Lower Nicola Watershed Connectivity Remediation Plan: 2021 - 2040

Canadian Wildlife Federation

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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. Field

assessments were completed for 28 longitudinal barriers on the preliminary barrier list and 12 lateral barriers that were Identified by the Scw'exmc Tribal Council and Richard Bailey during the summer of 2021, followed by a series of WCRP Update Workshops in spring 2021. The aim of these workshops was for the team to receive updates on progress made during the field season, review assessment results and identify priority barriers, revise the connectivity status assessment and goals, and update the Operational Plan for 2022. 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)).

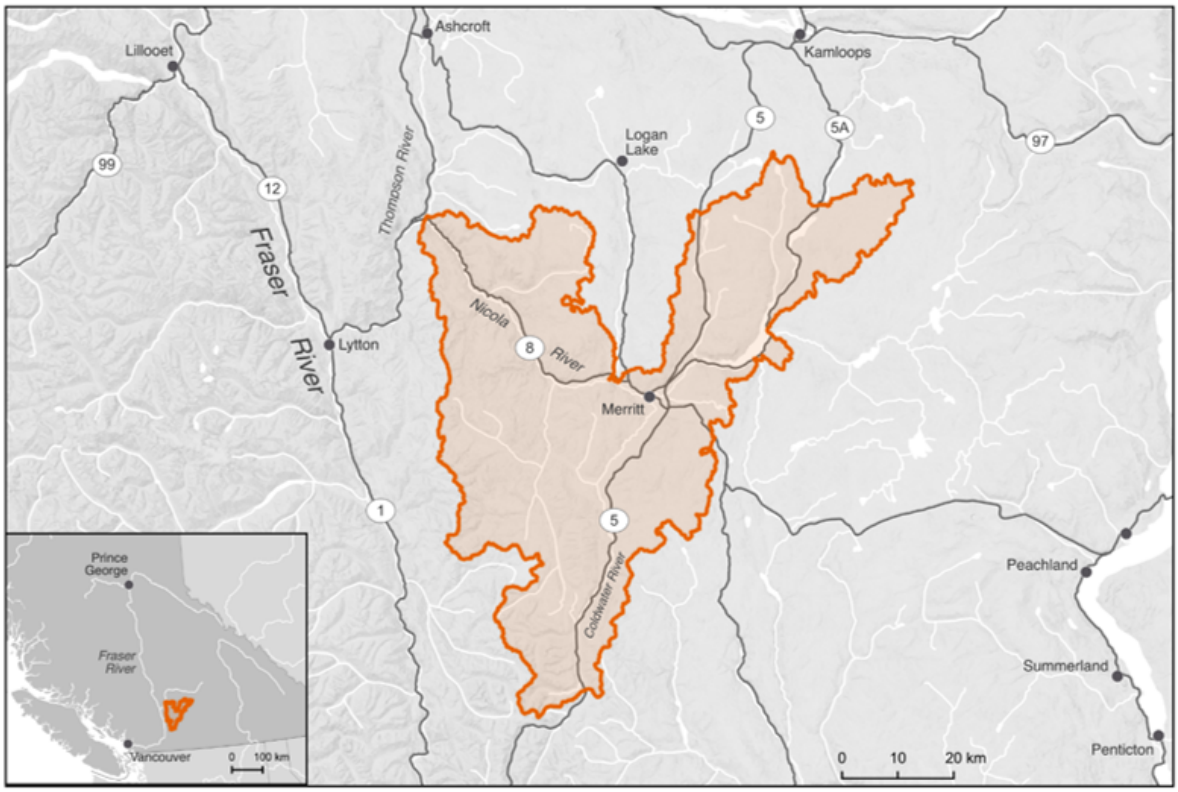

Figure 1: The primary geographic scope - the Lower Nicola River watershed, excluding the Guichon Creek drainage and the Nicola River and Quilchena Creek drainages upstream of Nicola Lake

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)).

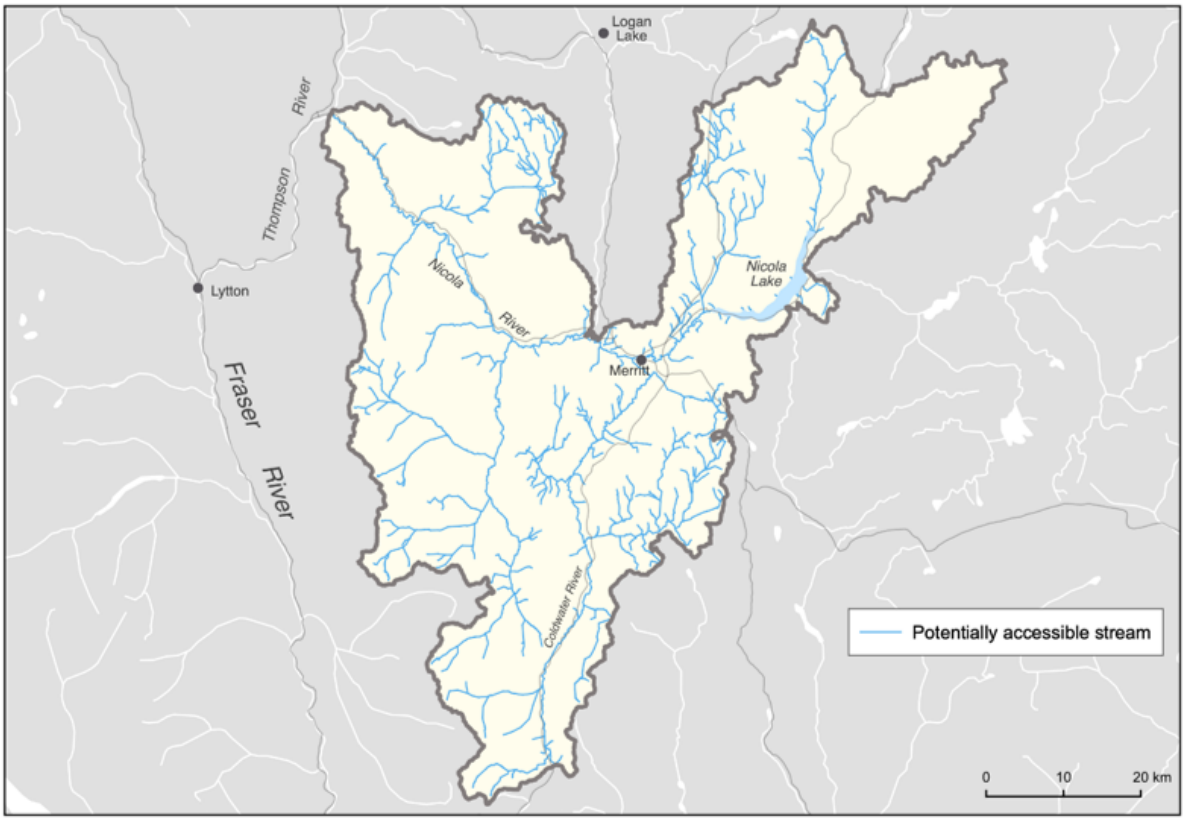

Figure 2: Potentially accessible stream segments within the Lower Nicola River watershed. These do not represent useable habitat types, but rather identify the stream segments within which habitat modelling and barrier mapping and prioritization was undertaken.

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 outmigrating 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 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 Lowe
An assessment of the Designated Unit 15 (Lower Thompson
was undertaken by the Committee on the Status of Endar
in 2020, but the final report has not yet been publicly rele

COSEWIC Designated	Status	Trend	Median percent change (last 3 generatio
15 - Lower Thompson (Stream, Spring)	Endangered	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
sessments undertaken by the Committee on the Statu
Canada (2016).

COSEWIC Designated Unit	Status	Trend	Median percent change (last 3 gen
Interior Fraser – Lower Thompson population	Threatened	N/A	119%

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), PSF 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 Ri
ments undertaken by the Committee on the Status of Endange
(2018).

COSEWIC Designated Unit	Status	Trend	Median percent change (last 3 generations)
Thompson River Population	Endangered	Declining	-79%

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
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)	High	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 17 mapped small dams on "potentially accessible" stream segments in the watershed, blocking a total of 351.83 km (~71.42% 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 80assessed 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 (Longitudinal)

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	P
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
Target Species	Available Spawning Habitat	% of total linear spawning habitat accessible Current Status:	<25%	26-50%

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	Fai
Anadromous Salmonids	Available Rearing Habitat	% of total linear rearing habitat accessible Current Status:	<25%	26-

Goals

Table 9: Goals to improve (1) off-channel thermal refuge, (2) spa connectivity for target species in the Lower Nicola Riv of the WCRP (2021-2031). The goals were establis the planning team and represent the resulting desire watershed. The goals are subject to change as more info over the course of the plan timeline (e.g., the current based on barrier field assessments).

Goal #	Goal
1	By 2031, the total area of groundwater-serviced off-channel thermal refuge accessible to anadromous
2	By 2025, the % of total linear spawning habitat accessible to anadromous salmonids will not decreas
3	By 2031, the % of total linear rearing habitat accessible to anadromous salmonids will increase from

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 Nicol
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 39 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	394.19	465.18	85%	96%	52.38

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 intermed

ID	Stream Name	Reason for Removal from Prioritization	Comments
1011302471	Voght Creek	Natural barrier present downstream	Not accessible to a
197696	Prospect Creek	Natural falls barrier downstream	GPS coordinates i
196997	Howarth Creek	Natural barrier present downstream	
196957 (1011304224)	Brook Creek	Burned out bridge collapsed	Not presenting an
1011304291	Brook Creek	Burned out bridge collapsed	Not presenting an
197695	Prospect Creek	Natural falls barrier downstream	Not accessible to a
197694	Prospect Creek	Natural falls barrier downstream	Not accessible to a
1011300844	Voght Creek	Natural barrier present downstream	Not accessible to a
1011303928	Spius Creek	Crossing does not exist	No crossing or bar
197888 (1011301312)	Kwinshatin Creek	Ford	Creek seasonably
197881 (1011301739)	Stumbles Creek	Passable	Scores as passable
1011304111	Kwinshatin Creek	No crossing	Trail stream cross
1011304215	Stumbles Creek	Crossing removed	Adult coho observ

ID	Stream name	Barrier type	Asessment status (completed to
197015	Midday Creek	Municipal road crossing	Assessed
197884(1011300751)	Stumbles Creek	Highway crossing	Assessed
1100002544	Midday Creek	Dam	Modeled
197036	Midday Creek	Resource road crossing	Habitat confirmation
1011303627	Midday Creek	Resource road crossing	Modeled
1011303791	Midday Creek	Resource road crossing	Modeled
196969	Murray Lake Creek	Resource road crossing	Assessed
1100002545	Midday Creek	Dam	Modeled
197880 (1011301738)	Stumbles Creek	Resource road crossing	Assessed
197882	Stumbles Creek	Resource road crossing	Assessed
197883(1011301743)	Stumbles Creek	Resource road crossing	Assessed
1011300797	Midday Creek	Municipal road crossing	Modeled

ID	Stream Name	Road name	Barrier owner	Barrier
1011301807	Brook Creek	Kettle Valley Railway	Kettle Valley Railway Association	Resourc
197039	Kwinshatin Creek	Coldwater Road	Coldwater Band	Municip

ID	Stream Name	Road name	Barrier owner	Barrier
197889	Skuhun Creek	Highway 8	MOTI	Concret
N/a	Skuhun Creek	N/a	N/a - natural feature	Perched
N/a	Clapperton Creek	N/a (dam)	Orphaned	Dam

Table 15

ID	Stream Name	Reason for Removal from Prioritization	Comments
1011302471	Voght Creek	Natural barrier present downstream	Not accessible to anadro
197696	Prospect Creek	Natural falls barrier downstream	GPS coordinates incorrec
196997	Howarth Creek	Natural barrier present downstream	nan
196957 (1011304224)	Brook Creek	Burned out bridge collapsed	Not presenting any passa
1011304291	Brook Creek	Burned out bridge collapsed	Not presenting any passa
197695	Prospect Creek	Natural falls barrier downstream	Not accessible to anadro
197694	Prospect Creek	Natural falls barrier downstream	Not accessible to anadro
1011300844	Voght Creek	Natural barrier present downstream	Not accessible to anadro
1011303928	Spius Creek	Crossing does not exist	No crossing or barrier pr
197888 (1011301312)	Kwinshatin Creek	Ford	Creek seasonably dry. Cr
197881 (1011301739)	Stumbles Creek	Passable	Scores as passable using
1011304111	Kwinshatin Creek	No crossing	Trail stream crossing has
1011304215	Stumbles Creek	Crossing removed	Adult coho observed upst

Out of the barriers on the intermediate list, 11 require further field assessment before selection as a final barrier to pursue for remediation:

Table 16: Field assessment requirements for the intermediate barrier list in the Lower Nicola 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 11 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	11	$2,530
Habitat Confirmation	$3,000	11	$33,000

Field assessment	Cost per barrier	Count	Total costs
Total:		22	$35,530

Based on the results of the prioritization analysis, 15 barriers from the priority and intermediate barrier list are required to be remediated to achieve the connectivity goals in this plan:

Table 17: Preliminary barrier remediation cost estimate to reach connectivity goals in the Lower Nicola 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
Dam	$750,000	3	$2,250,000
Resource road	$500,000	7	$3,500,000
Municipal/paved road	$1,500,000	3	$4,500,000
Abandoned railway crossing	$8,000	1	$8,000
Highway crossing	$5,200,000	1	$5,200,000
Total		15	$15,458,000

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.

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.

Strategy / Actions
Strategy 1: Crossing Remediation
1.1 – Remediate dykes and berms
1.2 – Reconnect channels to thermal refugia

Strategy / Actions
1.3 – Knowledge Gap: Improve mapping of lateral habitat and thermal refugia
1.4 - Knowledge Gap: Revisit previous remediation and off-channel habitat creation projects to assess whether
1.5 - Review LiDAR, aerial imagery, and field assessments to determine immediate lateral connectivity needs.
Strategy 2: Lateral Barrier Remediation
2.1 – Remove and decommission barriers
2.2 – Upgrade and resize crossings
2.3 – Install and maintain temporary mitigation
2.4 – Initiate a barrier owner outreach program
2.5 – Request regulatory action for non-compliant crossings
2.6 – Knowledge Gap: Identify barriers and map barrier ownership
2.7 – Knowledge Gap: Continue updating the barrier prioritization model
2.8 – Knowledge Gap: Adapt the provincial fish passage framework to account for ephemeral habitat
2.9 – Knowledge Gap: Assess barriers by applying an adapted version of the provincial fish passage framework
Strategy 3: Dam Remediation
3.1 - Remove dams
3.2 - Install fish passage
3.3 - Knowledge Gap: Continue updating the barrier prioritization model
3.4 - Knowledge Gap: Assess dams to determine whether they exist and are truly blocking fish habitat
3.5 - Knowledge Gap: Identify and map dam ownership
Strategy 4: Barrier Prevention
4.1 – Work with land users to improve their aquatic connectivity practices
4.2 – Monitor new crossing compliance with regulations regarding fish passage
Strategy 5: Progress Tracking Plan
5.1 - Engage and explore integration with existing regional initiatives
5.2 - Implement the WCRP Progress Tracking Plan
Total:
Fundraising total:
Proponent/government contribution total:

Annual Work Plan

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Version History

v.1.0 – March 2024

Project Partners

Planning Team

Table 19: 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

Individual or Organization Name	Role and Primary Interest
City Councillors of Merritt	Local government that would like to be apprised of this ini
Coldwater Band	A First Nation band with territory in the watershed and a
Fraser Basin Council (FBC)	The FBC website could be used to host the plan, and FBC
Nicola Basin Collaborative	Coordinated by the FBC, the Nicola Basin Collaborative c
Nicola Stock Breeders Association	Local agricultural landowners in the watershed. They can l
Nicola Watershed Governance Project (NWGP)	This project fosters a collaborative working relationship be
Shackan Band	A First Nation band with territory in the watershed and a
Stuwix Resources Joint Venture (SRJV)	A First Nations forestry company that balances successful

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.

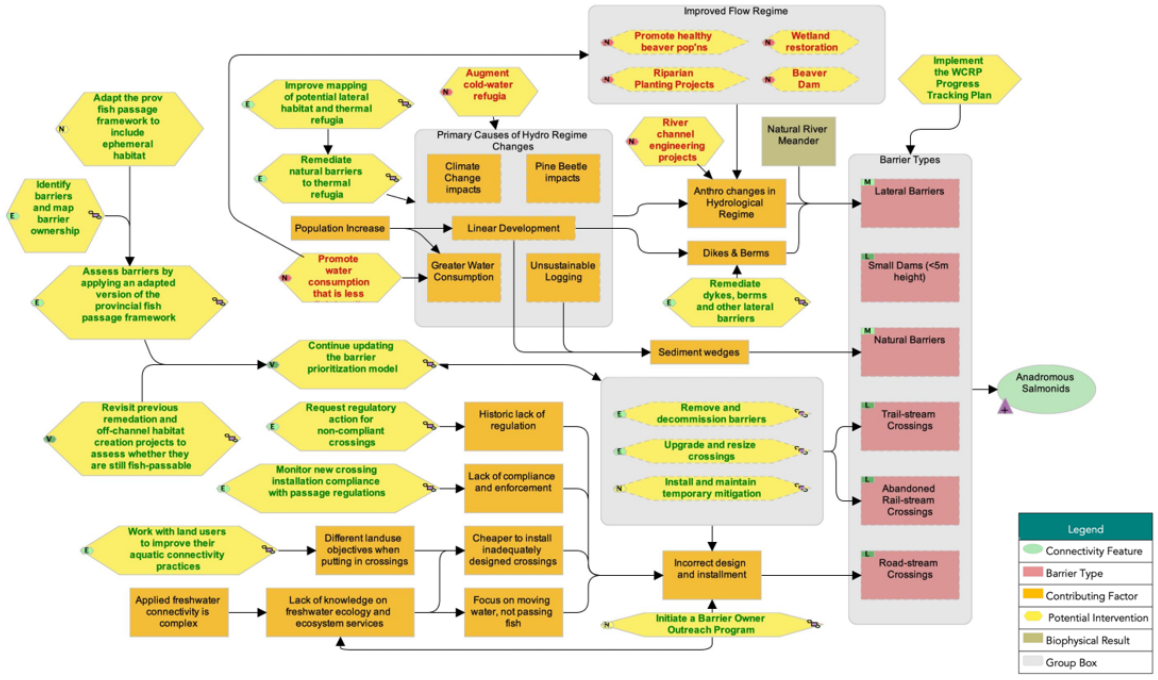


Figure 3: Situation analysis developed by the planning team to identify factors that contribute to fragmentation (orange boxes), biophysical results (brown boxes), and potential strategies/actions to improve connectivity (yellow hexagons) for target species in the Lower Nicola River watershed.

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

ID	Actions
1.1	Remediate dykes, berms, and other lateral barriers
1.2	Remediate natural barriers to lateral connectivity
1.3	Knowledge Gap: Improve mapping of lateral habitat and thermal refugia
1.4	Knowledge Gap: Revisit previous remediation and off-channel habitat creation projects to assess whether
1.5	Review LiDAR, aerial imagery, and field assessments to determine immediate lateral connectivity needs.

Strategy 2: Crossing Remidiation

ID	Actions
2.1	Remove and decommission barriers
2.2	Upgrade and resize crossings
2.3	Install and maintain temporary mitigation
2.4	Initiate a barrier owner outreach program
2.5	Request regulatory action for non-compliant crossings
2.6	Knowledge Gap: Identify barriers and map barrier ownership
2.7	Knowledge Gap: Continue updating the barrier prioritization model
2.8	Knowledge Gap: Adapt the provincial fish passage framework to account for ephemeral habitat
2.9	Knowledge Gap: Assess barriers by applying an adapted version of the provincial fish passage framework

Strategy 3: Dam Remediation

ID	Actions	Detai
3.1	Remove dams	
3.2	Install fish passage	
3.4	Knowledge Gap: Continue updating the barrier prioritization model	The r
3.5	Knowledge Gap: Assess dams to determine whether they exist and are truly blocking fish habitat	Focus
3.6	Knowledge Gap: Identify and map dam ownership	
3.6	Knowledge Gap: Identify and map dam ownership	

Strategy 4: Barrier Prevention

ID	Actions	Details
4.1	Work with land users to improve their aquatic connectivity practices	This can be done through the ba
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
5.2	Implement the WCRP Progress Tracking Plan	The WCRP Progress Tracking Plan wi

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.

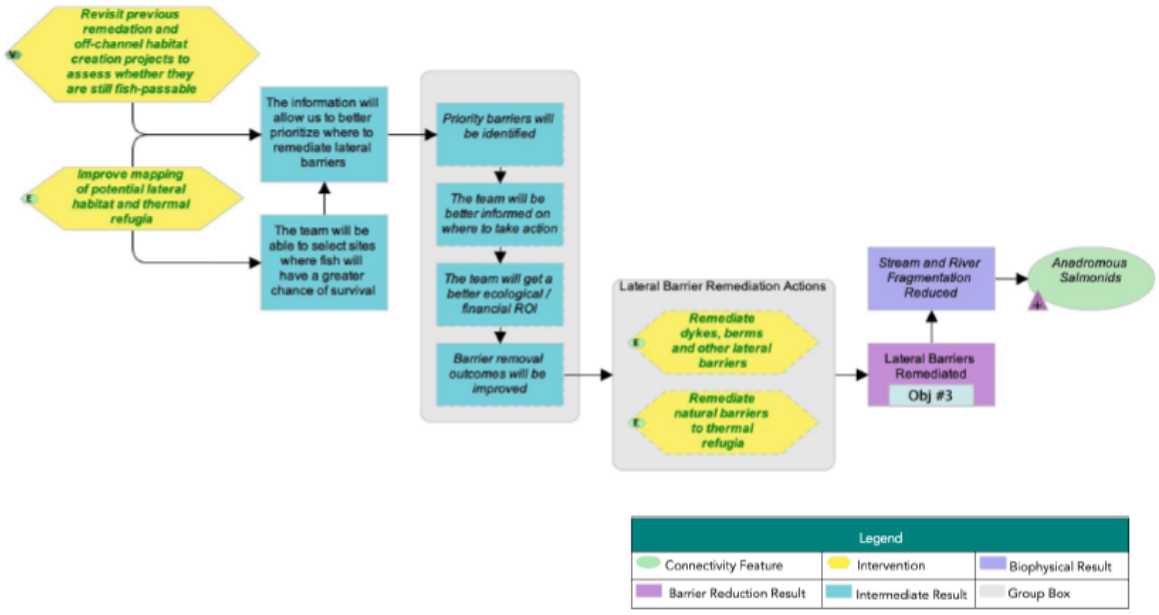


Figure 4: Theory of change developed by the planning team for the actions identified under Strategy 1: Lateral Barrier Remediation in the Lower Nicola River watershed.

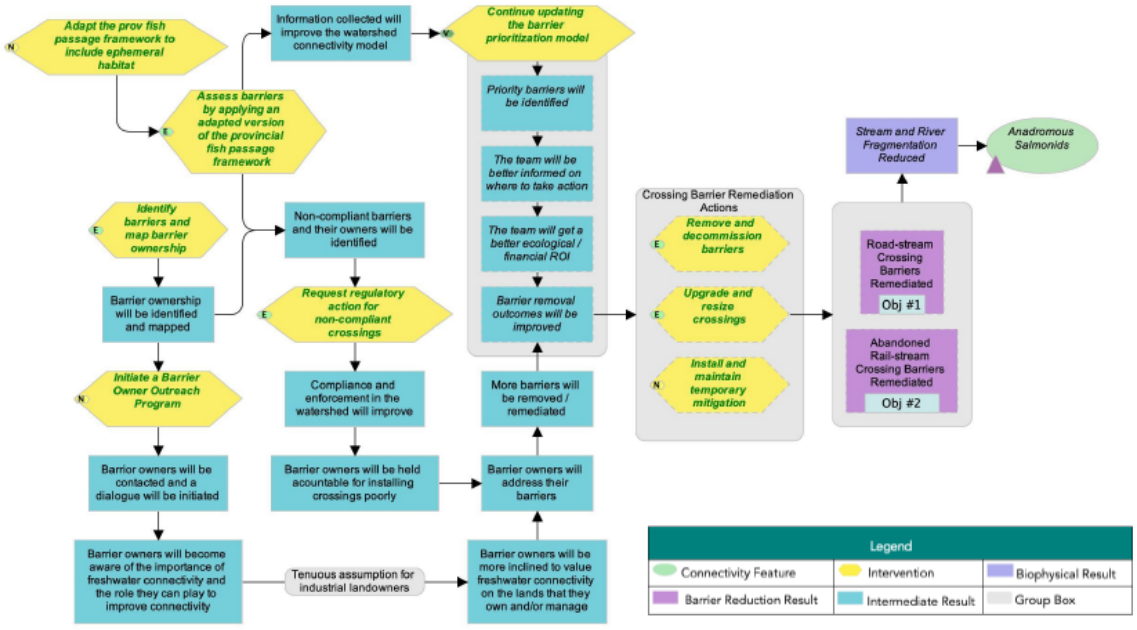


Figure 5: Theory of change developed by the planning team for the actions identified under Strategy 2: Stream Crossing Remediation in the Lower Nicola River watershed.

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.

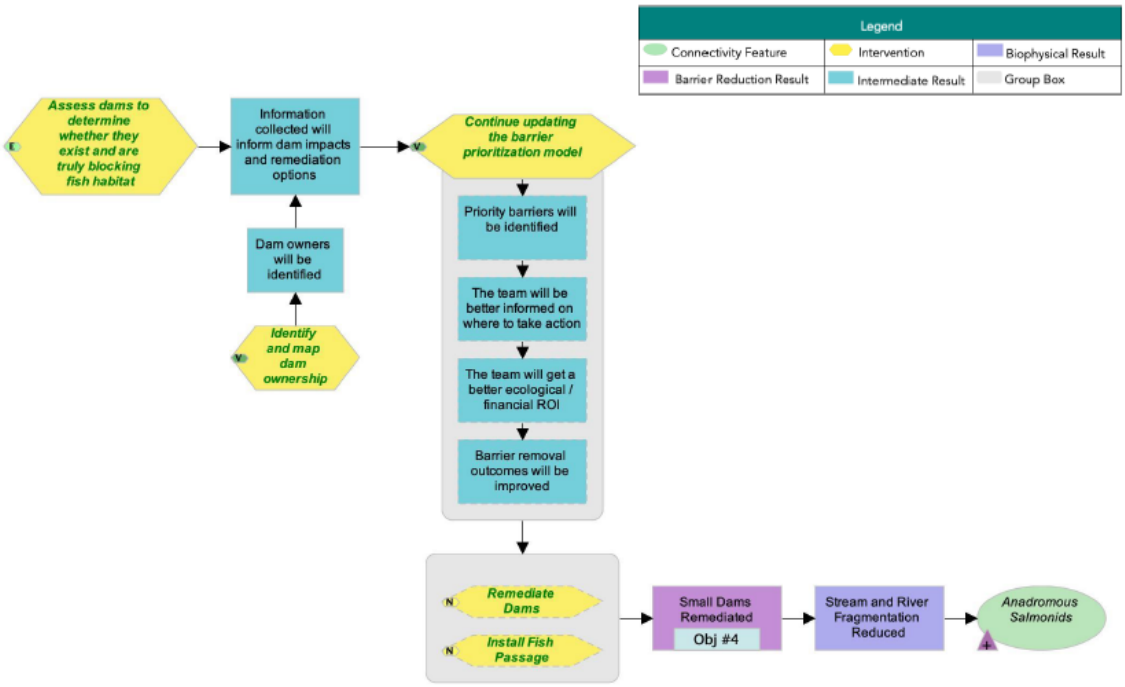


Figure 6: Theory of change developed by the planning team for the actions identified under Strategy 3: Dam Remediation in the Lower Nicola River watershed.

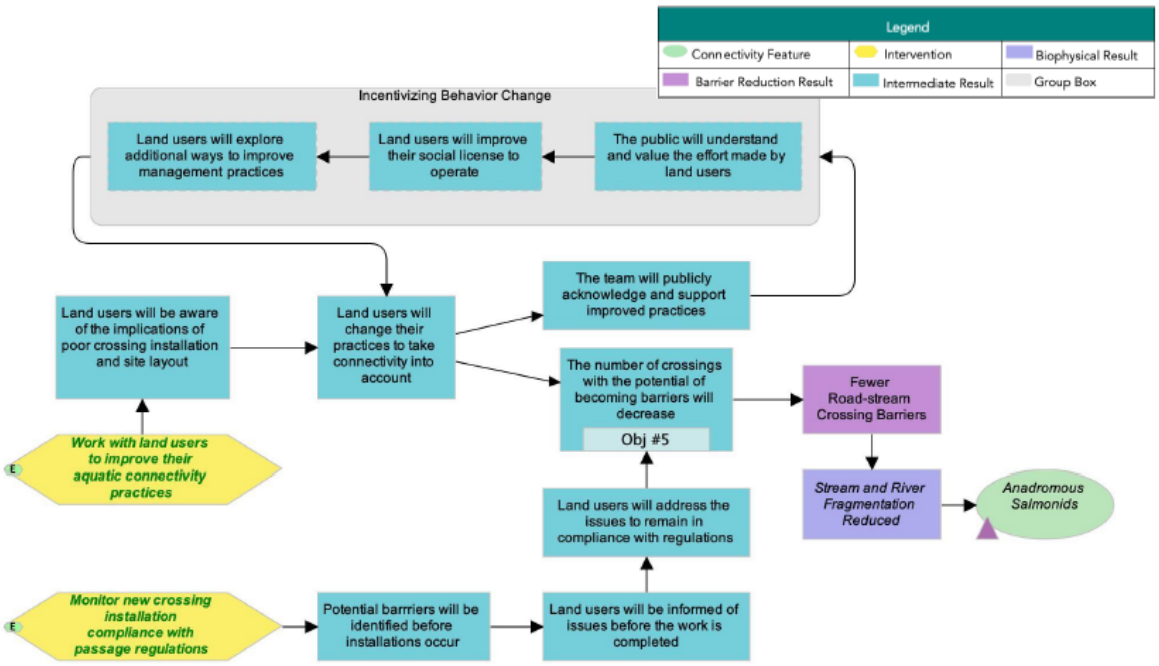


Figure 7: Theory of change developed by the planning team for the actions identified under Strategy 4: Barrier Prevention in the Lower Nicola River watershed.

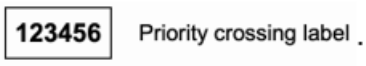
Strategy / Actions
Strategy 1: Crossing Remediation
1.1 – Remediate dykes and berms
1.2 – Reconnect channels to thermal refugia
1.3 – Knowledge Gap: Improve mapping of lateral habitat and thermal refugia
1.4 - Knowledge Gap: Revisit previous remediation and off-channel habitat creation projects to assess whether
1.5 - Review LiDAR, aerial imagery, and field assessments to determine immediate lateral connectivity needs.
Strategy 2: Lateral Barrier Remediation
2.1 – Remove and decommission barriers
2.2 – Upgrade and resize crossings
2.3 – Install and maintain temporary mitigation
2.4 – Initiate a barrier owner outreach program
2.5 – Request regulatory action for non-compliant crossings
2.6 – Knowledge Gap: Identify barriers and map barrier ownership
2.7 – Knowledge Gap: Continue updating the barrier prioritization model
2.8 – Knowledge Gap: Adapt the provincial fish passage framework to account for ephemeral habitat
2.9 – Knowledge Gap: Assess barriers by applying an adapted version of the provincial fish passage framework
Strategy 3: Dam Remediation
3.1 - Remove dams
3.2 - Install fish passage
3.3 - Knowledge Gap: Continue updating the barrier prioritization model
3.4 - Knowledge Gap: Assess dams to determine whether they exist and are truly blocking fish habitat
3.5 - Knowledge Gap: Identify and map dam ownership
Strategy 4: Barrier Prevention
4.1 – Work with land users to improve their aquatic connectivity practices
4.2 – Monitor new crossing compliance with regulations regarding fish passage
Strategy 5: Progress Tracking Plan
5.1 - Engage and explore integration with existing regional initiatives
5.2 - Implement the WCRP Progress Tracking Plan
Total:
Fundraising total:
Proponent/government contribution total:

Funding Sources

Funding Source	Spending Restrictions and Other Consideration
Land Based Investment Strategy	Assessment and remediation of fish passage usin
Environmental Enhancement Fund	Fish and wildlife passage improvements and rest
Pacific Salmon Foundation's Community Salmon Program	For projects supporting the protection, conserva
Southern Boundary Restoration and Enhancement Fund	Supports three activities: (1) develop improved
Enhancement and Restoration Grants	Projects that focus on freshwater wild fish, nativ
Environmental Damages Fund	Direct funds received from fines, court orders an
Habitat Stewardship Program for Aquatic Species at Risk	Program for non-profits, Indigenous government
Canada Nature Fund for Aquatic Species at Risk	Funding program aimed at addressing priority t
BC Salmon Restoration and Innovation Fund	Funding for Indigenous enterprises, academia, in
Aboriginal Fund for Species at Risk	Program for Indigenous groups for activities tha
Federal Gas Tax Fund - Community Works Fund	Funding available to local governments from fed
Disaster Mitigation and Adaptation Fund	For those projects where flood risk is high: fund
Community Gaming Grants	Funding for non-profit organizations (check func
Sitka Foundation	Funding for registered charities, universities and
TULA Foundation	Supports various environmental programs of int
Vancouver Foundation	Granting agency for community, social and envi
BC Conservation Foundation Small Project Fund	Funding available to Non-profits, fish and wildli
Real Estate Foundation of BC General Grants	Funding for First Nations, charities and societie

Data Download and Methods

Modelled Anadromous Salmon Habitat Maps

High-resolution PDF maps of the Lower Nicola River watershed and model results can be accessed here. The watershed is divided into multiple map 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 map sheet, priority barriers are symbolized using the following notation: 

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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 28. 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.

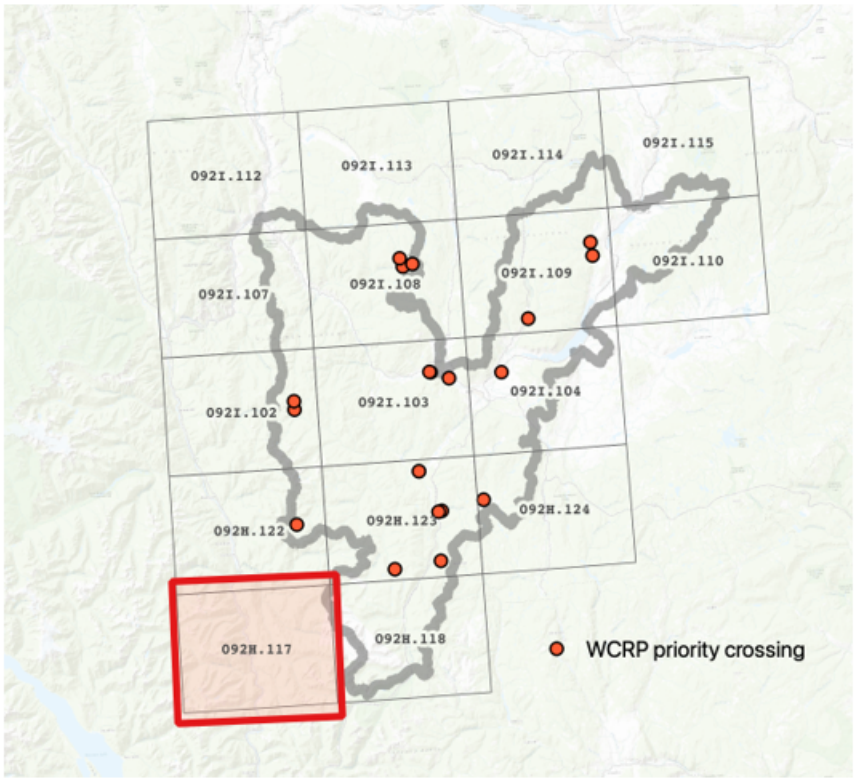

Figure 8: Lower Nicola River watershed overview map identifying the portions of the watershed covered by each map sheet (grey squares) and the prioritized barriers on the intermediate barrier list (orange points; see Appendix C).

Table 28: Parameters and thr
spawning and rear
watershed.

Species	Spawning Habitat Channel Gradient (%)	Spawning Habitat Mean annual discharge (
Chinook Salmon	0-3 [1] [2]	0.46-322.5 [3][4][5][6][7]
Coho Salmon	0-5 [6][10]	0.164-59.15 [3][4][5][10][11]
Steelhead	0-4 [2][15]	0.447-75 [3][4][6]

References: [1] Busch et al. (2011). [2] Cooney and Holzer (2006). [3] Bjornn and Reiser (1991). [4] Neuman and Newcombe (1977). [5] Woll, Albert, and Whited (2017). [6] Roberge et al. (2002). [7] Raleigh and Miller (1986). [8] Porter et al. (2008). [9] Agrawal et al. (2005). [10] Sloat, Reeves, and Christiansen (2017). [11] Mcmahon (1983). [12] Rosenfeld, Porter, and Parkinson (2000). [13] Burnett et al. (2007). [14] Lake (1999). [15] Sheer et al. (2009).