Lower Nicola Watershed Connectivity Restoration Plan: 2021 - 2040

Canadian Wildlife Federation

23-08-2024

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Acknowledgements

This plan represents the culmination of a collaborative planning process undertaken in the Lower Nicola 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, Canada Nature Fund for Aquatic Species at Risk, 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.

The Canadian Wildlife Federation recognizes that the lands and waters that form the basis of this plan are the traditional unceded territory of the Nlaka'pamux/Scw'exmx and Syilx 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 the Lower Nicola Indian Band for sharing the traditional Nłe kepmxcín (Nlaka'pamuxcin) names used in this plan.

We recognize the incredibly rich history of fish and fish habitat conservation and restoration work that has occurred in the Lower Nicola River watershed to date. A special thank you to Richard Bailey for providing background and contextual information on the myriad threats facing anadromous salmonid populations in the Lower Nicola. Thank you to Richard, Paul Mozin, Sarah Ostorforoff, and Tom Willms for identifying lateral barrier sites to assess during the 2021 field season. We are excited to continue partnering with local groups and organizations to build upon existing initiatives and provide a road map to push connectivity remediation forward over the next 10 years and beyond

Project Overview

Plan Purpose, Approach, and Scope

The following Watershed Connectivity Remediation Plan (WCRP) represents the culmination of a one-year collaborative planning effort, including action implementation, for the Lower Nicola River watershed, the overall aim of which is to build collaborative partnerships within the watershed to reduce the threat of aquatic barriers to migratory fish and the livelihoods that they support. This 10-year plan was developed to identify priority strategies that the Lower Nicola River WCRP planning team see Planning Team for a list of team members proposes to undertake between 2021-2031 to conserve and restore fish passage in the watershed, through lateral and thermal barrier remediation, crossing remediation, and barrier prevention strategies.

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 migratory fish. 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 fish and fish habitat conservation and restoration work in the Lower Nicola watershed that this WCRP builds upon and aims to compliment over the length of the plan. This includes work undertaken by the Scw'exmx Tribal Council and the five member or affiliate nations (see Project Scope), the Nicola Watershed Governance Project, the Nicola Basin Collaborative, and the Risk Assessment Methodology for Salmon (RAMS). The planning team will aim to work with the Nicola Watershed Governance Project and the Nicola Basin Collaborative to promote coordination, decision-making, and implementation related to this plan.

The planning team compiled existing location and assessment data for potential barriers, habitat data, and previously identified priorities in the watershed, and combined this with local and Indigenous knowledge to create a strategic watershed-scale plan to improve connectivity. To expand on this work, the Lower Nicola River WCRP planning team applied the WCRP planning framework to define the "thematic" scope of freshwater connectivity and refine the "geographic" scope to identify the portions of the watershed where connectivity 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 further field investigation 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 results presented in this plan to continuously improve the practice of aquatic barrier remediation for migratory fish in the Lower Nicola River Watershed. For more information on how WCRPs are developed, see Mazany-Wright, Noseworthy, et al. (2021).

Vision Statement

Healthy, well-connected streams and rivers within the Lower Nicola River watershed support thriving populations of migratory fish. In turn, these fish provide the continued sustenance, cultural, and ceremonial needs of the Nlaka'pamux/Scw'exmx and Syilx peoples, as they have since time immemorial. Both residents and visitors to the watershed work together to mitigate the negative effects of aquatic barriers, improving the resiliency of streams and rivers for the benefit and appreciation of all.

Project Scope

The primary geographic scope of this WCRP is the Lower Nicola River watershed, located in the Thompson drainage basin of the Fraser River system in south-central British Columbia with a drainage area of 376,064 ha (Figure 1). The scope constitutes the Lower Nicola "watershed group" as defined by the British Columbia Freshwater Atlas (FWA), which excludes the Guichon Creek drainage and the Nicola River and Quilchena Creek drainages upstream of Nicola Lake. A consistent spatial framework was necessary to undertake a watershed-selection process at the provincial scale to identify target watershed to improve connectivity for salmonids. The Lower Nicola River watershed was identified by the BC Fish Passage Restoration Initiative as one of four target watersheds for WCRP development (Mazany-Wright, Norris, et al. (2021b)) Culturally and economically important populations of Chinook Salmon (Oncorhynchus tshawtyscha), Coho Salmon (Oncorhynchus kisutch), and Steelhead (Oncorhynchus mykiss) are all found in the watershed, which historically supported Indigenous sustenance and trading economies (Table 1; L. N. I. Band (2015), E. T. Ltd. and Council (2019), C. Band (2021)).

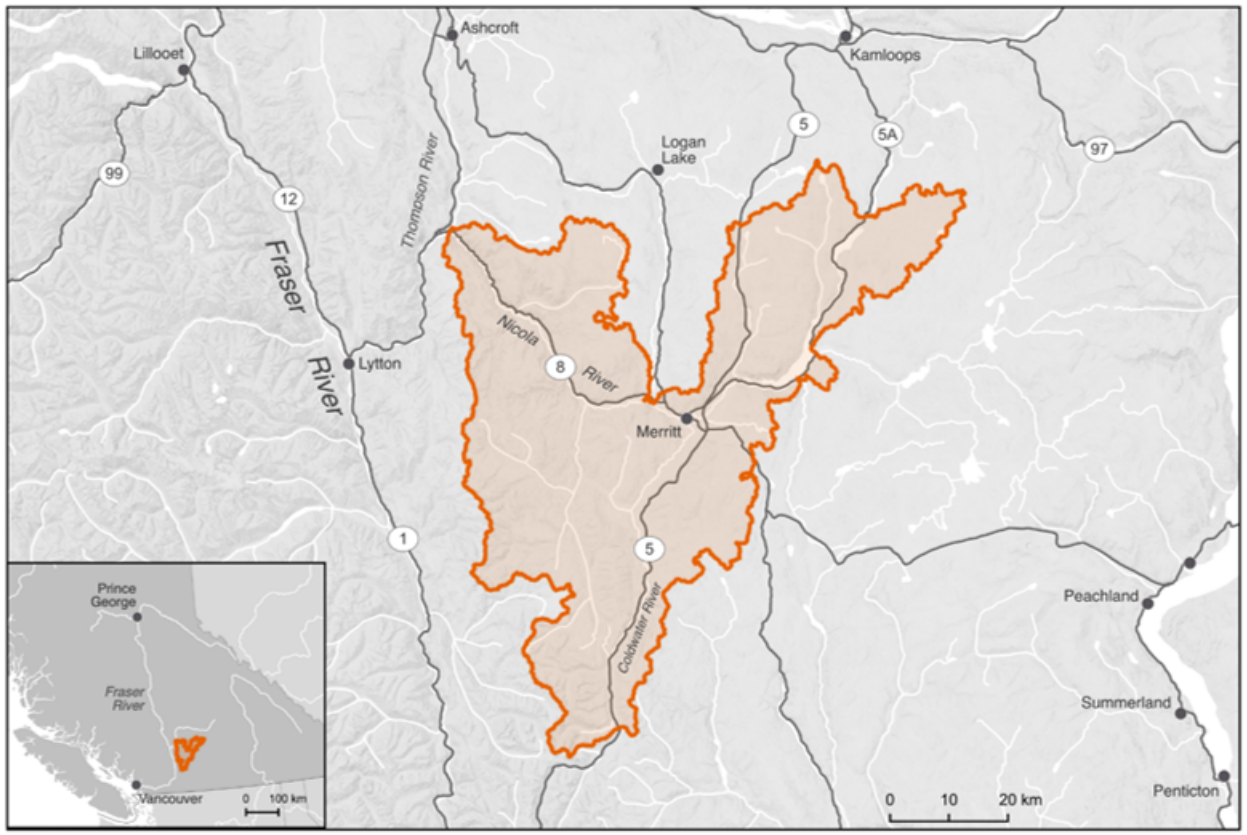

Figure 1: The primary geographic scope - the Lower Nicola River watershed, excluding the Guichon Creek drainage and the Nicola River and Quilchena Creek drainages upstream of Nicola Lake

Table 1: Target fish species in the Lower Nicola River watershed. The Nłe kepmxcín (Nlaka'pamuxcin), nqilx cn (nsyilxcən), and Western common and scientific species names are provided.

Nłe kepmxcín (Nlaka'pamuxcin)	nqilx cn (nsyilxcən)	Common Name	Scientific Name
k' y'í e/pəqéłus	ntytyix	Chinook Salmon	Oncorhynchus tshawytscha
sx̣ayqs	kisú	Coho Salmon	Oncorhynchus kisutch
có łe	wəyqwəy aća	Steelhead	Oncorhynchus mykiss

The Lower Nicola River watershed comprises parts of the traditional territory of the Nlaka'pamux/Scw'exmx and Syilx peoples, represented by the Scw'exmx Tribal Council, the four member nations (Coldwater Band, Nooaitch Band, Shackan Indian Band, and Upper Nicola Band), and the individual nations of the Lower Nicola Indian Band and the Cook's Ferry Band. The Nlaka'pamux/Scw'exmx and Syilx peoples steward the land and the waters of the Lower Nicola River watershed. The planning team will pursue early, meaningful, and continued engagement with First Nations communities involved in work and projects related to this plan. It will be necessary to receive permission from the communities 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, gradient barriers based on species-specific swimming abilities, and "watershed exclusion areas", which are portions of the watershed where barrier remediation efforts should not occur. These maps were explored by the planning team to incorporate additional local knowledge, ensure accuracy, and finalize the constraints on potentially accessible stream segments. The planning team identified a few tributaries to the mainstem Nicola River as watershed exclusion areas due to intermittent or insufficient flows to support restoring connectivity for the target species, including Hamilton Creek and agricultural irrigation ditches just downstream of Nicola Lake Dam. Additionally, Stumplake Creek and Peter Hope Creek were identified as watershed exclusion areas due to the presence of invasive Yellow Perch (Perca flavescens). It is unclear whether existing barriers located in these systems will be effective in preventing the downstream spread of Yellow Perch, but the planning team advised maintaining the barriers for the time being. All stream segments not identified as potentially accessible were removed from the scope for further consideration. The resulting 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, Norris, et al. (2021a)).

The thematic scope of this WCRP is freshwater connectivity. 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 and 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. Connectivity can be disrupted by physical barriers to connectivity in the longitudinal (i.e., upstream-downstream) and lateral (i.e., connectivity between the mainstem and adjacent wetlands, floodplains, side channels, and off-channel habitat) planes, including dams, weirs, stream crossings, dykes, linear infrastructure, waterfalls, and debris flows. Freshwater systems can also be disconnected by "physiological" barriers that prevent the free dispersal of species, including thermal (i.e., reaches where stream temperatures are too high) or flow (i.e., reaches where stream flow is insufficient to support the requirements of any life stage) barriers.

The broader Nicola basin has been designated as a temperature- and flow-sensitive watershed in British Columbia, and both factors significantly affect connectivity for fish species in the Lower Nicola (E. T. Ltd. and Council (2019), MFLNRORD 2018). The changing thermal regime of the Lower Nicola River watershed is a growing concern, with two scales of thermal disconnectivity occurring within the watershed — watershed-scale changes in thermal regimes and localized barriers preventing access to thermal refugia.

The watershed-scale changes to the thermal regime are linked to several landscape-scale drivers including increases in water withdrawals, changes in land use, deforestation (due to resource extraction and mountain pine beetle infestations), and climate change, which are exacerbated by subsequent changes to channel-forming processes (E. T. Ltd. and Council (2019)). These changes have created annual thermal barriers that prevent access to headwater reaches from the mainstem channels along the valley floor. This has resulted in the adaptation of an early-migrant Chinook Salmon population, which uses the upper portions of Spius Creek and tributaries and the upper reaches of the Coldwater River, where access to the spawning grounds requires passing through the lower sections before the stream temperatures create physiological thermal barriers. These returning adults pass through the lower reaches in May and June as the freshet starts to abate, then hold in deeper pools for two months until they spawn in mid-to-late August (R. Bailey, Nooaitch Band, pers. comm.).

Localized thermal disconnectivity in the lateral dimension occurs when rearing and out-migrating juveniles are unable to access side-channel and off-channel thermal refugia and holding pools due to changing channel processes exacerbated by upland management and the development of linear infrastructure including dykes, roads, railways, and trails. These groundwater-serviced reaches located in side channels or off-channel habitats provide thermal refuge for juvenile fish in the watershed, and can also provide critical refuge for returning spawners. When these lateral refugia become disconnected

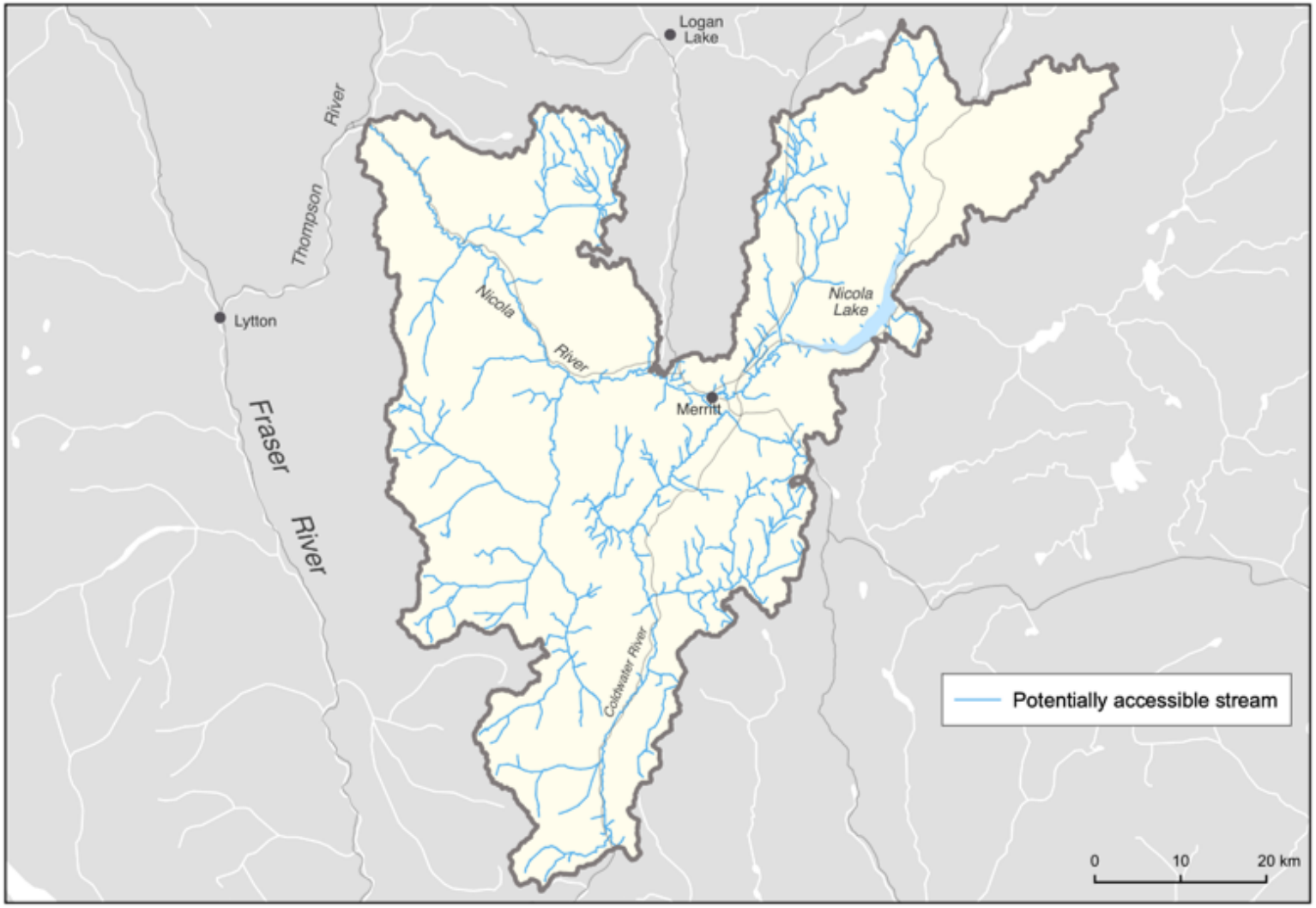

Figure 2: Potentially accessible stream segments within the Lower Nicola River watershed. These do not represent useable habitat types, but rather identify the stream segments within which habitat modelling and barrier mapping and prioritization was undertaken.

from mainstem channels, lethal stream temperatures can cause juvenile die-offs. Activities that restore and protect connectivity to these lateral refugia, particularly those cooled by groundwater sources, can help mitigate thermal disconnectivity in the watershed.

Mitigation of the landscape-scale drivers of changes to the thermal regimes are outside of the scope of this plan. While vital for the long-term resilience of the watershed, the broad land-use patterns, over-subscription of water withdrawals, and climate change that are causing chronic thermal issues in the watershed require more complex, coordinated, and resource-intensive solutions than this planning process can provide. This plan is intended to focus on the direct remediation and prevention of localized, physical barriers to lateral thermal refugia and longitudinal connectivity to maintain fish passage to spawning, rearing, and refuge habitat. Lateral, and associated thermal, connectivity was identified by the planning team as the primary connectivity concern in the watershed within the defined scope of this plan.

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 Lower Nicola River watershed, the planning team selected Anadromous Salmonids as the target species group, which comprises Chinook Salmon, Coho Salmon, and Steelhead. The selection of these target species was driven primarily by the target species of the primary funds 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 Kokanee (Oncorhynchus nerka), Bull Trout (Salvelinus confluentus), resident Rainbow Trout (Oncorhynchus mykiss), Whitefish (Coregonus clupeaformis), Burbot (Lota lota), and Pink Salmon (Oncorhynchus gorbuscha).

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 bears and other species (Schindler and Quay. (2003)). Salmon and Steelhead have enduring food, social, and ceremonial value for First Nations in Lower Nicola watershed – having sustained life, trading economies, and culture for the Nlaka'pamux/Scw'exmx and Syilx peoples since time immemorial (L. N. I. Band (2015), E. T. Ltd. and Council (2019), C. Band (2021)). The harvest and processing of these species have helped pass knowledge and ceremony to future generations (Council (n.d.), L. N. I. Band (2015)).

Anadromous salmonid populations in the Lower Nicola River watershed have declined significantly since the mid-1980s, leading First Nations communities to voluntarily reduce their harvest (E. T. Ltd. and Council (2019)). The Nlaka'pamux/Scw'exmx and Syilx peoples have always been stewards of the lands, resources, and fisheries in their traditional territories through an interconnected relationship based on respect and reverence, captured by the Syilx concept of Tmixw – the people only take the salmon that is needed (L. N. I. Band (2015), E. T. Ltd. and Council (2019), U. N. Band (2021)). The stewardship of their waters continues through the work of the Scw'exmx Tribal Council, the four member communities, the Lower Nicola Indian Band, and initiatives like the Nicola Watershed Governance Project. The Chinook Salmon (Endangered), Coho Salmon (Threatened), and Steelhead (Endangered) populations have all been assessed and proposed for Species at Risk Act (SARA) listing by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The development and implementation of this WCRP aims to support and supplement on-going work by the Nlaka'pamux/Scw'exmx, Syilx, and other local groups by providing an action plan to address the specific, tractable conservation threat posed by fragmentation through the restoration and preservation of habitat connectivity for these important species. See data methods for maps of modelled anadromous salmonid spawning and rearing habitat in the Lower Nicola River watershed.

Chinook Salmon | k' y'í e/pəqéłus | Oncorhynchus tshawytscha

Table 2: Chinook Salmon Designated Unit assessment in the Lower Nicola River watershed. An assessment of the Designated Unit 15 (Lower Thompson Chinook - Stream, Spring) was undertaken by the Committee on the Status of Endangered Wildlife in Canada in 2020, but the final report has not yet been publicly released.

COSEWIC Designated	Status	Trend	Median percent change (last 3 generations)	Median percent change (historic)	Generation length
15 - Lower Thompson (Stream, Spring)	Endangered	TBD	TBD	TBD	TBD

Chinook Salmon are one of the first species to return to the watershed each year, arriving as early as May, and the

population has been in decline since the mid-1990s (L. Ltd. (2007), E. Ltd. (2017)). Known and historic spawning locations include the mainstem Nicola River (mostly between the Coldwater River and Spius Creek confluences), Coldwater River, Spius Creek, lower portions of Clapperton Creek, and upstream of Nicola Lake in Moore Creek and the Upper Nicola River (L. Ltd. (2007), E. Ltd. (2017)). In addition to these spawning systems, important juvenile rearing areas have been observed in Juliet Creek and Voght Creek (L. Ltd. (2007)). Chinook Salmon stocks have been supplemented by the Spius Creek hatchery since the 1980s. Fry and smolt releases have occurred and the Nicola stock is current enhanced by ~200,000 coded-wire tagged yearling smolts annually as a component of the Pacific Salmon Commission (PSC) indicator stock study program (R. Bailey, pers. comm.).

Coho Salmon | sx̣ayqs | Oncorhynchus kisutch

Table 3: Coho Salmon Designated Unit assessment in the Lower Nicola River watershed. Assessments undertaken by the Committee on the Status of Endangered Wildlife in Canada (2016).

COSEWIC Designated Unit	Status	Trend	Median percent change (last 3 generations)	Median percent change (historic)	Generation length
Interior Fraser – Lower Thompson population	Threatened	N/A	119%	-21%	3 years

Coho Salmon begin to return to the watershed in September, with spawning beginning in late October and continuing through December. The population has been in decline since the mid1980s (DFO 1999, E. Ltd. (2017)). Coho Salmon stocks have been supplemented in recent decades by outplants from the Spius Creek Hatchery (E. Ltd. (2017)). The majority of Coho Salmon spawning and rearing occurs in the Coldwater River, Spius Creek, and Maka Creek, but has also been observed in Clapperton Creek, Prospect Creek, and the Upper Nicola River and Moore Creek (L. Ltd. (2007), Pacific-Salmon-Foundation (2020)). The lower reaches of many smaller tributaries are also important Coho Salmon rearing habitat.

Steelhead | có łe | Oncorhynchus mykiss

Table 4: Steelhead Designated Unit assessment in the Lower Nicola River watershed. Assessments undertaken by the Committee on the Status of Endangered Wildlife in Canada (2018).

COSEWIC Designated Unit	Status	Trend	Median percent change (last 3 generations)	Median percent change (historic)	Generation length
Thompson River Population	Endangered	Declining	-79%	N/A	5 years

Steelhead join Chinook Salmon as the first to appear in the watershed, arriving in the spring (L. Ltd. (2007)). The population is critically endangered and is seen as an extreme conservation concern (Bos 2006). Steelhead spawning and rearing is known to occur in the lower portion of the mainstem Nicola River, Skuhun Creek, Shakan Creek, Nuaitch Creek, Maka Creek, the Coldwater River, Juliet Creek, Voght Creek, Prospect Creek, and Clapperton Creek (L. Ltd. (2007)). Historically, almost all third-order and greater streams would have supported Steelhead, and groundwater-fed thermal refugia continue to provide important rearing and holding habitats (E. Ltd. (2017)).

Barrier Types

The following table highlights barrier types threatening 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 are limited spatial data to inform the assessment for a specific barrier type.

Table 5: Barrier types in the Lower Nicola 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 thermal refuge, spawning, and rearing habitat.

Barrier Types	Extent	Severity	Irreversibility	Overall Threat Rating:
Lateral Barriers (including to thermal connectivity)	High	Very High	Medium	High
Natural Barriers	High	Very High	Medium	High
Road-Stream Crossings	Very High	Low	Low	Medium
Small Dams(<5m height)	Medium	Low	Medium	Low
Abandoned Rail-stream Crossings (longitudinal)	Low	Low	Medium	Low
Trail-stream Crossings	Low	Low	Low	Low

Small Dams (<3 m height)

There are 34 mapped small dams on "potentially accessible" stream segments in the watershed, blocking a total of 359.3 km (~67.16% of the total habitat) of modelled spawning and rearing habitat for anadromous salmon, resulting in a medium extent. The extent rating of these structures was confirmed by the planning team. There are two known fish-passage structures in the watershed, including on the dam at the outlet of McKinley Lake. The remaining dams likely block passage for anadromous salmon and would require significant resources to remediate. However, due to the limited extent of dams in the watershed, a final pressure rating of Medium was assigned. Four small dams were identified on the priority barrier list. Three of the dams require further assessment and confirmation of upstream habitat quality, and the dam observed at the outlet of Kwun Lake does not exist.

Road-stream Crossings

Road-stream crossings are an abundant barrier type in the watershed, with 80 assessed and modelled crossings located on modelled Anadromous Salmonid habitat. Demographic road crossings (highways, municipal, and paved roads) block 55.39 km of habitat (57.4%), with 88% of assessed crossings having been identified as barriers to fish passage. Resource

roads block 34.04 km of habitat (35.3%), with 73% of assessed crossings identified as barriers. Significant land use and linear development throughout the valley bottom has disconnected the Nicola River from important habitat in some tributaries, including Highway 5 and Highway 8 see Barrier Prioritization. The collective experience and input from the planning team resulted in a Low irreversibility rating due to the existing body of knowledge and resources to support the remediation of road-stream crossings, though it was noted that there is significant variability between resource roads and highway crossings.

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 do not significantly impact passage for anadromous salmon. As most crossings will be fords or similar structures, remediation may not be required, or 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; however, the lack of ground-truthed evidence to support this rating was identified as a knowledge gap within this plan.

Lateral Barriers (Including to thermal connectivity)

There are numerous types of lateral barriers that potentially occur in the watershed, including dykes, berms, and linear development (i.e., road and abandoned rail lines), all of which can restrict the ability of anadromous salmonids to move into floodplains, riparian wetlands, offchannel habitats, and other groundwater-fed thermal refugia. No comprehensive lateral barrier dataset exists within the watershed, so pressure ratings were based on qualitative local knowledge. Lateral barriers were identified as the primary connectivity concern in the watershed due to a High extent for all target species' habitats and a Very high severity of barriers (i.e., almost all structures are blocking the movement of fish). Highway 5, Highway 8, and the two abandoned rail lines run along significant stretches of the Coldwater River and mainstem Nicola River and likely disconnect these mainstems from segments of their historic floodplains, off-channel habitats, and thermal refugia in certain locations. Other lateral barriers include irrigation infrastructure that occurs in the valley bottom on agricultural land. Overall, the planning team decided that a High pressure rating captured the effect that lateral barriers are likely having on connectivity in the watershed, particularly thermal connectivity, 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 major drivers of natural barriers were massive sediment aggradation that has occurred in the watershed in recent years and changes in the natural flow regime of the watershed. The associated channel destabilization creates impassable stream segments due to a lack of flow and increased lateral migration of streams. The extent, severity, and passability of these obstacles will vary over time depending on the season and year; however, current and historic land-use practices, including forest harvesting, agriculture, and water withdrawals have exacerbated the effect of natural barriers in the watershed. Due to the nature of these land-use practices, the severity of natural barriers was rated as Very high and the irreversibility as Medium, the latter due to the effort required to rectify poor land-use practices at a watershed scale. Overall, the planning team felt that a pressure rating of 'High' adequately captured the effects of natural barriers.

Small Dams (<5m height)

There are five mapped dams on modelled anadromous salmonid habitat in the watershed, blocking a combined 5.08 km (5.3%) of spawning and rearing habitat, resulting in a Low extent see barrier prioritization for dams included in the intermediate barrier list. The extent rating of these structures was confirmed by the planning team. There are three known fish passage structures in the watershed, including on Nicola Lake Dam, and the remaining dams likely block passage for anadromous salmonids. Many dams in the watershed are irrigation impoundments that are of little consequence to target species. Remediating dams requires significant resources; however, due to the minimal extent of dams in the watershed, a final pressure rating of Low was assigned to this barrier type

Abandoned Rail-Stream Crossings (Logitudinal)

There are no active rail lines in the Lower Nicola watershed; however, infrastructure remains in place from the historic Nicola Valley Railway and the Kettle Valley Railway in the form of abandoned railbeds and associated stream crossings. There are 4 modelled abandoned railstream crossings located on modelled anadromous salmonid habitat, blocking a combined 1.94 km of habitat (2.01% of the total habitat blocked; see barrier-prioritization for abandoned rail-stream crossings included in the intermediate barrier list). There are no data to support the assessment of the severity of these crossings, but the collective knowledge of the planning team resulted in a Low severity rating because most are believed

to be serviced by bridges or open-bottom structures. Despite the moderate technical knowledge and resources required to remediate these barriers, the low extent and low severity resulted in the overall pressure rating of Low. The abandoned rail lines, however, were identified by the planning team as a contributor to lateral and thermal disconnectivity in the watershed (see Lateral Barriers to Thermal Connectivity).

Trail-stream Crossings

There are 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 do not significantly restrict passage for anadromous salmonids. Because 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

Key Ecological Attributes and Current Connectivity Status

The planning team devised three Key Ecological Attributes (KEAs) and associated indicators to assess the current connectivity status of the watershed – Accessible Off-channel Thermal Refuge, 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 Salmonids 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 assessments for Accessible Spawning Habitat and Accessible Rearing habitat rely 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 data methods.

Table 6

Target Species	KEA	Indicator	Poor	Fair	Good	Very Good
Andromous Salmon	Available off-channel Thermal Refuge	Total Area (m2) of thermal refuge accessible Current Status:	?	?	?	?

Comments: No baseline data exists on the extent of overwintering habitat in the watershed. A priority action is included in the Operational Plan (strategy 2.3) to develop a habitat layer, and this will be used to inform this connectivity status assessment in the future.

Table 7

Target Species	KEA	Indicator	Poor	Fair	Good	Very Good
Target Species	Available Spawning Habitat	% of total linear spawning habitat accessible	<25%	26-50%	51-75%	>75%

Target Species	KEA	Indicator	Poor	Fair	Good	Very Good
		Current Status:				84

Comments: Indicator rating definitions are based on the consensus decisions of the planning team, including the decision not to define Fair. The current status is based on the CWF Barrier Prioritization Model output, which is current as of March 2022.

Table 8

Target Species	KEA	Indicator	Poor	Fair	Good	Very Good
Anadromous Salmonids	Available Rearing Habitat	% of total linear rearing habitat accessible Current Status:	<25%	26-50%	51-75%	>75% 76

Goals

Table 9: Goals to improve (1) off-channel thermal refuge, (2) spawning, and (3) rearing habitat connectivity for target species in the Lower Nicola 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 total area of groundwater-serviced off-channel thermal refuge accessible to anadromous salmonids will increase by 6,000 m2 within the Lower Nicola River watershed.
2	By 2025, the % of total linear spawning habitat accessible to anadromous salmonids will not decrease below 84% within the Lower Nicola River watershed.
3	By 2031, the % of total linear rearing habitat accessible to anadromous salmonids will increase from 76% to 90% within the Lower Nicola River watershed.

Barrier Prioritization

Lower Nicola Watershed Barrier Prioritization Summary

One conservation outcome of the WCRP is the remediation of barriers to connectivity in the Lower Nicola River watershed, including lateral barriers to thermal refugia and longitudinal barriers. As a step toward the selection of projects for implementation to improve connectivity in the watershed, candidate barriers were prioritized to guide field verification of the sites through barrier assessments and habitat confirmations. The barrier prioritization results represent the best available knowledge at the time of publishing and the barrier lists will be iteratively updated over time.

Lateral Barriers (Including to thermal refugia)

There is a lack of comprehensive data and mapping of lateral barriers and potential thermal refugia in the watershed to support a strategic prioritization currently (see Action 1.3). However, local knowledge was used to compile a list of candidate sites for field verification as a starting point to improve lateral and thermal connectivity.

Table 10: Identified priority lateral barrier remediation sites for field assessment in the Lower Nicola River watershed. UTM northing and eastings refer to Zone 10.

Waterbody	Easting	Northing	Comments
Nicola River			Off-channel complex across from Chutter Ranch on the Nicola River
Coldwater River	643286	5505166	Upstream of Mine Creek exit
Maka Creek	624687	5559767	Assess mouth for accessibility by early run Chinook Salmon
14 Mile Pond	629558	5573055	Assess for access for juvenile fish
Sherman Channel	646058	5556214	Assess for access for juvenile fish

Longitudinal Barriers

To achieve Goals 2 and 3 in this plan, it is necessary to prioritize and identify a suite of barriers that, if remediated, will provide access to a minimum of 69.33 km of modelled rearing habitat (Table 11).

Table 11: Rearing habitat connectivity gain requirements to meet WCRP goals in the Lower Nicola River watershed. The measures of currently accessible and total habitat values are derived from the intrinsic potential habitat model described in connectivity status.

Habitat Type	Currently accessible (km)	Total	Current Connectivity Status	Goal	Gain required (km)
Rearing	388.03	507.55	76.45%	90%	68.76

The barrier prioritization process comprises three stages:

Stage 1: preliminary barrier list

Stage 2: intermediate barrier list

Stage 3: priority barrier list

Initially, the barrier prioritization analysis ranked all barriers in the watershed by the amount of habitat blocked to produce a "preliminary barrier list", which also accounted for assessing "sets" of barriers for which remediation could be coordinated to maximize connectivity gains. From this list, the top-ranking subset of barriers - comprising more barriers than are needed to achieve the goals - is selected to produce an "intermediate barrier list". Barriers that did not rank highly in the model results, but were identified as priority barriers by the local partners were also added to the intermediate barrier list. A longer list of barriers is needed due to the inherent assumptions and uncertainty in the connectivity and habitat models 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, which will require additional field verification once barrier assessments have completed. As such, the intermediate barrier list below (Table 13) 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.

The intermediate barrier list was updated following the barrier assessments and habitat confirmations that were undertaken during the 2021 field season - some barriers were moved forward to the "priority barrier list" (Table 14) and others were eliminated from consideration due to one or more of the considerations discussed in Table 12. The priority barrier list represents structures that were confirmed to be partial or full barriers to fish passage and that block access to confirmed habitat. Barriers on the priority list were reviewed by planning team members and selected for inclusion for proactive pursual of remediation. For more details on the barrier prioritization model, please see Mazany-Wright, Norris, et al. (2021a).

Table 12: Crossings removed from the intermediate barriers list following field investigations.

ID	Stream name	Reason for Removal from Prioritization	Comments
1011302471	Voght Creek	Natural barrier present downstream	Not accessible to anadromous salmonids. Barrier not assessed.
197696	Prospect Creek	Natural falls barrier downstream	GPS coordinates incorrect
196997	Howarth Creek	Natural barrier present downstream	
1011301807	Brook Creek	No crossing	Crossing does not exist - no road observed.
196957	Brook Creek	Burned out bridge collapsed	Not presenting any passage or debris issues (LD Creek FSR)
1011304291	Brook Creek	Burned out bridge collapsed	Not presenting any passage or debris issues

ID	Stream name	Reason for Removal from Prioritization	Comments
197695	Prospect Creek	Natural falls barrier downstream	Not accessible to anadromous salmonids. High quality habitat may be worth pursuing remediation for non-target species.
197694	Prospect Creek	Natural falls barrier downstream	Not accessible to anadromous salmonids. High quality habitat may be worth pursuing remediation for non-target species.
1011300844	Voght Creek	Natural barrier present downstream	Not accessible to anadromous salmonids. Barrier not assessed.

Table 13: Intermediate barrier list resulting from the barrier prioritization analysis in the Lower Nicola River watershed. The barriers on this list require further assessment and/or monitoring before being actively pursued for design and remediation. All barrier assessment data are compiled from the BC Provincial Stream Crossing Inventory System.

Crossing ID	Stream Name	PSCIS Status	Barrier Status	Barrier Type	No. Downstream Barriers	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Status Completed to-date	Recommend Next Steps	Reason	Comments
1100002544	Midday Creek		POTENTIAL	DAM	1	1.79	2.45	Barrier assessment	Recommend removal from list	Irrigation dam does not appear to be blocking flows. Habitat not suitable for salmonids.	

Crossing ID	Stream Name	PSCIS Status	Barrier Status	Barrier Type	No. Down-stream Barriers	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Status Completed to-date	Recommend Next Steps	Reason	Comments
1011303791	Midday Creek		POTENTIAL	ROAD	3	0	0.75	Barrier assessment	Recommend removal from list	Area not suitable for salmonids. Currently flooded by beavers, unclear whether crossing exists.	
1100002545	Midday Creek		POTENTIAL	DAM	4	0	0.39	Barrier assessment	Recommend removal from list	Area not suitable for salmonids. Currently flooded by beavers, unclear whether crossing exists.	
1011303627	Midday Creek		POTENTIAL	ROAD	5	0	1.45	Barrier assessment	Recommend removal from list	Culvert is a barrier but habitat not suitable for salmonids (though 1 rainbow trout captured)	Organic be likely leads to oxygen depletion i summer. Slow flows through summer. Abundant sucker presence

Crossing ID	Stream Name	PSCIS Status	Barrier Status	Barrier Type	No. Down-stream Barriers	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Status Completed to-date	Recommend Next Steps	Reason	Comments
1011300797	Midday Creek		POTENTIAL	ROAD	6	0	0.18	Barrier assessment	Recommend removal from list	Crossing scores as a barrier but contains low quality rearing habitat suitable for Rainbow Trout only; no spawning or overwinter-ing habitat.	
197015	Midday Creek	ASSESSED	BARRIER	ROAD	7	0	2.80	Habitat confirma-tion	Recommend removal from list	Crossing scores as a barrier but contains low quality rearing habitat suitable for Rainbow Trout only; no spawning or overwinter-ing habitat.	
197036	Midday Creek	HABITAT CONFIR-MATION	BARRIER	ROAD	8	0	1.91	Habitat confirma-tion	Recommend removal from list	Crossing scores as a barrier but has moderate quality habitat suitable for Rainbow Trout only.	

Crossing ID	Stream Name	PSCIS Status	Barrier Status	Barrier Type	No. Down-stream Barriers	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Status Completed to-date	Recommend Next Steps	Reason	Comments
196969	Murray Lk Creek	ASSESSED	BARRIER	ROAD		0	3.03	Habitat confirma-tion	Recommend advancing to priority list	Confirmed barrier, excellent groundwater-influenced wetlands for Coho rearing upstream	Major con-tribution o sediments from road/culve impacting 200 m of spawning channel immediatel downstrean of culvert.
197880 (10113017380)	Stumbles Creek	ASSESSED	BARRIER	ROAD	0	0	0.27	Barrier assessment	Remove from list or advance to priority list	Partial barrier	Passable to CO fry at low flows and adult fish at all flows. The calculated water velocity is 0.23 m/s. CO fry, an L was captured. Important Migratory Corridor fo CO.

Crossing ID	Stream Name	PSCIS Status	Barrier Status	Barrier Type	No. Down-stream Barriers	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Status Completed to-date	Recommend Next Steps	Reason	Comments
197882 (10113042156)	Stumbles Creek	ASSESSED	BARRIER	ROAD	1	No	2.00	Barrier assessment	Assess juv passage: determine spring freshet velocities	Partial barrier	Passable to CO fry at low flows and adult fish at all flows. The calculated water velocity is 0.26 m/s. CO fry, and RB parr captured. Important Migratory Corridor fo CO.

Crossing ID	Stream Name	PSCIS Status	Barrier Status	Barrier Type	No. Down-stream Barriers	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Status Completed to-date	Recommend Next Steps	Reason	Comments
197883 (10113018430)	Stumbles Creek	ASSESSED	BARRIER	ROAD	2	0	0.20	Barrier assessment	Assess juv passage: determine spring freshet velocities	Partial barrier	Passable to CO fry at low flows and adult fish at all flows. The calculated water velocity is 0.22 m/s. CO fry captured. Water is diverted upstream o Hwy 8 for irrigation purposes during the growing season and regulated by a manua irrigation gate. Most water was diverted during the assessment In the fall, Mr. Miller (the property owner where the culvert is located) opens the gate to allow CO t spawn in the stream on his property. Important Migratory Corridor fo CO.

Crossing ID	Stream Name	PSCIS Status	Barrier Status	Barrier Type	No. Down-stream Barriers	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Status Completed to-date	Recommend Next Steps	Reason	Comments
197884 (10113007510)	Stumbles Creek	ASSESSED	BARRIER	ROAD	3	0	1.79	Barrier assessment	Assess juv passage: determine spring freshet velocities	Partial barrier	Passable to CO fry at low flows and adult fish at all flows. The calculated water velocity is 0.07 m/s. CO fry captured. Water is diverted upstream o Hwy 8 for irrigation purposes during the growing season and regulated by a manu irrigation gate. Most water was diverted during the assessment Mr. Miller observed CO spawning upstream o Hwy 8 afte the gate was opene in the fall. Important Migratory Corridor fo CO.

Crossing ID	Stream Name	PSCIS Status	Barrier Status	Barrier Type	No. Down-stream Barriers	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Status Completed to-date	Recommend Next Steps	Reason	Comments
197039	Kwinshatin Creek	ASSESSED	BARRIER	ROAD	0	0	2.20	Habitat confirma-tion	Advance to priority list or remove from con-sideration	Good Rainbow Trout stream with limited spawning potential for salmon	No suitable spawning habitat is present for salmon - only a couple of gravel pockets (< m^2 and ~20% fines usable for RB oppor-tunistic spawning were observed. No overwin tering habitat wa noted in th surveyed section. RI is common with sizes 70 - 200 mm. One fish exhibited hybridiza-tion characteris tics with CT (large mandible and heavy spotting). Moderate habitat value for RB.

Crossing ID	Stream Name	PSCIS Status	Barrier Status	Barrier Type	No. Downstream Barriers	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Status Completed to-date	Recommend Next Steps	Reason	Comments
197693	Manning Creek		BARRIER	ROAD	0	0	0.00	Barrier assessment	Advance to habitat confirmation	Rainbow/steelhead stream identified by David Lawrence in need of fixing	
197692	Manning Creek		BARRIER	ROAD	1	0	0.00	Barrier assessment	Advance to habitat confirmation	Rainbow/steelhead stream identified by David Lawrence in need of fixing	
????	Clapperton Creek			ROAD				Barrier assessment		Blown culvert adjacent to Zoht 14 identified by LNIB. Needs coordinates.	Rainbow/s stream

Table 14: Priority barrier list resulting from the barrier prioritization analysis in the Lower Nicola River watershed. The barriers on this have been selected for proactive remediation. All barrier assessment data are compiled from the BC Provincial Stream Crossing Inventory System.

Stream Name	Road Name	PSCIS Status	Barrier Status	Barrier Type	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Current Status	Next Steps	Lead for Next Steps	Reason
Clapperton Creek	n/a (adjacent to Mill Creek Road)	ASSESSED	BARRIER	DAM	TBD	TBD	Preliminary design	Complete detailed design	CWF, LNIB	Important Steelhead, Chinook, Coho stream

Stream Name	Road Name	PSCIS Status	Barrier Status	Barrier Type	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Current Status	Next Steps	Lead for Next Steps	Reason
Kwinshatin Creek	Colddwater Road	ASSESSED	BARRIER	ROAD	0	0.43	Habitat confirmation	Recommend removal from list OR advance to design	CWF	No suitable spawning habitat is present for salmon - only a couple of gravel pockets (<1 m^2 and ~20% fines) usable for RB opportunistic spawning were observed. No overwintering habitat was noted in the surveyed section. RB is common with sizes 70 - 200 mm. One fish exhibited hybridization characteristics with CT (large mandible and heavy spotting). Moderate habitat value for RB.

Stream Name	Road Name	PSCIS Status	Barrier Status	Barrier Type	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Current Status	Next Steps	Lead for Next Steps	Reason
Skuhun Creek	Highway 8	ASSESSED	BARRIER	ROAD	TBD	TBD	Complete	Backwater structure and reinforce banks	MOTI	Important Steelhead stream
Skuhun Creek	n/a - stream mouth	ASSESSED	BARRIER	Mouth	all	all	Monitor	Site being monitored for upcoming issues, and decide what should be done about the site	DFO, STC	Important Steelhead stream

Stream Name	Road Name	PSCIS Status	Barrier Status	Barrier Type	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Current Status	Next Steps	Lead for Next Steps	Reason
Brook Creek	KVR	ASSESSED	PASSABLE	ROAD	4.88	4.88	Passable	Recommend removal from list	CWF	Damaged bridge during 2021 flood - deck dropped by ~0.7 m. The debris jam ~70 m downstream is no longer a fish barrier. In the last two years, water flows caused downcut-ting under the jam and side channels around, passable to CO, ST, and RB at higher flows. The stream is passable to adult fish from the mouth. Only RB was captured in the stream. Moderate habitat value for RB and Important Migratory Corridor for CO and ST.

Stream Name	Road Name	PSCIS Status	Barrier Status	Barrier Type	Spawning Habitat Blocked (km)	Rearing Habitat Blocked (km)	Current Status	Next Steps	Lead for Next Steps	Reason

Table 15: List of barriers that were removed from consideration from first iteration of the intermediate barrier list (field assessments occurred during the 2021 field season). Removed following discussion with the planning team due to these structures not existing, being passable, not be associated with usable habitat, or deemed not feasible to remediate because of logistic considerations.

ID	Stream name	Reason for Removal from Prioritization	Comments
1011302471	Voght Creek	Natural barrier present downstream	Not accessible to anadromous salmonids. Barrier not assessed.
197696	Prospect Creek	Natural falls barrier downstream	GPS coordinates incorrect
196997	Howarth Creek	Natural barrier present downstream	nan
1011301807	Brook Creek	No crossing	Crossing does not exist - no road observed.
196957	Brook Creek	Burned out bridge collapsed	Not presenting any passage or debris issues (LD Creek FSR)
1011304291	Brook Creek	Burned out bridge collapsed	Not presenting any passage or debris issues
197695	Prospect Creek	Natural falls barrier downstream	Not accessible to anadromous salmonids. High quality habitat may be worth pursuing remediation for non- target species.
197694	Prospect Creek	Natural falls barrier downstream	Not accessible to anadromous salmonids. High quality habitat may be worth pursuing remediation for non- target species.
1011300844	Voght Creek	Natural barrier present downstream	Not accessible to anadromous salmonids. Barrier not assessed.

Work Planning

Annual Progress Report

The Lower Nicola Indian Band, Nooaitch Band, and Scw'exmx Tribal Council completed in-depth barrier assessments and habitat confirmations at several sites (Stumbles, Kwinshatin, Brook, Murray Lake, Midday creeks) on the intermediate barriers list. In addition, initial results from CWF's drone imagery project to identify thermal refugia were developed and reviewed at a working group meeting with program partners in 2023.

Annual Work Plan

Table 16: Work plan for the Lower Nicola Watershed.

Task	Lead for Next Step	Participants	Timeline	Notes
Complete barrier assessments for next set of crossings?	CWF	LNIB, Nooaitch, STC	June-July 2024	
Review 2023 and prior field results with WG and advance/reject crossings based on outcomes	CWF	WG		
Review lateral habitat report with partners working on lateral habitat identification in watershed to refine methods and identify sites to investigate in 2024	CWF	Nooaitch, NVIT	Jan-Feb 2024	

Task	Lead for Next Step	Participants	Timeline	Notes
Meet with partners individually to get feedback on: -Which barriers to confirm as priorities based on 2023 field assessements and CWF's lateral barrier analysis -Should CWF expand the WCRP to incorporate more lateral barrier actions, or instead support local iniatives to address lateral connectivity	CWF	WG	Jan-Feb 2024	Requires feedback from working group
Complete habitat confirmation on Manning Creek	CWF			
Complete barrier removal on Clapperton Creek	CWF	LNIB	Jul-24	
Update model with all current relvant information for Lower Nicola watershed	CWF			

Task	Lead for Next Step	Participants	Timeline	Notes
Review PSCIS assessments with good habitat upstream with group to determine if there is more work to be done there.	CWF	WG		
re-run connectivity models	CWF			
Develop 2025-2026 work plan	CWF	WG		
Update WCRP based on 2024 field results and partner feedback	CWF	WG		

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 Lower Nicola 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 17: Operational plan to support the implementa
species in the Lower Nicola River watershed.

Strategy / Actions	Lead(s)	Participa
Strategy 1: Crossing Remediation		
1.1 – Remediate dykes and berms	CWF, Scw'exmx Tribal Council (STC)	Upper Ni
1.2 – Reconnect channels to thermal refugia	CWF, STC	Upper Ni
1.3 – Knowledge Gap: Improve mapping of lateral habitat and thermal refugia	Tom Willms	CWF, Fr
1.4 - Knowledge Gap: Revisit previous remediation and off-channel habitat creation projects to assess whether they are still fish-passable	STC	CWF, Ma
1.5 - Review LiDAR, aerial imagery, and field assessments to determine immediate lateral connectivity needs.		
Strategy 2: Lateral Barrier Remediation		

Strategy / Actions	Lead(s)	Participa
2.1 – Remove and decommission barriers	CWF, STC	Upper Ni
2.2 – Upgrade and resize crossings	CWF, STC, Ministry of Transportation and Infrastructure	Upper Ni
2.3 – Install and maintain temporary mitigation	CWF	Upper Ni
2.4 – Initiate a barrier owner outreach program	TBD	CWF, Ni
2.5 – Request regulatory action for non-compliant crossings	TBD	CWF, DF
2.6 – Knowledge Gap: Identify barriers and map barrier ownership	Fraser Basin Council (FBC)	CWF, SR
2.7 – Knowledge Gap: Continue updating the barrier prioritization model	CWF	TBD
2.8 – Knowledge Gap: Adapt the provincial fish passage framework to account for ephemeral habitat	CWF	TBD
2.9 – Knowledge Gap: Assess barriers by applying an adapted version of the provincial fish passage framework	CWF	STC, DF
Strategy 3: Dam Remediation		
3.1 - Remove dams	TBD	TBD
3.2 - Install fish passage	TBD	TBD
3.3 - Knowledge Gap: Continue updating the barrier prioritization model	CWF	TBD
3.4 - Knowledge Gap: Assess dams to determine whether they exist and are truly blocking fish habitat	TBD	TBD
3.5 - Knowledge Gap: Identify and map dam ownership	TBD	TBD
Strategy 4: Barrier Prevention		
4.1 – Work with land users to improve their aquatic connectivity practices	TBD	TBD
4.2 – Monitor new crossing compliance with regulations regarding fish passage	TBD	TBD
Strategy 5: Progress Tracking Plan		
5.1 - Engage and explore integration with existing regional initiatives	CWF, Nicola Watershed Governance Project, FBC	TBD
5.2 - Implement the WCRP Progress Tracking Plan	CWF	TBD
Total:		
Fundraising total:		
Proponent/government contribution total:		

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Project Partners

Planning Team

Table 18: Lower Nicola 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
Nicolas Lapointe	Canadian Wildlife Federation
Sarah Sra	Canadian Wildlife Federation
Colin McGregor	Department of Fisheries and Oceans Canada
Sarah Ostoforoff	Department of Fisheries and Oceans Canada
Josh Noseworthy	Global Conservation Solutions
Simon Norris	Hillcrest Geographics
Roderick Malcom	Lower Nicola Indian band
Mark Philpotts	Ministry of Forests, Lands and Natural Resource Operations
Patrick Farmer	Ministry of Forests, Lands and Natural Resource Operations
Tom Willms	Nicola Valley Institute of Technology
Al Mackay-Smith	Nicola Watershed Community Roundtable
Lou Cook	Nicola Watershed Community Roundtable
Richard Bailey	Nooaitch Indian Band
Brian Holmes	Upper Nicola Band
Paul Mozin	Scw'exmx Tribal Council

Key Actors

Table 19: Additional key actors in the Lower Nicola 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. Key actors were identified by the planning team and do not reflect a commitment to contribute to the implementation and updating of this WCRP.

Individual or Organization Name	Role and Primary Interest
City Councillors of Merritt	Local government that would like to be apprised of this initiative's progress.
Coldwater Band	A First Nation band with territory in the watershed and a member of the Scw'exmx Tribal Council (STC). Through the STC and NWGP, the Coldwater Band will be a key actor for engagement and implementation.
Fraser Basin Council (FBC)	The FBC website could be used to host the plan, and FBC is open to helping CWF pursue future funding opportunities and supporting collaboration for the initiative where possible.
Nicola Basin Collaborative	Coordinated by the FBC, the Nicola Basin Collaborative comprises a number of groups, agencies, organizations, and private landowners to collaboratively plan, identify, prioritize, and address issues in the Nicola watershed. The collaborative includes a Research and Technical Committee, which can be a forum to promote coordination and collaboration for the implementation of this plan.

Individual or Organization Name	Role and Primary Interest
Nicola Stock Breeders Association	Local agricultural landowners in the watershed. They can help facilitate construction as well as consent to or facilitate complimentary works on private property to improve connectivity.
Nicola Watershed Governance Project (NWGP)	This project fosters a collaborative working relationship between five First Nations bands and the provincial government to resolve shared water-management issues in the watershed. The WCRP process can compliment existing work being undertaken by the Nicola Watershed Governance Project, and the planning team recommended that the NWGP should be a main decision-making body on any project implementation related to this plan.
Shackan Band	A First Nation band with territory in the watershed and a member of the Scw'exmx Tribal Council (STC). Through the STC and NWGP, the Shackan Band will be a key actor for engagement and implementation.

Individual or Organization Name	Role and Primary Interest
Stuwix Resources Joint Venture (SRJV)	A First Nations forestry company that balances successful First Nations business with sustainable forest resources management practices to create and promote healthy ecosystems and healthy independent communities. Shareholder/joint venture First Nations include: Lower Nicola Indian Band, Coldwater Band, Nooaitch Indian Band, Shackan Band, Upper Nicola Band, Cook's Ferry Band, Siska Indian Band, and Upper Similkameen Indian Band.

Supplementary Information

Situation Analysis

The following situation model was developed by the WCRP planning team 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.

Strategies & Actions

In 2021, the Lower Nicola River watershed and many other parts of BC experienced devastating forest fires and floods. Prior to this, CWF worked with the Scw'exmx Tribal Council to assess priority barriers that were identified through longitudinal models and undertake preliminary assessments of local priorities for potential lateral connectivity remediation. Recognizing that there may be other urgent restoration priorities in the watershed, the Planning Team decided that the current areas of focus will be on reviewing LiDAR, aerial imagery, and field assessments to determine immediate lateral connectivity needs (see Action 1.5 below), responding to new barriers that may have developed in the watershed, and addressing other emerging needs in the watershed. The Planning Team will focus on the remaining strategies and actions in the table below in future years.

Effectiveness evaluation of identified conservation strategies and associated actions to improve connectivity for target species in the Lower Nicola River watershed. The planning team identified five broad strategies to implement through this WCRP, (1) lateral barrier remediation (priority on reconnecting thermal refugia), (2) stream crossing remediation, (3) dam remediation, (4) barrier prevention, and (5) progress tracking plan. 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: Lateral Barrier Remediation

Table 20:

ID	Actions	Details
1.1	Remediate dykes, berms, and other lateral barriers	The group selected a feasibility rating of High based on the assumptio
1.2	Remediate natural barriers to lateral connectivity	This can include various methods, such as beaver dam analogues.
1.3	Knowledge Gap: Improve mapping of lateral habitat and thermal refugia	Thermal imagery collected via drones could be used to map thermal r
1.4	Knowledge Gap: Revisit previous remediation and off-channel habitat creation projects to assess whether they are still fish-passable	
1.5	Review LiDAR, aerial imagery, and field assessments to determine immediate lateral connectivity needs.	

Strategy 2: Crossing Remidiation

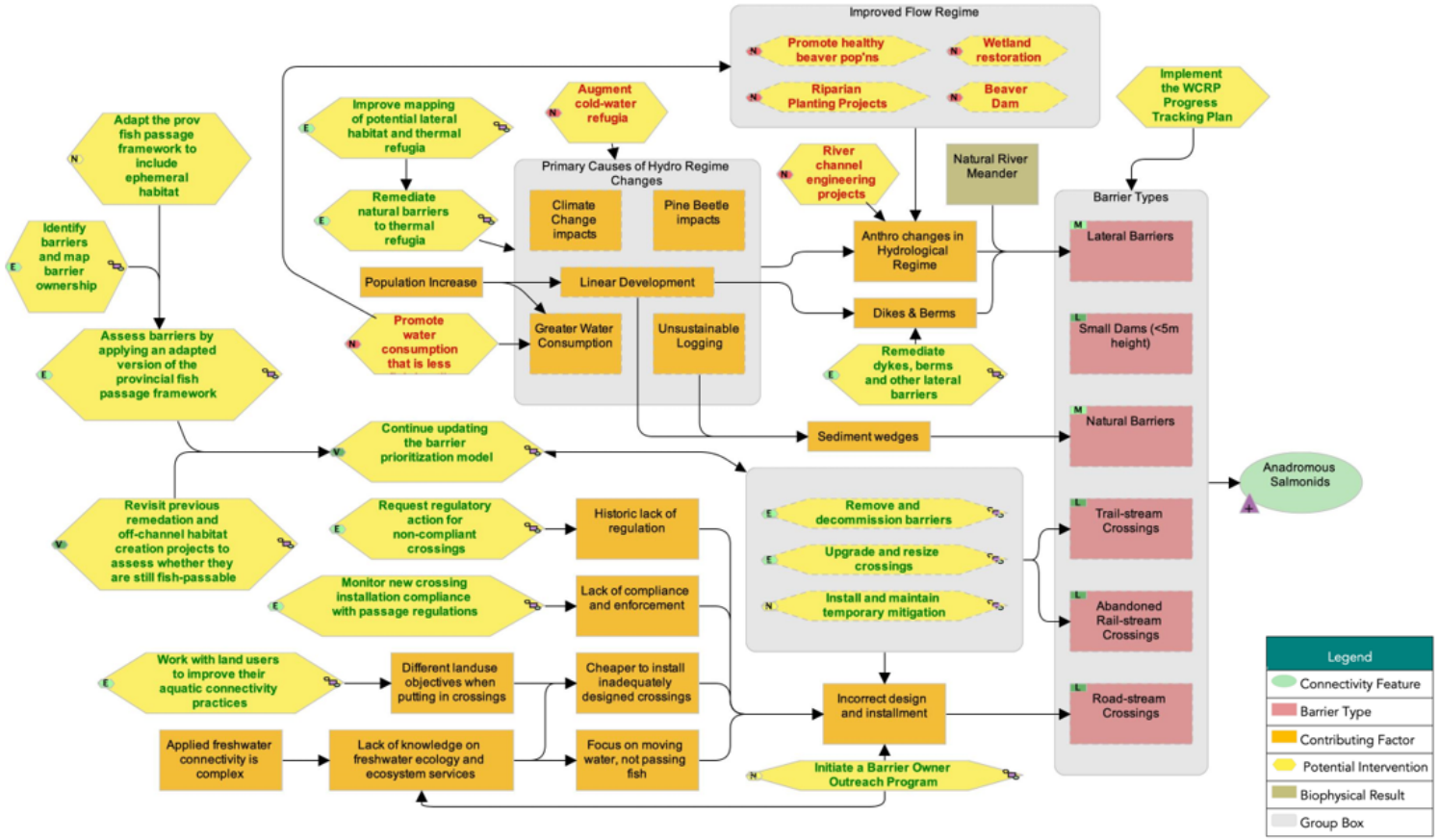

Figure 3: Situation analysis developed by the planning team to identify factors that contribute to fragmentation (orange boxes), biophysical results (brown boxes), and potential strategies/actions to improve connectivity (yellow hexagons) for target species in the Lower Nicola River watershed.

ID	Actions	Details
2.1	Remove and decommission barriers	
2.2	Upgrade and resize crossings	Examples include installing larger culverts, replacing closed- with open-bottom culverts, or upgra
2.3	Install and maintain temporary mitigation	Examples may include installing fish ladders on barriers that cannot be remediated.
2.4	Initiate a barrier owner outreach program	This can include reaching out to the Cattleman's Association, as well as potentially working with
2.5	Request regulatory action for non-compliant crossings	Request provincial and federal agencies to require that targeted, high-priority barriers be remedi
2.6	Knowledge Gap: Identify barriers and map barrier ownership	
2.7	Knowledge Gap: Continue updating the barrier prioritization model	The model process will be finalized, and priorities will be updated as new information becomes a
2.8	Knowledge Gap: Adapt the provincial fish passage framework to account for ephemeral habitat	Ephemeral habitat is especially important in the Lower Nicola River and need to be accounted fo
2.9	Knowledge Gap: Assess barriers by applying an adapted version of the provincial fish passage framework	The first three steps are, (1) barrier assessments, (2) habitat confirmations (including of ephemer

Strategy 3: Dam Remediation

Table 22: Strategy 3

ID	Actions	Details
3.1	Remove dams	
3.2	Install fish passage	
3.4	Knowledge Gap: Continue updating the barrier prioritization model	The model process will be finalized, and prioritizations will be updated as new information becomes avai
3.5	Knowledge Gap: Assess dams to determine whether they exist and are truly blocking fish habitat	Focus on identifying ownership of priority dams that we want to remediate in the short-term.
3.6	Knowledge Gap: Identify and map dam ownership	
3.6	Knowledge Gap: Identify and map dam ownership	

Strategy 4: Barrier Prevention

Table 23: Strategy 4

ID	Actions	Details
4.1	Work with land users to improve their aquatic connectivity practices	This can be done through the barrier ownership program, or for landowners that do not currently own barriers, this could include e
4.2	Monitor new crossing installation compliance with passage regulations	nan

Strategy 5: Communication and Education

ID	Actions	Details
5.1	Engage and explore integration with existing regional initiatives	Engage and coordinate with the Nicola Watershed Governance Project and Fraser Basin Council initiatives (e.g., RAMS) to inform decisio

ID	Actions	Details
5.2	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.

Theories of Change & Objectives

Theories of Change explicitly state assumptions around how the identified actions will achieve gains in connectivity and contribute to achieving 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.

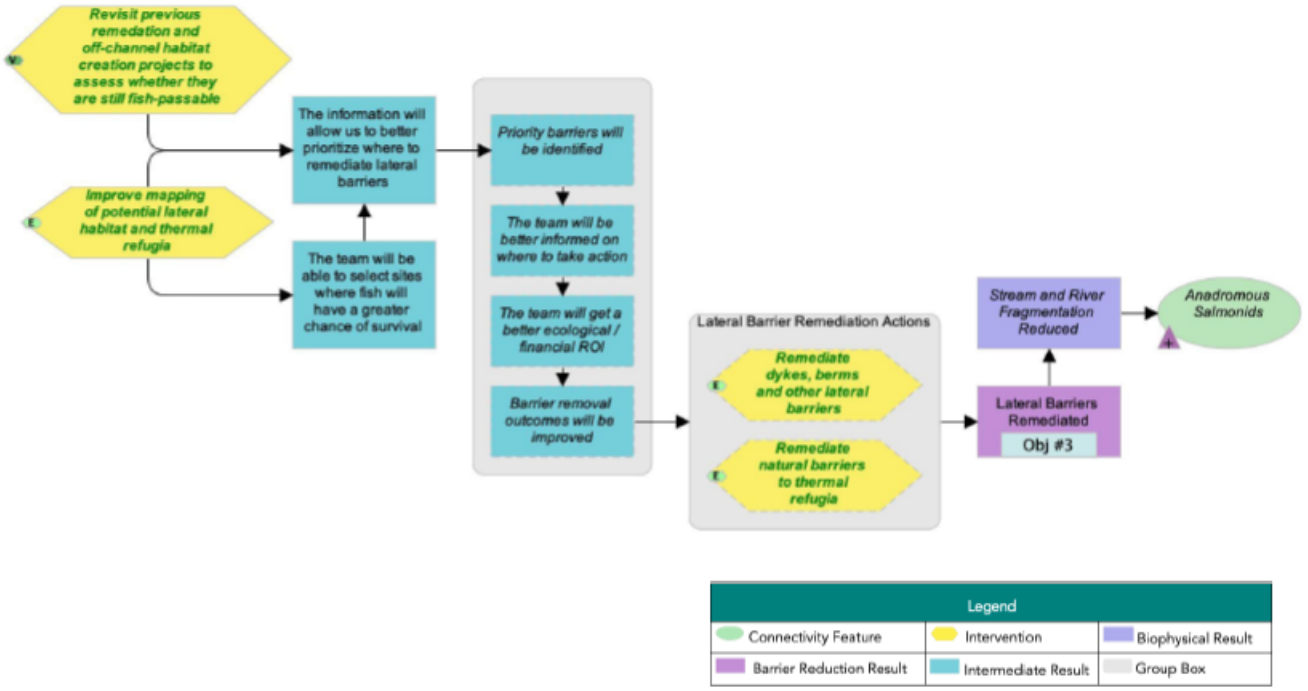

Figure 4: Theory of change developed by the planning team for the actions identified under Strategy 1: Lateral Barrier Remediation in the Lower Nicola River watershed.

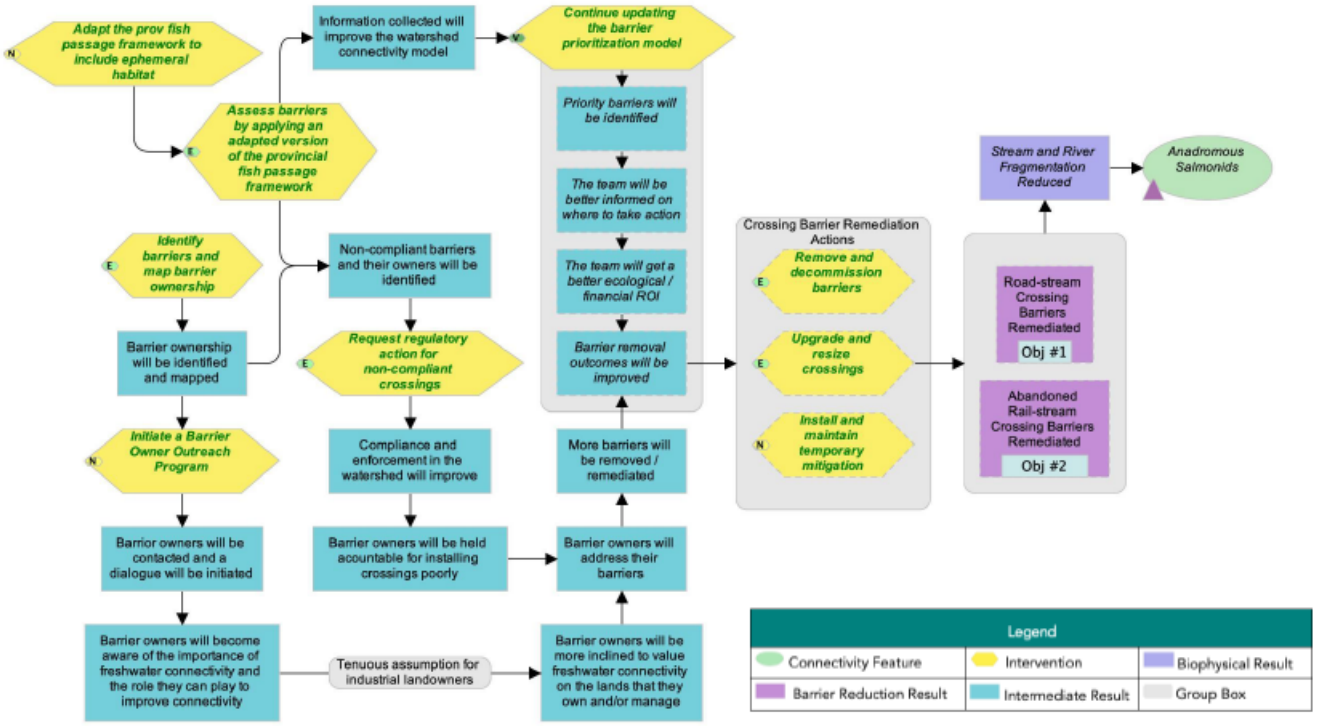

Figure 5: Theory of change developed by the planning team for the actions identified under Strategy 2: Stream Crossing Remediation in the Lower Nicola River watershed.

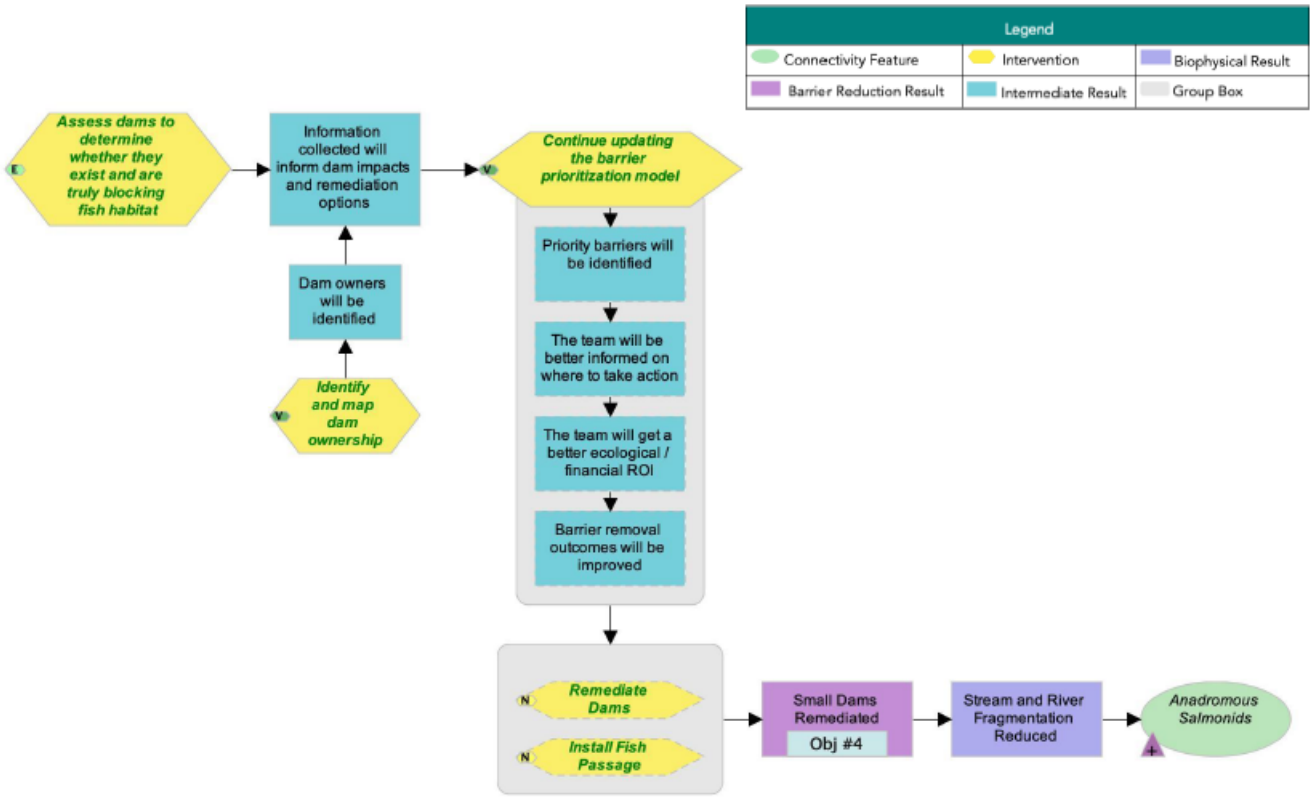

Figure 6: Theory of change developed by the planning team for the actions identified under Strategy 3: Dam Remediation in the Lower Nicola River watershed.

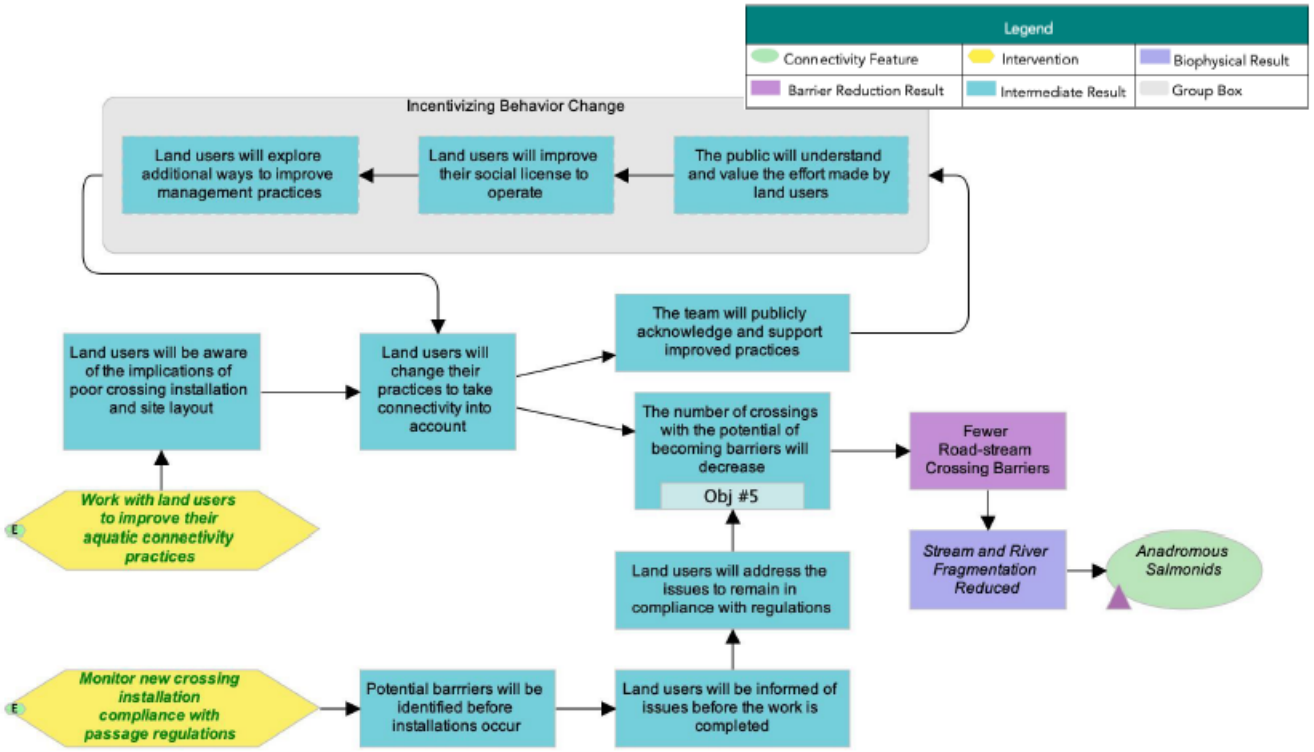

Figure 7: Theory of change developed by the planning team for the actions identified under Strategy 4: Barrier Prevention in the Lower Nicola River watershed.

Funding Sources

Table 25: Potential funding sources for plan implementation in the Lower Nicola 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 Ministry Of Transport and Infrastructure roads including culvert retrofits and replacement to restore Pacific salmon and trout access, and wildlife tunnels. Primarily for crossings linked to highway infrastructure.
Pacific Salmon Foundation's Community Salmon Program	For projects supporting the protection, conservation and enhancement or rehabilitation of Pacific salmon 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).

Funding Source	Spending Restrictions and Other Consideration
Southern Boundary 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.
Enhancement and Restoration Grants	Emphasis for funding is on stocks of conservation concern, particularly those contributing to a fishery and stocks of bilateral fishery relevance. Projects that focus on freshwater wild fish, native wildlife species and their habitats and 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, Westslope Cutthroat Trout. Requires 50% funding match.

Funding Source	Spending Restrictions and Other Consideration
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.
Habitat Stewardship Program for Aquatic Species at Risk	Program for non-profits, Indigenous governments, academic institutions for activities that align with recovery actions identified in SARA recovery documents and/or COSEWIC assessment documents. Project must address one or more of three broad categories: (1) important habitat for aquatic species at risk is improved and/or managed to meet their recovery needs; (2) threats to aquatic species at risk and/or their habitat are stopped, removed, and/or mitigated; and (3) collaboration and partnerships support the conservation and recovery of aquatic species at risk. Limited to at-risk species listed under COSEWIC and/or SARA as threatened, endangered, or special concern.

Funding Source	Spending Restrictions and Other Consideration
Canada Nature Fund for Aquatic Species at Risk	Funding program aimed at addressing priority threats for aquatic species at risk listed as endangered, threatened or Special Concern by COSEWIC, as they align with existing federal, provincial or other local recovery plans. Limited to species in the Columbia and Fraser basins in BC, among other priority areas across Canada. Focus on multi-year, multi-partner initiatives that apply an ecosystem or multi-species approach and create a legacy by enabling recovery actions that carry beyond the life of the funding program. Amounts from $100K-$1M available per year.

Funding Source	Spending Restrictions and Other Consideration
BC Salmon Restoration and Innovation Fund	Funding for Indigenous enterprises, academia, industry associations, stewardship groups and commercial groups to support initiatives that support the protection and restoration of wild Pacific salmon and other BC fish stocks or ensure fish and seafood sector in BC is environmentally and economically sustainable. Five main priorities including species of concern rebuilding through habitat restoration with priority for projects that are part of a watershed-scale restoration plan/prioritization effort; build on successful previous restoration efforts; focus on critical habitat and/or the rehabilitation of natural ecosystem processes.

Funding Source	Spending Restrictions and Other Consideration
Aboriginal Fund for Species at Risk	Program for Indigenous groups for activities that align with recovery actions identified in SARA recovery documents and/or COSEWIC assessment documents for species listed as Endangered, Threatened, or Special Concern by SARA or COSEWIC. Project must address one or more of four broad categories: (1) habitat for species at risk is improved and/or managed to meet their recovery needs; (2) threats to species at risk and/or their habitat are stopped, removed and/or mitigated; (3) collaboration, information sharing and partnership between Indigenous communities, governments and organizations and other interested parties (e.g. federal/provincial/territorial governments, academia, industry, private sector) is enhanced; and (4) capacity within Indigenous communities, to lead in the stewardship of species at risk and contribute to broader SARA implementation, is strengthened.

Funding Source	Spending Restrictions and Other Consideration
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.

Funding Source	Spending Restrictions and Other Consideration
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; or (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.

Funding Source	Spending Restrictions and Other Consideration
Vancouver Foundation	Granting agency for community, social and environmental initiative 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.

Data Download and Methods

Connectivity Status Assessment Methods

The connectivity status assessment for anadromous salmonids in the Lower Nicola 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, see Mazany-Wright, Norris, et al. (2021a). The variables and thresholds used to model potential spawning and rearing habitat for each target species are summarized in Table 26. The quantity of modelled habitat for each species was aggregated for each habitat type to inform two of the 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) a multiplier of 1.5x the length of the stream segments flowing through the polygons was applied.

Table 26: Parameters and thresholds used to inform the intrinsic potential habitat model for spawning and rearing habitat for each target species in the Lower Nicola River watershed.

Species	Spawning Habitat Channel Gradient (%)	Spawning Habitat Mean annual discharge (m3/s)	Rearing Habitat Channel Gradient (%)	Rearing Habitat Mean annual discharge (m3/s)	Rearing Habitat Multiplier (1.5x)
Chinook Salmon	0-3 (Busch et al. 2011, Cooney and Holzer 2006)	0.46-322.5 (Bjornn and Reiser 1991, Neuman and Newcombe 1977, Woll et al. 2017, Roberge et al. 2002, Raleigh and Miller 1986)	0-5 (Woll et al. 2017, Porter et al. 2008)	0.28-100 (Agrawal et al. 2005)	N/A
Coho Salmon	0-5	0.164-59.15	0-5	0.03-40	Wetland

Species	Spawning Habitat Channel Gradient (%)	Spawning Habitat Mean annual discharge (m3/s)	Rearing Habitat Channel Gradient (%)	Rearing Habitat Mean annual discharge (m3/s)	Rearing Habitat Multiplier (1.5x)
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)	N/A