Walter Hardman Project Water Use Plan

Lower Cranberry Creek: Rainbow Trout Biology/Abundance Monitoring

Implementation Year 2

Reference: WHNMON-5

Study Period: 2008-2009

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March 25, 2010

EXECUTIVE SUMMARY

Lower Cranberry Creek is located south of Revelstoke within the Monashee Mountains. The Walter Hardman Dam is a run of the river operation on Cranberry Creek. Recommended operational changes include a year round minimum discharge flow of 0.1 m^3/s. The minimum flow is expected to minimize fish strandings. Information is currently lacking on rainbow trout (*Oncorhynchus mykiss*) abundance and biology in the middle section of Lower Cranberry Creek. The effects of minimum flows on resident rainbow trout populations can be monitored by collecting basic population information. The study will not be able to detect changes in populations directly resulting from minimum flows since historical baseline data are lacking.

Seven sites were chosen in 2007, the first year of the study. Two new sites were included in 2008 to replace two sites from 2007, which were inaccessible to fish. These sites were visited again and either electrofished or snorkeled to estimate rainbow trout populations at each site. Wetted and bankfull width, velocity, depth, and site length were measured at each site. The substrate, cover and debris were also noted.

Most sites were dominated by gravel and cobble and had sufficient availability of refuge for fishes. The majority of sites contained large woody debris in the form of fallen trees. Three sites (LCEF03, LCSN05 and LCSN05.5) also contained submerged vegetation and undercut banks.

Fewer fish were observed in 2008 than in 2007. Observed depths in 2008 at the majority of the sites were greater than where juvenile rainbow trout are normally seen, which seem to be the majority age class in Lower Cranberry Creek.

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1.0 INTRODUCTION

The Walter Hardman Generating Station is located on Cranberry Creek in the Columbia-Shuswap Regional District approximately 25 kilometres south of Revelstoke within the Monashee Mountains. The Cranberry Creek Basin encompasses an area of 145 km^2, of which 100 km^2 lie upstream of the diversion dam of Walter Hardman Dam (BC Hydro 2006). The creek has the typical hydrological pattern of mountain streams with a spring peak of snow melt. Low flow periods occur during winter.

Project facilities include the diversion dam, diversion channel, two diversion control structures, the Walter Hardman headpond, the Walter Hardman dam, and the spillway. It is a run-of-river facility with a maximum of 4.3 m^3/sec of water flow being diverted for power generation with any excess spilling back into Cranberry Creek. It has minimal storage capacity in the headpond located downstream of the control structures and the diversion dam.

The Water Use Plan (WUP) for Cranberry Creek, a process that occurred in 2003 and 2004 went to the Comptroller of Water Rights, who then forwards an order to BC Hydro. BC Hydro has been instructed to undertake a monitoring program that will provide information for future operating decisions (BC Hydro 2006). One part of the monitoring program is the Rainbow Trout Inventory, which this study and report address.

There is a need to document the presence and abundance of rainbow trout (*Oncorhynchus mykiss*) in the mid section of Lower Cranberry Creek. Rainbow trout are resident in the mid section of Cranberry Creek throughout the year. It was thought that a lack of minimum flows to the Lower Cranberry Creek would limit the amount of rearing habitat available and in the end the productivity of the resident rainbow trout (BC Hydro 2006). This monitoring will provide baseline information against which future monitoring studies can measure a response to different recommended operational changes (BC Hydro 2006). For example, it is recommended that BC Hydro provide a year round minimum discharge flow of 0.1 m^3/s for Cranberry creek to minimize fish strandings.

The monitoring program is a five year program (2007-2011) that will look at rainbow trout abundance in Lower Cranberry Creek. The number and sites chosen are explained in Section 2.1 of this report. During the first year of study in 2007-2008, seven sites were electrofished to determine the presence of rainbow trout along a five kilometre stretch of Lower Cranberry Creek in August 15-16 and August 23-24 (Davis and LeBourdais 2007). Juvenile rainbow trout were observed at all sites.

This report documents Year 2 (2008-2009) of the rainbow trout biology and abundance study during the post-spawning period. This study is a habitat-based assessment of the potential benefits of minimum flows for rainbow trout in Lower Cranberry Creek. The objectives from the Terms of Reference for the project are:

1) To provide auxiliary information on the status of the rainbow trout population in Lower Cranberry Creek to support habitat assessments of the fisheries benefits of minimum flow release from the diversion weir.

2) To provide baseline rainbow trout abundance data against which future monitoring studies can measure a response.

2.0 METHODS

The methods for this project followed the Resource Inventory Committee (RIC) procedures for fish collection (RIC 1997; RIC 2001).

2.1 Reconnaissance Survey

A reconnaissance survey was conducted along Lower Cranberry creek between the impassable falls located 2.3 km upstream of Upper Arrow Lake and an unnamed tributary located 7.73 km upstream of Upper Arrow Lake, a total of 5.4 kms on April 27, 2007 to select electrofishing and snorkeling sites for the rainbow trout surveys. During this survey a two person crew consisting of one biologist and one technician hiked the 5.4 km section of the creek and selected sites representative of the habitat in the lower Cranberry Creek. Seven sites were selected to represent the one study reach for this monitoring program. Sites were chosen so that they contained both riffles and pools in similar proportions to those in the area contained by the study. Each site was marked with flagging tape, placement of markers/tags (e.g., re-bar or t-bar), and georeferenced. Sites were referenced by stream name (LC = Lower Cranberry), site number (1-10), and fish sampling method used (EF = electrofishing, SN = snorkeling). Two new sites were included in this year's study to replace sites used in previous years due to changes in site conditions. One site was rendered inaccessible due to the movement of the creek flow and the other site was no longer appropriate for salmonids due to stagnant water and over grown in-stream vegetation.

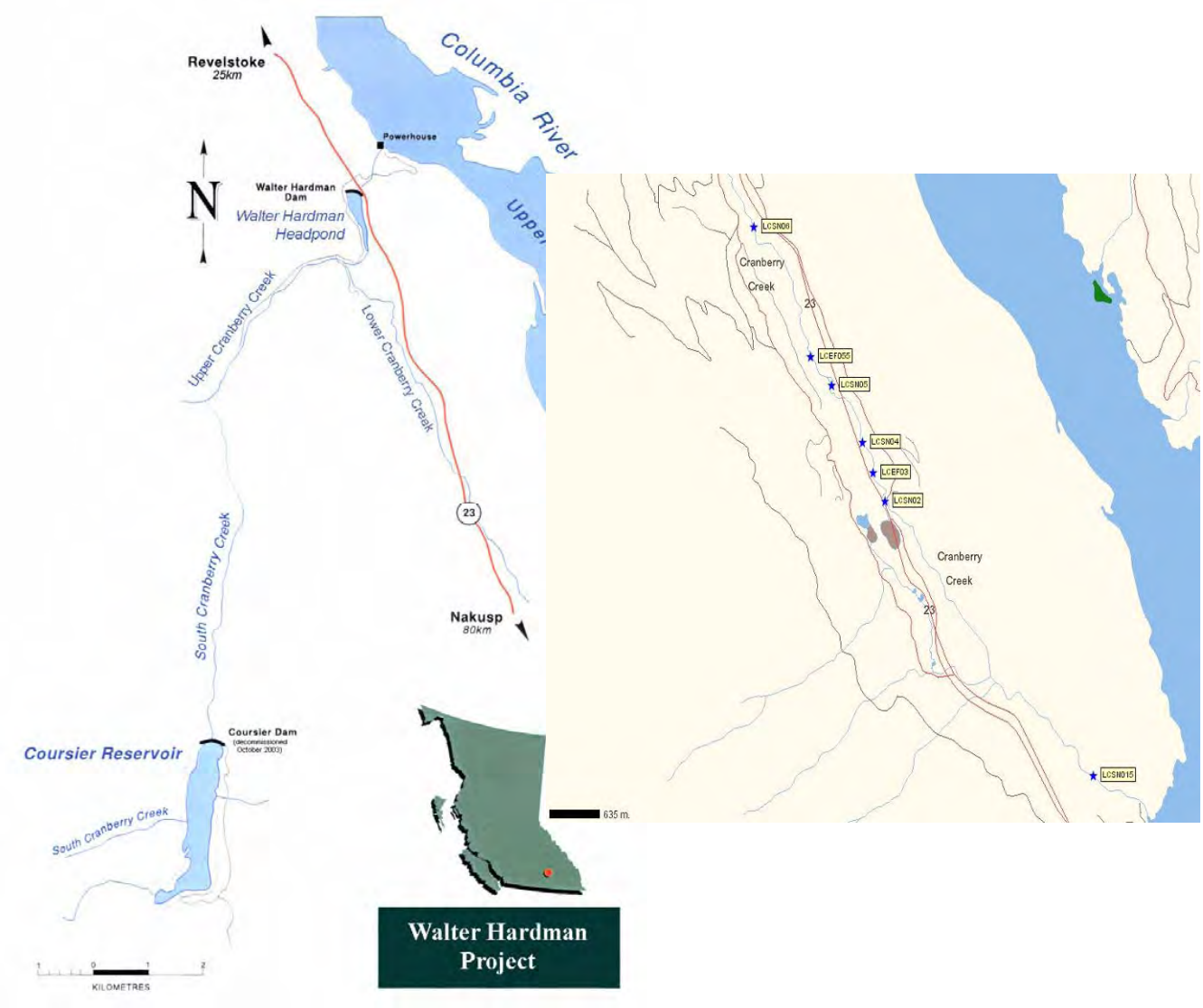

Figure 1 Map of Walter Hardman project and site locations used for fish and habitat surveys in Lower Cranberry Creek in 2008. (Source: Walter Hardman Project Use Plan, Monitoring Program Terms of Reference, 2006)

2.2 Physical Habitat Survey

The physical habitat survey was originally conducted while sampling fish in 2007. These surveys were repeated during the fish surveys on August 5-8, 2008 by Carla Davis, Keith Louis and Jim Clarricoates. This timing was chosen to coincide with low flow periods. Most sites were accessed from Highway 23. For each site there was reasonable foot access from Highway 23.

2.2.1 Field Assessment Procedures

The site length, wetted and bankfull width, velocity and depth were measured at each site under late summer, low flow conditions.

Site Length

The site length was determined during the first year reconnaissance survey where the length was to include multiple habitat types (i.e. riffles, pools) and repeated in the following year.

Wetted width and bankfull width

Measurements were taken at five even intervals along the site length. Wetted width was where the dry bank meets the water. The start and finishing points for bankfull width were the edges of the active stream channel and the beginning of the zone of rooted vegetation.

Velocity and depth

Each transect at mid-site was divided into five sections across the stream. Velocity was measured in each section with a Swoffer model 2100 current meter with the depth being recorded from the graduated rod on the meter. Velocity readings were taken at 40% of the depth from the bottom (or 60% of the depth from the water surface).

Creek Substrate, cover and debris

A general site assessment that looked at substrate, cover and debris were noted at each site. These measurements were based on visual observations and included:

- estimates of percent cover of large woody debris, small woody debris, boulders, undercut banks, overhanging vegetation, and deep pool; and
- percent estimates of substrate composition (boulder, cobble, gravel, sand, fines);

Diagrams were created noting habitat features of each site. Photographs were taken upstream and downstream of each site.

2.3 Fish Surveys

The sampling was completed during the post-spawning period for rainbow trout. Two sampling methods were used in the 2008 field season; electrofishing and snorkelling. When

both methods were done at a site snorkelling was completed first with a half hour delay before electrofishing occurred.

Snorkelling surveys.

Snorkelers entered upstream of the location to be surveyed (Dolloff et al. 1996) and floated downstream recording fish species and type of habitat where they were observed. Moving downstream was chosen due to higher velocities and after completing a test float from both the upstream and downstream directions at site LCSN02. While moving upstream it was necessary to grab on to rocks to move forward and this disturbed fishes. Snorkelers attempted to float sideways to try and minimize scaring fish while moving downstream.

Electrofishing.

Fishes were sampled using the three-pass depletion method (Hayes et. al. 2007). A three-person crew using a Smithroot Model B-12 backpack electrofisher. The sites were enclosed using stopnets with 9.5 mm mesh size. Electrofishing passes continued until a decline in catches occurred for rainbow trout to allow for population estimates**.** All fishes caught were placed in buckets equipped with aerators.

During the 2007 season water levels were too low to effectively snorkel the sites. All sites were thus sampled using electrofishing. In 2008 water levels were significantly higher, making electrofishing difficult at most sites. Site LCEF05.5 was electrofished while sites LCSN02, LCSN04, LCSN05, and LCSN06 were snorkelled (Figure 1). Site LCSN03 was first snorkelled and then electrofished a half an hour later to compare methods and their results between years.

2.3.1 Biological Sampling

All captured fishes were measured for fork length (mm) and wetted weight (g). All fishes were anaesthetized using Aquacalm before sampling to minimize handling stress. A maximum of two capfuls of Aquacalm solutions per 20 L of water was used (D. Southgate, DFO; personal communication 2008). Fishes were monitored for signs of stress. The fishes were then placed in a recovery container with aerator and released when all passes were completed and fishes had recovered from anaesthesia.

2.3.2 Calculations

Population Estimate

Closed population removal methods rely on sequentially removing fish from the population. The rate of decline in the population with each pass can be used to estimate the original population (Eq.1) (Hayes et al. 2007). The variance for the population estimate (V(N)) was calculated using equation 2.

$$N = \frac{6x^2 - 3xy - y^2 + y(y^2 + 6xy - 3x^2)^{1/2}}{18(x-y)} \qquad \text{Eq. 1}$$

$$V(N) = \frac{N(1-q)^3 q^3}{(1-q^3)^2-\{[t(1-q)]^2 q^2\}} \quad \text{Eq. 2}$$

where,

N = population estimate
$x = 2n_1 + n_2$
$y = n_1 + n_2 + n_3$
n_1 = number of fish caught on the first pass
n_2 = number of fish caught on the second pass
n_3 = number of fish caught on the third pass
V = variance of population estimate

where,

$$q = \frac{3x-y-(y^2+6xy-3x^2)}{2x} \quad \text{Eq. 3}$$

For instances where there were only two passes, the population estimates were made using the following equations (Eq.4 & 5) (Hayes et al. 2007);

$$N = \frac{n_1^2}{(n_1 - n_2)} \quad \text{Eq. 4}$$

$$V(N) = \frac{n_1^2\, n_1^2(n_1 + n_2)}{(n_1 - n_2)^4} \quad \text{Eq. 5}$$

where, N = population estimate
n_1 = number of fish caught on the first pass
n_2 = number of fish caught on the second pass

Fish Condition

There could be a wide variation in the weight for each length depending on the health of the fish. To compare fish condition between years, condition indices were used rather than length-weight relationships (Anderson and Neumann 1996). Any variation in condition reflects the state of maturity and degree of nourishment (Williams 2000). The condition factor of fishes was calculated using the formula:

$$K = \frac{100{,}000W}{L^3} \quad \text{Eq.6}$$

(Barnham & Baxter 1998; Anderson and Neumann 1996)

Where K is the condition factor; W is the weight of the fish in grams (g); L is the fork length of the fish in millimeters (mm). The value 100,000 (which is also written as 10^5) is a scaling

constant. For salmonids, the K values usually fall in the range of 0.8 to 2.0 (Barnham & Baxter 1998).

3.0 RESULTS AND DISCUSSION

3.1 Reconnaissance Survey

During the 2007 survey seven sites were chosen and permanently marked with rebar / t-bar for future sampling years (see Davis and LeBourdais 2007). Due to alterations in river flow pattern several sites had to be changed in the 2008 sampling season (Table 1). At site LCEF01 the stream bank collapsed into the side channel used in 2007 (Figure 2). This effectively eliminated the side channel originally sampled in 2007. To replace this site we identified a site approximately 0.5 km downstream with habitat features that better represented the features of this particular section of the creek. Site features included bedrock and large boulders with a large pool bounded by riffles (Figure 3). This site was labeled as site LCSN01.5.

Table 1 Cranberry Creek site names and locations where fish sampling and basic habitat surveys were completed for the Rainbow Trout Abundance monitoring program (2007-2011). Elevations taken from the GPS unit. Refer to Figure 1 for approximate locations.

Site Number	Temperature Logger	Elevation	Site Location
LCSN01.5	None		11U 0430205E 5618141N
LCSN02	WH#2 & WH#5	578m	11U 0427157E 5622453N
LCEF03/LCSN03	None	583m	11U 0427091E 5622784N
LCSN04	None	579m	11U 0426931E 5623050N
LCSN05	None	592m	11U 0426647E 5623700N
LCEF05.5	None		11U 0311505E 5524782N
LCSN06	None	620m	11U 0425857E 5625419N

Figure 2 Site LCEF01 was used in 2007 and not in 2008 due to the large number of trees which fell into the channel. The area was dewatered and not accessible to fish.

Figure 3 Lower Cranberry Creek, site LCEF01.5, showing habitat features such as the large boulders (bottom picture) and a deep pool (middle picture). The top picture is upstream of the site. The middle picture is at the site, while the bottom picture is the downstream section of the site.

We also replaced site LCEF07 with site LCEF05. The original site was located in the overflow area of the Walter Hardman headpond. This section of the creek was overgrown with algae and inaccessible to fishes due to the diversion channel (Figure 4).

Figure 4 Site LCEF07 was generally inaccessible to fishes due to the spillway on the headpond (top picture) and contained extremely stagnant water with high growth of grass and algae (orange and dark green brown water in lower picture).

3.2 Physical Habitat Surveys

On average, length of the sites surveyed was 30.9 m with a range of 18.1 m to 70.0 m.

The instream habitat which supports aquatic communities consists of substrate type, availability of refuge, and migration or passage potential (Michigan Department of Environmental Quality 1997). A variety of substrate material and habitat types are more capable of supporting a large variety of fish and macroinvertebrates than a more uniform substrate or single habitat type in one area.

Bottom substrate was variable throughout Cranberry Creek. Most sites were dominated by gravel and cobble (Table 2). Rock and gravel is considered the most desirable cover habitat for rainbow trout (Michigan Department of Environmental Quality 1997). The proportion of

each component varied among sites. Site LCEF01.5 was the only site dominated by bedrock and boulders. There was only a limited amount of fines within all sites (Table 2).

Most sites had sufficient refuge for fishes. The majority of sites contained large woody debris in the form of fallen trees. The amount of large woody debris in the stream was variable with LCEF03 having the largest quantity (Figure 5; Table 2). Site LCSN05.5 showed significant amounts of large woody debris and overhanging vegetation (Figure 6). Sites LCEF03, LCSN05 and LCSN05.5 also contained submerged vegetation and undercut banks. Undercutting provides excellent cover for fish (Platts et al. 1983). The riparian zone along all study sites had well-vegetated banks. Well-vegetated banks are usually stable regardless of bank undercutting (Platts et al. 1983).

Figure 5 Site LCEF03 showing the large woody debris over the stream site along the right bank facing downstream (top), upstream of site (middle right) and the right bank facing upstream (bottom).

Figure 6 Large woody debris (LWD) and overhanging vegetation at site LCSN05.5 during the 2008 sampling season. The top photo is the LWD upstream of the site, while the middle photo is the upstream section the site. The bottom photo shows the overhanging vegetation facing downstream of the site.

Water temperature at Site LCSN02 was found to be 17.5º C, which is above the preferred range for salmonids and may be due to a combination of depth of water, habitat type, area and time that temperature was taken and the shade provided from the riparian area. The high temperature found at this site cannot be tolerated by salmonids for a long period of time before it starts to cause stress and may lead to a decrease in survivorship.

Table 2 Physical habitat features for rainbow trout sampling sites.

Site	LCSN01.5	LCSN02	LCEF03	LCSN04	LCSN05	LCSN05.5	LCSN06
Date and time sampled	Aug 5 12:15	Aug5 16:00	Aug 6 14:30	Aug 7 9:30	Aug 7 12:00	Aug 7 16:11	Aug. 8 10:38
Water Temp (ºC)	13.0	17.5	13.5	12.5	14.0	11.5	12.0
Air Temp (ºC)	*	28.0	31.0	17.5	32.0	18.5	16.5
Site length (m)	25.0	70.0	18.1	38 .0	25.5	20.6	19.6
Average Wetted Width (m) (Range (m))	10.98 (10.4 - 11.6)	10.73 (9.6 - 12.1)	Main 15.30 (13.8 - 16.5), side 4.65 (2.9 - 6.4)	11.30 (10.3 - 12.3)	6.4 (5.2 - 7.3)	4.82 (4.3 - 5.1)	8.64 (7.5 - 9.8)
Bankfull width (m)	13.02	17.53	30.56	15.74	25.8	8.58	11.3
Average Velocities (m/s)	0.30	0.17	Main 0.33 Side 0.17	0.34	0.16	0.62	0.30
Average Depth (m) (Range (m))	0.64 (0.5 - 0.8)	0.49 (0.2 - 0.8)	Main 0.19 (0.05 - 0.38), side 0.28 (0.11 - 0.5)	0.32 (0.08 - 0.47)	0.60 (0.09 - 1.1)	0.15 (0.1 - 0.2)	0.49 (0.32 - 0.7)
Substrate	10% cobbles, 40% boulders, 50% bedrock	5% sand, 10% gravel, 60% cobble, 25% boulder	15% fines, 10% sand, 45% gravel, 30% cobble	2% fines, 1% sands, 10% gravel, 86% cobble, 1% boulder	10 % fines, 20 % sands, 40% gravel, 30% cobble	5 % sand, 35% gravel, 60% cobble, <1 % boulder	1% fines, 1 % sand, 1% gravel, 20% cobble, 62% boulder, 15% bedrock
Cover	No LWD or SWD	Trace (<1%) clumped LWD, trace (<1%) clumped SWD	70% of site, 70% LWD, trace SWD	Trace (3%) clumped LWD, trace (2%) SWD, undercut banks	6% of site with even LWD, 6% with SWD	10% of site with clumped LWD, 2% with SWD present	no LWD, no SWD,
Instream Vegetation	none	None	Submerged debris, undercut bank	none	submerged, overhead and undercut banks	submerged and undercut banks (20 % of right bank)	None
Site gradient	1-5%	1-5%	1-5%	1-5%	1-5%	1-5%	1-5%

LWD –Large woody debris
SWD –Small woody debris
* - Air temperature was not taken due to equipment malfunction

3.3 Fish Surveys

Snorkelling / Electrofishing

The largest rainbow trout was observed at site LCSN03 at the edge of large logs that extended into the creek. This is the same location where the largest fish was also captured in 2007. The rainbow trout from 2007 was 12.8 cm and 15.4 g. The fish seen in 2008 was estimated at 30 cm (Table 3). We cannot postulate whether it was the same fish since specific growth rates are unknown for rainbow trout in Lower Cranberry Creek, although it is unlikely that the fish would double in size in one year. This adult was in the deepest part of the site, as expected for larger rainbow trout (McPhail 2007). Small minnows, Cyprinidae family, were also observed and not captured at this site in a calm pool with reduced flow. At site LCSN01.5 all rainbow trout were observed in cracks between boulders.

Table 3 Snorkeling survey results from the fish survey at Cranberry Creek, August 2008.

Site	Species	Size (cm)	# Observed	Area (m^2)	Density (fish/m^2)
LCSN01.5	RBT	0-10	2	274.5	0.0073
	RBT	10-15	1	274.5	0.0036
	Sculpin		2	274.5	0.0072
LCSN02	No fish observed		0	751.1	0
LCSN03	RBT	0-10	2	84.2	0.0238
	RBT	30+	1	84.2	0.0119
LCSN04	RBT	0-10	1	429.4	0.0023
	Sculpin		3	429.4	0.0070
	RBT *	0-10*	3*	-	-
LCSN05	Sculpin		3	163.2	0.0184
LCSN06	No fish observed		0	169.3	0

RBT = rainbow trout

*These fish were stranded in a pool near a culvert along Highway 23. This is not part of the site but it was included for completeness

Site LCSN03 was sampled through both electrofishing and snorkelling (Tables 3 and 4). Although three rainbow trout were observed during snorkelling none were caught during electrofishing. This may be insufficient time for fish to return to their original position. It may be necessary to return to the site the next day to complete the second survey.

Site LCSN05.5 was a side channel with sufficient cover and fish shelter (Table 2). Three electrofishing passes were conducted. During these passes only three rainbow trout were caught. The average length with standard deviation was 14.55 ± 0.07 cm, while the weight was 29.35 ± 1.48 g for the first pass (Table 5). One fish was captured during the second pass which was 20 cm and 44.5 g. Due to the small number of fish caught it is impossible to determine a length-weight relationship. The range of condition indices of rainbow trout at this site was an average of 0.82 and a range of 0.56 to 0.98.

Table 4 Electrofishing results from the fish survey at Cranberry Creek in 2008.

Site	Species	# Observed	Pop'n Estimate	Total Biomass [1] (g)	Area (m^2)	Density (fish/m^2)	Biomass (g/m^2)
LCSN03	Minnows (Family Cyprinidae)	0	0		84.2		
	Sculpin (Superfamily Cottoidea)	0	0		84.2		
LCEF05.5	RBT	3	4[2]	142.6	99.3	0.04	1.23

1 Total biomass is average weight of fish x population estimate.
2 Population variance is 1.2.

Table 5 Biological Data for rainbow trout caught at site LCSN05.5.

Species	Fork L	Mass	K
Pass 1			
RBT	14.6	30.4	0.98
RBT	14.5	28.3	0.93
Pass 2			
RBT	20.0	44.5	0.56
Average	16.37	34.40	0.82
Standard Deviation	3.15	8.81	0.23

Sculpins were observed at all sites except LCSN02 and LCSN06 (Table 3), where no fish were observed. While snorkelling, sculpins generally held position between rocks along the bottom. When disturbed they tended to go further into these cracks and held there.

Physical habitat

Due to high water levels at most sites electrofishing could not be completed, and snorkelling counts were made instead. Most fish counts were low and may have been the result of higher flows, observer efficiency and/or snorkelling method used. Juvenile rainbow trout prefer runs with depths of <0.25m and velocities of 0.2-0.4 m/s (McPhail 2007). Water velocities varied significantly among sites from an average 0.133m/s (Site LCSN05) to average 0.624m/s (Site LCSN05.5; Table 2) with some values falling within the suitable range for juvenile rainbow trout, generally along the margins (sites LCSN01.5, LCSN04 and LCSN06). But observed depths were significantly above suitable values for juvenile rainbow trout and for the majority of the sites (Table 2; Appendix B).

The higher flows may have caused most rainbow trout to move to areas with large woody debris and lower flows. The observed rainbow trout were in areas of large or small woody debris. In small streams, overhead cover such as riparian vegetation and large woody debris is considered an essential component of good trout habitat (McPhail 2007).

4.0 CONCLUSIONS

The purpose of this study was to document fish habitat (flow, substrate, cover, etc.) at each of the sites over the 5 year program (2007-2011). In addition, the abundance of the rainbow trout population was calculated for each site as well to produce an overall abundance of rainbow trout. Although the abundance estimate cannot be directly linked with different flow conditions the information will provide a good baseline for future studies to determine how different flow conditions affect rainbow trout abundance and habitat. This information will help to determine minimum flows for fish.

The habitat metrics measured over the two years are important to infer whether or not there is stability within the stream and also if there is good habitat for rainbow trout life history phases. Cranberry Creek shows high biological potential and a network of complex habitat to support all life stages of rainbow trout during different environmental conditions. Rocks and cobbles have the highest habitat potential for rainbow trout (Michigan Department of Environmental Quality 1997) and were present at most sites. The low levels of fines seen at the sites promote good habitat for macroinvertebrates which serve as a food source for rainbow trout. In addition, the overhanging and mature riparian vegetation found along the stream course not only provides insects as food but adds nutrients into the stream. Well-vegetated banks are usually stable regardless of bank undercutting; undercutting actually provides excellent cover for fish (Platts et al. 1983).

In both years there was a low number of rainbow trout present throughout the creek. In 2008 rainbow trout densities were lower than in 2007 - 0.0053 vs. 0.0255 fish/m^2. The lower numbers seen in 2008 may be the result of fish moving to the side channels and areas with cover, where they would be unobservable or due to different methodology used.

4.0 REFERENCES

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Appendix A
Scientific Collection Permit

BRITISH COLUMBIA
The Best Place on Earth

Ministry of Environment

FISH COLLECTION PERMIT
Inventory

File: 34770-20

Permit No.: CB08-45974

Permit Holder: Okanagan Nation Alliance—Carla Davis
3255C Shannon Lake Road, Westbank, BC V4T 2H3

Client No.: 12723

Authorized Persons: Carla Davis, Jim Clarricoates, Keith Louie, Natasha Audy and Nelson Philip

Pursuant to section 19 of the *Wildlife Act*, RSBC 1996, Chap. 488, and section 18 of the Angling and Scientific Regulations, BC Reg. 125/90, the above named persons are hereby authorized to collect fish for scientific purposes from non-tidal waters subject to the conditions set forth in this Permit:

Permitted Sampling Period: July 28, 2008 to August 30, 2008
Permitted Waterbodies: Kootenay Region—Lower Cranberry Creek (300-735400)
Permitted Sampling Techniques: EF (subject to permit terms and conditions)
Target Species: RB (subject to permit terms and conditions)

Provincial Conditions: (Permit holders must be aware of all terms and conditions):

1. See Appendix A.

Region Specific Conditions:
See Appendix A.

Authorized by:
Wayne Stetski
Regional Manager, Environmental Stewardship Division
Kootenay Region

Wayne Stetski

Date: July 9, 2008 Permit Fee $25

Any contravention or failure to comply with the terms and conditions of this permit is an offense under the *Wildlife Act*, RSBC 1996, Chap. 488 and B.C. Reg. 125/90.

Ministry of Environment
Environmental Stewardship Division
Permit & Authorization Service Bureau
301 – 710 Redbrick Street
PO Box 9372 Stn Prov Gov
Victoria BC V8W 9M3
Telephone: 1.866.433.7272
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Appendix A: Fish Collection Permit Conditions

Any Variation of the following terms and conditions will require explicit authorization by the appropriate regional Fish & Wildlife Section Head.

Provincial Conditions

1. This collecting permit is not valid
   - in national parks,
   - in provincial parks unless a Park Use Permit is also obtained,
   - in tidal waters,
   - for eulachon or for salmon* other than kokanee, or
   - for collecting fish by angling unless the permittee and crew members possess a valid angling licence.

   This collecting permit is **only** valid for species listed as threatened, endangered or extirpated under the Species at Risk Act (SARA) **in conjunction with a permit issued under Section 73 of SARA from Fisheries and Oceans Canada.**

   *Contact the Department of Fisheries and Oceans for fish collecting permits for salmon, eulachon or SARA listed species (see Appendix B).

2. The permittee (or the project supervisor) named on the application for a scientific collection permit will carry a copy of this permit while engaged in fish collecting and produce it upon request of a conservation officer, fisheries officer or constable.

3. Any specimens surplus to scientific requirements and any species not authorized for collection in this permit shall be immediately and carefully released at the point of capture.

4. Fish collected under authority of this permit shall not be used for food or any purpose other than the objectives set out in the approved application for a scientific collection permit. The permittee shall not sell, barter, trade, or give away, or offer to sell, barter, trade or give away fish collected under authority of this permit. Dead fish shall be disposed of in a manner that will not constitute a health hazard, nuisance or a threat to wildlife.

5. No fish collected under authority of this permit shall be
   - transported alive unless authorized by this permit, or
   - transplanted unless separately authorized by the Federal/Provincial Fish Transplant Committee.

6. The permittee shall, within 90 days of the expiry of this permit, submit a report of fish collection activities. Interim reports may also be required and shall be submitted as required by the permit issuer. All submissions must be filed electronically to: http://www.env.gov.bc.ca/fish_data_sub/index.html

   Reporting specifications, information and templates are available from this website and outline the mandatory information requirements. Prior notification of submission or questions regarding data report standards can be made to: fishdatasub@gov.bc.ca

7. This collecting permit is subject to cancellation at any time and shall be surrendered to a conservation officer on demand or to the issuer upon written notice of its cancellation.

8. This permit is valid only for the activities approved on the application form and in accordance with any restrictions set out therein.

Appendix A: Fish Collection Permit Conditions Continued

9. This permit is valid only for trained, qualified staff named in the Application. The permittee will comply with all Worker's Compensation Board requirements and other regulatory requirements. Permit holders are responsible for ensuring staff members listed on the permit are properly certified for specific sampling methods or activities (e.g. electroshocking).

10. All sampling equipment that has been previously used outside of B.C. must be cleaned of mud and dirt and disinfected with 100mg/L chlorine bleach before using in any water course to prevent the spread of fish pathogens (e.g. Whirling disease) and / or invasive plant species. Any washed off dirt or mud must be disposed of in a manner such that it cannot enter a watercourse untreated.

11. No electrofishing is to take place in waters below five degrees C.

12. Electrofishing may not be conducted in the vicinity of spawning gravel, redds, or spawning fish, or around gravels which are capable of supporting eggs or developing embryos of any species of salmonid at a time of year when such eggs or embryos may be present.

13. Angling must only occur in accordance with the regulations specified in the current BC Freshwater Fishing Regulations Synopsis.

Region Specific Conditions

Region 4 (Kootenays)

- **No electrofishing will be permitted between September 15 and June 15 in streams containing bull trout.**

Appendix B: Table 1 - Species at Risk

The following are species at risk that have been listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as either endangered, threatened or a species of special concern. Species also listed under the Species at Risk Act (SARA) are identified with an asterisk, and are subject to additional permitting requirements through the Federal Department of Fisheries and Oceans (DFO).

Common Name	Scientific Name
Benthic Paxton Lake Stickleback	**Gasterosteus sp.*
Benthic Vananda Creek Stickleback	**Gasterosteus sp.*
Limnetic Paxton Lake Stickleback	**Gasterosteus sp.*
Limnetic Vananda Creek Stickleback	**Gasterosteus sp.*
Nooksack Dace	**Rhinichthys sp.*
Morrison Creek Lamprey	**Lampetra richardsoni*
Vancouver Lamprey (Cowichan Lake Lamprey)	**Lampetra macrostoma*
Cultus Pygmy Sculpin	**Cottus sp.*
Shorthead Sculpin	**Cottus confusus*
Hotwater Physa	**Physella wrighti*
Limnetic Enos Lake Stickleback	*Gasterosteus sp.*
Benthic Enos Lake Stickleback	*Gasterosteus sp.*
Salish Sucker	*Catostomus sp.*
Speckled Dace	*Rhinichthys osculus*
Charlotte Unarmoured Stickleback	*Gasterosteus aculeatus*
Columbia Mottled Sculpin	*Cottus bairdi hubbsi*
Giant Stickleback	*Gasterosteus sp.*
Green Sturgeon	*Acipenser medirostris*
Umatilla Dace	*Rhinichthys umatilla*
White Sturgeon	*Acipenser transmontanus*

Applications for permits to specifically collect and retain listed species must be reviewed by the appropriate Recovery Team, who will screen permits to ensure that any impacts on listed species are acceptable. For white sturgeon the contact is Steve McAdam (steve.mcadam@gov.bc.ca). For listed non-game freshwater fish the contact is Jordan Rosenfeld (jordan.rosenfeld@gov.bc.ca), co-chair of the Non-Game Freshwater Fish Recovery Team.

Please print out the notice verifying the information you submit as it becomes part of your permit and must be attached to your original Scientific Fish Collection Permit.

Appendix B
Raw Data for Habitat Survey

Site	LCSN01.5			**Date**	August 5/2008		
Crew	Jim Clarricoates, Keith Louis, Carla Davis						
Site length	25 m		**Location**	11U 4300205E 5618141N			
Water temp	13 °C (hand)						
	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	**Average**	**SD**
Wet Width (m)	10.4	11.1	11.3	10.5	11.6	**10.98**	**1.00**
Bankfull width (m)	13.3	13.2	12.9	13	12.7	**13.02**	**4.05**
Velocities	0.22	0.29	0.37	0.38	0.24	**0.3**	**0.07**
Depth (m)	0.5	0.8	0.8	0.6	0.5	**0.64**	**0.15**
Substrate	0 % fines, 0 % sands, 0% gravel, 10% cobble, 40% boulders, 50 % bedrock						
Total Cover	no LWD, no SWD,						
Cover	Boulders						
Instream Vegetation	none	**Riparian**	Sx, Willow, Alder –Mature				
Gradient	1-5 %						

Site	LCSN02			**Date**	August 5/2008		
Crew	Jim Clarricoates, Keith Louis, Carla Davis						
Site length	70 m		**Location**	11U 0427157E, 5622453N			
Water temp	17.5 °C		**Air Temp**	28 °C @ 4:02			
	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	**Average**	**SD**
Wet Width (m)	9.55	10.5	10.6	10.9	12.1	**10.73**	**0.92**
Bankfull width (m)	15.45	15.1	18.7	18	20.4	**17.53**	**2.24**
Velocities	0.12	0.19	0.3	0.21	0.01	**0.17**	**0.11**
Depth (m)	0.2	0.52	0.8	0.73	0.2	**0.49**	**0.28**
Substrate	5% sand, 10% gravel, 60% cobble, 25% boulder						
Total Cover	trace < 5%, LWD trace <1% clumped, SWD <2% trace, no submerged cover or undercut banks present						
Site gradient	1-5%						
Instream vegetation	none						

Site	LCEF03			**Date**	August 6/2008		
Crew	Jim Clarricoates, Carla Davis, Keith Louis						
Site length	18.1 m		**Location**	11U 0427091E, 5622784N			
Water temp	13.5 °C		**Air Temp**	31°C			
	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	**Average**	**SD**
Wet Width (m) main channel	16.5	15.8	15.1	13.8		**15.3**	**0.92**
side channel	6.4	6.35	4.2	3.4	2.9	**4.65**	**0.66**

Bankfull width (m)	31.7	29.8	30.4	30.1	30.8	**30.56**	**0.35**
Velocities Main channel	0.05	0.58	0.47	0.38	0.19	**0.334**	**0.14**
Side Channel	0.14	0.18	0.32	0.15	0.04	**0.166**	**0.14**
Depth (m) main channel	0.33	0.38	0.11	0.05	0.1	**0.194**	**0.03**
side channel	0.11	0.18	0.23	0.40	0.50	**0.284**	**0.14**
Substrate	15% fines, 10% sand, 45% gravel, 30% cobble						
LWD present	70% of site (dominant), trace SWD						
Total Cover	abundant (LWD), submerged debris, undercut banks						
Site gradient	1-5%						

Site	LCSN04			**Date**	August 7/2008		
Crew	Jim Clarricoates, Carla Davis, Keith Louis						
Site length	38 m		**Location**	11U 426931E 5623050N			
Water temp	12.5 °C		**Air Temp**	17.5 °C @ 9:30 am Sunny			
	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	**Average**	**SD**
Wet Width (m)	10.7	12.3	10.9	10.3	12.3	**11.3**	**0.94**
Bankfull width (m)	14.7	13.3	13.1	13.9	23.7	**15.74**	**4.49**
Velocities	0.08	0.18	0.61	0.44	0.37	**0.34**	**0.21**
Depth (m)	0.4	0.47	0.38	0.25	0.08	**0.32**	**0.15**
Substrate	2% fines, 1 % sand, 10% gravel, 86% cobble, 1% boulder						
Total Cover	trace (3% of site) clumped LWD, trace (2%) SWD, undercut banks present						
Instream vegetation	none	**Riparian**	Sx, Alder, Willow – Mature				
Site gradient	1-5%						

Site	LCSN05			**Date**	August 7/2008		
Crew	Jim Clarricoates, Carla Davis, Keith Louis						
Site length	25.5 m			**Location**	11U 426647E 5623700N		
Water temp	14 °C			**Air Temp**	32 °C @12:03 pm		
	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	**Average**	**SD**
Wet Width (m)	5.2	5.9	6.4	7.3	7.2	**6.4**	**0.89**
Bankfull width (m)	23	24.1	26.8	28	27.1	**25.8**	**2.14**
Velocities	0.000	0.110	0.250	0.360	0.080	**0.160**	**0.14**
Depth (m)	0.09	0.32	0.66	0.85	1.1	**0.604**	**0.40**
Substrate	10 % fines, 20 % sands, 40% gravel, 30% cobble						
Total Cover	6 % of site with even LWD, 6 %with SWD,						
Cover	submerged, instream, overhead and undercut banks						
Instream Vegetation	none	**Riparian**	Sx, Willow, Alder -Mature				
Site gradient	1-5 %						

Site	LCSN05.5		**Date**	August 7/2008			
Crew	Jim Clarricoates, Carla Davis, Keith Louis						
Site length	20.6 m		**Location**	11U 0311505E, 5524782N			
Water temp	11.5 °C		**Air Temp**	18.5 °C @4:11			
	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	**Average**	**SD**
Wet Width (m)	4.3	5.1	5	4.9	4.8	**4.82**	**0.31**
Bankfull width (m)	7.8	8.7	8.6	8.3	9.5	**8.58**	**0.62**
Velocities	0.81	0.75	0.83	0.59	0.14	**0.624**	**0.29**
Depth (m)	0.11	0.17	0.2	0.15	0.1	**0.146**	**0.04**
Substrate	5 % sand, 35% gravel, 60% cobble, 1 % boulder						
Cover	10% of site with clumped LWD, 2% with SWD present						
Instream Cover	submerged and undercut banks (20 % of right bank)						
Site gradient	1-5%						

Site	LCSN06		**Date**	August 8/2008			
Crew	Jim Clarricoates, Carla Davis, Keith Louis						
Site length	19.6 m		**Location**	11U 425857E 5625419N			
Water temp	12 °C		**Air Temp**	16.5 °C @10;38 am			
	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	**Average**	**SD**
Wet Width (m)	8.2	8.3	7.5	9.8	9.4	**8.64**	**0.94**
Bankfull width (m)	11.5	11.7	11	11.2	11.1	**11.3**	**0.29**
Velocities	0.18	0.68	0.51	0.1	0.02	**0.298**	**0.28**
Depth (m)	0.32	0.55	0.7	0.48	0.42	**0.494**	**0.14**
Substrate	1% fines, 1 % sand, 1% gravel, 20% cobble, 62% boulder, 15% bedrock						
Total Cover	no LWD, no SWD,						
Instream vegetation	None						
Site gradient	1-5%						