Bridge-Seton Water Use Plan

Lower Bridge River Adult Salmon and Steelhead Enumeration

2013

Implementation Year 2

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Executive Summary

The primary focus of the Water Use Plan monitoring program in the lower Bridge River is an evaluation of the effects of different flow releases on juvenile and adult salmon productivity. This monitor is developing new and refining old approaches for adult estimation to provide adult escapement data and thus egg deposition estimates. The data combined with juvenile data collected in Monitor 1, will allow over time the development of river specific stock recruitment models which should allow evaluation of the effects of flow separately from other factors such as marine survival and adult exploitation.

In 2013 as in 2012, data from visual stream walk spawner surveys were utilized to provide area under the curve (AUC) type escapement estimates of salmon to the lower Bridge River. These estimates were generated utilizing radio telemetry mark/recapture techniques to provide residence period and observer efficiency data. Twenty-seven Chinook salmon adults and 29 Coho salmon adults were tagged with radio tags, providing estimates of residence time of 11 and 19 days on the spawning grounds and observer efficiencies of 0.33 and 0.36 respectively. A total spawner estimate of 140 Chinook adults and 2,665 Coho adults were derived for the area upstream of the confluence with the Yalakom River using a maximum likelihood model.

When compared to previous year's visual count surveys, the application of spawner residence time data from the Bridge river collected in the 2012 and 2013 surveys, appears applicable. This is based on out-of watershed data (on file with DFO) and the two years of local validation. The data estimates derived to date appear to be very sensitive to observer efficiency which may be affected by water clarity, weather conditions, potential for tag sightings and the areas surveyed, both within and across years.

Examination of the sensitivity of AUC estimates indicates that small variations or error in calculating observer efficiency or residence data can affect estimates greatly. The installation of a full river fish counter in the fall of 2013 will allow for greatly improved spawner estimates on an annual basis. It will also provide for improved validation of AUC estimates in a historic context. Archived raw data will be examined and will allow for the development of models with multiple direct measures of observer efficiency across total spawners annually. Data for fish counter operations over part of the Coho migration period in the fall of 2013 indicated a partial escapement of 1,804 Coho adults.

Acknowledgments

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INTRODUCTION

1.1 Background

The Bridge River is an important salmon, Steelhead and hydroelectric power producing tributary of the middle Fraser River and has current and historic significance for the St’at’imc Nation. River discharge is affected by BC Hydro through the operation of Carpenter Reservoir (CR) and Bridge River Generating Stations #1 and #2 (BRGS). The river was initially impounded in 1948 by the construction of the Mission Dam approximately 40km upstream of the confluence with the Fraser River. The dam was subsequently raised to its present configuration (~60m high, ~366m long earth fill structure) in 1960 and renamed Terzaghi Dam in 1965. From 1960 to 2000 with the exception of periodic spill releases during high inflow years, all flows were diverted through the BRGS to the adjacent Seton catchment for further power production at the Seton Generating Station (Figure 1). As a result, a four kilometer section of the Bridge River channel immediately downstream of Terzaghi Dam remained dewatered. Downstream of this dewatered reach, the influence of groundwater and small tributaries accounted for the total in river discharge which was 1% of the mean annual discharge before regulation (Longe and Higgins 2002), approximately 1 m^3s^{-1} averaged across the year.

The lack of a continuous flow release from Terzaghi Dam was an issue of long-standing concern for the St'at'imc Nation, federal and provincial regulatory agencies, and the public. During the late 1980s, BC Hydro, the Department of Fisheries and Oceans, and the Provincial Ministry of Environment engaged in discussions over appropriate flow releases from the dam. In 1998, an agreement was reached for a continuous water release from Carpenter Reservoir, via a low-level flow control structure, to provide fish habitat downstream from the base of the dam. The agreement included the provision of a 3.0 m^3s^{-1} interim water budget for instream flow releases. This was based on a hydrograph that ranged from a minimum of 2 m^3s^{-1} to a maximum5 m^3s^{-1}. The Deputy Comptroller of Water Rights for British Columbia issued an Order under Section 39 of the Water Act to allow initiation of the interim flow releases from Carpenter Reservoir into the Lower Bridge River (LBR) and the continual release of water from Terzaghi Dam to the Lower Bridge River began on August 1st, 2000.

In response to concerns raised by the St'at'imc Nation and the regulatory agencies regarding environmental impacts of the introduction of water from Carpenter Reservoir, and the need to develop a better understanding of the influences of reservoir releases on the aquatic ecosystem of the Lower Bridge River, a condition of the Interim Flow Order (IFO) was the continuation of environmental monitoring studies. The Aquatic Ecosystem Monitoring Program was implemented (continuing as BRGMON-1, Bridge-Seton WUP Monitoring Terms of Reference 2012), and was designed to collect data on baseline conditions before the continuous release began, and to measure ecosystem response to the flow trials. Data on baseline conditions (no release flow) was collected from May 1996 to August 2000. The aquatic monitoring program for the 3 m^3s^{-1} hydrograph (Trial 1) was conducted from August 2000 until December 2010 (Sneep and Hall 2011).

The IFO continued until the Water Use Plan (WUP) for the Bridge-Seton system had been approved by the St'at'imc and regulatory agencies, and authorized by the Comptroller of Water Rights for the Province of British Columbia. The Bridge-Seton Water Use Plan consultative process was initiated in September 1999 and completed in December 2001. The Bridge-Seton Consultative Committee (BRS CC) participated in the draft Water Use Plan submitted to the Comptroller in September 2003. Subsequent recommendations by the St'at'imc in 2009 and 2010 were included, and a final WUP was submitted to the Comptroller of Water Rights on March 17th, 2011.

A 12 year test flow release program was proposed under the draft WUP to test three alternative flow release regimes (referred to as: 1 m^3s^{-1}/y, 3 m^3s^{-1}/y, 6 m^3s^{-1}/y treatments) that do not differ in the relative shape of the delivered hydrograph but rather the total magnitude of the flow regime in terms of annual water budget. The flow treatment was subsequently revised, and was set to 3 m^3s^{-1}/y from Aug 2000 to Apr 2011, and will be 6 m^3s^{-1}/y from May 1, 2011 to Apr 15, 2015. Detailed monitoring of physical habitat, aquatic productivity, and fish population response was recommended by the BRS CC and developed by the BRS Fisheries Technical Committee (BRS FTC) to obtain the required information to evaluate the physical and biological responses to instream flow.

The BRS FTC expressed uncertainty about the availability and relative importance of spawning habitat for anadromous species, and how this may affect interpretation of the juvenile salmonid response being monitored in BRGMON-1. Coincident time series data of salmon escapement and juvenile standing crop estimates during the flow trials are required so that any differences can be interpreted as the effects of flow rather than the influence of a spawner density effect associated with low or high numbers of spawners. Accordingly, the BRS CC recommended a monitoring program to evaluate effects of the flow regime on spawning habitat and distribution and to enumerate spawning escapements under the alternative test flow regimes (Adult Salmon and Steelhead Enumeration Program BRGMON-3, Bridge-Seton WUP Monitoring Terms of Reference 2012).
Escapement and distribution of spawning salmonids has been assessed previously on the Lower Bridge River and at various levels of intensity. Previous salmon and Steelhead escapement and distribution in the lower Bridge River have been derived from:

1. Overflight visual counts by helicopter, 1975-2002 (DFO data on file),
2. stream walks, 2002 to 2012 (BC Hydro, data on file),
3. a counting fence in Reach 3 (Figure 1) just upstream of the Yalakom confluence (Diversified Ova Tech Ltd. 1994),
4. Steelhead investigations using stream walks, aerial surveys, snorkel surveys and radio telemetry (Hebden 1981, Hebden and Baxter 1999, Baxter and Roome 1997, Webb et al. 2000, Hagen 2001), and
5. Spawning evaluations (Nishimura et al. 1995a, 1995b).

A secondary objective of the present monitoring program is to build on the previous studies by developing survey methods and analytical techniques that will produce rigorous, quantitative estimates of Bridge River salmon and Steelhead abundance and distribution to assist in evaluating the usefulness of historical archived data.

1.2 Management Questions

This monitoring program addresses two hypothesis:

H_1: Adult spawner escapement is not the limiting factor in the production of juvenile salmonids in the lower Bridge River.

and

H_2: The quantity and quality of spawning habitat in the lower Bridge River is sufficient to provide adequate area for the current escapement of salmonids.

The first hypothesis is associated with the interpretation of the results of the Aquatic Ecosystem Monitoring Program (BRGMON-1). The fundamental management question is related to how informative is the use of juvenile salmonid standing crop biomass as the primary indicator of flow impact. The adult enumeration monitoring program will collect the data needed to support evaluations of whether sufficient numbers of adults of each species are present in the system to produce progeny that would fully seed the available rearing habitat. For Chinook salmon, this will include obtaining an improved understanding of juvenile life history and movements, which is currently being assessed under BRGMON-1 (Sneep and Hall, 2012, Coldstream Ecology, 2013).

The second hypothesis is associated with filling data gaps identified during the development of the WUP. In addition to the value of this program to support interpretation of the findings of the aquatic monitoring program, the BRS WUP process identified that there is significant uncertainty about the quality and quantity of spawning habitat in the Lower Bridge River. The implementation of this monitoring program will improve the utility of the primary aquatic benefit response measure (juvenile standing crop) by relating it to egg deposition and the amount of spawning habitat available compared to adult escapement.

1.3 Key Water Use Decision Affected

The key water use plan decision influenced by the results of this monitoring program is the development of the long term flow regime for the Lower Bridge River. The Adult Salmon and Steelhead Enumeration Program (BRGMON-3) will provide the data needed to support Monitor 1 in the interpretation of the response of the aquatic ecosystem to the varied flow treatments (0 m^3s^{-1} vs. 3 m^3s^{-1} vs. 6 m^3s^{-1}) and thus a better understanding of how instream flow influences salmon spawning and rearing habitat quantity and quality in the Lower Bridge River.

2. METHODS

2.1 Objectives and Scope

The objective of the test flow program is to determine the relationship between the magnitude of flow release from the dam and the relative productivity of the Lower Bridge River aquatic and riparian ecosystem by observing fish responses to test flows. The objectives of BRGMON-3 include documenting the escapement of salmonids to:

1) Ensure changes in standing crop are associated with flow changes and not confounded by variations in spawner escapements due to factors external to the watershed, i.e. marine survival or harvest.

2) Fill data gaps associated with the effects of flow releases on salmon and Steelhead spawning habitat.

The scope of this program is limited to monitoring the changes in abundance and distribution of spawning salmon and Steelhead with particular focus on key stream rearing species in the Bridge River between its confluence with the Fraser River and Terzaghi Dam. Adult salmon and Steelhead escapement on its own is not considered a direct indicator of habitat condition because adult returns are affected by downstream conditions (ocean survival and fishing mortality) and there is a 2-4 year lag in the response of adults to changes in freshwater conditions experienced as juveniles (Korman and Higgins 1997). Rather, responses in juvenile production while accounting for adult spawner abundance variance will be the key metric of the impact of changes to discharge. This may be evaluated as egg to fry survival, smolts produced per spawner and/or fry/parr standing crop as a function of spawner abundance.

2.2 Monitoring Approach

The approach to this project is to develop and refine the stock assessment methodology, followed by annual implementation of detailed systematic assessment of the escapement of Chinook (*Onchorhynchus tshawytscha*), Coho (*O. kisutch*), and Steelhead (*O. mykiss*). Supplemental surveys will be conducted to estimate spawning population abundance of Sockeye (*O. nerka*) and odd year Pink salmon (*O.gorbushca*).

Two levels of survey intensity are utilized for developing spawning population abundance estimates. As Chinook, Coho and Steelhead are the only species of anadromous salmonids whose juveniles rear for an extended period in the Lower Bridge River; most effort is directed at those species to achieve accurate and precise estimates. Rigorous estimates of Chinook salmon escapement are particularly important, since the time series of juvenile stock assessment may be confounded by hypothesized temperature-mediated changes in juvenile life history due to dam release induced elevated winter temperatures (BRGMON-1, Bridge-Seton WUP Monitoring Terms of Reference 2012). Chinook salmon escapement may therefore become an important indicator of the effects on the ecosystem of variances in discharge, over and above just water quantity.

A fish enumeration facility (resistivity counter) was constructed in early fall of 2013 to evaluate the escapement of salmon and Steelhead trout into the lower Bridge River through 2021. This facility will allow for high precision estimates (with confidence limits of +/- 10% of estimate) of salmonid escapement above the selected location near the downstream end of Reach 3 (Figure 2 and 3). Construction started as soon as the low flow window was attained on October 3rd and was completed on October 17th. Combined with the methods described below (radio telemetry, PIT tag marking and recovery and visual counts) this facility should allow for back calculated estimates of historic spawning trends. The enumeration site was also designed to be capable of fish capture to allow biological sampling, tagging, and species identification.

Stream walk surveys of the Lower Bridge River are being continued annually for a minimum of five years following methodologies developed and implemented previously in BRGMON-1. These methods are used to estimate the abundance, distribution and biological characteristics of the populations of salmon and Steelhead adults and to provide the data for back-calculating historical escapement estimates from archived data. The visual survey area extends from the Terzaghi Dam to the confluence with Yalakom River (Figure 3 and Table 1).

Radio telemetry offers a means to address spawner distribution as highlighted above. As in 2012, radio tags were applied to Chinook, and Coho adults in late summer and fall 2013 and will be applied to Steelhead adults in the spring of 2014. Radio tracking relies on a sub-sample of a spawner population to identify key spawning areas and evaluate residence time, migration flow and timing (Brown and Mackay 1995, Bison 2006, McCubbing and Melville 2000). The approach provides representative data on localized habitat use. In conjunction with the fish enumeration facility and/or visual assessment methods (Korman et al. 2002) the results can be expanded to provide full river estimates of escapement by back calculation (Troffe et al. 2008) or by determining observer efficiency in Area-Under-the-Curve (AUC) estimates (English et al. 1992, Hilborn et al 1999).

Standardized data management and base mapping is being developed to determine the linkage between spawner survey program observations, habitat inventory and aquatic ecosystem productivity monitoring. This will include but may not be limited to: attempts to access historical raw stream walk data from DFO archives with translation to standard excel spreadsheets, evaluation of habitat and GIS mapping data collected in BRGMON-1 with an assessment of its applicability to spawner densities by reach, and spawning location/GIS mapping of all verified tagged spawners during all years of radio telemetry.

2.3 Radio Telemetry

2.3.1 Tag Application and Bio-sampling

Attempts to capture fish were conducted by skilled anglers fishing throughout the lower Bridge River (Figure 2). No Steelhead trout were sampled or tagged in 2013 as there was no way of enumerating the population's abundance in the absence of a fish counter. In 2013 Chinook and Coho were radio tagged using the same methodologies used for Coho in 2012:

- A MCF2-3A radio tag (Lotek Engineering Inc.) was gastrically implanted in the stomach of each fish (Appendix 1).

For both species a 5/8" Petersen disc tag was attached through the dorsal muscle mass so that technicians could visually identify radio tagged fish during stream walks and thus determine detection probability.

Fork length and gender were recorded during tagging and scale samples were taken from Coho adults for ageing. As in 2012, no scale samples were taken from Chinook adults in 2013, as these fish were in advanced spawning condition when captured, making scale recovery difficult and potentially a source of infection prior to spawning. After tagging, Coho and Chinook were held in a submersible holding tube for a minimum of 30 minutes prior to release to ensure fish health and proper tag placement, and to confirm that the tag had not been regurgitated.

Tag application was distributed throughout the migration period of Chinook and Coho. Efforts to ensure even distribution of tags between sexes was made, as migration behaviour and run timing of males and females differs (Korman et al. 2010; Troffe et al. 2010). The tagging schedule was adaptive in nature as fish access (suitable capture locations) is limited on the Lower Bridge River, and thus application timing depended on capture success, angler conditions, and fish behaviour.

2.3.2 Mobile Tracking

Mobile tracking with a hand held Lotek W31 radio receiver was conducted in reaches 3 and 4 (Figure 2) of the Lower Bridge River on average twice weekly. Weekly tracking was co-incident with stream walks during the period tags were present in the area based on fixed station analysis. Manual tracking was completed by vehicle or foot and in isolation of the technicians conducting the visual count to avoid observer bias, i.e. searching for known tags in the area. Fish location and tag code were recorded as well as visual sighting of tagged and untagged individuals by species. Dates for tracking included the periods from August 27th to September 27th for Chinook salmon, and October 11th to Dec 9th, 2013 for Coho salmon.

2.3.3 Fixed Station Telemetry Receivers

Fixed station logging was conducted at four sites (Figure 2 & Table 1) with Lotek W31 receivers linked to two Yagi 6-prong directional aerials oriented upstream and downstream. These stations were powered by 12v deep cycle (110amp hour) lead acid batteries. The fixed stations were operated from August 15th prior to tagging operations commencing and through to November 28th when the river froze over and movement of tagged Chinook and Coho salmon had ceased.

Locations included:

Site 1: 500 m upstream of Fraser River and Bridge Confluence (River Kilometer - RK 0.5)
Site 2: Yalakom River confluence with the Bridge River (RK 24)
Site 3: 500m upstream of Yalakom and Bridge River Confluence at DFO spawning bed (RK 24.5)
Site 4: 500m upstream of Reach 3 and 4 boundary (RK 37)

Fixed station data was used to corroborate fish location (during mobile tracking), identify entry and exit timing of each fish into each reach , and collect basic data on Chinook, and Coho adult migration and spawning behaviour in the lower Bridge River.

2.4 Visual Counts

Visual stream bank counts were undertaken for spawning Chinook, Sockeye, and Coho salmon bi-weekly in Reaches 3 and 4. These reaches have historically been known to hold fish during peak migration and spawning periods (BC Hydro, data on file). Methods replicated those utilized in previous surveys and data collected is relative abundance rather than total counts. Briefly, two observers walked in a downstream direction on the riverbank looking for visible signs of fish. Fish were classified by species and location and recorded in field notebooks. Viewing conditions, cloud cover and lateral water visibility were also recorded. Surveys commenced on August 27th for the enumeration of Chinook and Sockeye salmon and were completed for Coho salmon on December 9th when the river froze over.

2.5 Model Used to Estimate Escapement from Visual Count and Telemetry Data

An Area-Under-the-Curve (AUC) method was utilized to estimate escapement for Coho and Chinook salmon based on repeat visual counts from stream walks, combined with estimates of observer efficiency (o.e) and survey life from radio telemetry. Estimates were created by maximum likelihood using Hilborn et al.'s (1999) approach where spawn timing is modelled using a beta distribution,

1) $$S_t = E\frac{t}{T}^{(\alpha-1)}\left(1-\frac{t}{T}\right)^{(\beta-1)}$$

where S_t is the number of spawners in week t in the survey area (with a maximum week T), E is the total number of spawners over the spawning season (i.e., escapement), and α and β are parameters of the beta distribution that determine the proportion of the total spawners present on each week. We use a convenient re-parameterization of the beta distribution where the week of peak spawning (γ, the mode of the beta distribution) and the relative precision in spawn timing (α) are estimated, and β is computed from $\beta = \frac{\alpha-1}{\gamma} + 2 - \alpha.$

The predicted number of spawners present on each model week (s_t) is calculated as the difference between the cumulative number of spawners that have entered through week t (Eqn. 1) and the cumulative number that have died or left from,

2) $$s_t = (\sum_t S_t - \sum_t D_t)$$

where, D_t is number that died or left the survey area on week t, and is computed from $D_t = S_t\text{-}surv$, where surv is the survey life in weeks. Thus, we assume that survey life is constant over the spawning season.

The number of spawners that are observed on any survey date ($\hat{c}_t$) is computed from

3) $$\hat{c}_t = s_t * o.e$$

where, o.e is the observer efficiency. The model is then fitted to the data by minimizing the negative log likelihood (NLL) of a Poisson probability distribution whose kernel is,

(4) $$NLL = \sum_t \hat{c}_t - c_t \log(\hat{c}_t)$$

where, c_t is the observed count of spawners on a survey in week t.

Observer efficiency was calculated as the number of externally tagged fish observed in each visual enumeration stream walk divided by the total number of fish calculated as being present through manual and fixed station telemetry records. Each externally tagged fish was fitted with a radio tag so that the number of externally tagged fish in the count area was known on each survey date, through a combination of mobile tracking, generally on the day of visual count and through evaluation of fixed station downloads. Fish which were evaluated as deceased were not used in observer efficiency calculations as only live counts were used in AUC estimates. The date of each tagged fish's death was evaluated as the first day of which a significant (>1km) downstream movement was made or the day that the fish remained stationary in one location for the rest of the study period as recorded either by fixed station records or mobile tracking or the day that the fish ceased.

Residence time was estimated as the time period in which a live spawning fish was located within the visual counting zone (Reach 3 & 4) and was calculated as an average by species and survey year of all tagged fish which were marked either outside of the visual count zone or at the lower portion of the count zone, (within 50m of the lower boundary). Briefly, residence time was calculated as the number of days post tagging that a fish was observed moving in an upstream direction followed by a large (>1km) directional downstream movement. Fish which exhibited little or no upstream movement post tagging or during periods of extended residency in one location without directional movement (post spawning) were not used for calculations unless visually verified as live at the time of the survey.

The first day of survey life was evaluated as the week that historically fish have been observed as being present in the survey count zone, while the total survey days was calculated as the difference in days between the first zero count following peak spawning and the initial survey day as described.

2.6 Fish Counter Enumeration Data – Coho Salmon

The construction of the resistivity fish counter was completed on October 16th, 2013 and was operational on the 17th of October. The 2013 dataset will not provide complete escapement for Coho adults as fish were observed migrating past the site during construction. Nevertheless it likely represents the majority of migrants based on the visual count data before and after completion date.

Fish counter estimates of Coho salmon escapement in 2013 were based on methods used on the Deadman River in 1999 through 2008 (McCubbing and Bison 2009). In summary they were calculated by the following process:

1) All obvious spurious debris or wave action data was removed from the raw data set. These are characterised by large numbers of events on a single channel over a short period of time.

2) A frequency histogram of peak signal sizes was examined to determine the break point between Coho salmon (>4lb in weight) and sub-adult bull trout (typically 1-2lbs in weight) for species classification. This data indicated a PSS >90 represented the majority of Coho salmon and very few bull trout, although some miss-classification occurs for both species.

3) Video data were collected four days per week through the entire migration period on two channels (1 and 2). Data were recorded onto a battery powered 8 channel DVR (DVR90004N, Supercircuits) from an infra red camera (Lorax 700TVL). As the majority of Coho salmon passage was observed at night, all available night video data was evaluated for counter efficiency and species identification. This equated to a total of 58 hrs and 17 minutes of available footage. In addition a total of 30.25 hours of daylight video was also evaluated. The daytime video was sub-sampled with 2 to 4 hours evaluated each day. Each hourly period was selected using a random number generator and where video was available.

4) The total upstream escapement for each size class of fish on each channel was estimated as follows:

$$E = \sum_{t=0}^{k}\left(\frac{U_t}{q_{up}} - \frac{D_t}{q_{down}}\right) + \sum_{t=k}^{\infty}\left(\frac{U_t}{q_{up}}\right)$$

where U_t is the total number of daily upstream detections classified as fish by the firmware algorithm, D_t is the corresponding number of daily downstream detections, q_{up} is the detection efficiency of upstream moving fish and q_{down} is the detection efficiency of downstream moving fish, which were assessed independently from video validation experiments. The parameter *k* is the day that kelts began migrating downsteam. This parameter is estimated by examining the pattern of upstream and downstream detections of radio and PIT tagged fish over the season.

2.6.1 Variances from Typical Methodology

Data from channel 4 was excluded as a trap was operated above this channel and thus no fish passage was possible without the fish being manually handled. Any fish moved above the counter in this manner were added to the fish counter total for the day.

Down count data for channel 1 was estimated from a ratio of down counts to events noted on the video records for this channel. This was undertaken as there were very few downstream validated counter records where down counts were correctly assigned.
Do you want to talk about channel 3 data? It was not validated and efficiency of channel 2 was used.

2.7 Spawner Habitat Evaluation

An important part of the study is the requirement to evaluate the quantity, quality and distribution of spawning habitat for migratory salmonids in the lower Bridge River. Data from radio telemetry and visual observations in 2012 and 2013 have identified key spawning areas for Chinook, Coho, Pink and Sockeye salmon but currently no observations have been made for Steelhead trout. Radio telemetry data from fish tagged in the spring of 2014 will begin to identify these locations for Steelhead.

A provisional evaluation of macro habitat units by reach has been undertaken through examination of data collected as part of the juvenile fish monitor (BRGMON-1). These data while useful do not provide sufficient information to establish total available spawning habitat quantity or quality. Field data will therefore be collected in the spring and fall of 2014 during active spawning to further quantify these observations. This will include depth and velocity transects at spawning locations, assessment of gravel/cobble area, substrate use composition analysis and spawner Habitat Suitability Indexing (HSI). All the data collected will be transferred to GIS maps along with redd observation data from previous and future survey years.

Biometrics for spawners per habitat area will be collated along with the distributional variance between spawner abundance and reach selection. This will be undertaken for Coho, Chinook, Pink and Sockeye salmon to the reach level and in priority spawning areas. Higher river discharge during Steelhead spawning may preclude such detailed evaluations on this species as observations of spawning may be limited.

3. RESULTS

3.1 Radio Telemetry

3.1.1 Chinook Salmon

<u>Tag Application and Bio-sampling</u>

Anglers in teams of 2 attempted to capture 30 Chinook adults and apply internal radio tags into the stomach and external Petersen discs below the dorsal fin in the Lower Bridge River in 2013. Fish capture attempts commenced the week of August 18th and continued until the week of September 9th when no live fish were observed. Initially, attempts to capture fish were made downstream of the Yalakom confluence from 0.3km to 3.5 km upstream of the confluence of the Bridge and the Fraser River. This strategy was employed in both 2012 and 2013 in an attempt to better assess the distribution of Chinook throughout the Lower Bridge River. As in 2012 no fish were captured in this area. On August 22nd, 2013 Chinook were observed in the pool just upstream of the Yalakom confluence. This was very similar behaviour to what was observed in 2012 when Chinook were first observed and captured at this location on August 28th. In order to get fish tagged to assess the visual counts upstream of the Yalakom angler effort was re-directed from downstream to this area (Figure 2). Twenty seven (14 male and 13 female) were captured and tags applied over a fifteen day period; August 22nd to September 6th (Table 2). Mean length for male and female Chinook captured on the Lower Bridge River in 2013 was 783mm (range 522-990) and 751mm (range 600-895) respectively (Table 2).

Fixed and Mobile Tracking

Tags were detected by the series of fixed telemetry stations and by mobile tracking by vehicle and on foot. Twenty five of the twenty seven fish tagged were detected in locations upstream of the tagging location at the Yalakom confluence post tagging. Most of these fish were detected above the new fish counter site for some period of time. Of the remaining 2 fish tagged; one was not located after tagging and one moved downstream towards the Fraser R. confluence after remaining in the tagging location for approximately 5 days. (Figure 3 & Table 3).

The distribution of the 18 tagged fish that made significant upstream migration movement post tagging was as follows:

1. Only one tagged fish spawned in Reach 4
2. Four (22%) were assessed as most likely spawning in stream walk sections 3 to 5; RK 30.7-38.0, upper section of Reach 3.
3. Two (11%) were assessed as spawning in stream walk sections 2 and 3; RK 28.8-30.7, mid Reach 3.
4. Eleven fish (61%) attained Station 3 and were assessed as spawning in stream walk section 1, lower Reach 3.

The remaining seven fish migrated only a short distance above the tagging location and may or may not have spawned above the fish counter location.

An assessment of distribution (between Reach 1-2 & Reach 3- 4) and average migration time (days) from the confluence with the Fraser River (300-1500m upstream) to spawning location was not possible as no fish were tagged in Reach 1. This was similar to 2011 and 2012 where efforts to capture fish in reach 1 failed to produce fish for tagging.

3.1.2 Coho Salmon

Tag Application and Bio-sampling

Efforts to capture 30 Coho salmon adults commenced the week of October 1st, 2013 and continued through mid-November. A total of 29 fish were radio tagged and an additional 41 were PIT tagged in the Lower Bridge River in 2013. Coho were tagged in four distinct areas, Reach 1 (300 m to 1500 m above the Fraser confluence), Reach 2, (around Camoo Rd), Reach 3 (downstream of fixed station 3 at the Yalakom confluence) and in Reach 3 (at the counter site) (Figure 2).

Angling in Reach 1 and 2 resulted in 18 fish (8 males and 10 females) being radio tagged between October 8th and October 21st, 2013. As capture of fish in Reach 1 did not guarantee that the tagged fish would enter the visual count zone, additional angling effort was also applied in Reach 3 to ensure tags were available in the stream walk section (Reach 3 & 4) during visual counts. A total of 11 fish (6 males and 5 females) were tagged between October 8th and October 28th in Reach 3 at or close to (with 200m) the Yalakom/Bridge River confluence (Table 4 & 5).

In 2013 an additional 41 Coho were tagged with PIT tags only. These fish were generally tagged between the fish counter and the Yalakom/Bridge River confluence (37 of 41). Attempts at tagging these fish started after deployment of radio tags were completed on October 28th and ceased on Nov 14th. No external tags were placed on these fish so as not to confuse them with radio tagged individuals. Data were used to determine reach separation of spawning distribution.

Mean length for male and female Coho on the Lower Bridge River was 649 mm (range 530-815) and 588 mm (range 270-735) respectively (Table 4). Scale samples were taken from all fish and archived for ageing.

Fixed and Mobile Tracking – Radio Tags

Seven of the thirteen fish (54%) tagged in the lower river (Reach 1) were subsequently detected on the lower fixed station (station 1) post tagging. The remaining six fish tagged in this area had no fixed or mobile tracking records thus they likely dropped out into the Fraser River immediately after tagging. Four of the seven tagged fish which were determined as Bridge River spawners remained in the vicinity of Station #1-RK 0.7 throughout the assessment period; possibly spawning in the tagging area or potentially losing their tags. Three of the seven spawners made significant upstream migrations with all three reaching Station #4-RK 37.3 (Figure 2 & Table 5).

Five fish were tagged in Reach 2 (Camoo Ck. Confluence area) and all made migrations upstream with four reaching Station #3-RK 25.9 and one achieving Station #4-RK 37.3

In summary 12 of 18 fish tagged in reach 1 and 2 were confirmed as Bridge River spawners. Of these twelve spawners, eight or 67% were assessed as spawning in reach 3 or 4 above the Yalakom confluence. Evaluating the results from both years that fish were tagged in Reach 1, in 2013 three of seven or 42% of fish spawned in the upper reaches (3 and 4) compared to 44% in 2012.

Mean migration time (number of days to achieve assessed spawning location) of all the 8 fish tagged in reach 1 and 2 that made migrations upstream past Station #3 was 19 days with an SD of 5 days (Table 6).

<u>Fixed tracking – PIT tags</u>

Of the 41 PIT tags deployed on Coho salmon, 37 entered the area above the fish counter antenna site. Four of these fish were tagged in the lower river (Reach 1 & 2). Of the 37 fish, 16 continued upstream passage beyond the fixed station antenna at the reach 3/4 boundary indicating 42% of Coho that spawned above the Yalakom in this cohort utilized reach 4 for spawning. The average time for fish tagged in reach 1 and 2 to reach the fish counter site was 7.5 days, while it was 3 days for fish tagged at the Yalakom confluence. The average period of residence above the fish counter was 11 days from first detection to outmigration for fish that moved downstream post spawning. The condition of the fish that dropped back was unknown but video data collected at the counter indicated that some at least were passive migrants in a near moribund state. This residence time was lower for later PIT tagged fish than for earlier radio tagged fish perhaps indicating average residence time from radio tags may be bias high compared to the entire population.

3.2 Visual Counts

3.2.1 Chinook Salmon

Visual counts of Chinook salmon were conducted from August 27th through to September 27th, 2013 at which time spawning was assessed to be complete and no further Chinook adults were observed. The first group of holding fish was observed on the 22nd of August at the Yalakom confluence, with peak live fish count (52 fish) observed 12 days later on September 3rd (Figure 4, Table 7 & 8). The majority of these spawners were observed in stream walk section 3 (Figure 3 & Table 1) between the Cobra and the old fish fence site (14 fish). By the following week (September 10th) only 24 fish were visually counted, the majority above the counter site. Relative abundance of spawners in each stream walk section varied greatly but was highest in sections 1 through 5 (Yalakom Confluence to RK 34.4), with peak counts of 21-39% of total fish counted, and low for sections 6 through 8 where peak counts represented 9 to 16% of total counts.

A total of 5 tags were observed visually on the September 3rd stream walk. These were distributed throughout the stream walk section with tags being observed in section 1 (4 fish) and section 7 (1 fish). Four tagged fish were also observed on the Sept 10th survey all in section 1 (Table 7 & 8).

3.2.2 Coho Salmon

Visual counts of Coho salmon were conducted weekly from October 5st through to December 9th, 2013 at which time spawning was complete and few Coho adults (15) were observed. The first holding fish were observed on the 8th of October both in reach 1 and reach 3, with peak live fish count (673 fish) observed on November 15th. The majority of active spawners were observed above river kilometer 36.8 in sections 5 through 8 in the week starting November 8th (Table 7 & 8) with the lower sections showing about equal spawner distribution but at lower densities (1/3rd of upper sections).

Tags were observed visually on only two stream walks, one tagged fish on November 5th, and two on November 8th. This preceded the peak count data. Problems seeing Peterson disc tags were associated with poor water visibility due to suspended glacial till, which limited visibility to less than 0.5m. Often fish were observed as shadows where a small disc tag could have been present but would not have been visible. (Figure 3 & Table 7 & 8). As such, average observer efficiency based on visual tag recoveries in 2013 is likely a substantial underestimate of the true value and data are not used in AUC estimates. Instead the average observer efficiency during periods when tags were located is employed as we can be certain tags were visible to technicians.

3.2.3 Sockeye Salmon

Sockeye salmon were visually counted in moderate abundance specifically spawning in the area immediately downstream of the dam. The peak count was bimodal in 2013; with a high count of 855 fish on September 10th, declining to 14 fish on October 1st, before rising to 99 fish on October 8th. All spawning Sockeye observed on stream walks were located in stream walk section 8 just below the dam (Figure 3 & Table 9).

3.2.4 Pink Salmon

Pink salmon were highly abundant in 2013 with over 13,492 fish visually counted at peak spawning activity. Fish were distributed throughout all reaches. No observer efficiency or residence time data were collected so abundance estimates are not available. Peak of spawning was estimated to occur on the 24th of September, some two weeks after peak Chinook spawning. (Figure 3 & Table 9).

3.3 Visual Count Escapement Estimates

For the purposes of calculating 2013 spawner estimates from visual count data, the residence data collected in 2013 were applied for Chinook and Coho spawner calculations. Observer efficiency data at peak count in 2013 was utilized for Chinook AUC calculations but a substitute value was used for Coho salmon based on the previous described field observations. No calculation of Sockeye escapement was determined in 2011 through 2013 via AUC estimates as fish could not be captured for tagging which is required to generate observer efficiency and residence data.

3.3.1 Chinook Salmon

Data on observer efficiency (o.e) for Chinook salmon visual counts for AUC calculations were available based on re-sightings of a number of fish in the 2013 survey year. Tagged fish were observed during three of eight subsequent visual stream walk counts. On August 30th one tagged fish was observed in the count zone, while by September 3rd, five of a potentially 18 tagged fish were observed, giving an o.e. of 0.28 at peak count. On one later survey, September 10th, four of an estimated five live tagged fish were observed, all immediately above the counter site (Table 7 & 8).

Residence time in the visual count zone was calculated based on fish movements as described in the methods section of this report. Of the 26 tagged Chinook which moved above the counter site and remained in the visual count zone post tagging, through the spawning period, 22 provided reliable data on residence time. On average these fish spent 11 days alive in the counting area (SD = 3). In the remaining fish a clear delineation of when mortality or kelting occurred could not be discerned.

Using an o.e. value of 0.28, a residence time of 11 days, a survey start date of August 27th and a survey life of 32 days, we calculate the maximum likelihood estimate of Chinook spawners in 2013 in the area of the Lower Bridge River between the Yalakom Confluence to Terzaghi Dam at 127 fish (Figure 3 & 5). Assuming a 3 day variance in residence time around the mean data (calculated value of SD), this value varies from 98 to 175 fish. Examining the effect of variation in o.e. we calculated spawner estimates of 107-150 fish with one additional or one less live tag observation, while utilizing the mean residence time of 11 days.

3.3.2 Coho Salmon

Data are available on observer efficiency and visual counts for AUC calculations for Coho salmon in the 2013 survey year. Of the 29 fish which were radio tagged in 2013 a maximum of nineteen fish were recorded by fixed and mobile tracking as being available in the visual count zone for sighting. Tagged fish were only observed on two of the twelve days when live tags were evaluated as being available for enumeration in the visual count zone. Observer efficiency data were highly varied across surveys from 0% (0 of 12, and 0 of 16 tagged fish) in early surveys (25th October and 1st November) when fish were generally holding in deeper pools to 2 of 4 live tags on November 8th and 1 of 7 on November 5th. This gives an average 27% o.e. in the two surveys one week before peak count when at least some tags were observed, while at peak count 0 of 7 live tags were observed providing no data on observer efficiency (Table 8).

Residence time of live fish in the visual count zone was calculated based on fish movements as described in the methods section of this report. Of the 18 tagged Coho salmon which entered or remained in the visual count zone post tagging, all were utilized to provide data on residence time. On average these fish spent 19 days alive in the counting area (SD = 9).

Using an o.e. value of 0.27, a residence time of 19 days, a survey start date of October 8th and a survey life of 63 days, we calculated the maximum likelihood estimate of Coho spawners in the area of the Yalakom Confluence to Terzaghi Dam in 2013 at 2,862 fish (Figure 3 & 6). Assuming a 9 day variance in residence time around the mean data (value of SD) this value varies from 1,921 to 5,443 fish. A positive or negative change in the sighting of one tag during the period when tags were observed results in estimates that vary from 2,147 to 4,293 fish.

To evaluate full river spawner abundance we extrapolated the Yalakom to Terzaghi Dam population estimate based on the spawning distribution of Coho pre-spawners tagged in the lower river in 2013. Of the nine Bridge River spawners tagged in this area, 58% were assessed to have spawned between the Bridge/Fraser confluence and the Yalakom. This indicates that full river escapement may have been as high as 6,184 Coho in 2013 based on average o.e, residence time and spawner distribution.

3.4 Fish Counter

Examination of peak signal size data indicated the majority of larger bodied upstream Coho salmon migrants produced signal sizes in excess of 90 (Figure 7), while smaller sub-adult bull trout generated signal sizes much lower (average = 62 SD =13.1). A small number of larger bull trout were observed as co-migrants with the Coho adults and they created a PSS that would result in miss-classification using the PSS >90 = Coho adult rule. However these were small in number compared to the more numerous Coho adults and are accounted for in the calculation of counter efficiency during the validation exercise. Corroboration of the low passage rates of adult bull trout was also undertaken by examining PIT tag records at the counter site. Of the 23 bull trout tagged below the counter in the fall of 2013 none were observed passing over the counter during the migration period.

3.4.1 Video Validation Results

We estimated q_{up} to be 82.5% on channel 2 for Coho migrants with a PSS cut off, of >90. This was based on 52 up counts recorded on the counter with a PSS >90 during the validation period during which 63 Coho were observed on video records along with two adult bull trout. On channel 2, q_{down} was estimated as being 70 %. This was derived from 7 counter records with a PSS >90, compared with 10 down migrant Coho on the corresponding video records, 3 of which generated signal sizes less than 90. As the design of channel 3 was an exact replica of channel 2; it was assumed in 2013 that these data are comparable across both channels. The same q_{up} and q_{down} were used for Channel 3

We estimated q_{up} to be 42.9% on channel 1 for Coho migrants with a PSS cut off, of >90. This was based on 15 up counts recorded on the counter with a PSS >90 during the validation period during which 35 Coho were observed on video records. On channel 1, q_{down} was initially estimated as being 3.6% based on a small sample size (n=28). This was derived from 1 down counter record with a PSS >90, compared with 28 down migrant Coho on the corresponding video records, 12 of which generated signal sizes less than 90 and 1 which produced no counter record.

To address concerns on the uncertainty of down count efficiency on channel 1 we also evaluated all of the events and down counts with a PSS >57 recorded by the counter on channel 1 (n=1225). The smallest validated Coho salmon derived event record on the counter exhibited a PSS of 57, while the largest validated bulltrout produced a PSS of 56.

Of these 1225 events and down counts we video validated 52 records. This method resulted in an assessment of 21 up Coho counts, 26 down migrants and 5 events. We then used the ratios of these counts to determine the proportion of down counts from the entire sample. This results in an estimated 490 un-enumerated down counts on channel 1. We add to this the 31 enumerated down counts for a total of 521 down migrants on channel 1.

3.4.2 Coho Salmon Fish Counter Estimate

Estimates of Coho escapement were calculated using a PSS cut off in excess of 89, the efficiencies of the counter channels as described above. Kelts were removed from the total assuming all fish migrating downstream after November 25th were spawned out. This was derived from movements of PIT tagged fish that had stayed resident above the counter in excess of 5 days. These calculations resulted in a total upstream migration of 2,375 fish over the counter, with a downstream pre-kelting migration (down counts prior to Nov. 26th) of 973 fish for total spawner abundance above the counter of 1,402 Coho salmon in 2013. A total of 23 down counts were observed after November 26th that were assigned as post spawners. An unknown number of fish passed over the counter site in the week starting October 8th (visually observed) and are not included in this estimate. Migration timing (uncorrected for efficiency) indicated a peak of movement possibly related to stream temperature around late October (Figure 8).

3.5 Spawning Habitat Evaluation

The pattern of spawning in Chinook, Coho, Sockeye and Pink salmon has now been evaluated over a period of two years in the BRGMON-3 study, although as yet no data are available for Steelhead trout as these studies commenced in the spring of 2014. The data from visual observations, and mobile tracking of tagged fish have identified the primary areas where redds are formed. In 2014, measurements of substrate types, redd densities, redd depth, redd sizes and HSI measurements of water depth and velocity will be taken during visual surveys at the peak of spawning and again once spawning is completed. These data will be compared with literature values and plotted on GIS maps to evaluate distribution and potential limiting factors to spawning.

4. DISCUSSION

The primary goal of this study is to provide reliable, unbiased and precise estimates of adult salmon and trout spawner abundance along with behavioral data on spawning locations and timing. The second and important goal is to evaluate the quantity and quality of spawning habitat as it relates to spawner abundance. This data will be utilized in combination with data from BRGMON 1 to evaluate the egg and juvenile seeding levels of the area of the Lower Bridge River specifically between the Yalakom River Confluence and Terzaghi Dam (Reach 3 & 4), the upper limit of anadromous fish spawning. This reach of the river is predominantly regulated by discharges through Terzaghi dam with very minor tributary influences. Additional data will be collected when possible (i.e. depending on reach 1 and 2 tagging success) to evaluate complete watershed spawning abundance through marking of fish in Reach 1 of the Bridge River close to the confluence with the Fraser River. The proportion of these tagged fish which remain in the Bridge River (i.e. not fish that strayed in to the river then leave and spawn elsewhere) but do not spawn above the Yalakom can be used to evaluate a total river spawner escapement using back calculation methods (McCubbing 2012).

In 2013, data were collected for Chinook, Coho, Pink and Sockeye salmon. No Steelhead were tagged or enumerated in 2013 as migration into the river typically occurs in the spring period and spawning under elevated river discharges in the month of May, when due to poor visibility visual counts would be unlikely to produce reliable results. A new resistivity fish counter was installed as part of this project at a site approximately 200m above the Yalakom/Bridge confluence in part to address this shortfall in historic monitoring methods. Construction was started on October 4th and completed on October 17th. In the absence of resistivity fish counter information prior to October 17th, 2013, data for Pink, Chinook and Sockeye salmon were collected using historical stream walk methodologies. These data were collected in the same manner as previous years (pre WUP monitoring, DFO data on file, McCubbing et al 2013), and for the second year were validated by marking fish with external visual tags and radio tags. The data provided from these tagged fish which include observer efficiency and residence time in the counting zone, and for Coho salmon full river spawner distribution were combined with AUC methods allowing for the calculation of provisional estimates of salmon spawner escapements in 2013.

Ideally in AUC studies of this type, marking of individuals is undertaken remotely from the area of visual count. This is undertaken to provide data on full river escapement and residence time on the spawning grounds. Data which are derived from fish captured within the spawning area are not useful for residence time evaluations as they may have spent an unknown period of time within the area and could have been enumerated by visual counts prior to tagging. This was successfully achieved in 2013 with all Chinook and Coho salmon tagged below the fish counter site.

Efforts to tag Chinook salmon in Reach 1 of the Lower Bridge River that would allow for the production of a full river estimate continue to be unsuccessful despite almost daily visual checks for migrant fish. The reasons for this lack of success in 2011-2013 are likely related to low population abundance and a short duration of residence in the lower reaches of the river. Fish which are captured during aboriginal fisheries in the Fraser River at the mouth of the Bridge River are poor candidates for tagging as the majority are likely not destined to spawn in the Bridge River, instead migrating to tributaries higher in the Fraser Watershed. Based on observations of fish arrival in reach 3, target dates for lower river (reach 1) fish capture will be scheduled in future years during the second and third week of August, although evaluation of full river spawner estimates may remain a challenging endeavor for Chinook at current escapement numbers.

Using maximum likelihood methods, Reach 3 and 4 Chinook spawner escapements were estimated at 140 fish in 2013, 436 fish in 2012 and 81 fish in 2011, this represents a five-fold variation between years. These data are expected to be reasonably precise due to a high observer efficiency (0.28 to 0.54) which likely results from fish behavior. During spawning, Chinook salmon tend to hold in open water and are relatively undisturbed by bank side activity. However the population estimates are affected (biased high or low) by small changes in the value of estimated residence time utilized in calculations so additional years of local data collection are warranted. A large variance in this metric is unlikely as Chinook from this watershed are most likely of the Beringia glacial refuge "genetic" lineage which in interior Fraser River fish occur almost exclusively above the Thompson River/Fraser confluence. Chinook of this origin are typically observed in the absence of competition for spawning habitat or predation to exhibit spawning residence periods of 10-12 days (R.Bailey, DFO data on file). Our calculated value of 10 days in 2012 and 13 days in 2013 indicates typical residence behavior and that is most likely stable across sample years (see NFCP Technical Data Review 2005 - http://nfcp.org/Reports.html, which provides documentation). Future escapements from 2014 onwards will continue to be evaluated by visual counts and the new resistivity fish counter for comparative purposes. This will allow for an additional measure of observation efficiency and should provide data to validate historic visual count escapement abundances in reach 3 and 4. Derivation of estimates for full river escapement may prove more troublesome due to the canyon nature of the lower river, so additional effort will be placed on marking attempts to tag fish in this area (Reach 1 and 2).

Efforts to tag Coho salmon in the Lower Bridge River (reach 1 and 2), to provide a full river estimate were moderately successful with 18 fish radio tagged in 2013 (compared to 10 in 2012 and 11 in 2011). The earliest fish captured in the lower river was tagged on October 8th compared with October 12th in 2012 and 19th in 2011. In all years fish were tagged over a period of approximately 2-3 weeks.

Using maximum likelihood methods, Reach 3 and 4 Coho spawner escapements were estimated at 2,132 fish in 2013, 3,161 fish in 2012 and 5,142 fish in 2011. The precision of these data is unclear as observer efficiency resulting from fish behavior prior to and perhaps during spawning is low, associated with the fish being cryptic and avoiding detection. Our calculated residence time of 19 days in 2013 and 16 days in 2012 is slightly higher than typically seen in other interior BC watersheds, i.e. 10 days in South Thompson, and 12 days in North Thompson (DFO data on file). Using the proportion of fish which utilized reach 1 and 2 for spawning based on lower river tagged fish our full watershed estimates of spawners is 4,634 fish in 2013, 5,268 fish in 2012, and 8,570 fish in 2011. These estimated spawner escapements result in a spawner per kilometer abundance of between 115 to 214 fish per km for the full river and 203 to 313 fish in reach 3 and 4. These data indicate that seeding may be at the higher end of published data (Korman & Tompkins, 2008), and sufficient to utilize the available habitat to capacity. Efforts to increase confidence in o.e. data and residence data will in part be undertaken by marking fish at the new trap/resistivity counter facility. In particular the varied observer efficiency described in Chinook and especially in Coho salmon requires several years of additional data collection thus ensuring confidence in the values used to calculate escapement estimates. This will be undertaken both by radio tag observations, linked with the use of improved external tags (spaghetti type rather than disc tags) and by comparison to the estimated escapement derived from the fish counter. Additional effort to refine full river estimates will require many more fish, i.e. >30 Chinook and Steelhead and >100 Coho (see as example McCubbing et al 2012) to be tagged in the lower river (Reach 1). While attempts to achieve this goal with PIT tags will be undertaken in 2013 and beyond, the full river estimate may always be of much lower confidence due to access issues created by the canyon nature of this area, the lack of safe access roads or trails and the migration behaviour of the fish making it difficult to capture in this area, in particular Chinook.

No Steelhead trout spawner data are yet available for Bridge River at the current discharge regime as flows during the spring migration and spawning period are elevated (6-9 m^3s^{-1}) and visual observation techniques are of limited value. The fish counter will accurately assess escapement to reach 3 and 4, from the spring of 2014 onwards using the methods described in McCubbing and Bison (2009). Full river estimates will be calculated using radio tagged fish captured in reach 1 or in the Fraser River, in a mark recapture study similar to the methods used on the Thomspon River (Renn et al 2001). Evidence of relatively large numbers of resident trout (5 to 10 individuals captured in each days effort) were made during angling efforts for salmon tagging in the summer and fall of 2012 and 2013. While, these fish may be predominantly male an unknown portion will be females and will thus be contributing to egg deposition and trout production in the watershed (Hagen et al 2012). To evaluate their abundance relative to migratory Steelhead trout, all rainbow trout handled will be tagged with a PIT tag to evaluate movements during the spawning period and to potentially provide a basic population estimate through a mark recapture estimate at the trap/resistivity counter and/or by angling.

With the fish counter installation now completed, enumeration of Chinook, Coho, Sockeye and Pink salmon as well as Steelhead trout will be conducted at this site, (200m above the Yalakom confluence). Counts will be validated and are expected to be within 10% of total escapement (McCubbing and Ignace 2000, McCubbing and Gillespie 2008). A portion of salmon adults will be marked at a trap within the counter structure to allow for verification of future AUC visual escapement estimates thus allowing the annual variance in observer efficiency and residence time to be calculated. Once these data are sufficiently described, visual counts will cease as the counter will provide improved escapement accuracy over traditional methods (McCubbing and Espinoza 2012). The data collected during the period when both methods are being utilized will allow for back-calculations of historical escapements based on archived visual count data, 5 years of which was collected during the previous WUP discharge regime (annual water budget of 3 m^3s^{-1}). This back calculation exercise will require multiple years of observer efficiency data and residence data to provide accurate evaluation of population trends based on current observed annual changes in these parameters both between the two years assessed and between species. In addition, as sampling methods have changed during the time series of data collection, i.e. locations, stream walks vs. helicopter over-flights the raw data records are required for a forensic type audit to be conducted. This data are being requested for all species from DFO archives.

Methods to evaluate limitations to spawning success as measured by the availability and quality of spawning habitat have commenced. Existing data from previous habitat surveys have been reviewed and planning is underway to collect additional data during spawning activity in 2014 on all anadromous species. Methods utilized will assist in comparison to standard redd density dependence evaluations as explained for multiple species in Greene and Guilbault, 2008. GIS methods of evaluating potential spawning habitat (Hanrahan et. al. 2004) will be evaluated when over flight data are available but as access is available via road to all of reach 3 and 4; it is unlikely that this data will add substantially to on the ground field measurements and observations.

5. SUMMARY, CHALLANGES and RECOMMENDATIONS

In summary, the work undertaken in 2013 to generate adult spawner escapements on the Lower Bridge River below Terzaghi dam was successful. Area Under the Curve estimates of total Coho and Chinook spawners, a minimum count of Sockeye and Pink adults and a fish counter derived estimate of Coho salmon were obtained. Confidence in these estimates remain uncertain as they rely on limited radio tag data for evaluating observer efficiency and residence time in the visual count zone, although o.e. and residence data are within the expected range as observed in similar studies.

A number of recommendations are provided that are critical to improving estimates of adult spawner escapement and seeding levels on the Lower Bridge River, particularly in the area between the Yalakom confluence and Terzaghi Dam. These include:

1) Extensive video validation of the new counter to evaluate counter efficiency at a range of discharges.

2) Addition of a fixed telemetry station at the Camoo Creek (Reach 1-2 boundary) to provide data on post tagging but pre spawning fish “drop back” in Reach 1 & 2.

3) Installation of a third directional antenna at the fixed station on the Yalakom River confluence to assess use of Yalakom river by spawners.

4) Continue increased frequency of mobile tracking and visual stream walks around peak spawner abundance to improve o.e. estimates over the next three years. This will provide context on historical visual count numbers and potential escapement estimate derivation from archived data.

5) Re-allocation of angling effort to the lower river (reach 1) to obtain full river estimates of spawner abundance for Chinook salmon.

6) Revised tag allocation (Reach 1 & 2 vs. Reach 3) for Coho salmon to improve assessment of spawner distribution and o.e. and residence time data.

7) Opportunistic PIT tagging of all rainbow trout & bull trout encountered during salmon tagging to evaluate the potential resident trout contribution to *O. mykiss* juvenile production as monitored in BRGMON-1 and potential error in counter data created by upstream migration over the fish counter.

8) Genetic sampling of salmon and Steelhead trout to evaluate population lineage.

9) Continued operation of PIT tag arrays (installed in 2013) to delineate spawner distribution in the Yalakom to Terzaghi reach for Chinook, Coho, Pink and Sockeye salmon during angling for and at the fish counter trap site.

10) Field assessment of spawning habitat area – expansion of existing data collected during juvenile studies. Redd measurements, substrate composition and HSI data collection.

11) Evaluation of archived data available for egg deposition estimates and collection of field data as required.

6.0 TABLES

Table 1. Stream walk Section Designations and Fixed Station Telemetry Receiver Locations for the Lower Bridge River, 2013.

River Km	Location Description
0.0	Confluence of Bridge & Fraser Rivers
0.7	Fixed Station Telemetry Receiver Site 1
25.5	Downstream Boundary of Stream walk Section 1 & Fixed Station Telemetry Receiver Site 2 & Confluence of Yalakom & Bridge Rivers
25.9	Fixed Station Telemetry Receiver Site 3 & Counter
28.8	Downstream Boundary of Stream walk Section 2
30.7	Downstream Boundary of Stream walk Section 3
33.2	Downstream Boundary of Stream walk Section 4
34.4	Downstream Boundary of Stream walk Section 5
37.3	Fixed Station Telemetry Receiver Site 4
38.2	Downstream Boundary of Stream walk Section 6
38.8	Downstream Boundary of Stream walk Section 7
39.6	Downstream Boundary of Stream walk Section 8
40.0	Upstream Boundary of Section 8 & Terzaghi Dam

Table 2. Biological and tagging data of adult Chinook salmon migrants in the Lower Bridge River, 2013.

FISH #	CAPTURE DATE	TIME	CAPTURE LOCATION	RK CAPTU	REACH	CAPTURE METHOD	FREQUENCY	CH. CODE	FORK (mm)	SEX
1	22-Aug-13		Yalakom Confluence	25.5	3	angle	149.260	41	775	F
3	23-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	66	740	M
2	23-Aug-13		Yalakom Confluence	25.5	3	angle	149.260	53	770	M
4	23-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	63	800	M
5	23-Aug-13		Yalakom Confluence	25.5	3	angle	149.260	45	895	F
6	23-Aug-13		Yalakom Confluence	25.5	3	angle	149.260	42	985	M
7	23-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	70	990	M
8	26-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	69	780	M
9	27-Aug-13		Yalakom Confluence	25.5	3	angle	149.260	54	720	F
14	28-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	60	680	F
11	28-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	64	735	M
10	28-Aug-13		Yalakom Confluence	25.5	3	angle	149.260	47	740	F
15	28-Aug-13		Yalakom Confluence	25.5	3	angle	149.260	49	770	M
12	28-Aug-13		Yalakom Confluence	25.5	3	angle	149.260	46	885	M
13	28-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	61	950	M
19	29-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	59	522	M
21	29-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	56	640	M
20	29-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	68	680	F
23	29-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	62	680	F
22	29-Aug-13		Yalakom Confluence	25.5	3	angle	149.260	52	685	M
18	29-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	58	800	F
17	29-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	67	835	F
16	29-Aug-13		Yalakom Confluence	25.5	3	angle	149.500	57	875	F
24	30-Aug-13		Hippie Pool	26.5	3	angle	149.260	55	880	F
25	3-Sep-13		Hippie Pool	26.5	3	angle	149.500	65	655	M
26	3-Sep-13		Hippie Pool	26.5	3	angle	149.260	43	770	F
27	6-Sep-13		Hippie Pool	26.5	3	angle	149.260	48	600	F
Mean Length (mm)				**Fish Tagged**						
Male	Female			Male	Female					
783	751			14	13					

Table 3. Assessed spawning distribution of radio tagged Chinook salmon on the Lower Bridge River, 2013.

Tag #	Tagging Location	Tagging Rkm	Assumed RKm spawning location	Days to Migrate to Spawning Location
41	Yalakom Confluence	25.5	unknown	n/a
42	Yalakom Confluence	25.5	28.3	4
43	Hippie Pool	26.5	37.3	24
45	Yalakom Confluence	25.5	26	6
46	Yalakom Confluence	25.5	30	15
47	Yalakom Confluence	25.5	26	2
48	Hippie Pool	26.5	37.3	14
49	Yalakom Confluence	25.5	29	9
52	Yalakom Confluence	25.5	28	14
53	Yalakom Confluence	25.5	40	13
54	Yalakom Confluence	25.5	26	n/a
55	Hippie Pool	26.5	26	n/a
56	Yalakom Confluence	25.5	25.5	1
57	Yalakom Confluence	25.5	37	5
58	Yalakom Confluence	25.5	28.6	n/a
59	Yalakom Confluence	25.5	26.4	8
60	Yalakom Confluence	25.5	27.2	9
61	Yalakom Confluence	25.5	26	n/a
62	Yalakom Confluence	25.5	32	8
63	Yalakom Confluence	25.5	27	4
64	Yalakom Confluence	25.5	26.9	n/a
65	Hippie Pool	26.5	27	1
66	Yalakom Confluence	25.5	26.2	4
67	Yalakom Confluence	25.5	28.9	n/a
68	Yalakom Confluence	25.5	26	n/a
69	Yalakom Confluence	25.5	25.5	1
70	Yalakom Confluence	25.5	26	4

Table 4. Biological and tagging data of adult male Coho salmon migrants in the Lower Bridge River, 2013.

FISH #	CAPTURE DATE	CAPTURE LOCATION	RK CAPTURE	REACH	CAPTURE METHOD	PIT TAG	FREQUENCY	CODE	FORK (mm)	SEX
1	08-Oct-13	Lower Bridge		1	angle		149.320	17	640	M
2	08-Oct-13	Lower Bridge		1	angle		149.320	25	750	M
3	08-Oct-13	Hippie Pool	26.5	3	angle		149.780	32	580	M
4	08-Oct-13	Lower Bridge		1	angle		149.780	36	660	M
5	09-Oct-13	Lower Bridge		1	angle		149.320	13	595	M
6	10-Oct-13	Lower Bridge		1	angle		149.320	24	670	M
7	10-Oct-13	Hippie Pool	26.5	3	angle		149.780	28	560	M
8	10-Oct-13	Lower Bridge		1	angle		149.780	31	530	M
9	15-Oct-13	Yalakom Confluence	25.5	3	angle		149.780	23	620	M
10	15-Oct-13	Lower Bridge		1	angle		149.780	30	585	M
11	15-Oct-13	Yalakom Confluence	25.5	3	angle		149.780	34	720	M
12	16-Oct-13	Lower Bridge		1	angle		149.320	12	695	M
13	16-Oct-13	Yalakom Confluence	25.5	3	angle		149.320	18	620	M
14	17-Oct-13	Yalakom Confluence	25.5	3	angle		149.320	15	815	M
15	24-Oct-13	Hippie Pool	26.5	3	angle	183226371			660	M
16	24-Oct-13	Hippie Pool	26.5	3	angle	183225145			720	M
17	28-Oct-13	Lower Camoo		2	angle	183226025			665	M
18	29-Oct-13	Yalakom Confluence	25.5	3	angle	183226457			640	M
19	29-Oct-13	Yalakom Confluence	25.5	3	angle	183225631			590	M
20	29-Oct-13	Yalakom Confluence	25.5	3	angle	183225730			585	M
21	29-Oct-13	Yalakom Confluence	25.5	3	angle	183225309			780	M
22	29-Oct-13	Yalakom Confluence	25.5	3	angle	183226918			760	M
23	30-Oct-13	Yalakom Confluence	25.5	3	angle	183226480			645	M
24	30-Oct-13	Yalakom Confluence	25.5	3	angle	183227043			630	M
25	30-Oct-13	Yalakom Confluence	25.5	3	angle	183225816			640	M
26	31-Oct-13	Counter	25.9	3	angle	183225795			560	M
27	31-Oct-13	Yalakom Confluence	25.5	3	angle	183325231			570	M
28	31-Oct-13	Yalakom Confluence	25.5	3	angle	183225308			640	M
29	31-Oct-13	Hippie Pool	26.5	3	angle	183225278			640	M
30	31-Oct-13	Lower Bridge		1	angle	183227087			665	M
31	1-Nov-13	Hippie Pool	26.5	3	angle	183226854			630	M
32	1-Nov-13	Lower Bridge		1	angle	183226835			635	M
33	4-Nov-13	Yalakom Confluence	25.5	3	angle	183225654			660	M
34	5-Nov-13	Yalakom Confluence	25.5	3	angle	183225491			585	M
35	5-Nov-13	Yalakom Confluence	25.5	3	angle	183226304			670	M
36	6-Nov-13	Yalakom Confluence	25.5	3	angle	183225349			760	M
37	6-Nov-13	Yalakom Confluence	25.5	3	angle	183227095			670	M
38	13-Nov-13	Counter	25.9	3	angle	183225798			615	M
	Male									
Mean Length (mm)		**# Fish Tagged**								
649		38								

Table 5. Biological and tagging data of adult female Coho salmon migrants in the Lower Bridge River, 2013.

FISH #	CAPTURE DATE	CAPTURE LOCATION	RK CAPTURE	REACH	CAPTURE METHOD	PIT TAG	FREQUENCY	CODE	FORK (mm)	SEX
1	08-Oct-13	Hippie Pool	26.5	3	angle		149.780	33	590	F
2	09-Oct-13	Lower Bridge		1	angle		149.780	39	610	F
3	10-Oct-13	Lower Bridge		1	angle		149.780	40	670	F
4	15-Oct-13	Yalakom Confluence	25.5	3	angle		149.780	26	595	F
5	15-Oct-13	Lower Bridge		1	angle		149.780	35	550	F
6	16-Oct-13	Lower Bridge		1	angle		149.320	11	520	F
7	16-Oct-13	Hippie Pool	26.5	3	angle		149.780	27	620	F
8	17-Oct-13	Lower Camoo		2	angle		149.320	14	645	F
9	17-Oct-13	Lower Camoo		2	angle		149.320	16	530	F
10	17-Oct-13	Lower Bridge		1	angle		149.780	38	580	F
11	21-Oct-13	Lower Camoo		2	angle		149.320	20	570	F
12	21-Oct-13	Lower Camoo		2	angle		149.320	21	270	F
13	21-Oct-13	Lower Camoo		2	angle		149.320	22	590	F
14	23-Oct-13	Hippie Pool	26.5	3	angle		149.320	19	590	F
15	28-Oct-13	Yalakom Confluence	25.5	3	anlge		149.320	29	600	F
16	28-Oct-13	Yalakom Confluence	25.5	3	anlge	183225874			560	F
17	28-Oct-13	Yalakom Confluence	25.5	3	anlge	183226127			610	F
18	29-Oct-13	Yalakom Confluence	25.5	3	anlge	183226834			620	F
19	29-Oct-13	Yalakom Confluence	25.5	3	anlge	183225301			580	F
20	29-Oct-13	Yalakom Confluence	25.5	3	anlge	183225437			460	F
21	29-Oct-13	Yalakom Confluence	25.5	3	anlge	183225242			610	F
22	30-Oct-13	Counter Site	25.9	3	anlge	183225404			620	F
23	31-Oct-13	Hippie Pool	26.5	3	angle	183325504			570	F
24	31-Oct-13	Yalakom Confluence	25.5	3	angle	183225247			590	F
25	4-Nov-13	Upper Camoo		2	angle	183225633			580	F
26	5-Nov-13	Yalakom Confluence	25.5	3	angle	183226645			650	F
27	5-Nov-13	Yalakom Confluence	25.5	3	angle	183225138			540	F
28	5-Nov-13	Yalakom Confluence	25.5	3	angle	183226247			660	F
29	6-Nov-13	Yalakom Confluence	25.5	3	angle	183226711			655	F
30	12-Nov-13	Yalakom Confluence	25.5	3	angle	183225743			700	F
31	14-Nov-13	Yalakom Confluence	25.5	3	angle	183225246			735	F
32	no date	Yalakom Confluence	25.5	3	angle	183226923			560	F

Female	
Mean Length (mm)	**# Fish Tagged**
588	32

Table 6. Assessed spawning distribution of radio tagged Coho salmon on the Lower Bridge River, 2013.

Tag #	Tagging Location	Tagging Rkm	Assumed RKm spawning location	Days to Migrate to Spawning Location
11	Lower Bridge	1.0	unknown	n/a
12	Lower Bridge	1.0	unknown	n/a
13	Lower Bridge	1.0	39.6	20
14	Lower Camoo	18.3	34.4	15
15	Yalakom Confluence	25.5	31	15
16	Lower Camoo	18.3	34.2	22
17	Lower Bridge	1.0	unknown	n/a
18	Yalakom Confluence	25.5	25.5	1
19	Hippie Pool	26.5	26	0
20	Lower Camoo	18.3	36	22
21	Lower Camoo	18.3	37.3	15
22	Lower Camoo	18.3	33	11
23	Yalakom Confluence	25.5	26	7
24	Lower Bridge	1.0	unknown	n/a
25	Lower Bridge	1.0	39.4	24
26	Yalakom Confluence	25.5	38.4	21
27	Hippie Pool	26.5	40	20
28	Hippie Pool	26.5	28	8
29	Yalakom Confluence	25.5	36	15
30	Lower Bridge	1.0	39	26
31	Lower Bridge	1.0	26	0
32	Hippie Pool	26.5	29	10
33	Hippie Pool	26.5	26	1
34	Yalakom Confluence	25.5	unknown	n/a
35	Lower Bridge	1.0	unknown	n/a
36	Lower Bridge	1.0	unknown	n/a
38	Lower Bridge	18.3	unknown	n/a
39	Lower Bridge	1.0	unknown	n/a
40	Lower Bridge	1.0	unknown	n/a

Table 7. Visual stream walk and telemetry observations for Chinook and Coho salmon from the Lower Bridge River, 2013.

			Section 1: Yalokom to Hell RK 25.5-28.8				Section 2: Hell to Russel RK 28.8-30.7				Section 3: Russel to Fishfence RK 30.7-33.2				Section 4: Fishfence to Cobra RK 33.2-34.4			
			Observed		Present in Section		Observed		Present in Section		Observed		Present in Section		Observed		Present in Section	
Species	Date	Water Visibility (m)	Untagged	Tagged	Tracked # of tags	# of tags adjusted for survey life	Untagged	Tagged	Tracked # of tags	# of tags adjusted for survey life	Untagged	Tagged	Tracked # of tags	# of tags adjusted for survey life	Untagged	Tagged	Tracked # of tags	# of tags adjusted for survey life
CHA	27-Aug-13	n/a	0	0	7	7	0	0	0	0	0	0	0	0	0	0	0	0
CHA	30-Aug-13	1.0 - 1.5	10	1	17	17	0	0	1	1	0	0	0	0	0	0	0	0
CHA	3-Sep-13	1.0 - 1.5	11	4	15	15	11	0	1	1	5	0	0	0	14	0	0	0
CHA	6-Sep-13	1.0 - 1.5	10	0	12	11	4	0	3	3	2	0	1	1	1	0	0	0
CHA	10-Sep-13	1.0 - 1.5	13	4	12	3	0	0	1	0	0	0	1	0	0	0	2	2
CHA	12-Sep-13	1.0 - 1.5	6	0	13	2	2	0	2	1	0	0	1	0	2	0	1	1
CHA	17-Sep-13	0.0 - 0.5	0	0	10	2	0	0	1	0	0	0	2	1	0	0	0	0
CHA	20-Sep-13	0.0 - 0.5	0	0	11	2	0	0	1	0	0	0	1	0	0	0	0	0
CHA	24-Sep-13	0.0 - 0.5	2	0	13	3	0	0	1	0	0	0	1	0	0	0	0	0
CHA	27-Sep-13	0.0 - 0.5	0	0	12	1	0	0	1	0	0	0	1	0	0	0	0	0
CHA	1-Oct-13	0.0 - 0.5	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0
CHA	4-Oct-13	1.0 - 1.5	0	0	7	7	0	0	0	0	0	0	0	0	0	0	0	0
CHA	8-Oct-13	1.0 - 1.5	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
COA	8-Oct-13	1.0 - 1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
COA	11-Oct-13	0.0 - 0.5	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
COA	18-Oct-13	0.0 - 0.5	0	0	5	5	0	0	2	2	0	0	0	0	0	0	0	0
COA	22-Oct-13	0.0 - 0.5	0	0	4	4	0	0	1	1	0	0	1	1	0	0	0	0
COA	25-Oct-13	0.0 - 0.5	0	0	4	4	0	0	5	5	0	0	1	1	0	0	0	0
COA	29-Oct-13	0.0 - 0.5	8	0	3	3	6	0	2	2	6	0	2	2	6	0	0	0
COA	1-Nov-13	0.0 - 0.5	7	0	7	7	4	0	3	3	4	0	2	2	6	0	1	1
COA	5-Nov-13	0.0 - 0.5	13	0	6	2	0	0	1	0	0	0	3	2	2	0	0	0
COA	8-Nov-13	0.0 - 0.5	8	0	5	1	1	0	2	0	1	0	1	0	71	0	2	2
COA	12-Nov-13	0.0 - 0.5	29	0	3	1	2	0	3	0	2	0	0	0	28	0	3	2
COA	15-Nov-13	0.0 - 0.5	73	0	4	1	4	0	2	0	4	0	1	0	41	0	2	0
COA	19-Nov-13	0.0 - 0.5	0	0	5	0	15	0	2	0	15	0	1	0	75	0	2	0
COA	22-Nov-13	0.0 - 0.5	29	0	4	0	1	0	3	0	1	0	0	0	71	0	3	0
COA	26-Nov-13	0.0 - 0.5	0	0	5	0	0	0	2	0	0	0	1	0	24	0	1	0
COA	29-Nov-13	0.0 - 0.5	7	0	4	0	0	0	3	0	0	0	0	0	27	0	3	0
COA	9-Dec-13	0.0 - 0.5	0	0	4	0	0	0	1	0	0	0	0	0	0	0	3	0

Table 7 . cont.

			Section 5: Cobra to Bluenose				Section 6: Bluenose to Eagle				Section 7: Eagle to Longskinny				Section 8: Longskinny to Plungepool			
			RK 34.4-38.2				RK 38.2-38.8				RK 38.8-39.6				River km 39.6-40.0			
			Observed		Present in Section		Observed		Present in Section		Observed		Present in Section		Observed		Present in Section	
Species	Date	Water Visibility (m)	Untagged	Tagged	Tracked # of tags	# of tags adjusted for survey life	Untagged	Tagged	Tracked # of tags	# of tags adjusted for survey life	Untagged	Tagged	Tracked # of tags	# of tags adjusted for survey life	Untagged	Tagged	Tracked # of tags	# of tags adjusted for survey life
CHA	27-Aug-13	n/a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHA	30-Aug-13	1.0 - 1.5	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
CHA	3-Sep-13	1.0 - 1.5	0	0	1	1	0	0	0	0	2	1	0	0	4	0	1	1
CHA	6-Sep-13	1.0 - 1.5	13	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0
CHA	10-Sep-13	1.0 - 1.5	1	0	2	0	1	0	0	0	1	0	0	0	4	0	0	0
CHA	12-Sep-13	1.0 - 1.5	5	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
CHA	17-Sep-13	0.0 - 0.5	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0
CHA	20-Sep-13	0.0 - 0.5	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
CHA	24-Sep-13	0.0 - 0.5	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0
CHA	27-Sep-13	0.0 - 0.5	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0
CHA	1-Oct-13	0.0 - 0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHA	4-Oct-13	1.0 - 1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHA	8-Oct-13	1.0 - 1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COA	8-Oct-13	1.0 - 1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
COA	11-Oct-13	0.0 - 0.5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
COA	18-Oct-13	0.0 - 0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COA	22-Oct-13	0.0 - 0.5	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
COA	25-Oct-13	0.0 - 0.5	0	0	0	0	0	0	1	1	10	0	0	0	20	0	1	1
COA	29-Oct-13	0.0 - 0.5	0	0	1	1	4	0	0	0	10	0	0	0	68	0	1	1
COA	1-Nov-13	0.0 - 0.5	4	0	1	1	0	0	0	0	77	0	0	0	120	0	2	2
COA	5-Nov-13	0.0 - 0.5	85	1	2	1	16	0	0	0	178	0	1	1	250	0	1	1
COA	8-Nov-13	0.0 - 0.5	154	0	1	0	6	0	1	1	84	1	0	0	253	1	1	0
COA	12-Nov-13	0.0 - 0.5	167	0	3	2	24	0	0	0	173	0	2	2	223	0	1	0
COA	15-Nov-13	0.0 - 0.5	84	0	3	0	9	0	0	0	178	0	1	0	280	0	1	0
COA	19-Nov-13	0.0 - 0.5	82	0	2	1	5	0	0	0	146	0	0	0	187	0	1	0
COA	22-Nov-13	0.0 - 0.5	79	0	3	1	4	0	0	0	136	0	1	0	148	0	1	0
COA	26-Nov-13	0.0 - 0.5	60	0	3	0	2	0	0	0	129	0	1	0	101	0	2	0
COA	29-Nov-13	0.0 - 0.5	29	0	3	0	0	0	0	0	59	0	2	0	60	0	1	0
COA	9-Dec-13	0.0 - 0.5	0	0	3	0	0	0	0	0	4	0	2	0	0	0	1	0

Table 8. Summary of visual stream walk and telemetry observations for Chinook and Coho salmon from the Lower Bridge River, 2013.

			All Reaches			
			Total			
			Observed		Present in Section	
Species	Date	Water Visibility (m)	Untagged	Tagged	Tracked # of tags	# of tags adjusted for survey life
CHA	27-Aug-13	n/a	0	0	7	7
CHA	30-Aug-13	1.0 - 1.5	10	1	19	19
CHA	3-Sep-13	1.0 - 1.5	47	5	18	18
CHA	6-Sep-13	1.0 - 1.5	31	0	18	15
CHA	10-Sep-13	1.0 - 1.5	20	4	18	5
CHA	12-Sep-13	1.0 - 1.5	15	0	19	4
CHA	17-Sep-13	0.0 - 0.5	1	0	15	3
CHA	20-Sep-13	0.0 - 0.5	1	0	16	2
CHA	24-Sep-13	0.0 - 0.5	3	0	18	3
CHA	27-Sep-13	0.0 - 0.5	0	0	18	2
CHA	1-Oct-13	0.0 - 0.5	0	0	7	0
CHA	4-Oct-13	1.0 - 1.5	0	0	7	7
CHA	8-Oct-13	1.0 - 1.5	0	0	0	2
			128	10	180	87
					O.E	O.E
					6%	11%
COA	8-Oct-13	1.0 - 1.5	2	0	0	0
COA	11-Oct-13	0.0 - 0.5	4	0	1	1
COA	18-Oct-13	0.0 - 0.5	0	0	7	7
COA	22-Oct-13	0.0 - 0.5	3	0	6	6
COA	25-Oct-13	0.0 - 0.5	30	0	12	12
COA	29-Oct-13	0.0 - 0.5	108	0	9	9
COA	1-Nov-13	0.0 - 0.5	222	0	16	16
COA	5-Nov-13	0.0 - 0.5	544	1	14	7
COA	8-Nov-13	0.0 - 0.5	578	2	13	4
COA	12-Nov-13	0.0 - 0.5	648	0	15	7
COA	15-Nov-13	0.0 - 0.5	673	0	14	1
COA	19-Nov-13	0.0 - 0.5	525	0	13	1
COA	22-Nov-13	0.0 - 0.5	469	0	15	1
COA	26-Nov-13	0.0 - 0.5	316	0	15	0
COA	29-Nov-13	0.0 - 0.5	182	0	16	0
COA	9-Dec-13	0.0 - 0.5	4	0	14	0
			4308	3	180	72
					O.E	O.E
					2%	4%

Table 9. Visual stream walk observations for Sockeye salmon from the Lower Bridge River, 2013.

			Section 1: Yalokom to Hell	Section 2: Hell to Russel	Section 3: Russel to Fishfence	Section 4: Fishfence to Cobra	Section 5: Cobra to Bluenose	Section 6: Bluenose to Eagle	Section 7: Eagle to Longskinny	Section 8: Longskinny to Plungepool		All Reaches
			RK 25.5-28.8	RK 28.8-30.7	RK 30.7-33.2	RK 33.2-34.4	RK 34.4-38.2	RK 38.2-38.8	RK 38.8-39.6	River km 39.6-40.0		Total
Species	Date	Water Visibility (m)	Observed	Observed	Observed	Observed	Observed	Observed	Observed	Observed	Mortalities	Observed
SKA	30-Aug-13	1.0 - 1.5	150	65	1	19	16	0	0	9	1	261
SKA	03-Sep-13	1.0 - 1.5	220	227	40	4	4	2	5	0	27	529
SKA	06-Sep-13	1.0 - 1.5	330	111	135	4	2	0	0	0	13	595
SKA	10-Sep-13	1.0 - 1.5	504	236	12	80	5	0	7	0	11	855
SKA	12-Sep-13	1.0 - 1.5	440	268	2	90	12	8	15	10	46	891
SKA	17-Sep-13	0.0 - 0.5	153	43	20	62	0	5	3	4	21	311
SKA	20-Sep-13	0.0 - 0.5	89	0	0	28	0	0	0	0	29	146
SKA	24-Sep-13	0.0 - 0.5	33	8	2	10	2	3	4	0	5	67
SKA	27-Sep-13	0.0 - 0.5	49	1	1	6	4	0	11	2	0	74
SKA	01-Oct-13	0.0 - 0.5	9	0	0	4	0	0	0	1	0	14
SKA	04-Oct-13	1.0 - 1.5	83	2	0	0	0	0	0	0	0	85
SKA	08-Oct-13	1.0 - 1.5	85	0	0	8	2	4	0	0	0	99
SKA	11-Oct-13	0.0 - 0.5	8	0	0	4	0	5	0	0	0	17
SKA	15-Oct-13	0.0 - 0.5	15	0	0	1	0	1	1	0	0	18
SKA	18-Oct-13	0.0 - 0.5	24	0	0	0	0	3	0	1	0	28
SKA	22-Oct-13	0.0 - 0.5	19	0	0	0	0	9	0	0	0	28
SKA	25-Oct-13	0.0 - 0.5	20	10	0	0	0	0	0	0	0	30
SKA	29-Oct-13	0.0 - 0.5	20	10	0	0	0	5	2	0	0	37
SKA	01-Nov-13	0.0 - 0.5	11	0	0	0	0	0	0	0	0	11
												4096

Table 10. Visual stream walk observations for Pink salmon from the Lower Bridge River, 2013.

			Section 1: Yalokom to Hell	Section 2: Hell to Russel	Section 3: Russel to Fishfence	Section 4: Fishfence to Cobra	Section 5: Cobra to Bluenose	Section 6: Bluenose to Eagle	Section 7: Eagle to Longskinny	Section 8: Longskinny to Plungepool		All Reaches
			RK 25.5-28.8	RK 28.8-30.7	RK 30.7-33.2	RK 33.2-34.4	RK 34.4-38.2	RK 38.2-38.8	RK 38.8-39.6	River km 39.6-40.0		Total
Species	Date	Water Visibility (m)	Observed	Observed	Observed	Observed	Observed	Observed	Observed	Observed	Mortalities	Observed
PKA	30-Aug-13	1.0 - 1.5	0	0	0	0	0	0	0	0		0
PKA	03-Sep-13	1.0 - 1.5	0	0	0	0	0	0	10	29		39
PKA	06-Sep-13	1.0 - 1.5	2	0	1	12	80	500	0	100		695
PKA	10-Sep-13	1.0 - 1.5	45	62	31	85	25	0	500	5000		5748
PKA	12-Sep-13	1.0 - 1.5	200	205	8	140	600	1000	2000	4500		8653
PKA	17-Sep-13	0.0 - 0.5	452	416	165	650	467	1620	1515	3500		8785
PKA	20-Sep-13	0.0 - 0.5	2300	0	715	584	345	840	1502	1050	800	8172
PKA	24-Sep-13	0.0 - 0.5	2408	800	434	1020	845	705	980	4900	1400	13492
PKA	27-Sep-13	0.0 - 0.5	300	1200	900	300	515	435	410	1200		5260
PKA	01-Oct-13	0.0 - 0.5	2440	310	20	106	124	203	112	530		3845
PKA	04-Oct-13	1.0 - 1.5	230	180	30	30	100	63	150	n/a		783
PKA	08-Oct-13	1.0 - 1.5	1	16	1	8	8	15	1	63		113
PKA	11-Oct-13	0.0 - 0.5	68	10	0	0	38	20	50	5		191
PKA	15-Oct-13	0.0 - 0.5	0	0	0	6	8	6	2	12		34
PKA	18-Oct-13	0.0 - 0.5	0	0	0	0	5	0	0	0		5
PKA	22-Oct-13	0.0 - 0.5	0	0	0	0	2	0	4	2		8
PKA	25-Oct-13	0.0 - 0.5	0	0	0	0	0	0	0	0		0
												55823

7.0 FIGURES

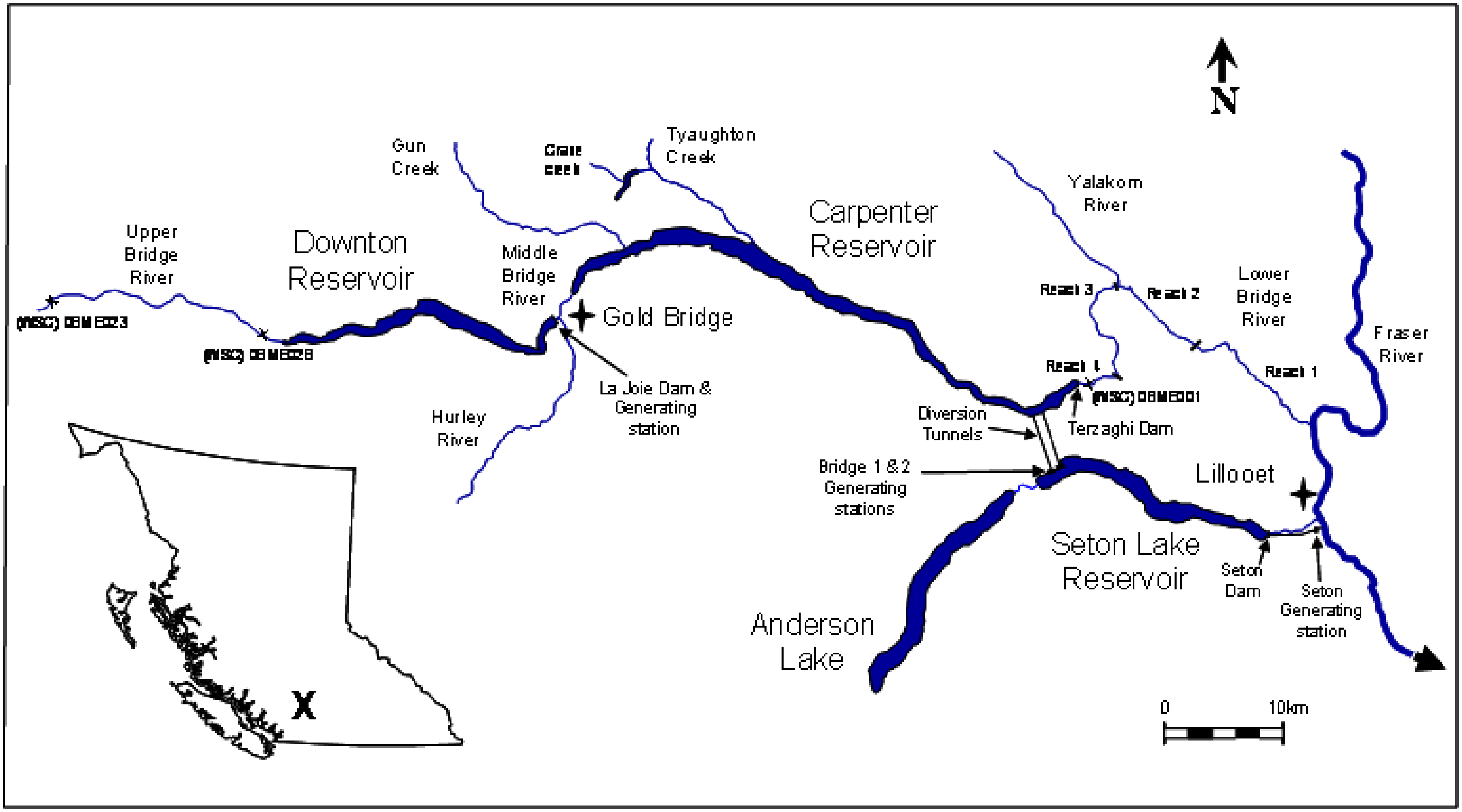

Figure 1. Bridge & Seton Watersheds showing Terzaghi Dam and diversion.

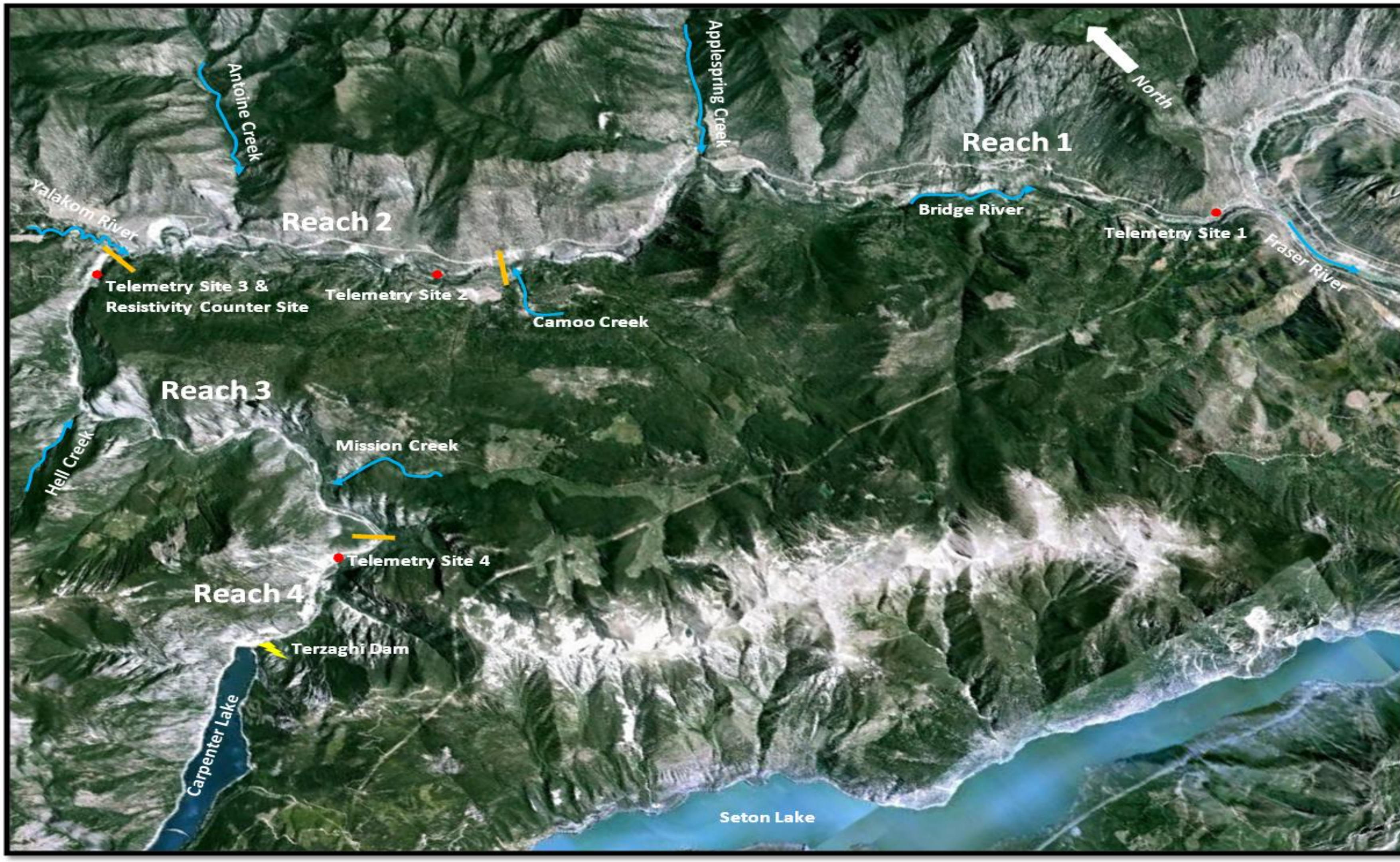

Figure 2. Bridge River Study Area showing Reach Breaks (indicated by orange lines) and Fixed Station Telemetry Receiver Sites (indicated by red dots).

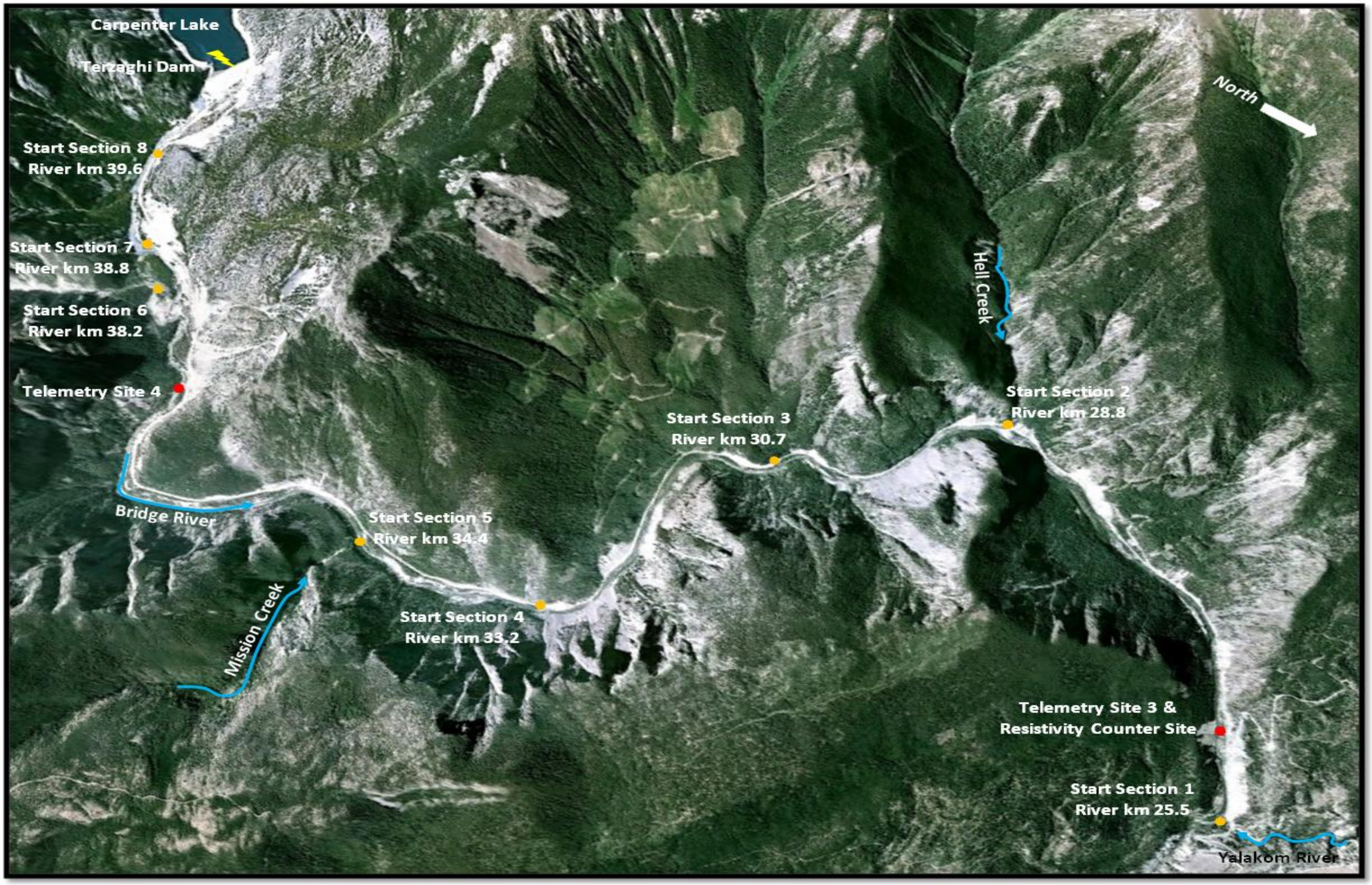

Figure 3. Lower Bridge River Streamwalk Section Boundaries (indicated by orange dots) & Fixed Station Telemetry Receiver Sites (indicated by red dots)

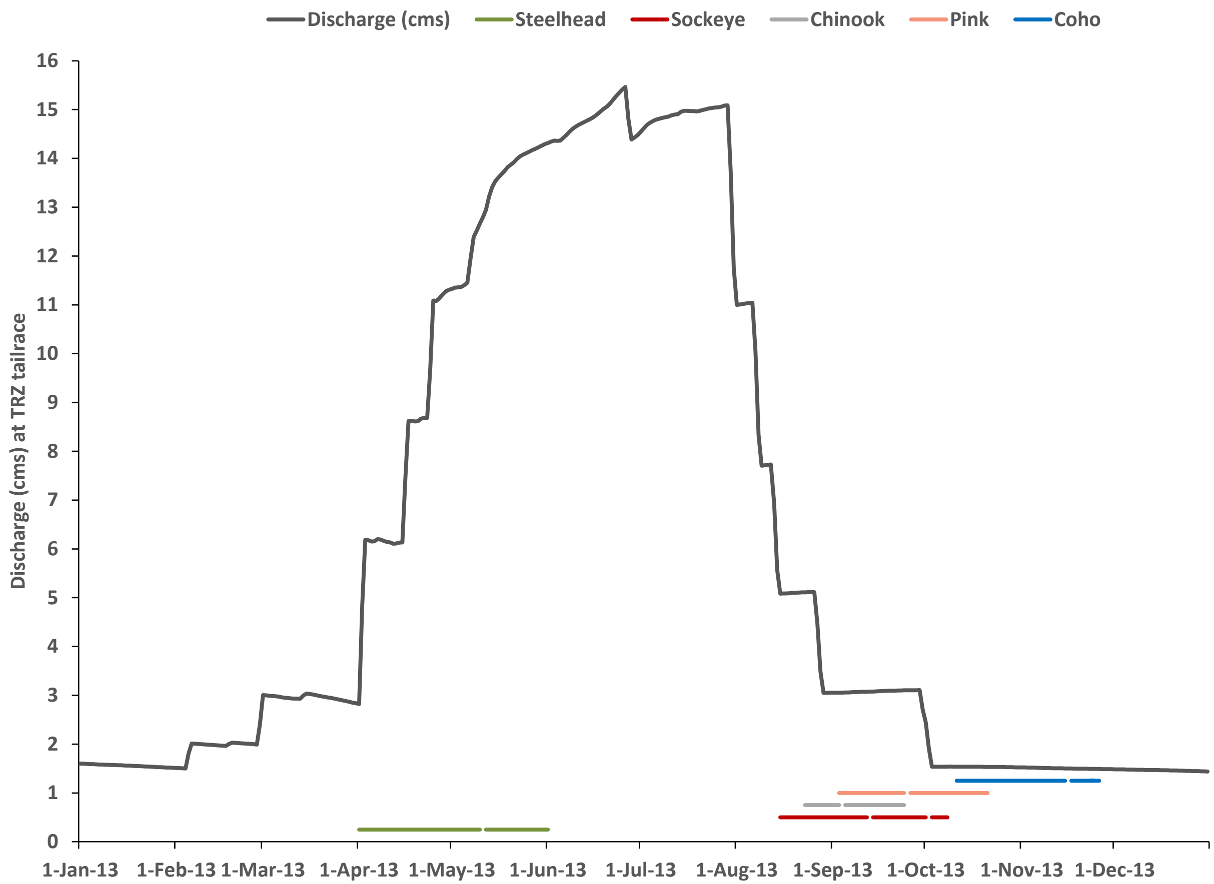

Figure 4. Migration timing of anadromous salmonids into the Bridge River, reach 3 and 4, based on visual count data, 2013 (Steelhead estimated based in historical data).

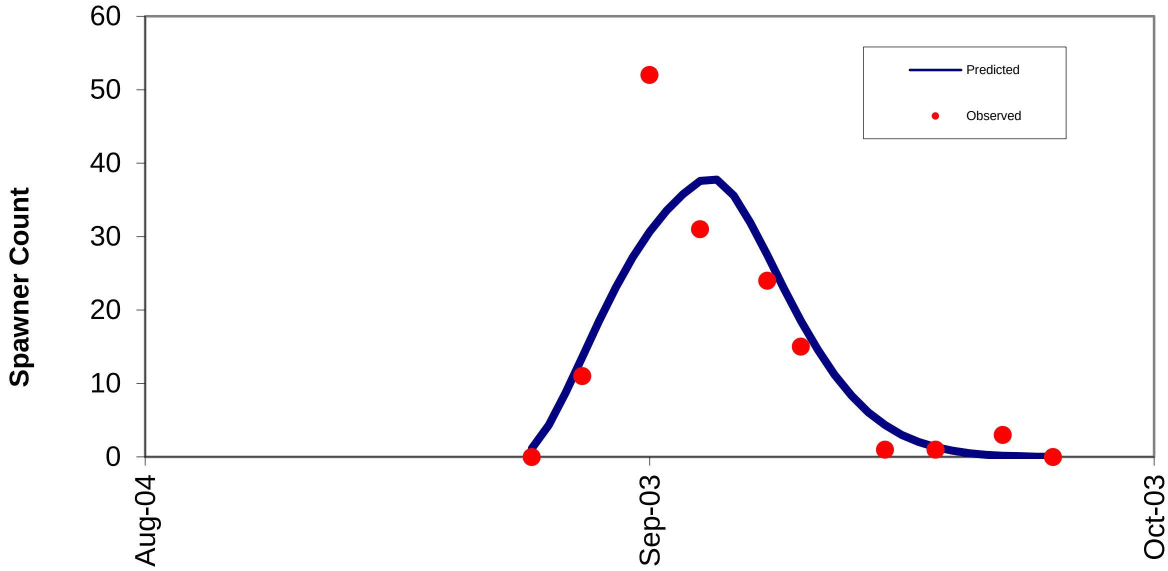

Figure 5. AUC estimate curves for Chinook adult spawners at the Bridge River in 2013 (dashed line) and observed visual counts (red circles).

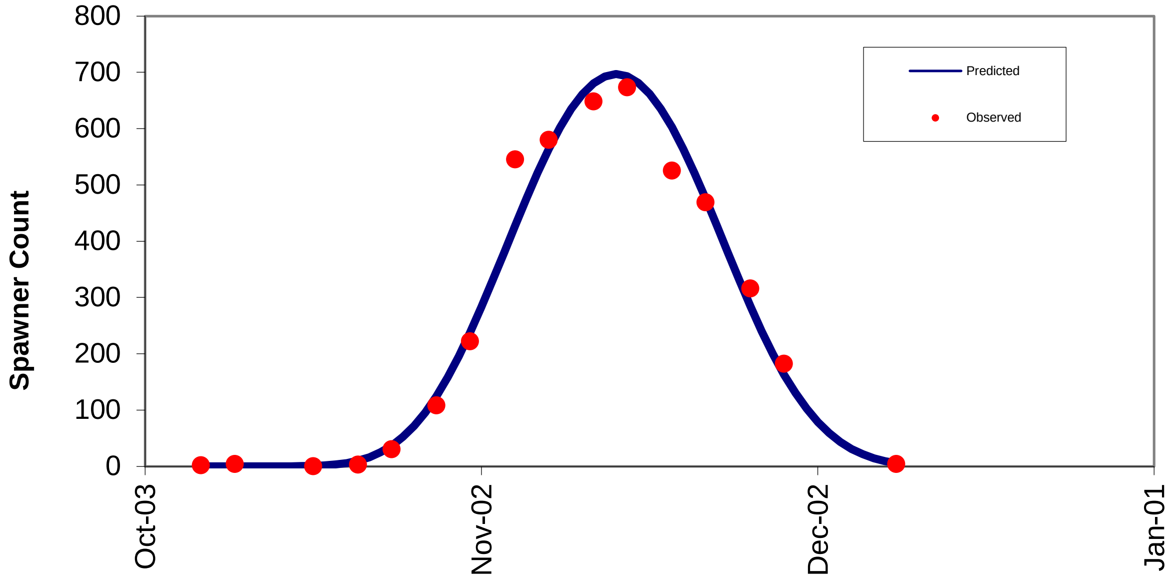

Figure 6. AUC estimate curves for Coho adult spawners at the Bridge River in 2013 (dashed line) and observed visual counts (red circles).

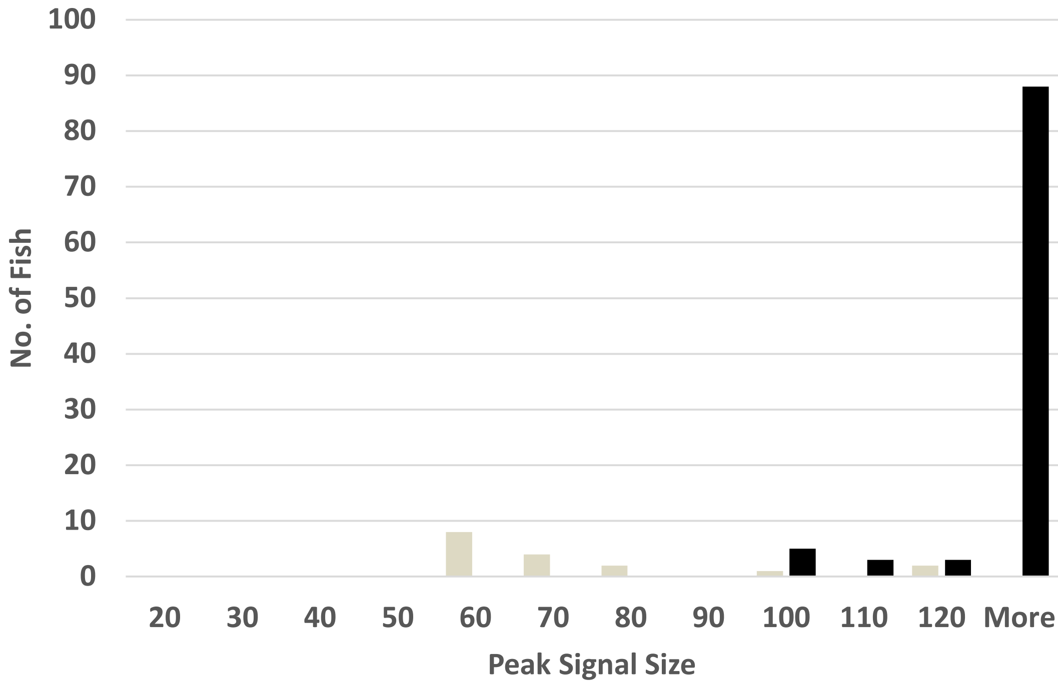

Figure 7. Peak Signal Size (PSS) relationship to fish species. Bull trout (gray bars) and Coho salmon (black bar).

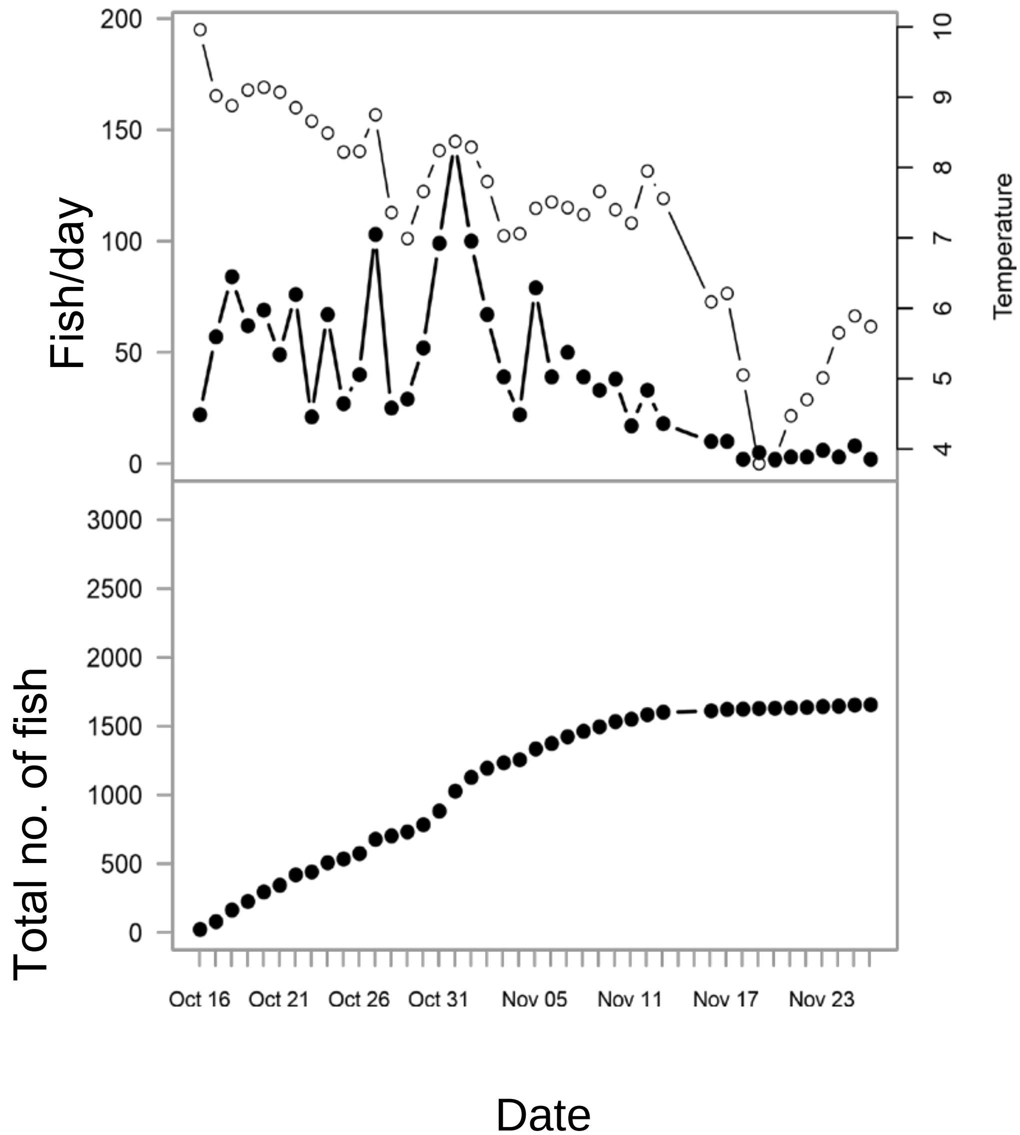

Figure 8. Upper graph indicates total daily up migration for fish creating a PSS>90 on channels 1-3 (black filled circles) and daily mean temperature Co of all temperature loggers in reach 3 (white filled circles). Lower graph shows cumulative daily migration totals uncorrected for counter efficiency (PSS>90 and channels 1-3).

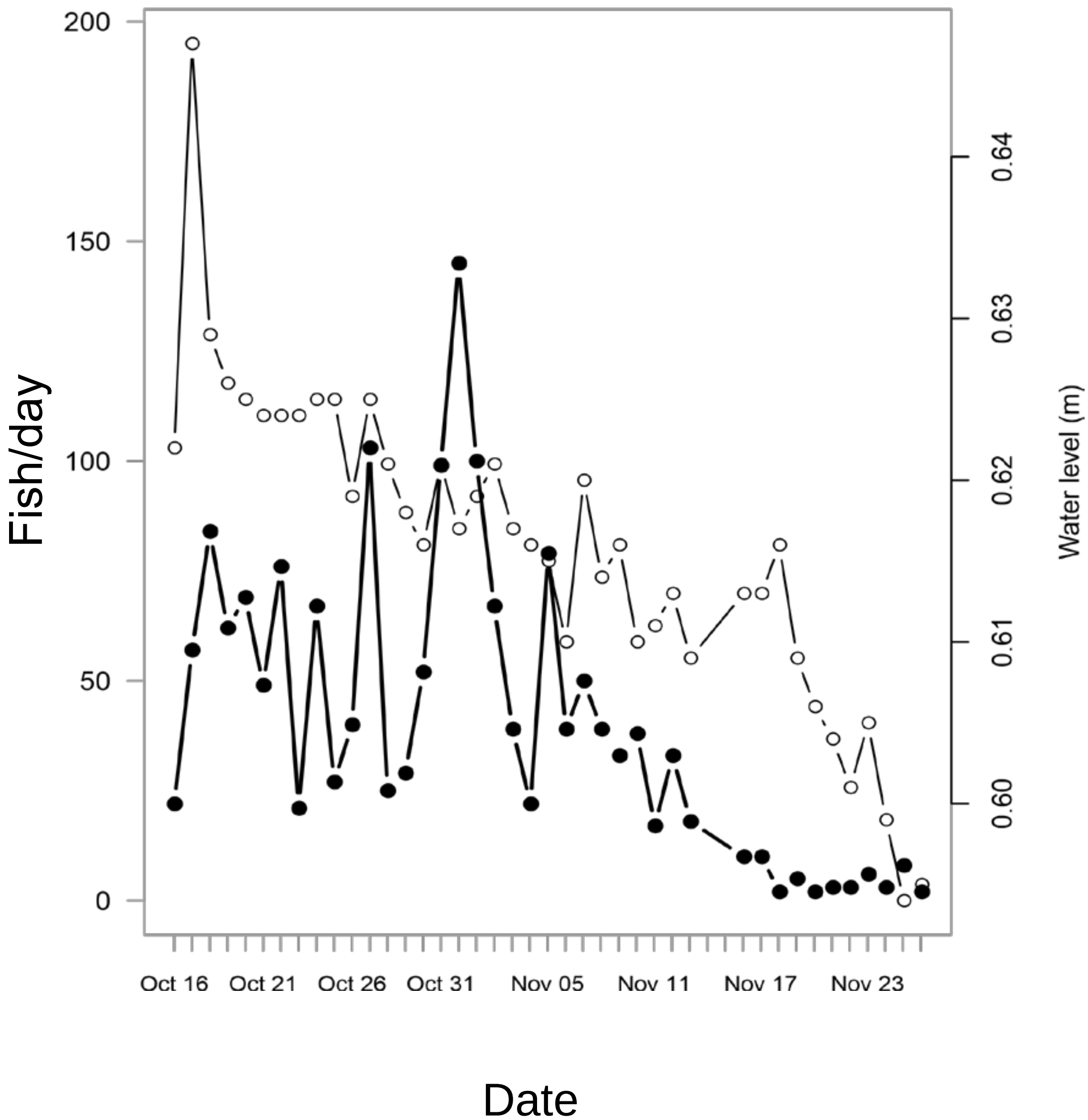

Figure 9. Daily up counts of PSS >90 at the fish counter, compared to mean stage water level (m) at Bridge 36.8 km Gauge Station in reach 4, Fall 2013.

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9.0 APPENDIX

Appendix 1 Fish tag placements