

**Columbia River Project Water Use Plan
Revelstoke Flow Management Plan**

Monitoring Program

Annual Report: 2017

Implementation Period: February 2016 to January 2017

- **CLBMON-15a Middle Columbia River Physical Habitat Monitoring**
- **CLBMON-15b Middle Columbia River Ecological Productivity Monitoring**
- **CLBMON-16 Middle Columbia River Fish Population Indexing Surveys**
- **CLBMON-17 Middle Columbia River Juvenile Fish Habitat Use**
- **CLBMON-18 Middle Columbia River Adult Fish Habitat Use**
- **CLBMON-53 Middle Columbia Juvenile Fish Stranding**

Conditional Water Licences for Kinbasket storage (27068 and 39432), Mica diversion (39431), Revelstoke diversion and storage (47215), and Arrow storage (27066)

February 28, 2017

BC Hydro Columbia River Project Water Use Plan Revelstoke Flow Management Plan Monitoring Programs Annual Report: 2017

1 Introduction

This document represents a summary of the status and the results of the Columbia River Revelstoke Flow Management Plan Water Use Plan (WUP) monitoring programs to January 31, 2017, as per the Columbia River Order under the *Water Act*, dated January 26, 2007. There are six monitoring programs.

2 Status

The following table outlines the dates that Terms of Reference (TOR) for the Revelstoke Flow Management Plan WUP monitoring programs were submitted to and approved by the CWR.

Table: 2-1: Dates of Revelstoke Flow Management Plan WUP TOR Submissions and Approvals by the Comptroller of Water Rights

Monitoring Program & Physical Works TOR	Order Clause	Original TOR Submission		Most Recent TOR Resubmission	
		Date Submitted	Date Approved	Date Submitted	Date Approved
CLBMON-15a Middle Columbia River Physical Habitat Monitoring	Schedule C, Clause 4 (a);	Mar 05, 2007	Mar 22, 2007	Jan 29, 2015	Mar 02, 2015
CLBMON-15b Middle Columbia River Ecological Productivity Monitoring	Schedule C, Clause 4 (a)	Mar 05, 2007	Mar 22, 2007	May 21, 2010	Jul 19, 2010
CLBMON-16 Middle Columbia River Fish Population Indexing Surveys	Schedule C, Clause 4 (b)	Mar 05, 2007	Mar 22, 2007	Jul 12, 2013	Jul 22, 2013
CLBMON-17 Middle Columbia River Juvenile Fish Habitat Use	Schedule C, Clause 4 (c)	Mar 05, 2007	Mar 22, 2007	May 21, 2010	Jul 19, 2010
CLBMON-18 Middle Columbia River Adult Fish Habitat Use	Schedule C, Clause 4 (d)	Mar 05, 2007	Mar 22, 2007	Mar 30, 2015	Apr 23, 2015
CLBMON-53 Middle Columbia River Juvenile Fish Stranding	Amended Order, Clause 2 (c)	Jul 31, 2008	Sep 11, 2008	Feb 02, 2009	Mar 26, 2009

3 Schedule

The following table outlines the current schedule for the monitoring programs being delivered for the Revelstoke Flow Management Plan WUP.

Table 3-1: Monitoring Programs Schedule as of January 31, 2017

Monitoring Programs	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	WLR YR1	WLR YR2	WLR YR3	WLR YR4	WLR YR5	WLR YR6	WLR YR7	WLR YR8	WLR YR9	WLR YR10	WLR YR11	WLR YR12	WLR YR13
CLBMON-15a Middle Columbia River Physical Habitat Monitoring	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	■	■	■
CLBMON-15b Middle Columbia River Ecological Productivity Monitoring	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	■	■	■
CLBMON-16 Middle Columbia River Fish Population Indexing Surveys	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	■	■	■
CLBMON-17 Middle Columbia River Juvenile Fish Habitat Use		✓	✓	✓	✓	✓	✓				◆		
CLBMON-18 Middle Columbia River Adult Fish Habitat Use		✓	✓	✓	x	x	x				◆		
CLBMON-53 Middle Columbia River Juvenile Fish Stranding			✓	✓	✓	x	✓F						

Legend:

- = Program to be undertaken/initiated in identified year
- ◆ = Program proposed to be undertaken in identified year (pending approval)
- ✓ = Program completed for the year
- x = Program started, but encountered operational or hydrological delays
- ✓F = All field work for this project is complete. No further field work is planned.
- PCR = Project Completion Report submitted

4 Monitoring Programs Terms of Reference

The monitoring programs being implemented under the Revelstoke Flow Management Plan WUP are described in Terms of Reference. These Terms of Reference and the reports for work completed to date can be found here:

http://www.bchydro.com/about/sustainability/conservation/water_use_planning/southern_interior/columbia_river/revelstoke-flow.html

5 Status of Monitoring Programs

5.1 CLBMON-15a Middle Columbia River Physical Habitat Monitoring

This monitoring program was initiated in 2007 and is being implemented annually over 13 years.

The objective of the monitoring program is to identify how physical habitat characteristics (e.g., water temperature, wetted area) respond to implementation of minimum flow releases from Revelstoke Dam and the operation of Revelstoke Unit 5.

As an outcome of the Revelstoke Flow Management Plan (RFMP) technical review in February 2014, BC Hydro resubmitted a TOR on January 29, 2015, and received CWR approval on March 2, 2015. The study team was successful in implementing the changes that were associated with the revised TOR, which included:

- Shifting the focus of water quality data collection towards hydraulic modeling as *in situ* sampling had thus far been insensitive to variations in flow changes, and;

- Removal of water stage level data collection, as the HEC-RAS model is now well calibrated for this variable.

Attached is the report for Year 9 (2015) dated December 2016.

5.2 CLBMON-15b Middle Columbia River Ecological Productivity Monitoring

This monitoring program was initiated in July 2007 and is being implemented annually over 13 years.

The objective of the monitoring program is to assess how the minimum flow release from Revelstoke Dam influences the benthic productivity as it relates to the availability of food for fish in the Middle Columbia River.

In 2017 and 2018, only spring sampling will be conducted, as sufficient data has already been collected during the fall. Refocusing efforts on spring sampling will best address the remaining uncertainties in the management questions.

Attached is the report for Year 9 (2015) dated October 1, 2016.

5.3 CLBMON-16 Middle Columbia River Fish Population Indexing Surveys

This monitoring program was initiated in October 2007 and is being implemented annually over 13 years.

The objective of the monitoring program is to identify changes in the abundance, biological condition, diversity, and spatial distribution of adult fish in the Middle Columbia River, and to monitor the response of these fish populations to the implementation of minimum flow releases from Revelstoke Dam and assess potential effects from operations of Revelstoke Unit 5.

In 2014 an independent review of the monitoring study was completed at the request of the Ministry of Environment. This monitoring study evaluated the impacts of electrofishing sampling methods during the fall. The review concluded that spring and fall sampling should continue; however, where there are budget constraints, it was concluded that consistent fall sampling is higher priority to best assess pre- and post-treatment effects of the minimum flow regime. In addition, the reviewers concluded that perceived threats to bull trout spawners were insufficiently supported to justify any prohibition of electrofishing during the time of sampling.

In 2015, we conducted both spring and fall sampling. For the remaining years of study (commencing in 2016), due to budget constraints, only fall sampling (pending annual receipt of the permit from MOE) will occur to gather data comparable to years prior to the flow regime change and to adequately address the management questions.

Attached is the report for Year 9 (2015) dated August 2016.

5.4 CLBMON-17 Middle Columbia River Juvenile Fish Habitat Use

This monitoring program was initiated in 2008 and was carried out over six years. While the study was completed according to the current TOR, the outcomes of the Revelstoke Flow Management Plan Technical Review in 2014 indicated that the resolution of some of the management questions would benefit from further analysis. Specifically, the Technical Review Committee recommended analysis of the relationship between discharge and juvenile habitat availability, taking into account habitat suitability indices derived from modelling in CLBMON-15a.

A TOR resubmission outlining the recommended additional analysis will be submitted by March 31, 2017.

5.5 CLBMON-18 Middle Columbia River Adult Fish Habitat Use

This monitoring program was initiated in 2008 and was originally scheduled to be carried out over six years. The first three years were completed in 2008-2010.

The principal objective of the monitoring program is to assess how movement patterns and activities of Bull Trout and Mountain Whitefish are affected by flow releases from Revelstoke Dam. As an outcome of the Revelstoke Flow Management Plan Technical Review in 2014, BC Hydro postponed the final three years of the monitoring project to develop a more flexible study approach as the maximum discharges anticipated from Revelstoke Unit 5 (REV 5) were not encountered during the initial three years of the study.

A TOR Addendum was approved on April 23, 2015, which included the request to postpone the remaining three years of post REV 5 field work to allow for modelling of Mountain Whitefish and Bull Trout activity at high discharge rates and magnitudes. The modelling would be approached in four stages (Tasks), with Task 1 conducting an extensive literature review on fish bioenergetics to confirm that enough data was available to provide a suitable model to predict the effects of the new flow regime on Mountain Whitefish and Bull Trout.

The literature review (Task 1) was completed on September 10, 2015, by the University of Montreal. This review concluded that the use of a model to assess the flow effects on Mountain Whitefish and Bull Trout is technically feasible utilizing the data collected during Years 1 through 3 under the original CLBMON-18 TOR (2007). As part of the external review process (Task 4), BC Hydro sought and received support from the Technical Review Committee in October 2015 to proceed with the implementation of the modelling program proposed (Tasks 2 and 3).

No changes are required to TOR Addendum 2 to conduct the modelling work. BC Hydro has submitted a notification letter to inform the CWR that we will be proceeding with the project as outlined in Addendum 2.

5.6 CLBMON-53 Middle Columbia River Juvenile Fish Stranding

This monitoring program was initiated in 2009 and completed in 2013. The project is now complete.

The primary objective of this program was to assess the risk of fish stranding in a discrete portion of the Columbia River (i.e., Greenslide Creek side channels area) in response to the forecasted operations of unit 5 at Revelstoke Dam.

6 Monitoring Programs Costs

The following table summarizes the Revelstoke Flow Management Plan WUP monitoring programs costs approved by the Comptroller and the Actual Costs to January 31, 2017.

Table 6-1: Revelstoke Flow Management Plan WUP Monitoring Programs Costs

Monitoring Programs	Costs approved by CWR	Life to Date Actuals (LTD)	Estimated to Complete (Forecast)	Total Forecast (LTD and Forecast)	Variance Total to Approved	Explanation	Corrective Action
CLB MP4 Revelstoke Flow Annual Report	\$5,463	\$4,520	\$2,508	\$7,028	(\$1,566)	Original forecast was conservative for annual report costs.	Letter to CWR for increase in budget will be resubmitted prior to exceeding approved budget.
C04M15A MID COL Phy Hab & Eco Prod	\$3,803,264	\$2,672,861	\$860,974	\$3,533,835	\$269,429	Efficiencies found during implementation.	
C04M15A MID COL PhyHab & EcoProd - OR DM	\$264,235	\$133,301	\$57,480	\$190,782	\$73,453		
C04M15A MID COL PhyHab & EcoProd- OR Imp	\$3,539,029	\$2,539,560	\$803,493	\$3,343,054	\$195,975		
C04M16A MID COL Fish Index	\$2,880,201	\$1,839,010	\$792,827	\$2,631,838	\$248,363	Efficiencies found during implementation.	
C04M16A MID COL Fish Index - OR DM	\$105,704	\$106,352	\$27,257	\$133,608	(\$27,904)		
C04M16A MID COL Fish Index - OR Imp	\$2,774,497	\$1,732,659	\$765,571	\$2,498,229	\$276,268		
C04M17A MID COL Juvenile Hat - ONR	\$103,056	\$103,074		\$103,074	(\$18)	This portion of the project is complete.	
C04M17A MID COL Juvenile Hat - ONR Imp	\$103,056	\$103,074		\$103,074	(\$18)		
C04M17A MID COL Juvenile Hat - OR	\$495,994	\$478,654	\$82,538	\$561,192	(\$65,198)	Revelstoke Flow Technical Review Committee has recommended further work.	TOR Addendum will be submitted by March 31, 2017
C04M17A MID COL Juvenile Hat - OR DM	\$39,494	\$44,650	\$15,238	\$59,888	(\$20,394)		
C04M17A MID COL Juvenile Hat - OR Imp	\$456,500	\$434,005	\$67,300	\$501,305	(\$44,805)		
C04M18A MID COL Adult Fish - ONR	\$178,104		\$178,104	\$178,104	\$0		
C04M18A MID COL Adult Fish - ONR Imp	\$178,104		\$178,104	\$178,104			
C04M18A MID COL Adult Fish - OR	\$960,358	\$585,784	\$150,020	\$735,804	\$224,554	Proceeding with modelling work as per TOR Addendum 2	Sent an update to CWR of planned modeling work on February 8, 2017.
C04M18A MID COL Adult Fish - OR DM	\$60,645	\$61,855	\$22,080	\$83,935	(\$23,290)		
C04M18A MID COL Adult Fish - OR Imp	\$899,713	\$523,929	\$128,140	\$652,069	\$247,644		
C04M53A MID COL Fish Strand	\$179,222	\$155,451	\$1,814	\$157,266	\$21,956	Project Complete. Final Completion report outstanding.	
C04M53A MID COL Fish Strand - ONR DM	\$58,310	\$40,181	\$1,814	\$41,996	\$16,314		
C04M53A MID COL Fish Strand - ONR Imp	\$120,912	\$115,270		\$115,270	\$5,642		

OR - Ordered Remissible
ONR - Ordered Non-Remissible

* Red values in parentheses denote overage.