



## **Columbia River Project Water Use Plan**

## **Monitoring Program Terms of Reference**

## **Revelstoke Flow Management Plan**

- **CLBMON-17 Middle Columbia River Juvenile Fish Habitat Use**

### **Addendum 2**

**January, 2017**

## Addendum 2 to CLBMON-17 Middle Columbia River Juvenile Fish Habitat Use

### 1.0 Monitoring Program Rationale

#### 1.1 Background

The Columbia River Water Use Plan Consultative Committee (WUP CC) supported the implementation of a year-round minimum flow release of 142 cms (cubic m per second) from Revelstoke Dam to enhance fish populations of the Middle Columbia River (BC Hydro 2005a, 2005b).

A key uncertainty related to the minimum flow release, as expressed by the WUP CC, was how the implementation would affect and/or benefit fish populations that use the Middle Columbia River. This monitoring program documents the pattern of habitat use and daily activity of some juvenile fish species that use large river habitats in the Middle Columbia River and how they are influenced by flow releases.

In 2007, BC Hydro received approval for the construction of a fifth unit (REV 5) at the Revelstoke Generating Station. REV 5 adds 500 MW to the station's generating capacity and its operation allows for peak discharge of 2124 cms, an additional 425 cms over current operations. The in-service date for full operation of REV 5 coincided with the start of the minimum flow in December 2010. Some of the predicted trends with REV 5 operations include a general increase in the frequency of high flows with corresponding increases in river elevations and velocities immediately downstream of the dam and a general increase in average daily discharge during low demand periods (BC Hydro 2006). An addendum to the WUP (BC Hydro 2010) included the provision to take into account REV 5 operations in these Terms of Reference. **Therefore, references to evaluating the minimum flow releases or operational changes should be interpreted as including REV 5 operations (henceforth referred to as the new flow regime).**

#### 1.2 Rationale for Addendum

Based on Consultative Committee discussions during the Columbia Water Use Plan negotiations (BC Hydro 2005), the key environmental objectives of the minimum flow release were to:

- 1) increase productivity of benthic communities,
- 2) develop habitat conditions that increase the recruitment of juvenile fish life stages and trigger rainbow trout spawning in mainstem habitats, and
- 3) maximize the abundance, condition, growth and survival of adults of key indicator populations.

Objectives 1 and 3 are addressed by studies CLBMON-15b (Middle Columbia River physical habitat and ecological productivity monitoring), CLBMON-16 (Middle Columbia River fish population indexing surveys) respectively. Objective 2 was to be resolved by CLBMON-17 and CLBMON-18 (Middle Columbia River adult fish habitat use). The field work for CLBMON-17 (Slivinski and Sykes 2014) documented the distribution and abundance of juvenile fishes downstream of Revelstoke Dam (principally in Reaches 3 and 4) and in some tributaries, three years before and three years after implementation of the new flow regime. The study did not report significant changes in juvenile fish

habitat characteristics and use following the implementation of the new flow regime. However, it noted that many of the habitat suitability indices (HSI) reviewed “were developed for non-regulated systems, which could limit their application to systems such as the Middle Columbia which experiences highly variable flow patterns” (Slivinski and Sykes 2014, p. 76). Moreover, one of the recommendations was that additional flow sampling was desirable to understand the effect that variation in discharge has on juvenile habitat suitability. An internal review of the project concluded that it was difficult to link changes in suitability of juvenile habitat directly to BC Hydro operations based on field data alone. The recent completion of a hydraulic model of the area makes the development of species-specific habitat suitability indices focused on the Middle Columbia possible, and will help reduce uncertainties associated with this objective.

### 1.3 Management Questions

According to the original terms of reference (BC Hydro 2007), the key management questions addressed by this monitoring program are:

- 1) What is the current seasonal abundance and distribution of juvenile life stages of fish in the Middle Columbia River?
- 2) How do juvenile fish use the mainstem habitats in Middle Columbia River?
- 3) What are the factors that limit recruitment and survival of juvenile life stages in the Middle Columbia River?
  - i) Do operational strategies for Revelstoke Dam and Arrow Reservoir impact the availability of preferred habitats?
  - ii) Do current operational strategies constrain availability of the food base for juvenile life stages?
  - iii) Do predators influence juvenile fish recruitment and habitat use in the Middle Columbia River?
- 4) What changes in recruitment of juveniles to mainstem rearing habitats result from implementation of the  $142 \text{ m}^3\text{s}^{-1}$  minimum flow release?

The previous work under CLBMON-17 (Slivinski and Sykes 2014) adequately addressed questions 1 and 2 and informed questions 3-ii and 3-iii. The remaining outstanding questions are:

3. *(i) Do operational strategies for Revelstoke Dam and Arrow Reservoir impact the availability of preferred habitats? and*
4. *What changes in recruitment of juveniles to mainstem rearing habitats result from implementation of the  $142 \text{ m}^3\text{s}^{-1}$  minimum flow release (aka the new flow regime)?*

These two management questions are addressed within this addendum through the refinement of existing habitat suitability indices for selected species of juvenile fish present in the Middle Columbia River.

### 1.4 Management Hypotheses

There is no management hypothesis associated with this addendum.

## 1.5 Key Water Use Decision Affected

The key water use planning decision affected by the results of this monitoring program is the implementation of the new flow regime. This monitoring program seeks to assess how the new flow regime affects fish habitat use in the Middle Columbia River. Information derived from the program will be used to indirectly assess how the new flow regime influences the quality of juvenile fish habitat in the Middle Columbia River. The results from this program will be integrated with the four other monitoring programs of the Revelstoke Flow Management Program (RFMP) (Physical Habitat Monitoring, Ecological Productivity Monitoring, Fish Population Indexing Surveys, and Juvenile Habitat Use) and will be used to support inferences about benefits of the minimum flows for fish. Results from the RFMP programs and associated inferences will be used to establish the long term operating release requirements for the Revelstoke Dam.

## 2.0 Monitoring Program Proposal

### 2.1 Objectives and Scope

The original objectives of the monitoring program are (BC Hydro 2010):

- 1) To provide information on juvenile fishes' use of the Middle Columbia River and on the suitability of these habitats to meet critical life history requirements (e.g., rearing) of these fish populations.
- 2) To assess the effects of the implementation of the 142 m<sup>3</sup>/s minimum flow and REV 5 on the recruitment of juvenile life stages of fishes of the Middle Columbia.

The objective of this addendum is to assess how the new flow regime affects juvenile fish habitat quality in the Middle Columbia River.

The geographic scope of the monitoring program is the ~10 km long section of the Middle Columbia River from the Illecillewaet River confluence to the Revelstoke Dam tailrace (Reaches 3 and 4).

### 2.2 Approach

The general approach is to refine existing habitat suitability indices (HSI) for juvenile fishes by using an existing 2-D flow model developed for the Middle Columbia River as part of the Revelstoke Unit 6 environmental assessment process (NHC 2016). These HSI will help infer changes in juvenile habitat in response to operations related to the new flow regime. The approach will focus on habitat changes based on flow modeling predictions and assumptions of habitat suitability from existing habitat suitability criteria developed during the Water Use Planning process and reviewed by experts in the field to ensure they are appropriate for the regional context. Final results will be used to address outstanding management questions about the effects of flows on juvenile fish habitat use under conditions of varying discharges.

### 2.3 Methods

The following tasks are required to complete juvenile habitat use assessment in the Middle Columbia River:

#### 2.3.1 Task 1: Project Management

Project coordination involves the general administrative and technical oversight of the program. This will include, but not be limited to: 1) budget management, 2) study team

management, 3) logistic coordination, 4) technical oversight and analyses, and 5) facilitation of data transfer among other investigators associated with the RFMP.

There is no field work expected and a safety plan is thus not required. In the advent that field work is deemed necessary, a safety plan will be developed and submitted to the BC Hydro contact for all aspects of the study involving field work, in accordance with BCH procedures and guidelines.

### **2.3.2 Task 2: Development of a Flow-Habitat Relationships for Target Species**

Three sub-tasks are planned for the development of flow habitat relationships of target species. At the end of this task, a comparison will be provided between key flow scenarios under different reservoir elevations, for both pre and post new flow regime.

#### **2.3.3 Task 2a: Refinement of Habitat Suitability Indices (HSI)**

To refine habitat suitability indices for juvenile fishes, data on existing depth, velocity and substrate will be reviewed for target species that are (a) of interest, and (b) sensitive to flow changes anticipated in the study area. Species studied thus far in this monitoring program include Rainbow Trout, Bull Trout, Mountain Whitefish, Prickly Sculpin, Largescale Sucker and Redside Shiner. These indices will be used to make predictions about changes in juvenile fish habitat use under conditions of high discharge amplitude (2124 cms and higher) and diel variation in discharge representative of hydropeaking. The data collected in Years 1-6 of the program (Slivinski and Sykes 2014) will be accessible from BC Hydro. Some or parts of other datasets (e.g., concurrent studies in the area such as an index study on adult fishes – CLBMON-16) could also be used and will be provided as needed. HSI relationships will be reviewed to ensure they consider any bioenergetics-based refinements (Jordan Rosenfeld, MoE, pers. comm.).

#### **2.3.4 Task 2b: Integration with 2-D Hydraulic Model**

BC Hydro's hydrotechnical department has recently acquired a Telemac-2D model of the area developed under the Revelstoke Unit 6 Project's Environmental Assessment process (NHC 2016). After initial model calibration, BC Hydro will run several scenarios developed by the chosen contractor and provide the data files and GIS shapefiles suitable to integrate habitat suitability indices and develop habitat areas for each scenario and species. In addition to flow-habitat relationships being developed for each species of interest, the contractor will use known habitat use information from previous assessments in this study program to calibrate the model results.

#### **2.3.5 Task 2c: Evaluation of Flow Scenarios**

Flow scenarios will be used to evaluate juvenile habitat suitability during high and low Arrow Lakes reservoir elevations, and for pre/post new flow regime (142 cms minimum flow/ Revelstoke Unit 5 operation). Potential scenarios are suggested in Table 1, but the contractor will be tasked with identifying critical flow scenarios that best pertain to juvenile habitat suitability for each species, and assess HSI based on seasonal and diel flow variations.

**Table CLBMON17-1: Suggested flow scenarios for evaluation of each juvenile species of interest. The contractor is to choose a reasonable set of flow scenarios that best describe juvenile habitat availability.**

Scenario		Pre-Rev5		Post-Rev5	
		High Arrow	Low Arrow	High Arrow	Low Arrow
Spring	Typical Base Flow	<b>Juvenile habitat area for each scenario</b>			
	Typical Peak-Base flow (habitat loss)				
	Peak flow				
Summer	Typical Base Flow				
	Typical Peak-Base flow (habitat loss)				
	Peak flow				
Fall	Typical Base Flow				
	Typical Peak-Base flow (habitat loss)				
	Peak flow				
Winter	Typical Base Flow				
	Typical Peak-Base flow (habitat loss)				
	Peak flow				

### 2.3.6 Task 3: Reporting

One report is required and will follow the standard format for WUP monitoring programs. This report will provide habitat suitability indices for juvenile species of fishes (cf. Task 2). Aside from the regular sections (Introduction, Methods, Results and Discussion) it may also include recommendations, the latter if needed.

The contractor will be required to present the results of the analyses at a workshop including BC Hydro, agencies and First Nation representatives and should include provision for this in the budget.

The final report will be provided in a hard copy and as Microsoft Word and Adobe Acrobat (\*.pdf) format. All maps and figures will be provided either as embedded objects in the Word file or as separate files.

### 2.4 Interpretation of Results

The results from this report will be annexed to the CLBMON-17 program, will be integrated with the three other monitoring programs of the RFMP (Physical Habitat, Ecological Productivity, Fish Population Indexing Surveys) and will be used to support inferences about benefits of the minimum flow for fish and effects of REV 5 operation. Results from the RFMP programs and associated inferences will be used to establish the long term operating requirements for the Revelstoke Dam.

### 2.5 Schedule

The duration for this program is a maximum of one year, starting from selection of proponent. The final schedule and deliverables dates will be set up after contacting the selected proponent.

### 2.6 Budget

Total revised program cost: \$501,305.

## 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
- BC Hydro. 2006. Revelstoke Unit 5 Project Environmental Assessment Certificate Application. Volume 1: Supplemental Information Report.
- BC Hydro 2007. Study terms of reference: Middle Columbia River Juvenile Fish Habitat Use (CLBMON-17). Prepared for the Comptroller of Water Rights, February 2007.
- BC Hydro 2010. Addendum #1 May 20, 2010: Middle Columbia River Juvenile Fish Habitat Use (CLBMON-17).
- NHC, 20165. Revelstoke Unit 6 Environmental Assessment TELEMAC Model Development and Hydraulic Assessment Report. Prepared for SNC Lavalin Inc. Prepared by Northwest Hydraulic Consultants Ltd. North Vancouver, BC. NHC 3000346. January 12, 2016
- Slivinski, D. and G. Sykes. 2014. Middle Columbia River Juvenile Habitat Use Assessment (Year 6 of 6). Report prepared for BC Hydro