White Salmon River Watershed

Anadromous Fish Passage Inventory

2009-2011 Survey Report

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PROJECT BACKGROUND & OBJECTIVES

The White Salmon Fish Passage Inventory (WS FPI) was initiated by Underwood Conservation District (UCD) in 2009 in order to coordinate and facilitate a thorough inventory of passage barriers, hazards and habitat restoration opportunities in the potentially anadromous fish streams of the White Salmon River watershed. The impetus to collaborate this information stemmed from a 1996 decision from the United States Federal Energy Regulatory Commission (FERC) that required that fish passage was reinstated at Condit Dam, located at River Mile (RM) 3.33 on the White Salmon River. Since 1913, Condit Dam has completely blocked upstream river access to migrating fish species. In 1999, Pacific Power, owner and operator of Condit Dam, determined that dam removal would be a more economically sound option than installation of a fish ladder.[1] After years of discussion and negotiation with local stakeholders, plans and permits were finalized to prepare for removal of the dam in October of 2011.

While there are many unknowns as to the re-colonization of salmonids in the watershed post-Condit Dam removal, the need for a passage inventory has been clearly identified by various partnering agencies, planning groups, and reports. Among others, the Klickitat Lead Entity's Technical Committee supported an inventory of fish passage barriers and hazards in the White Salmon River watershed. They recognized the inventory as a first step to conducting salmonid habitat restoration in the watershed, citing that passage barrier removal and hazard improvement will provide safe access to the fullest extent of new habitat as fish re-colonize the watershed. The White Salmon River Watershed Management Committee, a stakeholder group made up of resource professionals from a myriad of organizations including U.S. Geological Service (USGS), U.S. Fish and Wildlife Services (USFWS), U.S. Forest Service (USFS), Yakama Nation Fisheries (YN), as well as local landowners and resource user, also supported a passage inventory, agreeing that this is an integral effort in restoring access and habitat for anadromous and resident fish.

Land use in the watershed poses several presupposed potential blockages or limits to fish passage, including forest road crossings, residential and county road crossings, irrigation water diversions and withdrawals, and livestock watering withdrawals. As of 2009, a comprehensive fish passage barrier inventory had not been conducted throughout the potentially anadromous portion of White Salmon River watershed. Partial barrier inventories in the White Salmon River watershed include a survey done by UCD in the early 1990's, occasional Washington Department of Fish and Wildlife (WDFW) assessments of individual culverts which are evaluated for specific mitigation projects, and surveys by U.S. Forest Service and Washington Department of Natural Resources (DNR). As of 2009, these partial surveys had not been compiled in an effort to assess and cohesively prioritize the passage barriers. Data collected in the UCD fish passage inventory provides much needed information on where to prioritize passage improvements and habitat restoration projects in the watershed and aides future strategic planning in the watershed.

The primary project objectives of the White Salmon River Fish Passage Inventory were to:

1. Identify and assess passage barriers and hazards in potentially anadromous fish bearing streams of the White Salmon watershed.
2. Prioritize fish passage barriers for removal based on potential habitat quality, species utilization, production, and mobility, along with percentage passage improvement, and cost.
3. Identify stream and riparian habitat restoration projects to improve salmonid habitat.
4. Enter and submit data to Washington Department of Fish and Wildlife using the WDFW *Fish Passage and Diversion Screening Inventory Database.*
5. Produce report and database detailing fish passage barriers, instream features and habitat restoration opportunities.

STREAM SURVEY AREA

The UCD Fish Passage Inventory aimed to survey all potentially anadromous fish habitat in the White Salmon River basin. Potentially anadromous streams were initially identified using WDFW Salmonscape and DNR "F" type stream layers and

[1] Mead, Hunt and Kleinfelder. 2010. Condit Hydroelectric Decommissioning Project: Project Removal Design Report.

included streams thought to have low gradient (less than 20 percent) and scour line width greater than 1 meter. Additional streams were incorporated into the survey area as a result of on the ground observations which revealed potential anadromous habitat. The survey area included the mainstem White Salmon River, Little Spring, Little Buck, Mill, Buck, Spring, Indian, and Rattlesnake Creeks, as well as tributaries feeding into the mainstem at river mile (RM) 5.64, 6.45, 7.41, 7.49, 9.90 and 9.91. Tributaries feeding into streams were also surveyed.

As described below, streams were walked from the mouth to the end of natural fish passage, where landowner permission allowed; in total 44.1 miles of stream were walked throughout the potentially anadromous streams of the White Salmon River watershed. In some streams, the end of fish passage was not determined due to the lack of landowner permission to access lands or due to limited time and resources. To get a better idea of the amount of potential habitat beyond the surveyed streams, Technicians estimated habitat using WDFW Salmonscape and DNR "F" type stream layers; in total, they estimated an additional 21 miles of potentially anadromous habitat. The table and map below denotes surveyed miles versus estimated anadromous stream miles for each stream.

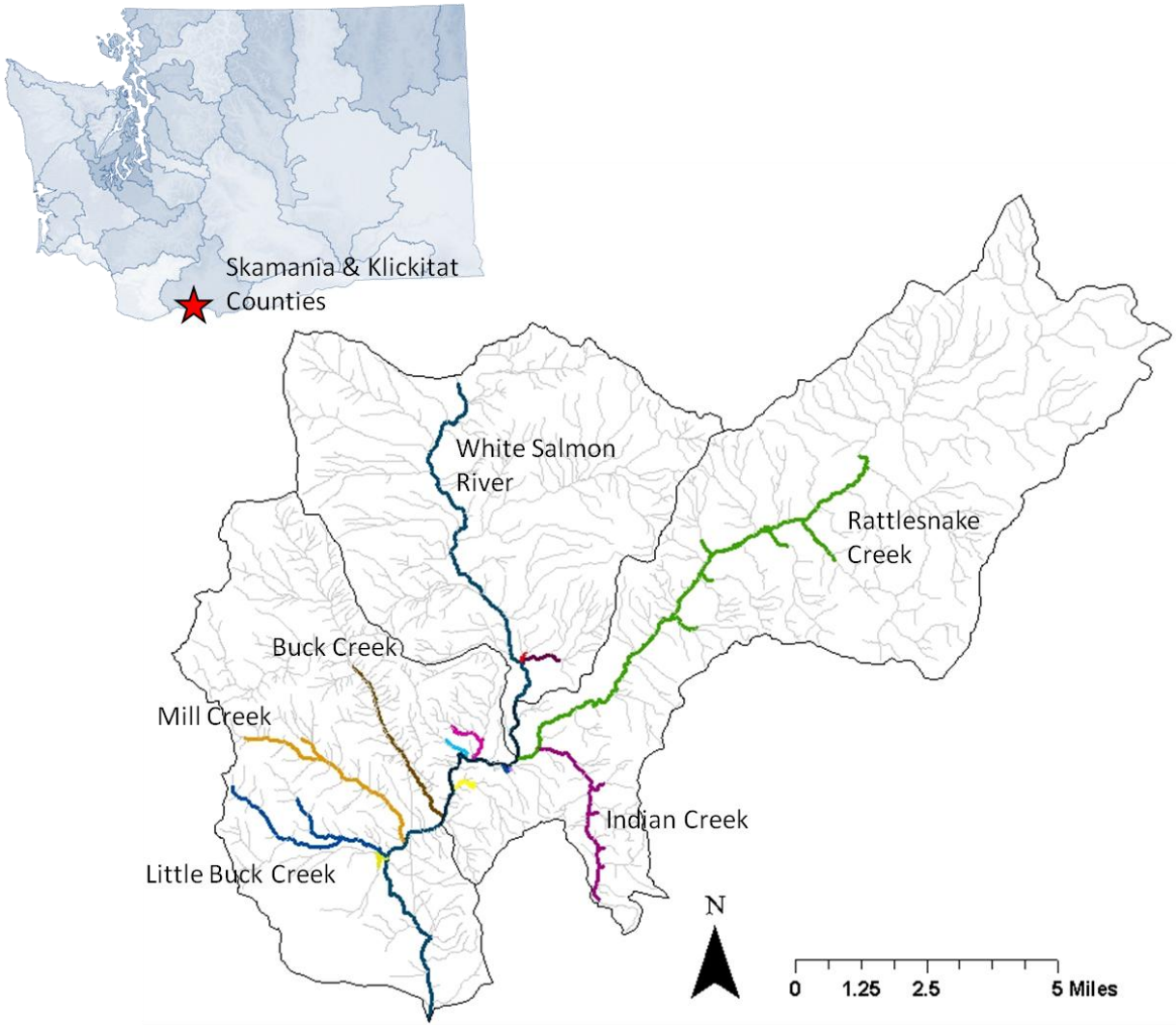

Figure 1 Survey Area included 65 miles of potentially anadromous fish habitat within the White Salmon River watershed.

Stream	Estimated Habitat*	Surveyed Habitat
White Salmon River	16.9	12.9
Rattlesnake Creek	18.5	13.9
Little Buck Creek**	6.5	2.2
Mill Creek	4.9	4.3
Spring Creek	4.8	0.4
Indian Creek	4.7	3.9
Buck Creek	3.4	3.4
RM 9.90 Tributary	1.5	0.8
RM 6.45 Tributary	1.2	0.6
RM 5.64 Tributary	0.8	0.7
Little Spring Creek	0.8	0.5
RM 7.41 Tributary	0.4	0.2
RM 7.49 Tributary	0.2	0.1
RM 9.91 Tributary	0.2	0.2

* Estimations derived from stream surveys, WDFW SalmonScape & DNR "F" type map layers

** Little Buck Creek is expected to have a natural waterfall barrier at confluence with the WSR once Condit Dam is removed and the reservoir is drained

Table 1 Estimated potentially anadromous habitat compared to surveyed potentially anadromous habitat listed by stream.

TASKS & SCHEDULE

In early 2009, UCD was awarded a grant from the Washington Salmon Recovery Funding Board (SRFB) to survey streams, assess stream crossings for fish passage, and identify habitat restoration projects in the potentially anadromous streams of the White Salmon River watershed.

During the spring of 2009, UCD Fish Passage Technicians prepared for the inventory by gathering and reviewing previous stream habitat and passage information collected in the watershed; and identifying areas where more information was needed (see list of resources consulted below). They also compiled a list of all of the landowners throughout the survey area and began working to establish outreach protocol aimed at gaining landowner buy-in for the stream surveys. Landowner outreach was carried out from May 2009 and continued into the summer of 2010. There were a total of 68 landowners contacted within the survey area. Once landowner permission was granted to access sections of stream, surveys were scheduled and streams were walked to identify, assess, map, and document all passage barriers, hazards and habitat restoration opportunities. Stream surveys were conducted from May through October in 2009 and 2010. As surveys progressed, information gathered was recorded and provided back to landowners for review.

Concurrent to the survey, Technicians worked with UCD staff and Engineers to conduct preliminary explorations of the feasibility of some of the identified passage corrections and restoration projects. This included contacting landowners of known barriers and hazards to discuss potential projects and to gain further support for partnering. Project development and outreach will continue through and beyond the duration of the Fish Passage Inventory to implement identified restoration needs.

As part of the project deliverables, stream survey details, including habitat data, observational information, barrier determination, and habitat restoration opportunities were compiled and summarized; these details are included in the *White Salmon Fish Passage GIS Database* as well as in the following report. Other major project deliverables include the WDFW Fish Passage & Diversion Screening Inventory database, the Top 10 Barrier Removal list and the Top 10

Restoration Project list (see pages 34 and 35 for lists). These lists will be submitted to the Klickitat Lead Entity for the Salmon Recovery Funding Board in spring 2012 and will be utilized for future project development.

EXTERNAL DATA COLLECTION AND SYNTHESIS

The Lower White Salmon River watershed has been the focus of various studies conducted by state and federal agencies. In order to gain a holistic sense of land-use, ecology, limiting factors, and past restoration efforts in the watershed, Fish Passage Technicians compiled existing data and past studies. Technicians met with past project leaders from U.S. Geological Service (USGS), Mid-Columbia Fisheries Enhancement Group (MCFEG), Yakama Nation Fisheries Program (YNFP), Friends of the White Salmon River, and UCD to discuss the past studies, limiting factors and data needs. Additionally, the following studies were reviewed and utilized in designing the Fish Passage Inventory:

- *Underwood Conservation District White Salmon Watershed Survey*; UCD, 1992-1993.
- *Assess Current and Potential Salmonid Production in Rattlesnake Creek*; US Geological Survey, Yakama Nation, UCD, 2001-2003.
- *Assessment of the White Salmon Watershed Using the Ecosystem Diagnosis and Treatment Model,* US Geological Service, 2003-2004.
- *Supplemental Environmental Impact Statement for the Condit Dam Removal*, Washington Department of Ecology, 2007.
- *Salmon and Steelhead Habitat Limiting Factors in WRIA 29;* Washington Conservation Commission, 1999.
- *White Salmon Subbasin Plan;* White Salmon Lead Entity Group, 2004.
- *White Salmon Watershed Enhancement Project List;* White Salmon River Watershed Management Committee, 2009-2011.
- *White Salmon River Bull Trout: Patches, Occupancy and Distribution*; US Fish & Wildlife Service, 2009.
- *White Salmon River Basin Lamprey Studies*, US Fish & Wildlife Service,
- Klickitat County 2009 GIS Layers: Landowner Parcels, Roads, and Waterways; Kim Gleason, GIS Coordinator Klickitat County, Washington.
- Skamania County 2009 GIS Layers: Landowner Parcels, Roads, Waterways, and Railroads; Rick Hollatz, GIS Coordinator, Skamania County, Washington.
- Underwood Conservation District Project Files

OUTREACH PROCESS & LANDOWNER PERMISSION

Underwood Conservation District provides financial and technical assistance to voluntary landowners who are interested in improving their current land use methods in an effort to shift to best management practices. Because of the voluntary nature of UCD's work and the goals of the Fish Passage Inventory, it was of utmost importance that all landowners willingly grant permission for UCD to access sections of streams that run through their property. The decision was made that all surveys would be preceded by landowner permission, preferably in writing.

Due to historical controversy over the removal of the Condit Dam and consequential reintroduction of anadromous fish species, much care was taken to create protocol that would address individual landowner concerns and needs in a manner that facilitated a future working relationship. Fish Passage Technicians worked with the UCD Board of Supervisors and staff to design an outreach strategy and materials that would address concerns that may be presented from landowners. This process began with numerous brainstorming and feedback sessions with the UCD Board and other project partners who have experience working within the White Salmon River watershed. The general landowner contact strategy is discussed below and additional phone scripts and outreach letters are available through UCD.

INITIAL OUTREACH EFFORTS

As a first step, a list was compiled of all stream-side landowners throughout the survey area using Klickitat and Skamania County GIS parcel layers obtained from the counties. This list was then given to UCD Board members as well as others

working within the watershed, including Tova Cochrane, Steve Stampfli, Margaret Neuman, Jim White, Lynn Bergeron and Brady Allen, with the intent to learn as much from past working experiences with area landowners as possible. This information allowed technicians to be better prepared to begin conversations and relationship-building with the survey area landowners. In order to build on established relationships and trust, UCD's Board members and staff were asked to contact landowners that they have worked with in the past and explain the focus and scope of the stream habitat surveys.

Phone calls were then made to each landowner to introduce the conservation district and program services, as well as to explain the fish passage inventory project goals and to solicit landowners' input as to any natural resource based concerns that they might have for their property. At this point, Technicians offered to provide additional information on the survey, as well as potential funding opportunities for projects and examples of past fish passage improvement projects facilitated by UCD. Additional information was mailed to all landowners who were contacted, along with a permission slip to be signed and returned in order to allow access through their property to the streams. Landowners were invited to walk with Fish Passage Technicians and were informed that they would be able to look over any notes or data gathered on their portion of stream prior to publishing the final report (see *Follow-up & Project Development Efforts* below).

A few weeks after background project information had been mailed to landowners, Technicians made follow-up calls to answer any questions or concerns that surfaced. They worked with interested landowners to set up survey dates, and encouraged participation during the stream survey. Landowners who opted out of the survey were sent a letter acknowledging their decision and encouraging them to contact UCD in the future for resource assistance.

In total, 68 out of 73 landowners were contacted by Technicians between 2009 and 2010; out of those contacted, 50.5 landowners responded allowing the survey to proceed in tributaries running through their land (see explanation below for partial landowner permission). Permission was granted to survey a total of 44.1 miles throughout the Lower White Salmon River basin, representing 68 percent of the total 65 miles of the estimated survey area. Only 10.5 landowners declined to participate in the survey, and seven did not respond to requests for access. Landowners who denied permission stated that they were not interested in participating in the survey; further reasoning was not provided. A total of 9.11 miles of stream were excluded from the survey due to disinclined landowners or non-responsive landowners. A major landowner throughout the watershed allowed Technicians to pass through their property to gain access to upstream or downstream properties, however, asked that data not be collected on their property. For this reason, it was considered that permission was partially granted and partially denied, hence the 50.5 agreeing landowners and the 10.5 who denied permission. As a result, 5.70 miles of stream were walked through the large landowner's property, including portions of Little Buck, Mill, Buck, Spring, Indian and Rattlesnake Creeks; habitat data was not gathered on these properties.

The majority of landowners that were contacted by Technicians expressed interest in the survey and supported UCD efforts. Many landowners were open to exploring opportunities to work with UCD in the future to improve stream and riparian habitat. In total, 14 landowners joined Technicians during surveys through their section. Additional technical assistance and materials were provided to those landowners upon their request. Notes from 2009-2011 landowner contact efforts are available through UCD.

FOLLOW-UP & PROJECT DEVELOPMENT EFFORTS

In the fall of 2009 and 2010, follow-up letters with survey details were sent to landowners that participated in the surveys. All habitat data and observations gathered along individual landowners' length of stream were provided as a courtesy prior to its inclusion in final reports. Landowners were given the opportunity to review the information and request omissions of specific information that they did not want included in the final report. No requests were made to exclude survey findings. In addition to details on survey data and observations, the review letters provided a list of potential habitat restoration projects and opportunities to work with UCD to implement projects. An example survey write-up is available through UCD.

In November 2009, as part of a Washington Department of Ecology (ECY) grant application process, Technicians worked with landowners along Rattlesnake Creek and Indian Creek who are interested in riparian planting projects on their property. In total, six landowners provided signed documentation stating that they are willing to partner with UCD on planting projects (although, the grant application was not successful, these projects will be pursued again in the future). Landowners and water users along Buck and Indian Creek also expressed interest in technical and financial assistance from UCD and in fall of 2010, representatives from UCD, WA Conservation Commission, Farmers Conservation Alliance and WA Department of Fish and Wildlife visited properties along Buck and Indian Creeks to provide initial project cost estimates and design advice. Additionally, UCD has partnered with Mid-Columbia Fisheries Enhancement Group (MCFEG) to begin project development for several of the potential projects noted during 2009 surveys. Future project development efforts with willing landowners will be planned as funding permits.

SCREEN OUTREACH EFFORTS

In 2011, Technicians contacted landowners that had noted surface water diversions on their property. Information was sent to landowners, detailing Washington Department of Fish and Wildlife (WDFW) water outtake screening requirements, potential funding opportunities and technical assistance options available through UCD. This outreach effort was aimed at connecting with landowners who are interested in improving their screen and outtake. Outreach materials were distributed to 15 surface water diverters along the mainstem of the White Salmon River.

STREAM SURVEY PROTOCOL

The White Salmon Fish Passage Inventory was conducted using WDFW's *Fish Passage and Surface Water Diversion Screening Assessment and Prioritization* protocol and database. This protocol, allows for uniform assessment and prioritization of fish passage barriers and surface water diversions throughout the state of Washington.

In May 2009, Dave Collins, WDFW Fish Passage Evaluation Coordinator, trained UCD Technicians in WDFW's fish passage assessment protocol. The three day training covered how to conduct, record and report data and findings from the passage surveys. Collins led Technicians in field data collection for multiple types of features (culverts, dams, etc.), as well as habitat data collection protocol upstream of human-made fish passage barriers.

STREAM SURVEYS

For the purpose of this survey, UCD Technicians used the *full survey (w*atershed based) approach as designed by WDFW. The *full survey* requires that all potentially anadromous streams are walked in their entirety, from the mouth to the end of natural fish passage. The end of fish passage on a stream is established only at natural barriers, which are determined by either a sustained gradient of >20 percent for a minimum of 160 meters, or a waterfall with a height >3.7 meters[2].

According to the WDFW protocol, a human-made barrier is any feature with a drop of ≥0.24 meters or a slope of ≥1 percent. WDFW fish passage parameters are based off of the ability of a 6 inch trout to safely pass a feature.[3] Stream survey protocol differs depending on whether or not human-made features are encountered along the stream. In streams where human-made passage barriers are not present, protocol calls for an *observational survey*, which involves walking the stream and recording basic habitat quality observations such as canopy and instream cover, dominant flora species and water temperature. However, when a human-made feature is encountered and determined to be a barrier, Technicians conduct a *habitat survey* upstream of the barrier until the end of fish habitat. Habitat surveys sample for data such as habitat unit type (rapid, riffle, pool, pond), length, depth, wetted width, ordinary high water width and substrate (boulder, cobble, gravel, fines).

[2] Washington Department of Fish and Wildlife. 2009. Fish Passage and Surface Water Diversion Screening Assessment and Prioritization Manual. Washington Department of Fish and Wildlife. Olympia, Washington.

[3] Ibid.

Stream surveys were divided into reaches based on similar habitat characteristics. Streams with human-made barriers and where habitat surveys were conducted begin at Reach 0; whereas streams without human-made barriers or where habitat data was not gathered, begin at Reach 1. Reach breaks were established at significant habitat type changes such as tributaries contributing 20 percent or more of the flow to the creek, sustained gradient shifts at 1, 3, 5, 7, 12 and 16 percent, or drastic changes in bed form, channel size, flow, or human-made barriers.

In addition to the WDFW fish passage protocol, UCD Technicians worked with MCFEG to identify gaps in previous data sets that would be beneficial to fill in while conducting surveys. These discussions resulted in collecting additional information about invasive species presence, location, type and approximate size, as well as potential restoration project opportunities.

FEATURE ASSESSMENTS

In the case that a human-made feature such as a culvert, dam, or irrigation outtake was encountered, Technicians assessed the feature to determine whether or not it poses a fish passage barrier. Depending on the type of feature, WDFW requires different information to be collected. For culverts, a Level A assessment is comprised of measuring physical characteristics and slope of the culvert as well as the outfall drop (change in water surface elevation as water flows through the culvert). Using the WDFW protocol, a Level A survey establishes if the feature is a barrier due to its slope or outfall drop. If the feature is not a slope or outfall drop barrier, a Level B survey is conducted, which determines the passability of the culvert based on high water elevation and the velocity of water passing through the culvert.

The flow charts below illustrate the WDFW protocol for Level A and Level B culvert assessments. This protocol uses simplified methods of establishing passability, and in some cases needs to be supplemented by other surveys to gain a more in-depth assessment. For instance, additional surveys may be warranted when there are multiple culverts transporting the flow or there is a grade break in the culvert.

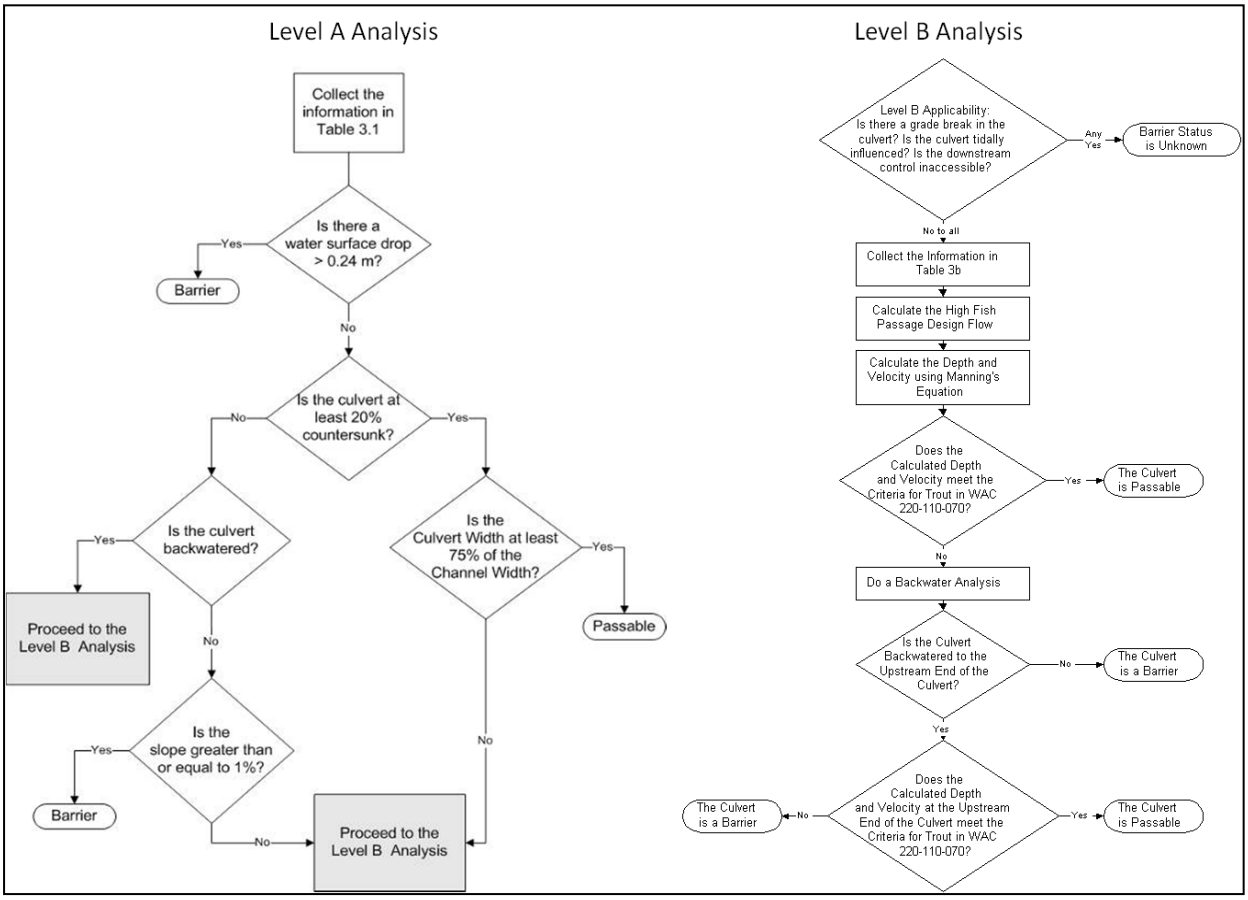

Figure 2 WDFW culvert assessment flow charts detailing Level A and Level B assessment protocols.

Surface water diversions are also assessed when encountered instream, with the intention of gathering physical information on the diversion and determining if the diversion meets state screening requirements. Ideally, flow is measured or estimated in order to help prioritize unscreened diversions for screening efforts, however, flow can only be recorded if there is a staff gauge and known flow rating curve, in-line flow meter, open diversion ditch in which to measure flow, or if there is a pump and the diameter of the outtake pipe is known.

On tributary streams, water surface diversion assessments were limited due to lack of diversion ditches associated with gravity diversions and on the mainstem White Salmon River, assessments were limited due to difficult access to outtakes due to high water velocity. Additionally, landowner permission was not granted to survey surface water diversions in specific areas. Outreach efforts have been initiated to provide information on screening requirements and funding opportunities to all landowners with known diversions; further surface water screening project development will continue as funding allows.

STREAM SURVEY FINDINGS

The following pages summarize instream and riparian habitat information gathered for each waterway surveyed in 2009 and 2010. The following information is intended to provide general habitat condition information, limiting factors and potential restoration projects noted as having positive habitat benefits. Additional information including riparian and instream habitat data and barrier assessment data is provided in Appendices 2 through 4; furthermore, stream notes detailing each mile of habitat surveyed are available through UCD. Maps detailing survey stream reaches, barriers and restoration projects are provided in Appendix 1. **All observations are noted from the perspective of looking upstream.**

HABITAT CHARACTERISTICS

According to WDFW protocol, the following habitat characteristics were assessed for each stream:

- Canopy cover – visual estimate of the percentage of forest canopy shading the stream
- Dominant riparian vegetation – visual assessment of key tree and shrub species throughout riparian area
- Instream cover – visual estimate of the amount of aquatic habitat provided by large woody debris, debris/wood jams, root wads, low vegetation, overhanging banks, and large boulders
- Gradient – measured using clinometers and averaged throughout the reach
- Stream habitat type – including rapids, riffles, pools, and ponds, measured for habitat surveys upstream of manmade fish barriers; dominant habitat type noted in observational surveys (see page 7 for more on habitat and observational survey requirements)
- Temperature – measured and recorded at beginning of survey and at tributary confluences

LIMITING FACTORS

During the survey, riparian and instream characteristics noted as limitations to the quality and quantity of fish habitat were documented. Common limiting factors observed in the White Salmon River watershed include low instream structure and complexity, low canopy or riparian cover, invasive plant species, fish passage barriers, inadequately screened water outtakes, and bank erosion contributing large amounts of road fill or fine sediments to the creek. These limitations are addressed in the potential restoration projects suggested for each creek.

POTENTIAL RESTORATION PROJECTS

The restoration opportunities listed for individual streams were noted during stream surveys conducted in 2009 and 2010. These projects are included in this report to guide UCD staff and project partners in assessing potential project areas to focus riparian and stream habitat restoration. A preliminary prioritization of projects was conducted by Fish Passage Technicians based on knowledge of the stream system, including limiting factors, upstream habitat and potential anadromous utilization, as well as project feasibility and landowner interest. Although this information was provided to landowners in survey summaries, it is necessary to highlight the importance of voluntary landowner involvement in these projects. **This list is not intended to be used for regulatory purposes.**

MAINSTEM WHITE SALMON RIVER

DRAINAGE BASIN: 135 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 16.9 (76% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: 6.7 meters waterfall (Big Brother Falls) at RM 16.9
NUMBER OF BARRIERS: 1
TYPE OF SURVEY: Observation

HABITAT CHARACTERISTICS:
For much of its length, the White Salmon River flows through narrow basalt canyons, with alternating pools and riffles and occasional cascades. Upstream of Northwestern Lake, the reservoir formed by Condit Dam, gradient increases and rapids and riffles dominate. On average, gradient ranges from 0 to 1.5 percent.

Instream habitat complexity is moderate and is made up of overhanging bedrock shelves, boulders, and sparse large woody debris. Bedrock cliffs line the river throughout the majority of the survey length and in some areas bedrock creates waterfalls, such as Steelhead Falls at RM 2.55 and Husum Falls at RM 7.88.

In sections not dominated by bedrock, the substrate consists mainly of silt, with some algae covered cobble. Spawning gravels are limited in the mainstem of the White Salmon River, however, a few sections of gravels were noted in pools just upstream of the mouth of the White Salmon River, as well as in riffles above Husum Falls and in a large bend near RM 9.90.

Vegetation composition shifts throughout the 16.9 miles of potentially anadromous habitat on the mainstem of the White Salmon River. Throughout the entire river corridor, mature trees shade the creek with a canopy cover ranging from 5 to 35 percent. The relatively low canopy cover is due to steep bedrock banks and narrow canopied tree species that line the banks. Downstream of Condit Dam, there are rocky slopes and cliffs dominated by Oregon white oak, as well as sections consisting mainly of Douglas-fir, big leaf maple, red alder and some Western red cedar; with vine maple, hazelnut and Oregon ash dominant in the subcanopy. Upstream of the dam, the riparian habitat is dense with Douglas-fir, Western red cedar, black cottonwood, red alder, big leaf maple, vine maple, oceanspray, willows, horsetail and Douglas spirea.

In total, 22 tributaries were noted feeding into the mainstem. Of these, 13 tributaries were surveyed and indentified as potential anadromous habitat and 9 were too steep to be considered habitat or enter the mainstem via barrier waterfalls. Additional information collected during tributary surveys is provided in the following pages.

LIMITING FACTORS:
The Condit Dam spans the White Salmon River at RM 3.33 and poses a 100 percent fish passage barrier. This barrier limits fish passage to a potential 62 miles of habitat upstream. Additionally, the mouth of the White Salmon River is a popular fishing post for boat and shore fishermen and concentrated fishing at the mouth may have an affect on upstream passage.

Large woody debris is limited in the mainstem, partially due to high boat traffic and the removal of wood for boater safety. Increasing debris jams and large wood would provide valuable rearing and spawning habitat to aquatic species. Additionally, spawning habitat is minimal due to few gravel beds and algae covered substrate.

A total of 17 water outtakes were noted along the mainstem; Reach 3 has the highest concentration of water outtakes with 14 noted along the banks. During the rafting survey, the focus was to locate pumps in order to identify landowners that can later be contacted for technical and financial assistance to improve or install screens on the pumps. Due to the complicated nature of WDFW screening standards, additional outreach and surveying is necessary in order to establish if outtakes are property placed and screened.

Invasive species are prevalent in Reaches 1 and 2; weed species such as Himalayan blackberry, European nightshade, Scotch broom, thistles, yellow iris, and knapweed dominate sections along the banks and limit native riparian shrubs from establishing.

POTENTIAL RESTORATION PROJECTS *(listed from high to low priority)*

1. **Improve Fish Screening at Water Outtakes:** There are 17 water outtakes along the potentially anadromous potions of the White Salmon River. The largest noted delivers water to the USFWS fish holding facility. A large three foot outtake diverts water from the right bank (looking upstream) and carries it downstream via a pipe along the right bank and into the fish holding ponds. This outtake, which is located at RM 1.63, is not screened. Of the other 16 outtakes only 2 were noted as having screens that appeared to meet requirements, however, further surveys of the pumps are necessary to determine if they pose entrapment barriers. A complete list of pump locations along the mainstem is available in the FPI Database.
2. **Irrigation Pump Outreach**: Provide education and outreach to pump owners along the mainstem to provide information on WDFW screening requirements and offer assistance in acquiring funding for screening.
3. **Large Woody Debris Enhancement**: Place key pieces of large wood in strategic locations along the mainstem to encourage gravel recruitment and pool development in shallow areas. Suggested locations include the first riffle in the lower mainstem, and in shallow riffles near the USFWS fish holding ponds, Condit Dam Powerhouse, and in floodplain habitat near the confluence of the mainstem and Tributaries 6.45, 7.49 (*Deadman's Curve*) and 9.90 (*Big Eddy*).
4. **Trash Removal at Mouth:** The mouth of the White Salmon River is a popular fishing spot; as a result of all of the traffic there is a fair amount of debris left behind at fishing outposts and camps. Numerous boats line the shores at the mouth, including some that are sunken and obviously discarded. In total there were 113 boats on the shores and approximately 12 sunken boats noted in 2009. Upstream, campsites and fish tackle debris are scattered along the banks.
5. **Invasive Weed Removal in Reaches 1 & 2:** Invasive weeds, such as Scotch broom, Himalayan blackberry, European bittersweet, thistle, yellow iris and knapweed have colonized throughout portions of Reaches 1 and 2. These species complete with local flora and should be removed to allow for native species establishment.
6. **River Recreation Management & Habitat Conservation at Tributaries 9.90 & 9.91 (Big Eddy):** Work with boaters to reduce traffic and establish rearing habitat at Tributaries 9.90 and 9.91 to promote fish access to tributaries. Boaters and rafting outfitters use the area along the mouths of the tributaries as a rest site. These areas will provide good habitat for salmonids and need to be protected.
7. **White Salmon River & Rattlesnake Creek Confluence Re-vegetation, Fencing & Signage:** Plant native trees and shrubs to stabilize bank and provide riparian habitat. Fencing heavily eroding section along the river would limit further detrimental foot and boat access. Educational signage could be installed to encourage stewardship by river users.
8. **Trail Maintenance to BZ Falls:** Several trees have fallen across the path to BZ Falls, damaging a small bridge. Currently, river users are walking off trail and trampling riparian plants. Maintaining and potentially extending the trail could benefit riparian vegetation.
9. **Mouth of White Salmon River Boat Ramp & Facility Construction**: Install a toilet and trash cans at the mouth of the White Salmon River for boaters and shore fishermen to help decrease water pollution and habitat degradation. A boat ramp could be installed to limit habitat disturbance resulting from dragging boats down the steep, dirt hill to the river.

LITTLE SPRING CREEK *(Enters the White Salmon River at RM 3.51 from the left bank)*
DRAINAGE BASIN: 0.70 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 0.77 (64% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: Sustained gradient barrier on mainstem at RM 0.35; spring source terminates stream and habitat on Tributary 2
NUMBER OF BARRIERS: ≥0
TYPE OF SURVEY: Observation

HABITAT CHARACTERISTICS:
Despite the limited amount of habitat available to fish, the habitat that is accessible is of high quality. Steep banks line the creek on both sides and as a result many trees have fallen into and across the creek. Large woody debris is prevalent instream throughout Little Spring Creek; and there is plenty of instream habitat created by large mossy rocks, undercut banks, roots and debris jams. Channel substrate is made up of small cobbles and gravel in the lower sections, and large boulders create cascades where the gradient increases. Some fine organic material is also present in the substrate due to the large amount of instream wood and rare eroding banks.

Riparian vegetation is mature and healthy, with a variety of species and age classes. Douglas-firs, Western red cedar, Pacific yew, big leaf maple, red alders, and hemlock contribute to the 85 percent canopy cover. Steep gradient is common throughout Little Spring Creek and on both the mainstem and Tributary 2 gradient creates a natural barrier within 0.35 miles of its confluence with the White Salmon River. Overall, gradient ranges from 5 to 42 percent.

When Technicians walked Little Spring Creek, they discovered that the creek's flow path is not accurately depicted on USGS maps. Tributary 1 spurs off of the mainstem and runs parallel to Little Buck Creek which flows through the drainage directly north of Little Spring Creek's Tributary 1 drainage. USGS maps show Tributary 1 veering south away from Little Buck Creek.

Like its name suggests, Little Spring Creek is heavily influenced by springs and seeps, with seeps pouring off of the hill and feeding the creek. Tributary 2 contributes approximately 1/5th of the flow to Little Spring Creek and originates from a large spring at the base of a maple tree. Tributary 2 does not have an obvious channel; instead, it flows down a 21 percent gradient and spreads over the ground with a width of 6 meters, flowing underground in some spots. Because of the multitude of springs that enter the creek, water is cold throughout the year; in June of 2009, water temperature was recorded at 46.4 degrees Fahrenheit.

LIMITING FACTORS:
Tributary 1 enters into the mainstem at RM 0.05 from the right bank and continues northwest. Throughout the 0.12 miles surveyed, this relatively low gradient reach runs through a Douglas-fir, Western red cedar, and big leaf maple dominated forest; however, beyond the survey section the surrounding riparian area has been previously clear-cut and canopy cover is limited. This is the same forest that borders Little Buck Creek and replanting would benefit both streams.

POTENTIAL PROJECTS: *(Listed from high to low priority)*

1. **Riparian Planting on Tributary 1:** Upstream of RM 0.12 there are bare sections of streambank resulting from forest practices; these areas should be re-vegetated with native species such as Douglas-fir, Western red cedar and big leaf maple to provide increased riparian vegetation, shade and future large woody debris recruitment.

LITTLE BUCK CREEK *(Enters the White Salmon River at RM 3.56 from the left bank)*
DRAINAGE BASIN: 3.77 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 6.56 (34% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: Not established on mainstem or NE Fork due to lack of landowner permission; the watershed boundary ends habitat on NW Fork at RM 1.59
NUMBER OF BARRIERS: ≥3
TYPE OF SURVEY: Observation and habitat

HABITAT CHARACTERISTICS:
It is unclear if Little Buck Creek will be anadromous fish habitat after the removal of Condit Dam; however, it is expected not to be anadromous habitat due to an expected natural barrier waterfall at the mouth. USGS Fish Biologist, Brady Allen, reported that because bathometry maps which show no valley depression at the mouth and the characteristic basalt cliffs photographed near Little Buck Creek prior to the construction of Condit Dam, it is likely that the creek enters the White Salmon River via a waterfall.[4] However, the mouth of Little Buck Creek will remain a mystery until the dam is removed. Due to this uncertainty, and a relatively large drainage basin for the Watershed, Technicians surveyed Little Buck Creek. Little Buck Creek surveys were divided into three main parts: the mainstem, the northeast fork and the northwest fork. Much of the mainstem was not surveyed due to a lack of landowner permission.

Habitat surveyed throughout the Little Buck Creek subbasin is of high quality with canopy cover ranging from 55 to 85 percent, consisting of Douglas-fir, Western red cedar, hemlock, black cottonwood and red alder. There are a few sections in Reach 2 on the mainstem and on the forks with no canopy cover (noted below).

Gradient is notably higher than other tributaries and ranges from 7 to 18 percent; creating many cascades and small waterfalls. Large boulders, root-wads, overhanging banks and small-medium wood jams provide high instream cover throughout the portions surveyed. Little Buck Creek appears to have heavy spring influence, contributing to cold water temperatures between 46 and 51 degrees Fahrenheit when measured in August, 2010.

One tributary was noted feeding into Little Buck Creek at RM 0.16. This tributary was partially surveyed and provides an estimated 0.10 miles of potentially anadromous habitat. Spawning and rearing habitat along the tributary is of moderate quality, with equal proportions of cobble, gravel and fine sediments and occasional rootwads providing instream cover. There is a barrier culvert located at RM 0.06 on Tributary 1.

LIMITING FACTORS:
A total of three barriers were identified in the Little Buck Creek subbasin. These barriers limit access to upstream habitat. Two out of three of the barriers are located under Skamania County maintained roads. During stream surveys, water flowing to the culvert on the NE Fork was being dammed with tarps and plywood upstream of the culvert. A large flexible pipe was present at the site so water could be diverted. This diversion created a downstream passage barrier in addition to the upstream barrier created by the culvert.

Invasive plant species such as Himalayan blackberry, curly dock, and European nightshade are present along Tributary 1. Additionally, there were a few sections in Reaches 2 and 3 along the mainstem and on the NE Fork, where canopy cover was limited due to forest harvest and transmission lines that transect the creek. Much of the land surrounding Little Buck Creek is designated forest land and may be harvested in the future.

In Tributary 1 of Little Buck Creek, heavy fine sediments were noted as a limiting factor to spawning habitat.

POTENTIAL PROJECTS: *(Listed from high to low priority)*

[4] Allen, B. and Connolly, P. 2005. Assessment of the White Salmon Watershed Using the Ecosystem Diagnosis and Treatment Model. United States Geological Service, Cook, Washington.

1. **Restore Fish Passage at RM 1.83:** This culvert is a full fish passage barrier due to a slope of 5.19 percent and an outfall drop of 0.37 meters.
2. **Restore Fish Passage at RM 0.73 on NE Fork:** This culvert is a full fish passage barrier due to a slope of 2.16 percent and an outfall drop of 1 meter.
3. **Riparian Planting & Conifer Under-planting**: Conifer under-planting in Reach 1 would increase species diversity and provide future large woody debris to the stream. Bare sections of bank in Reaches 2, 3 and along Tributary 1 should be re-vegetated with native species.
4. **Invasive Weed Removal & Replanting:** Himalayan blackberry, curly dock, European nightshade and mustards are growing along Tributary 1 of Little Buck Creek. These species should be removed, managed, and replaced by native shrubs and oak trees.
5. **Restore Fish Passage at RM 0.06 on Tributary 1:** This culvert is a 33 percent fish passage barrier due to an outfall drop of 0.29 meters.
6. **Large Woody Debris Enhancement on NE Fork:** Install large woody debris underneath the transmission lines on the NE Fork to provide instream cover and shade. The transmission lines and chain-link check dam structures limit riparian vegetation and providing shade could benefit the creek.

MILL CREEK (*Enters the White Salmon River at RM 3.99 from the left bank)*
DRAINAGE BASIN: 4.25 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 4.87 (89% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: Sustained gradient barrier at RM 4.24
NUMBER OF BARRIERS: ≥1
TYPE OF SURVEY: Observation and habitat

HABITAT CHARACTERISTICS:
Mill Creek is dynamic; short portions of stream are confined by cliffs which limit the channel width and other sections are wide and anatomizing. The anatomizing stream has created multiple channels which flow through channel spanning log jams, overhanging banks, and large boulders which create high instream complexity. Jams which include three foot diameter Douglas-fir logs form waterfalls that trap gravels and sediment, generating pools and well-vegetated gravel bars. Water temperature was 50.9 degrees Fahrenheit on September 9, 2009.

In the lower sections of Mill Creek, Douglas-fir dominates the canopy and even-aged red alder and vine maple grow underneath; further upstream, the forest matures and canopy cover diversifies to include Western red cedar, grand fir, Pacific yew, and big leaf maple. Vegetation in this confined, wet valley consists of devil's club, lady ferns, coltsfoot, evergreen blackberries, and red-osier dogwood. Overall, the canopy cover shifts between 70 to 95 percent.

There is heavy spring influence in the Mill Creek subbasin and seeps drip from tall cliffs along the bank. Over time, the steep cliffs contribute gravels and cobble to the stream system. The stream bed substrate primarily consists of gravels suitable for spawning, cobbles and some fines and in the upstream portions boulders and bedrock. Stream gradient ranges from 2 to 37 percent.

Overall, five tributaries were noted that enter Mill Creek, three of which were thought to be too steep to be considered fish habitat. Tributary 1 appeared to be potential anadromous fish habitat; this tributary provides approximately 0.63 miles of moderate quality habitat, made up of high gradient, step-pool habitat.

LIMITING FACTORS:
Throughout Reach 0 and 1, there are invasive plant species such as Himalayan blackberry, European bittersweet, jewelweed and reed canary grass. Additionally, there are a few sections that are dominated by hardwoods and could benefit from under-planting conifers such as Western red cedars, Pacific yew, ponderosa pines and Douglas-fir.

A number of horse trails cross the creek in Reach 1 and heavy horse traffic is creating mud and erosion at some of the crossings. There were some pools with significant amounts of fine sediment in the substrate and high amounts of fine sediments were noted as limiting factors to spawning habitat in Reaches 7 and 8.

POTENTIAL RESTORATION PROJECTS *(Listed from high to low priority)*
1. **Restore Fish Passage at RM 0.32**: The culvert under Northwestern Lake Road is a 100 percent fish passage barrier due to slope of 3.10 percent and an outfall drop of 0.27 meters.
2. **Invasive Weed Removal & Replanting**: A large area of Scotch broom is growing on the oak savanna hills near the mouth of Mill Creek. There are also patches of Himalayan blackberry in Reaches 0 and 1. Invasive weeds should be removed, managed, and replaced by native shrubs and Oregon white oak trees.
3. **Hardened Crossing**: A trail often used for recreational horseback rides could use improvements to reduce bank erosion and sediment introduction to the stream.
4. **Bank Stabilization & Erosion Control in Reach 1 & Tributary 1:** Sections of streambank are eroding in Reach 1 and along the first reach of Tributary 1. Some of this erosion is due to heavy horse traffic on trails along and through the creek; these trails are frequented by a neighboring stable and a hardened crossing may be an option to avoid future damage.

BUCK CREEK *(Enters the White Salmon River at RM 5.03 from the left bank)*
DRAINAGE BASIN: 13.9 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 3.39 (100% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: 4.26 meter waterfall at RM 3.23
NUMBER OF BARRIERS: 3
TYPE OF SURVEY: Observation and habitat

HABITAT CHARACTERISTICS:
Throughout the lower section of Buck Creek the channel shifts numerous times from open floodplain to constrained bedrock cliffs. Much of this portion of Buck Creek is constrained by tall, steep conglomerate cliffs with bedrock forming the stream bed in some areas. From the Buck Creek Road bridge that crosses at RM 2.10 and continuing upstream, the channel is constrained by bedrock banks. Throughout the entire stream, channel substrate consists mainly of bedrock and cobble with limited sections of gravels. Gradient ranges from 2.5 to 6 percent on the mainstem of Buck Creek.

Similarly to channel form, canopy cover also alternates throughout the lower portions of the stream, ranging from 55 to 80 percent on average. Dominant species present are Douglas-fir, Western red cedar, Pacific yew, red alder, and big leaf maple. Understory vegetation is healthy and consists of vine maple, ocean spray, goats beard, maidenhair, sword ferns, thimbleberry, devil's club and native blackberry.

Overall, instream complexity is low to moderate in Buck Creek; overhanging banks, root wads, rare large woody debris and small wood jams provide occasional instream shelter. Sections with deep, narrow pools and small vegetated cobble and gravel bars in the channel provide some of the only gravels in the stream system.

There are a number of small springs and seeps that contribute limited amounts of cold water to the Buck Creek system. Water temperatures recorded in June 2009 were between 48.2 to 50.0 degrees Fahrenheit.

Only two potentially anadromous tributaries were noted within the Buck Creek subbasin. These tributaries feed into Buck Creek near RM 1.95 and contribute 0.04 and 0.13 miles of habitat to the Buck Creek system. Barrier culverts are located at the mouth of both tributaries.

LIMITING FACTORS:
In some areas hardwoods dominate the riparian habitat, these areas would greatly benefit from under-planting conifer species such as Western red cedar, Pacific yew, ponderosa pine and Douglas-fir along the banks and floodplain. Many short sections in Reach 0 have very limited canopy cover and there are a number of long straight sections, ranging from 45 to 90 meters, with little to no instream habitat.

Invasive species such as Himalayan blackberry, herb Robert, St. Johns wort, reed canary grass and European bittersweet were noted growing throughout Reach 0. In some sections Himalayan blackberry is forming thickets where native plants are unable to grow, however, for the most part, invasive species patches are small, between 75 to 335 square meters.

Near the confluence of Buck Creek and the White Salmon River, there are four water outtakes diverting water to nearby cabins. Additionally, there are three man-made fish passage barriers on Buck Creek and its tributaries. Impassable culverts at the mouth of Tributary 1 and 2 limit access to these small tributaries. At RM 2.04 the White Salmon Irrigation District's diversion dam spans the entire creek and is a fish passage barrier. The dam directs water into the outtake pipe and open conveyance channel on the right bank, which is not screened to prevent fish from entering. In the summer, the White Salmon Irrigation District installs flash boards to pool limited flow for diversion; these boards make the structure a 100 percent fish passage barrier.

Fine sediments are contributed to the creek by Buck Creek Road; from RM 1.93 to RM 2.04, the road is particularly close to the creek and riparian buffer is very limited. Eroding driveways are also contributing sediments into the creek and threatening road failure.

POTENTIAL RESTORATION PROJECTS *(Listed from high to low priority)*

1. **White Salmon Irrigation District Diversion Screening & Fish Passage:** The irrigation dam is a full fish passage barrier during summer months when flash boards are installed to divert water; it is a 67 percent barrier when flash boards are not installed. The diversion is not currently screened and fish can easily pass into the diversion ditch and holding pond. Additionally, there is potential for large water savings through increased efficiency in conveyance.
2. **Large Woody Debris Enhancement in Reach 0:** A few areas appear to be nearly void of instream woody debris in Reach 0, specifically at RM 0.30, RM 1.27 and RM 2.58. Estimates of large woody debris loading were established by the USGS survey of Buck Creek conducted in summer 2010, and will provide information of how much wood should be added. Machine access is possible in some areas**.**
3. **Side Channel Access & Habitat Restoration in Reach 0:** Side channel habitat is very limited in most sections of Buck Creek and if enhanced, could provide rearing habitat for fish. A constructed rock berm prevents channel migration into a short side channel in Reach 0 and trash is spread throughout the migrating zone. Invasive weed removal would also benefit habitat in side channels in the lower sections of Buck Creek.
4. **Bank Stabilization & Erosion Control in Reach 0:** A section of streambank is eroding into the Buck Creek Road roadbed. The erosion is threatening the road infrastructure and may release a large input of angular gravels and fine sediments to Buck Creek. UCD Engineers have visited the site and provided initial cost estimates and project design for stabilization of the streambank. Boulders and large wood placement as part of the erosion mitigation would also provide instream habitat.
5. **Conifer Under-planting in Reach 0:** Abundant even-aged stands of red alder are growing along Buck Creek in this section; riparian habitat could benefit from thinning of the alder and under-planting with native conifers such as Western red cedar, Douglas-fir, and Pacific yew.
6. **Invasive Weed Removal & Replanting in Reach 0:** Dense patches of Himalayan blackberry, European bittersweet and herb Robert grow throughout Reach 0. These areas could be weeded, maintained, and replanted with native riparian shrubs and trees.
7. **PacifiCorp Cabins Pump Screening:** Several cabins near the mouth of Buck Creek pump water from Buck Creek. These diversions may not meet WDFW screening requirements to prevent impingement of small fishes.
8. **Restore Fish Passage at Tributary 1 & 2:** Two culverts pass under the DNR access road and are 67 percent and 100 percent fish passage barriers due to culvert slope. O. mykiss have been observed upstream on Tributary 1.[5].
9. **DNR Road Drainage & Decommissioning Survey**: Improve drainage or decommission roads in the Buck Creek drainage to mitigate fine sediment inputs and storm flood surges to the creek.

[5] Personal contact with Greg Morris, Yakama Nation Fisheries Biologist. 2009

TRIBUTARY 5.64 *(Enters the White Salmon River at RM 5.64 from the right bank)*
DRAINAGE BASIN: 0.63 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 0.79 (86% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: Not established due to lack of landowner permission
NUMBER OF BARRIERS: ≥0
TYPE OF SURVEY: Observation

HABITAT CHARACTERISTICS:
This tributary was recently added to DNR maps as a fish stream and provides quality spawning and rearing habitat throughout the alternating pool and riffle habitat. Gravels are prominent ranging from 25 to 90 percent of the substrate composition and overhanging banks, small wood jams and low vegetation provides moderate to high instream cover. Throughout the entirety of the creek, there are numerous springs and seeps that contribute to the stream flow and sustain water temperatures between 51.8 and 56.3 degrees Fahrenheit as measured in August 2010. Canopy cover is high in Reaches 1 and 3, ranging from 80 to 100 percent with Western red cedar, Douglas-fir, grand fir, Pacific yew, black cottonwood, big leaf maple, Oregon ash, red alder, and hazelnut. Ground vegetation is dominated by vine maple, dogwood, twinberry, Oregon grape, ceanothus and cattails, skunk cabbage, sedges, and hedge nettle in areas with heavy spring influence.

The channel is approximately 1.5 to 2.7 meters wide throughout Reaches 1 and 3, however, is more confined in Reach 2, with a scour line width of .60 meters. On average, gradient ranges from 2 to 3.5 percent.

Reach 2 is very different from Reaches 1 and 3. A historic beaver dam in Reach 2 created a pond that flooded out numerous large Western red cedars. The resulting habitat is open and flat, with a small channel flowing through dense reed canary grass with occasional bed elevation changes due to sediment build-up and mudstone scouring. A more recent beaver dam creates a pond in the upper portions of Reach 2. Canopy cover is low throughout the beaver pond complex.

Tributary 1 was noted as the only tributary within the survey area. Canopy and instream cover is high throughout the short 0.16 miles of Tributary 1. Habitat shifts from a narrow channel near its confluence with the main channel of Tributary 5.64 to a wide marshy area with multiple seeps and springs further upstream.

LIMITING FACTORS:
Invasive species are prominent in Reach 2 and were noted in small concentrations throughout Reaches 1 and 3 as well as sections off of the channel. Himalayan blackberry, European nightshade, Canada thistle, reed canary grass, tansy ragwort, Scotch broom and vetch are among the invasive species established along Tributary 5.64. With the exception of Reach 2, where reed canary grass and European nightshade dominate the riparian vegetation, invasive species are not dominant in other reaches and can be easily controlled at this point. However, in Reach 2, reed canary grass and European bittersweet are well established and native riparian shrubs and trees are limited.

A culvert poses a 33 percent fish passage barrier on a small contributing drainage that passes under Highway 141 upstream of the portion of Tributary 5.64 that was surveyed. From DNR map layers, it appears that the channel that the barrier culvert is on feeds into Tributary 1, however, onsite observations discovered that Tributary 1 ends downstream of the barrier culvert at a spring source. When the culvert was surveyed, Technicians noted that upstream the channel appears to be seasonal or road drainage, with angular cobbles and Oregon white oak and poison oak growing in the channel. The channel did not appear to be fish habitat. However, a complete survey of the downstream habitat would be beneficial in order to establish if there is any fish habitat available downstream.

POTENTIAL RESTORATION PROJECTS *(Listed from high to low priority)*

1. **Invasive Weed Removal & Replanting in Reaches 1, 2, & 3 -** Himalayan blackberry, European nightshade, Canada thistle, reed canary grass, tansy ragwort, Scotch broom and vetch are all present in riparian areas

throughout Tributary 5.64. In Reach 2, large reed canary grass and European nightshade concentrations dominant the riparian area and prevent native species from establishing. Additionally, smaller portions of invasive species are present in Reaches 1 and 3 as well as along Tributary 1 and a large open field off of the channel. These invasive weed species should be removed and the area replanted with native riparian and upland species.

TRIBUTARY 6.45 *(Enters the White Salmon River at RM 6.45 from the left bank)*
DRAINAGE BASIN: 0.60 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 1.24 (47% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: Not established due to lack of landowner permission
NUMBER OF BARRIERS: ≥2
TYPE OF SURVEY: Observation and Habitat

HABITAT CHARACTERISTICS:
From its confluence with the White Salmon River, flow in Tributary 6.45 is distributed into multiple channels that weave through marshy floodplain habitat. Within the first 76 meters from the mouth, the tributary enters dense Douglas-fir and ponderosa pine dominated forest. Throughout the section surveyed, canopy cover ranges from 65 to 95 percent with sections of Reach 1 and 2 with limited cover due to roads and power-lines. Big leaf maple, black cottonwood, Oregon white oak and multiple shrub species contribute to the high species and age diversity in the riparian area.

Instream habitat consists of alternating pool and riffle sections and an occasional boulder dominated cascade. Downed trees, small jams and boulders provide healthy instream cover within the first reach of the tributary; however, instream cover significantly decreases in upstream reaches, as does riparian species and age diversity.

Water temperatures recorded on June 22, 2010 ranged from 47 to 53 degrees Fahrenheit. Instream flow was limited in some sections and was completely subsurface throughout Reach 1 during the survey. Although numerous springs and seeps were noted in Reach 2, there were no tributaries within the area surveyed.

LIMITING FACTORS:
Seasonal low instream flows were noted in Reach 1 and could be problematic to upstream migrating species. Additionally, gravels and small cobbles from White Salmon River Road are entering the channel in sections with low riparian vegetation along the road. Subsurface flows are potentially caused by bed elevation changes due to a culvert and road fill eroding into the stream channel and could be mitigated with removal of the culvert and erosion control efforts.

Eroding banks contribute significant amounts of fine sediments to the stream and sections of low canopy and instream cover decrease instream and riparian habitat quality. Riparian vegetation in Reach 1 and 2 is limited in age and species diversity and consists primarily of younger age class regenerating Douglas-fir.

POTENTIAL PROJECTS: *(Listed from high to low priority)*

1. **Restore Fish Passage at RM 0.37**: This culvert was installed underneath the landowner's access road to their house and poses a 100 percent passage barrier due to a slope of 2.8 percent and outfall drop of 0.81 meters. This project may be eligible for the Forest Family Fish Passage Program. This project has been submitted to WDFW.
2. **Restore Fish Passage at RM 0.41**: This culvert runs under White Salmon River Road and poses a 67 percent passage barrier due to a slope of 3 percent and outfall drop of 0.25 meters. The road is a Klickitat County road.
3. **Riparian Planting in Reach 1 & 2:** Bare sections of streambank along White Salmon River Road and driveways could benefit from riparian planting. Because of the close proximity of the road to the creek, dense shrub species such as willows may be best suited to provide instream cover and form a barrier between the roads and stream habitat.
4. **Bank Stabilization & Erosion Control in Reach 1 & 2:** Sediments contributed to the stream could be mitigated with erosion control measures along roads and exposed slopes in Reach 1 and 2.

SPRING CREEK *(Enters the White Salmon River at RM 6.76 from the left bank)*
DRAINAGE BASIN: 2.40 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 4.75 (1% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: Not established due to lack of landowner permission
NUMBER OF BARRIERS: Unknown
TYPE OF SURVEY: Observation and habitat

HABITAT CHARACTERISTICS:
Spring Creek is a year round stream which offers a significant amount of habitat, however, the creek was not surveyed along the mainstem due to lack of landowner permission and unresponsive landowners. Sections of the creek are visible from the road and canopy cover is sufficient throughout most of lower and middle Spring Creek, with Douglas-fir, big leaf maple, black cottonwood, Oregon white oak, bitter cherry and red alder.

The only sections of Spring Creek that Technicians were able to gain permission to survey were along Tributary 1.
Tributary 1 feeds into Spring Creek at RM 0.44 from the right bank. This is a small, high gradient tributary with riffle dominated habitat and small shallow pools. Small debris jams and low, dense riparian vegetation provide limited instream habitat and cover in Tributary 1. The stream runs alongside and underneath Lower Spring Creek Road at a gradient ranging from 2.5 to 5 percent. Tributary 1 is limited in the amount of habitat due to seasonal flows in upstream portions and sustained gradient.

In Tributary 1, canopy cover is limited in some sections due to forestry practices; however, in general, mature conifers line the tributary and canopy cover is between 60 to 80 percent. Water temperature was not recorded in Tributary 1.

LIMITING FACTORS:
From site visits along Spring Creek Road and Lower Spring Creek Road, it is apparent that habitat access is limited due to potential passage barriers, including an earthen dam and pond, and potentially undersized culvert upstream of the pond on the mainstem of Spring Creek. On Tributary 1, there are at least 3 fish passage barrier culverts preventing upstream passage and 3 additional culverts noted upstream near the end of potential anadromous habitat that may be barriers as well; however, these culverts were not surveyed due to dense poison oak surrounding the culvert and lack of landowner permission.

Close proximity to the road also poses a problem for Tributary 1 which travels along Lower Spring Creek Road; the road contributes fine sediments and gravels to the creek via dust from passing cars and eroding road fill. Additionally, trees on the hillside to the south of Tributary 1 have been harvested and as a result there is low canopy cover along portions of the tributary.

Invasive weed species, such as Himalayan blackberry, reed canary grass, curly dock and European bittersweet are present in Reaches 2 and 3 along Tributary 1. Invasive weeds are likely to spread to areas with low vegetation cover due to forestry practices.

POTENTIAL RESTORATION PROJECTS *(Listed from high to low priority)*

1. **Restore Fish Passage at Spring Creek Dam:** This earthen dam across Spring Creek was not surveyed because Technicians were unable to make contact with the landowner; however, the dam is a known fish passage barrier. Continued outreach to the landowner could be beneficial. Upstream of the dam reservoir is a culvert and low-gradient wetland area. The length of habitat available upstream of this pond is unknown due to lack of landowner permission to survey.
2. **Restore Fish Passage on Tributary 1 at RM 0.04:** This culvert runs under Lower Spring Creek Road and is located just upstream of the confluence of Spring Creek and Tributary 1. It is a 100 percent passage barrier due to an outfall drop of 1.15 meters. The road is maintained by Klickitat County.

3. **Restore Fish Passage on Tributary 1 at RM 0.25***:* Just upstream of the culvert at RM 0.04, there is another culvert underneath Lower Spring Creek Road that poses a 100 percent passage barrier due to a slope of 1.82 percent and an outfall drop of 1.30 meters. This portion of Lower Spring Creek Road is maintained by Klickitat County.
4. **Invasive Weed Removal & Replanting on Tributary 1:** In Reach 2 of Tributary 1 there are populations of curly dock and European bittersweet that could be removed; similarly in Reach 3 there is a large Himalayan blackberry patch that has taken over the riparian area. These invasive species could be removed and replanted with native plants such as conifers, red osier dogwood, and willows.
5. **Riparian Planting & Conifer Under-planting:** Sections of Tributary 1 Reach 2 have limited conifer species in the riparian area; under-planting Douglas-fir and Western red cedar would increase species diversity and provide future woody debris to the creek. Additionally, in Reach 3 the stream runs along Lower Spring Creek Road and has very little riparian cover and protection from road sediments. Live-staking of red osier dogwood and willows would help shade the creek and prevent erosion from the roadbed.
6. **Restore Fish Passage on Tributary 1 at RM 0.45***:* This culvert passes under White Salmon River Road and is a 100 percent passage barrier due to a slope of 7.69 percent. The roadbed is deep and upstream habitat is limited; there are also additional culverts located upstream that were not surveyed; passage through the three culverts noted upstream is unknown.
7. **Install Hardened Crossing in Reach 0:** Technicians did not have permission to survey this portion of Spring Creek, however, there is a known horse trail crossing over Spring Creek that contributes sediment to the stream and could benefit from a hardened crossing.
8. **Landowner Outreach & Partnership Development:** Technicians had limited success gaining access to Spring Creek and tributaries due to lack of landowner willingness. This could be improved through efforts aimed at improving trust between Underwood Conservation District and Spring Creek landowners.

TRIBUTARY 7.41 *(Enters the White Salmon River at RM 7.41 from the right bank)*
DRAINAGE BASIN: 0.22 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 0.16 (36% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: Not established due to lack of landowner permission
NUMBER OF BARRIERS: ≥2
TYPE OF SURVEY: Observation

HABITAT CHARACTERISTICS:
This small tributary enters the mainstem White Salmon River from the right bank and a boulder-rich cascade approximately 3.90 meters tall is present at the mouth and channel width of approximately 3 meters. Upstream of this cascade, the channel meets size and habitat requirements to be considered anadromous fish habitat, although the cascade at the mouth will limit use and access to most fish species. In general, gradient ranges between 2 and 3 percent, with steeper sections at the mouth as well as upstream of Highway 141.

The stream is dominated by short riffles and long pools with substrate consisting of mostly fine sediments; there are some riffles that contain up to 15 percent gravels that could be utilized for spawning. Upstream substrate includes bedrock, cobble and hardened clay.

A dense subcanopy provides 60 to 80 percent stream cover, consisting primarily of red osier dogwood and vine maple, with a few larger Douglas-fir and ponderosa pines providing increased canopy cover near the White Salmon River. Instream cover is made up of small debris jams, but overall stream complexity is limited. Temperature was measured at 46 degrees Fahrenheit in August of 2010.

LIMITING FACTORS:
Seasonal low flow conditions may pose a challenge to upstream migrating fish trying to ascend the boulder area at the mouth of the stream. Habitat conditions are limited due to passage barriers, although the concrete culverts near the mouth may be easily removed.

Stream solarization was low due to good shading provided by a dense subcanopy. Conifer seedlings were noted growing in the riparian area, however, efforts to release young conifer seedlings from dense competition with shrubs will improve long term canopy cover. Planting conifers along the stream, as well as near Fordyce Rd would provide long term instream and riparian habitat benefits.

Upstream habitat characteristics are largely unknown. It appears that upstream flows are diverted for irrigation use and there may be barriers present upstream of Highway 141.

POTENTIAL RESTORATION PROJECTS *(Listed from high to low priority)*

1. **Restore Fish Passage at RM 0.03**: The stream is culverted between two sections of concrete pipe of 0.90 and 1.80 meters in length, and approximately one foot in diameter. It appears this partial passage barrier is not being used as a crossing and could easily be removed.
2. **Restore Fish Passage at RM 0.16**: This culvert runs under Highway 141 and was not surveyed due to traffic concerns; however, the culvert is expected to pose a passage barrier due to slope. The road is a Klickitat County road. Upstream habitat is marshy with an undefined channel, and fish habitat is estimated to continue for 0.28 miles upstream. Permission to survey upstream portions was not granted.
3. **Conifer Release & Riparian Planting in Reach 1 & 2:** Tributary 7.41 would benefit from activities that reduce competition for emerging conifer seedlings to allow them to break through the dense understory canopy. Portions of Reach 1 and along Fordyce Road could benefit from riparian planting of Douglas-fir and ponderosa pines.
4. **Invasive Weed Removal & Replanting in Reach 2:** Some areas near Fordyce Road had bull and Canada thistle and would benefit from weed removal and riparian planting.

TRIBUTARY 7.49 *(Enters the White Salmon River at RM 7.49 from the right bank)*
DRAINAGE BASIN: 0.55 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 0.20 (52% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: Not established due to lack of landowner permission
NUMBER OF BARRIERS: ≥2
TYPE OF SURVEY: Observation

HABITAT CHARACTERISTICS:
Tributary 7.49 flows through a short section of floodplain just before it enters the White Salmon River at a sharp river bend known as *Deadman's Curve*. The floodplain is open with large mature black cottonwood trees dominating the riparian habitat and providing approximately 70 percent shade. Other tree species include red alder and choke cherry. There is very little shrub vegetation in Reach 1 and grasses cover the forest floor. Upstream, near the top of Reach 1 and throughout Reach 2, riparian vegetation increases as vine maple and red osier dogwood fill in along the stream and Douglas-fir and Oregon ash contribute to canopy cover.

Spawning and rearing habitat is low quality throughout Tributary 7.49, with high concentrations of fine sediment in the substrate and very low instream cover consisting of an occasional boulder or low growing vegetation. During the survey, there were some sections of the tributary that were dry; however, where there was water, the water temperature was 56.3 degrees Fahrenheit as measured in August 2010.

There are an estimated 0.10 miles of potential fish habitat upstream of the section surveyed. The upstream portion of stream flows alongside a road and has dense red osier dogwood cover. At the time of the survey, there was significant flow in the channel upstream; however, flow appears to stop at a pond near the top of Husum Hills Golf Course road. It is unclear if the pond created from a dam or if it is a spring source, however, map layers do not show the stream continuing upstream of the pond.

LIMITING FACTORS:
There is very little instream cover throughout this short tributary stream. Combined with high amounts of fine sediment in the substrate, the rearing and spawning habitat is limited and of low quality. Additionally, low summer time flows limit access to fish.

Throughout the riparian area there is little species diversity and very few conifer trees. Invasive species such as reed canary grass and tansy ragwort are present; there is a large concentration of reed canary grass in Reach 1.

Two fish passage barriers are present within Reaches 1 and 2. The first is a steel culvert under an old, unused road. The culvert is laid in a tall bed of layered cobble. This culvert, located at RM 0.07 is a 100 percent passage barrier due to an outfall drop of 2.07 meters. Upstream at RM 0.09, a culvert located under Highway 141 poses a 33 percent barrier due to an outfall drop of 0.35 meters. These barriers are not high priority due to limited habitat quality and quantity.

POTENTIAL RESTORATION PROJECTS *(Listed from high to low priority)*
1. **Conifer Under-planting in Reach 1:** Due to low species diversity and very limited conifer presence, it would be beneficial to plant conifer species such as Douglas-fir and Western red cedar under the black cottonwood in Reach 1. Conifer species will add diversity and will eventually provide long lasting large woody debris and instream habitat to both the tributary and White Salmon River systems.
2. **Large Woody Debris Enhancement in Reach 1:** Habitat forming woody debris could be installed in the floodplain at the mouth of the tributary. This area is one of the only floodplain areas on the mainstem. Improving habitat complexity would provide resting and refuge for fish on upstream migration runs.
3. **Invasive Weed Removal in Reach 1:** The riparian habitat is dominated by reed canary grass and increased plant diversity would add to the riparian habitat throughout Reach 1. Species such as vine maple, red osier dogwood and willows would thrive in this floodplain area.

4. **Restore Fish Passage at RM 0.07:** Although this barrier is not a priority to remove due to the relatively limited habitat available upstream, it may be an easy culvert to remove because the road is no longer used for transport. The culvert is a 100 percent barrier and could be removed to open up 0.02 to 0.13 miles of habitat upstream.
5. **Restore Fish Passage at RM 0.09:** This barrier culvert passes under Highway 141 and appears to only have 0.11 miles of habitat available upstream. It is not a high priority barrier to mitigate; however, it does pose a 33 percent fish passage barrier to upstream migration.

RATTLESNAKE CREEK *(Enters the White Salmon River at RM 7.72 from the right bank)*
DRAINAGE BASIN: 56.0 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 18.5 (75% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: 16.8 meter waterfall at RM 10.51
NUMBER OF BARRIERS: None on mainstem; 9 on tributaries
TYPE OF SURVEY: Observation and habitat on tributaries

HABITAT CHARACTERISTICS:
Rattlesnake Creek is major tributary contributing a substantial portion of potentially anadromous habitat to the lower White Salmon River Basin. The creek alternates between bedrock canyons and wide anatomizing channels with shallow riffles and occasional deep pools. The mainstem of Rattlesnake Creek is low gradient, on average between 2 and 3.5 percent and has an average channel width of 6 to 8 meters. Substrate is characterized by bedrock, large, rounded cobble and boulders, and prominent gravels comprising 30 to 50 percent of the substrate. Exposed bedrock and low summertime flows contribute to high water temperatures. In July to September 2009 and 2010, water temperatures were recorded ranging between 53.6 and 61.7 degrees Fahrenheit.

Canopy cover is made up of mixed hardwoods including mature black cottonwood, red alder, Oregon white oak and mature ponderosa pine and Douglas-fir. Canopy cover ranges between 10 and 75 percent. Mock orange, beaked hazelnut, vine maple, red osier dogwood and willows were noted in the subcanopy. Large sections of Himalayan blackberry grow throughout the riparian area. Other noxious weeds including common tansy, St. John's wort, Canada thistle, European bittersweet were also noted along the creek.

Habitat forming large woody debris is limited in Rattlesnake Creek and instream cover is made up of overhanging rootwads, woody debris, and small wood jams. These small wood jams are primarily along bank edges and are comprised of transient hardwoods rather than longer lasting conifers. However, there is evidence of these accumulations collecting small woody debris and gravels on the upstream side.

Seven tributaries feed into Rattlesnake Creek are considered to be potentially anadromous habitat. Tributary 1 enters Rattlesnake Creek at RM 4.99 and contributes 0.58 miles of habitat to the system. There is a full fish passage barrier dam on Tributary 1. At RM 5.32, Tributary 2 enters Rattlesnake Creek and contributes an estimated 0.12 miles of habitat. There is a barrier culvert on Tributary 2. Tributary 3 contributes 0.41 miles of habitat where it feeds into Rattlesnake Creek at RM 6.11. This tributary also has a culvert barrier. At RM 6.41, Tributary 4 contributes an estimated 0.41 miles of habitat; a barrier culvert is located on Tributary 4. Tributary 5 feeds into Rattlesnake Creek at RM 7.97 and offers 0.68 miles of habitat. A total of 1.11 miles were surveyed on Tributary 6, which enters Rattlesnake Creek at RM 8.42. There may be up to 5.51 miles of habitat available in Tributary 6. The last tributary enters Rattlesnake Creek at RM 10.18 and only has 0.05 miles of potential anadromous habitat.

LIMITING FACTORS:
Summertime high temperatures in Rattlesnake Creek exceed Washington State core summer salmonid habitat water temperature standards (set at a maximum of 60.8 degrees Fahrenheit) and may be lethal for some salmonid species.[6] Low flow and natural bedrock and large boulder features may also limit upstream access to fish during certain times of the year.

Eroding banks in Reach 2, 3, and 5 and 6 contribute coarse and fine sediments to the creek and some sections of cobble and gravel are embedded in fine sediments. Additionally, suspended solids fill in pools and darken the color of the water which may also contribute to high water temperatures.

[6] Washington Department of Ecology, Temperature Standards and Criteria.
http://www.ecy.wa.gov/programs/wq/swqs/temperature.html

In some sections, limited canopy cover exposes the creek to long hours of sunlight and bedrock lined banks limit riparian vegetation and thus the quantity of habitat forming large woody debris as well.

Cattle use was noted in numerous areas of the Rattlesnake Creek basin. Cattle trample and browse riparian vegetation, cause erosion by entering and exiting the creek and widen the stream channel by creating streamside trails. Cattle also may wallow or swim where water is deep enough, stirring up sediments and disturbing pools where fish are taking refuge in deeper, cooler water. Landowners have voiced concerned about the number of cattle concentrated in Reaches 6 and 7.

Adjacent roads, such as Indian Creek Road and Rattlesnake Creek Road, impact the creek by contributing roadfill and eroding sediment into the stream system. Additionally, heavy riprap armoring constrains the creek and limits floodplain access near the mouth.

POTENTIAL RESTORATION PROJECTS *(Listed from high to low priority)*

1. **Large Woody Debris Enhancement**: The majority of Rattlesnake Creek lacks in-stream habitat and large woody debris. Supplemental wood placement would create valuable instream habitat in areas such as along Indian Creek Road, and areas from RM 3.24 to RM 4.90 and near RM 5.76.
2. **Invasive Weed Removal & Replanting in Reaches 0, 1, 2, 3, 4, & 6:** Himalayan blackberry and common tansy are noted as problematic species in Reaches 0, 1, 2, 3, 4 and 6; often covering large areas and restricting riparian plant diversity. Weed removal and replanting with conifers and native riparian shrubs would provide improved instream and riparian habitat complexity.
3. **Off Channel Livestock Watering & Management**: Cattle and wildlife can impact water quality by grazing riparian vegetation that would otherwise provide stream shade, by contributing mud to the stream with repeated stream bank access and by introducing fecal coliform and nutrients in the form of manure. Weed seeds may also be spread by cattle and wildlife. Cattle on open range have unrestricted access to much of the stream channel and cattle concentrations can be high during times. Cattle impacts were noted instream and in riparian areas throughout Reaches 4, 5, 6, 7 and Tributaries 1, 2, 3 and 4. Installing off stream watering troughs, continuing to distribute animal numbers to discourage loafing, installing hardened crossings, placing salt blocks away from the stream, and fencing critical areas can improve conditions.
4. **Indian Creek Road Redirection & Rip-Rap Removal**: Heavy riprap armoring near the mouth of Rattlesnake Creek limits riparian function and floodplain access. Rerouting traffic use away from Lower Indian Creek Road to an adjacent road and decommissioning a portion of the road could allow channel migration and floodplain use.
5. **Install Riparian Fencing**: Several areas, which are currently classified as "Open Range" could be fenced along Rattlesnake Creek. Areas throughout Lower and Middle Rattlesnake Creek are used heavily from cattle. Various landowners expressed interest in reducing cattle impacts and fencing projects. Fence maintenance in forested areas may be only a partial solution if fences cannot be maintained, so fence installation should be combined with other efforts to reduce cattle impacts.
6. **Continued Upper Rattlesnake Watershed Restoration Projects**: Water quality and quantity projects in Upper Rattlesnake Creek watershed have been a high priority for UCD over the past 10 years. Piezometer monitoring has been tracking the potential impact of installed check dams and restoration efforts. The expectation is that additional check-dams and wetland restoration will enable more infiltration and raise the water table in the upper watershed, leading to higher groundwater-fed summer base flows in Rattlesnake Creek. Additional areas to focus efforts have been identified and should be developed.
7. **Rattlesnake Creek Stream Gage**: Stream flow data was recorded at the base of Rattlesnake Creek from 2003-2006 as part of the Bonneville Power Administration Rattlesnake Creek project. The gage is located at RM 0.34. Reinstalling the gage to collect flow data will help assess the benefits of upstream wetland restoration efforts, check-dams, and instream flow leasing.
8. **Concrete Dam Removal in Reach 2**: This partial concrete l dam could be removed to improve instream habitat. Removal may allow better passage for steelhead during winter months.

9. **Riparian Trash Removal in Reach 5**: A large amount of trash has been deposited on a terrace above a side channel near RM 3.50 and RM 3.67. The quantity of material will require assistance to clean up. Landowner efforts to remove the trash and clean up the site are in progress.
10. **Gabion Removal & Replanting in Reach 5**: Remove rock gabions that line Rattlesnake Creek at RM 4.64 and restore riparian tree and shrub species to provide canopy cover and instream cover. This is also a viable site for large wood debris installation.
11. **Educational & On-ground Efforts to Discourage ORV's in Upper Prairie**: Construct gates and signage to discourage illegal use of ORV's in the Rattlesnake Creek subbasin. Landowners have expressed very strong feelings about the ORV use in the upper prairie and holiday weekends are reported to have the most ORV traffic.

INDIAN CREEK *(Enters Rattlesnake Creek at RM 0.47 from the right bank)*
DRAINAGE BASIN: 4.59 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 4.70 (84% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: subsurface flows at RM 3.88
NUMBER OF BARRIERS: ≥5; 1 unknown due to lack of permission to survey
TYPE OF SURVEY: Observation and habitat

HABITAT CHARACTERISTICS:
Overall, Indian Creek is characterized by alternating pool/riffle and step pool habitats, comprised of cobbles, with some small boulders and gravel. Gradient alternates between reaches as low as 2 percent and as high as 18 percent. Stream gradient in the lower sections ranges from 2.5 to 5.5 percent. In upper sections, the gradient ranges from 6 to 12 percent with steeper gradients occurring for short sections in Reaches 4 and 5.

A canopy of second growth Douglas-fir, red alder and big leaf maple provides between 75 and 85 percent canopy cover throughout lower reaches. Upstream sections of Indian Creek were comprised of mature Douglas-fir, Western red cedar, Pacific yew and red alder, with canopy cover averaging near 70 percent; although some reaches had limited canopy cover, closer to 20 to 35 percent. Vine maple, hazelnut and snowberry make up the subcanopy.

Much of Indian Creek is channelized, with tall bedrock and mudstone banks lining the creek. Multiple sections of eroding mudstone banks were noted as contributing fine sediment to the system, particularly in reaches 6 and 7 where fines makes up a majority of the substrate. Gravels are also deposited by eroding banks and were noted accumulating upstream of instream structures.

Instream structure consisted of rootwads, small jams, boulders, and some large woody debris. High juvenile abundance was noted in deep pools at the base of tree roots and boulder jams. Temperature was recorded as 63.5 degrees Fahrenheit on August 31st, 2009 in Reach 0. Further upstream, temperatures ranged from 45.5 to 57.2 degrees Fahrenheit.

Five tributaries enter Indian Creek and provide additional habitat. Tributary 1 provides very limited habitat and appears to be mostly hyporehic flow. Tributary 2 provides 0.36 miles of potential anadromous fish habitat, which ends due to a sustained gradient of 20 percent for 160 meters. Tributary 3 contributes 0.26 miles of habitat; although the gradient is steep throughout the length of potential habitat on Tributary 3. Fish use in unlikely in Tributary 4 due to very steep gradient and an undefined channel. A total of 0.10 miles of potential anadromous habitat is available in Tributary 5; with steep boulder rich cascades and high amounts of instream structure.

LIMITING FACTORS:
There are at least six culverts within the Indian Creek subbasin that limit fish access to upstream habitat. In 2009, UCD initiated efforts to mitigate the first barrier, located near the mouth at RM 0.05.

Abundant fine sediments were noted in Indian Creek, often contributing to a greyish appearance of the water. High turbidity is likely the result of a number of factors. Close proximity to Indian Creek Road contributes fine sediments and road fill for approximately 457 meters. The adjacent road has also been a contributing factor when machinery churns up sediments that run down the road and enter the creek. Truck and dirt bike trails were also noted crossing Indian Creek in areas. Another contributor of sedimentation is mass wasting events, as observed in Reaches 3 and 4, where cobble sized material spans the channel and often creates bed elevation changes. This instability may be a natural tendency of soil layers exacerbated by past road building and logging on steep slopes. Additionally, spring influence is high in these areas and likely contributes to soil saturation and instability.

In Reaches 6 and 7, s both rearing and spawning habitat complexity is very low, with some sections comprised nearly 100 percent of fine sediments. Canopy cover in these reaches is also limited species diversity, consisting mostly of dense vine maple or red alder and very little overstory vegetation.

Noxious weeds such as Himalayan blackberry, St. John's Wart and reed canary grass were noted throughout the riparian area. Additionally, trash including irrigation pipeline, discarded culverts and old cars was found sporadically throughout the subbasin.

POTENTIAL RESTORATION PROJECTS *(Listed from high to low priority)*

1. **Restore Fish Passage at RM 0.05, 1.20, & 3.33:** These culverts limit upstream migration and are full and partial barriers due to slope and outfall drop. UCD has commissioned designs for the replacement of the double culverts at RM 0.05 and is in the process of obtaining funding for construction.
2. **Large Woody Debris Enhancement in Reach 1:** Reach 1 has low volumes of large woody debris; adding instream cover would improve habitat and provide needed shade to areas with bedrock or exposed banks. There is also potential to restore side channel habitat in Reach 1.
3. **Invasive Weed Control & Replanting in Reach 1 & 3**: Himalayan blackberry, reed canary grass, and other invasive weed species grow along Indian Creek. Invasive species could be removed and replaced with native trees and shrubs.
4. **Conifer Under-planting:** Sections of Reaches 0, 1, 6 and 8 could benefit from conifer under-planting; species such as Western red cedar, Pacific yew, and Douglas-fir would add species diversity, as well as provide future large wood to the riparian and instream habitat.
5. **Bank Stabilization & Erosion Control in Reaches 0, 1, & 4**: Sections of streambank and roadbed are eroding into Indian Creek along Reaches 0, 1, and 4. UCD Engineers visited a large eroding bank in Reach 1 and provided initial cost and design information. Wattle fences are recommended for preventing further erosion and providing riparian vegetation.
6. **Stand Thinning in Reach 1:** Areas of Reach 1 riparian forest could benefit from conifer release and thinning of dense, overcrowded sections. Another section of Oregon white oak habitat could benefit from thinning of conifers and big leaf maple.
7. **Riparian Planting in Reach 0**: This area was damaged during past culvert construction and by the floods that blew out the culverts under Indian Creek Road. Currently, hardwoods are growing along the banks; however, planting a mixture of native shrubs and conifers would assist in recovery.
8. **Restore Fish Passage at RM 3.68 and 3.72:** These culverts are full fish passage barriers, however habitat quality and quantity is limited upstream of these culverts and passage restoration may not rank highly.
9. **Water Diversion Outreach**: Provide outreach to landowners regarding screen requirements to prevent small fish from impinging on diversions and subsequent juvenile fish mortality.
10. **Riparian Trash Removal in Reaches 1, 3, & 4**: Throughout Reaches 1, 3 and 4 there are small concentrations of trash in and along the stream; some trash would need to be removed with machine, while other sections could be cleaned by hand.

TRIBUTARY 9.90 *(Enters the White Salmon River at RM 9.90 from the right bank)*
DRAINAGE BASIN: 2.43 miles^2
MILES OF POTENTIALLY ANADROMOUS FISH HABITAT: 1.52 (56% surveyed)
END OF POTENTIAL ANADROMOUS FISH PASSAGE: Not established due to lack of landowner permission
NUMBER OF FISH PASSAGE BARRIERS: ≥4
TYPE OF SURVEY: Observation and habitat

HABITAT CHARACTERISTICS
This tributary enters the White Salmon River at a broad bend in the mainstem known as *Big Eddy*. Tributary 9.90 subbasin is characterized by areas of subsurface flow, sections of high quality riparian habitat, heavy spring influence, and sections of wetland marsh in the upper watershed. The tributary provides quality spawning and rearing habitat near its confluence with the White Salmon River, however, due to its location upstream of Husum Falls, Chinook and steelhead may be the only species able to utilize this tributary.

Tributary 9.90 has low gradient with alternating pool and riffle habitat and substrate consisting of medium sized gravel and small cobble. In some shallow pools, gravels are embedded in fine sediments.

Canopy cover ranges between 60 and 75 percent and is dominated by Douglas-fir, Western red cedar, black cottonwood, and red alder, with grand fir, vine maple, Pacific ninebark, mock orange and snowberry in the subcanopy. In sections of higher canopy cover, accumulations of small debris jams were adding to habitat complexity. Areas with very low canopy cover and open fields of reed canary grass were noted in upstream reaches.

Water temperatures in Tributary 9.90 were recorded between 50.9 and 52.7 degrees Fahrenheit in June of 2010. There were multiple springs and seeps feeding into the tributary, however, no additional contributing streams were noted feeding into the main channel.

LIMITING FACTORS
Four fish passage barriers limit upstream mobility on Tributary 9.90. The first barrier was not surveyed due to lack of landowner permission, however, it may be a slope or outfall drop barrier and is located immediately upstream of the confluence with the mainstem White Salmon River. Additionally, a large concrete dam poses a complete passage barrier at RM 0.59.

Heavy cattle use, forestry practices and close proximity of roadways contribute sediments to the stream system. In many portions of Reaches 1, 2, and 3, gravel roadways are located within 0.91 meters of the stream, depositing fine sediment and gravels instream.

Summertime low flows and areas of subsurface flow are also limiting factors. The creek frequently transitions between surface and subsurface flow and long stretches of subsurface flow were observed in numerous locations throughout the section surveyed. An irrigation well or pump was noted above Oak Ridge Road, and may have an influence on summertime low flows noted in downstream sections.

POTENTIAL RESTORATION PROJECTS *(Listed from high to low priority)*
1. **Assess Passage of Culvert at RM 0.04:** This culvert should be assessed using WDFW fish passage protocol. The culvert was not measured due to lack of landowner permission; however, it may be a slope or outfall drop barrier. This is a sensitive issue for the landowner. The culvert was approved under state RMAP regulations when it was installed but was later deemed a barrier requiring mitigation if timber was removed along road. Another road was installed and the landowner is not planning to use this road for timber extraction. Since other access roads are in place, this may be a potential decommissioning project if the landowner is willing.
2. **Restore Fish Passage at RM 0.31:** This culvert is located under a Klickitat County maintained road that is planned to be regarded. The culvert is a 67 percent passage barrier due to a slope of 2.58 percent.

3. **Restore Fish Passage at RM 0.48:** An old dirt road crosses Tributary 9.90 and intersects with a private driveway. The road does not appear to be heavily used and may be a good Family Forest Fish Passage Project. The culvert is a 67 percent passage barrier due to a slope of 2.68 percent.
4. **Restore Fish Passage at RM 0.59:** At RM 0.59 on Tributary 9.90 there is a full spanning irrigation dam that prevents up and downstream migration. The dam creates a reservoir that it used to pool irrigation water for summer use. Upstream habitat is of high quality, with cold spring water contributions and marshy rearing habitat.
5. **Install Cattle Exclusion & Trough:** Currently cattle have access points to Tributary 9.90 and may use the creek for watering. Installing troughs or alternative watering options for the cattle will decrease negative water quality inputs and impacts of erosion on streambanks. Exclusion fencing or vegetation can be installed to limit stream access.
6. **Invasive Weed Removal & Replanting in Reaches 1, 2, & 3**: Limited populations of Himalayan blackberry were noted along the stream corridor. Houndstongue was also observed in this area. These sections were comprised of one or two plants that could easily be removed before this becomes a more severe problem.

TRIBUTARY 9.91 *(Enters the White Salmon River at RM 9.91 from the right bank)*
DRAINAGE BASIN: 0.37 miles^2
MILES OF POTENTIAL ANADROMOUS FISH HABITAT: 0.17 (100% surveyed)
END OF POTENTIAL ANADROMOUS FISH HABITAT: Spring source at RM 0.17
NUMBER OF BARRIERS: 1
TYPE OF SURVEY: Observation

HABITAT CHARACTERISTICS:
This short, low gradient tributary feeds into the White Salmon River just upstream of Tributary 9.90 at *Big Eddy*; it is the highest potentially anadromous stream in the watershed. However, due to its location upstream of Husum Falls, access will most likely only be available to Chinook and steelhead. In the first reach of Tributary 9.91, dense riparian shrubs such as red osier dogwood and snowberry, cover the stream completely. Mature Douglas-fir, grand fir, black cottonwood and red alder dominate the canopy for the first 0.04 miles of stream. In Reach 0, at RM 0.04 there is a culvert and an old gravel road that passes over the creek; at this point, the riparian habitat shifts and canopy cover significantly decreases as the multi-channeled stream flows through a large grass field leased for cattle grazing. Upstream of the culvert at RM 0.04, riparian vegetation is very low and consists mainly of red alder.

Another road crosses the creek just downstream from a prolific springs that surfaces and sources the tributary at RM 0.17. This road and spring are heavily utilized by cattle and as a result, the road is thick, soft, mud. The spring source is clear and a small reservoir pond is created by the roadway. The culvert under this road was not surveyed due to lack of landowner permission; however, it appeared to be an outfall drop barrier.

LIMITING FACTORS:
Upstream fish passage is limited due to culverts located at the top of Reach 0 and 1. These culverts were not surveyed; however, both appeared to be likely barriers due to velocity in Reach 0 and outfall drop in Reach 1. Upstream of the culverts, habitat is limited due to the end of fish passage at the stream's spring source that surfaces at RM 0.17.

Grazing cattle have unrestricted access to the majority of the stream; many of the streambanks were deep mud, with little ground vegetation, and fecal matter was common throughout the upper reach. Chicory, an invasive weed species is prevalent throughout the field and riparian area.

Instream cover is limited in Reach 1, with small woody jams creating the only cover. Substrate appeared to be mostly made up of fine sediments; contributing to the severity of the effect of cattle presence.

POTENTIAL RESTORATION PROJECTS *(Listed from high to low priority)*

1. **Assess Passage of Culvert at RM 0.04:** This culvert should be assessed using WDFW fish passage protocol and passability issues should be mitigated to allow for upstream fish passage.
2. **Install Cattle Exclusion & Trough:** Currently cattle have unlimited access to Tributary 9.91 and utilize the creek for watering. Installing alternate water options for the cattle will lessen the impact on the tributary and exclusion fencing or vegetation can be installed to limit stream access.
3. **Install Hardened Crossing:** Just downstream of the spring source of Tributary 9.91, the cattle utilize a dirt road to cross the creek and access upper pasture and water sources. Due to the heavy use, the road is deep with mud and fecal matter. Additionally, there is not a riparian buffer between the road the creek. Installing a hardened crossing will decrease the potential of erosion from heavy use.
4. **Riparian Re-planting in Reach 1**: Native trees and shrubs can be planted and would improve instream and canopy cover for this small tributary. Creating a buffer between the cattle and the creek will also filter out fecal inputs from the field and detour cattle from accessing the creek and adding to eroding banks.
5. **Invasive Weed Removal & Replanting in Reach 1:** Invasive species were noted in the field along the stream and should be removed to prevent further spread. Replanting with species such as hawthorne and Oregon grape will increase species diversity and cover; these prickly plants will detour cattle from grazing on new vegetation.

BARRIER PRIORITIZATION INDEX

As a result of the 2009-2010 stream surveys, a total of 32 features within the potentially anadromous streams of the White Salmon River watershed were determined to be fish passage barriers. In order to prioritize passage improvements for these barriers, habitat data was collected and compiled for all of the upstream sections that data collection was permitted. Data was entered into the WDFW Fish Passage Inventory Priority Index database, which prioritizes the barriers based on the amount of habitat gained upstream, proportion of increased passability, species mobility, species production, species condition, and cost. The following equation is used to assign Priority Index for barrier removal.

$$PI = \sum_{All\ Species} \sqrt[4]{[(BPH) \times MDC]}$$

**PI is the fish passage Priority Index, B is the proportion of passage improvement, P is the annual adult equivalent production potential per square meter, H is the habitat gain in square meters, M is the mobility modifier, D is the species condition modifier and C is a consistent cost modifier.*

DATA LIMITATIONS

Because of lack of landowner permission to access some sections within the survey area, including portions of Little Buck and Spring Creeks, as well as Tributaries 6.45, 9.90 and 9.91, habitat data collection was not permitted. As a result, Technicians were not able to adequately assign PI numbers to barriers within these streams. PI numbers listed for barriers on the above stated streams do not include spawning and rearing habitat values for the entire length of potentially anadromous habitat; instead, PI values are calculated using only the sections surveyed. There are an estimated 9.1 miles of stream within the survey area that were not surveyed for habitat data due to lack of landowner permission.

DATA EXTRAPOLATION

As mentioned previously, a large landowner in the watershed agreed to allow Technicians access to upstream or downstream properties by passing through their land, however, they asked that data was not collected on their property. Because of this arrangement, Technicians were able to visually assess portions of stream and could accurately evaluate and identify specific habitat characteristics that were comparable to other portions of stream that had been surveyed. Where deemed acceptable, data collected from adjacent habitats was used to extrapolate rearing and spawning habitat for the sections of stream that were walked but not surveyed. Extrapolating this data enabled Technicians to assign Priority Index numbers to a handful of barriers that otherwise would not have been possible. Data was extrapolated for a total of 3.1 miles and included sections of Little Buck, Mill, and Indian Creeks.

WDFW PRIORITY INDEX TOP 10 BARRIER REMOVAL LIST

#	Stream & Reach	Site ID #	Priority Index	Notes
1	Mill_0	1510022	35.1	Data extrapolated for PI
2	Indian_0	1510003	25.7	Barrier removal project ongoing
3	Buck_0	1510007	24.9	Barrier removal project in development
4	L_Buck_3	1510066	21.3	May not be anadromous habitat; partial habitat data used for PI
5	L_Buck_NEF	1510065	20.3	May not be anadromous habitat; partial habitat data used for PI
6	Indian_5	1510060	14.5	Data extrapolated for PI; DS barrier not assessed
7	TRIB_9.90_2	1510054	13.8	Partial habitat data used for PI; DS barrier not assessed
8	Spring_T1R1	1510020	13.1	Partial habitat data used for PI
9	TRIB_9.90_2	1510063	12.6	Partial habitat data used for PI; DS barrier not assessed
10	TRIB_9.90_3	1510056	12.3	Partial habitat data used for PI; DS barrier not assessed

NEXT STEPS

The information gathered in this inventory is intended to be utilized in developing projects that improve instream passage, enhance and support habitat, ecosystem function and land use practices in the White Salmon River basin. This report and corresponding database are working documents and should be added to and updated as more information becomes available.

DATA GAPS

As mentioned above, landowner permission restrictions limited the reach of the inventory, with just over 9 miles of habitat not surveyed due to uninterested or unresponsive landowners. A total of 11.6 miles of lower priority streams were not surveyed due to limited time to survey or contact landowners (lower priority streams were mostly step gradient and narrow scour line width tributaries that are unlikely to be utilized for rearing and spawning). Some or all of the data gaps created by lack of access to land may be filled in the future. Filling habitat data gaps above fish passage barriers would allow for a more comprehensive use of the WDFW Prioritization Index. UCD will work with landowners to acquire further information in attempt to expand the data set in the future as opportunities arise.

FISH PASSAGE IMPROVEMENTS AND RESTORATION PROJECT DEVELOPMENT

Underwood Conservation District has initiated project development with a number of landowners throughout the survey area and will continue working with project partners to explore additional fish passage and habitat restoration projects identified through this inventory. Additionally, further prioritization of restoration projects will be conducted as funding permits.

Currently, UCD is considering the following projects to be of highest ranking throughout the watershed; UCD hopes to pursue these projects through grant funding and partnerships.

TOP 10 PROJECT LIST

1. **Buck Creek:** White Salmon Irrigation District dam and diversion fish passage and screening improvements
2. **Indian Creek:** fish passage restoration through culvert at RM 0.05
3. **Mill Creek:** Fish passage restoration through culvert at RM 0.32
4. **Indian Creek:** Fish passage restoration through culvert at RM 1.30
5. **Rattlesnake Creek:** habitat enhancement including mitigation of cattle impacts, riparian planting, LWD placement and invasive species removal
6. **Buck Creek:** habitat enhancement including instream, side channel and riparian habitats
7. **White Salmon River:** Habitat enhancement of floodplain
8. **White Salmon Tributary 9.90 and 9.91:** Fish passage restoration and riparian enhancement
9. **Indian Creek:** Riparian enhancement and thinning in Reach 1
10. **Upper Rattlesnake Creek:** Enhancement of hydrologic conditions

SURVEY DATA

The following appendices provide detailed information gathered during stream surveys including reach and habitat information by creek as well as barrier details. More information on specific instream and riparian habitat observations noted while in the field is available through UCD.