Fubar Creek Phase II Instream Restoration Project
Monitoring Report 2008

Fubar Creek Smolt Trap

Construction of logjam at meander bend 2007

Photo Point 3 pre-project 2007

Photo Point 3 post-project May 2008

November 2008

USDA Forest Service
Tongass National Forest
Craig Ranger District

SUMMARY

Stream restoration was conducted on a 600 meter reach of Fubar Creek during summer 2007. This report compiles data for channel morphology and adult fish monitoring conducted in the project area.

Monitoring tasks included the following:

- Established channel cross sections, measured longitudinal profile, and measured substrate to provide baseline data and characterize the dimensions, pattern, and profile of the channel prior to project implementation in 2007.
- Re-measured established 11 cross sections, one longitudinal profile, and pebble counts at 5 locations along the project reach to quantify channel changes that have occurred post-project.
- Quantified changes in fish habitat characteristics by comparing pool and large wood counts to habitat surveys completed in 1998.
- Monitored a series of 30 photo points throughout the reach to show changes in channel morphology and vegetation.
- Conducted in-stream adult pink and chum escapement counts through snorkel survey methods

Monitoring results confirm that changes have occurred from pre-project to post-project. Several indicators such as substrate, pool frequency, and large wood suggest a trend in positive change in Fubar Creek Phase II as a result of the stream restoration. There was an immediate increase in large wood which would be expected from a large wood placement project. Another positive indicator of recovery is the response of substrate which shows a coarsening of D_{50}, and a slight decrease in the D_{95}. Cross sectional data shows little change between 2007 and 2008 for all of the important channel morphology variables. This is not surprising given the amount of time that has passed since the project was completed.

Monitoring will be conducted again in the summer of 2009, 2011, and every five years thereafter with the exception of smolt trap data collection which will cease after 2009. Monitoring will concentrate on quantifying channel changes, qualitatively assessing changes in riparian vegetation and channel morphology through photo point documentation, and assessing adult coho, pink, and chum escapement throughout Fubar Creek through snorkel survey methods.

INTRODUCTION

Located on Prince of Wales Island in Southeast Alaska on the Tongass National Forest, Fubar Creek forms one of three sub basins of the Harris River Watershed. Historically, Fubar Creek provided high-quality spawning and/or rearing habitat for coho, pink and chum salmon, steelhead and cutthroat trout, and Dolly Varden char. This system is one of a number of Prince of Wales Island streams in which ecosystem function has been impaired as a result of forest management activities that took place from the 1950's through the 1970's. In the 2006 Conservation Action Planning (CAP) process for Prince of Wales Island ranked the Harris River watershed, including Fubar Creek, as a top restoration priority. In addition, the Harris River Watershed Condition Assessment and Harris River Watershed Restoration Plan identify restoration needs and opportunities for Fubar Creek. The watershed area is approximately 4 square miles (2,560 acres) and about 520 acres (20%) of the drainage was harvested and a total of 4.2 miles of road constructed from 1960 through 1987. Nearly the entire floodplain riparian corridor was clear-cut, negatively affecting riparian function. Timber harvest, road construction, and subsequent road failure and sedimentation occurred along the valley bottom including the riparian area. Timber harvest removed trees along the stream banks that would otherwise provide shade, rearing habitat for juvenile fish, protect stream banks from erosion, and contribute large woody debris (LWD) to influence stream morphology. As a result, Fubar Creek became wider and shallower and is largely disconnected from its flood plain, limiting access to winter rearing habitat for juvenile fish and exacerbating stream bank erosion and sedimentation. In 1993 a large storm event triggered eleven landslides in the Fubar Creek sub basin. Four of the eleven landslides reached Fubar Creek and deposited debris containing high volumes of gravel and sediment directly into the stream and floodplain. Significant downstream impacts occurred as a result and the channel heavily aggraded, producing a "bulge" of material in the stream channel just upstream of the highway bridge. This "bulge" caused Fubar Creek to abandon its historic channel and the resulting downstream channel has become incised and disconnected from the floodplain. Overall, the density of LWD and other habitat-forming structures within Fubar Creek was low, resulting in channel instability and less complex and diverse rearing habitat for juvenile fish.

The first sizeable in-stream restoration project on Fubar Creek occurred in 2006 (Fubar Phase I). Design work relied upon channel geometry equations, stream flow patterns, reference reach evaluation, and HEC-RAS modeling. A total of 2,500 linear feet of the historic channel and adjoining floodplain were reconstructed, and large log jams and pools were reestablished. Using heavy equipment, contract crews placed over 200 logs and other natural materials into the channel to create the complexity required for high quality salmon and steelhead habitat. Additional rock work was completed at the bridge site to ensure the long-term stability of the structure during all flows. As a result of this in-stream work, the first perennial flows occurred in the historic channel since the 1993 landslides.

Fubar Phase II in-stream restoration began in 2007 and extends downstream of Phase I approximately 2,900 feet to the confluence with the Harris River (**Figure 1**). This stream segment was considered disconnected from the floodplain due to channel degradation. Phase II focused on in-stream habitat improvement through floodplain roughening, bank stabilization, and placement of large wood. Over 150 logs, primarily young-growth averaging 24" dbh, were placed at eleven sites within the stream reach to create new log jams and debris complexes or to improve deteriorating log jams and debris complexes. This work is expected to accelerate natural recovery of fluvial processes

and to restore and increase available year-round rearing habitat for juvenile coho salmon and steelhead trout within the floodplain and mainstem of Fubar Creek. Re-establishing the health of the stream and riparian habitat will in turn influence the productivity of the surrounding terrestrial habitat and species inhabiting these areas.

An important component of this restoration project is monitoring, both quantitatively and qualitatively, the changes brought about to the stream channel and fish habitat by this project. The methods employed for monitoring the physical channel characteristics for Phase I and Phase II of the project included measuring channel morphology through permanent cross-sections and longitudinal profiles, habitat surveys, pebble counts, and photo points. Biological monitoring of the project utilized a rotary screw trap, which was placed toward the downstream of Fubar Phase I in spring 2007. This trap has monitored out-migrating coho and steelhead smolts and pink and chum salmon fry for the past two seasons and is scheduled to continue operation in 2009.

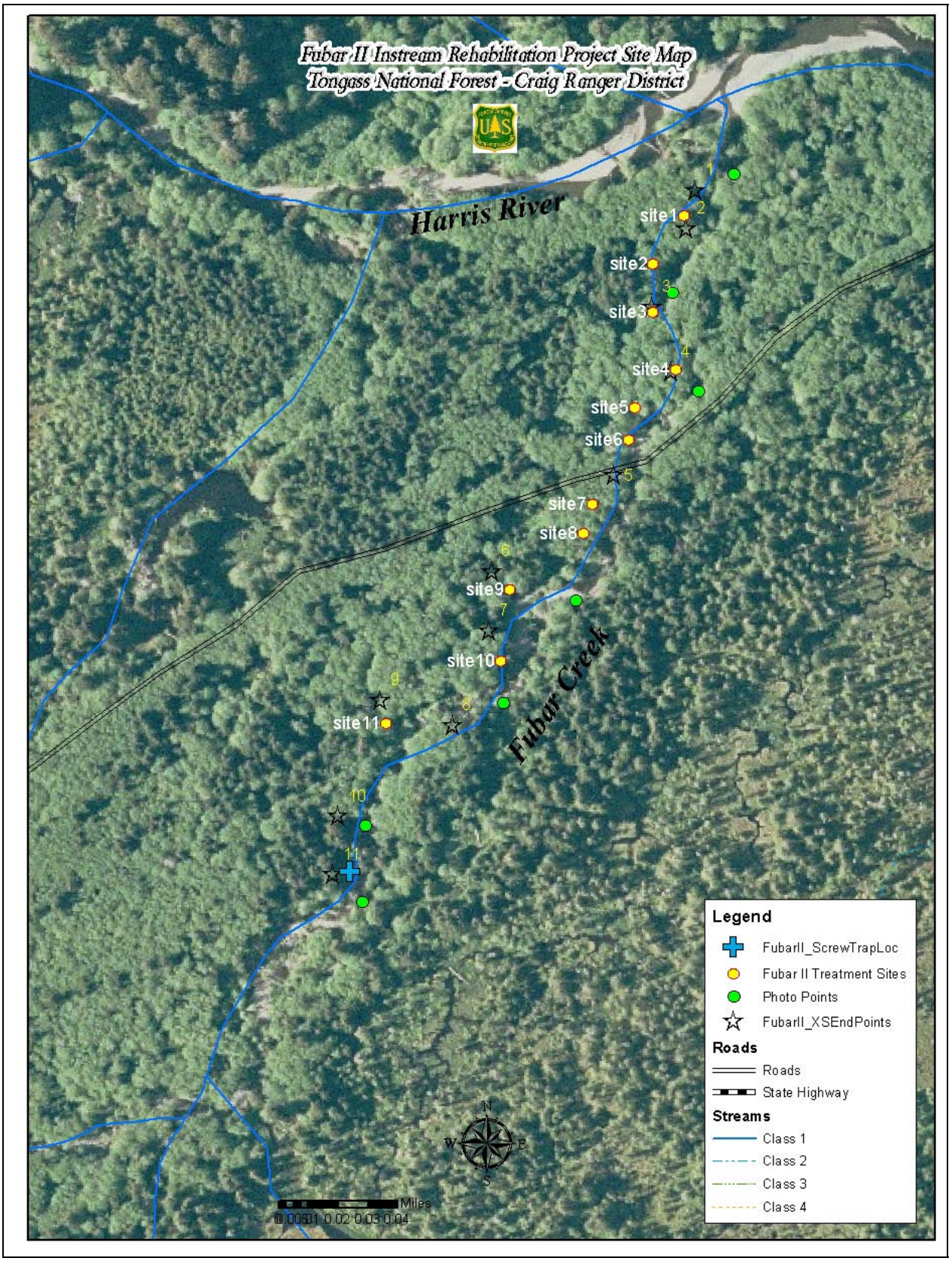

Figure 1. Site Map of Fubar Creek Phase II Instream Restoration Project.

MONITORING OBJECTIVES

The overall objective of monitoring the Fubar Creek Phase II Instream Restoration Project is to document, both qualitatively and quantitatively, both the effects of the project on fish and fish habitat as well as the recovery of fluvial processes. Specific objectives include:

- Compare changes in channel morphology resulting from the project by measuring the channel dimensions and profile.
- Quantify changes in fish habitat characteristics by comparing pool and large wood counts, sediment size and distribution.
- Estimate changes in fish production utilizing a smolt trap and spawner surveys.
- Show visual changes in channel characteristics and vegetation over time through photo point documentation.

MONITORING METHODS AND SCHEDULE

Monitoring efforts focus on channel location, channel morphology, sediment regime, fish habitat characteristics and population numbers, and channel-floodplain connectivity. Photo points, morphology surveys, and woody debris and pool counts will be used to document the response of the new channel to normal flow and floods following reconstruction. Biotic monitoring will employ adult pink and chum escapement counts and a Rotary Screw Trap to estimate smolt production throughout a minimum of a three-year period with future follow-up as budgets allow. The recommended period of time to monitor physical changes associated with this project would be a minimum of three years, however, fifty years would provide a far better understanding of channel changes through varying hydrologic conditions.

Fubar Creek Phase II pre-project monitoring occurred in July 2007, prior to implementation, with the first post-project monitoring occurring in September 2007 and again in 2008. Subsequent monitoring is scheduled for 2009 and 2011 and then every 5 years thereafter.

All stream channel and fish habitat characteristics monitoring utilizes the repeated measures concept where the baseline physical parameters of the stream are measured prior to treatment and these parameters are then remeasured and compared to the baseline data as well as to the normal range of expected variation for similar stream types over varying time intervals. Monitoring of the same core parameters over longer time intervals is necessary to quantify changes in stream habitat as the wood additions are subjected to high flows and other stressors.

Morphology Surveys
Channel morphology surveys were used to identify changes in channel location, width to depth ratios, and channel gradient. Cross-section and longitudinal surveys have been used to monitor segments of Fubar Creek over the last 16 years. The USDA Forest Service General Technical Report RM-245, Stream Channel Reference Sites: An Illustrated Guide to Field Techniques provides the exact protocol details for measuring cross sections, longitudinal profiles. In 2007, a 600m longitudinal profile survey was conducted along the Phase II Reach, and cross-sectional surveys were completed at five pools and five riffles located to capture key points throughout the channel (**Figure 1**). The longitudinal profile and cross-sections were remeasured in 2008.

The longitudinal surveys will be used to determine channel gradient over time. If the channel gradient changes following the project, it should be evident in the longitudinal profile. If the gradient changes enough to shift the channel location, this should be evident in the cross section surveys. Cross section surveys will show changes in channel location, channel erosion and channel sediment accumulation. The volume of accumulated or eroded sediments can then be calculated from cross-sectional data (see **Figure 2** for an example).

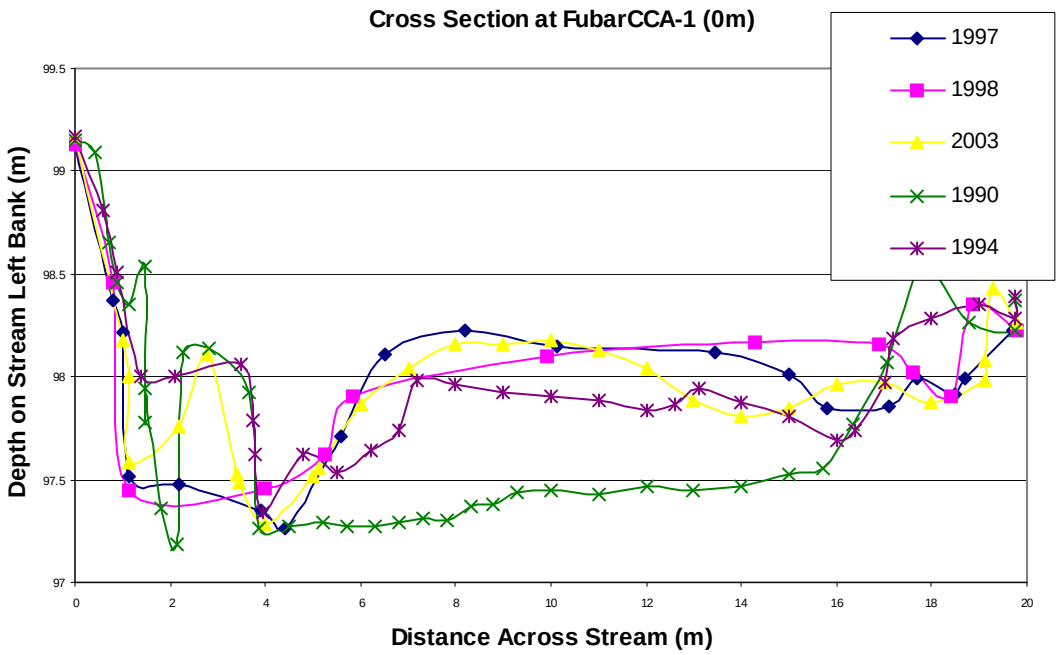

Figure 2. Example of a repeated cross section survey. Note the accumulation of sediment after the 1990 survey.

Habitat Surveys
The measurement of habitat characteristics can be used to show the amount and quality of habitat within the reach. The spatial distribution of large wood and pools may change through time in within a channel reach without a loss or gain of habitat, and as such the density or frequency of these habitat variables is what will indicate change. Less pool density within the channel reach would suggest less fish habitat and greater pool density may suggest more fish habitat. Large wood and pool counts were performed to supplement the morphology surveys and provide a clearer picture of

pre and post-project fish habitat. Habitat survey information on large wood and pool frequency was collected in 1998, and is used for the pre-project baseline data. Post-project implementation pool and wood counts were performed in 2008 according to the Alaska Region Aquatic Habitat Management Handbook Tier II stream survey protocol (USFS 2001). This survey is designed to efficiently measure pool, wood, and morphological characteristics and extract summary metrics that are the primary targets of restoration activities. Metrics derived from the Tier II survey can be compared to Region 10 habitat management objectives as well as project data throughout the restoration timeframe. The habitat survey was conducted along the same segment as the longitudinal survey in Fubar Creek.

Sediment Transport

Particle size distribution is used as an indicator of sediment regime, or the channel's ability to process sediments into, or out of, the channel reach. Pebble counts were performed along established cross sections as an indicator of channel storage, and hence bedload transport. Bedload transport is a function of flow and friction within the channel as well as channel morphological features. Changes in bedload can result from altered channel morphology, flow volumes, or flow velocities. Particle size surveys were conducted in 2007 and 2008 at cross section locations, with a minimum of 20 measurements per transect along 5 transects (minimum 100 count). Transects were located on the cross section as well as 5m and 10m upstream and downstream of the cross section. Transects went from bankfull to bankfull, and a gravelometer was used to sort the sediment into the following Wentworth size classes:

Less than 4 mm	Fines
4-5.7 mm	Fine Gravel
5.7-8 mm	Fine Gravel
8-11.3 mm	MediumGravel
11.3-16 mm	Medium Gravel
16-22.6 mm	Coarse Gravel
22.6-32 mm	Coarse Gravel
32-45 mm	Very Course Gravel
45-64 mm	Very Course Gravel
64-90 mm	Small Cobble
90-128 mm	Medium Cobble
128-180 mm	Large Cobble
180-256 mm	Very Large Cobble
256+ mm	Boulder

Changes in particle size distribution could suggest change in the sediment regime. Depending upon location within the channel, larger particle size may result from a loss in transport potential, or from a greater transport potential. An increased particle size at the end of a point bar may suggest increased velocity of flow at that location and hence increased transport potential. Particle size distribution can be used in combination with the channel morphology and habitat surveys to suggest fluvial and sediment processes occurring in specific channel sections.

Photo Points

For Fubar Creek Phase II Restoration, photo points were established to document changes in vegetation and channel morphology through repeated photography following the procedures outlined in the Photo Point Monitoring Handbook: Part A—Field Procedures (PNW-GTR-526, 2002). Information from photo points can be used qualitatively to show visual changes of channel characteristics through time. Photo points were established prior to construction, marked using a field stake, and surveyed onto a site map. Photo points were labeled for point identification, direction of photo, and recommended photo scales. Logjams, riffles, and riparian areas are a few of the channel morphologies intended for monitoring using photo points. Pre-project photos were taken in 2007 and the 2007 and 2008 post-implementation project photos were taken within two weeks of the date they were taken the previous year. Photo point monitoring will continue for three years post-project and continue to be conducted in sync with the physical habitat characteristics monitoring schedule.

Escapement Surveys

Escapement counts were completed once a week for 2-4 weeks in late August and early September, until a peak count of pink and chum adult salmon was achieved in both 2007 and 2008.

Smolt Trapping

A rotary screw trap was placed 400m downstream of the highway 913 bridge over Fubar Creek on the downstream end of the Phase I project, and upstream of Phase II. In 2007 the trap was fished for 47 days from April 24th to June 11th, and in 2008 the trap was fished for 50 days from April 15th to June 3rd. This sampling period is intended to coincide with the peak out-migration of steelhead and coho smolts. Figure 1 shows the location of the trap in reference to the restoration reaches.

MONITORING RESULTS

Surveys and data collection for Phase II were completed in 1998, 2007, and 2008. Not all data were collected in the three time frames, but pieces were collected within each. Channel morphology surveys were completed in 2007 and 2008. Wood and pool counts were sampled in 1998 and 2008.

Channel Morphology

Channel morphology surveys include longitudinal and cross section surveys. The surveys were completed pre-project in 2007 and post-project in 2008.

Cross Section

Cross sectional survey results were similar in 2008 when compared with 2007 pre-project data (**Tables 1 and 2**). A statistical analysis of all seven variables from the cross section data showed no significant difference between 2007 and 2008. There was a morphological change in two cross sections; however, the erosion in both cross sections was approximately balanced with deposition in the same section suggesting channel adjustment without additional deposition (**Figure 3**). Width to depth ratios remained similar between all cross sections except for Cross Section 3, where the average depth increased by 0.18 meters and the maximum depth increased by 0.15 meters, resulting in a decrease in the W/D ratio from 40 to 25 (**Figure 4**).

Table 1. Comparison of 2007 and 2008 Cross Sectional Data.

		Flood Prone Width		Bank Full Width		Entrenchment Ratio	
Site	Type	2007	2008	2007	2008	2007	2008
1	Pool	23.7	23.7	17.49	17.12	1.35	1.38
4	Pool	19.55	19.55	7.19	7.57	2.72	2.58
7	Pool	35	35.1	9.43	9.72	3.71	3.61
9	Pool	18.39	17.57	12.32	12.57	1.49	1.4
10	Pool	25.43	25.4	16.48	16.61	1.54	1.53
	Average	24.414	24.264	12.582	12.718	2.162	2.1
2	Riffle	19.09	20.52	12.79	14.02	1.49	1.46
3	Riffle	15.56	16	12.5	12.49	1.25	1.28
6	Riffle	50.12	45.37	26.25	22.79	1.91	1.99
8	Riffle	24.38	28.6	21.6	21.59	1.13	1.32
11	Riffle	24.13	24.1	18.01	15.67	1.34	1.54
	Average	26.656	26.918	18.23	17.312	1.424	1.518

Table 2. Comparison of 2007 and 2008 Cross Sectional Data continued.

		Mean Depth		Max Depth		Width/Depth Ratio		Cross Section Area	
Site	Type	2007	2008	2007	2008	2007	2008	2007	2008
1	Pool	0.61	0.61	0.79	0.92	28.67	28.07	10.67	10.4
4	Pool	0.57	0.53	0.84	0.73	12.61	14.28	4.13	4
7	Pool	0.91	0.94	1.31	1.61	10.36	10.34	8.57	9.16
9	Pool	0.18	0.16	0.39	0.28	68.44	78.56	2.18	2.07
10	Pool	0.82	0.74	1.12	1.12	20.1	22.45	13.48	12.34
	Average	0.618	0.596	0.89	0.932	28.036	30.74	7.806	7.594
2	Riffle	0.36	0.37	0.57	0.57	35.53	37.89	4.66	5.22
3	Riffle	0.31	0.49	0.61	0.76	40.32	25.49	3.92	6.08
6	Riffle	0.44	0.36	0.9	0.68	59.66	63.31	11.67	8.16
8	Riffle	0.49	0.56	0.96	1.65	44.08	38.55	10.65	12.04
11	Riffle	0.66	0.65	1.32	1.24	27.29	24.11	11.94	10.19
	Average	0.452	0.486	0.872	0.98	41.376	37.87	8.568	8.338

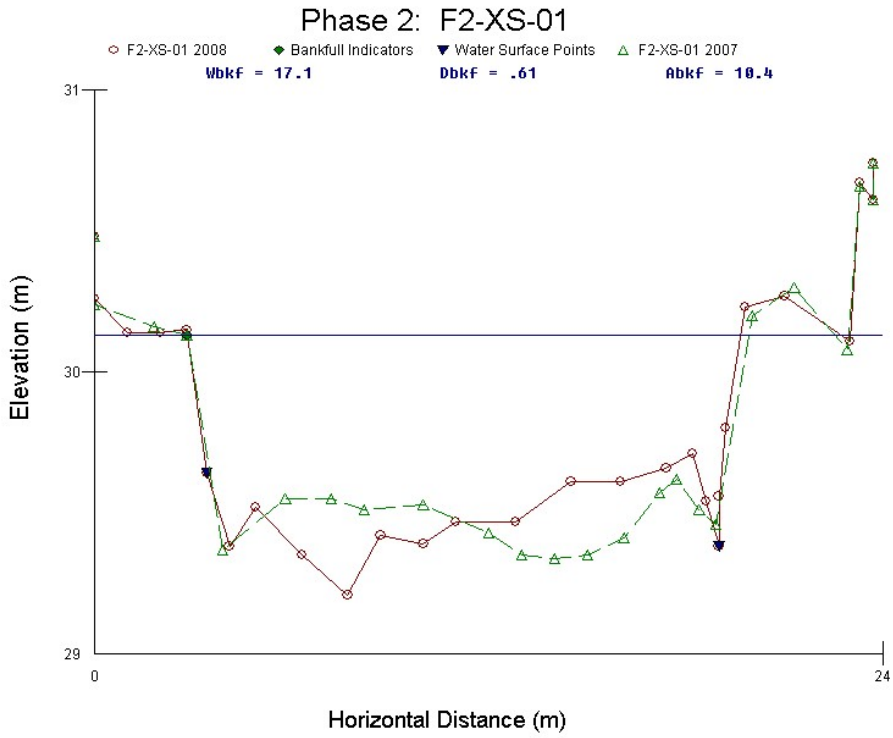

Figure 3. Changes in Fubar Phase II Cross Section XS-01 from 2007 to 2008.

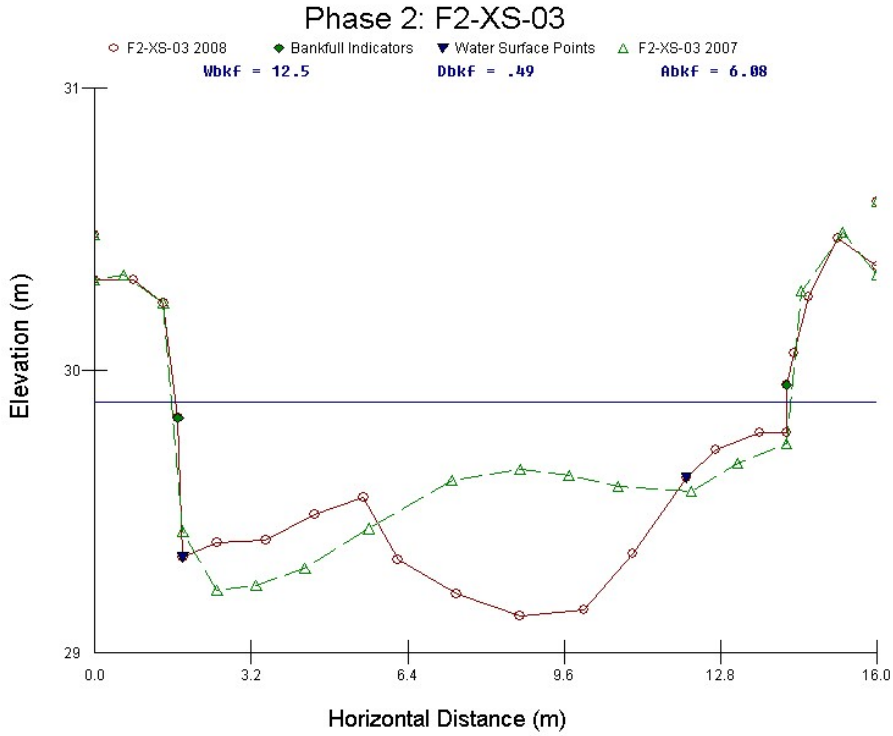

Figure 4. Changes in Fubar Phase II Cross Section XS-03 from 2007 to 2008.

Channel Profile

The slope of the longitudinal profile did not change between 2007 and 2008. The channel gradient remained 0.0096 along the profile length. Analysis of the longitudinal profile shows that residual pool depth in 2007 averaged 0.72 meters, while in 2008 the average decreased by 0.03 to 0.69 meters. The pool length in 2007 averaged 16.28 meters, while in 2008 the average pool length was 18.9 (**Table 3**). A statistical analysis shows no significant difference in either residual pool depth or pool length between 2007 and 2008.

Table 3. Comparison of 2007 and 2008 Residual Pool Depth and Pool Length.

2007		2008	
Residual Pool Depth	Pool Length	Residual Pool Depth	Pool Length
0.56	9.87	0.39	17
0.57	27.2	0.44	25.3
0.24	13.3	0.87	16.5
0.6	7.9	0.7	16.6
1.1	27.3	0.62	22.4
0.44	15.4	0.26	7.5
1.31	17.6	1.3	12.9
0.128	18	0.87	21.8
1.21	29.5	0.69	23.3
0.98	9.5	0.66	9.1
0.49	20.4	0.39	20
0.39	14.2	0.69	13.1
1.28	9.8	0.65	31.1
1.01	13.5	0.67	28
0.98	24.4	1.22	29.9
0.32	7.7	0.67	10.1
0.63	11.2	0.61	16.5
0.72	16.3	0.69	18.9

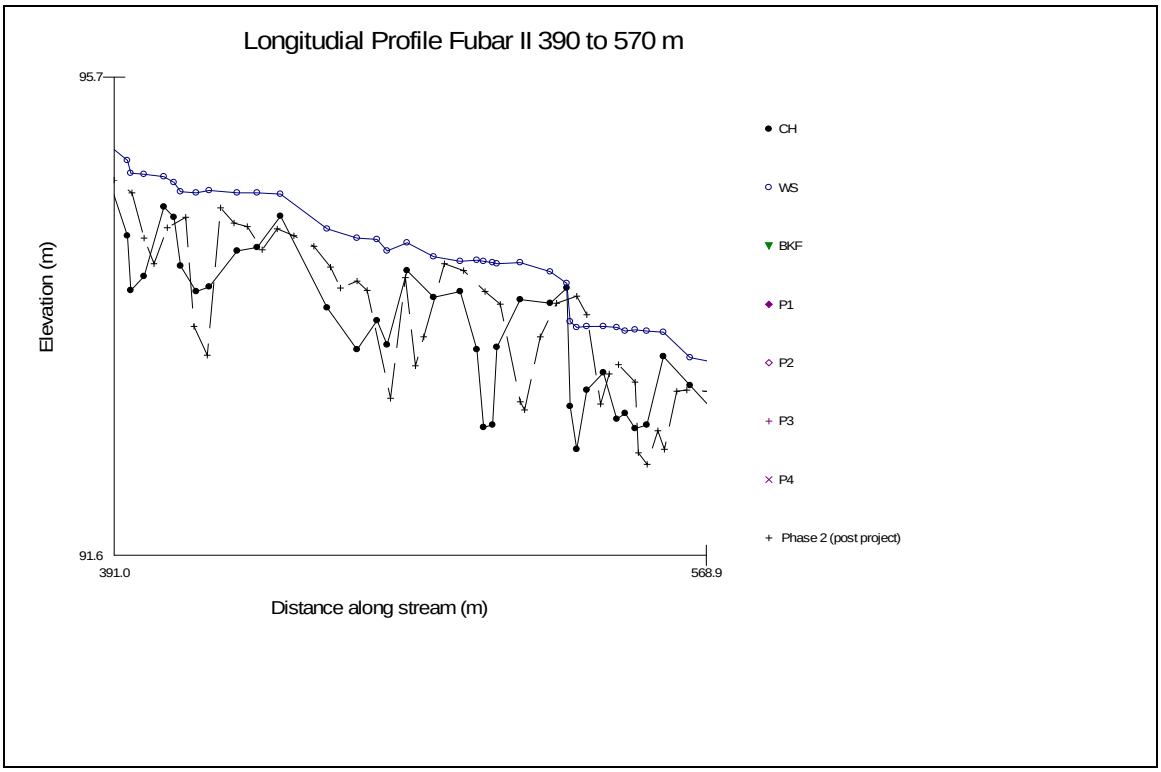

Figure 5. Longitudinal profile for Fubar Phase II showing 2007 data (dashed line) and 2008 data (solid line). Note the decrease in depth for several pools and pool movement.

Wood Debris Placement

One hundred and fifty pieces of wood meeting the Key Large Wood criteria (≥ 0.3 meters diameter and > 7.6 meter length) were placed in the Fubar Phase II reach to improve fish habitat and stream channel function. The large wood counts were conducted in 1998 and 2008. Unfortunately, there were no large wood counts taken just prior to project implementation in 2007. In comparing the 1998 and 2008 data, the total wood count increased greater than 100% between 1998 (200) and 2008 (445). This should be considered a minimum total wood count due to the inability of surveyors to measure wood which has been buried as part of the project or wood that is packed together in jams where length and diameter measurements were impossible to attain. Additionally, wood that was placed or exists within the floodplain outside of bankfull width is not counted as per protocol although it functions as a roughening agent during large flood events.

Table 4. Wood Counts for Fubar Phase II reach.

Phase 2 Segment	1998	2008
Total Wood Count	200	445
Total Pool Count	6	24
Avg. Residual Pool Depth	0.73 m	0.84 m

Pool Frequency
The pool counts increased 4 fold from 6 pools in 1998 to 24 pools in 2008. The Fubar II reach 2008 pool count falls within the 50th and 75th percentiles for pools according to the Region 10 habitat management objectives for undisturbed Floodplain (FP4) channels (Paustian 1992).

Sediment Transport
The pebble count information can be used to quantitatively evaluate the particle size distribution. **Table 5** shows the size percentage of substrate less than D16, D35, D50, D84 and D95, i.e., a D16 value of seven for 2007 data is translated to 16% of the substrate in the sample is less than 7mm in diameter (See **Figure 6** for an example). Note that pebble counts are inherently skewed toward the larger particles that resist movement at flows less than bankfull. Pebble counts were conducted pre-project in 2007 and post-project in 2008 at five sites. Statistical analysis shows that both the average D_{35} and D_{50} increased in diameter significantly ($P<0.05$) from 2007 to 2008. The average D_{50} increased post project from 24 mm to 32 mm and the percentage of gravel decreased from 82% to 76% (**Figure 7**). The change was largely noted in sites 2 and 8 where D_{50} increased from 24 mm to 37 mm and from 22 mm to 42 mm, respectively. There is less variability in grain sizes from 2007 to 2008 at sites 2 and 8. The variability in grain size had negligible change in the other three sites. It is important to note that while the D_{50} absolute value may change slightly (e.g. 39 mm to 48 mm) it is still a gravel bed channel. The D_{84} threshold has been determined to be the portion of the bed mobilized most frequently at the bankfull discharge and are the materials that determine channel bed form. The D_{84} values were almost identical between 2007 and 2008.

The composite trend that would indicate improvement would be a coarsening of the fine sediments, static or coarsening of median size and a fining of the larger particles. If the data showed improvement in two of three threshold values, the channel was improving. If there was improvement in only one threshold and no significant decline in the others the trend was considered static. If there was a decline in two or more thresholds the reach is in decline. Looking at the data, there is a significant ($P<0.04$) increase in the fine (sand) component (**Figure 8**), a significant coarsening of D_{50}, and a slight decrease in the D_{95}. Based upon the aforementioned criteria, the channel is considered to be improving.

Table 5. Comparison of Particle Size Distribution between 2007 and 2008.

	2007 Average (mm)	2008 Average (mm)	P value * Denotes Statistical Significance
D_{16}	7.0	9.1	0.32
D_{35}	15.2	21.5	0.05*
D_{50}	24.3	32.0	0.05*
D_{84}	67.7	67.7	0.99
D_{95}	101.9	93.5	0.27
% Sand	0.2	5.6	0.04*
%Gravel	82	76	0.08
% Cobble	17	20	0.25

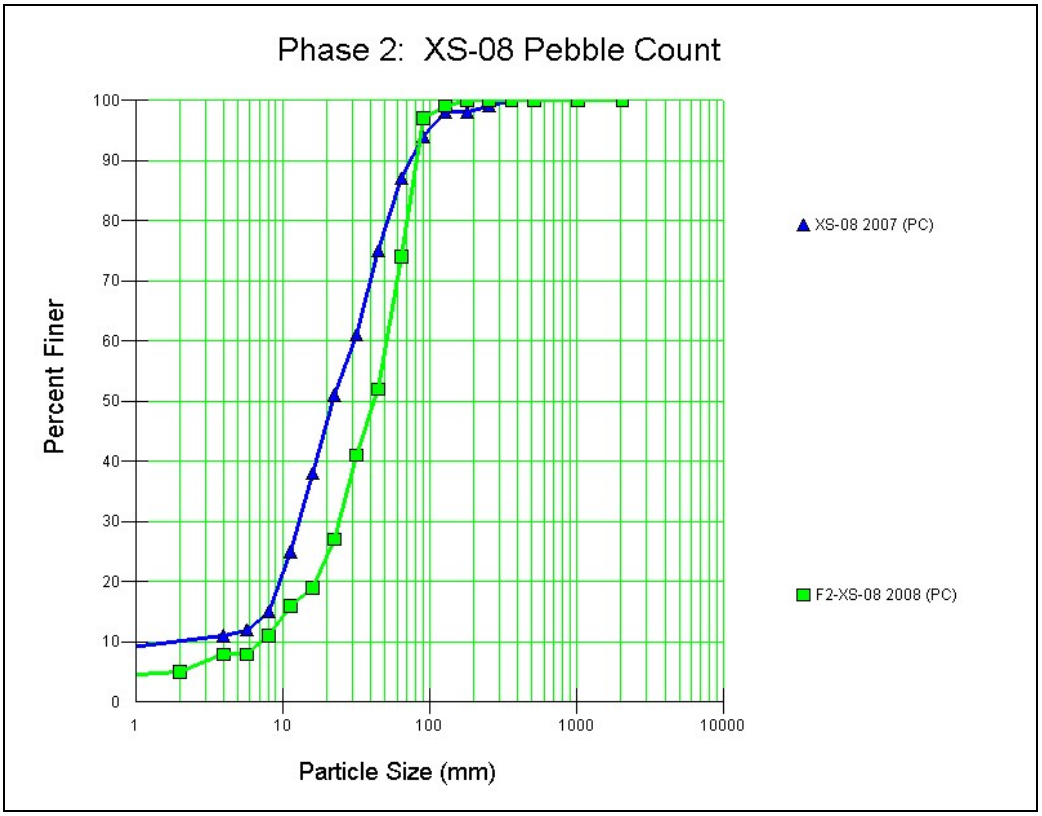

Figure 6. Particle Size Distribution for Cross Section 08.

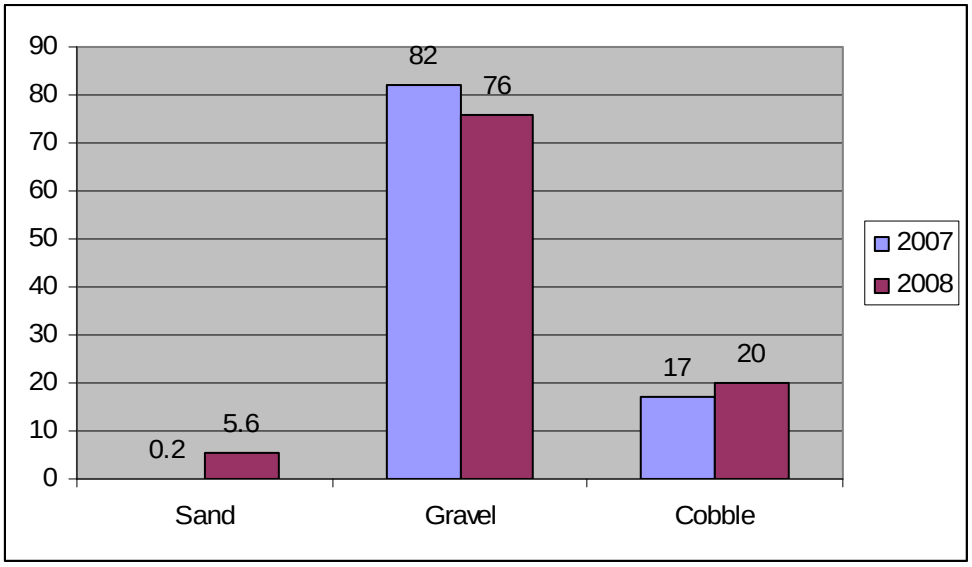

Figure 7. Comparison of Sediment Composition between 2007 and 2008.

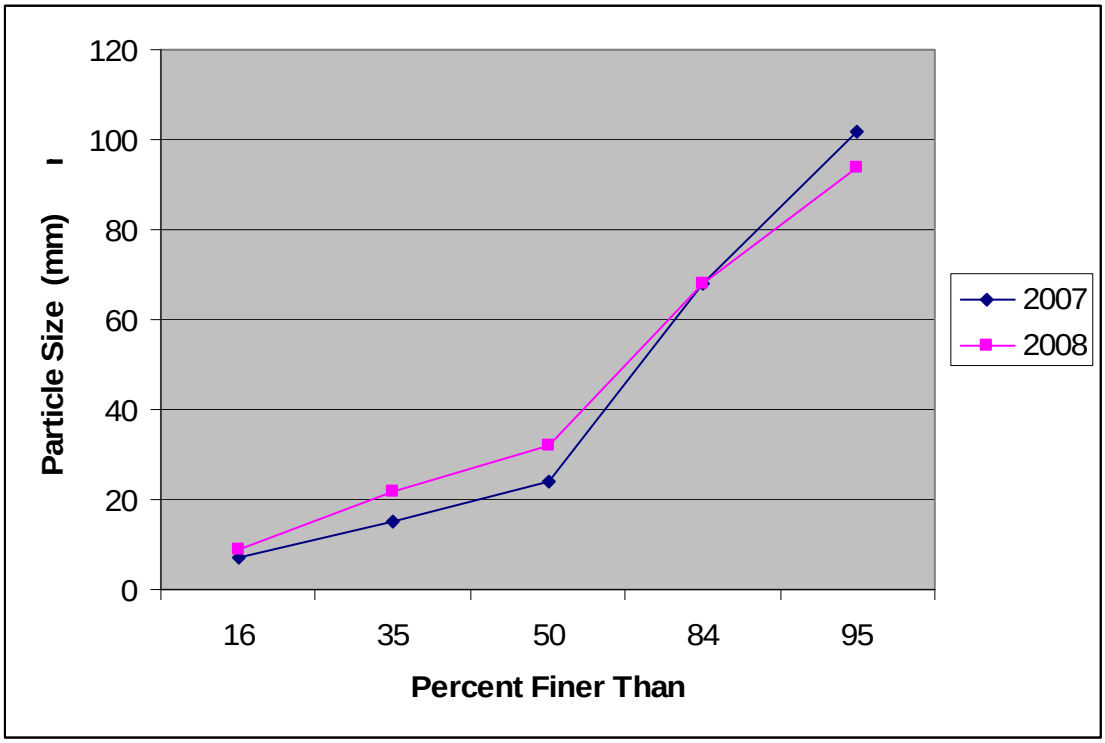

Figure 8. Comparison of D_{16}, D_{35}, D_{50}, D_{84} and D_{95} Particle Sizes (mm) between 2007 and 2008.

Photo Points

Photo points were used to qualitatively estimate the changes in several locations along the Fubar Phase II reach. There is an obvious increase in large wood between the pre-project and post-project photos (**Figure 9** displays two such examples). The photos indicate mostly stable wood placement with the exception of one existing stump that moved over the winter. Variable changes in sediment size were noted which could result from the placement of wood or from seasonal storms. Long term results will be more evident with time.

Site 2.3 pre-project in 2007.

Site 6.1 pre-project in 2007.

Site 2.3 Post-project in 2007.

Site 6.1 post-project in 2007.

Site 2.3 post-project in 2008.

Site 6.1 post- project in 2008.

Figure 9. Pre- and post-project photo point comparisons at two sites in Fubar Creek Phase II reach.

Escapement Surveys
Adult spawning surveys conducted along 600 meters of stream channel in the Fubar II Reach. In 2007 two surveys were conducted, one on August 20th and a second on August 28th, with a peak count of 5,281 pink salmon and 36 chum salmon. In 2008, three surveys were conducted - August 18th, August 25th, and September 4th - with a peak count of 3,614 pink salmon and 89 chum salmon. The resulting spawner densities in 2007 were 8.80 pink salmon and 0.06 chum salmon per meter of stream channel and in 2008 the densities were 6.02 pink salmon and 0.15 chum salmon per meter of stream channel. Even-year pink stocks appear to be lower than odd year stocks in a number of Prince of Wales Island watersheds. No coho or steelhead escapement counts were conducted during 2007 or 2008.

Fisheries
A rotary screw trap was placed just upstream of the Fubar Creek Phase II reach and was used to monitor the number of fish leaving the Fubar Phase I project area in spring 2007 and 2008. While the trap was not located within Phase II of the project, useful information can still be gained. In 2007 the trap was fished for 47 days from April 24th to June 11th, and in 2008 the trap was fished for 50 days from April 15th to June 3rd. This sampling period is intended to coincide with the peak out-migration of steelhead and coho smolts. Only coho and steelhead were marked to determine trap efficiency, therefore the population numbers for pink and chum salmon as well as Dolly Varden should be considered minimum outmigrant counts. Estimates of outmigrating fish are shown below in **Table 6**, and indicate a slight upward trend for coho and pink salmon and a slight decrease for steelhead trout and chum salmon. Coho production increased from 4,089 fish in 2007 to 5,189 in 2008, while steelhead production decreased from 1,775 fish in 2007 to 1,081 fish in 2008. The coho condition factor (K) decreased with no significant difference (P = 0.18) from 71 to 65 between years, while the steelhead condition factor increased significantly (P = 0.02) from 183 to 185. Additional data and analysis is available in the Fubar Creek Screw Trap Summary Report 2008 (available at Craig Ranger District).

Table 6. Outmigrant Estimates for Age 1+ Coho and Steelhead, and minimum outmigrant counts for pink and chum salmon smolts and Dolly Varden in 2007 and 2008.

Species	2007 Population Estimates	2008 Population Estimates
Coho	4,098 +/- 229 +/- 95% CI	5,189 +/- 231 +/- 95% CI
Steelhead	1,775 +/- 230 +/- 95% CI	1,081 +/- 445 +/- 95% CI
Pink	98,339	151,701
Chum	1,069	984
Dolly Varden	735	880

DISCUSSION

Several indicators such as substrate, pool frequency, and large wood suggest a trend in positive change in Fubar Creek Phase II as a result of the stream restoration. There was an immediate increase in large wood which would be expected from a large wood placement project. Unfortunately, a pre-project Tier II survey from 1998 is the only available information for comparison of pre- and post-project conditions. The most notable changes between per and post-

project are the repose of the substrate and the increase in pool frequency within the project area. Again, because the comparative data is from a 1998 survey, it is difficult to know if the increase in pool frequency is from the project, or if the channel is naturally recovering. A study conducted on Prince of Wales Island by Bryant et al. (2004) shows a positive significant relation between coho salmon fry and pool frequency and the pool frequency data indicates that coho salmon habitat is improving from what was surveyed in 1998.

Another positive indicator of recovery is the response of substrate which shows a coarsening of D_{50}, and a slight decrease in the D_{95}. While the Tier II habitat surveys show an increase in residual pool depth, the longitudinal profile shows conflicting data with a slight decrease in residual pool depth. This discrepancy in results is most likely the result of errors in surveying or interpretation of the data and will need to be further investigated. Cross sectional data shows little change between 2007 and 2008 for all of the important channel morphology variables. This is not surprising given the short length of time the channel has to adjust between treatment and resurvey, and the moderate water year during 2008.

The biotic data varies by species showing increased coho production and an insignificant decreased condition factor between 2007 and 2008, while steelhead are the opposite having a decrease in numbers and a significant increase in condition factor. Taken together, this may indicate that fish production is currently density dependant and that while spawning habitat may be improving; the production of aquatic organisms utilized by juvenile fish may take longer to respond. Given the paucity of data, it is difficult to draw any firm conclusions on the response of salmon and trout to the project.

Reviewing the totality of the data, it appears that the most cost effective physical habitat monitoring would be the use of photo points during the first several years. This should then be followed in 3 to 5 years, after the channel has time to adjust, by the more labor intensive longitudinal profiles and cross sections. Should biological monitoring be required, the minimum monitoring considered should be twice the life cycle of the organism of interest both pre and post project, i.e. coho salmon 3 year life cycle X 2 = 6 years, and should include both the adult spawners and juveniles. As this may not be practical in many situations and expensive, monitoring over a larger scale by placing a smolt trap on the lower end of a watershed where restoration will be ongoing for a number of years may be a better solution. However, given the costs associated with smolt trapping, utilizing the measurement of physical habitat and relating that to fish production by drawing upon contemporary research may be the most practical.

LESSONS LEARNED

As part of on ongoing effort to improve and learn from our projects, an After Action Review of the monitoring portion of Phase I and Phase II of the Fubar Creek Instream Restoration Project was conducted and the following bullets were compiled.

- Intensive monitoring the year after implementation will most likely not show changes in fish habitat and stream channel morphology for large wood placement projects. The use of photo points to show visually pre- and post-project change in habitat is more cost effective.

- Intensive longitudinal profile and cross section data should be collected immediately post-project and then every 5 years post-project to allow the channel time to adjust.
- Smolt trapping should have been conducted at the lower end of the project area (i.e. confluence with Harris River), rather than at the lower end of Phase I to capture the biotic response over the entire project.
- A longer pre-project baseline is required and should at a minimum include all of the cohorts for the organism of interest (e.g. coho salmon 3 years, chum salmon 5 years, pink salmon 2 years, etc.) if there are funds available and this is deemed necessary data in determining project success. This is an expensive venture and will not be necessary for all restoration monitoring projects.
- Adult spawner counts on index reaches over a predetermined length, or over the whole stream are needed to standardize smolt/parr/fry production between years to account for variation in runs size between years.
- Data collection and analysis methods need to be included in all restoration monitoring plans.
- All physical habitat monitoring parameters, such as Large Wood & Pool Frequency, need to have recent pre-project data as the use of earlier data may not be compatible with current methodologies.
- Bankfull observations need to be made during each survey, and the bankfull height needs to be established prior to the survey, so that surveyors have an idea of where to look for bankfull indicators.
- Longitudinal profiles may be more useful if a total station is used rather than a laser level.

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