



# HABITAT RESTORATION CONCEPTS FOR THE CHEWUCH RIVER

*For Lands Managed by the Okanogan-Wenatchee National Forest*



**A SUMMARY OF THE 2010 CHEWUCH RIVER REACH  
ASSESSMENT WITH SPECIAL FOCUS ON RESTORATION  
OPPORTUNITIES ON US FOREST SERVICE LANDS**

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**A Summary of the 2010 Chewuch River Reach  
Assessment with Special Focus on Restoration  
Opportunities on US Forest Service Lands**

**Yakama Nation Fisheries**

PO Box 151  
Toppenish, WA 98948  
509-865-5121



Prepared by  
**Inter-Fluve, Inc.**  
541-386-9003 | [www.interfluve.com](http://www.interfluve.com)

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# Overview

## PURPOSE

A Reach Assessment (RA) for the lower 20 miles of the Chewuch River was completed in spring 2010. The RA describes reach-scale physical and biological conditions and salmonid habitat restoration opportunities for the 20-mile study area. The purpose of this document is to summarize the RA for reaches within United States Forest Service (USFS) lands. The RA describes a total of 72 individual project opportunities either within or adjacent to USFS lands. These projects have been subsequently grouped into a total of 12 restoration "Project Groups" that include multiple interrelated projects. This document describes these Project Groups and also includes background information on the methods and rationale that were used for project evaluation and identification during the RA effort. The process for carrying forward Project Groups to subsequent phases of alternatives analysis and design is also described.

## SALMONID RESTORATION OBJECTIVES OF THE YAKAMA NATION

The Upper Columbia Habitat Restoration Program (UCHRP) unit of the Yakima Nation Fisheries Program, initiated through the Columbia Fish Accords, is tasked with developing restoration plans and carrying out restoration activities within the Upper Columbia Basin. The ultimate intent of restoration is recovery of endangered and threatened Salmonid species. Planning is underway in several major Upper Columbia tributaries including the Methow River basin. The Chewuch River sub-basin supports populations of salmonids that are currently listed under the Endangered Species Act (ESA), including spring Chinook salmon, summer steelhead, and bull trout. The UCHRP has

found that the river corridor within USFS properties on the Chewuch River provides important opportunities to accomplish several primary restoration goals:

- Address critical aquatic habitat impairments limiting the productivity of local salmonid populations.
- Develop and implement actions that protect and restore the dynamic landscape processes that support sustainable riparian and salmonid habitat.
- Develop and implement actions that improve and protect water quality to promote salmonid recovery.
- Coordinate efforts with local landowners, resource managers, and other stakeholders in order to establish collaborative efforts that contribute to the success of restoration strategies.

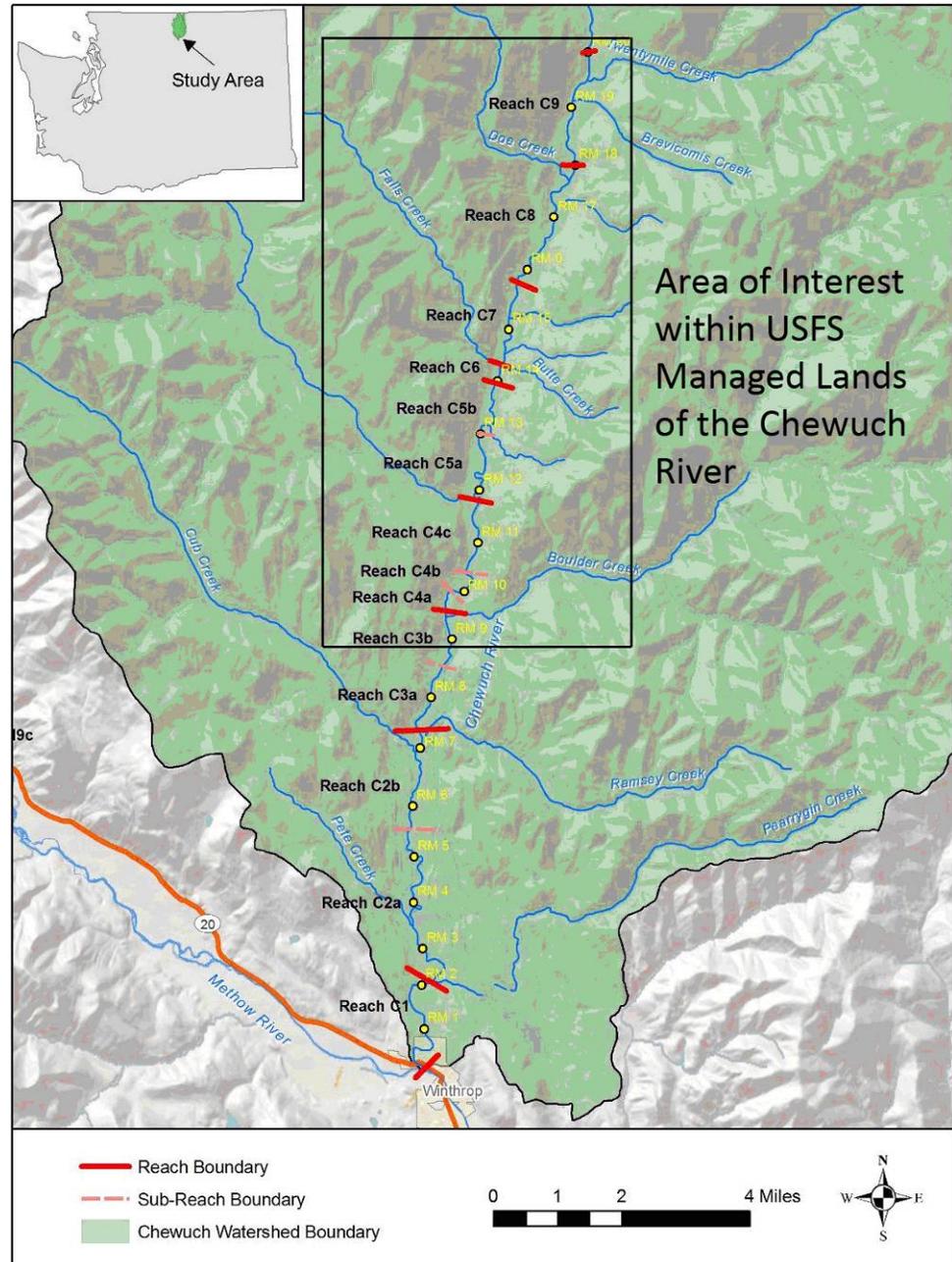
## CONTEXT WITHIN THE REGIONAL RECOVERY STRATEGY AND US FOREST SERVICE AQUATIC RESTORATION PLAN

The Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (Recovery Plan, UCSRB 2007) states that recovery of species viability will require reducing threats to the long-term persistence of fish populations, maintaining widely distributed and connected fish populations across diverse habitats of their native ranges, and preserving genetic diversity and life-history characteristics. The Recovery Plan calls for recovery actions within all of the "Hs" (Harvest, Hatchery, Hydropower, and Habitat). Restoration opportunities identified on the Chewuch River address the Habitat component of the Recovery Plan.

Restoration opportunities described here are consistent with the strategies identified in the Aquatic Restoration Plan for the Lower Chewuch River (USFS 2009 - DRAFT). Identified opportunities fall within the Tier 1 actions identified in the USFS plan.

# Study Area

The Chewuch River Basin is located on the east slope of the Cascade Mountains in Northern Washington. The Chewuch River is a tributary to the Methow River, flowing into the Methow near RM 51.5. The overall study area of the RA includes the Chewuch River channel and floodplain from RM 2.2 to RM 20.0. The reach assessment identified projects on USFS lands from RM 9.0 to RM 20.0. See Figure 1 for a locator map of the area of interest that includes that portion of the study area containing Forest Service properties and the geomorphic subdivisions (reaches) used in this study.

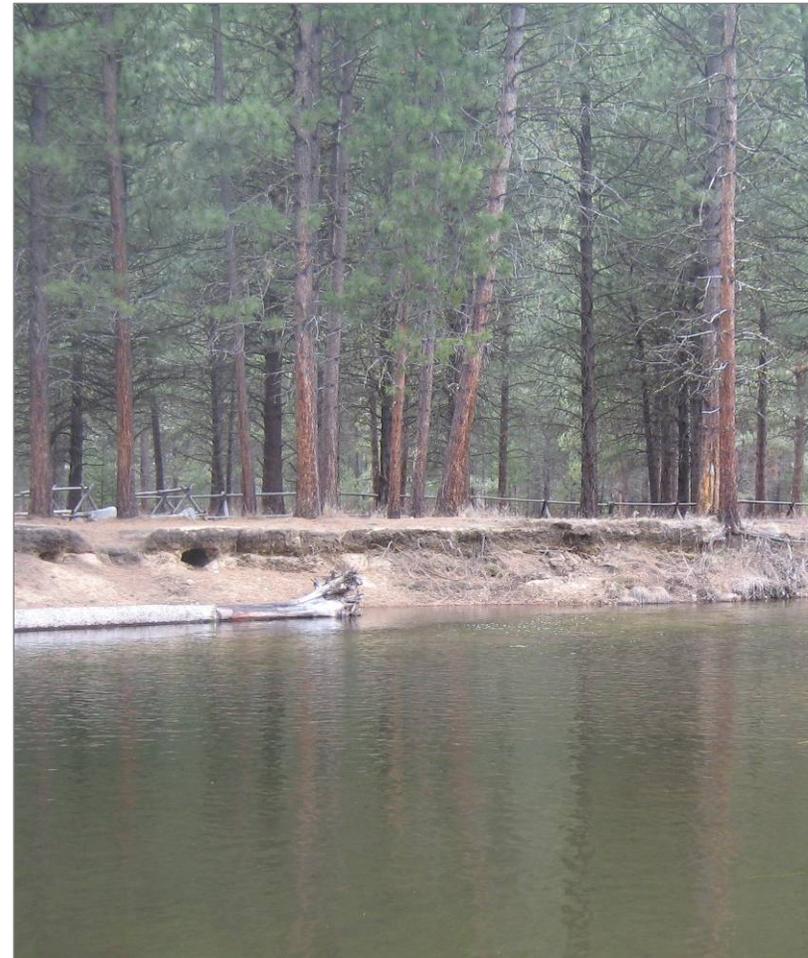


## Objectives and Need for Restoration

The UCHRP has sought to identify Upper Columbia Tributaries that provide the most complete combination of several important attributes: 1) opportunities to protect intact physical and ecological processes that sustain long-term formation and maintenance of salmonid habitat, 2) opportunities to protect existing high-quality salmonid habitat, 3) opportunities to enhance and reconnect river and riparian ecological processes and habitats, 4) opportunities for near-term increases in habitat diversity and complexity, 5) opportunities to develop long-term partnerships with local individuals, public, and private entities with the common goal of salmonid habitat preservation and restoration. Areas of river that encompass these attributes are more likely to achieve the objectives that have been set forth in major salmonid recovery plans for the Upper Columbia basin and its tributaries. The UCHRP believes that the Chewuch River within USFS lands has a beneficial combination of these attributes and that restoration of river processes and salmonid habitat within these reaches has a high chance of success.

The DRAFT Aquatic Restoration Plan for the Lower Chewuch River (USFS 2009) describes habitat limiting factors and restoration strategies for the lower Chewuch River and tributaries up to river mile 24.3. Tier 1 and 2 recommended habitat actions include restoration of water quantity, restoration of habitat diversity (habitat-forming processes, LWD, and side-channels), reduction in fine sediment, riparian restoration, and addressing ecological interactions. The project opportunities identified in the Yakama Nation RA are consistent with these

USFS restoration strategies and also reflect the objective of a collaborative approach to accomplishing meaningful habitat restoration within the lower Chewuch River.



## SALMONID USE AND POPULATION STATUS

Salmonid use of the Chewuch River includes spring Chinook salmon, summer run steelhead, bull trout, cutthroat trout, and resident rainbow trout. Species, ESA status, and life-stage usage of the study area are included in Table 1.

Human-induced changes to aquatic habitat have affected the key parameters used by federal agencies to evaluate the viability of salmonid populations; known collectively as the “viable salmonid population” (VSP) parameters: abundance, productivity, diversity, and spatial structure (UCSRB 2007). Specific habitat impacts are described in the following section.

Species	ESA Status	Life Stages	
		High Density or Abundant Use	General Use
Spring Chinook	Endangered	Migration	Spawning Rearing
Steelhead	Threatened	Migration	Spawning Rearing
Bull Trout	Threatened		Foraging Migration Over-wintering
Westslope cutthroat trout	Not listed		Present
Redband rainbow trout	Not listed		Present
Brook Trout	Not listed (non-native)		Present

Table 1. Species usage in the Chewuch River. Adapted from the US Bureau of Reclamation (2008).

## HABITAT CONDITIONS

In general, reaches of the Chewuch River within USFS lands provide some of the best habitat in the RA study area. Human-induced changes to the channel and floodplain are less common than in downstream reaches that flow through private lands. Nevertheless, habitat has been impacted by over a century of land uses within the stream corridor and contributing watershed, including logging, road building, bridges, bank armoring, riparian clearing, agriculture, and recreation. In order to summarize and characterize habitat conditions within the study area, previous USFS and recent Yakama Nation stream surveys were used to conduct a Reach-Based Ecosystem Indicators (REI) assessment. The full results of this assessment are presented in the RA; but a subset is included below for the USFS reaches (Table 2). Based on this assessment, several parameters were found to be consistently At Risk or Unacceptable. LWD was consistently in an Unacceptable condition; and pool frequency, pool quality, and canopy cover were commonly rated as At Risk. These deficiencies may be attributed to several past and on-going land uses including timber harvest, riparian clearing, road building, and LWD removal.

Additional geomorphic, vegetation, and habitat conditions are summarized in Table 3 for all of the reaches in the RA study area.

Table 2. REI results for USFS reaches in the lower Chewuch River downstream of river mile 20. Excerpted with modification from the Chewuch River Reach Assessment (2010).

General Characteristics	General Indicators	Specific Indicators	Reach C3b	Reach C4	Reach C5/6	Reach C7	Reach C8	Reach C9
Habitat Access	Physical Barriers	Main Channel Barriers	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>
Habitat Quality	Substrate	Dominant Substrate/Fine Sediment	<i>Adequate</i>	<i>At Risk</i>	<i>At Risk</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>
	LWD	Pieces per Mile at Bankfull	<i>Unacceptable</i>	<i>Unacceptable</i>	<i>Unacceptable</i>	<i>Unacceptable</i>	<i>Unacceptable</i>	<i>Adequate</i>
	Pools	Pool Frequency and Quality	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>	<i>At Risk</i>	<i>Adequate</i>	<i>At Risk</i>
	Off-Channel Habitat	Connectivity with Main Channel	<i>Adequate</i>	<i>At Risk</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>
Channel	Dynamics	Floodplain Connectivity	<i>Adequate</i>	<i>Unacceptable</i>	<i>At Risk</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>
		Bank Stability/ Channel Migration	<i>Adequate</i>	<i>At Risk</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>
		Vertical Channel Stability	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>
Riparian Vegetation	Condition	Structure	<i>No Data</i>					
		Disturbance (Human)	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>	<i>Adequate</i>
		Canopy Cover	<i>At Risk</i>	<i>Unacceptable</i>	<i>At Risk</i>	<i>At Risk</i>	<i>Unacceptable</i>	<i>Unacceptable</i>

Table 3. Summary of geomorphic and habitat conditions among reaches in the lower Chewuch River. Reaches that include USFS lands are C3b through C9. This table is excerpted from the Chewuch River Reach Assessment (2010).

	Channel Metric	Reach												
		C2a	C2b	C3a	C3b	C4a	C4b	C4c	C5a	C5b	C6	C7	C8	C9
	Sinuosity	1.25	1.06	1.1	1.08	1.12	1.75	1.1	1.19	1.21	1.06	1.05	1.2	1.2
	Gradient	0.005	0.007	0.009	0.015	0.0012	0.0029	0.0046	0.0025	0.0035	0.0144	0.006	0.003	0.01
	Floodplain Width (ft)	700	444	225	152	331 <sup>1</sup>	331 <sup>1</sup>	331 <sup>1</sup>	114 <sup>2</sup>	114 <sup>2</sup>	114 <sup>2</sup>	362	242	154
	BF Width (ft)	140	134	120	98	117 <sup>1</sup>	117 <sup>1</sup>	117 <sup>1</sup>	121 <sup>2</sup>	121 <sup>2</sup>	121 <sup>2</sup>	96	106	84
% of Habitat Area	Pools	55.6%	42.7%	27.4%	18.8%	45.3% <sup>1</sup>	45.3% <sup>1</sup>	45.3% <sup>1</sup>	45.8% <sup>2</sup>	45.8% <sup>2</sup>	45.8% <sup>2</sup>	35.3%	35.1%	25.2%
	Riffles	33.8%	40.7%	59.6%	53.0%	36.2% <sup>1</sup>	36.2% <sup>1</sup>	36.2% <sup>1</sup>	29.9% <sup>2</sup>	29.9% <sup>2</sup>	29.9% <sup>2</sup>	45.3%	38.2%	59.4%
	Glides	7.7%	14.8%	5.6%	4.6%	17.4% <sup>1</sup>	17.4% <sup>1</sup>	17.4% <sup>1</sup>	13.6% <sup>2</sup>	13.6% <sup>2</sup>	13.6% <sup>2</sup>	19.5%	22.8%	3.9%
	Side-Channel	2.9%	1.8%	7.5%	23.6%	1.1% <sup>1</sup>	1.1% <sup>1</sup>	1.1% <sup>1</sup>	10.7% <sup>2</sup>	10.7% <sup>2</sup>	10.7% <sup>2</sup>	0.0%	3.9%	11.5%
Human Alterations	% Floodplain Disconnected <sup>3</sup>	20.1%	12.6%	68.5%	0.0%	0.0%	63.7%	63.5%	0.0%	18.0%	59.2%	0.0%	0.0%	0.0%
	% Bank w/ Riprap <sup>4</sup>	0.3%	1.8%	1.7%	1.3%	8.6%	1.9%	12.1%	3.2%	0.0%	0.0%	0%	0%	0%
	% Native Riparian Vegetation	79.0% <sup>5</sup>	97.0% <sup>5</sup>	66.0% <sup>5</sup>	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	% Riparian Veg Cleared	3 - 25% <sup>6</sup>	3 - 25% <sup>6</sup>	10 - 35% <sup>6</sup>	10 - 35% <sup>6</sup>	13 - 17% <sup>6</sup>	13 - 17% <sup>6</sup>	13 - 17% <sup>6</sup>	Minimal <sup>6</sup>	Minimal <sup>6</sup>	<20% <sup>7</sup>	Minimal <sup>7</sup>	Minimal <sup>7</sup>	Minimal <sup>7</sup>

<sup>1</sup> Data available for reaches C4a, C4b, C4c were reported as a larger combined reach (BOR 2008a).

<sup>2</sup> Data available for reaches C5a, C5b, C6 were reported as a larger combined reach (USFS 2008).

<sup>3</sup> Floodplain disconnection is based on an analysis of Inner Zone and Outer Zone polygons (see Section 4.1).

<sup>4</sup> Percentage of the bank protected with riprap was calculated using human features data obtained through remote sensing and field surveys and compiled in a GIS database by the BOR (2008b) and Inter-Fluve (2009).

<sup>5</sup> Riparian vegetation species composition was analyzed using a 30 meter buffer on either side of the Chewuch River in combination with the BOR vegetation GIS data (BOR 2008b).

<sup>6</sup> USBR 2008b.

<sup>7</sup> Percent riparian vegetation (within 30 meter buffer) cleared based on aerial photo analysis.

## OBJECTIVES FOR LOWER CHEWUCH USFS REACHES

The overall objective is to protect and restore habitat-forming processes in order to benefit ESA-listed aquatic species. Habitat restoration work proposed within the USFS reaches focus primarily on addressing degraded physical processes and habitat limiting factors identified in the RA and the USFS Aquatic Restoration Plan (USFS 2009); including lack of LWD and degraded riparian areas. Proposed restoration efforts are aimed at providing habitat and restoring physical processes to provide abundant and complex in-channel and off-channel habitats that can be utilized by salmonids during key life history periods.

The various types of project categories that are proposed for USFS reaches are listed below with objectives and examples for each project type category.

### ***Reconnect Stream Channel Processes***

These project types focus on re-establishing dynamic processes in areas where stream bio-physical processes have been disconnected due to anthropogenic activities thus regaining habitat and process that was previously a functional part of the river system. The specific actions identified on USFS lands are:

- Riprap Removal or Modification
- Abandoned bridge abutment removal
- Re-Establish Channel LWD Dynamics
- LWD placement to enhance lateral connectivity



### ***Reconnect Floodplain Processes***

These projects are focused on reclaiming disconnected off-channel processes that have been lost due to anthropogenic activities, thus regaining habitat and process that was previously a functional part of the river system. The specific actions identified on USFS lands are:

- Off-Channel habitat reconnection
- Side-Channel habitat reconnection

### ***Riparian Re-Vegetation***

Riparian restoration projects are located in areas where native riparian vegetation communities have been significantly impacted by anthropogenic activities such that riparian functions and connections with the stream are compromised. Restoration actions are focused on restoring native vegetation communities in order to reestablish natural stream stability, stream shading, nutrient exchange, and large woody debris recruitment.

### ***Instream Habitat Enhancement***

Instream enhancement projects typically involve active restoration measures that either directly increase key habitat components or indirectly improve habitat through structural enhancements that restore habitat-forming processes (e.g. pool scour from a LWD jam). The specific actions identified on USFS lands are:

- Placement of LWD jams or individual pieces in natural wood depositional areas



### ***Off-Channel Habitat Enhancement***

These projects are located in off-channel areas (e.g. floodplains) where there is the potential to increase the quantity and quality of off-channel habitat. These projects may include excavation of off-channel areas to increase the quantity or connectivity of habitats. The specific actions identified on USFS lands are:

- Side-channel habitat enhancement
- Enhance Side-Channel Connectivity
- Wetland Habitat Enhancement
- Alcove Habitat Enhancement
- Off-Channel Habitat Enhancement



# Project Development and Risk Assessment

Inter-Fluve's design approach to restoration considers the biological benefit, feasibility, safety, and stability of projects through a repeatable process of assessing site conditions and evaluating the performance of project components. Hydrologic, hydraulic, and fluvial geomorphic analyses are essential components of feasibility studies and design. Design investigations regularly include field discharge measurements, statistical analysis of flood probabilities and return intervals, synthetic derivation of channel flow, and determination of channel-forming discharge using a wide variety of methods and models catered to each particular project site. Hydraulic analyses include one and two dimensional flow modeling; scour and incipient motion analyses; and hydraulic performance of structures.

## PROJECT DEVELOPMENT PROCESS

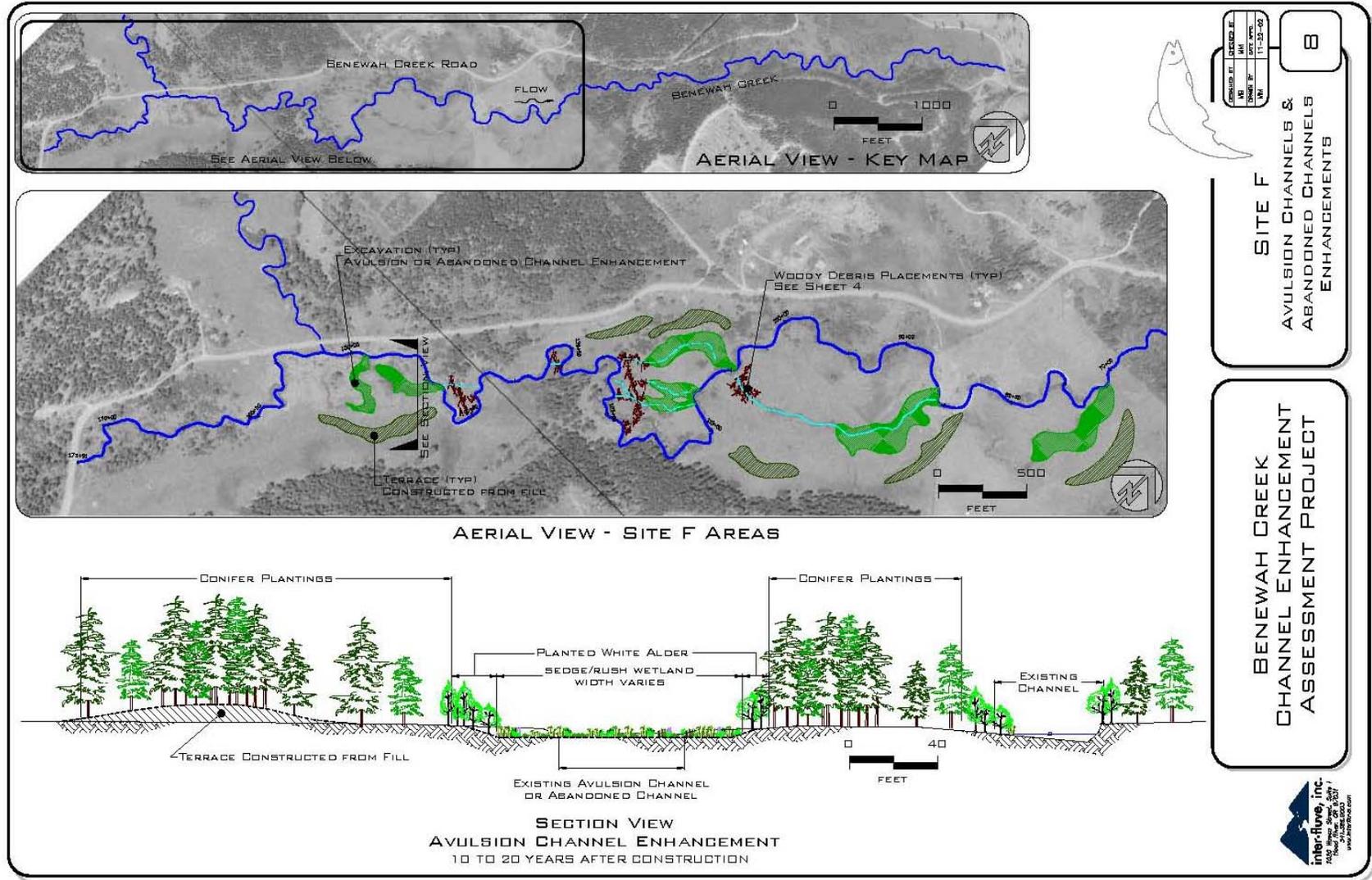
For most projects, the design process begins with stakeholder meetings to identify project objectives and constraints (including stability and safety) that are then transformed into actual design criteria to guide the design process. Once design criteria have been established, hydraulic, hydrologic, environmental, biological and fluvial geomorphic assessment is performed to identify risks and feasibility of project components. Habitat conditions and river processes are evaluated at the watershed-, reach-, and site-scales. Each project includes field reconnaissance, topographic

survey, and data collection depending on the type, scope, and scale of the project. Use of remote sensing data including aerial photography and digital terrain models are frequently used in combination with on-the-ground survey data. For most projects, field and remote-sensing data are used for flood inundation analysis, stream energy evaluations, and to characterize sediment transport conditions. Following analysis of baseline conditions, a range of conceptual design alternatives are typically developed for stakeholder/client review. Based on the input received, a preferred alternative is moved forward through final design, permitting, construction-ready documentation, and implementation. Inter-Fluve typically provides construction oversight for projects.

## RISK ASSESSMENT

Each project is guided by a set of design criteria that include not only habitat objectives but also performance objectives such as stability, public safety, and risk to infrastructure. During the design investigations, structural elements of the project are tested through hydraulic and hydrologic models to determine a final design that will hold through the 'design' event. The 'design' event is determined according to a number of potential considerations, including the proximity of infrastructure, recreational uses, permit requirements, and concerns of stakeholders. In some situations, projects can be designed to adjust in response to disturbance (e.g. floods) similar to how a natural system will respond to disturbance. In other situations, tolerance for adjustment may be low and structural elements must be designed to ensure long term stability and public safety.

Sample Conceptual Design Drawing.







## 1. BOULDER CREEK PROJECT GROUP: RM 8.4 – 9.2

### **Setting**

This is a locally steep, coarse, multi-thread channel downstream of the confluence of Boulder Creek and the Boulder Creek alluvial fan complex. There is dispersed camping along the terrace edge on river left where campers access the river and riparian clearing has occurred. This reach has a relatively low percentage of pool habitat (1.8%) but a high percentage of side-channel habitat (23%) compared to nearby geomorphic reaches. There is a major irrigation diversion near RM 9.2 that reduces flow during irrigation season. However, a return flow channel has been developed along the right margin of the floodplain that provides off-channel habitat.

### **Objectives**

Increase the connection between the active channel and active high-flow channels on the river right floodplain, or enhance the existing irrigation overflow channel to provide increased off-channel habitat. Enhance existing side-channel habitat along river left, potentially creating a perennially secondary channel using wood jams and select excavation. Work to protect and enhance riparian habitat near existing campgrounds on the river left terrace.

### **Project Descriptions**

Category: Off-Channel Habitat Enhancement.

Project: RM 8.8R - Side-Channel Habitat Enhancement.

Alternatives may include enhancing the connection of the natural channel system with select excavation and log jam placements, or enhancing the existing overflow channel to provide more floodplain habitat. There is a parcel of private property in the middle of the floodplain area. This is a highly dynamic section of channel and floodplain where the longevity of restoration work would need to be carefully considered in planning any restoration activities.

Category: Reconnect Stream Channel Processes.

Project: RM 9.05L - LWD Enhancement and Side-Channel Habitat Reconnection.

This project involves increasing connection between the main channel and an existing high flow side-channel along river left. LWD at the inflow and outflow points, and excavation as needed would connect the channel over a wider range of flows. This is a highly dynamic section of channel and floodplain where the longevity of restoration work would need to be carefully considered in planning any restoration activities.



## Boulder Creek Project Group (RM 8.4 - 9.2)

### Legend

● River Mile	— Bridge	— Diversion	— Headgate	— Riprap	□ Land Ownership
— Cabled Logs	— Filled Channel	— Levee	— Road		
— Dam	— Footbridge	— Log Structure	— Road-Bridge Embankment		
— Detroit Riprap	— Gabion	— Push-up Levee	— Waterpipe		



## 2. RM 9.5 PLUS PROJECT GROUP: RM 9.45 – 9.9

### **Setting**

The RM 9.5 Plus group is located in a confined channel section with near-surface bedrock on both sides of the valley, moderate sinuosity (1.12), and the Boulder Creek fan creates a downstream grade control that reduces reach gradient and drives deposition. This area had scarce amounts of in-channel LWD during stream surveys in 2008, with only 6 pieces of LWD/mile. Pools were relatively abundant and comprised approximately 45% of the habitat area in this and adjacent geomorphic reaches. There is good spawning habitat in the area dominated by gravel and small cobble sized substrate in riffle-pool and riffle-run sequences.

### **Objectives**

Re-establish natural channel processes and hydraulics by removing or modifying bank riprap along river right. Increase the quality and abundance of instream and off-channel habitat features using wood placements and select excavation.

### **Project Descriptions**

Category: Reconnect Stream Channel Processes.

Project: RM 9.7R - Riprap Removal or Modification.

Riprap along the toe of the road embankment alters channel hydraulics along river right. This material could be removed and replaced with wood, or left in place and modified with wood.

Category: Instream Habitat Enhancement

Projects: RM 9.5C and RM 9.85R - LWD Enhancement.

These projects involve placing log jams to increase the quality of instream habitat at select locations.

Category: Off-Channel Habitat Enhancement.

Projects: RM 9.6R - Side-Channel Habitat Enhancement and RM 9.7L - Alcove Habitat Enhancement.

These projects involve the use of wood placements and select excavation to increase connectivity and habitat quality in existing side-channels that connect to alcoves at their up or downstream ends.

Category: Off-Channel Habitat Enhancement.

Project: RM 9.9L - Alcove Habitat Enhancement.

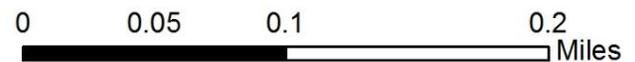
This project would enhance the habitat in an existing alcove using wood and potentially excavation.



## RM 9.5 Project Group (RM 9.45 - 9.9)

### Legend

- |                  |                |               |                        |        |                |
|------------------|----------------|---------------|------------------------|--------|----------------|
| ● River Mile     | Bridge         | Diversion     | Headgate               | Riprap | Land Ownership |
| — Cabled Logs    | Filled Channel | Levee         | Road                   |        |                |
| — Dam            | Footbridge     | Log Structure | Road-Bridge Embankment |        |                |
| — Detroit Riprap | Gabion         | Push-up Levee | Waterpipe              |        |                |



### **3. RM 11 PROJECT GROUP: RM 10.7 – 11.0**

#### ***Setting***

In the RM 11 Project Group area the channel is fairly straight and somewhat incised within glacial and alluvial terraces. The bed morphology is primarily riffle-run. Habitat complexity is low, with few side-channels, scarce LWD, and no connectivity to off-channel habitat. Anthropogenic disturbance includes a roadway along the east side of the valley with an occasional riprap bank where the river flows directly against the road embankment. There is residential development along river-left at the downstream end of the reach.

#### ***Objectives***

Re-establish natural channel processes and hydraulics by adding log jams to increase lateral dynamics. Increase the quality and abundance of off-channel habitat features using wood placements and select excavation.

#### ***Project Descriptions***

Category: Reconnect Stream Channel Processes

Project: RM 10.9C - Re-Establish Channel LWD Dynamics.

This project would create log jam features that would naturally occur in this area in order to create natural channel hydraulics and increase lateral dynamics.

Category: Off-Channel Habitat Enhancement.

Project: RM 10.8R - Off-Channel Habitat Enhancement.

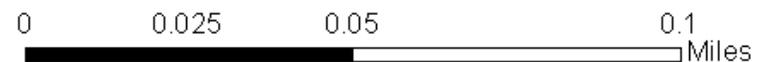
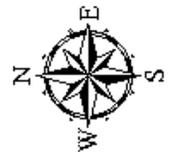
This project would use excavation to increase connectivity of a high-flow area on river right and create an off-channel backwater at the downstream end.



## RM 11 Project Group (RM 10.7-11.0)

### Legend

- |                  |                  |                 |                          |          |                  |
|------------------|------------------|-----------------|--------------------------|----------|------------------|
| ◆ River Mile     | — Bridge         | — Diversion     | — Headgate               | — Riprap | □ Land Ownership |
| — Cabled Logs    | — Filled Channel | — Levee         | — Road                   |          |                  |
| — Dam            | — Footbridge     | — Log Structure | — Road-Bridge Embankment |          |                  |
| — Detroit Riprap | — Gabion         | — Push-up Levee | — Waterpipe              |          |                  |



#### **4. EIGHTMILE RANCH PROJECT GROUP: RM 11.0 – 11.6**

##### ***Setting***

The 8 Mile Ranch Project Group is located downstream of the confluence of 8 Mile Creek in a confined, straight channel with low habitat complexity, no off-channel areas, scarce LWD, and riparian clearing that prohibits future LWD recruitment. Anthropogenic disturbance is focused on 8 Mile Ranch which is located on the terrace on river right. The riparian forest has been cleared in this area.

##### ***Objectives***

Re-establish a riparian corridor along river right in order to provide cover, thermal shading, and a long-term source for LWD. Increase the quality and abundance of existing instream habitat.

##### ***Project Descriptions***

Category: Riparian Restoration.

Project: RM 11.35R Riparian Revegetation.

Replant the native riparian forest along the channel margin to re-connect exiting patches of riparian vegetation creating a continuous riparian corridor along the channel, and a buffer between the channel and agricultural areas on the terrace.

Category: Instream Habitat Enhancement.

Projects: RM 11.0C and RM 11.5C - LWD Enhancement.

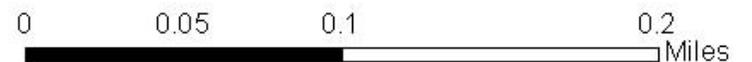
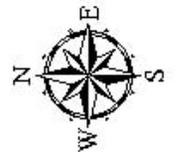
These projects involve placing log jams at multiple locations on both sides of the channel to increase the quality and abundance of instream habitat.



## 8 Mile Ranch Project Group (RM 11.0-11.6)

### Legend

◆ River Mile	— Bridge	— Diversion	— Headgate	— Riprap	□ Land Ownership
— Cabled Logs	— Filled Channel	— Levee	— Road		
— Dam	— Footbridge	— Log Structure	— Road-Bridge Embankment		
— Detroit Riprap	— Gabion	— Push-up Levee	— Waterpipe		



## 5. RM 12 PROJECT GROUP: RM 11.7 – 12.1

### *Setting*

The channel in this area is unconfined with low sinuosity and well-connected floodplain channels and active side-channels providing high quality habitat and complexity. Human alteration is minor and primarily includes a roadway that parallels the channel along the east side of the reach along the hillslope toe. There are also camping areas on terraces and in the floodplain. Geomorphic reaches in this area had relatively abundant amounts of in-channel LWD during stream surveys in 2008, with 17.6 pieces of LWD/mile. Pools were also relatively abundant, comprising approximately 46% of the habitat area. The surveys found excellent spawning gravel and noted that these reaches were some of the most productive in the Chewuch River for steelhead and spring Chinook.

### *Objectives*

Re-establish natural channel processes and hydraulics by removing or modifying bank riprap along river right. Increase the quality and abundance of instream and off-channel habitat features using wood placements and select excavation.

### *Project Descriptions*

Category: Reconnect Stream Channel Processes

Project: RM 11.75L - Riprap Removal or Modification.

Riprap along the toe of the road embankment alters channel hydraulics along river left. This material could be removed and replaced with wood, or left in place and modified with wood.

Category: Instream Habitat Enhancement.

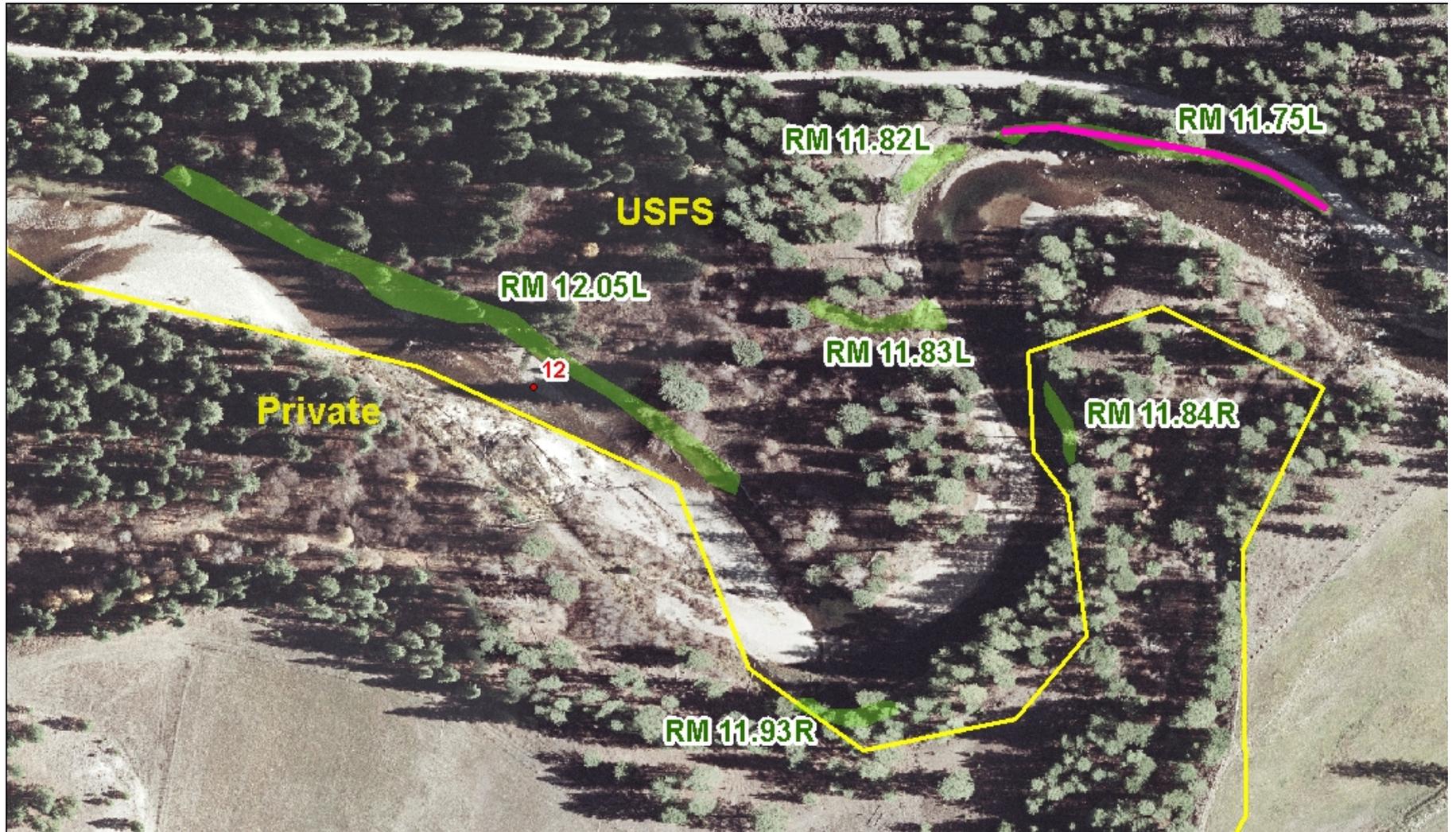
Projects: RM 11.82L, RM 11.84R, RM 11.93R, and RM 12.05R - LWD Enhancement.

These projects involve placing log jams along channel banks to increase the quality of instream habitat at select locations on both sides of the channel.

Category: Off-Channel Habitat Enhancement.

Project: RM 11.83L - Off-Channel Habitat Enhancement.

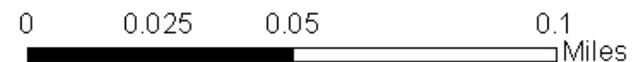
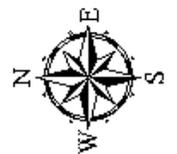
This project would enhance the habitat in an existing off-channel alcove using wood and potentially excavation. The location has potential for future channel avulsion, which would be assessed in more detailed investigation.



## RM 12 Project Group (RM 11.7-12.1)

### Legend

◆ River Mile	— Bridge	— Diversion	— Headgate	— Riprap	□ Land Ownership
— Cabled Logs	— Filled Channel	— Levee	— Road		
— Dam	— Footbridge	— Log Structure	— Road-Bridge Embankment		
— Detroit Riprap	— Gabion	— Push-up Levee	— Waterpipe		



## 6. EIGHTMILE CREEK PROJECT GROUP: RM 12.2 – 13.0

### **Setting**

The channel in this area is unconfined with low sinuosity and well-connected floodplain channels and active side-channels providing high quality habitat and complexity. Human alteration is minor and primarily includes a roadway that parallels the channel along the east side of the reach along the hillslope toe. There are also camping areas on terraces and in the floodplain. Geomorphic reaches in this area had relatively abundant amounts of in-channel LWD during stream surveys in 2008, with 17.6 pieces of LWD/mile. Pools were also relatively abundant, comprising approximately 46% of the habitat area. The surveys found excellent spawning gravel and noted that these reaches were some of the most productive in the Chewuch River for steelhead and spring Chinook.

### **Objectives**

Re-establish natural channel processes and hydraulics by reintroducing large wood jams that will encourage lateral channel dynamics, and scour/depositional processes. Re-establish natural channel/floodplain connectivity mitigating floodplain roadways and potentially excavating flood channel topography. Increase the quality and abundance of instream and off-channel habitat features using wood placements and select excavation.

### **Project Descriptions**

Category: Reconnect Stream Channel Processes.

Projects: RM 12.3C, RM 12.5L, RM 12.63L - LWD Placement to Enhance Lateral Connectivity and Mitigate Roadway Impacts.

Large apex and channel log jams would be used to increase the hydraulic complexity of the channel and re-establish natural channel processes such as lateral channel dynamics. In particular, lateral log jams would be used to encourage the river to migrate away from the road embankment on river left.

Category: Reconnect Floodplain Processes.

Project: RM 12.45R - Enhance Floodplain Connectivity.

The project would enhance connectivity to a large off-channel pond through culvert improvement, side-channel enhancement, or enhancement of downstream outlets.

Category: Instream Habitat Enhancement.

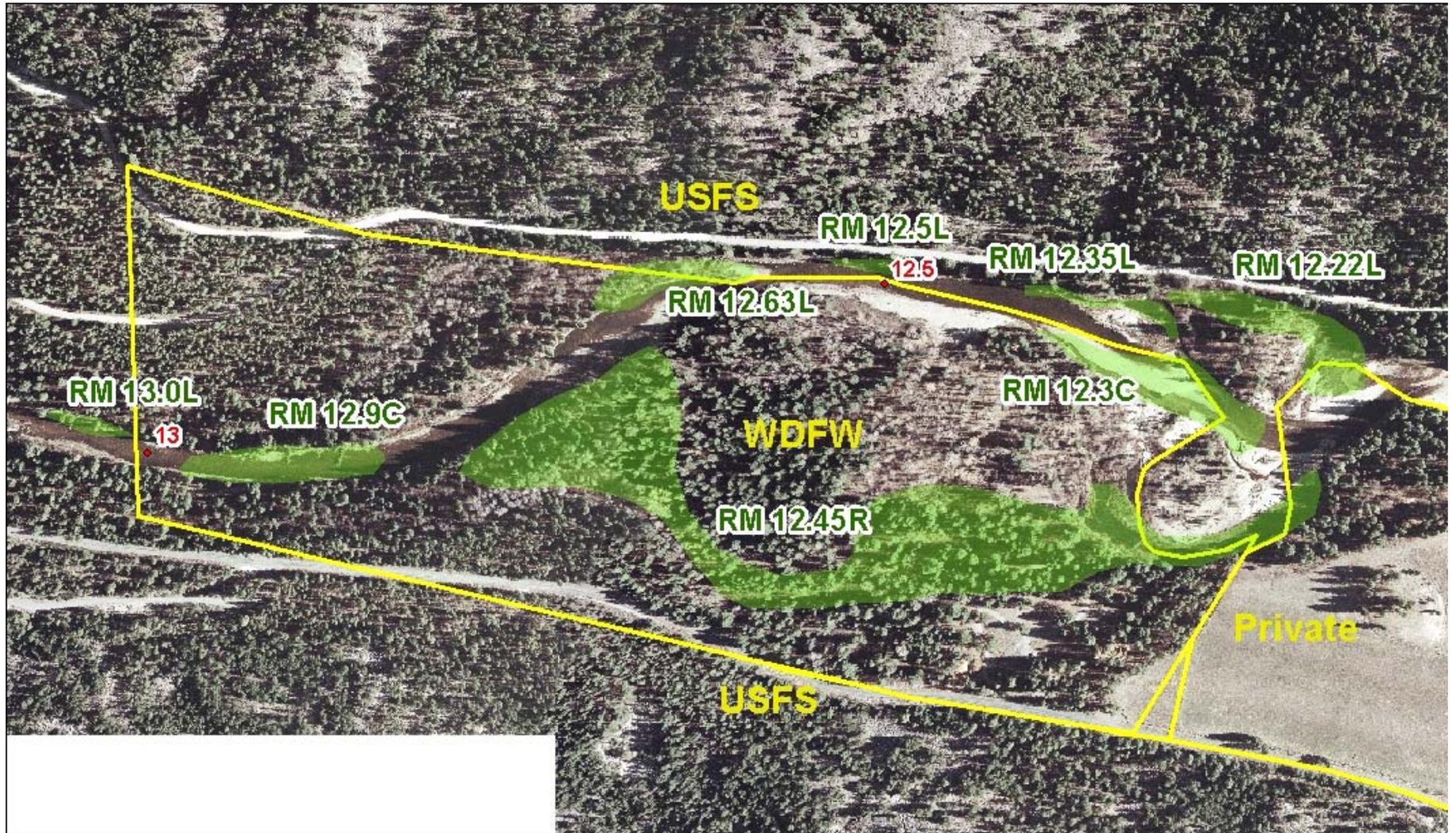
Projects: RM 11.82L, RM 11.84R, RM 11.93R, and RM 12.05R -LWD Enhancement.

These projects involve placing log jams along channel banks to increase the quality of instream habitat at multiple locations on both sides of the channel.

Category: Off-Channel Habitat Enhancement.

Projects: RM 12.22L - Alcove and Side-Channel Habitat Enhancement, and RM 12.35L - Alcove Habitat Enhancement.

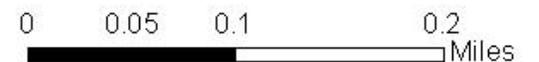
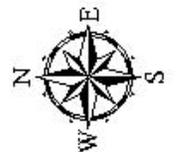
These projects will enhance the habitat in existing off-channel features including two alcoves and a well-connected side-channel using wood and potentially excavation.



## 8 Mile Creek Project Group (RM 12.2-13.0)

### Legend

◆ River Mile	— Bridge	— Diversion	— Headgate	■ Riprap	□ Land Ownership
— Cabled Logs	— Filled Channel	— Levee	— Road		
— Dam	— Footbridge	— Log Structure	■ Road-Bridge Embankment		
— Detroit Riprap	— Gabion	■ Push-up Levee	— Waterpipe		



## 7. FALLS CREEK PROJECT GROUP: RM 13.0 – 14.1

### **Setting**

In this area the channel is unconfined, low gradient (0.3%), sinuous, and actively meandering across a broad, flat valley with width ranging from 1,200 to 1,700 ft. Glacial terraces bound the valley on both sides. There is very little human development in the reach. Riparian forests are intact except for some agricultural clearing near the upstream end of the reach. Roads parallel the channel on both sides of the valley, but are located on hillslopes above the floodplain. Geomorphic reaches in this area had relatively abundant amounts of in-channel LWD during stream surveys in 2008, with 17.6 pieces of LWD/mile. Pools were also relatively abundant, comprising approximately 46% of the habitat area. The surveys found excellent spawning gravel and noted that these reaches were some of the most productive in the Chewuch River for steelhead and spring Chinook.

### **Objectives**

Re-establish natural channel processes and hydraulics by reintroducing large wood jams that will encourage lateral channel dynamics, and scour/depositional processes. Re-establish natural channel/floodplain connectivity mitigating floodplain roadways and potentially excavating flood channel topography. Increase the quality and abundance of instream and off-channel habitat features using wood placements and select excavation.

### **Project Descriptions**

Category: Reconnect Stream Channel Processes.

Project: RM 13.6C - LWD to Enhance Lateral Connectivity.

This project involves bar apex and channel margin jams to re-establish dynamic geomorphic processes.

Category: Riparian Restoration.

Project: RM 13.8R - Riparian Re-Vegetation.

Re-establish native riparian vegetation community to provide shade, cover, habitat quality, and future wood recruitment.

Category: Instream Habitat Enhancement.

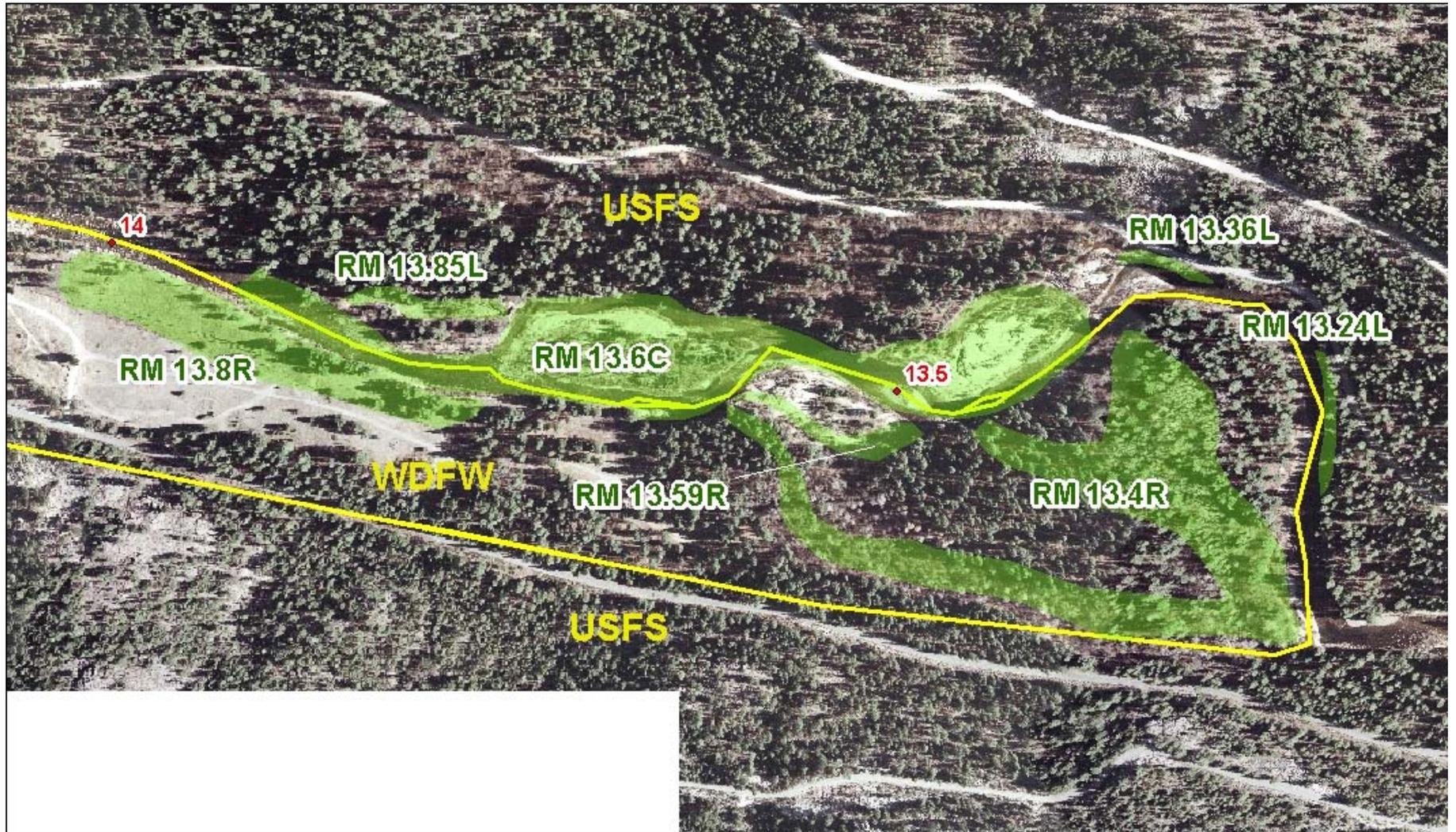
Projects: RM 13.24L and RM 13.36L - LWD Enhancement.

These projects involve placing log jams along channel banks to increase the quality of instream habitat at multiple locations on both sides of the channel, as well as to provide bank stability along areas where riparian clearing has removed natural stabilizing features.

Category: Off-Channel Habitat Enhancement.

Projects: RM 13.59R and RM 13.85L - Side-Channel Habitat Enhancement.

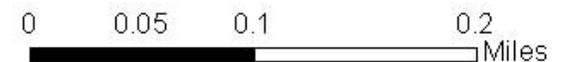
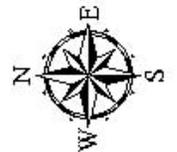
These projects would enhance the connectivity of existing side-channel features using wood and select excavation.



## Falls Creek Project Group (RM 13.0-14.1)

### Legend

◆ River Mile	— Bridge	— Diversion	— Headgate	— Riprap	□ Land Owners hip
— Cabled Logs	— Filled Channel	— Levee	— Road		
— Dam	— Footbridge	— Log Structure	— Road-Bridge Embankment		
— Detroit Riprap	— Gabion	— Push-up Levee	— Waterpipe		



## **8. SPRING CREEK PROJECT GROUP: RM 14.1 – 15.4**

### ***Setting***

This portion of the Chewuch River is a confined reach flowing between alluvial fan deposits to the east and bedrock and glacial deposits to the west. Habitat complexity is low in this reach, with few pools, no side-channels, and reduced fish production in comparison to nearby geomorphic reaches. There is very little human activity affecting the channel or floodplain areas. There are roads that parallel the river corridor on both sides of the valley for the entire length of the reach, but they do not impinge on the channel or floodplain except for short distances. This area had scarce amounts of in-channel LWD during stream surveys in 2008, with only 4.4 pieces of LWD/mile. Pools comprised approximately 35% of the habitat area. The substrate is relatively coarse and limits the availability of productive spawning habitat for steelhead and spring Chinook.

### ***Objectives***

Re-establish natural channel processes and hydraulics by reintroducing large wood jams that will encourage lateral channel dynamics and by removing remnant bridge infrastructure that alters local hydraulics. Increase the quality and abundance of instream habitat features using wood placements.

### ***Project Descriptions***

Category: Reconnect Stream Channel Processes.

Projects: RM 14.49C - Bridge Abutment Removal, and 14.53C - LWD Placement to Enhance Lateral Connectivity.

The LWD project involves placement of multiple jams on both sides of the channel and on a channel bar to increase scour/deposition and lateral dynamics. Removal of the bridge abutment is intended to return natural hydraulic conditions to the channel.

Category: Instream Habitat Enhancement.

Projects: RM 14.39L, RM 14.65R, 14.76L, and RM 15.15C - LWD Enhancement.

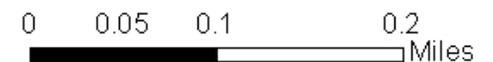
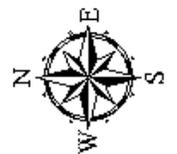
These projects involve placing log jams along channel banks and bars to increase the quality of instream habitat and geomorphic complexity at multiple locations. There is existing planform complexity that would benefit from the addition of natural levels of channel wood.



## Spring Creek Project Group (RM 14.1-15.4)

### Legend

◆ River Mile	— Bridge	— Diversion	— Headgate	— Riprap	□ Land Ownership
— Cabled Logs	— Filled Channel	— Levee	— Road		
— Dam	— Footbridge	— Log Structure	— Road-Bridge Embankment		
— Detroit Riprap	— Gabion	— Push-up Levee	— Waterpipe		



## 9. RM 16 PROJECT GROUP: RM 15.4 – 16.5

### **Setting**

In the area of this project group the channel is moderately confined. There are large, well-connected floodplain areas providing off-channel habitat. There is relatively high sinuosity, low gradient, and high channel and habitat complexity. An alluvial fan creates confinement at the downstream end of the group. The geomorphic reach containing the RM 16 Project Group had a moderate abundance of in-channel LWD during stream surveys in 2008, comprising 17 pieces of LWD/mile. Pools composed approximately 35% of the habitat area. The substrate is dominated by cobbles, which limits the availability of productive spawning habitat for steelhead and spring Chinook. Side-channel habitat was relatively abundant at 3.9% of the total habitat area, but there was some concern with filling of off-channel areas with sediment. The only sources of human disturbance in the reach are roads with riprap along the channel margin at a few locations on the west side of the valley.

### **Objectives**

Re-establish natural channel processes and hydraulics by reintroducing large wood jams that will encourage lateral channel dynamics, reconnecting side-channels, and removing or modifying riprap that alters local hydraulics. Re-establish natural floodplain processes by re-connecting off-channel habitat. Increase the quality and abundance of instream habitat features using wood placements.

### **Project Descriptions**

Category: Reconnect Stream Channel Processes.

Projects: RM 15.65R, 15.9C, and 16.4R - LWD Placement to Enhance Lateral Connectivity, and 15.8R - Riprap Removal or Modification.

The LWD projects involve placement of multiple jams on meander bends and channel bars to increase lateral dynamics and connectivity between the channel and a moderately connected side-channel. Riprap removal or modification involves material protecting the toe of the road embankment that may be potentially replaced or modified with wood.

Category: Reconnect Floodplain Processes.

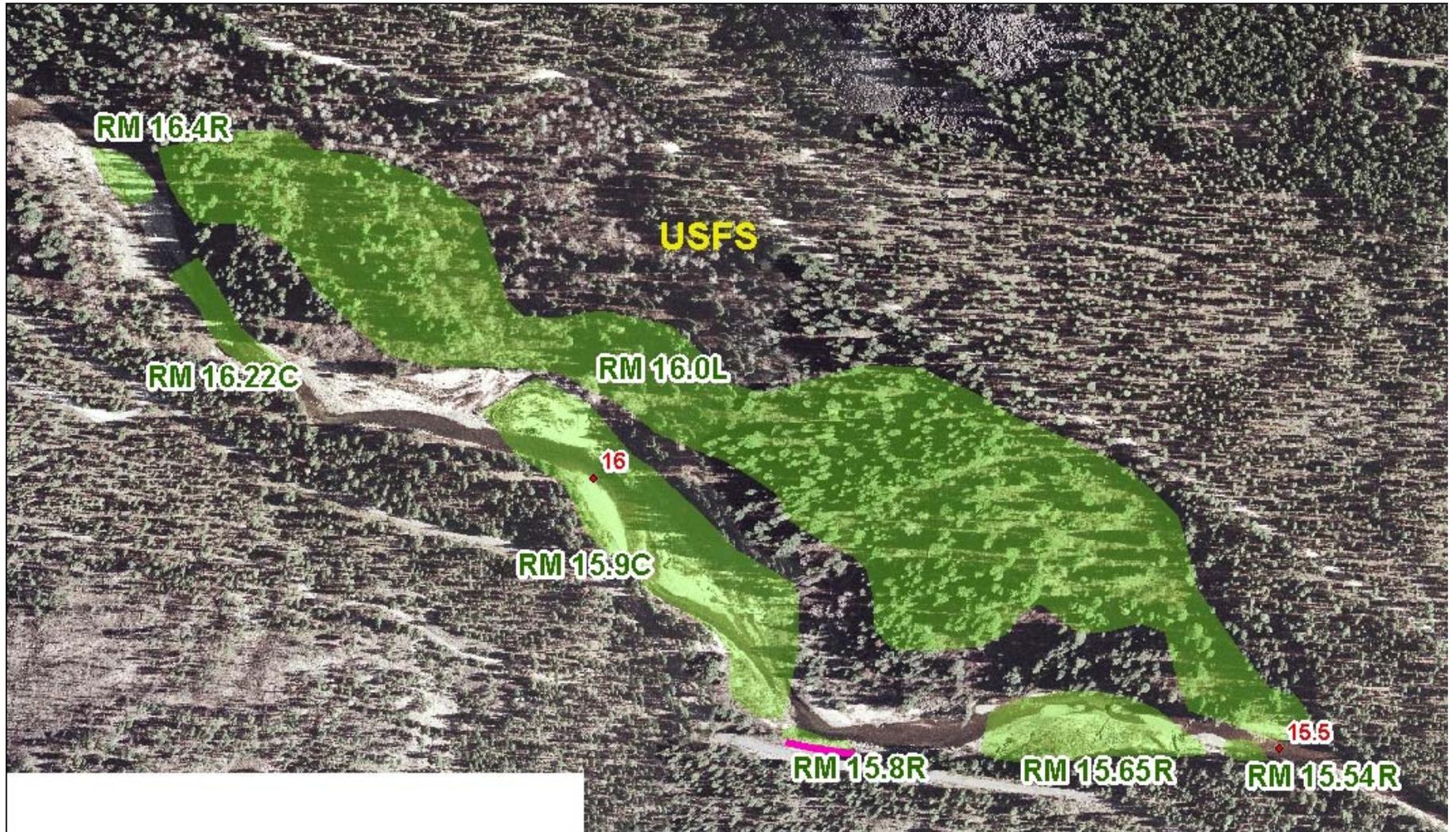
Project: RM 16.0L - Off-Channel Habitat Reconnection.

This project would use channel margin wood placements and excavation to create surface water connection to large off-channel wetlands and channel networks.

Category: Instream Habitat Enhancement.

Projects: RM 15.54R and RM 16.22C - LWD Enhancement.

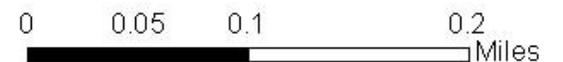
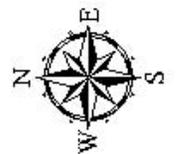
These projects involve placing log jams along channel banks and bars to increase the quality of instream habitat and geomorphic complexity at multiple locations. These projects would enhance existing cover on cut-banks with overhanging root wads.



## RM 16 Project Group (RM 15.4-16.5)

### Legend

◆ River Mile	— Bridge	— Diversion	— Headgate	— Riprap	□ Land Ownership
— Cabled Logs	— Filled Channel	— Levee	— Road		
— Dam	— Footbridge	— Log Structure	— Road-Bridge Embankment		
— Detroit Riprap	— Gabion	— Push-up Levee	— Waterpipe		



## 10. JUNIOR CREEK PROJECT GROUP: RM 16.5 – 17.5

### **Setting**

In the area of this project group the channel is moderately confined. There are large, well-connected floodplain areas providing off-channel habitat. There is relatively high sinuosity, low gradient, and high channel and habitat complexity. An alluvial fan creates confinement at the upstream end of the group. The geomorphic reach containing the Junior Creek Project Group had a moderate abundance of in-channel LWD during stream surveys in 2008, comprising 17 pieces of LWD/mile. Pools composed approximately 35% of the habitat area. The substrate is dominated by cobbles, which limits the availability of productive spawning habitat for steelhead and spring Chinook. Side-channel habitat was relatively abundant at 3.9% of the total habitat area, but there was some concern with filling of off-channel areas with sediment. The only sources of human disturbance in the reach are roads with riprap along the channel margin at a few locations on the west side of the valley.

### **Objectives**

Re-establish natural channel processes and hydraulics by reintroducing large wood jams that will encourage lateral channel dynamics, reconnecting side-channels, and removing or modifying riprap that alters local hydraulics. Re-establish natural floodplain processes by re-connecting off-channel habitat. Increase the quality and abundance of instream and off-channel habitat features using wood placements.

### **Project Descriptions**

Category: Reconnect Stream Channel Processes.

Projects: RM 16.65C and 17.16L - LWD Placement to Enhance Lateral Connectivity, 17.31R - Riprap Removal or Modification, and 17.45L - Side-Channel Habitat Reconnection.

The LWD projects involve placement of meander bend and bar apex jams to increase lateral dynamics and side-channel connectivity. The riprap project involves replacing or modifying riprap with LWD.

Category: Reconnect Floodplain Processes.

Project: RM 16.7L - Off-Channel Habitat Reconnection.

This project would use channel margin wood placements and excavation to create surface water connection to a network of floodplain channels and wet depressions. These features do not currently display active channel connections.

Category: Instream Habitat Enhancement.

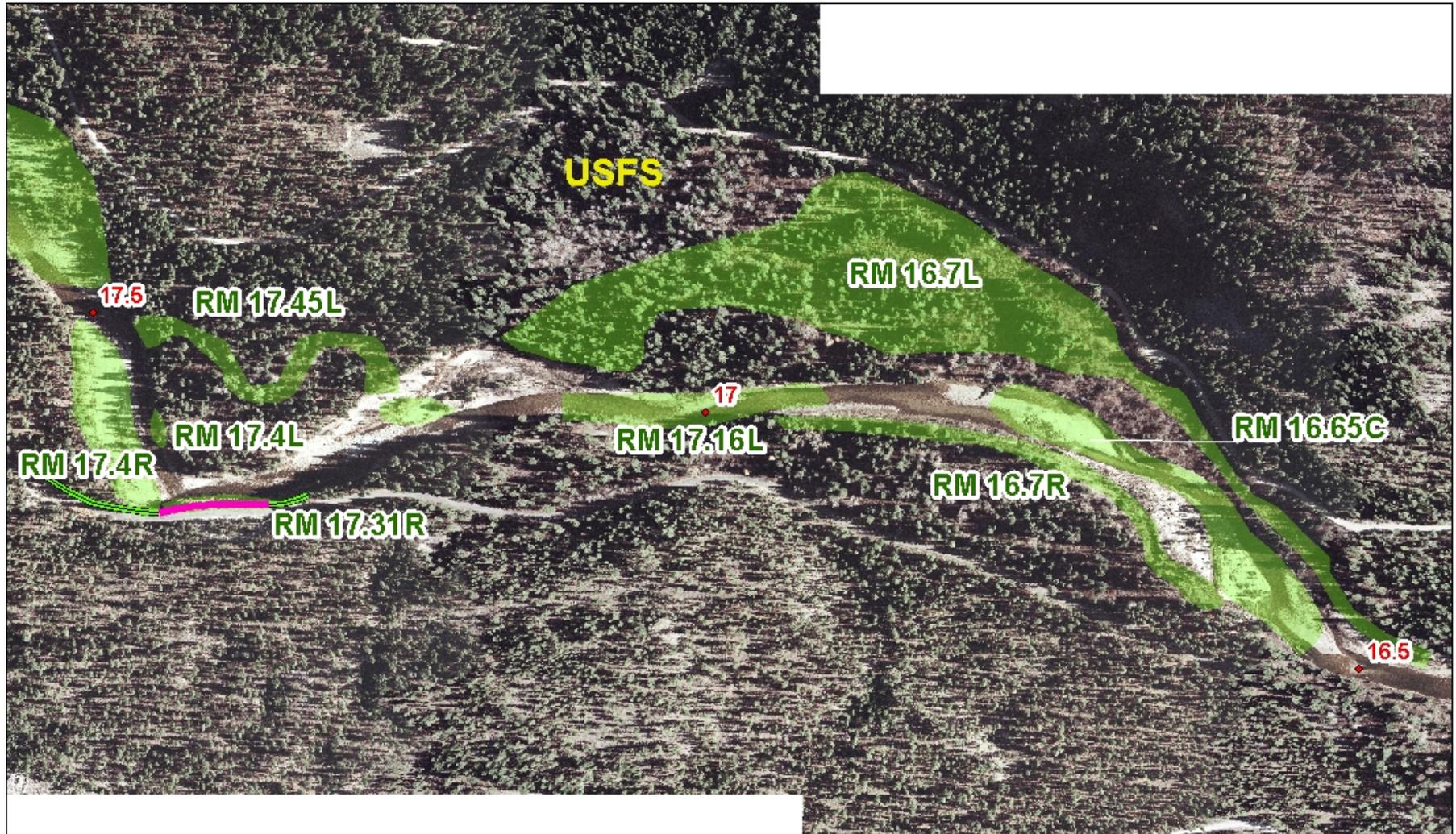
Projects: RM 17.0C and RM 17.4L - LWD Enhancement.

These projects involve jams along channel banks and bars to increase the quality of instream habitat and geomorphic complexity at multiple locations. These projects would enhance existing cover from overhanging vegetation, and add complexity to a relatively featureless section of river.

Category: Off-Channel Habitat Enhancement.

Projects: RM 16.7R and RM 17.4R - Side-Channel Habitat Enhancement.

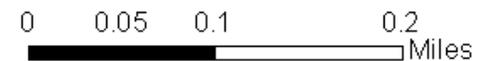
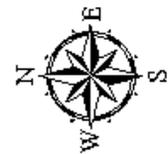
These projects would utilize bar apex log jams and channel margin log jams along with select excavation to increase the quality of habitat provided by existing high-flow channels.



## Junior Creek Project Group (RM 16.5-17.5)

### Legend

- |                  |                  |                 |                          |          |                  |
|------------------|------------------|-----------------|--------------------------|----------|------------------|
| ◆ River Mile     | — Bridge         | — Diversion     | — Headgate               | — Riprap | □ Land Ownership |
| — Cabled Logs    | — Filled Channel | — Levee         | — Road                   |          |                  |
| — Dam            | — Footbridge     | — Log Structure | — Road-Bridge Embankment |          |                  |
| — Detroit Riprap | — Gabion         | — Push-up Levee | — Waterpipe              |          |                  |



## 11. DOE CREEK PROJECT GROUP: RM 17.5 – 18.1

### *Setting*

In the area of this project group the channel is confined. An alluvial fan from the west pushes the channel against the east valley wall. Channel complexity increases somewhat near the downstream end of the project group. The geomorphic reach containing the Doe Creek Project Group had a moderate abundance of in-channel LWD during stream surveys in 2008, comprising 17 pieces of LWD/mile. Pools composed approximately 35% of the habitat area. The substrate is dominated by cobbles, which limits the availability of productive spawning habitat for steelhead and spring Chinook. Side-channel habitat was relatively abundant at 3.9% of the total habitat area, but there was some concern with filling of off-channel areas with sediment. The only sources of human disturbance in the reach are roads with riprap along the channel margin at a location on the east side of the valley.

### *Objectives*

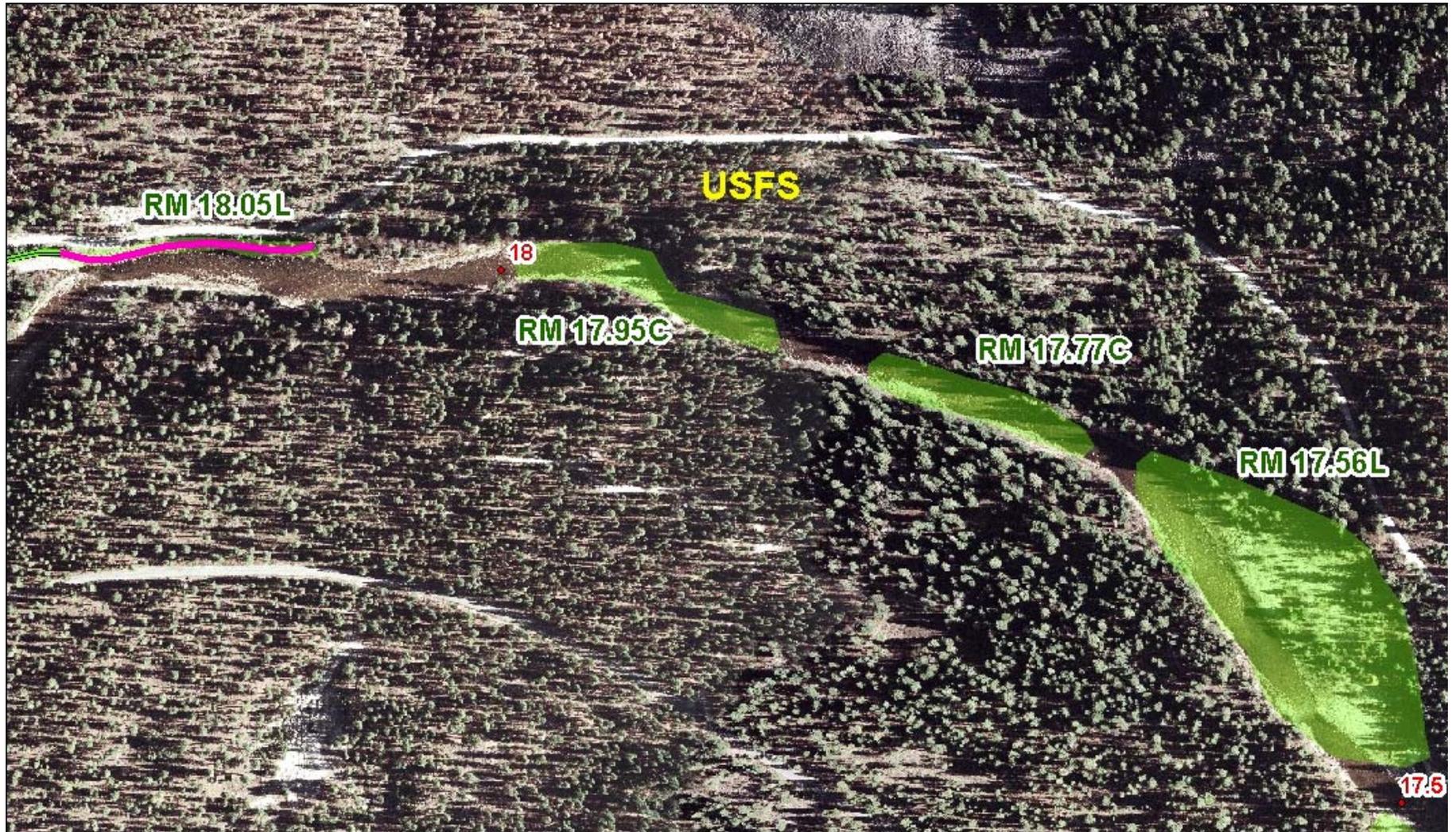
Re-establish natural channel processes and hydraulics by reintroducing large wood jams that will encourage more dynamic geomorphic conditions, and by removing or modifying riprap that alters local hydraulics.

### *Project Descriptions*

Category: Reconnect Stream Channel Processes.

Projects: RM 17.56L, 17.77C, 17.95C - LWD Placement to Enhance Habitat and Lateral Connectivity, and 18.05L - Riprap Removal or Modification.

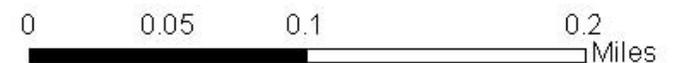
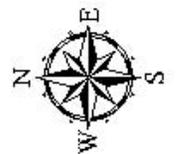
The LWD projects involve placement of multiple jams on meander bends and channel bars to increase lateral dynamics, large wood recruitment, and floodplain connectivity. In particular there may be the possibility to increase connectivity between the channel and a side-channel. Riprap removal or modification involves material protecting the toe of the road embankment that may be potentially replaced or modified with wood. In all cases, log jam placements will bring the channel towards natural in-channel wood densities.



## Doe Creek Project Group (RM 17.5-18.1)

### Legend

River Mile	Bridge	Diversion	Headgate	Riprap	Land Owners hip
Cabled Logs	Filled Channel	Levee	Road		
Dam	Footbridge	Log Structure	Road-Bridge Embankment		
Detroit Riprap	Gabion	Push-up Levee	Waterpipe		



## 12. BREVICORMIS CREEK PROJECT GROUP: RM 18.1 – 19.2

### **Setting**

The channel in the area of the Brevicormis Creek Project group is confined between coalescing alluvial fans to the east and bedrock to the west. The channel has low sinuosity and low geomorphic complexity. The channel here (including up to 2 miles upstream) had a low abundance of in-channel LWD during stream surveys in 2008, comprising 11.4 pieces of LWD/mile. Pools comprised approximately 25% of the habitat area. The substrate is dominated by cobbles, which limits the availability of productive spawning habitat for steelhead and spring Chinook. Fines comprised an average of 12% of the bed substrate based on 2 pebble counts. Side-channel habitat was abundant at 11.5% of the total habitat area, but the “No Snake” side-channel upstream of Reach C9 (but within the USFS survey reach) comprised much of the side-channel habitat area. There is very little human disturbance in the reach.

### **Objectives**

Re-establish natural channel processes and hydraulics by reintroducing large wood jams that will encourage lateral channel dynamics and connectivity, reconnecting side-channels, and removing or modifying riprap that alters local hydraulics. Increase the quality and abundance of instream and off-channel habitat features using wood placements and excavation.

### **Project Descriptions**

Category: Reconnect Stream Channel Processes.

Projects: RM 18.5C, RM 18.81C, 19.25R, and 19.6L – LWD Placement to Enhance Lateral Connectivity, RM 18.75R – Riprap Removal or Modification, and RM 19.0C - Abandoned Bridge Abutment Removal.

The LWD projects involve placement of multiple meander bend and bar apex jams to increase lateral dynamics and scour/deposition processes. There may be potential to increase connectivity with side-channel habitat. The riprap project involves the replacement or modification of riprap using LWD.

Category: Instream Habitat Enhancement.

Projects: RM 18.34L, RM 18.65L, RM 18.9L, RM 19.4R, and RM 19.45L - LWD Enhancement.

These projects involve placing log jams along channel banks and bars to increase the quality of instream habitat and geomorphic complexity at multiple locations. These projects would enhance existing cover from overhanging vegetation, undercut banks, and add complexity.

Category: Off-Channel Habitat Enhancement.

Projects: RM 18.4L - Wetland Habitat Enhancement, and RM 18.9R and RM 19.05R - Off-Channel/Side-Channel Habitat Enhancement.

These projects would utilize groundwater gallery development, excavation, and log jams to enhance off-channel connectivity and to increase the quality of existing off-channel habitat.

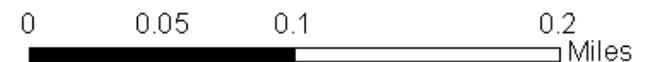
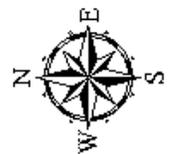


## Brevicormis Creek Project Group (RM 18.1-19.2)

*Downstream View*

### Legend

- |                  |                  |                 |                          |          |                  |
|------------------|------------------|-----------------|--------------------------|----------|------------------|
| ◆ River Mile     | — Bridge         | — Diversion     | — Headgate               | — Riprap | □ Land Ownership |
| — Cabled Logs    | — Filled Channel | — Levee         | — Road                   |          |                  |
| — Dam            | — Footbridge     | — Log Structure | — Road-Bridge Embankment |          |                  |
| — Detroit Riprap | — Gabion         | — Push-up Levee | — Waterpipe              |          |                  |



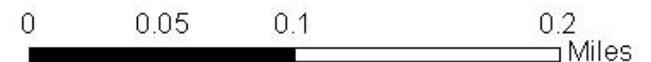
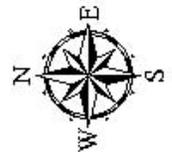


## Brevicormis Creek Project Group (RM 18.1-19.2)

*Upstream View*

### Legend

◆ River Mile	— Bridge	— Diversion	— Headgate	— Riprap	□ Land Owners hip
— Cabled Logs	— Filled Channel	— Levee	— Road		
— Dam	— Footbridge	— Log Structure	— Road-Bridge Embankment		
— Detroit Riprap	— Gabion	— Push-up Levee	— Waterpipe		





### **13. TWENTYMILE FAN PROJECT: RM 19.6**

#### ***Setting***

Twenty Mile Creek has formed an alluvial fan near RM 19.6 that is approximately one mile wide at its toe. Forest Road 700 runs across the fan surface near the toe of the fan which forms the east bank of the Chewuch River. There are four recently active channels that the road must cross along the fan. All four are on the relatively lower and more active southern portion of the fan. Following a flood in 1972, much of the existing channel was excavated and the material side cast to form a levee that prevents flow into adjacent channel networks south of the current main channel. A portion of the levee was breached in 1999 to allow water into one channel segment south of the current alignment. Field observations indicate that fan processes have been compromised through the channelization and levee work following the 1972 floods. It appears that flood velocities are higher now than before channel excavation and levee work, which if true, has likely increased both water and sediment routing to the Chewuch. An increase in sediment and water routing decreases sediment and water storage. This reduces fish habitat in the creek while at the same time increases the loading of fine grained sediment entering the Chewuch. Increased fine sediments are detrimental to fish spawning and river ecology.

#### ***Objectives***

Re-establish natural alluvial fan processes and hydraulics by modifying or removing road crossings and using excavation to re-establish natural channel geometry and dynamics. Mitigate the potential increase in sediment delivery from the channelized fan.

#### ***Project Descriptions***

Restore Fan Processes and Topography. This project would consider restoring the fan surface and channel grade to that which existed before the existing channel was confined. All of this work would place excavated side-cast levee material back where it came from (the channel). This type of work would enhance distributary channel inundation and improve sediment storage, water storage and fish habitat.

Road Removal. Road removal is the most cost effective and permanent solution. If the road was removed, access on either side of the fan would still be possible within several hundred feet of the existing creek location. Road removal would allow the benefits of fan processes to continue unimpeded (sediment storage, water storage, fish habitat and use). No future disturbance of the twenty mile channel crossing would be required to maintain the existing road crossing site.

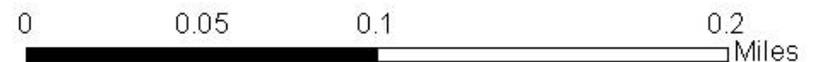
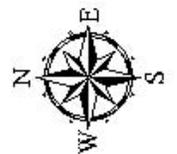
Road Relocation. A more expensive and permanent solution would re-locate the road upstream of the fan against the valley wall. An appropriately sized bridge above the head of the fan would have all the benefits of road removal. Although possible, a cost benefit analysis is recommended as this type of project would be an expensive undertaking.



## 20 Mile Creek Fan Project Group

### Legend

◆ River Mile	— Bridge	— Diversion	— Headgate	— Riprap	□ Land Owners hip
— Cabled Logs	— Filled Channel	— Levee	— Road		
— Dam	— Footbridge	— Log Structure	— Road-Bridge Embankment		
— Detroit Riprap	— Gabion	— Push-up Levee	— Waterpipe		



## References

- Upper Columbia Salmon Recovery Board (UCSRB). 2007. Upper Columbia spring Chinook salmon, steelhead, and bull trout recovery plan: Upper Columbia Salmon Recovery Board, Wenatchee, Washington, 300 pp. Web site: <http://www.ucsrb.com/plan.asp>
- U.S. Bureau of Reclamation (USBR). 2008. Methow Subbasin Geomorphic Assessment (including 19 technical appendices). February 2008. Prepared by Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado in cooperation with Pacific Northwest Regional Office, Boise, Idaho and Methow Field Station, Winthrop, Washington.
- U.S. Forest Service (USFS). 2009. Aquatic Restoration Plan for the Lower Chewuch River 10<sup>th</sup> Field Watershed – DRAFT November 3, 2009. Okanogan and Wenatchee National Forest, Methow Valley Ranger District. Prepared by Gene Shull, Fish Biologist.