Klickitat Watershed Enhancement Project

Annual Report for October 1, 2006 – September 31, 2007

BPA Project # 1997-056-00

BPA Contract # 31268

Prepared By:

Will Conley
Watershed Restoration Specialist

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

Prepared For:

Sabrina Keen, COTR
U.S. Department of Energy
Bonneville Power Administration
Fish and Wildlife Program

Submitted: April 7, 2008

TABLE OF CONTENTS

SUMMARY

The Klickitat Watershed Enhancement Project (KWEP) works to restore, enhance, and protect watershed function within the Klickitat subbasin. Project work emphasizes 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 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, 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 state, federal, tribal, and private entities.

Highlights of the October 1, 2006 – September 30, 2007 reporting period

- Completion of topographic surveys for 3 sites :
  - Little Muddy Cr. / Mt. Adams Lake Road
  - White Cr. / IXL Road
  - Swale Creek (RM 2.0) restoration

- Completion of designs for 8 sites (to be constructed during FY08):
  - Lower Klickitat Re-vegetation (Phase 2)
  - Upper Klickitat River Restoration Project (Phase 2 - Reach 1)
  - Upper Klickitat River Restoration Project (Phase 2 - Reach 3)
  - Upper Klickitat River Restoration Project (Phase 2 - Reach 4)
  - White Cr. / IXL Rd. replacement
  - Tepee Cr. / IXL Rd. replacement
  - EF Tepee Cr. / 175 Road replacement
  - Tepee Cr. / 175 Road replacement

- Construction of the Tepee Creek / IXL Meadows Restoration Project
  - Reconstruction of pool-riffle sequences along 1890’ of channel to raise bed elevation 3’
  - Removal of 2 culverts and related fill from an abandoned cross-valley road alignment
  - Restoration of access to four side channels totaling 835 lineal feet
  - 28 LWD jams constructed
  - Several dozen floodplain LWD placements
  - 2 acres of re-vegetation
  - 7.8 acres of weed control

INTRODUCTION

The Klickitat Watershed Enhancement Project (KWEP) enhances and restores watershed health in the Klickitat River subbasin. Project actions target stream reaches and watersheds that support steelhead (*Oncorhynchus mykiss*; ESA- listed as "Threatened") and/or spring Chinook (*O. tshawytscha*). Implemented by the Yakama Nation Fisheries Program (YNFP) and funded by Bonneville Power Administration, KWEP addresses habitat goals of the Yakima/Klickitat Fisheries Project (YKFP) as well as the Columbia Basin Fish & Wildlife Program of the Northwest Power and Conservation Council. KWEP is the principal project addressing salmonid habitat conservation and restoration in the Klickitat subbasin.

KWEP works to restore, enhance, and protect watershed function within the Klickitat subbasin. Project work emphasizes restoration and protection in watersheds and reaches that support native salmonid stocks, particularly steelhead (*Oncorhynchus mykiss*; listed as "Threatened" within the Mid-Columbia ESU), spring Chinook (*O. tshawytscha*) salmon, and bull trout (*Salvelinus confluentus*; ESA "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 (*O. kisutch*) salmon, 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 preventing degradation. Since 90% of the off-reservation project area is in private ownership, maximum effectiveness is accomplished via cooperation with state, federal, tribal, and private entities. KWEP addresses goals and objectives presented in the Klickitat Subbasin Plan, Klickitat Lead Entity Strategic Plan, and the 1994 NPCC Fish and Wildlife Program.

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

- correction of fish barriers at 3 sites restoring access to over 11.5 miles of habitat
- enhancement of over 7400' of stream including construction of 57 LWD jams
- installation of at least 9,000 plantings along 8,000' of stream
- fencing of over 10,000' of stream
- restoration of high-flow access to over 800 lineal feet of side channels
- monitoring streamflow at 13 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 10 projects resulting in:

- conservation 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 3400' of stream
- installation of at least 14,000 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

Current projects involve:

- replacement of 3 passage barriers that will restore access to over 5 miles of habitat
- treatment of over 2000 feet of road to restore access to 0.5 miles of side channels
- riparian re-vegetation of over 5000 plantings on 5 acres
- enhance over 3500 feet of active channel and restore access to over 4500 feet of side channels

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)

PROJECT GOALS

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:

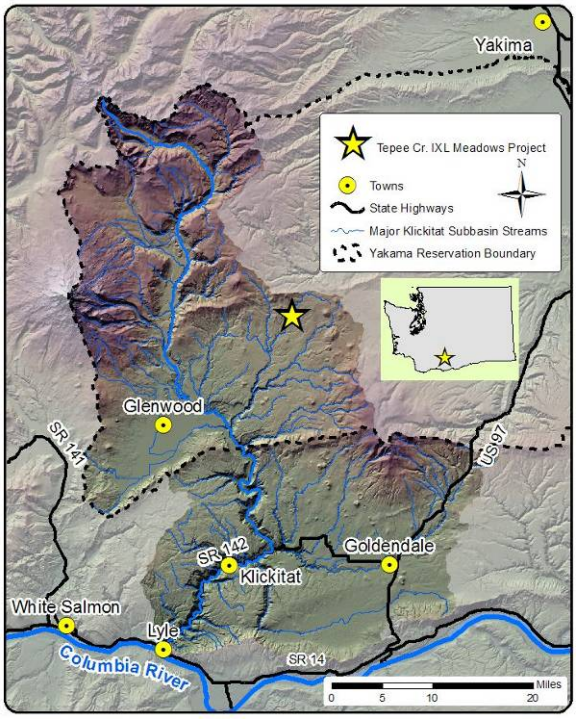
- *Assessment* of watershed and habitat conditions to prioritize sites for restoration activities. This involves data collection, compilation, and review of existing as well as historic habitat and watershed conditions. Identification and filling of data gaps is also a component of KWEP.

- *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 conditions to assess 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.

FEATURED FY2007 PROJECTS

Tepee Creek - IXL Meadows Restoration Project



Introduction: The project addresses limiting habitat features (bed degradation and pool structure) identified by the Subbasin Plan and KLESRS along 2000 feet of Tepee Creek. 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, the White Creek watershed has accounted for up to 40% 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; however in most years it likely accounts for between 5 and 10%. Extensive reaches of Tepee Creek have become incised and are now intermittent in many places that anecdotal information suggests were once perennial.

Site and Watershed Description: The project reach consists of 2000 feet of Tepee Creek immediately downstream of the IXL road crossing. The site is at 2965' elevation. The upper 40% of the project area is meadow and ponderosa pine parkland. The lower 60% of the project area is 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. Faulting along the northern margin of the watershed has generated steeper slopes that increase weathering rates and help generate the meager gravel supply for the watershed. Soils and banks are cohesive with a prevailing clay loam texture. Soils classify as aquandic Haploxeralfs and have a thin (4") A horizon (~20% clay), multiple Bt horizons (30 – 38% clay), and are typically 5' – 6' deep over a lag of sub-angular gravels embedded in a clayey matrix.

Fisheries Significance: Tepee Creek provides spawning and rearing habitat for ESA-listed ("threatened") Middle Columbia River steelhead. On average, Tepee Creek accounts for 6.3% 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. The project reach is incised, which has contributed to marginal spawning habitat and poor rearing conditions. The project reach dried up in 4 out 5 years preceding project implementation. Stranding and subsequent mortality of juvenile *O. mykiss* was a routine pre-project occurrence when the reach dried up (usually in early July). Summer freshets have been observed to create continuous surface flow through the reach. In one instance (August of 2004), flow reappeared temporarily (for 2-3 days)

in the reach, prompting juvenile migration from upstream reaches and resulted in a second round of stranding/mortality for at least three age classes of *O. mykiss* within a single season.

The primary mechanism for incision was initiated when an undersized bridge ½ mile downstream plugged causing Tepee Creek to capture the adjacent floodplain road. Headward migration of the incision propagated upstream until it was arrested by the culvert inverts at the upstream end of the project reach. Incision occurred largely within the planform of the historic channel, though there are a number of locations where meanders were cut off. Hydraulic modeling of pre-project conditions indicated that a 10-year recurrence flood was required for overbank access. Modeling correlated well with field indicators that suggested the channel had incised three to four vertical feet.

A secondary mechanism for incision is related to increased peak flows. The hydrologic effect of forest roads on peak discharges was modeled (using HEC-HMS) for a portion (~6.5 square-miles) of the contributing watershed in 2003. The model showed a 7.3% increase in discharge for a 2.5-year storm event due to forest roads. Unto itself, this increase creates additional energy resulting in additional erosive force on the stream bed and banks. The effect is compounded by the limited generation of bedload-sized material by the watershed (discussed above) because the weathering and delivery rate of gravels isn't keeping pace with the rate at which they are transported through and moved out of the system. Road drainage and decommissioning treatments are being implemented in the watershed as part of a separate project.

Hydrology: The Tepee Creek watershed has very challenging hydrology. Peak flows are driven by rain-on-snow events during the winter which tend to generate larger unit discharges than either snowmelt or purely rainfall-generated peaks. However, base flows (where they exist) are only 10 to 30 gallons per minute (gpm). Consequently, design must accommodate very high unit discharges while also providing habitat at low flows. At the time the project was designed, Tepee Creek was ungaged. In the one pre-project year (2006) where streamflow for the reach persisted through the summer, base flow was measured at the outfall of the culverts at the head of the reach and ranged between 10 and 12 gpm. Peakflow hydrology was estimated using regional regression equations developed by the USGS (Sumioka et al. 1997).

Table 1. Peak discharges calculated for the Tepee Cr. / IXL Meadows Project reach.

Recurrence Interval (yrs)	Region 6 USGS Equation Results	
	Discharge (cfs)[a]	Discharge (cfs)[b]
2	112.8	165.2
10	331.4	414.2
25	496.4	585.1
50	643.8	730.5
100	816.9	895.7

[a] using 17.4" MAP correlated with HEC-HMS model
[b] using 25.6" MAP from nearby RAWS station

Equations for this area require drainage area (in square-miles) and mean annual precipitation (MAP, in inches) for inputs. Drainage area was calculated based on a 10m Digital Elevation Model in ArcInfo.

Flows were calculated using two different MAP values: 1) from a weather station (RAW network) located approximately 3 miles from the site and 2) back-calculated from the HEC-HMS results.

The regression-calculated flows were linearly adjusted to the 2.5-year discharge calculated by the HEC-HMS study, then were applied on a unit basis to the drainage area of the treatment reach. Because of the disparity between the two values, a sensitivity analysis was conducted to evaluate the difference relative to existing overbank flow frequency (Table 2). The analysis indicated a 10-year flow event (for either method) was necessary to generate overbank flow for the pre-project channel.

Table 2. Results of pre-project overbank frequency analysis for 14 cross-sections within the Tepee Creek / IXL Meadows Project reach.

Modeled Cross-section	HEC-HMS Correlated Data MAP = 17.4" Q_{10}=331 cfs		Tepee Precip. Station Data MAP = 25.6" Q_{10}=414 cfs		Percent Difference
	Flood Width (ft)	Condition	Flood Width (ft)	Condition	
1668	19.2	In channel	19.9	In channel	4%
1586	22.1	In channel	23.0	In channel	4%
1495	38.1	In channel	40.4	In channel	6%
1378	20.8	In channel	23.5	In channel	13%
1252	21.1	In channel	24.1	In channel	14%
1034	18.4	In channel	19.2	In channel	4%
810	28.4	In channel	29.5	In channel	4%
606	50.0	On floodplain	64.8	On floodplain	30%
505	27.9	In channel	28.5	In channel	2%
338	56.2	On floodplain	69.2	On floodplain	23%
277	21.7	In channel	30.3	On floodplain	40%
234	27.8	In channel	34.6	On floodplain	24%
174	27.5	In channel	74.4	On floodplain	171%
53	23.8	In channel	26.3	In channel	11%

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

Design: The conceptual intent was to raise the streambed elevation to regain floodplain storage and restore overbank flow frequency. The basic approach employed was to import gravels and reconstruct pool-riffle sequences through the project reach. Large Woody Debris (LWD) was used to enhance pool quality and longevity as well as moderate bank erosion. The majority of design work occurred in 2005 and early 2006. The design team included the KWEP staff hydrologist and a geomorphologist and engineer from Interfluve, Inc.

A topographic survey of the site was conducted that focused on topographic breaks that produced the greatest influence on hydraulic conditions. The survey focused on the active with less detail on the adjacent floodplain. Sixty-one channel cross sections were generated from topographic survey data. The sections were imported to a one-dimensional hydraulic model (HEC-RAS) to represent approximately 2000 lineal feet of stream channel and adjacent floodplain.

A reach was identified approximately ¼ mile upstream of the treatment reach that appeared to represent pre-disturbance conditions of the treatment reach. This reach was used as a design analogue to help cross-check hydraulic calculations. The calculated bankfull discharge for the analogue was approximately 80 cfs. A pebble count was conducted to characterize bed surface substrate. Hydraulic modeling indicated that this discharge was capable of moving the D85 (41mm) at about 80 cfs. This was considered a good correlation for design purposes since the D84 particle size typically moves during a bankfull discharge in stable alluvial streams. An extrapolation of the calculated flow frequency values indicated that 80 cfs is approximately a 1.5-year flood. Regional analysis (Castro and Jackson 2001) indicates bankfull flow frequency in the area have a recurrence of 1.4 to 1.5 years.

Typical design dimensions were developed via an iterative process. Pre-project topographic data were edited to represent new channel dimensions. Each design scenario involved cross-checking cross-sectional geometry with the design analogue, regional geometry equations (Castro and Jackson 2001), and sediment:discharge hydraulics. Observations from areas within the project reach that showed signs of recovery helped guide design dimensions as well (Figure 1 – 8/25/04). The decision was made to design and construct cross-sections with higher width:depth ratios (Figure 1 – 10/2/07) that would minimize bed shear in the near term while facilitating deposition and development of an inset channel through time. The designed substrate distribution was derived from the analogue sample and modified using WDFW methods to reduce porosity. Given high fine sediment levels in the watershed, riffle crests found to be porous following construction are expected to seal quickly (2-3 years) and not significantly alter passage duration from adjacent reaches in the interim.

Figure 1. Pre- and post-construction photos of an isolated area (Station 10+80) within the project that showed signs of recovery prior to construction and were used to guide development of design dimensions.

The project was designed on an average longitudinal profile slope of 0.0093 ft/ft (Figure 2). Typical cross-section dimensions (Figure 3) had a bankfull top width of 18.4 feet and hydraulic radius of 1.04 (depth = 1.36 ft). Bankfull cross-sectional area was designed to be 19.7 ft^2 with 2:1 sideslopes

(horizontal : vertical). Drawings were brought to a 30% level with final constructed dimensions to be determined in the field by experienced oversight personnel. Floodplain areas that needed to be filled to maintain cross-sectional form were also identified on the drawings (Figure 4).

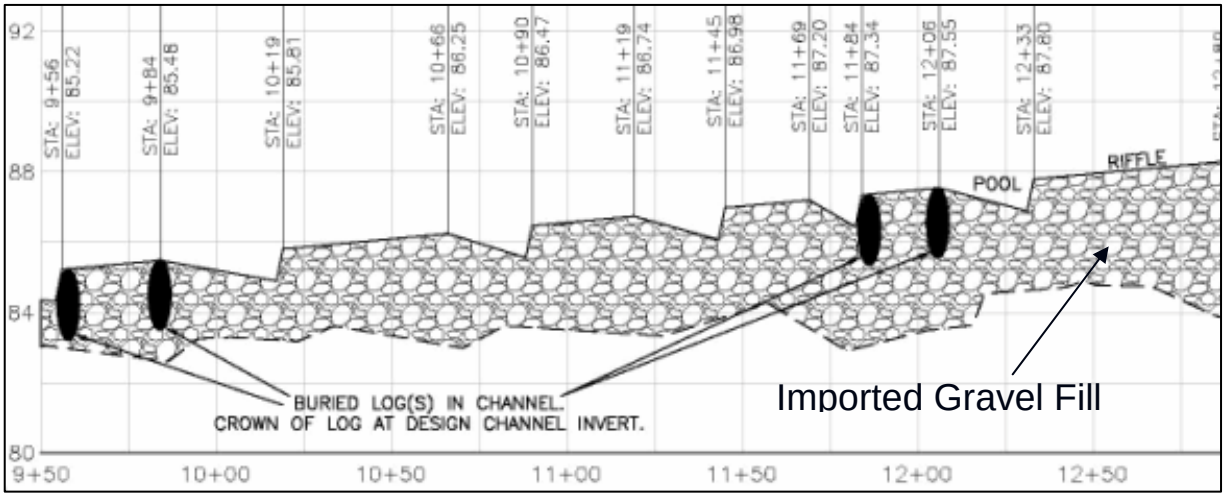


Figure 2. Design profile of a portion of the Tepee Creek /IXL Meadows Project reach.

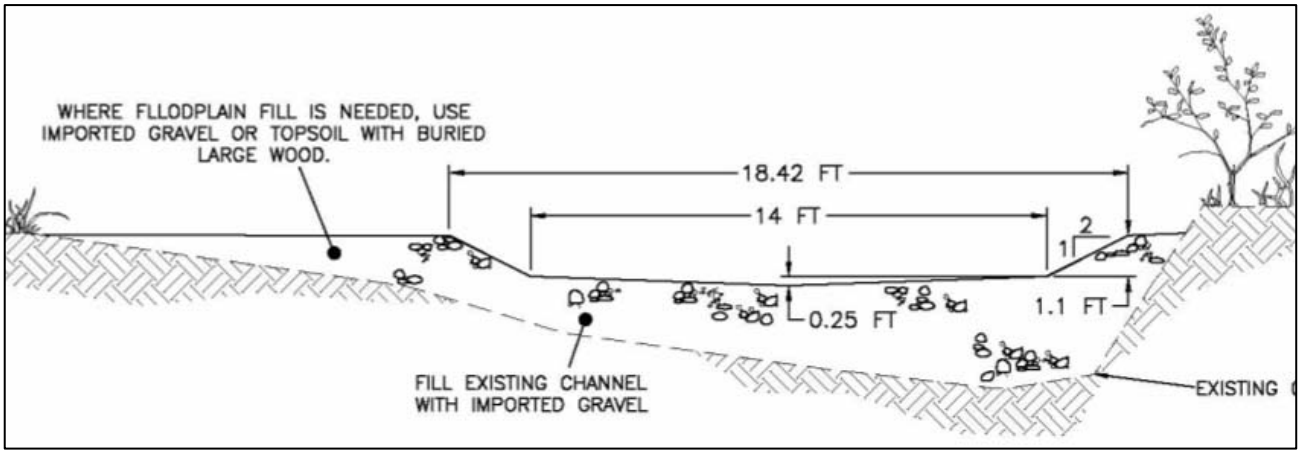


Figure 3. Typical design cross-section for riffles in the Tepee Creek /IXL Meadows Project reach.

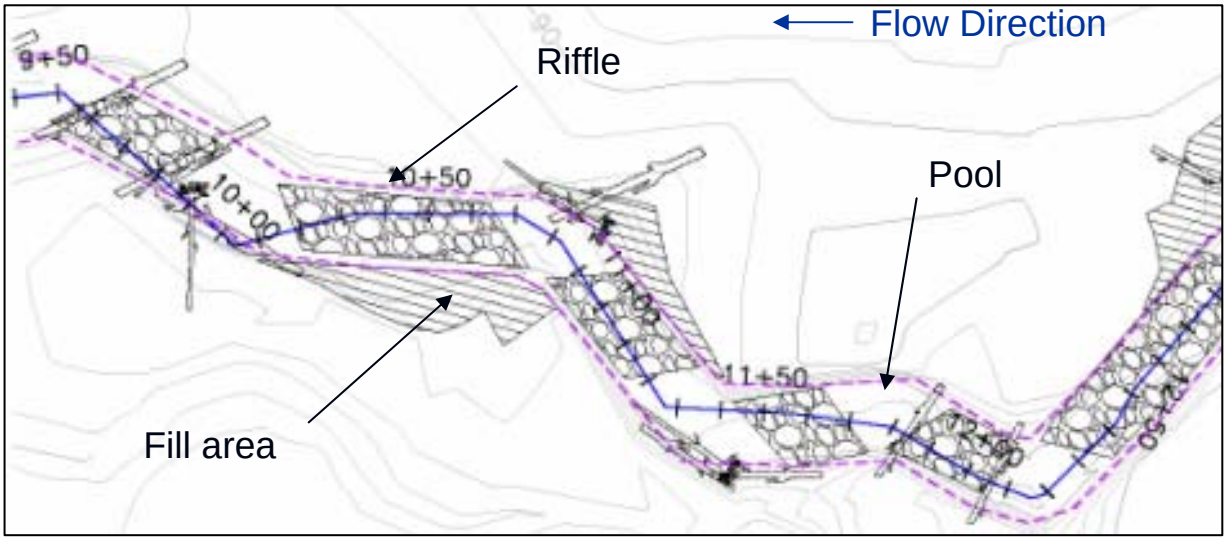


Figure 4. Typical plan-form design for the Tepee Creek /IXL Meadows Project reach.

Construction: Construction was initiated in October 2006 and was implemented over two field seasons:

- *Fall 2006* – gravel fill produced, hauled and stockpiled; riffles constructed to rough grade and dimension; coarsened grade-control riffle constructed; LWD debris collected, transported, and stockpiled; 95' of new channel constructed; riparian vegetation salvage completed; roughly half of LWD jams completed; temporary erosion control measures implemented

- *Summer 2007* – riffles and pools graded to finished elevation and dimension, floodplain LWD treatments completed, LWD jams completed, re-vegetation completed, and livestock exclusion fence constructed

Construction was funded by a YNFP-sponsored grant from the Washington State Salmon Recovery Funding Board (SRFB). KWEP provided funding for design and construction oversight. KWEP also funded non-LWD materials and supplies. Significant components of the implementation include:

- Construction of a 140'-long coarsened riffle at 3% grade to provide persistent grade control at the downstream end of the reach (Fig. 5)
- Importation of gravel to raise bed elevation (~3') and reconstruct pool/riffle sequences along 1740' (Fig. 6)
- Construction of 28 LWD jams constructed along channel margins to maintain pool depths, provide cover, and restrict bank erosion (Fig. 7)
- Construction of 95' of new stream channel to reconnect 135' of historic channel and lengthen the overall reach to 1990' (Fig. 8)
- Removal of two culverts and related fill from an abandoned cross-valley road alignment to restore high-flow access into a historic channel alignment
- Construction of several dozen LWD placements constructed on floodplain
- Planted shrubs and trees on 2 acres (cumulative) of riparian area and floodplain
- Re-seeded approximately 4.5 acres of floodplain and riparian area
- Weed control on 7.8 acres
- Construction of 3250' of livestock exclusion fence

Figure 5. Upstream end of grade control riffle (Station 2+20) before (left) and after (right) construction.

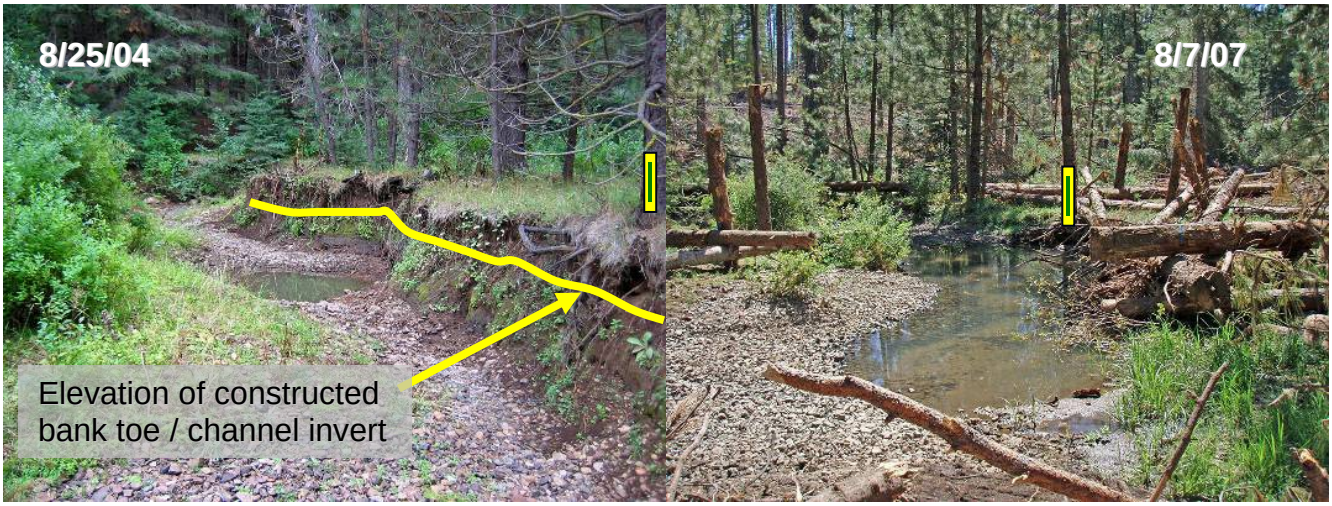


Figure 6. Riffles were filled with gravel to establish new base elevation (Station 6+60).

Figure 7. LWD jam constructed to enhance pool habitat complexity and reduce erosion (Station 13+40).

Figure 8. Ninety-five feet of new channel were constructed (visible on left side of 4/5/07 photo) and the stream was re-aligned into an old channel (Station 20+10).

Some of the techniques successfully employed during construction include:

- Extensive salvage of existing vegetation (sod mats and shrubs) for bank protection and to hasten riparian recovery rate (Fig. 9)
- Salvage of alluvial gravels (where they were present)
- Burial of logs into riffle subgrades (in areas where the hydraulic model indicated excess stream power)
- Ineffective areas along margins were left unfilled to encourage recruitment of fine sediments, hasten colonization by desired hydrophytes and minimize suitability for weeds (Fig. 10)

Figure 9. Salvage of sod mats and shrubs (foreground) and gravel fill for riffles (background)

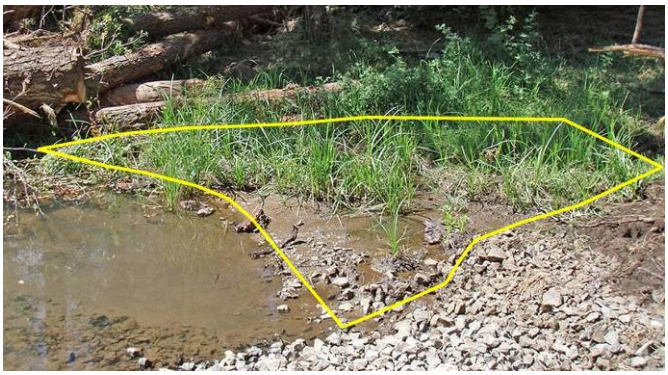


Figure 10. Area of ineffective flow left unfilled for fine sediment recruitment (Station 6+70).

- Plugs of native clayey material were built into the subgrade of roughly ½ dozen riffle crests to increase wetted summer pool depths and discourage subsurface flow
- Portions of 10 or 12 riffles were coarsened to add flow complexity, reinforce riffle toe stability (at pool transition), or reinforce crest stability (in closer proximity to LWD)

Results and Discussion: Preliminary results from the project have been encouraging. Quantitative monitoring is being conducted by KWEP for pools and groundwater. Fish usage is being monitored by the Klickitat M&E project which routinely conducts spawning surveys on Tepee Creek (inclusive of the project reach). KWEP personnel are also conducting photo-monitoring of the project reach.

Pools: Pool quantity was increased by sixty-five percent from 15 to 23 (Fig. 11). Pool quality was enhanced by LWD treatments (discussed previously) and increased residual depths (Fig. 11). It should be noted that some pools were under-filled during construction to save on cost. The creek is expected to partially fill these pools to an equilibrium depth that will result in a distribution with a median residual depth value somewhere in the 2.0' - 2.49' range, which is considerably more favorable for salmonid production than the 1.0' – 1.49' median of pre-project conditions.

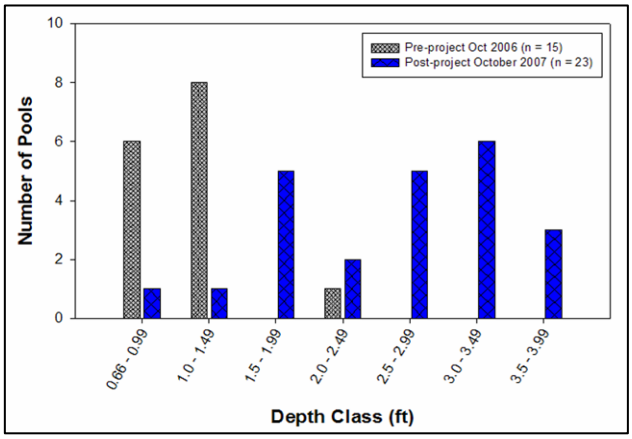


Figure 11. Residual pool depths with the Tepee Cr / IXL Meadows project reach

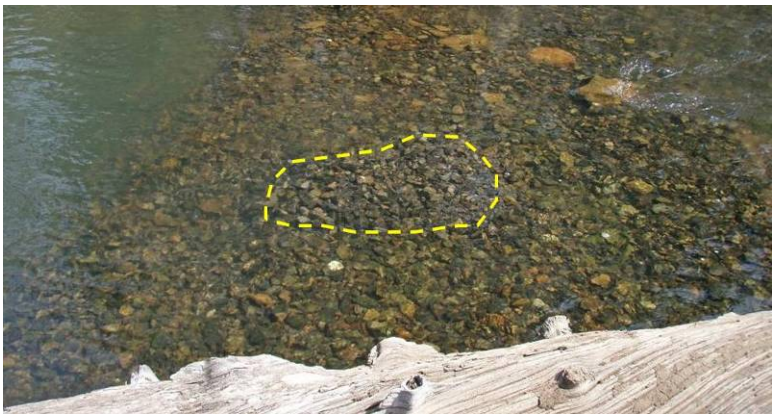


Figure 12. One of two steelhead redds observed within the Tepee Cr / IXL Meadows project reach in 2007

Steelhead Spawning (Fig 12): Two steelhead redds were observed within the project reach in May 2007. A third redd was observed within the reach, but was determined by M&E project personnel to be a "test redd" (where fish dig to test substrate and flow conditions but do not deposit eggs). Redds observed within the project reach accounted for 66% of the steelhead spawning observed in Tepee Creek and 3% of the total steelhead spawning observed in the Klickitat subbasin in 2007.

Groundwater: Three shallow (~6'-deep) monitoring wells were installed in the floodplain near the upstream end of the project reach in the fall of 2004. With the exception of a handful of data points, the pre- and post-project data sets are almost mutually exclusive (Fig. 13). Through the 2007 growing season a 3 - 4' increase in the summer water table was observed over pre-project conditions. Averaged over the course of the year this constituted a 1.8' increase in the water table. In addition to the increase in water table elevation, there was considerably less fluctuation amongst wells and less variability at any given point in time.

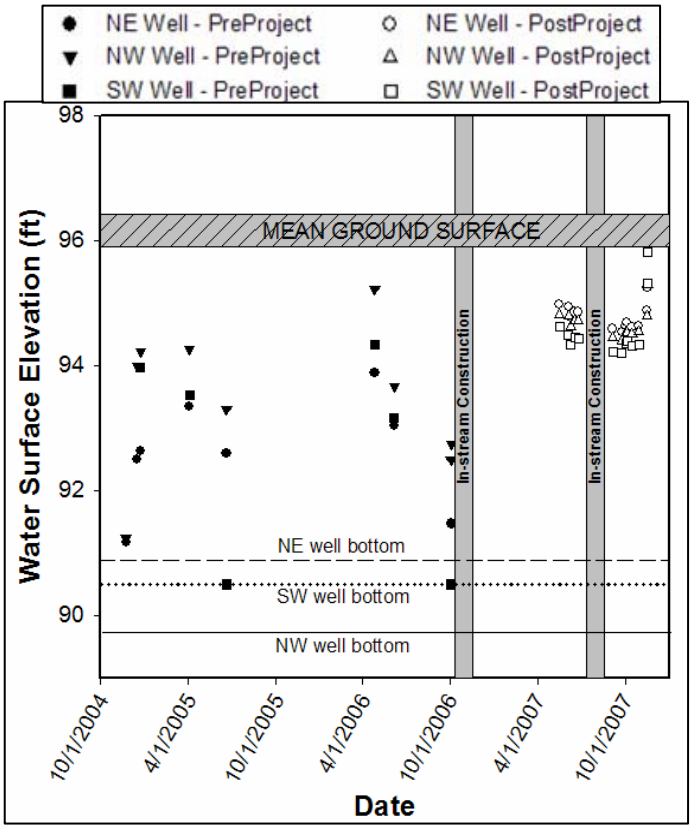


Figure 13. Groundwater data for 3 wells adjacent to the Tepee Cr. IXL Meadows project reach

Floodplain Connectivity: The maximum discharge over the winter of 2006/2007 was estimated at 143 cfs based on crest gage data ¼ mile upstream of the reach. This is well above the estimated bankfull discharge and within the range of estimated 2-year recurrence flows. Evidence of non-channelized overbank flow was observed at four different locations through the project reach when visited in April 2007. Access to four side channels (835 lineal feet cumulative) at bankfull or lower flows was restored, two of which were flowing at normal April flows.

Riparian Vegetation: Rapid recovery of riparian vegetation was observed. This was particularly notable where salvaged plant materials were placed. There was almost zero mortality of salvaged materials.

Macroinvertebrates: The project reach was colonized rapidly by at least three species each of Trichopterans (caddisflies) and Ephemeroptera (mayflies) and at least three other orders of aquatic insects.

Wetlands: Roughly ~3100 ft^2 of perennial emergent wetland was created (e.g. behind LWD in Fig 14.).

Figure 14. In-progress (10/12/06) and after (8/7/07) photos of Station 20+50 of Tepee Creek IXL Meadows project. Note emergent wetland (behind LWD) created by backwatering and water table rise.

Rearing: Juvenile salmonids were removed from the reach via electrofishing prior to dewatering for construction in early October of 2006 and again in early July 2007 (block nets were removed during the winter). Passage conditions were comparable in October 2006 and July 2007 in the sense that there was insufficient flow for fish to pass through riffles. There were roughly ten times as many fish in the reach in July 2007 as there had been the previous October, most of which were fry from the two redds located within the project reach. Even after excluding 0-aged fish, there were 2-3 times more parr within the project reach.

Fish passage: Project actions backwatered the culverts at the upstream end of the project reach, thereby eliminating the outfall drop that was acting as a partial fish passage barrier (Fig. 15).

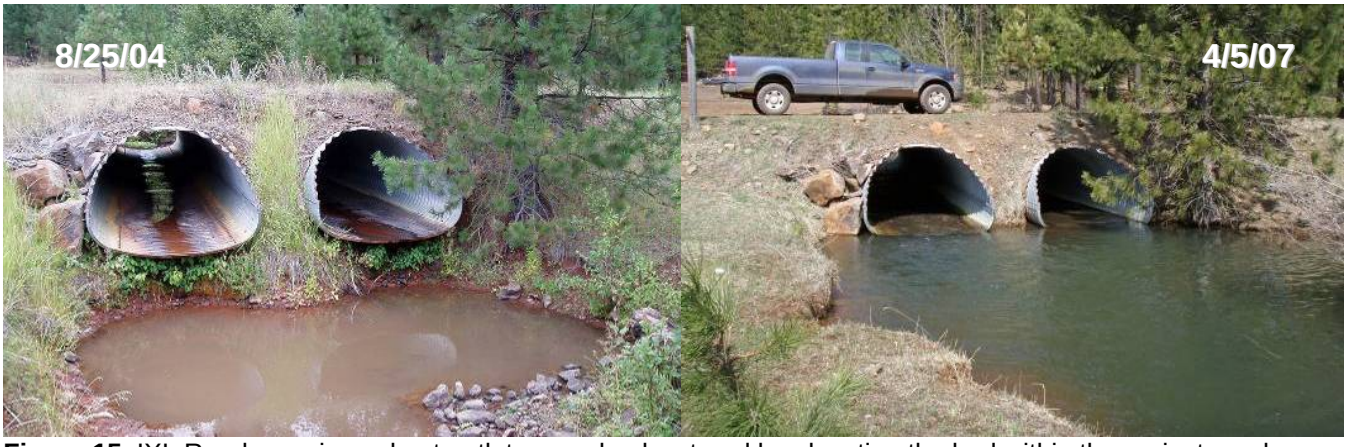
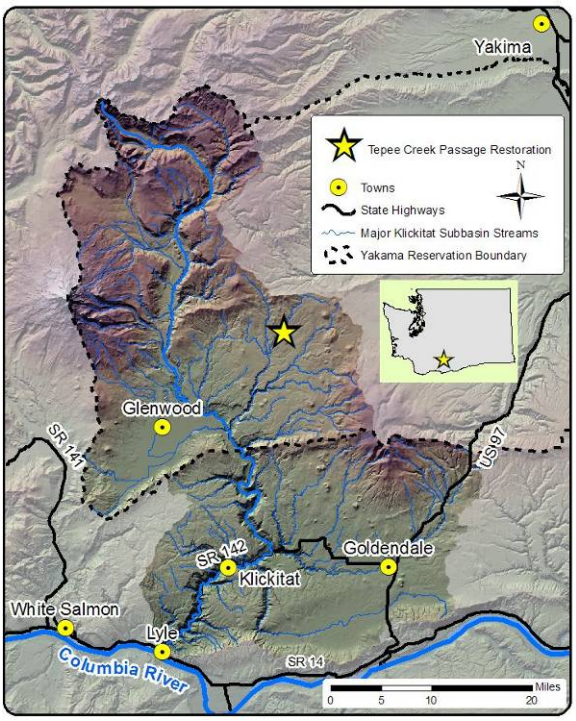


Figure 15. IXL Road crossing culvert outlets were backwatered by elevating the bed within the project reach.

Flow duration: One of the most encouraging results during the first year of the project was the persistence of water in the reach throughout the summer of 2007 (e.g. Fig. 5). Though flow did go subsurface through some of the riffles, all pools maintained water through the summer and fall? of 2007. This had only happened in 1 of the 5 years preceding the project. Previously, the reach normally dried in late June or early July and did not re-water until early November, except for rare periods of intermittency associated with summer storm activity (discussed above). The summer of 2006 was the only year that surface water (and fish) persisted within the project reach prior to implementing restoration treatments. This will be an aspect of the project that will continue to be monitored in the future.

Tepee Creek Fish Passage Restoration Project

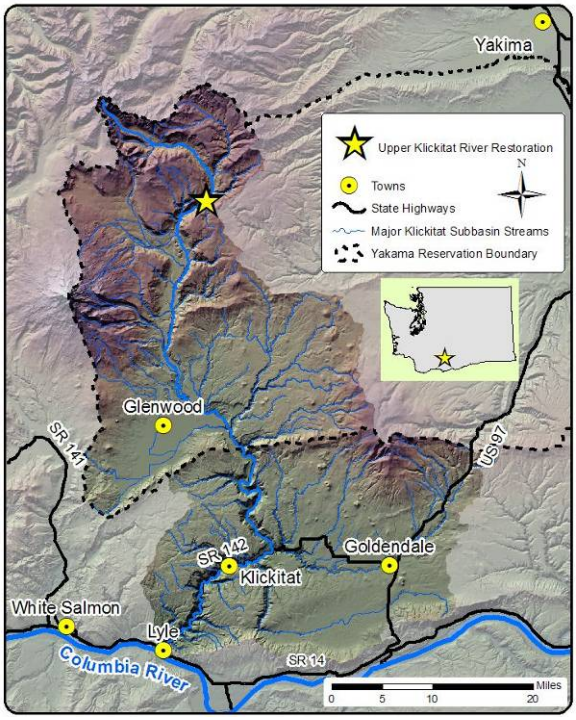
Background: The project addresses limiting features (passage) identified for this reach in a top geographic priority identified by the Subbasin Plan and KLESRS. Tepee Creek, a tributary to White Creek in the Klickitat River subbasin, provides important spawning and rearing habitat for ESA-listed Middle Columbia River steelhead. The White Creek watershed as a whole is likely the most important spawning and rearing tributary watershed within the Klickitat subbasin. In recent years, the White Creek watershed has accounted for up to 40% 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, however in most years it likely accounts for between 5 and 10%. However, movement by steelhead fry and juveniles is critical to their survival, and in some areas of Tepee Creek, there are very low to nonexistent base flow conditions at spawning areas and rearing sites.



Project Goal: To restore juvenile salmonid access to 8.7 miles (cumulative) of upstream habitat. This project will replace culverts (identified as partial barriers to fish migration using WDFW protocols) at three sites (Tepee Creek / IXL Road, Tepee Creek / 175 Road, and E.F. Tepee Creek / 175 Road) in the Tepee Creek watershed and also re-grade/resurface a cumulative total of approximately 0.4 miles of related road.

FY07 Activity: Design was completed for all three sites. Replacement structures (two bridges and one box culvert) were purchased and delivered. Bid documents were prepared, a pre-bid walk-through was conducted, and a contract was awarded for construction of the Tepee Creek / 175 Road site. Mobilization occurred at the end of September 2007 with construction occurring during FY08. Construction is being funded by a YNFP-sponsored SRFB grant.

Upper Klickitat River In-Channel and Floodplain Enhancement Project



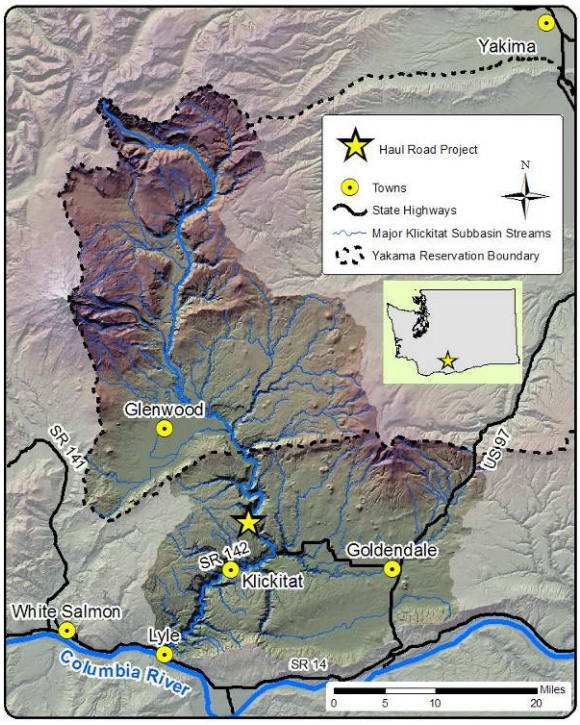
Background: The project addresses limiting features (channel confinement and habitat simplification) identified for this reach in a top geographic priority area identified by the Klickitat Subbasin Plan and Klickitat Lead Entity Salmon Recovery Strategy. The core EDT reach that encompasses the project sites ranks third overall in the Klickitat subbasin in restoration potential for combined performance of steelhead and spring Chinook. Project work addresses most of the top limiting factors identified for the reach between RM 70 and 74.5. Proposed activities build upon the experience of recent large woody debris (LWD)-based habitat projects completed in upper reaches of Klickitat River and its tributaries.

The primary cause of degradation in the reach is the presence of the 255 Road, the arterial road for the upper third of the Klickitat watershed. The embankment occupies and isolates portions of the Klickitat River's floodplain as well as historic channel alignments. Given WDFW reports from the 1950s that recommended removal of LWD jams from the river, it is highly likely that such removal occurred during construction of the 255 Road in the 1970s. Relocation of the road would be a more desirable option and allow for evolution of a more stable planform and profile. However, the size of the road and valley morphology make relocation cost prohibitive. Consequently, this phase of the project addresses three locations where the active channel of the Klickitat River contacts the 255 Road embankment.

Project Goal: 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. Roughly 3750 lineal feet of side channel will be reconnected.

FY07 Activity: Hydraulic modeling, design, and 30% drawings were completed for all three sites. Final design will be fit-in-the-field and occur during construction supervision by experienced personnel. Construction will involve a combination of floodplain and active channel treatments. In areas where the river contacts the road embankment, a 15'-wide or so floodplain will be constructed between the active channel and fill slope. The finished grade of the new floodplain will be constructed of LWD ballasted with boulders and backfilled with alluvium. It will be sized to be inundated by 2-year recurrence (and greater) floods. The new surface will be planted with dormant hardwood cuttings. Additionally, roughly 150' of new channel will be constructed to reconnect 3750' of side channel. The constructed channel is designed to carry 30-40% of bankfull discharge. In addition to increasing overall habitat quantity, side-channel reconnection will reduce downstream active channel forces. Work will involve reshaping and replanting 0.62 miles (cumulative) of bank and 2.1 acres of floodplain. YNFP-sponsored PCSRF and SRFB grants are cost-sharing in-stream implementation actions. LWD harvest sites have been identified and the Timber Committee of the Tribal Council has granted permission for donation of LWD materials, much of which will be salvaged blowdown, to the project.

Klickitat River (RM 18 to 32) Floodplain Conservation and Restoration (Haul Road) Project



Background: The 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 roughly 30%, 51%, and 38% of the annually observed basinwide spawning for steelhead, fall Chinook, and coho, respectively. 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 phases, both of which are funded primarily by SRFB grants. Columbia Land Trust is the sponsor for both grants and the lead for acquisition activities. KWEP is the technical lead for design and construction oversight of restoration actions as well as assisting planning activities.

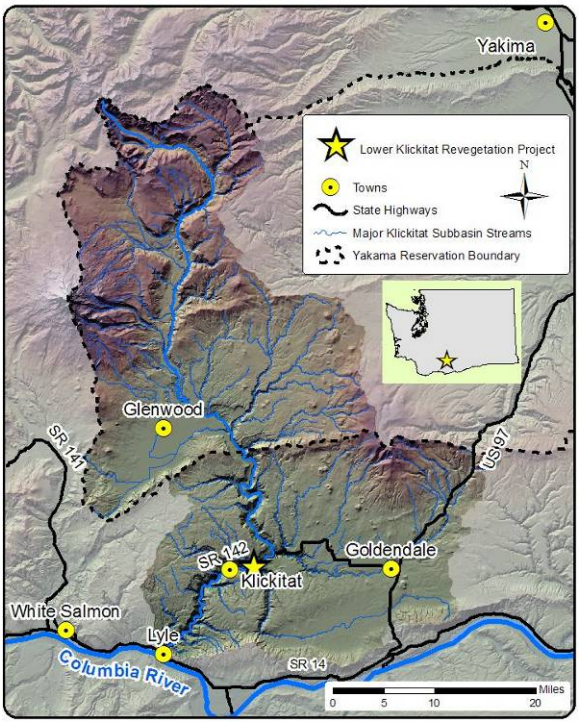
Project Goal: Phase 1 will prevent potential habitat fragmentation by acquiring a valley-bottom road as well as 320 acres of private inholdings with river frontage within the Klickitat Wildlife Management Area. Phase 2 of the project addresses limiting features for this reach by breaching portions of the road to restore floodplain connectivity and pulling back and re-vegetating fill materials in other portions to enhance riparian vegetation. Phase 2 will enhance and restore 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.

FY07 activity: The most critical portion of Phase 1 was completed in the winter of 2007 when Columbia Land Trust closed on the acquisition of the road and related parcels. This clears the way for restoration activities. KWEP and CLT staff conducted several field visits to refine design treatments and the geographic scope of Phase 2. A timeline for implementation was developed. In FY2008, an implementation plan will be developed and permit applications will be prepared with construction of Phase 2 to begin potentially as early as the winter of 2008-2009.

Lower Klickitat River Riparian Re-vegetation Project

Background: This project addresses limiting habitat features (poor riparian and floodplain vegetation) identified for this reach in a top geographic priority identified by the Subbasin Plan and Klickitat Lead

Entity Salmon Recovery Strategy. This reach is a migration and rearing corridor for nearly 100% of migratory fish in the Klickitat watershed and has accounted, on average, for 10% of observed basinwide steelhead spawning. The project area occurs within a reach identified by the Klickitat Technical Advisory Group (KTAG) as fourth out of 21 priority areas within the Klickitat Lead Entity's scope. Riparian conditions in this reach are generally poor due to a combination of 1996 flood deposits and channel encroachment by highway and railroad fill. Many of the flood deposits are well above the 2-year flood surface and at a comparable elevation to surfaces that are well-vegetated and are generally stable. Vegetation has been very slow in colonizing these coarse, well-drained substrates. Similar deposits from flooding in 1974 along Swale Creek (a Klickitat River tributary) are still bare. A SRFB grant sponsored by the Mid-Columbia Regional Fisheries Enhancement Group (MCRFEG) is funding implementation. KWEP is providing design, construction oversight, and monitoring support for the project.



Project Goal: The goal of this project is to increase native riparian and floodplain vegetation, woody debris recruitment, and potential for trapping fine sediment between river miles 2.6 and 18.3 of the Klickitat River. The first round of planting was completed in 2006 on five sites totaling approximately 6.6 acres. Plantings consisted of willow, cottonwood, and dogwood livestakes.

FY07 Activity: KWEP provided design, project planning, and permitting assistance for the second round of plantings (to be completed in 2008) which will occur at three sites totaling roughly 5 acres. KWEP staff in cooperation with the Mid-Columbia Regional Fisheries Enhancement Group also started a small nursery (Fig. 16) to grow containerized stock for the project. The site is located off the southwest corner of the YKFP's Klickitat Field Office (KFO) in Wahkiacus. There are several benefits to growing a portion of needed plant materials in-house. The first is a cost savings of at least 30-40% because of the partial use of volunteer labor. The second is that it avoids putting all of the "eggs" in a single basket. In other words, growing out plant materials at several different sites (a portion are still grown on contract by a local nursery) distributes the potential risk of die-offs due to disease, irrigation failure, etc. more widely making the likelihood of a total loss of plant materials very low. The other benefit is having plants that are as locally adapted as they can possibly be (short of establishing satellite nurseries at each of their destination sites).

A trial run of 100 dogwood cuttings was started in "tall-one" tree pots in April 2006. These pots are desirable for several reasons: 1) they are approximately 4" x 4" x 14" deep and thus encourage deeper root development, 2) plantings grown in the pots fit within the jaws of a hydraulic stinger for mechanical planting (where needed), 3) they are a manageable size (0.75 gallon) that can be planted by hand. The initial batch of dogwoods had excellent survival and growth and were planted at several sites throughout the Klickitat subbasin (including the Tepee IXL Meadows and Bear Creek sites) with great success in the summer of 2007.

In the winter of 2007, KWEP purchased 8 cases (1920) of "tall-one" tree pots. KWEP personnel constructed frames to contain the pots and designed and constructed a micro-irrigation system that runs off the well at the KFO. MCRFEG purchased the materials for the frames and irrigation system as well as the potting soil. MCRFEG also coordinated volunteers for collection of cuttings, filling tree pots, and planting cuttings. Approximately 1950 pots (roughly 30 were available from the previous year's dogwoods that had already been planted) were filled and planted. The tally as of December 2007 was 445 ponderosa pine, 412 black cottonwoods, 172 coyote willow, 577 Scouler's willow, 182 Geyer's willow, and 139 red alders.

Figure 16. Klickitat Field Office nursery.

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. FY07 was the first year of operation and the drill was rented to 7 landowners. Acreages planted ranged between 4.55 and 50 acres with most between 10-15 acres. Total acreage planted was 100.55 acres.

Bear Creek Fish Passage Restoration Project

A culvert replacement at the Peavine Ridge Road crossing of Bear Creek was completed in 2006 restoring access to 0.8 miles of upstream habitat. Re-vegetation treatments on some of the cut and fill

slopes did not take well over the winter of 2006/2007. During FY07 KWEP personnel re-seeded and mulched 0.25 acres of slopes with native grass species (slender wheatgrass, Idaho fescue, and bluebunch wheatgrass) and mulch. An additional 800 square feet of slopes were manually re-shaped to remove rilling. Thirty-two containerized shrubs (willows, dogwoods, and rose) were planted along portions of the stream disturbed during construction of the replacement culvert in 2006.

Streamflow Monitoring

KWEP stream gaging activity occurred at fourteen sites during FY2007. Activity included 39 instantaneous discharge measurements for use in rating curve development and maintenance. Activities also included installation of two crest gages (to record peak water surface elevation) and two sensor / data-loggers (to record water surface elevation continuously) at four sites. Surveys were conducted at 5 sites to compare stream channel hydraulic geometry through time. Sixteen visits were made to five sites with data loggers to download data and check field calibration. Maintenance was conducted at seven sites and repairs were necessary at two sites. Activities are summarized by site in Table 3.

Data are stored in Excel. Data are currently being validated but will be published to the YKFP website (http://www.ykfp.org/klickitat/Data_flow.htm) once quality control is complete.

Table 3. Services performed at 14 stream gaging sites in the Klickitat subbasin in Water-Year 2007

Site	Qmeas	Staff Read	Crest Read	Staff Install	Crest Install	Sensor Install	Down-load	Maint.	Repair	Survey	Total Visits
Bear Creek	1	1									1
Diamond Fk	4	4	1								5
Diamond Fk @ Klick. Mdw	2	2	2		1						3
East Fork Teepee Cr	2	4					4				6
Klickitat R at Cow Camp	5	8	5				1	1	1	2	11
Piscoe Creek	3	3	3					2			4
Summit Creek	7	10	5	1		1	3	3		3	13
Surveyor's Creek	2	3	3					3			4
Swale Creek	5	10	3		1		5	1	1	1	11
Teepee Cr abv IXL Rd	3	3	3								4
Trout Creek	1	1						1		1	2
White Creek (Lower)	4	9	3			1	3	3		1	11
White Cr abv 207 Rd			1								1
White Cr abv IXL Rd			1								1
Grand Total	39	58	30	1	2	2	16	14	2	8	77

Klickitat River Side Channel Inventory

Klickitat River side channels from the Piscoe Creek confluence (RM 74.9) to the Howard Lake Road crossing (RM 76.0) were mapped in October 2006. Location information for channel segments was collected with a Trimble GeoXT GPS unit and features were attributed in ArcPad 7.0.1. Attributes collected for each segment include whether or not water was present (dry, damp, standing, or flowing), dominant substrate (fines, gravel, cobble, or boulder), whether or not salmonids were present (yes / no), and the average bankfull width. Roughly 5.5 miles of side channel were mapped within the inventory area which encompassed roughly 0.9 miles of valley bottom (Fig 17).

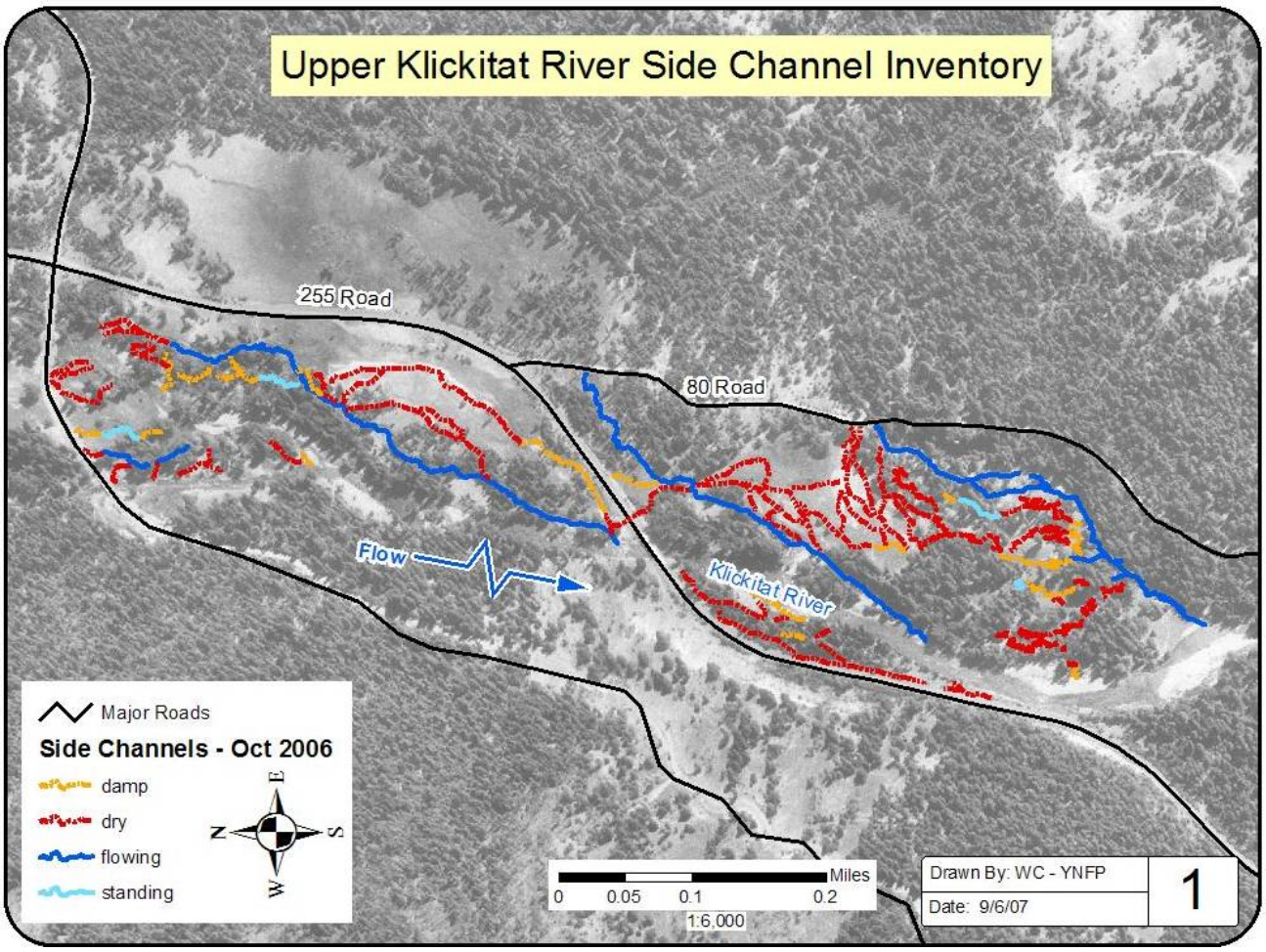


Figure 17. Side channels mapped along the upper Klickitat River in October 2006.

Stream Temperature Monitoring

During FY2007 KWEP personnel conducted 62 visits to 34 sites on 21 streams to download data and/or exchange sensors. Calibrations were performed for 50 temperature sensors/loggers to check accuracy relative to a NIST-certified thermometer. KWEP personnel also assisted YKFP Data Management staff with maintenance and continued development of the relational database that houses and manages all of the temperature data for the Klickitat subbasin. Data summaries are published in the Klickitat M&E Project's annual report. An example of the monthly data summary table is in Table 4 and field visits for FY07 are summarized by site in Table 5 . Monthly temperature reports are also available via an interactive map on the YKFP website: http://www.ykfp.org/klickitat/Data_thermo.htm.

Table 4. Example of monthly summary table for temperature sites.

TEPEEIXLRDX

2007	# Days Recorded	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
		< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22			
January	31	16	31	12	31	0	0	0	0	0	0	0	3.1	1.7	0.6
February	28	4	28	3	28	0	0	0	0	0	0	0	3.7	1.8	1.0
March	31	2	28	0	23	0	0	0	0	0	0	0	6.6	3.4	1.7
April	30	0	19	0	4	0	0	0	0	0	0	0	10.4	5.6	3.4

Table 5. Summary of FY2007 temperature-logger related field visits by stream and site.

Stream	SiteName	Visits		Stream	SiteName	Visits
Bear	BEARMOUTHX	2		Little Klickitat	LKLIKLODGE	1
Bowman	BOWMNMOUTH	2			LKLIKMOUTH	2
Bute Meadows	BUTTEMEDWS	3		Logging Camp	LOGGCAMPCR	2
Clearwater	CLEARWATER	2		McCreedy	MCCREEDRDX	2
Diamond Fork	DIALOWMEDW	3		Outlet	OUTLETRDXG	2
	DIAMOUTHRX	2		Piscoe	PISCOMOUTH	2
	DIAUPPMEDW	3		Snyder	SNYDERMILL	1
	KLMEDWSAIR	2		Summit	SUMITMOUTH	1
Dillacort	DILLACORTX	2		Surveyors	SURVEYORSX	1
Fish Lake	FISHLAKRDX	2		Tepee	EFTEPEE175RDX	2
Klickitat	COWCAMPAIR	1			TEPEEIXLRDX	2
	HATCAIRTEM	1		Trappers	TRAPPERRDX	2
	KLCASTLEBR	2		Trout	TROUTRVRTRDX	2
	KLCKYKFPHQ	1		West Fork	WESTFORKRX	2
	KLCOWCAMPX	2		White	WHITEIXLRDX	2
	KLHATCHTRP	1			WHITEMOUTH	2
	KYKFPHQAIR	1			WHITEUPPER	2

Dead Canyon Creek

The lower 5 miles of Dead Canyon Creek was surveyed for barriers, streamflow, and fish distribution (Fig. 18).

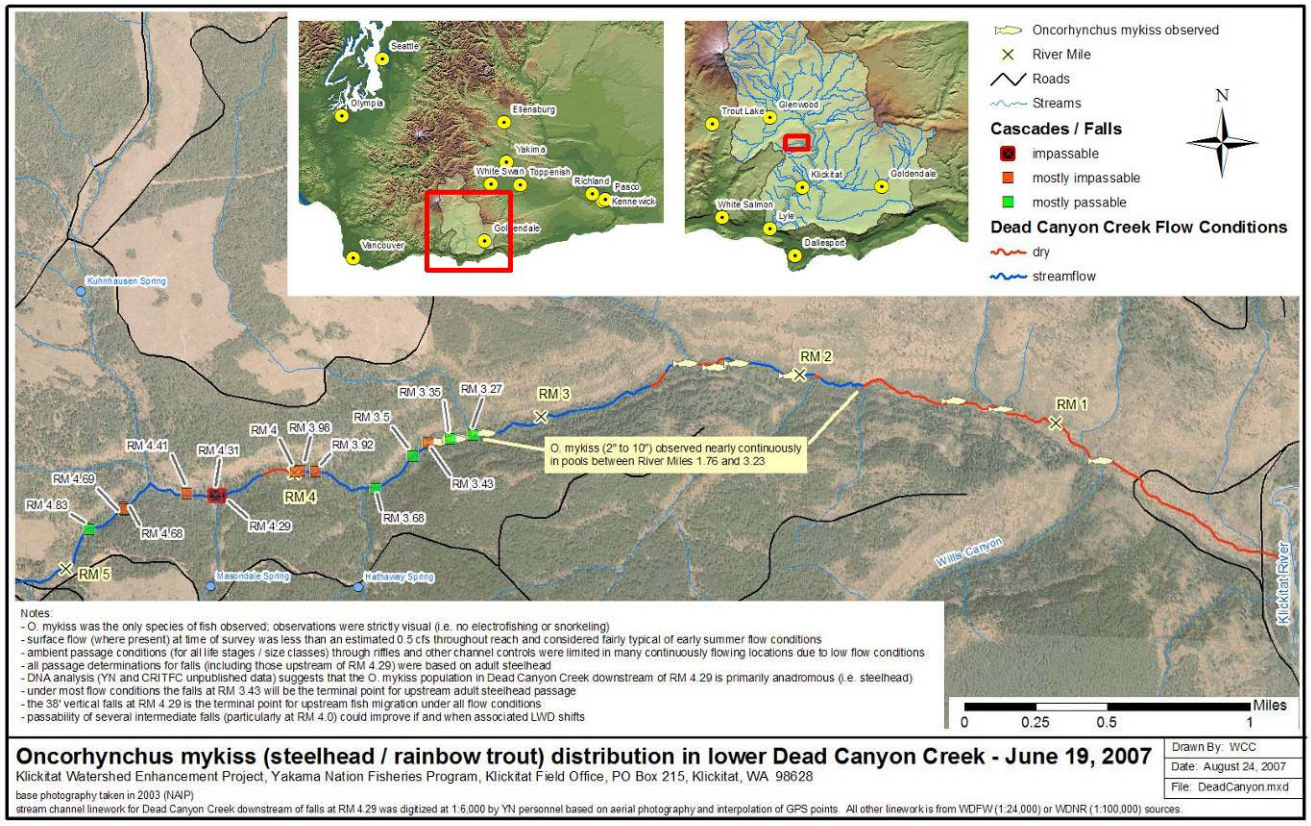


Figure 18. Results of June 19, 2007 survey of *O. mykiss* distribution and barriers on Dead Canyon Cr.

Spawning Gravel Data

KWEP staff conducted a quality review and entered data for 13 sites where Klickitat M&E Project staff had collected spawning gravel in the Fall of 2006. Data were entered into the relational database co-designed with YKFP Data Management staff. Reports for each of the 13 sites were generated from the database and published with the Klickitat M&E Project's annual report. Spawning gravel reports are also available via an interactive map on the YKFP website at http://www.ykfp.org/klickitat/Data_SedRpts.htm. A sample report is provided below (Fig. 19).

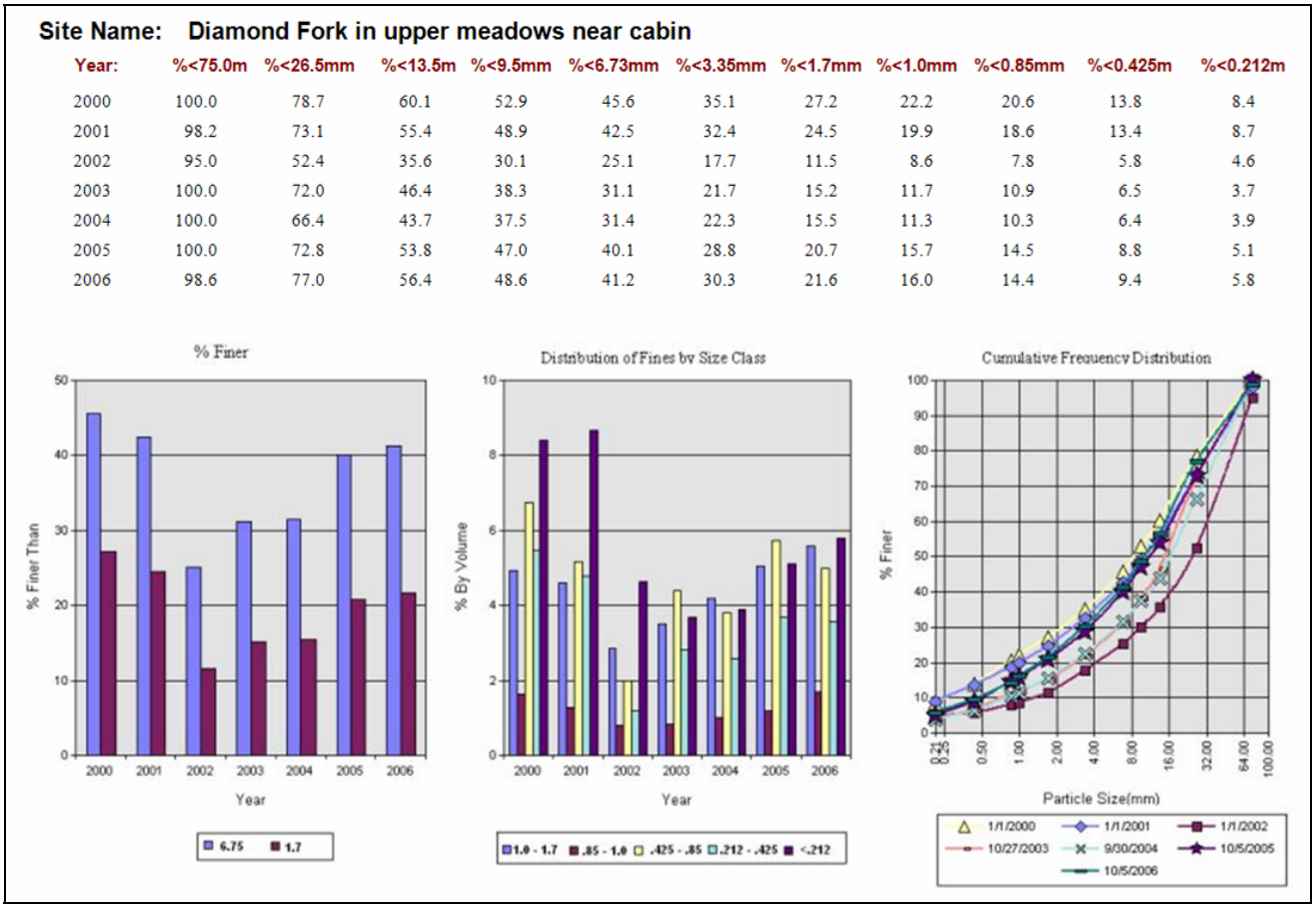


Figure 19. Spawning gravel composition by year for the upper Diamond Fork Creek site.

Safety

In addition to project-specific duties, KWEP staff planned and coordinated two different safety training classes for YKFP-Klickitat staff at the Klickitat Field Office.

- The first class was a combination basic First Aid and CPR training class taught by a local EMT (and licensed instructor). The class was attended by nine individuals.
- The second class was a Swiftwater Rescue Technician (SRT) class taught by a Rescue3-certified instructor and was attended by ten YKFP-Klickitat field staff (including both KWEP staff members) that regularly work in and around moving water. This was a re-certification for 6 of the 10 attendees.

Habitat Monitoring

The YKFP-Klickitat uses the Timber, Fish, and Wildlife (TFW) methodology for status and trend monitoring. Field data is collected primarily by Klickitat M&E project personnel. KWEP personnel designed and developed a relational database to enter, house, and analyze the data in cooperation with Klickitat Data Management project personnel. KWEP personnel provide QA/QC, data entry and error-checking, report design, and analysis as well as assistance to Data Management project personnel with maintenance and continued development of the database.

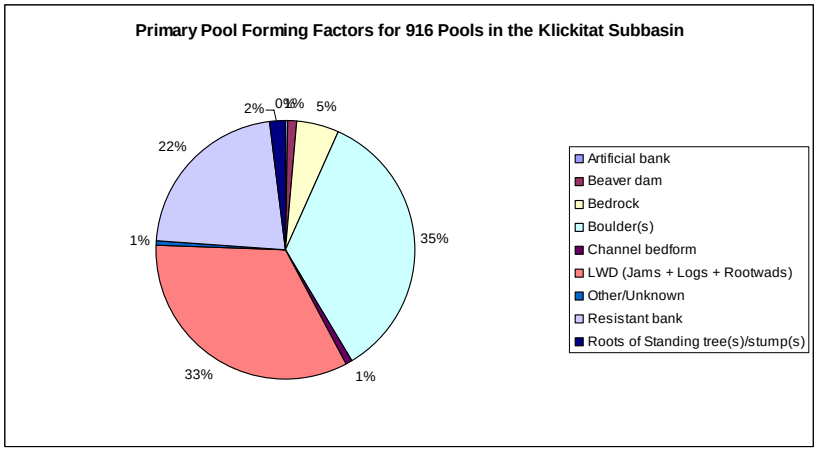


Figure 20. Summary of pool-forming factors for 916 pools from 67 segments in the Klickitat River subbasin

During FY07, data for the Reference Point (RP), Large Woody Debris (LWD), and Habitat data modules were entered into the TFW database (v5.1) for 17 seventeen segments. Data in the database was checked against the field data sheets for 67 segments (of which 17 were double-checked). Once data have been finalized, reports for RP, LWD, and Habitat will be available for each segment via an interactive map on the YKFP-Klickitat website: (http://www.ykfp.org/klickitat/Data_TFW.htm). Summary data will also be made available on the website as analyses are completed (e.g. Fig 20).

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 engaged in two types of education and outreach during FY2007 to help the public understand what we do and why we do it.

The first effort was part of the Salmon in the Classroom program (taught in conjunction with USFWS) where staff visited two local elementary schools (Goldendale and Klickitat). Staff describe our program and explain the cultural significance salmon have to native people, including demonstrations of traditional fishing methods (Fig. 21). The Goldendale presentation involved roughly 40 students and 3 teachers, while the Klickitat presentation involved 30 children and 2 teachers.

The second education and outreach effort involved a presentation at the 2007 White Salmon River Festival and Symposium. KWEP's lead project specialist was invited to give a presentation on LWD in rivers. The organizers and audience consisted largely of local river guides, so it was a great opportunity to educate people that could subsequently educate their clients. The presentation focused on the ecological function of LWD in rivers as well as interactions with boaters. A focal point of the presentation was to dispel the notion that all LWD is hazardous and should be removed from the river. There were approximately 60 attendees. The presentation can be viewed online at: http://ykfp.org/klickitat/LWDweb/WhiteSalmonRiverFest_LWD_Presentation_060607_forweb.html

Figure 21. Ralph Kiona, KWEP Watershed Technician and Yakama tribal fisherman demonstrates traditional fishing equipment to students.