BC Hydro

Campbell River Water Use Plan

Monitoring Program Terms of Reference

JHTMON-13 Campbell Watershed Riverine Fish Flow-Habitat Assessment

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1 Program Background

The Campbell River WUP Consultative Committee (CC) recognized there were some fisheries issues relating to proposed load factoring[1] at the John Hart Generating Station (BC Hydro 2004). Load factoring was considered important from an operational perspective, yet some of the main uncertainties were its effects on potential disruption of fish habitat such as fish spawning areas, and possible impacts on spawning behaviour and spawning success. One of the CC recommendations was to adaptively manage load factoring to "identify opportunities to alter the existing period of load factoring." (BC Hydro 2004, p. P-28).

The Comptroller of Water Rights subsequently ordered BC Hydro to:

- "correlate quantity and quality of spawning and rearing habitat with John Hart ramp rates and tripping events"; and
- "measure effects of proposed load factoring on spawning behaviour and spawning success" (CWR 2012, Schedule E, clauses C and D).

The original intent was to address these two clauses in the WUP Order as separate Terms of Reference (ToRs) – **JHTMON-13** to generate and validate a physical model of fish habitat / flows relationships to assess the effects of ramping rates and tripping events, and **JHTMON-14** to measure the effects of the proposed load factoring on spawning behaviour and spawning success through field studies to validate the physical model.

A Fisheries Technical Committee (FTC) formed of representatives from First Nations, agencies and BC Hydro met on January 23, 2020 to review the objectives of JHTMON-13 and 14[2]. After reviewing the current state of the newly constructed John Hart Generating Station, the WUP Order and the original CC recommended approach, the FTC first concurred that the downstream risks from generating unit tripping was well mitigated thanks to the bypass valves installed in the new John Hart Generating Station[3]. It was further agreed that the two ToRs could be merged into one study (hereto referred as JHTMON-13) to assess fish (salmonids) responses to ramping rates. The FTC recommended that the study consist of a phased approach, first focusing on understanding potential ramping impacts on fish, then on load factoring opportunities, the latter of which might entail a flow manipulation study once load factoring periods to be tested have been identified.

[1] Load factoring describes the process of generation patterns through changing ramping rates within a given day or week to compensate for changes in demand. The load factoring period for JHT as approved under the WUP Order is from January 1 to February 15.

[2] JHTMON-6 was also reviewed in the context of flow/habitat modelling.

[3] The new valves were installed as part of the John Hart Generating Station Replacement Project and went into service in late 2018. They are designed to automatically bypass flows within 3 minutes of tripping events.

2 Management Questions

The WUP CC hypothesized that load factoring may affect fishes through redd dewatering, and changes of spawning and rearing habitat. The FTC further agreed to add stranding mortality as a potential effect of load factoring. The areas of uncertainty identified by the FTC led to the following WUP related management questions:

1) What is the effect of load factoring / ramping rate on the accessibility and suitability of spawning areas, and how does it affect spawning behaviour, spawning success and incubation success?
2) What are the potential impacts of load factoring / ramping rate on fish stranding (incidence and mortality)?
3) What are the potential impacts from extending the allowable period of load factoring?

Addressing Management Questions 1-2 will inform on the relationship between ramping rate and habitat accessibility / suitability, fish stranding and survival. The biological significance of the effects will be assessed in each case.

3 Key Water Use Decision

Results of the monitoring program will help BC Hydro determine the bounds of its load factoring operational flexibility, and manage the power system load while minimizing impacts to Lower Campbell River fish communities. They may also lead to recommendations for physical works in lieu of operational changes to mitigate instances where stranding risk is not acceptable. Collectively, results of this program will improve the knowledge base from which future WUP-related decisions will be made.

4 Program Proposal

4.1 Objective and Scope

The main objective of this Monitoring Program is to understand fish responses to load factoring (load factoring is a subset or rapid form of ramping) through assessing the location and magnitude of the impacts of ramping scenarios on fishes downstream of the John Hart facility. This will clarify load factoring objectives, periods, and range of discharges (ramping rates), and will help BC Hydro to confirm the objectives of WUP flows. A second objective is to identify potential load factoring opportunities while minimizing impacts to fishes.

The species and life stages of interest are indicated in Table 2-1, derived from information from BC Hydro (2001).

Table 4-1 Life history timing for flow requirements in the Lower Campbell Rivers

		Start	End
Spawning	Chinook	early Oct	late Nov
	Coho	Mid Oct	mid Dec
	Rainbow	early Oct	mid Dec
	Winter Steelhead	early March	mid Apr
Rearing	Chinook fry	early March	late July
	Coho juveniles	mid May	late Oct
	Steelhead fry	late June	late Oct
	Steelhead parr	mid May	late Oct

The geographical scope of the study is the lower Campbell River between the John Hart Generating Station tailrace and the Highway 19 south-bound bridge.

4.2 Approach

The approach of the monitoring program is in two phases:

1. The first phase will consist of a literature review on fish behavioural responses to ramping and how to best measure them and assess the significance of their biological effect size.
2. Once the literature review is completed and reviewed by the FTC, the second phase will involve consulting with BC Hydro's Generation System Operations group (GSO) to clarify load factoring objectives, periods, and range of discharges (ramping rates) to be tested. These periods will be input into a fish habitat / flow model which will produce various scenarios of fish habitat changes. This will entail collaboration with JHTMON-6, which is developing in concert with BC Hydro a 2D model of habitat-flow relationships in the Lower Campbell River. The flow model will summarize habitat availability across a range of operations in the Lower Campbell River. These scenarios will then be validated in the field through experimental flow manipulations.

The effects of these load factoring / ramping scenarios on fish spawning habitat suitability, fish spawning behaviour and success, and fish stranding will be assessed.

4.3 Methods

Task 1: Project Management

Project management involves the general administrative and technical oversight of the project. This task includes, but is not be limited to: 1) budget management, 2) study team management, 3) logistics coordination, 4) technical oversight of field and analysis components, and 5) facilitation of data transfer among other investigators associated with various Campbell River WUP monitoring programs or other BC Hydro programs.

Task 2 Review of existing information

A literature review will be completed to summarize the behavioural responses of salmonids (with emphasis on, but not necessarily limited to, Lower Campbell River species) to ramping and load factoring, the likely magnitude of biological effects and their biological significance as they relate to management questions, and how to best measure the most relevant variables to test the predicted responses (note that this literature review was initiated under a separate study, JHTMON-6).

Material to be reviewed and summarized will include current ramping and load factoring restrictions detailed in the WUP, provincial guidelines on ramping rates and previous reports on ramping effects on fishes. Consultation with experts, both within and outside BC, is encouraged.

The review may also use results from a limiting factors analysis currently developed for key riverine fish species in the Lower Campbell River (JHTMON-6). This limiting factors analysis focuses on hydrology but also considers habitat availability for individual life stages, water quality, and spawning substrate quality.

The outcome of the review will help define the most pertinent variables to address the Management Questions. The predicted responses of these variables to load factoring and ramping rate scenarios will be tested in subsequent field trials.

Task 3 Presentation to Fish Technical Committee

The Fish Technical Committee (FTC) will meet to review the results of the JHTMON-6 limiting factors analysis and the literature review of the present program, and confirm management priorities (species, life stages) for the Lower Campbell River.

The contractor will also present detailed methodologies to test the effect of flows on the variables singled out by the literature review and a schedule for field trials, to be approved by the FTC.

The FTC will then confirm that data collection requirements for JHTMON-6 and JHTMON-13 are enough to address the objectives of each of the programs and will advise on the development of addenda to the ToR if necessary.

Task 4 Hydraulic model validation

The 2D model developed in collaboration with BC Hydro's Hydrotechnical Engineering Department will generate habitat-flow relationships which will eventually support decision-making for flow management. It is thus important that the model be validated in key areas. This will require collaboration with BC Hydro's Generation System Operations, who will provide the main periods of load factoring and the range of discharges contemplated.

The field work will validate the main predictions of the habitat-flow model about changes in spawning and rearing habitat and the areas most prone to stranding.

Task 5 Fish behavioural assessments

Fish behavioural responses to load factoring scenarios (different ramping rates) may be assessed, but are not necessarily limited to, spatial movements (distribution, location of spawners & spawning areas), spawning behaviour patterns (duration of spawning stage, frequency of spawning) and spawning success (number of redds, egg survival).

The methods to assess these performance measures may include but are not be limited to radio telemetry, redd surveys, snorkel surveys, drone flights, egg survival sampling or incubation cassettes.

All field sampling will be carried out in a standardized manner and follow a specified schedule to ensure consistency among years in data quality and collection procedures.

Task 6 Fish stranding

Stranding risk is a function of likelihood of incidence and consequence (effects on individuals and long term effects on populations). The effect of load factoring scenarios (different ramping rates) on stranding risk will be evaluated as functions of species (management, conservation status) and life history stage (adults or juveniles). The areas river and the time periods most prone to stranding will be categorized by scenario and surveyed. Isolated pools will be enumerated whenever possible and will be sampled (area and volume) pending on logistics. Fish species, life stage and morphometric / morbidity data will be tabulated.

Methods to assess the risk of stranding may include but not be limited to the use of level loggers, water quality meters, crew surveys and aerial surveys / drone flights.

Task 7 Data analyses

No statistical methods are prescribed as these may change through the course of the study as sampling conditions may vary and computing power and statistical refinements evolve. Emphasis will be given to assessing effect sizes and whether they are of biological significance and not only to statistical significance. Contractors and BC Hydro are expected to make the adjustments necessary to ensure that the best methods are used throughout the analytical process. All code (R or other package) will be part of the deliverables.

All data will be entered into a database developed in consultation with BC Hydro staff for subsequent analyses. This will ensure that data collected over the years are compatible and can be extracted and compared without concern regarding differences in file format. BC Hydro may provide direction on data entry and file formats. Some refinements may be required to the presentation formats and analyses following collection and review of data.

Task 8 Reporting

There will be regular updates to the BC Hydro representative, and a final report due at the conclusion of each year following the data collection period. The exact dates of the deliverables and their contents will be communicated to the

contractor during the first pre-work meeting. All data will be archived in a format to be developed in consultation with BC Hydro staff.

In general, annual data reports will summarize the year's findings with an Executive Summary and a table of Management Questions showing the current progress in addressing each Management Question. It will include a brief description of methods such that they are replicable by independent parties, present the data collected that year, and report on the results of all analyses. It will also provide a short discussion of how the year's data compare to that collected in previous year, emphasizing long term trends if relevant.

A final report will be prepared at the end of the program summarizing the results of the entire study, formally addressing each Management Question and discussing inferences that can be drawn about the impacts of the WUP over time. BC Hydro will provide the template for the final report, which will differ from yearly reports.

5 Safety Management

A safety plan must be developed and submitted to the BC Hydro contact for all aspects of the study involving field work, in accordance with Work Safe BC and BC Hydro procedures and guidelines. All field work must be carried out by a minimum two-person crew and appropriate check-in and checkout procedures must be followed. Specific safety training may be required.

6 Interpretation of Results

There are no null hypotheses to be accepted nor rejected. Rather the program focuses on assessing the effect of managed flows on various fish species habitats and their life history stages. Thus each management question will be addressed by providing in each case an effect size and most importantly, its biological significance.

The flow-habitat relationships model, once validated in the field and coupled with the answers to Management Questions, will provide BC Hydro with the ability to optimize power generation while minimizing impacts to Lower Campbell River fishes.

7 Schedule

The entire program is set to last three years: the first phase (Literature Review) will be completed within the first year (already underway as part of JHTMON-6); the second phase (field work) may be shortened or lengthened pending review from the FTC after the first phase. The entire program should be completed before the next WUP review period.

8 Budget

The total cost of the monitoring program is estimated at $455,395 (not including project contingency) based on a 2020 start.

9 References

BC Hydro. 2001. Campbell River Water Use Plan. Consultative Committee Report. Available at https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/environment-sustainability/water-use-planning/vancouver-island/campbell-river/campbell-river-water-use-plan.pdf

Comptroller of Water Rights (CWR). 2012. Province of British Columbia Water Act Order Sections 87 and 88.