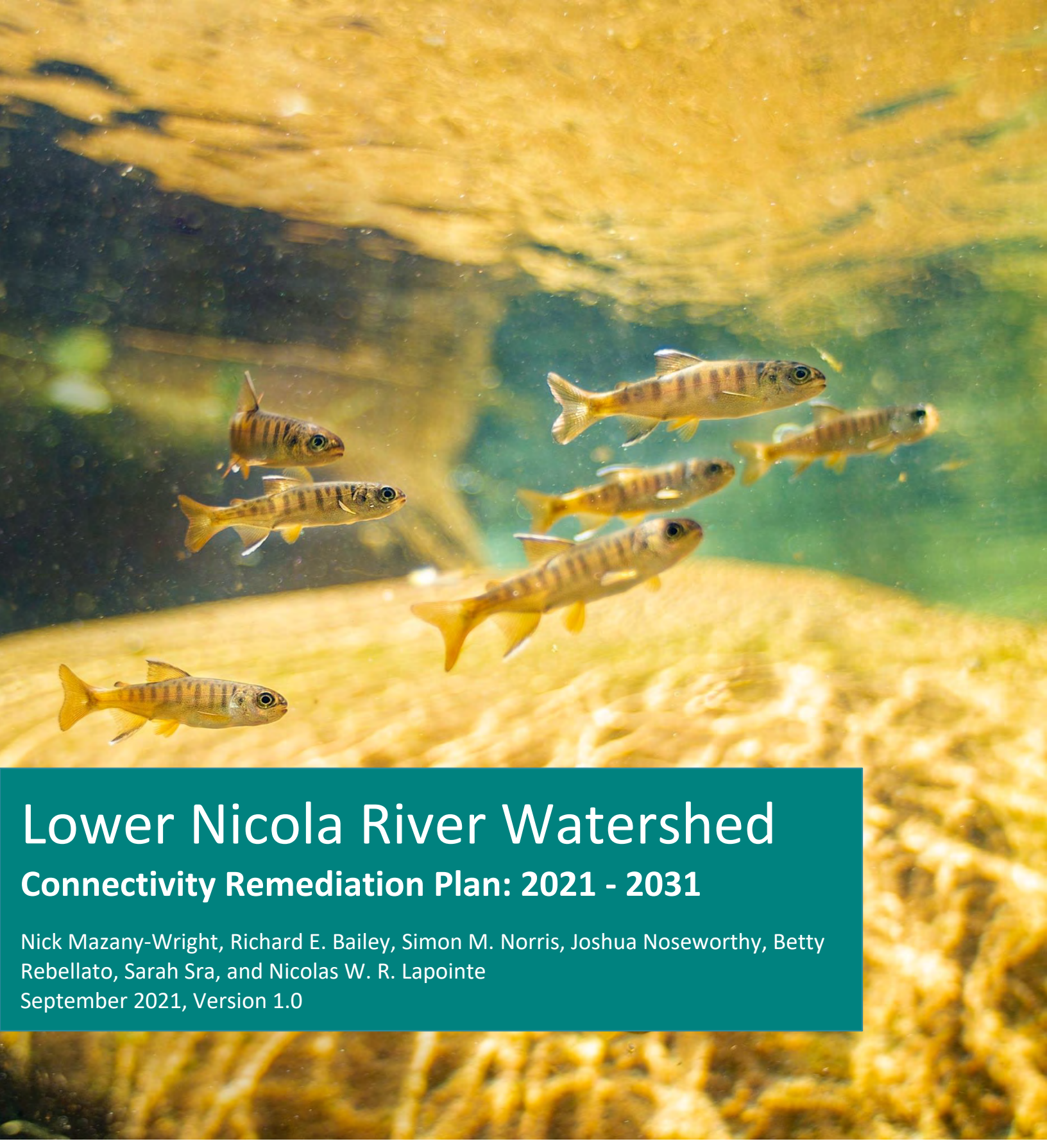

# Lower Nicola River Watershed

## Connectivity Remediation Plan: 2021 - 2031

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

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CANADIAN WILDLIFE FEDERATION
FÉDÉRATION CANADIENNE DE LA FAUNE

**Canadian Wildlife Federation**

**350 Michael Cowpland Drive**

**Kanata, Ontario K2M 2W1**

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

**www.cwf-fcf.org**


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*Cover Photo:* © Fernando Lessa

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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 Nłeʔkepmxcín (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.

# Table of Contents


**CONNECTIVITY PLAN PURPOSE AND APPROACH** ..... 3

**VISION STATEMENT** ..... 4

**PLANNING TEAM** ..... 4

**KEY ACTORS** ..... 5

**PROJECT SCOPE** ..... 6

**TARGET SPECIES** ..... 10

**KEY ECOLOGICAL ATTRIBUTES AND CURRENT CONNECTIVITY STATUS** ..... 13

**BARRIER TYPES** ..... 14

**SITUATION ANALYSIS** ..... 17

**GOALS** ..... 19

**STRATEGIES & ACTIONS** ..... 19

*Strategy 1: Lateral Barrier Remediation (priority on reconnecting thermal refugia)* ..... 20
*Strategy 2: Stream Crossing Remediation* ..... 20
*Strategy 3: Dam Remediation* ..... 22
*Strategy 4: Barrier Prevention* ..... 22
*Strategy 5: Planning and Progress Tracking Plan* ..... 23

**THEORIES OF CHANGE & OBJECTIVES** ..... 23

**PROGRESS TRACKING PLAN** ..... 28

**OPERATIONAL PLAN** ..... 30

**FUNDING SOURCES** ..... 34

**REFERENCES** ..... 38

**APPENDIX A: MODELLED ANADROMOUS SALMONID HABITAT MAPS** ..... 41

**APPENDIX B: CONNECTIVITY STATUS ASSESSMENT METHODS** ..... 42

**APPENDIX C: LOWER NICOLA RIVER WATERSHED BARRIER PRIORITIZATION SUMMARY** ..... 44

## Connectivity Plan Purpose and Approach

The following Watershed Connectivity Remediation Plan (WCRP) represents the culmination of a six-month collaborative planning effort 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 anadromous salmonids and the livelihoods that they support. This 10-year plan was developed to identify priority actions 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. These strategies will be shared with local First Nations, Fisheries and Oceans Canada (DFO), and others to inform coordinated efforts to restore fish productivity in the watershed.

WCRPs are long-term, actionable plans that blend local stakeholder and rightsholder knowledge with innovative GIS analyses to gain a shared understanding of where remediation efforts will have the greatest benefit for anadromous salmonids. The planning process is inspired by the Conservation Standards (v.4.0), which is a conservation planning framework that allows planning teams to systematically identify, implement, and monitor strategies to apply the most effective solutions to high priority conservation problems. There is a rich history of 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 four member nations (Coldwater Band, Nooaitch Band, Shackan Indian Band, and Upper Nicola Band), and the individual nation of the Lower Nicola Indian Band (see Project Scope), the Nicola Watershed Governance Project, the Nicola Basin Collaborative, and the Risk Assessment Methodology for Salmon (RAMS). We recognize a need to further coordinate 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 those 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 material presented in this plan to continuously improve aquatic

barrier remediation for anadromous salmonids, and coordinate with other on-going landscape-scale recovery actions to achieve best outcomes in the Lower Nicola River watershed. For more information on how WCRPs are developed, see Mazany-Wright et al. 2021c.

## Vision Statement

*Healthy, well-connected streams and rivers within the 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.*

## Planning Team

*Table 1. 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 |
| Nicolas Lapointe | Canadian Wildlife Federation |
| Nick Mazany-Wright | 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 |
| 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 |
| Paul Mozin | Scw'exmx Tribal Council |
| Brian Holmes | Upper Nicola Band |

## Key Actors

*Table 2. 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 / 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. |
| 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. |

| | |
|---|---|
| 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. |

## Project Scope

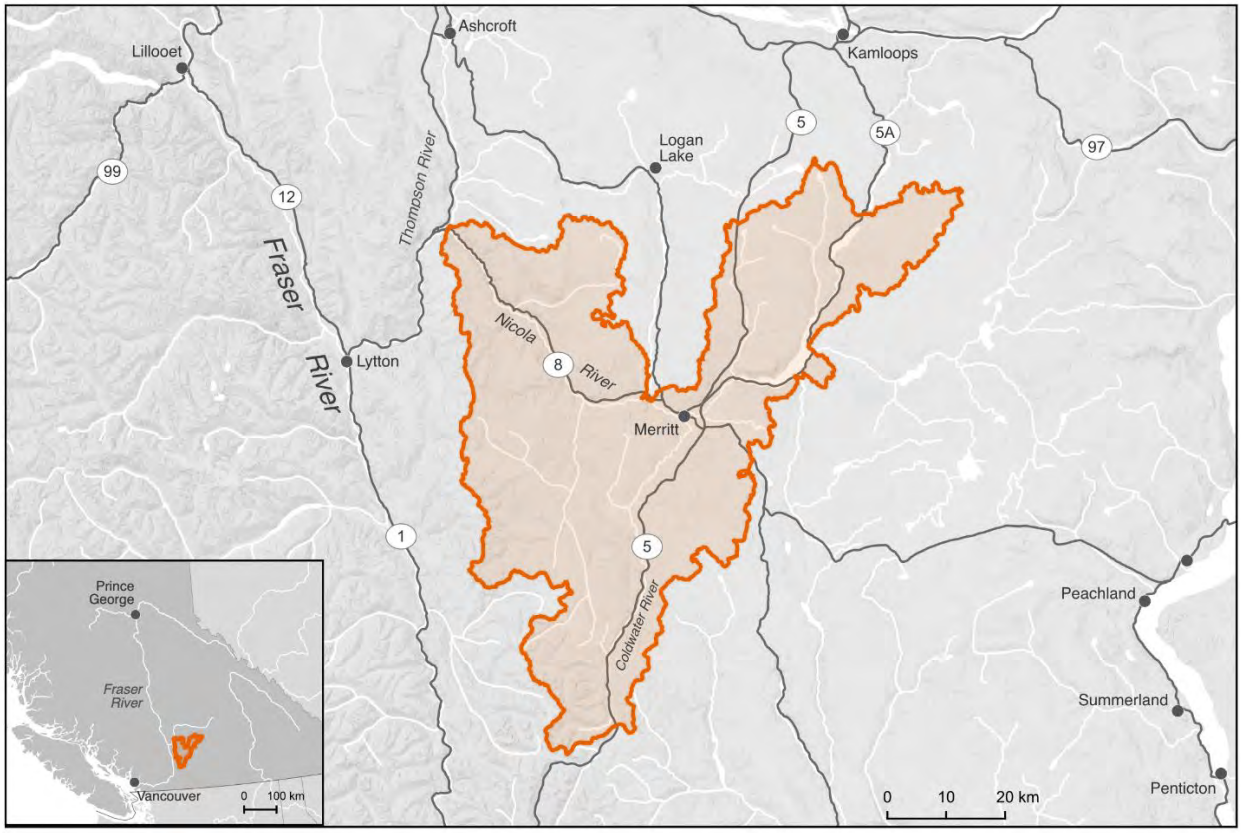


*Figure 1. The primary geographic scope - the Lower Nicola River watershed, excluding the Guichon Creek drainage and the Nicola River and Quilchena Creek drainages upstream of Nicola Lake.*

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 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 3; Lower Nicola Indian Band 2015, ESSA 2019, Coldwater Band 2021).

*Table 3. Target fish species in the Lower Nicola River watershed. The Nłeʔkepmxcín (Nlaka'pamuxcin), nqilxʷcn (nsyilxcən), and Western common and scientific species names are provided.*

| Nłeʔkepmxcín (Nlaka'pamuxcin) | nqilxʷcn (nsyilxcən)[1] | Common Name | Scientific Name |
|---|---|---|---|
| kʼʷyʼíʔe/pəqéłus | ntytyix | Chinook Salmon | *Oncorhynchus tshawytscha* |
| sx̣aẏqs | kisúʔ | Coho Salmon | *Oncorhynchus kisutch* |
| cóʕʷłeʔ | qʷəyqʷəyʕaćaʔ | 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

[1] nqilxʷcn (nsyilxcən) species names were obtained from https://www.firstvoices.com/.

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 et al. 2021a).

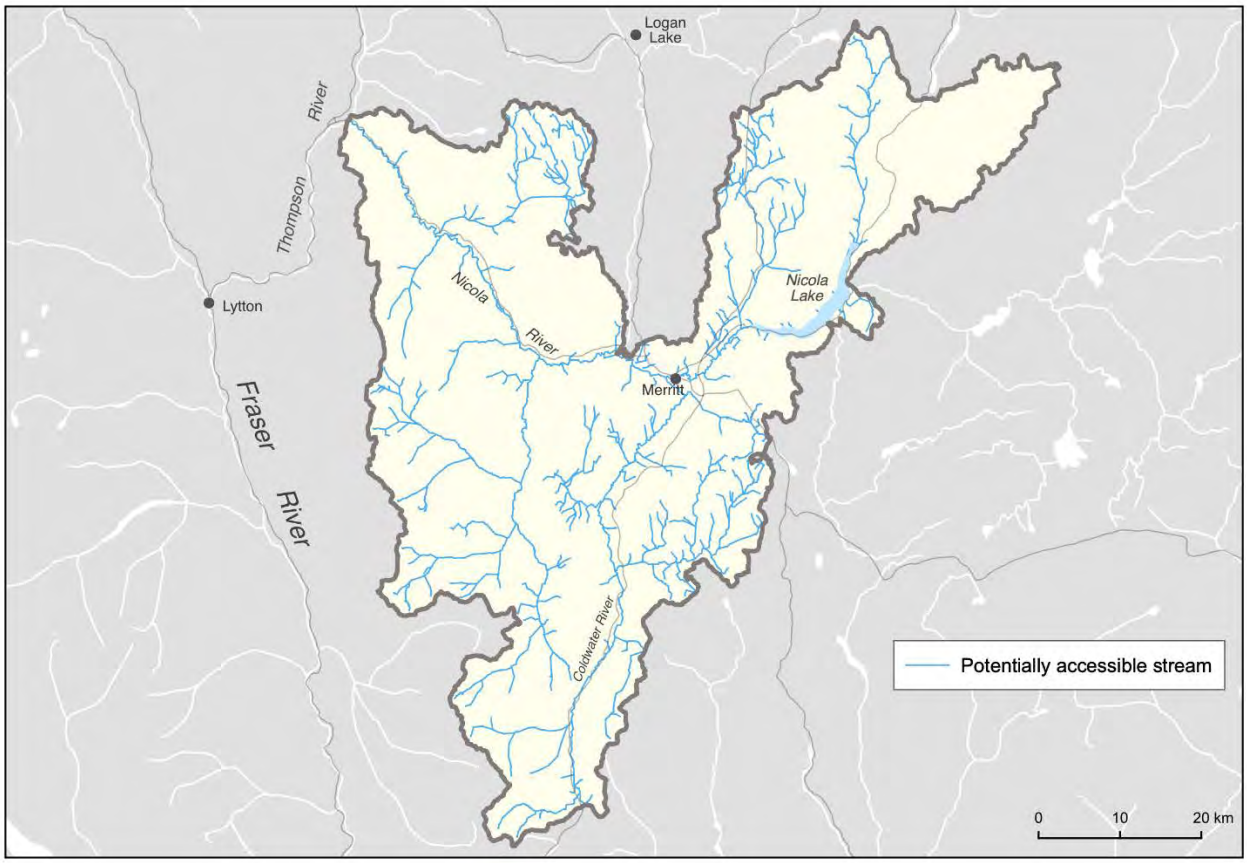


*Figure 2. Potentially accessible stream segments within the Lower Nicola River watershed. These do not represent useable habitat types, but rather identify the stream segments within which habitat modelling and barrier mapping and prioritization was undertaken.*

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 & 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 (ESSA 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 (ESSA 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 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 et al. 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 (Lower Nicola Indian Band 2015, ESSA 2019, Coldwater Band 2021). The harvest and processing of these species have helped pass knowledge and ceremony to future generations (Fraser Basin Council n.d., Lower Nicola Indian 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 (ESSA 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 Tmix$^{w}$ – the people only take the salmon that is needed (Lower Nicola Indian Band 2015, ESSA 2019, Upper Nicola 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 Appendix A for maps of modelled anadromous salmonid spawning and rearing habitat in the Lower Nicola River watershed.

### Chinook Salmon | kʼʷyʼíʔe/pəqéłus | Oncorhynchus tshawytscha

*Table 4. 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 Unit | 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 (LGL Ltd. 2007, Ecoscape 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 (LGL Ltd. 2007, Ecoscape 2017, PSF 2020). In addition to these spawning systems, important juvenile rearing areas have been observed in Juliet Creek and Voght Creek (LGL 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 | sx̣a̓yqs | Oncorhynchus kisutch**

*Table 5. 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 | NA | +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 mid-1980s (DFO 1999, Ecoscape 2017). Coho Salmon stocks have been supplemented in recent decades by outplants from the Spius Creek Hatchery (Ecoscape 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 (LGL Ltd. 2007, PSF 2020). The lower reaches of many smaller tributaries are also important Coho Salmon rearing habitat.

**Steelhead | cóʕʷɬeʔ | *Oncorhynchus mykiss***

*Table 6. 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% | NA | 5 years |

Steelhead join Chinook Salmon as the first to appear in the watershed, arriving in the spring (LGL 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 (LGL 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 (Ecoscape 2017).

## 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 Appendix B.

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

| A | | | **Indicator Ratings** | | | |
|---|---|---|---|---|---|---|
| **Target Species** | **KEA** | **Indicator** | **Poor** | **Fair** | **Good** | **Very Good** |
| Anadromous Salmonids | Available Off-channel Thermal Refuge | Total area ($m^2$) of off-channel thermal refuge accessible | ? | ? | ? | ? |
| **Current Status:** | | | | | | |
| **Comments:** No baseline data exists on the extent of off-channel habitat in the watershed. A priority strategy is included in the plan to develop an off-channel habitat layer for the watershed, and this will be used to inform this connectivity status assessment in the future. | | | | | | |

| B | | | Indicator Ratings | | | |
|---|---|---|---|---|---|---|
| **Target Species** | **KEA** | **Indicator** | **Poor** | **Fair** | **Good** | **Very Good** |
| Target Species | Available Spawning Habitat | % of total linear spawning habitat accessible | <25% | 25 - 50% | 51 – 75% | >75% |
| | | **Current Status:** | | | | **96%** |
| **Comments:** Indicator rating definitions are based on the consensus decisions of the planning team. The current status is based on the CWF Barrier Prioritization Model output, which is current as of August 2021. | | | | | | |

| C | | | Indicator Ratings | | | |
|---|---|---|---|---|---|---|
| **Target Species** | **KEA** | **Indicator** | **Poor** | **Fair** | **Good** | **Very Good** |
| Anadromous Salmonids | Available Rearing Habitat | % of total linear rearing habitat accessible | <25% | 25 - 50% | 51 – 75% | >75% |
| | | **Current Status:** | | | | **83%** |
| **Comments:** The current status is based on the CWF Barrier Prioritization Model output, which is current as of August 2021. | | | | | | |

## Barrier Types

The following table highlights 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 8. 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 | High | Low | **Medium** |
| Small Dams (<5 m height) | Low | Very high | Medium | **Low** |
| Abandoned Rail-stream Crossings (longitudinal) | Low | Low | Medium | **Low** |
| Trail-stream Crossings | Low | Low | Low | **Low** |

**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, off-channel 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.

**Road-stream Crossings**

Road-stream crossings are an abundant barrier type in the watershed, with 73 assessed and modelled crossings located on modelled anadromous salmonid habitat. Demographic road crossings (highways, municipal, and paved roads) are estimated to block 21.38 km of habitat (22.69% of the total blocked habitat), with 87% of assessed crossings having been identified as barriers to fish passage. Resource roads are estimated to block 63.71 km of habitat (67.6%), with 77% of assessed crossings identified as barriers. Significant land use and linear development throughout the valley bottom, including Highway 5 and Highway 8, has disconnected the Nicola River from important habitat in some tributaries. 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.

**Small Dams (<5 m height)**

There are five mapped dams on modelled anadromous salmonid habitat in the watershed, blocking a combined 4.36 km (4.6% of the total habitat blocked) of spawning and rearing habitat, resulting in a Low extent (see Appendix C 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 7 modelled abandoned rail-stream crossings located on modelled anadromous salmonid habitat, blocking a combined 4.77 km of habitat (5.06% of the total habitat blocked; see Appendix C 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.

## 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.

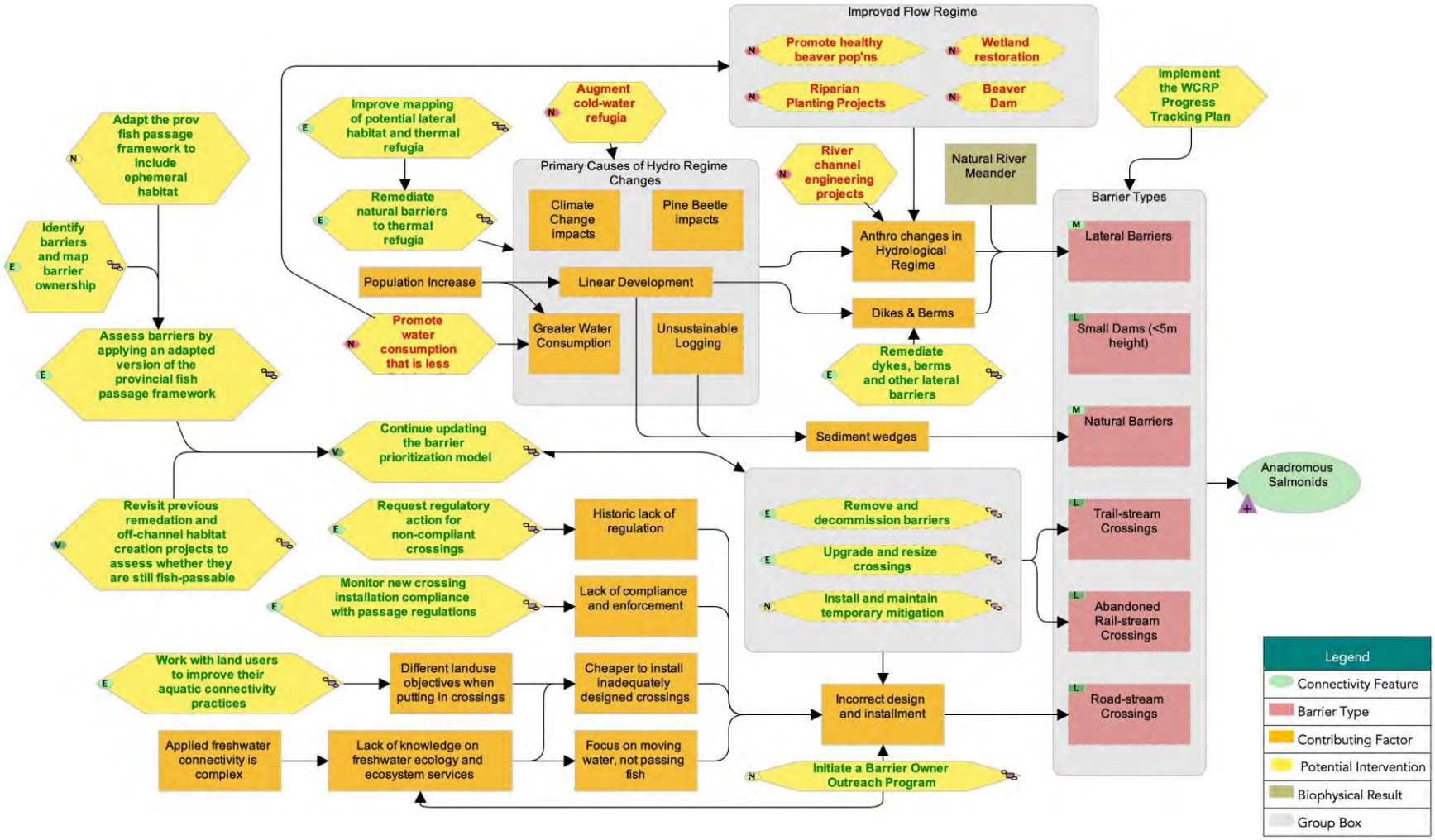


*Figure 3. Situation analysis developed by the planning team to identify factors that contribute to fragmentation (orange boxes), biophysical results (brown boxes), and potential strategies/actions to improve connectivity (yellow hexagons) for target species in the Lower Nicola River watershed.*

## 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 $m^2$ within the Lower Nicola River watershed. |
| 2 | By 2025, the % of total linear spawning habitat accessible to anadromous salmonids will not decrease below 96% within the Lower Nicola River watershed. |
| 3 | By 2031, the % of total linear rearing habitat accessible to anadromous salmonids will increase from 83% to 90% within the Lower Nicola River watershed. |

## Strategies & Actions

*Table 10. 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 (priority on reconnecting thermal refugia)

| ID | Actions | Details | Feasibility | Impact | Effectiveness |
|---|---|---|---|---|---|
| **1.1** | Remediate dykes, berms, and other lateral barriers | The group selected a feasibility rating of High based on the assumption that our focus will be on smaller and cheaper projects, such as reconnecting ephemeral habitat and maintenance around the railroad dyke to reconnect wetland habitat. | High | Very high | **Effective** |
| **1.2** | Remediate natural barriers to lateral connectivity | This can include various methods, such as beaver dam analogues. | High | Very high | **Effective** |
| **1.3** | **Knowledge Gap:** Improve mapping of lateral habitat and thermal refugia | Thermal imagery collected via drones could be used to map thermal refugia. | High | High | **Effective** |
| **1.4** | **Knowledge Gap:** Revisit previous remediation and off-channel habitat creation projects to assess whether they are still fish-passable | | Very high | Very high | **Very effective** |

### Strategy 2: Stream Crossing Remediation

| ID | Actions | Details | Feasibility | Impact | Effectiveness |
|---|---|---|---|---|---|
| **2.1** | Remove and decommission barriers | | High | Very high | **Effective** |
| **2.2** | Upgrade and resize crossings | Examples include installing larger culverts, replacing closed- with open-bottom culverts, or upgrading from culverts to bridges. | Very high | High | **Effective** |

| | | | | | |
|---|---|---|---|---|---|
| **2.3** | Install and maintain temporary mitigation | Examples may include installing fish ladders on barriers that cannot be remediated. | Medium | High | **Need more information** |
| **2.4** | Initiate a barrier owner outreach program | This can include reaching out to the Cattleman's Association, as well as potentially working with producers to adapt water-management practices. The outputs and materials generated could be exported outside the watershed to assist other watershed organizations with landowner engagement as well. | High | Medium | **Need more information** |
| **2.5** | Request regulatory action for non-compliant crossings | Request provincial and federal agencies to require that targeted, high-priority barriers be remediated. | High | High | **Effective** |
| **2.6** | **Knowledge Gap**: Identify barriers and map barrier ownership | | High | Very high | **Effective** |
| **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 available. | Very high | Very high | **Very effective** |
| **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 for in habitat surveys and evaluated on a case-by-case basis. | High | Very high | **Effective** |
| **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 ephemeral habitat), and (3) remediation designs. | High | Very High | **Effective** |

### Strategy 3: Dam Remediation

| ID | Actions | Details | Feasibility | Impact | Effectiveness |
|---|---|---|---|---|---|
| **3.1** | Remove dams | | Medium | Very high | **Need more information** |
| **3.2** | Install fish passage | | Medium | High | **Need more information** |
| **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 available. This can also include data related to flows. | Very high | Very high | **Very Effective** |
| **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. | Very high | High | **Effective** |
| **3.6** | **Knowledge Gap**: Identify and map dam ownership | | Very high | Very high | **Very Effective** |

### Strategy 4: Barrier Prevention

| ID | Actions | Details | Feasibility | Impact | Effectiveness |
|---|---|---|---|---|---|
| **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 encouraging better consultation before crossings are installed. | High | High | **Effective** |
| **4.2** | Monitor new crossing installation compliance with passage regulations | | Very high | High | **Effective** |

### Strategy 5: Planning and Progress Tracking Plan

| 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 decision-making and implementation related to the strategies developed in this plan. These strategies will be shared with local First Nations, DFO, and others to inform coordinated efforts to restore fish productivity in the watershed Connectivity work will be incorporated where appropriate to achieve the greatest returns and longevity of benefits. |
| **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.

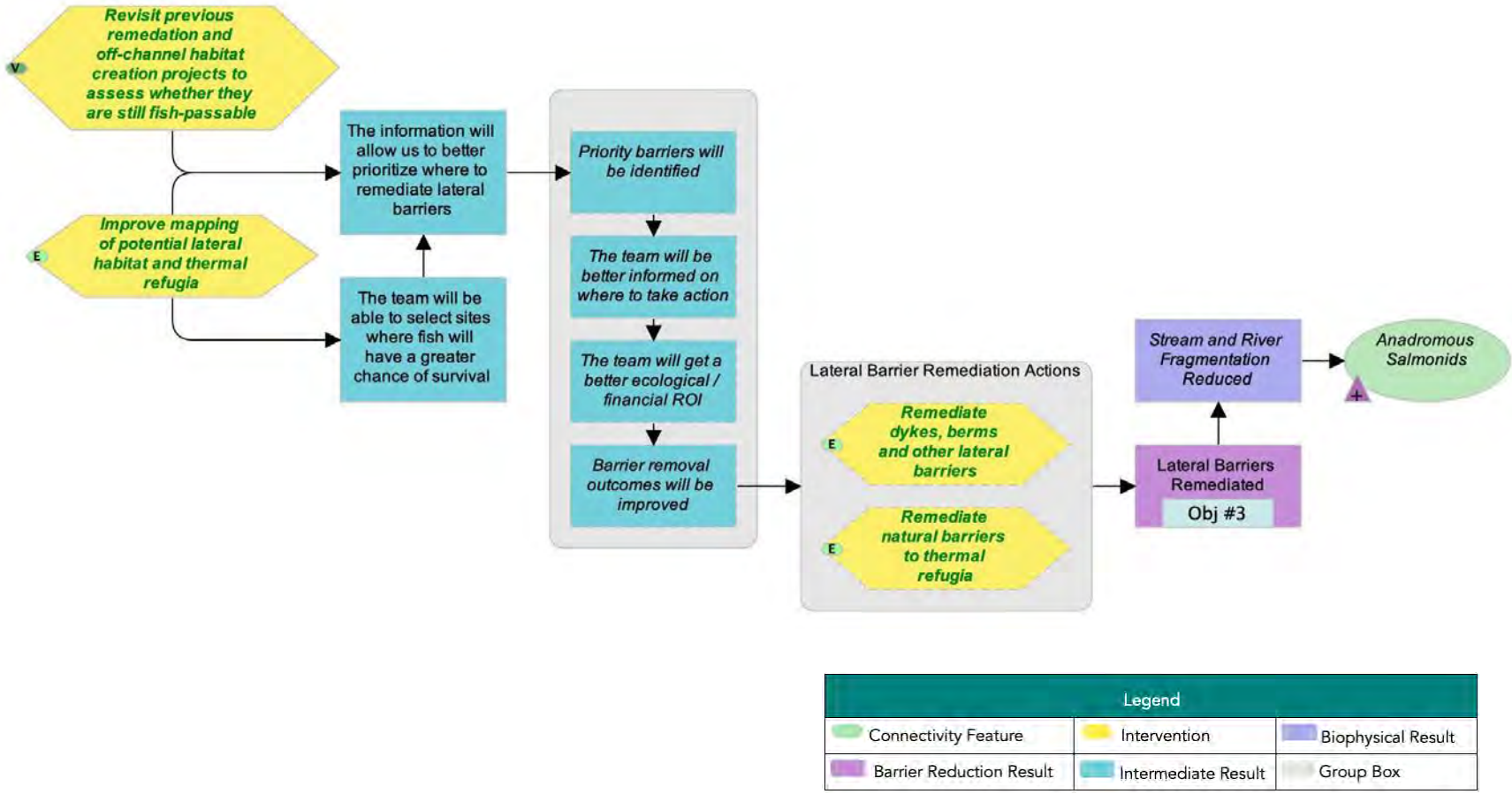


*Figure 4. Theory of change developed by the planning team for the actions identified under Strategy 1: Lateral Barrier Remediation in the Lower Nicola River watershed.*

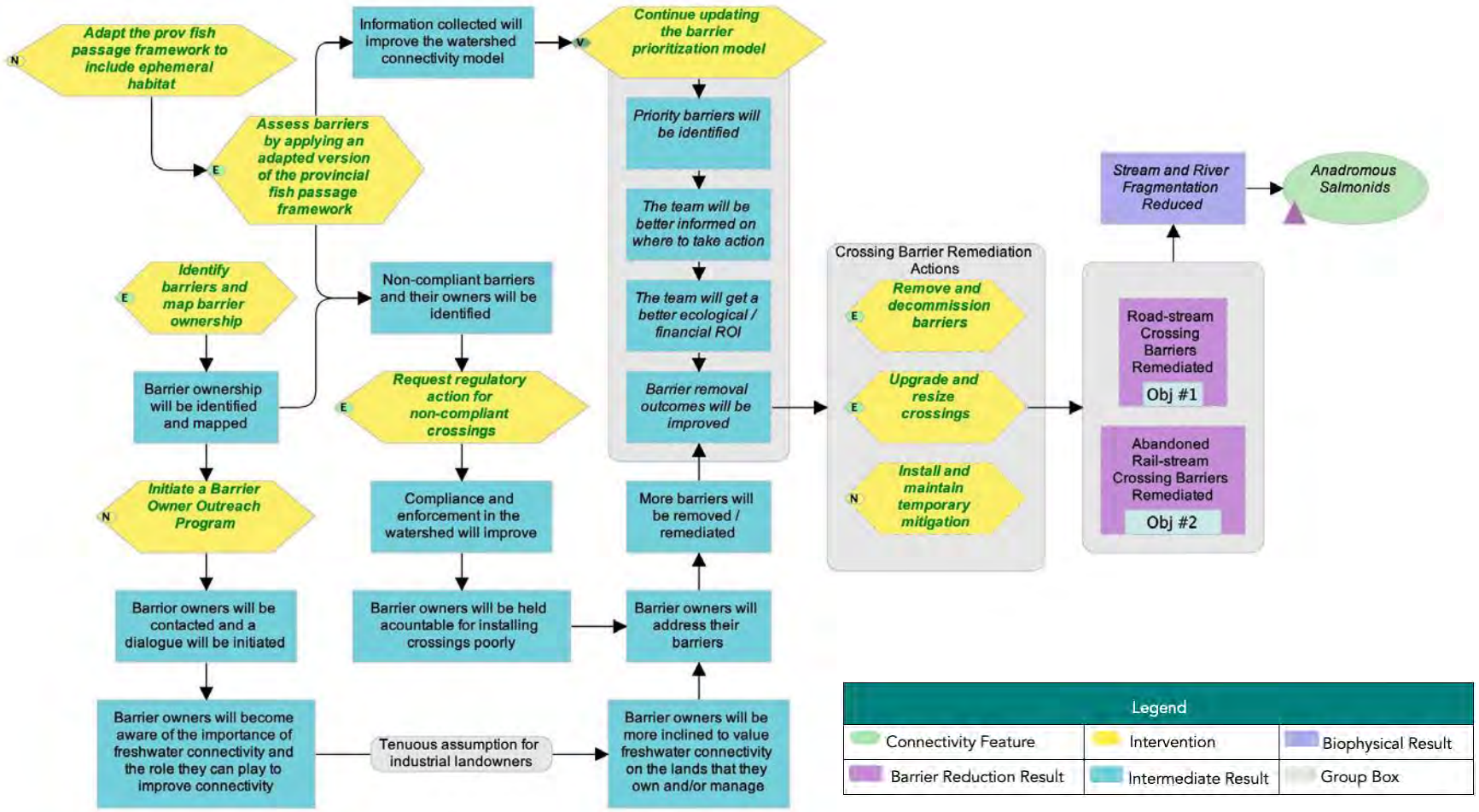


*Figure 5. Theory of change developed by the planning team for the actions identified under Strategy 2: Stream Crossing Remediation in the Lower Nicola River watershed.*

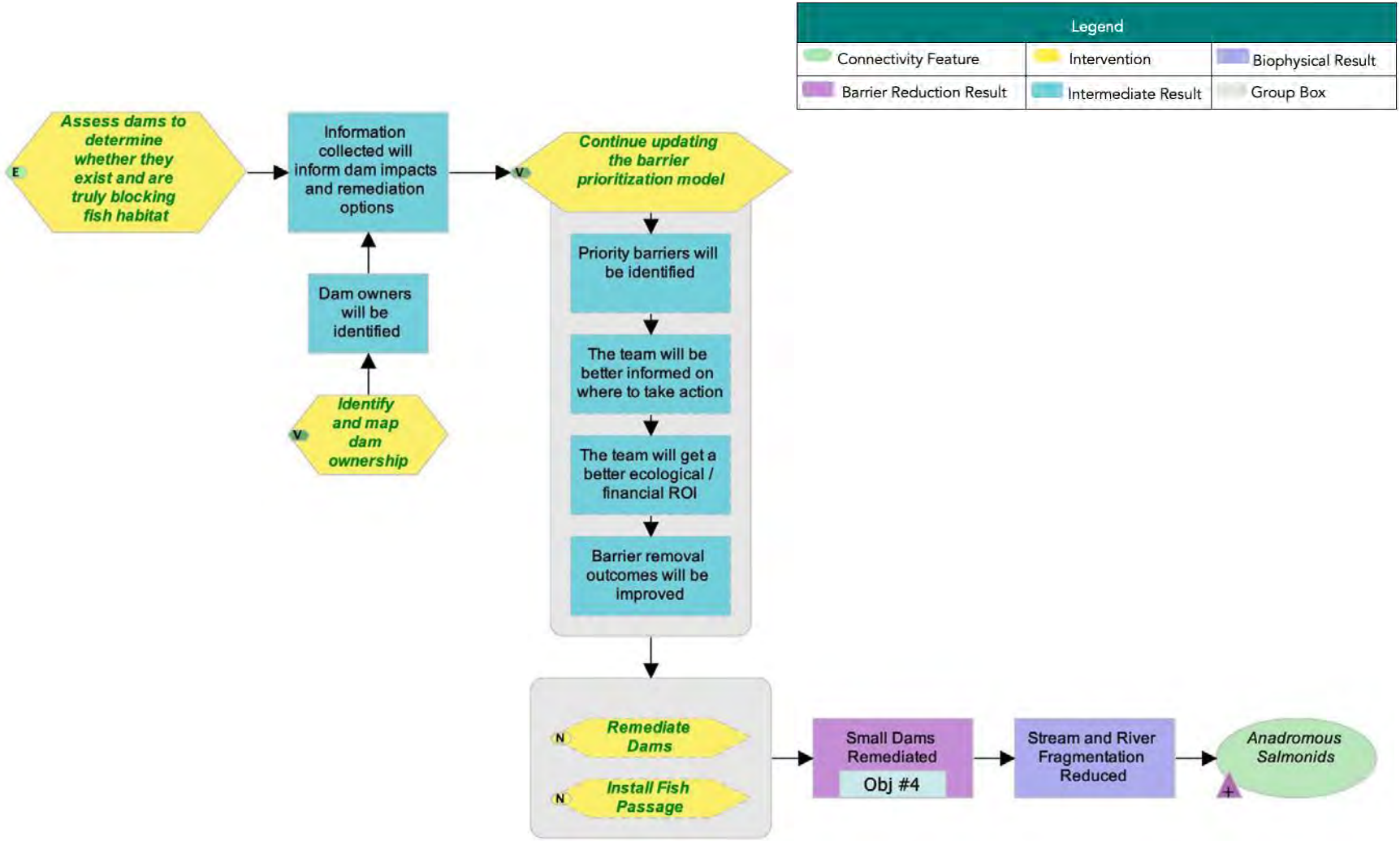


*Figure 6. Theory of change developed by the planning team for the actions identified under Strategy 3: Dam Remediation in the Lower Nicola River watershed.*

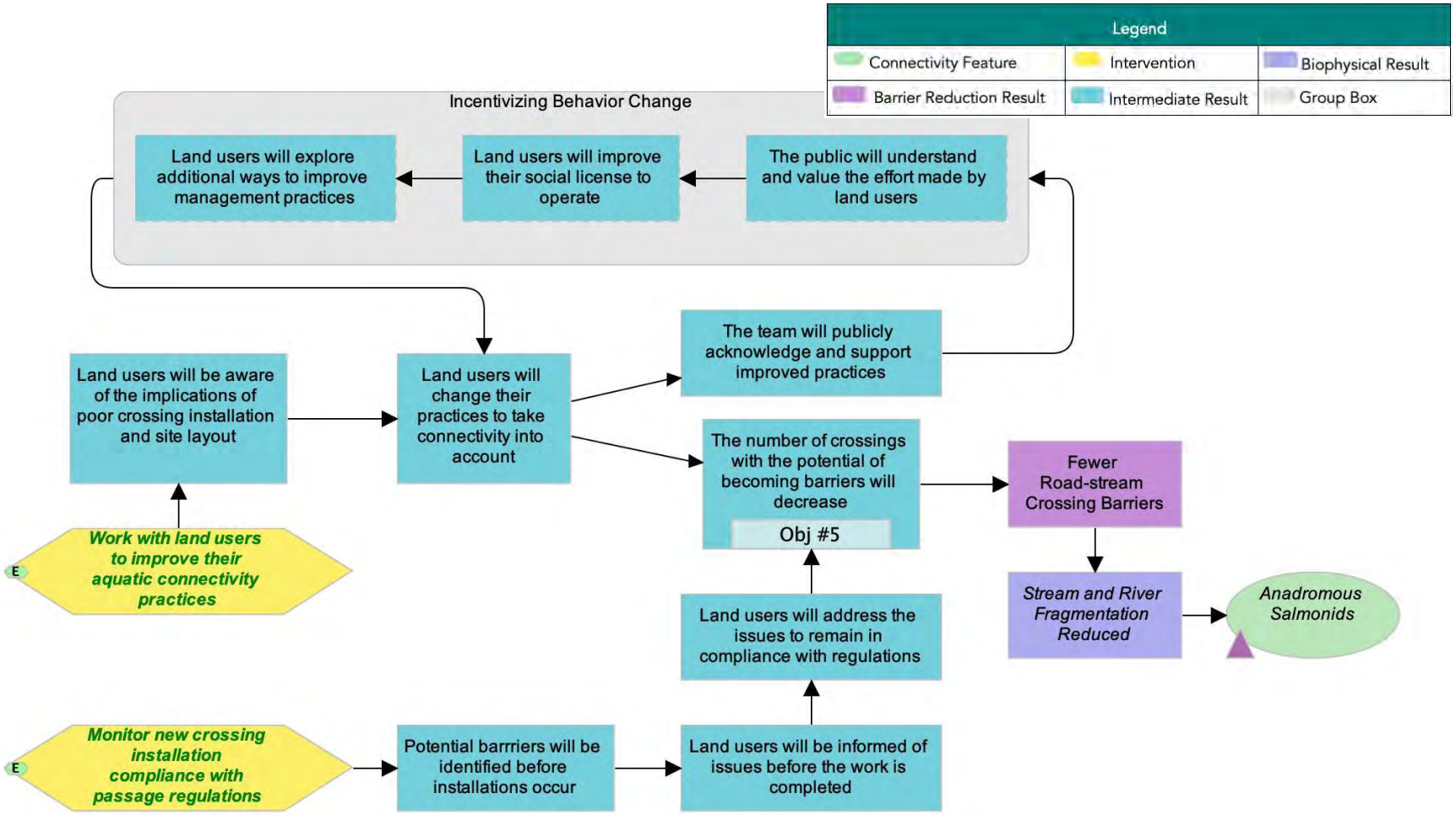


*Figure 7. Theory of change developed by the planning team for the actions identified under Strategy 4: Barrier Prevention in the Lower Nicola River watershed.*

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

| Objective # | Objective |
|---|---|
| 1 | By 2031, a minimum of 2 lateral barriers will be remediated in the Lower Nicola River watershed |
| 2 | By 2031, 5 road-stream crossing barriers will be remediated in the Lower Nicola River watershed |
| 3 | By 2031, 2 abandoned rail-stream crossing barriers will be remediated in the Lower Nicola River watershed |
| 4 | By 2031, 1 dam will be remediated in the Lower Nicola River watershed |
| 5 | By 2031, 100% of new road-stream crossings will be passable to anadromous salmonids in the Lower Nicola River watershed |

## Progress Tracking Plan

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

| Goals / Objectives | Indicator | Methods | Timeframe | Who | Comments |
|---|---|---|---|---|---|
| **Goal 1**: By 2031, the total area of groundwater-serviced off-channel habitat accessible to Anadromous Salmonids will increase by 6,000 $m^2$ within the Lower Nicola River watershed. | Total area ($m^2$) of groundwater-serviced off-channel habitat | *TBD* | *TBD* | CWF | Identified as a knowledge gap. Specifics are TBD. |
| **Goal 2**: By 2025, the % of total linear spawning habitat accessible to Anadromous Salmonids will not | Percent (%) of total linear spawning habitat accessible | Field assessments and reports and audits of new | Annually | CWF | See CWF companion document for |

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| decrease below 96% within the Lower Nicola River watershed. | | barriers, informing the CWF Barrier Prioritization Model | | | detailed GIS procedures |
| **Goal 3**: By 2031, the % of total linear rearing habitat accessible to Anadromous Salmonids will increase from 83% to 90% within the Lower Nicola River watershed. | Percent (%) of total linear rearing habitat accessible | Field reports & as-built drawings informing the CWF Barrier Prioritization Model | Annually | CWF | See CWF companion document for detailed GIS procedures |
| **Objective 1:** By 2031, a minimum of 2 lateral barriers will be remediated in the Lower Nicola River watershed. | The number (#) of lateral barriers remediated | *TBD* | *TBD* | CWF | Identified as a knowledge gap. Specifics are TBD. |
| **Objective 2:** By 2031, 5 road-stream crossing barriers will be remediated in the Lower Nicola River watershed. | The number (#) of road-stream crossings remediated | CWF tracking within the Barrier Prioritization Model + PSCIS database | Annually | CWF | See CWF companion document for detailed GIS procedures |
| **Objective 3:** By 2031, 2 abandoned rail-stream crossing barriers will be remediated in the Lower Nicola River watershed. | The number (#) of rail-stream crossings remediated | CWF tracking within the Barrier Prioritization Model + PSCIS database | Annually | CWF | See CWF companion document for detailed GIS procedures |
| **Objective 4:** By 2031, 1 dam will be remediated in the Lower Nicola River watershed. | The number (#) of dams remediated | CWF tracking within the Barrier Prioritization Model | Annually | CWF | See CWF companion document for detailed GIS procedures |

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|---|---|---|---|---|---|
| **Objective 5:** By 2031, 100% of new road-stream crossings will be passable to Anadromous Salmonids in the Lower Nicola River watershed. | % of new road-stream crossings properly installed | *TBD* – either inspect all new crossings or a subset | Annually | *TBD* | *TBD* |

## Operational Plan

The operational plan represents a preliminary exercise undertaken by the planning team to identify the potential leads, potential participants, and estimated cost for the implementation of each action in the 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 13. Operational plan to support the implementation of strategies and actions to improve connectivity for target species in the Lower Nicola River watershed.*

| Strategy / Actions | Lead(s) | Potential Participants | Estimated cost |
|---|---|---|---|
| **Strategy 1: Lateral Barrier Remediation** | | | **$4,038,000.00** |
| 1.1 – Remediate dykes and berms | CWF, **Scw'exmx Tribal Council (STC)** | Upper Nicola Band, Lower Nicola Indian Band, Nooaitch Band, **Shackan Indian Band**, **Stuwix Resources Joint Venture (SRJV)**, **Coldwater Band**, **Cooks Ferry Band**, Trout Unlimited, Fisheries and Oceans Canada (DFO) | $3,600,000.00 |
| 1.2 – Reconnect channels to thermal refugia | CWF, **STC** | Upper Nicola Band, Lower Nicola Indian Band, Nooaitch Band, **Shackan Indian Band**, **SRJV**, **Coldwater Band**, **Cooks Ferry Band**, Trout Unlimited, DFO | $288,000.00 |
| 1.3 – **Knowledge Gap:** Improve mapping of lateral habitat and thermal refugia | Tom Willms | CWF, **Fraser Basin Council** | $50,000.00 |
| 1.4 - **Knowledge Gap:** Revisit previous remediation and off-channel habitat creation projects to assess whether they are still fish-passable | **STC** | CWF, **Mark Gaboury**, DFO, Tom Willms | $100,000.00 |
| **Strategy 2: Crossing Remediation** | | | **$12,986,140.00** |
| 2.1 – Remove and decommission barriers | CWF, **STC** | Upper Nicola Band, Lower Nicola Indian Band, Nooaitch Band, **Shackan Indian Band**, **SRJV**, **Coldwater Band**, **Cooks Ferry Band**, DFO | $1,008,000.00 |

| | | | |
|---|---|---|---|
| 2.2 – Upgrade and resize crossings | CWF, **STC**, Ministry of Transportation and Infrastructure | Upper Nicola Band, Lower Nicola Indian Band, Nooaitch Band, **Shackan Indian Band**, **SRJV**, **Coldwater Band**, **Cooks Ferry Band**, DFO | $10,962,000.00 |
| 2.3 – Install and maintain temporary mitigation | CWF | Upper Nicola Band, Lower Nicola Indian Band, Nooaitch Band, **Shackan Indian Band**, **SRJV**, **Coldwater Band**, **Cooks Ferry Band**, DFO | $630,000.00 |
| 2.4 – Initiate a barrier owner outreach program | *TBD* | CWF, Nicola Watershed Community Round Table, **Nicola Stockbreeders Association** | $100,000.00 |
| 2.5 – Request regulatory action for non-compliant crossings | *TBD* | CWF, DFO (C&P) | $10,000.00 |
| 2.6 – **Knowledge Gap:** Identify barriers and map barrier ownership | **Fraser Basin Council (FBC)** | CWF, **SRJV**, **Provincial government** | $100,000.00 |
| 2.7 – **Knowledge Gap:** Continue updating the barrier prioritization model | CWF | *TBD* | $100,000.00 |
| 2.8 – **Knowledge Gap:** Adapt the provincial fish passage framework to account for ephemeral habitat | CWF | *TBD* | *TBD* |
| 2.9 – **Knowledge Gap:** Assess barriers by applying an adapted version of the provincial fish passage framework | CWF | STC, DFO | $76,140.00 |
| **Strategy 3: Dam Remediation** | | | ***TBD*** |
| 3.1 - Remove dams | *TBD* | *TBD* | *TBD* |
| 3.2 - Install fish passage | *TBD* | *TBD* | *TBD* |

| | | | |
|---|---|---|---|
| 3.3 - **Knowledge Gap:** Continue updating the barrier prioritization model | CWF | *TBD* | $0.00 |
| 3.4 - **Knowledge Gap:** Assess dams to determine whether they exist and are truly blocking fish habitat | *TBD* | *TBD* | *TBD* |
| 3.5 - **Knowledge Gap:** Identify and map dam ownership | *TBD* | *TBD* | *TBD* |
| **Strategy 4: Barrier Prevention** | | | ***TBD*** |
| 4.1 – Work with land users to improve their aquatic connectivity practices | *TBD* | *TBD* | *TBD* |
| 4.2 – Monitor new crossing compliance with regulations regarding fish passage | *TBD* | *TBD* | *TBD* |
| **Strategy 5: Progress Tracking Plan** | | | ***TBD*** |
| 5.1 - Engage and explore integration with existing regional initiatives | CWF, **Nicola Watershed Governance Project, FBC** | *TBD* | *TBD* |
| 5.2 - Implement the WCRP Progress Tracking Plan | CWF | *TBD* | *TBD* |
| | | **Total:** | **$17,024,140.00** |
| | | **Fundraising total:** | **$9,024,140** |
| | | **Proponent/government contribution total:** | **$8,000,000** |

## Funding Sources

*Table 14. 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 Infrastrucure 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). |
| 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. Emphasis for funding is on stocks of conservation concern, particularly those contributing to a fishery and stocks of bilateral fishery relevance. |
| Enhancement and Restoration Grants | 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. |
| 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. |
| 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. |
| 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. |
| 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. |
| Federal Gas Tax Fund - Community Works Fund | Funding available to local governments from federal gas tax, with funds to be allocated for a variety of municipal projects/initiatives, including local roads/bridges and disaster mitigation. |
| Disaster Mitigation and Adaptation Fund | For those projects where flood risk is high: funding available to local, regional and provincial governments, private sector, non-profit organizations, and Indigenous groups for projects aimed at reducing the socio-economic, environmental and cultural impacts triggered by natural hazards and extreme weather events and taking into consideration current and future impacts of climate change in communities and infrastructure at high risk. Includes both new construction of public infrastructure and modification/reinforcement of existing infrastructure. Projects must have a minimum of $20 M in eligible expenditures and can be bundled together. |
| Community Gaming Grants | Funding for non-profit organizations (check funding program guidelines for specific eligibility requirements) for programs that help to protect and improve the environment by: (1) conserving or revitalizing local ecosystems; (2) reducing greenhouse gas emissions; (3) providing community education or engagement opportunities related to the environment and agriculture; or (4) supporting the welfare of domestic animals and/or wildlife. Grants range from $100K-250K per year. |
| Sitka Foundation | Funding for registered charities, universities and government agencies (qualified Canadian organizations) for projects related to coastline and watershed conservation and climate change in four key areas: (1) land, water, and ocean conservation; (2) scientific research for nature and the environment; (3) public engagement around the importance of a healthy environment; 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. |
| 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. |

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## Appendix A: Modelled Anadromous Salmonid 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: **123456** Priority crossing label.

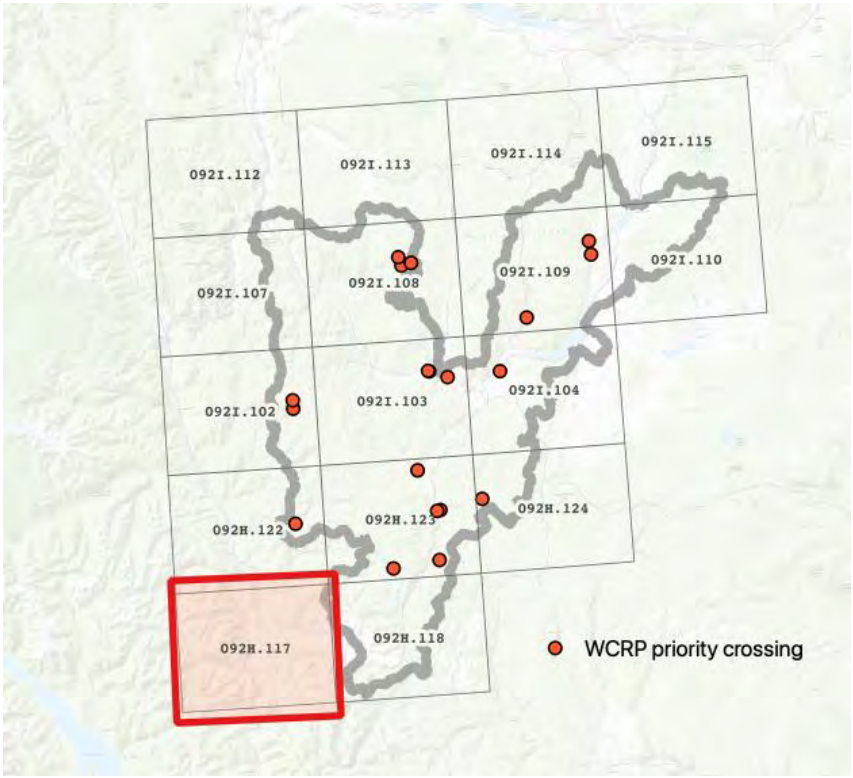


*Figure 8. Lower Nicola River watershed overview map identifying the portions of the watershed covered by each map sheet (grey squares) and the prioritized barriers on the intermediate barrier list (orange points; see Appendix C).*

## Appendix B: 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 et al. 2021a. The variables and thresholds used to model potential spawning and rearing habitat for each target species are summarized in Table 15. 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 15. 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.*

| | Spawning Habitat | | Rearing Habitat | | |
|---|---|---|---|---|---|
| Species | Channel Gradient (%) | Mean annual discharge (m3/s) | Channel Gradient (%) | Mean annual discharge (m3/s) | Multiplier (1.5x) |
| Chinook Salmon | 0-3 | 0.46-322.5<br>(Bjornn and Reiser 1991, Neuman and | 0-5<br>(Woll et al. 2017, Porter et al. 2008) | 0.28-100<br>(Agrawal et al. 2005) | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | Busch et al. 2011, Cooney and Holzer 2006) | Newcombe 1977, Woll et al. 2017, Roberge et al. 2002, Raleigh and Miller 1986) | | | |
| Coho Salmon | 0-5<br>(Roberge et al. 2002, Sloat et al. 2017) | 0.164-59.15<br>(Bjornn and Reiser 1991, Sloat et al. 2017, Neuman and Newcombe 1977, Woll et al. 2017, McMahon 1983) | 0-5<br>(Porter et al. 2008, Rosenfeld et al. 2000) | 0.03-40<br>(Agrawal et al. 2005, Burnett et al. 2007) | Wetland |
| Steelhead | 0-4<br>(Sheer and Steel 2006, Cooney and Holzer 2006) | 0.447-75<br>(Bjornn and Reiser 1991, Neuman and Newcombe 1977, Roberge et al. 2002) | 0-7.4<br>(Porter et al. 2008) | 0.02-60<br>(Agrawal et al. 2005, Burnett et al. 2007) | N/A |

## Appendix C: Lower Nicola River 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 16. 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 37 km of modelled rearing habitat (Table 17).

*Table 17. 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 Appendix B.*

| Habitat Type | Currently accessible (km) | Total (km) | Current Connectivity Status | Goal | Gain required (km) |
|---|---|---|---|---|---|
| Rearing | 469.84 | 563.08 | 83% | 90% | 36.93 |

The barrier prioritization analysis ranked barriers by the amount of habitat blocked to produce an "intermediate barrier list" comprising more barriers than are needed to achieve the goals. A longer list of barriers is needed due to the inherent assumptions in the connectivity model, habitat model, and gaps in available data. Barriers that have been modelled (i.e., points where streams and road/rail networks intersect) are assumed to be barriers until field verification is undertaken and structures that have been assessed as "partial" barriers (e.g., may be passable at certain flow levels or for certain life history stages) may require further investigation before a definitive remediation decision is made. Additionally, the habitat model identifies stream segments that have the potential to support spawning or rearing habitat for target species but does not attempt to quantify habitat quality or suitability (see Appendix B), which will require additional field verification once barrier assessments have completed. As such, the intermediate list of barriers below (Table 18) 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. Some structures will likely be passable, others will not be associated with usable habitat, and others may not be feasible to remediate because of logistic considerations. A web map displaying the location of each priority barrier can be found at: https://www.hillcrestgeo.ca/projects/cwf_wcrp/. For more details on the barrier prioritization model, please see Mazany-Wright et al. 2021a.

*Table 18. Intermediate barrier list resulting from the barrier prioritization analysis in the Lower Nicola River watershed. The barriers on this list exceed the connectivity goals of the plan. Barriers highlighted in the same colour represent sets of barriers that have been prioritized as a group because all must be remediated before their full connectivity gains are realized. In the Barrier Status column, P = potential barrier and B = confirmed barrier or partial barrier. All barrier assessment data are compiled from the BC Provincial Stream Crossing Inventory System.*

| ID | Stream name | Data source | Barrier type | Assessment status (completed to date) | Barrier status | Number of downstream barriers | Spawning habitat blocked – all species (km) | Rearing habitat blocked – all species (km) |
|---|---|---|---|---|---|---|---|---|
| 1011302471 | Voght Creek | Modelled crossing | Resource road crossing | | Potential | 1 | 3.00 | 27.49 |
| 1011301807 | Brook Creek | Modelled crossing | Resource road crossing | | Potential | 3 | 4.88 | 4.88 |
| 197696 | Prospect Creek | PSCIS | Resource road crossing | Assessed | Barrier | 2 | 0 | 1.99 |
| 196997 | Howarth Creek | PSCIS | Municipal road crossing | Assessed | Barrier | 2 | 0 | 9.01 |
| 1011304224 | Brook Creek | Modelled crossing | Abandoned rail-stream crossing | | Potential | 0 | 0.49 | 2.05 |
| 197695 | Prospect Creek | PSCIS | Resource road crossing | Assessed | Barrier | 1 | 0 | 1.73 |
| 197694 | Prospect Creek | PSCIS | Resource road crossing | Assessed | Barrier | 0 | 0 | 1.71 |
| 1011300844 | Voght Creek | Modelled crossing | Highway crossing | | Potential | 0 | 0.76 | 0.76 |
| 1011304291 | Brook Creek | Modelled crossing | Abandoned rail-stream crossing | | Potential | 1 | 0.08 | 0.36 |
| 1011303928 | Spius Creek | Modelled crossing | Resource road crossing | | Potential | 0 | 0 | 1.71 |
| 197015 | Midday Creek | PSCIS | Municipal road crossing | Assessed | Barrier | 7 | 0 | 2.8 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1011301312 | Kwinshatin Creek | Modelled crossing | Resource road crossing | | Potential | 2 | 0 | 1.77 |
| 1011300751 | Stumbles Creek | Modelled crossing | Highway crossing | | Potential | 4 | 0 | 1.79 |
| 1100002544 | Midday Creek | BC Dams | Dam | | Barrier | 1 | 1.79 | 2.45 |
| 197036 | Midday Creek | PSCIS | Resource road crossing | Habitat confirmation | Barrier | 8 | 0 | 1.91 |
| 1011303627 | Midday Creek | Modelled crossing | Resource road crossing | | Potential | 5 | 0 | 1.45 |
| 1011301739 | Stumbles Creek | Modelled crossing | Resource road crossing | | Potential | 1 | 0 | 0.82 |
| 1011303791 | Midday Creek | Modelled crossing | Resource road crossing | | Potential | 3 | 0 | 0.75 |
| 197039 | Kwinshatin Creek | PSCIS | Municipal road crossing | Assessed | Barrier | 1 | 0 | 0.43 |
| 1011304111 | Kwinshatin Creek | Modelled crossing | Abandoned rail-stream crossing | | Potential | 0 | 0 | 0.42 |
| 1100002545 | Midday Creek | BC Dams | Dam | | Barrier | 4 | 0 | 0.39 |
| 1011301738 | Stumbles Creek | Modelled crossing | Resource road crossing | | Potential | 0 | 0 | 0.27 |
| 1011301743 | Stumbles Creek | Modelled crossing | Resource road crossing | | Potential | 3 | 0 | 0.2 |
| 1011300797 | Midday Creek | Modelled crossing | Municipal road crossing | | Potential | 6 | 0 | 0.18 |
| 1011304215 | Stumbles Creek | Modelled crossing | Resource road crossing | | Potential | 2 | 0 | 0.17 |
| | | | | | | **Total gain:** | **11** | **67.49** |

Out of the 25 barriers on the intermediate list, 24 require further field assessment before selection as a final barrier to pursue for remediation:

*Table 19. 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 18 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 | 18 | $4,140.00 |
| Habitat Confirmation | $3,000 | 24 | $72,000.00 |
| | **Total:** | **42** | **$76,140.00** |

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

*Table 20. 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 |
|---|---|---|---|
| Abandoned railway crossing | $1,700,000 | 2 | $3,400,000 |
| Highway crossing | $5,200,000 | 1 | $5,200,000 |
| Municipal/paved road | $1,500,000 | 1 | $1,500,000 |
| Resource road | $500,000 | 5 | $2,500,000 |
| **Total:** | | **9** | **$12,600,000** |