Bulkley River Watershed (Laxyip | Wedzin Kwah)

Connectivity Remediation Plan: 2021 - 2031

Nick Mazany-Wright, Simon M. Norris, Joshua Noseworthy, Betty Rebellato, Sarah Sra, and Nicolas W. R. Lapointe

August 2021, Version 1.0

CANADIAN WILDLIFE FEDERATION FÉDÉRATION CANADIENNE DE LA FAUNE

Canadian Wildlife Federation

350 Michael Cowpland Drive

Kanata, Ontario K2M 2W1

Telephone: 1-877-599-5777 | 613-599-9594

www.cwf-fcf.org

Suggested Citation:

Mazany-Wright, N., S. M. Norris, J. Noseworthy, B. Rebellato, S. Sra, and N. W. R. Lapointe. 2021. Bulkley River Watershed Connectivity Remediation Plan: 2021- 2031. Canadian Wildlife Federation. Ottawa, Ontario, Canada.

Cover Photo: © Fernando Lessa

Acknowledgements

This plan represents the culmination of a collaborative planning process undertaken in the Bulkley River watershed over many months of work with a multi-partner planning team of individuals and groups passionate about the conservation and restoration of freshwater ecosystems and the species they support. Plan development was funded by the BC Salmon Restoration and Innovation Fund and the RBC Bluewater Project. We were fortunate to benefit from the feedback, guidance, and wisdom of many groups and individuals who volunteered their time throughout this process — this publication would not have been possible without the engagement of our partners and the planning team (see Table 1).

We recognize the incredible fish passage and connectivity work that has occurred in the Bulkley River watershed to date, and we are excited to continue partnering with local groups and organizations to build up existing initiatives and provide a road map to push connectivity remediation forward over the next 10 years and beyond.

The Canadian Wildlife Federation recognizes that the lands and waters that form the basis of this plan are the traditional unceded territory of the Wet'suwet'en and Gitxsan peoples. We are grateful for the opportunity to learn from the stewards of this land and work together to benefit Pacific Salmon and Steelhead. A special thank you to Dallas Nikal, Mike Ridsdale, and Elaine Sampson for sharing the traditional Witsuwit'en and Gitxsanimax names used in this plan.

Table of Contents

Connectivity Plan Purpose and Approach

The following Watershed Connectivity Remediation Plan (WCRP) represents the culmination of a six-month collaborative planning effort for the Bulkley River watershed (excluding the Morice River, see below), the overall aim of which is to clarify and reduce the threat of aquatic barriers to anadromous salmonids and the livelihoods that they support, including the values and laws of First Nations, as well their continued sustenance, cultural, and ceremonial needs both now and into the future. This 10-year plan was developed to identify priority actions that the Bulkley River WCRP planning team (see Planning Team for a list of team members) will undertake between 2021-2031 to conserve and restore fish passage in the watershed through strategies aimed at barrier remediation, barrier prevention, and strengthening Indigenous connections to land and water.

WCRPs are long-term, actionable plans that blend local stakeholder and rightsholder knowledge with innovative GIS analyses to gain a shared understanding of where remediation efforts will have the greatest benefit for anadromous salmonids. The planning process is inspired by the Conservation Standards (v.4.0), which is a conservation planning framework that allows planning teams to systematically identify, implement, and monitor strategies to apply the most effective solutions to high priority conservation problems. There is a rich history of connectivity and fish passage planning and remediation work in the Bulkley River watershed that this WCRP builds upon, including the work undertaken by the BC Fish Passage Technical Working Group, the Skeena Fisheries Commission, the Office of the Wet'suwet'en, the Wet'suwet'en First Nation, and the Society for Ecosystem Restoration in Northern British Columbia (SERNbc), among others (Wilson and Rabnett 2007, McCarthy and Fernando 2015, Smith 2018, Casselman and Stanley 2010, Irvine 2018). The Canadian Wildlife Federation will continue to engage and coordinate with local partners and existing initiatives, in part through the Skeena Environmental Stewardship Initiative. SERNbc is also currently undertaking fish passage work in the Bulkley River watershed, with some overlap and some differences in scope compared to the work and processes described in this WCRP. The SERNbc project relies on expert knowledge and field assessments in both the Bulkley and Morice watersheds to improve passage for all fish, including fluvial and resident species, and focuses on stream crossings that act as barriers (Irvine 2021). This WCRP focuses specifically on improving connectivity for anadromous salmonid species and uses consensus-based planning exercises and spatial model implementation to develop watershed-scale status assessments, goal setting, and prioritization for multiple barrier types. SERNbc and the WCRP planning team are currently collaborating on the development of the bcfishpass connectivity model and will continue to work together to promote coordination and collaboration between the two initiatives moving forward.

The planning team compiled existing barrier location and assessment data, habitat data, and previously identified priorities, and combined this with local and Indigenous knowledge to create a strategic watershed-scale plan to improve connectivity. To expand on this work, the Bulkley River WCRP planning team applied the WCRP planning framework to define the "thematic" scope of freshwater connectivity and refine the "geographic" scope to identify those

portions of the watershed where barrier prioritization will be conducted, and subsequent remediation efforts will take place. Additionally, the team selected target fish species, assessed their current connectivity status in the watershed, defined concrete goals for gains in connectivity, and developed a priority list of barriers for remediation to achieve those goals. While the current version of this plan is based on the best-available information at the time of publishing, WCRPs are intended to be "living plans" that are updated regularly as new information becomes available, or if local priorities and contexts change. As such, this document should be interpreted as a current "snap-shot" in time, and future iterations of this WCRP will build upon the material presented in this plan to continuously improve aquatic barrier remediation for migratory fish in the Bulkley River watershed. For more information on how WCRPs are developed, see Mazany-Wright et al. 2021c.

Vision Statement

Healthy, well-connected streams and rivers within the Bulkley River watershed support thriving populations of migratory and resident fish. In turn, these fish provide the continued sustenance, cultural, and ceremonial needs of the Wet'suwet'en and Gitxsan peoples, as they have since time immemorial. First Nations, residents, and visitors to the watershed work together for environmental stewardship to clarify, implement, and assess the effectiveness of actions to mitigate the negative effects of aquatic barriers, improving the resiliency of streams and rivers for the benefit and appreciation of all.

Planning Team

Table 1. Bulkley River watershed WCRP planning team members. Planning team members contributed to the development of this plan by participating in a series of workshops and document and data review. The plan was generated based on the input and feedback of the local groups and organizations list in this table.

Name	Organization
Betty Rebellato	Canadian Wildlife Federation
Nick Mazany-Wright	Canadian Wildlife Federation
Nick O'Hanley	Canadian Wildlife Federation
Nicolas Lapointe	Canadian Wildlife Federation
Sarah Sra	Canadian Wildlife Federation
Simon Norris	Hillcrest Geographics
Natalie Newman	Department of Fisheries and Oceans Canada
Peter Dekoning	Department of Fisheries and Oceans Canada
Sandra Devcic	Department of Fisheries and Oceans Canada

Bill Blackwater	Gitxsan Nation
Brian Williams	Gitxsan Nation
Elaine Sampson	Gitxsan Nation
Gordon Sebastian	Gitxsan Nation
Kenji Miyazaki	Ministry of Forests, Lands and Natural Resource Operations
Al Irvine	Society for Ecosystem Restoration in Northern BC
Jesse Stoeppler	Skeena Watershed Conservation Coalition
David Dewit	Office of the Wet'suwet'en
Mike Ridsdale	Office of the Wet'suwet'en
Dallas Nikal	Witset First Nation
Josh Noseworthy	Global Conservation Solutions

Key Actors

Table 2. Additional Key Actors in the Bulkley River watershed. Key Actors are the individuals, groups, and/or organizations, outside of the planning team, with influence and relevant experience in the watershed, whose engagement will be critical for the successful implementation of this WCRP.

Individual / Organization Name	Role and Primary Interest
B.C. Fish Passage Technical Working Group	The provincial government of B.C. can assist with local knowledge, data, expertise and can help facilitate barrier remediation work.
Cindy Verbeek/ A Rocha Canada, Upper Bulkley Streamkeepers	A Rocha educates and coordinates environmental stewardship activities for local people in the upper Bulkley watershed and can advise and support where needed. A Rocha Canada runs the Upper Bulkley River Streamkeepers project working with local environmental organizations, churches, schools, governments and citizens to ensure the watershed is healthy and flourishing. They have bio-inventory surveying data, water temperature data, and can help ensure that salmon reach their spawning ground.
Canadian National Rail (CN Rail)	CN Rail is a major proponent and barrier owner that can play a role in improving and replacing crossings in the valley bottom of the Bulkley River watershed.
David Wilford – Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRO)	Dave Wilford is a hydrologist and researcher working in the watershed.

Gitksan Watershed Authorities	Gitksan Watershed Authorities is a traditional and science-based body of fisheries professionals, biologists, field technicians, community leaders and support staff. This group is governed according to the traditional Gitksan house system. The GWA functions to represent the Gitksan for the management of fisheries on the Skeena and within the Gitksan territories.
Jeff Anderson	Jeff Anderson is a hydrologist at Geomorphic Consulting working in the watershed.
Skeena Knowledge Trust	The Skeena Knowledge Trust can help with data management.
Ken Rabnett	Ken Rabnett is a researcher, field lead and an excellent source of local knowledge.
Ministry of Transportation and Infrastructure (MOTI)	MOTI is a major proponent and barrier owner that can play a role in improving and replacing crossings in the valley bottom of the Bulkley River watershed.
Ministry of Forests, Lands, Natural Resource Operations, and Rural Development (FLNRORD)	FLNRORD can assist with engineering and design work for remediation projects.
Environmental Stewardship Initiative – Skeena Sustainability Assessment Forum (ESI:SSAF)	ESI:SSAF is a forum that allows first Nations and the Province to Fully collaborate to enhance environmental sustainability, and to address First Nation's long standing concerns with stewardship of the land and cumulative impacts in their traditional territories by creating meaningful space for traditional ecological knowledge alongside western science. ESI:SSAFF should be engaged to coordinate local implementation of the outcomes of the WCRP and support future planning updates.
SkeenaWild Conservation Trust	SkeenaWild engages in applied scientific research on salmon ecosystems and can help provide data.
Stu Barns/Skeena Fisheries Commission	The Skeena Fisheries Commission is an umbrella organization for First Nations and works directly with the Office of the Wet'suwet'en and the Gitxsan Watershed Authority. They can advise and support where needed.

Project Scope

Connectivity is a critical component of freshwater ecosystems that encompasses a variety of factors related to ecosystem structure and function, such as the ability of aquatic organisms to disperse and/or migrate, the transportation of energy and matter (e.g., nutrient cycling and sediment flows), and temperature regulation (Seliger & Zeiringer 2018). Though each of these factors are important when considering the health of a watershed, for the purposes of this WCRP the term "connectivity" is defined as the degree to which aquatic organisms can disperse and/or migrate freely through freshwater systems. Within this context, connectivity is primarily

constrained by physical barriers including anthropogenic infrastructure such as dams, weirs, and stream crossings, and natural features such as waterfalls and debris flows. This plan is intended to focus on the direct remediation and prevention of localized, physical barriers instead of the broad land-use patterns that are causing chronic connectivity issues in the watershed. The planning team decided that the primary focus of this WCRP is addressing barriers to longitudinal connectivity (i.e., along the upstream-downstream plane) due to the magnitude of the threat posed by linear development (i.e., road and rail lines) in the watershed.

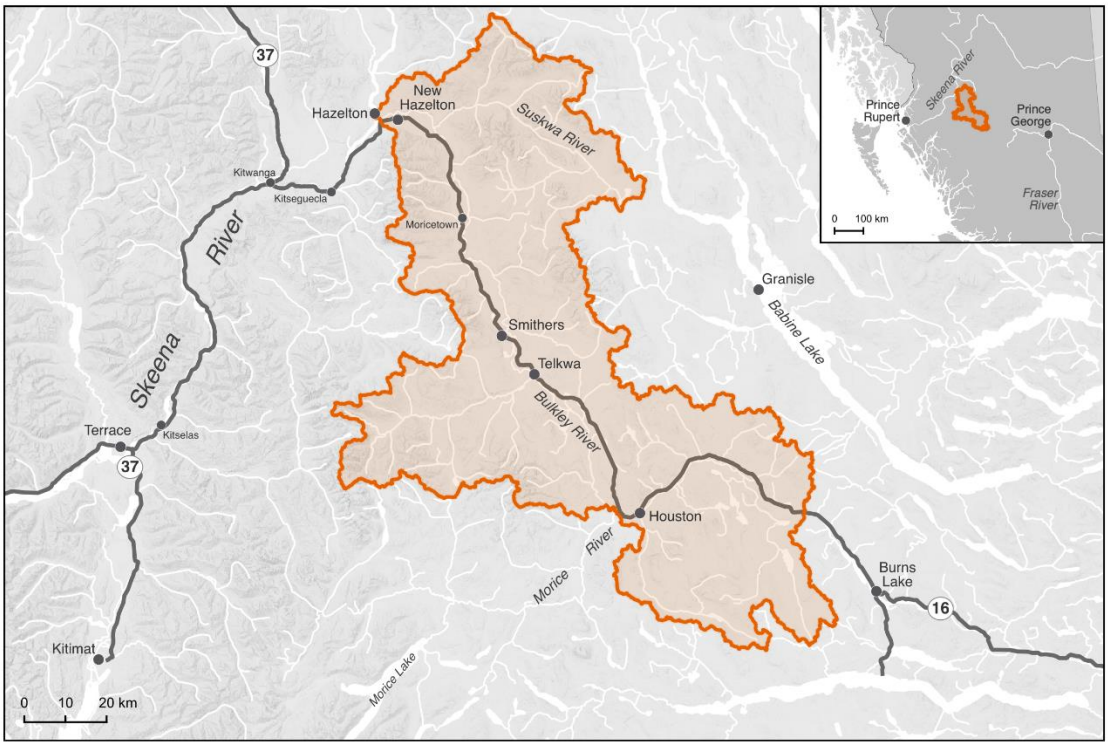

Figure 1. The primary geographic scope — the Bulkley River watershed, excluding the Morice River drainage.

The primary geographic scope of this WCRP is the Bulkley River watershed, located in the mid-eastern portion of the Skeena River drainage basin in northwestern British Columbia (Figure 1). The scope constitutes the Bulkley River "watershed group" as defined by the British Columbia Freshwater Atlas (FWA), which excludes the Morice River drainage area due to an effort made to standardize spatial scales of the watershed groups. A consistent spatial framework was necessary to undertake a watershed-selection process at the provincial scale to identify target watersheds to improve connectivity for salmonids. The Bulkley River watershed was identified by the BC Fish Passage Restoration Initiative as one of four target watersheds for WCRP development (Mazany-Wright et al. 2021b). The Bulkley River watershed has a drainage area of 776,200 ha, spanning from Bulkley Lake in the southeast to the confluence with the Skeena

River in the northwest. The watershed is generally divided into the "lower" Bulkley River and the "upper" Bulkley River by the confluence with the Morice River near the town of Houston. Culturally and economically important populations of Chinook Salmon, Coho Salmon, Sockeye Salmon, and Steelhead are all found in the watershed, which historically supported Indigenous sustenance and trading economies (Table 3; Irvine 2021).

Table 3. Target fish species in the Bulkley River watershed. The Gitxsanimax, Witsuwit'en, and Western common and scientific species names are provided.

Gitxsanimax	Witsuwit'en	Common Name	Scientific Name
Ya'aa	Ggïs	Chinook Salmon	*Oncorhynchus tshawytscha*
Eek	Deedzex	Coho Salmon	*Oncorhynchus kisutch*
Mi'soo	Taalook	Sockeye Salmon	*Oncorhynchus nerka*
Milit	Tësdlï	Steelhead	*Oncorhynchus mykiss*

The Bulkley River watershed comprises parts of the traditional territories of two matrilineal nations:

- **Gitxsan** peoples– the traditional Gitxsan Laxyip spans the northern portion of the watershed, including the Suskwa River, and is governed by a hereditary system of 60 Wilps or House Groups who are represented by Simgigyat (hereditary chiefs). Each Wilp has jurisdiction over several Anaat, or fishing sites. The Wilp groups that have territory coinciding with the Bulkley River watershed include Djogaslee, Gyet'm Galdo'o, Luutkudziiwas, Axtii Tsex, Yagosip, and Spookw (G. Sebastian pers. comm.). The Gitxsan steward the land and waters based on Ayookw (Gitxsan law) and Adaakw (oral histories; Gitxsan 2019, Irvine 2021). It is necessary to receive permission from the individual Wilp chief for any work to occur on their territory.
- **Wet'suwet'en** peoples– the Wedzin Kwah (Bulkley River watershed) is part of the larger Wet'suwet'en traditional territory. The hereditary territory is governed by a system made up of five clans – Gilseyhu (Big Frog), Laksilyu (Small Frog), Tsayu (Beaver), Gitdumden (Wolf/Bear) and Laksamshu (Fireweed) – each of which comprises multiple Yikhs (House Groups) represented by hereditary chiefs. The Wet'suwet'en steward the land based on Inuk Nu'at'en (Wet'suwet'en law), and the principle of Yintahk, meaning everything is connected to the land (Office of the Wet'suwet'en 2013, Irvine 2021). It is necessary to receive permission from the appropriate bands (Witset First Nation or Wet'suwet'en first Nation, Skin Tyee, Nee Tahi Buhn, or Burns Lake Band), nation representatives (Office of the Wet'suwet'en), and the individual Yikh chiefs for any work to occur on their territory.

The geographic scope of this WCRP was further refined by identifying “potentially accessible” stream segments, which are defined as streams that target species should be able to access in the absence of anthropogenic barriers (Figure 2). Potentially accessible stream segments were spatially delineated using fish species observation and distribution data, as well as data on "exclusionary points", which are waterfalls greater than 5 m in height and gradient barriers based on species-specific swimming abilities. These maps were explored by the planning team to incorporate additional local knowledge, ensure accuracy, and finalize the constraints on potentially accessible stream segments. All other stream segments were removed from the scope for further consideration. The "constrained geographic scope" formed the foundation for all subsequent analyses and planning steps, including mapping and modelling useable habitat types, quantifying the current connectivity status, goal setting, and action planning (Mazany-Wright et al. 2021a).

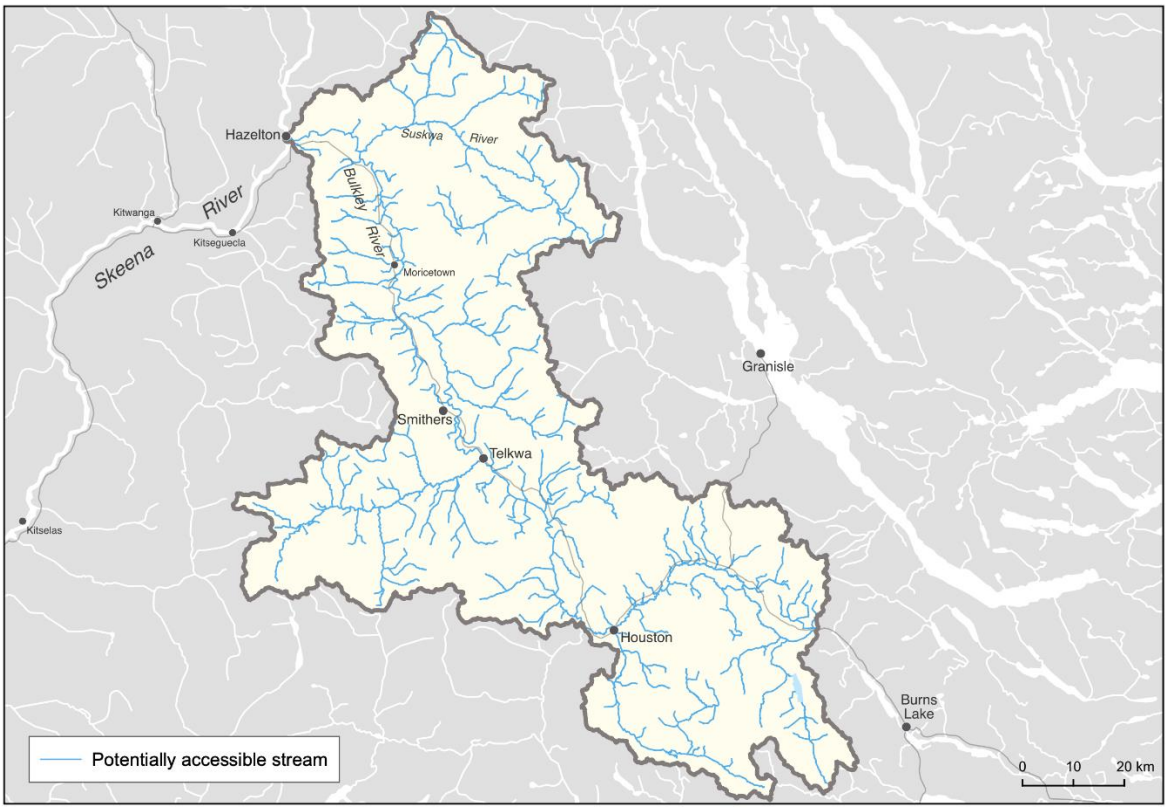

Figure 2. Potentially accessible stream segments within the Bulkley River watershed. These do not represent useable habitat types, but rather identifies the stream segments within which habitat modelling and barrier mapping and prioritization was undertaken.

Target Species

Target species represent the ecologically and culturally important species for which habitat connectivity is being conserved and/or restored in the watershed. In the Bulkley River watershed, the planning team selected *Anadromous Salmonids* as the target species group, which comprises Chinook Salmon, Coho Salmon, Sockeye Salmon, and Steelhead. Anadromous salmonids also include Pink Salmon (*Oncorhynchus gorbuscha*) and Chum Salmon (*Oncorhynchus keta*) as beneficiary species (i.e., species that are not actively targeted through the planning process but will also benefit from connectivity improvements for target anadromous species in the watershed). The selection of these target species was driven primarily by the target species of the primary fund supporting this planning work. The planning team also identified other culturally and ecologically important species within the watershed to consider for inclusion in future iterations of the WCRP, including Pacific Lamprey (*Entosphenus tridentatus*) and Bull Trout (*Salvelinus confluentus*).

Anadromous Salmonids

Anadromous salmonids are cultural and ecological keystone species that contribute to productive ecosystems by contributing marine-derived nutrients to the watershed and forming an important food source for grizzly bears and other species (Schindler et al. 2003). Salmon have enduring food, social, and ceremonial value for the Gitxsan and Wet'suwet'en peoples and contribute significant economic value for recreational and commercial fisheries. Salmon have sustained the culture and economies of Indigenous peoples in the watershed since time immemorial – providing the primary food source for communities, supporting wide-ranging trade systems, and helping pass knowledge and ceremony to future generations through fishing and fish processing (SSAF 2021, Office of the Wet'suwet'en 2013, Rescan 2012).

Anadromous salmonid populations in the Bulkley River watershed have declined significantly in recent decades, leading both the Gitxsan and Wet'suwet'en nations to declare harvest moratoriums or fishing bans in their territories (Office of the Wet'suwet'en 2013, Gitxsan Huwilp Government 2019). The stewardship of these resources in their territories are imbued in the spirit and culture of these nations through a symbiotic relationship with these fish species – threats to the fish are threats to the well-being of the Wet'suwet'en and Gitxsan peoples (SSAF 2021). The stewardship of their waters continues through the work of the Gitksan Watershed Authorities and the Wet'suwet'en Fisheries Program, as well as collaborative initiatives like the Skeena Environment Stewardship Initiative.

For the purposes of this WCRP, anadromous salmonid populations are defined using Fisheries and Oceans Canada's Conservation Units. A Conservation Unit (CU) is a group of wild Pacific salmon sufficiently isolated from other groups that, if extirpated, is very unlikely to recolonize naturally within an acceptable timeframe, such as a human lifetime or a specified number of salmon generations. Conservation Units are not defined for Steelhead, as such there is no assessment information to provide for the Bulkley River watershed population. See Appendix A for maps of modelled anadromous salmonid spawning and rearing habitat in the Bulkley River watershed.

Chinook Salmon | Ya'aa | Ggïs| Oncorhynchus tshawytscha

Table 4. Chinook Salmon Conservation Units assessments in the Bulkley River watershed. Assessments undertaken by the Pacific Salmon Foundation (2020).

Conservation Unit	Biological Status	Run timing	Trend in spawner abundance (all available data)	Trend in spawner abundance (last 3 generations)
Middle Skeena – Mainstem Tributaries	Good	July-September	575%	-63%
Upper Bulkley River	Data Deficient	Data Deficient	Data Deficient	Data Deficient

The Middle Skeena – Mainstem Tributaries Chinook Salmon spawn in the mainstem Bulkley River (downstream of the confluence with the Morice River) and in key tributaries, including Telkwa River, Goathorn Creek, Howson Creek, Kathlyn Creek, Suskwa River, Harold Price Creek, and Natlan Creek. The Middle Skeena Chinook Salmon stocks have seen a decline in recent years, particularly over the last three generations of spawners (Pacific Salmon Explorer).

The upper Bulkley River Chinook Salmon (upstream of the confluence with the Morice River) are the first salmon to return in the year, usually early-to-mid June, marking the start of the salmon fishery in the watershed (Office of the Wet'suwet'en 2013). The upper Bulkley River population is known to spawn in the mainstem and tributaries of the Bulkley River, including Buck Creek, Byman Creek, Richfield Creek, Maxan Creek, and Foxy Creek. In some years, low water flows prevent adult Chinook Salmon from migrating past Bulkley Falls. The upper Bulkley Chinook Salmon stocks have been observed to be in decline and are threatened, in part, by habitat degradation, including linear development (e.g., highway, rail, and road infrastructure) that fragments tributaries (Office of the Wet'suwet'en 2013, Pacific Salmon Explorer).

Coho Salmon | Eek | Deedzex | Oncorhynchus kisutch

Table 5. Coho Salmon Conservation Unit assessment in the Bulkley River Watershed. Assessments undertaken by the Pacific Salmon Foundation (2020).

Conservation Unit	Biological Status	Run timing	Trend in spawner abundance (all available data)	Trend in spawner abundance (last 3 generations)
Middle Skeena	Good	July-September	82%	-26%

Coho Salmon are the most widely dispersed anadromous salmonid species in the Bulkley River watershed due to their ability to move into smaller tributaries, including headwater streams. Coho Salmon spawning migration peaks in early-to-mid August, though traditionally the main Coho Salmon fishery occurs later in the season (Office of the Wet'suwet'en 2013). Spawning

and rearing of the Middle Skeena population is known to occur within the watershed in the mainstem channels of the Bulkley, Telkwa, and Suskwa Rivers, and key tributaries, including Buck Creek, Aitken Creek, McQuarrie Creek, Byman Creek, Richfield Creek, Ailport Creek, and Maxan Creek. In recent decades, Coho Salmon distribution has often been limited to areas downstream of Bulkley Falls, but in years with sufficient flow, tributaries upstream of the falls are well-used by rearing juveniles (M. Risdale pers. comm.). The Coho Salmon population in the watershed appeared to begin recovering around 1998 but has since declined over the last three generations of spawners (Office of the Wet'suwet'en 2013, PSF 2014). Additionally, since 1989, tens of thousands of Coho Salmon fry have been released into the upper Bulkley River mainstem from the Toboggan Hatchery on Toboggan Creek (Office of the Wet'suwet'en 2013).

Sockeye Salmon | Mi'soo | Taalook | Oncorhynchus nerka

Table 6. Sockeye Salmon Conservation Unit Assessments in the Bulkley River watershed. There were not enough data to support assessments for Sockeye Salmon populations at the time of analysis. Assessments undertaken by the Pacific Salmon Foundation (2020).

Conservation Unit	Biological Status	Run timing	Trend in spawner abundance (all available data)	Trend in spawner abundance (last 3 generations)
Bulkley/Maxan (Lake type)	Data Deficient	Data Deficient	Data Deficient	Data Deficient
Skeena River (River-type)	Data Deficient	Data Deficient	Data Deficient	Data Deficient

Sockeye Salmon have cultural and commercial importance within the watershed, especially for First Nations communities, in part due to their fat content which is optimal for the smoke-drying process. Limitations on the Sockeye Salmon harvest in the watershed have hindered the ability of the Wet'suwet'en and Gitxsan to practice important cultural activities and the associated sharing of oral traditions and histories (SSAF 2021, Office of the Wet'suwet'en 2013). The Sockeye Salmon runs generally follow the spring Chinook Salmon migrations in the Bulkley River system, but Bulkley Falls and flows in some parts of Maxan Creek can limit migration during low-flow years. Data are insufficient for population assessments; however, it is believed that the Bulkley/Maxan populations are at risk of extirpation. There are two Sockeye Salmon populations present in the watershed with distinct life histories – the lake-type and the river-type (Office of the Wet'suwet'en 2013, PSF 2014). Two lake-type Sockeye Salmon sub-populations spawn and rear in and around Bulkley Lake and Maxan Lake, and a third lake-type sub-population was extirpated from Toboggan Lake. River-type Sockeye distribution and habitat use within the Bulkley River watershed is not well documented; however, there are records of Sockeye Salmon river spawners in the mainstem Bulkley River around Richfield Creek, McQuarrie Creek, the Morice River confluence, and the Suskwa River mainstem near Natlan Creek.

Steelhead | Milit | Tësdlï | Oncorhynchus mykiss

Steelhead migrations coincide with the arrival of Coho Salmon in the watershed and are an important traditional food source to augment winter stores (Office of the Wet'suwet'en 2013). Steelhead are known to spawn and rear in the mainstem Bulkley River and important tributaries, including the Telkwa River, Hubert Creek, Buck Creek, McQuarrie Creek, Byman Creek, Richfield Creek, Ailport Creek, Johnny David Creek, and Robert Hatch Creek. In the lower part of the watershed, Steelhead are known to spawn and rear throughout the Suskwa River system, all the way up through Harold Price Creek and Blunt Creek. Local knowledge indicates that Steelhead populations have been declining in recent decades and are currently in poor condition throughout the entire watershed. In response, some stocking enhancement actions have been undertaken in an attempt to increase the population in the watershed (Office of the Wet'suwet'en 2013, Chudyk 1979).

Key Ecological Attributes and Current Connectivity Status

The planning team devised two Key Ecological Attributes (KEAs) and associated indicators to assess the current connectivity status of the watershed – Accessible Spawning Habitat and Accessible Rearing Habitat. KEAs are the key aspects of anadromous salmonid ecology that are being targeted by this WCRP. The connectivity status for the Anadromous Salmonid KEAs were used to establish goals to improve habitat connectivity in the watershed and will be the baseline against which progress is tracked over time.

The current connectivity status assessment relies on GIS analyses to map known and modelled barriers to fish passage, identify stream reaches that have potential spawning and rearing habitat, estimate the proportion of habitat that is currently accessible to target species, and prioritize barriers for field assessment that would provide the greatest gains in connectivity. To support a flexible prioritization framework to identify priority barriers in the watershed, two assumptions are made: 1) any modelled (i.e., passability status is unknown) or partial barriers are treated as complete barriers to passage and 2) the habitat modelling is binary, it does not assign any habitat quality values. As such, the current connectivity status will be refined over time as more data on habitat and barriers are collected. For more detail on how the connectivity status assessments were conducted, see Appendix B.

Table 7. Connectivity status assessment for spawning (a) and rearing (b) habitat in the Bulkley River watershed. The two KEAs - Accessible Spawning Habitat and Accessible Rearing Habitat - are evaluated by dividing the length of linear habitat (of each type) that is currently accessible to target species by the total length of all linear habitat (of each type) in the watershed.

a

			Indicator Ratings			
Target Species	**KEA**	**Indicator**	**Poor**	**Fair**	**Good**	**Very Good**
Anadromous Salmonids	Available Spawning Habitat	% of total linear spawning habitat accessible	<50%	51 - 75%	76 – 90%	>90%
		Current Status:			**84%**	
Comments: Indicator rating definitions are based on the consensus decisions of the planning team. The current status is based on the CWF Barrier Prioritization Model output, which is current as of August 2021.						

b

			Indicator Ratings			
Target Species	**KEA**	**Indicator**	**Poor**	**Fair**	**Good**	**Very Good**
Anadromous Salmonids	Available Rearing Habitat	% of total linear rearing habitat accessible	<50%	51 - 75%	76 – 90%	>90%
		Current Status:		**65%**		
Comments: Indicator rating definitions are based on the consensus decisions of the planning team. The current status is based on the CWF Barrier Prioritization Model output, which is current as of August 2021.						

Barrier Types

The following table highlights which barrier types pose the greatest threat to anadromous salmonids in the watershed. The results of this assessment were used to inform the subsequent planning steps, as well as to identify knowledge gaps where there is little spatial data to inform the assessment for a specific barrier type.

Table 8. Barrier Types in the Bulkley River watershed and barrier rating assessment results. For each barrier type listed, "Extent refers to the proportion of anadromous salmonid habitat that is being blocked by that barrier type, "Severity" is the proportion of structures for each barrier type that are known to block passage for target species based on field assessments, and "Irreversibility" is the degree to which the effects of a barrier type can be reversed and connectivity restored. The amount of habitat blocked used in this exercise is a representation of total amount of combined spawning and rearing habitat.

Barrier Types	Extent	Severity	Irreversibility	Overall Threat Rating:
Large Dams (>3m height)	Low	Very High	High	**Low**
Small Dams (<3m height)	Low	Very High	Medium	**Low**
Road-stream Crossings	High	Very High	Medium	**High**
Rail-stream Crossings	High	High	Medium	**High**
Trail-stream Crossings	Medium	Medium	Low	**Low**
Lateral Barriers	Medium	Very High	Medium	**Medium**
Natural Barriers	Medium	High	Medium	**Medium**

Large Dams (>3m height) and Small Dams (<3m height)

There are 24 mapped large and small dams on “potentially accessible” stream segments in the watershed, blocking 12.09 km (1.7% of the total blocked habitat) of modelled spawning and rearing habitat, resulting in a Low extent. The extent rating of these structures was confirmed by the planning team. There is only one known fish passage structure in the watershed and the remaining dams likely block passage for anadromous salmonids. Remediating these dams will require significant resources; however, due to the Low extent of dams in the watershed, a final pressure rating of Low was assigned.

Road-stream Crossings

Road-stream crossings are the most abundant barrier type in the watershed, with over 3,000 assessed and modelled crossings located on “potentially accessible” stream segments. Demographic road crossings (highways, municipal, and paved roads) block 165.63 km of habitat (23.1% of the total blocked habitat), with 81% of assessed crossings having been identified as barriers to fish passage. Resource roads block 494.37 km of habitat (68.9%), with 63% of assessed crossings have been identified as barriers. Significant land use and linear development throughout the valley bottom has disconnected the Bulkley River from important habitat in many tributaries, including Highway 16 which represents one of the main drivers of fragmentation in the watershed (see Appendix C - Barrier Prioritization results). The collective experience and input from the planning team resulted in a Medium irreversibility rating due to the technical complexity and resources required to remediate road-stream crossings, though it was noted that this differs considerably between resource roads and highway crossings.

Rail-stream Crossings

There are relatively few rail-stream crossings in the watershed (126 crossings on "potentially accessible" streams), but those that exist block significant amounts of habitat (45.41 km or 6.3% of the total habitat blocked), with more than half of assessed crossings (55.6%) acting as barriers to anadromous salmonids. All rail-stream crossings in the watershed are associated with the Canadian National (CN) railway running along the Bulkley River. With significant financial costs, technical challenges, and stakeholder engagement required with CN to remediate these barriers, the planning team decided on an overall pressure rating of High for this barrier type.

Trail-stream crossings

There is very little spatial data available on trail-stream crossings in the watershed, so the planning team was unable to quantify the true Extent and Severity of this barrier type. However, the planning team felt that trail-stream crossings are not prevalent within the watershed and that where they do exist, they rarely significantly block passage for anadromous salmonids. Given that most crossings will likely be fords or similar structures, the remediation costs associated with these barriers would be quite low. Overall, the planning team felt that the pressure rating for trail-stream crossings was likely Low.

Lateral Barriers

There are numerous types of lateral barriers that potentially occur in the watershed, including dykes, berms, and linear development (i.e., road and rail lines), all of which can restrict the ability of anadromous salmonids to move into floodplains, riparian wetlands, and other off-channel habitats. No comprehensive lateral barrier data exists within the watershed, so pressure ratings were based on qualitative local knowledge. Lateral barriers are not thought to be as prevalent as road- or rail-stream crossings but are likely very severe where they do exist. Highway 16 and the CN rail line that run along a significant stretch of the Bulkley River were identified as major lateral barriers that disconnect the mainstem river from its historic floodplain and off-channel habitat. Overall, the planning team decided that a Medium pressure rating adequately captured the effect that lateral barriers are having on connectivity in the watershed, while recognizing that the lack of data on lateral barriers in the watershed is an important knowledge gap to fill.

Natural Barriers

Natural barriers to fish passage can include debris flows, log jams, sediment deposits, etc., but natural features that have always restricted fish passage (e.g., waterfalls) are not considered under this barrier type. Natural barriers are difficult to include in a spatial prioritization framework due to their transient nature. The planning team felt that the extent of natural barriers in the watershed is seasonal and fluctuates with freshet flow levels. Both current and historic land-use practices, including historic mining and current forest-harvesting impacts, have created sediment wedges that can act as significant barriers to anadromous salmonids. Due to the nature of these land-use practices, the severity of natural barriers was rated as High

and the irreversibility as Medium, the latter due to the nature of what would be required to rectify poor land-use practices at a watershed scale. Overall, the planning team felt that a pressure rating of Medium adequately captured the effects of natural barriers.

Situation Analysis

The following situation model was developed by the WCRP partnership to “map” the project context and brainstorm potential actions for implementation. Green text is used to identify actions that were selected for implementation (see 'Strategies & Actions'), and red text is used to identify actions that the project team has decided to exclude from the current iteration of the plan, given that they were either outside of the project scope or were deemed to be ineffective by the planning team.

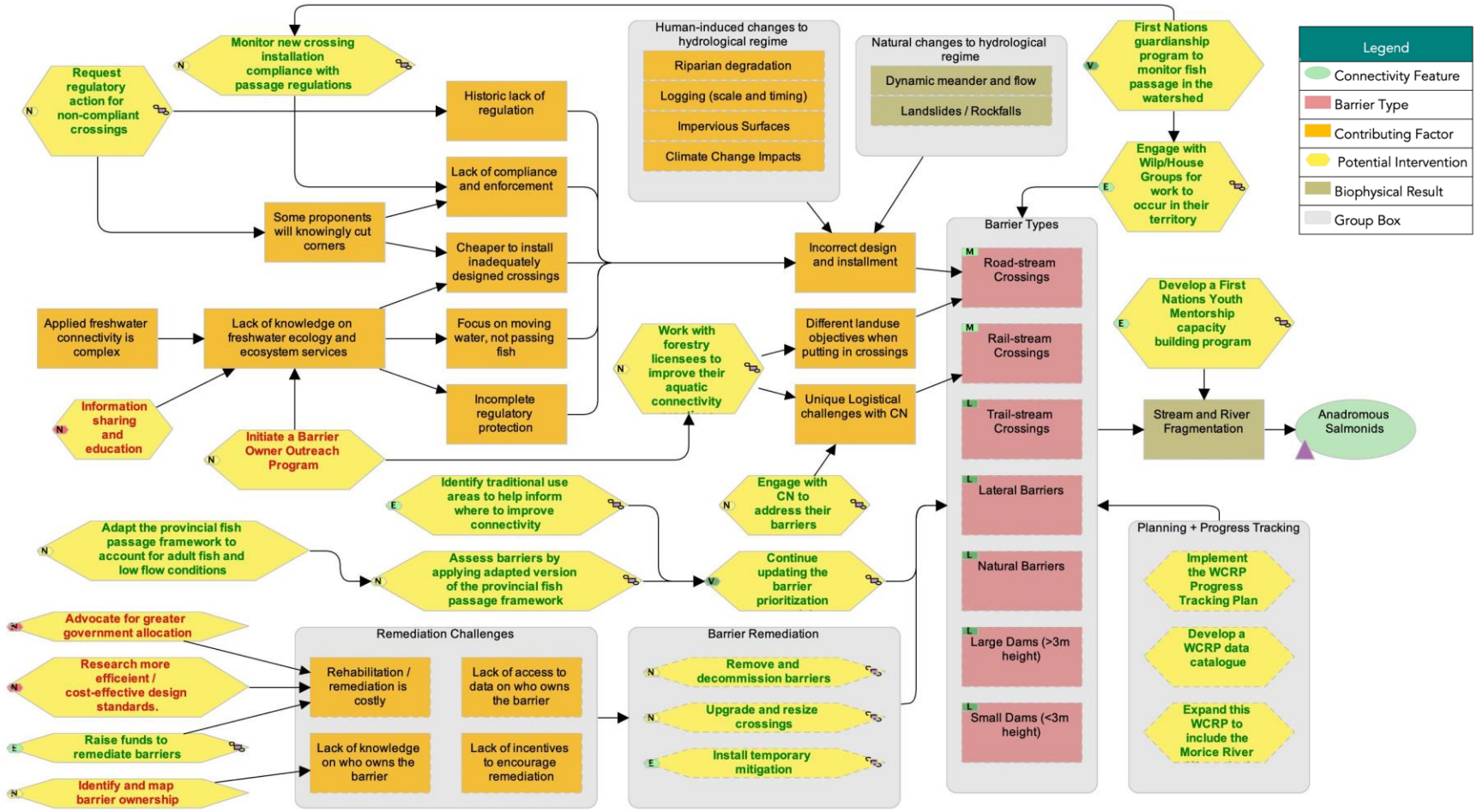

Figure 2. Situation analysis developed by the planning team to identify factors that contribute to fragmentation (orange boxes), biophysical results (brown boxes), and potential strategies/actions to improve connectivity (yellow hexagons) for target species in the Bulkley River watershed.

Goals

Table 9. Goals to improve spawning (1) and rearing (2) habitat connectivity for target species in the Bulkley River watershed over the lifespan of the WCRP (2021-2031). The goals were established through discussions with the planning team and represent the resulting desired state of connectivity in the watershed. The goals are subject to change as more information and data are collected over the course of the plan timeline (e.g., the current connectivity status is updated based on barrier field assessments).

Goal #	Goal
1	By 2031, the percent (%) of total linear spawning habitat accessible to anadromous salmonids will increase from 84% to 91% within the Bulkley River watershed (i.e., reconnect at least 91 km of spawning habitat).
2	By 2031, the percent (%) of total linear rearing habitat accessible to anadromous salmonids will increase from 65% to 80% within the Bulkley River watershed (i.e., reconnect at least 297 km of rearing habitat).

Strategies & Actions

Table 10. Effectiveness evaluation of identified conservation strategies and associated actions to improve connectivity for target species in the Bulkley River watershed. The planning team identified four broad strategies to implement through this WCRP, 1) barrier remediation, 2) barrier prevention, 3) strengthen Indigenous connections to land and water, and 4) planning and progress tracking. Individual actions were qualitatively evaluated based on the anticipated effect each action will have on realizing on-the-ground gains in connectivity. Effectiveness ratings are based on a combination of "Feasibility and "Impact", Feasibility is defined as the degree to which the project team can implement the action within realistic constraints (financial, time, ethical, etc.) and Impact is the degree to which the action is likely to contribute to achieving one or more of the goals established in this plan.

Strategy 1: Barrier Remediation

ID	Actions	Details	Feasibility	Impact	Effectiveness
1.1	Remove and decommission barriers	This action represents some projects that would be led by the planning team with conservation funds (e.g., orphaned barriers or those owned by individuals), while other remediation projects would be the responsibility of the barrier owner. Industry will have to be engaged to successfully implement this intervention.	**Medium**	**Very high**	**Need more information**
1.2	Upgrade and resize crossings	Examples include installing larger culverts, replacing closed- with open-bottom culverts, or upgrading from culverts to bridges. Important to engage with the agriculture community for some crossing upgrades.	**Medium**	**Very high**	**Need more information**
1.3	Install temporary mitigation	Examples may include installing fish ladders on barriers that cannot be remediated; however, temporary mitigation does not replace the need for barrier remediation and removal. There are specific cases where temporary fixes are appropriate, but	**High**	**High**	**Effective**

		we will focus on long-term solutions wherever possible.			
1.4	Raise funds to remediate barriers	See “Funding Sources” for more information. Consider inviting potential funders to a fundraising sub-committee.	**High**	**Very high**	**Effective**
1.5	Request regulatory action for non-compliant crossings	Request provincial and/or federal agencies to require that targeted, high-priority barriers be remediated. This should be a last resort after working to engage barrier owners and ground-truthing the situation. It will be important to identify obstacles to applying compliance and enforcement measures in order to provide the appropriate information on these opportunities.	**Very high**	**Medium**	**Need more information**
1.6	Engage with CN to address their barriers	Build relationships with CN to open a two-way discussion on the scale, priority and impact to their business of barrier remediation. Include the financial and ecological cost/benefits of remediation options, with emphasis on the financial. This could start as a letter from both First Nations to show that each community, elected chief, and hereditary house sees this as an issue that needs to be resolved.	**Very high**	**Medium**	**Need more information**
1.7	**Knowledge Gap**: Continue updating the barrier prioritization model	The model process will be finalized, and prioritizations will be updated as new information becomes available.	**Very high**	**Very high**	**Very effective**
1.8	**Knowledge Gap:** Adapt the provincial fish passage framework to account for		**Very high**	**Medium**	**Need more information**

	adult fish and low-flow conditions				
1.9	**Knowledge Gap**: Assess barriers by applying adapted version of the provincial fish passage framework	The first three steps are, (1) barrier assessments, (2) habitat confirmations, and (3) remediation designs. Barrier assessment data should be captured in the PSCIS database, which is available to all partners.	**Medium**	**High**	**Need more information**

Strategy 2: Barrier Prevention

ID	Actions	Details	Feasibility	Impact	Effectiveness
2.1	Work with forestry licensees to improve their aquatic connectivity practices	This should include encouraging better consultation before crossings are installed in the first place.	**High**	**Medium**	**Need more information**
2.2	Monitor new crossing installation compliance with regulations regarding fish passage	This action could be directly tied to action 3.3 - First Nations guardianship program.	**Medium**	**Medium**	**Need more information**

Strategy 3: Strengthen Indigenous Connections to Land and Water

ID	Actions	Details	Feasibility	Impact	Effectiveness
3.1	Develop a First Nations Youth Mentorship capacity building program	The program should emphasize: (1) working with First Nations youth, with emphasis on females, to help build capacity around waterway management, and (2) two-way mentorship to strengthen relationships and knowledge sharing with non-Indigenous youth (e.g., sharing knowledge on the	**High**	**Very high**	**Effective**

		importance of the land and the watershed according to Ayook, Adaakw, Inuk Nu'at'en, and Yintahk).			
3.2	Engage with Wilp/Yikh for work to occur in their territory	Obtain permission from the appropriate Wilp/Yihk before conducting any work, including barrier assessments, habitat confirmations, and remediation work.	**Very High**	**High**	**Effective**
3.3	First Nations guardianship program to monitor fish passage in the watershed		**Very High**	**High**	**Effective**
3.4	**Knowledge Gap:** Identify traditional use areas to help inform where to improve connectivity	Used as decision support to choose which projects to proceed with. This information is proprietary, can only be used with permission, and should not be communicated externally. Proper protocols will be followed to ensure this knowledge and information is protected by the knowledge holders.	**Very High**	**Very high**	**Very Effective**

Strategy 4: Planning and Progress Tracking

ID	Actions	Details
4.1	Implement the WCRP Progress Tracking Plan	The WCRP Progress Tracking Plan will help the team to determine whether we are achieving our goals and objectives
4.2	Develop a data catalogue on all current information related to aquatic connectivity in the Bulkley Watershed	
4.3	Explore expanding this WCRP to include the Morice River Watershed	

Theories of Change & Objectives

Theories of Change are explicit assumptions around how the identified actions will achieve gains in connectivity and contribute towards reaching the goals of the plan. To develop Theories of Change, the planning team developed explicit assumptions for each strategy which helped to clarify the rationale used for undertaking actions and provided an opportunity for feedback on invalid assumptions or missing opportunities. The Theories of Change are results oriented and clearly define the expected outcome. The following theory of change models were developed by the WCRP planning team to “map” the causal (“if-then”) progression of assumptions of how the actions within a strategy work together to achieve project goals.

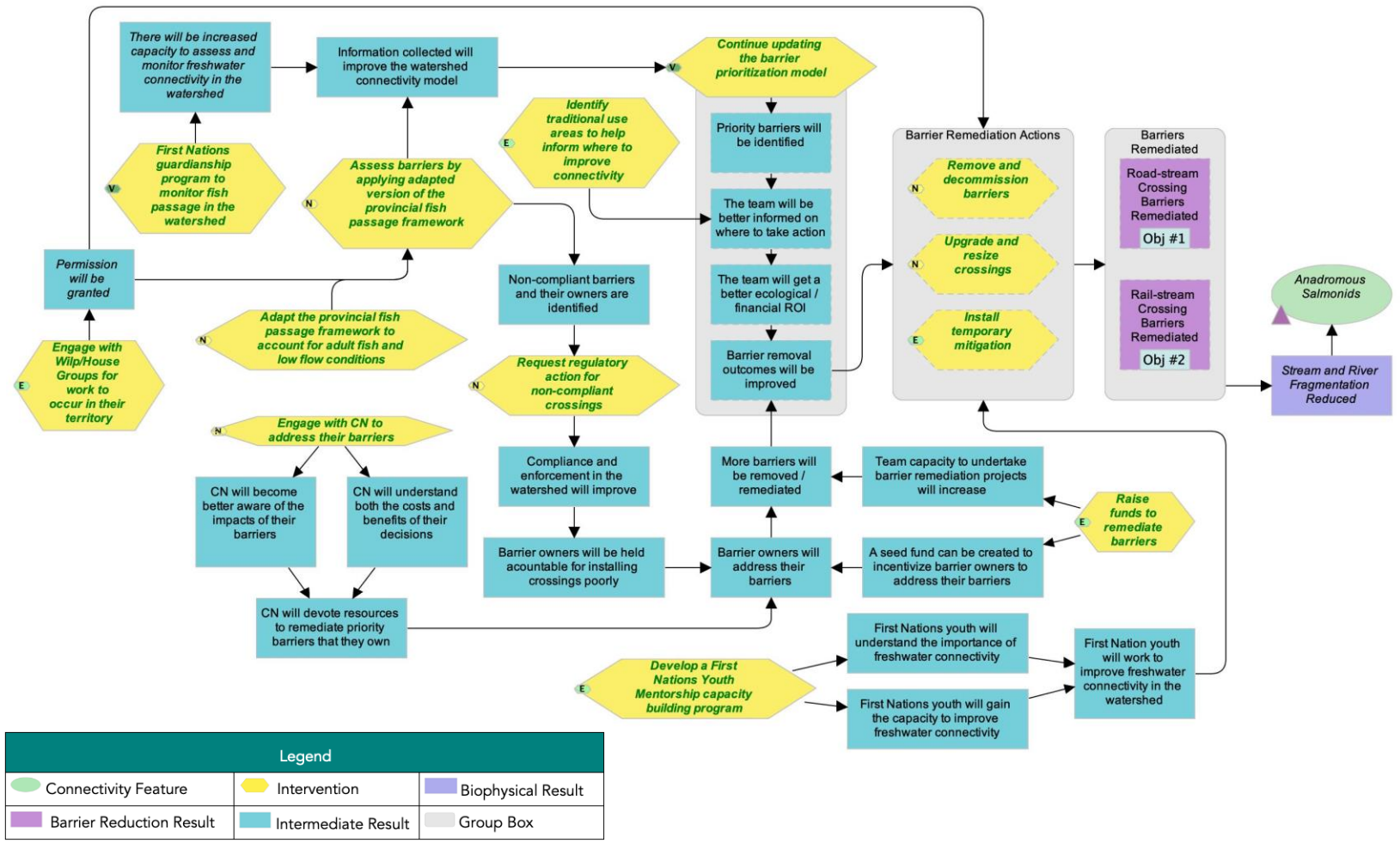

Figure 3. Theory of change developed by the planning team for the actions identified under Strategy 1: Barrier Remediation in the Bulkley River watershed.

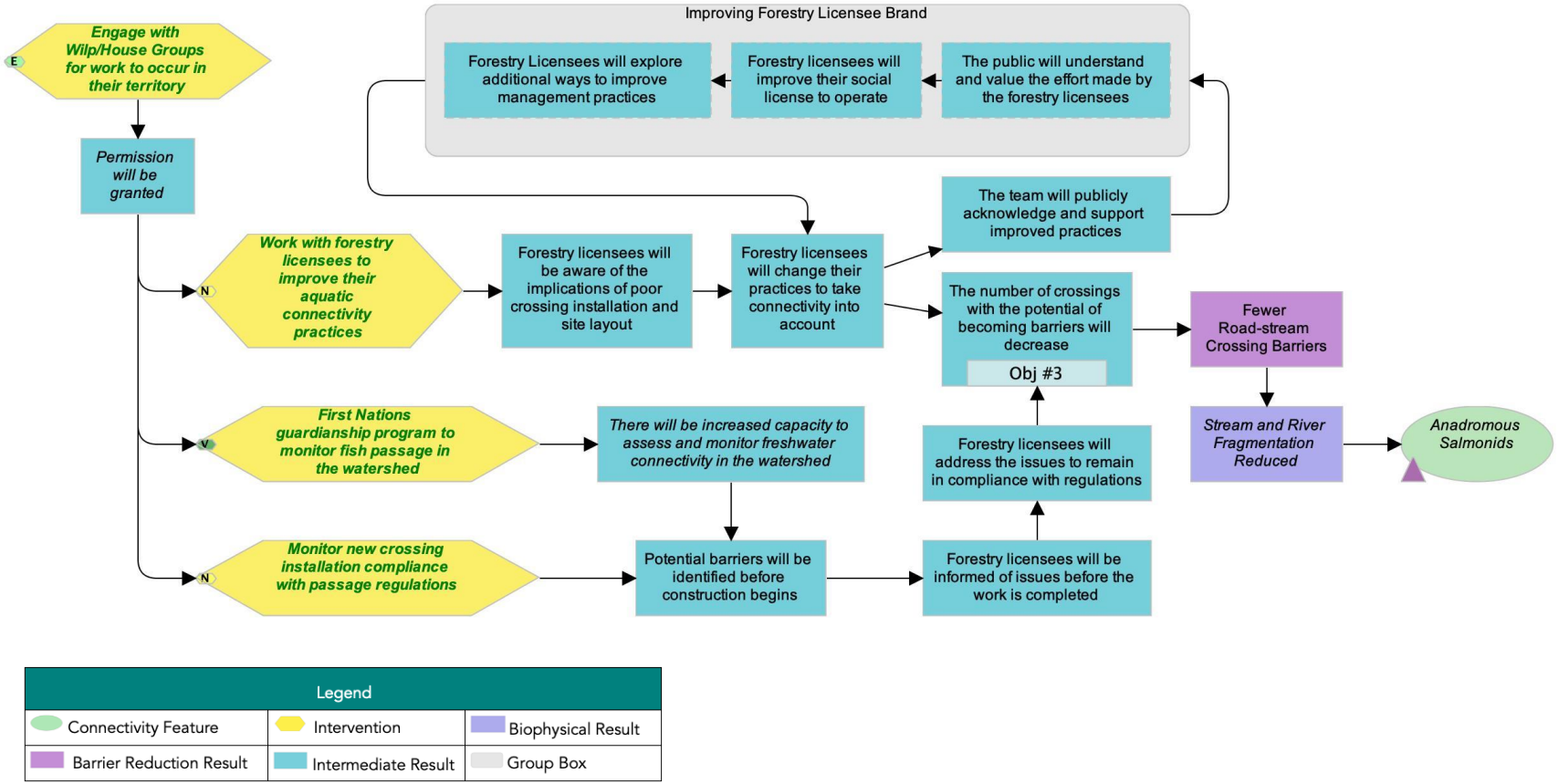

Figure 4. Theory of change developed by the planning team for the actions identified under Strategy 2: Barrier Prevention in the Bulkley River watershed.

Table 11. Objectives to improve connectivity for target species in the Bulkley River watershed. Objectives are formal statements of the desired future outcomes of plan implementation and are used to track progress towards those outcomes.

Objective #	Objective
1	By 2031, 29 road-stream crossing barriers will be remediated in the Bulkley River watershed
2	By 2031, 4 rail-stream crossing barriers will be remediated in the Bulkley River watershed
3	By and beyond 2025, 100% of new road-stream crossings will be passable to anadromous salmonids in the Bulkley River watershed

Progress Tracking Plan

Table 12. Progress Tracking Plan for the Bulkley River watershed to capture results of plan implementation.

Goals / Objectives	Indicator	Methods	Timeframe	Who	Comments
Goal 1: By 2031, the percent (%) of total linear spawning habitat accessible to anadromous salmonids will increase from 84% to 91% within the Bulkley River watershed.	Percent (%) of total linear spawning habitat accessible	Field reports & as-built drawings informing the CWF Barrier Prioritization Model	Annually	CWF – Nick M.	See CWF companion document for detailed GIS procedures
Goal 2: By 2031, the percent (%) of total linear rearing habitat accessible to anadromous salmonids will increase from 65% to 80% within the Bulkley River watershed.	Percent (%) of total linear rearing habitat accessible	Field reports & as-built drawings informing the CWF Barrier Prioritization Model	Annually	CWF – Nick M.	See CWF companion document for detailed GIS procedures
Objective 1: By 2031, 29 road-stream crossing barriers will be remediated in the Bulkley River watershed.	The number (#) of road-stream crossings remediated	CWF tracking within the Barrier Prioritization Model + PSCIS database	Annually	CWF - Nick M. & Betty	See CWF companion document for

					detailed GIS procedures
Objective 2: By 2031, 4 rail-stream crossing barriers will be remediated in the Bulkley River watershed.	The number (#) of rail-stream crossings remediated	CWF tracking within the Barrier Prioritization Model + PSCIS database	Annually	CWF - Nick M. & Betty	See CWF companion document for detailed GIS procedures
Objective 3: By 2031, 100% of new road-stream crossings will be passable to anadromous salmonids in the Bulkley River watershed.	% of new road-stream crossings properly installed	*TBD* – either inspect all new crossings or a subset	Annually	*TBD*	*TBD*

Operational Plan

The operational plan represents a preliminary exercise undertaken by the planning team to identify the potential leads, potential participants, and estimated cost for the implementation of each action in the Bulkley River watershed. The table below summarizes individuals, groups, or organizations that the planning team felt could lead or participate in the implementation of the plan and should be interpreted as the first step in on-going planning and engagement to develop more detailed and sophisticated action plans for each entry in the table. The individuals, groups, and organizations listed under the "Lead(s)" or "Potential Participants" columns are those that provisionally expressed interest in participating in one of those roles or were suggested by the planning team for further engagement (denoted in bold), for those that are not members of the planning team. The leads, participants, and estimated costs in the operational plan are not binding nor an official commitment of resources, but rather provide a roadmap for future coordination and engagement to work towards implementation of the WCRP.

Table 13. Operational plan to support the implementation of strategies and actions to improve connectivity for target species in the Bulkley River watershed.

Strategy / Actions	Lead(s) [1]	Participants[3]	Total Budget
Strategy 1: Barrier Remediation			$66,385,830.00
1.1 – Remove and decommission barriers	CWF, SERN	Office of the Wet'suwet'en, Skeena Watershed Conservation Coalition, **Ministry of Transportation and Infrastructure (MoTI)**, Fisheries and Oceans Canada (DFO), **Ministry of Environment (MoE)**	$5,248,000.00

1 Leads and participants denoted in **bold** represent those that will be invited to participate but are currently unconfirmed.

1.2 – Upgrade and resize crossings	CWF, SERN	Office of the Wet'suwet'en, Skeena Watershed Conservation Coalition, **MoTI**, DFO, **MoE**	$57,072,000.00
1.3 – Install temporary mitigation	SERN	Office of the Wet'suwet'en, Skeena Watershed Conservation Coalition, **MoTI**, DFO, **MoE**, CWF	$3,280,000.00
1.4 – Raise funds to remediate barriers	CWF, SERN	Office of the Wet'suwet'en, **BCTS**	$400,000.00
1.5 – Request regulatory action for non-compliant crossings	*TBD*	Office of the Wet'suwet'en, CWF	$0.00
1.6 – Engage with CN to address their barriers	SERN	CWF, **ESI/SSAF**	$100,000.00
1.7 – Knowledge Gap: Continue updating the barrier prioritization model	CWF	Witset First Nation, SERN	$200,000.00
1.8 - Knowledge Gap: Adapt the provincial fish passage framework to account for adult fish and low flow conditions	CWF	*TBD*	*TBD*
1.9 – Knowledge Gap: Assess barriers by applying adapted version of the provincial fish passage framework	Fish Passage Technical Working Group, CWF, SERN	Witset First Nation, **ESI/SSAF**	$22,830.00
Strategy 2: Barrier Prevention			$200,000.00
2.1 – Work with forestry licensees to improve their aquatic connectivity practices	SERN	Witset First Nation, **ESI/SSAF**	$100,000.00

2.2 – Monitor new crossing installation compliance with regulations regarding fish passage	TBD	Witset First Nation, **ESI/SSAF**	$100,000.00
Strategy 3: Strengthen Indigenous Connections to Land and Water			$420,000.00
3.1 – Develop a First Nations Youth Mentorship capacity building program	**ESI/SSAF**	CWF + CCC, Witset First Nation (Nico Ridge Consulting Inc.), SERN	$100,000.00
3.2 – Engage with Wilp/House Groups for work to occur in their territory	**ESI/SSAF**	CWF, SERN	$20,000.00
3.3 – First Nations guardianship program to monitor fish passage in the watershed	**ESI/SSAF**	Witset First Nation, SERN, Office of the Wet'suwet'en	$150,000.00
3.4 – Knowledge Gap: Identify traditional use areas to help inform where to improve connectivity	**ESI/SSAF**	CWF	$150,000.00
Strategy 4: Progress Tracking Plan			*TBD*
4.1– Implement the WCRP Progress Tracking Plan	CWF, SERN	*TBD*	*TBD*
4.2 – Develop a data catalogue on all current information related to aquatic connectivity in the Bulkley Watershed	*TBD*	CWF	*TBD*
4.3 – Expand this WCRP to include the Morice River Watershed	*TBD*	CWF	*$50,000.00*
		Total:	**$67,005,830.00**
		Fundraising total:	**$9,105,830**
		Proponent/government contribution total:	**$57,900,000**

Funding Sources

Table 14. Potential funding sources for plan implementation in the Bulkley River watershed. The Canadian Wildlife Federation and the planning team can coordinate proposal submission through these sources.

Funding Source	Spending Restrictions and Other Consideration
Land Based Investment Strategy	Assessment and remediation of fish passage using provincial strategic approach. Primarily for remediation of Ministry-owned/orphaned barriers on forest service roads.
Environmental Enhancement Fund	Fish and wildlife passage improvements and restoration at stream and animal crossings at MOTI roads including culvert retrofits and replacement to restore Pacific salmon and trout access, and wildlife tunnels. Primarily for crossings linked to highway infrastructure.
Community Salmon Program	For projects supporting the protection, conservation and enhancement or rehabilitation of Pacific salmonids and their habitat. Funding for volunteer and not-for-profit community-based groups. Applicant must have a significant volunteer component to their group and to the project. Requires 50% match for funding (volunteer, in-kind, donation or other grants).
Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund	Supports three activities: (1) develop improved information for resource management; (2) rehabilitate and restore marine and freshwater habitat; and (3) enhance wild stock production through low technology techniques. Emphasis for funding is on stocks managed under the Pacific Salmon Treaty and that contribute significantly to the fisheries in the project area.
Habitat Conservation Trust Foundation Enhancement and Restoration Grants	Projects that focus on freshwater wild fish, native wildlife species and their habitats, have the potential to achieve a significant conservation outcome, while maintaining or enhancing opportunities for fishing, hunting, trapping, wildlife viewing and associated outdoor recreational activities. Primary focus is on provincially managed fisheries such as Steelhead and Westslope Cutthroat Trout. Requires 50% funding match.
Environmental Damages Fund	Direct funds received from fines, court orders and voluntary payments to priority projects that will benefit Canada's natural environment, under four categories of improvement (in order of preference):

	(1) restoration, (2) environmental quality improvement, (3) research and development, and (4) education and awareness.
Federal Gas Tax Fund - Community Works Fund	Funding available to local governments from federal gas tax, with funds to be allocated for a variety of municipal projects/initiatives, including local roads/bridges and disaster mitigation.
Disaster Mitigation and Adaptation Fund	For those projects where flood risk is high: funding available to local, regional, and provincial governments, private sector, non-profit organizations, and Indigenous groups for projects aimed at reducing the socio-economic, environmental and cultural impacts triggered by natural hazards and extreme weather events and taking into consideration current and future impacts of climate change in communities and infrastructure at high risk. Includes both new construction of public infrastructure and modification/reinforcement of existing infrastructure. Projects must have a minimum of $20 M in eligible expenditures and can be bundled together.
Community Gaming Grants	Funding for non-profit organizations (check funding program guidelines for specific eligibility requirements) for programs that help to protect and improve the environment by: (1) conserving or revitalizing local ecosystems, (2) reducing greenhouse gas emissions, (3) providing community education or engagement opportunities related to the environment and agriculture or (4) supporting the welfare of domestic animals and/or wildlife. Grants range from $100K-250K per year.
Sitka Foundation	Funding for registered charities, universities, and government agencies (qualified Canadian organizations) for projects related to coastline and watershed conservation and climate change in four key areas: 1. land, water, and ocean conservation 2. scientific research for nature and the environment 3. public engagement around the importance of a healthy environment 4. innovative conservation efforts in Canadian communities, at the local, provincial, and federal levels
TULA Foundation	Supports various environmental programs of interest to the Foundation on a case-by-case basis.
Vancouver Foundation	Granting agency for community, social and environmental initiatives for qualified Canadian organizations (charitable organizations, universities, government agencies). Granting programs change on an annual basis.

BC Conservation Foundation Small Project Fund	Funding available to non-profits, fish and wildlife clubs (sportsmen's associations), businesses, local/regional governments, public organizations and First Nations for projects with demonstrated positive impact for fish, wildlife and habitat, including outreach programs. Preference given to projects where BCCF is not the sole funder.
Real Estate Foundation of BC General Grants	Funding for First Nations, charities and societies, non-governmental organizations, universities and colleges, trade associations, local and regional governments, and social enterprises registered as C3s for sustainable land use and real estate practices in BC. Funds up to 50% of cash portion of a project.

References

Agrawal, A., R. S. Schick, E. P. Bjorkstedt, R. G. Szerlong, M. N. Goslin, B. C. Spence, T. H. Williams, and K. M. Burnett. 2005. Predicting the potential for historical Coho, Chinook, and Steelhead habitat in northern California. National Oceanic and Atmospheric Administration, NOAA-TM-NMFS-SWFSC-379.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. In Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. American Fisheries Society Special Publication 19: 83-138.

Burnett, K. M., G. H. Reeves, D. J. Miller, S. Clarke, K. Vance-Borland, K. Christiansen. 2007. Distribution of salmon-habitat potential relative to landscape characteristics and implications for conservation. Ecological Applications 17: 66-80.

Busch, D. S., M. Sheer, K. Burnett, P. McElhany, and T. Cooney. 2011. Landscape-level model to predict spawning habitat for lower Columbia River fall Chinook Salmon (*Oncorhynchus tshawytscha*). River Research Applications 29: 291-312.

Casselman, J., and D. Stanley. 2010. Bulkley/Fulton Watershed Fish Passage Culvert Assessment Program.

Chudyk, W.E. 1979. Suskwa River Steelhead Trout: The Colonization of Harold-Price Creek with Hatchery-Reared Steelhead. Skeena Fisheries Report No. 79-1 (SEP). https://data.skeenasalmon.info/dataset/e59016eb-fff5-403f-96d7-31d828a75808/resource/c34a5581-54e0-433a-a569-54150b8681aa/download/suskwa_river_steelhead_trout_colonization_harold-price_creek_hatchery-reared_steelhead.pdf.

Cooney, T., and D. Holzer. 2006. Appendix C: Interior Columbia basin stream type Chinook Salmon and Steelhead populations: habitat intrinsic potential analysis. National Oceanic and Atmospheric Administration, Northwest Fisheries Center.

Gitxsan Hulwip Government. 2019. Release: Gitxsan chiefs Extend Fishing Ban to 2020 & Urge Canada, BC and Ministries to Step Up. http://gitxsan.ca/release-gitxsan-chiefs-extend-fishing-ban-to-2020-season-urge-canada-bc-and-flnro-to-step-up/.

Irvine, A. 2018. Analysis and priority identification of existing fish passage data: Bulkley River. http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=56648.

Irvine, A. 2021. Bulkley River and Morice River Watershed Groups Fish Passage Restoration Planning. Prepared on behalf of Society for Ecosystem Restoration Northern BC. https://www.newgraphenvironment.com/fish_passage_bulkley_2020_reporting/Bulkley.pdf.

Lake, R. G. 1999. Activity and spawning behaviour in spawning Sockeye salmon. Thesis, University of British Columbia.

Mazany-Wright, N., S. M. Norris, N. W. R. Lapointe, and B. Rebellato. 2021a. A Freshwater Connectivity Modelling Framework to Support Barrier Prioritization and Remediation in British Columbia. Canadian Wildlife Federation, Ottawa, Ontario.

Mazany-Wright, N., S. M. Norris, N. W. R. Lapointe, and B. Rebellato. 2021b. B.C. Fish Passage Restoration Initiative Target Watershed Selection Process: Technical Documentation. Canadian Wildlife Federation, Ottawa, Ontario.

Mazany-Wright, N., J. Noseworthy, S. Sra, S. M. Norris, and N. W. R Lapointe. 2021c. Breaking Down Barriers: a Practitioners' Guide to Watershed Connectivity Remediation Planning. Canadian Wildlife Federation, Ottawa, Ontario.

McCarthy, M., and A. Fernando. 2015. 2015 Inventory of High Priority Culverted Fish Passage Barriers in the Lower/Middle Skeena, Bulkley, Morice, and Babine River Watersheds.

McMahon, T. E. 1983. Habitat suitability index models: Coho salmon. U.S. Department of the Interior, Fish and Wildlife Service. FWS/OBS-82/10.49. 29 pp.

Neuman H. R., and C. P. Newcombe. 1977. Minimum acceptable stream flows in British Columbia: a review. Fisheries Management Report No. 70.

Office of the Wet'suwet'en. 2013. Wet'suwet'en Title and Rights Regarding Canada Department of Fisheries & Oceans and Pacific Trails Pipeline. http://www.wetsuweten.com/files/PTP_FHCP_Response_to_DFO-25Nov13-Final.pdf.

Pacific Salmon Foundation. 2020. Methods for Assessing Status and Trends in Pacific Salmon Conservation Units and their Freshwater Habitats. The Pacific Salmon Foundation, Vancouver, British Columbia. https://salmonwatersheds.ca/libraryfiles/lib_459.pdf.

Porter, M., D. Pickard, K. Wieckowski, and K. Bryan. 2008. Developing Fish Habitat Models for Broad-Scale Forest Planning in the Southern Interior of B.C. ESSA Technologies Ltd. and B.C. Ministry of Environment.

Raleigh, R. F., and W. J. Miller. 1986. Habitat suitability index models and instream flow suitability curves: chinook salmon. U.S. Fish and Wildlife Service Biological Reports 82. 64pp.

[Rescan] Rescan Environmental Services Ltd. 2012. KSM Project: Gitxsan Nation Traditional Knowledge and Use Desk-based Research Report. Prepared for Seabridge Gold Inc. by Rescan Environmental Services Ltd.: Vancouver, British Columbia. https://www.ceaa.gc.ca/050/documents_staticpost/49262/89282/Chapter_30_Appendices/Appendix_30-D_Gitxsan_Tradnl_Use_Desk_Based_Research_Report.pdf.

Roberge, M., J. B. M. Hume, C. K. Minns, and T. Slaney. 2002. Life history characteristics of freshwater fishes occurring in British Columbia and the Yukon, with major emphasis on stream habitat characteristics. Fisheries and Oceans Canada, Marine Environment and Habitat Science Division, Cultus Lake, British Columbia.

Rosenfeld, J., M. Porter, and E. Parkinson. 2000. Habitat factors affecting the abundance and distribution of juvenile cutthroat trout (*Oncorhynchus clarki*) and coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 57: 766-774.

Schindler, D. E. P. R. Leavitt, C. Brock, S. P. Johnson, and P. D. Quay. 2003. The importance of marine-derived nutrients to lake productivity and salmon population dynamics over the last five centuries in southwest Alaska. Presentation at the 2003 Annual Meeting, The Geological Society of America.

Seliger, Carina, and Bernhard Zeiringer. 2018. River Connectivity, Habitat Fragmentation and Related Restoration Measures. In Riverine Ecosystem Management: Science for Governing Towards a Sustainable Future, edited by Stefan Schmutz and Jan Sendzimir, 171–86. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-73250-3_9.

Sheer, M. B., D. S. Busch, E. Gilbert, J. M. Bayer, S. Lanigan, J. L. Schei, K. M. Burnett, and D. Miller. 2009. Development and management of fish intrinsic potential data and methodologies: State of the IP 2008 summary report. Pacific Northwest Aquatic Monitoring Partnership Series 2009—4, 56 p.

Sheer, M. B., and E. A. Steel. 2006. Lost watersheds: barriers, aquatic habitat connectivity, and salmon persistence in the Willamette and Lower Columbia basins. Transactions of the American Fisheries Society 135: 1654-1669.

Sloat M. R., G. H. Reeves, and K. R. Christiansen. Stream network geomorphology mediates predicted vulnerability of anadromous fish habitat fish habitat to hydrologic change in southeast Alaska.

Smith, J. 2018. Assessing Barriers to Fish Passage within the Wet'suwet'en First Nation Traditional Territory. LGL Limited Environmental Research Associates and Yinka Dene Economic Development Limited Partnership Inc.

[SSAF] Skeena Sustainability Assessment Forum. 2021. Skeena Sustainability Assessment Forum's State of the Value Report for Fish & Fish Habitat. Final draft prepared by Carolyn King and Jesse Fraser of Ministry of Forests, Lands, Natural Resource Operations, and Rural Development for the Skeena Environmental Stewardship Initiative Science and Technical Committee (STC).

Wilson, T., and K. Rabnett. 2007. Fish Passage Assessment of Highway 16 and CN Rail in the Bulkley Watershed. https://data.skeenasalmon.info/dataset/fish-passage-assessment-highway-16-cn-rail-bulkley.

Woll, C., D. Albert, and D. Whited. 2017. A Preliminary Classification and Mapping of Salmon Ecological Systems in the Nushagak and Kvichak Watersheds, Alaska. The Nature Conservancy.

Appendix A: Modelled Anadromous Salmonid Habitat Maps

High-resolution PDF maps of the Bulkley River watershed and model results can be accessed here. The watershed is divided into multiple maps sheets to allow for detailed examination of modelled spawning and rearing habitat and priority barriers identified through this planning process. The locations of WCRP priority barriers and associated map sheet numbers are shown below. In each individual map sheet, priority barriers are symbolized using the following notation: **123456** Priority crossing label .

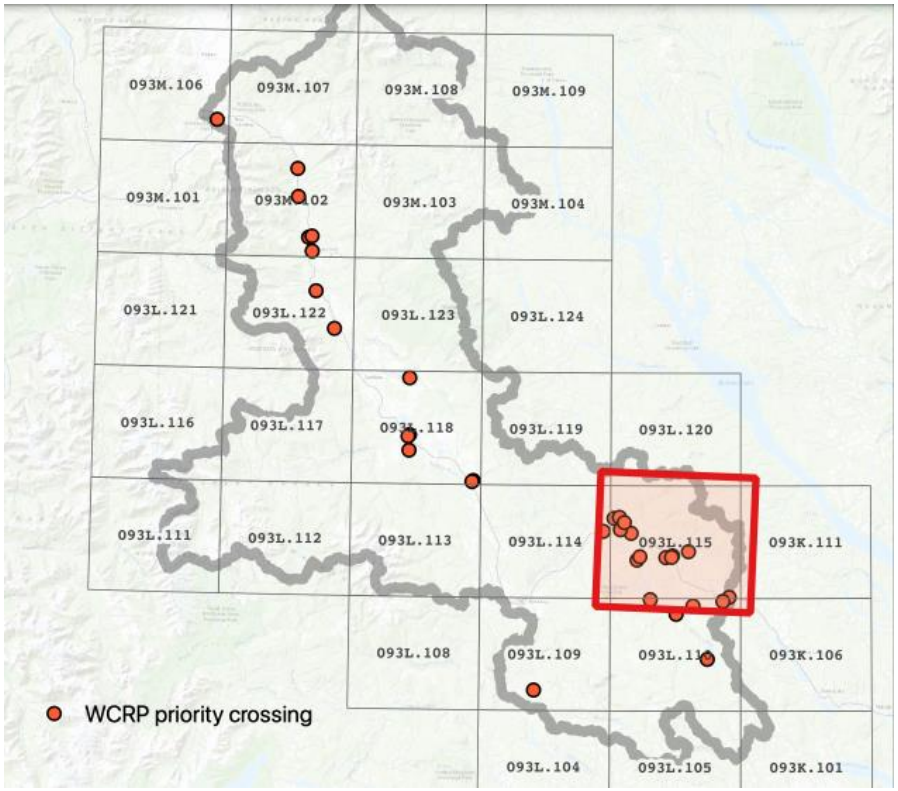

Figure 5. Bulkley River watershed overview map identifying the portions of the watershed covered by each map sheet (grey squares) and the prioritized barriers on the intermediate barrier list (orange points; see Appendix C).

Appendix B: Connectivity Status Assessment Methods

The connectivity status assessment for anadromous salmonids in the Bulkley River watershed builds on existing connectivity modelling work undertaken by the BC Fish Passage Technical Working Group, resulting in a flexible, customizable open-source spatial model called "bcfishpass". The model spatially locates known and modelled barriers to fish passage, identifies potential spawning and rearing habitat for target species, and estimates the amount of habitat that is currently accessible to target species. The model uses an adapted version of the Intrinsic Potential (IP) fish habitat modelling framework (see Sheer et al. 2009 for an overview of the IP framework). The habitat model uses two geomorphic characteristics of the stream network — channel gradient and mean annual discharge — to identify potential spawning habitat and rearing habitat for each target species. The habitat model does not attempt to definitively map each habitat type nor estimate habitat quality, but rather identifies stream segments that have high potential to support spawning or rearing habitat for each species based on the geomorphic characteristics of the segment. For more details on the connectivity and habitat model structure and parameters, please see Mazany-Wright et al. 2021a. The variables and thresholds used to model potential spawning and rearing habitat for each target species are summarized below. The quantity of modelled habitat for each species was aggregated for each habitat type to inform the two KEAs — Accessible Spawning Habitat and Accessible Rearing Habitat — and represents a linear measure of potential habitat. To recognize the rearing value provided by features represented by polygons for certain species (e.g., wetlands for Coho Salmon and lakes for Sockeye Salmon) a multiplier of 1.5x the length of the stream segments flowing through the polygons was applied.

Table 15. Parameters and thresholds used to inform the Intrinsic Potential habitat model for spawning and rearing habitat for each target species in the Bulkley River watershed.

	Spawning Habitat		Rearing Habitat			
Species	Channel Gradient (%)	Mean annual discharge (m3/s)	Channel Gradient (%)	Mean annual discharge (m3/s)	Minimum Lake area (ha)	Multiplier (1.5x)
Chinook Salmon	0-3 (Busch et al. 2011, Cooney	0.46-322.5 (Bjornn and Reiser 1991, Neuman and Newcombe 1977, Woll et al. 2017,	0-5 (Woll et al. 2017, Porter et al. 2008)	0.28-100 (Agrawal et al. 2005)	NA	NA

	and Holzer 2006)	Roberge et al. 2002, Raleigh and Miller 1986)				
Coho Salmon	0-5 (Roberge et al. 2002, Sloat et al. 2017)	0.164-59.15 (Bjornn and Reiser 1991, Sloat et al. 2017, Neuman and Newcombe 1977, Woll et al. 2017, McMahon 1983)	0-5 (Porter et al. 2008, Rosenfeld et al. 2000)	0.03-40 (Agrawal et al. 2005, Burnett et al. 2007)	NA	Wetland
Sockeye Salmon	0-2 (Lake 1999, Hoopes 1972)	0.175-65 (Bjornn and Reiser 1991, Woll et al. 2017, Neuman and Newcombe 1977, Roberge et al. 2002)	NA	NA	200 (Woll et al. 2017)	Lake
Steelhead	0-4 (Sheer and Steel 2006, Cooney and Holzer 2006)	0.447-75 (Bjornn and Reiser 1991, Neuman and Newcombe 1977, Roberge et al. 2002)	0-7.4 (Porter et al. 2008)	0.02-60 (Agrawal et al. 2005, Burnett et al. 2007)	NA	NA

Appendix C: Bulkley River Watershed Barrier Prioritization Summary

The primary conservation outcome of the WCRP is the remediation of barriers to connectivity in the Bulkley River watershed. To achieve Goals 1 and 2 in this plan, it is necessary to prioritize and identify a suite of barriers that, if remediated, will provide access to a minimum of 90.69 km of spawning habitat and 296.56 km of rearing habitat (Table 16).

Table 16. Spawning and rearing habitat connectivity gain requirements to meet WCRP goals in the Bulkley River watershed. The measures of currently accessible and total habitat values are derived from the Intrinsic Potential habitat model described in Appendix B.

Habitat Type	Currently accessible (km)	Total (km)	Current Connectivity Status	Goal	Gain required (km)
Spawning	1,042.53	1,245.30	84%	91%	90.69
Rearing	1,322.31	2,023.59	65%	80%	296.56

The barrier prioritization analysis ranked barriers by the amount of habitat blocked to produce an "intermediate barrier list" comprising more barriers than are needed to achieve the goals. A longer list of barriers is needed due to the inherent assumptions in the connectivity model, habitat model, and gaps in available data. Barriers that have been modelled (i.e., points where streams and road/rail networks intersect) are assumed to be barriers until field verification is undertaken and structures that have been assessed as "potential" barriers (e.g., may be passable at certain flow levels or for certain life history stages) require further investigation before a definitive remediation decision is made. Additionally, the habitat model identifies stream segments that have the potential to support spawning or rearing habitat for target species but does not attempt to quantify habitat quality or suitability (see Appendix B), which will require additional field verification once barrier assessments have completed. As such, the intermediate list of barriers below (Table 15) should be considered as a starting point in the prioritization process and represents structures that are a priority to evaluate further through barrier assessment and habitat confirmations because some structures will likely be passable, others will not be associated with usable habitat, and others may not be feasible to remediate because of logistic considerations. A web map displaying the location of each priority barrier can be found at: https://www.hillcrestgeo.ca/projects/cwf_wcrp/. For more details on the barrier prioritization model, please see Mazany-Wright et al. 2021a.

Table 17. Intermediate barrier list resulting from the barrier prioritization analysis in the Bulkley River watershed. The barriers on this list were prioritized to exceed the connectivity goals of the plan. Barriers highlighted in the same colour represent sets of barriers that have been prioritized as a group. In the Barrier Status column, P = potential barrier and B = confirmed barrier. All barrier assessment data is compiled from the BC Provincial Stream Crossing Inventory System.

ID	Stream name	Data source	Barrier type	Assessment status (completed to date)	Barrier status	Number of downstream barriers	Spawning habitat blocked – all species (km)	Rearing habitat blocked – all species (km)
1001805665	Canyon Creek	Modelled Crossing	Resource road crossing		P	0	23.51	49.13
1001800752	Tributary to Elwin Lake	Modelled Crossing	Resource road crossing		P	2	0	26.61
1001801969	Tributary to Bulkley River	Modelled Crossing	Resource road crossing		P	1	3.53	23.72
1001803682	Crow Creek	Modelled Crossing	Resource road crossing		P	1	10.41	17.54
1001802760	Deep Creek	Modelled Crossing	Resource road crossing		P	1	8.63	17.44
123770	John Brown Creek	PSCIS	Highway crossing	Assessed	B	0	11.71	15.88
57944	Toboggan Creek	PSCIS	Highway crossing	Assessed	B	0	8.38	14.92
1024704566	Corya Creek	Modelled Crossing	Railway crossing		P	1	9.07	12.34
1001802044	Ailport Creek	Modelled Crossing	Resource road crossing		P	3	4.88	11.63
1001802089	Johnny David Creek	Modelled Crossing	Resource road crossing		P	1	7.49	11.22

123446	Tyhee Creek	PSCIS	Minicipal road crossing	Assessed	P	1	0	10.56
124500	Helps Creek	PSCIS	Municipal road crossing	Assessed	B	0	0.84	8.86
1001804694	Tributary to Maxan Lake	Modelled Crossing	Resource road crossing		P	0	0	7.62
1001800050	Bulkley River	Modelled Crossing	Highway crossing		P	1	4.28	7.41
1001802088	Robert Hatch Creek	Modelled Crossing	Resource road crossing		P	2	1.26	7.28
197640	Tributary to Buck Creek	PSCIS	Municipal road crossing	Assessed	B	0	1.12	6.56
124420	Station Creek	PSCIS	Highway crossing	Assessed	B	0	2.96	6.26
1001805553	Glass Creek	Modelled Crossing	Railway crossing		P	1	3.29	5.89
124487	Porphyry Creek	PSCIS	Highway crossing	Assessed	B	0	3.9	5.71
1001805532	Crow Creek	Modelled Crossing	Railway crossing		P	0	5	5.55
197658	Byman Creek	PSCIS	Highway crossing	Assessed	B	0	4.99	5.3
1001801773	Boulder Creek	Modelled Crossing	Resource road crossing		P		1.88	5.14
1001801122	Ailport Creek	Modelled Crossing	Resource road crossing		P	2	5.03	5.09
197662	Richfield Creek	PSCIS	Highway crossing	Assessed	B		4.86	4.85
1001801133	Tributary to Bulkley River	Modelled Crossing	Resource road crossing		P		0.99	4.79

197663	Johnny David Creek	PSCIS	Highway crossing	Assessed	B		2.79	2.79
1001800422	Ailport Creek	Modelled Crossing	Resource road crossing		P		1.36	2.32
1001805529	Bulkley River	Modelled Crossing	Railway crossing		P		1.8	1.8
1001802106	Robert Hatch Creek	Modelled Crossing	Resource road crossing		P	1	1.54	1.7
1001802820	Deep Creek	Modelled Crossing	Resource road crossing		P		0.34	1.19
123776	Corya Creek	PSCIS	Highway crossing	Assessed	B		0.87	0.87
1001800355	Ailport Creek	Modelled Crossing	Highway crossing		P	1	0.4	0.4
123445	Tyhee Creek	PSCIS	Highway crossing	Assessed	B		0	0
						Total gain:	**137.11**	**308.37**

All 33 barriers on the intermediate list require further field assessments before selection as a final barrier to pursue for remediation:

Table 18. Field assessment requirements for the intermediate barrier list in the Bulkley River watershed. The cost per barrier values are estimates based on previously completed field work. The habitat confirmation count is based on the assumption that the 21 barriers requiring barrier assessments will also require a subsequent confirmation. In the case that some barriers are identified as unsuitable candidates for habitat confirmations, the total cost will be reduced.

Field assessment	Cost per barrier	Count	Total costs
Barrier Assessment	$230	21	$4,830
Habitat Confirmation	$3,000	27	$81,000
Total:		**48**	**$85,830**

Based on the results of the prioritization analysis, 30 barriers from the intermediate barrier list are required to be remediated to achieve the connectivity goals in this plan:

Table 19. Preliminary barrier remediation cost estimate to reach connectivity goals in the Bulkley River watershed. Cost per barrier values are estimated based on the average cost of previously completed projects. Barrier counts and total costs are subject to change as more information is collected through the implementation of this plan.

Barrier Type	Cost per barrier	Count	Total Cost
Rail	$1,700,000	4	$6,800,000
Highway	$5,200,000	9	$46,800,000
Municipal/paved road	$1,500,000	3	$4,500,000
Resource road	$500,000	15	$7,500,000
Total:		**30**	**$65,600,000**

.