Columbia River Project Water Use Plan

Lower Columbia River Fish Management Plan

Lower Columbia River Physical Habitat and Ecological Productivity Monitoring

Implementation Year 8

Reference: CLBMON-44

Lower Columbia River Physical Habitat and Productivity Monitoring

Study Period: January 2015 - December 2015

Ecoscape Environmental Consultants Ltd. #102 - 450 Neave Court
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ECOSCAPE
Environmental Consultants Ltd.

Memorandum

Date:	July 8, 2016
To:	Phil Bradshaw, Natural Resource Specialist and Dr. Guy Martel, Ecosystems Scientist, BC Hydro
From:	Mary Ann Olson-Russello, M.Sc., R.P.Bio
File:	11-744 / 15-1682
Subject:	CLBMON-44: Summary of 2015 Works and Updated Datasets

1.0 BACKGROUND

CLBMON-44 is a multi-year study of physical habitat and ecological productivity on the Lower Columbia River (LCR) between the outflow of the Hugh L. Keenleyside Dam and the Birchbank gauging station. The aim of the study is to address management questions and hypotheses that examine the influence of three different flow periods (Mountain Whitefish (MWF) Jan 1 - Mar 31; Rainbow Trout (RBT) Apr 1 - Jun 30; and fall fluctuating (FFF) Sep 1 - Oct 31) on select physical habitat and ecological productivity measures. Appendix A provides a summary of the the management questions, hypotheses and results to date.

2.0 PROJECT CHANGES

In December 2015, CLBMON-44 budget discussions took place between Phil Bradshaw and Guy Martel of BC Hydro and Mary Ann Olson-Russello of Ecoscape. The goal was to continue collecting productivity data in 2016 and 2018 during the winter, summer and fall sampling sessions. This was an ambitious sampling plan given that the budget during the last four years of the contract (2016-2019) was considerably less than in previous years. To achieve the work plan goals, several changes were made to the sampling program. In short, the changes are as follows:

- No further water quality sampling during 2016-2019. It was decided to eliminate this component of the program, because the current sampling regime (point samples collected four times annually) does not provide enough data to statistically inform the potential effects of the three flows periods on the water quality of LCR. The previous years of water quality sampling have been useful to understand the baseline conditions of LCR, and that, along with other lines of evidence have been used to address the water quality related hypotheses.
- Budget has not been allocated for the temperature and stage data collection in 2017 and 2019. However, it should be noted that sensors

will remain in place throughout the duration of the project. Sensor data will be opportunistically downloaded at least three times annually during April, July and October in 2017 and 2019, when Ecoscape field crews are working on LCR for other contracts;

- Comprehensive data reports will be prepared following data collection in 2016 and 2018 only. A brief memo and data submission will be submitted in February 2016 that summarizes 2015 program activities (this report).

3.0 SUMMARY OF CLBMON-44 2015 WORKS

The data collection schedule for CLBMON-44 during years 2011 – 2015 consisted of alternating years, with productivity data collection occurring in 2012 and 2014 (Table 2). The physical parameters collected during 2015 consisted of water quality, water temperature and water stage monitoring. Each of these parameters were collected four times during the year on April 1, June 24, August 18 and October 20, 2015. The data was collected at five water quality index stations on the Columbia River between the Hugh Keenleyside Dam and the Birchbank gaging station and at two tributary sites located on the Kootenay River and on Norns Creek.

Table 2. CLBMON-44 Data collection during years 2011-2015.

Year	Field Data Collection
2011	Physical parameters (water quality, water temperature, stage data)
2012	Physical parameters and productivity data (benthic invertebrates and periphyton)
2013	Physical parameters
2014	Physical parameters and productivity data
2015	Physical parameters

Existing master datasets were updated with the 2015 data and preliminary graphing was undertaken to review the quality of the data and to ensure that the field sensors for temperature and stage monitoring were functioning properly. To address the physical management questions, several outside datasets (e.g. collected by others) are used as predictors within several analytical models. These 2015 datasets have been obtained and are included within the data submission (Table 3). In addition, productivity datasets are also provided which were last updated with 2014 data (Table 4).

Table 3. CLBMON-44 physical data files and outside datasets that were updated in 2015.

File Name	Source	Description
LCR.mast.ArrowElevNAK.8Dec15	Fish and Wildlife Compensation	Elevation of Arrow Lake at Nakusp 2008-2015
LCR.mast.ArrowDailyTemp.8Dec15	Fish and Wildlife Compensation	Arrow lake Temperature 2008-2015
LCR.mast.ArrowElevNAK.8Dec15	Fish and Wildlife Compensation	Elevation of Arrow Lake at Nakusp 2008-2015
LCR.mast.BRDHeadpondElev.8Dec2015	Columbia Power Corporation	Elevation of headpond behind Brilliant Dam 2008-2015
LCR.mast.CastlegarAirTemp.8Dec15	Downloadable Data	Air temperature of Castlegar 2008-2015
LCR.mast.KLTemp.11Dec15	MOE	Kootenay Lake water temperature
LCR.mast.LevelLogger.7Dec15	Ecoscape/TG Logic	Elevation and Temperature by reach
LCR.Mast.MeanDailyDischarge1Dec.15	Poisson Consulting Ltd.	Mean daily flow at Birchbank, Brilliant, and Hugh Keenlenyside 2008-2015
LCR.mast.WQT.8Dec15	Ecoscape/TG Logic	Water Quality for all reaches 2008-2015

Table 4. Productivity datasets that were last updated with 2014 data.

File Name	Source	Description
LCR.LightTemp.2008-2014.02March15	Ecoscape/TG Logic	Light and Temperature data by productivity site 2008-2014
LCR.mast.BI.wide.2008_2014.25Feb15	Ecoscape/TG Logic	Benthic Invertebrate abundance, taxonomy, biomass, and metrics for all transects
LCR.mast.fieldvelocities.05Feb15	Ecoscape/TG Logic	Velocities for all transect at deployment and retrieval
LCR.master.peri.wide.24August15	Ecoscape/TG Logic	Periphyton productivity: Live and Dead biovolume, abundance, and chl-a
LCR.Master.Substrates.09-14.11.Feb.15	Ecoscape/TG Logic	Substrate percentages and/or substrate score by site/transect
Periphyton Master Taxonomy Jan12 2015	Larratt Aquatic/TG Logic	Taxonomy for all P-codes found in LCR.master.peri.wide.24August15

3.0 CLOSURE

If there are any questions in regards to this summary memo or the provided data, please contact the undersigned at your convenience.

Respectively submitted,

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Appendix A - CLBMON-44 Status of Objectives, Management Questions and Hypotheses After Year 8

Table 1: CLBMON-44 Status of Objectives, Management Questions and Hypotheses After Year 8

Management Questions	Management Hypotheses	Year 8 (2015) Status
Physical Habitat Monitoring Q.1. How does continued implementation of MWF and RBT flows during winter and spring, and fluctuating flows during fall affect water temperature in LCR? What is the temporal scale (diel, seasonal) of water temperature changes? Are there spatial differences in the pattern of water temperature response?	Ho1phy: Continued implementation of MWF and RBT flows during winter and spring, and fluctuating flows during fall, does not alter the seasonal water temperatures regime of LCR.	Regression modeling of the studies cumulative data to date indicates that the influence of flow on LCR water temperature is relatively low compared to other model predictors. When all flow periods were considered, LCR water temperatures were most strongly correlated with air temperature and reservoir water temperature. Flow was positively associated with river temperature during the MWF and FFF periods, and negatively associated with river temperature during the RBT flow period. Based on this analysis, flow is not an important determinant of river temperature. These findings are consistent with that reported by Scofield *et al.* (2011) and Olson-Russello (2014) for previous years of the study. Given the nominal influence of flow on LCR water temperature, the null hypothesis is tentatively accepted.
Physical Habitat Monitoring Q.2. How does continued implementation of MWF and RBT flows during winter and spring, and fluctuating flows during fall affect the seasonal and inter-annual range and variability in river level fluctuation in LCR?	Ho2phy: Continued implementation of MWF and RBT flows does not affect seasonal water levels in LCR.	Regression modeling suggests that river flow is an important determinant of water levels. At all locations, the river level difference between MWF maximum peak spawning and minimum incubation was greater during pre-MWF flows than during post and continuous MWF flows. Similarly, river elevation data from monitoring stations WQIS2 and WQIS3 were regressed with flow data. For both stations, the cumulative elevation drops that occurred during pre-RBT flows (1984-1991) were significantly higher than those determined during post (1992-2007) and continuous (2008-2014) flow periods. We therefore reject all three null hypotheses.
	Ho2Aphy: Continued implementation of MWF flows does not reduce the river level difference between the maximum peak spawning flow (1 Jan to 21 Jan) and the minimum incubation flow (21 Jan to 31 Mar).	
	Ho2Bphy: Continued implementation of RBT flows does not maintain constant water level elevations at Norns Creek fan between 1 Apr and 30 Jun.	
Physical Habitat Monitoring Q.3. How does continued implementation of MWF and RBT flows during winter and spring, and fluctuating flows during fall affect electrochemistry and biologically active nutrients in LCR?	Ho3phy: Continued implementation of MWF and RBT flows during winter and spring, and fluctuating flows during fall, does not alter the water quality of LCR.	Water quality parameters that address electrochemistry include: conductivity, TDS, hardness, alkalinity, dissolved metals ions and pH. Biologically active nutrient parameters include: nitrate, ammonia, total P and ortho phosphate (SRP). Based on data collected throughout the study, LCR has good water quality. Parameters rarely exceeded water quality guidelines or objectives. Due to the limited water quality sampling regime (3-4 collections per year) it has been difficult to statistically test whether flows within each flow period have an effect on water quality. Variability in flow had a positive effect on the availability of nutrients (No^2+No^3 and total
	Ho3Aphy: Continued implementation of MWF and RBT flows during winter and spring, and fluctuating flows during fall, does not alter the electrochemistry of LCR.	

Management Questions	Management Hypotheses	Year 8 (2015) Status
	Ho3Bphy: Continued implementation of MWF and RBT flows during winter and spring, and fluctuating flows during fall, does not alter the availability of biologically active nutrients of LCR.	phosphorus). Operations during the MWF and RBT flow periods were also factors in predicting total phosphorus, but were less important than variability in flow. Modelling of electrochemistry parameters was not informative. Although these initial results are consistent with what has been previously reported, additional modelling is necessary to further understand what is driving the water quality in LCR. Based on our understanding of the system to date, we believe that the influence of fish flows on water quality is subtle compared to the stronger effects on water quality in freshet, anthropogenic nutrient donation, groundwater inputs, and even photosynthesis within LCR. We anticipate that fish flows may cause small decreases in electrochemistry parameters through dilution, and may improve particulate and dissolved nutrient delivery under low to moderate flow conditions, but that they are unlikely to have a discernible effect on pH, or on the overall nutrient status of LCR. We therefore continue to tentatively accept the management hypotheses HO_{3phy}, HO_{3Aphy}, and HO_{3Bphy} and assume that fish flows, whether they be MWF, RBT or FF flows, have no effect on the water quality of LCR.
Ecological Productivity Monitoring Q.1. What are the composition, abundance, and biomass of epilithic algae and benthic invertebrates in LCR?	Ho1: Continued implementation of MWF and RBT flows during winter and spring, and fluctuating flows during fall, do not affect the biomass, abundance and composition of benthic invertebrates in LCR.	Regression modelling indicated that velocity is an important determinant of the benthic invertebrate community. Variability in flow was also important during the MWF flow period, and to a lesser extent during RBT and FFF periods. These modelling results suggest that there may be a direct link between operations and benthic invertebrate production. The results are preliminary as additional analysis is needed to further elucidate relationships and to understand how flow variability and operations affect the benthic invertebrate community. At this time, we continue to tentatively reject all four null hypotheses.
	Ho1Aeco: Continued implementation of MWF does not affect the biomass, abundance and composition of benthic invertebrates in LCR.	
	Ho1Beco: Continued implementation of RBT flows does not affect the biomass, abundance and composition of benthic invertebrates in LCR.	
	Ho1Ceco: Continued fluctuations of flow during the fall do not affect the biomass, abundance and composition of benthic invertebrates in LCR.	
Ecological Productivity Monitoring Q.2. What is the influence of MWF and RBT flows during winter and spring, and fluctuating flows during fall on the abundance, diversity, and biomass of benthic invertebrates?	Ho2eco: Continued implementation of MWF and RBT flows during winter and spring, and fluctuating flows during fall, do not increase total biomass accrual of periphyton in LCR.	Similar to benthic invertebrates, when considering all flow periods and metrics, regression modelling indicated that velocity was the most important determinant of the periphyton community. Variability in flow was also important. This result suggests that a direct link between productivity and operations may exist. Since this is the first attempt to explicitly test the management questions through modelling, results are considered preliminary and further analysis with additional years of data
	Ho2Aeco: Continued implementation of MWF does not increase total biomass accrual of periphyton in LCR.	
	Ho2Beco: Continued implementation of RBT flows does not increase total biomass accrual of periphyton in LCR.	

Management Questions	Management Hypotheses	Year 8 (2015) Status
	Ho2Ceco: Continued fluctuations of flow during the fall do not increase total biomass accrual of periphyton in LCR.	is needed to better understand how flow variability and operations may affect periphyton productivity. We tentatively reject Ho2 A B and Ceco, that RBT, FFF and MWF flows do not increase total biomass accrual of periphyton in LCR.
Ecological Productivity Monitoring Q.3. Are organisms that are used as food by juvenile and adult MWF and RBT in LCR supported by benthic production in LCR?	Ho3eco: Continued implementation of MWF and RBT flows during winter and spring, and fluctuating flows during fall, do not increase the availability of fish food, organisms in LCR	Regression modelling indicated that velocity and substrate score were important determinants of the benthic invertebrate community that is considered high quality forage by fish. Although there was some variation by flow period, high quality forage was positively associated with velocity and substrate size. We continue to tentatively reject all four null hypotheses because operational changes have a downstream effect on velocity and ultimately the availability of food for fish. These effects are relevant across all flow periods.
	Ho_{3Aeco}: Continued implementation of MWF flows does not increase availability of fish food organisms in LCR.	
	Ho_{3Beco}: Continued implementation of RBT flows does not increase availability of fish food organisms in LCR.	
	Ho_{3Ceco}: Continued fluctuations of flows during the fall do not increase availability of fish food organisms in LCR.	