

Alouette Project Water Use Plan

Monitoring Program Terms of Reference

- **ALUMON#1 Smolt Enumeration**
- **ALUMON#2 Kokanee Out-migration**
- **ALUMON#3 Substrate Quality**
- **ALUMON#4 Sockeye Adult Enumeration**
- **ALUMON#5 Water Temperature**
- **ALUMON#6 Kokanee Age Class Structure**
- **ALUMON#7 Archaeological Monitoring**

October 15, 2009

Alouette Project Monitoring Program Terms of Reference

1.0 OVERVIEW

This document presents Terms of Reference for both the fisheries and archaeological monitoring programs recommended by the Alouette Water Use Plan Consultative Committee and required per the 20 October 2009 Water Act Order issued by the Comptroller of Water Rights (Table 1). These monitoring programs involve effectiveness monitoring to assess the response of the aquatic environment to licenced BC Hydro operations as well as monitoring to assess the effects of BCH operations on archaeological sites situated within the drawdown zone of the Alouette Lake Reservoir and a section of the South Alouette River.

Table 1. Alouette Fisheries and Archaeological Monitoring Plan Terms of Reference Submission Information

Name of Monitoring Program	Order Clause Fulfilled	Submitted with this Package	Previously Submitted To CWR	Submission Date	Leave to Commence
ALUMON#1 Smolt Enumeration	Section 16.a	Yes	No	20 Oct 2009	-
ALUMON#2 Kokanee Out-migration	Section 16.b	Yes	No	20 Oct 2009	-
ALUMON#3 Substrate Quality	Section 16.c	Yes	No	20 Oct 2009	-
ALUMON#4 Sockeye Adult Enumeration	Section 16.d	Yes	No	20 Oct 2009	-
ALUMON#5 Water Temperature	Section 16.e	Yes	No	20 Oct 2009	-
ALUMON#6 Kokanee Age Class Structure	Section 16.f	Yes	No	20 Oct 2009	-
ALUMON#7 Archaeological Monitoring	Section 16.g	Yes	No	20 Oct 2009	-

Fisheries Monitoring Program Terms of Reference

1.0 INTRODUCTION

As the Alouette Lake Water Use Plan (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.

The framework for WUP process requires that it be reviewed on a periodic and ongoing basis. Therefore, in the years subsequent to the implementation the WUP, there will be a need for compliance monitoring and effectiveness monitoring to gain the information necessary to address these uncertainties. Compliance monitoring consists of monitoring activities to ensure that BC Hydro complies with the conditions of its water license. Effectiveness monitoring is more complex. It involves the observation, measurement, and evaluation of streamflows, fish and wildlife habitat, and population changes to test the efficacy of the WUP.

Effectiveness monitoring for the Alouette Lake system will require the collection of data in order to quantify relationships between specific fish population parameters and different aspects of BC Hydro operations. Monitoring will assess whether a predicted biological response to changes in operations actually occurred as predicted, and thereby assess whether the objectives of greater abundance and/or diversity were met.

2.0 OVERVIEW

At the conclusion of the Alouette Lake WUP Review process, the Consultative Committee (CC) recommended several key changes to the way Alouette Dam is operated. They are believed to have at least some impact to the ecology of resident fish species. The proposed changes are in addition to the operational changes made in 1996 as part of the original water license review process:

1. Spring surface release starting April 15 and ending June 14.
2. A higher reservoir elevation (122.5) during the peak recreation season starting June 15 and ending Labour Day (September 5).
3. Short recreation shoulder season ending Sep 15 when water levels are above 121.25m.
4. Removing the need for a prescribed flushing flow to clear fine sediments

When recommending these operational changes, the CC acknowledged that there was a need for additional fish related information that would add greater certainty to their decision making, but could not be collected at the time of the WUP review process or had to be monitored *in situ* to confirm their assumed consequences. In particular, the CC identified the following critical uncertainties:

1. Long term impact on Alouette River smolt output
2. Success of surface release in allowing kokanee to leave to reservoir and begin their seaward migration.
3. Long term impact on the transport of fine sediments in Alouette River.
4. Success of the kokanee re-anadromisation initiative, and hence an evaluation of the need for the surface release.
5. Water temperature impacts on the Alouette River.
6. Long term impact on the kokanee reproductive success.

In addition to the uncertainties above, the CC also recommended that an Alouette Monitoring Review Committee be created to oversee the general progress of the monitor, review all reports before general release, and recommend changes regarding the monitoring program's implementation as deemed necessary. Committee membership is to include representatives from BC Hydro, BC Ministry of Environment, Fisheries and Oceans Canada, Katzie First Nation, District of Maple Ridge, and Alouette River Management Society.

3.0 COST

The total cost of the 7 year monitoring program, including year 1 (2008) and a component of year 2 expenditures through July 2009, is estimated to be roughly \$1,316,879 (in 2006 dollars). When incorporating a future annual inflation rate of 2%, the anticipated cost of the program is expected to be closer to \$1,437,623. Average annual cost for the remaining 5 full implementation years is expected to be \$185,258 (in 2006 dollars), but will vary between \$172,107 and \$203,909 depending on the tasks to be completed or the equipment to be purchased.

ALUMON-2

Kokanee Out-migration

1.0 PROGRAM RATIONALE

1.1 Background

In the early spring of 2005, a $3 \text{ m}^3\text{s}^{-1}$ test surface release from the Alouette Dam was carried out to determine whether stocked coho smolts would cue to the surface currents near the gate and migrate out of the reservoir. The unexpected result was an out migration of kokanee smolts, prompting the CC to recommend the surface release be done annually with the expectation this could re-establish an Alouette River sockeye run extirpated since the mid 1920 following impoundment of the reservoir. Because of uncertainty in run timing, the CC recommended that the surface release be carried out for a period of 8 weeks. To shorten the duration of this release, and hence reduce the flood risk that it entails, the CC also recommended that a monitor be implemented to identify the typical start of the out-migration run, its duration, and identify its peak.

The FTC expressed uncertainty in whether the magnitude of the release would be sufficient to promote migration among all smolts driven to move seaward. To address this uncertainty, an experimental post-surface release flush was proposed every second year for the duration of the monitor to determine whether additional migrants could be induce to move out of the reservoir with a doubling of flows. The post-surface release flush will consist of a $6\text{-}9 \text{ m}^3\text{s}^{-1}$ release from the spillway gates lasting a period of 7 days following the tail end of the out migration period as determined by a downstream smolt enumeration monitor (located adjacent to the confluence of Mud Creek). The total duration of the surface release regime is not to exceed the 8 week period identified above.

A possible ancillary benefit of the surface release is a cue for the out-migrating kokanee to continue their seaward migration out of the Alouette system. The CC recommended a monitor to test this hypothesis as well, but this is considered part of monitor 1, as it entails the use of downstream traps located at the 224th and 216th St Bridges.

1.2 Management Questions

The FTC identified three management questions that are to be addressed through the kokanee out-migration monitor:

1. Is the surface release of at least $3 \text{ m}^3\text{s}^{-1}$ from the Alouette Dam (obtained through the spillway gate) adequate to promote the downstream migration of kokanee smolts out of the Alouette Reservoir?

2. Does a post-surface release flush of $6-9 \text{ m}^3\text{s}^{-1}$, lasting 7 days following the tail end of the out migration period, encourage more smolts to leave the system?
3. How long should the surface release last to ensure out migration of all smolts prepared to leave the system?

1.3 Summary of Hypotheses

The management questions identified in section 1.2 are to be addressed through tests of the following set of hypotheses. Management Question 1 is to be addressed through the following hypothesis statement.

H₀1: The seaward movement of kokanee smolts, as identified from rotary screw trap data collected at the confluence of Mud Creek, has a start, peak and end that is characteristic of kokanee/sockeye smolts found in other coastal systems (e.g. Cultas Lake stocks).

For Management Question 2, the following hypothesis is to be tested;

H₀2: The seaward movement of kokanee smolts, as identified from rotary screw trap data collected at the confluence of Mud Creek, has a second start, peak and end (i.e., a bimodal out migration pattern) during those years when a post-surface release flush of $6-9 \text{ m}^3\text{s}^{-1}$ is implemented. (The post-surface release flush will be implemented on average every two years)

Management question 3 will be addressed through a weight of evidence approach that considers the results of the two hypotheses identified above, the start, peak and end dates of the migration period, the duration of the surface release, the results of the downstream movement pattern assessment in Monitor 1, and the smolt out-migration data of other coastal systems. This will form the basis for an alternative surface release regime to be considered at the next WUP review in 2014.

1.4 Key Water Use Decision

The kokanee out-migration monitor is linked to the effectiveness of the surface release operation designed to promote the seaward movement of kokanee smolts out of the Alouette Reservoir. Management question 1 and hypothesis H₀1 is concerned primarily with whether the operation consistently results in this seaward movement every year, and contributes valuable information concerning the duration and shape of the release. Management question 2 and H₀2 is designed to test the utility, and hence need, for a post surface release flush where the outflow through the spillway gate is doubled or more for a period of one week. It also is designed to provide valuable information concerning the duration and shape of the release regime, which will collectively be used to design an alternative surface release regime (if necessary) for consideration at the next WUP review in 2014.

2.0 PROGRAM PROPOSAL

2.1 Approach

The general approach to the monitor will be to install and operate a rotary screw trap in the vicinity of the Mud Creek confluence and using sand bags to deflect more water towards the trap as necessary. The trap will be operated for the duration of the spring $3 \text{ m}^3\text{s}^{-1}$ surface release and post-surface release flush of $6\text{-}9 \text{ m}^3\text{s}^{-1}$, starting April 15 and ending June 15. Fishing procedures for the trap, including general maintenance, trap efficiency estimation and catch sub-sampling will be identical to that used in the downstream rotary screw trap below the 224th St. Bridge. In addition, a sub-sample of the catch (maximum 20 individuals) will be held for stock identification through genetic analysis, which will be carried out at the Pacific Biological Station laboratory in Nanaimo, BC.

2.2 Objective and Scope

The objective of this monitor is to collect the data necessary to test the hypotheses outlined in Section 1.3 and hence, address the management questions presented in Section 1.2. The following aspects define the scope of the study:

1. The study area will consist primarily of the riverine habitat located downstream of the Alouette Lake Reservoir to the confluence of Mud Creek, where a rotary screw trap will be installed and fished for the duration of the surface release period.
2. The monitor will be carried out annually until the next WUP review period (2014)
3. Part of the monitor in year 1 will consist of a literature review on kokanee/sockeye out-migration behaviour in coastal lake systems, including a collation of known out-migration timing data.
4. The scope of this monitor should include provision to collect a yearly sub-sample of kokanee smolts (maximum 20 individuals per year based on price of \$100 per sample) for genetic analysis to clearly define Alouette stock membership. The analysis be done at Pacific Biological Station laboratory in Nanaimo, BC
5. A data report, include a detail executive summary and short presentation, will be prepared annually summarising the data collected to date, as well as discuss inferences and present conclusions as they pertain to the impacts of the WUP over time. The year 1 report will include a summary section on kokanee out-migration behaviours in coastal lake systems.
6. A final report will be prepared at the end of the monitor that summarises the results of the entire monitoring program, discusses inferences that can be drawn

from the data pertaining to the impacts of the WUP over time, and presents conclusions concerning the hypotheses and the management question in Section 1.2. Included in the conclusion will be a proposal for an alternative surface release regime should it be deemed necessary.

2.3 Methods

2.3.1 Field Methods

Field methods will follow that described in Cope (2005) so that all data collected will be consistent with prior years of monitoring. This includes the following elements:

1. Use of a single 1.5m rotary screw trap located in the vicinity of the Mud Creek confluence. Installation is to include the appropriate use materials such as sand bags to improve volume and direction of flow to the trap. It will be fished continuously for the duration of the spring release period (April 15 to June 14, or earlier depending the results of the monitor).
2. The traps will be maintained and adjusted as required to ensure consistent trapping conditions through time.
3. Gear efficiency will be determined twice weekly using caudal fin clipped smolts released far enough upstream to ensure adequate dispersion in the system.
4. Fish morphology data will not be collected (it will be collected as part of Monitor 1).
5. Collection and preservation of a sub-sample of the catch (maximum 20 individuals per year based on price of \$100 per sample) to be kept for stock identification through genetic analysis, which carried out at the Pacific Biological Station laboratory in Nanaimo, BC (to be used on Monitor 5)
6. All incidental catches from upstream studies will be noted.

2.3.2 Safety Concerns

A safety plan will have to be developed for all aspects of the study in accordance to BCH procedures and guidelines. It is important to note that monitor must always be carried out by crews of at least two members, that appropriate safety equipment is available at the site, and that appropriate check-in and checkout procedures are followed.

2.3.3 Data Analysis

All data will be entered into a common database in a standard format for analysis. This will ensure that all data collected over the years on monitoring are compatible and can be analysed with transformation.

Hypotheses will be tested by comparing plots cumulative distributions of migrant count data over time. The comparisons will be largely descriptive in nature, but may incorporate formal statistical procedures where warranted (e.g., comparisons of 50 %-tile values or goodness-of-fit tests that compare whole distributions) (Zar 1974).

2.3.4 Reporting

Project reporting will consist of annual data reports and a comprehensive final report at the conclusion of the monitor. The annual data reports will summarise the year's findings and include a short discussion of how the year's data compare to that collected in previous years. It will include a brief description of methods, present the data collected that year, and report on the results of all analyses.

At the conclusion of the monitor, a final comprehensive report will be prepared from all of the annual reports written to date that:

1. Re-iterates the objective and scope of the monitor,
2. Presents the methods of data collection,
3. Describes the compiled data set and presents the results of all analyses, and
4. Discusses the consequences of these results as they pertain to the current WUP operation, and how it may or could factor into future decision making.

All reports will be submitted to regulatory agencies for review and comment prior to being finalised for general release.

2.4 Interpretation of results

Results of this monitor are linked directly to the utility and value of the proposed spring surficial release operation designed to promote the seaward migration of kokanee smolts. Rejection of H_01 would suggest that the pattern, timing and or magnitude of release may be insufficient to promote the expected 'normal' pattern of emigration experienced in sockeye salmon stocks elsewhere. It should be noted that this response could also be the result of a loss in propensity for migration among the Alouette Kokanee stock, and may not be related to the pattern of release. It is hoped that there would be sufficient inter-annual variability in the patterns of surficial release that the latter alternative hypothesis can be tested.

Test of hypothesis H_02 , would also provide valuable information to help assess the stock's propensity for migration. Rejection of H_02 would suggest that the pattern of migration is relatively insensitive to the range of surface release conditions experienced at the dam. This combined with a rejection of H_01 would suggest that there may be a reduction in propensity to emigrate since that dam was impounded almost than 80 years ago. Conversely, it may be inferred that the range of surficial releases at the dam is inadequate to promote and sustain high levels of seaward migration among the Alouette kokanee population.

When combined with the acceptance of H_01 , rejection of H_02 would indicate a lack of sensitivity to the nature of the surface release, that the post surface release flush is unnecessary and can be abandoned at the next WUP review period (provided that the results of Monitor 1 are consistent with this as well).

Given the range of surface release patterns experience on the river, along with the corresponding pattern of migration response, there may be sufficient information to develop an alternative more efficient surface release pattern for consideration at the next WUP review period.

2.5 Schedule

The kokanee smolt enumeration program will be carried out annually commencing 2008 until the next WUP review period in 2014. Enumeration will begin in the second week in April and continue until roughly the last week in May to coincide with the spring surface release operation. A data report and executive summary of the year's data will be due the 1st week of February the following year. The final report will be due just prior to the start of the next WUP review process in 2014, though the precise due date will be set at BC Hydro's discretion.

2.6 Budget

The total cost of the 7-year kokanee out-migration monitor, including 2008 (year 1) through July 2009 (year 2) expenditures of \$70,985 is estimated to be \$311,858 in 2006 dollars and assumes that it will be carried out in coincidentally with Monitor 1 to reduce costs. Taking into account an average inflation rate of 2%, the total cost is expected to be closer to \$270,833 over the remaining 6-year period. The average annual cost of the monitor, not taking into account inflation, is expected to be about \$43,960 per year.

Genetic analysis assumes a price of \$100 per sample for a total genetic analysis budget of \$16,000 for the seven year period. This price could not be verified at the time this terms of reference was written. Should the price differ for the assumed value, the number of samples collected and analysed will be adjusted accordingly.

2.7 References

Cope, S. 2005. Alouette River Salmonid Smolt Migration Enumeration: 2005 Data Report. *Prepared by Westlope Fisheries Ltd. for the Alouette Management Committee and BC Hydro Generation.* September 2005. 48 pp.+ App.

Zar, J.H. 1974. *Biostatistical Analysis.* Prentice-Hall, Inc. Englewood Cliffs, N.J. 620 pp.