Twelvemile Creek

Mainstem Instream Restoration

Monitoring Summary

Twelvemile Creek during road building and timber harvest in 1960.

March 2, 2015

Tongass National Forest, Craig Ranger District

Table of Contents

CONTRIBUTORS

Betsy Krier, Sean Claffey, Tom Cady, Sarah Brandy: Craig Ranger District
KK Prussian: Tongass National Forest

INTRODUCTION

This document provides a summary of the monitoring efforts related to instream restoration work in the lower Twelvemile Creek mainstem. It contains brief background information, the project objectives, a monitoring plan for future data collection, and a summary of preliminary results. It is primarily intended for an internal (Forest Service) audience, and so assumes some familiarity with the project area and Regional habitat survey protocols. Due to the fact that the instream restoration was implemented in 2012 and 2013, it is too early to make conclusions about the long term effectiveness of the treatment, so this document will primarily focus on summarizing the information to date.

PROJECT BACKGROUND

The Twelvemile Creek watershed restoration project area is located on central Prince of Wales Island in Southeast Alaska (USFS 2011). The restoration project was developed to reflect the purpose and need outlined in prior documents that assessed the condition of the watershed and its related natural resources. These documents include: a Twelvemile Arm Landscape Assessment (USFS 2007a), a Watershed Rehabilitation Plan for Twelvemile Creek (USFS 2007b), and two Environmental Assessments (USFS 2011 and USFS 2012). As a foundation for those documents, in 2007 the habitat conditions in tributary and mainstem sections of Twelvemile Creek were surveyed using Region 10 protocols, and the results were compared to Tongass Fish Habitat Objective (FHO) values for similar channel types (Kelliher 2007). Some key observations made in Twelvemile during that analysis included simplified morphology, the absence of key large woody debris, low numbers of pools, and an anticipated decline in future condition due to the deterioration of residual key pieces of legacy wood (USFS 2007b and Kelliher 2007). With those observations in mind, Phase I of the instream restoration project was developed for implementation in Fiscal Year 2012 (USFS 2011). Phase II of the project was developed for implementation in Fiscal Year 2013 (USFS 2012). Project costs and accomplishments are available in Appendix D.

The **project objectives** for both phases include:

- Increase or maintain the Total and Key Large Woody Debris densities to meet the Fish Habitat Objective's 'excellent' condition for a Large Floodplain channel type (Table 1).
- Increase or maintain the Number of Pools per Meter to meet the Fish Habitat Objective's 'excellent' condition for a Large Floodplain channel type (Table 1).
- Decrease the Width to Depth ratio at the reach scale.
- Build relatively stable, functional, wood structures that meet documented objectives.
- Protect eroding banks from mass failure in order to support existing early seral riparian vegetation.
- Increase or maintain the abundance and condition of the adult and juvenile native fish populations.

After the project was implemented, high flow events occurred in January of 2014 and March of 2014. These monitoring data do include surveys conducted after the flow events, so channel responses to the high flows are included in this summary. The magnitude of the high flow events prompted a second report to evaluate project design parameters and implementation methods. That report is the *Twelvemile Creek Restoration-Assessment of 2014 Flooding* (USFS 2015) (referred to as "Flood Report" in this document).

MONITORING PLAN

The methods used to monitor this project's progress in attaining the stated objectives will include habitat surveys, channel morphology measurements, the visual capture of channel condition and wood placement stability through photography, and fish counts. The specific parameters used are both quantitative and qualitative. They include:

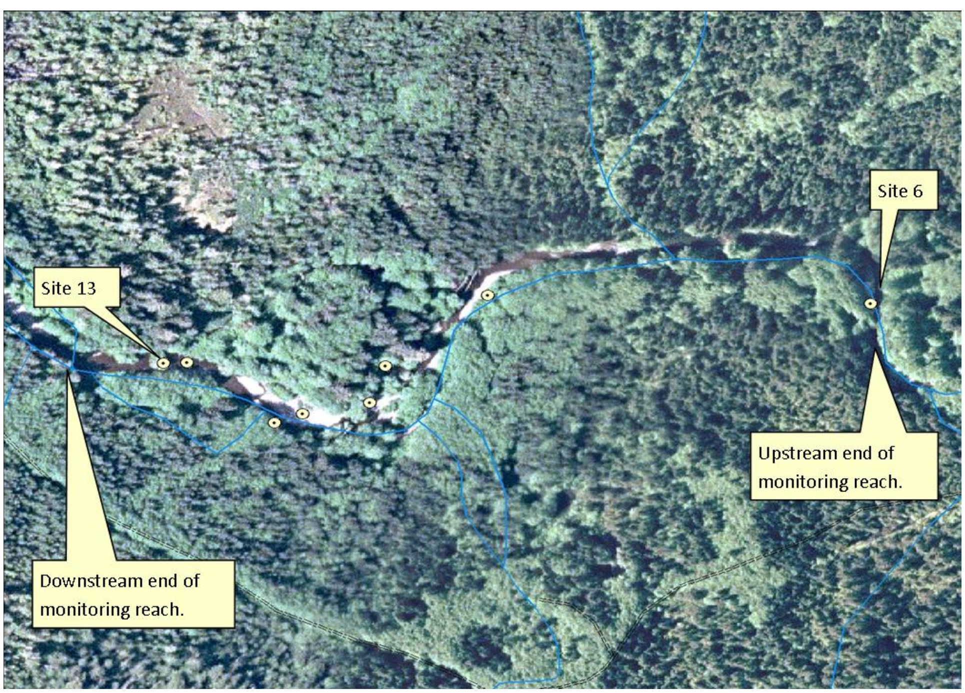
- **Habitat characteristics:** density, length, and spacing of pools, and number of large wood pieces (quantitative)
- **Channel morphology**: channel width and depth, sediment size (quantitative)
- **Relative stability and function of large wood:** photos and structure objective tracking (qualitative)
- **Estimated fish production:** outmigrating smolt enumeration, adult snorkel counts

Site Locations

Phase I

The Phase I instream project area includes 20 treatment sites along approximately one mile of the mainstem of Twelvemile Creek. This section of the creek runs between the pulled crossings of the 2100200 road on the downstream end and the 2122000 road on the upstream end. A 700 meter segment of the total instream project area has been and will be monitored for changes in habitat characteristics. This monitoring reach covers 8 treatment sites that have various objectives. The stream segments surveyed in the 2007 WRP analysis and in earlier Channel Condition Assessments did not include this exact project area, so baseline habitat condition data was only gathered immediately prior to implementation. Monitoring will occur at intervals noted in the monitoring schedule in Table 2.

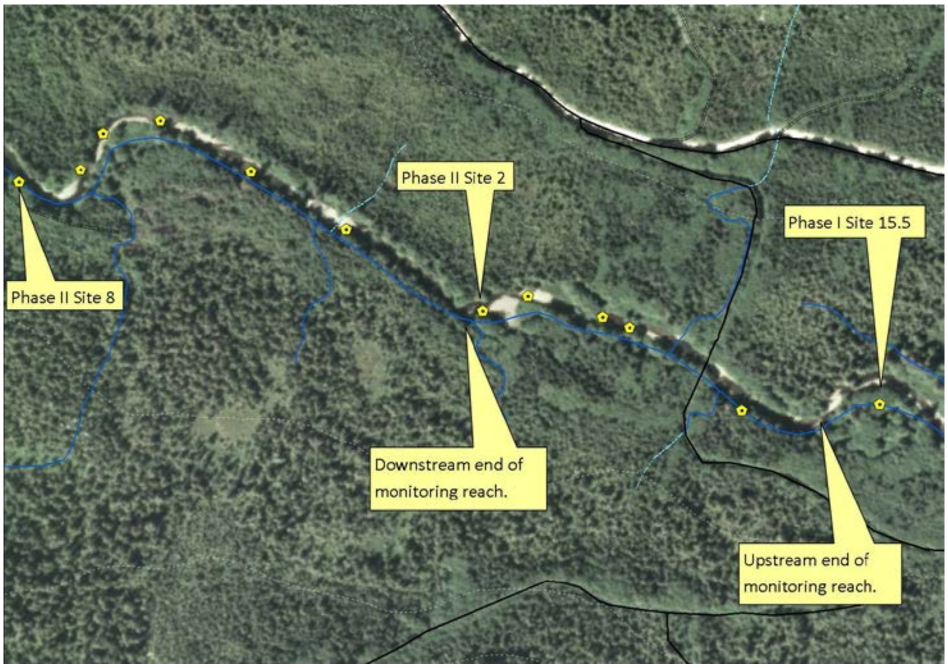
Figure 1: Phase I Monitoring Reach



Phase II

This phase constructed log structures at 12 treatment sites along approximately 0.75 miles of stream immediately downstream of the lower extent of Phase I. The Phase II section begins just upstream of the 2100200 pulled road crossing and extends down to the temporary road 2100000_5.44R. A 500 meter section of the Phase II project area will be monitored on a schedule indicated in Table 2. This monitoring reach overlaps with channel sections that were surveyed in 1997 and in 2007.

Figure 2: Phase II Monitoring Reach



Methods

Habitat Variable Assessment: In order to monitor the changes in habitat and woody debris characteristics, we use habitat survey protocols from the US Forest Service Region 10 Aquatic Management Handbook 2090.21 to compare the pre and post treatment conditions to the Tongass Fish Habitat Objectives for the a Large Floodplain channel type (USDA 2001). The comparison is based on the percentiles and associated condition value for each variable (Tucker and Caouette 2008). The habitat objective values in Table 1 below are derived from surveys in reference or "unmanaged" reaches. The habitat objectives are used to evaluate the condition of managed systems, such as Twelvemile Creek, relative to the regional natural system variability of the reference reach data set. The objective levels for Twelvemile Creek are based on the 75th percentile ("excellent condition") values (Table 1). Appendix A shows the calculations for each metric. Appendix C has additional details about the collection of the habitat data.

<u>Tier II Habitat Survey</u>- The key variables obtained from the Tier II survey will be the Number of Pools per kilometer of stream (Pools/Km), Pool Length per meter of stream (Plength/m), and Pool Spacing (Pool Space).

<u>Tier IV Large Wood Counts</u>- The attributes of interest in regards to large woody debris will be the Total Number of Pieces per meter of stream (TLWD/m) and the number of Key Sized Pieces per meter of

stream (TKWD/m). The Tier IV survey also places each piece of LWD into a size category, which produces a more precise assessment of the large woody debris characteristics through the comparison of the number of pieces in each size class over time.

Cross Section and Sediment Size Comparisons

Cross sections within the Phase II Monitoring Reach were established during a 1997 Channel Condition Assessment. These same cross sections will continue to be monitored to determine changes in bed profile, width/depth ratios, and sediment size over time.

Structure Objectives

To determine whether or not the placed log structures are stable and meeting their design objectives, we will track the structure status using the forms and protocol in Appendix B. Initially, these forms are used to establish the objectives for each structure and subsequently used to monitor their effectiveness through time. While subjective, this type of information will be critical in determining whether or not our anticipated objectives are being fulfilled by the implemented designs.

Photo Points

In conjunction with the Structure Objective data, photos of the treatment sites and their associated stream reaches will be compared prior to and after restoration implementation throughout the entire project area. These photos will be assessed for large scale changes in the log structures as well as the channel features above and below the structures. Photo points will be documented using the forms in Appendix B.

Low Altitude Aerial Photography

Low altitude aerial photos of the Twelvemile Creek mainstem were taken in the spring of 2010, prior to any restoration treatment. Post restoration aerial photos were taken in 2013 and 2014 and are planned for 2017. These images will be mosaicked together and compared to subsequent photo-sets to assess for large scale changes in the placement of log structures and stream channel response/migration.

Table 1: Restoration Objectives and Corresponding Monitoring Method

Twelvemile Project Restoration Objectives	Habitat Objective Value	Monitoring Method
Improve to, or maintain Pools/KM at 'excellent' level	25	Tier II Survey
Decrease to, or maintain Plength/M at 'excellent' level	0.44	Tier II Survey
Decrease to, or maintain Pool Space at, 'excellent' level	1.7	Tier II Survey
Improve to, or maintain TLWD/M at 'excellent' level	0.46	Tier IV Wood Survey
Improve to, or maintain TKWD/M at 'excellent' level	0.08	Tier IV Wood Survey
Improve to, or maintain W/D ratio at 'excellent' level	23	Cross Sections
Build and maintain stable, functional wood structures that achieve the objectives of each site.	+/-	Photo Points, Structure Objective Surveys

Table 1 continued…

Table 1 continued…

Reduce stream bank erosion and resulting lateral channel migration to protect regenerating riparian forest vegetation.	+/-	Low Altitude Aerial Photography
Increase or maintain the abundance and health of the native fish populations within the watershed.	+/-	Adult Escapement Counts, Juvenile Outmigrant Smolt Trapping

Adult Salmonid Escapement Counts

Annual adult steelhead and coho escapement counts have been conducted in the anadromous portion of the Twelvemile Creek mainstem. These surveys will continue based on the ability of district personnel and the cooperation of stream flows during the peak timing. The Craig Ranger District has a developed protocol with specific reach locations (USFS 2010). The location of steelhead redds during peak counts have also been documented during some surveys.

Juvenile Outmigrant Monitoring

A smolt trap was installed and operated in Twelvemile mainstem in 2012-2014 and will continue for a minimum of one more year to monitor and enumerate smolt migrating to the ocean. Summarization of this aspect of monitoring will be included in a separate report.

Table 2: Monitoring Schedule

Twelvemile Mainstem Instream Restoration Monitoring Schedule	
Year	**Task**
Annually	**Phase I and II:** Snorkel Counts for Steelhead in April and Coho in October
2010	**Phase I and II:** Low Altitude Aerial Photos: April, prior to leaf out
2012- Prior to Phase I Implementation	**Phase I :**Tier II and Tier IV Habitat Survey in monitoring reach: June Log Structure Objectives for all treatment sites: May Photo point establishment: May
2012- Post Phase I Implementation	**Phase I:** Tier II and Tier IV Habitat Survey in monitoring reach: September Photo point monitoring: August/September **Phase II:** Log Structure Objectives for all treatment sites: Sept/October Photo point establishment: October
2013- Prior to Phase II Implementation	**Phase I and II:** Low Altitude Aerial Photos: April **Phase I:** Tier II and Tier IV Habitat Survey in monitoring reach: May Photo point monitoring: April/May **Phase II:** Tier II and Tier IV Habitat Survey in monitoring reach: May Cross Sections and Pebble Counts: April/May
2013- Post Phase II Implementation	**Phase I and II:** Low Altitude Aerial Photos: November **Phase II:** Tier II and Tier IV Habitat Survey in monitoring reach: September Cross Sections and Pebble Counts: September Photo point monitoring: September and October
2014	**Phase I and II:** Tier II and Tier IV Habitat Survey in monitoring reach: August Log Structure Objectives for all treatment sites: April Cross Sections and Pebble Counts: April/May Photo point monitoring: April Low Altitude Aerial Photos: March

Table 2 continued…

2015	**Phase II:** Tier II and Tier IV Habitat Survey in monitoring reach: August Log Structure Objectives for all treatment sites: April Cross Sections and Pebble Counts: April/May Photo point monitoring: April
2017, 2022 (5 and 10 year)	**Phase I and II:** Low Altitude Aerial Photos: April, prior to leaf out Tier II and Tier IV Habitat Survey in monitoring reach: April/May Cross Sections and Pebble Counts: April/May Log Structure Objectives for all treatment sites: April/May Photo point monitoring: April/May

RESULTS AND DISCUSSION

Habitat Variable Assessment

This section will present and discuss the results of the habitat and woody debris monitoring data collected from 2007 to 2014. Table 3 compares the Tongass Fish Habitat Objectives to the calculated value for each monitoring effort over time. The results are broken out by the two implementation phases for the following reasons: 1) The implementation timing was different (2012 versus 2013). More post treatment data is available for Phase I, and the structures were exposed to a larger range of flows over the additional year in-stream. 2) The wood sources for the phases differed. Phase I incorporated more qualifying key piece material (e.g.; larger diameter), while Phase II used material with a lesser percentage qualifying as key. 3) The design and implementation methods varied from Phase I to Phase II (Flood Report, USFS 2015) 4) Phase II overlapped with habitat surveys from 2007 so additional pre-project information is available for that segment.

Table 3: Habitat Variable results by year for both phases of implementation.

Habitat Variable	PHASE I				PHASE II				Objective Value
	Year				Year				
	2012 Pre	2012 Post	2013 Post	2014	2007 Pre	2013 Pre	2013 Post	2014	
Pools per Kilometer (Pools/Km)	29	32	31	27	11	13	15	24	25
Pool Length per Meter (Plength/m)	0.59	0.8	0.78	0.7	0.53	0.57	0.56	0.69	0.44
Pool Space (Pl Spc)	1.65	1.59	1.65	1.87	5.93	4.13	3.52	2.12	1.7
Total Wood per Meter (TLWD/m)	0.56	0.47	0.81	0.6	0.18	0.41	0.58	0.63	0.46
Total Key Wood per Meter (TKWD/m)	0.04	0.06	0.12	0.06	0.02	0.04	0.08	0.09	0.08
Width/Depth Ratio (W/D)					33	27	37	34	23

Each variable for both phases is also depicted below in Figures 3-4, with the column on the left pertaining to Phase I and the column on the right pertaining to Phase II. The thickest, darkest, horizontal lines in each graph represent the Objective Value ("excellent" condition) where applicable, with the progressively lighter bars representing the "good" and "fair" values. To begin, the Phase I pool variables will be discussed, followed by Phase II pools. After that, the woody debris results will be presented and discussed, first for Phase I, then for Phase II.

<u>*Pool Characteristics*</u>: In **Phase I** the **Number of Pools** per Kilometer and **Pool Spacing** values have been maintained in excellent condition since implementation. The **Pool Length** per meter has remained in fair condition, with more than 50% of the stream length qualifying as pool habitat. This means that the number and spacing of pools along

this part of Twelvemile are meeting the restoration objective levels, except the length of pools exceeds the natural range in variability for the size and channel type. All three habitat values have also been relatively stable over time. As shown in the bottom graph in Figure 3, the **ratio of pools to riffles** along the length of the stream increased after implementation, but the total length of habitat also increased. This reflects rising habitat complexity due to an increase in longitudinally overlapping habitat types (a riffle running parallel to a pool). The decrease in riffle length from 2012 pre-treatment condition to 2014 was 6% (approximately 50meters). Riffle *area* may not have changed, since widths are not measured for each habitat unit. These data suggest that the habitat for adult and juvenile salmonids in Phase I remain in high quality condition, and that the hydrologic functions in the channel appear to be reaching a state of dynamic equilibrium.

Figure 3: Pool Habitat Variable Results for Phase I and II by Year.

PHASE I **PHASE II**

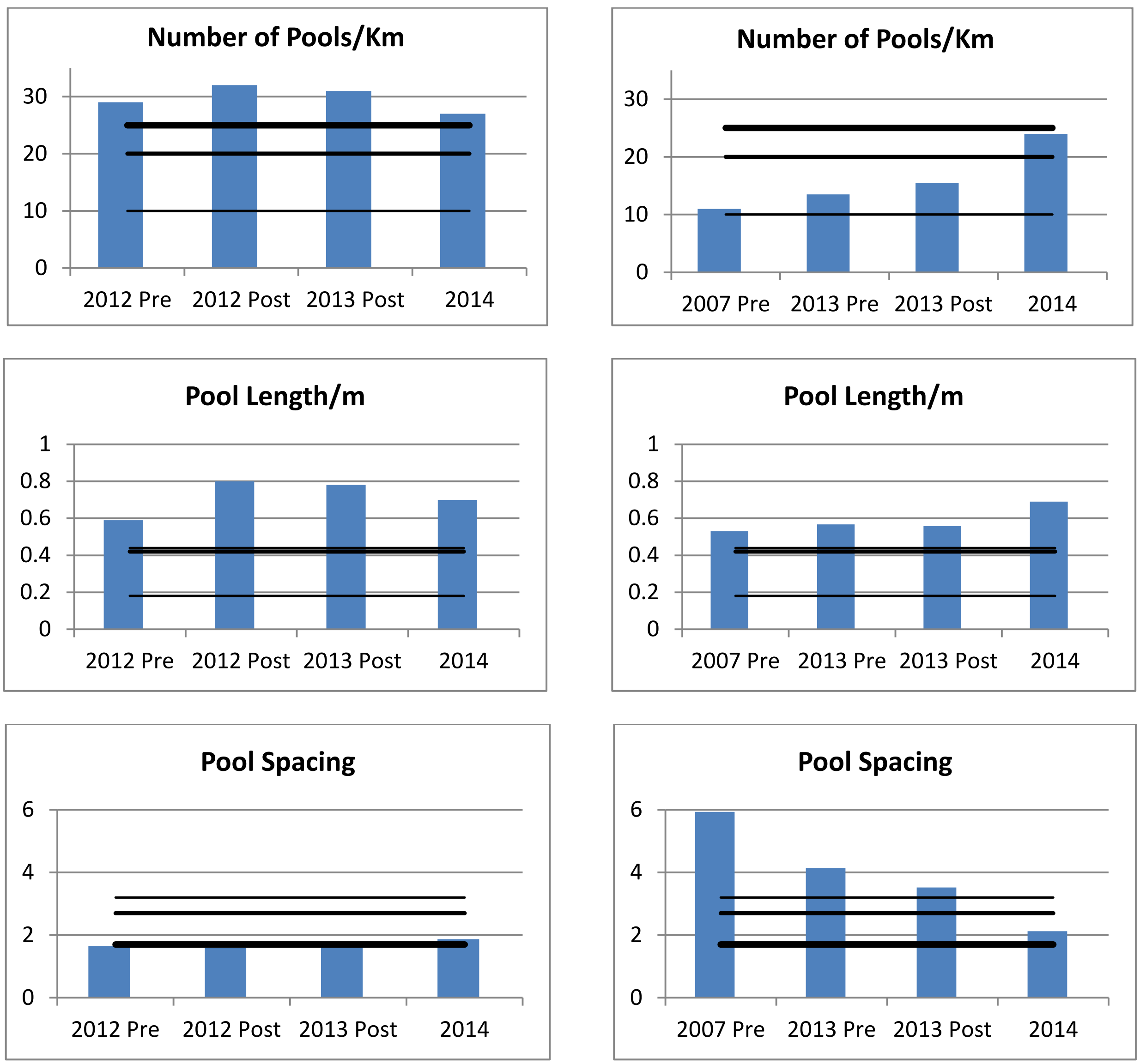
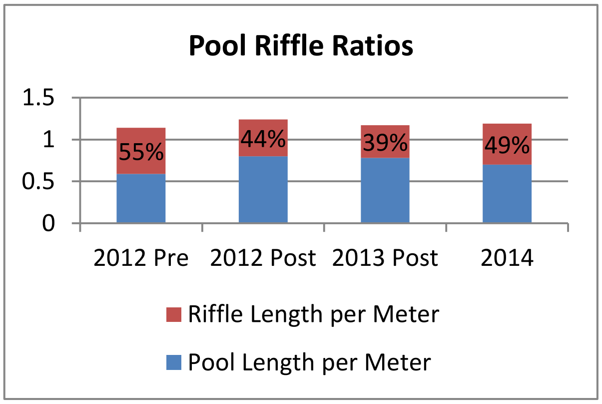
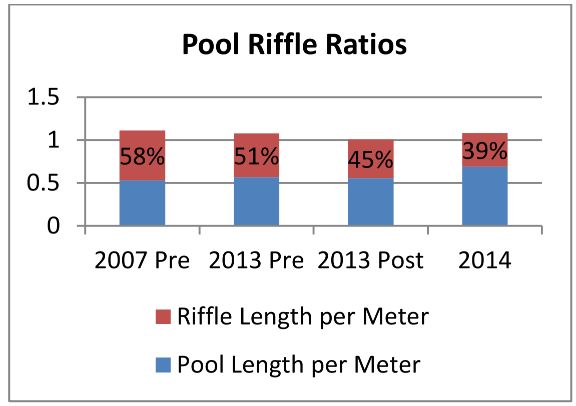


Figure 3 continued…

Figure 3 continued…





"excellent" "good" "fair"

In **Phase II**, the **Number of Pools** per kilometer has increased since implementation, and is now just below the target value of 25. The **Pool Length** per meter remains above the target value. The **Pool Spacing** values have been steadily decreasing since 2007 (meaning that there is less distance between the pools) and as of 2014 are near the target value of 1.7. This means the number of pools and the distance between them in the stream is approaching the restoration objective condition. The length of the pools remains above the objective level, which is also reflected in the **ratio of pool to riffle** length. On average, the riffle length has decreased by approximately 12% since implementation. Again, riffle *area* may not have changed, since widths are not measured for each habitat unit. To be clear, loss of riffle length does not necessarily equate to a loss of spawning habitat for adult salmonids because habitat that is measured as a pool according to the survey protocols (e.g. exceeds minimum depth requirement) includes pool tail outs as well as margins of a pool which are utilized by spawning fish. The desired objective, based on the Pool Length per meter values, is to have approximately half of the stream length comprised of riffle and half of pool. Continued monitoring will assess trends pertaining to that metric but spawning habitat will not be directly measured. In general, the habitat conditions in Phase II are trending towards the restoration objective conditions, which will provide high quality areas for adult and juvenile salmonids.

Woody Debris: The results of the wood surveys are depicted in Figure 4, again with Phase I on the left and Phase II on the right. In **Phase I**, the **Total Wood** and **Key Wood** counts increase from 2012 to 2013, reflecting the additions of wood during implementation. Both the Total and Key Wood then decline from 2013 to 2014. This could be attributed to a combination of: 1) Movement of wood out of the surveyed reach due to high flow events during January and March of 2014 (prior to survey). Photo documentation of treatment sites does show change in the position and number of pieces at some sites. 2) Deterioration in the size of attached rootwads. Rootwads greater than 3 meters in width, regardless of bole diameter of the attached tree, were counted as key pieces. In the 2014 survey, noticeable wear on the rootwads may have reduced their width to less than 3 meters, lowering the total number of key pieces counted. Of the eighty-eight Key pieces in 2013, twenty-two of them were attached rootwads, while in 2014 only 4 key pieces were included based on attached rootwad diameter. 3) Observer bias. Though not quantified, observer bias is a factor in the repeatability of wood counts and size categorization.

Above, in Table 3, are "objective values" for Total Wood and Total Key pieces, but it should be noted that the restoration design was not guided exclusively by these values. Instead, design took into account the size of the wood available and identified the quantity needed for a given structure to achieve site specific objectives. As of the survey in 2014, the reach level objective was met for the Total Wood. Total Key pieces is short of the objective value but has improved from pre-project levels, increasing by 66% from 2012 to 2014. The lower graphs in Figure 4 quantify the wood pieces by total length and bole diameter. The increases from 2012 to 2013 include both small and large dimension pieces, reflecting both the large size of the material placed during implementation and an increase in the retention of smaller pieces racking up on the new structures. Conversely, much of the reduction in Total Wood from 2013 to 2014 can be attributed to the smaller sized pieces. From 2013 to 2014 the total number of pieces dropped by 121 pieces, and 98 of them were less than 0.3 meters in diameter (the smallest diameter category). Any wood moving out of Phase I may be moving downstream and getting lodged in structures within Phase II.

In **Phase II**, the **Total and Key Wood** numbers attained the objective target value after implementation in 2013 and remained there through the 2014 survey. The increase in the number of pieces over 15 meters long and over 0.3 meters in diameter post implementation is also reflected strongly in the lower graphs. This highlights the size of the young growth material used during implementation. The differences between Phase I and Phase II in the total number of pieces is due to the length of the surveyed reach (Phase I is about 40% longer).

Figure 4: Woody Debris Habitat Variable Results for Phase I and II by Year.

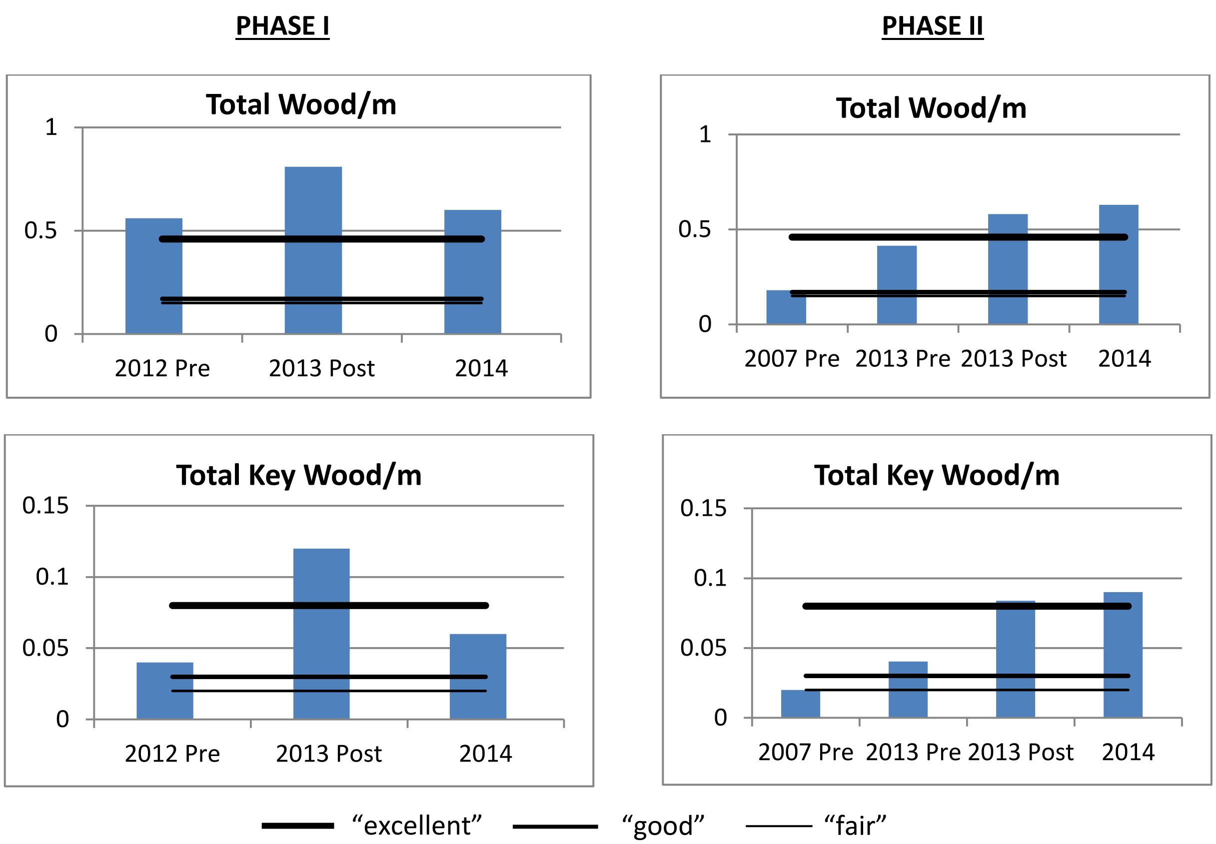
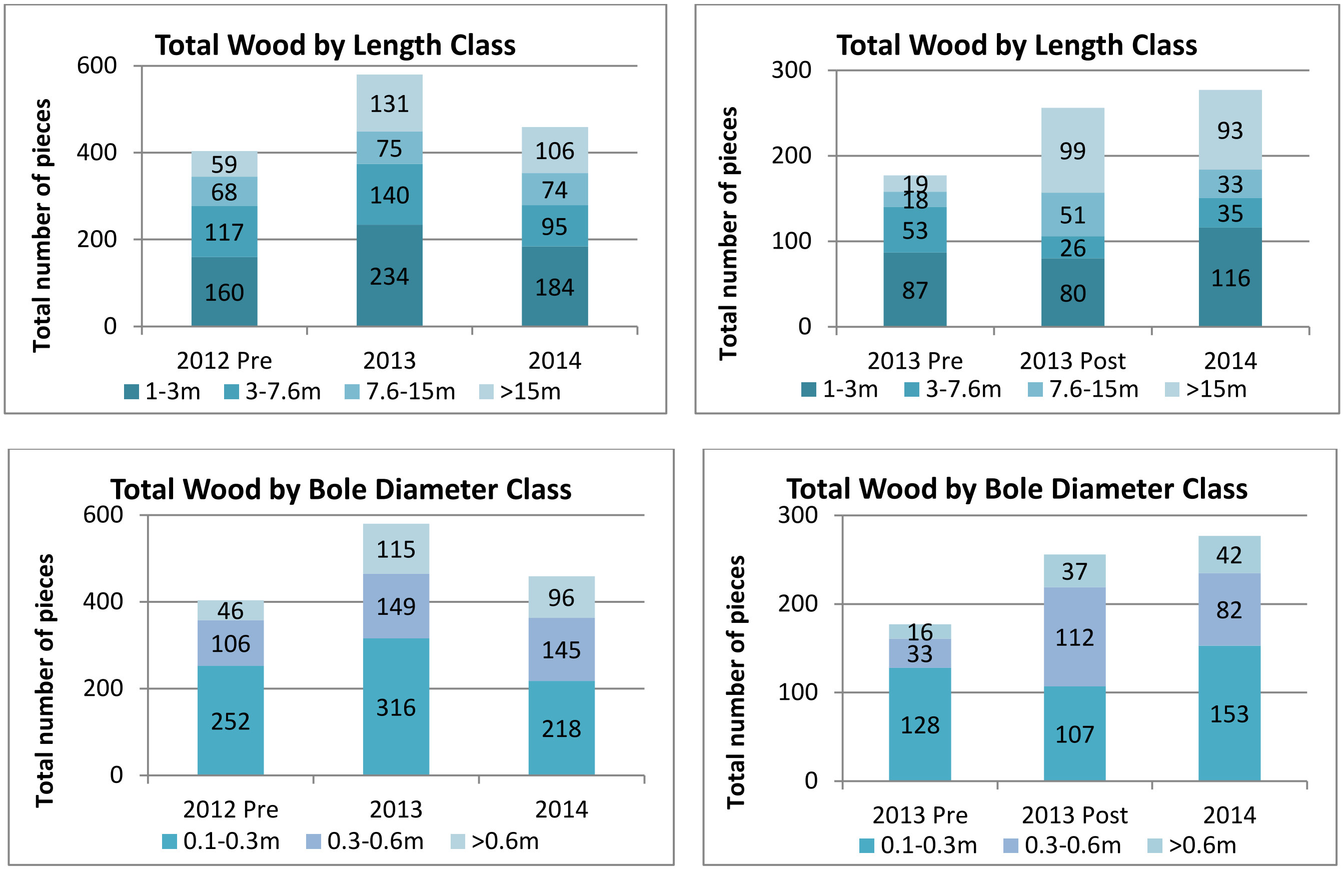


Figure 4 continued…

Figure 4 continued…



Based on observations made during the wood surveys and during photo point and structure objective monitoring, shifts occurred in the position and number of wood pieces at the treatment sites following the high flow events in the winter and spring of 2014. In some locations wood moved from treatment sites and accumulated in loosely formed, complex, cross channel structures. As of the time of the 2014 surveys, most of the surveyed wood numbers were still meeting the objective levels. This shows that at the reach level (rather than the site level) the wood density objectives were met, despite redistribution of the individual pieces. Wood from Phase I may also be contributing to increased levels of wood accumulation in Phase II. It is likely in both phases that some wood is leaving the surveyed reach and going downstream while additional wood is being recruited from upstream. Continued monitoring should capture any continued movement of placed wood at the site level with photo points, and at the reach level with the Tier IV wood surveys.

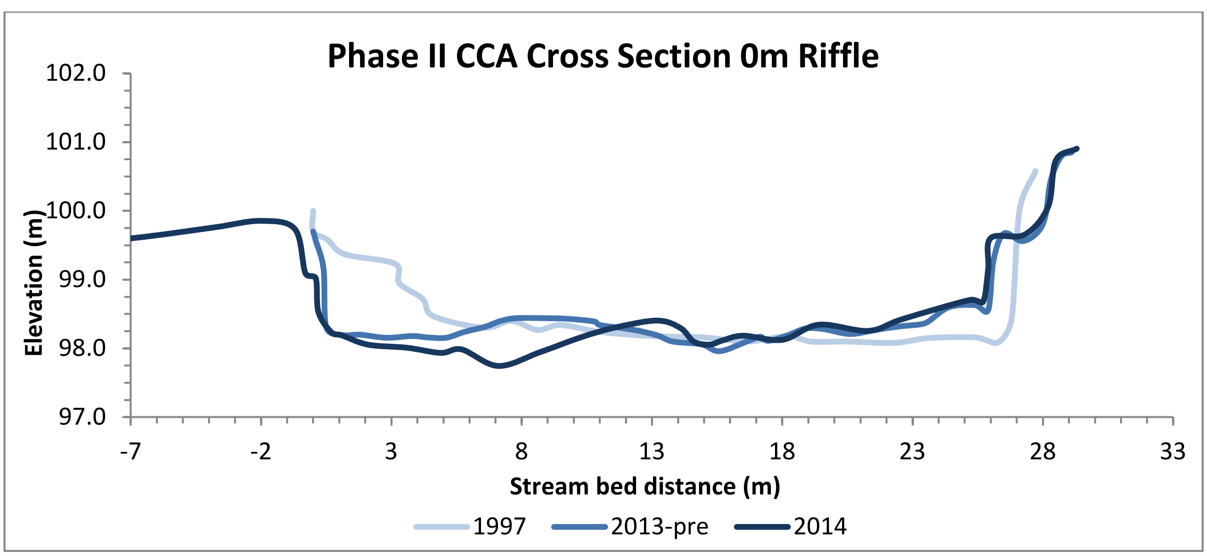
Cross Section and Sediment Size Comparisons

There are some changes in the cross sections at the five locations in Phase II (Table 4). No restoration synthesis is made at this point because more data is needed to determine change through time. In some cases, width or depth changed (relative to pre-project) and a corresponding particle size changed. The following are the changes noted by site and some background information relating to the condition.

Table 4. Results of the cross section including bankfull widths and depths, width-to-depth ratios and median particle size (D50). The blank data represent times when pebble counts did not occur, in some cases due to salmon redds instream.

Cross-section	Year	BF width (m)	Ave BF depth (m)	W/D	D50
0 meter (Downstream end)	1997	27.0	1.0	27	
	2013 Pre	25.7	0.9	28	17
	2013 Post	25.6	0.6	43	(redds*)
	2014	25.8	0.8	31	18
90 meter	1997	17.0	0.9	19	(pool)
	2013 Pre	15.0	0.9	16	(pool)
	2013 Post	15.3	0.8	18	(redds*)
	2014	17.8	1.3	14	(pool)
177 meter	1997	22.7	0.7	33	24
	2007	22.4	0.5	23	23
	2013 Pre	18.0	0.6	31	24
	2013 Post	16.7	0.5	31	(redds*)
	2014	26.7	0.6	48	16
270 meter	1997	23.6	0.4	55	22
	2007	23.2	0.6	43	30
	2013 Pre	21.5	0.5	41	26
	2013 Post	21.2	0.4	55	(redds*)
	2014	22.0	0.6	37	24
360 meter (Upstream end)	1997	17.7	1.2	15	14
	2007	19.3	1.4	14	
	2013 Pre	19.5	1.1	18	26
	2013 Post	18.8	0.5	38	(redds*)
	2014	19.5	1.0	19	27

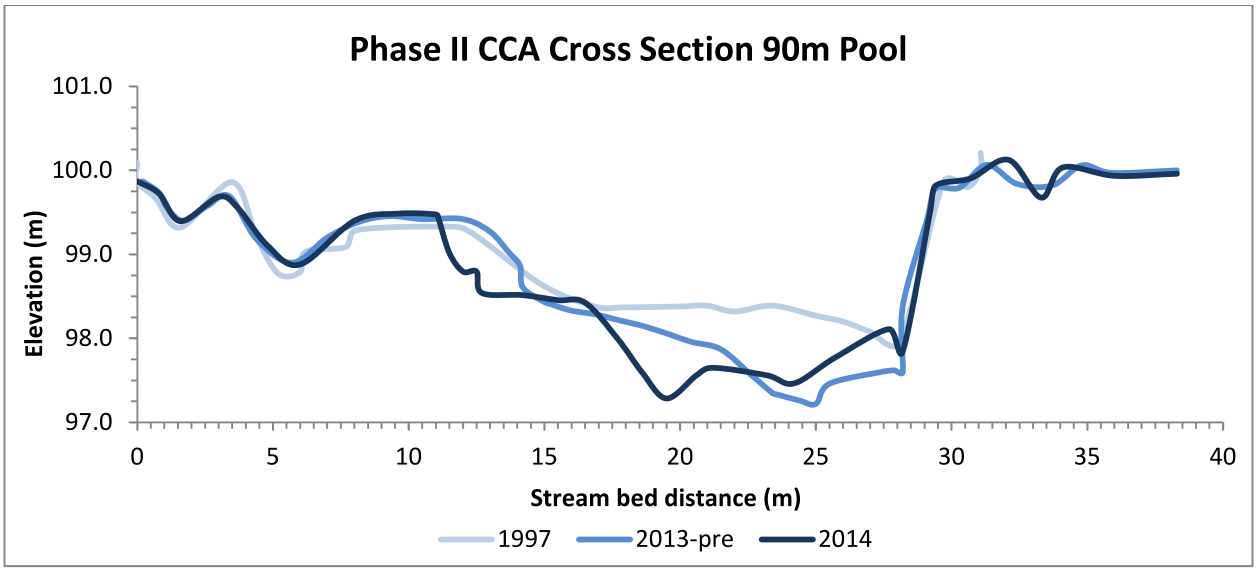
Figure 5: Cross section profile of the 0m riffle, looking downstream.



The riffle at 0 meters appears to have shifted thalweg locations from 1997 (thalweg on the right) to 2013/2014 (thalweg on left) (Figure 5). This would not be out of the ordinary considering the elapsed time and the nature of floodplain channels. Despite shifting, the width/depth ratio has remained fairly consistent through time. Immediately post restoration there was a decrease in depth and an increase in W/D ratio, possibly reflecting the presence of wood from Treatment site 18 which is in the immediate vicinity. These numbers returned to pre-project conditions in 2014.

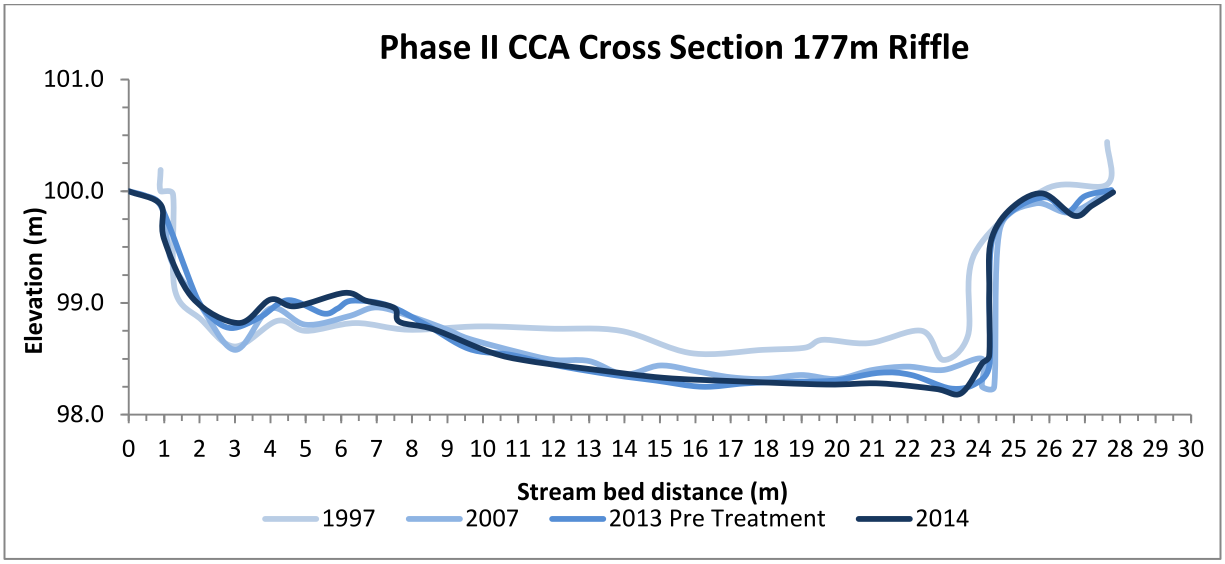
The 90m pool showed little change between pre and post 2013; however a slight increase in both width and depth in 2014. There was also a decrease in W/D ratio in 2014. This is the same pool shown in the photos of Treatment site 17 in Figure 13. Observations during photo point and structure objective monitoring have also indicated expansion of the pool and slight widening on the left bank in 2014, possibly due to the wood placement and/or the high flow events of 2013.

Figure 6. Cross section profile of the 90m pool, looking downstream.



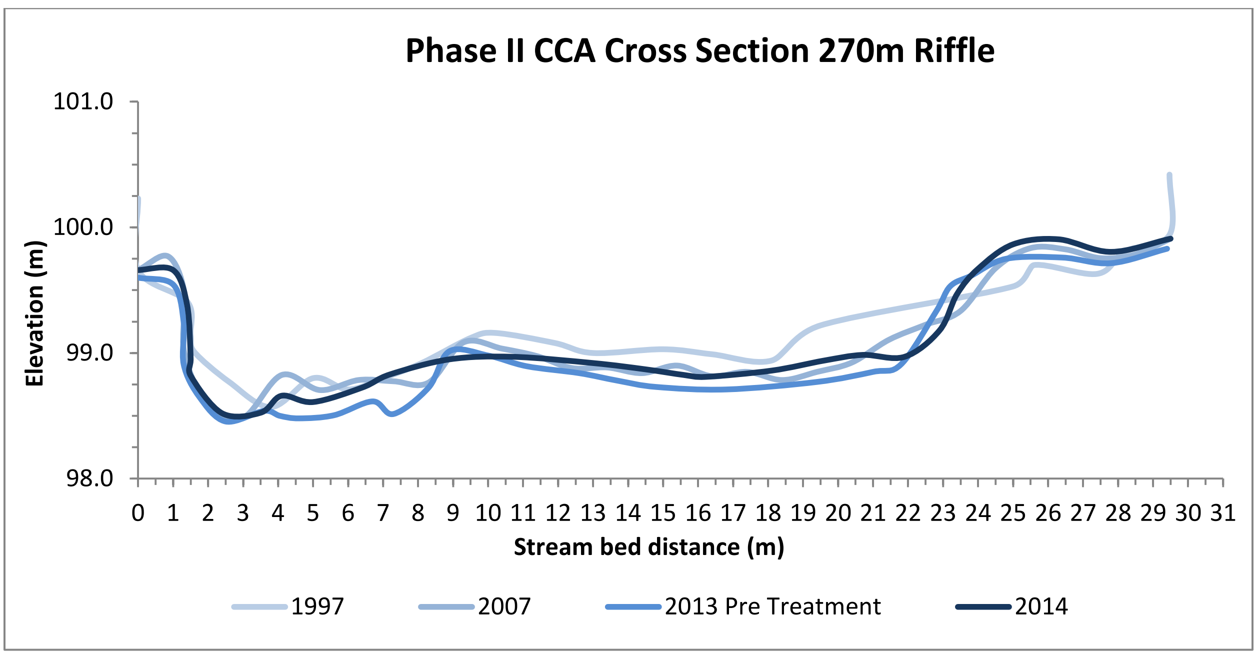
The 177m riffle has had consistent depths, but has changed in width, W/D ratio, and particle size over time (Figure 7). The left bank here was affected by a large legacy piece of wood present from prior to 1997 to 2013, which made discerning bankfull widths difficult. During implementation in July of 2013 the piece was shifted into the channel and subsequently mobilized downstream during a flow event in September 2013, where it remains, acting as a key piece forming a large channel spanning structure. This shift in wood may explain the increased width, increased W/D ratio, and decreased particle size at cross section 177m in 2014. Additional surveys will better show how this site adjusts to both the increased wood from restoration and the annual channel forming floods.

Figure 7. Cross section profile of the 177m riffle, looking downstream.



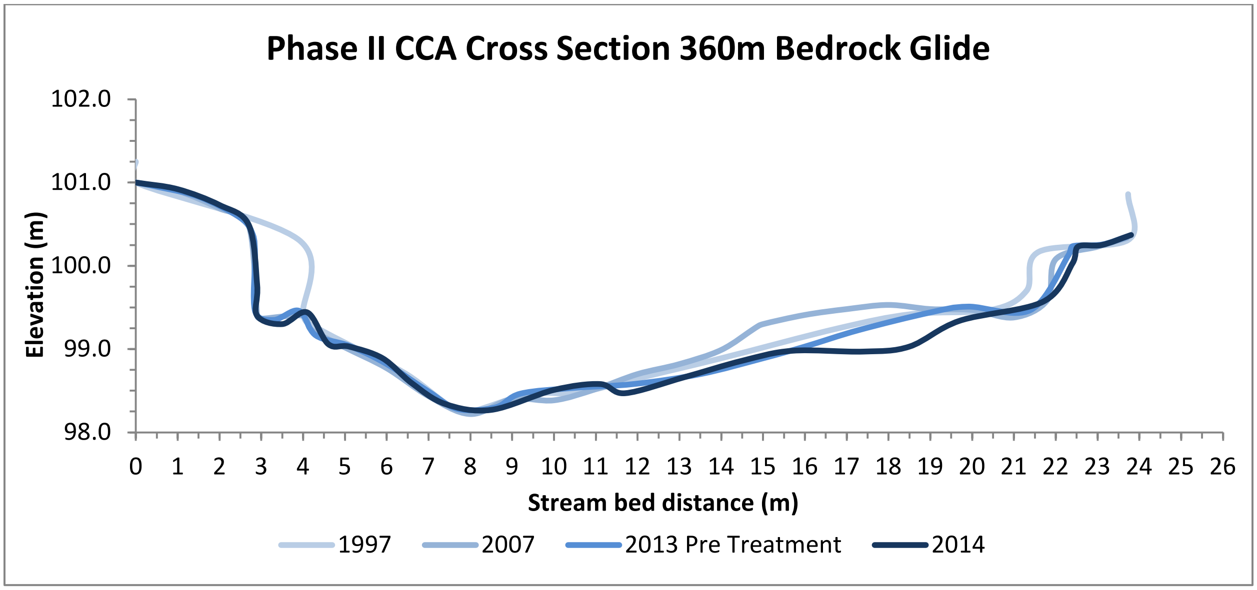
There is little consistency in the data from the 270m riffle (Figure 8). Overall, the W/D ratio has decreased through time and the D50 has remained relatively stable.

Figure 8. Cross section profile of the 270m riffle, looking downstream.



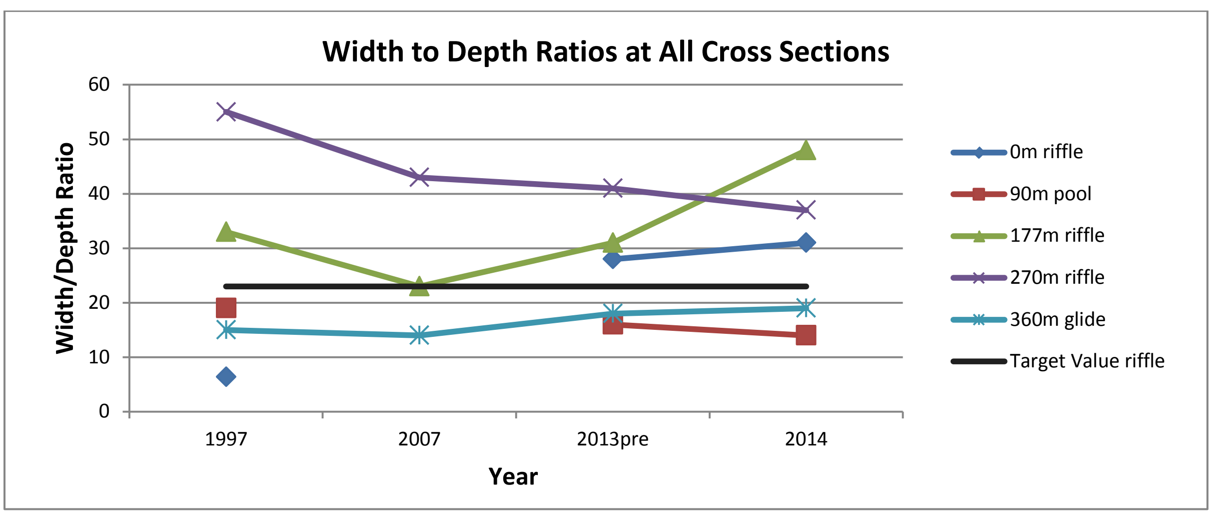
The 360m glide cross section is in a bedrock reach (Figure 9). The widths are fairly consistent but depth and subsequently W/D ratio were different immediately post-project than all other surveys. The site has returned to pre-project conditions. Bankfull heights are difficult to determine on the left bank.

Figure 9. Cross section profile of the 360m glide, looking downstream.



There are varying trends in the width-to-depth ratio at these cross sections relative to the target value (Figure 10). The 270m riffle and 360m glide both show trends towards the target habitat value for floodplain channels (23). The 177m riffle shows a departure from the target value. The 0m riffle and 90m pool show minor departure, but have fewer data points. The clustered distribution of pre-project cross-sections in Phase I (all centered around one treatment site) makes them unsuited to monitoring width/depth ratios at the reach scale, so monitoring of this metric is currently limited to Phase II. Continued monitoring may show long term trends relative to restoration. Future monitoring will look also at large wood and channel constrictions relative to the cross section locations. These additional data may explain the varying results of channel response (relative to width/depth ratio) and provide insight into channel function and habitat.

Figure 10. Width-to-depth ratio at 5 cross-sections in Phase II and the target Habitat Value.

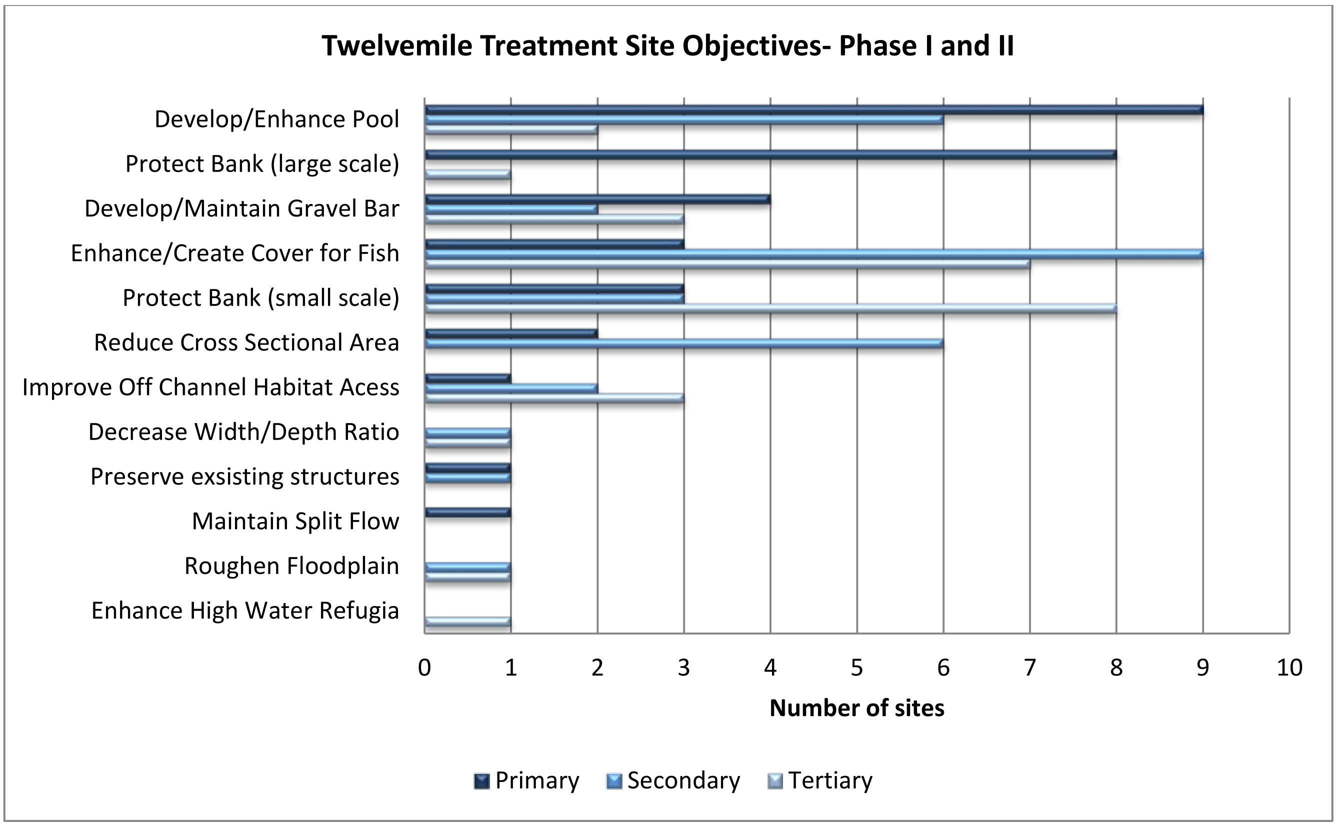


Sediment Size was evaluated using the median particle size (D50) taken from pebble counts at the cross sections. There was little change in the D50 at most sites with the exception of the cross section at 177m. The D50 at cross section 177m decreased from 24mm pre project to 16mm post project suggesting the velocities have decreased through this site. Reduced velocities are likely the result of the newly formed channel spanning jam downstream of the cross section.

Structure Objectives

As mentioned in the Project Background (pg 3), several *project level objectives* applied to the entire treatment reach. The foremost objective was to increase or maintain the total and key sized woody debris densities. Rather than randomly placing more pieces of wood in the stream, particular installations of wood were placed at designated treatment sites. The placement and design of each treatment site was guided by site specific "structure objectives". The documented structure objectives for both phases of implementation are listed in Figure 11. These are the pre-implementation objectives that each structure (or combination of structures) was designed to meet at each site. Each site typically had multiple objectives and they were prioritized as Primary, Secondary, and Tertiary. Phase I had twenty sites and Phase II had twelve, for a total of thirty-two.

Figure 11: Treatment Site Objectives for Twelvemile Project Area



The short term results of the structure objective monitoring are shown below in Figure 12. No threshold of acceptability has been established, but the goal is to learn from effective and ineffective structures. After the series of flood events in 2014 three of the 32 sites were completely displaced, while others were either partially displaced or accumulated wood and gained complexity. Structures that were the least effective in meeting objectives were structures designed to Develop/Maintain Gravel Bars (22% success), Improve Off Channel Access (17% success), and Reduce Cross Sectional Area (38%). Structures that had the most success meeting objectives include Protect Bank (78%), Enhance/Create cover (78%), and Develop/Enhance Pool (76%). For further evaluation of structure types and there relative effectiveness, please refer to the Flood Report (USFS, 2015). The effectiveness and relative stability of the placed structures (and those that have formed in other locations) will respond to future flow events, and will be better evaluated over a longer time period. Since only two years have passed since implementation, continued assessment will indicate future levels of success and durability. The decrease in site objective achievement from 2013 to 2014 in Phase I is likely related to the magnitude of the winter and spring flows of 2014. The decrease in wood levels observed in the habitat surveys are also related to these events. The lower treatment site-specific success in Phase II necessitated further investigation by those involved in the design and implementation of the project (see Flood Report, USFS 2015). Nevertheless, site-specific structure durability does not necessarily equate to success or failure of project objectives at the reach scale, as reflected in the habitat variable monitoring results to date. During the monitoring process it was observed that while a specific site may not be meeting an objective, the wood was often fulfilling the same or different objective where it had migrated. Future project designs may want to consider this aspect; do we continue with the design of site specific targets with rigid structures or would a more loosely dispersed addition of wood into a floodplain channel –with the expectation that the wood would move- be just as likely to meet reach-scale objectives?

Figure 12. Relative effectiveness of structures at treatment sites for the Twelvemile Project Area

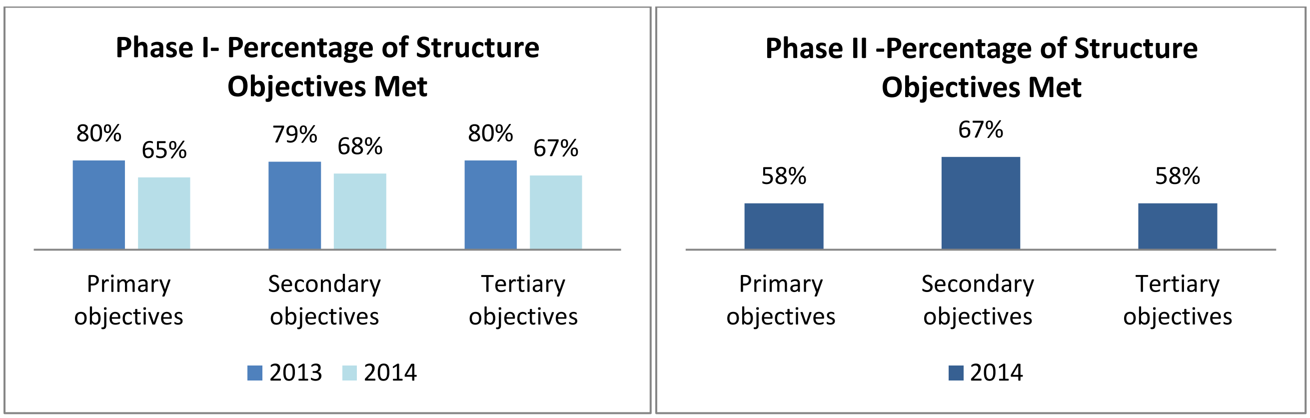


Photo Points

Photo point documents for both Phases have been compiled. For Phase I, complete sets are available pre-project and post project 2012-2014. Phase II sets are available pre-project and post project for 2013-2014. The documents are available on the O drive at O:\NFS\Tongass\Program\2500WatershedAirMgmt\ 2510WatershedPlanning\POW\01 POW Watersheds\Twelvemile\Twelvemile_PhaseI_Implementation\Photos (or upon request). These photos have been very effective at capturing changes in the placement of wood and to a lesser extent, the channel bed over time. The utility and importance of these photos cannot be overstated. They offer a cost effective, comprehensive look at the conditions, and will be useful in long term comparisons of project effectiveness. One example from Phase II, Treatment Site 17 is presented below in Figure 13. Changes through time can be detected in the stability of the pieces of wood, the relative depth and expanse of the related pool, and the presence of the riffle upstream.

Figure 13: Example of Photo Point Comparisons, Phase II Site 17

Low Altitude Aerial Photography

Full assessment still needs to be undertaken. The most recent aerial photos have been mosaicked and are available on the Z drive, but the 2010 pre-project photos still have not been processed. The camera equipment used originally takes more post-processing effort and has yet to be completed. Efforts to delineate beaver pond areas and off-channel habitat need to be completed and monitored over time.

Adult Salmonid Escapement Counts

The annual snorkel counts of the anadromous extent of mainstem Twelvemile are a valuable source of information for this project, and for Prince of Wales. This watershed has the District's most complete dataset for adult steelhead and coho, for one of the longest periods of time, and should therefore be prioritized for continued data collection (Figures 14 and 15). Trends in adult numbers (either increasing or decreasing) will not be able to be attributed directly to restoration actions due to the multitude of other factors that affect their survival prior to returning from the ocean, but major changes could initiate more critical assessment into the possible causes. Continuing with this relatively low cost monitoring tool could yield valuable results over the long term. Snorkel count monitoring for adult steelhead for an additional 9 years (from 2014) is considered the minimum amount of time to yield data necessary to detect change (total of 26 years) (conversation with Phil Roni; S. Jacobson, 2014). For adult coho snorkel counts an additional 6-7 years of escapement index surveys is recommended to detect a change (conversation with Phil Roni; S. Jacobson, 2014).

Figure 14: Adult Coho Numbers per Year

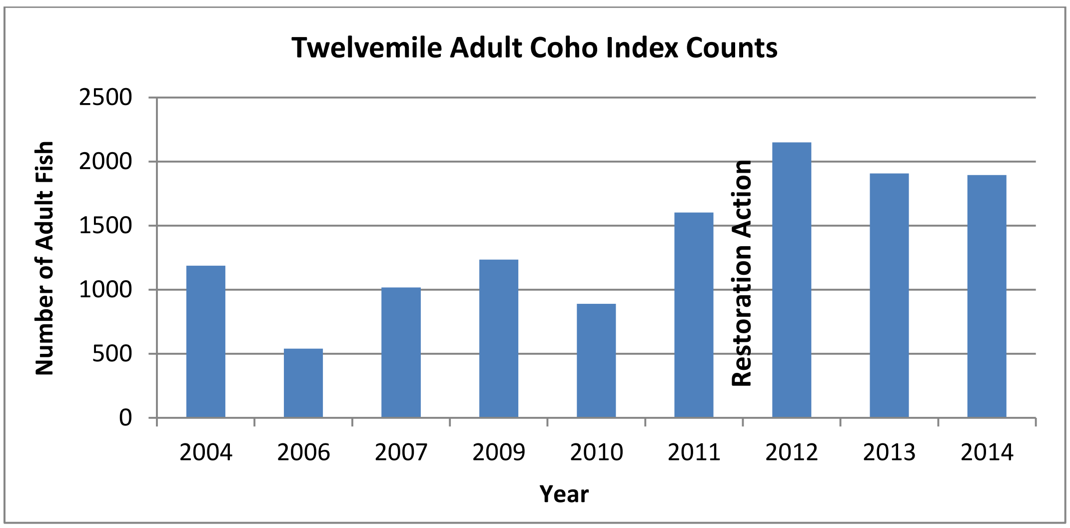
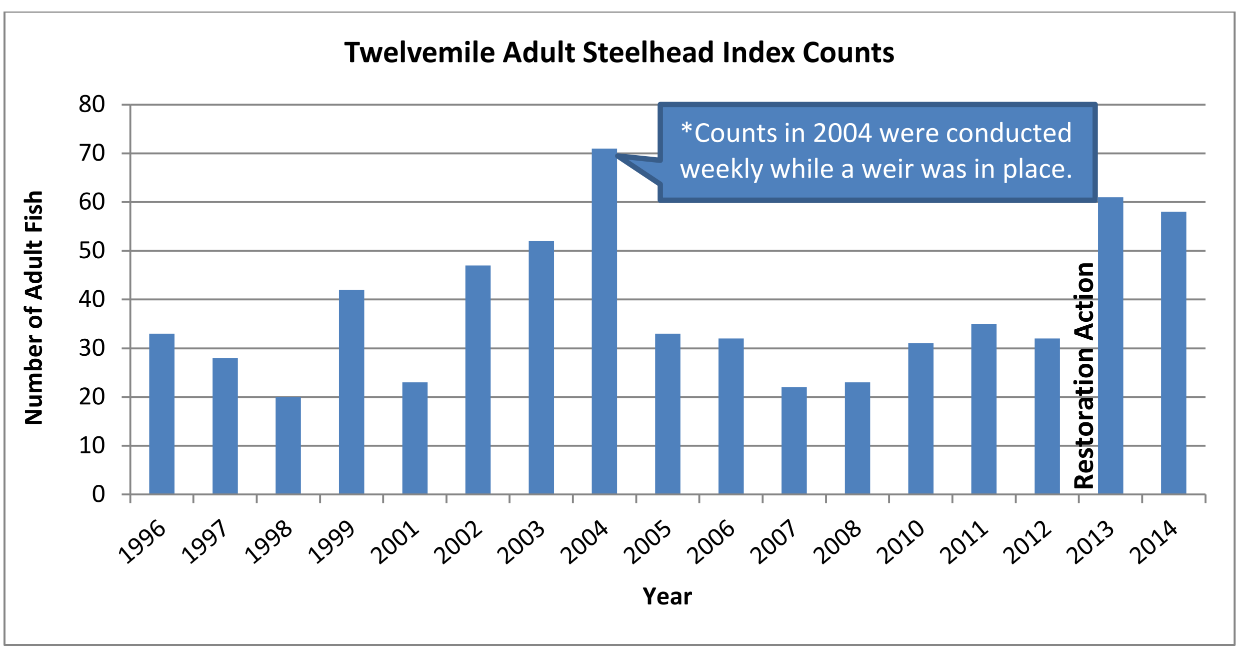


Figure 15: Adult Steelhead Numbers per Year



Juvenile Outmigrant Monitoring

These results will be included in a separate report.

SUMMARY

On the whole, based on field observations (both qualitative and quantitative), habitat conditions in Twelvemile Creek are currently more complex and dynamic than they were pre-project. The simplified morphology and lack of woody debris noted during the 2007 surveys no longer characterizes the mainstem within the project area. Movement of placed wood has occurred but is still functioning in the channel (see Flood Report, USFS 2015). It is estimated that less than 5% (30 pieces) of the total wood placed in Phase I and II restoration efforts has mobilized downstream of restoration reach (observation, 2014). In general, wood that migrated out of one treatment site area often lodged in another, increasing the size and complexity of several sites. In some cases, accumulations of wood formed large, channel spanning jams whose function and stability will need to be monitored. Legacy pieces and jams that had been stable over the last 5-10 years did shift or migrate after the project but it cannot be determined whether it was due to the influence of more pieces of wood racking against them or due to the flood flows experienced during 2014 (or both). The levels of erosion and deposition within the channel appear to be in relative equilibrium, as no large scale evidence is indicating otherwise. Observations made during adult snorkel counts have shown increased utilization of both adults and juveniles of various species in areas where restoration wood increased complexity and cover. The increased number of wood jams have also noticeably captured and retained many spawned out adult carcasses, retaining nutrients that would have likely been flushed out of the treatment reaches.

In conclusion, though the combination of photos, site objectives, habitat surveys, wood counts, cross sections, and fish enumeration provides many opportunities for interpretation, more time is necessary in order to measure overall project effectiveness. To date, habitat conditions are generally meeting the target objectives at the reach scale, but in many cases site specific objectives were not met, or were partially met. Longer term assessment will be valuable in tracking the effect of the project, the habitat conditions of the channel, and the abundance and condition of the native salmonids.

LESSONS LEARNED/OPPORTUNITES FOR IMPROVEMENT

Setting objectives: In this project, some of the objectives were numerically based on the “excellent” Fish Habitat Objective condition levels. One limitation with that concept is that the dataset currently driving the reference condition values for the Large Flood Plain metrics is small (n=8). Large flood plains are some of the most productive areas and were often early targets for timber harvest, so finding intact watersheds with this channel type is difficult. A concentrated effort to double the sample size and reanalyze the dataset is being pursued by the Tongass. Additionally, it is unlikely that any channel (even in reference condition) will meet the “excellent” level in all metrics. Therefore, for future projects, the objectives should be more trend based; with goals of moving conditions in managed streams toward those of reference streams, rather than achieving a numeric target.

Mobility of wood: The observed movement of wood in both Phases has led to many questions and opportunities to evaluate our restoration objectives, design, and implementation methods. Floodplain stream channels are dynamic and the added LWD is *not* meant to be static, therefore some amount of shifting and movement is expected during large peak flow flood events, especially like those in 2014. For more in depth discussion on the project design, implementation methods, and wood movement please refer to the Flood Report (USFS, 2015). Admittedly, we must continue to assess what the movement means to the utility of the project as a whole.

Monitoring Expectations: Monitoring efforts of this scale are time consuming and expensive. While the results will be valuable in assessing the effectiveness of the project, each project on POW will probably not be monitored to this extent. Development of monitoring plans for future projects should occur in collaboration with the Supervisors Office and budgetary direction. The Tongass Core Monitoring Guidance also provides helpful direction.

Monitoring Width/Depth Ratios: For projects where decreasing the width/depth ratio is a reach scale objective, collect information at several cross section locations distributed throughout the project area. Consider aiming for one cross section every 5-10 channel bed widths. Monumenting the cross sections may not be necessary due to the potential that the area may convert from a riffle to a pool or may not be possible to survey with wood additions. Refer to the WREM protocols for additional guidance. Revisit whether affecting width/depth ratios on a reach scale is a realistic objective in this environment without a substantial increase in survey data collected (e.g.; total station). Decreasing width/depth ratios as a site-specific objective is probably not appropriate, rather leave it with the "develop/enhance pool" objective: if pool depth is increased at a site, one can infer the width/depth ratio has decreased. Further, reducing cross sectional area at a pool head may be a more appropriate descriptor for a site specific objective.

Commonalities for (un)successful objectives: As the dataset of structure objective monitoring grows, more effort should be applied to searching for commonalities among objectives that are commonly met and which may be more difficult to achieve. This assessment could have impacts on adaptive management and the design of future restoration projects.

Consistency: To reduce observer bias or inconsistency, ensure all members of the monitoring crew have been through the appropriate training and are familiar with the protocols. Attempt to repeat the data collection at similar times of year, and review the existing data. Strive to repeat the photo monitoring as precisely as possible to make the most use out of the comparisons over time. Prioritize the adult snorkel counts to build the long term information available for Twelvemile.

References

Tucker, E. and J. Caouette. June 2008. *Updated Statistics for Aquatic Habitat Response Variables: Design, Analysis and Future Work.* Tongass National Forest White Paper, Draft. June 2008.

USFS 2001. US Forest Service Region 10 Aquatic Habitat Management Handbook. USDA Forest Service, Alaska Region. FSH 2090.21-2001-1. November 2001.

USFS 2007a. Twelvemile Arm Landscape Assessment. USDA Forest Service, Tongass National Forest, Craig Ranger District. March, 2007.

USFS 2007b. Twelvemile Creek Watershed Rehabilitation Plan. USDA Forest Service, Tongass National Forest, Craig Ranger District. 2007.

Kelliher, Dan. 2007. Twelvemile Creek Habitat Analysis. USDA Forest Service, Tongass National Forest, Supervisor's Office. October 2007.

USFS 2010. 2010 Craig Ranger District Escapement Protocol and Maps. USDA Forest Service, Tongass National Forest, Craig Ranger District. 2010.

USFS 2011. Twelvemile Creek Restoration Environmental Assessment. USDA Forest Service, Tongass National Forest, Craig Ranger District. R10-MB-738. December 2011.

USFS 2012. Twelvemile Creek Restoration -Phase II Environmental Assessment. USDA Forest Serivce, Tongass National Forest, Craig Ranger District. R10-MB-755a. December 2012.

USFS 2015. Twelvemile Creek Restoration – Assessment of 2014 Flooding. USDA Forest Service, Tongass National Forest, Craig Ranger District; TEAMS Enterprise Unit Watershed Restoration Division. February 2015

Appendix A: Data Collection Method and Equation Used to Calculate the Habitat Response Variables.

Habitat response variable	Equation	Data Collection Methods
Pools/Km (POOLS/KM)	Total Number of Pools / Meters Surveyed * 1000	Total count of pools. Total length of stream surveyed.
Pool Length/Meter (PLNGTH/M)	Total Pool Length / Total Length of Stream Surveyed	Sum of all pool lengths. Total length of stream surveyed.
Pool Spacing (POOL SPACE)	Length of Stream Surveyed / Channel Bed Width / Total Number of Pools	Total length of stream surveyed. Average channel bed width (width of active channel bed from bottom of bank to bottom of bank) averaged for the reach. Total number of pools.
Total Large Wood pieces / Meter (TLWD/M)	Total Pieces / Meters Surveyed	Total count of large wood pieces >1 m long and 0.1m in diameter. Total length of stream surveyed.
Total Key Pieces Large Wood/Meter (TKWD/M)	Total Key Pieces / Meters Surveyed	Total count of key large wood pieces. (Key piece size based on average channel bed width of stream surveyed.) Total length of stream surveyed.
Width-to-depth ratio (WD)	Bankfull width / mean bankfull depth	Bankfull width Bankfull depth ($\sum$ depths within bankfull / n+1) averaged for the reach

Appendix B: Structure Monitoring Field Forms

Wood Structure Objective and Photo Point Description Field Form

Date:		Crew:		Flow Level:	
Reach Location:		Start Description		End Description	

Site number:		GPS Coordinates:		Placement:	□Heli □HvyEqu □Hand
Structure type:	□ FMF □ Apex □ Porous □ Bar Buddy □ Channel Spanning □ Up/downstream V □ Deflector □ Grade Control □ Cover □ Bank Protector □ Other □ Floodplain				
Location:	□ Main Channel □ Side Channel	□ Inside Bend □ Outside Bend □ Straight Reach			
	□ Downstream Right Bank □ Downstream Left Bank □ Mid-channel □ Island			Sketch drawn?	□ Yes □ No □ Digital design instead
Current Primary Habitat Association:	□ Pool □ Riffle □ Gravel Bar □ Bank □ Floodplain □ Off Channel				
Design Objectives: Identify the original Primary, Secondary and Tertiary objectives of the structure by **numbering them 1-3**.					
____Protect Bank (small scale)		____Develop/Enhance Pool		____Maintain Split Flow	
____Protect Bank (large scale)		____ Enhance/Create Cover for Fish		____Control Access to Side Channel	
____Generate Underscour		____Develop/Maintain Undercut Bank		____Roughen Floodplain	
____Develop/Maintain Gravel Bar		____Improve Off Channel Habitat Access		____Increase Access to Floodplain	
____Reduce Cross Sectional Area		____ Provide High Water Refugia Along Margin		____Redirect or diffuse stream flow	
____Decrease Width/Depth Ratio		____		____	
Is the primary objective currently being met? ___Yes ___No			**Are the secondary and tertiary objectives currently being met? ___Yes ___No**		
Rationale:					
Photo Point Tag Location Description (marker type, bank, dist from channel)					
Camera Location Description: (orientation, dist and bearing from tag)					

Site number:	Picture #:	GPS Coordinates:		Placement:	□Heli □HvyEqu □Hand
Structure type:	□ FMF □ Apex □ Porous □ Bar Buddy □ Channel Spanning □ Up/downstream V □ Deflector □ Grade Control □ Cover □ Bank Protector □ Other □ Floodplain				
Location:	□ Main Channel □ Side Channel	□ Inside Bend □ Outside Bend □ Straight Reach			
	□ Downstream Right Bank □ Downstream Left Bank □ Mid-channel □ Island			Sketch drawn?	□ Yes □ No □ Digital design instead
Current Primary Habitat Association:	□ Pool □ Riffle □ Gravel Bar □ Bank □ Floodplain □ Off Channel				
Design Objectives: Identify the original Primary, Secondary and Tertiary objectives of the structure by **numbering them 1-3**.					
____Protect Bank (small scale)		____Develop/Enhance Pool		____Maintain Split Flow	
____Protect Bank (large scale)		____ Enhance/Create Cover for Fish		____Control Access to Side Channel	
____Generate Underscour		____Develop/Maintain Undercut Bank		____Roughen Floodplain	
____Develop/Maintain Gravel Bar		____Improve Off Channel Habitat Access		____Increase Access to Floodplain	
____Reduce Cross Sectional Area		____ Provide High Water Refugia Along Margin		____Redirect or diffuse stream flow	
____Decrease Width/Depth Ratio		____		____	
Is the primary objective currently being met? ___Yes ___No			**Are the secondary and tertiary objectives currently being met? ___Yes ___No**		
Rationale:					
Photo Point Tag Location Description (marker type, bank, dist from channel)					
Camera Location Description: (orientation, dist and bearing from tag)					

Wood Structure Objective and Photo Point Desciption Field Form Instructions

Objective

This survey is meant to provide a general description of each structure within a selected reach of treated stream. This can be done both in the design phase and after the treatment has been completed. The purpose is to determine whether or not the structures are meeting their original design objectives. This Description Field Form will provide the baseline data for further monitoring efforts.

Header Information

Date	Enter the mm/dd/yyyy.
Crew	Enter the first initial and last name of each crew member.
Flow Level	Record stage data if available, otherwise use relative description of High, Medium, or Low.
Reach Location	Describe the general location of the reach you are sampling. (i.e. Harris River Intensive Monitoring Reach)
Start Description End Description	Describe the exact starting and end points of the survey- be specific enough so that the survey could be replicated.

Structure Information

Site Number	Consecutively number each structure along the reach. Label each structure with a large brightly colored vinyl tag.
GPS Coordinates	Record the coordinates of the approximate center of the structure. Use WGS 84 datum by default or make note of any other datum used.
Placement	Check the box of the method planned/used to build the structure (Helicopter, Heavy Equipment, or Hand Crew/saw and winch)
Structure Type	Check the box of the general type of structure.
Location	Check one of each of the three location groups to describe the position of the structure.
Sketch drawn?	In the design phase, either hand draw or digitally design the structures to illustrate desired results. When possible during monitoring, sketch the current condition to bolster the rationale behind meeting/falling short of original objectives. Include thalweg flow direction and habitat units.
Current Primary Habitat Association	Check one of the boxes that describes the dominant habitat unit associated with the structure's immediate vicinity.
Design Objectives	Identify the original Primary, Secondary and Tertiary objectives that the structure is/was designed to accomplish.
Are the objectives being met?	In the monitoring phase, use subjective and professional judgment to state whether the original objectives for each site are being met by the structure.
Rationale	In the design phase, describe the rationale for determining the purpose and need of a site. In the post implementation monitoring phase, describe whether or not the structures are meeting their objectives, and why.
Photo Point Tag Location	Hang at least one large, brightly colored vinyl tag on a tree both visible from the channel but far enough back to be protected. Locate the tag (and/or stake) as near as possible to the best vantage point for observing changes at a treatment site. Include a description of its location.
Camera Location	Describe each location where a photo point is taken. Record the distance and bearing of the camera location from the Photo Point tag/stake on the bank. Include orientation details (upstream/downstream, distance from edge of vegetation). **Also include upstream and downstream photos of the site from the center of the channel** (no distance or bearing required).

Appendix C: Specific Standard Operating Procedures

<u>Tier II and Tier IV Habitat Surveys</u>

These surveys encompass a very valuable segment of the monitoring data for this project. The importance of conducting these surveys thoroughly, accurately, and consistently cannot be overstated. *Prior to conducting these surveys, refamiliarize all survey participants with the protocol in the 2001 Region 10 Aquatic Habitat Management Handbook, just to be absolutely certain that the surveys are conducted correctly.* At least one of the crew members on the survey crew should have attended the Fish and Aquatic Stream Habitat Survey Training. In addition, follow the clarifications below:

<u>Tier II Surveys</u>

- □ Surveys should start and end near the same point each year and follow the **centerline of the active channel** through the last habitat unit (pool, riffle), sometimes going beyond the upper extent of the reach if necessary.
- □ Detailed notes and hip chain distances should be recorded at features like treatment sites, start and end points, the upper or lower extent of the survey, tributary confluences, road crossings, cross sections, entry and exit points of side channels, and any other obvious features.
- □ All side channels should be fully surveyed.

<u>Tier IV Surveys</u>

- □ In reference to counting clusters; *tally the number of clusters in each habitat unit, but also tally each piece of wood within cluster individually, according to the appropriate size class.* Additionally, *count all qualifying pieces of wood that are touching at least one other piece of wood in the cluster, regardless of the zone in which they are located*. For example, if you are counting the individual pieces in a cluster that begins within bankfull width or height, include all touching pieces even if some of the other pieces are located in the floodplain (not within bankfull width or height).
- □ Indicate whether or not a key-sized or non key-sized rootwad is attached to each piece of wood.
- □ In order to reduce single observer bias, perform the Tier IV with at least 2-3 people, and measure the length and diameter of all pieces until all members of the group are calibrated and confident.

<u>Data Entry</u>

- □ After collecting field data on the appropriate datasheet, all data (including survey notes) should be entered into an excel workbook, and double checked for accuracy. Using a copy of the digital version of the datasheet is the most effective method for data entry.
- □ Store all data on the O drive under O:\NFS\Tongass\Program\2500WatershedAirMgmt\ 2510WatershedPlanning\POW\Watersheds\Twelvemile Watershed\Twelvemile_Surveys_Data

<u>Photo Points</u>

Be sure to take a printed copy of the most recent photo monitoring document. Use the descriptions and tags (where applicable) to reoccupy the same space, and use the photos to align the shot in the exact same way as the previous years. The photos and objectives will be incorporated into a document and stored on the O drive under O:\NFS\Tongass\Program\2500WatershedAirMgmt\ 2510WatershedPlanning\POW\Watersheds\Twelvemile Watershed\ Twelvemile_PhaseI_Implementation\Photos (or Phase II_Implementation).

<u>Aerial Photos</u>

Schedule these flights well in advance and request that they be flown prior to the leaf out of the alders along the riparian areas (March or early April).

Appendix D: FY 13 Report--Watersheds Moved to an Improved Condition

Forest Name: Tongass National Forest

Watershed Name and HUC12 #: Twelvemile Creek 190101030501

Watershed Characteristics:

Size: Total Watershed Area Acres = 12,830

FS Ownership: 71% (NonFS Area = 29%)

Values: Forest, wildlife, fisheries

Important Ecological Values:

The Twelvemile Creek watershed has important terrestrial and aquatic ecological values. The densely forested uplands consist of robust stands of hemlock, spruce and cedar. These forests support good numbers of black bear and Sitka blacktail deer. Twelvemile Creek supports three species of salmon – coho, pink, and chum; as well as resident and anadromous forms of coastal cutthroat, rainbow/steelhead trout, and Dolly Varden char. The watershed has 13 miles of anadromous stream and 13.5 miles of resident fish stream.

Ecological/Watershed Condition:

Pre-treatment Condition Class: 1.8 **Current Condition Class: 1**

The Twelvemile watershed rated as '*Functional At Risk'* prior to treatments that started in 2011. Indicators for aquatic habitat, riparian vegetation condition, road density and proximity to sensitive aquatic habitats were all rated as '*Impaired*'. In FY 2011, 2012 and 2013, the US Forest Service addressed aquatic habitat, riparian and upland habitat, and road density issues in the Twelvemile watershed. The work accomplished upgraded the overall rating of the watershed to '*Functional*'.

Problems/issues:

Twelvemile Creek became impaired because of logging practices that took place during an era when there was little riparian and stream habitat protection. Riparian corridors were clear-cut to the stream banks, large wood was deliberately removed from streams, gravel was extracted from streams to build roads, and riparian corridors were used to yard logs to roadside landings. Direct impacts of past management activities include erosion from roads, introduced invasive plants, and impaired fish and wildlife habitat. The deficient large wood (LW) recruitment in the main stem and young growth riparian zones resulted in altered sediment transport, low pool counts, long homogenous stream reaches, and excessive channel widening.

The watershed has 59 miles of road, and an average road density of 3.1 miles per square mile. Such high road densities tend to negatively impact aquatic habitat through increased rates of sedimentation from erosion, road failures, blocked fish passage, and reduced hydrologic connectivity. Twelvemile Creek has over 16 miles of road no longer needed for public access or current forest management activities. Of those 16 miles, 9.3 miles were identified as being ‘problem’ roads or roads that were negatively affecting aquatic habitat.

Restoration objective:

The objectives for Twelvemile Creek were primarily to restore stream bank and stream channel processes, restore natural and beneficial quantities of large wood (LW) over the short and long term, restore fish habitat and maintain optimum water temperatures for fish. The objectives of the project meet the requirements of the Forest Plan to restore the natural range and frequency of aquatic habitat conditions on the Tongass National Forest, sustain the diversity and production of fish and other freshwater organisms, and meet water quality standards.

Restoration/Improvement treatment/activities

Accomplishments:

- **2.5 stream miles restored** (2 miles main stem, 0.5 miles tributary)
- **40 acres of riparian vegetation improvement**
- **65 acres of upland/wildlife vegetation improvement**
- **7.83 miles of road storage** (These roads may be needed for future timber sales and were treated to be self-maintaining, with most or all, fish crossing culverts/bridges removed, most cross drains removed, and waterbars and erosion control seeding applied where needed.)
- **1.63 miles of road decommissioning** (These were temporary logging roads. All culverts and bridges have been removed and waterbars and erosion control seeding were applied where needed.)
- **47 sites on existing roads treated by either removing drainage structures or constructing waterbars**

- **12 road structures removed for fish migration** (Two culverts were completely blocking fish migration. Their removal provided access to 0.21 miles of known fish habitat.)
- **Project monitoring** (includes baseline and post-treatment stream morphology, aquatic habitat, and fish metrics)

Costs:

Source	Project Planning	NEPA and Design	Implementation	Project Monitoring
Forest Service	$88,000	$494,000	$130,000	$180,000
Partner	$0	$0	$662,000	$110,000
Total	$88,000	$494,000	$792,000	$390,000
			Grand Total	$1,664,000

Partners:

- National Forest Foundation
- The Nature Conservancy
- Prince of Wales Resource Advisory Committee, Title II Secure Rural Schools
- National Fish and Wildlife Foundation
- Fish America Foundation
- Alaska Sustainable Salmon Fund

Project Contact Name & phone number:

Sean Claffey, District Hydrologist (907) 826-1612 or Sarah Brandy, District Fisheries Biologist (907) 826-1634; Craig Ranger District

Photos:

Photo set 1 – Phase II, Structure Number 16, looking downstream right bank before and after LW placement.

This photo is looking downstream at an example of a multifaceted structure with multiple objectives. This structure will stabilize a rapidly eroding bank, improve the quality of the pools along the bank, and improve surface water connection of side channel beaver habitat immediately upstream of the structure. The three facets of this structure (the bar structure, the channel spanning members, and the stabilized bank) will work together to achieve these objectives. The bar structure will encourage deposition on the bar to reduce the width/depth ratio and focus flow through the pool, the spanning members will encourage scour, and the stabilized bank will provide a hard, stable bank to scour against.

Photo set 2 – Phase II, Structure Number 16.5, looking downstream right bank before and after LW placement.

The objective of this multifaceted LW placement is to protect the bank from further erosion and provide cover for fish. In addition, there is a row of conifers on the downstream right bank which the stream was undercutting. These conifers were at risk of being undercut before they were mature and could become future, naturally occurring, LW in the stream system. Fish can be seen in the bottom photo.

Photo set 3 – Phase II, Structure Number 18, looking downstream before and after LW placement.

This site had small remnant wood within the reach and a mid-channel bar. The objectives are to maintain and enhance the existing small jam, build scour and cover for the downstream right bank pool, construct an apex jam to maintain split flow, protect the left bank along the riffle, add floodplain wood to the left bank, construct a bar on left bank and place a formidable multi-faceted structure on the right bank.

Photo 4 - Road decommission.

This photo is of a road that was decommissioned in the Twelvemile watershed. Fallen trees help reduce erosion and sediment loads to nearby waterways. All structures on this road were removed using heavy equipment. Downed alders were placed to prevent motor vehicle access, and seed was applied at the disturbed ground sites to further reduce erosion.

Photo set 5 – Road decommission before and after treatment.

The Twelvemile watershed improvement included the storage and decommissioning of abandoned, or ‘legacy’, logging roads. This photo displays a bridge that was removed with explosives because it was not easily accessible with heavy equipment, the typical method for removing such structures. This technique is utilized to treat specific sites that pose resource risk on roads with limited access, without creating the disturbance and expense of heavy equipment operation. The use of explosives is an effective way to remove log culvert s and log bridges and create waterbars. Turbidity--seen in the post-treatment photo on the right—is a temporary, localized effect of instream restoration and subsides to clear water baseline conditions within a few hours. The long term intent of these actions is to reduce the erosion and the transport of road fill into streams, restore hydrologic connectivity, and improve aquatic species migration where possible.