Sensitive Habitat Inventory Mapping and Aquatic Habitat Index

East Barrière River

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Secwépemc
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Commission

East Barrière River Sensitive Habitat and Inventory Mapping and Aquatic Habitat Index

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Introduction

Project Background

This Sensitive Habitat Inventory Mapping and Aquatic Habitat Index project for East Barrière River, herein referred to as the "Project", was completed by Secwépemc Fisheries Commission (SFC) with funding from the Canada Nature Fund for Aquatic Species at Risk (CNFASAR) (Contribution Agreement: 2022-NF-PAC-014). The Project is a component of a larger SFC led initiative that aims to implement priority actions that will benefit salmon ecosystems in Secwépemc territory while considering impacts from climate change and human uses. The Project has also been integrated into the Simpcw "Séwllkwe" initiative, which involves enhancing and protecting fish habitat, improving riparian areas, and enhancing slope stability throughout the territory.

Sensitive Habitat Inventory Mapping (SHIM) is a field-based methodology that maps and compiles data for British Columbian watercourses (Mason and Knight, 2001). The field data collected by the SHIM was used to identify areas of sensitive habitat for key fish species as well as evaluate stream and bank conditions. This information can be used to inform management decisions, prioritize future restoration sites, and monitor changes in the stream through time.

This report is based on a desktop review of available information and field data collection conducted from August 23 – 24, 2023. The scope of this report includes:

- A description of the study area and key fish species in East Barrière River.
- A summary of the methodology used from the SHIM, data analysis for the Aquatic Habitat Index (AHI) and the Level of Impact (LOI) scoring.
- A summary of the results from the SHIM, AHI, and LOI.
- Recommendations for fish habitat restoration planning and prioritization including priority restoration site maps.

This report also serves to meet the habitat assessment summary report deliverable under Activity 1 of the CNFASAR funding for the 23/24 fiscal year (Year 2).

Study Area

The East Barrière River is located in the Barrière River drainage within the traditional hunting, fishing, and gathering territory of the Simpcw First Nation (SFN). It is a low gradient riffle-pool stream with gravel beds and sections of cobble (Summit Environmental Consultants Ltd., 2001). At 23.5 km long, it is the largest tributary to the Barrière River and flows through the largest lake in the watershed—the East Barrière Lake (Grinton, 1994).

The Barrière River drainage has been impacted by areas of agriculture, forestry, recreation, and residential development (Arc Environmental, 2000; Grinton, 1994). The East Barrière sub basin has an area of 12 382 ha, with over 712 ha of private land ownership (Summit Environmental Consultants Ltd., 2001). Substantial residential development and private land has occurred along the East Barrière River up to East Barrière Lake (Arc Environmental, 2000). The SHIM survey in 2023 focused on the section of the river downstream of the lake which has been impacted by human developments. The river discharge is driven by snowmelt, and a variety of fish species utilize its cool, stable flows (Table 1) (Arc Environmental, 2000; Grinton, 1994).

Table 1. Documented fishes and their life history stages (where applicable) in the Barrière River watershed.

Species	Documentation
Coho *(Oncorhynchus kisutch)*	(Grinton, 1994)
Chinook *(Oncorhynchus tshawytscha)*	(Grinton, 1994)
Pink salmon *(Oncorhynchus gorbuscha)*	(Grinton 1994; ARC Environmental, 2000)
Kokanee *(Oncorhynchus nerka)*	(Grinton 1994; ARC Environmental, 2000)
Rainbow Trout *(Oncorhynchus mykiss)*	(Grinton 1994; ARC Environmental, 2000)
Bull trout *(Salvelinus confluentus)*	(Grinton, 1994)
Redside shiner *(Richardsonius balteatus)*	(Grinton 1994; ARC Environmental, 2000)
Sculpin *(Cottus rhoteus and Cottus asper)*	(Grinton, 1994)
Long-nosed Dace *(Rhinichthys cataractae)*	(Grinton, 1994)
Northern pikeminnow *(Ptycheilus oregonensis)*	(Grinton 1994; ARC Environmental, 2000)
Largescale sucker *(Catostomus macrocheilus)*	(Grinton 1994; ARC Environmental, 2000)
Bridgelip sucker *(C. columbianus)*	(Grinton 1994; ARC Environmental, 2000)
Mountain Whitefish *(Prosopium williamsoni)*	(Grinton 1994; ARC Environmental, 2000)

Key Fish Species

As mentioned, a diversity of fishes utilize the Barrière River watershed. The key fish species considered in this report are socially, economically, and culturally significant. The habitat requirements and residence time of the key species are used in establishing the Aquatic Habitat Index (AHI). The key fish species considered are rainbow trout, Interior Fraser Coho (IFC), and pink salmon. Sockeye and Chinook salmon may use the river for spawning and rearing, but specific spawning data are not available, and use is believed to limited (Arc Environmental, 2000; Grinton, 1994; Pacific Salmon Explorer, 2024). Adfluvial bull trout rear in the Barrière River before migrating to Saskum, North Barrière, and Kamloops Lakes, however they appear to be absent from the East Barrière River downstream of East Barrière Lake (Grinton, 1994). Table 2 displays timing of freshwater use by pink salmon, coho salmon, and rainbow trout.

Table 2. Timing of usage by steelhead/rainbow trout (RB), Chinook (CH), coho (CO) and pink (PK) salmon.

Life History Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Incubation RB	CO, PK	CO, PK	CO, PK	CO, PK	CO, RB	RB	RB			CH, PK	CO, PK	CO, PK
Juvenile Rearing	RB, CO	RB, CO	RB, CO	RB, CO	RB, CO	RB, CO	RB, CO	RB, CO	RB, CO	RB, CO	RB, CO	RB, CO
Migration and Spawning	RB	RB	RB	RB	RB			PK	CO, PK	CO, PK, RB	CO, PK, RB	CO, RB

Salmonids that spawn in the East Barrière River downstream of East Barrière Lake include but may not be limited to rainbow trout, pink, and coho salmon. Escapement data for IFC are available from

1975 to 2021 (Figure 1). These data were retrieved from the Pacific Salmon Explorer and internal databases (Pacific Salmon Explorer, 2024).

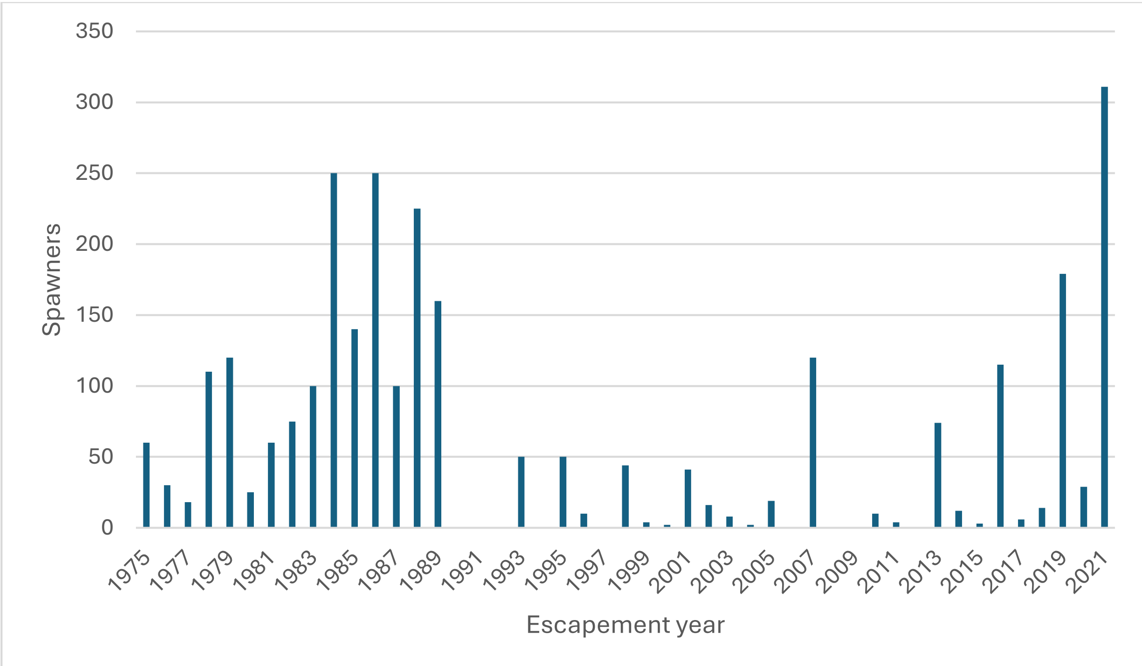

Figure 1. Historic IFC spawner abundance in the East Barrière River.

Threats to the species in this watershed are overlapping and include the compounding impacts of drought, fires, pine beetle kill, logging, and riparian losses from agriculture and residential development (Arc Environmental, 200; COSEWIC, 2020). These impacts have resulted in altered seasonal hydrographs, loss of hillslope stability, degraded channel stability, decreased habitat and floodplain connectivity, and increased stream temperatures (Nelitz et al., 2011; COSEWIC 2020).

Rainbow Trout

Rainbow trout (*Oncorhynchus 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 (Neave, 1944; Doctor et al., 2014). Stream residents remain in small headwaters their entire life (COSEWIC, 2014). Freshwater migrants move to larger rivers or to lakes as adults, returning to their natal stream to spawn. Individuals that migrate to lakes (adfluvial) 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.

Adult Migration

The absence of 3+ age class fish in the East Barrière River suggest that local populations are adfluvial (Grinton, 1994). Migration into the river coincides with increasing spring temperatures in the spring and tends not to occur until water temperatures approach 8 degrees (Roberge et al., 2002; COSEWIC, 2020). Outmigration occurs shortly after spawning, and some individuals may survive to repeat spawn.

Spawning and Incubation

Rainbow trout prefer cold, clear water with a fast current (COSEWIC, 2020). Spawning occurs in the spring at stream temperatures of 10–15 °C in gravel substrates above and below pools at riffle transitions (Roberge et al, 2002; COSEWIC, 2020). Ideal substrate is 0.4–1.5 cm in diameter with low sediment and silt levels and high dissolved oxygen levels (Bjornn and Reiser, 1991). Fecundity is strongly correlated to body size, and may vary from 300 – 12, 600 eggs (COSEWIC, 2020). Spawning occurs in the spring at stream temperatures of 10–15 °C (Roberge et al, 2002). Repeat spawning is common but depends on condition after spawning, availability of food, and is inversely correlated with the total number of spawners (Hartman et al. 1962; Schwanke, 2002).

Juvenile Rearing

Based on findings from Grinton in 1994, rainbow juveniles in the Barrière River watershed appear to spend 1 to 3 years in rivers before migrating to nearby lakes to mature. Juveniles value shallow streams with abundant cover in the form of vegetated banks, overstream vegetation, woody debris, and boulder gardens (COSEWIC, 2020). Pools and areas of sub-gravel flow are important overwintering habitat for juveniles and adults (COSEWIC, 2015).

Interior Fraser 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).

IFC 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).

Adult Migration

Adults return to spawn at 3 years of age, so their success depends equally on quality freshwater and marine habitats. Appropriate flows, depths, and temperatures are necessary for migrating, holding, and spawning adults. Depths of at least 17 cm, velocities 30-90 cm/s, and temperatures between 12-14 degrees Celsius are preferred (Bjornn and Reiser, 1991). Deep pools, woody debris, groundwater input, and healthy riparian areas with overhanging vegetation provide cover and cooler temperatures for returning adults.

Spawning and Incubation

Spawning and egg incubation occurs in a variety of habitats and is not thought to be limiting (COSEWIC, 2016). Coho spawn in the late fall, often in very small streams and the side channels of larger rivers. Discharge decreases in the fall and winter, putting redds at risk of dewatering and freezing if spawning occurs too early (Decker and Irvine, 2013).

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. Groundwater also moderates ambient stream temperatures, further decreasing the risk of dewatering or freezing (McRae et al., 2012). 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.

Juvenile Rearing

Fry emerge from the gravel during spring freshet, when high discharge causes increased bed shear and the creation of flooded habitats. These ephemeral floodplains are shallow and warm quickly. This accelerates the growth of terrestrial plants and prey species (invertebrates and plankton), providing extremely valuable areas of elevated growth conditions for juvenile salmonids in the spring (Jeffres et al., 2007). Channel complexity is also important and gradients of less than 3% are preferred. Pools, backwaters, and beaver ponds have the highest density of juveniles (Decker and Irvine, 2013). Groundwater ponds, side-channels, and other off-channel habitats support Coho overwinter and during summer low flow.

Pink Salmon

Pink salmon are the most abundant Pacific salmon, comprising 70% of all Pacific salmon (Ruggerone et al., 2023). Their range and abundance have been increasing spectacularly, reaching record highs from 2005-2021. They have been able to adapt to a warming climate faster than other species, and, combined with hatchery inputs have been able to exert competitive dominance over other salmonids for shared prey species (Ruggerone, 2023).

Adult Migration

Pink salmon return to freshwater in their second year to spawn (DFO, 2023). Pink salmon are smaller than other North American Pacific salmonids and can tolerate lower minimum depths required for migration (Bjornn and Reiser, 1991). Although Pacific Salmon can migrate past many obstacles that appear to be barriers, pink salmon are less tolerant of excessive velocities, and are at a greater risk from the challenges posed by waterfalls and debris jams (Bjornn and Reiser, 1991). The Hell's Gate landslide of 1913 blocked nearly all migration of pink salmon and decimated the Upper Fraser stocks (DFO, 1995). It took many decades for these stocks to rebuild, and the Fraser River canyon continues to hinder migration at certain flows (DFO, 1995).

Spawning and Incubation

Fraser River pink salmon spawn almost entirely in odd years (DFO, 2023). Peak spawn timing is usually between 0ctober 10th and 18th in the Thompson watershed (DFO, 1995). Pink salmon prefer temperatures from 7.2-12.8 degrees Celsius for spawning and substrates 13-102 mm in diameter (Bjornn and Reiser, 1991).

Juvenile Rearing

Juvenile Fraser River pink salmon emerge from spawning gravels in early spring and immediately migrate downstream to the rear in the Fraser River estuary (DFO, 1995). They spend very little time in freshwater as juveniles, and therefore have lower use of freshwater fish habitat features compared to other salmon and trout that may spend several years or their entire lives in these natal streams.

Methodology

Sensitive Habitat Inventory Mapping

SHIM is a high-level planning tool designed for watercourses in residential, commercial, agricultural, industrial, and recreational land use areas. The SHIM assessment was conducted by following the standards and procedures outlined in the manual for Sensitive Habitat Inventory and Mapping (Mason and Knight, 2001). Technicians recorded biophysical and anthropogenic attributes using a Trimble R2 unit and an iPad tablet. These attributes can be used to divide a stream into segments that can be ranked in terms of their relative level of disturbance, and their relative contribution to fish habitat and productive capacity. These 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.
- Highlight water quality issues.
- 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.

The goal of the project was to map fish habitat features and issues impacting salmonid habitat. Since anadromous salmonids are not known to spawn upstream of East Barrière Lake, the survey was conducted from the outlet of the lake downstream to the confluence with the Barrière River.

Stream Centreline

The centreline of the stream was mapped along the centre of bankful width. The centreline was divided into segments based on hydraulic class (gradient), riparian class, substrate, land use, and disturbance factors (Table 3). Segments were designated when these conditions remained sufficiently uniform for at least 100 m.

Table 3. 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; Large woody debris; Small woody debris; Overstream vegetation;
Line length	(m)

Point Features

Point features provide a measure of fish habitat quality and relative disturbance. Table 4 provides a list of features surveyed for and mapped.

Table 4. Overview of point 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 (spawning/rearing/cover); Length/width; Image
Obstruction	Type; Length; Image
Modification	Type; Length; Image

Thompson Shuswap Salmon Collaborative 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 Thompson Shuswap Salmon Collaborative (TSSC) Mapping Tool and can be accessed online. Corrections and adjustments can be made to the database as necessary.

Aquatic Habitat Index

The habitat requirements of salmonids vary by species and life history stage. Depending on the time of year, migrant adults, eggs, rearing juveniles, and resident adults will be present in the East Barrière River. 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).
- Large woody debris (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 and adapted for this assessment. It uses the relative value of fish habitat features to rank segments by the quantity and quality of available fish habitat. This ranking can be used to indicate which segments may be the most sensitive to change.

Table 5 provides a list of fish habitat features that were mapped. 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 productivity and sensitivity). Each habitat feature was assigned a score (where 1 = *low value*, 2 = *moderate value*, and 3 = *high value*) for each key species at 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 (Figure 2). The relative spatial coverage of each feature type in a segment was multiplied by the weighted score that was calibrated for the East Barrière River.

Table 5. Relative value (RV) and weighted score (WS) of fish habitat features in the East Barrière River.

	Rearing		General Living		Spawning	
Fish Habitat Features	**RV**	**WS**	**RV**	**WS**	**RV**	**WS**
Instream Vegetation	0.67	23.33	0.33	3.33	0.00	0.00
Boulder	0.67	23.33	0.33	3.33	0.33	11.67
Overstream Vegetation	0.50	17.50	0.33	3.33	0.11	3.89
Small Woody Debris	0.67	23.33	0.33	3.33	0.11	3.89
Deep Pool	1.00	35.00	0.83	8.33	0.67	23.33
Undercut Bank	0.67	23.33	0.67	6.67	0.44	15.56
Large Woody Debris	1.00	35.00	0.83	8.33	0.44	15.56
Groundwater Influence	1.00	35.00	1.00	10.00	1.00	35.00
Off-Channel Habitat	1.00	35.00	0.83	8.33	0.11	3.89
Tributary	0.83	29.17	0.83	8.33	0.78	27.22

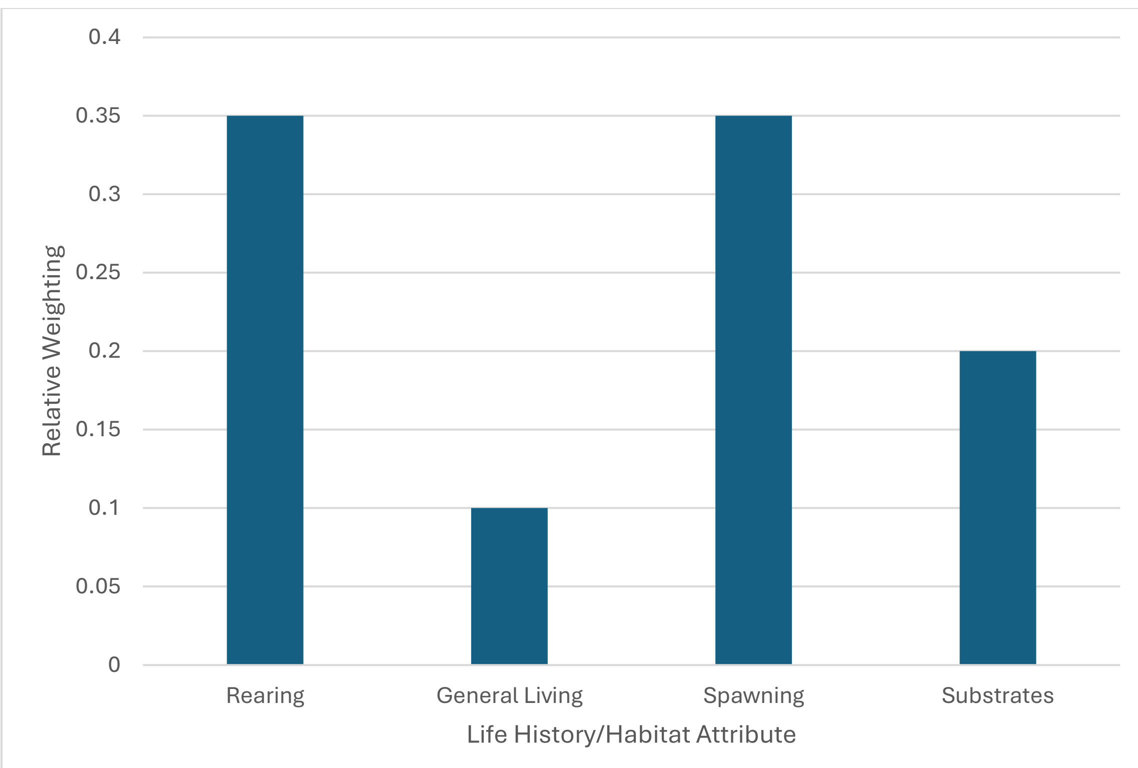

Figure 2. Relative weighting of a given life history stage or attribute.

The AHI adapted for the East Barrière River considered the life history stages of spawning, rearing and general living, as well as the habitat attributes of substrate (Figure *2*). A score for each segment was calculated using the following equation:

$$AHI_{\text{segment}} = \sum [\, A_{\text{sp}}/A_t \times W_{\text{sp}}] + \sum [\, A_{\text{gen}}/At \times W_{\text{gen}}] + \sum [\, A_{\text{rear}}/At \times W_{\text{rear}}] + \sum [\, \mathrm{P}_{\text{sub}} \times W_{\text{sub}}]$$

Where *A* represents area, *sp* represents a spawning habitat feature, *t* represents total stream area, *W* is the weighting of the habitat feature, *gen* represents general living, *rear* represent rearing, and P represents the percentage of stream area.

Level of Impact

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.

To compare the relative condition of each segment, the left and right banks of each segment were assigned a condition of either *High*, *Moderate*, *Low*, or *Nil*. 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; *Nil* represents the local natural potential. Banks with a rating of Nil were attributed a score of 3, while banks designated *High* received a score of zero. Thus, a segment with a rating of *Nil-Nil* would score a total of 6, while a *High-High* segment would score 0. This scoring system is further outlined in Table 6.

Table 6. 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

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.

Summary of Results

Stream centreline and land use distribution

Seven segments were designated over approximately 7 km of surveyed stream length. The channel character is mainly riffle-pool. The substrate is predominately cobble and large gravel, with higher gradient sections supporting boulder gardens. Land use and disturbance factors are one of the main qualifiers of segment designation. Stream alterations are limited, but agriculture and increasing private land developments threaten the right bank in several segments. These alterations and physical characteristics of segments are further described in Table 7. Approximately 20 % of streambanks have been modified by human activities in Segment 3, Segment 6, and Segment 7. These impacts influence riparian function, sediment transport, and water velocity.

Table 7. Stream segment lengths and total surveyed stream length.

Segment	Length (m)	% of surveyed length	Gradient (degrees)	Substrate	Stream character	Main land use and streambank alterations
1	746	10.5%	3.0%	C, LG	Riffle	Rural residential, linear development with some bank armouring,
2	641	9.0%	5.4%	C, LG, B	riffle	Some residential development and land clearing near the streambanks.
3	965	13.5%	2.8%	LG, C	Riffle-pool	Residential developments with sites of extensive and highly disruptive land clearing and instream works.
4	628	8.8%	7.4%	C, LG, B	Riffle-pool	Limited development with a few bridges.
5	1741	24.4%	5.2%	C, B, LG	Riffle-pool	Some residential developments with limited clearing.
6	821	11.5%	4.9%	G, C, F, O	Riffle-pool	Linear developments on the right bank.
7	1596	22.4%	2.8%	O, F	Pool	Residential developments and land clearing near the outlet of the lake.

The seven segments extended from the confluence with the Barrière River upstream to the outlet of East Barrière Lake (Figure 3).

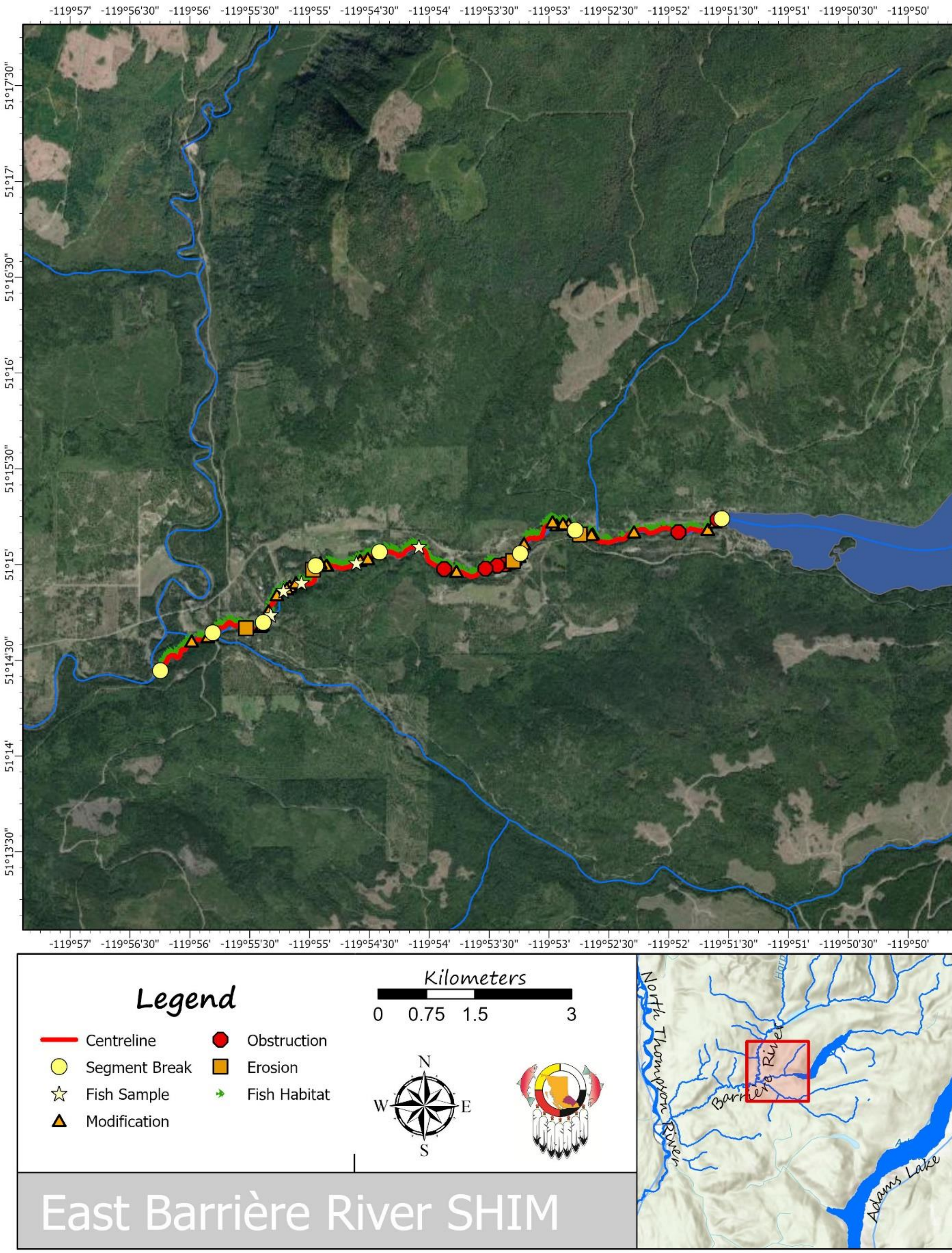

Figure 3. The surveyed length of the East Barrière River with stream segments delineated.

Modification

Modifications to the stream channel have been limited but are a growing concern as development related impacts increase. Modifications to the stream channel from instream works in Segment 3 were the source of the greatest disturbance to the channel (Table 8).

Table 8. Summary of modified features in the East Barrière River.

Modification Type	Total Length (m)	Number of features mapped
Instream works	265	2
Road/Trail	243	9
Bridge	156	7
Riprap	112	3
Dam/weir	28	3
Dock	17	2
Garbage/pollution	10	6
Water withdrawal	3	2
Drainpipe	2	1

Segment 3 had the greatest total length of modified streambank (289 m) (Figure 4). Much of this disturbance appears to be from private landowners using heavy equipment instream to divert or alter flows. One particular property had done extensive damage to the streambanks and streambed. The property is located at the end of Creekside Road. Both banks and the streambed along approximately 120 m of the channel have been excavated, upturned, and channelized (Figure 5, Figure 6). A dam was constructed by depositing substrate at the upstream end of the disturbed area, creating a potential barrier.

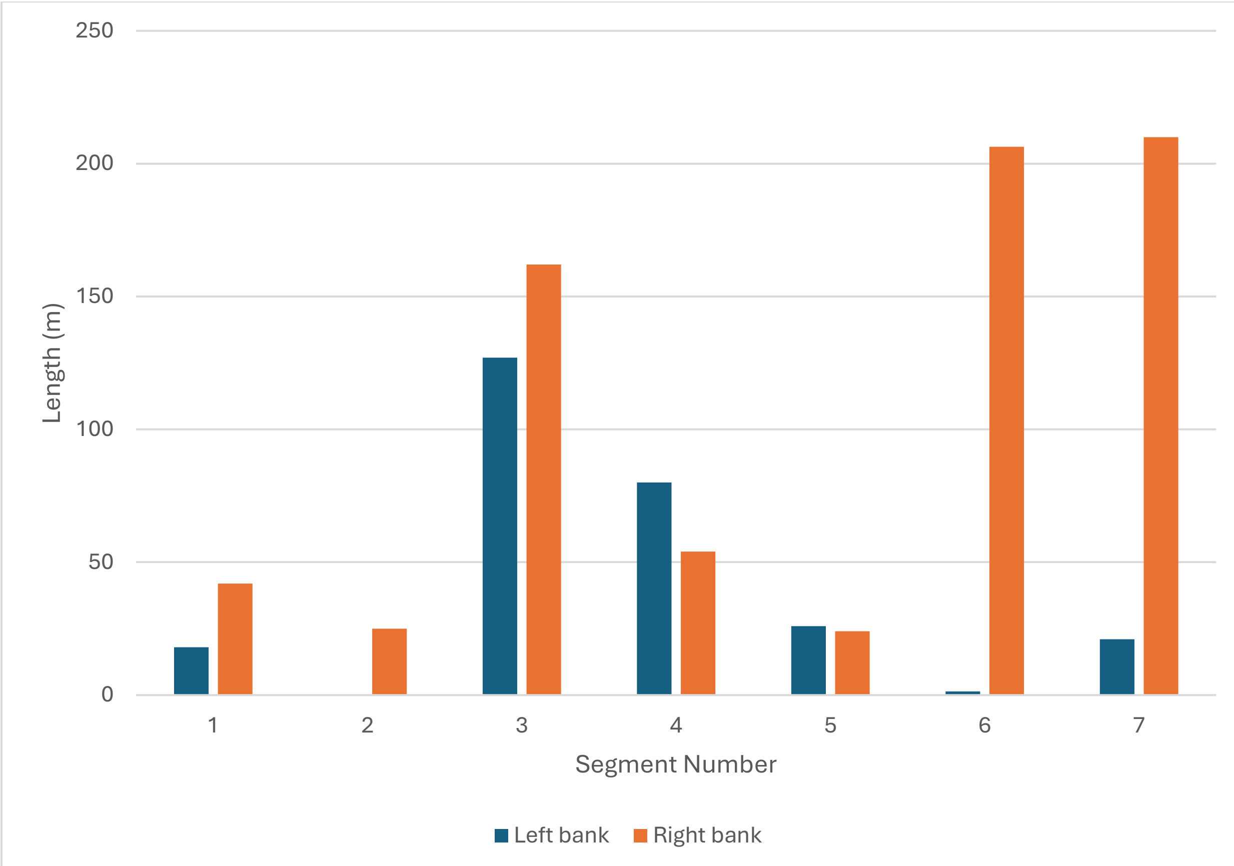

Figure 4. Total length of modified streambank by segment in the East Barrière River.

Figure 5. Gravel placement appears to have been placed to block a side channel and machinery tracks are visible instream (left). Riparian vegetation has been cleared, and bed material has been excavated along a property at the end of Creekside Road.

Figure 6. Machinery was used instream at the Creekside Road property (left) and the banks and bed of the river were excavated to channelize the river (right).

Erosion

The most significant streambank erosion in the East Barrière River occurs in Segment 3 (Figure 7). Many of the eroding banks observed were the result of natural slope failures along incised segments (Figure 8). However, development and land clearing in Segment 3 has resulted in elevated and accelerated levels of erosion. Erosion and fine sediment mobilization is a concern in Segment 3 until substantial streambank restoration efforts are completed. These streambank alterations have a potential to impact downstream migration and spawning, egg incubation, as well as rearing and resident fishes.

The naturally occurring slope failures observed were on outside bends of high velocities areas. These occurrences were generally small and are not likely to present a large-scale introduction of fine sediment to the watershed (Figure 7).

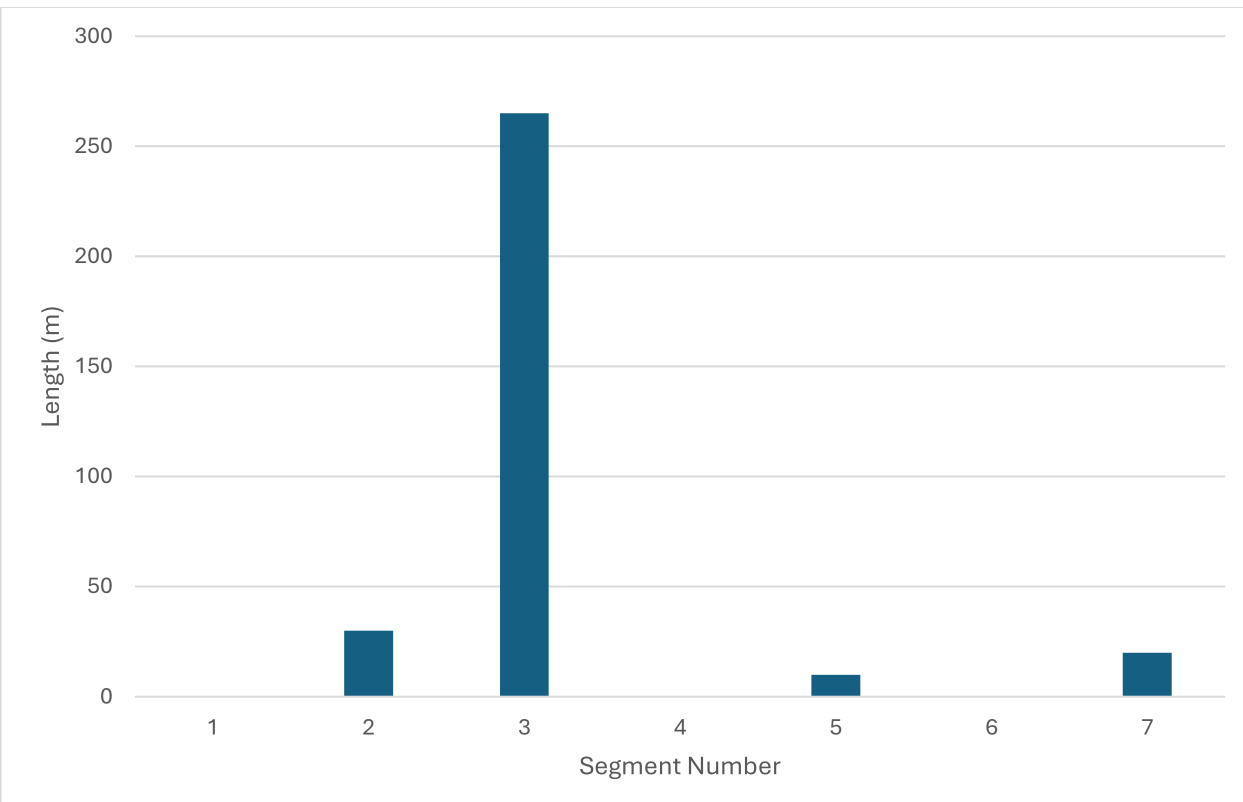

Figure 7. Total length of eroding streambank in the East Barrière River.

Figure 8. Natural incision (left) and accelerated downcutting (right) with riparian removal/thinning along the bank top.

Fish Habitat

The East Barrière River has abundant high-quality habitat for anadromous and resident salmonids. The habitat requirements of salmonids vary by species and life history stage. Depending on the time of year, migrant adults, eggs, rearing juveniles, and resident adults may be present in the river. Measures of habitat quality generally depend on habitat feature complexity, frequency and distribution. Deep pools, woody debris, and off-channel habitat were the most common fish habitat features observed (Table 9).

Table 9. Areal and linear abundance of fish habitat features in the East Barrière River.

Feature Type	Total Area (m^2)	Cumulative length (m)	Relative linear abundance in surveyed length (38 018 m)
Boulder	739	204	2.9%
Deep pool	1355	675	9.4%
Groundwater influence	13	25	0.4%
Instream vegetation	88	310	4.3%
Large woody debris	3362	1928	27.0%
Off-channel habitat	440	476	6.7%
Overstream vegetation	383	74	1.0%
Small woody debris	457	559	7.8%
Tributary	4	4	0.1%
Undercut bank	543	87	1.2%

LWD was found throughout the surveyed stream length, while deep pools were abundant in Segment 7, and off-channels were most common in Segments 1, 3, and 6. Segments 5 and 7 were the longest segments surveyed and had the greatest total length of fish habitat features (Figure 9). Segments 3, 4, and 5 had the highest feature density (habitat complexity).

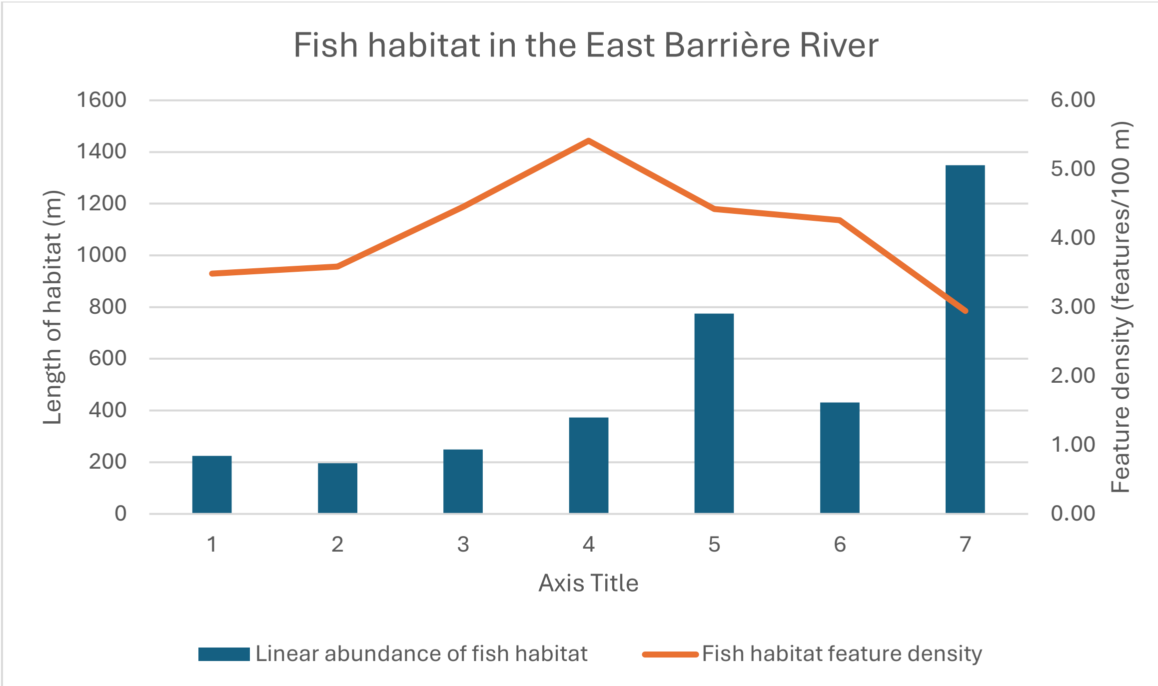

Figure 9. Distribution of the linear abundance of mapped fish habitat features (blue) and density of features (orange) in the East Barrière River.

Hundreds of spent pink salmon carcasses were observed in Segment 1, but none were seen upstream of the bridge on South Barrière Lake FSR. Spawning and holding IFC were observed in upstream segments and these locations were mapped. Segment 3 had the highest abundance of spawning or holding coho salmon (Figure 10).

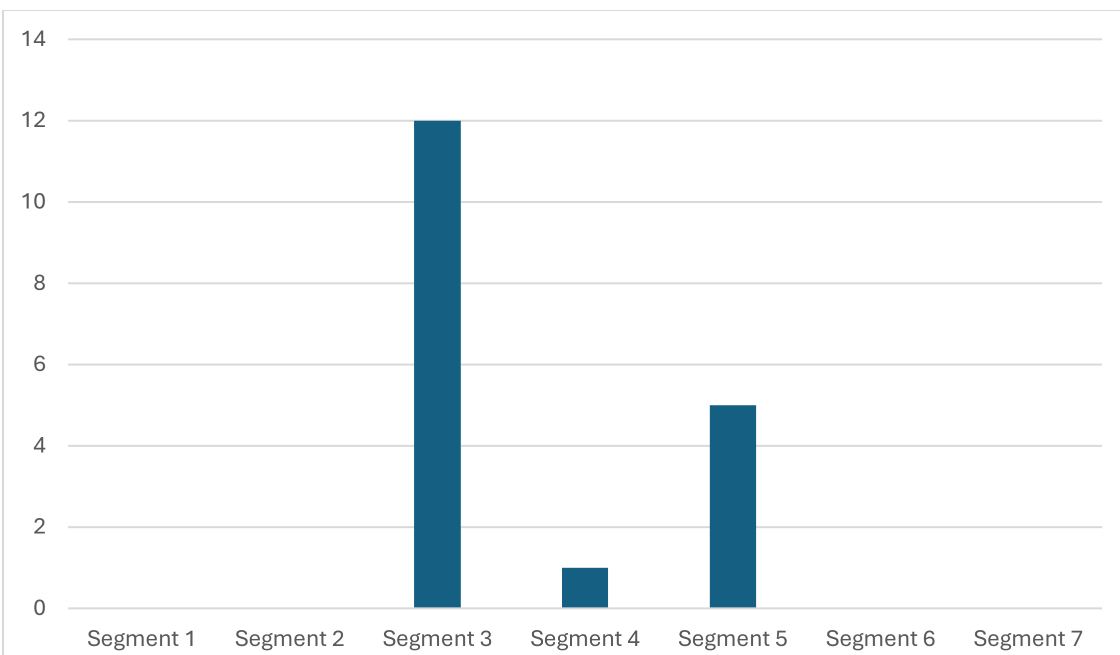

Figure 10. The number of spawning or holding IFC by segment observed during the 2023 SHIM survey on East Barrière River.

Aquatic Habitat Index

The AHI results are outlined in Figure 11. The AHI scores consider not only the amount of fish habitat features, but the relative value of each feature to the key fish species in the East Barrière River. Segments 3, 5, 6, and 7 had the highest fish habitat value, making the greatest contributions to overall fish habitat in the surveyed area. Segment 7 scored well in the AHI mainly because it is one continuous, large deep pool due to its backwatered, slough nature. Despite its high score it may not be suitable rearing habitat since it is homogenous (lacking complexity and frequency of cover), and its lentic nature may create hypoxic conditions.

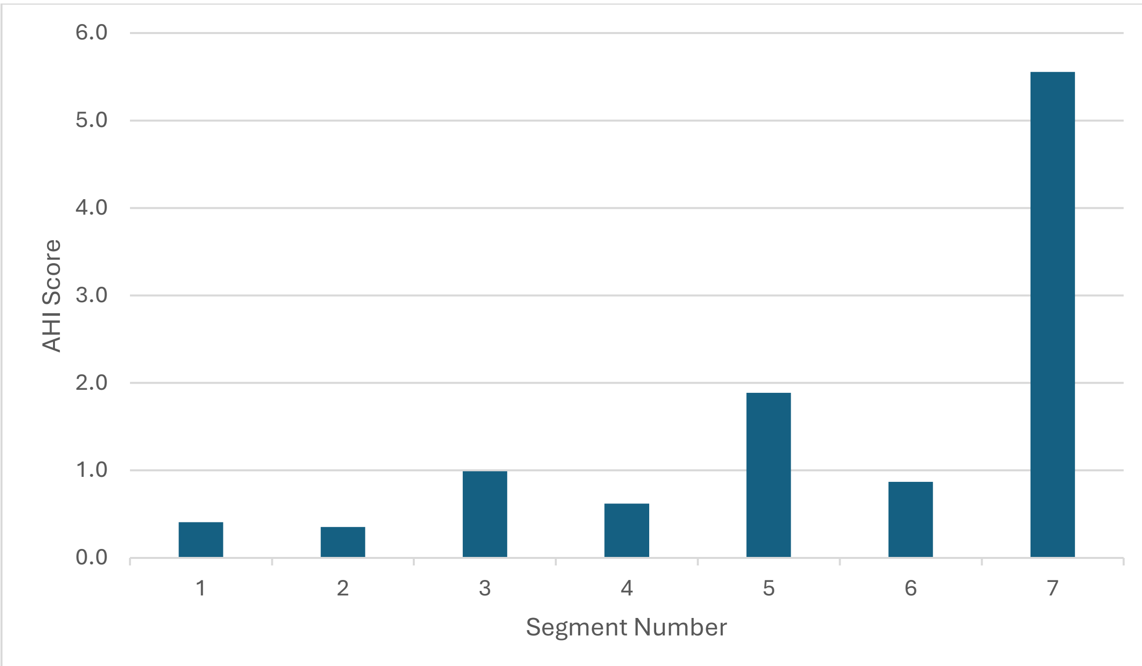

Figure 11. AHI scores of segments in the East Barrière River. Segments 3, 5, 6, and 7 had the highest contribution to fish habitat in the surveyed length of river.

Level of impact

A Level of Impact (LOI) score was calculated for each segment based on its relative bank condition (Table 10). The main impacts observed included alterations to streambanks in the form of riprap, linear and rural developments, and erosion. Segment 3 was rated *Mod-Mod* because of the considerable alterations to the channel at the property near the end of Creekside Road (noted in Figures 4 and 5 above). Segments 4 and 7 had some impacts from rural developments, and Segment 6 was confined by East Barrière Lake FSR in some stretches.

The overall stream condition score for the East Barrière River was 58.5%. This score can be used to monitor changes in stream condition with future assessments, as well as changes in the bank condition of specific segments.

Table 10. Relative impact scores and overall stream condition of the East Barrière River.					
Bank Impact Rating	**Impacted Segments**	**Length of Segment(s) (m)**	**Bank Condition Score**	**% of Stream Length**	**Weighted Segment Score**
High-High			0.00		
High-Mod			1.00		
High-Low			2.00		
High-Nil			3.00		
Mod-Mod	3	965	2.00	13.5%	0.27
Mod-Low	4, 7	2224	3.00	31.2%	0.93
Mod-Nil	6	821	4.00	11.5%	0.46
Low-Low	1, 5	2487	4.00	34.8%	1.39
Low-Nil	2	641	5.00	9.0%	0.45
Nil			6.00		0.14
Total		**7138**			**3.51/6**
Overall Stream Condition					**58.5%**

Discussion

The East Barrière River provides a large amount of high-quality habitat for anadromous and resident salmonids. Anthropogenic disturbance to the channel downstream of East Barrière Lake is limited, however increasing private tracts of land are being cleared along the streambanks. Hundreds of spent pink salmon carcasses were observed in Segment 1, but none were seen upstream of the bridge on South Barrière Lake FSR. This may be because the river becomes too steep for them to swim, since pink salmon are less tolerant of excessive velocities (Bjornn and Reiser, 1991). Segments 3, 4, and 5 had high quality fish habitat with high habitat complexity and were the only segments with spawning or holding IFC observations. Segment 3 had the highest frequency of adult IFC observations, but also had the highest level of streambank and channel disturbance. Segments 6 and 7 were also impacted by alterations to the streambanks but appeared to have less adult fish use. Beaver dams and log jams may obstruct fish passage, and partial removal during migration timing is an effective strategy for enabling upstream fish passage. Due to the timing of the survey and given that most coho that were observed were holding in pools, it is possible that some fish continued to move upstream into Segments 6 and 7 after the survey was completed.

Past restoration opportunities have mainly been limited to road fill stabilization along East Barrière Lake Road and improvements to drainage structures (Summit Environmental Consultants Ltd., 2001). Current restoration opportunities in East Barrière River are limited. The main goal of future restoration efforts should seek to align with values of collaborators (residents, water managers, fisheries managers, agricultural producers, etc.) to maximize ecological, cultural, and socioeconomic benefits (Fisheries and Oceans Canada, 2023). To achieve this, the goals of restoration should be to:

- Benefit fish habitat by considering the root causes (direct and indirect) of degradation and employing self sustaining solutions.
- Buffer against environmental change (flood and high flow, drought, wildfires) to create ecosystem and community resilience.
- Improve hydrology and water temperature (ex. shading and energy dissipating structures).
- Be feasible (cost-effective solutions that will provide the greatest benefit to ecosystems and land managers).
- Align values, strengthen relationships, and provide opportunities for collaboration.
- Improve condition of species at-risk and culturally important species.

Many of these goals can be achieved by protecting and restoring limited wetland and riparian habitats. The findings of the SHIM survey were used to identify potential restoration sites. Areas with high quality fish habitat and elevated human impacts were prioritized for restoration. The East Barrière River has limited disturbance along its streambanks, and priority restoration can be limited to one specific site at the end of Creekside Road. Restoration efforts should be combined with outreach to residents to ensure that similar construction does not occur within the river without proper permitting and consultation. Recommendations for restoration at this site are outlined in Figure 12 below.

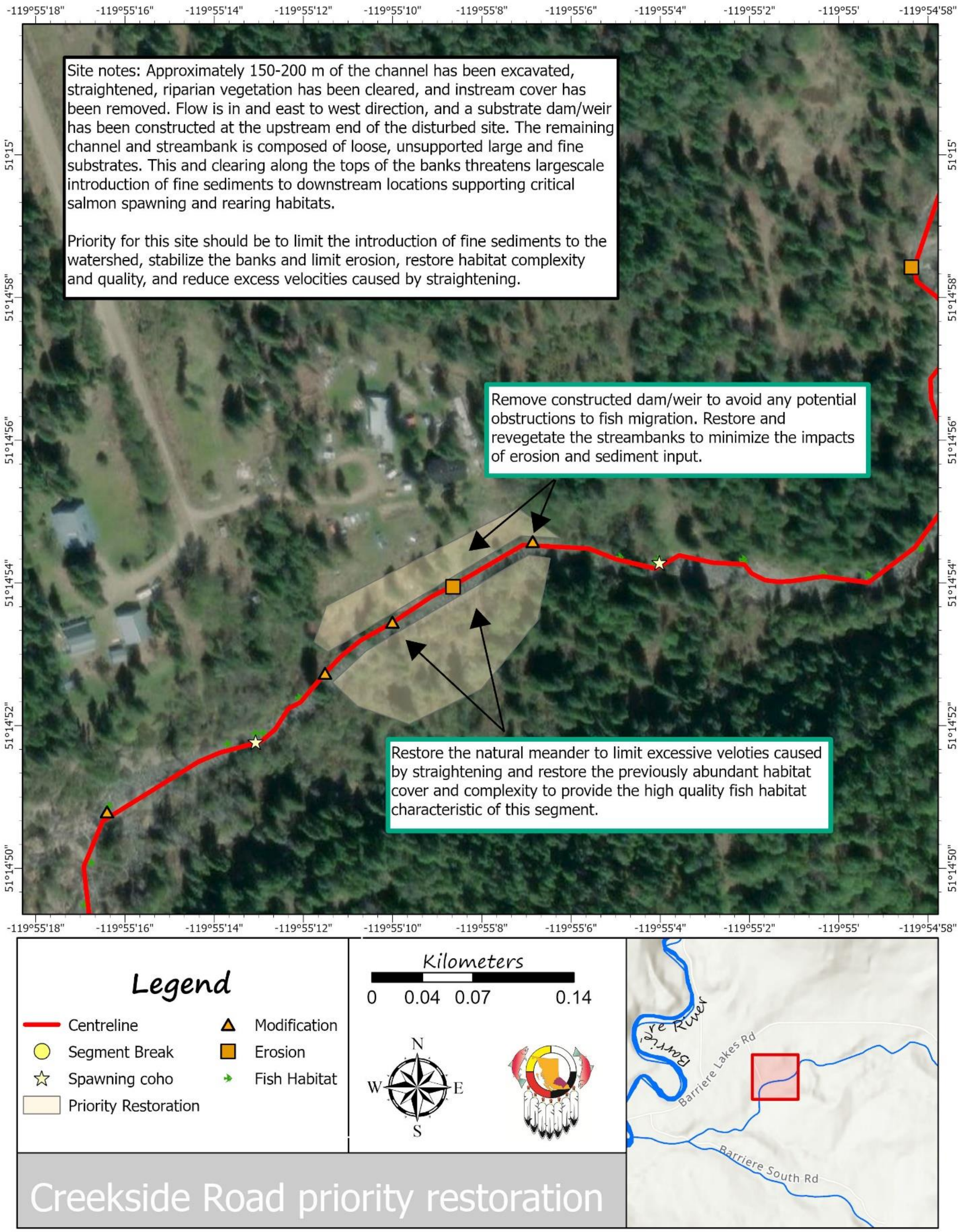

Figure 12. The area identified for priority restoration located near the end of Creekside Road.

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