McNeil Substrate Sampling Program
2015 Summary Report

Photo Credit: Ben Meunier

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BRITISH COLUMBIA

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EXECUTIVE SUMMARY

Substrate core samples were taken at four index sites from four classified streams in the East Kootenay Region of British Columbia during the winter of 2015. The purpose of this project was to collect and analyse stream substrate material/sediment levels in order to produce trend data valuable in monitoring suitability of stream reaches identified as critical for bull trout spawning. This project expands, and was based on; an initial study conducted on East Kootenay steams from 2003-2008 by the B.C. Ministry of Forests, Lands and Natural Resource Operations (FLNR, formerly Ministry of Environment) - Fisheries Program (Heidt, 2008).

Analysis of materials less than 6.35mm collected from substrate core samples over the study period indicate a significant amount of variability, both within and between sample sites. The mean percent of fines less than 6.35mm ranged from a low of 21% at the Blackfoot Creek site to a high of 39% at the Skookumchuck Creek site, with an overall mean of 32% (± 12%, 95% confidence interval) between the 4 sites.

A noteworthy result from the study is the low percentage of fine sediments in the Blackfoot Creek samples, given that this system indicated significant morphological change as a result of the 2013 1:200 year spring flood event. However, the Blackfoot Creek site did have the highest variability between in-site data, which is not unexpected due to the result from the disturbance event.

The results from this study are informative when looking at the suitability of preferred bull trout spawning indexes in upper Kootenay River tributary systems, and in estimating egg to fry survival as a predictor of long term population recruitment and stability. However, it should be noted that this report presents data from only one study year. The scope of this project is to collect data from the selected systems over 5 years, utilizing a larger time series data set and analysis to evaluate and predict changes and/or trends in substrate/sediment composition over time and between study periods. Comparative data will be analysed and presented in the 5 year summary report.

ACKNOWLEDGEMENTS

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This project was delivered as part of the Kootenay River Guardian Program and partially funded by the Habitat Conservation Trust Foundation (HCTF) through classified waters licence surcharges. HCTF was created by an act of legislature and is a non-profit charitable foundation acting as a Trustee of the Habitat Conservation Trust. HCTF licence surcharges are invested in projects that maintain and enhance the health and biological diversity of British Columbia's fish, wildlife and habitats so that people can use, enjoy and benefit from these resources. The Kootenay Fisheries Program would like to recognize the anglers and angling guides who support the management and protection of Kootenay Region Classified Waters through licence contributions to HCTF and the funding of the River Guardian Program.

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1.0 INTRODUCTION

The East Kootenay Region of British Columbia is home to a number of streams that are supportive of healthy bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhynchus clarki lewisi*) populations. The Wigwam River itself has been characterized as the single most important bull trout spawning system in the Kootenay Region (Baxter and Westover, 2000), and has been the focus of numerous studies in the last ten years (Westover and Conroy, 1997; Cope, 1998; Kohn Crippen Consultants Ltd., 1998; Westover, 1999a; Westover, 1999b; Cope and Morris, 2001; Cope *et al.,* 2002). Bighorn Creek, a significant tributary to the Wigwam River, contributes considerably to the suitable spawning habitat for bull trout in the Wigwam system. Additionally, the Skookumchuck Creek and the White River both act as crucial spawning streams contributing to the upper Kootenay River bull trout population (Westover and Heidt, 2003), and much work has been done on these systems regarding population dynamics, spawning migration timing, and habitat assessments and monitoring (B.C. Ministry of Environment; Cope, 2002; Cope and Morris, 2003; Cope, 2003, Heidt, 2015). Blackfoot Creek, a tributary to the White River, has been identified as one of the primary spawning systems utilized by bull trout in the lower reaches of the White River system (B.C. Ministry of Environment; Masse, 2000; Cope, 2003).

Bull trout are a cold-water species, and have the most specific habitat requirements of all salmonids (Reiman and McIntyre, 1993). Due to their specialization as a cold water species and their requirement for clean, well oxygenated water, bull trout are highly influenced by riparian habitat alteration (harvesting, road building, wildfire, and other natural/anthropogenic disturbance events). The impact of increased in-stream sediment on eggs and alevin of salmonids has been well documented, and studies have shown reductions in both the survivability of eggs and alevin in different salmonid species due to increased in-stream fine sediment (Johnsen *et. al,* 1952; Stuart, 1953; Cooper, 1965). Habitat degradation activities can increase in-stream sediment, which infill gravel spawning sites, reduce oxygen availability to eggs and alevin, reduce feeding opportunity through increased turbidity and covering of aquatic invertebrates, and physically impair and abrade fish gills (Hammond, 2004).

While bull trout populations in the East Kootenay Region remain healthy, many populations in British Columbia are in decline, and consequently, bull trout were blue listed as vulnerable in British Columbia by the B.C. Conservation Data Centre (Cannings, 1993), and remain a species of special concern. Declines and distribution limitations are evident in the north-western United States (Rieman *et al*., 2011), and bull trout in this area, within the Columbia River watershed, were listed as threatened in 1998 under the Endangered Species Act by the U.S. Fish and Wildlife Service.

1.1 Objectives

The objectives of this study are as follows:

(1) To assess the suitability and composition of substrate and fine sediment materials within select bull trout spawning indexes in four primary classified rivers within the upper Kootenay River watershed

(2) Provide a potential measure of future impacts to critical bull trout spawning habitat from natural events (i.e. wildfires), resource extraction and additional anthropogenic disturbances.

(3) Utilize study data and analysis to predict and/or mitigate impacts to bull trout recruitment and population stability/health (i.e. direct management actions and regulatory regimes)

(4) Utilize study data and analysis to inform potential stream rehabilitation efforts to improve recruitment and survivability specific to fluvial and adfluvial bull trout populations in the upper Kootenay River watershed

2.0 STUDY AREA

The area included in this study is located in the southern portion of the East Kootenay Region of British Columbia within portions of both the Purcell and Rocky Mountain ranges (Figure 1). These watersheds cover approximately 2,750 km^2, encompassing a large portion of the southern Rocky Mountain Trench and are all direct or indirect tributaries to the upper Kootenay River, which flows into the United States near Libby, Montana. The five stream systems included in the previous study were Bighorn Creek (tributary of the Wigwam River), Blackfoot Creek (tributary of the White River), the White River (tributary of the upper Kootenay River), Wigwam River (tributary of the Elk River) and Skookumchuck Creek (tributary of the upper Kootenay River) (Heidt, 2008). Unfortunately, due to access issues based on snow conditions, the Wigwam River was unable to be sampled in the 2015 season. All of the four sampled streams have been identified as containing reaches significantly important for bull trout spawning (Westover and Heidt, 2003; Heidt, 2015).

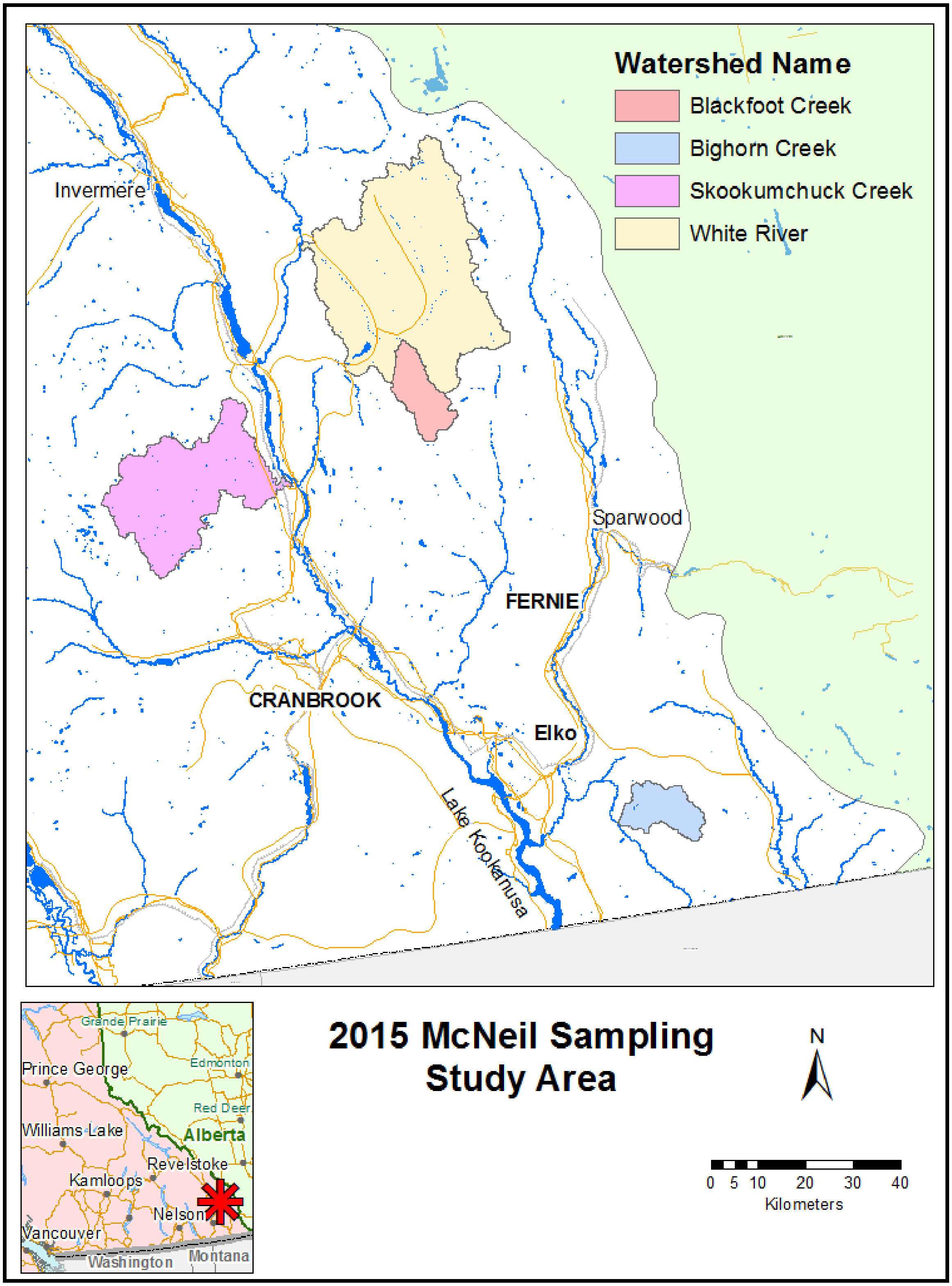

Figure 1. Overview map of the study area.

3.0 METHODS

3.1 Site location and timing

Sample sites were marked prior to sampling based on previous identification of bull trout spawning locations. Sites were marked with flagging tape on both the upstream and downstream margins of the spawning locations. Furthermore, GPS locations were recorded for each sampling site (Appendix 1), to ensure accurate relocation during the sampling period. Site lengths/sampling area were variable between and within systems and indexes

Timing of sample extraction at each site was dependent on ice conditions in the stream, as ideal sampling is done at first ice off. Consideration was also given to snow stability and safety of the field crew, as the majority of sites required travel through avalanche terrain. Sampling commenced on February 11th 2015, and ended on February 22nd 2015.

3.2 Transportation to sampling sites

Because sampling was conducted during winter months and study locations are located in remote, high elevation areas, significant portions of the forest service roads were not accessible by truck. FLNR staff transported equipment with 4wd vehicles on maintained FSRs to a point nearest location sites. From these points, snowmobiles were used to access the sites (up to 70 km one way at each site). Due to deep snow conditions at many of the sites, visits prior to sampling were required to pack down a trail into the sites. This allowed for snowmobiles to easily pull the weighted trailer out with the samples (Heidt, 2008). The snowmobiles used for this project were two 2013 Polaris RMK 700's (for trail-setting), a 2010 Yamaha Multipurpose 500, a 2009 Bombardier Tundra 800, and a 1995 Bombardier Skandic 500. A trailer pulled by the Yamaha Multipurpose and Bombardier Tundra was used to transport the McNeil sampler and additional equipment to and from the sites, as well as hauling the bagged substrate materials back to the vehicles.

3.3 Substrate sampling and processing

Substrate sampling was conducted utilizing a standard 15.2 cm hollow core sampler (McNeil and Ahnell, 1964) as well as the equipment and material listed in Appendix II. Sampling procedures generally followed the methodology outlined in Weaver and Fraley (1991). At each sampling location, four core samples were taken across two to four transects. Whenever possible, coring sites on each transect were located at the tail ("mound") of a bull trout redd. Sampling involved working the corer into the streambed to a depth of approximately 15 cm. All materials were removed from inside the core cylinder and placed in the inside tray of the sampler. Using a cup, 1000 ml of water and fine sediment was removed from the sampler and placed in an Imhoff settling cone (Shepard and Graham, 1982) for 20 minutes and then the amount of sediment per litre of water was recorded. After taking the Imhoff cone sample, the total volume of turbid water inside the corer was determined by measuring the depth of water from the substrate at the bottom of the core cylinder to the water surface. After slowly removing the water from the sampler, the remaining substrate materials were placed in a heavy-duty plastic bag and placed into a sand bag for transport. Each bag was labelled on the outside and inside (on waterproof paper) and then transported to a laboratory for gravimetric analysis (Tepper, 2002; Heidt, 2008). The samples were processed by Artech Consulting Ltd. in Cranbrook, British Columbia.

The product of the Imhoff cone reading (mg of sediment per litre) and the total volume of turbid water inside the McNeil corer produced an approximation of the dry weight (g) for the suspended material. The bagged substrate samples were oven dried and sieve separated into 17 size classes ranging from 101.5 mm to 0.075 mm in diameter (Table 1). Materials retained on each sieve were weighed and a calculation of the percent dry weight was produced for each size class. The estimated dry weight of the suspended fine material (Imhoff cone results) was added to the weight observed in the pan, yielding the percent of material <0.075 mm. Percentages were summed and a cumulative particle size distribution was obtained for each sample (Tappel and Bjornn, 1983; Tepper, 2002; Heidt, 2008).

Table 1. Mesh size of sieves used to gravimetrically analyse hollow core (McNeil and Ahnell, 1964; Tepper, 2002; Heidt, 2008) stream substrate samples collected from the Wigwam River mainstem from 2003-2008.

Mesh Size (mm)	Mesh Size (Inches/Sieve #)
101.50	4.0”
76.10	3.0”
50.80	2.0”
38.10	1.5”
25.40	1.0”
19.05	0.75”
12.70	0.5”
9.52	0.375”
6.35	0.25”
2.36	#8
2.00	#10
1.18	#16
0.841	#20
0.60	#30
0.30	#50
0.15	#100
0.075	#200
PAN + Imhoff (< 0.075)	

3.4 Data analysis.

The overall composition of the stream-bed substrate samples was expressed as percent finer than the indicated sieve size. Substrate statistics were then calculated from the data on the overall composition of each sample in the study area. Specifically, percent materials less than 6.35 mm were calculated directly from the sieving results (Tepper, 2002; Heidt, 2008). This median size class was used by Weaver and Fraley (1991) to describe bull trout spawning gravel quality in numerous watersheds within the Flathead River drainage in Montana, United States. A mean for each site was calculated from the 12 samples collected. These means were plotted against a threshold of 35% fines (<6.35mm), which indicates a threatened system for bull trout populations (Weaver, 1996).

4.0 RESULTS SUMMARY

4.1 Bighorn Creek

4.1.1 Study area

Bighorn Creek originates from the Macdonald Range of the Rocky Mountains, in the southeast corner of the Rocky Mountain Trench, approximately 35 km southeast of Fernie, BC. This system has a mainstem length of approximately 25 km, flowing in an easterly direction to its confluence with the Wigwam River. Bighorn Creek has a total watershed area of approximately 139 km^2 and has a flow regime comparable to other interior streams, with peak flow occurrence in June/July and low flows in late fall and winter (Heidt, 2008). Specific discharge statistics are not available for this system.

The Bighorn Creek watershed is located within the Engleman Spruce Sub-Alpine Fir Dry Cool biogeoclimatic sub-zone (Summit Environmental Consultants Ltd., 2001). The upper reaches of the watershed were extensively logged throughout the 1960’s and 1970’s. In addition, natural disturbance events occurring in this watershed include a wildfire in the 1930’s which devastated the lower reaches, and a 1995 flood event which is thought to occur every 100 to 200 years (Cope, 2002). Research from restoration projects suggest that recent changes in land use and forest cover may have significantly affected the hydrology and sediment structure of the watershed (Heidt, 2008). In addition, research information also suggests that watershed geology contributes to a naturally dynamic and unstable environment, which are specifically impacted by changes in land use and forest cover (Cope, 2002). A combination of these factors has resulted in increased flows and sediment contribution, leading to both vertical and horizontal channel changes and subsurface flows in certain reaches during low flow conditions (Heidt, 2008).

4.1.2 Site Description

One permanent sample site was established on Bighorn Creek, approximately 700 metres upstream of its confluence with the Wigwam River at approximately km 44 on the Wigwam River Road (Figure 2, Appendix I). This site was established based on annual observations of natural bull trout spawning occurrences (Heidt, 2008; Heidt, pers. comm., 2015). A total of 12 gravel samples were taken at this site on February 22nd 2015. Specific site measurements at this site were: wetted width = 5.5 m, total length = 20 m, and an average water depth of samples = 370 mm.

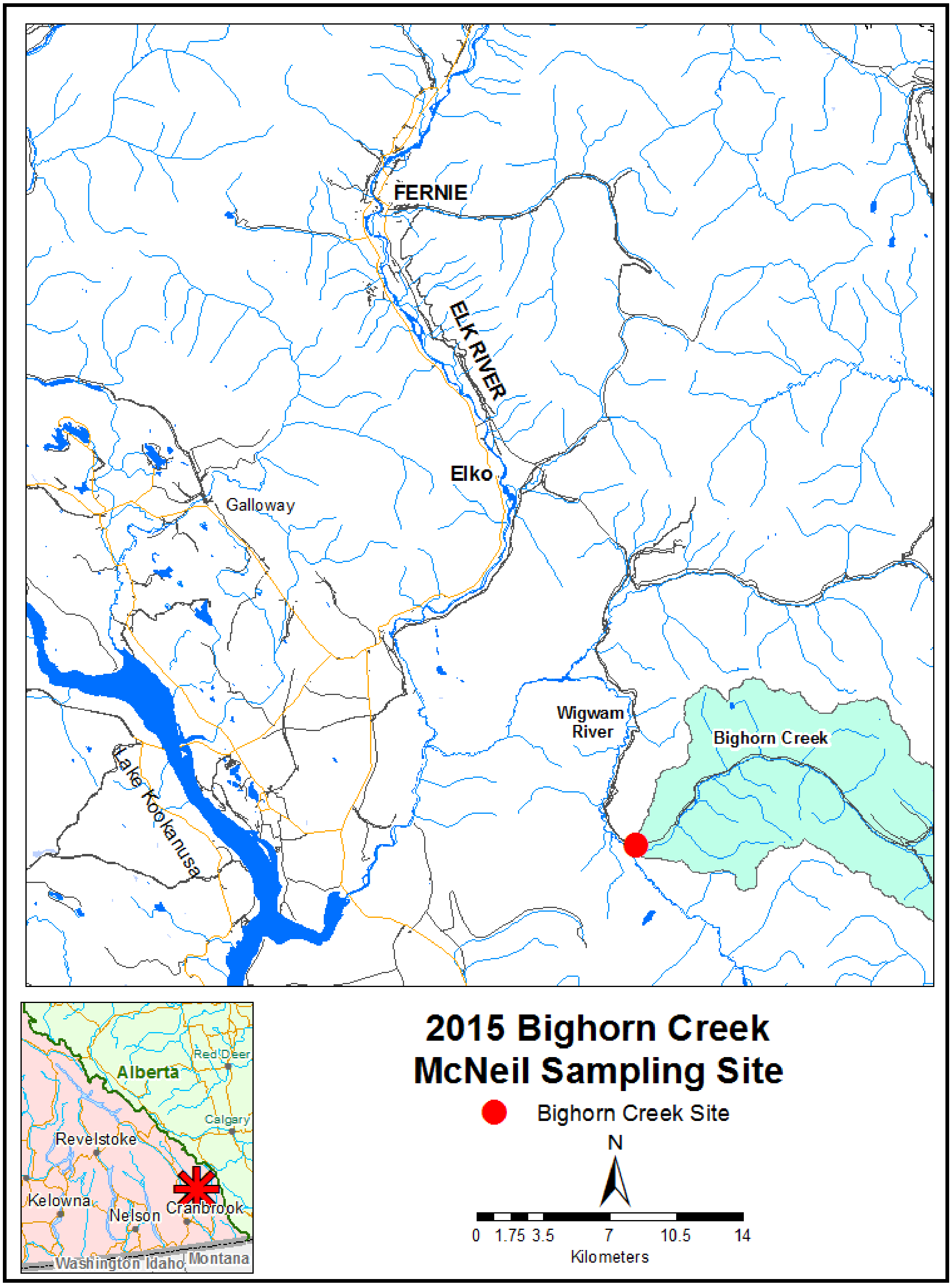

Figure 2. Bighorn Creek McNeil sampling site.

4.1.3 Results

The majority of samples from Bighorn Creek were below the 35% threshold for threatened systems, although four of twelve samples showed the percentage of fines passed were slightly above the threshold. Bighorn Creek samples ranged from 19% fines passed, to a high of 44% fines passed, with an average of 31.2% (+/-4.8%; 95% Confidence Interval) (Fig. 3).

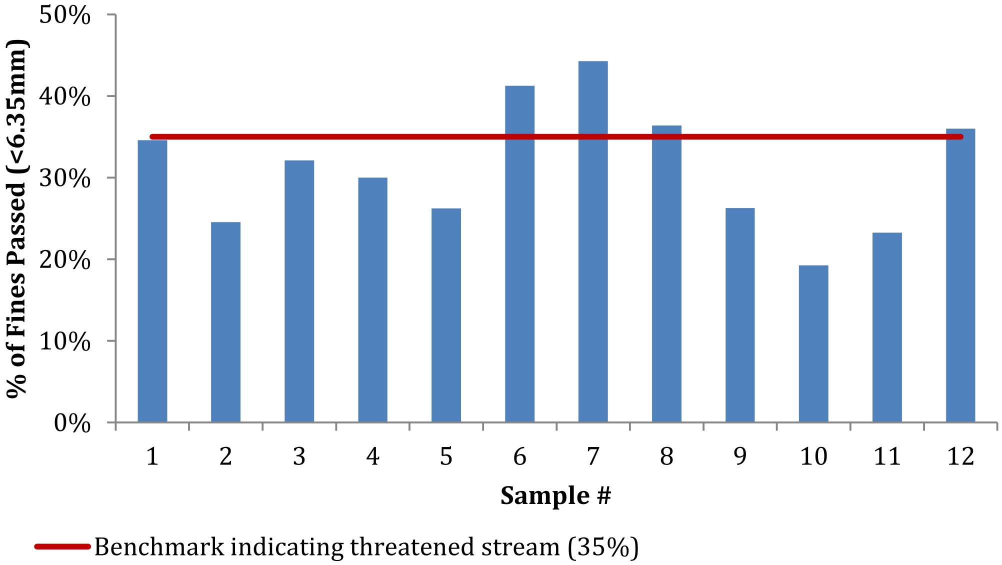

Figure 3. Percent of materials less than 6.35 mm at Bighorn Creek.

The majority of samples on Bighorn Creek were taken from bull trout redd mounds, with a few select samples showing evidence of emerging alevin and/or eggs; sample 2 had many swimming alevin and a few eggs, sample 3 had a few dead eggs, and sample 4 and 5 had many swimming alevin.

4.2 Blackfoot Creek

4.2.1 Study area

Blackfoot Creek originates in the Quinn Range of the Rocky Mountains in southeastern British Columbia, approximately 60 km from the town of Canal Flats, BC. This system has a length of approximately 50 kms, flowing in a north/northwest direction to its confluence with the mainstem White River. Blackfoot Creek has a total watershed area of approximately 152 km^2 and has a flow regime comparable to other interior streams, with peak flow occurrence in June/July and low flows in late fall and winter (Masse, 2000; Heidt, 2008). Specific discharge statistics are not available for this system.

This system is characterized by a long, narrow valley running through steep and rugged mountain terrain and falls within the Dry Cool Englemann Spruce-Subalpine Fir and Dry Cool Parkland Englemann Spruce-Subalpine Fir biogioclimatic sub zones and the Alpine Tundra biogioclimatic zone at higher elevations (Masse, 2000). The headwaters of Blackfoot Creek were devastated by wildfire in 1985 and significant salvage logging has occurred, leaving portions of riparian areas severely degradaded (Cope, 2003). Logging is currently occurring in several areas adjacent to the mainstem and significant portions of tributary basins from mid to upper portions of the watershed. Most tributary streams entering the system are characterized by short, steep ravines and seasonal debris torrents. A historic flood event occurred in 1995 which is thought to occur every 100 to 200 years (Heidt, 2008). A 1:200 year flood event occurred during the spring of 2013, causing extensive debris movement and morphologic changes throughout the system.

4.2.2 Site Description

One permanent sample site was established on Blackfoot Creek at approximately 63 km on the Blackfoot FSR (Figure 4, Appendix I). This site was established based on 2014 visual observations of bull trout redds (FLNR-Fisheries Program). A total of 12 gravel samples were taken at this site. Specific site measurements at this site were: wetted width = 3m, total length = 23m, and an average water depth of samples = 210mm. .

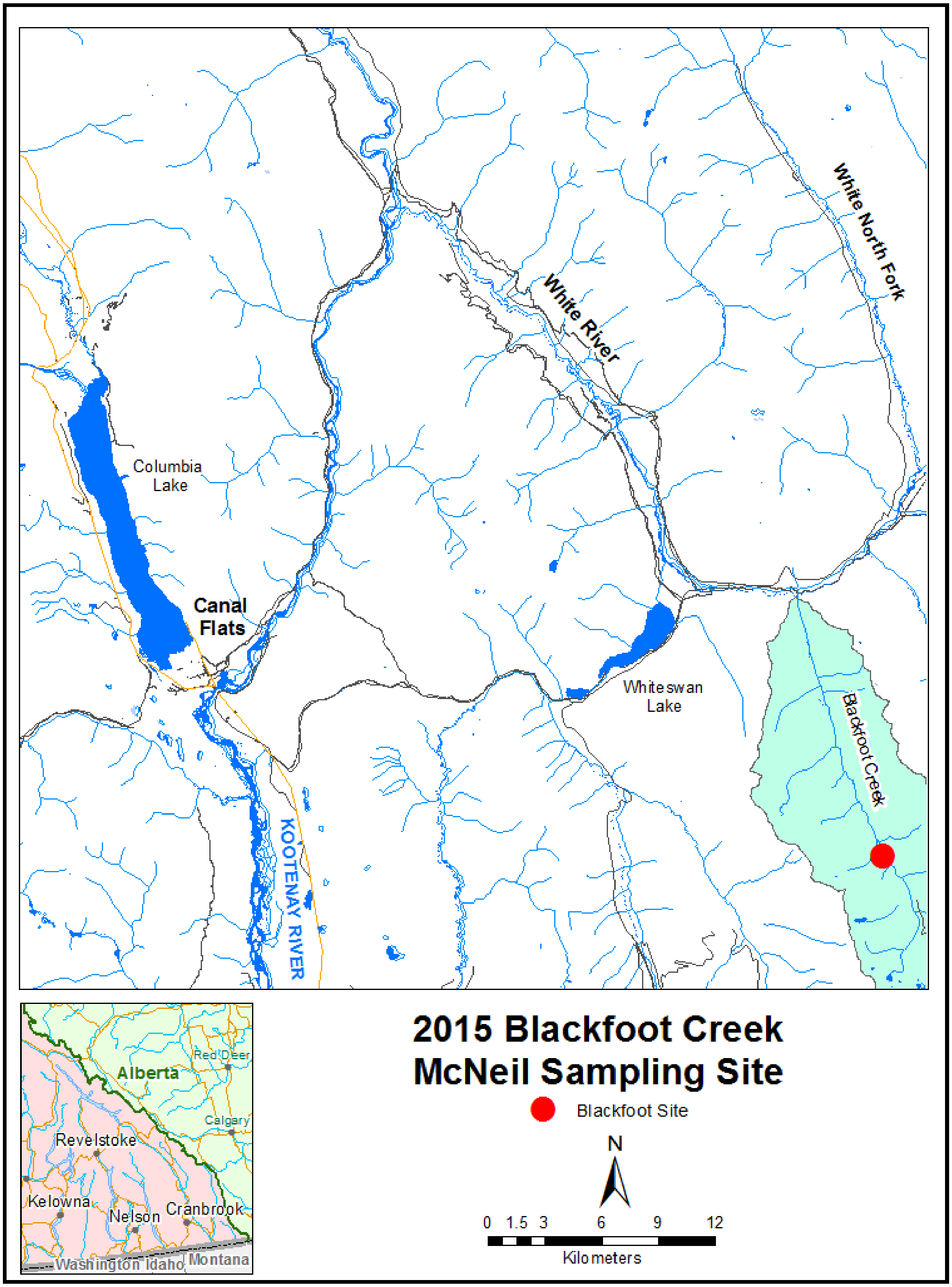

Figure 4. Blackfoot Creek McNeil sampling site.

4.2.3 Results

Sample analysis from the Blackfoot Creek site indicates a suitable system regarding bull trout spawning habitat. Most samples, with the exception of samples 7 and 8, show passed fine sediment levels below the 35% mark indicating a threatened system (Figure 5). The Blackfoot Creek site had an average of 21.4% fines (<6.35mm) passed from the 2015 samples (+/-6.0%; 95% Confidence Interval).

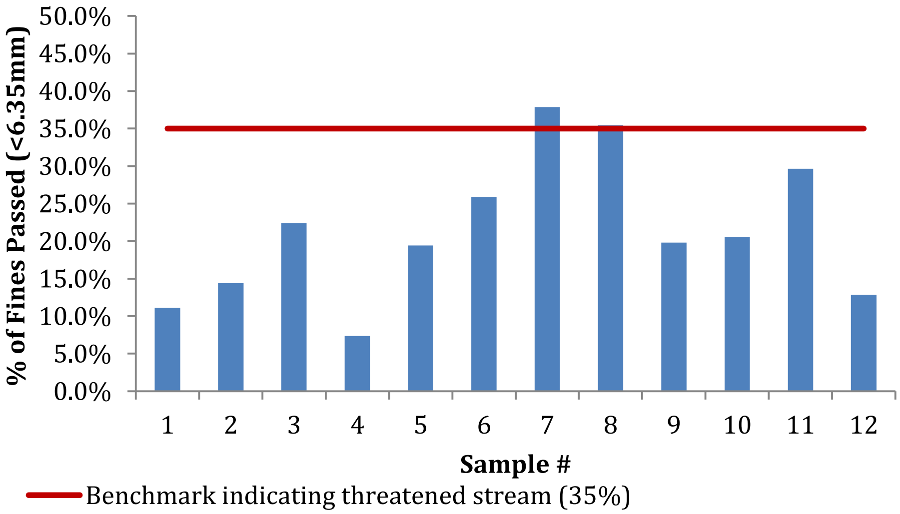

Figure 5. Percent of materials less than 6.35mm at Blackfoot Creek.

Most samples were taken on bull trout redd mounds, and sample 9 showed a swimming alevin with the yolk sac nearly fully absorbed. A dead alevin was released from the gravel in sample 12.

4.3 White River

4.3.1 Study area

The White River originates from glacier-fed lakes in the Height of the Rockies Wilderness Area (HOTR), between the Park and Front Ranges of the southern Rocky Mountains in southeastern British Columbia. The upper basin of the White River is divided into three large forks. The North Fork White River and the Middle Fork White River flow south approximately 40 km until they join the East Fork of the White River, which flows directly west from its headwaters. From the East Fork confluence, the White River flows west/southwest for approximately 10 km. At Whiteswan Provincial Park the river turns north/northwest for its final 34 km stretch until it empties into the upper Kootenay River, approximately 30 km northeast of the village of Canal Flats (Cope, 2003; Heidt, 2008) (Figure 1). The White River has a total watershed area of 987 km^2 with a mean annual discharge of 23.3 m^3/s (Water Survey of Canada). The flow regime is comparable to most interior streams with peak flows occurring in June or July and expected low flows in late fall and winter. Significant tributaries to the North and Middle Forks include Schofield Creek, Nilksuka Creek, Nipakoo Creek, Colin Creek, Maiyuk Creek, Kotsats Creek, Klookuh Creek and Rock Canyon Creek. Significant tributaries to the White River below the East Fork confluence include Grave Creek, Thunder Creek, Blackfoot Creek, Outlet Creek, Ptarmigan Creek, Elk Creek and Moscow Creek (Heidt, 2008).

The White River is characterized by long, narrow and forested valleys running through the rugged Rocky Mountains. Elevated layers of limestone dominate the geology. Three biogeoclimatic zones dominated the valleys. Montane Spruce at lower elevations, Engelmann Spruce and Sub alpine fir at middle elevations are the most common and alpine tundra at higher elevations (above approximately 2300 m) (Cope, 2003). In 1936, a forest fire burned much of the HOTR and the upper Middle Fork White River watershed. Historic forest fire salvage logging was extensive in these reaches. In 2003, a wildfire again burned the upper Middle Fork White River and the HOTR (Cope, 2003). Aggressive salvage logging was undertaken within the entire upper basin of the Middle Fork White River, below the HOTR, resulting in severe impacts to riparian areas throughout the upper reaches (Heidt, 2008).

4.3.2 Site Description

One sample site was established on the Middle Fork White River, at approximately 63 km (Figure 6, Appendix I). This site was established based on visual observation of bull trout redds during the fall of 2014 (FLNR-Fisheries Program). A total of 12 gravel samples were taken at this site (n=12). Specific site measurements at the site were: wetted width = 6.5m, total length = 25m, and average water depth of samples = 187mm.

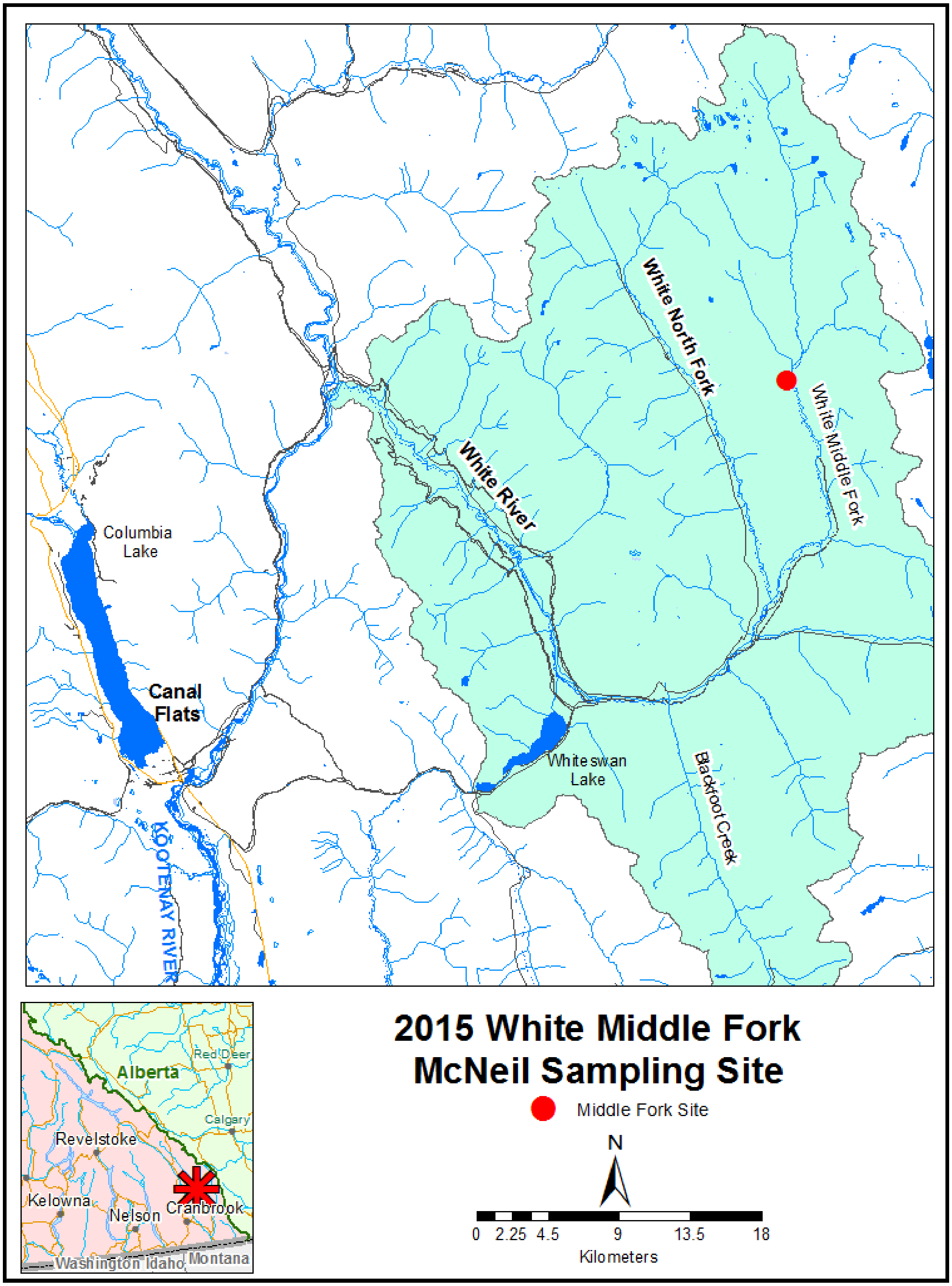

Figure 6. White River McNeil sampling sites.

4.3.3 Results

4.3.3.1 White River Middle Fork site.

Sample analysis from the White River Middle Fork site indicates a relatively consistent trend of samples bordering on the 35% threshold (Figure 7). The average percentage of fines passed for the White River Middle Fork site in 2015 was 34.8% (+/-2.7%; 95% Confidence Interval).

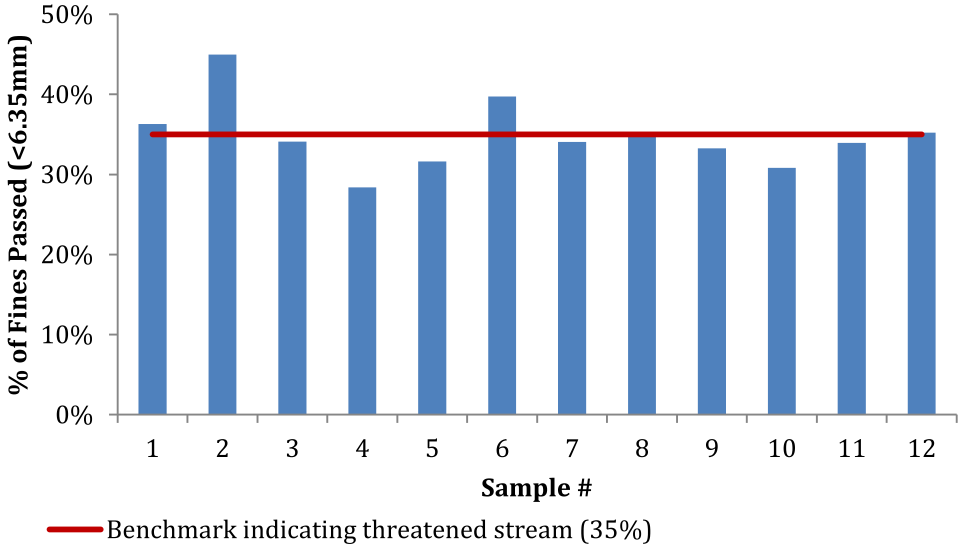

Figure 7. Percent of materials less than 6.35mm at White km 63.

Although a number of these samples were taken on the mound of bull trout redds, no eggs or alevin were evident.

4.5 Skookumchuck Creek

4.5.1 Study area

Skookumchuck Creek originates in the South Purcell Mountains within the Purcell Wilderness Conservancy. From its headwaters, the stream flows east/northeast for approximately 62 km to its confluence with the upper Kootenay River, near the town of Skookumchuck, BC. The headwaters of the Skookumchuck drainage originate at an elevation of approximately 2,250 m and declines to 750 m. Skookumchuck Creek has a drainage area of approximately 637 km^2, with a mean annual discharge of 10.3 m^3/s (Water Survey of Canada). The flow regime is comparable to most interior streams with peak flows occurring in June and expected low flows in late fall and winter (Cope, 2003). Significant tributaries to Skookumchuck Creek include Buhl Creek, Bradford Creek and Sandown Creek (Heidt, 2008).

The Skookumchuck Creek valley is characterized by five biogeoclimatic zone variants: Kootenay dry mild ponderosa pine, Kootenay dry mild interior Douglas-fir, dry cool montane spruce, fry cool Engelmann spruce sub-alpine fir and alpine tundra (Braumandl and Curran, 1992; Cope, 2003). The upper reaches of Skookumchuck Creek flow through a narrow alluvial floodplain, characterized by channel-confining bedrock outcrops, bordered by steep mountain slopes. The lower reaches are almost entirely confined to a long, narrow bedrock canyon, surrounded by steep, densely forested terrain. The watershed has a long timber harvesting history, with records of harvest activities dating back to 1916 (Cope, 2003). Pine beetle salvage logging has been extensive throughout the mid-upper portions of the watershed in recent years, which may be contributing to elevated levels of sediments, shifts in substrate composition and changes to channel morphology (Heidt, 2015).

4.5.2 Site Description

The sample site was established on Skookumchuck Creek, at approximately 38 km on the Skookumchuck FSR (Figure 8, Appendix I). This site was established from the previous McNeil study (Heidt, 2008) based on annual observations of bull trout redds (B.C. Ministry of FLNR). Within the sample site, samples were taken from two separate transects (A and B), with 8 samples coming from transect A and 4 from transect B. A total of 12 gravel samples were taken at the site (n=12). Site-specific measurements at this site were: wetted width = 6m, total length = 20m, and an average water depth of samples = 216mm.

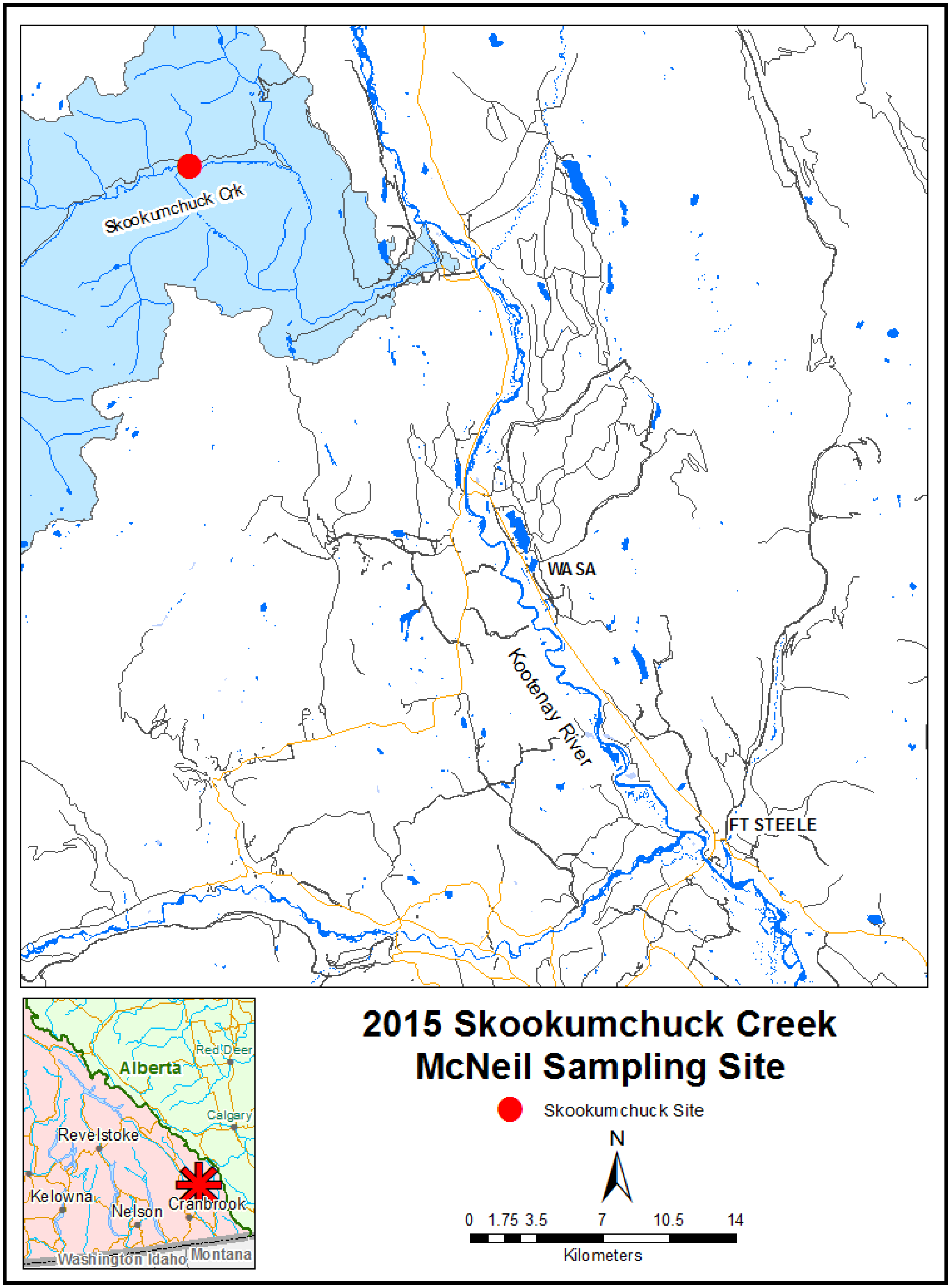

Figure 8. Skookumchuck Creek McNeil sampling sites.

4.5.3 Results

Sample analysis from the Skookumchuck Creek site indicates an inconsistent range of results from the 12 samples. The samples varied from a low of 25% fines passed to a high of nearly 50% fines passed, with an overall average of 38.7% fines passed (+/- 5.4%; 95% Confidence Interval) (Figure 9). It is important to note that bull trout redd counts conducted over the previous study year had documented very little bull trout spawning activity at this site. However, this may also be due to a lack of groundwater evident at the site and not directly attributable to material composition (Heidt, 2008).

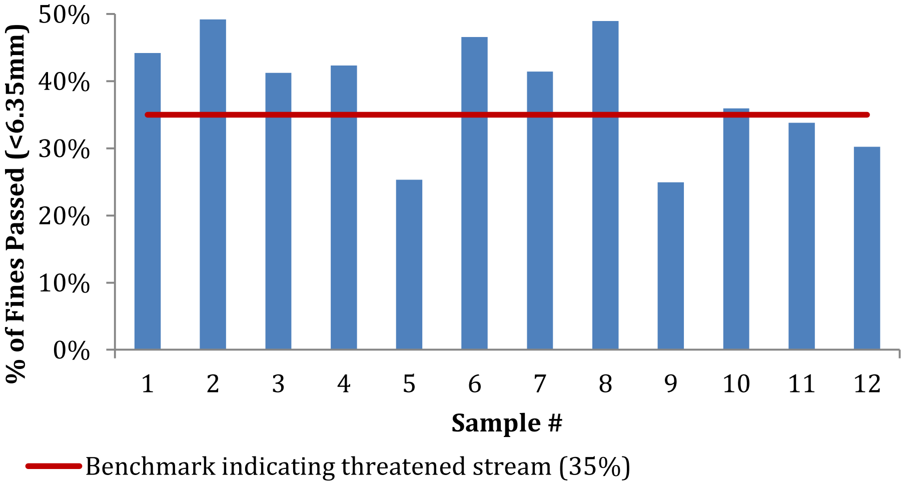

Figure 9. Percent of materials less than 6.35 mm at Skookumchuck Creek.

A few samples from transect A were taken on visible bull trout redds, with two samples showing eggs inside the core sampler. All 4 samples in transect B were taken on visible redds, but no samples showed evidence of alevin or eggs.

5.0 DISCUSSION AND RECOMMENDATIONS

Results from this study show variation between sampling sites, with an average high of 39% fines in the Skookumchuck site, and an average low of 21% in the Blackfoot Creek site. Bighorn Creek and the White River had 31% and 35% fines on average respectively (Figure 10).

Having sufficient clean gravel with adequate interstitial space between un-bedded cobbles is extremely important for bull trout egg-to-fry survival (Dambacher and Jones, 1997). Thus, these results suggest that special attention be given to the Skookumchuck Creek site, as it has passed the benchmark identified by Weaver (1996) indicating a threatened system for bull trout. Skookumchuck Creek showed significant downcutting, bedload movement, redistribution of large woody debris, and channel migration during the 2013 1:200 year flood event. It is suspected that bull trout have been forced to rediscover suitable spawning locations within this system (Heidt, 2015). During the fall of 2015, FLNR Fisheries Program staff documented an increase of bull trout spawners in different locations than previous years. It is recommended that the “Substrate Sampling Program” adapt to the new spawning locations and analyse the fine sediment composition in these sites as a true suitability index and recruitment/survival predictor.

The White River samples showed an average of percent fines that bordered the 35% threshold. This draws concern to this system, as it is a critical system for bull trout spawning activity in the upper Kootenay River watershed. It is recommended that bull trout spawner numbers be monitored over the next 5-10 years to investigate whether these high sediment levels attribute to decreased spawner numbers when the 2015 seasons’ eggs have reached maturity. In addition to this, FLRN Fisheries Program staff identified a new spawning index through 2014 aerial reconnaissance and ground truthing in the headwaters of the White River Middle Fork (Heidt, 2014). This index appears very stable with unaltered floodplains, intact riparian vegetation, and a sinuous meandering channel type with favourable riffle, pool and glide meso-habitats. It is recommended that the “Substrate Sampling Program” include this index in future sampling projects, as this index can act as a benchmark for a stable, relatively undisturbed system for future comparisons.

Blackfoot Creek, the site with the lowest fines composition, was the site that presented the most physical change from the recent 2013 1:200 year flood event. The channel showed significant evidence of disturbance, with clear signs of widening, downcutting and redistribution of gravel bars and large woody debris. It was suspected that this site would present high levels of fine in-stream sediment as the stream morphology is relatively new and unstable. However, the flood event may have acted as a cleansing agent for the system, flushing sediments downstream to settle in areas with less velocity. Special attention should be directed to this site, including redd counts and future McNeil sampling to determine the impact from recent morphological changes on returning bull trout and egg to fry survival. It should be noted that FLNR Fisheries Program staff observed numerous juvenile bull trout during annual redd counts, which confirms the importance of this stream for juvenile rearing (Heidt, 2015).

Due to unfavourable snowpack conditions and early break-up on the Wigwam River during 2015 sampling, samples were unable to be collected. It is recommended that sample collection from the Wigwam River be made a priority for 2016. Accessing the Wigwam sampling site should be attempted whenever snowpack conditions are favourable, preferably earlier in the sampling period, as it is difficult to access when snowmelt begins due to sun-exposure on South facing slopes.

It is recommended that preliminary bull trout population assessments be initiated on the Wildhorse River near Ft Steele, BC, due to reports of bull trout usage, historical First Nations significance, and limited fisheries inventory knowledge (Heidt, pers. comm., 2015). This system has also experienced a significant amount of disturbance from recreation, forest harvest activities, and hydraulic mining. After bull trout spawning locations have been identified, it is recommended that this system be added to the McNeil Substrate Sampling Program.

Following collection of sufficient McNeil substrate sampling data, bull trout redd count numbers in the same systems should be compared to Mcneil substrate data from 5-6 years prior. This would allow for the investigation into any correlation between fine sediment levels in spawning locations, egg-to-fry survival, and consequently, return numbers of spawners when they have reached maturity (5-7 years) (Fraley and Shepard, 1989).

Finally, more detailed information should be recorded on egg and alevin activity inside each sample to allow for the relationship between individual site sediment levels and egg and alevin activity to be analysed. This will provide a smaller scale view on egg survival rather than using an overview of the entire site.

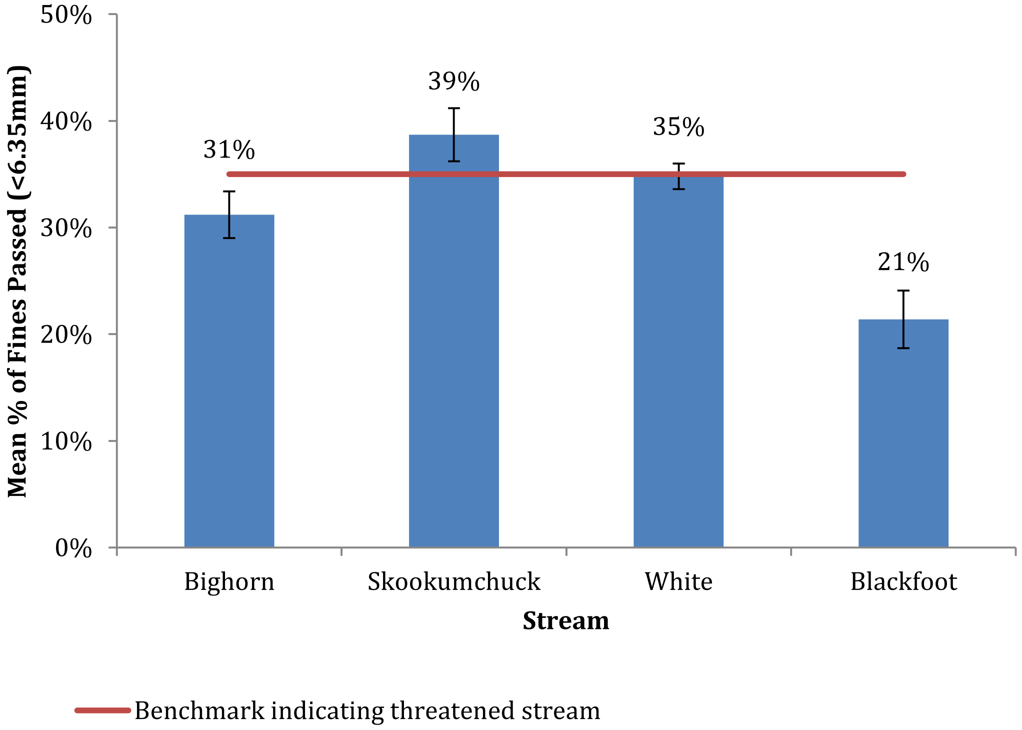

Figure 10. Percent of materials less than 6.35 mm for all sites.

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Appendix I. UTM (NAD 83) Coordinates of the 8 McNeil Sample Sites

Stream System	Site Location	Zone	Easting	Northing
Bighorn Cr.	Under Wigwam FSR bridge at kilometer 44	11	648948	5449666
Blackfoot Cr.	Adjacent to Blackfoot FSR at kilometer	11	619481	5542759
Skookumchuck Cr.	A: Kilometer 38 (Glide)	11	575603	5536291
	B: Kilometer 38 (Riffle)	11	575553	5536316
White R. (Middle Fork)	Kilometer on Middle Fork FSR	11	626977	5576217

Appendix II. Equipment List & Procedure for McNeil Substrate Sampling

Equipment

- Large Pack (Hunting Pack) – if samples will be carried any distance
- McNeil Sampler
- 12+ Heavy Duty Garbage Bags (Trash Compactor Bags – 2 Ply)
- 12+ Sand Bags
- Wire or small rope to tie Sand Bags
- Clip Board
- Forms (pre-made) – WATER PROOF
- 12 Labels (pre-made) – for each sample
- Long rubber gloves
- Large Plastic Cup
- 4 Cones – to measure fine sediment
- Wooden Cone holder - fits in a large Bucket (needs to made)
- Black Felt Pen – to mark outside of Sand Bags
- Metal meter stick
- Camera
- Flagging Tape – to mark site for the 1st time
- Rebar, Spray Paint & Hammer - to mark site for the 1st time
- Satellite Phone – safety reason to communicate with other team if needed

Procedure

1. Mark location of each transect with rebar (left bank – looking d/s) and flagging tape on trees/shrubs.
2. Take u/s, x/s and d/s photo of each transect site.
3. Locate redds within transect and twist and press the McNeil sampler into the gravel “mound” of the redd, until gravel nears the top of the inside cylinder of the sampler.
4. Remove the gravel from the inside of the cylinder to the inside “tray” section of the sampler, until the “teeth” of the sampler can be felt with your hand at the bottom of the cylinder.
5. Use the cup to remove 1000ml of water and fine sediment from inside the sampler to the sampling/measuring cone – record time to check cone on the form (20 min. from time sample is placed in cone). Ensure this is done immediately after gravel is removed from cylinder.
6. After 20 min. measure the amount of sediment that has accumulated in the bottom of the cone.
7. Use metal meter stick to measure in “mm” the distance from the substrate at the bottom of the cylinder to the water surface – record on the form.
8. Slowly pour water out of the sampler.
9. Pour gravel into garbage bag, “rinse” remaining fine gravel with water, slowly pour off water and dump remaining gravel & fines into a garbage bag. Place pre-made labels into the garbage bag and seal bag with a “knot”. Mark location and sample # on outside of bag.
10. Place garbage bag into a sand bag and seal sand bag with wire or fine rope.