Alouette Water Use Plan

Monitoring Programs

Annual Report: 2011

Implementation Period: May 2010 to April 2011

- 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 Structure Analysis
- ALUMON-7 Archaeological Monitoring

For Water Licences 124724, 124725, 124726

May 27, 2011
BC Hydro Alouette Water Use Plan
Monitoring Programs Summary Report: 2011

1 Introduction

This document represents a summary of the status and the results of the Alouette Project Water Use Plan (WUP) monitoring programs to 30 April 2011, as per the Alouette Project Order under the Water Act, dated 20 April 2009. There are seven monitoring programs:

a) ALUMON-1 Smolt Enumeration
b) ALUMON-2 Kokanee Out-migration
c) ALUMON-3 Substrate Quality
d) ALUMON-4 Sockeye Adult Enumeration
e) ALUMON-5 Water Temperature
f) ALUMON-6 Kokanee Age Structure Analysis
g) ALUMON-7 Archaeological Monitoring

2 Background

The water use planning process for BC Hydro’s Alouette storage/hydroelectric project was initiated in May 2005 and completed in May 2006. The conditions proposed in the WUP for the operation of the project reflect the August 2006 recommendations of the WUP Consultative Committee (CC).

In April 2006, as a component of the Alouette Water Use Plan, the draft TOR for the fisheries component of the Alouette WUP monitoring program was confirmed by the WUP fish technical committee (FTC) including Fisheries and Oceans Canada (DFO), Ministry of Environment (MOE), Katzie First Nation, City of Maple Ridge, BC Corrections (Alco Hatchery) and Alouette River Management Society.

On 20 November 2007 the Alouette WUP Monitor Committee including DFO, Ministry of Environment, Alouette River Management Committee, Katzie First Nation, City of Maple Ridge, and BC Corrections (Alco Hatchery) and local stewards met to confirm the draft TOR for the fisheries component of the Alouette WUP monitoring program with full endorsement provided based on minor revisions to the Sockeye Adult Enumeration and Smolt Enumeration TOR.

In January 2008 BC Hydro committed to the Alouette Monitoring Committee (AMC) that all recommended WUP monitoring programs including the Archaeology monitoring would be implemented in 2008 to ensure continued progress of the Alouette Sockeye Restoration Program which is contingent on three of the recommended WUP monitoring programs as well as to stay within the originally committed seven year review period through 2014.

In an attempt to facilitate the Comptroller of Water Rights (CWR) TOR review process, on 22 January 2008 BC Hydro forwarded the draft TOR for the fisheries
components of the Alouette WUP monitoring program to the CWR for consideration given impending Order issue and communicated CWR work load issues. BC Hydro acknowledged that no TOR leave to commence would be provided from the CWR until after the Alouette Order was issued.

The TOR for the WUP recommended Archaeology Monitoring was accepted by Katzie FN in January 2009 and the BC Archaeology Branch in November 2008.

In April 2009, BC Hydro submitted a revised Alouette WUP to the CWR.

On 21 April 2009, BC Hydro was ordered to implement the conditions proposed in the Alouette WUP and submit monitoring programs TOR as well as provide a summary of WUP monitoring work done to date.

Based on initial AMC TOR endorsement in November 2007, a further seven minor revisions to the fisheries component TOR including both budget increases and methodology changes were accepted by the AMC between September 2008 and September 2009.

On 19 October 2009 the Alouette WUP monitoring programs TOR were submitted to the CWR for review and approval.

On 16 November 2009, the CWR accepted the TOR for the Smolt Enumeration, Kokanee Out-migration, Substrate Quality, Sockeye Adult Enumeration, Water Temperature, Kokanee Age Structure Analysis, and Archaeological Monitoring.

On 27 September 2010, the Comptroller accepted the TOR addendums for the Smolt Enumeration and Kokanee Out-migration including revised implementation budgets accounting for cost increases related to fish trap safety upgrades and labour support.

The Order will be implemented until 2014, when BC Hydro will assess the results of the monitoring programs and merge the Stave and Alouette into a single Water Use Plan that better reflects the integrated nature of the Alouette, Stave Falls, and Ruskin hydroelectric power developments.
3 Status

The following table outlines the status and schedule for the Alouette WUP monitoring programs.

Table 3-1: Status of Alouette WUP Monitoring Programs Implementation.

<table>
<thead>
<tr>
<th>Monitoring Program</th>
<th>2008 WLR Yr1</th>
<th>2009 WLR Yr2</th>
<th>2010 WLR Yr3</th>
<th>2011 WLR Yr4</th>
<th>2012 WLR Yr5</th>
<th>2013 WLR Yr6</th>
<th>2014 WLR Yr7</th>
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</thead>
<tbody>
<tr>
<td>Smolt Enumeration</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>U/W</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Kokanee Outmigration</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>U/W</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Substrate Quality</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>U/W</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Sockeye Adult Enumeration</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>U/W</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Water Temperature</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>U/W</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Kokanee Age Class Structure Analysis</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>U/W</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Archaeological Monitoring</td>
<td>DEL</td>
<td>✓</td>
<td>✓</td>
<td>U/W</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend: ■ = Project to be undertaken/initiated in identified year
U/W = Project is underway
DEL = Project is delayed for this year
✓ = Project is complete for the year

Footnotes:
1. Programs initiated prior to receipt of monitoring program leave to commence from CWR.
2. Archaeological Monitoring delay until 2009 based on delayed TOR approval by Katzie First Nation and BC Archaeological Branch

4 Summary of Alouette WUP Monitoring Programs

This section provides a summary of the Alouette WUP monitoring programs as per the Order under the Water Act dated 20 April 2009. The following table summarizes the monitoring programs results according to the key monitoring indicators for each program.
<table>
<thead>
<tr>
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<tr>
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<tr>
<td>Smolt Enumeration</td>
<td>(a) Coho Smolt Density (Production)</td>
<td>1,400 smolts/km³</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>1,473 (16,200)</td>
<td>931 (10,234)</td>
<td>1,818 (20,003)</td>
<td>1,253 (13,786)</td>
<td>1,100 (12,102)</td>
<td>1,799 (19,358)</td>
<td>1,534 (16,880)</td>
<td>1,183 (13,020)</td>
<td>1,359 (14,651)</td>
<td>276 (3,040)</td>
<td>562 (6,568)</td>
<td>3,651 (40,156)</td>
<td>1,806 (19,885)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(b) Steelhead Smolt Density (Production)</td>
<td>418 smolts/km³</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Low Capture</td>
<td>164 (1,803)</td>
<td>308 (3,392)</td>
<td>208 (2,286)</td>
<td>343 (3,768)</td>
<td>215 (2,364)</td>
<td>305 (3,356)</td>
<td>227 (2,490)</td>
<td>Low Capture</td>
<td>Low Capture</td>
<td>Low Capture</td>
<td>Low Capture</td>
<td>564 (6,204)</td>
<td>563 (6,191)</td>
<td>1,375 (15,130)</td>
</tr>
<tr>
<td></td>
<td>(c) Chum Fry Production</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>8.3M</td>
<td>13.4M</td>
<td>6.8M</td>
<td>4.3M</td>
<td>15.6M</td>
<td>54.3M</td>
<td>10.1M</td>
<td>5.5M</td>
<td>15.6M</td>
<td>54.3M</td>
<td>5.5M</td>
<td>15.6M</td>
<td>54.3M</td>
<td>5.5M</td>
<td>15.6M</td>
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<td></td>
<td>(d) Pink Fry Production</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>65K</td>
<td>N/A</td>
<td>190K</td>
<td>N/A</td>
<td>143.3K</td>
<td>N/A</td>
<td>1.25M</td>
<td>N/A</td>
<td>175.6K</td>
<td>N/A</td>
<td>279.2K</td>
<td>N/A</td>
<td>118,068</td>
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<td>Kokanee Outmigration</td>
<td>Number of Outmigrating Kokanee Smolts</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>7,900</td>
<td>5,064</td>
<td>62,923</td>
<td>8,257</td>
<td>4,287</td>
<td>14,201</td>
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<tr>
<td>Substrate Quality</td>
<td>Substrate Quality (areal fraction of fine sand &lt; 2mm)</td>
<td>20%</td>
<td>31</td>
<td>16</td>
<td>13</td>
<td>12</td>
<td>17</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>20</td>
<td>10</td>
<td>9</td>
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<td>12</td>
<td>16</td>
<td>10</td>
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<td>Sockeye Adult Enumeration</td>
<td>Number of Returning Adult Sockeye</td>
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<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
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<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>28</td>
<td>54</td>
<td>45</td>
<td>115</td>
</tr>
<tr>
<td>Water Temperature</td>
<td>(a) Number of days with temperatures &gt; 25 (Degrees Celsius)¹</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
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<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(b) Number of days with daily average temperatures &gt; 16 (Degrees Celsius)²</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
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<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>28</td>
<td>61</td>
<td>92</td>
<td>71</td>
<td>67</td>
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<tr>
<td>Kokanee Age Class Structure Analysis</td>
<td>kokanee Fry Abundance</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
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<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>Not Studied</td>
<td>230,000</td>
<td>130,196</td>
<td>120,668</td>
<td>121,149</td>
</tr>
</tbody>
</table>

1. Monitoring as per 1996 Alouette Water Use Plan recommendations.
2. Monitoring as per 2006 Alouette Water Use Plan recommendations.
5. Fisheries and Oceans Canada (2007) estimated Alouette River maximum chum fry production.
6. Fisheries and Oceans Canada (2007) estimated Alouette River maximum pink fry production based on historic escapement records. Note odd year pink salmon spawning cycle.
8. Upper lethal temperature threshold for stream dwelling juvenile salmonids.
9. Average upper sustained temperature threshold for stream dwelling juvenile salmonids.
11. Steelhead smolt density likely biased by the low recaptures in 2010.
4.1 ALUMON-1 Smolt Enumeration

4.1.1 Management Questions

The key management questions addressed by this monitoring program are:

1) Is the average base-flow release of 2.6 m³s⁻¹ from the Alouette Dam (obtained by fully opening the low level outlet) adequate to sustain or improve current levels of salmonid smolt production downstream of the dam?

2) Following their migration out of Alouette Lake, do the kokanee smolts immediately continue their migration out of the Alouette River or do they delay their seaward migration for a period of time?

3) Using chum salmon counts at the Alco Park Hatchery as an indicator of run strength and the results of the substrate quality monitor, is there evidence of a persistent, declining trend in egg to smolt survival that would suggest a degrading condition in spawning substrate quality?

4.1.2 Overview

Monitoring Indicator (a) smolt production (coho, steelhead, pink, chum, chinook)

Monitoring Indicator (b) Kokanee smolt migration timing (Mud Creek trap downstream to 224th trap locations)

Monitoring Indicator (c) Chum egg to smolt survival

This monitoring program is comprised of several study components involving:

- Instream trapping of fry and smolt outmigrating from the Alouette River; and
- Observations of salmon adults returning to spawn

4.1.3 Status

This program commenced in 1998 as a component of the initial 1996 Alouette WUP commitments. As a result, it is in its fourteenth year of full implementation. The 2010 study program report¹, which is a summary of studies between 1998 and 2010, was submitted in March 2011. The 2011 study program report is due for submission in March 2012 and will be submitted with the 2012 Annual Report.

4.1.4 Interpretation of Data

The 2010 chum fry out-migrant estimate was 10.08 million fish. This represents a decrease of (300%) in fry production for this cycle-year. Low fry production following very high spawner escapements are evidence of density dependent mortality (i.e., evidence of a plateau or decline in recruitment) as a result of degraded habitat conditions including water quality and redd superimposition. These results indicate the 2007 and 2010 years represent over-escapement and maximum chum fry production would be achieved in the range of 60,000 to 100,000 chum spawners at the Alco Hatchery fence.

The 2010 pink fry out-migrant estimate was 118,068 fish. The current emigrating pink fry estimate represents a decrease of 58% over the last year (2008) and was the second lowest ranked year since 1998. It is likely that pink egg-to-fry survival was impacted by the very high chum spawner escapement.

The 2010 sockeye smolt out-migration estimate was 8,143. This represents 57% of the upstream estimate at Mud Creek (14,201 sockeye smolts) and was consistent with expectations. It is clear from the time difference of only a day or two in out-migration peaks or pulses between the two trapping locations that sockeye smolts, following their emigration from Alouette Reservoir, continue their migration out of the Alouette system without delay. Furthermore, the 6 m$^3$s$^{-1}$ flushing flow dam releases in 2009 and 2010 did not “flush out” reluctant sockeye migrants residing within the South Alouette River.

Increased flow releases, stocking, and restoration efforts within the Alouette River have resulted in the following salmon restoration milestones:

- Prior to 1975, the South Alouette River stock of chum salmon was reduced to average run sizes less than 3,000 spawners. Substantial increases were first noted in the early 1980s, partly due to the returns from the Alco Hatchery. This stock has continued rebuilding to spawning escapements well in excess of 200,000 fish. Egg-to-fry survival now appears to be variable indicating the Alouette River has hit the point of significant density-dependent mortality during high escapement years.

- Prior to 1985, the Alouette River stock of pink salmon was considered extinct. This stock had been re-building to run sizes that range between 4,500 to 20,000 spawners.

- Chinook salmon have re-colonized the Alouette River and a small but stable trend of successful spawning, incubation and out-migration of smolts has been documented.

- While characterized by variability, annual coho smolt production estimates are in the 20,000 smolt range. The 2010 coho smolt out-migration estimate of 19,885 met expectations. The 13-year average coho out-migration estimate is 15,828 smolts.

- Before 2008, annual steelhead smolt production estimates were typically in the 3,000 smolts range. In 2008 and 2009, after moving the trapping location to
improve trap efficiency, the annual steelhead smolt estimates increased to 6,000 smolts. The 2010 estimate of 15,130 smolts is approximately twice that which was expected and was a direct result of the low recaptures in 2010. The mean trap efficiency of 3.7% was inconsistent with previous years trap efficiency at this location (2008=11.1%, 2009=12.0%). Irrespective of the uncertainty in the 2010 estimate, results suggest steelhead smolt production in the South Alouette River is exceeding expectations and may have increased in recent years.

Moving the rotary screw trapping location upstream to 224th St. and incorporating efficiency or flow deflection panels, both undertaken in 2008, has proven successful in restoring smolt catch success. These results demonstrate the declines in coho and steelhead smolt out-migration in 2006-07, and perhaps, the more subtle declines since 2003, were an artifact of trapping bias due to the increasing effect of backwatering from the tidal influence of the Pitt River at the 216th St. location.

4.2 ALUMON-2 Kokanee Outmigration

4.2.1 Management Questions

The key management questions addressed by this monitoring program are:

1) Is the surface release of at least 3 m$^3$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 m$^3$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?

4.2.2 Overview

Monitoring Indicator (a) Number of outmigrating kokanee smolts.

This monitoring program involves instream trapping of smolts outmigrating from the system.

4.2.3 Status

Supporting program data was collected from 2005 through 2007 by the BC Hydro Bridge Coastal Restoration Program as a component of an Alouette sockeye restoration initiative to assess salmonid smolt passage response with spill releases in the order of 3 m$^3$s$^{-1}$ over the Alouette Dam. In 2006 the kokanee outmigration monitoring program was confirmed as a component of the Alouette WUP recommended monitoring program. As a result, it is in its seventh year of implementation. The 2010 study program (WUP monitor Year 3) report$^2$, which is a

$^2$ Mathews, M., Bocking, B. 2011. Evaluation of the Migration Success of O. nerka (Kokanee/Sockeye) from the Alouette Reservoir, 2010. Prepared for BC Hydro, Burnaby, BC.
summary of studies between 2005 -2010, was submitted in April 2011. The 2011 study program report is due for submission in April 2012 and will be submitted with the 2012 Annual Report.

4.2.4 Interpretation of Data

In 2010, 4,600 kokanee were captured in the Alouette River as they migrated from the Alouette Reservoir, and an estimate of 15,434 was calculated for the period of 16 April to 24 May. This is the second largest estimated since monitoring began in 2005.

Spillway gate flows were maintained between 2.98 and 4.45 m3/s from 15 April to 25 May, and were comparable to the flows maintained during the previous years of full migration monitoring.

The 2010 run timing followed a similar trend as previous years, beginning mid April and tapering off at the end of May; the 2009, 2007 and 2006 migration continued approximately an additional week after the 2010, 2008 and 2005 migrations tapered off. The 2010 migration began with the highest first day catch recorded of all years, indicating the migration may have started earlier had the spillway been open. The peak in 2010 occurred early in the migration (24 April) which was very close to the 2008 peak (23 April) and comparable to the 2007 peak (30 April) but significantly earlier than the 2009 peak (18 May).

2010 was the first year of successful monitoring of a post-surface release flush at the spillway with the flush maintained for the full seven days scheduled, reaching maximum flows of 7.32 m3/s. Only one unmarked kokanee was captured during the seven day period; however catches of steelhead and coho smolts continued, indicating the RST was fishing effectively for salmonids during the heavy flows.

4.3 ALUMON-3 Substrate Quality

4.3.1 Management Questions

The key management questions addressed by this monitoring program are:

1) Do the results of the Toe-Pebble count procedure reflect the general composition of bed materials within the channel downstream of the Alouette Dam?

2) Is the < 20% fines threshold adequate to distinguish a state in substrate quality that would require a prescribed flushing event?

3) Is an alternative methodology required to qualify/calibrate the results of the Toe-Pebble count procedure?

4) For each year of the monitor, is a prescribed flushing flow necessary given the current state of substrate quality?
4.3.2 Overview

The objective of this program is to assess Alouette River substrate quality considering underlying management questions to evaluate the general composition of bed material and to confirm the threshold of fine sediments less than 2 mm diameter to maintain productive salmonid habitat. Program findings will be evaluated to confirm the need for an Alouette Dam flushing flow.

Monitoring Indicator (a) Substrate Quality (areal fraction of fine sand < 2 mm)

This program will involve direct instream observations of substrate quality at index sites in the Alouette River.

4.3.3 Status

This program commenced in 1998 as a component of the initial 1996 Alouette WUP commitments. In 2006 the monitoring program was confirmed as a component of the Alouette WUP Consultative Committee recommended monitoring program. As a result, it is in its ninth year of full implementation. The 2010 study program report\(^3\), which is a summary of studies between 1998 -2010, was submitted in March 2011. The 2010 study program report is due for submission in March 2012 and will be submitted with the 2012 Annual Report.

4.3.4 Interpretation of Data

The 2009 Alouette River substrate sampling showed an overall decrease in fine particles less than 2 mm diameter of 6.0% since 2009 with an average of 10% for all monitoring sites. This overall average of 10% in fine particles is well within the 20% threshold for protection of fish habitat in Pacific Northwest Streams. Analyses indicated that the levels of fines in the river declined sharply during the 1995 high water event, and then have remained relatively stable since that time.

As with prior year sampling results, 2010 sampling showed that the amount of spawning gravel sized 16-128 mm diameter increased overall (38-45%).

All observations made during the duration of the Alouette studies have supported the study management question which asks if the < 20% fines threshold is adequate to distinguish a state in substrate quality that would require a prescribed flushing event.

2010 program findings indicate that a directed flush flow could benefit upriver lower velocity sites by removing accumulated fines from certain sections of the lower velocity side habitats. However, these did not appear to be having a negative effect on area salmonids and / or their food sources. In addition, negative sedimentation impacts such as compaction at a level that would hinder or prevent spawning were not encountered at any site. Other assessments that were made during the study, such as examining the abundance and variety of macro invertebrates, strongly suggest that sedimentation is not a limiting factor on salmonid habitat. Accordingly,

\(^3\) Davies, R., 2011 South Alouette River Substrate Monitoring 2010 Data Report. Prepared for BC Hydro, Burnaby, BC.
an Alouette Dam flushing flow was not seen as a critical requirement to enhance fish habitat quality in Alouette River.

Discussion to support study Management Questions 1 and 3, relating to the validity of results provided by the Toe-Pebble count procedure, are provided in the 2008 annual data report. Given the site specific conditions observed at the Alouette River monitoring sites the Toe-Pebble count procedure was confirmed as an acceptable method to reflect the general composition of bed materials within the channel downstream of the Alouette Dam.

4.4 ALUMON-4 Sockeye Adult Enumeration

4.4.1 Management Questions

The key management question addressed by this monitoring program is:

1) Are the Alouette Lake kokanee smolts successfully adapting to an anadromous existence by returning from the ocean environment to spawn in Alouette Lake?

4.4.2 Overview

Supporting objectives of the main study management question include:
1) confirmation that the adult sockeye returns are members of the ‘Alouette stock’ and not strays from other nearby coastal systems, 2) confirmation of the adult sockeye return run timing to allow streamlining of enumeration efforts, and 3) confirmation that ocean survival rates of returning re-anadromised kokanee comparable to that of sockeye stocks found elsewhere.

Monitoring Indicator (a) Number of returning adult sockeye

This program will involve enumeration of adult sockeye captures at the Alco Hatchery fish collection facility.

4.4.3 Status

This program was supported in 2007 by the BC Hydro Bridge Coastal Restoration Program as a sockeye restoration initiative. The monitoring program was further confirmed as a component of the Alouette WUP Consultative Committee recommended monitoring program in 2006. As a result, it is in its fifth year of implementation with the 2010 third year WUP recommended study program report submitted in March 2011. The 2010 study program report is due for submission in March 2012 and will be submitted with the 2012 Annual Report.

4.4.4 Interpretation of Data

The 2010 Alouette sockeye salmon run saw 115 adults returning between July 7 and October 20. This was the highest on record since initiation of monitoring in 2006 and was more than double the previous 2008 peak return of 54.

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With a smolt to adult survival of 1.32% in 2010, the Alouette sockeye run is comparable to other summer-run sockeye in the Fraser River. 2010 saw the return of approximately 34 million sockeye to the Fraser River, which was the largest seen since 1913. The large return was presumed to be based on good ocean conditions.

The 2010 Alouette sockeye return were caught at the Allco Fish Hatchery with 103 released in the Alouette Reservoir. Genetic testing was completed for 112 of the 2010 returning adult sockeye. The results indicated 106 adults were Alouette stock and six adults were Weaver stock. The six sockeye determined to be Weaver stock were the last six sockeye arriving in October.

The 2010 Alouette Sockeye run continues to demonstrate timing comparable to a summer run, arriving in the Alouette Watershed in July and August. The peak of the Alouette sockeye run for 2008-2010 is over last week of July to the first week of August.

Based on three years of continuous spring through fall ALCO fish fence operations the final four years of study implementation will involve fence operation will from mid June through early fall.

### 4.5 ALUMON-5 Water Temperature

#### 4.5.1 Management Questions

The key management questions addressed by this monitoring program are:

1) How often are water temperatures ≥ 25°C, the incipient lethal temperature of most stream rearing salmonid species, including the duration of each event and the frequency of occurrence?

2) Is the duration of observed warm water events less than 1 day, thus limiting exposure to warm waters and therefore thermal stress impacts?

3) Are warm temperature events restricted to certain sections of river, indicating the inflow of cooler waters into system (most likely ground water)?

4) Is the duration and frequency of warm water events such that it would promote a shift in fish community structure and/or reduce summer survival and growth of rearing juvenile salmonids, as indicated by a change in salmonid smolt numbers?

5) Given the extent of thermal stratification in the reservoir and the location of the LLO, is there an operational change that can be implemented to mitigate the occurrence of warm water events.

#### 4.5.2 Overview

The objective of this monitoring program is assess if high summer water temperatures in Alouette River downstream of Alouette Dam approach incipient lethal limits of rearing salmonids that would impact survival and growth during the
summer critical rearing period. A supporting objective includes whether a general increase in stream temperatures shifts fish community structure from a cold-water, primarily salmonid system to a warm-water primarily cyprinid system.

Monitoring Indicators (a) Number of days with temperatures > 25°C

Monitoring Indicators (b) Number of days with daily average temperatures > 16°C

The monitoring program is comprised of continuous temperatures loggers situated in the Alouette Dam forebay as well as four Alouette River downstream locations.

4.5.3 Status

This program commenced in 2001 as a component of the initial 1996 Alouette WUP commitments. The Year 3 WUP recommended program report\(^5\) submitted in April 2011 summarizes the temperature data collected since the beginning of the WUP monitoring program (October 2008) and also summarizes the available data collected earlier through 2001. The 2011 study program report is due for submission in April 2012.

4.5.4 Interpretation of Results

Water temperatures in the plunge pool just downstream of the Alouette Dam generally ranged from a low of about 4°C in December and January and generally increased from February with peak temperatures observed in late August and early September. Water temperatures reached a high of 19°C to 22°C from 2000 through 2010. Weekly mean water temperatures were highest at the end of August and were near 18°C in the summer of 2010. In 2010, the overall mean temperature for August (the warmest month) was highest at the plunge pool site and lower in downstream sites.

The upper lethal temperatures for juvenile salmonids in the range of 25°C has not been approached at any of the Alouette Dam forebay or down river monitoring sites since initiation of monitoring. However, the upper sustained temperatures threshold of 16°C was surpassed throughout the summer in 2010 and all previous monitoring years through 2001.

Of the salmonid species present, the high summer temperatures potentially impact summer rearing coho and steelhead as well as resident trout species. For coho, water temperatures surpassed the upper sustained temperature range for juveniles in August 2010. Steelhead are within the optimum temperature range for adult migration and incubation. The optimum temperature for juveniles is; however, surpassed in August and the upper sustained temperature range is approached for a brief period.

Fish productivity (smolt production) has been relatively stable and increasing over the monitoring period with little correlation observed between high summer water temperatures decreased smolt production. Summer temperature data will continue to

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be assessed to confirm any correlation between smolt production and summer water temperatures.

4.6 ALUMON-7 Kokanee Age Class Structure Analysis

4.6.1 Management Questions

The key management questions addressed by this monitoring program are:

1) Is the existing kokanee population in the Alouette Lake reservoir recruitment limited?

2) If there is evidence of a recruitment constraint to productivity, can it be linked to reservoir operations, in particular the extent of reservoir fluctuation during the spawning and incubation period (deemed to be mid-October to the end of February)?

3) If found linked to reservoir operation, what is the nature of the relationship and can it guide the development of possible mitigative reservoir operations?

4.6.2 Overview

The objective of this monitoring program is to determine if there is any correlation between the extent of Alouette Reservoir fluctuation during the spawning and incubation period and reduced juvenile kokanee recruitment caused by habitat dewatering.

Monitoring Indicator (a) Total kokanee fry production.

This monitoring program is comprised of several study components involving both hydro acoustic assessments and gill netting in Alouette Reservoir:

4.6.3 Status

This program was initiated in fall 2008 as part of the 2006 Alouette WUP recommendations. Year 1 field components were completed in fall 2008 with a final report submitted in April 2010. The fall 2009 and 2010 field components were completed as scheduled in fall 2009 with a 2-year study report submitted in April 2011 and will be submitted with the 2012 Annual Report.

The flexible reporting period for this study is related to BC Ministry of Environment (MOE) study delivery and reliance on hydroacoustic data collected via BC Hydro’s non-WUP, Alouette Reservoir Fertilization program. The submission timing of the report related to the fall 2011 field component has yet to be confirmed with MOE delivery staff.

4.6.4 Interpretation of Data

A model based approach was used to assess whether the Alouette Reservoir kokanee population was recruitment\(^7\) limited and whether reservoir fluctuations during the spawning and incubation period affected subsequent fry and adult abundance. The study utilized a size-at-age model of the kokanee collected from gillnet data from 1998-2010 to determine if the population’s size-at-age is stable or decreasing. In addition, a kokanee stock-recruitment model was developed from hydroacoustic data collected from 2000-2010 to assess if reservoir fluctuations affected fry abundance and whether any drops in fry abundance persisted to affect the numbers of older age classes.

Use of stock recruitment modelling allowed for a preliminary assessment of whether reservoir fluctuations affect fry abundance and whether any drops in fry abundance persisted to affect the numbers of older age classes through time. Analysis of reservoir operations on fry abundance indicated no discernable relationship despite increasing estimates of fry in the reservoir since nutrient addition.

Further assessment of the kokanee population also indicates that the Age 1 kokanee population could potentially be impacted by spring surface flow releases from the Alouette Dam. Spillway releases from the dam during the spring have occurred since 2005 and were implemented to determine the volitional migration success of kokanee smolts from the reservoir. Data suggests that large emigration events similar to that observed in 2007 could have an impact upon the adult kokanee population in the reservoir and warrants continued monitoring of out-migrating kokanee.

In consideration of MOE kokanee monitoring and associated biostandards from other BC large lake systems, the abundance of Alouette Reservoir age 3 adult kokanee appears to be fluctuating within the expected range of 9,000 – 27,000.

Incorporation of more data over the remaining monitoring years will assist in supporting the models for analyses and assessing mechanisms regulating the kokanee population in Alouette Reservoir.

4.7 ALUMON-7 Archaeological Assessment

4.7.1 Management Questions

The key management questions addressed by this monitoring program are:
1) Where are the archaeological sites in the reservoir;
2) What are the relative heritage values of identified sites;
3) What is the nature and extent of the impacts to archaeological sites that are caused by reservoir operations;
4) Are there archaeological resources that are impacted by river flows; and

\(^7\) Recruitment is generally defined as the number of new juvenile fish reaching a size where they can be sampled.
4.7.2 Overview

The objective of this monitoring program is to address a knowledge gap regarding the number, location, elevation, condition, susceptibility to erosion and relative importance of archaeological sites within the Alouette reservoir and Alouette River study area.

Monitoring Indicator (a) N/A

This monitoring program is comprised of several study components involving field survey of the Alouette Reservoir drawdown zone and Alouette River as well as an archival literature review.

4.7.3 Status

This proposed one-year program was initiated in April 2009 as part of the 2006 Alouette WUP recommendations. The 2009 field components are complete with Alouette Reservoir drawdown and Alouette River surveys complete. The program study report8 was finalized in fall 2010.

Based on the short duration of the 2009 Alouette Reservoir drawdown zone exposure further field reconnaissance was recommended in the associated program report. To ensure adequate consideration of the study management questions the continuation of field studies in 2011 was approved. The phase 2 field program will be completed within the approved budget and will include submission of a phase 2 program report in April 2012 and will be submitted with the 2012 Annual Report.

4.7.4 Interpretation of Data

Phase 1 archaeological assessment findings include the identification of three new archaeological sites along the southwest shoreline of Alouette Reservoir and an area of high archaeological potential in the Alouette River between 232nd Street and 216th Street.

A total of eight archaeological sites have been identified within the Alouette Reservoir drawdown zone. The sites have been ranked as having a moderate scientific significance based on the following criteria:

- are fairly rare mid-elevation transitory sites;
- evidence of tool manufacture, variety of tool types and/or contain a significant cultural feature (petroglyph); and
- although the true scientific significance of these sites has been most likely impacted by the erosional forces of the reservoir, there is still a possibility that cultural deposits are under water.

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Recommendations for further study to be addressed through phase 2 investigations include:

1) Further testing of the landscape hypotheses\(^9\) in the Alouette Reservoir;
2) Revisit known archaeological sites at lower reservoir levels;
3) Conduct additional archaeological survey of lands exposed at low reservoir levels;
4) Include studies of culturally significant resources and resource areas such as wapato harvesting areas, fishing locations, trails and alpine hunting locations; and
5) Conduct repeated surveys downstream between 232nd Street and 216th Street on the South Alouette River.

5 Alouette Project WUP Monitoring Programs Costs

The following table summarizes the Alouette Project WUP monitoring programs costs approved by the Comptroller and the actual costs to 30 April 2011.

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\(^9\) Landscape hypothesis: H\(_0\): Landforms with level surfaces or a gentle sloping (~5\%) southern aspect in close proximity (~50 m) to water and fishing resources have greater potential for archaeological sites than areas that do not exhibit these attributes.
## Table 5-1: Alouette Project WUP Monitoring Programs Cost

<table>
<thead>
<tr>
<th>Monitoring Programs</th>
<th>Activity</th>
<th>Costs approved by CWR</th>
<th>Total Forecast (Life to Date Actuals and Forecast)</th>
<th>Variance Total to Approved</th>
<th>Explanation</th>
<th>Corrective Action</th>
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* Red values in parentheses denote overage.