Walter Hardman Project Water Use Plan

Lower Cranberry Creek: Rainbow Trout Biology/Abundance Monitoring

Implementation Year 1

Reference: WHNMON-5

Study Period: 2007

Carla Davis and Sunny LeBourdais

November 2007

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

As part of Water Use Plan for the Walter Hardman Dam, the Okanagan Nation Alliance was contracted to sample Lower Cranberry Creek to assess Rainbow Trout (RBT) (*Oncorhynchus mykiss*) biology and abundance. The Water Use Plan is a sustainable work practice of BC Hydro that seeks to balance benefits from power generation with other water uses that provide social, environmental and economic benefits to British Columbians. The Consultative Committee recommended an operating alternative for the Walter Hardman including a provisional minimum flow of 0.1 m^3s^{-1} past the diversion dam and into Lower Cranberry Creek. The *Monitoring of Rainbow Trout Abundances and Biology in Lower Cranberry Creek* project is a 5 year project designed to document the rainbow trout population for a natural range of flows over the years of the study. The study is intended to provide systematically collected baseline data against which future monitoring studies could use for measuring responses to the intended operating changes.

1.1 Objectives:

This study will run from April 2007 until October 2011 in concurrence with the post-spawning period for rainbow trout. This report summarizes the findings from year one of the project. The objectives 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.

1.2 Study Area:

Cranberry Creek is located in the Columbia-Shuswap Regional district approximately 25 kilometres south of Revelstoke within the Monashee Mountains (Figure 1). The Cranberry Creek Basin is 145 km^2 of which 100 km^2 lies 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. Winter generally has the low flow period. The annual precipitation within the study location is between 100 to 150 mm per year.

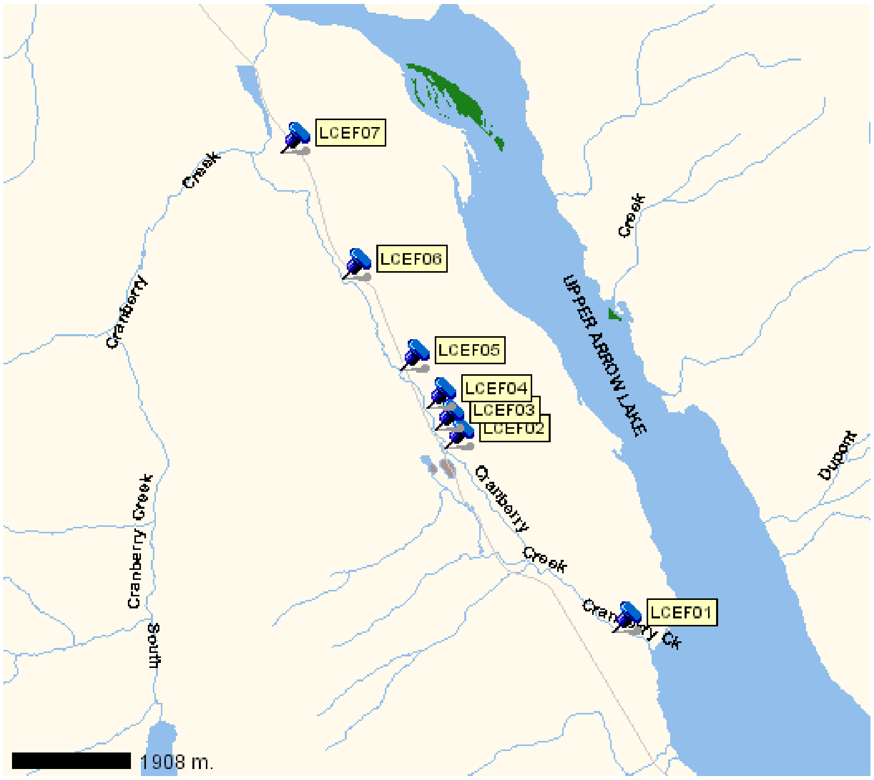

Figure 1 Sites identified during the reconnaissance survey.

November 2007

2.0 METHODS

The methods for this project followed the Reconnaissance Fish and Fish Habitat Inventory: Standards and Procedures and the Fish Collection Methods and Standards Volume 1 set out by the Resource Inventory Standards Committee (RIC). RIC documents provide information for standard data collection, methods and procedures for fish inventories in lakes and streams in B. C. (RIC 1997, RIC 2001).

2.1 Reconnaissance Survey:

A reconnaissance survey was conducted on April 27, 2007 to identify electrofishing and snorkeling sites for the fall RBT surveys. During this survey a two person crew consisting of one biologist and one technician hiked the 5.4 km reach and selected sites representative of the habitat is the lower Cranberry. Seven sites were selected which adequately represent the study reach and its pool: riffle ratio. Each site selected was identified through flagging, placement of a permanent marker/tag (e.g. re-bar or t-bar) and marked using GPS along with initial photo documentation. Each site was identified by its stream (LC = Lower Cranberry), site number (1-10), and fish sample method to be used (EF = electrofishing, SN = snorkeling).

2.2 Permits:

Before the field work commenced all proper permits were obtained through the Fisheries Branch of the Ministry of Environment (Appendix A). The sampling of fish in the Lower Cranberry Creek required a scientific collection permit and/or a capture permit. These permits were carried with the field crew during their field work.

2.3 Fish Habitat Measurements:

Fish habitat measurements were recorded to characterise each site such as the wetted and bankfull width, velocity, depths, and site length. Substrate, cover and debris were noted at each site. Photographs were taken both upstream and downstream of the site.

2.4 Fish Capture:

Fish population estimates were calculated using a three pass depletion method (Hayes et. al. 2007). The following conditions are assumed to be true to ensure the accuracy of depletion efforts (Lockwood and Schneider 2000);

1) Emigration and immigration during the sampling period must be negligible;
2) All fish within a specified sample group must be equally vulnerable to capture during a pass;
3) Vulnerability to capture of fish in a sample group must remain constant for each pass;
4) Collection effort and conditions which affect collection efficiency, such as water clarity must remain constant.

Stop nets were placed upstream and downstream of each site and secured to the stream bed. Depletion estimates were made by removing fish from the sites and then recording fish by species. This process was repeated three times. All fish during a pass were placed in a large bucket for enumeration and biological sampling.

2.4 Biological Sampling:

All captured fish were measured for fork length and wetted weight from each site. Large rainbow trout parr had scale samples taken for ageing at a later date. All fish were anaesthetized using Alka Seltzer before sampling to minimize handling stress. Concentrations were used based on previous experiments with Rainbow trout. A maximum of 2 Alka Seltzer tablets per 20 L of water was used. Fish were monitored for signs of stress. The fish were then placed in a recovery container with aerator and released when all passes were completed and fish had recovered from anaesthetic. .

2.5 Calculations:

The formula used to convert fish catch from each of the three passes to a population estimate follows from the recommendations of Hayes et al. 2007;

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

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

Since only two passes were made for LCEF04 and site LCEF06, the two pass depletion population estimates were made using the following equations (Hayes et al. 2007, Lockwood and Schneider 2000);

$$N = \frac{n_1^2}{(n_1 - n_2)}$$

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

Other calculations used in the comparison include

1) Fish numbers (fish/m) = sum of fish caught / site length
2) Fish densities (fish/m^2) = N / site area (site length x average wetted width)
3) Total salmonid biomass (g) = n x mean fish weight
4) Salmonid biomass (g/m^2) = total biomass / site area

The condition of fish (K factor) is based on work by Fulton (1902). The condition factor of fish was calculated using the formula (Barnham & Baxter 1998):

$$K = \frac{10^N W}{L^3}$$

Where K is the condition factor of coefficient of condition; W is the weight of the fish in grams (g); L is the fork length of the fish in millimeters (mm). Based on the measurements of thousands of salmonids, the value of N is set at this figure to bring the value of K close to unity (N = 5). 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 this survey 7 sites were chosen and permanently marked to be used for fish and habitat sampling (Table 1, Figure 1). Site 5 from the Summit study (2000) was included as one of these study sites. Thermograph sites were noted so that data from those units maybe compared with the fish populations within that area.

Table 1 Selected sites for Sampling.

Site Number	Temperature Logger	Elevation	Latitude	Longitude
LCEF01	WH# 6 & WH# 1	490m	50°43.12.8N	117°59.56.4W
LCEF02	WH#2 & WH#5	578m	50°44.57.4N	118°01.57.2W
LCEF03	none	583m	50°45.08.1N	118°02.00.8W
LCEF04	none	579m	50°45.19.4N	118°02.09.6W
LCEF05	none	592m	50°45.38.7N	118°02.23.0W
LCEF06	none	620m	50°46.30.6N	118°03.03.2W
LCEF07	WH#3 & WH#4	643m	50°47.40.6N	118°03.43.0W

3.2 Fish Habitat Measurements:

During the fish and habitat sampling all sites were done except number LCEF07 since the water levels were significantly lower than observed in reconnaissance surveys.

Habitat features were present at all sites that would make them suitable for over wintering and rearing habitat. Most sites had a rocky substrate with a considerable number of areas suitable for hiding within the cobble. Many of the rainbow trout and sculpins were caught from between rocks and under larger rocks present at the site. The sizes of the rocky substrate ranged from fines to large boulders and bedrock (Table 2). Next year as part of the habitat work, each substrate type will ranked according to which type is most prevalent at each site.

Most sites had cover present that also serve as suitable cover for fish. Most sites contained large woody debris in the form of fallen trees (Figure 2). The amount of large woody debris in the stream was variable with LCEF05 having the largest quantity (Figure 3). Although, at this site LCEF05 water levels were so low that the stream was reduced to a series of pools with only a small narrow channels connecting them. Fish were still present at this site. This site also had the permanent markers washed away. These will be reinstalled in 2008.

Figure 2 Site LCEF04 showing the large woody debris over the stream site.

Figure 3 Large woody debris at site LCEF05.

Table 2 Site Description for Rainbow Trout Sampling Sites.

Site	LCEF01	LCEF02	LCEF03	LCEF04	LCEF05	LCEF06
Site length (m)	49	70	57	37	39	32
Water Temp (ºC)	17.2	15.5	17.4	17.0	10.7	17
Wet Width (m)	4.49	8.23	10.66	10.66	5.46	5.20
Bankfull width (m)	23.50	20.38	24.27	24.27	22.46	12.22
Velocities (m/s)	0.03	0.03	0.04	0.04	0.01	0.07
Depth (m)	0.10	0.13	0.18	0.18	0.23	0.39
Substrate	cobble, boulder	fines, sands, gravel, cobble	sand, gravel, cobble	fines, sand, gravel, cobble	sands, gravel, cobble	sand, gravel, cobble, boulders, bedrock
LWD present	SWD present	small quantity LWD and SWD	SWD present	LWD	LWD	SWD present
Cover	instream cover	overhead vegetation	instream cover and undercut bank	instream cover, overhead vegetation, undercut bank	submerged, instream cover, overhead vegetation, undercut banks	overhead vegetation,
Site gradient	1-5%	0-1% (pool) 1-5% (riffles)	0-1%	0-1% (pool) 1.5% (run)	0-1%	1-5%

LWD –Large woody debris
SWD –Small woody debris

2.4 Biological Sampling:

For most sites three passes of the electrofisher was performed. For site LCEF04 only two was conducted due to the lack of Rainbow trout caught or observed during the passes. At site LCEF07 a hole in waders made it unsafe to proceed with continuing passes with the electrofisher.

Biological sampling was completed for all sites (Table 3, Figure 4). The size of fish caught increased as you moved downstream. The fish caught were generally within the condition factor expected for RBT (Table 4). The fish were caught in areas with cover that was usually large woody debris or between rocks and boulders. The only other fish observed were sculpins.

Table 3 Summary of fish biomass densities and populations in Lower Cranberry Creek.

	Observed	# of Passes	Pop'n Estimate	Fish Numbers (fish/m)	Tot. Salmonid Biomass (g)	Area (m^2)	Fish Density (fish/m^2)	Salmonid biomass (g/m^2)
LCEF01	15	3	16	0.31	11.99	220.11	0.073	0.054
LCEF02	3	3	4	0.04	14.78	389.73	0.010	0.037
LCEF03	6	3	6.5	0.11	20.48	606.22	0.011	0.034
LCEF04	1	2	1	0.03	13.1	139	0.010	0.090
LCEF05	4	3	4	0.10	83.59	215.12	0.019	0.389
LCEF06	4	2	5	0.13	304.75	165.36	0.030	1.843

Table 4 The summary of biosampling details for Rainbow trout at Lower Cranberry Creek sites.

	Mean Length	Mean Weight	Average K
LCEF01	4.31	0.75	0.91
LCEF02	8.93	3.90	1.01
LCEF03	5.38	3.13	1.07
LCEF04	11.4	13.1	088
LCEF05	12.83	20.68	0.92
LCEF06	17.28	60.95	1.11

Figure 4 Rainbow trout caught at sites LCEF02, LCEF04 and LCEF05 from top to bottom.

4.0 REFERENCES

Barnham, C. and A. Baxter. 1998. Fisheries Notes: Condition factor, K, for salmonid fish. State of Victoria, Department of Primary Industries. FN0005. ISSN 1440-2254.

BC Hydro. 2006. Walter Hardman Project Water Use Plan. BC Hydro.

Fulton, T. 1902. Rate of growth of seas fishes. Scientific Investigation Fisheries Division of Scotland. Report 20.

Hayes, D.B., J.R. Bence, T.J. Kwak, and B.E. Thompson. 2007. Abundance, Biomass and Production Estimates. Chapter 8 in Analysis and Interpretation of Freshwater Fisheries Data. M. Bram (Ed). American Fisheries Society Special Publication. Bethesda, MD.

Lockwood, R.N. and J.C. Schneider. 2000. Stream fish population estimates by mark and recapture and depletion methods. Chapter 7 *in* Schneider, J.C. (ed.) 2000. Manual of Fisheries Survey Methods II. with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Resources Information Committee (RIC). Fish Collection Methods and Standards, Version 4.0 and Errata. 1997.

Resources Information Committee (RIC). Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures, Version 2.0. 2001.

Summit Environmental Consultants. Cranberry Creek Fisheries and Hydrology Study, Volumes I (Text) and II (Appendices). 2000. Vernon. BC.

Appendix A
Scientific Collection Permit

November 2007

BRITISH COLUMBIA
The Best Place on Earth

Ministry of Environment

FISH COLLECTION PERMIT
Inventory

File: 34770-20

Permit No.: CB07-36584

Permit Holder: Okanagan Nation Alliance—Carla Davis
3255C Shannon Lake Road, Westbank, BC V4T 1V4

Client No.: 12723

Authorized Persons: Carla Davis, Ryan Benson, Chris Beers, Heidi McGregor and Jan Clarricoates

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 24, 2007 to July 23, 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:
Yvonne Foxall
Manager
Permit and Authorization Bureau

YFoxall

Date: July 24, 2007

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.

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 to the Permit and Authorization Service Bureau a summary report of collecting 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. Permits covering multiple watersheds or extended time periods:
    a. Are applicable only in the identified regions and for the identified time periods;
    b. Do not apply to the collection of adult salmonids unless specifically authorized;
    c. Include electrofishing, minnow trapping and seining techniques only;

14. 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
Reconnaissance Survey

November 2007

Site number	Location Description	Temperature Logger	Elevation (m)	Latitude	Longitude	Notes	Marker	Picture
LCEF01	about 200-300m u/s of moı	WH# 6 & WH# 1	490m	50.43.12.8N	117.59.56.4W	Site was not located at Summit	Rebar, Orange stake, and pink flagging tape, pink flagging tape trail from skid road to site on right bank creek.	
LCEF02	about 50m d/s of reach par	WH#2 & WH#5	578m	50.44.57.4N	118.01.57.2W	site at a bend in the creek	Rebar, orange stake and pink flagging tape, on bench visible from road right bank	
LCEF03	about 100m u/s of reach pa	none	583m	50.45.08.1N	118.02.00.8W	site at the top of an island	Rebar, orange stake, and pink flagging tape, u/s from reach parallel to road and marker on right stream bank	
LCEF04	d/s of bridge	none	579m	50.45.19.4N	118.02.09.6W		Rebar, orange stake, and pink flagging tape, hike in from highway #23, right bank	
LCEF05	about 200m u/s of bridge	none	592m	50.45.38.7N	118.02.23.0W	Creek branched and splits	Rebar, orange stake, and pink flagging tape, hike in from bridge, marker beside large conifer on left bank	
LCEF06	below access road	none	620m	50.46.30.6N	118.03.03.2W		Rebar, orange stake and pink flagging tape, a the bottom of the left embankment	
LCEF07	about 150m d/s of diversioı	WH#3 & WH#4	643m	50.47.40.6N	118.03.43.0W	Creek very organic and discolo	Rebar, orange stake and pink flaggin tape, on right bank	
LCEF08	Suggestion of one more site about 200-300m d/s of site LCEF07 in order to increase replication in reach where the diversion may have the most effect, did not mark and complete due to failing light and snow conditions.							

Site number	Temperature Logger	Elevation (m)	Latitude	Longitude
LCEF01	WH# 6 & WH# 1	490m	50.43.12.8N	117.59.56.4W
LCEF02	WH#2 & WH#5	578m	50.44.57.4N	118.01.57.2W
LCEF03	none	583m	50.45.08.1N	118.02.00.8W
LCEF04	none	579m	50.45.19.4N	118.02.09.6W
LCEF05	none	592m	50.45.38.7N	118.02.23.0W
LCEF06	none	620m	50.46.30.6N	118.03.03.2W
LCEF07	WH#3 & WH#4	643m	50.47.40.6N	118.03.43.0W
LCEF08				

Appendix C
Raw Data and Analysis for Habitat and Rainbow Trout Survey

November 2007

Site	LCEF01	**Date**	August 16/2007
Crew	Jim Clarricoates, Heidi McGregor, Carla Davis		

Site length	49 m
Water temp	17.8 (hand)
	17.2 (dig)

						Average	sd	
Wet Width	5.6	3.81	3.12	4.98	4.95	**4.492**	**1.00**	
Bankfull width	24.2	21.69	28.8		19.32	**23.5025**	**4.05**	3.12
Velocities	0.03	0.04	0.06	0.03	0.01	**0.034**	**0.02**	
Depth	0.14	0.12	0.09	0.12	0.03	**0.1**	**0.04**	

Substrate	cobble, boulder
LWD present	SWD present
Cover	instream overhead
Site gradient	1-5%

Pass #	Species	Maturity	Fork Length	Mass	Scale #	Photo	Count	Mean Length	Mean Weight	K
1	RBT	imm	4.2	0.7						0.94
1	RBT	imm	4.6	0.9						0.92
1	RBT	imm	4.8	0.9						0.81
1	RBT	imm	4.3	0.7						0.88
1	RBT	imm	4.1	0.8						1.16
1	RBT	imm	3.9	0.5						0.84
1	RBT	imm	5	1.6						1.28
1	RBT	imm	4.7	0.8						0.77
1	RBT	imm	4.6	0.8						0.82
1	Sculpin		5.1	1.2						
1	Sculpin		5.6	2.4						
						Pass Ave	9	4.47	0.86	
2	RBT	imm	3.6	0.3						0.64
2	RBT	imm	4	0.8						1.25
2	RBT	imm	4.2	0.7						0.94
2	RBT	imm	4.5	1.1						1.21
2	RBT	imm	4.7	0.8						0.77
2	Sculpin		5.8	2.6						
							5	4.2	0.74	
3	RBT	imm	3.5	0.4						0.93
3	Sculpin		5.9	2.4						
						Pass Ave	1	3.5	0.4	
					Total Average		15	4.31	0.79	

Pass1	Voltage = 400V, Frequency =G, Pulse width= 4	time =1101
Pass 2	Voltage = 400V, Frequency =G, Pulse width= 4	time = 397
Pass 3	Voltage = 400V, Frequency =G, Pulse width= 4	time =327

$$N = \frac{6x^2 - 3xy - y^2 + y(vy^2 + 6xy - 3x^2)}{18(x-y)}$$

x	y
23	15

N = population estimate

$x = 2n_1 + n_2$ 2313.124041

$y = n_1 + n_2 + n_3$ 144

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

Site Summary

N	16
Total Biomass	12.64
Area (m^2)	220.108
Density (fish/m^2)	0.072979
Biomass (g/m^2)	0.057411

Descriptive Statistics for K	
Mean	0.91
Standard Error	0.04
Median	0.88
Mode	0.94
Standard Deviation	0.17
Sample Variance	0.03
Kurtosis	0.05
Skewness	0.79
Range	0.61
Minimum	0.64
Maximum	1.25
Sum	13.71
Count	15.00
Largest(1)	1.25
Smallest(1)	0.64
Confidence Level(95.C	0.10

Site	LCEF02			**Date**	August 17/2007	
Crew	Jim Clarricoates, Heidi McGregor, Carla Davis					
Site length	70					
Water temp	15 (dig)		**Air Temp**			
	15.5 (hand)					

						Average	
Wet Width	7.45	7.8	8.4	9.25		**8.225**	at pool
	3.2	3.2	2.8	2.55	2.8	**2.91**	downstream
Bankfull width	21.7	19.3	16.6	23.3	21	**20.38**	
Velocities	0.07	0.03	0.02	0.02	0.03	**0.034**	
Depth	0.07	0.11	0.15	0.14	0.16	**0.126**	

Substrate	fines, sands, gravel, cobble			
LWD present	small qunatity -1 fallen tree		SWD present	small quantity
Cover	overhead			
Site gradient	0-1% at pool	1-5% at riffles		

Pass #	Species	Maturity	Fork Length (	Mass	Scale #	Photo	Count	Mean Length	Mean Weight	K
1	RBT	imm	3.4	0.3	37554 #5	LCEF02 RBT				0.76
1	RBT	imm	8.4	7.5		LCEF02 RBT (1)				1.27
1	Sculpin		10.9	12.8						
1	Sculpin		10.1	13						
1	Sculpin		9.5	11.1						
1	Sculpin		13.1	23.9						
						Pass Ave	2	5.90	3.90	
2	Sculpin		8.3	6.5						
2	Sculpin		15.2	37						
2	Sculpin		8.1	8.6						
2	Sculpin		5.2	1.5						
							0	0	0	
3	Sculpin		8.6	9.7						
3	RBT (obs)		15							
						Pass Ave	1	15		
						Total Average	3	8.93	3.90	1.01

Pass1	*Voltage = 400Hz, Frequency =50 Hz, Pulse width= 4*	*time =484*
Pass 2	*Voltage = 400Hz, Frequency =50 Hz, Pulse width= 4*	*time = 226*
Pass 3	*Voltage = 400Hz, Frequency =50 Hz, Pulse width= 4*	*time = 175*

$$N = \frac{6x^2 - 3xy - y^2 + y(vy^2 + 6xy - 3x^2)}{18(x-y)}$$

x	y
4	3

68.23368794

18

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

Site Summary

N	4
Total Biomass	14.78397
Area (m^2)	389.725
Density (fish/m^2)	0.009727
Biomass (g/m^2)	0.037934

Descriptive Statistics for K for LCEF02	
Mean	1.01
Standard Error	0.25
Median	1.01
Mode	#N/A
Standard Deviation	0.36
Sample Variance	0.13
Kurtosis	#DIV/0!
Skewness	#DIV/0!
Range	0.50
Minimum	0.76
Maximum	1.27
Sum	2.03
Count	2.00
Largest(1)	1.27
Smallest(1)	0.76
Confidence Level(95.0%)	3.19

Site	LCEF03			**Date**	August 23/2007		
Crew	Jim Clarricoates, Carla Davis						
Site length	56.89						
Water temp	17.3 (dig)		**Air Temp**	23.4			
	17.5 (hand)						

								Average
Wet Width	11.05	9.88	10.29	11.23	10.83			**10.656**
Bankfull width	21.6	23.1	21.86	24.27	30.5			**24.266**
Velocities	0.02	0.05						**0.035**
Depth	0.032	0.193	0.115	0.27	0.06	0.24	0.32	**0.1757143**

Substrate	sand, gravel, cobble
LWD present	SWD present
Cover	instream and undercut bank
Site gradient	0-1%

Pass #	Species	Maturity	Fork L	Mass	Scale #	Photo	Count	Mean L	Mean W	K
1	RBT	maturing	12.8	15.4						0.73
1	RBT	imm	3.2	0.3						0.92
1	RBT	imm	4.1	0.3						0.44
1	sculpin		7.4	4.6						
1	sculpin		6.7	3.4						
1	sculpin		1.7	0.2						
1	sculpin		5.2	1.5						
						Pass Ave	3	6.70	5.33	
2	RBT	imm	4.1	0.9						1.31
2	RBT	imm	3.8	1.2						2.19
2	RBT	imm	4.3	0.7						0.88
2	Sculpin		9.6	10.1						
2	Sculpin		4.9	1.4						
2	Sculpin		5.3	1.8						
							3	4.07	0.93	
3	Sculpin		5.4	1.4						
3	Sculpin		10.8	12.1						
3	Sculpin		6.5	2.3						
3	Sculpin		5.6	1.9						
						Pass Ave	0	0.00	0.00	
						Total Ave	6	5.38	3.13	1.08

Pass1	*Voltage = 400Hz, Frequency =I, Pulse width= 4*	*time =380*
Pass 2	*Voltage = 400Hz, Frequency =I, Pulse width= 4*	*time = 439*
Pass 3	*Voltage = 400Hz, Frequency =I, Pulse width= 4*	*time = 609*

$$N = \frac{6x^2 - 3xy - y^2 + y(vy^2 + 6xy - 3x^2)}{18(x-y)}$$

x	y
9	6

352.89992

54

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

Site Summary

N	7
Total Biomass	20.47690911
Area (m^2)	606.21984
Density (fish/m^2)	0.010780221
Biomass (g/m^2)	0.033778025

Descriptive Statistics for K for LCEF03	
Mean	1.08
Standard Error	0.25
Median	0.90
Mode	#N/A
Standard Deviation	0.61
Sample Variance	0.38
Kurtosis	2.23
Skewness	1.39
Range	1.75
Minimum	0.44
Maximum	2.19
Sum	6.46
Count	6.00
Largest(1)	2.19
Smallest(1)	0.44
Confidence Level(95.0%)	0.64

Site	LCEF04			**Date**	August 23/2007		
Crew	Jim Clarricoates, Carla Davis						
Site length	36.8						
Water temp	16.4 (dig)		**Air Temp**	23.4			
	17.5 (hand)						
	16.95						
							Average
Wet Width	1.9	2.7	4.5	4.5	5.3		**3.78**
Bankfull width	15.58	16.8	12.26	17.1	13.59		**15.066**
Velocities	0.02	0.05	17.1				**5.72333333**
Depth	0.102 ..256		0.225	0.161	0.354	0.153	**0.199**

Substrate	fines, sand, gravel, cobble		
LWD present			
Cover	instream, overhead and undercut bank		
Site gradient		0-1% (pool)	1.5% (run)

Pass #	Species	Maturity	Fork L	Mass	Scale #	Photo	Count	Mean L	Mean W	K
1	RBT	maturing	11.4	13.1	37554 #4	LCEF04 RBT				0.884213
1	sculpin		4.8	1.4						
1	sculpin		9.7	9.1						
						Pass Ave	1	11.40	13.10	
2	Sculpin		9.7	9.1						
							0	0	0	
	RBT (obs)		15							
	Sculpin (obs)									
	Sculpin (obs)									
							Total Ave	11.40	13.10	

Pass1 *Voltage = 400Hz, Frequency =I, Pulse width= 3* *time =364*
Pass 2 *Voltage = 400Hz, Frequency =I, Pulse width= 3* *time = 329*

$$N = \frac{n_1^2}{(n_1 - n_2)}$$

N 1
1

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

$$K = \frac{10NW}{L^3}$$

Site Summary

N	1
Total biomass	13.10
Area (m^2)	139.10
Density (fish/m^2)	0.01
Biomass (g/m^2)	0.09

Site	LCEF05			**Date**	August 24/2007		
Crew	Jim Clarricoates, Carla Davis						
Site length	39.4						
Water temp	10.4 (dig)		Air Temp	19.1			
	11.0 (hand)						
							Average
Wet Width	3.9	4.1	8	7.5	3.8		**5.46**
Bankfull width	23.5	26.5	25.4	15.85	21.05		**22.46**
Velocities	0.015	0.014					**0.015**
Depth	0.144	0.207	0.391	0.019	0.39	0.209	**0.230**

Substrate sands, gravel, cobble
LWD present
Cover submerged, instream, overhead and undercut banks
Site gradient 0-1%

Pass #	Species	Maturity	Fork L	Mass	Scale #	Photo	Count	Mean L	Mean W	K
1	Sculpin		10.4	10.7			)			
1	RBT	maturing	11.1	12.7						0.93
1	RBT	maturing	13.8	14.9	67554 #3					0.57
1	RBT	maturing	11.2	14.7	67554 #2					1.05
1	Sculpin		4.7	1.3						
1	Sculpin		5.6	1.7						
1	Sculpin		4.6	1.2						
						Pass Ave	3	12.03	14.10	
2	Sculpin		9.7	9.1						
2	Sculpin		8.9	8.7						
2	Sculpin		4.6	1.2						
2	Sculpin		8.3	6.3						
2	Sculpin		6.1	2.5						
2	Sculpin		7.4	5						
2	RBT	maturing	15.2	40.4	67554 #1	LCEF05 RBT, LCEF05 RBT1				1.15
						Pass Ave	1	15.2	40.4	
3	Sculpin		8.2	7.3						
3	Sculpin		5.9	2.5						
3	Sculpin		11.1	10.5						
	4 Sculpins (obs)						0	0	0	
						Average	4	12.83	20.68	

Pass1	*Voltage = 400Hz, Frequency =50 Hz, Pulse width= 4*	*time =369*
Pass 2	*Voltage = 400Hz, Frequency =50 Hz, Pulse width= 4*	*time = 310*
Pass 3	*Voltage = 400Hz, Frequency =50 Hz, Pulse width= 4*	*time = 342*

$$N = \frac{6x^2 - 3xy - y^2 + y(vy^2 + 6xy - 3x^2)}{18(x-y)}$$

x	y
7	4

218.33105
54

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

SiteSummary

N	4
Total biomass	83.59249002
Area (m^2)	215.124
Density (fish/m^2)	0.018794591
Biomass (g/m^2)	0.388578169

Descriptive Statistics for K for LCEF05		
Mean		0.92
Standard Error		0.13
Median		0.99
Mode	#N/A	
Standard Deviation		0.25
Sample Variance		0.06
Kurtosis		1.68
Skewness		-1.28
Range		0.58
Minimum		0.57
Maximum		1.15
Sum		3.69
Count		4.00
Largest(1)		1.15
Smallest(1)		0.57
Confidence Level(95.0%		0.40

Site	LCEF06			**Date**	August 24/2007	
Crew	Jim Clarricoates, Carla Davis					
Site length	31.8					
Water temp	17		**Air Temp**	19.1		

							Average
Wet Width	5.1	4.5	5.5	5.9	5		**5.2**
Bankfull width	11.5	12.4	12	12.8	12.4		**12.22**
Velocities	0.08	0.05					**0.065**
Depth	0.52	0.439	0.511	0.288	0.174	0.188	**0.386**

Substrate sand, gravel, cobble, boulders and bedrock
no LWD SWD present
Cover overhead
Site gradient 1-5%

Pass #	Species	Maturity	Fork L	Mass	Scale #	Photo	Count	Mean L	Mean W	K
1	RBT	maturing	14.6	36.7	67554 #6					1.18
1	RBT	maturing	19.9	103.4	67554 #7					1.31
1	RBT	maturing	15.2	37.1						1.06
1	Sculpin		10.9	9.7						
1	Sculpin		10.9	16.2						
1	Sculpin		9.9	11.4						
1	Sculpin		7.7	5.9						
1	Sculpin		8.4	8.5						
						Pass Ave	3	16.57	59.07	
2	Sculpin		9.96	13						
2	Sculpin		11.3	17						
2	Sculpin		11	15.5						
2	Sculpin		9.4	10.4						
2	Sculpin		4.9	1.1						
2	Sculpin		5.8	1.7						
2	Sculpin		6.9	3.5						
2	RBT	maturing	19.4	66.6						0.91
						Pass Ave.	1	19.4	66.6	
						Average	4	17.28	60.95	

Pass1 *Voltage = 400Hz, Frequency =I, Pulse width= 4* *time =392*
Pass 2 *Voltage = 400Hz, Frequency =I, Pulse width= 4* *time = 419*

$$N = \frac{n_1^2}{(n_1 - n_2)}$$

N 4.5
5

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

$$K = \frac{10NW}{L^3}$$

Site Summary

Total Biomass	304.75
Area (m^2)	165.36
Density (fish/m^2)	0.030237059
Biomass (g/m^2)	1.842948718

Descriptive Statistics for K for LCEF06	
Mean	1.11
Standard Error	0.09
Median	1.12
Mode	#N/A
Standard Deviation	0.17
Sample Variance	0.03
Kurtosis	-0.86
Skewness	-0.08
Range	0.40
Minimum	0.91
Maximum	1.31
Sum	4.46
Count	4.00
Largest(1)	1.31
Smallest(1)	0.91
Confidence Level(95.0%)	0.27