Sheep Creek Bull Trout Spawning Platforms: Feasibility Study

Report Prepared For:

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EXECUTIVE SUMMARY

- Field staff of Baxter Environmental have suggested that bull trout spawning in the Salmo River tributary Sheep Creek may be limited, based on observations of apparent redd superimposition and hydrological factors that have limited gravel recruitment. Although spawning habitat limitation likely cannot be demonstrated directly, this report details a cursory feasibility study for potential spawning habitat enhancements.

- Spawning habitat enhancements are not normally suitable for systems that have elevated sediment loads, high peak flows, or highly erodable bank materials. Unstable debris/sediment jams, large bed material particle size, and steep gradient in Sheep Creek suggest that the system has a relatively high capability for sediment transport. The system should therefore not be considered as a candidate for substantial investment in instream structures without the approval of a hydrological engineer or fluvial geomorphologist.

- Simple gravel placements, especially if done with community involvement, may be an inexpensive method of spawning habitat enhancement but would require regular, perhaps annual, maintenance. Because of the low construction and maintenance costs of simple gravel placements (both can be done largely by hand), such platforms are relatively low-risk. In this report we detail a technique that has proven effective at creating bull trout spawning habitat in other areas of British Columbia and identify the four most suitable sites within the mainstem of Sheep Creek. If spawning habitat enhancement is considered desirable, despite the obvious risks, these sites require further assessment by a fluvial geomorphologist or hydrological engineer prior to commencing construction.

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INTRODUCTION AND BACKGROUND

Although there is a great deal of uncertainty in speculation about the minimum population size necessary to reduce a population's extinction risk to acceptable levels, both genetics- and population dynamics-based models of extinction support lower limits of no less than 100-250 individuals (Boyce 1992; Nunney and Campbell 1993). The total size of the bull trout population of the Salmo River watershed in southeastern British Columbia may be currently less than 200 individuals (Baxter and Nellestijn 2000), and is therefore at or near recommended conservation minimum's. The British Columbia Ministry of Environment, Lands, and Parks (MELP) now considers the Salmo population one of special conservation concern, and has responded by closing the river to retention of bull trout caught by angling. As it is likely that the development of hydroelectric dams on the Pend d'Oreille and Columbia rivers downstream of the Salmo have affected the river's bull trout, (by cutting off access of bull trout to downstream fluvial habitats and access to the Salmo River by anadromous salmonids), this population is a target for fisheries compensation activities by BC Hydro and the Columbia-Kootenay Fisheries Renewal Partnership.

Field staff of Baxter Environmental have been conducting bull trout spawner enumeration in the watershed since 1997, and have suggested that bull trout spawning habitat in Sheep Creek (Figure 1), one of two primary spawning tributaries of the Salmo, may be limited. Fish species with extended tributary rearing phases, such as the bull trout, are typically thought to be limited by rearing rather than spawning, so in British Columbia spawning habitat enhancements are not commonly recommended for these species (Whyte et al. 1997). Nonetheless, a preliminary feasibility assessment for spawning habitat enhancement in Sheep Creek was recommended to the Columbia-Kootenay Fisheries Renewal Partnership by Baxter Environmental based on the following evidence for spawning habitat limitation in Sheep Creek.

i) Observations that suitable gravel substrate is in short supply along the reach used by bull trout spawners.

ii) Most areas visually estimated to be suitable for bull trout spawning had been utilized by bull trout spawning pairs.

iii) On repeat surveys, new spawning pairs were observed on redd sites known to have been utilized by previous spawning pairs (redd superimposition).

iv) As many as 30% of the identified spawning areas showed evidence of redd superimposition.

Although further quantification of this evidence is possible and recommended, it should be noted that it is likely not feasible to directly demonstrate spawning habitat limitation in Sheep Creek prior to a spawning habitat manipulation. The need for enhancement, therefore, cannot be directly demonstrated prior to doing the work, and afterwards only by careful monitoring of its affects on the population.

The purpose of this report is to briefly discuss some of the information that compensation fund managers and regulatory agency personnel must consider before deciding whether to pursue feasibility assessment further, which would mean involving a professional hydrological engineer or fluvial geomorphologist. More specifically the objectives of this report are:

1. to describe the evidence for spawning habitat limitation, as has been done above.

2. to discuss to what degree normal criteria for determining the feasibility of spawning habitat enhancements are being met by sites in Sheep Creek, and to identify the most suitable of these sites.

3. to describe potential spawning habitat enhancements and recommend a suitable method if one exists.

4. to identify further assessment requirements beyond the very limited scope of this project.

SITE DESCRIPTION

Sheep Creek, along with the South Salmo River, is one of two fourth-order tributaries of the Salmo River. The Water Survey of Canada maintains a gauging station on the Salmo River near the town of Salmo (Anonymous 1977). Mean annual discharge in the Salmo River (1949-1976) averaged 32.5 m^3/s, with mean monthly minimum and maximum values of 7.5 and 128.5 m^3/s corresponding to the months of February and May, respectively. Sheep Creek comprises 10.9% of the watershed area, so rough discharge estimates for that stream are 0.82 and 14.0 m^3/s for the mean monthly minimum and maximum values, respectively.

Bull trout that use Sheep Creek for reproduction, spawn primarily in a section extending from Aspen Creek (approximately 6 km upstream of the Salmo River confluence) to an area typically blocked by a series of unstable debris jams (upstream approximately 5.3 km). This debris jam is located at the base of an area of substantial hillside erosion (Figure 2), approximately 1500 m upstream of the Waldie Creek Forest Service Road bridge. This, then, was the stream section that was surveyed by foot for spawning habitat suitability and enhancement feasibility on August 7th and 8th, 2000. The 1.3 km immediately upstream from Aspen Creek has very low suitability for spawning and was not included in the analysis. Mean channel width for the remainder of the reach was 12.9 m, mean gradient was 4.2%, and mean wetted bed material particle size 23.8 cm (measured as D50, the diameter of the piece for which smaller and larger particles make up 50% of the wetted channel area). The channel is confined for the majority of the reach by the wall of the narrow valley, and the stream bank typically appears stable. However, the large bed material pieces, gradient, and mean height to the high water mark (1.2 m) suggest a relatively high-energy system with extreme spring discharge. Suitable spawning sites were infrequent. The estimate of the total area within the spawning reach suitable for bull trout spawning was 137.5 m^2 (visually estimated according to depth and velocity criteria established during adult bull trout spawner surveys in other areas – Baxter and McPhail 1996; McPhail and Baxter 1996). The highest concentration of quality spawning sites in the reach was found in a 400 m section located between 1.0 and 1.4 km downstream of Waldie Creek (Figure 3).

Determining the importance of Sheep Creek spawning habitats to the overall Salmo River bull trout population is not straightforward, as the size of the South Salmo River spawner population is unknown (Baxter 2001 in preparation; Baxter 1999). Sheep Creek is obviously an important spawning tributary - the average redd count in Sheep Creek for the years 1999 and 2000 was 35, equivalent to the combined total for the remaining two identified spawning tributaries, Clearwater Creek and the upper Salmo River.

SPAWNING HABITAT ENHANCEMENT SITE SELECTION CRITERIA

There are two basic methods in use for creating spawning habitat for salmonids in existing stream channels - placement of gravels directly or the construction of structures for gravel recruitment. Gravel placement is normally suitable only for streams for which: i) a source for gravel recruitment is lacking; ii) sites display characteristics conducive to gravel retention, such as the outlets of lakes or groundwater channels; and iii) there is little or no sediment transport (Whyte et al. 1997). Structures for gravel recruitment mimic natural deposition areas, such as: i) the tails of pools created by weirs; or ii) deposition associated with wing deflectors, either solo or in tandem and constructed from either rock or logs. Cluster-log complexing is frequently associated with weirs or deflectors in order to provide cover (Whyte et al. 1997). Because instream structures for gravel recruitment are of substantially higher cost, both during the design and construction phases of the projects, the risk of structure failure should be carefully evaluated during feasibility assessment. Evaluating the potential physical success or failure of any given structure or project is difficult, as these are determined by complex and multi-scale interactions between watershed conditions, fluvial processes, and structure design (Frissel and Nawa 1992). However, past failures have been linked generally to lateral or vertical instability in stream channels (related to bank resistance to erosion and sediment transport), steep gradients (over 2-4%), and elevated sediment loads (Frissel and Nawa 1992; Whyte et al. 1997). Additionally, the suitability of created spawning habitat in particular is sensitive to changes in flow pattern or bed material composition, as the ranges of depth, velocity, and bed material particle size usable by spawning salmonids are relatively narrow for any particular species.

The bull trout spawning reach of Sheep Creek is confined along most of its length by the valley wall, suggesting a large degree of lateral channel stability. However, the large bed material particle size, steep gradient, and height of high water mark suggest high peak flows. Furthermore, mass wasting and shifting debris/sediment jams upstream suggest the possibility of elevated sediment loads. Sheep Creek does not appear, therefore, to be a suitable candidate for substantial investment in instream structures to recruit gravel, as such structures may be vulnerable to failure or unsatisfactory function because of watershed conditions.

Simple placements of gravel in such a high energy system would not generally be expected to be stable over the longer term, so should not be considered here unless regular, perhaps annual, maintenance is feasible and the cost of such maintenance is low. Nonetheless, this method is more attractive in that the low construction and maintenance costs present much less financial risk relative to instream structures, given the apparent watershed conditions. It is possible that volunteer efforts by members of the community would greatly reduce construction and maintenance costs.

If gravel placements are considered desirable for Sheep Creek then every effort should be made to maximize their suitability for bull trout spawning and to minimize maintenance requirements. We propose that the stability of gravel placements will be maximized if: i) minimal modifications are made to the pre-existing channel to achieve suitable flow characteristics (suitable depths/velocities already); ii) the channel is sufficiently stable that flow cannot shift around the placements (i.e. confined in high banks of erosion-resistant material and a relatively narrow channel); and iii) locations of natural gravel deposition - tails of stable pools or natural rock deflectors within runs - are utilized (expanded). During our survey of the entire 5.3 km of the bull trout spawning reach (Aspen Creek to Clyde Creek) we identified four sites that met these criteria and one other that could be considered above the current debris jam/barrier. All sites had reasonable access from the road. Summaries of the physical characteristics of each of these sites (along with site photographs) are presented in Appendix I, and field data forms are presented in Appendix II. All sites are marked permanently with flagging tape.

Site 1, located approximately 600 m upstream of Waldie Creek and 80 m upstream of the Sheep Creek Forest Service Recreation Site, is ideal. Machine access may be possible up the channel from the recreation site, banks are high boulder and bedrock, and the bedrock forms two, natural wing deflectors behind which two, 1.5 X 3.0 m gravel platforms can be constructed. Site 2, located immediately adjacent to the Forest Service recreation site, similarly has ideal access and a natural bedrock wing deflector behind which two, 1.5 X 3.0 m gravel platforms can be constructed. Site 3, located 185 m downstream of the Sheep Creek Forest Service Recreation Site, has good access from the road and potential for machine access, and two gravel platforms of 1.5 X 3.0 m and 1.5 X 4.0 m can be constructed behind a natural wing deflector formed from a cluster of large boulders. Bull trout spawned on the natural gravel accumulation at site 3 during the fall of 2000 (Baxter 2001 in preparation). Site 4 is located 280 m downstream of the recreation site and has good access to the road. A cluster of very large boulders forms a natural wing deflector behind which gravel platforms of 2.0 X 2.0 m and 1.5 X 3.0 m can be constructed. Accumulations of gravel already exist at these sites - the enhancements would be an expansion of the usable area. We estimated that the total increase of spawning habitat (total area minus existing suitability) at these sites would be 31.4 m^2, which would be an increase of approximately 23% in the spawning habitat of Sheep Creek available to bull trout.

Bustard and Finnegan (1999) utilized a gravel placement method in tributaries of Thutade Lake, northern British Columbia that has proven durable and highly attractive to spawning bull trout, and which is an attractive model for gravel placements in Sheep Creek. At spawning sites chosen for channel stability, gravel retention potential, and flow characteristics suitable for spawning adults, the coarse, naturally occurring bed material was excavated to a depth of 30 cm. The back of the excavation was lined with interlocking, large bed material pieces to form a control weir to prevent downstream gravel transport, and the excavation filled to the naturally occurring bed level with gravel consisting of approximately 80% 10 – 50 mm gravel and 20% 100 mm gravel and coarse sand. Cluster-log complexes associated with deeper or more turbulent water were constructed as cover for each gravel placement site (Figure 4). Most of the construction was done by hand using pry bars and shovels, suggesting that the method is ideal for community involvement and can be highly cost-effective. The Sheep Creek sites have the advantage of close road access, and thus pre-mixed gravel can be trucked close to the sites and moved by wheelbarrow or conveyor, at a fraction of the cost of placement by helicopter. If gravel and cover placement in Sheep Creek can be done inexpensively, and all the materials involved are natural, there would little financial or environmental risk associated with them, despite the likelihood that the long-term integrity of spawning enhancements in Sheep Creek environment is low, and the possibility that spawning habitat is not limiting the bull trout population.

A hydrological engineer can be involved as the next step in the assessment project, at a total cost (including assessment, design sketches of enhancement projects, and construction cost estimates for suitable sites) of $5000.00 (R. Rodman, Klohn-Crippen Consultants Ltd., Nelson, B.C.; personal communication). We recommend that this step be taken before proceeding further, even though the risk in proceeding may be low.

One final point that should be addressed when considering spawning habitat improvements in Sheep Creek is the recurring debris jam accumulation that results in a barrier to upstream migration of spawning bull trout. If this section of stream could be engineered to limit the formation of debris jams, a significant amount of spawning habitat would be made available to bull trout upstream of the barrier. Perhaps this could be an annual community fisheries project that would improve bull trout passage, increase the amount of available spawning habitat without doing instream work, and allow for significant community stewardship of this bull trout population. We recommend that MELP be contacted regarding the options available to the partnership, and the community, in carrying out such a project on an annual basis in the spring.

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FIGURES

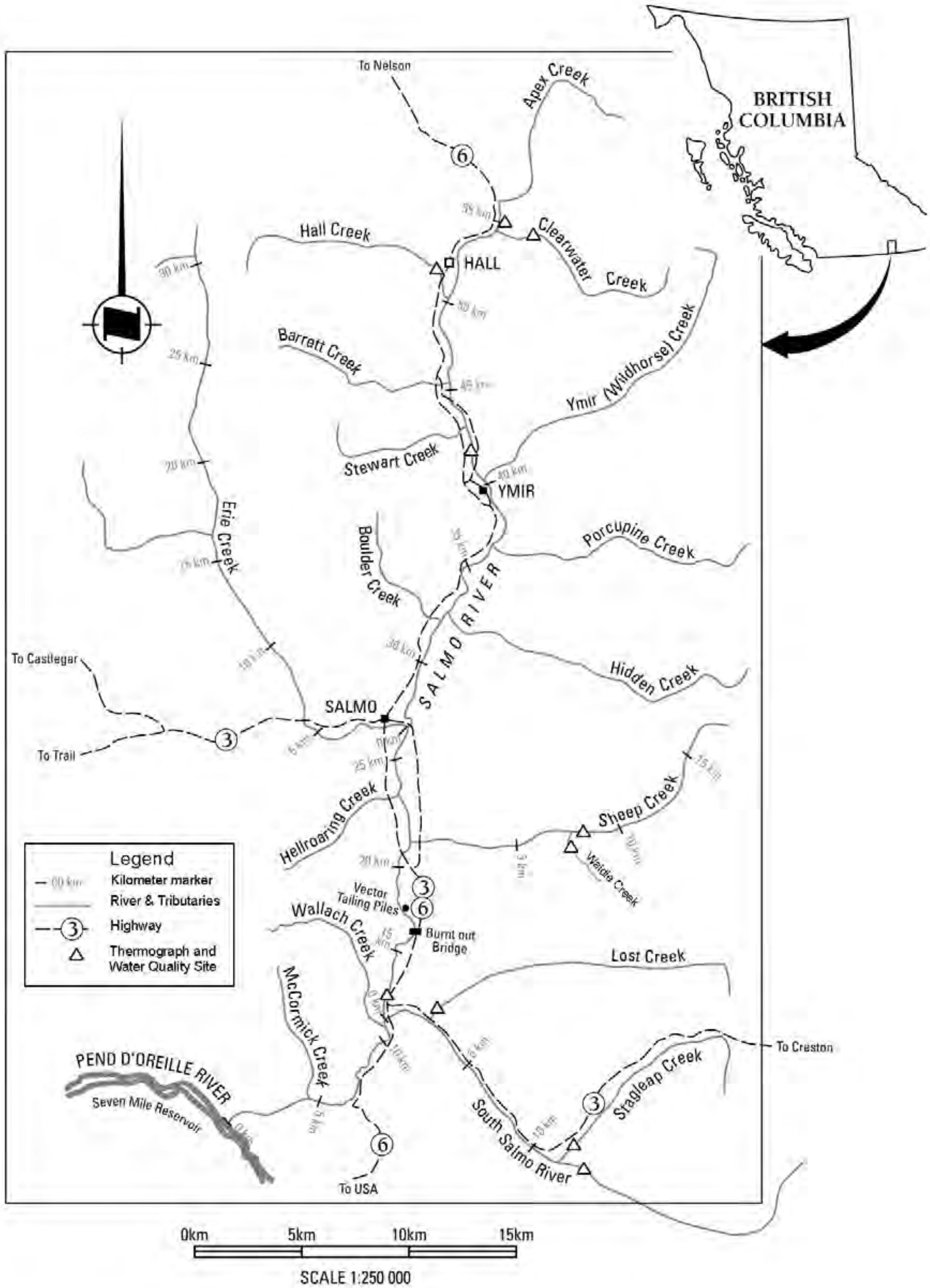

Figure 1. Location of Sheep Creek within the Salmo River watershed.

Figure 2. Unstable debris/sediment jam (barrier) at the upstream extent of adult bull trout access within Sheep Creek.

Figure 3. Natural bull trout spawning site on Sheep Creek.

Figure 4. Site drawing for gravel placements in a northern British Columbia bull trout spawning tributary (from Bustard and Finnegan 1999).

APPENDICES

Appendix I. Summary of physical characteristics of potential enhancement sites 1-4.

Photo

Site 1. Looking upstream towards potential gravel placements, two of which would be located downstream of natural bedrock wing deflector on river left bank.

<u>Summary of physical site characteristics - potential spawning enhancement site 1</u>

Average channel width		11.0 m		
Average wetted width (Aug.)		7.2 m		
Site gradient		2.5%		
Bank height	Left:	2.4 m	Right:	2.2 m
Bank composition	Left:	bedrock	Right:	boulder
Current spawning suitability		0.65 m^2		
Platform #1 area		4.5 m^2		
Platform #2 area		4.5 m^2		
Access from road		78 m		

Comment:

- Site 1 is located approximately 600 m upstream of Waldie Creek and 80 m upstream of the Sheep Creek Forest Service Recreation Site. Machine access may be possible up the channel from the recreation site. The bedrock bank on river left forms two, natural wing deflectors behind which the two gravel platforms can be constructed.

Photo

Site 2. Looking across and downstream towards potential gravel placements, two of which would be located downstream of natural bedrock deflector on river left bank (upstream edge of photo).

Summary of physical site characteristics - potential spawning enhancement site 2

Average channel width		14.0 m		
Average wetted width (Aug.)		8.4 m		
Site gradient		1.5%		
Bank height	Left:	1.5 m	Right:	0.8 m
Bank composition	Left:	bedrock	Right:	boulder
Current spawning suitability		1.3 m^2		
Platform #1 area		4.5 m^2		
Platform #2 area		4.5 m^2		
Access from road		adjacent		

Comment:

- Site 2, located immediately adjacent to the Forest Service recreation site, has ideal access (machine access possible) and a natural bedrock wing deflector that is part of the river left bank behind which the two gravel platforms can be constructed.

Photo

Site 3. Looking upstream at natural wing deflector formed by cluster of large boulders extending from river left bank. Gravel and cluster log complexes would be placed downstream of the deflector on the same side.

Summary of physical site characteristics - potential spawning enhancement site 3

Average channel width		12.5 m		
Average wetted width (Aug.)		7.9 m		
Site gradient		1.5 %		
Bank height	Left:	1.2 m	Right:	1.4 m
Bank composition	Left:	boulder	Right:	boulder
Current spawning suitability		1.6 m^2		
Platform #1 area		6.0 m^2		
Platform #2 area		4.5 m^2		
Access from road		13 m of small second growth conifers		
Comment:				

- Site 3, located 185 m downstream of the Sheep Creek Forest Service Recreation Site, has good access from the road and potential for machine access. Two gravel platforms can be constructed behind the natural wing deflector formed from the cluster of large boulders. Bull trout spawned on the natural gravel accumulation at site 3 during fall of 2000.

Photo

Site 4. Looking upstream towards potential gravel placements, two of which would be located in the foreground of the picture downstream of the natural wing deflector formed by the cluster of very large boulders on river right.

<u>Summary of physical site characteristics - potential spawning enhancement site 4</u>

Average channel width		11.4 m		
Average wetted width (Aug.)		7.0 m		
Site gradient		1.0 %		
Bank height	Left:	1.6 m	Right:	1.2 m
Bank composition	Left:	boulder	Right:	boulder
Current spawning suitability		2.0 m^2		
Platform #1 area		4.0 m^2		
Platform #2 area		4.5 m^2		
Access from road		18 m through small conifers		

Comment:

- Site 4 is located 280 m downstream of the recreation site and has good access to the road. A cluster of very large boulders forms a natural wing deflector behind which gravel platforms can be constructed.