ASOTIN CREEK
INTENSIVELY MONITORED WATERSHED:

2013 PROGRESS REPORT

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EXECUTIVE SUMMARY

The Asotin Creek Intensively Monitored Watershed was implemented in 2008 after an extensive selection process coordinated by the Snake River Salmon Recovery Board and consultation with the Regional Technical Team. Asotin Creek was chosen as an IMW location in southeast Washington because there was extensive fish and habitat data going back to the 1980's, ongoing fish-in fish-out monitoring, minimal hatchery influence, moderate seeding levels of steelhead, and agency and public support. Based on previous habitat assessments and preliminary IMW monitoring it was decided that riparian function and instream habitat complexity were impaired. The restoration proposed was fencing, native plant revegetation, weed control to enhance riparian function in the long-term, and the addition of large woody debris (LWD) in the short-term to increase habitat diversity and promote a more dynamic channel (e.g., increase sediment sorting, pool frequency, and floodplain connection).

An experimental design and restoration plan was developed and revised based on an adaptive management approach. The design has three study creeks in the upper part of the watershed: Charley Creek, North Fork Asotin Creek and South Fork Asotin Creek. The first 12 km of each stream is divided into three 4 km long sections: one section of each stream is a treatment section and two sections are control sections. We are monitoring juvenile steelhead abundance, growth, survival, and movement in each section using mark-recapture surveys in 300-600 m fish sites. All steelhead ≥70 mm are PIT tagged, weighed (nearest 0.1 g), and measured (fork length nearest mm) and a subsample of scales are collected to estimate the age distribution. Mark-recapture surveys are conducted in the summer (June-July) and fall (September-October) every year and mobile PIT tag surveys are conducted in the winter (December-January) and spring (March-April) each year to allow for estimation of seasonal population parameters. Stream and riparian habitat was measured using the Pacfish-Infish Biological Opinion protocol (PIBO) from 2008-2009 but we now use the Columbia Habitat Monitoring Protocol (CHaMP). LiDAR, aerial photography, temperature, and discharge monitoring are also used throughout the watershed.

The treatment section of South Fork Asotin Creek was restored in 2012 (after summer mark-recapture and habitat surveys). A total of 196 LWD structures were built consisting of 564 pieces of LWD (≥ 0.1 m diameter and ≥ 1.0 m in length). The LWD structures were built mostly by hand using wooden fence posts driven into the stream bottom to secure LWD in place. These structures consisted of deflector, mid-channel, spanners/debris jams, and key piece structures. In 2013, the treatment section of Charley Creek was restored in a similar manner to the South Fork Asotin Creek and a total of 207 LWD structures were built and 497 pieces of LWD were added. The majority of the LWD added to the South Fork was 15-30 cm diameter whereas in Charley Creek the majority of the LWD added was < 15 cm diameter.

A complete assessment of the initial responses to restoration will be reported on in an upcoming report in June 2014. Preliminary assessments of the treatment response in South Fork Asotin Creek suggest a non-significant increase in juvenile steelhead abundance in the South Fork treatment and a significant decrease in growth compared to the control sections. Survival estimates are being recalculated and will be available in the upcoming report. Geomorphic change analysis using the CHaMP topographic data from 2011-2012 and measurement of habitat units suggests there was little change in channel habitat due to the addition of LWD structures other than an increase in fish cover. An extremely low spring discharge in 2013 may be one reason for a limited fish and habitat response. An estimate of smolts per spawner will be presented in the upcoming report for the study creeks and compared to smolts per spawner estimates from the WDFW fish-in fish-out monitoring of the Asotin Watershed. The final restoration treatment will be implemented in North Fork Asotin Creek in 2014 and monitoring will continue until 2018. These data and continued monitoring the Asotin Creek IMW are expected to

provide valuable information on the response of wild steelhead to LWD additions and how to improve the effectiveness of restoration actions in other watersheds.

ACKNOWLEDGEMENTS

The Asotin Intensively Monitored Watershed (IMW) is a collaborative multi-agency initiative sponsored by the Snake River Salmon Recovery Board (SRSRB). The SRSRB provides oversight and technical review of all the Asotin Creek IMW activities through support from the Regional Technical Team (RTT) and National Oceanic and Atmospheric Administration (NOAA) staff. The majority of the IMW takes place on Washington Department of Fish and Wildlife (WDFW) and US Forest Service (USFS) land, and both agencies have supported the development and implementation of the project. Funding for the primary research components of the IMW are from the NOAA Pacific Coastal Salmon Recovery Fund (PCSRF). Funding for the restoration activities comes from PCSRF through the State of Washington's Salmon Recovery Funding Board (SRFB), BPA, Conservation Commission, USFS, and WDFW. We are particularly grateful for support we receive from Ethan Crawford of WDFW in the form of field staff from the Clarkston office to assist in all aspects of the IMW project, and Bonneville Power Administration (BPA) which supports WDFW's efforts to collect fish in-fish out data in Asotin Creek. Bob Dice, the manager of the Clarkston Wildlife Office, has also provided the IMW with accommodation, transportation, and access since the start of the project. We also wish to thank the Koch and Thornton families for graciously providing us access to private property along Charley Creek to conduct monitoring and restoration. Brad Johnson, WRIA 35/Asotin County Public Utilities District (PUD) has also been an indispensable part of the IMW team working with the local landowners and agencies to help secure land access, operating permits, and local support and sponsorships for the IMW. The PUD provides us with office space and storage for field gear. Del Groat of the USFS has provided generous donations of time and large wood for the restoration treatments and Billy Bowels, also with USFS, has help with safety training for field crews. Bruce Heiner, WDFW Habitat Engineer and Barry Sutherland, USDA Natural Resources Conservation Service (NRCS) Fluvial Geomorphologist provided comments of the earlier versions of the restoration plan. The following groups have provided direct support to the IMW in either goods or services and we wish to thank them for their help with this important fisheries conservation project: Avista Power, Clearwater Power, Collier Electric, Inland Metals Electric, TDS Telecom, WDFW, and USFS.

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LIST OF ABBREVIATIONS

ACCD	- Asotin County Conservation District
CHaMP	- Columbia Habitat Monitoring Protocol
DEM	- Digital elevation model
DoD	- Geomorphic change detection using the difference between two DEMs
DOE	- Washington State Department of Ecology
DWS	- Dynamic woody structure (main restoration technique proposed)
ELR	- Eco Logical Research Inc.
IMW	- Intensively Monitored Watershed
ISEMP	- Integrated Status and Effectiveness Monitoring Program
LWD	- Large woody debris
NOAA	- National Oceanic and Atmospheric Administration's
NRCS	- Natural Resources Conservation Service
PCSRF	- Pacific Coastal Salmon Recovery Fund
PTAGIS	- PIT Tag Information System
PUD	- Public Utility District
RTT	- Regional Technical Committee
RCO	- Washington State Recreation and Conservation Office
SRSRB	- Snake River Salmon Recovery Board
USDA	- United States Department of Agriculture
USGS	- United States Geological Survey
WDFW	- Washington Department of Fish and Wildlife
WRIA	- Washington Water Resource Inventory Area

1. INTRODUCTION

1.1 Background

In 2008, Asotin Creek was chosen as a location to implement an Intensively Monitored Watersheds (IMW) project in southeast Washington (Figure 1). A series of IMWs have been established in the Pacific Northwest to assess the effect of different restoration actions on populations of salmonids at the watershed scale (Bilby et al. 2005). IMWs use an experimental framework to increase the probability of detecting a population level response to restoration actions. A detailed account of the process to select and design the Asotin Creek IMW can be found in Bennett and Bouwes (2009) and a summary of the IMW monitoring methods and data collection can be found in Bennett et al. (2012). A summary of the fish-in fish-out monitoring conducted by the Washington Department of Fish and Wildlife (WDFW) in Asotin Creek is summarized by Crawford et al. (2013) .

An experimental study design has been developed and refined for the Asotin Creek IMW that includes treatment and control sections within the Asotin Creek tributaries of Charley Creek, North Fork Asotin Creek, and South Fork Asotin Creek (hereafter referred to as “study creeks”; Figure 2). The study creeks generally exhibit homogenized and degraded habitats, with exceptionally low availability of pool habitat for summer and overwintering refugia, which is thought to be limiting salmonid production (SRSRB 2011). The low amount of large woody debris (LWD) in the channel and low LWD recruitment has been identified as a significant limiting factor for the wild steelhead population that exists in Asotin Creek (ACCD 2004, Bennett and Bouwes 2009). A detailed Restoration Plan was developed that proposed ***riparian enhancement and large woody debris additions as restoration treatments in the Asotin Creek IMW*** (Wheaton et al. 2012). The riparian enhancement treatments include a mix of short and longer term measures ranging from fencing, planting, and weed control to create a more diverse riparian corridor (in terms of age and species structure) that is sustained by fluvial processes and more regular interaction and exchange with the channel (Opperman and Merenlender 2004). Among the long-term benefits of such a riparian treatment are the reestablishment of sustainable levels of wood recruitment (of all sizes) to the channel. By contrast, the LWD additions focus on intensive additions of high densities of LWD designed to work in concert with one other to initiate and promote more dynamic creation, shaping and maintenance of active bar and pool habitat by fluvial processes.

The Asotin Creek IMW is funded from NOAA's Pacific Coastal Salmon Recovery Fund (PCSRF). The PCSRF funds are used to fund the ongoing fish and habitat monitoring and data collection and analysis. These funds are now administered via the Governors Salmon Recovery Office. A separate project funded by the Bonneville Power Administration (BPA) and implemented by the WDFW provides fish-in, fish-out monitoring for the Asotin watershed (Crawford et al. 2013). Funding for the restoration actions will come from a myriad of sources including, but not limited to, Pacific Coast Salmon Recovery Fund (PCSRF) through the State of Washington's Salmon Recovery Funding Board (SRFB), BPA, Conservation Commission, US Forest Service, and WDFW.

Eco Logical Research Inc., is the primary contractor that manages the Asotin Creek IMW and implements the restoration. This report is intended as a brief progress report on work completed to date with specific reference to the work completed during the latest contract period which lasted from October 1, 2012 to Sept 30, 2013. A more complete analysis of the monitoring data through 2008-2013, especially the response of habitat and fish to the recent restoration actions, will be completed by June 30, 2014.

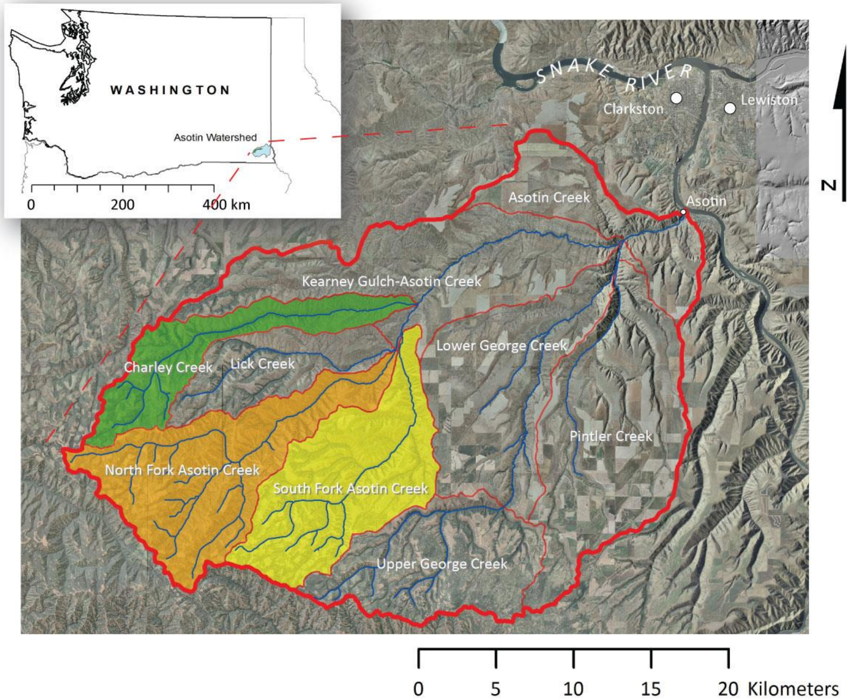


Figure 1. Location of Asotin Creek within Washington and the Asotin Creek Intensively Monitored Watershed study creek watersheds (i.e., three colored watersheds) within the Asotin Creek.

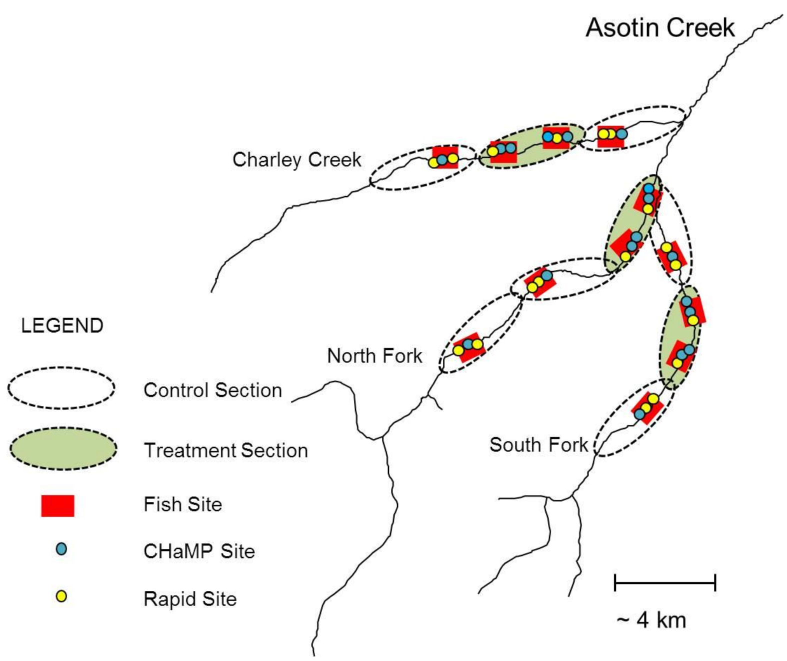


Figure 2. Experimental and monitoring design layout. The green sections are restoration treatments: South Fork restoration was implemented in 2012, Charley Creek in 2013, and North Fork will be restored in 2014. All sections not colored will be controls throughout the project. Fish sites and habitat survey sites (CHaMP and rapid) are nested within each section.

1.2 Restoration Schedule and Experimental Design Setting

A detailed review of our experimental design and rationale can be found in Bennett and Bouwes (2009) and Wheaton et al. (2012). Briefly, each study creek has three sections each 4 km long (Figure 2). One section in each stream will be a treatment section where LWD will be added and the remaining sections will be used as controls. The streams will be treated in different years for logistical reasons and to prevent a year effect from biasing the results of the study (Walters et al. 1988, Loughin et al. 2007). South Fork Asotin Creek was treated in 2012, Charley Creek will be treated in 2013, and the North Fork will be treated in 2014. The location of the treatments has been revised since the start of the IMW based on logistical limitations and a power analysis that suggested treating all the streams would give us a higher probability of detecting a fish response. The final design has the middle section of the South Fork and Charley Creek being treated and the lower section of North Fork. Out-of-basin controls are being evaluated in the John Day watershed, Oregon and the Potlatch watershed in Idaho.

1.3 Study Area

Asotin Creek is a tributary of the Snake River, flowing through the town of Asotin, in the southeast portion of Washington and the SRSRR (Figure 1). The Asotin Creek watershed is within the Columbia Plateau and Blue Mountains level III ecoregions. These ecoregions are dominated by deep narrow canyons cut into underlying basalt lithology and surrounded by semi-arid sagebrush steppe and grasslands at lower elevations and open conifer dominated forests at higher elevations (Omernik 1987, Clarke 1995, Omernik 1995). The Asotin watershed is approximately 842 km^2 and the average annual precipitation ranges from 115 cm at higher elevations in the Blue Mountains to less than 30 cm at lower elevations (240 m) along the Snake River. The study creeks occupy the western half of the watershed and drain the headwaters of the Asotin Watershed. Charley Creek is a left bank tributary to the mainstem Asotin Creek and its confluence is approximately 2 km downstream of the split between the South Fork Asotin Creek and North Fork Asotin Creek confluence.

The study creeks have a predominantly plane bed form with a relatively steep gradient, low sinuosity and large substrate (Table 1). The study creeks flow through steep V-shaped valleys with narrow (< 100 m wide) floodplain areas. Much of the riparian corridor is dominated by alder and scattered Douglas-fir and cottonwood which provides good shading. However, the trees are relatively young (20-40 years old) and so are not contributing much LWD to the stream. South Fork Asotin Creek has larger fluctuations in flow and temperature compared to Charley and North Fork creeks and exceeds WDFW water temperature criteria more frequently (Figure 3 and Figure 4).

Table 1. Summary of stream characteristics for Charley, North Fork, and South Fork Creeks*.

Stream	Sinuosity	Gradient (%)	D50 (mm)	% fines < 2 mm	% fines < 6 mm	BFW (m)	Pools/ 100 m	RPD (m)	LWD/ 100 m
Charley	1.20	3.01	53.2	11.1	19.1	4.8	2.1	0.26	15.3
North Fork	1.17	1.65	76.3	5.3	12.9	9.8	1.5	0.30	16.7
South Fork	1.15	2.63	72.2	6.3	12.8	6.4	2.3	0.20	10.6

* Data collected using the CHaMP habitat protocol at sites from 2011-2013 (CHaMP 2012). Grad = % slope; D50 based on Wolman pebble counts; % fines = pool tail fines; BFW = bankfull width; Pool/ 100 m = number of pools per 100 m; RPD= average residual pool depth; LWD/ 100 m = number of large woody debris pieces >= 1.0 m long and >= 0.1 m in diameter per 100 m.

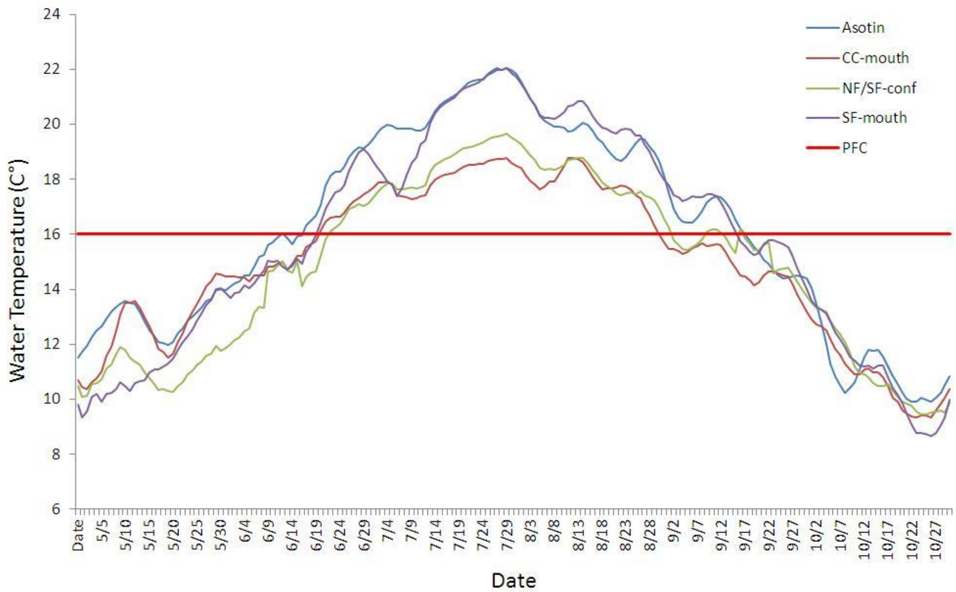


Figure 3. Average summer water temperature 2008-2011 near the mouth of Asotin, Charley, North Fork (at confluence with South Fork), and South Fork creeks. Horizontal red line represents the proper functioning condition (PFC) for juvenile salmonids as defined by WDFW.

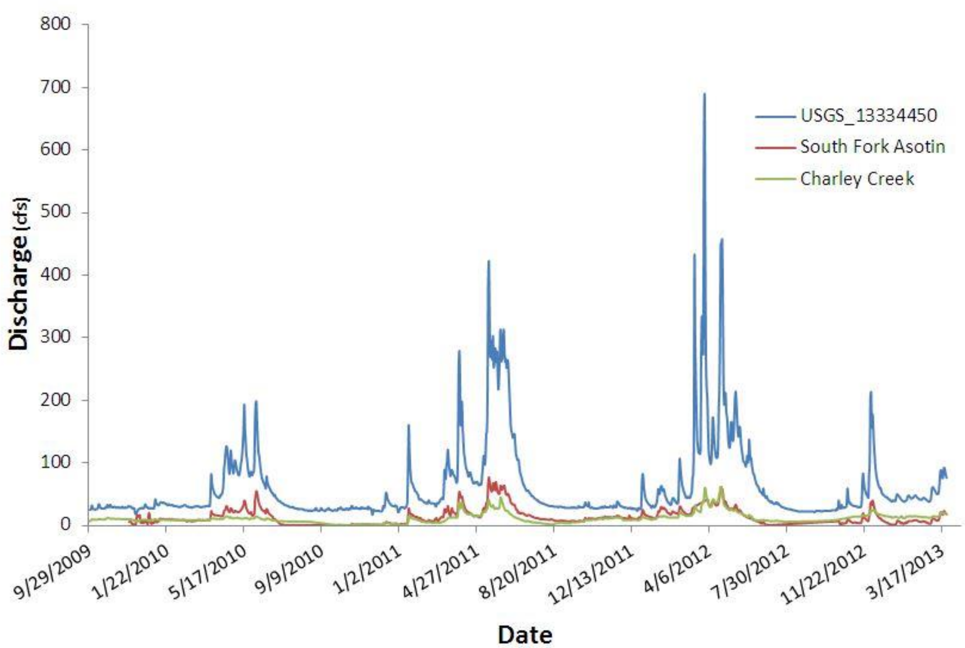


Figure 4. Average daily discharge (cfs) in Charley Creek and South Fork Creek as calculated from water height gauges installed as part of the IMW. Combined discharge of North Fork and South Fork is represented by the blue line which is the USGS gauge at the bridge over the mainstem Asotin Creek just downstream from the confluence of the North Fork and South Fork.

2 MONITORING METHODS

The monitoring design is composed of four components: fish, instream habitat, stream channel/floodplain, and riparian habitat monitoring. We are using a set of monitoring protocols for these components that are either regionally recognized protocols or well supported monitoring methods from the literature. This will allow for efficient and precise data collection, data sharing between various agencies, and the detection of biologically and geomorphologically significant changes due to restoration actions. Most monitoring activities are focused on the three study creeks: Charley Creek, North Fork, and South Fork.

2.1 Watershed Context

Considerations of fish and habitat responses to restoration activities will be most informative if appraised within the appropriate spatio-temporal context (e.g., Wohl et al. 2005, Hemstad and Newman 2006). This requires the collection, analysis and presentation of geospatial data describing baseline and changed environmental conditions as well as some conceptual model within which biological and physical relationships are appraised. To support this end, we are in the process of developing the Biophysical Framework for Asotin Creek (Figure 5). Development of this framework and its application are based on the River Styles Framework (Brierley and Fryirs 2005) which provides a description of landscape units and reach types (e.g., river styles) as well as the geomorphic and fluvial processes that shape river channels and ultimately constrain the types of fish habitat that can be present. This procedure will provide us with the context in which to interpret and understand the habitat responses to restoration actions and enable better transfer of the lessons learned in the Asotin Creek IW to other watersheds. Our preliminary assessment indicate there are seven dominant river styles in the Asotin Creek watershed. We will develop this framework further in our next report.

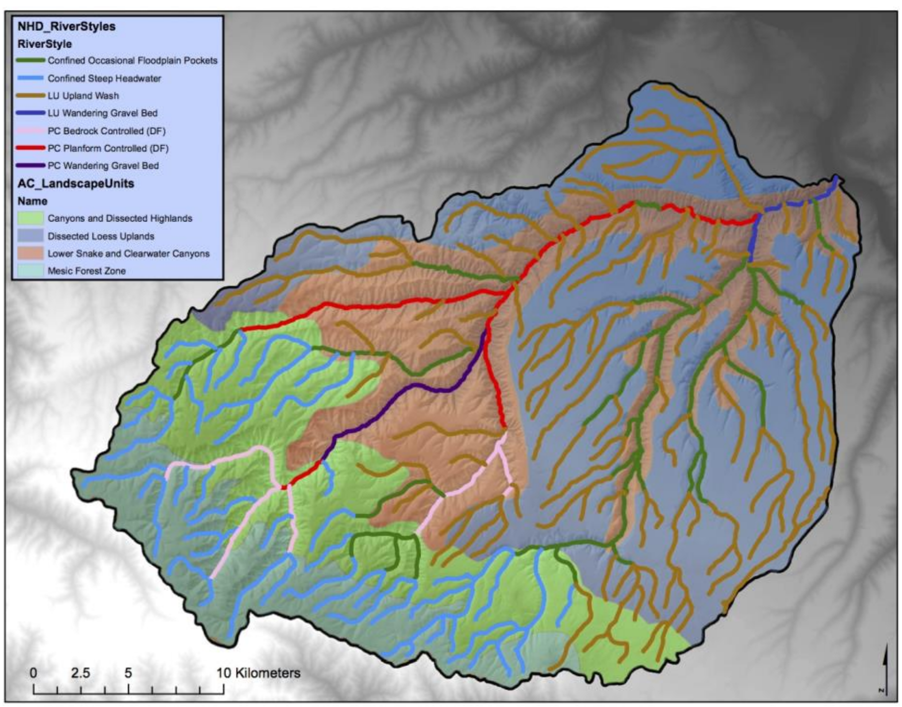


Figure 5. Draft landscape units and river styles of Asotin Creek.

2.2 Monitoring Infrastructure

We have developed a monitoring infrastructure based on the experimental design and project objectives. The restoration treatments will be implemented in the three study creeks and therefore most of our sampling effort is directed to the lower 12 km of the study creeks. The monitoring infrastructure has been developed from preexisting monitoring programs (e.g., WDFW Asotin Program, USGS gauges) and new installations, such as new juvenile steelhead and habitat sampling sites, PIT tag arrays, temperature probes, and water levels gauges (Figure 6). This base infrastructure will allow us to relate responses of fish populations to hydrologic attributes (i.e., discharge and water temperature) and specific stream habitat attributes at the site/reach, stream, subbasin, and watershed scale.

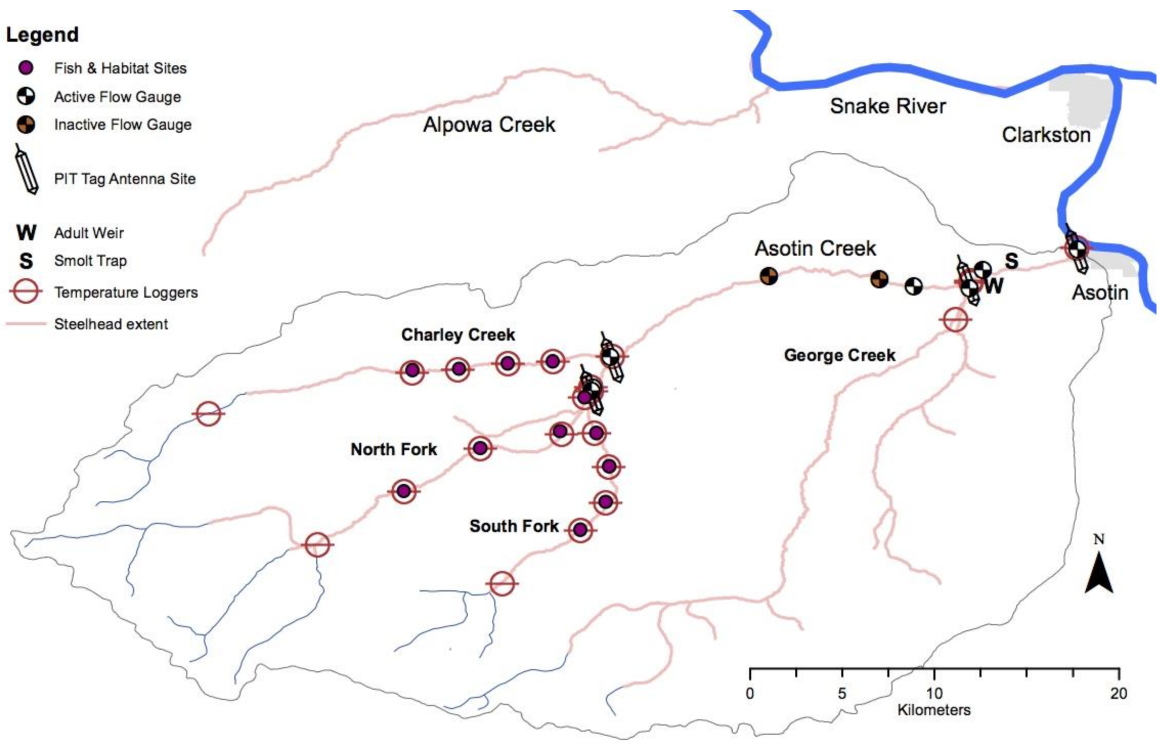


Figure 6. Monitoring infrastructure including fish and habitat sites in Charley Creek, North Fork Asotin Creek, and South Fork Creek, temperature and discharge gauges, PIT tag antenna arrays, and the WDFW adult weir and smolt trap for fish-in fish-out monitoring.

2.3 Fish Monitoring

Our fish monitoring program is primarily focused on juvenile steelhead capture, PIT tagging, and recapturing or resighting of fish within the study creeks. We are focusing on this proportion of the population because it will provide the best measure of freshwater production that is most directly influenced by stream habitat conditions and restoration actions. These fish monitoring efforts will be enhanced by WDFW monitoring of outmigrating smolts and returning adults with the mainstem smolt trap and adult weir respectively (Crawford et al. 2013). Spawning surveys are also conducted by WDFW and IMW staff as stream conditions permit. Below we report on the monitoring to date and any changes in the monitoring protocols. For detailed methods see Bennett et al. (2012).

One of the reasons that Asotin Creek was chosen as a site for an IMW was that the steelhead population has been monitored continually since 1984, it was designated a wild steelhead refuge in 1997, and it is currently undergoing a detailed assessment of steelhead abundance, productivity, and distribution. The smolt trap and adult weir efforts began in 2004 and 2005 respectively. The goals of the Asotin Creek Steelhead Assessment are to "… determine the abundance and current productivity of the Asotin Creek steelhead population and to estimate life stage survival rates in the mainstem of Asotin Creek" (Crawford et al. 2013).

To assess the direct effects of stream restoration we are capturing and PIT tagging juvenile steelhead within the treatment and control sections of the study creeks. Juvenile tagging in the study creeks will allow us to determine juvenile abundance, growth, movement, and survival pre and post restoration. We started tagging juvenile steelhead in 2008 (a pilot year) where we captured and PIT tagged juveniles at three fish sites in each study creek. The current tagging program calls for 12 sites to be sampled but the arrangement of the sites has changed to four fish sites in each study creek to ensure replication of sample sites within the treatment sections. Each fish site is visited twice a year during a summer tagging session (June to July) and a fall tagging session (September to October). The two tagging sessions allow us to calculate the population parameters over shorter time periods (i.e., summer to fall and fall to the following summer; Table 2). We also conduct mobile PIT tag surveys in the winter and spring to detect PIT tagged juvenile steelhead overwintering in the study area. These detections, along with the summer and fall capture sessions, are used to calculate seasonal survival rates.

Table 2. Fish sample site matrix with completed and proposed sample schedule through to the end of the IMW project. Grey shading represents the length of time each section will be in a "post-restoration" state. All "X's" without shading represent control samples.

Stream	Section	Fish Site	Year 2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Charley	1	CC-F1		X	X	X							
		CC-F2	X	X	X	X	X	X	X	X	X	X	X
	2	CC-F3	X	X	X		X	X	X	X	X	X	X
		CC-F4		X	X			X	X	X	X	X	X
	3	CC-F5	X	X	X	X	X	X	X	X	X	X	X
		CC-F6		X	X	X	X						
North Fork	1	NF-F1	X	X	X	X	X	X	X	X	X	X	X
		NF-F2					X	X	X	X	X	X	X
	2	NF-F3											
		NF-F4	X	X	X	X	X	X	X	X	X	X	X
	3	NF-F5											
		NF-F6	X	X	X	X	X	X	X	X	X	X	X
South Fork	1	SF-F1											
		SF-F2	X	X	X	X	X	X	X	X	X	X	X
	2	SF-F3	X	X	X	X	X	X	X	X	X	X	X
		SF-F4					X	X	X	X	X	X	X
	3	SF-F5	X	X	X	X	X	X	X	X	X	X	X
		SF-F6											
Total Sites/Year			**9**	**12**	**12**	**10**	**12**	**12**	**12**	**12**	**12**	**12**	**12**

2.4 Habitat Monitoring

We began using the Columbia Basin Habitat Monitoring Protocol (CHaMP) to survey habitat sites in 2011 (Table 3). CHaMP collects data on instream, channel, and riparian characteristic and provides a topographic survey of the site. We now monitor 18 CHaMP sites a year; four sites are allocated to each treatment section (12 sites) and one site is allocated to each control section (6 sites). This level of effort will result in approximately 30-40 restoration structures being "captured" by the topographic surveys in each treatment section. The remainder of each fish site will be surveyed with a rapid protocol that focuses on large wood, pools, and sediment sources (18 sites). LiDAR and aerial photography were collected in 2010 and will be collected again between 2015-2017 to determine changes to floodplain. See Bennett et al. (2012) for more detail.

Table 3. Location of completed (2008-2013) and proposed (2014-2018) habitat surveys within Charley, North Fork, and South Fork Creeks. Grey shading represents the length of time each treatment section will be in a "post-restoration" state. We are using two methods to survey habitat: CHaMP to collect topographic data ("C") and rapid surveys to measure attributes that are a focus of the IMW (i.e., LWD, pools, sediment sources; "R").

					Year/Protocol											
					PIBO		DRAFT CHaMP		FULL CHaMP							
Stream	Section	Type	Fish Site	IMW Habitat Site	2008	2009	2010	CHaMP Site#	2011	2012	2013	2014	2015	2016	2017	2018
Charley	1	Control	CC-F1	Detailed (H1)		X	X									
				Detailed (H2)		X	X	ASW00001-CC-F1 P2BR	C	Dropped from sample design						
				Rapid (H3)			X									
			CC-F2	Detailed (H1)	X	X	X	ASW00001-CC-F2 P1BR	C	C	C	C	C	C	C	C
				Rapid (H2)		X	X			R	R	R	R	R	R	R
				Rapid (H3)			X			R	R	R	R	R	R	R
	2	Treatment	CC-F3	Detailed (H1)		X	X	ASW00001-CC-F3 P1BR		R	C	C	C	C	C	C
				Detailed (H2)	X	X	X	ASW00001-CC-F3 P2BR		C	C	C	C	C	C	C
				Rapid (H3)			X			R	R	R	R	R	R	R
			CC-F4	Rapid (H1)	R		X				R	R	R	R	R	R
				Detailed (H2)	R	X	X	ASW00001-CC-F4 P2BR			C	C	C	C	C	C
				Detailed (H3)	R	X	X	ASW00001-CC-F4 P3BR			C	C	C	C	C	C
	3	Control	CC-F5	Detailed (H1)	X	X	X	ASW00001-CC-F5 P1BR	C	C	C	C	C	C	C	C
				Rapid (H2)		X	X	ASW00001-CC-F5 P2BR		C	R	R	R	R	R	R
				Rapid (H3)			X			R	R	R	R	R	R	R
			CC-F6	Detailed (H1)		X	X	ASW00001-CC-F6 P1BR	C	C						
				Detailed (H2)		X	X	ASW00001-CC-F6 P2BR		C	Dropped from sample design					
				Rapid (H3)			X			R						
North Fork	1	Treatment	NF-F1	Detailed (H1)		X	X	ASW00001-NF-F1 P1BR		C	C	C	C	C	C	C
				Detailed (H2)	X	X	X	ASW00001-NF-F1 P2BR	C	C	C	C	C	C	C	C
				Rapid (H3)			X			R	R	R	R	R	R	R
			NF-F2	Detailed (H1)				ASW00001-NF-F2 P1		C	C	C	C	C	C	C
				Detailed (H2)				ASW00001-NF-F2 P2		C	C	C	C	C	C	C
				Rapid (H3)						R	R	R	R	R	R	R
	2	Control	NF-F3	Not sampled												
			NF-F4	Detailed (H1)	X	X	X	ASW00001-NF-F4 P1BR	C	C	C	C	C	C	C	C
				Rapid (H2)		X	X			R	R	R	R	R	R	R
				Rapid (H3)			X			R	R	R	R	R	R	R
	3	Control	NF-F5	Not sampled												
			NF-F6	Rapid (H1)		X	X			R	R	R	R	R	R	R
				Detailed (H2)	X	X	X	ASW00001-NF-F6 P2BR	C	C	C	C	C	C	C	C
				Rapid (H3)			X			R	R	R	R	R	R	R
South Fork	1	Control	SF-F1	Not sampled												
			SF-F2	Rapid (H1)		X	X			R	R	R	R	R	R	R
				Detailed (H2)	X	X	X	ASW00001-SF-F2 P2BR	C	C	C	C	C	C	C	C
				Rapid (H3)			X			R	R	R	R	R	R	R
	2	Treatment	SF-F3	Rapid (H1)		X	X			R	R	R	R	R	R	R
				Detailed (H2)	X	X	X	ASW00001-SF-F3 P2BR	C	C	C	C	C	C	C	C
				Detailed (H3)			X	ASW00001-SF-F3 P3BR		C	C	C	C	C	C	C
			SF-F4	Detailed (H1)				ASW00001-SF-F4 P1		C	C	C	C	C	C	C
				Detailed (H2)				ASW00001-SF-F4 P2		C	C	C	C	C	C	C
				Rapid (H3)						R	R	R	R	R	R	R
	3	Control	SF-F5	Rapid (H1)			X			R	R	R	R	R	R	R
				Rapid (H2)		X	X			R	R	R	R	R	R	R
				Detailed (H3)	X	X	X	ASW00001-SF-F5 P3BR	C	C	C	C	C	C	C	C
			SF-F6	Not sampled												
Total FULL CHaMP Sites/Year					**9**	**24**	**36**		**10**	**18**	**18**	**18**	**18**	**18**	**18**	**18**
Total Rapid Survey Sites/Year					**-**	**-**	**-**		**-**	**18**	**18**	**18**	**18**	**18**	**18**	**18**

X - pre CHaMP surveys (i.e., PIBO and CHaMP stick and tape)
C - full CHaMP survey (topo and auxiliary data)
R - rapid survey (i.e., fluvial audit georeferencing all LWD, pools, and sediment sources/sinks)

3 RESTORATION METHODS

3.1 Restoration Goals and Objectives

The restoration goals can be split into long-term and short-term objectives. In the long-term, we hope to restore riparian function by promoting the development and maintenance of a healthy riparian zone that more resembles historic conditions. This forest will be dominated by native species, have a diversity of seral stages appropriate to the natural disturbance regime of the vegetation and ecosystem type types they represent, and provide a suite of attributes that will benefit the streams they border. A separate riparian restoration proposal is being developed by the Asotin County Conservation District to achieve these objectives.

In the short-term, we are adding LWD to the study creeks at densities similar to or exceeding the mean reference conditions. The goals of the treatments are to learn how LWD additions change the hydrologic and geomorphic conditions in the study creeks. Ultimately, we want to cause a positive population response in wild steelhead as a result of the LWD additions and understand what the mechanisms are that lead to the response. A secondary goal is to develop an inexpensive, low impact, and widely applicable LWD restoration method that can be used in many small to medium sized tributaries to increase habitat complexity.

The specific objectives of the LWD treatments are to:

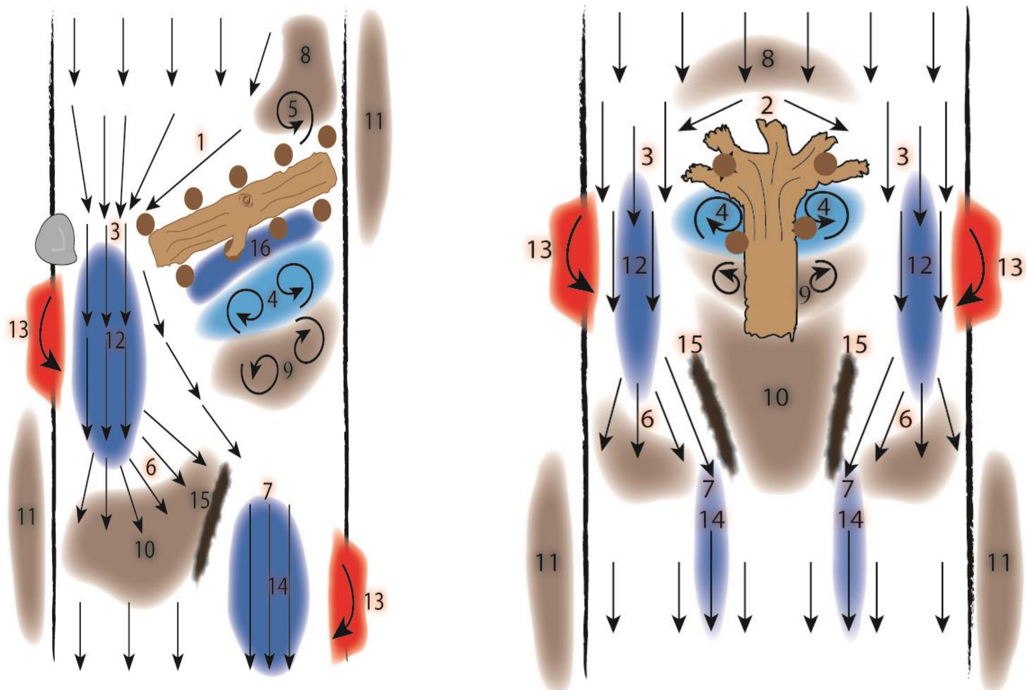
1. Increase channel width variability,
2. Increase instream habitat diversity (e.g., fish cover, pool frequency and depth), and
3. Promote mobilization and sorting of sediment by encouraging bar development, bed scour, bank erosion, and substrate sorting.

3.2 Treatment and Structure Design

We are adding pieces of LWD that were small enough to carry by hand instead of using heavy machinery to minimize potential damage to the existing riparian vegetation. The pieces of LWD were installed at each site and usually secured in place with wooden fence posts driven into the stream bed with a hydraulic driver (Figure 7 and Figure 8). Three structure types are secured in place with posts: deflectors, mid channel, and debris jams (Figure 9). Some LWD was installed with no posts to act as seeding (allowed to move) and some very large pieces (often with rood wads) were installed using an excavator to act as “key pieces” more resistant to high flows. See Wheaton et al. (2012) to see how the treatments were designed and the specific hypotheses developed for each structure type.

Figure 7. Example of the hydraulic post driver that is used to install large woody debris structures in Asotin Creek.

Figure 8. Example of the hydraulic power unit used to power the post driver for installing DWS in the Asotin Creek Watershed. The post driver can be manipulated by two people and has a 25 m hose connected to a gas engine power unit. The driver weighs approximately 30 kg and the power pack weighs approximately 75 kg. The power unit has large rubber wheels to improve transport over rough terrain. The power unit can also be carried by 2-4 people when the terrain is too rough for wheeling.



a) b)

Figure 9. Design and expected responses of a) deflector structure and b) mid-channel structure. Red indicates bank erosion, blue indicates scour, brown indicates deposition, and arrows indicate flow direction. See Wheaton et al. (2012) for a description of the geomorphic and hydraulic responses which are represented by the numbers.

4 PRELIMINARY RESULTS

4.1 Fish Monitoring

Since 2008 we have tagged 21,071 juvenile steelhead $\geq$ 70 mm in the three study creeks of the IMW (Table 4). We capture relatively few bull trout and Chinook and have only tagged 25 bull trout and 82 Chinook since the start of IMW.

Table 4. Summary of the number of juvenile steelhead (> 70 mm) PIT tagged in Asotin Creek from 2005 to 2013 at the smolt trap on the Asotin mainstem by WDFW and in the IMW study creeks by Eco Logical Research Inc. WDFW counts are provisional for 2012 & 2013.

Stream	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Asotin	2,462	1,552	1,895	1,862	946	2,605	4,002	4,680	3,378	23,382
Charley	-	-	-	423	1,294	1,953	1,282	1,136	1,247	7,335
North Fork	-	-	-	372	470	1,396	906	932	1,809	5,885
South Fork	-	-	-	549	735	1857	1275	1495	1940	7851
IMW subtotal	-	-	-	1,344	2,499	5,206	3,463	3,563	4,996	21,071
Total	**2,462**	**1,552**	**1,895**	**3,206**	**3,445**	**7,811**	**7,465**	**8,243**	**8,374**	**44,453**

The density of juvenile steelhead is very similar across all three study creeks and generally tracks across years (Figure 10). South Fork tends to have the highest densities of juvenile steelhead and the North Fork tends to have the lowest. The average density of juvenile steelhead in the South Fork appears to be increasing in 2013 compared to the density in Charley Creek and North Fork. A preliminary assessment of this trend was analyzed using an intervention analyses where we calculated the average density of juvenile steelhead in the South Fork treatment section and subtracted the average density of steelhead across all the control sections combined (Figure 11). The average difference between the density of juvenile steelhead increased from 3.3/ 100 m^2 to 7.4/ 100 m^2 from pre to post restoration indicating the density of steelhead increased in the treatment section compared to the control section after restoration. However, this trend was not significant when compared using a ttest (P 0.12).

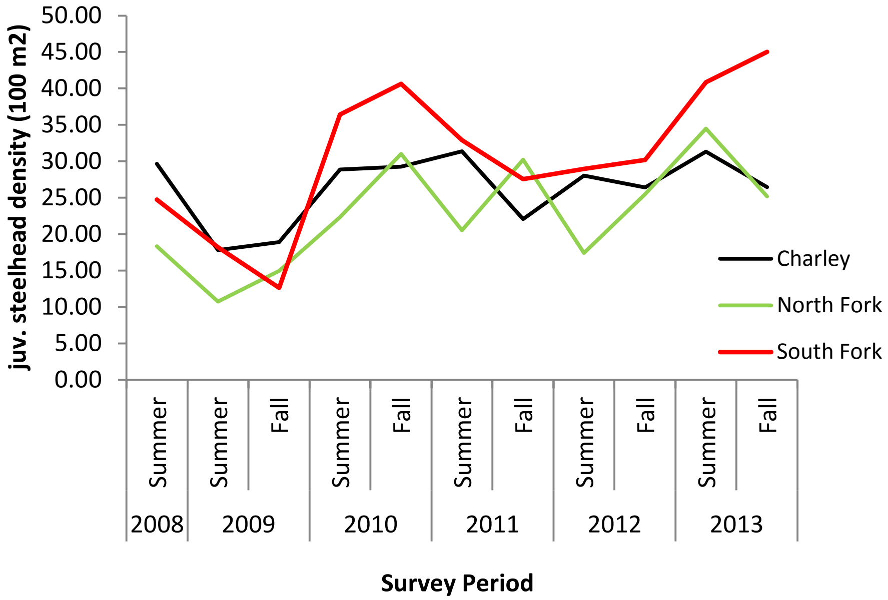


Figure 10. Average density of juvenile steelhead > 70 mm by study creek, season, and year: 2008-2013.

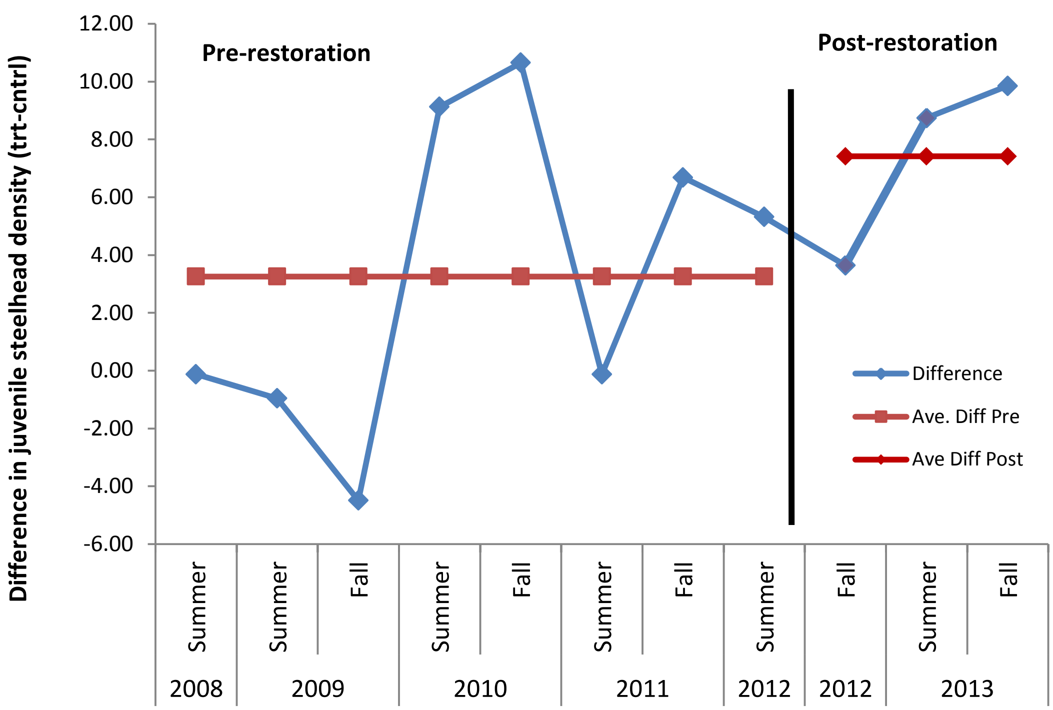


Figure 11. Difference of juvenile steelhead density between South Fork treatment section (section 2) and all controls combined (blue line). Red lines represent the average of differences in density (treatment minus control) pre and post restoration. Differences between pre and post restoration are not significant (*P* =0.13).

We conducted the same analysis for growth, comparing the average growth in the South Fork treatment section to the average growth in all other control sections (Figure 12). The average growth in the South Fork treatment section appeared to decrease significantly after the restroation was implemented compared to growth in the control sections. We have not conducted this analysis for survival but will be doing so for the next summary report.

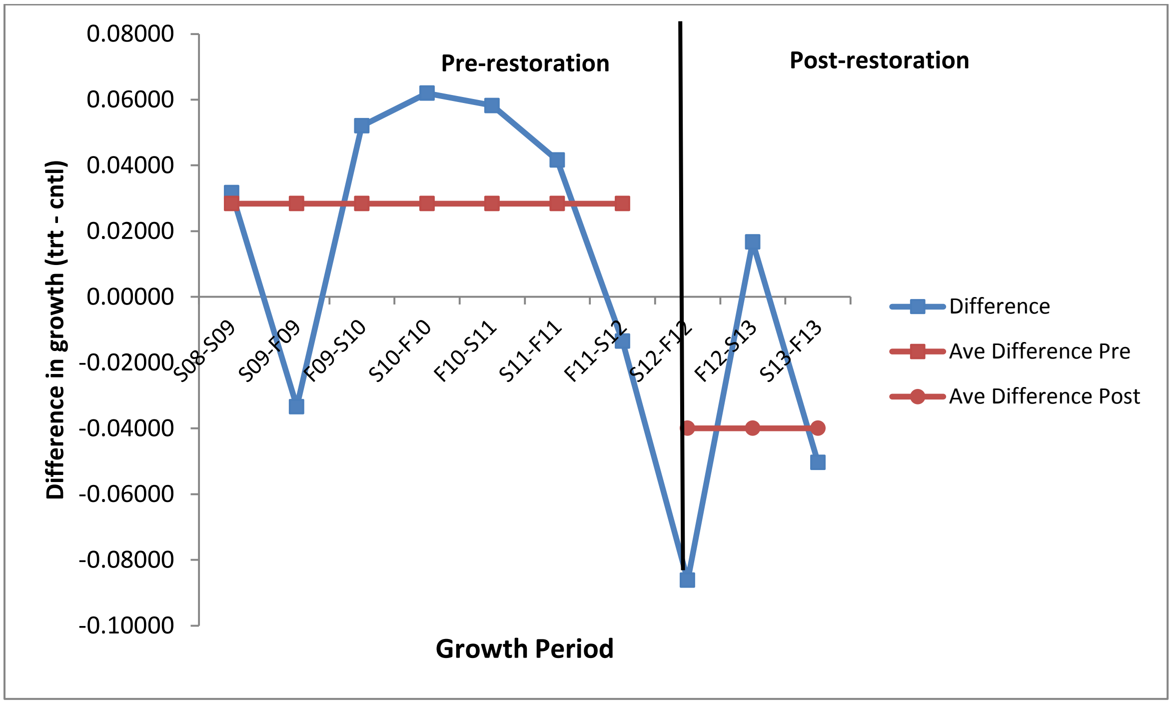


Figure 12. Difference of juvenile steelhead growth between South Fork treatment and all controls combined (blue line). Red lines represent the average of differences in growth (treatment minus control) pre and post restoration in the South Fork. Difference between pre and post treatment is significant (*P* =0.02).

A preliminary assessment of juvenile and adult steelhead movement was presented in previous reports (Bennett et al. 2012). It appears that there is limited movement of juvenile steelhead between fish sites within a stream (i.e., most fish captured at site X are recaptured at site X). There is also little juvenile movement between streams (i.e., fish tagged in stream Y are recaptured in stream Y). We have documented a significant proportion of juvenile steelhead that migrate from the study creeks and spend up to one year in the mainstem Asotin Creek before they smolt and leave the watershed. Approximately 40-50% of the adult steelhead migrating past the WDFW adult weir on the mainstem of Asotin Creek above George Creek enter one of the IMW study creeks.

4.2 Habitat Monitoring

The number of pieces of wood ($\geq$ 0.1 m diameter and $\geq$ 1.0 m long) has remained relatively low in the study creeks throughout the monitoring period. The average number of pieces of LWD in the South Fork treatment section was consistently lower than the LWD in all the other control sections combined throughout the study until 2013 after the restoration (Figure 13). However, the addition of LWD does not appear to have caused an increase in the average number of pools in the treatment section as predicted (Figure 14). Topographic surveys and geomorphic change detection in the South Fork treatment section confirms the assessment of pool habitat as there was very little erosion of deposition of sediment detected between 2012 and 2013 (Figure 15).

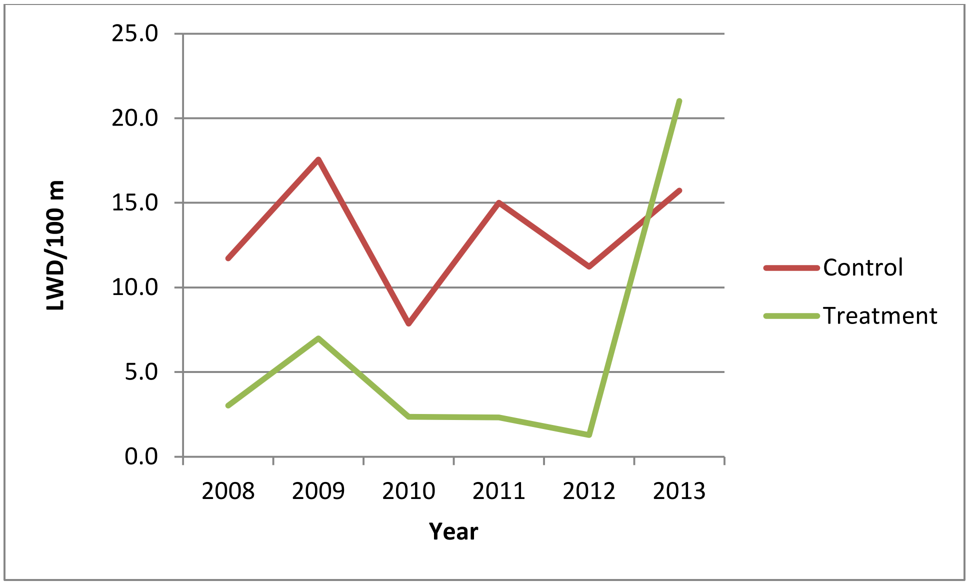


Figure 13. Average frequency of large woody debris (LDW) per 100 m in the South Fork treatment section (green) and all other control sections combined (red): 2008-2013.

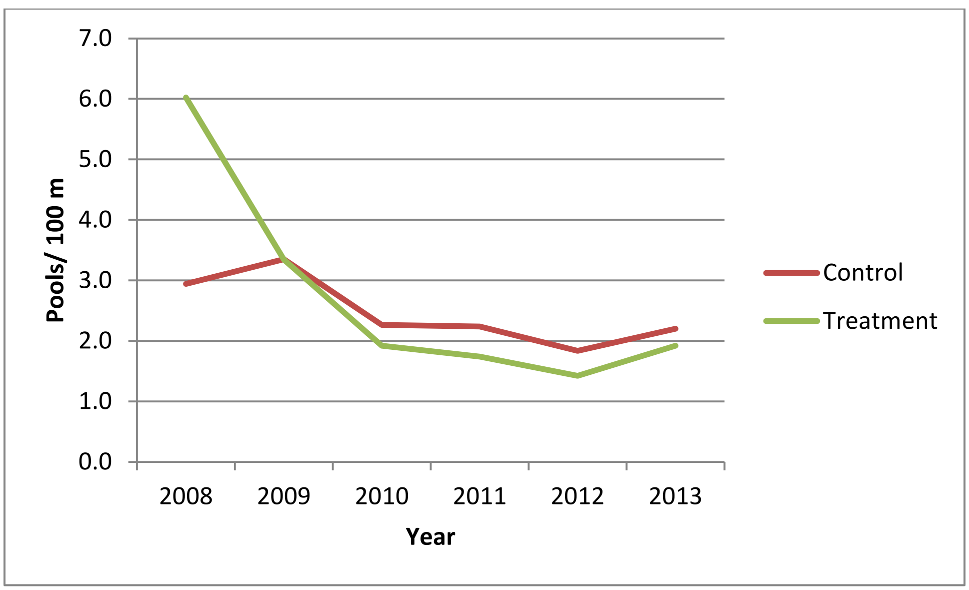


Figure 14. Average frequency of pools/100 m in the South Fork treatment section (green) and all other control sections combined: 2008-2013.

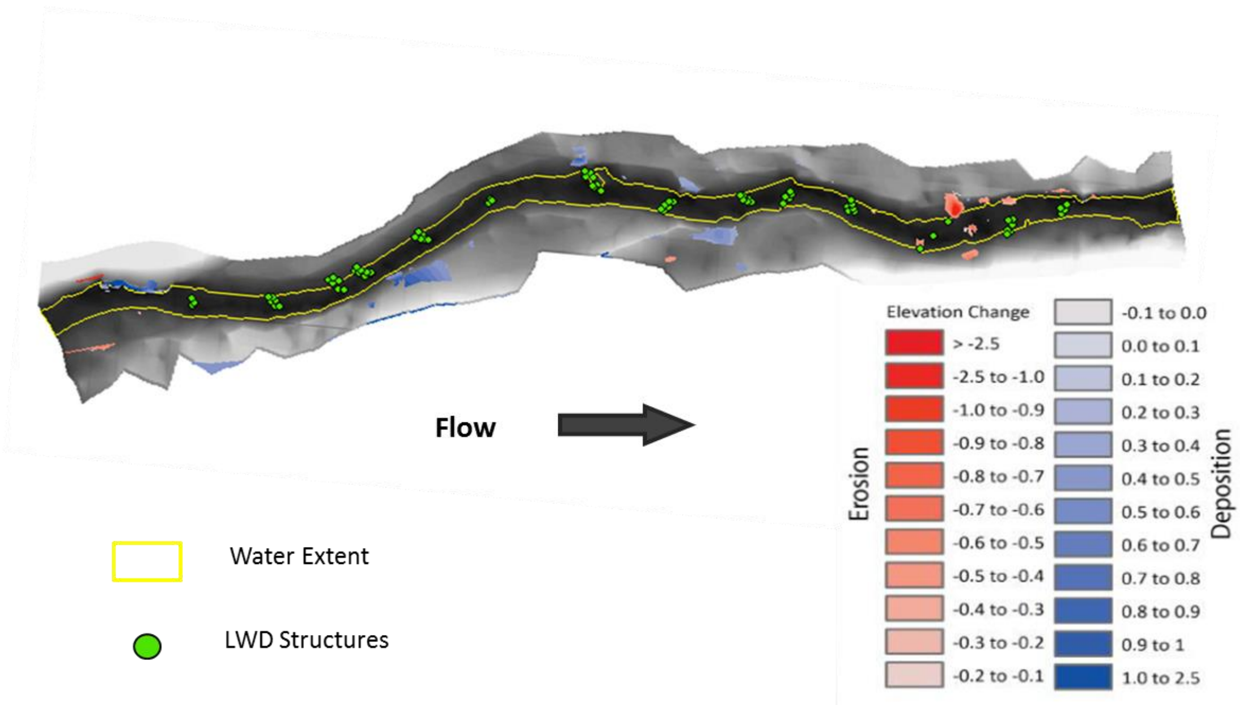


Figure 15. Example of geomorphic change detection for South Fork Asotin Creek, CHaMP site ASW00001-SF-F3P2BR. Image is the digital elevation model of difference (DoD) resulting from the 2013 DEM minus the 2012 DEM. Only changes (erosion = red, deposition = blue) within 95% confidence interval limits are shown.

5 RESTORATION IMPLEMENTATION

5.1 Extent of Restoration and Structure Types

We built 197 structures in the South Fork Asotin Creek treatment section and 208 in the Charley Creek treatment section. The total number of pieces of LWD added to each treatment section was 564 pieces in the South Fork and 497 pieces in Charley Creek. The majority of structures were deflectors in both streams (Figure 16). On average the structures were approximately 20 m apart and the average length and diameter of LWD added to structures was larger in the South Fork compared to Charley Creek (Figure 17). The average frequency of LWD increased in the treatment section of South Fork and all control sections from 2012 to 2013. The average LWD frequency increased from 1.3 LWD/100 m to 21.5 LWD/100 m in the South Fork treatment section (1569% increase) and 14.3 LWD/100 m to 15.4 LWD/100m in the control sections (8% increase). Examples of photos of deflector, mid-channel, debris jams, and key pieces are presented in Appendix I.

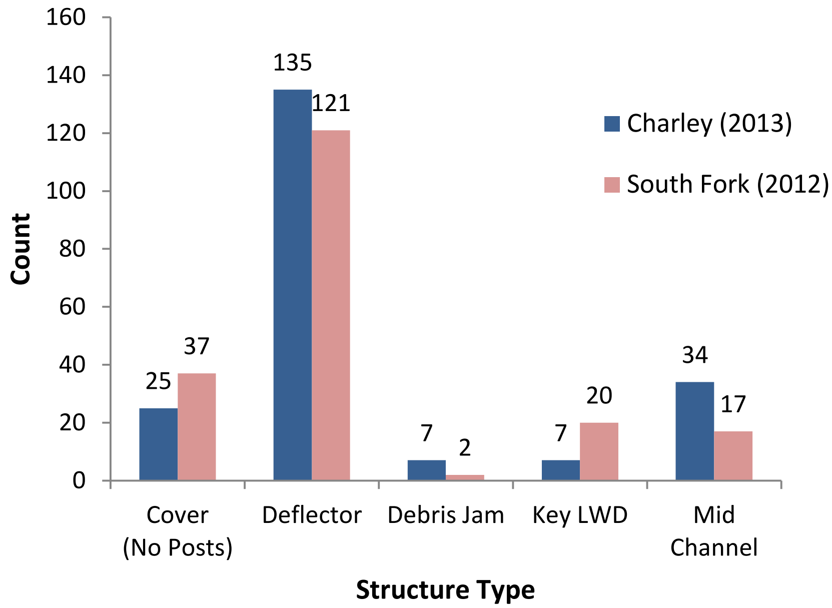


Figure 16. Count of each large woody debris structure type built in the South Fork Asotin Creek treatment section in 2012 and Charley Creek treatment section in 2013.

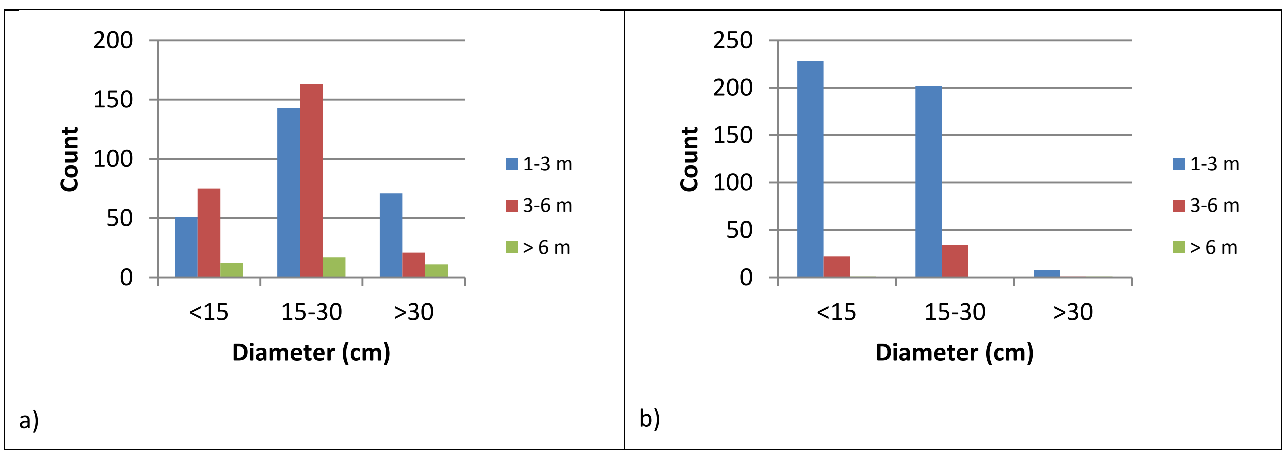


Figure 17. Count of large woody debris added to a) South Fork Asotin Creek restoration section in 2012 and b) Charley Creek restoration section in 2013 by diameter size class and length size class. Size classes based on the Columbia Habitat Monitoring Protocol (CHaMP 2012).

6 DISCUSSION AND FUTURE WORK

A complete assessment of the initial responses to restoration will be reported in an upcoming report. Preliminary assessments of the treatment response in South Fork Asotin Creek suggest a non-significant increase in the abundance of juvenile steelhead in the South Fork treatment section and a significant decrease in growth compared to the control sections. Geomorphic change analysis using the CHaMP topographic data and measurement of habitat units suggest there was little change due to the addition of LWD structures other than an increase in fish cover. An extremely low spring discharge in 2013 may be one reason for a limited fish and habitat response (Figure 18). An estimate of smolts per spawner will be presented in the upcoming report for the study creeks and compared to smolts per spawner estimates from the WDFW fish-in fish-out monitoring of the Asotin Watershed. The final restoration treatment will be implemented in North Fork Asotin Creek in 2014 and monitoring will continue until 2018. These data and continued monitoring of Asotin Creek IMW are expected to provide valuable information on the response of wild steelhead to LWD additions and how to improve the effectiveness of restoration actions in other watersheds.

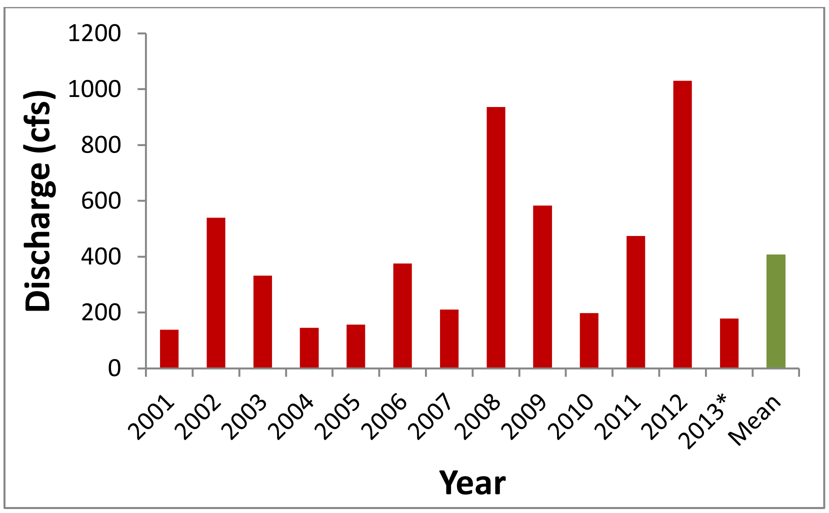


Figure 18. Peak discharge record for Asotin Creek below the confluence of North Fork and South Fork Asotin Creek: 2001-2013 (USGS gauge 1334450).

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8 APPENDIX I. EXAMPLES OF THE TYPES OF LWD STRUCTURES BUILT IN SOUTH FORK ASOTIN CREEK (2012) AND CHARLEY CREEK (2013)

 Mid-channel structures in Charley Creek.	 Debris jam Charley Creek
 Deflector structure Charley Creek	 Deflector structure Charley Creek

 Mid-channel structure South Fork Asotin Creek	 Key piece South Fork Asotin Creek
 Debris jam South Fork Asotin Creek	 Deflector South Fork Asotin Creek