Bridge-Seton Water Use Plan

Monitoring Program Terms of Reference

- BRGMON-9 Seton River Habitat and Fish Monitoring
1 Monitoring Program Rationale

1.1 Background

A critical environmental concern expressed throughout the development of the Bridge-Seton Water Use Plan (BRG WUP) was the development of an acceptable instream flow regime for Seton River. The BRG CC set environmental objectives for Seton River that are measured in terms of the abundance and diversity of fish populations using the river. Seton River is well known to provide spawning and rearing habitat to several anadromous (chinook, coho, pink salmon, steelhead) and resident species (bull trout (rearing only), whitefish, rainbow trout). However, there are relatively limited data to describe the biological characteristics of the population in terms of the abundance, productivity, and life history. The available information relating these biological data to habitat use and the expected way the flow regime will influence the fish populations is even poorer.

To evaluate alternative instream flow regimes for Seton River, performance measures were developed to reflect the quality and quantity of the spawning and rearing habitats for several selected key species and life stages, with assumptions that this ultimately is related to population abundance and diversity. Performance measures were developed in a phased manner. Initially, physical habitat simulation models developed in earlier efforts to resolve instream flow issues at Seton were applied to investigate the effect of the in stream flow regime on the rearing and spawning phases of key anadromous species. Discussion of model output lead to uncertainty about the use of the physical habitat simulation approach for establishing the flow regime and the desire to manage the instream flow releases to provide more naturalized conditions in the river. There was consensus that the physical habitat modeling was flawed because: 1) it did not account for all physical or biological factors influencing the productivity of the fish populations, and 2) there was insufficient spatial resolution to confidently extrapolate habitat conditions to the entire river. This uncertainty resulted in the development of new fish performance measures that reflected the degree to which the hydrograph shape and magnitude conformed to that observed prior to operation of the Bridge diversion. Application of these new performance measures was also found to be problematic because there is no objective way to weight the value of conformity of the different measures of the “natural hydrograph”. With increasing acknowledgement of technical uncertainty performance measure development progressed in a recursive fashion, where there was a trend from very detailed mechanistic analysis of habitat conditions, to criteria for naturalize conditions, and finally to the application of simple three stage (i.e., 0-bad, 1-OK, 2-better) qualitative scoring system.
Despite the central role that Seton Dam flow releases play in development of the BRG WUP, the fish habitat performance measures for Seton River fish populations remained uncertain. The simple measures did ultimately allow trade-off decisions to be made to select the final alternative (N2-P). The BRG CC expressed concern about uncertainty about how habitat changes would influence fish abundance and diversity. Given poor baseline data on habitat and populations in Seton River, the BRG recommended implementation of habitat and population monitoring studies to help validate or refute the selection of the hydrograph and to provide information needed to develop more certain and effective performance measures for future water use planning purposes.

Following the CC process, concern was raised about the potential impact of Seton Generating Station operations on fish habitat in the Fraser River (summarized in Higgins 2010). The effects of Seton operations on Fraser River discharge are greater at low Fraser River discharge (typically Dec to Mar). Thus, concern was focused on the effects of Seton Generating Station operations during winter, and operations during this period are now managed to mitigate potential impacts. The hydrological response of the Fraser River to Seton Generating Station winter shutdowns has been examined, and the likely biological impacts associated with these changes have been estimated (Higgins 2010). This monitoring program will further investigate these potential impacts in the Fraser River and provide additional physical and biological information to help reduce uncertainty on the effects to fish and fish habitat.

1.2 Management Questions

The four primary management questions were identified in discussion of the effects of the flow regime on fish habitat in Seton River were:

1) What are the basic biological characteristics of the rearing and spawning populations in Seton Rivers in terms of relative abundance, distribution, and life history?

2) How does the proposed Seton hydrograph influence the hydraulic condition of juvenile fish rearing habitats in downstream of Seton Dam?

3) What is the potential risk for salmon and steelhead redds dewatering due to changes in flow between spawning and incubation periods imposed by the Seton hydrograph?

4) How will the Seton hydrograph influence the short term and long term availability of gravel suitable for use by anadromous and resident species for spawning and egg incubation?

5) Does discharge from Seton Generating Station impact fish habitat in Fraser River above and beyond natural variation in Fraser River discharge?

Small changes in Seton River discharge can have considerable impact of the hydraulics (depth, velocity) in the Seton River mainstem river channel. Similarly, the impacts of high flow levels on juvenile fish was assumed to be buffered by 1) overflow of the Seton River main stem into side channels that provide favorable habitat for juvenile and subadult fish; 2) a possible “dynamic equilibrium” of suitable
hydraulic conditions (i.e., for different flow levels there is a fixed volume of hydraulic habitat that conforms to tolerances or preferences of small fish). There was concern that seasonal changes in flow regime between the spawning period and the emergence of larvae could similarly impact the potential for redd dewatering. The potential for dewatering is largely unknown because of the dependence on where fish deposit eggs, the interaction between channel geometry and the observed flow regime. The selected hydrograph may also impact on the quantity of suitable gravel for spawning because 1) there little (if any) gravel recruitment to the river channel below the dam and 2) the implemented hydrograph may result in river discharges that mobilize spawning gravel. The combination of redd dewatering and gravel mobilization may erode the quantity and effectiveness of spawning habitats in the river.

To obtain improved understanding of the operational impacts of the implementation of the Seton hydrograph on fish habitat, the BRG CC recommended the implementation of a study to assess how the implemented hydrograph performed with respect to critical habitat issues. The recommended focus of this monitoring was: 1) documenting the hydraulic conditions in the river that are provided by the hydrograph; 2) collection further information on juvenile fish habitat use in the Seton River as it pertains to flow; 3) monitor the salmon and steelhead spawning locations to assess the potential for redd dewatering impacts; and 4) monitoring changes in quantity and spatial location of gravel suitable for fish spawning. The purpose is to document how the implemented hydrograph influences habitat and to gain further information useful in the refinement of future performance measures for fish resources in Seton River.

1.3 Detailed Hypotheses about the Hydraulic Impacts of Seton Dam Operation on Fish Habitat

Three primary null hypotheses (and sub-hypotheses) associated with these management questions are:

H1: The amount of hydraulic habitat that can be inhabited by juvenile fish is independent of discharge from Seton Dam.

H1A: Juvenile standing crop biomass per unit area is inversely related to flow velocity.

H1B: Juvenile standing crop biomass per unit area is independent of flow depth

H1C: Juvenile standing crop biomass per unit area is independent of both flow velocity and depth.

H2: The selected Seton River hydrograph does not result in dewatering of salmon or steelhead redds.

H3: The selected Seton River hydrograph does not result in mobilization of gravel or net loss of gravel from the system.
Each of these hypotheses could have important consequences for the predicted impacts of operations on fish; however, they could not be resolved during the WUP. This is because the technical data to do so do not exist and there is expected to be some inter-annual variation in the hydrograph, which could not be predicted with the power modeling studies. Data from the program will be collected to explicitly test these null hypotheses.

1.4 Key Water Use Decision Affected

Seton Dam and generating station are a ‘hydraulic bottleneck’ in the Bridge-Seton system, and changes in the operation of the dam (i.e., in stream flow release) have considerable upstream impact on the management of Carpenter and Downton Reservoir. This hydraulic characteristic has two practical consequences. First, there are periodic high flows in the river that are necessitated by water management concerns. For example, in high inflow years water is managed in the system and to prevent excessive flow releases from Terzaghi Dam which result in power losses as well as environmental impacts. Because Seton power canal imposes a limitation on water that can be “generated” out of the system water management requires release of water discharge rates that are greater than that thought to be beneficial for fish. Second, variable inflows patterns to the system the Seton River on seasonal and inter-annual basis have resulted in highly variable and unpredictable changes in flow in Seton River which are believed to reduce the productive capacity of the habitat. Implicit in the decision to select a given operations is a trade-off between providing instream flow regimes to protect/enhance fish resources in Seton River and expected riparian performance in Carpenter Reservoir. This trade-off was pervasive during the development of the BRG WUP. There was great uncertainty in making this trade-off so this monitoring program directly addresses this uncertainty. Follow-up monitoring was recommended by the BRG CC so that better estimates of the impacts of alternative flow regimes could be made and this would support more informed decisions about this trade-off in the future.

2 Monitoring Program Proposal

2.1 Objective

The objectives of this monitoring program are to monitor the response of fish habitat and fish populations to Seton Dam operations.

2.2 Approach

The general approach to this monitoring program will be to conduct field studies to provide three critical pieces of information improving the capability to make wise decisions regarding flow management at Seton. First, field studies will provide direct observation of key uncertainties about the impacts of the hydrograph on the quality of juvenile habitats, redd dewatering, and gravel scour in the river channel. Second this collection of habitat and population data simultaneously will allow more reliable judgments about the short term impacts of habitat alteration on population abundance and diversity. Finally, the monitoring studies will provide the time series data on juvenile and adult populations that allow long term inferences about the effect of the flow regime on population abundance and diversity.
The approach to the work will be to collect coincident habitat and population information on Seton River fish populations, and use this information to better understand the effects of the flow regime on critical habitat characteristics and to relate how habitat conditions influence habitat use and relative productivity. Supplemental topographic data from the Seton River will be collected to add to the current topographic database to allow development of a digital elevation model of the system. The spatial referencing approach is critical for linking and managing data associated with the hydraulic modeling, rearing habitat observations, spawner enumeration, redd dewatering observations, and gravel mapping components of the proposed program. Since Seton River is relatively short, and much of the topographic data and recent airphotos currently exist, this can be accomplished at low cost. Annual surveys will be conducted to 1) index population abundance and distribution in relation to habitat conditions 2) quantify redd dewatering; and 3) quantify/map changes in spawning gravel location and quantity. These surveys will contribute to the overall data base, where it is integrated, analyzed and be stored in the GIS system. Annual data reports will be produced to summarize methods and results of each year’s program and a final completion report will be completed to synthesize the results in terms of the hydrograph that was actually delivered during the monitoring period.

2.3 Methods

The proposed monitoring program has 3 primary tasks:

2.3.1 Task 1 Project Coordination

Project coordination involves the general administrative and technical oversight of the program. This will include but not be limited to: 1) budget management, 2) staff selection, 3) logistic coordination, 4) technical oversight in field and analysis components; and 5) liaison with regulatory and first nations groups.

2.3.2 Task 2 Field Studies

Supplemental Topographic Surveys, Basemap Development, and Hydraulic Modeling

A significant amount of topographic survey data is available for Seton River channel and floodplain, but this is insufficient to develop the base digital elevation model for spatial referencing of habitat information, redd locations, sediment mapping and hydraulic modeling. Topographic survey of the Seton River channel from Seton Dam to the Fraser River confluence will be conducted to develop a fully georeferenced GIS database appropriate for storing spatial (x,y,z) information on physical and biological data collected during the monitoring program. Building on past modeling efforts, a hydraulic model will then be developed for the entire river (e.g., HEC RAS, Riv 2D) and validated, to allow linkage of habitat characteristics and local population abundance to river hydraulics. Together, the GIS basemap and hydraulic model provides data management and analysis required for the proposed project.

Rearing and Spawning Habitat Monitoring
Juvenile habitat use surveys will be conducted to collect quantitative information on habitat conditions and standing crop to better understand 1) extent of use of main stem and side channels, and 2) factors that control habitat quality. Diurnal snorkel surveys will be used to describe habitat use in relation to hydraulic conditions and quantitative electrofishing will be used to evaluate patterns of growth (monthly) and fish habitat in terms of juvenile standing crop during fall. This information helps evaluate the outcome of the implementation of the Seton hydrograph, as well as provide information needed to develop future performance measures for rearing fish.

Spawner count and redd surveys will be conducted approximately weekly during spawning migrations of key species fall spawning species (Chinook, pink, Coho). The presence of steelhead redds can be checked at potential locations during late-April and May. Abundance of each species will subsequently be calculated using estimates of observer efficiency and area-under-the-curve. The focus of the monitoring is to provide better information on the abundance and distribution of the spawning fish in the system. Foot surveys will be conducted from Seton Dam to the confluence with the Fraser River to: 1) enumerate spawning fish, 2) document distribution, and 3) locate redds (GPS). At selected location of high redd density, continuous stage monitoring devises will be installed to follow the progression of the hydraulic conditions at the redd locations during the incubation period (i.e., when the hydrograph is descending to its minimum). With sufficient number of redds to follow, elevation referencing of the stage to the redds will allow statistical quantification of redd dewatering risks (see Korman 2009 as an example). Using annual redd locations from the entire Seton River, redd dewatering for the whole river can be estimated using the hydraulic model, and model estimates compared to field observations.

Annual gravel mapping surveys will be conducted to survey the extent of gravel movement resulting from the implementation of the Seton hydrograph. Annual topographic surveys will occur during periods of low water to map the channel sediment composition. Assessment of changes in spatial location, composition, and total area of gravel suitable for salmon spawning will be attained through GIS. Annual surveys allow resolution of data needed to identify loss rate from the system, as well determine hydrograph specific characteristics that increase gravel loss rates. The data collected during this phase of the monitor will be used to determine whether there is a gravel transport issue and what the appropriate mitigative action is.

It is expected that the first year of fish sampling will examine the effectiveness of a range of fish sampling gears, in a range of habitats, to help determine the most effective sampling program for the duration of the program.

Fraser River Fish and Fish Habitat

To estimate potential impacts to fish and fish habitat, the rate of stage change and fish stranding risk at fish habitats in the Fraser River judged to be at highest risk will be monitored following reductions in Seton Generating Station discharge. The rate of stage change and an assessment of fish stranding will occur during large flow reductions (>80 cms reductions) from the Seton Generating Station. Surveys will occur opportunistically over 5 years (estimated at once or twice per year) and over a range of low to moderate discharge in the Fraser River (~500 to 1200 cms at Texas Creek WSC gauge). It is estimated that two sites that are relatively close to the
generating station and with higher risk of bar stranding will be monitored. Stage monitoring at key sites will continue for the entire 10 years of the program.

2.3.3 Task 3 Reporting

A data report will be prepared annually. A synthesis report will be prepared in Years 5 and 10.

2.4 Interpretation of Monitoring Program Results

Upon completion of the program a synthesis report will be prepared. This synthesis will include, but may not be limited to:

1) More comprehensive description of the rearing and spawning habitat use and relative productive capacity of habitats in the Seton River
   Improved understanding of the patterns of habitat use and relative abundance of rearing and spawning fishes in the mainstem and sidechannel habitats in the Seton River will fundamentally provide a better basis for evaluating the current hydrograph and developing future performance measures.

2) Assessment of Risk of Redd Dewatering
   A fundamental, yet uncertain, assumption of the Seton hydrograph is that it will not result in significant dewatering of salmon or steelhead redds. The proposed studies will provide a quantitative assessment of redd dewatering from field data as well as provide modeling platform for evaluating how alternative flow regimes result in risk of redd dewatering.

3) Assessment of Influence of the Flow Regime on Gravel Mobilization
   Another fundamental uncertain assumption was that the implemented hydrograph would not cause significant mobilization and loss of gravel suitable for fish spawning from the system. Topographic mapping and monitoring will assess this assumption.

4) Assessment in trends in abundance of juvenile and spawning fish in relation to the habitat conditions provided by the delivered instream flow regime
   Trend information can be interpreted to help understand whether the selected Seton Hydrograph will have a positive, negative or undetectable impact on Seton fish populations.

5) Assessment of Seton Generating Station flow reductions on Fraser River fish and fish habitat

2.5 Schedule

This program will be conducted for 10 years, with a formal review of the program after 5 years.
2.6 Budget

Total Program Cost: 1,099,994.

3 References Cited
