Document ID #P146433

Klickitat Watershed Enhancement Project (KWEP)

Yakima/Klickitat Fisheries Project (YKFP)

Report for January 1, 2014 - December 31, 2014

BPA Project # 1997-056-00

Report covers work performed under BPA contract #(s) 56662 REL 23, 56662 REL 44

Report was completed under BPA contract #(s) 56662 REL 44

1/1/2014 - 12/31/2014

David Lindley and Will Conley

Yakama Confederated Tribes, Klickitat, WA, 98628

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

This report should be cited as follows: David Lindley and Will Conley, Klickitat Watershed Enhancement Project, 1/1/2014 - 12/31/2014 Annual Report, 1997-056-00

Table of Contents

List of Figures

List of Tables

I. Executive Project Summary/Abstract

This report describes restoration/enhancement activities and on-going watershed monitoring in the Klickitat River subbasin implemented by the Klickitat Watershed Enhancement Project (KWEP). The activities described were funded in part by the Bonneville Power Administration's (BPA) Yakima-Klickitat Fisheries Project (YKFP). Funds provided by BPA are matched with in-kind donations from the Yakama Nation in the form of materials and supplies, and cash donations awarded through the solicitation of competitive grants such as the Salmon Recovery Funding Board (SRFB) administered by the Washington State Recreation and Conservation Office. Project work emphasizes restoration and protection in watersheds and reaches that support native salmonid stocks, particularly steelhead/rainbow trout) (*Oncorhynchus mykiss*), spring Chinook salmon (*O. tshawytscha*), and bull trout (*Salvelinus confluentus*).

Restoration activities conducted during 2014 focused on restoring side channel and floodplain connectivity along the mainstem Klickitat River, creation of diverse active channel hydraulic conditions (varying depths and velocities), enhancement of the quality and quantity of salmonid rearing habitat, and the restoration of deformable stream banks and hillslope interaction.

As part of the Upper Klickitat Phase 4 Project, a total of 11 log jams were constructed, one of which is a large apex jam that splits mainstem flow into two channels (low-flow and side channel). By constructing 450 feet of new channel, an existing Klickitat River side channel was augmented with additional flow and extended down valley 1,000 linear feet. Phase 5 of the Haul Road Project removed 1.75 miles of asphalt and graded the embankment to enhance riverine and floodplain function. Nearly 750 feet of high-flow channel was constructed, 2 log jams built, and 600 feet of bedrock was exposed during an abbreviated construction season.

Monitoring/assessment activities focused on the characterization of hydrologic and geomorphic conditions within the mainstem Klickitat River and tributaries. This is accomplished through a network of stream gages, a subset of which have more focused objectives (Klickitat Delta Pilot Study and Big Muddy Creek), and RAHAP surveys. The purpose of these data collection activities is to inform watershed assessment, land use planning and the focus of watershed and fisheries restoration efforts. Post-project monitoring is conducted on select sites to refine future projects by documenting whether or not intended physical and biological responses occurred. Completed projects are presented as case studies at professional meetings to facilitate discussion and advance knowledge of restoration ecology.

II. Introduction

The Klickitat Watershed Enhancement Project (KWEP) works to restore, enhance, and protect watershed function within the Klickitat [River] subbasin. Project work emphasizes restoration and protection in watersheds and reaches that support native salmonid stocks, particularly steelhead (*Oncorhynchus mykiss*; listed under the Endangered Species Act as "Threatened" within the Mid-Columbia Evolutionarily Significant Unit), spring Chinook Salmon (*O. tshawytscha*), and Bull Trout (*Salvelinus confluentus*; "Threatened"). 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 fall Chinook (*O. tshawytscha*) and Coho salmon (*O. kisutch*), resident Rainbow Trout, 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 reducing habitat degradation. Since 90% of the off-reservation project area is in private ownership, cooperation with state, federal, tribal, and private entities increases project effectiveness. KWEP addresses goals and objectives presented in the 2004 Klickitat Subbasin Plan and the Klickitat Lead Entity Salmon Recovery Strategy.

PROJECT GOALS

The overall goal of KWEP is to restore watershed processes to aid recovery of salmonid stocks in the Klickitat subbasin. There are three sub-goals:

• Assess watershed and habitat conditions to prioritize sites for restoration activities. This involves data collection, compilation, and review of existing and historic habitat and watershed conditions. Identification and filling of data gaps is also a component of KWEP.

• Protect, restore, and enhance priority watersheds and reaches to increase riparian, wetland, and stream habitat quality. In-situ and watershed-scale restoration activities mitigate or alleviate conflicting historic, present, and/or future land-uses. Protect areas of existing high-quality habitat condition and prevent further habitat degradation. Restore areas of degraded stream channel and/or habitat condition.

• Monitor watershed conditions to assess trends and effectiveness of restoration activities. Monitoring is a critical component to evaluating project success and guiding adaptive practices. Site-specific and basin-wide spatial scales are addressed. KWEP complements the Klickitat Monitoring & Evaluation Project (BPA project #1995-06-335) by assisting [with] data collection, providing Quality Assurance /Quality Control (QA/QC) and analysis of channel morphology, streamflow, temperature, habitat, and channel substrate.

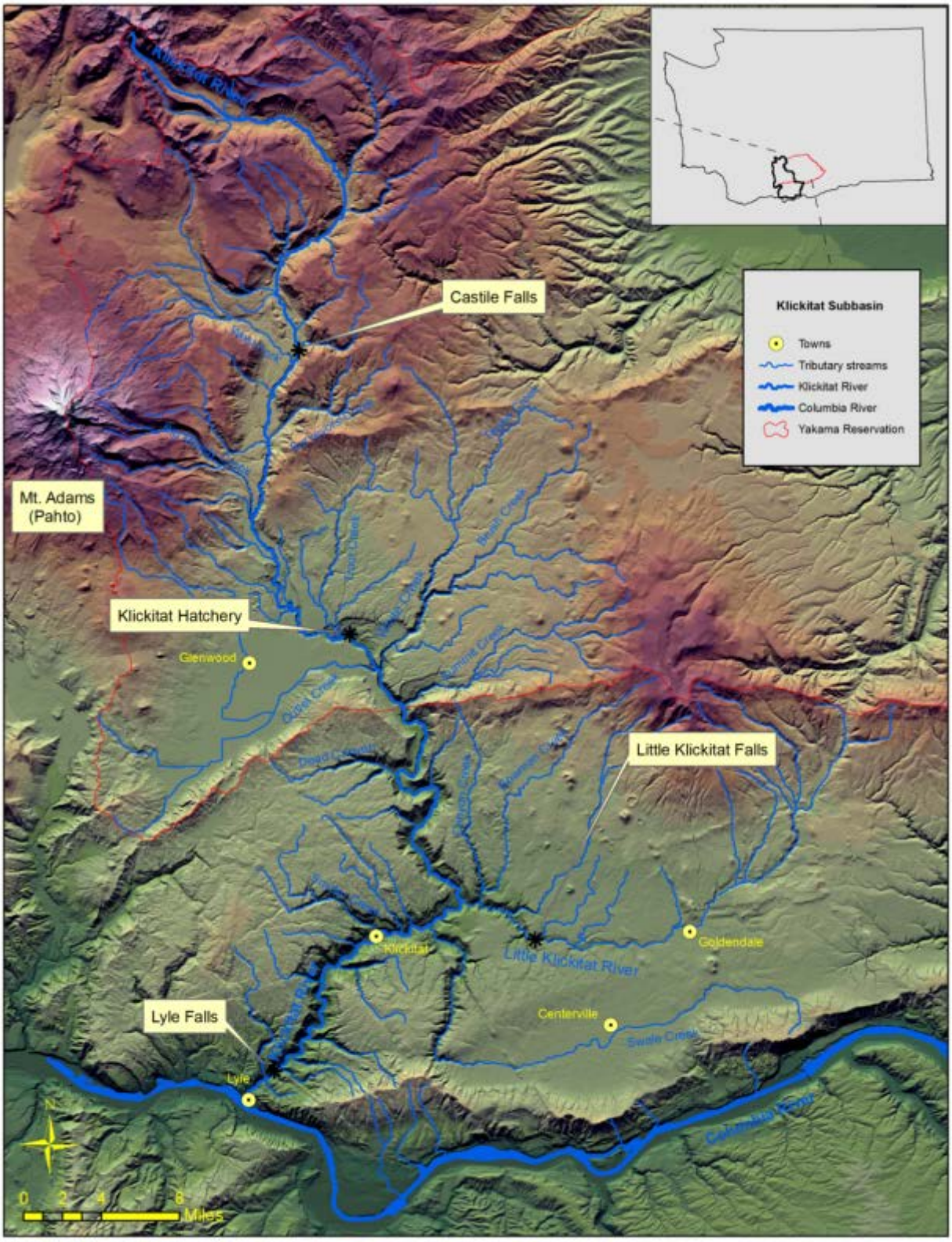

Figure 1. Klickitat River Subbasin

III. Work Elements/ Deliverables

Tributary Habitat Restoration and Protection

Upper Klickitat River In-channel and Floodplain Enhancement - Phase 4

Introduction: The project addresses limiting habitat features (channel confinement and 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 site ranks third overall in the Klickitat subbasin in restoration potential for combined performance of steelhead and spring Chinook (NPCC, 2004). Project work addresses limiting factors identified for the reach between river mile (RM) 74-76.

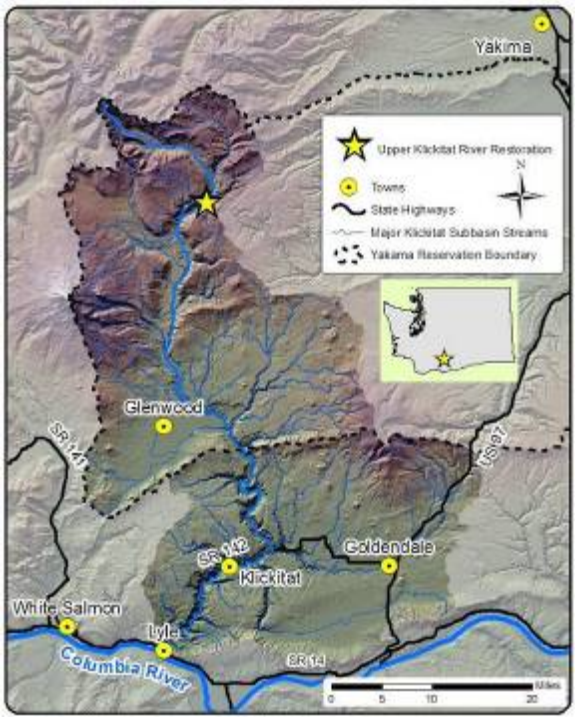

Figure 2. Upper Klickitat Restoration site location (star) within Klickitat watershed.

Site and Watershed Description: The project location is on the mainstem of the Klickitat River in the vicinity of river mile 75.5 (Fig 2). This area has the potential to provide critical spawning and rearing habitat for ESA-listed Middle Columbia River steelhead and spring Chinook. The project area consists of a ~2700 foot plane-bed riffle. The project reach is located between 2950-3240' above sea level. The contributing drainage area is 89 mi^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). Limited steelhead and spring Chinook passage was possible prior to construction of a small headworks dam above Falls 11 in the 1960's. Washington Department of Fisheries constructed the dam to provide grade-control for the intake to a fishway. 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. Upstream passage was obstructed under 99% of flow conditions from the combined effect of the dam and fishway, based on monitoring 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 project sites in the years to come.

Pre-project Problem: Channel simplification is the primary problem [in this reach], likely resulting from the placement of the 255 Road in the floodplain of the Klickitat River**.** Pools were absent from the 2700' long mainstem reach. The shift to a plane-bed morphology is believed to have been triggered by stream cleaning and concentration of flood flows. Historically high flows that were distributed across a 240' wide floodplain were constricted to approximately 95' due to the placement of the 255 road. The conditions in the project are a result of a cross-valley road embankment that has forced an anatomizing channel form into a single channel to accommodate a single bridge crossing.

In addition to the road's influence on channel 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 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 the floodplain, it seems highly likely that stream cleaning occurred in the project reach.

Project Goal: Enhance river function and increase habitat quantity and quality for steelhead and spring Chinook along roughly 2700' of the Klickitat River in the vicinity of river mile 75. The project area is located within the "Upper Klickitat Mainstem: McCreedy Creek (RM 70) to Diamond Fork" reach that is ranked in the top tier of priority geographic areas identified in the Klickitat Lead Entity Region Salmon Recovery Strategy.

2014 Treatment: The Klickitat River Phase 4 Enhancement Project was designed to improve aquatic habitat and to reverse channel incision downstream of the Klickitat River Road Bridge. Approximately 100 feet downstream of the bridge, the channel was split from a single thread into two channels (Fig. 3). Baseflows are transported through the right (west) channel while a portion of flows larger than 100 cfs are routed into a side channel in the left (east) floodplain. The right channel bottom width was reduced from 60 ft to 20 ft. In the right/main channel, 9 log jams were placed along the margin to retard lateral migration. At the apex of the flow split, 2 log jams were installed. The jams are intended to provide aquatic habitat, bank stability, and create a backwater effect. Jam construction involved excavation of the bed, placement of logs, structural components (vertical snags/pilings and boulder ballast), and backfilling with native alluvium.

Administration – Design for in-stream habitat enhancement elements (LWD placement and side-channel excavation) was conducted jointly by Yakama Nation Fisheries personnel and Inter-Fluve Inc. staff of

Hood River, OR. The design evolved significantly from early iterations based on feedback from YNF that stressed the importance of a process-based approach that engaged the floodplain during higher flows Fig. 2). The initial design called for several constructed LWD jams along the margins of the main channel but did not include any side channel work or significant floodplain interaction. Additional topographic survey work was conducted and a 3-D model generated to inform the subsequent design (Fig. 4). The disciplines of the design team were: hydrologist, habitat biologist, geomorphologist, and professional engineer. Construction activities were performed by Tom Arnold Logging Inc. of White Salmon, WA.

Figure 3. Site Plan Upper Klickitat Phase 4 depicting LWD placement and side channel reconnection.

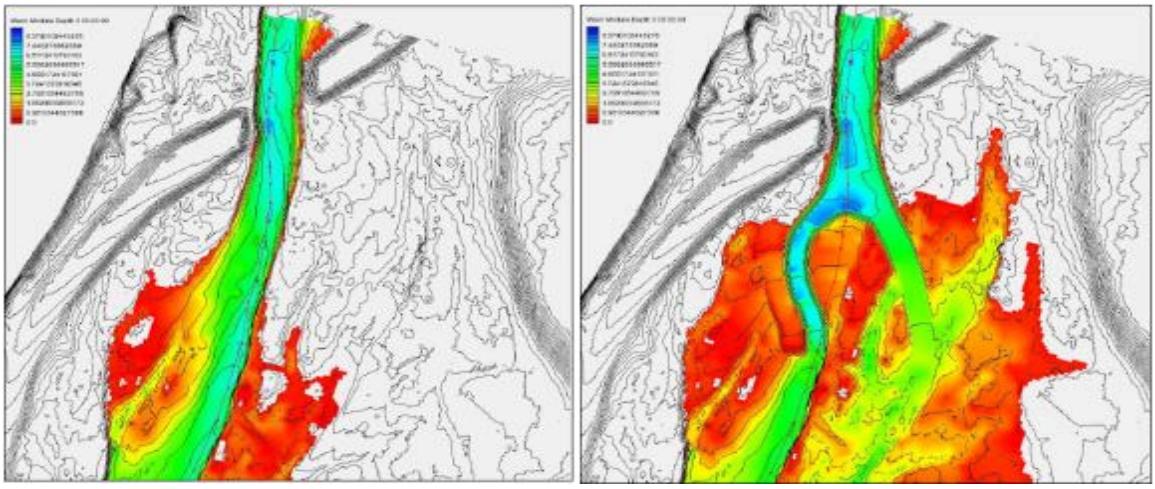

Figure 4. Water depths during 100-year flood under pre-project conditions (left) and under post-project conditions (right).

Construction - The primary outcome of the project was the restoration of floodplain connectivity and the reconnection of an existing side channel for a .50 mile reach of the mainstem Klickitat River (Figure 6). As a result, floodplain storage should increase, hydraulic severity during high flow events will be reduced, and off-channel habitat will increase. The cumulative effect will be more diversified aquatic habitat across a range of streamflow conditions. Construction project elements include:

- Collection and delivery of 150 ballast boulders
- Transport and sorting of 200 logs (~40% with rootwads)
- Construction of approx. 450' of side channel at sites F and H. Constructed side channel ties into existing side channel alignment. The existing side channel extended approx. 1,000' down-valley
- Construction/re-grading of approx. 250' of main channel to serve as the new low-flow channel
- Constructed 11 LWD jams
- Installed floodplain roughness at 3 locations
- Racked small diameter logs into the face of all constructed LWD jams
- Planted 10+ cottonwood cuttings (pole size) in each of the 11 LWD jams

Figure 5. Pre- (left) and post-project (right) photos looking downstream from the 255 road crossing of the Klickitat River.

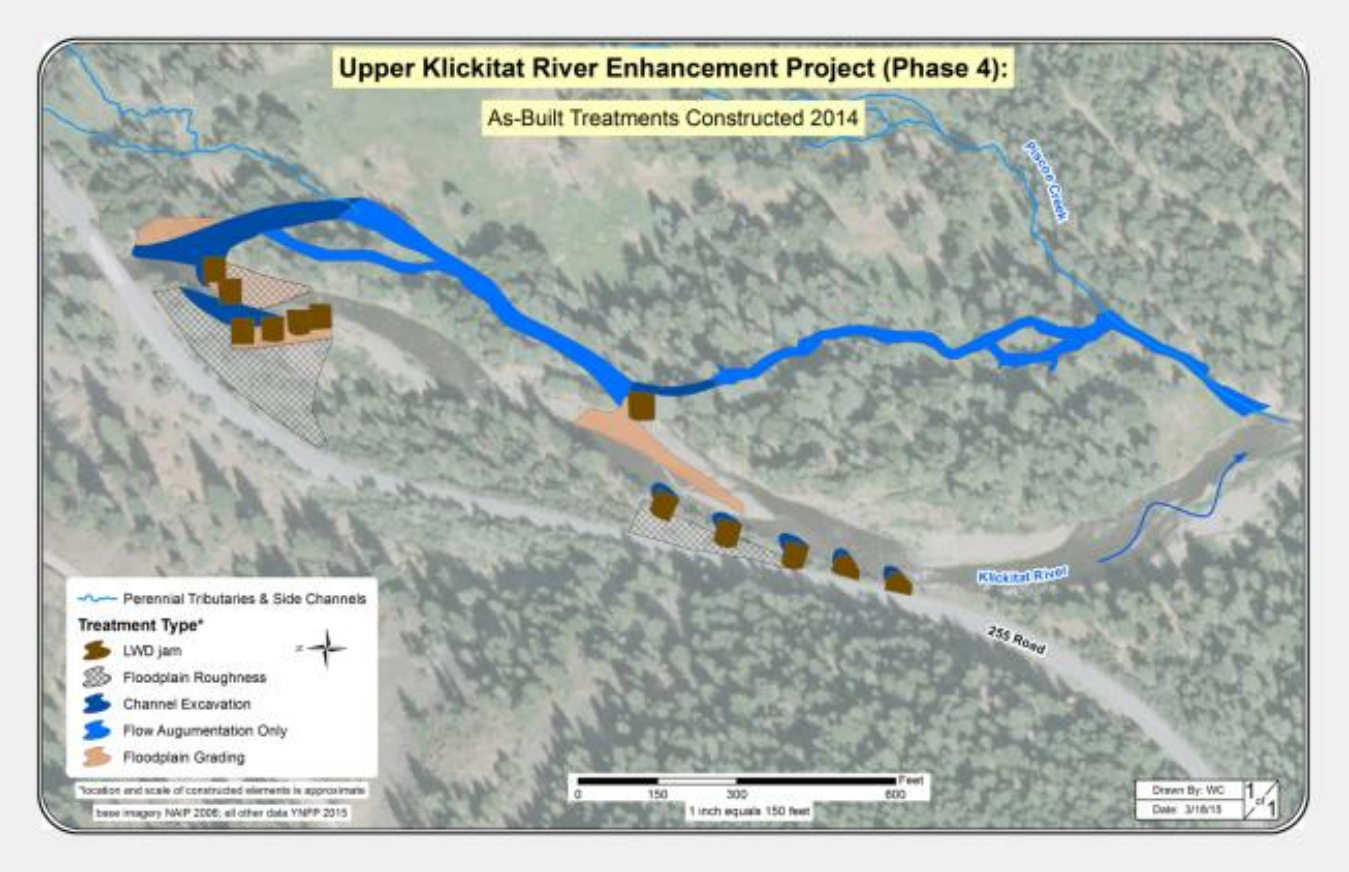

Figure 6. GIS-generated map of as-built treatments constructed 2014.

Figure 7. Pre- (left) and post-project (right) photos of constructed log jams along the right bank of the Klickitat River adjacent to 255 road.

Klickitat River Floodplain Conservation and Restoration (Haul Road) Project –Phase 5

Background: The Haul Road project addresses a limiting feature (channel confinement) identified for the Klickitat River between river miles 18.3 and 32.2 (Fig. 8) by the Klickitat Subbasin Plan and Klickitat Lead Entity Salmon Recovery Strategy (KLESRS, 2012). 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 threatened winter and summer steelhead, 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 19% (2-40%), 42% (24-65%), and 15% (0-37%) of the annually observed basinwide spawning for steelhead, fall chinook, and coho, respectively (2002-2013). Riparian and floodplain conditions have been degraded by a combination of channel encroachment and floodplain isolation by road fill and 1996 flood deposits. The absence of other floodplain development coupled with less-confined valley conditions affords this reach greater resiliency than reaches downstream. 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 sponsor for SRFB grants. KWEP is the technical lead for design and construction oversight of restoration actions as well as assisting with planning activities, including Road Maintenance and Abandonment Plan (RMAP) revisions.

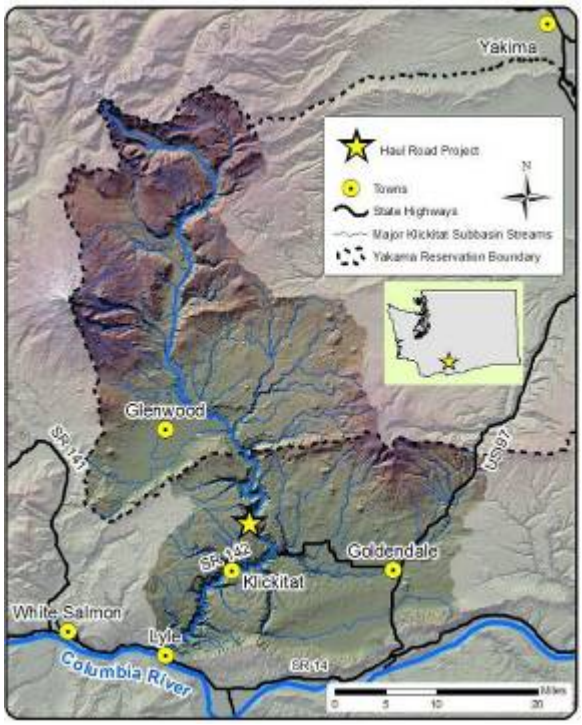

Figure 8. Klickitat River Restoration site location (star) within Klickitat watershed.

Project Goal: 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. Activities completed during Phase 2 were the enhancement and restoration of 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. Once road removal and grading, and habitat enhancement features were completed roughly 7.5 acres of riparian and floodplain habitat were revegetated. Phases 3 and 4 cumulatively removed 3.25 miles of asphalt, restored access to 9.75 acres of floodplain, removed 14 culverts (one on a

seasonal fish-bearing tributary), placed 45+ pieces of wood placed for floodplain roughness, and restored hillslope interaction.

2014 activity: Project planning, administration 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 5. KWEP staff determined stationing for road segments delineated during the geomorphic assessment (Conley and Lindley 2012) and performed lay-out prior to soliciting bids for phase 5. An application for Phase 6 of the Haul Road co-sponsored by CLT and the YN was submitted during the 2014 SRFB grant round. Local project review is performed by two subcommittees of the Klickitat Lead Entity. The local technical committee ranked the Haul Road Phase 6 first on a list of potential projects. However, the Citizens Review Committee ranked the project second due to a time-sensitive conservation easement proposal in Rock Creek (Eastern Klickitat County). There were not sufficient funds to fund both projects, so the Haul Road Phase 6 was put forth as an alternate*.

*In early 2015 it was determined that the landowner was unwilling to go forward with the Rock Creek conservation easement, and thus the funds were reallocated to the Haul Road Phase 6 project. Due to the delayed notification, Phase 6 will not be implemented until Spring/Summer 2016 at the earliest.

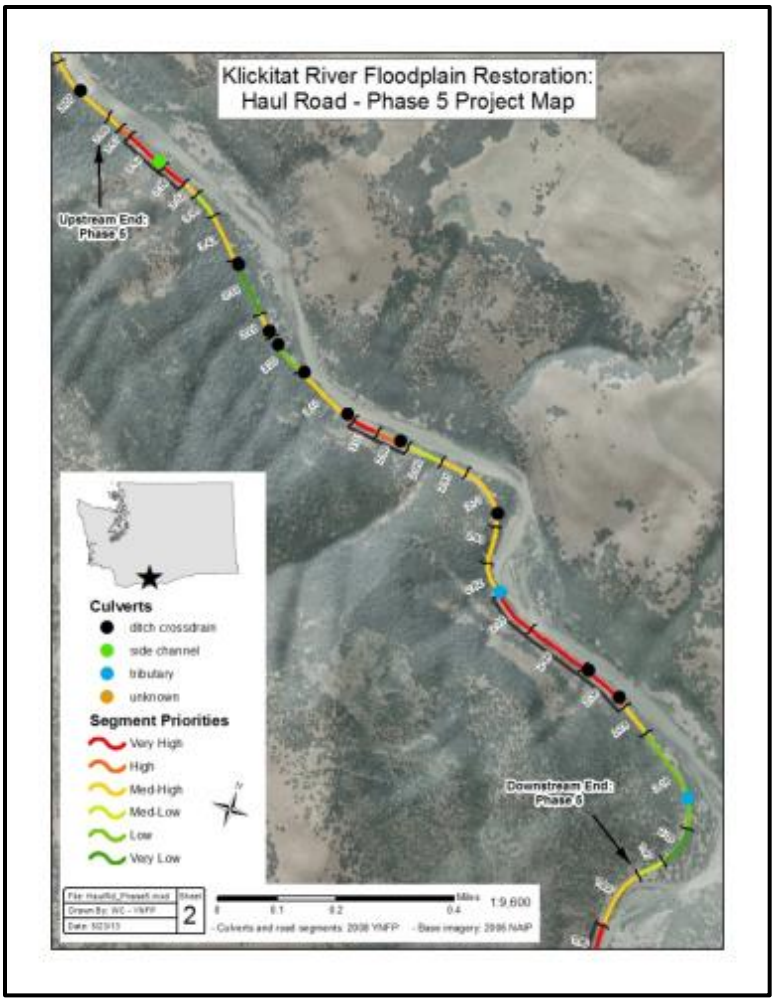

Figure 9. Klickitat River Floodplain Conservation and Restoration (Haul Road) - Phase 5 Project Map.

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. Additionally, the YN hydrologist provided field oversight of construction activities and directed fit-in-the-field implementation.

Construction – Construction activities took place August-October 2014. The project was suspended in October in order to ease concerns from local river users regarding short-term turbidity spikes resulting from construction activities. Phase 5 was approximately 60% complete when the project was shuttered and heavy equipment demobilized for the year. Construction activities will resume in 2015 following coordination (YN, CLT, DNR and WDFW) and discussion on timing of a suitable "fish window".

Activities completed in 2014:

- Asphalt grinding and hauling completed
- Finish-grading and erosion control on ~2000 l.f. completed
- Excavation and grading of ~750 l.f. high-flow channel

- Two log jams constructed
- Completed ~1150 l.f. of in-water work including 600 l.f. of bedrock exposure
- Completed ~500 l.f. of pullback
- Completed ~700 l.f. of regrading
- Seeding and erosion control completed for all areas

Figure 10. Example of daylighting of bedrock feature, pre- (left) and post-project (right).

Manage Native Plant Nursery

KWEP personnel constructed a small nursery at the Klickitat Field Office (KFO) in Wahkiacus, WA in 2006 to reduce the costs associated with revegetation efforts, have a supply of locally sourced plants, and generate a source of in-kind match for grant-based funds. The nursery consists of constructed wooden frames sized appropriately to hold treepot style containers (Stuewe & Sons, Corvallis, OR). Live cuttings are harvested from native hardwoods each spring prior to leaf-out, cut to size, and rooted in a planting medium in treepot containers. Plants are then irrigated 3 times weekly throughout the growing season and are typically out-planted the same year. The nursery has the capacity to grow 3,600 containerized plants within treepots with additional irrigated space to house purchased plants or holdovers from a previous growing season. In 2014 approximately 2,500 plants were grown at the KFO nursery. Containerized plants are typically a mix of pine (*Pinus ponderosa*), rose (*Rosa nutkana*), redosier dogwood (*Cornus sericea,* willow (*Salix scouleriana*), red alder (*Alnus rubra*), black cottonwood (*Populus trichocarpa*) and Douglas' spirea (*Spiraea douglasii*). All plants grown at KFO in 2014 were planted at the Haul Road Phase 4 & 5 in the spring of 2015.

Figure 11. Nursery at Klickitat Field Office.

Invasive Plant Control

Typically, sites selected for restoration or enhancement projects have a history of disturbance or perturbation. As a result, non-native vegetation is present to some degree and poses a potential threat to be "released" once soils are disturbed during construction activities. In order to prevent this spread and to afford native plants the opportunity to become established, KWEP personnel make annual visits to project sites both pre- and post-treatment to monitor and control invasive plants.

Site visits were made to fourteen completed project sites (63.75 acres) in 2014 in order to control the spread of weeds. 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. On-Reservation, the Yakama Nation currently has a no-spray policy, thus hand removal is conducted. Off-Reservation, KWEP consults with Klickitat County Noxious Weed Board staff in order to develop the most effective strategy.

Tributary Habitat RM&E

Habitat Enhancement Project Monitoring

KWEP staff annually visit past project sites to photo-monitor performance of treatments implemented since 2002. Photos are taken at specific points within project areas that are typically linear in planform. Either prominent landmarks (trees, rocks, stumps) or stations along the stream continuum are used to reorient/relocate photo points. A photo record facilitates comparisons between and among years to determine whether changes have occurred over time. Photos used throughout this document are a result of photo documentation at project sites over time.

All photos taken as part of photo-monitoring are saved digitally, filed electronically in subdirectories by their respective project name and stored on the KWEP server. Examples of photographic comparison

pre- and post-project are presented in the Tributary Habitat Restoration and Protection section of this report.

Streamflow Monitoring

KWEP, cooperatively with Klickitat M&E and the YN Water Program (YNWP), monitors stream flow throughout the Klickitat sub-basin. Cooperative activity during 2014 included twenty-eight instantaneous discharge measurements for use in rating curve development (Table 1 and 2).

KWEP staff operated stream gages with continuous dataloggers at fourteen sites during the reporting period. Two new sites were established by KWEP (Dillacort and Snyder Creeks). Site establishment entailed installation of a staff gage (for manual observation of stage elevation) and sensor / data-loggers (to record continuous water surface elevation and water temperature). A total of eighty-nine visits were made to fourteen sites with data loggers for installation, data download and field calibration (KWEP). Activities conducted at all eighteen sites are summarized in Table 1.

Table 1. Services performed by KWEP and YNWP at 18 stream gaging sites in the Klickitat subbasin during 2014.

Site	Q	Staff Read	Crest Read	Staff Install	Sensor Install	Download	Maint.	Repair	Survey	Total Visits
Big Muddy Creek @ 255 x-ing		7				3	7		1	7
Dillacort Creek	2	13		2	1	4			2	13
East Fork Tepee Creek	1	1					1			1
Klickitat River @ Klickitat Hatchery		1				1	1			2
Klickitat River blw Summit Ck		5				3	4			5
Klickitat River @ Wahkiacus		9				9	1			9
Logging Camp Creek	4	8				2	1			11
Piscoe Creek nr mouth	1	1					1			1
Snyder Creek	1	4		1	1	1				4
Summit Creek nr mouth	3	11	1			4	3			11
Surveyors Creek	1	1	1							1
Swale Creek nr mouth	4	9				3	5			9
Tepee Creek abv. 175 Rd	1	9				8	3			9
Tepee Creek abv. IXL Rd	1	6	1			5	1			6
Wheeler Creek	2	7				2				7
White Creek abv. IXL	1	1	1				2			2
White Creek @ Cedar Valley Rd	3	3							1	3
White Creek nr mouth	3	8	3			3	3			8
Grand Total	**28**	**104**	**7**	**3**	**2**	**48**	**33**	**0**	**4**	**109**

Table 2. Data collected by YNWP personnel at sites which KWEP operates continuous dataloggers.

Site	Date	Stage	Discharge
Summit Creek nr mouth	2/20/2014	5.81’	78.0 cfs
Summit Creek nr mouth	3/4/2014	5.62’	61.0 cfs
Summit Creek nr mouth	5/16/2013	5.58’	54.7 cfs
Swale Creek nr mouth	3/4/2014	3.55’	68.0 cfs
Swale Creek nr mouth	3/4/2014	3.53’	70.0 cfs
Swale Creek nr mouth	3/11/2014	3.69’	92.8 cfs
Swale Creek nr mouth	4/7/2014	2.52’	6.2 cfs
Tepee Creek abv. IXL Road	4/29/2014	4.18’	5.0 cfs
Tepee Creek abv. 175 Road	5/13/2014	0.90’	3.8 cfs
White Creek nr mouth	3/4/2014	2.32’	71.0 cfs
White Creek nr mouth	4/14/2014	2.35’	68.9 cfs

Figure 12. New streamflow gaging station installed in 2014 on Snyder Creek, a Klickitat River Tributary.

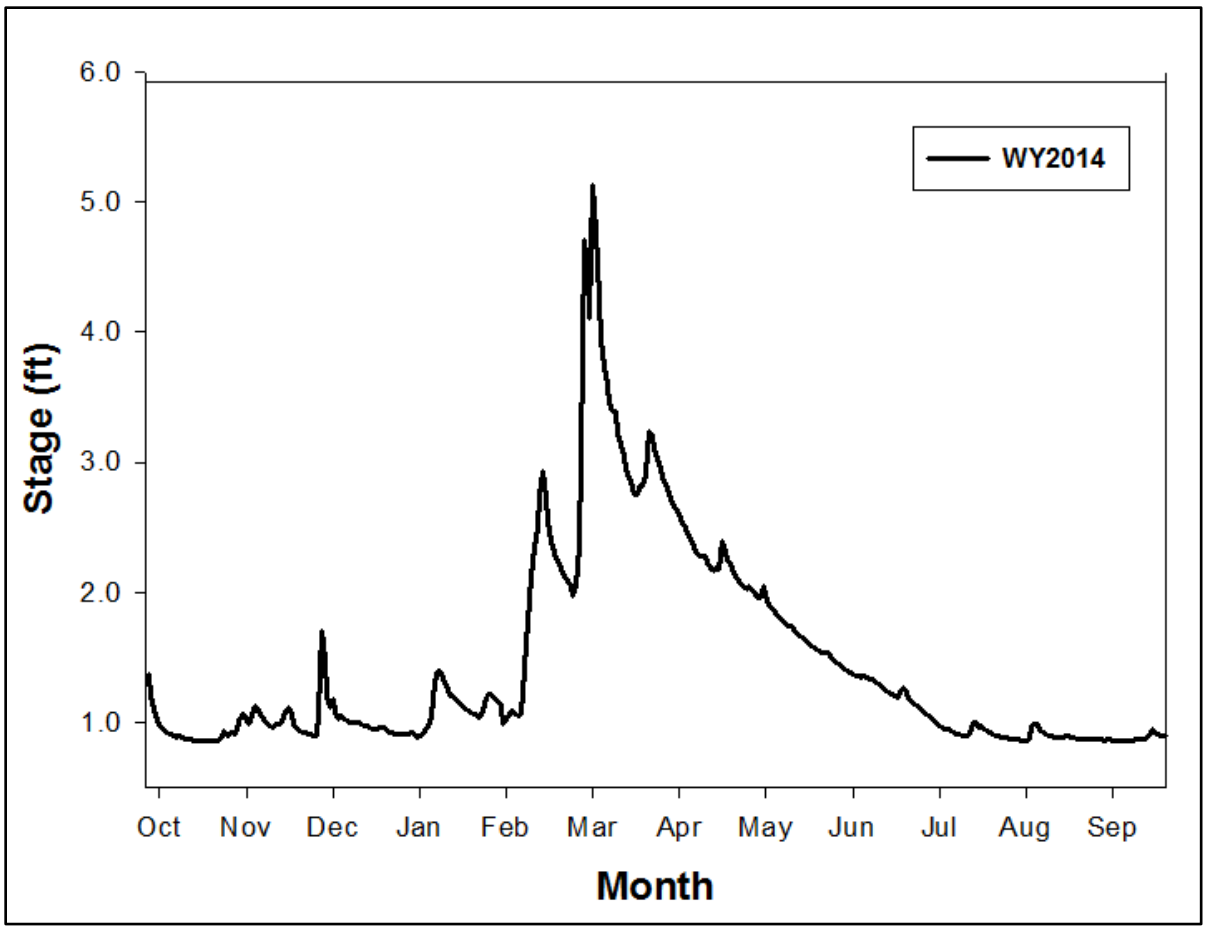

Figure 13. White Ck stage at the gaging site near the confluence with the Klickitat River for Water Year 2014.

Conduct Food Web Study on Tepee and White Creeks (Effectiveness Monitoring)

The objective of the study is to examine how instream restoration efforts along a 0.7-mile section of Tepee Creek affect aquatic and terrestrially derived invertebrate prey sources and the diet of residualized *Oncorhynchus mykiss* and juvenile steelhead. Sampling has occurred and will continue on Tepee and White Creeks. Specific objectives of the study include the following:

- Quantify riparian habitat conditions in treatment and control reach sample sections.
- Compare invertebrate abundance, biomass and composition from benthic, drift, and allochthonous sources among treatment and control reach sample sections.
- Compare fish diet (abundance, biomass and composition) among treatment and control reach sample sections.
- Evaluate seasonal variation in prey availability and diet of residualized *Oncorhynchus mykiss* and juvenile steelhead trout in sub-reach sample sections.

Methods

Study Area

Tepee Creek, a tributary to White Creek, is one of the major tributaries supporting natural production of steelhead in the Klickitat subbasin. The White Creek watershed is 138 square miles in area. Elevations range from 1140 to 5100 ft.; most of the watershed lies between 2500 and 3300 ft. in elevation. Average annual precipitation is between 20 and 29 in., with roughly half falling as snow. Current habitat conditions in Tepee Creek and White Creek reflect past riparian timber harvest and road construction throughout the drainage. Instream large woody debris (LWD) levels are low in some reaches, and base flows are very low to non-existent in many reaches. Changes in channel morphology are attributable to numerous landscape-level activities such as livestock grazing, road interactions, up-slope timber harvest, and in some locations, historic removal of instream LWD.

Study reaches are located on Tepee Creek (treatment) and White Creek (control). There are four sample sections within each reach. The control and treatment study reaches have similar drainage areas and channel morphology. Sample section lengths range from 61-101 m in Tepee Creek and 80-107 m in White Creek. Bankfull widths ranged from 10.7-26.1 m and 16.3-28.8 m in Tepee Creek and White Creek, respectively. Pool-riffle sequences characterize sample sections.

During 2014, two components of the Food Web Study were sampled: fish abundance and shallow groundwater. Annual fish abundance sampling was conducted in June 2014 by the Klickitat M&E project as part of the broader White Creek PIT tag study. KWEP staff monitored groundwater elevations throughout 2014 via physical measurements and continuously deployed dataloggers (Figs. 10 and 11).

Fish abundance

In partnership with M&E staff, juvenile *O. mykiss* (Steelhead/Rainbow trout) populations are estimated using a multiple-pass electroshocking technique. In each sampling event, a multiple-pass electrofishing survey is conducted in each of the four Tepee (treatment) and White Creek (control) reaches. All juvenile steelhead and rainbow trout greater than or equal to 65 mm in length are tagged with a Passive Integrated Transponder (PIT) tag and have length and weight measurements 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.

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. 12). 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 13. In-stream construction was initiated in October 2012 and completed in November 2013. Continuous groundwater elevation data from 2014 in Wells 1, 5, and 6 reveal a prolonged period of raised ground water elevations (approx. 8 months), followed by a recession in October to base level elevations. Similar time periods in 2010-2012 show brief periods of elevated groundwater followed shortly by a receding limb of the hydrograph. The data suggest that water is being stored within the project reach as groundwater, but does not persist year-round, and may not necessarily be expressed within the reach as surface flow in Tepee Creek.

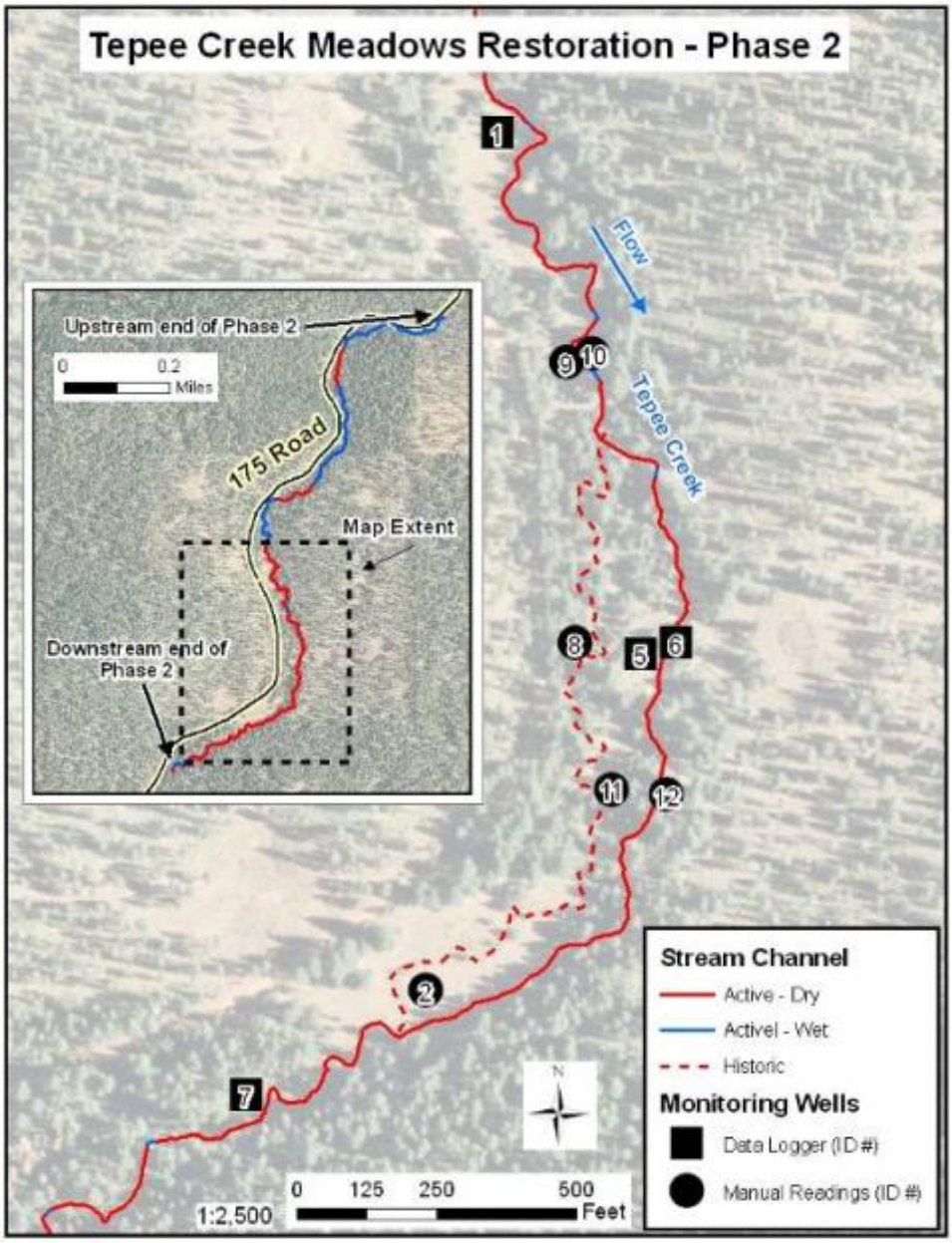

Figure 14. Distribution of monitoring wells and the portions of Tepee Creek with perennial water as observed on September 21, 2009.

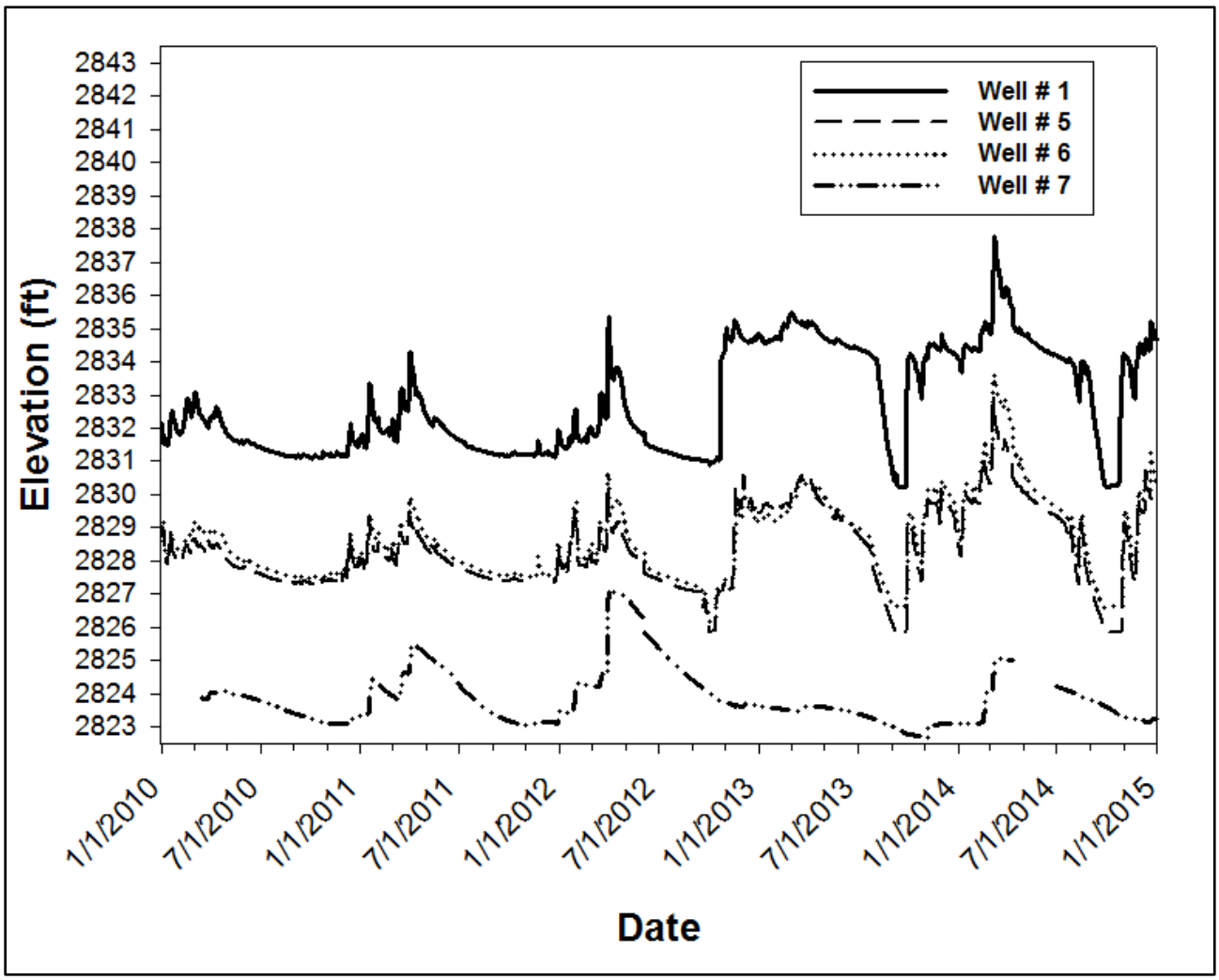

Figure 15. Groundwater surface elevations by date for wells 1, 5, 6, (treatment) and 7 (control) for 2010-2014.

Habitat Assessment

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

- Determine the effectiveness of habitat enhancement projects by quantifying differences between pre- and post-project aquatic habitat conditions.
- Expand the spatial extent of known baseline conditions within the anadromous-bearing portion of the Klickitat subbasin.
- Identify 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 trends 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 (Pleus et al. 1999, and Schuett-Hames et al. 1999) and the Aquatic Inventory Project (Moore et al. 2010). 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 geomorphic 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.

In the spring of 2014, one Klickitat River tributary, Swale Creek, was surveyed via the RAHAP methodology. The survey was conducted in mid-May as the water level in this seasonal tributary was beginning to recede. Approximately 8.1 kilometers were surveyed prior to the crew encountering long stretches of dry channel. The surveys were discontinued on May 21, 2014 and will be resumed at a later date because the upstream extent of anadromy extends beyond what was surveyed in 2014. Swale Creek was selected due to large contributing drainage area, its watershed position (RKM 28.1) and documented usage by multiple species of salmonids. The size of the drainage and timing of surveys necessitated multiple survey crews working concurrently.

In the late summer of 2014, another Klickitat River tributary, Summit Creek, was surveyed via the RAHAP methodology. The anadromous-bearing portion of Summit Creek is approximately 2km and was surveyed in three days (9/15-9/17/14). Summit Creek was selected to be surveyed because it is a perennial tributary and due to its position in the Klickitat watershed (RKM 59.9).

In comparison, the two tributaries surveyed in 2014 are quite different in respect to average habitat unit area, pool depth, number of LWD pieces, and presence of LWD jams. Summit and Swale creeks have similar average habitat unit areas when all habitat types are lumped. Pool area in Swale Creek is five times greater than that in Summit Creek on average, but the pools in Summit Creek are 0.22m deeper

on average than in Swale Creek. There is one fewer pool per kilometer on Summit Creek (Table 3, Figs. 16 & 17). Pools in Swale Creek are quite large and deep, but generally lack cover other that than provided under and around boulders.

Large woody debris jams occur at a rate slightly less than 1 per kilometer on Swale Creek (0.85/km) but barely meet the minimum criterion of being comprised of 10 or more individual wood pieces (average 11.8/km). LWD jams were non-existent on Summit Creek. There are nearly twice as many LWD pieces per kilometer on Summit Creek, and piece volume is 2.5x greater than that observed in Swale Creek (Table 4). The riparian forest on Swale Creek is composed of small-diameter deciduous trees (Fig. 18), whereas Summit Creek is bordered by a mature coniferous forest. The presence of beaver and beaver-engineered features was noted at several points along Swale Creek (Fig. 19).

Bedrock is an important pool-forming and channel-influencing feature in the Klickitat subbasin. On Summit Creek, bedrock was present along 260.2 meters of stream length or 12.4% of the overall length. The extent of bedrock was comparable on Swale Creek: 11.6% of overall length or 939.2 total meters.

Figure 16. Typical swiftwater habitat (left) and lower gradient glide habitat (right), Summit Creek.

Figure 17. Bedrock slide, upstream extent of RAHAP survey on Summit Creek.

Table 3. Summary of aquatic habitat inventory data collected May and September 2014. Parentheses denote values from side channels.

Purpose	Survey Date	Stream	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)
Baseline Survey of Section with Anadromy	**9/15-17/2014**	**Summit Ck**	**2,133.1**	**9476.95**	**7.2**	**3.25**	**121.50**	**6.1**	**0.85**
Baseline Survey of Section with Anadromy	**5/14-5/21/2014**	**Swale Ck**	**8,157.6 (982.9)**	**44,280.6 (2194.0)**	**13.4 (6.8)**	**4.77 (2.3)**	**141.02 (43.9)**	**7.1 (9.1)**	**0.63 (0.31)**

Table 4. Summary of Large Woody Debris (LWD) and LWD Jam inventory data collected May and September 2014. Parentheses denote values from side channels.

Purpose	Survey Date	Stream	Total Survey Length (m)	Total Survey Area (m^2)	# LWD Pieces (pieces/km)	Average LWD Piece Volume (m^3)	# LWD Jams (jams/km)	# Jam Pieces (pieces/km)
Baseline Survey of Section with Anadromy	**9/15-17/2014**	**Summit Ck**	**2,133.1**	**9476.95**	**24.2**	**3.62**	**0**	**0**
Baseline Survey of Section with Anadromy	**5/14-21/2014**	**Swale Ck**	**8,157.6 (982.9)**	**44,280.6 (2194.0)**	**13.95 (6.06)**	**1.42 (1.04)**	**0.85 (2.0)**	**11.8 (37.6)**

Figure 18. Alder-lined uniform habitat in Swale Creek (left) and the upper extent of RAHAP surveys, point where active channel went dry in mid-May (right).

Figure 19. Pool habitat in Swale Creek (left) and recent beaver dam-building activity (right)

Collect water surface elevation data - Klickitat/Columbia River Confluence (Klickitat Delta Assessment)

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 Inter-Tribal Fish Commission (CRITFC).

During the reporting period, the sensor array installed in August of 2009 was operated continuously (Fig. 20). Data collection was primarily monitored via a File Transfer Protocol (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 that dictated site visits for troubleshooting purposes. Additional site visits were conducted to collect staff gage observations during a range of stages (Fig. 20) to establish stage reference points. These reference points are utilized to quality-control data collected by deployed sensors.

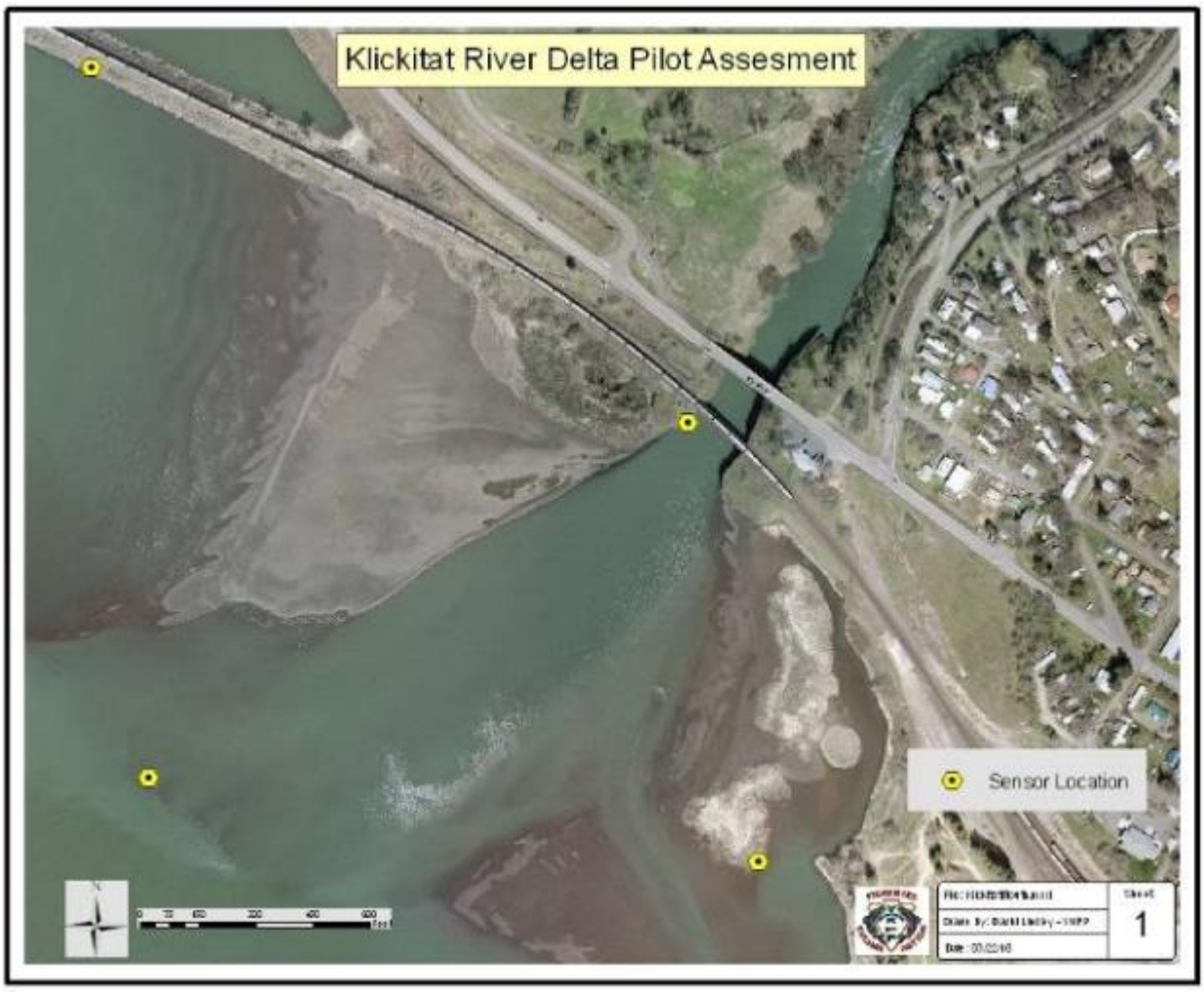

Figure 20. Locations for sensors sampling water temperature, water surface elevation, wind direction, and wind speed for the Klickitat River delta.

Several site visits were conducted to the East Delta site during 2014 to change out the 12-volt marine battery. The configuration of two solar panels was unable to maintain a voltage in excess of 11 volts.

Encroaching vegetation and low light exacerbated this situation. In September 2014, a third solar panel was added to the mast (Fig. 18), which resolved the power consumption issue.

Figure 21. Mast and three-solar-panel array at East Delta (left) and February icing conditions.

Figure 22. Klickitat River Delta under low Bonneville Pool and turbid conditions as observed on August 14, 2014.

Measure turbidity timing and duration associated with Big Muddy Creek

Big Muddy Creek is a Klickitat River tributary that originates on the south-eastern flank of Mt. Adams and is a known source of debris flows. In the past, debris flows have contributed to salmonid mortality observed in the mainstem Klickitat River. In 2011, a data collection effort was initiated to document patterns associated with runoff production and sediment generation. Data will be utilized to inform decision-making regarding location and type of enhancement projects to be implemented. Dependent upon the duration of the data collection effort, longer-term trends regarding the timing, duration and frequency of turbidity events may be characterized. In the future, as time and budget permits,

suspended sediment may be measured to develop a rating curve between observed turbidity and suspended sediment loads.

In 2013, KWEP staff installed telemetry equipment at two existing sites to facilitate remote data transmission (Big Muddy Ck @ 255 rd x-ing and Klickitat River ds of Summit Ck). Due to the remoteness of the sites and critical nature of having functioning equipment during episodes of increased turbidity, remote monitoring is made possible via the GOES satellite network. Data are accessed via the Web multiple times a week to ensure the station is functioning properly. The turbidity-monitoring network was utilized by construction and project managers to monitor turbidity resulting from construction activities at the Haul Road Phase 5 during late summer and fall 2014. The long-term status-and-trend turbidity dataset that this network provides allows managers to compare the short-term, lower magnitude turbidity events resulting from Haul Road deconstruction to naturally occurring, longer-duration, higher-magnitude turbidity events. In 2014, the two telemeterized sites functioned well without interruption of data collection or transmission.

Figure 23. Naturally occurring summer turbidity event on the Klickitat River, July 16, 2014, as observed from Horseshoe Bend Rd Bridge, Wahkiacus, WA.

Education and Project 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 made one presentation at a conference in 2014 and conducted multiple field tours for various audiences. 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 authored one presentation delivered at the Klickitat and White Salmon Rivers (Columbia Gorge) Fisheries and Watershed Science Conference in 2014 entitled: "Development of a Customized Software Application to Increase Project Efficiency".

ACKNOWLEDGEMENTS

Michael Babcock - Data Manager, Yakama Nation Fisheries Program (YKFP)

Jamie Brisbois - Bookkeeper, Yakama Nation Fisheries Program (FRM)

Jeanette Burkhardt – Watershed Planner, Yakama Nation Fisheries Program (YKFP)

Lindsay Cornelius – Stewardship Lead, Columbia Land Trust

Ralph Kiona - Watershed Technician, Yakama Nation Fisheries Program (YKFP)

Scott Ladd – Hydrologist, Yakama Nation Water Program

Deanna Lamebull - Bookkeeper, Yakama Nation Fisheries Program (YKFP)

Nicolas Romero - Fisheries Biologist, Yakama Nation Fisheries Program (YKFP)

Ian Sinks – Stewardship Manager, Columbia Land Trust

IV. References

Conley, W. and D. Lindley. 2012. Klickitat Watershed Enhancement Project: Annual Report for January 1, 2008 to December 31, 2008. Project No. 1997-056-00. Prepared for Bonneville Power Administration, Portland, OR.

Klickitat Lead Entity (KLE). 2012. Klickitat Lead Entity Region Salmon Recovery Strategy. Available online at: http://www.klickitatcounty.org/NaturalR/FilesHtml/SalmonHabitatRecovery/Klickitat%20LE%20Strategy%205-22-12%20Draft%20for%202012%20Grant%20Round.pdf

LeMier, E., H. Wendler, and L. Rothfus. 1957. Stream Appraisal of Klickitat River Above Castile Falls: July 25-26, 1957. State of Washington, Department of Fisheries.

Lindley, D. 2014. "Proactive Contract Management Through the Development of a Customized Software Application." Invited presentation Klickitat and White Salmon Rivers Fisheries and Watershed Conference, April 15, 2014. Columbia Gorge Discovery Center, The Dalles, OR. http://ykfp.org/klickitat/SciCon/SciCon14/Presentations/14_Lindley_041014.pdf

Moore, K. K. Jones, J. Dambacher, and C. Stein. 2010. Aquatic Inventories Project: Methods for Stream Habitat Surveys. Oregon Department of Fish and Wildlife, Aquatic Inventories Project, Conservation and Recovery Program, Corvallis, OR 97333.

Northwest Power and Conservation Council (NPCC). 2004a. Klickitat Subbasin Plan. http://www.nwcouncil.org/fw/subbasinplanning/klickitat/plan/.

Pleus, A.E., D. Schuett-Hames, and L. Bullchild. 1999. TFW Monitoring Program methods manual for the habitat unit survey. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-00-003. DNR #105.

Romero, N. and D. Lindley 2012. Rapid Aquatic Habitat Assessment Protocol Methods for Stream Inventory Surveys. Version 1.0, February 2012.

Roper et. al 2010. A Comparison of the Performance and Compatibility of Protocols used by Seven Monitoring Groups to Measure Stream Habitat in the Pacific Northwest. North American Journal of Fisheries Management. American Fisheries Society 2010.

Schuett-Hames, D., A.E. Pleus, J. Ward, M. Fox, and J. Light. 1999. TFW Monitoring Program method manual for the large woody debris survey. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-00-004. DNR #106.

Schuett-Hames, D., A.E. Pleus, and D. Smith. 1999. TFW Monitoring Program method manual for the salmonid spawning habitat availability survey. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-00-007. DNR #109. November.