

# Sensitive Habitat Inventory Mapping and Aquatic Habitat Index

---

## Tranquille River

March 2023



**Secwepemc  
Fisheries  
Commission**



# Tranquille River Sensitive Habitat and Inventory Mapping and Aquatic Habitat Index

Prepared For:

Ministry of Environment and Climate Change Strategy

Prepared By:

Secwepemc Fisheries Commission

680 Athabasca St W

Kamloops, BC

V2H 1C4

March 2023

## Table of Contents

List of Figures .....	<b>Error! Bookmark not defined.</b>
List of Tables .....	4
List of Appendices .....	<b>Error! Bookmark not defined.</b>
Introduction .....	6
Methodology.....	6
Stream Centreline .....	7
Point Features .....	8
Thompson Shuswap Salmon Collaborative (TSSC) Data Explorer.....	8
Key Species.....	8
Coho Salmon .....	9
Rainbow Trout.....	10
Habitat Suitability and Productive Capacity .....	10
Impact rating.....	12
Summary of Results .....	13
Disturbance factors and land use distribution.....	13
Stream channel and hydraulic character .....	13
Fish habitat results.....	13
Erosion .....	15
Gold panning.....	16
Modification.....	20
Obstruction .....	20
Level of Impact (LOI) .....	22
AHI.....	22
Discussion.....	23
Recommended Actions .....	24
References .....	27
Appendices.....	28
Appendix A: Supplementary Figures and Tables. ....	28
Appendix B – Map sets.....	28

## List of Figures

Figure 1. SFC stream-walk survey data for Tranquille coho. ....	<b>Error! Bookmark not defined.</b>
Figure 2. Relative weighting of a given life history stage or attribute. ....	12
Figure 3. Distribution of total area of fish habitat features mapped (blue), and density of features (orange).....	14
Figure 4. Total length of eroding streambank by segment.....	15
Figure 5. Above: Piles of cobbles lay on the surface of the soil stratum, delaying revegetation and contributing to bank erosion. ....	15
Figure 6. Fast moving waters during freshet and impaired riparian zones result in deep, down-cut, eroding banks. Areas of exposed banks are commonly targeted by gold panners, which can be seen in the background of the picture. ....	16
Figure 7. Total area of disturbed streambed and banks disturbed by gold panning.....	18
Figure 8. A channel was excavated (left) to divert water to a dig site approximately 3 m long and 1.5 m wide (right). Note the heaping pile of fines in the river. ....	18
Figure 9. A technician inspects one of the largest dig sites, measuring over 15 m long and up to 2 m wide.....	19
Figure 10. Above: Historic placer tailings confine stream flow and increase water velocities. They prevent revegetation, healthy riparian zones, and flood plain connectivity. ....	19
Figure 11. Left: The water diversion structure obstructs fish passage to high quality habitat upstream. Right: Water diversion exacerbates low flow and high temperature conditions, as seen at the mouth...	21
Figure 12. Left: Waterfalls 5-7 km from the mouth may be passable to adult salmon.....	21
Figure 13. Left: Several leaks are obvious in an exposed section of pipe. Right: Leaking water has pooled in several locations and created artificial wetlands that are not connected to the river. ....	22
Figure 14. AHI Segments Scores. ....	23
Figure 16. Surveyed length within Lac du Bois Grasslands Protected Area. ....	29
Figure 17. Segment breaks along the stream centreline.....	30
Figure 18. Location of notable surveyed features. ....	31
Figure 19. Location of significant bank erosion in segment 2. ....	32

## List of Tables

Table 1. Overview of centreline features.....	7
Table 2. Lengths of the 5 surveyed stream segments.....	8
Table 3. Overview of centreline features.....	8
Table 4. Documented fishes and their life history stages (where applicable) in the Tranquille River.....	9
Table 5. Relative value (RV) of fish habitat features.....	11
Table 6. Relative value and weighted scores of mapped substrate composition.....	11
Table 7. Level of Impact rating criteria. Nil=3; Low =2; Mod=1; High=0.....	13
Table 8. Areal abundance of fish habitat features.....	14
Table 9. Summary of modification features in the Tranquille River.....	20
Table 10. Summary of obstructions in the Tranquille River.....	21
Table 11. Relative impact scores and overall stream condition of the Tranquille River.....	22

Table 12. Length of disturbed bank and primary land uses by segment breaks.....28  
Table 13. Water Licences Summary for Tranquille River Watershed.....28

## Introduction

For tens of thousands of years, millions of salmon journeyed from the Pacific Ocean to British Columbia's Interior, linking the ocean to the inland. During this time the indigenous people in Canada depended on the prosperity of salmon for their own survival. Today, salmon populations are steadily and rapidly declining. Changing environmental conditions, growing industries, urban development, and recreation have negatively impacted First Nations' ability to engage with their fishing culture and tradition. Communities have adapted in order to maintain their culture, identity, and socio-economic wellbeing. Focus has transitioned to conservation and population recovery through effective management of Food, Social and Ceremonial Fisheries, and fisheries related tourism. Limited natural harvest of salmon from local lakes and rivers support opportunities to develop and engage traditional values. The Secwepemc people have a close relationship to the Tranquille watershed. The river provided salmon, and later gold as a means of living. The middle/upper watershed was a popular mining area for Tk'emlups. Today, the Tranquille River is an important spawning ground for recovering Interior Fraser Coho (*Threatened*).

In 2022, the Secwepemc Fisheries Commission (SFC) prepared a report detailing the known salmonid habitat, existing fish population data, and watershed impacts in the Tranquille River. The Tranquille River has significant fish value, supporting populations of several anadromous and resident fish species along its 56 km length. The lower reaches of the river are heavily impacted by the effects of historic and recreational placer mining, industry, linear development, and agriculture. A water intake structure 4 km from the mouth and a series of falls 5-7 km from the mouth were previously identified as barriers to fish passage.

A workplan was proposed to address data gaps and to assess aquatic habitat in the lower reaches within Lac du Bois Park Boundaries. Sensitive Habitat Inventory Mapping (SHIM) is a methodology that maps and compiles data in British Columbian watercourses (Mason and Knight, 2001). A SHIM was conducted along an 8.5 km length, extending from the mouth upstream to the Tranquille Slot Canyons. The intent of the project was to provide baseline information on the channel condition and environmental values in order to inform management decisions. An Aquatic Habitat Index (AHI) was developed to identify areas of sensitive habitat based on their relative value to key fish species. A Level of Impact score was generated using the processed field data to evaluate stream and bank conditions. These rating systems can be used to monitor changes as the river continues to evolve.

## Methodology

Technicians recorded biophysical and anthropogenic attributes using a Trimble R2 unit and an iPad tablet. SHIM is a high-level planning tool designed for watercourses in residential, commercial, agricultural, industrial, and recreational land use areas. The full standards for data collection can be viewed at: [https://cmnmaps.ca//cmn/files/methods/shim\\_manual/shim\\_10jun02.pdf](https://cmnmaps.ca//cmn/files/methods/shim_manual/shim_10jun02.pdf)

The data collected can be used to:

- Identify sensitive habitats for fish and wildlife.
- Assist in determining setbacks and fish/wildlife sensitive zones.
- Monitor for changes in habitat resulting from disturbance.
- Highlight areas of channel instability and water quality.

- Provide baseline mapping data for future monitoring.
- Map and identify riparian vegetation available to wildlife and fisheries resources.
- Provide preliminary data for analyses which can be used to indicate potential trends in resources that may require further study.

### Stream Centreline

Stream centreline was mapped along the centre of bankful width. Centreline was divided into segments based on hydraulic class (gradient), riparian class, substrate, land use and disturbance factors (Table 1). Segments were designated when these conditions remained sufficiently uniform for at least 100 m.

**Table 1. Overview of centreline features.**

Main Attribute	Detailed feature collected
Hydraulic character	Cascade; Falls; Glide; Riffle; Riffle-pool; Slough; Wetland; Other
Gradient	Degrees
Primary character (state of stream)	Modified; Natural; Wildfire; Other
Secondary character	Beaver pond; Ephemeral; Flumed; Intermittent; Side-channel; Wetland; Braided; Other
Riparian corridor	Unvegetated; Shrubs/grasses; Coniferous; Deciduous; Mixed Forest
Seral stage	Early seral; Mid-seral; Late seral; Local natural potential
Canopy closure	0-20; 20-40; 40-70; 70-90; >90
Substrate	Organics; Fines; Gravel; Cobble; Boulder; Bedrock
Bankful width	(m)
Wetted width	(m)
Disturbance factors	Agriculture; Fire; Forestry; Linear roads; Urban development, Recreation; Natural
Floodplain connectivity	Yes/No
Spawning gravels	Yes/No/Potential; Anadromous; Resident; Anadromous/Resident
% Instream cover	Boulder; Deep pools; LWD; SWD; Overstream vegetation;
Line length	(m)

Five segments were designated over the 8 km of stream surveyed. Segment 1 begins at the mouth of Tranquille River and extends approximately 1.3 km to the Red Lake Road bridge. Reach 2 is between Red Lake Road bridge and the water intake structure, about 2.7 km. Reach 3 extends another 2.4 km through an initial series of canyons, deep pools, and falls. Reach 4 is less confined and extends 1.5 km upstream to a second series of enclosed canyon walls. Reach 5 is accessed via the Tranquille Slot Canyons Parking area on Tranquille Criss Creek Road. It is a shorter series of pools and falls that runs 440 m (Table 2). The hydraulic character of the Tranquille River was primarily riffle-pool, with a short section of cascade (segment 5). The primary disturbance factors and land uses were recreational (61%), natural (23%) and agricultural (16%).

**Table 2. Lengths of the 5 surveyed stream segments.**

Segment	Length (m)	% of total surveyed stream length (8440.6 m)
1	1327.22	15.7%
2	2737.84	32.4%
3	2398.4	28.4%
4	1536.29	18.2%
5	440.61	5.2%

## Point Features

Point features provide a measure of fish habitat quality and relative disturbance. Table 3 provides a list of features surveyed for and mapped.

**Table 3. Overview of centreline features.**

Main Attribute	Detailed features collected
Bank disturbance	Type; Length; Image
Culvert	Type; Barrier (yes/no); Length/diameter; Slope; Image
Erosion	Source erosion; Length; Image
Enhancement	Type; Length/width; Image
Fish Habitat	Type; Length/width; Image
Gold Panning	Length/width; Image
Obstruction	Type; Length; Image
Modification	Type; Length; Image

## Thompson Shuswap Salmon Collaborative (TSSC) Data Explorer

Field data was synced to the Trimble Connect app at the end of each day and backed up on ArcGIS Online. Each mapped attribute had an associated picture, together making up a detailed photo log. This database will be incorporated into the public TSSC Mapping Tool and can be accessed online. Corrections and adjustments can be made to the database as necessary.

## Key Species

Populations of Interior Fraser Coho (IFC) are supported in the lower reaches of Tranquille River, within the Lac du Bois Park (Figure 1). It is also an important river for resident rainbow trout, Kamloops Lake rainbow trout and headwater lake residents. Chinook and kokanee salmon have been documented within the system at multiple life stages (Table 4). Chinook, pink and kokanee salmon have high fisheries and cultural value; however, there is a lack of escapement data, and it is less clear the extent to which these species use the river. As a result, chinook, pink and

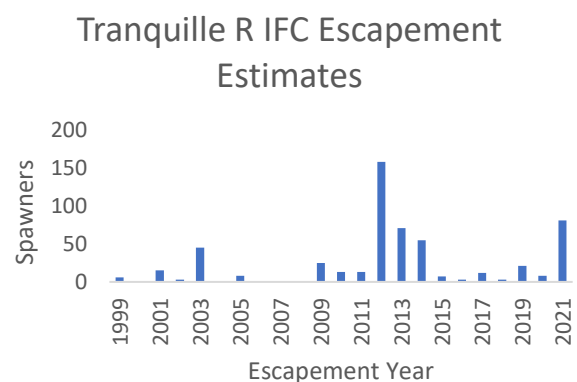


Figure 1. SFC stream-walk survey data for Tranquille coho.

kokanee salmon have been omitted from the development of the AHI and habitat requirement criteria that follow.

<b>Table 4. Documented fishes and their life history stages (where applicable) in the Tranquille River.</b>			
<b>Species</b>	<b>Spawning</b>	<b>Migrating/Rearing</b>	<b>Documented Distribution</b>
Coho	Yes	Y	0-5 km (Fiss, 1996; McLeod, 2021; Stalberg et al., 1997; SFC escapement data, 1999-present)
Chinook	Unknown	Yes	Delta area up to 5km upstream (FISS, 1996; McLeod, 2021; Stalberg et al., 1997)
Kokanee	Yes	Yes	Kamloops lake kokanee from 0-5 km; Tranquille population 7 km to Tranquille Lake (+56 km) (Arc Environmental, 1998; Burns and Philip, 1978b; M.J. Milne & Associates Ltd., 2009)
Rainbow Trout	Yes	Yes	Throughout (Arc Environmental, 1998; Burns 1978a; FISS, 1996; McLeod, 2021; M.J. Milne & Associates Ltd., 2009; MoELP Release Records Database)
Prickly Sculpin	N/A	N/A	0-5 (McLeod, 2021)
Mottled Sculpin	N/A	N/A	Throughout (Arc Environmental, 1998; M.J. Milne & Associates Ltd., 2009; Trumbley Environmental Consulting Ltd. 1996)
Long-nosed Dace	N/A	N/A	0-5 km (McLeod, 2021)
Carp	N/A	N/A	0-5 km McLeod, 2021)
Burbot	N/A	N/A	0-5 km (McLeod, 2021)
Rocky Mountain Whitefish	N/A	N/A	0-5 km (McLeod, 2021)

### Coho Salmon

Interior Fraser coho (IFC) are a genetically distinct population of coho salmon (*Oncorhynchus kisutch*). Populations from the middle/upper Columbia colonized the Fraser River watershed via post-glacial lake connections. The Columbia populations are now extinct, and IFC are the remaining representatives of this unique hereditary group (Northcote and Larkin 1989). Coho salmon have a high degree of spawning site fidelity, which also contributes to the large number of genetically distinct populations within the species. There are five sub-groups within IFC: the North Thompson, South Thompson, Lower Thompson, Fraser Canyon area, and Middle/Upper Fraser (Holtby and Ciruna, 2007).

Coho were designated *Endangered* by COSEWIC in 2002. Their decline has been attributed to poor conditions in the marine environment, overexploitation, and freshwater habitat loss. A slight reverse in the trend has led to them being redesignated as *Threatened* (COSEWIC, 2016).

Coho spawn in the late fall, in small streams and the side channels of larger rivers. Discharge decreases in the fall in winter, putting redds at risk of dewatering and freezing if spawning occurs too early. Ideal streams are lake-headed, which provides stability of flow and temperature (Decker and Irvine, 2013). Spawning site preference is given to riffle-pool transitions, with groundwater upwelling and good circulation. Eggs are usually deposited in areas less than 30 cm deep and in gravels and cobbles less than 15 cm in diameter (Sandercock, 1991). Eggs are particularly vulnerable to siltation, predation, freezing, and disease. The eggs hatch in the spring and the juveniles remain in freshwater for up to 18 months before journeying to the ocean. Adults return to spawn at 3 years of age, so their success depends equally on quality freshwater and marine habitats.

Freshwater rearing habitat is mainly in small tributaries and off-channels of main stem rivers, with gradients of less than 3% preferred. Pools, backwaters and beaver ponds have the highest density of juveniles (Decker and Irvine, 2013).

### Rainbow Trout

Rainbow trout (*O. mykiss*) are a member of the Salmonidae family and exhibit two distinct life histories: migratory and resident. Genetics and environmental conditions contribute to whether an individual fish will be migratory or resident. Stream residents remain in small headwaters their entire life. Freshwater migrants move to mainstems or to lakes as adults, returning to their natal stream to spawn. Individuals that migrate to lakes are typically much larger and switch from an insectivorous to piscivorous diet. The age at maturity is usually between 3 to 5 years of age. In some populations environmental cues trigger juveniles to migrate to the ocean, adopting an anadromous lifestyle. These fish return to natal streams to spawn and are referred to as Steelhead (COSEWIC, 2014).

Rainbow trout prefer cold, clear water with a fast current. They spawn over fine gravel substrates, both above and below pools at riffle transitions. Ideal substrate is 0.4-1.5 cm in diameter with low sediment and silt levels and high dissolved oxygen levels. Juveniles value shallow streams with abundant cover in the form of vegetated banks, overstream vegetation, woody debris, and boulder gardens. Pools and areas of sub-gravel flow are important overwintering habitat for juveniles and adults. Spawning occurs in the spring at stream temperatures of 10 to 15 degrees (Roberge et al, 2002).

### Habitat Suitability and Productive Capacity

The habitat requirements of salmonids vary by species and life history stage. Depending on the time of year in the Tranquille River, migrant adults, eggs, rearing juveniles and resident adults will be present. Measures of habitat quality (Johnson and Slaney, 1996) generally depend on:

- Adult holding pools.
- Spawning gravel.
- Area and frequency of rearing ponds.
- Cover in pools and riffles (complexity).
- LWD (frequency and distribution).
- Extent of off-channel habitat.

An Aquatic Habitat Index (AHI) is a method of estimating the productive capacity and suitability of fish habitat. This methodology was developed for River Inventory Mapping (RIM) through cooperation between Fisheries and Oceans Canada and Ecoscape Environmental Consultants Ltd. It uses the relative value of fish habitat features to rank segments from *Very High* to *Very Low* sensitivity. The relative value of each feature type depends on the key species and life history stages present. The AHI was adapted and calibrated through professional opinion and reference to other habitat indices developed for similar watercourses. Habitat features have been weighted to reflect their relative habitat value (contribution to overall habitat sensitivity). Each habitat feature was assigned a score (where 1 = *low value*, 2 = *moderate value*, and 3 = *high value*) for each key species, for each life history stage. The relative value was calculated by summing species scores for a given feature and dividing by the maximum possible score. The weighted score is the product of the relative value of the feature and the weighting of a given life history stage (Table 5). This scoring system for segments was also applied to the substrate composition of a segment (Table 6).

**Table 5. Relative value (RV) of fish habitat features.**

Habitat Feature	Rearing		General Living		Spawning	
	RV	Wt. Score	RV	Wt. Score	RV	Wt. Score
Instream Vegetation	0.67	16.67	0.33	1.67	0.00	0.00
Boulder	0.50	12.50	0.33	1.67	0.33	8.33
Overstream Vegetation	0.50	12.50	0.17	0.83	0.00	0.00
Small Woody Debris	0.67	16.67	0.33	1.67	0.00	0.00
Deep Pool	1.00	25.00	0.83	4.17	0.67	16.67
Undercut Bank	0.67	16.67	0.50	2.50	0.33	8.33
Large Woody Debris	1.00	25.00	0.83	4.17	0.33	8.33
Groundwater Influence	1.00	25.00	1.00	5.00	1.00	25.00
Off-channel	1.00	25.00	1.00	5.00	0.50	12.50
Tributary	0.67	16.67	0.83	4.17	0.50	12.50
Substrate						

The relative spatial coverage of each feature type in a segment was multiplied by the relative habitat value and the weighted constant value that was calibrated for the Tranquille River.

**Table 6. Relative value and weighted scores of mapped substrate composition.**

Substrate Class	Relative Value	Weighted Score
Organic	0.3	6.0
Fines (silt/sand)	0.2	4.0
Gravel	1.0	20.0
Cobble	0.6	12.0
Boulder	0.5	10.0
Bedrock	0.1	2.0

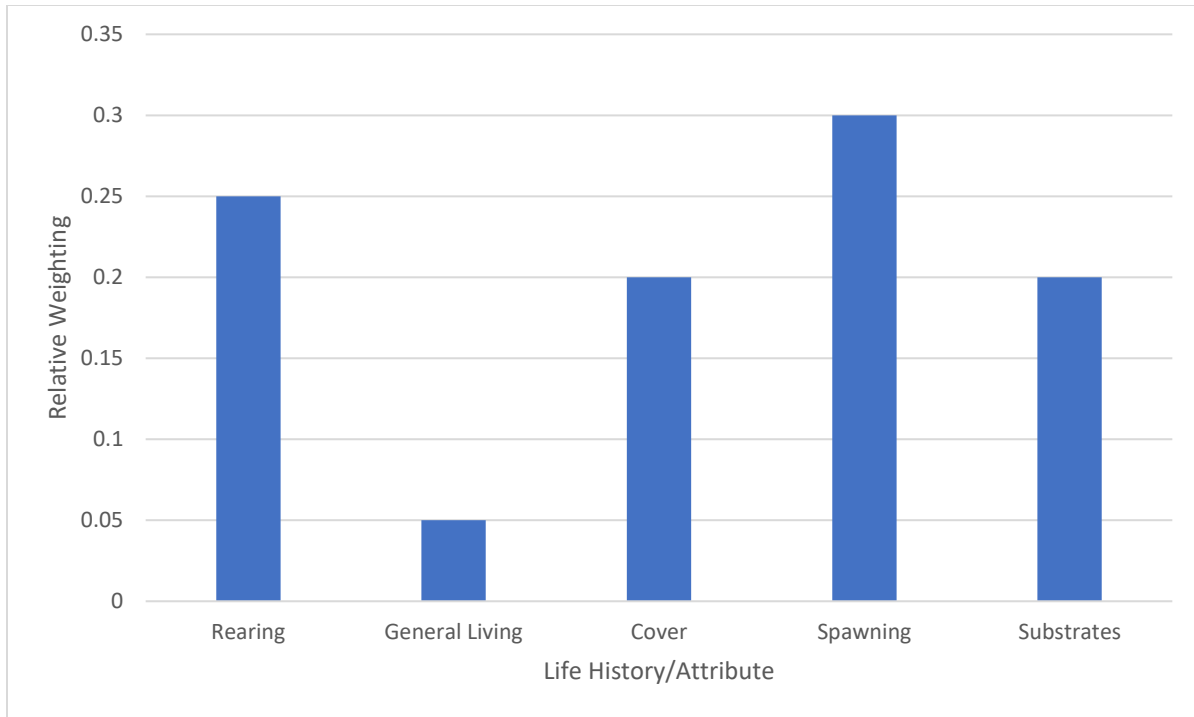


Figure 2. Relative weighting of a given life history stage or attribute.

The centreline AHI adapted for the Tranquille River considered the life history stages of spawning, rearing and general living. A score for each segment was calculated using the following equation:

$$AHI_{\text{segment}} = \sum [A_{sp}/A_t \times W_{sp}] + \sum [A_{gen}/A_t \times W_{gen}] + \sum [A_{rear}/A_t \times W_{rear}] + \sum [P_{sub} \times W_{sub}]$$

Where  $A$  represents area,  $sp$  represents a spawning habitat feature,  $t$  represents total stream area,  $W$  is the weighting of the habitat feature,  $P$  is the percent and  $sub$  is the substrate.

## Impact rating

Baseline studies often require a measure of impact in a watercourse. A Level of Impact (LOI) describes existing environmental conditions. It is a qualitative assessment of the overall health of the bank condition and considers land use, riparian impacts, and disturbance/modification feature types and density. Generally, a *High* LOI score refers to a segment with >40% alteration along banks; *Moderate* is between 10 and 40%; *Low* is mainly natural with <10% alteration. The LOI provides a basis for future impact prediction and monitoring. In this report it is used in conjunction with measures of habitat suitability to create a priority list of habitat restoration sites and recommendations.

To compare the relative condition of each segment, each bank is assigned a condition of either *High*, *Moderate*, *Low*, or *Nil*. Banks with a rating of *Nil* are attributed a score of 3, while banks designated *High* receive a score of zero. Thus, a segment with a rating of *Nil-Nil* scores a total of 6, while a *High-High* segment scores 0. This scoring system is further outlined in Table 7.

**Table 7. Level of Impact rating criteria. Nil=3; Low =2; Mod=1; High=0**

Stream Bank Impact Rating	Combined Bank Condition Score
Nil-Nil	6
Nil-Low	5
Nil-Mod	4
Nil-High	3
Low-Low	4
Low-Mod	3
Low-High	2
Mod-Mod	2
Mod-High	1
High-High	0

## Summary of Results

### Disturbance factors and land use distribution

As outlined in the stream centreline section, land use and disturbance factors are one of the main qualifiers of segment designation. The majority of the surveyed length was recreational (61%), with natural (23%) and agriculture (16%) being the two other land uses present.

### Stream channel and hydraulic character

The primary character of the Tranquille River is riffle-pool with a short section of cascade in Segment 5. Much of the stream is naturally confined by steep hillsides and canyon walls. There are some wider sections in Segments 3 and 4, and much of segments 1 and 2 are in the fan near the mouth. In many of these wider sections the stream remains confined by extensive piles of cobbles. The result is a straighter channel with less instream cover, less riparian vegetation, increased water velocity, increased sediment transport and larger, more compact substrate. These piles of cobbles are the result of historic placer mining, and it is difficult to estimate what the natural stream may have looked like prior to disturbance. These issues are further outlined in the section titled *Gold Panning*.

### Fish habitat results

The Tranquille River has suitable habitat for coho and rainbow trout, with deep pools and large woody debris (LWD) being the most common fish habitat features (Table 8). Juvenile salmonids require deep pools and areas of groundwater upwelling for overwintering habitat and late summer, low water refugia. Deep pools are important holding areas for migrants and provide cover to spawning and resident fish. The tail outs of pools are common spawning areas, since they offer cover to adults and are often sources of groundwater upwelling. Over 80% of the total area of deep pools is located upstream of the water diversion structure. The total area of fish habitat features is greatest in segments 3 and 4 and the density of habitat features (complexity) is highest above the water diversion structure (Segments 3, 4 and 5) (Figure 3). No spawning fish were observed because low flows and braiding prevented coho from entering Tranquille at the mouth. Other important fish habitat features like off-channel habitat, instream and overstream vegetation were less abundant and could be the focus of future restoration efforts.

Table 8. Areal abundance of fish habitat features.			
Feature Type	Total Area (m <sup>2</sup> )	Cumulative Length	Relative linear abundance in surveyed area (8440.4 m)
Boulder	1675	325	3.9%
Deep Pool	5673	1217	14.4%
Groundwater influence	5	5	0.1%
Instream Vegetation	14	8	0.1%
LWD	2088.4	681	8.1%
Off-channel habitat	585.5	276	3.3%
Overstream Vegetation	243	82	1.0%
Spawning Fish/redds	0	0	0%
SWD	17.5	18.5	0.2%
Tributary	7	7	0.1%
Undercut Bank	198.95	316	3.8%

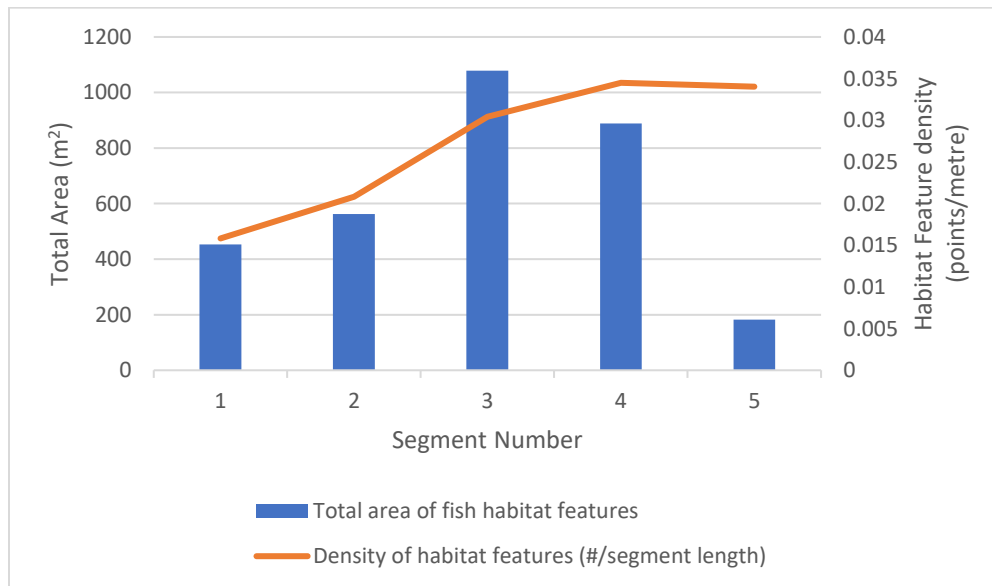


Figure 3. Distribution of total area of fish habitat features mapped (blue), and density of features (orange).

## Erosion

Much of the erosion in segments 3 and 4 is the result of the confined nature of the channel, and natural bed and sediment mobility. As such, they are not suitable targets for restoration. The most significant erosion in Tranquille River occurs in segment 2 (Figure 4), where there is a high level of disturbance from recreation, linear development and the legacy effects of placer mining. Over a century of large-scale and recreational placer mining in the Tranquille River has disrupted the alluvium and natural geology of the channel. Large cobbles which would normally appear in the stratum below gravel, soils and organics, instead lay on the surface (Figure 5). This increases surface water velocity, prevents natural revegetation and leads to the erosion of streambanks in many areas. These areas of high disturbance facilitate the establishment of invasive species like knapweed, tansy and burdock. Sections of exposed banks are attractive areas to recreational gold panners who further excavate and weaken the streambanks (Figure 6). This leads to continued bank erosion and disturbance of riparian vegetation.

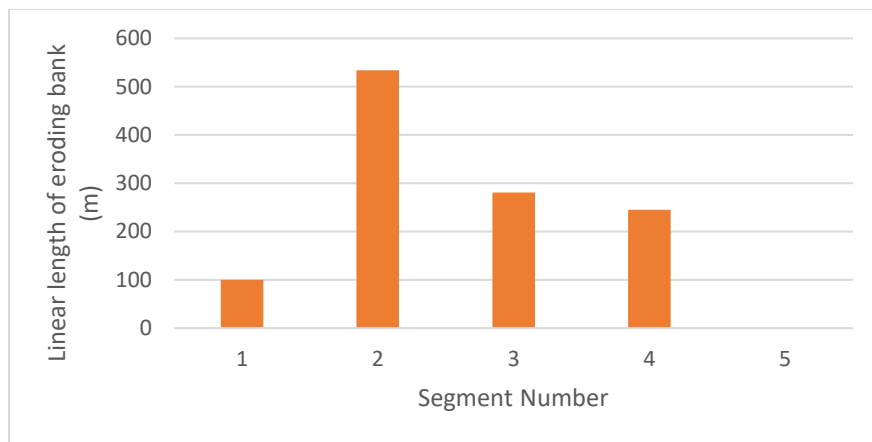


Figure 4. Total length of eroding streambank by segment.



Figure 5. Above: Piles of cobbles lay on the surface of the soil stratum, delaying revegetation and contributing to bank erosion.



*Figure 6. Fast moving waters during freshet and impaired riparian zones result in deep, down-cut, eroding banks. Areas of exposed banks are commonly targeted by gold panners, which can be seen in the background of the picture.*

### Gold panning

The Tranquille River has a long history of gold panning that dates back to the mid-1800s. In BC, the *Mineral Tenure Act* is the main document that authorizes mineral and placer titles and allows individuals to hand pan on Crown land for recreational purposes. Recreational gold panning is popular in the Tranquille watershed and is currently permitted within the Lac du Bois Protected Area.

Gold was discovered in the Tranquille River in 1857, attracting more than 30 000 miners within the next year alone. Mining activity faded over the next decade but increases in technology created a second boom in 1892 (Favrholdt, 2021). During this era, an estimated 18 000 to 250 000 kg of mercury were used in the Fraser and Caribou gold rushes to amalgamate and extract gold (Lamothe, 2021). Sediment cores corresponding to the gold rush era collected from the Fraser River delta and the Strait of Georgia have returned elevated mercury concentrations (Johannessen et al. 2005). In California, efforts by the USGS to investigate contamination of watersheds from abandoned gold mining sites found that fish from these reservoirs and streams have bioaccumulated sufficient mercury to pose a risk to human

health (USGS, 2005). Although mercury is no longer used in current mining activities, the effects of recreational and placer mining are five-fold:

- The bed and bank are cut, altering channel morphology and stream hydraulics.
- The sand and cobble are deposited elsewhere in the stream.
- Large quantities of fine sediments are released into the water column.
- Legacy mercury can be excavated in the sediment, broken into small particles and re-enter the ecosystem.
- Unique and diverse riparian vegetation is disturbed, further weakening bank stability.

In British Columbia, mining in watersheds with known salmon, trout and char habitat requires specific permitting and site-specific mining plans. Healthy aquatic ecosystems are critical to supporting sustainable salmonid populations and fisheries resources. Although there are no clear guidelines for gold panning within the Lac du Bois Protected Area Land and Resource Management Plan (LRMP), several federal and provincial policies attempt to address concerns relating to in-stream activities.

*The Fisheries Act* is the primary legislation protecting fisheries resources and habitat. The harmful alteration, disruption or destruction of fish habitat and the deposition of deleterious substances are prohibited under Sections 35 and 36. The introduction of sediment into fish habitat is prohibited, as well as any activity resulting the killing of fish other than by fishing.

The *Wild Salmon Policy* aims to restore and maintain healthy and diverse salmon populations and their habitat for the benefit and enjoyment of Canadians. Conservation is the first priority for resource management decisions and considerations of impacts to wildlife are intentionally broad. These include any human activity that might harm salmon habitat (WSP).

The *Water Sustainability Act* prohibits changes in and about a stream This includes any modification to the land, vegetation and natural environment of a stream. It also includes the flow of water in streams and any activity or construction within a stream channel that has or may have an impact on a stream or a stream channel.

Considering the conflict between the effects of recreational gold panning and these policies, the SHIM sought to identify sites of recent recreational gold panning within bankful width. These sites were mapped, and length and width were recorded. The total area of mined sites is represented in Figure 7 below. The highest frequency and the greatest total area of panning occurred in segment 2, followed by segment 3. This is likely due to their proximity to the parking lot area. The size of the gold panning excavations ranged from a bucket full to several square metres. The largest site was approximately 50 m<sup>2</sup> and consisted of a series of rock weirs and pits. Most excavations were an average of 1-4 m<sup>2</sup>. Historic placer spoils were noted where they were observed along the channel, however their total magnitude was not mapped since they often extended beyond 50 m from the streambanks. One notable area was located just upstream of the water diversion structure (Figure 10). It is at the tail out of a confined section of canyons where the valley widens slightly. Such areas were commonly targeted by prospectors because they are deposition zones where gold and other transported sediments would settle out in a predictable fashion. Placer mining effectively turns the streambed upside down, leading to larger substrates on top, channel confinement, reduced floodplain connectivity, and impaired riparian areas.

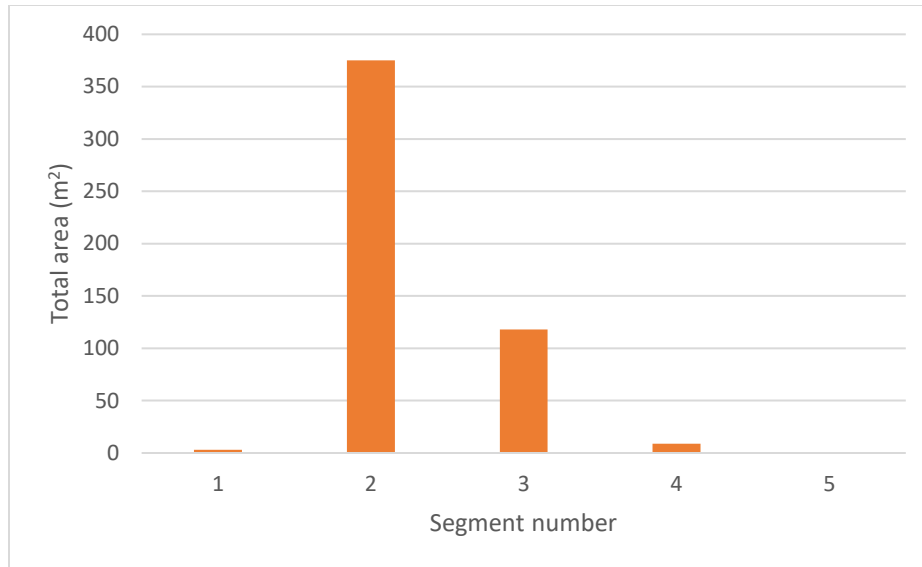


Figure 7. Total area of disturbed streambed and banks disturbed by gold panning.

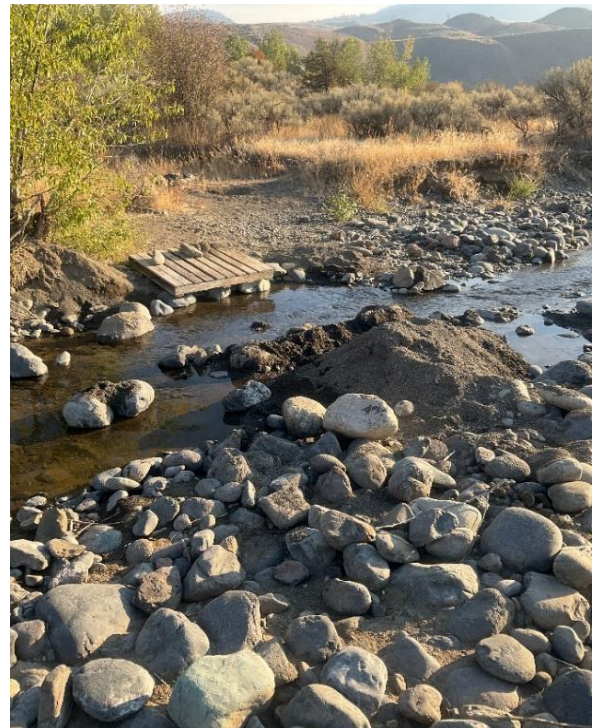


Figure 8. A channel was excavated (left) to divert water to a dig site approximately 3 m long and 1.5 m wide (right). Note the heaping pile of fines in the river.



*Figure 9. A technician inspects one of the largest dig sites, measuring over 15 m long and up to 2 m wide.*



*Figure 10. Above: Historic placer tailings confine stream flow and increase water velocities. They prevent revegetation, healthy riparian zones, and flood plain connectivity.*

## Modification

Habitat modifications were recorded as point features and are summarized in Table 9. The Tranquille River is not heavily modified. Linear development is the most notable impact, occurring mainly in the lower segments outside of Park boundaries.

**Table 9. Summary of modification features in the Tranquille River.**

Modification Type	Sum of Length (m)	Number of features mapped
Bridge	115	2
Culvert	5	1
Fences	15	1
Garbage/pollution	14	3
Retaining wall/bank stabilization	32	2
Water withdrawal	40	1

## Obstruction

Obstructions were mapped as point features and are summarized in Table 10. Not all mapped features may present a permanent barrier to fish passage. Obstructions are one of the main factors limiting fish habitat in the Tranquille River. A blown-out beaver dam was observed just upstream of the Red Lake Road Bridge and should be monitored for activity in the future. Beaver dams create valuable wetlands which provide overwintering and late summer habitat for juvenile and resident salmonids. They are often porous enough to allow juvenile outmigration, however they can become barriers to adult migration in some cases.

Previous reporting indicated that fish passage was obstructed at the 5-7 km mark by a series of waterfalls. The SHIM conducted by SFC revealed three small waterfalls approximately one metre high (Figure 11). These falls are all the result of boulders becoming lodged in the bedrock and steep canyon walls. It is possible they change slightly each year as new rocks become lodged or dislodged in the same location. Migrating adult coho salmon are known to leap several metres in the air to clear obstacles. There are long, shaded pools at the base of each waterfall that are several metres deep. These pools would provide protected, cool areas for holding. They would also enable adult salmon to swim to the bottom, effectively getting a “run-up” to leap over the falls. At the conditions SFC observed these falls, it is not likely they are a barrier to adult salmonid migration, nor to juvenile outmigration.

The water diversion structure (approx. 4 km from the mouth) obstructs fish access to several kilometres of high-quality spawning and rearing habitat upstream. In 2022, the structure was diverting large quantities of water out of the river during key coho spawning and migration timing. No holding or spawning fish were observed in the river during the SHIM. Braided stretches at the mouth of the river were barriers to fish passage until the water diversion was closed and flow levels increased downstream (Figure 12). Additionally, the infrastructure and piping that diverts the water has become dilapidated and leaks an unknown amount of this water into the ground, creating several artificial, disconnected wetlands at multiple downstream locations (Figure 13). Some wildlife may use these wetlands, but they have little to no fish value because they are not attached to the main channel. It is hard to quantify the

total impact of the water diversion. It obstructs access to high-quality habitat upstream, limits downstream flow during critical late summer periods and limits flow during fall migration and spawning.

**Table 10. Summary of obstructions in the Tranquille River.**

Obstruction Type	Sum of Length (m)	Number of features mapped
Beaver dam	2.5	1
Cascade	1.5	1
Dam	10	1
Falls	3	2
Log jam	50	1
Water Depth	232.8	5

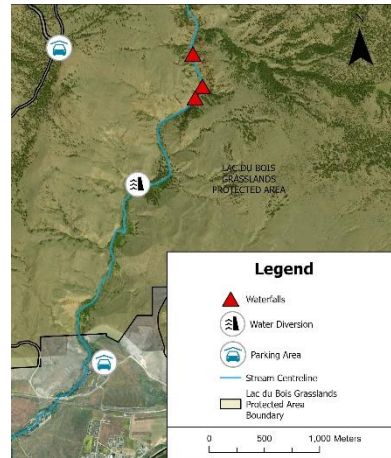


Figure 11. Left: Waterfalls 5-7 km from the mouth may be passable to adult salmon.

Right: Waterfall locations. An enlarged version of map is available in Appendix B.



Figure 12. Left: The water diversion structure obstructs fish passage to high quality habitat upstream. Right: Water diversion exacerbates low flow and high temperature conditions, as seen at the mouth.



Figure 13. Left: Several leaks are obvious in an exposed section of pipe. Right: Leaking water has pooled in several locations and created artificial wetlands that are not connected to the river.

### Level of Impact (LOI)

A LOI score was calculated for each segment based on its relative bank condition. Segment 1 was rated *high-high* because it has been impacted by agriculture and linear development along the full length of both banks. Segment 2 was rated *mod-high* due to linear development and recreational land use while segment 3 was rated *mod-mod* and segments 4 and 5 *nil-nil*. The overall stream condition score was 43% for the Tranquille River (Table 11, Appendix A).

**Table 11. Relative impact scores and overall stream condition of the Tranquille River.**

Bank Impact Rating	Length of Segment	Bank Condition Score	% of stream length	Weighted segment Score
High-High	1327.22	0	15.72%	0.00
Mod-High	2737.84	1	32.44%	0.32
Low-Mod	2398.4	3	28.42%	0.85
Nil-Nil	1976.9	6	23.42%	1.41
<b>Sum</b>	<b>8440.36</b>			<b>2.58/6</b>
<b>Overall Stream Condition</b>				<b>43.00%</b>

### AHI

The centreline AHI results are outlined in Figure 14. The AHI generated considered not only the amount of fish habitat features, but the relative value of each feature to key fish species in the Tranquille River. Segments 3 and 4 have the highest potential productive capacity, making the greatest contribution to the overall aquatic habitat quality of the surveyed area.

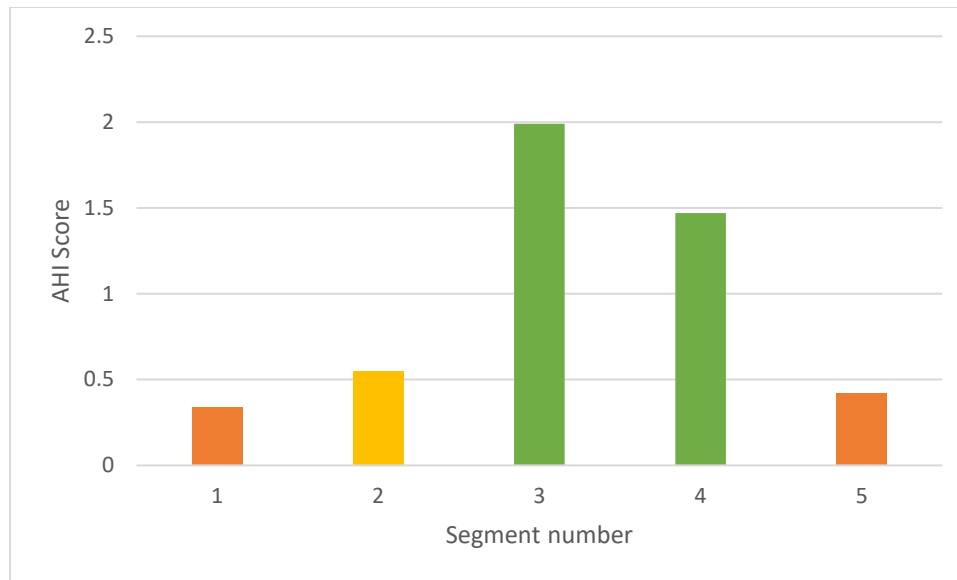


Figure 14. AHI Segments Scores.

## Discussion

The length of the Tranquille River within the Lac du Bois Protected Area contains high quality fish habitat but is severely limited by anthropogenic features and activity. At any given time of year, one or several life stages of sensitive fish species resides in the Tranquille River. Migrating and spawning adult IFC reside in the river during the fall and early winter, while rainbow trout spawn in the spring. Eggs and alevin are particularly susceptible to disturbance and siltation in the following months. Juveniles are impacted by siltation, habitat fragmentation, and lethal flow and temperature thresholds. Pink salmon, chinook and kokanee may also be negatively affected.

The main factors adversely affecting fish habitat and ecologically significant riparian zones include:

- Agriculture and linear development impacts.
- Bank erosion and instability.
- Historic effects of large-scale placer mining.
- Recreational gold panning.
- The water diversion structure and its degraded infrastructure.

These issues contribute to flow and temperature sensitivity in an already arid and drought sensitive ecosystem. They cause habitat fragmentation, stream confinement, impaired riparian/wetland function, increased siltation, bank destabilization/riparian disturbance, and they negatively impact local First Nations traditions and culture. The highest quality and quantity of spawning and rearing habitat is currently inaccessible as a result of the water diversion structure 4 km from the mouth. Bank erosion has led to wider, shallower streams and the loss of riparian vegetation. Agriculture, infrastructure, and recreational activities further limit the natural stream cooling mechanisms.

Gold panning within the park boundaries is extensive and has significant negative effects on instream and riparian areas. Although there are no clear guidelines for gold panning within the Lac du Bois LRMP, it is in clear conflict with several provincial and federal policies. Since various life stages of *Threatened* IFC reside in the river year-round, temporal restrictions for gold panning activities are not recommended. Areas with lower habitat complexity and increased levels of bank disturbance are not suitable for gold panning since this further contributes to riparian, bank and instream degradation. Different areas within the watercourse may be used differentially by salmonids depending on the flow regime, thus spatial limitations are not recommended as guidelines for gold panning activities either.

Water managers calculate water release in relation to licensed water use, so that the estimated water being diverted is matched by reservoir release. The licensed volume in Tranquille is only 5% of total annual flow. Flows are considered natural with an additional 5% released to naturalize discharge (Epp, 2018). The mean monthly flows in the Tranquille River for September and October are 0.200 m/s<sup>3</sup> and 0.253 m/s<sup>3</sup>, respectively (Appendix A). As of 2018, monthly diversion volumes for two irrigation and one waterworks licence held by the Tranquille Farm property were excluded from the diversion calculations. This was because an associated storage licence held by the Farm property exceeded the demand of these licences. While conducting 2022 coho stream walks, SFC biologists observed the water diversion structure diverting approximately half the volume of the river into the piping infrastructure. The water was not backwatering (as designed) and was instead flowing out. This is because the pipe leaks any excess water instead of backwatering it. This has resulted in several artificial, disconnected wetlands which are visible on the hiking trails downstream of the structure. As a result of these leaks, environmental flow needs (EFN) are not being met, and water management does not support a naturalized flow. Although the artificial wetlands support some wildlife, several kilometres of aquatic and riparian habitat are negatively affected downstream of the diversion. IFC migration and stream residence were negatively affected until the diversion was closed because water levels were too low at the mouth for them to enter the stream.

### Recommended Actions

The Tranquille River area makes up a distinct ecological community within the surrounding grasslands. The watershed has high social, ecological and cultural value and its conservation is an important goal. Conservation of intact ecosystems is often more cost effective when compared to the cost of restoration. The simplest way to do this is to promote low impact forms of recreation like bird watching, wildlife viewing and hiking, and to design modifications using environmentally sensitive methods. Clearly defined guidelines and policies should be used in management strategies to ensure recreation does not impact natural values. Actions recommended to protect the natural integrity of the Tranquille River within Lac du Bois Protected Area include:

#### **Action 1: Collaborate with fellow stakeholders and develop a system wide approach to restoration and water management.**

Undertaking elaborate restoration efforts will not be meaningful if they do not consider downstream issues that impact fish passage, or the effective water management from the headwater lakes.

- Establish a community steering committee with representatives from water managers, developers, Parks, and First Nations partners.

- Install hydrometric stations in the Tranquille River. Realtime flow data from Criss Creek is used as a surrogate for flow patterns and variability (Epp, 2018). In light of a changing climate, stream specific flow and temperature monitoring will benefit planning and ensure water release matches instream flow needs.

**Action 2: Restore fish passage to the water diversion structure.**

- Combine short and long-term strategies for fish passage.
- Clear the existing fish ladder of debris and repair it for immediate results.
- Construct a bypass channel to ensure a long-term solution to fish passage.

**Action 3: Address the degrading water diversion infrastructure.**

- Work with the Tranquille Farms property to transition to well or lake withdrawal for domestic water needs or fix the leaking pipe and closely monitor it and the associated structure.

**Action 4: Restore aquatic habitat to pre-disturbance conditions.**

- Segment 2 is a good candidate for restoration since it is the most heavily disturbed and is currently the main spawning area.
- Segment 2 would benefit from greater pool density, sinuosity and wetland connectivity. These would help the river to retain and slow water, promote riparian growth and instream cover, and increase thermal refuge and overwintering habitat.
- Stage Zero or “Process-Based-Restoration” (PBR) is a low-tech, holistic restoration method that utilizes natural processes (transport and deposition) to return watercourses to pre-disturbance condition. It may represent the most long-term, sustainable approach to restoration when compared to traditional methods like rock-log structures and bank armouring. It attempts to fully reconnect a river to its former floodplain and is increasingly being used by the US Forest Service. More information can be found here: <http://stagezeroriverrestoration.com/>
- Beaver Dam Analogues are a form of PBR and have been used extensively south of the border. They were more recently piloted in the Nicola/Merritt area and are a great way to increase wetland and floodplain connectivity and function.
- There are many suitable locations in segments 2 and 3, such as the section of long eroding bank (Figure 19, Appendix B), and a particularly bad section of historic placer spoils (Figure 19, Appendix B).
- The cost of heavy machinery and the logistics of building access roads to historic placer spoils preclude traditional methods of restoration and make PBR a viable option.

**Action 5: Establish clear guidelines and policies for recreational gold panning in the Lac du Bois Protected Area.**

- Considering the unique social, cultural, traditional values, and ecological values of the Tranquille River within the surrounding Ponderosa Bunchgrass Zones, gold panning is not recommended as an acceptable park activity. Gold panning was found to have a significant negative impact on aquatic habitat and riparian zones within the surveyed stream length.
- Clearly defined principles and policies will help clear ambiguity regarding park use and help protect special natural features.

**Action 6: Target education and outreach efforts that communicate the natural value of the area to stakeholders and recreators.**

- Adjust signage to reflect any changes in policy that affects park users.
- Prepare an educational program for park users that increases understanding of the value in protecting the ecological integrity of the area.
- Promote wildlife viewing through the use of interpretive trail signs.

**Action 7: Monitor habitat restoration efforts and changes in baseline conditions.**

- Implement a monitoring program to measure effectiveness of restoration activity and protection measures.
- Use baseline SHIM data as a comparison.

## References

- COSEWIC. 2016. Coho salmon (*Oncorhynchus kisutch*) interior Fraser population: COSEWIC assessment and status report 2016 [https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/coho-salmon-interior-fraser-2016.html#\\_pre](https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/coho-salmon-interior-fraser-2016.html#_pre)
- COSEWIC. 2014. COSEWIC assessment and status report on the Rainbow Trout *Oncorhynchus mykiss* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 60 pp. (Species at Risk Public Registry website). <https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/rainbow-trout-2014.html>
- Decker, A.S., and J.R. Irvine. 2013. pre-COSEWIC assessment of Interior Fraser Coho Salmon (*Oncorhynchus kisutch*). Canadian Science Advisory Secretariat Research Document 2013/121: 57p.
- Epp, P. 2018. Tranquille Reservoir Storage Release Recommendations (Draft).
- Favrholdt, K. 2021. Kamloops History: There's gold in that thar Tranquille. Kamloops This Week. Available at: Available at: <https://www.kamloopsthisweek.com/community/kamloops-history-theres-gold-in-that-thar-tranquille-4447837>
- Holtby, L.B., and K.A. Ciruna. 2007. Conservation units for Pacific salmon under the Wild Salmon Policy. Canadian Science Advisory Secretariat Research Document 2007/070.
- Johannessen S., Macdonald, R., and Eek, M. "Historical Trends in Mercury Sedimentation and Mixing In the Strait of Georgia, Canada," *Environmental Science and Technology* 39, 12 (2005): 4361.
- Johnson, N.T., and P.A. Slaney. 1996. Fish habitat assessment procedures. BC Ministry of Environment Lands and Parks and BC Ministry of Forests, Watershed Restoration Technical Circular No. 8.
- Lamothe, T. 2021. Mercury Loss from Gold Rush Era Placer Mines in the Fraser Basin. *Simon Fraser University*.
- Mason, B., and R. Knight. 2001. Sensitive Habitat Inventory and Mapping. Community Mapping Network, Vancouver, British Columbia. 315pp + viii. M. Johannes, Editor.
- Northcote, T.G., and P.A. Larkin. 1989. The Fraser River: A major salmonine productive system. In *Proceedings of the International Large River Symposium*. Edited by D. Dodge. Canadian Special Publications Fisheries and Aquatic Science No. 106. pp. 174-204.
- Roberge, M., J.M.B. Hume, C.K. Minns, and T. Slaney. 2002. Life history characteristics of freshwater fishes occurring in British Columbia and the Yukon, with major emphasis on stream habitat characteristics. Fisheries and Oceans Canada. Marina Environmental and Habitat Science Division. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2611.
- Sandercock, F.K. 1991. Life history of Coho Salmon (*Oncorhynchus kisutch*). In *Pacific Salmon Life Histories*. Edited by C. Groot and L. Margolis. UBC Press, Vancouver, BC. pp. 397-445.
- U.S. Geological Survey (USGS). 2005. Mercury Contamination from Historical Gold Mining in California. Available at: [https://pubs.usgs.gov/fs/2005/3014/#:~:text=The%20total%20amount%20of%20mercury,Nevada%20\(C%20hurchill%2C%202000\).](https://pubs.usgs.gov/fs/2005/3014/#:~:text=The%20total%20amount%20of%20mercury,Nevada%20(C%20hurchill%2C%202000).)

## Appendices

### Appendix A: Supplementary Figures and Tables.

Table 12. Length of disturbed bank and primary land uses by segment breaks.

Segment	Reach Length	Impacted bank (m)		Land Use
		LB	RB	
1	1327.22	1327.22	1327.22	Ag-Ag
2	2737.84	508.64	452	Linear/Urban Park
3	2398.4	278.25	101	Natural/urban park
4	1536.29	0	3	Natural
5	440.61	0	9	Natural

Table 13. Water Licences Summary for Tranquille River Watershed.

Purpose	Licences	Annual Volume MY	Annual Volume m <sup>3</sup> /s	Apr m <sup>3</sup> /s	May m <sup>3</sup> /s	Jun m <sup>3</sup> /s	Jul m <sup>3</sup> /s	Aug m <sup>3</sup> /s	Sep m <sup>3</sup> /s	Oct m <sup>3</sup> /s
Irrigation	2 <sup>1</sup>	1,512,740	0.048	-	0.088 <sup>1</sup>	0.146 <sup>1</sup>	0.146 <sup>1</sup>	0.146 <sup>1</sup>	0.058 <sup>1</sup>	-
Irrigation	13 <sup>2</sup>	140,099	0.004	-	0.016 <sup>2</sup>	0.026 <sup>2</sup>	0.026/0 <sup>2</sup>	-	-	-
Waterworks	1 <sup>3</sup>	165,932	0.005	0.005 <sup>3</sup>	0.005 <sup>3</sup>	0.005 <sup>3</sup>	0.005 <sup>3</sup>	0.005 <sup>3</sup>	0.005 <sup>3</sup>	0.005 <sup>3</sup>
Domestic	2 <sup>4</sup>	1,659	0.000 <sup>4</sup>	0.000 <sup>4</sup>	0.000 <sup>4</sup>	0.000 <sup>4</sup>	0.000 <sup>4</sup>	0.000 <sup>4</sup>	0.000 <sup>4</sup>	0.000 <sup>4</sup>
Total Diversion	18	1,820,430	0.057	0.006	0.110	0.178	0.152	0.152	0.064	0.006
Storage	1	2,294,273	0.073		0.857 <sup>5</sup>					

## Appendix B – Map sets

<sup>1</sup> Irrigation allowed from April 1 to Sept 30. Distributed as April - 0%, May 15%, Jun-25%, Jul - 25%, Aug -25% & Sep -10%. Note that this volume is backed by storage.

<sup>2</sup> Irrigation allowed from April 1 or May 1 to Jul 15. Distributed as April - 0%, May 29%, Jun-48%, Jul - 24 to Jul 15, and assumed to be 0% after Jul 15. This volume is not backed by storage.

<sup>3</sup> Water use allowed year-round. Assumed to be 1/12 of total per month. Note that this volume is assumed to be supplied from storage although it is not directly linked to storage in the water licence.

<sup>4</sup> Water use allowed year-round. Assumed to be 1/12 of total per month. Not backed by storage.

<sup>5</sup> All of the storage refill is shown in May, although storage refill would begin in April and could extend into June depending on management and runoff. Note too that this volume is applicable to refill from full drawdown in the previous year, which is not normal practice under current operating conditions.



Figure 15. Surveyed length within Lac du Bois Grasslands Protected Area.

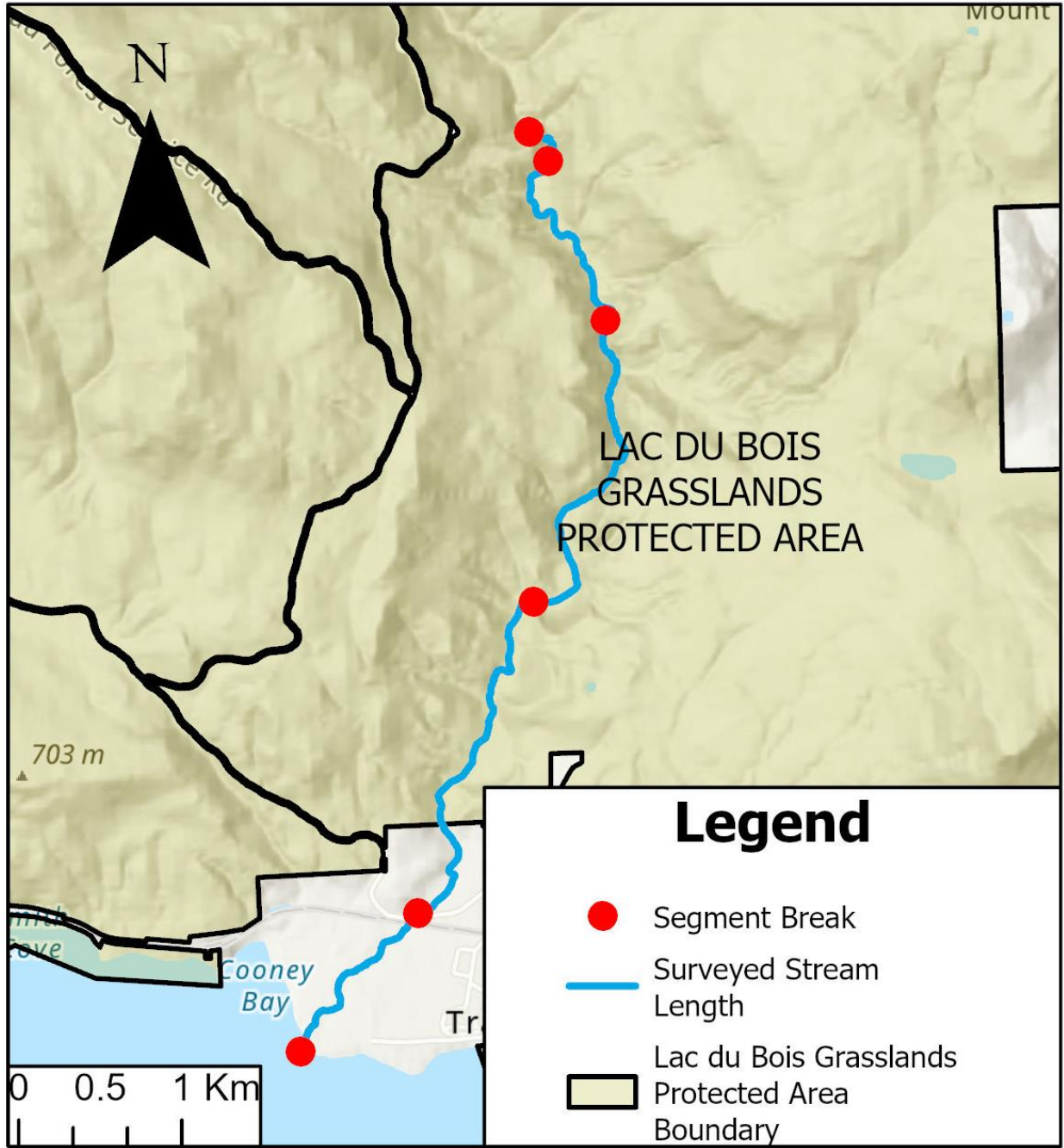


Figure 16. Segment breaks along the stream centreline.

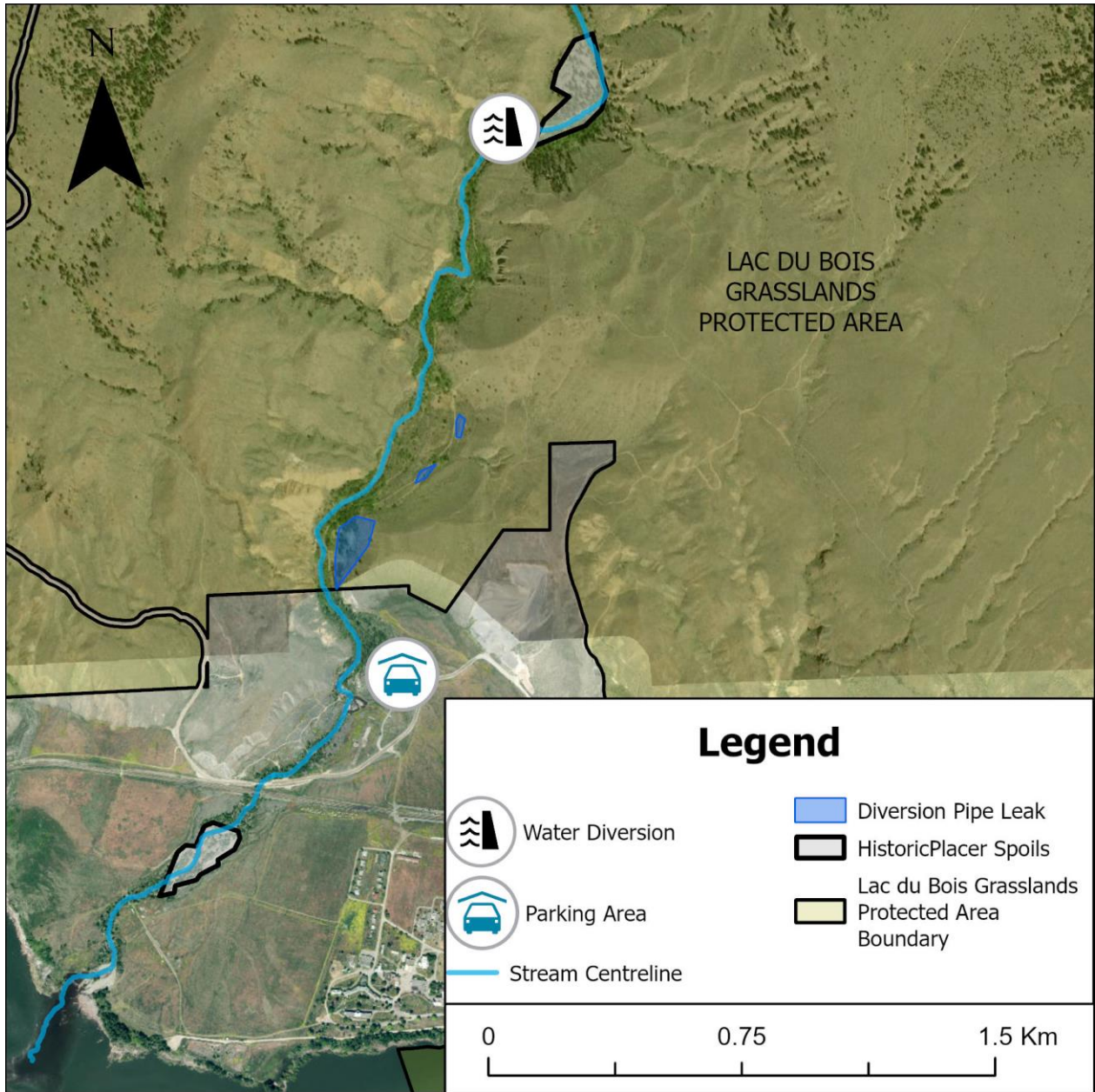


Figure 17. Location of notable surveyed features.

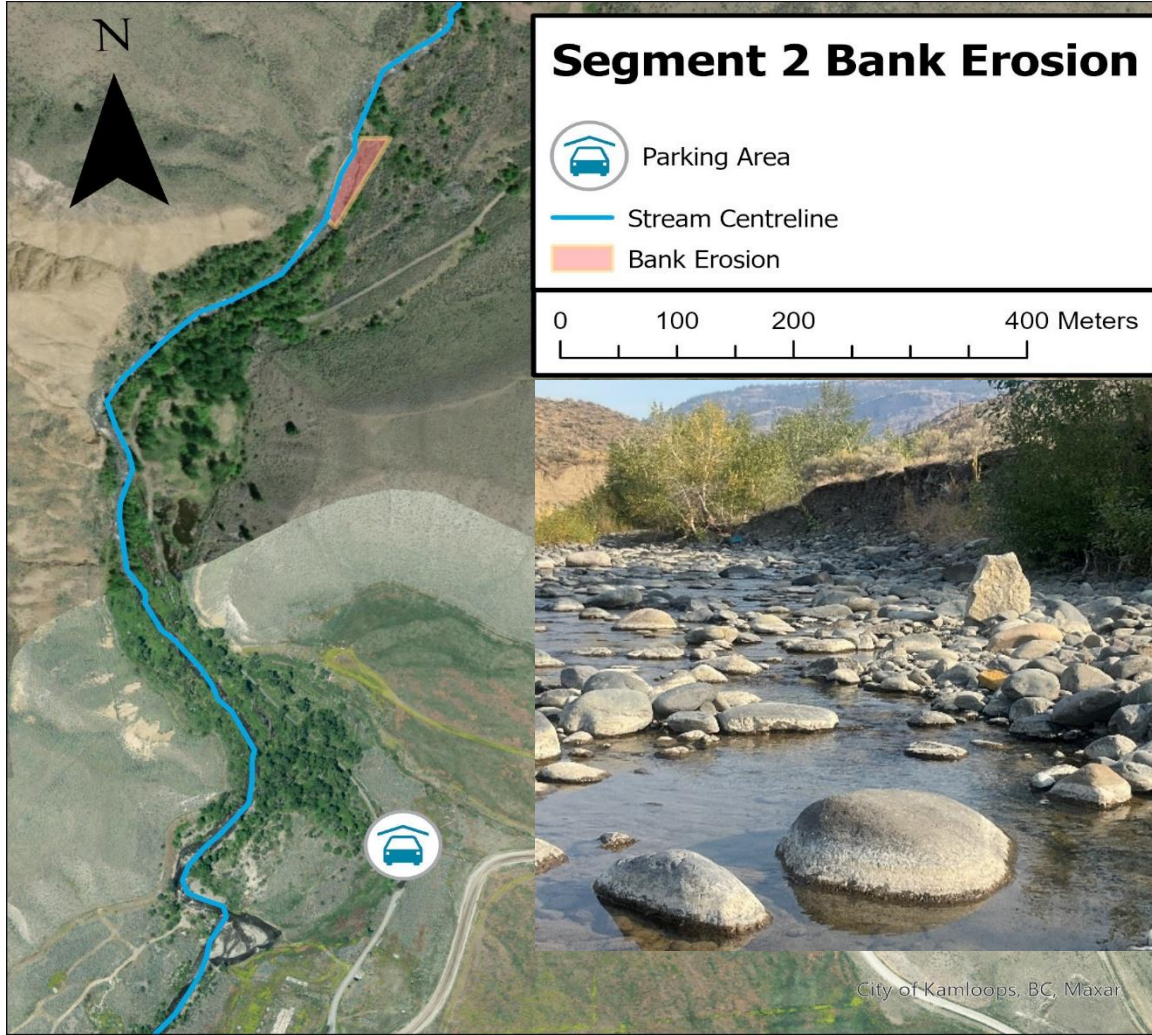


Figure 18. Location of significant bank erosion in segment 2.

||

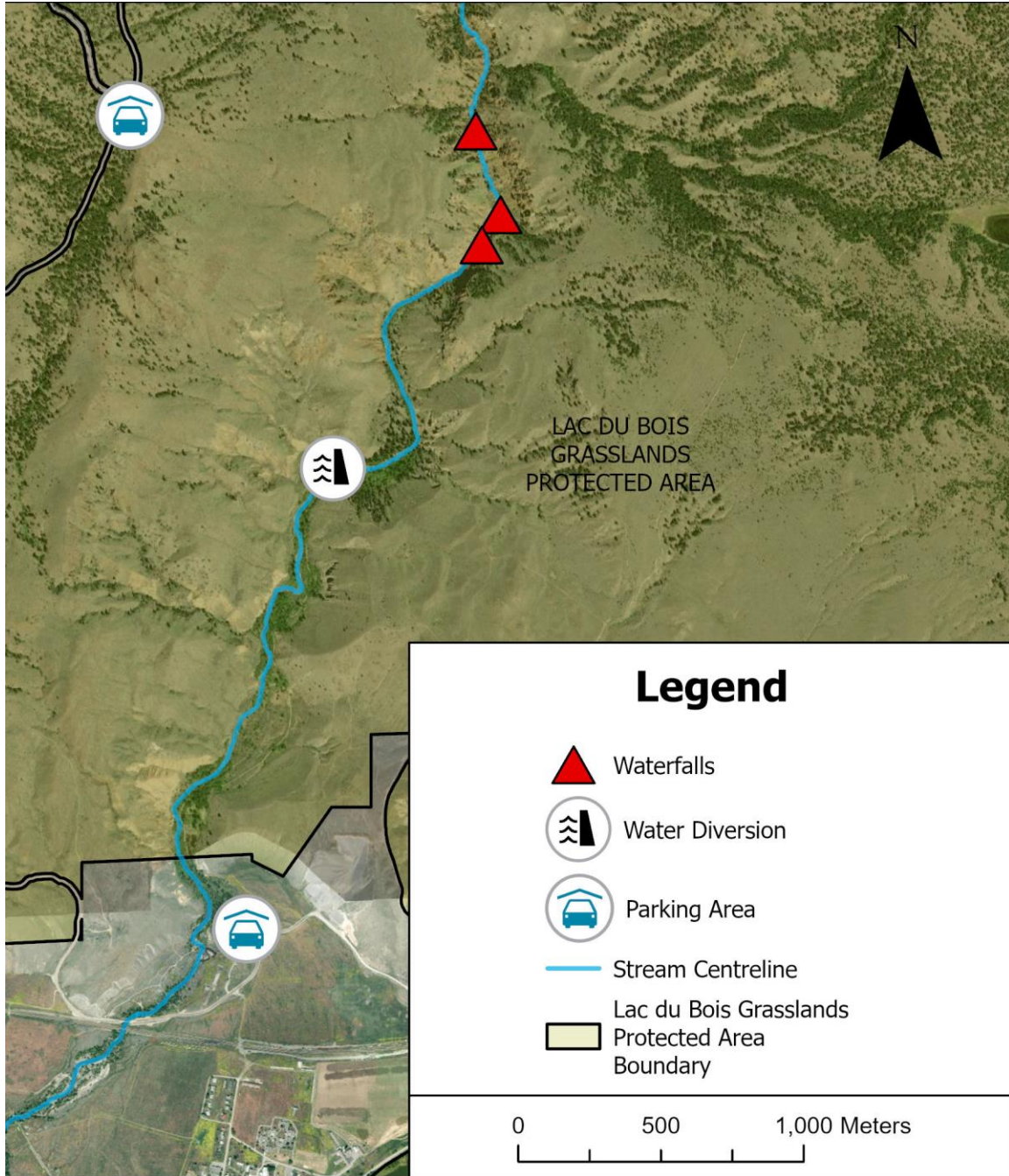


Figure 19. Waterfall locations previously described as barriers to fish passage.

