White Salmon River Bull Trout: Patches, Occupancy and Distribution

2007 Progress Report

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Introduction

Bull trout (*Salvelinus confluentus*) were listed threatened in the coterminous United States November 1, 1999 (USFWS 1999). Previously, the Columbia River distinct population segment (DPS) of bull trout had been listed as threatened since June 10, 1998. Factors contributing to the listing of bull trout include range wide declines in distribution, abundance and habitat quality. Land and water uses that alter or disrupt habitat requirements of bull trout can threaten the persistence of the species. Examples of such activities include: water diversions, dams, timber extraction, mining, grazing, agriculture, nonnative fish competition and/or hybridization, poaching, past fish eradication projects, and channelization of streams. Threats to the persistence of bull trout are prevalent throughout the Columbia River basin (USFWS 2000, 2002).

Flowing from the south side of the 3,742 m peak of Mount Adams, the White Salmon River drains into the Columbia River at river km 269 (Figure 1). Many of the upper tributaries of the White Salmon River are high gradient seasonal streams created by snow and glacial run off. Relatively low gradient tributaries such as Trout Lake Creek enter the mainstem from the west. Core habitat has been identified for bull trout within the White Salmon River (USFWS 2002), but recent investigations have yet to produce observations (Byrne et al. 2001, Thiesfeld et al. 2001). Two sightings above Condit Dam have been recorded in the past two decades by Washington Department of Fish and Wildlife biologists, a gillnet operation in 1986 and a creel census in 1989 (USFWS 2002).

Within the drainage, Condit Dam lies approximately 5.3 km upstream from the Columbia River confluence. PacifiCorp, a utilities company that owns and operates Condit dam, has proposed to decommission this dam and remove it in the fall of 2010. This dam was constructed in 1913 and has since been a barrier to migrating fish. Upon removal, the subbasin will be reconnected with the Columbia River. The objective of our work is to delineate bull trout patches (putative population boundaries) in the White Salmon River subbasin (following Dunham and Rieman, 1999, as modified in RMEG 2008). Patches are intended to represent areas conducive to spawning and early rearing. Bull trout occupancy of the patches as well as bull trout distribution within occupied patches will be determined both pre- and post-dam removal. Given the unique circumstances of this situation (i.e., removal of a dam behind which bull trout are likely functionally extirpated), this initial work will provide a quantitative baseline against which to compare changes in occupancy and distribution of bull trout in the White

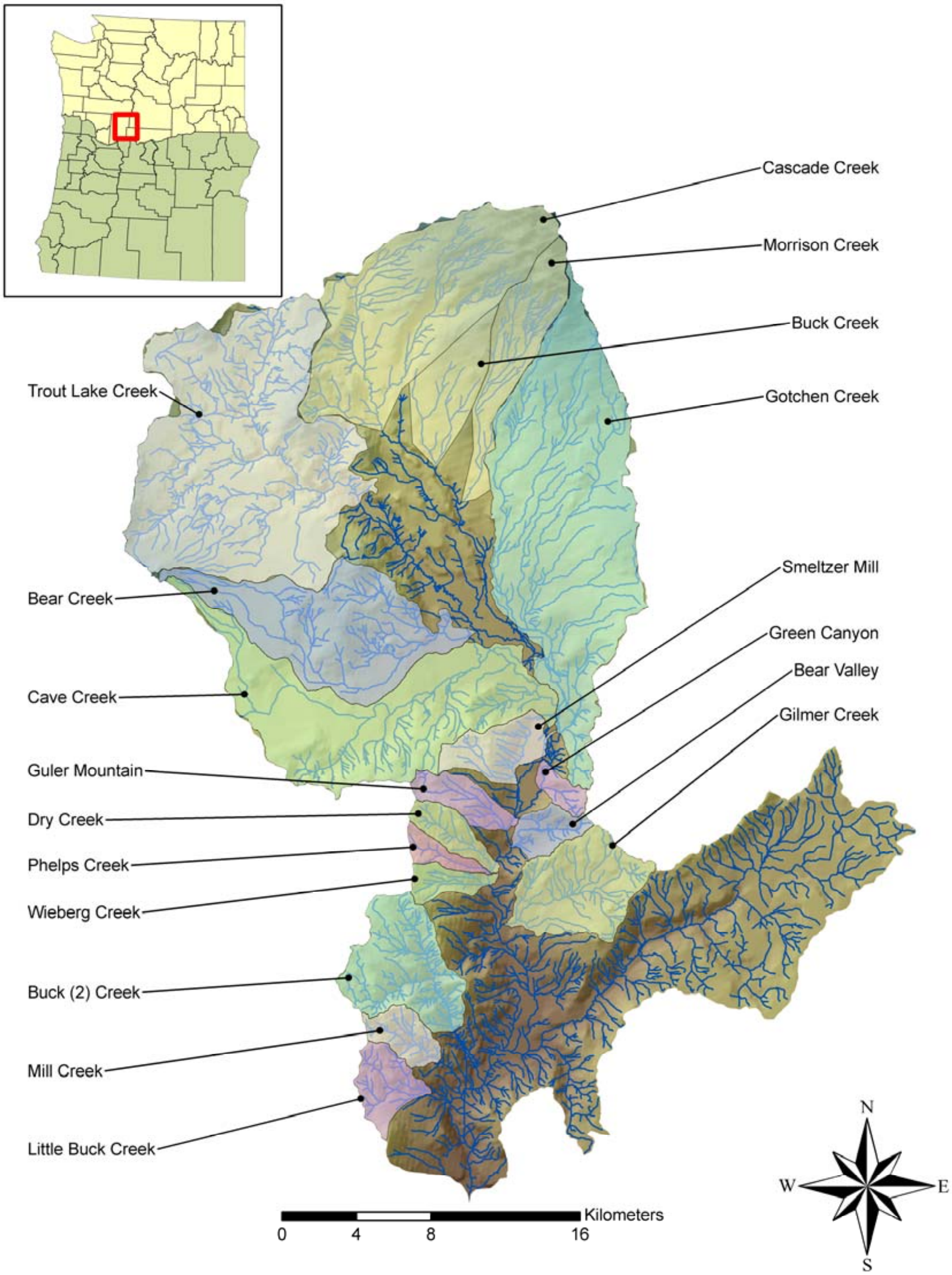

Figure 1. The White Salmon River subbasin and delineated patches.

Salmon River subbasin subsequent to reconnection of the system with the mainstem Columbia River.

Guidance from the Bull Trout Recovery Monitoring and Evaluation Technical Workgroup (RMEG 2008) recommends utilizing maximum annual stream temperature, stream size and catchment area as filters for determining potential bull trout habitat. Many other factors identified by Dunham and Rieman (1999) may also influence bull trout distribution (e.g., connectivity, stream gradient, geology, hydrologic regimes, presence of nonnative species, road density, solar radiation). However, maximum annual stream temperature (and the corresponding elevation) effectively dictates the range of this species (Rieman and McIntyre 1995) and patch size (catchment area) may be the most important factor determining bull trout occurrence (Dunham and Rieman 1999). Utilizing these three filters, provides the opportunity to evaluate this approach as a tool using information that most managers can readily acquire.

Maximum annual stream temperature can be determined from any stream temperature monitoring efforts occurring in a subbasin through the summer months. This type of data can be linked to a location, and subsequently to an elevation. Gathering this information from state and federal agencies, academic institutions, and other reliable sources can go a long way toward building a useful dataset to build temperature:elevation relationships within a subbasin. Should this information not be readily available or the resulting dataset be insufficient to build temperature:elevation relationships due to large data gaps, it may be possible to acquire this information from a similar subbasin proximate in geographic location.

Stream size and catchment area can be determined for watersheds or subwatersheds within a subbasin using information easily acquired from the internet. Recent digital elevation models (DEMs) and stream layers can be obtained free of charge from government agencies. This information can then be analyzed using ArcGIS to identify stream size and determine catchment area above the elevation that is within the acceptable temperature threshold for bull trout. Streams too large and catchment areas too small than may be necessary for persistence of bull trout populations can then be dropped from further consideration.

The use of these three filters provides a starting point for determining a framework by which the distribution of bull trout within a subbasin can be evaluated. There may be exceptions to the potential distribution identified using this tool. Some bull trout populations may exist outside these patches due to geologic anomalies or other factors in the subbasin. Bull trout distribution within an identified patch may be limited or nonexistent due to barriers, hydrologic regimes or other factors. However, by using this tool, it is possible to implement a sampling approach that focuses limited resources in areas that may have a higher probability of supporting bull trout populations in a subbasin.

By researching the possible distribution of bull trout within the White Salmon River drainage, we can improve our understanding of this threatened species. This work will establish a quantitative baseline for bull trout occupancy and distribution prior to the removal of Condit Dam. Implementation of this approach through a long-term monitoring program subsequent to dam removal will provide information on recolonization of bull trout. This understanding will allow us to work towards restoration and recovery of bull trout populations within the Lower Columbia Recovery Unit as well as range wide. Specific tasks for 2007 are to delineate patches for the White Salmon River subbasin and assess bull trout occupancy in five of those patches.

Methods

Patch Delineation

The approach to describing bull trout patches in the White Salmon River subbasin follows RMEG recommendations (RMEG 2008). Patches were identified using temperature:elevation relationships, stream order and determining catchment areas for subwatersheds that fall within the acceptable temperature and stream size thresholds.

Digital Elevation Models (DEMs, 10 m resolution) were acquired for each quadrangle in the White Salmon subbasin from the University of Washington (GIS at Earth Space and Science, http://duff.ess.washington.edu/data). The quadrangles were appended to one another to construct a single White Salmon subbasin DEM. A 1:100k resolution stream layer for the White Salmon subbasin was acquired from the National Hydrography Dataset web site (http://nhd.usgs.gov).

A maximum annual stream temperature of 16^{o}C was identified as the threshold for supporting bull trout populations. Temperature data was acquired from water quality monitoring conducted from 1995-2006 (Underwood Conservation District). The maximum annual stream temperature for various stream locations in the White Salmon River subbasin were determined for the overall time period. In other words, if one year of monitoring occurred at a location, then the maximum temperature from that year was used. If several years of monitoring occurred at a location, then the highest maximum temperature achieved over all years was used. No consideration was given to the duration of the highest annual maximum temperature (e.g., one v. several days). Geographic coordinates (UTM NAD 83) were determined for all stream locations used and elevation was determined using the constructed White Salmon subbasin DEM. Temperature:elevation relationships were investigated using regression analysis (SigmaStat, SPSS Inc.) and resulted in determination of an elevation threshold above which the maximum annual stream temperature would not be expected to exceed 16^{o}C.

Patch delineation was conducted using ArcGIS. Watersheds were initially delineated by eliminating all areas that fell below the elevation threshold. Then, all remaining areas in which the stream size was larger than a 3rd order (at a 1:100,000 scale) were eliminated. Finally, any remaining watersheds that were smaller than 400 hectares were eliminated, resulting in the final patch delineation for the White Salmon River basin.

Sample Design

The determination of sample sites was done using a random, spatially-balanced design (Generalized Random-Tesselation Stratified design) developed by the Environmental Protection Agency Environmental Monitoring and Assessment Program. Sample sites were identified on a 1:100 k stream layer for all but six patches using Program R (Gentleman and Ihaka, 1996) at a density of 1 site every 500 m. Sample sites for the Bear Creek, Cave Creek, Smeltzer Mill, Guler Mountain, Green Canyon, and Bear Valley patches were identified on a 1:24 k stream layer due to incomplete 1:100 k coverage in these areas. Each sample site represented a 50 m reach. No site-specific detection probability information is available for the White Salmon River, so available data from the Lewis River was used as a surrogate. The site-specific detection probability for bull trout in the Lewis River, a similar watershed, was 37.5% (Cook et al. 2009). Given this detection probability, guidance provided by RMEG (2008) indicates that if three sites per patch were sampled with a backpack electrofisher and less than two age classes of bull trout were captured, we could be 80% certain that the patch was unoccupied by a population. Given the lack of empirical information in the White Salmon subbasin, seven sites were sampled to ensure at least an 80% confidence level that bull trout were not present when not detected. If two age classes (as determined by size classes > 30 mm difference in fork length) of bull trout were captured within the patch, it was considered occupied by a population.

Sample Approach

Sampling was conducted for occupancy and distribution assessments using backpack electrofishing. Each 50 m reach was sampled from the downstream to the upstream boundary. All fish encountered were captured and identified. Length and mass were documented to facilitate size class determination. *Salvelinus* species were carefully scrutinized for distinguishing features before identification, as both bull trout and brook trout (*Salvelinus fontinalis*) may inhabit these watersheds and hybridization between the two could occur. Trout fry (TF) were identified as *Oncorhynchus* spp. when too small to reliably differentiate as *O. clarki* or *O. mykiss*. All fish captured were released alive within the sampled reach.

After the completion of fish sampling, habitat data was collected from the study reach. The gradient of each sampling site was measured using a hand-held clinometer. Gradient was measured and recorded twice at each site, from the top of the reach to the middle, and again from the middle to the bottom of the reach. The eye level height of the person sighting the gradient was measured against the person standing downstream. One surveyor stood level with the water's edge upstream and measured the percent gradient against the second surveyor standing downstream at level with the water's edge.

Transects were flagged along the thalweg at every 10 meter mark from 0 to 50 meters. Channel dimensions were then measured along each of the six designated transects within the 50 meter sampling reach. For each transect, measurements were completed for the current wetted width, maximum depth along the transect line, and depth recordings at ¼, ½, and ¾ marks across the wetted width. Total length of the reach measured along the bank was also recorded as an index of sinuosity.

Within each reach, large woody debris (LWD) was categorized and quantified. Wood was classified into four categories: LWD > 10 cm in diameter and > 3 m in length, LWD > 60 cm in diameter and > 10 m in length, root wads and LWD piles (aggregates of > 4 pieces of wood together). Only pieces of wood directly within the channel or within one meter of the water's surface were considered.

The number, type and size of undercut banks were measured along both sides of the sampling reach. Undercuts were defined as areas under boulders, banks, wood, or bedrock along the stream bank that were > 5 cm deep, > 10 cm in length, and > 5 cm in height (e.g., PIBO; Kershner et al. 2004). Only undercuts within 0.5 meter of the stream surface were considered.

Results

Patch Delineation

Patch delineation in the White Salmon River subbasin resulted in the identification of 19 patches. Specific temperature:elevation relationships were determined for three separate areas of the subbasin because initial qualitative analysis of the data indicated distinct temperature profiles. A threshold elevation of 710 m was determined for the Rattlesnake Creek drainage, resulting in no patches in that portion of the subbasin. A threshold elevation of 670 m was determined for the Trout Lake Creek drainage, resulting in one patch in that portion of the subbasin. The threshold elevation for the remainder of the White Salmon River subbasin was 220 m, resulting in the remaining 18 patches (Figure 1; Table 1).

Table 1. Dileneated patches and number of sample sites drawn.

Patch Name	Total Number of Sites Drawn
Bear Creek	240*
Bear Valley	39*
Buck (2) Creek	34
Buck Creek	34
Cascade Creek	134
Cave Creek	282*
Dry Creek	10
Gilmer Creek	26
Gotchen Creek	281
Green Canyon	14*
Guler Mountain	40*
Little Buck Creek	19
Mill Creek	8
Morrison Creek	67
Phelps Creek	8
Smeltzer Mill	61*
Trout Lake Creek	166
Wieberg Creek	7

* Sample sites identified on 1:24 k stream layer

Sample Approach 2007

Field work in the White Salmon River basin occurred between July 24 and August 23 of 2007. Electrofishing effort for all reaches of the White Salmon subbasin totaled 6,856 seconds, with an average of 254 seconds of electrofishing per 50 m reach. Five patches were completed during sampling (Buck Creek, Cascade Creek, Morrison Creek, Gotchen Creek, and Trout Lake Creek; Table 2). Among these patches a total of 58 sites were visited, 27 were sampled and 31 were dry or inaccessible (Figure 2).

The Trout Lake Creek patch proved to be the only patch in which any species of fish were observed (bull trout were not present). *O. mykiss* and brook trout were the only fish species observed (Table 2). This patch had the highest average water temperature (11.6°C) and the fewest dry sites.

The entire patch of Gotchen Creek (9 sites) was found to be dry and was therefore not surveyed. The Buck Creek patch also contained little water during the time of sampling (2.01 m mean wetted width, 0.19 m mean max. depth). Only the lower six sites in this watershed had enough water to be sampled and no fish were observed.

No fish or amphibians were observed while sampling the Morrison Creek patch. This patch appeared to have a great deal of damage done to it from previous flooding events resulting in woody debris, washed out areas, and sandy substrate. This patch had the most LWD recorded in the habitat data as well as the lowest average temperature (7.0 °C; Table 3).

The majority of the sites for Cascade Creek were located above 1,524 m on the slopes of Mount Adams. The tributaries appeared to be seasonal streams resulting from snow and glacial melt with little pooling (pools were found in three of seven sampled sites). The majority of the stream banks were unstable and most of the mainstem sites were high flow white-water conditions, often creating unsafe sampling conditions. There was little undercutting in the patch (6%) relative to all other patches sampled in 2007 and the highest conductivity (88.2 µs) (Table 3; Figure 3).

Discussion / Findings

Field work in 2007 improved our knowledge of the White Salmon River drainage and potential bull trout habitat. Based on water temperatures, catchment areas and stream size, 18 patches were initially identified as potential habitat supporting bull trout in the White Salmon River subbasin. Sampling in five of these patches resulted in only one containing any observations of fish. However, these samples did not include bull trout. Thus, we conclude that 0% (0 of 5) of the White Salmon River subbasin patches sampled in 2007 were occupied by bull trout. Work in 2008 will focus on continuing to assess occupancy of remaining patches in the White Salmon River subbasin.

Table 2. White Salmon sites sampled and species found 2007. *Salvelinus fontinalis* (BK), *Oncorhynchus* spp.fry (TF).

Patch	Site	Date	Sample Status	Salmonids	Non-Salmonids
Trout Lake Creek	1	7/25/2007	Sampled	BK, *O. mykiss*	
	2	7/25/2007	Sampled	BK	
	3	7/26/2007	Sampled	*O. mykiss*, TF	
	4	7/25/2007	Sampled	BK, TF	
	5	7/24/2007	Sampled	BK	
	6	7/24/2007	Sampled	*O. mykiss*	
	7	7/24/2007	Not Sampled-Dry		
	8	7/31/2007	Sampled	BK, *O. mykiss*	
Buck Creek	1	8/2/2007	Sampled		Dicamptodon, Frog
	2	8/2/2007	Not Sampled-Dry		
	3	8/2/2007	Not Sampled-Dry		
	4	8/2/2007	Not Sampled-Dry		
	6	8/2/2007	Not Sampled-Dry		
	8	8/2/2007	Sampled		Dicamptodon, Frog
	10	8/3/2007	Sampled		Frog
	14	8/3/2007	Sampled		
	19	8/3/2007	Not Sampled-Dry		
	24	8/2/2007	Sampled		Dicamptodon
	26	8/3/2007	Sampled		Tadpole
	33	8/3/2007	Not Sampled-Dry		
	34	8/3/2007	Not Sampled-Dry		
Morrison Creek	1	8/7/2007	Not Sampled-Dry		
	2	8/7/2007	Not Sampled-Dry		
	3	8/7/2007	Sampled		
	4	8/7/2007	Sampled		
	5	8/7/2007	Not Sampled-Dry		
	6	8/8/2007	Not Sampled-Dry		
	9	8/8/2007	Sampled		
	10	8/8/2007	Not Sampled-Dry		
	11	8/9/2007	Sampled		
	13	8/9/2007	Sampled		
	14	8/10/2007	Sampled		
	16	8/9/2007	Sampled		
Gotchen	All	8/14/2008	Not sampled-Dry		
Cascade Creek	1	8/22/2007	Not sampled-Dry		
	2	8/22/2007	Not sampled-Dry		
	3	8/22/2007	Not Sampled-Unstable		
	4	8/22/2007	Not sampled-Dry		
	5	8/22/2007	Not Sampled-Unstable		
	6	8/16/2007	Sampled		Frog
	7	8/16/2007	Sampled		Frog
	8	8/22/2007	Sampled		
	9	8/22/2007	Not sampled-Dry		
	10	8/22/2007	Not sampled-Dry		
	11	8/22/2007	Not sampled-Dry		
	12	8/23/2007	Sampled		
	13	8/22/2007	Not sampled-Dry		
	14	8/23/2007	Sampled		
	15	8/22/2007	Sampled		
	17	8/23/2007	Sampled		

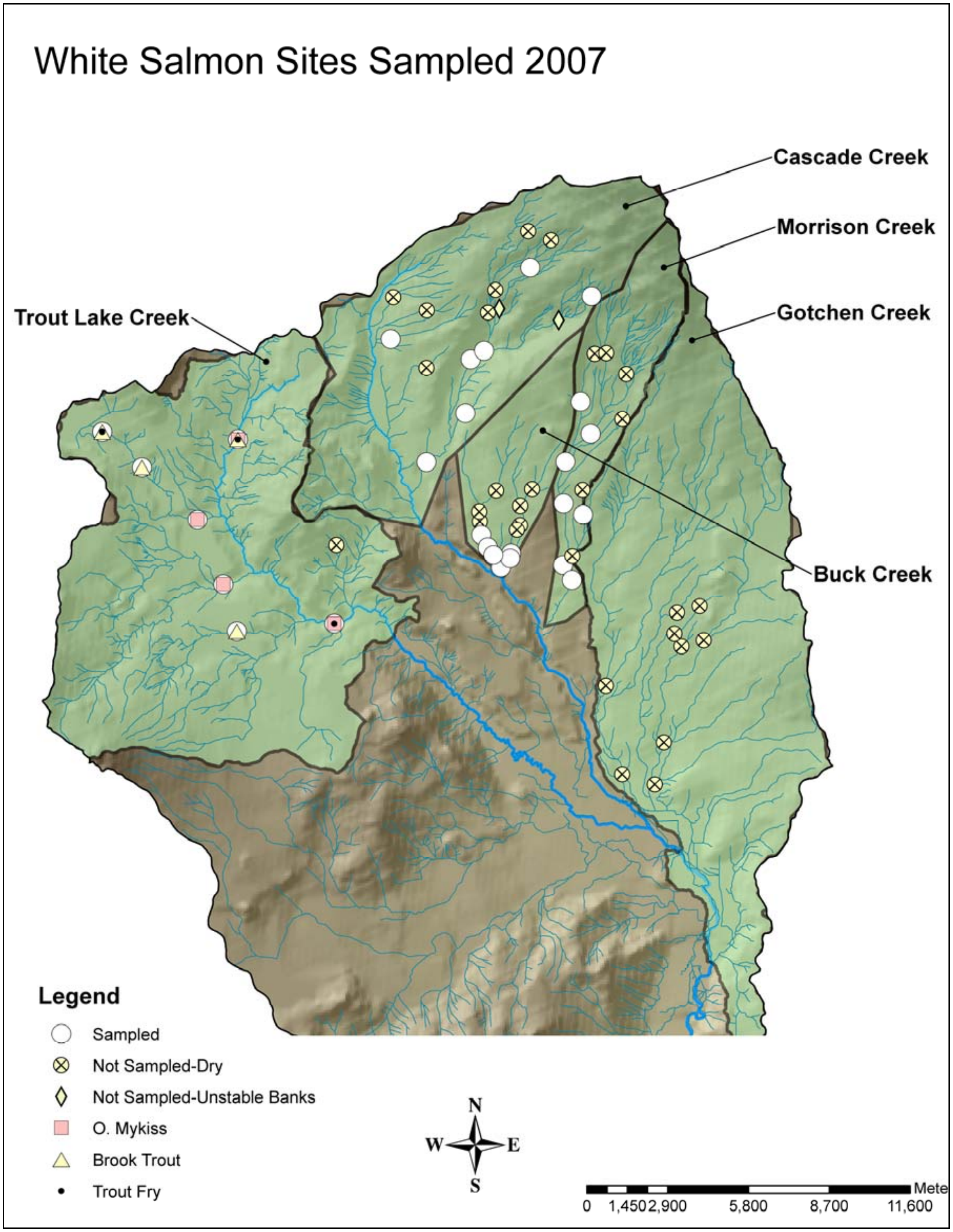

Figure 2. Sites sampled in White Salmon Subbasin 2007.

Table 3. Habitat data collected for the White Salmon Subbasin 2007.

		Trout Lake Creek							Buck Creek					
	Site	1	2	3	4	5	6	8	1	8	10	14	24	26
	Date	7/25	7/25	7/26	7/25	7/24	7/24	7/31	8/2	8/2	8/3	8/3	8/2	8/3
	Time Start	13:40	11:17	10:15	8:54	12:56	15:05	11:20	12:40	11:10	12:32	9:20	9:39	10:37
	Time End	-	12:15	11:30	10:25	14:11	16:15	12:31	13:30	11:50	13:11	10:06	10:45	11:30
	Temperature (°C)	11.3	10.5	13.0	10.8	9.2	15.2	11.4	12.5	9.7	10.1	11.5	9.6	10.7
	Conductivity (µs)	55.0	40.5	45.1	39.7	41.8	40.5	44.8	35.9	38.2	35.6	36.5	34.2	36.6
	Bank Length	47.2	48.3	49.1	47.9	48.2	49.2	50	48	47	47	48.7	44	48.4
	Thalweg Length	50	50	50	50	50	50	50	50	50	50	50	50	50
	Pools?	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
Large Woody Debris	**# >3m length >10cm diameter**	15	13	0	25	11	1	2	39	27	32	22	29	52
	LWD Piles (>4 pieces of LWD together)	3	1	0	4	1	0	1	4	2	0	3	5	2
	# >10 m in length >60 cm diameter	5	5	0	4	1	1	0	4	7	3	5	7	6
	# Root Wads	7	0	0	12	1	0	0	4	2	1	1	2	4
	Average Depth (m)	1.08	0.86	1.60	0.80	0.93	1.10	0.91	0.35	0.58	0.86	0.46	0.26	0.33
	Average Wetted Width (m)	7.2	5.50	13.50	5.00	4.70	7.30	10.40	2.23	1.75	3.13	2.16	1.70	1.36
	% Undercut	45.4	44.20	0	50.9	29.0	3.0	12.5	6.9	35.7	1.4	20.8	49.0	10.4

		Morrison (Crofton) Creek							Cascade Creek						
	Site	3	4	9	11	13	14	16	6	7	8	12	14	15	17
	Date	8/7	8/7	8/8	8/9	8/9	8/10	8/9	8/16	8/16	8/22	8/23	8/23	8/22	8/23
	Time Start	16:00	13:49	12:00	11:13	12:58	9:50	15:08	13:21	14:48	12:05	14:02	16:00	13:46	15:25
	Time End	16:50	15:00	13:06	12:10	13:45	10:35	16:00	14:00	15:40	12:21	14:32	-	14:09	16:05
	Temperature (°C)	7.8	7.4	7.9	6.4	5.9	5.7	8.2	16.8	14.5	9.0	6.7	6.4	5.6	13.9
	Conductivity (µs)	38.7	40.9	38.7	44.7	41.9	21.6	5.0	100.7	83.5	36.5	48.8	54.4	181.2	112.1
	Bank Length	48	46.2	47.2	47.3	46.3	47.3	48.4	48	46.7	47.5	48.1	47.6	46.7	49.6
	Thalweg Length	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Pools?	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	N
Gradient	**Clinometer Top (%)**	3	2	7	5	3	13	12	9	8	20	44	13	11	4
	Clinometer Bottom (%)	12	18	12	11	4	15	6	4	6	18	44	13	11	2
	Clinometer Average (%)	7.5	10	9.5	8	3.5	14	9	6.5	7	19	44	13	11	3
Large Woody Debris	**# >3m length >10cm diameter**	36	35	36	21	26	18	13	0	0	0	1	13	1	1
	LWD Piles (>4 pieces of LWD together)	2	4	2	4	3	2	5	0	0	0	0	3	0	0
	# >10 m in length >60 cm diameter	4	6	5	8	10	1	14	0	0	0	3	18	0	4
	# Root Wads	0	0	0	3	1	0	0	0	0	0	0	0	0	0
	Average Depth (m)	1.65	1.17	0.61	1.38	1.29	0.57	0.24	0.24	1.10	0.25	0.15	0.95	0.68	1.99
	Average Wetted Width (m)	4.60	6.85	1.93	9.02	3.07	2.87	0.85	1.88	6.53	1.70	1.22	4.52	2.92	5.8
	% Undercut	25.0	22.6	22.8	23.3	6.1	35.6	0	0	0	0	0	5.8	0	33.2

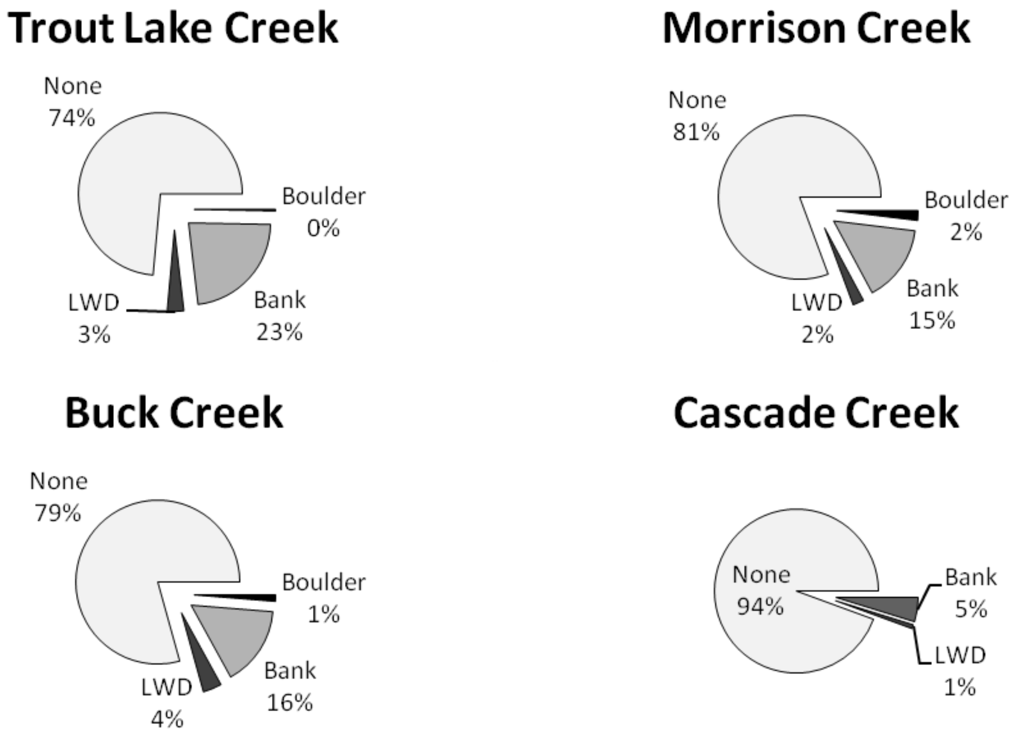

Figure 3. Bank undercut composition.

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