Clowhom Lake Water Use Plan

Monitoring Program Terms of Reference

COMMON-1 Monitor of Aquatic Wildlife in Wetlands affected by Dam Operations

Revision 1
February 28, 2019

COMMON-1 – AQUATIC WILDLIFE IN WETLANDS AFFECTED BY DAM OPERATIONS
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1.0 Monitoring Program Rationale

1.1 Introduction

This project is submitted in response to the Clowhom Water Use Plan (WUP) Order dated April 20, 2005. Specifically, Schedule 1 (a) of the Clowhom WUP Order requires that BC Hydro develop a monitoring program to evaluate the potential:

> *"Effects of reservoir operations on wildlife. This program shall consist of an annual survey carried out over twenty years, undertaken to evaluate potential reservoir operational impacts to aquatic wildlife at the confluence of the Clowhom River and Clowhom Lake Reservoir*."

A Terms of Reference (TOR) for the study (COMMON-1) was approved by the Comptroller of Water Rights on October 28, 2005. Field monitoring was initiated in 2006, and the annual monitoring program will be completed in 2025.

This document outlines a revision to the original TOR to direct the final years of COMMON-1 (e.g., 2019 to 2025).

1.2 Background

As the Clowhom Lake WUP reached completion, a number of uncertainties were identified regarding the effect of BC Hydro operations on aquatic resources. The primary consequence of these uncertainties was a limited ability to predict the response of fish and wildlife populations to operational changes as a result of WUP implementation. This in turn highlighted the general uncertainty surrounding the likelihood that the expected fish and wildlife benefits of the WUP operation will be realised.

One critical uncertainty was the impact of facility operations on wildlife (Bruce 2003a and b). The development of a performance measure could not be completed within the timing of the WUP process; instead of developing a performance measure, the Consultative Committee recommended that a monitor be put in place to track future wildlife impacts so that they may be considered at an appropriate WUP review period.

1.3 Revision Rationale

With insufficient pre-existing knowledge on reservoir wildlife ecology, the original TOR outlined a monitoring program that was generalized to capture a wide scope of effects with relatively low detail. Since then, WUP studies have collected information on reservoir wildlife ecology, developed research methods, and

COMMON-1 has provided wildlife data specific to Clowhom Lake Reservoir. In review of the COMMON-1 TOR, BC Hydro now recognizes several avenues for improving this study, and has therefore revised the TOR.

The key revisions to this TOR include:

- Revised Management Questions (MQ) to improve clarity;
- Removed MQ-4 (design of physical works) which was not directly related to the Order, is poorly related to the monitoring study, and is too open ended. The question of physical works can be addressed better by a dedicated project if deemed necessary;
- Removal of the original Management Hypotheses. These were phrased for statistical hypothesis testing, were complex, and unlikely to be testable;
- Addition of five new simple Management Hypotheses which are phrased as working hypotheses, or predictions, based on our understanding of reservoir ecology and this particular system. These are useful to state as they are used as assumptions in the design of the field study, and form a context for addressing the MQ's;
- Narrowing of the seasonal timing of the monitoring program to focus on the time of year when interactions between reservoir operations and wildlife productivity are most likely;
- Increased specificity with respect to the study area in the reservoir drawdown zone; and
- Re-design of monitoring tasks to focus on impacts of reservoir operations on birds and amphibians which breed/nest within the reservoir drawdown zone, and vulnerable to having their productivity impacted by reservoir operations. Birds and amphibians are also readily observable, and are important populations to consider.

1.4 Management Questions

The WUP specified an operational constraint by increasing the minimum pool elevation (49 masl) during normal reservoir operations (BC Hydro 2005); this constraint does not apply during annual maintenance activities that require a full drawdown of the pool (e.g., in March). In this revised TOR, implementation of the WUP specifically refers to the new operational constraint.

COMMON-1 is designed to address the following wildlife-related MQ's as they pertain to a small wetland area (i.e., the study area) located in the drawdown zone, near the confluence of the Clowhom River and the Clowhom Lake Reservoir (Figure 1):

1) What is the diversity and distribution of breeding birds and amphibians in the study area, and how are these related to habitat and elevation in the reservoir drawdown zone?

2) How, and to what extent, might the reservoir operations affect productivity of birds and amphibians in the drawdown zone study area?

3) How, and to what extent, might the implementation of the WUP alter the impact of reservoir operations on the productivity of birds and amphibians in the drawdown zone study area?

Empirical observation of wildlife distributions among distinct drawdown zone habitat types will be used to address MQ-1, and will provide necessary information for addressing MQ-2 and MQ-3. MQ-2 will be addressed by drawing inferences based on when and how reservoir operations inundate different drawdown zone habitat classes, combined with knowledge of wildlife distributions among these habitat types. MQ-3 will consider whether the operational constraint introduced by the WUP has altered the impacts identified by MQ-2.

1.5 Management Hypothesis

To address the MQ's, several predictions are helpful to define:

H_1: The diversity and density of wildlife are related to habitat and vegetation complexity in the drawdown zone.

H_2: Habitat and vegetation complexity are reduced at lower elevations in the drawdown zone due to an increased frequency of inundation.

H_3: The diversity and density of wildlife decrease at lower elevations in the drawdown zone.

H_4: Variation in reservoir operations within the upper elevations of the drawdown zone are most pertinent to understanding impacts to wildlife.

H_5: Variation in reservoir operations within the lower elevations of the drawdown zone are least pertinent to understanding impacts to wildlife.

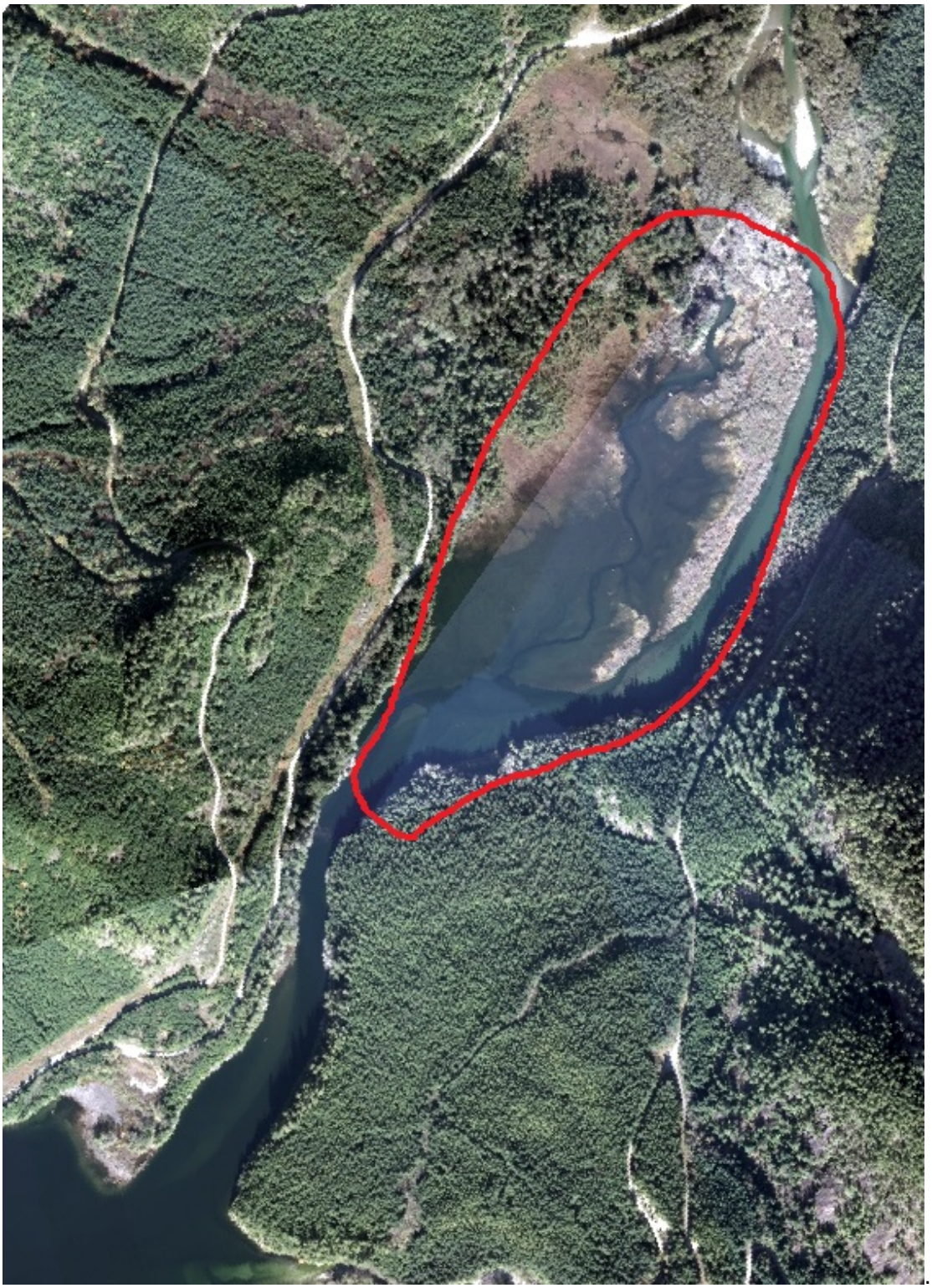
The above predictions are commonly supported in other reservoir drawdown zones (e.g., Miller et al. 2015).

1.6 Key Water Use Decision Affected

During the WUP evaluation of operating alternatives, an assumption was made that the wetland habitat would benefit or at least be minimally affected by WUP operations. This assumption was made with little supportive information, and therefore subject to error. Validation of this assumption is required in order to evaluate the overall effectiveness of the final WUP decision to wildlife interests, as well as to assess future proposals for operational changes. Addressing the MQ's and considering the Management Hypotheses will be used to support or refute the WUP assumption.

This study will inform future considerations on Clowhom Water Use Planning.

Figure 1: The red line encircles the approximate extent of the study area. The exact study area is defined as the habitat at the east end of the Clowhom Lake Reservoir east of the narrows, that is less than 53.34 m above sea level, and which is not inundated during at least one of the surveys.



2.0 Monitoring Program Proposal

The TOR revision allows the remaining part of the monitoring study to adapt and build on progress made during the initial monitoring phase. The program proposed here has been revised from what was proposed in the original TOR in order to: (1) adjust the spatial design of data collection towards elevations where wildlife impacts from reservoir operations are most likely; (2) focus the monitoring schedule on the time of year when wildlife are most likely to be affected by reservoir operations; and (3) refine monitoring tasks.

2.1 Objective and Scope

The objective of the project will be to address the MQ's. The scope of this program proposal will be limited to field surveying the distribution of habitat use by birds and amphibians breeding in the drawdown zone of the Clowhom Lake Reservoir (Figure 1). All drawdown zone habitat classes that are not inundated during surveys should be monitored including those that are unlikely to be used by wildlife. For the final years of the monitoring program, field effort will only occur during spring (approximately March through June), especially when reservoir elevations are most conducive to detecting focal species.

2.2 Approach

This monitoring program will not follow an approach of directly observing impacts to productivity measures (e.g., nesting success), because that approach is challenging to accomplish effectively, especially in remote settings such as Clowhom. Rather, the approach to be taken will be to characterize the timing of wildlife habitat inundation in relation to wildlife habitat use.

An Interim report will be drafted to finalize all previous COMMON-1 monitoring work done under the original TOR. In the remaining field seasons the field work will follow a new methodology.

The primary task for future field survey work will be to address MQ-1 by:

- Reviewing, and possibly updating the COMMON-1 habitat map of the drawdown zone study area which differentiates relevant wildlife habitat types. Possible habitat classifications could include ponds, draws, non-vegetated sediment, gravel/cobble, sedge meadow, shrub, etc.); and

- Gathering empirical observations of wildlife habitat-use across drawdown zone habitat types; this will include but not be limited to documenting the locations of: singing birds, bird nests, alarmed birds, adults engaged in nesting (nest building, provisioning young), fledged young, adult amphibians, larval amphibians, and amphibian egg-masses.

Desktop analysis for MQ-1 will include:

- Ranking habitat classes for wildlife usage on a species-specific basis for common species;

- Ranking wildlife species diversity based on which species were observed in each habitat type; and

- Determine the stratification of habitats types, survey coverage, and wildlife observations across elevation bands. This will be determined with the utilization of LiDAR or similar digital elevation mapping products.

The MQ-1 results will be required for addressing MQ-2, and MQ-3. The primary desktop analysis tasks to address MQ-2 and MQ-3 will include:

- Determination of the phenology of wildlife sensitive periods (e.g., nesting season). This will be estimated using field observation records coupled with desktop review of species-specific breeding phenology; and

- Determination of species-specific[1] risks of habitat inundation during breeding period, depending on their elevational range of habitat use, and the historic frequency of inundation. Historic data on reservoir elevations will represent normal reservoir operations (before and after the 2005 WUP implementation). Empirical observation and general knowledge of species-specific breeding habits (breeding habitat, location, and phenology) will be used to assess vulnerabilities to impacts associated with inundation, dewatering, and altered habitat availability (e.g., Anteau et al. 2012, Anteau et al. 2014, van Oort et al. 2015, Swan et al. 2015, and Evelyn et al. 2016).

2.3 Methods Details

2.3.1 Task 1: Interim Report

An interim report considering data gathered by the monitoring program up to the end of 2018 will summarize the data to show spatial, seasonal, and among-year variability in wildlife diversity and abundance. Particular focus should be allocated to species that are most likely to be influenced by reservoir operations (e.g., ground nesting birds, amphibians). Spatial variability should focus on habitat types, and variability related to sampling elevation relative to the full pool elevation of the Clowhom Lake Reservoir (53.34 masl).

2.3.2 Task 2: Drawdown Zone Mapping

High-resolution aerial photography will be acquired when the reservoir is sufficiently low to map drawdown zone habitats. The imagery will be used to refine existing habitat mapping of the drawdown zone within the study area. All habitat types that can be readily described and delineated in the drawdown zone from the full pool elevation down to the shoreline of the reservoir pool will be considered by the monitoring program (e.g., shrub-sedge, sedge, sand-silt, gravel, etc.).

A digital elevation model (DEM) will be created and used to define the upper boundary of the study area based on the full pool elevation (53.34 masl). The

[1] Appropriate species groups can also be considered; for example, species that have similar habitat requirements and similar exposure to reservoir impacts.

DEM will be produced via standard stereophotography, LiDAR or other remote sensing techniques. The production of the DEM will be prioritized as it is required to define the extent of the study area, and to inform the study design. Topographic modelling with derived mapping tools such as drawdown zone contour coverage in the study area will also be required for determining how wildlife and wildlife habitats are distributed in the drawdown zone, and for assessing the potential impacts of reservoir operations on wildlife.

2.3.3 Task 3: Field Data Collection

Field data will be collected during one-day field sampling occasions carried out three times per year, during the spring field season, for each of the remaining seven years (2019-2025). Field sampling will aim to map bird- and amphibian-use in each of the drawdown zone habitat types available across the exposed (i.e. not concurrently inundated) drawdown zone elevations. All field monitoring should aim to precisely map locations where evidence of breeding wildlife are observed (e.g., amphibian egg masses, adult amphibians, singing male songbirds, bird nests, or alarmed birds). The recorded coordinates will allow each observation to be classified by habitat type and elevation using GIS queries.

The search area(s) will be controlled and mapped on each survey occasion. The approach taken in terms of spatial replication and plot size should differ for birds and amphibians.

For birds, which can be easily detected, it might be possible to survey the entire study area on each occasion, depending on how many birds are present, and on the accessibility of the study area. Complete census counts are desirable, and avoid the need for statistical extrapolation. This task would involve spot-mapping or territory mapping breeding activities of birds. All potentially breeding bird species will be recorded, which is likely to include songbirds, shorebirds, and potentially waterfowl, but could include other taxa; however, the census approach is maybe best suited to songbirds which are most easily detected.

For amphibians or other more cryptic wildlife, a sampling approach is likely more appropriate. For amphibians, surveys should aim to sample (1) all permanent wetted areas in the drawdown zone study area; and (2) some reservoir shoreline habitat (this will change depending on reservoir elevation). For the latter sampling, a stratified random approach is suggested, whereby a new set of randomly selected survey plots are surveyed in each habitat type on each survey occasion so that many independent sampling plots are monitored over time across a maximal diversity of habitat types and elevations. For amphibians, it will be important to visit and map as many ponds or potential breeding sites as possible. If point count methods are used for songbirds, each relevant[2] detection will be mapped with precise coordinates for the birds (not the observer) so that habitat and elevation can be determined.

[2] Relevant detections are those that show habitat use of drawdown zone habitats indicting importance of the habitat class within which the detection is made; for example, many aerial insectivore detections (e.g., perching in, or flying over the drawdown zone) will generally not have relevance unless in close proximity to a nest site.

Regardless of the approach used (complete census or sampling), survey effort will be recorded in terms of the number of plots monitored, and total person-hours per plot (in the case of a complete census there will be only one plot repeatedly monitored).

The reservoir elevation on the day of surveys will limit the availability of habitat for sampling on each survey occasion because a proportion of the drawdown zone will be submerged, and sometimes because access throughout the study area may become logistically challenging at certain reservoir elevations. The potential for tree stump vegetation to provide habitat should be considered during periods of deep inundation. It is recommended that survey scheduling is not rigidly pre-determined, and is instead allowed to adapt to take advantage of opportunities when weather conditions are conducive to monitoring birds, and when reservoir levels are relatively low allowing a maximal range of drawdown zone habitats to be surveyed and likely facilitating access; otherwise, sampling should occur as evenly as possible throughout the survey season. All spring months will be important for amphibian sampling; May will be important for documenting bird diversity and abundance. Opportunities survey in late February or June can be considered, but these periods are likely to have snow or high reservoir elevations, so have limited opportunities for observing habitat use.

2.3.4 Task 4: Data Analysis

Data analysis will focus on qualitative and quantitative descriptions of diversity and density of wildlife in the study area, particularly as a function of habitat and elevation. While the analysis will not require hypothesis testing and classical statistics, there will be a need to control for the search effort and also the spatial distribution of habitats across elevations.

The primary goals of the analysis will be to provide data that will allow a quantitative and/or a qualitative assessment of:

- How density and diversity of breeding amphibians and birds are associated with habitat and elevation in the drawdown zone study area;
- Breeding phenology of species breeding in the drawdown zone;
- The temporal nature of reservoir impoundment of the study area during breeding seasons; and
- The potential ramifications of reservoir operations on the more common (or endangered) breeding species in the drawdown zone.

2.3.5 Task 5: Final Report

The final report will focus on addressing the MQ's. COMMON-1 data will likely be the primary source of material for addressing the COMMON-1 MQ's; however, relevant available data and results from other studies should be reviewed and utilized if appropriate. BC Hydro will provide a template outline for the Final Report.

2.4 Interpretation of Monitoring Program Results

Addressing the MQ's will inform future decisions related to Water Use Planning, and will assess whether the current WUP has been beneficial for wildlife, or at least has not negatively impact wildlife utilizing the wetland. The results can be used to:

- Describe the potential scope for negative impacts of reservoir operations on productivity of wildlife;
- Inform which aspects of reservoir operations have the greatest risk for wildlife and whether these are WUP-related or otherwise;
- Highlight important data gaps (e.g., a high risk wildlife group with insufficient data); and potentially
- To inform drawdown zone habitat management (e.g., physical works projects).

3.0 Schedule

Monitoring program to continue to 2025 as per the 2005 TOR, with similar overall effort, but with noted alterations to field schedule - modified as per methods.

The Interim Report will be delivered by April 2020. The final report will be delivered by April 2026.

4.0 Budget

No change in the existing budget.

5.0 TOR Revision Changes

Table 1 highlights a detailed account of changes made to the COMMON-1 TOR. and rationale for their inclusion

Section	Change	Rationale
1.0 Monitoring Program Rationale	• The Background was modified to include some content paraphrased from the Clowhom Monitoring Program Summary to make it a stand-alone and a more complete account.	• The background did not provide enough information when not paired with the Clowhom Monitoring Program Summary, as per the original TOR
1.4 Management Questions	• Altered introductory wording to be more explicit, as per the Order. • MQ1 altered to be explicit about fauna (not flora) and spatial distribution (elevation) related to reservoir operations • MQ2 and 3 were simplified to focus on all res ops impacts in general terms • MQ4 was removed	• The original introductory wording was poor – suggesting that work should monitor above the drawdown zone. • Original MQ1 considered flora which is misleading, and was vague with respect to temporal vs spatial variability in impacts. Temporal variability is not appropriate for this study, which is more suited to consider spatial variability (elevation). • MQ2 and 3 were difficult to interpret. • MQ4 was removed because suggesting WPW projects is very open-ended with many considerations that the monitoring study does not have the capacity to assess (e.g., logistics, costs, regulations). WPW conceptualization is not part of the Order.
1.5 Management Hypothesis	• 5 new MH's presented as predictions to identify what we think is likely to be true.	• Old MH's were removed as they were complex and written for null hypothesis testing which is unrealistic.
1.6 Key Water Use Decision Affected	• Minor edit for clarity	• Improve clarity.
2.0 Monitoring Program Proposal	• All new proposal. • New resources required for Interim report and DEM • Focus on spring and early summer timing • Focus on well-defined drawdown zone habitat types • Focus on understanding bio-geography and how this is stratified in the drawdown zone • Addresses MQ's by comparing elevations of habitat/use vs reservoir operations.	• It is now clear that there is considerable room to improve the study, which is possible with no change to field effort.
3.0 Schedule	• Minor change to include Interim Report	• Interim report is required to transition from phase 1 (original TOR) into phase 2 (revised TOR)
Budget	• Changes	• Focus on spring and early summer timing

6.0 References

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