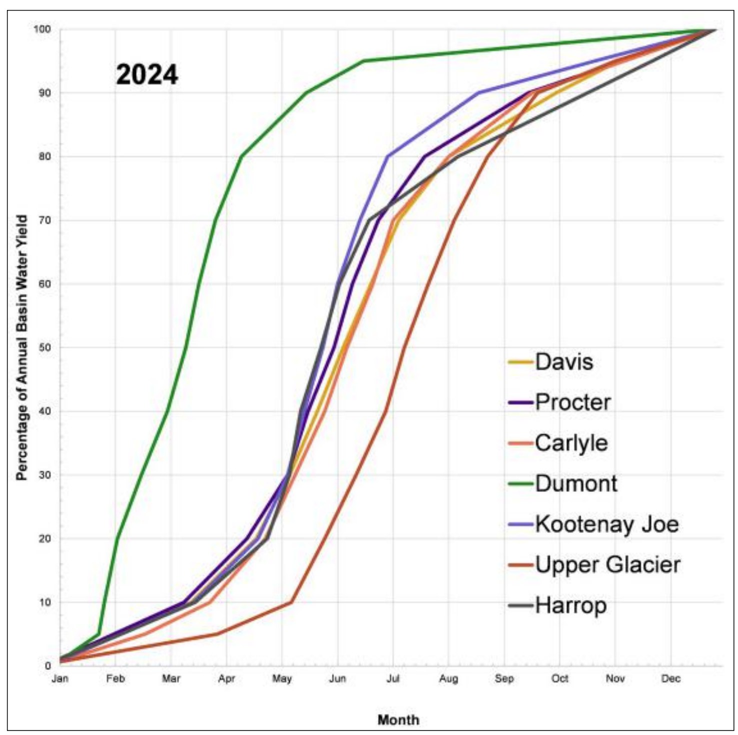
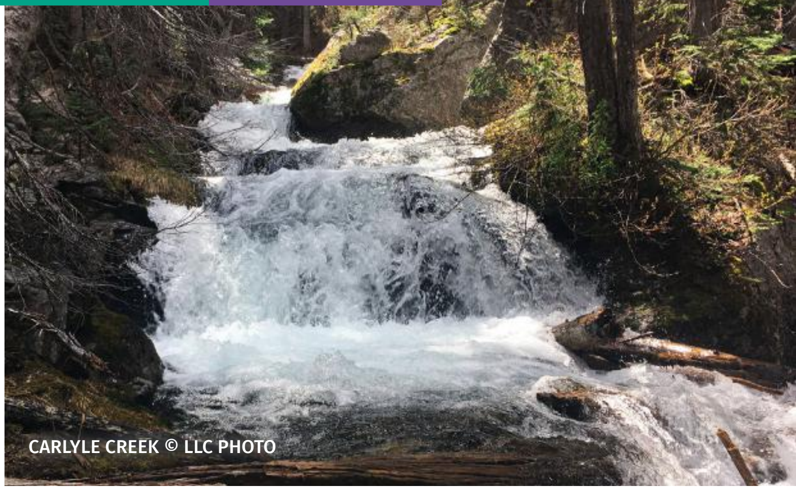


Figure 5. Cumulative runoff curves for a collection of smaller watersheds in (a) 2023 and (b) 2024; CBWMF data.



how landscape features — such as elevation, sun exposure, and the ability to store water — affect how basins respond to changing seasonal conditions. Upper Glacier is also partially glaciated, which provides late-season water from glacial melt, shifting its runoff curve to the right in Figure 5.

These relationships between flow timing and basin characteristics can be especially distinctive in smaller watersheds.


CARLYLE CREEK © LLC PHOTO

In situations of rapid spring and early-summer heating, these local traits play a particularly important role in watershed response. In 2023 and 2024, Kootenay Joe Creek, monitored at low elevation and with a mean elevation of 1,625 metres, delivered its annual water output relatively quickly. In contrast, Carlyle watershed, with a mean elevation of 2,075 metres, shows a delay of substantial snowmelt until May, much later than watersheds with wider (and lower) elevation ranges.

Most of the 2024 curves (Figure 5b) show an overall slower runoff response across all sampled watersheds than in 2023, whereas Carlyle and Upper Glacier show little change. The rapid melt of 2023 was generally due to higher temperatures, particularly during the spring season. Significant wildfires occurred across the West Kootenay in 2023. Despite being more sun-exposed, Carlyle watershed melted later than the north-facing Harrop and Procter watersheds because of Carlyle's higher elevation.

These datasets not only allow for these kinds of comparisons between different watershed types, elevations, and responses to climate, but also provide detailed information needed to fine-tune simulation models that predict how water flows through both small and large basins.

PACE IN SUMMER TIMING OF ANNUAL WATER YIELD

Using CBWMF data from specific basins, we can also look at the relative pace of within-year timing of percentage water yield from small watersheds (Figures 6). This means looking at the points in the year when a specific percentage of the total annual runoff has occurred (e.g., by what date has 20% or 50% of the annual flow happened?). This analysis of seasonal timing breaks down how water availability is shifting within each year.

For some small watersheds near Kootenay Lake (see Table A1 and Figure A2 in Appendix), there is over a decade of CBWMF data now available.

Bjerkness (Figure 6a) and Harrop (Figure 6b) watersheds, with generally cool aspects and including low-to-moderate elevations, show little change in the timing of their annual water runoff.

In these two small basins, there is no indication that water yield is starting earlier (due to earlier snowmelt) or completing earlier, which is a good sign for downstream water supplies.

Figure 6a. Trends in percentage water yield for the Bjerkness watershed, showing little change in the timing of its annual water runoff; [CBWMF data](#).

This highlights the future value of north-facing watersheds as community water supplies.

In contrast, Kootenay Joe (Figure 6c) and Carlyle (Figure 6d) may be signalling that they are melting out earlier. In Kootenay Joe's short four-year record, the points in the year when 50%, 70%, and 90% of the total annual water flow has occurred have shifted to earlier dates, meaning the stream is releasing most of its annual water earlier in the year during this monitoring period — potential signs of climate-driven changes of annual water runoff. While these changes may be the direct result of climate change, the changes may also be indirectly enhanced by climate change through contributions of a 2022 wildfire, which burned portions of the Kootenay Joe watershed, reducing forest cover and water storage on the landscape.

With a longer 11-year record, Carlyle shows no change in the timing of the 20%, 50%, and 70% yields, but the point when 90% of the annual water has flowed out of the watershed is now happening about a month earlier than it did 11 years ago. This suggests that summer heating may be accelerating the loss of its high-elevation snowpack.

Watersheds with similar characteristics to Carlyle would normally be important water-source areas in the fall for fish habitat and community water supply, so this trend is concerning because it suggests that less water may be available later in the season when it's most needed for sustaining aquatic ecosystems and meeting community demands. North-facing, high-elevation watersheds may still be relatively unaffected and able to contribute to late-September and October flows.

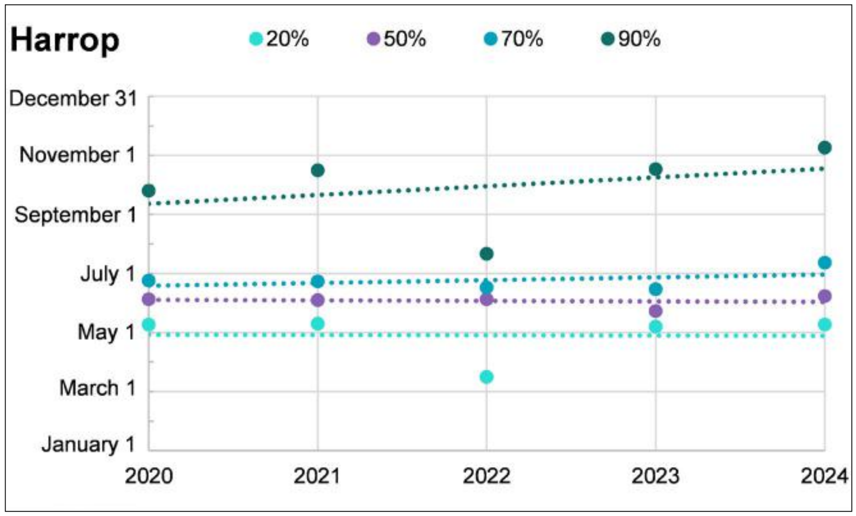


Figure 6b. Trends in percentage water yield for the Harrop watershed. This watershed is monitored in collaboration with the Harrop-Procter Watershed Protection Society; [CBWMF data](#).

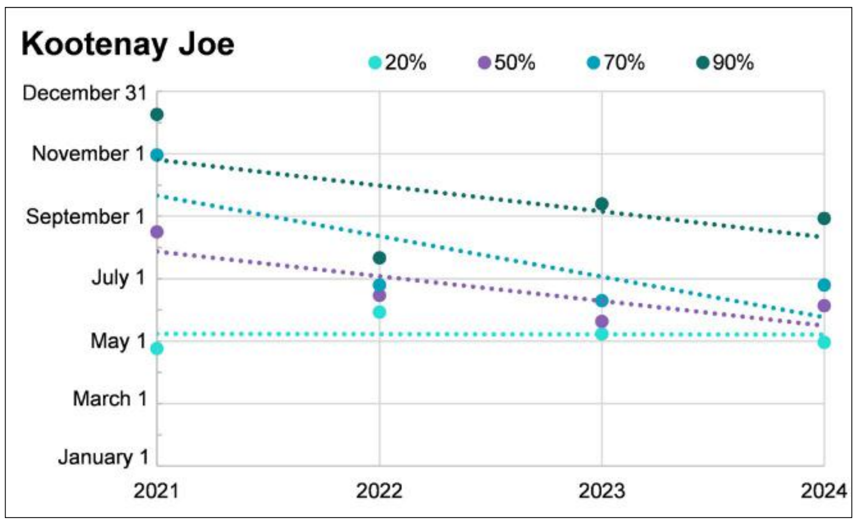


Figure 6c. Trends in percentage water yield for Kootenay Joe watershed, showing signs of potential climate-driven changes of annual water runoff; [CBWMF data](#).

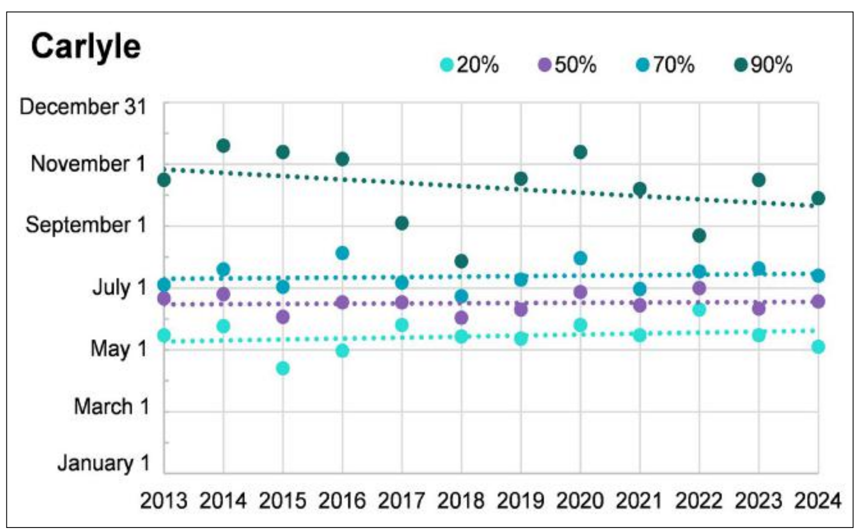


Figure 6d. Trends in percentage water yield for Carlyle watershed, showing signs of potential climate-driven changes of annual water runoff; [CBWMF data](#).

DISCUSSION & KEY TAKEAWAYS

These new CBWMF data sets may be used across the West Kootenay region to assess drought potential in small watersheds and develop adaptation strategies.

Climate change projections and the long-term streamflow trends within the West Kootenay depict water supplies that are in jeopardy and becoming more uncertain into the future. In this region, these variable and vulnerable small watersheds are often the primary source of water for communities and aquatic ecosystems.

With diverse landscape characteristics and extensive forest and soil disturbances across the region, runoff response to climate change will not happen uniformly. In this turbulent transition, smaller watersheds like Dumont will likely be first to see water-availability challenges, followed by other exposed watersheds lacking high-elevation snowpacks; this raises pressing questions of mitigation and adaptation to water stress. More drastic mitigation strategies, such as developing water-storage options, potentially in alignment with projected ecosystem shifts, may be required.

Fortunately, some watersheds are more resilient to the drier summer conditions being brought on by climate change, particularly those that include north-facing terrain and/or portions at higher elevations. Local examples like the Bjerkness and Harrop watersheds show little change in the timing of their annual water runoff. When considering downstream water supplies, the future value of north-facing watersheds as community water supplies should be considered.

Without a sharp reduction in global carbon emissions, water stress and scarcity will increasingly affect watersheds of all sizes during late summer and fall.

While shifting trends in seasonality and consistency of flow in this region are already impacting communities and ecosystems, we also need to consider the future risks to our health and safety. Factors such as water security at the community level, impacts to hydroelectric generation, and health risks like higher pollutant concentrations and compromised sanitation infrastructure could result from ignoring these observable trends.

The data collected through the CBWMF network provides a deeper understanding of how small watersheds respond to changing conditions by revealing essential information that is often missing from larger-scale models and planning tools.

> “In many ways, the smaller watersheds of the Canadian Columbia Basin together act as a canary in the coalmine and, as our understanding of them improves, they can be used to track changes in water reliability for community resilience and ecosystem health.” *~Dr. Martin Carver, Consulting Geoscientist & CBWMF Science Advisor*

BJERKNESS CREEK © LLC PHOTO

These findings highlight the following priorities for watershed management:

- **Enhancing climate resilience** by revealing trends in runoff timing and volume that can inform proactive water management.
- **Improving accuracy of other modeling platforms** by applying CBWMF in model calibration, particularly for smaller watersheds.
- **Supporting risk ranking** by enabling more detailed analysis of runoff responses, identifying which watersheds are more vulnerable to climate extremes.
- **Recognizing watershed-specific resilience** by showing that not all watersheds respond the same way to drought or warming, highlighting the need for tailored approaches.
- **Informing smarter land and water-use decisions** by emphasizing that conservation, restoration, and human-use strategies should reflect each watershed's unique characteristics and vulnerabilities.

Together, these insights offer a path toward smarter, more adaptive watershed management. As the CBWMF data sets grow in both duration and geographic reach, they will support deeper analysis and stronger decision making. By continuing to expand and analyze CBWMF data, we can better prepare for unpredictable climate disruptions and ensure the long-term protection of water resources, ecosystems, and communities across the Columbia Basin.

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APPENDIX

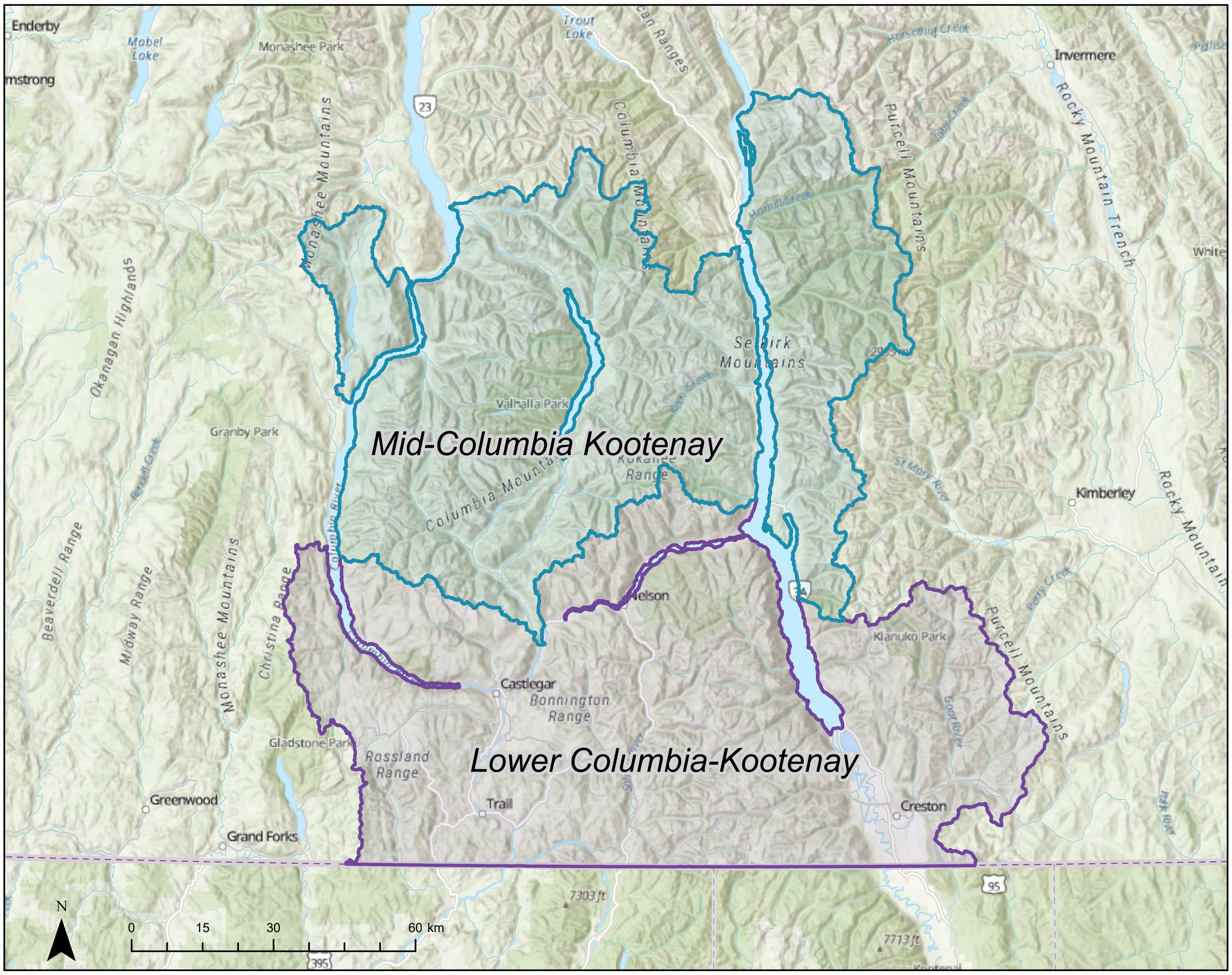

Figure A1. The Mid-Columbia Kootenay and Lower Columbia-Kootenay Hydrologic Regions of the West Kootenay. © LLC Map.

Table A1. Characteristics of selected watersheds monitored through the CBWMF network.

Station Name	Drainage Area (km^2)	Station Elevation (m)	Maximum Elevation (m)	Dominant Aspect	Mean Elevation[1] (m)
Bjerkness	26.7	625	2530	ENE	1578
Carlyle	4.13	1530	2620	SE	2075
Davis	63.6	580	2640	NE	1610
Dumont	6.51	694	1553	W	1124
Harrop	43.9	684	2336	N	1510
Kootenay Joe	6.03	890	2360	W	1625
Procter	7.17	739	2267	N	1503
Upper Glacier	42.8	1424	3178	N	2301

1 – calculated as the simple mean of each watershed's maximum and minimum elevations

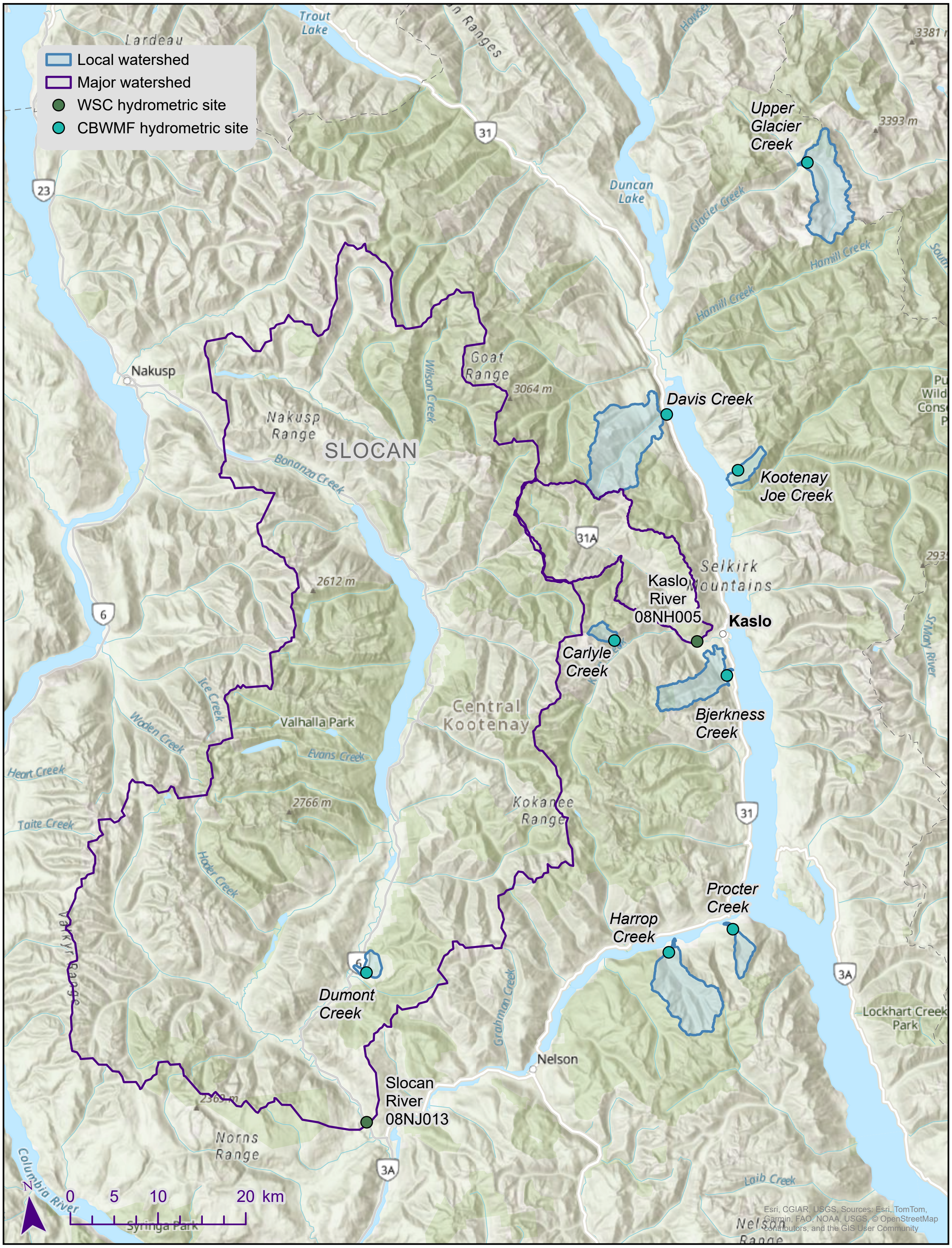

Figure A2. Selected watersheds monitored through the CBWMF network. © LLC Map.