Columbia River Project Water Use Plan
Revelstoke Flow Management Plan

Middle Columbia River Juvenile Fish Habitat Use

Implementation Year 4 of 6

Reference: CLBMON-17

Study Period: 2011-2012

Greg Sykes, M.Sc., R.P.Bio.
Triton Environmental Consultants Ltd.

April 2012

Triton Project 4471

Middle Columbia River Juvenile Fish Habitat Use

Final

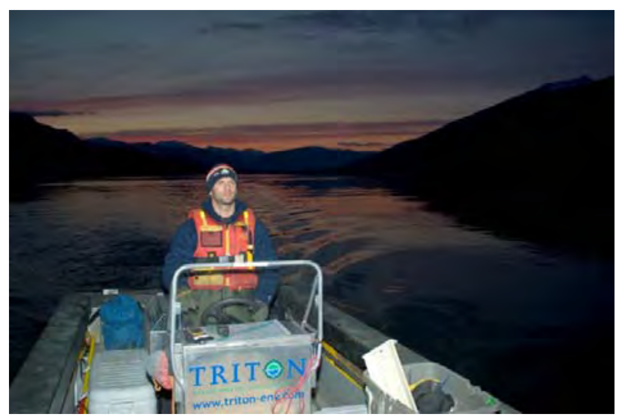
CLBMON-17

Year 4 (2011) of 6

April 2012

Prepared for:

BC Hydro
6911 Southpoint Drive Floor 11
Burnaby, British Columbia
V3N 4X8



Prepared by:

Greg Sykes, M.Sc., R.P. Bio.
Biologist/Project Manager
Triton Environmental Consultants Ltd.

TRITON
ENVIRONMENTAL CONSULTANTS LTD.

1326 McGill Ave.

Kamloops, BC. Canada V2C 6N6
Phone (250) 851-0023
Fax (250) 851-0074
www.triton-env.com

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 at 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. 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 fish, in general, within the Middle Columbia. The Middle Columbia River Juvenile Fish Habitat Use project (CLBMON-17) was initiated in order to determine if this objective was met for juvenile life stages.

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. 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, as well as lengths and weights of up to 30 randomly selected individuals from each species, were recorded. Three sampling trips have been completed annually since 2008: Trip 1 in the spring (May), Trip 2 in the summer (June/July), and Trip 3 in the fall (September). Years 1–3 (2008–2010) of the study represent the baseline conditions (i.e., before implementation of minimum base flows), while Years 4–6 (2011–2013) form the after-implementation data set.

This report summarizes Year 4 of sampling, which was the first year following the implementation of the minimum base flow. In total, 6,504 fishes were captured in 2011 compared to 8,861 in 2010, 7,763 in 2009, and 2,091 in 2008. In total, 17 species were

captured during the three sampling trips in 2011, which was the same number of species captured in 2010 and 2009 and two more than in 2008. The length, weight, and condition factor of the three target species in 2011 were similar to those in the three years of baseline data, which suggests that the rearing environment was relatively constant. The results of the three years of baseline data showed that, in general, fish usage tended to be higher and more consistent in the lower reaches where conditions were less variable compared to the upper reaches which experienced greater fluctuation in discharge. This trend was also observed in 2011.

The catch-per-unit-effort (CPUE) of juvenile Rainbow Trout, Bull Trout, and Mountain Whitefish from Year 4 was compared to that of Years 1–3. For each species a significant increase in CPUE was noted at 1 of 15 reach and trip combinations while at the remaining 14 no differences were detected. This suggests no change has occurred in any of the three populations following the first year of post-Rev 5 implementation. An additional two years of “after-implementation” data will be collected in 2012 and 2013.

CLBMON #17 STATUS of OBJECTIVES, MANAGEMENT QUESTIONS and HYPOTHESES after Year 4

Objectives	Management Questions	Management Hypotheses	Year 4 (2011) Status
To provide information on Juveniule 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?	Ho1: Juveniles do not use mainstem habitats in the absence of minimum flow releases. Ho2: Juveniles do not use mainstem habitats during 142 m3/s minimum flow releases.	Juvenile fish make use of the mainstem for rearing and presumeably overwintering. Juvenile fish continued to make use of the mainstem following the implementation of minimum flow.
To assess the effects of the implementation of the 142 m3/s minimum flow and REV5 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?	Ho3: The provision of a minimum flow does not affect the average abundance of juvenile life stages in mainstem habitats	CPUE of Rainbow Trout, Bull Trout and Mountain Whitefish did not change significantly in any reach or season following the implementation of minimum base flow. Changes to availability of food will be addressed in Year 6 following review of CLBMON 15 (Ecological Productivity) results. Effects of predators will be addressed in Year 6 following review of CLBMON 16 and 18 results.

Acknowledgements

Triton Environmental Consultants Ltd. would like to thank the following for their contribution to the 2011 Middle Columbia River Juvenile Fish Habitat Use project:

Karen Bray	BC Hydro, Revelstoke, B.C.
Guy Martel	BC Hydro, Burnaby, B.C.
Jason Watson	BC Hydro, Burnaby, B.C.
Tracey Hooper	Technical Editor

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

Greg Sykes, R.P.Bio., M.Sc.	Manager/Fisheries Biologist/Contributing Author
Ryan Liebe, R.P.Bio.	Fisheries Biologist/Contributing Author
Bill Rublee, R.P.Bio.	Senior Fisheries Biologist/Report Reviewer
Scott Atherton, Dip. Tech.	GIS Technician
Shawn Johnston, R.P.Bio.	Fisheries Biologist
Damian Slivinski, B.I.T.	Fisheries Biologist
Andrea Battistal	Fisheries Biologist
Ryan Tomlinson	Fisheries Biologist

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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). 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, reaches 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 system 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 subadult and adult life stages of fishes, with very few juvenile life stages present (RL&L 1994; Golder Associates Ltd. 2005; Triton 2009). These findings suggest that mainstem habitats within the Middle Columbia are either unsuitable for juvenile fishes, that localized recruitment is limited, or that sufficient, preferable habitat exists elsewhere.

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 is met for juvenile life stages, baseline data on the current relative abundance, distribution, and habitat use of juvenile life stages are 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, as stated in the Terms of Reference (BC Hydro 2010), for the project are:

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.*

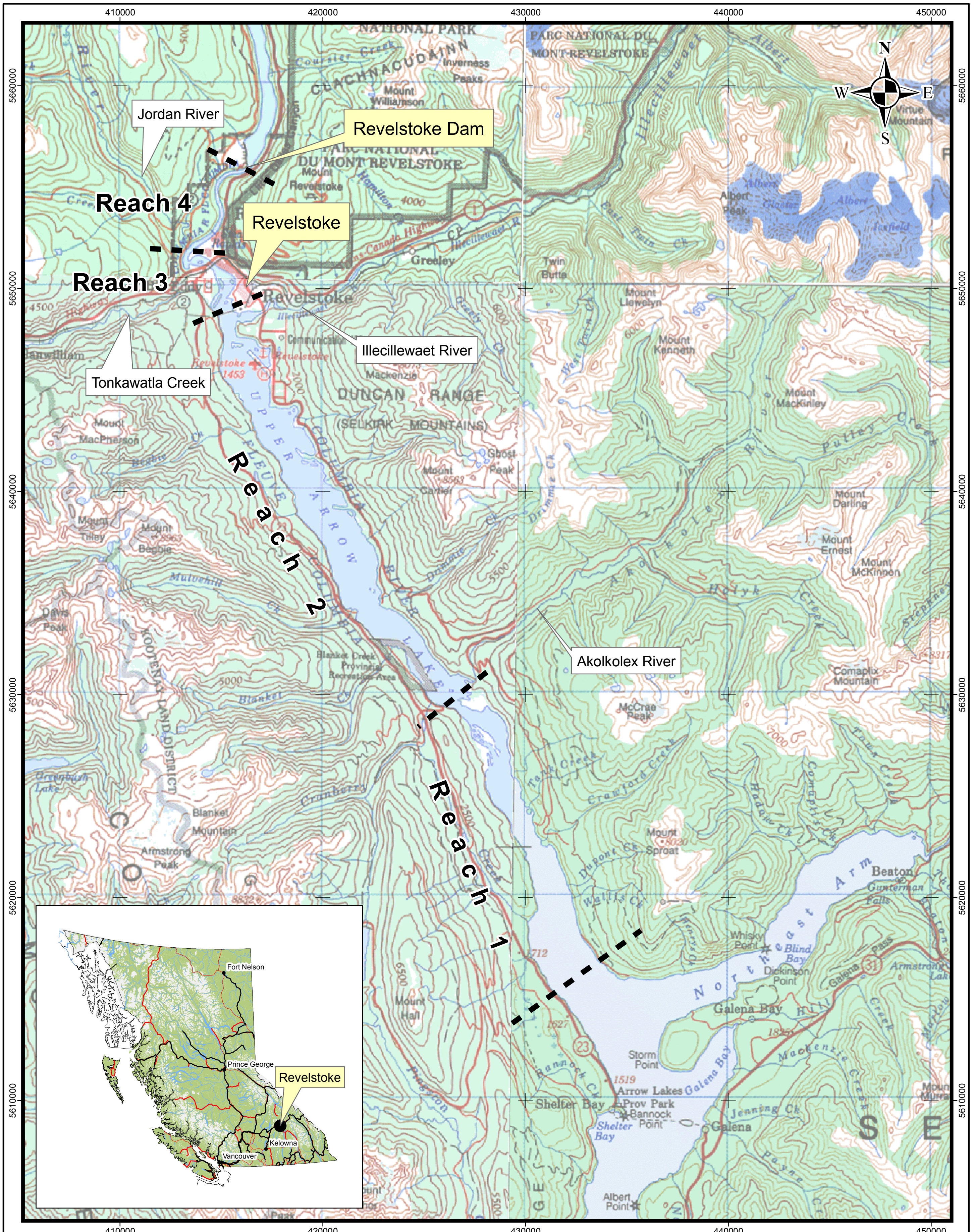
3. H_{o3}*: The provision of a minimum flow does not affect the average abundance of juvenile life stages in mainstem habitats.*

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 the Revelstoke Dam downstream to the Beaton Arm of the Arrow Lakes (Figure 1-1), as well as selected tributaries within this section of river. However, the focus of the study is on the riverine reaches (reaches 3 and 4) located closer to the dam (BC Hydro 2010).

It should be noted that the original Terms of Reference for the project (i.e. those that applied to years 1 – 3 of the project; BC Hydro [2007]) identified three key species as the focus of the study. These "target species" were 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. To that end, efforts have been made to expand the analysis as per the revised Terms of Reference, but in order to allow for comparison with the data from years 1 – 3, some focus on the target species has been maintained.



MIDDLE COLUMBIA RIVER JUVENILE FISH HABITAT USE	Basemap Source: NTS 1:250,000	0 1,000 2,000 4,000 6,000 8,000 Meters Scale: 1:250,000		Map Datum: UTM NAD 83 Zone 11
FIGURE 1-1. Overview of Study Area	Project No: 3789	File No: Map#: N:\ACTIVE\3943_BC_Hydro_Columbia\MXD\Location_Fig1.mxd	Date: Feb 12, 2009	TRITON ENVIRONMENTAL CONSULTANTS LTD.

Year 1 of the program (2008 field season) included an initial habitat assessment and the development of a stratified random sampling plan that resulted in the identification of 55 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.

Year 2 (2009 field season), Year 3 (2010 field season), and Year 4 (2011 field season) included sampling during low (May) and high (July and September) reservoir elevations to determine the relative abundance and seasonal distribution of juvenile fishes. The same sites were sampled in each of the first four years of the study, with Years 1–3 forming the baseline for pre-Rev 5 conditions. This report describes Year 4 results, which was the first year of sampling following the Rev 5 unit coming online. Comparison with pre-Rev 5 data (Years 1–3) is also included.

2.0 METHODS

Year 4 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 the site is located on (left or right when facing downstream), the project ID (e.g. 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. This naming convention was applied to all CLBMON-17 sample sites in 2011, 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.

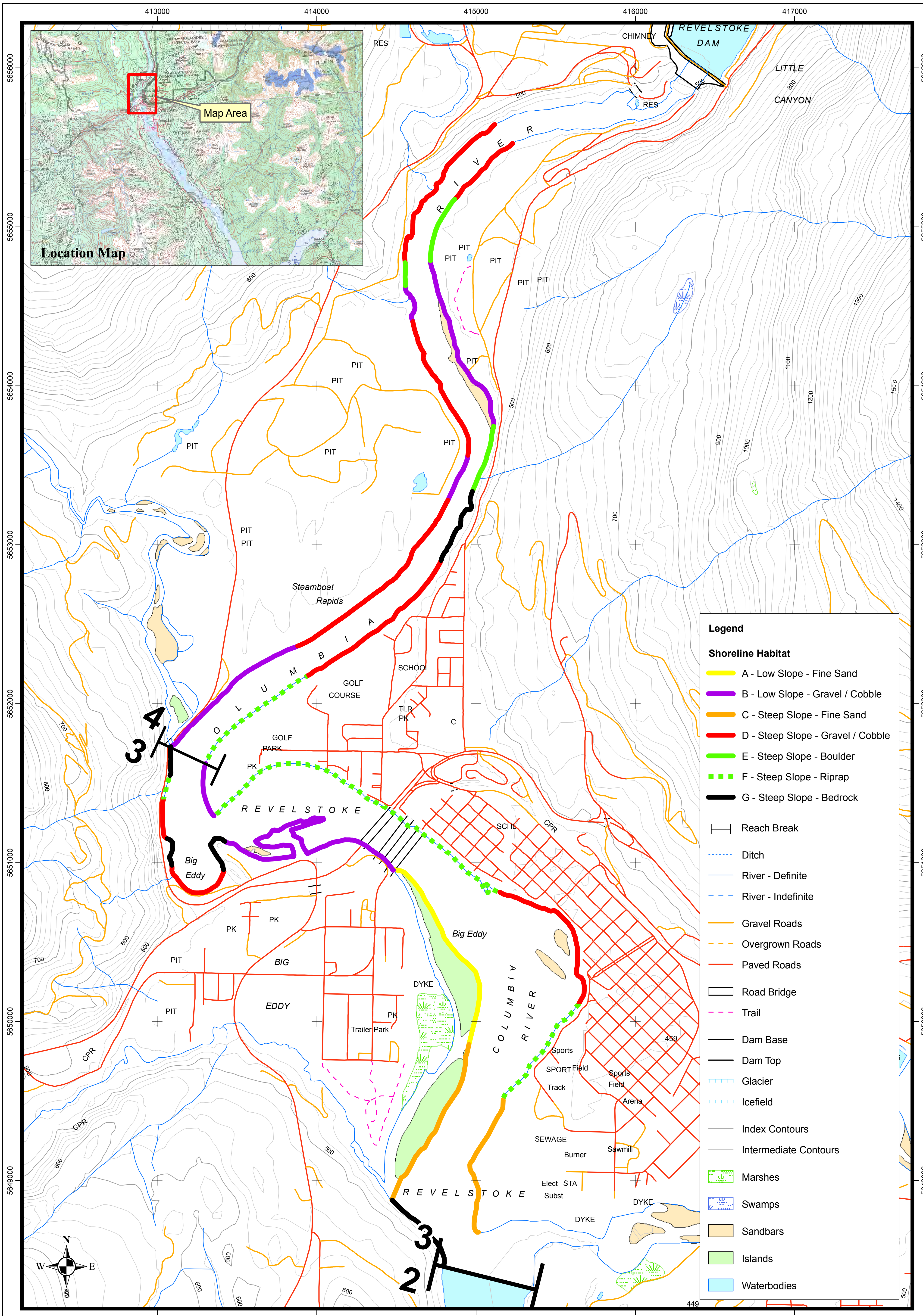
2.1 HABITAT INVENTORY

2.1.1 INITIAL SAMPLING DESIGN

The initial habitat inventory for the project was completed April 17–20, 2008, and included the 50-km long study area between the Revelstoke Dam and Beaton Flats (Figure 2-1). In total, 60 sites were identified for sampling 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* = 16) 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, seven of the original sites in reaches 1 and 2 could not be sampled during the summer and fall trips because they were inundated by the ALR. These sites were dropped from summer and fall sampling, and 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 new sites were referred to as “Bias 1–7” since they were not selected using the stratified random methodology. Two other sites (sites 46 and 47) in Reach 2 also had to be moved due to a change in accessibility from steep angle, fine-dominated habitat to steep angle, bedrock-dominated habitat. In 2011, the seven bias sites were sampled during all three sampling trips to increase overall sampling effort.



MIDDLE COLUMBIA RIVER
JUVENILE FISH HABITAT USE

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

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 2011 sample sites by reach

Habitat Class	Reach 1	Reach 2	Reach 3	Reach 4	Total
Low angle – Gravel/Cobble	0	0	4	5	9
Steep angle – Fines	3	6	6	0	15
Steep angle – Gravel/Cobble	0	3	5	7	15
Steep angle – Boulder	0	0	0	2	2
Steep angle – Rip-rap	0	0	5	2	7
Steep angle – Bedrock	2	2	1	2	7
Total	**5**	**11**	**21**	**18**	**55**

2011 Sites Sampled	Reach 1	Reach 2	Reach 3	Reach 4	Total
Trip 1 (May)	5	10	20	25	60
Trip 2 (July)	4	8	21	25	58
Trip 3 (September)	4	10	21	25	60

The number of sites sampled in the Middle Columbia River in each of the three trips in 2011 exceeded the 55 sites identified during the initial study design (see Triton 2009). All of the seven bias sites added to Reach 4 during Year 1 were sampled in each of the three trips in 2011. During trips 2 and 3, 10 sites were not sampled due to increased ALR elevation. During trip 2, four sites in Reach 2 (sites 43, 45, 49, and 50), one site in Reach 1 (site 53), and one tributary section (Drimmie downstream) could not be sampled. During trip 3, two sites in Reach 2 (sites 49 and 50), one site in Reach 1 (site 53), and one tributary section (Drimmie upstream) could not be sampled.

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 (one in Reach 4, two in Reach 3, two 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 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, gradient, morphology, and cover) were collected at these sites.

2.2 SEASONAL FIELD SURVEYS

Sampling trips in 2011 were completed in May, July, and September, which was consistent with the timing of sampling in 2008, 2009, and 2010. The only exception was that the summer trip in 2009 was completed in June prior to the ALR backwatering into Reach 3, whereas in 2008, 2010, and 2011 it was completed in July after the ALR had backwatered into Reach 4. During each trip, habitat data and fish abundance and distribution data were collected. Following 2008, it was noted that depending on the time night sampling was completed, habitat conditions at a given site could change substantially depending on water level. To reduce this potential variability, in 2009, 2010, and 2011 sampling in reaches 3 and 4 targeted the daily minimum discharge. This was based on the rationale that sampling during the period of minimum base flows would help ensure that physical conditions (e.g., site depth and velocity) were comparable between years. 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, 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 a handheld digital sonar where depth was greater than approximately 2.5 m. 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 CSx 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 60–80 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 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 2.7 m fibreglass pole would then retrieve the stunned fishes and place them in a 150 L aerated cooler. A third crew member manoeuvred the boat along the shoreline. Sampling was conducted at night, with halogen bow lights and a pivoting halogen light bar on the boat 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. Clove oil was added to the water to anesthetize the fish (2 ml per 5 L of water). Length (fork or total length to the nearest mm) and weight (to the nearest 0.1 g) were collected from all target fish species (i.e., Bull Trout, Rainbow Trout, and Mountain Whitefish[1]) and from a random subsample of 30 fish from each of the other species. 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. For sport fish (i.e., Rainbow Trout, Bull Trout, Mountain Whitefish, Kokanee), a size of 250 mm was set as the cut-off between juveniles and adults.

2.3 DATA ENTRY AND ANALYSES

Field data were entered into an MS 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 fishes. The coefficient of condition (K) was calculated using Equation (1):

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

[1] Refer to Table 2-2 for Linnaean nomenclature.

where:

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

Weight–length regressions were completed for target 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 (2) was used because it generally describes the weight–length relationship of most fishes:

$$\log_{10}(W) = a + b(\log_{10}L) \qquad (2)$$

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.

2.3.1 STATISTICAL ANALYSES

The dependent variable used in the 2011 data analyses was CPUE of juvenile fishes of the three target species. This variable 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 between reaches, habitat types, and sampling year were completed using parametric statistics (ANOVA) with a post-hoc Sidak test for individual comparisons. Reaches 1 and 2, which are farthest from the dam and therefore less influenced by flow management decisions, were considered to be controls. Conversely, Reaches 3 and 4 are closer to the dam and therefore are more likely to be influenced by fluctuations in discharge. All statistical analyses were completed using Stata (ver. 9.2), 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 2-2.

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

Common Name	Code	Family	Scientific Name
Bull Trout	BT	Salmonidae	*Salvelinus confluentus*
Brook Trout	EB	Salmonidae	*Salvelinus fontinalis*
Burbot	BB	Gadidae	*Lota lota*
Common Carp	CP	Cyprinidae	*Cyprinus carpio*
Kokanee	KO	Salmonidae	*Oncorhynchus nerka*
Largescale Sucker	CUS	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*
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 2-3).

Table 2-3: 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 TEMPERATURE

Surface water temperatures at the sites sampled in May (Trip 1) ranged from a low of 3.3°C at site Biased 1 (Reach 4) to a high of 8.4°C in the tributaries (Table 3-1). Reach 1 had the highest mean temperature (7.2°C), while Reach 4 had the lowest (4.7°C). Mean temperatures in Reaches 1, 2, and 3 were cooler than in 2009 and 2010 but were warmer than in 2008. Reach 4 mean temperatures were cooler than in all previous years. Mean temperature at the tributary sites (6.3°C) was similar to that in 2008 (6.6°C) but was approximately 1°C cooler than in 2009 and 2010.

Surface water temperatures at sites sampled in July (Trip 2) ranged from a low of 7.7°C in Drimmie Creek to a high of 12.4°C at two sites in Reach 1 (Table 3-1). Mean reach temperatures all increased from May, and Reach 1 was again the warmest (11.9°C). Mean temperatures for all reaches were warmer than in 2009 but cooler than in 2008 and 2010. Mean temperature at the tributary sites (10.1°C) was cooler than 2008 and 2010 but warmer than 2009.

Surface water temperatures at sites sampled in September (Trip 3) ranged from a low of 8.7°C at the Jordan River to a high of 12.4°C at four sites in Reach 1 (Table 3-1). Mean temperature in each reach was higher than in May but was similar to that during the July sampling period. Reach 2 had the highest mean temperature (11.0°C), while Reach 4 had the lowest (9.6°C). In general, mean temperature in each of the four reaches in 2011 were cooler than in 2008-2010, presumably due to cooler air temperatures. Mean water temperature at the tributary sites (10.4°C) was consistent with 2008 and 2010 but a degree cooler than in 2009.

Table 3-1: Minimum, maximum, mean, and standard deviation (SD) of surface water temperature recorded at electrofishing sites by month and river reach, Columbia River, 2011. Means for 2008, 2009, and 2010 are presented for comparison.

Month	Reach	Temperature (°C)							
		Min	Max	Mean	SD	*N*	2008 Mean	2009 Mean	2010 Mean
May	Reach 1	6.8	7.5	**7.2**	0.2	5	5.4	8.6	8.6
	Reach 2	5.1	7.2	**6.5**	0.7	12	5.4	6.9	10.0
	Reach 3	4.8	6.8	**5.2**	0.4	21	5.0	7.0	7.0
	Reach 4	3.3	5.1	**4.7**	1.0	25	4.9	6.2	7.8
	Tributaries	4.7	8.4	**6.3**	1.2	10	6.6	7.4	7.5
July	Reach 1	10.8	12.4	**11.9**	0.8	4	12.4	9.0	18.2
	Reach 2	9.1	10.8	**10.3**	0.6	8	12.4	8.1	11.5
	Reach 3	8.7	10.0	**9.2**	0.4	21	10.2	7.4	11.1
	Reach 4	8.5	10.1	**9.5**	0.9	25	10.3	8.9	10.3
	Tributaries	7.7	10.9	**10.1**	0.9	9	12.2	8.2	13.2
September	Reach 1	10.1	10.1	**10.1**	0.0	4	11.4	12.4	12.6
	Reach 2	10.0	12.4	**11.0**	1.2	10	11.4	12.0	13.1
	Reach 3	9.4	11.0	**9.8**	0.4	21	11.0	10.6	11.3
	Reach 4	9.5	9.7	**9.6**	0.7	25	10.5	10.7	10.2
	Tributaries	8.7	12.1	**10.4**	1.3	9	10.0	11.3	10.7

3.1.2 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 (538 m^3/s) compared to the July and September trips (818 m^3/s and 749 m^3/s, respectively).

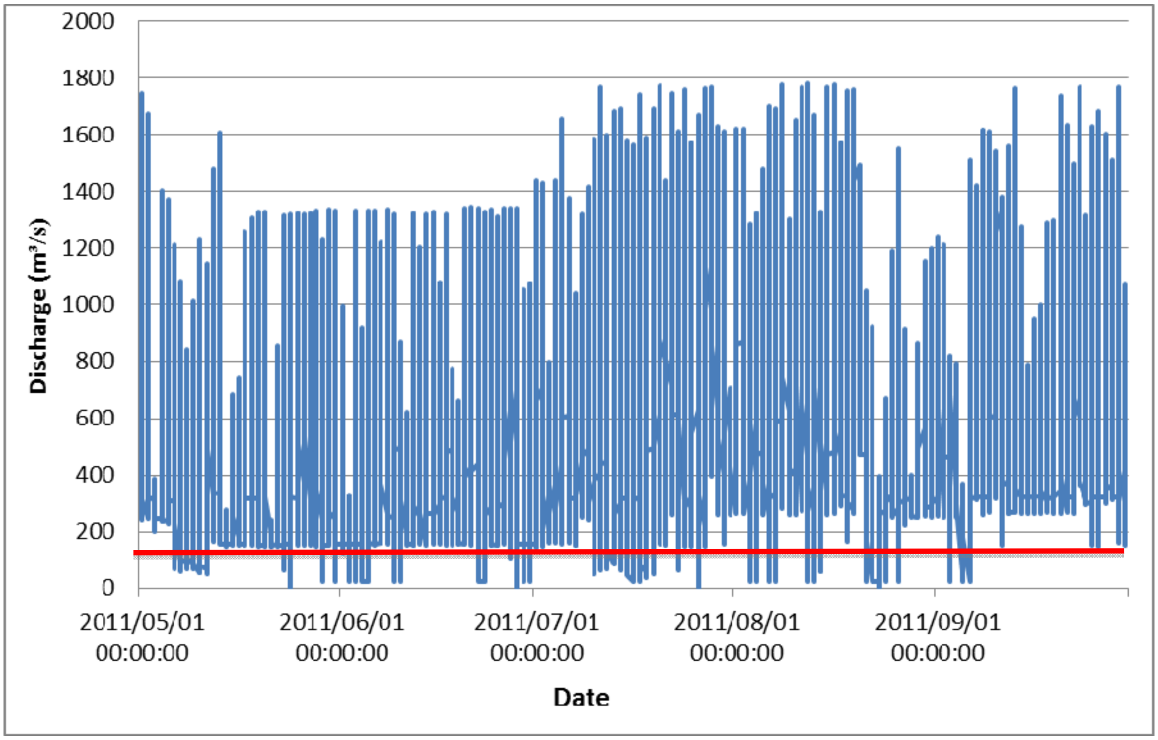


Figure 3-1: Discharge (10-minute mean) from Revelstoke Dam from May 1, 2011 to September 30, 2011. The red line indicates the minimum flow (142 m^3/s)

Discharge from the Revelstoke Dam followed a highly variable and unpredictable pattern throughout the year. During the spring sampling (May 26–June 3), river discharge ranged from a high of 1,338 m^3/s at 10:10 a.m. on May 30 to a low of 23 m^3/s from approximately 2:00 p.m. to 5:00 p.m. on May 29, at approximately 7:30 p.m.–8:00 p.m. on May 31, and at approximately 1:00 p.m.–4:00 p.m. on June 2 (Figure 3-2a). During the summer sampling (July 19–27), river discharge ranged from a high of 1,773 m^3/s at 10:00 a.m. on July 20 to a low of 51 m^3/s at 5:10 a.m. on July 19 (Figure 3-2b). During the fall sampling (September 13–20), river discharge ranged from a high of 1,764 m^3/s at 12:40 p.m. on September 13 to a low of 260 m^3/s at 5:00 a.m. on September 14 (Figure 3-2c). Figure 3-2 shows that all three sampling periods occurred at similarly variable conditions.

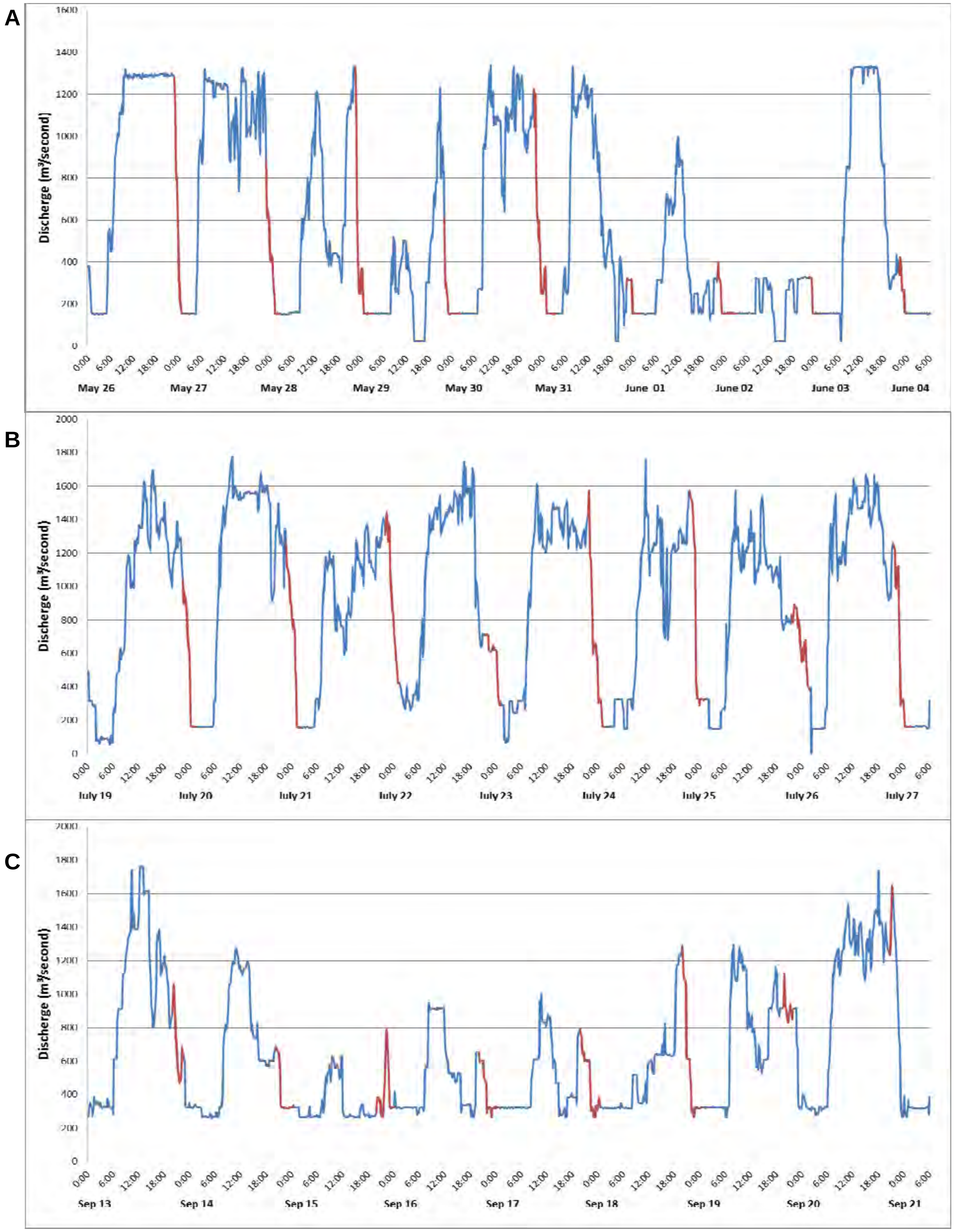


Figure 3-2: Discharge (10-minute intervals) for the Columbia River at the Revelstoke Dam during the three sampling periods of (a) May 26–June 3, (b) July 19–27, and (c) September 13–20, 2011. The red lines indicate the daily sampling periods.

3.1.3 TURBIDITY

Water clarity was assessed as clear at most sites during the May (92 per cent), July (97 per cent), and September (97 per cent) sampling trips. During the May sampling, five sites had low turbidity and one site had moderate turbidity. Most of these sites were tributary sites. During the July sampling, low turbidity sites were limited to the two Illecillewaet River sites. During the September sampling, the upstream Illecillewaet River site had low turbidity and the downstream site had moderate 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.

3.2 FISH CATCHES AND SPECIES DISTRIBUTION 2011

In total, 17 species were captured within the Middle Columbia River during the three sampling trips in 2011 (Figure 3-3). The same number of species were captured in 2009 and 2010 and 2 more than 2008. Three invasive species were encountered during the 2011 sampling: Common Carp, Tench, and Yellow Perch. Brook Trout, a non-native species introduced in B.C. in the 1920s (McPhail 2007), was also encountered. Species richness was relatively constant between sampling events in the various reaches and tributaries. In reaches 1 and 2, 11 species were captured in May, 13 in July, and 13 in September (Figure 3-3). In reaches 3 and 4, 12 species were captured in May, 13 in July, and 12 in September. At tributary sites, six species were captured in May, eight in July, and nine in September (Figure 3-4).

Species that were not encountered in reaches 3 and 4 during any of the sampling events included Common Carp, Pygmy Whitefish, and Peamouth Chub. The only species that was not encountered in reaches 1 and 2 during any of the sampling events was Tench. Species that were not encountered in the tributaries during any of the sampling events included Burbot, Common Carp, Tench, Peamouth Chub, and Pygmy Whitefish.

Comparison of sampling results between riverine (Trip 1) and predominantly lacustrine conditions (Trip 2 and 3) showed a transition from Redside Shiners being dominant in reaches 1 and 2 in the spring to sculpins in summer (Trip 2) and back to Redside Shiners in the fall (Trip 3). In reaches 3 and 4, sculpins were dominant during all three sampling trips suggesting low seasonal variation in distribution. At the tributary sites, Rainbow Trout were dominant in the spring but sculpins were dominant in the summer and fall.

The following are some additional observations:

- Kokanee numbers increased in all reaches in September compared to May and June as a result of spawners making their way to tributaries.
- Tench numbers in 2011 exceeded those in 2008, 2009, and 2010 numbers. Eleven were encountered at seven different sites in 2011 compared to four captured in 2008, and one in both 2009 and 2010.
- Common Carp were rare in 2011. Only one was captured at site 43 in September (none were captured in 2008, 11 were captured in 2009, and one was captured in 2010).
- White Sturgeon, though known to occur in the study area, were not captured or observed during any of the sampling periods.
- General trends observed at tributary sites in 2011 were that in Trip 1, more fish were caught at the downstream site for Jordan River, Begbie Creek, and Drimmie Creek but at the upper site for Illecillewaet River and Tonkawatla Creek. In Trip 2, more fish were captured in the Jordan River and Tonkawatla Creek than in the Begbie Creek, Illecillewaet River, or Drimmie Creek, though in all tributaries more fish were captured at the upstream sites than at the downstream sites. Drimmie downstream was not sampled. In Trip 3, sampling could not be completed at the upstream end of Drimmie due to spawning Kokanee. At the Jordan River and Tonkawatla Creek, more fish were captured at the lower site, while at Begbie Creek and Illecillewaet River, more fish were captured at the upper site.

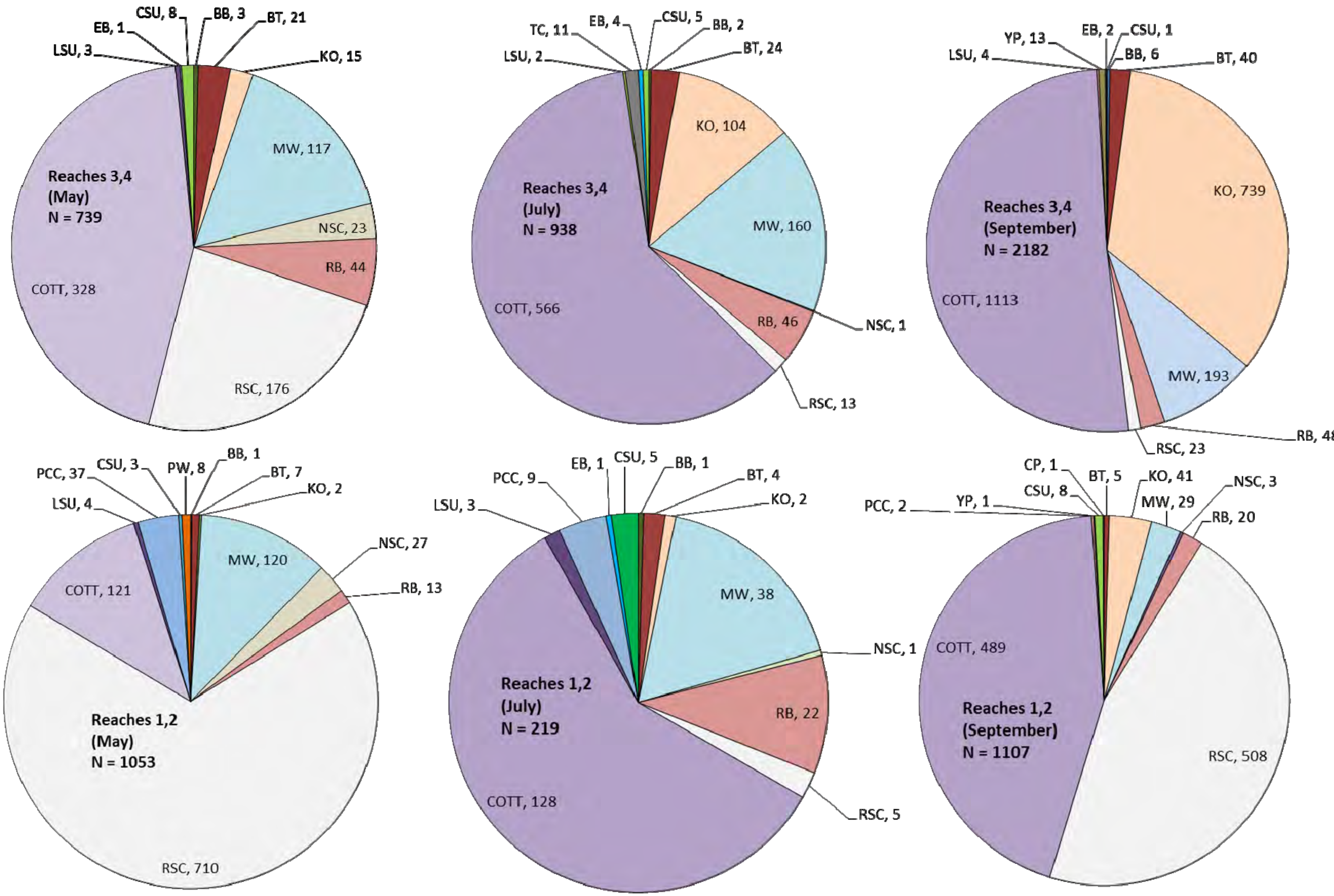


Figure 3-3: Species composition by reach and sampling season (2011). Refer to Table 2-2 for fish species codes. The COTT group is the combination of Prickly, Slimy, and unidentified sculpin, and the SU group is the combination of Longnose, Largescale, and unidentified suckers. Reaches 1 and 2 are lacustrine; 3 and 4 are riverine.

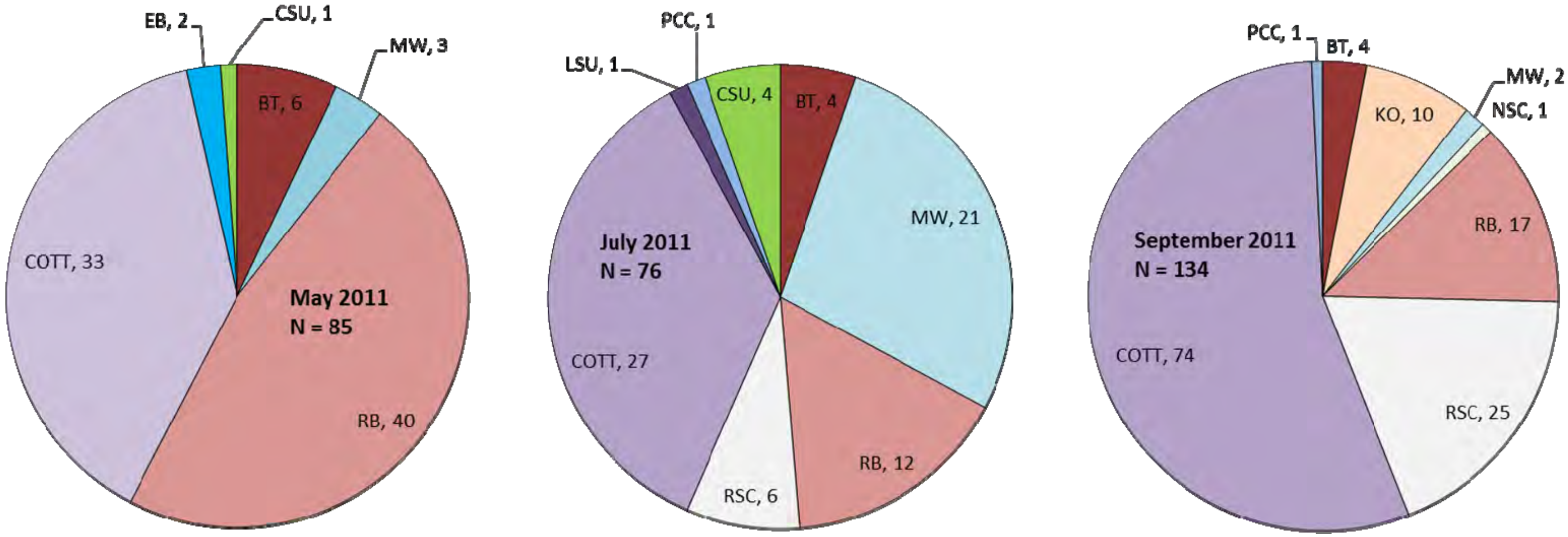


Figure 3-4: Species composition in tributary sites during the three sampling events in 2011. Refer to Table 2-2 for fish species codes. The COTT group is the combination of Prickly, Slimy, and unidentified sculpin, and the SU group is the combination of Longnose, Largescale, and unidentified suckers.

3.2.1 Trip 1 (May)

Sampling in reaches 1 and 2, which are considered to be controls with regards to the influence of dam operation, resulted in the capture of a total of 1,053 individuals of 13 species (Figure 3-3). Redside Shiners were the dominant species (67 per cent relative abundance), followed by Mountain Whitefish (12 per cent), and sculpins (12 per cent). The sculpin specimens included both Prickly Sculpins (6 per cent) and Slimy Sculpins (1 per cent); the remaining 5 per cent were visual observations that were not identified to species. Sampling in reaches 3 and 4, which are most influenced by dam operation, resulted in the capture of 739 individuals of 12 species. Sculpins were the most abundant (44 per cent relative abundance), followed by Redside Shiners (24 per cent). Sampling in the tributaries resulted in the capture of 85 individuals of five species (Figure 3-4). Rainbow Trout were most abundant (47 per cent), followed by sculpins (39 per cent).

The mean number of fishes captured in May in Reach 2 was significantly higher than in reaches 3 and 4 and the tributary sites (ANOVA: $F = 6.33$, df = 72, $p < 0.001$; Sidak $p =$ 0.003, 0.001, and 0.003, respectively) (Table 3-2). No significant difference between Reach 1 and any of the other reaches or the tributary sites was identified. The greatest catch ($n = 258$) was at site 48 in Reach 2. Fish were not captured at four sites: site 17 in Reach 4, sites 24 and 27 in Reach 3, and the Drimmie Creek upstream site.

3.2.2 Trip 2 (July)

Sampling in reaches 1 and 2 resulted in the capture of 219 individuals of 13 species (Figure 3-3). Sculpins were the dominant species (58 per cent relative abundance), followed by Mountain Whitefish (17 per cent), and Rainbow Trout (10 per cent). Sculpin species included both Prickly Sculpins (18 per cent) and Slimy Sculpins (2 per cent); the remaining 38 per cent were visual observations that were not identified to species. Sampling in reaches 3 and 4 resulted in the capture of 938 individuals of 14 species. Sculpins were the dominant species (74 per cent relative abundance) followed by Mountain Whitefish (17 per cent), Kokanee (11 per cent), and Rainbow Trout (5 per cent). Sculpin specimens consisted of Prickly Sculpin (25 per cent), Slimy Sculpin (2 per cent), and visual observation (47 per cent) that were not identified to species. Sampling in the tributaries in July resulted in the capture of 76 individuals of eight species. Sculpins were the dominant species (38 per cent relative abundance) followed by Mountain Whitefish (30 per cent) and Rainbow Trout (17 per cent) (Figure 3-4). Sculpin specimens consisted of Prickly Sculpin (10 per cent), Slimy Sculpin (13 per cent), and visual observations (15 per cent) which were not identified to species.

The mean number of fishes captured was significantly higher in Reach 4 than in the tributaries (ANOVA: $F = 3.46$, df = 71, $p = 0.01$; Sidak: $p = 0.04$), but no other significant differences were detected (Table 3-3). The greatest number of fishes ($n = 117$) was captured at site 13 in Reach 4, with sculpins being the most abundant species (n = 115 fish). Fishes were captured at all sites.

Comparing Trips 1 and 2, the mean number of fishes captured per site increased in Reach 4, while it remained approximately the same in Reach 3 and the tributaries. Reaches 1 and 2 showed a decline in fishes caught. However, none of the changes was significant ($p > 0.05$).

3.2.3 TRIP 3 (SEPTEMBER)

Sampling in reaches 1 and 2 resulted in the capture of 1,108 individuals of 12 species (Figure 3-3). Redside Shiners were the dominant species (46 per cent relative abundance), followed by sculpins (44 per cent relative abundance). Sculpins consisted of Prickly Sculpin (7 per cent) and visual observations (37 per cent) that were not identified to species. Sampling in reaches 3 and 4 resulted in the capture of 2,182 individuals of 12 species. Sculpins were the dominant species (51 per cent relative abundance), followed by Kokanee (34 per cent). Sculpins consisted of Prickly Sculpin (15 per cent), Slimy Sculpin (1 per cent), and visual observations (35 per cent) that were not identified to species. Sampling in the tributaries resulted in the capture of 134 individuals of nine species (Figure 3-4). Sculpins were the most abundant (55 per cent relative abundance) followed by Redside Shiners (13 per cent). Sculpin specimens consisted of Prickly Sculpin (29 per cent), Slimy Sculpin (5 per cent), and visual observations (33 per cent) which were not identified to species. There were no significant differences in mean number of fish per site between the river reaches; however, Reach 1 had significantly higher numbers of fish per site than did the tributary sites (ANOVA: $F = 4.30$, df = 69, *p*

= 0.004; Sidak: $p = 0.01$) (Table 3-4). This was due primarily to high numbers of Redside Shiners encountered at sites 52 and 55 in Reach 1. The greatest number of fishes captured per site in September was at site 55 in Reach 1 ($n = 293$), and the catch was comprised primarily of Redside Shiners ($n = 244$). Fishes were captured at all sites.

Table 3-2: Mean, maximum, and minimum number of fishes caught per site by reach, May 2011.

	Significance[1]	Mean	Max	Min	SD	Number of Sites
Reach 1	A/B	54.0	98	26	30.0	5
Reach 2	A	65.3	258	3	79.3	12
Reach 3	B	17.4	49	0	14.0	21
Reach 4	B	15.0	45	0	12.1	25
Tributaries	B	8.5	22	0	7.4	10

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

Table 3-3: Mean, maximum, and minimum number of fishes caught per site for sites sampled in July 2011, by reach

	Significance[1]	Mean	Max	Min	SD	Number of Sites
Reach 1	A/B	13.3	16	11	2.2	4
Reach 2	A/B	20.8	63	4	19.1	8
Reach 3	A/B	14.0	46	2	6.3	21
Reach 4	A	25.8	117	3	23.9	25
Tributaries	B	7.8	16	1	4.7	9

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

Table 3-4: Mean, maximum, and minimum number of fishes caught per site for sites sampled in September 2011, by reach

	Significance[1]	Mean	Max	Min	SD	Number of Sites
Reach 1	A	120.5	293	8	125.4	4
Reach 2	A/B	62.6	168	14	52.6	10
Reach 3	A/B	61.0	133	6	35.2	21
Reach 4	A/B	36.0	117	4	41.0	25
Tributaries	B	12.2	58	3	17.5	9

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

Compared to Trips 1 and 2, the mean number of fishes captured per site during Trip 3 increased in Reaches 1, 3, and 4, and at the tributary sites. In Reach 2, although the mean increased from Trip 2, it was slightly lower than the mean for Trip 1 (65 vs. 63 fish per site). The differences between sampling trips were significant for Reach 3 (Trip 1 vs. Trip 3: Sidak $p < 0.001$; Trip 2 vs. Trip 3: Sidak $p < 0.001$), and for Reach 4 (Trip 1 vs. Trip 3: Sidak $p = 0.011$).

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, and Mountain Whitefish, along with comparisons across the three years of baseline data collection, are presented in the following sections.

3.3.1 RAINBOW TROUT

In 2011, data on length and weight were collected from 248 Rainbow Trout, which ranged in length from 35 to 450 mm. Figure 3-5 shows the weight to length regression for Rainbow Trout captured in the Middle Columbia River in 2011. The regression line for the 2008–2010 (red-dashed line) shows that length-weight relationship in 2011 was similar to that of 2008-2010. This suggests relatively consistent growing conditions for Rainbow Trout in the system since 2008.

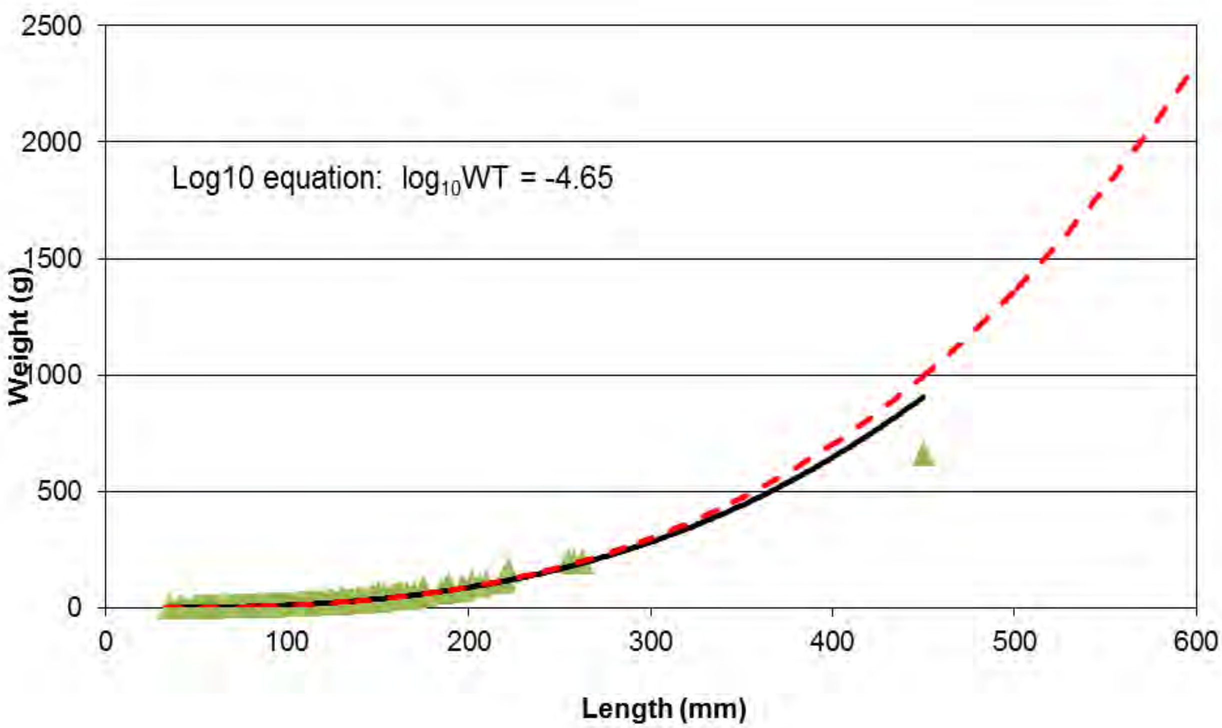


Figure 3-5: Weight–length regression for Rainbow Trout captured during the 2011 field program (*N* = 248). The combined 2008–2010 weight–length regression line (red dashed line) is shown for comparison.

Condition factors for Rainbow Trout captured in 2011 were comparable to those captured in 2008 through 2010 (Triton 2009, 2010, 2011; Figure 3-6). In each of the years of sampling, condition factor for Rainbow Trout tended to be within the range of 1.0 to 1.5. 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, Rainbow Trout in the Middle Columbia River are considered to be fair to good, suggesting that the fish are well-proportioned in terms of length and weight. Exceptions to this included Reach 4 in Trip 1 (May) of 2011 where condition factor was less than 1. This was likely due to cooler water temperatures as compared to previous year (see Table 3-1). During each of the sampling trips, greater variability in condition factor tended to occur in the reaches closer to the dam (i.e. reaches 3 and 4) and the tributary sites. This suggests rearing conditions were also likely more variable in those areas. Lastly, it has been noted that during Trip 1, the tributary sites tended to contain fish with higher condition factor then those in the riverine reaches. This suggests spring rearing conditions in the tributaries may be more favourable than that of the riverine reaches.

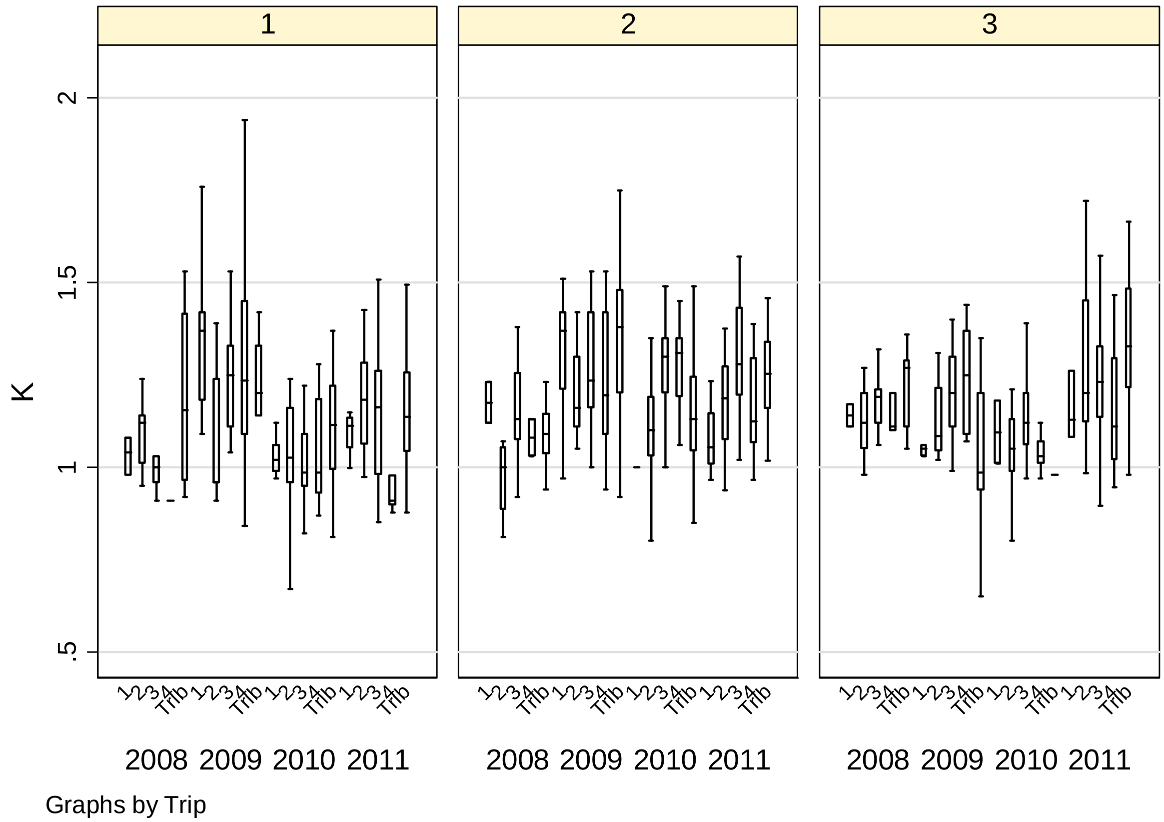


Figure 3-6. Boxplot of condition factor (K) of Rainbow Trout captured in the Middle Columbia River by reach (1-4; "trib" = tributary sites) from 2008 to 2011 for each of the three annual sampling trips (Trip 1 = May, Trip 2 = July, Trip 3 = September).

3.3.2 BULL TROUT

In 2011, data on length and weight were collected from 104 Bull Trout, which ranged in length from 54 to 610 mm. Figure 3-7 shows the weight to length regression for Bull Trout captured in the Middle Columbia River in 2011. The regression line for the 2008–2010 data (red-dashed line) shows that length-weight relationship in 2011 was similar to that of 2008-2010. This suggests relatively consistent growing conditions for Bull Trout in the system since 2008.

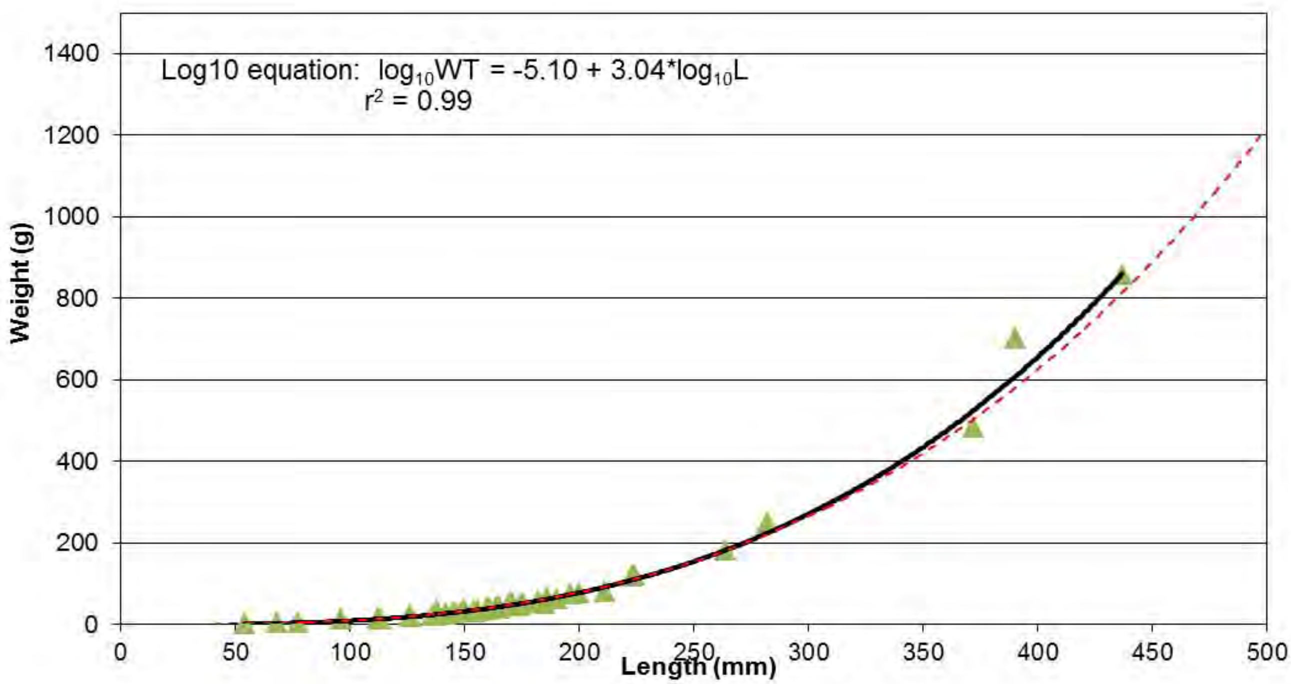


Figure 3-7: Weight–length regression for Bull Trout captured during the 2011 field program (*N* = 104). The 2008–2010 weight–length regression line (red dashed line) is shown for comparison.

Condition factors for Bull Trout captured in 2011 ranged from 0.50 to 1.29, with an overall mean of 0.99 for the three sampling trips. In general, condition factors of Bull Trout captured in 2011 were comparable to those captured in 2008 through 2010 (Triton 2009, 2010, 2011; Figure 3-8), which suggests that growing conditions in the system are relatively consistent. In general, condition factor of Bull Trout is lower as compared to Rainbow Trout, with many values less than 1. However, this is to be expected given that Bull Trout tend to have longer and skinner body shapes as compared to Rainbow Trout and Mountain Whitefish (McPhail, 2007). Similar to Rainbow Trout, the Bull Trout captured in the tributaries in Trip 1, tended to have higher condition factors than those captured in the river. This suggests rearing conditions for Bull Trout in the spring may be more favourable in the tributaries compared to the mainstem. In the summer and fall (Trip 2 and 3 respectively) condition factor in the tributaries tends to drop while it increases in the river.

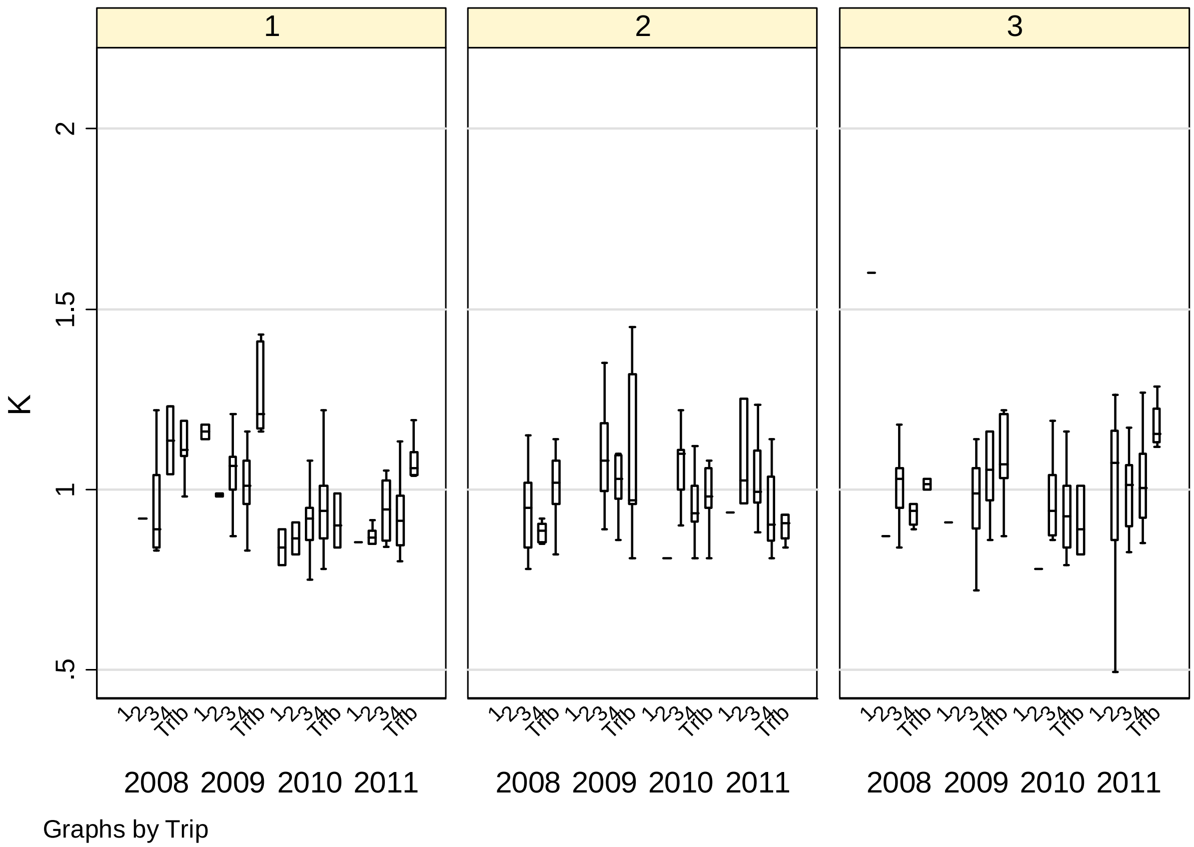


Figure 3-8. Boxplot of condition factor (K) of Bull Trout captured in the Middle Columbia River by reach (1-4; "trib" = tributary sites) from 2008 to 2011 for each of the three annual sampling trips (Trip 1 = May, Trip 2 = July, Trip 3 = September).

3.3.3 MOUNTAIN WHITEFISH

In 2011, data on length and weight were collected from 559 Mountain Whitefish, which ranged in length from 40 to 335 mm. Figure 3-9 shows the weight to length regression for Mountain Whitefish captured in the Middle Columbia River in 2011. The regression line for the 2008–2010 data (red-dashed line) shows that length-weight relationship in 2011 was similar to that of 2008-2010. This suggests relatively consistent growing conditions for Mountain Whitefish in the system since 2008.

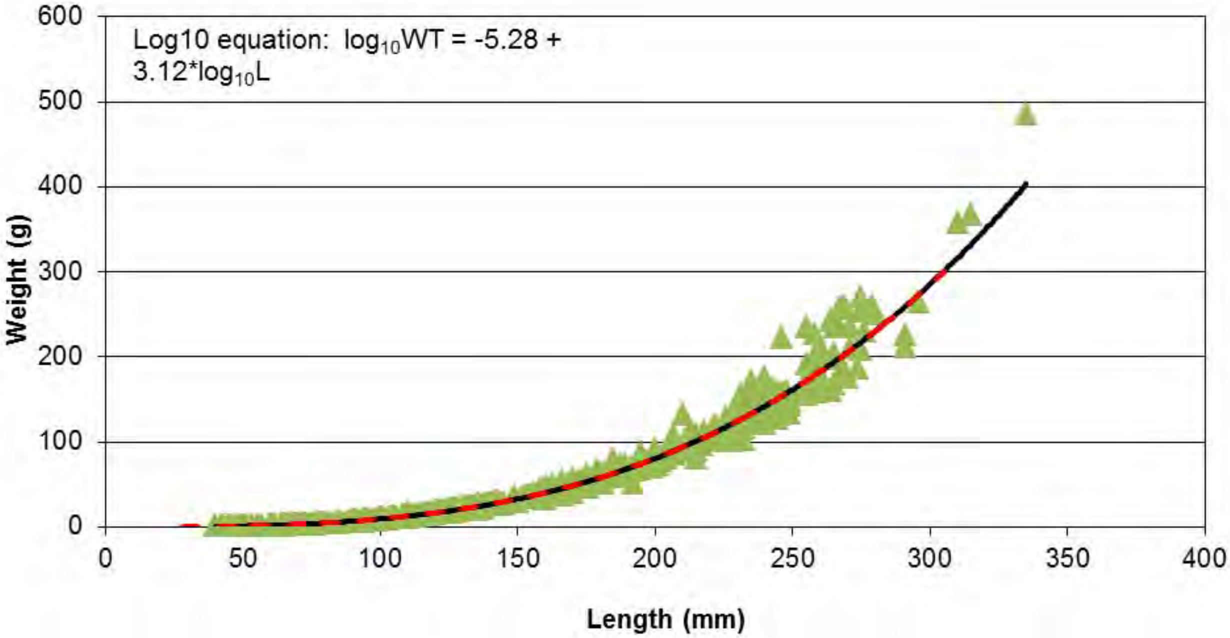


Figure 3-9: Weight–length regression for Mountain Whitefish captured during the 2011 field program (*N* = 559). The 2008–2010 weight–length regression line (red dashed line) is shown for comparison.

Condition factors for Mountain Whitefish captured in 2011 ranged from 0.48 to 1.69, with an overall mean of 0.98 for the three sampling trips. Condition factors of Mountain Whitefish captured in 2011 were comparable to those captured in 2008–2010 (Triton 2009, 2010, 2011; Figure 3-10). In general, condition factor of Mountain Whitefish captured in the system in spring (Trip 1) and summer (Trip 2) were close to 1 suggesting fish that were in reasonable condition. However, in each of the years of study, condition factor tended to be below 1 in each reach as well as in the tributaries for the fall sampling. This could suggest a reduction in food availability late in the summer or could possibly be related to the onset of spawning (typically in October and November; McPhail [2007]) with fish beginning to focus on reproduction as opposed to feeding and rearing.

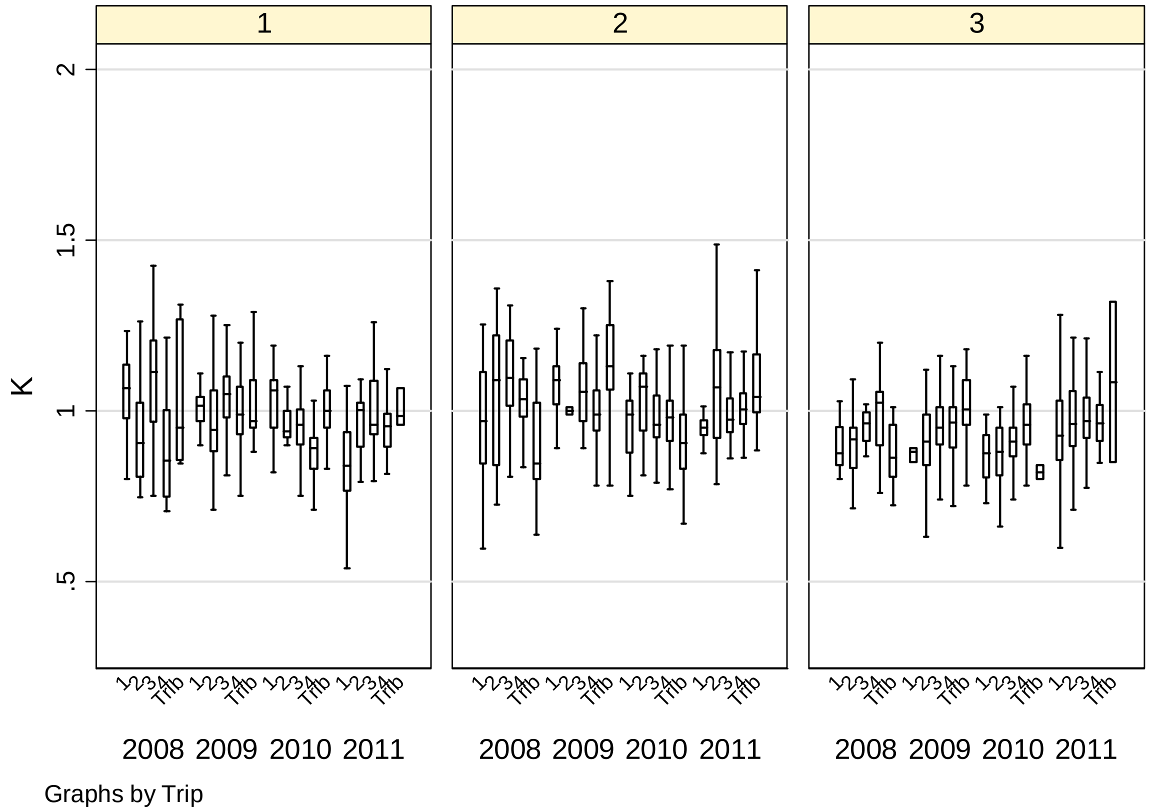


Figure 3-10. Boxplot of condition factor (K) of Mountain Whitefish captured in the Middle Columbia River by reach (1-4; "trib" = tributary sites) from 2008 to 2011 for each of the three annual sampling trips (Trip 1 = May, Trip 2 = July, Trip 3 = September).

3.4 CATCH-PER-UNIT-EFFORT

3.4.1 TRIBUTARIES

There were no significant differences in CPUE of Rainbow Trout, Bull Trout, or Mountain Whitefish between the upper and lower tributary sites for any of the three sampling trips in 2011 (ANOVA: $F < 1$, $p > 0.30$ for each). This was consistent with observations from previous years. As a result, data from the upper and lower tributary sites have been pooled for comparison with the river reaches found in the subsequent sections.

3.4.2 RAINBOW TROUT

The CPUE of Rainbow Trout captured during Trip 1 in 2011 (Figure 3-11) was found to be significantly higher in the tributaries than at any of the river reaches (ANOVA: F = 6.62, df = 72, $p < 0.001$). This suggests that during spring juvenile Rainbow Trout may be utilizing the tributary habitats preferentially over the mainstem reaches for rearing. Similar trends were observed in 2010 (CPUE of tributaries greater than that of reaches 1, 3, and 4; ANOVA: F = 5.29, df = 69, p = 0.001) and 2009 (CPUE of tributaries significantly greater than that of reach 4; ANOVA: F = 3.03, df = 66, p = 0.024) but not 2008 (ANOVA: F = 1.23, df = 64, p = 0.31). This suggests that that trend of Rainbow Trout making use of tributary habitats in the spring is not related to flow regime changes associated with Rev-5.

The CPUE of Rainbow Trout captured during Trip 2 in 2011 was not found to be significantly different between any of the river or tributary reaches (ANOVA: F = 1.37, df = 71, p = 0.25). Similar trends were identified in 2008 and 2010 with no significant difference in Rainbow Trout CPUE between any of the river or tributary reaches (ANOVA: F = 1.01 and 2.33, respectively). During each of those years the ALR was backwatered into Reach 3 (2008) and Reach 4 (2010 and 2011) resulting in more lacustrine conditions. Year 2 (2009) was the only year of sampling during which Trip 2 was completed with the ALR influence below Reach 3. During that trip CPUE of juvenile Rainbow Trout in the tributaries was found to be significantly higher than that of reach 3 or 4 (ANOVA: F = 5.49, df = 65, $p < 0.001$; 0.011 fish/second tributaries vs.0.002 fish/second in reach 3 and 0.0008 fish/second in reach 4). This suggests that in 2009 juvenile Rainbow Trout showed a preference for the tributaries over the river reaches, however as noted that trend was not observed in any of the other years. Therefore it could be an artifact of annual variation or potentially related to lower ALR elevation. For example, ALR backwatering in reaches 3 and 4 may be favourable for Rainbow Trout for rearing and feeding and when absent, the tributaries are preferred over reaches 3 and 4 in the summer. Additional data will be required to further assess this potential trend.

The CPUE of Rainbow Trout captured during Trip 3 in 2011 was found to be significantly higher in the tributaries than reaches 3 and 4 (ANOVA: F = 5.76, df = 69, p

< 0.001). These results could suggest a trend of Rainbow Trout beginning to move back into the tributaries and out of the mainstem. No significant difference in Rainbow Trout CPUE between any of the river or tributary reaches were identified 2008, 2009, or 2010 (ANOVA: F = 2.10, 0.91, and 2.11, respectively). Tributary temperatures in 2011 were similar to 2008 and 2010 and less than 2009 (see Table 3-1) and therefore it is unclear why an earlier migration to the tributaries may have occurred. Additional sampling will be required to determine if this result could potentially be related to the flow regime changes associated with Rev-5.

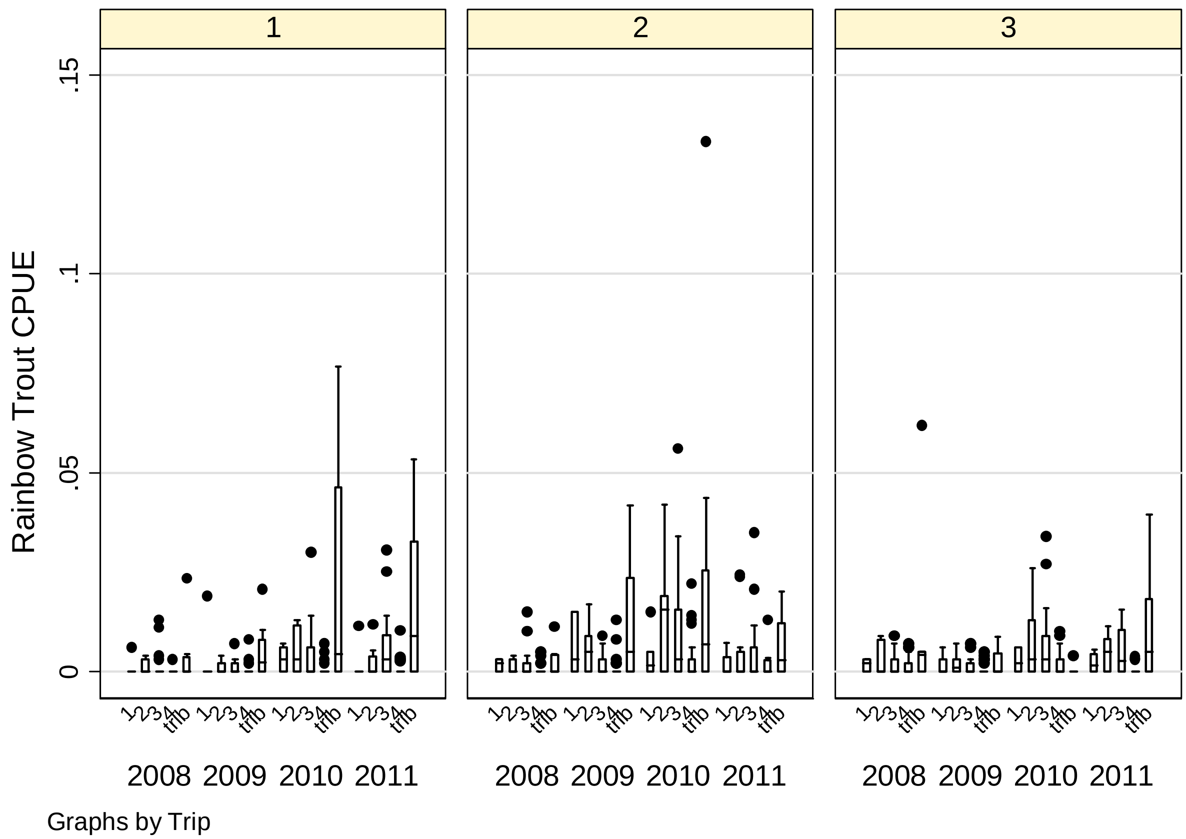


Figure 3-11. Box plot of catch-per-unit-effort (CPUE) of juvenile Rainbow Trout by reach for 2008–2011 for each of the three sampling trips (Trip 1 = May, Trip 2 = July, Trip 3 = September).

In regards to habitat usage, comparison of juvenile Rainbow Trout CPUE between the six identified habitat classes (see Table 2-1) showed that in 2011 sites dominated by rip rap were significantly higher than at least one of the other classes in both the spring (Trip 1) and summer (Trip 2) sampling (Trip 1: F = 3.51, df = 72, p = 0.005; Trip 2: F = 6.17, df = 71, p < 0.001). This suggests a potential preference for that habitat type. However, the trend was not observed in the fall trip when no significant difference was detected between any of the habitat types (ANOVA: $F = 2.29$, df = 69, $p = 0.05$). During the baseline years, rip rap sites were found to have a significantly higher CPUE of juvenile Rainbow Trout than at least one of the other habitat classes during the summer trip in 2008 (ANOVA: $F = 2.55$, df = 65, $p = 0.03$) and the fall trip 2009 (ANOVA: $F = 3.27$, df = 73, $p = 0.007$) and 2010 (ANOVA: $F = 11.08$, df = 63, $p < 0.001$).

3.4.3 BULL TROUT

The CPUE of Bull Trout captured during Trip 1 in 2011 (Figure 3-12) was not found to be significantly different in any of the river reaches or tributaries (ANOVA: $F = 1.05$, df = 72, $p = 0.39$). During the baseline years, only 2009 was found to have a significant difference in juvenile Bull Trout CPUE during Trip 1 with the tributaries being significantly higher than Reach 4 (ANOVA: $F = 3.30$, df = 66, $p = 0.02$; 0.0032 fish/second vs. 0.00037 fish/second). Therefore in 3 of the 4 years of study, Bull Trout did not show a preference for the tributary habitats in the spring. Further, based on Year 4 results, this trend has not changed in relation to flow regime changes associated with Rev-5. However, additional years of data will be required to further support that conclusion.

The CPUE of Bull Trout captured during Trip 2 in 2011 was not found to be significantly different between any of the river or tributary reaches (ANOVA: $F = 1.19$, df = 70, $p = 0.32$). Similar trends were identified in 2008 and 2010 with no significant difference in Bull Trout CPUE between any of the river or tributary reaches (ANOVA: $F = 0.39$, df = 65, $p = 0.81$ and $F = 2.28$, df = 67, $p = 0.07$, respectively). During each of those years the ALR was backwatered into Reach 3 (2008) and Reach 4 (2010 and 2011) resulting in more lacustrine conditions. Over the four years of sampling, juvenile Bull Trout have never been captured in Reach 1 during the summer trip. Further in 2008 and 2009 no juvenile Bull Trout were captured in Reach 2. This could suggest a tendency for juvenile Bull Trout to utilize the upper reaches and tributaries during periods of high ALR elevation where lacustrine influences of the ALR are reduced to some extent. Year 2 (2009) was the only year of sampling during which Trip 2 was completed with the ALR influence below Reach 3. During that trip CPUE of juvenile Bull Trout in Reach 3 was found to be significantly higher than that of Reach 4 (ANOVA: $F = 5.67$, df = 73, $p < 0.001$; 0.0027 fish/second vs. 0.00021 fish/second). This could suggest that when riverine conditions persist into the summer, Bull Trout may have a preference for habitat in reach 3 versus that of Reach 4.

The CPUE of Bull Trout captured during Trip 3 in 2011 was not found to be significantly different between the river reaches or tributaries (ANOVA: $F = 0.81$, df = 69, $p = 0.52$). However it should be noted that no juvenile Bull Trout were captured in Reach 1 and only one individual in Reach 2 suggesting a preference for Reaches 3 and 4 where lacustrine effects of the ALR are somewhat reduced. No significant difference in juvenile Bull Trout CPUE between any of the river or tributary reaches was identified 2008 or 2010 (ANOVA: $F = 2.49$, df = 62, $p = 0.06$ and $F = 1.25$, df = 63, $p = 0.30$, respectively). However in 2008 only one individual was captured in each of Reach 1 and 2 and none were captured in either reach in 2010. This is the same trend observed in 2011 further supporting the assumption that juvenile Bull Trout have a preference for the more riverine habitats of Reaches 3 and 4. In 2009 a significant difference in juvenile Bull Trout CPUE was identified (ANOVA: $F = 5.67$, df = 73, $p < 0.001$) with the tributaries being significantly higher than each of the river reaches. This suggests a migration of Bull Trout into the tributaries potentially for spawning or rearing. Water temperature in the tributaries in September of 2009 was found to be almost a degree warmer than in 2008, 2010 or 2011 (see Table 3-1) which could explain the earlier migration.

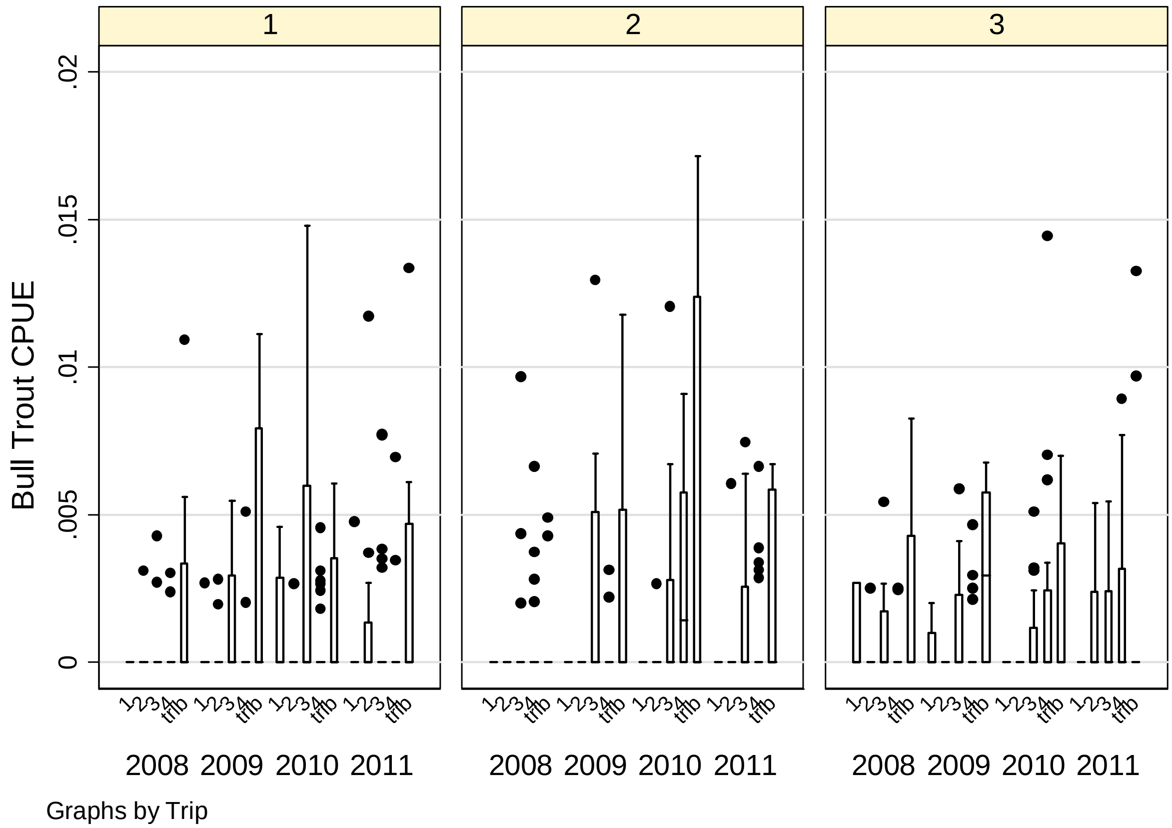


Figure 3-12. Box plot of catch-per-unit-effort (CPUE) of juvenile Bull Trout by reach for 2008–2011 for each of the three sampling trips (Trip 1 = May, Trip 2 = July, Trip 3 = September).

Comparison of juvenile Bull Trout CPUE between the habitat types did not identify any significant differences during any of the trips in any of the four years of study. This lack of apparent habitat preference displayed by juvenile Bull Trout could suggest that their distribution is more affected by factors such as ALR elevation or the distribution of prey species.

3.4.4 Mountain Whitefish

The CPUE of juvenile Mountain Whitefish captured during Trip 1 in 2011 (Figure 3-13) was found to be significantly greater in Reach 1 than in any of the other river reaches or tributaries (ANOVA: $F = 7.70$, df = 72, $p < 0.001$). This trend was not observed in any of the baseline years and was driven by two sites in reach 1 with high juvenile Mountain

Whitefish catches (site 53 = 21 fish and site 56 = 30 fish). Additional sampling will be required to see if increase usage of Reach 1 by juvenile Mountain Whitefish continues. In 2008, no significant difference in juvenile Mountain Whitefish CPUE was identified between any of the reaches or tributaries (ANOVA: $F = 1.42$, df = 64, $p = 0.24$). In 2009 CPUE of juvenile Mountain Whitefish in May was found to be significantly greater in Reach 3 (0.023 fish/second) as compared to Reach 4 (0.003 fish/second) and the tributaries (0.004 fish/second) but not Reach 1 (0.007 fish/second) or 2 (0.01 fish/second). This suggests that in that year, juvenile Mountain Whitefish showed less of a preference for the tributaries or Reach 4 possibly due to less favourable habitat contained therein. Alternatively in 2010, the tributaries were found to have a significantly higher CPUE of juvenile Mountain Whitefish than any of the river reaches (ANOVA: $F = 4.41$, df = 69, $p = 0.003$). Based on the results of all four years it is clear that juvenile Mountain Whitefish usage of the study in the spring is variable with no obvious trends emerging. Additional sampling in year 5 and 6 will be required to see if trends emerge with the flow regime changes associated with Rev-5.

The CPUE of juvenile Mountain Whitefish captured during Trip 2 in 2011 (Figure 3-13) was not found to be significantly different in any of the river reaches or tributaries (ANOVA: $F = 0.31$, df = 70, $p = 0.87$). This was also the situation in each of the baseline years (2008: $F = 0.89$, df = 65, $p = 0.47$; 2009: $F = 0.84$, df = 65, $p = 0.51$; 2010: $F = 2.16$, df = 67, $p = 0.08$). This suggests more even distribution of juvenile Mountain Whitefish throughout the study area in the summer and when the ALR elevation is high and that this has not changed following the first year of flow regime changes associated with Rev-5.

The CPUE of juvenile Mountain Whitefish captured during Trip 3 in 2011 (Figure 3-13) was found to be significantly higher in Reach 3 as compared to the tributaries (ANOVA: $F = 3.19$, df = 69, $p = 0.02$) but not the other river reaches. It is unclear whether this is potentially related to increased Rainbow Trout presence in the tributaries at the same time which was also observed (see section 3.4.2). No significant differences were observed in any of the three baseline years (2008: $F = 1.69$, df = 62, $p = 0.09$; 2009: $F = 01.93$, df = 73, $p = 0.11$; 2010: $F = 1.38$, df = 63, $p = 0.25$). Continued monitoring of juvenile

Mountain Whitefish will be required in order to determine whether the results of 2011 are potentially related to the flow regime changes associated with Rev-5.

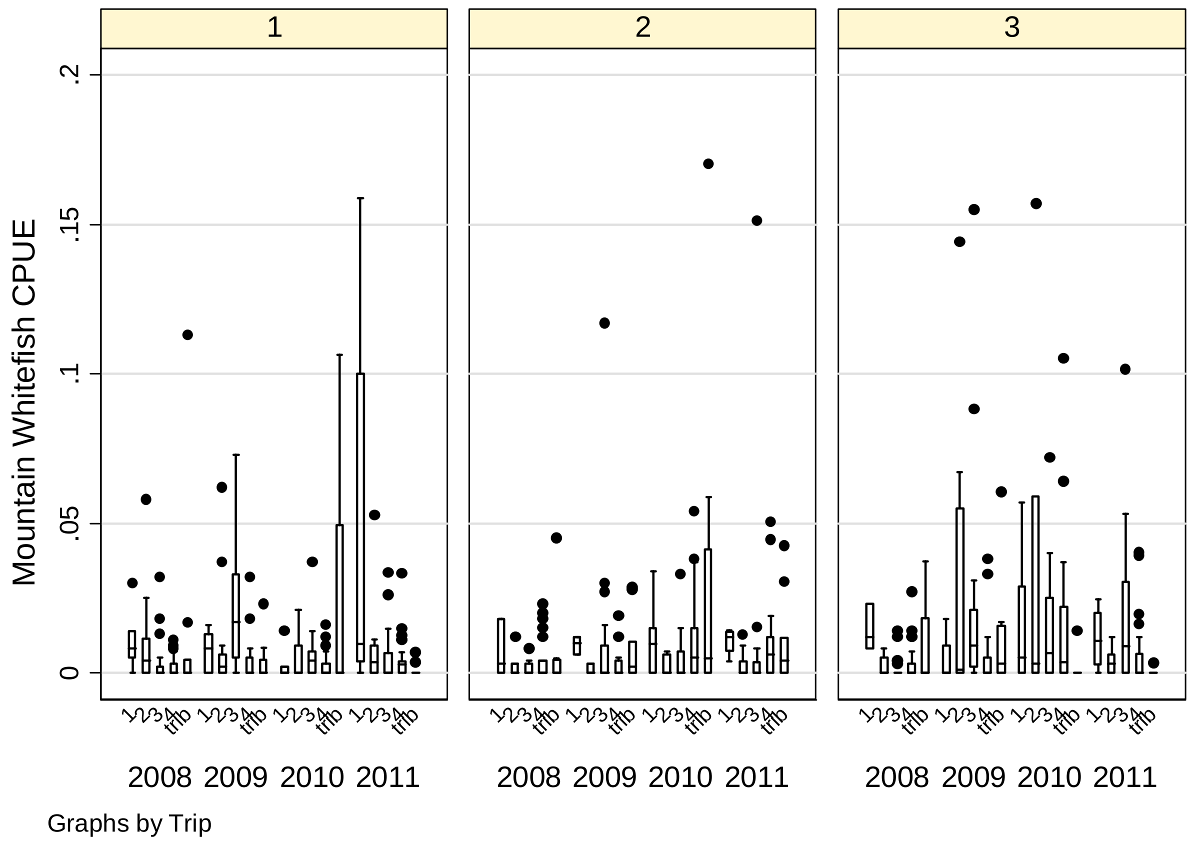


Figure 3-13: Box plot of catch-per-unit-effort (CPUE) of Mountain Whitefish by reach for 2008–2011 for each of the three sampling trips (Trip 1 = May, Trip 2 = July, Trip 3 = September).

As was observed with Bull Trout, comparison of juvenile Mountain Whitefish CPUE between the habitat types did not identify any significant differences during any of the trips in any of the four years of study. This lack of apparent habitat preference displayed by juvenile Mountain Whitefish could suggest that their distribution is more affected by factors such as ALR elevation or food availability.

3.4.5 BEFORE-AFTER-CONTROL-IMPACT

Before-After-Control-Impact (BACI) is a standard study design for environmental impact assessments to determine if a change has occurred and to estimate the magnitude of the effects (Stewart-Oaten and Bence 2001). The BACI builds upon a basic before-after comparison by including control sites, where presumably no effect of the impact will be felt. Inclusion of the control sites allows for the temporal variation that naturally occurs to be measured. This can then be accounted for in the total change that occurs at the non-control sites (termed "impact"), and the residual can be used to quantify the environmental impact.

For the current study, data from Years 1–3 (2008–2010) form the "before" data set, while data from Years 4–6 (2011–2013) form the "after" data set. Data from reaches 1 and 2 are the "controls", while data from reaches 3 and 4 are the "impacts". Figure 3-14 shows the CPUE of juvenile Rainbow Trout for each reach by trip both before and after Rev 5 implementation. An ANOVA was used to compare the before and after datasets and only Reach 3 Trip 1 was found to have a significant difference in juvenile Rainbow Trout CPUE. CPUE after (2011) was significantly higher than in 2008-2010. Two additional years of after data will be collected and included in this analysis to further assess if changes in the juvenile Rainbow Trout population are occurring. However, preliminary results suggest that flow regime changes associated with Rev-5 have not had an effect on juvenile Rainbow Trout in the study area.

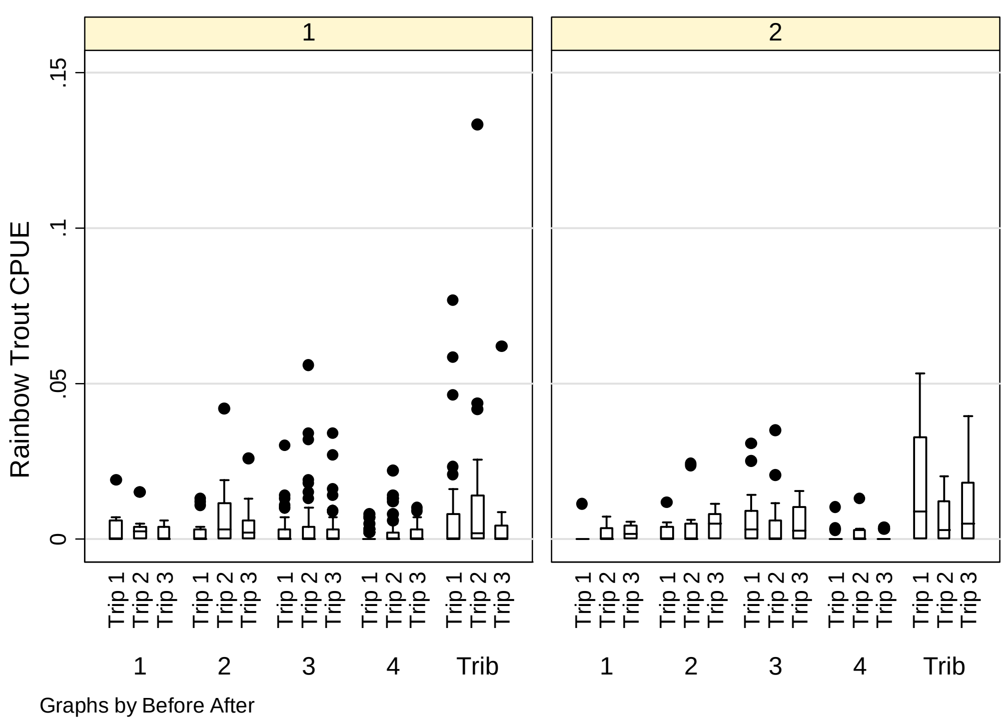


Figure 3-14: Catch-per-unit-effort (CPUE) of juveniles Rainbow Trout by trip and reach before (2008-2010; graph 1) and after (2011; graph 2) Rev 5.

Figure 3-15 shows the CPUE of juvenile Bull Trout for each reach by trip both before and after Rev 5 implementation. An ANOVA was used to compare the before and after datasets and only Reach 2 Trip 3 was found to have a significant difference in juvenile Bull Trout CPUE. CPUE after was significantly higher than before. Two additional years of after data will be collected and included in this analysis to further assess if changes in the juvenile Bull Trout population are occurring. However, preliminary results suggest that flow regime changes associated with Rev-5 have not had an effect on juvenile Bull Trout in the study area.

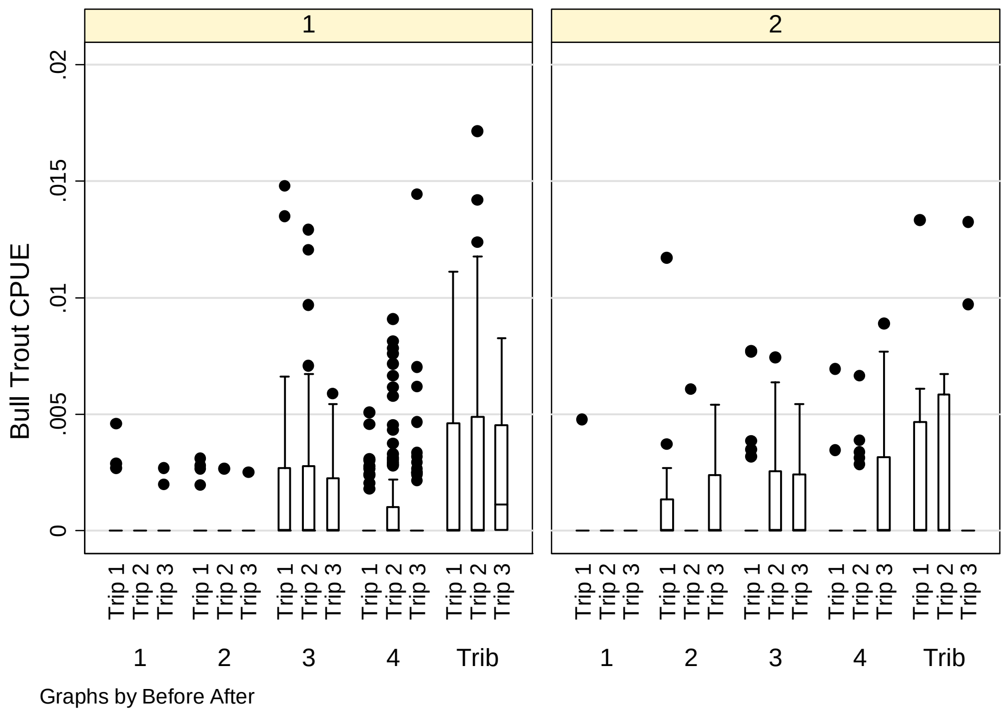


Figure 3-15: Catch-per-unit-effort (CPUE) of juvenile Bull Trout by trip and reach before (2008-2010; graph 1) and after (2011; graph 2) Rev 5.

Figure 3-16 shows the CPUE of juvenile Mountain Whitefish for each reach by trip both before and after Rev 5 implementation. An ANOVA was used to compare the before and after datasets and only Reach 1 Trip 1 was found to have a significant difference in juvenile Mountain Whitefish CPUE. CPUE after was significantly higher than before.

Two additional years of after data will be collected and included in this analysis to further assess if changes in the juvenile Mountain Whitefish population are occurring. However, preliminary results suggest that flow regime changes associated with Rev-5 have not had an effect on juvenile Mountain Whitefish in the study area.

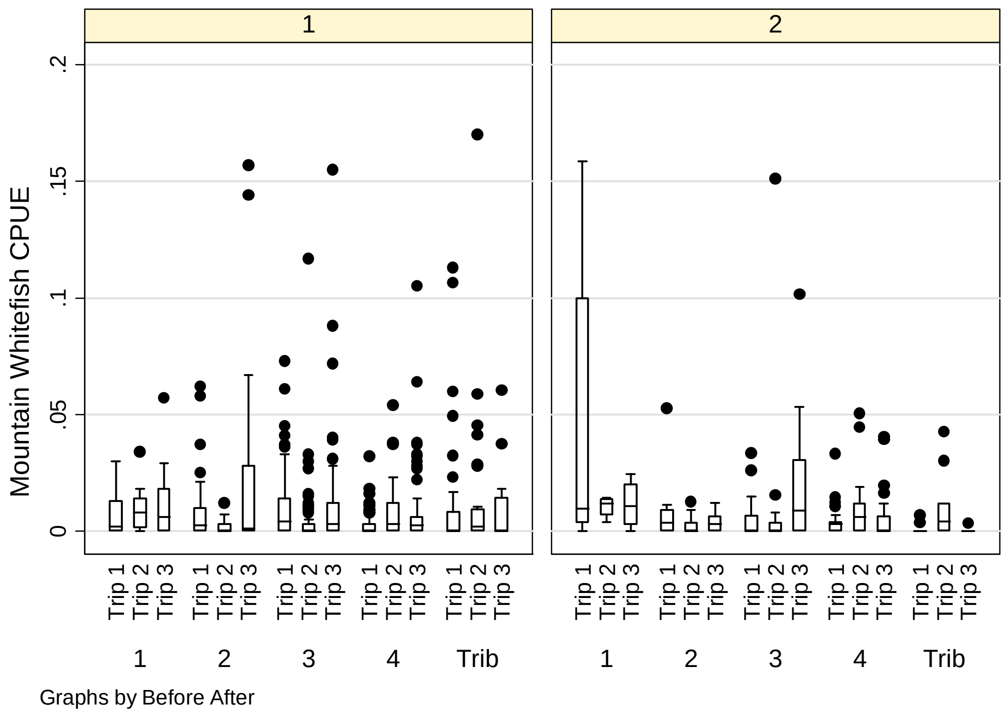


Figure 3-16: Catch-per-unit-effort (CPUE) of juvenile Mountain Whitefish by trip and reach before (2008-2010; graph 1) and after (2011; graph 2) Rev 5.

3.5 HABITAT SUITABILITY FOR JUVENILES

Sites with the highest CPUE of juveniles of each of the three target species for 2008–2011 were identified (Table 3-5). 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. Sites included in Table 3-5 constitute approximately 25 per cent of the total catch for each species each year.

Sites with the highest juvenile Bull Trout CPUE in 2011 tended to be steep and dominated by coarse substrates (boulder: 1 site; bedrock: 2 sites; rip-rap: 1 site). Mean depths in 2011 ranged from 0 m to 2.90 m, which was slightly deeper than in previous years (0 m to 1.49 m in 2008; 0 m to 1.37 m in 2009; 0 m to 1.59 m in 2010). This can be attributed to the two bedrock-dominated sites (sites 10 and 47), both of which are deeper than the sites where Bull Trout CPUE was highest in previous years. Velocities in 2011 ranged from 0 m/s at the shore to 0.27 m/s at 3 m from the shore, which was the same as in 2010 but higher than in 2009 (max. 0.13 m/s) and lower than 2008 (0.38 m/s). None of the sites had high CPUE in more than one trip in 2011, which suggests there was a lack of site fidelity and opportunistic habitat use. Bull Trout are piscivorous and habitat used is often influenced by the presence of other fish species (McPhail, 2007). There were 15 sites in 2011 where two or more Bull Trout were captured compared to 24 sites in 2010, 13 sites in 2009, and four sites in 2008.

The CPUE of juvenile Rainbow Trout at the highest ranked sites in 2011 was slightly less than that in 2010 but was greater than that of the highest ranked sites in either 2008 or 2009 (Table 3-5). Four of the top six ranked sites in 2011 were dominated by rip-rap, while the remaining two were dominated by bedrock, which is consistent with previous years. Mean depths in 2011 ranged from 1.46 m to 2.04 m, and were consistent with those of previous years. Similarly, mean velocities were comparable to those of previous years. Each of the five top ranked sites in 2011 was also a top ranked site in terms of Rainbow Trout CPUE in previous years of the study. Further, site 35 (steep rip-rap) had high CPUE during both trips 1 and 2 in 2011, and in 2010 (trip 3) and 2008 (trip 3). 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), 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)

The highest CPUE of juvenile Mountain Whitefish in 2011 (site 56: 0.159 fish/second of electrofishing) was comparable to that in 2010 (site 43: 0.157 fish/second of electrofishing) and 2009 (site 27: 0.155 fish/second of electrofishing), all of which were higher than in 2008 (site 42: 0.058 fish/second of electrofishing) (Table 3-5). Habitat conditions in 2011 at the highest ranked Mountain Whitefish CPUE sites were characterized by steep banks with a mix of fine and gravel/cobble substrates. This was consistent with the 2008, 2009, and 2010 results, with Mountain Whitefish in the study area showing an apparent affinity for steeper sites. The only exception to this was site 19 in 2011 and site 27 in 2009, which were both low gradient gravel and cobble. Depths in 2011 ranged from 0 m to 0.85 m and velocities ranged from 0 m/s to 0.08 m/s, which was similar to the 2009 results but tended to be shallower and slower than in 2008 or 2010. 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).

Juvenile Rainbow Trout captured in tributaries in 2011 accounted for 27 per cent of the total juvenile Rainbow Trout catch. This was the same percentage as in 2010 and is comparable to that in 2008 (26 per cent) but is lower than that in 2009 (34 per cent). Juvenile Bull Trout captured in tributaries in 2011 accounted for 18 per cent of the total juvenile Bull Trout catch, which was higher than in 2010 (15 per cent) but lower than in both 2008 and 2009, when 28 per cent and 29 per cent were caught in tributaries, respectively. Juvenile Mountain Whitefish captured in tributaries in 2011 accounted for only 4 per cent of the total catch of that species, which was the lowest level of the four years of study (2010: 16 per cent, 2009: 7 per cent, and 2008: 18 per cent). 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, which tend to prefer deeper water, were less abundant in the tributaries than in the mainstem.

Habitat preferences of juveniles of the target species are summarized in Table 3-6.

Table 3-5: Habitat characteristics of sites with the highest catch-per-unit-effort (CPUE) of the target species for 2008 – 2011

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
	19	2	0.004	Low G/C	539	0.07	0.43	0.57	0	0.01	0.09
	21	3	0.005	Bedrock	757	0.67	1.18	1.49	0.20	0.25	0.38
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
	27	3	0.006	Low G/C	13	0	0.50	0.55	0	0	0.02
	38	2	0.006	Steep Fine	16	0	0.93	1.37	0	0	0
	39	2	0.006	Steep Fine	16	0	0.62	1.00	0	0	0
2010	28	1	0.015	Steep Fine	19	0	0.42	0.58	0	0.13	0.21
	Bias 7	3	0.014	Bedrock	420	0	0.90	1.59	0	0.18	0.27
	22	1	0.014	Steep G/C	318	0	0.43	0.83	0	0.04	0.07
	22	2	0.012	Steep G/C	95	0	0.38	0.71	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	0.80	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	2.90	0	0.18	0.27
Rainbow Trout											
2008	35	2	0.015	Rip-rap	267	0.12	1.28	> 2	0	0	0
	34	1	0.013	Rip-rap	1217	0	1.04	1.86	0	0.06	0.14
	44	3	0.009	Bedrock	636	0	0.88	1.65	0	0	0
	26	2	0.009	Rip-rap	585	0	0.43	1.27	0	0	0
	29	3	0.009	Rip-rap	596	0	0.57	1.20	0	0.06	0.09
	35	3	0.009	Rip-rap	9	0.12	0.93	2.00	0	0.01	0.01
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	0.60	1.07	0	0	0
	67	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
2010	35	3	0.056	Rip-rap	338	0	1.01	2.20	0	0.10	0.18
	47	2	0.042	Bedrock	441	0.03	0.91	1.90	0	0	0
	29	2	0.034	Rip-rap	336	0	0.31	0.99	0	0.01	0.19
	34	2	0.034	Rip-rap	338	0	0.84	1.65	0	0.02	0.05
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

Year	Site	Trip	CPUE	Habitat[1]	Discharge (m^3/s)	Mean Depth (m) at station from shore:			Mean Vel. (m/s) at station from shore:		
						0 m	1.5 m	3 m	0 m	1.5 m	3 m
Mountain Whitefish											
2008	42	1	0.058	Steep G/C	1571	0	0.33	0.55	0	0.02	0.24
	10	2	0.020	Bedrock	268	0.65	4.00	> 2	0.02	0.18	0.34
	11	3	0.027	Bedrock	813	0	0.50	1.28	0	0.03	0.19
	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	> 2	0	0.03	0.06
2009	27	3	0.155	Low 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	Steep G/C	16	0	0.50	1.15	0	0	0
2010	43	3	0.157	Steep Fine	961	0	0.61	0.87	0	0	0
	Bias 5	3	0.105	Steep G/C	23	0	0.30	0.42	0	0.02	0.10
	31	3	0.072	Steep Fine	981	0	0.22	0.49	0	0.15	0.21
	10	3	0.064	Bedrock	23	0	0.77	1.58	0	0.02	0.07
2011	56	1	0.159	Steep Fine	250	0	0.53	0.85	0	0	0
	19	2	0.151	Low G/C	313	0	0.31	0.46	0	0.04	0.05
	20	3	0.101	Steep G/C	323	0.11	0.30	0.45	0.03	0.02	0.08
	53	1	0.100	Steep Fine	1225	0	0.33	0.48	0	0	0.01

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

Table 3-6: Summary of velocity and substrate of sites with the highest density of target species based on the 2008–2011 sampling results

Species	Preferred velocities	Preferred substrates
Bull Trout	0–0.38 m/s	Fines and Gravel/cobble
Rainbow Trout	0–0.34 m/s	Rip-rap
Mountain Whitefish	0– 0.24 m/s	Gravel/cobble

4.0 DISCUSSION

4.1 TEMPERATURE AND DISCHARGE

The use of handheld meters to collect surface water temperatures was considered sufficient to document site conditions related to juvenile fish use and habitat in the Middle Columbia River. Recorded temperatures in 2011 were typically within the middle of the range of temperatures observed during the three years of baseline (i.e., neither the warmest nor coolest temperatures observed over the four years of sampling). The exception to this was the May sampling in Reach 4 and tributaries, where mean temperatures were the coolest of the four years of sampling. Temperatures during sampling in fall 2011 tended to be cooler than in the previous three baseline years.

Discharge from the Revelstoke Dam was highly variable during all three sampling trips, with high discharge typically occurring during the day and early evening, and daily low discharge occurring after midnight. In 2008, the first one or two hours of sampling after dark were typically completed during high flows, followed by two or three hours of sampling during rapidly decreasing discharge as the turbines at the Revelstoke Dam were shut down for the night. For the 2009, 2010, and 2011 programs, the sampling times for riverine sites (reaches 3 and 4) were specifically targeted toward the minimum flow period. This was based on research completed on the Colorado River that showed catch rates of age-0 Rainbow Trout in nearshore areas were at least two to four times higher at daily minimum flows compared to daily maximum flows (Korman and Campana 2009). Assuming juvenile fishes in the Middle Columbia respond similarly to fluctuating flows, it was theorized that sampling riverine sites at low flow periods would result in increased catch rates.

4.2 FISH SIZE

Electrofishing was effective at capturing juvenile life stages of the target fish and all life stages of most of the smaller fish species (e.g., cyprinids). Approximately 96 per cent percent of measured fishes from 2008 to 2011 were less than 250 mm (Figure 4-1). The majority of captured fishes were within the 51–100 mm size class and were considered to be juveniles. Larger fishes typically evaded captured due to their burst speed and were frequently observed darting away from the boat. The majority of individuals of the target species measured in 2011were also less than 250 mm (Figure 4-2) with the size range of 151-200 mm being most commonly encountered.

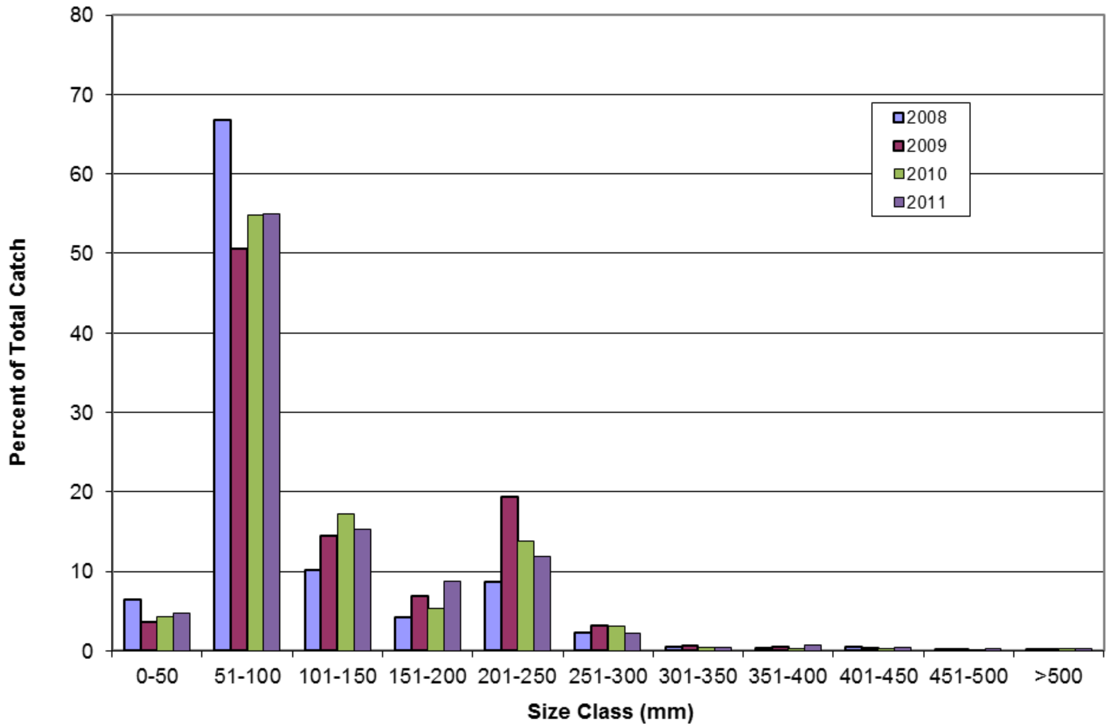


Figure 4-1: Length frequency histogram for fishes measured during the 2008–2011 field seasons (*N* = 2,920 for the 2011 field season)

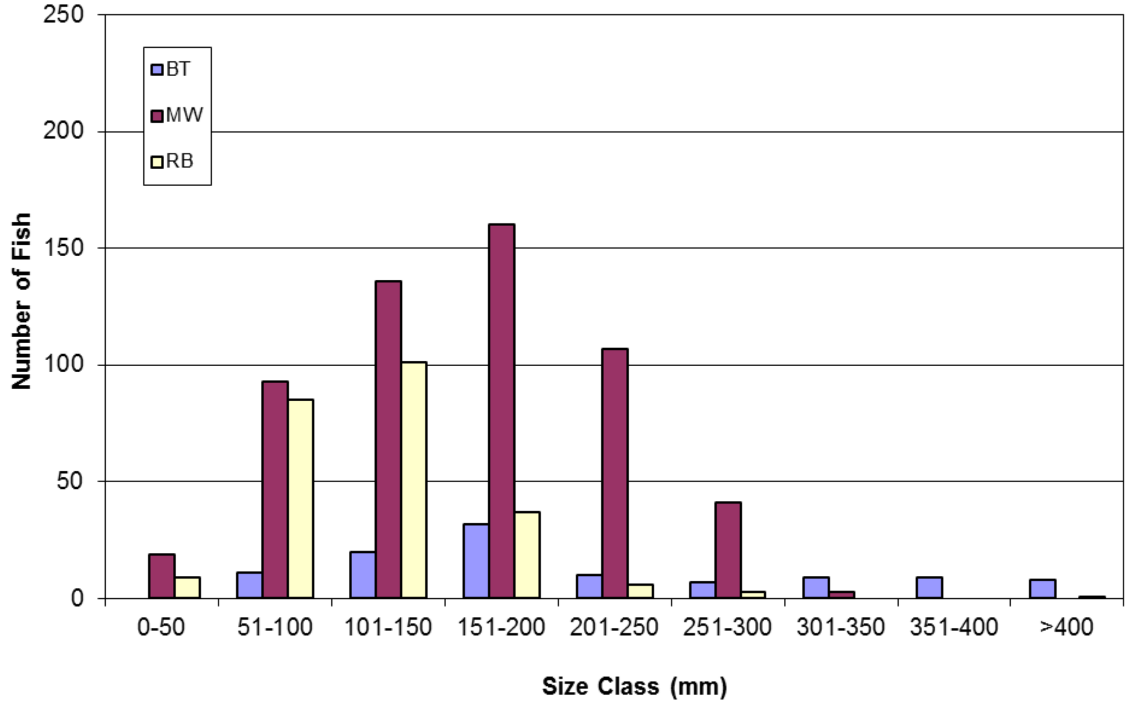


Figure 4-2: Length frequency histogram for target fish species (Bull Trout [BT], Mountain Whitefish [MW], and Rainbow Trout [RT]) measured during the 2011 field season (*N* = 1,152). Note: sizes less than 250 mm were considered to be juveniles.

4.3 FISH DISTRIBUTION

Similar to Years 1–3, the focus of the data analyses for Year 4 was to compare fish abundances between river reaches and habitat units and confirm that the methodology would be able to address the overall goals of the project:

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 requirement (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.*

Sampling in 2011 was completed in three discrete periods: May, July, and September. All reaches were considered "riverine" (containing flow) during the May sampling, whereas by July, all had become inundated by the ALR and were more lacustrine. By September, the ALR elevation had receded such that Reach 4 had returned to riverine conditions, while reaches 1–3 remained inundated. In May and September, the highest densities of fish (fish/m of shoreline) were found in Reach 1. Therefore, during periods where the reaches closer to the dam are not influenced by the ALR and therefore subject to large daily fluctuations in discharge, higher densities were found downstream where the influence of the dam is reduced. However, in July, when the ALR had backwatered throughout the study area thus mitigating the influence of the discharge changes at the dam, Reach 4 was found to have the highest density. A similar trend was observed in 2010 with Reach 1 having the highest densities in spring and fall but Reach 3 being highest in July when the ALR was at high elevation. However both years differed from 2009 during which reaches 1 and 2 had the highest density in all three sampling periods. Additional data will be required to determine if there is a consistent seasonal trend in fish density within the study area. Lastly, the similarity between the 2010 and 2011 data suggests that changes to the flow regime associated with Rev-5 are not yet having an effect on the distribution of fish in the system.

Species richness was consistent between Years 1–4 of the study, with 17 species being captured in 2009–2011 and 15 in 2008. The highest species richness during the three sampling events in 2011 was 12 species in reaches 1 and 2 in both May and September. The three target species (Bull Trout, Rainbow Trout, and Mountain Whitefish) were encountered in each reach during the 2011 sampling with the exception of Reach 1 in September (no Bull Trout were captured). During the September sampling in reaches 3 and 4, abundance of Kokanee in 2011 (n = 739) was similar to that in 2009 (n = 892) and 2010 (n = 671) but higher than that in 2008 (n = 162), which was likely due to the natural variation in spawning run size or timing.

4.3.1 HABITAT SUITABILITY FOR JUVENILES

Habitat Suitability Index (HSI) curves for juveniles of the three target species 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 regimes. 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 white fish 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.

Based on these criteria, it was expected that sites exhibiting similar substrate, depth, and velocity characteristics would have the highest catch rates of target 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 3-8). 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 20 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 4-1). 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.

Table 4-1: 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	1.5 m	3 m	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

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 rip-rap and bedrock. The relatively stable depths and velocities at sites with steep, large diameter substrates over a range of discharges could potentially explain the higher densities of target species captured at those sites (Table 3-8). These habitats 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, which thus limits the need for daily migrations between habitats (Korman and Campana, 2009).

5.0 COMPARISON OF 2011 (YEAR 4) TO BASELINE (YEARS 1–3) SUMMARY

The following sections provide a summary of the sampling conditions and results during the first year of the post-Rev 5 flow regime compared to each of the three years of baseline data collection.

Physical Environment

Year 4 (2011) was the first year of sampling following the completion of Rev 5. Therefore, the results (along with those of Years 5 and 6) are expected to address the second management objective for the project: "*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.*". A review of the data on discharge from the Revelstoke Dam at 10-minute intervals from May 1 to October 16, 2011 (169 days) showed that during that period, discharge still dropped below the 142 m^3/s threshold on 59 days (35 per cent of the time) and generally for periods of more than one hour. For comparison, discharge dropped below 142 m^3/s on 112 days (66 per cent of the time) during the same period in 2010. Sampling in 2011 did not occur at discharges below142 m^3/s; however, it is not known what effect, if any, the continuing drop in discharge below the threshold might have on identifying before/after trends in the data.

Another factor that confounds the ability to assess the influence of the minimum base flow is the influence of the ALR on the study area. Specifically, 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. Therefore sampling during riverine conditions provides the best opportunity to assess the effect of the minimum base flow. However, river conditions in each of the three years of baseline data collection (2008–2010), as well as in the first year after the implementation of minimum flows (Year 4), have differed during at least one of the sampling trips each year due to changes in ALR elevation (Table 5-1). Trip 1 (May) was the only trip where conditions were consistent across the three years of baseline and the first year of minimum flows, with all four reaches considered riverine with no influence of the ALR for the duration of the sampling. For Trip 2 (June/July), influence of the ALR was observed in all four reaches in 2010, in reaches 1, 2, and 3 in 2008 and 2011, and only in reaches 1 and 2 in 2009. For Trip 3 (September), influence of the ALR was observed in reaches 1, 2, and 3 in 2008 and 2011, but only in reaches 1 and 2 in 2009 and 2010.

Table 5-1: Summary of river conditions at each reach during each of the three sampling events for 2008–2011 (R = reach). Red border indicates start of minimum flows

Trip	Condition	2008	2009	2010	2011
May	River Reservoir	R 1–4	R 1–4	R 1–4	R 1–4
June/July	River Reservoir	R 4 R 1–3	R 3–4 R 1–2	 R 1–4	R4 R 1–3
September	River Reservoir	R 4 R 1–3	R 3–4 R 1–2	R 3–4 R 1–2	R 4 R 1–3

The addition of a fifth generator at the Revelstoke Dam also increased the potential 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). Therefore, if changes in juvenile fish habitat use are identified, it will be difficult to determine whether they are attributable to the minimum base flow or the increased maximum flow.

However conditions in the system during the 2011 study period were not substantially different from those that could occur under the four unit operation in terms of maximum discharge. The pre-Rev 5 maximum of 1,700 m^3/s was exceeded on only 21 days (12 per cent of the time) and generally for periods of less than one hour. Further, the maximum discharge observed during that period was only 1,779 m^3/s.

Recorded water temperatures in 2011 were typically within the middle of the range of temperatures observed during the three years of baseline data collection (i.e., neither the warmest nor coolest temperatures observed over the four years of sampling). The exception to this was the May sampling in Reach 4 and tributaries, where mean temperatures were the coolest of the four years of sampling. Temperatures during sampling in fall 2011 tended to be cooler than that of the fall sampling in each of the three baseline years (Table 3-1), however for Rainbow Trout, Bull Trout, and Mountain Whitefish this did not translate into significant differences in CPUE as compared to 2008-2010 (see Section 3.4.5).

Sampling Results

Results from Years 1–3 of the study show an increase in species richness, total abundance, target species abundance, and CPUE of juveniles of the target species over the three years (Table 5-2). In Year 4, species richness was similar to that in Years 1–3, but total abundance decreased and target species abundance increased. However, comparison of CPUE, which standardizes by results by effort, shows that for the Rainbow Trout, Bull Trout, and Mountain Whitefish, the 2011 results were comparable to that of 2009 and 2010. Results from 2008 were lower than the other years in terms of species richness, abundance (all species and target species) and CPUE. The rational for this is unclear however it could be associated with reduced sampling efficiency associated with the first year of the study.

Table 5-2: Summary of sampling results for 2008–2011, all reaches combined

Year	Species Richness	Abundance (all species)	Abundance (target spp.)	CPUE (juv. target spp.)
2008	15	2,091	337	0.006
2009	17	7,763	805	0.012
2010	17	8,861	903	0.015
2011	17	6,504	1,060	0.014

Comparison of CPUE of juveniles of Rainbow Trout, Bull Trout, and Mountain Whitefish before and after Rev 5 only identified significant differences at 1 of the 15 trip/reach combinations for each species (see Section 3.4.5). This suggests that populations of those species have not changed following one year of post-rev 5 flow regime. However, it is important to note that the discharge during the sampling period in 2011 did not differ substantially from pre-Rev 5 conditions, and therefore it is not surprising that an effect was not observed.

5.1 RECOMMENDATIONS

The remaining two years of the study (Years 5 and 6) should use the same sites, sampling techniques, and procedures used in Years 1–4. Trips should be completed during the same time of year, and reservoir forecasts should be monitored to ensure sampling occurs while river conditions (i.e., river vs. reservoir) are similar to those of the baseline data set. Specifically, the second trip should either be completed early enough such that reaches 3 and 4 are still riverine (as in 2009), or be delayed until July (as in 2008, 2010, and 2011). In addition, habitat data (depth, velocity, substrate composition) should continue to be collected in order to identify any changes in physical habitat conditions that may help explain observed changes in fish distribution. During trips when reaches 3 and 4 are riverine, sampling should be conducted at daily minimum flows, which is the period where the effects of the minimum base flow will be most evident.

6.0 MANAGEMENT QUESTION SUMMARY

The following is a summary of the answers to the management questions following year 4 of the 6 year study:

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

    - Seasonal abundances and distribution of juveniles species captured in each of the annual reports. A synthesis report will be produced in year 6 (as per the Terms of Reference) that summarizes the data for each of the 6 years of study.

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. Overwintering is assumed to occur as well, however this is beyond the scope of the study.

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 of the habitats accessed and sampled in years 1-3 of the study were accessible in year 4. The minimum base flow and influence of the ALR does not limit habitat access.
        - Habitat characteristics of sites with high abundance of Rainbow Trout, Bull Trout, and Mountain Whitefish in year 4 were comparable to that of years 1-3. This suggests operational strategies have not influenced the availability of preferred habitats.

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

        - Length, weight and condition factor data of Rainbow Trout, Bull Trout and Mountain Whitefish captured in Year 4 were comparable to that of fish captured in Years 1 – 3. This suggests growth conditions are consistent over the four years.
        - Data from CLBMON-15 (Ecological Productivity) will be reviewed and incorporated into the final (year 6) report. It is expected that study will be able to provide additional insight into any changes to the food base that may have occurred in the system.

    c. *Do predators influence fish recruitment and habitat use in the Middle Columbia River?*
        - Adult piscivorous fish such as Bull Trout are present in the system and are known to prey on many species. However, it is unknown what influence predators have on fish recruitment and habitat use at this stage. Review of the results of CLBMON 16 (Fish Population Indexing) and CLBMON 18 (Adult Fish Habitat Use) may provide additional insight into this question. This analysis will be incorporated into the year 6 synthesis report.

7.0 CLOSURE

This report was written by Greg Sykes of Triton Environmental Consultants Ltd. (Kamloops), with review completed by Mr. Ryan Liebe and Mr. Bill Rublee (Kamloops).

Lead Author:

Greg Sykes, M.Sc., R.P.Bio
Triton Environmental Consultants Ltd.

8.0 REFERENCES

Addley, C., K. Clipperton, T. Hardy, and A. Locke. 2003. Fish habitat suitability criteria (HSC) curves: South Saskatchewan River basin, Alberta Canada. Prepared for Alberta Environment, Edmonton, Alta.

Barnham, C., and A. Baxter. 1998. Condition factor, K, for salmonid fishes. Fisheries Notes (FN0005), Department of Primary Industries, State of Victoria, Australia.

B.C. Fisheries, Information Services Branch (B.C. Fisheries). 2001. Reconnaissance (1:20,000) fish and fish habitat inventory: standards and procedures. Version 2.0. Prepared for the Resources Inventory Committee, Victoria, B.C.

BC Hydro. 2005. Consultative Committee Report: Columbia Water Use Plan, Volumes 1 and 2. Report prepared for the Columbia River Water Use Plan Consultative Committee by BC Hydro, Burnaby, B.C.

BC Hydro 2007. Columbia River Project Water Use Plan – Monitoring Program Terms of Reference Revelstoke Flow Management Plan – CLBMON 17 Middle Columbia River Juvenile Fish Habitat Use. Prepared for the Columbia River Water Use Plan Consultative Committee by BC Hydro, Burnaby, BC.

BC Hydro 2010. Columbia River Project Water Use Plan—Monitoring Program Terms of Reference Revelstoke Flow Management Plan—CLBMON 17 Middle Columbia River juvenile fish habitat use. Prepared for the Columbia River Water Use Plan Consultative Committee by BC Hydro, Burnaby, B.C.

B.C. Ministry of Environment, Lands and Parks. 1997. Fish collection methods and standards. Version 4.0. Prepared for the Aquatic Ecosystems Task Force, Resources Inventory Committee, Victoria, B.C

Beamer, E.M., and R.A. Henderson. 1998. Juvenile salmonid use of natural and hydromodified stream bank habitat in the mainstem Skagit River, northwest Washington. Skagit System Cooperative. LaConner, Washington.

Golder Associates Ltd. 2005. Large river fish indexing program: Middle Columbia River —2004 Phase 4 investigations. Golder Report No. 041480048F. Report prepared for BC Hydro Power Supply Environmental Services, Burnaby, B.C.

Kaufmann, P., and F. Robison. 1993. A quantitative habitat assessment protocol for field evaluation of physical habitat in small wadable streams. Oregon State University in cooperation with U.S. Environmental Protection Agency, Corvallis, Oreg.

Korman, J., and S. Campana. 2009. Effects of hydropeaking on nearshore habitat use and growth of age-0 Rainbow Trout in a large regulated river. Transactions of the American Fisheries Society 138:76–87.

McPhail, J.D. 2007. The freshwater fishes of British Columbia. University of Alberta Press, Edmonton, Alta.

Pope, K.L, and C.G. Kruse. 2007. Condition. *In* Analysis and interpretation of freshwater fisheries data. *Edited by* C.S. Guy and M.L. Brown. American Fisheries Society Bethesda, Md. pp. 423–472

Quigley, J.T. and Harper, D.J. 2004. Streambank protection with rip-rap: an evaluation of the effects on fish and fish habitat. Can. Manuscr. Rep. Fish. Aquat. Sci. 2701: xiv + 76 p.

Ricker, W.E. 1975. Computation and interpretation of the biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada 191.

RL&L Environmental Services Ltd. (RL&L). 1994. Fish stock and habitat assessments of the Columbia River below Revelstoke Canyon Dam. RL&L Report No. 340F. Report prepared for BC Hydro, Environmental Resources.

Stewart-Oaten, A., and J.R. Bence. 2001. Temporal and spatial variation in environmental impact assessment. Ecological Monographs 71(2): 305–339.

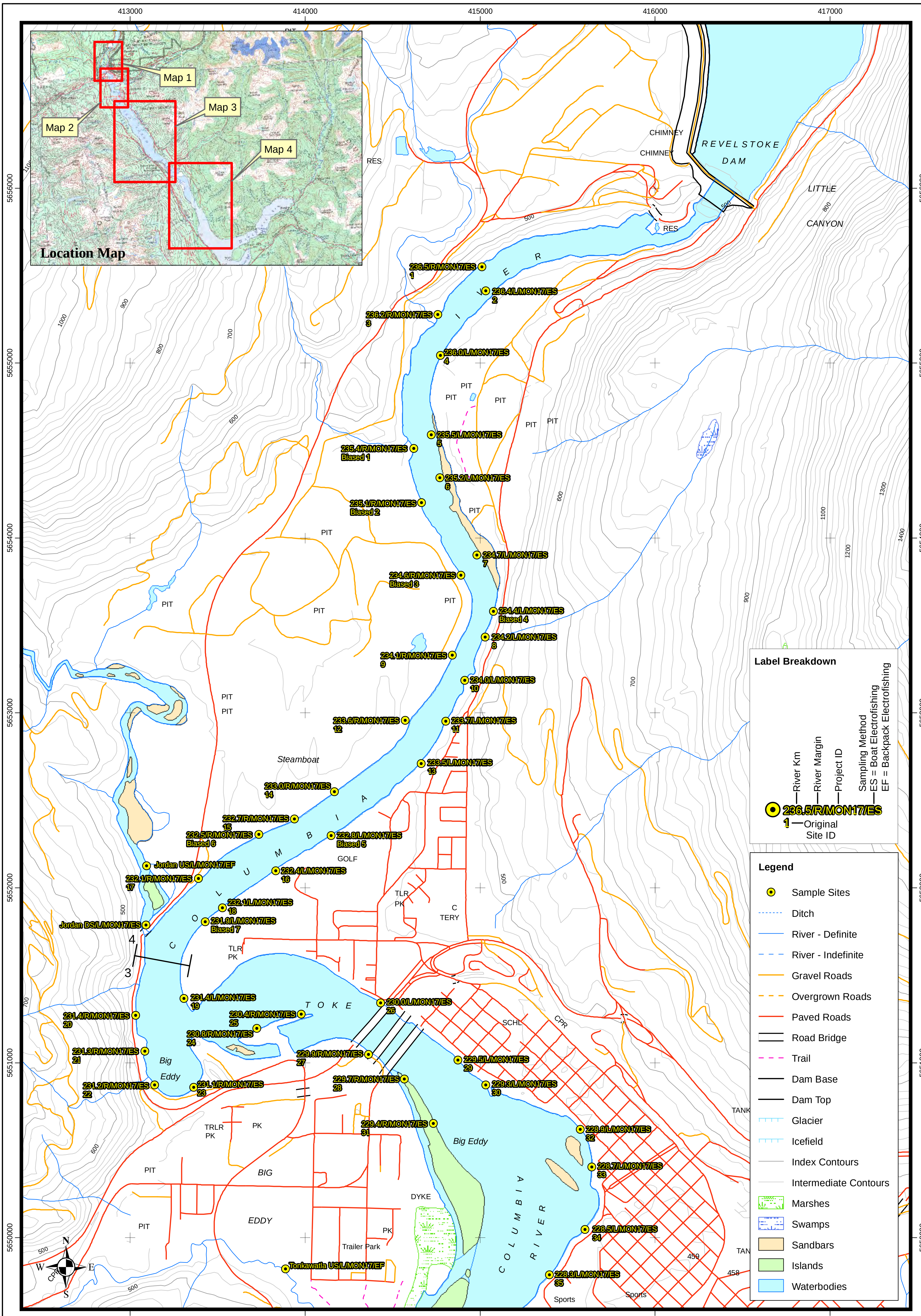
Triton Environmental Consultants Ltd. (Triton). 2009. CLBMON 17—2008 Middle Columbia River juvenile fish habitat use. Report Prepared for BC Hydro, Revelstoke, BC.

Triton Environmental Consultants Ltd. (Triton). 2010. CLBMON 17—2009 Middle Columbia River juvenile fish habitat use. Report Prepared for BC Hydro, Revelstoke, BC.

Triton Environmental Consultants Ltd. (Triton). 2011. CLBMON 17—2010 Middle Columbia River juvenile fish habitat use. Report Prepared for BC Hydro, Revelstoke, BC.

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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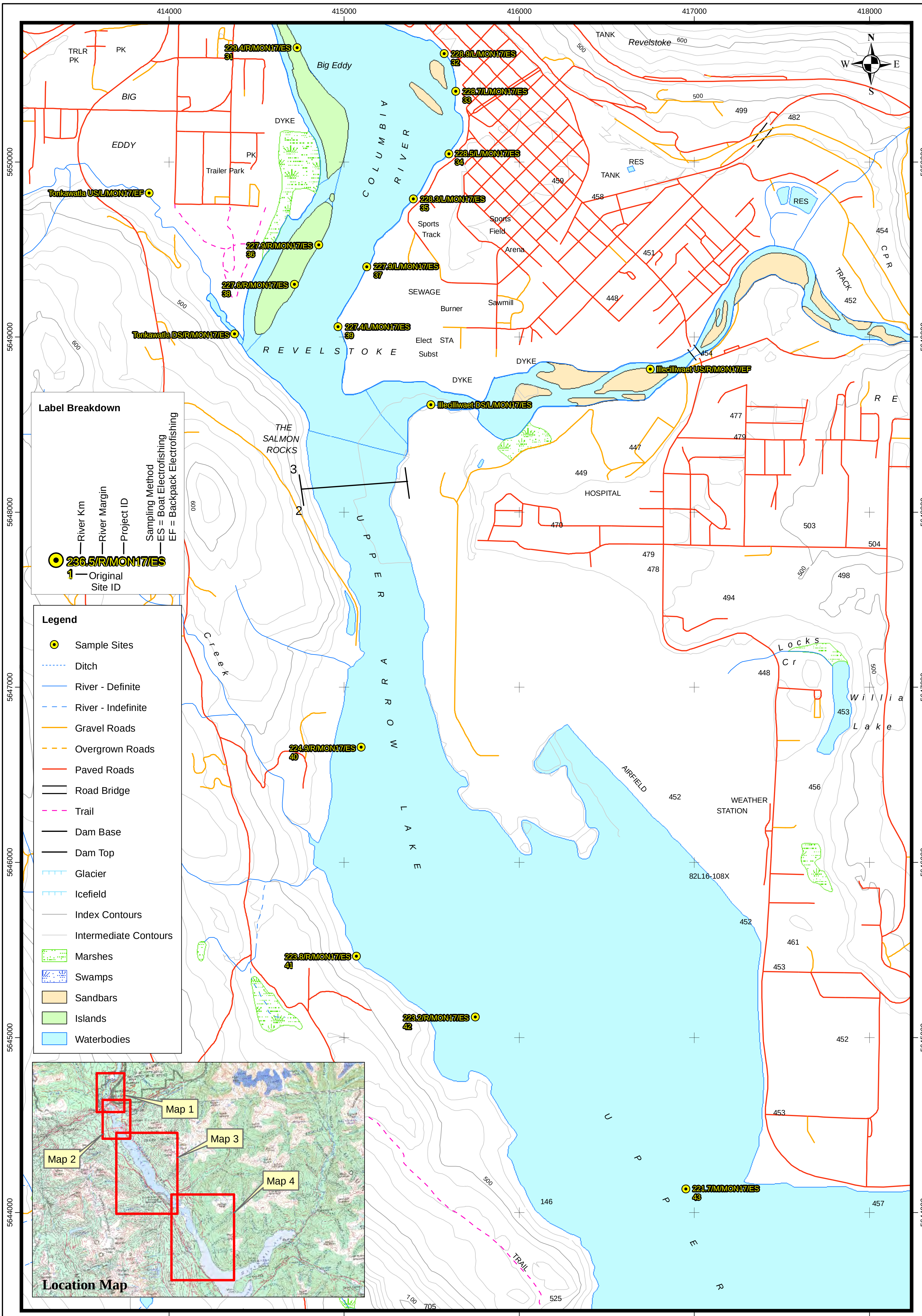
Date: Feb 1, 2012

TRITON ENVIRONMENTAL CONSULTANTS LTD.



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

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

File No: Map#: N:\ACTIVE\3943_BC_Hydro_Columbia\MXD\2012\Basemap2c_SM.mxd

Date: Feb 1, 2012

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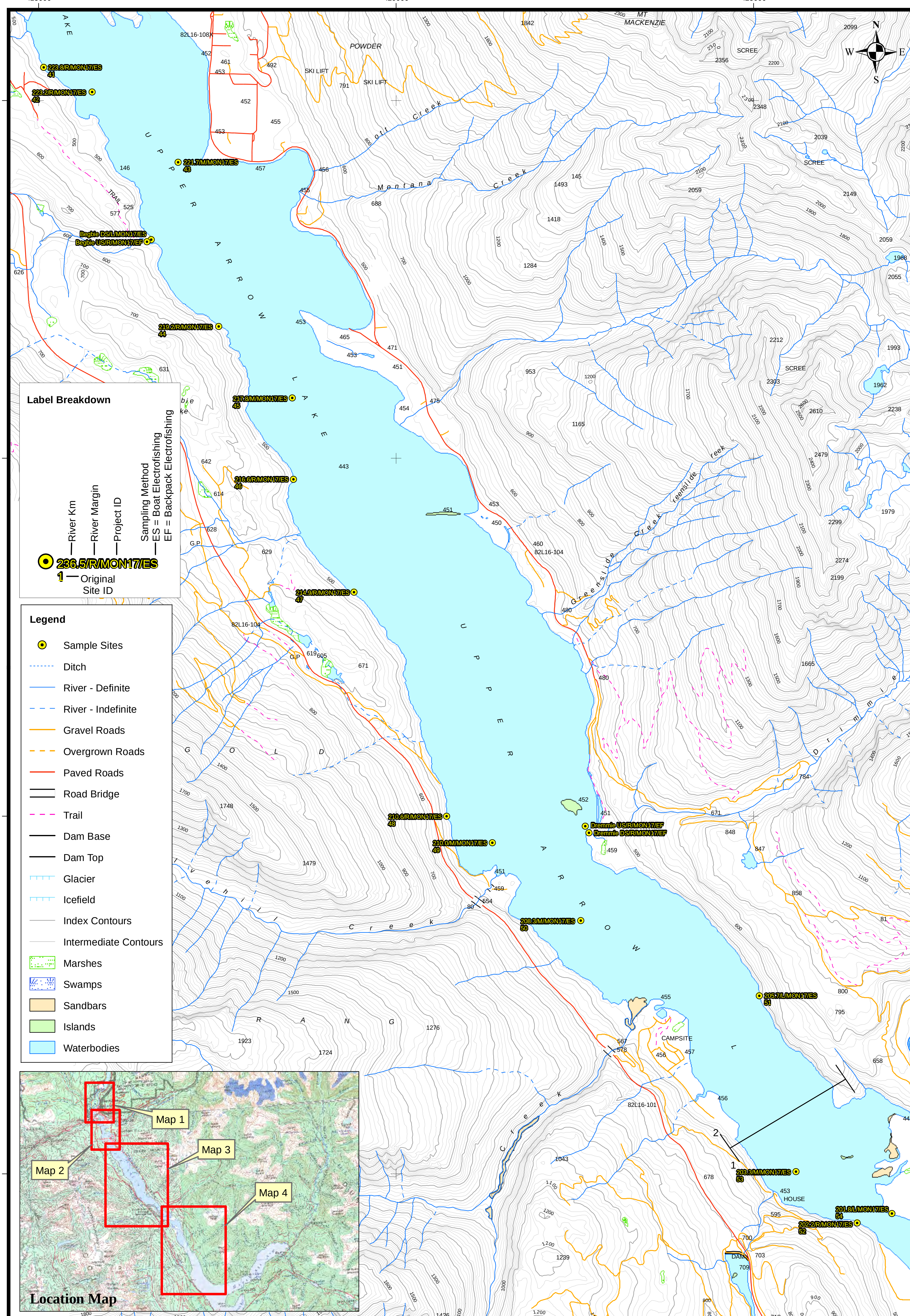


MIDDLE COLUMBIA RIVER
JUVENILE HABITAT USE

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

Scale: 1:50,000

TRIM Basemap
MAP 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

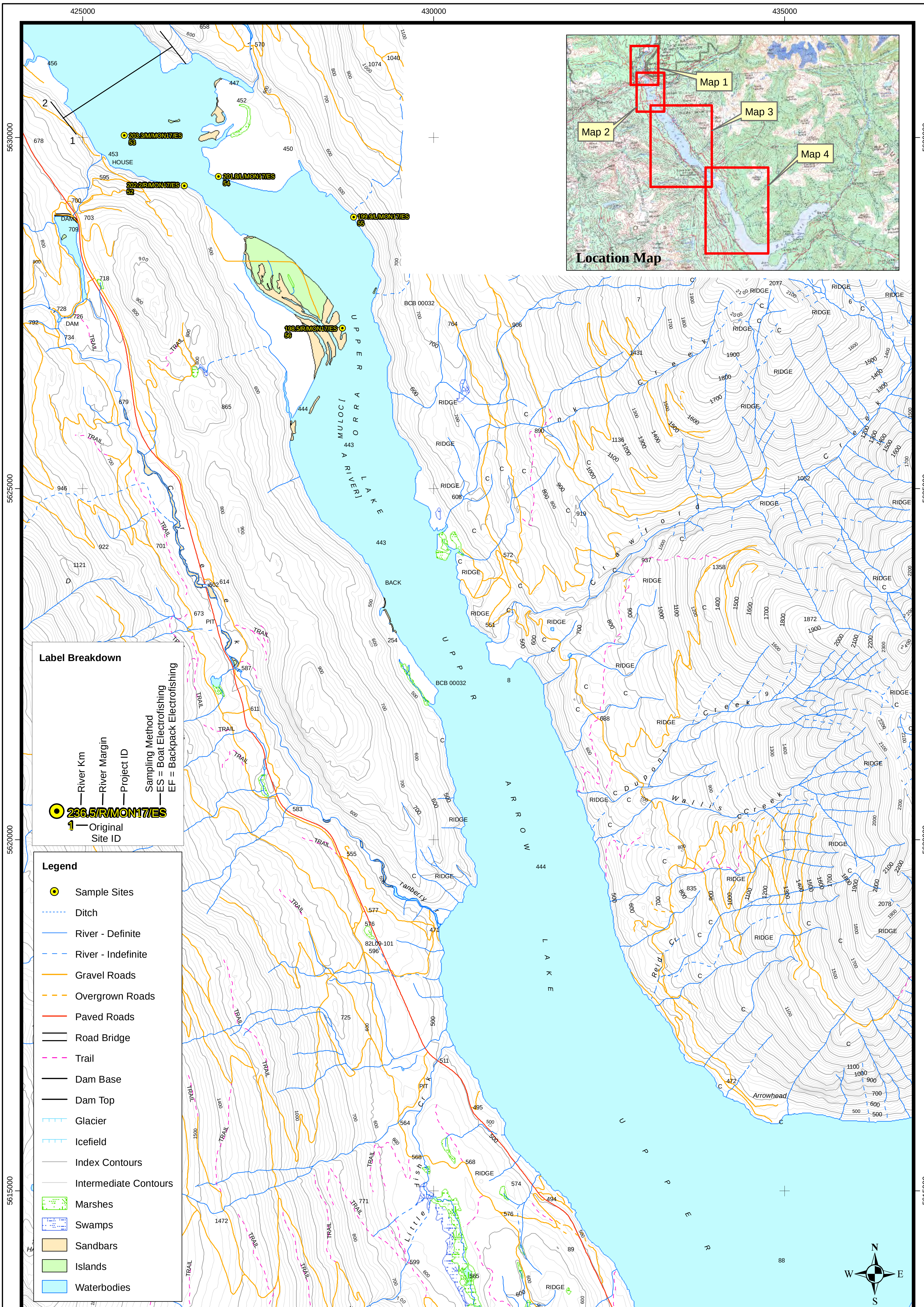
Map Datum: UTM NAD 83 Zone 11

Project No: 3943

File No: Map#: N:\ACTIVE\3943_BC_Hydro_Columbia\MXD\2012\Basemap3c_SM.mxd

Date: Feb 1, 2012

TRITON ENVIRONMENTAL CONSULTANTS LTD.



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
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

File No: Map#: N:\ACTIVE\3943_BC_Hydro_Columbia\MXD\2012\Basemap4c_SM.mxd

Date: Feb 1, 2012

TRITON ENVIRONMENTAL CONSULTANTS LTD.

Appendix 1b

Site Label Summary

Original Site Label	Reach	UTM Zone	Easting	Northing	River km	2011 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	231.1/R/MON17/ES

Original Site Label	Reach	UTM Zone	Easting	Northing	River km	2011 Site Label
					140m	
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	216.6/R/MON17/ES

Original Site Label	Reach	UTM Zone	Easting	Northing	River km	2011 Site Label
					600m	
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	Dremmie US/R/MON17/EF
Dremmie Creek U/S	2	11	422696	5634766	209Km 0m	Dremmie DS/R/MON17/EF
Illecilliwaet D/S	2	11	415497	5648614	226Km 740m	Illecilliwaet DS/L/MON17/ES

Original Site Label	Reach	UTM Zone	Easting	Northing	River km	2011 Site Label
Illecilliwaet U/S	2	11	416749	5648818	226Km 620m	Illecilliwaet 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 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 3a. Typical steep slope site with boulder substrates (Site 4, Reach 4). High flow.

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

Plate 2a. Typical shallow slope site with gravel and cobble substrates (Site 6, Reach 4). High flow.

Plate 2b. Typical shallow slope site with gravel and cobble substrates (Site 6, Reach 4). Low flow.

Plate 2a. Typical shallow slope site with gravel substrates (Bias 1, Reach 4). High flow.

Plate 2b. Typical shallow slope site with gravel substrates (Bias 1, Reach 4). Low flow.

Appendix 2b

Representative Fish Photographs (2008-2010)

Plate 9. Bull trout.

Plate 10. Rainbow trout.

Plate 11. Mountain whitefish.

Plate 12. Burbot.

Plate 13. Kokanee.

Plate 14. Eastern brook trout.

Plate 15. Tench.

Plate 16. Yellow perch.

Plate 17. Common carp.

Appendix 3

Site Summary Information

Appendix 3a. Site summary information for the May 2010 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	415081	5655345	27-May-11	23:36	23:45	100	3	1.5	4.5	C	glide	Gravel	Cobble	60
2	4	415109	5655190	28-May-11	0:05	0:10	100	3	1	4.5	C	glide	Cobble	Gravel	60
3	4	414834	5655062	28-May-11	0:20	0:30	100	3	2	4.5	C	glide	Gravel	Cobble	50
4	4	414855	5654834	28-May-11	1:00	1:10	100	3	1.5	4.5	C	glide	Cobble	Boulder	80
5	4	414799	5654382	28-May-11	1:25	1:35	100	3	1	5	C	glide	Gravel	Cobble	50
6	4	414846	5654130	28-May-11	2:10	2:20	100	3	1.5	5	C	glide	Gravel	Cobble	60
7	4	415070	5653379	29-May-11	0:05	0:12	100	3	1	4.5	C	glide	Gravel	Cobble	40
8	4	415103	5653229	29-May-11	1:10	1:22	100	3	2	4.7	C	glide	Bed Rock	Fines	79
9	4	414928	5653128	29-May-11	1:40	1:47	100	3	1	4.9	C	glide	Gravel	Cobble	30
10	4	414990	5652979	29-May-11	1:56	2:10	100	3	4	4.9	C	glide	Bed Rock	Gravel	4
11	4	414871	5652741	29-May-11	2:30	2:40	100	3	3	4.9	C	glide	Bed Rock	Boulder	1000
12	4	414677	5652721	29-May-11	3:00	3:05	100	3	1.5	4.9	C	glide	Gravel	Cobble	60
13	4	414749	5652523	27-May-11	23:00	23:13	100	3	2	5.1	C	glide	Cobble	Gravel	30
14	4	414255	5652337	29-May-11	22:31	22:42	100	3	1.5	4.8	C	glide	Cobble	Gravel	50
15	4	414024	5652175	28-May-11	23:10	23:20	100	3	2.5	4.5	C	glide	Gravel	Cobble	50
16	4	413906	5651891	29-May-11	23:22	23:32	100	3	2.5	4.8	C	glide	Riprap	none	150
17	4	413515	5651768	30-May-11	0:16	0:23	100	3	0.5	4.8	C	glide	Gravel	Cobble	30
18	4	413582	5651665	29-May-11	23:50	23:58	100	3	2	4.8	C	glide	Riprap	none	200
19	3	413289	5651185	30-May-11	1:13	1:19	100	3	0.5	4.8	C	glide	Cobble	Gravel	50
20	3	413127	5651040	27-May-11	1:07	1:15	100	3	1.5	5	C	glide	Cobble	Gravel	30
21	3	413171	5650852	27-May-11	0:30	0:40	100	3	4.3	5	C	glide	Riprap	Gravel	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	413225	5650663	27-May-11	0:07	0:16	100	3	2	5	C	glide	Gravel	Cobble	100
23	3	413444	5650648	26-May-11	23:37	23:49	100	3	2.5	5	C	glide	Gravel	Cobble	20
24	3	413780	5651068	27-May-11	2:15	2:27	100	3	1.5	5	C	glide	Gravel	Cobble	10
25	3	414193	5651142	27-May-11	1:37	1:46	100	3	0.6	5	C	glide	Gravel	Cobble	25
26	3	414506	5651131	26-May-11	22:52	23:07	100	3	2.5	5.2	C	glide	Riprap	none	150
27	3	414505	5650889	03-Jun-11	23:36	23:56	100	3	0.5	5.3	C	glide	Gravel	Cobble	30
28	3	414653	5650705	03-Jun-11	23:13	23:20	100	3	0.8	5.3	C	glide	Gravel	Cobble	30
29	3	414954	5650796	30-May-11	2:05	2:13	100	3	3	4.9	C	glide	Riprap	none	200
30	3	415101	5650667	30-May-11	1:48	1:55	100	3	3	4.9	C	glide	Gravel	Cobble	60
31	3	414824	5650496	31-May-11	22:06	22:17	100	3	1	6.8	C	glide	Gravel	Cobble	20
32	3	415647	5650407	31-May-11	22:42	22:52	100	3	2	5.1	C	glide	Gravel	Cobble	50
33	3	415718	5650200	31-May-11	23:13	23:20	100	3	2	5.1	C	glide	Gravel	Cobble	30
34	3	415670	5649838	31-May-11	23:35	23:46	100	3	3	5.1	C	glide	Riprap	Gravel	150
35	3	415477	5649588	01-Jun-11	0:16	0:24	100	3	3	5.1	C	glide	Riprap	none	200
36	3	414960	5649313	01-Jun-11	0:37	0:46	100	3	1.5	5.1	C	glide	Fines	Gravel	20
37	3	415204	5649204	01-Jun-11	1:10	1:18	100	3	2	5.1	C	glide	Fines	Gravel	50
38	3	414807	5649061	02-Jun-11	22:05	22:14	100	3	1.5	6	C	glide	Fines	Gravel	15
39	3	415021	5648859	01-Jun-11	1:34	1:39	100	3	1	5.1	C	glide	Cobble	Gravel	30
40	2	415208	5646450	03-Jun-11	0:03	0:11	100	3	1.5	5.1	C	glide	Gravel	Cobble	20
41	2	415164	5645254	03-Jun-11	0:32	0:40	100	3	1.5	5.1	C	glide	Cobble	Gravel	40

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												
42	2	415831	5644909	02-Jun-11	2:42	2:52	100	3	0.7	6.4	L	reservoir	Gravel	Fines	5
43	2	417033	5643927	02-Jun-11	1:47	1:56	100	3	1	6.4	L	reservoir	Fines	none	1
44	2	417611	5641638	02-Jun-11	1:01	1:10	100	3	4.5	6.4	C	reservoir	Bed Rock	Boulder	400
45	2	418630	5640634	02-Jun-11	0:38	0:45	100	3	0.7	6.4	C	reservoir	Fines	Gravel	5
46	2	418682	5639494	02-Jun-11	0:14	0:23	100	3	2	6.4	C	reservoir	Fines	Bed Rock	400
47	2	419493	5637900	01-Jun-11	23:22	23:39	100	3	2.5	6.4	C	reservoir	Boulder	Bed Rock	150
48	2	420808	5634784	31-May-11	1:50	1:58	100	3	5	7.2	C	reservoir	Bed Rock	Cobble	200
49	2	421443	5634413	31-May-11	1:22	1:29	100	3	1	7.2	C	reservoir	Fines	none	1
50	2	422646	5633341	31-May-11	0:51	0:57	100	3	1	7.2	C	reservoir	Fines	none	1
51	2	425146	5632281	31-May-11	0:03	0:14	100	3	2.5	7.2	C	reservoir	Cobble	Boulder	150
52	1	426537	5629114	30-May-11	23:00	23:12	100	3	2	7.2	C	reservoir	Boulder	Cobble	200
53	1	425671	5629803	30-May-11	23:34	23:42	100	3	1	7.2	C	reservoir	Fines	Gravel	5
54	1	426778	5629309	30-May-11	22:40	22:45	100	3	1.5	7.2	C	reservoir	Fines	Gravel	10
55	1	428932	5628650	30-May-11	22:00	22:10	100	3	3	6.8	C	reservoir	Cobble	Bed Rock	400
56	1	428848	5626967	30-May-11	21:33	21:41	100	3	3	7.5	C	reservoir	Fines	none	1
Bi 1	4	414718	5654302	01-Jun-11	22:09	22:19	100	3	1	3.3	C	glide	Cobble	Gravel	50
Bi 2	4	414751	5653993	01-Jun-11	22:20	22:30	100	3	2.5	5	C	glide	Gravel	Cobble	70
Bi 3	4	414974	5653584	28-May-11	1:50	2:00	100	3	1.5	4.5	C	glide	Cobble	Gravel	200
Bi 4	4	415156	5653366	28-May-11	2:40	2:50	100	3	2	4.5	C	glide	Boulder	Cobble	250
Bi 5	4	414212	5652088	28-May-11	23:45	23:55	100	3	2	4.8	C	glide	Boulder	Cobble	60
Bi 6	4	413808	5652097	29-May-11	0:40	0:55	100	3	2	4.5	C	glide	Cobble	Gravel	60

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												
Bi 7	4	413507	5651601	30-May-11	0:31	0:39	100	3	3	4.8	C	glide	Riprap	none	200
Begbie D/S	trib	416658	5642848	01-Jun-11	2:50	3:00	50	3	1	6	C	riffle	Cobble	Gravel	30
Begbie U/S	trib	416598	5642828	01-Jun-11	3:17	3:25	50	3	1.5	6	C	riffle	Bed Rock	Cobble	60
Dremmie D/S	trib	422476	5634818	28-May-11	23:40	23:44	50	3	0.5	4.7	C	riffle	Fines	Gravel	5
Dremmie U/S	trib	422728	5634646	28-May-11	21:45	21:55	50	3	0.5	4.7	C	riffle	Gravel	Fines	5
Illi D/S	trib	415262	5648159	28-May-11	22:30	22:43	50	3	1	7.5	L	glide	Gravel	Cobble	20
Illi U/S	trib	416888	5648618	29-May-11	22:00	22:10	50	3	1	6.8	L	glide	Gravel	Cobble	15
Jordan D/S	trib	413171	5651578	29-May-11	22:36	22:47	50	3	3	5.3	C	glide	Riprap	none	100
Jordan U/S	trib	413173	5651925	28-May-11	22:30	22:40	50	3	0.6	5.8	C	riffle	Cobble	Gravel	50
Tonk D/S	trib	414460	5648829	30-May-11	2:50	3:00	50	3	0.8	8.4	M	riffle	Fines	Gravel	65
Tonk U/S	trib	413966	5649611	31-May-11	3:17	3:25	50	3	1.2	7.3	L	glide	Fines	Gravel	15

Appendix 3b. Site summary information for the July 2010 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	415065	5655375	20-Jul-11	22:44	22:47	100	3	1	9.1	C	glide	Gravel	Fines	5
2	4	415119	5655188	20-Jul-11	23:00	23:16	100	3	1.5	9.1	C	glide	Cobble	Gravel	12
3	4	414833	5655066	20-Jul-11	23:18	23:30	100	3	1.2	9.1	C	glide	Gravel	Cobble	10
4	4	414856	5654833	20-Jul-11	23:36	23:50	100	3	1.3	9.1	C	glide	Cobble	Gravel	10
5	4	414805	5654374	21-Jul-11	0:10	0:20	100	3	0.5	8.5	C	glide	Gravel	Cobble	5
6	4	414858	5654131	21-Jul-11	0:55	1:10	100	3	0.7	9.5	C	glide	Cobble	Gravel	10
7	4	415062	5653695	21-Jul-11	1:30	1:43	100	3	0.5	9.6	C	glide	Gravel	Cobble	5
8	4	415103	5653228	25-Jul-11	21:55	22:20	100	3	1.6	10.1	C	glide	Boulder	Bed Rock	150
9	4	414919	5653130	25-Jul-11	22:25	22:40	100	3	1.1	10.1	C	glide	Cobble	Boulder	45
10	4	414995	5652976	25-Jul-11	22:50	23:10	100	3	5.5	10.1	C	glide	Bed Rock	Cobble	400
11	4	414885	5652756	25-Jul-11	23:20	23:42	100	3	2.9	10.1	C	glide	Bed Rock	Boulder	400
12	4	414669	5652731	25-Jul-11	23:45	0:00	100	3	1.6	10.1	C	glide	Cobble	Boulder	40
13	4	414745	5652509	26-Jul-11	0:30	0:50	100	3	1.1	10	C	glide	Cobble	Gravel	30
14	4	414250	5652342	26-Jul-11	0:56	1:15	100	3	1.5	10	C	glide	Cobble	Gravel	25
15	4	414020	5652181	26-Jul-11	1:16	1:28	100	3	1.6	10	C	glide	Gravel	Cobble	25
16	4	413916	5651890	26-Jul-11	23:10	23:22	100	3	2.1	9	C	glide	Riprap	Cobble	100
17	4	413510	5651877	26-Jul-11	22:15	22:30	100	3	0.9	9	C	glide	Fines	Gravel	10
18	4	413585	5651664	26-Jul-11	23:45	23:59	100	3	2.5	9	C	glide	Riprap	Cobble	90
19	3	413390	5651150	19-Jul-11	0:20	0:33	100	3	0.5	9	C	glide	Gravel	Cobble	12
20	3	413109	5651047	19-Jul-11	23:44	23:55	100	3	1.6	9	C	reservoir	Riprap	none	1
21	3	413163	5650858	19-Jul-11	23:02	23:14	100	3	4	9	C	reservoir	Bed Rock	Riprap	1000

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	413221	5650667	19-Jul-11	22:46	22:59	100	3	1.6	9	C	reservoir	Fines	Gravel	5
23	3	413442	5650662	19-Jul-11	22:21	22:27	100	3	1.9	9	C	reservoir	Gravel	Fines	5
24	3	413806	5650991	20-Jul-11	0:56	1:10	100	3	1.2	10	C	reservoir	Gravel	Cobble	10
25	3	414059	5651060	20-Jul-11	1:17	1:30	100	3	1.3	10	C	reservoir	Cobble	Gravel	12
26	3	414510	5651143	21-Jul-11	22:03	22:16	100	3	2	8.9	C	reservoir	Riprap	Fines	100
27	3	414472	5650835	21-Jul-11	22:29	22:45	100	3	1.1	8.9	C	glide	Fines	Gravel	1
28	3	414649	5650704	21-Jul-11	23:04	23:20	100	3	2.1	8.9	C	glide	Fines	Gravel	1
29	3	414946	5650809	27-Jul-11	1:09	1:25	100	3	4.5	8.7	C	glide	Cobble	Riprap	90
30	3	415107	5650670	27-Jul-11	1:27	1:39	100	3	2.1	8.7	C	reservoir	Riprap	Fines	1
31	3	414816	5650448	21-Jul-11	23:20	23:40	100	3	1.5	8.9	C	glide	Fines	Gravel	1
32	3	415562	5650410	22-Jul-11	0:00	0:20	100	3	2	9.8	C	glide	Fines	Gravel	1
33	3	415715	5650205	22-Jul-11	0:25	0:35	100	3	2.5	9.8	C	glide	Fines	Gravel	1
34	3	415667	5649823	22-Jul-11	1:05	1:25	100	3	2.5	9.8	C	glide	Riprap	Cobble	150
35	3	415476	5649578	22-Jul-11	0:50	1:05	100	3	2.6	9.8	C	glide	Riprap	Gravel	150
36	3	414939	5649317	23-Jul-11	0:23	0:33	100	3	2	9.1	C	glide	Fines	Gravel	5
37	3	415215	5649183	23-Jul-11	0:55	1:10	100	3	1.5	9.1	C	reservoir	Fines	Gravel	5
38	3	414792	5649083	23-Jul-11	0:05	0:20	100	3	3.5	9.1	C	reservoir	Fines	Gravel	7
39	3	415044	5648851	22-Jul-11	23:42	23:55	100	3	2	9.1	C	reservoir	Fines	Gravel	10
40	2	415198	5646452	22-Jul-11	22:12	22:30	100	3	2	9.1	C	reservoir	Fines	Gravel	10
41	2	415152	5645252	25-Jul-11	0:40	1:05	100	3	5	10	C	reservoir	Fines	none	1
42	2	415840	5644924	25-Jul-11	0:22	0:35	100	3	2	10	C	reservoir	Fines	none	1

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)
44	2	417602	5641628	24-Jul-11	22:40	22:49	100	3	2.6	10.5	C	reservoir	Bed Rock	Boulder	400
46	2	418656	5639495	24-Jul-11	22:16	22:35	100	3	2.5	10.5	C	reservoir	Bed Rock	Boulder	400
47	2	419495	5637896	24-Jul-11	21:30	22:00	100	3	2.5	10.5	C	reservoir	Bed Rock	Boulder	300
48	2	420792	5634781	24-Jul-11	0:25	0:40	100	3	1.1	10.8	C	reservoir	Bed Rock	Boulder	300
51	2	425151	5632274	23-Jul-11	23:25	23:40	100	3	2	10.8	C	reservoir	Bed Rock	Boulder	300
52	1	426531	5629108	23-Jul-11	22:57	23:10	100	3	3	10.8	C	reservoir	Bed Rock	Boulder	400
54	1	426876	5629367	23-Jul-11	22:30	22:46	100	3	1	12.4	C	reservoir	Fines	Gravel	15
55	1	428943	5628673	23-Jul-11	22:00	22:20	100	3	2.5	12.4	C	reservoir	Bed Rock	Cobble	400
56	1	428761	5626926	23-Jul-11	21:39	21:50	100	3	2.5	12	C	reservoir	Fines	Gravel	4
Biased 1	4	414702	5654290	21-Jul-11	0:30	0:40	100	3	1.5	9.5	C	glide	Gravel	Cobble	15
Biased 2	4	414717	5653980	21-Jul-11	1:15	1:25	100	3	1	9.5	C	glide	Cobble	Gravel	12
Biased 3	4	414980	5653581	21-Jul-11	1:52	2:10	100	3	1	9.5	C	glide	Cobble	Boulder	100
Biased 4	4	415167	5653372	25-Jul-11	21:30	21:49	100	3	1.4	10.1	C	reservoir	Boulder	Cobble	200
Biased 5	4	414234	5652092	26-Jul-11	1:32	1:43	100	3	1	10	C	glide	Cobble	Boulder	40
Biased 6	4	413821	5652091	26-Jul-11	22:43	23:00	100	3	2	9	C	glide	Fines	Cobble	90
Biased 7	4	413511	5651597	27-Jul-11	0:10	0:25	100	3	2.5	9	C	glide	Riprap	Cobble	90
Begbie d/s		416658	5642848	24-Jul-11	23:05	23:15	50	3	1.7	10.5	C	reservoir	Gravel	Cobble	30
Begbie u/s		416598	5642828	24-Jul-11	23:15	23:40	50	3	1.8	10.5	C	riffle	Cobble	Gravel	50
Dremmie u/s		422742	5634603	24-Jul-11	1:11	1:30	50	3	0.7	7.7	C	riffle	Fines	Cobble	20
Illecill d/s		415578	5648412	22-Jul-11	21:40	22:00	50	3	1.5	10	L	glide	Gravel	Cobble	10
Illecill u/s		416885	5648612	22-Jul-11	21:22	21:35	50	3	1.3	10	L	glide	Gravel	Fines	10

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												
Jordan d/s		413177	5651585	26-Jul-11	21:47	22:02	50	3	2.5	10.2	C	glide	Riprap	Cobble	100
Jordan u/s		413178	5651922	26-Jul-11	21:30	21:45	50	3	0.7	10.9	C	riffle	Gravel	Cobble	20
Tonk d/s		414460	5648809	22-Jul-11	22:43	22:54	50	3	2.2	10.5	C	reservoir	Fines	Gravel	5
Tonk u/s		414190	5649336	22-Jul-11	23:00	23:10	50	3	2.1	10.5	C	glide	Fines	Gravel	5

Appendix 3c. Site summary information for the September 2010 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	415081	5655328	15-Sep-11	19:55	20:05	100	3	1.2	9.5	C	glide	Cobble	Bed Rock	60
2	4	415109	5655200	15-Sep-11	20:25	20:32	100	3	1.5	9.5	C	glide	Cobble	Boulder	60
3	4	414835	5655056	15-Sep-11	20:41	20:50	100	3	1.2	9.5	C	glide	Cobble	Boulder	60
4	4	414850	5654830	15-Sep-11	21:10	21:17	100	3	1.2	9.5	C	glide	Cobble	Boulder	60
5	4	414801	5654376	15-Sep-11	22:15	22:25	100	3	1.2	9.5	C	glide	Cobble	Gravel	50
6	4	414849	5654129	15-Sep-11	22:43	22:52	100	3	1.5	9.5	C	glide	Cobble	Gravel	40
7	4	415061	5653688	15-Sep-11	23:30	23:40	100	3	1	9.5	C	glide	Gravel	Cobble	30
8	4	415096	5653226	17-Sep-11	20:00	20:09	100	3	2.2	9.7	C	glide	Bed Rock	Boulder	100
9	4	414919	5653136	17-Sep-11	20:35	20:43	100	3	1.5	9.7	C	glide	Gravel	Cobble	18
10	4	414996	5652985	17-Sep-11	21:00	21:10	100	3	4	9.7	C	glide	Bed Rock	Boulder	100
11	4	414885	5652761	17-Sep-11	21:32	21:40	100	3	3	9.7	C	glide	Bed Rock	Boulder	100
12	4	414672	5652718	17-Sep-11	21:47	21:57	100	3	1.8	9.7	C	glide	Cobble	Gravel	28
13	4	414745	5652509	17-Sep-11	22:19	22:27	100	3	1.3	9.7	C	glide	Cobble	Gravel	20
14	4	414252	5652340	17-Sep-11	22:37	22:46	100	3	2	9.7	C	glide	Cobble	Gravel	15
15	4	414020	5652185	17-Sep-11	23:31	23:41	100	3	2.1	9.7	C	glide	Cobble	Gravel	24
16	4	413916	5651892	18-Sep-11	0:20	0:30	100	3	2.1	9.7	C	glide	Riprap	none	100
17	4	413448	5651806	20-Sep-11	20:12	20:18	100	3	0.7	9.6	C	glide	Cobble	Gravel	10
18	4	413607	5651681	20-Sep-11	20:24	20:32	100	3	2	9.6	C	glide	Riprap	none	50
19	3	413309	5651145	14-Sep-11	23:16	23:24	100	3	1.1	9.9	C	glide	Gravel	Cobble	9
20	3	413113	5651042	14-Sep-11	22:23	22:35	100	3	1.5	10	C	glide	Fines	Cobble	12
21	3	413164	5650858	14-Sep-11	21:45	22:00	100	3	2.1	10	C	glide	Bed Rock	Boulder	100

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	413224	5650669	14-Sep-11	21:13	21:22	100	3	1.5	10	C	glide	Gravel	Cobble	8
23	3	413442	5650650	14-Sep-11	20:52	20:59	100	3	2.1	10	C	glide	Gravel	Fines	8
24	3	413777	5651052	14-Sep-11	23:40	23:53	100	3	1	9.9	C	glide	Gravel	Cobble	8
25	3	414078	5651149	15-Sep-11	0:01	0:18	100	3	0.8	9.9	C	glide	Cobble	Gravel	18
26	3	414512	5651128	14-Sep-11	20:00	20:15	100	3	2.1	9.9	C	glide	Riprap	none	100
27	3	414470	5650841	14-Sep-11	23:07	23:20	100	3	0.6	10.7	C	glide	Gravel	Fines	2
28	3	414654	5650706	13-Sep-11	22:20	22:35	100	3	0.7	11	C	glide	Fines	Gravel	10
29	3	414945	5650812	18-Sep-11	20:10	20:20	100	3	1.8	9.7	C	glide	Riprap	Cobble	80
30	3	415103	5650666	18-Sep-11	20:25	20:35	100	3	2	9.7	C	glide	Riprap	Gravel	50
31	3	414814	5650451	18-Sep-11	19:40	19:50	100	3	1.2	9.7	C	glide	Fines	Gravel	12
32	3	415650	5650408	18-Sep-11	21:05	21:15	100	3	1.2	9.7	C	glide	Gravel	Fines	12
33	3	415720	5650203	18-Sep-11	21:35	21:45	100	3	1.2	9.7	C	glide	Gravel	Fines	12
34	3	415673	5649842	18-Sep-11	22:05	22:16	100	3	2	9.7	C	glide	Riprap	Gravel	120
35	3	415474	5649584	18-Sep-11	22:45	22:55	100	3	3	9.4	C	glide	Riprap	none	150
36	3	414940	5649320	18-Sep-11	23:00	23:12	100	3	1.5	9.4	C	reservoir	Gravel	Fines	4
37	3	415203	5649178	19-Sep-11	0:33	0:40	100	3	1	9.4	C	reservoir	Fines	none	1
38	3	414793	5649081	18-Sep-11	23:35	23:45	100	3	1.5	9.4	C	reservoir	Fines	none	1
39	3	415029	5648855	18-Sep-11	23:55	0:05	100	3	1	9.4	C	reservoir	Cobble	Fines	10
40	2	415198	5646433	16-Sep-11	23:37	23:47	100	3	2.1	12.4	C	reservoir	Fines	Gravel	2
41	2	415154	5645253	16-Sep-11	23:19	23:29	100	3	2.2	12.4	C	reservoir	Fines	none	2
42	2	415831	5644909	16-Sep-11	22:51	23:00	100	3	2.1	12.4	C	reservoir	Fines	Gravel	2

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	417033	5643927	16-Sep-11	22:32	22:43	100	3	2.1	12.4	C	reservoir	Fines	Gravel	2
44	2	417611	5647638	16-Sep-11	21:04	21:15	100	3	3.1	10.2	C	reservoir	Bed Rock	Boulder	400
45	2	418630	5640634	16-Sep-11	20:45	20:56	100	3	2	10.2	C	reservoir	Fines	Gravel	2
46	2	418682	5639494	16-Sep-11	20:00	20:19	100	3	3	10.2	C	reservoir	Fines	Bed Rock	100
47	2	419493	5637900	16-Sep-11	19:47	19:58	100	3	2.1	10.2	C	reservoir	Bed Rock	Boulder	100
48	2	420789	5634793	19-Sep-11	21:58	22:08	100	3	3	10	C	reservoir	Bed Rock	Boulder	200
51	2	425145	5632275	19-Sep-11	21:30	21:40	100	3	2.5	10.2	C	reservoir	Bed Rock	Boulder	200
52	1	426535	5629120	19-Sep-11	20:44	20:52	100	3	2.1	10.1	C	reservoir	Bed Rock	Boulder	500
54	1	426765	5629332	19-Sep-11	20:33	20:40	100	3	1.2	10.1	C	reservoir	Fines	none	1
55	1	428920	5628644	19-Sep-11	19:51	20:02	100	3	3	10.1	C	reservoir	Bed Rock	Fines	100
56	1	428853	5626963	19-Sep-11	19:38	19:44	100	3	1.5	10.1	C	reservoir	Fines	Gravel	2
Biased 1	4	414713	5654284	15-Sep-11	21:30	21:40	100	3	1	9.5	C	glide	Cobble	Gravel	40
Biased 2	4	414744	5653991	15-Sep-11	23:00	23:10	100	3	1.2	9.5	C	glide	Cobble	Gravel	45
Biased 3	4	414987	5653580	15-Sep-11	23:50	23:57	100	3	2	9.5	C	glide	Bed Rock	Cobble	120
Biased 4	4	415160	5653374	17-Sep-11	19:41	19:52	100	3	2	9.7	C	glide	Boulder	Cobble	50
Biased 5	4	414230	5652090	17-Sep-11	23:15	23:25	100	3	0.8	9.7	C	glide	Cobble	Boulder	15
Biased 6	4	413873	5652007	18-Sep-11	0:06	0:13	100	3	1	9.7	C	glide	Cobble	Gravel	12
Biased 7	4	413510	5651597	20-Sep-11	20:40	20:47	100	3	3	9.6	C	glide	Riprap	none	50
Drimmie d/s		422476	5634818	18-Sep-11	22:38	22:44	50	3	3	9.9	C	reservoir	Fines	Gravel	3
Illecill d/s		415579	5648411	17-Sep-11	0:12	0:19	50	3	1.5	9.7	M	glide	Fines	Gravel	5
Illecill u/s		416886	5648618	13-Sep-11	20:05	20:14	50	3	1.5	11.6	L	glide	Cobble	Gravel	30

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												
Jordan d/s		413183	5651593	20-Sep-11	21:11	21:19	50	3	2	8.7	C	glide	Riprap	none	100
Jordan u/s		413169	5651919	13-Sep-11	21:30	21:41	50	3	0.4	12.1	C	riffle	Cobble	Boulder	30
Tonk d/s		414463	5648810	17-Sep-11	0:32	0:39	50	3	2	10.8	C	glide	Fines	none	3
Tonk u/s		413980	5649599	13-Sep-11	20:56	21:00	50	3	1.2	12	C	riffle	Gravel	Fines	8

Appendix 4

Habitat Summary Information

Appendix 4a. Habitat summary information for the May 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 meters 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	27-May-11	0	0.45	0.82	0	0.01	0.13	0	70	20	10	0	0	0	0.4	1.05	0	0.38	0.45	0	60	35	5	0	0
2	4	28-May-11	0	0.42	1	0	0.03	0.3	0	15	80	5	0	0	0	0.6	0.93	0	0.15	0.31	0	10	85	5	0	0
3	4	28-May-11	0	0.51	0.97	0	0	0	0	80	15	5	0	0	0	0.67	1.2	0	0.14	0.44	0	50	40	10	0	0
4	4	28-May-11	0	0.37	0.79	0	0.02	0.2	0	10	70	20	0	0	0	0.35	0.57	0	0.24	0.2	0	20	70	10	0	0
5	4	28-May-11	0	0.46	0.75	0	1.24	0.36	0	35	60	5	0	0	0	0.37	0.6	0	0.07	0.23	0	70	25	5	0	0
6	4	28-May-11	0	0.62	1.32	0	0	0.08	0	25	70	5	0	0	0	0.5	1.04	0	0	0.16	0	60	35	5	0	0
7	4	29-May-11	0	0.22	0.4	0	0	0.12	0	70	25	5	0	0	0	0.23	0.53	0	0.19	0.26	0	70	25	5	0	0
8	4	29-May-11	0	0.45	1.35	0	0	0.07	5	0	0	45	50	0	0	0.56	0.9	0	0.13	0.28	0	0	10	60	30	0
9	4	29-May-11	0	0.54	0.82	0	0	0	0	20	70	10	0	0	0	0.27	0.4	0	0	0	5	80	15	0	0	0
10	4	29-May-11	0.5	1.08	2.3	0	0.1	0.22	0	0	0	10	90	0	0.5	0.95	2.21	0	0.03	0.08	0	0	0	0	100	0
11	4	29-May-11	0	1.07	2.05	0	0	0	0	0	0	5	95	0	0	0.38	0.58	0	0	0	0	0	0	10	90	0
12	4	29-May-11	0	1.7	0.24	0	0	0	0	70	20	10	0	0	0	0.68	1.04	0	0.44	0.56	0	70	25	5	0	0
13	4	27-May-11	0	0.52	0.76	0	0.27	0.52	0	30	70	0	0	0	0	0.48	0.89	0	0.33	0.43	0	70	30	0	0	0
14	4	29-May-11	0	0.58	1.21	0	0.23	0.24	0	30	70	0	0	0	0	0.66	1.6	0	0.19	0.61	0	60	35	5	0	0
15	4	28-May-11	0	1.26	1.9	0	0.83	0.9	0	40	60	0	0	0	0	0.5	1.55	0	0.2	0.47	0	70	30	0	0	0
16	4	29-May-11	0	0.87	1.8	0	0.03	0.05	0	0	0	0	0	100	0	0.65	0.72	0	0.07	0.31	0	0	0	0	0	100
17	4	30-May-11	0	0.28	0.58	0	0	0.09	0	90	10	0	0	0	0	0.39	0.59	0	0	0.08	0	70	30	0	0	0
18	4	29-May-11	0	0.9	1.22	0	0.01	0.44	0	0	0	0	0	100	0	0.76	1.5	0	0.05	0.02	0	0	0	0	0	100
19	3	30-May-11	0	0.35	0.45	0	0	0	0	30	60	10	0	0	0	0.36	0.46	0	0.11	0.14	0	20	60	20	0	0
20	3	27-May-11	0	0.4	0.65	0	0	0	100	0	0	0	0	0	0	0.18	0.23	0	0.2	0.18	0	30	60	10	0	0
21	3	27-May-11	0	0.78	1.34	0	0.16	0.23	0	5	5	60	0	60	0	1.02	1.9	0	0.07	0.45	0	0	0	10	90	0
22	3	27-May-11	0	0.3	0.75	0	0.01	0.18	10	70	20	0	0	0	0	0.7	1	0	0	1.11	10	50	40	0	0	0
23	3	26-May-11	0	0.58	1.07	0	0.07	0.09	10	60	30	0	0	0	0	0.55	1.01	0	0.1	0.15	60	35	5	0	0	0
24	3	27-May-11	0	0.32	0.4	0	0.71	0.8	0	30	70	0	0	0	0	0.29	0.44	0	0.39	0.65	0	70	30	0	0	0
25	3	27-May-11	0	0.19	0.3	0	0	0	0	100	0	0	0	0	0	0.25	0.34	0	0.13	0.12	0	40	60	0	0	0
26	3	26-May-11	0	0.64	1.38	0	0.03	0.11	0	0	0	0	0	100	0	0.72	1.07	0	0.25	0.41	0	20	10	0	0	70

			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	03-Jun-11	0	0.18	0.18	0	0	0.01	0	80	15	5	0	0	0	0.61	0.47	0	0	0	10	80	10	0	0	0
28	3	03-Jun-11	0	0.58	0.71	0	0.15	0.22	0	90	10	0	0	0	0	0.25	0.45	0	0.03	0.15	10	65	20	5	0	0
29	3	30-May-11	0	1	2.25	0	0.84	1.07	0	0	0	0	0	100	0	0.67	1.85	0	0.4	0.73	0	0	0	0	0	100
30	3	30-May-11	0	0.5	1.05	0	0.15	0.07	0	10	80	10	0	0	0	1.07	2.3	0	0.06	0.41	0	0	0	0	0	100
31	3	31-May-11	0	0.27	0.36	0	0.22	0.21	0	95	5	0	0	0	0	0.2	0.5	0	0.25	0.56	0	70	30	0	0	0
32	3	31-May-11	0	0.85	1.5	0	0.09	0.26	0	90	10	0	0	0	0	0.55	1.06	0	0	0.07	50	40	10	0	0	0
33	3	31-May-11	0	0.82	1.48	0	0.18	0.31	10	85	5	0	0	0	0	0.69	1.45	0	0.07	0.23	0	30	70	0	0	0
34	3	31-May-11	0	0.91	3	0	0.05	0.15	0	0	0	0	0	100	0	0.59	1.07	0	0	0.03	0	80	20	0	0	0
35	3	01-Jun-11	0	0.76	1.55	0	0.13	0.21	0	0	0	0	0	100	0	0.71	1.48	0	0.07	0.08		0	0	0	0	100
36	3	01-Jun-11	0	0.3	0.31	0	0	0	0	90	10	0	0	0	0	0.25	0.65	0	0	0	90	5	5	0	0	0
37	3	01-Jun-11	0	0.29	0.61	0	0	0.06	60	30	10	0	0	0	1	1.07	1.8	0	0	0	9	10	0	0	0	0
38	3	02-Jun-11	0	0.36	0.43	0	0	0.18	50	40	10	0	0	0	0	0.41	0.68	0	0	0.01	80	20	0	0	0	0
39	3	01-Jun-11	0	0.3	0.57	0	0	0	0	20	70	10	0	0	0	0.39	0.69	0	0	0	0	10	90	0	0	0
40	2	03-Jun-11	0	0.41	1.1	0	0.09	0.32	0	60	40	0	0	0	0	0.39	1.05	0	0.1	0.18	0	90	10	0	0	0
41	2	03-Jun-11	0	0.56	1	0	0	0	0	80	20	0	0	0	0	0.55	1.22	0	0	0	0	10	60	30	0	0
42	2	02-Jun-11	0	0.3	0.55	0	0	0	70	30	0	0	0	0	0	0.18	0.35	0	0	0	60	40	0	0	0	0
43	2	02-Jun-11	0	0.32	0.56	0	0	0	100	0	0	0	0	0	0	0.31	0.5	0	0	0	100	0	0	0	0	0
44	2	02-Jun-11	0	3	4.5	0	0.01	0.01	0	0	0	20	80	0	0	0.75	1.81	0	0.08	0	0	0	0	0	100	0
45	2	02-Jun-11	0	0.31	0.61	0	0	0	50	40	10	0	0	0	0	0.31	0.6	0	0	0	80	20	0	0	0	0
46	2	02-Jun-11	0	0.5	0.66	0	0	0	100	0	0	0	0	0	0	0.79	0.87	0	0	0	0	0	0	0	100	0
47	2	01-Jun-11	0	1.22	2.2	0	0.1	0.01	0	0	30	40	30	0	0	0.84	1.57	0	0	0	0	50	15	40	40	0
48	2	31-May-11	0	0.7	0.91	0	0	0	0	30	70	0	0	0	0	0.68	4.3	0	0	0	0	0	0	0	100	0
49	2	31-May-11	0	0.39	0.75	0	0	0.08	100	0	0	0	0	0	0	0.2	0.38	0	0	0	100	0	0	0	0	0
50	2	31-May-11	0	0.25	0.35	0	0	0	100	0	0	0	0	0	0	0.51	0.58	0	0	0	100	0	0	0	0	0
51	2	31-May-11	0	0.55	1.25	0	0	0	0	10	70	20	0	0	0	0.7	1.17	0	0	0	0	10	70	20	0	0
52	1	30-May-11	0	0.68	1.65	0	0.02	0.01	10	0	10	80	0	0	0	0.66	1.7	0	0.01	0.06	0	0	20	80	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**
55	1	30-May-11	0	0.63	0.98	0	0	0	0	10	70	20	0	0	0	0.85	1.65	0	0	0	0	0	40	60	0	0
56	1	30-May-11	0	0.6	1	0	0	0	100	0	0	0	0	0	0	0.43	0.66	0	0	0	100	0	0	0	0	0
Biased 1	4	28-May-11	0	0.32	0.41	0	0	0	0	70	30	0	0	0	0	0.25	0.54	0	0.13	0.23	0	40	60	0	0	0
Biased 2	4	28-May-11	0	0.42	0.92	0	0	0	5	20	70	5	0	0	0	0.26	0.49	0	0	0	0	70	20	10	0	0
Biased 3	4	28-May-11	0	0.7	0.9	0	0.24	0.73	0	20	70	10	0	0	0	0.7	0.96	0	0.05	0.25	0	50	20	30	0	0
Biased 4	4	29-May-11	0	0.55	1.05	0	0.01	0.06	0	0	10	60	30	0	0	0.74	1.45	0	0.04	0.1	0	0	10	85	5	0
Biased 5	4	29-May-11	0	0.36	0.36	0	0	0	0	10	20	70	0	0	0	0.48	0.82	0	0	0	0	5	25	70	0	0
Biased 6	4	28-May-11	0	0.8	1.4	0	0.65	0.93	0	55	40	5	0	0	0	0.6	1.4	0	0.25	0.79	40	10	50	0	0	0
Biased 7	4	30-May-11	0	0.86	1.4	0	0	0	0	0	0	0	0	100	0	0.86	1.19	0	0	0.14	0	0	0	0	0	100
Begbie d/s		01-Jun-11	0	0.41	0.38	0	1.53	2.34	10	30	60	0	0	0	0	0.42	0.3	0	1.25	0.89	0	60	40	0	0	0
Begbie u/s		01-Jun-11	0	0.63	0.8	0	0.09	1.31	5	20	60	15	0	0	0	0.45	0.65	0	0.45	1.41	0	30	10	60	0	0
Dremmie d/s		31-May-11	0	0.33	0.15	0	0.45	0	45	50	5	0	0	0	0	0.3	0.62	0	0.03	0.33	70	30	0	0	0	0
Dremmie u/s		31-May-11	0	0.12		0	0.94		0	100	0	0	0	0	0	0.13	0	0	0.68	0	30	70	0	0	0	0
Illecill d/s		02-Jun-11	0	0.67	1.45	0	0.44	0.31	80	20	0	0	0	0	0	0.62	1.4	0	0.7	0.94	0	85	15	0	0	0
Illecill u/s		03-Jun-11	0	0.41	0.68	0	0.54	0.76	10	70	20	0	0	0	0	0.65	0.95	0	1.02	1.29	25	50	20	5	0	0
Jordan d/s		28-May-11	0.1	1.7	2.55	0	0.13	0.37	0	0	0	0	0	100	0	0.93	2.18	0	0	0.01	0	0	0	0	0	100
Jordan u/s		29-May-11	0	0.25	0.63	0	0.52	1.03	0	60	40	0	0	0	0	0.23	0.4	0	0.1	0.2	60	10	30	0	0	0
Tonk d/s		02-Jun-11	0	0.2	0.34	0	0.18	0.28	60	30	10	0	0	0	0	0.6	0.75	0	0.53	0.55	75	0	0	25	0	0
Tonk u/s		03-Jun-11	0	0.66	0.8	0	0.55	0.67	80	0	20	0	0	0	0	0.11	0.38	0	0.45	0.74	50	50	0	0	0	0

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

Appendix 4b. Habitat summary information for the July 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	20-Jul-11	0	0.48	0.71	0	0	0	40	40	10	10	0	0	0	0.6	0.91	0	0	0.2	40	50	10	0	0	0
2	4	20-Jul-11	0	0.25	0.5	0	0.05	0.3	10	30	60	0	0	0	0	0.25	0.5	0	0.05	0.3	30	10	40	10	0	0
3	4	20-Jul-11	0	0.55	1.2	0	0.1	0.25	10	60	30	0	0	0	0	0.7	1	0	0.25	0.35	20	40	40	0	0	0
4	4	20-Jul-11	0	0.62	1.15	0	0.12	0.25	10	40	40	10	0	0	0	0.74	1.23	0	0.26	0.35	10	20	50	20	0	0
5	4	21-Jul-11	0	0.25	0.4	0	0.05	0.15	10	70	20	0	0	0	0	0.25	0.4	0	0.05	0.15	10	70	20	0	0	0
6	4	21-Jul-11	0	0.3	0.65	0	0	0	20	30	50	0	0	0	0	0.3	0.65	0	0	0.05	0	40	60	0	0	0
7	4	21-Jul-11	0	0.23	0.4	0	0.02	0.05	10	60	30	0	0	0	0	0.2	0.4	0	0	0.02	5	70	25	0	0	0
8	4	25-Jul-11	0	0.59	1.15	0	0.15	0.18	0	0	20	60	20	0	0	0.94	1.25	0	0.16	0.2	0	10	20	50	20	0
9	4	25-Jul-11	0	0.55	0.94	0	0	0.09	10	20	60	10	0	0	0	0.46	1	0	0	0.1	0	20	70	10	0	0
10	4	25-Jul-11	0.05	3	5.5	0.03	0.92	0.95	0	0	0	0	100	0	0	1.15	1.85	0	0.09	0.08	0	0	0	0	100	0
11	4	25-Jul-11	0	0.64	1.1	0	0.3	0.56	10	20	20	40	10	0	0	0.35	0.62	0	0	0	0	10	20	10	60	0
12	4	25-Jul-11	0	0.87	1.58	0	0.03	0.23	30	20	40	10	0	0	0	0.35	0.69	0	0.15	0.2	40	20	60	10	0	0
13	4	26-Jul-11	0	0.3	0.84	0	0.21	0.2	0	30	70	0	0	0	0	0.5	0.98	0	0.13	0.35	10	40	40	10	0	0
14	4	26-Jul-11	0	0.7	1.41	0	0.12	0.17	10	40	40	10	0	0	0	0.44	1.39	0	0	0.15	20	30	40	10	0	0
15	4	26-Jul-11	0.5	1.1	1.58	0	0.17	0.38	10	50	40	0	0	0	0	0.55	1.35	0	0.1	0.2	10	50	40	0	0	0
16	4	26-Jul-11	0	0.74	2.01	0	0.03	0.16	0	0	0	0	0	100	0	1.06	1.71	0	0	0.14	0	0	20	0	0	80
17	4	26-Jul-11	0.55	0.75	0.81	0	0	0.04	90	10	0	0	0	0	0	0.65	0.75	0	0.12	0.42	80	10	10	0	0	0
18	4	26-Jul-11	0	0.7	2.47	0	0	0.22	0	0	0	0	0	100	0	0.93	1.75	0	0.16	0.21	0	0	20	0	0	80
19	3	19-Jul-11	0	0.32	0.52	0	0	0.08	30	40	30	0	0	0	0	0.3	0.3	0	0	0	20	70	10	0	0	0
20	3	19-Jul-11	0	0.91	1.47	0	0	0	0	0	0	0	0	100	0	1.2	1.55	0	0.01	0.07	0	0	0	0	0	100
21	3	19-Jul-11	0	1.5	2.25	0	0.04	0.03	0	0	0	25	5	70	0	0.84	1.28	0	0.23	0.29	0	0	0	40	60	0
22	3	19-Jul-11	0	0.65	1.39	0	0	0	55	45	0	0	0	0	0	0.8	1.65	0	0	0.05	50	40	10	0	0	0
23	3	19-Jul-11	0	1	1.81	0	0	0	35	65	0	0	0	0	0	0.9	1.55	0	0	0	35	65	0	0	0	0
24	3	20-Jul-11	0	0.51	0.72	0	0	0.04	20	50	30	0	0	0	0	0.4	0.82	0	0	0	20	50	30	0	0	0
25	3	20-Jul-11	0	0.27	0.45	0	0	0	10	40	50	0	0	0	0	0.86	1.27	0	0	0	10	40	50	0	0	0
26	3	21-Jul-11	0	0.44	1.08	0	0.07	0.17	0	0	0	0	0	100	0	1.21	1.9	0	0.08	0.07	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	21-Jul-11	0	0.65	1	0	0.01	0.03	95	5	0	0	0	0	0	0.35	0.6	0	0	0	90	5	5	0	0	0
28	3	21-Jul-11	0	1.15	2.05	0	0.02	0.08	100	0	0	0	0	0	0	1	1.3	0	0.01	0.02	100	0	0	0	0	0
29	3	27-Jul-11	0.75	3.5	4.2	0	0	0	10	10	50	30	0	0	1	1.5	2.03	0	0	0	0	10	20	20	0	50
30	3	27-Jul-11	0	1.32	2	0	0	0	10	0	0	0	0	90	0	0.65	1.4	0	0	0	0	0	0	0	0	100
31	3	21-Jul-11	0	0.35	0.9	0	0	0	100	0	0	0	0	0	0	0.4	1	0	0	0	90	5	5	0	0	0
32	3	22-Jul-11	0	1	1.95	0	0	0	100	0	0	0	0	0	0	0.51	1.05	0	0	0	90	10	0	0	0	0
33	3	22-Jul-11	0	1.2	2.2	0	0	0	90	10	0	0	0	0	0	1.3	2.25	0	0	0	80	10	10	0	0	0
34	3	22-Jul-11	0	0.75	1.26	0	0	0.02	0	20	20	0	0	60	0	1.15	1.7	0	0	0	60	10	10	0	0	20
35	3	22-Jul-11	0	1.13	2.3	0	0.02	0.04	0	0	0	0	0	100	0	0.78	2.6	0	0.01	0.02	0	0	10	20	0	70
36	3	23-Jul-11	1.48	1.74	0.7	0	0	0	100	0	0	0	0	0	0	0.54	1.03	0	0	0.01	90	10	0	0	0	0
37	3	23-Jul-11	0	0.5	0.51	0	0	0	100	0	0	0	0	0	0.65	0.82	0.96	0	0	0	100	0	0	0	0	0
38	3	23-Jul-11	1.79	0.44	3.2	0	0	0	80	10	10	0	0	0	0.67	0.84	1.14	0	0	0	100	0	0	0	0	0
39	3	22-Jul-11	0.46	1.11	1.32	0	0.01	0.01	70	20	10	0	0	0	0	0.65	0.85	0	0	0.01	70	20	10	0	0	0
40	2	22-Jul-11	1	1	1.85	0	0	0	90	10	0	0	0	0	1.55	1.75	2	0	0	0	80	10	10	0	0	0
41	2	25-Jul-11	3	3.7	3.5	0	0	0	100	0	0	0	0	0	0.47	3.5	5	0	0	0	100	0	0	0	0	0
42	2	25-Jul-11	1.7	1.79	1.92	0	0	0	100	0	0	0	0	0	1.55	1.58	1.79	0	0	0	100	0	0	0	0	0
44	2	24-Jul-11	0	0.98	2.11	0	0	0	0	0	0	10	90	0	0	1.22	1.19	0	0	0	0	0	0	10	90	0
46	2	24-Jul-11	0	0.95	2.24	0	0	0	0	0	0	0	100	0	0	0.45	0.95	0	0	0	0	0	0	20	80	0
47	2	24-Jul-11	0	1.35	2.5	0	0.03	0.04	0	0	0	10	90	0	0	0.73	1.42	0	0	0	0	0	30	10	60	0
48	2	24-Jul-11	0	0.39	0.4	0	0	0	10	20	60	10	0	0	0	0.47	0.95	0	0	0	10	20	20	30	20	0
51	2	23-Jul-11	0	0.68	1.5	0	0	0	10	0	10	20	60	0	0.05	0.94	1.95	0	0	0	0	0	0	50	50	0

Site	Reach	Date	Downstream Depth (m) 0 m	Downstream Depth (m) 1.5 m	Downstream Depth (m) 3 m	Downstream Velocity (m/s) 0 m	Downstream Velocity (m/s) 1.5 m	Downstream Velocity (m/s) 3 m	Downstream Substrate F	Downstream Substrate G	Downstream Substrate C	Downstream Substrate B	Downstream Substrate R	Downstream Substrate RR	Upstream Depth (m) 0 m	Upstream Depth (m) 1.5 m	Upstream Depth (m) 3 m	Upstream Velocity (m/s) 0 m	Upstream Velocity (m/s) 1.5 m	Upstream Velocity (m/s) 3 m	Upstream Substrate F	Upstream Substrate G	Upstream Substrate C	Upstream Substrate B	Upstream Substrate R	Upstream Substrate RR
Biased 1	4	21-Jul-11	0	0.25	0.65	0	0	0	60	30	10	0	0	0	0	0.3	0.5	0	0	0.3	0	100	0	0	0	0
Biased 2	4	21-Jul-11	0	0.6	1.25	0	0.04	0.11	5	15	70	10	0	0	0	0.36	0.56	0	0.02	0.02	10	20	60	10	0	0
Biased 3	4	21-Jul-11	0	0.3	0.45	0	0	0.05	10	10	30	50	0	0	0	0.42	0.6	0	0	0	10	30	40	20	0	0
Biased 4	4	25-Jul-11	0	0.63	0.97	0	0.08	0.29	10	0	30	60	0	0	0	0.74	1.21	0	0	0.02	10	0	10	50	30	0
Biased 5	4	26-Jul-11	0	0.42	0.5	0	0	0	0	0	50	50	0	0	0	0.32	0.91	0	0	0	10	0	40	50	0	0
Biased 6	4	26-Jul-11	1.7	1.86	1.89	0.41	0.58	0.63	20	40	40	0	0	0	1.45	1.68	1.87	0.52	0.55	0.62	60	20	20	0	0	0
Biased 7	4	27-Jul-11	0	1.19	1.86	0	0	0	0	0	20	0	0	80	0	0.7	2.47	0	0	0.22	0	0	0	0	0	100
Begbie d/s		24-Jul-11	0	0.3	0.4	0	0	0	5	70	25	0	0	0	0	1.08	1.55	0	0	0	5	45	50	0	0	0
Begbie u/s		24-Jul-11	0.25	0.82	1	0.19	0.76	0.9	0	20	60	20	0	0	0.15	0.42	0.48	0.01	0.32	0.75	0	30	60	10	0	0
Dremmie u/s		24-Jul-11	0	0.2	0.45	0	0.16	0.27	90	10	0	0	0	0	0.35	0.35	0.55	0.74	0.78	0.67	0	30	70	0	0	0
Illecill d/s		22-Jul-11	0	0.6	1.34	0	0	0	10	80	10	0	0	0	0	0.4	0.8	0	0	0	10	80	10	0	0	0
Illecill u/s		22-Jul-11	0	0.55	1.26	0	0.1	0.62	50	30	20	0	0	0	0	0.38	1.08	0	0.13	0.76	20	70	10	0	0	0
Jordan d/s		26-Jul-11	0.1	1.45	2.41	0	0.01	0.41	0	0	0	0	0	100	0	1	1.99	0	0	0.01	0	0	5	0	0	95
Jordan u/s		26-Jul-11	0	0.3	0.63	0	0	0.42	10	40	40	10	0	0	0	0.34	0.55	0	0	0.14	10	50	40	0	0	0
Tonk d/s		22-Jul-11	1.71	1.99	2.16	0	0	0	90	10	0	0	0	0	0	0.99	1.1	0	0	0	90	10	0	0	0	0
Tonk u/s		22-Jul-11	0	0.38	1.73	0	0	0.05	80	10	10	0	0	0	0	0.93	2.02	0	0	0.18	80	10	10	0	0	0

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

Appendix 4c. Habitat summary information for the September 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-11	0	0.46	0.78	0	0.22	0.54	0	10	70	20	0	0	0	0.75	1.04	0	0.29	0.57	0	10	70	20	0	0
2	4	15-Sep-11	0	0.67	0.93	0	0.3	0.49	0	10	60	30	0	0	0	0.45	0.54	0	0	0.08	0	70	15	15	0	0
3	4	15-Sep-11	0	0.57	0.64	0	0.04	0.1	0	70	20	10	0	0	0	0.8	0.94	0	0.26	0.43	0	30	60	10	0	0
4	4	15-Sep-11	0	0.84	0.7	0	0.14	0.05	0	20	50	30	0	0	0	0.68	0.77	0	0.37	0.49	0	10	50	40	0	0
5	4	15-Sep-11	0	0.8	101	0	0.65	0.63	0	20	60	20	0	0	0	0.72	0.87	0	0.23	0.33	0	30	50	20	0	0
6	4	15-Sep-11	0	0.83	1.15	0	0.03	0.05	0	30	60	10	0	0	0	1	1.3	0	0.19	0.37	0	30	60	10	0	0
7	4	15-Sep-11	0	0.46	0.68	0	0.22	0.32	0	70	20	10	0	0	0	0.27	0.55	0	0.01	0.09	0	70	20	10	0	0
8	4	17-Sep-11	0	0.36	0.9	0	0.1	0.19	0	0	10	60	30	0	0	0.41	0.79	0	0.14	0.28	0	10	10	40	40	0
9	4	17-Sep-11	0	0.46	0.7	0	0.07	0.01	0	30	50	20	0	0	0	0.24	0.46	0	0	0.14	0	100	0	0	0	0
10	4	17-Sep-11	0	2	3	0	0	0	0	0	0	20	80	0	0	2.5	4	0	0.23	0.45	0	0	0	10	90	0
11	4	17-Sep-11	0	0.88	1.03	0	0.22	0.68	0	0	30	40	30	0	0	0.66	1.12	0	0.04	0.11	0	10	20	40	30	0
12	4	17-Sep-11	0	0.45	0.94	0	0.23	0.24	0	30	40	30	0	0	0	0.25	0.46	0	0.16	0.17	0	50	40	10	0	0
13	4	17-Sep-11	0	0.81	1.05	0	0.05	0.08	0	20	60	20	0	0	0	0.49	0.9	0	0.4	0.34	0	45	45	10	0	0
14	4	17-Sep-11	0	0.7	1.05	0	0.13	0.2	0	40	40	20	0	0	0	0.74	1.19	0	0.44	0.4	0	20	50	30	0	0
15	4	17-Sep-11	0	0.71	0.95	0	0.25	0.4	0	20	50	30	0	0	0	0.53	0.87	0	0.06	0.28	0	40	40	20	0	0
16	4	18-Sep-11	0	0.76	1.32	0	0.12	0.29	0	0	0	0	0	100	0	0.61	0.83	0	0.05	0.31	0	0	0	0	0	100
17	4	20-Sep-11	0	0.38	0.6	0	0	0.03	30	40	30	0	0	0	0.21	0.37	0.39	0	0.01	0.02	20	40	40	0	0	0
18	4	20-Sep-11	0	0.83	1.05	0	0.19	0.32	0	0	0	0	0	100	0	0.96	1.2	0	0.31	0.36	0	0	0	0	0	100
19	3	14-Sep-11	0.37	0.39	0.44	0.18	0.2	0.15	0	90	10	0	0	0	0.33	0.45	0.4	0.04	0.07	0.07	0	70	30	0	0	0
20	3	14-Sep-11	0	0.32	0.57	0	0	0	100	0	0	0	0	0	0.33	0.45	0.47	0.08	0.07	0.23	5	20	75	0	0	0
21	3	14-Sep-11	0	0.85	1.25	0	0.15	0.1	0	0	10	30	60	0	0	0.93	1	0	0.06	0.32	0	0	0	0	100	0
22	3	14-Sep-11	0	0.45	0.8	0	0.01	0.01	20	40	40	0	0	0	0	0.52	1	0	0.12	0.22	60	30	10	0	0	0
23	3	14-Sep-11	0	0.75	0.9	0	0.02	0.06	30	40	30	0	0	0	0	0.6	0.9	0	0	0	60	30	10	0	0	0
24	3	14-Sep-11	0	0.32	0.4	0	0.05	0.06	0	90	5	5	0	0	0	0.35	0.61	0	0	0.02	10	20	30	40	0	0
25	3	15-Sep-11	0	0.5	0.55	0	0.01	0.03	0	25	50	25	0	0	0	0.32	0.45	0	0	0.02	0	10	65	25	0	0
26	3	14-Sep-11	0	0.65	1.5	0	0.04	0.01	0	0	0	0	0	100	0	0.75	1.2	0	0.11	0.09	0	0	10	10	0	80

			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	14-Sep-11	0	0.25	0.33	0	0.06	0.1	40	60	0	0	0	0	0	0.26	0.51	0	0	0	10	90	0	0	0	0
28	3	13-Sep-11	0	0.17	0.42	0	0.06	0.18	40	60	0	0	0	0	0	0.31	0.59	0	0	0	60	40	0	0	0	0
29	3	18-Sep-11	0	1.11	1.32	0	0.38	0.38	0	10	60	20	0	10	0	1.3	1.2	0	0.35	0.74	0	0	10	10	0	80
30	3	18-Sep-11	0	0.7	1.2	0	0.15	0.01	0	0	0	0	0	100	0	1.07	1.32	0	0.08	0.2	0	0	0	10	0	90
31	3	18-Sep-11	0	0.5	0.97	0	0.15	0.21	80	15	5	0	0	0	0	0.68	1	0	0.21	0.25	10	70	20	0	0	0
32	3	18-Sep-11	0	0.6	0.76	0	0	0	40	50	10	0	0	0	0	0.8	1	0	0	0	80	20	0	0	0	0
33	3	18-Sep-11	0	0.8	1.3	0	0	0.03	10	90	0	0	0	0	0	0.5	0.9	0	0	0.07	10	90	0	0	0	0
34	3	18-Sep-11	0	1.2	1.6	0	0	0.06	0	5	0	0	0	95	0	0.64	1.04	0	0	0	30	50	10	0	0	10
35	3	18-Sep-11	0	1.14	3	0	0.06	0.2	0	0	0	0	0	100	0	0.9	1.5	0	0	0.11	0	0	0	0	0	100
36	3	18-Sep-11	0	1.37	1.45	0	0.03	0.09	100	0	0	0	0	0	0	0.45	0.65	0	0.07	0.05	20	80	0	0	0	0
37	3	19-Sep-11	0	0.68	0.8	0	0	0	100	0	0	0	0	0	0	0.45	0.7	0	0	0	100	0	0	0	0	0
38	3	18-Sep-11	0	0.9	1.3	0	0	0.03	100	0	0	0	0	0	0	1.06	1.35	0	0	0.05	100	0	0	0	0	0
39	3	18-Sep-11	0	0.6	0.77	0	0	0.11	10	40	40	10	0	0	0	0.64	0.87	0	0	0	10	10	80	0	0	0
40	2	16-Sep-11	0.4	0.6	0.85	0	0	0	100	0	0	0	0	0	0	0.44	0.88	0	0	0	100	0	0	0	0	0
41	2	16-Sep-11	0	0.9	1.25	0	0	0	100	0	0	0	0	0	0	0.85	1.5	0	0	0	100	0	0	0	0	0
42	2	16-Sep-11	0.2	0.6	0.8	0	0	0	100	0	0	0	0	0	0.5	0.8	1.4	0	0	0.05	100	0	0	0	0	0
43	2	16-Sep-11	1	1.4	1.8	0	0	0	100	0	0	0	0	0	1	1.2	1.6	0	0	0	100	0	0	0	0	0
44	2	16-Sep-11	0	1.2	2.8	0	0	0	0	0	0	10	90	0	0	1.4	1.5	0	0	0	0	0	0	10	90	0
45	2	16-Sep-11	0.8	1.2	1.6	0	0	0	100	0	0	0	0	0	0.85	1.1	1.5	0	0	0	100	0	0	0	0	0
46	2	16-Sep-11	1	1.2	2	0	0	0	100	0	0	0	0	0	0	0.4	0.65	0	0	0	70	0	10	5	15	0
47	2	16-Sep-11	0	1.2	1.8	0	0	0	0	0	0	0	100	0	0	0.75	1.3	0	0	0	0	5	5	20	70	0
48	2	19-Sep-11	0	0.62	0.9	0	0	0	0	0	0	10	90	0	0	0.85	1.7	0	0	0	0	0	30	60	10	0
51	2	19-Sep-11	0	1.3	2.6	0	0	0	0	0	0	0	100	0	0	1.2	2.1	0	0	0	0	0	0	0	100	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**
55	1	19-Sep-11	0	0.56	1.12	0	0	0	50	5	30	10	5	0	0	0.67	1.16	0	0	0	0	0	5	5	90	0
56	1	19-Sep-11	0	0.53	1.05	0	0	0	100	0	0	0	0	0	0	0.56	0.75	0	0	0	100	0	0	0	0	0
Biased 1	4	15-Sep-11	0	0.51	0.67	0	0	0	10	60	30	0	0	0	0	0.52	0.64	0	0	0.01	5	90	5	0	0	0
Biased 2	4	15-Sep-11	0	0.85	1	0	0.09	0.13	0	50	30	20	0	0	0	0.47	0.74	0	0	0.14	0	40	40	20	0	0
Biased 3	4	15-Sep-11	0	1.31	1.45	0	0.13	0.14	0	10	40	50	0	0	0	0.4	0.64	0	0.14	0.2	0	10	30	60	0	0
Biased 4	4	17-Sep-11	0	0.87	0.97	0	0.59	0.33	0	0	10	90	0	0	0	0.55	0.97	0	0	0.05	0	10	40	50	10	0
Biased 5	4	17-Sep-11	0.45	0.54	0.63	0.33	0.21	0.21	0	40	40	20	0	0	0	0.37	0.65	0	0	0	0	20	40	40	0	0
Biased 6	4	18-Sep-11	0.65	0.5	0.75	0.69	0.69	1	0	40	60	0	0	0	0	0.4	0.45	0	0.24	0.28	0	45	50	5	0	0
Biased 7	4	20-Sep-11	0	0.9	1.31	0	0.08	0.15	0	0	0	0	0	100	0	1.4	3	0	0.22	0.17	0	0	0	0	0	100
Begbie d/s		16-Sep-11	0	0.47	0.8	0	0	0.01	70	30	0	0	0	0	0	0.21	0.35	0	0.59	0.76	5	70	10	15	0	0
Begbie u/s		16-Sep-11	0	0.25	0.41	0	0.21	0.83	0	10	20	70	0	0	0	0.45	0.6	0	0.52	1.33	0	10	20	60	10	0
Drimmie d/s		18-Sep-11	1.4	1.6	2	0	0	0	100	0	0	0	0	0	0	1.5	3	0	0	0	60	40	0	0	0	0
Illecill d/s		17-Sep-11	0	0.52	0.8	0	0.05	0.12	60	40	0	0	0	0	0	0.9	1.15	0	0.15	0.21	80	20	0	0	0	0
Illecill u/s		13-Sep-11	0	0.6	75	0	0.3	0.43	10	30	60	0	0	0	0	0.63	0.8	0	0.33	0.53	10	30	60	0	0	0
Jordan d/s		20-Sep-11	0	0.87	2.5	0	0.01	0.01	0	0	0	0	0	100	0	0.84	2.5	0	0.01	0.02	0	0	0	0	0	100
Jordan u/s		13-Sep-11	0	0.2	0.3	0	0.13	0.37	0	5	80	15	0	0	0	0.11	0.06	0	0	0	0	5	80	15	0	0
Tonk d/s		17-Sep-11	0	1.46	2	0	0	0.02	100	0	0	0	0	0	0	1.47	1.7	0	0	0	100	0	0	0	0	0
Tonk u/s		13-Sep-11	0	0.37	0.5	0	0.04	0.23	20	75	5	0	0	0												

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 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	CSU A	CSU J	COTT A	COTT J
1	4	27-May-11	278				0	2		2	3						0	1									
2	4	28-May-11	353														0	3								2	3
3	4	28-May-11	314					0	1																	1	2
4	4	28-May-11	292															4	2							2	4
5	4	28-May-11	343					0	3	0	1							5	1							10	5
6	4	28-May-11	307					0	2	0	1							10	2					0	1		
7	4	29-May-11	320		0	1		0	2	0	1			0	1			1	1							1	1
8	4	29-May-11	282		0	1			1	6	1	0	1		1	5	4	1								2	1
9	4	29-May-11	273							0	4	0	1				1	2	1							3	2
10	4	29-May-11	323		0	4				4	4	0	8		0	3	0	3								5	
11	4	29-May-11	342		0	1				6	1	0	4		0	6	0	6								5	3
12	4	29-May-11	245														0	1							0	1	
13	4	27-May-11	326											0	1		0	7							0	4	
14	4	29-May-11	293							0	2						0	2							0	2	
15	4	28-May-11	371													0	1										
16	4	29-May-11	329						0	1					0	5	0	1									
17	4	30-May-11	231																								
18	4	29-May-11	373						0	1		0	2		1	13	1	4								3	2
19	3	30-May-11	286			0	1																				
20	3	27-May-11	301							1	2																
21	3	27-May-11	332	1						0	1				1	2	0	2									
22	3	27-May-11	332						0	1					3	12	7	1									
23	3	26-May-11	326													18	13										
24	3	27-May-11	257																								
25	3	27-May-11	329		0	1				1	11																
26	3	26-May-11	259			1	2					0	2		3	7											
27	3	03-Jun-11	470																								
28	3	03-Jun-11	390			0	3							0	2		0	2									
29	3	30-May-11	283						0	1				0	4		0	2	0	1					1	7	
30	3	30-May-11	279							2	2				7	1	0	4							0	10	
31	3	31-May-11	293							0	2										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	LSU A	LSU J	PCC A	PCC J	EB A	EB J	CSU A	CSU J	COTT A	COTT J	PW A	PW J
32	3	31-May-11	331						0	8					3	12	7	2	1											2	2		
33	3	31-May-11	281													2	1	6												10	30		
34	3	31-May-11	313			0	1								4	14	2	5									0		0	5			
35	3	01-Jun-11	261	1		0	1		0	1		0	1		8	1	0	7				0	1							10	3		
36	3	01-Jun-11	272	1	0	1				1	4						0	1											0	4			
37	3	01-Jun-11	232							1	1				1	9	5	2								0	1						
38	3	02-Jun-11	269							4	7																						
39	3	01-Jun-11	239							1	1				1	3	1	6	1	1										3	2		
40	2	03-Jun-11	179							0	2											0	1										
41	2	03-Jun-11	269							0	1						0	3	0	4										10	3		
42	2	02-Jun-11	282							0	3	0	5			5	1	3	0	2		0	1	0	15								
43	2	02-Jun-11	280							0	1				0	5		7	1	2				0	5				0	3			
44	2	02-Jun-11	373			0	1					0	4		2	77	16	1															
45	2	02-Jun-11	293									0	1			6	1	0	1					0	4								
46	2	02-Jun-11	353									0	1			3	1	10	0	2													
47	2	01-Jun-11	341	1		0	4						10	1	4	31	3	1				0	2										
48	2	31-May-11	270			0	1			1	2	0	2		1	135	111												0	5			
49	2	31-May-11	228					1	1	0	12				0	1	0	15											1	5			
50	2	31-May-11	235							1	1						0	5									0	2		15	6		
51	2	31-May-11	250												1	163	20						0	2					0	2			
52	1	30-May-11	311						0	1		0	4			51	41						0	1									
53	1	30-May-11	210							1	20						0	1					0	3							0	3	
54	1	30-May-11	210			0	1			0	2						1	6					0	6					0	5	0	5	
Bi 1	4	28-May-11	369						2	1	4																			2	2		
Bi 2	4	28-May-11	325														0	2												0	30		
Bi 3	4	28-May-11	317														0	3															
Bi 4	4	29-May-11	290				1	1		4	1	0	1		3	6	2	4				0	1						1	10	10		
Bi 5	4	29-May-11	301							5	10				0	1		0	1														
Bi 6	4	28-May-11	266					0	1	0	1																						
Bi 7	4	30-May-11	288			0	2					0	3		0	11	0	4															

Site	Reach	Date	EF sec.	BT A	BT J	MW A	MW J	RB A	RB J	CAS A	CAS J	CCG A	CCG J	EB A	EB J	CSU A	CSU J	COTT A	COTT J
Begbie d/s		01-Jun-11	150	0	2			0	5		0	2							
Begbie u/s		01-Jun-11	268					0	7			0	5						
Dremmie d/s		31-May-11	214	0	1			0	7										
Dremmie u/s		31-May-11	146																
Illecill d/s		02-Jun-11	137	1													0	1	
Illecill u/s		03-Jun-11	288			0	2		1	1	1	1	2						
Jordan d/s		28-May-11	179					0	1	0	1							1	1
Jordan u/s		29-May-11	361						0	1									
Tonk d/s		02-Jun-11	328	0	2				4	11	2						0	3	
Tonk u/s		03-Jun-11	281			0	1	0	15						2	1			

BB = burbot
NSC = northern pikeminnow
CCG = slimy sculpin
CSU = largescale sucker
BT = bull trout
RB = rainbow trout
LSU = longnose sucker
COTT = sculpin (general)
KO = kokanee
RSC = redside shiner
PCC = peamouth chub
PW = pygmy whitefish
MW = mountain whitefish
CAS = prickly sculpin
EB = brook trout

A = adult
J = juvenile

Appendix 5b. Fish collection summary information for the July 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	EB A	EB J	CSU A	CSU J	COTT A	COTT J
1	4	20-Jul-11	337							0	4																						
2	4	20-Jul-11	332							1	2																						
3	4	20-Jul-11	314					3	1								0	1															
4	4	20-Jul-11	320			0	1										0	13													0	22	
5	4	21-Jul-11	320						1	1	3																				0	2	
6	4	21-Jul-11	308						1	2	2																						
7	4	21-Jul-11	291						7	1								3	2	1												0	3
8	4	25-Jul-11	297			0	1		1	9	15		0	1	0	1		2	1												0	15	
9	4	25-Jul-11	301			0	2		1	1	4			0	1			11	1													20	15
10	4	25-Jul-11	336		0	1				0	1				0	8		7	1													8	5
11	4	25-Jul-11	318		0	1		0	1	0	6			0	1			7	1						0	1						8	1
12	4	25-Jul-11	329					1	1	0	6			0	1			5	2													15	10
13	4	26-Jul-11	304							0	1							20	2						0	1						68	25
14	4	26-Jul-11	331						0	1				0	1		0	3									0					16	5
15	4	26-Jul-11	349			0	1			1	4			0	1																	5	3
16	4	26-Jul-11	299	1										0	1		0	10														3	1
17	4	26-Jul-11	286					0	39									0	1														
18	4	26-Jul-11	308											1	4		0	4														0	1
19	3	19-Jul-11	278					0	1	0	42							1	1													0	1
20	3	19-Jul-11	314					1	2								0	2				0	1		0	1					0	2	
21	3	19-Jul-11	330			0	2	0	1					1	1			11	1														
22	3	19-Jul-11	330						1	2	1			0	2			2	1									1	2			0	8
23	3	19-Jul-11	272		0	1			1	1				0	1		0	3													0	2	
24	3	20-Jul-11	249							0	2								0	1											0	2	
25	3	20-Jul-11	299					0	1	0	1						0	2													0	2	
26	3	21-Jul-11	347		0	1		0	4					1	4		0	4								1	1				0	1	
27	3	21-Jul-11	392			0	1	0	5	0	6						0	2															
28	3	21-Jul-11	350					0	1								0	1															
29	3	27-Jul-11	280							0	1			0	2		1	6													0	4	
30	3	27-Jul-11	298					0	1					0	2		0	2	0	1												2	1
31	3	21-Jul-11	333						2	1				0	1		0	2	0	1												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	LSU A	LSU J	PCC A	PCC J	TC A	TC J	EB A	EB J	CSU A	CSU J	COTT A	COTT J
32	3	22-Jul-11	336		0	1								0	1		0	2	0	1	0	1											
33	3	22-Jul-11	312						4	1								3	1													2	2
34	3	22-Jul-11	339			0	2		5	1				0	7		1	4	0	2					0	2						0	2
35	3	22-Jul-11	314			0	2		1	1					11	1	0	3							0	3					0	2	
36	3	23-Jul-11	269			0	2	0	9	0	1						0	1														1	1
37	3	23-Jul-11	338			0	1	0	1								0	3											0	1		5	3
38	3	23-Jul-11	338							3	1	0	1						0	1												0	1
39	3	22-Jul-11	287		0	1				0	1						0	2		1	1				0	1						3	2
40	2	22-Jul-11	298					0	2												0	1							0	1			
41	2	25-Jul-11	276						0	3				0	1				0	1			0	1					1	1			
42	2	25-Jul-11	296		0	1				11	1										0	1											
44	2	24-Jul-11	330			0	2							0	8		0	6	0	2												3	2
46	2	24-Jul-11	250	0	1					0	1				0	2		0	1														
47	2	24-Jul-11	295											0	7		0	5														10	2
48	2	24-Jul-11	317							0	4							5	1	1			0	2								30	20
51	2	23-Jul-11	329							0	3			0	2		1	9													0	10	
52	1	23-Jul-11	307		0	1				1	4	1			0	2	0	1													0	6	
54	1	23-Jul-11	270							0	1						0	7					1	1								1	1
55	1	23-Jul-11	279							2	3			2	2		0	4											0	1			
56	1	23-Jul-11	280							0	4												0	5					0	2			
32	3	22-Jul-11	336		0	1								0	1		0	2	0	1	0	1											
33	3	22-Jul-11	312						4	1								3	1													2	2
Bi 1	4	21-Jul-11	359		0	1	0	2		1	16																						
Bi 2	4	21-Jul-11	267							0	3							6	2													10	12
Bi 3	4	21-Jul-11	294		0	1				0	4						0	6	0	1												4	4
Bi 4	4	25-Jul-11	289					0	4	0	2				0	1	0	10													0	15	
Bi 5	4	26-Jul-11	258			0	1			0	1							1	1	1												5	6
Bi 6	4	26-Jul-11	295							0	1																		0	4			
Bi 7	4	27-Jul-11	271	0	1				0	1								10	1								0	1				2	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	LSU A	LSU J	YP A	YP J	EB A	EB J	CSU A	CSU J	COTT A	COTT J
Begbie d/s		01-Jun-11	150			0	2							0	5				0	2											
Begbie u/s		01-Jun-11	268											0	7					0	5										
Dremmie d/s		31-May-11	214			0	1							0	7																
Dremmie u/s		31-May-11	146																												
Illecill d/s		02-Jun-11	137		0	1																							0	1	
Illecill u/s		03-Jun-11	288							0	2			0	1			1	1	1	2										
Jordan d/s		28-May-11	179											0	1			0	1											1	1
Jordan u/s		29-May-11	361														0	1													
Tonk d/s		02-Jun-11	328			0	2							0	4			11	2										0	3	
Tonk u/s		03-Jun-11	281							0	1			0	15												2	1			

BB = burbot
BT = bull trout
KO = kokanee
MW = mountain whitefish
NSC = northern pikeminnow
RB = rainbow trout
RSC = redside shiner
CAS = prickly sculpin
CCG = slimy sculpin
LSU = longnose sucker
PCC = peamouth chub
YP = yellow perch
TC = tench
EB = brook trout
CSU = largescale sucker
COTT = sculpin (general)

A = adult
J = juvenile

Appendix 5c. Fish collection summary information for the September 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	YP A	YP J	EB A	EB J	CSU A	CSU J	COTT A	COTT J	CP A	CP J
1	4	15-Sep-11	230				0	11		0	9																				0	5			
2	4	15-Sep-11	321					3	9								0	3														3	2		
3	4	15-Sep-11	307					3	2	0	6							5	3	1															
4	4	15-Sep-11	332		0	1	0	9		0	2						0	5													0	7	5		
5	4	15-Sep-11	327					2	7	2							0	1													0	6			
6	4	15-Sep-11	220					7	2								0	1													0	2			
7	4	15-Sep-11	371					8	3	0	6																				0	2			
8	4	17-Sep-11	337			1	3	1	1	0	4				0	2	0	1													0	5			
9	4	17-Sep-11	288					51	1						0	1																12	5		
10	4	17-Sep-11	390			7	3	19		1	1						0	2								0	1				0	15			
11	4	17-Sep-11	218					91	2								0	3														10	5		
12	4	17-Sep-11	268				1	22						0	1		0	10				0	1												0
13	4	17-Sep-11	310				0	29		0	1						0	5														20	8		
14	4	17-Sep-11	319				0	11						0	1		0	4													0	30			
15	4	17-Sep-11	297					37	1									7	1	1												50	20		
16	4	18-Sep-11	303	2	1		2	18							1	2	0	6													0	50			
17	4	20-Sep-11	318					0	4	0	1																								
18	4	20-Sep-11	307			1	1	13	2					0	1			15	4									0	1						
19	3	14-Sep-11	269					2	1	0	2						0	1																	
20	3	14-Sep-11	266		0	1		23	21	0	27						0	2														8	10		
21	3	14-Sep-11	274		0	3		60	12	12	9				3	1	0	1														12	5		
22	3	14-Sep-11	301			2	1	3	20	1	16			0	1			0	1								0	1				10	3		
23	3	14-Sep-11	260			1	1	4	3					0	1		0	6														20	10		
24	3	14-Sep-11	245					3	2	0	6								0	1		0	1								0	2			
25	3	15-Sep-11	288					0	1	0	3						0	1													0	5			
26	3	14-Sep-11	423					0	14	0	2			2	5		0	13			0	1			0	1						75	20		
27	3	14-Sep-11	531					0	2	0	7							4	1																
28	3	13-Sep-11	495					0	10					0	4			13	1	1												0	6		
29	3	18-Sep-11	368				2	8	2					0	1		1	22	2	3												10	5		
30	3	18-Sep-11	395				1	13	6	0	12				6	2		11	1	0	2					0	1					10	5		
31	3	18-Sep-11	294					23	6	0	13						1	1													0	2			

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	EB A	EB J	CSU A	CSU J	COTT A	COTT J	CP A	CP J
32	3	18-Sep-11	415				1	9	7	0	1				3	1		27	4	2												25	5		
33	3	18-Sep-11	410					10	6									28	11	6						0	1					15	20		
34	3	18-Sep-11	452	1			0	3							7	2		21	4	2						0	1		0	1		30	20		
35	3	18-Sep-11	404		1	2	1								6	5		14	1							0	1				0	28			
36	3	18-Sep-11	415					1	5	0	2				1	1		6	4							0	2					15	7		
37	3	19-Sep-11	386					1	22	0	15			0	4		2	8	2	3		0	1									20	15		
38	3	18-Sep-11	339					8	10	3	3				0	1		4	1							0	4					15	5		
39	3	18-Sep-11	346					0	10	0	6				0	1		13	2	1												15	10		
40	2	16-Sep-11	343			0	1	0	16	0	1															0	1					40	10		
41	2	16-Sep-11	353					0	3						4	1	0	25														75	30		
42	2	16-Sep-11	299						5	2	1						0	1											0	1	0	4			
43	2	16-Sep-11	323				0	7		0	2						0	3											0	1			0	1	
44	2	16-Sep-11	434			0	1								3	3		3	1	2	1											25	15		
45	2	16-Sep-11	334					0	2	0	4	0	1				0	1					0	1							1	5			
46	2	16-Sep-11	420			0	1			0	2			0	3			0	1										0	1		15	10		
47	2	16-Sep-11	370			0	2			0	1				3	2	1	7	2													20	15		
48	2	19-Sep-11	329												1	33	8	5											0			15	5		
51	2	19-Sep-11	315							0	2				3	80	31	1	1													30	20		
52	1	19-Sep-11	315									0	1		1	66	27	2													2	20	10		
54	1	19-Sep-11	285							0	7					11	1	15	5													10	3		
55	1	19-Sep-11	359				0	8		0	2	0	1		2	146	98	3	1				0	1							1	15	15		
56	1	19-Sep-11	319							0	5						0	1													0	2			
Bi 1	4	15-Sep-11	347		0	1		9	2	0	14																								
Bi 2	4	15-Sep-11	370					1	4								0	1													0	2			
Bi 3	4	15-Sep-11	355				0	11		0	4						0	4														16	5		
Bi 4	4	17-Sep-11	316			0	1	0	5	0	2														0	1						12	4		
Bi 5	4	17-Sep-11	256				0	4										3	2																
Bi 6	4	18-Sep-11	208				0	3									0	1																	
Bi 7	4	20-Sep-11	234	1		1	1										0	8																	

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	COTT A	COTT J
Begbie d/s		16-Sep-11	206	0	2							0	1		0	1								0	2
Begbie u/s		16-Sep-11	151	0	2							0	4					0	2					0	2
Drimmie d/s		18-Sep-11	251						0	1					0	1						0	1		
Illecill d/s		17-Sep-11	228				0	1							0	2									
Illecill u/s		13-Sep-11	293					0	1		0	1				5	5	0	1						
Jordan d/s		20-Sep-11	166										3	1	0	4									
Jordan u/s		13-Sep-11	307												0	2	0	2					0	2	

BB = burbot
NSC = northern pikeminnow
LSU = longnose sucker
CCG = slimy sculpin
BT = bull trout
RB = rainbow trout
PMC = peamouth chub
CSU = largescale sucker
KO = kokanee
RSC = redside shiner
YP = yellow perch
COTT = sculpin (general)
MW = mountain whitefish
CAS = prickly sculpin
EB = brook trout
CP = common carp

A = adult
J = juvenile

Appendix 6

Reporting requirements for the SARA permit obtained for the study

SARA Permit Reporting

A permit was issued under Section 73 of the Species at Risk Act (SARA) for activities associated with the Middle Columbia River Juvenile Fish Habitat Use project that had the potential to incidentally affect a listed species (white sturgeon).

Permit Number: SECT 08 SCI 026
Species: White Sturgeon

Reporting Contact: Courtney Druce
200-401 Burrard Stret
Vancouver, BC, V6C 3S4
Phone: (604) 666-2792
Email: Courtney.Druce@dfo-mpo.gc.ca

Duration of Permit: Valid until December 31, 2010
Date of Issue: May 14, 2008

Reporting Conditions: A comprehensive report must be filed detailing any activity, authorized by the permit, which results in killing, harming, harassing, capturing or taking of any individuals of the affected species. If the individuals were captured and are being held, indication must be provided as to where they are being held and what is planned for captured individuals.

2008 Reporting: Triton Environmental Consultants Ltd. is not aware of any activities that were conducted as part of the CLBMON-17 Middle Columbia River Juvenile Fish Habitat Use project during the 2010 field season that resulted in the killing, harming, harassing, capturing or taking of white sturgeon. White sturgeon (juvenile or otherwise) were not captured or observed during electrofishing or general boating activities associated with the project on the Middle Columbia River including the portions of the Arrow Lakes Reservoir within the study area.

Should you have any questions or require additional information, please contact me by phone (250 851-0023) or email (rliebe@triton-env.com).

Yours truly, **Triton Environmental Consultants Ltd.**

Ryan Liebe, R.P. Bio., CPESC
Kamloops Operations Manager