SOCIETY FOR ECOSYSTEM RESTORATION IN NORTHERN BRITISH COLUMBIA

# Skeena Watershed Fish Passage Restoration Planning 2024

**Prepared for**
**Habitat Conservation Trust Foundation - CAT23-6-288**
**BC Fish Passage Remediation Program**
**Ministry of Transportation and Infrastructure**


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**on behalf of**
**Society for Ecosytem Restoration in Northern British Columbia**



**DRAFT Version 0.1.0 2025-03-31**

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## Acknowledgement

Modern civilization has a long journey ahead to acknowledge and address the historic and ongoing impacts of colonialism that have resulted in harm to the cultures and livelihoods living interconnected with our ecosystems for many thousands of years.

## Executive Summary

This report is available as a PDF and as an online interactive report at https://newgraphenvironment.github.io/fish_passage_skeena_2024_reporting. We recommend viewing online as the web-hosted HTML version contains more features and is more easily navigable. Please reference the website for the latest version stamped PDF from fish_passage_skeena_2024.pdf.

Since 2020, the Society for Ecosystem Restoration Northern British Columbia (SERNbc) has been actively involved in planning, coordinating, and conducting fish passage restoration efforts within the Bulkley River and Morice River watershed groups, which are sub-basins of the Skeena River watershed. In 2022, the study area was expanded to include the Zymoetz River watershed group and the Kispiox River watershed group, followed by an extension in 2023 to encompass sections of the Kitsumkalum River watershed group, particularly where Highway 16 intersects the watershed. This has resulted in an extremely large study area with thousands of crossings and numerous restoration options involving multiple stakeholders.

The primary objective of this project is to identify and prioritize fish passage barriers within these study areas, develop comprehensive restoration plans to address these barriers, and foster momentum for broader ecosystem restoration initiatives. While the primary focus is on fish passage, this work also serves as a lens through which to view the broader ecosystems, leveraging efforts to build capacity for ecosystem restoration and improving our understanding of watershed health. We recognize that the health of life - such as our own - and the health of our surroundings are interconnected, with our overall well-being dependent on the health of our environment.

Although the main purpose of this report is to document 2024 field work data and results, it also builds on reporting from field activities conducted from 2020 to 2023 and all reports can be considered living documents that can be updated and improved over time. In addition to the numerous assessments at sites undocumented in past years of the project, field activities in 2024 were also conducted at sites where habitat confirmations were previously documented within the reports linked below. The reports for these sites were edited and updated with 2024 data.

- Bulkley River and Morice River Watershed Groups Fish Passage Restoration Planning (2020)
- Bulkley River and Morice River Watershed Groups Fish Passage Restoration Planning 2021
- Bulkley River Watershed Fish Passage Restoration Planning 2022
- Skeena Watershed Fish Passage Restoration Planning 2022
- Skeena Watershed Fish Passage Restoration Planning 2023

Fish passage assessment procedures conducted through SERNbc in the Skeena River Watershed since 2020 are amalgamated online within the Results and Discussion section of the report found here which includes links to project reporting for each site.

- Field assessments were conducted between September 17, 2024 and October 03, 2024 by Al Irvine, R.P.Bio., Lucy Schick, B.Sc., Tieasha Pierre, Vern Joseph, Jesse Olson, and Jessica Doyon.
- In 2024, A total of 16 Fish Passage Assessments were completed, including 9 Phase 1 assessments and 7 reassessments.
- During the 2024 field assessments, habitat confirmation assessments were conducted at 8 sites within the Morice River, Kispiox River, and Bulkley River watershed groups. A total of approximately 6 km of stream was assessed.
- In 2024, fish sampling was conducted at 15 sites within 5 streams, with a total of 314 fish captured. Fork length, weight, and species were documented for each fish.
- In 2024, engineering designs for remediation of fish passage were completed for the following sites:
    - Waterfall Creek – PSCIS 124421 - 11th Avenue. This crossing is within New Hazelton. Waterfall Creek flows into Station Creek downstream of this site. Remediation efforts, led by Gitksan Watershed Authorities, in collaboration with SERNbc, Skeena Fisheries Commission, the Department of Fisheries and Oceans, Gitsxan House representives, the Chicago Creek Community Environmental Enhancement Society and the District of New Hazelton are tentatively planned for summer 2025. Through this year's project - SERNbc funded the engineering design for a bridge to replace the open bottom culverts - drafted by Pacific North Coast Consulting Services.
    - Tributary to Owen Creek – PSCIS crossing 197378 is located on Klate Lake Road. Through 2024/25 project activities SERNbc funded an engineering design completed by Pacific North Coast Consulting Services. Proposed works include the replacement of the existing 1.0m wide round culvert with a 12m free span bridge. This site has been earmarked for replacement through the Bii Wenii Kwa Restoration/Recovery Plan which is a collaboration between the Wet'suwet'en Treaty Society, Fisheries and Oceans Canada, BC Ministry of Forests, and Water, Land and Resource Stewardship, Morice Water Monitoring Trust, and Northwest Research and Monitoring. The Bii Wenii Kwa Watershed Restoration and Recovery Plan aims to improve watershed health and support both resident and anadromous fish while helping the Wet'suwet'en, and Federal and Provincial governments address habitat risks by enhancing and restoring fish habitat, consolidating existing data, prioritizing restoration work with cost estimates, and providing monitoring recommendations (Morgan and Reese-Hansen 2024).
- In 2024 - PSCIS crossing 198217 on a Tributary to Skeena River - Sik-E-Dakh Water Tower Road was replaced with a clear-span bridge with remediation work led by the Gitskan Watershed Authorities.
- Five streams where habitat confirmations were conducted in the past were revisited in 2024 to gather data to further inform prioritization and or to provide data for effectiveness monitoring. Below are sites visited:

- Stock Creek - PSCIS 195943 - Barrett Station Rd (electrofishing). Bulkley River watershed group.

- Taman Creek- PSCIS 197967 - Highway 16. Construction activities took place to replace this crossing between 2022 and 2024.
  Effectiveness monitoring was conducted in 2024 with results of the 2024 monitoring presented in Taman Creek - 197967 - Appendix (page 59). Bulkley River watershed group.

- Waterfall Creek – PSCIS 124421 - 11th Avenue. In addition to the aquisition of a design for PSCIS crossing 124421 on 11th Avenue discussed earlier - in 2024 a field visit was conducted which included a habitat survey covering the area from 10th avenue (Highway 16) to the waterfall located above town. Additionally an aerial survey was conducted with a drone to map the historic Waterfall Creek wetland areas located north of Highway 16/10th avenue (east of Churchill Street) to support restoration planning. Bulkley River watershed group.

  - Tributary to McDonell Lake - PSCIS 8547 - McDonell Forest Service Road. This site was visited in 2024 with the intent of conducting electrofishing to support an engineering design commissioned by SERNbc (in collaboration with Giotsxan Watershed Authorities) through this project. However, water temperatures were too low for effective sampling at that time. Although preliminary data was collected to inform an engineering design, resources were ultimately redirected to Waterfall Creek in New Hazelton. This decision followed an assessment of the stream by DFO, which suggested the stream was unlikely to support a salmon-bearing cohort. Because the associated grant funding provided to the Gitxsan Watershed Authorities was from the Salmon Restoration and Innovation Fund the site was not pursued further under that funding stream. Zymoetz River watershed group.

- Sandstone Creek - PSCIS 8530 - McDonell Forest Service Road. Electrofishing was conducted at the sites below to understand fish community composition as part of both the prioritization process and baseline monitoring. Salmonids with fork lengths >60mm were PIT-tagged to facilitate long-term tracking of health and movement with data amalgamated into past reporting here. Zymoetz River watershed group.

A major challenge in advancing fish passage restoration is the complexity of working across jurisdictions and with multiple stakeholders—rail and highway authorities, forestry ministries, licensees, and private landowners. These partners are often being asked to accommodate priorities that originate outside their mandates and budgets. Convincing them to invest in difficult, high-cost interventions—like modifying crossings or relocating infrastructure—requires navigating uncertainty about costs and ecological outcomes, as well as a disconnect between the benefits to watershed health and the internal pressures or performance goals of these agencies. It's a tough ask: to take on massive, uncertain projects when they're already stretched thin with their own responsibilities.

Fish passage restoration within the Skeena and across British Columbia is further complicated by the legacy of infrastructure deeply embedded in the landscape. Roads, railways, highways, community infrastructure and private assets often constrain floodplains and disrupt natural hydrological processes. While targeted repairs to individual barriers are essential, they won't resolve the broader systemic issues without rethinking and restructuring how infrastructure interacts with watershed function. Loss of riparian vegetation and intensive beaver management only add to the degradation. Addressing these challenges means making strategic, well-communicated choices—picking battles carefully, building trust, and staying committed to a longer-term transformation.

In 2024, all field activities since 2020—including fish passage and habitat confirmation assessments, fish sampling, drone imagery collection, engineering design, remediations, and effectiveness monitoring—were consolidated into a centralized interactive table. This tool enables multi-criteria querying (e.g., by watershed group, stream name, road name, PSCIS ID, or top-ranked sites) with direct links to supporting documentation.

While preliminary top remediation priorities are provided by watershed group, these rankings are inherently subjective and depend on the capacity and willingness of infrastructure owners and tenure holders to support implementation—both financially and over the often multi-year project timelines. In practice, we must often act opportunistically, pursuing simpler, lower-cost options to maintain momentum and achieve near-term progress.

Government, community groups, landowners, and other stakeholders should work collaboratively to address the highest-ranked barriers identified online within the Results and Discussion section of the report found here. Although the table presents many options, linked reports specify whether each site is a low, moderate, or high priority. Progress on any front is meaningful, and aiming to remediate at least one high-priority site per year per watershed group—regardless of its overall rank—is a practical and effective approach.

Of key importance as well - the placement and design of infrastructure often drives floodplain disconnection and watershed degradation. Thus, sustainable restoration must extend beyond culvert upgrades toward reimagining how infrastructure interacts with the landscape—supporting reconnection of floodplains, wetland restoration, and coexistence with keystone species such as beaver, which create wetlands and slow flows, and salmon, which deliver marine nutrients to upstream ecosystems. Foundation species like cottonwood and old-growth conifers further support watershed health by stabilizing banks, shading streams, and contributing organic material, and their restoration and conservation must be integrated alongside fish passage reconnection in any comprehensive watershed planning effort.

Although subject to revisions and updates, this report provides a snapshot of the current state of fish passage restoration within study area watershed groups in the Skeena River watershed. It is intended to inform and engage stakeholders, including Indigenous communities, government agencies, and the public, in the ongoing work of restoring fish passage and improving watershed health. We hope that this report will inspire further collaboration and action to address the challenges of fish passage restoration in the context of overall watershed health in the Skeena River basin and beyond.

# 1 Introduction

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The health and viability of freshwater fish populations can depend on access to tributary and off channel areas which provide refuge during high flows, opportunities for foraging, overwintering habitat, spawning habitat and summer rearing habitat (Bramblett et al. 2002; Swales and Levings 1989; Diebel et al. 2015). Culverts can present barriers to fish migration due to low water depth, increased water velocity, turbulence, a vertical drop at the culvert outlet and/or maintenance issues (Slaney, Zaldokas, and Watershed Restoration Program (B.C.) 1997; Cote et al. 2005). As road crossing structures are commonly upgraded or removed there are numerous opportunities to restore connectivity by ensuring that fish passage considerations are incorporated into repair, replacement, relocation and deactivation designs.

Although remediation and replacement of stream crossing structures can have benefits to local fish populations, the costs of remedial works can be significant and the impacts of the work often complex to evaluate and quantify. Additionally, allocation of ecosystem restoration funding towards infrastructure upgrades on transportation right of ways are not always considered ethical under all circumstances from all perspectives. When funds are finite and invested groups are engaged in fund raising, cost benefits and the ethics of crossing replacements should be explored collaboratively alongside the cost benefits and ethics of alternative investment activities including transportation corridor relocation/deactivation, land procurement/covenant, cattle exclusion, riparian/floodplain restoration, habitat complexing, water conservation, commercial/recreational fishing management, salt water interventions and research.

Please note that at the time of reporting this document can be considered a living document. Version numbers are logged for each release with modifications, enhancements, and other changes tracked in the Changelog (page 119) with issues and proposed/planned enhancements tracked here.

# 2 Background

The study area includes the Bulkley River, Zymoetz River, Kispiox River, Morice River and Kitsumkalum River watershed groups (Figure 2.1) and is within the traditional territories of the Wet’suwet’en, Gitxsan and Tsimshian.

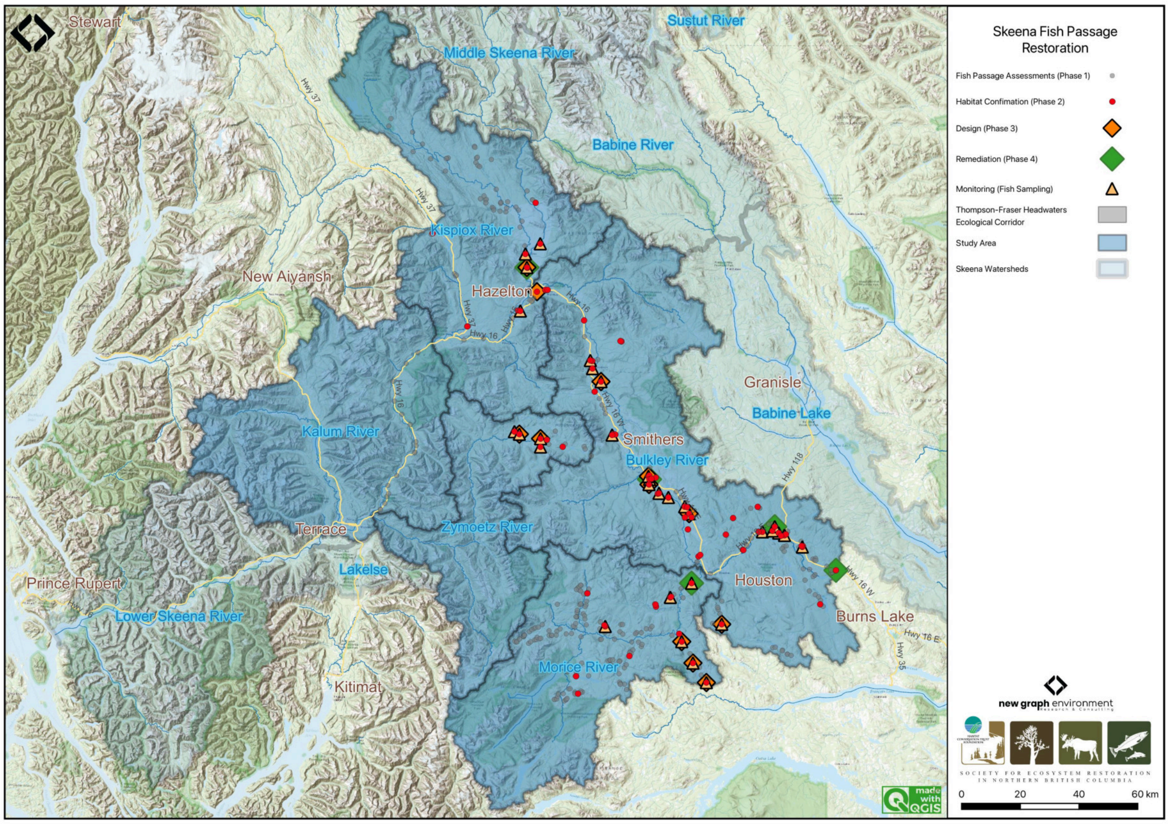



Figure 2.1: Overview map of Study Areas

## 2.1 Wet’suwet’en

Wet’suwet’en hereditary territory covers an area of 22,000km$^2$ including the Bulkley River and Morice River watersheds and portions of the Nechako River watershed. The Wet’suwet’en people are a matrilineal society organized into the Gilseyhu (Big Frog), Laksilyu (Small Frog), Tsayu (Beaver clan), Gitdumden (Wolf/Bear) and Laksamshu (Fireweed) clans. Within each of the clans there are are a number of kin-based groups known as Yikhs or House groups. The Yikh is a partnership between the people and the territory. Thirteen Yikhs with Hereditary Chiefs manage a total of 38 distinct territories upon which they have jurisdiction. Within a clan, the head Chief is entrusted with the stewardship of the House territory to ensure the Land is managed in a sustainable manner. Inuk Nu’at’en (Wet’suwet’en law) governing the harvesting of fish within their lands are based on values founded on thousands of years of social, subsistence and environmental dynamics. The Yintahk (Land) is the centre of life as well as culture and it's management is intended to provide security for sustaining salmon, wildlife, and natural foods to ensure the health and well-being of the Wet'suwet'en (Office of the Wet'suwet'en 2013; "Office of the Wet'suwet'en" 2021; FLNRORD 2017).

## 2.2 Gitxsan

Gitxsan means "People of the River Mist". The Gitxsan Laxyip (traditional territories) covers an area of 33,000km$^2$ within the Skeena River and Nass River watersheds. The Laxyip is governed by 60 Simgiigyet (Hereditary Chiefs), within the traditional hereditary system made up of Wilps (House groups). Anaat are fisheries tenures found throughout the Laxyip. Traditional governance within a matrilineal society operates under the principles of Ayookw (Gitxsan law) ("Gitxsan Huwilp Government" n.d.). Many band members live in Hazelton, Kispiox and Glen Vowell (the Eastern Gitxsan) as well as within Kitwanga, Kitwankool and Kitsegukla (the Western Gitxsan) (Powell, Jensen, and Pedersen 2018).

## 2.3 Tsimshian

The Kitsumkalum community, part of the Tsimshian Nation, maintains a rich cultural heritage rooted in ancient traditions and values. Their society, governed by Tsimshian Law (ayaawx), emphasizes strong connections through marriages, adoptions, and resource sharing with other Tsimshian tribes. The community upholds its cultural and spiritual practices, including fishing, harvesting, and land stewardship, despite the impacts of colonization (Kitsumkalum Band n.d.).

Kitsumkalum's social structure is based on matrilineal kinship, with significant emphasis on family ties through the mother's lineage. Their cultural identity is expressed through crest groups (pteex), lineage houses (waap), and the importance of landed property (laxyuup), which ties them to their ancestral territories. The community combines traditional governance with modern administrative functions, reflecting their resilience and commitment to preserving their heritage (Kitsumkalum Band n.d.).

The Kitsumkalum River salmon populations have been an important part of their culture and economy (A. Gottesfeld and Rabnett 2007).

## 2.4 Bulkley River

The Bukley River is an 8th order stream that drains an area of 7,762km$^2$ in a generally northerly direction from Bulkley Lake on the Nechako Plateau to its confluence with the Skeena River at Hazleton. It has a mean annual discharge of 138.7 m$^3$/s at station 08EE004 located near Quick

(~27km south of Telkwa) and 19 m$^3$/s at station 08EE003 located upstream near Houston. Flow patterns at Quick are heavily influenced by inflows from the Morice River (enters just downstream of Houston) resulting in flow patterns typical of high elevation watersheds which receive large amounts of precipitation as snow leading to peak levels of discharge during snowmelt, typically from May to July (Figure 2.2). The hydrograph peaks faster and generally earlier (May - June) for the Bulkley River upstream of Houston where the topography is of lower lower elevation (Figure 2.2).

Changes to the climate systems are causing impacts to natural and human systems on all continents with alterations to hydrological systems caused by changing precipitation or melting snow and ice increasing the frequency and magnitude of extreme events such as floods and droughts (Calvin et al. 2023; ECCC 2016). These changes are resulting in modifications to the quantity and quality of water resources throughout British Columbia and are likely to compound issues related to drought and flooding in the Bulkley River watershed where numerous water licenses are held with a potential over-allocation of flows identified during low flow periods (ILMB 2007).

The valley bottom has seen extensive settlement over the past hundred years with major population centers including the Village of Hazelton, the Town of Smithers, the Village of Telkwa and the District Municipality of Houston. As a major access corridor to northwestern British Columbia, Highway 16 and the Canadian National Railway are major linear developments that run along the Bulkley River within and adjacent to the floodplain with numerous crossing structures impeding fish access into and potentially out from important fish habitats. Additionally, as the valley bottom contains some of the most productive land in the area, there has been extensive conversion of riparian ecosystems to hayfields and pastures leading to alterations in flow regimes, increases in water temperatures, reduced streambank stability, loss of overstream cover and channelization (ILMB 2007; Wilson and Rabnett 2007).

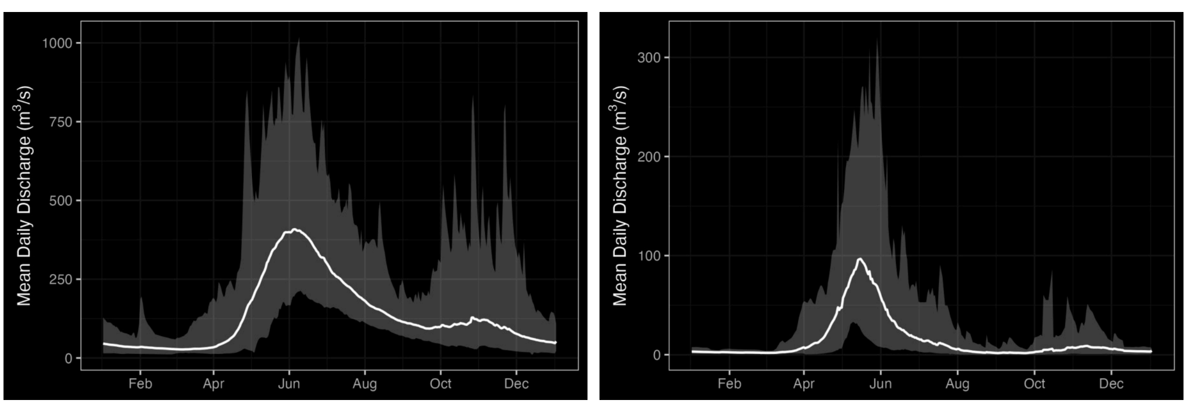



Figure 2.2: Hydrograph for Bulkley River at Quick (Station #08EE004) and near Houston (Station #08EE003).

## 2.5 Morice River

The Morice River watershed drains 4,379km$^2$ of Coast Mountains and Interior Plateau in a generally south-eastern direction. The Morice River is an 8th order stream that flows approximatley 80km from Morice Lake to the confluence with the upper Bulkley River just north of Houston. Major tributaries include the Nanika River, the Atna River, Gosnell Creek and the Thautil River. There area numerous large lakes situated on the south side of the watershed including Morice Lake, McBride Lake, Stepp Lake, Nanika Lake, Kid Price Lake, Owen Lake and others. There is one active hydrometric station on the mainstem of the Morice River near the outlet of Morice Lake and one historic station that was located at the mouth of the river near Houston that gathered data in 1971 only (Canada 2024). An estimate of mean annual discharge for the one year of data available for the Morice near it's confluence with the Bulkley River is 113 m$^3$/s. Mean annual discharge is estimated at 75 m$^3$/s at station 08ED002 located near the outlet of Morice Lake. Flow patterns are typical of high elevation watersheds influenced by coastal weather patterns which receive large amounts of winter precipitation as snow in the winter and large precipitation events in the fall. This leads to peak levels of discharge during snowmelt, typically from May to July with isolated high flows related to rain and rain on snow events common in the fall (Figure 2.3).

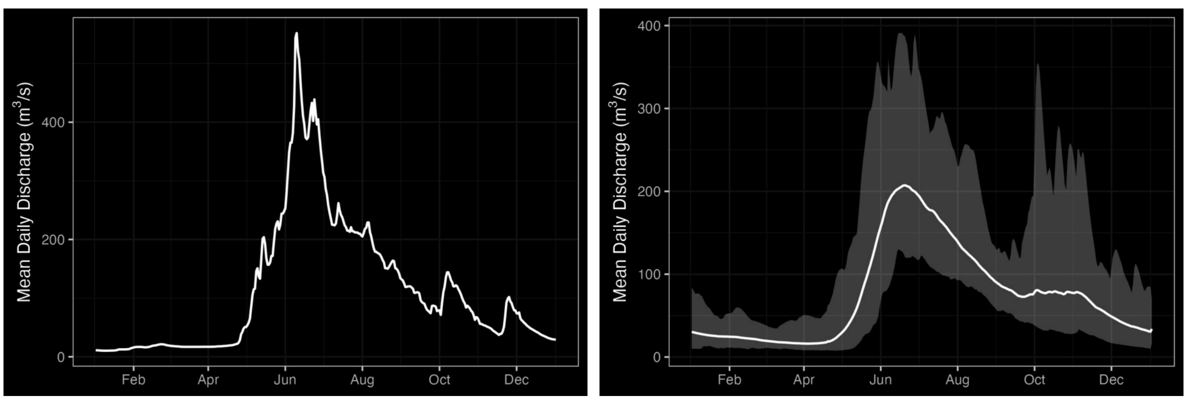



Figure 2.3: Left: Hydrograph for Morice River near Houston (Station #08ED003 - 1971 data only). Right: Hydrograph for Morice River near outlet of Morice Lake (Station #08ED002).

## 2.6 Zymoetz River

The Zymoetz River (known locally as the Copper River) watershed is an eighth order stream that drains an area of 3026km$^2$ in a generally westerly direction. It is considered a major tributary of the Skeena River, as it contributes approximately 10% of the flow. The headwater lakes are located approximately 20km southwest of Smithers, and they include Aldrich, Dennis and McDonell Lakes. The upper and lower portions of the watershed are accessed via logging roads off of Highway 16 from Smithers and Terrace, respectively. Access to the middle watershed is difficult due to road wash out. The Zymoetz River flows roughly 120km, starting just west of Hudson Bay mountain near Smithers and ending at the confluence of the Skeena River, approximately 8km north-east of

Terrace. Elevations in the watershed range from 120m at the confluence, to 2740m in the Howson Range. The Duthie mine operated on the south-west slope of Hudson Bay Mountain during the 1930's and 1950's, and reports have documented contaminated streams and lakes in the surrounding area (Allen Gottesfeld, Rabnett, and Hall 2002). The lower end of the Zymoetz watershed has seen a significant reduction in riparian habitat due to fires, forest development practices, pipe line and road construction (Allen Gottesfeld, Rabnett, and Hall 2002). Snowmelt plays a big role in controlling the stream hydrology, with a mean annual discharge estimated at 106 $m^3/s$ at station 08EF005 located near Smithers. Peak discharge happens in May to early June, which is typical of a high elevation watershed like this (Figure 2.4).

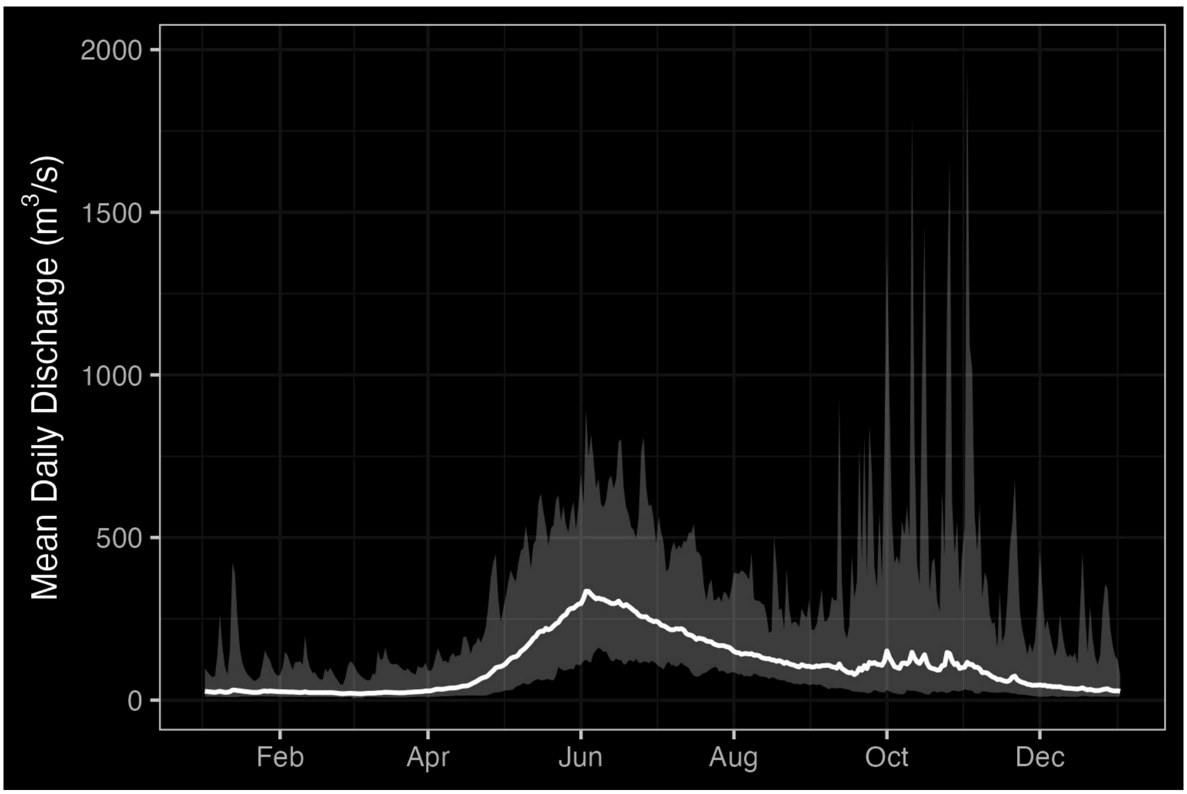



Figure 2.4: Zymoetz River Above O.k. Creek (Station #08EF005 - Lat 54.49363 Lon -128.32466). Available mean daily discharge data from 1963 to 2021.

### 2.6.1 Kispiox River

The Kispiox River watershed is a seventh order stream that drains an area of 2100$km^2$ in a south east direction. It is a large tributary of the Skeena River, contributing approximately 9% of its flow. It flows 140km to the confluence of the Skeena River, near Kispiox Village. Elevations in the watershed range from 200m at the mouth to as high as 2090m on Kispiox Mountain. The mainstream of the Kispiox is fed mainly by glacier melt and high elevation snow melt. Swan and

Stephens Lakes (located in the upper watershed) are important sockeye systems. Swan Lake drains via Club Lake into Stephens Lake which in turn flows via Stephens Creek into the mainstem of the Kispiox River. Some of the biggest threats to aquatic ecosystems in the Kispiox valley are reported as erosion, obstructions, sedimentation, and altered water yield. The upper third of the Kispiox watershed (upstream of the Nangeese River) is well protected from development by the Swan Lake Kispiox River Provincial Park and because it contains few roads with little forestry development (Allen Gottesfeld, Rabnett, and Hall 2002). The Kispiox River has a mean annual discharge estimated at 45 $m^3/s$ at station 08EB004 located near Hazelton. Peak discharge happens in May and June as a result of the spring snowmelt (Figure 2.5).

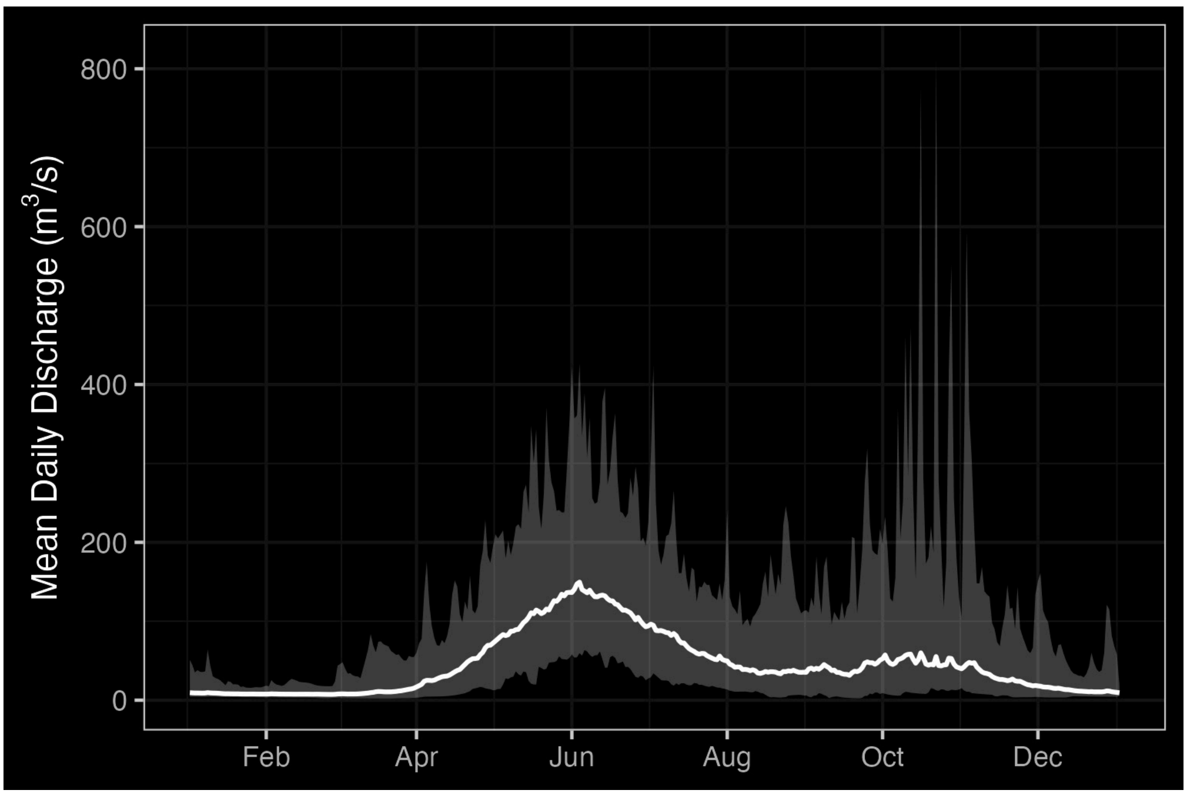



Figure 2.5: Kispiox River Near Hazelton (Station #08EB004 - Lat 55.43385 Lon -127.71616). Available mean daily discharge data from 1963 to 2022.

## 2.7 Kitsumkalum River

The Kitsumkalum River is a sixth order stream that flows east from the Coast Mountains to Kitsumkalum lake then south to Terrace where it joins the Skeena River, draining an area of 2289$km^2$. Major tributaries to the Kitsumkalum River include the Cedar River, Nelson River, Mayo Creek, Goat Creek, Lean-To Creek and Deep Creek (McElhanney 2022). Peak flows occur in May-June from snow melt with subsequent peaks the fall from rain events (McElhanney 2022). There is one hydrometric station below Kitsumkalum lake which has been active since 2018, and has a mean annual discharge of 123 $m^3/s$ (Figure 2.6). From 1929-1954, there was a hydrometric station near Terrace, which estimated the mean annual discharge to be 138$m^3/s$.

The Kitsumkalum River watershed has been highly impacted by logging. Many of the tributaries to the Kitsumkalum River have altered channel morphology, increased bedload movement, bank failures, sediment loading, and debris accumulation (A. Gottesfeld and Rabnett 2007).

There has been a significant amount of work done to enhance salmon populations within the watershed. The SkeenaWild Conservation Trust is conducting riparian restoration surveys on several tributaries to the Kitsumkalum River, including Willow Creek, Spring Creek, Lean-To Creek, and Deep Creek (Healthy Watersheds Initiative 2021). The Deep Creek Hatchery, operated by the Terrace Salmonid Enhancement Society, has been supporting Kitsumkalum River chinook populations since 1984 (A. Gottesfeld and Rabnett 2007). Additionally, there is a small groundwater facility for the incubation and rearing coho and chum, run by the Kitsumkalum First Nation (A. Gottesfeld and Rabnett 2007). In 2000 The Clear Creek Eastern Side Channel was constructed to enhance juvenile rearing habitat and adult spawning habitat for coho salmon on Clear Creek, a tributary to the Kitsumkalum River, however the site has not been maintained and beaver activity has obstructed fish accessibility to much of the channel (Elmer 2021).

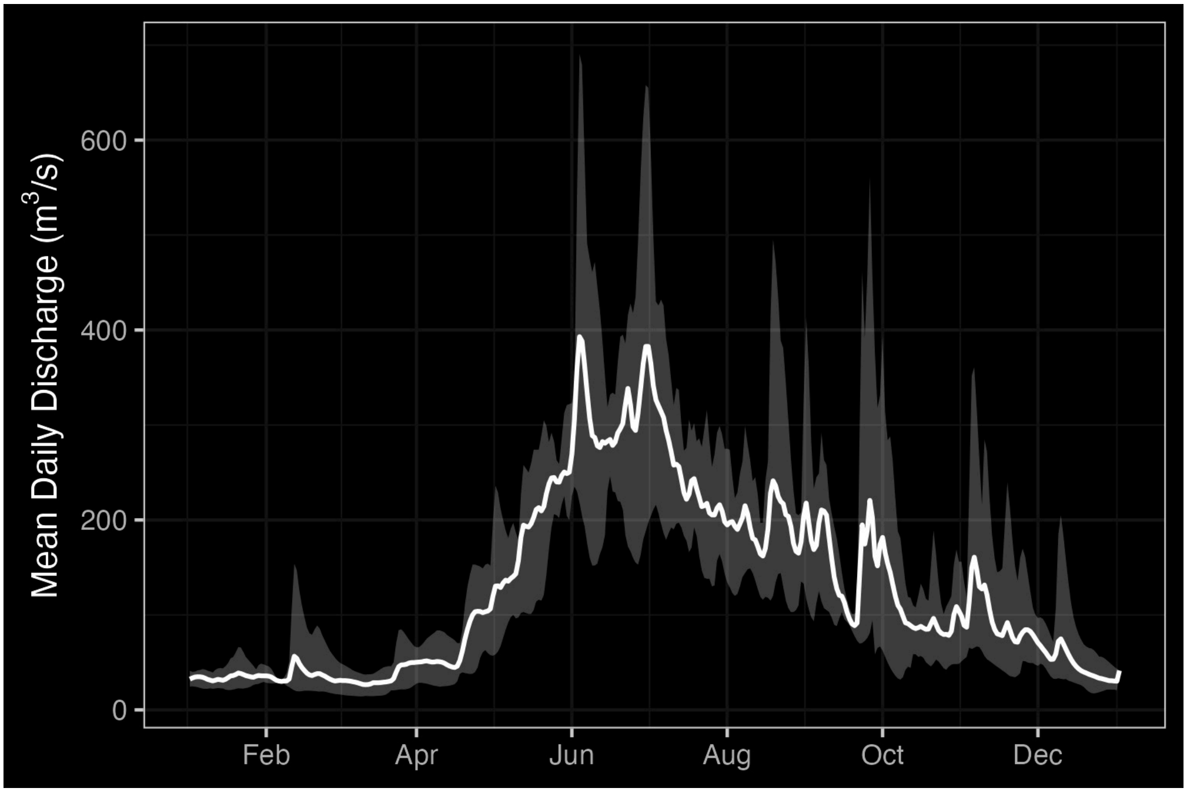



Figure 2.6: Kitsumkalum River Below Alice Creek (Station #08EG019 - Lat 54.6793 Lon -128.74396). Available mean daily discharge data from 2018 to 2022.

### 2.8 Fisheries

In 2004, IBM Business Consulting Services (2006) estimated the value of Skeena Fisheries at an annual average of $110 million dollars. The Bulkley-Morice watershed is an integral part of the salmon production in the Skeena drainage and supports an internationally renown steelhead, chinook and coho sport fishery (Tamblyn 2005).

#### 2.8.1 Bulkley River

Traditionally, the salmon stocks passing through and spawning in the greater Bulkley River were the principal food source for the Gitxsan and Wet'suwet'en people living there (Wilson and Rabnett 2007). Anadromous lamprey passing through and spawning in the upper Bulkley River were traditionally also an important food source for the Wet'suwet'en (A. Gottesfeld and Rabnett (2007); pers comm. Mike Ridsdale, Environmental Assessment Coordinator, Office of the Wet'suwet'en). A. Gottesfeld and Rabnett (2007) report sourceing information from Department of Fisheries and Oceans (1991) that principal spawning areas for chinook in the Neexdzii Kwah include the mainstem above and below Buck and McQuarrie Creeks, between Cesford and Watson Creeks, and the reaches upstream and downstream of Bulkley Falls.

## 2.8 Fisheries

Renowned as a world class recreational steelhead and coho fishery, the greater Bulkley River receives some of the heaviest angling pressure in the province. In response to longstanding angler concerns with respect to overcrowding, quality of experience and conflict amongst anglers, an Angling Management Plan was drafted for the river following the initiation of the Skeena Quality Waters Strategy process in 2006 and an extensive multi-year consultation process. The plan introduces a number of regulatory measures with the intent to provide Canadian resident anglers with quality steelhead fishing opportunities. Regulatory measures introduced with the Angling Management Plan include prohibited angling for non-guided non-resident aliens on Saturdays and Sundays, Sept 1 - Oct 31 within the Bulkley River, angling prohibited for non-guided non-resident aliens on Saturdays and Sundays, all year within the Suskwa River and angling prohibited for non-guided non-resident aliens Sept 1 - Oct 31 in the Telkwa River. The Neexdzii Kwah is considered Class II water and there is no fshing permitted upstream of the Morice/Bulkley River Confluence (FLNRO 2013a, 2013b; FLNRORD 2019).

### 2.8.1.1 Upper Bulkley Falls

A detailed field assessment and write up regarding the upper Bulkley falls was conducted as part of fish passage restoration in the watershed - is presented in Irvine (2021) with a condensed summary here. The site was assessed on October 28, 2021 by Nallas Nikal, B.i.T, and Chad Lewis, Environmental Technician. The top of the falls is located at 11U.678269.6038266 at an elevation of 697m approximatley 11.3km downstream of Bulkley Lake and upstream of Ailport Creek. Within the Bulkley River immediately below the 12 - 15m high bedrock falls, the channel width was 17.4m and the wetted width was 15.6m. Two channels comprised the falls. The primary channel was 20m long, had a channel/wetted width of 8.5m, a 16% grade and water depths ranging from 35 - 63cm. The secondary channel was 25m long, with channel/wetted widths of 7.5m, a grade of 12% and water depths ranging from 3 - 13cm (Irvine 2021).

Dyson (1949) and Stokes (1956) report substantial use of habitat above Bulkley Falls by steelhead, chinook, coho and sockeye utilization in the past (pre-1950) based on spawning reports. Both authors concluded that the Bulkley Falls pose a partial obstruction to migrating fish based on flow levels. Chinook, which migrate early in the summer when water levels are high, have been noted as able to ascend the falls in normal to high water years and in high water years it was thought that coho and steelhead could ascend. A. Gottesfeld and Rabnett (2007) report that the falls are almost completely impassable to all salmon during low water flows. Stokes (1956) reports that there was high value spawning habitat located within the first 3km of the Neexdzii Kwah from the outlet of Bulkley Lake.

Wilson and Rabnett (2007) reported that approximately 11.3 km downstream of the Bulkley Lake outlet and just upstream of Watson Creek, the upper Bulkley falls is an approximately 4m high narrow rock sill that crosses the Neexdzii Kwah, producing a steep cascade section. This obstacle to fish passage is recorded as an almost complete barrier to fish passage for salmon during low water flows. Wilson and Rabnett (2007) also reported that coho have not been observed beyond the falls since 1972.

### 2.8.2 Morice River

Detailed reviews of Morice River watershed fisheries can be found in Bustard and Schell (2002), Allen Gottesfeld, Rabnett, and Hall (2002), Schell (2003), A. Gottesfeld and Rabnett (2007), and ILMB (2007) with a comprehensive review of water quality by Oliver (2018) Overall, the Morice watershed contains high fisheries values as a major producer of chinook, pink, sockeye, coho and steelhead.

### 2.8.3 Zymoetz River

Within the Zymoetz Watershed, there are many areas with high fishery values. Steelhead are the most extensively documented fish species in the Zymoetz River watershed. Adults enter the river from July to November and then go on to spawn the following year in late spring to early summer. The Zymoetz River is a relatively steep system. Two canyons are located 6.4 and 19.6 kilometers upstream of the Skeena River confluence. These canyons make access to the Zymoetz difficult for pink and chum salmon (Allen Gottesfeld, Rabnett, and Hall 2002). The Zymoetz River is renowned for its aggressive steelhead that have been known to take flies or lures. There is a 50km stretch upstream of Limonite Creek that's very remote and offers high quality fishing opportunities for anglers (FLNRORD 2013).

Traditional First Nations use of the upper Zymoetz River watershed by the Gitxsan and Wet'suwet'en people differed between community sites, residences, and fish houses, and was large and diverse. From the upper to lower Zymoetz River and to the Skeena River, a significant ancient grease trail connected, with a branch track forking through Limonite Creek and flowing down the Telkwa River. The fishery used a weir at the mouth of McDonell Lake and spears at Six Mile Flats, near Dennis Lake. There is no information on native fisheries on the lower Zymoetz River. The Zymoetz is considered to be one of the top ten steelhead rivers in BC (Allen Gottesfeld, Rabnett, and Hall 2002).

### 2.8.4 Kispiox River

Kispiox River salmon are a important food source and cultural symbol for the Gitxsan people with sockeye and coho historically the two most significant species. Gitangwalk and Lax Didax, two significant villages that were both abandoned in the early 1900s, were situated on the Kispiox in such a way as to block the sockeye and coho salmon's upstream migration to the Upper Kispiox

River spawning grounds providing opportunities to gather and preserve a significant amount of high-quality food over relatively short time periods (Allen Gottesfeld, Rabnett, and Hall 2002). The 100 km of mainstem and 300km of tributary streams in the Kispiox River Watershed are considering high value fish habitat supporting migration, spawning and rearing for many fish species. The Kispiox fisheries supports both recreational and commercial fishing while also enhancing the ecology, nutrient regime, and structural diversity of the drainage. Since 1992, sockeye and coho escapements from the Kispiox Watershed have been documented by the Gitxsan Watershed Authorities as they creates strong cultural, economic, and symbolic ties for the local communities (Allen Gottesfeld, Rabnett, and Hall 2002).

### 2.8.5 Kitsumkalum River

The Kitsumkalum River is an important waterway for all species of salmon. It is one of the three main chinook producing rivers in the Skeena watershed and supports all five species of pacific salmon, steelhead, and other resident trout and char species (McElhanney 2022). Most notably, the Kitsumkalum River has consistently produced the largest-bodied chinook in the Skeena Watershed, as well as on most of the Pacific coast (A. Gottesfeld and Rabnett 2007). The watershed supports strong recreational coho, steelhead, and chinook fishing. Kitsumkalum salmon also play an important role in the culture and economy of the Kitsumkalum Band (A. Gottesfeld and Rabnett 2007).

### 2.8.6 Salmon Stock Assessment Data

Fisheries and Oceans Canada stock assessment data was accessed via the NuSEDS-New Salmon Escapement Database System through the Open Government Portal. A brief memo on the data extraction process is available here.

### 2.8.7 Fish Species

Fish species recorded in the Morice, Bulkley, Zymoetz, Kispiox, and Kitsumkalum Rivers watershed groups are detailed in Table 2.1 (MoE 2019). Coastal cutthrout trout and bull trout are considered of special concern (blue-listed) provincially. Summaries of some of the Skeena fish species life history, biology, stock status, and traditional use are documented in Schell (2003), Wilson and Rabnett (2007), Allen Gottesfeld, Rabnett, and Hall (2002) and Office of the Wet'suwet'en (2013). Wilson and Rabnett (2007) discuss chinook, pink, sockeye, coho, steelhead and indigenous freshwater Bulkley River fish stocks within the context of key lower and upper Bulkley River habitats such as the Suskwa River, Station Creek, Harold Price Creek, Telkwa River and Buck Creek. Key areas within the upper Bulkley River watershed with high fishery values, documented in Schell (2003), are the upper Bulkley mainstem, Buck Creek, Dungate Creek, Barren Creek, McQuarrie Creek, Byman Creek, Richfield Creek, Johnny David Creek, Aitken Creek and Emerson Creek.

Some key areas of high fisheries values for chinook, sockeye and coho are noted in Bustard and Schell (2002) as McBride Lake, Nanika Lake, and Morice Lake watersheds. A draft gantt chart for select species in the Morice River and Bulkley River watersheds was derived from reviews of the aforementioned references and is included as Figure 2.7. The data is considered in draft form and will be refined over the spring and summer of 2021 with local fisheries technicians and knowledge holders during the collaboratory assessment planning and fieldwork activities planned.

In the 1990's the Morice River watershed, A. Gottesfeld and Rabnett (2007) estimated that chinook comprised 30% of the total Skeena system chinook escapements. It is estimated that Morice River coho comprise approximatley 4% of the Skeena escapement with a declining trend noted since the 1950 in A. Gottesfeld and Rabnett (2007). Coho spawn in major tributaries and small streams ideally at locations where downstream dispersal can result in seeding of prime off channel habitats including warm productive sloughs and side channels. Of all the salmon species, coho rely on small tributaries the most (Bustard and Schell 2002). Bustard and Schell (2002) report that much of the distribution of coho into non-natal tributaries occurs during high flow periods of May - early July with road culverts blocking migration into these habitats.

Summaries of historical fish observations in the Bulkley River and Morice River watershed groups (n=4033), graphed by remotely sensed average gradient as well as measured or modelled channel width categories for their associated stream segments where calculated with `bcfishpass` and `bcfishobs` and are provided in Figures 2.8 - 2.9.

Table 2.1: Fish species recorded in the Morice River, Bulkley River, Zymoetz River, Kispiox River, and Kitsumkalum River watershed groups.

| Scientific Name | Species Name | BC List | COSEWIC | Bulkley | Kispiox | Kalum | Morice | Zymoetz |
|---|---|---|---|---|---|---|---|---|
| Catostomus catostomus | Longnose Sucker | Yellow | – | Yes | Yes | – | Yes | Yes |
| Catostomus commersonii | White Sucker | Yellow | – | Yes | Yes | Yes | Yes | – |
| Catostomus macrocheilus | Largescale Sucker | Yellow | – | Yes | Yes | Yes | Yes | Yes |
| Chrosomus eos | Northern Redbelly Dace | Yellow | – | Yes | – | – | – | – |
| Coregonus clupeaformis | Lake Whitefish | Yellow | – | Yes | Yes | – | Yes | – |
| Coregonus sardinella | Least Cisco | Blue | – | – | – | Yes | – | – |
| Cottus aleuticus | Coastrange Sculpin (formerly Aleutian Sculpin) | Yellow | – | Yes | Yes | Yes | Yes | – |
| Cottus asper | Prickly Sculpin | Yellow | – | Yes | Yes | Yes | Yes | Yes |
| Cottus cognatus | Slimy Sculpin | Yellow | – | – | Yes | Yes | – | – |
| Couesius plumbeus | Lake Chub | Yellow | DD | Yes | Yes | Yes | Yes | – |
| Entosphenus tridentatus | Pacific Lamprey | Yellow | – | Yes | – | Yes | Yes | – |
| Gasterosteus aculeatus | Threespine Stickleback | Yellow | – | – | Yes | Yes | – | – |
| Hybognathus hankinsoni | Brassy Minnow | No Status | – | Yes | – | – | – | – |
| Lampetra ayresii | River Lamprey | Yellow | – | – | – | Yes | – | – |
| Lota lota | Burbot | Yellow | – | Yes | Yes | Yes | Yes | Yes |
| Mylocheilus caurinus | Peamouth Chub | Yellow | – | Yes | Yes | Yes | Yes | Yes |
| Oncorhynchus clarkii | Cutthroat Trout | No Status | – | Yes | Yes | Yes | Yes | Yes |
| Oncorhynchus clarkii | Cutthroat Trout (Anadromous) | No Status | – | Yes | Yes | – | – | Yes |
| Oncorhynchus clarkii clarkii | Coastal Cutthroat Trout | Blue | – | Yes | Yes | Yes | Yes | Yes |
| Oncorhynchus clarkii lewisi | Westslope (Yellowstone) Cutthroat Trout | Blue | SC (Nov 2016) | – | Yes | Yes | – | – |
| Oncorhynchus gorbuscha | Pink Salmon | Not Reviewed | – | Yes | Yes | Yes | Yes | Yes |
| Oncorhynchus keta | Chum Salmon | Not Reviewed | – | Yes | Yes | Yes | Yes | Yes |
| Oncorhynchus kisutch | Coho Salmon | Not Reviewed | – | Yes | Yes | Yes | Yes | Yes |
| Oncorhynchus mykiss | Rainbow Trout | Yellow | – | Yes | Yes | Yes | Yes | Yes |
| Oncorhynchus mykiss | Steelhead | Yellow | – | Yes | Yes | Yes | Yes | Yes |
| Oncorhynchus mykiss | Steelhead (Summer-run) | Yellow | – | Yes | – | – | Yes | – |
| Oncorhynchus mykiss | Steelhead (Winter-run) | Yellow | – | – | Yes | – | – | Yes |
| Oncorhynchus nerka | Kokanee | Not Reviewed | – | Yes | Yes | Yes | Yes | Yes |
| Oncorhynchus nerka | Sockeye Salmon | Not Reviewed | – | Yes | Yes | Yes | Yes | Yes |
| Oncorhynchus tshawytscha | Chinook Salmon | Not Reviewed | E/T/SC/DD/NAR (Nov 2020) | Yes | Yes | Yes | Yes | Yes |
| Prosopium coulterii | Pygmy Whitefish | Yellow | NAR (Nov 2016) | Yes | Yes | – | Yes | – |
| Prosopium coulterii pop. 3 | Giant Pygmy Whitefish | Yellow | NAR (Nov 2016) | Yes | – | – | – | – |
| Prosopium cylindraceum | Round Whitefish | Yellow | – | – | – | Yes | – | – |
| Prosopium williamsoni | Mountain Whitefish | Yellow | – | Yes | Yes | Yes | Yes | Yes |
| Ptychocheilus oregonensis | Northern Pikeminnow | Yellow | – | Yes | Yes | – | Yes | Yes |

| Scientific Name | Species Name | BC List | COSEWIC | Bulkley | Kispiox | Kalum | Morice | Zymoetz |
|---|---|---|---|---|---|---|---|---|
| Rhinichthys cataractae | Longnose Dace | Yellow | – | Yes | Yes | Yes | Yes | Yes |
| Rhinichthys falcatus | Leopard Dace | Yellow | NAR (May 1990) | – | – | – | Yes | – |
| Richardsonius balteatus | Redside Shiner | Yellow | – | Yes | Yes | Yes | Yes | Yes |
| Salvelinus confluentus | Bull Trout | Blue | SC (Nov 2012) | Yes | Yes | Yes | Yes | Yes |
| Salvelinus fontinalis | Brook Trout | Exotic | – | Yes | – | – | Yes | – |
| Salvelinus malma | Dolly Varden | Yellow | – | Yes | Yes | Yes | Yes | Yes |
| Salvelinus namaycush | Lake Trout | Yellow | – | Yes | Yes | – | Yes | – |
| – | All Salmon | – | – | – | Yes | Yes | – | – |
| – | Arctic Char | – | – | – | – | – | Yes | – |
| – | Chub (General) | – | – | – | Yes | – | – | – |
| – | Cutthroat/Rainbow cross | – | – | Yes | Yes | Yes | – | – |
| – | Dace (General) | – | – | – | – | – | Yes | – |
| – | Lamprey (General) | – | – | Yes | Yes | Yes | Yes | – |
| – | Minnow (General) | – | – | Yes | Yes | – | Yes | – |
| – | Mottled Sculpin | – | – | Yes | – | – | – | – |
| – | Salmon (General) | – | – | Yes | Yes | – | Yes | Yes |
| – | Sculpin (General) | – | – | Yes | Yes | Yes | Yes | Yes |
| – | Squanga | – | – | – | Yes | – | – | – |
| – | Stickleback (General) | – | – | – | Yes | Yes | – | – |
| – | Sucker (General) | – | – | Yes | Yes | Yes | Yes | Yes |
| – | Verified DV BT hybrid | – | – | – | – | Yes | – | – |
| – | Whitefish (General) | – | – | Yes | Yes | Yes | Yes | Yes |

* COSEWIC abbreviations :
SC - Special concern
DD - Data deficient
NAR - Not at risk
E - Endangered
T - Threatened

BC List definitions :
Yellow - Species that is apparently secure
Blue - Species that is of special concern
Exotic - Species that have been moved beyond their natural range as a result of human activity

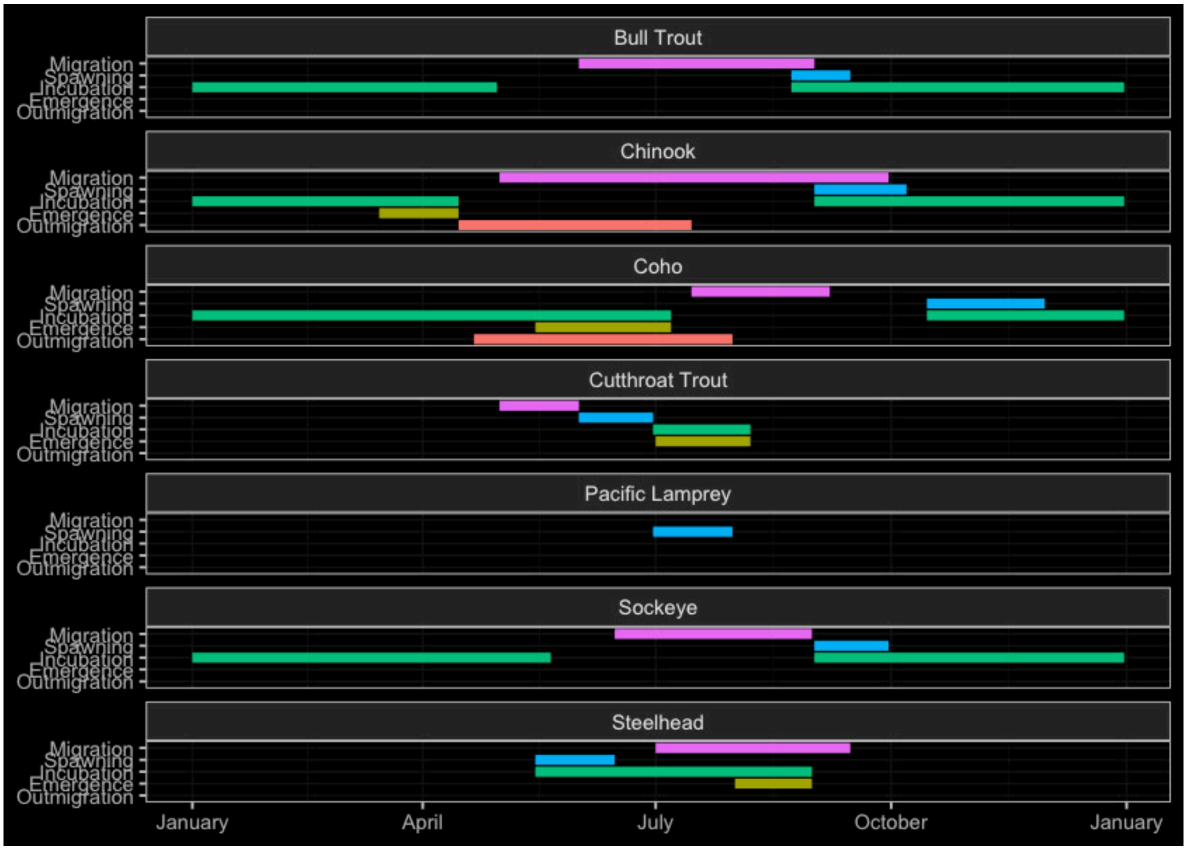



Figure 2.7: Gantt chart for select species in the Morice River and Bulkley River watersheds. To be updated in consultation with local fisheries techicians and knowledge holders.

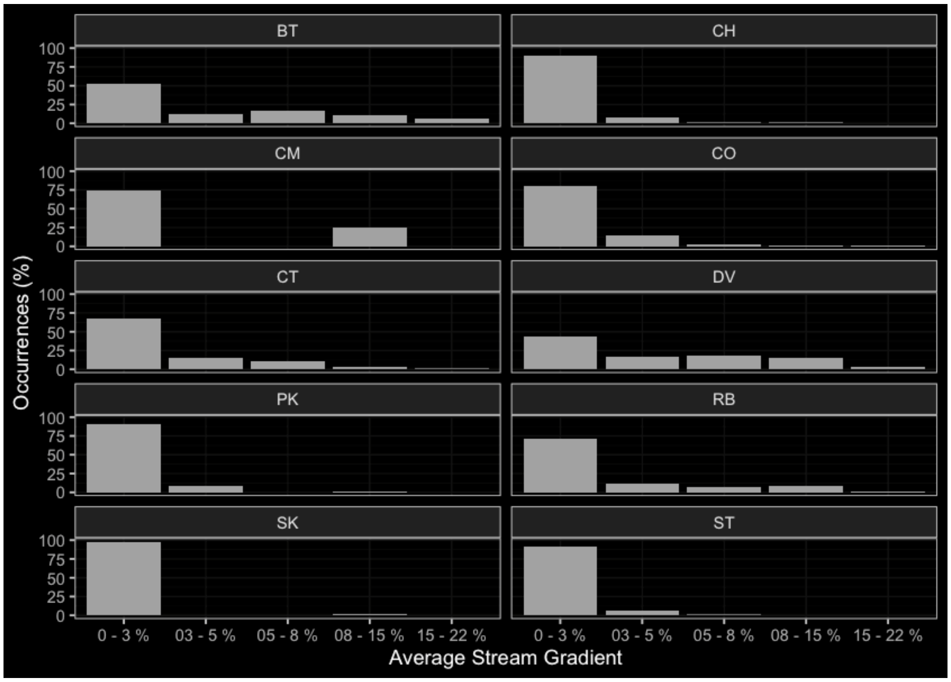



Figure 2.8: Summary of historic salmonid observations vs. stream gradient category for the Bulkley River watershed group.

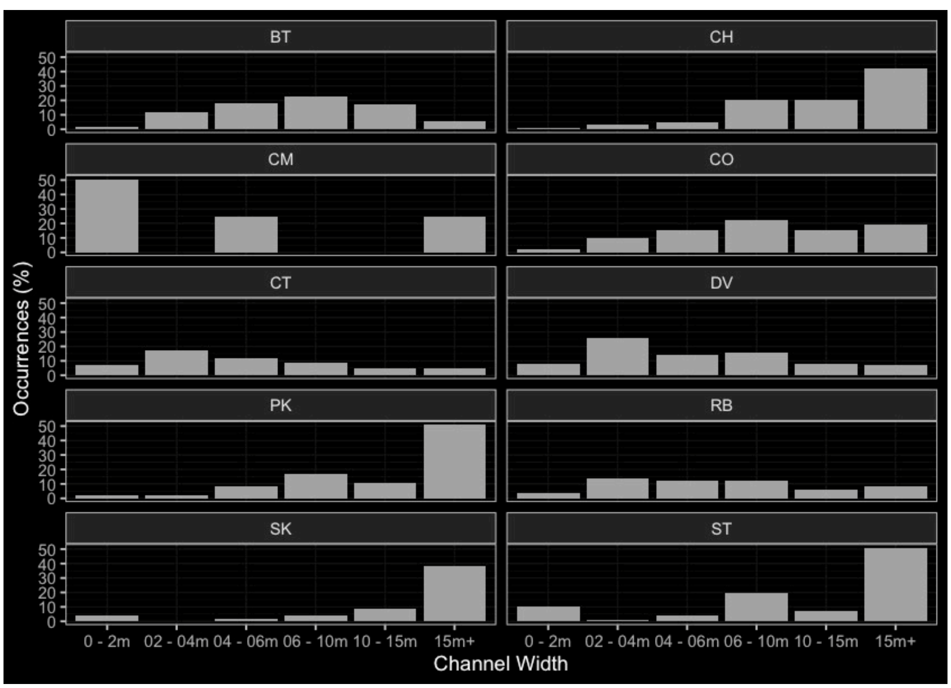



Figure 2.9: Summary of historic salmonid observations vs. channel width category for the Bulkley River watershed group.

## 2.8 Fisheries

# 3 Methods

## 3.1 Collaborative GIS Environment

Geographical Information Systems are essential for developing and communicating restoration plans as well as the reasons they are required and how they are developed. Without the ability to visualize the landscape and the data that is used to make decisions, it is difficult to conduct and communicate the need for restoration, the details of past and future plans as well as and the potential results of physical works.

To facilitate the planning and implementation of restoration activities, a collaborative GIS environment has been established using QGIS and is served on the cloud using source code stored here. This environment is intended to be a space where project team members can access, view, and contribute to the amalgamation of background spatial data and the development of restoration as well as monitoring for the project. The collaborative GIS environment allows users to view, edit, and analyze shared, up to date spatial data on personal computers in an office setting as well as on phones and tablets in the field. At the time of reporting, the environment was being used to develop and share maps, conduct spatial analyses, communicate restoration plans to stakeholders as well as to provide a central place to store methodologies and tools for conducting field assessments on standardized pre-developed digital forms. The platform can also be used to track the progress of restoration activities and monitor changes in the landscape over time, helping encourage the record keeping of past and future restoration activities in a coordinated manner.

The shared QGIS project was created using scripts currently kept in `dff-2022` with the precise calls to project creation scripts tracked in the `project_creation_and_permissions.txt` document kept in the main QGIS project directory. Information about the scripts used for GIS project creation and updates can be viewed here with outcomes of their use summarized below:

- Download and clip user specified layers from the BC Data Catalogue as well as data layers stored in custom Amazon Web Services buckets for an area of interest defined by a list of watershed groups and load to a geopackage called `background_layers.gpkg` stored in the main directory of the project.
- A project directory is created to hold the spatial data and `QGIS` project information (ie. layer symbology and naming conventions, metadata, etc.).
- Metadata for individual project spatial layers is kept in the `rfp_tracking` table within the `background_layers.gpkg` along with tables related to user supplied stream width/gradient inputs to `bcfishpass` to model potentially high value habitat that is accessible to fish species of interest.

### 3.1.1 Mapping

The workflows to produce the georeferenced `pdf` maps include using a QGIS layer file defining and symbolizing all layers required and are continuously evolving. At the time of reporting - mapping scripts and associated layer file were kept under version control within `bcfishpass` here. Loading the QGIS layer file within a QGIS project, allows load and representation of all map component layers provided the user points to a postgresql database populated via `bcfishpass` outputs.

## 3.2 Planning

### 3.2.1 Habitat Modelling

Habitat modelling used to help guide planning for field assessments is generated by `bcfishpass` (Norris [2020] 2024) which has been designed to prioritize potential fish passage barriers for assessment or remediation by generating a simple model of aquatic habitat connectivity. We utilize the `bcfishpass` access model, linear spawning/rearing habitat model and lateral habitat connectivity for planning purposes. These models provide a valuable starting point, but their results are not definitive and should always be considered with professional judgment. Detailed information regarding model methodology, select parameters and known model limitations are detailed in Norris ([2020] 2024) with key documentation linked below:

- Access model
- Linear spawning/rearing habitat models
- Lateral habitat model

Table 3.1 documents the custom species-specific thresholds for stream gradient and channel width applied to the linear spawning and rearing habitat model for this year's project planning. Although parameter values were often modified to provide a more conservative estimate of habitat, the thresholds used in the model are loosely based on the references provided in Table 3.2.

#### 3.2.1.1 Statistical Support for `bcfishpass` Fish Habitat Modelling Updates

This project provided the statistical background for updates to `bcfishpass` that facilitated incorporation of channel width (observed or predicted) into species specific linear spawning/rearing habitat models. In early 2021, Bayesian statistical methods were developed to predict channel width in all provincial freshwater atlas stream segments where width measurements had not previously been measured in the field. The model was based on the relationship between watershed area and mean annual precipitation weighted by upstream watershed area (J. Thorley and Irvine 2021). In December of 2021, J. Thorley and Irvine (2021) methods were updated using a power model derived by Finnegan et al. (2005) which relates stream discharge to watershed area and mean annual precipitation resulting in J. L. Thorley, Norris, and Irvine (2021) which was utilized for channel width estimates within `bcfishpass` modelling at the time of reporting. More detailed documentation of the methodology used to facilitate both the data collection and statistical analysis can be sourced in Irvine ([2021] 2022) and J. L. Thorley, Norris, and Irvine (2021).

In 2024, in collaboration with Poisson Consulting - stream discharge and temperature causal effects pathways were mapped with the intent of focusing aquatic restoration actions in areas of highest potential for positive impacts on fisheries values (ie. elimination of areas from intrinic models where water temperatures are likely too cold to support fish production). The project began with a custom mechanistic model (visually represented here), but the model struggled to converge. The project then shifted to the air2stream model, which offers a middle ground between fully mechanistic models—often data-intensive and reliant on quantities that are difficult to measure or estimate—and purely statistical models, which lack physical justification and perform poorly when extrapolated to new conditions (Toffolon and Piccolroaz (2015)). After several adaptations, the expected stream temperatures were best modeled using the four-parameter version of the air2stream model, with added random effects by site for each of the four parameters (Hill, Thorley, and Irvine (2024)). The data used for the model were sourced from the following locations, for years 2019-2021:

- Water temperature data collected in the Nechako Watershed were downloaded from [Zenodo] (Gilbert et al. 2022).
- Hourly air temperature data were obtained from the ERA-5-Land dataset via the Copernicus Climate Change Service (Muñoz Sabater (2019))
- Daily baseflow and surface runoff data were sourced from the [Pacific Climate Impacts Consortium's Gridded Hydrologic Model Output] using the ACCESS1-0_rcp85 scenario (Pacific Climate Impacts Consortium (n.d.)).

Table 3.1: Stream gradient and channel width thresholds used to model potentially highest value fish habitat.

| Variable | Chinook Salmon | Chum Salmon | Coho Salmon | Pink Salmon | Sockeye Salmon | Steelhead |
|---|---|---|---|---|---|---|
| Spawning Gradient Max (%) | 4.5 | 6.5 | 5.5 | 6.5 | 2.5 | 4.5 |
| Spawning Width Min (m) | 4.0 | 2.1 | 2.0 | 2.1 | 2.0 | 4.0 |
| Rearing Width Min (m) | 1.5 | – | 1.5 | – | 1.5 | 1.5 |
| Rearing Gradient Max (%) | 5.5 | – | 5.5 | – | – | 8.5 |
| * | | | | | | |

Table 3.2: References considered for stream gradient and channel width thresholds used to model potentially highest value fish habitat. Preliminary and subject to revisions.

| Variable | Chinook Salmon | Coho Salmon | Steelhead | Sockeye Salmon |
|---|---|---|---|---|
| Spawning Gradient Max (%) | 0.03 (Kirsch et al. 2004, Busch et al. 2011, Cooney and Holzer 2006) | 0.05 (Roberge et al. 2002, Sloat et al. 2017) | 0.04 (Scheer and Steel 2006, Cooney and Holzer 2006) | 0.02 (Lake 1999, Hoopes 1972) |
| Spawning Width Min (m) | 3.7 (Busch et al. 2011, Cooney and Holzer 2006) | 2 (Sloat et. al 2017) | 3.8 (Cooney and Holzer 2006) | 2 (Woll et al. 2017) |
| Rearing Gradient Max (%) | 0.05 (Woll et al. 2017, Porter et al. 2008) | 0.05 (Kirsch et al. 2004, Porter et al. 2008, Rosenfeld et al. 2000) | 0.074 (Porter et al. 2008) | – |

* The maximum gradient for steelhead rearing has been adjusted to 8.5% based on professional judgment, although references indicate 7.49%

## 3.3 Fish Passage Assessments

### 3.3.1 Natural Barriers to Fish Passage

Our assessments may include natural features such as waterfalls that could limit fish passage. This informs whether upstream culvert upgrades would restore access for anadromous species (e.g., salmon) or primarily benefit resident fish already upstream. We document these features by measuring height, gradient, and pool depth, recording field observations, capturing site photographs, and reviewing background sources for context.

### 3.3.2 Road Stream Crossings

In the field, crossings prioritized for follow-up were first assessed for fish passage following the procedures outlined in “Field Assessment for Determining Fish Passage Status of Closed Bottomed Structures” (MoE 2011). The reader is referred to (MoE 2011) for detailed methodology. Crossings surveyed included closed bottom structures (CBS), open bottom structures (OBS) and crossings considered “other” (i.e. fords). Photos were taken at surveyed crossings and when possible included images of the road, crossing inlet, crossing outlet, crossing barrel, channel downstream and channel upstream of the crossing and any other relevant features. The following information was recorded for all surveyed crossings: date of inspection, crossing reference, crew member initials, Universal Transverse Mercator (UTM) coordinates, stream name, road name and kilometer, road tenure information, crossing type, crossing subtype, culvert diameter or span for OBS, culvert length or width for OBS. A more detailed “full assessment” was completed for all closed bottom structures and included the following parameters: presence/absence of continuous culvert embedment (yes/no), average depth of embedment, whether or not the culvert bed resembled the native stream bed, presence of and percentage backwatering, road fill depth, outlet drop, outlet pool depth, inlet drop, culvert slope, average downstream channel width, stream slope, presence/absence of beaver activity, presence/absence of fish at time of survey, type of valley fill, and a habitat value rating. Habitat value ratings were based on channel morphology, flow characteristics (perennial, intermittent, ephemeral), fish migration patterns, the presence/absence of deep pools, un-embedded boulders, substrate, woody debris, undercut banks, aquatic vegetation and overhanging riparian vegetation (Table 3.3).

Table 3.3: Habitat value criteria (Fish Passage Technical Working Group, 2011).

| Habitat Value | Fish Habitat Criteria |
|---|---|
| High | The presence of high value spawning or rearing habitat (e.g., locations with abundance of suitably sized gravels, deep pools, undercut banks, or stable debris) which are critical to the fish population. |
| Medium | Important migration corridor. Presence of suitable spawning habitat. Habitat with moderate rearing potential for the fish species present. |
| Low | No suitable spawning habitat, and habitat with low rearing potential (e.g., locations without deep pools, undercut banks, or stable debris, and with little or no suitably sized spawning gravels for the fish species present). |

Fish passage potential was determined for each stream crossing identified as a closed bottom structure as per MoE (2011). The combined scores from five criteria: depth and degree to which the structure is embedded, outlet drop, stream width ratio, culvert slope, and culvert length were used to screen whether each culvert was a likely barrier to some fish species and life stages (Tables 3.4 - 3.5). These criteria were developed based on data obtained from various studies and reflect an estimation for the passage of a juvenile salmon or small resident rainbow trout (Clarkin et al. 2005; Bell 1991; Thompson 2013). For crossings determined to be potential barriers or barriers based on the data, a culvert fix and recommended diameter/span was proposed.

Table 3.4: Fish Barrier Risk Assessment (MoE 2011).

| Risk | LOW | MOD | HIGH |
|---|---|---|---|
| Embedded | >30cm or >20% of diameter and continuous | <30cm or 20% of diameter but continuous | No embedment or discontinuous |
| Value | 0 | 5 | 10 |
| Outlet Drop (cm) | <15 | 15-30 | >30 |
| Value | 0 | 5 | 10 |
| SWR | <1.0 | 1.0-1.3 | >1.3 |
| Value | 0 | 3 | 6 |
| Slope (%) | <1 | 1-3 | >3 |
| Value | 0 | 5 | 10 |
| Length (m) | <15 | 15-30 | >30 |
| Value | 0 | 3 | 6 |

Table 3.5: Fish Barrier Scoring Results (MoE 2011).

| Cumlative Score | Result |
|---|---|
| 0-14 | passable |
| 15-19 | potential barrier |
| >20 | barrier |

The habitat gain index is the quantity of modelled habitat upstream of the subject crossing and represents an estimate of habitat gained with remediation of fish passage at the crossing. For this project, a gradient threshold between accessible and non-accessible habitat was set at 20% (for a minimimum length of 100m) intended to represent the maximum gradient of which the strongest swimmers of anadromous species (steelhead) are likely to be able to migrate upstream.

For reporting of Phase 1 - fish passage assessments within the body of this report (Table 3.4), a “total” value of habitat <20% output from `bcfishpass` was used to estimate the amount of habitat upstream of each crossing less than 20% gradient before a falls of height >5m - as recorded in MoE

(2020) or documented in other `bcfishpass` online documentation. For Phase 2 - habitat confirmation sites, conservative estimates of the linear quantity of habitat to be potentially gained by fish passage restoration, steelhead rearing maximum gradient threshold (8.5%) was used. To generate estimates for area of habitat upstream ($m^2$), the estimated linear length was multiplied by half the downstream channel width measured (overall triangular channel shape) as part of the fish passage assessment protocol. Although these estimates are not generally conservative, have low accuracy and do not account for upstream stream crossing structures they allow a rough idea of the best candidates for follow up.

Potential options to remediate fish passage were selected from MoE (2011) and included:

- Removal (RM) - Complete removal of the structure and deactivation of the road.
- Open Bottom Structure (OBS) - Replacement of the culvert with a bridge or other open bottom structure. Based on consultation with FLNR road crossing engineering experts, for this project we considered bridges as the only viable option for OBS type .
- Streambed Simulation (SS) - Replacement of the structure with a streambed simulation design culvert. Often achieved by embedding the culvert by 40% or more. Based on consultation with FLNR engineering experts, we considered crossings on streams with a channel width of <2m and a stream gradient of <8% as candidates for replacement with streambed simulations.
- Additional Substrate Material (EM) - Add additional substrate to the culvert and/or downstream weir to embed culvert and reduce overall velocity/turbulence. This option was considered only when outlet drop = 0, culvert slope <1.0% and stream width ratio < 1.0.
- Backwater (BW) - Backwatering of the structure to reduce velocity and turbulence. This option was considered only when outlet drop < 0.3m, culvert slope <2.0%, stream width ratio < 1.2 and stream profiling indicates it would be effective..

### 3.3.3 Cost Estimates

Cost estimates for structure replacement with bridges and embedded culverts were generated based on the channel width, slope of the culvert, depth of fill, road class and road surface type. Road details were sourced from FLNRORD (2020b) and FLNRORD (2020a) through `bcfishpass`. Interviews with Phil MacDonald, Engineering Specialist FLNR - Kootenay, Steve Page, Area Engineer - FLNR - Northern Engineering Group and Matt Hawkins - MoTi - Design Supervisor for Highway Design and Survey - Nelson were utilized to help refine estimates which have since been adjusted for inflation in 2020 and based on past experience.

Base costs for installation of bridges on forest service roads and permit roads with surfaces specified in provincial GIS road layers as rough and loose was estimated at $30000/linear m and assumed that the road could be closed during construction and a minimum bridge span of 15m. For streams with channel widths <2m, embedded culverts were reported as an effective solution with total installation costs estimated at $100k/crossing (pers. comm. Phil MacDonald, Steve Page then adjusted for inflation in 2020). For larger streams (>6m), estimated span width increased proportionally to the size of the stream. For crossings with large amounts of fill (>3m), the replacement bridge span was increased by an additional 3m for each 1m of fill >3m to account for cutslopes to the stream at a 1.5:1 ratio. To account for road type, a multiplier table was generated to estimate incremental cost increases with costs estimated for structure replacement on paved surfaces, railways and arterial/highways costing up to 15 times more than forest service roads due to expenses associate with design/engineering requirements, traffic control and paving. The cost multiplier table (Table 3.7) should be considered very approximate with refinement recommended for future projects.

### 3.3.4 Climate Change Risk Assessment

In collaboration with the Ministry of Transportation and Infrastructure (MoTi), a new climate change replacement program aims to prioritize vulnerable culverts for replacement (pers. comm Sean Wong, 2022) based on data collected and ranked related to three categories - culvert condition, vulnerability and priority. Within the "condition" risk category - data was collected and crossings were ranked based on erosion, embankment and blockage issues. The "climate" risk category included ranked assessments of the likelihood of both a flood event affecting the culvert as well as the consequence of a flood event affecting the culvert. Within the "priority" category the following factors were ranked - traffic volume, community access, cost, constructability, fish bearing status and environmental impacts (Table 3.6). This project is still in its early stages with methodology changes going forward.

Table 3.6: Climate change data collected at MoTi culvert sites

| Parameter | Description |
|---|---|
| erosion_issues | Erosion (scale 1 low - 5 high) |
| embankment_fill_issues | Embankment fill issues 1 (low) 2 (medium) 3 (high) |
| blockage_issues | Blockage Issues 1 (0-30%) 2 (>30-75%) 3 (>75%) |
| condition_rank | Condition Rank = embankment + blockage + erosion |
| condition_notes | Describe details and rational for condition rankings |
| likelihood_flood_event_affecting_culvert | Likelihood Flood Event Affecting Culvert (scale 1 low - 5 high) |
| consequence_flood_event_affecting_culvert | Consequence Flood Event Affecting Culvert (scale 1 low - 5 high) |
| climate_change_flood_risk | Climate Change Flood Risk (likelihood x consequence) 1-6 (low) 6-12 (medium) 10-25 (high) |
| vulnerability_rank | Vulnerability Rank = Condition Rank + Climate Rank |
| climate_notes | Describe details and rational for climate risk rankings |
| traffic_volume | Traffic Volume 1 (low) 5 (medium) 10 (high) |
| community_access | Community Access - Scale - 1 (high - multiple road access) 5 (medium - some road access) 10 (low - one road access) |
| cost | Cost (scale: 1 high - 10 low) |
| constructability | Constructibility (scale: 1 difficult -10 easy) |
| fish_bearing | Fish Bearing 10 (Yes) 0 (No) - see maps for fish points |
| environmental_impacts | Environmental Impacts (scale: 1 high -10 low) |
| priority_rank | Priority Rank = traffic volume + community access + cost + constructability + fish bearing + environmental impacts |
| overall_rank | Overall Rank = Vulnerability Rank + Priority Rank |
| priority_notes | Describe details and rational for priority rankings |

Table 3.7: Cost multiplier table based on road class and surface type.

| Class | Surface | Class Multiplier | Surface Multiplier | Bridge $/15m | Streambed Simulation $ |
|---|---|---|---|---|---|
| FSR | Rough | 1 | 1 | 450,000 | 100,000 |
| FSR | Loose | 1 | 1 | 450,000 | 100,000 |
| Resource | Loose | 1 | 1 | 450,000 | 100,000 |
| Resource | Rough | 1 | 1 | 450,000 | 100,000 |
| Permit | Unknown | 1 | 1 | 450,000 | 100,000 |
| Permit | Loose | 1 | 1 | 450,000 | 100,000 |
| Permit | Rough | 1 | 1 | 450,000 | 100,000 |
| Unclassified | Loose | 1 | 1 | 450,000 | 100,000 |
| Unclassified | Rough | 1 | 1 | 450,000 | 100,000 |
| Unclassified | Paved | 1 | 2 | 750,000 | 150,000 |
| Unclassified | Unknown | 1 | 2 | 750,000 | 150,000 |
| Local | Loose | 4 | 1 | 1,500,000 | 200,000 |
| Local | Paved | 4 | 2 | 3,000,000 | 400,000 |
| Collector | Paved | 4 | 2 | 3,000,000 | 400,000 |
| Arterial | Paved | 15 | 2 | 11,250,000 | 1,500,000 |
| Highway | Paved | 15 | 2 | 11,250,000 | 1,500,000 |
| Rail | Rail | 15 | 2 | 11,250,000 | 1,500,000 |

## 3.4 Habitat Confirmation Assessments

Following fish passage assessments, habitat confirmations were completed in accordance with procedures outlined in the document "A Checklist for Fish Habitat Confirmation Prior to the Rehabilitation of a Stream Crossing" (Fish Passage Technical Working Group 2011). The main objective of the field surveys was to document upstream habitat quantity and quality and to determine if any other obstructions exist above or below the crossing. Habitat value was assessed based on channel morphology, flow characteristics (perennial, intermittent, ephemeral), the presence/absence of deep pools, un-embedded boulders, substrate, woody debris, undercut banks, aquatic vegetation and overhanging riparian vegetation. Criteria used to rank habitat value was based on guidelines in Fish Passage Technical Working Group (2011) (Table 3.3).

During habitat confirmations, to standardize data collected and facilitate submission of the data to provincial databases, information was collected on "Site Cards". Habitat characteristics recorded included channel widths, wetted widths, residual pool depths, gradients, bankfull depths, stage, temperature, conductivity, pH, cover by type, substrate and channel morphology (among others). When possible, the crew surveyed downstream of the crossing to a minimum distance 300m and upstream to a minimum distance of 500 - 600m. Any potential obstacles to fish passage were inventoried with photos, physical descriptions and locations recorded on site cards. Surveyed routes were recorded with time-signatures on handheld GPS units.

### 3.4.1 Fish Sampling

#### 3.4.1.1 Electrofishing

Fish sampling was conducted on a subset of sites when biological data was considered to add significant value to the physical habitat assessment information. Electrofishing was utilized for fish sampling according to stream inventory standards and procedures found in the Reconnaissance (1:20 000) Fish and Fish Habitat Inventory Manual (Resources Inventory Committee 2001). A Haltech 2000 backpack electrofisher was used within discrete site units both upstream and downstream of the subject crossing with electrofisher settings and seconds, water quality parameters (i.e. conductivity, temperature and ph), start and end locations, length of site and wetted widths (average of a minimum of three) recorded.

#### 3.4.1.2 Fish Handling and Processing

Captured fish were held in buckets with sufficient water to minimize stress until processing, and multiple buckets were used when catch numbers were high. For each fish captured, fork length, weight and species was recorded with results documented in the fish data submission spreadsheet.

#### 3.4.1.3 Pit Tagging

Fish with a fork length greater than 60 mm and belonging to species approved under the scientific fish collection permit SM24-882238 were tagged with Passive Integrated Transponders (PIT tags) using the Abdominal Cavity method outlined by Biomark. To anesthetize fish prior to pit tagging, we used a solution of approximately 0.1 mL of clove oil per 1 L of water (1:10,000). This concentration was selected for its efficiency in providing effective sedation with minimal residual effects, making it ideal for studies in which fish are released back into their natural habitats (Fernandes et al. 2017). The clove oil solution was prepared in advance by dissolving pure clove oil in ethyl alcohol in a 1:9 ratio (clove oil: ethyl alcohol) to enhance solubility, then mixed into the water bucket (Fernandes et al. 2017). Fish were immersed in this solution until they reached an appropriate level of anesthesia for handling and then were tagged. To maintain needle sharpness and minimize injury risk, needles were replaced approximately every 10 fish. Each tagged fish was scanned with the PIT reader, and both the PIT tag ID and row ID were recorded. Once tagged, fish were placed into a bucket of fresh water and allowed to recover before being released back into the stream. Fish information and habitat data will be submitted to the province under scientific fish collection permit SM24-882238.

### 3.4.2 Aerial Imagery

Scripted processing and serving of UAV imagery collected during the project is available at https://github.com/NewGraphEnvironment/stac_uav_bc/ (Irvine [2025] 2025). `OpenDroneMap` was utilized to produce orthomosaics, digital surface models (DSMs), and digital terrain models (DTMs) (OpenDroneMap Authors [2014] 2025). To support efficient web-based access - imagery products were converted to cloud-optimized GeoTIFFs (COGs) using `rio-cogeo`, then collated accordiong to the SpatioTemporal Asset Catalog (STAC) specification with `pystac` and uploaded to S3 storage Amazon Web Services (2025). A `titiler` tile server was set up to facilitate interactive viewing of the orthoimagery and an Application Program Interface (API) leveraging `stac-fastapi-pgstac` is served at https://images.a11s.one to enable linking of collection images through QGIS as well as remote spatial and temporal querying using open source software such as `rstac` (Development Seed [2019] 2025; stac-utils 2025; Simoes et al. 2021).

## 3.5 Engineering Design

Engineering designs were signed and sealed by professional engineers. When possible - completed designs are loaded to the PSCIS data portal.

## 3.6 Remediations

Structure replacement was conducted by project specific contractors. If not already completed, as-built drawings will be loaded to the PSCIS data portal.

## 3.7 Monitoring

onitoring of fish passage restoration sites — both proposed and completed - is essential to ensure restoration investments lead to meaningful ecological outcomes. Monitoring enables evaluation of whether remediation actions improve connectivity for fish and provides critical feedback to refine future prioritization and restoration strategies.

Baseline data collection, including fish sampling and aerial surveys via drone, are core components of this monitoring. While detailed methods for these activities are included in the previous habitat confirmation section, they are also fundamental to effectiveness monitoring, as they provide context to not only facilitate prioritization and communications but also for detecting change following restoration.

To support consistent and targeted assessment, a custom field form was developed for routine effectiveness monitoring based loosely on Forest Investment Account (2003) but tailored specifically for fish passage projects. Table 3.8) outlines the monitoring metrics used.

Table 3.8: Description of monitoring metrics used for effectiveness monitoring.

| Parameter | Description |
|---|---|
| Dewatering | Have the remediation works led to dewatering of the channel due to substrate aggradation or other factors? |
| Velocity | Are flow velocities similar to those within the natural channel? Are they expected to exceed swim speeds of particular fish species/life stages of interest? |
| Constriction | Have the remediation works led to constriction of the channel. Compare channel width underneath structure and within construction footprint to average channel widths upstream and downstream? |
| Substrate | Is the substrate within/under and adjacent to the remediated structure generally equivalent to that found upstream and downstream where natural channel conditions exist? |
| Riparian | What is the condition of the riparian area within the construction footprint? |
| UAV Flight | Was a flight conducted with unmmanned aerial vehicle to document conditions at time of monitoring? |
| Flow_depth | What are the flow depths at the time of assessment within project footprint. Are depths expected to be sufficient to facilitat upstream passage for specific species/life stages of interest? |
| Stability | Does the structure appear to be stable or is there evidence of erosion/shifting? |
| Revegetation | How were riparian areas rehabillitated and are they improving fish habitat value? |
| Cover | Is cover available for fish within the construction footprint in the form of overhanging vegetation, large/small woody debris, boulders, undercut banks, etc? |
| Maintenance | If required, provide maintenance recommendations. |
| Recommendations | General recommendations for follow up. Could include revegetation, addition of substrate, fish sampling, etc. |

# 4 Results and Discussion

## 4.1 Site Assessment Data Since 2020

Fish passage assessment procedures conducted through SERNbc in the Skeena River Watershed since 2020 are amalgamated online within the Results and Discussion section of the report found here.

Since 2020, orthoimagery and elevation model rasters have been generated via presented athttps://newgraphenvironment.github.io/fish_passage_skeena_2024_reporting/results-and-discussion.html.

## 4.2 Collaborative GIS Environment

In addition to numerous layers documenting fieldwork activities since 2020, a summary of background information spatial layers and tables loaded to the collaborative GIS project (sern_skeena_2023) at the time of writing (2025-03-31) are included online here.

## 4.3 Planning

### 4.3.1 Habitat Modelling

Habitat modelling from `bcfishpass` including access model, linear spawning/rearing habitat model and lateral habitat connectivity models for watershed groups within our study area were updated for the spring of 2025 and are included spatially in the collaborative GIS project. A snapshot of these outputs related to each modeled and PSCIS stream crossing structure are also included within an `sqlite` database within this year's project reporting/code repository here.

#### 4.3.1.1 Statistical Support for `bcfishpass` Fish Habitat Modelling Updates

Initial mapping of stream discharge and temperature causal effects pathways for the future purpose of focusing aquatic restoration actions in areas of highest potential for positive impacts on fisheries values (ie. elimination of areas from intrinsic models where water temperatures are likely too cold to support fish production) are detailed in Hill, Thorley, and Irvine (2024) which is included as Attachment 3 (page 135).

### 4.4 Fish Passage Assessements

Field assessments were conducted between September 17, 2024 and October 03, 2024 by Al Irvine, R.P.Bio., Lucy Schick, B.Sc., Tieasha Pierre, Vern Joseph, Jesse Olson, and Jessica Doyon.

#### 4.4.1 Natural Barriers to Fish Passage

An assessment of Buck falls was conducted on September 19, 2024 with results included in Buck Falls - Appendix (page 57).

#### 4.4.2 Road Stream Crossings

A total of 16 Fish Passage Assessments were completed, including 9 Phase 1 assessments and 7 reassessments.

Of the 16 sites where fish passage assessments were completed, 9 were not yet inventoried in the PSCIS system. This included 4 crossings considered “passable”, 1 crossings considered a “potential” barrier, and 4 crossings were considered “barriers” according to threshold values based on culvert embedment, outlet drop, slope, diameter (relative to channel size) and length (MoE 2011).

Reassessments were completed at 7 sites where PSICS data required updating.

A summary of crossings assessed, a rough cost estimate for remediation, and a priority ranking for follow-up for Phase 1 sites is presented in Table 4.1. Detailed data with photos are presented in Appendix.

The “Barrier” and “Potential Barrier” rankings used in this project followed MoE (2011) and represent an assessment of passability for juvenile salmon or small resident rainbow trout under any flow conditions that may occur throughout the year (Clarkin et al. 2005; Bell 1991; Thompson 2013). As noted in Bourne et al. (2011), with a detailed review of different criteria in Kemp and O’Hanley (2010), passability of barriers can be quantified in many different ways. Fish physiology (i.e. species, length, swim speeds) can make defining passability complex but with important implications for evaluating connectivity and prioritizing remediation candidates (Bourne et al. 2011; Shaw et al. 2016; Mahlum et al. 2014; Kemp and O’Hanley 2010). Washington Department of Fish & Wildlife (2009) present criteria for assigning passability scores to culverts that have already been assessed as barriers in coarser level assessments. These passability scores provide additional information to feed into decision making processes related to the prioritization of remediation site candidates and have potential for application in British Columbia.

Table 4.1: Upstream habitat estimates and cost benefit analysis for Phase 1 assessments ranked as a 'barrier' or 'potential' barrier. Steelhead network model used for habitat estimates (total length of stream network

| PSCIS ID | External ID | Stream | Road | Barrier Result | Habitat value | Habitat Upstream (km) | Stream Width (m) | Priority | Fix | Cost Est ( $K) |
|---|---|---|---|---|---|---|---|---|---|---|
| 8530 | – | Sandstone Creek | McDonnell FSR | Barrier | High | 24.0 | 3.90 | high | OBS | 990 |
| 195934 | – | Dunalter Creek | Barret Station Road | Barrier | Medium | 15.9 | 1.60 | low | SS-CBS | 200 |
| 195935 | – | Dunalter Creek | Houston Airport Road | Barrier | Medium | 15.9 | 1.70 | mod | SS-CBS | 400 |
| 195943 | – | Stock Creek | Barrett Station Road | Barrier | Medium | 23.1 | 2.60 | mod | OBS | 3000 |
| 197967 | – | Taman Creek | Highway 16 | Potential | Medium | 150.7 | 5.50 | – | OBS | 20250 |
| 203122 | 1805555 | Simpson Creek | Railway | Barrier | High | 4.1 | 5.00 | low | OBS | 11250 |
| 203123 | 8300088 | Tributary to Gershwin Creek | Comeau Road | Potential | Low | 1.8 | 0.50 | low | SS-CBS | 200 |
| 203124 | 8300015 | Tributary to Gershwin Creek | Comeau Road | Barrier | Medium | 3.2 | 0.95 | low | SS-CBS | 200 |
| 203125 | 2024092550 | Gershwin Creek | Private property | Barrier | High | 6.0 | 6.00 | mod | OBS | – |
| 203126 | 2024092003 | Simpson Creek | Private driveway | Barrier | High | 5.4 | 7.00 | low | OBS | – |

## 4.5 Habitat Confirmation Assessments

During the 2024 field assessments, habitat confirmation assessments were conducted at 8 sites within the Morice River, Kispiox River, and Bulkley River watershed groups. A total of approximately 6 km of stream was assessed. Electrofishing surveys were conducted at all habitat confirmation sites. Georeferenced field maps are provided in Attachment 1.

As collaborative decision making was ongoing at the time of reporting, site prioritization can be considered preliminary. Results are summarized in Tables 4.2 - 4.2 with raw habitat and fish sampling data included in Attachment 2. A summary of preliminary modeling results illustrates the estimated Chinook, coho, and steelhead spawning and rearing habitat potentially available upstream of each crossing, based on measured/modelled channel width and upstream accessible stream length, as presented in Figure 4.1. Detailed information for each site assessed with Phase 2 assessments (including maps) are presented within site specific appendices to this document.

Table 4.2: Overview of habitat confirmation sites. Steelhead rearing model used for habitat estimates (total length of stream network

| PSCIS ID | Stream | Road | Tenure | UTM | UTM zone | Fish Species | Habitat Gain (km) | Habitat Value | Priority | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 198935 | Tributary to Knapper Creek | Gold Creek FSR | Canfor R075496 | 636440 6020756 | 9 | CT | 0.9 | Medium | High | The stream was surveyed upstream for ~700 m. The stream exhibited medium-value habitat with a good flow and abundant gravels throughout. A mature mixed forest, including cottonwood, provided excellent bank stabilization, resulting in deeply undercut banks and intermittent pools up to 60 cm deep within the surveyed area. Electrofishing conducted downstream of the crossing captured rainbow trout, cutthroat trout, and Dolly Varden. Upstream sampling captured rainbow trout, cutthroat trout, and cutthroat trout/rainbow trout hybrids. The low-gradient habitat is suitable for cutthroat trout, rainbow trout, and coho juvenile rearing, as well as adfluvial and anadromous spawning. A sizeable beaver dam complex was present at the upper end of the surveyed area, coinciding with the confluence of a tributary mapped in the Freshwater Atlas. There is suspected interconnection between wetlands in this watershed and adjacent watersheds, suggesting the current mapping may misrepresent the watershed's size. This remains unconfirmed, but LiDAR analysis could be used to verify these connections. |
| 198940 | Tributary to Knapper Creek | HM7504 | Canfor R0754916 | 636706 6020960 | 9 | CT;RB | 1.2 | Medium | High | The stream was surveyed in the downstream direction, starting at the upstream crossing on Gold Creek FSR, down to this crossing on road/spur HM7504, approximately 340 m. This section of stream provided medium-value habitat, with good flow, abundant gravels for spawning, and suitable rearing areas within undercut banks and occasional deep pools. Evidence of historic beaver activity is present throughout the area surveyed, including one large breached dam near the upstream end of the site. The riparian zone consists of a healthy shrub and herbaceous flood-tolerant plant community. The stream corridor is approximately 40–50 m wide, bordered by mature coniferous forest on both sides. Electrofishing conducted at the upstream crossing on Gold Creek FSR captured rainbow trout, cutthroat trout, cutthroat trout/rainbow trout hybrids, and Dolly Varden. |
| 58245 | Simpson Creek | Lake Kathlyn Road | MoTi | 615383 6075125 | 9 | CO;CT;DV;MW;RB;SA;ST | 2.0 | High | Low | The stream was surveyed from the railway downstream to Lake Kathlyn Road, covering approximately 1 km. The upper 750 m of the stream is in relatively good condition, with mostly intact riparian vegetation, abundant gravels, deep pools, and large woody debris throughout. The |

| PSCIS ID | Stream | Road | Tenure | UTM | UTM zone | Fish Species | Habitat Gain (km) | Habitat Value | Priority | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| lower 250–500 m is heavily impacted by adjacent private lands, with riparian vegetation removal, stream channelization, and bank armouring. Extensive beaver activity was observed within the lower ~300 m, with dams ranging from 0.4 to 1 m in height. An additional crossing was noted on private land just upstream of Lake Kathlyn Road on a driveway. This stream is a major contributor to the greater Kathlyn Creek watershed, with flow volumes during the assessment slightly less than the Kathlyn Creek mainstem. The stream provides high-value habitat upstream, particularly in the upper sections, within this known steelhead, coho, and historically Chinook spawning system. Electrofishing upstream of Nielsen Road captured rainbow trout, while downstream sampling confirmed the presence of Dolly Varden, rainbow trout, cutthroat trout/rainbow trout hybrids, and coho. The coho were captured approximately 350 m downstream of Nielsen Road. | | | | | | | | | | |
| 198916 | Gershwin Creek | Railway | CN Rail | 580463 6115769 | 9 | – | 0.0 | Medium | High | This survey covers the area from the railway culvert (crossing 198916, ~100m long and from the 1920s) upstream to the crossing on Highway 16 (crossing 198913), spanning approximately 900 m. A separate habitat confirmation was conducted upstream of Highway 16. Therefore, this site encompasses both 198916_us and 198913_ds. A large woody debris jam was observed approximately 250 m upstream of the culvert, creating a 17% gradient over a 9 m section due to a fallen tree. The stream had good flow in this steeper section, supported by a healthy, mature mixed riparian forest that stabilized the banks. Occasional pockets of gravels suitable for coho, Dolly Varden, and cutthroat trout spawning were present. Electrofishing was conducted and Dolly Varden and cutthroat trout were captured above and below the highway crossing. WP79 markes the confluence with a steel bridge on private land. |
| 198913 | Gershwin Creek | Highway 16 | MOTi | 581250 6115660 | 9 | – | 0.0 | Medium | Moderate | The stream has frequent poo- |

| PSCIS ID | Stream | Road | Tenure | UTM | UTM zone | Fish Species | Habitat Gain (km) | Habitat Value | Priority | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| Is suitable for overwintering fish, with spawning gravel present despite a significant amount of fines. It has a low gradient near the culvert and flows through agricultural fields, but maintains sufficient riparian cover with large cottonwoods throughout the 600 m survey. A landowner-constructed bridge with two culverts is located ~250 m upstream of the highway crossing. Two ~1 m high logjams are present but remain passable for fish. Electrofishing was conducted and Dolly Varden and cutthroat trout were captured above and below the highway crossing. | | | | | | | | | | |
| 58264 | Simpson Creek | Nielson Road | MoTi | 614280 6074951 | 9 | – | 0.4 | High | High | The stream was surveyed from Nielsen Road upstream for approximately 650 m, to roughly 200 m upstream of the powerlines. The stream had a steeper gradient with predominantly boulder cover and pockets of gravels suitable for coho, steelhead, and Dolly Varden spawning. Pools were infrequent. The upper end of the site was located just upstream of a short cascade with a 20% gradient. The riparian zone consisted of a healthy, mature mixed forest. This stream is a major contributor to the greater Kathlyn Creek watershed, with flow volumes during the assessment slightly less than the Kathlyn Creek mainstem. The stream provides high-value habitat, particularly below Nielsen Road, as this is a known steelhead, coho, and historically Chinook spawning system. The culvert on Nielsen Road has a significant outlet drop and likely limits fish passage. Electrofishing upstream of Nielsen Road captured rainbow trout, while downstream sampling confirmed the presence of Dolly Varden, rainbow trout, cutthroat trout/rainbow trout hybrids, and coho. The coho were captured approximately 350 m downstream of Nielsen Road. |

Table 4.3: Summary of Phase 2 fish passage reassessments.

| PSCIS ID | Embedded | Outlet Drop (m) | Diameter (m) | SWR | Slope (%) | Length (m) | Final score | Barrier Result |
|---|---|---|---|---|---|---|---|---|
| 58245 | No | 0.00 | 2.50 | 2.80 | 2.0 | 20 | 24 | Barrier |
| 58264 | No | 1.00 | 2.40 | 2.33 | 5.0 | 23 | 39 | Barrier |
| 198913 | No | 0.35 | 1.50 | 3.33 | 3.0 | 40 | 42 | Barrier |
| 198916 | No | 0.45 | 1.50 | 2.93 | 6.0 | 100 | 42 | Barrier |
| 198935 | No | 0.15 | 1.20 | 2.25 | 1.5 | 20 | 29 | Barrier |
| 198940 | No | 0.00 | 0.95 | 4.53 | 2.0 | 25 | 24 | Barrier |
| 203122 | No | 0.05 | 3.00 | 1.67 | 2.0 | 25 | 24 | Barrier |

Table 4.4: Cost benefit analysis for Phase 2 assessments. Steelhead rearing model used for habitat estimates (total length of stream network

| PSCIS ID | Stream | Road | Barrier Result | Habitat value | Stream Width (m) | Fix | Cost Est ( $K) | Habitat Upstream (m) | Cost Benefit (m / $K) | Cost Benefit (m2 / $K) |
|---|---|---|---|---|---|---|---|---|---|---|
| 58245 | Simpson Creek | Lake Kathlyn Road | Barrier | High | 6.0 | OBS | 3000 | 2014 | 671.3 | 2349.7 |
| 58264 | Simpson Creek | Nielson Road | Barrier | High | 8.9 | OBS | 3000 | 401 | 133.7 | 374.3 |
| 198913 | Gershwin Creek | Highway 16 | Barrier | Medium | 6.0 | OBS | 11250 | 0 | 0.0 | 0.0 |
| 198916 | Gershwin Creek | Railway | Barrier | Medium | 4.4 | OBS | 26625 | 0 | 0.0 | 0.0 |
| 198935 | Tributary to Knapper Creek | Gold creek fsr | Barrier | Medium | 2.5 | OBS | 540 | 897 | 1661.1 | 2242.5 |
| 198940 | Tributary to Knapper Creek | HM7504 | Barrier | Medium | 2.8 | OBS | 450 | 1236 | 2746.7 | 5905.3 |
| 203122 | Simpson Creek | Railway | Barrier | High | 6.2 | OBS | 11250 | 1582 | 140.6 | 351.6 |

Table 4.5: Summary of Phase 2 habitat confirmation details.

| PSCIS ID | Length surveyed upstream (m) | Average Channel Width (m) | Average Wetted Width (m) | Average Pool Depth (m) | Average Gradient (%) | Total Cover | Habitat Value |
|---|---|---|---|---|---|---|---|
| 58245 | 1000 | 6.0 | 4.3 | 0.7 | 1.1 | moderate | high |
| 58264 | 615 | 8.9 | 4.7 | 0.3 | 7.3 | moderate | medium |
| 198106 | 475 | 4.3 | 3.3 | 0.3 | 1.9 | moderate | high |
| 198913 | 600 | 6.0 | 4.0 | 0.6 | 2.8 | abundant | high |
| 198916 | 900 | 4.4 | 3.3 | 0.4 | 4.4 | moderate | medium |
| 198935 | 700 | 2.5 | 1.9 | 0.4 | 2.2 | moderate | medium |
| 198940 | 340 | 2.8 | 1.2 | 0.3 | 2.7 | moderate | medium |
| 203122 | 950 | 6.2 | 3.5 | 0.6 | 4.1 | moderate | high |

Table 4.6: Summary of watershed area statistics upstream of Phase 2 crossings.

| Site | Area Km | Elev Site | Elev Min | Elev Max | Elev Median | Elev P60 | Aspect |
|---|---|---|---|---|---|---|---|
| 198913 | 5.7 | 296 | 277 | 1996 | 700 | 505 | W |
| 198916 | 12.9 | 264 | 201 | 2019 | 575 | 411 | W |
| 198935 | 4.1 | 797 | 799 | 1131 | 923 | 903 | SE |
| 198940 | 4.1 | 785 | 799 | 1131 | 923 | 903 | SE |
| 58245 | 13.1 | 503 | 495 | 2477 | 1311 | 1068 | E |
| 58264 | 6.8 | 533 | 931 | 2478 | 1757 | 1696 | SE |

* Elev P60 = Elevation at which 60% of the watershed area is above

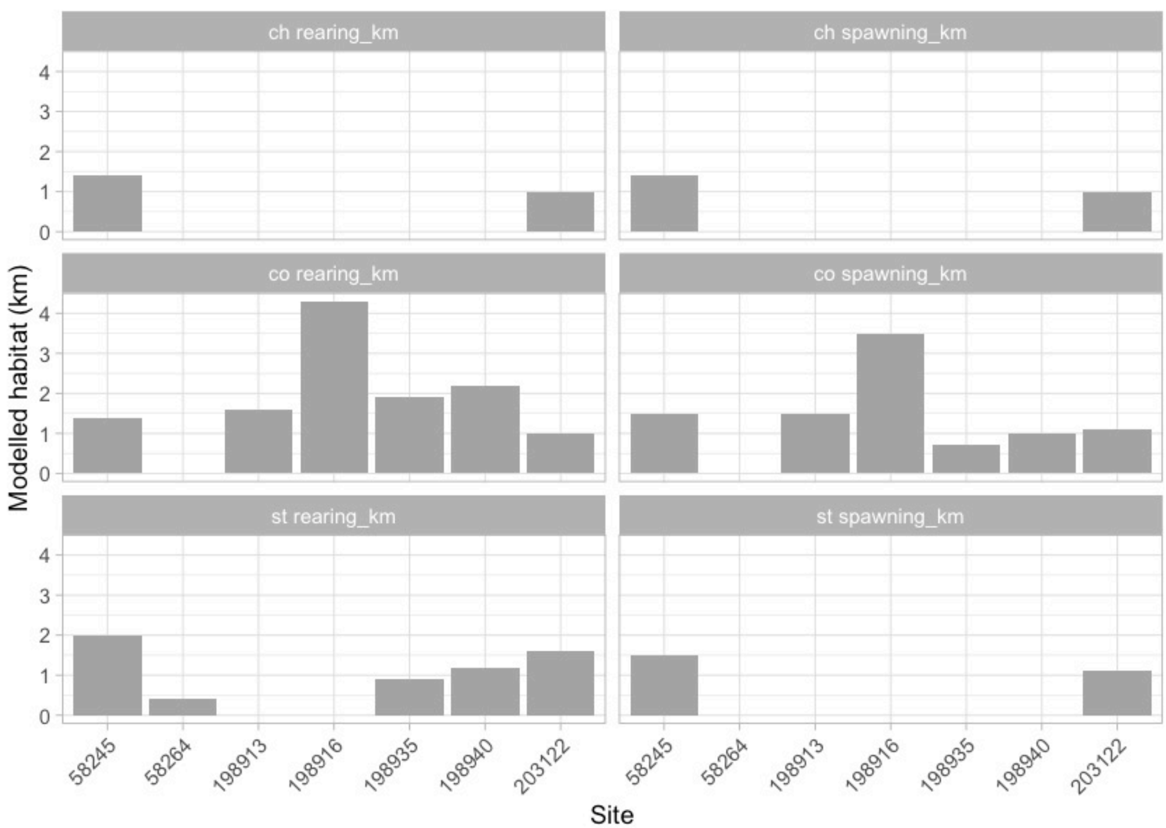



Figure 4.1: Summary of potential rearing and spawning habitat upstream of habitat confirmation assessment sites. See Table 3.1 for modelling thresholds.

### 4.5.1 Fish Sampling

In 2024, fish sampling was conducted at 15 sites within 5 streams, with a total of 314 fish captured. Fork length, weight, and species were documented for each fish. PIT tags were inserted into 29 fish.

Fork length data was used to delineate salmonids based on life stages: fry (0 to 65mm), parr (>65 to 110mm), juvenile (>110mm to 140mm) and adult (>140mm) by visually assessing the histograms presented in Figure 4.3. A summary of sites assessed are included in Table 4.7 and raw data is provided in Attachment 2. A summary of density results for all life stages combined of select species is also presented in Figure 4.2.

Results are presented in greater detail within individual habitat confirmation site appendices within this report as well as for Sandstone Creek within Irvine and Schick (2023) here and Stock Creek within Irvine (2023) here.

Table 4.7: Summary of electrofishing sites.

| site | stream | passes | ef_length_m | ef_width_m | area_m2 | enclosure |
|---|---|---|---|---|---|---|
| 8530_ds_ef1 | Sandstone Creek | 1 | 30 | 2.8 | 84.0 | partial enclosure |
| 8530_us_ef1 | Sandstone Creek | 1 | 35 | 1.8 | 63.0 | partial enclosure |
| 198935_ds_ef1 | Tributary To Knapper Creek | 1 | 8 | 1.1 | 8.8 | partial enclosure |
| 198935_us_ef1 | Tributary To Knapper Creek | 1 | 30 | 1.6 | 48.0 | partial enclosure |
| 195943_ds_ef1 | Stock Creek | 1 | 30 | 2.1 | 63.0 | partial enclosure |
| 195943_us_ef1 | Stock Creek | 1 | 40 | 1.4 | 56.0 | partial enclosure |
| 58264_ds_ef1 | Simpson Creek | 1 | 25 | 3.3 | 82.5 | partial enclosure |
| 58264_ds_ef2 | Simpson Creek | 1 | 30 | 2.7 | 81.0 | partial enclosure |
| 58264_us_ef1 | Simpson Creek | 1 | 32 | 3.5 | 112.0 | partial enclosure |
| 198916_ds_ef1 | Gershwin Creek | 1 | 34 | 3.1 | 105.4 | partial enclosure |
| 198916_ds_ef2 | Gershwin Creek | 1 | 7 | 5.8 | 40.6 | partial enclosure |
| 198916_us_ef1 | Gershwin Creek | 1 | 43 | 3.4 | 146.2 | partial enclosure |
| 198913_ds_ef1 | Gershwin Creek | 1 | 7 | 6.0 | 42.0 | partial enclosure |
| 198913_ds_ef2 | Gershwin Creek | 1 | 20 | 3.3 | 66.0 | open |
| 198913_us_ef1 | Gershwin Creek | 1 | 30 | 3.0 | 90.0 | partial enclosure |

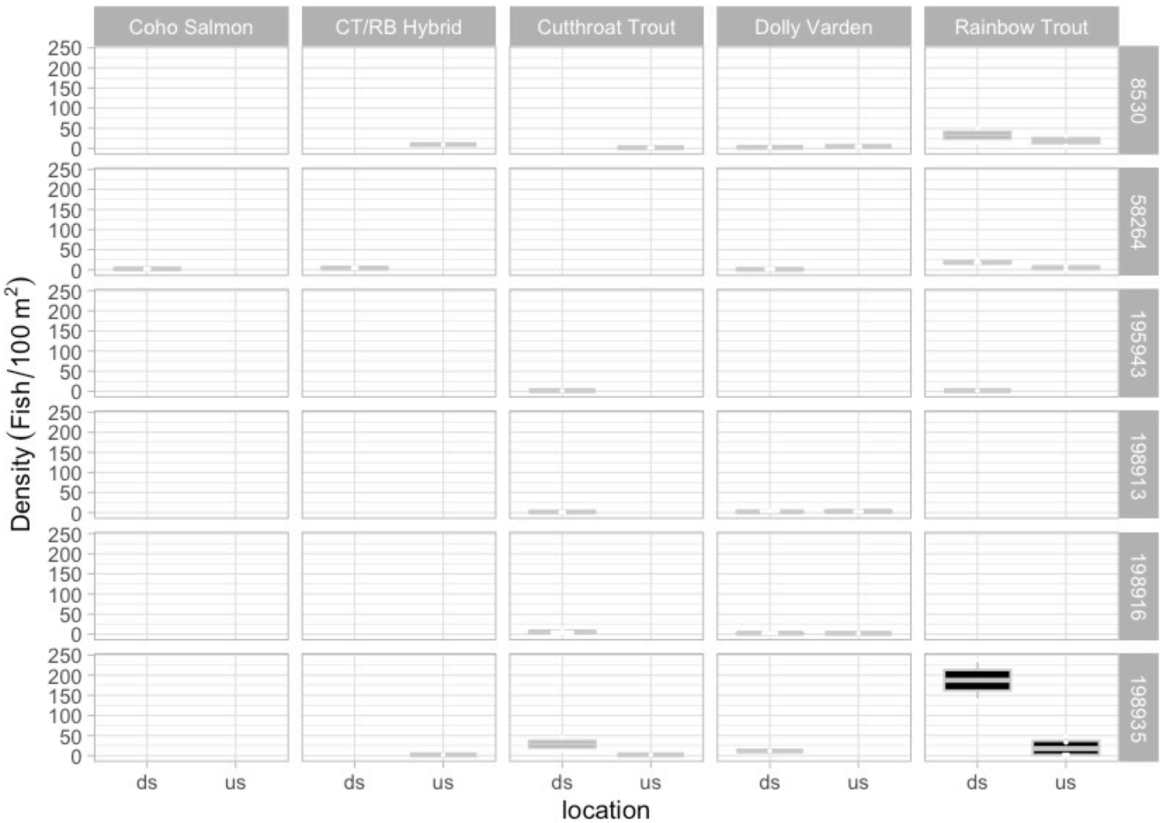



Figure 4.2: Boxplots of densities (fish/100m2) of fish captured downstream (ds) and upstream (us) by electrofishing during habitat confirmation assessments.

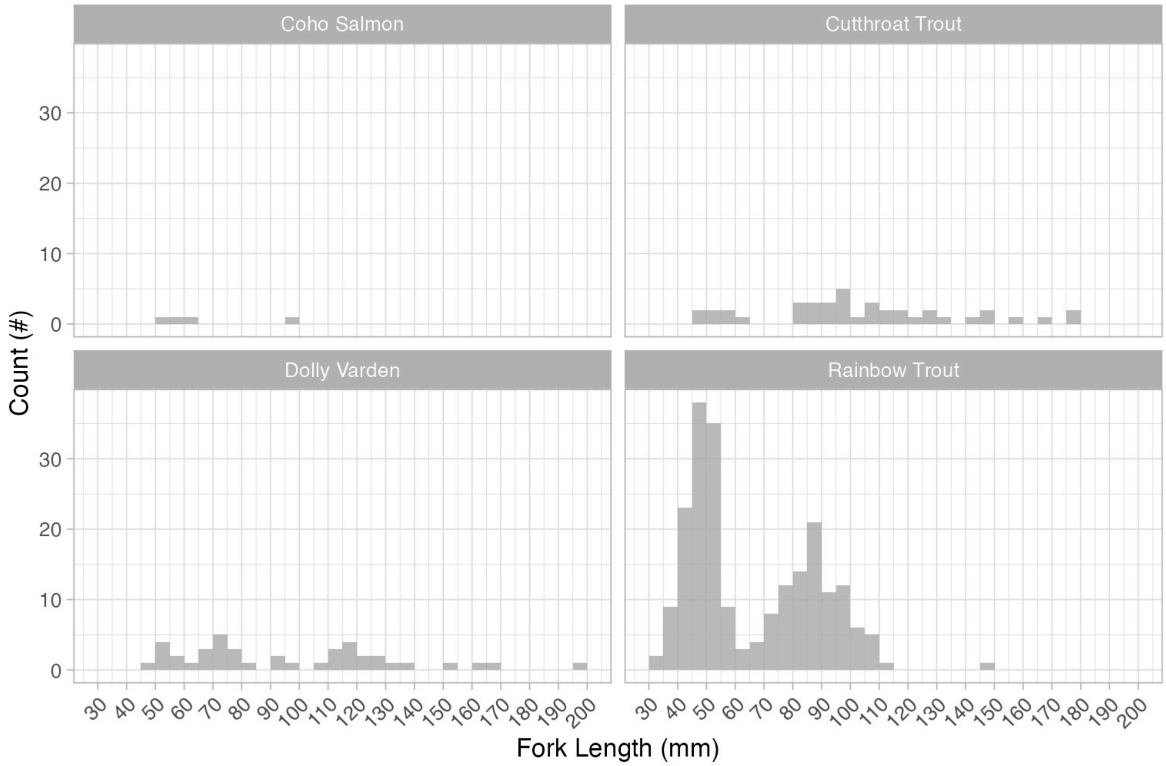



Figure 4.3: Histograms of fish lengths by species. Fish captured by electrofishing during habitat confirmation assessments.

## 4.6 Engineering Design

All sites with a design for remediation of fish passage can be found online within the Results and Discussion section of the report found here. In 2024, designs for remediation of fish passage were completed for the following site within the Bulkley River watershed group:

- Waterfall Creek – PSCIS 124421 - 11th Avenue. This crossing is within New Hazelton. Waterfall Creek flows into Station Creek downstream of this site. Remediation efforts, led by Gitksan Watershed Authorities, in collaboration with SERNbc, Skeena Fisheries Commission, the Fisheries and Oceans Canada, Gitsxan House representives, the Chicago Creek Community Environmental Enhancement Society and the District of New Hazelton are tentatively planned for summer 2025. Through this year's project - SERNbc funded the engineering design for a bridge to replace the open bottom culverts - drafted by Pacific North Coast Consulting Services. Reporting updated with 2024 data along with background information for the Station Creek and Waterfall Creek watersheds are presented here and here.

- Tributary to Owen Creek – PSCIS crossing 197378 is located on Klate Lake Road. Through 2024/25 project activities SERNbc funded an engineering design completed by Pacific North Coast Consulting Services. Proposed works include the replacement of the existing 1.0m wide round culvert with a 12m free span bridge. This site has been earmarked for replacement through the Bii Wenii Kwa Restoration/Recovery Plan which is a collaboration between the Wet'suwet'en Treaty Society, Fisheries and Oceans Canada, BC Ministry of Forests, and Water, Land and Resource Stewardship, Morice Water Monitoring Trust, and Northwest Research and Monitoring. The Bii Wenii Kwa Watershed Restoration and Recovery Plan aims to improve watershed health and support both resident and anadromous fish while helping the Wet'suwet'en, and Federal and Provincial governments address habitat risks by enhancing and restoring fish habitat, consolidating existing data, prioritizing restoration work with cost estimates, and providing monitoring recommendations (Morgan and Reese-Hansen 2024). Klate Lake Road provides access to forestry areas under the tenure of Yinka Dene Economic Development Limited Partnership (YLP) which is the corporate business arm of the Wet'suwet'en First Nation. Additionally this road provides access to the Nadina Mountain Provincial Park, which features the Nadina Mountain Trail(BC Parks 2025). Background information updated in 2025 and also including habitat confirmation reporting and fish sampling conducted in 2021 and 2023 is presented in Irvine and Schick (2023)here. Design drawings for the proposed bridge installation are available here.

## 4.7 Remediations

All sites where remediation of fish passage has been completed since 2020 can be found online within the Results and Discussion section of the report found here. Since 2020, remediation of fish passage has been completed at the following sites (listed by watershed group):

### 4.7.1 Bulkley River

- McDowell Creek -PSCIS 58159 - Private Road. Replaced with a clear-span bridge in 2022 with remediation work led by the Canadian Wildlife Federation. Background presented [here](https://www.newgraphenvironment.com/fish_passage_bulkley_2020_reporting/.
- Robert Hatch Creek - PSCIS 197912 - Unnamed Road. Removal of the collapsed bridge in 2022 with remediation work led by the Canadian Wildlife Federation. Background presented here here.
- Taman Creek - PSCIS 197967 - Highway 16. Between 2022 and 2024, the Ministry of Transportation and Infrastructure replaced this crossing with a streambed simulation structure (ie. embedded round pipe). Background reporting regarding the habitat confirmation assessment is documented here.

### 4.7.2 Kispiox River

- Tributary to Skeena River - 198217 - Sik-E-Dakh Water Tower Road. Replacement of the crossing with a clear-span bridge in 2024 with remediation work led by the Gitskan Watershed Authorities. Updated reporting can be found here.

### 4.7.3 Morice River

- Peacock Creek - 197962 - Morice River Forest Service Road. In 2021, the Ministry of Forests, Canfor and TC Energy collaborated to replace the crossing with a clear-span bridge. Background reporting regarding the habitat confirmation and baseline monitoring is documented here.

## 4.8 Monitoring

Five streams where habitat confirmations were conducted in the past were revisited in 2024 to gather data to further inform prioritization and or to provide data for effectiveness monitoring. Below are sites visited (listed by watershed group) with details of data collected and links to reporting provided.

### 4.8.1 Bulkley River

- Stock Creek - PSCIS 195943 - Barrett Station Rd. Electrofishing was conducted at the sites below to understand fish community composition as part of both the prioritization process and baseline monitoring. Reporting updated here.

- Taman Creek- PSCIS 197967 - Highway 16. Construction activities took place to replace this crossing between 2022 and 2024.
  Effectiveness monitoring was conducted in 2024. Background information was updated here with results of the 2024 monitoring presented in within this document in Taman Creek - 197967 - Appendix (page 59).

- Waterfall Creek – PSCIS 124421 - 11th Avenue. This crossing is within New Hazelton. In addition to the aquisition of a design for PSCIS crossing 124421 on 11th Avenue discussed earlier - in 2024 a field visit was conducted which included a habitat survey covering the the area from 10th avenue (Highway 16) to the waterfall located above town. Additionally an aerial survey was conducted with a drone to map the historic Waterfall Creek wetland areas located north of Highway 16/10th avenue (east of Churchill Street) to support restoration planning (orthomosaics available here). Reporting updated with 2024 data along with background information for the Station Creek and Waterfall Creek watersheds are presented here and here.

### 4.8.2 Zymoetz River

- Tributary to McDonell Lake - PSCIS 8547 - McDonell Forest Service Road. This site was visited in 2024 with the intent of conducting electrofishing to support an engineering design commissioned by SERNbc (in collaboration with Giotsxan Watershed Authorities) through this project. However, water temperatures were too low for effective sampling at that time. Although preliminary data was collected to inform an engineering design, resources were ultimately redirected to Waterfall Creek in New Hazelton. This decision followed an assessment of the stream by DFO, which suggested the stream was unlikely to support a salmon-bearing cohort. Because the associated grant funding provided to the Gitxsan Watershed Authorities was from the Salmon Restoration and Innovation Fund the site was not pursued further under that funding stream.

- Sandstone Creek - PSCIS 8530 - McDonell Forest Service Road. Electrofishing was conducted at the sites below to understand fish community composition as part of both the prioritization process and baseline monitoring. Salmonids with fork lengths >60mm were PIT-tagged to facilitate long-term tracking of health and movement with data amalgamated into past reporting here.

## 5 Recommendations

Recommendations for potential incorporation into collaborative watershed connectivity planning include:

- Government, community groups, landowners, and other stakeholders should work collaboratively to address highest ranked barriers identified online within the Results and Discussion section of the report found here. While the table presents a wide range of options, the linked individual reports indicate whether each site is a low, moderate, or high priority. Progress on any front is valuable, and aiming to remediate at least one high-priority site per year per watershed group—regardless of its overall rank—is a practical and effective approach.

- Continue collaborating with Gitksan Watershed Authorities and Skeena Fisheries Commission to implement fish passage restoration at Waterfall Creek – PSCIS 124421 (11th Avenue, New Hazelton) within the Bulkley River watershed group. Lessons from the successful 2024 replacement of crossing 198217 on a Skeena River tributary near Sik-e-dakh Water Tower Road can now inform work at Waterfall Creek. Restoration here has a rich history with coho transplants by the Chicago Creek Community Environmental Enhancement Society beginning in 1990 [donas2022MissionCreek]. Despite impacts from urban and industrial development, the greater Station/Mission Creek watershed offers strong potential for public engagement and ecosystem function gains. Collaborative efforts—led by Gitksan Watershed Authorities, Chicago Creek Community Environmental Enhancement Society, Skeena Fisheries Commission, Fisheries and Oceans Canada, SERNbc and others aim to build on 2024 engineering designs and fieldwork to advance these goals in collaboration with the District of New Hazelton, CN Rail, Ministry of Transportation, Kispiox Band, Gitksan House representatives, Skeena Watershed Conservation Coalition and others.

- PSCIS crossing 197378 is located on a tributary to Owen Creek along Klate Lake Road, within the Morice River Watershed Group area. Through 2024 project activities - the site now has a completed design, with a proposed replacement of the existing 1.0m culvert with a 12m free-span bridge. We recommend moving forward by coordinating with the Bii Wenii Kwa Restoration/Recovery Plan to secure funding, define delivery partners, and schedule implementation. This initiative brings together the Wet'suwet'en Treaty Society, Fisheries and Oceans Canada, BC Ministry of Forests, Water, Land and Resource Stewardship, Morice Water Monitoring Trust, and Northwest Research and Monitoring to support collaborative, priority-driven habitat restoration across the watershed.

- Integrate fish passage restoration planning with other restoration and enhancement initiatives in the region to maximize benefits to fish populations as well as for communities within the Skeena River watershed. This includes working with the Gitskan Watershed Authorities (GWA), Skeena Fisheries Commission, Skeena Watershed Conservation Coalition, Wet'suwet'en Treaty Society, Morice Watershed Monitoring Trust, Fisheries and Oceans Canada, Provincial Regulators, Bulkley Valley Research Centre, the Environmental Stewardship Initiative (Skeena Sustainability Assessment Forum) and others to leverage funding, knowledge and resources for fish passage restoration towards other projects related to watershed health in the region. Examples of where this is already taking place is leveraging of Morice River watershed group fish passage sites into the Bii Wenii Kwa

Restoration/Recovery Plan and incorporation of Upper Bulkley River sites into the Neexdzii Kwah Restoration Planning(Irvine and Schick 2025).

- Continue to refine the prioritization tools using the metrics established in reporting since 2024—such as habitat quality, habitat quantity, species presence, remediation cost, and other relevant factors. Integrate these metrics into a more accessible format by linking interactive mapping outputs to the filterable table presented in the results section of this report. Continue to update and clarify individual site memos, incorporating additional contextual information to improve cross-stakeholder communication and facilitate funding and implementation efforts.

- Develop strategies to explore cost and fisheries production benefits of stream crossing structure upgrades alongside alternative/additional restoration and enhancement investments such as land conservation/procurement/covenant, cattle exclusion, riparian restoration, habitat complexing, water conservation, commercial/recreational fishing management, water treatment and research. Ideentify and pursue opportunities to collaborate and leverage initiatives together in study area watersheds (ex. fish passage rehabilitation, riparian restoration and cattle exclusion) for maximum likely restoration benefits.

## Buck Falls - Appendix

Buck falls are located just downstream of the Buck Flats Road bridge on the Buck Creek mainstem - mapped in the freshwater atlas as 46.7km upstream of its confluence with the Bulkley River. The falls have not yet been documented in the FISS database (MoE 2024b) but have been previously noted in A. Gottesfeld and Rabnett (2007), the World Waterfall Database ("Buck Falls, British Columbia, Canada - World Waterfall Database" n.d.), and on the Houston Hikers website ("Buck Falls I Adventures" n.d.). Although rainbow trout, mountain whitefish, kokannee and other non-salmonid resident species have been documented upstream of the falls in the FISS database - no salmon species have been documented upstream (MoE 2024a). However, Wilson and Rabnett (2007) report Neelhdzii Teezdlii Ceek as historic Wet'suwet'en traditional fisheries location upstream approximately 24km (stream length) upstream of Buck Falls at the outlet of Goosly Lake. Species noted as captured upstream of the falls at Neelhdzii Teezdlii Ceek include coho salmon and chinook salmon. An assessment of the falls was conducted on September 19, 2024.

The falls consist of a series of three separate vertical and cascade sections over and approximately 200m section of stream. The upper falls consisted of a ~4 m high vertical drop, presenting a substantial barrier to fish passage (Figure 5.1). Approximately 25 m downstream, the second falls was a ~3.5 m high sheer drop to bedrock, with minimal pool depth available to facilitate fish passage (Figure 5.1). Further downstream ~100 m, the third step comprised a ~1.5 m vertical drop with an overlying cascade, exhibiting a ~15% gradient over a 1.0 m height (Figure 5.2). An additional cascade, located a further ~25 m downstream, featured a ~2 m high drop with a ~30% gradient extending over a 5 m length (Figure 5.2).

Although the size of the documented drops indicate that it is highly unlikely that any species or life stage of salmon can easily ascend the sequence of drops associated with Buck Falls, documentation of Neelhdzii Teezdlii Ceek as a historic Wet'suwet'en traditional fisheries location upstream of Buck Falls suggests that the falls were passed by salmon in the past and may again ascend in the future (personal communications - Kenny Rabnett - local fisheries biologist and legend).


Figure 5.1: Left: Buck Falls – The upper falls featured a ~4m high vertical drop. A 2m tall net is included for scale. Right: Buck Falls – The second falls consisted of a ~3.5m high sheer drop to bedrock.


Figure 5.2: Left: Buck Falls – The third step consisted of a ~1.5 m vertical drop with an overlying cascade, exhibiting a ~15% gradient over a 1.0m height. Right: Buck Falls – An additional cascade featured a ~2m high drop with a ~30% gradient extending over a 5 m length. A 2m tall net is included for scale.

## Taman Creek - 197967 - Appendix

### Site Location

PSCIS crossing 197967 is located on the Bulkley River approximately 22.5km east of Topley, BC within the Bulkley River watershed group. The site is situated on Highway 16, approximately 2.5km upstream from Bulkley Lake. Although the stream is named the Bulkley River in the BC Freshwater Atlas, the stream at the highway is commonly referred to as Taman Creek (including on highway signage) as Taman Creek flows into this stream approximately 750m upstream of the highway. The culvert is the responsibility of the Ministry of Transportation and Infrastructure (chris_hwy_structure_road_id 33227).

### Background

Detailed background for this site is available in Irvine ([2021] 2022) related to the habitat confirmation conducted in 2021 which can be found here. A map of the watershed is provided in map attachment 093L.115.

Between 2022 and 2024, the Ministry of Transportation and Infrastructure contracted Enviro-Ex Contracting Ltd. to replace the crossing with an extensive streambed simulation structure at a cost of $16,000,000 (Link 2023). The 3m wide un-embedded round culvert was replaced with a 5.6m wide fully embedded round streambed simulation culvert.

### Monitoring

In 2024, crews revisited the site for monitoring purposes, with results summarised in Tables @ref(tab:tab-monitoring-197967 - 5.2). The structure was well-constructed, with nearly 2m of embedded material within the new structure consisting of large boulders, cobbles, and gravels. Upstream, woody debris and boulder structures were cabled together within the reconstructed stream channel to provide habitat complexity and bank stabilization Figure 5.3. This large-scale construction project involved substantial fill, extending for approximately 60m downstream and over 200m upstream.

Photos showing a comparison of the culvert assessment conducted in 2021 versus the completed replacement structure in 2024 are presented in Figure 5.3.

Table 5.1: Summary of monitoring metric results for site 197967.

| Parameter | Description |
|---|---|
| Pscis Crossing Id | 197967 |
| Stream Name | Taman Creek |
| Road Name | Highway 16 |
| Crossing Subtype | ROUND |
| Span | 5.6 |
| Width | 40 |
| Assessment Comment | This is a brand-new replacement structure, extremely well built with extensive embedment that includes numerous large boulders, cobbles, and gravel. The multiplate round structure is embedded nearly 2 m. Upstream, woody debris and boulder structures are cabled together for added stability. This massive construction project involved a substantial amount of fill extending 60 m downstream and over 200 m upstream. The site now offers migration conditions significantly better than before. |
| Dewatering | No dewatering |
| Velocity | Velocity appeared reasonable, with a low gradient effectively connecting upstream and downstream sections. The boulders placed in the culvert, along with cabled woody debris and boulder structures upstream, would help reduce velocity and enhance habitat complexity over time. |
| Constriction | The culvert diameter was wide (5.6m) and did not appear to be constricting the channel. |
| Substrate | The culvert had extensive embedment of natural substrate materials, including large boulders, cobbles, and gravels. The substrates within the culvert closely matched those observed upstream and downstream. |
| Riparian | Some riparian vegetation was removed, but it appeared to have been replanted with grasses. The riparian area upstream on the right bank remained the most intact and similar to its natural state. The channelized banks directly upstream and downstream of the culvert, for approximately 50m, were reinforced with riprap, with no apparent riparian planting or fill covering the riprap.If future work is considered at this site, additional re-vegetation is recommended, including planting willow whips into the riprap and increasing vegetation on the stream banks to improve overhead cover for fish. |
| Flow Depth | Flow depths were adequate, and at higher flows, deeper sections would likely form behind the boulders and chained logs.NULL |
| Stability | The structure was well built, with the road column extensively reinforced with fill. Road runoff areas along the embankment were armored with rock for added stability. |
| Revegetation | There did not appear to be significant re-vegetation efforts, as much of the riprap remained exposed and only grasses seemed to have been planted. More effort could have been directed toward re-vegetation; however, the overall condition of the riparian area was adequate. If future work is considered at this site, additional re-vegetation is recommended, including planting willow whips into the riprap and increasing vegetation on the stream banks to improve overhead cover for fish. |
| Cover | The boulders placed in the culvert, along with the woody debris and boulder structures cabled together upstream, will provide cover over time. However, overhead cover was sparse within the construction footprint, with no signs of vegetative planting to enhance cover.If future work is considered at this site, additional re-vegetation is recommended, including planting willow whips into the riprap and increasing vegetation on the stream banks to improve overhead cover for fish. |
| Maintenance | No maintenance required. |

Table 5.2: Summary of fish passage assessment for PSCIS crossing 197967.

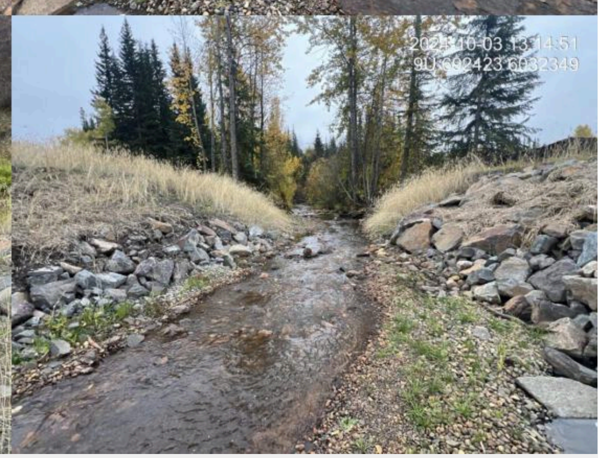
| Location and Stream Data | • | Crossing Characteristics | – |
|---|---|---|---|
| Date | 2024-10-03 | Crossing Sub Type | Round Culvert |
| PSCIS ID | 197967 | Diameter (m) | 5.6 |
| External ID | – | Length (m) | 40 |
| Crew | AI | Embedded | Yes |
| UTM Zone | 9 | Depth Embedded (m) | 2 |
| Easting | 692426 | Resemble Channel | Yes |
| Northing | 6032341 | Backwatered | No |
| Stream | Taman Creek | Percent Backwatered | – |
| Road | Highway 16 | Fill Depth (m) | 7 |

| **Location and Stream Data** | • | **Crossing Characteristics** | – |
|---|---|---|---|
| Road Tenure | MoTi | Outlet Drop (m) | 0 |
| Channel Width (m) | 5.5 | Outlet Pool Depth (m) | 0 |
| Stream Slope (%) | 2 | Inlet Drop | No |
| Beaver Activity | Yes | Slope (%) | 3 |
| Habitat Value | Medium | Valley Fill | Deep Fill |
| Final score | 16 | Barrier Result | Potential |
| Fix type | Replace with New Open Bottom Structure | Fix Span / Diameter | 27 |
| Comments:<br>This is a brand-new replacement structure, extremely well built with extensive embedment that includes numerous large boulders, cobbles, and gravel. The multiplate round structure is embedded nearly 2 m. Upstream, woody debris and boulder structures are cabled together for added stability. This massive construction project involved a substantial amount of fill extending 60 m downstream and over 200 m upstream. The site now offers migration conditions for fish that are equal to or better than previous conditions. MoTi chris_culvert_id: 2076452 | | | |
| Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet. | | | |

| Location and Stream Data | • | Crossing Characteristics | – |
|---|---|---|---|





## Conclusion

In 2024, conditions for upstream fish passage through the highway crossing at Taman Creek was greatly improved through installation of a streambed simulation structure featuring a large culvert width, embedded natural streambed substrates, and the addition of well designed habitat features within the reconstructed channel. Future monitoring of the site could repeat monitoring metrics conducted in 2024, track morphological changes to the channel in the years following construction (via drone generated elevation models or lidar) and include fish sampling and/or eDNA presence surveys to understand fish use upstream and downstream of the crossing.


Figure 5.3: Left: Woody debris and boulder structures located upstream of 197967 in 2024. Right: Photos of crossing 197967 in 2021.

## Comeau Creek - 198916 & 198913 - Appendix

### Site Location

Freshwater atlas mapping of this watershed is incorrect as the main stream at the confluence with the Skeena River is actually Cormeau Creek vs Gershwin Creek - as it is labelled in provincial mapping (Figure ). Gershwin Creek is a much smaller tributary that flows into Cormeau Creek approximately 270m downstream of Highway 16 at a location 2.5km upstream from the Cormeau Creek / Skeena River confluence. As noted in M. McCarthy (2000) - the mainstem of Cormeau Creek deviates from the mapped Cormeau Creek stream line approximately 5.3km upstream of the incorrectly mapped confluence of Cormeau Creek and the Skeena River and enters the drainage labelled as Gershwin Creek at a location 4.8km upstream of the true Cormeau Creek confluence with the Skeena River. PSCIS crossing 198916 is located on Gershwin Creek on the CN Railway 1.8km upstream of the confluence of Gershwin Creek and the Skeena River. PSCIS crossing 198913 is located on Comeau Creek at Highway 16. Comeau Creek flows into Gershwin Creek just downstream of the highway. Both sites are within the Kispiox River watershed group. PSCIS crossing 198916 is owned by CN Rail and 198913 is the responsibility of the Ministry of Transportation and Infrastructure.

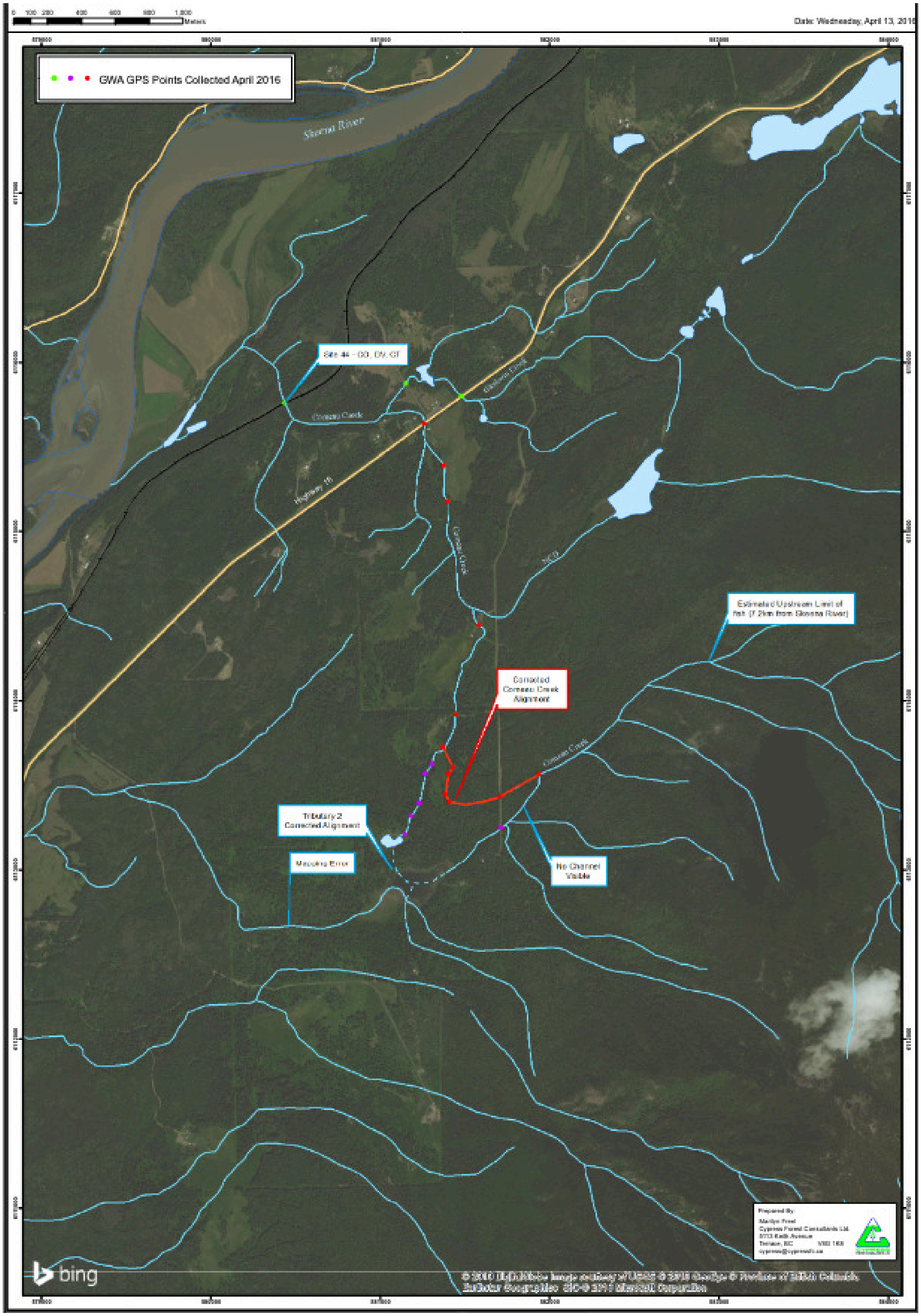

Meters
Date: Wednesday, April 13, 2016
GWA GPS Points Collected April 2016
Skeena River
Site 44 - CO, DV, CT
Comeau Creek
Highway 16
Estimated Upstream Limit of fish (7.2km from Skeena River)
Corrected Comeau Creek Alignment
Comeau Creek
Tributary 2 Corrected Alignment
Mapping Error
No Channel Visible
Prepared By:
bing

Figure 5.4: Comeau Creek and Gershwin Creek. Map provided by Gitskan Watershed Authorities

## Background

In 1999, M. McCarthy (2000) conducted a detailed survey of Comeau Creek including the area from the confluence with the Skeena River to a point estimated as the upstream limit to fish (7.2km distance). During that survey two pairs of coho salmon were observed spawning at location approximately 100m and 130m upstream of the Skeena River confluence. A 2m high beaver dam located ~50m further upstream was noted as likely limiting migration of both spawning adults and rearing juveniles at that time. M. McCarthy (2000) document the culverts located on the CN Railway and Highway 16 (among others) and note that the CN Railway crossing is likely impassible for fish migrating upstream due to its length (98m) shallow water depths (7cm) and high velocity discharge (2 m/s). Also noted within this study was extensive minnowtrapping upstream of Highway 16 with Dolly Varden and cutthrout trout captured.

M. McCarthy and Fernando (2015) ranked crossing 198916 on the CN Railway as a high priority for restoration and recommend improving upstream fish migration conditions through the installation of baffles and backwatering structures.

In 2023, fish passage assessments were completed for Comeau Creek PSCIS crossings 198916, 198913 on the CN railway and Highway 16 respectively as well as for Gerswhin Creek - PSCIS crossing 198907 on Braucher Road with assessment ata and photos presented in Irvine and Schick (2023) here. These assessments documented high-value habitat upstream of the railway and fish in the outlet pool downstream of the Highway 16 crossing.

Within provincial databases, coho salmon and pink salmon spawning is noted 90m and 750m upstream of the confluence of Coreau Creek and the Skeena River. Additionally, are documented in the lake upstream of the Highway 16 crossing (198913) (Norris [2018] 2024; MoE 2024a).

In 2024 habitat confirmations and fish sampling were conducted upstream and downstream of Comeau Creek PSCIS crossings 198916, 198913 on the CN railway and Highway 16. Additionally, in 2024, two crossings on Comeau Road were also assessed with fish passage assessments. The first - PSCIS crossing 203124 on Gershwin Creek was located approximately 100m up the road from the highway.
The second crossing - PSCIS 203123 - on a tributary to Comeau Creek - was located at approximately 1.6km up the road from the highway. Field assessment results and review of freshwater atlas mapping of the area between these two crossings indicates that the lake/wetland area mapped as upstream of the second crossing where observations of Dolly Varden and cutthrout have been recorded likely drains north-west to Gershwin Creek and not south-east to Comeau Creek as indicated in the provincial mapping.

A map of the watershed is provided in map attachment 093M.101.

### Stream Characteristics at Crossings 198916 and 198913

At the time of assessment, PSCIS crossing 198916 on the CN Railway was un-embedded, non-backwatered and ranked as a barrier to upstream fish passage according to the provincial protocol (MoE 2011) (Table 5.3). Constructed in the 1920s, this crossing is a concrete box culvert approximately 100 m in length, located beneath the CN railway with approximately 30–40 m of fill above it. It features a 0.45m outlet drop that adult fish could likely overcome but is presumed to act as a barrier to juvenile fish due to high velocities caused by the culvert's steep slope (6%) and shallow flow depths.

PSCIS crossing 198913 on Highway 16 was un-embedded, non-backwatered and ranked as a barrier to upstream fish passage according to the provincial protocol (MoE 2011) (Table 5.4). The crossing had a 0.35m outlet drop and a 0.85m deep outlet pool, suggesting the culvert is undersized for the stream.

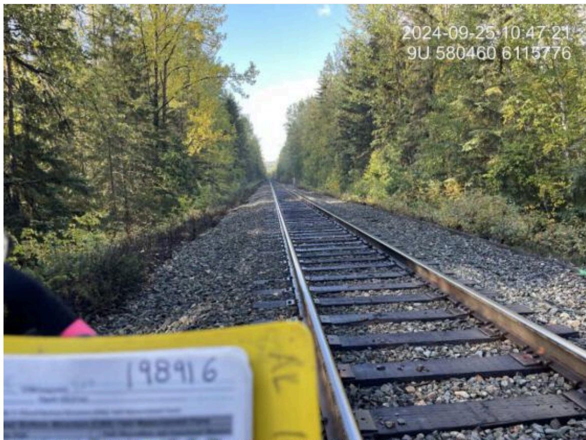
Water temperature was 7.6°C, pH was 8.1 and conductivity was 305 uS/cm.

Data and photos for Comeau Road crossings assessed with fish passage assessments are presented in Appendix - Phase 1 Fish Passage Assessment Data and Photos (page 0). For PSCIS crossing 203124 on Gershwin Creek located approximately 100m up the road from the highway - debris was partially clogging the pipe inlet had caused water to pool upstream of the road with a very small defined channel downstream (<1m).
The second crossing - PSCIS 203123 - on a tributary to Comeau Creek - was located at approximately 1.6km up the road from the highway.
At this location the stream had no visible channel.

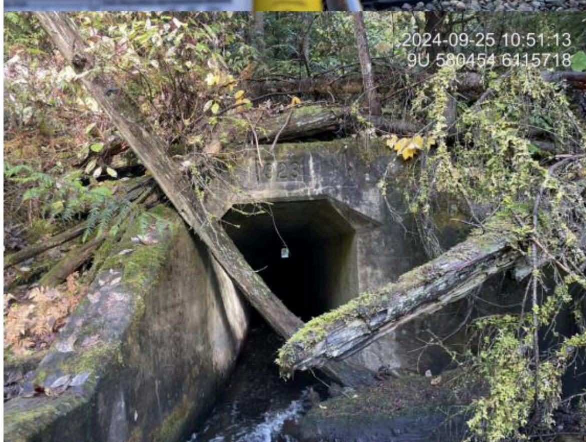
Table 5.3: Summary of fish passage assessment for PSCIS crossing 198916.

| **Location and Stream Data** | • | **Crossing Characteristics** | **–** |
|---|---|---|---|
| Date | 2024-09-25 | Crossing Sub Type | Concrete Box |
| PSCIS ID | 198916 | Diameter (m) | 1.5 |
| External ID | – | Length (m) | 100 |
| Crew | LS JD | Embedded | No |
| UTM Zone | 9 | Depth Embedded (m) | – |
| Easting | 580463 | Resemble Channel | – |
| Northing | 6115769 | Backwatered | No |
| Stream | Gershwin Creek | Percent Backwatered | – |
| Road | Railway | Fill Depth (m) | 9.9 |
| Road Tenure | CN Rail | Outlet Drop (m) | 0.45 |
| Channel Width (m) | 4.4 | Outlet Pool Depth (m) | 0.35 |
| Stream Slope (%) | 4.4 | Inlet Drop | No |
| Beaver Activity | No | Slope (%) | 6 |
| Habitat Value | Medium | Valley Fill | Deep Fill |
| Final score | 42 | Barrier Result | Barrier |
| Fix type | Replace with New Open Bottom Structure | Fix Span / Diameter | 35.5 |
| Comments: The concrete box culvert is approximately 100 m long beneath a railway crossing, with about 30 to 40 m of fill above it. A swift current flows through the culvert, and installing baffles could improve fish passage. Fish sampling captured cutthroat trout and Dolly Varden. There is a moderate outlet drop, but adult fish could likely move upstream. The habitat upstream features good flow through a steeper section with a healthy, mature mixed riparian forest, stable banks, and gravel pockets suitable for spawning coho, Dolly Varden, and cutthroat trout. Downstream, abundant boulders create step pools alongside frequent large woody debris, though high flows limited suitable fish habitat during the survey. Although construction would be expensive and challenging, this site is a high priority for restoration follow-up.Culvert length 100 m but changed to 99.9 m to meet submission requirements.Fill depth 30 m but changed to 9.9 m to meet submission requirements. | | | |
| Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet. | | | |

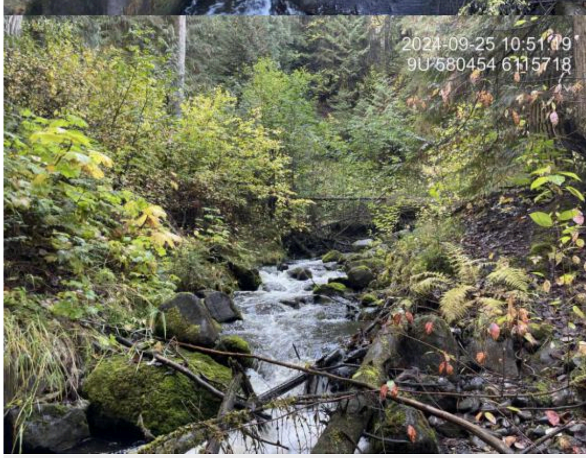
| Location and Stream Data | • | Crossing Characteristics | – |
| --- | --- | --- | --- |

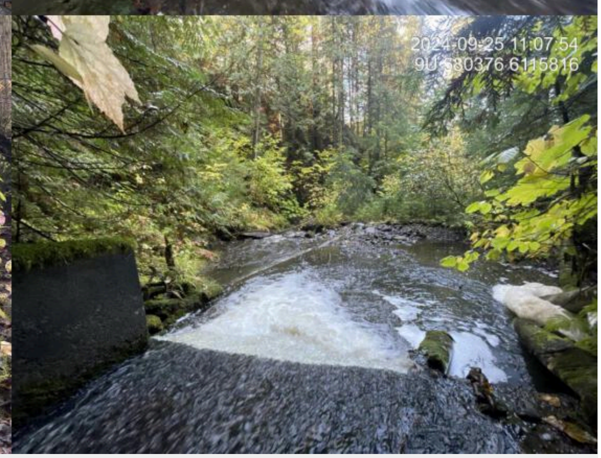










| Location and Stream Data | • | Crossing Characteristics | – |
|---|---|---|---|
| Date | 2024-09-25 | Crossing Sub Type | Round Culvert |
| PSCIS ID | 198913 | Diameter (m) | 1.5 |
| External ID | – | Length (m) | 40 |
| Crew | AI JO | Embedded | No |
| UTM Zone | 9 | Depth Embedded (m) | – |
| Easting | 581250 | Resemble Channel | – |
| Northing | 6115660 | Backwatered | No |
| Stream | Gershwin Creek | Percent Backwatered | – |
| Road | Highway 16 | Fill Depth (m) | 2.5 |
| Road Tenure | MOTi | Outlet Drop (m) | 0.35 |
| Channel Width (m) | 5 | Outlet Pool Depth (m) | 0.85 |
| Stream Slope (%) | 3 | Inlet Drop | No |
| Beaver Activity | No | Slope (%) | 3 |
| Habitat Value | Medium | Valley Fill | Deep Fill |
| Final score | 42 | Barrier Result | Barrier |
| Fix type | Replace with New Open Bottom Structure | Fix Span / Diameter | 15 |

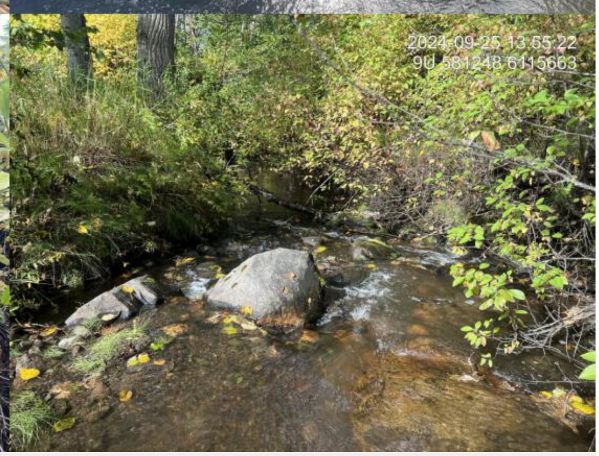
Comments:
There is a deep outlet pool, suggesting the culvert is undersized for the stream. High-quality gravels were present at the pool,Äôs outlet, and upstream of the crossing, there was high-value habitat with frequent overwintering pools, spawning gravels, and adequate riparian cover with large cottonwoods throughout. This site was part of a habitat confirmation assessment, with the stream surveyed from the downstream railway crossing up to this location and an additional 600 m upstream. Downstream, crossing 198916 consists of a large, long box culvert beneath the railway with minimal flow depth and a swift current, making it unlikely that fish from the mainstem of the Skeena River can access this site until the railway barrier is addressed. Fish sampling at this site captured cutthroat trout and Dolly Varden. MoTi chris_culvert_id: 8300872

Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.

| Location and Stream Data | • | Crossing Characteristics | – |
|---|---|---|---|








## Stream Characteristics Downstream of Crossing 198916

The stream was surveyed downstream from crossing 198916 for 300m . The stream contained numerous boulders forming step pools; however, moderate flows at the time of assessment limited the availability of pools suitable for fish. The first pool suitable for overwintering fish, with adequately reduced flow, was located approximately 250m downstream of the culvert. There were occasional gravels suitable for spawning and frequent large woody debris, which contributed to the formation of additional steps. (Figure 5.7). The average channel width was 5.9m, the average wetted width was 3.7m, and the average gradient was 5.1%.The dominant substrate was cobbles with gravels sub-dominant.Total cover amount was rated as moderate with boulders dominant. Cover was also present as small woody debris, large woody debris, and overhanging vegetation. The habitat was rated as medium value suitable for salmonid rearing and spawning.

### Stream Characteristics Upstream of Crossing 198916 and Downstream of Crossing 198913

The stream was surveyed from the railway crossing (198916) upstream to the Highway 16 crossing (198913), a distance of approximately 900 m (Figures 5.7- 5.8). A large woody debris jam was observed approximately 250m upstream of the railway crossing, creating a 17% gradient over a 9m section due to a fallen tree. The stream maintained good flow through this steeper section, supported by a healthy, mature mixed riparian forest that stabilized the banks. The dominant substrate was cobbles with boulders sub-dominant.The average channel width was 4.4m, the average wetted width was 3.3m, and the average gradient was 4.4%.Total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, boulders, and overhanging vegetation. The habitat was rated as medium value and contained occasional pockets of gravels suitable for spawning by coho salmon, Dolly Varden, and cutthroat trout.

### Stream Characteristics Upstream of Crossing 198913

The stream was surveyed upstream from crossing 198913 - located on Highway 16 for 600m. The stream had frequent pools suitable for overwintering fish, with spawning gravels present despite a significant amount of fines. In the ~200 m section just upstream of the crossing, the stream maintained a low gradient and flowed through agricultural fields with mature cottonwood riparian cover throughout the entire area surveyed (Figure 5.8).The dominant substrate was gravels with fines sub-dominant.The average channel width was 6.0m, the average wetted width was 4m, and the average gradient was 2.8%.Total cover amount was rated as abundant with large woody debris dominant. Cover was also present as small woody debris, boulders, deep pools, and overhanging vegetation. The habitat was rated as high value for salmonid rearing an spawning.

### Fish Sampling

Electrofishing was conducted on Coreau Creek below and above the railway crossing (198916) as well as upstream and downstream of the crossing on Highway 16 (198913).

Coreau Creek railway crossing (198916 results are summarised in Tables 5.6 - 5.8 and Figure 5.5. A total of 35 fish were captured downstream including Dolly Varden and cutthroat trout, and 3 Dolly Varden were captured upstream (Figures 5.10).

Electrofishing results for upstream and downstream of the crossing on Highway 16 (198913) are summarised in Tables 5.7 - 5.9 and Figure 5.6. A total of 12 fish were captured downstream including Dolly Varden and cutthroat trout, and 9 Dolly Varden were captured upstream (Figures 5.10).

### Structure Remediation and Cost Estimate

Should restoration/maintenance activities proceed, replacement of the railway crossing (198916) with a bridge or open bottom structure is estimated to cost $ 26,625,000. As noted in M. McCarthy and Fernando (2015) - installing baffles within the culvert would likely improve fish passage conditions as a less expensive interim solution.

Until the downstream railway crossing is upgraded, replacement of the upstream crossing on Highway 16 (198913) is not recommended. If the downstream crossing is upgraded, the Highway 16 crossing could be replaced with a bridge spanning 15m. At the time of reporting in 2025, the estimated cost for the replacement was $ 11,250,000.

### Conclusion

PSCIS crossings 198916 and 198913 are located on Comeau Creek which provides medium to high-value habitat suitable for coho salmon, Dolly Varden, and cutthroat trout. Conservative estimates indicate approximately 2.3km of mainstem habitat upstream of the railway crossing likely suitable for coho rearing.

PSCIS crossing 198916 on the CN Railway is an exceptionally long concrete box culvert under 30–40m of fill. It is likely a barrier to upstream migration to all species and life stages due to its extensive length, 0.45m outlet drop, steep slope, shallow flows and high flow velocities within the structure. The site was rated as a high priority for replacement - however, given the significant cost and scale of such a project, baffle installation and backwatering could be explored as an alternate interim solution to improve fish passage conditions. Replacement of PSCIS crossing 198913 on Highway 16 could be explored if upgrades to the downstream railway crossing are planned.

Although the size of the stream and gradients observed within the areas of Comeau Creek surveyed in 2024 indicate the stream is suitable for coho, none were captured downstream of the railway via electrofishing indicating that the species was not utilizing the areas fished at the time of sampling. These observations align with reporting from M. McCarthy (2000) - which noted beaver activity likely blocking upstream coho migration near the confluence with the Skeena River. M.

McCarthy (2000) recommend efforts be undertaken to trasfer coho salmon juveniles to upstream of the beaver dam with the intent of increasing coho productivity in the stream. Provided beaver dams are present and coho spawners still utilize this system, implementing this recommendation could be considered. A full assessment of the area between the railway crossing and the confluence of the Skeena River is recommended during the fall to scope for coho and pink spawners and update the state of knowledge regarding natural and man-made barriers in this section of stream.

Table 5.5: Summary of habitat details for PSCIS crossings 198916 and 198913.

| Site | Location | Length Surveyed (m) | Average Channel Width (m) | Average Wetted Width (m) | Average Pool Depth (m) | Average Gradient (%) | Total Cover | Habitat Value |
|---|---|---|---|---|---|---|---|---|
| 198913 | Upstream | 600 | 6.0 | 4.0 | 0.6 | 2.8 | abundant | high |
| 198916 | Downstream | 300 | 5.9 | 3.7 | 0.3 | 5.1 | moderate | medium |
| 198916 | Upstream | 900 | 4.4 | 3.3 | 0.4 | 4.4 | moderate | medium |

Table 5.6: Fish sampling site summary for 198916.

| site | passes | ef_length_m | ef_width_m | area_m2 | enclosure |
|---|---|---|---|---|---|
| 198916_ds_ef1 | 1 | 34 | 3.1 | 105.4 | partial enclosure |
| 198916_ds_ef2 | 1 | 7 | 5.8 | 40.6 | partial enclosure |
| 198916_us_ef1 | 1 | 43 | 3.4 | 146.2 | partial enclosure |

Table 5.7: Fish sampling site summary for 198913.

| site | passes | ef_length_m | ef_width_m | area_m2 | enclosure |
|---|---|---|---|---|---|
| 198913_ds_ef1 | 1 | 7 | 6.0 | 42 | partial enclosure |
| 198913_ds_ef2 | 1 | 20 | 3.3 | 66 | open |
| 198913_us_ef1 | 1 | 30 | 3.0 | 90 | partial enclosure |

Table 5.8: Fish sampling density results summary for 198916.

| local_name | species_code | life_stage | catch | density_100m2 | nfc_pass |
|---|---|---|---|---|---|
| 198916_ds_ef1 | Cutthroat Trout | adult | 1 | 0.9 | FALSE |
| 198916_ds_ef1 | Cutthroat Trout | fry | 4 | 3.8 | FALSE |
| 198916_ds_ef1 | Cutthroat Trout | juvenile | 4 | 3.8 | FALSE |
| 198916_ds_ef1 | Cutthroat Trout | parr | 8 | 7.6 | FALSE |
| 198916_ds_ef1 | Dolly Varden | adult | 1 | 0.9 | FALSE |
| 198916_ds_ef1 | Dolly Varden | juvenile | 1 | 0.9 | FALSE |
| 198916_ds_ef2 | Cutthroat Trout | adult | 1 | 2.5 | FALSE |
| 198916_ds_ef2 | Cutthroat Trout | fry | 3 | 7.4 | FALSE |
| 198916_ds_ef2 | Cutthroat Trout | juvenile | 3 | 7.4 | FALSE |
| 198916_ds_ef2 | Cutthroat Trout | parr | 5 | 12.3 | FALSE |
| 198916_ds_ef2 | Dolly Varden | adult | 2 | 4.9 | FALSE |
| 198916_ds_ef2 | Dolly Varden | fry | 1 | 2.5 | FALSE |
| 198916_ds_ef2 | Dolly Varden | juvenile | 1 | 2.5 | FALSE |
| 198916_us_ef1 | Dolly Varden | parr | 3 | 2.1 | FALSE |

* nfc_pass FALSE means fish were captured in final pass indicating more fish of this species/lifestage may have remained in site. Mark-recaptured required to reduce uncertainties.

Table 5.9: Fish sampling density results summary for 198913.

| local_name | species_code | life_stage | catch | density_100m2 | nfc_pass |
|---|---|---|---|---|---|
| 198913_ds_ef1 | Cutthroat Trout | adult | 1 | 2.4 | FALSE |
| 198913_ds_ef1 | Dolly Varden | adult | 1 | 2.4 | FALSE |
| 198913_ds_ef1 | Dolly Varden | fry | 1 | 2.4 | FALSE |
| 198913_ds_ef1 | Dolly Varden | juvenile | 3 | 7.1 | FALSE |
| 198913_ds_ef2 | Cutthroat Trout | adult | 1 | 1.5 | FALSE |
| 198913_ds_ef2 | Dolly Varden | fry | 1 | 1.5 | FALSE |
| 198913_ds_ef2 | Dolly Varden | juvenile | 3 | 4.5 | FALSE |
| 198913_ds_ef2 | Dolly Varden | parr | 1 | 1.5 | FALSE |
| 198913_us_ef1 | Dolly Varden | fry | 1 | 1.1 | FALSE |
| 198913_us_ef1 | Dolly Varden | juvenile | 3 | 3.3 | FALSE |
| 198913_us_ef1 | Dolly Varden | parr | 5 | 5.6 | FALSE |

* nfc_pass FALSE means fish were captured in final pass indicating more fish of this species/lifestage may have remained in site. Mark-recaptured required to reduce uncertainties.

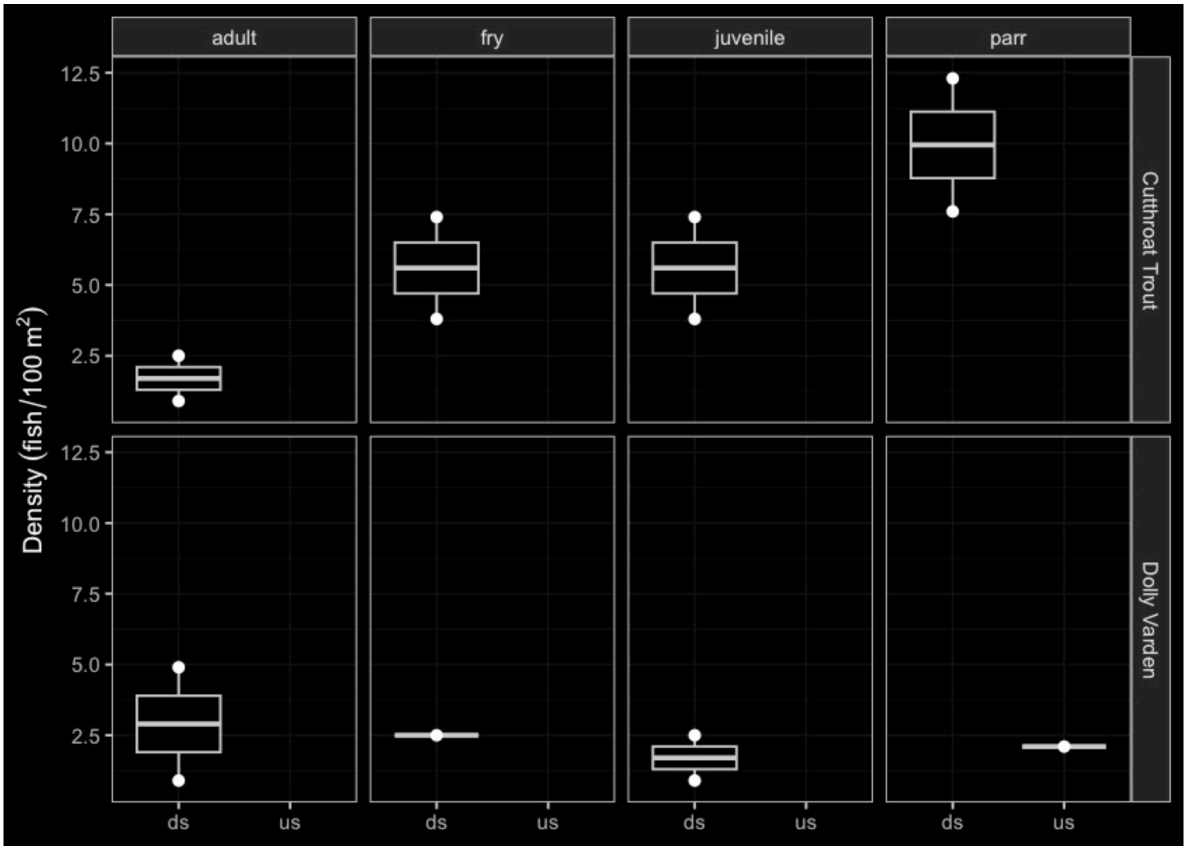



Figure 5.5: Densites of fish (fish/100m2) captured upstream and downstream of PSCIS crossing 198916.

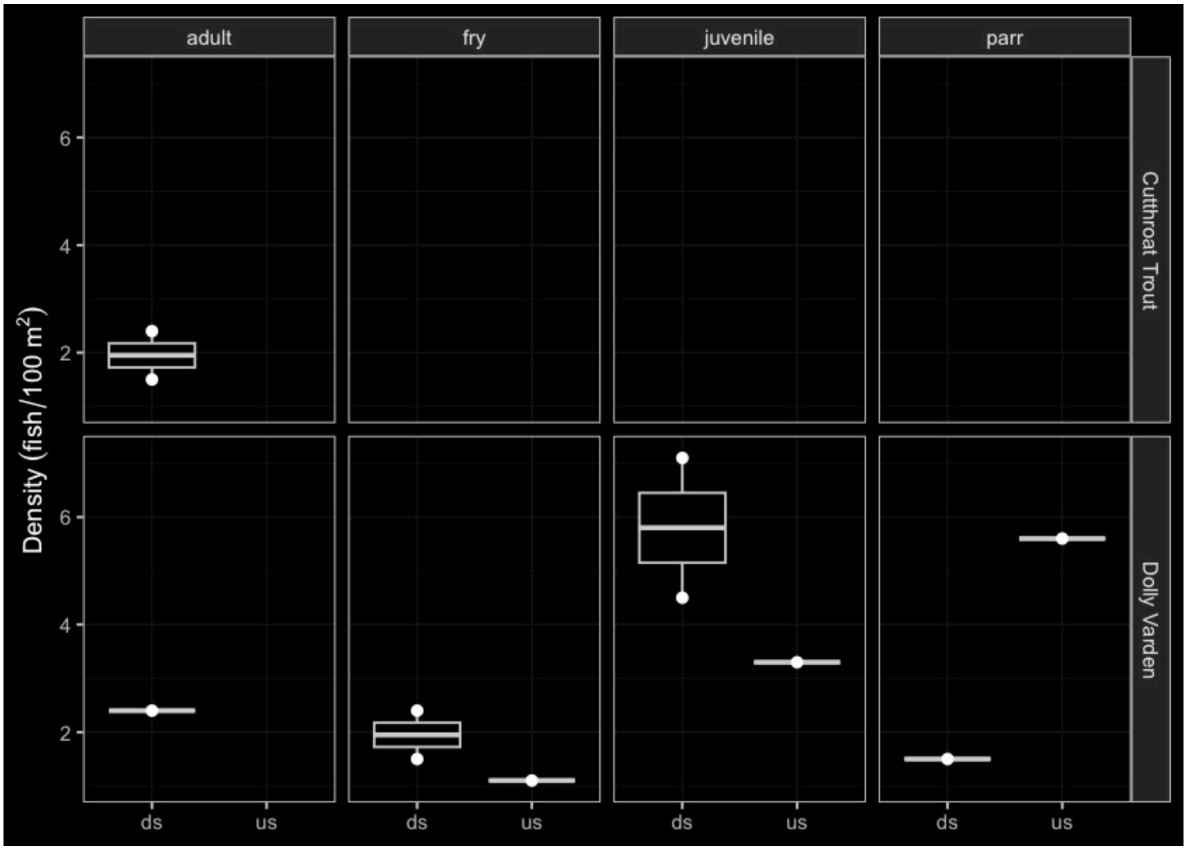



Figure 5.6: Densites of fish (fish/100m2) captured upstream and downstream of PSCIS crossing 198913.


Figure 5.7: Left: Typical habitat downstream of PSCIS crossing 198916. Right: Typical habitat upstream of PSCIS crossing 198916.


Figure 5.8: Left: Typical habitat downstream of PSCIS crossing 198913. Right: Typical habitat upstream of PSCIS crossing 198913.

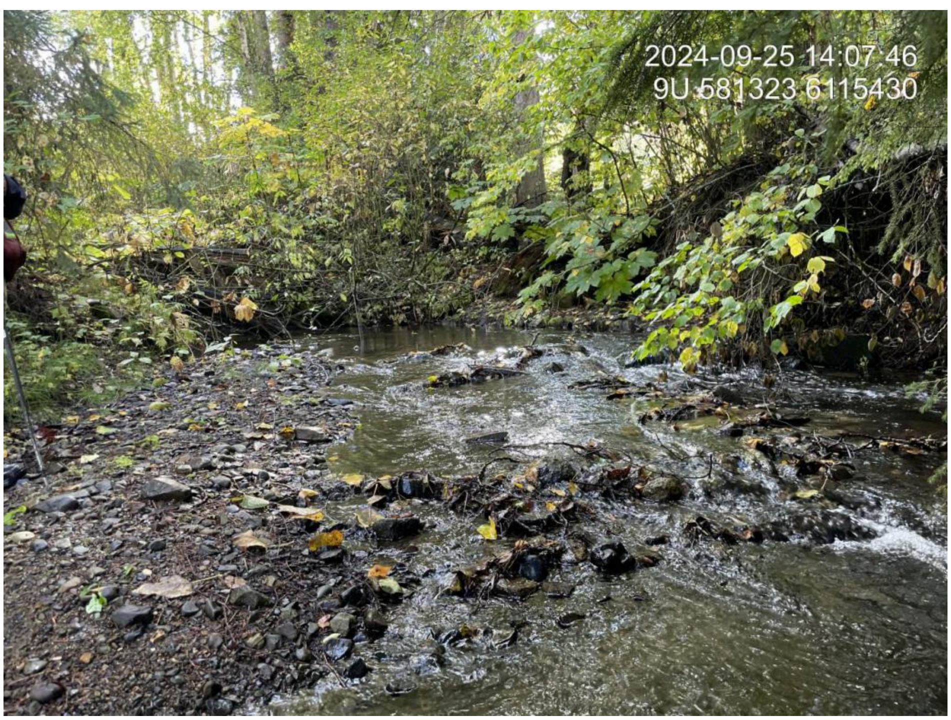



Figure 5.9: Typical habitat upstream of PSCIS crossing 198913.


Figure 5.10: Left: Cutthroat trout captured downstream of crossing 198916. Right: Typical habitat upstream of PSCIS crossing 198913.

## Tributary to Knapper Creek - 198940 & 198935 - Appendix

### Site Location

PSCIS crossings 198940 and 198935 are located on Tributary to Knapper Creek, approximately 22km southwest of Houston, BC within the Morice River watershed group. Tributary to Knapper Creek flows into Knapper Creek, which joins the Morice River approximately 2km downstream. PSCIS crossing 198940 is located 1.3km upstream of the confluence of the subject tributary and Knapper Creek, on spur HM7504 which is the responsibility of Canfor R07549 16. Approximately 350 m upstream, crossing 198935 is located on Gold creek fsr which is the responsibility of Canfor R07549 6.

### Background

At this location, Tributary to Knapper Creek is a second order stream and drains a watershed of approximately 4.1km$^2$. The watershed ranges in elevation from a maximum of 1131m to 785m near the lower crossing (Table 5.10). There is suspected interconnection between wetlands in this watershed and adjacent watersheds, suggesting the current estimates may under-represent the watershed's size.

In 2023, crossings 198940 and 198935 were assessed with fish passage assessments (Irvine and Schick 2023). These sites were prioritized for follow-up with habitat confirmation assessments due to the presence of high-value habitat observed upstream and fish observed during the 2023 assessment (Irvine and Schick 2023). Previously, cutthroat trout and rainbow trout have been documented upstream of crossing 198940 (Norris [2018] 2024; MoE 2024a).

Table 5.10: Summary of derived upstream watershed statistics for PSCIS crossing 198940.

| Site | Area Km | Elev Site | Elev Min | Elev Max | Elev Median | Elev P60 | Aspect |
|---|---|---|---|---|---|---|---|
| 198940 | 4.1 | 785 | 799 | 1131 | 923 | 903 | SE |

* Elev P60 = Elevation at which 60% of the watershed area is above

Outputs are presented in Table 5.11). A map of the watershed is provided in map attachment 093L.108.

Table 5.11: Summary of fish habitat modelling for PSCIS crossing 198940.

| Habitat | Potential | Remediation Gain | Remediation Gain (%) |
|---|---|---|---|
| ST Network (km) | 7.7 | 0.3 | 4 |
| ST Lake Reservoir (ha) | 0.1 | 0.0 | 0 |
| ST Wetland (ha) | 2.0 | 0.0 | 0 |
| ST Slopeclass03 Waterbodies (km) | 0.2 | 0.0 | 0 |
| ST Slopeclass03 (km) | 1.2 | 0.3 | 25 |
| ST Slopeclass05 (km) | 3.3 | 0.0 | 0 |
| ST Slopeclass08 (km) | 2.1 | 0.0 | 0 |
| ST Spawning (km) | 0.0 | 0.0 | – |
| ST Rearing (km) | 1.2 | 0.3 | 25 |
| CH Spawning (km) | 0.0 | 0.0 | – |
| CH Rearing (km) | 0.0 | 0.0 | – |
| CO Spawning (km) | 1.0 | 0.3 | 30 |
| CO Rearing (km) | 2.2 | 0.3 | 14 |
| CO Rearing (ha) | 0.0 | 0.0 | – |
| SK Spawning (km) | 0.0 | 0.0 | – |
| SK Rearing (km) | 0.0 | 0.0 | – |
| SK Rearing (ha) | 0.0 | 0.0 | – |

* Model data is preliminary and subject to adjustments.

### Stream Characteristics at Crossings 198940 and 198935

At the time of the 2024 assessment, PSCIS crossing 198940 on spur HM7504 was un-embedded, and ranked as a barrier to upstream fish passage according to the provincial protocol (MoE 2011) (Table 5.12). However, the culvert was backwatered to 30%, making it unlikely to be a barrier to fish passage. The pipe was significantly undersized for the stream, and the road appeared to be failing, likely due to a partially clogged inlet and spring freshet impacts.

PSCIS crossing 198935 on Gold creek fsr was un-embedded, non-backwatered and ranked as a barrier to upstream fish passage according to the provincial protocol (MoE 2011) (Table 5.13). This culvert had a significant 0.8 m deep outlet pool, and was deteriorating at the inlet.

At all crossings, the water temperature was 4.9°C, pH was 8.2 and conductivity was 236 uS/cm.

Table 5.12: Summary of fish passage assessment for PSCIS crossing 198940.

| **Location and Stream Data** | • | **Crossing Characteristics** | **–** |
|---|---|---|---|
| Date | 2024-09-18 | Crossing Sub Type | Round Culvert |
| PSCIS ID | 198940 | Diameter (m) | 0.95 |
| External ID | – | Length (m) | 25 |
| Crew | AI | Embedded | No |
| UTM Zone | 9 | Depth Embedded (m) | – |
| Easting | 636706 | Resemble Channel | – |
| Northing | 6020960 | Backwatered | Yes |
| Stream | Tributary to Knapper Creek | Percent Backwatered | 30 |
| Road | HM7504 | Fill Depth (m) | 1.75 |
| Road Tenure | Canfor R07549 16 | Outlet Drop (m) | 0 |
| Channel Width (m) | 4.3 | Outlet Pool Depth (m) | 0.9 |
| Stream Slope (%) | 3 | Inlet Drop | Yes |
| Beaver Activity | Yes | Slope (%) | 2 |
| Habitat Value | Medium | Valley Fill | Deep Fill |
| Final score | 24 | Barrier Result | Barrier |
| Fix type | Replace with New Open Bottom Structure | Fix Span / Diameter | 15 |

| Location and Stream Data | • | Crossing Characteristics | – |
|---|---|---|---|

Comments: Very nice stream with good flow, abundant gravels for spawning, and undercut banks and occasional deep pools for rearing. Confirmed populations of cutthroat trout, rainbow trout, and Dolly Varden. The culvert is significantly undersized for the stream, and the road appears to be failing, likely due to a partially clogged inlet and spring freshet. Habitat confirmations were completed for this crossing and the next upstream crossing (198935) on the Gold FSR.

Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.

Table 5.13: Summary of fish passage assessment for PSCIS crossing 198935.

| **Location and Stream Data** | • | **Crossing Characteristics** | **–** |
|---|---|---|---|
| Date | 2024-09-18 | Crossing Sub Type | Round Culvert |
| PSCIS ID | 198935 | Diameter (m) | 1.2 |
| External ID | – | Length (m) | 20 |
| Crew | LS | Embedded | No |
| UTM Zone | 9 | Depth Embedded (m) | – |
| Easting | 636440 | Resemble Channel | – |
| Northing | 6020756 | Backwatered | No |
| Stream | Tributary to Knapper Creek | Percent Backwatered | – |
| Road | Gold creek fsr | Fill Depth (m) | 4 |
| Road Tenure | Canfor R07549 6 | Outlet Drop (m) | 0.15 |
| Channel Width (m) | 2.7 | Outlet Pool Depth (m) | 0.8 |
| Stream Slope (%) | 2.2 | Inlet Drop | No |
| Beaver Activity | Yes | Slope (%) | 1.5 |
| Habitat Value | Medium | Valley Fill | Deep Fill |
| Final score | 29 | Barrier Result | Barrier |
| Fix type | Replace with New Open Bottom Structure | Fix Span / Diameter | 18 |

| Location and Stream Data | • | Crossing Characteristics | – |
|---|---|---|---|
| Comments: The culvert is deteriorating at the inlet. Large outlet pool where fish were captured during sampling. The stream flows from the outlet pool along the left-hand side into a well-defined channel with gravels suitable for spawning and several pools, providing good habitat. A moderate amount of road fill is present. | | | |
| Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet. | | | |

### Stream Characteristics Downstream of Crossing 198940

The stream was surveyed downstream from crossing 198940 for 300m (Figure 5.12).. The habitat was rated as medium, with good flow, abundant gravels, overhanging banks, and healthy riparian vegetation, providing good rearing and spawning habitat for coho, rainbow trout, Dolly Varden, and cutthroat trout. The average channel width was 3.3m, the average wetted width was 1.5m, and the average gradient was 3.3%.Total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, large woody debris, and overhanging vegetation.The dominant substrate was gravels with cobbles sub-dominant..

### Stream Characteristics Upstream of Crossing 198940 and Downstream of Crossing 198935

The stream was surveyed in the downstream direction, starting at the upstream crossing on Gold Creek FSR (198935), down to the crossing on road/spur HM7504 (198940), a distance of approximately 340 m (Figure 5.12 The dominant substrate was gravels with fines sub-dominant.The average channel width was 2.8m, the average wetted width was 1.2m, and the average gradient was 2.7%.Total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, large woody debris, deep pools, and overhanging vegetation. The habitat was rated as medium value with good flow, abundant spawning gravels, and suitable rearing habitat in undercut banks and occasional deep pools. Historic beaver activity was evident, including a large breached dam near the upstream end of the site. The riparian zone consisted of a healthy shrub and herbaceous flood-tolerant plant community. The stream corridor, approximately 40–50 m wide, was bordered by mature coniferous forest on both sides.

### Stream Characteristics Upstream of Crossing 198935

The stream was surveyed upstream from crossing 198935 for 700m . (Figure 5.13). The habitat was rated as medium value with a good flow and abundant gravels throughout. A mature mixed forest, including cottonwood, provided excellent bank stabilization, resulting in deeply undercut banks and intermittent pools up to 60 cm deep within the surveyed area. The average channel width was 2.5m, the average wetted width was 1.9m, and the average gradient was 2.2%.Total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, large woody debris, deep pools, and overhanging vegetation.The dominant substrate was gravels with fines sub-dominant.

### Fish Sampling

Electrofishing was conducted upstream and downstream of crossing (198935) with results summarised in Tables 5.15 - 5.16 and Figure 5.11. A total of 39 fish were captured downstream including rainbow trout, cutthroat trout, and Dolly Varden. Upstream of the crossing 43 fish were captured including rainbow trout, cutthroat trout, and cutthroat trout/rainbow trout hybrid (Figure 5.13). .

## Structure Remediation and Cost Estimate

Should restoration/maintenance activities proceed, replacement of the Gold Creek FSR crossing (198935) with a bridge (18 m span) is recommended. At the time of reporting in 2025, the cost of the work is estimated at $ 450,000.

At the time of assessment, the downstream crossing on road/spur HM7504 was unlikely a barrier to fish passage, and restoration efforts should prioritize the upstream crossing on Gold Creek FSR. However, should restoration activities proceed at crossing 198940, replacement with a bridge spanning 15 m is recommended. At the time of reporting in 2025, the estimated cost for the replacement is $ 540,000.

## Conclusion

Tributary to Knapper Creek contains moderate-value rearing and spawning habitat for coho, rainbow trout, Dolly Varden, and cutthroat trout. Electrofishing at the time of assessment confirmed the presence of rainbow trout, cutthroat trout, cutthroat/rainbow trout hybrids, and Dolly Varden. Habitat modelling identified 1.2km of steelhead rearing habitat upstream of crossing 198940, with approximately 300m less upstream of 198935. There is suspected interconnection between wetlands in this watershed and adjacent watersheds, suggesting the current modelling may under-represent the watershed’s size.

Should restoration activities proceed, efforts should focus on PSCIS crossing`r as.character(my_site2)` on Gold Creek FSR, which had a small outlet drop and a deep outlet pool. PSCIS crossing 198940 on Road/Spur HM7504 was backwatered and not presumed to be a barrier to fish passage. Both crossings were noted as undersized for the stream.

Table 5.14: Summary of habitat details for PSCIS crossings 198940 and 198935.

| Site | Location | Length Surveyed (m) | Average Channel Width (m) | Average Wetted Width (m) | Average Pool Depth (m) | Average Gradient (%) | Total Cover | Habitat Value |
|---|---|---|---|---|---|---|---|---|
| 198935 | Upstream | 700 | 2.5 | 1.9 | 0.4 | 2.2 | moderate | medium |
| 198940 | Downstream | 300 | 3.3 | 1.5 | 0.4 | 3.3 | moderate | medium |
| 198940 | Upstream | 340 | 2.8 | 1.2 | 0.3 | 2.7 | moderate | medium |

Table 5.15: Fish sampling site summary for 198935.

| site | passes | ef_length_m | ef_width_m | area_m2 | enclosure |
|---|---|---|---|---|---|
| 198935_ds_ef1 | 1 | 8 | 1.1 | 8.8 | partial enclosure |
| 198935_us_ef1 | 1 | 30 | 1.6 | 48.0 | partial enclosure |

Table 5.16: Fish sampling density results summary for 198935.

| local_name | species_code | life_stage | catch | density_100m2 | nfc_pass |
|---|---|---|---|---|---|
| 198935_ds_ef1 | Cutthroat Trout | adult | 1 | 11.4 | FALSE |
| 198935_ds_ef1 | Cutthroat Trout | parr | 4 | 45.5 | FALSE |
| 198935_ds_ef1 | Dolly Varden | parr | 1 | 11.4 | FALSE |
| 198935_ds_ef1 | Rainbow Trout | fry | 12 | 136.4 | FALSE |
| 198935_ds_ef1 | Rainbow Trout | parr | 21 | 238.6 | FALSE |
| 198935_us_ef1 | Cutthroat Trout | adult | 1 | 2.1 | FALSE |
| 198935_us_ef1 | Cutthroat Trout /Rainbow Trout hybrid | fry | 1 | 2.1 | FALSE |
| 198935_us_ef1 | Rainbow Trout | adult | 1 | 2.1 | FALSE |
| 198935_us_ef1 | Rainbow Trout | fry | 23 | 47.9 | FALSE |
| 198935_us_ef1 | Rainbow Trout | juvenile | 1 | 2.1 | FALSE |
| 198935_us_ef1 | Rainbow Trout | parr | 16 | 33.3 | FALSE |

* nfc_pass FALSE means fish were captured in final pass indicating more fish of this species/lifestage may have remained in site. Mark-recaptured required to reduce uncertainties.

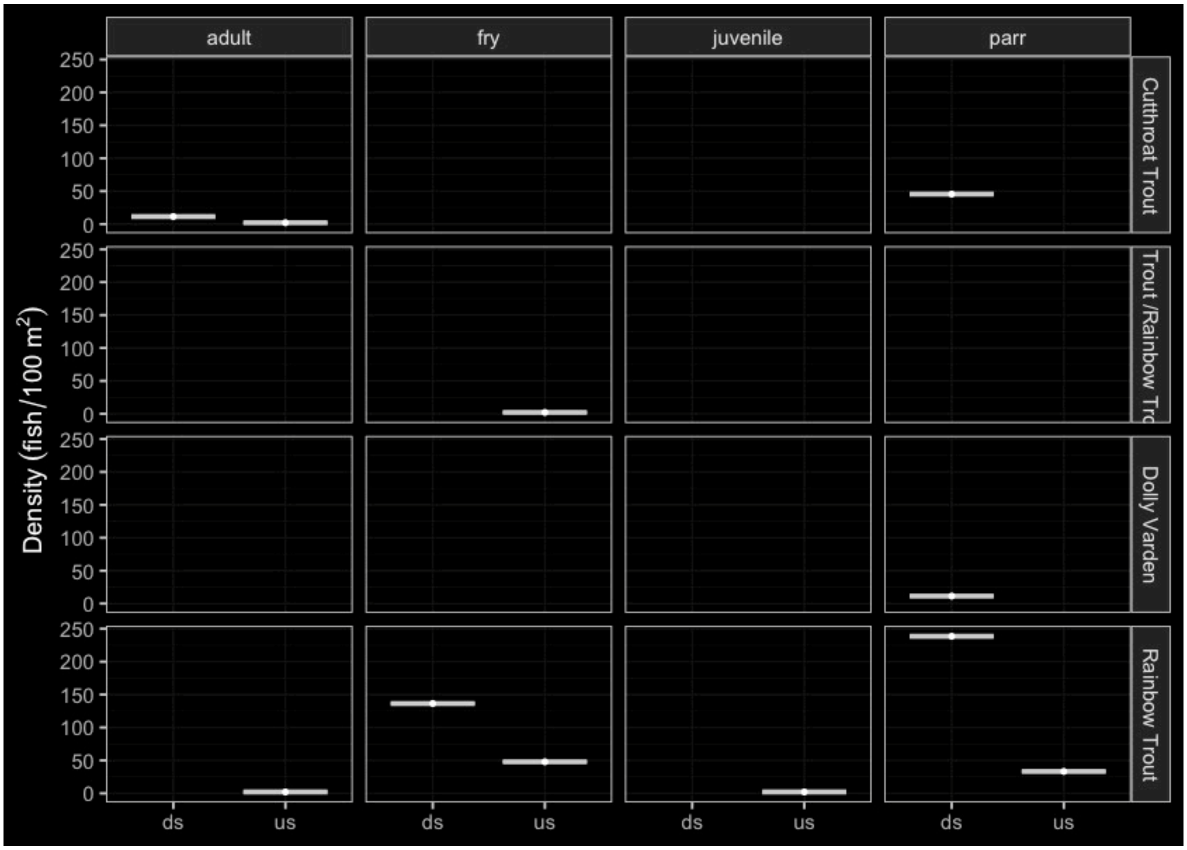



Figure 5.11: Densites of fish (fish/100m2) captured upstream and downstream of PSCIS crossing 198935.


Figure 5.12: Left: Typical habitat downstream of PSCIS crossing 198940. Right: Typical habitat upstream of PSCIS crossing 198940.


Figure 5.13: Left: Typical habitat upstream of PSCIS crossing 198935. Right: Rainbow trout captured downstream of crossing 198935.

# Simpson Creek - 58245 & 203122 & 58264 - Appendix

## Site Location

PSCIS crossings 58245, 203122, and 58264 are located on Simpson Creek, approximately 3km northwest of Smithers, BC. Within the BC Freshwater Atlas, the stream is incorrectly mapped at multiple locations including immediately adjacent to Kathlyn Creek as well as the entire section of stream between the CN Railway line to approximately 300m upstream of Neilson Road (Figure . Simpson Creek flows into Kathlyn Creek, which joins the Bulkley River approximalety 4km downstream. PSCIS crossing 58245 is located 70m upstream of the confluence of Simpson Creek and Kathlyn Creek, on Lake Kathlyn Road. Approximately 530 m upstream, crossing 203122 is located on and is the responsibility of the Canadian National Railway. A further 950m upstream, crossing 58264 is located on Nielson Road. The Lake Kathlyn Road and Nielson Road crossings are the responsibility of the Ministry of Transportation and Infrastructure and all crossing are within the Bulkley River watershed group.

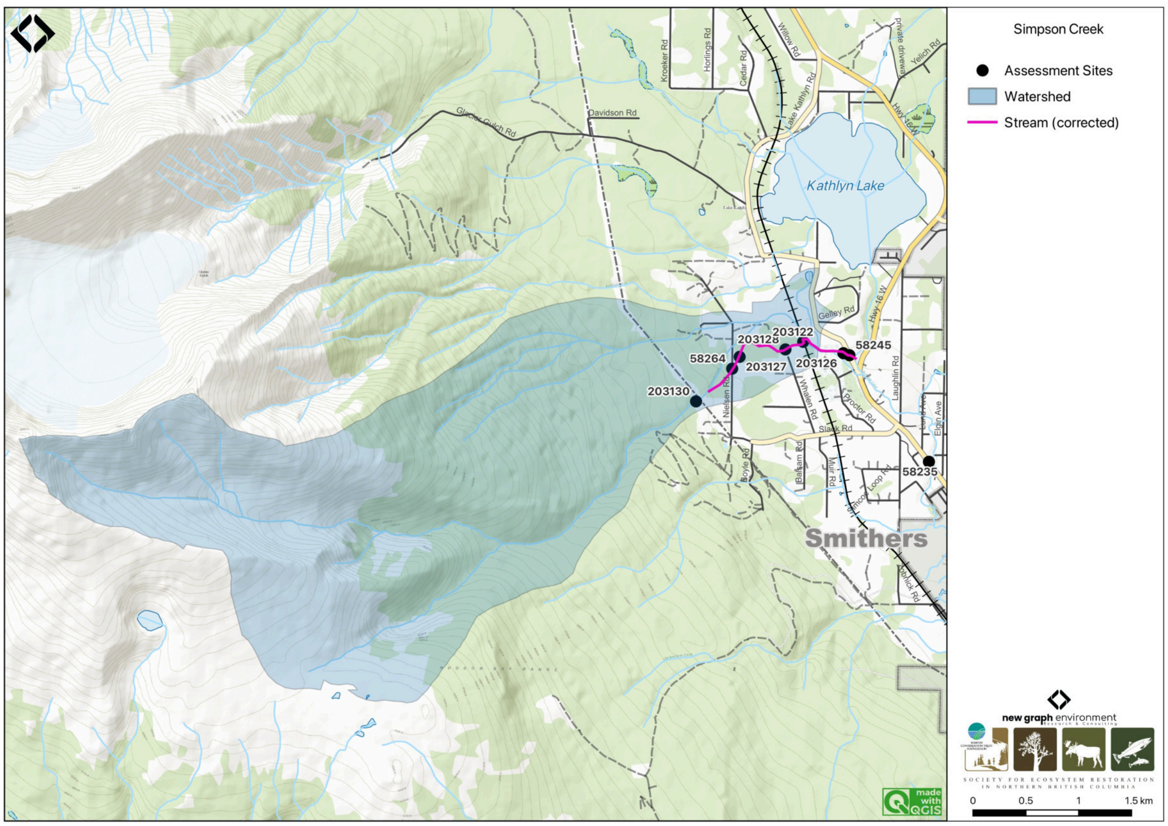



Figure 5.14: Map of Simpson Creek

## Background

At PSCIS crossing 58245, Simpson Creek is a third order stream and drains a high elevation watershed of approximately 13.1km$^2$. The watershed ranges in elevation from a maximum of

2477m to 503m near the lower crossing (Table 5.17). Simpson Creek is a major contributor to the greater Kathlyn Creek watershed, with flow volumes during the 2024 assessment slightly less than the Kathlyn Creek mainstem.

In 2012, PSCIS crossings 58245 and 58264 were assessed with fish passage assessments by Marlim Ecological Consulting Ltd. and both were ranked as barriers (MarLim Ecological Consulting Ltd. 2013).

A. Gottesfeld and Rabnett (2007) report that Simpson Creek has been a spawning location for coho salmon from the Kathln Creek system, noting that since 1986, coho have been transplanted into the Kathlyn Creek system from the Toboggan Creek Hatchery (A. Gottesfeld and Rabnett 2007). Kathlyn Creek also supports a small population of pink salmon, and steelhead are known to inhabit Kathlyn Lake and spawn upstream of the Chicken Creek confluence, which would include areas near the Simpson Creek confluence (A. Gottesfeld and Rabnett 2007). Adjacent to the crossing on Nielson Road (58264), coho salmon, cutthroat trout, rainbow trout, steelhead, mountain whitefish, and Dolly Varden have been documented in the past (Norris [2018] 2024; MoE 2024a). A landowner adjacent to the stream reported observing steelhead and coho spawning within the last decade and chinook spawning historically near their property located approximately 360 m downstream of Nielson Road.

According to a nearby landowner, the crossing on Nielson Road (58264) was originally a bridge but was replaced with the current culvert during an emergency flood event in the 1990s. Materials from the flood were used to construct dikes upstream and downstream of the crossing, which remained in place at the time of the 2024 assessment. Upstream of the Nielson Road crossing, a trail runs parallel to the stream for 400m up to the power line, offering an excellent opportunity for community engagement. By connecting people to the land, the trail can foster stewardship and advocacy for the stream, potentially leading to future restoration efforts.

Table 5.17: Summary of derived upstream watershed statistics for PSCIS crossing 58245.

| Site | Area Km | Elev Site | Elev Min | Elev Max | Elev Median | Elev P60 | Aspect |
|---|---|---|---|---|---|---|---|
| 58245 | 13.1 | 503 | 495 | 2477 | 1311 | 1068 | E |

* Elev P60 = Elevation at which 60% of the watershed area is above

Habitat modelling outputs from `bcfishpass` indicated 1.6km of steelhead and 1.4km of coho rearing habitat upstream of crossing 58245 on Lake Kathlyn Road (gradients <8.5% for steelhead and <5.5% for coho). Upstream of the crossing on Nielson Road, only 100m of habitat is modelled for steelhead and coho rearing due to a steeper stream gradient exceeding 8.5%. Outputs are presented in Table 5.18). A map of the watershed is provided in map attachment 093L.122.

Table 5.18: Summary of fish habitat modelling for PSCIS crossing 58245.

| Habitat | Potential | Remediation Gain | Remediation Gain (%) |
|---|---|---|---|
| ST Network (km) | 5.4 | 0 | 0 |
| ST Lake Reservoir (ha) | 0.6 | 0 | 0 |
| ST Wetland (ha) | 0.0 | 0 | – |
| ST Slopeclass03 Waterbodies (km) | 0.1 | 0 | 0 |
| ST Slopeclass03 (km) | 2.5 | 0 | 0 |
| ST Slopeclass05 (km) | 0.4 | 0 | 0 |
| ST Slopeclass08 (km) | 0.8 | 0 | 0 |
| ST Spawning (km) | 1.5 | 0 | 0 |
| ST Rearing (km) | 2.0 | 0 | 0 |
| CH Spawning (km) | 1.4 | 0 | 0 |
| CH Rearing (km) | 1.4 | 0 | 0 |
| CO Spawning (km) | 1.5 | 0 | 0 |
| CO Rearing (km) | 1.4 | 0 | 0 |
| CO Rearing (ha) | 0.0 | 0 | – |
| SK Spawning (km) | 0.0 | 0 | – |
| SK Rearing (km) | 0.0 | 0 | – |
| SK Rearing (ha) | 0.0 | 0 | – |

* Model data is preliminary and subject to adjustments.

## Stream Characteristics at Crossings 58245, 203122, and 58264

At the time of the 2024 assessment, PSCIS crossing 58245 on Lake Kathlyn Road was un-embedded, non-backwatered and although it ranked as a barrier to upstream fish passage according to the provincial protocol, neither of the two culverts at this location had an outlet drop, therefore it is unlikely a barrier to fish passage (MoE 2011) (Table 5.19).

Approximately 530 m upstream of Lake Kathlyn Road, PSCIS crossing 203122 on the CN Railway was un-embedded, non-backwatered and ranked as a barrier to upstream fish passage according to the provincial protocol (MoE 2011) (Table 5.20). The two culverts were roughly 30 m apart, the southern pipe was dry and fully embedded, while the northern pipe was currently conveying the main flow of Simpson Creek.

A further 950m upstream, PSCIS crossing 58264 on Nielson Road was un-embedded, non-backwatered and ranked as a barrier to upstream fish passage according to the provincial protocol (MoE 2011) (Table 5.21). This concrete oval culvert had a significant 1 m outlet drop and 1.2 m deep outlet pool.

At all crossings, the water temperature was 6.1°C, pH was 7.7 and conductivity was 107 uS/cm.

Table 5.19: Summary of fish passage assessment for PSCIS crossing 58245.

| **Location and Stream Data** | • | **Crossing Characteristics** | **–** |
|---|---|---|---|
| Date | 2024-09-20 | Crossing Sub Type | Round Culvert |
| PSCIS ID | 58245 | Diameter (m) | 2.5 |
| External ID | – | Length (m) | 20 |
| Crew | AI | Embedded | No |
| UTM Zone | 9 | Depth Embedded (m) | – |
| Easting | 615383 | Resemble Channel | – |
| Northing | 6075125 | Backwatered | No |
| Stream | Simpson Creek | Percent Backwatered | – |
| Road | Lake Kathlyn Road | Fill Depth (m) | 2.2 |
| Road Tenure | MoTi | Outlet Drop (m) | 0 |
| Channel Width (m) | 7 | Outlet Pool Depth (m) | 0.3 |
| Stream Slope (%) | 1.5 | Inlet Drop | No |
| Beaver Activity | Yes | Slope (%) | 2 |
| Habitat Value | High | Valley Fill | Deep Fill |
| Final score | 24 | Barrier Result | Barrier |
| Fix type | Replace with New Open Bottom Structure | Fix Span / Diameter | 15 |

| **Location and Stream Data** | • | **Crossing Characteristics** | – |
|---|---|---|---|
| Comments: Two 1.25 m pipes are present and are heavily corroded. Upstream and downstream, the streambanks are heavily modified adjacent to private land, including riparian vegetation removal, stream channelization, and bank armouring. High-value steelhead, coho, and chinook spawning habitat is documented further upstream above the railway crossing. MoTi chris_culvert_id: 1514706, 1514705 | | | |
| Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet. | | | |

Table 5.20: Summary of fish passage assessment for PSCIS crossing 203122.

| **Location and Stream Data** | • | **Crossing Characteristics** | – |
|---|---|---|---|
| Date | 2024-09-20 | Crossing Sub Type | Round Culvert |
| PSCIS ID | 203122 | Diameter (m) | 3 |
| External ID | – | Length (m) | 25 |
| Crew | AI | Embedded | No |
| UTM Zone | 9 | Depth Embedded (m) | – |
| Easting | 614941 | Resemble Channel | Yes |
| Northing | 6075232 | Backwatered | No |
| Stream | Simpson Creek | Percent Backwatered | – |
| Road | Railway | Fill Depth (m) | 1 |
| Road Tenure | CN Rail | Outlet Drop (m) | 0.05 |
| Channel Width (m) | 5 | Outlet Pool Depth (m) | 0.9 |
| Stream Slope (%) | 1 | Inlet Drop | Yes |
| Beaver Activity | Yes | Slope (%) | 2 |
| Habitat Value | High | Valley Fill | Deep Fill |
| Final score | 24 | Barrier Result | Barrier |
| Fix type | Replace with New Open Bottom Structure | Fix Span / Diameter | 15 |

Comments: Although this culvert is on Simpson Creek, it is not currently conveying the main flow and remains mostly dry. Two 1.5 m diameter pipes run under the railway, approximately 30 m apart. The southern pipe is fully embedded with an average embedment depth of 25 cm, while the northern pipe is currently passing all stream flow. This is a high-value stream with extensive gravel areas suitable for steelhead, coho, and chinook salmon spawning upstream. The adjacent landowner has reported recent observations of steelhead spawning and has historical knowledge of chinook spawning approximately 300 m downstream from Nielsen Road.

Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.

| Location and Stream Data | • | Crossing Characteristics | – |
|---|---|---|---|



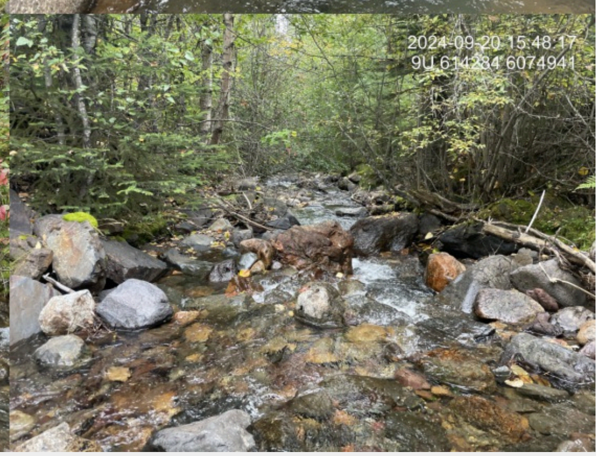


| **Location and Stream Data** | • | **Crossing Characteristics** | **–** |
|---|---|---|---|
| Date | 2024-09-20 | Crossing Sub Type | Oval Culvert |
| PSCIS ID | 58264 | Diameter (m) | 2.4 |
| External ID | – | Length (m) | 23 |
| Crew | LS TP | Embedded | No |
| UTM Zone | 9 | Depth Embedded (m) | – |
| Easting | 614280 | Resemble Channel | – |
| Northing | 6074951 | Backwatered | No |
| Stream | Simpson Creek | Percent Backwatered | – |
| Road | Nielson Road | Fill Depth (m) | 0.4 |
| Road Tenure | MoTi | Outlet Drop (m) | 1 |
| Channel Width (m) | 5.6 | Outlet Pool Depth (m) | 1.2 |
| Stream Slope (%) | 13 | Inlet Drop | No |
| Beaver Activity | No | Slope (%) | 5 |
| Habitat Value | High | Valley Fill | Deep Fill |
| Final score | 39 | Barrier Result | Barrier |
| Fix type | Replace with New Open Bottom Structure | Fix Span / Diameter | 15 |
| Comments: This concrete oval culvert has a significant 1 m outlet drop, likely inhibiting fish passage. The stream is incorrectly mapped in the Freshwater Atlas, located south of the mapped channel. Upstream habitat includes boulder cover, gravel pockets suitable for coho, steelhead, and Dolly Varden spawning, and a healthy mature mixed forest riparian zone. Downstream habitat transitions to lower-gradient, high-value conditions with extensive gravels, deep pools (up to 90 cm), large woody debris, and abundant cover, supporting recent steelhead and historically chinook spawning, as reported by the adjacent landowner. Habitat confirmations were completed at this site and all downstream crossings to the confluence with Kathlyn Creek. The stream is a major contributor to the greater Kathlyn Creek watershed, with flow volumes during the assessment slightly less than the Kathlyn Creek mainstem. Electrofishing upstream of Nielsen Road captured rainbow trout, while downstream sampling confirmed the presence of Dolly Varden, rainbow trout, cutthroat trout/rainbow trout hybrids, and coho. The coho were captured approximately 350 m downstream of Nielsen Road. According to the landowner, this crossing was originally a bridge but was replaced with the current culvert during an emergency flood event in the 1990s. | | | |
| Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet. | | | |

| Location and Stream Data | • | Crossing Characteristics | – |
|---|---|---|---|






## Stream Characteristics Downstream of Crossing 58245

The stream was surveyed downstream from crossing 58245 for 70m , to the confluence with Kathlyn Creek. The stream ran adjacent to the road along one bank, which had limited riparian vegetation consisting primarily of shrubs. The opposite bank, bordered by private property, had minimal vegetation and no significant riparian cover. Multiple sections of bank armouring and channelization were observed near the private property, and only small pockets of gravels suitable for spawning were observed (Figure 5.16). The average channel width was 6.2m, the average wetted width was 3.9m, and the average gradient was 2%.Total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, deep pools, and overhanging vegetation.The dominant substrate was fines with cobbles sub-dominant. The habitat was rated as medium value for salmonid rearing and spawning.

### Stream Characteristics Upstream of Crossing 58245 and Downstream of Crossing 203122

The stream was surveyed from Lake Kathlyn Road (crossing 58245) to the CN railway (crossing 203122), a distance of approximately 650m. Above Lake Kathlyn Road, the stream was heavily impacted by adjacent private lands, with riparian vegetation removed, the stream channelized, and banks armoured (Figure 5.16). Extensive beaver activity was observed in the lower stream, with dams ranging in height from 0.4 to 1 m. Nearing the railway crossing, the stream consisted of mostly intact riparian vegetation, abundant gravels, deep pools, and large woody debris. The average channel width was 6m, the average wetted width was 4.3m, and the average gradient was 1.1%.The dominant substrate was fines with gravels sub-dominant.Total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, large woody debris, deep pools, and overhanging vegetation. The habitat was rated as high value for salmonid spawning and rearing.

PSCIS crossing 203126, situated approximately 70m upstream of Lake Kathlyn Road, was also assessed during the survey, with the culvert assessment provided in Appendix 1 (page 0). The crossing consisted of three 0.95m pipes running beneath a private driveway, with two pipes appearing fully embedded. The crossing was non-backwatered and ranked as a barrier to upstream fish passage according to the provincial protocol (MoE 2011). Evidence of beaver activity was observed including debris accumulation at the inlet, and the landowner reported previous blockages caused by beavers, which required periodic inlet clearing and the removal of significant accumulated material through dredging.

### Stream Characteristics Upstream of Crossing 203122 and Downstream of Crossing 58264

The stream was surveyed from the CN railway (crossing 203122) to Nielson Road (crossing 58264), a distance of approximately 950m (Figure 5.17). From the railway crossing upstream, the gradient was low (2–3%), with high-quality habitat characterized by abundant gravels, deep pools up to 90cm, large woody debris, and diverse cover. In this section, the adjacent landowner reported recent steelhead and coho spawning, as well as historical Chinook spawning. Approximately 300m downstream of Nielson Road, the gradient increased (5–6%), transitioning into straight riffle-cascade sections with confined, channelized, dyke-like banks. Total cover amount was rated as moderate with deep pools dominant. Cover was also present as small woody debris, large woody debris, undercut banks, and overhanging vegetation.The dominant substrate was gravels with cobbles sub-dominant.The average channel width was 6.2m, the average wetted width was 3.5m, and the average gradient was 4.1%. The habitat was rated as high value for salmonid spawning and rearing.

### Stream Characteristics Upstream of Crossing 58264

The stream was surveyed upstream from crossing 58264 for 615m . This section of the stream featured a steeper gradient, predominantly characterized by boulder cover with occasional pockets of gravels suitable for coho, steelhead, and Dolly Varden spawning (Figure 5.17). Pools were infrequent throughout. The riparian zone was composed of a healthy, mature mixed forest, providing stability and shading. The upper end of the site was situated just upstream of a short cascade with a 20% gradient. The habitat was rated as medium value for salmonid rearing an spawning. The average channel width was 8.9m, the average wetted width was 4.7m, and the average gradient was 7.3%.Total cover amount was rated as moderate with boulders dominant. Cover was also present as large woody debris.The dominant substrate was cobbles with boulders sub-dominant.

### Fish Sampling

Electrofishing was conducted upstream and downstream of crossing (58264) with results summarised in Tables 5.23 - 5.24 and Figure 5.15. A total of 20 fish were captured downstream including rainbow trout, cutthroat trout/rainbow trout hybrid, and Dolly Varden. Upstream of the crossing 12 rainbow trout were captured (Figure 5.18). .

Electrofishing was conducted at one site approximately 360 m downstream of Nielsen Road, with results summarised in Tables 5.23 - 5.24 and Figure 5.15. At this location, the adjacent landowner had reported recent steelhead and coho spawning and historically Chinook spawning. A total of 43 fish were captured including coho salmon, cutthroat trout/rainbow trout hybrid, and Dolly Varden (Figure 5.18).

### Structure Remediation and Cost Estimate

Should restoration/maintenance activities proceed, replacement of the Nielson Road crossing (58264) with a bridge (15 m span) is recommended. The significant 1 m outlet drop at this crossing, combined with the presence of salmonids in the system, makes it a top priority for remediation. At the time of reporting in 2025, the cost of the work is estimated at $ 3,000,000.

PSCIS crossing 203122 on the CN Railway presented a minimal barrier to fish passage and is considered a low priority for replacement. However, if restoration activities are undertaken, replacing the existing structure with a bridge spanning 15 m is recommended. As of 2025, the estimated replacement cost is $ 11,250,000, with the high cost attributed to the complexities of working within a railway corridor.

At the time of assessment, the downstream crossing on Lake Kathlyn Road was unlikely a barrier to fish passage. However, should restoration activities proceed, replacement with a bridge spanning 15 m is recommended. At the time of reporting in 2025, the estimated cost for the replacement is $ 3,000,000.

## Conclusion

Simpson Creek is a significant contributor to the Kathlyn Creek watershed, with flow volumes during the 2024 assessment slightly less than those observed in the Kathlyn Creek mainstem. The habitat was rated as value for salmonid spawning and rearing. Simpson Creek has historically supported a variety of salmonids, and coho captured during electrofishing at the time of assessment further confirm the stream’s continued importance as salmonid habitat. PSCIS crossing 58264 on Nielsen Road is a strong candidate for remediation, given its large outlet drop (1m) and low traffic volume, it is a high priority for replacement. Upstream of this crossing, a trail runs alongside the stream offering opportunities for community engagement and education, which could foster stewardship and advocacy for the stream. PSCIS crossing 203122 on the CN Railway presented a minimal barrier at the time of assessment and was considered a low priority for replacement. However, if restoration activities proceed at the upstream crossing on Nielsen Road, this crossing should be reassessed. PSCIS crossing 58245 on Lake Kathlyn Road is not presumed to be a significant barrier to fish passage and was rated as a low priority for replacement. However, the culverts were heavily corroded and located in an area impacted by riparian vegetation removal, stream channelization, and bank armouring, which presents a valuable opportunity for community-led restoration efforts and education. The proximity of these sites to Smithers, BC, enhances opportunities for public involvement and education, further supporting long-term restoration goals for Simpson Creek.

Table 5.22: Summary of habitat details for PSCIS crossings 58245 and 58264.

| Site | Location | Length Surveyed (m) | Average Channel Width (m) | Average Wetted Width (m) | Average Pool Depth (m) | Average Gradient (%) | Total Cover | Habitat Value |
|---|---|---|---|---|---|---|---|---|
| 58245 | Downstream | 70 | 6.2 | 3.9 | 0.3 | 2.0 | moderate | medium |
| 58245 | Upstream | 1000 | 6.0 | 4.3 | 0.7 | 1.1 | moderate | high |
| 58264 | Upstream | 615 | 8.9 | 4.7 | 0.3 | 7.3 | moderate | medium |

Table 5.23: Fish sampling site summary for 58264.

| site | passes | ef_length_m | ef_width_m | area_m2 | enclosure |
|---|---|---|---|---|---|
| 58264_ds_ef1 | 1 | 25 | 3.3 | 82.5 | partial enclosure |
| 58264_ds_ef2 | 1 | 30 | 2.7 | 81.0 | partial enclosure |
| 58264_us_ef1 | 1 | 32 | 3.5 | 112.0 | partial enclosure |

Table 5.24: Fish sampling density results summary for 58264.

| local_name | species_code | life_stage | catch | density_100m2 | nfc_pass |
|---|---|---|---|---|---|
| 58264_ds_ef1 | Cutthroat Trout /Rainbow Trout hybrid | parr | 2 | 2.4 | FALSE |
| 58264_ds_ef1 | Dolly Varden | juvenile | 2 | 2.4 | FALSE |
| 58264_ds_ef1 | Dolly Varden | parr | 1 | 1.2 | FALSE |
| 58264_ds_ef1 | Rainbow Trout | parr | 15 | 18.2 | FALSE |
| 58264_ds_ef2 | Coho Salmon | fry | 3 | 3.7 | FALSE |
| 58264_ds_ef2 | Coho Salmon | parr | 1 | 1.2 | FALSE |
| 58264_ds_ef2 | Cutthroat Trout /Rainbow Trout hybrid | parr | 5 | 6.2 | FALSE |
| 58264_ds_ef2 | Dolly Varden | fry | 1 | 1.2 | FALSE |
| 58264_ds_ef2 | Rainbow Trout | fry | 20 | 24.7 | FALSE |
| 58264_ds_ef2 | Rainbow Trout | parr | 13 | 16.0 | FALSE |
| 58264_us_ef1 | Rainbow Trout | fry | 1 | 0.9 | FALSE |
| 58264_us_ef1 | Rainbow Trout | parr | 11 | 9.8 | FALSE |

* nfc_pass FALSE means fish were captured in final pass indicating more fish of this species/lifestage may have remained in site. Mark-recaptured required to reduce uncertainties.

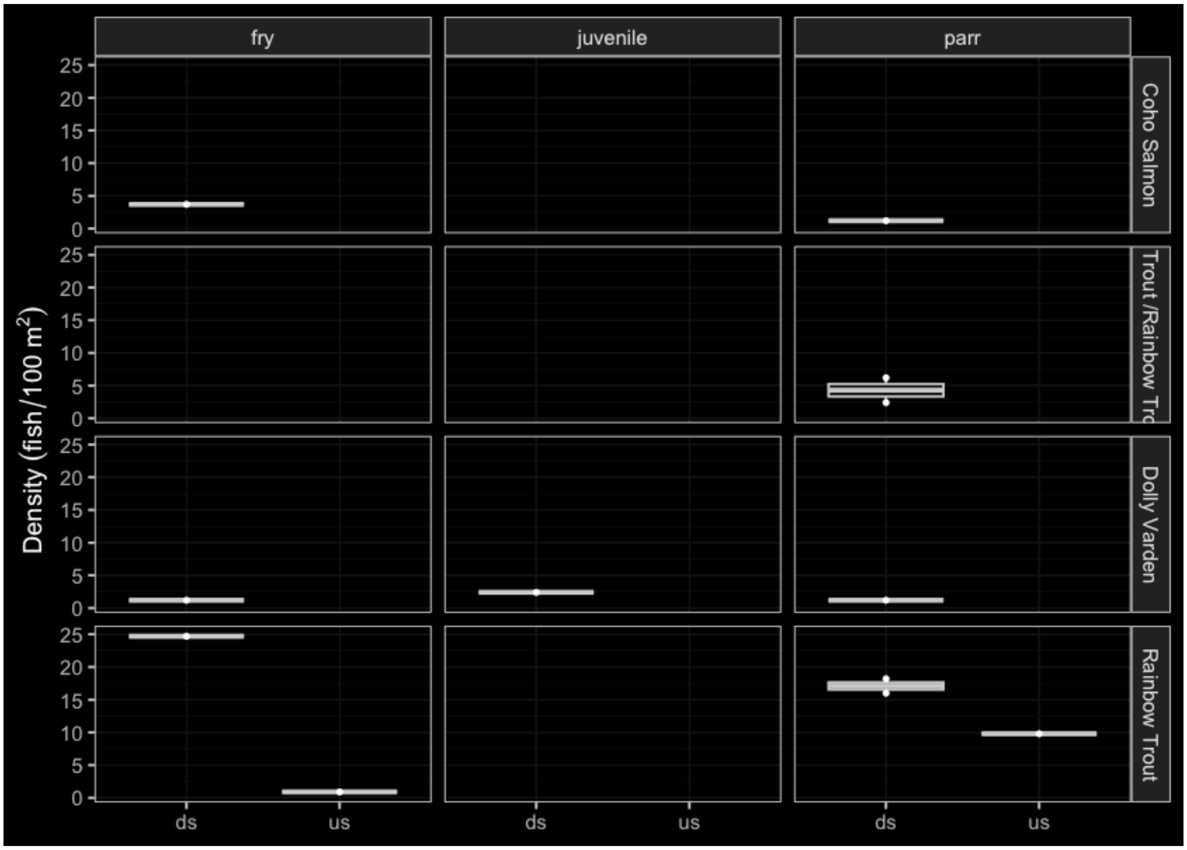



Figure 5.15: Densites of fish (fish/100m2) captured upstream and downstream of PSCIS crossing 58264.


Figure 5.16: Left: Typical habitat downstream of PSCIS crossing 58245. Right: Typical habitat upstream of PSCIS crossing 58245 and downstream of PSCIS crossing 203122, with signs of bank armouring and channelization.


Figure 5.17: Left: Steelhead spawning location upstream of PSCIS crossing 203122 and downstream of PSCIS crossing 58264, as reported by the adjacent landowner. Right: Typical habitat upstream of PSCIS crossing 58264.


Figure 5.18: Left: Rainbow trout captured downstream of crossing 58264. Right: Coho salmon captured approximately 360 m downstream of crossing 58264.

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Note that this reference was not actually cited in the body of the report but rather in the `index.Rmd` file `yaml` headerj under the `no_cite` key.

## Changelog

### Skeena Watershed Fish Passage Restoration Planning 2024 - 0.1.0 (20250330) {-}

- Add executive summary
- Add recommendations
- incorperate top ranked sites from each watershed group to summary table in results
- Rework methods and results
- Move Buck Falls to appendix
- Rename Gershwin to Comeau
- Add maps to Comeau and Gershwin
- Rework Comeau

### Skeena Watershed Fish Passage Restoration Planning 2024 - 0.0.1 {-}

- *2025-02-04*
    - Initial draft of the 2024 report.

### Session Info

Information about the computing environment is important for reproducibility. A summary of the computing environment is saved to `session_info.csv`, which can be viewed and downloaded from here.

```
## — Session info
```

```
## setting  value
## version  R version 4.4.2 (2024-10-31)
## os       macOS Sequoia 15.3.2
## system   aarch64, darwin20
## ui       RStudio
## language (EN)
## collate  en_US.UTF-8
## ctype    en_US.UTF-8
## tz       America/Vancouver
## date     2025-03-31
## rstudio  2024.12.0+467 Kousa Dogwood (desktop)
## pandoc   3.2 @
/Applications/RStudio.app/Contents/Resources/app/quarto/bin/tools/aarch6-
```

```
4/ (via rmarkdown)
##
## ─ Packages
```

```
────────────────────────────────────
## package          * version    date (UTC) lib source
## archive            1.1.9      2024-09-12 [2] CRAN (R 4.4.1)
## backports          1.5.0      2024-05-23 [1] CRAN (R 4.4.1)
## base64enc          0.1-3      2015-07-28 [1] CRAN (R 4.4.1)
## bcdata             0.5.0      2024-12-12 [1] CRAN (R 4.4.1)
## bibtex             0.5.1      2023-01-26 [2] CRAN (R 4.4.0)
## bit                4.5.0.1    2024-12-03 [1] CRAN (R 4.4.1)
## bit64              4.6.0-1    2025-01-16 [1] CRAN (R 4.4.1)
## blob               1.2.4      2023-03-17 [1] CRAN (R 4.4.0)
## bookdown         * 0.42       2025-01-07 [1] CRAN (R 4.4.1)
## brew               1.0-10     2023-12-16 [1] CRAN (R 4.4.1)
## bslib              0.9.0      2025-01-30 [1] CRAN (R 4.4.1)
## cachem             1.1.0      2024-05-16 [1] CRAN (R 4.4.1)
## cellranger         1.1.0      2016-07-27 [1] CRAN (R 4.4.0)
## chk                0.10.0     2025-01-24 [1] CRAN (R 4.4.1)
## chromote           0.4.0      2025-01-25 [1] CRAN (R 4.4.1)
## class              7.3-22     2023-05-03 [2] CRAN (R 4.4.2)
## classInt           0.4-11     2025-01-08 [1] CRAN (R 4.4.1)
## cli                3.6.3      2024-06-21 [1] CRAN (R 4.4.1)
## codetools          0.2-20     2024-03-31 [2] CRAN (R 4.4.2)
## colorspace         2.1-1      2024-07-26 [1] CRAN (R 4.4.1)
## conflicted       * 1.2.0      2023-02-01 [1] CRAN (R 4.4.0)
## crayon             1.5.3      2024-06-20 [1] CRAN (R 4.4.1)
## crosstalk          1.2.1      2023-11-23 [1] CRAN (R 4.4.0)
## curl               6.2.0      2025-01-23 [1] CRAN (R 4.4.1)
## DBI                1.2.3      2024-06-02 [1] CRAN (R 4.4.1)
## dbplyr             2.5.0      2024-03-19 [1] CRAN (R 4.4.0)
## devtools         * 2.4.5      2022-10-11 [2] CRAN (R 4.4.0)
## digest             0.6.37     2024-08-19 [1] CRAN (R 4.4.1)
## dplyr            * 1.1.4      2023-11-17 [1] CRAN (R 4.4.0)
## DT                 0.33       2024-04-04 [1] CRAN (R 4.4.0)
## e1071              1.7-16     2024-09-16 [1] CRAN (R 4.4.1)
## ellipsis           0.3.2      2021-04-29 [2] CRAN (R 4.4.0)
## english            1.2-6      2021-08-21 [2] CRAN (R 4.4.0)
## evaluate           1.0.3      2025-01-10 [1] CRAN (R 4.4.1)
## exifr              0.3.2      2021-03-20 [1] CRAN (R 4.4.0)
## farver             2.1.2      2024-05-13 [1] CRAN (R 4.4.1)
## fasstr             0.5.3      2024-09-27 [1] CRAN (R 4.4.1)
## fastmap            1.2.0      2024-05-15 [1] CRAN (R 4.4.1)
## fishbc             0.2.1      2021-05-12 [1] CRAN (R 4.4.0)
## forcats          * 1.0.0      2023-01-29 [1] CRAN (R 4.4.0)
## fpr              * 1.2.0      2025-02-21 [1] Github
(newgraphenvironment/fpr@7943230)
## fs                 1.6.5      2024-10-30 [1] CRAN (R 4.4.1)
## generics           0.1.3      2022-07-05 [1] CRAN (R 4.4.1)
## ggdark           * 0.2.1      2019-01-11 [1] CRAN (R 4.4.0)
```

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##  glue                1.8.0      2024-09-30 [1] CRAN (R 4.4.1)
##  gtable              0.3.6      2024-10-25 [1] CRAN (R 4.4.1)
##  here                1.0.1      2020-12-13 [1] CRAN (R 4.4.1)
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##  httr                1.4.7      2023-08-15 [1] CRAN (R 4.4.0)
##  janitor             2.2.1      2024-12-22 [1] CRAN (R 4.4.1)
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##  jsonlite            1.8.9      2024-09-20 [1] CRAN (R 4.4.1)
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(haozhu233/kableExtra@a9c509a)
##  KernSmooth          2.23-24    2024-05-17 [2] CRAN (R 4.4.2)
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##  leaflet.providers   2.0.0      2023-10-17 [1] CRAN (R 4.4.0)
##  leafpop             0.1.0      2021-05-22 [1] CRAN (R 4.4.0)
##  lifecycle           1.0.4      2023-11-07 [1] CRAN (R 4.4.1)
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##  magrittr            2.0.3      2022-03-30 [1] CRAN (R 4.4.1)
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##  poisutils           0.0.0.9010 2024-05-14 [2] Github
(poissonconsulting/poisutils@8310dc4)
##  processx            3.8.5      2025-01-08 [1] CRAN (R 4.4.1)
##  profvis             0.3.8      2023-05-02 [2] CRAN (R 4.4.0)
##  promises            1.3.2      2024-11-28 [1] CRAN (R 4.4.1)
##  proxy               0.4-27     2022-06-09 [1] CRAN (R 4.4.1)
##  ps                  1.8.1      2024-10-28 [1] CRAN (R 4.4.1)
##  purrr             * 1.0.4      2025-02-05 [1] CRAN (R 4.4.1)
##  R6                  2.5.1      2021-08-19 [1] CRAN (R 4.4.1)
##  rappdirs            0.3.3      2021-01-31 [1] CRAN (R 4.4.1)
```

```
## rbbt                 0.0.0.9000 2024-06-26 [2] local
## Rcpp                 1.0.14     2025-01-12 [1] CRAN (R 4.4.1)
## RcppRoll             0.3.1      2024-07-07 [1] CRAN (R 4.4.1)
## readr              * 2.1.5      2024-01-10 [1] CRAN (R 4.4.0)
## readwritesqlite    * 0.2.0.9006 2025-02-21 [1] Github
(poissonconsulting/readwritesqlite@d178ad5)
## readxl               1.4.3      2023-07-06 [1] CRAN (R 4.4.0)
## RefManageR           1.4.0      2022-09-30 [2] CRAN (R 4.4.0)
## remotes              2.5.0      2024-03-17 [2] CRAN (R 4.4.0)
## reprex             * 2.1.1      2024-07-06 [1] CRAN (R 4.4.0)
## rfp                * 0.0.0.9000 2024-11-18 [2] local
## rlang                1.1.5      2025-01-17 [1] CRAN (R 4.4.1)
## rmarkdown          * 2.29       2024-11-04 [1] CRAN (R 4.4.1)
## roxygen2             7.3.1      2024-01-22 [2] CRAN (R 4.4.0)
## RPostgres          * 1.4.7      2024-05-27 [1] CRAN (R 4.4.0)
## rprojroot            2.0.4      2023-11-05 [1] CRAN (R 4.4.1)
## rsconnect            1.3.4      2025-01-22 [2] CRAN (R 4.4.1)
## RSQLite              2.3.9      2024-12-03 [1] CRAN (R 4.4.1)
## rstudioapi           0.17.1     2024-10-22 [1] CRAN (R 4.4.1)
## rvest                1.0.4      2024-02-12 [1] CRAN (R 4.4.0)
## s2                   1.1.7      2024-07-17 [1] CRAN (R 4.4.0)
## sass                 0.4.9      2024-03-15 [1] CRAN (R 4.4.0)
## scales               1.3.0      2023-11-28 [1] CRAN (R 4.4.0)
## servr                0.32       2024-10-04 [1] CRAN (R 4.4.1)
## sessioninfo          1.2.2      2021-12-06 [2] CRAN (R 4.4.0)
## sf                 * 1.0-19     2024-11-05 [1] CRAN (R 4.4.1)
## shiny                1.10.0     2024-12-14 [1] CRAN (R 4.4.1)
## shrtcts              0.1.2      2024-05-14 [2] Github
(gadenbuie/shrtcts@41051cf)
## snakecase            0.11.1     2023-08-27 [1] CRAN (R 4.4.0)
## staticimports        0.0.0.9001 2025-02-14 [1] local
## stringdist           0.9.12     2023-11-28 [2] CRAN (R 4.4.0)
## stringi              1.8.4      2024-05-06 [1] CRAN (R 4.4.1)
## stringr            * 1.5.1      2023-11-14 [1] CRAN (R 4.4.0)
## svglite              2.1.3      2023-12-08 [1] CRAN (R 4.4.0)
## systemfonts          1.2.1      2025-01-20 [1] CRAN (R 4.4.1)
## terra                1.8-21     2025-02-10 [1] CRAN (R 4.4.1)
## tibble             * 3.2.1      2023-03-20 [1] CRAN (R 4.4.0)
## tidyhydat            0.7.0      2024-10-04 [1] CRAN (R 4.4.1)
## tidyr              * 1.3.1      2024-01-24 [1] CRAN (R 4.4.1)
## tidyselect           1.2.1      2024-03-11 [1] CRAN (R 4.4.0)
## tidyverse          * 2.0.0      2023-02-22 [1] CRAN (R 4.4.0)
## tidyxl               1.0.10     2025-03-04 [1] Github
(nacnudus/tidyxl@7e2fbe7)
## timechange           0.3.0      2024-01-18 [1] CRAN (R 4.4.1)
## tzdb                 0.4.0      2023-05-12 [1] CRAN (R 4.4.0)
## units                0.8-5      2023-11-28 [1] CRAN (R 4.4.1)
```

```
##  urlchecker          1.0.1      2021-11-30 [2] CRAN (R 4.4.0)
##  usethis           * 2.2.3      2024-02-19 [2] CRAN (R 4.4.0)
##  uuid                1.2-1      2024-07-29 [1] CRAN (R 4.4.1)
##  vctrs               0.6.5      2023-12-01 [1] CRAN (R 4.4.0)
##  viridisLite         0.4.2      2023-05-02 [1] CRAN (R 4.4.1)
##  vroom               1.6.5      2023-12-05 [1] CRAN (R 4.4.0)
##  websocket           1.4.2      2024-07-22 [1] CRAN (R 4.4.1)
##  withr               3.0.2      2024-10-28 [1] CRAN (R 4.4.1)
##  wk                  0.9.4      2024-10-11 [1] CRAN (R 4.4.1)
##  xciter            * 0.0.0.9001 2025-03-28 [1] local
##  xfun                0.50       2025-01-07 [1] CRAN (R 4.4.1)
##  xml2                1.3.6      2023-12-04 [1] CRAN (R 4.4.1)
##  xtable              1.8-4      2019-04-21 [1] CRAN (R 4.4.1)
##  yaml                2.3.10     2024-07-26 [1] CRAN (R 4.4.1)
##  yesno               0.1.3      2024-07-26 [1] CRAN (R 4.4.1)
##
##  [1] /Users/airvine/Library/R/arm64/4.4/library
##  [2] /Library/Frameworks/R.framework/Versions/4.4-
arm64/Resources/library
##
##
```

## Attachment 1 - Maps

All georeferenced field maps are presented at:

- 'https://hillcrestgeo.ca/outgoing/fishpassage/projects/bulk/archive/2022-09-06/
- 'https://hillcrestgeo.ca/outgoing/fishpassage/projects/morr/archive/2022-09-06/
- https://hillcrestgeo.ca/outgoing/fishpassage/projects/zymo/archive/2022-09-06/
- https://hillcrestgeo.ca/outgoing/fishpassage/projects/kisp/archive/2022-09-06/

Maps are also available zipped for bulk download at:

- https://hillcrestgeo.ca/outgoing/fishpassage/projects/bulk/archive/2022-09-06/2022-09-06.zip
- https://hillcrestgeo.ca/outgoing/fishpassage/projects/morr/archive/2022-09-06/2022-09-06.zip
- https://hillcrestgeo.ca/outgoing/fishpassage/projects/zymo/archive/2022-09-06/2022-09-06.zip
- https://hillcrestgeo.ca/outgoing/fishpassage/projects/kisp/archive/2022-09-06/2022-09-06.zip

## Attachment 2 - Habitat Assessment and Fish Sampling Data

All field data collected is available here.

Habitat assessment data (including fish sampling and PIT tagging information) is available for download here.

Raw fish data is available for download here.

## Attachment 3 - Bayesian analysis to map stream discharge and temperature causal effects pathways

Details of this analysis and subsequent outputs can be reviewed in the report Spatial Stream Network Analysis of Nechako Watershed Stream Temperatures 2022b (Hill, Thorley, and Irvine 2024). At the time of reporting, ongoing work regarding the project was tracked here and here.