Elk River Watershed | Qukin ?amak?is Connectivity Remediation Plan: 2021 - 2041

Canadian Wildlife Federation

14-11-2024

Table of contents

# Acknowledgements



This plan represents the culmination of a collaborative planning process undertaken in the Elk 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, the 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 project partners](project-partners.qmd).

We recognize the incredible fish passage and connectivity work that has occurred in the Elk River watershed to date, and we are excited to continue partnering with local groups and organizations to build up existing initiatives and provide a road map to push connectivity remediation forward over the next 20 years and beyond.

The Canadian Wildlife Federation recognizes that the lands and waters that form the basis of this plan are the traditional unceded territory of the Ktunaxa people. We are grateful for the opportunity to work to benefit Westslope Cutthroat Trout (Oncorhynchus clarkii lewisi).

# Project Overview

## Plan Purpose, Approach, and Scope

The following Watershed Connectivity Remediation Plan (WCRP) represents the culmination of a one-year collaborative planning effort for the Elk River watershed, the overall aim of which is to reduce the threat of aquatic barriers to resident, fluvial, and adfluvial fish and the livelihoods that they support, including the continued sustenance, cultural, and ceremonial needs of the Ktunaxa people both now and into the future. This 30-year plan was developed to identify priority actions that the Elk River WCRP planning team see [Planning Team](#project-partners) for a list of team members will undertake between 2021-2041 to conserve and restore fish passage in the watershed through strategies aimed at barrier remediation and barrier prevention.

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 fish. The planning process is inspired by the [Conservation Standards](https://cmp-openstandards.org/wp-content/uploads/2020/07/CMP-Open-Standards-for-the-Practice-of-Conservation-v4.0.pdf) (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 Elk River watershed that this WCRP builds upon, including the work undertaken by the Ktunaxa Nation, the Province of British Columbia, and industry proponents, among others. The Canadian Wildlife Federation will continue to engage and coordinate with local partners and existing initiatives, including the [Elk Valley Cumulative Effects Management Framework](https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/cumulative-effects-framework/regional-assessments/kootenay-boundary/elk-valley-cemf), the Elk Valley Fish and Fish Habitat Committee, and the [Elk River Watershed Collaborative Monitoring Program](https://elkrivercollaborative.ca/).

The planning team compiled existing barrier location and assessment data, habitat data, and previously identified priorities, and combined this with local knowledge to create a strategic watershed-scale plan to improve connectivity. To expand on this work, the Elk River WCRP planning team applied the WCRP planning framework to define the thematic scope of freshwater connectivity and refine the geographic scope to identify those portions of the watershed where barrier prioritization will be conducted, and subsequent remediation efforts will take place. Additionally, the team selected target fish species, assessed their current connectivity status in the watershed, defined concrete goals for gains in connectivity, and developed an intermediate list of barriers for remediation to achieve those goals. Field assessments were completed for 31 barriers above Elko Dam, and 21 barriers below Elko Dam on the preliminary barrier list during the summer of 2021, followed by a series of WCRP Update Workshops in winter 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 material presented in this plan to continuously improve aquatic barrier remediation for fish in the Elk 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 Elk River watershed support thriving populations of Westslope Cutthroat Trout. Watershed users work together to mitigate the negative impacts of aquatic barriers, improving the resiliency of streams and rivers for the benefit and appreciation of all.

## Project Scope

Connectivity is a critical component of freshwater ecosystems that encompasses a variety of factors related to ecosystem structure and function, such as the ability of aquatic organisms to disperse and/or migrate, the transportation of energy and matter (e.g., nutrient cycling and sediment flows), and temperature regulation (Seliger 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. Within this context, connectivity is primarily constrained by physical barriers including anthropogenic infrastructure such as dams, weirs, and stream crossings, and natural features such as waterfalls and debris flows. This plan is intended to focus on the direct remediation and prevention of localized, physical barriers instead of the broad land-use patterns that are causing chronic connectivity issues in the watershed. The planning team decided that the primary focus of this WCRP is addressing barriers to longitudinal connectivity (i.e., along the upstream-downstream plane) due to the magnitude of the threat posed by linear development (i.e., road and rail lines) in the watershed. In the Elk River watershed, an additional connectivity consideration is identifying barriers that should not be remediated to protect genetically pure Westslope Cutthroat Trout (Oncorhunchus clarkii lewisi) populations and mitigate the threat of introgression due to aquatic invasive species (AIS).

|  |
| --- |
| Figure 1: The primary geographic scope — the Elk River watershed. |

The primary geographic scope of this WCRP is the Elk River watershed, located in the Kootenays along the southeastern portion of the British Columbia-Alberta border. The scope constitutes the Elk River “watershed group” as defined by the [British Columbia Freshwater Atlas (FWA)](https://catalogue.data.gov.bc.ca/dataset/freshwater-atlas-watershed-groups), due to an effort made to standardize spatial scales of the watershed groups. A consistent spatial framework was necessary to undertake a watershed-selection process at the provincial scale to identify target watersheds to improve connectivity for salmonids. The Elk 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)). The Elk River watershed has a drainage area of 430,937 ha, spanning from the Rocky Mountains in the northeast, the border with the United States in the south, and the confluence with the Koocanusa Reservoir in the southwest ([Figure 1](#fig-geoscope)).

| Secwepemctsín | Common Name | Scientific Name |
| --- | --- | --- |
| Kekèsu | Chinook Salmon | Oncorhynchus tshawytscha |
| Sxeyqs | Coho Salmon | Oncorhynchus kisutch |
| Sqlelten7ùwi | Sockeye Salmon | Oncorhynchus nerka |

**?(caption)**

The Elk River watershed comprises part of the traditional territory of the Ktunaxa peoples, and contains culturally and economically important populations of Westslope Cutthroat Trout, which historically supported Indigenous sustenance and trading economies. The geographic scope for this WCRP was further refined by the planning team through the exclusion of the Flathead River system from the defined watershed group. The Flathead River is hydrographically and topographically distinct from the rest of the watershed and does not flow into the Elk River and Columbia River systems, but is considered part of the watershed group in the FWA. The planning team decided that the watershed connectivity planning process should focus on just the Elk River system and the important Westslope Cutthroat Trout populations supported by the streams and rivers there.

Additionally, the planning team decided to divide the remaining watershed into two discrete WCRP units— 1) Upstream of the Elko Dam and 2) Downstream of the Elko Dam. The Elko Dam was constructed in 1924 on the site of a series of waterfalls that were natural barriers to upstream fish passage, and the dam facility remains impassable to all fish species (J. Bisset, Bisset & Associates, pers. comm., Ladell and Baxter (n.d.)). The Elko Dam plays an important role in preventing the upstream dispersal of invasive/hybridized trout populations from the Columbia River thereby acting as an important barrier to introgression (Lamson (2018)). This role, coupled with the waterfalls acting as natural barrier prior to dam construction, provided the justification to remove the Elko Dam from consideration as a barrier to remediate. Each WCRP unit has Westslope Cutthroat Trout populations with unique life-history forms, and was evaluated independently for connectivity status assessments, goal setting, and barrier prioritization analyses.

Finally, “potentially accessible” stream segments, which are defined as streams that Westslope Cutthroat Trout should be able to access in the absence of anthropogenic barriers, were modelled to set constraints on the geographic scope ([Figure 2](#fig-strseg)). Potentially accessible stream segments were spatially delineated using Westslope Cutthroat Trout observation and distribution data, as well as data on “exclusionary points”, which are waterfalls greater than 5 m in height and gradient barriers where the stream slope exceeds 30% (only in cases where no known populations or observations exist upstream of these points). These maps were explored by the planning team to incorporate additional local knowledge, ensure accuracy, and finalize the constraints on potentially accessible stream segments. All 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 Upstream of the Elko Dam (light blue) and Downstream of the Elko Dam (dark blue) units in Elk River watershed. These do not represent useable habitat types, but rather identifies the stream segments within which habitat modelling and barrier mapping and prioritization was undertaken. |

## Target species

Target species represent the ecologically and culturally important species for which habitat connectivity is being conserved and/or restored in the watershed. In the Elk River watershed, the planning team selected Westslope Cutthroat Trout as the target species. The selection of this target species was driven primarily by the target species of the primary fund supporting this planning work. The planning team also identified other culturally and ecologically important species within the watershed to consider for inclusion in future iterations of the WCRP, including Burbot (Lota lota), Bull Trout (Salvelinus confluentus), and Whitefish (Prosopium williamsoni).

### Westslope Cutthroat Trout | Oncorhynchus clarkii lewisi

Westslope Cutthroat Trout is a cultural and ecological keystone species in the Elk River watershed, playing an important role in structuring aquatic ecosystems and contributing to nutrient recovery for riparian vegetation and forests in cold water streams and lakes, including small, steep streams not accessible to other fish species (Willson and Halupka (1995), COSEWIC (2016)). Westslope Cutthroat Trout are a traditionally important species for the Ktunaxa people and provide substantial economic value for recreational and commercial fisheries. Westslope Cutthroat Trout populations have declined in recent decades due to a combination of threats including, introgressive hybridization with AIS (particularly Rainbow Trout; Oncorhynchus mykiss), habitat degradation, fragmentation, overexploitation, and rising water temperatures due to climate change (COSEWIC (2016), Lamson (2018)). Most relevant to this WCRP, road networks have disrupted many parts of the Elk River watershed thereby increasing the density of stream crossings, leading to stream fragmentation and limiting upstream fish passage. Additionally, some entire headwater reaches have been disrupted or have disappeared due to rock drains associated with mining activity in the watershed (COSEWIC (2016)).

| COSEWIC Designated Unit | Status | Trend | Generation length |
| --- | --- | --- | --- |
| Pacific populations | Special concern | Declining | 4-8 years |

**?(caption)**

Westslope Cutthroat Trout populations and subpopulations found in the Elk River watershed are captured by the “Pacific populations” Designated Unit as defined by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), which has a core distribution covering the upper Kootenay River drainage (**?@tbl-wctrout**). Specifically, the Elk River watershed contains the Elk River and Upper Kootenay population groups, with each population group containing multiple sub-populations with variable life history forms (**?@tbl-wcrp-pop**). High levels of hybridization exist in most waterbodies connected to the Koocanusa Reservoir (i.e., the Upper Kootenay population group), including the Elk River mainstem downstream of the Elko Dam and much of the Wigwam and Lodgepole systems. Generally, the hybridization levels upstream of Elko Dam are quite low, though there is known hybridization occurring in the Michel Creek sub-drainage (COSEWIC (2016); H. Lamson, BC Ministry of Environment pers. comm.). Pure Westslope Cutthroat Trout sub-populations exist in the upper Fording River (upstream of Josephine Falls), Greenhills Creek, Forsyth Creek, Grave Creek, Harmer Creek, Morrissey Creek, Weary Creek, upper Lodgepole Creek, and the upper Elk River (Lamson (2018)).

| WCRP Unit | Population Group | Waterbodies | Life History Forms | Threat of Hybridization |
| --- | --- | --- | --- | --- |
| Upstream of the Elko Dam | Elk River | Elk River mainstem and all tributaries above Elko Dam | Stream-resident and fluvial | Low |
| Downstream of the Elko Dam | Upper Kootenay | Elk River mainstem below Elko Dam and Wigwam and Lodgepole systems (connected to the Koocanusa Reservoir) | Stream resident, fluvial, and adfluvial | High |

**?(caption)**

Adult Westslope Cutthroat Trout overwinter in deep pools or lakes and then generally move upstream to spawning habitat during high spring flows, with spawning peaking between May and June. Fry emergence occurs between July and August, with individuals migrating to lower velocity rearing habitats in and around natal streams (COSEWIC (2016), ERA (n.d.)). Westslope Cutthroat Trout exist with three distinct life history forms in the Elk River watershed (Oliver (2009), ERA (n.d.)):

* Stream-resident — individuals spend their entire life history within a restricted distribution of headwater streams, often because movement is restricted by natural barriers.
* Fluvial — individuals migrate between tributaries and larger mainstem rivers to complete various life-history stages (e.g., spawning, overwintering).
* Adfluvial — individuals migrate between tributaries and lakes/reservoirs to complete life-history stages. See Appendix A for maps of modelled Westslope Cutthroat Trout habitat in the Elk River watershed.

## Barrier Types

The following table highlights which barrier types pose the greatest threat to Westslope Cutthroat Trout 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 little spatial data to inform the assessment for a specific barrier type.

Table 1: Barrier types in the Elk River watershed and barrier rating assessment results. For each barrier type listed, ‘Extent’ refers to the proportion of Westslope Cutthroat Trout 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.

| Barrier Types | Extent | Severity | Irreversibility | Overall Threat Rating: |
| --- | --- | --- | --- | --- |
| Dams | Medium | Low | High | Low |
| Road-Stream Crossings | High | Low | Medium | High |
| Rail-stream Crossings | Low | High | High | Medium |
| Trail-stream Crossings | Low | Low | Low | Low |
| Lateral Barriers | Low | Low | High | Low |
| Sediment Wedges | Low | Low | Medium | Low |
| Landslides | Low | Low | High | Low |

### Dams

There are 9 mapped dams on potential habitat in the watershed, blocking698.19 km (39.83% of the total blocked habitat) of modelled spawning and rearing habitat, resulting in a Low extent. The Elko Dam is excluded from this assessment due to its function in preventing introgression and the spread of AIS upstream, and the historic natural barrier at this site. The extent rating of these structures was confirmed by the planning team — there are a small number of known dams in the watershed, mostly associated with mining activity (e.g., settling/tailing ponds). The Harmer Creek Dam was identified by the planning team as an important dam to remediate to benefit a genetically pure Westslope Cutthroat Trout population in the Grave-Harmer system, and Teck Resources Ltd. is currently undertaking an assessment process to evaluate potential remediation options (W. Franklin, Teck Resources Ltd., pers. comm.). There are no known fishways in the watershed, and the identified dams likely block passage for Westslope Cutthroat Trout. Due to the significant resources required to remediate dams and the Low extent of dams in the watershed, a final pressure rating of Low was assigned.

### Road-stream Crossings

Road-stream crossings are the most abundant barrier type in the watershed, with 18 assessed and modelled crossings located on potential habitat. Demographic road crossings (highways, municipal, and paved roads) block 56.38 km of habitat (~40% of the total blocked habitat), with 0% of assessed crossings having been identified as barriers to fish passage. Resource roads potentially block 698.19 km of habitat (~40%), with 0% of assessed crossings have been identified as barriers. Significant land use and linear development throughout the valley bottom, including Highways 3 and 43, have disconnected the Elk River from important habitat in many tributaries. The resource road-stream crossings are primarily associated with mining and forestry activities in the watershed. The collective experience and input from the planning team resulted in a Medium irreversibility rating due to the technical complexity and resources required to remediate road-stream crossings, though it was noted that this differs considerably between resource roads and highway crossings.

### Rail-stream crossings

There are relatively few rail-stream crossings in the watershed (65 crossings on potential habitat), potentially blocking only 13.99 km of habitat (~3% of the total habitat blocked). Only 14 rail-stream crossings have been assessed in the watershed, and of these 45% are considered to be barriers. All rail- stream crossings in the watershed are associated with the Canadian Pacific (CP) rail lines running along the Elk River, Fording River, and Michel Creek. With significant financial costs, technical challenges, and stakeholder engagement required with CP to remediate these barriers, the planning team decided on an overall pressure rating of Medium for this barrier type.

### Trail-stream crossings

There are very little spatial data available on trail-stream crossings in the watershed, so the planning team was unable to numerically quantify the Extent and Severity of this barrier type. The planning team felt that recreational trail network crossings rarely significantly block passage for Westslope Cutthroat Trout. Given that most crossings will likely be fords or similar structures, the remediation costs associated with these barriers would be quite low. Overall, the planning team felt that the pressure rating for trail-stream crossings was likely Low.

### Lateral Barriers

There are numerous types of lateral barriers that potentially occur in the watershed, including dykes, berms, and linear development (i.e., road and rail lines), all of which can restrict the ability of Westslope Cutthroat Trout to move into floodplains, riparian wetlands, and other off-channel habitats. No comprehensive lateral barrier data exist within the watershed, so pressure ratings were based on qualitative local knowledge. Lateral barriers are not thought to be as prevalent as road- or rail-stream crossings and are likely to be passable for at least certain parts of the year where they do exist. Highway 3, Highway 43, and the CP rail line were identified as potential lateral barriers that disconnect the mainstem channels from their historic floodplain and off-channel habitat. Overall, the planning team decided that a Low pressure rating adequately captured the effect that lateral barriers are having on connectivity in the watershed, while recognizing that the lack of data on lateral barriers in the watershed is an important knowledge gap to fill.

### Sediment Wedges

Sediment wedges include both mass wasting events and chronic bank erosion that can lead to the deposition of sediment to such an extent as to limit fish passage. The extent and severity of sediment wedges acting as barriers fluctuates seasonally and annually due to natural and human-induced changes to the flow regime, and natural barriers of this type are difficult to include in a spatial prioritization framework due to their transient nature. Both current and historic land-use practices, including mining and forest-harvesting impacts, contribute to the formation of sediment wedges in the watershed; however, the planning team felt that the extent and severity were Low overall.

### Landslides

Though a relatively rare occurrence, landslides that result in impediments to fish passage do occur in the watershed and can be technically and financially difficult to remediate when they occur. Overall, the planning team felt that a Low rating adequately captured the effects of landslides, but felt that it was an important barrier type to identify in this WCRP.

# Connectivity Status Assessment and Goals

## Connectivity Status Assessment

The planning team devised two Key Ecological Attributes (KEAs) and associated indicators to assess the current connectivity status of the watershed – Accessible habitat above Elko Dam and Accessible habitat below Elko Dam ([Table 4](#tbl-connectivity)). KEAs are the key aspects of Westslope Cutthroat Trout ecology that are being targeted by this WCRP. The connectivity statuses for the Westslope Cutthroat Trout KEAs were used to establish goals to improve habitat connectivity in the watershed and will be the baseline against which progress is tracked over time.

The current connectivity status assessment relies on GIS analyses to map known and modelled barriers to fish passage, identify stream reaches that have potential spawning and rearing habitat, estimate the proportion of habitat that is currently accessible to target species, and prioritize barriers for field assessment that would provide the greatest gains in connectivity. For the connectivity status assessments and barrier prioritization analysis the amount of spawning and rearing habitat is aggregated without duplication (i.e., a stream segment is only counted once if it is classified as both spawning and rearing habitat; see [data methods](#data-download-and-methods)). To support a flexible prioritization framework to identify priority barriers in the watershed, two assumptions are made: 1) any modelled (i.e., the 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](#data-download-and-methods).

Table 2: Connectivity status assessment for (a) habitat upstream of Elko Dam and (b) habitat downstream of Elko Dam in the Elk River watershed. The two KEAs - Accessible habitat upstream of Elko Dam and Accessible habitat downstream of Elko Dam - are evaluated using the Longest Fragment approach (Diaz et al. 2021), whereby the length of linear habitat that currently comprises the longest connected section in the watershed is divided by the total length of all linear habitat in the watershed.

| Target Species | KEA | Indicator | Poor | Fair | Good | Very Good |
| --- | --- | --- | --- | --- | --- | --- |
| Westslope Cutthroat Trout | Accessible habitat upstream of Elko Dam | Longest Fragment (%) | <25% | 26-50% | 51-75% | >75% |
|  |  | Current Status: |  |  | 70 |  |

**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 November 2022.

| Target Species | KEA | Indicator | Poor | Fair | Good | Very Good |
| --- | --- | --- | --- | --- | --- | --- |
| Westslope Cutthroat Trout | Accessible habitat downstream of Elko Dam | Longest Fragment (%) | <25% | 26-50% | 51-75% | >75% |
|  |  | Current Status: |  |  |  | 98 |

**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 November 2022.

## Goals

Table 3: Goals to improve habitat connectivity for Westslope Cutthroat Trout, upstream and downstream of Elko Dam, in the Elk River watershed over the lifespan of the WCRP (2021-2041). The goals were established through discussions with the planning team and represent the resulting desired state of connectivity in the watershed. The goals for the Downstream of the Elko Dam unit assume that remediation can be undertaken while mitigating the risk of introgressive hybridization (see action 1.11 in Strategies & Actions). 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 Longest Fragment (%) for Westslope Cutthroat Trout will increase from 70% to 83% above the Elko Dam (i.e., reconnect at least 126.96 of habitat). |
| 2 | By 2041, the Longest Fragment (%) for Westslope Cutthroat Trout will increase to 86% above the Elko Dam (i.e., reconnect at least an additional 29.04 km of habitat). |
| 3 | By 2031, the Longest Fragment (%) for Westslope Cutthroat Trout will increase from 98% to 99% below the Elko Dam (i.e., reconnect at least 2.34 km of habitat). |
| 4 | By 2041, the Longest Fragment (%) for Westslope Cutthroat Trout will not decrease from 99% below the Elko Dam. |

# Barrier Prioritization

## Elk River Watershed Barrier Prioritization Summary

The primary conservation outcome of the WCRP is the remediation of barriers to connectivity in the Elk River watershed. To achieve the 2041 connectivity goals in this plan (Goals 2 and 4), it is necessary to prioritize and identify a suite of barriers for both the Upstream of Elko Dam and Downstream of Elko Dam units that, if remediated, will provide access to a minimum of 142 km of habitat and 3 km of habitat, respectively ([Table 4](#tbl-connectivity)).

Table 4: Habitat connectivity gain requirements to meet WCRP goals in each WCRP unit of the Elk River watershed. The measures of currently accessible and total habitat values are derived from the Intrinsic Potential habitat model described in the data methods.

| WCRP Unit | Currently accessible (km) | Total | Current Connectivity Status | Goal | Gain required (km) |
| --- | --- | --- | --- | --- | --- |
| Upstream of Elko Dam | 676.38 | 967.88 | 70% | 86% | 156.0 |
| Downstream of Elko Dam | 191.34 | 195.64 | 98% | 99% | 2.34 |

The barrier prioritization process comprises three stages:

* Stage 1: preliminary barrier list
* Stage 2: intermediate barrier list
* Stage 3: priority barrier list

The barrier prioritization analysis ranked barriers by the amount of habitat blocked to produce an “intermediate barrier list” comprising more barriers than are needed to achieve the goals. A longer list of barriers is needed due to the inherent assumptions in the connectivity model, habitat model, and gaps in available data. Barriers that have been modelled (i.e., points where streams and road/rail networks intersect) are assumed to be barriers until field verification is undertaken and structures that have been assessed as “potential” barriers (e.g., may be passable at certain flow levels or for certain life history stages) require further investigation before a definitive remediation decision is made. Additionally, the habitat model identifies stream segmentsthat have the potential to support spawning or rearing habitat for target species but does not attempt to quantify habitat quality or suitability see [data methods](#data-download-and-methods), which will require additional field verification once barrier assessments have been completed. As such, the intermediate list of barriers (**?@tbl-removed-below**) should be considered as a starting point in the prioritization process and represents crossings 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, some crossings may not exist, 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”(**?@tbl-priority**) and others were eliminated from consideration due to one or more of the considerations discussed above see (**?@tbl-removed-above**) and (**?@tbl-removed-below**). 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 remediation. For more details on the barrier prioritization model, please see Mazany-Wright, Norris, et al. (2021a).

| ID | Stream name | Reason For Removal | Comments |
| --- | --- | --- | --- |
| 112336 | Alexander Creek | Improperly mapped on mainstem. Located on tributary with limited habitat value. | High up in watershed, steep terrain. |
| 1024735443 | Abruzzi Creek | Does not exist | Recreational trail erroneously mapped in Digital Road Atlas |
| 62245 | Tobermory Creek | Remediated | Open bottom clearspan bridge |
| 197527 | Crossing Creek | Low quality habitat |  |
| 1004606284 | Fording River | Ford | Confirmed via literature: Cope et al. (2016) |
| 197826 (1004603334) | Fording River | ford |  |
| 1100002606 | Boivin Creek | Off channel, not a barrier |  |
| 197818 (1004606007) | Weigert Creek | Ford |  |
| 197820 (1024735049) | Weigert Creek | Ford |  |
| 197837 (1004602163) | Morrissey Creek | Ford | Crossing removed |
| 197821 (1004606545) | Cummings Creek | Ford |  |
| 197846 (1004607449) | Tributary to Ewin Creek | Ford | Crossing Removed |
| 197847 (1004600533) | Chauncey Creek | Ford | Crossing Removed |
| 197805 (1004601280) | Tributary to Harmer Creek | Ford | Crossing Removed |
| 197839 (1004607022) | McCool Creek | Ford |  |
| 197823(1024706614) | Henretta Creek | Ford | Crossing Removed |
| 197824 (1004604696) | Henretta Creek | Crossing does not exist |  |
| 197803 (1004602514) | Harmer Creek | Ford |  |
| 197838 (1004601704) | Morrissey Creek | Ford | Crossing removed |
| 197816 (1004602949) | Weigert Creek | Ford |  |
| 1004603432 | Tributary to Cadorna Creed | Crossing does not exist |  |

**?(caption)**

| ID | Stream name | Reason For Removal | Comments |
| --- | --- | --- | --- |
| 197789 (1004603791) | Tributary to Lodgepole Creek | Ford | Road Deactivated |
| 197792 (1004605499) | Tributary to Bean Creek | Bridge |  |
| 197867 (1004603553) | Bighorn Creek | Ford |  |
| 1004605216 | Tributary to Wigwam river | No Crossing | Crossing does not exist |
| 197785 (1004606129) | Tributary to Wigwam river | No channel | No defined channel - lake drains to basin upstream with no visible channel between lake and road |
| 197782 (1004602359) | Rabbit Creek | Bridge (Collapsed) | Collapsed bridge but not blocking flows |
| 197861 (1004602646) | Tributary to Wigwam river | No crossing |  |
| 197794 (1004603480) | Bean Creek | Bridge |  |
| 197790 (1004606411) | Tributary to Lodgepole Creek | Ford |  |
| 197796 (1004601984) | Tributary to Lodgepole Creek | Short habitat gain | 2.3 m falls ~60 m upstream |
| 1004605338 | Tributary to Wigwam river | No Crossing, no channel | Dry area with no channel |
| 197797 (1004606926) | Bighorn Creek | Ford | Crossing removed |
| 197780 (1004601993) | Rabbit Creek | Ford |  |
| 197781 (1004601995) | Rabbit Creek | Bridge (Collapsed) | Collapsed bridge but not blocking flows |
| 1004603793 | Lodgepole Creek | Ford | Crossing removed |
| 197795 (1024733953) | Tributary to Lodgepole Creek | Bridge |  |

**?(caption)**

| ID | Stream name | Barrier type | Assessment Status | Barrier Status | Number of downstream barriers | Spawning and Rearing Habitat Blocked (KM) | Next Steps | Comments |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 197559 | Brûlé Creek | Highway crossing | Habitat confirmation | Barrier | 1 | 22.22 | In-depth habitat investigations | Currently under investigation to determine habitat capacity for WCT |
| 61504 | Coal Creek | Resource road crossing | Assessed | Barrier | 0 | 14.75 | Monitor | Road has washed out, not currently a barrier. Mintor as road is rebuilt |
| 1004603413 | Henretta Creek | Resource road crossing | Modelled Crossing | Potential | 2 | 5.84 | Barrier assessment | Determine presence and barrier status from teck Coal |
| 50185 | Tributary to Morrisey Creek | Resource road crossing | Habitat confirmation | Barrier | 0 | 2.13 | In-depth habitat investigations | Currently under investigation to determine habitat capacity for WCT |
| 197534 | Weigert Creek | Highway crossing | Habitat confirmation | Barrier | 0 | 0.17 | In-depth habitat investigations | Currently under investigation to determine habitat capacity for WCT |
| 197533 | Brûlé Creek | Municipal road crossing | Habitat confirmation | Barrier | 0 | 0.13 | In-depth habitat investigations | Currently under investigation to determine habitat capacity for WCT |
|  |  |  |  |  | Total Gain: | 45.24 |  |  |

**?(caption)**

| ID | Stream name | Barrier type | Assessment Status | Barrier Status | Number of downstream barriers | Spawning and Rearing Habitat Blocked (KM) | Next Steps | Comments |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 197783 (1004605937) | Tributary to Wigwam River | Resource road crossing | Barrier Assessment | Barrier | 0 | 0.79 | In-depth habitat investigations | Currently under investigation to determine habitat capacity for WCT |
| 197787 (1004606370) | Lodgepole Creek | Resource road crossing | Habitat confirmation | Potential | 0 | 0.61 | In-depth habitat investigations | Currently under investigation to determine habitat capacity for WCT |
| 197793 (1004606347) | Bean Creek | Resource road crossing | Habitat confirmation | Barrier | 0 | 0.88 | In-depth habitat investigations | Currently under investigation to determine habitat capacity for WCT |
| 197786 (1004606398) | Lodgepole Creek | Resource road crossing | Habitat confirmation | Barrier | 1 | 0.49 | In-depth habitat investigations | Currently under investigation to determine habitat capacity for WCT |
| 197844 (1004605514) | Tributary to Bighord Creek | Resource road crossing | Habitat confirmation | Barrier | 0 | 0.60 | In-depth habitat investigations | Currently under investigation to determine habitat capacity for WCT |
|  |  |  |  |  | Total Gain: | 3.37 |  |  |

**?(caption)**

There are currently 21 barriers on the priority barrier list, which will be pursued for proactive remediation to achieve the connectivity goals in this plan:

| ID | Stream name | Road Name | Barrier Owner | Barrier Type | PSCIS Status | Barrier Status | Number of downstream barriers | Spawning and Rearing Habitat Blocked (KM) | Priority Status | Comments |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 197827 (1004600762) | Fording River | FRO Coal Haul | Teck Coal | Resource road crossing | Barrier Assessment | Barrier | 0 | 8.04 | Teck Design | Explore design and remediation options (Teck Coal leading) |
| 1100001086 | Harmer Creek | N/A | Teck Coal | Dam | Barrier Assessment | Barrier | 0 | 5.24 | Teck Design | Explore design and remediation options (Teck Coal leading) |
| 62181 | Dry Creek | Rail | CP Rail | Railway crossing | Habitat Confirmation | Partial | 1 | 4.53 | Teck Design | Explore design and remediation options (Teck Coal leading) |
| 197542 | Hartley Creek | Dicken Road | BC Ministry of Transportation and Infrastructure | Municipal road crossing | Habitat Confirmation | Barrier | 0 | 4.46 | MOTI Design | Explore design and remediation options with MOTI |
| 62416 | Grace Creek | Line Road | CanWel Forest Products | Resource road crossing | Habitat Confirmation | Barrier | 1 | 0.98 | Owner Engagement | Persuade/confirm owner will address crossing |
| 197825 (1004604677) | Henretta Creek | Unnamed | Teck Coal | Resource road crossing | Barrier Assessment | Barrier | 1 | 0.36 | Teck Design | Explore design and remediation options (Teck Coal leading) |
| 62182 | Dry Creek | Fording Highway | Teck Coal | Highway crossing | Habitat Confirmation | Partial | 0 | 0.03 | Teck Design | Explore design and remediation options (Teck Coal leading) |
| 62505 | Tributary to Lizard Creek | Mount Fernie Parkway | BC Parks | Resource road crossing | Habitat Confirmation | Barrier | 0 | 0.25 | Design | Advance to design |
| 50152 | Stove Creek (Tributary to Lizard Creek) | Mount Fernie Parkway | BC Parks | Resource road crossing | Habitat Confirmation | Barrier | 0 | 0.36 | Design | Advance to design |
| 1004602974 | Grace Creek | Line Road | CanWel Forest Products | Resource road crossing | Barrier Assessment | Barrier | 0 | 3.24 | Owner Engagement | Persuade/confirm owner will address crossing based onconfirmed high quality habitat upstream of 62416 |
|  |  |  |  |  |  |  | Total Gain: | 27.49 |  |  |

**?(caption)**

# Work Planning

## Annual Progress Report

CWF continues to work with program partners to identify and address priority barriers in the Elk River watershed. CWF worked with BC Parks to replace a barrier culvert on a tributary to Lizard Creek with an clearspan bridge in Mount Fernie Park in 2023 and is developing designs for a second replacement in the park on Stove Creek, with the intent of replacing that crossing with a geotextile reinforced arch culvert in 2025. The BC Ministry of Transportation and Infrastructure is advancing plans for the Hartley Creek crossing, with work currently going through the regulatory approvals process. Teck Coal is actively advancing work to remove the Harmer dam, and a multiplate crossing on the FRO Coal Haul road is anticipated in the near future. CWF is also working with program partners to continue to complete barrier assessments in the watershed during summer/fall 2024 and has begun to investigate ways to improve the Westslope Cutthroat Trout habitat model that is currently being used to assist in identify potential candidate sites for assessment.

## 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 Elk River watershed. Table 8 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 plan for entries into this 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 parentheses), 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 5: Operational plan to support the implementation of strategies and actions to improve connectivity for target species in the Horsefly River watershed.

| Strategy / Actions | Lead(s) | Participants | Total Budget |
| --- | --- | --- | --- |
| Strategy 1: Crossing Remediation |  |  | $16,137,390.00 |
| 1.1 - Remediate resource road barriers | CWF |  | $8,500,000.00 |
| 1.2 - Remediate dams | CWF |  | $435,000,000.00 |
| 1.3 - Remediate major infrastructure crossings |  | CWF | $6,700,000.00 |
| 1.4 - Barrier mititgation | CWF, SERN | CWF | \*Built-in to 1.1 and 1.2 |
| 1.5 - Work with crossing owners to identify and remediate barriers | Elk River Alliance (ERA) | (Windsight), CWF | $20,000 |
| 1.6 - Advocate for increased compliance and enforcement for specific, priority barriers | ERA | (Windsight), CWF | $20,000.00 |
| 1.7 - Work with FLNRORD to encourage road decommissioning that returns sites to a more natural condition | ERA | (Windsight) | $5,000.00 |
| 1.8 - Integrate with other regional initiatives | CWF | ERA | $25,000.00 |
| 1.9 - Raise funds to remediate barriers (ownership dependent) | CWF |  | $200,000.00 |
| 1.10 - Knowledge Gap: Assess barriers by applying the provincial fish passage framework | CWF |  | $84,890.00 |
| 1.11 - Knowledge Gap: Identify key barriers for hybridization prevention below Elko Dam |  | CWF | $11,000.00 |
| 1.12 - Knowledge Gap: Identify and map owners of priority barriers | ERA | CWF | $1,500.00 |
| 1.13 - Knowledge Gap: Prioritize barriers for the Upper Fording and Grave-Harmon populations | CWF |  | Completed |
| 1.14 - Knowledge Gap: Continue updating the barrier prioritization model | CWF |  | $50,000 |
| 1.15 - Knowledge Gap: Desktop mapping of lateral habitat and barriers; define lateral connectivity goals | ERA | CWF | $20,000.00 |
| 1.16 - Knowledge gap: Ground truth lateral habitat and barriers |  | CWF, ERA | $65,000 |
| 1.17 - Knowledge gap: Monitor temperature and flows; assess effectiveness of barrier remediation projects | ERA | CWF | $50,000 |
| Strategy 2: Barrier Prevention |  |  | $250,000.00 |
| 2.1 - Engage with land managers to share and implement best practices on stream crossings and fish passage | ERA | CWF | $100,000.00 |
| 2.2 - Support and engage with First Nations guardians programs where appropriate |  | CWF, KNC? | $140,000.00 |
| 2.3 - Engage with ATV clubs/recreation groups to share and implement best practices on stream crossings and fish passage |  |  |  |
| Total: |  |  | $17,024,140.00 |
| Fundraising total: |  |  | $9,024,140 |
| Proponent/government contribution total: |  |  | $8,000,000 |

## Annual Work Plan

# References

Agrawal, A, R S Schick, E P Bjorkstedt, R G Szerlong, M N Goslin, B C Spence, T H Williams, and K M Burnett. 2005. *Predicting the Potential for Historical Coho, Chinook, and Steelhead Habitat in Northern California*. *National Oceanic and Atmospheric Administration*.

Bjornn, T C, and D W Reiser. 1991. “Habitat Requirements of Salmonids in Streams.” *Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats* 19: 83–138.

Burnett, Kelly M, Gordon H Reeves, Daniel J Miller, Sharon Clarke, Ken Vance-Borland, and Kelly Christiansen. 2007. “Distribution of Salmon-Habitat Potential Relative to Landscape Characteristics and Implications for Conservation.” *Ecol. Appl.* 17 (1): 66–80.

Busch, D S, M Sheer, K Burnett, P Mcelhany, and T Cooney. 2011. “Landscape-Level Model to Predict Spawning Habitat for Lower Columbia River Fall Chinook Salmon (Oncorhynchus Tshawytscha).” *River Research Applications* 29: 291–312.

Cooney, T, and D Holzer. 2006. *Appendix c: Interior Columbia Basin Stream Type Chinook Salmon and Steelhead Populations: Habitat Intrinsic Potential Analysis. National Oceanic and Atmospheric Administration*. Northwest Fisheries Center: Northwest Fisheries Center.

COSEWIC. 2016. *COSEWIC Assessment and Status Report on the Westslope Cutthroat Trout (Oncorhynchus Clarkii Lewisi), Saskatchewan-Nelson River Populations and Pacific Populations, in Canada. Committeee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario.* https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/westslope-cutthroat-trout-2016.html.: ECC.

Díaz, K. Górski, G., and E. Habit. 2021. *The Longest Fragment Drives Fish Beta Diversity in Fragmented River Networks: Implications for River Management and Conservation. Science of the Total Environment 766.* https://doi.org/10.1016/j.scitotenv.2020.144323.

ERA. n.d. *Westslope Cutthroat Trout in the Elk River Watershed. Elk River Alliance, Fernie, British Columbia.* https://d3n8a8pro7vhmx.cloudfront.net/elkriveralliance/pages/282/attachments/original/156089171 2/WCT\_Poster 1.pdf?1560891712.

Hoopes, D Y. 1972. *Selection of Spawning Sites by Sockeye Salmon in Small Streams*. Fishery Bulletin.

Ladell, J. D. McPhail, J., and J. S. Baxter. n.d. *BC Hydro Dam Impact Footprint Review - Whitefish, Westslope Cutthroat Trout, Cottids, Cyprinids & Catostomids. Prepared for Fish and Wildlife Compensation Program.* https://a100.gov.bc.ca/pub/acat/documents/r40025/BCH\_Dam\_Impac\_Cottids\_1385051732450\_504 1247788.pdf.: UBC.

Lake, R G. 1999. *Activity and Spawning Behaviour in Spawning Sockeye Salmon. Thesis*. UBC.

Lamson, H. M. 2018. *Evaluation of Current Westslope Cutthroat Trout Hybridization Levels in the Upper Kootenay Drainage - Project Year 2 (2017/18). Prepared for Fish and Wildlife Compensation Program. UKE-F18-f-2461.*

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

———. 2021b. “Fish Passage Restoration Initiative Target Watershed Selection Process: Technical Documentation.” *Canadian Wildlife Federation*.

Mazany-Wright, N, J Noseworthy, S Sra, S M Norris, and N W Lapointe. 2021. “Breaking down Barriers: A Practitioners’ Guide to Watershed Connectivity Remediation Planning.” *Canadian Wildlife Federation*.

Mcmahon, T E. 1983. “Habitat Suitability Index Models: Coho Salmon.” *U.S. Department of the Interior, Fish and Wildlife Service* 29.

Neuman, H R, and C P Newcombe. 1977. *Minimum Acceptable Stream Flows in British Columbia: A Review*. Fisheries Management Report No. 70.

Oliver, G. G. 2009. *Towards a Westslope Cutthroat Trout Management Plan for the Province of British Columbia. Prepared for b.c. Ministry of Environment, Cranbrook, British Columbia.*

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

Raleigh, R F, and W J Miller. 1986. *Habitat Suitability Index Models and Instream Flow Suitability Curves: Chinook Salmon. U.S. Fish and Wildlife Service Biological Reports 82*. USFW.

Roberge, M, J B M Hume, C K Minns, and T Slaney. 2002. *Life History Characteristics of Freshwater Fishes Occurring in British Columbia and the Yukon, with Major Emphasis on Stream Habitat Characteristics.* Cultus Lake, British Columbia: Fisheries; Oceans Canada, Marine Environment; Habitat Science Division.

Rosenfeld, Jordan, Marc Porter, and Eric Parkinson. 2000. “Habitat Factors Affecting the Abundance and Distribution of Juvenile Cutthroat Trout (Oncorhynchus Clarki) and Coho Salmon (Oncorhynchus Kisutch).” *Can. J. Fish. Aquat. Sci.* 57 (4): 766–74.

Seliger, Carina, and Bernhard Zeiringer. 2018. “River Connectivity, Habitat Fragmentation and Related Restoration Measures,” 171–86.

Sheer, M B, D S Busch, E Gilbert, J M Bayer, S Lanigan, J L Schei, K M Burnett, and D Miller. 2009. *Development and Management of Fish Intrinsic Potential Data and Methodologies: State of the IP 2008 Summary Report*. Pacific Northwest Aquatic Monitoring Partnership Series 2009—4, 56 pp.

Sloat, Matthew R, Gordon H Reeves, and Kelly R Christiansen. 2017. “Stream Network Geomorphology Mediates Predicted Vulnerability of Anadromous Fish Habitat to Hydrologic Change in Southeast Alaska.” *Glob. Chang. Biol.* 23 (2): 604–20.

Willson, M. F., and K. C. Halupka. 1995. *Anadromous Fish as Keystone Species in Vertebrate Communities. Conservation Biology 9: 489-497*.

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

# Version History

[v.1.0 – August 2024](https://v1-0--elkr-wcrp.netlify.app/)

# Project Partners

## Planning Team

The Ktunaxa National Council (KNC) was invited to participate in the planning process, but was unable to at this time. CWF desires to collaborate with KNC on this plan in the future, and the planning team has tried to reflect our understanding of the rights and values of the Ktunaxa people in this WCRP. We are committed to correcting any errors in assumption or interpretation that are identified in this plan.

| Name | Organization |
| --- | --- |
| Betty Rebellato | Canadian Wildlife Federation |
| David Hillary | Canadian Wildlife Federation |
| Justin Duncan | Canadian Wildlife Federation |
| Nick Mazany-Wright | Canadian Wildlife Federation |
| Nicolas Lapointe | Canadian Wildlife Federation |
| Sarah Sra | Canadian Wildlife Federation |
| Simon Norris | Hillcrest Geographics |
| Kristin Singer | Department of Fisheries and Oceans Canada |
| Marlena McCabe | Department of Fisheries and Oceans Canada |
| Quinn Anderson | Department of Fisheries and Oceans Canada |
| Chad Hughes | Elk River Alliance |
| Joshua Noseworthy | Global Conservation Solutions |
| Camille Des Rosiers-Ste.Marie | Jon Bisset and Associates |
| Jon Bisset | Jon Bisset and Associates |
| John Bransfield | LOTIC Environmental |
| Mike Robinson | LOTIC Environmental |
| Herb Tepper | Ministry of Forests, Lands, Natural Resource Operations & Rural Development |
| Bill Arling | North Coal |
| Patty Vadnais | North Coal |
| Dave Baines | NWP Coal Canada Ltd. |
| Mindy Sheer | Sheer Ecology |
| John Huryn | Sparwood & District Fish and Wildlife Association |
| Lindsay Watson | Teck Resources |
| Warn Franklin | Teck Resources |
| Jason Gravelle | Tobacco Plains Indian Band |
| Myra Juckers | Tobacco Plains Indian Band |
| Randal McNair | Wildsight BC |
| Wyatt Petryshen | Wildsight BC |

**?(caption)**

## Key Actors

# Supplementary Information

## Situation Analysis

The following situation model was developed by the 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) and potential strategies/actions to improve connectivity (yellow hexagons) for Westslope Cutthroat Trout in the Elk River watershed. |

## Strategies & Actions

Effectiveness evaluation of identified conservation strategies and associated actions to improve connectivity for Westslope Cutthroat Trout in the Elk River watershed. The planning team identified two broad strategies to implement through this WCRP, 1) barrier remediation and 2) barrier prevention. Individual actions were qualitatively evaluated based on the anticipated effect each action will have on realizing on-the-ground gains in connectivity. Effectiveness ratings are based on a combination of “Feasibility” and “Impact”, Feasibility is defined as the degree to which the project team can implement the action within realistic constraints (financial, time, ethical, etc.) and Impact is the degree to which the action is likely to contribute to achieving one or more of the goals established in this plan.

## Strategy 1: Barrier Remediation

Table 6: Strategy 1

| ID | Actions | Details | Feasibility | Impact | Effectiveness |
| --- | --- | --- | --- | --- | --- |
| 1.1 | Remediate resource road barriers | This action represents some projects that would be led by the planning team with conservation funds (e.g., orphaned barriers or those owned by individuals), while other remediation projects would be the responsibility of the barrier owner. Industry will have to be engaged to successfully implement this intervention. | High | Very high | Effective |
| 1.2 | Remediate dams | Identify owners of dams that appear on the intermediate barrier lists (see Appendix C) and engage with them to explore technical and financial options. | Medium | Very high | Need more information |
| 1.3 | Remediate major infrastructure crossings | In most cases, the planning team will engage with barrier owners, but the owners of the barrier would be responsible for the financial cost of remediation. This includes building relationships with CP rail to open a two-way discussion on the scale, priority, and impact to their crossings on the watershed. Include the financial and ecological cost/benefits of remediation options in communication with infrastructure owners. | Medium | Very high | Need more information |
| 1.4 | Barrier mititgation | Examples may include installing fish ladders on barriers that cannot be remediated; however, temporary mitigation does not replace the need for barrier remediation and removal. There are specific cases where temporary fixes are appropriate, but we will focus on long-term solutions wherever possible. | Medium | High | Need more information |
| 1.5 | Work with crossing owners to identify and remediate barriers |  | High | High | Effective |
| 1.6 | Advocate for increased compliance and enforcement for specific, priority barriers | Request provincial and/or federal agencies to require that targeted, high-priority barriers be remediated. This should be a last resort after working to engage barrier owners and ground-truthing the situation. It will be important to identify obstacles to applying compliance and enforcement measures in order to provide the appropriate information on these opportunities. | Very high | High | Effective |
| 1.7 | Work with FLNRORD to encourage road decommissioning that returns sites to a more natural condition | Encourage sharing and implementation of best practices for fish-passage-"friendly" road decommissioning. | Very high | Very high | Very effective |
| 1.8 | Integrate with other regional initiatives | Engage and pursue coordination and collaboration with existing initiatives, (e.g., Elk Valley Cumulative Effects Management Framework, the Upper Fording River Recovery Group, the Elk Valley Fish and Fish Habitat Committee, and terrestrial connectivity working groups). | Very high | Very high | Very effective |
| 1.9 | Raise funds to remediate barriers (ownership dependent) | Where appropriate, collaborate within the planning team to raise conservation funds for remediation projects. See “Funding Sources” for more information. | High | Very high | Effective |
| 1.1 | Knowledge Gap: Assess barriers by applying the provincial fish passage framework | The first three steps are, (1) barrier assessments, (2) habitat confirmations, and (3) remediation designs. Barrier assessment data should be captured in the PSCIS database, which is available to all partners. | Very high | Very high | Very effective |
| 1.11 | Knowledge Gap: Identify key barriers for hybridization prevention below Elko Dam | Barrier remediation below the Elko dam presents the potential increased risk of hybridization of genetically pure Westslope Cutthroat Trout populations due to reconnection to the Koocanusa Reservoir. As such, prior to any decision, a series of site assessments will need to be performed to assess the risk of hybridization. This action does not directly contribute to the goals, but implementation is necessary for the success of other actions. This strategy should be revisited with First Nations and government agents to determine whether it should be kept as a knowledge gap or if a different approach (i.e., to look at it from a watershed functionality perspective with less concern about hybridization risks) should be adopted. |  |  | Need more information |
| 1.12 | Knowledge Gap: Identify and map owners of priority barriers |  | High | High | Effective |
| 1.13 | Knowledge Gap: Prioritize barriers for the Upper Fording and Grave-Harmon populations | Due to the importance of these genetically pure populations within the watershed, ensure that barriers within these systems are evaluated if they do not rank highly in initial barrier prioritization efforts. | Very high | Very high | Very effective |
| 1.14 | Knowledge Gap: Continue updating the barrier prioritization model | The model process will be finalized, and prioritizations will be updated as new information becomes available. | Very high | Very high | Very effective |
| 1.15 | Knowledge Gap: Desktop mapping of lateral habitat and barriers; define lateral connectivity goals | This action does not directly contribute to the current goals, but setting lateral goals is a priority. Lateral barriers are considered a low threat in the Elk valley, however work on a provincial scale is underway to determine the impact of rail lines on lateral habitats. |  |  | Need more information |
| 1.16 | Knowledge gap: Ground truth lateral habitat and barriers | This action does not directly contribute to the current goals, but is an important step following action 1.15. |  |  | Need more information |
| 1.17 | Knowledge gap: Monitor temperature and flows; assess effectiveness of barrier remediation projects | Effectiveness monitoring study design (Lotic) for remediation sites. $35K monitoring equipment for ERA (CNFASAR). |  |  | Need more information |

## Strategy 2: Barrier Prevention

Table 7: Strategy 2

| ID | Actions | Details | Feasibility | Impact | Effectiveness |
| --- | --- | --- | --- | --- | --- |
| 2.1 | Engage with land managers to share and implement best practices on stream crossings and fish passage | This should include encouraging better consultation before crossings are installed in the first place. | High | High | Effective |
| 2.2 | Support and engage with First Nations guardians programs where appropriate | This could include approaching KNC about their existing guardian program. | Very high | High | Effective |
| 2.3 | Engage with ATV clubs/recreation groups to share and implement best practices on stream crossings and fish passage | Trail-stream crossings have a low extent and severity in the watershed, and it is unlikely that ATV groups are creating barriers to fish passage. | High | Low | Not Effective |

## Theories of Change & Objectives

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

|  |
| --- |
| Figure 4: Theory of change developed by the planning team for the actions identified under Strategy 1: Barrier Remediation in the Elk River watershed. |

|  |
| --- |
| Figure 5: Theory of change developed by the planning team for the actions identified under Strategy 2: Barrier Prevention in the Elk 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 Elk River watershed. Table 8 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 plan for entries into this 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 parentheses), 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 8: Operational plan to support the implementation of strategies and actions to improve connectivity for target species in the Horsefly River watershed.

| Strategy / Actions | Lead(s) | Participants | Total Budget |
| --- | --- | --- | --- |
| Strategy 1: Crossing Remediation |  |  | $16,137,390.00 |
| 1.1 - Remediate resource road barriers | CWF |  | $8,500,000.00 |
| 1.2 - Remediate dams | CWF |  | $435,000,000.00 |
| 1.3 - Remediate major infrastructure crossings |  | CWF | $6,700,000.00 |
| 1.4 - Barrier mititgation | CWF, SERN | CWF | \*Built-in to 1.1 and 1.2 |
| 1.5 - Work with crossing owners to identify and remediate barriers | Elk River Alliance (ERA) | (Windsight), CWF | $20,000 |
| 1.6 - Advocate for increased compliance and enforcement for specific, priority barriers | ERA | (Windsight), CWF | $20,000.00 |
| 1.7 - Work with FLNRORD to encourage road decommissioning that returns sites to a more natural condition | ERA | (Windsight) | $5,000.00 |
| 1.8 - Integrate with other regional initiatives | CWF | ERA | $25,000.00 |
| 1.9 - Raise funds to remediate barriers (ownership dependent) | CWF |  | $200,000.00 |
| 1.10 - Knowledge Gap: Assess barriers by applying the provincial fish passage framework | CWF |  | $84,890.00 |
| 1.11 - Knowledge Gap: Identify key barriers for hybridization prevention below Elko Dam |  | CWF | $11,000.00 |
| 1.12 - Knowledge Gap: Identify and map owners of priority barriers | ERA | CWF | $1,500.00 |
| 1.13 - Knowledge Gap: Prioritize barriers for the Upper Fording and Grave-Harmon populations | CWF |  | Completed |
| 1.14 - Knowledge Gap: Continue updating the barrier prioritization model | CWF |  | $50,000 |
| 1.15 - Knowledge Gap: Desktop mapping of lateral habitat and barriers; define lateral connectivity goals | ERA | CWF | $20,000.00 |
| 1.16 - Knowledge gap: Ground truth lateral habitat and barriers |  | CWF, ERA | $65,000 |
| 1.17 - Knowledge gap: Monitor temperature and flows; assess effectiveness of barrier remediation projects | ERA | CWF | $50,000 |
| Strategy 2: Barrier Prevention |  |  | $250,000.00 |
| 2.1 - Engage with land managers to share and implement best practices on stream crossings and fish passage | ERA | CWF | $100,000.00 |
| 2.2 - Support and engage with First Nations guardians programs where appropriate |  | CWF, KNC? | $140,000.00 |
| 2.3 - Engage with ATV clubs/recreation groups to share and implement best practices on stream crossings and fish passage |  |  |  |
| Total: |  |  | $17,024,140.00 |
| Fundraising total: |  |  | $9,024,140 |
| Proponent/government contribution total: |  |  | $8,000,000 |

## Funding Sources

| Funding Source | Scope of Work | Amount |
| --- | --- | --- |
| Fish and Wildlife Compensation Program | Barrier assessments and habitat confirmations (2021-2022) | $63,000 |
| Environmental Damages Fund | Engineering designs and remediation implementation (2021-2022, 2022-2023, 2023-2024) | $500,000 |
| Canada Nature Fund for Aquatic Species at Risk | Conservation planning, barrier assessments, habitat confirmations, engineering designs, and barrier remediation (2019-2020, 2020-2021, 2021-2022, 2022-2023) | ~$300,000 |
|  |  |  |

**?(caption)**

| Funding Source | Spending Restrictions and Other Consideration |
| --- | --- |
| Land Based Investment Strategy | Assessment and remediation of fish passage using provincial strategic approach. Primarily for remediation of Ministry-owned/orphaned barriers on forest service roads. |
| Environmental Enhancement Fund | Fish and wildlife passage improvements and restoration at stream and animal crossings at MOTI roads including culvert retrofits and replacement to restore Pacific salmon and trout access, and wildlife tunnels. Primarily for crossings linked to highway infrastructure. |
| Habitat Conservation Trust Foundation Enhancement and Restoration Grants | Projects that focus on freshwater wild fish, native wildlife species and their habitats, have the potential to achieve a significant conservation outcome, while maintaining or enhancing opportunities for fishing, hunting, trapping, wildlife viewing and associated outdoor recreational activities. Primary focus is on provincially managed fisheries such as Steelhead and Westslope Cutthroat Trout. Requires 50% funding match. |
| Environmental Damages Fund | Direct funds received from fines, court orders and voluntary payments to priority projects that will benefit Canada’s natural environment, under 4 categories of improvement (in order of preference): (1) restoration, (2) environmental quality improvement, (3) research and development, and (4) education and awareness. |
| Fish and Wildlife Compensation Program | Funding to conserve and enhance fish and wildlife in watersheds impacted by BC Hydro dams. Funding is for priority actions identified in the Columbia Region Action Plan. Funding available to First Nations, consultants, NGOs, individuals, agencies, and academic institutions. |
| 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 3 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; (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. |
| 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 4 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. |
| Colombia Basin Trust Envrionment Grants | Small (<$5K) and large grants (>$5K) for First Nation communities, municipalities and regional districts. Businesses may be considered depending on the project and its broad community impact. Enhance or conserve ecosystems and/or species of conservation concern. Funding for water projects, environmental education projects, and ecosystems projects: 1) reduce the threat of significant invasive species to terrestrial and aquatic ecosystems; and 2) ecosystem related research projects that contribute to ecosystem conservation and/or enhancement. |
| 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 4 key areas: (1) land, water, and ocean conservation, (2) scientific research for nature and the environment, (3) public engagement around the importance of a healthy environment, (4) innovative conservation efforts in Canadian communities, at the local, provincial, and federal levels |
| TULA Foundation | Supports various environmental programs of interest to the Foundation on a case-by-case basis. |
| Vancouver Foundation | Granting agency for community, social and environmental initiatives for qualified Canadian organizations (charitable organizations, universities, government agencies). Granting programs change on an annual basis. |
| BC Conservation Foundation Small Project Fund | Funding available to Non-profits, fish and wildlife clubs (sportsmen’s associations), businesses, local/regional governments, public organizations and First Nations for projects with demonstrated positive impact for fish, wildlife and habitat, including outreach programs. Preference given to projects where BCCF is not the sole funder. |
| Real Estate Foundation of BC General Grants | Funding for First Nations, charities and societies, non-governmental organizations, universities and colleges, trade associations, local and regional governments, and social enterprises registered as C3s for sustainable land use and real estate practices in BC. Funds up to 50% of cash portion of a project. |

**?(caption)**

# Data Download and Methods

## Modelled Anadromous Salmon Habitat Maps

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

|  |
| --- |
| Figure 6: Elk 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). |

## Connectivity Status Assessment Methods

The connectivity status assessment for Westslope Cutthroat Trout in the Elk 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”](https://github.com/smnorris/bcfishpass). The model spatially locates known and modelled barriers to fish passage, identifies potential spawning and rearing habitat for Westslope Cutthroat Trout, and estimates the amount of habitat that is currently accessible as part of the Longest Fragment for each WCRP unit. The Longest Fragment approach is adapted from Díaz and Habit (2021) and is calculated as the ratio between the length of largest connected set of habitat patches and the total length of all habitat patches in each WCRP unit. In the Elk River watershed, the longest fragment represents the mainstem Elk River and all currently connected tributaries, both upstream and downstream of the Elko Dam. As such, meeting the connectivity goals set in this plan requires prioritizing barriers for remediation that will reconnect tributaries to the existing longest fragments see [barrier prioritzation](#barrier-prioritization).

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 target species. For the purposes of this plan, rearing habitat is used as an umbrella term to capture the requirements for Westslope Cutthroat Trout rearing, maintenance, and overwintering habitat. 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 Westslope Cutthroat Trout based on the geomorphic characteristics of the segment. For more details on the connectivity and habitat model structure and parameters, please see Mazany-Wright, Norris, et al. (2021a). The variables and thresholds used to model potential spawning and rearing habitat are summarized below. The quantity of modelled habitat was aggregated for each habitat type to inform the two KEAs — Accessible Habitat Upstream of Elko Dam and Accessible Habitat Downstream of Elko Dam — and represents a linear measure of potential habitat. To recognize the rearing value provided by features represented by polygons (e.g., lakes for overwintering) a multiplier of 1.5x the length of the stream segments flowing through the polygons was applied.

| Spawning Habitat Channel Gradient (%) | Spawning Habitat Mean annual discharge (m3/s) | Rearing Habitat Channel gradient (%) | Rearing Habitat Mean Annual discharge (m3/s) | Rearing Habitat Minimum Lake area (ha) | Rearing Habitat Multiplier (1.5x) |
| --- | --- | --- | --- | --- | --- |
| 0-3 [1] [2] | 0.46-322.5 [3][4][5][6][7] | 0-5 [5][8] | 0.28-100 [9] |  |  |
| 0-5 [6][10] | 0.164-59.15 [3][4][5][10][11] | 0-5 [8][12] | 0.03-40 [8][13] |  | Wetland |
| 0-2 [14][15] | 0.175-65 [3][4][5][6] |  |  | 200 [5] | Lake |

**?(caption)**

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] Hoopes (1972).