Monitor and Protect Wigwam River Bull Trout for Koocanusa Reservoir

Wigwam River McNeil Substrate Sampling Program

Summary Report

1998 - 2002

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BONNEVILLE POWER ADMINISTRATION

Wigwam River McNeil Substrate Sampling Program: 1998 – 2002 Summary Report

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1.0 Introduction

The Wigwam River is an important fisheries stream in the East Kootenay region of British Columbia that supports healthy populations of both bull trout (*Salvelinus confluentus*) and Westslope cutthroat trout (*Oncorhynchus clarki lewisi*). The river has been characterized as the single most important bull trout spawning steam in the Kootenay Region (Baxter and Westover 2000), and thus has been the focus of numerous studies in the last ten years (Cope 1998; Cope and Morris 2001; Cope, Morris and Bisset 2002; Kohn Crippen Consultants Ltd. 1998; Westover 1999a; Westover 1999b; Westover and Conroy 1997).

Although bull trout populations in the East Kootenay region remain healthy, bull trout populations in other parts of British Columbia and within their traditional range in north-western United States have declined. Thus, 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. Bull trout in the north-western United States, within the Columbia River watershed, were listed as threatened in 1998 under the Endangered Species Act by the U.S. Fish and Wildlife Service.

In 1999, the Ministry of Water, Land and Air Protection applied and received funding from the Bonneville Power Administration (BPA) to assess and monitor the status of wild, native stocks of bull trout in tributaries to Lake Koocanusa (Libby Reservoir) and the upper Kootenay River. The purpose of this report is to summarize one of the many studies undertaken to “Monitor and Protect Bull Trout for Koocanusa Reservoir” (BPA Project Number 2000-04-00).

1.1 Objectives

Three permanent sampling sites were established on the Wigwam River in April 1998. At each site, substrate samples were obtained using a McNeil Core sampler in April of each year from 1998 to 2002. The objectives of this study were to assess the quality of stream-bed substrates used by bull trout for spawning prior to major resource development in the Wigwam watershed, thus providing one potential measure of future impact to bull trout spawning habitat.

1.2 Study Area

As described in Baxter and Westover (2000) and Cope, Morris and Bisset (2002), the Wigwam River originates in the Rocky Mountains within the state of Montana and flows northwest between the Galton and MacDonald ranges in British Columbia for approximately 47 km until it empties into the Elk River, a tributary to Lake Koocanusa (Figure 1). The headwaters of the Wigwam drainage originate at an elevation of 2135 m and decline to 800 m at its confluence with the Elk River. The drainage is comprised of three major east slope tributaries (Lodgepole, Bighorn, and Desolation Creeks) all of which rise out of the MacDonald Range. The Wigwam River valley is characterized by four biogeoclimatic zone variants; Kootenay dry mild interior Douglas-fir, dry cool montane spruce, Kootenay moist cool interior cedar hemlock, and dry cool Engelman spruce sub-alpine fir (Braumandl and Curran 1992). The flow regime of the Wigwam River is comparable to most interior systems with high annual run-off reaching it’s peak in May (peak mean daily discharge 74 m^3/s on 24 May 2000) and expected low flows in late fall and winter (2.1 m^3/s; Prince and Cope 2001).

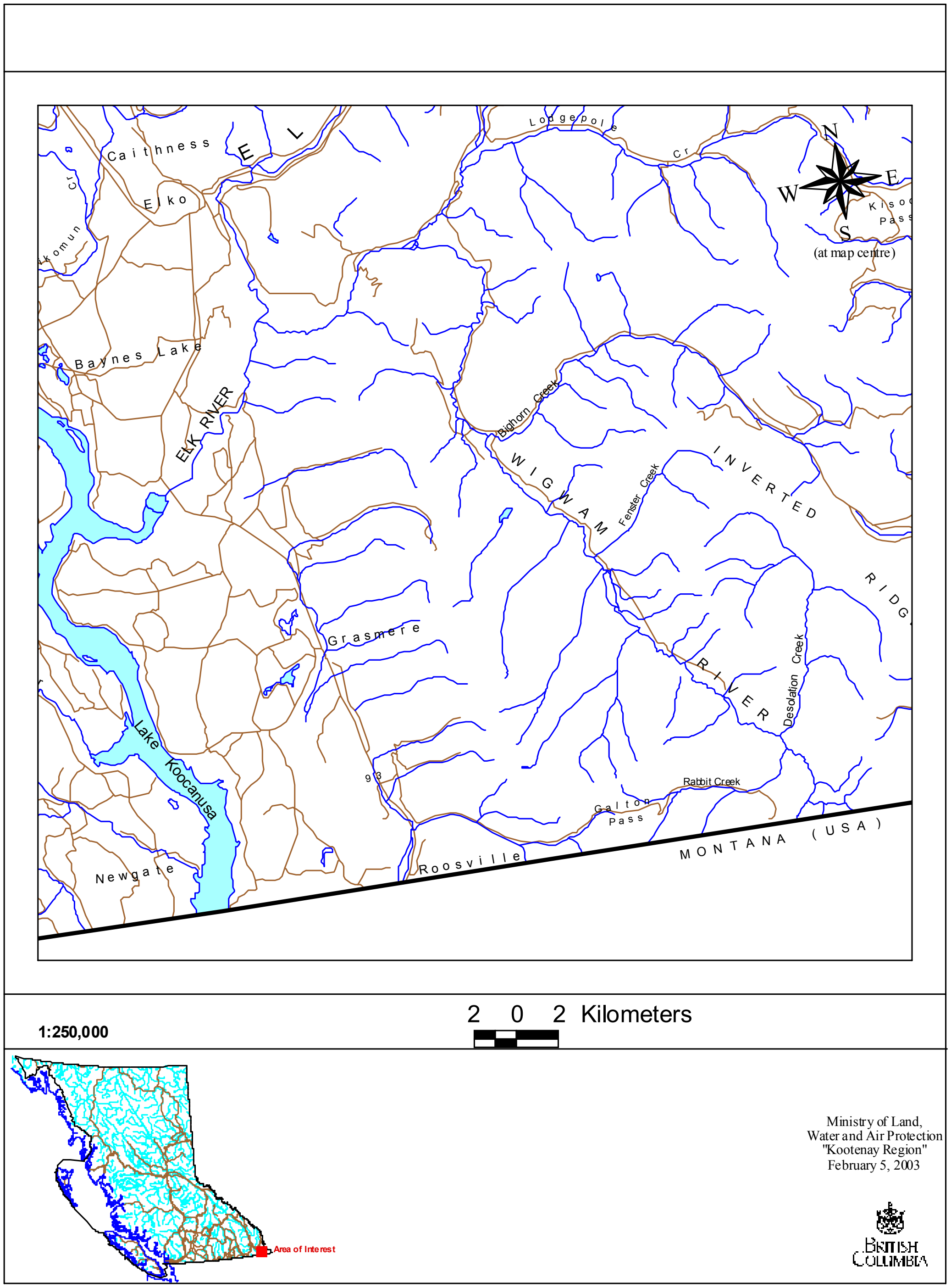

Figure 1. Location of the Wigwam River Study Area.

A number of natural and anthropogenic disturbance events over time appear to have contributed a substantial volume of coarse sediment to the river including: wildfires in the 1930's, extensive logging in the headwaters of Bighorn Creek and the headwaters of the Wigwam River from 1950 to 1980, a slide in 1993, and the 1995 flood event thought to occur every 100 to 200 years (Oliver and Cope 1999; Kohn Crippen Consultants Ltd. 1998). Frequent lateral channel migrations over time have resulted in erosion of adjacent terraces, coarse sediment delivery to the mainstem river, and have created numerous sections of braided channel comprised of sorted gravels and cobbles that provide prime spawning habitat for bull trout (Oliver and Cope 1999). The provision of suitably sized bed materials (<70 mm) in a low gradient, low water velocity location with associated groundwater have been identified as repeating patterns of preferred bull trout spawning habitat (McPhail and Baxter 1996).

The majority of Wigwam River bull trout studies have been conducted over a large portion of its mainstem from the top of the canyon (km 42) to near its headwaters in Montana, as well as in Bighorn Creek and in Lodgepole Creek upstream to the falls at km 26. This study was conducted at three sites on the mainstem Wigwam River between Bighorn Creek and the headwaters in Montana (Figure 2). Appendix A lists the UTM coordinates of the three sites.

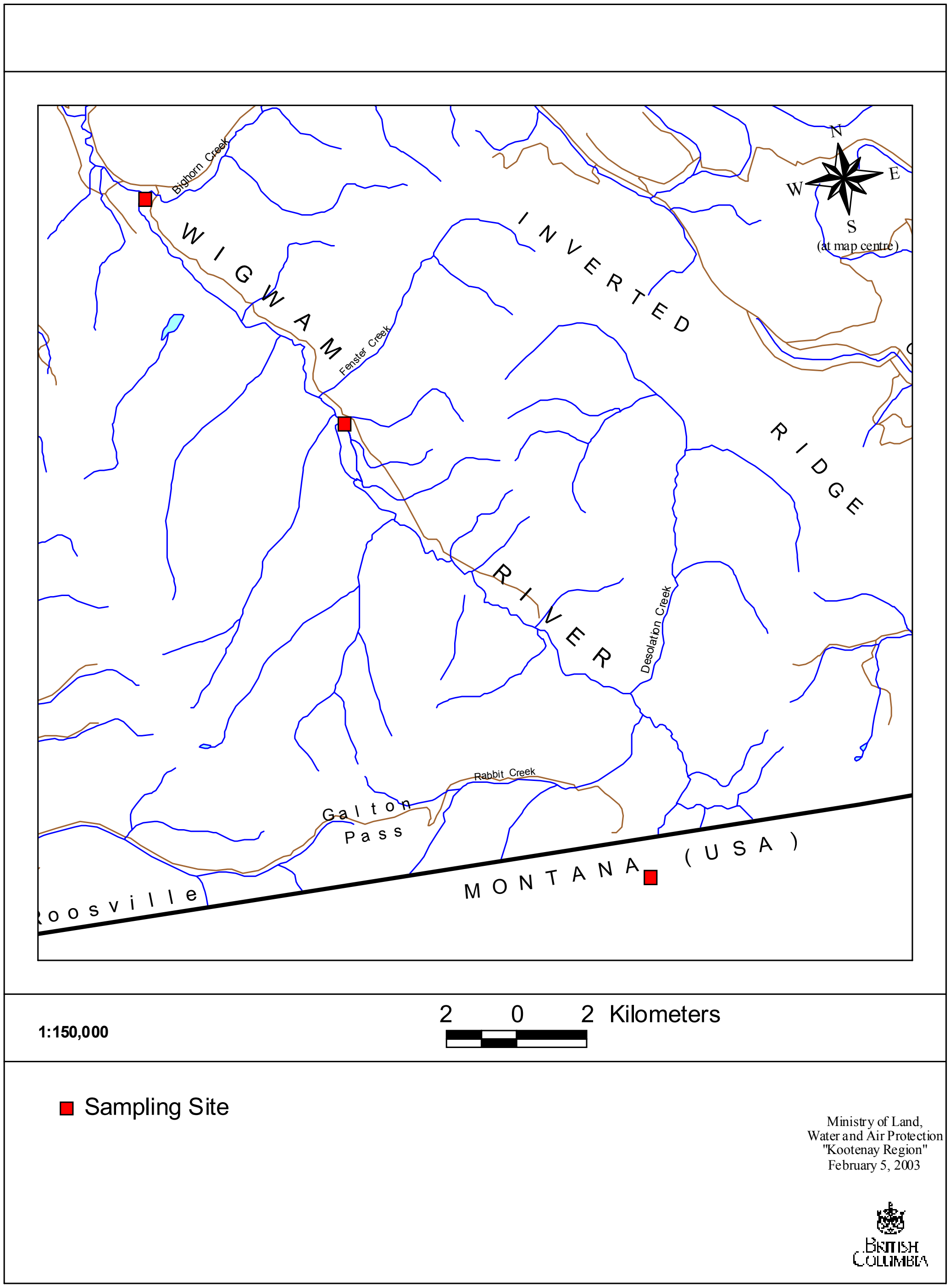

Figure 2. Location of the Three Sites for the Wigwam River McNeil Substrate Sampling Program

2.0 Methods

Three permanent sample sites were established in reaches five, six and eleven of the Wigwam River mainstem in April, 1998 (refer to Cope, Morris and Bisset 2002, Appendix A for 1:50,000 reach break map). Sampling sites were chosen based on annual observations of natural bull trout spawning occurrences. Each sampling location was permanently marked with a rebar stake on the left bank (downstream view) and with flagging tape. In reach five, twelve substrate samples were taken annually, four downstream and eight upstream of the confluence with Bighorn Creek. In reach six, ten to twelve substrate samples were taken annually downstream from the local guide outfitters camp. In reach eleven, six to twelve substrate samples were taken annually at one of two different locations depending on presence of spawning gravels.

2.1 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 B. 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 place 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 place in a heavy duty plastic bag. Each bag was labelled on the outside and inside (on waterproof paper) and then transported to a laboratory for gravimetric analysis. The samples were processed in 1998-2000 by the Hydro Lab of the US Forest Service in the Libby District of Montana, USA and then in 2001 and 2002 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).

2.2 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

Table 1. Mesh size of sieves used to gravimetrically analysis hollow core (McNeil and Ahnell 1964) stream substrate samples collected from the Wigwam River mainstem from 1998-2002.

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)	

composition of substrate samples for each site over the five year study period. Specifically, percent materials less than 2.00 mm and 6.35 mm were calculated directly from the sieving results. Log-probability plots of stream-bed particle size composition were utilized to calculate geometric mean diameter (dg) and a Fredle Index (FI). Geometric mean diameter was estimated using the following equation (Platts, Shirazi and Lewis 1979):

$$dg = (d_{84} \times d_{16})^{0.5}$$

where: d_{84} = particle diameter at the 84^{th} percentile (i.e. 84 per cent of the sampled population is equal to or finer than the representation particle diameter)
D_{16} = particle diameter at the 16^{th} percentile

Fredle Index was estimated using the following equation (Lotspeich and Everest 1980):

$$FI = dg/So$$

Where: So = sorting coefficent = $(d_{75}/d_{25})^{0.5}$
d_{75} = particle diameter at the 75^{th} percentile
d_{25} = particle diameter at the 25^{th} percentile

3.0 Results

Analysis of substrate core samples of materials less than 2 mm and 6.35 mm indicated a substantial amount of variability, both within and between sampling sites over the five year study period (Figures 3 and 4). According to MacDonald and McDonald (1987), within site variability (i.e. differences between cores on the same transect) can result from differences in stream flow pattern at each core location. With the exception of 1998, fine sediments (materials <2 mm and <6.35 mm) were higher at the Reach 5 (Bighorn) and Reach 6 (Outfitter) sites compared to the Reach 11 (USA) site. The average amount (+/-1 Standard Deviation (StdDev)) of substrate material less than 2.00 mm, when all samples for the five year study period where combined, for the Bighorn, Outfitter and USA sites was 15.7 +/- 4.2%, 14.2 +/- 5.1 %, and 9.7 +/- 4.7 %, respectively. The average amount (+/- 1 StdDev) of substrate material less than 6.35 mm, when all samples for the five year study period where combined, for the Bighorn, Outfitter and USA sites was 31.7 +/- 8.1%, 28.2 +/- 9.2 %, and 25.2 +/- 7.8 %, respectively.

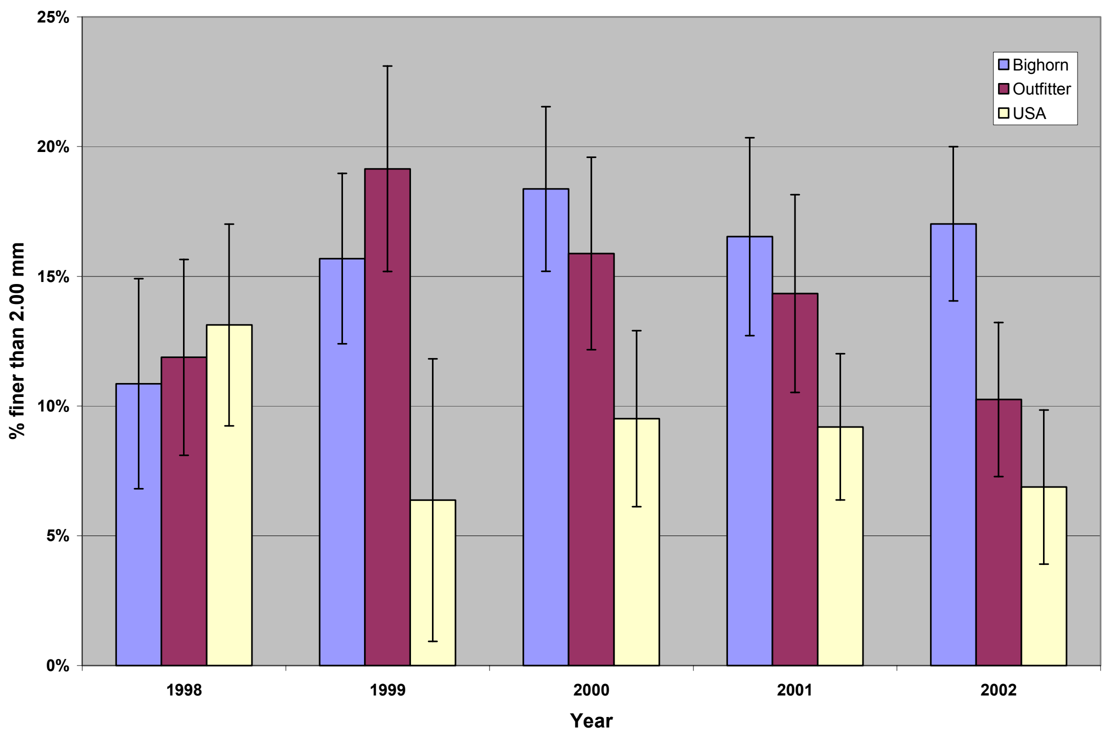

Figure 3. Wigwam River 1998 - 2002 - McNeil Substrate Sampling (% finer than 2 mm) - Averages (+/- 1 StdDev) from 6 to 12 core samples at 3 sites.

A comparison of the overall composition of the substrate samples, using the geometric mean diameter (dg) and Fredle Index (FI) calculations, showed an increasing trend to larger materials from the Bighorn site to the USA site (Figures 5 and 6). The average dg (+/- 1 StdDev) over the five year study period for the Bighorn, Outfitter and USA sites was 11.1 +/- 2.2 mm, 13.2 +/- 3.2 mm, and 15.4 +/- 2.0 mm, respectively. The average FI (+/- 1 StdDev) over the five year study period for the Bighorn, Outfitter and USA sites was 4.0 +/-1.9 mm, 5.2 +/-3.0 mm, and 5.6 +/- 1.2 mm, respectively.

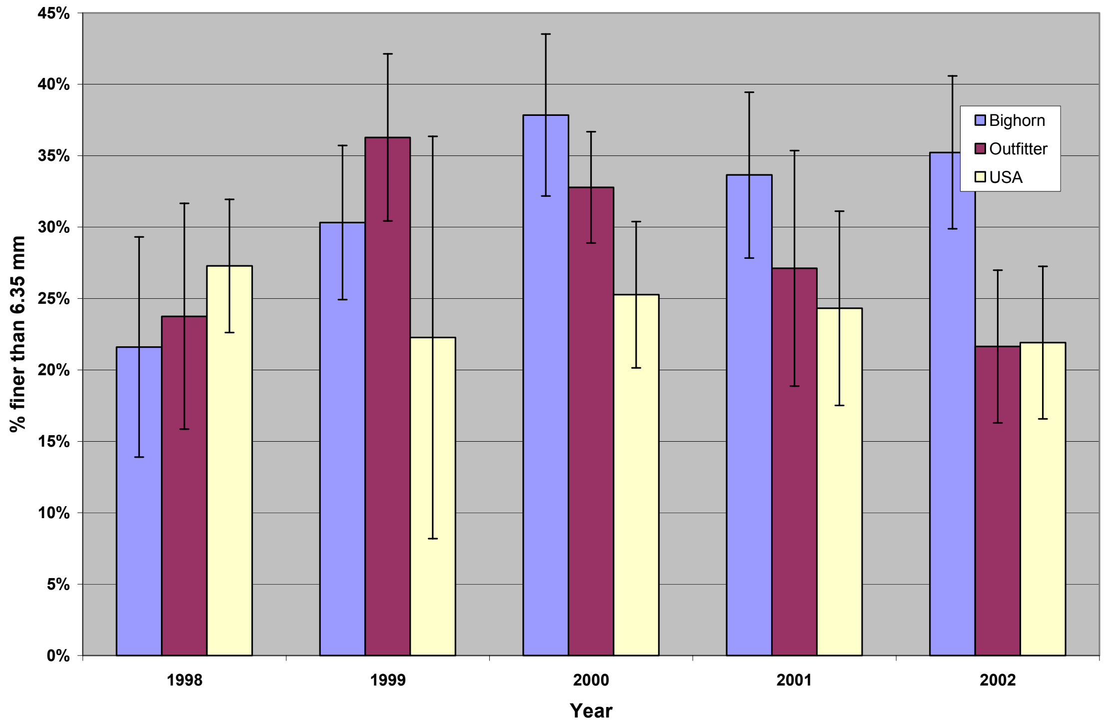

Figure 4. Wigwam River 1998 - 2002 - McNeil Substrate Sampling (% finer than 6.35 mm) - Averages (+/- 1 StdDev) from 6 to 12 core samples at 3 sites.

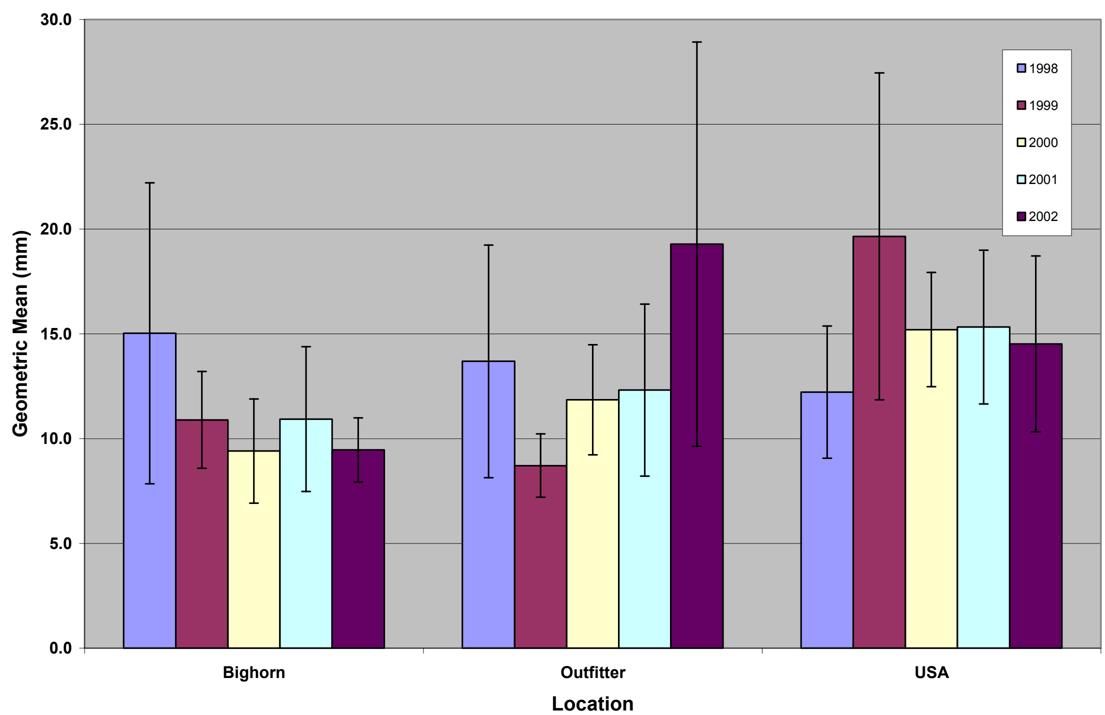

Figure 5. Wigwam River 1998 - 2002 - McNeil Substrate Sampling - Geometric Mean Comparison - Averages (+/- 1 StdDev) from 6 to 12 core samples at 3 sites.

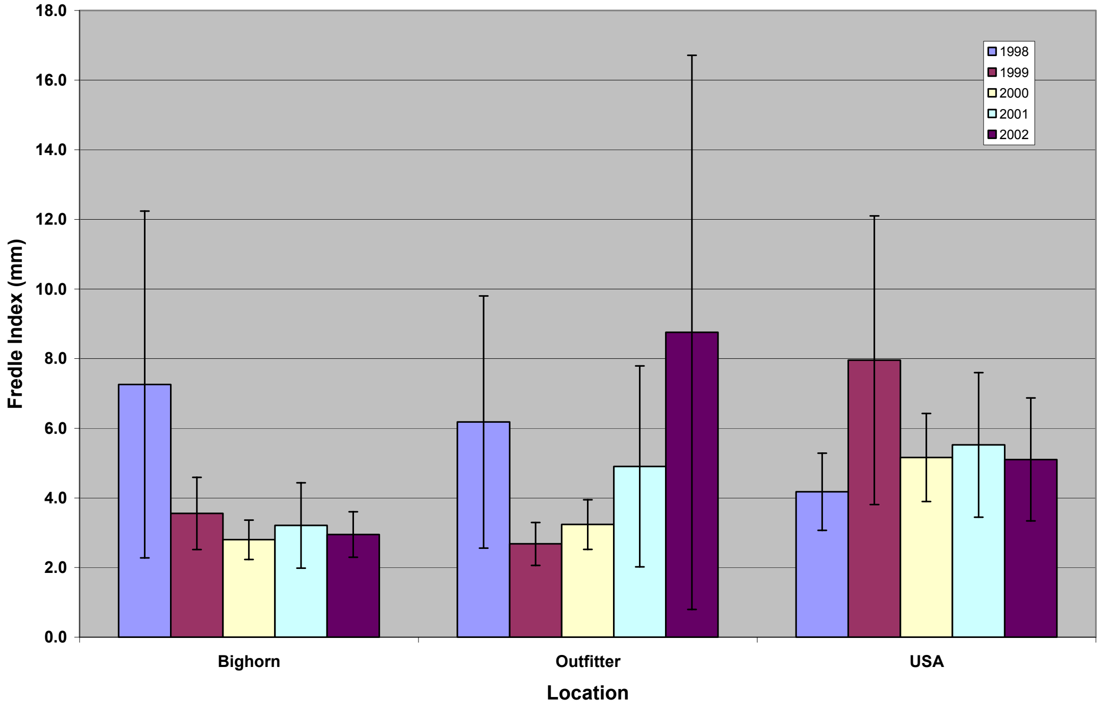

Figure 6. Wigwam River 1998 - 2002 - McNeil Substrate Sampling - Fredle Index Comparison - Averages (+/- 1 StdDev) from 6 to 12 core samples at 3 sites.

Substrate core samples were also compared using the median percentage less than 6.35 mm in diameter (Figure 7). 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. Figure 8 combines the data seen in Figure 7 and illustrates that there was an increasing trend in the average amount (+/- 1 StdDev) of fine sediment (median % < 6.35 mm) from the upstream (USA) site (24% +/- 3%) to the downstream (Bighorn) site (32% +/- 5%) over the five year study period.

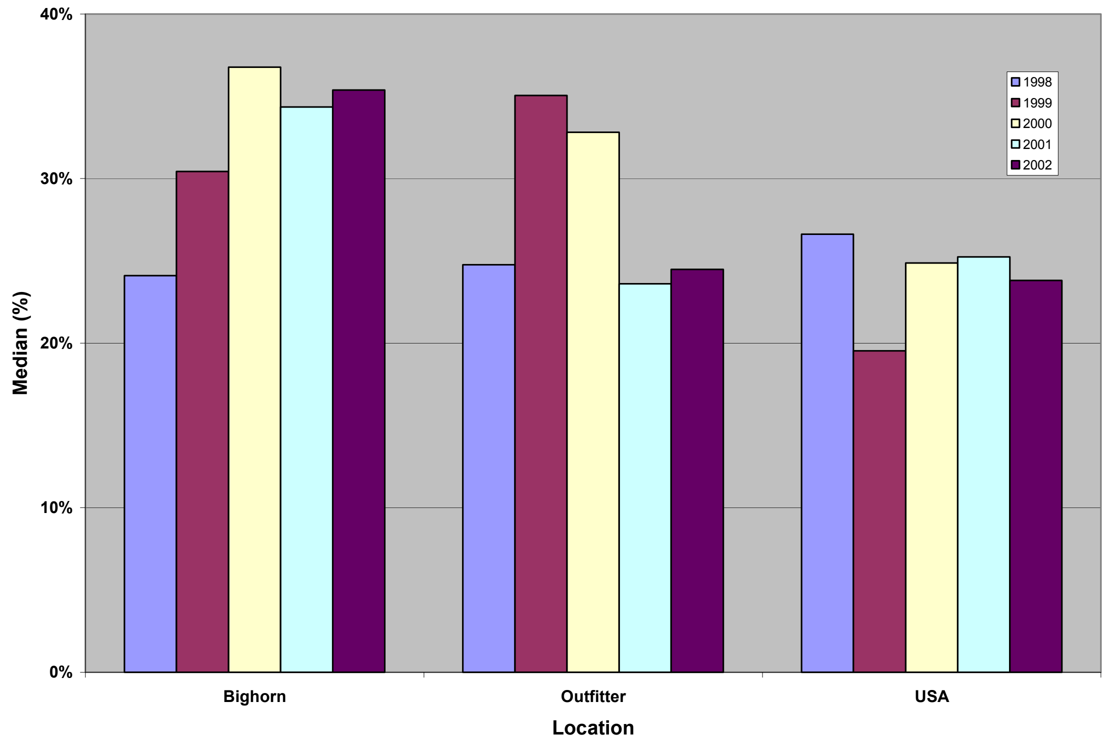

Figure 7. Wigwam River 1998 - 2002 - McNeil Substrate Sampling - Median % for materials <6.35 mm from 6 to 12 core samples at 3 sites.

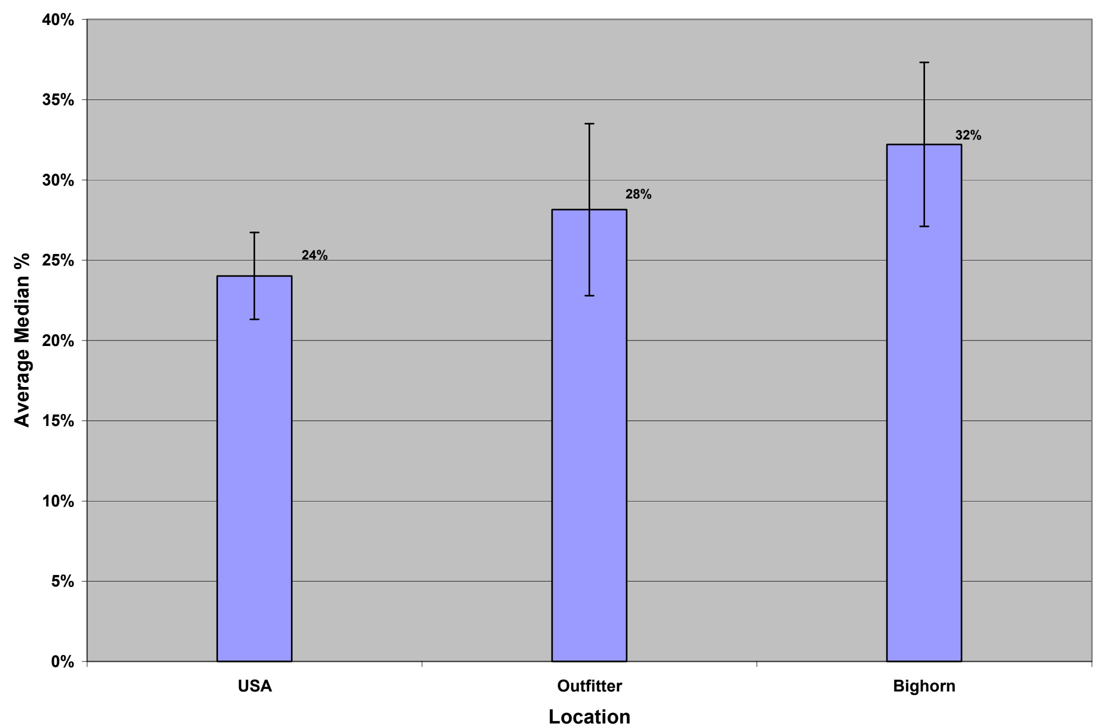

Figure 8. Wigwam River 1998 - 2002 - McNeil Substrate Sampling - Increasing tend in the amount of materials <6.35 mm (average median % +/- 1 StdDev) from the upstream USA site to the downstream Bighorn site over the 5 year study period.

4.0 Discussion

Substrate analysis over a five year period at three sites on the Wigwam River indicated that the overall substrate size composition decreased, while the amount of fine sediment (materials < 6.35 mm) increased from the upstream (USA) site to the downstream (Bighorn) site. The differences in overall size composition of the substrate samples at the three sites may have resulted from slight differences in the physical characteristics (i.e. depth, width, velocity and gradient) of the channel which were not measured. The increase in the amount of fine sediment from the upstream to downstream site may have resulted from increased channel migrations that have occurred over time as the river proceeds down the valley. As previously mentioned, these channel migrations are due to the natural and anthropogenic disturbance events that have occurred in the Wigwam River watershed over time.

Weaver and Fraley (1991) observed a significant inverse relationship between the amount of material less than 6.35 mm and bull trout fry emergence success, when bull trout eggs were planted in different mixtures of gravel. Using the empirical formula derived by Weaver and Fraley (1991), Figure 9 illustrates that the predicted egg to fry emergence success decreased from 39.8% to 31.7% as the amount of fine sediment (materials < 6.35 mm) increases from the upstream (USA) site to the downstream (Bighorn) site, respectively.

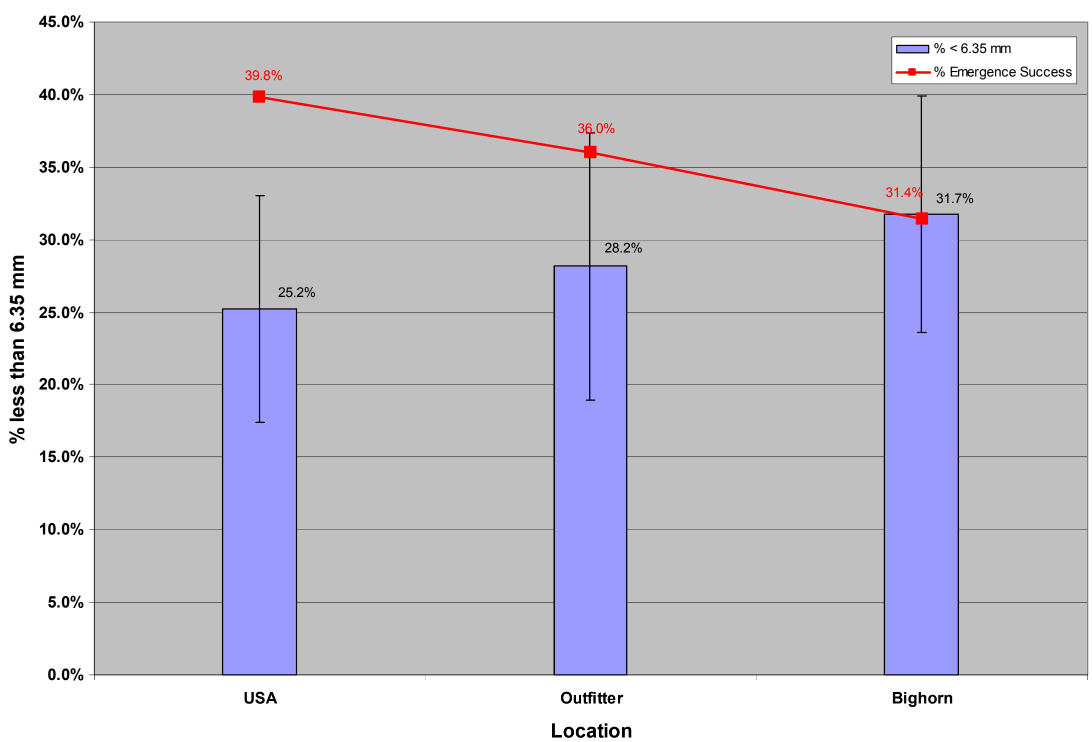

Figure 9. Wigwam River 1998 - 2002 - McNeil Substrate Sampling – Predicted decreasing trend in egg to fry emergence success as the percent materials less than 6.35 mm increased from the upstream USA site to the downstream Bighorn site over the 5 year study period (% < 6.35 mm based on averages, +/- 1 StdDev, when combining all 5 years of sample data for each site and emergence success based on the empirical formula derived by Weaver and Fraley (1991)).

As stated in MacDonald and McDonald (1987), predicted emergence success rates are only a relative index of the impacts of measured increases in fine sediment. Actual emergence success rates are also influenced by factors such as extreme flow events, unfavourable temperature regimes, and the presence of toxic chemicals and disease organisms.

Weaver (1996) stated that when the median percent of materials less than 6.35 mm are greater than 35% in any give year, the stream is considered threatened as a bull trout spawning and/or rearing stream. If materials less than 6.35 mm exceed 40% the stream would be considered impaired. Over the five year study period on the Wigwam River, the 35% level was only exceeded once at the Bighorn site in 2000 (37%). Future substrate samples should be taken in 5 to 10 years on the Wigwam River to determine if current land management activities have affected streambed particle size composition at these three bull trout spawning sites.

5.0 References

Baxter, J.S. and W.T. Westover. 2000. An overview of the Wigwam River bull trout program (1995-1999) – Habitat Conservation Trust Fund final report. Fisheries Project Report KO 58. British Columbia Ministry of Water, Land, and Air Protection, Cranbrook, B.C. 23 p.

Braumandl, T.F. and M.P. Curran [eds.]. 1992. A field guide for site identification and interpretation for the Nelson Forest Region. British Columbia, Ministry of Forests, Land Management Handbook No. 20.

Cannings, S.G. 1993. Rare freshwater fish of British Columbia. Conservation Data Centre, Report #1. B.C. Ministry of Water, Land, and Air Protection. Victoria, B.C.

Cope, R.S. 1998. Wigwam River Fish-Forestry Study: Preliminary Surveys (1997). Prepared for Ministry of Water, Land, and Air Protection, Kootenay Region. 53 p. + map enclosure + app.

Cope, R.S. and K. Morris. 2001. Wigwam River Juvenile Bull Trout and Fish Habitat Monitoring Program: 2000 Data Report (Activity No. 2000-004-01). Prepared for the Ministry of Land, Water, and Air Protection, Cranbrook, B.C. Prepared by Westslope Fisheries, Cranbrook, B.C. 28 pp + 5 app.

Cope, R.S., K. Morris and J.E. Bisset. 2002. Wigwam River Juvenile Bull Trout and Fish Habitat Monitoring Program: 2001 Data Report (Activity No. 2000-004-01). Prepared for the Ministry of Land, Water, and Air Protection, Cranbrook, B.C. Prepared by Westslope Fisheries, Cranbrook, B.C. 28 pp + 5 app.

Klohn Crippen Consultants Ltd. 1998. Bighorn Creek integrated WRP Project – Final Report. Prepared for Ministry of Environment, Lands, and Parks, Cranbrook, B.C. Prepared by Klohn Crippen Consultants Ltd. Richmond, B.C. 182 p. + 7 app.

Lotspeich, F.B. and F.H. Everest. 1980. A new method for reporting and interpreting textural composition of spawning gravel. United States Forest Service Research Note PNW-369. Corvallis, Oregon. 11 pp.

McNeil, W.J. and W.H. Ahnell. 1964. Success of pink salmon spawning relative to size of spawning bed materials. U.S. Fish and Wildlife Services, Special Scientific Report. Fisheries 469. 15 pp.

Oliver, G.G. and R.S. Cope. 1999. Fisheries implications – Wigwam River forest development plan review. Correspondence to Lloyd A. Havens, Crestbrook Forest Industries Ltd., Cranbrook, B.C. February 9, 1999. 9 p.

Platts, W.S., M.A. Shirazi and D.H. Lewis. 1979. Sediment particle sizes used by salmon for spawning and methods for evaluation. EPA-600/3-79-043. Corvallis Environmental Research Laboratory. Corvallis, Oregon. 32 pp.

Prince, A. and R.S. Cope. 2001. Upper Wigwam River water quality and quantity monitoring program 2000 data report (Activity No. 00-RIP-FRBC-501). Report prepared for Tembec Industries Inc., Cranbrook, B.C. Prepared by Westslope Fisheries, Cranbrook, B.C. 60 p. + 3 app.

Shepard, B.B. and P.J. Graham. 1982. Completion report. Monitoring spawning bed material used by bull trout on the Glacier View District, Flathead National Forest, MDFWP, Kalispell, MT. 37 pp.

Tappel, P.D and T.C. Bjornn. 1983. A new method of relating size of spawning gravel to salmonid embro survival. North American Journal of Fisheries Management. 3:123-135.

Weaver, T.M. 1996. Fisheries Monitoring on Swan River and Stillwater State Forests. MDFWP, Kalispell, MT. 10 pp.

Weaver, T.M., and J.J. Fraley. 1991. Fisheries habitat and fish populations. Flathead basin forest practices, water quality and fisheries cooperative program. Flathead Basin Commission, Kalispell, MT.

Westover, W.T. 1999a. Wigwam River bull trout (creel surveys). Habitat Conservation Trust Fund Progress Report (1999). Fisheries Project Report KO 56. British Columbia Ministry of Water, Land, and Air Protection, Fisheries Branch, Cranbrook, B.C. 6 p. + app.

Westover, W.T. 1999b. Wigwam River bull trout (creel surveys). Habitat Conservation Trust Fund Progress Report (1998). Fisheries Project Report KO 55. British Columbia Ministry of Water, Land, and Air Protection, Fisheries Branch, Cranbrook, B.C. 8 p. + app.

Westover, W.T. and D. Conroy. 1997. Wigwam River bull trout – habitat conservation trust fund progress report for 1996/97. Fisheries Project Report KO 51. British Columbia Ministry of Water, Land, and Air Protection, Fisheries Branch, Cranbrook, B.C. 19 p. + app.

Appendix A – UTM (NAD 83) Coordinates of the Three Sample Sites

Site	Zone.Easting.Northing
Reach 11 – USA[1]	11.658897.5428389
Reach 11 – USA	11.659554.5429206
Reach Six – Outfitter	11.653652.5442441
Reach Five – Upstream of the Confluence with Bighorn Creek	11.648646.5449580
Reach Five – Upstream of the Confluence with Bighorn Creek	11.648672.5449719

1. Sampling in Reach 11 occurred at one of two locations depending on the presence of spawning gravels, which tended to vary from year to year.

Appendix B - Equipment List & Procedure – McNeil Substrate Sampling – Wigwam River

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.