Alouette Sockeye Adult Enumeration Monitor (Bridging Year 2016)

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Prepared for:
Fish and Wildlife Compensation Program

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Executive Summary

Originally, through BC Hydro's Water Use Plan for the Alouette Watershed, a spring surface release from the Alouette Dam has allowed for kokanee/sockeye smolts to migrate to the ocean from 2007 to 2016. The first surface releases occurred in 2005 and in 2007 the first adult sockeye returned to the Alouette Watershed. The 2016 Alouette sockeye salmon run saw 6 adults returning between July 19 and August 7, 2016. All six sockeye were in great condition and were sampled at the Allco trap location before being transported to Alouette Lake. Fork length measurements for all six sockeye were taken along with scale and tissue samples. The measurements indicated an average fork length of 60cm.

Of the 6 scale samples taken by BC Corrections, four were useable for aging with all four of these adults being four years old. One of the remaining two was upside down and could not be read and the other was a partial reading, recording two years spent in the ocean. The genetic sampling identified all adults originated from Alouette stock. Between the return years of 2005-2012, the smolt to adult (return to the hatchery fish fence) survival of the Alouette sockeye has ranged from a low of 0.06% in the 2011 smolt year to a high of 1.33% in the 2008 smolt year. (Mathews et al. 2015).

The peak of the 2016 Alouette adult sockeye return was on 26 July, when 2 fish arrived at the Allco fish fence. Since 2007, up to and including the 2016 season, 318 adult sockeye salmon have returned to the Allco fish fence.

This project aligns with the Fish and Wildlife Compensation Program's Alouette Watershed Coastal Action Plan and the Alouette Salmonid Action Plan. The priorities which are addressed are:

- Sub-objective 1 - Maximize the viability of anadromous salmonids. Compensation requires increasing present biological productivity to offset hydro development-related declines in productivity. There are myriad ways to compensate for fisheries impacts, and some work better for some species than others and some may be more suited to certain physical settings.

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Introduction

During the 2006 review of the Alouette Water Use Plan (WUP), the consultative Alouette Monitoring Committee identified the restoration of an anadromous sockeye salmon run as a key issue in the Alouette River system. Construction of the dam in the 1920's impounded the reservoir and extirpated the sockeye run soon after. As a means of re-establishing the stock, a spring surface release from the dam was integrated into the WUP. The testing of a specific surface release of $3m^3s^{-1}$ from April to June has indeed facilitated kokanee/sockeye out-migration from the reservoir. Since 2005, smolts have successfully out-migrated through the spillway gate during the spring release and to the ocean via the Alouette River (Table 1, Mathews et al. 2015).

Table 1 Estimated number of smolts leaving the Alouette Reservoir during the spring surface release, 2005-2015.

Year of Smolt Migration	Estimated Abundance of Smolts
2005	7,900
2006	5,064
2007	62,915
2008	8,257
2009	4,287
2010	15,434
2011	35,542
2012	728
2013	6,264
2014	2,358
2015	677*
2016	- ◊

**Note: 2015 season did not have the rotary screw trap in operation at the collection site when BC Hydro had a controlled release of water prior to the usual start-up date due to storm events.*

◊Note: 2016 the FWCP funding application was denied to run the rotary screw trap and therefore no smolts were enumerated.

The viability and authenticity of kokanee smolt "re-anadromization" is dependent on the stocks ability to adapt to salt water conditions, to adopt behavioural strategies to compete and avoid predation in an ocean environment, and to recognize and return to their native lake/stream system to spawn (Bocking & Gaboury 2003). Through the original Alouette Adult Sockeye Enumeration monitoring program, sockeye returning to the Alouette River were collected, counted, aged, genetically tested and released into Alouette Lake. In 2007, returning sockeye salmon trapped at the Allco Fish Fence were genetically proven to be Alouette stock (Balcke, 2009).

The main purpose of the original seven year Alouette Adult Sockeye Enumeration monitoring program as funded under BC Hydro's Alouette Water Use Plan was to establish whether out-migrating Alouette Lake Reservoir kokanee/sockeye smolts were capable of adapting to an

anadromous existence. Adaptation is considered successful when sockeye return from the ocean environment to spawn in Alouette Lake. Additionally, the original monitoring program sought to establish the timing and genetic structure of the returning sockeye run and to assess whether ocean survival rates of returning re-anadromized kokanee were comparable to that of sockeye stocks found elsewhere. During the first three years of the program (2008-2010), the Allco Hatchery fish fence was operated from April to December to determine the timing and volume of the run (Crowston & Borick-Cunningham, 2012). Based on the results of these efforts, the following seven years (2011-2016) had a shorter fence operation timeframe, which commenced mid-June through to the fall. Tissue samples for DNA analysis were also collected from all captured sockeye to ensure that returning adults were Alouette stock and not strays from other nearby coastal systems.

Objectives

The 2016 project objectives were to continue the adult enumeration program initially as a bridging year in 2015 between the Alouette Sockeye Adult Enumeration monitoring program (ALUMON#4), as funded by BC Hydro under its Alouette Water Use Plan and the upcoming review of the Alouette and Stave Water Use Plans (expected sometime in 2017). This bridging year would allow continued data collection on the number of adult sockeye returning to the Alouette system and up to the Allco fish fence including completion of another year of genetic sampling. Continued sampling would reinforce the baseline data for sockeye as part of many years of ongoing efforts to re-introduce sockeye into the upper Alouette Watershed (Alouette Watershed – Salmonid Action Plan). The bridging year would include the continuation to trap, enumerate, sample, and with the assistance of the BC Corrections supervisor and crew, transfer sockeye into the Alouette Reservoir.

As discussed in the Plate et al. technical feasibility report (Oct 2014), there have been a variety of monitoring studies including the Alouette Sockeye Adult Enumeration Monitor (ALUMON#4) which have contributed to many years of research and data collection about the genetics, parentage and age of the Alouette adult sockeye (sockanee) returns. These studies were compiled in 2013-2014, along with the Kokanee Outmigration Monitor (ALUMON#2) and other studies, into a technical feasibility report which synthesized all the research done to date on Alouette sockeye and the process needed to be taken to re-establish sockeye in the Alouette Reservoir. This synthesis report outlines and recommends various ways in which sockeye can be brought back to the reservoir including hatchery intervention and speaks to the importance of the ongoing adult enumeration and sampling which will be a vital part of this future work.

Study Area

The South Alouette Watershed (144 km^2), comprised of the South Alouette River and Alouette Lake Reservoir, are located within the communities of Maple Ridge and Pitt Meadows (Figure 1). The site of the Alouette Adult Sockeye Enumeration program is approximately 8 km downstream from the Alouette Reservoir at the Allco Fish Hatchery operated by BC Corrections Fraser Regional Correctional Centre. The hatchery is well positioned to intercept all migrating adult sockeye on their way back to the reservoir.

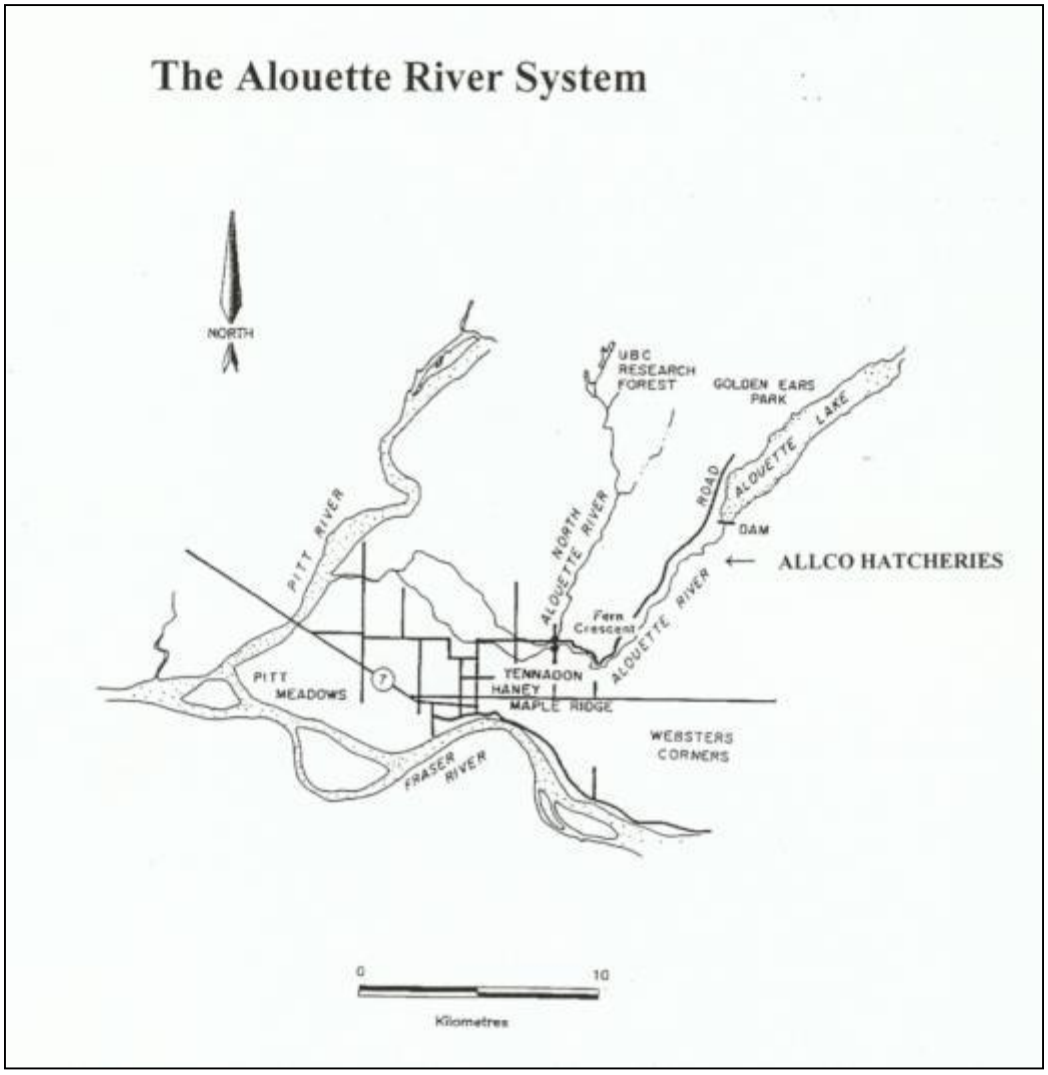

Figure 1 Map of the Alouette Watershed

Methods

From the first year of monitoring in 2008, the adult sockeye run appeared to be a summer run, arriving in the Alouette Watershed in July and August (Balcke, 2009). Taking this into consideration, as well as the maintenance requirements, and downstream steelhead kelt passage, the Alouette Monitoring Committee decided that in both the 2009 and 2010 the fence would be in operation between April and December, rather than year round (Cruickshank, 2010). In 2011, the fence operation was shortened and the monitor began on June 15, 2011. In 2016, although the Allco fish fence went up on June 15, returning sockeye sampling dates commenced on July 19 when the first adult arrived and completed on August 7, 2016 when the last adult arrived. The Allco fish fence went down briefly in late September 2016 but was put back up again in early-mid October when the chum salmon started returning and egg-take operations started. The fence went back down again in January 2017 to facilitate passage of steelhead.

Figure 2 Allco Fish Hatchery fence and trap, April 2016

Figure 3 Allco Fish Hatchery fence and bladder, April 2016

The fish fence was designed to direct sockeye and other salmon into the trap, which was monitored daily in 2016 by BC Corrections staff and crew. In case of a failure at the Allco fish fence, BC Hydro operates a trap at the low level outlet of the Alouette Dam to catch returning sockeye that are not captured at the Allco fence. There were no fish reported in the Hydro trap in 2016.

Figure 4 Sockeye transport tanks, May 2014

For each returning sockeye in 2016, the date of capture and release was recorded. Additionally, fork length measurements and pictures were taken for all returning sockeye. Scale and tissue samples were collected from all six returning adult sockeye (Figure 5 - 8). The tissue and scale samples were sent to the Pacific Biological Station (Department of Fisheries and Oceans) laboratories in Nanaimo, B.C. for genetic analysis and ageing.

Figure 5 Returning sockeye photographed and dated – July 19, 2016

Figure 6 Returning sockeye photographed for sex identification – July 19, 2016

Figure 7 Returning sockeye photographed and dated – July 21, 2016

Figure 8 Returning sockeye photographed and dated – July 23, 2016

Results

Adult Sockeye Returns

A total of six sockeye returned to the Alouette Watershed during the 2016 run (Table 2). Of the six sockeye caught, all appeared in good condition. All six sockeye were sampled and transported to Alouette Reservoir.

Table 2 Number of returned adult sockeye to the Alouette Watershed, 2007-2016

Year of Adult Return	Number of Returned Adults	Number of Adults Released Alive into Alouette Reservoir
2007	28	5
2008	54	53
2009	45	43
2010	115	103
2011	11	8
2012	45	43
2013	10	7
2014	0	0
2015	4	0*
2016	**6**	**6**
Totals	**318**	**268**

*Transported to the Alouette Sockeye Research Facility for holding, all were pre-spawn mortalities.

In 2016, all six sockeye were captured in the Allco fish fence trap. Two adult sockeye were trapped at the fence on July 26.

Fork Length

Fork length measurements were collected for all six returning sockeye. The fork lengths ranged from 58 - 62 cm, with an average fork length of 60.1cm (Appendix A).

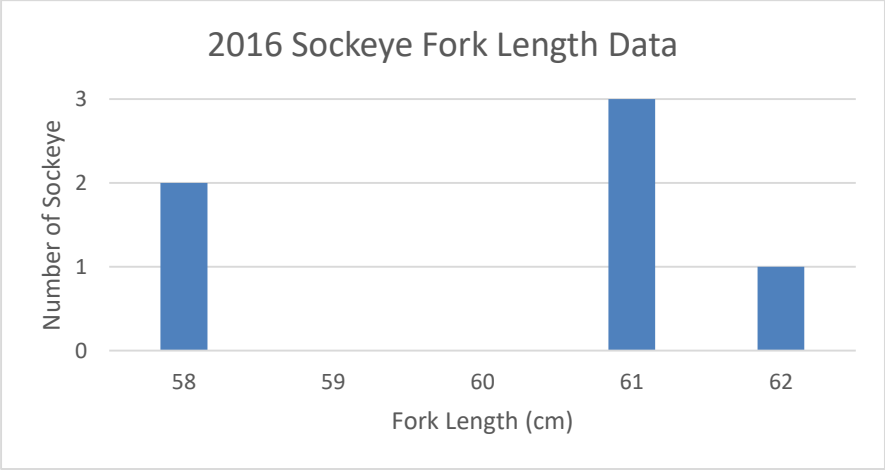

Figure 9 Sockeye fork length measurement for 2016

Age Structure

Scale samples were analyzed from six sockeye to determine the 2016 run age structure. See Godbout, L. 2017. (Appendix A).

Table 3 Age class for Alouette Adult Sockeye 2016 (Godbout, L. et al 2017)

DNA vial/ FISH ID	Origin	Age Field/ PBS
2217	Alouette	4_2
2218	Alouette	4_2
2219	Alouette	NA
2220	Alouette	4_2
2221	Alouette	4_2
2222	Alouette	Partial Reading: 2 years in ocean

Genetic Sampling

Results from this study indicate that all six of the returning adults to the Allco fish fence in 2016 were from the Alouette Lake Reservoir (Godbout, L. et al unpublished 2017). No parental analysis was performed on the 2016 samples.

Smolt to Spawner Survival

Smolt to spawner survival has ranged from a low of 0.063% to a high of 1.332% since 2005 to 2013 smolt migration years (see Table 4). Smolt-to-spawner survival was calculated from age specific estimates of the number of smolts migrating out from the Alouette Lake Reservoir and the number of adults returned to the reservoir (Bob Bocking pers. comm.[1]).

Table 4 Alouette sockeye brood survivals, 2005-2012

Year of Smolt Migration	Survival (smolts:TRS)
2005	0.532%
2006	0.750%
2007	0.081%
2008	1.332%
2009	0.171%
2010	0.292%
2011	0.063%
2012	0.275%
2013	0.065%
2014	-

Discussion

Adult Sockeye Returns

The 2016 Alouette Sockeye run continues to demonstrate timing comparable to a Fraser summer run of Sockeye Salmon, arriving at the Allco Fish Hatchery trapping location in July and August (Figure 10). The peak of the Alouette sockeye run for 2008-2016 is typically over the last week of July to the second week of August.

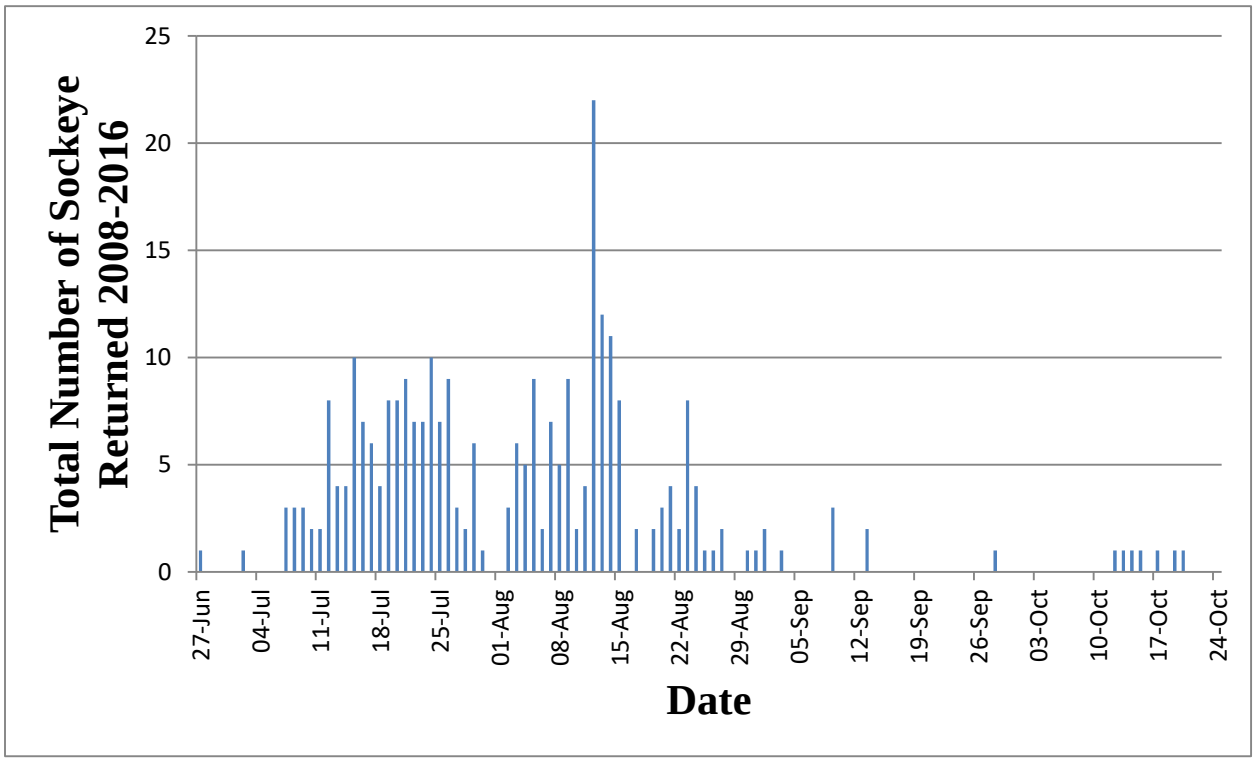

Figure 10 Total number of sockeye returned to Alouette watershed 2008-2016 over the season.

A total of 318 adult sockeye returned to the Allco fish fence during the 2007–2016 runs, of which 268 have been successfully released back into the Alouette Lake Reservoir since 2007. Although the number of total adult sockeye returns is low, the data shows that re-anadromization of kokanee/sockeye to the Alouette watershed is possible.

Fork Length

Measurements were collected for all of the 2016 returning sockeye. This represented a sample size which showed an increase from the previous year in 2015 where four sockeye returned to the Allco fish fence. The average fork length measured in 2016 was 60.1 cm which is the second highest average recorded. (Table 5; Figure 11).

Table 5 Average sockeye fork length, 2008-2016

Year of Adult Return	Number of Adults Measured	Average Fork Length (cm)
2008	54	59.3
2009	15	59.1
2010	115	58.1
2011	10	60.4
2012	42	57.8
2013	8	46.6
2014[a]	0	0
2015	4	52.5
2016	6	60.1

a – No sockeye returned to the Allco fence in 2014.

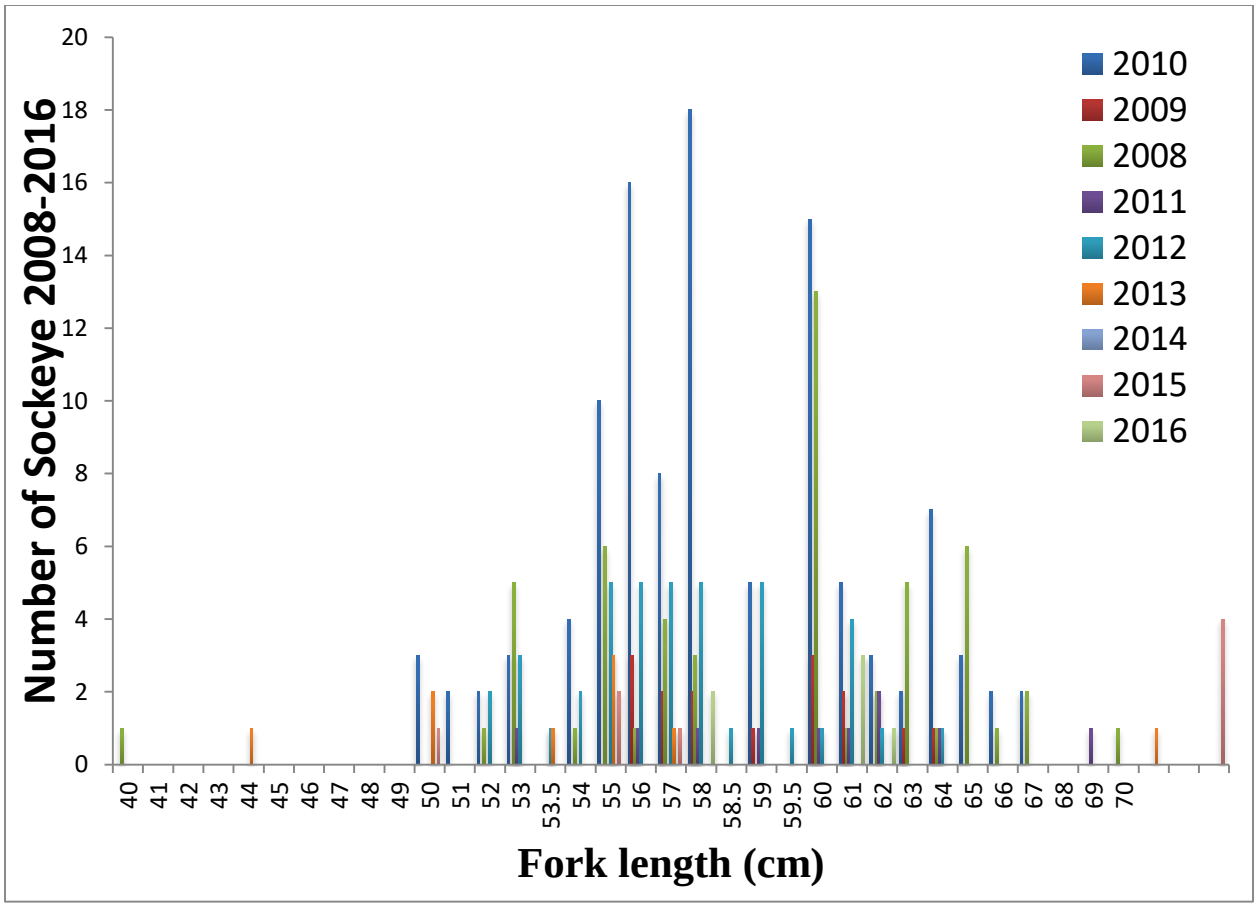

Figure 11 Fork length of returning sockeye 2008-2016

Age Structure

The age class analysis completed by the Pacific Biological Station (Fisheries and Oceans Canada) for the 2016 season showed that the returning adult Alouette sockeye were represented by six fish in one age class, 4_2. (Appendix A Godbout. L (2017), unpublished data.)

The overall number of sampled sockeye count for 2007 to 2016 was 181. The majority (58%) of these sampled returning spawners were age 4.2 years and 24% were age 5.3 years fish. Five other age classes have been identified for the Alouette sockeye, representing 17% of the fish sampled (Table 6).

As background, up until and including 2014, the age class analyses were completed by the Pacific Salmon Commission. In 2008 and 2009, the returning sockeye salmon were evenly distributed between 4.2 and 5.3 age classes. The 2010 returning sockeye also showed this distribution which may be typical for Alouette sockeye, with 53% and 19% respectively. The 2011 returning sockeye had fish in the 6.3 age class, which had not been seen in other study years (Table 6; Latham, unpublished data, 2011). In 2007, there was a large smolt outmigration, which corresponded to the 2009 (4.2) and 2010 (5.3) age classes. In 2011, the age class structure was spread from 4.2 to

6.3 age classes. The low returns for 2011 left considerable uncertainty in these age results (Table 6; Bocking, unpublished data, 2012). The age structure for 2012 showed a distribution from 4.2 to 6.4 age classes. There were 3 aged 4.2 scale samples which were determined to be resorbed. This may indicate that the age of these 3 sockeye were actually 5.2 due to the unreliability of the samples in 2012.

Table 6 Alouette adult sockeye age structure analysis, 2008-2016

Year (% of sampled)	Age Class (Gilbert Rich Scale)								
	2 years in ocean	3.2	4.2	4.3	5.2	5.3	5.4	6.3	6.4
2007 (28)			28 (100%)						
2008 (53)			19 (36%)	1 (2%)	14 (26%)	19 (36%)			
2009 (11)			7 (63%)			4 (36%)			
2010 (68)			36 (53%)		3 (4%)	13 (19%)	1 (1%)		15 (22%)
2011 (6)			3 (50%)			1 (17%)		2 (33%)	
2012 (29)			20 (69%)			8 (28%)			1(3%)
2013[a] (4)			2 (50%)			2 (50%)			
2014[b] (0)									
2015 (4)		1 (25%)	1 (25%)		1 (25%)	1 (25%)			
2016[c] (4)	2 (33%)		4 (67%)						
Total (207)	**2 (1%)**	**1 (0.05%)**	**120 (58%)**	**1 (0.05%)**	**18 (9%)**	**48 (23%)**	**1 (0.05%)**	**2 (1%)**	**16 (8%)**

[a] Of the four fish sampled in 2013 only two were successfully aged at 4.2, the other two samples were hypothesized to be age 5.3.
[b] No adult sockeye returned to the Allco fish fence in 2014.
[c] Due to sampling error, only partial reading could be taken in 2016.

Recommendations

- To ensure the beginning of the sockeye run is captured, the Allco fish fence should continue to operate from the middle of June each year.
- Sockeye should continue to be caught and sampled with the assistance of appropriately trained staff from ARMS to ensure proper data collection procedures are followed and clear pictures are taken.
- Sockeye sampling will continue in 2017 as per 2016, with fork length, scale and tissue samples taken for all returning sockeye.
- All sockeye will then be transported for release to the Alouette Reservoir in 2017.
- Measures will continue to be taken to ensure future scale samples are obtained from the correct location above the lateral line on the fish body, correctly placed in the sample booklets, and not taken near scars.

Acknowledgements

This project was part of the Alouette River Sockeye Reanadromization Project committee's efforts to establish fish passage over the Alouette Dam. Committee members include: Alouette River Management Society (ARMS), BC Corrections Allco Fish Hatchery, BC Hydro, Department of Fisheries and Oceans, City of Maple Ridge, Katzie First Nations, LGL Limited and Ministry of the Environment. Our appreciation is extended to the following individuals: Geoff Clayton and Ken Stewart (ARMS); Dr. Chris Wood and Lyse Godbout (Pacific Biological Station-DFO); Bob Bocking, Megan Matthews, and Elmar Plate (LGL Limited); Shannon Harris and Dr. Brett Van Poorten (Ministry of the Environment); Ron MacLean and Mike Ilaender (BC Corrections Allco Fish Hatchery); Maurice Coulter-Boisvert, Michael Crowe, and Dave Nanson (Fisheries and Oceans Canada); Dr. Dan Selbie (Cultus Lake Research Facility – DFO), Brent Wilson, Alf Leake, and Alexis Hall (BC Hydro); Debbie Miller and Rick Bailey (Katzie First Nation).

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Appendix A

Alouette project - L. Godbout

Introduction

This report summarizes investigations of adult *O. nerka* returning to the Alouette River in 2016. Our objectives were to:

- Identify their population of origin
- Determine their sex
- Determine their age and assign to brood year

Methods

In summer 2016 six adult sockeye caught in Alouette River were samples for tissues and fish scale, prior to their transfer to the Alouette reservoir. Pictures of the vent was taken for sex determination.

Tissue samples were analyzed for DNA (14 microsatellite loci) based on procedures described by Beacham et al. (2005) and used to determine the population of origin stock ID using 90 coast-wide populations of sockeye and kokanee. The probability of an individual's belonging to a given population was calculated, and each individual was assigned to the population for which it had the highest marginal probability.

Results:

Stock of origin and fish age

Genetic analysis revealed that the probability of the 6 returning adults in the Alouette River in 2016 to be O. nerka originating from the Alouette Reservoir was on average 0.998 (0.99 =1.00) (Table 1). Four out of the six sockeye were aged as 4_2 while partial scale reading of the fifth sockeye revealed 2 years in the ocean before returning to Alouette R. Of the three adults with a picture of the vent, two were identified as females and one was likely a male.