Columbia River Project Water Use Plan

Monitoring Program Terms of Reference

LOWER COLUMBIA RIVER
FISH MANAGEMENT PLAN

- **CLBMON-47 Lower Columbia River Whitefish Spawning Ground Topography Survey**

24 October 2007

TERMS OF REFERENCE FOR THE COLUMBIA RIVER PROJECT WATER USE PLAN MONITORING PROGRAMS LOWER COLUMBIA RIVER FISH MANAGEMENT PLAN

1.0 OVERVIEW

This document presents Terms of Reference for the effectiveness monitoring programs for the Lower Columbia River Fish Management Plan (Table 1). These programs will evaluate the effects of whitefish and rainbow trout flow conditions on the lower Columbia River and provide a physical and ecological health barometer against which the lower Columbia River monitoring programs can be evaluated.

This document provides detailed Terms of Reference for the following programs:

1) CLBMON-42 Lower Columbia River Fish Stranding Assessment and Ramping Protocol: a 13-year program to monitor planned and opportunistic flow reductions to establish impacts of flow reductions on fish populations in the lower Columbia River and the required operational procedures to mitigate ramping impacts.

2) CLBMON-43 Lower Columbia River Sculpin and Dace Life History Assessment: a 5-year program to monitor the life history and habitat use of sculpin and dace, in particular species listed under the federal Species at Risk Act and the BC Wildlife Act, in the lower Columbia River in relation to seasonal operations at Keenleyside Dam.

3) CLBMON-44 Lower Columbia River Physical Habitat and Ecological Productivity Monitoring: a 12-year program to monitor physical habitat parameters, periphyton and benthic invertebrates below Keenleyside Dam to evaluate net change in trophic productivity and overall ecological health in relation to rainbow trout and mountain whitefish flow regimes.

4) CLBMON-45 Lower Columbia River Fish Population Indexing Surveys: a 13-year program to monitor trends in the biological characteristics, distribution and abundance of mountain whitefish, rainbow trout and walleye populations in the lower Columbia River in relation to rainbow trout and mountain whitefish flow regimes.

5) CLBMON-46 Lower Columbia River Rainbow Trout Spawning Habitat Assessment: a 10-year program to monitor the relative abundance, distribution, spawning site selection and timing of rainbow trout spawning in the lower Columbia River in relation to rainbow trout and mountain whitefish flow regimes.

6) CLBMON-47 Lower Columbia River Whitefish Spawning Ground Topographic Surveys: a 3-year program to monitor spawning locations of whitefish in the lower Columbia River using detailed topographic surveys to improve the effectiveness of the whitefish flow regime in the lower Columbia River.

7) CLBMON-48 Lower Columbia River Whitefish Life History and Egg Mat Monitoring: a 5-year program to monitor whitefish life history, including spawning and egg mat sampling in the lower Columbia River, to establish the effectiveness of the current whitefish flow regime on egg survival, juvenile recruitment, and adult populations.

8) CLBMON-49 Lower Columbia River Effects on Great Blue Heron: a 4-year program to determine the importance of Waldie Island as an overwintering site for juvenile and adult heron from the Revelstoke colony.

Table 1 Lower Columbia River Fish Management Plan Monitoring Program Terms of Reference Submission Information

Name of Monitoring Program	Order Clause Fulfilled	Submitted with this Package	Previously Submitted To CWR	Submission Date	Leave to Commence
CLBMON-42 Lower Columbia River Fish Stranding Assessment and Ramping Protocol	Schedule E: 2.a	No	Yes	10 September 2007	No
CLBMON-43 Lower Columbia River Sculpin and Dace Life History Assessment	Schedule E: 2.b	Yes	No	26 October 2007	No
CLBMON-44 Lower Columbia River Physical Habitat and Ecological Productivity Monitoring	Schedule E: 2.c	Yes	No	26 October 2007	No
CLBMON-45 Lower Columbia River Fish Population Indexing Surveys	Schedule E: 2.d	No	Yes	10 September 2007	No
CLBMON-46 Lower Columbia River Rainbow Trout Spawning Habitat Assessment	Schedule E: 2.e	Yes	No	26 October 2007	No
CLBMON-47 Lower Columbia River Whitefish Spawning Ground Topographic Surveys	Schedule E: 2.f	Yes	No	26 October 2007	No
CLBMON-48 Lower Columbia River Whitefish Life History and Egg Mat Monitoring	Schedule E: 2.g	Yes	No	26 October 2007	No
CLBMON-49 Lower Columbia River Effects on Great Blue Heron	Schedule E: 2.h	Yes	No	26 October 2007	No

2.0 MONITORING PROGRAM RATIONALE

The trophic productivity and ecological health of the lower Columbia River and, therefore, the quality and quantity of large river habitat are partially dependent on the operation of Hugh L. Keenleyside (HLK) Dam. As such, the Columbia River Water Use Plan Consultative Committee (WUP CC) recognized operational impacts of the dam on fish productivity of the lower river as a key environmental concern to be addressed during the water use planning process.

The WUP CC initially explored ways of achieving specific elements of a preferred fish hydrograph for the lower Columbia River through modifying operation of Arrow Lakes Reservoir. However, it became apparent that BC Hydro would have only limited operational flexibility to unilaterally change flows in the lower Columbia River given the need to meet prescribed weekly flow releases at the border under the Columbia River Treaty (CRT). The WUP CC did not consider the existing flexibility to be biologically significant and, therefore, focused on more substantial flow changes that could be made by deviating from CRT flows through annual negotiations with the U.S. These included:

- rainbow trout protection flows, which involve stabilizing or increasing flows from 01 April to 30 June to minimize dewatering and potential egg losses of mid-timed spawning rainbow trout, and
- mountain whitefish flow, which involve limiting maximum flows during the peak spawning period (1 to 20 January) and smoothing flows until hatch (end March) to minimize subsequent egg dewatering and mortality, and maintaining February/March total stage changes less than 0.5 m.

Water levels in the lower Columbia River are typically managed to limit high flows in January and to stabilize or increase flows through to the end of June; flows increase through the summer and flow fluctuations are allowed in the fall as a treaty trade-off for whitefish flows.

During the development of flow management recommendations, it was recognized that there are significant data gaps regarding the effects of flow shaping on the physical environment and ecological productivity of the lower Columbia River. Monitoring projects were designed to examine the effectiveness of these flow options, and to address existing data gaps between flows and other endpoints of interest[1] (Table 1).

The key objectives of the Lower Columbia Monitoring Program are to: 1) evaluate the effects of whitefish and rainbow trout flow conditions on the lower river and, 2) provide a physical and ecological health barometer against which the Middle Columbia monitoring program can be evaluated.

Rainbow Trout Protection Flows

Prior to 1992, the typical flow regime below HLK Dam was characterized by declining discharge over the March to May period, and increasing discharge over the June to July period. This discharge pattern resulted in reduced water levels at Norns Creek Fan (a primary rainbow trout spawning area), causing a significant number of rainbow trout redds constructed at higher elevations to become dewatered when flows were subsequently reduced. Since 1993, BC Hydro has successfully negotiated Non-Power Use Agreements with the U.S., in consultation with the fish agencies, with the aim of providing better flow regimes for rainbow trout spawning below HLK Dam than would normally occur under the CRT operations. BC Hydro has secured these flow changes by providing 1 MAF of storage from Arrow Lakes Reservoir in July-August for U.S. salmon flow augmentation.

An important objective of rainbow trout protection flow is to maintain minimum river levels at Norns Creek Fan between 1 April and 30 June to ensure that eggs deposited after 1 April

[1] A parallel study in the Middle Columbia River will assess the environmental benefits of the establishment of a year-round $142 m^3 s^{-1}$ minimum flow release from Revelstoke Dam.

remain wetted until fry emergence occurs, which is typically by the end of June. These flows are designed to minimize potential egg losses for the mid-timed rainbow spawners (April and May) by providing stable or increasing discharge over this period. This is typically achieved by delivering flows between 15 and 20 kcfs from HLK Dam. The initial discharge is set so that there is a high probability that the downstream river level can be maintained until the end of the spawning and incubation period without causing Treaty storage to draft below planned levels under the CRT.

The implementation of the rainbow trout flow policy in the lower Columbia River has coincided with a general increasing trend in rainbow trout population abundance over the past 10 years. While there may be many reasons for this population increase, BC Hydro and the fish agencies view this as a successful management strategy in protecting rainbow trout populations in the lower river. However, the WUP CC recognized that a significant tradeoff exists between providing protection flows in the lower Columbia to protect rainbow trout spawning and incubation, and its negative impact on other interests upstream in Arrow Lake Reservoir and mid Columbia River (i.e., vegetation, wildlife, large river habitat) due to the additional 1 MAF of storage in spring. Because of potential benefits that could be achieved upstream if annual provision of the protection flows were halted, the WUP CC discussed whether it is essential that this flow management be implemented every year to maintain or enhance these populations. It was recognized that a long-term commitment to monitoring would be required to better understand the linkage between rainbow trout flow implementation and population abundance.

Whitefish Flow Management

Despite over a decade of implementing whitefish flow management actions in the lower Columbia River, there remains uncertainty regarding the relationship between flow conditions and egg mortality, and the significance of egg loss to the productivity of the whitefish population. The WUP CC recognized that resolution of this uncertainty is critical for establishing winter flow release regimes for HLK and Brilliant dams.

Mountain whitefish spawn in the lower Columbia and Kootenay rivers during early winter with peak spawning typically occurring during the first three weeks of January each year (see Figure 1, RLL 2001). Eggs are broadcast into the water column, and are distributed throughout a variety of locations and depths depending on river flow conditions during spawning. Flows supplied to the river from HLK and Brilliant dams into the lower Columbia River during whitefish reproductive period are typically high during the peak mountain whitefish spawning period and decline to an annual minimum by 01 April. Flows can vary widely during the spawning and egg incubation periods, and have been observed to dewater whitefish eggs.

The conceptual approach to whitefish flow management is to stabilize (to the degree possible) regulated flow releases into the lower Columbia River during whitefish reproduction. This requires additional agreements outside of the CRT, including 1) the Whitefish Operating Agreement, which allows storage at Kinbasket and Arrow Lakes reservoirs during the January to reduce Arrow outflow, and 2) the Fall Provisional Storage Agreement and March Whitefish Flow Agreement, which allows for a provisional draft of Arrow Lakes Reservoir and higher releases during the fall in compensation to the U.S. for lost energy benefits associated with stabilization of winter flow.

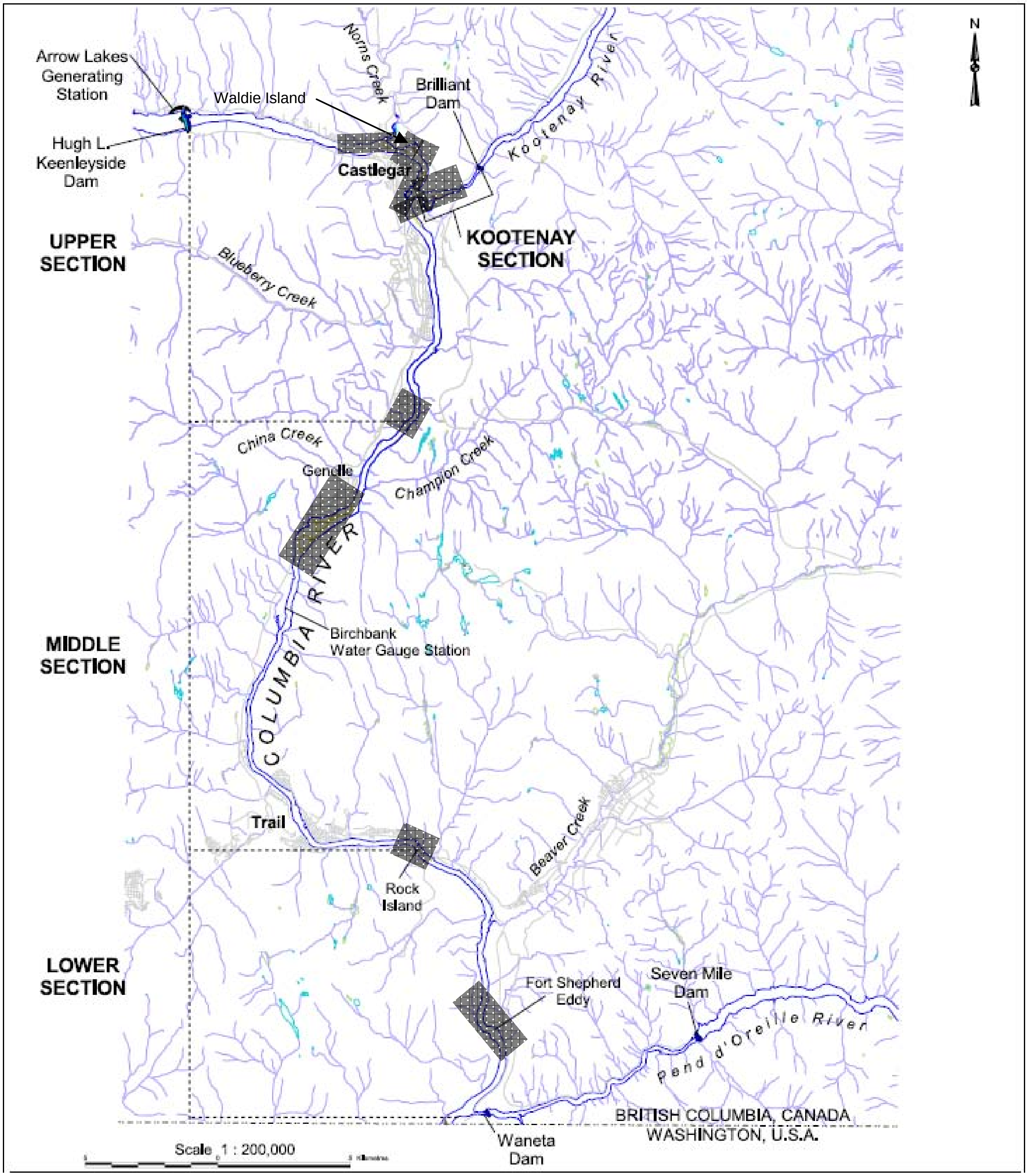
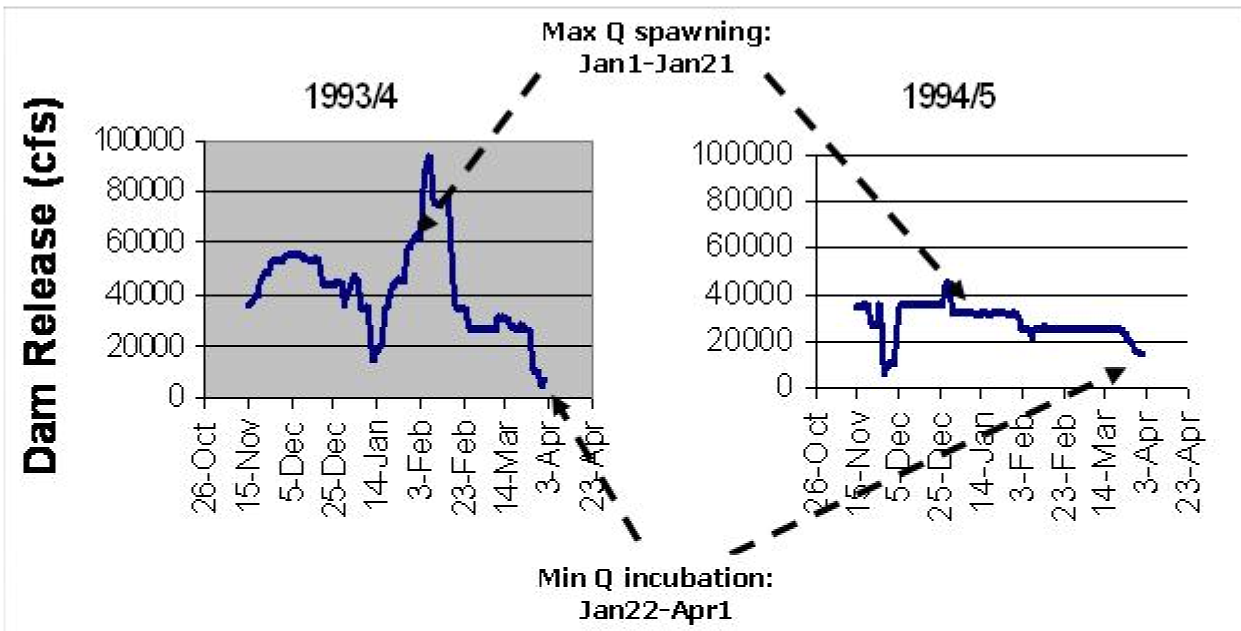


Figure 1 **Map of the Columbia River below Hugh Keenleyside dam showing the study area boundaries, known whitefish spawning areas (grey hatched boxes), Great Blue heron overwintering habitats at Waldie Island, and reach breakdown used for whitefish population index monitoring program initiated in 2001, and proposed for the whitefish adaptive management program.**

Operationally, whitefish flow management is achieved by minimizing the difference between the maximum flow during the peak spawning period (January 1 -21, Q_{Smax}) and the minimum flow prior to egg hatch (January 22 – Apr 1, Q_{Imin}). The relative degree of flow stabilization (and risk of egg loss) is indexed by a simple hydrologic metric, Q_{Smax}-Q_{Imin} (see Figure 2). As a result of annual variation in hydrology, power demand, dam operating conditions, and other factors that govern the flow regime of the Columbia River, there is variation in the success of stabilization efforts. Figure 3 shows the relative degree of stabilization achieved prior (1984-1994) to and after (1995-2005) implementation of whitefish flow management actions.



Flow Stabilization Index (Q_{Smax}-Q_{Imin}) = Maximum Flow (Jan 1 to Jan 21) - Minimum Flow (Jan 22 to Apr 1)

Figure 2 **Example of computation of the Q_{smax}-$Q_{i\ min}$ flow stabilization index and patterns of daily flow releases from Hugh Keenleyside Dam during whitefish reproduction periods before (1993/4) and after (1994/5) the implementation of WFM practices.**

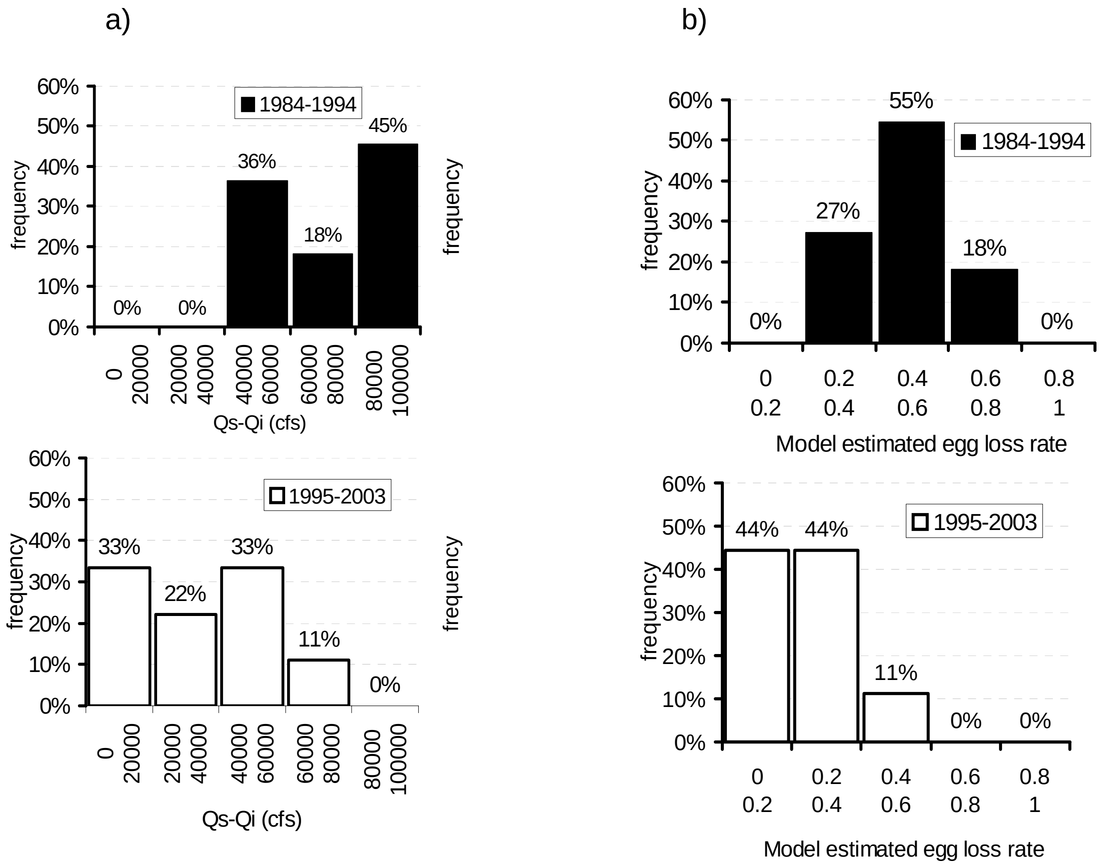


Figure 3 **Distributions of flow stabilization index ($Q_{Smax} - Q_{Imin}$) and modelled egg losses for periods before and after the implementation of WFM. a) $Q_{Smax} - Q_{Imin}$ is difference between the maximum spawning flows during peak spawning (Jan 1 – Jan 21, Q_{Smax}) and the minimum egg incubation flows (Jan 22- Apr 1, Q_{Imin}) for historical operation (1984-1994, black bars) and during WFM implementation (1995-2005, white bars); b) Estimated egg loss observed prior to (black bars) and after (white bars) the implementation of WFM .**

The biological rationale for whitefish flow management is based on three hypotheses that link the physical effects of flow variation to inter-annual abundance of the adult population:

H_1: Management of flow in the lower Columbia River during peak spawning (Jan 1- Jan 21) and stabilization of post spawning flows (22 Jan -01 Apr) will reduce egg losses resulting from dewatering.

H_2: Reduced egg losses increase the recruitment of young-of-the-year whitefish

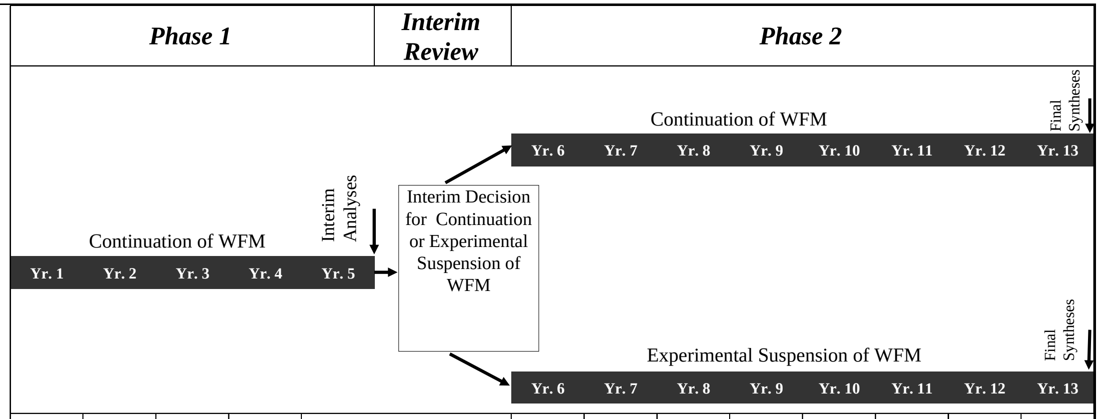
H_3: Increased young-of-the-year recruitment results in a stable or increasing abundance of the reproductively active adult whitefish population (i.e., F.L. >250 mm)

To determine the effectiveness of whitefish flow management for conserving whitefish populations, the WUP CC recommended a 13-year phased adaptive management program (Figure 4). In Phase 1 of the program, standard whitefish flows will be implemented for five years to provide a total of 12 continuous years (2000-2012) of population index monitoring coincident to implementation of this flow regime (Years 1–7 Pre-Water Use Plan; Years 8-12 under the Water Use Plan). The objectives of this phase of the program are to: 1) extend time series of systematic whitefish population monitoring to allow quantitative assessment of the influence of WFM on the whitefish population, and 2) fill critical gaps in understanding about the life history, biology, and spawning habitats of whitefish to support management hypotheses testing. Winter flows will be actively managed through the existing flow management framework with the objective of providing an egg loss risk exposure consistent with that observed during the period of implementation (1995-2003, Figure 3). Continuation of fish population index surveys will provide uninterrupted time series of population data. Biological monitoring will be implemented to improve understanding of the whitefish life history and reproductive biology, as well as better description of the physical characteristics of key spawning locations. These data will be combined with historical information for the refinement of the existing egg loss model, to test key model assumptions, or to, where possible, modify the model to provide more reliable egg loss estimates.

The CC was also concerned with potential negative effects of whitefish flow management on overwintering habitats used by Great Blue herons in the lower Columbia River. Monitoring has indicated a heron aggregation during the fall and early winter periods near to and upstream of the confluence of the Kootenay and Columbia rivers. This period corresponds to a period of high and variable flow releases prior to whitefish spawning, which are operationally required to allow stabilized flows during the peak of whitefish reproduction. To address this concern, a monitoring program was recommended to better understand seasonal patterns of heron movement and how the whitefish flow management effects shallow-water foraging habitat utilization by Great Blue heron.

At the end of Phase 1, an Interim Analysis of the biological effectiveness of whitefish flows will be conducted. Annual flow data, egg loss risk estimates, patterns of young of the year recruitment, and trends in abundance of the adult population will be analyzed to test the three primary conceptual hypotheses linking flow management to biological effects on whitefish populations. The primary objectives of the Interim Analysis will be to: 1) document the relationship between winter flow conditions, egg dewatering and the population response of whitefish under the WFM regime, and 2) support a decision regarding experimental suspension of whitefish flow management in Phase 2 of the adaptive management program (see Figure 4).

In Phase 2 of the program, an experimental suspension of flow management was recommended as option by the CC, where deemed safe and informative to do so. The objective will be to increase the contrast in annual egg loss conditions more aggressively to test the biological response of the population without flow protection. The target level of winter flow stabilization is that observed prior to implementation of whitefish flow management (Figure 3). During Phase 2 of the program, adult population index monitoring will continue for an additional 7 years to provide a total of 20 years of systematically collected population data. In the final year of Phase 2, a comprehensive data synthesis will be undertaken. A Final Synthesis will integrate results from all aspects of the program to re-test the three conceptual hypotheses underpinning whitefish flow management, and to contrast biological responses of whitefish under the two alternative winter flow management regimes. The Final Synthesis will be used to inform the decision regarding the long-term continuation of protection flows during the planned review of the Columbia River Water Use Plan.



#	Monitoring Program	2008	2009	2010	2011	2012		2013	2014	2015	2016	2017	2018	2019	2020
CLBMON-45 Lower Columbia River Fish Population Indexing															
	Systematic Field Sampling Pgm.	X	X	X	X	X		X	X	X	X	X	X	X	X
	Fish Population Data Synthesis						XXX								XXX
CLBMON-47Lower Columbia River Whitefish Spawning Ground Topographic Surveys															
	Topographic Surveys			X	X										
	Egg Loss Model Dev & Applic.					X	XXX								XXX
CLBMON-48 Lower Columbia River Whitefish Life History and Egg Mat Monitoring															
	Spawner Assessments	X	X	X	X	X									
	Juvenile Assessments	X	X	X	X	X									
	Egg monitoring		X	X	X	X									
CLBMON-49a Lower Columbia River Effects of Whitefish Flows on Great Blue Heron Use of Waldie Island															
	Winter Heron Abundance		X	X	X										
	Foraging Habitat Assessment		X	X	X		X								X

Figure 4 **Conceptual approach and annual schedule for the implementation of monitoring programs and key activities for the evaluation of the biological effectiveness of WFM for the conservation of the mountain whitefish population in the lower Columbia River.**

Monitoring Study No. CLBMON-47 Lower Columbia River Whitefish Spawning Ground Topographic Survey

1.0 MONITORING PROGRAM RATIONALE

1.1 Background

The Columbia River Water Use Plan Consultative Committee (WUP CC) supported the implementation of an adaptive management program for evaluating the effectiveness of the whitefish flow management (WFM) to conserve mountain whitefish populations of the lower Columbia River (BC Hydro 2005a, 2005b). An objective of the adaptive management program was to collect better information on the topographic characteristics of whitefish spawning locations, and utilize that information to achieve better understanding of how regulated flow changes create potential risks for egg dewatering in the lower Columbia and Kootenay Rivers.

Monitoring has confirmed that whitefish eggs are dewatered by flow changes in the lower Columbia River (Golder 2003). However, egg losses estimates derived from field data were not precise enough to support trade-off decision making processes surrounding WFM implementation. In 2003, a process-based whitefish egg loss model (ELM) was developed on limited field data to improve estimates of the relative risk of egg loss under alternative flow scenarios for WFM planning purposes (Golder 2003). The whitefish ELM is now the primary analytical tool for quantifying egg losses that occur as a consequence of changing flow patterns. The model utilizes daily flow data and river cross-section information to model river stage at index spawning areas during spawning and egg development periods. Biological assumptions of the seasonal timing of spawning, development rates of ova and the vertical distribution of deposited eggs in the river channel are incorporated to estimate daily losses of eggs resulting from flow changes. The model provides a transparent quantitative framework for evaluating egg loss risk. However, the WUP CC expressed concern about the reliability of the ELM for quantifying the egg loss resulting from regulated flow changes during the adaptive management program.

A key data gap identified by the WUP CC was the low quality and quantity of topographic data to describe characteristics of whitefish spawning locations. Limited availability of relevant topographic data resulted in the use of as few as one channel cross-section through a representative whitefish spawning area to predict flow dependent changes in river stage and areas of channel dewatering. Limited topographic information at spawning areas contributed to reduced confidence in the degree to which existing data represented the habitats of concern, and overall reliability of egg loss estimates. To reduce this uncertainty, the WUP CC recommended implementing a monitoring program to: a) document topographic characteristics of representative whitefish spawning locations; and b) update the existing whitefish ELM to include new topographic and biological data collected in the whitefish adaptive management program (via CLBMON-48 Lower Columbia River Whitefish Life History and Egg Mat Monitoring, and CLBMON-44 Lower Columbia River Physical Habitat and Ecological Productivity Monitoring).

1.2 Management Questions

The key management questions for this monitoring program are associated with uncertainties related to how changes in dam releases influence the area of wetted channel area at key whitefish spawning locations. These questions are:

1) What are the topographic characteristics of the key spawning locations for mountain whitefish in the lower Columbia and Kootenay rivers?

2) What is the hydraulic response of the river to discharge fluctuations at these key spawning locations? How do changes in river discharge influence river stage, and how does river stage relate to wetted channel area at these key spawning locations?

3) How do daily flow changes contribute to cumulative channel dewatering in key spawning areas over the whitefish reproductive period?

1.3 Management Hypotheses

This monitoring program is designed to fill a critical information gap and update and enhance a primary impact analysis tool required for the implementation of the adaptive management program. As the goal is to improve the accuracy and reliability of the ELM, there are no direct management hypotheses proposed for this monitoring program.

1.4 Key Water Use Decision Affected

The key operating decision that will be affected by implementation of the overall whitefish adaptive management program is regarding the long-term continuation or suspension of WFM actions for the conservation of whitefish populations in the lower Columbia. The decision regarding the long-term implementation of WFM will be based on a synthesis of output of two key analytical tools: 1) an integrated physical and biological model to estimate relative egg loss associated with alternative flow management scenarios, and 2) systematic index population monitoring and fish population dynamics modeling to provide a comprehensive assessment of fish population response to flow changes. This monitoring program will support this water use planning decision in two ways. First, it will supply information needed for the improvement and validation of key biological assumptions about the life history, reproductive ecology, egg dispersal used in the egg loss modeling. Second, it will address critical information gaps regarding the seasonal patterns of movement and habitat use of juvenile, sub-adult, and adult whitefish. These data are required to reliably interpret monitoring data, and determine where refinements would improve overall monitoring program reliability.

2.0 MONITORING PROGRAM PROPOSAL

2.1 Objectives and Scope

The objective of the Lower Columbia River Whitefish Spawning Ground Topographic Survey is to:

1) To design and implement controlled topographic surveys to describe the characteristics of representative whitefish spawning locations in the lower Columbia and Kootenay Rivers.

2) Assemble, verify, analyze and input new topographic data of the representative whitefish spawning locations into an existing 1-dimensional steady state hydraulic model.

3) Test and calibrate the model to improve the accuracy of the model.

4) Refine and redevelop the ELM, as appropriate, to enhance the reliability of outputs from the model.

5) Document changes to the model and compare inter-annual egg loss estimates in relation to the flow stabilization index.

6) Assess the impact of the increased number of cross-sections and survey detail from the previous model, and comment on the accuracy and reliability of the previous model.

7) Make recommendations for further refinement of both the topographic survey and ELM.

The geographic scope of the mountain whitefish monitoring program is the ~55 km long section of the lower Columbia River from HLK Dam to the US border. In addition some work may occur in the lower Kootenay River downstream of Brilliant Dam (Figure 1).

2.2 Approach

The approach to implementation of this program will be sequential, where the detailed location of work is dependent on the outcome of other programs associated with the adaptive management program (CLBMON-48 Lower Columbia River Whitefish Life History and Egg Mat Monitoring). There are two primary components to the work: 1) field surveys to document topographic characteristics of whitefish spawning habitats, and 2) the updating of the physical and biological assumptions of the ELM.

The field component of the program will be implemented in Year 3 of Phase 1 of the adaptive management program and conducted for over two or possibly three years (Figure 4). The reason for delaying the start of the field work is to allow utilization of historic information regarding whitefish spawning areas, observation of current patterns of migration of adult whitefish during spawning periods, and subsequent egg sampling to confirm the location of key spawning areas. Egg sampling data will also be required to establish spatial boundaries for topographic survey at each location. In Year 3 of Phase 1, the topographic surveys will be undertaken. Topographic surveys should occur during low flows if possible to reduce the proportion of the survey that needs to be conducted over wetted channel area. In Year 4, a second year of survey at spawning locations will be undertaken to complete the required topographic data acquisition. In Year 5 of Phase 1, the topographic data will be assembled and used to redevelop the hydraulic model used for wetted area calculations and update the egg loss model itself. The CC recommendation was for a 2-year program, however, that recommendation overlooked a requirement to assemble these data and incorporate them into the egg loss model critical for effectiveness assessments to be conducted in the Interim Review and Final Syntheses of the whitefish adaptive management program.

2.3 Tasks

2.3.1 Task 1: Project Management

Project management will involve the general administrative and technical oversight of the project. This task will include but not be limited to: 1) budget management, 2) study team management, 3) logistic coordination, 4) technical oversight of field and analysis components, and 5) 5) facilitation of data transfer among other investigators associated with the Lower Columbia River Fish Management Plan.

2.3.2 Task 2: Field Sampling Program

The location and spatial dimensions of sites proposed for survey will be determined from historical data and data collected during the companion study CLBMON-48 Lower Columbia River Whitefish Life History and Egg Mat Monitoring. Permanent benchmarks will be established at each of the spawning areas chosen for detailed topographic survey to facilitate repeat or augmentation surveys as desired.

The number and interval of the cross-sections and survey point density required to adequately characterize the spawning area will depend of the complexity of the river bottom and should be sufficient to produce accurate and precision water level and wetted area predictions derived from steady state 1-d or 2-d hydraulic modeling approaches.

Site Identification

A representative number of sites should be chosen to represent the range of river channel conditions where whitefish are known to spawn. The determination of sites should be derived from 1) review of known whitefish spawning locations in the Lower Columbia and Kootenay Rivers, and 2) results from telemetric monitoring of adult whitefish movement patterns and egg sampling during the known spawning periods. The latter will require close coordination with the study team implementing the biological program associated with the whitefish adaptive management program (CLBMON-48 Lower Columbia River Life History and Egg Monitoring). The number and location of sites should be chosen according to: 1) where the majority of whitefish spawning occurs, 2) representation of the range of habitat conditions within which whitefish spawn, 3) the expected range hydraulic impact of flow changes (due to attenuation and tributary effects), 4) feasibility of collecting reliable results, and 5) available budget resources for the topographic survey.

Topographic Survey

Field surveys will be conducted to provide accurate and precise topographic information on whitefish spawning locations in the Lower Columbia and Kootenay rivers. The approach of the survey should be chosen to ensure acquisition of data at a spatial resolution and accuracy sufficient for 1-d or 2-d modeling of stage and wetted river channel area at spawning locations. Surveys may be conducted using a combination of land- or water-based approaches, but should be tied to explicit geodetic benchmark/references to allow re-occupation of the survey grid as may be required to refine the topographic database at each spawning location. Surveys should be timed annually to maximize the reliability of data capture and to minimize the cost of data collection.

2.3.3 Task 3: Hydraulic Model Updating / Development

In the past, predictions of hydraulic changes in the existing egg loss model have been produced using a 1-d steady model (HEC RAS). This model was originally constructed for flood assessment and was useful for only general routing of the flows in the Lower Columbia and Kootenay rivers. Additional data collected during this field program will be used to provide more accurate hydraulic predictions at locations chosen to represent whitefish spawning locations. The Hydraulic Model Updating task is required to first evaluate the existing model and then to reconfigure the hydraulic model with new data to provide hydraulic response predictions to the egg loss model. The anticipated steps in this task will include, but not be limited to, the following:

a) Assess the existing model and any alternative hydraulic models available for the lower Columbia River) and determine adequacy for flow routing from in a) the Lower Columbia below Hugh L. Keenleyside dam, and b) Kootenay River below Brilliant Dam.

b) Assemble new topographic survey data and integrate those data into the chosen hydraulic model.

c) Configure the model to provide flow dependent estimates of wetted channel area by vertical strata within the river channel at each of the representative spawning locations chosen for use in the egg loss model (25 cm strata recommended).

d) Conduct standard procedures to calibrate (to the extent possible with available level information) and verify the chosen model.

e) Configure the model or use the model to produce model output to be explicitly input in the egg loss model to provide daily estimates of wetted habitat area by vertical strata.

2.3.4 Task 4: Egg Loss Model Updating / Development

Golder (2003) provides a detailed description of the existing Egg Loss model. To address a key concern regarding the reliability of the egg loss model, physical and biological studies were undertaken to address key uncertain biological assumptions of the egg loss model and to improve overall topographic data quality at spawning sites. The Egg Loss Modeling Updating task is required to incorporate improved hydraulic response predictions (this program) and new biological information on reproductive behaviour (CLBMON-48 Lower Columbia River Whitefish Life History and Egg Monitoring) information that will improve the reliability for egg loss model for quantifying annual egg loss risk resulting from the observed flow patterns. The anticipated steps in this task will include, but not be limited to, the following:

a) Evaluation of the existing software platform (MS EXCEL Spreadsheet) for ease and reliability of implementation of the egg loss model, identification of alternatives, and selection of most appropriate software platform for future analysis.

b) Assembly of relevant historical and new information regarding the elements and assumptions of the biological components of egg loss model including: seasonal spawning timing and intensity of egg deposition, the rate of egg development, and the vertical distribution of eggs deposited in the river channel.

c) Assembly of the new hydraulic model or hydraulic modeling results (see Task 2.3.3) for representative spawning locations.

d) Redevelopment of the Egg Loss Model to using the information from b) and c) on the software platform identified in a)

e) Undertaking and reporting on a direct comparison of the historic Egg loss model developed by Golder (2003) and that developed as part of this program.

2.3.5 Task 5: Analysis and Reporting

To facilitate effective management of data obtained from the monitoring program, an annual technical report will be prepared to: 1) describe the methods used to address the statement of work, 2) present the data and results of annual field investigations, and 3) discuss key findings of the field program and investigations.

2.4 Interpretation of Monitoring Program Results

Data collected from this work are key inputs for the modeling of how daily flow changes result in changes in wetted area in the river channel at whitefish spawning locations. These data, in combination with the biological information collected through the life history and egg monitoring program (CLB-48 Lower Columbia River Whitefish Life History and Egg Monitoring) form the basis for the Egg Loss Model. The Egg Loss Model is the primary analytical tool required to judge the how flow changes affect the risk of whitefish egg losses, and the output will be used directly in the assessment of effectiveness of WFM during Interim Analysis following Phase 1 of the adaptive management program and the Final Synthesis planned at its conclusion.

The results of this program will be integrated with a number of other monitoring programs being implemented under the Lower Columbia River Fish Management Plan, including CLBMON-44 Lower Columbia River Physical Habitat and Ecological Productivity Monitoring, CLBMON-45 Lower Columbia River Fish Population Index Surveys and CLBMON-48 Lower Columbia River Whitefish Life History and Egg Mat Monitoring. The synthesis of the results from these monitoring programs will help to assess if the variability in whitefish population abundance can be attributed to egg loss due to WFM or other, as yet unknown, confounding factors.

2.5 Schedule

The Lower Columbia River Mountain Whitefish Spawning Area Survey program will be conducted annually for 3 years (topographic surveys 2 years; ELM development and application 1 year) during the implementation period for the Columbia River WUP (Figure 4).

2.6 Budget

The total annual cost for the monitoring program is estimated at $121,519 (in 2004 dollars), and an average annual cost of $84,674 (assuming a 2% rate of inflation and 5% contingency). The annual study budget recommended by the WUP CC in 2004 was $100,000.

Table CLBMON-47-1 provides a detailed breakdown of the costs of the monitoring program.

3.0 REFERENCES

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

BC Hydro. 2005b. Columbia River Project, Draft Water Use Plan. 38 pp. + appendices.

Golder Associates Ltd. 2003. Estimates of Mountain Whitefish Egg Stranding Mortality for potential Columbia River Flow Reductions in 2002 - 2003. Report prepared for BC Hydro, Castlegar, BC. Golder Report No. 02-28-057D: 12 p.