Bridge River Water Use Plan

Lower Bridge River Aquatic Monitoring

Implementation Year 1

Reference: BRGMON-1

2012 Annual Data Report

Study Period: January 1, 2012 – December 31, 2012

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July 31, 2013

Bridge-Seton Watershed

Lower Bridge River Aquatic Monitoring Program
2012 Annual Data Report

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1.0 EXECUTIVE SUMMARY

Historically, the Bridge River Valley was a thriving, productive river valley that harbored a rich and abundant diversity of aquatic and terrestrial life. This diversity contributed vast benefits to local and regional culture, society and the environment. These benefits were partially the result of interconnectedness between the headwaters of the Bridge River and the confluence of the Fraser River. In 1948, the interconnectedness was broken by the building of Mission Dam, and in 1960 the system was fully fragmented by the finalization of Terzaghi Dam.

Terzaghi dam blocked off all flow into the Lower Bridge River (LBR) between 1960 and 2000, converting approximately 4km of its uppermost reach from aquatic to terrestrial habitat. During this time period, the St’at’imc First Nation and the Bridge River Band and others raised environmental concerns about the lack of water released from Terzaghi Dam. To address these concerns, a long term monitoring program was designed that would test two main flow releases (Trials 1 and 2) against a zero-flow baseline scenario, which represented the previous 40 years. The zero flow was classified as a Pre-Trial baseline and data were collected from 1996-2000. Trial 1 was an annual water budget of 3 m^3s^{-1}, which was implemented from August 2000 to April 2011; Trial 2 is an annual water budget of 6

m^3s^{-1}, which was initiated in May 2011 and will be implemented for 4 years (until April, 2015).

Data from this monitoring program is used to inform the management of the Lower Bridge River flow regime, and a future water use decision. Following the flow trials, St'át'imc Nation, the Bridge River Band, BC Hydro, regulatory agencies and other stakeholders will work together to determine a long term flow release strategy for the LBR. A quantitative comparison of the two flow releases relative to the baseline will occur, with the optimal hydrograph being chosen. This process will begin in April, 2015. The existing LBR aquatic monitoring program is scheduled for an additional 6 years, however this is conditional on the outcome of an interim review). following the water use decision and implementation of the flow release strategy. In order to inform any management decisions, a suite of biotic and abiotic aquatic indicators were chosen and are explained in detail within this report.

The main purpose of the program in 2012 was to continue monitoring the influence of the flow release from Terzaghi Dam on fish resources and the aquatic environment in Reaches 2, 3 and 4 of the Lower Bridge River. Four monitoring activities were conducted as part of the monitoring program: 1) constant temperature and water stage recording; 2) water chemistry, aquatic invertebrate diversity and periphyton accrual during fall; 3) sampling to monitor juvenile salmonid growth; and 4) a fall standing stock assessment for fish distribution and relative abundance indices. In addition, a rampdown monitoring component was integrated into the Lower Bridge River Aquatic Monitoring Program during the summer and fall seasons.

The main findings from this year are consistent with past years in the flow trial experiment. Broadly, the continual water release from Carpenter Reservoir has altered the physical habitat and associated ecological, social and cultural benefits. Relative to pre-release (i.e., baseline) conditions, the seasonal temperature regime was modified, and the wetted area of the river was observed to be larger. Since the flow trial began, these effects were observed most acutely in the upper reaches (i.e., Reaches 3 and 4) and less in Reach 2 due to the influence of the Yalakom River inflows , groundwater and the differing channel morphology.

Specifically, water chemistry parameters for 2012 were similar to those reported in previous non-pink salmon spawning years (across the flow trials) and concentrations were within the water quality guidelines established by British Columbia. Periphyton accrual increased as the fall season progressed, and a sharp increase in periphyton biovolume was observed in November. The invasive algal species rock snot (*Didymosphenia geminate*) was prevalent within the LBR at this time and may explain this increase. An increase in aquatic invertebrate biodiversity during 2012 versus other study years suggests a flow regime change may have positively affected the invertebrate community structure.

The mean size of fish for each reach was analyzed during the late summer and fall seasons. Size was slightly smaller than 2011, but was overall similar to flow Trial 1 (for non-pink years). Fish density, relative abundance and spatial distribution derived from standing stock data followed similar patterns across the reaches in 2012 as during the previous flow trials. However, salmonid biomass was on the low side of the ranges observed within the 3 m^3s^{-1} and 6 m^3s^{-1} trials. Reach 4 had the highest biomass estimate for the eleventh consecutive year since the flow trials began. Reach 3 had a higher biomass estimate than Reach 2, but was lower than biomass estimates observed under baseline (no flow) conditions. This trend has also been observed since the flow trials began.

The reasons for these observed parameter changes and the differences between flow trials are varied and uncertain. However, they are likely influenced by the changed thermal regime of the river, habitat alterations due to differing flow regimes, and nutrient inputs from pink salmon spawners. In addition, there are certainly other influences upon the aquatic ecosystem that are outside the scope of this monitoring program.

2.0 INTRODUCTION

The Bridge River, a tributary of the middle Fraser River, is an important fish bearing river in Southern Interior British Columbia. While it was used historically as a major food source, today it is used for a variety of purposes including hydroelectric power. Traditionally, fish comprised 60% of the local diet (Kennedy and Bouchard, 1992). However, the benefits to society from this fish resource extended much farther than just as a source of food. This fishery was also integral to a complex trading network where salmon and salmon oil were highly prized and considered the foundation of commerce in the region. The health and productivity of the Bridge River aquatic ecosystem contributed to the rich fish resource and culture in St'at'imc territory. Overall, this resource generated significant benefits towards the health and well-being of the St'at'imc Nation and trading partners.

In 1960, the Bridge River was fully impounded by Terzaghi Dam (formally called Mission Dam), which was built at the head of a long, narrow canyon approximately 40 km. upstream of the confluence with the Fraser River. This impoundment created Carpenter Reservoir, which serves as a water source for hyrdropower production in the Seton watershed, and fragmented the Bridge River, creating a controlled lower section called the Lower Bridge River. Initially, all flow was diverted to Seton Lake for hydroelectricity, with the exception of infrequent high-water spillover events. Consequently, 4kms of the river directly below the dam were dewatered for 40 years (1960-2000). Downstream of the dewatered reach, groundwater and tributary influence created a flow less than 1% of the historic mean annual discharge upstream of the Yalakom River (Longe and Higgins, 2002).

Concerns were raised and discussed over the lack of water flowing in the Lower Bridge River by the St'at'imc, federal and provincial regulatory agencies, and the public. After discussions in the 1980s, an agreement was reached to continuously release water to provide fish habitat downstream of Terzaghi Dam. An adaptive management approach was used to develop an environmental monitoring program. This program gathers empirical data to inform the flow management of the LBR, and aims to generate a a better understanding of the effects of the introduction of water from Carpenter Reservoir on the aquatic ecosystem productivity and the ecosystem services, or benefits which the river generates, below the dam. A 3.0 m^3s^{-1} interim water budget, based on a hydrograph that ranged from a minimum of 2 m^3s^{-1} to a maximum 5 m^3s^{-1} was initially allocated for in-stream flow releases into the Lower Bridge River (LBR). Water was released on August 1, 2000 and continued at this level from August 2000 until spring 2011. Prior to this release, data were collected from 1996-2000, to provide baseline information on the pre-release ecosystem and the ecological services the river provided, and to facilitate measuring and comparing the response of the aquatic environment to different flow trials. Currently, a second test flow of 6.0 m^3s^{-1} is being implemented from 2011-2014.

This report was prepared to demonstrate compliance with conditions of the Water Use Plan (WUP) Order to release water and monitor the environmental impacts of the flow trial on the aquatic ecosystem. It is also used to describe data collection methods and to present results from 2012 under the 6.0 m^3s^{-1} flow trial (Trial 2), with the water budget hydrograph ranging from 1.5 m^3s^{-1} to 15 m^3s^{-1} on a seasonal basis. Ultimately, these data will be used to inform the management of the LBR. The present implementation of this aquatic monitoring program is part of the Bridge-Seton Water Use Plan. St'át'imc Eco- Resources (SER), an incorporated company owned by the St'át'imc Chiefs Council, has been contracted by BC Hydro to undertake this work. Subsequently, Coldstream Ecology, Ltd. has been subcontracted to implement the monitoring program. Detailed descriptions of past monitoring activities and results of past years can be found in Riley et al. (1997, 1998), Higgins and Korman (2000), Longe and Higgins (2002), Sneep and Higgins (2003, 2004), and Sneep and Hall (2005 to 2010).

2.1 Management Questions

This ecological monitoring program utilizes an adaptive management framework to address uncertainties about the expected benefits of releasing water from Carpenter Reservoir downstream of Terzaghi Dam. This lack of certainty constitutes a major impediment for decision-making. The water use decision in May of 2015 will have significant implications for important ecological resources and benefits derived from the Lower Bridge River, St'at'imc cultural values, and energy production. Consequently, the long-term monitoring program was designed to provide defensible data defining the functional relationship between the magnitude of flow releases, and physical and biological responses in the Lower Bridge River channel. As identified in the Water Use Plan Terms of Reference for this monitoring program, four key management questions that directly describe the uncertainties are:

1) How does the in-stream flow regime alter the physical conditions in aquatic and riparian habitats of the Lower Bridge River ecosystem?

2) How do differences in physical conditions in aquatic habitat resulting from the in-stream flow regime influence community composition and productivity of primary and secondary producers in the Lower Bridge River?

3) How do changes in physical conditions and trophic productivity resulting from flow changes together influence the recruitment of fish populations in the Lower Bridge River?

4) What is the appropriate 'shape' of the descending limb of the 6 m^3s^{-1} hydrograph, particularly from 15 m^3s^{-1} to 3 m^3s^{-1}?

Juvenile salmonid biomass is used as a primary criterion for examination and study because it is a highly valued ecological component of the aquatic ecosystem. In addition, it integrates the effects of flow on trophic productivity and habitat conditions in the LBR. The monitoring program was designed to test the following hypotheses regarding the ecological benefits and the effects of flow on the fish populations in Lower Bridge River:

H_O: "High flow is better"

H_A: "Low flow is better"

The data provided in this annual data report summarize the 2012 program. These data are part of a larger dataset (i.e., 1996-2012) which will address management questions 1-3 (above) during synthesis report preparation in 2015. At the conclusion of this flow Trial, the synthesis report will inform the key Water Use Plan decision in 2015. The decision will surround the magnitude of the long term flow regime (i.e., 0 vs. 3 vs. 6 m^3s^{-1}). The fourth question is being addressed by a ramp down monitoring component that was integrated into this WUP monitoring in 2012. Information collected from this component will inform the optimal "shape" of the hydrograph throughout annual ramp down activities.

2.2 Objectives and Scope

The Lower Bridge River aquatic ecosystem provides benefits to society and the environment. These benefits, are heavily influenced by the magnitude of the flow release from Terzaghi Dam. The primary objectives of this monitoring program are twofold: 1) to reduce uncertainty regarding the effects of the flow release on the relative aquatic productivity of the ecosystem and these benefits; and 2) to design a summer and fall ramp down strategy that reduces the risk of fish stranding while meeting environmental objectives. To this end, this program monitored the response of key biological and physical indicators to the test flows, and the results will be used to inform the long-term flow management of the river. Specifically, monitoring program activities continued to focus on:

1) water temperature, dam discharge, and river stage;
2) water chemistry parameters, periphyton accrual and diversity, and the relative abundance and diversity of aquatic invertebrates during the fall series; and
3) growth, distribution, and relative abundance of juvenile salmonids, especially coho salmon (*Oncorhynchus kisutch*), chinook salmon (*O. tshawytscha*), steelhead and rainbow trout[1] (*O. mykiss*), within the study area; and
4) summer and fall ramp down monitoring and salvage activities.

In future years, the scope will be guided by the outcome of the interim reviews in 2015.

2.3 Approach

The Lower Bridge River Aquatic Monitoring program has been implemented for nearly two decades (i.e. 1996-2012). As such, methodologies for each sampling component have been standardized to facilitate comparisons across flow trials.

2.4 Study Area

The Bridge River lies within the St'at'imc Territory, in Southern Interior British Columbia. The Lower Bridge River is the section between the confluence of the Fraser River and Terzaghi Dam. It is divided into 4 reaches, which are defined in Table 1 and illustrated in a map in Figure 1. In 2012, like previous years, data collection focused in Reaches 2, 3, and 4, i.e., between the mouth of Camoo Creek and Terzaghi Dam. Water chemistry data were also collected at the surface of Carpenter Reservoir, Mission Creek, Yankee Creek, Russell

[1] Throughout this report, juvenile O. mykiss are referred to as rainbow trout, although a large (but undefined) proportion of these fish in the LBR are anadromous steelhead.

Springs, Hell Creek, Michelmoon Creek, the Yalakom River, Antoine Creek, and Camoo Creek.

Table 1. Reach break designations and descriptions for the Lower Bridge River

Reach	Boundary (Rkm)		Description
	Downstream	Upstream	
1	0.0	20.0	Fraser River Confluence to Camoo Creek
2	20.0	25.5	Camoo Creek to Yalakom River confluence
3	25.5	36.8	Yalakom R. confluence to upper extent of groundwater in-flow
4	36.8	40.9	Upper extent of groundwater in-flow to Terzaghi Dam

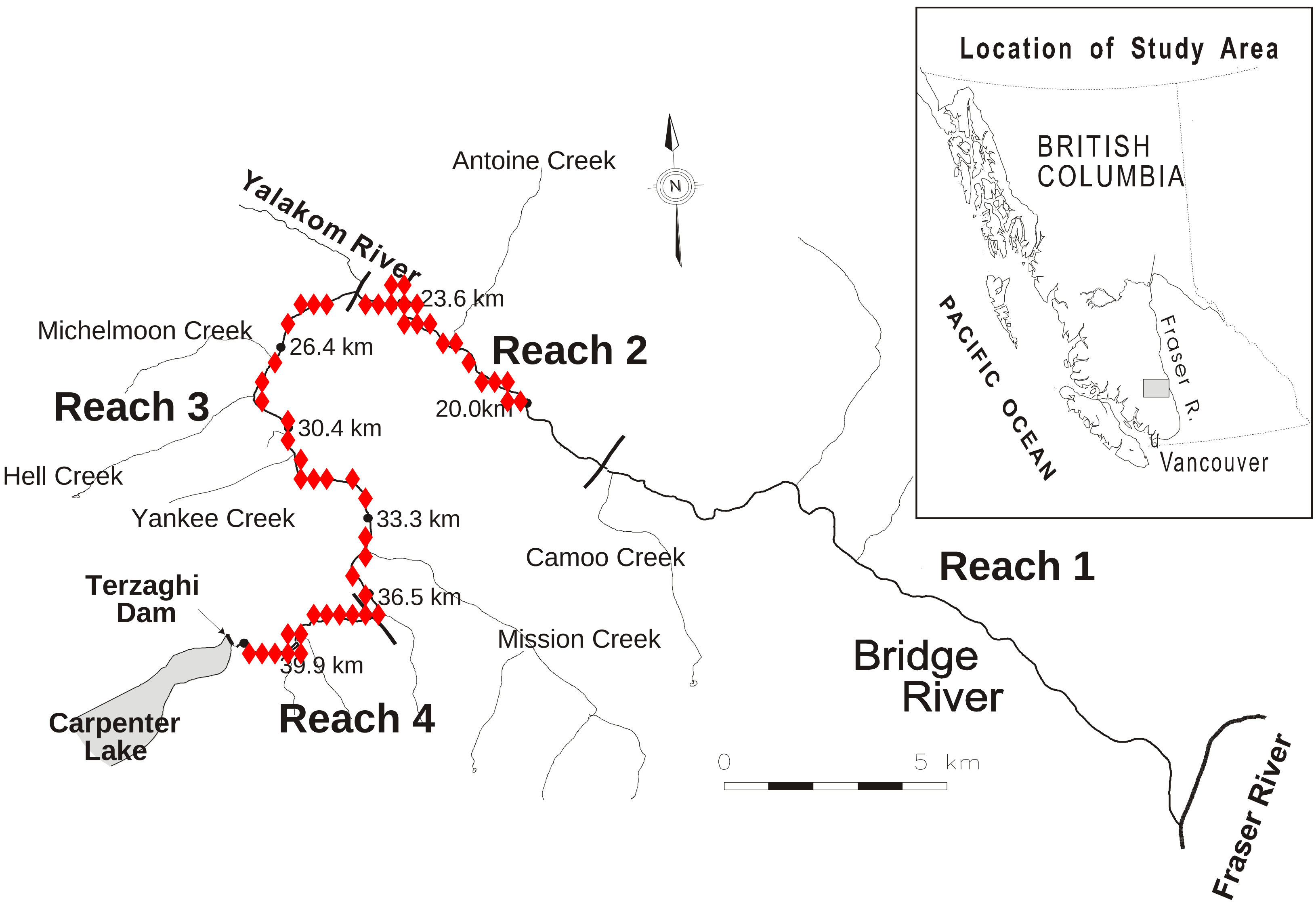

Figure 1. The Lower Bridge River Aquatic Monitoring Program study area, including reach breaks, index sample site locations (indicated by black dots), and the locations of tributaries between Terzaghi Dam and the Fraser River. The red diamonds indicate the approximate locations of the 50 fall standing stock assessment sites.

2.5 Study Period

Table 2. Schedule of Sampling Sessions, 2012.

Sample Session	2012 Dates	Activities
Ramp down	1 to 29 August; 1 to 2 October	Rampdown surveys: fish salvage and staff stage, temperature and turbidity data collection
Fall Stock Assessment	5 Sept to 10 October	Depletion Sampling (electrofishing)
Early Fall	27 to 30 September	Deploying algae and bug samplers
Fall	October 17	Water sampling (nutrients); Discharge transects
Late Fall	14 to 20 November, 27 -30 November	Electrofishing; Retrieving algae and bug samplers; Water sampling (nutrients); Logger downloads; Discharge transects
Early Winter	Dec 18	Logger Downloads, Discharge transects

The monitoring occurred during six sampling sessions in 2012. A general description of the activities and sampling timing are presented in Table 2. No sampling was conducted prior to the August rampdown monitoring, due to a transition of program implementation. Details of the omitted sampling are discussed below in section 3.1.1.

3.0 METHODS

3.1 The Aquatic Monitoring Program

3.1.1 Overview

Monitoring methods and protocols utilized in 2012 were identical to those used in 2011. These methods and protocols originated from a general template of monitoring initiated at the start of the baseline flow monitoring phase (1996 – 2000) and have since undergone adaptations through the 3 m^3s^{-1} flow treatment (2000 to 2010) and 6 m^3s^{-1} flow treatment (2011 – present). The major data collection components of the LBR sampling design include:

- Water temperature
- River stage
- Flow release
- Water nutrient/chemistry
- Primary Productivity (periphyton)
- Secondary productivity (macroinvertebrate)
- Juvenile salmonid growth

- Fall standing stock

Data collection in 2012 occurred at seven index sites located at 3 km. intervals along the LBR (Figure 1). In descending order from Terzaghi Dam, these include the following river kilometers: 39.9, 36.5, 33.3, 30.4, 26.4, 23.6, and 20.0. River kilometer (Rkm) 39.9 is a more recent index site where monitoring began at the start of the 3 m^3s^{-1} flow release on 1 August 2000.

The timing and frequency of data collection were similar to 2011 with a few exceptions. This deviation included no juvenile salmonid growth samples being collected before September 2012, no high flow discharge transects conducted, no habitat sampling, and fewer reference photographs. This was a consequence of a transition of leadership of the entire LBR Aquatic Monitoring Program into a BC Hydro Water Use Plan WUP, which happened in August 2012. The implications of these missing data won't be known until a synthesis is conducted, however future years of data collection at Flow Trial 2 should mitigate these missing data.
Additionally, safety concerns were raised regarding high flows and the program methodologies used for discharge and habitat surveys. Consequently, high flow discharge transects and habitat sampling were not conducted and this was identified as a methodology gap. This is still a concern and high flow habitat surveys, using the same methodology as the program has used in the past, is not possible at this time due to a discharge of 15cms. However, as these data were mainly used to determine fish densities at the lower flows, the omission of this data collection is likely not be a problem. Similarly for discharge surveys, additional data collected under BRGMon-3 for discharge will fill in high discharge data gaps.

3.1.2 Water temperature, River Stage, and Flow Release

Water temperature was recorded at an hourly rate on every day of 2012 using data loggers manufactured by the Onset Computer Corporation (UTBI-001). These data loggers were located at the seven site index locations as well as an additional logger located at 100 meters upstream of the confluence of the LBR and the Yalakom River. Temperature loggers were anchored at locations and were submerged by river water. They were both checked and downloaded for data every 3 to 4 months to ensure data quality.

Relative river stage was recorded by PS9000 submersible pressure transducers (Instrumentation Northwest, Inc.) which were coupled with Lakewood 310-UL-16 data recorders. Data were collected at three Rkm locations: 20.0, 26.1, and 36.8. River stage was recorded every 15 minutes per day every day of the year. Loggers were regularly checked and downloaded by Via-Sat Data Systems to ensure data quality. In addition, discharge data were collected in October and November at two designated transect locations in Reaches 3 and 4. Water depth and velocity measurements were taken every 0.5 meters.

Data on flow release were provided by BC Hydro Power Records and are maintained by BC Hydro. These data represent hourly discharge from the Lower Level Outlet (LLO) gates at Terzaghi Dam, every day of the year.

3.1.3 Water Chemistry and Nutrient Sampling

Water chemistry and nutrient data collection occurred in the early fall session on October 17, 2012, and November 27 and 30th, 2012 for the late fall session. On these two dates, water samples were taken from all site index locations, Carpenter Reservoir, and the following LBR tributaries: Antoine Creek, Camoo Creek, Hell Creek, Michelmoon Creek, Mission Creek, Russell Springs, Yalakom River, and Yankee Creek (refer to Figure 1). These water samples were submitted to the Fisheries and Oceans Canada (DFO) laboratory at Cultus Lake and analyzed for the following nutrient levels: NH_4, NO_2/NO_3, Soluble Reactive Phosphorus, Total Dissolved Phosphorous, turbidity, and Total Phosphorus; the chemical parameters included total alkalinity and pH. Methods used for the field sampling and laboratory techniques are explained in further detail within Riley et al. (1997) as well as specific LBR detailed methods in Appendix D. Supplemental water quality data were measured at each site using a WTW handheld field meter and these included conductivity, pH, and spot water temperature.

3.1.4 **Primary and Secondary Productivity Sampling**

Primary productivity was monitored using periphyton accrual as the main parameter. Macroinvertebrate abundance and diversity was the main indicator of secondary productivity. At each of the seven index site locations, both periphyton and macroinvertebrate data were collected at three replicate subplot locations spaced approximately 20 meters apart. At each replicate subplot, a depth and velocity measurement was taken using a top-set wading rod and velocity meter manufactured by Swoffer Instruments, Inc. The data was collected to assist in the characterization of inter-annual variations of primary and secondary productivity.

The medium used to accrue periphyton consisted of a 30 x 30 x 1 cm cell Styrofoam sheet that was rubber banded to a plywood backing which was bolted to a 30 x 30 x 10 cm concrete block. At each site index, periphyton accrual samplers were placed at each replicate in areas relatively similar in water depth and velocity. Periphyton accrual data were collected approximately every week at all the replicate subplots and for all seven site index locations between October 5 and November 22, 2012. Each weekly sample involved the removal of a core of Styrofoam using the open end of a 7-dram plastic vial (8.5 cm^2 core area). These samples were then sent to the DFO lab at Cultus Lake for measurement of Chlorophyll a concentration. At the end of the fall series, an additional Styrofoam core was extracted and sent to Limnotek so that species composition and cell counts per unit could be measured. More detailed methods regarding LBR specific field techniques for periphyton accrual methods can be found in Appendix D.

The medium used to measure macro-invertebrate abundance and diversity included a standardized metal basket filled with river gravel and substrate collected at each site. These prepared baskets were placed at similar water depths and velocities at each of the site locations and proximal to the periphyton accrual samplers. The baskets were left undisturbed for the duration of the eight week fall sampling series at which point they were carefully lifted out of the water and placed into buckets. The contained substrates were carefully removed from the baskets and were hand scrubbed in order to remove all attached material. This material was filtered through a mesh sieve (Nitex), and placed into a sample jar that contained 10% formalin solution. As was done in previous years, the sample jars were sent to Mike Stamford at Stamford Environmental to be sorted, identified to family, and enumerated.

3.1.5 **Sampling for juvenile salmonid growth data**

In 2012, juvenile salmonids were collected for growth data at each index site in order to characterize temporal and spatial patterns of fish growth. The intent of this sampling was to collect a target of approximately 30 salmonids within each age/species class; as this was the target number utilized in previous studies. Live fish were collected using a backpack electroshock approach whereby fish were anaesthetized, identified to species, forklength (nearest millimeter) measurements taken and weights (to the nearest .01 gram) recorded. Following a brief recovery, all fish were released very close to their initial collection area.

3.1.6 **Fall Standing Stock Assessment**

The objective of the fall standing stock assessment is to estimate the abundance and distribution of juvenile chinook salmon, coho salmon, and rainbow trout in Reaches 2, 3, and 4. Unlike the fish growth sampling, the standing stock assessment has a much larger geographic scope, spanning 50 sites along the LBR. The fall stock assessment was conducted during a 3 m^3s^{-1} hydrograph. The timeframe and flow magnitude during this sampling is the same in Trials 1 and 2 (Figure 2).

Upon arrival to each site, the standing stock survey area was enclosed with three ¼-inch mesh stop nets in size ranging from 50 to 150 m^2. Perpendicular to the bank, two shorter panels were used as stop nets upstream and downstream of the bank while a longer net was used parallel to the bank. Stop nets were attached to bipods and anchored down to the shore so that they were fixed during sampling. As crews changed over the yeas and the river changed, net placement deviated slightly between crews and was dependent on site habitat and site conditions at the time of sampling. This is minimized to ensure that no sampling biases occur.

A four-pass depletion method using electrofishers was executed within the netted enclosure by using a 400 volts DC. Live fish were anaesthetized, identified to species, forklength (nearest millimeter) measurements taken, and weights (nearest .1 gram) recorded. Fish were kept in a live basket in the stream until the sampling was complete and fish were then released near the original electroshock location.

Upon completion of the electroshocking, physical (abiotic) data of the site was measured and recorded. Length measurements of the netted enclosure were recorded and included offshore, mid, and inshore; followed by three width measurements which included upstream, mid, and downstream. The length and width measurements were taken in order to calculate the area sampled. After the net enclosure was removed, water depth and flow velocity was recorded via three transects at upstream, mid, and downstream locations. At each transect, five depths and five velocities were measured at equidistant intervals from bank to the offshore extent of the sampled area. Water velocity was measured with a Swoffer™ current meter at a depth of 0.6 m. Maximum depth and velocity were also noted at each site.

Supplementary site data included sampling effort (Electrofishing seconds), date, dominant habitat type, D90, substrate composition, and mean particle size.

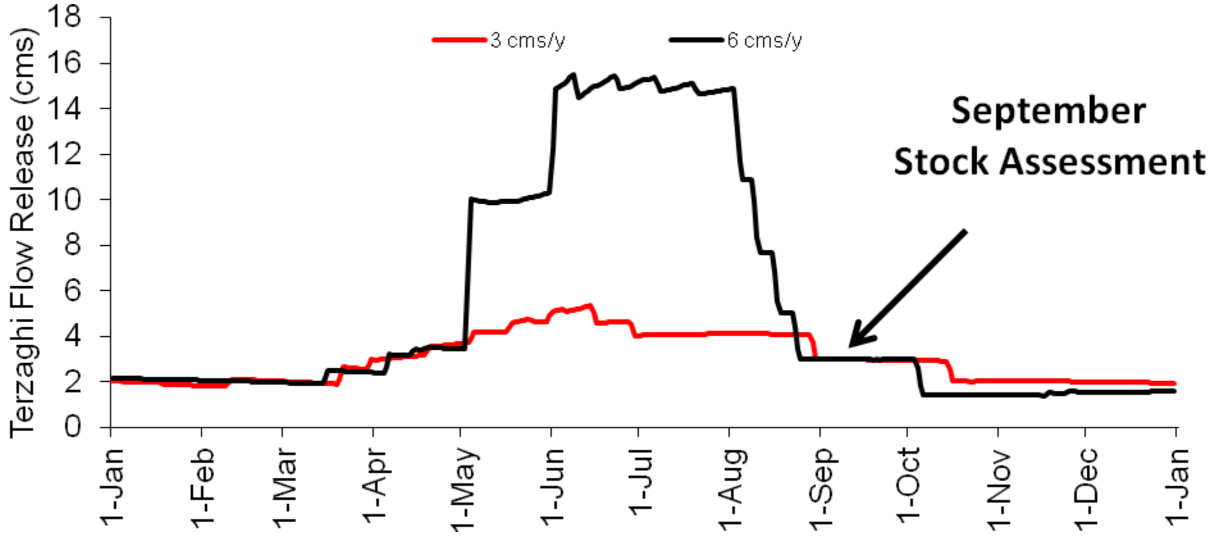

Figure 2. Lower Bridge River hydrographs at the 3 m^3s^{-1} and 6 m^3s^{-1} water budgets. Arrow indicates the timing of the annual fall standing stock assessment sampling.

3.2 Flow Rampdown Surveys

3.2.1 **Overview**

The focus area of the LBR flow rampdown occurs between Terzaghi Dam and the confluence of the Yalakom River, a river length of 16 km. At the start of each rampdown day, a preliminary baseline reconnaissance of the entire 16 km was conducted. The physical progress of the flow reduction was monitored, and close attention was paid to those areas with historically high fish stranding potential.

Once reconnaissance was complete and areas with potential risk identified, salvage crews were dispatched to those areas. Upon arrival, these crews documented the physical attribute characteristics of the area; and if necessary, crews begin fish salvage. At the start of the work day, fish salvage efforts started closest to Terzaghi dam and highest priority was given to the following river habitats: sidechannels, low gradient edge habitats, and ‘potholes’ from historical gold mining endeavors.

3.2.2 **Communications**

In order to mitigate rampdown operations it was critical that field personnel at various locations along the river were able to communicate promptly with BC Hydro electricians at Terzaghi Dam. Field personnel provided the on-the-ground feedback to the BC Hydro electricians so field personnel could adjust the timing and magnitude of gate changes at Terzaghi Dam.

At the beginning of each rampdown day, all involved parties congregated at a safety tailboard meeting. There all personnel discuss the objective, plans, and logistics for that day. After crews are dispersed, two-way radio communications were used with line-of-site radios tuned to BC Hydro's simplex channel (F1) and outside of line-of-site the duplex channel (F2 – Bridge River repeater) were used. Periodic check-ins occurred via radio communication.

3.2.3 **Terzaghi Flow Release and River Stage**

Hourly flow release data were provided by BC Hydro and are determined from the water surface elevation of flows over the top of the weir at the end of the LLO gate. Scaling factors were used to transform the water surface elevation readings into flow release data.
River stage was a critical factor during the rampdown because it triggers timing and focus of fish salvage operations downstream. River stage was recorded electronically every fifteen minutes using PS9000 submersible pressure transducers (Instrumentation Northwest, Inc.) coupled to Lakewood 310-UL-16 data recorders. The electronic stage loggers were maintained by Via-Sat Data Systems Inc. of Burnaby, BC. During the rampdown surveys, rampdown staff also recorded river stage on a manual basis. Two staff gauges were permanent (Rkms 36.8 and 33.3) while two were temporary (Rkms 40.9 and 25.0).

3.2.4 **Water Temperature and Turbidity**

Significant fluctuations in temperature and/or turbidity can impact ecological processes as well as have detrimental effects on salmonids. During the rampdown surveys water temperature and turbidity were recorded to measure the amount of change that occurred before, during, and after the steps of the rampdown. Hourly water temperature was recorded electronically by permanent loggers located at Rkms: 39.9, 36.5, 33.3, 30.4, and 26.4. Periodic manual readings of temperature were also recorded using handheld meters by rampdown staff.

In order to collect water turbidity, staff collected water samples just below the plunge pool at the start and end of each rampdown day. A clean sample bottle was used for each sample, rinsed three times with river water, and finally plunged under the surface until full. All turbidity samples were measured using a turbidimeter and the results reported as Nephelometric Turbidity Units (NTUs).

3.2.5 **Fish Salvage**

When crews arrived to an identified fish salvage site, physical habitat attribute information were recorded as notes. These notes include:

- Date, time, full names of crew members, operational changes being assessed
- General site description (i.e. reach #, river km, bank location, proximity to landmarks, etc.)
- NAD 1983 UTM Zone 10 North coordinates

- Estimated dewatering time for the site
- Additional Comments

Upon arrival at each site, crews assessed the overall abundance of fish present and size of habitat that will likely dewater. A strategy for moving fish out of the affected area and back into the main river was determined. Captured fish were categorized into the following:

- Incidental - fish habitats that were not yet isolated, and fish still had the opportunity to move to deeper areas on their own;
- Isolated – fish in wetted areas that were isolated from the main flow of the river (i.e. strand pools)
- Stranded – fish that were found in habitats that had completely dewatered, but were still alive when salvaged;
- Mortality – fish that were found dead in habitats that were isolated or completely dewatered.

Fish that were herded from shallow water into the main channel were considered 'incidental'. When sites were completely isolated from the main channel and fish could not be captured in an incidental manner, they were captured by hand, dipnet, and backpack electrofishing. The aforementioned methods used were kept to a minimum (minimal handling and low electrofisher settings) as they can induce a high level of stress to fish. All captured fish were counted and identified to species before returning them back to the main channel. A subset of the captured fish were measured to forklength (to the nearest mm). All fish data were recorded as written notes.

3.3 Chinook Life History

Juvenile chinook salmon densities have decreased since the start of the flow release trials. Early egg development and premature fry emergence, (relative to the pre-flow release incubation period), has been observed nearly every year since the flow trials began (Sneep and Hall, 2010). This can be partially attributed to the altered thermal regime of the Lower Bridge River (relative to pre-flow temperatures), since the flow trials began. The hypolimnetic release from Carpenter Reservoir during the fall spawning season and thereafter into the winter has been creating warmer water temperatures, particularly in the upper reaches (Reaches 3 and 4) of the Lower Bridge River. There is uncertainty in how the altered temperature regime is contributing to this observed decline, or whether the decline can be partially attributed to a change in life history characteristics. According to Bradford and Taylor (1997) juvenile chinook also undertake seasonal movement and dispersal patterns and have been observed having differing life histories. To understand how the flow release and temperature regime is affecting juvenile chinook, a pilot monitoring program specifically focusing on these knowledge gaps was initiated.

Year 1 focused on strategy refinement, planning and logistics of the pilot program. Starting in 2013, juvenile and adult chinook salmon will be collected and otoliths will be extracted for microchemistry analyses. These data, coupled with seasonal water chemistry parameters (i.e., a trace metals analysis), will help managers understand the implications of each flow trial hydrograph on the LBR thermograph, and the subsequent impacts on juvenile chinook egg development and premature fry emergence. Details of the pilot program are provided in Appendix C.

4.0 AQUATIC MONITORING RESULTS

4.1 Physical Conditions

The Lower Bridge River physical conditions, discharge and the benefits from water are controlled by outflow from Terzaghi Dam. In 1960, after the dam was completed, all flow from the Bridge River was diverted to the Seton-Anderson watershed through tunnels in Mission Mountain. These flows feed two generation stations on Seton Lake, Bridge 1 and 2. Consequently, downstream of Terzaghi Dam, the mean annual discharge (MAD) was less than a 1% of that prior to impoundment, with water entering the system only from tributaries and groundwater seepage in Reaches 3 and 4, with the exception of an occasional (i.e., about once per decade) spillover event for flood control above the dam.

On August 1, 2000, water was released from Terzaghi Dam into the Lower Bridge River and the flow trials began. Under the 3 m^3s^{-1}, which lasted from August 2000 - April 2010, the flow release from Terzaghi Dam typically varied from a spring peak of approximately 5 m^3s^{-1} down to a winter low of approximately 2 m^3s^{-1} (Figure 3). The second flow trial was initiated in May 2011 at an annual water budget of 6 m^3s^{-1}. 2012 was the second year under the 6 m^3s^{-1} flow trial. Details of this year's hydrograph and flow release are shown in the results below.

4.1.1 **River Stage**

Relative stage data (i.e., mean daily river level) recorded at three sites (Rkm 20.0, 26.1, and 36.8) along with discharge data from LLO are presented in Figure 3.

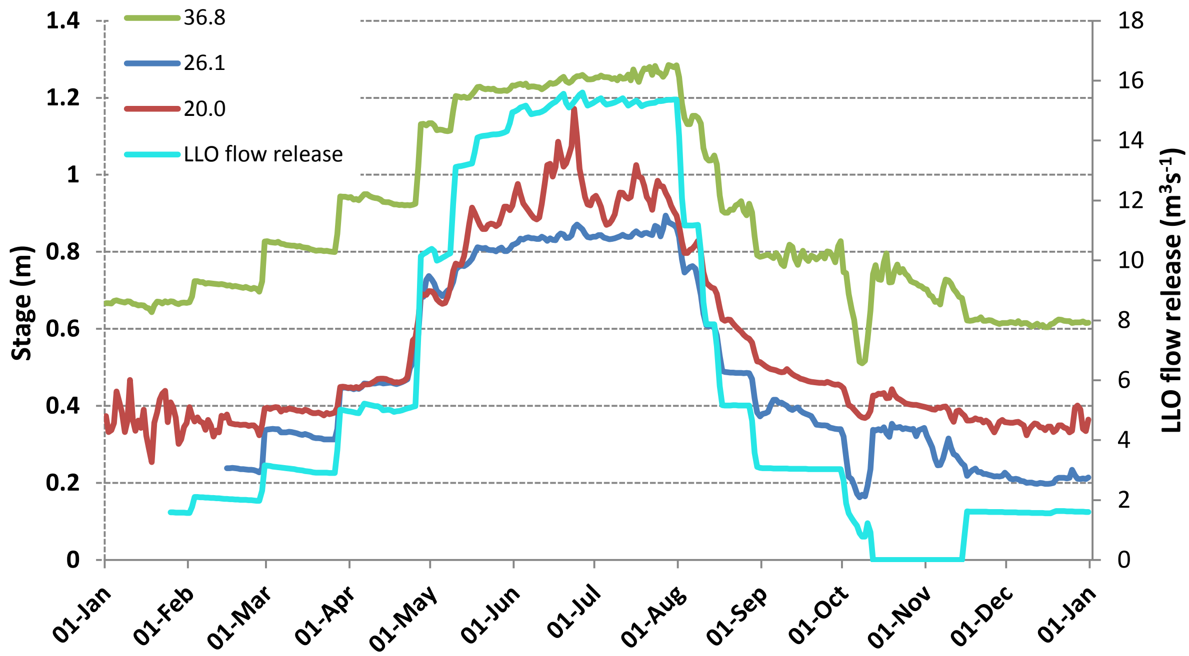

Figure 3. Relative river stage levels at three locations on the Lower Bridge River and mean daily flow releases from the LLO (lower level outlet) gate at Terzaghi Dam during 2012 (2° axis).

As shown in LLO flow release, under the target Trial 2 hydrograph (i.e., 6 m^3s^{-1}), target seasonal flows range from a spring and summer peak of 15 m^3s^{-1} (June and July) to a fall and winter low of 1.5 m^3s^{-1} (October to March). During the month of August, the flow release was ramped down from 15 m^3s^{-1} to 3 m^3s^{-1} in stages. In October, the LBR was further ramped down to 1.5 m^3s^{-1} over a period of two days. The 1.5 m^3s^{-1} fall and winter flow in Trial 2 is lower than the respective fall and winter flow in Trial 1. This reduction in winter flow magnitude was recently incorporated to reduce the elevated water temperature in the upper reaches of the river during the fall spawning and winter incubation periods, in an attempt to mitigate the effects of the warmer thermal regime on incubating chinook eggs, Figure 4 presents the Trial 2 hydrograph (i.e.,6 m^3s^{-1}) and flow release during 2012, 2011 and the beginning of 2013.

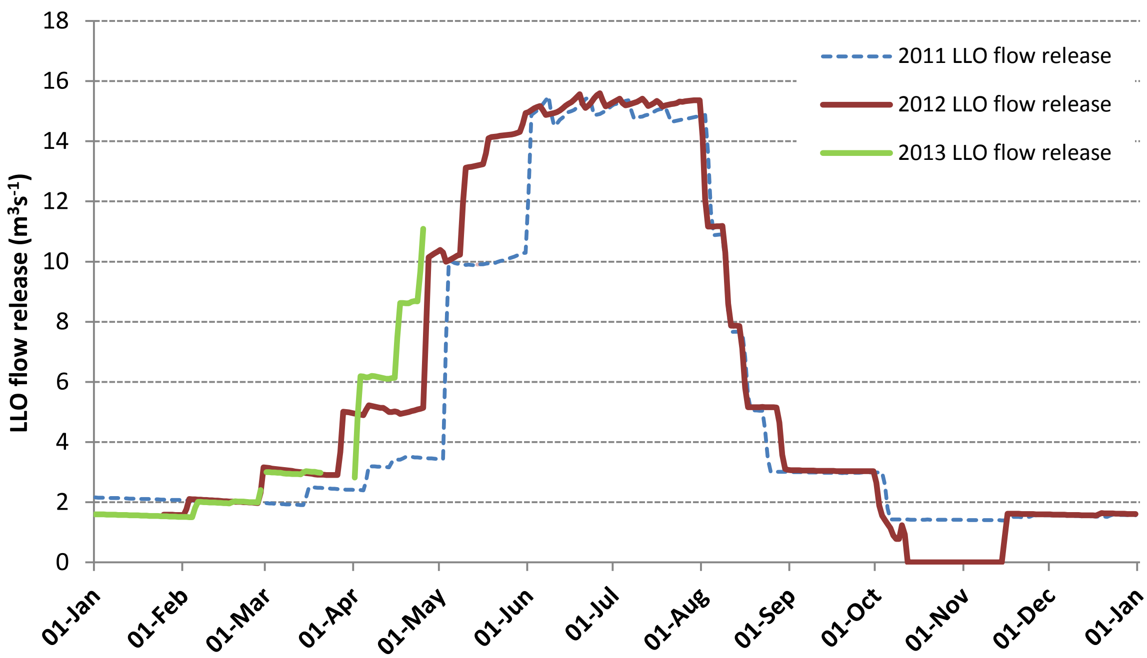

Figure 4. Mean daily flow releases from the LLO (lower level outlet) gate at Terzaghi Dam during 2011, 2012, and the start of 2013.

A slight deviation occurred in 2012 from the planned hydrograph due to a LLO gate malfunction which began during the first week of October, after the final ramp down to the planned 1.5 m^3s^{-1} (Figure 4). For approximately a five week period, water was released from the top of Carpenter Reservoir over the spillway, or a mixture of the LLO and spillway, to sustain flow downstream of the dam. Figure 3 reflects this correction and demonstrates how the relative stages of Reaches 2 - 4 were influenced by the flow release (Rkm 20.0 represents Reach 2; 26.1 represents Reach 3; and 36.8 represents Reach 4). In addition, the slightly different pattern on the ascending arm of the hydrograph is the result of an adaptation to the flow regime in the spring to account for a lower fall and winter flow (which was changed to 1.5cms during the 6cms flow Trial).

4.1.2 **Water temperature**

Annual mean daily water temperatures for Reaches 2, 3 and 4 of the Lower Bridge River for 2012 are presented in Figure 5. Annual mean daily water temperatures by reach, comparing Pre-trial trends (i.e., 1996-2000) Trials 1 (i.e., 2000-2010) and 2 (i.e., 2011, 2012) are presented in Appendix Figures A2.1 – A2.3. Water temperature data are also presented and broken down by reach, over the fall spawning period (i.e., Sep. – Dec.; Appendix A, Figures A2.4 – A2.6) and winter (Jan. –April; Figure A2.7 – A2.9). Temperatures in Reaches 3 and 4 during the fall spawning period are presented below (Figures 6 and 7).

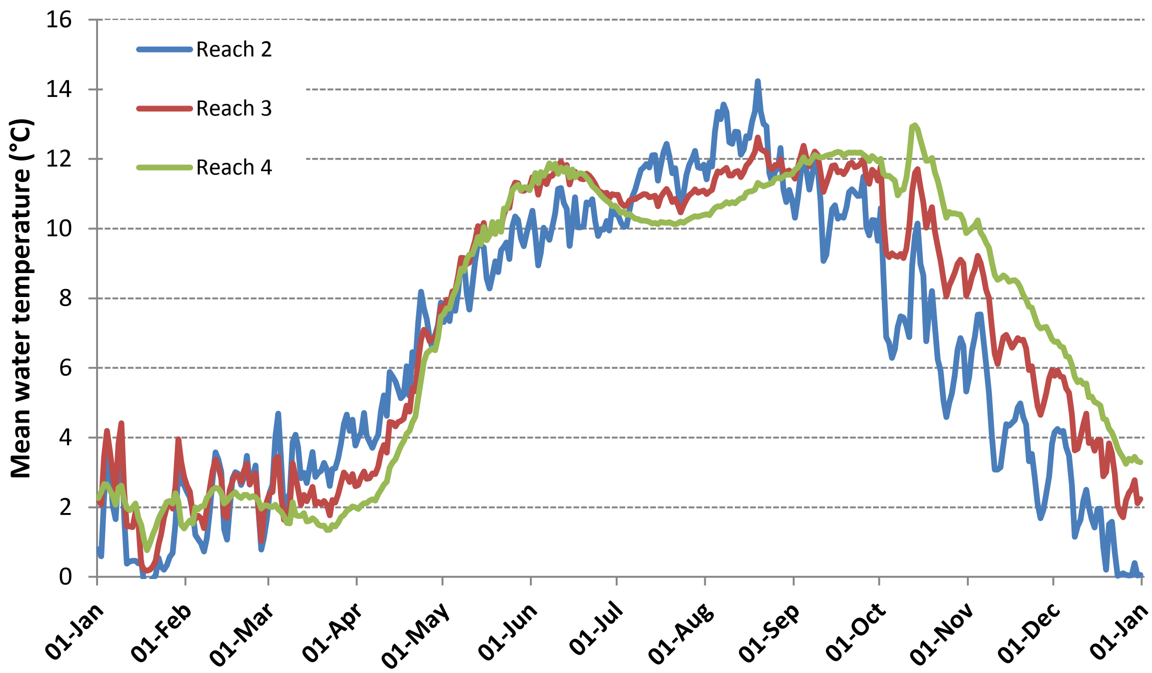

Figure 5. Mean daily water temperatures recorded in the Lower Bridge River, 1 January to 31 December 2012.

Seasonal temperature trends in Reaches 2 - 4 of the Lower Bridge River were generally similar to those observed in 2011, as well as those documented under flow Trial 1 (Sneep and Hall 2010; Figure 5; Appendix Figures A2.1 – A2.3). Water temperatures in Reach 4 reflected the principal influence of the hypolimnetic flow from the reservoir. During the higher spring and summer flows this was observed farther downstream in Reach 3. Reaches 3 and 4 typically have warmer temperatures during late spring and fall, and cooler temperatures during early spring and summer relative to Reach 2, which is more influenced by the temperature regime of tributary in-flows rather than Carpenter Reservoir (Figure 5).

Water temperatures during the fall spawning season were generally warmer under Trial 1 relative to Pre-Trial conditions (Figure 6; Sneep and Hall 2011). To mitigate these effects. the fall and winter flow magnitude was adapted and reduced for Trial 2 (6 m^3s^{-1}). This reduction in fall flow magnitude during the 6 m^3s^{-1} hydrograph was intended to reduce the warming influence of Carpenter Reservoir flow on the incubation of chinook salmon eggs in the fall. Reducing the volume of flow at this time of the year should amplify the effect of the seasonally-cooling ambient temperatures on the LBR. Figures 6 and 7 presents mean daily temperatures during the fall salmon spawning season in Reaches 3 and 4 (respectively).

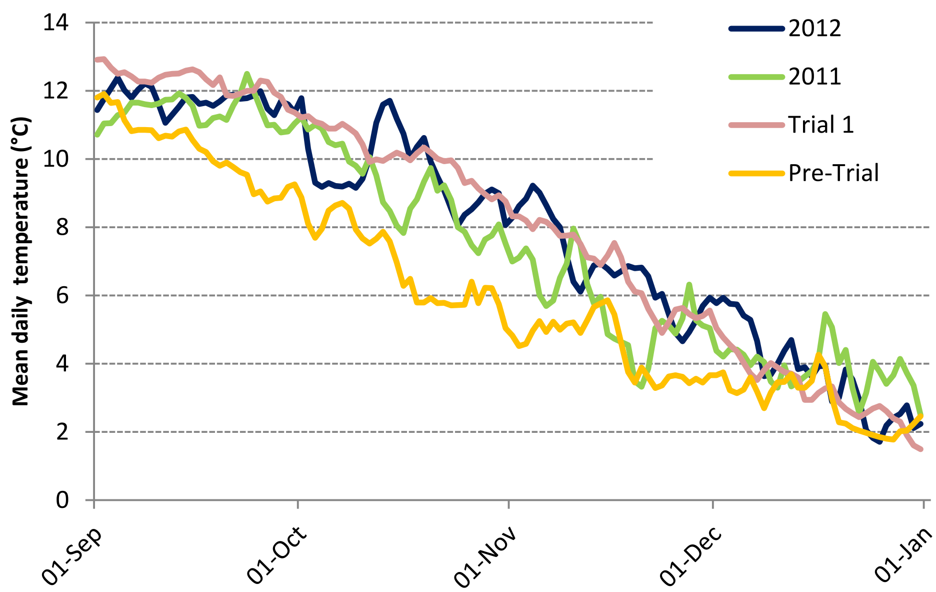

Figure 6. Mean daily temperatures for Reach 3 during fall spawning season (Sept-Dec) for Pre-Trial (1996-1999), Trial 1 (2000-2010), and Trial 2 (2011, 2012).

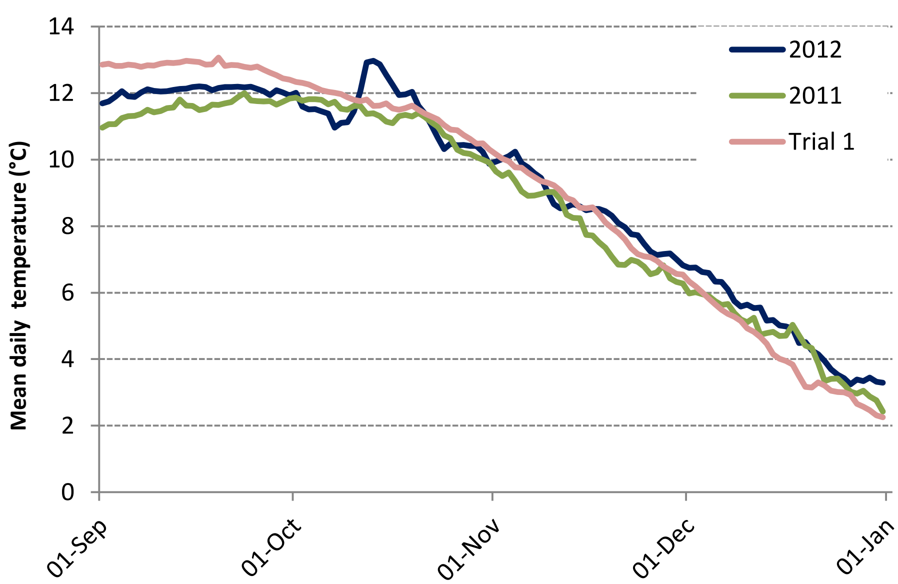

Figure 7. Mean daily temperatures for Reach 4 during fall spawning season (Sept-Dec) for Trial 1(2000-2010), and Trial 2 (2011, 2012). Pre-Trial data are not applicable because Reach 4 was not wetted at this time. Reach 2 is included in Appendix A, A2.4.

As a result of decreased fall flow release from Trial 1 to Trial 2, an intended cooling effect of water temperatures appears to have been achieved in both Reaches 3 and 4 in 2011 (Figure 6; Sneep and Hall, 2011). In contrast, the desired cooling effect was not consistently achieved in Reaches 3 and 4 throughout the fall spawning period in 2012 (Figures 6 and 7; Appendix Figures A2.5, A2.6).

During the LLO gate malfunction, the upper reaches experienced warmer temperatures in 2012, compared 2011 and Trial 1. Figure 8 displays mean daily temperatures for each reach during the duration of the gate malfunction. Mean daily temperatures were observed to drop at a steady rate as less and less water was being released from the LLO gate (see Figure 11; Figure 8). Before the LLO gate was entirely shut off (approximately October 10, see Figure 11) a pulse of water was released from the LLO gate. Following this pulse, water was released by Terzaghi dam's spillway (SPOG), which resulted in the daily mean water temperature spiking several degrees C warmer than flow Trial 1, and 2 to 3 degrees C warmer than Trial 2 in 2011, during the period October 9 - 15 (Figures A2.4 – A2.6). Until approximately November 18, when the LLO outlet gates were repaired and put online, Reaches 3 and 4 in 2012 generally experienced warmer daily mean temperatures than 2011. In addition, temperatures were not consistently cooler than Trial 1 (Figure A2.5-A2.6). Because of the gate malfunction, water temperatures likely did not follow the trend expected under Flow Trial 2. Therefore, a closer examination of fall spawning water temperatures should take place in the following years to determine trends in water temperature with the lower fall flow release for Trial 2.

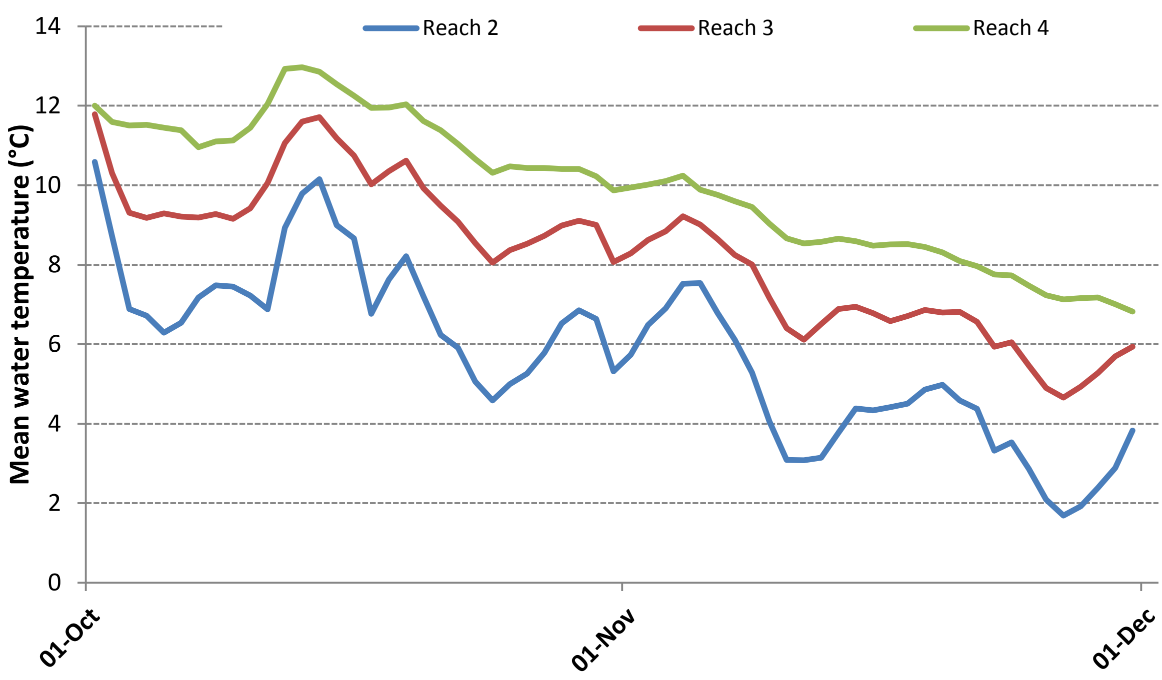

Figure 8. Mean daily temperatures for Reaches 2, 3, and 4 covering the duration of the LLO gate malfunction (approximately October 3 – November 18).

4.1.3 **Water Chemistry**

Water chemistry samples were collected from the LBR, Carpenter Reservoir, and tributaries within the study area during the October and November sessions in 2012. Results for flow Trial 2, 2011 and 2012 are presented in Appendix A, A4.1. The water chemistry parameters observed in 2012, (i.e., alkalinity levels, concentrations of nitrates and nitrites, and pH) were similar to those reported in previous non-pink salmon spawning years. Furthermore, they have remained relatively stable since the flow trials began. As such, these differences cannot be easily distinguished from natural variations between years using descriptive graphical comparison.

4.2 Periphyton and Macroinvertebrates

4.2.1 **Periphyton**

Periphyton accrual rates (measured as cumulative concentration of Cholorphyll a) were highest throughout the sampling period for Reach 3 (Figure 8). Reaches 2 and 4 were relatively similar in their accrual rate until early November when Reach 4 showed increased rates over Reach 2. When broken out by index site (Figure A3.3), periphyton accrual appears to increase at a slight rate for nearly all sites from the start to finish of the sampling period. Index sites in Reach 3 exhibit higher accrual rates than Reaches 2 and 4. Index site 30.4 exhibited the highest values throughout the sampling period for all sites and showed a significant and sustained spike in early November (Figure A3.3). In 2012, Reach 2 showed lower levels of periphyton accrual than it did in 2011. This may have been due to 2012 having no pink salmon spawners.

Total mean periphyton biovolume and total mean periphyton cell counts (Figures A3.1, A3.2) were markedly higher in Reach 3 than in Reaches 2 and 4. At the site level, two of the replicates for index site 30.4 had the highest periphyton biovolume value of any index site replicate. This periphyton biovolume was the invasive algal species rock snot (*Didymosphenia geminate*) and may explain the early November spike for periphyton accrual described above.

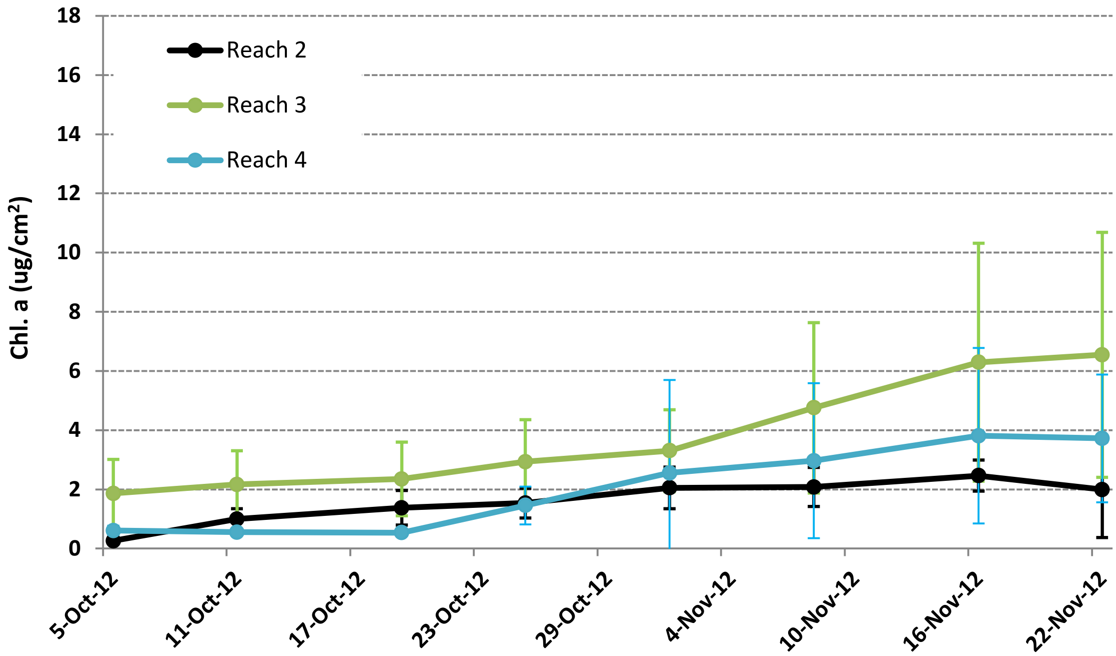

Figure 8. Mean periphyton accrual (measured as Chlorophyll a) on artificial substrates in the Lower Bridge River, during the fall series sampling in 2012. Each point represents an average accrual for all stations within a reach; bars represent +/- 1 standard dev.

4.2.2 **Macroinvertebrates**

Macroinvertebrate results were conclusive in some cases while in others variable and difficult to explain. Figure 9 indicates both the total mean abundance per taxa as well as total biodiversity of taxa in 2012. For the total mean abundance of individuals among index sites, the 2012 results were variable. For instance, Figure 9 shows that the taxa Ephemeroptera decline in abundance from upstream to downstream. However, the taxa Diptera appear to increase in abundance from upstream to downstream. Of the other taxa, index sites do not indicate strong longitudinal correlation for abundance. In a detailed report containing the same 2012 LBR macroinvertebrate data combined with the years 2008-2010, Stamford and Vidmanic (2013) similarly found taxa abundance was not significantly different among sites (ANOVA; $p=0.15$). This report is available upon request from St'at'imc Eco-Resources and BC Hydro.

Total taxa biodiversity among sites appear to have stronger correlation with longitudinal changes than total mean taxa abundance. In 2012, taxa biodiversity appeared to follow an increasing trend from upstream to downstream (Figure 9). A similar finding was described in Stamford and Vidmanic (2013) who found that taxa biodiversity was significantly lower upstream in sites 36.5 and 39.9 ($p<0.0001$) for all study years (Figure A6.1A) and that taxa assemblage diversity furthest downstream was higher during all study years.

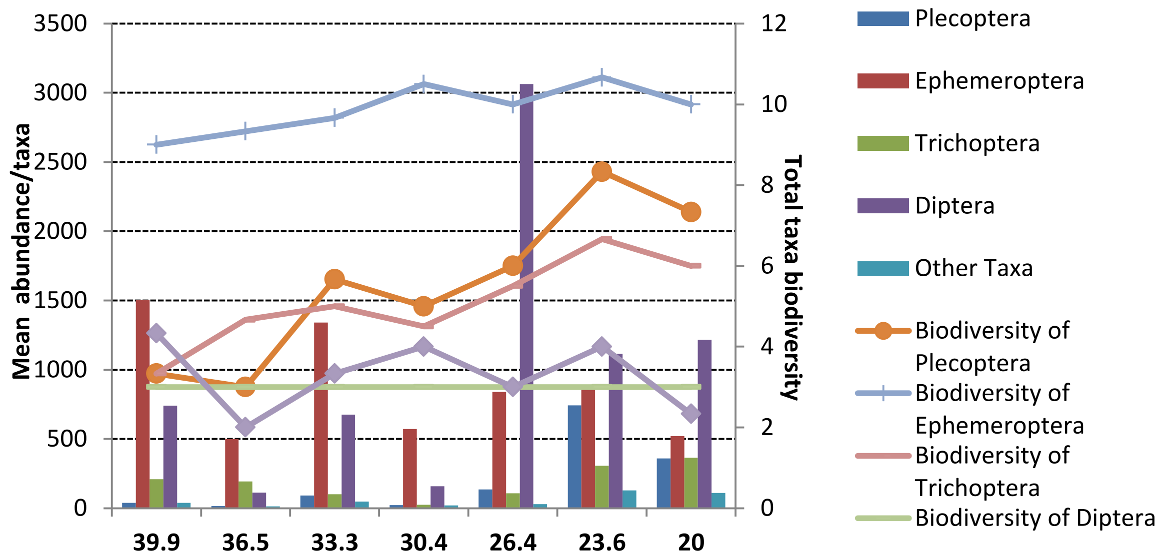

Figure 9. Macroinvertebrate mean abundance per taxa (primary axis) and total taxa biodiversity (secondary axis) at site index locations 39.9, 36.5, 33.3, 30.4, 26.4, 23.6, and 20.

4.3 Fish Sampling

Fish sampling in the LBR aquatic monitoring program is conducted during a fall standing stock assessment as well as periodic juvenile growth sampling. A total of 3,582 fish were sampled during backpack electrofishing during the annual fall standing stock assessment (Reach 2, *n*=553; Reach 3, *n*=1654; Reach 4, *n*=1375) which was conducted between 5 Sept to 10 October. 50 sites were sampled using a stratified sampling design, as has been done in years past, including 18 in Reach 2, 20 in Reach 3, and 12 in Reach 4. A total of 519 fish were caught during the November session (Reach 2, *n*=129; Reach 3, *n*=303; Reach 4, *n*=87). Water temperatures less than 5° C throughout the study area during the scheduled winter fish growth and field ecology sampling session (i.e., December) prohibited fish sampling, and consequently winter juvenile growth data was not collected. The spring and summer sessions were not conducted due to a transition in implementation into the WUP program and a change in management/contractual duties.

4.3.1 Fish Growth

Table 3 presents the size ranges and age classes for the September and November juvenile growth sessions. Detailed data on the weight (minimum, maximum and mean sizes) of fish for these sampling sessions is included in Tables A1.1 – A1.4. Overall, mean weights (Tables A1.2 & A1.3) as well as minimum and maximum forklengths (Tables A1.1 and A1.4) were lower in 2012 than in 2011 for nearly all reaches and species age classes. A total of 24 chinook were caught in the November session, all of which were age-0+. In September, 104 Age 0+ chinook were collected and weighed with the majority (67) of these fish caught in Reach 3. No Age 1 chinook were caught in September in any of the LBR reaches. In addition, November samples included a total of 169 Age 0+ coho and 326 rainbows, with all reaches combined.

An early emergence of chinook fry, relative to the pre-release incubation period, has been observed several years since 2002. However, it was not observed in the 2012 November sample session or the December field visits so emergence timing could not be confirmed. Despite a lack of samples, it is possible that emergence timing was still several months early given water temperature readings in Reaches 3 and 4 during the fall incubation season were not observed to be cooler in 2012 than in Trial 1 (See Appendix A Figures A2.5 and A2.6).

Table 3. Size ranges (in mm) for each age-class of salmonids captured in the Lower Bridge River for growth information, May to November 2012.

Species & Age Class	May	July	August	Sept/Oct[a]	Nov
CH - 0+	-	-	-	55 - 107	60 - 97
CH - 1	-	-	-	-	-
CO - 0+	-	-	-	35 - 98	45 - 96
CO - 1 [b]	-	-	-	-	-
RB - 0+	-	-	-	15 - 79	44 - 89
RB - 1	-	-	-	80 - 151	91 - 165
RB - 2	-	-	-	155 - 221	170 - 280
RB - 3	-	-	-	250 - 270	-

[a] Growth data for September was derived from fish sampled during the annual stock assessment.
[b] Indicates species-age class not sampled.

4.3.2 **Standing Stock Assessment**

Estimated mean biomass of chinook, coho and rainbow by age-class are presented in Table 4. Only the standing stock assessment data were used to calculate estimated biomass per site and per species by age class which was then averaged to each reach level. Detailed information regarding the standing stock assessments in 2011 and 2012 can be found in Tables A1.3, 4 and A1.6, 7. For more information on the relative biomass contribution of each species and age-class per each reach, the spatial variation of estimated mean salmonid biomass, and a comparison of total biomass values for all study years until 2011, see Sneep and Hall 2012.

Table 4. Estimated mean biomass (g/100 m^2) of salmonids captured in the Lower Bridge River during the standing stock assessment, 5 September to 10 October, 2012.

Species & Age Class	Reach 2	Reach 3	Reach 4
CH - 0+	15	23	7
CH - 1 [a]	-	-	-
CO - 0+	37	99	151
CO - 1 [a]	-	-	-
RB - 0+	54	46	127
RB - 1	34	186	376
RB - 2	-	33	128
RB - 3	-	14	19
Total[b]	**139**	**402**	**807**

[a] Indicates age class not sampled.
[b] Total mean biomass for all species and age classes in each reach.

Estimates of total mean biomass per reach are similar to results reported in 2011, although they are slightly lower across the reaches as can be expected due to 2012 being a non-pink year (i.e., without pink salmon spawning.) Comparable to 2011 and previous years, total estimated biomass was highest in Reach 4, and lowest in Reach 2. All of the target species (i.e., chinook, coho, and rainbow) were represented in each reach. However, age-1 chinook were not captured in the sampled reaches, and rainbow trout in age classes 2 and 3 were not sampled in Reach 2. The highest biomass estimate for chinook age-0 occurred in Reach 3. As was observed in 2011, the highest estimates for age-0 coho and age-0 rainbow were in Reach 4. Age-0 coho biomass declined more than the others across the reaches; estimates in Reach 4 were 48% lower than in 2011; Reach 3 estimates were 36% lower than in 2011.

In Reach 4, total estimated biomass is 807g/100m^2. In past years, biomass estimates during the flow Trials have indicated a stabilization for Reach 4 within the range of 700 - 800 g/100m^2 , which is comparable to Reach 3 estimates prior to the flow release. Data from 2012 under the 6 m^3s^{-1} water budget follow this trend. Rainbow trout juveniles, particularly age-1, make up just under half of the total proportion of biomass in this reach. Chinook biomass estimates were similar to past years. The mean Trial 1 estimate was 755 g/100 m^2 (ranging between 666 and 826 g/100 m^2). The high estimates in this reach relative to the reaches further downstream reflect the suitability of salmonid spawning and rearing habitats in Reach 4 that have been made available by the rewetting of the river channel. Estimates fall within the range of stabilization so this indicates that the high flows and subsequent flow rampdowns may not be influencing recruitment and rearing in a detrimental way, specifically in Reach 4.

Reach 3 biomass estimates during 2012 total 402 g/100 m^2. This is a lower total than pre-flow release estimates, which ranged from ca. 600 to 1200 g/100m^2 from 1996 to 1999 (mean ≈ 840 g/100m^2). However, it is similar to the estimates for the 3 m^3s^{-1}/y water budget (from 2001 to 2010) which varied between ca. 330 and 588 g/100m^2 (mean ≈ 461 g/100m^2)

and reflected a mean drop of ca. 379 g/100m^2 between pre-flow and flow Trial 1 (Sneep and Hall, 2012). Under the high flow Trial, Reach 3 estimates for 2012 follow a similar trend as 2011, which was reported as 411 g/100m^2 (Sneep and Hall, 2012). The reasons for this shift are not certain, but suggest a geographic move to better habitat in Reach 4. It may also suggest a change in habitat characteristics (e.g. depth and flow velocities) resulting from an increased magnitude in water from the flow Trial.

In general, Reach 2 estimates have been consistent throughout the study, relative to the changes observed in the upper reaches. The total biomass estimate for 2012 was 139 g/100 m^2. Average biomass estimates were ca. 145, 183 and 164 g/100m^2 during the 0, 3 and 6 m^{3}s^{-1}/y flow regimes, respectively. Coho and rainbow trout fry (age-0) stayed relatively the same as 2011, however chinook fry biomass estimates dropped by 71% (as compared to 2011) to a low of 15 g/100m^2.

5.0 RESULTS AND DISCUSSION

5.1.1 **Answering the Management Questions and Current Challenges**

The four key management questions that directly describe the uncertainties about the effects of flow on the Lower Bridge River are listed above (Section 2.1). It is important to annually assess if the program is on track to answering these questions and address any challenges towards this effort.

The LBR aquatic ecosystem monitoring program is well on it's way to answering the management questions, although it does face challenges to ensure a proper synthesis assessment in conducted. It is important to recognize that only 2 years of data have been collected under Flow Trial 2, i.e., the 6cms flow regime. Consequently, present data limitations prohibit a quality synthesis assessment and report by the May 2015 deadline. Several of the current challenges are listed below:

-Data from Flow Trial 2 (i.e., 6cms) is currently limited to two years (2011, 2012).
-Data from all years and all necessary components are currently not amalgamated into the database. This presently inhibits synthesis assessment and reporting, however discussions are underway on hot to rectify this and get the database up to date, including 2012 data. However, at the start of the WUP program and planning, the scope of the historical updating of the BRGMON-1 database was underestimated. Significant effort needs to be focused on this to ensure that all data are in proper form and accessible from the database as soon as possible. Currently, this is not feasible given the regular BRGMON-1 budget.
-Out of the two years of data collection under Trial 2, the years were different in that pink salmon spawned in 2011 and did not in 2012. Therefore it would benefit the program to have at least 2 more years of data collection to have 2 years of pink spawners and 2 yrs of no pink salmon spawning.
- It is difficult to determine juvenile recruitment with only 1 fall season of data collected under the fish counter for BRGMON-3, the adult program. More data (additional years) need to be collected to correlate escapement numbers and juvenile recruitment.
-More data are needed within the high flow Trial to determine how community composition and productivity of primary and secondary producers in the LBR are affected. Currently the program has only analyzed 1 year (2012) of invertebrate data under the high Flow Trial 2

(i.e., 6cms). Invertebrates were archived in 2011, the first year of the high flow. Discussions are ongoing as to when these will be processed.

6.0 FLOW RAMPDOWN SURVEY RESULTS

All flow rampdown survey results can be found in Appendix B.

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8.0 SUMMARY COST TABLE

Table 5. *Summary Cost Table:* Costs per study are shown as a total per year including inflation and contingency.

Lower Bridge River Aquatic Monitoring	***2012***
BRGMon-1	Implementation Yr 1
Total cost	$188,997

9.0 APPENDIX A

9.1 Additional Tables and Figures

(Note: The appendix tables and figures are contained in a separate file and can be obtained from St'at'imc Eco-Resources or BC Hydro upon request)

10.0 APPENDIX B

10.1 Flow Rampdown Survey Results

10.1.1 Terzaghi Dam Flow Release and River Stage Results

Mean hourly river level (relative stage) was recorded by three data loggers located at or near the reach breaks (i.e., Rkms 36.8, 26.1, and 20.0), and mean hourly flow releases from Terzaghi Dam for the rampdowns in August and October 2011, are presented in Figures 10 and 11, respectively. Following the ramp down in October, Lower Level Outlet (LLO) gates malfunctioned at Terzaghi Dam. Water was released via the top spillway to prevent dewatering of the river below the dam. Figure 12 presents the relative stage at the same sites during November, illustrating the continual flow release from Carpenter Reservoir during the gate malfunction period in October and November. Manual readings, located at the top of Reach 4 (plunge pool), the break between Reaches 4 and 3 (Rkm 36.8), the middle of Reach 3 (Rkm 33.3), and the Yalakom River were also recorded from both permanent and temporary staff gages during August and are presented below in Figure 13.

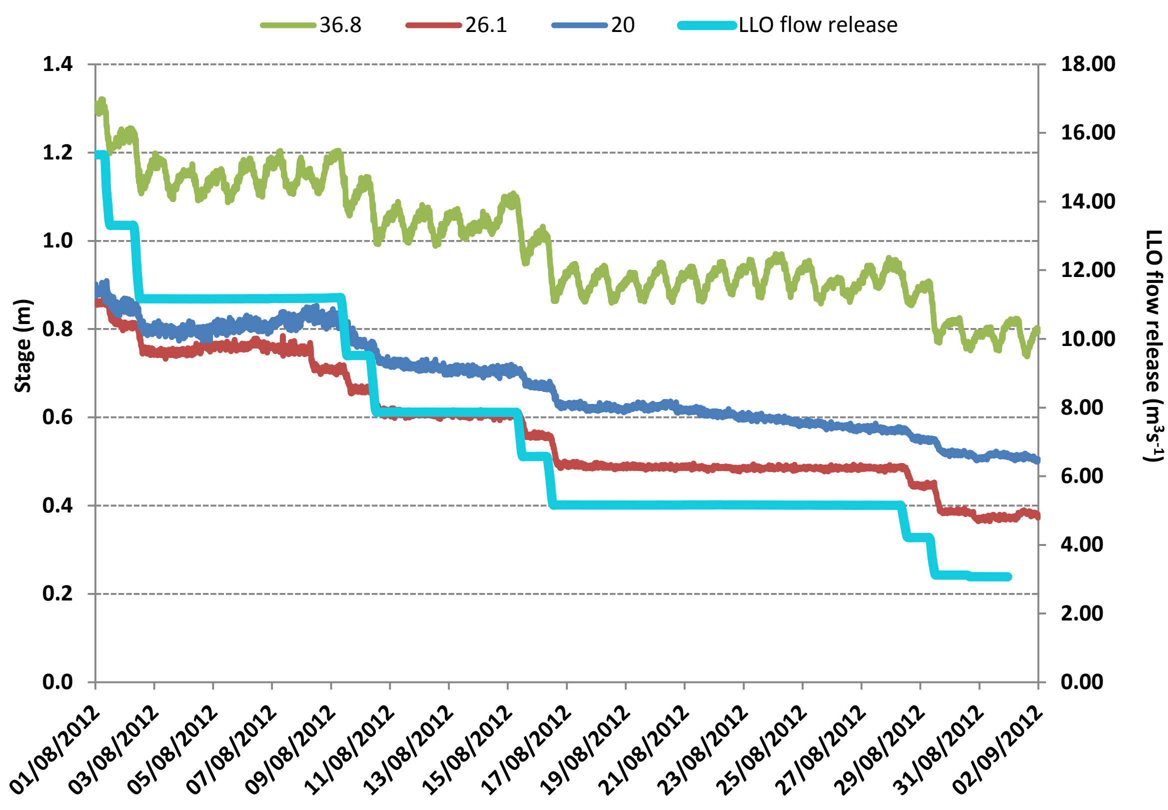

Figure 10. 15 minute stage levels at or near the reach breaks on the Lower Bridge River (1° axis), and hourly flow releases from Terzaghi Dam (2° axis), August 2012.

During the August ramp down event, the relative stage data decreased across all sites in correspondence with the decrease in flow coming from the LLO gates at Terzaghi Dam. Camoo Creek (site 20.0) and RKm 36.8 demonstrate the relative influence of other tributaries which contribute to the Lower Bridge River flow (exhibited by the fluctuations in the curve due to local site affects). The smooth curve of site 26.1 is indicative of a more stable local site condition on a 15 minute basis.

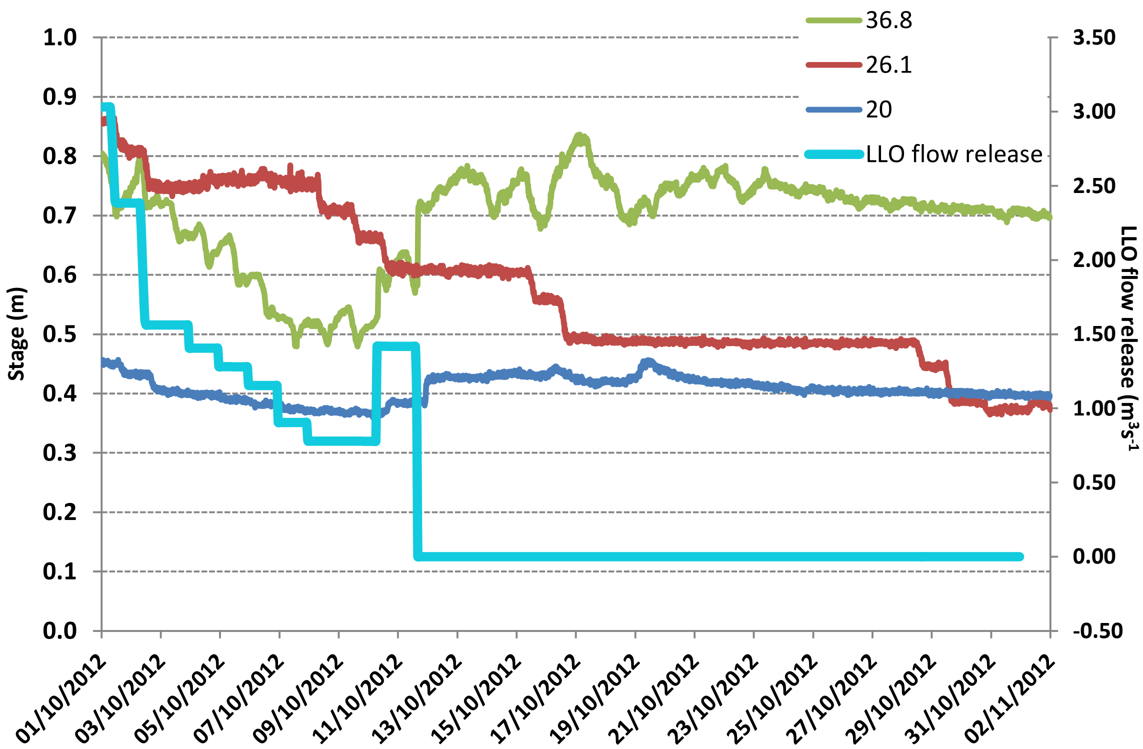

Figure 11. 15 minute stage levels at or near the reach breaks on the Lower Bridge River (1° axis), and hourly flow releases from Terzaghi Dam (2° axis), October 2012.

The final planned rampdown occurred on October 1 and 2 and river levels slowly declined in correspondence with the rampdown event. However, following the ramp down, the Lower Level Outlet (LLO) gates malfunctioned and eventually no water was entering the river through the LLO gates (Oct. 12). Corrective action was taken immediately upon notice and water was spilled over the top of the dam via the spillway to ensure continuous flow downstream of the dam. Figures 11 and 12 (October and November, respectively) demonstrate the relative stage of the river during the spillover event from the top of the reservoir.

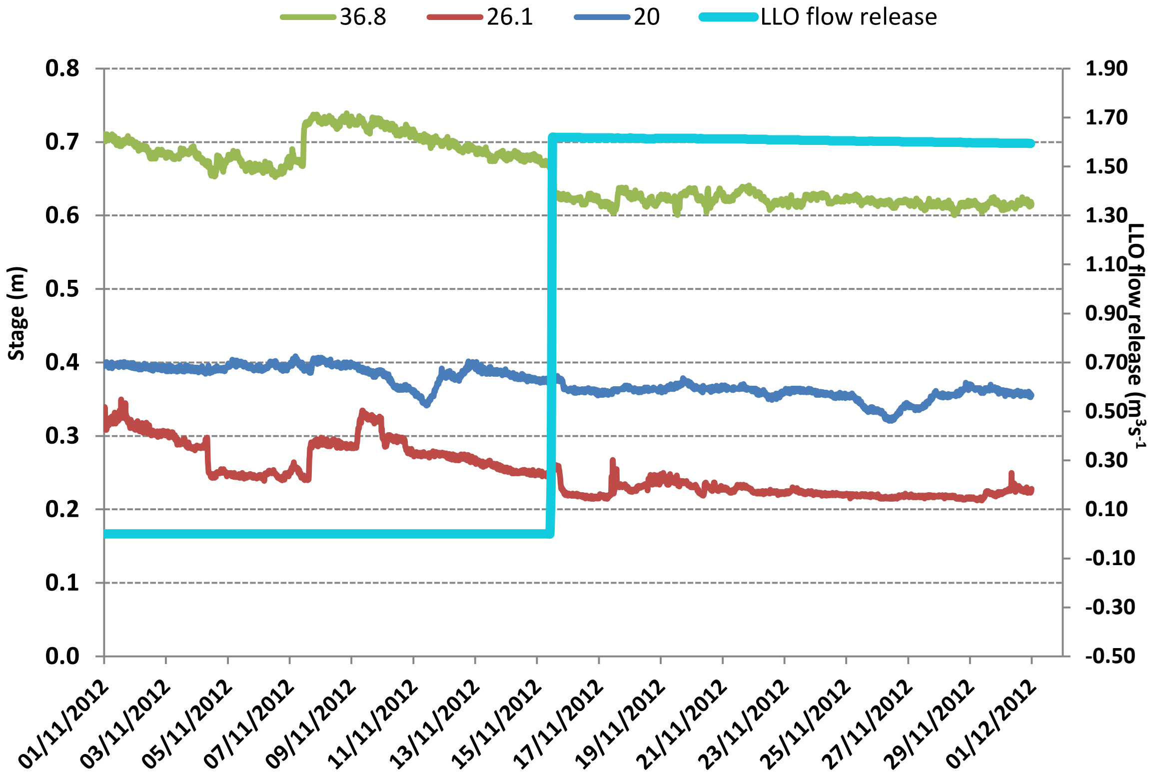

Figure 12. 15 minute stage levels at or near the reach breaks on the Lower Bridge River (1° axis), and hourly flow releases from (2° axis), November, 2012.

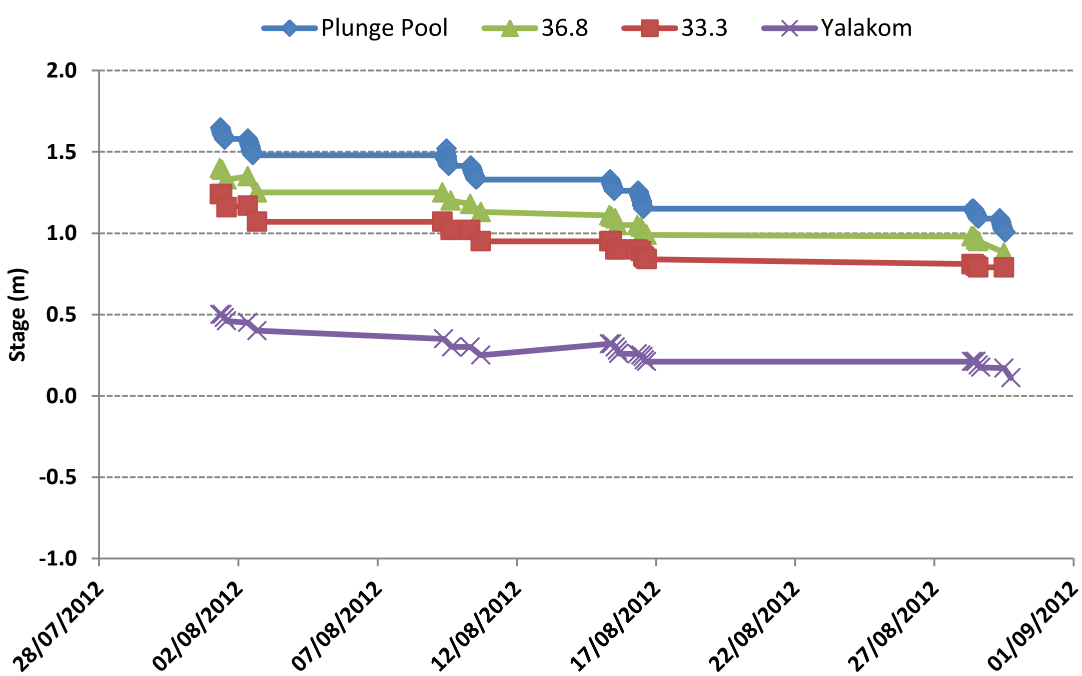

Figure 13. Relative river stage levels recorded from observations of staff gauges at four locations in the Lower Bridge River, August 2012.

Manual stage readings as recorded by observers at permanent (i.e., Rkm 36.8 and 33.3) and temporary (i.e., Plunge Pool and Yalakom River) staff gages clearly demonstrate the stage changes during the ramp down in August. These readings occur only when staff are physically present on site checking gages. Therefore, these data do not provide information regarding the relative stage during each period in between the active ramp down sessions. Data are not provided for the October ramp down because they were not collected due to minimal crew sizes.

Table 6 summarizes the total changes in the river stage elevation and the flow release volume for each ramping date in August and October. The maximum daily flow change was observed both on August 1 and 2, with a drop of 2.1 cms. The minimum reduction of 0.6 cms was observed on October 1. Throughout the ramp down, the plunge pool site exhibited the most stage reduction, and these effects diminished as distance from Terzaghi Dam increased. In addition, as was reported in years past, the degree of stage change relative to the volume of flow change increased from the first ramp event to the last. The cross-sectional channel shape is influential; as the river volume drops, the effect of each 1 cms flow reduction on river stage elevation increases. Consequently, to maintain a target stage change rate, the amount of flow reduction that can be accomplished must decrease on each successive ramp down date (Crane Creek Enterprises, 2012).

Table 6. Summary of stage changes at various locations downstream of Terzaghi Dam on each ramping date, August and October 2012.

Ramp Date	Daily change in flow release (cms)	PP	36.8	33.3	Yalakom
August-01-12	-2.1	-7.0	-7.0	-8.0	-4.0
August-02-12	-2.1	-10.0	-10.0	-10.0	-5.0
August-09-12	-1.7	-6.5	-5.0	-5.0	-5.0
August-10-12	-1.5	-8.5	-5.0	-7.0	-5.0
August-15-12	-1.3	-7.0	-6.0	-5.0	-6.0
August-16-12	-1.3	-11.5	-6.0	-6.0	-4.8
August-28-12	-0.9	-6.0	-3.0	-2.0	-3.5
August-29-12	-1.1	-8.5	-7.0	*	-6.5
August Total	**-11.9**	**-65.0**	**-49.0**	**-43.0**	**-39.8**
October-01-12	-0.6	-7.0	*	-10.0	*
October-02-12	-0.8	-8.0	*	*	*
October Total	**-1.5**	**-15.0**	*****	**-10.0**	*****

**Data were not collected for these locations and dates.*

Due to geographic characteristics and in-stream substrate, the Lower Bridge River is sensitive to fish stranding. Consequently, potential mortality is directly associated with the ramping rate; the slower the river is ramped down, the lower the risk for adverse effects on fish. Based on a variety of considerations, a target ramp maximum rate of 2.5cm of stage change per hour was decided on for all BC Hydro Bridge River Generation facilities, immediately below the facility where operational changes occur. In addition, daily ramping duration is constrained by a target daily stage change of less than 15 cm at the plunge pool, as well as accounting for the time lag effects of ramping to reach the bottom of the study area (up to 6 hours to reach the Yalakom River confluence; see Appendix Table A5.1). Table 7 presents the ramp hourly duration as measured at the Plunge Pool (PP), the maximum hourly change and the mean hourly change for each day of the ramp down in the summer and fall.

Table 7. Maximum and mean hourly stage changes at the Plunge Pool site on each ramping date, August and October 2012.

Ramp Date	Ramp Duration (hrs)	Maximum Hourly change (cm)	Mean hourly change (cm)
01-Aug-12	4.00	-2.5	-1.8
02-Aug-12	3.75	-3.0	-2.4
09-Aug-12	4.25	-2.0	-1.5
10-Aug-12	4.25	-2.0	-2.0
15-Aug-12	3.50	-2.0	-2.0
16-Aug-12	4.50	-3.0	-2.4
28-Aug-12	4.75	-1.5	-1.1
29-Aug-12	4.25	-3.0	-2.0
01-Oct-12	3.50	-2.0	-2.0
02-Oct-12	4.00	-2.0	-2.0

The ramp duration was relatively constant throughout, ranging from 3.5 hrs to 4.75 hours. Maximum stage change observed at the PP conformed to the target 2.5 cm/hr standard for seven out of 10 days. The maximum hourly change briefly exceeded the limit and reached 3.0cm/hr on three dates. The mean hourly change was under 2.5cm/hr throughout the rampdown in August and October, with a range of 1.1 to 2.4. Whenever the ramp rate exceeded the target 2.5cm/hr, crews notified the BC Hydro electrician on site. Ramping was immediately halted until the hourly ramp rate returned to below the target maximum levels. Appendix Table A5.1 is a summation of the amount of time it takes to observe the stage changes down the river, after gate manipulation at the dam. As the LLO gate flow decreases, the velocities within the main river channel decrease. Subsequently, stage effects downstream take longer to observe the more the river is ramped down. This table can be used for planning purposes for future ramp downs.

10.1.2 **Water Temperature and Turbidity**

Hourly water temperatures during the ramp down are presented in Figures 14 (August), 15 (October) and 16 (November) for four sites within the study area (Rkm 39.9; Rkm 36.5; Rkm 33.3; and Rkm 30.4). Annual mean daily temperatures by reach for all of 2012, and a comparison of temperatures by reach to 2011 and the 3 $^3s^{-1}$ water budget are presented in Appendix Figures A2.1- A2.3. In addition, mean inter-daily water temperature fluctuations for each reach are presented in Appendix Figures A2.10 – A2.12. Mean turbidities of water samples were collected at the plunge pool at the start and end of each flow change. Figure 17 presents those results.

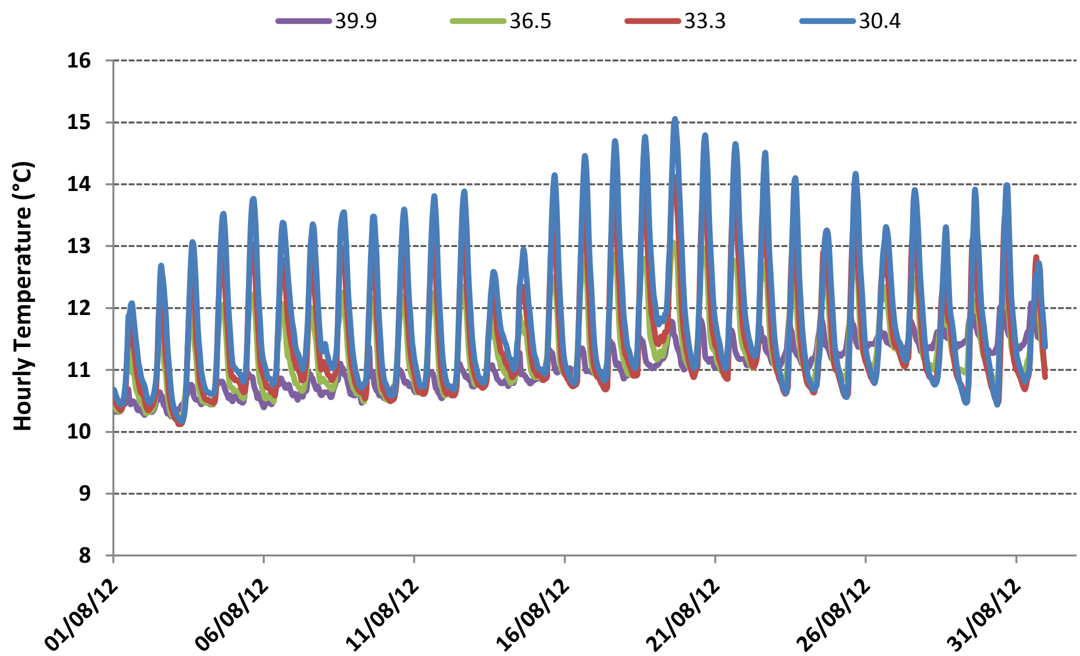

Figure 14. Hourly water temperatures recorded from the Lower Bridge River at ca. 3 km intervals downstream of Terzaghi Dam, August 2012.

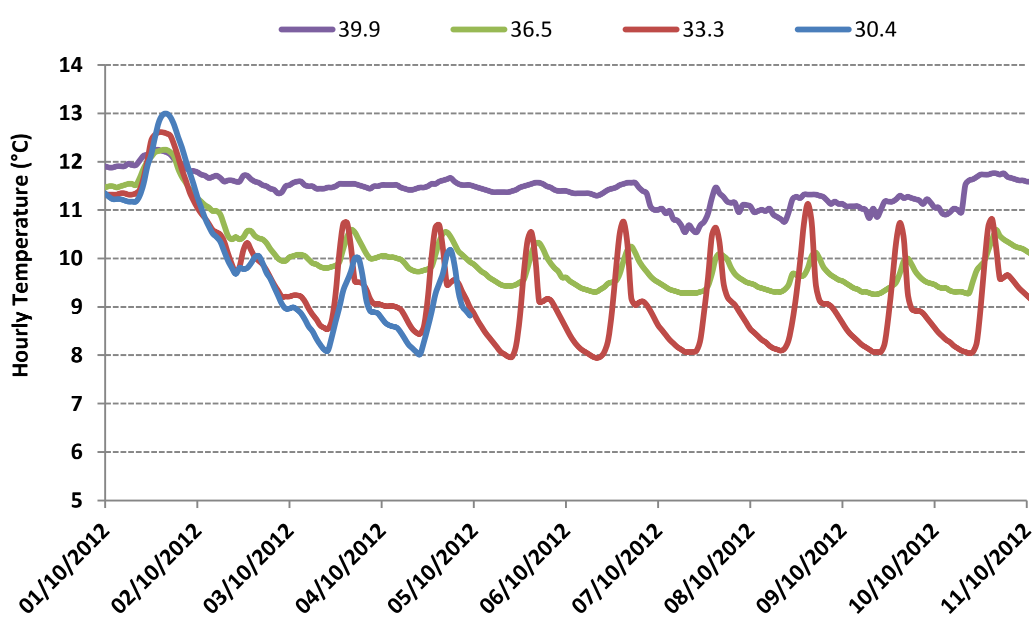

Figure 15. Hourly water temperatures recorded from the Lower Bridge River at ca. 3 km intervals downstream of Terzaghi Dam, October 2012.

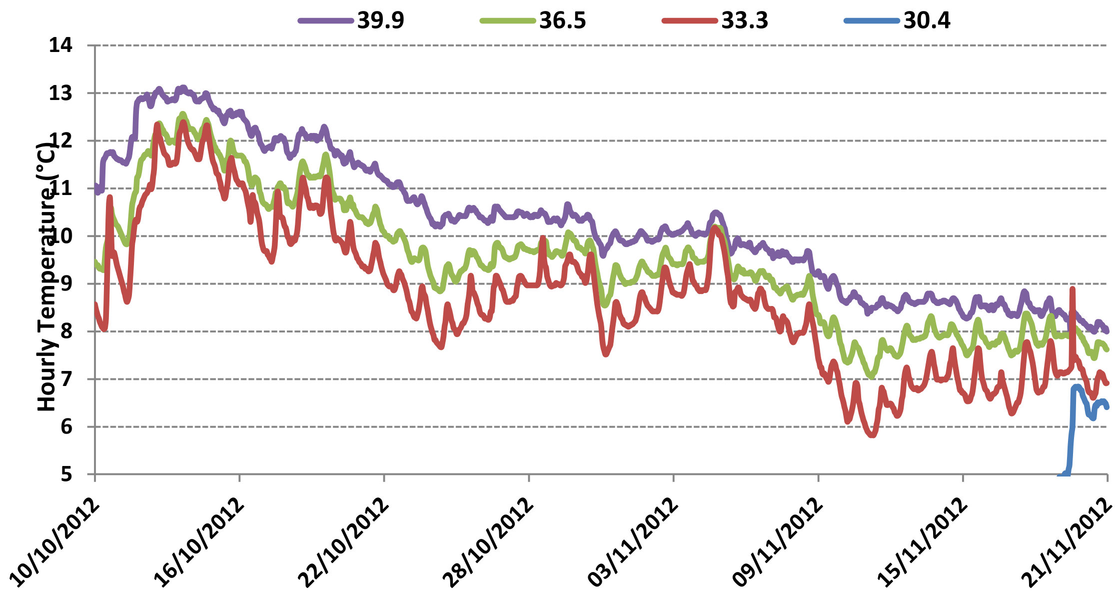

Figure 16. Hourly water temperatures recorded from the Lower Bridge River at ca. 3 km intervals downstream of Terzaghi Dam during most of the duration of the gate malfunction in October and November, 2012.

The 6 m^3s^{-1}. annual water budget resulted in cooler temperatures during the rampdown events in August and October, relative to the 3 and 0 m^3s^{-1} flow regimes. These data are similar to those reported in 2011, and the predominant factor influencing temperature in Reaches 3 and 4 is the flow release coming from Carpenter Reservoir. These cooler temperatures were evident briefly before the LLO gate malfunction. However, during the start of the gate malfunction, water temperatures (most strongly exhibited in Reaches 3 and 4) steadily decreased over days, then increased rapidly, and finally experienced a sharp drop in temperature. For the fall spawning season, 2012 water temperatures were definitely warmer than in 2011 and no cooler than mean water temperatures during Trial 1. See Section 4.1.2 for earlier discussion on water temperature during the gate malfunction and Figure 7 for mean daily temperatures for each reach during the duration of the gate malfunction.

No obvious changes in turbidity measurements were observed during the ramp down events (Figure 17). In August, turbidity was generally between 2 and 9 NTUs and did not differ more than 1 NTU from start to finish of the ramp. The October turbidity measurements were much higher than August (ranging from 12.5 to 16 NTUs) and did not differ more than 1 NTU from the start of the ramp until the end. This high turbidity can likely be attributed to Bridge Glacier silt, which settles in the old Bridge River channel at the bottom of Carpenter Lake during summer glacial melt. The sediments from this melt gradually making its way through the dam and into the Lower Bridge River through the LLO gates during the early fall season. Similar to temperature, no consistent or obvious trends in turbidity were observed in the results that could be attributed to direct impacts from planned flow ramp down events.

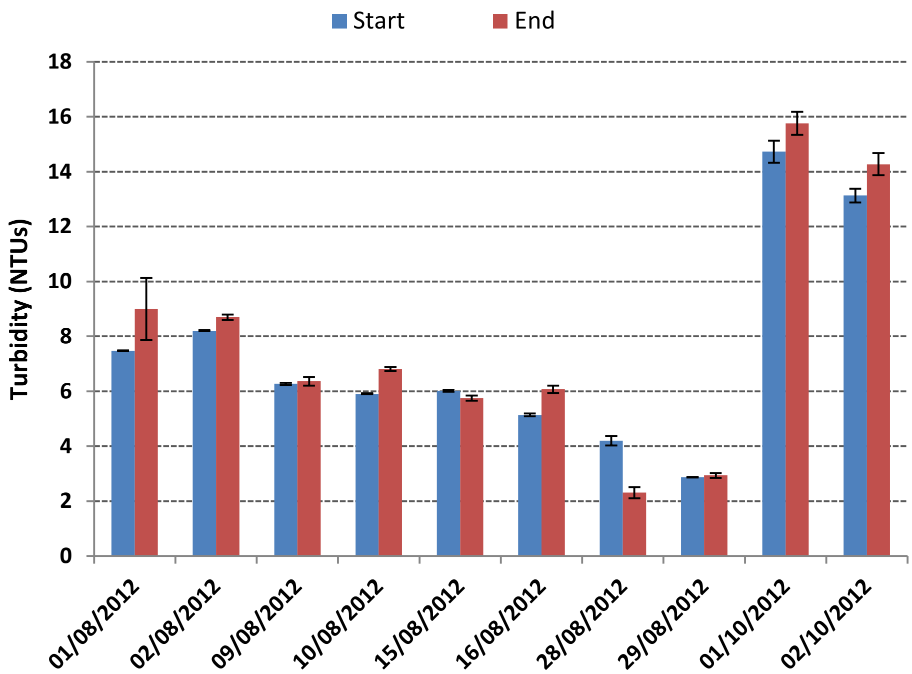

Figure 17. Mean turbidities recorded for water samples collected at the start and end of flow changes on each ramping date, August and October 2012. Black lines represent standard deviation for the individual measurements.

10.1.3 **Physical Habitat Attributes**

A summary of the physical habitat attributes recorded for each of the fish salvage locations during both the August and October ramping periods is provided in Table 8. These data and attributes were recorded in 2011, the first year of the 6 m^3s^{-1} flow trial.

Table 8. Summary of site attributes for all fish salvage locations on the Lower Bridge River between Terzaghi Dam and the Yalakom River confluence.

Reach	Rkm	Site Name	Bank	Easting	Northing	Area (m^2)[a]	Description
4	40.6	Rkm 40.6	L	555338	5626404	75	Isolated pools
4	39.9	Rkm 39.9	L	555649	5626314	30	Small bar
4	39.8	Long Skinny	L			45	Grassy edge
4	39.7	Rkm 39.7	R			75	Grassy edge/SC and isolated pool
4	39.6	Rkm 39.6	L			30	Side pool
4	39.5	Eagle Lake	L	556253	5626520	3900	Grassy bench
4	39.2	Bluenose	L	556759	5626389	140	Short SCs
4	37.0	Rkm 37.0	L	557539	5627014	525	Isolated pools/SC
4	36.9	Rkm 36.9	L	558225	5626775	45	Isolated pools
3	36.6	Rkm 36.6	L	558250	5627275	150	Isolated pools/SCs
3	35.9	Rkm 35.9	L	558033	5627045	680	Network of SCs and isolated pools
3	33.3	Rkm 33.3	L	558109	5629483	120	Sidechannels
3	30.4	Russell Springs	L	556469	5631133	210	Sidechannels
3	28.8	Hell Bar	R	555900	5632500	625	Sidechannel
3	28.4	Rkm 28.4	L	555703	5632380	280	Network of SCs
3	26.4	Rkm 26.4	L	557275	5634375	150	Isolated pools/SC
3	26.4	Grizzly Bar	R	557275	5634375	2050	Sidechannel
3	26.3	House Rock	L	556981	5634545	75	Isolated pools/SC
3	25.5	Hippy Pool	L	557698	5634815	120	Isolated pools
3	25.0	Yalakom Confl.	R	558183	5635000	80	Sidechannel
Total Fish Salvage Area						**9405**	

It is important to note that due to access issues and safety considerations related to river crossing, it was not possible to survey much of the river-right side of the channel on most of the August ramp dates. In addition, due to a lack of personnel available to monitor the rampdown, inconsistencies in data collection and new crew on the river, not all sites were visited, or recorded as visited during the ramp down.

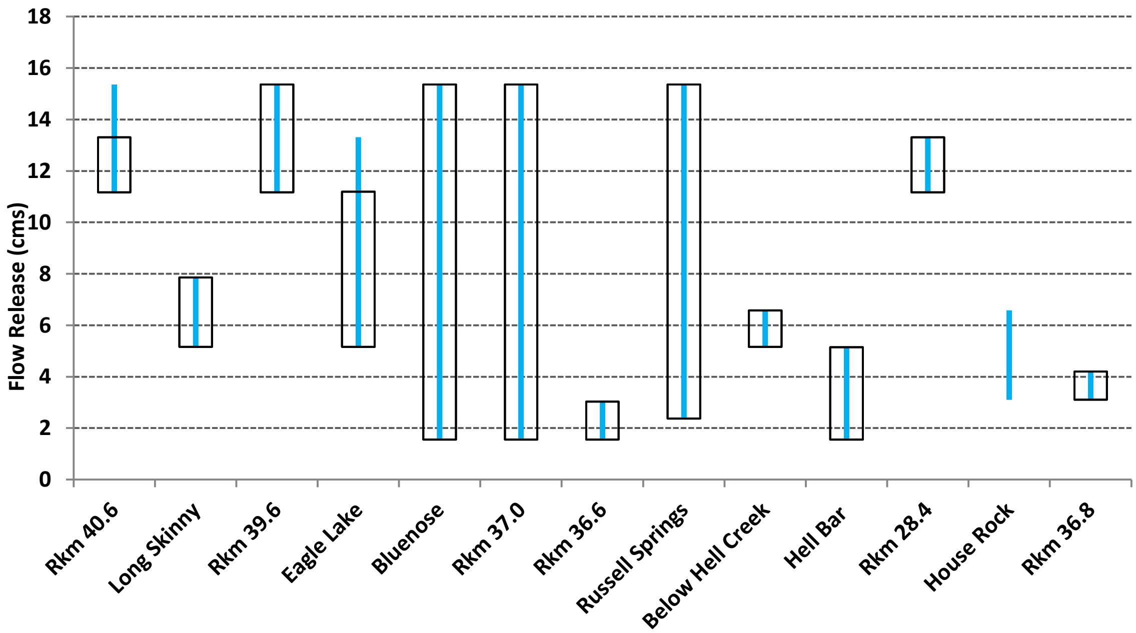

Figure 18. Range of flows where fish salvage operations were required at each site during flow ramping in 2012. The vertical light blue lines indicate the flow changes that required incidental fish captures as fish were being 'pushed' out of dewatering habitats. The solid black rectangles indicate the flow ranges where isolated habitats were observed and active fish salvaging was conducted.

Figure 18 presents a summation of salvage operations, per site, per flow release level in August and October 2012. As some sites may not have been visited in 2012, Figure 9 from the 2011 data report (Crane Creek Enterprises 2012) should be used as a tool for timing and salvage operations per level of flow release, in future years, rather than Figure 18, above. It is recommended that data collection sheets, including a site check list, be developed to ensure consistency in data collection at each site, but also to ensure sites are visited at appropriate times.

10.1.4 **Fish Salvage**

A series of tables below (Tables 9 - 13) summarize the number of fish salvaged by date, type of activity (e.g. incidental “push” or active salvage), species and age-class, and reach. In total, 3,318 fish were salvaged during the ramp down events in August and 456 in October. Salvaging isolated fish, i.e., fish that were still in wetted habitat but were isolated from the main channel, made up the majority of salvage type throughout both of the ramp downs (63% in August, 70% in October). Very few fish out of the total were mortalities (3%), and this result is similar to that presented in 2011 (i.e., 6%, Crane Creek Enterprises 2012). Even fewer (<1%) were found stranded in dewatered habitat but still alive. The remainder of fish were considered incidental captures, which means that fish were occupying habitat that was still connected to the main flow, and were “pushed” or encouraged to vacate habitat areas that would isolate or dewater as the ramp down continued. Overall, total percentage capture for August was 33% Incidental, 63% Isolated, 3% Mortalities, and <1% Stranded. In October, percentages of capture were approximately 25% Incidental, 70% Isolated, 5% Mortalities, and zero Stranded.

Table 9. Summary of numbers of fish salvaged by ramping date, August and October 2012.

Date	Incidental	Isolated	Morts	Stranded	Total
01-Aug-12	25	165			190
02-Aug-12	65	187	5	12	269
09-Aug-12	55	602	18		675
10-Aug-12	140	373	40		553
15-Aug-12	12	520	20	12	564
16-Aug-12	40	190	12		242
28-Aug-12	375	38			413
29-Aug-12	392	20			412
August Totals	**1104**	**2095**	**95**	**24**	**3318**
01-Oct-12	113	78	8		199
02-Oct-12		240	17		257
October Totals	**113**	**318**	**25**	**0**	**456**

With the exception of 10 fish, all fish salvaged during the August ramp down event were comprised of age-0+ coho and rainbow trout. Similar proportions are evident in the October ramping. Age 0+ coho represented 32%; age- 0+ rainbow trout 61%; and rainbow age 1 represented 7% of the catch. Most of these fish (i.e., the age-0+ class) prefer shallow, grassy, protected habitat for rearing. Unfortunately, this habitat type is likely to dewater when flows are ramped down in the Lower Bridge River.

Table 10. Summary of numbers of fish salvaged by species and age class, August 2012.

Species and Age Class	Incidental	Isolated	Morts	Stranded	Total	% of total catch
CAL - 0+	8				8	<1%
CO - 0+	385	1226	58	6	1,675	51
RB - 0+	709	869	37	18	1,612	49
RB - 1	2				2	<1%

Table 11. Summary of numbers of fish salvaged by species and age class, October 2012.

Species and Age Class	Incidental	Isolated	Morts	Total	% of total catch
CO - 0+	48	98		146	32
Lamprey - 0+		3		3	<1%

RB - 0+	65	199	13	277	61
RB - 1		18	12	30	7

Most of the fish salvaged in August were captured in Reach 4 (67%). In October, most of the fish were salvaged from sites in Reach 3 (83%). This is because Reach 4 has a higher elevation gradient in between the main channel and preferred habitat areas that dewater relative to the other reaches, as well as a higher overall fry density. Consequently, Reach 4 sites tend to dewater earlier than sites in Reach 3 (Crane Creek Enterprises, 2012).

Table 12. Summary of numbers of fish salvaged by Reach, August 2012.

Reach	Incidental	Isolated	Morts	Stranded	Total	% of total catch
3	807	284			1091	33
4	297	1804	95	24	2220	67

Table 13. Summary of numbers of fish salvaged by Reach, October 2012.

Reach	Incidental	Isolated	Morts	Total	% of total catch
3	113	254	12	379	83
4		64	13	77	17

Figures 19 and 20 present the number of fish captured per site, by salvage condition in August and October, respectively. In August, Eagle Lake represented a significant salvage location, with > 1,200 fish salvaged there. Hell Bar fish numbers neared 800 requiring mostly incidental salvage activities. Numbers of fish salvaged exceeded 200 at Russel Springs, Bluenose, 37.0 and Long Skinny. In October, Site 36.6 was the most significant sight in the salvage, requiring the capture of nearly 300 fish. All other sites where active salvage activity occurred in October retrieved fewer than 100 fish. Grizzly Bar and House Rock, two main salvage sites in the 2011 ramp down events, remained connected to main channel flow throughout the rampdown in October due to manual habitat modifications (i.e, trenching and boulder removal).

Table 14 presents the mean, minimum and maximum forklength measured by species and age-class. In summation, by implementing salvage activities in August and October, the majority of fish were successfully salvaged prior to stranding or subsequent mortality.

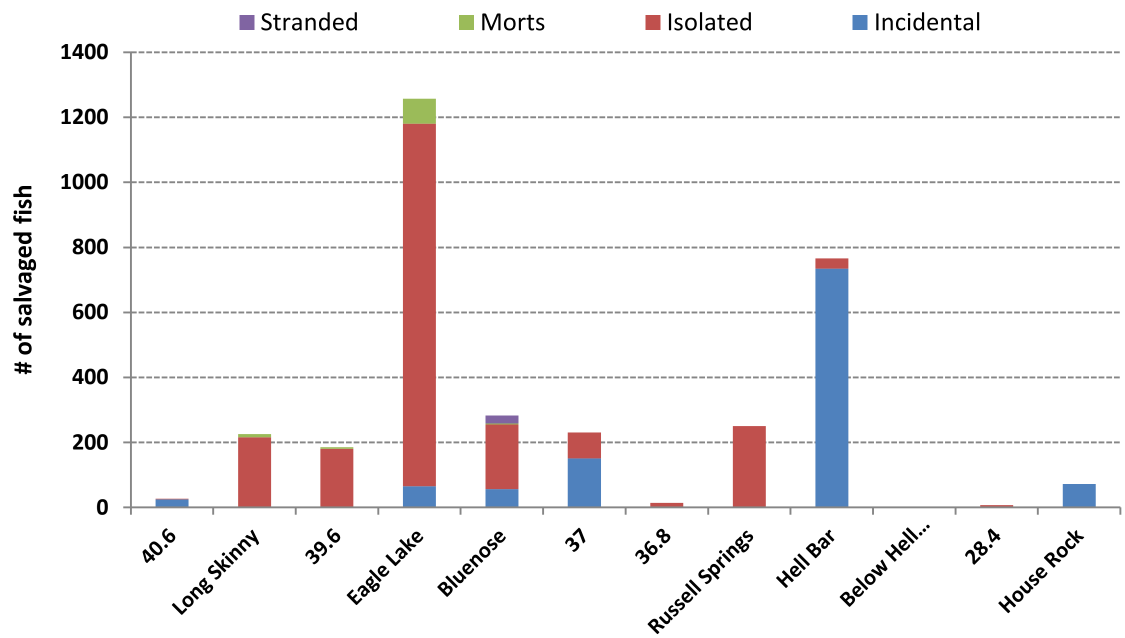

Figure 19. Numbers of fish salvaged by condition at capture for each site during the rampdown events in August 2012.

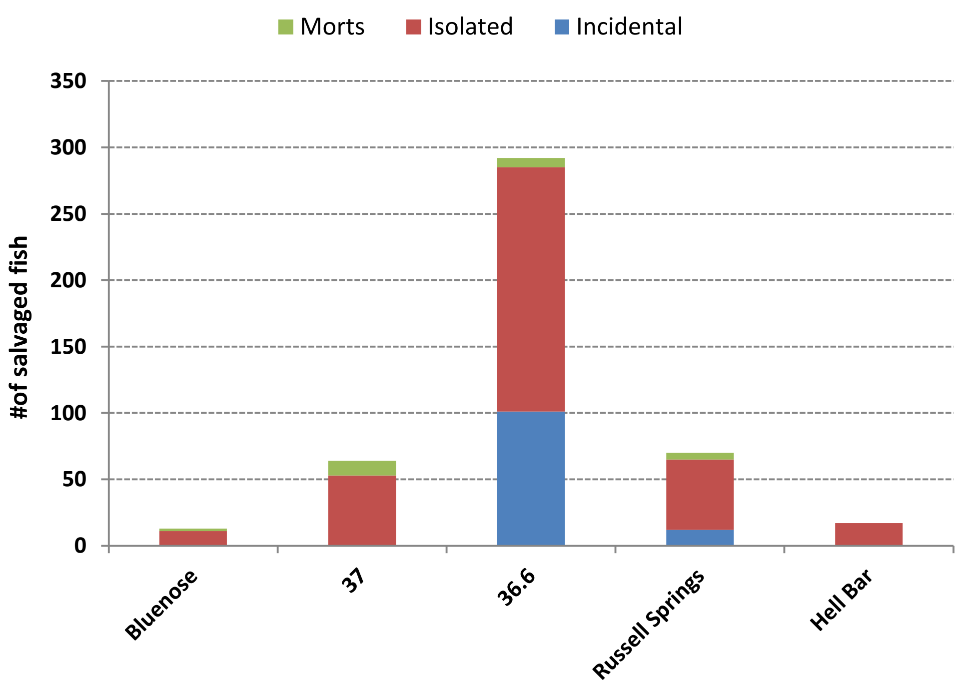

Figure 20. Numbers of fish salvaged by condition at capture for each site during the rampdown events in October 2012.

Table 14. Summary of sizes for fish that were measured for forklength, August 2012.

Species and Age summary	*n*	Min of FL (mm)	Max of FL (mm)	Mean Length
CO - 0+	95	29	70	44
RB - 0+	73	22	45	32

10.1.5 Recommendations and Discussion

In 2012, rampdown surveys were conducted to the greatest extent possible. However, the overall work that was completed was not as thorough as that in 2011. This was partially due to the LBR Aquatic Monitoring Program being in managerial transition; however, additional issues and recommendations were present and are discussed further.

Datasheets currently do not exist for any LBR rampdown methods or protocols. Datasheets would streamline workflow, increase quality assurance and control, and diminish missing data. Maps of the LBR specifically designed for rampdown surveys, which currently do not exist, would increase logistical inefficiencies related to navigation as well as aide in planning at tailboard meetings. Historical maps of the various affected dewatered areas during the various stages of rampdown would increase efficiency and the overall efficacy of the rampdown survey.

In comparison to 2011, the 2012 rampdown survey had a smaller work force. A reduced workforce most greatly impacts the amount of fish salvage operations that can be conducted. Another concern that was identified after the rampdown surveys were conducted was a lack of overall project coordination and centralized leadership. Without the proper oversight, some members of the team were not aware to whom they were accountable. This created difficulties in logistical planning, organization, and collecting data in a consistent, high quality and complete manner.

After presenting the former discussion points, we propose the following as recommendations for the 2013 rampdown surveys:

- Provide datasheets and LBR rampdown maps.
- Promptly transcribe paper datasheets to digital format as soon as possible
- Maintain a viable, trained, and safety-oriented workforce

An incident command system or equivalent should be in place to provide needed leadership and coordination.

11.0 APPENDIX C

11.1 Chinook Life History Sampling

The chinook pilot program strategy and sampling design was refined and planned. During implementation year 2, the program will undertake a reconnaissance effort to determine the feasibility of using otolith microchemistry analysis, specifically targeting non-physiological elements (i.e., Ca, Ba, Sr) to address these data gaps in the Lower Bridge River. Shrimpton et. al. (2009) have used this approach to identify the rearing locations and movements of juvenile chinook salmon in nearby watersheds. Elemental chemistry will be measured and analyzed within fish otoliths and water chemistry data. Examination of water chemistry data for the Lower Bridge River will be undertaken to determine if sufficient differences in elemental signatures can be detected within the river system, including the Yalakom River and the Fraser River. Based on data provided by the analyses, if the technique proves successful, a model to discriminate the rearing habitats selected during the juvenile phase will be developed, similar to the model described in Golder and Associates 2010. If it is determined that this methodology may not work for the Lower Bridge River, an alternative strategy will be developed.

Eight sites have been chosen for proposed locations of fish and water sampling:

1. Fraser River Confluence (at and below confluence);
2. Reach 1: Access from Applespring Creek Restoration Site on River Right;
3. Reach 2: Camoo Creek;
4. Yalakom River Confluence (at and below confluence);
5. Reach 3: Series Sampling Site 33.3
6. Reach 3: Series Sampling Site: 26.4
7. Reach 3: Series Sampling Site: 36.5
8. Reach 4: Series Sampling Site 39.9

Five juveniles from each site will be the initial collection goal in the first year. Water samples will be collected seasonally (early spring, summer and fall). Adrian Clark was identified as the otolith specialist who will be subcontracted to conduct the chinook life history microchemistry analysis and reporting in implementation year 2. He has several years of experience with otolith analysis and microchemistry, and has been involved in a similar study in the Peace River Watershed with BC Hydro. ALS laboratory will be conducting the dissolved trace metals analysis.

12.0 APPENDIX D

12.1 Details regarding methods and locations of sampling sites.

The sections below detail the methodologies and site locations for the following monitoring components: water sampling, chlorophyll sampling, temperature logger download locations and reference photographs are included below. These procedures, methodologies, and specific site locations were amalgamated in 2012.

12.1.1 Nutrient Samples Collection Procedure

Below is a description of the specific methods for the Lower Bridge River Water Sampling. This task is usually completed by 1 biologist and 1 technician.

BEFORE YOU HEAD INTO THE FIELD:

Supplies needed for LBR Water Sampling:

- 2 x 1L bottles of Distilled De-ionized Water (DDW)
- 16 Large (500 mL) plastic bottles
- 34 Small (250 mL) plastic bottles
- 80 Glass vials (in 2 plastic vial holders)
- Sticky labels (80 round; 50 square shaped)
- 1 to 2 Syringes (60 cc)
- Ashed filters (at least 20 so you have a few extras)
- 1 to 2 Filter holders (light blue or cream-colored)
- Handheld pH & conductivity meter (there are two of them -- one is a backup or spare; Use the blue one as the primary meter.
- Ball point pen (important, so the ink doesn't run on the labels when they get wet)
- Field notebook
- Extra cooler (for putting filled sample bottles into)
- Blunt-tip tweezers
- Backpack or cruiser's vest
- Small bag for used filters and any other garbage

- Fill out the round labels as follows (4 for each Site):
  - TP-'A' **OR** TP-'B' **OR** TDP-'A' **OR** TDP-'B' (The TPs are the 2 replicates for Total Phosphorus and the TDPs are the 2 replicates for Total Dissolved Phosphorus)
  - Sampling Date (i.e., 9-Oct-12)
  - Site Name (Name on Label from Table above)

- Fill out the square labels as follows (3 for each Site):
  - Alk. **OR** Nit. **OR** SRP (Alk. = Alkalinity; Nit. = Nitrates/Nitrites; SRP = Soluble Reactive Phosphorus)
  - Sampling Date (i.e., 9-Oct-12)

- Site Name (as above) -- **Note: There is no Alkalinity sample for the blank**

- Attach the round labels to the tops of the glass vial lids ahead of time (each site gets a row of 4), but leave the bottle labels until you are in the field.

- Calibrate the pH/Conductivity meter. There should be a few laminated sheets with explicit calibration instructions in the case for the meter. You will need the pH 4.0, pH 7.0, and 1412 uS/cm conductivity calibration solutions which Steve also has. The pH probe is the blue and white one with a fitted rubbery cap on the end, the conductivity probe is all black with no cap. Just put enough calibration solution in the small labelled bottles (in the case) to submerse the probe tips. You can pour a small amount of the DDW to rinse the probes between calibration solutions and use a tissue to wipe them off. Note: the calibration solutions may have recently expired. They are probably fine to use for this season, but some new solutions should be ordered for next year (from Hoskins Scientific).

Table 15. Site names and sampling locations for water collection (i.e., nutrients and chlorophyll).

Name on Label	Full Site Name	Site Type	Sample Location
Carp Surf	Carpenter Reservoir Surface	Reservoir	From Boat Ramp above Dam
39.9	River km 39.9	LBR Mainstem	By Plate/Basket 'B'
36.5	River km 36.5	LBR Mainstem	By Plate/Basket 'C'
Mission	Mission Creek	Tributary	Just above mouth
33.3	River km 33.3	LBR Mainstem	By Plate/Basket 'A'
Yankee	Yankee Creek	Tributary	Side of Road 40
Russell Sp	Russell Springs	Tributary	Side of Pull-out
30.4	River km 30.4	LBR Mainstem	By Plate/Basket 'C'
Hell	Hell Creek	Tributary	Side of Road 40
Michelmoon	Michelmoon Creek	Tributary	Side of Road 40
26.4	River km 26.4	LBR Mainstem	By Plate/Basket 'C'
Yalakom	Yalakom River	Tributary	Upstream side of Road 40 bridge
23.6	River km 23.6	LBR Mainstem	By Plate/Basket 'B'
Antoine	Antoine Creek	Tributary	Upstream side of Road 40
20.0	River km 20.0	LBR Mainstem	By Plate/Basket 'C'
Camoo	Camoo Creek	Tributary	Mouth of pond, just above culvert
Blank	N/A	N/A	N/A

<u>IN THE FIELD:</u>

- When you get to your first site (and before every site thereafter):
  - Grab the 4 glass vials for that site (i.e., Carp Surf);
  - Apply the Nit. and SRP square labels to the sides of two SMALL bottles for that site;
  - Apply the Alk. square label to the side of a LARGE bottle;

  - Open one of the filter holders (if it isn't already);
  - Open the cannister of ashed filters (be careful if it's windy as they blow away easily!);
  - Using the blunt-tipped tweezers (not your fingers!) grab a filter, making sure you take just one, and place it bumpy-side up on the round plastic screen in the filter holder; After the filter holder is wet (e.g., after first use) the filter will absorb the moisture and adhere itself to the screen;
  - Put the top of the filter holder in place (align the tabs on the sides into the slots) and screw them together by hand (reasonably tight) using the threaded ring.
  - Pull the plunger all the way out of the syringe; Hold the syringe upright and cap your finger over the opening at the bottom; Fill the syringe to the very top with DDW; Re-seat the plunger into the top of the syringe (you may have to ease your finger off and let a little water squirt out in order to get the plunger in);
  - Push the tip of the syringe into the small opening at the top of the filter holder (should fit tightly together, but beware the tip of the syringe can snap off if you're not careful);
  - Prep the filter apparatus: Steadily push the DDW through the filter holder by depressing the plunger and let the water run out onto the ground; There should be a reasonable amount of back pressure due to the filter and the water should all drain out the bottom (if you see water coming out other parts of the filter holder it needs to be tightened or seated together better); Once you've pushed one full syringe through the filter, it is prepped and ready for use;
  - <u>**Be sure to prep the filter (as above) every time before collecting a sample from each site!**</u>
  - Go to the sampling location

- At the sampling spot for each site:
  - Remove the cap from the pH probe and place the tips of both the pH and conductivity probes in flowing water (unfortunately, I don't think the tops of the probes are waterproof where the wires go in, so do your best to just submerge the tips--e.g., hang from a branch, drape over a rock, etc.); Set the pH/Conductivity meter on the ground and let it equilibrate while the water samples are collected;
  - <u>**Dunk Samples**</u>: Collect the <u>**TP-'A'**</u> and <u>**TP-'B'**</u> and <u>**Alk.**</u> samples by dunking the 2 glass vials and large plastic bottle (respectively) a couple inches below the surface of the water; It is important to be below the surface so you aren't collecting the scuz that may be floating on the top; Fill the vials and bottle until the meniscus is within the 'shoulder' on the glass vials, and the volume is up to the 'shoulder' on the bottle as well; Replace lids; Note: if you over-fill a vial, you can remove small amounts of volume by holding the vial upright and ‘jerking it’ away from you; if you over-fill a bottle, just pour the excess out;
  - <u>**Filtered Samples**</u>: Collect the <u>**TDP-'A'**</u>, <u>**TDP-'B'**</u>, <u>**Nit.**</u> and <u>**SRP**</u> samples by plunging the tip of the syringe (no filter holder attached!) an inch or so under the surface of the water (being careful not to suck anything up off the bottom!); draw back the plunger to completely fill the syringe; attach the filled syringe to the prepped filter holder (as above), place over the open mouth of the sample container to be filled, and depress the plunger to fill through the filter (again, be careful not to break the syringe tip); As with the dunk

samples, fill each to within the 'shoulder' of the vial or bottle and replace the lids; One full syringe will fill both vials, but it will take 2 syringe-fulls to fill each small bottle;
    - Record the **Time, pH, Conductivity (uS/cm)**, **mV**, and **water temperature** in the field notebook for each site once the meter has equilibrated/stabilized; Turn the meter off between sites to conserve battery life and replace the cap on the pH probe (which protects the fragile glass tips);
    - Return to vehicle;

- At the vehicle:
    - Place the filled sample bottles and vials into 2nd cooler;
    - Open filter holder; remove used filter using tweezers and discard into garbage bag;
    - Replace with new filter (bumpy-side up) and prep with DDW as described above;
    - Grab vials and label bottles for next site;
    - Put all supplies for next site and pH/Cond. meter into backpack or cruiser's vest;
    - Drive to next site (Note: Mission Creek (across from "Cobra Mine" is the only location that requires waders -- you need to cross the LBR mainstem in order to access this site)

- Collect the Blank Sample
    - Pour DDW into the two TP tubes (A & B) with 'Blank' on the label instead of a site name; fill until the meniscus is within the 'shoulder' of the vial. If you over-fill the vial, you can deal with the excess volume as described above;
    - For the filtered samples (TDP tubes, Nit, and SRP) start with a fresh filter and rinse it with DDW through the filter holder as you would at any other site;
    - To start collecting the blank "sample", do it the same as you do to prep the filter only collect the filtered water in the sample containers: i.e., open the syringe, cap your finger over the bottom, completely fill with DDW, re-seat the plunger, fit syringe tip into top of filter holder, depress plunger, fill sample container, and repeat until each container has the appropriate volume;
    - You should have enough DDW to fill the 4 vials and 2 small bottles, but there isn't always a lot extra for spillage!
    - **There is no Alkalinity sample for the Blank**.

FIELD DIRECTIONS FROM LAB:

For TP samples, at each depth, fill labeled test tube with unfiltered sample water, cap, shake tube to rinse and discard sample water. Refill test tube with unfiltered sample water. **Be sure to fill the test tube completely**. Put lids on tightly and make sure all labels are legible and state the lake, station, date, depth and test. Once per field trip, prepare 2 labeled test tubes with unfiltered DDW for TP blanks**. Do not freeze test tubes, but keep them cool**.

Avoid finger contact with filters, use only clean blunt-nosed forceps to handle filters. For the plastic bottles and TDP tubes, use a 47-mm Swinnex holder with an ashed GFF filter and a clean 60-cc syringe. Prepare GFF filter by placing it in the Swinnex holder and rinsing it with 3 full syringes of DDW. If the water runs through with little or no resistance, the filter is either torn or not seated properly in holder. Readjust filter or replace it if readjustment does not rectify the problem. Use one ashed GFF filter for each station unless filtering efficiency becomes hampered (i.e. filter becomes plugged).

For nitrate or ammonia/srp samples, at each depth, filter one full syringe of sample water into the appropriate labeled plastic bottle. Put cap on bottle, shake, and discard sample water. Refill bottle to the shoulder with filtered sample water. Put lids on tightly and make sure all labels are legible and state the lake, station, date, depth, test (Ammonia/SRP or NO3) and **freeze bottles immediately** after filtration. Once per field trip, prepare 2 filtered DDW blanks for Ammonia/SRP and Nitrate tests.

For TDP samples, at each depth, filter one full syringe of sample into the appropriate labeled test tube. Put cap on test tube, shake and discard sample water. Refill test tube with filtered sample water. **Be sure to fill the test tube completely**. Put lids on tightly and make sure all labels are legible and state the lake, station, date, depth and test. Once per field trip, prepare 2 labeled test tubes with filtered DDW for TDP blanks. **Do not freeze test tubes, but keep them cool**. **Use only round labels on test tubes** and do not write on the tubes or place extra labels on the side of the test tube (this creates a lot of unnecessary extra work for the lab personnel before the samples can be processed).

Be sure not to touch the test tube mouth or inside of the cap as the Total Phosphorus and Total Dissolved Phosphorus analysis are extremely sensitive.

<u>WHEN YOU RETURN:</u>

- Preserve the Samples until they can be shipped to the Powerteck Labs as follows:
  - Put the glass vials and Large Alkalinity bottles in the fridge (make sure they don't freeze or the glass vials will break);
  - Put the Nit. and SRP bottles in the freezer;

- Fill out the water sample record (attached to the email), print, and send along with each set of samples so the lab knows what they are getting and you have a record of what was collected and sent. Take the samples out of the fridge/freezer just before they will be shipped and pack carefully so the vials are reasonably protected from breakage in transit. Cover the samples with cubed ice to keep them cool/frozen as long as possible.

- After the September (Fall Series In) set of samples are collected, arrange with the lab to have another set of supplies prepared for the November session (Fall Series Out) sampling. This way you may be able to coordinate delivering the samples to the lab and picking up the next set of supplies at the same time, or some such efficiency.

- Take the last filter out of the wet filter holder and leave open to the air to dry; Separate the syringe and plunger; Dry out the cooler(s); Wipe off the pH/Conductivity probes (if dirty) and **<u>Important! Pour a small amount of electrolyte solution into the pH probe cap before putting it back on.</u>** This solution helps maintain the appropriate electrolyte balance within the probe between uses.

Shipping Procedure

When ready to ship samples, send an e-mail with the courier waybill information and reference number to Powertech Labs. If you are planning on sending samples later in the week, be sure that you have confirmed with the courier company that they can have the samples to the lab earlier in the day on the Friday. If possible, it is best to ship the samples early on in the week. It is very important that the waybill information and reference number are sent so that the samples can be tracked down if they do not arrive when they are expected at the lab.

Make sure that nutrient samples are kept frozen and test tubes cool during transport. This is critically important so use as much cubed ice as necessary. Be sure to use lots of cubed ice (do not use ice packs as they will not keep the samples frozen) and protect the test tubes so that they will not freeze or break during transport. . Prepare a field sample submission sheet and submit it along with the sample.

12.1.2 **Chlorophyll Sampling**

For chlorophyll samples, use only clean blunt-nosed forceps designated to handle only chlorophyll filters and a 47 mm filter holder that has been taped with black electrical tape to limit light exposure. Open the filter holder and insert the chlorophyll filter, making sure that the o-ring is seated properly in the filter holder. Place the filter holder into the top of the vacuum flask and attach to a pump that is regulated to 7 inches Hg. Rinse graduate cylinder with sample water and then filter a suitable sized aliquot of lake water, usually between 250 - 500 mls is sufficient. Preserve the filtered sample by placing the filter, folded in half in an aluminum weighing dish. Make sure that the dish has been labelled with the lake, station, date, depth and **filtered amount** on the bottom of the dish with a nail or dry pen (**do not use a pen with ink**). Aluminum dishes may be stacked (make sure that the top filter is covered with an empty dish) and tape together using masking tape. Make sure that the tape is labelled for easy identification in the lab. Place stack in a whirlpac bag or ziploc and **freeze immediately. Chlorophyll samples must be kept in the dark and frozen at all times.**

12.1.3 **Lower Bridge River Temperature Logger Locations**

Table 16. Site names and sampling locations for temperature loggers

Site	Reach	Location
39.9	4	Cable tethered to rock bolt for ‘A’ plate & basket
36.5	3	Cable tethered to rock bolt for ‘C’ plate & basket
33.3	3	Cable tethered to rock bolt on river-left boulder d/s of ‘C’
30.4	3	Cable tethered to tree on river-left adjacent to ‘A’
26.4	3	Cable tethered to rock bolt on river-left boulder next to ‘C’
Yal. R.	N/A	Cable tethered to tree on river-right just d/s of road bridge
23.6	2	Cable tethered to rock bolt for ‘A’ plate & basket
20.0	2	Cable tethered to rock bolt for ‘C’ plate & basket

Note: All of the temperature loggers are attached to a piece of angle-iron with a zap strap and weighted with a piece of substrate to help hold them in place during high flows (otherwise they can tend to come to the surface or end up out of the water).

12.1.4 **Photograph Reference Site Descriptions**

Table 17 details each of the site locations for the reference photographs that are taken throughout the year. These photographs are taken for BRG MON-16.

Table 17. Lower Bridge River Site Reference Photos Descriptions (Also refer to the set of Sample Reference Photos) taken for BRGMON-16

Site	Upstream Photo	Across Photo	Downstream Photo	30 sec Video Direction	Comments
Dam	Reservoir	-[a]	Plunge Pool	-	From top of dam
39.9	Yes	Yes	Yes	D/S	Series Sampling Site
36.5	Yes	Yes	Yes	Across	Series Sampling Site + additional D/S photo below 36.5 ‘C’
35.3	-	-	Yes	-	From Road Edge
33.3	Yes	Yes	Yes	Across	Series Sampling Site
33.1	Yes	-	Yes	D/S	Slide on River Right
30.4	Yes	Yes	Yes	Across	Series Sampling Site
29.3	Yes	-	Yes	-	Above Stock Ass. site 29300
28.0	-	-	Yes	-	Repeat 28.0_DS1 Photo (Others provided for location reference)
26.4	Yes	Yes	Yes	Across	Series Sampling Site
25.5	Yes	Yes	Yes	D/S	Immediately u/s of Yalakom confluence
Yal. R.	Yes	-	Yes	U/S + D/S	From Road Bridge
23.6 Rim	1 shot zoomed out; 1 shot zoomed in			-	From Rim by pull-out on road
23.6 Cabin Island	Yes	Yes	Yes	D/S	From Cabin Island above 23.6 ‘B’
Camoo Bridge	Yes	-	Yes	U/S + D/S	From Camoo Bridge
20.0	Yes	Yes	Yes	U/S	From Right Bank by old bridge footing