



# Special Investigation: Conserving Fish Habitat under the Forest and Range Practices Act

PART 2: An Evaluation of Forest and  
Range Practices on the Ground

May 2020

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# BOARD COMMENTARY

This report concludes the Board's two-part project examining the protection of fish habitat under the *Forest and Range Practices Act* (FRPA). In July 2018, the Board published Part 1, which looked at what the BC Government is doing to conserve fish habitat under FRPA. That report concluded there are opportunities to strengthen FRPA's requirements to conserve fish habitat and to monitor FRPA's effectiveness at the watershed scale. The Board encourages readers to review the findings contained in the Part 1 report which is available on our website.<sup>1</sup>

In spring 2018, the Board commenced work on Part 2 (this report) looking at planning, monitoring and what licensees are actually doing on the ground in five case-study watersheds. At the site level, the Board found that practices such as maintaining fish passage and riparian management are quite good. However, sediment from roads into streams was a high risk to fish habitat in three of the five watersheds assessed and requires significant improvement.

In this and other reports, the Board has found most licensees are meeting or exceeding legal requirements for riparian buffers—areas adjacent to streams that are critical for the protection of water quality and fish habitat. While the results for riparian management in this investigation were generally good, the Board did find there is room for improvement on the management of some small streams.

In its 2014 report on Community Watersheds,<sup>2</sup> the Board concluded that a culture of good riparian protection is now entrenched in forest management. The findings of this report reinforce that conclusion. The term *culture* implies that good stewardship is a normal part of forest industry practices. This culture is the result of government setting clear expectations for good riparian management, licensees knowing how to achieve those expectations on the ground, and practicing foresters supporting improved practices as new information becomes available—this is the concept of continuous improvement.

A new culture for the management of sediment from roads into streams is needed! Greater attention must be paid to sediment management in all phases of a road including design, construction, maintenance and deactivation. Government needs to set clear expectations in regulation to minimize sediment to protect fish habitat and water quality. Resource

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<sup>1</sup> <https://www.bcfpb.ca/wp-content/uploads/2018/07/SR56-Fish-Habitat-Conservation.pdf>

<sup>2</sup> <https://www.bcfpb.ca/wp-content/uploads/2016/04/SIR40-Community-Watersheds-From-Objectives-to-Results-on-the-Ground.pdf>

professionals, along with road construction and maintenance operators, need guidance and on-going training on effective methods of erosion and sediment control. In the past couple of years, government has held several training sessions. This is an encouraging start but much more needs to be done to ensure the culture of sediment management is entrenched across the forest industry.

In order to reduce sediment from roads into streams, the Board makes the following recommendations under section 131(2) of the *Forest and Range Practices Act*:

*Government should amend FRPA and/or its regulations to ensure that there is a clear and enforceable requirement to minimize sediment entering streams during road construction, maintenance and deactivation.*

And

*Government should update guidance and standards for road construction and maintenance to clearly identify practices needed to minimize sediment entering streams during road construction, deactivation, and on an ongoing basis during road maintenance.*

These recommendations should be accompanied by government, professional associations, and industry taking steps to raise awareness of the importance of good sediment management on resource roads in BC.

Professional and industry associations can assist by making their members aware of training and development materials that are available for sediment management.

Under section 132 of FRPA, the Board requests a response from government by November 1, 2020.

# EXECUTIVE SUMMARY

In 2018, the Forest Practices Board (the Board) published a special report about conservation of fish habitat under the *Forest and Range Practices Act* (FRPA) (Part 1 of a two-part project). The report describes what the BC Government is doing to conserve fish habitat that overlaps areas of forestry activity under FRPA and found that improvements may be required in relation to:

- how FRPA addresses cumulative effects at the watershed scale;
- the adequacy of riparian buffers adjacent to small streams; and
- the deposition of sediment into streams, primarily from roads.

Also in 2018, the Board started work on a field-based special investigation (i.e., Part 2) to examine whether, and to what extent, planning and practices by forest and range licensees are contributing to the protection of fish habitat at both the site and watershed-scales.

With assistance from staff of the Ministries of Forests, Lands, Natural Resource Operations and Rural Development, and Environment and Climate Change Strategy, the Board selected five case-study watersheds. Selection criteria included watersheds known to support important fish populations, a diverse history of forest harvesting, forest tenure type, range use and other land-uses not regulated by FRPA. In each case-study watershed, investigators assessed whether, and to what extent, licensees are planning for the protection of fish habitat. On the ground, investigators spent up to five days assessing the condition of the watersheds and examining how well licensees are implementing FRPA's requirements for the protection of fish and fish habitat.

The investigation found that licensees in three of the five watersheds are carrying-out planning and assessment at the watershed-scale with the intent of minimizing the hydrological-related effects of forest harvesting on stream channels. However, no monitoring has been done to establish whether the planning and assessment undertaken by licensees is achieving protection of fish habitat.

On the ground, the investigation found that licensees are providing for fish passage at stream crossings, mostly opting to avoid culverts and use bridges and other open-bottom structures on fish-streams. However, to varying degrees in case-study watersheds, other forest and range practices are likely resulting in an existing or potential risk of harm to fish habitat.

The sources of harm to fish habitat include:

- sediment from roads into streams, which is identified as a chronic problem;
- riparian buffers damaged because they are too narrow to withstand the effects of wind;
- livestock access to streams, especially where limited riparian buffers have been retained; and
- site-level impacts from multiple land-uses in addition to forestry and range, which are cumulatively affecting fish habitat.

The deposition of sediment from roads into streams is resulting in a moderate or high existing or potential risk of harm to fish habitat in four of the five case-study watersheds. To lower this risk, improvements are required in how sediment from roads into streams is regulated and how licensees apply well-established practices on the ground to control erosion and sedimentation.

# PURPOSE, SCOPE & APPROACH

## Purpose

Part 1 of the Board's two-part project described and evaluated the BC government's approach conserving fish habitat under the *Forest and Range Practices Act* (FRPA) (published July 2018<sup>i</sup>). Several areas of concern about the conservation of fish habitat were identified in the special report, including:

- the cumulative effects of development activities at the watershed-scale can affect the quality of fish habitat, particularly where there are no legal objectives to manage rate of change in the watershed;
- roads can be a chronic source of sediment into streams and fish habitat;
- riparian retention adjacent to small streams is not always adequate;
- government has been slow to implement the tools under FRPA to address high value and sensitive fish habitat requiring special management; and
- government does limited monitoring of the effectiveness of FRPA at the watershed-scale and only for watersheds at high risk.

Part 2 (this report) was initiated in 2018 as a field-based special investigation to evaluate:

1. licensees' compliance with FRPA's requirements to protect fish habitat; and
2. whether, and to what extent, planning and on the ground practices by forest and range licensees are contributing to the protection of fish habitat at both the site and watershed-scales in case-study watersheds.

## Changes to investigation approach

The Board originally intended to assess licensees' compliance with FRPA's practice requirements as they relate to the protection of fish and fish habitat. However, as the investigation was proceeding, it became apparent that FRPA's primary requirement for the protection of fish habitat (section 57 of the *Forest Planning and Practices Regulation* [FPPR]) has limitations in its application to some factors that have the potential to affect fish habitat. Notably, investigators identified sediment from roads into streams as a chronic problem affecting fish and fish habitat in most case-study watersheds.

Section 57 suggests that *likely harm to fish or fish habitat* must be avoided when carrying out a *primary forest activity*, which includes road construction, maintenance and deactivation. The Board found that

avoidable harm is frequently the result of the *failure* to carry out adequate road maintenance, rather than the act of *carrying out* maintenance activities.

Sedimentation from roads into fish habitat occurs at any time, particularly during and after inclement weather. Therefore, much of the harmful result that section 57 seeks to avoid is not necessarily related to when or how a person is carrying out a primary forest activity. The harm is the result of acts of omission rather than commission.<sup>3</sup> With respect to sediment, the legislation does not create a positive duty to carry out the maintenance activities that are necessary to minimize sediment from roads into streams.<sup>4</sup> This is in contrast with FRPA's requirements for fish passage (section 56 of the FPPR). In this section, FRPA requires fish passage to be provided at the time the stream crossing structure is installed (section 56[1]) and fish passage must be maintained on an on-going basis (section 56[2]).

In light of the limitations that exist in the current legislation, the Board decided to examine all planning and practices with a lens on effectiveness, rather than compliance.

## Scope

The investigation focused on forest and range practices occurring in a 10-year period between 2009 and 2018 (referred to as FRPA-era). Forest harvesting that occurred during the Forest Practices Code (1995-2005), prior to 1995 (pre-Code) and roads that no longer have maintenance obligations (referred to as *non-status roads*) were also considered. Observations were made of other land-uses in the watershed, however, the effects of these land-uses on fish habitat were not specifically evaluated.

Since a case-study approach was used, the findings should not be directly extrapolated to other watersheds in BC that were not field-assessed. The case-study approach does, however, provide indications of the variety of existing and potential risks affecting effective fish habitat conservation under FRPA, as well as from other land-uses.

### FRPA's Practice Requirement for the Protection of Fish Habitat

Section 57 of the FPPR: "An authorized person who carries out a primary forest activity must conduct the primary forest activity at a time and in a manner that is unlikely to harm fish or destroy, damage or harmfully alter fish habitat" (similar requirements exist in FRPA regulations pertaining to range agreement holders and woodlot licensees).

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<sup>3</sup> While section 5 of the *Offence Act* provides that "omitting to do an act that [an enactment] requires to be done" is also an offence, section 103 of FRPA stipulates that this section of the *Offence Act* does not apply.

<sup>4</sup> There is a duty to maintain a road in section 79(6) of the FPPR, but it is limited to protecting the structural integrity of the road prism and clearing width, ensuring drainage systems are functional, and ensuring it is safe for industrial users. Section 81 has similar limitations for wilderness roads that are not being used by industrial users, although it includes a duty to ensure there is no material adverse effect on a forest resource.



# Approach

## Selection of case-study watersheds

Investigators used a case-study approach to examine five watersheds across BC (see Figure 1 and Table 1).<sup>5</sup> Watersheds were selected with input from regional planners and fish habitat specialists within the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) and the Ministry of Environment and Climate Change Strategy. The selected watersheds represent:

- various levels of special management in place to conserve fish habitat;
- a mix of fish habitat values and locations across BC (each of the three FLNRORD regional areas are represented);
- a mix of historical forest use, as well as planning and practices under FRPA between 2009-2018, and range agreements; and
- watersheds between 5 000 and 22 000 hectares in area (a watershed or sub-basin of a larger watershed), to ensure adequate coverage during the available time for fieldwork.

Appendix 1 shows the case-study watersheds within various FLNRORD administrative boundaries and the number of forest licensees and range agreement holders operating in the watersheds. Appendix 2 provides additional information on fish values, rationale for case-study selection and land-uses in the watersheds.



**Figure 1.** Location of case-study watersheds.

<sup>5</sup> The Board selected five watersheds as a sufficiently reasonable sample to identify potential factors affecting fish habitat on the ground.

**Table 1.** Location and Rationale for Case-Study Watershed Selection

CASE-STUDY WATERSHED	FLOWS INTO	WATERSHED AREA (HA)	NEAREST CITY/TOWN	RATIONALE FOR SELECTION AS A CASE-STUDY WATERSHED
Ainslie	Fraser River	8,236	Boston Bar	The south part of the watershed presents a unique opportunity to assess harvesting that has only occurred since 1997 (just after the Forest Practices Code came into effect); recent forest practices under FRPA
Memekay	Salmon River	21,700	Campbell River	High fisheries values; early example of designated fisheries sensitive watershed (FSW) <sup>6</sup> under the Forest Practices Code and continued under FRPA (2005); extensive monitoring by the Forest and Range Evaluation Program; recent forest practices under FRPA.
Owen	Morice River	21,301	Houston	High fisheries values; candidate FSW; recent forest practices under FRPA; multiple other land-uses.
Pennask	Pennask Lake	8,981	Kelowna	High fisheries values; Pennask Creek Provincial Park corridor along mainstem; recent forest practices and range use under FRPA; multiple other land-uses.
Woodjam	Horsefly River	7,916	Horsefly	High fisheries values; recently designated as a FSW (2018); fish habitat-related requirements within a land-use order; agriculture in lower reaches; recent forest practices and range use under FRPA.

## Investigation team

The investigation team consisted of three professional biologists, of which two are fish habitat specialists and the third is a specialist in erosion and sediment control. The team also included a forest hydrologist.

## Watershed level planning, assessment and monitoring

Investigators reviewed the content of applicable forest stewardship plans and watershed-type assessments prepared by licensee professionals, as part of evaluating the licensees' overall approach to conserving fish habitat in case-study watersheds. The Forest and Range Evaluation Program's (FREP) staff were consulted to discuss monitoring undertaken within the case-study watersheds and all available information on fish species, distribution and habitat assessment was obtained from FLNRORD staff or government databases.

Interviews were conducted with FLNRORD and Ministry of Environment and Climate Change Strategy staff (in headquarters, regions and natural resource districts), as well as forest licensees, range agreement holders, and various professionals retained by licensees and government.

To facilitate field assessments and site selection, investigators described physical characteristics including topography, climate, soil, vegetation, channel structure, history of forest harvesting, range use and other land-uses for each case-study watershed.

<sup>6</sup> FSW is a designation under the *Government Actions Regulation* (a regulation of FRPA). The designation enables government to establish legal objectives for the conservation of fish habitat (see endnote reference 'i' for further information).

## **Field-based evaluation of practices with the potential to impact fish and fish habitat**

### **Overview**

This investigation used a *rapid assessment* or *reconnaissance-level* approach, where up to five days of fieldwork was allocated for each case-study watershed to examine fish passage, sediment from roads into streams, riparian buffers, range use and channel condition.

Prior to conducting site assessments, in most watersheds investigators completed an aerial overview of the watershed by helicopter to gain a better perspective of the watershed, land-uses and to identify possible issues warranting further assessment on the ground. During fieldwork, most roads in the watersheds were travelled by vehicle and considerable portions of the mainstem channels were traversed on foot. Travelling most roads by vehicle enabled examination of the majority of stream crossings and livestock trails from roads to riparian areas.

### **Fish passage**

Fish passage was assessed at culvert structures (installed after 1995) on confirmed fish-streams using a methodology developed by the Ministry of Environment and Climate Change Strategy.<sup>ii</sup>

### **Sediment from roads into streams**

The amount of fine sediment from roads into known fish-streams or direct tributaries to fish-streams was quantified using FREP's water quality effectiveness evaluation protocol.<sup>iii</sup> The protocol was used where investigators visually observed that sediment was entering streams or had the potential to enter streams at thresholds that appeared to exceed the low (i.e., <1.0 m<sup>3</sup>/year) rating category established in the protocol.

### **Riparian buffers**

The effectiveness of riparian buffers was derived from the indicators used to assess channel condition (see methodology for channel condition).

### **Range use**

Where range use related impacts to fish habitat were identified, investigators visually estimated damage to the stream channel, as well as impacts to spawning, rearing and overwintering habitat.

### **Channel condition**

Most channel condition assessments were completed along stream/riparian reaches that were in direct proximity to FRPA-era forest harvesting. Some assessments were completed along known fish bearing mainstem reaches to assess overall channel condition that could be affected by both FRPA-era forest harvesting and cumulative land-uses within the watershed. Factors affecting channel condition were identified at a site only where a direct and

positive link could be made to stream condition; otherwise they were recorded as unknown.

The assessment of channel condition used a rapid *proper functioning condition* approach based on a checklist adapted, in part, from FREP’s fish/riparian protocol.<sup>iv</sup> The checklist (see Appendix 3) was completed by visual observation and measurements were only obtained if indicators were not clearly over or under the threshold values.

**Site selection and interpreting existing or potential risk of harm to fish habitat**

The selection of sites examined in the case-study watersheds was primarily targeted to forest and range practices regulated under FRPA (e.g., roads, cutblocks and range use) (see *Scope* section of this report).

Given the rapid assessment nature of the field investigation, detailed site assessments for factors including sediment from roads into streams and range use were only completed if there was an observed existing or potential risk of harm to fish habitat.

For each factor examined in the field, a ranking of low, moderate or high existing or potential risk of harm to fish habitat at the watershed-scale was assigned. The ranking of risk is professional opinion determined by the investigation team based on several considerations including:

- the cumulative magnitude of existing impacts and potential risks identified at individual sites;
- the known presence of fish; and
- the quality and quantity of fish habitat affected.<sup>7</sup>

The rankings reflect the existing or potential risk of harm to fish habitat at the time the values were assessed.

<sup>7</sup> For channel condition, the ranking of risk was determined by professional opinion based the percentage of total sites assessed in each case-study watershed that were in proper functioning condition or functioning condition but at risk as follows: 70 percent or greater = low; 40-69 percent = moderate; 39 percent or less = high.

**What information can channel condition assessments provide about cumulative effects?**

Channel condition assessments provide information about the current condition for a variety of indicators within and adjacent to stream channels (i.e., the riparian area). If channel condition has been impacted then it is likely that fish habitat has also been affected.

The factors affecting channel condition, like harvesting, other land-uses or natural landslides, are mostly cumulative (meaning multiple factors) in nature and provide information about why fish habitat in the watershed may be impacted.

The assessment is completed on fish-streams, as well as non fish-streams. This is because all streams within a watershed contribute to the productive capacity of fish habitat.

**What is the difference between existing vs. potential risk of harm to fish habitat?**

EXISTING	POTENTIAL
Sites where damage to fish habitat was <u>visible</u> and quantified. For example, this would include a stream channel impacted by trees that have blown over and damaged the stream channel; heavy livestock use within the high water mark of a stream or an impassable culvert structure, etc.	Sites where damage to fish habitat was likely but <u>not visible</u> . For example, the amount of sediment that has eroded from a road and deposited into a stream can be measured. However, due to fast flowing water etc., it is often not possible to measure the impact to fish habitat because the sediment was carried downstream.

# RESULTS & DISCUSSION

## Watershed protections, planning and monitoring

### Watershed protections



*Pennask Creek within the Pennask Creek Provincial Park. This creek is widely recognized as being one of the most important rainbow trout streams in BC and possibly North America.*

Three case-study watersheds (Memekay, Pennask and Woodjam) have some type of protections in place—in addition to FRPA’s practice requirements—to protect fish habitat.

The Memekay watershed was designated a fisheries sensitive watershed (FSW) under the Forest Practices Code and continued under FRPA (2005). The legal order creating the FSW includes general objectives around the amount, timing and distribution of forest harvesting. In the Pennask watershed, a provincial park was established following completion of the Okanagan

Shuswap Land and Resource Management Plan (2001). The park consists of a 250+ metre wide corridor along the majority of the mainstem of Pennask and Sunset Creeks. Forestry activities are not permitted in the park but range use that existed prior to the establishment of the park is allowed to continue.

In 2005, government published the *Horsefly Sustainable Resource Management Plan* (includes the Woodjam sub-basin), which documents land-use, watershed values and provides non-legal direction for implementing the *Cariboo-Chilcotin Land use Plan Order*.<sup>v</sup> Specific to the Woodjam watershed, the order requires enhanced riparian management adjacent to small fish-streams (i.e., streams less than 1.5 metres in width). In 2018, the Horsefly was designated as a FSW. The order includes specific objectives related to the deposition of sediment from roads into streams, fish passage, landslides and riparian management. Although objectives for the Horsefly FSW have legal effect, the two-year transition period provided in FRPA has not yet passed and so the objectives are not required to be incorporated into licensees’ forest stewardship plans until June 2020.

### Licensee planning and assessment

In three of the five watersheds (Memekay, Owen and Woodjam) licensees have conducted watershed-level assessments with the intent of limiting the

negative hydrological responses of harvesting on stream channels.<sup>8</sup> In the Memekay watershed, the one forest licensee commits in its forest stewardship plan to complete regular watershed-level assessments, including monitoring, if the equivalent clearcut area exceeds 20 percent. The most recent watershed assessment was completed in 2011 and, according to the licensee, the next assessment will be completed in 2021.

Although there are no FRPA-related watershed protections in the Owen watershed, in 2018, one licensee retained a qualified professional to conduct a GIS-based watershed-level risk assessment as part of implementing its sustainable forest management plan—a voluntary commitment under its forest certification system. The assessment indicates that, based on a number of factors, the Owen watershed has a very high watershed sensitivity rating. Various levels of maximum equivalent clearcut area are recommended in order to achieve a low, moderate or high risk rating (the report does not state the current equivalent clearcut area of the watershed). This assessment was completed prior to a wildfire that burned a large part of the southern end of the watershed.

For the Woodjam watershed, forest licensees conduct voluntary updates to watershed-level assessments every one to two years. The most recent update indicates an equivalent clearcut area of around 30 percent. Licensees told investigators they will collaborate on planning and assessment in the future to meet the 20 percent equivalent clearcut area threshold set out in the FSW order.

For all three watersheds, the assessments completed by licensees do not include a description of the existing extent or quality of fish habitat or the relationship between the equivalent clearcut area threshold and the expected hydrological response from harvesting (i.e., how will limiting the equivalent clearcut area reduce the negative hydrological responses of harvesting on fish habitat and/or fish abundance and how will it be monitored?).

## Monitoring

FREP has completed eight watershed-scale effectiveness monitoring projects on fish/riparian condition across BC in watersheds where forestry and range are the primary land-use. Two of those watersheds (Memekay and Owen) were selected for this investigation.

The results of fish/riparian (i.e., channel condition) monitoring in the Memekay watershed (data collected in 2012), were published by FLNRORD in 2018 and incorporated into this report. The investigation team field-checked data collected by FREP on the ground and completed several

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<sup>8</sup> Refer the Forest Practices Board's Part 1 report on conserving fish habitats for further information on hydrological assessments.

additional assessments. Water quality effectiveness evaluation data were considered but not directly incorporated into the report. This is because the amount of sediment loss at stream crossings may have changed significantly since the initial data was collected in 2012.

### **Importance of Frequent Monitoring of Land-Use Activities in Watersheds**

Investigators observed examples where the condition of watersheds resulting from some land-uses had changed over time, but the change was not always negative.

For example, in 2010, the Ministry of Environment and Climate Change Strategy completed a risk assessment of land-uses affecting fish habitat in the Pennask watershed. The report identified several sources of impact including chronic sediment from roads and widespread range-use related impacts.

During 2018, when investigators assessed the Pennask watershed, they also identified chronic sediment from roads, however, range use was not a significant problem, unlike the 2010 findings.

Investigators did not identify the reason for the change in condition regarding range use. However, one explanation could be modified range practices that were implemented after the 2010 report was published.

2014 fish/riparian monitoring data collected for the Owen watershed was not incorporated into the Board's report because the information has not yet been published by FLNRORD.

In 2013, the Office of the Wet'suwet'en completed a GIS-based analysis of fish habitats in the Owen. For the Pennask and Woodjam watersheds, regular inventories of fish populations had been done, but there was no watershed-scale effectiveness monitoring to link FRPA activities to the condition of fish habitats. No watershed-scale monitoring had occurred in the Ainslie.

Some site-level monitoring (referred to as resource stewardship monitoring) has been done in the case-study watersheds. For the assessment of fish/riparian (i.e., channel condition), FREP has completed 11 sites: 6 are in the Memekay watershed; 2 are in the Owen and 1 site each in

the Ainslie, Pennask and Woodjam. For the water quality effectiveness evaluation (i.e., sediment from roads into streams), 89 sites have been assessed including 30 sites in the Ainslie watershed and 59 sites in the Memekay watershed.

## **Field-based evaluation of practices**

In the five case-study watersheds, investigators examined fish passage and sediment from roads into streams at 200 sites over 133 kilometres of road. Investigators assessed a total of 47 sites to evaluate the effects of harvesting on riparian buffers and channel condition (an additional 48 sites for the Memekay watershed obtained by FREP were included in the investigation). The effects of range use on fish habitat were examined in three case-study watersheds (there was limited or no range use in two watersheds) (see Table 2).

**Table 2.** Number of Sites Assessed in the Case-Study Watersheds

CASE-STUDY WATERSHED	NUMBER OF SITES / KMS OF ROAD ASSESSED TO EXAMINE FISH PASSAGE AND SEDIMENT FROM ROADS INTO STREAMS	NUMBER OF SITES ASSESSED TO EXAMINE RIPARIAN BUFFERS AND CHANNEL CONDITION	AREA ASSESSED TO EXAMINE RANGE USE
Ainslie	80 sites/32 kms of road	13	No range use
Memekay	14 sites/17 kms of road	50 (48 by FREP* in 2012)	Limited range use
Owen	28 sites/39 kms of road	11	Watershed-wide
Pennask	32 sites/27 kms of road	14	Watershed-wide
Woodjam	46 sites/18 kms of road	7	Watershed-wide
<b>Total</b>	<b>200 sites/133 kms of road</b>	<b>95 (48 by FREP)</b>	

\*FREP – Forest and Range Evaluation Program

## Fish passage

Since 1995, forest licensees have been required to maintain fish passage at stream crossings.<sup>9</sup> This investigation did not find fish passage issues on stream crossing structures installed after 1995 (Table 3).<sup>10</sup> This is because licensees avoided installing structures, like closed-bottom culverts, that often result in a partial or full barrier to fish passage. Instead, licensees chose to install open-bottom structures, like bridges, on fish streams.

The findings in this investigation related to fish passage are very positive. The good outcome likely reflects the clear requirements for fish passage in FRPA and significant investments that government made since 1995 in providing training and guidance (like the Fish-stream Crossing Guidebook) to forest licensees.

In most of the case study watersheds—similar to all watersheds provincially—there are some culverts installed before 1995 that are barriers to fish passage. Restoration of fish passage at older culvert structures is led by government on a priority basis based on available funding.

## Sediment from roads into streams

In contrast to fish passage, investigators found significant problems related to sediment from roads getting into streams and fish habitat. Of the 200 sites assessed on the ground, 50 were identified as a sediment source and at 37 of those 50 sites, sediment is impacting or has the potential to impact fish habitat.

In four of the five case-study watersheds, investigators found that sediment from roads is resulting in a ‘moderate’ (Woodjam) or ‘high’ (Ainslie, Owen

**Table 3.** Fish Passage: Existing or Potential Risk of Harm to Fish Habitat at the Watershed-Scale

CASE-STUDY WATERSHED	LEVEL OF RISK
Ainslie	Low
Memekay	Low
Owen	Low
Pennask	Low
Woodjam	Low

<sup>9</sup> See requirements for fish passage in section 56 of the FPPR (similar requirements exist in FRPA regulations pertaining to range agreement holders and woodlot licensees).

<sup>10</sup> The level of risk assigned in Table 3 only applies to culvert structures installed since 1995. Older culvert structures that exist in the watersheds were not assessed but may be impacting fish passage.



**Table 4.** Sediment From Roads: Existing or Potential Risk of Harm to Fish Habitat at the Watershed-Scale

CASE-STUDY WATERSHED	LEVEL OF RISK
Ainslie	High
Memekay	Low
Owen	High
Pennask	High
Woodjam	Moderate

and Pennask) existing or potential risk of harm to fish habitat at the watershed-scale (Table 4). Most of the factors contributing to sediment from roads could have been avoided by following long-established erosion and sediment control best management practices, many of which are developed by or available to licensees (see endnotes vi and vii for examples).

Factors identified by investigators in the four watersheds include, but are not limited to:

- exposed soil surfaces resulting from a lack of or ineffective re-vegetation;
- older stream or cross-drain culverts damaged and/or plugged with sediment and debris;
- long grader berms without breaks necessary to divert water away from streams and into the forest;
- road surface not crowned or sloped towards stream crossings;
- road surface erosion depositing sediment directly into fish-streams or tributaries to fish-streams;
- soil accumulation on bridge decks releasing sediment into fish-streams;<sup>11</sup>
- stream openings used as *snow dumps*, resulting in sediment mixed with snow to be deposited directly into fish habitat; and
- poorly designed or not maintained water control structures such as ditch blocks.

### Effects of Sediment on Fish

If sediment enters streams beyond natural (or background) levels, it can impact fish, fish habitat and other aquatic organisms by:

- covering spawning beds; entrapping or smothering incubating fish eggs;
- affecting the ability of fish to obtain required oxygen from water;
- covering feeding areas and reducing benthic invertebrate abundance and production; and
- reducing feeding efficiency and changing the general movement behaviour of fish.

Even though fish are adapted to survive in streams that occasionally experience high sediment loads (for example, in spring freshet), long term studies demonstrate that elevated sediment levels caused by humans are harmful or lethal to fish.

In addition to roads, in some watersheds landslides (potentially linked to historical harvesting and roads) were contributing sediment to streams.

In the Memekay watershed, most roads appeared to have low surface erosion and low delivery of sediment to fish habitat. As a result, the existing or potential risk of harm to fish habitat at the watershed-scale is rated as *low*. This finding is generally consistent with the results of monitoring undertaken in the Memekay watershed by the FREP in 2012.

<sup>11</sup> In the Pennask watershed, one licensee installed “sediment stops” on the edge of bridge decks and had a program to clean bridge decks that it was responsible for at least once annually.

Investigators observed several practices leading to the positive results in the Memekay including the crowning of roads, surfacing roads with coarse material and well vegetated ditches. Also, many bridge structures were installed so they are higher than the road approaches, reducing the potential for surface runoff to enter streams. Overall, sediment management practices in the Memekay were good, resulting in a low risk to fish habitat.

Despite the extensive scientific literature on the effects of sediment on fish and the numerous industry and government published best management practices, there appeared to be a lack of regard for the importance of limiting sediment from roads into streams in four of the five case-study watersheds. But it is unclear why managing sediment from roads remains an issue, as the measures are typically cost effective and straightforward to implement. It is possible that the limitations and lack of clarity of FRPA’s primary fish habitat protection requirement (section 57 of FPPR) does not help to ensure that controlling sediment is at the forefront of road construction, maintenance and deactivation. Also, a lack of awareness and training for people responsible for road construction, maintenance and deactivation could be contributing factors.

In the Woodjam watershed, sediment-related objectives in the FSW order may be one solution to addressing the limitations of section 57. Once the order is incorporated into forest stewardship plans, licensees will be required to ensure that sediment deposition into a stream at a crossing does not exceed a low rating criterion, as defined in FREP’s water quality effectiveness evaluation’ protocol (i.e., < 1.0m<sup>3</sup>/year). The benefit of this objective for the Woodjam is that compliance can be easily determined. However, the objective does not address the cumulative effect of sediment from multiple stream crossings in the watershed.<sup>viii</sup>

## Riparian buffers

**Table 5.** Riparian Buffers: Existing or Potential Risk of Harm to Fish Habitat at the Watershed-Scale

CASE-STUDY WATERSHED	LEVEL OF RISK
Ainslie	Low
Memekay	Low
Owen	Moderate
Pennask	Low
Woodjam	Low

as a result, had a low existing or potential risk of harm to fish habitat (Table 5).



*In some areas, the Morice-Owen Forest Service Road is located immediately adjacent to Owen Creek—a high value fish-stream. Sediment from the road directly enters the stream. In these areas, the riparian buffers have also been impacted.*

In all five case-study watersheds, riparian buffers retained by licensees during harvesting met or exceeded requirements set out in FRPA and, in the case of the Woodjam watershed, additional requirements in the Cariboo-Chilcotin Land Use Plan Order. In the Memekay, Pennask and Woodjam watersheds, riparian buffer retention was effective and, as

In these watersheds, investigators identified several different practices that likely contributed to effective riparian buffers:

- retained 10-metre wide no-harvest buffer adjacent to small streams (streams generally less than 1.5 metres wide);
- variable amounts of basal area retention adjacent to streams;
- use of a riparian budget approach, where variable buffer widths are applied according to local site characteristics; and
- implementing various strategies to address the risk of windthrow.

### Managing Windthrow in Riparian Buffers

There are well-established best management practices to reduce or prevent windthrow (see photo). The principles are the same for managing windthrow risk on the coast and the interior but timing and patterns of winds are complex and differ significantly based on local topography, harvesting patterns and soils.

Because of these complexities, it may be helpful to ensure that results and strategies for riparian management in forest stewardship plans provide sufficient flexibility so that forest professionals can vary riparian management according to site conditions and windthrow risk.



In the Owen watershed and, to a lesser extent the Ainslie watershed, some retained buffers on small, non-fish-bearing streams were not effective because they had been impacted by windthrow. In addition, harvesting related slash was left in the channel on 4 of 11 sites in the Owen and 2 of 13 sites in the Ainslie. On sites affected by windthrow, trees were uprooted immediately adjacent to the channel and there was a high number of downed trees within the channel itself. Investigators generally observed that the initial buffers retained by licensees were likely too narrow to withstand the effects of wind. Also in the Owen, in some areas the Morice-Owen Forest Service Road is immediately adjacent to Owen Creek and riparian buffers have been impacted. Overall, riparian buffers in the Owen watershed are rated as having moderate existing or potential risk of harm to fish habitat at the watershed-scale (Table 5).

Monitoring by FREP has shown that impacts often occur to small streams when riparian vegetation is removed.<sup>ix</sup> Where some level of riparian buffers adjacent to streams were in place in case-study watersheds, investigators generally observed sound stream channel condition, unless factors such as natural disturbance, windthrow or sediment from roads into streams were influencing the sites.

The role of riparian buffers in the protection of fish habitat and overall watershed health is well known. Therefore, harvesting near streams requires careful consideration of windthrow risk and application of best management practices to ensure that riparian buffers are wind firm.

## Range use

In the Pennask and Woodjam watersheds, range use has caused site-level impacts to fish habitat. In all cases where livestock damage to streams was identified, the riparian buffer had been removed. On the highest impact sites, the riparian buffer was removed because of non-forestry land-uses.

In the Woodjam watershed, long-term livestock access to a section of the lower reach of Woodjam Creek has impacted the functional condition of about 300 metres of fish habitat. At this site, much of the riparian vegetation (tree cover) appears to have been removed many decades ago and has not recovered. Based on the amount of fish habitat impacted and the importance of the lower reach of Woodjam Creek for salmon, the level of existing or potential risk of harm to fish habitat for the watershed is rated as moderate (Table 6).

In addition to this site, a small assumed fish-stream adjacent to a recently harvested cutblock was found to be *not properly functioning* and the primary factor was damage by livestock.<sup>x</sup>

In the Pennask watershed, livestock use is causing impacts to fish habitat in Pennask Creek at two sites. However, the overall existing or potential risk of harm to fish habitat at the watershed-scale is rated as low (Table 6). One site is located within the clearing width of a powerline transmission corridor. At the site, users of off-road vehicles have pioneered a crossing of Pennask Creek and investigators observed heavy use of that area by livestock. The other site is under the bridge crossing of Pennask Creek on the Coquihalla Connector. At this site, about 100 metres of fish habitat has been impacted by livestock. Impacts include trampling of riparian vegetation and portions of the stream channel banks (the fish habitat within the channel itself is largely intact). Livestock access to the site is the result of the removal of all trees to facilitate installation of the bridge structure as well as an access road that is situated immediately adjacent to the creek.

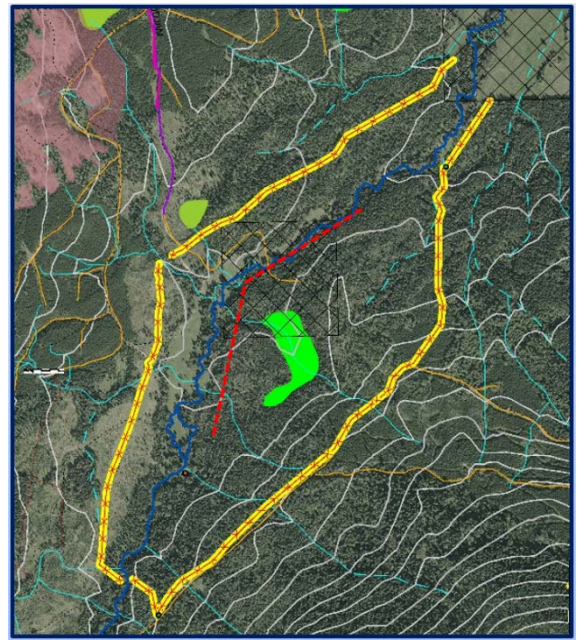
**Table 6.** Range Use: Existing and/or Potential Risk of Harm to Fish Habitat at the Watershed-Scale

CASE-STUDY WATERSHED	LEVEL OF RISK
Ainslie	No range use
Memekay	Low
Owen	Low
Pennask	Low
Woodjam	Moderate

## Positive Steps Taken to Address Issues Identified in the Case-Study Watersheds

Once the field-work portion of the Board’s investigation was complete, investigators discussed watershed specific observations with forest licensees, range agreement holders and FLNRORD staff.

In the lower reaches of the Woodjam, for example, investigators observed that prolonged livestock use had impacted about 300 metres of fish habitat (see red dotted line on map). Following field work, investigators arranged an on-site visit with the range agreement holder and FLNRORD range staff. After the meeting, range staff started the process to fence off the affected area of the creek (see photo)—an investment of nearly \$80,000.



## Channel condition

Investigators completed a total of 47 channel condition assessments in the 5 case-study watersheds. An additional 48 channel condition assessments were completed in the Memekay watershed in 2012 by FREP and were the primary basis for the overall assessment of channel condition in that watershed (see Table 7 and Appendix 4, which provide additional details about the functioning condition of channels assessed).

**Table 7.** Channel Condition: Existing or Potential Risk of Harm to Fish Habitat at the Watershed-Scale

CASE-STUDY WATERSHED	PROPERLY FUNCTIONING CONDITION (PFC)	FUNCTIONING BUT AT RISK (FR)	FUNCTIONING BUT AT HIGH RISK (FHR)	NOT PROPERLY FUNCTIONING (NPF)	TOTAL	LEVEL OF RISK
Ainslie	6	2	2	3	13	Moderate
Memekay	18	13	11	8	50	Moderate
Owen	2	4	3	2	11	Moderate
Pennask	13	1	0	0	14	Low
Woodjam	4	1	0	2	7	Low
<b>Total</b>	<b>42 (45%)</b>	<b>21 (23%)</b>	<b>16 (17%)</b>	<b>15 (15%)</b>	<b>95</b>	

### What is a ‘functioning condition’ assessment?

It is a measure of overall riparian, stream and aquatic habitat condition or “health”. A stream channel in ‘properly functioning condition’ (PFC) is healthy. Three other categories are used to define declining stream channel health. A channel in the poorest condition (unhealthy) is ‘not properly functioning’ (NPF). Appendix 3 describes the indicators used to assess functioning condition.

The Ainslie, Memekay and Owen watersheds all had less than 70 percent of sites in *properly functioning condition* or *functioning but at risk*. As a result, the watersheds were assigned a moderate level of existing or potential risk of harm to fish habitat.

For the Ainslie watershed, factors affecting channel condition include natural and FRPA-era landslides, impacts from non-status roads and forest debris left in the stream channel during FRPA-era harvesting.

In the Memekay watershed, riparian monitoring by FREP found that the functioning condition of the watershed was impaired due to extensive pre-Code (prior to 1995) streamside harvesting, as well as naturally occurring landslides. The Board's assessment of the watershed is consistent with those findings. Additionally, investigators suspect that the productive capacity of fish habitat will not likely improve without implementing a variety of channel restoration strategies (typically the responsibility of government).

High levels of windthrow damage to riparian buffers (FRPA-era harvesting) and significant and widespread freshet flooding were the primary factors affecting functioning condition in the Owen watershed. Riparian buffers intended to be retained adjacent to small stream channels were likely too narrow in relation to site factors such as wind patterns, soils and topography.

For the Pennask and Woodjam watersheds, greater than 70 percent of the sites assessed were in *proper functioning condition* or *functioning but at risk*. As an indicator of watershed-scale functioning condition, these watersheds have a low existing or potential risk of harm to fish habitat.

Of all case-study watersheds, the Pennask had the greatest variety of land-uses including forestry, the Coquihalla Connector highway, range use, recreation, water diversion, wind power, transmission lines and an egg-take station as part of the provincial Freshwater Fisheries Society of BC lake stocking program. Despite the multiple land-uses, the watershed had 100 percent of sites in the top two condition categories (properly functioning condition and functioning but at risk). Pennask Creek Provincial Park, which consists of a 250+ metre wide protected corridor along the mainstem of Pennask and Sunset Creeks, is likely a significant factor in the functioning condition of sites assessed.

### Effects of Historical Harvesting

The Memekay watershed has a long history of harvesting with over 70 percent of the watershed logged since the 1940s and very high road densities at 2.7 km/km<sup>2</sup>. Watershed-scale monitoring by FREP in 2012 found that riparian and stream channel condition was impaired, mainly due to the effects of pre-1995 logging and roads. The lower Memekay, in particular, exemplifies the changes to fish habitat quality and productivity that occurred when streams were routinely logged to the their edge and large instream woody debris—critical for channel stability and fish habitat—was removed or disappeared over time from the stream.



Although the stream channels were determined to be functional, at 8 sites on Pennask Creek investigators observed a thick layer of sand—up to 50 centimetres in depth—on top of the channel bed, which is likely affecting the quality of spawning habitat. The source of the sediment was not identified but could be natural fine sediment production as opposed to deposition from various land-uses. This is because the layer of sediment was also observed upstream of forestry activities.

In the Woodjam watershed, despite an extensive harvest history, five of seven sites were in the top two condition categories. Two sites were in *not properly functioning* condition and the primary factor was damage by livestock. Requirements in the Cariboo-Chilcotin Land Use Plan Order for enhanced riparian management adjacent to small fish-streams (i.e., S4) and certain lake and wetland classes, may be a factor in the high percentage of sites found to be in functioning condition.

### Summary: Field-based evaluation of practices

On the ground, the investigation found that, in all five case-study watersheds, there is at least one factor (e.g., riparian buffers) resulting in an existing or potential risk of harm to fish habitat at the watershed-scale (see Table 8). The factors are mostly the result of multiple site-level impacts from the same land-use (e.g., roads) but also include cumulative impacts from different types of land-uses (e.g., pre-Code and current forest harvesting and roads, range use, recreation, private land, etc.).

**Table 8.** Summary Assessment of Factors Affecting Fish Habitat in Case-Study Watersheds

CASE-STUDY WATERSHED	EXISTING OR POTENTIAL RISK OF HARM TO FISH HABITAT AT THE WATERSHED-SCALE				
	FRPA-era Practices				Channel Condition
	Fish Passage	Sediment from Roads	Riparian Buffers	Range Use	
Ainslie	Low	High	Low	No range use	Moderate
Memekay	Low	Low	Low	Low	Moderate
Owen	Low	High	Moderate	Low	Moderate
Pennask	Low	High	Low	Low	Low
Woodjam	Low	Moderate	Low	Moderate	Low

# Priority actions to improve protection of fish habitat in the case-study watersheds

The five case-study watersheds are recognized by government as having high value or critical fish habitat. However, some practices observed on the ground do not appear consistent with the importance of these watersheds. Although the investigation findings are limited to the five case-study watersheds, they provide insight into the possible extent and magnitude of issues affecting fish habitat in watersheds across BC—and the actions that may be required to address the key factors affecting fish habitat (Table 9).

**Table 9.** Summary of Priority Actions Required to Address the Existing or Potential Risk of Harm to Fish Habitat in Case-Study Watersheds

CASE-STUDY WATERSHED	LICENSEE AND/OR RANGE AGREEMENT HOLDER RESPONSIBILITY				GOVERNMENT RESPONSIBILITY	
	Watershed-Scale Planning to Reduce Risk of Harm to Fish Habitat <sup>a</sup>	Reduce Sediment From Roads Into Streams <sup>b</sup>	Improve Riparian Mgmt.	Improve Mgmt. of Livestock Access to Streams	Restore Fish Habitat Affected by Pre-1995 Harvesting	Conduct Watershed-Scale Monitoring
Ainslie	✓	✓	✓			✓
Memekay	✓				✓	
Owen	✓	✓	✓			✓
Pennask	✓	✓		✓		✓
Woodjam	✓	✓		✓		✓

<sup>a</sup> In addition to assessing the hydrological response of forest harvesting, planning to reduce the risk of harm to fish habitat involves having detailed knowledge of fish and fish habitat and existing risks within watersheds, coupled with necessary actions coordinated amongst licensees, such as minimizing road densities.

<sup>b</sup> Applies to government on non-status roads.

## CONCLUSIONS

### What do the findings say about protection of fish habitat?

The investigation found that in three of five case-study watersheds, licensees are carrying-out planning and assessments at the watershed-scale with the intent of minimizing the hydrological-related effects of forest harvesting on stream channels. However, no monitoring has been done to establish whether the planning and assessment undertaken by licensees is achieving protection of fish habitat.



On the ground, the investigation found that, in all five case-study watersheds, there is at least one factor (e.g., riparian buffers) resulting in an existing or potential risk of harm to fish habitat at the watershed-scale (see Table 8). The factors are mostly the result of multiple site-level impacts from the same land-use (e.g., roads) but also include cumulative impacts from different types of land-uses (e.g., pre-Code and current forest harvesting and roads, range use, recreation, private land, etc.). Two watersheds have long been recognized by government as requiring special forest management (both are fisheries sensitive watersheds) but the requirements under FRPA may not be sufficient to address the key issues affecting fish habitat.

Licensees are providing for fish passage at stream crossings, mostly opting to avoid culverts and use bridges and other open-bottom structures on fish-streams. However, to varying degrees in the case-study watersheds, other forest and range practices are likely resulting in an existing or potential risk of harm to fish habitat. The sources of harm to fish habitat include:

- sediment from roads into streams, which is identified as a chronic problem;
- riparian buffers damaged due to wind, sometimes also resulting in damage to stream channels;
- livestock access to streams, especially where limited riparian buffers have been retained; and
- site-level impacts that are contributing to cumulative effects (from all land-uses).

The Board's *Special Report: Conserving Fish Habitats under FRPA* (Part 1) examined the current state of the BC Government's approach to conserving fish habitat. Included in the report are areas of concern affecting fish habitat identified mostly by fish habitat specialists in government and academia. To varying degrees in the five case-study watersheds, this investigation confirmed that the areas of concern do exist at the site and watershed-scale (see bullets above).

Based on the findings of this investigation, priority actions are necessary to improve the protection of fish habitat in the five case-study watersheds—and likely most watersheds provincially that are important for fish. These priority actions include watershed-scale planning, monitoring, and implementation of erosion and sediment control at stream crossings during road design, construction, maintenance and deactivation.

# APPENDIX 1: FLNRORD Administrative Boundaries, Forest Licensees and Range Agreement Holders in the Case-Study Watersheds

CASE-STUDY WATERSHED	FLNRORD AREA/REGION	FLNRORD NATURAL RESOURCE DISTRICT	TIMBER SUPPLY AREA / TREE FARM LICENCE	FOREST LICENSEES/RANGE AGREEMENTS
Ainslie	Coast / South Coast	Chilliwack	Fraser timber supply area	1 forest licensee
Memekay	Coast / West Coast	Campbell River	Tree farm licence	1 forest licensee 1 range agreement holder
Owen	North / Skeena	Nadina	Morice timber supply area	2 forest licensees 2 range agreement holders
Pennask	South / Thompson Okanagan	Okanagan-Shuswap	Okanagan timber supply area	3 forest licensees 3 range agreement holders
Woodjam	South / Cariboo	Cariboo-Chilcotin	Williams Lake timber supply area	2 forest licensees 2 range agreement holders

# APPENDIX 2: Additional Details of Fish Values, Rationale for Case-Study Selection and Land-Use

## Ainslie watershed

Salmon are known to occur at the confluence of Ainslie Creek with the Fraser River and rainbow trout and char species at higher elevations. Overall, the Ainslie watershed has low value for fish, likely limited by steep channel gradients and natural impediments to fish movement (the Fraser River does have high value fish habitat, which is potentially affected by activities in tributary watersheds).

The Ainslie is a rare example of a watershed at the coast-interior transition where one sub-drainage has a long history of forest development and the other sub-drainage (South Ainslie) has only been developed since 1997, after the introduction of the Forest Practices Code. Although the Ainslie does not have known high value fish habitat, this situation allowed investigators to visit two similar and proximal watersheds with different histories of development.

The South Ainslie was logged starting in the 1950s and there is evidence of wildfire events throughout the watershed. The North Ainslie was not harvested until after 1997. Forestry activity is the main use, occurring mostly at mid to upper elevations. There is no range use in the watershed.

## Memekay watershed

All four sub-basins of the Memekay watershed are fish-bearing (North Memekay, Middle Memekay, Memekay River, and Cooper Creek). However, only the Memekay and Cooper Creek sub-basins are accessible to salmon. Cooper Creek is a significant spawning and rearing area for threatened east Vancouver Island steelhead stocks.

The Memekay was selected as a coastal watershed with recognized fisheries values and a long history of forestry activity. It was designated as a fisheries sensitive watershed (FSW) under the Forest Practices Code and continued under the *Forest and Range Practices Act* (FRPA) in 2005 and has had several assessments completed by the licensee, as well as the Forest and Range Evaluation Program (FREP).

The Memekay has been logged since the 1940s and it represents several eras of approaches to forestry development. Based on documented logging and satellite imagery, approximately 75 percent of the watershed has been logged over time. A small portion of a range agreement area overlaps the confluence with the Salmon River.

## Owen watershed

Owen Creek contains some of the most productive steelhead habitat in the Morice River system. The watershed supports numerous other resident fish species, including rainbow and lake trout, Dolly Varden and/or bull trout, and whitefish. The watershed has high potential for Coho salmon but beaver

dams and low stream flows limit access of fall spawners during most years. The Wet'suwet'en report that, historically, sockeye used to spawn upstream of Owen Lake.

The Owen watershed has been harvested since the mid-1970s and forestry is a predominant activity. Other land uses include mineral exploration, mine development, range use, recreation and private settlement. The Morice-Owen Forest Service Road, built in the 1950s, is a major through-road that runs directly parallel and within close proximity to the mainstem of Owen Creek.

A large fire in the 1980s affected a large portion of the watershed and some forested area has been very slow to regenerate. In 2018, shortly after the Board's field visit, another large fire burnt the south end of the watershed, between Owen Lake and Nadina Mountain.

Owen Creek was selected as an example of a high value fish-stream in the north-central part of the province with a long history of development and multiple land uses. Several studies examining fish habitat values have been completed.

## Pennask watershed

The Pennask supports the largest spawning population of wild rainbow trout in BC and is regarded by BC Parks as "an internationally significant rainbow trout brood fishery."<sup>xi</sup> About 40 percent of wild rainbow trout eggs for provincial hatcheries are obtained from an egg-take station located just upstream of the confluence of Pennask Creek with Pennask Lake.

The watershed has a long history of harvesting. Other uses include range use, energy development (wind power and a BC Hydro transmission line), a major water diversion, and the Okanagan Connector (Highway 97C).

## Woodjam watershed (a sub-basin of the Horsefly watershed)

The Horsefly River has some of the highest fish values in BC. The Woodjam sub-basin is an alluvial stream that supports spawning and rearing chinook and coho salmon in the lower reaches. Rainbow trout and longnose dace are present throughout the sub-drainage. Approximately 9 kilometres of critical fish habitat exists directly downstream of the confluence of Woodjam Creek with the Horsefly River. Therefore, forest and range practices in the Woodjam watershed potentially have a significant influence on the critical fish habitat in the Horsefly River. The entire Horsefly River watershed was designated a FSW in 2018.

Forestry and range are the two land-use activities on Crown land in the Woodjam watershed. The lower reaches of Woodjam Creek flows through private land that was cleared decades ago for ranching. On the private land, the majority of the riparian area adjacent to Woodjam Creek has been fenced to reduce channel disturbance from livestock. Forestry activities have occurred in the sub-basin since the early 1970s. The history of range use is not known but likely spans many decades.

The Woodjam sub-drainage was selected because it has high fish values, distinct operating areas for two forest licensees and has been assessed by FLNRORD as high risk to fish habitat due to existing levels of development. (Due its large size, the Horsefly River watershed could not be included as a case-study. Therefore, a sub-basin was selected.)

# APPENDIX 3: Checklist of Indicators Used to Assess Riparian and Stream Channel Functioning Condition

RIPARIAN AND STREAM CHANNEL INDICATORS EXAMINED IN THE FIELD	ASSESSMENT OF FUNCTION CONDITION
<ul style="list-style-type: none"> <li>✓ Riparian retention conditions (forest age, buffer width, percent retention)</li> <li>✓ Structural condition of channel bed, channel banks and stream morphology</li> <li>✓ Presence of functional woody debris processes</li> <li>✓ Connectedness of stream elements</li> <li>✓ Diversity of fish cover/ refuge</li> <li>✓ Moss abundance and vigour</li> <li>✓ Evidence of fine sediment inputs to stream</li> <li>✓ Diversity of invertebrates</li> <li>✓ Windthrow from riparian retention</li> <li>✓ Bare, erodible or compacted ground</li> <li>✓ Vegetation sufficient for an adequate root network or large woody debris supply</li> <li>✓ Vegetation sufficient to maintain normal bank microclimate conditions</li> <li>✓ Presence of disturbance-increaser plants, noxious weeds or invasive plants</li> <li>✓ Comparison of riparian/stream function to characteristics of a healthy or properly functioning riparian/stream</li> </ul>	<p><i>Properly functioning condition (PFC):</i> a maximum of two issues about the riparian and stream channel indicators are present.</p> <p><i>Functioning but at risk (FR):</i> three to four issues about the riparian and stream channel indicators are present (i.e., overall condition is poorer than a stream that is in 'properly functioning condition').</p> <p><i>Functioning condition but at high risk (FHR):</i> five to six issues about the riparian and stream channel indicators are present (i.e., overall condition is distinctly poorer than a stream that is in 'properly functioning condition').</p> <p><i>Not properly functioning (NPF):</i> more than six issues present about the riparian and stream channel indicators (i.e., overall condition is outside the natural range of variability for streams in watersheds with little to no human activity).</p>

# APPENDIX 4: Additional Information on Watershed Assessments and Field Evaluations

*Note: Information is only provided where it is not included in the body of the report.*

## Ainslie watershed

### Sediment from roads into streams

- High existing or potential for sediment input at 23 sites, including at three bridges on fish-streams. In many cases, sediment inputs are occurring on non-fish bearing tributaries to fish-streams.
- Long sections of steep road with surface runoff directed into streams. Some sections on the main haul road with grader berms, causing water to be channeled to stream crossings.

### Riparian buffers

- Windthrow and logging debris in the stream channel at two sites, resulting in blocked stream channels and impaired channel condition.

### Stream channel functioning condition

- Of 13 sites assessed for functioning condition:
  - 6 were in ‘properly functioning condition’ (PFC)
  - 2 were ‘functioning but at risk’ (FR)
  - 2 were ‘functioning but at high risk’ (FHR)
  - 3 were ‘not properly functioning’ (NPF)
- One FR site required a riparian reserve, but windthrow has altered channel processes, including log jams that alter streamflow, causing the deposition of large sediment wedges.
- At one FHR site, which is located on a stream that is a direct tributary to a major fish-stream, an historic natural slide has recently failed again and sloughed large amounts of material into the creek and downstream. A 2017 terrain assessment—completed as part of cutblock planning—concluded that the terrain risk adjacent to the slide was not high enough to warrant moving the cutblock boundary. At the other FHR site, logs from recent harvesting have rolled into the stream, creating jams that have backed up with sediment and redirected the water course.
- The first NPF site is next to a clearcut and most of the stream channel was observed to be full of debris from harvesting operations. The second NPF site is buffered on both sides of an S6 stream (i.e., non-fish-stream, less than 3-metres wide). Problems with stream condition were mainly linked to a road failure upstream, made worse by trees that were felled across and into the channel. At the third NPF site, frequent slumping was present along the stream. A large road-related landslide, allocated about 500-metres upstream of the assessment site may have been a contributing factor but would require further assessment.

# Memekay watershed

## Watershed assessment, planning and monitoring

- The licensees' forest stewardship plan commits to regular watershed level assessments. The licensee will coordinate with other tenured land-users where activities overlap at the watershed scale.
- FREP completed a Tier 1 GIS-based watershed status evaluation in 2015 and a Tier 2 field-based evaluation in 2012 (published in 2018). The Tier 2 evaluation included an assessment of fish passage, sediment production and fish/riparian condition. The evaluation found that the Memekay watershed was impaired, due in equal parts to pre-Code harvesting, unknown upstream factors and natural conditions. Current (post-Code) harvesting and roads contributed a proportionately small amount to the impairment.<sup>xii</sup>

## Sediment from roads into streams

- In general, most roads appeared to have low surface erosion, low delivery of sediment and limited to no impacts on fish or fish habitat. Most issues were with pre-FRPA and pre-Code infrastructure with some crossing structures in need of maintenance. The forest licensee in this watershed has been proactive in assessing watershed condition and has managed roads and crossings to minimize potential for input of sediments into streams, particularly on fish-streams.

## Riparian buffers

- Overall, FRPA-era riparian buffers were effective. At one site adjacent to a small, non fish-stream (S6), cross stream falling and yarding had impacted stream condition.

## Stream channel functioning condition

- Of 48 sites assessed for functioning condition by FREP in 2012 and two additional sites assessed by Board investigators:
  - 18 were in PFC
  - 13 were FR
  - 11 were FHR
  - 8 were NPF
- Seven PFC sites were in areas not harvested, five sites were pre-FRPA harvesting and six sites were FRPA harvesting. Natural impacts (primarily mass wasting, windthrow) were responsible for 65 percent of the negative responses on functioning condition assessments, while pre-FRPA harvesting also caused some of the negative responses. FRPA harvesting and roads together accounted for only a minor proportion of the observed impacts to channel condition.
- Most FR sites were associated with pre-FRPA harvesting, the remainder were split between unharvested and FRPA harvested sites. FRPA harvesting had relatively little impact on stream channel functioning condition. Pre-FRPA harvesting that affected slope stability, woody debris processes and stand conditions were the cause of most impacts, though natural impacts (primarily slides, sloughs, torrents, some windthrow) and unknown sediment sources upstream, were equally damaging. Roads were not a factor.

- Five FHR sites were FRPA-era harvesting, and five sites were pre-Code harvesting. One site was unharvested. Current FRPA harvesting had little impact on stream conditions. Rather, impacts affecting stream condition were mainly the result of upstream mass wasting events (natural slides, caused by pre-Code harvesting or unknown causes); site level impacts from pre-Code harvesting (sloughing, slides, altered stand and woody debris processes); or site-level impacts from natural floods or torrents.
- Six NPF sites were pre-Code harvesting, one site was FRPA-era harvesting and one site was unharvested. The site that was not harvested had the highest number of impacts due to a natural debris slide, while impacts on the FRPA-era site were mainly due to cross-stream falling and yarding. Impacts on the six remaining sites (all pre-Code harvesting) were due to: sloughing, slides, bank erosion, channel infilling, clearcutting, altered stand, channel and woody debris characteristics; natural mass wasting and floods, mass wasting of unknown causes; and, a misaligned, undersized culvert.

## Owen watershed

### Watershed assessment, planning and monitoring

- A watershed sensitivity assessment was completed in 2018. One licensee conducts annual watershed level assessments to ensure activities do not exceed a moderate risk rating.
- Assessments are being updated to incorporate changes to forest cover following a large wildfire in the southern part of the watershed in August 2018.
- In 2013, the Office of the Wet'suwet'en (OW) completed a GIS-based Habitat Indicator Monitoring Project that included the Owen.
- A FREP Tier 1 GIS-based watershed status evaluation was completed in 2015. A FREP Tier 2 field-based watershed status evaluation was completed in 2014 (not yet published).

### Sediment from roads into streams

- High existing or potential for sediment input into fish-streams at 7 of 12 sites examined along the main Morice-Owen FSR, a heavily used main haul road adjacent to Owen Creek and Owen Lake (at some points, Owen Creek is within 50 metres of the FSR).
- The running surface of the FSR appears sound, however, investigators observed a lack of care and attention with road maintenance to prevent sediment entering streams. Ineffective grading operations are a major contributing factor resulting in increased sediment deposition.
- At eight sites on the Morice-Owen FSR, pre-Code culverts are damaged or show signs they are significantly undersized for existing stream flows. Some of the culverts are on fish-streams.
- Generally, other roads in the watershed appeared to be in sound condition, well vegetated and have low surface erosion into streams.



## Range use

- Although part of the watershed overlaps a range agreement area, investigators did not observe active range use (or impacts related to range use) during the field assessment. Monitoring by FREP in 2014 revealed that range use had impacted streams, mainly adjacent to older harvested areas. Also, livestock use had caused damage to streams on private land.

## Stream channel functioning condition

- Of 11 sites assessed for functioning condition:
  - 2 were in PFC
  - 4 were FR
  - 3 were FHR
  - 2 were NPF
- PFC was assessed where fish-streams and non fish-streams (S3, S4, S5 and S6) were buffered using variable retention to reduce windthrow risk.
- One FR site was on a fish-stream (S2) buffered by old forest, but naturally impacted by flooding and channel bed mobilization. The other three FR sites were S6 streams buffered by narrow reserves of old forest, which were damaged by extensive windthrow. At two sites, retention was poorly located in ravines without sufficient retention at the top of the ravine. At one site, windthrow occurred along a narrow buffer adjacent to a clearcut.
- One FHR site was on a large fish-stream (S2) buffered by mature forest on the left and early seral forest on the right. The stream banks were disturbed, in part, due to the adjacent road that impinges on the stream. Fine sediments from the road surface (dust and run-off) resulted in lack of moss and a thin layer of fine sediment over the stream channel bed. The second FHR site was a large fish-stream (S2) that was well-buffered by undisturbed mature to old forest and a large wetland. The stream appeared to have been impacted by high freshet stream flows in 2018. The third FHR site was a small non fish-stream (S6) adjacent to a large clearcut. Retained trees adjacent to the S6 had windthrow. The riparian buffer was likely too narrow (8-10 metres wide) for a deep ravine and likely should have been set back 10 or more metres from the top of the ravine bank.
- NPF sites were at two sections of Avin Creek, within and downstream of the Avin Lake complex. Both channels were very disturbed by flooding to a point just upstream of the Morice-Owen FSR, causing extensive channel and bank damage. It was not clear to investigators what factors led to the flooding (e.g., rain on snow event).

# Pennask watershed

## Watershed assessment, planning and monitoring

- Watershed level assessments were undertaken in 2008 and 2010 to identify risks from past and current land-use activities.
- One licensee conducts assessments within their operating area, comprising the upper portion of the watershed. This licensee intends to limit the equivalent clearcut area to 25 percent.

## **Sediment from roads into streams**

- High existing or potential for sediment input at two bridge structures on fish-streams, an in-block road and a 500-metre section of non-status road. The in-block road was the responsibility of the holder of a non-replaceable forest licence and the licensee is now insolvent. As a result, the BC government has assumed responsibility for the road. Evidence of sediment deposition was observed at numerous other crossings but individually, the amount of deposition at those crossings would not likely result in material harm to fish.
- At one site on the Sunset Main FSR, a fish-stream crossing was used as a snow dump. Investigators found a layer of dirt covering the fill slope, exposed portion of the culvert and exposed boulders around the culvert inlet.
- Sediment from roads into streams associated with other land-uses was observed. This includes one of the two powerline transmission corridors and the Coquihalla Highway bridge crossing on Pennask Creek—the latter being a significant sediment source.
- A stream in close proximity to works associated with the acid rock drainage mitigation along the highway was observed to be turbid (i.e., sediment was in the water).

## **Riparian buffers**

- Small fish-streams (i.e., S4) are well buffered by mature forest.
- Pennask Creek Provincial Park provides a large (approximately 250-metres wide) contiguous buffer adjacent to Pennask and Sunset Creeks. This buffer is likely a major factor in the functioning condition of these creeks.

## **Stream channel functioning condition**

- Of 14 sites assessed for functioning condition:
  - 13 were in PFC
  - 1 was FR
  - 0 were FHR
  - 0 were NPF
- PFC - All PFC sites were well buffered by mature and old forest. Large quantities of sand-sized sediments on the channel bed were present at most sites on Pennask Creek. The cause and source for the sand-sized sediment was not determined. While this was not enough to reduce the functioning condition rating for the stream channel, it could be having a significant effect on fish spawning and rearing habitat.
- FR - Although the S3 stream at this FR site was well-buffered by old forest, road wash-outs combined with naturally high water flows and excessive tree mortality and deadfall had impacted stream and habitat condition.

# Woodjam watershed

## Watershed assessment, planning and monitoring

- An office-based FREP Tier 1 status evaluation was completed in 2015.

## Sediment from roads into streams

- Moderate existing or potential for sediment input into larger fish-streams at three bridge structures and small assumed fish-stream (S4). The bridge decks were covered with more than 10 centimeters of a mix of compacted and loose dirt that is susceptible to being deposited into the streams, especially during inclement weather. The dirt was deposited onto the bridge decks from road surface erosion (i.e., the road approaches slope down to the bridge deck).
- Prompt revegetation following road construction at one site and road deactivation at another site had resulted in stable road surfaces with little evidence of erosion despite wet conditions.
- There is evidence of natural (i.e., not related to forestry) hillslope landslides and windthrow events along the mainstem.

## Riparian buffers

- At all sites, streams were buffered by old forest. Buffering of small (S4) streams is required under the Cariboo-Chilcotin Land Use Plan.

## Range use

- In addition to livestock damage to fish habitat at two sites (as detailed in the report), livestock had damaged water control structures built along forestry roads to prevent ditch water from entering fish-streams. This had resulted in visible channeling of water and sediment towards a fish-stream.

## Stream channel functioning condition

- Of 7 sites assessed for channel condition:
  - 4 were in PFC
  - 1 was FR
  - 0 were FHR
  - 2 were NPF

At PFC sites, wide buffers of mature and old forest, ranging between 20- and 100-metres wide, have helped to maintain stream channel condition including the structure of riffles and pools.

FR - At the one site assessed as proper functioning at risk, the substrate has alluvial gravel and cobbles under a thick layer of fine sand. This may be due to erosion from a road upstream as well as natural sediment inputs.

NPF - Both sites assessed as not in functioning condition (a headwater S4 stream and a lower mainstem S2 stream) were altered mainly by livestock use.

# ENDNOTES

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- <sup>i</sup> BC Forest Practices Board, 2018. Special report: *Conserving Fish Habitats under the Forest and Range Practices Act. Part 1: A Review of the BC Government Approach*. Report# FPB/SR/56. Available at <https://www.bcfpb.ca/wp-content/uploads/2018/07/SR56-Fish-Habitat-Conservation.pdf>
- <sup>ii</sup> Fish passage was assessed using the following procedure: Ministry of Environment, 2011. Field assessment for determining fish passage status of closed bottom structures. 4<sup>th</sup> edition. Available at: <https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/land-based-investment/forests-for-tomorrow/field-assessment-for-determining-fish-passage-status-of-cbs.pdf>
- <sup>iii</sup> D. Maloney, B. Carson, S. Chatwin, M. Carver, P. Beaudry and S. Bleakley, 2018. Protocol for Evaluating the Potential Impact of Forestry and Range Use on Water Quality (Water Quality Effectiveness Evaluation). Forest and Range Evaluation Program, B.C. Min. Forest Range and Natural Resource Operations and B.C. Min. Environment, Victoria, BC. Available at: [https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/frep/protocol-documents/2018\\_wqee\\_protocol.pdf](https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/frep/protocol-documents/2018_wqee_protocol.pdf)
- <sup>iv</sup> Tripp, D.B., P.J. Tschaplinski, S.A. Bird and D.L. Hogan, 2019. Field Supplement to Evaluating the Condition of Streams and Riparian Management Areas (Riparian Management Routine Effectiveness Evaluation). Forest and Range Evaluation Program, B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Victoria, B.C. 48 pgs. Available at: [https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/frep/frep-docs/riparian\\_fieldguide\\_2019.pdf](https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/frep/frep-docs/riparian_fieldguide_2019.pdf)
- <sup>v</sup> Ministry of Agriculture, Integrated Land Management Bureau, 2011. Cariboo Chilcotin Land Use Plan Order (Objectives #12 and #22). Available at: [https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/crown-land/land-use-plans-and-objectives/cariboo-region/cariboochilcotin-rlup/cariboo\\_chilcotin\\_order\\_amending\\_riparian\\_obj\\_lupa.pdf](https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/crown-land/land-use-plans-and-objectives/cariboo-region/cariboochilcotin-rlup/cariboo_chilcotin_order_amending_riparian_obj_lupa.pdf)
- <sup>vi</sup> BC Timber Sales, Kamloops Business Area, undated. Sediment and Erosion Control Field Guide. Available at: <https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/bc-timber-sales/ems-sfm-certification/business-area/kamloops/tka-sediment-and-erosion-control-field-guide.pdf>
- <sup>vii</sup> FP Innovations, 2007. Erosion and Sediment Control for Forest Roads and Stream Crossings: A Practical Guide. 87 pgs.
- <sup>viii</sup> According to FREP, the Woodjam watershed has approximately 76 stream crossings. Therefore, if applied cumulatively to all stream crossings, the objective implies a maximum limit of sediment deposition to be 76 m<sup>3</sup>/year. Reference for number of stream crossings: M. Porter, S. Casley, N. Ochoski, and S. Huang. 2015. Watershed status evaluation: an assessment of 71 watersheds meeting BC's fisheries sensitive watershed criteria. Victoria BC FREP Report 39. Available at: <http://www.for.gov.bc.ca/hfp/frep/publications/index.htm> (note: the report provides a watershed area of 91.7 km<sup>2</sup> and a stream crossing density of 0.83 crossings per km<sup>2</sup> = 76 crossings).
- <sup>ix</sup> References:
- Tschaplinski, P.J., and D. Tripp, 2017. Post-harvest condition of stream channels, fish habitats, and adjacent riparian areas: Resource stewardship monitoring to evaluate the effectiveness of riparian management 2005 – 2014. FREP Extension Note #39. Available at: [https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/frep/extension-notes/frep\\_extension\\_note\\_39.pdf](https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/frep/extension-notes/frep_extension_note_39.pdf)
- Nordin, L., J. Rex, and P. Tschaplinski, 2017. The condition of small streams after harvesting: A summary of FREP data from 2006 – 2015. BC Forest and Range Evaluation Program Extension Note #40. Available at: [https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/frep/extension-notes/frep\\_extension\\_note\\_40.pdf](https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/frep/extension-notes/frep_extension_note_40.pdf)
- Rex, J., D. Maloney, E. MacIsaac, H. Herunter, P. Beaudry, and L. Beaudry, 2011. Small stream riparian retention: the Prince George Small Streams Project. Extension Note 100. B.C. Ministry of Forests and Range, Forest Science Program. Available at: [www.for.gov.bc.ca/hfd/pubs/Docs/En/En100.htm](http://www.for.gov.bc.ca/hfd/pubs/Docs/En/En100.htm)
- <sup>x</sup> The importance of maintaining riparian buffers during forestry operations, as a means of restricting livestock access to riparian areas (also referred to as 'natural range barriers'), is increasingly being recognized by government and forest licensees and has been reported by the Forest Practices Board in its 2015 special investigation of natural range barriers. Available at: <https://www.bcfpb.ca/wp-content/uploads/2016/04/SIR42-Natural-Range-Barriers.pdf>
- <sup>xi</sup> See reference at: [http://www.env.gov.bc.ca/bcparks/explore/parkpgs/pennask\\_crk/](http://www.env.gov.bc.ca/bcparks/explore/parkpgs/pennask_crk/)
- <sup>xiii</sup> Pickard, D., D. Tripp, M. Porter, L. Reese-Hansen, R. Thompson, B. Carson, and P. Tschaplinski. 2018. Memekay River Watershed Status Evaluation Report. FREP WESP Extension Note #1. Available at: [https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/integrated-monitoring/190430\\_wse\\_memekay\\_final\\_v164.pdf](https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/integrated-monitoring/190430_wse_memekay_final_v164.pdf)



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