Alouette Project Water Use Plan

Substrate Quality

Implementation Year 7

Reference: ALUMON-3

Study Period: 2014

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South Alouette River Substrate Monitoring
2014 Data Report

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Executive Summary

Changes in substrate condition at 23 sample sites on the South Alouette River were measured by way of Wolman pebble count, in order to identify trends that would help to determine the need for a directed flushing flow. This project is a component of the 2005 Alouette Water Use Plan initiated by BC Hydro and approved by the Comptroller of Water Rights in April 2009 to confirm operational requirements for the Alouette hydroelectric system. Water Use Plan implementation oversight is provided by the Alouette Management Committee, which consists of representatives from the public, Department of Fisheries and Oceans, Ministry of Environment, B.C. Hydro, Katzie First Nation, and the District of Maple Ridge.

The primary goal of the project is to look at the long term transport of fine sediment in the South Alouette River by collecting data necessary to test the hypothesis that the proportion of fine sediments less than 2mm in size measured in the substrate monitor does not exceed 20% composition of bed materials and hence address the following management questions (BC Hydro 2009): Alouette Project Water Use Plan Monitoring Program Terms of Reference. ALUMON3 Substrate Quality. A BC Hydro Water Use Plan Monitoring Terms of Reference.

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

Whether or not the results of the Toe-Pebble count procedure reflect the general composition of the bed materials within the channel downstream of Alouette Dam was not specifically tested; however, the sampling results during this time have been consistent with other observations of substrate condition.

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

All observations made during the duration of the Alouette studies have supported Terms of Reference Management Question #2, which asks if the < 20% fines threshold is adequate to distinguish a state in substrate quality that would require a prescribed flushing event. In addition, background research supports this as well. For example, Kondolf (2000) compared 4 studies that determined that a fry emergence of 50% would be achieved by a percentage of particles less than 2mm diameter of 14% or lower, while Cover and Resh (2006) determined that fines in excess of 10-30% inversely affected fry emergence.

The 20% level is still uncertain on Alouette, since this level had only been significantly exceeded once (31% in 1995). It should be noted that this preceded the Minimum Flow Agreement.

(3) Is an alternative methodology required to qualify / calibrate the results of the Toe-Pebble count procedure?For each year of the monitor, is a prescribed flushing flow necessary given the current state of substrate quality?

The toe-pebble procedure has been proven over time to be a suitable method for assessing changes in substrate condition on this system. Given that the objective of the study is to determine the long term impact on the transport of fine sediment in the Alouette River it is felt that the Toe Pebble count procedure provides an efficient and adequate measure of substrate quality change and that alternative methodologies are not required to qualify or calibrate the results.

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

The 2014 data suggests that that a directed flushing flow could benefit certain sections of the river, but only on a very localized basis, and subject to examination of the results of the 3 controlled releases of 2014-2015.

The 2014 sampling showed an overall increase in fine particles less than 2mm diameter of 6.0% since 2013. Regression analyses showed 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, with an overall increase from 2010-2014.

The 2014 sampling showed that the amount of gravel sized 16-128mm diameter decreased overall (42-36%), with the largest decreases (51-39%) occurring in the lower sections. Upper sites decreased from 44-34%, while middle sections increased from 31-35%.
Regressions of Wolman data show an increase in the percentage of gravels for all sites and sections following the 2000 Bridge Coastal Restoration Program gravel placement project at Mud Creek and Alouette Dam.

Analyses of streamflow for the period 1995 to 2014 show that the largest effects on substrate composition were produced by the high flow events of November / December 1995 and October 2003. Although it is likely that the event of March 2007 produced similar results, the lack of sampling data for 2006 and 2007 means that these impacts were not documented.

Although the substrate condition is an important indicator of overall habitat performance, there is no conclusive correlation in the data between substrate condition and chum fry abundance.

Acknowlegements

The author gratefully thanks Darin Nishi of B.C. Hydro and Scott Cope of Westslope Fisheries for providing data that was incorporated into this report.

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1.0 Introduction

The purpose of this project was to document the substrate condition at 23 sample sites on the South Alouette River in 2014, in order to identify trends that would help to determine the need for a directed flushing flow. This project is a component of the 2005 Alouette Water Use Plan initiated by BC Hydro and approved by the Comptroller of Water Rights in April 2009 to confirm operational requirements for the Alouette hydroelectric system. Water Use Plan implementation oversight is provided by the Alouette Management Committee, which consists of representatives from the public, Department of Fisheries and Oceans, Ministry of Environment, B.C. Hydro, Katzie First Nation, the District of Maple Ridge, and the Alouette River Management Society.

1.1 Objectives

The primary goal of the project is to look at the long term transport of fine sediment in the South Alouette River by collecting data necessary to test the hypothesis that the proportion of fine sediments less than 2mm in size measured in the substrate monitor does not exceed 20% composition of bed materials and hence address the following management questions (BC Hydro 2009): Alouette Project Water Use Plan Monitoring Program Terms of Reference. ALUMON3 Substrate Quality. A BC Hydro Water Use Plan Monitoring Terms of Reference.

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

1.2 Study Area / background

The South Alouette River originates at the southwest end of Alouette Lake, at Alouette Dam. From there, the river flows roughly 25 kilometers westward to reach its confluence with the Pitt River (Figure 1.)

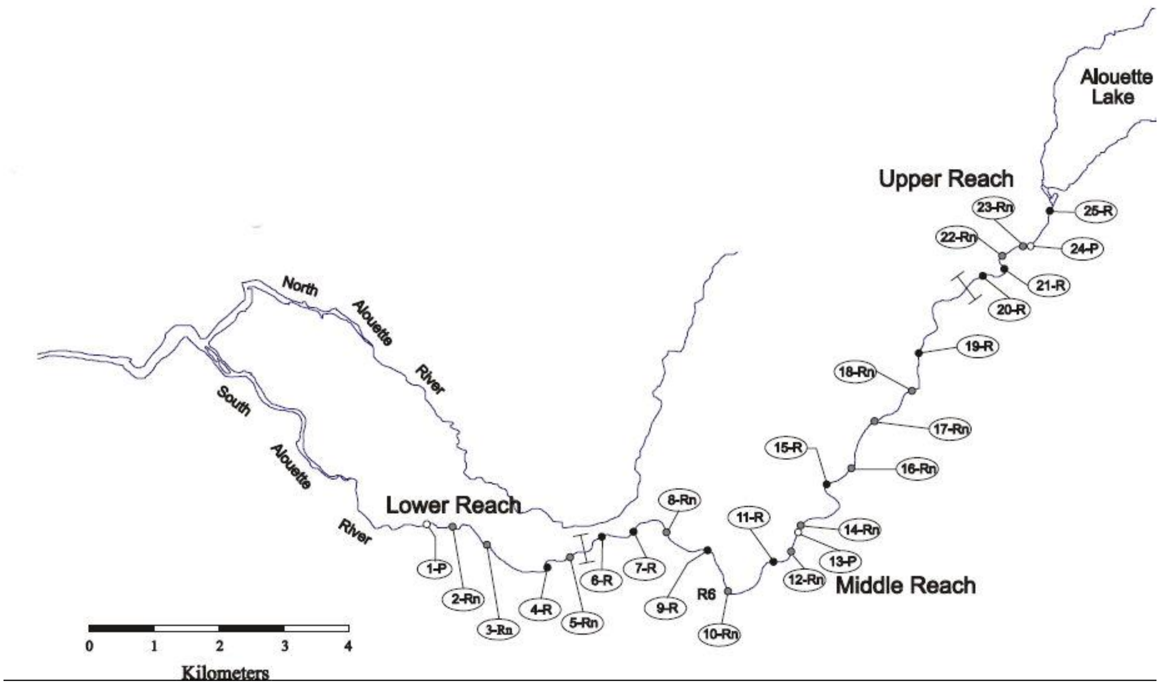


Figure 1. Study area on South Alouette.

Three distinct reaches within 25 sample sites were identified in 1995 for the purpose of the ongoing Wolman pebble count studies. Sites 1-5 are contained within the lower section, 6-19 are in the middle section, and 20-25 are in the upper section. Two of the sites, Site 13 and 14, were abandoned after 1995 due to chronic private property access issues. The presence of Alouette Dam provides the river with a much more stable flow regime than a typical unregulated coastal B.C. stream, with tributary effects increasing with distance downstream from the dam. The river is characterized by low gradients throughout its length.

2.0 Methods

Each of the 23 sites were sampled using the Wolman pebble count technique as described by Kondolf (1997). At each site, the sampler walked heel to toe perpendicular to the channel. After each step, the pebble touching a mark on the front of the samplerὂs boot was picked up and measured. This procedure was repeated until a minimum of approximately 100 particles were sampled and recorded into Wentworth size classes. Reference: (Wentworth 1922) Wentworth, C.K., 1922. A scale and grade and class terms for clastic sediments; Journal of Geology, 30: 377-392 (Table 1). The determination of which size class to record was determined by whether the particle would be able to pass through a sieve of the size range diameter. To help reduce observer bias, the same sampler was used for the duration of the project, and the samplerôs eyes were averted while picking up the pebble, in order to eliminate visual selection. If the site was too deep to wade, an underwater viewer was used and the particle sizes were visually estimated.

Table 1: Wentworth particle size classes

Particle size (mm)
<2
2-4
4-8
8-16
16-32
32-64
64-128
128-256
256-512
512-1024
1024-2048
2048-4096

One change implemented in 2008 is that the sampling is now conducted on an annual basis, and at the same time of the year. This will improve the documentation of the effects of flow events on the condition of the substrate, as well as avoiding seasonal variations caused by factors such as the actions of spawning chum salmon.

Informal observations were made at all sites concerning the level of substrate compaction as well as the presence / absence of various indicator aquatic invertebrates.

The percentages of fines <2mm diameter as well as gravels of 16-128mm were analyzed, since it is generally accepted that the conditions of these two substrate categories have the largest effect on salmonids and / or their food items, with <2mm diameter size range impairing fish production and 16-128mm size class providing suitable habitat for spawning (Burner, 1951). Statistical analyses were applied to the data in order to better identify trends. Specifically, a square root transformation was used to normalize the data in cases where the proportional values were either 0 or 1. Next, the following arcsine transformation was used:

$$Angle(S) = (360/2\pi) * (\arcsin(\sqrt{S}))$$

Where S = raw proportion data

The data was then back transformed by the formula:

$$(\sin((2\pi/360)*Angle(s))\wedge 2$$

3.0 Results and Discussion

3.1 2013 vs. 2014 trends

The 2014 sampling showed an overall increase in fine particles less than 2mm diameter of 6.0% (Table 2). Sampling sites in the lower sections experienced an increase from 32% fines in 2013 to 43% in 2014. Middle sections remained unchanged while upper sections increased from 14% to 23%.

Table 2. Percent fines, 2013 vs. 2014

Sections	% fines 2013	% fines 2014	Change 2013-2014
Lower	32	43	+11
Middle	4	4	0
Upper	14	23	+9
Overall	15	21	+6

It should be noted that instream changes at a localized level sometimes affect certain sites. For example, at Site 1 a large tree fell into the channel along the right bank in 2009, changing the hydrology and subsequent substrate characteristics of the site, by increasing the velocity on the left bank and causing a temporary reduction in fine sediments on the left bank. However, this effect was short-lived as the tree was gradually de-limbed by the current. A similar situation exists at Site 16 (Figure 2), where fallen trees have affected the distribution and composition of substrate materials within that site. In both cases, these effects were confined to the specific sites.

Another event of note is a significant slide that occurred in January 2013 on a tributary upstream of Mud Creek. This has caused several periods of higher than normal sediment loads in the river since that time.

Figure 2: Site 16 in July 2014; site characteristics changed due to fallen trees

There was a decrease in the amount of gravel sized 16-128mm diameter overall (42-36%). Riffle sites recorded an increase in 6 of 10 sites, while run sites experienced a decrease at 7 of 11 sites. The 4 decreases in gravel for riffle sites were at Sites 4, 6, 15 and 25, while decreases in gravels in run sites occurred at sites 2, 3, 5, 16-18, and 23.

Table 3. Percent gravels 16-128mm diameter, 2013 vs. 2014

Sections	% gravels 2013	% gravels 2014	Change 2013-2014
Lower	51	39	-12
Middle	31	35	+4
Upper	44	34	-10
Overall	42	36	-6

Figure 3: Effects of the tributary slide of January 2013 at Mud Creek.

The 2014 sampling run was the fourth consecutive year that the sampling was not preceded by at least one controlled flow release from Alouette Dam.

In summary, the 2014 sampling showed an increase in percent fines since 2013, following the decrease from 2012-2013. 2014 marks the first time that the percent fines has exceeded the 20% threshold since the 31% that was recorded in 1995 prior to the Minimum Flow Agreement. However, 3 controlled flow releases from Alouette Dam followed the sampling in late 2014 and early 2015 (Appendix 1). The sudden resumption of discharges of this magnitude after a four year absence may well have had significant effects on the substrate composition.

3.2 1995 to 2014 trends

Regression analyses for all habitat types and sections for the period 1995 to 2014 show that the substantial high water event of November 1995 (96.6-121.0 cms for a period of approximately 48 hours as recorded at Alouette Dam) resulted in a 31%-16% decrease of fine particles from most sites, with some deposition occurring in the lower river at certain low velocity sites. The overall percentage of fine sediments has remained relatively stable since that time. One fluctuation of note occurred between 2003 and 2004, when the overall percentages of fines dropped from 20% to 10%. This is likely due to the significant high water event of October 2003 (31.0-33.0 cms from Alouette Dam for a period of approximately 48 hours) and particularly the 6-day period in January 2004 that saw Alouette Dam discharges of 21.5-32.7 cms.

Analyses of gravels sized 16-128mm show some interesting trends. In 2000, 460 tons of spawning gravel was placed at two locations in the upper Alouette River; at Mud Creek, and downstream of the free spill crest as part of a Bridge Coastal Restoration Program initiative. Regressions of Wolman data show an increase in the percentage of gravels for all sites and sections following the 2000 project. A portion of this gravel was marked with environmentally friendly orange paint at the time of this placement. Marked pebbles of 32-64mm diameter have subsequently been found as far as 10km downstream on several different occasions.

Figures 4 to 11 show regression analyses of percentages of fine sediments as well as gravels along with lower and upper confidence intervals.

One site that is of particular interest is Site 20, due to its close downstream proximity to the Mud Creek settling pond. This site has been problematic from time to time during the duration of the years of Wolman sampling. Up until 2013, neither the levels of fine particles or the levels of substrate compaction had ever been observed to be in excess of what constitutes good salmonid spawning and rearing habitat. This had been true for Site 20 as well as the two next closest sample sites downstream. It is likely that the clay based nature of the runoff from Mud Creek meant that the particles remained in suspension for an extremely long period, possibly long enough to completely exit the Alouette system. However, the 2014 sampling showed an average increase of 12% in fine sediments for the 5 sites downstream from Site 20, and this appeared to be lingering effects of the significant upstream tributary slide of January 2013. In 2009, the primary source of fine sediments was originating at a debris slide located upstream of Mud Creek, 5.1 kilometers by road from the Alouette Dam road access gate. Figure 3 shows the January 2013 slide. In 2010, at least two significant sediment releases originated from Mud Creek following the 2010 sampling run, and there was also a short term sediment event associated with sanitary sewer construction.

In summary, the sampling exercises that have taken place since the 1996 Minimum Flow Agreement have shown that the levels of fine sediments do tend to fluctuate across the sites and / or river sections from year to year, but while this yearôs results slightly exceeded the 20% threshold, overall there has not been any evidence of steadily increasing sedimentation or substrate compaction. The standardized seasonal sampling that is part of this Monitor should help to verify this trend over time, by minimizing seasonal confounding factors such as the activities of chum salmon.

Observations described in this report indicated that a directed flush flow could benefit certain sites, by removing accumulated fines from certain sections of the side habitat. It is also theoretically possible to restore pool habitat downstream of Site 21 via a directed flushing flow. However, none of these localized affects appear to be having a negative effect on area salmonids and / or their food sources, when one considers the river channel as a whole. In addition, negative sedimentation impacts such as spawning prevented by compaction were not encountered at any site. Other assessments that were made during the study, such as examining the abundance and variety of macro invertebrates, as well as examinations of several sites following the approximately 48-hour controlled flow release of 40-42 cubic meters per second in November 2009, strongly suggest that sedimentation is not a limiting factor on salmonid habitat at this time (Figure 16). What must also be considered are what the effects may have been from the 3 controlled releases (Appendix 1) that occurred following the 2014 sampling run. All observations made during the duration of the Alouette studies have supported Terms of Reference Management Question #2, which asks if the < 20% fines threshold is adequate to distinguish a state in substrate quality that would require a prescribed flushing event. In addition, background research supports this as well. For example, Kondolf (2000) compared 4 studies that determined that a fry emergence of 50% would be achieved by a percentage of particles less than 2mm diameter of 14% or lower, while Cover and Resh (2006) determined that fines in excess of 10-30% inversely affected fry emergence.

Table 4. Percent fines by reach, all years

Year	% fines, lower reach	% fines, middle reach	% fines, upper reach	% fines, entire river
1995	39	13	39	31
1996	40	4	13	16
1997	40	6	6	13
1998	22	9	10	12
1999	36	10	12	17
2003	42	11	14	20
2004	31	3	6	10
2005	30	4	3	9
2008	23	7	10	12
2009	34	8	13	16
2010	26	3	9	10
2011	33	5	11	14
2012	43	6	15	18
2013	32	4	14	15
2014	43	4	23	21

Figure 4: Percent fines, all sites, all years

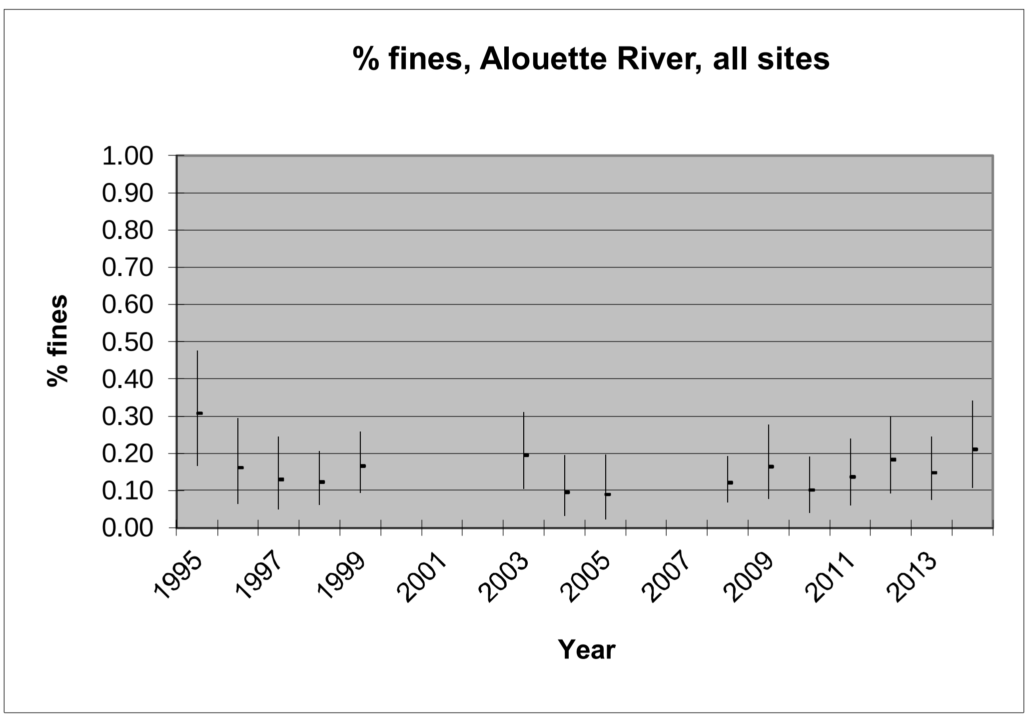


Figure 5: Percent fines, lower sites, all years

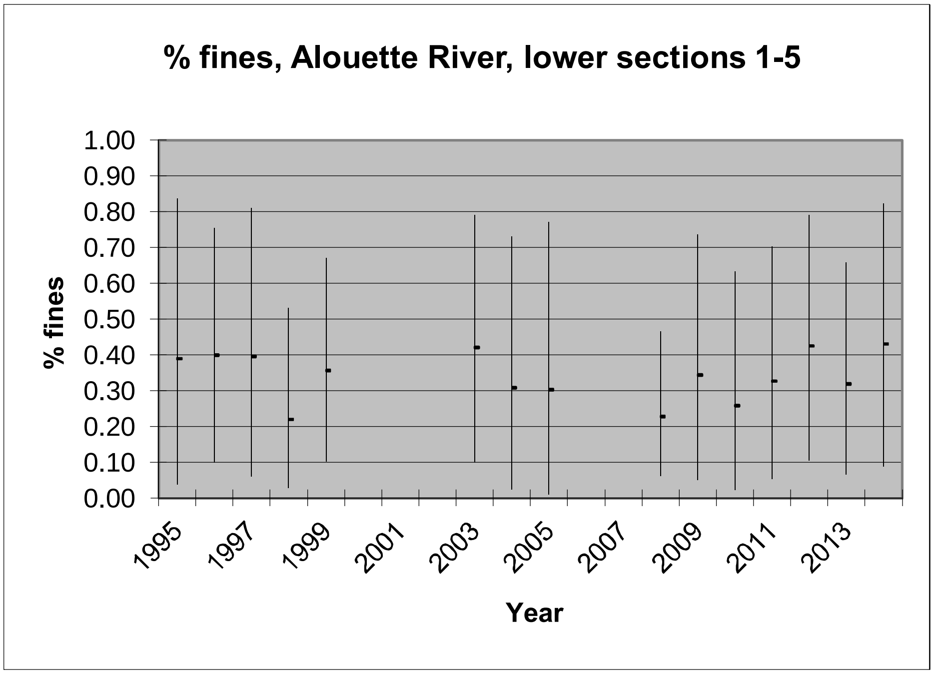


Figure 6: Percent fines, middle sites, all years

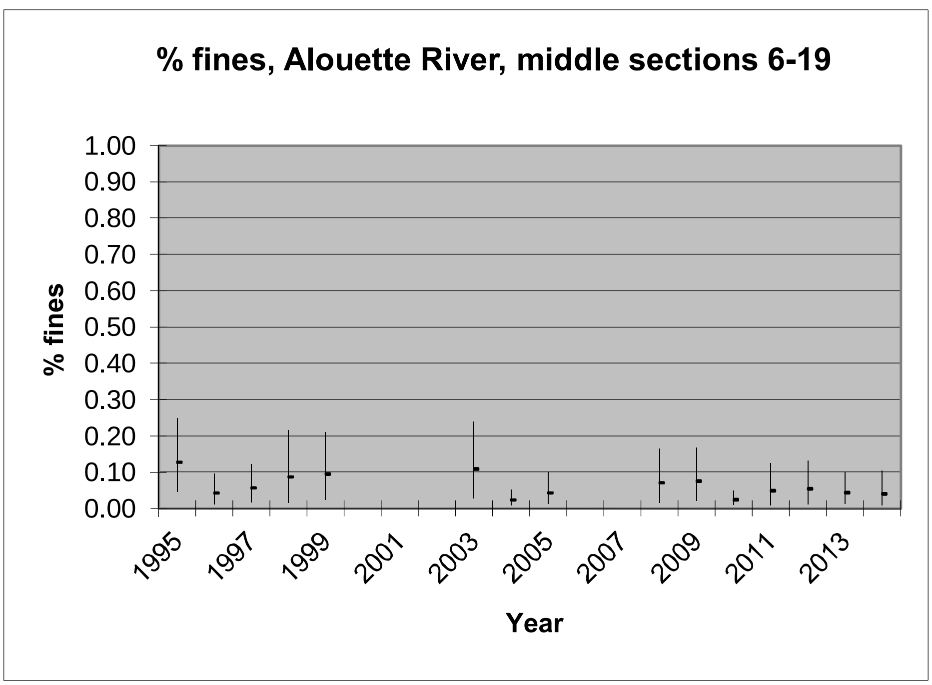


Figure 7: Percent fines, upper sites, all years

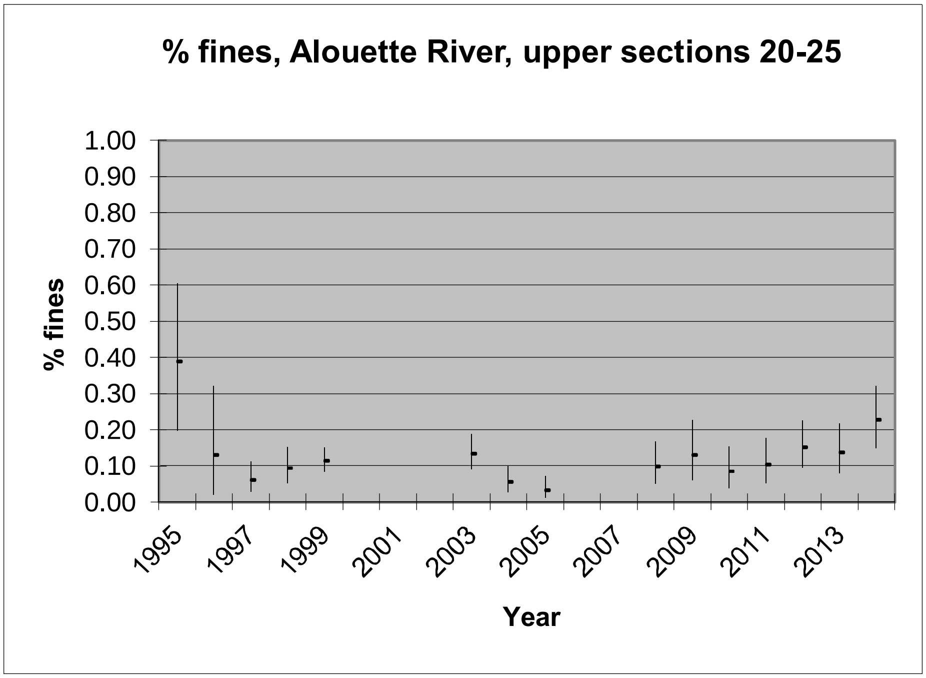


Figure 8: Percent gravels, all sites, all years

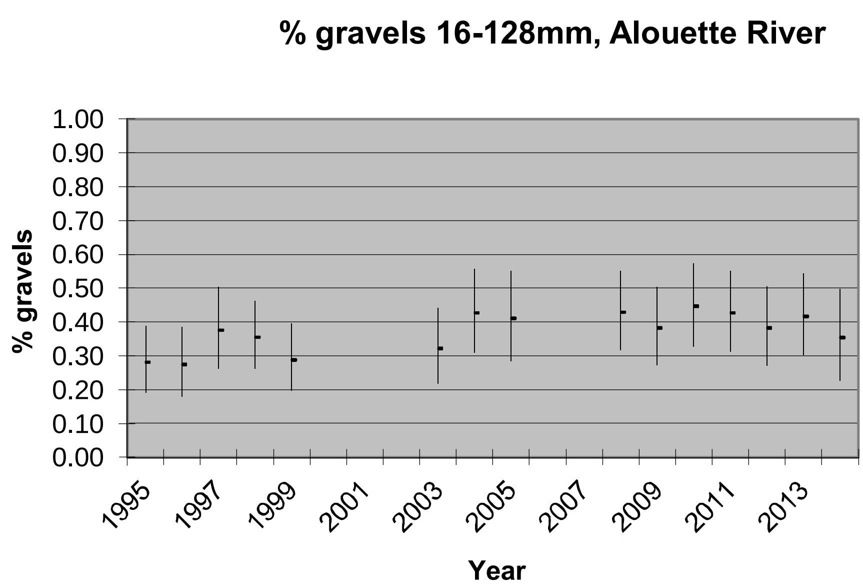


Figure 9: Percent gravels, lower sites, all years

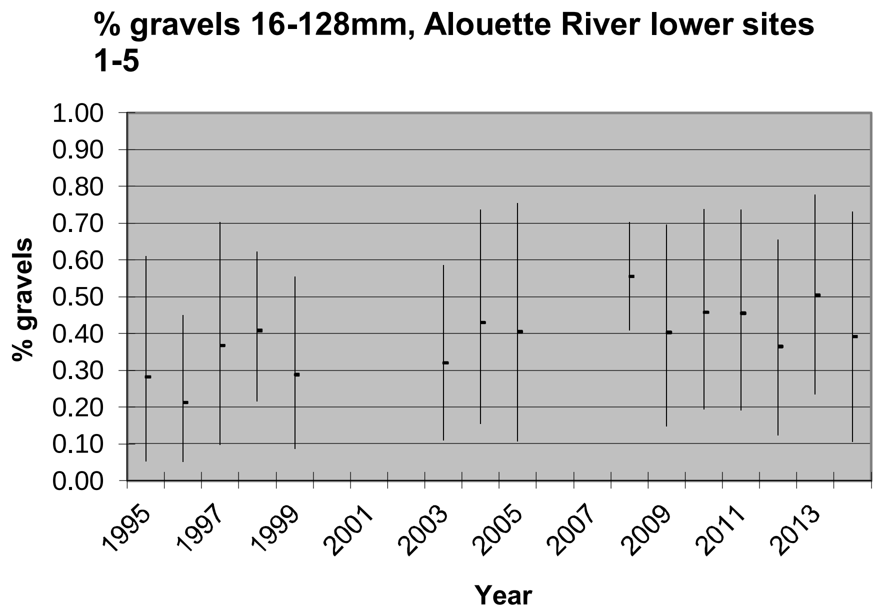


Figure 10: Percent gravels, middle sites, all years

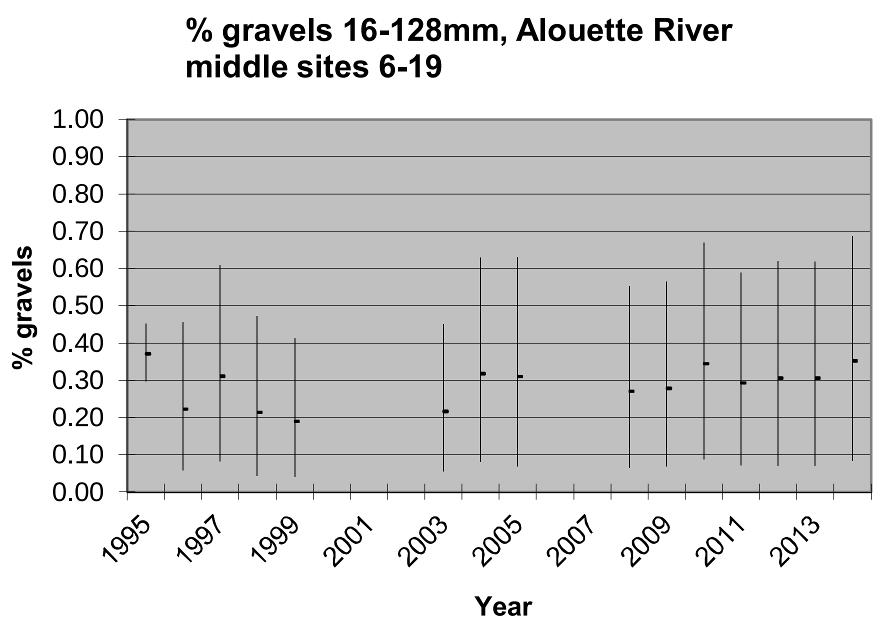
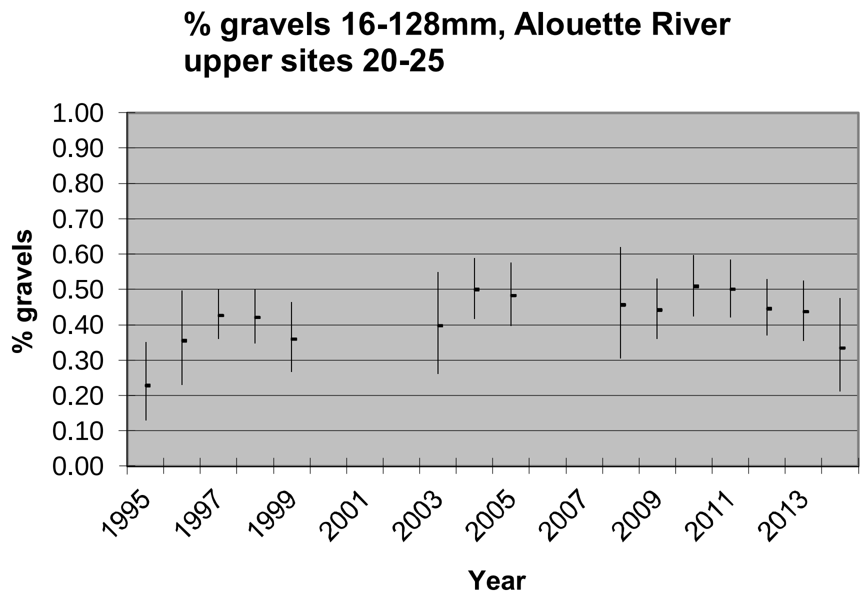


Figure 11: Percent gravels, upper sites, all years



3.3 Substrate condition versus chum fry abundance

Data from Alouette River fry enumeration activities (Cope 2014) was plotted against the percentages of fines as well as gravel in order to determine if a correlation exists between the data sets. The fry data were used for this exercise since the trapping locations are located downstream of the majority of the chum spawning areas, while the adult fence counts at Allco Hatchery are upstream of much of the spawning areas.

Figures 12 and 13 show the comparisons between percent fines and gravels versus chum fry abundance respectively. There was generally a steady increase in chum populations during the Wolman studies of 1995-2009, and then a drop during 2010-2012. It is not possible to solely attribute these changes to substrate conditions. While high quality substrate is a critical component of productive salmonid habitat, there is a complex relationship with other factors including flow regimes and the increase of available habitat produced by the Minimum Flow Agreement. The substrate condition could therefore be looked at as a benefactor and important indicator of overall habitat performance.

Figure 12: Percent fines vs chum fry migration

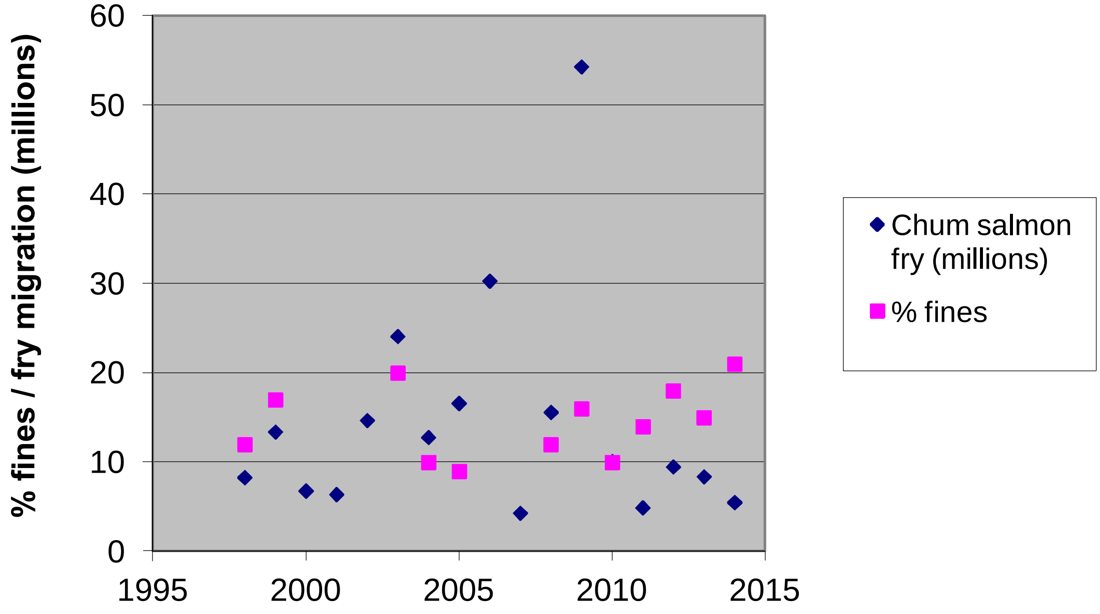
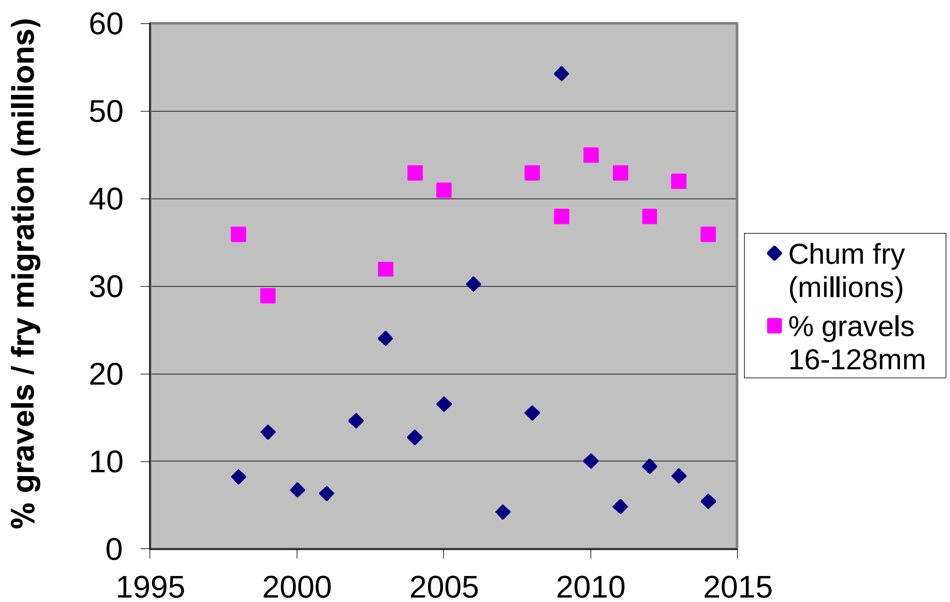


Figure 13: Percent gravels vs chum fry migration



3.4 Substrate condition versus flow

Alouette River discharge data was plotted against the percentages of fines as well as gravel in order to determine if a correlation exists between the data sets. Figures 14 and 15 show that the largest changes of percent fines and gravels during the period of 1995 ï 2014 occurred following the peak flow events of 54.5 cms in 1995 and 31.2 cms in 2003. Another large event occurred in March of 2007, when flows exceeded 45cms for several days. Although this likely caused significant changes to the substrate composition, these changes were not documented due to the fact that Wolman sampling was not carried out in 2006 or 2007 due to an absence of directed funds for this purpose. The 48 hour, 40-42cms event of November 2009 is thought to have contributed to the 6% drop in fine sediments between 2009 and 2010. The fine sediment proportion approached the 20% threshold in 2012, and finally slightly exceeded it in 2014 following a decrease in 2013.

Figure 14: Percent fines vs ALU flow

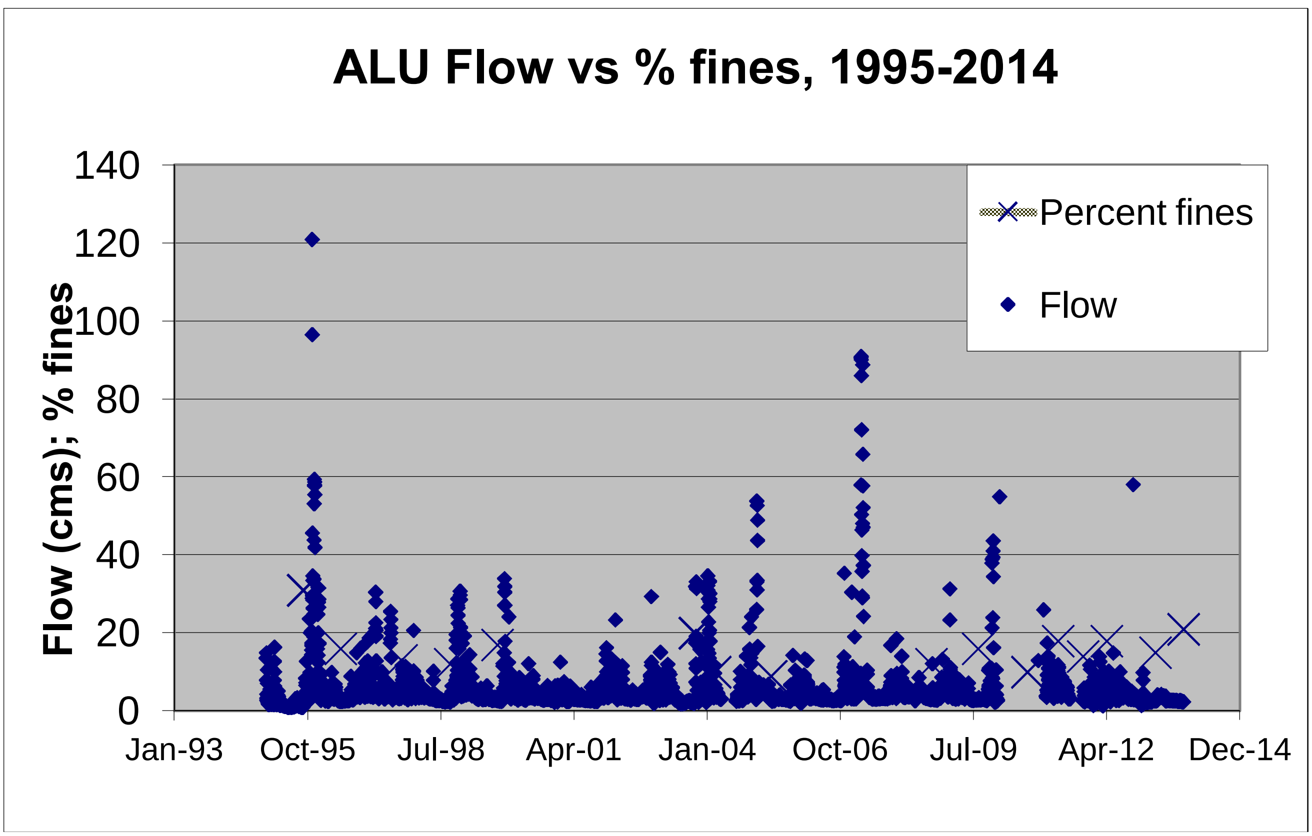


Figure 15: Percent gravels vs ALU flow

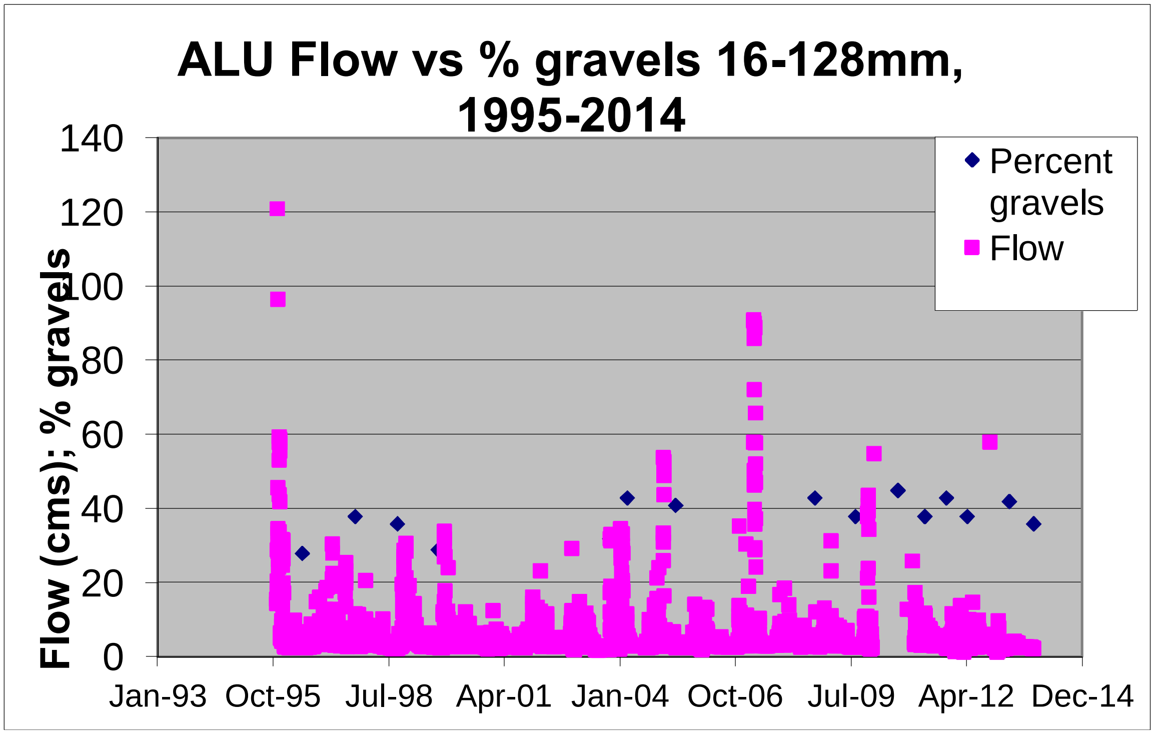


Figure 16. Upper river, upstream of Site 25 near Alouette Dam, September 2011.

3.5 2008-2014 trends

The following set of graphs show the trends of fine sediments as well as gravels during the time window of the current WUP (2008-2014). Figure 17 indicates an overall increase in percent fines between 2010 and 2014, which corresponds to the period in which controlled Alouette Dam releases did not occur.

Figure 17: Percent fines, all sites, 2008-2014

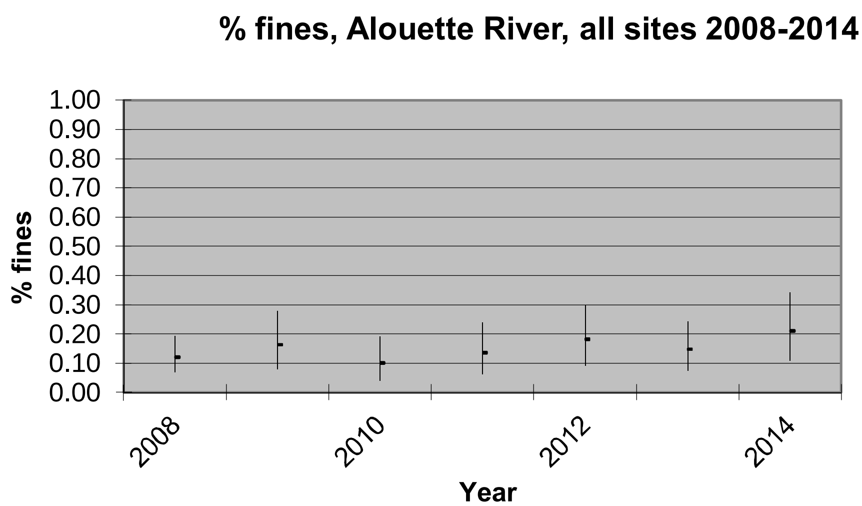


Figure 18: Percent fines, upper sites, 2008-2014

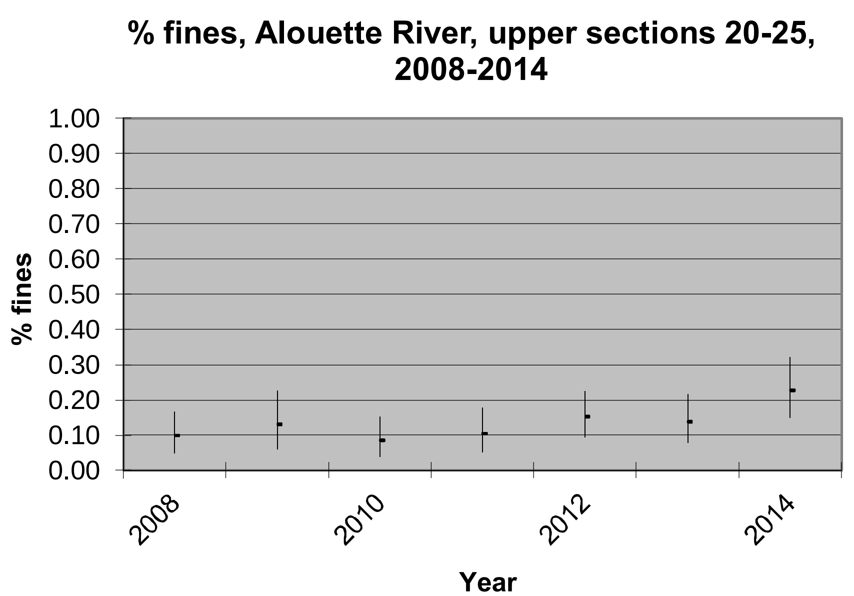


Figure 19: Percent fines, middle sites, 2008-2014

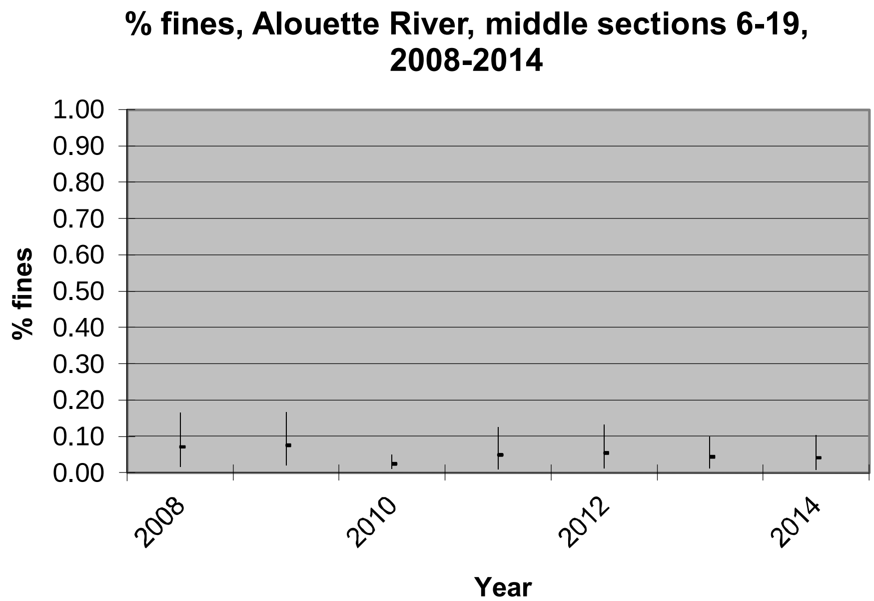


Figure 20: Percent fines, lower sites, 2008-2014

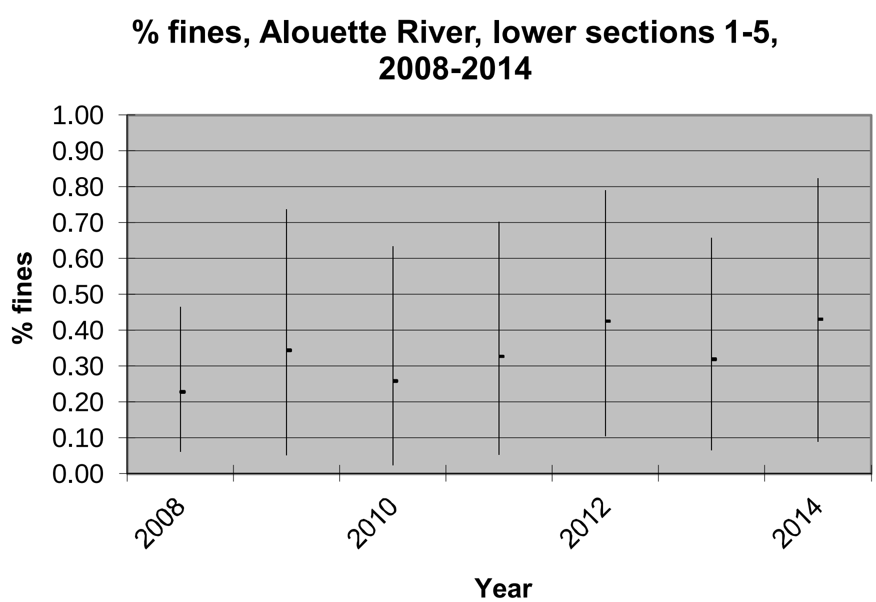


Figure 21: Percent gravels, all sites, 2008-2014

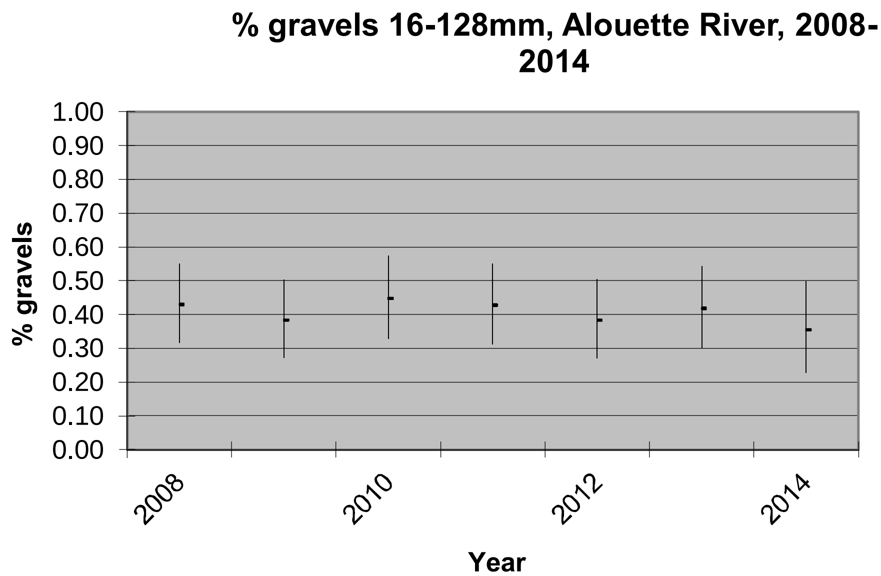


Figure 22: Percent gravels, upper sites, 2008-2014

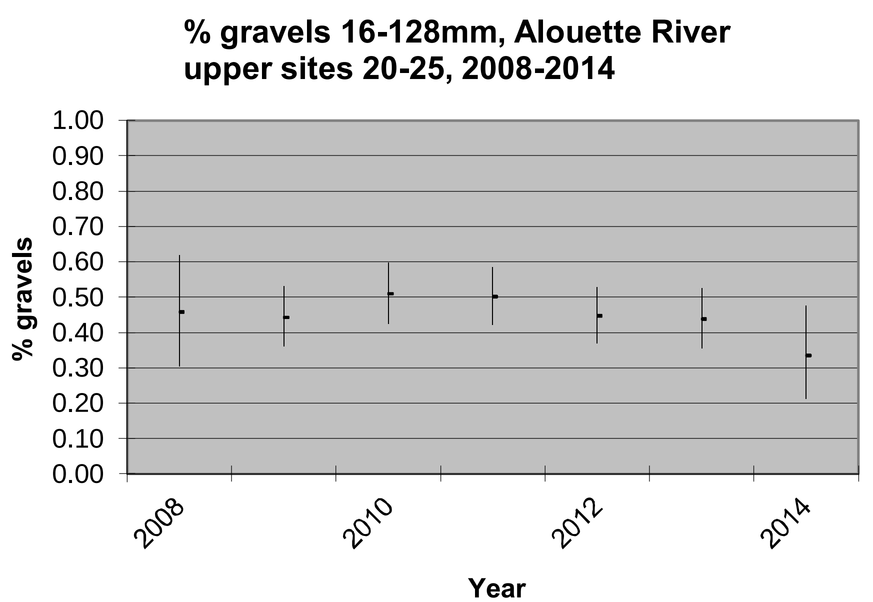


Figure 23: Percent gravels, middle sites, 2008-2014

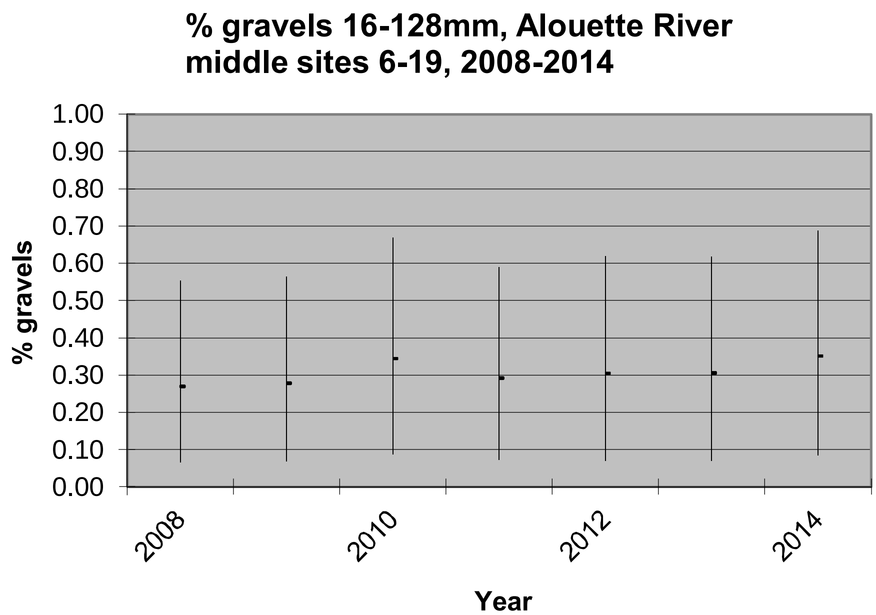


Figure 24: Percent gravels, lower sites, 2008-2014

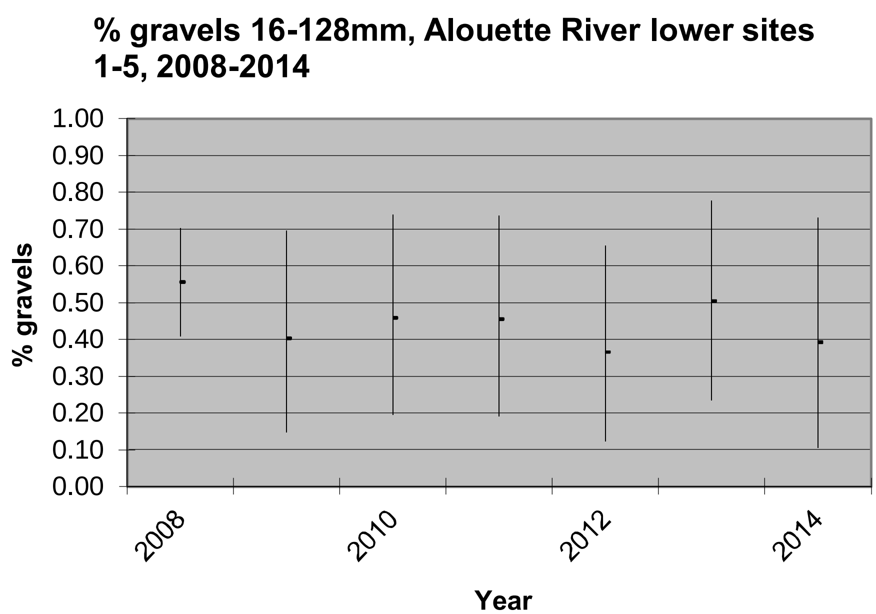


Figure 25: Percent fines vs ALU flow, 2008-2014

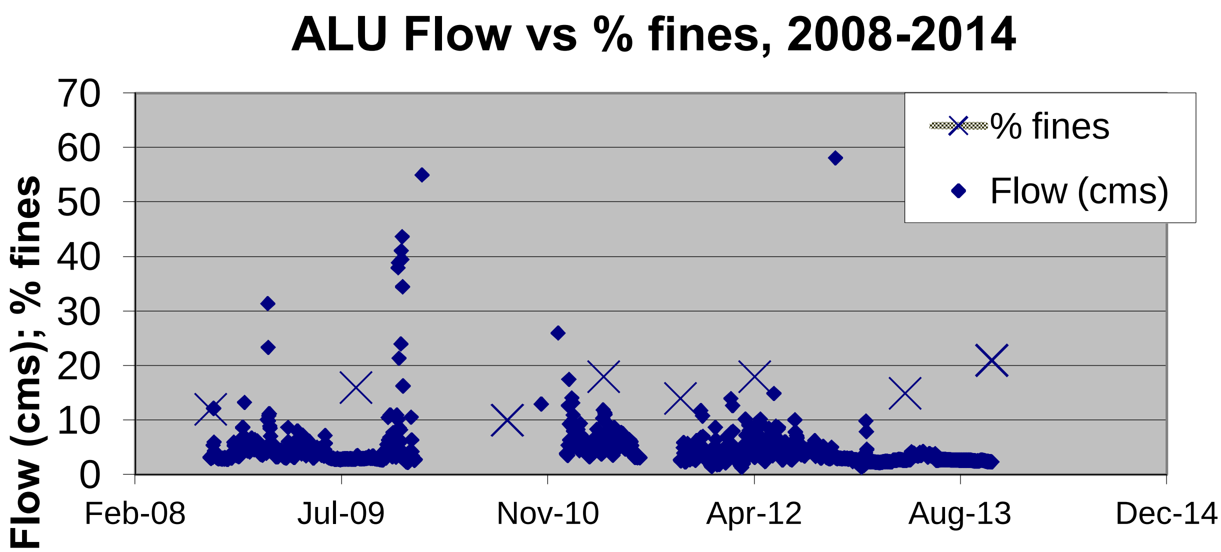
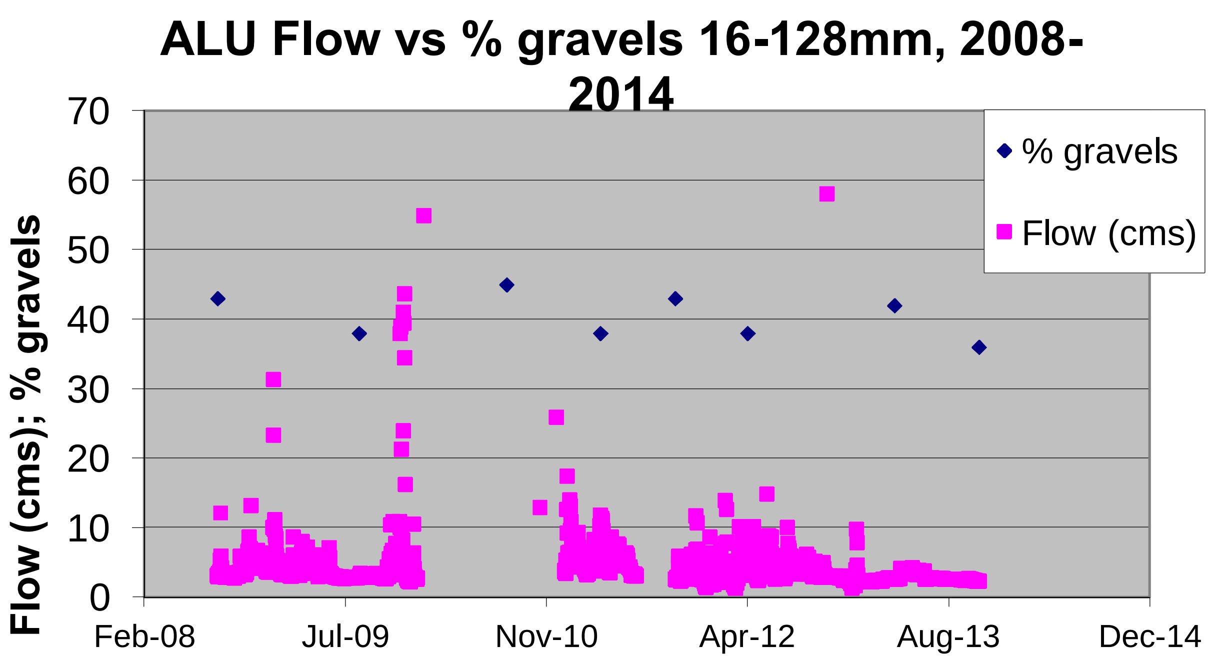


Figure 26: Percent gravels vs ALU flow, 2008-2014



3.6 Results related to Management Questions and Null Hypothesis

One of the purposes of this monitor is to attempt to address the following Management Questions as identified in the Terms of Reference:

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

The completion of the 2014 sampling concluded the 14th year of pebble count sampling on the Alouette. Whether or not the results of the Toe-Pebble count procedure reflect the general composition of the bed materials within the channel downstream of Alouette Dam was not specifically tested; however, the sampling results during this time have been consistent with other observations of substrate condition. This procedure has proven effective to monitor sediment quality changes over time on other systems (Potyondy and Hardy 1994. Use of Pebble Counts to Evaluate Fine Sediment Increase in Stream Channels. JAWRA Journal of the American Water Resources Association Volume 30, Issue 3, pages 509-520, June 1994.

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

In summary, the sampling exercises that have taken place since the 1996 Minimum Flow Agreement have shown that the levels of fine sediments do tend to fluctuate across the sites and / or river sections from year to year, but while this yearỗs results slightly exceeded the 20% threshold, overall there has not been any evidence of steadily increasing sedimentation or substrate compaction. The standardized seasonal sampling that is part of this Monitor should help to verify this trend over time, by minimizing seasonal confounding factors such as the activities of chum salmon. Observations described in this report indicated that a directed flush flow could benefit certain sites, by removing accumulated fines from certain sections of the side habitat. It is also theoretically possible to restore pool habitat downstream of Site 21 via a directed flushing flow. However, none of these localized affects appear to be having a negative effect on area salmonids and / or their food sources, when one considers the river channel as a whole. In addition, negative sedimentation impacts such as spawning prevented by compaction were not encountered at any site. Other assessments that were made during the study, such as examining the abundance and variety of macro invertebrates, as well as examinations of several sites following the approximately 48-hour controlled flow release of 40-42 cubic meters per second in November 2009, strongly suggest that sedimentation is not a limiting factor on salmonid habitat at this time (Figure 16). What must also be considered are what the effects may have been from the 3 controlled releases (Appendix 1) that occurred following the 2014 sampling run. All observations made during the duration of the Alouette studies have supported Terms of Reference Management Question #2, which asks if the < 20% fines threshold is adequate to distinguish a state in substrate quality that would require a prescribed flushing event. In addition, background research supports this as well. For example, Kondolf (2000) compared 4 studies that determined that a fry emergence of 50% would be achieved by a percentage of particles less than 2mm diameter of 14% or lower, while Cover and Resh (2006) determined that fines in excess of 10-30% inversely affected fry emergence.

The 20% level is still uncertain on Alouette, since this level had only been significantly exceeded once (31% in 1995). It should be noted that this preceded the Minimum Flow Agreement.

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

The toe-pebble procedure has been proven over time to be a suitable method for assessing changes in substrate condition on this system. During the 2009 sampling run, a triangulation method was attempted in order to provide a comparison to the toe-pebble method, but the sheer size and velocity of the sample sites on the Alouette rendered the triangulation method impossible. Sources of variability in conducting pebble counts indentified by Olsen et. al. 2005 have been accounted for in the study design to provide a good annual comparison of changes in substrate quality. Reference: (Olsen et. al., 2005) Olsen et. al. 2005. Olsen, Darren S., Breet B. Ropper, Jeffrey L. Kershner, Richard Henderson, and Eric Archer. Sources of Variability in Conducting Pebble Counts: Their Potential Influence on the Results of Stream Monitoring Programs. Journal of the American Water Resources Association October 2005.

Variability in particle measurement and particle selection were controlled using a single technician to replicate results across years (Wohl et. al. 1996). Site variability was controlled by establishing permanent sample sites (Roper et. al. 2003) and sampling at the same time of year. References: Wohl, E.E., D.J. Anthony, S.W. Madsen, and D.M. Thompson, 1996. A Comparison of Surface Sampling Methods for Coarse Fluvial Sediments. Water Resources Research 32:3219-3226. Roper, B.B., J.L. Kershner, and R.C. Henderson 2003. The Value of Using Permanent Sites When Evaluating Stream Attributes at the Reach Scale. Journal of Freshwater Ecology 18:585-592.

Given that the objective of the study is to determine the long term impact on the transport of fine sediment in the Alouette River it is felt that the Toe Pebble count procedure provides an efficient and adequate measure of substrate quality change and that alternative methodologies are not required to qualify or calibrate the results.

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

The 2014 data suggests that that a directed flushing flow could benefit certain sections of the river, but only on a very localized basis, and subject to examination of the results of the 3 controlled releases of 2014-2015.

4.0 Conclusions

Information contained within this report suggests that:

- The levels of fine particles in the Alouette substrate have remained relatively stable since the significant drop that occurred with the 1995 flood.
- The 2014 sampling run recorded a 15-21% increase in fine sediments.
- The Wolman sampling exercises have recorded a percentage increase of gravels sized 16-128mm following the gravel placement conducted via a Bridge Coastal Restoration Project in 2000.
- Regression analyses for the period 1995 to 2014 show that the largest effects on substrate composition were produced by the high flow events of November / December 1995 and October 2003 / January 2004. Although it is likely that the event of March 2007 produced similar results, the lack of sampling data for 2006 and 2007 means that these impacts were not documented.
- Although the substrate condition is an important indicator of overall habitat performance, there is no conclusive correlation in the data between substrate condition and chum fry abundance.
- Informal observations made during the fieldwork showed that compaction levels were seldom in excess of levels that would begin to affect salmonid spawning, rearing, or food production.
- The 2014 sampling run followed a prolonged period of relatively quiet flow conditions, but the sampling was followed by 3 significant Alouette Dam flow releases in 2014-2015.
- During the current WUP, the period of 2010-2014 saw an overall increase of percent fines from 10% to 21%, and this was concurrent with an absence of controlled flow releases during this time period.

Information contained in this report suggests that a directed flushing flow could benefit certain sections of the river, but only on a very localized basis.

5.0 Appendices

5.1 Appendix 1: Alouette River Controlled Releases: November 2014-February 2015

Alouette River Controlled Releases: November 2014-February 2015

The fall and winter of 2014-2015 was characterized by mild conditions with a number of heavy precipitation events. This resulted in 3 controlled flow releases from Alouette Dam of approximately 42.5cms each. The high flow conditions lasted 4-6 days during each event, which took place on or about November 29 and December 11, 2014, and February 7, 2015. Following are photos of each release, and a photo immediately after the November 29 release showing accumulated sand on the bank. This type of observation was widespread along the river, leading to the assumption that the 3 controlled releases may have had significant effects on percent fines in the river.

Controlled release getting underway 1.8km east of 232nd Street, November 29th, 2014

The second controlled release of Fall 2014, December 11th.

Controlled release, February 7, 2015 at Davidsons Pool.

Accumulated sand on right bank following high water event, 1.8 km east of 232nd Street, December 7th 2014.

5.0 References

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