Columbia River Project Water Use Plan

Middle Columbia River Juvenile Habitat Use Assessment (Year 6 of 6)

Reference: CLBMON#17

Columbia River Water Use Plan Monitoring Program:

Middle Columbia River Juvenile Fish Habitat Use

Study Period: 2013-2014

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Middle Columbia River Juvenile Fish Habitat Use

Final

CLBMON-17

Year 6 (2013) of 6

June 2014

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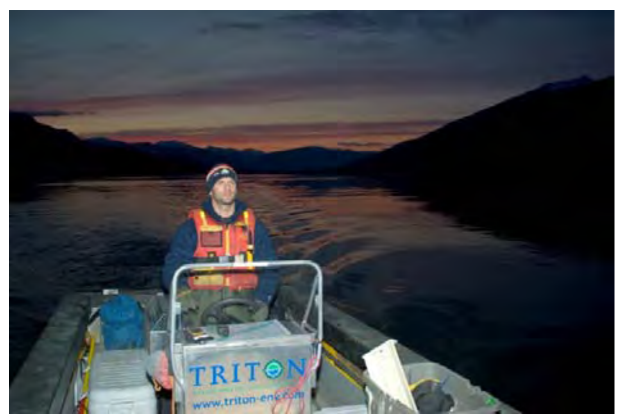

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Executive Summary

The Middle Columbia River, located downstream of the Revelstoke Dam, forms the upstream end of the Arrow Lakes Reservoir. The Middle Columbia River is affected by flows from the Revelstoke Dam at its upstream end, and by fluctuating reservoir elevations at the downstream end from water impounded behind the Hugh Keenleyside Dam near the city of Castlegar. The impacts of the operation of the Revelstoke Dam and Arrow Lakes Reservoir on fish and fish habitat in the Middle Columbia River were recognized in the Columbia River Water Use Plan. Specifically, installation of a fifth turbine at the Dam (Rev-5) and associated changes to the flow regime and the implementation of a minimum flow release of 142 m^3/s which was proposed with the objective of improving habitat conditions for fish, were focuses of the study. The Middle Columbia River Juvenile Fish Habitat Use project (CLBMON-17) was initiated in order to determine if the objective of the minimum flows was met for fish juvenile life stages and to assess the overall effect of Rev-5 on juvenile fish habitat in the system.

CLBMON 17 was a 6 year study (2008-2013) with 3 years of sampling pre-implementation of minimum flows (2008-2010) and 3 years of sampling post-implementation (2011-2013). Sampling was completed 3 times annually in the spring (May), summer (June/July) and fall (September). Year 1 of the program (2008) included an initial habitat assessment and the development of a stratified random sampling plan that resulted in the identification of 60 sites including 55 representative river sites located throughout the study area, as well as in five tributary sites. Sampling was completed 3 times annually (spring, summer, and fall) over the 6 years of the study. All river sites were sampled at night using a boat electrofisher with an anode pole, while tributary sites were typically sampled using a backpack electrofisher. Data on water depth, velocities, substrates, slope, temperature, pH, and discharge were collected at each site. Fish sampling focused on juveniles within the study area and the total numbers of all species captured; lengths and weights of up to 30 randomly selected individuals from each species were recorded.

This report summarizes Year 6 of sampling, which was the third year following the implementation of the minimum base flow and Rev5. In total 4005 fishes were captured which was 4th highest of the 6 years (2010>2009>2011>2013>2008>2012). The number of species encountered in each year was relatively constant ranging from a low of 15 to a high of 17. Juveniles of Rainbow Trout, Bull Trout, Mountain Whitefish, Kokanee, Redside Shiner, Largescale Suckers and sculpins accounted for the majority of all juveniles caught and observed. The length, weight, and condition factor of the species assessed were relatively constant across the 6 years of study which suggests that the rearing environment was relatively stable.

Mean catch-per-unit-effort (CPUE) by reach was lower post minimum flow, though the difference was not statistically significant. Three-way interaction between flow, Reach and Trip on CPUE indicates that CPUE varied by trip within the Reaches. During Trip 1 (spring sampling), there was little effect of minimum flow and Rev5 on CPUE in any reach. During Trip 2 (summer sampling), however, CPUE was reduced in all reaches after minimum flow and Rev5 was established. In contrast, during Trip 3 (fall sampling), there was an increase in CPUE in reaches 1-3 post-Rev 5.

General conclusions from the 6 years of data collected include:

- Seasonal abundances and distribution of juvenile species are variable in the MCR. Generally abundance was higher in the fall than in the spring and summer from Year 1 to 6. Several of the Reaches experience significantly greater numbers of fish in the fall than in the spring or summer. However, variable ALR and discharge conditions during the summer and fall trips likely influenced distribution and catchability. Fish usage both before and after minimum flow/REV5 tended to be higher and more consistent in the lower reaches (Reaches 1 and 2) than the higher reaches (Reaches 3 and 4).
- Habitat characteristics of sites with high abundance of the most common species were similar throughout Years 1 to 6 suggesting that operational strategies have not influenced the availability of preferred habitats.
- All habitats sampled in Years 1-6 of the study were accessible and no changes in habitat quality, quantity or accessibility were noted post-

minimum flow. The minimum base flow and influence of the ALR do not limit habitat access.

- In order to determine the potential longer-term effects of minimum flow and Rev-5 on the system, additional follow sampling is recommended. To reduce costs and the confounding influence of the ALR, sampling should focus on Reach 3 and 4 only and on the spring sampling period.

CLBMON #17 STATUS of OBJECTIVES, MANAGEMENT QUESTIONS and HYPOTHESES after Year 6

Objectives	Management Questions	Management Hypotheses	Year 6 (2013) Conclusions
To provide information on Juvenile fishes' use of the Middle Columbia River and on the suitability of these habitats to meet critical life history requirements.	What are the seasonal abundances and distribution of juvenile life stages of fishes in the Middle Columbia River? How do juvenile fishes use the mainstem habitats in the Middle Columbia River?	$H_0$1: Juveniles do not use mainstem habitats in the absence of minimum flow releases. $H_0$2: Juveniles do not use mainstem habitats during 142 m3/s minimum flow releases.	Juvenile fish make use of the mainstem for rearing and presumably for overwintering. Generally abundance is higher in the fall than in the spring and summer. $H_0$1 is rejected. Juvenile fish continued to make use of the mainstem for rearing following the implementation of minimum flows. $H_0$2 is rejected.
To assess the effects of the implementation of the 142 m3/s minimum flow and REV 5 on the recruitment of juvenile life stages of fishes of the Middle Columbia**.**	What factors affect recruitment of juvenile life stages in the Middle Columbia River? Do operational strategies for Revelstoke Dam and Arrow Lake Reservoir influence the availability of juvenile fishes' preferred habitats? Do current operational strategies affect availability of the food base for juvenile fish life stages? Do predators influence fish recruitment and habitat use in the Middle Columbia River?	$H_0$3: The provision of a minimum flow does not affect the average abundance of juvenile life stages in mainstem habitats	No significant change in CPUE of juvenile fish was noted following the implementation of minimum flows. However, seasonal changes were noted in the summer and fall but other factors such as high ALR elevation and discharge could also have an effect. $H_0$3 is accepted. Food base availability directly correlates with submergence time which is affected by discharge from the dam. Predator pressure has likely remained constant throughout the study period

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The following employees of Triton assisted with the completion of the project:

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1.0 INTRODUCTION

The Middle Columbia River, located downstream of the Revelstoke Dam, forms the upstream end of the Arrow Lakes Reservoir (ALR). CLBMON-17 study area extends from the base of Revelstoke Dam approximately 37 kms downstream. The ALR is formed by the Hugh Keenleyside Dam in Castlegar, B.C. Water levels in the Middle Columbia River fluctuate daily based on discharge from the Revelstoke Dam. The ALR fills through spring, nears full-pool in June or July, remains high throughout the summer, and is drawn down through late fall and the winter. As the ALR fills, the study area changes from riverine to predominantly lacustrine as the floodplain of the Middle Columbia River becomes inundated, typically upstream of the city of Revelstoke. This inundation reduces the length of the river by approximately 50 km. When the reservoir reaches full-pool, the ALR “backwaters” to the base of the Revelstoke Dam (BC Hydro 2010) resulting in lacustrine conditions downstream of that point. Complex flood control treaties and water storage agreements with the United States and downstream facilities drive the operation of the reservoir. The general operating regime provided here is a very simplistic overview. The Revelstoke Dam is a peaking facility, with discharge tied to energy demand. This can result in widely fluctuating discharges that typically remain high during the day when power demand is greatest, and are reduced during the night when demand drops. The dam historically housed four turbines; an additional turbine (known as Rev 5) came online in December 2010. The pre-Rev 5 discharge from the facility ranged from a minimum of 0 m^3/s to a maximum of approximately 1,700 m^3/s (BC Hydro 2010). The addition of the fifth generating unit increases the projected maximum discharge from the facility to approximately 2,125 m^3/s, with an established minimum base flow of 142 m^3/s (BC Hydro 2010).

Past fisheries studies on the Middle Columbia River have shown that the mainstem river habitats are used primarily by sub adult and adult life stages of fishes, with very few juveniles of specific life stages present (RL&L 1994; Golder Associates Ltd. 2005). The findings further suggested that, due to changing flows, mainstem habitats within the Middle Columbia (in the study reaches upstream of the highway bridge) are unsuitable for young-of-year and yearling juvenile fishes. However these studies did not specifically focus on sampling juvenile life stages and as such results may have been biased due to methodology or study design.

The impacts of the operations of the Revelstoke Dam and ALR on fishes and fish habitat in the Middle Columbia River were recognized in the Columbia River Water Use Plan. Implementation of a minimum flow release of 142 m^3/s from the Revelstoke Dam was proposed with the objective of improving habitat conditions for fishes, in general, within the Middle Columbia (BC Hydro 2005). In order to determine if this objective was met for juvenile life stages, baseline data on the relative abundance, distribution, and habitat use of juvenile life stages were necessary. The six-year monitoring program associated with this project (CLBMON-17 Middle Columbia River Juvenile Fish Habitat Use) consists of three years of pre- and three years of post-minimum flow surveys. The overall management objectives for the project are, as stated in the Terms of Reference (BC Hydro 2010):

1. *To provide information on juvenile fishes' use of the Middle Columbia River and on the suitability of these habitats to meet critical life history requirements (e.g., rearing) of these fish populations.*

2. *To assess the effects of the implementation of the 142 m^3/s minimum flow and Rev 5 on the recruitment of juvenile life stages of fishes of the Middle Columbia.*

The management hypotheses, as stated in the Terms of Reference (BC Hydro 2010), for the project are:

1. H_{o1}: *Juvenile life stages do not use mainstem habitats in the absence of minimum flow releases.*

2. H_{o2}: *Juvenile life stages do not use mainstem habitats during 142 m^3/s minimum flow releases.*

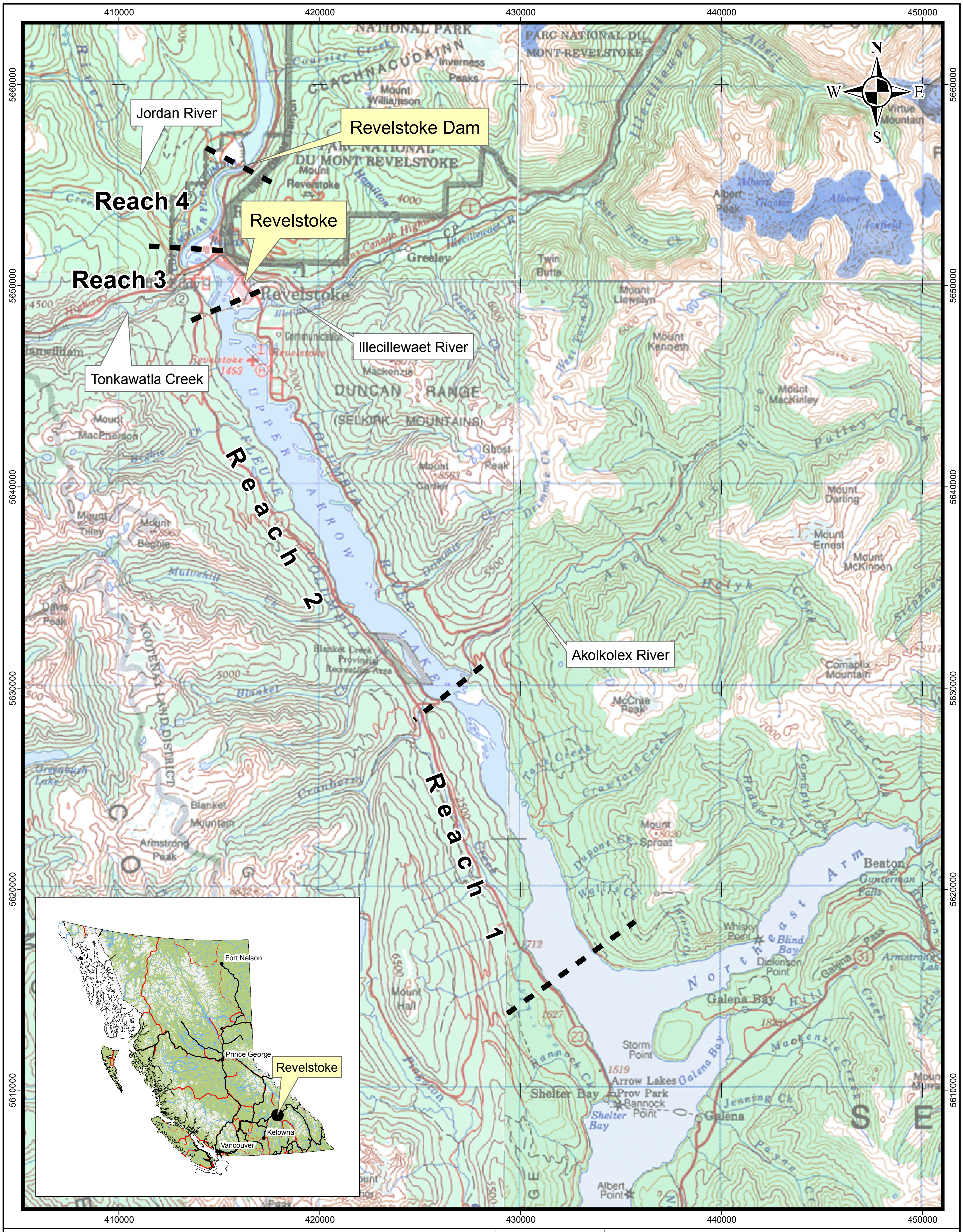
3. H_{o3}: *The provision of a minimum flow does not affect the average abundance of juvenile life stages in mainstem habitats.*

The Juvenile Fish Habitat Use study was designed to monitor the relative abundance and seasonal distribution of juvenile fishes, to determine the range of habitats available within the study area that are used by the juvenile life stages of key fish species, and to assess changes in habitat use by juvenile life stages in response to implementation of a minimum flow release from Revelstoke Dam. The specific management questions to be addressed by CLBMON-17 are as follows (BC Hydro, 2010):

1. *What are the seasonal abundances and distribution of juvenile life stages of fishes in the Middle Columbia River?*
2. *How do juvenile fishes use the mainstem habitats in the Middle Columbia River?*
3. *What factors affect recruitment of juvenile life stages in the Middle Columbia River?*
    a. *Do operational strategies for Revelstoke Dam and Arrow Lake Reservoir influence the availability of juvenile fishes' preferred habitats?*
    b. *Do current operational strategies affect availability of the food base for juvenile fish life stages?*
    c. *Do predators influence fish recruitment and habitat use in the Middle Columbia River?*

The study area includes the Middle Columbia River from Revelstoke Dam downstream to Akolkolex Narrows, about 15 km upstream of Beaton Arm of the Arrow Lakes (Figure 1-1), as well as selected tributaries within this section of river. However, the majority of the sample sites were located on the riverine reaches (Reaches 3 and 4; upstream of the mouth of the Illecillewaet River) where the influence of the dam is greater due to proximity (BC Hydro 2010).

It should be noted that the original Terms of Reference for the project (those that applied to Years 1 – 3 of the project; BC Hydro [2007]) identified three key fish species as "target species": Rainbow Trout, Bull Trout, and Mountain Whitefish. As a result, the data analysis and reporting for those years focused primarily on those three species. The Terms of Reference were revised in 2010 for Years 4-6 and the focus on those key species was removed in favour of a more general summary of all species in the study area. This report (Year 6 - 2013) describes Year 6 results and compares Years 1 – 6 of the study.



MIDDLE COLUMBIA RIVER JUVENILE FISH HABITAT USE

Basemap Source: NTS 1:250,000

Scale: 1:250,000 (0 – 8,000 Meters)

Map Datum: UTM NAD 83 Zone 11

FIGURE 1-1. Overview of Study Area

Project No: 3789

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Date: Feb 12, 2009

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2.0 METHODS

Year 6 (2013 field season) of the Middle Columbia River Juvenile Fish Habitat Use project involved seasonal sampling for fishes and associated data entry and reporting. The study area (Figure 1-1) was divided into four sections (corresponding to Reaches), with the Revelstoke Dam at the upstream end (Reach 4) and Beaton Arm at the downstream end (Reach 1). The focus of the study was on the riverine sections, which included Reaches 3 and 4 (Illecillewaet River to Revelstoke Dam).

In 2011 BC Hydro developed a naming convention for sample sites in all BC Hydro studies on the Middle Columbia River. Each site label includes the river kilometre as measured from the U.S./Canada border, the side of the river where the site is located (left or right when facing downstream), the project ID (MON-17 for this project), and the sampling technique (boat electrofishing: ES; backpack electrofishing: EF). For example, the former site 1 has been relabelled 236.5/R/MON17/ES. The application of this naming convention was in 2012, but the site labels used in Years 1–3 have been maintained in the report, while both the old and new labels are reported in the database and are displayed on the maps for ease of comparison. Appendix 1b provides a summary of the sites with both old and new labels.

2.1 HABITAT INVENTORY

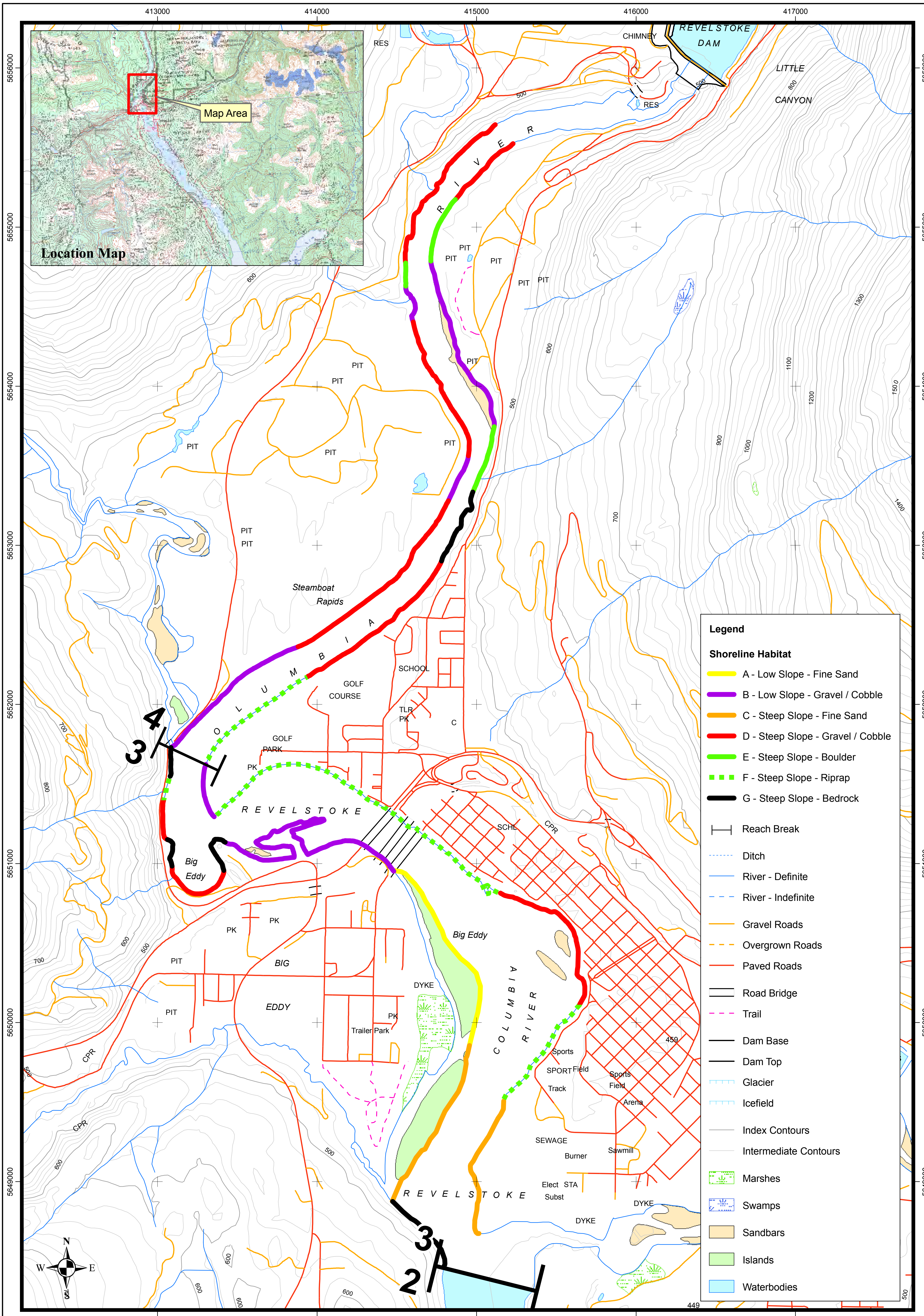
2.1.1 INITIAL SAMPLING DESIGN

Year 1 of the program (2008 field season) included an initial habitat assessment (April 17-20, 2008) of the entire 50-km long study area between the Revelstoke Dam and Beaton Flats (Figure 2-1). A stratified random sampling plan was used that resulted in the identification of 56 sites located throughout the study area based on the proportion of shoreline habitats within each of 12 habitat categories. Habitat categories were based on bank slope (steep or low) and substrate (sand, gravel, cobble, boulder, rip-rap, bedrock). Five tributary sites were also included in the sampling plan to help determine the relative use of tributaries by juvenile fishes compared to mainstem habitats.

The 61 sites that were originally identified (56 riverine sites plus 5 tributary sites) have been sampled annually during three periods: spring (May), summer (June/July), and fall (September). Given that the focus of the study was on the Reaches that remain riverine (i.e., flowing) throughout most of the year, 65 per cent of the sites (n = 39) were located in Reaches 3 and 4, while 27 per cent (n = 17) were located in Reaches 1 and 2. The remaining 8 per cent (n = 5) were located in tributaries. A detailed summary of the habitat inventory and initial site selection is provided in Triton (2009). A summary of the sites sampled by reach and habitat class is provided in Table 2-1.

2.1.2 MODIFIED SAMPLING DESIGN

Following the May sampling in 2008, it was discovered that seven of the original sites (sites 40, 42, 43, 45, 49, 50, and 53) in Reaches 1 and 2 would most likely not be able to be sampled during the summer and fall trips because they would be inundated by the ALR. Therefore, these sites were dropped from summer and fall sampling (Trips 2 and 3), and seven additional sites were added to Reach 4 to increase the number of riverine sites sampled at high reservoir elevations (riverine sites being most relevant to the management questions). The seven new sites were referred to as “Biased 1 to 7” since they were not selected using the stratified random methodology. In addition, two other sites (sites 46 and 47) in Reach 2 had to be moved to new locations due to a change in accessibility from steep angle, fine-dominated habitat to steep angle, bedrock-dominated habitat. Since Trip 2 in 2008 the seven Biased sites have been sampled during all three sampling trips to increase overall sampling effort. Thus, the maximum number of riverine sites that can be sampled during any trip is 63 (56 original sites plus 7 Biased).



MIDDLE COLUMBIA RIVER
JUVENILE FISH HABITAT USE

Scale: 1:22,000

FIGURE 1-2
Habitat Inventory Map for Reaches 3 and 4

NO.	DATE (yyyy/mm/dd)	REVISION	BY
1	2008/04/23	Initial Draft	SM
2	2009/02/12	Turned off sites	SM
3	2009/03/26	Added Reach Breaks	SM

Basemap Source: TRIM Data

Map Datum: UTM NAD 83 Zone 11

Project No: 3943

File No: Map#: 3943_BC_Hydro_Columbia\MXD\HabitatInventory_Fig2.mxd

Date: Mar 26, 2009

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Table 2-1: Habitat summary and 2013 sample sites by reach

Habitat Class	Reach 1	Reach 2	Reach 3	Reach 4	Total
Low angle - Fines	2	3	2	0	7
Low angle – Gravel/Cobble	0	1	4	5 + 2 Biased	12
Steep angle – Fines	2	1	4	0	7
Steep angle – Gravel/Cobble	0	2	5	7 + 3 Biased	17
Steep angle – Boulder	0	0	0	2 + 1 Biased	3
Steep angle – Rip-rap	0	0	5	2+1 Biased	8
Steep angle – Bedrock	1	5	1	2	9
Total	**5**	**12**	**21**	**25**	**63**
Tributaries[B]	0	4	4	2	10
Total	**5**	**16**	**25**	**27**	**73[A]**

2013 Sites Sampled[B]	Reach 1	Reach 2	Reach 3	Reach 4[C]	Total
Spring Trip (May/June)	4	12	25	26	67
Summer Trip (July)	3	10	25	27	65
Fall Trip (September)	5	14	26	27	72

[A] Includes the 61 originally proposed sites along with 7 biased sites. High ALR elevations during the summer (Trip 2), and sometimes, the fall (Trip 3) trips typically reduce the total that can be sampled by up to seven sites which become inundated.
[B] Including tributary sites. 5 tributaries with 2 sites each (termed "*upstream*" and "*downstream*") is a maximum of 10 tributary sites per trip.
[C] Includes Biased sites – the seven sites added in Reach 4 to compensate for the seven sites that are typically flooded (high reservoir elevation) in Reaches 1 and 2 during the summer trip (Trip 2).

The number of sites sampled in the Middle Columbia River during each of the sampling trips in 2013 was equal to or exceeded the 61 sites identified during the initial study design (56 mainstem sites plus 5 tributary locations). During the spring trip, one tributary in Reach 2 (Begbie Creek "*upstream*" and "*downstream*") and Jordan River "*downstream*" were not sampled due to high discharge while three reservoir sites (Reach 2: sites 49 and 50; Reach 1: site 53) were not sampled due to high ALR elevation. During the summer trip, Drimmie Creek "*downstream*" and seven reservoir sites (Reach 1: sites 53 and 56, Reach 2: sites 40, 43, 45, 49 and 50) were not sampled due to high

ALR elevation. During the fall trip the upstream portions of Drimmie Creek and Begbie Creek were not sampled due to the presence of spawning Kokanee.

2.1.3 TRIBUTARY SAMPLING

Tributaries were sampled to compare species composition and abundance with mainstem sites. Five tributary sample sites were dispersed throughout the study area (1 in Reach 4, 2 in Reach 3 and 2 in Reach 2) to assess juvenile fishes' use of tributary habitats and the relative importance of those habitats to juvenile fish production. Tributaries were selected based on the criteria of size — large enough to safely sample at night (e.g., absence of dense riparian vegetation overhanging the wetted channel)—and accessibility for sampling at the confluence (i.e., within the portion inundated by the ALR) as well as upstream of the greatest zone of influence of the ALR (identified by the presence of mature, riparian vegetation).

At each site, one 50-m long site was sampled at the confluence (within the zone influenced by the reservoir), and one 50-m long site was sampled upstream in a section above the reservoir high water level. Selected tributaries included the Jordan River, Tonkawatla Creek, Illecillewaet River, Begbie Creek, and Drimmie Creek (see Appendix 1a for site locations). Data on habitat parameters (substrate composition, gradient, morphology, and cover) were collected at these sites.

2.2 SEASONAL FIELD SURVEYS

Sampling trips in 2013 were completed in May/June, July, and September, consistent with the timing of sampling in 2008 – 2012 (Table 2-2). The only exception was that the summer trip (Trip 2) in 2009 was completed in late-June prior to the ALR backwatering into Reach 3, whereas in 2008 and in 2010 - 2013 they were completed in July after the ALR had backwatered into Reach 4.

Table 2-2. Timing of sampling and average reservoir elevation (m) for sampling Trips 1, 2 and 3 in 2008 through 2013.

	Year 1 (2008)		Year 2 (2009)		Year 3 (2010)		Year 4 (2011)		Year 5 (2012)		Year 6 (2013)	
Sampling Trip	Date	Reservoir Elevation (masl)	Date	Reservoir Elevation (masl)	Date	Reservoir Elevation (masl)	Date	Reservoir Elevation (masl)	Date	Reservoir Elevation (masl)	Date	Reservoir Elevation (masl)
Spring	May 14-22	431.6	May 26-June 3	432.8	May 25 - June 1	434.6	May 26-June 3	433.1	May 28-June 5	433.0	May 28-June 6	435.1
Summer	July 21-29	439.3	June 20-30	437.1	July 24-Aug 1	437.9	July 19-27	439.3	July 9-18	440.4	July 2-11	439.6
Fall	Sept 9-18	438.2	Sept 8-17	435.5	Aug 30-Sept 7	436.0	Sept 13-20	437.0	Sept 10-19	435.1	Sept 11-18	432.5

Reservoir elevations are means for the trip period. The elevation data is from the BCH Nakusp Reservoir monitoring station on Upper Arrow Lake.

During each trip, habitat, fish abundance and distribution data were collected. Following 2008, it was noted that depending on the time of night when sampling was completed, habitat conditions (e.g., bank slope and substrate type) at a given site could change substantially depending on water level. To help minimize this potential variability, sampling in Reaches 3 and 4 targeted the daily minimum discharge in subsequent years. This was based on the rationale that sampling during the period of lower flows would help ensure that physical conditions (e.g., site depth and velocity) were comparable between years. However, due to daily operational decisions at the Dam, there were nights when flows did not drop to minimum. Due to their distance from the dam and the influence of the reservoir on Reaches 1 and 2, it was not considered necessary to sample those reaches during the period of minimum dam discharge.

2.2.1 HABITAT DATA

Data on substrate composition, slope, water velocity, water depth, water temperature (surface), conductivity, and turbidity were collected at each site during the three sampling trips to facilitate habitat grouping and comparison of results. Substrate composition was assessed by visual observations according to the categories defined by Kaufmann and Robison (1993): fines (< 2 mm), gravels (2–64 mm), cobbles (64–256 mm), boulders

(256–4,000 mm), or bedrock (> 4,000 mm). D_{95}, the diameter of bed material larger than 95 per cent of the total substrate, was measured with a folding ruler where substrate could be easily accessed or by visual estimate in deeper waters. Slope was measured using a handheld clinometer (per cent slope), and sites were classified as low angle (< 10 per cent) or steep angle (> 10 per cent).

Water velocity was measured at 40 per cent of the water depth using a velocity sensor (Swoffer Instruments, Seattle, Washington), and depths were measured using a graduated rod or, where depth was greater than approximately 2.5 m, a handheld digital sonar device (HawkEye Electronics). Water temperature and conductivity were measured at the surface using a handheld digital meter (Hanna Combo Meter HI98129). Turbidity was visually assessed as *clear*, *lightly turbid*, *moderately turbid*, or *turbid* as per the Reconnaissance Fish and Fish Habitat Inventory standards (BC Fisheries 2001), where:

- turbid water is muddy and brown, and visibility is restricted to a few centimetres;
- moderately turbid water is muddy with increased visibility in shallow areas;
- lightly turbid water allows features in shallow areas to be distinguished, and has limited visibility in deeper pools (up to 1.5 m); and
- clear water has excellent visibility except in very deep areas.

Site coordinates were documented with a Garmin GPSmap 60CSx GPS. Navigation between sites was assisted by use of a Trimble Juno ST handheld unit, which displayed real-time location onto navigational charts for the study area.

2.2.2 FISH SAMPLING

A Smith-Root Generator Powered Pulsator (5.0 GPP) electrofisher based out of a 6.1 m Ali-Craft aluminium river boat was used to sample fish. The electrofisher was set at a frequency of 60 Hz direct current, with an amperage target of 1.0–1.5 A, typically obtained by using the high output setting (100–1,000 volts) at 20–50 per cent output.

Electrofishing involved manoeuvring the boat in an upstream direction, approximately 3 m from shore. Two crew members were positioned on the railed platform at the bow of the boat, with one crew member operating a 2.7 m long anode wand (similar to those used with backpack electrofishers). The use of a wand allowed the electrical pulse to be directed to specific locations, with the current controlled by the person observing the fish. A second crew member with a dip net on a 2.2 m fibreglass pole would then retrieve the stunned fishes and place them in a partially filled 150 L aerated cooler. A third crew member manoeuvred the boat along the shoreline. Sampling was conducted at night, with articulating halogen bow lights and a pivoting halogen light bar at the center console. These lights were used to illuminate the water between the boat and the shoreline.

A Smith-Root 12B backpack electrofisher was used to sample the majority of tributary sites and the occasional mainstem sites that were too shallow to sample by boat. Backpack electrofisher voltage settings varied according to site conditions and tributary conductivity, but the frequency was set to 60 Hz, similar to the boat-based electrofisher. Captured fishes were processed after the completion of each site. All fishes captured were anaesthetized using a solution of clove oil and river water (0.03g clove oil per L water) as recommended by Anderson et al. (1997) to reduce handling stress before being weighed and measured. Length (fork or total length to the nearest mm) and weight (to the nearest 0.1 g) were collected from a random subsample of up to 30 fish from each of the species encountered. Total numbers of each species captured were also recorded to calculate catch-per-unit-effort (CPUE; fish per second of electrofishing). Once recovered, fishes were returned to their site of capture.

2.3 DATA ENTRY AND ANALYSES

Field data were entered into an Microsoft ACCESS database developed specifically for the project. A front-end data entry tool was developed to facilitate the data entry process and ensure that all required data were entered. Fulton’s condition factor (Ricker 1975), a measure of relative condition, robustness, or well-being of fish, was calculated for juvenile salmonid fishes. The coefficient of condition for salmonids, (K), was calculated using Equation (1). For non-salmonid species, Ricker proposed a modified version of Fulton’s K equation to more accurately portray health condition. Ricker proposed replacing the cube-power, associated with length variable, with the slope value of the

$\log_{10}$ length-weight regression curve for the species being measured. He referred to this as Relative Condition factor K′ (Equation 2):

$$K = 10^5 W/L^3 \quad (1)$$

where:

K = coefficient of condition; often referred to as the "K-value"
W = weight of fish (g)
L = fork length of fish (mm)
10^5 = scaling constant

$$K' = 10^5 W/L^b \quad (2)$$

where:

K′ = coefficient of relative condition
W = weight of fish (g)
L = fork length of fish (mm)
b = slope value of $\log_{10}$ length-weight regression curve for species in question
10^5 = scaling constant

Weight–length regressions were completed for the seven most abundant fish species. Data were analyzed after being logarithmically transformed. Logarithmic transformation accounts for more of the variation in weight and minimizes overall model error (Pope and Kruse 2007). Based on the least-squares regression model, Equation (3) was used because it generally describes the weight–length relationship of most fishes:

$$\log_{10}(W) = a + b(\log_{10} L) \quad (3)$$

where:

W = weight of fish (g)
L = fork length of fish (mm)
a = y-intercept ($\log_{10}$ scaling)
b = slope of the line

Weight–length scatterplots with a best-fit trend line for non-transformed data were produced for ease of visually determining length and weight characteristics.

In 2013, species diversity and evenness indices were calculated from the collected data. To quantify diversity and to describe the assemblage structure of the study's juvenile fish community the Shannon (Shannon-Wiener) Index was used. This index is one of the most widely used indices in aquatic systems and quantifies the uncertainty in predicting the type, here "species", one might capture or observe in the study area (Washington 1984 as cited in Pope and Kruse 2007). The lower the index value, the lower the uncertainty of what species will next be captured or observed relative to the same sample unit. Diversity takes into account species richness (the number of different species present), relative abundance (the number of each species caught) and evenness (the degree of similarity between the abundances of different species). Diversity is greatest when both abundance and richness are high. Equation (4) uses richness and relative abundance as variables to calculate the diversity index value (H') and Equation (5) uses richness and H' to calculate evenness (J').

$$H' = -\sum_{i=1}^{s}(p_i)(\log_e p_i) \qquad (4)$$

where:

s = number of different species

p_i = proportion of the total sample represented by the *i*th species

To describe evenness, Pielou's evenness index (J') was used (Pope and Kruse 2007). Values range from 0 to 1. The higher the value, the greater the greater the contribution of the species to the total abundance.

$$J' = \frac{H'}{H'_{max}} = \frac{H'}{\log_e s} \qquad (5)$$

where:

$H'_{max} = \log_e s$ = maximum possible value of Shannon's index

e = constant = 2.718

s = number of species

2.3.1 STATISTICAL ANALYSES

The dependent variable used in the 2013 data analyses was CPUE of juvenile fishes of the seven most abundant species captured in the study area. For Years 1-3 (2008-2010), Rainbow Trout, Bull Trout and Mountain Whitefish were identified by the ToR as target species (BC Hydro, 2007). However, the ToR was redefined in 2010 and the reference to specific target species was removed (BC Hydro, 2011). As a result, four additional species were added to the analyses based on abundance: Kokanee, Prickly Sculpin, Redside Shiner and Largescale Sucker. Together these seven species comprised greater than 50 per cent of the total number of fishes captured and observed each year. The remaining species that were captured and observed typically accounted for less than 10 per cent of the total while the remaining approximately 40 per cent were comprised of individuals of the genus *Cottus* that were observed but not captured and therefore not identified to species. CPUE of juvenile fishes was chosen because it provides a more accurate estimate of relative abundance at each site compared to total count since it factors in the sampling effort (electrofishing seconds).

Comparisons of CPUE in 2013 were carried out between Reaches, habitat types, and sampling trips. As Year 6 was the final year of the study, this synthesis report contains additional CPUE comparisons between study years and pre- and post- Rev 5 years as groups. These comparisons were completed using parametric statistics (ANOVA) with a post-hoc Tukey test for individual comparisons. Data transformations were not required. All statistical analyses were completed using R (ver. 2.15.2; R Core Team, 2012), and significance was set at alpha = 0.05.

2.4 DATA QA/QC

A systematic QA/QC consisted of running various queries of the database and looking for outliers (e.g., water velocities greater than 3 m/second). Length versus weight plots and condition factors were used to identify outliers in the individual fish data. After systematic data queries were completed, the fish summary fields for all site cards were reviewed for accuracy because these fields are critical to the study design and interpretation of results. Additional QA/QC functions were completed using GIS software to map site locations to ensure that UTMs corresponded to the correct Reach and position on the river or reservoir.

2.5 REPORTING

Fish species codes used in this report and in the associated database follow those in the *Fish Collection Methods and Standards* (BC Ministry of Environment, Lands and Parks 1997), and are summarized in Table 2-3.

Table 2-3: Fish species codes used for CLBMON-17

Common Name	Code	Family	Scientific Name
Bull Trout	BT	Salmonidae	*Salvelinus confluentus*
Eastern Brook Trout	EB	Salmonidae	*Salvelinus fontinalis*
Burbot	BB	Gadidae	*Lota lota*
Common Carp	CP	Cyprinidae	*Cyprinus carpio*
Kokanee	KO	Salmonidae	*Oncorhynchus nerka*
Largescale Sucker	CSU	Catostomidae	*Catostomus macrocheilus*
Longnose Sucker	LSU	Catostomidae	*Catostomus catostomus*
Mountain Whitefish	MW	Salmonidae	*Prosopium williamsoni*
Northern Pikeminnow	NSC	Cyprinidae	*Ptychocheilus oregonensis*
Peamouth Chub	PCC	Cyprinidae	*Mylocheilus caurinus*
Prickly Sculpin	CAS	Cottidae	*Cottus asper*
Pygmy Whitefish	PW	Salmonidae	*Prosopium coulteri*
Rainbow Trout	RB	Salmonidae	*Oncorhynchus mykiss*
Redside Shiner	RSC	Cyprinidae	*Richardsonius balteatus*
Sculpin (General)	COTT	Cottidae	*Cottus sp.*
Slimy Sculpin	CCG	Cottidae	*Cottus cognatus*
Tench	TC	Cyprinidae	*Tinca tinca*
Yellow Perch	YP	Percidae	*Perca flavescens*

Other abbreviations used refer to substrate composition (Table 2-4).

Table 2-4: Substrate types, size classes, and abbreviations (Kaufmann and Robison 1993)

Substrate Type	Size (mm)	Abbreviation
Fines	< 2	F
Gravels	2 – 64	G
Cobbles	64 – 256	C
Boulders	256 – 4,000	B
Bedrock	> 4,000	R
Rip-rap	N/A	RR

3.0 RESULTS

3.1 PHYSICAL CONDITIONS

3.1.1 WATER TEMPERATURE

Across the three trips in 2013, surface water temperatures were generally warmer in the more lacustrine reaches (Reach 1 and 2) than the more riverine reaches (Reaches 3 and 4). This trend was consistently observed across all years of the study (Table 3.1). Tributary temperatures were similar to mainstem temperatures in the spring and fall but higher during the summer trip, except when compared to Reach 1.

Mean surface water temperatures at the sites sampled during the spring trip in 2013 ranged from a low of 5.7°C in the Jordan River (Reach 3) to a high of 9.6°C in Reach 1 sites (Table 3-1). Reach 1 had the highest mean temperature (9.6°C), while Reach 4 had the lowest (6.7°C). Mean temperatures in mainstem and tributary sites in spring 2013 was warmer than all previous years except for Reaches 2 and 4 in spring 2010 and tributaries in spring 2009 and 2010. Reach 1 and 3 mean temperatures in 2013 were warmer than in all previous years (Table 3-1).

Mean surface water temperatures at sites sampled during the summer trip in 2013 ranged from a low of 8.0°C at Biased 5 to a high of 12.5°C at the Tonkawatla sites (both *downstream* and *upstream* sites were inundated by ALR) (Table 3-1). Mean temperatures all reaches increased from the spring trip with Reach 1 the warmest (12.2°C). Mean temperatures for Reaches and tributaries in the summer of 2013 were warmer than in 2012 and 2009, but cooler than in 2008, 2010 while 2011 mean temperatures were similar.

Mean surface water temperatures at sites sampled in during the 2013 fall trip ranged from a low of 10.2°C at Sites 36 to 39 (Reach 3) to a high of 13.4°C at the Jordan River - *downstream* site (inundated by ALR) (Table 3-1). The next highest mean temperature was found at the Reach 2 sites 48 to 51. Mean temperature in each Reach was higher than in May and July in 2013. Mean temperature in Reaches 1, 4 and the tributaries were warmer than all previous years of the program. Mean water temperatures for Reach 2 were warmer than 2008, 2011 and 2012 and cooler than 2009 and 2010. In Reach 3, mean temperatures were equal to that in 2008 and 2012, cooler than in 2010 and warmer than in 2011.

Table 3-1: Minimum, maximum, mean, and standard deviation (SD) of surface water temperature recorded at electrofishing sites by month and river Reach, Middle Columbia River, 2013. Means for 2008 to 2012 are presented for comparison.

Trip	Reach	Temperature (°C)									
		Min	Max	2013 Mean	SD	*N*	2008 Mean	2009 Mean	2010 Mean	2011 Mean	2012 Mean
Spring	Reach 1	9.6	9.6	**9.6**	0	4	5.4	8.6	8.6	7.2	7.0
	Reach 2	7.0	9.3	**8.7**	0.61	13	5.4	6.9	10.0	6.5	6.6
	Reach 3	6.4	8.2	**7.2**	0.81	20	5.0	7.0	7.0	5.2	5.6
	Reach 4	6.1	7.9	**6.7**	0.59	25	4.9	6.2	7.8	4.7	5.9
	Tribs.	5.7	9.6	**7.2**	1.47	7	6.6	7.4	7.5	6.3	5.9
Summer	Reach 1	12.2	12.2	**12.2**	0	3	12.4	9.0	18.2	11.9	10.8
	Reach 2	8.5	12.2	**9.8**	1.65	7	12.4	8.1	11.5	10.3	9.7
	Reach 3	8.7	9.5	**9.0**	0.26	20	10.2	7.4	11.1	9.2	8.8
	Reach 4	8.0	9.4	**8.8**	0.62	25	10.3	8.9	10.3	9.5	8.2
	Tribs.	8.4	12.5	**10.4**	1.72	9	12.2	8.2	13.2	10.1	10.5
Fall	Reach 1	12.7	12.7	**12.7**	0	5	11.4	12.4	12.6	10.1	11.1
	Reach 2	11.2	12.9	**11.8**	0.84	12	11.4	12.0	13.1	11.0	10.9
	Reach 3	10.2	12.3	**11.0**	0.85	21	11.0	10.6	11.3	9.8	11.0
	Reach 4	11.1	11.2	**11.2**	0.09	18	10.5	10.7	10.2	9.6	10.9
	Tribs.	10.5	13.4	**11.7**	1.02	7	10.0	11.3	10.7	10.4	10.0

3.1.2 River Discharge

River discharge varied during each day of sampling as well as between the different months of sampling (Figure 3-1). Discharge tended to peak daily during the mid-morning or late afternoon, with low discharge usually in the early morning hours (12:00 a.m. – 4:00 a.m.). Daily discharges tended to be lower on weekends than on weekdays. Over the three sampling periods, mean daily discharge was lower during the May trip (580 m^3/s) than in July and September. Table 3-2 summarizes mean discharge per trip for each year of the study.

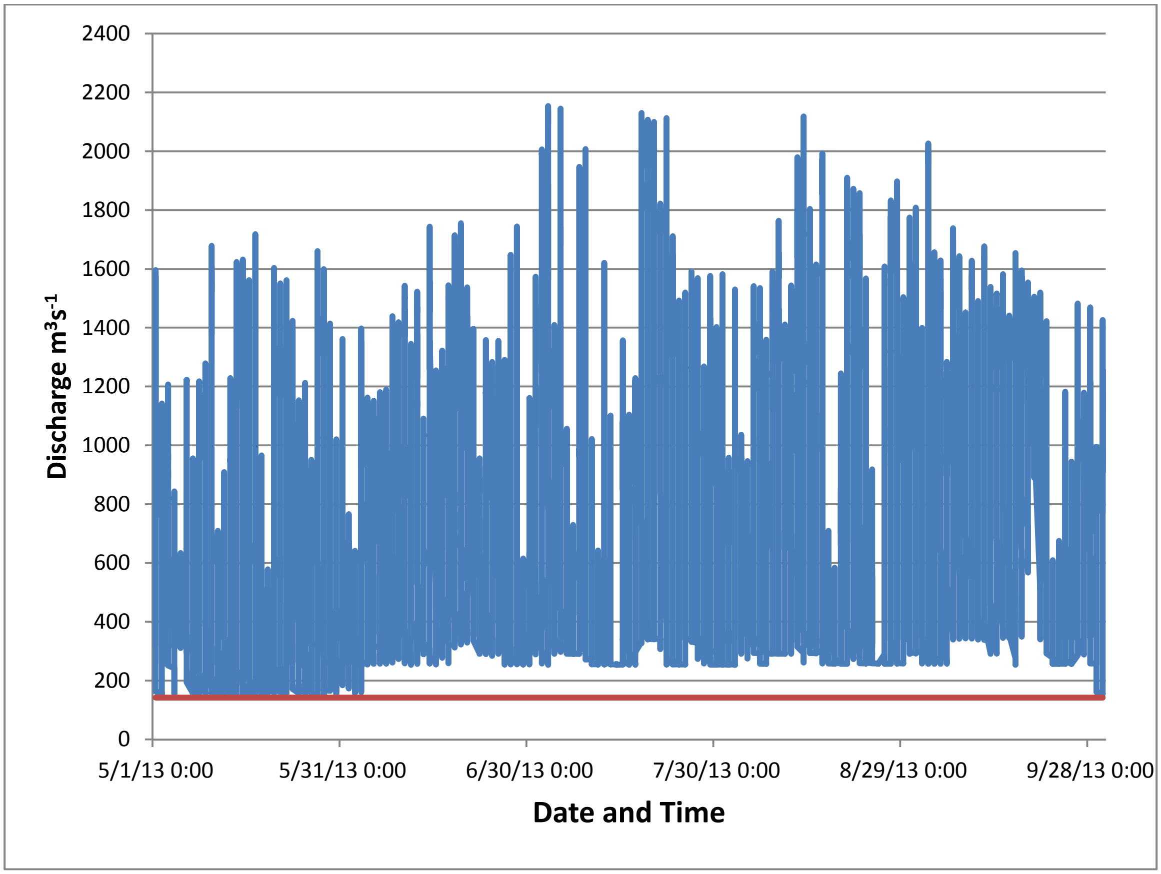

Figure 3-1: Hourly discharge from Revelstoke Dam from May 1, 2013 to September 30, 2013. The red line indicates the minimum flow (142 m^3/s)

Discharge from the Revelstoke Dam during the sampling period in 2013 is summarized in Table 3-2. During the spring sampling (May 28–June 6), river discharge ranged from a high of 1,598 m^3/s at 1:00 p.m. on May 28 to a low of 151 m^3/s at 3:00 a.m. on May 28 (Figure 3-2A). During the summer sampling Trip (July 2–11), river discharge ranged from a high of 2,154 m^3/s at 4:00 p.m. on July 3 to a low of 253 m^3/s at 6:00 a.m. on July 3 (Figure 3-2B). During the fall sampling (September 11 – 18), river discharge ranged from a high of 1,676 m^3/s at 8:00 p.m. on September 11 to a low of 254 m^3/s at 4:00 a.m. on September 16 (Figure 3-2C).

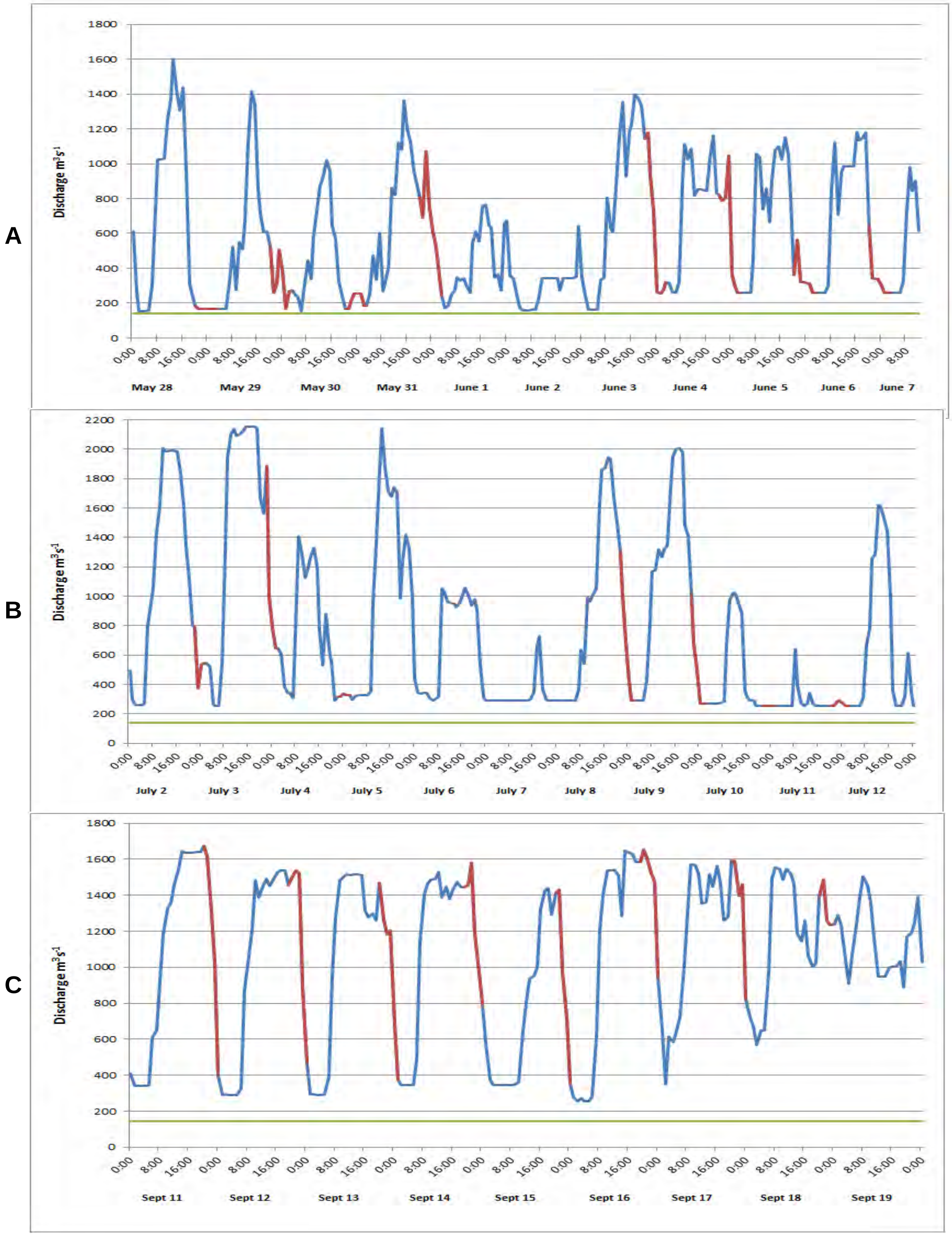

Figure 3-2: Discharge (hourly means) for the Columbia River at the Revelstoke Dam during the three 2013 sampling periods of (A) May 28–June 7, (B) July 2–12, and (C) September 11–19, 2013. The red lines are the daily sampling periods while the green line represents minimum flow (142 m^3s^{-1})

Over the course of the study a wide range of discharges were experienced (Table 3-2). Trip 2 in 2012 had the highest (2215 m^3/s) discharge of the study while a discharge of 0 m^3/s was experienced in Trip 3 in 2008 and 2009 and in Trip 2 of 2009 and 2012. In 2010-2013 mean discharges in the spring tended to be lower than that of the summer and fall trips whereas in 2008 and 2009 it was highest in the spring. Mean discharge pre-Rev 5 tended to be lower in the summer and fall trips but was relatively consistent with post-Rev 5 discharge means in the spring trip.

Table 3-2: Minimum, maximum, mean and standard deviation of river discharge (m^3/s) by trip for Years 1 to 6 (2008-2013) of CLBMON-17.

	Trip 1 (Spring)				Trip 2 (Summer)				Trip 3 (Fall)			
Year	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**
2008	19	1781	**857**	571	19	1786	**507**	421	0	1787	**594**	444
2009	242	1379	**759**	383	0	1458	**650**	429	0	1342	**755**	372
2010	19	1044	**318**	240	21	798	**422**	178	21	1720	**553**	344
2011	23	1339	**580**	450	51	1773	**946**	512	261	1764	**629**	380
2012	153	1551	**845**	448	0	2215	**1239**	736	164	1695	**1031**	424
2013	151	1598	**580**	373	253	2154	**794**	608	254	1676	**1083**	460

3.1.3 TURBIDITY

In general, the tributary sites were more turbid than the mainstem sites, particularly during the spring and summer (May and July) sampling trips, due to increased runoff in those systems. Water clarity was assessed as *clear* at most sites during the three trips (May 96 per cent; July 73 per cent; September 68 per cent). During the May sampling, one site had low turbidity (Reach 1) and two sites were moderately turbid (tributary sites). During the July sampling, clear sites were observed throughout all the Reaches and several of the tributaries while low turbidity sites were found mainly in Big Eddy and Reach 2 sites. Similar to July sampling, during September sampling clear sites were observed throughout all the Reaches and several of the tributaries while low turbidity sites were found mainly in Big Eddy and Reaches 1 and 2 sites. Moderate and Turbid observations were recorded in the Jordan and Illecillewaet Rivers. Overall, turbidity was not considered to have an effect on sampling efficiency and specifically detectability during the course of the study.

3.2 SPECIES ASSEMBLAGE, DIVERSITY AND EVENNESS

In total, 15 different species were captured and observed in the Middle Columbia River during the three sampling trips in 2013 (Figure 3-5). This is one less than in 2012 (n = 16), two less than in 2011, 2010, 2009 (n = 17), and equal to 2008 (n = 15). Similar to 2012 one invasive species was encountered during the 2013 sampling: Yellow Perch (*Perca flavescens*). Brook Trout (*Salvelinus fontinalis*), a non-native species introduced in B.C. in the 1920s (McPhail 2007), was also encountered during the 2013 sampling.

In Reaches 1 and 2, 10 species were captured in May, 8 in July, and 12 in September (Figure 3-5). In Reaches 3 and 4, 11 species were captured in May, 13 in July, and 13 in September. At tributary sites, 6 species were captured in May, 10 in July, and 10 in September (Figure 3-6).

White Sturgeon, Common Carp and Pygmy Whitefish were not encountered in any of the reaches or tributaries during any of the sampling trips in 2013. Along with these species, Longnose Sucker, Tench, and Brook Trout were not encountered in Reaches 1 and 2 during any of the sampling trips which have been caught in these reaches in previous years (eg: 2011). However, historic abundance of these species has been low (i.e., less than 5) during all trips. Yellow Perch were not encountered in Reaches 3 and 4 during any of the sampling trips in 2013 (compared to 2 in 2012, 13 in 2011, 37 in 2010, 1 in 2009 and 53 in 2008). Longnose Sucker, Eastern Brook Trout, Yellow Perch and Tench were not encountered in the tributaries during any of the sampling events in 2013. Low abundances ($n \leq 3$ in any one trip; n = 0 for Tench) have historically been captured in the *downstream* sites of the tributaries in previous years of the study (2008 – 2011).

Comparison of sampling results between riverine (spring trip) and predominantly lacustrine conditions (summer and fall trips) showed that for Reaches 1 and 2 in 2013 Redside Shiners were most abundant species captured during the spring and fall trips while Mountain Whitefish were the most abundant species caught during the summer trip.

In Reaches 3 and 4, sculpins were the most abundant throughout the three trips in 2013. At the tributary sites, Rainbow Trout were dominant in the spring and Sculpins in the summer and fall.

The following are some additional observations:

- Kokanee numbers increased in all reaches in September compared to May and July as a result of spawners making their way to tributaries. Overall, Kokanee numbers in 2013 were the third lowest observed in the six years of the study (2008 = 173; 2012 = 178; **2013 = 257**; 2010 = 631; 2011 = 780; 2009 = 954) and the lowest in terms of CPUE (2011>2009>2010>2008>2012>2013).
- Tench numbers in 2013 equalled the lowest number in the six years of the study - one individual compared to five in 2012, eleven in 2011, four in 2008, and one in both 2009 and 2010.
- As in 2008 and 2012, no Common Carp were captured in 2013, compared to one captured in both 2010 and 2011 and 11 captured in 2009.
- White Sturgeon, though known to occur in the study area, were not captured or observed during any of the sampling trips, which is consistent with the five previous years of the study.
- General trends observed at tributary sites in 2013 were that in Trip 1, more fishes were caught at the *downstream* sites while the reverse trend was seen in Trip 2. In Trip 3, sampling could not be completed at the *upstream* sites of Drimmie, Begbie and Tonkawatla Creeks due to the presence of spawning adult Kokanee. At the Jordan River more fishes were captured at the *upstream* site than the *downstream* site, while the reverse was true at the Illecillewaet River.

Species diversity is one of many descriptors of the assemblage structure of an ecological community and is useful when comparing to similar communities in the ecosystem or the same community through time. However, the relationship between diversity and the productivity of a system or stability of a population, for example, is unclear (Pope and Kruse 2007). Species diversity analysis included:

1. Species richness: the number of different species captured during each trip,
2. Relative abundance: the number of individuals caught per species, and
3. Evenness: the degree of similarity between the relative abundance of different species caught

Using Equations (4) and (5) (Section 2.3) diversity and evenness were calculated for each Reach for all sampling trips in 2013 (Figure 3-3).

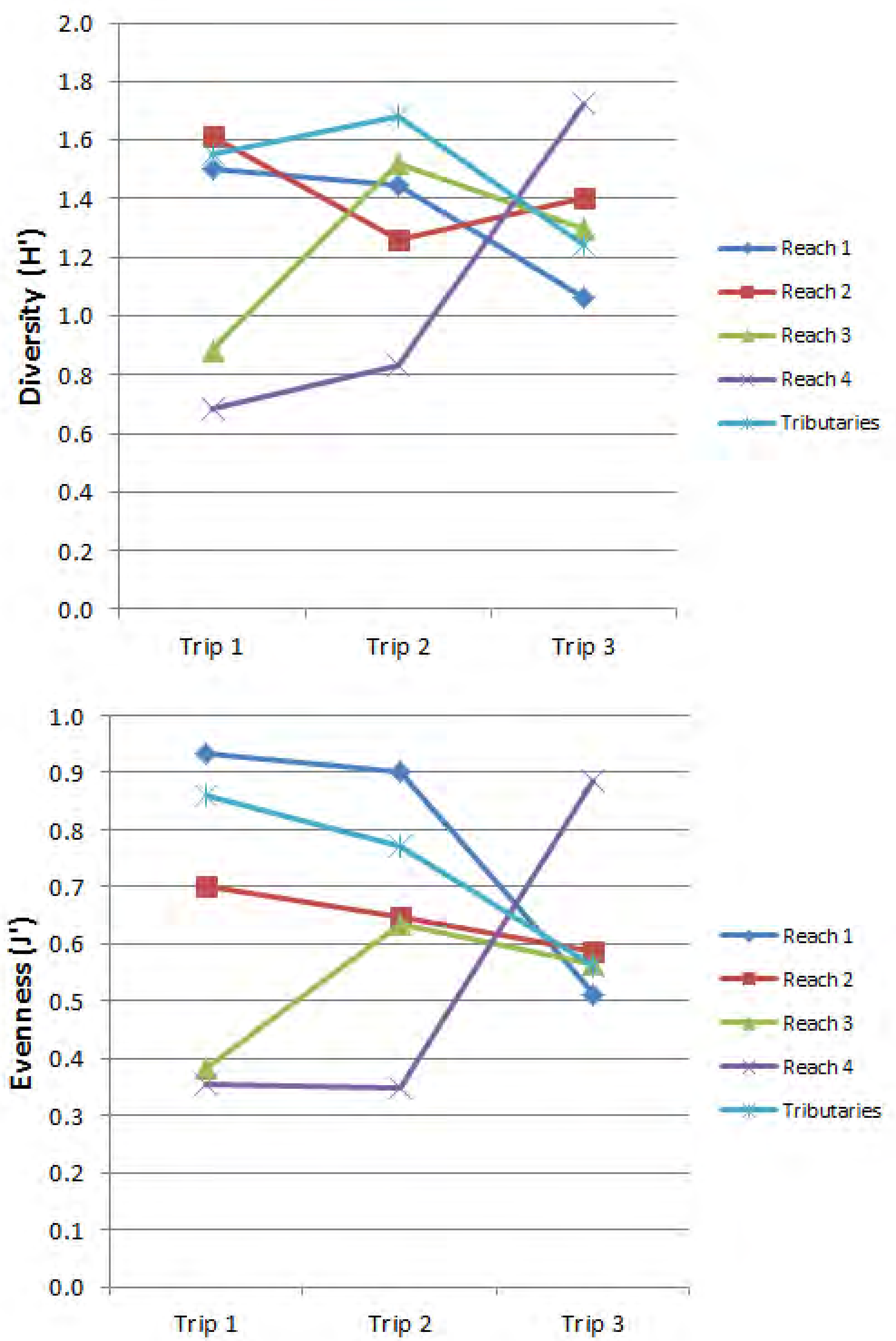

Figure 3-3. Species Diversity and Evenness trends for Year 6 (2013) of CLBMON-17.

In 2013 diversity and evenness generally decreased in Reach 1, 2 and the tributaries over the three trips, while the opposite trend was observed in Reaches 3 and 4. This suggests that while habitats in Reaches 1 and 2 may become less suitable for several species as the MCR in the study area transitioned from riverine (spring) to lacustrine (summer and fall), Reaches 3 and 4 may become more suitable for some species. Reach 3 seemed to have the greatest variability in terms of diversity and evenness which could be related to the widespread change in flow experienced throughout the reach as the MCR transitions from riverine in the spring to lacustrine in the summer and back to riverine in the fall.

Diversity and evenness in Reaches 2, 3 and 4 generally increased from 2008 until 2011 (Reach 4) or 2012 (Reach 2 and 3) before decreasing in 2013. Alternatively, Reach 1 peaked in 2009 before decreasing until 2012 and increasing slightly in 2013.

As species richness was not as variable in the reaches and tributaries, proportional abundance of each species seemed to be the more influential variable in determining the diversity index. For example, the spring and fall trips in Reach 1 in 2011 both had 9 different species captured and observed but diversity was 30% higher in Trip 1 than in Trip 3. This was mainly attributed to the high proportion of Redside Shiner captured in the fall (72 per cent of the catch) compared to the spring (49 per cent of the catch).

Figure 3-4 shows diversity and evenness of the reaches and tributaries through the six years of the study.

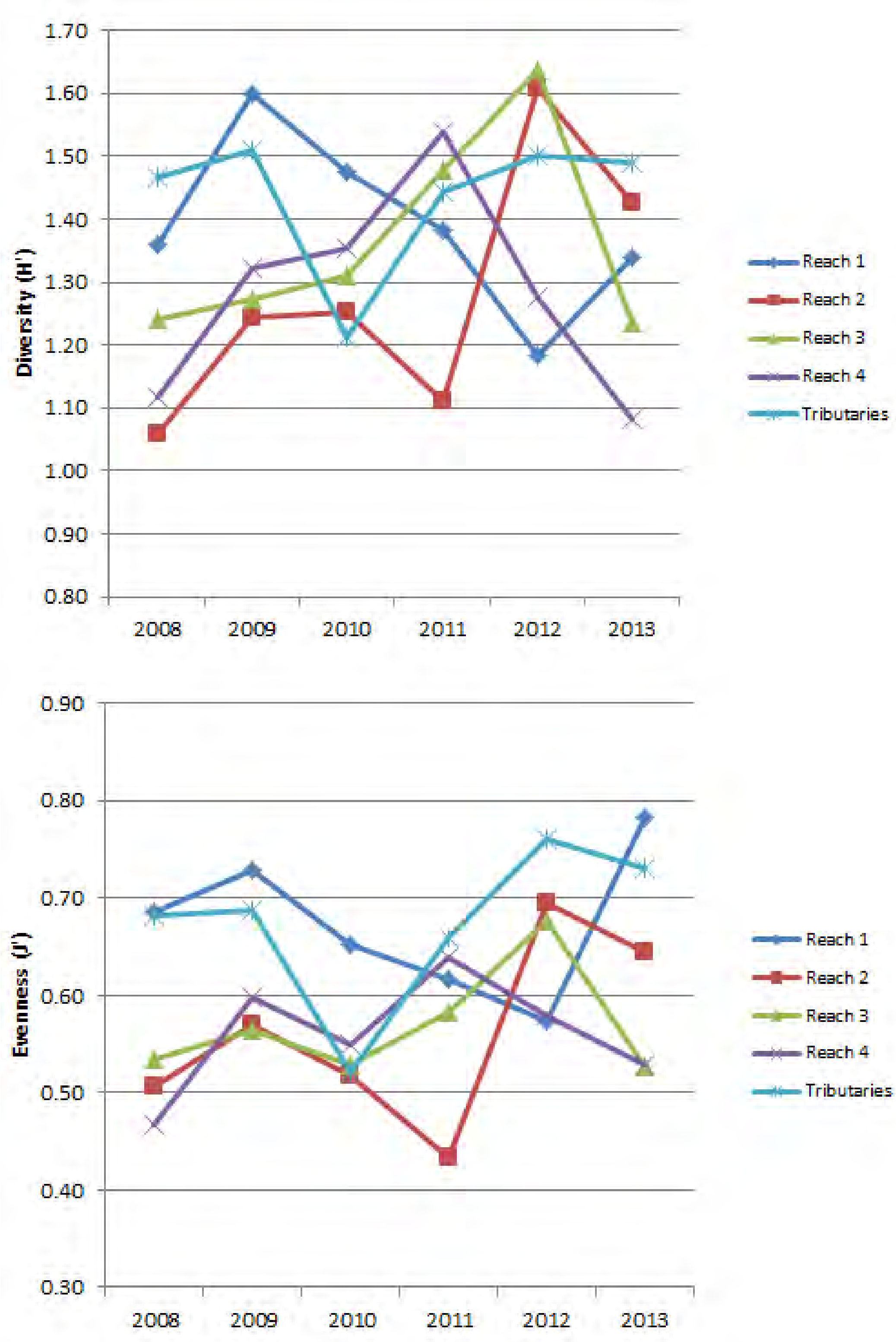

Figure 3-4. Species Diversity and Evenness trends for Year 1 (2008) – Year 6 (2013) of CLBMON-17

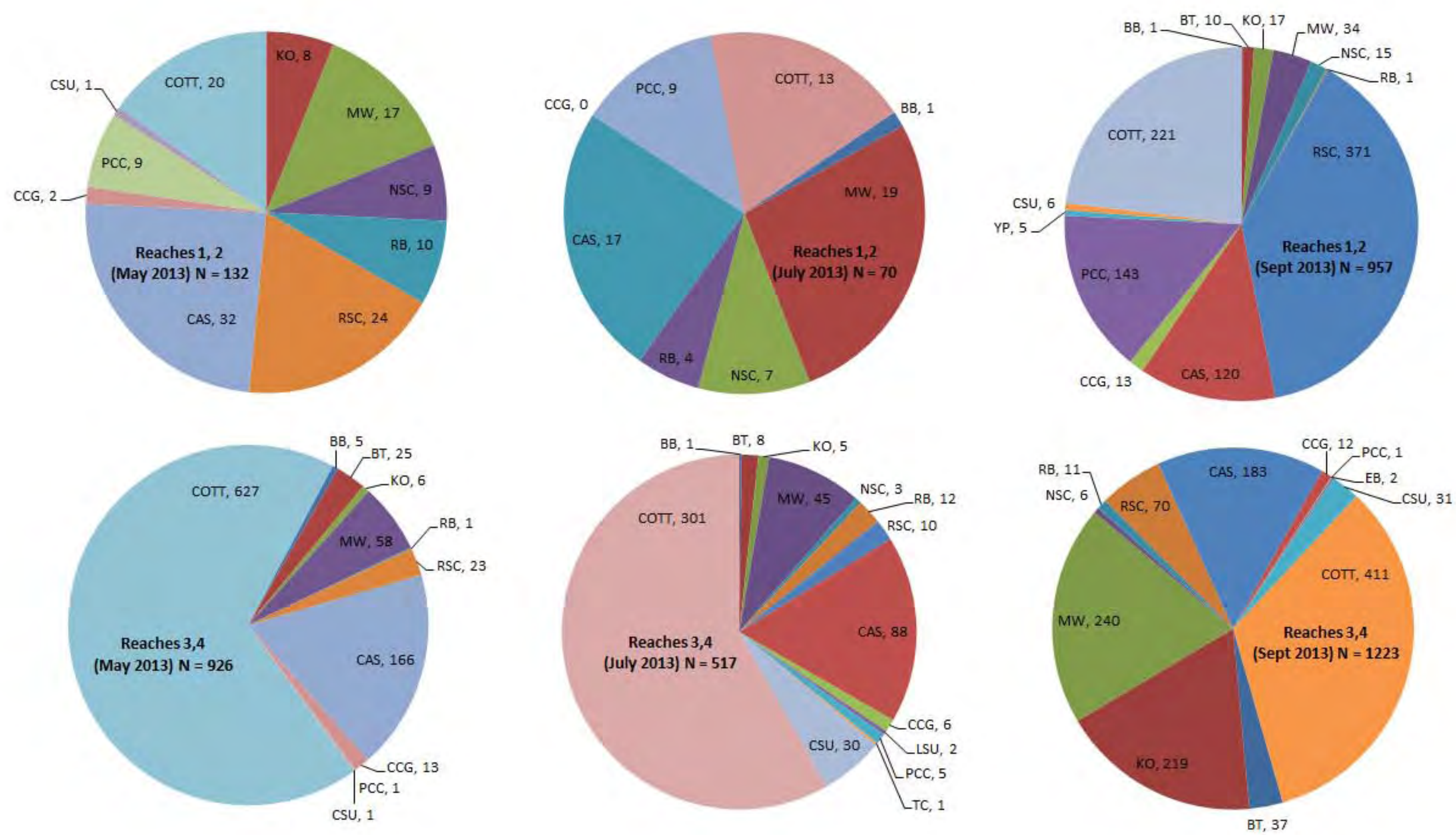

Figure 3-5: Species composition by reach and sampling season (2013). Refer to Table 2-2 for fish species codes. The COTT group is the combination of Prickly, Slimy, and unidentified Sculpin. Reaches 1 and 2 are lacustrine; 3 and 4 are riverine.

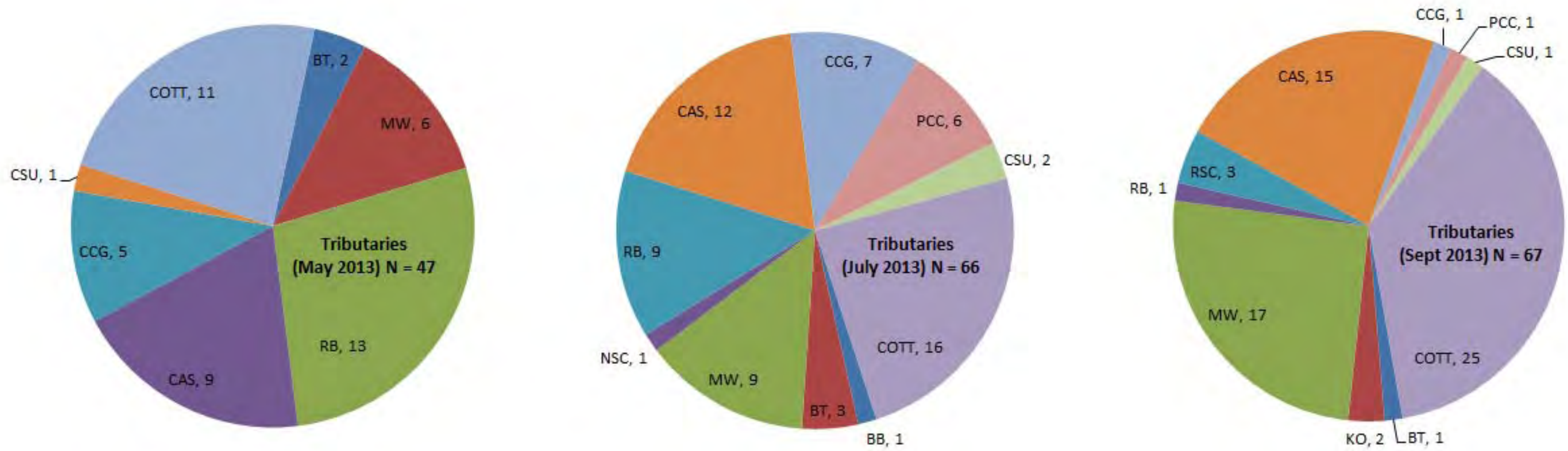

Figure 3-6: Species composition in tributary sites during the three sampling events in 2013. Refer to Table 2-2 for fish species codes. The COTT group is the combination of Prickly, Slimy, and unidentified Sculpin.

3.2.1 SPRING TRIP (MAY/JUNE) 2013

Sampling in Reaches 1 and 2 resulted in the capture and observations of a total of 132 individuals of 10 species[1] (Figure 3-5). Sampling in Reaches 3 and 4, which are most influenced by dam-operation, resulted in the capture and observation of 926 individuals of 10 species.

A difference in the mean number of fishes per site in Trip 1 in 2013 was suggested by the significant results of the ANOVA (ANOVA:$F = 2.52$, df = 4, $p = 0.04996$). However the Tukey test revealed no significantly different pairwise comparisons (Tukey: *p*-values ranged from 0.11 to 1.0 among all interactions). The greatest catch ($n = 73$) was at site 29 in Reach 3 with Sculpin General being the most abundant ($n = 60$). Fish were not captured or observed at three sites during the spring trip: site 25 in Reach 3 and site 13 in Reach 4 while three sites (site 53 in Reach 1 and sites 49 and 50 in Reach 2) were not sampled due to inundation by high ALR elevation.

Table 3-3: Mean, maximum, and minimum number of fishes caught per site by Reach, May/June 2013.

	Significance[1]	Mean	Max	Min	SD	Number of Sites
Reach 1	A	7.8	13	3	5.0	4
Reach 2	A	10.1	23	2	5.9	10
Reach 3	A	16.2	73	0	20.2	21
Reach 4	A	23.4	56	0	17.3	25
Tributaries	A	6.7	14	1	5.5	7

[1] Reaches with different letters were significantly different from one another. Pair-wise comparisons completed using the Tukey test.

[1] To avoid "double-counting", *Cottus* was not included in the total number of different species caught and observed (in Reaches within a Trip) if both Prickly and Slimy Sculpin were captured. This also avoids overestimating Diversity and underestimating Evenness when carrying out these respective calculations. However, *Cottus* numbers were included in the relative abundance proportion.

3.2.2 SUMMER TRIP (JULY) 2013

Sampling in Reaches 1 and 2 resulted in the capture of 70 individuals of seven species (Figure 3-4). Mountain Whitefish was the most abundant species (27 per cent relative abundance), followed by Prickly Sculpin (24 per cent) and Sculpin General (19 per cent). The remaining 30 per cent included Peamouth Chub (12), Northern Pikeminnow (10), Rainbow Trout (5), Burbot and Slimy Sculpin at 1.5 per cent each. Sampling in Reaches 3 and 4 resulted in the capture of 517 individuals of 12 species. Sculpin General were dominant (58 per cent relative abundance) followed by Prickly Sculpin (17 per cent, Mountain Whitefish (9 per cent) and Largescale Sucker (6 per cent). The remaining 10 per cent was comprised of Rainbow Trout, Redside Shiner and Bull Trout (together comprising 6 per cent) and Kokanee, Slimy Sculpin, Peamouth Chub, Northern Pikeminnow, Longnose Sucker, Burbot and Tench together comprising 4 per cent. Sampling in the tributaries resulted in the capture of 66 individuals of 9 species. Sculpin General was dominant (24 per cent relative abundance) followed by Prickly Sculpin (18 per cent), Rainbow Trout and Mountain Whitefish (both at 14 per cent). The remaining 30 per cent were represented by Slimy Sculpin (11), Peamouth Chub (9), Bull Trout (5), Largescale Sucker (3), Burbot and Northern Pikeminnow (combined 3 per cent) (Figure 3-6).

The mean number of fishes captured was marginally higher in Reach 4 than in Reach 3 but the difference was not significant (ANOVA: $F = 2.09$, df = 4, $p = 0.09$; Tukey: $p = 0.088$). No other significant differences were detected (Table 3-4). The greatest number of fishes captured and observed ($n = 58$) was at site 11 in Reach 4 with Sculpin General being most abundant ($n = 47$). Fish were not captured at five sites: sites 52 and 43 in Reaches 1 and 2 and sites 5, 6 and Biased 2 in Reach 4. Additionally, four mainstem sites and one tributary site were not sampled due to inundation by the ALR: sites 43, 45, 49 and 50 in Reach 2 and Drimmie Creek "*downstream*" site.

Table 3-4: Mean, maximum, and minimum number of fishes caught per site for sites sampled in July 2013, by Reach

	Significance[1]	Mean	Max	Min	SD	Number of Sites
Reach 1	A	7.0	10	3	3.6	3
Reach 2	A	7.0	21	0	7.1	7
Reach 3	A	6.5	26	1	6.7	21
Reach 4	A	15.2	58	0	16.2	25
Tributaries	A	7.3	17	3	5.1	9

[1] Reaches with different letters were significantly different from one another. Pair-wise comparisons completed using the Tukey test.

3.2.3 Fall Trip (September) 2013

Sampling in Reaches 1 and 2 resulted in the capture and observation of 957 individuals of 12 species (Figure 3-5). Redside Shiners were the dominant species (39 per cent relative abundance), followed by Sculpin General (23 per cent), Peamouth Chub (15 per cent) and Prickly Sculpin (13 per cent). The remaining 10 per cent were represented by Mountain Whitefish (4), Kokanee (2), Northern Pikeminnow (2), and Bull Trout, Largescale Sucker, Yellow Perch, Rainbow Trout and Burbot (combined 2 per cent). Sampling in Reaches 3 and 4 resulted in the capture and observation of 1223 individuals representing 11 different species. Sculpin General was dominant at 36 per cent relative abundance followed by Mountain Whitefish (20 per cent), Kokanee (18 per cent) and Prickly Sculpin (15 per cent). The remaining 11 per cent consisted of Redside Shiner (6) and Bull Trout (3) with Largescale Sucker, Slimy Sculpin, Rainbow Trout, Northern Pikeminnow, Eastern Brook Trout and Peamouth Chub comprising 2 per cent. Sampling in the tributaries resulted in the capture and observation of 67 individuals of 9 species (Figure 3-6). Sculpin General was dominant at 37 per cent relative abundance followed by Mountain Whitefish (25 per cent) Prickly Sculpin (22 per cent). The remaining 16 per cent was comprised of Redside Shiner (4.5), Kokanee (3) Bull Trout, Rainbow Trout, Slimy Sculpin, Peamouth Chub and Largescale Sucker representing 8.5 per cent.

In the fall, the mean number of fishes captured and observed was significantly higher in Reach 2 than Reach 4, Reach 3 and the tributaries (ANOVA: F = 5.88, df = 4, p =

0.0004; Tukey: p = 0.0006, p = 0.018 and p = 0.002). No other significant differences were detected (Table 3-4). The greatest number of fishes captured per site in September was at site 43 in Reach 2 (n = 175), with Peamouth Chub being the most abundant (n = 125). Fish were not captured at three sites: site 24 in Reach 3, Begbie "*downstream*" and Jordan "*downstream*". As well, three tributary sites were not sampled due to the presence of spawning adult Kokanee: the "*upstream*" sites of Drimmie, Begbie and Tonkawatla Creeks.

Table 3-5: Mean, maximum, and minimum number of fishes caught per site for sites sampled in September 2013, by Reach

	Significance[1]	Mean	Max	Min	SD	Number of Sites
Reach 1	A/B	42.2	112	5	42.7	5
Reach 2	B	62.2	175	9	50.8	12
Reach 3	A	30.7	76	0	19.6	23[2]
Reach 4	A	20.7	59	1	16.9	25
Tributaries	A	9.6	31	0	10.7	7

[1] Reaches with different letters were significantly different from one another. Pair-wise comparisons completed using a Tukey test.
[2] Includes the two Masse Sites

3.2.4 RELATIVE ABUNDANCE WITHIN REACHES BETWEEN TRIPS IN 2013

There was no significant difference in the mean number of fishes per site between any of the three trips in Reach 1 (ANOVA: $F = 2.15$, df = 2, $p = 0.17$). A significant difference was observed in Reach 2 with the fall trip having greater mean number of fish per site than both the spring and summer trips (ANOVA: $F = 8.98$, df = 2, $p = 0.001$; Tukey: $p = 0.003$ and $p = 0.005$, respectively). A significant difference was observed in Reach 3 (ANOVA: $F = 11.53$, df = 2, $p < 0.001$) with the fall trip having greater mean number of fish per site than the spring and summer trips (Tukey: $p = 0.016$ and $p < 0.0001$, respectively). No difference was detected between spring and summer (Tukey: p = 0.16). No significant difference was observed in Reach 4 (ANOVA: $F = 1.55$, df = 2, $p = 0.22$) or the tributaries in 2013 (ANOVA: $F = 0.30$, df = 2, $p = 0.75$).

3.2.5 RELATIVE ABUNDANCE IN EACH REACH BETWEEN YEARS

Table 3-6 summarizes the mean, maximum, minimum and standard deviation of the number of fish captured and observed per site for each reach for 2008 – 2013 while the means for each reach were plotted against study year (Figure 3-7). Variation between Reach abundances was greatest in 2009 and 2011. General trends showed an increase in the mean number of fish caught and observed from 2008 to 2010 in Reaches 3, 4 and the tributaries followed by a general decrease in their respective means in 2011 and 2012 with what may be a recovery in 2013. Reach 1 mean number of fish caught and observed generally increased from 2008 to 2011 before decreasing in 2012 to 2013. Reach 2 was more dissimilar compared to the other reaches, increasing to a study-high in 2009 then generally decreasing through 2013.

Mean number of fish captured in Reach 2 in 2009 was greater than in 2008 and 2012 (ANOVA: $F = 4.95$, df = 5, $p = 0.0002$; Tukey: $p = 0.005$ and $p = 0.004$, respectively). Mean number of fish captured per site in Reach 2 was also greater in 2011 compared to 2008 and 2012 (ANOVA: $F = 4.95$, df = 5, $p = 0.0002$; Tukey: $p = 0.038$ and $p = 0.033$, respectively). No other significant differences for Reach 2 were detected.

For Reach 3 mean number of fish captured per site was higher in 2009 than in 2008, 2012 and 2013 (ANOVA: $F = 12.70$, df = 5, $p < 0.0001$; Tukey: $p = 0.002$, $p = 0.0001$ and $p = 0.0001$, respectively). As well for Reach 3 mean number of fish captured per site was higher in 2010 than in 2008, 2011, 2012 and 2013 (ANOVA: $F = 12.70$, df = 5, $p < 0.0001$; Tukey: $p < 0.0001$, $p = 0.0015$, $p < 0.0001$ and $p < 0.0001$, respectively). No additional significant differences were detected for Reach 3.

For Reach 4 mean number of fish captured per site was higher in 2010 than all other years of the study (2008 – 2013: ANOVA: $F = 12.12$, df = 5, $p < 0.0001$; Tukey: $p < 0.0001$, $p = 0.0003$, $p < 0.0001$, $p < 0.0001$ and $p < 0.0001$, respectively). Additionally, mean number of fish captured per site in 2009 was greater than in 2012 (ANOVA: $F = 12.12$, df = 5, $p < 0.0001$; Tukey: $p = 0.037$). No other significant differences were detected for Reach 4.

Lastly, mean number of fish captured per site in tributaries was greater in 2010 than in 2008, 2011, 2012 and 2013 (ANOVA: $F = 4.08$, df = 5, $p = 0.002$; Tukey: $p = 0.011$, $p = 0.005$, $p = 0.003$ and $p = 0.006$, respectively). Mean number of fish captured per site in 2010 was marginally higher than in 2009 as well (ANOVA: $F = 4.08$, df = 5, $p = 0.002$; Tukey: $p = 0.06$). No other significant differences were detected.

Table 3-6: Mean, maximum, minimum and standard deviation of fish captured and observed per site per reach for 2008 – 2013.

		Reach 1	Reach 2	Reach 3	Reach 4	Tributaries
2008	Mean	**20.5**	**17.1**	**22.1**	**22.5**	**12.7**
	Max	51	69	112	83	97
	Min	3	1	0	0	0
	SD	15.7	18.3	26.6	19.3	19.9
2009	Mean	**41.9**	**60.7**	**46.0**	**27.3**	**19.9**
	Max	81	285	264	112	184
	Min	16	4	0	0	0
	SD	23.7	64.8	58.2	27.1	34.2
2010	Mean	**45.1**	**47.4**	**55.0**	**47.3**	**57.7**
	Max	105	131	149	308	436
	Min	17	7	0	1	1
	SD	29.2	32.9	37.4	47.8	114.7
2011	Mean	**61.9**	**52.5**	**30.8**	**25.6**	**9.5**
	Max	293	258	133	117	58
	Min	8	3	0	0	0
	SD	78.7	60.9	31.0	24.9	10.9
2012	Mean	**24.0**	**17.2**	**17.8**	**12.9**	**7.3**
	Max	91	96	82	95	20
	Min	0	3	0	0	0
	SD	28.6	18.8	20.1	19.5	5.7
2013	Mean	**21.9**	**30.9**	**18.2**	**19.9**	**7.8**
	Max	112	175	76	59	31
	Min	3	0	0	0	0
	SD	31.5	41.9	19.4	17.0	7.1

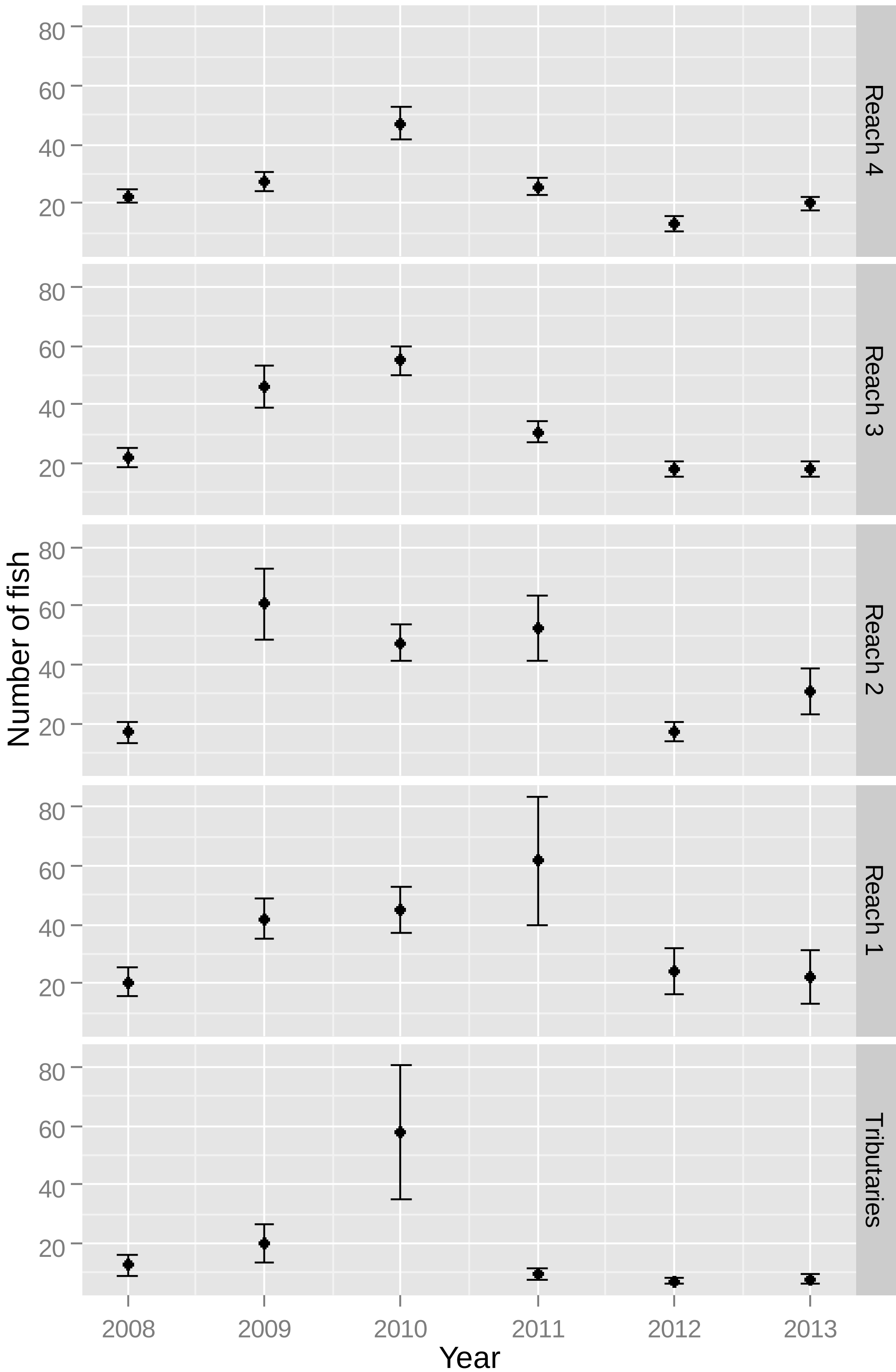

Figure 3-7: Mean number of fish captured per site for each reach for 2008 – 2013 of CLBMON-17. Error bars are ± SD.

3.3 MORPHOMETRICS

Length and weight data for all captured fishes are provided in the project database (Attachment 1). Summaries for Rainbow Trout, Bull Trout, Mountain Whitefish, Kokanee, Prickly Sculpin, Redside Shiner and Largescale Sucker are provided in subsequent sections.

3.3.1 RAINBOW TROUT

In 2013, data on length and weight were collected from 60 Rainbow Trout (38 from mainstem sites, 22 from tributaries) which ranged in length from 59 to 460 mm. The majority of Rainbow Trout captured were considered juveniles (n = 52, 87%: 30 from mainstem sites and 22 from tributaries including 21 weighed and measured and 1 visual observation). The trend lines were similar between all years (Figure 3-8). This suggests relatively consistent growing conditions for Rainbow Trout in the system since 2008.

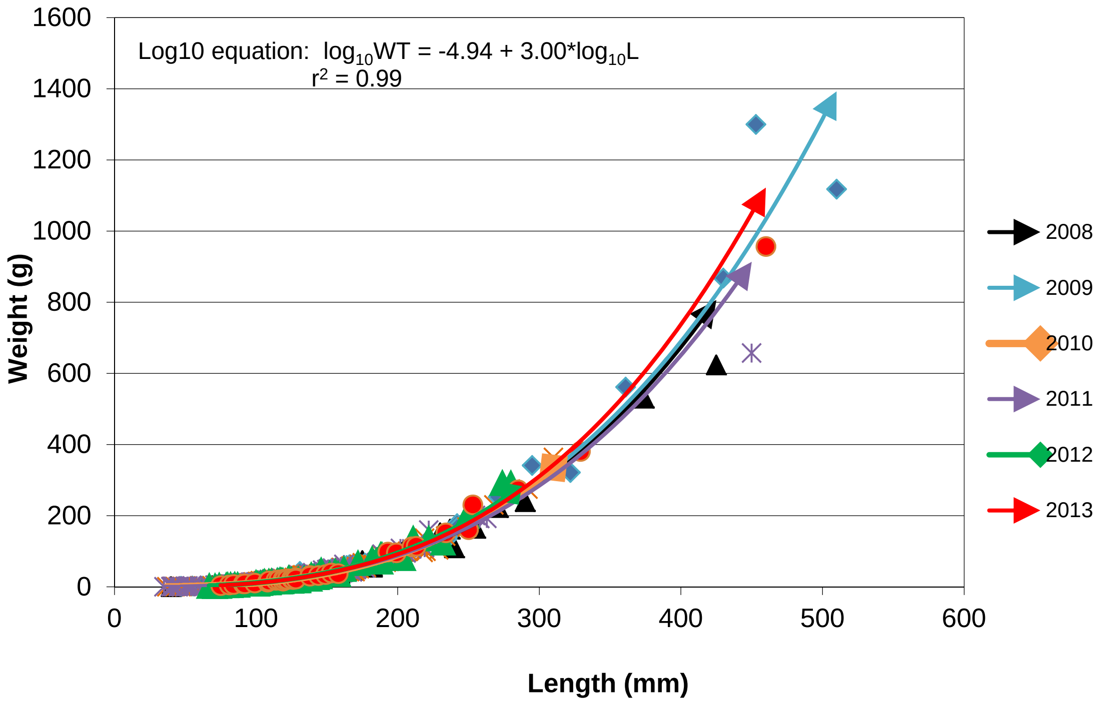

Figure 3-8: Weight–length regression for all Rainbow Trout captured in the mainstem during the 2013 field program (*N* = 38). The 2008 to 2012 weight–length regression data and trend lines are plotted for comparison.

Condition factors for juvenile Rainbow Trout captured in 2013 in the mainstem ranged from 0.94 to 1.37, with an overall mean of 1.15 (SD = 0.11, n = 30) for the three sampling trips (Table 3-7). For tributary sites, condition factors for captured juvenile Rainbow Trout ranged from 1.24 to 1.49, with a mean of 1.33 (SD = 0.15, n = 21) for the three sampling trips. Barnham and Baxter (1998) proposed a grading scale for fish condition factor in which a value of 1.2 suggests "a fair fish, acceptable to many anglers", whereas a value of 1.4 suggests "a good, well-proportioned fish". Values less than 1.0 are considered "poor" and are characterized by long, skinny bodies. Based on this scale, collectively, juvenile Rainbow Trout condition in the Middle Columbia River is considered to be fair to good, suggesting that the fish are well-proportioned in terms of length and weight. Across the six years of the study no reach was found to have a consistently higher condition factor. This suggests suitable juvenile rearing for Rainbow Trout exists throughout the reaches. Rainbow Trout tributaries condition factors tended to be consistently at the higher end of what was observed in the mainstem reaches. This may suggest that rearing habitat value is better in the tributaries than the mainstem for juvenile Rainbow Trout.

Table 3-7. Summary of Condition Factor (K) for Juvenile Rainbow Trout for Year 1 through Year 6 (2008 to 2013).

		2008	**2009**	**2010**	**2011**	**2012**	**2013**
Reach 1	Mean	1.12	1.29	1.04	1.12	1.07	1.11
	Min	1.04	0.97	0.97	0.97	0.94	1.08
	Max	1.23	1.76	1.18	1.26	1.18	1.17
	SD	0.07	0.21	0.07	0.10	0.09	0.05
	n	6	16	8	8	5	3
Reach 2	Mean	1.10	1.18	1.07	1.24	1.25	1.15
	Min	0.95	0.91	0.80	0.94	1.00	0.94
	Max	1.27	1.61	1.35	2.54	1.56	1.28
	SD	0.10	0.18	0.12	0.26	0.19	0.12
	n	16	26	75	44	7	9
Reach 3	Mean	1.14	1.24	1.18	1.22	1.18	1.17
	Min	0.91	0.99	0.82	0.82	0.93	0.95
	Max	1.38	1.61	1.58	1.57	1.43	1.37
	SD	0.12	0.17	0.16	0.17	0.15	0.11
	n	38	35	143	99	38	17
	Mean	1.12	1.27	1.17	1.10	1.20	1.09

		2008	2009	2010	2011	2012	2013
Reach 4	Min	0.77	0.94	0.87	0.88	1.1	1.09
	Max	1.37	1.94	1.45	1.47	1.3	1.09
	SD	0.15	0.24	0.16	0.18	0.1	n/a
	n	18	25	55	22	5	1
Tributaries	Mean	1.12	1.27	1.11	1.25	1.20	1.27
	Min	0.92	0.65	0.84	0.88	0.9	1.12
	Max	1.53	1.75	1.49	2.07	1.3	1.49
	SD	0.13	0.26	0.14	0.21	0.1	0.08
	n	30	46	92	59	9	21

[A]NFC – No Juvenile Fish Captured

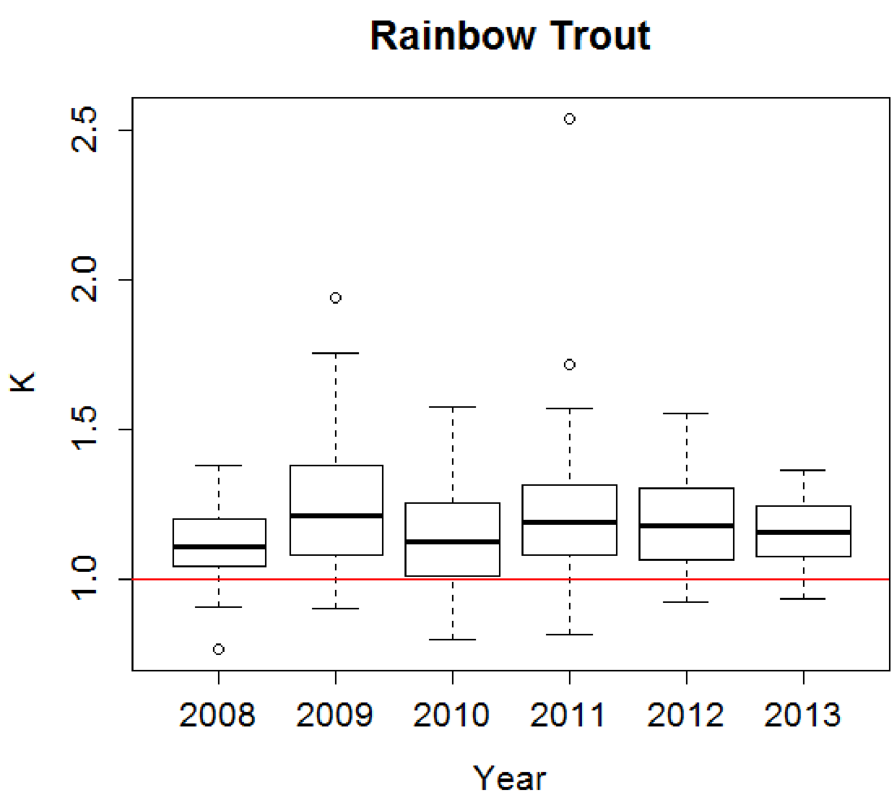

Figure 3-9. Boxplot of condition factor (K) of juvenile Rainbow Trout captured in the Middle Columbia River by Year (2008: n=78; 2009: n=102; 2010: n=281; 2011: n=173; 2012: n=55; 2013: n=30). K values below the red line denote "poor" fish condition.

Condition factor of juvenile Rainbow Trout was significantly greater in 2009 than in both 2008 and 2010 (ANOVA: $F = 7.78$, df = 5, $p < 0.0001$; Tukey: $p < 0.0001$ for both). Similarly, condition factor was significantly greater in 2011 than in both 2008 and 2010 (ANOVA: $F = 7.78$, df = 5, $p < 0.0001$; Tukey: $p = 0.008$ and $p = 0.002$). These results could suggest more favourable rearing conditions occurred in 2009 and 2011, or less favourable conditions occurred in 2008 and 2010. However, despite the significant difference Figure 3-9 shows relatively consistent condition factors over the years and does not show any trend that condition factor is changing in the system.

3.3.2 BULL TROUT

In 2013, data on length and weight were collected from 72 Bull Trout[2]. Of the 69 weighed and measured, 64 were from mainstem sites and 5 from tributaries. Lengths ranged from 36 to 710 mm. Forty seven per cent of Bull Trout captured were considered juveniles (n = 34; 30 from mainstem sites (28 weighed and measured) and 4 from tributaries). Figure 3-10 shows the length weight regression for juvenile Bull Trout captured in the Middle Columbia River mainstem in 2013. The regression lines for the 2008–2012 data are included for comparison. The plot shows similar trend lines between all years. This suggests relatively consistent growing conditions for Bull Trout in the system since 2008.

[2] There were 3 BT caught and their length measured but no weight recorded; 121mm, 127mm and 710mm, FL.

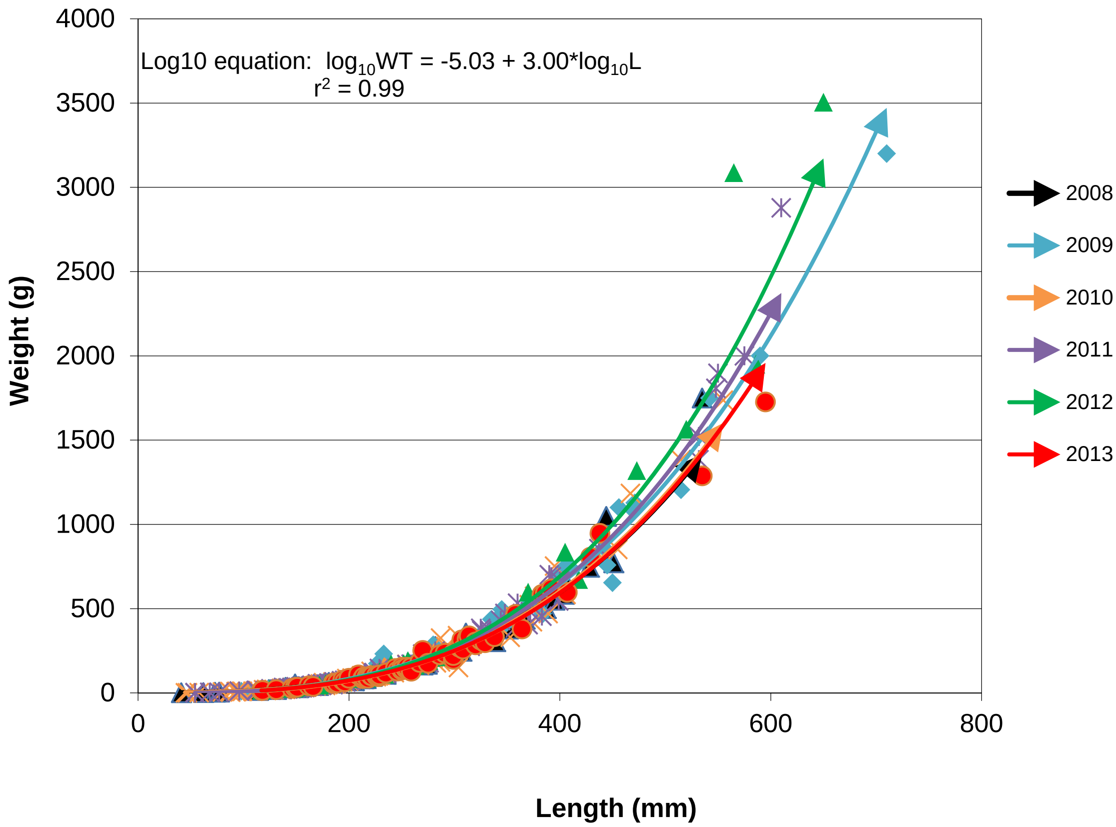

Figure 3-10: Weight–length regression for all Bull Trout captured in the mainstem during the 2013 field program (*N* = 69). The 2008 to 2012 weight–length regression data and trend lines are plotted for comparison.

Condition factors for juvenile Bull Trout captured in 2013 in the mainstem ranged from 0.82 to 1.18, with an overall mean of 0.93 (SD = 0.08, n = 28) for the three sampling Trips (Table 3-6). For tributary sites, condition factors for captured juvenile Bull Trout ranged from 0.81 to 1.10, with a mean of 0.92 (SD = 0.14, n = 4) for the three sampling Trips. Individuals captured in 2013 were therefore considered to be of fair condition, suggesting that the fish are adequately-proportioned in terms of length and weight. Similar to previous years of the study, condition factors of juvenile Bull Trout tended to be somewhat higher with closer proximity to the Dam (Figure 3-11). This suggests higher value rearing habitat for juvenile Bull Trout in the riverine reaches than the reservoir reaches.

Table 3-8. Summary of Condition Factor (K) for juvenile Bull Trout for Year 1 through Year 6 (2008 to 2013).

		2008	2009	2010	2011	2012	2013
Reach 1	Mean	1.60	1.05	0.84	0.86	0.95	NFC[A]
	Min	1.60	0.91	0.79	0.86	0.89	
	Max	1.60	1.18	0.89	0.86	1.01	
	SD	n/a	0.19	0.07	n/a	0.08	
	n	2	2	2	1	2	
Reach 2	Mean	0.90	0.99	0.85	0.94	0.97	0.87
	Min	0.87	0.99	0.81	0.50	0.88	0.87
	Max	0.92	0.99	0.91	1.26	1.05	0.87
	SD	0.03	n/a	0.05	0.21	0.08	n/a
	n	2	1	3	13	5	1
Reach 3	Mean	1.00	1.09	0.96	0.97	0.99	0.94
	Min	0.82	0.87	0.75	0.83	0.85	0.86
	Max	1.22	1.83	1.32	1.23	1.20	1.09
	SD	0.12	0.17	0.12	0.11	0.13	0.07
	n	14	34	37	26	7	12
Reach 4	Mean	0.89	1.15	0.95	0.96	0.99	0.93
	Min	0.85	0.86	0.78	0.83	0.86	0.82
	Max	0.94	1.49	1.14	1.21	1.24	1.18
	SD	0.03	0.23	0.09	0.10	0.12	0.09
	n	6	6	40	21	8	15
Tributaries	Mean	NFC[A]	1.14	0.95	1.02	0.96	0.99
	Min		0.81	0.81	0.80	0.85	0.87
	Max		1.45	1.08	1.29	1.17	1.17
	SD		0.19	0.10	0.15	0.11	0.14
	n		17	16	12	8	4

[A]NFC – No Juvenile Fish Captured

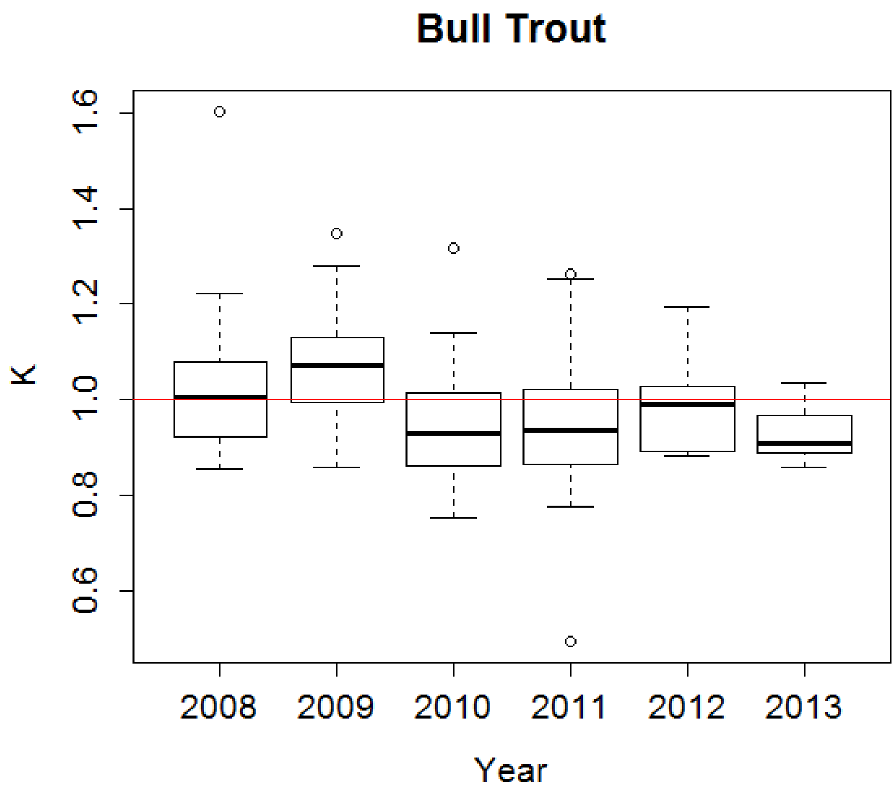

Figure 3-11. Boxplot of condition factor (K) of juvenile Bull Trout captured in the Middle Columbia River mainstem by Year (2008: n=16; 2009: n=37; 2010: n=58; 2011: n=51; 2012: n=14; 2013: n=28). K values below the red line denote "poor" fish condition.

Condition factor of juvenile Bull Trout was significantly greater in 2009 than in 2010, 2011 and 2013 (ANOVA: F = 6.00, df = 5, p < 0.0001; Tukey: p = 0.0001, p = 0.0007 and p = 0.009, respectively). No other significant differences were detected. A similar trend was observed with Rainbow Trout with 2009 showing higher condition factor and 2010 being low. However Rainbow Trout also showed increased condition factor in 2011, which was not observed in Bull Trout. Results from 2010 to 2013 for Bull Trout are relatively consistent and no overall trends were observed that suggest rearing conditions are changing in the system.

3.3.3 MOUNTAIN WHITEFISH

In 2013, data on length and weight were collected from 353 Mountain Whitefish (326 in the mainstem and 27 in tributaries), which ranged in length from 39 to 345 mm. Forty seven per cent of the individuals captured in 2013 were considered juveniles (n = 165: 152 in the mainstem, 13 in tributaries). Figure 3-12 shows the weight to length regression for all Mountain Whitefish captured in the Middle Columbia River mainstem in 2013. The regression lines for the 2008–2012 data are included for comparison. The plot shows similar trend lines between all years. This suggests relatively consistent growing conditions for Mountain Whitefish in the system since 2008.

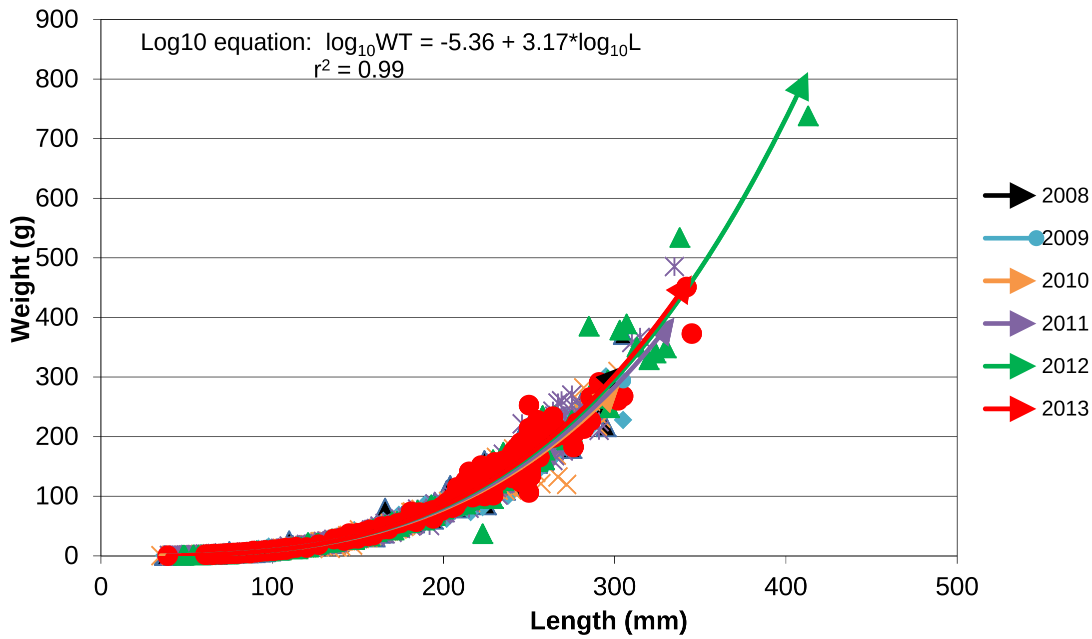

Figure 3-12: Weight–length regression for Mountain Whitefish captured in the mainstem during the 2013 field program (*N* = 326). The 2008 to 2012 weight–length regression data and trend lines are plotted for comparison.

Condition factors for juvenile Mountain Whitefish captured in 2013 in the mainstem ranged from 0.64 to 1.25, with an overall mean of 0.95 (SD = 0.10, n = 152) for the three sampling Trips (Table 3-7). For tributary sites, condition factors for captured juvenile Mountain Whitefish ranged from 0.81 to 1.10, with a mean of 0.92 (SD = 0.09, n = 13) for the three sampling Trips. Individuals captured in 2013 were considered to be of fair condition in terms of length and weight. Similar to previous sampling years, condition factors of juvenile Mountain Whitefish tended to be somewhat higher with closer proximity to the Dam. This may suggest higher value rearing habitat for juvenile Mountain Whitefish in the riverine reaches and tributaries than the reservoir reaches.

Table 3-9. Summary of Condition Factor (K) for juvenile Mountain Whitefish for Year 1 through Year 6 (2008 to 2013).

		2008	2009	2010	2011	2012	2013
Reach 1	Mean	0.95	0.98	0.91	0.86	0.97	0.86
	Min	0.60	0.77	0.73	0.48	0.69	0.64
	Max	1.73	1.44	1.19	1.28	1.26	1.04
	SD	0.20	0.14	0.11	0.13	0.15	0.14
	n	28	25	44	78	23	7
Reach 2	Mean	0.89	0.91	0.89	0.96	0.90	0.90
	Min	0.71	0.32	0.66	0.67	0.76	0.73
	Max	1.91	1.29	1.13	1.33	1.06	1.03
	SD	0.21	0.14	0.09	0.14	0.09	0.07
	n	36	120	75	43	25	23
Reach 3	Mean	0.98	1.01	0.93	0.96	0.99	0.94
	Min	0.78	0.69	0.74	0.56	0.83	0.77
	Max	1.75	1.63	1.26	1.69	1.18	1.17
	SD	0.21	0.14	0.08	0.14	0.08	0.09
	n	20	201	158	157	60	82
Reach 4	Mean	0.92	0.95	0.93	0.98	1.04	1.01
	Min	0.71	0.44	0.52	0.72	0.92	0.79
	Max	1.09	1.50	1.22	1.20	1.21	1.25
	SD	0.12	0.17	0.11	0.08	0.08	0.10
	n	33	67	146	115	32	40
Tributaries	Mean	0.87	1.04	0.95	1.01	1.08	0.92
	Min	0.64	0.78	0.67	0.85	1.01	0.81
	Max	1.09	1.38	1.18	1.16	1.17	1.10
	SD	0.11	0.13	0.11	0.08	0.05	0.09
	n	39	44	83	15	11	13

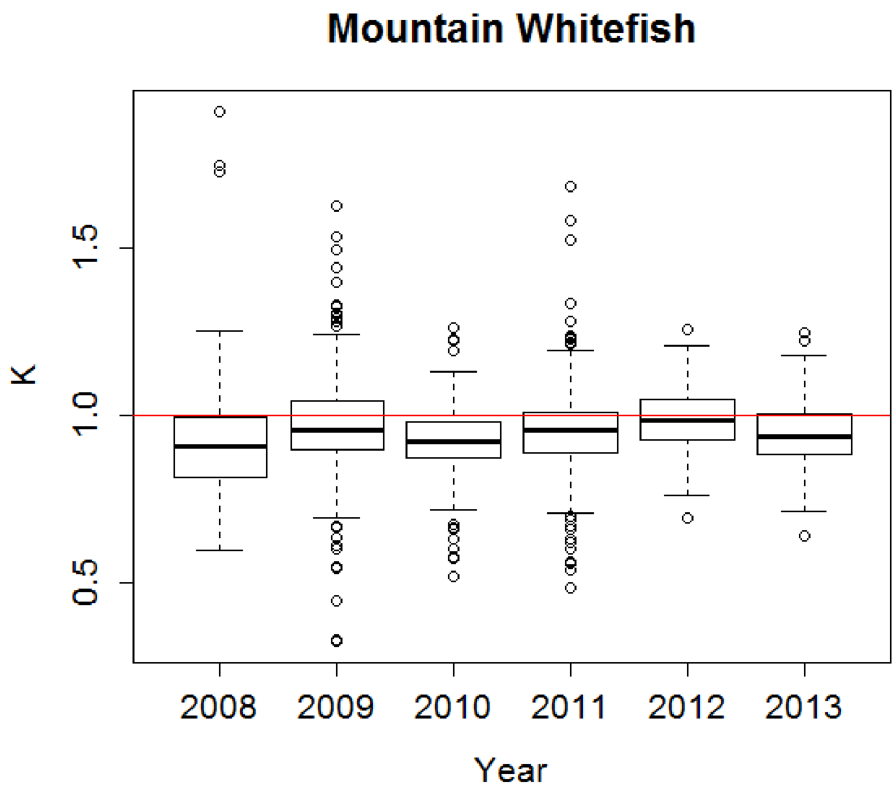

Figure 3-13 Boxplot of condition factor (K) of juvenile Mountain Whitefish captured in the Middle Columbia River mainstem by Year (2008: n=118; 2009: n=409; 2010: n=423; 2011: n=388; 2012: n=140; 2013: n=152). K values below the red line denote "poor" fish condition.

Condition factor of juvenile Mountain Whitefish was significantly greater in 2009 than in 2008 and 2010 (ANOVA: $F = 8.74$, df = 5, $p < 0.0001$; Tukey: $p = 0.036$ and $p < 0.0001$, respectively). Condition factor was also greater in 2012 than in 2008 and 2010 (ANOVA: $F = 8.74$, df = 5, $p < 0.0001$; Tukey: $p = 0.022$ and $p < 0.0001$, respectively). No other significant differences were detected.

3.3.4 KOKANEE

In 2013, data on length and weight were collected from 134 Kokanee (133 in the mainstem and 1 in tributaries[3]), which ranged in length from 44 to 330 mm. Forty two per

[3] The single tributary capture (an adult) was during Trip 3 when Kokanee move to various tributaries to spawn. Sampling was not carried out during the study when spawning Kokanee were observed.

cent of Kokanee captured in 2013 were considered juveniles (n = 56; all caught in the mainstem). Figure 3-14 shows the weight to length regression for all Kokanee captured in the Middle Columbia River mainstem in 2013. The regression lines for the 2008–2012 data are included for comparison. The plot shows similar trend lines between all years. This suggests relatively similar growing conditions for Kokanee in the system since 2008.

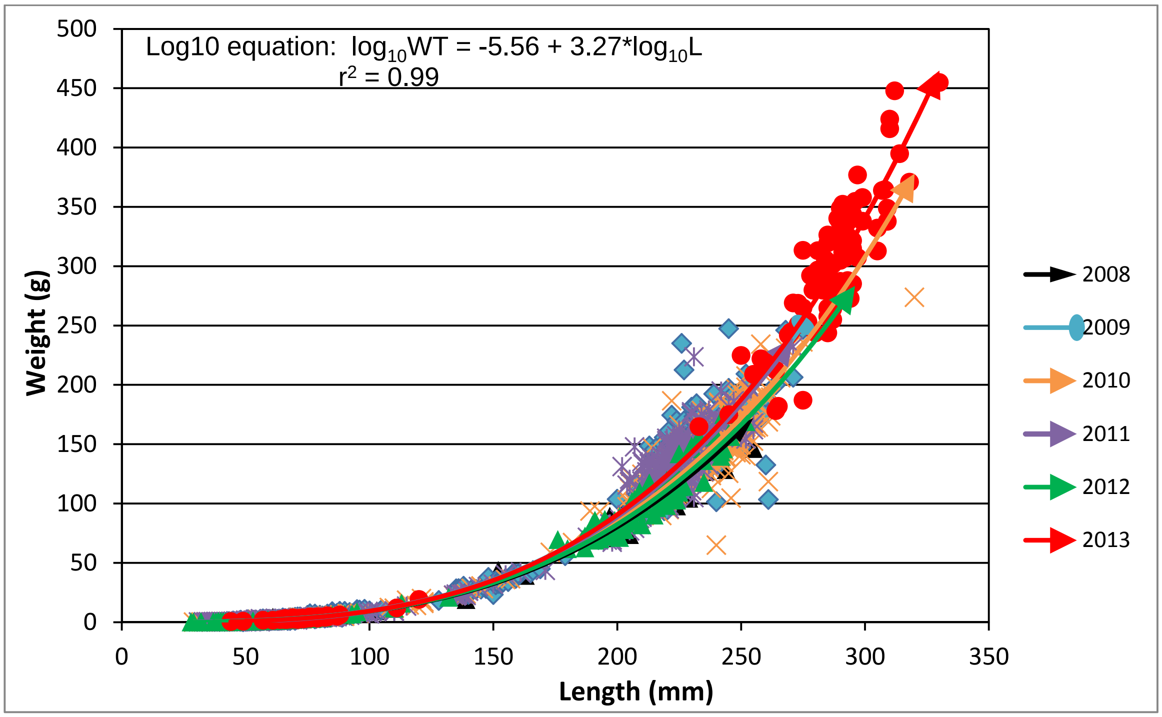

Figure 3-14. Weight–length regression for Kokanee captured in the mainstem during the 2013 field program (*N* = 132[4]). The 2008 to 2012 weight–length regression data and trend lines are plotted for comparison.

Condition factors for juvenile Kokanee captured in 2013 in the mainstem ranged from 0.67 to 1.17, with an overall mean of 0.87 (SD = 0.09, n = 55[5]) for the three sampling Trips (Table 3-10). Juvenile individuals captured in 2013 were therefore considered to be in poor to fair condition, suggesting that the fish are thin for their weight. In contrast, the adults captured had a mean K of 1.25 (SD = 0.12, n = 78) which suggests that growing conditions are such that the adult life stage is satisfactorily supported. No juvenile

[4] One captured individual was measured for length but not weighed, thus n = 132 for the graph
[5] Weight of one captured individual was not measured, thus K could not calculated and n=55.

Kokanee were captured in tributaries in 2013 during the three sampling trips although adult spawners were present in Drimmie Creek and Tonkawatla Creek in Trip 3 at the "upstream" sites. Due to the presence of spawners these sites were not sampled. The majority of juvenile Kokanee were caught in the fall trip (n = 38) compared to the spring (n = 13) and summer (n = 4).

Table 3-10. Summary of Condition Factor (K) for juvenile Kokanee for Year 1 through Year 6 (2008 to 2013).

		2008	2009	2010	2011	2012	2013
Reach 1	Mean	NFC[A]	NFC[A]	NFC[A]	NFC[A]	0.83	NFC[A]
	Min					0.77	
	Max					0.86	
	SD					0.04	
	n					4	
Reach 2	Mean	0.88	0.83	0.91	0.85	0.87	0.82
	Min	0.77	0.49	0.79	0.48	0.72	0.67
	Max	1.09	1.34	1.22	1.68	1.02	1.05
	SD	0.12	0.18	0.11	0.30	0.10	0.08
	n	5	35	28	30	9	17
Reach 3	Mean	0.86	1.03	0.88	0.85	0.91	0.89
	Min	0.53	0.67	0.69	0.26	0.45	0.71
	Max	1.66	1.62	1.41	1.40	1.46	1.17
	SD	0.13	0.22	0.12	0.15	0.16	0.10
	n	108	96	85	160	86	28
Reach 4	Mean	0.85	0.89	0.85	0.80	0.9	0.88
	Min	0.55	0.31	0.63	0.53	0.7	0.77
	Max	1.83	1.27	1.14	1.03	1.3	0.97
	SD	0.17	0.17	0.10	0.10	0.1	0.06
	n	69	90	36	96	26	10
Tributaries	Mean	0.79	1.12	1.02	1.12	NFC[A]	NFC[A]
	Min	0.79	1.03	1.02	0.97		
	Max	0.79	1.21	1.02	1.30		
	SD	n/a	0.13	n/a	0.17		
	n	1	2	1	3		

[A]NFC – No Juvenile Fish Caught

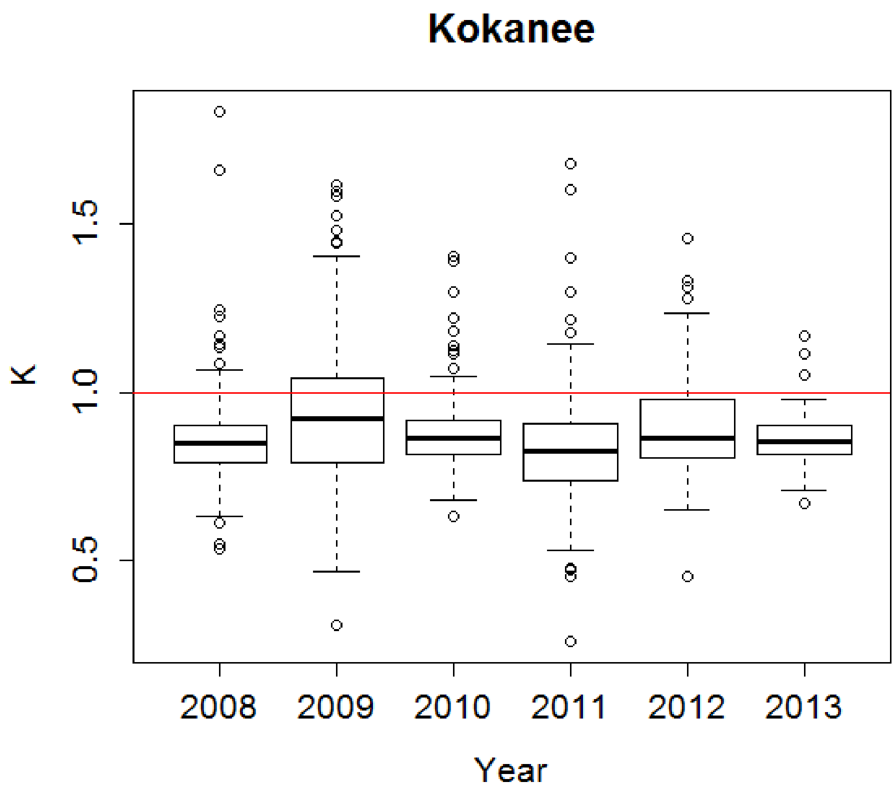

Figure 3-15. Boxplot of condition factor (K) of juvenile Kokanee captured in the Middle Columbia River mainstem by Year (2008: n=182; 2009: n=221; 2010: n=149; 2011: n=286; 2012: n=125; 2013: n=55). K values below the red line denote "poor" fish condition.

Condition factor of juvenile Kokanee was significantly greater in 2009 than in 2008, 2010, 2011 and 2013 (ANOVA: $F = 12.84$, df = 5, $p < 0.0001$; Tukey: $p < 0.0001$, $p = 0.0034$, $p < 0.0001$ and $p = 0.031$, respectively). Condition factor was also significantly higher in 2010 and 2012 than in 2011 (ANOVA: $F = 12.84$, df = 5, $p < 0.0001$; Tukey: $p = 0.040$ and $p = 0.0006$, respectively). No other significant differences were detected.

3.3.5 PRICKLY SCULPIN (CAS)

In 2013, data on length and weight were collected from 633 Prickly Sculpins (597 from mainstem sites and 36 from tributary sites), which ranged in length from 20 to 149mm. Approximately 12 per cent were considered juveniles (n = 78; 69 from mainstem sites and 9 from tributary sites). Figure 3-16 shows the weight to length regression for Prickly

Sculpins captured in the Middle Columbia River mainstem in 2013. The regression lines for the 2008 to 2012 data are included for comparison. Similar trend lines suggest relatively consistent growing conditions for Prickly Sculpin in the system since 2008. However, weights in 2009 were higher than every other year of the study in all reaches and tributaries.

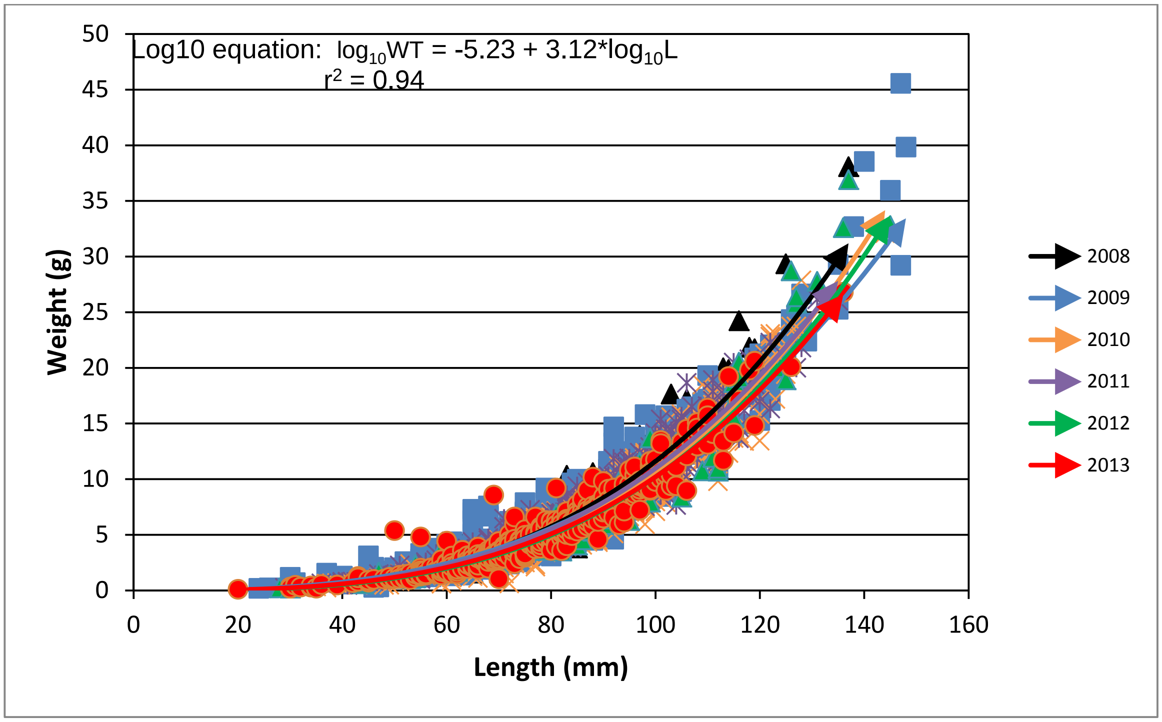

Figure 3-16. Weight–length regression for Prickly Sculpin captured in the mainstem during the 2013 field program (N = 633). The 2008 to 2012 weight–length regression data and trend lines are plotted for comparison.

Relative condition factor (K′) for juvenile CAS captured in 2013 in the mainstem ranged from 0.30 to 1.02, with an overall mean of 0.58 (SD = 0.12, n = 69) for the three sampling trips (Table 3-9). Relative condition factor was similar between the reaches with individuals captured in tributaries having lower condition factors. Over the six years of the study and comparing between the different reaches, condition factor of juvenile Prickly Sculpins was variable with no particular reach consistently having the highest or lowest values. This may suggest similar growing conditions throughout the study area. Weights in 2009 were higher than all other years of the study. Relative condition factor was significantly higher in 2009 than all other years (ANOVA: F = 156.99, df = 5, p =

0.0000000). The high weight values (two to five-times) were recorded in the field across the three trips and throughout the reaches. Other species captured at the same site had similar weights to other individuals of their species in previous years. Juvenile Prickly Sculpin feed predominantly on the nymphs and larvae of aquatic insects such as mayflies and caddisflies (Northcote 1954 as cited in McPhail 2007). Perhaps these particular aquatic insect species were more abundant in 2009 than other years of the study.

Table 3-11. Summary of Relative Condition Factor (K′) for juvenile Prickly Sculpin for Year 1 through Year 6 (2008 to 2013).

		2008	2009	2010	2011	2012	2013
Reach 1	Mean	0.64	2.51	0.42	0.72	NFC[A]	0.54
	Min	0.53	1.56	0.34	0.71		0.30
	Max	0.72	4.39	0.49	0.73		0.86
	SD	0.08	0.73	0.08	0.01		0.28
	n	4	15	3	2		3
Reach 2	Mean	0.70	1.83	0.39	0.69	0.74	0.60
	Min	0.58	1.34	0.20	0.54	0.33	0.47
	Max	0.94	2.64	0.49	0.89	0.74	1.02
	SD	0.12	0.40	0.09	0.10	0.16	0.14
	n	7	12	19	9	5	15
Reach 3	Mean	0.62	2.05	0.45	0.83	0.48	0.56
	Min	0.52	1.26	0.36	0.45	0.33	0.48
	Max	0.77	4.96	0.56	1.25	0.80	0.72
	SD	0.06	0.91	0.06	0.18	0.14	0.07
	n	20	17	26	31	11	11
Reach 4	Mean	0.66	1.68	0.43	0.74	0.45	0.57
	Min	0.43	0.41	0.13	0.52	0.32	0.40
	Max	1.22	3.13	0.72	1.02	0.80	0.99
	SD	0.13	0.66	0.10	0.12	0.14	0.12
	n	72	30	38	31	9	40
Tributaries	Mean	0.64	1.72	0.46	0.90	0.54	0.49
	Min	0.51	0.90	0.39	0.62	0.47	0.33
	Max	0.82	3.88	0.57	1.56	0.61	0.63
	SD	0.09	0.89	0.07	0.32	0.10	0.08
	n	10	13	8	11	2	9

[A]NFC – No Juvenile Fish Caught

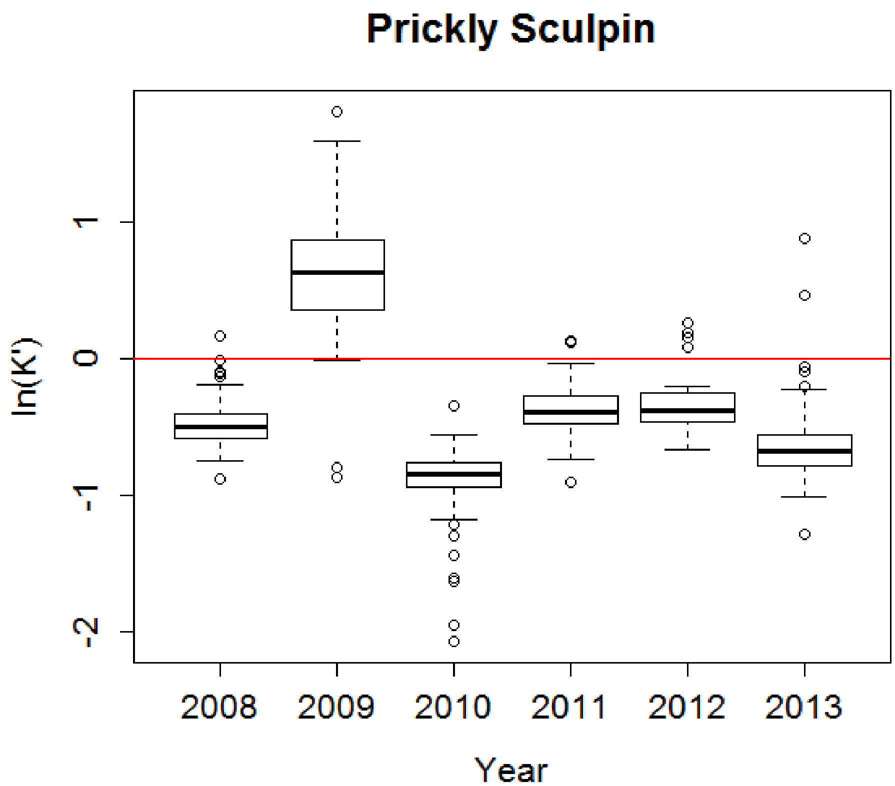

Figure 3-17. Boxplot of natural log of relative condition factor (K') of juvenile Prickly Sculpin captured in the Middle Columbia River mainstem by Year (2008: n=103; 2009: n=75; 2010: n=86; 2011: n=68; 2012: n=26; 2013: n=69). Natural log was used to reduce variance between groups. logK' values below the red line denote "poor" fish condition.

Condition factor of juvenile Prickly Sculpin was significantly greater in 2009 than in 2008, 2010, 2011, 2012 and 2013 (ANOVA: F = 156.99, df = 5, p < 0.0001; Tukey: p < 0.0001 for all years). Condition factor was also significantly higher in 2011 and 2012 than in 2010 (ANOVA: F = 156.99, df = 5, p < 0.0001; Tukey: p = 0.00025 and p = 0.0048, respectively). Condition factor was also significantly higher in 2008 than in 2010 (ANOVA: F = 156.99, df = 5, p < 0.0001; Tukey: p = 0.0048).No other significant differences were detected.

3.3.6 Redside Shiner

In 2013, data on length and weight were collected from 253 Redside Shiners (250 from mainstem sites and 3 from tributaries), which ranged in length from 28 to 116 mm. Twenty-one percent of individuals captured in 2013 were considered juveniles (n = 53; 52 from mainstem sites and 1 from tributary sites). Figure 3-16 shows the weight to length regression for Redside Shiners captured in the Middle Columbia River mainstem in 2013. The regression lines for 2008 to 2012 are included for comparison. The plot shows 2009 weights greater than in other years of the study.

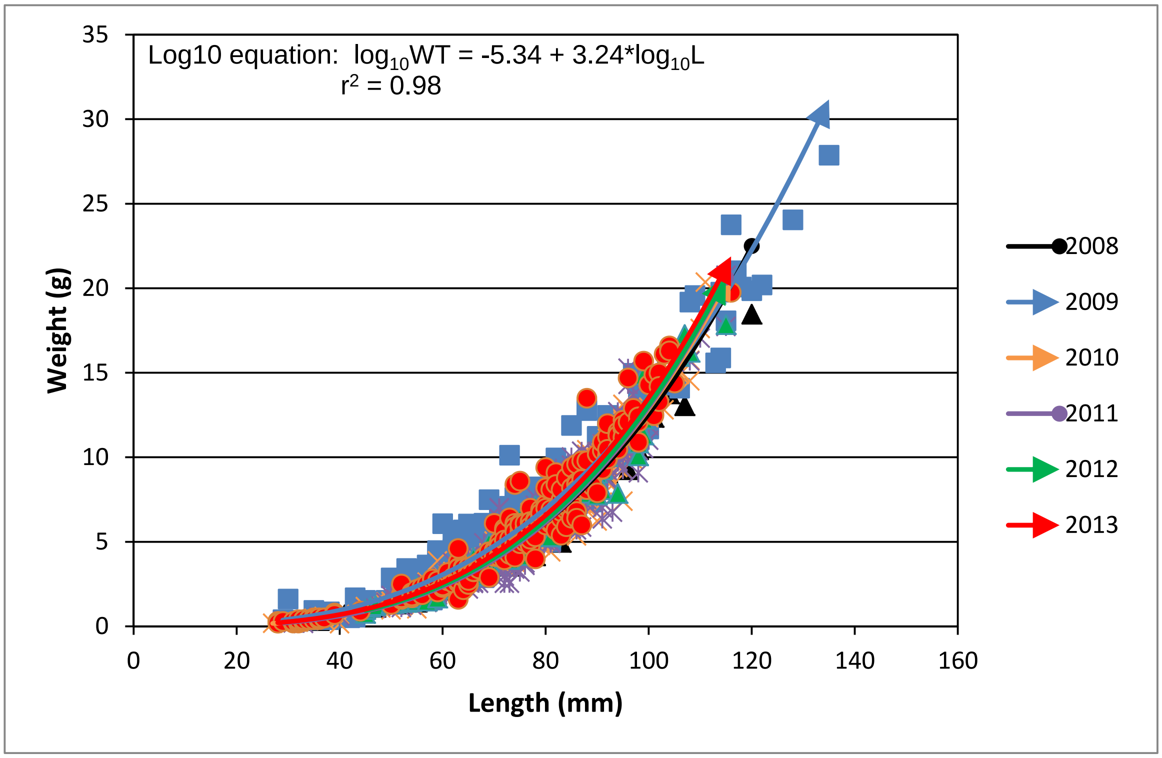

Figure 3-18. Weight–length regression for Redside Shiner captured in the mainstem during the 2013 field program (N = 250). The 2008 to 2012 weight–length regression data and trend lines are plotted for comparison.

Relative condition factors for juvenile Redside Shiners captured in 2013 in the mainstem ranged from 0.27 to 0.71, with an overall mean of 0.48 (SD = 0.08, n = 53). Juveniles were caught in all reaches and in Tonkawatla Creek (*downstream* site) in Trip 3. Mean condition factors of juvenile Redside Shiners were similar between Reaches 1, 2 and 3 while Reach 4 mean was lower. This suggests that growing conditions for juvenile Redside Shiner are more suitable in lower velocity flow that characterizes Reaches 1, 2 mainly. Similar to CAS in 2009, weights for RSC in 2009 were higher than all other years of the study. Relative condition factor was significantly higher in 2009 than all other years (ANOVA: $F = 556.99$, df = 5, $p = 0.0000000$). The high weight values (two to six-times) were recorded in the field across the three trips and throughout the reaches. Juvenile Redside Shiners also feed predominantly on the nymphs and larvae of aquatic insects as well as fry and eggs of their own and other species (McPhail 2007). Perhaps insect hatches in 2009 on the Arrow Lakes were more abundant and frequent than in other years providing valuable forage for juvenile Redside Shiners.

Table 3-12. Summary of Relative Condition Factor (K′) for juvenile Redside Shiner for Year 1 through Year 6 (2008 to 2013).

		2008	**2009**	**2010**	**2011**	**2012**	**2013**
Reach 1	Mean	0.42	1.61	0.38	0.28	0.39	0.47
	Min	0.40	1.02	0.31	0.19	0.29	0.37
	Max	0.43	2.14	0.45	0.39	0.46	0.63
	SD	0.02	0.37	0.05	0.05	0.05	0.06
	n	3	9	13	16	11	18
Reach 2	Mean	0.41	1.99	0.38	0.28	0.42	0.48
	Min	0.31	0.97	0.09	0.15	0.32	0.27
	Max	0.47	3.33	0.50	0.42	0.51	0.71
	SD	0.05	0.53	0.11	0.05	0.06	0.09
	n	12	24	16	23	12	29
Reach 3	Mean	0.40	2.23	0.43	0.26	0.37	0.50
	Min	0.35	1.68	0.32	0.21	0.29	0.43
	Max	0.44	3.02	0.66	0.37	0.43	0.61
	SD	0.03	0.48	0.12	0.03	0.04	0.08
	n	8	11	6	24	10	4
Reach 4	Mean	0.45	1.83	0.41	0.29		0.38
	Min	0.44	1.17	0.38	0.27		0.38
	Max	0.47	2.76	0.43	0.32	NFC[A]	0.38
	SD	0.02	59	0.03	0.02		n/a
	n	2	6	3	5		1
Tributaries	Mean		1.73	0.45			0.51
	Min		1.05	0.45			0.51
	Max	NFC[A]	2.07	0.45	NFC[A]	NFC[A]	0.51
	SD		0.38	n/a			n/a
	n		9	1			1

[A]NFC – No Juvenile Fish Caught

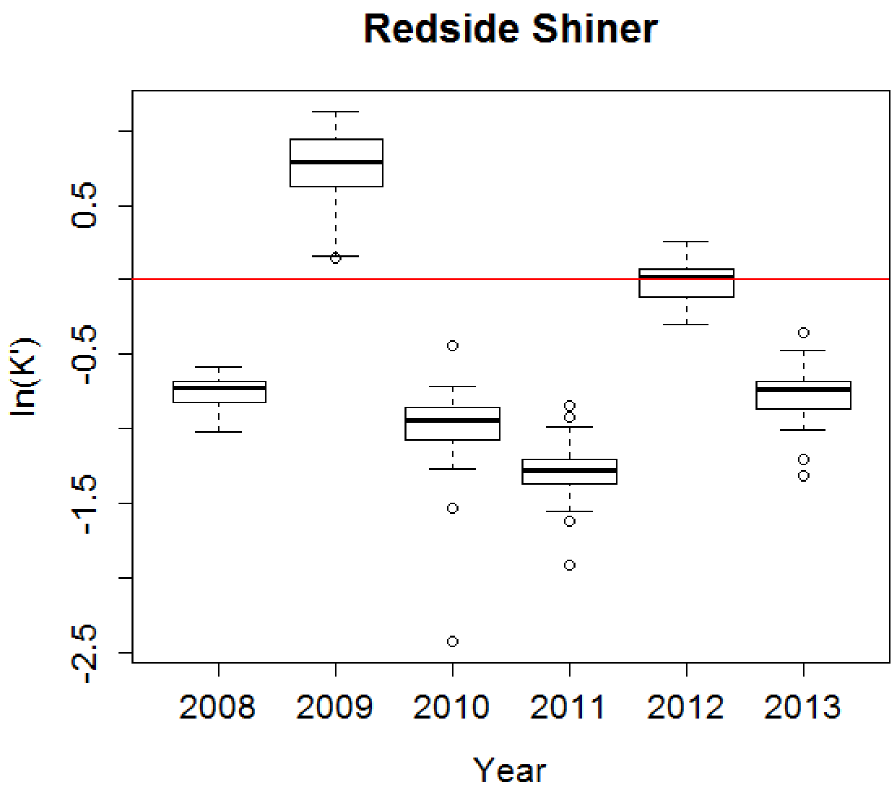

Figure 3-19. Boxplot of natural log of relative condition factor (K') of juvenile Redside Shiner captured in the Middle Columbia River mainstem by Year (2008: n=24; 2009: n=44; 2010: n=38; 2011: n=68; 2012: n=33; 2013: n=52). Natural log was used to reduce variance between groups. lnK' values below the red line denote "poor" fish condition.

Condition factor of juvenile Redside Shiner was significantly greater in 2009 than in 2008, 2010, 2011, 2012 and 2013 (ANOVA: F = 556.35, df = 5, p < 0.0001; Tukey: p < 0.0001 for all years). Condition factor was also significantly higher in 2012 than in 2013, 2011, 2010 and 2008 (ANOVA: F = 556.35, df = 5, p < 0.0001; Tukey: p < 0.0001 for all). As well, condition factor was higher in 2008 than in 2011 (ANOVA: F = 556.35, df = 5, p < 0.0001; Tukey: p = 0.001). Lastly, condition factor was significantly higher in 2013 than in 2011 (ANOVA: F = 556.99, df = 5, p < 0.0001; Tukey: p < 0.0001). No other significant differences were detected.

3.3.7 Largescale Sucker

In 2013, data on length and weight were collected from 50 Largescale Suckers (all from mainstem sites), which ranged in length from 85 to 510 mm. The majority of individuals captured in 2013 were adults (n = 48; 96 per cent). Figure 3-20 shows the weight to length regression for Largescale Suckers captured in the Middle Columbia River mainstem in 2013. The regression lines for 2008 to 2012 are included for comparison. Similar regression lines suggest relatively consistent growing conditions for Largescale Suckers in the system since 2008.

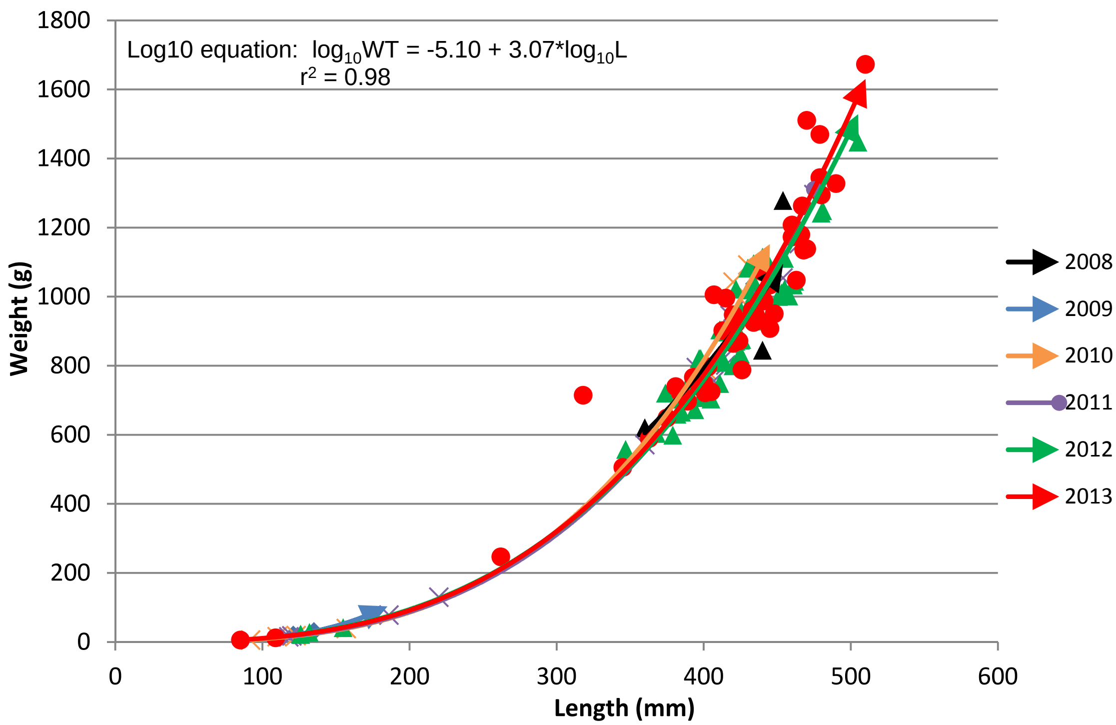

Figure 3-20. Weight–length regression for Largescale Sucker captured in the mainstem during the 2013 field program (N = 50). The 2008 to 2012 weight–length regression data and trend lines are plotted for comparison.

Relative condition factor (K′) for juvenile Largescale Suckers captured in 2013 in the mainstem ranged from 0.70 to 0.73, with an overall mean of 0.71 (SD = 0.03, n = 2) for the three sampling Trips (Table 3-11). Juvenile Largescale Suckers were captured in Reach 2 (Trips 1 and 3) and Reach 3 (Trip 1). The low number of juveniles captured suggests that the preferred habitat type for juvenile Largescale Sucker may not have sampled or may not be abundant. Porter and Rosenfeld (1999) (as cited in McPhail 2007) found, in the Nazko River, that juvenile sucker preferred shallow (0.25 – 0.50 m), low water velocity (0 – 0.1 m/s) habitats over sandy/silty substrates which, in the study area, is represented by several sites Reaches 1 and 2. It is possible that this study simply doesn't have enough sites characterized by this type of habitat to yield capture of large numbers of juvenile Largescale Sucker.

Table 3-13. Summary of Relative Condition Factor (K′) for juvenile Largescale Sucker for Year 1 through Year 6 (2008 to 2013).

		2008	2009	2010	2011	2012	2013
Reach 1	Mean	NFC[A]	1.22	NFC[A]	NFC[A]	1.09	NFC[A]
	Min		1.17			1.08	
	Max		1.28			1.09	
	SD		0.08			0.003	
	n		2			2	
Reach 2	Mean	NFC[A]	NFC[A]	0.34	0.56	1.18	0.73
	Min			0.34	0.53	1.18	0.73
	Max			0.34	0.59	1.18	0.73
	SD			n/a	0.05	n/a	n/a
	n			1	2	1	1
Reach 3	Mean	NFC[A]	NFC[A]	0.39	0.58	NFC[A]	0.70
	Min			0.36	0.58		0.70
	Max			0.42	0.58		0.70
	SD			0.04	n/a		n/a
	n			2	1		1
Reach 4	Mean	NFC[A]	NFC[A]	0.28	0.47	1.12	NFC[A]
	Min			0.28	0.47	1.12	
	Max			0.28	0.47	1.12	
	SD			n/a	n/a	n/a	
	n			1	1	1	
Tributaries	Mean	NFC[A]	NFC[A]	NFC[A]	NFC[A]	NFC[A]	NFC[A]
	Min						
	Max						
	SD						
	n						

[A]NFC – No Juvenile Fish Caught

3.4 CATCH-PER-UNIT-EFFORT

Unlike the annual reports for Years 1 – 4 of CLBMON 17 which used catch-per-unit-effort (CPUE) of juveniles of the three target species (Rainbow Trout, Bull Trout, Mountain Whitefish), Year 6, like Year 5, includes CPUE of juveniles of the most abundant species (Rainbow Trout, Bull Trout, Mountain Whitefish, Kokanee, Sculpins[6], Redside Shiner and Largescale Suckers). In order to compare CPUE between all years, data from 2008 – 2011 were recalculated to include the same seven species.

3.4.1 SPRING TRIP (MAY/JUNE) 2013

A total of 363 juvenile fishes of the seven most abundant species were captured and observed during the spring sampling trip in 2013 (332 from the mainstem reaches and 31 from the tributaries; Table 3-13). Mean CPUE per site was not significantly different between reaches or tributaries in 2013 (ANOVA: $F = 0.75$, df = 4, $p = 0.56$). In the mainstem CPUE ranged from a low of 0 (at 8 sites spanning Reaches 3 and 4) to 0.192 fish/second of electrofishing at site 30 in Reach 3. CPUE in the tributaries ranged from 0.004 fish/second of electrofishing at Drimmie Creek "*upstream*" to 0.031 fish/second of electrofishing at Tonkawatla Creek "*downstream*".

Table 3-14. Mean, maximum, and minimum CPUE of juvenile fishes captured per site by reach, May 2013.

	Significance[1]	Mean	Max	Min	SD	Number of Fish	Number of Sites[2]
Reach 1	A	0.006	0.008	0.004	0.002	8	4
Reach 2	A	0.013	0.032	0.003	0.009	46	10
Reach 3	A	0.027	0.192	0	0.046	156	21
Reach 4	A	0.018	0.058	0	0.018	122	25
Tributaries	A	0.017	0.031	0.004	0.013	31	7

[1] Reaches with different letters were significantly different from one another. Pair-wise comparisons completed using the Tukey test.
[2] Tributary sites included two, 50 m sites (termed "*upstream*" and "*downstream*").

[6] CPUE data for all Sculpin species was combined to maximize the size of the data set. This included Prickly Sculpins, Slimy Sculpins and "Sculpin General" – those that were not able to be captured but were positively identified as belonging to the *Cottus* genus.

3.4.2 SUMMER TRIP (JULY) 2013

A total of 204 juvenile fishes of the seven most abundant species were captured and observed during the summer sampling trip in 2013 (184 from the mainstem and 20 from tributaries; Table 3-13). A significant difference in mean CPUE between the reaches in Trip 2 in 2013 was suggested by the ANOVA (ANOVA: $F = 2.91$, df = 4, $p = 0.028$). However the Tukey test revealed no significantly different pairwise comparisons (Tukey: *p*-values ranged from 0.91 to 1.0 among all interactions). In the mainstem CPUE ranged from a low of 0 (at 22 sites throughout Reaches 1 – 4) to 0.066 fish/second of electrofishing at site 12 in Reach 4. For tributaries CPUE ranged from 0 at Illecillewaet River "*downstream*", Jordan River "*downstream*" and Tonkawatla Creek "*downstream*" to 0.036 fish/second of electrofishing at Illecillewaet River "*upstream*".

Table 3-15. Mean, maximum, and minimum CPUE of juvenile fishes captured per site by reach, July 2013.

	Significance[1]	Mean	Max	Min	SD	Number of Fish	Number of Sites[2]
Reach 1	A	0.000	0.000	0	0.000	0	3
Reach 2	A	0.002	0.011	0	0.004	4	7
Reach 3	A	0.007	0.046	0	0.013	41	21
Reach 4	A	0.018	0.066	0	0.018	139	25
Tributaries	A	0.011	0.036	0	0.012	20	9

[1] Reaches with different letters were significantly different from one another. Pair-wise comparisons completed using the Tukey test.
[2] Tributary sites included two, 50 m sites (termed "*upstream*" and "*downstream*").

3.4.3 FALL TRIP (SEPTEMBER) 2013

A total of 597 juvenile fishes of the seven most abundant species were captured and observed during the fall sampling trip in 2013 (572 from the mainstem reaches and 25 from the tributaries; Table 3-14). Mean CPUE per site in Reach 2 was significantly greater than in Reach 4 (ANOVA: $F = 3.42$, df = 4, $p = 0.013$; Tukey: $p = 0.007$). No additional differences were noted. In the mainstem CPUE ranged from a low of 0 (at 5 sites in Reaches 1, 3 and 4) to 0.188 fish/second of electrofishing at site 31 in Reach 3. For tributaries CPUE ranged from 0 at Begbie Creek "*downstream*", Jordan River "*downstream*" and Illecillewaet River "upstream" to 0.103 fish/second of electrofishing at Tonkawatla Creek "*downstream*".

Table 3-16. Mean, maximum, and minimum CPUE of juvenile fish captured per site by reach, September 2013.

	Significance[1]	Mean	Max	Min	SD	Number of Fish	Number of Sites[2]
Reach 1	A/B	0.047	0.154	0	0.064	68	5
Reach 2	A	0.068	0.159	0.009	0.058	200	12
Reach 3	A/B	0.040	0.188	0	0.049	200	21
Reach 4	B	0.016	0.047	0	0.013	104	25
Tributaries	A/B	0.023	0.103	0	0.037	25	7

[1] Reaches with different letters were significantly different from one another. Pair-wise comparisons completed using the Tukey test.
[2] Tributary sites included two, 50 m sites (termed "*upstream*" and "*downstream*").

3.4.4 CPUE of Reaches between Trips in 2013

There were no significant differences in mean CPUE per site in Reaches 1 and 4 as well as the tributaries between the three sampling trips (ANOVA: F = 1.52, df = 2, p = 0.27; F = 0.07, df = 2, p = 0.93 and F = 0.49, df = 2, p = 0.62, respectively). For Reach 2, CPUE was significantly higher in the fall compared to the spring trip (ANOVA: F = 8.58, df = 2, p = 0.0014; Tukey: p = 0.0071) and the summer trip (ANOVA: F = 8.58, df = 2, p = 0.0014; Tukey: p = 0.0035). For Reach 3 CPUE was significantly higher in spring than in summer (ANOVA: F = 8.49, df = 2, p = 0.0006; Tukey: p = 0.005) and fall (ANOVA: F = 3.79, df = 2, p = 0.028; Tukey: p = 0.022). No other significant differences between Reaches over the three Trips were detected ($p > 0.05$).

3.4.5 CPUE Pre and Post Rev 5/Minimum Flow

Mean CPUE before and after the implementation of the 142 m^3/s minimum flow and Rev 5 was analyzed in 2013. Mean CPUE for study Years 1 – 3 (2008 – 2010; pre-Rev 5) were compared to Years 4 – 6 (2011 – 2013; post-Rev 5). CPUE was slightly reduced after minimum flow was established (mean = 0.0267, SD = 0.0426, n = 525) compared to before (mean=0.0298, SD = 0.0335, n = 526). The difference was not significant however (p = 0.14), suggesting there was no overall main effect of flow on CPUE (Figure 3-21).

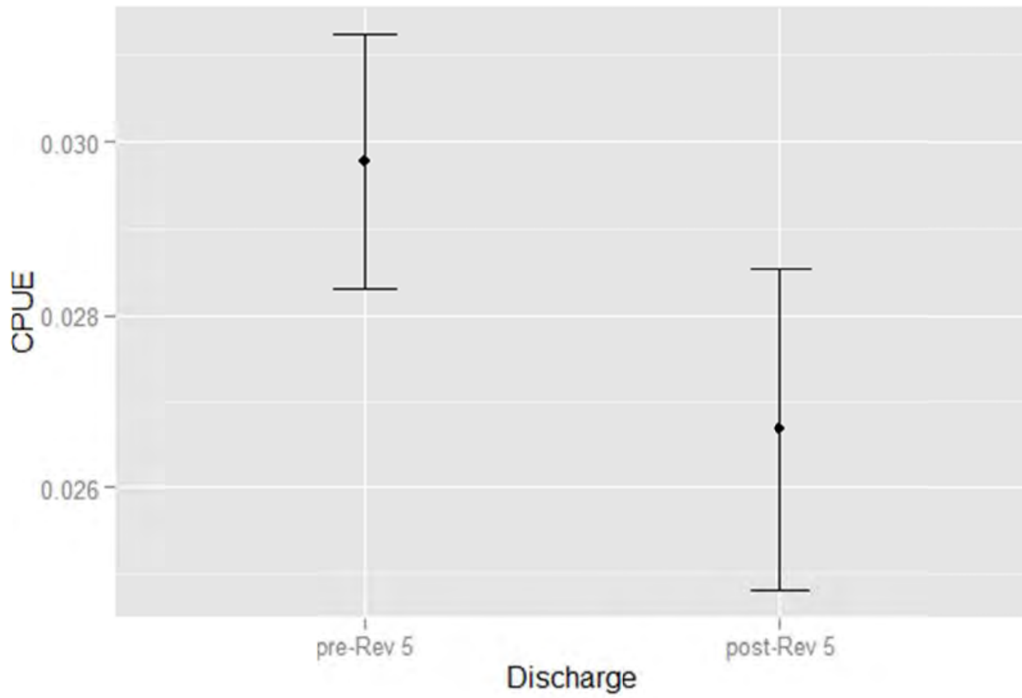

Figure 3-21. Mean CPUE pre and post minimum flow and Rev 5. Error bars represent 95% confidence intervals.

Although there was no main effect of flow on CPUE, the significant three-way interaction between flow, trip, and reach indicates that the effect of flow on CPUE does vary by sampling trip within reaches (Table 3-17). During Trip 1 (spring sampling), there was little effect of minimum flow and Rev 5 on CPUE in any reach (Figure 3-22). During Trip 2 (summer sampling), however, CPUE was reduced in all reaches after minimum flow and Rev 5 was established. In contrast, during Trip 3 (fall sampling), establishing minimum flow increased CPUE in most reaches, except Reach 4.

Table 3-17. ANOVA output examining effects of minimum flow ("Flow": pre-Rev 5 2008-2010, post Rev-5 2011-2013), year, trip and reach on CPUE for CLBMON – 17, 2008 – 2013.

Variable	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Flow	1	0.00251	0.002509	2.1677	0.141
Reach	3	0.04012	0.013373	11.5562	**< 0.001**
Trip	2	0.02166	0.01083	9.3587	**< 0.001**
Year	4	0.11813	0.029533	25.5203	**< 0.001**
Flow:Reach	3	0.00696	0.002319	2.0037	0.112
Flow:Trip	2	0.02255	0.011276	9.7437	**< 0.001**
Reach:Trip	6	0.0279	0.00465	4.0181	**< 0.001**
Reach:Year	12	0.06071	0.005059	4.3715	**< 0.001**
Trip:Year	8	0.01976	0.002469	2.1339	**0.030**
Flow:Reach:Trip	6	0.03125	0.005208	4.5001	**< 0.001**
Reach:Trip:Year	24	0.05836	0.002432	2.1011	**0.002**

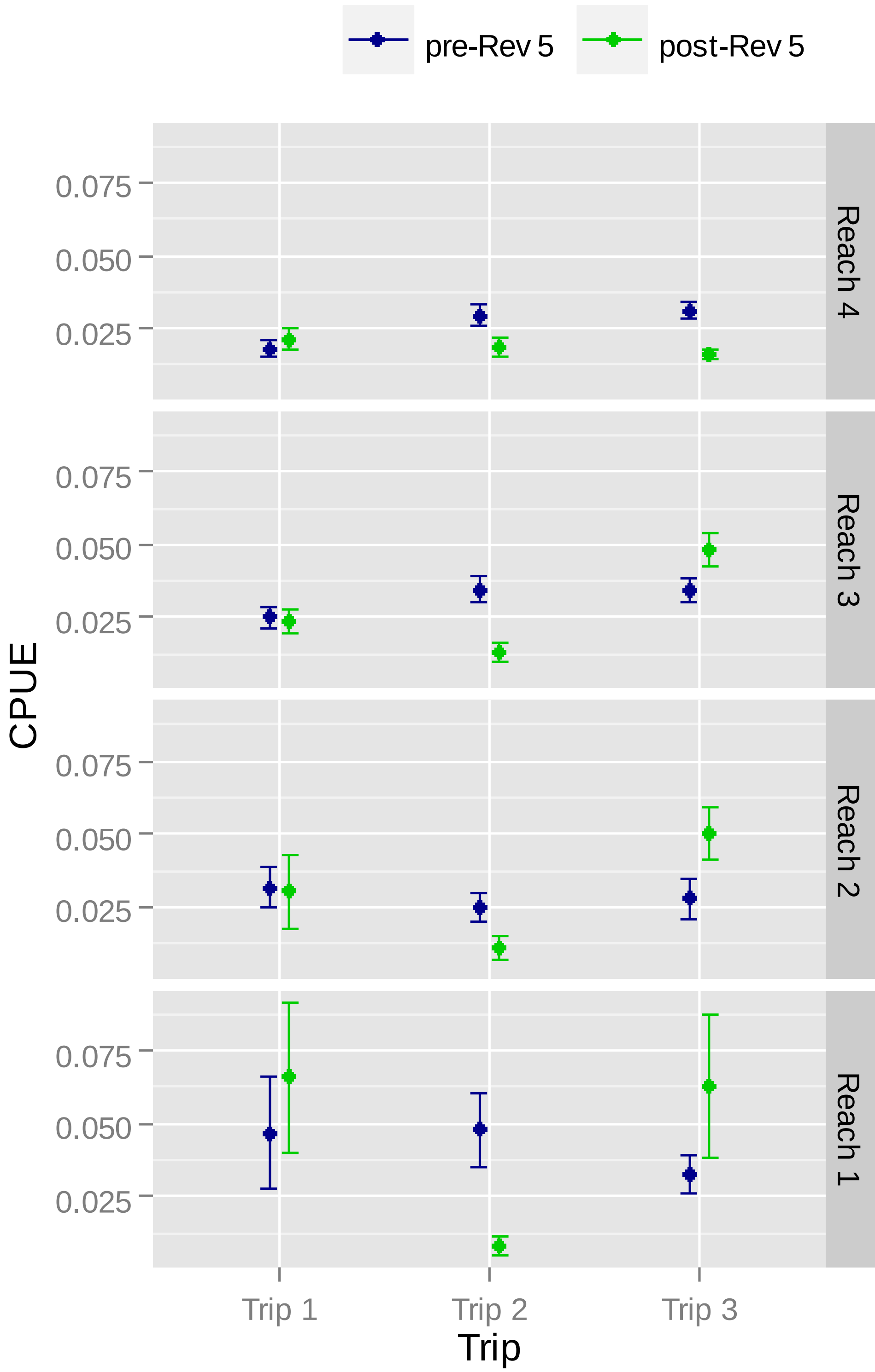

Figure 3-22. CPUE (all species combined) pre- and post-Rev 5 by reach and trip. Error bars are ±SD.

3.5 HABITAT SUITABILITY FOR JUVENILES

CPUE of juveniles of Rainbow Trout, Bull Trout, Mountain Whitefish, Kokanee, Sculpins (*Cottus Sp*.), Redside Shiner and Largescale Sucker for 2008–2013 is summarized per site in (Table 3-18). The habitat characteristics of each site (substrate, slope, discharge, depth, and velocity at 0, 1.5, and 3 m from shore) were used to make inferences about the habitat preferences of each species within the study area. The sites included in Appendix 1c in 2013 were the top three to six highest CPUE sites and constituted at least 33 per cent of the total catch for each species each year (100 per cent for Largescale Suckers in 2012).

Table 3-18: Summary of velocity and substrate of sites with the highest density of the seven most abundant species based on the 2008–2013 sampling results

Species	Preferred velocities	Preferred substrates
Bull Trout	0–0.66 m/s	Fines and Gravel/cobble
Rainbow Trout	0–0.42 m/s	Rip-rap
Mountain Whitefish	0– 0.59 m/s	Gravel/cobble
Kokanee	0 – 1.30 m/s	Gravel/cobble
Sculpins	0 – 0.66 m/s	Gravel/cobble
Redside Shiner	0 – 0.28 m/s	Bedrock
Largescale Sucker	0 – 0.98 m/s	Gravel/cobble and Bedrock

Sites with the highest juvenile Bull Trout CPUE in 2013, similar to most previous years, tended to be steep and dominated by coarser substrates such as rip rap, boulder and gravel/cobble though the second highest CPUE in 2013 was at site 38 which is a steep, fines-dominated bank. 2009 was the only year that deviated from this trend with four of the top six highest CPUE sites having steep fines dominant shorelines. As in all previous years, except 2008, none of the sites in 2013 had high CPUE in more than one Trip, which suggests there was a lack of site fidelity and opportunistic habitat use. Bull Trout are piscivorous and habitat use is often influenced by the presence of other fish species (McPhail, 2007) suggesting habitat preference will vary with season depending on prey preferences. There were seven sites in 2013 where more than one juvenile Bull Trout was captured, compared to only one site in 2012, fifteen sites in 2011, twenty-four sites in 2010, thirteen sites in 2009, and four sites in 2008. Habitat use was similar across all years of the study with Reaches 1, 2 and 3 consistently having the highest CPUE. No change in habitat use by Bull Trout pre- and post-Rev 5 was observed.

Similar to previous years of the study, CPUE for Rainbow Trout in 2013 was highest at rip rap sites (5 of 6 sites in 2013) and didn't appear to change throughout the study (pre- vs. post-Rev 5). Two of the six top-ranked sites in 2013 (sites 34 and 35) have consistently been in the top –five ranked sites for CPUE in each year of the study regardless of Trip. Both of these sites consist of steep, rip-rap substrates (D_{95} 100 to 200 cm). These results suggest possible site fidelity and that juvenile Rainbow Trout in the study area show an affinity for coarse substrates (i.e., rip-rap and bedrock). This is consistent with observations in other systems such the Skagit River (Washington State, USA), where juvenile Rainbow Trout were found to be more abundant along banks with boulder-size rip-rap (~25.6 cm) than along natural banks (Beamer and Henderson, 1998 as cited in Quigley and Harper, 2004). Abundant escape and resting cover is essential to high value Rainbow Trout rearing habitat for stream populations and is characterized by cobble/boulder substrates, undercut banks and large woody debris. These areas provide refuge from predators, staging for forage locations and resting areas (Raleigh et al. 1984 as cited in Triton 2013).

The highest CPUE values of Mountain Whitefish in 2013 were attained in the fall trip, which is consistent with 2009, 2010 and 2012. Habitat conditions in 2013 at the highest ranked sites were represented by two of the seven habitat classes (steep fines and steep gravel/cobble). This was consistent with previous years with Mountain Whitefish in the study area showing an apparent affinity for steeper-sloped sites. However four of the top-five highest CPUE sites in 2011 consisted of low angle gravel/cobble and fines substrates. This suggests that juvenile Mountain Whitefish are opportunistic when choosing suitable rearing habitats and are able to utilize areas over different substrate types. Literature review suggests Mountain Whitefish make use of a wide range of habitats which is consistent with observations from the Middle Columbia. McPhail (2007) suggests adults favour shallower habitats in the spring (i.e. < 1.0 m) and deeper habitats (i.e. > 1 m) in the summer and fall with coarse substrates are also preferred over fines. Juveniles are more likely to be found in glides and runs as opposed to riffles and backwaters with larger substrates and moderate currents (0.25 – 0.60 m/s) (McPhail, 2007). Lastly, young-of-year tend to be found in shallow water (<0.5 m) with fine gravel or sand substrates (McPhail, 2007).

Similar to previous years of the study, the majority of the top-ranked CPUE sites for Kokanee in 2013 were sampled during the fall trips (77 per cent; n = 23). Site 31 (Reach 3) CPUE was the highest compared to all other sites across the reaches through the three trips with nearly twice the CPUE of the next highest site (site 37, Reach 3). Site 31 consisted of gravel-cobble substrates with moderate (0 m to 0.26 m) depths and moderate velocities (0 m/s to 0.24 m/s). Forty-seven per cent of the top ranked sites through the six years of the study consisted of low-angle shorelines with gravel/cobble or fines substrates (n=14) with the highest CPUE of the study at site 17 (low-angle fines) in 2011. The remaining five habitat types were represented by the remaining sixteen sites. No change in habitat use for Kokanee was observed over the course of the study.

Compared to previous years, depths at the top-ranked sites for juvenile Sculpin CPUE in 2013 were generally deeper while velocities were generally higher. Near-shore habitat at these sites consisted mainly of larger diameter substrates (rip rap and boulder) and was steep as opposed to low-angle. Association with moderate water velocities is typical of Sculpins in the Columbia River. R.L. & L Environmental Services Ltd (1995a) found that Sculpins in the Columbia River below Keenleyside Dam were associated with boulder substrates and average water velocities of 0.34 m/s (McPhail, 2007). Throughout the six years of this study, Sculpin species have consistently been the most abundant and been associated with the widest range of habitat types (low-fines to bedrock; riverine to lacustrine) and stream morphologies (zero velocity pools to high velocity runs in both shallow and deep areas). It was not unexpected that high CPUE for each year was at sites with variable depths and velocities. However, through the six year study, there appeared to be a preference for steep, large substrate sites.

The four highest-ranked capture sites for juvenile Redside Shiners based on CPUE were located in Reaches 1 (site 54) and 2 (sites 43, 44, 51) and represented 81 per cent of the total juvenile Redside Shiner catch for 2013 (n=126). Through the six years of the study, the highest CPUE for juvenile Redside Shiners was generally at sites located in Reaches 1 and 2, except for 2010 when the top four sites were located in Reaches 3 and 4 (sites 1, 5, 12 and 22). Depths in 2013 were similar to previous years and ranged from 0 m at the shoreline to 1.95 m at 3 m from shore and velocities ranged from 0 m/s at the shoreline to 0.23 m/s at 3 m from shore. Similar to previous years, the highest CPUE for the year was attained at a site where maximum velocity was generally low (2013: 0.07 m/s; 2012: 0.02 m/s; 2011: 0 m/s; 2010: 0.28 m/s; 2009: 0.25 m/s; 2008: 0.02 m/s). Substrate associated with the top –ranked sites in 2013 consisted of mainly steep fines, boulder and bedrock substrates while one site (site 43, third highest CPUE) was low-angle fines. Substrate associated with the top-ranked sites through the six years of the study was generally steep angle with bedrock or boulder. Redside Shiners associated with deep, bedrock-dominated sites with near zero water velocities is consistent with reviewed literature (McPhail, 2007).

The CPUE of juvenile Largescale Sucker in 2013 was the lowest of the seven most abundant species and ranged from 0.0026 to 0.0032 fish/second of electrofishing. Only three juveniles were captured in 2013 over three sites: Sites 35 and 43 during the spring trip and Site 42 during the fall trip. The number of juvenile captures in 2013 was similar to previous years (2012: n = 4; 2011: n = 3; 2010: n = 4; 2009: n = 2; 2008: n = 0). Compared to previous years, 2011 was the only other year where the top-ranked CPUE sites had low-angle fines as the substrate. The remaining top-ranked sites consisted of bedrock, steep boulder and steep gravel/cobble habitats. Literature on the habitat preferences of juvenile Largescale Sucker British Columbia is quite limited but juveniles seem to prefer relatively shallow (< 0.5 m), slow-water (<0.1 m/s) areas over gravel/fines substrates (McPhail, 2007). Data collected during the six years of this study suggest that juvenile Largescale Suckers may also prefer boulder and bedrock-dominated habitats when available. However the limited sample size makes inferences difficult.

3.5.1 TRIBUTARIES

As noted in the methodology sample site location, length, and effort at the tributary sites was relatively consistent in each sampling Trip to allow for direct comparisons of relative abundance. Juvenile Bull Trout captured in tributaries in 2013 accounted for 11 per cent of the total juvenile Bull Trout catch (n = 4) compared to 32 per cent in 2012 (n = 8), 18 per cent in 2011 (n = 13), 15 per cent in 2010 (n = 15), 28 per cent in 2009 (n = 19) and 29 per cent in 2008 (n = 11). Juvenile Rainbow Trout captured in tributaries in 2013 accounted for 40 per cent of the total juvenile Rainbow Trout catch (n = 23) compared to 41 per cent in 2012 (n = 34), 27 per cent in 2011 and 2010 (n = 68 and n = 105), 31 per cent in 2009 (n = 49) and 27 per cent in 2008 (n = 32). This was the second-highest proportion of all years of the study with lowest number of captures. Tonkawatla Creek "*upstream*" site through the six years of the study, consistently had the greatest proportion of juvenile Rainbow Trout captured of any of the tributary site. The only exception was in 2012 when Begbie Creek "*upstream*" site had the highest proportion of juvenile Rainbow Trout captured. The Tonkawatla site is characterized by riffle-pool morphology, gravel substrates and excellent habitat complexity. Gradient is low and access to the site is good throughout the year. The Begbie site also has good habitat complexity but tends towards larger substrates with steeper gradient and experiences high velocity discharge in the spring which could limit habitat use in that area.

Juvenile Mountain Whitefish captured in tributaries in 2013 accounted for 3 per cent of the total juvenile Mountain Whitefish captures (n = 6), the lowest proportion for the six-year study, compared to 8 per cent in 2012 (n = 13), 4 per cent in 2011 (n = 19), 16 per cent in 2010 (n = 107), 6.5 per cent in 2009 (n = 45) and 18% in 2008 (n = 49).

In general, habitat conditions in the tributaries are considered favourable for both Rainbow Trout and Bull Trout, both of which are strongly associated with higher velocity, steeper, riffle-pool habitats found in several of the tributaries (McPhail, 2007). Alternatively Mountain Whitefish tend to prefer deeper water and were less abundant in the tributaries than in the mainstem.

Similar to 2012, no juvenile Kokanee or Largescale Sucker were captured or observed during the 2013 field season in the five sampled tributaries. Further, during the six years of the study, no juvenile Largescale Suckers have ever been captured or observed at any tributary site. However, there are several "*upstream*" tributary sites every year that are typically not sampled due to visual observation of spawning adult Kokanee (e.g.

Drimmie, Begbie and Tonkawatla Creeks). Through the six years of the study, Kokanee and Redside Shiner captures in tributaries has been low, with only a few individuals of each species being caught per year. The exception for Redside Shiner was 2009 at Tonkawatla "*downstream*" where 80 juvenile Redside Shiners were captured during the fall trip. It should be noted however that site morphology at this site in the fall tends to be more lacustrine than riverine due to backwater effect of Arrow Lake Reservoir. Overall, low capture numbers of juvenile Kokanee, Redside Shiner and Largescale Sucker were not unexpected as juveniles of these species typically prefer off-shore, lacustrine habitat over fluvial habitat for rearing (McPhail, 2007).

Juvenile Sculpin captured and observed in tributaries accounted for just 5 per cent of the total catch of Sculpin species in 2013 (n = 32) and was below 10% in all years of sampling.

Habitat preferences of juveniles of the seven most abundant species are summarized in Appendix 1c.

4.0 DISCUSSION

4.1 TEMPERATURE AND DISCHARGE

Recorded temperatures in 2013 were marginally warmer than in 2012 which were within the middle of the range of temperatures observed during the three years of baseline. Similar to previous years of the study, Reach 1 was generally the warmest and Reach 4 the coolest with spring sampling having the coolest overall temperatures. This is likely attributed to proximity to dam. The lowest recorded surface temperature in 2013 was 6.7 °C in Reach 4 in spring while the highest was 12.7 °C in Reach 1 in the fall trip. Spring sampling observed a range of 6.7 – 9.6 °C (Reach 4 – Reach 1) while the summer trip observed a range of 9.0 – 12.2 °C (Reach 4 – Reach 1) and the fall trip observed 11.1 – 12.7 °C.

As was the case in previous years of the study, the range in temperatures between all reaches within each trip likely was not a major variable in influencing recruitment of juvenile fishes in 2013. Within each trip in 2013, the difference in temperatures between all sampled reaches was not great: 2.9 °C (spring), 3.2 °C (summer) and 1.6 °C (fall) and were all within preferred ranges for the species present in the system (McPhail 2007). In general the Middle Columbia River is a cold system with measured summer temperatures over the six years of study not exceeding 13°C. No changes in temperatures beyond what would be expected through natural variation were noted following the implementation of minimum flow.

Dam discharge and ALR elevation in 2013 were second highest compared to all other sampling years (2012 being the highest) with the summer trip having the greatest daily discharge maximums (Table 3-2) and greatest reservoir elevation (Table 2-2). This resulted in high velocity flows (especially in Reaches 4 and 3) and increased depths that resulted in flooding into the riparian vegetation at many sites. For nearly every year of the program, the catch during Trip 2 was lower than Trips 1 and 3. The exception being 2010 when Trip 2 had a higher catch than Trip 1, although 66 per cent of the catch comprised visual observations of species belonging to the *Cottus* genus. The spring trip was found to have the most consistent sampling conditions with all four study reaches being riverine over the six years of the study (Table 4-1). Alternatively, the summer trip was highly variable with all four reaches inundated in 2010, 2012 and 2013, three reached inundated in 2008 and 2011, and only two inundated in 2009. Similarly the fall trip also experienced variable conditions over the 6 years, but primarily at Reach 3 which fluctuated between riverine and reservoir. The potential effects of the variable conditions on sampling efficiency, distribution, and data analysis is discussed in the following sections.

Table 4-1: Summary of river conditions at each Reach during each of the three sampling events for 2008–2013 (R = Reach). Red border indicates start of minimum flows

Trip	Condition	2008	2009	2010	2011	2012	2013
May/June	River	R 1–4	R 1–4	R 1–4	R 1–4	R 1-4	R 1-4
	Reservoir						
June/July	River	R 4	R 3–4		R4		R4[B]
	Reservoir	R 1–3	R 1–2	R 1–4	R 1–3	R 1-4	R 1-3
September	River	R 4	R 3–4	R 3–4	R 4	R 2-4	R1-4
	Reservoir	R 1–3	R 1–2	R 1–2	R 1–3	R 1-2[A]	

[A] The influence of the reservoir reached part-way into Reach 2 in September 2012
[B] The influence of the reservoir reached part-way into Reach 4 in July 2013

4.2 FISH ABUNDANCE AND DISTRIBUTION

A total of 35,483 fishes of 17 species were captured during the 6 years of sampling of CLBMON 17 (Table 4-2). The total number of species encountered in 2013 (n = 15) was the same as in 2008, one less than 2012, and two less than 2009, 2010 and 2011. The number of individuals captured and observed in 2013 was higher than 2008 and 2012 but lower than 2009, 2010 and 2011 (Table 4-4). This shows that species richness was fairly constant over the course of the program.

2012 had the lowest catch of any of the six years of sampling in the summer and fall due to high ALR elevation and high discharge. The ALR elevation during summer the trip was higher than in all previous summer trips (Table 2-2) resulting in significant backwatering throughout the reaches. Some of sample sites were backwatered into riparian vegetation thus limiting the ability to reach the shore to carry out electrofishing.

As such, these sites were sampled in deeper-than-usual water. Additionally discharge from the dam was high during the summer trip in 2012 and in particular from July 16 to 18 when sampling in Reaches 3 and 4 was completed discharge remained above 1200 m^3/s throughout (Figure 3-2). The increased depth and velocity at sample sites (compared to previous years of the study) decreased the efficiency of capture (deeper sampling sites offer increased potential of fishes escaping the electric field). As well, juvenile fishes likely sought refuge from increased water velocity in the shallows in the flooded riparian where sampling was not possible.

Table 4-2: Summary of sampling results for 2008–2013, all Reaches and tributaries combined

Year	Spring Trip		Summer Trip		Fall Trip		Total	
	# fish	# species	# fish	# species	# fish	# species	# fish	# species
6 (2013)	1105	12	653	14	2247	14	4005	15
5 (2012)	1230	12	330	14	1339	12	2899	16
4 (2011)	1877	15	1227	15	3400	17	6504	17
Year 4-6 Mean	1404	13	737	14	2329	14	4469	16
3 (2010)	2337	15	3782	16	4355	17	10474	17
2 (2009)	1406	12	1001	10	5356	11	7763	17
1 (2008)	454	14	1345	15	2178	15	3977	15
Year 1-3 Mean	1399	14	2043	14	3963	14	7405	16

Table 4-3 shows the change in percent composition of each species pre- and post-Rev 5. The majority of species showed little or no change remaining relatively constant on average between the two periods. The two species that showed the largest increase in percent composition were Mountain Whitefish (+2.8%) and Redside Shiner (+9.2%). Alternatively Kokanee (-3.5%) and Cottus (-11%) showed the largest decrease in overall percent composition of fish captured and/or visually observed. In terms of total abundance, all species with the exception of Redside Shiner, suckers (general), Peamouth Chub, Tench, and Pigmy Whitefish decreased post-Rev 5. Despite the apparent decreasing trend in abundance of the majority of species it is unclear whether it is due to the implementation of minimum flows. Factors such as high ALR elevation and high discharge in the summer and fall in 2012 and 2013 reduced sampling efficiency particularly for bottom dwelling species such as Cottus and increase lacustrine and flooded vegetation habitats which would favour species such as Redside Shiners, suckers, chub and tench. However, since the high ALR elevation and increased discharge experienced post-Rev 5 are independent of minimum flows, the changes in abundance observed cannot be linked to the influence of minimum flow alone. Similarly annual cycles of Kokanee abundance will have an effect and the degree to which they are influenced by the minimum flows is unknown. A degree of annual variation in fish abundance is to be expected and it is worth noting that the numbers of fish captured by species in 2012 and 2013 (after REV5 and min flows) were similar to that of 2008 (before REV5 and min flows). A longer-term study would be required to better characterize the annual variation and better compare the influence of minimum flows if any.

Table 4-3. Total fishes captured[1], percent composition, and change in percent composition at mainstem sites pre- and post-Rev 5 for CLBMON-17

Species	2008	2009	2010	Total Pre-Rev 5	% of Total Catch Pre-Rev 5	2011	2012	2013	Total After	% of Total Catch Post-Rev 5	Difference Pre-Post
BB	20	122	44	186	0.8%	13	9	9	31	0.2%	0.6%
BT	61	108	142	311	1.4%	115	65	86	266	2.0%	-0.6%
KO	263	1142	1642	3047	13.8%	913	222	257	1392	10.4%	3.5%
MW	304	829	705	1838	8.3%	683	363	445	1491	11.1%	-2.8%
NSC	43	77	24	144	0.7%	56	21	41	118	0.9%	-0.2%
RB	124	169	395	688	3.1%	262	100	62	424	3.2%	0.0%
RSC	297	774	831	1902	8.6%	1466	427	501	2394	17.8%	-9.2%
COTT	2779	4356	6371	13506	61.3%	2880	1532	2346	6758	50.3%	11.0%
SU	13	101	49	163	0.7%	52	131	75	258	1.9%	-1.2%
PCC	12	50	4	66	0.3%	50	19	175	244	1.8%	1.5%
YP	58	13	80	151	0.7%	14	4	5	23	0.2%	0.5%
TC	4	1	1	6	0.0%	11	5	1	17	0.1%	-0.1%
EB	1	5	13	19	0.1%	10	1	2	13	0.1%	0.0%
CP	0	11	1	12	0.1%	1	0	0	1	0.0%	0.0%
PW	0	5	1	6	0.0%	8	0	0	8	0.1%	-0.1%
Total	**3979**	**7763**	**10303**	**22045**	**100%**	**6534**	**2899**	**4005**	**13438**	**100%**	

[1] Includes positively identified observations

In order to investigate the potential influence of minimum flows without the influence of the ALR, Table 4-4 shows abundance and percent composition by species for the spring trip only (i.e. before ALR elevation increases). It is also limited to data from Reaches 3 and 4 only which would be expected to be most influenced by minimum flows. Results show that the majority of species remained relatively unchanged in terms of percent composition (< 1% change) but only Northern Pikeminnow, Redside Shiner, and Peamouth Chubb increased in abundance post-Rev 5. Mountain Whitefish showed the largest decrease in percent composition despite showing an overall increase when all Trips and Reaches were combined (Table 4-3). The decrease in percent composition of Cottus and Kokanee was also less than was observed when all Trips and Reaches combined suggesting ALR influence and high discharge in the summer and fall resulting in reduced sampling efficiency did have an effect. Additional sampling would be required to determine whether the trend in abundance and percent composition post-Rev 5 will continue.

Table 4-4. Total fishes captured[1], percent composition, and change in percent composition in Reaches 3 and 4 mainstem sites during the spring sampling only pre- and post-Rev 5 for CLBMON-17.

Species	Total Pre-Rev 5	% of Total Catch Pre-Rev 5	Total Post-Rev 5	% of Total Catch Post-Rev 5	Difference Pre-Post
BB	26	1.0%	10	0.5%	0.5%
BT	77	3.0%	54	2.6%	0.4%
KO	88	3.4%	26	1.3%	2.2%
MW	352	13.7%	200	9.6%	4.0%
NSC	13	0.5%	32	1.5%	-1.0%
RB	81	3.1%	50	2.4%	0.7%
RSC	266	10.3%	394	19.0%	-8.7%
COTT	1644	63.8%	1280	61.7%	2.1%
SU	22	0.9%	14	0.7%	0.2%
PCC	1	0%	13	0.6%	-0.6%
YP	0	0%	0	0%	0%
TC	0	0%	0	0%	0%
EB	6	0.2%	1	0%	0.2%
CP	0	0%	0	0%	0%
PW	0	0%	0	0%	0%
Total	**2576**	**100%**	**2074**	**100%**	

4.3 HABITAT SUITABILITY FOR JUVENILES

Habitat Suitability Index (HSI) curves for Rainbow Trout, Bull Trout and Mountain Whitefish juveniles were reviewed to determine preferences for rearing depth and velocities.

The HSI curves for Bull Trout and Rainbow Trout were from the Water Use Planning (WUP) process and were developed by Ron Ptolemy (Instream Flow Specialist, Ministry of Environment, Victoria, B.C., pers. comm.). However, these curves were developed for non-regulated systems, which could limit their application to systems such as the Middle Columbia which experiences highly variable flow patterns. According to these curves, velocities from 0 m/s to 1.0 m/s are suitable for both species, but Rainbow Trout prefer velocities ranging from 0.25 m/s to 0.50 m/s (HSI = 1.0), whereas Bull Trout prefer slightly faster waters with velocities ranging from 0.40 m/s to 0.69 m/s. Both species show a preference (HSI = 1.0) for depths greater than 0.3 m.

HSI curves for Mountain Whitefish were not available from the WUP process but were developed for juvenile rearing depths and velocities for the South Saskatchewan River, Alberta (Addley et al. 2003). Based on those curves, juvenile Mountain Whitefish show a preference (HSI = 1.0) for velocities ranging from 0 m/s to 0.7 m/s and for depths greater than 0.3 m.

Juvenile Kokanee prefer lacustrine rearing habitat over fluvial rearing habitat thus they tend spend most of their time off-shore with periodic daytime movements towards the shore to forage (McPhail, 2007). This is consistent with data gathered for juvenile Kokanee in 2008 through 2013.

From observations gathered throughout the six years of this study, Prickly Sculpin seem to be relatively opportunistic species in terms of the habitat types with which they associate. Juveniles and adults have been caught and observed in low or zero velocity sites (e.g., reservoir) in Reaches 1 and 2 to higher water velocity sites found in Reaches 3 and 4. Throughout the study, Prickly Sculpin have been caught and observed in both shallow water (<0.30 m) and deep water (>2.0 m) and over a variety of substrates such as fines, cobble/boulder, rip-rap and bedrock.

In contrast to Prickly Sculpins, throughout all years of this study, adult and juvenile Redside Shiners were caught and observed in mainly low velocity, deep water sites in Reaches 1 and 2 over boulder and bedrock substrates.

Juvenile Largescale Suckers were not encountered often, though adults were. Similar to 2012, only 4 juvenile Largescale Suckers were captured in 2013. Literature review found that Largescale Suckers are not well-studied in British Columbia. However, juvenile Largescale Suckers seem to be associated with slow water velocities (0 – 0.1 m/s) and fines-dominated substrates (Miura 1962 and Porter and Rosenfeld 1999 as cited in McPhail 2007). In 2013, three of four individuals were captured in the reservoir (Reaches 1 and 2).

Based on these criteria, it was expected that sites exhibiting similar substrate, depth, and velocity characteristics would have similar catch rates of the seven most abundant species. However, while sites with the highest numbers of target species were generally within preferred depth ranges (greater than 0.3 m), their velocities tended to be lower than those from the HSI curves (Table 3-18). However, because conditions at each site are highly variable due to the Revelstoke Dam operation as well as ALR elevation, the depth and velocities measured at the sites during sampling do not necessarily reflect the conditions during most of the day. For example, a decrease in discharge from approximately 700 m^3/s to approximately 25 m^3/s at a site results in a 0.4 m/s–0.7 m/s decrease in velocity at that same site (Table 4-5). Therefore, certain sites will be within the typical HSI ranges for species but at other times will be outside that range. For that reason, definition of a Middle Columbia habitat suitability range based on velocities is not practical. Additionally, as distance from the Dam increases, effects from variable velocity and river elevation due to Dam discharge decrease. This, in turn, is affected by backwatering from the ALR in the summer months which further minimizes the effects of high discharge from the Dam. In these months, it is typically only the upper half of Reach 4 that can potentially experience highly variable flow. The results of the diversity and evenness analyses (Section 3.2) suggest that the higher water velocities associated with Rev 5 are likely not the main driver in distributing fish within the study area.

Table 4-5: Mean depth and velocities at representative sites based on discharges (2010 site data)

Site	Habitat	Discharge (m^3/s)	Depth (m) at station			Velocity (m/s) at station		
			0 m[1]	1.5 m[2]	3 m[3]	0 m	1.5 m	3 m
15	Steep Gravel/Cobble	700	0	0.88	1.28	0	0.51	0.71
		735	0	0.85	1.21	0	0.47	0.55
		25	0	0.65	0.87	0	0.09	0.31
16	Steep Rip-Rap	721	0	0.85	1.17	0	0.60	0.78
		624	0	0.65	0.98	0	0.47	0.64
		16	0	0.55	0.93	0	0	0.05

[1] **0 m** is the wetted edge; [2] **1.5 m** is 1.5 m from the wetted edge; [3] **3 m** is 3 m from the wetted edge

At sites where Bull Trout were captured, the substrate tended to be steep and dominated by either gravel/cobble or fines. Alternatively, Rainbow Trout showed a stronger preference for coarser substrates, such as boulder, rip-rap and bedrock. The relatively stable habitat conditions at sites with steep, large diameter substrates over a range of discharges could potentially explain the higher densities of species such as Rainbow and Bull Trout captured at those sites (CPUE Table Appendix 1c). These habitats also provide interstitial spaces for refuge areas for juvenile fish. Since there is both an energetic cost and increased risk of predation associated with moving from one habitat to another as flows change, it is reasonable to expect juveniles to focus on habitats that are more stable, thus limiting the need for daily migrations between habitats (Korman and Campana, 2009).

4.4 FOOD-BASE PRODUCTIVITY EFFECTS

As discussed in section 3.3, condition factors for the majority of the species studied were relatively consistent across the six years of the study. Slight annual variation was observed however typically was within the range of natural variation that would be expected. Exceptions to this were Prickly Sculpin and Redside Shiner, both of which showed greater variation and had notably high relative condition factor (K′) in 2009 (Figure 3-15 and 3-17, respectively). Stomach content data from adults collected from

2007 to 2010 show that both species feed primarily on benthic invertebrates and specifically the taxa Chironomidae and Ephemeroptera (Schleppe et al. 2012). These results could therefore suggest increased food availability and hence productivity in that year. However, since other species did not show the same trend it also suggests that if increased food was responsible it was limited to those invertebrate taxa. In addition, since the increase in condition factor for both species was limited to 2009 and followed by decreases in subsequent years, it is assumed to be the result of natural annual variation as opposed to operational strategies which would be expected to result in more consistent increases or decreases in relative condition factor.

In order to further address the management question "*Do current operational strategies affect availability of the food base for juvenile fish life stages*?" Triton reviewed the results of CLBMON-15b – Middle Columbia River Ecological Productivity Monitoring (Schleppe et al., 2012 and 2013). Preliminary results of that study suggest that the establishment of minimum flows will increase the availability of fish food because of a direct correlation between productivity and submergence. Specifically the CLBMON-15b data suggest that the abundance, biomass, and overall availability of fish food are directly dependent upon time spent in the water. Therefore any operational strategy that results in an increase in wetted productive habitat or reduction in periods of desiccation should cause a subsequent increase in fish food availability. However Ecoscape also noted that since the minimum flows typically occur at night, when productivity is lower, the overall effect on productivity may be reduced.

Despite the hypotheses outlined above, the actual magnitude and extent of the benefit to productivity as well as how that translates into the quantity of fish food in the MCR is unknown. Stomach samples from juveniles collected during CLBMON-17 have not yet been analyzed (Jason Schleppe, Ecoscape, pers. comm.) but may provide some insight into the food preferences of individual species in the system. Inferences on the effect of minimum flow on food fish may then be able to be drawn based on the results of the productivity monitoring and specifically the specific food taxa utilized by juvenile fish. It is assumed that subsequent years of assessment under CLBMON-15b will help to further address this management question.

4.5 EFFECTS OF PREDATORS

Following the completion of Year 6 of CLBMON-17, there is still substantial uncertainty regarding the role of predators on fish recruitment and habitat use in the Middle Columbia River. Stomach content data from adults collected from 2007 to 2010 showed that the diet of Bull Trout, Rainbow Trout, Mountain Whitefish and Redside Shiner as well as sucker and sculpin taxa all include fish (Schleppe et al. 2013). However, since for that study the “fish” food group included eggs it is assumed that only Bull Trout and Rainbow Trout were feeding on fish while the others were primarily feeding on eggs. Adult Prickly Sculpin mainly feed on aquatic insects but some studies have shown than beyond a length of 70 mm, adults will begin to forage on fry of other species (Northcote 1954; Patten 1962 as cited in McPhail 2007). McPhail (2007) also notes that Redside Shiner target the nymph and larval stages of aquatic insects and, as they mature, add the eggs and fry of other species into their diet. In addition, literature review also identified adult Burbot and Northern Pikeminnow as being primarily piscivorous (McPhail, 2007).

A review of the results of CLBMON-16 (Middle Columbia River Fish Population Indexing Program) confirms that the populations of the adult piscivorous species in the Middle Columbia River have remained relatively constant since 2007 (Golder et al., 2013). The exception being Bull Trout which have shown a slight decreasing trend since 2011. This suggests that the implementation of minimum flows has not affected predator populations to date. Similarly, results from CLBMON-17 show relatively stable juvenile fish abundances from 2008 to 2013 for the majority of species. It should be noted however that species such as Kokanee and Cottus have decreased and overall abundances tended to be lower in 2011-2013 compared to 2008-2010 for most species. It is unknown however, whether this trend will continue or if it is due natural variation in the system. Based on the data collected to date it is assumed that with relatively stable adult and juvenile populations in the system pre- and post-Rev 5, that predatory pressure will also have remained relatively constant over the same period. Consequently whatever influence predators were having on fish recruitment pre-Rev 5 has likely remained similar post-Rev 5. Additional years of sampling would assist in further identifying changes in the predator-prey relationship in the system if they exist.

In regards to habitat use, the sites with the highest CPUE over the 6 years of study in CLBMON - 17 tended to be those dominated by steep banks and coarse substrates. Rip-rap sites in particular had consistently high CPUE pre- and post-Rev 5. Given the clarity of the water in the Middle Columbia, it is reasonable to expect higher usage of sites by juveniles that provide cover from predatory species. This trend remained constant pre- and post-Rev 5 once again suggesting that predator influence on habitat usage has remained constant. It is recognized however that many other factors will influence both recruitment and habitat usage and it cannot be said with any certainty what role, if any, predators play in either. A study focused solely on that management question would be required to further assess the role of predators in the system. However, unless a notable change in fish populations, habitat availability and usage is identified, this does not seem necessary.

4.6 CPUE AND PRE AND POST MINIMUM FLOW/REV 5

CLBMON-17 used CPUE as the dependent variable in measuring any effects of the new flow regime instituted in 2010. Variance analysis was carried out to discern any significant differences in CPUE of fishes before and after the flow regime change. Results of the ANOVA indicate that CPUE within the study area of the Columbia River system was highly variable (Table 3-16). Background spatial and temporal variation – as indicated by the significant effects of year, trip and reach, including their interactions – are to be expected in a complex aquatic system such as the MCR and the direct effects of these factors are not the focus of this study. Instead, the analysis focused on the effect of establishing a minimum flow release for Revelstoke Dam. As stated in Section 3.4.5, CPUE decreased slightly after minimum flow was established (mean = 0.0267, SD = 0.0426, n = 525) compared to before (mean=0.0298, SD = 0.0335, n = 526). The difference was not significant however ($p = 0.14$), suggesting that the change was within the natural variation that occurs in the system.

However, when temporal (seasonal) and spatial (reach, or distance from the Dam) are considered, the effect of minimum flow on CPUE varies. As stated in Section 3.4.5, during spring sampling, there was little change in CPUE in any reach. During summer sampling however, CPUE was reduced in all reaches in the years after minimum flow was established. In contrast, during fall sampling, CPUE increased post-minimum at reaches 1-3, but decreased in Reach 4. These somewhat contradictory results suggest that if minimum flows are having an effect on juvenile populations in the MCR, those effects may differ depending on the season. Additionally, as has been previously discussed (Section 4.2) the implementation of minimum flows is not the only factor that might be influencing fish populations. In particular the ALR influence and specifically the seasonal change from riverine to lacustrine must also be considered. During the summer trip when the ALR elevation is high (typically mid-June to early winter), its influence obscures any effect the minimum base flows might be having on the system as a result of the backwater effect. In both 2012 and 2013 ALR elevation was high and sampling conditions particularly in Reach 4 were not ideal. Therefore, the fact that CPUE was found to be lower post-minimum flow at all reaches could also be related to ALR influence and not solely due to minimum flow. Similarly, during the fall trip it was noted that CPUE increased in Reaches 1-3 post-minimum flow but decreased in Reach 4. This notably similar to how the ALR influences the reaches in the fall with Reach 4 typically being riverine but the downstream reaches still influenced to some degree by the ALR. Therefore the apparent difference in effect of minimum flow on CPUE with distance from the dam could have more to do with the ALR influence than changes in flow.

As a result of the potential confounding influence of the ALR on flows, sampling during riverine conditions (i.e. without ALR influence) likely provides the best opportunity to assess the effect of the minimum base flow. As summarized in Table 4-1 Trip 1 (May) was the only trip where conditions were consistent across the three years of pre- and three years of post-minimum flows. In addition, that was the only trip where there was no difference in CPUE of juvenile fish between pre- and post. This supports the conclusion that at least for the period studied, minimum flow likely has not had an effect on juvenile fish populations and, that factors such as seasonal changes in river conditions due to the ALR may be obscuring whatever influence it does have. However data from individual species from the spring trip only for Reaches 3 and 4 showed that sculpin (general), Mountain Whitefish, and Kokanee decreased in percent composition of total catch while Redside Shiner, Northern Pikeminnow and Peamouth Chub all increased. Therefore, while overall combined results suggest no change, shifts in species composition may still be occurring. Longer term data will be required to determine whether or not the trends observed will continue.

It is also important to note that at the same time that the minimum flows were implemented the addition of a fifth generator at the Revelstoke Dam also increased the peak daily discharge of the facility by up to 20 per cent (from a maximum of 1,700 m^3/s to 2,125 m^3/s) (BC Hydro 2009). Between May 1 and September 30 (152 days) the pre-Rev 5 maximum of 1700 m^3/s was surpassed on 31 days (20%) in 2013, 56 days (37%) in 2012, and 58 days (38%) in 2011. Therefore, any changes in juvenile fish habitat use that might exist could also be due to the increased maximum flow.

Lastly, another factor that needs to be considered is whether or not three years would be a long enough time frame for any changes in juvenile populations that resulted from the implementation of minimum flows to manifest. The minimum flow volume is relatively small in comparison to the daily variations that can occur in the system (<10% of the maximum flow), is typically only in place for a few hours, and does not necessarily occur every night (may stay higher through the night). Further, the discharge records show that there were many occasions pre-minimum flow where the discharge did not drop below 142 m^3/s and that there were several dates post-minimum flow where discharge still dropped below the 142 m^3/s threshold for short periods of time. A review of the data on hourly-average discharge from the Revelstoke Dam from May 1 to September 30 (152 days), post-implementation of minimum flow showed that during that period, discharge dropped below the 142 m^3/s threshold on 0 days in 2013, 13 days (9%) in 2012, and 59 days (35%) in 2011. For comparison, discharge dropped below 142 m^3/s on 112 days (66 per cent of the time) during the same period in 2010. Data for 2008 and 2009 for the same period was not acquired but is assumed to be similar to 2010.

Changes in productivity in the system as a result of the minimum flow may take longer to occur as well and how such change affects juvenile fish longer still. Similarly the change in predator abundance and their influence on juveniles may not be apparent for many years, if at all. Therefore while results of the study three years post-minimum flow do not suggest an effect on juvenile fish species, it may be worthwhile to consider follow up studies at longer intervals to identify any long term trends that might result. Follow up sampling in Years 9 (6 years post-minimum flow) and 12 (9 years post-minimum flow) for example would help address this uncertainty and provide direction for future management decisions. To reduce costs, effort could be focussed on Reaches 3 and 4 only and on the spring sampling when the confounding influence of the ALR can be avoided.

4.7 RECOMMENDATIONS

2013 was the final year of the 6-year CLBMON-17 study. As such there are no additional years of sampling planned. While the current study does address each of the specific management questions, the completion of ongoing MCR studies (e.g. CLBMON 15a, 15b, 16, and 18) and additional analysis could provide further information on the effects of minimum flows on the juvenile communities in the system.

- CLBMON-15a: Physical Habitat Monitoring: A component of this study will include the collection of data for the development of a HEC-RAS computer model to predict hydraulic changes in the system as a result of discharge changes. If the resolution of this model allows for quantification of the amount of wetted habitat gained with the implementation of the minimum flow (i.e. the difference in wetted habitat at 142 m^3/s vs. 0 m^3/s) inferences may be able to be made about the overall benefit (eg. increased availability of potential rearing habitat) to juvenile life stages.
- CLBMON-15b: Ecological Productivity: The completion of this study will provide an analysis of the overall effect of minimum flows on productivity in the system. Assessment of juvenile fish stomach content samples collected by CLBMON-17 will allow for the development of a juvenile fish food index and assessment of what effect if any minimum flows have had on those specific food sources.

- CLBMON-16: Fish Population Indexing: This long term study on fish populations in the Middle Columbia will help identify trends in abundance and distribution and specifically any changes that have occurred following the implementation of minimum flows. With a focus on adult species this study will also provide further data on the populations of predator species in the system.
- CLBMON-18: Adult Fish Habitat Use: Upon completion this study will provide additional details on the effects of flow changes on Bull Trout and Mountain Whitefish in the system which may help address the question of the effects of predators on recruitment and how that has changed with minimum flows.

In an independent review of CLBMON-17 it was recommended that:

1. Additional data analysis be undertaken to attempt to control for the confounding variables using a 'weight of evidence' modeling approach. In particular factors such as ALR elevations, variation in discharge from the Dam, and water quality could be included in the model analysis to assess changes in CPUE with those factors taken into account. However, given the amount of variability in conditions over the 6 years of study and the short duration of the post-minimum flow dataset, it seems unlikely that more complicated modeling will yield conclusions that differ from those presented in this report. Three years of data is simply too short to allow for changes that may occur in juvenile populations to manifest and be observed and;

2. Periodic monitoring at set intervals that allow time for changes to manifest would be recommended. For example, repeating the study in Year 9 (6 years post minimum flow: 2016) and 12 (9 years post minimum flow: 2019) would allow for the identification of trends over the long term. To reduce costs, follow up sampling could focus on only Reaches 3 and 4 in the spring (i.e. prior to ALR elevation increasing).

5.0 MANAGEMENT QUESTION SUMMARY

The following is a summary of the answers to the management questions following Year 6 of the study:

1. *What are the seasonal abundances and distribution of juvenile life stages of fishes in the Middle Columbia River (MCR)?*

    - Seasonal abundances and distribution of juvenile species are variable in the MCR. Generally abundance was higher in the fall than in the spring and summer from Year 1 to 6. Several of the Reaches experience significantly greater numbers of fish in the fall than in the spring or summer. However, variable ALR and discharge conditions during the summer and fall trips likely influenced distribution and catchability. Fish usage both before and after minimum flow/REV5 tended to be higher and more consistent in the lower reaches (Reaches 1 and 2) than the higher reaches (Reaches 3 and 4).

2. *How do juvenile fishes use the mainstem habitats in the Middle Columbia River?*

    - Juvenile habitat use in the Middle Columbia River is primarily associated with rearing (April to September). In addition it is reasonable to assume that overwintering likely occurs within the study area since depths and habitat conditions would be suitable. However, sampling did not occur in the winter and therefore this assumption cannot be validated.

3. *What factors affect recruitment of juvenile life stages in the Middle Columbia River?*
    a. *Do operational strategies for Revelstoke Dam and Arrow Lake Reservoir influence the availability of juvenile fishes' preferred habitats?*

        - All habitats sampled in Years 1-6 of the study were accessible and no changes in habitat quality, quantity or accessibility were noted post-minimum flow. The minimum base flow and influence of the ALR do not limit habitat access.
        - Habitat characteristics of sites with high abundance of the most common species were similar throughout Years 1 to 6 suggesting that operational strategies have not influenced the availability of preferred habitats. Although overall catch-per-unit-effort of juvenile fish decreased post-minimum flow, the difference was not statistically significant. In the spring when conditions were most consistent across the 6 years of study, there were no differences in CPUE at any reach pre- vs. post-minimum flow. In the summer, CPUE pre-minimum flow was higher at all reaches but in the fall was only higher in Reach 4.

    b. *Do current operational strategies affect availability of the food base for juvenile fish life stages?*

- Length, weight and condition factor data of the most abundant species in the system were stable in Years 1 – 6 with no apparent trend with respect to the change in flow associated with minimum flow and Rev 5.
- Data from CLBMON-15b (Ecological Productivity) was reviewed and preliminary analysis shows that increasing the amount of time the food base (periphyton and invertebrates) is submerged, increases overall biomass of these organisms. Further conclusions are expected as CLBMON-15b progresses in coming years.

c. *Do predators influence fish recruitment and habitat use in the Middle Columbia River?*
    - Adult piscivorous fish such as large Rainbow Trout, Bull Trout, Sculpins and Redside Shiners are present in the system and are known to prey on other species. Review of the results of CLBMON 16 (Fish Population Indexing) show that the adult population of potential predators has been relatively constant throughout 2008 to 2013 suggesting that the implementation of minimum flows has not effected predator populations. As the results of CLBMON-17 also show a relatively stable juvenile fish community it is likely that predation pressure has also remained relatively constant. Consequently, whatever effect predation had on juvenile recruitment pre Rev 5, the same pressure exits post Rev 5.

6.0 CLOSURE

This report was written by Damian Slivinski and Greg Sykes (Triton – Kamloops) with statistical analysis completed by Grahame Gieliens (Triton – Kamloops). The draft report was reviewed by Greg Sykes (Triton – Kamloops).

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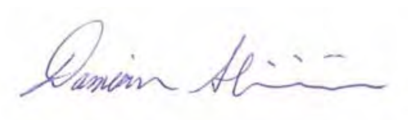

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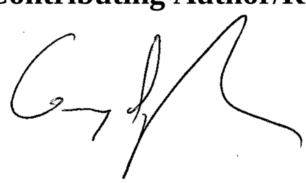

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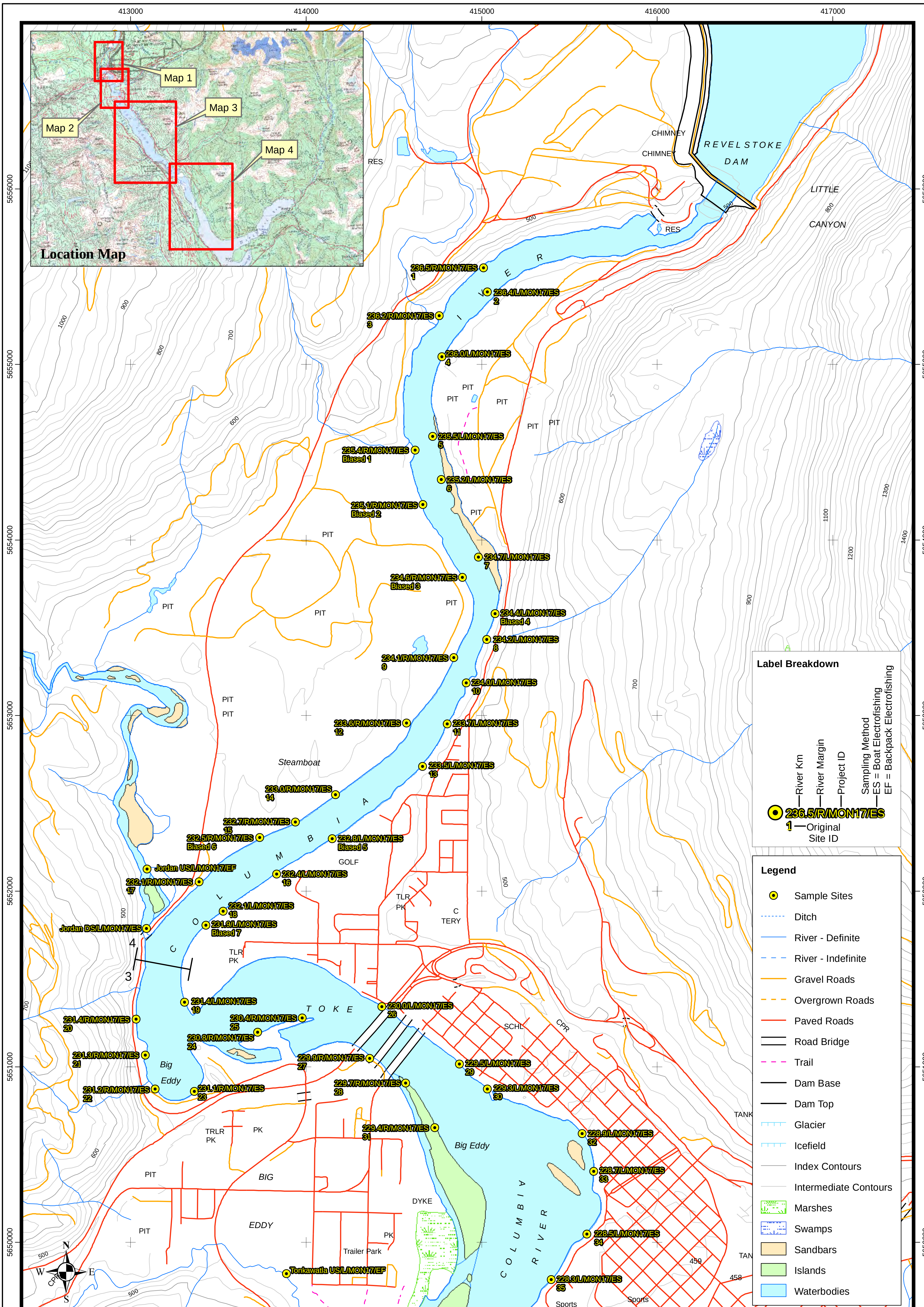
Appendix 1a

Site Location Maps



MIDDLE COLUMBIA RIVER
JUVENILE HABITAT USE

0 100 200 400 600 800 1,000 1,200 Meters

Scale: 1:20,000

TRIM Basemap
MAP 1

NO.	DATE (yyyy/mm/dd)	REVISION	BY
1	2008/04/23	Initial Draft	SM
2	2008/07/18	May 2008 Waypoints added	DW
3	2008/09/08	Updated with July High Reservoir Waypoints	DW
4	2009/02/12	Replaced sites with new data	SM

Basemap Source: TRIM Data

Map Datum: UTM NAD 83 Zone 11

Project No: 3943

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Date: Feb 1, 2012

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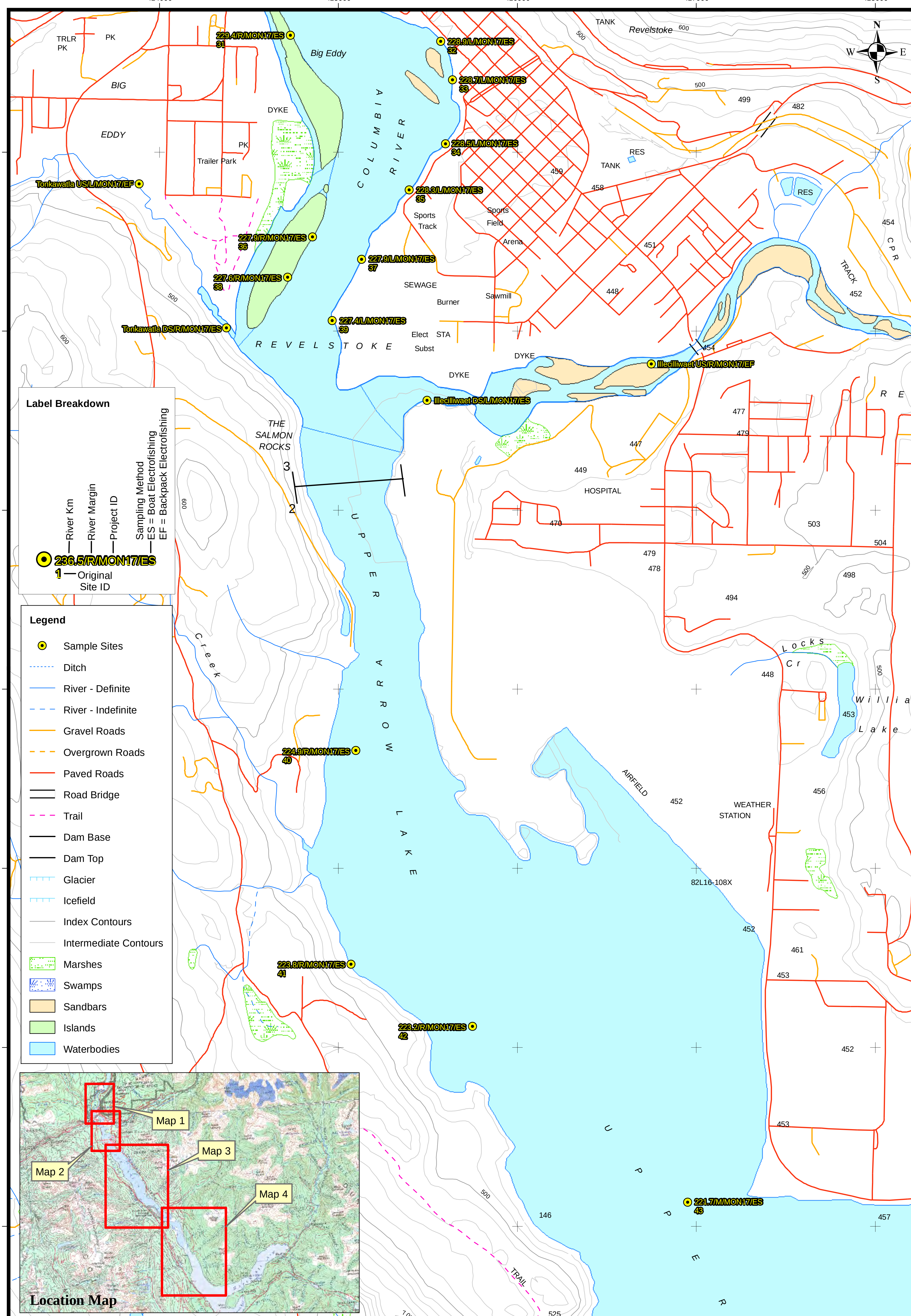

MIDDLE COLUMBIA RIVER
JUVENILE HABITAT USE

0 100 200 400 600 800 1,000 1,200 Meters

Scale: 1:20,000

TRIM Basemap
MAP 2

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2	2008/07/18	May 2008 Waypoints added	DW
3	2008/09/08	Updated with July High Reservoir Waypoints	DW
4	2009/02/12	Replaced sites with new data	SM

Basemap Source: TRIM Data

Map Datum: UTM NAD 83 Zone 11

Project No: 3943

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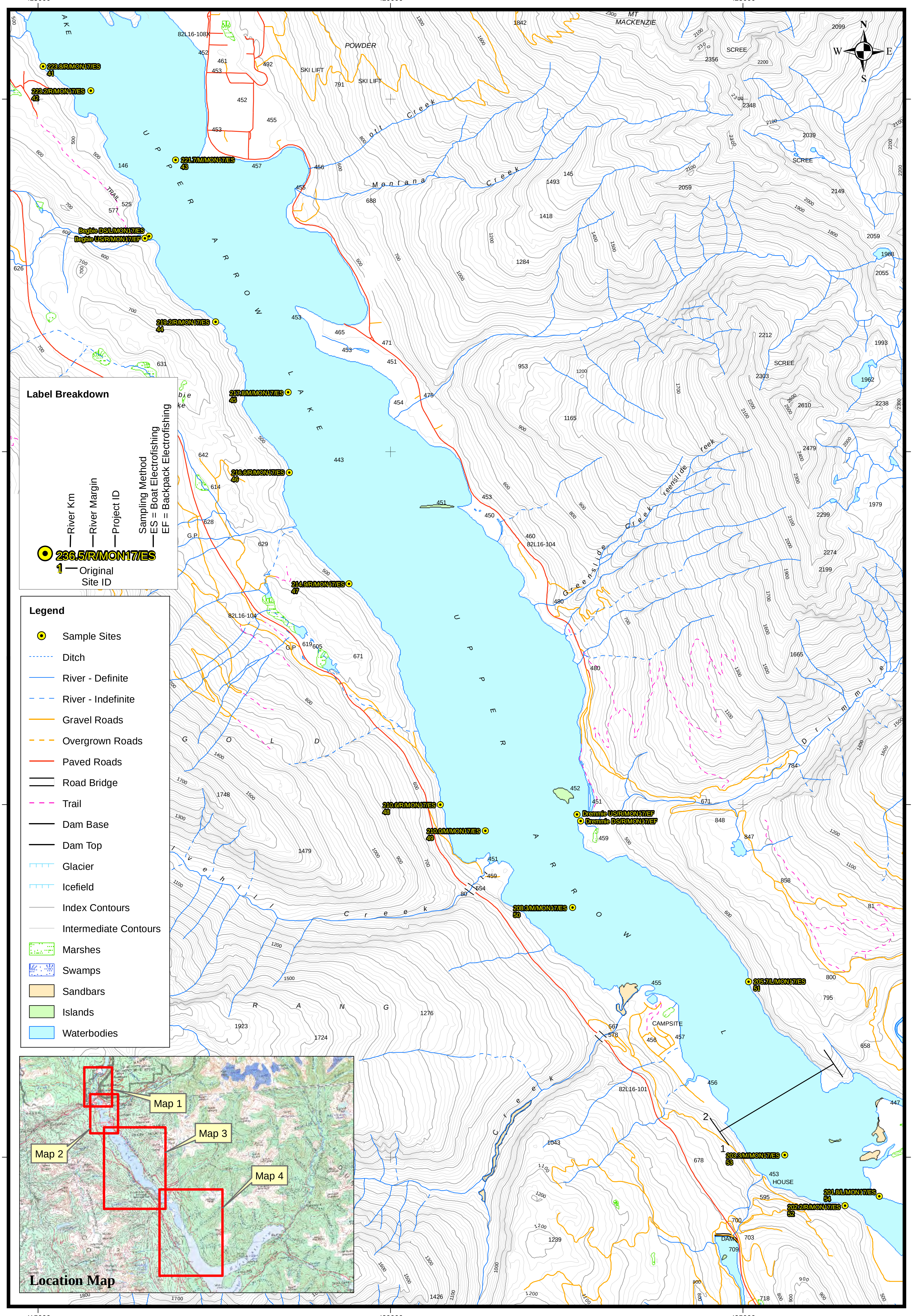

415000 420000 425000

MIDDLE COLUMBIA RIVER
JUVENILE HABITAT USE

0 250 500 1,000 1,500 2,000 2,500 3,000 Meters

Scale: 1:50,000

TRIM Basemap
MAP 3

NO.	DATE (yyyy/mm/dd)	REVISION	BY
1	2008/04/23	Initial Draft	SM
2	2008/07/18	May 2008 Waypoints added	DW
3	2008/09/08	Updated with July High Reservoir Waypoints	DW
4	2009/02/12	Replaced sites with new data	SM

Basemap Source: TRIM Data

Map Datum: UTM NAD 83 Zone 11

Project No: 3943

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Date: Feb 1, 2012

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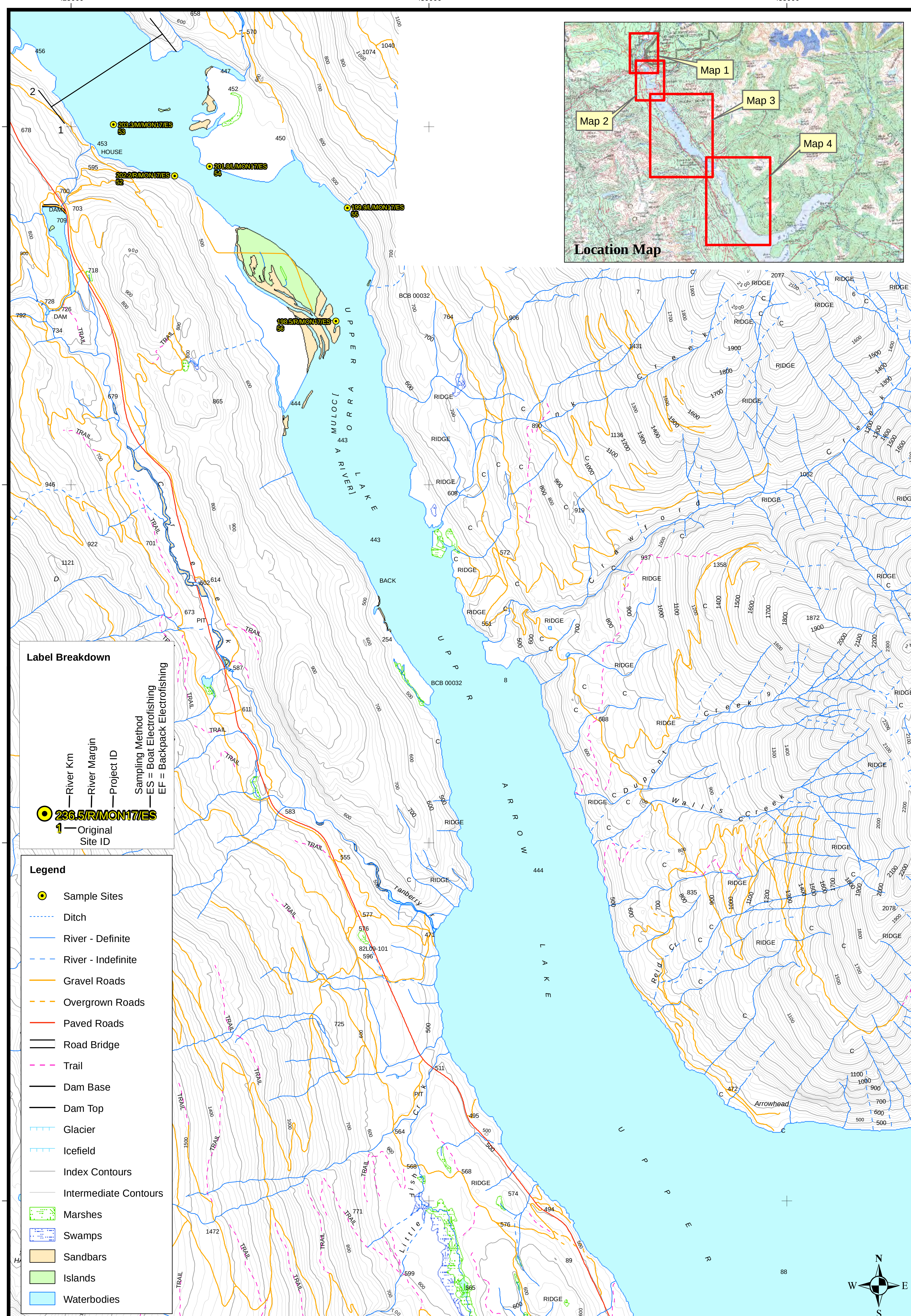

MIDDLE COLUMBIA RIVER JUVENILE HABITAT USE

0 250 500 1,000 1,500 2,000 2,500 3,000 Meters

Scale: 1:50,000

TRIM Basemap
MAP 4

NO.	DATE (yyyy/mm/dd)	REVISION	BY
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2	2008/07/18	May 2008 Waypoints added	DW
3	2008/09/08	Updated with July High Reservoir Waypoints	DW
4	2009/02/12	Replaced sites with new data	SM

Basemap Source:	Map Datum:
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Appendix 1b

Site Label Summary

Original Site Label	Reach	UTM Zone	Easting	Northing	River km	2013 Site Label
1	4	11	415011	5655550	236Km 520m	236.5/R/MON17/ES
2	4	11	415033	5655414	236Km 440m	236.4/L/MON17/ES
3	4	11	414759	5655278	236Km 160m	236.2/R/MON17/ES
4	4	11	414774	5655044	235Km 980m	236.0/L/MON17/ES
5	4	11	414721	5654590	235Km 460m	235.5/L/MON17/ES
6	4	11	414771	5654345	235Km 200m	235.2/L/MON17/ES
7	4	11	414983	5653903	234Km 700m	234.7/L/MON17/ES
8	4	11	415029	5653434	234Km 240m	234.2/L/MON17/ES
9	4	11	414842	5653330	234Km 60m	234.1/R/MON17/ES
10	4	11	414913	5653186	233Km 980m	234.0/L/MON17/ES
11	4	11	414804	5652953	233Km 720m	233.7/L/MON17/ES
12	4	11	414572	5652958	233Km 600m	233.6/R/MON17/ES
13	4	11	414664	5652711	233Km 460m	233.5/L/MON17/ES
14	4	11	414168	5652550	232Km 980m	233.0/R/MON17/ES
15	4	11	413940	5652395	232Km 700m	232.7/R/MON17/ES
16	4	11	413832	5652098	232Km 440m	232.4/L/MON17/ES
17	4	11	413391	5652054	232Km 80m	232.1/R/MON17/ES
18	4	11	413528	5651887	232Km 60m	232.1/L/MON17/ES
19	3	11	413308	5651369	231Km 380m	231.4/L/MON17/ES
20	3	11	413031	5651272	231Km 320m	231.4/R/MON17/ES
21	3	11	413084	5651067	231Km 260m	231.3/R/MON17/ES
22	3	11	413140	5650874	231Km 220m	231.2/R/MON17/ES
23	3	11	413363	5650860	231Km 140m	231.1/R/MON17/ES

Original Site Label	Reach	UTM Zone	Easting	Northing	River km	2013 Site Label
24	3	11	413725	5651198	230Km 820m	230.8/R/MON17/ES
25	3	11	413978	5651279	230Km 440m	230.4/R/MON17/ES
26	3	11	414432	5651342	230Km 40m	230.0/L/MON17/ES
27	3	11	414363	5651049	229Km 900m	229.9/R/MON17/ES
28	3	11	414568	5650908	229Km 660m	229.7/R/MON17/ES
29	3	11	414874	5651016	229Km 500m	229.5/L/MON17/ES
30	3	11	415033	5650874	229Km 300m	229.3/L/MON17/ES
31	3	11	414733	5650653	229Km 360m	229.4/R/MON17/ES
32	3	11	415573	5650619	228Km 880m	228.9/L/MON17/ES
33	3	11	415639	5650404	228Km 740m	228.7/L/MON17/ES
34	3	11	415600	5650047	228Km 480m	228.5/L/MON17/ES
35	3	11	415397	5649789	228Km 280m	228.3/L/MON17/ES
36	3	11	414857	5649527	227Km 860m	227.9/R/MON17/ES
37	3	11	415131	5649401	227Km 860m	227.9/L/MON17/ES
38	3	11	414717	5649302	227Km 600m	227.6/R/MON17/ES
39	3	11	414966	5649060	227Km 420m	227.4/L/MON17/ES
40	2	11	415098	5646658	224Km 940m	224.9/R/MON17/ES
41	2	11	415071	5645464	223Km 820m	223.8/R/MON17/ES
42	2	11	415750	5645118	223Km 220m	223.2/R/MON17/ES
43	2	11	416952	5644136	221Km 700m	221.7/M/MON17/ES
44	2	11	417518	5641842	219Km 220m	219.2/R/MON17/ES
45	2	11	418549	5640843	217Km 760m	217.8/M/MON17/ES
46	2	11	418566	5639705	216Km 600m	216.6/R/MON17/ES

Original Site Label	Reach	UTM Zone	Easting	Northing	River km	2013 Site Label
47	2	11	419413	5638130	214Km 900m	214.9/R/MON17/ES
48	2	11	420707	5634996	210Km 620m	210.6/R/MON17/ES
49	2	11	421348	5634623	210Km 0m	210.0/M/MON17/ES
50	2	11	422583	5633535	208Km 320m	208.3/M/MON17/ES
51	2	11	425079	5632489	205Km 680m	205.7/L/MON17/ES
52	1	11	426448	5629314	202Km 180m	202.2/R/MON17/ES
53	1	11	425593	5630028	203Km 280m	203.3/M/MON17/ES
54	1	11	426935	5629443	201Km 800m	201.8/L/MON17/ES
55	1	11	428860	5628865	199Km 880m	199.9/L/MON17/ES
56	1	11	428700	5627286	198Km 500m	198.5/R/MON17/ES
Biased 1	4	11	414622	5654512	235Km 400m	235.4/R/MON17/ES
Biased 2	4	11	414666	5654202	235Km 100m	235.1/R/MON17/ES
Biased 3	4	11	414891	5653788	234Km 640m	234.6/R/MON17/ES
Biased 4	4	11	415077	5653582	234Km 400m	234.4/L/MON17/ES
Biased 5	4	11	414149	5652299	232Km 820m	232.8/L/MON17/ES
Biased 6	4	11	413737	5652306	232Km 460m	232.5/R/MON17/ES
Biased 7	4	11	413429	5651806	231Km 920m	231.9/L/MON17/ES
Begbie Creek D/S	2	11	416576	5643056	220Km 660m	Begbie Creek D/S
Begbie Creek U/S	2	11	416517	5643027	220Km 640m	Begbie Creek U/S
Dremmie Creek D/S	2	11	422646	5634859	209Km 80m	DrImmie US/R/MON17/EF
Dremmie Creek U/S	2	11	422696	5634766	209Km 0m	DrImmie DS/R/MON17/EF
Illecillewaet D/S	2	11	415497	5648614	226Km 740m	Illecilliwaet DS/L/MON17/ES

Original Site Label	Reach	UTM Zone	Easting	Northing	River km	2013 Site Label
Illecillewaet U/S	2	11	416749	5648818	226Km 620m	Illecillewaet US/R/MON17/EF
Jordan River D/S	3	11	413091	5651788	231Km 720m	Jordan DS/L/MON17/ES
Jordan River U/S	3	11	413095	5652126	231Km 940m	Jordan US/L/MON17/ES
Tonkawatla Creek D/S	3	11	414376	5649018	227Km 380m	Tonkawatla DS/R/MON17/ES
Tonkawatla Creek U/S	3	11	413888	5649823	227Km 700m	Tonkawatla US/L/MON17/EF

Appendix 1c

Habitat characteristics of sites with the highest catch-per-unit-effort (CPUE) of juveniles of the seven most abundant species for 2008 – 2013.

Year	Site	Trip	CPUE	Habitat[1]	Discharge (m^3/s)	Mean Depth (m) at station from shore: 0 m	1.5 m	3 m	Mean Vel. (m/s) at station from shore: 0 m	1.5 m	3 m
Bull Trout											
2008	22	2	0.010	Steep G/C	463	0.08	0.59	0.93	0	0	0
	Bias 3	2	0.007	Steep G/C	264	0	0.43	0.83	0	0	0.03
	21	3	0.005	Bedrock	757	0.67	1.18	1.49	0.20	0.25	0.38
	19	2	0.004	Low G/C	539	0.07	0.43	0.57	0	0.01	0.09
	21	1	0.004	Bedrock	258	0	0.85	1.73	0	0.26	0.33
	Bias 6	2	0.004	Low G/C	265	0.30	0.65	0.93	0	0	0
2009	31	2	0.013	Steep Fine	403	0	0.41	0.70	0	0.08	0.13
	23	2	0.007	Steep G/C	16	0	0.50	1.15	0	0	0
	36	2	0.007	Steep Fine	16	0	0.63	1.00	0	0	0
	39	2	0.006	Low G/C	16	0	0.62	1.00	0	0	0
	38	2	0.006	Steep Fine	16	0	0.93	1.37	0	0	0
	27	3	0.006	Steep Fine	13	0	0.50	0.55	0	0	0.02
2010	24	1	0.015	Low G/C	19	0	0.10	0.29	0	0.06	0.30
	Bias 7	3	0.014	Bedrock	420	0	0.90	1.59	0	0.18	0.27
	18	1	0.013	Rip-rap	19	0.01	0.54	1.10	0	0.17	0.01
	31	1	0.011	Steep Fine	614	0	0.23	0.36	0	0.14	0.34
	17	3	0.009	Low G/C	358	0	0.23	0.43	0	0.01	0.05
	Bias 3	2	0.009	Steep G/C	21	0	0.25	0.56	0	0	0
2011	47	1	0.012	Bedrock	154	0	1.12	2.01	0	0.03	0
	8	3	0.009	Steep B	598	0	0.47	0.88	0	0.10	0.20
	26	1	0.008	Rip-rap	1284	0	0.8	1.37	0	0.10	0.24
	28	1	0.008	Steep Fine	159	0	0.43	0.62	0	0.12	0.12
	10	3	0.008	Bedrock	604	0	1.72	2.9	0	0.18	0.27
2012	44	1	0.006	Bedrock	603	0	0.72	2.57	0	0.14	0.19
	23	1	0.0045	Steep G/C	1058	0	0.57	1	0	0.07	0.12
	3	3	0.0041	Steep G/C	1268	0	0.55	1.06	0	0.21	0.39
	42	1	0.004	Steep G/C	230	0	0.35	0.59	0	0.01	0.01
	Bias 5	2	0.0036	Steep G/C	1629	0	0.31	0.62	0	0.01	0.08
2013	29	1	0.013	Rip-rap	168	0	0.95	1.59	0	0.44	0.66
	38	1	0.011	Steep Fine	317	0	0.36	0.92	0	0.05	0.12
	Bias 4	3	0.008	Steep B	355	0	0.51	1.08	0	0.08	0.15
	Bias 3	3	0.008	Low G/C	355	0	0.48	0.94	0	0.11	0.47
	10	3	0.007	Bedrock	315	0.16	2.08	2.57	0.30	0.22	0.38
	39	3	0.005	Steep G/C	1396	0	0.50	0.97	0	0.31	0.59
Rainbow Trout											
2008	35	2	0.015	Rip-rap	267	0.12	1.28	7.23	0	0	0
	34	1	0.013	Rip-rap	1217	0	1.04	1.86	0	0.06	0.14
	35	1	0.011	Rip-rap	1179	0	1.37	2.07	0	0.14	0.34
	22	2	0.01	Steep G/C	463	0.08	0.59	0.93	0	0	0
	26	2	0.01	Rip-rap	585	0	0.43	1.27	0	0	0
	44	3	0.009	Bedrock	636	0	0.88	1.65	0	0	0
2009	55	1	0.019	Bedrock	998	0	0.76	1.51	0	0	0
	48	2	0.017	Steep G/C	785	0.03	0.87	1.20	0	0	0
	55	2	0.015	Bedrock	272	0	0.6	1.07	0	0	0
	Bias 7	1	0.013	Rip-rap	330	0.02	1.19	1.70	0	0.07	0.11
	30	2	0.009	Rip-rap	979	0	0.83	1.57	0	0.06	0.09
	47	2	0.009	Bedrock	16	0	1.33	1.87	0	0	0

Year	Site	Trip	CPUE	Habitat[1]	Discharge (m^3/s)	Mean Depth (m) at station from shore: 0 m	1.5 m	3 m	Mean Vel. (m/s) at station from shore: 0 m	1.5 m	3 m
2010	23	2	0.052	Steep G/C	178	0	0.45	0.72	0	0	0
	31	1	0.052	Steep Fine	614	0	0.23	0.36	0	0.14	0.34
	22	2	0.048	Steep G/C	95	0	0.38	0.71	0	0	0
	28	2	0.042	Steep Fine	438	0	0.45	0.61	0	0.01	0.01
	12	2	0.040	Steep G/C	21	0	0.23	0.52	0	0	0
	25	3	0.037	Low G/C	1110	0	0.35	0.57	0	0.07	0.12
2011	35	2	0.035	Rip-rap	459	0	0.76	2.04	0	0.01	0.03
	35	1	0.031	Rip-rap	154	0	0.74	1.80	0	0.10	0.21
	30	1	0.025	Rip-rap	153	0	0.79	1.46	0	0.17	0.34
	44	2	0.024	Bedrock	1275	0.03	0.99	1.92	0	0	0
	47	2	0.024	Bedrock	1569	0	0.93	1.81	0	0.02	0.02
	34	2	0.021	Rip-rap	427	0	0.89	1.48	0	0	0
2012	34	3	0.017	Rip-rap	1318	0	0.63	1.40	0	0.15	0.18
	35	2	0.011	Rip-rap	434	0	0.57	2.69	0	0	0
	26	3	0.011	Rip-rap	715	0	0.78	1.48	0	0.01	0.10
	55	1	0.010	Bedrock	671	0	0.65	2.04	0	0.03	0.02
	21	1	0.008	Bedrock	920	0	1.17	1.50	0	0.34	0.70
2013	35	2	0.019	Rip-rap	272	0.19	1.00	2.75	0	0	0.02
	30	3	0.015	Rip-rap	1519	0	0.72	1.11	0	0.16	0.42
	44	2	0.011	Bedrock	786	0	1.50	2.60	0	0	0
	34	2	0.008	Rip-rap	271	0.34	1.15	1.84	0	0	0
	26	3	0.007	Rip-rap	683	0	0.77	1.66	0	0.16	0.19
	26	2	0.006	Rip-rap	545	0	0.91	1.77	0	0	0.01
Mountain Whitefish											
2008	42	1	0.058	Steep G/C	1571	0	0.33	0.55	0	0.02	0.24
	22	1	0.032	Steep G/C	261	0	0.42	0.85	0	0.05	0.07
	55	1	0.030	Bedrock	1527	0	0.75	4.15	0	0.03	0.06
	11	3	0.027	Bedrock	813	0	0.50	1.28	0	0.03	0.19
	43	1	0.025	Steep Fine	1376	0	0.32	0.78	0	0.14	0.13
	11	2	0.023	Bedrock	19	0	0.68	1.37	0	0.02	0.02
2009	27	3	0.155	Steep G/C	13	0	0.50	0.55	0	0	0.02
	45	3	0.144	Steep G/C	13	0	0.56	0.89	0	0	0.01
	23	2	0.117	Rip-rap	16	0	0.50	1.15	0	0	0
2010	10	3	0.119	Bedrock	23	0	0.77	1.58	0	0.02	0.07
	Bias 5	3	0.105	Steep G/C	23	0	0.30	0.42	0	0.02	0.10
	44	3	0.070	Bedrock	1032	0	0.89	1.72	0	0.01	0.01
	12	3	0.059	Steep G/C	537	0	0.33	0.69	0	0.32	0.34
2011	56	1	0.360	Steep Fine	1225	0	0.53	0.85	0	0	0
	19	2	0.151	Low G/C	313	0	0.35	0.41	0	0	0.03
	20	3	0.102	Low Fine	323	0.11	0.30	0.45	0.03	0.02	0.08
	53	1	0.095	Low Fine	250	0	0.33	0.48	0	0	0.01
	22	3	0.053	Low G/C	336	0	0.41	0.73	0	0.05	0.08
2012	30	3	0.048	Rip-rap	961	0	0.37	0.97	0	0.01	0.26
	53	3	0.034	Steep Fine	1650	0.41	0.61	0.77	0.01	0.01	0.01
	20	3	0.030	Steep G/C	741	0.27	0.51	0.7	0.12	0.2	0.2
	43	3	0.028	Steep Fine	1668	0.19	0.69	1.01	0	0.01	0.14
	29	3	0.027	Rip-rap	961	0	0.56	0.88	0	0.08	0.23
	Bias 1	3	0.025	Low G/C	1268	0	0.4	1.29	0	0.06	0.05

Year	Site	Trip	CPUE	Habitat[1]	Discharge (m^3/s)	Mean Depth (m) at station from shore: 0 m	1.5 m	3 m	Mean Vel. (m/s) at station from shore: 0 m	1.5 m	3 m
2013	39	3	0.136	Steep G/C	1396	0	0.50	0.97	0	0.31	0.59
	31	3	0.105	Steep G/C	1474	0	0.56	0.84	0	0.09	0.24
	38	3	0.036	Steep Fine	1589	0	0.62	1.13	0	0.27	0.43
	50	3	0.036	Steep Fine	890	0.22	0.34	0.54	0.01	0.01	0.01
	30	3	0.021	Steep G/C	1519	0	0.72	1.11	0	0.16	0.42
	42	1	0.021	Steep Fine	288	0	0.26	0.59	0	0.01	0.02
Kokanee											
2008	38	2	0.041	Steep Fine	680	0	0.62	3.88	0	0	0
	19	2	0.033	Low G/C	539	0.07	0.43	0.57	0	0.01	0.09
	17	2	0.032	Low G/C	510	0	0.17	0.35	0	0	0
	31	2	0.024	Steep Fine	19	0.48	0.88	2.93	0	0	0
	4	3	0.024	Steep B	972	0	0.62	1.10	0	0.17	0.28
	30	3	0.022	Rip-rap	699	0.07	0.68	1.40	0	0.02	0.04
2009	22	3	0.098	Steep Fine	314	0	0.52	0.66	0	0	0.02
	23	3	0.086	Rip-rap	299	0	0.41	0.66	0	0	0
	40	3	0.035	Steep Fine	1091	0	0.67	1.05	0	0.07	0.16
2010	17	3	0.060	Low G/C	358	0	0.23	0.43	0	0.01	0.05
	9	3	0.050	Low G/C	562	0	0.42	0.74	0	0.01	0.04
	7	3	0.035	Low G/C	283	0	0.26	0.60	0	0.17	0.27
	34	3	0.034	Rip-rap	338	0	0.84	1.65	0	0.02	0.05
	19	3	0.024	Low G/C	368	0	0.34	0.47	0	0.11	0.10
	54	3	0.023	Steep Fine	962	0	0.57	0.99	0	0	0.00
2011	17	2	0.136	Low Fine	1109	0.33	0.65	0.73	0	0.09	0.25
	20	3	0.079	Low Fine	323	0.11	0.30	0.45	0.03	0.02	0.08
	22	3	0.066	Low G/C	336	0	0.41	0.73	0	0.05	0.08
	37	3	0.057	Low Fine	323	0	0.53	0.69	0	0	0
	40	3	0.047	Low Fine	320	0.13	0.51	0.91	0	0	0
	21	3	0.044	Bedrock	322	0	0.73	0.98	0	0.21	0.44
2012	27	3	0.098	Low G/C	1281	0	0.15	0.26	0	0.02	0.04
	4	3	0.027	Steep G/C	1268	0	0.63	1.64	0	0.33	0.65
	37	3	0.026	Steep Fine	1478	0	0.58	0.94	0	0.16	0.25
	37	2	0.019	Low Fine	434	1.25	1.55	1.93	0	0	0
2013	31	3	0.082	Steep G/C	1474	0	0.56	0.84	0	0.09	0.24
	37	3	0.045	Steep G/C	1396	0	1.22	1.58	0	1.28	1.30
	20	3	0.014	Rip-rap	1304	0	0.50	0.77	0	0.13	0.27
	23	3	0.012	Steep G/C	1615	0.33	0.95	1.49	0.01	0.02	0.05
	45	1	0.010	Low Fine	1582	0.00	0.35	0.94	0.00	0.16	0.48

Year	Site	Trip	CPUE	Habitat[1]	Discharge (m^3/s)	Mean Depth (m) at station from shore: 0 m	1.5 m	3 m	Mean Vel. (m/s) at station from shore: 0 m	1.5 m	3 m
Sculpins											
2008	12	3	0.045	Steep G/C	315	0	0.35	0.65	0	0.06	0.12
	9	2	0.037	Low G/C	263	0	0.53	0.97	0	0.01	0.03
	30	3	0.034	Rip-rap	699	0.07	0.68	1.40	0	0.02	0.04
	21	2	0.033	Bedrock	267	1	3.82	3.64	0	0	0
	Bias 1	2	0.027	Low G/C	263	0	0.40	0.79	0	0	0
	Bias 2	2	0.027	Steep G/C	267	0	0.48	0.98	0	0.02	0.04
2009	20	2	0.077	Rip-rap	16	0	0.36	0.49	0	0	0
	21	2	0.073	Low G/C	16	0	1.47	2.73	0	0	0
	54	2	0.068	Bedrock	656	0	0.50	0.73	0	0	0
	33	2	0.064	Steep Fine	169	0	0.83	1.37	0	0	0.03
	33	3	0.063	Steep Fine	13	0	0.75	1.28	0	0.06	0.11
	Bias 2	2	0.054	Bedrock	16	0	0.47	0.71	0	0	0
2010	52	1	0.303	Bedrock	21	0	0.95	1.97	0	0	0
	Bias 2	1	0.184	Steep G/C	19	0	0.32	0.72	0	0	0.01
	29	1	0.146	Rip-rap	371	0.02	0.27	0.38	0	0.11	0.14
	22	2	0.120	Steep G/C	95	0	0.38	0.71	0	0	0
	Bias 2	2	0.111	Steep G/C	21	0	0.29	0.62	0	0	0
	19	2	0.108	Low G/C	435	0	0.19	0.40	0	0.09	0.21
2011	33	1	0.107	Steep G/C	318	0	0.73	1.45	0	0.14	0.26
	Bias 2	1	0.092	Steep G/C	152	0	0.29	0.83	0	0	0
	13	2	0.089	Steep G/C	666	0	0.47	0.96	0	0.16	0.30
	41	3	0.085	Low Fine	320	0	0.85	1.38	0	0	0
	33	3	0.076	Steep G/C	511	0	0.78	1.11	0	0.04	0.06
	15	3	0.071	Steep G/C	330	0	0.64	0.94	0	0.14	0.32
2012	15	1	0.152	Steep B	312	0	0.69	1.18	0	0.30	0.48
	Bias 7	1	0.110	Rip-rap	317	0	0.63	1.53	0	0.17	0.25
	33	3	0.070	Steep G/C	891	0	0.52	1.42	0	0.20	0.37
	33	1	0.063	Steep G/C	155	0	0.77	1.29	0	0.25	0.41
2013	30	1	0.192	Rip-rap	168	0	0.93	2.48	0	0.05	0.32
	45	3	0.144	Low Fine	1582	0	0.35	0.94	0	0.16	0.48
	29	1	0.088	Rip-rap	168	0	0.95	1.59	0	0.44	0.66
	47	3	0.077	Steep B	1454	0	1.09	2.06	0	0.20	0.32
	12	2	0.066	Steep G/C	423	0	0.61	0.85	0	0.06	0.12
	35	1	0.065	Rip-rap	254	0.07	1.31	1.88	0	0.05	0.15
Redside Shiner											
2008	51	1	0.093	Bedrock	159	0	0.83	1.28	0	0.02	0.02
	44	1	0.086	Bedrock	734	3.68	4.03	4.43	0.02	0.06	0.26
	32	1	0.033	Steep G/C	1163	0	0.71	1.19	0	0.03	0.04
	52	1	0.023	Bedrock	1436	0	0.97	4.50	0	0.07	0.09
2009	44	1	0.192	Bedrock	1053	0.23	2.00	2.55	0.01	0.16	0.25
	52	1	0.073	Bedrock	608	0	0.93	2.23	0	0	0
	51	1	0.067	Bedrock	333	0	0.69	0.89	0	0	0
	52	2	0.053	Steep Fine	603	0	0.87	1.57	0	0	0
2010	5	3	0.049	Low G/C	279	0	0.52	1.91	0	0.12	0.28
	1	3	0.044	Steep G/C	626	0	0.44	0.79	0	0.17	0.27
	22	1	0.041	Steep G/C	318	0	0.43	0.83	0	0.04	0.07
	12	1	0.036	Steep G/C	19	0	0.26	0.40	0	0.14	0.15

Year	Site	Trip	CPUE	Habitat[1]	Discharge (m^3/s)	Mean Depth (m) at station from shore: 0 m	1.5 m	3 m	Mean Vel. (m/s) at station from shore: 0 m	1.5 m	3 m
2011	48	1	0.411	Bedrock	156	0	1.29	3.07	0	0	0
	55	3	0.273	Bedrock	1020	0	0.68	1.28	0	0	0
	52	1	0.132	Steep B	599	0	0.85	1.62	0	0.01	0.03
	51	3	0.098	Bedrock	906	0	1.23	2.22	0	0	0
2012	55	1	0.105	Steep B	671	0	0.65	2.04	0	0.01	0.02
	51	1	0.067	Steep B	557	0	0.84	1.47	0	0	0
	55	3	0.052	Bedrock	1642	0	0.73	1.63	0	0	0
	32	1	0.036	Steep G/C	155	0	0.63	1.24	0	0.09	0.13
2013	54	3	0.148	Steep Fine	1536	0	0.49	0.83	0	0.07	0.06
	44	3	0.133	Steep B	1383	0	0.91	1.95	0	0.18	0.18
	43	3	0.121	Low Fine	969	0	0.51	0.98	0	0.13	0.23
	51	3	0.068	Bedrock	1522	0	0.71	1.23	0	0	0
Largescale Sucker											
2008	-	-	-	-	-	-	-	-	-	-	-
2009	16	3	0.021	Steep G/C	13	0	0.54	0.87	0	0.07	0.14
	52	1	0.005	Bedrock	608	0	0.93	2.23	0	0	0
2010	37	3	0.0039	Steep Fine	23	0	0.29	0.55	0	0.003	0.003
	18	3	0.0035	Rip-rap	355	0	0.73	1.31	0	0.06	0.17
	12	1	0.0030	Steep G/C	19	0	0.26	0.40	0	0.14	0.15
	16	3	0.0029	Rip-rap	595	0	0.85	1.61	0	0.24	0.43
2011	49	1	0.0044	Low Fine	Err[2]	0	0.28	0.48	0	0	0.03
	29	1	0.0035	Rip-rap	154	0	0.85	1.96	0	0.73	0.98
	6	1	0.0033	Steep G/C	155	0	0.54	1.18	0	0	0.08
	55	3	0.0028	Rip-rap	Err	0	0.68	1.28	0	0	0
2012	51	3	0.0033	Bedrock	1659	0	0.78	1.47	0	0	0
	55	1	0.0032	Steep B	671	0	0.65	2.04	0	0.01	0.02
	9	3	0.0032	Steep G/C	1489	0	0.58	1.0	0	0.15	0.18
	52	1	0.0029	Steep B	574	0	1.12	2.33	0	0.01	0.04
2013	43	1	0.0032	Low Fine	288	0	1.06	1.50	0	0.05	0.08
	35	1	0.0026	Rip-rap	254	0.07	1.31	1.88	0	0.05	0.15

[1] G/C = Gravel/Cobble; B = Boulder

[2] Err – System error in discharge data output from Revelstoke Dam

Appendix 2a

Representative Site Photographs

Comparison of high discharge (2008 site inventory) and low discharge conditions (5:00 - 5:30 AM on June 2, 2010)

Plate 1a. Typical steep slope site with gravel and cobble substrates (Site 1, Reach 4). High flow.

Plate 1b. Typical steep slope site with gravel and cobble substrates (Site 1, Reach 4). Low flow.

Plate 2a. Typical steep slope site with gravel and cobble substrates (Site 2, Reach 4). High flow.

Plate 2b. Typical steep slope site with gravel and cobble substrates (Site 2, Reach 4). Low flow.

Plate 3a. Typical steep slope site with gravel and cobble substrates (Site 3, Reach 4). High flow.

Plate 3b. Typical steep slope site with gravel and cobble substrates (Site 3, Reach 4). Low flow

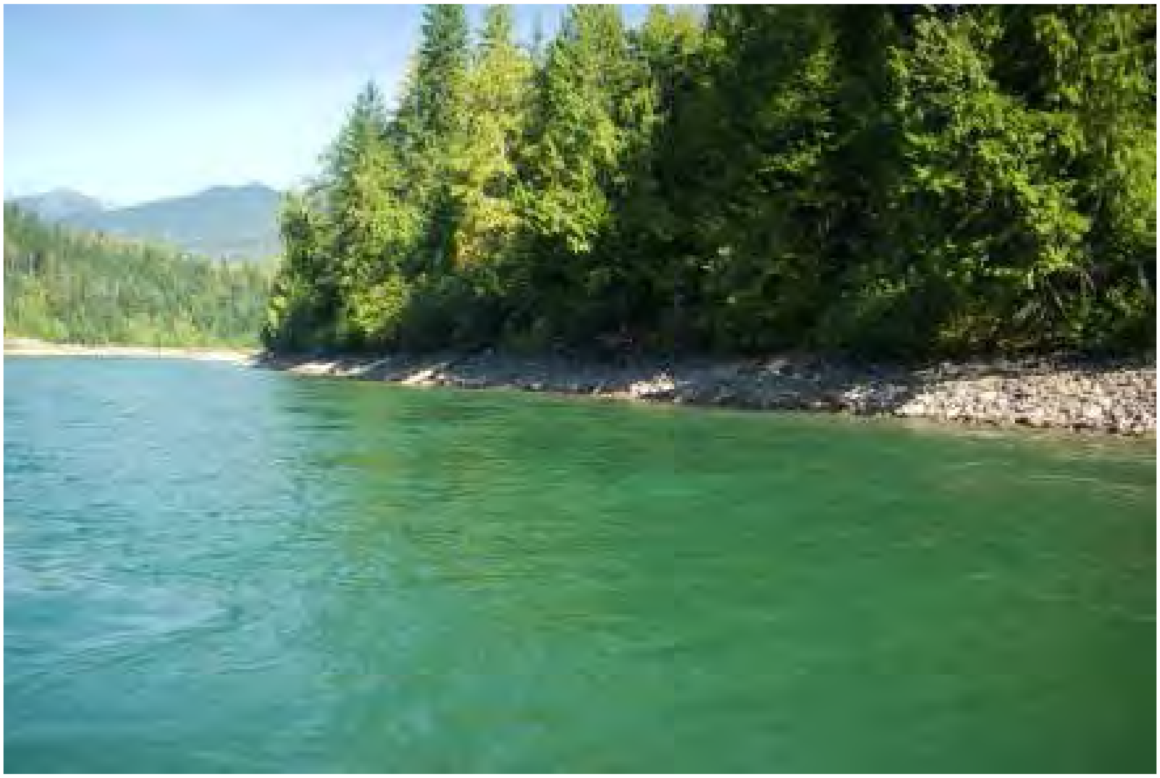

Plate 4a. Typical steep slope site with boulder substrates (Site 4, Reach 4). High flow.

Plate 4b. Typical steep slope site with boulder substrates (Site 4, Reach 4). Low flow.

Plate 5a. Typical shallow slope site with gravel and cobble substrates (Site 6, Reach 4). High flow.

Plate 5b. Typical shallow slope site with gravel and cobble substrates (Site 6, Reach 4). Low flow.

Plate 6a. Typical shallow slope site with gravel substrates (Bias 1, Reach 4). High flow.

Plate 6b. Typical shallow slope site with gravel substrates (Bias 1, Reach 4). Low flow.

Appendix 2b

Representative Fish Photographs
(2008-2010)

Plate 7. Juvenile Bull Trout.

Plate 8. Juvenile Rainbow Trout.

Plate 9. Juvenile Mountain Whitefish.

Plate 10. Adult Burbot.

Plate 11. Juvenile Kokanee

Plate 12. Juvenile Eastern Brook Trout.

Plate 13. Juvenile Tench.

Plate 14. Adult Yellow Perch.

Plate 15. Juvenile Common Carp.

Appendix 3

Site Summary Information

Appendix 3a. Site summary information for the May/June 2013 sampling trip.

Site	Reach	UTM 11		Date	Start Time	End Time	Site Length (m)	Site Width (m)	Max Site Depth (m)	Water Temp (°C)	Turbidity	Morphology	Dominant Substrate	Sub-Dominant Substrate	D_{95} (cm)
		Easting	Northing												
1	4	414990	5655518	30-May-13	21:32	21:38	100	3	1	6.4	C	r	Boulder	Cobble	71
2	4	415047	5655424	30-May-13	21:47	21:54	100	3	0.7	6.4	C	r	Boulder	Cobble	80
3	4	414761	5655272	30-May-13	22:16	22:24	100	3	1	6.4	C	r	Boulder	Cobble	60
4	4	414827	5655152	30-May-13	22:33	22:38	100	3	1	6.4	C	lc	Boulder	Cobble	70
5	4	414720	5654593	30-May-13	23:01	23:07	100	3	0.6	6.4	C	lc	Gravel	Cobble	60
6	4	414762	5654364	30-May-13	23:53	23:59	100	3	1.5	6.1	C	lc	Cobble	Boulder	55
7	4	414976	5653898	31-May-13	0:28	0:44	100	3	0.7	6.1	C	lc	Cobble	Boulder	50
8	4	415017	5653443	31-May-13	1:36	1:42	100	3	2	6.4		lc	Bed Rock	Fines	400
9	4	414852	5653318	28-May-13	22:50	22:56	100	3	0.6	6.7	C	lc	Gravel	Cobble	30
10	4	414913	5653190	28-May-13	23:21	23:28	100	3	4	6.4	C	lc	Bed Rock	Bed Rock	500
11	4	414797	5652965	28-May-13	22:30	22:37	100	3	2	6.7	C	lc	Bed Rock	Bed Rock	150
12	4	414590	5652916	28-May-13	22:00	22:08	100	3	1.2	6.7	C	rp	Cobble	Gravel	40
13	4	414573	5652758	28-May-13	21:45	21:50	100	3	1	6.7	C	rp	Cobble	Boulder	50
14	4	414170	5652549	29-May-13	0:00	0:07	100	3	2	6.4	C	lc	Cobble	Boulder	40
15	4	413944	5652391	29-May-13	0:49	0:55	100	3	1	6.7	C	lc	Boulder	Cobble	60
16	4	413834	5652103	3-Jun-13	21:36	21:43	100	3	2	7.9	C	lc	Riprap	Riprap	100
17	4	413483	5652087	3-Jun-13	22:30	22:42	100	3	1.2	7.9	C	lc	Gravel	Cobble	12
18	4	413506	5651878	3-Jun-13	21:51	22:02	100	3	2.2	7.9	C	lc	Riprap	Riprap	100
19	3	413216	5651349	29-May-13	23:02	23:12	100	3	0.9	6.5	C	lc	Cobble	Gravel	60
20	3	413040	5651246	29-May-13	22:31	22:45	100	3	1	6.5	C	lc	Cobble	Gravel	40
21	3	413090	5651059	29-May-13	22:14	22:21	100	3	2	6.5	C	lc	Bed Rock	Bed Rock	400

Site	Reach	UTM 11 Easting	UTM 11 Northing	Date	Start Time	End Time	Site Length (m)	Site Width (m)	Max Site Depth (m)	Water Temp (°C)	Turbidity	Morphology	Dominant Substrate	Sub-Dominant Substrate	D_{95} (cm)
22	3	413150	5650872	29-May-13	21:47	21:55	100	3	2	6.5	C	lc	Gravel	Fines	200
23	3	413359	5650880	29-May-13	21:34	21:40	100	3	1	6.5	C	lc	Fines	Cobble	100
24	3	413688	5651256	29-May-13	23:27	23:34	100	3	1.5	6.5	C	lc	Cobble	Boulder	65
25	3	414036	5651376	29-May-13	23:46	23:53	100	3	1	6.5	C	lc	Gravel	Cobble	40
26	3	414430	5651338	30-May-13	0:04	0:11	100	3	3	6.4	C	lc	Riprap	Riprap	250
27	3	414423	5651096	31-May-13	23:55	0:09	100	3	0.5	6.9	C	rp	Gravel	Cobble	28
28	2	414563	5650916	4-Jun-13	23:22	23:44	100	3	0.7	7	C	rp	Fines	Gravel	5
29	3	414859	5651016	30-May-13	0:40	0:46	100	3	2	6.4	C	lc	Riprap	Riprap	100
30	3	415016	5650879	30-May-13	0:50	1:00	100	3	4	6.4	C	lc	Riprap	Riprap	100
31	3	414787	5650673	5-Jun-13	21:30	21:37	100	3	1.5	8.2	C	lc	Gravel	Fines	11
32	3	415565	5650626	3-Jun-13	23:14	23:20	100	3	2	7.9	C	lc	Gravel	Cobble	40
33	3	415673	5650425	3-Jun-13	22:59	23:05	100	3	1.5	7.9	C	lc	Gravel	Cobble	15
34	3	415591	5650050	3-Jun-13	23:42	23:50	100	3	1.5	7.9	C	lc	Gravel	Riprap	200
35	3	415396	5649795	4-Jun-13	0:08	0:16	100	3	2.5	7.9	C	lc	Riprap	Riprap	150
36	3	414863	5649529	5-Jun-13	23:04	23:11	100	3	1.5	8.2	C	lc	Gravel	Fines	10
37	3	415133	5649433	5-Jun-13	23:34	23:40	100	3	2	8.2	C	lc	Fines	Gravel	35
38	3	414714	5649295	5-Jun-13	23:48	23:55	100	3	1.5	8.2	C	lc	Fines	Gravel	3
39	3	414943	5649056	5-Jun-13	23:51	23:57	100	3	2	8.2	C	lc	Gravel	Cobble	40
40	3	415123	5646655	5-Jun-13	1:25	1:32	100	3	1.2	8.8	C	res	Gravel	Fines	30
41	2	415077	5645461	5-Jun-13	1:05	1:12	100	3	2	8.8	C	res	Gravel	Cobble	30
42	2	415756	5645117	5-Jun-13	0:41	0:48	100	3	1	8.8	C	res	Fines	Gravel	5

Site	Reach	UTM 11		Date	Start Time	End Time	Site Length (m)	Site Width (m)	Max Site Depth (m)	Water Temp (°C)	Turbidity	Morphology	Dominant Substrate	Sub-Dominant Substrate	D_{95} (cm)
		Easting	Northing												
43	2	416958	5644136	5-Jun-13	0:06	0:13	100	3	2	8.8	C	res	Fines	Fines	0
44	2	417530	5641839	4-Jun-13	23:46	23:51	100	3	3	8.8	C	res	Bed Rock	Bed Rock	400
45	2	418562	5640856	4-Jun-13	23:20	23:28	100	3	1	8.8	C	res	Fines	Gravel	5
46	2	418563	5639801	4-Jun-13	22:56	23:02	100	3	2.5	8.8	C	res	Bed Rock	Gravel	400
47	2	419421	5638115	4-Jun-13	22:28	22:36	100	3	2.6	8.8	C	res	Bed Rock	Boulder	300
48	1	420718	5635000	7-Jun-13	0:06	0:12	100	3	3	9.3	C	res	Bed Rock	Fines	400
49[A]	1			7-Jun-13	0:00	0:01									
50[A]	1			6-Jun-13	23:55	23:56									
51	1	425066	5632491	6-Jun-13	23:07	23:15	100	3	2	9.3	C	res	Bed Rock	Bed Rock	400
52	1	426453	5629325	6-Jun-13	22:45	22:52	100	3	2.2	9.6	C	res	Bed Rock	Bed Rock	400
53[A]	1			6-Jun-13	22:58	22:58									
54	1	426679	5629541	6-Jun-13	22:30	22:36	100	3	1	9.6	M	res	Fines	Gravel	0
55	1	428851	5628863	6-Jun-13	22:04	22:11	100	3	3	9.6	C	res	Bed Rock	Cobble	400
56	1	428755	5627191	6-Jun-13	21:41	21:48	100	3	1.5	9.6	C	res	Fines	Fines	1
Biased 1	4	414629	5654496	30-May-13	23:16	23:25	100	3	1	6.1	C	lc	Cobble	Boulder	70
Biased 2	4	414669	5654207	31-May-13	0:07	0:13	100	3	1	6.1	C	lc	Boulder	Cobble	70
Biased 3	4	414905	5653794	31-May-13	0:54	1:01	100	3	1.5	6.1	C	lc	Boulder	Cobble	500
Biased 4	4	415072	5653582	31-May-13	1:19	1:25	100	3	2	6.4	C	lc	Riprap	Riprap	300
Biased 5	4	414123	5652354	29-May-13	0:20	0:25	100	3	0.5	6.4	C	lc	Gravel	Cobble	35
Biased 6	4	413809	5652244	29-May-13	1:15	1:24	100	3	1	6.7	C	lc	Cobble	Boulder	45
Biased 7	4	413428	5651812	3-Jun-13	22:22	22:27	100	3	2.5	7.9	C	lc	Riprap	Riprap	150

[A] These sites were flooded at time of assessment and thus not sampled

Site	Reach	UTM 11		Date	Start Time	End Time	Site Length (m)	Site Width (m)	Max Site Depth (m)	Water Temp (°C)	Turbidity	Morphology	Dominant Substrate	Sub-Dominant Substrate	D_{95} (cm)
		Easting	Northing												
Drimmie d/s	1	422418	5635030	7-Jun-13	0:25	0:30	50	3	1.5	6.2	C	res	Fines	Fines	1
Drimmie u/s	1	422666	5634796	6-Jun-13	20:51	20:59	50	3	0.6	6.4	C	r	Gravel	Cobble	15
Illicil d/s	3	415524	5648620	5-Jun-13	21:54	22:01	50	3	0.8	8.7	C	lc	Gravel	Fines	20
Illicil u/s	3	416810	5648821	31-May-13	22:00	22:10	50	3	1	7.5	M	rp	Cobble	Gravel	30
Jordan u/s	4	413110	5652067	31-May-13	23:20	23:36	50	3	0.4	5.7	C	rp	Cobble	Boulder	28
Tonk d/s	3	414387	5649018	5-Jun-13	22:23	22:29	50	3	2	9.6	C	glide	Fines	Boulder	100
Tonk u/s	3	413890	5649821	31-May-13	22:34	22:58	50	3	1	6.2	L	rp	Cobble	Gravel	30

Appendix 3b. Site summary information for the July 2013 sampling trip.

Site	Reach	UTM 11 Easting	UTM 11 Northing	Date	Start Time	End Time	Site Length (m)	Site Width (m)	Max Site Depth (m)	Water Temp (°C)	Turbidity	Morphology	Dominant Substrate	Sub-Dominant Substrate	$D_{95\,(cm)}$
1	4	414989	5655541	5-Jul-13	22:03	22:09	100	3	1.5	9.3	C	lc	Boulder	Cobble	40
2	4	415045	5655416	5-Jul-13	22:18	22:25	100	3	1.5	9.3	C	lc	Cobble	Gravel	40
3	4	414755	5655274	5-Jul-13	22:38	22:48	100	3	1.3	9.3	C	lc	Gravel	Cobble	40
4	4	414775	5655042	5-Jul-13	22:57	23:03	100	3	1.5	9.3	C	lc	Boulder	Cobble	50
5	4	414723	5654596	6-Jul-13	0:42	0:48	100	3	1.7	9.2	C	lc	Cobble	Gravel	40
6	4	414770	5654348	5-Jul-13	23:55	0:01	100	3	2	9.2	C	lc	Cobble	Boulder	45
7	4	414982	5653903	6-Jul-13	0:24	0:30	100	3	1.4	9.2	C	lc	Cobble	Gravel	35
8	4	415021	5653429	8-Jul-13	22:12	22:21	100	3	2.8	8.1	C	lc	Bed Rock	Boulder	400
9	4	414842	5653333	8-Jul-13	22:36	22:46	100	3	1.5	8.1	C	lc	Cobble	Boulder	32
10	4	414913	5653183	8-Jul-13	22:53	23:08	100	3	4	8	C	lc	Bed Rock	Boulder	400
11	4	414803	5652959	8-Jul-13	23:25	23:34	100	3	2.5	8	C	lc	Bed Rock	Boulder	400
12	4	414591	5652939	8-Jul-13	23:48	23:54	100	3	1.8	8	C	lc	Cobble	Boulder	27
13	4	414683	5652748	9-Jul-13	0:04	0:13	100	3	1.7	8.3	C	lc	Boulder	Cobble	30
14	4	414169	5652551	9-Jul-13	0:30	0:38	100	3	1.6	8	C	lc	Cobble	Gravel	27
15	4	413941	5652391	9-Jul-13	0:59	1:09	100	3	3	8	C	lc	Cobble	Gravel	28
16	4	413834	5652102	11-Jul-13	20:53	21:03	100	3	2.2	9.4	C	lc	Riprap	Riprap	65
17	4	413483	5652087	11-Jul-13	23:09	23:14	100	3	1.6	9.4	C	lc	Gravel	Cobble	10
18	4	413514	5651878	11-Jul-13	23:21	23:26	100	3	2.2	9.4	C	lc	Riprap	Riprap	60
19	3	413315	5651354	2-Jul-13	23:45	23:55	100	3	1.2	8.7	C	lc	Fines	Cobble	40
20[B]	3	413031	5651256	2-Jul-13	23:25	23:32	100	3	3	9.3	L	res			
21[B]	3	413086	5651053	2-Jul-13	23:06	23:13	100	3	3.1	9.3	L	res			

[B] The substrate could not be seen given the depth

Site	Reach	UTM 11		Date	Start Time	End Time	Site Length (m)	Site Width (m)	Max Site Depth (m)	Water Temp (°C)	Turbidity	Morphology	Dominant Substrate	Sub-Dominant Substrate	D_{95} (cm)
		Easting	Northing												
22	3	413144	5650874	2-Jul-13	22:43	22:49	100	3	3	9.3	L	res	Gravel	Fines	25
23	3	413398	5650907	2-Jul-13	22:26	22:31	100	3	2.8	9.3	L	res	Gravel	Fines	30
24	3	413645	5651153	3-Jul-13	0:10	0:17	100	3	2	8.8	L	res			
25	3	414003	5652273	3-Jul-13	0:25	0:31	100	3	3	8.8	L	res			
26	3	414431	5651344	3-Jul-13	0:50	0:58	100	3	2.2	8.8	C	res	Riprap	Riprap	50
27	3	414391	5651050	3-Jul-13	1:04	1:11	100	3	2.5	8.8	L	res	Gravel	Fines	20
28	3	414563	5650913	12-Jul-13	0:05	0:10	100	3	2.3	9.5	C	res	Fines	Fines	1
29	3	414869	5651022	12-Jul-13	0:44	0:50	100	3	2.3	9.5	L	res	Riprap	Boulder	45
30	3	415013	5650895	12-Jul-13	0:34	0:39	100	3	2	9.5	C	res	Fines	Boulder	32
31	2	414734	5650657	12-Jul-13	0:17	0:22	100	3	2.5	9.5	C	res	Gravel	Fines	10
32	3	415564	5650625	10-Jul-13	1:48	1:56	100	3	4	9	C	lc	Gravel	Cobble	20
33	3	415638	5650409	10-Jul-13	1:30	1:40	100	3	5.5	8.9	C	lc	Cobble	Gravel	20
34	3	415596	5650049	10-Jul-13	1:05	1:11	100	3	2.3	9	C	lc	Gravel	Cobble	80
35	3	415400	5649796	10-Jul-13	0:47	0:58	100	3	4.6	9	C	lc	Riprap	none	85
36	3	414857	5649529	9-Jul-13	23:40	23:46	100	3	2.2	9	C	lc	Fines	none	1
37	3	415132	5649402	10-Jul-13	0:24	0:34	100	3	3	9	C	lc	Fines	none	1
38	3	414718	5649309	9-Jul-13	23:11	23:28	100	3	4	9	C	lc	Fines	none	1
39	3	414958	5649063	10-Jul-13	0:11	0:20	100	3	2	9	C	lc	Fines	Gravel	5
41	2	415073	5645461	4-Jul-13	0:12	0:19	100	3	5.5	8.5	L	res			
42	2	415814	5645095	4-Jul-13	0:34	0:39	100	3	2.5	8.5	L	res			
43	2	416948	5644135	4-Jul-13	0:48	0:49	0	0		9.1	L	res			

Site	Reach	UTM 11		Date	Start Time	End Time	Site Length (m)	Site Width (m)	Max Site Depth (m)	Water Temp (°C)	Turbidity	Morphology	Dominant Substrate	Sub-Dominant Substrate	D_{95} (cm)
		Easting	Northing												
44	2	417523	5641837	3-Jul-13	23:16	23:23	100	3	3.2	9.1	L	res	Bed Rock	Bed Rock	400
45[C]	2	418541	5640852	3-Jul-13	23:00	23:01	0	0		9.1	L	res			
46	2	418576	5639682	3-Jul-13	22:48	22:54	100	3	3	9.1	L	res	Bed Rock	Bed Rock	400
47	2	419410	5638109	3-Jul-13	22:14	22:21	100	3	4	9.1	L	res	Bed Rock	Bed Rock	400
48	2	420715	5634991	10-Jul-13	23:37	23:44	100	3	2	12.2	C	res	Fines	Boulder	45
49[C]	2	421378	5634605	10-Jul-13	23:30	23:31	0	0		12.2	C	res			
50[C]	2	422586	5633535	10-Jul-13	23:25	23:26	0	0		12.2	C	res			
51	2	425073	5632486	10-Jul-13	23:09	23:15	100	3	4	12.2	C	res	Bed Rock	Bed Rock	400
52	1	426451	5629317	10-Jul-13	22:42	22:48	100	3	4.5	12.2	C	res	Bed Rock	Bed Rock	400
53[C]	1	425584	5630035	10-Jul-13	23:00	23:01	0	0		12.2	C	res			
54	1	426792	5629568	10-Jul-13	22:22	22:30	100	3	1.1	12.2	C	res	Fines	Gravel	12
55	1	428854	5628871	10-Jul-13	21:52	21:59	100	3	2.5	12.2	C	res	Bed Rock	Bed Rock	400
56[C]	1	428772	5627172	10-Jul-13	21:35	21:36	0	0		12.2	C	res			
Biased 1	4	414618	5654497	5-Jul-13	23:13	23:20	100	3	2.4	9.2	C	LC	Cobble	Gravel	75
Biased 2	4	414664	5654204	6-Jul-13	0:08	0:14	100	3	1.5	9.2	C	LC	Cobble	Gravel	55
Biased 3	4	414892	5653787	6-Jul-13	0:26	0:32	100	3	1.5	9.2	C	lc	Boulder	Cobble	400
Biased 4	4	415081	5653586	8-Jul-13	21:53	22:05	100	3	1.5	8.1	C	lc	Boulder	Bed Rock	400
Biased 5	4	414163	5652309	9-Jul-13	0:46	0:54	100	3	1.5	8	C	lc	Cobble	Boulder	40
Biased 6	4	413835	5652339	11-Jul-13	20:37	20:42	100	3	2.4	9.4	C	lc	Cobble	Gravel	30
Biased 7	4	413425	5651805	11-Jul-13	23:34	23:40	100	3	2	9.4	C	lc	Riprap	Riprap	105

[C] These sites were flooded at time of assessment and thus not sampled

Site	Reach	UTM 11		Date	Start Time	End Time	Site Length (m)	Site Width (m)	Max Site Depth (m)	Water Temp (°C)	Turbidity	Morphology	Dominant Substrate	Sub-Dominant Substrate	$D_{95\ (cm)}$
		Easting	Northing												
Begbie d/s	2	416576	5643061	4-Jul-13	0:27	1:03	100	3	2	8.7	C	res	Fines	Gravel	30
Begbie u/s	2	416589	5643020	4-Jul-13	1:18	1:27	50	3	0.8	8.4	C	riffle	Cobble	Gravel	28
Drimmie d/s[D]	2			10-Jul-13											
Drimmie u/s	2	422670	5634793	10-Jul-13	0:05	0:15	50	3	0.7	9.1	C	riffle	Gravel	Cobble	10
Illicil d/s	3	415525	5648625	9-Jul-13	22:11	22:20	50	3	3.5	11.8	L	lc	Fines	Gravel	15
Illicil u/s	3	416812	5648827	9-Jul-13	21:47	21:55	50	3	1.5	11.9	L	lc	Cobble	Fines	17
Jordan d/s	4	413103	5651804	11-Jul-13	20:12	20:18	50	3	3	9.4	C	lc	Riprap	Riprap	160
Jordan u/s	4	413100	5652119	11-Jul-13	21:45	21:53	50	3	0.4	9.4	C	rp	Gravel	Cobble	40
Tonk d/s	3	414380	5649017	9-Jul-13	22:27	22:35	50	3	4.2	12.5	L	lc	Fines	Fines	0
Tonk u/s	3	414104	5649551	9-Jul-13	22:45	22:54	50	3	1.9	12.5	L	lc	Fines	Fines	1

[D] This site was flooded at time of assessment and thus not sampled

Appendix 3c. Site summary information for the September 2013 sampling trip.

Site	Reach	UTM 11		Date	Start Time	End Time	Site Length (m)	Site Width (m)	Max Site Depth (m)	Water Temp (°C)	Turbidity	Morphology	Dominant Substrate	Sub-Dominant Substrate	$D_{95\ (cm)}$
		Easting	Northing												
1	4	414980	5655538	15-Sep-13	20:00	20:07	100	3	2.5	11.1	C	lc	Gravel	Cobble	40
2	4	415038	5655399	15-Sep-13	20:12	20:18	100	3	1.5	11.1	C	lc	Gravel	Cobble	60
3	4	414749	5655270	15-Sep-13	20:38	20:45	100	3	2	11.1	C	lc	Gravel	Cobble	65
4	4	414780	5655041	15-Sep-13	20:50	20:55	100	3	2	11.1	C	lc	Gravel	Cobble	60
5	4	414724	5654586	15-Sep-13	21:40	21:45	100	3	2	11.1	C	lc	Cobble	Gravel	40
6	4	414767	5654344	15-Sep-13	21:53	22:00	100	3	2	11.1	C	lc	Gravel	Cobble	45
7	4	415474	5650686	15-Sep-13	22:45	22:50	100	3	1.5	11.1	C	lc	Gravel	Cobble	60
8	4	415028	5653441	15-Sep-13	23:45	23:50	100	3	2.5	11.1	C	lc	Boulder	Cobble	400
9	4	414841	5653338	18-Sep-13	21:44	21:47	100	3	2	11.1	C	lc	Cobble	Gravel	50
10	4	414918	5653183	15-Sep-13	23:55	0:05	100	3	3.5	11.1	C	lc	Bed Rock	Bed Rock	400
11	4	414804	5652965	18-Sep-13	21:16	21:23	100	3	2.5	11.1	C	lc	Boulder	Cobble	300
12	4	414590	5652949	18-Sep-13	20:53	20:58	100	3	2.5	11.1	C	lc	Cobble	Gravel	60
13	4	414695	5652762	18-Sep-13	20:38	20:45	100	3	2	11.1	C	lc	Gravel	Cobble	50
14	4	414154	5652543	13-Sep-13	20:02	20:12	100	3	2	11.3	C	lc	Cobble	Boulder	30
15	4	413941	5652387	13-Sep-13	20:45	20:54	100	3	3.2	11.3	C	lc	Cobble	Boulder	30
16	4	413832	5652104	13-Sep-13	21:12	21:23	100	3	2.5	11.3	C	lc	Riprap	n/a	100
17	4	413483	5652090	13-Sep-13	21:42	21:52	100	3	1.2	11.3	C	lc	Cobble	Gravel	250
18	4	413523	5651885	13-Sep-13	21:55	22:03	100	3	1.6	11.3	C	lc	Riprap	Riprap	60
19	3	413266	5651328	11-Sep-13	22:19	22:27	100	3	1	12.1	L	lc	Cobble	Gravel	28
20	3	413034	5651255	11-Sep-13	21:41	21:50	100	3	1	12.3	L	lc	Riprap	Cobble	100
21	3	413080	5651060	11-Sep-13	21:20	21:36	100	3	2.5	12.3	L	lc	Bed Rock	Riprap	200

Site	Reach	UTM 11		Date	Start Time	End Time	Site Length (m)	Site Width (m)	Max Site Depth (m)	Water Temp (°C)	Turbidity	Morphology	Dominant Substrate	Sub-Dominant Substrate	D_{95} (cm)
		Easting	Northing												
22	3	413143	5650878	11-Sep-13	20:45	20:55	100	3	2	12.3	L	lc	Fines	Cobble	10
23	3	413361	5650868	11-Sep-13	20:27	20:38	100	3	2	12.3	L	lc	Fines	Cobble	35
24	3	413665	5651215	13-Sep-13	23:03	23:11	100	3	1.5	11.3	C	lc	Gravel	Cobble	35
25	3	414003	5651364	13-Sep-13	23:22	23:34	100	3	2.2	11.3	C	lc	Cobble	Gravel	12
26	3	414429	5651337	13-Sep-13	23:25	23:36	100	3	2.2	12.2	L	lc	Riprap	n/a	80
27	3	414407	5651057	16-Sep-13	23:01	23:10	100	3	1	10.5	C	lc	Gravel	Cobble	20
28	3	414565	5650914	16-Sep-13	22:40	22:50	100	3	1.5	10.5	C	lc	Gravel	Fines	45
29	3	414866	5651018	16-Sep-13	21:50	21:56	100	3	2	10.5	C	lc	Riprap	none	250
30	3	415008	5650892	16-Sep-13	21:40	21:45	100	3	1.5	10.5	C	lc	Gravel	Riprap	60
31	3	414735	5650657	16-Sep-13	22:20	22:30	100	3	2	10.5	C	lc	Gravel	Fines	30
32	3	415550	5650640	16-Sep-13	21:12	21:17	100	3	0.3	10.5	C	lc	Gravel	Fines	7
33	3	415639	5650429	16-Sep-13	21:00	21:06	100	3	1.5	10.5	C	lc	Gravel	Cobble	30
34	3	415592	5650048	16-Sep-13	20:10	20:26	100	3	2	10.5	C	lc	Riprap	Gravel	300
35	3	415398	5649800	16-Sep-13	20:45	20:50	100	3	2.2	10.5	C	lc	Riprap	none	300
36	3	414859	5649529	17-Sep-13	20:48	20:53	100	3	2	10.2	C	lc	Fines	Gravel	15
37	3	415414	5649440	17-Sep-13	21:37	21:40	100	3	2	10.2	C	lc	Gravel	Cobble	50
38	3	414721	5649309	17-Sep-13	20:37	20:43	100	3	1.5	10.2	C	lc	Fines	Gravel	3
39	3	414946	5649061	17-Sep-13	21:15	21:20	100	3	1.5	10.2	C	lc	Gravel	Cobble	35
40	2	415125	5646650	14-Sep-13	23:45	23:52	100	3	1.5	11.2	C	lc	Gravel	Cobble	20
41	2	415076	5645475	14-Sep-13	22:24	22:29	100	3	1.7	11.2	C	lc	Gravel	Cobble	45
42	2	415726	5645136	14-Sep-13	23:00	23:07	100	3	1.5	11.2	T	lc	Fines	Gravel	20

Site	Reach	UTM 11		Date	Start Time	End Time	Site Length (m)	Site Width (m)	Max Site Depth (m)	Water Temp (°C)	Turbidity	Morphology	Dominant Substrate	Sub-Dominant Substrate	$D_{95\ (cm)}$
		Easting	Northing												
43	2	416948	5644135	14-Sep-13	22:22	22:30	100	3	1.2	11.2	M	lc	Fines	n/a	5
44	2	417524	5641849	14-Sep-13	20:58	21:05	100	3	2	11.2	C	lc	Boulder	Bed Rock	400
45	2	418541	5640852	14-Sep-13	20:42	20:50	100	3	1	11.2	C	res	Fines	Gravel	20
46	2	418661	5639593	14-Sep-13	20:10	20:18	100	3	1.5	11.2	L	res	Fines	Fines	1
47	2	419418	5638119	14-Sep-13	19:52	20:01	100	3	2.5	11.2	C	res	Boulder	Cobble	200
48	2	420729	5634997	12-Sep-13	23:23	23:33	100	3	3	12.9	L	res	Bed Rock	Cobble	200
49	2	421378	5634605	12-Sep-13	23:06	23:16	100	3	0.5	12.9	L	lc	Fines	Gravel	0
50	2	422586	5633535	12-Sep-13	22:52	23:00	100	3	0.7	12.9	L	res	Fines	none	0
51	1	425063	5632488	12-Sep-13	21:55	22:04	100	3	2	12.9	L	res	Bed Rock	Boulder	400
52	1	426462	5629329	12-Sep-13	21:08	21:19	100	3	2.3	12.7	C	res	Boulder	Bed Rock	200
53	1	425584	5630035	12-Sep-13	21:30	21:36	100	3	1	12.7	L	res	Fines	Gravel	5
54	1	426704	5629516	12-Sep-13	20:40	20:51	100	3	1.2	12.7	L	res	Fines	Gravel	30
55	1	428846	5628868	12-Sep-13	20:08	20:16	100	3	1.8	12.7	L	res	Boulder	Cobble	200
56	1	428772	5627172	12-Sep-13	19:55	20:02	100	3	1.3	12.7	L	res	Fines	Fines	1
Biased 1	4	414616	5654506	15-Sep-13	21:12	21:20	100	3	2	11.1	C	lc	Gravel	Cobble	60
Biased 2	4	414663	5654199	15-Sep-13	21:20	22:26	100	3	1.5	11.1	C	lc	Cobble	Gravel	60
Biased 3	4	414891	5653789	15-Sep-13	23:00	23:05	100	3	2.5	11.1	C	lc	Cobble	Gravel	70
Biased 4	4	415077	5653581	15-Sep-13	23:25	23:30	100	3	2.3	11.1	C	lc	Cobble	Bed Rock	200
Biased 5	4	414157	5652302	13-Sep-13	20:15	20:22	100	3	1.4	11.3	C	lc	Boulder	Cobble	70
Biased 6	4	413722	5652294	13-Sep-13	20:56	21:07	100	3	1.5	11.3	C	lc	Cobble	Boulder	28
Biased 7	4	413421	5651805	13-Sep-13	22:26	22:34	100	3	2	11.3	C	lc	Riprap	none	80

Site	Reach	UTM 11		Date	Start Time	End Time	Site Length (m)	Site Width (m)	Max Site Depth (m)	Water Temp (°C)	Turbidity	Morphology	Dominant Substrate	Sub-Dominant Substrate	D_{95} (cm)
		Easting	Northing												
Begbie d/s	2	416586	5643020	15-Sep-13	21:41	21:47	50	3	1.3	12.3	C	rp	Gravel	Cobble	50
Begbie u/s[E]	2	416588	5643020	17-Sep-13											
Jordan d/s	4	413093	5651791	13-Sep-13	22:46	22:52	50	3	2.5	13.4	M	run	Riprap	n/a	100
Tonk u/s	3	413091	5652133	18-Sep-13	20:00	20:10	50	3	0.5	11.3	L	lc	Cobble	Gravel	12
Tonk d/s	3	414286	5649022	17-Sep-13	20:15	20:20	50	3	2	12.5	C	run	Fines	Bed Rock	150
Illicil d/s	3	415536	5648623	17-Sep-13	19:52	20:00	50	3	1	11	T	lc	Gravel	Cobble	20
Illicil u/s	3	416809	5648822	17-Sep-13	22:27	22:37	50	3	1.2	10.5	T	lc	Cobble	Gravel	10
Drimmie d/s	2	422401	5634983	13-Sep-13	0:30	0:42	50	3	0.1	11.2	C	run	Gravel	Cobble	15
Masse Control	3	413582	5651511	11-Sep-13	22:55	23:11	100	3	1.7	12.2	L	lc	Cobble	Riprap	80
Masse rip rap	3	413483	5651414	11-Sep-13	22:35	22:42	100	3	1.5	12.2	L	lc	Riprap	n/a	50

[E] This site had spawning adult Kokanee at time of assessment and thus was not sampled

Appendix 4

Habitat Summary Information

Appendix 4a. Habitat summary information for the May/June 2013 sampling trip. Mid-site data has been omitted from table for clarity. Depth and velocity data are provided for stations at the shoreline (0 m), and 1.5 m and 3.0 m from the shoreline.

			Downstream End of Site												Upstream End of Site											
			Depth (m)			Velocity (m/s)			Substrate Composition						Depth (m)			Velocity (m/s)			Substrate Composition					
Site	**Reach**	**Date**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**
1	4	30-May-13	0	0.37	0.66	0	0	0.24	0	10	30	60	0	0	0	0.43	0.9	0	0.27	0.39	0	10	30	60	0	0
2	4	30-May-13	0	0.45	0.79	0	0.16	0.3	0	10	30	60	0	0	0	0.44	0.57	0	0.08	0.2	0	10	30	60	0	0
3	4	30-May-13	0	0.27	0.68	0	0.02	0.04	0	10	35	55	0	0	0	0.41	0.89	0	0.26	0.39	0	10	35	55	0	0
4	4	30-May-13	0	0.12	0.36	0	0.14	0.32	0	10	20	70	0	0	0	0.27	0.62	0	0.11	0.33	0	40	45	5	0	0
5	4	30-May-13	0	0.41	0.9	0	0.07	0.11	0	20	30	50	0	0	0	0.6	0.6	0	0.81	0.81	10	80	10	0	0	0
6	4	30-May-13	0	0.65	1.33	0	0.01	0.03	0	30	40	30	0	0	0	0.6	1.14	0	0.08	0.4	0	30	40	30	0	0
7	4	31-May-13	0	0.39	0.56	0	0.09	0.26	0	20	75	5	0	0	0	0.41	0.55	0	0.17	0.28	0	10	65	25	0	0
8	4	31-May-13	0	0.68	0.85	0	0	0	10	0	0	0	90	0	0	0.64	0.61	0	0.1	0.18	0	0	0	0	100	
9	4	28-May-13	0	0.55	0.6	0	0	0	0	80	15	5	0	0	0	0.25	0.4	0	0.03	0.02	0	80	15	5	0	0
10	4	28-May-13	0	1.26	2.2	0	0	0.17	0	0	0	0	100	0	0	1.6	2.3	0	0.24	0.28	0	0	0	0	100	0
11	4	28-May-13	0	0.7	1.7	0	0.18	0.29	0	0	0	0	100	0	0	0.27	0.55	0	0	0.01	0	0	0	0	100	0
12	4	28-May-13	0	0.56	0.75	0	0	0	0	30	60	10	0	0	0	0.6	1	0	0.14	0.42	0	30	60	10	0	0
13	4	28-May-13	0	0.25	0.45	0	0	0.01	0	10	60	30	0	0	0.8	0.9	1.01	0.7	0.81	0.89	0	40	60	0	0	0
14	4	29-May-13	0	0.68	1.05	0	0.04	0.4	0	20	50	30	0	0	0	0.7	1	0	0.17	0.64	0	20	50	30	0	0
15	4	29-May-13	0	0.8	0.96	0	0.19	0.31	0	10	35	55	0	0	0	0.55	0.83	0	0.21	0.41	0	10	35	55	0	0
16	4	3-Jun-13	0	0.89	1.74	0	0.07	0.26	0	0	0	0	0	100	0	0.63	1.5	0	0.14	0.41	0	0	0	0	0	100
17	4	3-Jun-13	0.5	0.75	0.93	0.48	0.53	0.52	0	90	10	0	0	0	0.42	0.78	1.1	0.23	0.45	0.56	0	90	10	0	0	0
18	4	3-Jun-13	0.05	1.01	2.17	0	0.48	1.14	0	0	0	0	0	100	0	1.02	1.8	0	0.11	0.6	0	0	0	0	0	100
19	3	29-May-13	0	0.8	0.94	0	0.3	0.39	0	45	55	0	0	0	0	0.93	1.25	0	0.94	1.06	0	45	45	10	0	0
20	3	29-May-13	0	0.29	0.47	0	0	0.04	100	0	0	0	0	0	0	0.21	0.47	0	0.16	0.25	0	50	50	0	0	0
21	3	29-May-13	0	0.9	1.44	0	0.06	0.16	0	0	0	0	100	0	0	0.38	2.3	0	0.17	0.35	0	0	0	0	100	0
22	3	29-May-13	0	0.57	0.9	0	0	0.06	65	30	5	0	0	0	0	0.67	0.94	0	0.06	0.02	20	70	10	0	0	0
23	3	29-May-13	0	0.45	0.76	0	0.1	0.18	50	0	30	20	0	0	0	0.34	0.55	0	0	0	75	20	5	0	0	0
24	3	29-May-13	0	0.58	1	0	1.32	1.35	0	30	50	20	0	0	0	0.54	1	0	1.34	1.36	0	60	35	5	0	0
25	3	29-May-13	0	0.71	0.73	0	0.47	0.56	0	55	45	0	0	0	0	0.2	0.36	0	0.02	0.07	0	55	40	5	0	0
26	3	30-May-13	0	0.68	0.72	0	0	0	0	0	0	0	0	100	0	0.72	1.55	0	0	0	0	0	0	0	0	100

			Downstream End of Site												Upstream End of Site											
			Depth (m)			Velocity (m/s)			Substrate Composition						Depth (m)			Velocity (m/s)			Substrate Composition					
Site	**Reach**	**Date**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**
27	3	31-May-13	0	0.15	0.2	0	0.17	0.31	0	80	10	10	0	0	0	0.11	0.18	0	0.17	0.24	0	100	0	0	0	0
28	2	4-Jun-13	0	0.3	0.5	0	0.15	0.27	30	70	0	0	0	0	0	0.3	0.7	0	0.11	0.21	85	15	0	0	0	0
29	3	30-May-13	0	1.1	1.65	0	0.6	0.78	0	0	0	0	0	100	0	0.7	1.55	0	0.31	0.5	0	0	0	0	0	100
30	3	30-May-13	0	1.1	1.5	0	0.04	0.15	0	0	0	0	0	100	0	0.79	3.25	0	0.06	0.5	0	0	0	0	0	100
31	3	5-Jun-13	0.6	0.8	0.87	0.85	1	1	20	60	20	0	0	0	0	0.31	0.6	0	0	0	10	85	5	0	0	0
32	3	3-Jun-13	0	0.58	1.18	0	0	0.03	5	85	10	0	0	0	0	0.58	1.05	0	0	0	5	90	5	0	0	0
33	3	3-Jun-13	0	0.77	1.55	0	0.15	0.37	5	85	10	0	0	0	0	0.65	1.35	0	0.24	0.42	5	85	10	0	0	0
34	3	3-Jun-13	0	1.22	2.9	0	0.05	0.36	0	0	0	0	0	100	0	0.7	1.38	0	0	0.32	10	75	10	5	0	0
35	3	4-Jun-13	0	0.91	1.9	0	0.09	0.27	0	0	0	0	0	100	0.2	1.6	1.85	0	0.01	0.07	0	0	0	0	0	100
36	3	5-Jun-13	0	0.5	0.91	0	0.06	0.12	50	50	0	0	0	0	0	0.34	0.59	0	0	0.02	0	100	0	0	0	0
37	3	5-Jun-13	0	0.24	0.6	0	0.05	0.12	65	35	0	0	0	0	0	0.46	1.6	0	0	0.31	5	30	55	10	0	0
38	3	5-Jun-13	0	0.42	1.1	0	0.01	0.15	100	0	0	0	0	0	0	0.3	0.74	0	0.07	0.08	95	5	0	0	0	0
39	3	5-Jun-13	0	0.43	1.65	0	0.06	0.25	0	88	10	2	0	0	0	0.43	0.85	0	0.02	0.11	0	60	40	0	0	0
40	3	5-Jun-13	0	0.47	0.93	0	0.09	0.15	0	95	5	0	0	0	0.1	0.53	0.74	0	0.07	0.13	10	85	5	0	0	0
41	2	5-Jun-13	0	0.87	1.55	0	0	0.03	5	65	25	5	0	0	0	0.85	1.45	0	0.01	0.14	10	60	25	5	0	0
42	2	5-Jun-13	0	0.2	0.81	0	0	0	80	20	0	0	0	0	0	0.49	0.75	0	0.02	0.07	100	0	0	0	0	0
43	2	5-Jun-13	0	1.23	1.5	0	0.05	0.02	100	0	0	0	0	0	0	0.95	1.5	0	0.05	0.13	100	0	0	0	0	0
44	2	4-Jun-13	0	1.6	2.4	0	0	0	0	0	0	0	0		0	1.05	1.55	0	0	0						
45	2	4-Jun-13	0	0.23	0.46	0	0	0	98	2	0	0	0	0	0	0.45	0.87	0	0.01	0.06	100	0	0	0	0	0
46	2	4-Jun-13	0	1.11	2.1	50	0	0	0	25	20	5	50	0	0	0.8	1.36	0	0	0	5	5	0	0	90	0
47	2	4-Jun-13	0	1.37	1.8	0	0.01	0.01	0	0	0	0	100	0	0	0.8	1.75	0	0.03	0.03	0	5	15	80	0	0
48	1	7-Jun-13	0	0.96	1.45	0	0	0	10	0	0	0	90	0	0	0.93	1.5	0	0	0	0	0	0	0	100	0
49	1	7-Jun-13																								
50	1	6-Jun-13																								
51	1	6-Jun-13	0	0.95	1.8	0	0	0	0	0	0	0	100	0	0	0.55	1.25	0	0	0	0	0	0	0	100	0
52	1	6-Jun-13	0	0.89	2.2	0	0	0	0	0	0	0	100	0	0	1.3	2	0	0	0	0	0	0	0	100	0

Sites 49 and 50 were flooded and therefore not sampled

			Downstream End of Site												Upstream End of Site											
			Depth (m)			Velocity (m/s)			Substrate Composition						Depth (m)			Velocity (m/s)			Substrate Composition					
Site	**Reach**	**Date**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**
53	1	6-Jun-13																								
54	1	6-Jun-13	0	0.41	0.72	0	0	0	100	0	0	0	0	0	0	0.26	0.71	0	0	0	100	0	0	0	0	0
55	1	6-Jun-13	0	0.78	1.73	0	0	0	0	0	0	0	100	0	0	0.96	1.9	0	0	0	0	0	10	0	90	0
56	1	6-Jun-13	0	0.44	1.21	0	0	0	100	0	0	0	0	0	0	0.33	0.78	0	0	0	100	0	0	0	0	0
Biased 1	4	30-May-13	0	0.65	1.12	0	0	0	5	30	60	5	0	0	0	0.36	0.74	0	0.04	0.05	0	10	55	35	0	0
Biased 2	4	31-May-13	0	0.45	0.7	0	0	0.06	0	15	25	60	0	0	0	0.46	0.84	0	0.08	0.02	0	15	25	60	0	0
Biased 3	4	31-May-13	0	0.45	0.97	0	0.05	0.25	0	5	5	90	0	0	0	0.31	0.59	0	0	0.05	0	30	30	40	0	0
Biased 4	4	31-May-13	0	0.9	1.07	0	0.03	0.09	0	0	0	0	0	100	0	1.03	1.6	0	0	0.2	0	0	0	0	0	100
Biased 5	4	29-May-13	0	0.5	0.5	0	0.44	0.46	0	55	40	5	0	0	0	0.44	0.44	0	0.34	0.23	0	65	20	5	0	0
Biased 6	4	29-May-13	0	0.43	0.43	0	0.46	0.46	0	10	60	30	0	0	0	0.64	0.73	0	0.5	0.56	0	20	80	0	0	0
Biased 7	4	3-Jun-13	0	0.83	1.96	0	0.03	0.35	0	0	0	0	0	100	0	1.05	2.23	0	0.51	1.22	0	0	0	0	0	100
Drimmie d/s	1	7-Jun-13	0.61	1.05	1.35	0	0	0	100	0	0	0	0	0	0.52	1.07	1.44	0.1	0.13	0.17	100	0	0	0	0	0
Drimmie u/s	1	6-Jun-13	0	0.1	0.51	0	0.55	1.59	0	65	35	0	0	0	0	0.21	0.43	0	1.16	1.78	0	50	50	0	0	0
Illicil d/s	3	5-Jun-13	0	0.4	0.84	0	0.61	0.86	30	65	5	0	0	0	0	0.71	0.95	0	0.73	1.1	0	95	5	0	0	0
Illicil u/s	3	31-May-13	0	0.58	0.8	0	0.49	0.79	10	40	50	0	0	0	0	0.76	1.2	0	1.12	1.38	0	40	50	10	0	0
Jordan u/s	4	31-May-13	0	0.25	0.4	0	0.35	0.78	0	20	60	20	0	0	0	0.2	0.35	0	0.12	0.2	0	40	50	10	0	0

Site 53 was flooded and therefore not sampled

F = fines G = gravel C = cobble B = boulder R = bedrock RR = riprap

Appendix 4b. Habitat summary information for the July 2013 sampling trip. Mid-site data has been omitted from table for clarity. Depth and velocity data are provided for stations at the shoreline (0 m), and 1.5 and 3.0 from the shoreline.

			Downstream End of Site												Upstream End of Site											
			Depth (m)			Velocity (m/s)			Substrate Composition						Depth (m)			Velocity (m/s)			Substrate Composition					
Site	**Reach**	**Date**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**
1	4	5-Jul-13	0	0.36	0.6	0	0	0.07	30	20	20	30	0	0	0	0.36	1.19	0	0.11	0.27	0	20	50	30	0	0
2	4	5-Jul-13	0	0.51	1.23	0	0.08	0.23	0	10	85	5	0	0	0	0.49	1.25	0	0	0.27	0	10	85	5	0	0
3	4	5-Jul-13	0	0.55	1.13	0	0	0	5	60	10	25	0	0	0	0.37	0.91	0	0	0.11	0	60	30	10	0	0
4	4	5-Jul-13	0	0.45	1.14	0	0.16	0.2	0	30	40	30	0	0	0	0.51	0.82	0	0	0.22	5	5	20	70	0	0
5	4	6-Jul-13	0	0.71	1.5	0	0	0	0	45	50	5	0	0	0	0.25	1.15	0	0	0.09	0	50	45	5	0	0
6	4	5-Jul-13	0.33	1	1.6	0.09	0.13	0.13	0	20	40	40	0	0	0.31	0.87	1.35	0.02	0.15	0.18	0	45	45	10	0	0
7	4	6-Jul-13	0.9	0.94	1.1	0.25	0.25	0.27	5	65	30	0	0	0	0.94	0.97	1.17	0.23	0.26	0.28	0	30	60	10	0	0
8	4	8-Jul-13	0	0.55	1.65	0	0.23	0.4	10	10	10	20	50	0	0	0.6	1.29	0	0.2	0.24	5	10	10	15	60	0
9	4	8-Jul-13	0	0.57	1.56	0	0	0.09	10	0	30	60	0	0	0	0.67	1.1	0	0.05	0.07	20	45	30	5	0	0
10	4	8-Jul-13	0.2	2.4	3.8	0.15	0.58	0.73	0	0	0	0	100	0	0.25	2.85	3.8	0.14	0.57	0.75	0	0	0	0	100	0
11	4	8-Jul-13	0	0.55	1.5	0	0.14	0.46	0	5	5	30	60	0	0	0.51	0.95	0	0	0	5	5	10	25	50	0
12	4	8-Jul-13	0	0.75	1.4	0	0.03	0.22	5	5	50	40	0	0	0	0.49	0.59	0	0.15	0.12	10	25	50	15	0	0
13	4	9-Jul-13	0	0.59	1.57	0	0	0.14	5	10	25	50	0	0	0	0.49	0.95	0	0.15	0.23	10	35	35	20	0	0
14	4	9-Jul-13	0	0.91	1.55	0	0	0.04	5	35	35	25	0	0	0	0.8	1.5	0	0	0.1	5	30	55	10	0	0
15	4	9-Jul-13	0	1.02	1.55	0	0.08	0.19	10	30	50	10	0	0	0.8	1.7	2.65	0.1	0.19	0.31	10	30	50	10	0	0
16	4	11-Jul-13	0	1.31	2.23	0	0.05	0.03	0	0	0	0	0	100	0	0.91	1.25	0	0.11	0.1	0	0	0	0	0	100
17	4	11-Jul-13	0.9	0.9	0.9	0.06	0.06	0.06	0	80	20	0	0	0	1.27	1.38	1.4	0.3	0.35	0.4	0	80	20	0	0	0
18	4	11-Jul-13	0	1.07	2.13	0	0.29	0.37	0	0	0	0	0	100	0	1	1.97	0	0	0.15	0	0	0	0	0	100
19	3	2-Jul-13	0	0.71	0.97	0	0	0.09	90	10	0	0	0	0	0.86	0.98	1.05	0.14	0.26	0.25	75	5	10	10	0	0
20	3	2-Jul-13	0.9	1.8	2.25	0	0	0							1.8	2.06	2.11	0.02	0.02	0.02						
21	3	2-Jul-13	2	2.75	3.1	0	0	0.03							1.2	1.55	2.75	0.11	0.15	0.15						
22	3	2-Jul-13	1.6	1.95	2.65	0.12	0.1	0.14							1.65	2.32	2.6	0.02	0.02	0.02						
23	3	2-Jul-13	1	1.91	2.44	0	0.02	0.02	30	60	10	0	0	0	1	1.85	2.45	0	0.02	0.02	30	60	10	0	0	0
24	3	3-Jul-13	1.1	1.6	1.75	0.05	0.08	0.15							1.16	1.55	1.86	0.02	0.05	0.11						
25	3	3-Jul-13	1.17	1.35	1.52	0.03	0.05	0.1							0.72	1.23	2.55	0.13	0.34	0.38						
26	3	3-Jul-13	0	0.63	1.35	0	0	0	0	0	0	0	0	100	0	1.07	1.97	0	0	0.02	0	0	0	0	0	100

			Downstream End of Site												Upstream End of Site											
			Depth (m)			Velocity (m/s)			Substrate Composition						Depth (m)			Velocity (m/s)			Substrate Composition					
Site	**Reach**	**Date**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**
27	3	3-Jul-13	1.95	2.03	2.09	0	0	0	10	70	20	0	0	0	2.5	2.57	2.58	0	0	0	80	15	5	0	0	0
28	3	12-Jul-13	1.45	1.64	2.01	0	0	0	100	0	0	0	0	0	1.47	1.63	2.04	0	0	0.02	100	0	0	0	0	0
29	3	12-Jul-13	0	0.63	1.59	0	0	0	0	0	0	0	0	100	0	1.18	1.94	0	0	0	0	0	0	100	0	0
30	3	12-Jul-13	0	0.75	1.7	0	0	0	100	0	0	0	0	0	0	0.91	1.67	0	0	0	0	0	15	85	0	0
31	2	12-Jul-13	0.65	1.84	2.19	0	0	0	90	10	0	0	0	0	0.64	1.87	2.07	0	0	0	15	60	25	0	0	0
32	3	10-Jul-13	0.85	1.41	2.3	0	0	0	10	60	30	0	0	0	2.15	2.65	2.93	0	0	0	10	60	30	0	0	0
33	3	10-Jul-13	3	4.5	5.75	0	0	0	10	60	30	0	0	0	2	3.75	5.5	0	0	0	10	60	30	0	0	0
34	3	10-Jul-13	0	0.8	1.68	0	0	0	0	0	0	0	0	100	1.01	1.8	2.25	0	0	0	5	60	35	0	0	0
35	3	10-Jul-13	0.37	1.4	4.6	0	0	0.03	0	0	0	0	0	100	0.09	0.96	1.85	0	0	0.02	0	0	0	0	0	100
36	3	9-Jul-13	1.35	1.75	2.2	0	0	0.01	100	0	0	0	0	0	0	0.72	1.05	0	0	0	100	0	0	0	0	0
37	3	10-Jul-13	0.62	2.15	2.9	0	0	0.01	100	0	0	0	0	0	0.74	1.96	2.61	0	0	0.01	100	0	0	0	0	0
38	3	9-Jul-13	0.91	1.15	4	0	0	0.06	100	0	0	0	0	0	1	1.26	2.85	0	0	0.05	100	0	0	0	0	0
39	3	10-Jul-13	0.79	1.16	1.5	0	0.01	0.01	80	20	0	0	0	0	1.46	1.65	1.8	0	0	0.01	100	0	0	0	0	0
41	2	4-Jul-13	2.8	3.8	5	0	0	0							2.75	3.8	5	0	0	0						
42	2	4-Jul-13	1.93	2.11	2.15	0.04	0.04	0.04							1.97	2.19	2.14	0.08	0.08	0.08						
43	2	4-Jul-13																								
44	2	3-Jul-13	0	1.71	2.97	0	0	0	0	0	0	0	100	0	0	0.66	1.81	0	0	0	0	0	0	0	100	0
45	2	3-Jul-13																								
46	2	3-Jul-13	0	22.9	3.25	0	0	0	0	0	0	0	100	0	0.95	1.54	2.54	0	0	0	0	0	0	0	100	0
47	2	3-Jul-13	0	1.6	2.7	0	0.06	0.1	0	0	0	0	100	0	1.09	1.81	3.29	0	0	0.08	0	0	0	0	100	0
48	2	10-Jul-13	1	1.44	1.82	0	0	0	75	10	5	10	0	0	0	0.56	0.81	0	0	0	50	10	10	30	0	0
49	2	10-Jul-13																								
50	2	10-Jul-13																			0	30	50	20	0	0
51	2	10-Jul-13	0.27	2.24	2.76	0	0	0	0	0	0	0	100	0	0.3	0.67	2.99	0	0	0	0	0	0	0	100	0
52	1	10-Jul-13	0	0.85	1.61	0	0	0	0	0	0	0	100	0	0.2	1.47	2.48	0	0	0	0	0	0	0	100	0
53	1	10-Jul-13																								

Sites 43, 45, 49, 50 and 53 were flooded and thus not sampled

			Downstream End of Site												Upstream End of Site											
			Depth (m)			Velocity (m/s)			Substrate Composition						Depth (m)			Velocity (m/s)			Substrate Composition					
Site	Reach	Date	0 m	1.5 m	3 m	0 m	1.5 m	3 m	F	G	C	B	R	RR	0 m	1.5 m	3 m	0 m	1.5 m	3 m	F	G	C	B	R	RR
54	1	10-Jul-13	0	0.4	1.05	0	0	0	90	10	0	0	0	0	0	0.45	0.89	0	0	0	85	10	5	0	0	0
55	1	10-Jul-13	1.55	2.75	1.9	0	0	0	0	0	0	0	100	0	1.47	1.76	2.33	0	0	0	0	0	0	0	100	0
56	1	10-Jul-13																								
Biased 1	4	5-Jul-13	0	0.42	0.76	0	0	0.01	5	30	50	15	0	0	0	0.74	1.09	0	0	0.01	10	15	30	45	0	0
Biased 2	4	6-Jul-13	0	0.84	1.31	0	0	0.01	0	40	40	20	0	0	0	0.54	0.8	0	0.05	0.17	0	30	50	20	0	0
Biased 3	4	6-Jul-13	0	0.6	0.8	0	0.07	0.24	0	10	10	80	0	0	0	0.51	1.08	0	0.01	0.03	0	30	40	30	0	0
Biased 4	4	8-Jul-13	0	0.88	1.32	0	0.29	0.38	0	10	25	65	0	0	0	0.41	1.36	0	0.07	0.14	0	5	5	10	80	0
Biased 5	4	9-Jul-13	0	0.31	0.41	0	0	0	0	15	65	30	0	0	0	0.5	1.02	0	0.04	0.11	0	10	50	40	0	0
Biased 6	4	11-Jul-13	0.79	0.79	0.72	0.45	0.45	0.14	0	30	65	5	0	0	0	0.52	1.26	0	0.07	0.17	5	20	70	5	0	0
Biased 7	4	11-Jul-13	0	1.01	1.47	0	0	0.02	0	0	0	0	0	100	0	1.03	1.49	0	0	0.02	0	0	0	0	0	100
Drimmie d/s	2	10-Jul-13																								
Drimmie u/s	2	10-Jul-13	0.5	0.51	0.54	0.36	0.37	0.34	0	70	30	0	0	0	0.25	0.25	0.5	0.09	0.25	0.86	10	80	10	0	0	0
Illicil d/s	3	9-Jul-13	0.75	1	1.8	0.02	0.1	0.23	40	35	25	0	0	0	2	3	3.5	0.04	0.13	0.24	40	35	25	0	0	0
Illicil u/s	3	9-Jul-13	0	1.35	1.4	0	0.56	0.83	25	25	50	0	0	0	0	1.4	1.5	0	0.89	0.99	25	25	50	0	0	0
Jordan d/s	4	11-Jul-13	0	1.29	2.13	0	0.13	0.38	0	0	0	0	0	100	0.1	1.58	2.85	0	0.19	0.38	0	0	0	0	0	100
Jordan u/s	4	11-Jul-13	0	0.36	0.41	0	0.45	0.7	0	60	30	10	0	0	0	0.19	0.34	0	0.01	0.1	0	60	30	10	0	0
Tonk d/s	3	9-Jul-13	0.92	1.3	2.1	0	0	0	100	0	0	0	0	0	1.9	2.15	4.15	0	0	0.01	100	0	0	0	0	0
Tonk u/s	3	9-Jul-13	1.55	1.85	1.95	0	0.05	0.12	100	0	0	0	0	0	1.07	1.41	1.7	0	0.1	0.15	100	0	0	0	0	0
Begbie d/s	2	4-Jul-13	0	0.48	0.69	0	0	0	5	45	35	5	0	0	0	0.87	1.65	0	0	0	65	20	10	5	0	0
Begbie u/s	2	4-Jul-13	0	0.51	0.77	0	0.46	1.23	20	40	30	10	0	0	0	0.41	0.8	0	0.78	1.67	10	20	40	30	0	0

Sites 56 and Drimmie d/s were flooded and thus not sampled

F = fines G = gravel C = cobble B = boulder R = bedrock RR = riprap

Appendix 4c. Habitat summary information for the September 2013 sampling trip. Mid-site data has been omitted from table for clarity. Depth and velocity data are provided for stations at the shoreline (0 m), and 1.5 and 3.0 from the shoreline.

			Downstream End of Site												Upstream End of Site											
			Depth (m)			Velocity (m/s)			Substrate Composition						Depth (m)			Velocity (m/s)			Substrate Composition					
Site	**Reach**	**Date**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**
1	4	15-Sep-13	0	0.74	1.35	0	0.12	0.42	5	80	10	5	0	0	0	0.58	1.2	0	0.68	1.03	0	80	20	0	0	0
2	4	15-Sep-13	0.68	0.65	0.62	0.7	0.77	0.87	0	80	20	0	0	0	0	1.08	1.24	0	0.36	0.29	0	60	30	10	0	0
3	4	15-Sep-13	0	0.61	1.33	0	0.25	0.5	0	80	15	5	0	0	0	0.74	1.32	0	0.68	0.78	0	80	15	5	0	0
4	4	15-Sep-13	0	0.69	1.65	0	0.47	0.78	0	70	30	0	0	0	0	0.7	1.46	0	0.46	0.6	0	50	30	20	0	0
5	4	15-Sep-13	0.63	1.32	1.55	0.73	0.86	0.97							0.7	0.82	1.43	0.18	0.05	0.45						
6	4	15-Sep-13	0.57	0.59	0.85	0.57	0.45	0.43	0	70	30	0	0	0	0.47	0.81	1.96	0.38	0.26	0.47	0	80	20	0	0	0
7	4	15-Sep-13	0.37	0.5	0.75	0.3	0.47	0.49	0	60	40	0	0	0	0.4	0.54	0.8	0.36	0.58	0.49	0	70	25	5	0	0
8	4	15-Sep-13	0	0.58	1.34	0	0.01	0.01	0	10	50	30	10	0	0	0.51	1.02	0	0.16	0.24	0	5	25	50	20	0
9	4	18-Sep-13	0	0.51	1.09	0	0.02	0.21	10	20	60	10	0	0	0	0.49	1.03	0	0.08	0.19	10	30	50	10	0	0
10	4	15-Sep-13	0.1	1.7	2.3	0.45	0.2	0.39	0	0	0	0	100	0	0.2	2.6	3	0.15	0.21	0.4	0	0	0	0	100	0
11	4	18-Sep-13	0	0.53	1.51	0	0.76	0.71	0	10	10	80	0	0	0	0.59	0.85	0	0	0.05	10	10	20	60	0	0
12	4	18-Sep-13	1.5	1.82	2.22	0.84	0.86	0.9	10	40	40	10	0	0	1.52	1.79	2.45	0.88	0.89	0.94	5	20	70	5	0	0
13	4	18-Sep-13	0	0.4	0.81	0	0.16	0.64	10	20	65	5	0	0	0	0.36	0.87	0	0	0.07	5	70	20	5	0	0
14	4	13-Sep-13	0	0.68	1.37	0	0.21	0.5	15	15	25	45	0	0	0	0.85	1.55	0	0.08	0.41	5	30	45	20	0	0
15	4	13-Sep-13	2	2.6	3	1.18	1.23	1.31	10	10	50	30	0	0	1.6	2.4	3.2	1.24	1.28	1.28	10	10	50	30	0	0
16	4	13-Sep-13	0	1.34	2.26	0	0.11	0.25	0	0	0	0	0	100	0	0.67	1.23	0	0.19	0.35	0	0	0	0	0	100
17	4	13-Sep-13	0.66	0.75	0.94	0.47	0.44	0.46	5	15	75	5	0	0	0.72	0.76	0.81	1.01	1.01	1.05	5	30	60	5	0	0
18	4	13-Sep-13	0	0.62	1.27	0	0.13	0.51	0	0	0	0	0	100	0	0.84	1.6	0	0.21	0.61	0	0	0	0	0	100
19	3	11-Sep-13	0.51	0.6	0.62	0.11	0.1	0.11	5	35	60	0	0	0	0.61	0.6	0.95	0.11	0.15	0.17	5	30	60	5	0	0
20	3	11-Sep-13	0	0.75	0.88	0	0.09	0.04	0	0	0	0	0	100	0	0.41	0.72	0	0.31	0.35	50	10	10	10	10	10
21	3	11-Sep-13	0	0.75	1.6	0	0.59	0.37	0	0	0	0	0	100	0	0.79	0.97	0	0	0.03	60	30	10	0	0	0
22	3	11-Sep-13	0	1.21	1.59	0	0.02	0.05	90	5	5	0	0	0	0	0.91	1.23	0	0.09	0.02	70	10	20	0	0	0
23	3	11-Sep-13	0	0.75	1.35	0	0	0.01	80	5	15	0	0	0	1	1.3	1.84	0.03	0.05	0.1	75	5	20	0	0	0
24	3	13-Sep-13	1	1.04	1.07	1.35	1.4	0.89	0	90	10	0	0	0	0.85	1.09	1.15	1.25	1.33	1.23	0	80	20	0	0	0
25	3	13-Sep-13	0.7	0.7	0.84	0.41	0.41	0.45	0	40	60	0	0	0	0.77	0.85	1.1	0.55	0.51	0.75	0	40	60	0	0	0
26	3	13-Sep-13	0	0.9	1.33	0	0.07	0.21	0	0	0	0	0	100	0	0.62	1.95	0	0.22	0.19	0	0	0	0	0	100

			Downstream End of Site												Upstream End of Site											
			Depth (m)			Velocity (m/s)			Substrate Composition						Depth (m)			Velocity (m/s)			Substrate Composition					
Site	**Reach**	**Date**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**
28	3	16-Sep-13	0	0.47	0.66	0	0	0.04	90	10	0	0	0	0	0	0.29	0.7	0	0	0.15	0	95	5	0	0	0
29	3	16-Sep-13	0	0.86	1.25	0	0.51	0.51	0	0	0	0	0	100	0	0.86	1.33	0	0.18	0.35	0	0	0	0	0	100
30	3	16-Sep-13	0	0.69	0.97	0	0.19	0.18	10	85	5	0	0	0	0	0.75	1.29	0	0.14	0.6	5	70	5	0	0	20
31	3	16-Sep-13	0	0.67	0.91	0	0.17	0.27	80	20	0	0	0	0	0	0.4	0.82	0	0.01	0.24	15	80	5	0	0	0
32	3	16-Sep-13	0	0.49	1.14	0	0.14	0.2	5	75	20	0	0	0	0	0.8	1.2	0	0	0	60	30	10	0	0	0
33	3	16-Sep-13	0	0.91	1.61	0	0.05	0.24	10	70	20	0	0	0	0	0.71	1.49	0	0.25	0.36	10	80	10	0	0	0
34	3	16-Sep-13	0	1.11	2.2	0	0.27	0.32	0	0	0	0	0	100	0	0.76	1.57	0	0.18	0.45	10	40	20	0	0	30
35	3	16-Sep-13	0.15	0.66	1.9	0	0.89	0.69	0	0	0	0	0	100	0.15	0.75	1.45	0	0	0.41	0	0	0	0	0	100
36	3	17-Sep-13	0	1.15	1.64	0	0.33	0.54	100	0	0	0	0	0	0	0.4	0.6	0	0.25	0.65	20	80	0	0	0	0
37	3	17-Sep-13	0	0.31	0.42	0	0	0.01	100	0	0	0	0	0	0	1.95	2.2	0	1.9	1.93	10	60	20	10	0	0
38	3	17-Sep-13	0	0.55	1.07	0	0.27	0.32	100	0	0	0	0	0	0	0.63	1.19	0	0.16	0.45	80	20	0	0	0	0
39	3	17-Sep-13	0	0.45	0.71	0	0.3	0.8	5	85	10	0	0	0	0	0.54	1.27	0	0.29	0.32	0	60	40	0	0	0
40	2	14-Sep-13	0	0.56	1.28	0	0.28	0.45	0	95	5	0	0	0	0	0.49	1.19	0	0.2	0.23	5	90	5	0	0	0
41	2	14-Sep-13	0	0.61	1.27	0	0.28	0.6	0	40	60	0	0	0	0	0.67	1.61	0	0.11	0.13	10	50	40	0	0	0
42	2	14-Sep-13	0	0.35	0.66	0	0	0.07	80	20	0	0	0	0	0	0.21	0.55	0	0.07	0.15	70	30	0	0	0	0
43	2	14-Sep-13	0	0.3	0.91	0	0	0.03	100	0	0	0	0	0	0	0.74	1.1	0	0.29	0.57	100	0	0	0	0	0
44	2	14-Sep-13	0	1.05	2.41	0	0.11	0.23	0	0	0	90	10	0	0	0.77	0.95	0	0.19	0.19	10	20	10	50	10	0
45	2	14-Sep-13	0	0.41	0.96	0	0.19	0.45	40	40	20	0	0	0	0	0.35	0.96	0	0.17	0.51	40	40	20	0	0	0
46	2	14-Sep-13	0	0.4	0.78	0	0.12	0.2	100	0	0	0	0	0	0	0.25	0.53	0	0	0.19	100	0	0	0	0	0
47	2	14-Sep-13	0	1.15	2.46	0	0.2	0.46	0	0	10	90	0	0	0	1.03	1.71	0	0.19	0.21	20	20	40	20	0	0
48	2	12-Sep-13	0	0.73	1.41	0	0	0.06	15	40	40	5	0	0	0	1.4	2.3	0	0	0	0	0	0	0	100	0
49	2	12-Sep-13	0	0.41	1.01	0	0.26	0.39	95	5	0	0	0	0	0	0.51	1.05	0	0.1	0.17	95	5	0	0	0	0
50	2	12-Sep-13	0.24	0.33	0.46	0.02	0.02	0.01	100	0	0	0	0	0	0.19	0.33	0.59	0	0.01	0.01	100	0	0	0	0	0
51	1	12-Sep-13	0	0.79	1.05	0	0	0	0	5	10	65	20	0	0	0.56	1.29	0	0	0	0	10	10	20	60	0
52	1	12-Sep-13	0	0.97	1.5	0	0.01	0.01	0	10	30	30	30	0	0	0.94	1.94	0	0	0.11	0	10	20	40	30	0
53	1	12-Sep-13	0.17	0.36	0.48	0	0	0.11	60	40	0	0	0	0	0	0.44	0.6	0	0	0	100	0	0	0	0	0

			Downstream End of Site												Upstream End of Site											
			Depth (m)			Velocity (m/s)			Substrate Composition						Depth (m)			Velocity (m/s)			Substrate Composition					
Site	**Reach**	**Date**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**	**0 m**	**1.5 m**	**3 m**	**0 m**	**1.5 m**	**3 m**	**F**	**G**	**C**	**B**	**R**	**RR**
54	1	12-Sep-13	0	0.46	0.8		0	0	90	10	0	0	0	0	0	0.49	0.8	0	0.22	0.17	90	10	0	0	0	0
55	1	12-Sep-13	0	0.51	1.2	0	0	0	20	25	25	20	10	0	0	1	1.11	0	0	0	5	5	15	25	50	0
56	1	12-Sep-13	0	0.72	1.13	0	0	0	100	0	0	0	0	0	0	0.8	1.1	0	0	0	100	0	0	0	0	0
Biased 1	4	15-Sep-13	0	0.41	1.03	0	0.08	0.05	10	60	30	0	0	0	0	1.14	1.64	0	0.1	0.08	0	90	10	0	0	0
Biased 2	4	15-Sep-13	0	0.75	1.37	0	0	0	0	60	40	0	0	0	0	0.57	0.95	0	0.12	0.33	0	30	70	0	0	0
Biased 3	4	15-Sep-13	0	0.43	0.69	0	0.11	0.67	0	20	60	20	0	0	0	0.54	0.99	0	0.04	0.27	0	60	30	10	0	0
Biased 4	4	15-Sep-13	0	0.71	1.4	0	0.13	0.26	0	15	70	15	0	0	0	0.38	0.9	0	0	0	0	20	50	30	0	0
Biased 5	4	13-Sep-13	0	0.6	0.69	0	0.17	0.29	10	10	30	20	0	30	0	0.88	1.37	0	0.07	0.04	10	10	20	30	0	30
Biased 6	4	13-Sep-13	1.13	1.14	1.13	0.56	0.45	0.56	10	20	40	30	0	0	1.27	1.19	1.1	0.35	0.78	0.8	30	20	25	25	0	0
Biased 7	4	13-Sep-13	0	0.68	1.35	0	0.08	0.15	0	0	0	0	0	100	0	0.65	1.55	0	0.14	1.51	0	0	0	0	0	100
Begbie d/s	2	15-Sep-13	0	0.26	0.32	0	0.56	1.12	5	60	30	5	0	0	0	0	0	0	0	0	5	60	30	5	0	0
Begbie u/s	2	17-Sep-13																								
Drimmie u/s	2	13-Sep-13																								
Drimmie d/s	2	13-Sep-13	0.1	0.15	0.14	0.31	0.81	0.65	40	55	5	0	0	0	0.07	0.05	0.12	0.36	0.5	0.64	10	85	5	0	0	0
Illicil d/s	3	17-Sep-13	0	0.41	0.84	0	0.16	0.26	5	85	10	0	0	0	0	0.57	1.05	0	0.2	0.44	0	95	5	0	0	0
Illicil u/s	3	17-Sep-13	0	0.36	0.67	0	0.41	0.65	10	10	80	0	0	0	0.34	0.64	0.83	0	0.81	1.15	10	10	80	0	0	0
Jordan d/s	4	13-Sep-13	0	1.34	2.35	0	0.06	0.09	0	0	0	0	0	100	0	0.86	2.05	0	0.01	0.07	0	0	0	0	0	100
Tonk d/s	3	17-Sep-13	0.19	1.09	1.62	0	0	0	100	0	0	0	0	0	0	1.05	1.32	0	0	0	90	0	0	10	0	0
Tonk u/s	3	18-Sep-13	0	0.17	0.35	0	0.06	0.1	10	20	60	10	0	0	0	0.12	0.19	0	0	0	10	20	50	20	0	0
Masse Control	3	11-Sep-13	0	0.98	1.65	0	0.04	0.25	0	0	0	0	0	100	0	0.71	1.2	0	0.27	0.25	0	20	65	10	0	5
Masse rip rap	3	11-Sep-13	0	0.86	1.15	0	0.17	0.15	0	0	0	0	0	100	0	1	1.32	0	0.03	0.03	0	0	0	0	0	100

Begbie u/s and Drimmie u/s had adult spawning Kokanee present and therefore not sampled

F = fines G = gravel C = cobble B = boulder R = bedrock RR = riprap

Appendix 5

Fish Collection Summary Information

Appendix 5a. Fish collection summary information for the May/June 2013 sampling trip.

Site	Reach	Date	EF sec.	BB A	BB J	BT A	BT J	KO A	KO J	MW A	MW J	NSC A	NSC J	RB A	RB J	RSC A	RSC J	CAS A	CAS J	CCG A	CCG J	PCC A	PCC J	CSU A	CSU J	COTT A	COTT J
1	4	30-May-13	281	0	0	0	0	0	0	5	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	30	7
2	4	30-May-13	259	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	20	9
3	4	30-May-13	265	1	0	0	0	0	0	0	1	0	0	0	0	0	0	4	1	0	0	0	0	0	0	8	0
4	4	30-May-13	281	0	0	0	0	0	0	0	1	0	0	0	0	0	0	7	3	0	0	0	0	0	0	20	10
5	4	30-May-13	315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	10	0
6	4	30-May-13	255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	16	0
7	4	31-May-13	285	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	20	0
8	4	31-May-13	250	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	22	0
9	4	28-May-13	317	0	0	1	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	25	10
10	4	28-May-13	367	0	0	1	0	0	0	0	0	0	0	0	0	6	1	2	1	0	0	0	0	0	0	10	0
11	4	28-May-13	272	0	0	0	0	0	0	2	2	0	0	0	0	1	0	10	1	0	0	0	0	0	0	30	10
12	4	28-May-13	294	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0		0	0	0	0	6
13	4	28-May-13	243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	4	29-May-13	295	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	1	1	0	0	0	0	0	40	0
15	4	29-May-13	258	0	0	0	1	0	0	0	0	0	0	0	0	0	0	18	1	2	0	0	0	0	0	0	0
16	4	3-Jun-13	254	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
17	4	3-Jun-13	296	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	3
18	4	3-Jun-13	342	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1
19	3	29-May-13	253	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	3	29-May-13	312	0	0	2	0	0	0	7	4	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1
21	3	29-May-13	266	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	8	7
22	3	29-May-13	283	0	0	0	1	0	0	3	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0	1	0
23	3	29-May-13	232	0	0	0	0	0	0	0	1	0	0	0	0	5	0	1	1	0	0	0	0	0	0	13	0
24	3	29-May-13	220	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	3	29-May-13	230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	3	30-May-13	252	0	0	1	0	0	1	0	0	0	0	0	0	0	0	6	1	0		0	0	0	0	12	10
27	3	31-May-13	408	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	3	4-Jun-13	489	0	0	0	2	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0
29	3	30-May-13	240	0	0	0	3	0	0	0	1	0	0	0	0	0	0	7	0	1	1	0	0	0	0	40	20
30	3	30-May-13	234	1	1	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	15	45
31	3	5-Jun-13	295	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Site	Reach	Date	EF sec.	BB A	BB J	BT A	BT J	KO A	KO J	MW A	MW J	NSC A	NSC J	RB A	RB J	RSC A	RSC J	CAS A	CAS J	CCG A	CCG J	PCC A	PCC J	CSU A	CSU J	COTT A	COTT J
32	3	3-Jun-13	360	0	0	0	1	0	1	5	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
33	3	3-Jun-13	306	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0
34	3	3-Jun-13	331	0	0	0	0	0	0	2	0	0	0	0	1	2	0	1	0	0	0	0	0	0	0	2	8
35	3	4-Jun-13	387	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	5	25
36	3	5-Jun-13	273	0	0	0	0	0	0	0	1	0	0	0	0	1	0	2	1	1	0	1	0	0	0	0	0
37	3	5-Jun-13	274	0	0	0	1	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
38	3	5-Jun-13	263	0	0	1	3	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1
39	3	5-Jun-13	319	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
40	2	5-Jun-13	331	0	0	0	0	0	2	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
41	2	5-Jun-13	345	0	0	0	0	0	3	0	0	0	0	0	1	0	0	9	1	0	0	0	0	0	0	8	1
42	2	5-Jun-13	341	0	0	0	0	0	2	0	7	0	0	0	1	3	0	1	1	0	0	0	0	0	0	0	0
43	2	5-Jun-13	316	0	0	0	0	0	0	0	1	0	1	0	1	0	1	2	2	0	0	0	1	0	1	0	0
44	2	4-Jun-13	412	0	0	0	0	0	0	0	0	0	0	0	2	4	1	0	0	2	0	0	0	0	0	0	0
45	2	4-Jun-13	330	0	0	0	0	0	1	0	2	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	2
46	2	4-Jun-13	306	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
47	2	4-Jun-13	365	0	0	0	0	0	0	0	0	0	1	0	1	0	0	2	0	0	0	0	0	0	0	0	2
48	2	7-Jun-13	343	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	0	0	0	0	0	0	0	0	6
49	2	7-Jun-13	0																								
50	2	6-Jun-13	0																								
51	2	6-Jun-13	380	0	0	0	0	0	0	0	0	0	3	0	0	4	0	0	0	0	0	0	0	0	0	0	1
52	1	6-Jun-13	394	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
53	1	6-Jun-13	0																								
54	1	6-Jun-13	281	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
55	1	6-Jun-13	417	0	0	0	0	0	0	4	1	1	1	0	2	4	0	0	0	0	0	0	0	0	0	0	0
56	1	6-Jun-13	237	0	0	0	0	0	0	0	0	0	1	0	0	3	1	0	0	0	0	6	0	0	0	0	0
Biased 1	4	30-May-13	352	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	20	3
Biased 2	4	31-May-13	258	0	0	0	1	0	0	1	0	0	0	0	0	0	0	9	1	0	0	0	0	0	0	30	10
Biased 3	4	31-May-13	317	0	0	0	0	0	0	0	2	0	0	0	0	0	0	4	0	0	0	0	0	0	0	2	2
Biased 4	4	31-May-13	240	0	0	0	0	0	0	1	2	0	0	0	0	1	0	12	3	0	0	0	0	0	0	22	0
Biased 5	4	29-May-13	242	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	11
Biased 6	4	29-May-13	248	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Biased 7	4	3-Jun-13	291	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	1

Site	Reach	Date	EF sec.	BB A	BB J	BT A	BT J	KO A	KO J	MW A	MW J	NSC A	NSC J	RB A	RB J	RSC A	RSC J	CAS A	CAS J	CCG A	CCG J	PCC A	PCC J	CSU A	CSU J	COTT A	COTT J
Drimmie d/s	2	7-Jun-13	173	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Drimmie u/s	2	6-Jun-13	261	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Illicil d/s	3	5-Jun-13	264	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	2	6
Illicil u/s	3	31-May-13	204	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	1	0	0	0	0	3	0
Jordan u/s	4	31-May-13	417	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Tonk d/s	3	5-Jun-13	257	0	0	1	0	0	0	0	5	0	0	0	1	0	0	4	2	1	0	0	0	0	0	0	0
Tonk u/s	3	31-May-13	298	0	0	0	0	0	0	0	0	0	0	0	9	0	0	1	0	0	0	0	0	0	0	0	0

BB = Burbot
NSC = Northern Pikeminnow
CCG = Slimy Sculpin
BT = Bull trout
RB = Rainbow Trout
PCC = Peamouth Chub
KO = Kokanee
RSC = Redside Shiner
CSU = Largescale Sucker
MW = Mountain Whitefish
CAS = Prickly Sculpin
COTT = Sculpin (general)

A = Adult
J = Juvenile

Appendix 5b. Fish collection summary information for the July 2013 sampling trip.

Site	Reach	Date	EF sec.	BB A	BB J	BT A	BT J	KO A	KO J	MW A	MW J	NSC A	NSC J	RB A	RB J	RSC A	RSC J	CAS A	CAS J	CCG A	CCG J	LSU A	LSU J	PCC A	PCC J	TC A	TC J	CSU A	CSU J	COTT A	COTT J
1	4	5-Jul-13	235	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2	4	5-Jul-13	236	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0	0	0	0	0	0	0	0	0	3	2
3	4	5-Jul-13	239	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
4	4	5-Jul-13	322	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
5	4	6-Jul-13	234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	4	5-Jul-13	245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	4	6-Jul-13	297	0	0	0	0	0	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	4	8-Jul-13	308	0	0	0	0	0	0	0	1	0	0	0	1	0	0	3	0	0	0	0	1	0	0	0	0	0	0	9	4
9	4	8-Jul-13	368	0	0	0	1	0	0	1	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	25	11
10	4	8-Jul-13	429	0	0	1	0	0	0	0	2	1	0	0	0	7	0	4	0	0	0	0	0	0	0	0	0	4	0	0	0
11	4	8-Jul-13	361	0	0	1	0	0	0	0	2	0	0	0	0	1	0	6	1	0	0	0	0	0	0	0	0	0	0	31	16
12	4	8-Jul-13	303	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	0	0	4	18
13	4	9-Jul-13	289	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	1	0	0	0	0	0	0	0	0	0	0	24	16
14	4	9-Jul-13	296	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	7	4
15	4	9-Jul-13	341	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	8	6
16	4	11-Jul-13	293	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	9
17	4	11-Jul-13	238	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	4	11-Jul-13	320	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	3
19	3	2-Jul-13	268	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	4
20	3	2-Jul-13	342	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
21	3	2-Jul-13	311	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
22	3	2-Jul-13	279	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
23	3	2-Jul-13	228	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
24	3	3-Jul-13	316	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
25	3	3-Jul-13	340	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
26	3	3-Jul-13	317	0	0	0	0	0	1	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0
27	3	3-Jul-13	313	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
28	3	12-Jul-13	205	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	3	12-Jul-13	242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
30	3	12-Jul-13	216	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	1
31	3	12-Jul-13	263	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0

Site	Reach	Date	EF sec.	BB A	BB J	BT A	BT J	KO A	KO J	MW A	MW J	NSC A	NSC J	RB A	RB J	RSC A	RSC J	CAS A	CAS J	CCG A	CCG J	PCC A	PCC J	CSU A	CSU J	COTT A	COTT J
32	3	10-Jul-13	278	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
33	3	10-Jul-13	245	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	0	6	0	0	0
34	3	10-Jul-13	263	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	1	0	0	0	1	0	11	9
35	3	10-Jul-13	262	0	0	0	0	0	0	0	0	0	0	0	5	0	0	7	0	0	0	0	0	0	0	6	7
36	3	9-Jul-13	196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
37	3	10-Jul-13	262	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	2	0	0	0
38	3	9-Jul-13	219	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2	0	0	0
39	3	10-Jul-13	257	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
41	2	4-Jul-13	247	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	2	4-Jul-13	310	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	2	4-Jul-13	0																								
44	2	3-Jul-13	266	0	0	0	0	0	0	0	0	0	0	0	3	0	0	5	0	0	0	0	0	0	0	13	0
45	2	3-Jul-13	0																								
46	2	3-Jul-13	294	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	2	3-Jul-13	253	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	2	10-Jul-13	248	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0
49	2	10-Jul-13	0																								
50	2	10-Jul-13	0																								
51	2	10-Jul-13	250	0	1	0	0	0	0	0	0	1	1	0	0	0	0	4	1	0	0	0	0	0	0	0	0
52	1	10-Jul-13	255	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
53	1	10-Jul-13	0																								
54	1	10-Jul-13	258	0	0	0	0	0	0	0	0	1	1	0	0	0	0	4	0	0	0	4	0	0	0	0	0
55	1	10-Jul-13	310	0	0	0	0	0	0	2	0	1	0	0	0	0	0	1	0	0	0	4	0	0	0	0	0
56	1	10-Jul-13	0																								
Biased 1	4	5-Jul-13	347	0	0	0	1	0	1	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biased 2	4	6-Jul-13	326	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biased 3	4	6-Jul-13	333	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	2	3
Biased 4	4	8-Jul-13	279	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7	1	0	0	0	0	0	0	13	6
Biased 5	4	9-Jul-13	243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	2
Biased 6	4	11-Jul-13	269	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Biased 7	4	11-Jul-13	282	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1	0	0	0	0	0	0	11	7

Sites 43, 45, 49, 50, 53 and 56 were flooded at time of assessment and therefore not sampled

Site	Reach	Date	EF sec.	BB A	BB J	BT A	BT J	KO A	KO J	MW A	MW J	NSC A	NSC J	RB A	RB J	RSC A	RSC J	CAS A	CAS J	CCG A	CCG J	PCC A	PCC J	CSU A	CSU J	COTT A	COTT J
Begbie d/s	2	4-Jul-13	167	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0
Begbie u/s	2	4-Jul-13	218	0	0	0	2	0	0	1	0	0	0	0	3	0	0	0	0	2	0	0	0	0	0	0	0
Drimmie d/s	2	10-Jul-13	0																								
Drimmie u/s	2	10-Jul-13	270	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
Illicil d/s	3	9-Jul-13	150	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Illicil u/s	3	9-Jul-13	169	0	0	0	0	0	0	1	0	0	0	0	2	0	0	2	0	1	0	0	0	0	0	7	4
Jordan d/s	4	11-Jul-13	205	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Jordan u/s	4	11-Jul-13	238	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	1
Tonk d/s	3	9-Jul-13	136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0
Tonk u/s	3	9-Jul-13	171	0	0	0	0	0	0	2	0	1	0	0	1	0	0	6	0	0	0	1	0	0	0	4	0

Drimmie d/s was flooded at time of assessment and therefore not sampled

BB = Burbot
NSC = Northern Pikeminnow
CCG = Slimy Sculpin
EB = Eastern Brook Trout

BT = Bull trout
RB = Rainbow Trout
LSU = Longnose Sucker
CSU = Largescale Sucker

KO = Kokanee
RSC = Redside Shiner
PCC = Peamouth Chub
COTT = Sculpin (general)

MW = Mountain Whitefish
CAS = Prickly Sculpin
TC = Tench

A = Adult
J = Juvenile

Appendix 5c. Fish collection summary information for the September 2013 sampling trip.

Site	Reach	Sample Date	Effort	BB A	BB J	BT A	BT J	KO A	KO J	MW A	MW J	NSC A	NSC J	RB A	RB J	RSC A	RSC J	CAS A	CAS J	CCG A	CCG J	LSU A	LSU J	PCC A	PCC J	EB A	EB J	CSU A	CSU J	COTT A	COTT J
1	4	15-Sep-13	245	0	0	2	0	0	1	3	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	4	15-Sep-13	228	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
3	4	15-Sep-13	253	0	0	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
4	4	15-Sep-13	229	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	2	3
5	4	15-Sep-13	216	0	0	2	1	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	2
6	4	15-Sep-13	322	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	4	15-Sep-13	251	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	5	2
8	4	15-Sep-13	235	0	0	1	0	0	1	3	0	0	0	0	1	0	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0
9	4	18-Sep-13	216	0	0	1	1	4	0	3	0	0	0	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	12	4
10	4	15-Sep-13	280	0	0	1	2	0	0	18	2	1	1	1	0	1	0	6	0	0	0	0	0	0	0	0	0	0	0	12	7
11	4	18-Sep-13	226	0	0	2	0	20	0	17	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	4	3
12	4	18-Sep-13	234	0	0	1	0	0	0	1	2	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	7	3
13	4	18-Sep-13	253	0	0	1	0	11	0	1	1	0	0	0	0	0	0	9	1	0	0	0	0	0	0	0	0	0	0	20	10
14	4	13-Sep-13	274	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3	2
15	4	13-Sep-13	347	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
16	4	13-Sep-13	247	0	0	0	0	0	1	0	0	0	0	0	0	5	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
17	4	13-Sep-13	293	0	0	0	0	4	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	4	13-Sep-13	272	0	0	0	0	0	0	0	0	0	0	0	0	8	0	4	2	0	0	0	0	0	0	0	0	0	0	4	3
19	3	11-Sep-13	268	0	0	0	0	2	0	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
20	3	11-Sep-13	294	0	0	2	0	5	4	2	1	0	0	0	0	3	0	8	0	0	0	0	0	0	0	0	0	0	0	2	2
21	3	11-Sep-13	264	0	0	1	0	15	1	1	0	0	0	0	0	1	0	7	0	0	0	0	0	0	0	0	1	1	0	0	0
22	3	11-Sep-13	345	0	0	0	1	27	1	14	2	0	1	0	0	0	0	5	0	0	0	0	0	0	0	0	0	1	0	12	6
23	3	11-Sep-13	321	0	0	0	0	7	4	1	0	0	0	0	0	1	0	6	1	0	0	0	0	0	0	0	0	1	0	8	5
24	3	13-Sep-13	322	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	3	13-Sep-13	230	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	3	13-Sep-13	281	0	0	0	0	6	0	1	1	1	0	0	2	2	0	7	0	1	0	0	0	0	0	0	0	1	0	10	0
27	3	16-Sep-13	257	0	0	0	1	0	0	0	2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28	3	16-Sep-13	253	0	0	1	1	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	8	0	0	0
29	3	16-Sep-13	265	0	0	0	1	4	0	3	0	0	0	0	0	1	0	4	0	2	0	0	0	0	0	0	0	0	0	6	5
30	3	16-Sep-13	194	0	0	1	0	3	0	0	4	0	0	0	3	6	1	7	1	1	0	0	0	0	0	0	0	0	0	4	2
31	3	16-Sep-13	256	0	0	0	0	5	21	2	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site	Reach	Sample Date	Effort	BB A	BB J	BT A	BT J	KO A	KO J	MW A	MW J	NSC A	NSC J	RB A	RB J	RSC A	RSC J	CAS A	CAS J	CCG A	CCG J	LSU A	LSU J	PCC A	PCC J	YP A	YP J	CSU A	CSU J	COTT A	COTT J
32	3	16-Sep-13	213	0	0	0	0	1	1	4	1	0	0	0	1	6	1	3	0	0	0	0	0	0	0	0	0	1	0	7	3
33	3	16-Sep-13	237	0	0	0	1	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	44	15
34	3	16-Sep-13	229	0	0	0	0	1	1	0	0	0	0	0	0	6	0	6	0	0	0	0	0	0	0	0	0	0	0	10	5
35	3	16-Sep-13	220	0	0	0	1	0	0	0	0	0	0	0	1	6	1	1	0	0	0	0	0	0	1	0	0	0	0	7	3
36	3	17-Sep-13	240	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	1	6	0	0	0	0	0	0	0	0	0	7	3
37	3	17-Sep-13	200	0	0	0	0	6	9	0	0	1	1	0	0	8	0	1	0	0	0	0	0	0	0	0	0	1	0	12	4
38	3	17-Sep-13	220	0	0	0	0	2	1	0	8	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	17	2
39	3	17-Sep-13	198	0	0	0	1	1	1	0	27	0	0	0	0	2	0	3	3	1	0	0	0	0	0	0	0	0	0	20	0
40	2	14-Sep-13	267	0	0	0	0	5	2	5	0	1	0	0	0	2	0	11	0	0	0	0	0	1	1	0	0	2	0	20	10
41	2	14-Sep-13	247	0	0	1	0	1	0	4	1	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	30	10
42	2	14-Sep-13	220	0	0	1	0	1	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
43	2	14-Sep-13	224	0	0	5	0	1	1	0	0	3	1	0	0	2	27	2	2	0	0	0	0	0	125	0	0	0	0	2	4
44	2	14-Sep-13	264	0	0	0	0	0	0	3	0	0	2	0	0	45	35	3	0	1	0	0	0	0	0	0	0	1	0	10	5
45	2	14-Sep-13	208	0	0	0	0	0	2	0	0	0	0	0	0	1	1	7	5	0	0	0	0	0	4	0	0	0	0	5	25
46	2	14-Sep-13	231	0	0	0	1	0	1	0	3	0	0	0	0	4	0	1	0	0	0	0	0	0	2	0	0	0	0	15	0
47	2	14-Sep-13	259	0	1	0	0	0	2	0	0	0	0	0	0	33	0	14	0	10	0	0	0	0	0	0	1	0	0	40	20
48	2	12-Sep-13	282	0	0	0	0	0	0	0	0	0	0	0	0	16	2	4	1	0	0	0	0	0	0	4	0	0	0	3	0
49	2	12-Sep-13	263	0	0	0	0	0	1	0	0	0	0	0	0	1	1	4	2	0	0	0	0	0	0	0	0	0	0	0	0
50	2	12-Sep-13	222	0	0	0	0	0	0	1	8	0	0	0	0	0	0	5	0	0	0	0	0	5	0	0	0	0	0	0	0
51	2	12-Sep-13	293	0	0	0	0	0	0	0	0	0	1	0	0	32	20	23	5	1	1	0	0	0	0	0	0	0	0	0	0
52	1	12-Sep-13	305		0	0	0	0	0	0	0	1	0	0	0	13	0	7	0	0	0	0	0	0	1	0	0	0	0	3	0
53	1	12-Sep-13	250	0	0	0	0	0	0	1	3	0	1	0	0	6	0	2	0	0	0	0	0	1	0	0	0	0	0	3	0
54	1	12-Sep-13	298	0	0	2	0	0	0	0	0	0	1	0	0	0	44	1	2	0	0	0	0	0	2	0	0	0	0	0	0
55	1	12-Sep-13	290	0	0	0	0	0	0	0	0	0	1	0	1	73	12	8	0	0	0	0	0	1	0	0	0	0	0	12	4
56	1	12-Sep-13	222	0	0	0	0	0	0	0	1	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biased 1	4	15-Sep-13	257	0	0	1	0	17	0	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Biased 2	4	15-Sep-13	248	0	0	0	1	1	1	4	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	7	3
Biased 3	4	15-Sep-13	257	0	0	1	2	0	1	1	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	1	0	12	6
Biased 4	4	15-Sep-13	241	0	0	1	2	3	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	1	0	12	3
Biased 5	4	13-Sep-13	281	0	0	0	0	0	0	0	2	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	1	0	4	3

Site	Reach	Sample Date	Effort	BT A	BT J	KO A	KO J	MW A	MW J	NSC A	NSC J	RB A	RB J	RSC A	RSC J	CAS A	CAS J	CCG A	CCG J	LSU A	LSU J	PCC A	PCC J	CSU A	CSU J	COTT A	COTT J
Biased 6	4	13-Sep-13	372	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	1	0	0	0	0	4	0	0	0
Biased 7	4	13-Sep-13	274	0	0	1	0	0	0	0	0	0	0	0	0	7	0	1	0	0	0	0	0	0	0	3	3
Begbie d/s	2	15-Sep-13	171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Begbie u/s	2	17-Sep-13	0																								
Drimmie u/s	2	13-Sep-13	0																								
Drimmie d/s	2	13-Sep-13	245	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0		0	6
Illicil d/s	3	17-Sep-13	125	0	0	1	0	0	0	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Illicil u/s	3	17-Sep-13	200	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2	0
Jordan d/s	4	13-Sep-13	142	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Masse Control	3	11-Sep-13	312	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	15	0
Masse rip rap	3	11-Sep-13	246	0	0	0	0	0	0	0	0	0	0	0	0	3	0	7	0	0	0	0	0	0	0	4	0
Tonk d/s	3	17-Sep-13	136	0	0	0	0	1	0	1	5	0	0	0	0	1	1	4	3	0	0	1	0	1	0	8	5
Jordan u/s	3	18-Sep-13	224	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	1	0	0	0	0	0	0	2	0

Begbie u/s and Drimmie u/s had spawning adult Kokanee present and therefore were not sampled

BB = Burbot
NSC = Northern Pikeminnow
CCG = Slimy Sculpin
COTT = Sculpin (general)
BT = Bull trout
RB = Rainbow Trout
LSU = Longnose Sucker
EB = Eastern Brook Trout
KO = Kokanee
RSC = Redside Shiner
PCC = Peamouth Chub
MW = Mountain Whitefish
CAS = Prickly Sculpin
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A = Adult
J = Juvenile