2009/10 FINAL REPORT

FSWP File Number*	07350-35/FSWP 09 D HWRS 22

* Please use the FSWP File Number provided in previous FSWP project correspondence.

1. Project Information

1.1. Project Title

FSWP Restoration Effectiveness Monitoring

1.2. Proponent's Legal Name

BC Conservation Foundation

1.3. Project Location

Multiple River Systems - Alouette River; Chehalis River; Silverhope Creek

1.4. Contact for this report

Name: Kerry Baird	Phone: 604-576-1433	Email: Kbaird@bccf.com

1.5 Funding Amount

Original Approved Grant Amount:	Total FSWP Expenditures:	Final Invoice Amount:	Final Non-FSWP leveraging, including cash and in-kind:
$10,000	$10,000	$2,000.00 (final invoice only)	

2. Project Summary

Please provide a single paragraph describing your project, its objectives, and the results. As this summary may be used in program communications, clearly state the issue(s) that were addressed and avoid overly technical descriptions. Maximum 300 words.

Mainstem river fish habitat restoration projects have been conducted in a number of impacted watersheds across the Lower Mainland/South Coast of British Columbia by the BC Conservation Foundation Fisheries Recovery Program. The primary habitat restoration methods used to improve juvenile fish rearing habitat was the Large Woody Debris (LWD) engineered style log jam, and side-channel re-connections. This FSWP project was funded to assess the biological performance, and structural integrity of the restoration projects. Rather than attempting to evaluate all restoration projects, a sub-set of projects was deemed practical. In the Fraser Valley, the Alouette and Chehalis River, and the Silverhope Creek have been selected (Appendix I – Map).

Using fish habitat restoration effectiveness monitoring industry guidelines, LWD structures, and select control sites were evaluated to determine fish abundance using underwater snorkel survey methodology. The key focus was enumerating juvenile steelhead trout (*Oncorhynchus mykiss*), and coho salmon (*Oncorhynchus kisutch*) at treated (restored), control (un-restored), and where available,

natural wood controls (natural wood). This involved summer day-time, and winter night-time snorkel survey assessments, conducted to capture data representing seasonal habitat use variability. Snorkel surveys were conducted between August 18 and August 26, 2009 for summer evaluations, and February 2 and March 15, 2010 for winter evaluations. Overall, underwater snorkel survey observations indicate a high salmonid fish use at wood restored sites, as well as natural wood sites, relative to the controls with no wood present (refer to section 3.2 "Effectiveness" for study results). Additionally, a side-channel mark and re-capture juvenile salmonid population estimate was conducted on one of two re-connected side-channels in the Silverhope Creek.

Large Woody Debris structural performance (habitat development) was rated using a standardized methodology. Of all 75 LWD restored sites that were evaluated, 94% and 92% are at or above the "meets expectations" criteria ranking for "pool development and gravel deposition" and "fish habitat cover", respectively.

OPTIONAL **Please give a short statement (up to 100 words) of the most compelling activity or outcome from your project.**

3.Final Project Results and Effectiveness

3.1 Copy EXPECTED OUTCOMES from your detailed proposal and insert into this section. Add additional rows as needed. Then please list the FINAL OUTCOMES (the tangible end products resulting from this work) associated with expected outcome.

If FINAL OUTCOMES differ from the original EXPECTED OUTCOMES please describe why, and the implications for the project.

EXPECTED OUTCOMES	FINAL OUTCOMES
1. A thorough structural integrity examination of large woody debris structures will be performed, followed by written documentation of the status. This level of evaluation is crucial to avoid future liability and hazardous conditions.	A total of 75 LWD structures were inspected to insure structural integrity: Alouette (28); Chehalis (6); and Silverhope (41). The inspection looked at the quality of cables, cable connections, anchor points, and wood. Stream banks were inspected to insure no major erosion is occurring at sites. The inspection provides an opportunity to respond to situation of attention if deemed necessary.
2. A spatial and temporal evaluation of juvenile fish use amongst large woody debris and side-channels will provide the field data necessary to determine and illustrate optimal habitat conditions and benefits, and non-performing restoration techniques.	A goal was to enumerate fish in the mainstem as well as side-channel habit in both, summer and winter, habitat use periods. Unfortunately, in the Silverhope Creek, due to an extremely dry summer, with low flow the mark and re-capture component was omitted to avoid stressing fish. A full mark and re-capture study was conducted in the winter period though. Additionally, both summer and winter mainstem snorkel surveys were conducted in the Alouette, Chehalis, and Silverhope Creek. Results are presented in

	Appendix II and III.
3. An effectiveness evaluation will illustrate the value of on-the-ground, tangible habitat restoration activities at producing favorable habitat conditions for fish species being targeted for recovery.	As a component of the structural integrity inspection, four key water depth measurements which are associated with the LWD structure are recorded; a) maximum water depth; mean water depth; c) depth off of the apex of the structure; and d) depth within the centre of the structure. This provides a measure of success to evaluate the ability of the structure s to scour the stream bed, providing greater fish habitat and cold water ground water influence from the scoured zone. Additionally, a subjective ranking by experienced biologists provides a value to the habitat cover created through successive woody debris capture at the structures, for "fish habitat cover" and "pool development and gravel deposition". Results are presented in Appendix II.
4. Data collected through this project will contribute towards an instructive and publication quality evaluation of habitat restoration works; beneficial to re-assure past and future project funders of their instream restoration investments.	This project is designed and collaborating with fish and habitat monitoring work concurrently being conducted through BCCF; Vancouver Island. The data collected this year, is a small component of the overall data that is being collected to assimilate a multi-year, multi-partner document which will be completed in 2010-2011.

3.2 Please evaluate the EFFECTIVENESS of your project in achieving Project Objectives. Please identify the indicators you have used to measure the effectiveness of your project. Please include any notable successes or challenges.

Please refer to results and measures of success in Appendices

3.3 REQUIRED: attach all DOCUMENTATION of Final Outcomes, and LIST attachments here. These may include technical reports, maps, photos, evidence of communications, lists of meeting participants, etc.

APPENDIX I – Spatial map of project activities

APPENDIX II – Biological and Physical Study results

APPENDIX III – Silverhope Creek Side-channel Population Estimate

3.4 Please describe how the benefits of this project will be sustained and/or be built upon into the future. What are the planned next steps, or recommendations for further work, if applicable?

The ultimate achievement is to increase freshwater habitat capability through the placement of large woody debris habitat structures, and development or re-connection of side-channel habitat. The findings from this habitat restoration evaluation may extend further than solely identifying our project results, and potentially influence peoples perspectives on the value of wood in rivers. By scientifically illustrating the high value of habitat rehabilitation, both the general public, as well as government officials can better understand the need for these projects to recover our fish stocks. Support for similar rehabilitation work, or added ecosystem and fisheries protection is a desired outcome from this project.

One final year of field data capture, will be followed by the development of the final multi-year, multi-partner habitat restoration effectiveness monitoring document.

3.5 What are the top three lessons learned from this project that could be useful to communicate to others doing similar work in the Basin?

1. Prepare for unforeseen weather conditions when working in remote areas.

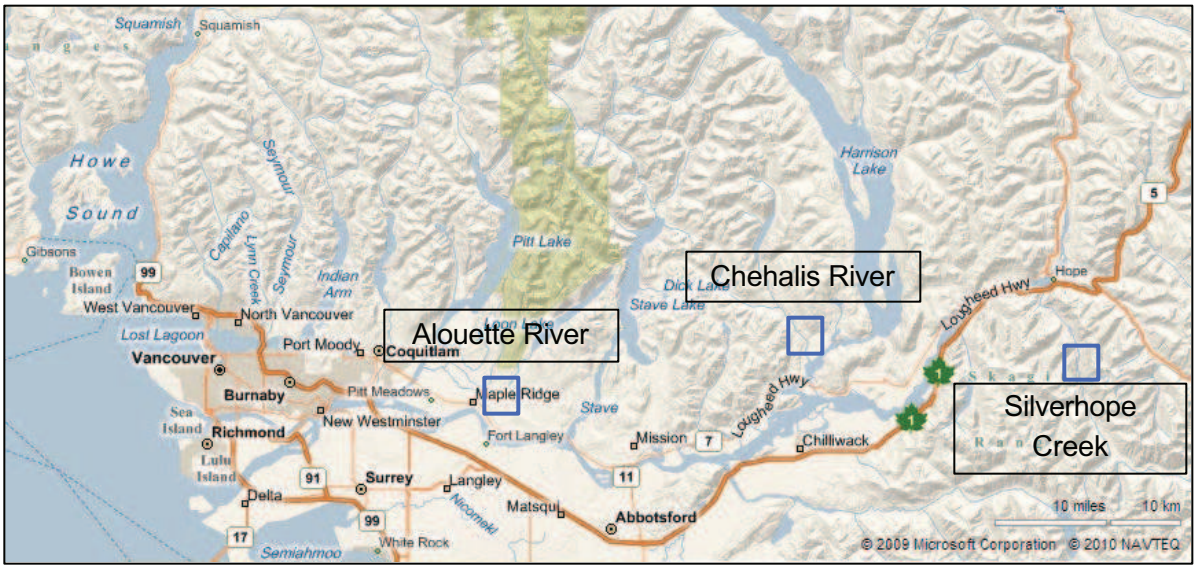
2. Additional support, whether paid labor or volunteer personnel is extremely beneficial, and often more efficient to complete activities

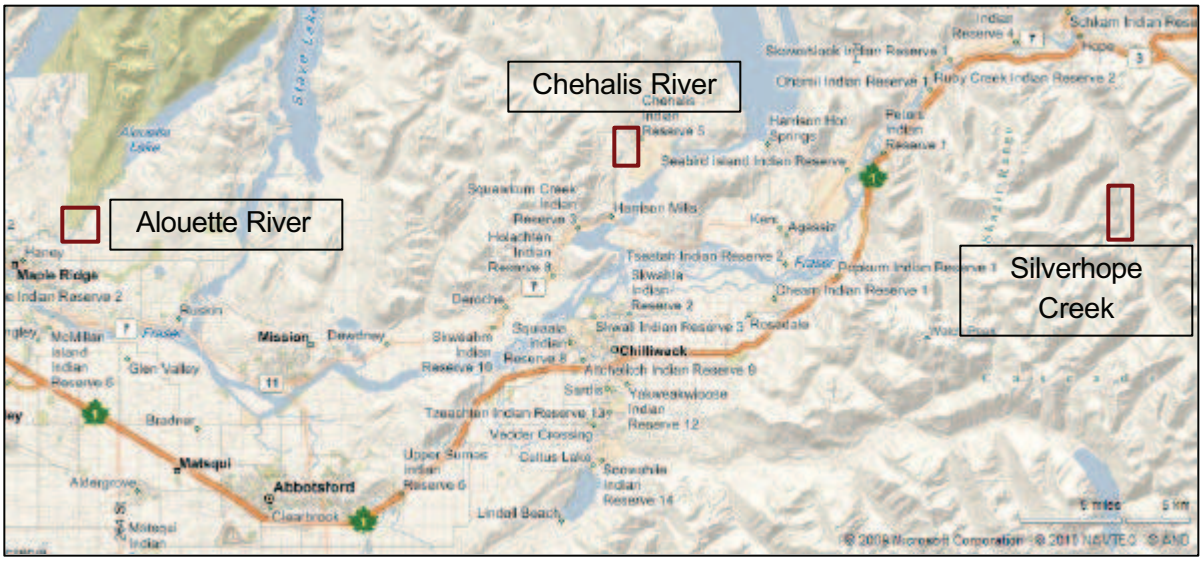
3. The greater your network base, the more effective and efficient a project can operate.

8. Appendices

REQUIRED: attach all DOCUMENTATION of Final Outcomes, listed above in section 3.3. These may include technical reports, maps, photos, evidence of communications, lists of meeting participants, etc.

APPENDIX I – Spatial map of project activities





APPENDIX II – Biological and Physical Study results

BIOLOGICAL ASSESSMENT

A post-treatment monitoring design is commonly utilized for effectiveness monitoring of habitat restoration treatments (Roni 2005; Slaney 2006). This involved summer day-time, and winter night-time snorkel survey assessments, conducted to capture seasonal variability of habitat use. Salmonids emerge from concealment at different diel periods during summer and winter months; diurnal (summer) and nocturnal (winter). Summer surveys were completed when water temperatures and flows result in typical daytime foraging behaviour observed in salmonids. Winter snorkel surveys were completed when flows are moderated by snow-packs, and parr still inhabit over-wintering habitats before spatial re-distribution (Slaney 2006). Winter underwater fish counts are critical, because harsh over-wintering conditions have been shown to cause the highest juvenile mortality rates in coastal streams (Ward and Slaney 1988), and this is a period when steelhead parr maximize use of juvenile mainstem LWD habitat (Roni and Quinn 2001).

Underwater fish enumeration surveys, focusing on size/age classes, were used to evaluate fish abundance within the study site types. Three site categories were chosen to reflect the diversity of habitat characteristics, and illustrate the effects of woody debris at a *site* monitoring level:

a) Treated: Sites of introduced large woody debris habitat that were artificially constructed;

b) Control: Sites were selected with otherwise good fish habitat characteristics, though void of natural woody debris. These sites are chosen to represent the pre-treatment state of restored sites;

c) Wood Control: Sites were chosen to exhibit prime natural fish habitat conditions, with natural woody debris characteristics.

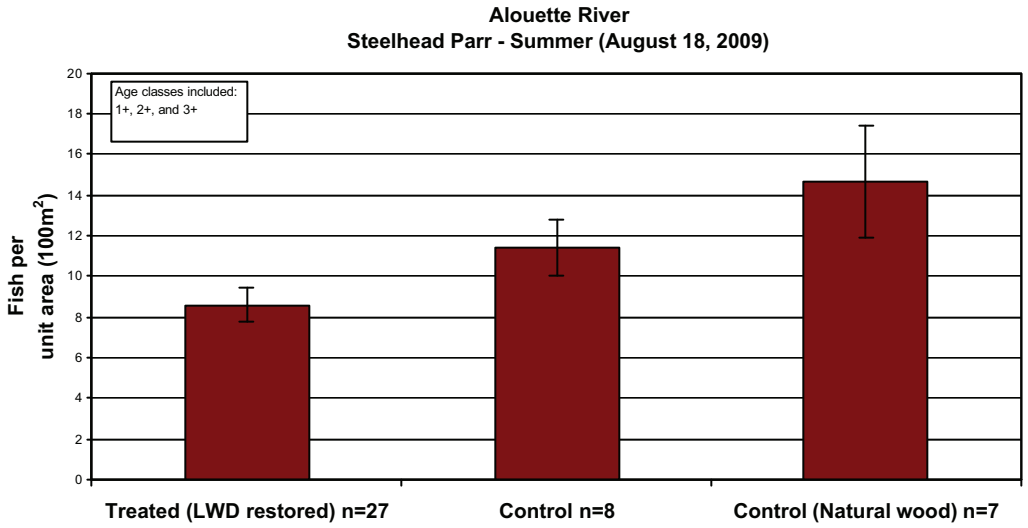
Site dimensions (per site type), were determined based on river morphology and hydraulics associated with the site. Treated sites included the entire area that was influenced by the introduced woody debris, on three sides: upstream and downstream limitations of the woody debris structures and off of the apex of the structure. Control, and wood control sites were selected predominately using longitudinal river reach characteristics to set the upper and lower survey site boundaries. Noticeable scour depth changes in a cross-sectional plane were used to determine the width of the survey site. An upper and lower riffle would typically set the longitudinal site break. Site dimensions' were visually estimated. Sites were randomly selected for "test" measurements to ensure that the site estimations that were being made by personnel were acceptable. Site dimensions were later used to express the abundance of fish observed per area (100 m^2).

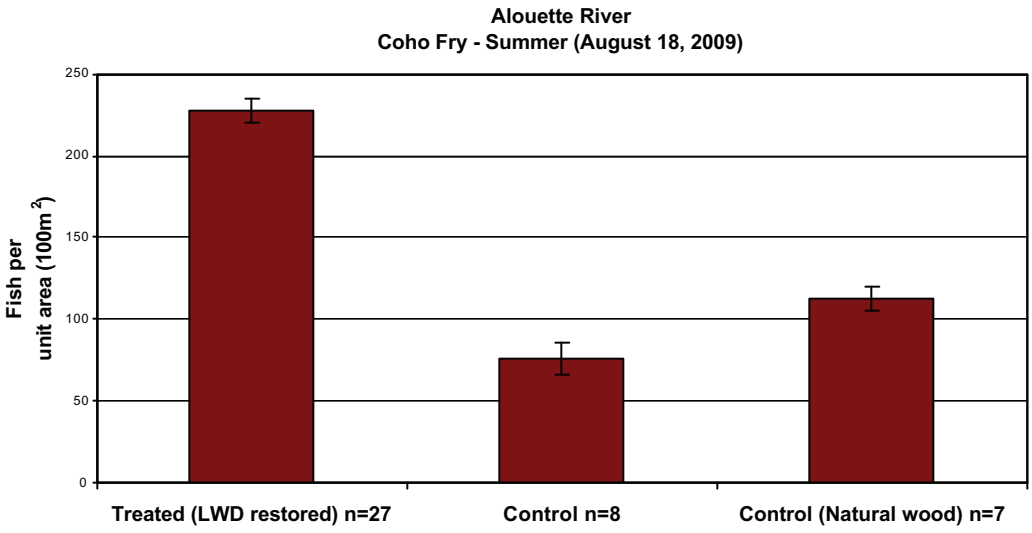
Systematic underwater fish counts, targeted steelhead parr, and steelhead fry and coho fry; however, all species observed were counted. Fish were counted by age class based on length estimations made visually by experienced snorkelers. Day-time counts were conducted after mid-day when water temperatures increased and fish activity peaked. Winter swims were conducted after darkness, or after 2100 hrs, to ensure that sun light would not trigger fish concealment behaviours.

Standard counting lanes were used with the lane width set according to the observers' visual (fish-detectable) distance. All three swimmers record fish straight ahead, and towards the stream bank from them (constitutes their lane); until the next swimmers lane. Winter, night-time enumerations are carried-out identical to summer day time swims, though sealed underwater LED (light Emitting Diode) dive lights are used. Night-time swims were conducted at a slower pace to ensure complete enumeration of habitat occurred with the dive lights.

ALOUETTE RIVER - Summer

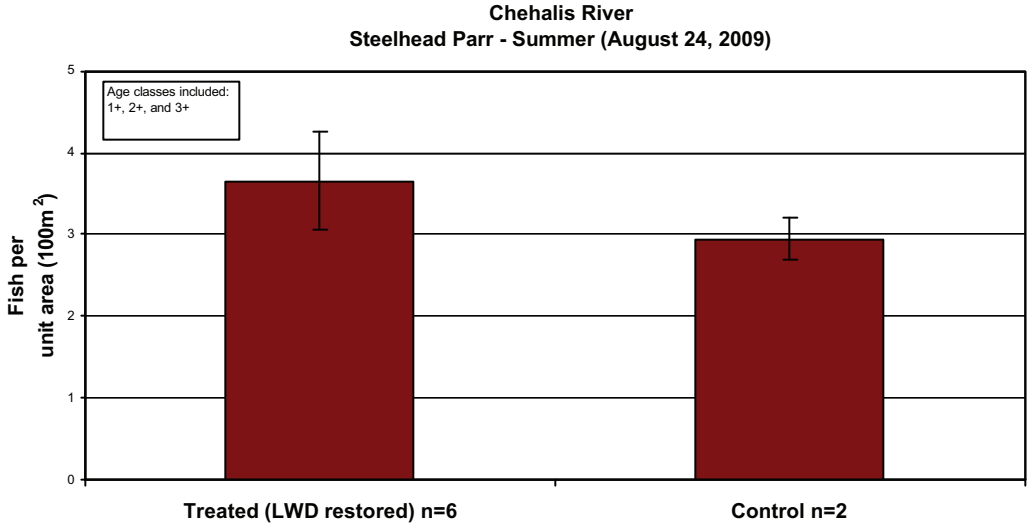
Summer				Steelhead			
Site Type	**Total Area Surveyed (m^2)**	**Fish Abundance**	**Co**	**0+**	**1+**	**2+**	**3+**
LWD Sites n=27	2419	Total Count	5114	298	139	51	2
		Avg. per 100 m^2	228	13	6	2	0
		Age class composition (%)	N/A	60.8	28.4	10.4	0.4
Control Sites n=8	669	Total Count	467	127	49	24	1
		Avg. per 100 m^2	76	19	8	3	0
		Age class composition (%)	N/A	63.2	24.4	11.9	0.5
Wood Control Sites n=7	690	Total Count	813	123	67	24	1
		Avg. per 100 m^3	113	17	11	3	0
		Age class composition (%)	N/A	57.2	31.2	11.2	0.5

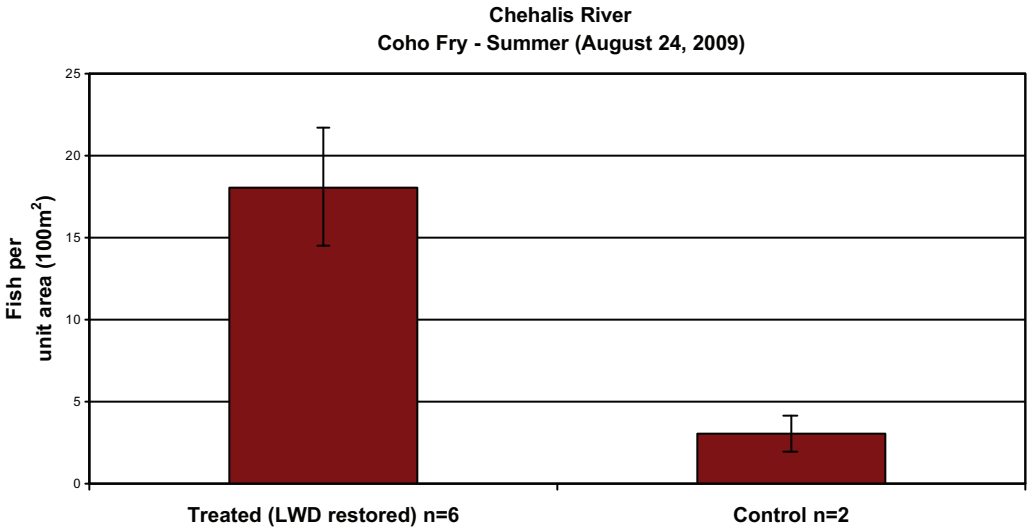




CHEHALIS RIVER - Summer

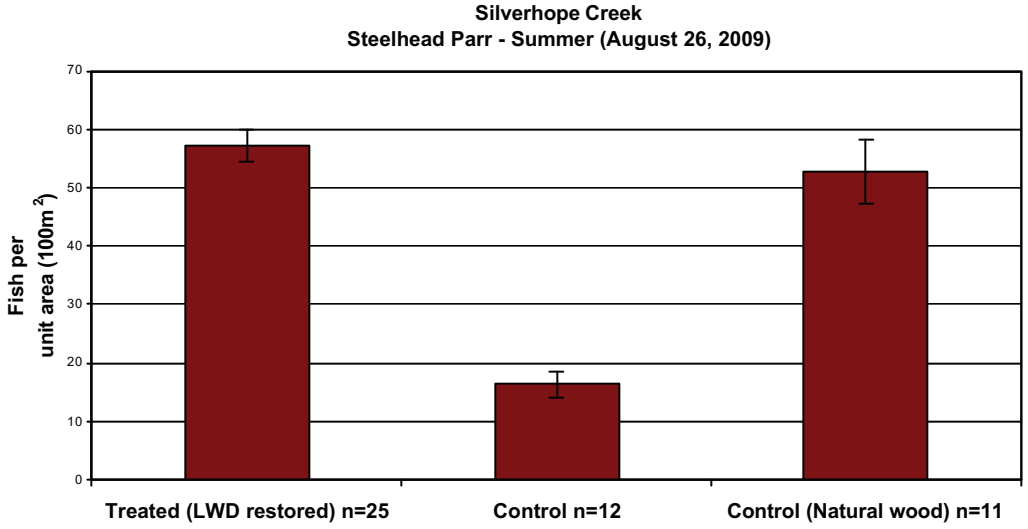
Summer				Steelhead			
Site Type	**Total Area Surveyed (m^2)**	**Fish Abundance**	**Co**	**0+**	**1+**	**2+**	**3+**
LWD Sites n=6	605	Total Count	114	43	18	1	3
		Avg. per 100 m^2	18	7	3	0	1
		Age class composition (%)	N/A	66.2	27.7	1.5	4.6
Control Sites n=2	240	Total Count	7	8	7	0	0
		Avg. per 100 m^2	3	3	3	0	0
		Age class composition (%)	N/A	53.3	46.7	0.0	0.0

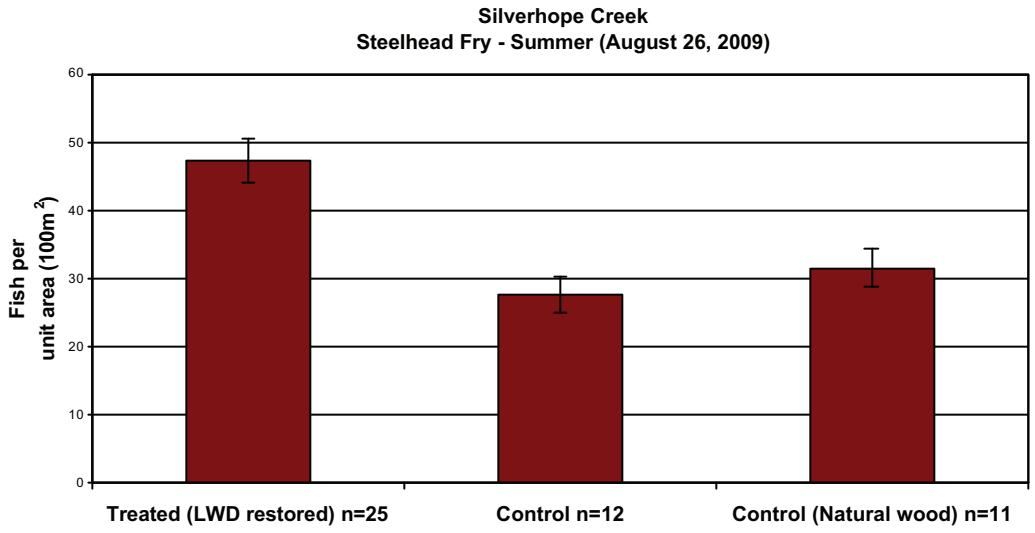




SILVERHOPE CREEK - Summer

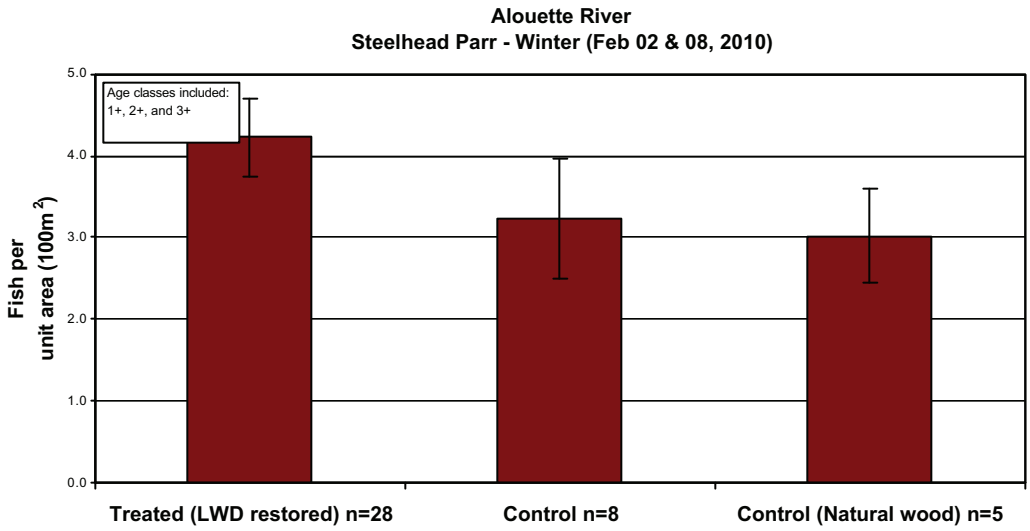
Summer			Steelhead			
Site Type	**Total Area Surveyed (m^2)**	**Fish Abundance**	**0+**	**1+**	**2+**	**3+**
LWD Sites n=25	3307	Total Count	1309	1080	510	105
		Avg. per 100 m^2	47	36	17	4
		Age class composition (%)	43.6	36.0	17.0	3.5
Control Sites n=12	1244	Total Count	324	157	55	2
		Avg. per 100 m^2	28	12	4	0
		Age class composition (%)	60.2	29.2	10.2	0.4
Wood Control Sites n=11	1004	Total Count	330	326	174	16
		Avg. per 100 m^3	31	34	17	2
		Age class composition (%)	39.0	38.5	20.6	1.9

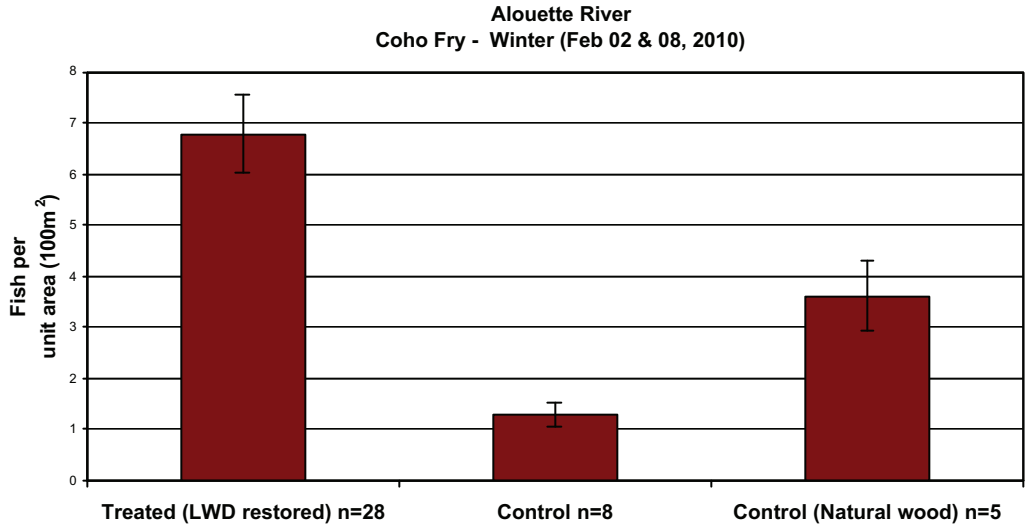




ALOUETTE RIVER - Winter

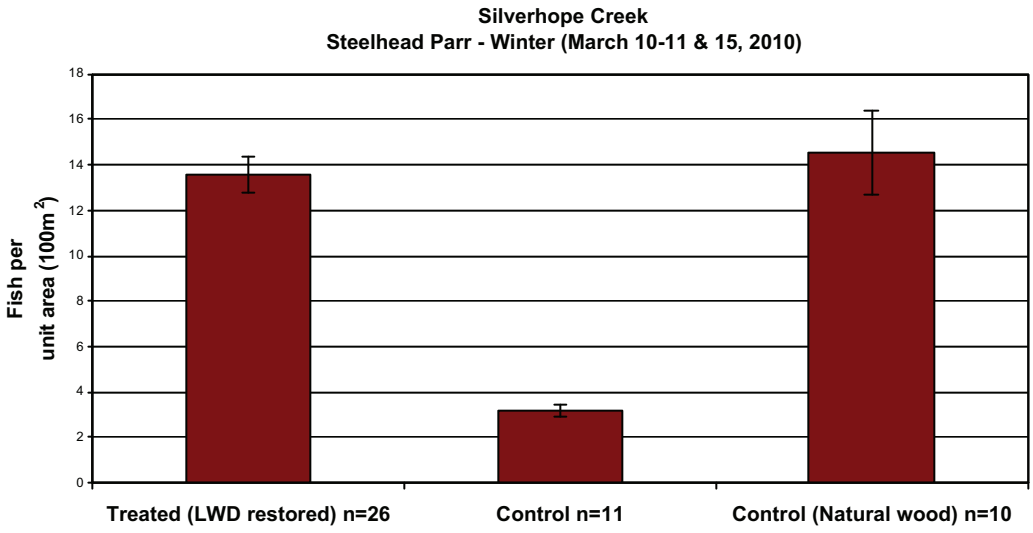
Winter				Steelhead			
Site Type	**Total Area Surveyed (m^2)**	**Fish Abundance**	**Co**	**0+**	**1+**	**2+**	**3+**
LWD Sites n=28	2496	Total Count	179	147	76	33	2
		Avg. per 100 m^2	7	6	3	1	0
		Age class composition (%)	N/A	57.0	29.5	12.8	0.8
Control Sites n=8	679	Total Count	9	27	18	2	0
		Avg. per 100 m^2	1	4	3	0	0
		Age class composition (%)	N/A	57.4	38.3	4.3	0.0
Wood Control Sites n=5	488	Total Count	16	30	14	3	1
		Avg. per 100 m^3	4	7	2	0	0
		Age class composition (%)	N/A	62.5	29.2	6.3	2.1

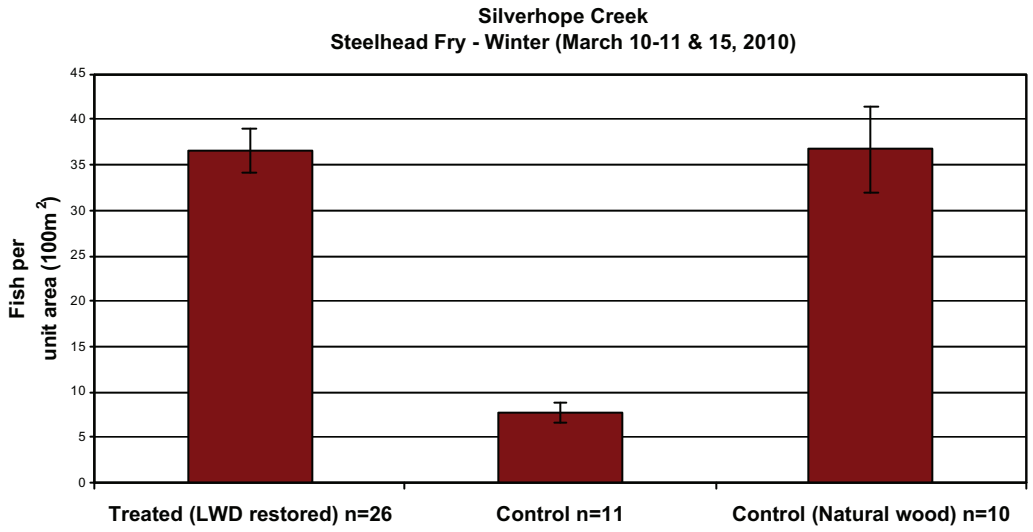




SILVERHOPE CREEK - Winter

Winter			Steelhead			
Site Type	Total Area Surveyed (m^2)	Fish Abundance	0+	1+	2+	3+
LWD Sites n=26	3454	Total Count	1009	280	112	23
		Avg. per 100 m^2	36	9	4	1
		Age class composition (%)	70.9	19.7	7.9	1.6
Control Sites n=11	1150	Total Count	88	19	12	6
		Avg. per 100 m^2	8	2	1	0
		Age class composition (%)	70.4	15.2	9.6	4.8
Wood Control Sites n=10	886	Total Count	274	96	28	10
		Avg. per 100 m^3	37	11	3	1
		Age class composition (%)	67.2	23.5	6.9	2.5

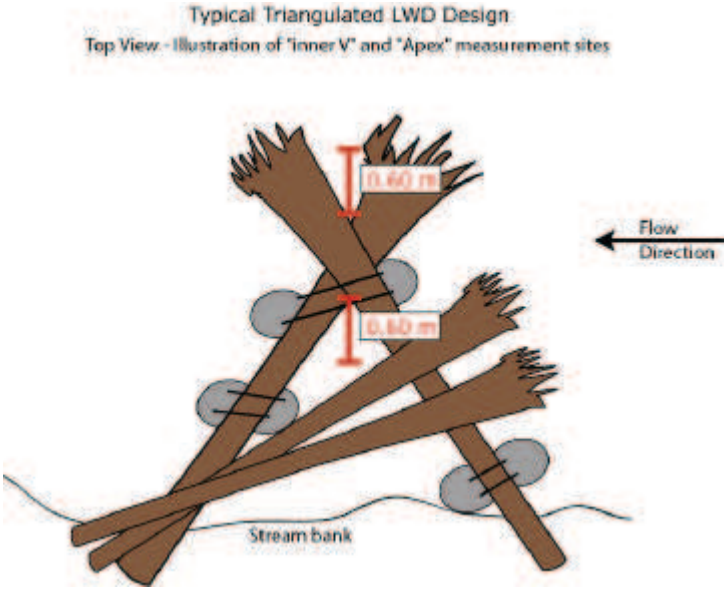




PHYSICAL EVALUATION OF LWD

Using a modified version of the Watershed Restoration Program – Forest Investment Account protocol *Guidelines for in-stream and off-channel effectiveness evaluation* (Anonymous 2003) physical stream bed changes (ie. scour) caused by the interaction of the wood structures with the natural hydraulic processes were assessed. The inspection evaluated: pool development and gravel deposition; stream bank protection; and stream/habitat cover. These three parameters were ranked using a standardized key which gives a rating from 0-4, with 4 being the optimal value. Using a measuring rod, water depths were recorded for: mean, maximum, "apex" (off of the point of the triangulated structure), and "inner v" (within the v formed in the triangulated structure) depths (figure 2). Similarly, the integrity of the structures was evaluated, and any concerns/issues documented for later adaptive response.

The LWD integrity component reviews: fastening components (epoxy adhesive, cable clamps, "farmers eye", log staples); sufficient cable attachments to secure tree bases and boulders ballast; sufficient boulder ballast; evidence of structure shifting; and any potential human, or physical hazards.



Standardized locations for measuring water depth at triangulated LWD structures. Measurements are taken in the "inner V" and off of the "Apex", as well as mean and maximum depths with the area of influence of the structure.

ALOUETTE RIVER	% Composition of Evaluated Sites	
	Pool Development and Gravel Deposition	Fish Habitat Cover
Exceeds Expectations	32	18
Between "Exceeds" and "Meets"	0	0
Meets Expectations	57	71
Between "Meets" and "Does Not Meet"	0	0
Does Not Meet Expectations	11	11
Habitat Unit Failure	0	0

ALOUETTE RIVER				
	Mean Depth (m)	Max Depth (m)	Apex Depth (m)	Inner "v" Depth (m)
Minimum	0.3	0.9	0.9	0.1
Maximum	0.9	1.2	0.7	0.8
Mean	0.4	0.8	0.8	0.4

CHEHALIS RIVER	% Composition of Evaluated Sites	
	Pool Development and Gravel Deposition	Fish Habitat Cover
Exceeds Expectations	0	0
Between "Exceeds" and "Meets"	33	33
Meets Expectations	67	67
Between "Meets" and "Does Not Meet"	0	0
Does Not Meet Expectations	0	0
Habitat Unit Failure	0	0

CHEHALIS RIVER				
	Mean Depth (m)	Max Depth (m)	Apex Depth (m)	Inner "v" Depth (m)
Minimum	0.5	1.0	0.7	N/A
Maximum	0.7	1.1	1.1	N/A
Mean	0.6	1.0	0.8	N/A

SILVERHOPE CREEK	% Composition of Evaluated Sites	
	Pool Development and Gravel Deposition	Fish Habitat Cover
Exceeds Expectations	41.5	41.5
Between "Exceeds" and "Meets"	22.0	7.3
Meets Expectations	29.3	39.0
Between "Meets" and "Does Not Meet"	0.0	0.0
Does Not Meet Expectations	7.3	12.2
Habitat Unit Failure	0.0	0.0

SILVERHOPE CREEK				
	Mean Depth (m)	Max Depth (m)	Apex Depth (m)	Inner "v" Depth (m)
Minimum	0.3	0.6	0.4	0.1
Maximum	1.5	2.3	2.3	1.5
Mean	0.6	1.0	0.9	0.7

APPENDIX III – Silverhope Creek Side-channel Population Estimate

Between February 23 - 25, 2010, a side-channel juvenile mark and re-capture study was performed on a restored side-channel at the Silverhope Creek. Minnow/Gee traps were placed in the channel and spaced ~5m apart and in the most suitable locations for trapping fish. The channel measured a total linear length of 360m (average width was 1.5m). Eighty chum roe baited gee traps were placed in the channel. In 2008 a pilot study was conducted by BCCF in this same channel to gain an understanding so that a more thorough trapping exercise could be conducted this year. The trapping density in 2008 was originally based on studies conducted in the Cheakamus River off-channel projects (one trap per 10m segment).

The population estimate is 824 steelhead juveniles, age classes 0+, 1+, and 2+. The population range is 1107 to 599. The number of steelhead juveniles per $100m^2$ equates to 1.52. A modified version of the Lincoln-Peterson mark and re-capture estimation (Chapman 1954) has been used for this population estimate.

Silverhope Creek - Restored Side-channel mark and re-capture study. February 23-25, 2010								
	Day 1 - # of fish captured and marked	Day 2 - # of fish re-captured (TOTAL)	Day 2 - # of fish re-captured - (MARKED)	Day 2 - # of fish re-captured - (NO MARK)	Pop'n Est.	Marked fish as a percent of pop'n est.	Total Marked fish X Total Captured Fish	4 X Pop'n Est.
Upper channel	67	423	34	389	824	8.13	28341	3295

* Data includes steelhead only, no char data included

1) It has been recommended that, in order for a mark-recapture estimate to be statistically valid, the number of marked fish per site must amount to at least 20% of the catch or population estimate (N) (Robson and Regier 1964).
2) In addition, the total number of fish marked (Day 1) multiplied by the number of captured fish should be more than 4 times the total estimated population to avoid low number bias.