

S O C I E T Y F O R E C O S Y S T E M R E S T O R A T I O N
I N N O R T H E R N B R I T I S H C O L U M B I A

DRAFT - Bulkley River and Morice River Watershed Groups Fish Passage Restoration Planning

Prepared for
Habitat Conservation Trust Fund
BC Fish Passage Remediation Program
Canadian Wildlife Federation

Prepared by
Al Irvine, B.Sc., R.P.Bio.
New Graph Environment
6 Regent St
Nelson, BC V1L 2P1

on behalf of
Society for Ecosystem Restoration Northern BC

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new graph environment
Environmental Research & Consulting

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Executive Summary

The Society for Ecosystem Restoration Northern BC and New Graph Environment were retained by the Habitat Conservation Trust, the Provincial Fish Passage Remediation Program and the Canadian Wildlife Federation in 2020 to plan and conduct fish passage and habitat confirmation assessments at road-stream crossings as part of connectivity restoration planning. Although planning was conducted for both the Morice River watershed group and the Bulkley River watershed group, on the ground surveys in 2020 focused primarily within Bulkley River tributaries.

A total of 31 Phase 1 assessments were conducted with 13 crossings considered “passable”, 3 crossings considered “potential” barriers and 15 crossings considered “barriers” according to threshold values based on culvert embedment, outlet drop, slope, diameter (relative to channel size) and length.

Habitat confirmation assessments were conducted at 23 sites with a total of approximately 18 km of stream assessed. Thirteen crossings were rated as high priorities for proceeding to design for replacement, 7 crossings were rated as moderate priorities for proceeding to design for replacement, 3 crossings were rated as a low priority.

1 Introduction

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).

Reconnection of fragmented habitats by culvert removal or replacement is a management action that can generate high ecological returns relative to other habitat restoration techniques (Saldi-Caromile et al. 2004; Roni, Hanson, and Beechie 2008). 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 and deactivation designs.

2 Background

As a result of high-level direction from the provincial government, a Fish Passage Strategic Approach protocol has been developed for British Columbia to ensure that the greatest opportunities for restoration of fish passage are pursued. A Fish Passage Technical Working Group has been formed to coordinate the protocol and data is continuously amalgamated within the Provincial Stream Crossing Inventory System (PSCIS). The strategic approach protocol involves a four-phase process as described in Fish Passage Technical Working Group (2014) :

- Phase 1: Fish Passage Assessment – Fish stream crossings within watersheds with high fish values are assessed to determine barrier status of structures and document a general assessment of adjacent habitat quality and quantity.
- Phase 2: Habitat Confirmation – Assessments of crossings prioritized for follow up in Phase 1 studies are conducted to confirm quality and quantity of habitat upstream and down as well as to scope for other potential nearby barriers that could affect the practicality of remediation.
- Phase 3: Design – Site plans and designs are drawn for priority crossings where high value fish habitat has been confirmed.
- Phase 4: Remediation – Reconnection of isolated habitats through replacement, rehabilitation or removal of prioritized crossing structure barriers.

2.1 Project Location

The project area includes the Bulkley River and Morice River watershed groups (Figure [2.1](#)) and is within the traditional territories of the Gitxsan and Wet'suwet'en. 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. The watersheds are within the Skeena, Stikine, and the Nadina Natural Resource Districts.

The Bulkley River is an 8th order stream that drains an area of 7,762 km² in a generally northerly direction from Bulkley Lake on the Nechako Plateau to its confluence with the Skeena River at Hazelton. It has a mean annual discharge of 139.4 m³/s at station 08EE004 located near Quick and 19.6 m³/s at station 08EE003 located upstream near Houston. Flow patterns are typical of high elevation watersheds on the west side of the northern Rocky Mountains which receive large amounts of precipitation as snow leading to peak levels of discharge during snowmelt, typically from May to July (Figures [2.2](#) - [2.3](#)).

Numerous water licenses are held within the watershed with a potential over-allocation of flows identified during low flow periods (ILMB 2007). 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 as droughts (IPCC 2014; ECCC 2016). These changes are resulting in

2 Background

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.

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 blocking fish access to 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).

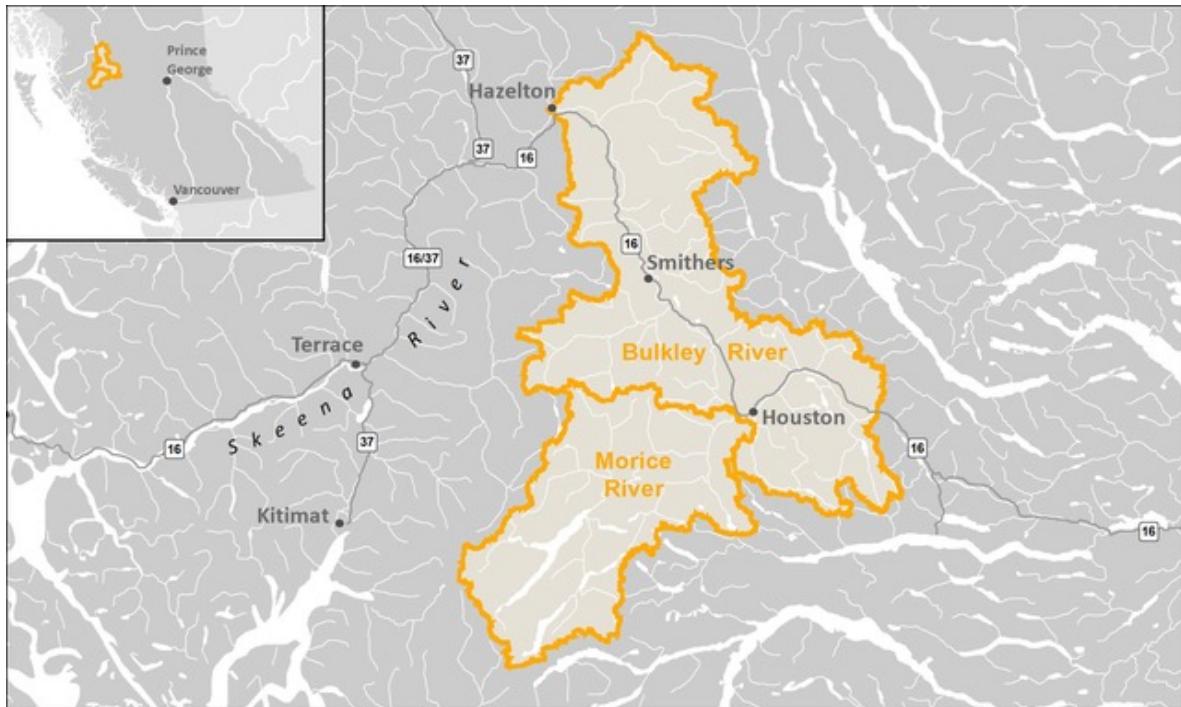


Figure 2.1: Overview map of Study Areas

2.2 Wet'suwet'en

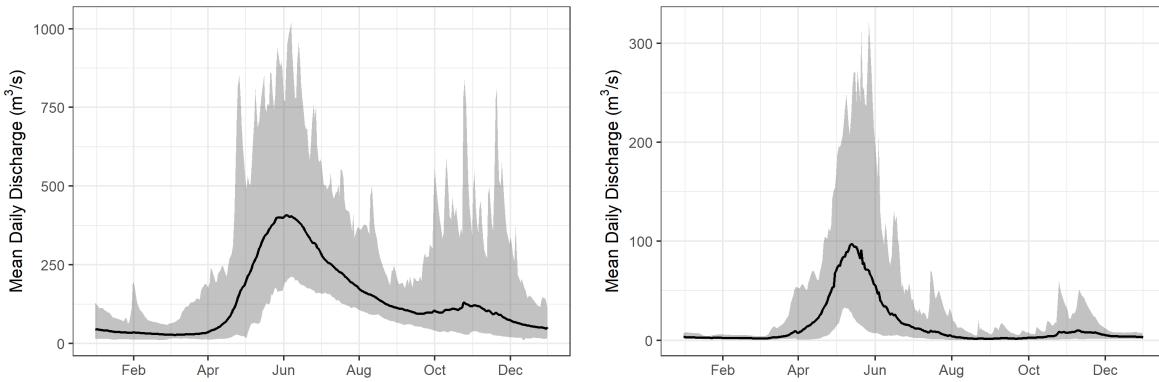


Figure 2.2: Hydrograph for Bulkley River at Quick (Station #08EE004 - daily discharge data from 1930 to 2018) and near Houston (Station #08EE003 - daily discharge data from 1980 to 2018).

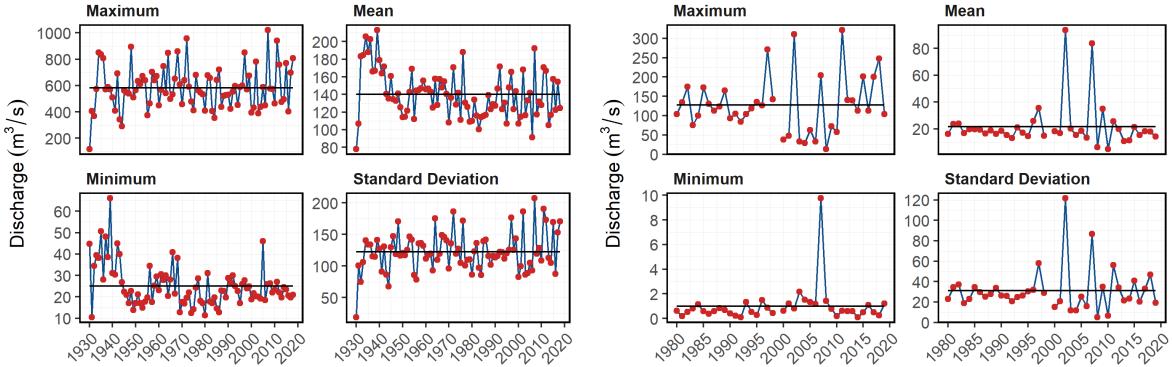


Figure 2.3: Summary of hydrology statistics for Bulkley River at Quick (Station #08EE004) and near Houston (Station #08EE003).

2.2 Wet'suwet'en

Wet'suwet'en hereditary territory covers an area of 22,000km² 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 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 its management is intended to provide security for sustaining salmon, wildlife, and natural foods to ensure the health

2 Background

and well-being of the Wet'suwet'en (Office of the Wet'suwet'en 2013; "Office of the Wet'suwet'en" 2021; FLNRORD 2017).

2.3 Gitxsan

The Gitxsan Laxyip (traditional territories) covers an area of 33,000km² 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). Traditional governance of the Gitxsan is guided by the principles of Ayookw (Gitxsan law) ("Gitxsan Huwilp Government" 2021).

2.4 Fisheries

Fish species recorded in the Bulkley River and Morice watershed groups are detailed in Table 2.1 (MoE 2020a). Coastal cutthroat trout and bull trout are considered of special concern (blue-listed) provincially.

Table 2.1: Fish species recorded in the Bulkley River and Morice River watershed groups.

Scientific Name	Species Name	Species Code	BC List	Provincial FRPA	COSEWIC	SARA	Bulkley	Morice
Catostomus catostomus	Longnose Sucker	LSU	Yellow	—	—	—	Yes	Yes
Catostomus commersonii	White Sucker	WSU	Yellow	—	—	—	Yes	Yes
Catostomus macrocheilus	Largescale Sucker	CSU	Yellow	—	—	—	Yes	Yes
Chrosomus eos	Northern Redbelly Dace	RDC	Yellow	—	—	—	Yes	—
Coregonus clupeaformis	Lake Whitefish	LW	Yellow	—	—	—	Yes	Yes
Cottus aleuticus	Coastrange Sculpin (formerly Aleutian Sculpin)	CAL	Yellow	—	—	—	Yes	Yes
Cottus asper	Prickly Sculpin	CAS	Yellow	—	—	—	Yes	Yes
Couesius plumbeus	Lake Chub	LKC	Yellow	—	DD	—	Yes	Yes
Entosphenus tridentatus	Pacific Lamprey	PL	Yellow	—	—	—	Yes	Yes
Hybognathus hankinsoni	Brassy Minnow	BMC	No Status	—	—	—	Yes	—
Lota lota	Burbot	BB	Yellow	—	—	—	Yes	Yes
Mylocheilus caurinus	Peamouth Chub	PCC	Yellow	—	—	—	Yes	Yes
Oncorhynchus clarkii	Cutthroat Trout	CT	No Status	—	—	—	Yes	Yes
Oncorhynchus clarkii	Cutthroat Trout (Anadromous)	ACT	No Status	—	—	—	Yes	—
Oncorhynchus clarkii clarkii	Coastal Cutthroat Trout	CCT	Blue	—	—	—	Yes	Yes
Oncorhynchus gorbuscha	Pink Salmon	PK	Yellow	—	—	—	Yes	Yes
Oncorhynchus keta	Chum Salmon	CM	Yellow	—	—	—	Yes	Yes
Oncorhynchus kisutch	Coho Salmon	CO	Yellow	—	—	—	Yes	Yes
Oncorhynchus mykiss	Rainbow Trout	RB	Yellow	—	—	—	Yes	Yes
Oncorhynchus mykiss	Steelhead	ST	Yellow	—	—	—	Yes	Yes
Oncorhynchus mykiss	Steelhead (Summer-run)	SST	Yellow	—	—	—	Yes	Yes
Oncorhynchus nerka	Kokane	KO	Yellow	—	—	—	Yes	Yes
Oncorhynchus nerka	Sockeye Salmon	SK	Yellow	—	—	—	Yes	Yes

2.3 Gitxsan

Oncorhynchus tshawytscha	Chinook Salmon	CH	Yellow	--	--	Yes	Yes
Prosopium coulterii	Pygmy Whitefish	PW	Yellow	--	NAR (Nov 2016)	Yes	Yes
Prosopium coulterii pop. 3	Giant Pygmy Whitefish	GPW	Yellow	--	--	Yes	--
Prosopium williamsoni	Mountain Whitefish	MW	Yellow	--	--	Yes	Yes
Ptychocheilus oregonensis	Northern Pikeminnow	NSC	Yellow	--	--	Yes	Yes
Pungitius pungitius	Ninespine Stickleback	NSB	Unknown	--	--	Yes	--
Rhinichthys cataractae	Longnose Dace	LNC	Yellow	--	--	Yes	Yes
Rhinichthys falcatus	Leopard Dace	LDC	Yellow	--	NAR (May 1990)	--	Yes
Richardsonius balteatus	Redside Shiner	RSC	Yellow	--	--	Yes	Yes
Salvelinus confluentus pop. 26	Bull Trout	BT	Blue	--	--	Yes	Yes
Salvelinus fontinalis	Brook Trout	EB	Exotic	--	--	Yes	Yes
Salvelinus malma	Dolly Varden	DV	Yellow	--	--	Yes	Yes
Salvelinus namaycush	Lake Trout	LT	Yellow	--	--	Yes	Yes
-	Arctic Char	AC	-	--	--	--	Yes
-	Cutthroat/Rainbow cross	CRS	-	--	--	Yes	--
-	Dace (General)	DC	-	--	--	--	Yes
-	Lamprey (General)	L	-	--	--	Yes	Yes
-	Minnow (General)	C	-	--	--	Yes	Yes
-	Salmon (General)	SA	-	--	--	Yes	Yes
-	Sculpin (General)	CC	-	--	--	Yes	Yes
-	Sucker (General)	SU	-	--	--	Yes	Yes
-	Whitefish (General)	WF	-	--	--	Yes	Yes

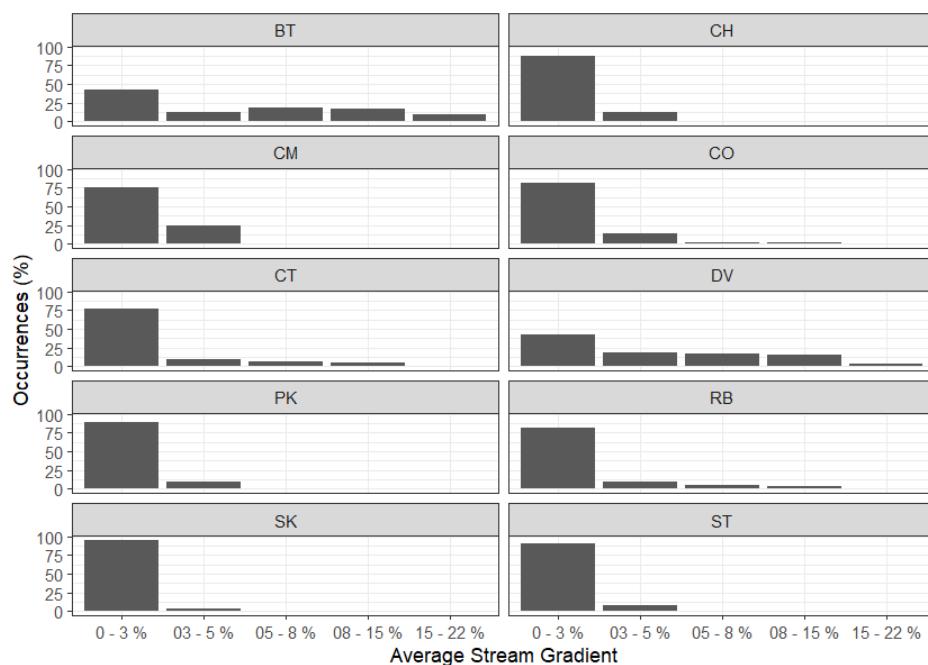


Figure 2.4: Summary of historic salmonid observations vs. stream gradient category for the Bulkley River watershed group.

2 Background

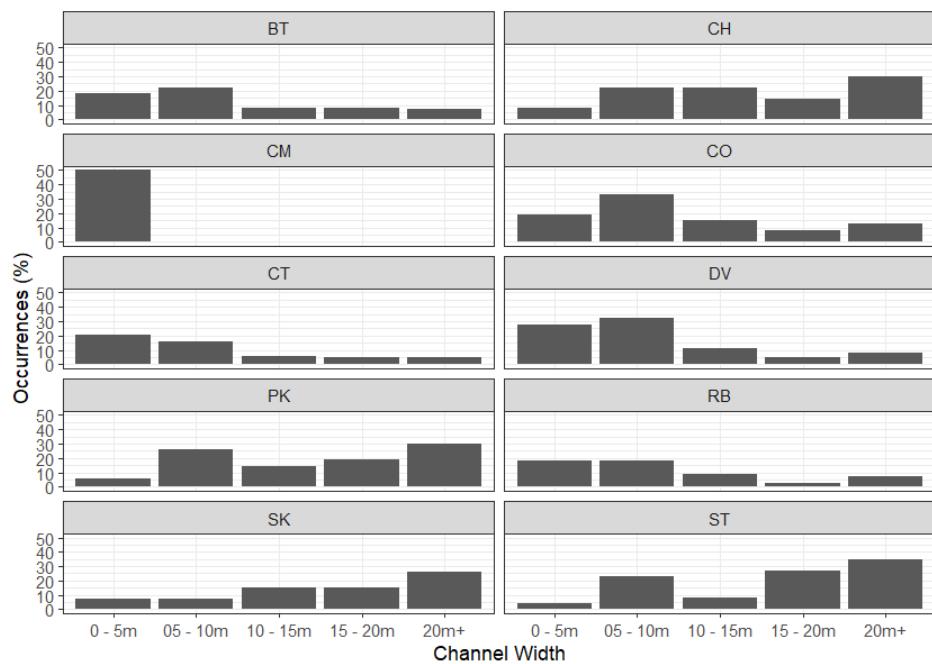


Figure 2.5: Summary of historic salmonid observations vs. channel width category for the Bulkley River watershed group.

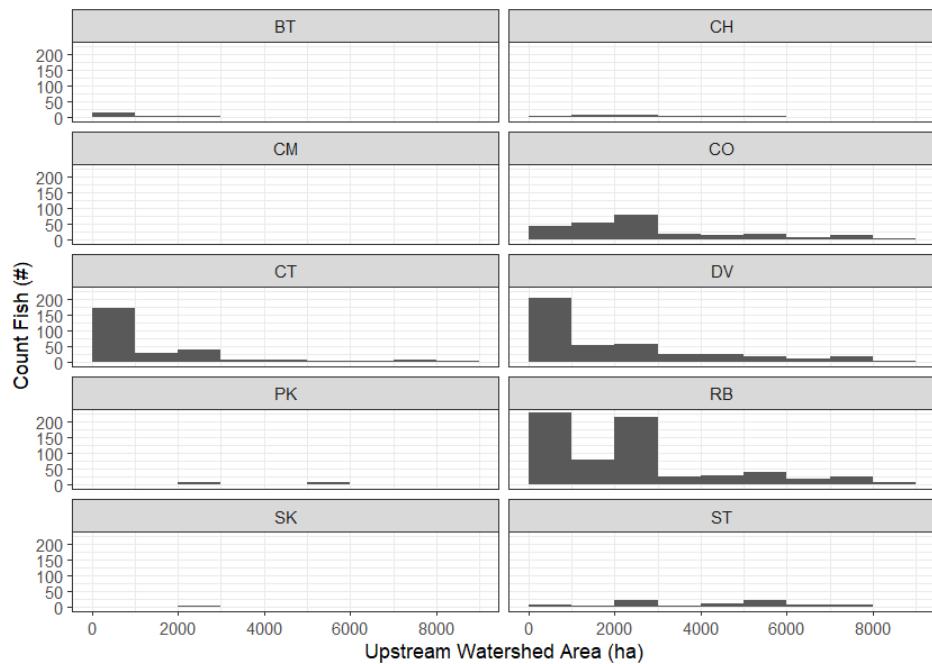


Figure 2.6: Summary of historic salmonid observations vs. watershed size category for the Bulkley River watershed group.

3 Methods

Workflows for the project have been classified into planning, fish passage assessments, habitat confirmation assessments and reporting. All components leveraged the R programming language and environment for statistical computing to facilitate workflow tracking and reproducibility (R Core Team 2020).

3.1 Planning

To identify priorities for crossing structure rehabilitation, background literature, fisheries information, PSCIS, Fish Habitat Model outputs modified from Norris and Mount (2016) and bcfishpass (Norris 2020b) outputs were reviewed. The Fish Habitat Model was developed by the BC Ministry of Environment to provide estimates of the amount of fish habitat potentially accessible to fish upstream of crossing locations. The model calculates the average gradient of BC Freshwater Atlas [stream network lines](#) at minimum 100m long intervals starting from the downstream end of the streamline segment and working upstream. The network lines are broken into max gradient categories with new segments created when the average gradient of the stream lines exceeds user provided gradient thresholds.

bcfishpass is comprised of sql and python based shell script libraries that “generate a simple model of aquatic habitat connectivity by identifying natural barriers to fish passage (plus hydro dams that are not feasible to remediate) and classifying all streams not upstream of these barriers as ‘potentially accessible’” (Norris 2020b). On potentially accessible streams, bcfishpass scripts “identify known barriers and additional anthropogenic features (primarily road/railway stream crossings, i.e. culverts) that are potentially barriers. To prioritize these features for assessment or remediation,” the scripts “report on how much modelled potentially accessible aquatic habitat the barriers may obstruct. The model can be refined with known fish observations. Depending on the modelling scenario, all aquatic habitat downstream of a given fish observation can be classified as ‘observed accessible’, overriding any downstream barriers.”

Following delineation of “non-fish habitat” with the Fish Habitat Model, the average gradient of each stream segment within habitat classified as below the 22% threshold was calculated and summed using bcfishpass to quantify upstream habitat potentially available for salmonids and facilitate stream line symbology based on stream morphology. bcfishpass summed average gradients of stream network line segments within seven categories (0 - 3%, 3 - 5%, 5 - 8%, 8 - 15%, 15 - 22%, 22 - 30% and >30%) with these outputs further amalgamated to summarize and symbolize potential upstream habitat in four categories: riffle/cascade (0 - 5%), step-pool (5 - 15%), step-pool very steep (15-22%) and extremely steep (22 - 30%) (Table 3.1). For each crossing location, the area of lake and wetland habitat upstream, species documented upstream and an estimate of watershed area was also collated using bcfishpass, fwapg (Norris 2020c) and bcfishobs (Norris 2020a) to provide an indication of the potential quantity and quality of habitat potentially gained should fish passage be restored.

Table 3.1: Stream gradient categories (threshold and average) and associated channel type.

Gradient	Channel Type
0 - 5%	Riffle and cascade pool
5 - 15%	Step pool
15 - 22%	Step pool - very steep
22 - 30%	Step pool - extremely steep (bull trout only)
>30%	Non fish habitat

To prepare for Phase 1 and 2 assessments in the study area, past fish passage assessment reports for the Bulkley River and Morice River watershed groups were first reviewed to identify crossing structures not yet assessed or previously ranked as priorities for rehabilitation (Casselman and Stanley 2010; Irvine 2018; McCarthy and Fernando 2015; Smith 2018; Wilson and Rabnett 2007). To determine which of those crossings had not yet been assessed with Phase 1 and Phase 2 assessments we cross-referenced these reports with the PSCIS database, available background info and viewed sites within the output of the Fish Habitat Model and bcfishpass. Outputs for modelled and PSCIS crossings (barriers and potential barriers) that met the following criteria underwent a detailed review to facilitate prioritization for Phase 1 - Fish Passage Assessments and Phase 2 - Habitat Confirmations.

- Confirmed fish presence upstream of the structure.
- Stream width documented as > 2.0m in PSCIS.
- Linear lengths of modelled upstream habitat <22% gradient for ≥1km for PSCIS crossings or ≥2km for modelled crossings.
- Crossings located on streams classified as 3rd order or higher.
- Crossings located on streams with >5 ha of modeled wetland and/or lake habitat upstream.
- Habitat value rated as “medium” or “high” in PSCIS.

3.2 Fish Passage Assessments

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). 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, fill depth, outlet

3.2 Fish Passage Assessments

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 3.2). For crossings determined to be potential barriers or barriers based on the data (see [Barrier Scoring \(page 11\)](#)), a culvert fix and recommended diameter/span was proposed.

Table 3.2: 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).

3.2.1 Barrier Scoring

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 (Table 3.3, Table 3.4). 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).

Table 3.3: 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
3.4:**

Fish Barrier Scoring Results (MoE 2011).

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

3.2.2 Cost Benefit Analysis

A cost benefit analysis was conducted for each crossing determined to be a barrier based on an estimate of cost associated with remediation or replacement of the crossing with a structure that facilitates fish passage and the amount of potential habitat that would be made available by remediating fish passage at the site (habitat gain index).

3.2.2.1 Habitat Gain Index

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 minimum length of 100m) intended to represent the maximum gradient of which anadromous species are likely to be able to migrate upstream. For Phase 1 assessments a “net” value of habitat quantity output from bcfishpass was used to estimate the amount of habitat upstream of each crossing less than 20% gradient before either a falls of height >5m - as recorded in MoE (2020b), a road-stream crossing recorded in PSCIS as a barrier, or a modelled unassessed crossing. For Phase 2 assessments, to provide a conservative estimate of habitat to be potentially gained by fish passage restoration, the amount of habitat upstream of each crossing was estimated by measuring the amount of mainstem and stream segments > 1st order upstream of the crossing using the measure tool within QGIS (QGIS Development Team 2009).

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. For this project we considered bridges as the only viable option for OBS type based on consultation with FLNR road crossing engineering experts. It should be noted however, that box culverts could be considered a viable and economical option as they have been observed as successfully facilitating fish passage on the west coast of the province (Betty Rebellato, Canadian Wildlife Federation - Project Biologist).
- 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

3.2 Fish Passage Assessments

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..

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.

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 \$12500/linear m and assumed that the road could be closed during construction and a minimum bridge span of 10m. For streams with channel widths <2m, embedded culverts were reported as an effective solution with total installation costs estimated at \$25k/crossing (pers. comm. Phil MacDonald, Steve Page). For larger streams (>6m), span width increased proportionally to the size of the stream (ex. for an 8m wide stream a 12m wide span was prescribed). 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 also generated to estimate incremental cost increases with costs estimated for structure replacement on paved surfaces, railways and arterial/highways costing up to 20 times more than forest service roads due to expenses associated with design/engineering requirements, traffic control and paving. The cost multiplier table (Table 3.5) should be considered very approximate with refinement recommended for future projects.

3 Methods

Table 3.5: Cost multiplier table based on road class and surface type.

Class	Surface	Class Multiplier	Surface Multiplier	Bridge \$K/10m	Streambed Simulation \$K
Forest Service Road	Loose	1	1	125	25
Resource	Loose	1	1	125	25
Road Permit	Loose	1	1	125	25
Unclassified	Loose	1	1	125	25
Unclassified	Rough	1	1	125	25
Local	Loose	4	1	500	100
Local	Paved	4	2	1000	200
Highway	Paved	20	2	5000	1000
Rail	Rail	20	2	5000	1000

3.3 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 3.2).

During habitat confirmations, to standardize data collected and facilitate submission of the data to provincial databases, information was collated 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 the point where fish presence had been previously confirmed and upstream to a minimum distance of 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.

Fish sampling was conducted a subset of sites when biological data was considered to add significant value to the physical habitat assessment information. When possible, electrofishing was utilized within discrete site units both upstream and downstream of the subject crossing with electrofisher settings, water quality parameters (i.e. conductivity, temperature and ph), start location, length of site and wetted widths (average of a minimum of three) recorded. For each fish captured, fork length and species was recorded, with results included within the fish data submission spreadsheet. Fish information and habitat data will be submitted to the province under scientific fish collection permit CB20-611971.

3.4 Reporting

3.4 Reporting

Reporting was generated with bookdown (Xie 2016) from Rmarkdown (Allaire et al. 2020) with primarily R (R Core Team 2020) and SQL scripts. In addition to numerous spatial layers sourced through the BC Data Catalogue then stored and queried in local and remote postgresql databases, [data inputs](#) for this project include:

- Populated [Fish Data Submission Spreadsheet Template - V 2.0, January 20, 2020](#)
- Populated [pscis_assessment_template_v24.xls](#)
- [Fish Habitat Model/bcfishpass](#) outputs.
- [Custom CSV file](#) detailing Phase 2 site:
 - priority level for proceeding to design for replacement
 - length of survey upstream and downstream
 - a conservative estimate of the linear length of mainstem habitat potentially available upstream of the crossing
 - fish species confirmed as present upstream of the crossing
- [GPS tracks](#) from field surveys.
- [Photos](#) and [photo metadata](#)

4 Results and Discussion

Field assessments were conducted between August 26 2020 and September 05 2020 by Allan Irvine, R.P.Bio. and Kyle Prince, P.Biol.

4.1 Phase 1

During 2020 field surveys, a total of 30 Phase 1 assessments were conducted with 12 crossings considered “passable”, 3 crossings considered “potential” barriers and 11 crossings considered “barriers” according to threshold values based on culvert embedment, outlet drop, slope, diameter (relative to channel size) and length (MoE 2011). Site details and photos are presented in [Appendix - Phase 1 Fish Passage Assessment Data and Photos] with maps stored [here](#). A cost benefit analysis for Phase 1 sites that were determined to be barriers or potential barriers is presented in Table [4.1](#).

Barrier passability criteria used in this project follows MoE (2011), and reflects an estimation for the passage of a juvenile salmon or small resident rainbow trout (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) as well as the temporal variation of physical characteristics (ex. due to flow volumes/velocities a particular culvert is passable 50% of the time to fish with a defined physiological capacity) make defining passability difficult with important implications for watershed connectivity modelling (Bourne et al. 2011; Shaw et al. 2016; Mahlum et al. 2014; Kemp and O’Hanley 2010).

Table 4.1: Upstream habitat estimates and cost benefit analysis for Phase 1 assessments.

PSCIS ID	Stream	Road	Result	Habitat value	Stream Width (m)	Priority	Fix	Cost Est (\$K)	Habitat Upstream (km)	Cost Benefit (m / \$K)	Cost Benefit (m ² / \$K)
3067	Byman Creek	North Road	Barrier	High	9.0	high	OBS	162	3.99	24.6	110.8
58158	McDowell Creek	Highway 16	Barrier	High	2.5	high	OBS	6500	9.90	1.5	1.9
123463	Victor Creek	Tyee Lake Road	Barrier	Medium	1.8	mod	SS-CBS	200	1.80	9.0	8.1
124502	Tributary to Bulkley River	Lawson Road	Barrier	Medium	3.2	mod	OBS	500	8.68	17.4	27.8
197640	Tributary to Buck Creek	Buck Flats FSR	Barrier	High	5.1	high	OBS	–	19.96	–	–
197646	Tributary to Buck Creek	Spur off Parrot FSR	Barrier	Medium	1.4	mod	SS-CBS	25	5.11	204.4	143.1
197647	Tributary to Buck Creek	Carrier FSR	Barrier	Low	1.5	low	SS-CBS	25	1.78	71.2	53.4
197653	Perow Creek	Perow Loop Rd	Barrier	Medium	2.5	mod	OBS	1000	34.23	34.2	42.8
197654	Tributary to Buck										

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Creek	Balsam FSR	Barrier	Medium	1.5 mod	SS-CBS	25	3.34	133.6	100.2
197655	McInnes Creek	Highway 16	Potential	Low	1.0 low	SS-CBS	1000	15.15	15.2
197656	Tributary to Bulkley River	Highway 16	Potential	Low	5.0 low	OBS	5000	7.16	1.4
197657	Perow Creek	Highway 16	Potential	High	3.2 mod	OBS	5000	0.19	0.0
197658	Byman Creek	Highway 16	Barrier	High	11.1 high	OBS	7550	178.46	23.6
197662	Richfield Creek	Highway 16	Barrier	High	12.5 high	OBS	8250	289.39	35.1
197663	Johnny David Creek	Highway 16	Barrier	High	6.3 high	OBS	5150	85.39	16.6
197667	Moan Creek	CN Railway	Barrier	High	3.8 high	OBS	5000	9.68	1.9
197668	Coffin Creek	CN Railway	Barrier	High	5.3 high	OBS	5000	38.12	7.6
197669	Riddeck Creek	Private	Barrier	High	2.6 high	OBS	125	0.34	2.7
									3.5

4.2 Phase 2

Habitat confirmation assessments were conducted at 23 sites with a total of approximately 15 km of stream assessed. Thirteen crossings were rated as high priorities for proceeding to design for replacement, Seven crossings were rated as moderate priorities for proceeding to design for replacement, 3 crossings were rated as a low priority and 0 rated as “no fix”. Results are summarized in Tables [4.2 - 4.5](#) with raw habitat and fish sampling data included in digital format as [Attachment 2](#). Detailed information for each site assessed with Phase 2 assessments is included within site specific reports included as appendices to this document with pdf maps stored [here](#).

Table 4.2: Overview of habitat confirmation sites.

PSCIS ID Stream Road UTM (9U) Fish Species Habitat Gain (km) Habitat Value

4.2 Phase 2

Priority Comments									
Number	Location	Location Type	Comments	Comments	Comments	Comments	Comments	Comments	Comments
3042	Barren Creek	Barren Creek FSR	654451 6042827	RB				1.7	Medium moderate –
3054	Johnny David Creek	North road	664881 6052688	RB				7.5	Medium moderate –
3139	Trib to McQuarrie Creek	North Road	656657 6048544	RB				7.3	Medium moderate –
58159	McDowell Creek	Woodmere Nursery Road	627643 6060449	RB, CO				0.8	Medium high –
123445	Tyhee Creek	Highway 16	627238 6061456	BB,C,CAS,CC,CH,CM,CO,CT,GPW,LSU,MW,NSC,PCC,PK,PW,RB,RDC,RSC,SA,SK,ST,SU				6.0	Medium high –
123446	Tyhee Creek	Tyee Lake Road	627527 6061771	BB,C,CAS,CC,CH,CM,CO,CT,GPW,LSU,MW,NSC,PCC,PK,PW,RB,RDC,RSC,SA,SK,ST,SU				5.5	Medium moderate –
123794	Tributary to Blunt Creek	Blunt Creek FSR	616100 6106763	(RB)				0.5	Medium moderate –
123795	Tributary to Blunt Creek	Blunt Creek FSR	615760 6106892	–				–	Medium moderate –
124487	Porphyry Creek	Highway 16	603073 6113363	RB, DV				8.0	High high –
124500	Helps Creek	Lawson Road	627552 6058697	CT,DV,LNC,LSU,RB, ST, CO, L				9.0	Medium low –
124501	Moan Creek	Lawson Road	630661 6055713	CO, CH, RB, CT, DV, BT				2.8	High low –
124504	Coffin Creek	Lawson Road	634323 6054587	CO, CSU,CT,DV,LSU,MW,RB,RSC				4.0	High high –
195288	Gibson Creek	Schnider Road	640899 6051559	RB, CT				4.5	Medium high –
195290	Gibson Creek	Highway 16	640014 6051697	RB, CT, CO, BT				1.0	Medium high –
197360	Riddeck Creek	Morice-Owen FSR	649936 5992406	RB, LSU				1.2	High high –
197640	Tributary to Buck Creek	Buck Flats Road	654312 6012383	RB				4.2	High high –
197658	Byman Creek	Highway 16	666847 6044305	CO,CSU,LNC,LSU,RB,RSC,ST				6.0	High high –
197662	Richfield Creek	Highway 16	672405 6044146	CH,CO,LNC,LSU,RB,ST				2.0	High high –
197663	Johnny David Creek	Highway 16	670241 6044772	CO, RB, MW				10.0	High high –
197664	Barren Creek	Highway 16	660454 6037919	CH,CO,CT,L,RB,SST,ST				6.2	High moderate –
197665	Barren Creek	CN Railway	660627 6037843	CH,CO,CT,L,RB,SST,ST				6.4	High low –
197667	Moan Creek	CN Railway	631092 6055866	CO, CH, RB, CT, DV, BT				3.3	High high –
197668	Coffin Creek	CN Railway	634336 6054609	CO, CSU,CT,DV,LSU,MW,RB,RSC				4.0	High high –

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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
3042	No	0.00	1.00	1.0	1.5	23	21	Barrier
3054	No	0.76	3.00	1.2	2.0	40	34	Barrier
3139	No	1.02	1.20	3.2	2.0	27	34	Barrier
58159	No	0.36	1.00	2.3	3.0	14	36	Barrier
123445	No	0.90	0.90	3.1	3.0	50	42	Barrier
123446	No	0.00	1.85	1.4	1.1	21	24	Barrier
123794	No	0.25	0.90	1.9	5.0	13	31	Barrier
123795	No	0.17	0.90	1.6	1.0	15	29	Barrier
124487	No	2.50	5.00	2.2	4.0	99	42	Barrier
124500	No	0.00	1.50	2.4	1.0	14	21	Barrier
124501	Yes	0.30	1.60	2.8	6.0	25	34	Barrier
124504	Yes	0.20	3.00	1.8	1.0	16	24	Barrier
195288	No	0.30	1.20	2.5	1.0	11	31	Barrier
195290	No	0.66	0.80	3.0	1.5	0	31	Barrier
197360	No	0.24	1.20	1.8	1.0	27	29	Barrier
197640	No	0.40	1.50	3.4	1.5	12	31	Barrier
197658	No	2.00	4.00	2.8	4.0	24	39	Barrier
197662	No	0.20	4.20	3.0	2.0	24	29	Barrier
197663	No	0.00	1.75	3.6	2.0	25	24	Barrier
197664	Yes	0.00	2.50	1.9	2.0	15	14	Passable
197665	Yes	0.00	0.90	3.9	1.0	25	14	Passable
197667	No	0.58	2.50	1.5	4.0	17	39	Barrier
197668	No	0.27	3.00	1.8	2.0	15	29	Barrier

Table 4.4: Cost benefit analysis for Phase 2 assessments.

PSCIS ID	Stream	Road	Result	Habitat value	Stream Width (m)	Fix	Cost Est (in \$K)	Habitat Upstream (m)	Cost Benefit (m / \$K)	Cost Benefit (m ² / \$K)
3042	Barren Creek	Barren Creek FSR	Barrier	Medium	2.3	SS-CBS	25	1700	68.0	156.4
3054	Johnny David Creek	North road	Barrier	Medium	2.6	OBS	388	7500	19.3	50.3
3139	Trib to McQuarie Creek	North Road	Barrier	Medium	3.3	OBS	162	7300	45.1	148.7
58159	McDowell Creek	Woodmere Nursery Road	Barrier	Medium	2.2	OBS	125	780	6.2	13.7
123445	Tyee Creek	Highway 16	Barrier	Medium	2.1	OBS	12500	6000	0.5	1.0
123446	Tyee Creek	Tyee Lake Road	Barrier	Medium	8.5	OBS	1000	5500	5.5	46.8
123794	Tributary to Blunt Creek	Blunt Creek FSR	Barrier	Medium	1.9	SS-CBS	25	525	21.0	39.9
123795	Tributary to Blunt Creek	Blunt Creek FSR	Barrier	Medium	1.4	OBS	62	—	—	—
124487	Porphyry Creek	Highway 16	Barrier	High	10.7	OBS	15500	8000	0.5	5.5
124500	Helps Creek	Lawson Road	Barrier	Medium	4.8	OBS	500	9000	18.0	86.4
124501	Moan Creek	Lawson Road	Barrier	High	4.8	OBS	500	2800	5.6	26.9
124504	Coffin Creek	Lawson Road	Barrier	High	5.8	OBS	500	4000	8.0	46.4
195288	Gibson Creek	Schnider Road	Barrier	Medium	2.0	OBS	1000	4500	4.5	9.0
195290	Gibson Creek	Highway 16	Barrier	Medium	2.0	OBS	9500	1000	0.1	0.2
197360	Riddeck Creek	Morice-Owen FSR	Barrier	High	3.3	OBS	125	1200	9.6	31.7
197640	Tributary to Buck Creek	Buck Flats Road	Barrier	High	4.4	OBS	500	4200	8.4	37.0

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197658	Byman Creek	Highway 16	Barrier	High	12.9	OBS	7550	6000	0.8	10.3
197662	Richfield Creek	Highway 16	Barrier	High	13.2	OBS	8250	2000	0.2	3.2
197663	Johnny David Creek	Highway 16	Barrier	High	6.6	OBS	5150	10000	1.9	12.8
197664	Barren Creek	Highway 16	Passable	High	7.2	—	—	6200	—	—
197665	Barren Creek	CN Railway	Passable	High	—	—	—	6400	—	—
197667	Moan Creek	CN Railway	Barrier	High	—	OBS	5000	3300	0.7	—
197668	Coffin Creek	CN Railway	Barrier	High	—	OBS	5000	4000	0.8	—

Table 4.5: Summary of Phase 2 habitat confirmation details.

PSCIS ID	Length surveyed upstream (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
3042	400	2.3	2.2	0.2	3	moderate	moderate
3054	725	2.6	2.1	0.3	5.3	moderate	moderate
3139	625	3.3	2.7	0.4	7.2	abundant	high
58159	440	2.2	1.8	0.4	2	abundant	moderate
123445	540	2.1	1.6	—	0.5	moderate	moderate
123446	100	8.5	7.5	0.8	0.2	abundant	moderate
123794	525	1.9	1.6	0.2	9.6	moderate	moderate
123795	650	1.4	1.3	0.3	7.2	abundant	moderate
124487	540	10.7	9.9	0.3	4.8	moderate	high
124500	1100	4.8	4.1	—	0.8	moderate	moderate
124501	520	4.8	3.1	0.4	6.3	moderate	high
124504	415	5.8	3.5	0.4	2.3	moderate	high
195288	180	2	2	—	0	—	moderate
195290	150	2	1.6	0.6	1.3	abundant	moderate
197360	1200	3.3	1.8	0.4	2.7	moderate	high
197640	535	4.4	2.2	0.3	2.5	moderate	moderate
197658	1400	12.9	7.9	0.6	2.1	moderate	high
197662	1200	13.2	9	0.8	2.1	moderate	high
197663	690	6.6	4.4	0.4	3	moderate	high
197664	800	7.2	4.7	3	3	moderate	high
197665	100	—	—	—	—	—	moderate
197667	100	—	—	—	—	—	high
197668	40	—	—	—	—	—	high

Appendix - 3139 - Trib to McQuarrie Creek

Site Location

PSCIS crossing 3139 is located on a Trib to McQuarrie Creek at km 31 of North Road. North Road can be accessed from Summit Lake Rd East which meets Highway 16 approximately 11km east of Houston. The culvert is located approximately 490m upstream from the confluence with McQuarrie Creek. North Road is the responsibility of FLNR - Nadina Forest District.

Background

At crossing 3139, Trib to McQuarrie Creek is a third order stream with a watershed area upstream of the crossing of approximately 8.9km², containing an estimated 23ha of wetland and 23ha of lake. The elevation of the watershed ranges from a maximum of 1200m to 935m at the crossing. Upstream of North Road, no fish have previously been recorded (MoE 2020a).

Downstream in McQuarrie Creek, longnose sucker, redside shiner, cutthroat trout, coho salmon, rainbow trout, steelhead, and chinook salmon have been recorded as present. Although MoE (2020a) note steelhead in McQuarrie Creek near the confluence with the subject stream (with source reference noted as "personal communications"), NCFDC (1998) recorded a 4-5 m impassable falls (significant overhanging section, lack of plunge pool) in the canyon downstream (UTM 9.662200.6045550). This falls was not recorded in provincial databases at the time of planning and reporting.

Beginning in 2016, the BC Ministry of Forests, Land, Natural Resource Operations and Rural Development (FLNRORD), Land and Water Section established a continuous discharge monitoring station on McQuarrie Creek just upstream of the highway (Westcott 2020). Additionally, three water temperature sensors have been deployed in the watershed. One is located in McQuarrie Creek just above Highway 16, another is in McQuarrie Creek above North Road and one is in McQuarrie Lake (Westcott 2020). Sensors in McQuarrie Creek have been gathering water temperature data at 1hour intervals since 2016 and the sensor in McQuarrie Lake is gathering maximum temperature information from 1m below the surface since July 2018. Data from the two McQuarrie Creek temperature monitoring stations is available through the Skeena Salmon Data Centre (DFO/FLNRO 2019c, 2019b).

The McQuarrie Creek watershed has been selected as a focus watershed for Environmental Stewardship Initiative (ESI) research including critical flow monitoring, benthic invertebrate sampling, water quality monitoring and fisheries assessments (pers. comm Don Morgan, Ministry of Environment and Climate Change Strategy).

PSCIS stream crossing 3139 was ranked as a high priority for follow up in Irvine (2018). It was also selected for follow up with habitat confirmation because McQuarrie Creek was noted as an important rearing area for steelhead by Tredger (1982), because the stream is lake headed (which can stabilize system flows), as steelhead were noted near the confluence, and due to engagement activities with Wet'suwet'en, FLNRO, and Ministry of Environment and Climate Change Strategy representatives that indicated that there could be potential benefits in fish passage remediation/monitoring activities in ESI target watersheds.

Of note, an erroneous input into the provincial database for PSCIS crossing 3138 indicated that the oval culvert structure located on McQuarrie Creek just upstream of the confluence with the subject stream was an open bottomed structure and fully passable. The error was discovered during review of PSCIS photos as part of the background review for drafting of this report. NCFDC (1998) noted that this culvert was a barrier to upstream fish passage at low flows, was undersized and was causing fill slope erosion at the road crossing. A map of the watershed is provided in map attachment [093L.114](#).

Stream Characteristics at Crossing

At the time of the survey, the culvert under North Road was un-embedded, non-backwatered and ranked as a barrier to upstream fish passage according to the provincial protocol (MoE 2011). The pipe was 1.2m in diameter with a length of 27m, a culvert slope of 2%, a stream width ratio of 3.2 and an outlet drop of 1.02m (Table [4.6](#)). Water temperature was 11°C, pH was 7.7 and conductivity was 89uS/cm.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 285m to the confluence with Buck Creek (Figure [??](#)). Total cover amount was rated as moderate with overhanging vegetation dominant. Cover was also present as small woody debris, large woody debris, and undercut banks (Table [4.7](#)). The average channel width was 3.1m, the average wetted width was 2.2m and the average gradient was 3.9%. The dominant substrate was cobbles with boulders subdominant. There were occasional pockets of gravels suitable for resident salmonids. The habitat was rated as high value for resident salmonid rearing.

Stream Characteristics Upstream

The stream was surveyed immediately upstream from 3139 for approximately 625m (Figure [??](#)). Within the area surveyed, total cover amount was rated as abundant with deep pools dominant. Cover was also present as small woody debris, large woody debris, boulders, undercut banks, and overhanging vegetation (Table [4.7](#)). The average channel width was 3.3m, the average wetted width was 2.7m and the average gradient was 7.2%. The dominant substrate was cobbles with gravels subdominant. Extensive areas of gravels suitable for spawning resident salmonids were present

and fry were observed throughout the surveyed area. Habitat value was rated as high value resident salmonid rearing and spawning.

Structure Remediation and Cost Estimate

Replacement of PSCIS crossing 3139 with a bridge (13m span) is recommended. The cost of the work is estimated at \$162,000 for a cost benefit of 45.1 linear m/\$1000 and 148.7m²/\$1000.

Conclusion

A conservative estimate of mainstem habitat upstream of crossing 3139 is 7.3km to the top end of a 71ha wetland where rainbow trout have been recorded. Habitat in the areas surveyed upstream of the culvert were rated as high value for salmonid rearing and spawning with extensive areas of wetland and lake habitat located upstream. As there is a 4-5 m impassable falls downstream in McQuarrie Creek, remediation of fish passage at the crossing would benefit resident fish species in the watershed and not anadromous fish populations migrating from the Bulkley River mainstem. North Road is the responsibility of the Ministry of Transportation and Infrastructure. Crossing 3139 was ranked as a moderate priority for proceeding to design for replacement.

Table 4.6: Summary of fish passage assessment for PSCIS crossing 3139.

Location and Stream Data	.	Crossing Characteristics –	
Date	2020-09-01	Crossing Sub Type	Round Culvert
PSCIS ID	3139	Diameter (m)	1.2
External ID	–	Length (m)	27
Crew	KP, AI	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	656657	Resemble Channel	No
Northing	6048544	Backwatered	No
Stream	Trib to McQuarrie Creek	Percent Backwatered	–
Road	North Road	Fill Depth (m)	4
Road Tenure	MoTi local	Outlet Drop (m)	1.02
Channel Width (m)	3.9	Outlet Pool Depth (m)	0.25
Stream Slope (%)	3.1	Inlet Drop	No
Beaver Activity	No	Slope (%)	2
Habitat Value	Medium	Valley Fill	Deep Fill
Final score	34	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	13
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Comments: Inlet plugged with small and large woody debris. Fry and juvenile fish observed upstream.



Table 4.7: Summary of habitat details for PSCIS crossing 3139.

Site Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
3139 Downstream	285	3.1	2.2	0.4	3.9	moderate	high
3139 Upstream	625	3.3	2.7	0.4	7.2	abundant	high



Figure 4.1: Left: Habitat downstream of PSCIS crossing 3139. Right: Habitat downstream of crossing 3139.



Figure 4.2: Left: Habitat upstream of PSCIS crossing 3139. Right: Habitat upstream of PSCIS crossing 3139.

Appendix - 58159 - McDowell Creek

Site Location

PSCIS crossing 58159 is located on McDowell Creek on the Woodmere Nursery Road accessed from Houston, BC. The Woodmere Nursery Road is a private road owned by the Woodmere Nursery. At the time of field surveys it was used to access a newly constructed agricultural facility and by nursery operations to access a waste storage/burn pile area.

Background

McDowell Creek drains McDowell Lake (35ha), Dorsay Lake (4ha) and one other unnamed lake (9ha) flowing from McDowell Lake in a south then west direction for approximately 9km to the confluence with the Bulkley River. At crossing 58159, McDowell Creek is a third order stream with a watershed area upstream of the crossing of approximately 15.9km². The elevation of the watershed ranges from a maximum of 1000 to 520m at PSCIS crossing 58159. McDowell Creek is known to contain coho and rainbow trout upstream of the subject culvert (MoE 2020a).

PSCIS stream crossings 58159 and 58158 were rated as high priorities for follow up by both Irvine (2018) and Smith (2018) due to significant quantities of upstream habitat suitable for salmonid rearing. A map of the watershed is provided in map attachment [093L.118](#).

Stream Characteristics at Crossing

At the time of the survey, the culvert was un-embedded, non-backwatered and considered a barrier to upstream fish passage. The pipe was 1m in diameter with a pipe length of 14m, a culvert slope of 3%, a stream width ratio of 2.3 and an outlet drop of 0.36m (Table [4.8](#)). Water temperature was 11° C, pH was 8.2 and conductivity was 324uS/cm.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 135m (Figure [??](#)). Overall, total cover amount was rated as abundant with large woody debris dominant. Cover was also present as small woody debris, undercut banks, overhanging vegetation, and instream vegetation (Table [4.10](#)). The average channel width was 2.2m, the average wetted width was 1.7m and the average gradient was 3.8%. The dominant substrate was cobbles with gravels subdominant. Habitat was rated as moderate as it was considered an important migration corridor with moderate value habitat for fry/juvenile salmonid rearing.

Stream Characteristics Upstream

The stream was surveyed upstream from 58159 for 440m (Figure [??](#)). Within the area surveyed, total cover amount was rated as abundant with large woody debris dominant. Cover was also present as small woody debris, undercut banks, overhanging vegetation, and instream vegetation (Table [4.10](#)). The average channel width was 2.2m, the average wetted width was 1.8m and the average gradient was 2%. Habitat value was rated as moderate for salmonid rearing and spawning.

PSCIS culvert 58158 was documented on McDowell Creek, 500m upstream on Highway 16. The culvert has been newly replaced and is baffled with a natural type substrate throughout. Although ranked as a barrier to upstream fish passage using the provincial metric the crossing is likely not a barrier during most flows for adult anadromous salmon and fluvial salmonids migrating upstream from the Bulkley River. The pipe was 2.5m in diameter with a pipe length of 53m, a culvert slope of 5.5%, a stream width ratio of 1 and an outlet drop of 0.36m (Table [4.9](#)).

Fish Sampling

To assess potential impacts of the culvert on fisheries values in the stream, electrofishing was conducted upstream and downstream of the crossing. A total of 9 coho were captured downstream with 1 coho captured upstream. Although there is only moderate confidence in their identification, 19 fish captured were identified as chinook. With the exception of one coho, only rainbow trout (19 fish) were captured upstream. Sampling results are summarized in Tables [4.11](#) - [4.12](#) and Figure [4.5](#).

Structure Remediation and Cost Estimate

Structure replacement with a bridge (10m span) is recommended to provide access to the habitat located upstream of PSCIS crossing 58159. The cost of the work is estimated at \$125,000 for a cost benefit of 6.2 linear m/\$1000 and $13.7\text{m}^2/\$1000$.

Conclusion

There is 0.8km of habitat upstream of crossing 58159. Habitat in this area was rated as moderate value for salmonid rearing/spawning. Woodmere Nursery Road is on private land owned by the Woodmere Nursery. The crossing was ranked as a high priority for proceeding to design for replacement.

Stream Characteristics Upstream

Table 4.8: Summary of fish passage assessment for PSCIS crossing 58159.

Location and Stream Data	.	Crossing Characteristics –	
Date	2020-09-03	Crossing Sub Type	Round Culvert
PSCIS ID	58159	Diameter (m)	1
External ID	–	Length (m)	14
Crew	KP, AI	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	627643	Resemble Channel	No
Northing	6060449	Backwatered	No
Stream	McDowell Creek	Percent Backwatered	–
Road	Woodmere Nursery Road	Fill Depth (m)	0.75
Road Tenure	MoTi local	Outlet Drop (m)	0.36
Channel Width (m)	2.3	Outlet Pool Depth (m)	0.8
Stream Slope (%)	3.8	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	3
Habitat Value	Medium	Valley Fill	Deep Fill
Final score	36	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	10

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

Appendix - 58159 - McDowell Creek

Comments: Stream flows through the Woodmere Nursery from small culvert on burn pile access road to the Highway. Electrofishing conducted. Abundant cover available primarily as overhanging vegetation and cobbles. Upstream culvert under Highway 16 has been recently replaced by horizontal drilling. Baffles at upstream crossing. Coho fry captured below the Highway crossing.



Stream Characteristics Upstream

Date	2020-09-03	Crossing Sub Type	Round Culvert
PSCIS ID	58158	Diameter (m)	2.5
External ID	–	Length (m)	53
Crew	AI, KP	Embedded	Yes
UTM Zone	9	Depth Embedded (m)	0.5
Easting	628044	Resemble Channel	Yes
Northing	6060527	Backwatered	No
Stream	McDowell Creek	Percent Backwatered	–
Road	Highway 16	Fill Depth (m)	4
Road Tenure	MoTi highway	Outlet Drop (m)	0.36
Channel Width (m)	2.5	Outlet Pool Depth (m)	0.45
Stream Slope (%)	3	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	5.5
Habitat Value	High	Valley Fill	Deep Fill
Final score	34	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	13
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Appendix - 58159 - McDowell Creek



Table 4.10: Summary of habitat details for PSCIS crossing 58159.

Site	Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
58159	Downstream	135	2.2	1.7	0.2	3.8	abundant	moderate
58159	Upstream	440	2.2	1.8	0.4	2	abundant	moderate

Stream Characteristics Upstream



Figure 4.3: Left: Typical habitat downstream of PSCIS crossing 58159. Right: Chinook captured downstream of PSCIS crossing 58159.



Figure 4.4: Left: Typical habitat upstream of PSCIS crossing 58159. Right: Coho captured upstream of PSCIS crossing 58159.

Table 4.11: Electrofishing sites for PSCIS crossing 58159.

Site Location	Width (m)	Length (m)	Area (m ²)	Effort (s)	Effort (s/m ²)
41 Downstream	2.00	5	10	71	7.1
42 Downstream	1.75	33	58	104	1.8

43	Downstream	1.63	47	77	176	2.3
44	Downstream	2.00	50	100	147	1.5
45	Upstream	1.90	23	44	107	2.4
46	Upstream	1.80	31	56	268	4.8
47	Upstream	1.80	26	47	144	3.1
48	Upstream	2.50	4	10	57	5.7

**Table 4.12: Fish densities
(fish/100m²) for PSCIS crossing
58159.**

Site	Location	Species	Fry	Parr	Juvenile	Adult
41	Downstream	CH	30	0	0	0
42	Downstream	CH	1.7	0	0	0
43	Downstream	CH	3.9	1.3	0	0
44	Downstream	CH	8	3	0	0
43	Downstream	CO	5.2	0	0	0
44	Downstream	CO	5	0	0	0
48	Upstream	CO	0	10	0	0
41	Downstream	RB	70	20	0	0
42	Downstream	RB	24.1	1.7	3.4	0
43	Downstream	RB	10.4	3.9	3.9	1.3
44	Downstream	RB	13	5	0	0
45	Upstream	RB	9.1	2.3	0	0
46	Upstream	RB	0	3.6	5.4	0
47	Upstream	RB	4.3	2.1	2.1	0
48	Upstream	RB	40	0	10	0

Stream Characteristics Upstream

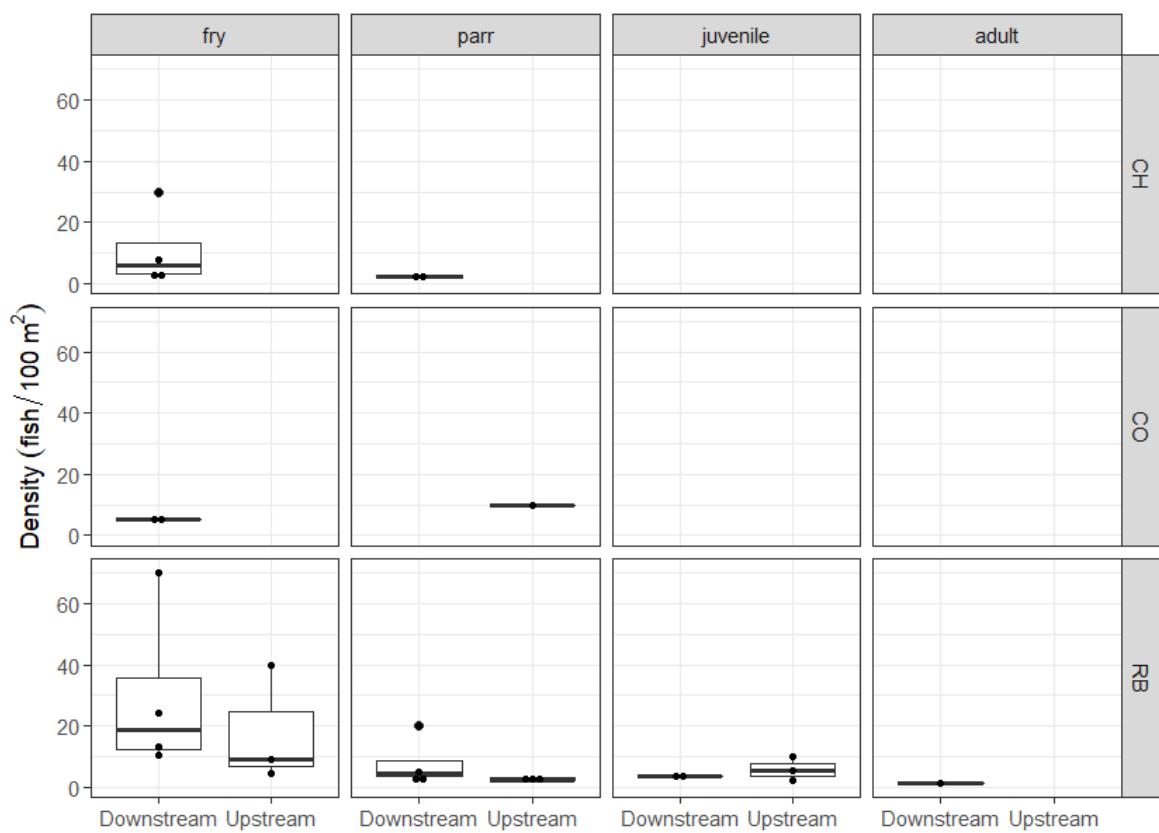


Figure 4.5: Densities of fish captured (fish/100m²) during electrofishing upstream and downstream of PSCIS crossing 58159.

Appendix - 123445 & 123446 - Tyhee Creek

Site Location

PSCIS crossing 123445 is located on Tyhee Creek on Highway 16 approximately 2km south of Telkwa, BC. The highway is located approximately 170m upstream from the confluence with the Bulkley River. PSCIS crossing 123446 is located on Tyee Lake Road approximately 540m upstream of Highway 16. Both crossings are the responsibility of the Ministry of Transportation and Infrastructure.

Background

At crossing 123445, Tyhee Creek is a third order stream with a watershed area upstream of the crossing of approximately 35km². The elevation of the watershed ranges from 1000m to 520m at the highway. Numerous fish species have been documented upstream of both crossings including sucker (general), longnose sucker, minnow (general), northern redbelly dace, peamouth chub, northern pikeminnow, redside shiner, burbot, salmon (general), cutthroat trout, pink salmon, chum salmon, coho salmon, rainbow trout, steelhead, sockeye salmon, chinook salmon, giant pygmy whitefish, pygmy whitefish, mountain whitefish, sculpin (general), and prickly sculpin (MoE 2020a).

Tyhee Lake is located approximately 800m upstream of crossing 123446. Tyhee Lake has a surface area of 3.18km², a mean depth of 11.1m, a maximum depth of 22.2m and a mean water retention time estimated at 5 years (Reavie et al. 2000). Reavie et al. (2000) report that Tyhee Lake was a naturally productive system that has experienced moderate eutrophication over time due to adjacent land use. In response to concerns expressed by the Tyhee Lake Protection Society, a management plan was drafted for the lake in 1999 with the objective of slowing down or eliminating eutrophication (Rysavy et al. 1999). Fish passage issues at the highway have also been highlighted by the protection society in the past (Hatlevik 1992). Cutthroat trout have been observed unsuccessfully attempting to ascend upstream into the culvert at the highway (pers comm Mike Ridsdale, Environmental Assessment Coordinator - Office of the Wet'suwet'en). Tyhee Lake has been historically stocked with rainbow trout since 1955 with annual stocking events noted since 1990 (BC Ministry of Environment 2021).

There are five tributaries that flow into the lake from the east and north with all systems containing crossings previously inventoried as barriers or potential barriers.

PSCIS stream crossings 123445 and 123446 were rated high priorities for follow up by Wilson and Rabnett (2007) and Irvine (2018) due to significant quantities of lake habitat upstream and historical records of steelhead and salmon upstream. A map of the watershed is provided in mapsheet attachment [093L.118](#).

Stream Characteristics at Crossings 123445 and 123446

At the time of the survey, the 123445 on Highway 16 was un-embedded, non-backwatered and considered a barrier to upstream fish passage according to the provincial protocol. Downcutting of the downstream area was apparent and due likely to high flow velocities through the pipes during elevated flow events. The pipes were 0.9m in diameter with lengths of 50m, a culvert slope of 3%, a stream width ratio of 3.1 and an outlet drop of 0.9m (Table [4.13](#)). Water temperature was 11°C, pH was 8.1 and conductivity was 418uS/cm.

Crossing 123446 on Tyee Lake Road was un-embedded, 10% backwatered and classified as a barrier to upstream fish passage. The pipe was 1.85m in diameter with a length of 21m, a culvert slope of 1.1%, a stream width ratio of 1.4 and an outlet drop of 0m (Table [4.14](#)).

Stream Characteristics Downstream of 123445

The stream was surveyed downstream from the culvert for 170m to the confluence with the Bulkley River (Figure [??](#)). Flows were very low at the time of the surveyd and the stream channel went subsurface near the Bulkley River floodplain. Overall, total cover amount was rated as moderate with overhanging vegetation dominant. Cover was also present as small woody debris, large woody debris, boulders, and undercut banks (Table [4.16](#)). The average channel width was 2.8m, the average wetted width was 1.5m and the average gradient was 3%. The dominant substrate was cobbles with boulders subdominant. Some gravels suitable for spawning were observed and unidentified fry/juvenile fish (3 @ 50mm, and 1 @ 90mm) were observed. Habitat was rated as moderate as it was considered an important migration corridor with moderate value habitat for fry/juvenile salmonid rearing.

Stream Characteristics Upstream of 123445 and downstream of 123446

The stream was surveyed from 123445 for 540m to 123446(Figure [??](#)). Within the area surveyed, total cover amount was rated as moderate with overhanging vegetation dominant. Cover was also present as small woody debris, large woody debris, undercut banks, and instream vegetation (Table [4.16](#)). The average channel width was 2.1m, the average wetted width was 1.6m and the average gradient was 0.5%. Water within the narrow channel was noted as often stagnant with aquatic vegetation present throughout. Some riparian disturbance by adjacent livestock was also noted. Although, habitat value was considered of low value for rearing and spawning it was rated as moderate overall as it was considered an important migration corridor providing access to the lake.

Stream Characteristics Upstream of 123446

Tyhee Creek was surveyed upstream from 123446 for 100m with the survey discontinued due to difficult survey conditions within the wetland type habitat and the presence of adjacent private land (Figure ??). Within the area surveyed, total cover amount was rated as abundant with overhanging vegetation dominant. Cover was also present as small woody debris, large woody debris, deep pools, and instream vegetation (Table 4.16). The average channel width was 8.5m, the average wetted width was 7.5m and the average gradient was 0.2%. Beaver activity was prevalent in the area surveyed and there was a large agricultural field located on the right bank of the stream. Habitat value was rated as moderate as it was considered an important migration corridor providing access to the lake.

Crossing 123463 is located on Victor Creek and Tyhee Lake Road. Victor Creek flows into the east side of Tyhee Lake approximately 1.7km upstream from the mouth. At the time of the survey, the round culvert appeared to have been recently replaced. The structure was un-embedded, non-backwatered and considered a barrier to upstream fish passage according to the provincial protocol. The pipe was 0.6m in diameter with a length of 18m, a culvert slope of 3%, a stream width ratio of 3.1 and an outlet drop of 0m (Table 4.15).

Structure Remediation and Cost Estimate

Structure replacement with bridges for 123445 (25m span) and 123446 (10m span) could be considered to provide access to the habitat located upstream. An estimate of cost for replacement of 123445 is \$12,500,000 and \$1,000,000 for 123446.

Conclusion

As Tyhee Lake is located upstream of both crossings surveyed with steelhead and multiple salmon species historically recorded upstream of the highway, the restoration of fish passage at 123445 was rated as a moderate priority for proceeding to design for replacement. Although classified as a “potential” barrier to upstream fish passage according to the provincial protocol, crossing 123446 was considered as less of a pressing concern for providing passage for adult salmonids to Tyhee Lake if passage to above the highway was facilitated and subsequently ranked as a high priority for proceeding to design for replacement. Adjacent land use has been documented as negatively impacting fish habitat values in the watershed and the multiple strategies to quantify and reduce those impacts noted in Rysavy et al. (1999) should be considered alongside restorative works addressing fish passage in the watershed.

Table 4.13: Summary of fish passage assessment for PSCIS crossing 123445.

Location and Stream Data		Crossing Characteristics –	
Date	2020-08-29	Crossing Sub Type	Round Culvert
PSCIS ID	123445	Diameter (m)	0.9
External ID	–	Length (m)	50
Crew	KP, AI	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	627238	Resemble Channel	No
Northing	6061456	Backwatered	No
Stream	Tyhee Creek	Percent Backwatered	–
Road	Highway 16	Fill Depth (m)	8
Road Tenure	MoTi unclassified	Outlet Drop (m)	0.9
Channel Width (m)	2.8	Outlet Pool Depth (m)	0.42
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	25

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

Stream Characteristics Upstream of 1...

Comments: Important migration corridor to Tyee Lake. Large outlet drop seems unlikely passable by any life stage or species.



Table 4.14: Summary of fish passage assessment for PSCIS crossing 123446.

Location and Stream Data	• Crossing Characteristics –
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Stream Characteristics Upstream of 1...

Date	2020-08-29	Crossing Sub Type	Round Culvert
PSCIS ID	123446	Diameter (m)	1.85
External ID	–	Length (m)	21
Crew	AI, KP	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	627527	Resemble Channel	No
Northing	6061771	Backwatered	Yes
Stream	Tyhee Creek	Percent Backwatered	10
Road	Tyee Lake Road	Fill Depth (m)	1.3
Road Tenure	MoTi highway	Outlet Drop (m)	0
Channel Width (m)	2.5	Outlet Pool Depth (m)	0.1
Stream Slope (%)	0.5	Inlet Drop	No
Beaver Activity	Yes	Slope (%)	1.1
Habitat Value	Medium	Valley Fill	Deep Fill
Final score	24	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	10
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Stream Characteristics Upstream of 1...

Comments: Important migration corridor to get to Tyee Lake from Bulkley River. Crossing does not appear to be barrier to most life stages/species at most flows.



Table 4.15: Summary of fish passage assessment for PSCIS crossing 123463.

Location and Stream Data	• Crossing Characteristics –
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Appendix - 123445 & 123446 - Tyhee ...

Date	2020-08-29	Crossing Sub Type	Round Culvert
PSCIS ID	123463	Diameter (m)	0.6
External ID	-	Length (m)	18
Crew	AI, KP	Embedded	No
UTM Zone	9	Depth Embedded (m)	-
Easting	627570	Resemble Channel	No
Northing	6064562	Backwatered	Yes
Stream	Victor Creek	Percent Backwatered	30
Road	Tyee Lake Road	Fill Depth (m)	1
Road Tenure	MoTi local	Outlet Drop (m)	0
Channel Width (m)	1.8	Outlet Pool Depth (m)	0.3
Stream Slope (%)	1	Inlet Drop	No
Beaver Activity	No	Slope (%)	3
Habitat Value	Medium	Valley Fill	Deep Fill
Final score	29	Barrier Result	Barrier
Fix type	Replace Structure with Streambed Simulation CBS	Fix Span / Diameter	5

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

Stream Characteristics Upstream of 1...

Comments: No habitat confirmation conducted in 2020. Newly replaced crossing. ID# 8 21 18 01 .



Table 4.16: Summary of habitat details for PSCIS crossings 123445 and 123446.

Site Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
123445 Downstream	170 2.8	1.5	—	3	moderate	moderate	
123445 Upstream	540 2.1	1.6	—	0.5	moderate	moderate	
123446 Upstream	100 8.5	7.5	0.8	0.2	abundant	moderate	



Figure 4.6: Left: Typical habitat downstream of PSCIS crossing 123445. Right: Typical habitat downstream of PSCIS crossing 123445.



Figure 4.7: Left: Habitat upstream of PSCIS crossing 123445. Right: Habitat upstream of PSCIS crossing 123445.

Stream Characteristics Upstream of 1...



Figure 4.8: Left: Habitat upstream of PSCIS crossing 123446. Right: Habitat upstream of PSCIS crossing 123446.

Appendix - 123794 - Tributary to Blunt Creek

Site Location

PSCIS crossing 123794 is located on tributary to Blunt Creek at km 19.3 of the Blunt Creek FSR. The site is accessed via Moricetown Road through Witset approximately 40km north of Smithers. The culvert is located approximately 670m upstream from the confluence with a major tributary to Blunt Creek. Blunt Creek flows into the Suskwa River which in turn enters the Bulkley River near Hazelton BC. Blunt Creek FSR is the responsibility of the FLNR - Skeena Stikine District.

Background

At crossing 123794, tributary to Blunt Creek is a second order stream. The elevation of the watershed ranges from a maximum of 1350m to 530m at PSCIS crossing 123794. Upstream of the Blunt Creek FSR, dolly varden have been previously recorded as present (MoE 2020a). MoE (2020a) also indicates that salmon (unidentified species) have been recorded in an adjacent tributary.

PSCIS stream crossing 123794 was ranked as a high priority for follow up by Irvine (2018) because there was salmon noted nearby, due to the presence of a small lake upstream and because PSCIS data indicated a larger channel containing habitat rated as high value. Although on a smaller stream, the crossing's location on a forest service road was considered advantageous as these sites are often eligible for funding through forestry supported funds such as the Land Based Investment Fund if restoration of fish passage is warranted. A map of the watershed is provided in map attachment [093M.103](#).

Stream Characteristics at Crossing

At the time of the survey, the culvert under Blunt Creek FSR was un-embedded, non-backwatered and ranked as a barrier to upstream fish passage according to the provincial protocol (MoE 2011). The pipe was 0.9m in diameter with a length of 13m, a culvert slope of 5%, a stream width ratio of 1.9 and an outlet drop of 0.25m (Table [4.17](#)). Water temperature was 9°C, pH was 7.7 and conductivity was 73uS/cm.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 250m (Figure [??](#)). 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 (Table [4.18](#)). The average channel width was 1.7m, the average wetted width was 1.8m and the average gradient was 5%. The dominant substrate was gravels with cobbles subdominant. Within the area surveyed, the stream had good

flow volume and frequent patches of gravel suitable for spawning for coho and resident salmonids. The habitat was rated as moderate value.

Stream Characteristics Upstream

The stream was surveyed immediately upstream from 123794 for approximately 525m (Figure ??). Within the area surveyed, 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 (Table 4.18). The average channel width was 1.9m, the average wetted width was 1.6m and the average gradient was 9.6%. The dominant substrate was gravels with cobbles subdominant. the channel was noted as containing good complexity, abundant gravels suitably sized for both coho and resident salmonid spawning. Some small woody debris/large woody debris steps (30-50cm in height) were present intermittently starting approximatley 400m above the culvert. A fish was observed approximately 500m upstream of the culvert. A 4m high falls was noted at the top end of the site and represents an impassable barrier to upstream migration. Habitat value was rated as moderate for salmonid spawning and rearing.

Structure Remediation and Cost Estimate

Replacement of PSCIS crossing 123794 with a bridge (5m span) is recommended in the long term. The cost of the work is estimated at \$25,000 for a cost benefit of 21 linear m/\$1000 and 39.9m²/\$1000.

Conclusion

A conservative estimate of mainstem and major tributary habitat upstream of crossing 123794 is 0.5km. Habitat in the areas surveyed was rated as moderate value for salmonid rearing and spawning. Blunt Creek FSR is the responsibility of FLNR - Skeena Stikine District.. The crossing was ranked as a moderate priority for proceeding to design for replacement. Future fish sampling is recommended upstream and downstream to scope for anadromous species.

Table 4.17: Summary of fish passage assessment for PSCIS crossing 123794.

Location and Stream Data	.	Crossing Characteristics –	
Date	2020-08-24	Crossing Sub Type	Round Culvert
PSCIS ID	123794	Diameter (m)	0.9
External ID	–	Length (m)	13
Crew	AI, KP	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	616100	Resemble Channel	No

Stream Characteristics Upstream

Northing	6106763	Backwatered	No
Stream	Tributary to Blunt Creek	Percent Backwatered	–
Road	Blunt Creek FSR	Fill Depth (m)	0.75
Road Tenure	FLNR Nadina 9111	Outlet Drop (m)	0.25
Channel Width (m)	1.73	Outlet Pool Depth (m)	0.43
Stream Slope (%)	5	Inlet Drop	No
Beaver Activity	No	Slope (%)	5
Habitat Value	Medium	Valley Fill	Deep Fill
Final score	31	Barrier Result	Barrier
Fix type	Replace Structure with Streambed Simulation CBS	Fix Span / Diameter	5
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Comments: Smaller stream with good flow. Salmon points noted in adjacent stream. Recommend sampling upstream and downstream and habitat assessment of stream at associated PSCIS crossing 123785.



Table 4.18: Summary of habitat details for PSCIS crossing 123794.

Site	Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
123794	Downstream	250	1.7	1.8	0.3	5	moderate	moderate
123794	Upstream	525	1.9	1.6	0.2	9.6	moderate	moderate

Stream Characteristics Upstream



Figure 4.9: Left: Habitat downstream of PSCIS crossing 123794. Right: Habitat downstream of crossing 123794.



Figure 4.10: Left: Habitat upstream of PSCIS crossing 123794. Right: Cascade upstream of PSCIS crossing 123794.

Appendix - 124487 - Porphyry Creek

Site Location

PSCIS crossing 124487 is located on Porphyry Creek and Highway 16 approximately 18km south of New Hazelton, BC. The crossing located approximately 145m upstream from the confluence with the Bulkley River. Highway 16 is the responsibility of the Ministry of Transportation and Infrastructure.

Background

At crossing 124487, Porphyry Creek is a fourth order stream with a watershed area upstream of the crossing of approximately 43.5 km^2 . The elevation of the watershed ranges from a maximum of 2300 to 330m at PSCIS crossing 124487. Upstream of the highway rainbow trout and dolly varden have been recorded (MoE 2020a). A large railway tressel bridge is located over the stream approximatley 500m upstream of the highway.

PSCIS stream crossing 124487 was ranked as a high priority for follow up by Irvine (2018) due to the large quantity of habitat modelled upstream and selected for assessment in 2020 following consultation with Alecia Fernando from the Gitksan Watershed Authority. Wilson and Rabnett (2007) assessed the site and reported it as not a priority restoration site due to “the limited amount of high value habitat upstream of Highway 16”. A map of the watershed is provided in map attachment [093M.102](#).

Stream Characteristics at Crossing

At the time of the survey, the culvert under Highway 16 was un-embedded, non-backwatered and ranked as a barrier to upstream fish passage (MoE 2011). The pipe was 5m in diameter with a length of 99m, a culvert slope of 4%, a stream width ratio of 2.2 and an outlet drop of 2.5m (Table [4.19](#)). Water temperature was 9°C , pH was 7.6 and conductivity was 73uS/cm. Survey conditions were difficult at the time of assessment as stream flows were high due to recent rain events.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 145m to the confluence with the Bulkley River (Figure [??](#)). Total cover amount was rated as moderate with boulders dominant. Cover was also present as small woody debris, large woody debris, and overhanging vegetation (Table [4.20](#)). The average channel width was 11.2m, the average wetted width was 10.2m and the average gradient was 2.8%. The dominant substrate was boulders with cobbles subdominant. The cascade-boulder habitat was rated as moderate valuable as it was considered an important migration corridor with moderate value habitat for salmonid rearing. During the survey, an approximately 40cm long salomonid was observed attempting to ascend from the outlet pool into the culvert outlet.

Stream Characteristics Upstream

The stream was surveyed upstream from 124487 for 540m (Figure ??). Within the area surveyed, total cover amount was rated as moderate with boulders dominant. Cover was also present as small woody debris, large woody debris, deep pools, and overhanging vegetation (Table 4.20). The average channel width was 10.7m, the average wetted width was 9.9m and the average gradient was 4.8%. The dominant substrate was boulders with cobbles subdominant. There were pockets of gravel suitable for spawning for resident and anadromous species with minimal pool habitat observed. Habitat value was rated as high for salmonid rearing and spawning.

Structure Remediation and Cost Estimate

Structure replacement with a bridge (31m span) is recommended to provide access to the habitat located upstream of PSCIS crossing 124487. The cost of the work is estimated at \$15,500,000 for a cost benefit of 0.5 linear m/\$1000 and 5.5m²/\$1000.

Conclusion

There are 8km of habitat upstream of crossing 124487 modelled as suitable for steelhead rearing with 3km of habitat suitable for chinook/cohoh rearing. Additionally, there are 4km of habitat modelled as suitable for coho spawning with 2km modelled as suitable for steelhead spawning. Habitat in surveyed areas upstream of the crossing was rated as high value for salmonid rearing/spawning. The crossing represents a complete barrier to upstream migration for fish in the Bulkley River watershed regardless of species or life stage. Highway 16 is the responsibility of the Ministry of Transportation and Infrastructure. The crossing was ranked as a high priority for proceeding to design for replacement.

Table 4.19: Summary of fish passage assessment for PSCIS crossing 124487.

Location and Stream Data	.	Crossing Characteristics –	
Date	2020-08-25	Crossing Sub Type	Round Culvert
PSCIS ID	124487	Diameter (m)	5
External ID	–	Length (m)	99
Crew	AI, KP	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	603073	Resemble Channel	No
Northing	6113363	Backwatered	No
Stream	Porphyry Creek	Percent Backwatered	–
Road	Highway 16	Fill Depth (m)	9.99
Road Tenure	FLNR Nadina 7543	Outlet Drop (m)	2.5
Channel Width (m)	11.2	Outlet Pool Depth (m)	4

Stream Characteristics Upstream

Stream Slope (%)	2.8	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	4
Habitat Value	High	Valley Fill	Deep Fill
Final score	42	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure		Fix Span / Diameter 31

Comments: Unpassable to all life stages and species. Fill depth is approximately 35m. Salomid (50cm) observed trying to ascend to outlet of main pipe.

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



Table 4.20: Summary of habitat details for PSCIS crossing 124487.

Site	Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
124487	Upstream	540	10.7	9.9	0.3	4.8	moderate	high
124487	Downstream	145	11.2	10.2	0.5	2.8	moderate	moderate



Figure 4.11: Left: Outlets of PSCIS crossing 124487. Right: Typical habitat downstream of crossing 124487 below the railway bridge and adjacent to the Bulkley River mainstem.

Stream Characteristics Upstream



Figure 4.12: Left: habitat upstream of PSCIS crossing 124487. Right: Habitat upstream of PSCIS crossing 124487.

Appendix - 124500 - Helps Creek

Site Location

PSCIS crossing 124500 is located on Helps Creek on Lawson Road approximately 5km south of Telkwa. The culvert is located approximately 1.7km upstream from the confluence with the Bulkley River. Lawson Road is the responsibility of the Ministry of Transportation and Infrastructure.

Background

At crossing 124500, Helps Creek is a fourth order stream with a watershed area upstream of the crossing of approximately 41.4km². The elevation of the watershed ranges from a maximum of 1350m to 530m at PSCIS crossing 124500. Upstream of the Lawson Road, longnose sucker, longnose dace, cutthroat trout, rainbow trout, and dolly varden have been previously recorded as present upstream of the crossing and coho, steelhead, rainbow trout and burbot have been observed below (MoE 2020a). A backwatered and passable rail stream crossing consisting of three round culverts (PSCIS 197666) is located under the railway approximately 1.2km downstream. There is one major tributary to Helps Creek that intersects the mainstem of the creek approximately 1.7km upstream of Lawson Road. There are several stream crossing structures documented on this tributary with the first of which located 4.7km upstream of Lawson Road. The adjacent landowner anecdotally reported a drop in numbers of fry/parr in stream over last 20 years. At the time of the survey a staff gauge was present just upstream of crossing.

PSCIS stream crossing 124500 was ranked as a high priority for follow up by Irvine (2018). The site was assessed by Smith (2018) in 2017 with maintenance to clear the inlet of debris recommended and replacement of the crossing assessed as a low priority. A map of the watershed is provided in map attachment [093L.118](#).

Stream Characteristics at Crossing

At the time of the survey, the culvert under Lawson Road was un-embedded, non-backwatered and ranked as a barrier to upstream fish passage according to the provincial protocol (MoE 2011). The pipe was 1.5m in diameter with a length of 14m, a culvert slope of 1%, a stream width ratio of 2.4 and an outlet drop of 0m (Table [4.21](#)). Water temperature was 10°C, pH was 7.6 and conductivity was 236uS/cm.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 415m beginning at the culvert location with a short survey conducted adjacent to the downstream railway (Figure [??](#)). Total cover amount was rated as abundant with overhanging vegetation dominant. Cover was also present as small woody debris, large woody debris, undercut banks, deep pools, and instream vegetation (Table

[4.23](#)). The average channel width was 3.6m, the average wetted width was 2.3m and the average gradient was 2.5%. The dominant substrate was gravels with fines subdominant. Within the area surveyed, the channel flowed through an agricultural field with minimal riparian buffer present. The habitat was rated as high value with gravels present suitable for resident, fluvial and anadromous salmonid spawning throughout. At the railway culverts located 1.3km downstream of Lawson Road, the habitat transitioned to wetland type habitat with low velocities likely influenced by beaver (Table [4.22](#)). The landowners of the adjacent property noted that they had seen large numbers of lamprey in the culvert in the past.

Stream Characteristics Upstream

The stream was surveyed immediately upstream from 124500 for approximately 200m then an adjacent road was walked to access the stream 1100m upstream of the crossing within an area comprised of swamp (Figure [??](#)). Within the area immediately upstream of Lawson Road, the stream had multiple braided channels flowing within beaver influenced wetland areas. Within the area surveyed, total cover amount was rated as moderate with small woody debris dominant. Cover was also present as large woody debris, undercut banks, deep pools, overhanging vegetation, and instream vegetation (Table [4.23](#)). The average channel width was 4.8m, the average wetted width was 4.1m and the average gradient was 0.8%. The dominant substrate was fines with gravels subdominant. At top end of the site, the beaver ponds had wetted widths of approximately 12-14m wide and estimated depths of 1m. Habitat value was rated as moderate for salmonid rearing with habitat noted as suitable for coho and cutthroat rearing.

Structure Remediation and Cost Estimate

Replacement of PSCIS crossing 124500 with a bridge (10m span) is recommended in the long term. The cost of the work is estimated at \$500,000 for a cost benefit of 18 linear m/\$1000 and $86.4\text{m}^2/\$1000$.

Conclusion

A conservative estimate of mainstem and major tributary habitat upstream of crossing 124500 is 9km. Habitat in the areas surveyed was rated as moderate value for salmonid rearing with habitat noted as particularly suitable for coho and cutthroat. Although classified as a “barrier” according to the provincial metric, the crossing is likely passable to adult salmonids during moderate flows. During low flow periods, water depths in the culverts may be an impediment to upstream passage for large adult fish. Lawson Road is the responsibility of the Ministry of Transportation and Infrastructure. The crossing was ranked as a low priority for proceeding to design for replacement.

Stream Characteristics Upstream

Table 4.21: Summary of fish passage assessment for PSCIS crossing 124500.

Location and Stream Data		Crossing Characteristics –	
Date	2020-08-31	Crossing Sub Type	Round Culvert
PSCIS ID	124500	Diameter (m)	1.5
External ID	–	Length (m)	14
Crew	KP, AI	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	627552	Resemble Channel	No
Northing	6058697	Backwatered	No
Stream	Helps Creek	Percent Backwatered	–
Road	Lawson Road	Fill Depth (m)	0.8
Road Tenure	MoTi local	Outlet Drop (m)	0
Channel Width (m)	3.6	Outlet Pool Depth (m)	1.3
Stream Slope (%)	2.5	Inlet Drop	No
Beaver Activity	Yes	Slope (%)	1
Habitat Value	Medium	Valley Fill	Deep Fill
Final score	21	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	10

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

Appendix - 124500 - Helps Creek

Comments: Wetland type habitat upstream with stream channel containing abundant gravels downstream.



Stream Characteristics Upstream

Table 4.22: Summary of fish passage assessment for PSCIS crossing 197666.

Location and Stream Data		.	Crossing Characteristics	–
Date	2020-08-29	Crossing Sub Type	Round Culvert	
PSCIS ID	197666	Diameter (m)	2	
External ID	2020083101	Length (m)	22	
Crew	AI, KP	Embedded	Yes	
UTM Zone	9	Depth Embedded (m)	0.15	
Easting	628108	Resemble Channel	Yes	
Northing	6059632	Backwatered	Yes	
Stream	Helps Creek	Percent Backwatered	100	
Road	CN Railway	Fill Depth (m)	1	
Road Tenure	Canadian National	Outlet Drop (m)	0	
Channel Width (m)	6	Outlet Pool Depth (m)	0.3	
Stream Slope (%)	0	Inlet Drop	No	
Beaver Activity	Yes	Slope (%)	0	
Habitat Value	High	Valley Fill	Deep Fill	
Final score	14	Barrier Result	Passable	
Fix type	–	Fix Span / Diameter	–	

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

Appendix - 124500 - Helps Creek

Comments: Passable and fully backwatered structure. Landowner reports that lamprey (~40cm x 20) at crossing inside of the culvert in the past.



Table 4.23: Summary of habitat details for PSCIS crossing 124500.

Site Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
124500 Upstream	1100	4.8	4.1	-	0.8	moderate	moderate
124500 Downstream	415	3.6	2.3	0.7	2.5	abundant	high

Stream Characteristics Upstream



Figure 4.13: Left: Habitat downstream of PSCIS crossing 124500. Right: Habitat downstream of crossing 124500 below the railway culverts.



Figure 4.14: Left: Habitat upstream of PSCIS crossing 124500. Right: Habitat upstream of PSCIS crossing 124500.

Appendix - 195290 & 195288 - Gibson Creek

Site Location

PSCIS crossing 195290 is located on Gibson Creek on Highway 16 approximately 10km south of Telkwa, BC. PSCIS crossing 195288 is also located on Gibson Creek on Schnider Road approximately 1.5km upstream of 195290. Both roads are the responsibility of the Ministry of Transportation and Infrastructure.

Background

Gibson Creek flows through an estimated 24ha of wetland type habitat into Deep Creek approximately 150m downstream of the crossing 195290. From the confluence with Gibson Creek, Deep Creek flows for approximately 1.5km to the Bulkley River. At the crossing location, Gibson Creek is a third order stream with a watershed area upstream of the highway of approximately 17.1km². The elevation of the watershed ranges from a maximum of 1300 to 575m at PSCIS crossing 195290. Gibson Creek is known to contain rainbow trout and cutthroat trout upstream of 195290 (MoE 2020a).

PSCIS stream crossings 195290 and 195288 were rated high priorities for follow up by both Irvine (2018) and Smith (2018) due to significant quantities of habitat suitable for salmonid rearing. A map of the watershed is provided in map attachment [093L.113](#).

Stream Characteristics at Crossing

Surveys were conducted with a remotely piloted aircraft immediately upstream and downstream of both crossings. The resulting images were stitched into orthomosaics and 3-dimensional models (4cm resolution) with models presented [here](#) and [here](#). Google earth model kmz files are downloadable [here](#) and [here](#).

Figure 4.15: Interactive 3D model of habitat immediately upstream and downstream of PSCIS crossing 195290.

Figure 4.16: Interactive 3D model of habitat immediately upstream and downstream of PSCIS crossing 195288.

At the time of the survey, the 195290 was un-embedded, non-backwatered and considered a barrier to upstream fish passage. The pipe was 0.8m in diameter with a pipe length of 0m, a culvert slope of 1.5%, a stream width ratio of 3 and an outlet drop of 0.66m (Table 4.24). Crossing 195288 on Schnider Road was also un-embedded, non-backwatered and ranked as a barrier to upstream fish passage. The pipe was 1.2m in diameter with a pipe length of 11m, a culvert slope of 1%, a stream width ratio of 2.5 and an outlet drop of 0.3m (Table 4.25). Water temperature was 13°C, pH was 7 and conductivity was 315uS/cm.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 150m to the confluence with Deep Creek (Figure ??). Overall, total cover amount was rated as abundant with overhanging vegetation dominant. Cover was also present as small woody debris, large woody debris, undercut banks, and instream vegetation (Table 4.26). The average channel width was 2.4m, the average wetted width was 2m and the average gradient was 1.7%. The dominant substrate was fines with gravels subdominant. Riparian vegetation consisted primarily of a well developed shrub layer and there were occasional pockets of small gravel present suitable for resident salmonid spawning. Habitat was rated as moderate as it was considered an important migration corridor with moderate value habitat for fry/juvenile salmonid rearing.

Stream Characteristics Upstream of 195290 and downstream of 195288

The stream was surveyed upstream from 195290 for 150m to where survey conditions became difficult due to the wetland type habitat (Figure ??). Immediately upstream of the crossing for approximately 50m, the riparian area is dominated by well developed shrub and mature primarily deciduous forest. Upstream of this location the riparian area transitions to dense shrub and grass with a narrow and deep channel influenced by beaver activity. Within the area surveyed, total cover amount was rated as abundant with overhanging vegetation dominant. Cover was also present as small woody debris, large woody debris, undercut banks, deep pools, and instream vegetation (Table 4.26). The average channel width was 2m, the average wetted width was 1.6m and the average gradient was 1.3%. Abundant gravels and small cobbles suitable for resident, fluvial, adfluvial and anadromous salmonid spawning were present throughout the area surveyed. Habitat value was rated as moderate for salmonid rearing and spawning.

Stream Characteristics Upstream of 195288

Gibson Creek was surveyed upstream from 195288 for 180m via remotely piloted vehicle as survey conditions were difficult due to the wetland type habitat present. Images acquired from the survey were stitched into an orthomosaic with stream habitat measurements estimated based on interpretation of the orthomosaic. The average channel width was estimated at 2m, the average wetted width was estimated at 2m and the average gradient was estimated at 0%. Habitat value was rated as moderate as it was considered an important migration corridor with moderate value habitat for fry/juvenile salmonid rearing.

Fish Sampling

To assess potential impacts of the culvert on fisheries values in the stream, electrofishing and minnowtrapping was conducted upstream and downstream of the crossing. A total of 14 fish were captured upstream with 25 fish captured downstream (Figure ??). Species captured downstream included coho, bull trout (or potentially dolly varden) and rainbow trout. Only rainbow trout were captured upstream. Electrofishing results are summarized in Tables 4.27 - Tables 4.28 and Figure 4.17 with minnowtrapping results summarized in Table 4.29.

Structure Remediation and Cost Estimate

Structure replacement with bridges for 195290 (19m span) and 195288 (10m span) are recommended to provide access to the habitat located upstream. An estimate of cost for replacement of 195290 is \$9,500,000 resulting in cost benefits of 0.1 linear m/\$1000 and $0.2\text{m}^2/\$1000$. An estimate of cost for replacement of 195288 is \$1,000,000 resulting in cost benefits of 4.5 linear m/\$1000 and $9\text{m}^2/\$1000$.

Conclusion

There is 1km of habitat upstream of crossing 195290 and downstream of PSCIS barrier culvert 195288. Upstream of 195288 there is another 1km of habitat modelled as <5% and containing wetland areas suitable for coho rearing. Habitat in the areas surveyed was rated as moderate value for salmonid rearing/spawning. Highway 16 and Schnider Road are the responsibility of the Ministry of Transportation and Infrastructure. Although the sample size is small, the presence of coho downstream of the crossing and absence of this species at sites upstream indicates that the crossing may be blocking upstream migration of this species. The large outlet drop at 195290 (0.66m), long pipe length (0m) and high stream width ratio (3) are good indicators that the crossing is likely not passable in an upstream direction by any species or lifestage. The crossings were ranked as high priorities for proceeding to design for replacement.

Table 4.24: Summary of fish passage assessment for PSCIS crossing 195290.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-04	Crossing Sub Type	Round Culvert
PSCIS ID	195290	Diameter (m)	0.8
External ID	–	Length (m)	0
Crew	KP, AI	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	640014	Resemble Channel	No

Appendix - 195290 & 195288 - Gibso...

Northing	6051697	Backwatered	No
Stream	Gibson Creek	Percent Backwatered	–
Road	Highway 16	Fill Depth (m)	6
Road Tenure	MoTi local	Outlet Drop (m)	0.66
Channel Width (m)	2.4	Outlet Pool Depth (m)	0.7
Stream Slope (%)	1.7	Inlet Drop	No
Beaver Activity	Yes	Slope (%)	1.5
Habitat Value	Medium	Valley Fill	Deep Fill
Final score	31	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	19
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Fish Sampling

Comments: Flows into Deep Creek downstream. Electrofished upstream and downstream. Wetland type habitat upstream with CO captured below only. Candidate for backwatering?



NO IMAGE AVAILABLE



Table 4.25: Summary of fish passage assessment for PSCIS crossing 195288.

Location and Stream Data	• Crossing Characteristics –
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Appendix - 195290 & 195288 - Gibso...

Date	2020-09-04	Crossing Sub Type	Round Culvert
PSCIS ID	195288	Diameter (m)	1.2
External ID	–	Length (m)	11
Crew	AI, KP	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	640899	Resemble Channel	No
Northing	6051559	Backwatered	No
Stream	Gibson Creek	Percent Backwatered	–
Road	Schnider Road	Fill Depth (m)	1.2
Road Tenure	MoTi highway	Outlet Drop (m)	0.3
Channel Width (m)	3	Outlet Pool Depth (m)	1.5
Stream Slope (%)	2	Inlet Drop	Yes
Beaver Activity	Yes	Slope (%)	1
Habitat Value	Medium	Valley Fill	Deep Fill
Final score	31	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	10
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Fish Sampling

Comments: Wetland type habitat upstream and downstream. Drone flight conducted upstream to map immediate area upstream.



Table 4.26: Summary of habitat details for PSCIS crossings 195290 and 195288.

Site Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
195288 Downstream	250	2.1	1.9	0.7	0.5	abundant	moderate
195288 Upstream	180	2	2	-	0	-	moderate
195290 Downstream	150	2.4	2	0.3	1.7	abundant	moderate

195290	Upstream	150	2	1.6	0.6	1.3	abundant	moderate
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Table 4.27: Electrofishing sites for PSCIS crossing 195290.

Site	Location	Width (m)	Length (m)	Area (m ²)	Effort (s)	Effort (s/m ²)
51	Downstream	1.8	8	14	42	3.0
50	Upstream	1.6	65	104	152	1.5
52	Upstream	2.8	16	45	71	1.6

Table 4.28: Densities of fish captured (fish/100m²) during electrofishing upstream and downstream of PSCIS crossing 195290.

Site	Location	Species	Fry	Parr	Juvenile
51	Downstream	CO	7.1	7.1	0
51	Downstream	RB	14.3	14.3	21.4
50	Upstream	RB	1	1	3.8
52	Upstream	RB	0	2.2	0

Fish Sampling

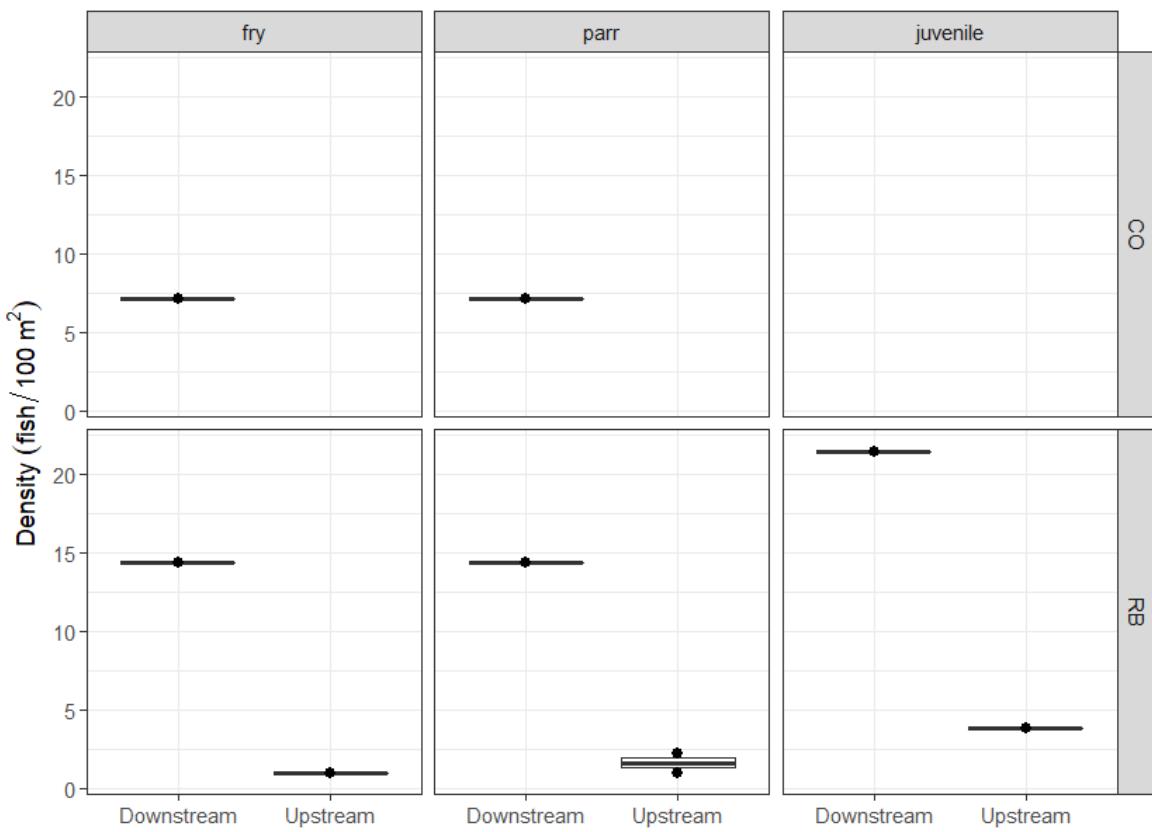


Figure 4.17: Densities of fish (fish/100m²) capture upstream and downstream of PSCIS crossing 195290.

Table 4.29: Fish captured in minnowtraps set overnight upstream and downstream of PSCIS crossing 195290.

Location	Species	fry	parr	adult	juvenile
Downstream	CO	6	1	0	0
Downstream	DV	0	0	1	0
Downstream	RB	1	7	0	0
Upstream	RB	0	1	0	6



Figure 4.18: Left: Typical habitat downstream of PSCIS crossing 195290. Right: Coho captured downstream of PSCIS crossing 195290.



Figure 4.19: Left: Typical habitat upstream of PSCIS crossing 195290. Right: Wetland habitat upstream of PSCIS crossing 195290.

Appendix - 197360 - Riddeck Creek

Site Location

PSCIS crossing 197360 is located on Riddeck Creek at km 47 of the Morice-Owen FSR accessed from Houston, BC. The Morice-Owen FSR is a forest tenure road and the responsibility of the BC Ministry of Forests, Lands, Natural Resource Operations & Rural Development (FLNR) - Nadina District. The area immediately to the south of the subject crossing is a conservation area managed by the Nature Trust of British Columbia.

Background

Riddeck Creek flows through an extensive area of wetland type habitat into the top end of Owen Lake approximately 1km downstream of the crossing. Owen Lake is drained by Owen Creek emptying into the Morice River approximately 20km to the north. At the crossing location, Riddeck Creek is a 4th order stream with a watershed area upstream of the highway of approximately 29km². The elevation of the watershed ranges from a maximum of 1140 to 750m at PSCIS crossing 197360. Riddeck Creek is known to contain longnose sucker and rainbow trout upstream of the subject culvert (MoE 2020a). On the north side of the upper watershed, at an elevation of 1160m, are the 25ha Neuch Lakes. The limit of fish distribution in the Riddeck Creek mainstem is documented by Bustard and ssociates Ltd. (1999) as a 6m high waterfall located 2.4km upstream of the FSR with the three main tributary systems classified as either non-fish bearing or fish bearing for only short distances (<200m) from the mainstem.

At the time of reporting, as an initiative of the Forest and Range Evaluation Program as well as the Bulkley Valley Research Centre, FLNR and the BC Ministry of Environment and Climate Change Strategy were undertaking a watershed status evaluation of the Owen Creek watershed (Pickard et al., n.d.). The evaluation uses remotely sensed and field based surveys to interpret the current functioning condition of the watershed as well as its possible future state as a result of continuing human and natural activities by ranking eight indicators of watershed pressure related to riparian health, fish passage and fine sediment delivery (Pickard et al. 2014; Porter et al. 2019).

PSCIS stream crossing 197360 was prioritized for follow up with a habitat confirmation through consultation with Lars Reese-Hansen (Aquatic Habitat Specialist, FLNR) and Don Morgan (Wildlife Habitat Specialist, MoE). They indicated (pers comm.) that following fish passage assessments in 2014 (implemented through watershed status evaluation field surveys throughout the Owen Creek watershed), Riddeck Creek upstream of the crossing contained the highest value habitat potentially blocked by a road-stream crossing barrier. A map of the watershed is provided in map attachment [093L.104.](#)

Stream Characteristics at Crossing

At the time of the survey, the culvert was un-embedded, non-backwatered and considered a barrier to upstream fish passage. The pipe was 1.2m in diameter with a pipe length of 27m, a culvert slope of 1%, a stream width ratio of 1.8 and an outlet drop of 0.24m (Table [4.30](#)). Water temperature was 15°C, pH was 6.8 and conductivity was 140uS/cm.

A survey was conducted with a remotely piloted aircraft immediately upstream and downstream of the crossing. The resulting images were stitched into a 3-dimensional model (4cm resolution) covering an area of approximatley 12ha presented [here] (https://www.mapsmadеeasy.com/maps/public_3D/421d3b7404d74cacad6471612260bb41/) and downloadable as a google earth kmz file [here](#).

Figure 4.20: Interactive 3D model of habitat immediately upstream and downstream of PSCIS crossing 197360.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 300m (Figure [??](#)). Overall, total cover amount was rated as moderate with overhanging vegetation dominant. Cover was also present as small woody debris, large woody debris, undercut banks, deep pools, and instream vegetation (Table [4.31](#)). The average channel width was 3.7m, the average wetted width was 3.2m and the average gradient was 1.1%. The dominant substrate was fines with gravels subdominant. A somewhat recent burn was noted within a forested area on left bank of stream. Habitat was rated as moderate as it was considered an important migration corridor with moderate value habitat for fry/juvenile salmonid rearing.

Stream Characteristics Upstream

The stream was surveyed upstream from 197360 for 1200m (Figure [??](#)). Immediately upstream of the crossing for a distance of approximately 150m is a beaver influenced wetland with a beaver dam structure located approximately 40m upstream of the road. Within the area surveyed, total cover amount was rated as moderate with deep pools dominant. Cover was also present as small woody debris, large woody debris, boulders, undercut banks, and overhanging vegetation (Table [4.31](#)). The average channel width was 3.3m, the average wetted width was 1.8m and the average gradient was 2.7%. Abundant gravels and small cobbles suitable for resident, fluvial, adfluvial and anadromous salmonid spawning were present throughout the area surveyed. Habitat value was rated as high for salmonid rearing and spawning.

Fish Sampling

PSCIS culvert 197669 was documented on Riddeck Creek, 1.2km upstream of the FSR and PSCIS crossing 197360. The culvert was un-embedded, non-backwatered and considered a barrier to upstream fish passage. The pipe was 1.25m in diameter with a pipe length of 6m, a culvert slope of 2%, a stream width ratio of 2.1 and an outlet drop of 0.45m (Table [4.32](#)).

Fish Sampling

To assess potential impacts of the culvert on fisheries values in the stream, electrofishing was conducted upstream and downstream of the crossing. Two sites were sampled upstream and one site was sampled downstream. A total of 14 rainbow trout captured upstream with 2 rainbow trout captured downstream. Raw results are included in digital format as [Attachment 2](#) and summarized in Tables [4.33 - 4.34](#) and Figure [4.23](#).

Structure Remediation and Cost Estimate

Structure replacement with a bridge (10m span) is recommended to provide access to the habitat located upstream of PSCIS crossing 197360. In addition to not facilitating high velocities and erosion due resulting from flow constriction, structures with large openings in relation to stream channel size have been demonstrated to reduce the likelihood of structure blockage due to beaver (Jensen et al. 2001). The cost of the work is estimated at \$125,000 for a cost benefit of 9.6 linear m/\$1000 and 31.7m²/\$1000.

Conclusion

There is 1.2km of habitat upstream of crossing 197360 and downstream of PSCIS barrier culvert 197669. Habitat in this area was rated as high value for salmonid rearing/spawning. Remediation of PSCIS culvert 197669 would facilitate fish passage to an additional 1.5km of habitat upstream of the area surveyed and should also be considered. Densities of rainbow trout fry captured at upstream sites were higher than the density of fish captured downstream however this may have been a result of habitat differences and difficult electrofishing conditions downstream including thick shrub overhead cover and areas deep water. Although only rainbow trout were captured both upstream and downstream the stream contains habitat likely suitable for spawning and rearing for other species including lamprey, burbot, coho salmon and others. In order to delineate pre-road channel locations/conditions and to inform the positioning of a replacement bridge, a pre-road hydrology assessment could be undertaken. Morice-Owen FSR is under tenure of the Ministry of Forests, Lands, Natural Resource Operations & Rural Development. The crossing was ranked as a high priority for proceeding to design for replacement.

Table 4.30: Summary of fish passage assessment for PSCIS crossing 197360.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-05	Crossing Sub Type	Round Culvert
PSCIS ID	197360	Diameter (m)	1.2
External ID	–	Length (m)	27
Crew	AI, KP	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	649936	Resemble Channel	No
Northing	5992406	Backwatered	No
Stream	Riddeck Creek	Percent Backwatered	–
Road	Morice-Owen FSR	Fill Depth (m)	2.5
Road Tenure	FLNR Nadina 9947	Outlet Drop (m)	0.24
Channel Width (m)	2.2	Outlet Pool Depth (m)	1.6
Stream Slope (%)	1.5	Inlet Drop	No
Beaver Activity	Yes	Slope (%)	1
Habitat Value	High	Valley Fill	Deep Fill
Final score	29	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	10

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

Fish Sampling

Comments: Wetland type habitat for first 300m upstream then 3m wide channel with cover available in all forms with pools suitable for juvenile RB and CO overwintering. Abundant gravels and small cobbles throughout suitable for CO or RB/ST spawning.



Table 4.31: Summary of habitat details for PSCIS crossing 197360.

Site Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
197360 Downstream	300	3.7	3.2	0.6	1.1	moderate	moderate
197360 Upstream	1200	3.3	1.8	0.4	2.7	moderate	high



Figure 4.21: Left: Typical habitat downstream of PSCIS crossing 197360. Right: Aerial view of typical habitat downstream of PSCIS crossing 197360.



Figure 4.22: Left: Typical habitat upstream of PSCIS crossing 197360. Right: Rainbow trout captured upstream of PSCIS crossing 197360.

Table 4.32: Summary of fish passage assessment for PSCIS crossing 197669.

Location and Stream Data	• Crossing Characteristics -
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Fish Sampling

Date	2020-09-05	Crossing Sub Type	Round Culvert
PSCIS ID	197669	Diameter (m)	1.25
External ID	14000079	Length (m)	6
Crew	AI, KP	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	650567	Resemble Channel	No
Northing	5993274	Backwatered	No
Stream	Riddeck Creek	Percent Backwatered	–
Road	Private	Fill Depth (m)	0.3
Road Tenure	unclassified	Outlet Drop (m)	0.45
Channel Width (m)	2.6	Outlet Pool Depth (m)	0.7
Stream Slope (%)	4	Inlet Drop	No
Beaver Activity	No	Slope (%)	2
Habitat Value	High	Valley Fill	Deep Fill
Final score	31	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	10
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Comments: Extensive rearing habitat and gravels suitable for spawning. Stream eventually flows into top end of Owen Lake.



Table 4.33: Electrofishing sites for PSCIS crossing 197360.

Site	Location	Width (m)	Length (m)	Area (m ²)	Effort (s)	Effort (s/m ²)
57	Downstream	2.0	9	18	94	5.2
55	Upstream	1.9	20	38	48	1.3

Fish Sampling

56 Upstream 2.0 10 20 33 1.6

Table 4.34: Rainbow trout densities (fish/100m²) for PSCIS crossing 197360.

Site	Location	Species	Fry	Juvenile
57	Downstream	RB	11.1	0
55	Upstream	RB	15.8	0
56	Upstream	RB	30	10

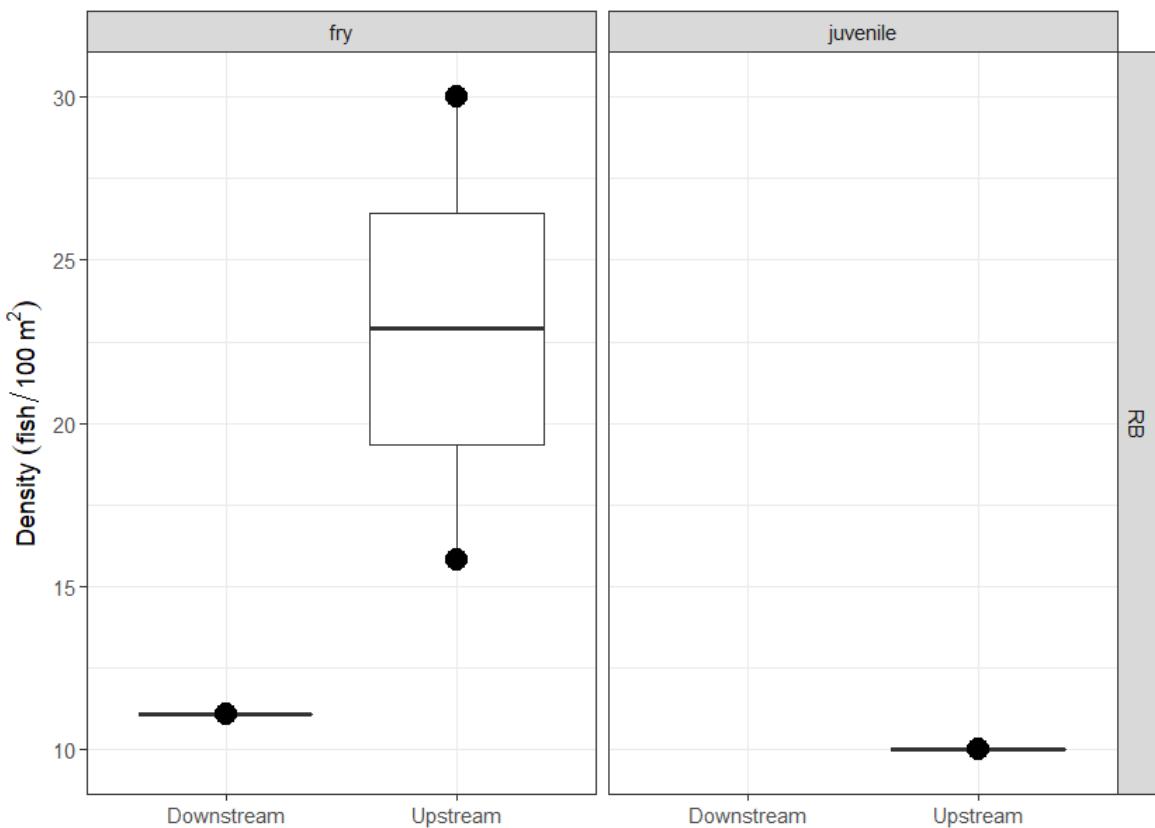


Figure 4.23: Densities of rainbow trout (fish/100m²) capture upstream and downstream of PSCIS crossing 197360.

Appendix - 197640 - Tributary to Buck Creek

Site Location

PSCIS crossing 197640 is located on a tributary to Buck Creek on Buck Flats Road approximately 18km south of Houston and immediately south of the Carrier FSR turn-off. The culvert is located approximately 70m upstream from the confluence with the Bulkley River. Buck Flats Road is a the responsibility of the B.C. Ministry of Transportation and Infrastructure.

Background

At crossing 197640, tributary to Buck Creek is a second order stream with a watershed area upstream of the crossing of approximately 23.9km² containing an estimated 129ha of wetland. The elevation of the watershed ranges from a maximum of 1460m to 820m at PSCIS crossing 197640. Upstream of Buck Flats Road, rainbow trout have been previously recorded as present. Chinook, coho and pink salmon noted as spawning downstream in Buck Creek (MoE 2020a; Wilson and Rabnett 2007; NCFDC 1998). Pink salmon have been noted as spawning in the first reach with coho spawners noted to Reach 3 and chinook spawners to Reach 5 where the subject tributary enters the mainstem (NCFDC 1998). DFO (1991) report that Buck Creek supports a small chinook population ranging from 12-100 spawners.

Three water temperature sensors have been deployed on the Buck Creek mainstem since 2016 (Westcott 2020). The closest water sensor to the subject stream is near the 9km mark of Buck Flats Road approximately 100m upstream of the bridge on the left bank cabled to alder in run habitat (UTM: 9U.653072.6019700). The sensor has been gathering water temperature data at 1hour intervals since 2017 with data available through the Skeena Salmon Data Centre (DFO/FLNRO 2019a).

There are multiple tributaries entering the mainstem of the subject stream upstream of crossing 197640 containing numerous modelled road stream crossings however these tributaries are not expected to contain valuable habitats due to the small size of their contributing watersheds.

PSCIS stream crossing 197640 was ranked as a high priority for follow up following 2020 Phase 1 - fish passage assessments that targeted all major streams in the Buck Creek watershed. Crossing 197640 was noted as located on the stream with the highest value habitat in the watershed that was potentially blocked to anadromous species by a road-stream crossing structure. A map of the watershed is provided in map attachment [093L.109](#).

Stream Characteristics at Crossing

At the time of the survey, the culvert under Buck Flats Road was un-embedded, non-backwatered and ranked as a barrier to upstream fish passage according to the provincial protocol (MoE 2011). The pipe was 1.5m in diameter with a length of 12m, a culvert slope of 1.5%, a stream width ratio of 3.4 and an outlet drop of 0.4m (Table [4.35](#)). Water temperature was 10°C, pH was 7.6 and conductivity was 226uS/cm.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 70m to the confluence with Buck Creek (Figure [??](#)). 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 (Table [4.37](#)). The average channel width was 4.6m, the average wetted width was 2.5m and the average gradient was 3%. The dominant substrate was gravels with cobbles subdominant. A fish (130mm) was observed in the culvert outlet pool and a substance suspected to be didymo was noted on the substrate. The habitat was rated as moderate value as it was considered an important migration corridor with habitat suitable for fry and juvenile salmonid rearing.

Stream Characteristics Upstream

The stream was surveyed immediately upstream from 197640 for approximately 535m (Figure [??](#)). Within the area surveyed, total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, large woody debris, boulders, deep pools, and overhanging vegetation (Table [4.37](#)). The average channel width was 4.4m, the average wetted width was 2.2m and the average gradient was 2.5%. The dominant substrate was cobbles with boulders subdominant. Rare pockets of gravel suitable for spawning resident, fluvial and anadromous salmonids were noted. The stream appeared to be aggraded with side bars common. One salmonid (110mm) was observed just upstream of Buck Flats Road. Habitat value was rated as moderate value with moderate rearing potential for fry and juvenile salmonids.

One crossing (PSCIS 197647) was assessed on an upstream tributary crossed by the Carrier FSR (Table [4.36](#)). This tributary that enters the subject stream approximately 3.3km upstream of 197640, was dry at the time of the survey and did not provide any viable fish habitat. Numerous fish inventory sample sites were located downstream of the location of 197647 within the adjacent tributary to the subject stream with no fish observations recorded in two seasons of sampling (MoE 2020c).

Structure Remediation and Cost Estimate

Replacement of PSCIS crossing 197640 with a bridge (10m span) is recommended. The cost of the work is estimated at \$NA for a cost benefit of NA linear m/\$1000 and NAm²/\$1000.

Conclusion

Conclusion

A conservative estimate of mainstem habitat upstream of crossing 197640 is 4.2km to the top end of a 71ha wetland where rainbow trout have been recorded. Habitat in the areas surveyed upstream of the culvert were rated as moderate value for salmonid rearing with areas of wetland habitat likely suitable for rainbow trout, coho and steelhead rearing. Buck Flats Road is the responsibility of the Ministry of Transportation and Infrastructure. The crossing was ranked as a high priority for proceeding to design for replacement.

Table 4.35: Summary of fish passage assessment for PSCIS crossing 197640.

Location and Stream Data	•	Crossing Characteristics –	
Date	2020-09-26	Crossing Sub Type	Round Culvert
PSCIS ID	197640	Diameter (m)	1.5
External ID	–	Length (m)	12
Crew	AI, KP	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	654312	Resemble Channel	No
Northing	6012383	Backwatered	No
Stream	Tributary to Buck Creek	Percent Backwatered	–
Road	Buck Flats Road	Fill Depth (m)	1
Road Tenure	MoTi local	Outlet Drop (m)	0.4
Channel Width (m)	5.1	Outlet Pool Depth (m)	1.2
Stream Slope (%)	3	Inlet Drop	No
Beaver Activity	No	Slope (%)	1.5
Habitat Value	High	Valley Fill	Deep Fill
Final score	31	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	10
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Comments: Large tributary on section of tributary connected to salmon bearing Buck Creek. Fish rising in outlet pool (estimated 130mm). Some cattle access points downstream.



NO IMAGE AVAILABLE



NO IMAGE AVAILABLE



Conclusion

Table 4.36: Summary of fish passage assessment for PSCIS crossing 197647.

Location and Stream Data	•	Crossing Characteristics	-
Date	2020-08-26	Crossing Sub Type	Round Culvert
PSCIS ID	197647	Diameter (m)	1
External ID	1804986	Length (m)	16
Crew	KP, AI	Embedded	No
UTM Zone	9	Depth Embedded (m)	-
Easting	651263.5	Resemble Channel	No
Northing	6012508	Backwatered	No
Stream	Tributary to Buck Creek	Percent Backwatered	-
Road	Carrier FSR	Fill Depth (m)	1.8
Road Tenure	FLNR Nadina 9772	Outlet Drop (m)	0.3
Channel Width (m)	1.5	Outlet Pool Depth (m)	0
Stream Slope (%)	2	Inlet Drop	No
Beaver Activity	No	Slope (%)	1.5
Habitat Value	Low	Valley Fill	Deep Fill
Final score	34	Barrier Result	Barrier
Fix type	Replace Structure with Streambed Simulation CBS	Fix Span / Diameter	3

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

Appendix - 197640 - Tributary to Buck...

Comments: Suspect no fish. Multiple fish survey sites located downstream. Dry at time of survey.



Table 4.37: Summary of habitat details for PSCIS crossing 197640.

Site	Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
197640	Downstream	70 4.6	2.5	—	3	moderate	moderate	
197640	Upstream	535 4.4	2.2	0.3	2.5	moderate	moderate	

Conclusion



Figure 4.24: Left: Habitat downstream of PSCIS crossing 197640. Right: Habitat downstream of crossing 197640 at the confluence with Buck Creek.



Figure 4.25: Left: Habitat upstream of PSCIS crossing 197640. Right: Habitat upstream of PSCIS crossing 197640.

Appendix - 197658 - Byman Creek

Site Location

PSCIS crossing 197658 is located on Byman Creek on Highway 16 approximately 20km east of Houston, BC with the crossing located approximately 2.5km upstream from the confluence with the Bulkley River. Highway 16 is the responsibility of the Ministry of Transportation and Infrastructure.

Background

At crossing 197658, Byman Creek is a fifth order stream with a watershed area upstream of the crossing of approximately 89.9km². The elevation of the watershed ranges from a maximum of 1240 to 680m at PSCIS crossing 197658. Upstream of the highway, coho, steelhead, rainbow trout, longnose dace, redside shiner, longnose sucker and largescale sucker have been previously recorded as present (MoE 2020a). Chinook, coho and steelhead have been noted as spawning in Byman Creek with chinook documented as present up to the highway culvert only (Gottesfeld, Rabnett, and Hall 2002; DFO 1991). A bridge (PSCIS 197660) is located on the stream under the railway approximately 1.3km downstream. Although there are numerous crossings modelled upstream, a series of three impassable waterfalls are located approximately 6km upstream of the highway (pers. comm. Jonathan Van Barneveld, Forester - FLNR). There are only two modelled crossings (1800233, 1801084) located on a small tributary entering the mainstem below the falls.

In the summer of 1998, the Nadina Community Futures Development Corporation (NCFDC) contracted the British Columbia Conservation Foundation to carry out a detailed Level 1 Fish, Fish Habitat and Riparian Assessment in the first reach of Byman Creek as well as several other large Upper Bulkley River tributary streams and the Upper Bulkley mainstem. The area surveyed extended to 4.2km from the mouth covering 2.5km of habitat upstream of the culvert (NCFDC 1998). Building on these assessments and detailed fish sampling, NCFDC (1998) developed restoration prescriptions for the lower reaches of the Byman Creek. Prescriptions were developed to address what the authors termed moderately to severely disturbed habitat, which comprised 90% of the area surveyed. Impacts included extensive bars, elevated mid-channel bars, minimal pool frequency, eroding banks, abandoned channels, and poor LWD function due to:

- straightening/diversion of main channel below Highway 16.
- loss of riparian forest and soil compaction in areas used for agriculture, the powerline corridor, transportation corridors and at housing developments within the floodplain.
- loss of the shrub/herb layer and soil compaction from cattle grazing where overstory still present.
- removal of large woody debris which controls lateral channel movement and plant community distribution on the floodplain.

Overall, NCFDC (1998) report that, in an unimpacted state, the first reach of Byman Creek (including the 2.5km upstream of the culvert) is a critical and productive area for spawning and rearing particularly for coho and steelhead. They also note that the area may be an important area for chinook salmon summer rearing and summer/fall spawning habitat as it contains larger substrate, greater foraging opportunities, greater channel complexity and cooler temperatures than present in the adjacent Bulkley mainstem. The proximity of the reach to the mainstem provides easy access to overwintering habitat, mainstem rearing areas for older juvenile salmonids and options for refuge during high flow events. Detailed prescriptions for restorative measures that address noted impacts are documented in NCFDC (1998).

Overwintering studies using minnowtrapping were conducted downstream of the highway culvert between 2005 and 2009 with coho and rainbow trout/steelhead captured. Results are summarized in Donas and Newman (2006), Donas and Newman (2007), Donas and Newman (2008) and Donas and Newman (2010). During these assessments, fry were observed actively migrating up through the culvert (pers comm Cindy Verbeek, Upper Bulkley Streamkeepers).

PSCIS stream crossing 197658 was ranked as a high priority for follow up by Smith (2018) and was assessed as a barrier to upstream migration during low flows (low water depth) by McCarthy and Fernando (2015). In 2007, Wilson and Rabnett (2007) assessed the site reported that fish passage at 197658 was not hindered by the culverts at that time although they were not using the assessment protocol standardized by the Fish Passage Technical Working Group (MoE 2011). A map of the watershed is provided in map attachment [093L.114](#).

Stream Characteristics at Crossing

At the time of the survey, the culvert under Highway 16 was un-embedded, non-backwatered and ranked as a barrier to upstream fish passage according to the provincial protocol (MoE 2011). The pipe was 4m in diameter with a length of 24m, a culvert slope of 4%, a stream width ratio of 2.8 and an outlet drop of 2m (Table [4.38](#)). Water temperature was 12°C, pH was 7.9 and conductivity was 103uS/cm.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 300m beginning at the culvert location and then for another 330m downstream of the railway bridge (Figure [??](#)).

In the area immediately below the culvert, total cover amount was rated as trace with large woody debris dominant. Cover was also present as small woody debris (Table [4.39](#)). The average channel width was 11.2m, the average wetted width was 9.8m and the average gradient was 1.2%. The dominant substrate was cobbles with gravels subdominant. Within the area surveyed, the channel flowed through cattle rangeland and appeared to be straightened with low complexity. Cattle impacts were evident on both banks with grazing of riparian vegetation evident. There was minimal

Stream Characteristics Upstream

cover available with no pools, and extensive riffles. The habitat was rated as moderate value as it was considered an important migration corridor and because the larger substrate could provide important fry rearing habitat, particularly in low velocities margins.

Below the railway bridge, the habitat was noted as far more complex than the area immediately below the highway culvert. Total cover amount was rated as abundant with overhanging vegetation dominant. Cover was also present as small woody debris, large woody debris, undercut banks, and deep pools. The average channel width was 8.6m, the average wetted width was 7.5m and the average gradient was 0.8%. The dominant substrate was cobbles with gravels subdominant. There were extensive sections of channel with deep glides (50-70 cm deep at the time of survey) with well developed riparian vegetation creating good structure for all species and life stages of salmonids. An algae layer was noted on the substrate. There were abundant large gravels and small cobbles present suitable for salmon spawning.

Stream Characteristics Upstream

The stream was surveyed upstream from 197658 for 1400m (Figure ??). Within the area surveyed, total cover amount was rated as moderate with deep pools dominant. Cover was also present as small woody debris, large woody debris, boulders, undercut banks, and overhanging vegetation (Table 4.39). The average channel width was 12.9m, the average wetted width was 7.9m and the average gradient was 2.1%. The dominant substrate was cobbles with boulders subdominant. Within the area surveyed, riparian areas adjacent to both banks were used as rangeland with several cattle access points on the stream and evidence of understory shrub degradation from cattle grazing. The large stream had high habitat complexity including numerous pools up to 2m deep and frequent glide sections to 1m deep throughout. There were also extensive areas of gravel suitable for spawning for resident and anadromous species. Habitat value was rated as high for salmonid rearing and spawning.

Fish Sampling

Minnowtrapping was conducted with three traps set overnight upstream as well as downstream of the crossing. A total of 5 coho and 6 rainbow trout were captured downstream with 1 coho and 9 rainbow trout captured upstream (Table 4.40 and (Figure 4.28).

Structure Remediation and Cost Estimate

Structure replacement with a bridge (15.1m span) is recommended to provide access to the habitat located upstream of PSCIS crossing 197658. The cost of the work is estimated at \$7,550,000 for a cost benefit of 0.8 linear m/\$1000 and 10.3m²/\$1000.

Conclusion

There is 6km of habitat upstream of crossing 197658. Habitat in this area was rated as high value for salmonid rearing/spawning. The crossing may present a barrier not only to fry and juvenile salmonids at moderate and high flow velocities, but also due to shallow water depths when adult salmon potentially migrate upstream to spawn during low flows. Restoration of riparian forests, cattle exclusion, bank stabilization and habitat complexing could be considered alongside fish passage restoration activities. Highway 16 is the responsibility of the Ministry of Transportation and Infrastructure. The crossing was ranked as a high priority for proceeding to design for replacement.

Conclusion

Table 4.38: Summary of fish passage assessment for PSCIS crossing 197658.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-08-27	Crossing Sub Type	Oval Culvert
PSCIS ID	197658	Diameter (m)	4
External ID	-	Length (m)	24
Crew	AI, KP	Embedded	No
UTM Zone	9	Depth Embedded (m)	-
Easting	666847.2	Resemble Channel	No
Northing	6044305	Backwatered	No
Stream	Byman Creek	Percent Backwatered	-
Road	Highway 16	Fill Depth (m)	1.6
Road Tenure	MoTi highway	Outlet Drop (m)	2
Channel Width (m)	11.1	Outlet Pool Depth (m)	3.8
Stream Slope (%)	1.2	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	4
Habitat Value	High	Valley Fill	Deep Fill
Final score	39	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	15.1

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

Appendix - 197658 - Byman Creek

Comments: Culvert is likely as passable for most species and life stages at most non-peak and non-lowest flows. Streamkeepers have observed fry moving through culvert in overwintering studies.



Table 4.39: Summary of habitat details for PSCIS crossing 197658.

Site	Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
197658	Upstream	1400	12.9	7.9	0.6	2.1	moderate	high
197658	Downstream	330	8.6	7.5	0.9	0.8	abundant	high
197658	Downstream	300	11.2	9.8	—	1.2	trace	moderate

Conclusion

Table 4.40: Fish captured in minnowtraps set overnight upstream and downstream of PSCIS crossing 197658.

Location	Species	fry	parr	juvenile
Downstream	CO	5	0	0
Upstream	CO	1	0	0
Downstream	RB	2	4	0
Upstream	RB	1	5	3



Figure 4.26: Left: Typical habitat immediately downstream of PSCIS crossing 197658. Right: Typical habitat downstream of crossing 197658 below the railway bridge and adjacent to the Bulkley River mainstem.

Appendix - 197658 - Byman Creek



Figure 4.27: Left: habitat upstream of PSCIS crossing 197658. Right: Habitat upstream of PSCIS crossing 197658.



Figure 4.28: Left: Coho captured downstream of PSCIS crossing 197658. Right: Coho captured upstream of PSCIS crossing 197658.

Appendix - 197662 - Richfield Creek

Site Location

PSCIS crossing 197662 is located on Richfield Creek on Highway 16 approximately 30km east of Houston, BC with the highway located approximately 1km upstream from the confluence with the Bulkley River. Highway 16 is the responsibility of the Ministry of Transportation and Infrastructure.

Background

Richfield Creek drains one of the largest tributary watersheds in the upper Bulkley River. At crossing 197662, Richfield Creek is a fifth order stream with a watershed area upstream of the crossing of approximately 161.3km². The elevation of the watershed ranges from a maximum of 1660 to 680m at PSCIS crossing 197662. Upstream of the highway, Richfield Creek is known to contain coho, chinook, steelhead, rainbow trout, longnose dace and longnose sucker (MoE 2020a). Steelhead, coho and chinook spawning has been noted in the downstream reaches of the stream with historical escapements ranging from 0-100 spawners in the reach adjacent to the Bulkley River confluence (Gottesfeld, Rabnett, and Hall 2002; Hancock, Leaney-East, and Marshall 1983). Gottesfeld, Rabnett, and Hall (2002) note that in some years during low flow conditions, Richfield is partially dewatered and impassable to fish. A bridge (modelled crossing 1805593) is located under the railway approximately 830m downstream of the crossing which is reported by Wilson and Rabnett (2007) to constrict the channel. Although numerous modelled crossings are located upstream of the highway an impassable waterfall is located approximately 2km upstream of the highway (pers. comm. Jonathan Van Barneveld, Forester - FLNR).

In the summer of 1998, the Nadina Community Futures Development Corporation (NCFDC) contracted the British Columbia Conservation Foundation to carry out a detailed Level 1 Fish, Fish Habitat and Riparian Assessment in the first two reaches of Richfield Creek as well as several other large Upper Bulkley River tributary streams and the Upper Bulkley mainstem. The area surveyed extended to approximately 2km upstream of the culvert where an 18m high waterfall is located (NCFDC 1998). Building on these assessments and detailed fish sampling, NCFDC (1998) developed restoration prescriptions for the lower reaches of the watershed based on the following assessment of impacts:

- loss of riparian forest and soil compaction in areas used for agriculture, the powerline corridor, transportation corridors and at housing developments within the floodplain.
- loss of the shrub/herb layer and soil compaction from cattle grazing where overstory still present.
- removal of large woody debris which controls lateral channel movement and plant community distribution on the floodplain.

Overall, NCFDC (1998) report that, in an unimpacted state, the first reach of Richfield Creek (including the 2.5km upstream of the culvert) is a critical and productive area for spawning and

rearing particularly for coho and steelhead. They also note that the area may be an important area for chinook salmon summer rearing and summer/fall spawning habitat as it contains larger substrate, greater foraging opportunities, greater channel complexity and cooler temperatures than present in the adjacent Bulkley mainstem. The proximity of the reach to the mainstem provides easy access to overwintering habitat, mainstem rearing areas for older juvenile salmonids and options for refuge during high flow events. Detailed prescriptions for restorative measures that address noted impacts are documented in NCFDC (1998).

Overwintering studies using minnowtrapping were conducted downstream of the highway culvert between 2006 and 2009 with coho, rainbow trout/steelhead and northern pikeminnow captured. Results are summarized in Donas and Newman (2007), Donas and Newman (2008) and Donas and Newman (2010).

A water temperature monitoring station has been operational on Richfield Creek just upstream of the highway since November 2014 with results presented in Westcott (2020). Westcott (2020) also reports that a continuous water level and temperature monitoring station is proposed on the stream.

Although in 2007, Wilson and Rabnett (2007) reported that fish passage at 197662 was not hindered by the culverts at that time the site was rated as a priority for follow up following background review and a Phase 1 assessment in 2020 indicating that the crossing was not passable according to provincial metrics and due to the presence of significant quantities of upstream habitat suitable for salmonid rearing and spawning. A map of the watershed is provided in map attachment [093L.115](#).

Stream Characteristics at Crossing

At the time of the survey, the two culverts under Highway 16 were un-embedded, non-backwatered and considered a barrier to upstream fish passage. The pipes were 4.2m in diameter with lengths of 24m, a culvert slope of 2%, a stream width ratio of 3 and an outlet drop of 0.2m (Table [4.41](#)). Water temperature was 11°C, pH was 7.8 and conductivity was 80uS/cm.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 300m (Figure [??](#)). Overall, 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 (Table [4.42](#)). The average channel width was 12.5m, the average wetted width was 8.8m and the average gradient was 1.5%. The dominant substrate was cobbles with gravels subdominant. There were unembedded gravels and cobbles suitable for spawning present throughout.

Stream Characteristics Upstream

Immediately downstream of the culverts for approximately 80m, channel structure was simplified, with armoured banks, no pools and high flow velocities out of crossing structure pipes. Further downstream, the channel flows through a residential area with some deep pools and glides to over 1m deep. Riparian vegetation is comprised of a narrow band of mature cottonwood forest with some areas lacking treed riparian near houses. There was evidence of large woody debris removal from channel (chainsaw cut logs in the stream) and some stream corners were armoured with rock, concrete and old vehicles. Habitat was rated as high as it was considered an important migration corridor with moderate value habitat for fry/juvenile salmonid rearing.

Stream Characteristics Upstream

The stream was surveyed upstream from 197662 for 1200m (Figure ??). Within the area surveyed, 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 (Table 4.42). The average channel width was 13.2m, the average wetted width was 9m and the average gradient was 2.1%. The dominant substrate was gravels with cobbles subdominant. Within the area surveyed, riparian areas adjacent to both banks were used as rangeland with several cattle access points on the stream and evidence of understory shrub degradation from cattle grazing. There was a debris jam (up to 1m high in places) located just upstream. The large stream had high habitat complexity including numerous pools up to 2m deep and frequent glide sections to 1m deep throughout. There were also extensive areas of gravel suitable for spawning for resident and anadromous species. Robert Hatch Creek enters the main channel approximately 400m upstream of the culvert and was comprised of beaver influenced wetland type habitat adjacent to Richfield Creek. Habitat value was rated as high for salmonid rearing and spawning.

Fish Sampling

Minnowtrapping was conducted with three traps set overnight upstream as well as downstream of the crossing. A total of 6 coho and 8 rainbow trout were captured downstream. Only rainbow trout (8 fish) were captured upstream (Table 4.43 and (Figure 4.31).

Structure Remediation and Cost Estimate

Structure replacement with a bridge (16.5m span) is recommended to provide access to the habitat located upstream of PSCIS crossing 197662. The cost of the work is estimated at \$8,250,000 for a cost benefit of 0.2 linear m/\$1000 and 3.2m²/\$1000.

Conclusion

There is 2km of habitat upstream of crossing 197662. Habitat in the area surveyed upstream of the crossing was rated as high value for salmonid rearing/spawning. The crossing may present a barrier

not only to fry and juvenile salmonids due to the small outlet drop and high flow velocities within the pipes but also to adult salmon potentially migrating upstream to spawn during low flows due to shallow water depths. Electrofishing upstream and downstream of the crossing is recommended to provide presence/absence as well as density data for chinook salmon, coho salmon and other species. Highway 16 is the responsibility of the Ministry of Transportation and Infrastructure and was ranked as a high priority for proceeding to design for replacement.

Table 4.41: Summary of fish passage assessment for PSCIS crossing 197662.

Location and Stream Data	.	Crossing Characteristics –	
Date	2020-08-28	Crossing Sub Type	Round Culvert
PSCIS ID	197662	Diameter (m)	4.2
External ID	–	Length (m)	24
Crew	KP, AI	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	672404.7	Resemble Channel	No
Northing	6044146	Backwatered	No
Stream	Richfield Creek	Percent Backwatered	–
Road	Highway 16	Fill Depth (m)	1
Road Tenure	MoTi highway	Outlet Drop (m)	0.2
Channel Width (m)	12.5	Outlet Pool Depth (m)	1
Stream Slope (%)	1.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	2
Habitat Value	High	Valley Fill	Deep Fill
Final score	29	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	16.5
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Stream Characteristics Upstream

Comments: Habitat confirmation and minnowtrapping completed.



Table 4.42: Summary of habitat details for PSCIS crossing 197662.

Site	Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
197662	Upstream	1200	13.2	9	0.8	2.1	moderate	high
197662	Downstream	300	12.5	8.8	0.8	1.5	moderate	high

Table 4.43: Fish captured in minnowtraps set overnight upstream and downstream of PSCIS crossing 197662.

Location	Species	fry	parr	juvenile
Downstream	CO	5	1	0
Downstream	RB	2	4	2
Upstream	RB	4	3	1



Figure 4.29: Left: Typical habitat downstream of PSCIS crossing 197662. Right: Typical habitat downstream of PSCIS crossing 197662.

Stream Characteristics Upstream



Figure 4.30: Left: Gravel and cobble substrate upstream of PSCIS crossing 197662. Right: Typical habitat upstream of PSCIS crossing 197662.



Figure 4.31: Left: Coho captured downstream of PSCIS crossing 197662. Right: Rainbow trout captured upstream of PSCIS crossing 197662.

Appendix - 197663 & 3054 - Johnny David Creek

Site Location

PSCIS crossing 197663 is located on Johnny David Creek on Highway 16 approximately 25km east of Houston, BC with the highway located approximately 1km upstream from the confluence with the Bulkley River. Highway 16 is the responsibility of the Ministry of Transportation and Infrastructure.

PSCIS crossing 3054 is located on North road at km 42.4 approximately 10km upstream of Highway 16. North road is the responsibility of FLNR - Nadina Forest District.

Background

The Johnny David Creek creek watershed upstream of the highway is approximately 43.5km² in area with an estimated 91ha of wetland documented upstream. At the highway, (575m of elevation) Johnny David Creek is a fourth order stream with a maximum watershed elevation of 1300. Fish documented as present downstream of 197663 include coho, chinook, cutthroat, dolly varden, steelhead and rainbow trout (MoE 2020a). Upstream of the crossing, only rainbow trout have been previously documented. One road stream crossing structure is modelled as present approximately 3km upstream of the highway (modelled crossing id 1802089).

The Johnny David Creek creek watershed upstream of 3054 is approximately 13km² in area with an estimated 71ha of wetland documented upstream. The stream is third order at this location with rainbow trout documented as present upstream (MoE 2020a).

Wilson and Rabnett (2007) recommended that PSCIS crossing 197663 be a high priority for remedial works to backwater the crossing by establishing a series of pools to step up to the outfall pool. A rehabilitation design was prescribed by Gaboury and Smith (2016). Smith (2018) reported that in 2017, the Wet'suwet'en First Nation - Yinka Dene Economic Development Limited Partnership Inc. and LGL Limited constructed three rock riffles and berms on both banks to backwater the stream and raise the outlet pool water level to above the elevation of the base of the culvert.

PSCIS stream crossing 3054 was rated a moderate priority for follow up by Irvine (2018) as it was rated as having moderate value habitat by Casselman and Stanley (2010) and due to significant quantities of stream and wetland habitat modelled upstream. A map of the watershed is provided in map attachment [093L.115](#).

Stream Characteristics at Crossings 197663 and 3054

At the time of the survey, the 197663 on Highway 16 was un-embedded, non-backwatered and considered a barrier to upstream fish passage according to the provincial protocol. The pipe was 1.75m in diameter with a length of 25m, a culvert slope of 2%, a stream width ratio of 3.6 and an outlet drop of 0m (Table 4.44). The inlet of the culvert was damaged with the metal folded up by incoming debris. Water temperature was 11°C, pH was 8.1 and conductivity was 186uS/cm.

Crossing 3054 on North road was also un-embedded, non-backwatered and again ranked as a barrier to upstream fish passage. The pipe was 3m in diameter with a length of 40m, a culvert slope of 2%, a stream width ratio of 1.2 and an outlet drop of 0.76m (Table 4.45). Water temperature was 10°C, pH was 7.5 and conductivity was 85uS/cm.

Stream Characteristics Downstream of 197663

The stream was surveyed downstream from the culvert for 300m (Figure ??). Overall, total cover amount was rated as moderate with large woody debris dominant. Cover was also present as small woody debris, undercut banks, deep pools, and overhanging vegetation (Table 4.46). The average channel width was 5.3m, the average wetted width was 3.3m and the average gradient was 2.6%. The dominant substrate was cobbles with boulders subdominant. Abundant gravels suitably sized for coho, rainbow and steelhead spawning were present. Habitat was rated as high as it was considered an important migration corridor with moderate value habitat for fry/juvenile salmonid rearing.

Stream Characteristics Upstream of 197663 and downstream of 3054

The stream was surveyed upstream from 197663 for 690m (Figure ??). Within the area surveyed, total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, large woody debris, boulders, deep pools, and overhanging vegetation (Table 4.46). The average channel width was 6.6m, the average wetted width was 4.4m and the average gradient was 3%. Abundant gravels and small cobbles suitable for resident, fluvial, adfluvial and anadromous salmonid spawning were present throughout the area surveyed. Habitat value was rated as high for salmonid rearing and spawning.

The stream was surveyed downstream from 3054 for 300m (Figure ??). Within the area surveyed, total cover amount was rated as abundant with undercut banks dominant. Cover was also present as small woody debris, large woody debris, overhanging vegetation, and instream vegetation (Table 4.46). The average channel width was 3.5m, the average wetted width was 2.3m and the average gradient was 3.3%. Some pockets of gravels suitable for resident and anadromous (if present) salmonids were present throughout the area surveyed. Stream gradients were steepest immediately below the FSR then leveled off with a series of three beaver dams. No deep pools were observed downstream of the beaver influenced areas. Habitat value was rated as moderate as it was

considered an important migration corridor containing suitable spawning habitat with moderate rearing potential for resident adult or fry/juvenile anadromous salmonid rearing and spawning.

Stream Characteristics Upstream of 3054

Johnny David Creek was surveyed upstream from 3054 for 725m until an area of wetland type habitat (Figure ??). The stream winds through a canyon section for approximately 300m after the first 100m of beaver influenced wetland located directly upstream of the culvert. Within the area surveyed, total cover amount was rated as moderate with large woody debris dominant. Cover was also present as small woody debris, undercut banks, deep pools, and overhanging vegetation (Table 4.46). The average channel width was 2.6m, the average wetted width was 2.1m and the average gradient was 5.3%. Substrate was noted as colored black from periphyton with pockets of gravel suitable for resident (~20cm) salmonids present. A fish observed (~150mm long) was observed above the culvert approximately 100m. Habitat value was rated as moderate for younger life stages of fluvial and anadromous salmonid rearing and resident adult salmonid spawning.

Fish Sampling

To assess potential impacts of the culvert on fisheries values in the stream, electrofishing and minnowtrapping was conducted upstream and downstream of 197663. A total of 30 fish were captured upstream with 60 fish captured downstream (Figure ??). Species captured downstream included coho and rainbow trout with coho, rainbow trout and mountain whitefish captured upstream. Electrofishing results are summarized in Tables 4.47 - 4.48 and Figure 4.32 with minnowtrapping results summarized in Table 4.49.

Structure Remediation and Cost Estimate

Structure replacement with bridges for 197663 (10.3m span) and 3054 (31m span) are recommended to provide access to the habitat located upstream. An estimate of cost for replacement of 197663 is \$5,150,000 resulting in cost benefits of 1.9 linear m/\$1000 and 12.8m²/\$1000. An estimate of cost for replacement of 3054 is \$388,000 resulting in cost benefits of 19.3 linear m/\$1000 and 50.3m²/\$1000.

Conclusion

Although no natural barriers to upstream passage are documented within provincial databases on Johnny David Creek upstream of the highway, large waterfalls have been documented within adjacent streams on both sides (Byman Creek and Richfield Creek pers. comm. Jonathan Van Barneveld, Forester - FLNR) at points approximately 6km upstream from the highway. For this reason, there is potential that there exists a natural barrier to fish passage within Johnny David Creek within this same band of slope. Although, the stream was not surveyed at the location of a modelled road stream crossing approximately 3km upstream of the highway (modelled crossing id 1802089), it is suspected that the crossing is not present as the roads in the area appear old and un-maintained in aerial imagery. Future assessment to scope for a natural barrier at approximately

6km above the highway and to assess the stream at the location of modelled crossing 1802089 is recommended.

There is 10km of mainstem habitat upstream of crossing 197663 to 3054. Habitat in the areas surveyed immediately upstream of 197663 was rated as high value for salmonid rearing/spawning. Although the sample size is small, the electrofishing results indicate that there are higher densities of coho and rainbow trout downstream of the crossing than above which could be an indication of impact by the structure. Although some works have already been conducted to reduce the impact of the crossing on upstream migration of fish, the culvert is damaged and likely presents a barrier to smaller life stages during moderate to high flows (due to flow velocities) and to large adult fish during low flows (due to shallow flow depths). The crossing was ranked as a high priority for proceeding to design for replacement.

Although there is some potential that there may be a natural barrier downstream of North Road, there is 7.5km of mainstem habitat modelled upstream of 3054. Habitat in the areas surveyed immediately upstream of 3054 was rated as moderate value for salmonid rearing/spawning. FLNR - Nadina Forest District is responsible for North road. The crossing was ranked as a moderate priority for proceeding to design for replacement.

Table 4.44: Summary of fish passage assessment for PSCIS crossing 197663.

Location and Stream Data		Crossing Characteristics –	
Date	2020-08-28	Crossing Sub Type	Round Culvert
PSCIS ID	197663	Diameter (m)	1.75
External ID	–	Length (m)	25
Crew	KP, AI	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	670240.8	Resemble Channel	No
Northing	6044772	Backwatered	No
Stream	Johnny David Creek	Percent Backwatered	–
Road	Highway 16	Fill Depth (m)	3
Road Tenure	MoTi highway	Outlet Drop (m)	0
Channel Width (m)	6.3	Outlet Pool Depth (m)	1.35
Stream Slope (%)	5.5	Inlet Drop	Yes
Beaver Activity	No	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	10.3
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Stream Characteristics Upstream of 3...

Comments: Habitat confirmation and sampling completed.



Table 4.45: Summary of fish passage assessment for PSCIS crossing 3054.

Location and Stream Data	•	Crossing Characteristics -
Date	2020-09-03	Crossing Sub Type Round Culvert

Stream Characteristics Upstream of 3...

PSCIS ID	3054	Diameter (m)	3
External ID	–	Length (m)	40
Crew	KP, AI	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	664881	Resemble Channel	No
Northing	6052688	Backwatered	No
Stream	Johnny David Creek	Percent Backwatered	–
Road	North road	Fill Depth (m)	9.99
Road Tenure	MoTi local	Outlet Drop (m)	0.76
Channel Width (m)	3.5	Outlet Pool Depth (m)	0.8
Stream Slope (%)	3.3	Inlet Drop	No
Beaver Activity	Yes	Slope (%)	2
Habitat Value	Medium	Valley Fill	Deep Fill
Final score	34	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	31
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Stream Characteristics Upstream of 3...

Comments: Fill depth approximatley 12m. Fish observed upstream of crossing.



NO IMAGE AVAILABLE



Table 4.46: Summary of habitat details for PSCIS crossings 197663and 3054.

Site Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
3054 Downstream	350 3.5	2.3	0.3	3.3	abundant	moderate	
3054 Upstream	725 2.6	2.1	0.3	5.3	moderate	moderate	
197663 Upstream	690 6.6	4.4	0.4	3	moderate	high	
197663 Downstream	300 5.3	3.3	0.5	2.6	moderate	high	

Table 4.47: Electrofishing sites for PSCIS crossing 197663.

Site	Location	Width (m)	Length (m)	Area (m ²)	Effort (s)	Effort (s/m ²)
53	Downstream	3.75	5.1	19	199	10.5
54	Upstream	2.50	12.7	32	283	8.8

Table 4.48: Densities of fish (fish/100m²) captured during electrofishing upstream and downstream of PSCIS crossing 197663.

Site	Location	Species	Fry	Parr	Juvenile	Adult
53	Downstream	CO	57.9	5.3	0	0
54	Upstream	CO	0	12.5	0	0
54	Upstream	MW	0	3.1	0	0
53	Downstream	RB	42.1	31.6	15.8	0
54	Upstream	RB	21.9	28.1	6.2	3.1

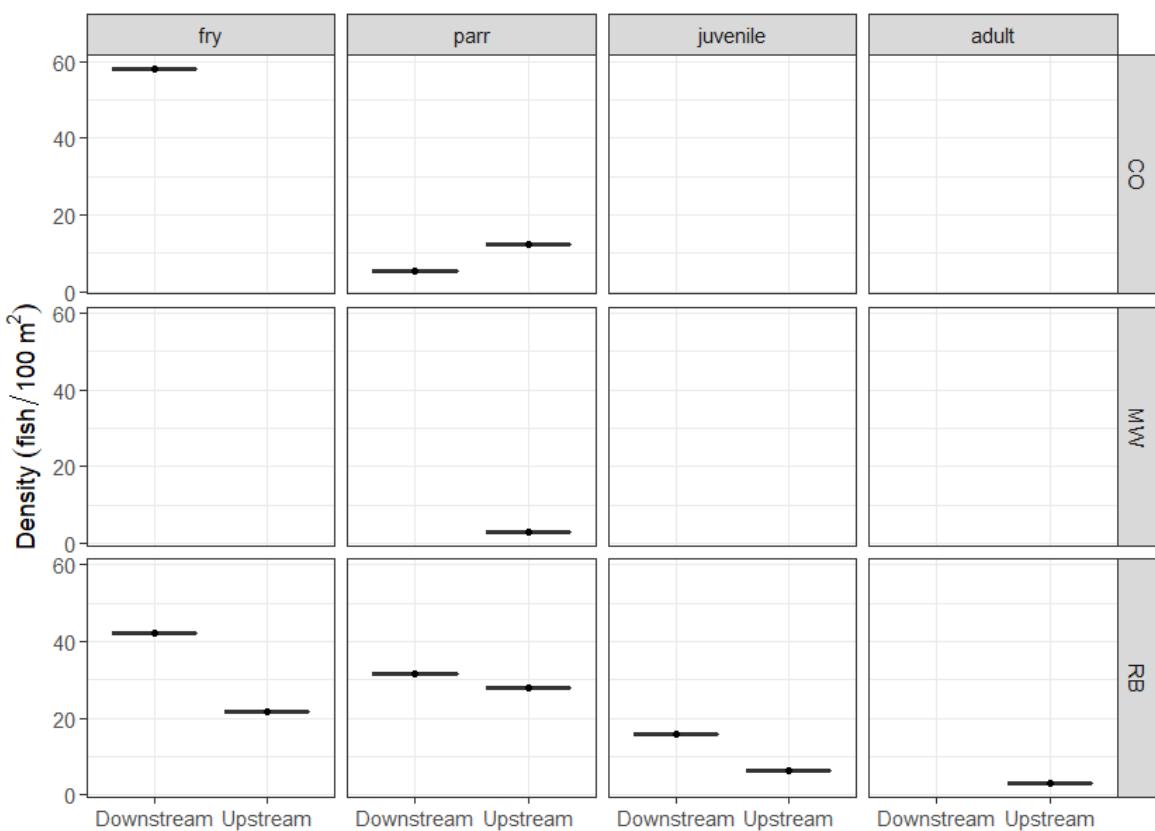


Figure 4.32: Densities of fish (fish/100m²) capture upstream and downstream of PSCIS crossing 197663.

Table 4.49: Fish captured in minnowtraps set overnight upstream and downstream of PSCIS crossing 197663.

Location	Species	fry	juvenile	parr
Downstream	CO	14	1	0
Upstream	CO	0	0	2
Downstream	RB	7	1	8
Upstream	RB	0	0	4



Figure 4.33: Left: Typical habitat downstream of PSCIS crossing 197663. Right: Typical habitat downstream of PSCIS crossing 197663.



Figure 4.34: Left: Habitat upstream of PSCIS crossing 197663. Right: Habitat upstream of PSCIS crossing 197663.

Stream Characteristics Upstream of 3...



Figure 4.35: Left: Coho captured downstream of PSCIS crossing 197663. Right: Coho captured upstream of PSCIS crossing 197663.



Figure 4.36: Left: Habitat downstream of PSCIS crossing 3054. Right: Habitat upstream of PSCIS crossing 197663.

Appendix - 197665 & 197664 & 3042 - Barren Creek

Site Location

PSCIS crossing 197665 is located on Barren Creek on CN Railway approximately 25km east of Houston, BC with the railway located approximately 20m upstream from the confluence with the Bulkley River. CN Railway is the responsibility of CN Rail.

PSCIS crossing 197664 is located on Highway 16 with the highway culvert located approximately 120m upstream from the confluence with the Bulkley River and 100m upstream of the railway. Highway 16 is the responsibility of the Ministry of Transportation and Infrastructure.

PSCIS crossing 3042 is located at km 13.5 of Barren Creek FSR and approximately 10km upstream of Barren Creek FSR. Barren Creek FSR is the responsibility of FLNR - Nadina Forest District.

Background

The Barren Creek creek watershed upstream of the highway is approximately 24.5km² in area with an estimated 11ha of wetland and 29ha of lake documented upstream. At the highway, (600m of elevation) Barren Creek is a fourth order stream with a maximum watershed elevation of approximately 1300m. Fish documented as present upstream of the highway include cutthroat trout, coho salmon, rainbow trout, steelhead, chinook salmon, and lamprey (general) (MoE 2020a). Although not available in MoE (2020b) at the time of reporting, an impassable falls (Wilson Falls) has been documented approximately 6.2km upstream from the highway (pers. comm. Jonathan Van Barneveld, Forester - FLNR). Although there are several unassessed road stream crossing structures and crossings documented in PSCIS as barriers on tributary systems to the Barren Creek mainstem downstream of the falls as well as upstream of Barren Creek FSR, the quantity of habitat in these blocked and potentially blocked stream segments likely very minimal and with low fisheries value due to the small size of the upstream watersheds.

PSCIS crossing 8733, located at km 18.2 of North Road (Michelle Bary FSR) and approximately 1.5km upstream from Highway 16, was replaced with a bridge by Canadian Forest Products in 2018 (MoE 2021; Patterson 2010).

The Barren Creek creek watershed upstream of 3042 is approximately 3.9km² in area with an estimated 4ha of wetland and 4ha of lake documented upstream. The stream is fourth order at this location. Although fish have not been previously documented upstream of 3042 in MoE (2020a), FINS Consulting (2014) report rainbow trout fry downstream of the lake at the top end of the watershed.

In the summer of 1998, the Nadina Community Futures Development Corporation (NCFDC) carried out a detailed Level 1 Fish, Fish Habitat and Riparian Assessment in the first and second reaches of Barren Creek as well as several other large Upper Bulkley River tributary streams and the Upper Bulkley mainstem. The area surveyed extended to 4.2km from the mouth covering near 4km of habitat upstream of the culvert 197664 (NCFDC 1998). Building on these assessments and detailed fish sampling, NCFDC (1998) developed restoration prescriptions for the lower reaches of the Barren Creek. Prescriptions were developed to address what the authors termed moderately to severely disturbed habitat. Impacts included extensive bars, extensive riffles, minimal pool area, eroding banks and sediment wedges due to:

- loss of riparian forest and soil compaction in areas used for agriculture, the powerline corridor, transportation corridors and at housing developments within the floodplain.
- loss of the shrub/herb layer and soil compaction from cattle grazing where overstory still present.
- removal of large woody debris which controls lateral channel movement and plant community distribution on the floodplain.

Overall, NCFDC (1998) report that, in an unimpacted state, the first two reaches of Barren Creek are critical and productive areas for spawning and rearing particularly for coho and steelhead. They also note that the area up to North Road may be utilized for juvenile chinook rearing. Detailed prescriptions for restorative measures that address the noted impacts are documented in NCFDC (1998).

Overwintering studies using minnowtrapping were conducted downstream of the highway culvert between 2005 and 2009 with coho and rainbow trout/steelhead captured. Results are summarized in Donas and Newman (2006), Donas and Newman (2007), Donas and Newman (2008) and Donas and Newman (2010).

PSCIS stream crossings 197665 and 197664 were rated as high priorities for habitat confirmation assessments after consultation with the Office of Wet'suwet'en, Fisheries and Oceans Canada representatives and Canadian Wildlife Federation due to concerns related to the ongoing dredging taking place at upstream and downstream of Highway 16. Crossing 3042 was rated as a high priority for follow up in Irvine (2018) and Casselman and Stanley (2010). A map of the watershed is provided in map attachment [093L.114](#).

Stream Characteristics at Crossings 197665 and 197664

At the time of the survey, the crossing 197665 structures under the CN Railway were fully embedded and considered passable according to the provincial protocol. Each pipe was 0.9m in

Stream Characteristics Downstream o...

diameter with a length of 25m, a culvert slope of 1%, a stream width ratio of 3.9 and an outlet drop of 0m (Table [4.50](#)).

Crossing 197664 on Highway 16 was also embedded and again ranked passable. The pipe was 2.5m in diameter with a length of 15m, a culvert slope of 2%, a stream width ratio of 1.9 and an outlet drop of 0m (Table [4.51](#)). Water temperature was 12°C, pH was 8 and conductivity was 156uS/cm.

Crossing 3042 on Barren Creek FSR was unembedded, not backwatered and considered a barrier to fish passage according to the provincial protocol. The pipe was 1m in diameter with a length of 23m, a culvert slope of 1.5%, a stream width ratio of 1.9 and an outlet drop of 0m (Table [4.52](#)). Water temperature was 10°C and pH was 7.4.

Stream Characteristics Downstream of 197665

Crossing 197665 is located 30m upstream of the Bulkley River and within the active floodplain.

Stream Characteristics Upstream of 197665 and downstream of 197664

The stream was surveyed upstream from 197665 for 100m to Highway 16 (Figure [??](#)). Within the area surveyed, total cover amount was rated as moderate with overhanging vegetation dominant. Cover was also present as small woody debris (Table [4.53](#)). The average channel width was 4.7m, the average wetted width was 2.7m and the average gradient was 1.8%. Abundant gravels and small cobbles suitable for resident, fluvial, adfluvial and anadromous salmonid spawning were present throughout the area surveyed. Habitat was rated as moderate value with habitat present suitable for resident and anadromous fry/juvenile salmonid rearing and spawning.

Stream Characteristics Upstream of 197664

Barren Creek was surveyed upstream from 197664 for 800m (Figure [??](#)). Within the area surveyed, 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 (Table [4.53](#)). The average channel width was 7.2m, the average wetted width was 4.7m and the average gradient was 3%. An active cut was noted approximately 100m upstream of culvert. It is suspected that this area is constantly depositing gravels into stream. There extensive areas of gravels suitable for CO spawning. Riparian vegetation consisted of a mature cottonwood forest with right bank armouring and riparian removal along the adjacent private road. Habitat was rated as high value for resident and anadromous salmonid rearing and spawning.

Stream Characteristics Downstream of 3042

Barren Creek was surveyed upstream from 3042 for 400m (Figure ??). The area surveyed consisted of a series of beaver dams with impounded areas upstream ranging in length from 10 - 100m and dam heights ranging from 0.7 - 1.2m. Total cover amount was rated as moderate with undercut banks dominant. Cover was also present as deep pools, overhanging vegetation, and instream vegetation (Table 4.53). The average channel width was 18m, the average wetted width was 15m and the average gradient was 0.5%. At the bottom end of the site, flooded forest and shrub areas transitioned to a small marsh with emergent aquatic vegetation and extensive areas of open water. Water depths in the marsh were estimated at over 1m. Habitat value was rated as moderate for resident salmonid rearing and overwintering.

Stream Characteristics Upstream of 3042

Barren Creek was surveyed downstream from 3042 for 400m (Figure ??). A beaver influenced wetland was located immediately upstream of crossing and extended upstream for more than 200m. Detailed habitat characteristics were collected in an area located approximately 900m upstream of crossing. Within the area surveyed total cover amount was rated as moderate with undercut banks dominant. Cover was also present as deep pools, overhanging vegetation, and instream vegetation (Table 4.53). The average channel width was 2.3m, the average wetted width was 2.2m and the average gradient was 3%. The area surveyed varied from cobble/boulder channel flowing freely to primarily glide habitat with depths ranging from 60 - 100 cm in depth. There were occasional pockets of gravels in the channel near the start of the survey with some pools associated with large woody debris associated throughout. A large beaver pond/lake area was located at the top end of the site. Additional habitat information for areas upstream of the crossing are recorded in the provincial fisheries information summary system (MoE 2020c). Habitat value was rated as moderate for resident salmonid rearing and overwintering.

Structure Remediation and Cost Estimate

Costs to replace 197665 and 197664 with bridges are estimated at \$5,000,000 per crossing. Structure replacement with an embedded culvert is recommended for 3042 (5m span) with an estimated cost of \$25,000 resulting in cost benefits of 68 linear m/\$1000 and $156.4\text{m}^2/\$1000$.

Conclusion

Although 197665 and 197664 are considered passable, both structures appear to be nearing end of life and with ongoing dredging required to keep 197664 from directing flows over Highway 16 during high flow events. Additionally, the active bank cut located approximately 100m upstream of the crossing could contribute important gravel substrates to the lower reach of Barren Creek as well as to the mainstem of the Bulkley River when replacement structures are installed.

There is 1.7km of mainstem habitat upstream of crossing 3042 including an estimated 4ha of wetland and 4ha of lake. Habitat in the areas surveyed upstream of was rated as moderate value for salmonid rearing/spawning. Wilson Falls is located downstream of the crossing so restoration of

Stream Characteristics Downstream o...

passage at Barren Creek FSR could benefit resident rainbow trout only. The crossing was ranked as a low priority for proceeding to design for replacement.

Table 4.50: Summary of fish passage assessment for PSCIS crossing 197665.

Location and Stream Data	.	Crossing Characteristics	–
Date	2020-08-28	Crossing Sub Type	Round Culvert
PSCIS ID	197665	Diameter (m)	0.9
External ID	–	Length (m)	25
Crew	AI, KP	Embedded	Yes
UTM Zone	9	Depth Embedded (m)	0.3
Easting	660627	Resemble Channel	Yes
Northing	6037843	Backwatered	Yes
Stream	Barren Creek	Percent Backwatered	10
Road	CN Railway	Fill Depth (m)	2
Road Tenure	Canadian National	Outlet Drop (m)	0
Channel Width (m)	3.5	Outlet Pool Depth (m)	0.4
Stream Slope (%)	3	Inlet Drop	No
Beaver Activity	No	Slope (%)	1
Habitat Value	High	Valley Fill	Deep Fill
Final score	14	Barrier Result	Passable
Fix type	–	Fix Span / Diameter	–

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

Comments: Targeted for habitat confirmation due to upstream aggradation and dredging associated impacts on coho

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NO IMAGE AVAILABLE



Table 4.51: Summary of fish passage assessment for PSCIS crossing 197664.

Location and Stream Data	•	Crossing Characteristics –
Date	2020-08-28	Crossing Sub Type Round Culvert

Appendix - 197665 & 197664 & 3042 ...

PSCIS ID	197664	Diameter (m)	2.5
External ID	1801069	Length (m)	15
Crew	KP, AI	Embedded	Yes
UTM Zone	9	Depth Embedded (m)	1.9
Easting	660454.3	Resemble Channel	Yes
Northing	6037919	Backwatered	No
Stream	Barren Creek	Percent Backwatered	–
Road	Highway 16	Fill Depth (m)	1
Road Tenure	MoTi highway	Outlet Drop (m)	0
Channel Width (m)	4.7	Outlet Pool Depth (m)	0
Stream Slope (%)	1.8	Inlet Drop	No
Beaver Activity	Yes	Slope (%)	2
Habitat Value	High	Valley Fill	Deep Fill
Final score	14	Barrier Result	Passable
Fix type	–	Fix Span / Diameter	–

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

Comments: Habitat confirmation completed.

Comments: Targeted for habitat confirmation due to aggradation and dredging associated impacts on coho.

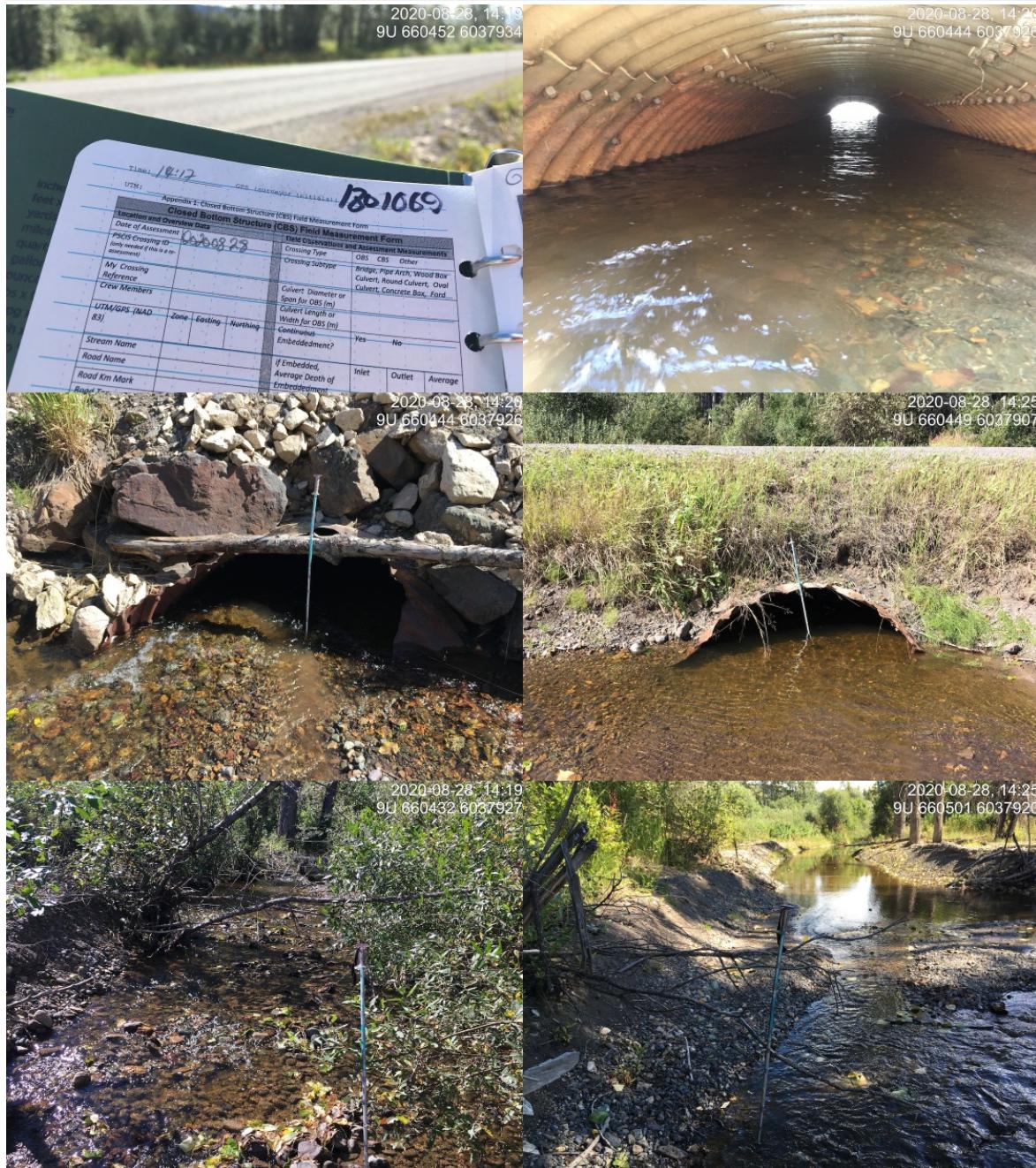


Table 4.52: Summary of fish passage assessment for PSCIS crossing 3042.

Location and Stream Data	• Crossing Characteristics –
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Stream Characteristics Downstream o...

Date	2020-09-01	Crossing Sub Type	Round Culvert
PSCIS ID	3042	Diameter (m)	1
External ID	–	Length (m)	23
Crew	KP, AI	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	654451	Resemble Channel	No
Northing	6042827	Backwatered	No
Stream	Barren Creek	Percent Backwatered	–
Road	Barren Creek FSR	Fill Depth (m)	2
Road Tenure	MoTi highway	Outlet Drop (m)	0
Channel Width (m)	1	Outlet Pool Depth (m)	0.5
Stream Slope (%)	0.5	Inlet Drop	Yes
Beaver Activity	Yes	Slope (%)	1.5
Habitat Value	Medium	Valley Fill	Deep Fill
Final score	21	Barrier Result	Barrier
Fix type	Replace Structure with Streambed Simulation CBS	Fix Span / Diameter	5
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			



Table 4.53: Summary of habitat details for PSCIS crossings 197665 and 197664.

Site	Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
3042	Upstream	400	2.3	2.2	0.2	3	moderate	moderate
3042	Downstream	260	18	15	1	0.5	moderate	moderate
197664	Upstream	800	7.2	4.7	3	3	moderate	high
197664	Downstream	240	4.7	2.7	—	1.8	moderate	high

Stream Characteristics Downstream o...

197665 Downstream 20 4.2 1.8 – 2.5 moderate high



Figure 4.37: Left: Typical habitat downstream of PSCIS crossing 197664. Right: Typical habitat downstream of PSCIS crossing 197664.



Figure 4.38: Left: Habitat upstream of PSCIS crossing 197664 and location of cutslope. Right: Habitat upstream of PSCIS crossing 197664.



Figure 4.39: Left: Habitat downstream of PSCIS crossing 3042. Right: Habitat downstream of PSCIS crossing 3042.



Figure 4.40: Left: Habitat upstream of PSCIS crossing 3042. Right: Habitat upstream of PSCIS crossing 3042.

Appendix - 197667 & 124501 - Moan Creek

Site Location

PSCIS crossings 197667 and 124501 are located on Moan Creek approximately 5.5km south-east of Telkwa, BC. Crossing 197667 is located on the railway line and crossing 124501 is located on Lawson Road. The crossings are located approximately 475m apart from each other with the railway crossing immediately upstream (15m) from the confluence with the Bulkley River. Crossing 197667 is the responsibility of the Canadian National Railway Company (CN Rail) and Lawson Road is the responsibility of the B.C. Ministry of Transportation and Infrastructure.

Background

The Moan Creek watershed upstream of the railway is approximately 14.9km² in area containing an estimated 1ha of lake and 15ha of wetland. The watershed elevation ranges from approximately 1350m to 530m at the railway where Moan Creek is a third order stream. Fish species documented upstream of both crossings include rainbow trout and dolly varden (MoE 2020a). Cutthroat trout have been documented in MoE (2020a) upstream of 197667 and Wilson and Rabnett (2007) report coho salmon and chinook salmon observations within the lower 500m of the stream.

Wilson and Rabnett (2007) recommended that PSCIS crossing 197667 be a high priority for remedial works to backwater the crossing by establishing a series of pools to step up to the outfall pool. In the spring of 2016, Gaboury and Smith (2016) noted that the baffled concrete box culvert (PSCIS 124501) at Lawson Road was likely a significant impediment to upstream fish passage at various discharges due to the height of the outfall drop, steep culvert slope and high water velocities. Rehabilitation designs for both crossings were prescribed by Gaboury and Smith (2016) and in both cases included the installation of downstream backwatering structures. For the railway crossing (197667), CN Rail indicated that the design proposed was not feasible for installation, so at the time of reporting, remedial actions had not yet been implemented (pers. comm. Karla Graf, CN Environment, Manager-Environmental Impact). Smith (2018) reported that in 2017, the Wet'suwet'en First Nation constructed three rock riffles and a right-bank berm to backwater the Lawson Road (124501) outlet. A map of the watershed is provided in map attachment [093L.118](#).

Stream Characteristics at Crossings 197667 and 124501

At the time of the survey, the 197667 on CN Railway was un-embedded, non-backwatered and considered a barrier to upstream fish passage according to the provincial protocol. The pipe was 2.5m in diameter with a length of 17m, a culvert slope of 4%, a stream width ratio of 1.5 and an outlet drop of 0.58m (Table [4.54](#)).

Crossing 124501 on Lawson Road was embedded and non-backwatered and although it was ranked as a barrier to upstream fish passage, we considered it passable for adult salmonids

(resident and anadromous). The concrete box culvert containing baffles was 1.6m in width with a length of 25m, a culvert slope of 6%, a stream width ratio of 2.8 and an outlet drop of 0.3m (Table [4.55](#)). Water temperature was 9°C, pH was 8 and conductivity was 86uS/cm.

Stream Characteristics Downstream of 197667

The Bulkley River is located approximately 30m downstream of the outlet of 197667.

Stream Characteristics Upstream of 197667 and downstream of 124501

The stream was surveyed upstream from 197667 for 450m to 124501 (Figure [??](#)). Within the area surveyed, 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 (Table [4.56](#)). The average channel width was 4.5m, the average wetted width was NAm and the average gradient was 4.5%. There were pockets of gravels and small cobbles suitable for resident, fluvial, adfluvial and anadromous salmonid spawning present throughout the area surveyed. Habitat value was rated as high for salmonid rearing and spawning.

Stream Characteristics Upstream of 124501

Moan Creek was surveyed upstream from 124501 for 520m (Figure [??](#)). Within the area surveyed, total cover amount was rated as moderate with deep pools dominant. Cover was also present as small woody debris, large woody debris, boulders, undercut banks, and overhanging vegetation (Table [4.56](#)). The average channel width was 4.8m, the average wetted width was 3.1m and the average gradient was 6.3%. There were multiple debris jams present upstream from 350m above Larson Road with heights ranging from 0.4 - 1m high. Habitat value was rated as high for younger life stages of fluvial and anadromous salmonid rearing with some habitat present suitable for resident rainbow trout and cutthroat trout as well as coho salmon.

Fish Sampling

Minnowtrapping was conducted upstream and downstream of 197667 with traps set in the best available habitat and left overnight. A total of 1 rainbow trout were captured upstream with 4 rainbow trout captured downstream (Table [4.57](#)).

Structure Remediation and Cost Estimate

A cost estimate for replacing 197667 with a bridge (10m span) is \$5,000,000 resulting in cost benefits of 0.7 linear m/\$1000 and NAm²/\$1000. Although 124501 on Lawson Road was considered passable for most species/life stages during most flows, an estimate of cost for replacement (10m span) is \$500,000 resulting in cost benefits of 5.6 linear m/\$1000 and 26.9m²/\$1000.

Conclusion

There is 3.3km of habitat upstream of crossing 197667 and below 124501. Upstream of Lawson Road there is an additional 2.8km of habitat modelled. Habitat in the areas surveyed upstream of 197667 and 124501 was rated as high value for salmonid rearing with some habitat also suitable for spawning in both areas. Crossing 197667 on the railway was ranked as a high priority for proceeding to design for replacement. Although not quantified with current assessment protocols the low depth of water in pipe during moderate to low flows (such as those observed during the 2020 survey) could prevent upstream migration (particularly for larger fish such as coho and chinook salmon). Although classified as a “barrier” according to provincial metrics, crossing 124501 is embedded, baffled and without a significant outlet drop. As such we suspect that it is passable to adult salmonids during most flows. The crossing was assessed as a low priority for proceeding to design for replacement.

Table 4.54: Summary of fish passage assessment for PSCIS crossing 197667.

Location and Stream Data	•	Crossing Characteristics –	
Date	2020-08-31	Crossing Sub Type	Round Culvert
PSCIS ID	197667	Diameter (m)	2.5
External ID	–	Length (m)	17
Crew	KP, AI	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	631092	Resemble Channel	No
Northing	6055866	Backwatered	No
Stream	Moan Creek	Percent Backwatered	–
Road	CN Railway	Fill Depth (m)	0.8
Road Tenure	Canadian National	Outlet Drop (m)	0.58
Channel Width (m)	3.8	Outlet Pool Depth (m)	0.57
Stream Slope (%)	4.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	4
Habitat Value	High	Valley Fill	Deep Fill
Final score	39	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	10
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Comments: Approximately 17m from the outlet to the Bulkley River.



Table 4.55: Summary of fish passage assessment for PSCIS crossing 124501.

Location and Stream Data	•	Crossing Characteristics –
Date	2020-08-31	Crossing Sub Type Round Culvert

PSCIS ID	124501	Diameter (m)	1.6
External ID	–	Length (m)	25
Crew	KP, AI	Embedded	Yes
UTM Zone	9	Depth Embedded (m)	0.15
Easting	630661	Resemble Channel	Yes
Northing	6055713	Backwatered	No
Stream	Moan Creek	Percent Backwatered	–
Road	Lawson Road	Fill Depth (m)	1
Road Tenure	MoTi resource	Outlet Drop (m)	0.3
Channel Width (m)	4.5	Outlet Pool Depth (m)	0.7
Stream Slope (%)	4.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	6
Habitat Value	High	Valley Fill	Deep Fill
Final score	34	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	10

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



Table 4.56: Summary of habitat details for PSCIS crossings 197667 and 124501.

Site	Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
124501	Upstream	520	4.8	3.1	0.4	6.3	moderate	high
124501	Downstream	450	4.5	2.8	0.4	4.5	moderate	high
197667	Upstream	100	–	–	–	–	–	high

Conclusion

Table 4.57: Fish captured in minnowtraps set overnight upstream and downstream of PSCIS crossing 197667.

Location	Species	parr
Downstream	RB	4
Upstream	RB	1



Figure 4.41: Left: Typical habitat upstream of PSCIS crossing 197667. Right: Typical habitat upstream of PSCIS crossing 197667.



Figure 4.42: Left: Habitat upstream of PSCIS crossing 124501. Right: Habitat upstream of PSCIS crossing 124501.

Appendix - 197668 & 124504 - Coffin Creek

Site Location

PSCIS crossings 197668 and 124504 are located on Coffin Creek approximately 9km south-east of Telkwa, BC. Crossing 197668 is located on the railway line and crossing 124504 is located on Lawson Road. The crossings are located approximately 30m apart from each other with the railway crossing 300m upstream from the confluence with the Bulkley River. Crossing 197668 is the responsibility of the Canadian National Railway Company (CN Rail) and Lawson Road is the responsibility of the B.C. Ministry of Transportation and Infrastructure.

Background

The Coffin Creek watershed upstream of the railway is approximately 45.2km² in area containing an estimated 74ha of lake and 133ha of wetland. The watershed elevation ranges from approximately 1400m to 530m at the railway where Coffin Creek is a fifth order stream. Numerous fish species have been documented upstream of both crossings including coho salmon, longnose sucker, largescale sucker, redside shiner, cutthroat trout, rainbow trout, mountain whitefish, and dolly varden (MoE 2020a; Wilson and Rabnett 2007).

Coffin Lake is a shallow lake (max depth 2m) located approximately 4.5km upstream of Lawson Road. In the late 1980s, Ducks Unlimited raised water levels in Coffin Lake and a downstream wetland area by installing a 63m long X 2.3m high earthen dam incorporating a variable crest weir capable of a 1.0m drawdown. Additionally excavated level ditching (1800m) within the sedge willow meadow was planned. The intent of the works was to provide a more secure and stable water regime, improve water/cover interspersion and provide territorial, loafing and nesting sites for waterfowl (Hatlevik 1985; Simpson 1986; MoE 2020b). Feedback on the preliminary development proposal by a regulatory fisheries technician noted that an ideal dam structure would be one providing options to either allow fish passage or comprise a complete barrier. Documentation detailing specifics of the final design of the dam and potential fishway was not obtained with a search of available literature.

There is one unassessed modelled crossing located on the mainstem of Coffin Creek (modelled crossing 1802798) approximately 1.3km upstream from Lawson Road and approximately 800m downstream of the hydro transmission line. Review of aerial imagery indicates that this crossing is likely a ford. There are two fords documented in PSCIS on the mainstem of Coffin Creek. The first is located on the hydro power transmission line approximately 2km upstream of the lake inlet and the second (PSCIS 195972) is located approximately 2km upstream of the inlet of Coffin Lake. There is a 10m high falls recorded adjacent to PSCIS 195972 likely representing the upstream fish distribution limit in the mainstem. There are several fords located on tributary streams approximately 2km upstream of the Coffin Lake inlet and several other culverts further upstream previously assessed as barriers.

Wilson and Rabnett (2007) recommended that PSCIS crossing 197668 be a high priority for remedial works to backwater the crossing by establishing a series of pools to step up to the outfall pool. A rehabilitation design was prescribed by Gaboury and Smith (2016) in the spring of 2016 and completed by CN Rail in the fall of 2016 by constructing two rock weirs downstream of the outlet. Smith (2018) reported that in 2017, the lowermost riffle required repairs using larger sized rocks. Wilson and Rabnett (2007)

The Coffin Creek watershed has been selected as a focus area for Environmental Stewardship Initiative (ESI) sampling research critical flow monitoring, benthic invertebrate sampling and fisheries assessments (pers. comm Don Morgan, Ministry of Environment and Climate Change Strategy).

PSCIS stream crossings 197668 was rated as a high priority for follow up due to the large amount of low gradient stream/wetland/lake habitat upstream, information communicated in Wilson and Rabnett (2007) and Smith (2018) related to the need for the work and the potential failures of 2017 remedial works, and because engagement activities with Wet'suwet'en, FLNRO and Ministry of Environment and Climate Change Strategy representatives indicated that there could be potential efficiencies by overlapping fish passage assessment/remediation/monitoring in ESI watersheds. A map of the watershed is provided in map attachment [093L.118](#).

Stream Characteristics at Crossings 197668 and 124504

At the time of the survey, the 197668 on CN Railway was un-embedded, non-backwatered and considered a barrier to upstream fish passage according to the provincial protocol. The pipe was 3m in diameter with a length of 15m, a culvert slope of 2%, a stream width ratio of 1.8 and an outlet drop of 0.27m (Table [4.58](#)). Water temperature was 13°C, pH was 7.9 and conductivity was 92uS/cm.

Crossing 124504 on Lawson Road was embedded but non-backwatered and ranked as a barrier to upstream fish passage. The pipe was 3m in diameter with a length of 16m, a culvert slope of 1%, a stream width ratio of 1.8 and an outlet drop of 0.2m (Table [4.59](#)).

Stream Characteristics Downstream of 197668

The stream was surveyed downstream from the culvert for 300m (Figure [??](#)). Overall, total cover amount was rated as moderate with large woody debris dominant. Cover was also present as small woody debris, undercut banks, deep pools, and overhanging vegetation (Table [4.60](#)). The average channel width was 5.3m, the average wetted width was 3.7m and the average gradient was 2%.

The dominant substrate was cobbles with gravels subdominant. Abundant gravels suitably sized for coho, rainbow and steelhead spawning were present. Habitat was rated as high as it was considered an important migration corridor with moderate value habitat for fry/juvenile salmonid rearing.

Stream Characteristics Upstream of 124504

Coffin Creek was surveyed upstream from 124504 for 415m until an area of wetland type habitat (Figure ??). The stream winds through a canyon section for approximately 300m after the first 100m of beaver influenced wetland located directly upstream of the culvert. Within the area surveyed, total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, large woody debris, boulders, deep pools, and overhanging vegetation (Table 4.60). The average channel width was 5.8m, the average wetted width was 3.5m and the average gradient was 2.3%. Substrate was noted as colored black from periphyton with pockets of gravel suitable for resident (~20cm) salmonids present. A fish observed (~150mm long) was observed above the culvert approximately 100m. Habitat value was rated as high for younger life stages of fluvial and anadromous salmonid rearing and resident adult salmonid spawning.

Fish Sampling

Minnowtrapping was conducted upstream and downstream of 197668. A total of 14 fish were captured upstream with 14 fish captured downstream (Figure ??). Species captured upstream included coho and rainbow trout with coho, sucker and rainbow trout captured downstream. Results are summarized in Table 4.61.

Structure Remediation and Cost Estimate

Replacement with bridges for 197668 (10m span) and 124504 (10m span) are recommended to provide unimpeded access to the habitat located upstream. An estimate of cost for replacement of 197668 is \$5,000,000 resulting in cost benefits of 0.8 linear m/\$1000 and NAm²/\$1000. An estimate of cost for replacement of 124504 is \$500,000 resulting in cost benefits of 8 linear m/\$1000 and 46.4m²/\$1000.

Conclusion

There is 4km of habitat upstream of crossings 197668 and 124504 to the earthen dam constructed by Ducks Unlimited in the late 1980s. Habitat in the areas surveyed upstream of 197668 and 124504 was rated as high value for salmonid rearing/spawning. Although some works have already been conducted to reduce the impact of crossing 197668 on upstream fish migration, the works do not appear to be functioning as intended and replacement of the crossing with a bridge will increase passability for all life stages and species. The crossing was ranked as a high priority for proceeding to design for replacement. Although classified as a “barrier” according to provincial metrics, crossing 124504 is partially embedded and we suspect that it is passable to most juvenile and adult

salmonids during most flows. Although the crossing should be replaced with an open bottomed structure in the long term, the crossing was assessed as a high priority for proceeding to design.

Table 4.58: Summary of fish passage assessment for PSCIS crossing 197668.

Location and Stream Data	.	Crossing Characteristics –	
Date	2020-08-31	Crossing Sub Type	Round Culvert
PSCIS ID	197668	Diameter (m)	3
External ID	–	Length (m)	15
Crew	KP, AI	Embedded	No
UTM Zone	9	Depth Embedded (m)	–
Easting	634336	Resemble Channel	No
Northing	6054609	Backwatered	No
Stream	Coffin Creek	Percent Backwatered	–
Road	CN Railway	Fill Depth (m)	0.8
Road Tenure	Canadian National	Outlet Drop (m)	0.27
Channel Width (m)	5.3	Outlet Pool Depth (m)	0.47
Stream Slope (%)	2	Inlet Drop	No
Beaver Activity	No	Slope (%)	2
Habitat Value	High	Valley Fill	Deep Fill
Final score	29	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	10

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

Stream Characteristics Upstream of 1...

Comments: CN crossing has had Newbury riffles constructed to decrease the size of the outlet drop but drop still present. Abundant gravels suitable for spawning chinook and coho present. Some deep pools available for fry/parr overwintering.

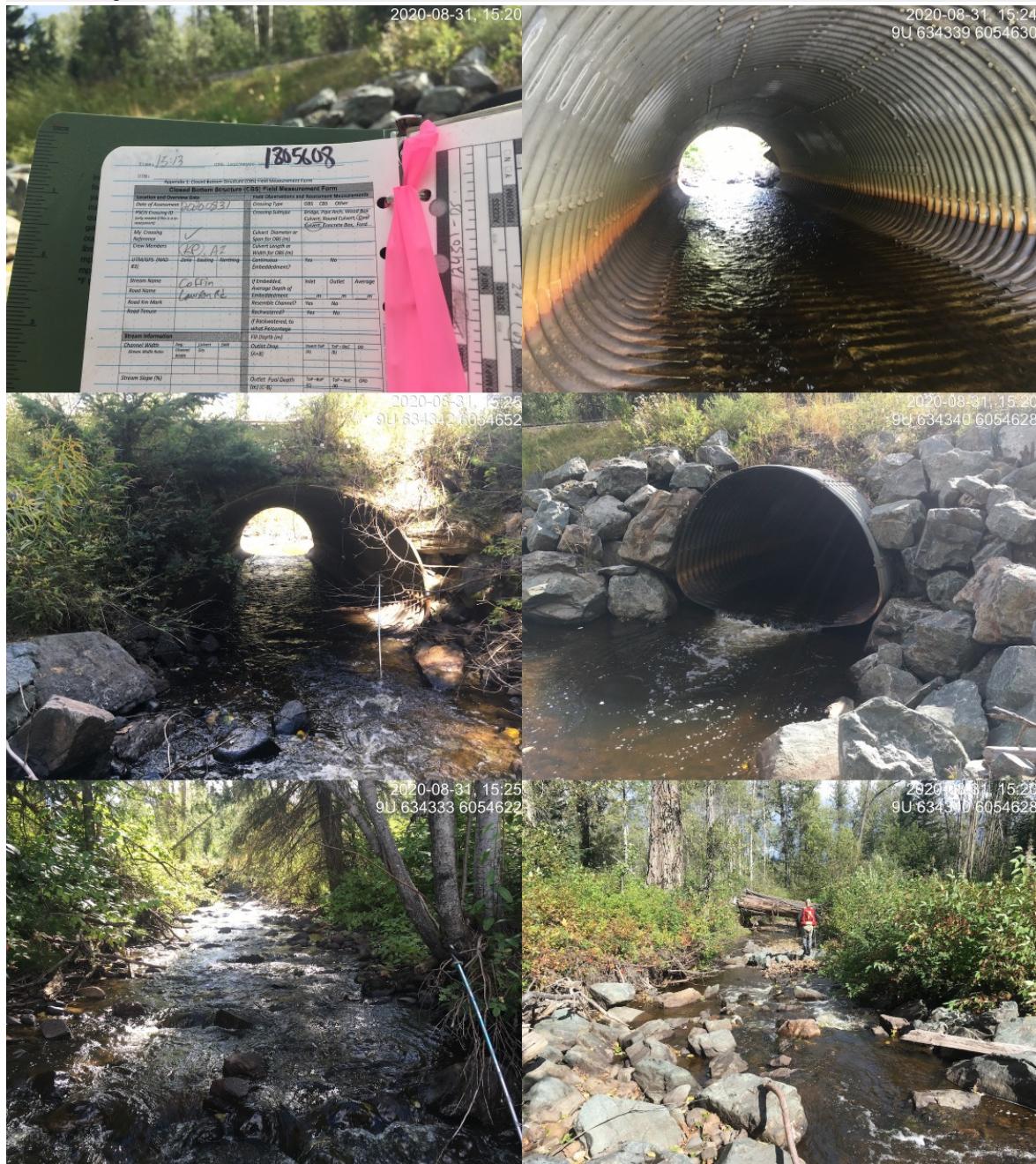


Table 4.59: Summary of fish passage assessment for PSCIS crossing 124504.

Stream Characteristics Upstream of 1...

Date	2020-08-31	Crossing Sub Type	Round Culvert
PSCIS ID	124504	Diameter (m)	3
External ID	–	Length (m)	16
Crew	KP, AI	Embedded	Yes
UTM Zone	9	Depth Embedded (m)	0.15
Easting	634323	Resemble Channel	Yes
Northing	6054587	Backwatered	No
Stream	Coffin Creek	Percent Backwatered	–
Road	Lawson Road	Fill Depth (m)	0.5
Road Tenure	MoTi resource	Outlet Drop (m)	0.2
Channel Width (m)	5.3	Outlet Pool Depth (m)	0.1
Stream Slope (%)	2	Inlet Drop	No
Beaver Activity	No	Slope (%)	1
Habitat Value	High	Valley Fill	Deep Fill
Final score	24	Barrier Result	Barrier
Fix type	Replace with New Open Bottom Structure	Fix Span / Diameter	10
Photos: From top left clockwise: Road/Site Card, Barrel, Outlet, Downstream, Upstream, Inlet.			

Stream Characteristics Upstream of 1...

Comments: Partially embedded with several large boulders (30 - 50cm) in culvert. No outlet drop at the time of survey but there may be at lowest flow levels.



Table 4.60: Summary of habitat details for PSCIS crossings 197668and 124504.

Site Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
124504 Upstream	415 5.8	3.5	0.4	2.3	moderate	high	
197668 Downstream	300 5.3	3.7	0.4	2	moderate	high	
197668 Upstream	40 –	–	–	–	–	–	high

Table 4.61: Fish captured in minnowtraps set overnight upstream and downstream of PSCIS crossing 197668.

Location	Species	fry	parr	juvenile
Downstream	CO	4	1	0
Upstream	CO	1	2	0
Downstream	RB	4	1	3
Upstream	RB	3	8	0
Downstream	SU	0	1	0



Figure 4.43: Left: Typical habitat downstream of PSCIS crossing 197668. Right: Coffin Creek downstream of PSCIS crossing 197668 at confluence with the Bulkley River.

Stream Characteristics Upstream of 1...



Figure 4.44: Left: Habitat upstream of PSCIS crossing 124504. Right: Habitat 2.1km upstream of PSCIS crossing 124504.

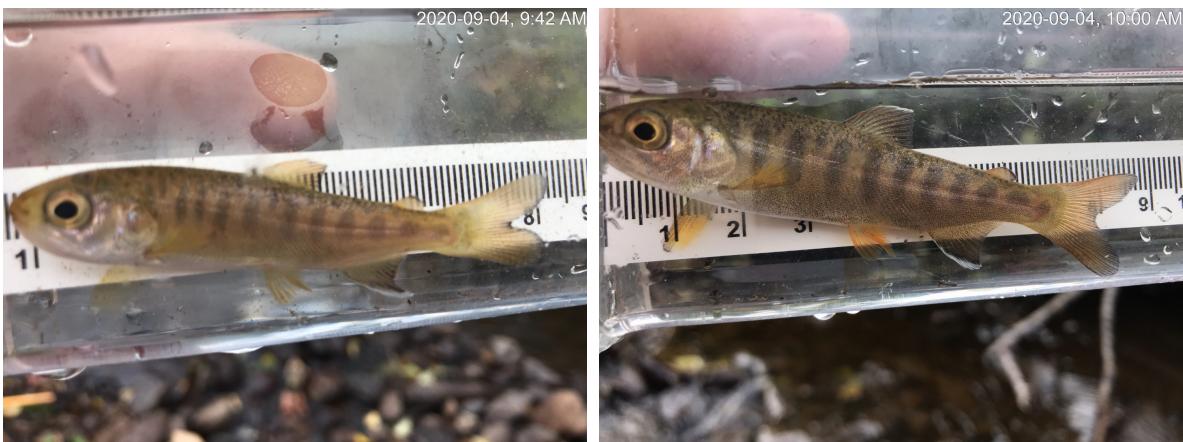


Figure 4.45: Left: Coho captured downstream of PSCIS crossing 197668. Right: Coho captured upstream of PSCIS crossing 124504.

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