Klickitat Watershed Enhancement Project

Annual Report for January 1, 2010 – December 31, 2011

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Prepared By:

David Lindley
Habitat Restoration Specialist

Will Conley
Watershed Restoration Specialist

Yakima – Klickitat Fisheries Project
Yakama Nation Fisheries Resource Management Program
P.O. Box 151
Toppenish, WA 98948

Prepared For:

Mary Todd Haight, COTR
U.S. Department of Energy
Bonneville Power Administration
Fish and Wildlife Program

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SUMMARY

The overall goal of KWEP is to restore watershed health to aid recovery of salmonid stocks in the Klickitat subbasin. This is accomplished via a three-pronged approach:

- *Assessment* of watershed and habitat conditions to prioritize sites for restoration activities. This involves data collection, compilation, and review of existing as well as historic habitat and watershed conditions. Identification and filling of data gaps is also a component of KWEP.
- *Protection*, *restoration*, and *enhancement* of priority watersheds and reaches to increase riparian, wetland, and stream habitat quality. In situ and watershed-scale restoration activities mitigate or resolve conflicting historic, present, and/or future land uses. Protect areas of existing high-quality habitat condition and prevent further deterioration of degraded habitats. Restore areas of degraded stream channel and/or habitat condition.
- *Monitoring watershed c*onditi*ons to asse*ss trends and effectiveness of restoration activities. Monitoring is a critical component in evaluating project success and guiding adaptive practices. Site-specific and basin-wide spatial scales are addressed. KWEP augments the Klickitat M&E and Klickitat Data Management projects by providing data QA/QC, database design, and oversight of physical habitat parameters including temperature, habitat, and channel substrate. KWEP is responsible for collection and analysis of geomorphic and hydrologic data.

<u>Highlights of the January 1, 2010 – December 31, 2011 reporting period:</u>

- Completion of Design and Specifications for Tepee Creek Meadows Restoration – Phase 2

- Construction of Upper Klickitat In-Channel and Floodplain Enhancement Project (Phase 2)
  - Constructed 5 LWD jams and 4 floodplain benches
  - Installed floodplain roughness elements
  - Adjustments made to constructed side-channel (~2900')

- Construction of Phase 2 of the Klickitat River Floodplain Conservation and Restoration (Haul Road) Project
  - ~6700 l.f. of embankment graded to enhance riverine and floodplain function
  - ~1780' of floodplain channel constructed
  - Construction of 11 woody debris jams in floodplain and floodplain channel

- Habitat Assessments
  - Post-project (year +1) habitat survey (RAHAP) of Upper Klickitat Phase 2 project site
  - Pre-project (year -1) habitat survey (RAHAP) of Upper Klickitat Phase 3 project site
  - Pre-project (year -2) habitat survey (RAHAP) of Upper Klickitat Phase 4 project site

INTRODUCTION

The Klickitat Watershed Enhancement Project (KWEP) restores, enhances, and protects watershed function within the Klickitat subbasin. Activities emphasize restoration and protection in watersheds and reaches that support native salmonid stocks, particularly steelhead (*Oncorhynchus mykiss*; listed as "Threatened" within the Mid-Columbia ESU) and spring Chinook (*O. tshawytscha*) salmon. KWEP addresses goals and objectives of the Klickitat Subbasin Plan, Klickitat Lead Entity Strategic Plan, the Northwest Power & Conservation Council (NPCC) Fish and Wildlife Program and the NMFS Biological Opinion.

KWEP implements habitat and watershed project actions of the Yakima Klickitat Fisheries Project (YKFP) in the Klickitat Subbasin. Restoration activities are aimed at restoring stream processes by removing or mitigating watershed perturbances and improving habitat conditions and water quality. Watershed and habitat improvements also benefit bull trout (*Salvelinus confluentus*; ESA "Threatened"), fall Chinook (*O. tshawytscha*) and coho (*O. kisutch*) salmon, resident rainbow trout (*O. mykiss*), and cutthroat trout (*O. clarki*) and enhance habitat for many terrestrial and amphibian wildlife species. Protection activities complement restoration efforts within the subbasin by securing refugia and preventing degradation. Since 90% of the off-reservation project area is in private ownership, maximum effectiveness is accomplished via cooperation with other governmental, non-governmental, and/or private entities.

Since 2000, KWEP has implemented over 18 projects encompassing over 60 sites resulting in:

- correction of fish barriers at 6 sites restoring access to over 14.8 miles of habitat
- enhancement of over 12,100’ of stream including construction of 90 LWD jams
- installation of at least 11,000 plantings along 19,700’ of stream
- fencing of over 10,000’ of stream
- restoration of high-flow access to over 4930 lineal feet of side channels
- monitoring streamflow at 16 sites
- morphologic and habitat assessment of over 74 miles of stream
- assessment of over 145 miles of road and railroad
- treatment of 10.5 miles of road for drainage improvements

KWEP works interactively with other BPA-funded projects including YKFP-Klickitat Data Management (#1998-120-35) and YKFP-Klickitat Monitoring and Evaluation (#1995-063-35). KWEP has cooperated with numerous private and public entities, including:

- Mid-Columbia Regional Fisheries Enhancement Group
- Washington Department of Natural Resources
- Washington Department of Fish & Wildlife
- Washington State Parks & Recreation
- Central & Eastern Klickitat Conservation Districts
- Klickitat County
- Columbia Land Trust
- Yakama Nation Water Program
- Underwood Conservation District
- Yakama Forest Products
- BIA Forestry and BIA Range
- private individuals

These partnerships have involved an additional 11 projects resulting in:

- acquisition of over 1050 acres and 4 miles of fish-bearing streams and side channels
- correction of 4 fish passage barriers restoring access to 3.3 miles of habitat
- enhancement of over 4000’ of stream and construction of 52 LWD jams
- installation of at least 19,400 plantings along 3,000’ of stream

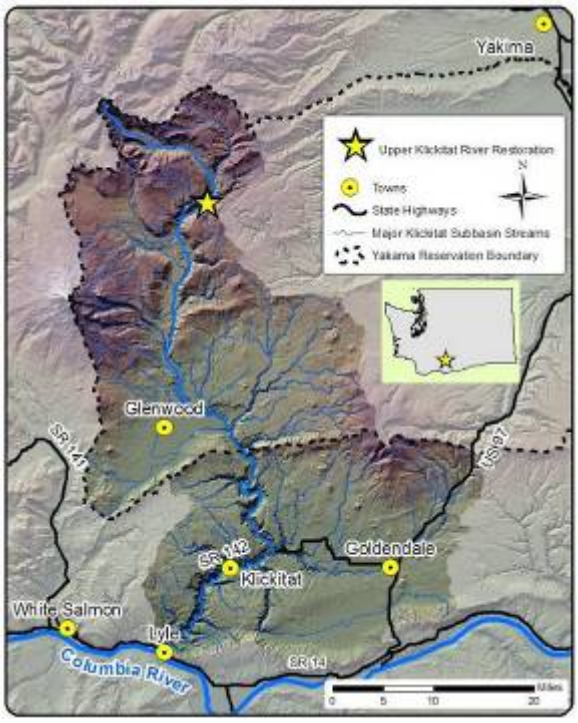
- design and development of relational databases to efficiently manage and analyze habitat, temperature, and sediment data
- implementation of no-till agricultural practices on local farmlands

Additionally, KWEP staff have provided technical support to private landowner and assisted various planning processes including:

- Subbasin Planning (Northwest Power Council)
- Salmon Recovery Planning (NOAA Fisheries)
- Strategic Planning (Washington Salmon Recovery Funding Board)
- Watershed Planning (Washington Department of Ecology)

FEATURED 2010-2011 PROJECTS

Upper Klickitat River In-Channel and Floodplain Enhancement Project (Phase 2)



Introduction: The project addresses limiting features (channel confinement and habitat simplification) identified for this reach by the Klickitat Subbasin Plan and Klickitat Lead Entity Salmon Recovery Strategy (KLESRS). The core Ecosystem, Diagnosis & Treatment (EDT) reach that encompasses the project sites ranks third overall in the Klickitat subbasin in restoration potential for combined performance of steelhead and spring Chinook (NPCC, 2004). Project work addresses most of the top limiting factors identified for the reach between RM 70 and 74.5.

Site and Watershed Description: The project location is on the mainstem Klickitat River between river mile 70 and 75. This area provides critical spawning and rearing habitat for ESA-listed Middle Columbia River steelhead and spring Chinook. The project area consists of two reaches totaling 2.3 miles (cumulative). Both reaches are primarily forested and moderately incised, resulting primarily from encroachment by a floodplain road. The reaches are located between 2950-3240' above sea level. The contributing drainage area ranges from 130 mi^2 (Reach 1) to 89 mi^2 (Reach 2) and is predominantly forested by Douglas fir, grand fir, ponderosa pine, and lodgepole pine. Annual precipitation ranges from 60 to 65 inches and occurs primarily as snow. Streamflows are primarily snowmelt driven, though the highest peak events on record (e.g. 1996) tend to be associated with large regional rain-on-snow events.

Fisheries Significance: Castile Falls is a series of 11 waterfalls located at RM 64 of the Klickitat River (roughly 5.0 – 10.0 miles downstream of the project site). Some steelhead and some spring Chinook passage was apparently possible prior to construction of a small headworks dam above Falls 11 in the 1960's to provide grade-control for the intake of a fishway constructed by the Washington Department of Fisheries. The fishway was constructed with the intent of improving spring Chinook salmon and steelhead passage and functioned properly for several years before becoming plugged with bedload at which point the fishway became a velocity barrier. The combined effect of the dam and fishway was obstruction of upstream passage under an estimated 99% of flows for which monitoring has occurred since 1996. There are no anecdotal accounts of adult steelhead or Chinook observations in intervening years. The Yakama Nation completed modifications to the upper fishway and the fishway at Falls 4/5 in 2003 and 2004, respectively. Fisheries managers anticipate that natural straying of wild steelhead will recolonize upstream habitats including those in the vicinity of Upper Klickitat enhancement sites.

Pre-project Problem: The primary problem is channel simplification. The reach appears to have historically been a forced-pool and pool-riffle morphology had become a plane-bed. The channel had incised 1-2' and was largely armored with large cobble and small boulder material. Pools had become infrequent and where they did occur, residual depths were generally shallow (12-18"). The shift to a plane-bed is believed to have been triggered by realignment and filling of the channel and floodplain

associated with a construction of the 255 Road in the mid-1970s and subsequently magnified by flooding. Prior to commencing project work there were six locations where the active channel contacted this arterial road and erodes the embankment.

In addition to the road's influence on morphology and habitat, it seems likely that stream cleaning occurred at some point. The Washington Department of Fisheries conducted a habitat survey between Castile Falls and McCormick Meadows in 1957 (LeMier, et al. 1957) and noted, "many log and debris jams caused by windfalls are present in the stream area covered ranging in size to 200 feet long, 50 feet wide, and 18 feet high." The report notes other conditions (depth and pool frequency) that were more favorable to salmonids than those observed pre-project. In particular, the reach within which the Upper Klickitat Phase 2 project occurs contained, "The largest and most serious log jams." The report went on to prescribe "…therefore, removal of these obstacles is mandatory if the [Castile] falls improvement work is undertaken." Stream cleaning was a common practice throughout the Pacific Northwest into the 1980s and the construction of the 255 Road would have made the reach much more accessible to the practice had it not occurred previously. Given the absence of jams or older relics of jams on floodplain, it seems highly likely that stream cleaning occurred in the project reach.

Project Goal: Increase physical habitat complexity and reduce river-road interaction. Enhance instream habitat and water quality to benefit mid-Columbia steelhead (ESA - Threatened) and spring Chinook (WDFW - Depressed) at three priority sites totaling 0.29 river miles (cumulative) along the Klickitat River between RM 70 and 74.5. Reconnect roughly 3750 lineal feet of side channel.

Design: The general premise of the project was to convert the plane-bed morphology to forced-pool morphology. Pre-project there were a few isolated "islands" of recovering channel where large woody debris (LWD) recruited from bank mass-wasting has been deposited into jams and locally controls gradient and flow direction. These areas tended to have fair to good pool formation immediately upstream and downstream as well as accumulations of gravel.

The overall approach of the project is to mimic these areas and effectively fill the gaps in between them. YKFP staff developed the design in cooperation with Interfluve, Inc (Conley 2008). We developed a 30% paper design based on collection of topographic data and a 1-dimensional hydraulic model. Typical treatments were developed and continuous field supervision was provided to the construction contractor by YKFP and/or Interfluve staff. Constructed jams were not installed at scour depth, but were built to accommodate scour and settling. There were three main types of treatments:

- *Floodplain benches* were constructed at Reach 1 where the active channel contacts the road to provide a buffer between the toe of the road fill and active channel. Excavation along the left (non-road) channel margin maintained channel capacity and provided a source for alluvial material to backfill the bench on the right-bank / road-side. A base layer of boulders and LWD was be placed to create the core of the new floodplain surface then backfilled with native cobbles and gravels using a dig-and-pitch approach (Fig 1). This realigned the channel to be compatible with the bench treatment, yet maintain flow capacity. The finished grade of the new floodplain was constructed to be inundated at approximately a 5-year recurrence (and greater) flood and provide a 10 to 25 horizontal foot buffer from road fill. The new surface was planted with dormant hardwood cuttings. Due to the greater hydraulic force in these areas, LWD was stabilized via posts, cabling, boulder ballast and alluvial backfill. In some cases pools and runs were excavated adjacent to the benches and LWD treatments.

- *LWD jams* were constructed on the mainstem (Reaches 1,2,3 and 4) and side channel to encourage channel complexity and improve local hydraulic conditions to facilitate retention and sorting of sediments and pool formation/maintenance (Figures 2 and 3). Jams consisted of 2-3 "key" pieces (>30" diameter) with additional members added as necessary. Stability of the jams was provided by site selection, partial burial/keying, orientation and sizing of key pieces, as well as placement of additional members as ballast. In some cases, cabling and ballasting with boulders, backfill, and/or posts was employed to increase stability.
- *Channel reconnection* occurred at site 4 where a LWD jam constructed in 2009 was reconfigured in order to allow increased streamflow into the constructed channel (Fig. 4). The jam was positioned in 2009 to mediate flows in to the newly constructed channel for the first run-off cycle.

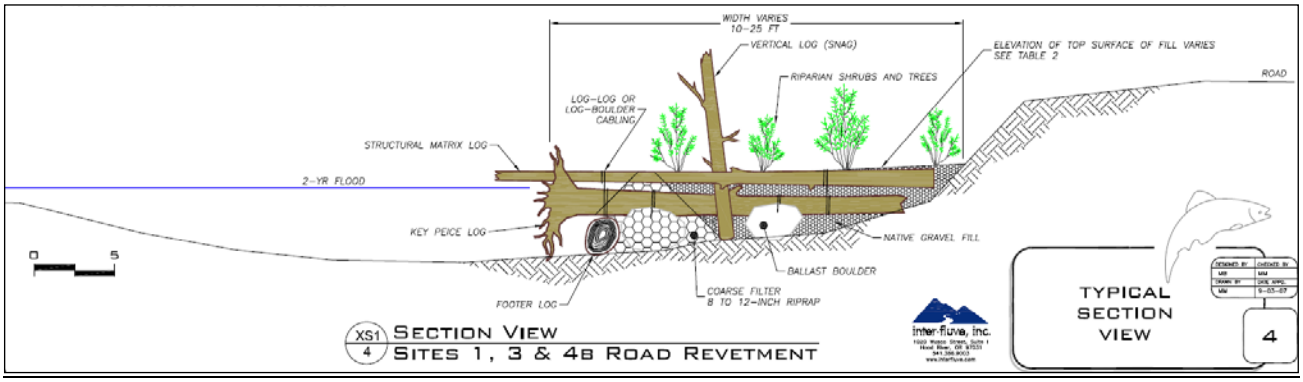


Figure 1. Typical design cross-section for construction of floodplain benches in the Upper Klickitat River In-Channel and Floodplain Enhancement Project (Phase 2).

Construction: Construction at sites 1 and 4A occurred in the fall of 2010.

- Site 1:
  - Construction completed totaling approximately 650' of bank
  - Constructed 5 LWD jams and 4 floodplain benches
  - Installed approx. 40 floodplain roughness elements (individual logs)

Figure 2. Site 1 (looking downstream) pre- (left) and post-treatment (right).

Figure 3. Site 1 (looking upstream) spring time flows pre- (left) and post-treatment (right).

- Site 4A – adjustments were made to the position of the LWD jam at the side channel inlet to increase the percentage of mainstem flow directed into side channel.

Figure 4. Constructed portion of side channel (approx. 2000').

Construction in 2010 built upon previous project elements completed in 2008 and 2009. The project was jointly funded by YNFP sponsored grants from the Washington State Salmon Recovery Funding Board (SRFB) and the Pacific Coastal Salmon Recovery Fund (PCSRF). The Yakama Nation made in-kind donations of materials (LWD and boulders). KWEP provided funding for design (2008-2010), construction oversight (2008-2010), and construction (2010). KWEP also funded materials and supplies (2008-2010).

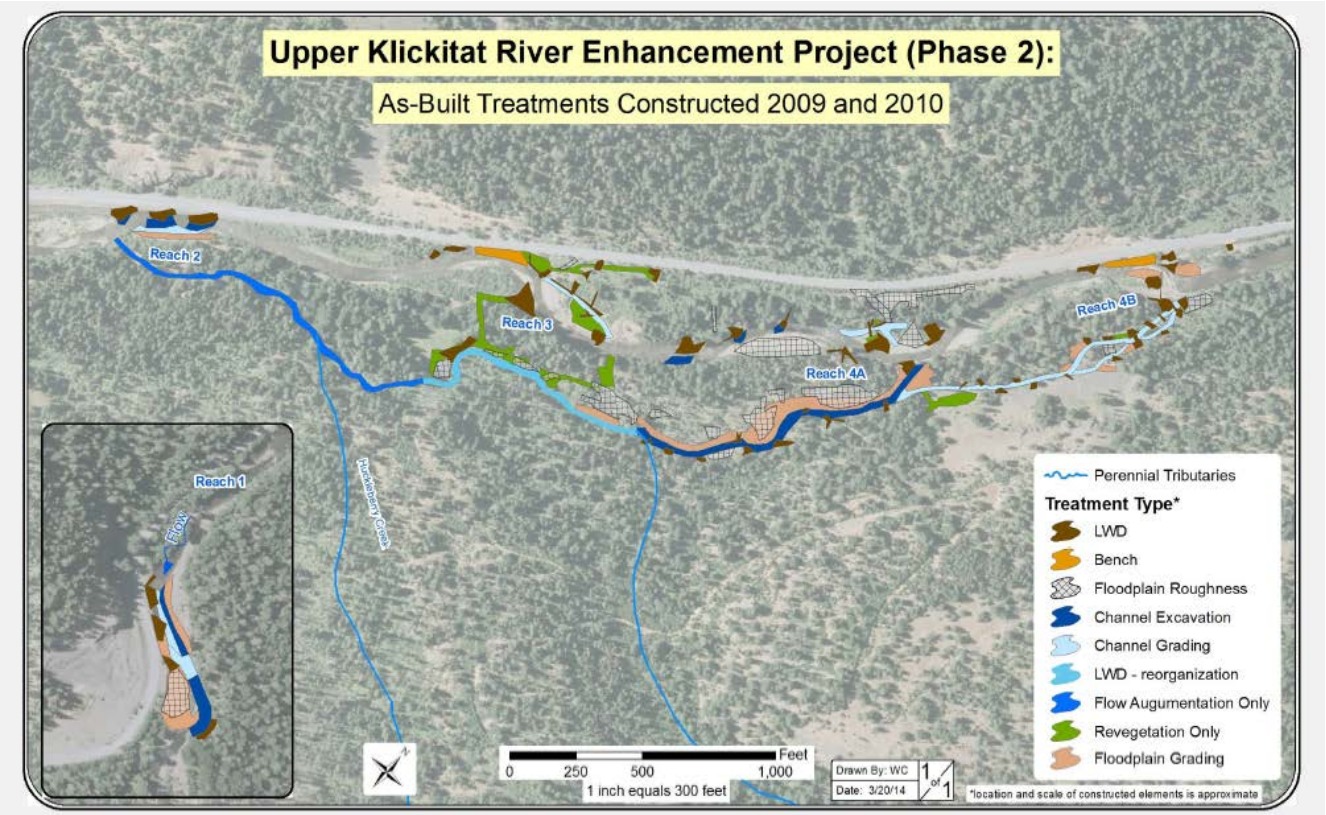


Figure 5. As-built map of Upper Klickitat Phase 2 (/23/2010).

Assessment: Sampling designed to assess the effectiveness of Phase 2 project elements was conducted internally (YKFP personnel) and by a third-party (Tetra Tech Inc.). The YKFP sponsored habitat assessment focused on the mainstem Klickitat River. The side channel portion of the project was selected by the SRFB as part of the Reach Scale Effectiveness Monitoring Program established in 2004. The program utilizes standardized protocols to sample a randomly selected subset of projects funded throughout Washington State (O'Neal et. al. 2012).

YKFP personnel utilized the Rapid Aquatic Habitat Assessment Protocol (RAHAP) to survey the Phase 2 reach pre – (2008) and post-treatment (2010). RAHAP quantifies physical habitat, cover characteristics, and wood abundance and size. Summary products include reach statistics (Table 1 and 2) and maps (Fig. 5) depicting the spatial distribution of habitat types. For additional detail on the methodology refer to the habitat assessment section.

Pre- and post-treatment comparison of aquatic habitat:

- Change in overall reach length (mainstem) was negligible
- Wetted area decreased; partly as a result of differing streamflows at time of survey (35% reduction in flow post-survey) and due to the effect of reconnected side channel
- Average habitat unit area decreased from 1835 meters^2 to 705.1 meters^2
- Habitat diversity increased (number of habitat units increased by a factor of 2)
- Pool frequency (3x) and residual pool depths increased
- LWD pieces (not associated with jams) remained constant
- The number of LWD jams increased (2.5x) [constructed]
- The number of individual LWD pieces per jam increased (3x)

The effect of these changes is a shift from a fairly homogenous habitat structure to a more complex and diverse reach (Fig. 6). The intent of the project was to increase habitat complexity and instream habitat quality. Preliminary results of monitoring conducted one year post-treatment suggest this goal has been accomplished for the short term. Year +3 (2014) and +5 (2017) monitoring are anticipated to assess duration/persistence.

Table 1. Summary of aquatic habitat inventory data collected August 8, 2009 and October 6, 2010. Parentheses denote side channel values. (-) denotes no data collected.

Project	Total Survey Length (m)	Total Survey Area (m^2)	# of Habitat Units	Avg. Bankfull Width (m)	Avg. Habitat Unit Width (m)	Avg. Habitat Unit Area (m^2)	Pool Frequency (pools/km)	Avg. Residual Pool Depth (m)
Upper Klickitat - Phase 2 Pre-Treatment (Reach 2 - Reach 4B)	1297 (57)	20189 (340)	15	31.7 (-)	14.3 (5.1)	1835 (84.9)	1.5 (0.0)	0.59 (0.0)
Upper Klickitat - Phase 2 Post-Treatment (Reach 2 - Reach 4B)	1253 (114)	18334 (551)	31	26.5 (-)	13.5 (5.2)	705 (110)	4.8 (0.0)	0.66 (0.0)

Table 2. Summary of Large Woody Debris (LWD) and LWD Jam inventory data collected August 8, 2010 and October 6, 2010. Parentheses denote side channel values.

Project	Survey Date	Stream	Discharge*	# LWD Pieces (pieces/km)	# LWD Jams (jams/km)	# Jam Pieces (pieces/km)
Upper Klickitat – Phase 2 Pre-Treatment (Reach 2 – Reach 4B)	08 Aug. 2009	Klickitat R.	118 cfs	47.1 (0.0)	3.9 (0.0)	94.9 (0.0)
Upper Klickitat - Phase 2 Post-Treatment (Reach 2 - Reach 4B)	06 Oct. 2010	Klickitat R.	77 cfs	48.7 (0.0)	10.4 (0.0)	280.0 (0.0)

*Discharge obtained from USGS Klickitat River above West Fork near Glenwood, WA gage (#14107000).

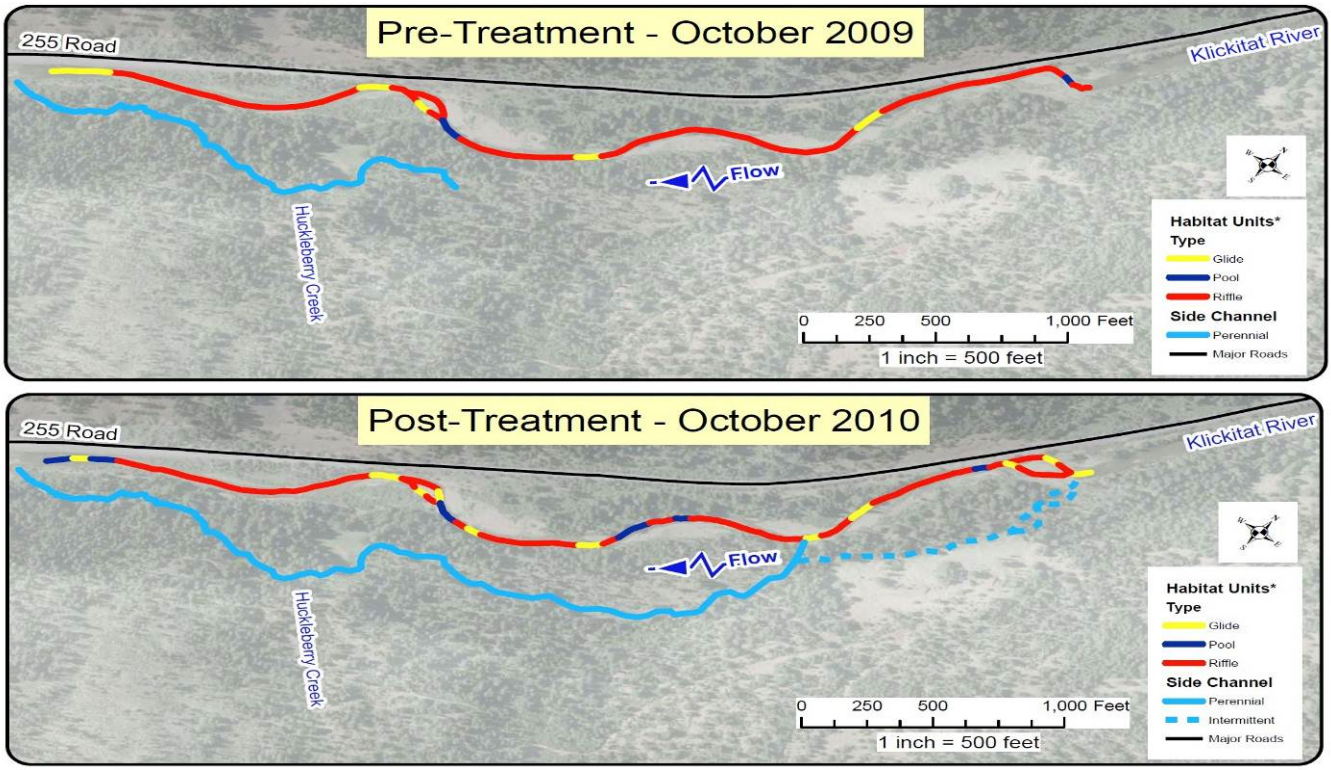


Figure 6. Distribution of aquatic habitat types pre- (top) and post-treatment (bottom) Upper Klickitat River Phase 2.

Tetra Tech Inc. personnel, contracted by the SRFB, utilized a before-after-control-impact study design to monitor the effectiveness of the side channel portion of the project. At both the control and impact reaches (Fig. 7) riparian conditions, pool characteristics, channel morphology, thalweg profile, and fish density were sampled.

Figure 7. Control reach (left) and impact reach (right) post-treatment in 2011. Photo courtesy of Jennifer O'Neal, Tetra Tech Inc.

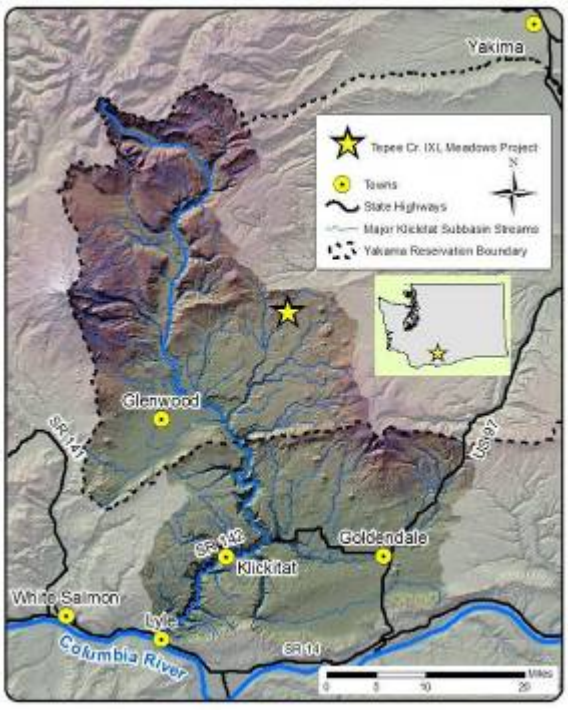
Pre-project, the impact reach was primarily a dry channel, except for intermittent sections in the vicinity of Huckleberry Creek. Reconnection of the side channel created off-channel habitat suitable to support salmonid species. A snorkel survey conducted one year after project completion confirmed use of the new channel by *O. mykiss* (O'Neal et. al. 2012). To facilitate access to the side channel for

construction equipment some riparian vegetation was cleared. As a result, canopy density and riparian structure decreased post-treatment (Table 3). These values should increase with time as vegetation reestablishes. Mean residual pool depth increased significantly in the impact reach. Changes in channel morphology and pool characteristics will evolve over time and should be documented by monitoring in subsequent years.

Table 3. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring from O'Neal et al. 2012.

Variable	Year 0 (2007)		Year 1 (2011)	
	Control	**Impact**	**Control**	**Impact**
Stream Physical Characteristics				
Mean Residual Pool Vertical Profile Area (m^2/reach)	27.13	3.73	23.96	30.02
Mean Residual Pool Depth (cm)	18.09	2.49	15.97	20.01
Riparian Characteristics				
Canopy Density (1-17)	10.23	12.05	13.23	11.32
Riparian Vegetation Structure (%)	50.0	68.2	68.2	59.1
Fish Data				
Steelhead Parr (fish/m^2)	0.0658	0	0.0374	0.1672
Channel Connectivity				
Channel Connected? (y/n)	N/A	No	N/A	Yes
Data collected July 12 - 13, 2007 (Year 0) and July 26-27, 2011 (Year 1)				

Tepee Creek Meadows Restoration - Phase 2



Introduction: Tepee Creek is a tributary to White Creek and provides important spawning and rearing habitat for ESA-listed Middle Columbia River steelhead and is a top geographic priority. The White Creek watershed as a whole is likely the most important spawning and rearing tributary watershed within the Klickitat subbasin. In recent years (2002-2011), the White Creek watershed on average accounts for 26% (11-55%) of the observed steelhead spawning in the entire Klickitat subbasin. Tepee Creek has accounted for up to 21% of the observed spawning in the Klickitat subbasin in recent years (2002-2011), however on average it accounts for 7%. Extensive reaches of Tepee Creek are incised 3-5' and are now intermittent in many places that anecdotal information suggests were once perennial. The project addresses limiting habitat features (bed degradation and pool structure) identified by the Subbasin Plan (NPPC 2004) and KLESRS (2008) along 2000 feet of Tepee Creek.

Site and Watershed Description: The project reach consists of approximately 1 mile of Tepee Creek in the vicinity of river-mile 5 (Fig. 8) and immediately downstream of the IXL Meadows Restoration Project (completed 2007; Conley 2008). The site is at 2900' elevation. The reach is a mix of meadow,

ponderosa pine parkland and mixed conifer forest. The contributing drainage area is 8.4 square-miles in size and occurs primarily between 3000' and 4000' feet in elevation. Basal geology is the Grand Ronde Basalt of the Columbia River Basalt Group which contributes both to low to moderate topographic relief and to resistant parent materials. Surficial parent material likely originates as ash from Cascade and volcanic rocks and ash from the Simcoe Volcanic field. Faulting associated with the Yakima Fold Belt along the northern margin of the watershed has generated steeper slopes that increase weathering rates and contribute to an otherwise meager gravel supply for the watershed. Soils and banks on-site are cohesive with a prevailing clay loam texture.

Fisheries Significance: Tepee Creek provides spawning and rearing habitat for ESA-listed ("threatened") Middle Columbia River steelhead. On average, Tepee Creek accounts for 7% of the total observed spawning in the Klickitat subbasin. The project area occurs within a reach that has been identified by the Klickitat Technical Advisory Group as one of the top priority areas for salmon recovery in the Klickitat Subbasin.

Problem: In general, summer rearing habitat in the White Creek watershed is highly limited. Summer refugia, in the form of perennially-flowing stream reaches or remnant pools in otherwise dry reaches, are highly limited in Tepee Creek and are necessary for successful rearing within the watershed. Stream channel incision throughout much of the watershed limits floodplain storage. Upstream, in the IXL Project reach, pre-project hydraulic modeling indicated that most cross-sections required at least a 10-year recurrence flood to generate overbank flow (Interfluve 2004). Where wetlands and floodplains are intact, such as in the headwaters of Tepee and in the East Fork Tepee Creek watershed perennial flows do exist. Where perennial pool habitat is present, survival appears to be good, particularly for 0+ and 1+ aged fish. Currently, downstream migrants resulting from summer freshets which fail to provide downstream continuity to perennial habitats are often stranded in areas that dry up. Additional refugia are critical for increased survival. Anecdotal evidence, along with watershed size, elevation, and precipitation, suggest that more reaches had perennial flow historically.

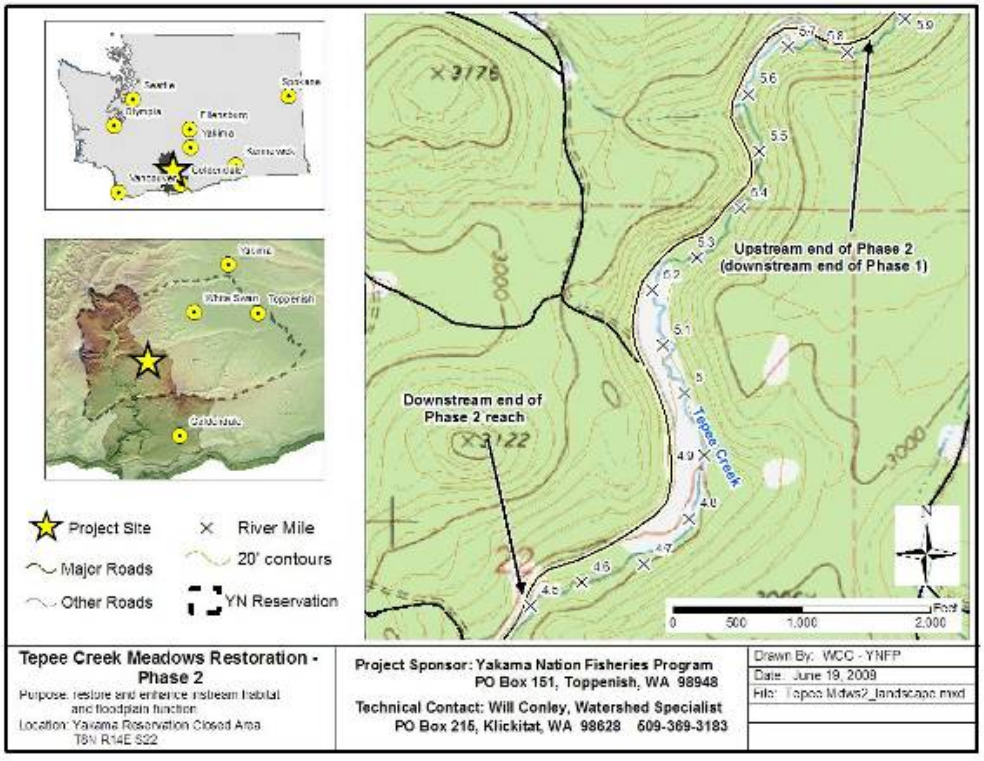


Figure 8. Map of Tepee Creek Meadows Restoration – Phase 2.

Currently, most of the incised reaches in the White Creek watershed (including the project reach) dry up from July through October. Anecdotal accounts from the 1960s suggest that at least some of these reaches were historically perennial. Many of the same reaches showing signs of bed armoring are also characterized by a simplified morphology with low pool frequencies, rectangular, canal-like cross sections, and an absence of LWD.

The trigger for incision in the Phase 2 reach appears to be largely of local origin. There is a perched, abandoned channel in the lower half of the reach possessing different channel geometry than the adjacent, active channel. The abandoned channel is much narrower and more sinuous and has remains of a low-head timber bridge near its inlet at the diversion point with the active channel.

The most probable mechanism for the reach's current condition seems to be: 1) an undersized bridge was installed, 2) the road on either side was at-grade on native materials (i.e. no embankment), 3) the road on the east side ran parallel to the valley bottom, 4) a runoff event exceeded the channel capacity at the bridge section and was pushed out-of-bank, 5) ruts from vehicles and/or equipment channelized overbank flow along the down-valley road segment, 6) a head-cut was initiated where flow channelized by the road re-entered the stream channel at a steep, local gradient irregularity (e.g. where channel at re-entry point was over-fit for the discharge in question), 7) with substrate consisting only of fines and lacking form-roughness, the road began incising and captured an increasing amount of flow, 8) incision progressed to the point where the base-elevation of the captured channel was lower than the historic channel, and 9) incision advanced headward / upstream of the diversion point.

Livestock grazing (in the form of altered riparian vegetation, bank erosion, and channel incision) may have also pre-disposed the site to its response. These site-based effects coupled with watershed scale management responses are the most probable causes of currently observed conditions. Hydrologic modeling (nhc 2003) indicated increased stormflow and volume in the upper White Creek and Tepee Creek watersheds due to density and drainage characteristics of forest roads.

Project Goals:

1) Increase floodplain storage
2) Reduce severity of active channel hydraulic conditions during high flows
3) Enhance quantity and quality of steelhead spawning and rearing habitat
4) Potentially restore base flows to this and downstream reaches
5) Restore suitability of valley bottom for medicinal and traditional food plants

2010-2011 Activity: Project activities during the reporting period consisted of administration, assessment, and design.

- *Administrative* – Project activities are primarily funded by two separate grants (Design-only and Construction) awarded by the Washington State Salmon Recovery Funding Board (SRFB) in 2008 and 2009 respectively. The design was finalized in September of 2010 satisfying contract deliverables for the SRFB design grant. The timeline for in-stream construction is for initiation in late-summer/fall 2012 and completion in spring 2013.

- *Design* – The design-only SRFB grant was awarded in 2008. The topographic survey portion of the design process was conducted in mid-November 2009 and consisted of 5 days of field surveys. These surveys were led by a subcontractor (Interfluve, Inc.) and assisted by KWEP project staff. Data collected from these surveys was compiled and analyzed during the winter of 2009-2010.

The end product, completed summer 2010, was a 30% design for restoration of floodplain connectivity for a 3500' reach of Tepee Creek between river miles 4.5 to 5.85 (Figs. 9-10). The 30% design will guide a "fit in the field" implementation approach. This approach has been utilized on numerous projects where KWEP staff or, in some cases, designated representatives, provide field oversight to contractors to guide installation and final grading of project elements.

Conceptual design for enhancement of the Phase 2 reach raises stream bed elevation and reconnects historic channel and floodplain. This strategy provides a greater potential benefit than other alternatives (e.g. excavating new floodplain) as it maximizes wetter perimeter for discharges greater than 1.4 return intervals and has the potential to store water increasing hydroperiods over the valley width. The central design goal is to configure the channel such that more frequent out-of-bank flooding will occur, which will improve primary channel hydraulic conditions for fish while promoting better wetland habitats and water storage late in the year. In-channel treatment will involve importing gravel into the existing channel in combination with channel cross-sectional area adjustments and planform modifications.

Design templates were configured such that the channel will convey the existing sediment supply, while mitigating the tendency to degrade. Planform modifications were determined by design slope and hydraulic geometry. Hydraulic geometry, including bankfull width, was refined by analysis of upstream analog cross-sections and slopes, regional hydraulic geometry relationships, and the creation of a hydraulic model for the project reach. A design hydrology that approximates actual and anticipates future conditions as much as possible was selected to guide hydraulic geometry development. Proposed channel components allow some threshold movement and deformation.

Methods/Elements:

- Constructed bedforms – Primary treatment to raise stream bed elevation by importing gravel to construct riffles. Riffle crests will be constructed on an average reach gradient of 0.4%. Pools will be formed by default in locations where fill is not introduced. Because of the bedload-limited nature of the watershed, material will be sized to be immobile at the bankfull discharge ($\sim Q_{1.3}$). The specification for size gradation incorporates sufficient fines to control porosity to ensure lower discharges flow over the riffle crests for as much of the flow-duration curve as possible without introducing so many fines as to destabilize imported material.

- Channel margins – Native bank materials are cohesive and moderately resistant to lateral erosion, particularly in the rooting zone. Large woody debris will be used on the outside of corners to encourage local scour that will help maintain pool depths and volumes, control lateral erosion, and provide primary habitat (Fig. 9). Channel edges (banks) constructed with wood will be less expensive and more erosion resistant than if fabric were used.

- Vertical control - A roughened channel, on a steepened grade (approximately 5%) will be constructed at the downstream end of the reach to transition between restored bed elevations and the somewhat incised channel downstream. This feature will set the gradient for the upstream (constructed) reach and increase the stability of constructed riffles.

- Revegetation - Existing riparian vegetation will be salvaged where possible. Use of sod mats salvaged from the pre-project inset-floodplain of the IXL reach was very effective and dramatically reduced recovery time. Woody and herbaceous species native to the watershed will be used where salvaged materials are insufficient or inappropriate. Woody species will be propagated primarily from dormant cuttings of local origin. Seed for herbaceous revegetation will be sourced from a producer with source genetics suitable for the site. Existing riparian vegetation in localities with invasive weeds (e.g. Canada thistle) will not be salvaged, but will be buried instead.

- Floodplain roughness - Large woody debris will be strategically placed on the reactivated floodplain to prevent avulsions and flanking of constructed riffles.

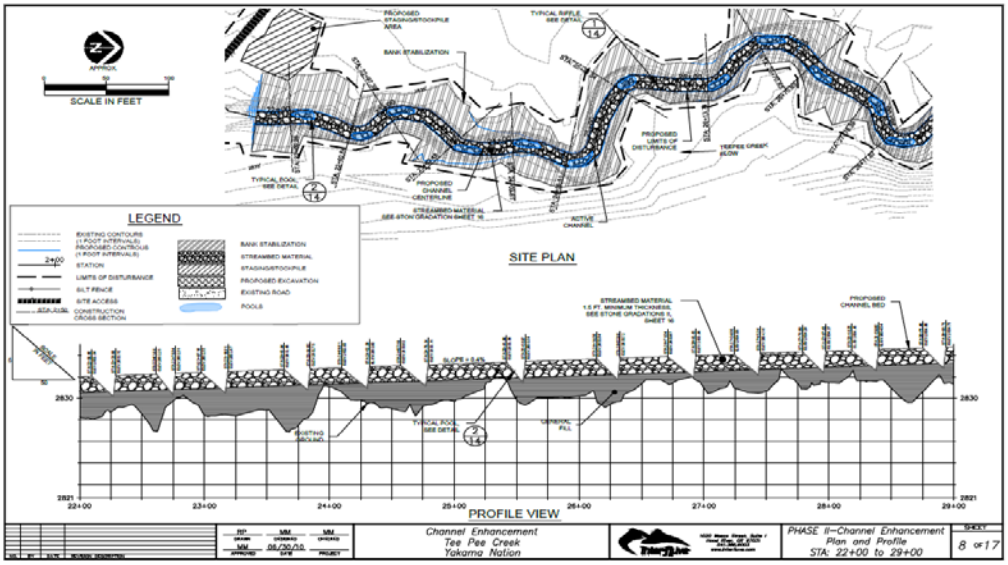


Figure 9. Site plan and profile view of the Tepee Creek Meadows Restoration (Phase 2).

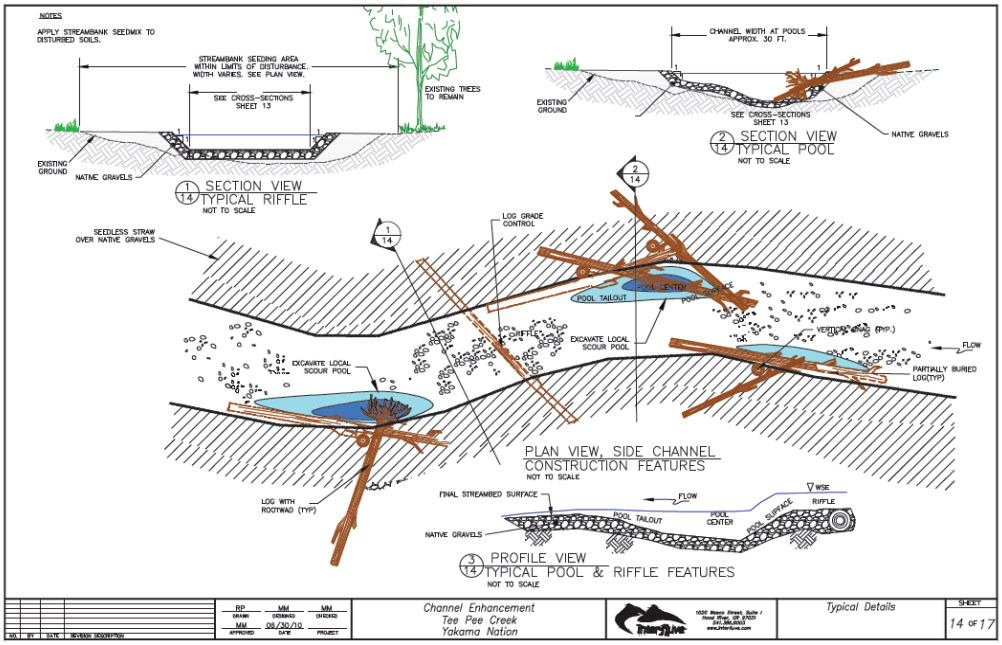


Figure 10. Plan view design of the historic channel portion of the Tepee Creek Meadows Restoration (Phase 2).

- *Assessment* - intensive sampling program was initiated in 2009 to document and assess pre-project baseline conditions. Elements include: groundwater, low-flow refugia mapping, habitat survey/mapping, vegetation inventory, juvenile *Onchorhynkus mykiss* (Steelhead/Rainbow trout) abundance estimation, and a food web study.

    - Groundwater: Twelve shallow (~6.5' deep) wells were installed to characterize existing groundwater conditions. They will be used for post-project effectiveness monitoring if future funding permits. Two wells are located outside of the project reach as controls (one upstream and one downstream). The remaining ten wells are dispersed strategically throughout the project reach to characterize local geohydrology (Fig. 11). Six wells (including both controls) have sensors that measure and record water level once every hour; data are downloaded several times per year using a field computer. KWEP staff take manual measurements of water level with an e-tape at the remaining six wells approximately once per month (on average). Data from four wells with continuous sampling are presented in Figure 12.

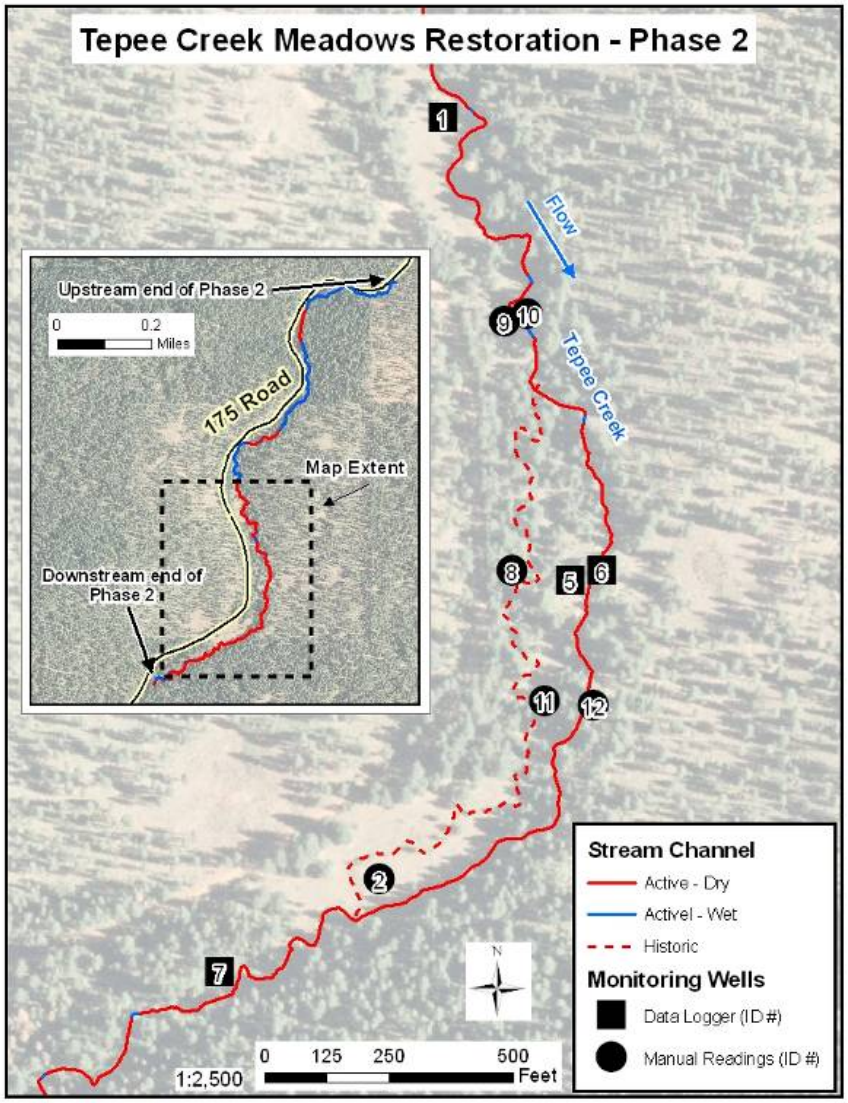


Figure 11. Distribution of monitoring wells and the portions of Tepee Creek with perennial water as observed on September 21, 2009.

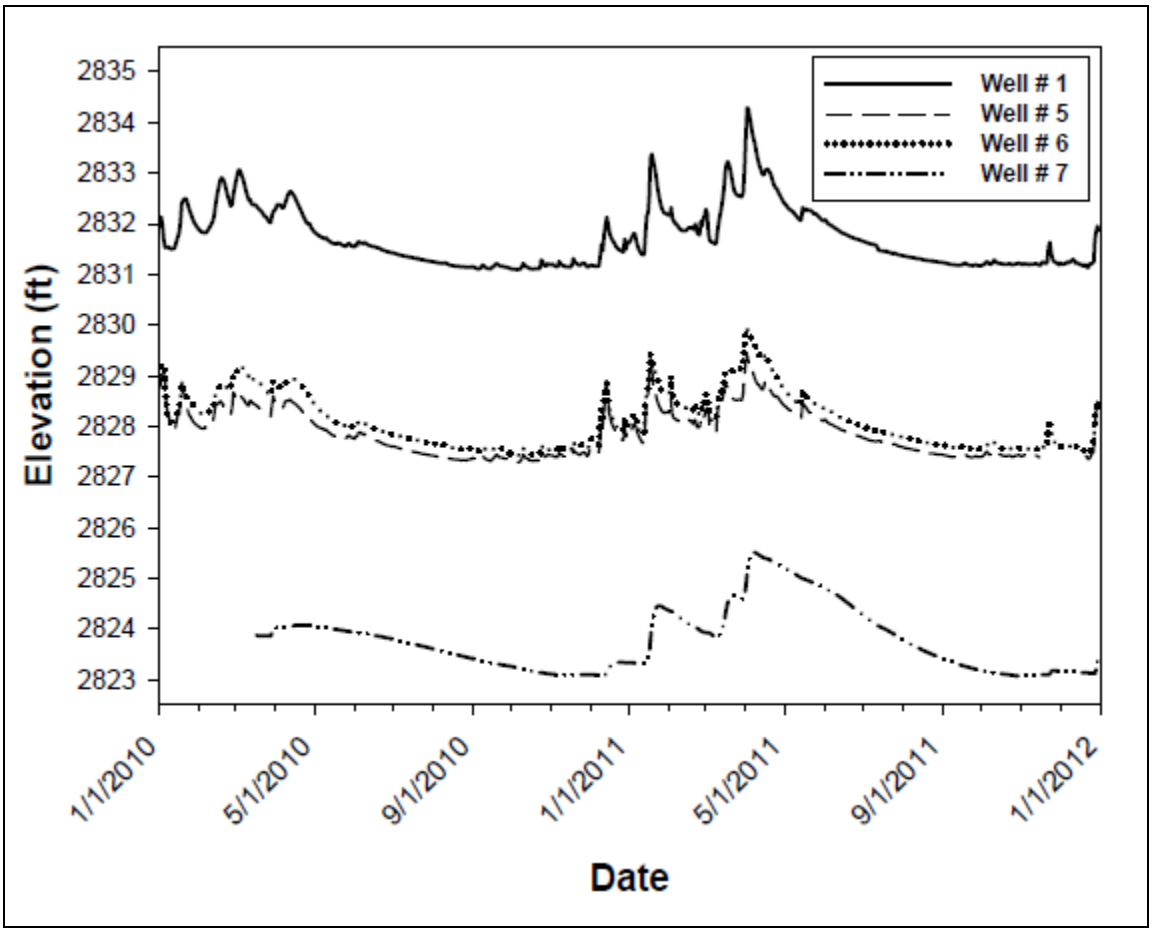


Figure 12. Groundwater surface elevations by date for wells 1, 5, 6, and 7.

- Fish abundance: In partnership with M&E staff, juvenile *O. mykiss* (Steelhead/Rainbow trout) populations were estimated using a multiple-pass electroshocking technique. During the reporting period there were four sampling events, summarized in Table 4. In each sampling event a multiple-pass electrofishing survey was conducted in each of the four Tepee (treatment) and White Creek (control) reaches. All juvenile steelhead and rainbow trout that were greater than or equal to 60 mm in length were tagged with a Passive Integrated Transmitter (PIT) tag. Length and weight measurements were also taken. A fixed PIT tag detection array installed by the M&E project at the mouth of White Creek will facilitate survival and migration timing analysis on those fish tagged within the project reach.

- Food web: In partnership with M&E staff, a study was initiated in 2009 to examine if and how restoration project actions affect physical habitat as well as biological response by the invertebrate community and fish population (steelhead / rainbow trout). The study examines aquatic and terrestrially derived invertebrate prey sources and resident rainbow trout and juvenile steelhead diet and biometrics. Aside from project effectiveness, this comprehensive study explores a significant gap of current scientific understanding (Miller, et al. 2009). Specific objectives of the study will include the following:

  - Quantify riparian habitat conditions in treatment and control sub reach sample sections.
  - Compare invertebrate biomass and composition from benthic, drift, and allochthonous sources among treatment and control sub reach sample sections.

- Compare fish diet (biomass and composition) among treatment and control sub reach sample sections.
- Evaluate seasonal variation in prey availability and diet of juvenile steelhead trout in sub reach sample sections.

Table 4. Summary totals of food web samples collected pre-treatment (October 2009 – October 2011). (-) denotes no data collected.

Stream	Treatment or Control	Year	Season	# Benthic Samples	# Drift Samples	# Pan Trap Samples	# Stomach Samples
Tepee Ck	Treatment	2009	Fall	3	4	36	20
		2010	Spring	12	-	-	-
		2010	Summer	12	16	35	74
		2010	Fall	12	16	35	77
		2011	Fall	12	16	35	70
			Total	**51**	**52**	**141**	**241**
White Ck	Control	2009	Fall	3	4	36	26
		2010	Spring	12	-	-	-
		2010	Summer	12	16	33	67
		2010	Fall	12	16	35	61
		2011	Fall	12	16	36	75
			Total	**51**	**52**	**140**	**229**

Klickitat River Delta Pilot Assessment

Background: YKFP fisheries biologists have expressed concern about adult fish passage at the mouth of the Klickitat River. KWEP staff initiated sampling water surface data (august 2009) to provide data for evaluation of depth-frequency. Data will document inundation frequency of landforms in the vicinity of the delta and be used to evaluate potential factors limiting salmonid production. The initial phase of the project consists of: 1) collection of water level data at four locations in the vicinity of the delta fan and 2) compilation of historic information. Data are anticipated for use in subsequent assessments such as evaluation of water temperature, growth of aquatic vegetation, juvenile and/or adult fish passage, and/or predation. Funding for the pilot assessment is being cost-shared by a grant received from Columbia River Intertribal Fish Commission (CRTIFC).

2010-2011 Activity: During the reporting period the sensor array installed in August of 2009 was operated continuously (Fig. 13). Primarily data collection was monitored via an ftp site KWEP staff can access from the Klickitat Field Office. KWEP staff from time to time observed discrepancies, errors, data gaps, or non-reporting dictated site visits for troubleshooting purposes. Additional site visits were conducted to collect staff gage observations to establish stage reference points. These reference points are utilized to quality control data collected by deployed sensors. Multiple instances of vandalism have occurred at the Basalt Cliff and East Delta sites. Acts of vandalism include: rock throwing at solar panels, bent communication mast, and tampering with power supply (12V marine battery).

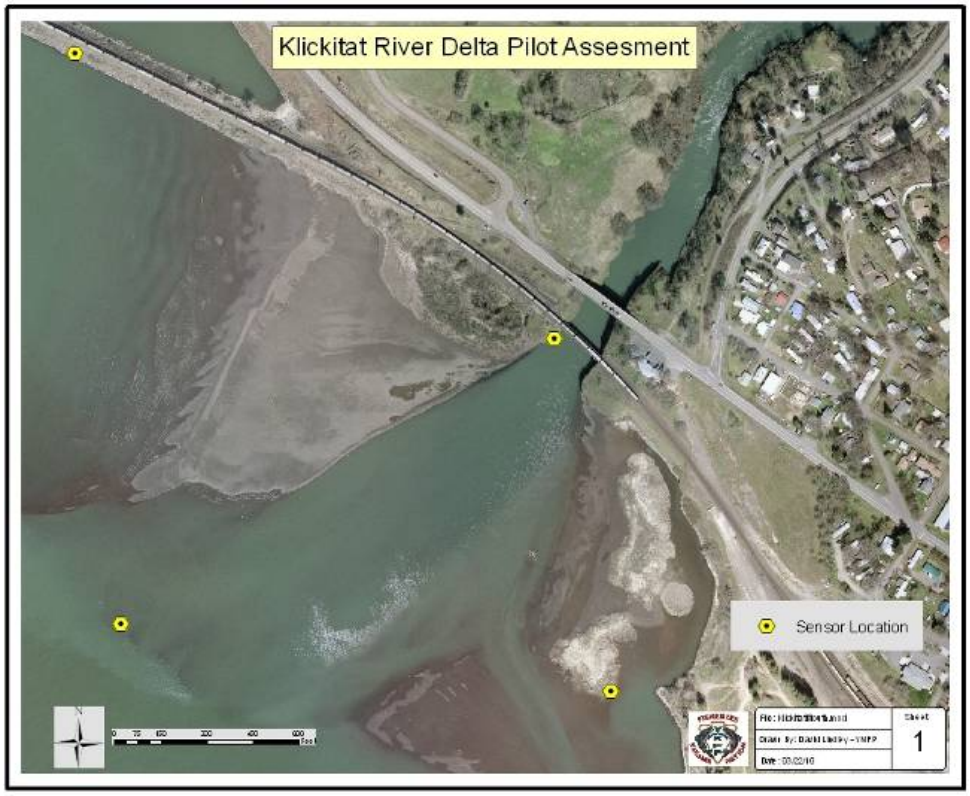


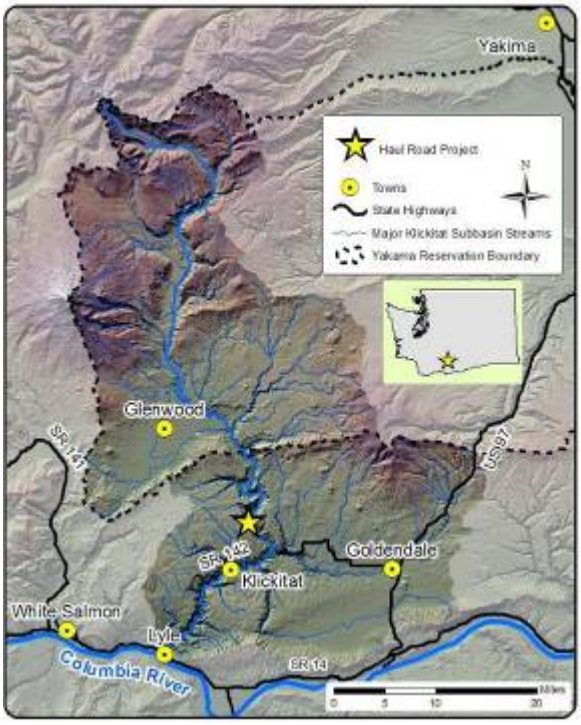
Figure 13. Sampling locations for the Klickitat River delta.

Examples of visits conducted for maintenance, repair or refinements:

- February 23, 2010 – two Hobo temperature loggers were deployed in the vicinity of the West Delta site (one south of railroad tracks in Columbia River and one north of railroad tracks in Chamberlain Lake) in order to verify water temperatures collected by the deployed INW PT12 and contrast temperature differential of impounded water in Chamberlain Lake from Columbia River.
- August 16-18, 2010 the Corps of Engineers operated Bonneville Pool at a lower than average elevation. During this time period the sensor located at the East Delta site was moved further into the active channel to facilitate collection of low pool elevation points.
- March 29, 2011 the sensor communication hub was moved from the Daybeacon site to East Delta in order to make it more accessible.
- June 1, 2011 visit conducted during high Bonneville Pool Stage to check on the status of the Daybeacon 55 site. At the time of visit the water surface elevation was within 0.40' of swamping the sensor housing box. A back-up sensor was installed at a higher elevation on the Daybeacon to ensure uninterrupted data collection in the event the primary sensor was inundated (Fig. 14).
- November 10, 2011 the four staff gages were surveyed to a common vertical datum (NAVD 88) by Pioneer Surveying Incorporated of Goldendale, Washington. Data collected on local datums will be converted to facilitate the analysis of water surface elevations from the four stations dispersed throughout the Klickitat and Columbia River confluence.

Figure 14. Klickitat River delta Daybeacon 55 site at high (left) and low Bonneville Pool stage (right). Photos of stage levels were taken on June 1, 2011 and September 26, 2011, respectively.

Klickitat River Floodplain Conservation and Restoration (Haul Road) Project



Background: The Haul Road project addresses limiting features (channel confinement) identified for the Klickitat River between river miles 18.3 and 32.2 by the Klickitat Subbasin Plan and Klickitat Lead Entity Salmon Recovery Strategy. This portion of the river has the greatest habitat complexity of any reach in the lower Klickitat River and provides critical spawning, migration and rearing habitat for winter and summer steelhead (ESA-"Threatened"), Chinook salmon (spring and fall runs), and coho salmon. This reach provides a high proportion of the basinwide spawning habitat for all three species, accounting for on average 21% (2-40%), 43% (24-56%), and 13% (0-37%) of the annually observed basinwide spawning for steelhead, fall Chinook, and coho, respectively (2002-2011). Riparian and floodplain conditions have been degraded by a combination of channel encroachment and floodplain isolation by road fill as well as 1996 flood deposits. The absence of other floodplain development coupled with somewhat less-confined valley conditions affords this reach greater resiliency than downstream reaches. The project is occurring in two stages: 1) acquisition (Phase 1 funding) and 2) restoration (all subsequent phases of funding). Columbia Land Trust (CLT) acquired the property completing Phase 1 in 2007 and is the primary for SRFB grants. KWEP is the technical lead for design and construction oversight of restoration actions as well as assisting planning activities, including Road Maintenance and Abandonment Plan (RMAP) revisions.

Project Goal: The overall project goals are to prevent habitat fragmentation and restore floodplain connectivity and geomorphic processes to the valley bottom. CLT completed acquisition of the road and 480 acres of private riparian and upland in holdings within the Klickitat Wildlife Management Area in 2007 (Conley 2008). Phase 1 was completed in 2009 with removal of a cross-valley railroad embankment in Dead Canyon (tributary at upstream end of project reach). The Phase 2 grant addresses limiting features for a portion of this reach by restoring floodplain connectivity and pulling back and re-vegetating fill materials in other portions to enhance riparian vegetation. Phase 2 enhanced and restored riparian and floodplain habitat by modifying 2.1 miles (cumulative) of road to reduce channel confinement and restore floodplain access along 0.94 miles of the road. Roughly 7.5 acres of riparian and floodplain habitat will also be revegetated.

2010-2011 activity: Project planning, development and construction activities were conducted during the reporting period.

- *Planning* - KWEP and CLT staff conducted several field visits to refine treatments and geographic scope of Phase 2, as well as generate a timeline for implementation of future phases. KWEP staff determined stationing for road segments delineated during assessment (Conley and Lindley 2012) and performed lay-out prior to bidding. Concurrently, the GIS database culvert layer was updated, improving the precision of location data, type, and condition. An application for Phase 3 of the Haul Road co-sponsored by CLT and the YN was submitted during the 2011 SRFB grant round. The funding decision to award the grant was received on December 8, 2011.
- *Administration* – During the construction process KWEP project staff supported CLT with permitting, RMAP revisions, request for proposals (by providing quantities and specifications), bidding, contract award, and contract administration process. Additionally, the YN hydrologist provided field oversight of construction activities and directed fit in-the-field implementation.
- *Construction* (fall 2010) –
  - Approximately 6700 l.f. of embankment graded to enhance riverine and floodplain function:
    - ~1780’ of floodplain channel constructed
    - Construction of 11 woody debris jams in floodplain and floodplain channel (Fig. 15)
    - Restore deformability of channel margins = lateral channel migration and LWD source
    - Restore hillslope interaction
  - Removed asphalt from 4.5 miles of floodplain road
- *Vegetation Management* -
    - Invasive species plant removal via hand pulling (spring and fall 2010 and 2011)
    - Native seed and straw mulch were applied to disturbed surfaces
    - Containerized stock planted with either hoedad or power auger (determined by stock, species and microsite conditions):
      - 400 spiraea (*Spiraea douglasii*) tubelings
      - 1,950 containerized plantings (14”x4” tree pots)
        - Scoulers Willow (*Salix scouleriana*)
        - Dogwoods (*Cornus nuttallii*)
        - Cottonwood (*Populus deltoids*
      - Test-planted approx.. 2,000 locally-sourced acorns (*Quercus garryana*)

Figure 15. Before (left) and after (right) removal of road prism, construction of channel, and grading of floodplain (Phase 2).

ACTIVITIES INVOLVING PAST PROJECTS

Project Management/Weed Control

Site visits were made to eight completed project sites (19.25 acres) in 2010 and 2011 in order to control the spread of weeds. In 2011, one additional site (10 acres) was visited pre-project in order to reduce the infestation of weeds prior to ground disturbing activities. Treatments involved manual pulling of target species, primarily knapweed and non-native thistles. An initial pass was made through each site followed later by a second pass to focus removal on newly emergent plants and those that had been missed previously.

OTHER KWEP ACTIVITIES

Promote No-till Farming Practices

In late 2005, the Yakama Nation Fisheries Program purchased a small no-till (a.k.a. direct-seed) drill with a grant received from CRITFC. The goal is to increase awareness and implementation of no-till practices. These practices increase residual ground cover (stubble) in agricultural fields between crop cycles and reduce disturbance to the soil profile, producing greater infiltration of precipitation into the soil profile and less surface runoff and soil erosion. A Memorandum of Agreement was signed in 2006 with the Central and Eastern Klickitat County Conservation Districts (CEKCCD) to administer operation of the drill. This project targets smaller farmers (typically 80 ac or less) for whom it is not economical to purchase such equipment. CEKCCD provides necessary maintenance and rents the drill to small landowners for a small fee (sufficient to cover maintenance expenses). The landowners provide their own tractor, transportation of the drill, and are responsible for covering all of their own expenses. 2010 and 2011 were the fifth and sixth years of drill operation. The drill was rented to 15 landowners. Total acreage planted over the two years was 145 acres.

Streamflow Monitoring

KWEP, cooperatively with Klickitat M&E and the YN Water Program (YNWP), monitors stream flow throughout the Klickitat sub-basin. In 2011 the funding of activities (instantaneous discharge measurements) conducted by YNWP in the Klickitat Basin transitioned from KWEP to M&E. Cooperative activity during 2010-2011 included eighty-five instantaneous discharge measurements for use in rating curve development (Table 5).

KWEP staff operated stream gages with continuous dataloggers at nine sites during the reporting period. Three new sites were established by KWEP (Big Muddy CK @ 255 x-ing, Klickitat River @ Wahkiacus, and Klickitat River below Summit Ck). Site establishment entailed installation of three staff gages (for manual observation of stage elevation) and three sensor / data-loggers (to record water surface elevation, water temperature, and turbidity continuously). A total of twenty-six visits were made to nine sites with data loggers for installation, data download and field calibration (KWEP). Activities conducted at all sixteen sites are summarized in Table 5. Figure 17 provides an example of continuous water surface elevation measurements at one site (Swale Creek near mouth).

Big Muddy Creek at the 255 road crossing (Fig. 16) is in a narrow canyon which presents challenges to traditional stream gaging instrumentation. An approach utilizing a non-contact water level sensor (OTT radar level sensor (RLS)) was designed and tested. Ultimately, this technology was incapable of collecting consistent data due to too much turbulence on the water surface. Upon ruling out alternative sampling equipment, a pressure transducer was installed in the one feasible location approx. 50' of the road crossing.

Table 5. Services performed by KWEP and YNWP at 16 stream gaging sites in the Klickitat subbasin during 2010-2011.

Site	Q Measure	Staff Read	Crest Read	Staff Install	Sensor Install	Download	Maint.	Repair	Survey	Total Visits
Big Muddcy Creek @ 255 x-ing		14		1	2	17	9	2	2	26
Diamond Fork @ Klickitat River	4	4	3							4
East Fork Tepee Creek	8	8								8
Klickitat River @ Cow Camp	4	4								4
Klickitat River @ Klickitat Hatchery		12				12				13
Klickitat River blw Summit Ck		3		1	1	1			1	4
Klickitat River @ Wahkiacus		18			1	16	2			21
Piscoe Creek nr mouth	3	4	2							4
Summit Creek nr mouth	8	22	2			14				23
Surveyors Creek	6	11	10							11
Swale Creek nr mouth	10	22				11		1		22
Tepee Creek abv. 175 Rd	9	29				13		1		20
Tepee Creek abv. IXL Rd	9	23	8			14		2		32
White Creek abv. IXL	9	9	4							9
White Creek @ Cedar Valley Rd	10									10
White Creek nr mouth	5	21				17			1	28
Grand Total	**85**	**204**	**29**	**2**	**4**	**115**	**11**	**6**	**4**	**239**

Table 6. Stage and instantaneous discharge measurements from 5 sites for the period 1/1/10-12/31/11. Table depicts data collected by YNWP at sites that KWEP operates continuous dataloggers. Stage and instantaneous discharge measurements were conducted at an additional seven sites during the reporting period but are not depicted in Table 5.

Site	Date	Stage	Discharge
Summit Creek nr mouth	1/19/10	5.05′	62.3 cfs
Summit Creek nr mouth	2/11/2010	4.80′	44.5 cfs
Summit Creek nr mouth	2/18/2010	4.93′	56.3 cfs
Summit Creek nr mouth	3/2/2010	4.93′	51.9 cfs
Summit Creek nr mouth	5/5/2010	4.80′	45.9 cfs
Summit Creek nr mouth	9/15/2010	4.23′	13.7 cfs
Summit Creek nr mouth	11/16/2010	4.27′	16.2 cfs
Summit Creek nr mouth	1/31/2011	5.10′	80.0 cfs
Swale Creek nr mouth	2/9/2010	3.57′	68.7 cfs
Swale Creek nr mouth	210/2010	3.49′	60.9 cfs
Swale Creek nr mouth	3/1/2010	3.22′	36.0 cfs
Swale Creek nr mouth	4/6/2010	3.15′	28.5 cfs
Swale Creek nr mouth	4/13/2010	2.92′	20.9 cfs
Swale Creek nr mouth	5/17/2010	2.29′	2.3 cfs
Swale Creek nr mouth	11/2/2010	2.33′	0.6 cfs
Swale Creek nr mouth	12/14/2010	4.53′	298.0 cfs
Swale Creek nr mouth	2/1/2011	3.10′	36.3 cfs
Swale Creek nr mouth	3/16/2011	3.85′	172.5 cfs
Swale Creek nr mouth	4/14/2011	3.07′	32.1 cfs
Tepee Creek abv. IXL Road	3/3/2010	4.32′	14.5 cfs
Tepee Creek abv. IXL Road	3/31/2010	4.29′	14.2 cfs
Tepee Creek abv. IXL Road	5/13/2010	4.11′	5.6 cfs
Tepee Creek abv. IXL Road	8/11/2010	3.90′	0.8 cfs
Tepee Creek abv. IXL Road	2/2/2011	4.25′	7.6 cfs
Tepee Creek abv. IXL Road	4/13/2011	4.34′	20.5 cfs
Tepee Creek abv. IXL Road	5/16/2011	4.24′	13.2 cfs
Tepee Creek abv. IXL Road	8/25/2011	3.88′	0.7 cfs
Tepee Creek abv. 175 Road	3/3/2010	1.40′	16.0 cfs
Tepee Creek abv. 175 Road	3/31/2010	1.36′	14.7 cfs
Tepee Creek abv. 175 Road	4/28/2010	1.16′	9.6 cfs
Tepee Creek abv. 175 Road	5/13/2010	1.00′	6.1 cfs
Tepee Creek abv. 175 Road	8/11/2010	0.61′	0.6 cfs
Tepee Creek abv. 175 Road	11/8/2010	0.90′	0.7 cfs
Tepee Creek abv. 175 Road	5/16/2011	1.43′	14.1 cfs
Tepee Creek abv. 175 Road	9/7/2011	0.57′	0.3 cfs
White Creek nr mouth	2/11/2010	2.57′	88.0 cfs
White Creek nr mouth	3/8/2010	2.83′	116.9 cfs
White Creek nr mouth	4/7/2010	3.14′	123.2 cfs
White Creek nr mouth	7/13/2010	1.31′	8.8 cfs
White Creek nr mouth	1/31/2011	2.83′	121.0 cfs
White Creek nr mouth	5/23/2011	2.67′	107.0 cfs

Figure 16. Big Muddy Creek at 255 road x-ing (left) and Summit Creek near mouth (right) streamflow gaging stations.

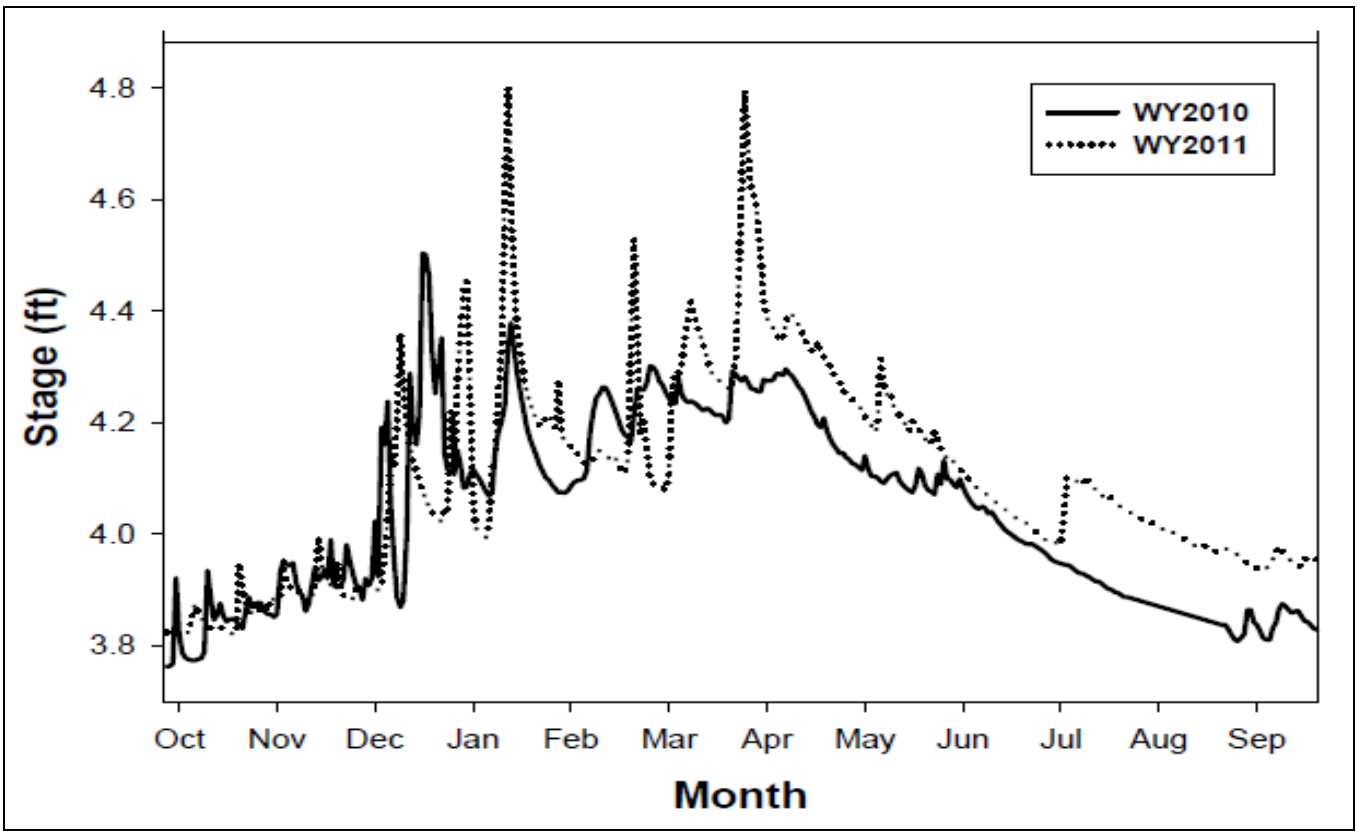


Figure 17. Tepee Creek stage at the gaging site above IXL Road x-ing for Water Year 2010 and 2011.

Habitat Assessment

In late 2009, KWEP and M&E began a review of the aquatic habitat protocol (TFW) utilized by M&E in the Klickitat subbasin to determine if it met current needs. Established aquatic habitat assessment needs are:

1. Determine the effectiveness of habitat enhancement projects by quantifying differences between pre-and-post project aquatic habitat conditions.
2. Expand the spatial extent of known baseline conditions within the anadromous bearing portion of the Klickitat subbasin.
3. Identification of stream sections that warrant further investigation as sites with potential for enhancement via intervention.

The objectives for the stream habitat assessment protocol are to provide a single approach for effectiveness monitoring, status and trend monitoring, and to inform need, location, type, and project development.

A variety of existing stream habitat protocols were reviewed and compared to determine if they fulfilled the defined management objectives. While there are numerous stream habitat assessments currently utilized in the Pacific Northwest, they vary in their performance, compatibility, and repeatability (Roper et. al. 2010). Based on this review, a new protocol was subsequently developed that combined two widely used Pacific Northwest stream classification systems, TFW and the Aquatic Inventory Project (Moore et al. 2010, Pleus et al. 1999, and Schuett-Hames et al. 1999). Data collected in the future to characterize large woody-debris will be backward compatible with the historic TFW data. The new protocol is the Rapid Aquatic Habitat Assessment Protocol (RAHAP) (Romero and Lindley 2012). The RAHAP approach is: 1) spatially continuous, 2) relatively fast (per unit of collection), and 3) collects paired physical and fisheries data.

RAHAP utilizes field crews comprised of two people to delineate reaches, habitat units, spawning patches, wood pieces, and wood jams. Surveys are conducted in the upstream direction by defining and sequentially numbering each habitat unit. The following metrics are collected for each habitat unit: habitat type (pool, riffle, or glide), wetted width, maximum and residual pool depth, percent undercut banks, and bankfull width. Delineated habitat units are geo-referenced and photo documented. Surveys to quantify LWD (jams and individual pieces) are conducted concurrently with the habitat surveys and spatially linked to the defined habitat units. Following the completion of the habitat inventories fish abundance surveys are conducted. Single-pass fish surveys (by electrofishing or snorkeling) are conducted to spatially quantify fish distribution, composition, and relative abundance.

Refinement of the RAHAP methodology occurred throughout the 2010 field season, as oversights or limitations of the protocol were identified. By early 2011 the metrics and field collection protocol had solidified and an expanded pilot season was warranted. Four tributaries located in the lower Klickitat River (Dillacort Creek, Logging Camp Creek, Wheeler Creek, and Snyder Creek) presented an opportunity to test all of the metrics across a range of environments. Each of these streams is disconnected from the mainstem Klickitat River during a portion of the year (early summer – late fall) when surface flow is non-existent. Some scattered TFW data existed, but no quantitative information on juvenile rearing existed.

In the spring of 2011, a total of 11.1 kilometers (collectively) of stream length was surveyed in the four tributaries identified above (Tables 7 and 8). Surveys were limited to the anadromous bearing portions

of the each of the four watersheds. The creeks were intentionally selected due to their close proximity to one another and the Klickitat Field Office, and there similar drainage areas. The Snyder Creek watershed is significantly larger and thus the surveyed length and area was greater than the other three creeks surveyed. Total habitat unit area was lowest in Logging Camp Creek and greatest in Snyder Creek. Pool frequency was highest in Dillacort Creek and lowest in Wheeler Creek. Residual pool depths were similar among Dillacort Creek, Wheeler Creek, and Snyder Creek but substantially shallower in Logging Camp Creek. The number of LWD pieces was 3, 1.7, and 1.5 times greater in Logging Camp Creek compared to Dillacort Creek, Wheeler Creek, and Snyder Creek, respectively. LWD jams were infrequent or non-existent in all of the surveyed creeks. These comparisons are applicable for the optimal time of the year (spring) and would not apply during the limiting time of year (fall).

Subsequent to the initial RAHAP surveys, the Lower Klickitat River Tributary Study was initiated in spring 2011 to describe *O. mykiss* life history strategies displayed in four tributaries (Dillacort Creek, Logging Camp Creek, Wheeler Creek, and Snyder Creek) of the lower Klickitat River. In each of these four streams surface flow across the alluvial fan ceases sometime in June or July and does not reconnect until October, November or December. Intermittent flow restricts fish movement between tributary and mainstem aquatic habitat. In each stream PIT tag arrays will be installed seasonally and annual fish surveys will be conducted to PIT tag *O. mykiss.* Fish detection data collected at the fixed PIT arrays will be utilized to quantify the proportion of *O. mykiss* displaying anadromy, the timing of in- and out-migration, proportion of hatchery vs. wild adult returns, and the usage of rearing habitat by juveniles. This study will be conducted collaboratively by KWEP and M&E project staff.

Table 7. Summary of aquatic habitat inventory data collected September 2010 – June 2011. Parentheses denote side channel values. (-) denotes data not collected.

Purpose/ Geographic Unit	Survey Date	Stream	Discharge	Total Survey Length (m)	Total Survey Area (m^2)	Avg. Bankfull Width (m)	Avg. Habitat Unit Width (m)	Avg. Habitat Unit Area (m^2)	Pool Frequency (pools/km)	Avg. Residual Pool Depth (m)
Upper Klickitat - Phase 3 Pre-Treatment (Side Channel Reconnection)	9/14/2010	Klickitat R.	85 cfs*	(1,218)	(2,859)	(6.0)	(2.3)	(33)	(20.5)	(0.49)
Upper Klickitat - Phase 4 Pre-Treatment (255 Bridge - Twin Bridges)	9/15/2010	Klickitat R.	85 cfs*	771 (178)	11,595 (1007)	23.1 (11.4)	14.5 (5.0)	828 (92)	3.9 (16.9)	0.78 (0.36)
Baseline Klickitat R. Tributary Conditions	4/13-14/ 2011	Dillacort Ck.	9.3 cfs**	1,636 (34)	7,670 (110)	7.5 (-)	4.6 (2.9)	59 (18)	23.8 (0.0)	0.58 (0.0)
Baseline Klickitat R. Tributary Conditions	4/26-29/ 2011	Wheeler Ck.	14.5 cfs**	1,765 (87)	7,501 (306)	8.2 (-)	4.0 (3.3)	58 (44)	18.1 (11.5)	0.59 (0.36)
Baseline Klickitat R. Tributary Conditions	5/9-23/ 2011	Logging Camp Ck.	1.3 - 2.9 cfs**	1,915 (58)	6,261 (97)	4.4 (-)	3.1 (1.7)	42 (24)	19.8 (0.0)	0.33 (0.0)
Baseline Klickitat R. Tributary Conditions	6/3-15/ 2011	Snyder Ck.	3.7 - 6.4 cfs**	5,429 (152)	27,074 (520)	8.2 (-)	4.8 3.3	70 (29)	22.7 (13.2)	0.50 (0.24)

*Discharge obtained from USGS Klickitat River above West Fork near Glenwood, WA gage (#14107000).

**Instantaneous discharge measurements taken during sampling period.

Table 8. Summary of Large Woody Debris (LWD) and LWD Jam inventory data collected September 2010 – June 2011. Parentheses denote side channel values to differentiate from mainstem values

Purpose/ Geographic Unit	Survey Date	Stream	Total Survey Length (m)	Total Survey Area (m^2)	# LWD Pieces (pieces/km)	# LWD Jams (jams/km)	# Jam Pieces (pieces/km)
Upper Klickitat - Phase 3 Pre-Treatment (Side Channel Reconnection)	9/14/2010	Klickitat R.	(1,218)	(2,859)	(45.9)	(0.82)	(10.7)
Upper Klickitat - Phase 4 Pre-Treatment (255 Bridge - Twin Bridges)	9/15/2010	Klickitat R.	771 (178)	11,595 (1007)	41.5 (61.8)	7.9 (5.6)	191.9 (376.6)
Baseline Klickitat R. Tributary Conditions	4/13-14/ 2011	Dillacort Ck.	1,636 (34)	7,670 (110)	15.9 (88.2)	0.6 (0.0)	4.9 (0.0)
Baseline Klickitat R. Tributary Conditions	4/26-29/ 2011	Wheeler Ck.	1,765 (110)	7,501 (306)	28.3 (0.0)	0.6 (0.0)	9.6 (0.0)
Baseline Klickitat R. Tributary Conditions	5/9-23/ 2011	Logging Camp Ck.	1,915 (58)	6,261 (97)	48.0 (17.2)	0.0 (0.0)	0.0 (0.0)
Baseline Klickitat R. Tributary Conditions	6/3-15/ 2011	Snyder Ck.	5,429 (152)	27,024 (520)	33.0 (72.4)	0.7 (0.0)	10.5 (0.0)

Education and Outreach

Though education and outreach constitutes a minor portion of overall KWEP staff time allocation, it is a critical component of the project. KWEP staff conducted several public presentations from 2010-2011. These activities are oriented toward helping the public understand what we do, why we do it and communicating lessons-learned to improve overall practice of watershed and stream restoration.

- *Public presentations*: KWEP staff delivered 8 presentations at six professional meetings during 2010 and 2011, including:

  - 2010 Klickitat and White Salmon Rivers Fisheries and Watershed Science Conference: KWEP staff were invited to give an oral presentation on Phase 2 of the Tepee Creek Restoration Project (Conley 2010a).

  - River Restoration Northwest's 9th Annual Northwest Stream Restoration Symposium (2010): KWEP staff delivered a peer-reviewed presentation entitled "Reversing Channel Incision in Tepee Creek: Lessons Learned and Implications for Future Work". The presentation touched on the design, implementation, lessons learned and future phases of the project (Conley 2010b).

  - River Restoration Northwest's 10th Annual Northwest Stream Restoration Symposium (2011): KWEP staff presented a peer-reviewed poster providing an overview of habitat effectiveness monitoring activities conducted cooperatively with Klickitat M&E within the Klickitat Subbasin (Lindley, Romero & Conley 2011a). The poster session was a designated hour and a half segment of the Symposium that facilitated the one-on-one interaction of participants with KWEP staff.

  - 2011 Klickitat and White Salmon Rivers Fisheries and Watershed Science Conference: KWEP staff were invited to give two oral presentations. One on the YKFP approach to habitat effectiveness monitoring in the Klickitat subbasin (Lindley, Romero & Conley 2011b) and the second on restoring floodplain connectivity along the mainstem Klickitat River (Conley 2011a).

  - 2011 Salmon Habitat Conference: KWEP staff were invited to give two oral presentations to the biennial conference affiliated with the Washington Salmon Recovery Funding Board (SRFB):
    - "In-stream wood: Thoughts from a recreational rafter and restoration practitioner" (Conley 2011b) focused on misconceptions regarding the hazards of woody debris in rivers.
    - "The Snyder Creek / Klickitat Mill Fish Passage Project" (Conley 2011c) provided a history of the Snyder Ck Fish Passage Project. It highlighted project partnerships (state and local governments, non-profits and private landowners), design challenges, and lessons learned from this unique project.

  - 2011 ASCE Environment & Water Resources Group Conference: KWEP staff were invited to give an oral presentation on woody debris in rivers related to risk, hazards and potential mitigation (Conley 2011d).

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