# Appendix A

## Stream Habitat Assessment

Upper Methow River Reach Assessment

*December 2015*

Habitat Inventory: Weeman Bridge (RM 61) to Trout Creek (RM 80)

*Survey: July 16 – August 14, 2014*

# Table of Contents

**1 Introduction & Background ..... 1**

**2 Methods ..... 2**

**3 Summary of Results ..... 5**

3.1 Channel morphology ..... 5
3.2 Habitat Unit Composition ..... 6
3.3 secondary Channel habitat ..... 7
3.4 Large Wood ..... 9
3.5 Substrate & Fine Sediment ..... 10
3.6 Instability & Disturbance ..... 12
3.7 Fish Passage Barriers ..... 12
3.8 Riparian Corridor ..... 12

**4 Comparisons to Past Surveys ..... 16**

4.1 Habitat area ..... 16
4.2 Streamflow ..... 17
4.3 Sediment ..... 18
4.4 Large Wood ..... 19
4.5 Pools ..... 21
4.6 Water Temperatures ..... 22

**5 Stream Habitat Reach Reports ..... 25**

5.1 Reach 1 ..... 25
5.1.1 Habitat Unit Composition ..... 27
5.1.2 Pools ..... 27
5.1.3 Secondary Channel Habitat ..... 27
5.1.4 Large Woody Material ..... 27
5.1.5 Substrate & Fine Sediment ..... 28
5.1.6 Riparian Corridor ..... 30
5.2 Reach 2 ..... 31
5.2.1 Habitat Unit Composition ..... 31
5.2.2 Pools ..... 33
5.2.3 Secondary Channel Habitat ..... 34
5.2.4 Large Woody Material ..... 35
5.2.5 Substrate & Fine Sediment ..... 36
5.2.6 Riparian Corridor ..... 38
5.3 Reach 3 ..... 40
5.3.1 Habitat Unit Composition ..... 42
5.3.2 Pools ..... 42
5.3.3 Secondary Channel Habitat ..... 43
5.3.4 Large Woody Material ..... 44

5.3.5 Substrate & Fine Sediment ..... 44
5.3.6 Riparian Corridor ..... 46
5.4 Reach 4 ..... 48
5.4.1 Habitat Unit Composition ..... 50
5.4.2 Pools ..... 50
5.4.3 Secondary Channel Habitat ..... 51
5.4.4 Large Woody Material ..... 51
5.4.5 Substrate & Fine Sediment ..... 53
5.4.6 Riparian Corridor ..... 54
5.5 Reach 5 ..... 56
5.5.1 Habitat Unit Composition ..... 56
5.5.2 Pools ..... 58
5.5.3 Secondary Channel Habitat ..... 59
5.5.4 Large Woody Material ..... 60
5.5.5 Substrate & Fine Sediment ..... 60
5.5.6 Riparian Corridor ..... 62
5.6 Reach 6 ..... 64
5.6.1 Habitat Unit Composition ..... 66
5.6.2 Pools ..... 66
5.6.3 Secondary Channel Habitat ..... 67
5.6.4 Large Woody Material ..... 70
5.6.5 Substrate & Fine Sediment ..... 70
5.6.6 Riparian Corridor ..... 72
5.7 Reach 7 ..... 74
5.7.1 Habitat Unit Composition ..... 76
5.7.2 Pools ..... 76
5.7.3 Secondary Channel Habitat ..... 77
5.7.4 Large Woody Material ..... 78
5.7.5 Substrate & Fine Sediment ..... 79
5.7.6 Riparian Corridor ..... 80
5.8 Reach 8 ..... 82
5.8.1 Habitat Unit Composition ..... 84
5.8.2 Pools ..... 84
5.8.3 Secondary Channel Habitat ..... 85
5.8.4 Large Woody Material ..... 86
5.8.5 Substrate & Fine Sediment ..... 87
5.8.6 Riparian Corridor ..... 87
5.9 Reach 9 ..... 89
5.9.1 Habitat Unit Composition ..... 91
5.9.2 Pools ..... 91
5.9.3 Secondary Channel Habitat ..... 92
5.9.4 Large Woody Material ..... 92

5.9.5 Substrate & Fine Sediment ..... 93
5.9.6 Riparian Corridor ..... 94

**6 References ..... 101**

# 1 Introduction & Background

The Methow River originates from the Cascade Crest in Okanogan County, Washington at 6,700 feet. It enters the Columbia River near the town of Pateros, WA on the east slopes of the Cascade Mountains. As part of the Reach Assessment work performed for the Yakama Nation, Inter-Fluve, Inc. conducted a 19-mile habitat survey of the upper Methow River on July 16 – August 14, 2014 from RM 61 (Weeman Bridge) to RM 80 (confluence with Trout Creek). The flow rate on July 16 was 711 cfs at USGS gage #12447383 on the Methow River above Goat Creek near Mazama, Washington. The August 14 flow rate was 314 cfs. Flows at the gage dropped as low as 110 cfs during the survey period (Figure 1). Stream flow was not measured as part of this survey.

The objective of the Habitat Assessment is to characterize the habitat quantity and quality for salmonid species native to the upper Methow River by quantifying in-channel morphologic features, characterizing riparian conditions, and identifying anthropogenic features influencing aquatic habitat. This information is used to inform potential restoration/preservation actions and will provide a baseline for evaluating future habitat trends and measuring the effectiveness of restoration efforts.

To our knowledge, the earliest habitat assessment performed on the upper Methow River was completed in 1994 by Okanogan National Forest Methow Valley Ranger District (USFS 1997). It was a Hankin and Reeves Level 2 survey from Goat Creek to the impassable bedrock falls 20.0 miles upriver. This is the first comprehensive stream habitat survey and assessment for this portion of the upper Methow River. Additional surveys in the basin by the Okanogan National Forest Methow Valley Ranger District included Early Winters Creek in 2009 (USFS 2009), and the West Fork Methow River from the confluence with Lost River to the waterfall barrier above Brush Creek in 2003 (USFS 2003).

# 2 Methods

Nine geomorphic reaches were delineated in this stream assessment. The same reach delineations were used for both the stream assessment and the geomorphology assessment to maintain consistency.

Field methods for the habitat survey followed the US Forest Service Region 6 Level I & II Stream Inventory Handbook, Version 2.13 (USFS 2013). All protocols were followed when safe, and most of the suggested forest inventory options were applied in the survey. Due to high water levels at the beginning of the survey and also the last two days of the survey, surveyors estimated some instream measurements from the bank.

Flow rates at the USGS River Gage #12447383 above Goat Creek and near Mazama (at RM 65.5) were slightly above average throughout much of the survey, beginning at 711 cfs (median for July 16 is 570 cfs), and ending at 359 cfs (median for August 14 is 129 cfs). A spike in river levels on the last two days of the survey occurred due to heavy, unseasonal rainfall. River levels on August 13 reached 411 cfs (Figure 1).

All reach-scale metrics were calculated using GIS measurements as opposed to reach lengths measured in the field by tape. We chose GIS measurements because GIS provides a more accurate measurement at a reach scale.

All measurements were done at an $n^{th}$ unit measurement frequency of 20%, or 1 unit measured in every 5. This choice was made to ensure that the $n^{th}$ unit measurements were representative of the field area. In total, 40 $n^{th}$ units were measured in Reaches 1-9. At $n^{th}$ units the surveyors recorded the wetted channel width with a 100-foot or 200-foot tape. Flood prone widths (FPW) – width of the floodplain at twice the maximum bankfull depth -- were measured in the field when accurate measurements were possible, or done in the office via GIS where the floodplain was excessively wide. At every channel unit measured, modern unstable banks were tallied for both the left and right channel banks. This is one metric where the Stream Inventory Handbook protocol was not followed. Instead of measuring all actively eroding stream banks, only modern or active bank erosion that appeared to be "human-caused" was measured. As a result, total unstable bank measurements were much lower than past surveys.

Depth of pools, riffles, and glides was measured using an 8-foot graduated survey rod carried by the observer. Where water velocity or depth was unsafe for surveying (especially at the beginning and end of the survey), the observer either estimated depth or measured as close to the thalweg as possible.

Pebble counts were completed by the geomorphology team across the channel and exposed active bar surfaces at riffle crests. Two pebble counts were performed within Reaches 2-7 and one was performed in Reach 1. No pebble counts were completed in Reach 8 or 9 because of the large bedload size relative to channel geometry and the lack of LiDAR for conducting hydraulic modeling.

Open water wetlands on floodplains were measured and recorded when connected to the main river. When differentiating between wetlands and other secondary channels was challenging,

vegetation was used as the primary indicator. Open water wetlands were not included in the overall secondary channel calculations because the width of some of these features is significantly wider, and thus not representative, of other secondary channels throughout the project reach.

The term "secondary channel" is being used to include both side channel and off-channel habitat. For this assessment, we consider "side-channels" as secondary channels that are, or would be, naturally connected to the mainstem flow at their upstream and downstream ends at average annual flow; this definition also includes artificially disconnected side channels. We consider "off-channels" to be all other types of secondary channels including backwater channels/alcoves, groundwater-fed channels, wall-base channels, abandoned oxbows, and other types of floodplain channels and open-water floodplain wetlands.

Secondary channel units were identified when the main channel split to form a stable island with soil or fine sediment deposits and with establishing vegetation older than 2 to 3 years. Each secondary channel was determined to be fast or slow, and its average width and length measured. Both total and wetted lengths were recorded. Wetted lengths are used in the report that follows, unless otherwise noted. Where secondary channels were either too long (some were several thousand feet long), or impassible due to downed wood, GIS was used to measure total channel length. Large wood (LWD) was counted in each secondary channel. Two side channels, one in Reach 2 and one in Reach 6, were further categorized as *disconnected* side channels. In both instances, human-built features block or alter the natural historical connection to the mainstem.

Water temperature in secondary channels and tributaries were recorded. In most instances, the main channel temperature was recorded within an hour of each secondary channel or tributary temperature recording. Due to the variety of thermometers used (three), daily fluctuations in air temperature, and variability in the water temperature depending on the depth of the measurement, the water temperature data is best interpreted in relation to other measurements taken within the hour or day for determining the relative water temperatures between main channel and secondary channel/tributaries.

No units were designated as "braided," which is defined as a series of three or more roughly parallel channels structured during bankfull flow and separated from each other by unstable islands. LWD was counted using guidelines from the USFS Stream Inventory Guidebook for Eastside Forests. In the case of log jams, all individual logs that met guidelines and were attached to a log jam were counted, even if they were above the bankfull flow.

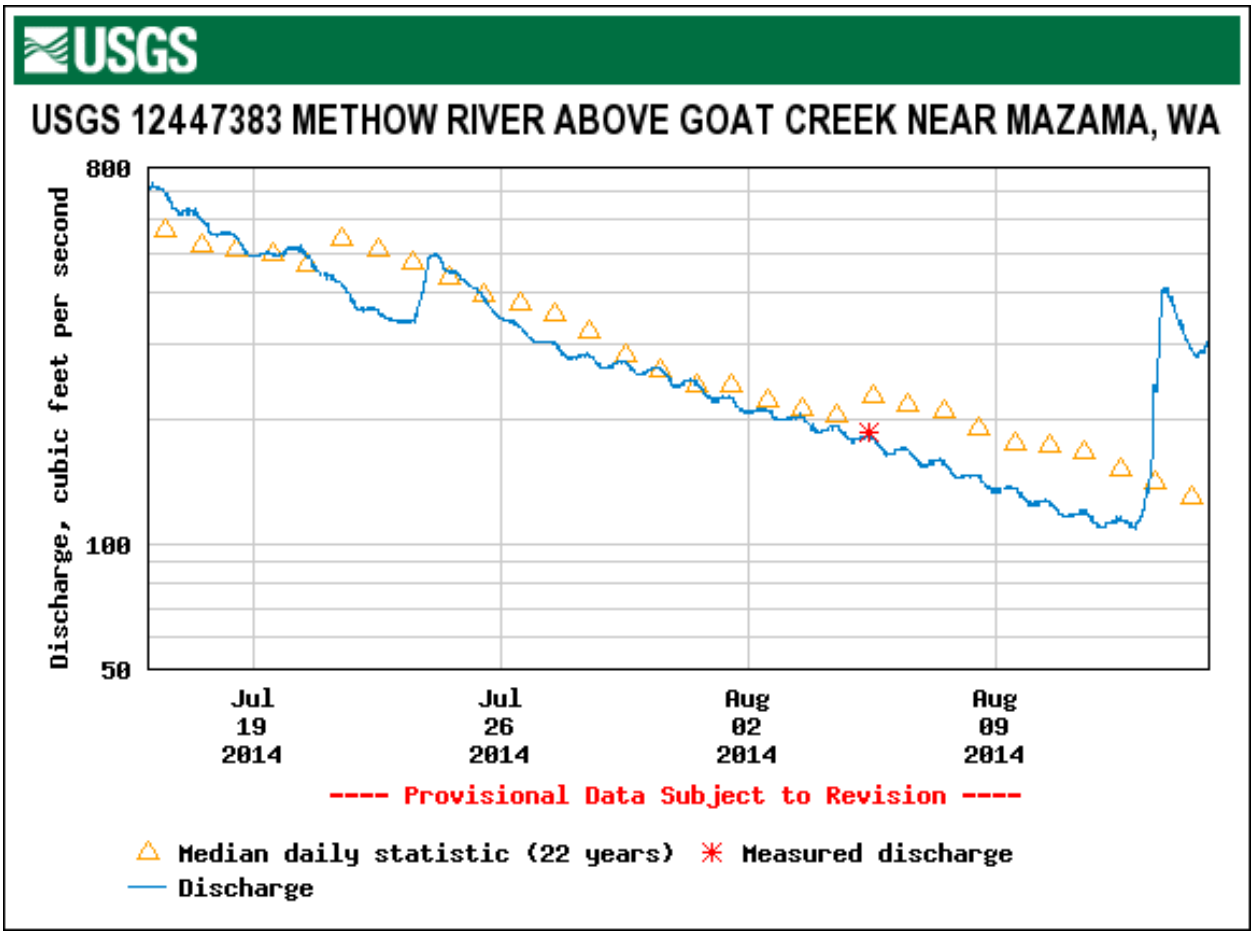



***Figure 1. Flow measurements on the Methow River at USGS gauge 12447383 during the study (July 16 – August 14, 2014).***

# 3 Summary of Results

This section summarizes the results for all nine reaches surveyed in between RM 61 to 80. Detailed reach summaries with reach-specific results are included in Section 5 of this report.

## 3.1 CHANNEL MORPHOLOGY

According to this survey, the upper Methow River reaches are dominated by pool-riffle and plane-bed morphology, with some partially confined step-pool channels in Reach 8. Overall, channel bed substrate consisted primarily of cobbles (48%) and gravels (48%) with 2% boulder and 2% sand (Figure 8). Bedrock was not recorded in significant amounts, although it is present at various places throughout the study area.

Channel geometry varied within the study area. In general, the channel becomes narrower going upstream as quantity of relative discharge decreases due to reduced upland drainage area and tributary inputs. Reach 1 has a mean width of 172 feet, based on one measurement; the average width decreases to 52 feet by Reach 9 (also based on one measurement). Reach 8 and 9 are more confined channels with less variation in width (Table 1). Mean bankfull depths also decrease going upstream, ranging from an average bankfull depth of 3.9 feet in Reach 1, to an average of 1.6 feet in Reach 9. The maximum mean bankfull depth is 4.0 feet in Reach 2 (Table 2). Flood prone widths vary substantially in the project area, ranging from 3,400 feet in Reach 1, to 70 feet in Reach 9 where the river is constrained by glacially carved walls for parts of the reach.

***Table 1. Minimum (min), maximum (max), and mean bankfull widths (in feet) recorded in reaches 1-9.***

| | Bankfull widths (feet) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Reach 1** | **Reach 2** | **Reach 3** | **Reach 4** | **Reach 5** | **Reach 6** | **Reach 7** | **Reach 8** | **Reach 9** |
| **Min** | 172.0 | 105.0 | 145.0 | 92.0 | 72.0 | 69.0 | 52.0 | 52.0 | 52.0 |
| **Max** | 172.0 | 170.0 | 173.0 | 162.0 | 108.0 | 130.0 | 102.0 | 60.0 | 52.0 |
| **Mean** | 172.0 | 140.5 | 159.0 | 129.0 | 95.0 | 100.3 | 75.7 | 56.0 | 52.0 |
| **St Dev** | n=1 | 23.9 | 19.8 | 27.8 | 20.0 | 22.5 | 25.1 | 5.7 | n=1 |

***Table 2. Minimum (min), maximum (max), and mean bankfull depths recorded in reaches 1-9. Bankfull depths were measured at all glides and riffles (fast water) by taking 10 measurements evenly distributed across the unit. The mean values identified below were calculated by first averaging the 10 depths recorded at each of the nth units, and then averaging the results for the Reach.***

| Bankfull depths (feet) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Reach 1** | **Reach 2** | **Reach 3** | **Reach 4** | **Reach 5** | **Reach 6** | **Reach 7** | **Reach 8** | **Reach 9** |
| **Min** | 3.9 | 3.4 | 3.1 | 2.8 | 2.4 | 1.7 | 1.8 | 2.3 | 1.6 |
| **Max** | 3.9 | 4.4 | 3.2 | 3.7 | 3.3 | 3.1 | 2.5 | 2.8 | 1.6 |
| **Mean** | 3.9 | 4.0 | 3.2 | 3.2 | 2.7 | 2.6 | 2.2 | 2.6 | 1.6 |
| **St Dev** | n=1 | 0.5 | 0.1 | 0.4 | 0.5 | 0.5 | 0.4 | 0.3 | n=1 |

***Table 3. Minimum (min), maximum (max), and mean flood prone widths for reaches 1-9 (in feet). Mean values are an average of all flood prone widths calculated in each reach. Where flood prone width could not be measured in the field, they were estimated using LiDAR.***

| Flood prone widths (feet) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Reach 1** | **Reach 2** | **Reach 3** | **Reach 4** | **Reach 5** | **Reach 6** | **Reach 7** | **Reach 8** | **Reach 9** |
| **Min** | 3400 | 1150 | 1100 | 350 | 800 | 600 | 1300 | 60 | 70 |
| **Max** | 3400 | 3200 | 2100 | 1200 | 1750 | 2500 | 1750 | 1125 | 70 |
| **Mean** | 3400 | 2075 | 1600 | 817 | 1200 | 1375 | 1467 | 593 | 70 |
| **St Dev** | n=1 | 762.1 | 707.1 | 312.5 | 492.4 | 681.7 | 246.6 | 753.1 | n=1 |

## 3.2 HABITAT UNIT COMPOSITION

Riffles are the dominant habitat type, comprising 54% of the total habitat unit composition for the study area. Glides comprise 22% of the area, and pools and secondary channels each comprise 12% of the project area (Figure 3). In general, glide area habitat decreases and riffle area habitat increases as the grade increases going upstream. Reaches 5, 6, and 7 maintain some of the most complex habitat with higher ratios of secondary channels and pools than other reaches (Figure 2).

Pool frequency ranged from 0 pools per mile (Reach 1), to 7.5 pools per mile (Reach 7), with an average pool frequency throughout the project of 3.6 pools per mile. Reaches 3 and 6 have the most pool area habitat (21% and 27% respectively). Reaches 3 and 6 have the shortest pool spacing (19.7 and 19.6 channel widths per pool, respectively), while Reach 8 has the longest pool spacing (79.6 channel widths per pool). Reaches 5 and 6 have the most pools exceeding 3 feet (9 and 14 pools respectively). The majority of pools throughout the project area had residual depths of less than three feet (72%). Of the 28% of pools with residual depths of less than three feet, 47% (9 pools) are located in Reach 6.

The mean wetted width of the main channel is 51.9 feet. Mean riffle depths were 1.6 feet with mean maximum riffle depths of 3.0 feet. Due to slightly higher than normal flows, it is likely that depths at the end of the summer during normal water years would be lower than those recorded here.

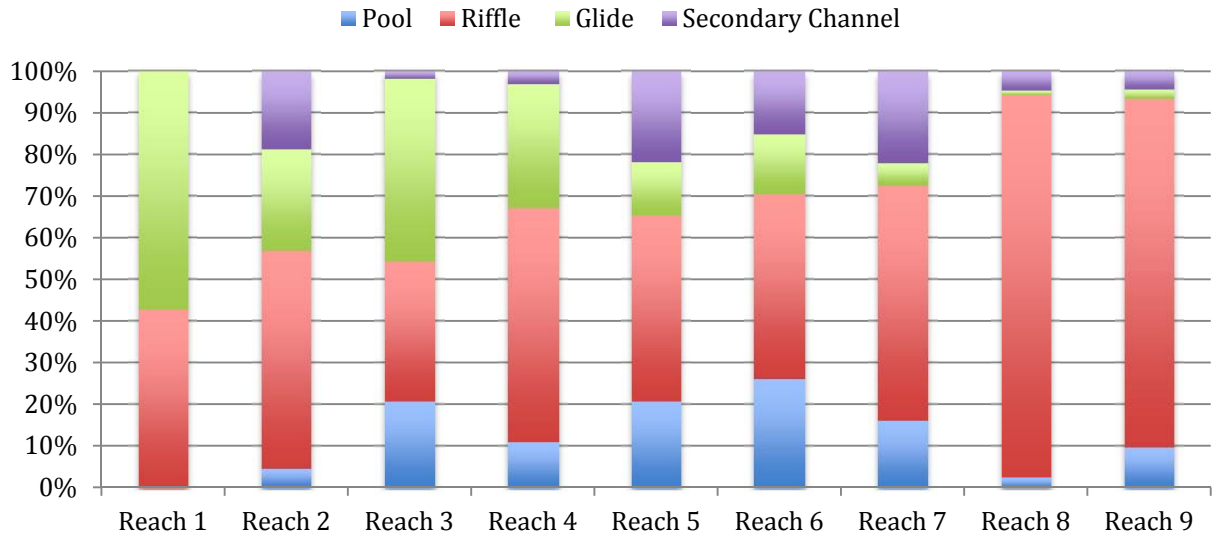



***Figure 2. Habitat unit composition by reach.***

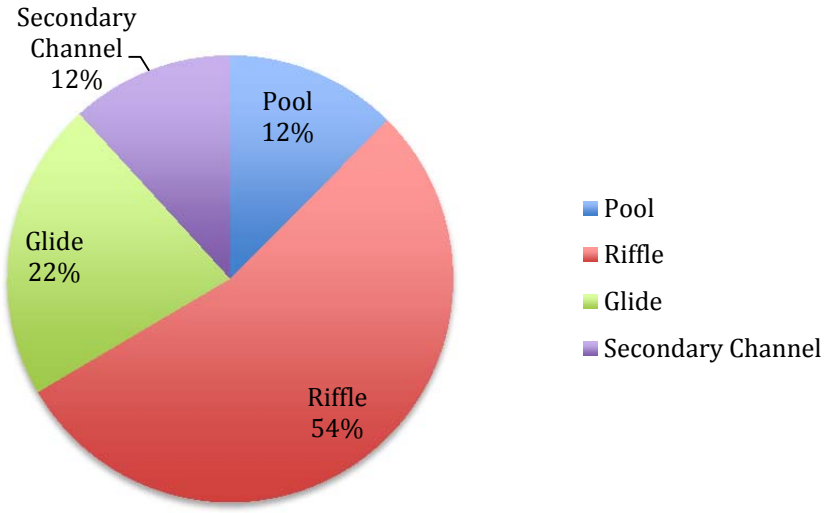



***Figure 3. Habitat unit composition of reaches 1-9. Three open water floodplain wetlands that were recorded in Reach 2 are not included in the secondary channel habitat calculations for Figure 2 and Figure 3.***

## 3.3 SECONDARY CHANNEL HABITAT

For this assessment, we consider "side-channel" features as secondary channels that are, or would be, naturally connected to the mainstem flow at their upstream and downstream ends at average annual flow; this definition also includes artificially disconnected side channels. We consider "off-channel" features to be all other types of secondary channels including backwater channels/alcoves, groundwater-fed channels, wall-base channels, abandoned oxbows, and other types of floodplain channels and open-water floodplain wetlands. For secondary channel habitat that has a dry

component, e.g., a side channel with 1,000 feet of wetted length and 500 feet of additional dry length, only the wetted length is used to calculate secondary channel habitat.

Secondary channel habitat accounted for approximately 12% of the habitat area throughout the project area (Figure 3). In total, 48 secondary channel units were observed. Unless otherwise noted, all channel lengths identified in the report are wetted length. The average secondary channel was 1,042 feet (StDev 1,068 feet). While Reach 2 has the most overall secondary channel habitat area within the project area, the longest secondary channel observed was in Reach 6 (4,850 feet). No secondary habitat was observed in Reach 1 (Figure 2). Reaches 5 and 7 have the highest ratio of secondary channel habitat by reach (30% and 22%, respectively). Mean secondary channel width was 14 feet (StDev 12) throughout the project area. Two side channels, one in Reach 2 and one in Reach 6, were further categorized as being disconnected side channels. Both of these side channels have an inlet and outlet connected to the main channel but they are disconnected to one of those connection points due to a human constructed impediment.

Three open water floodplain wetland units (open water wetlands located on the floodplain) that were identified in Reach 2 of the assessment are not included in secondary channel calculations above. Together, they totaled 5.8 acres. While this type of habitat is important because it contains food sources (invertebrates), LWD, refuge, and rearing habitat for fish and wildlife species when connected to the mainstem channel, and is included in the definition of secondary channel habitat, these three units were not included because of their width, which is not representative of the majority of secondary channel habitat. The three units are outlined in Table 10.

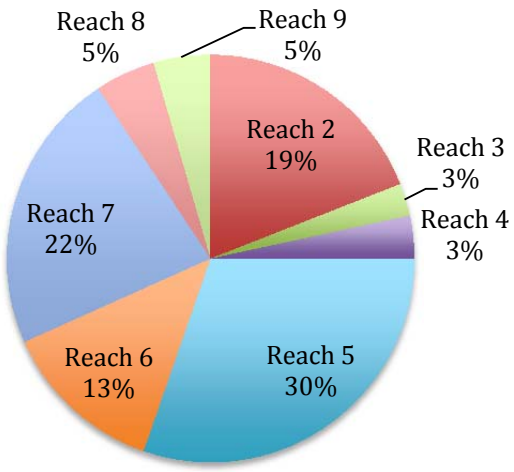



***Figure 4. Percentage of secondary channel habitat in each reach. Three open water floodplain wetlands that were recorded in Reach 2 are not included in the secondary channel habitat calculations above.***

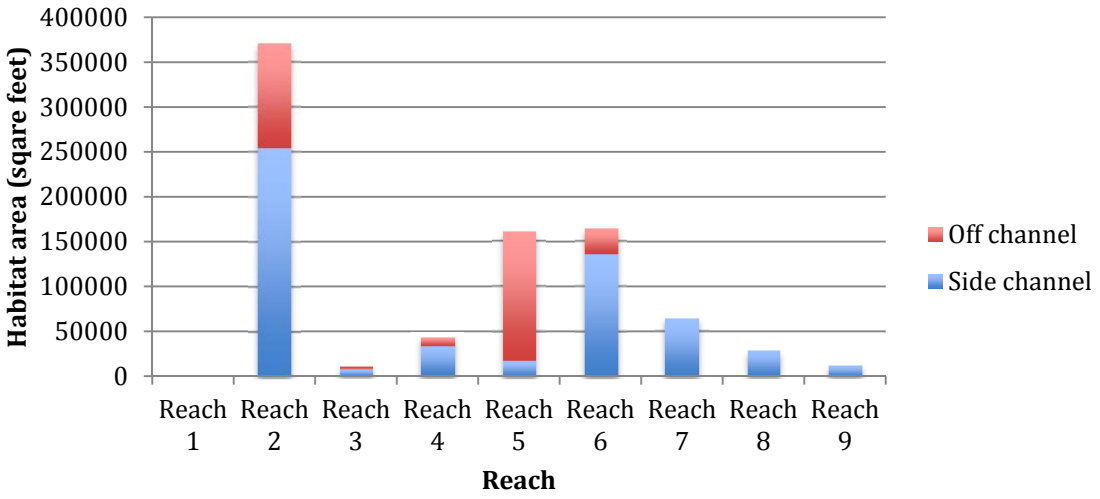



***Figure 5. Secondary channel habitat by reach. Off-channel and side channel habitat identified. Three open water floodplain wetlands that were recorded in Reach 2 are not included in the secondary channel habitat calculations above.***

## 3.4 LARGE WOOD

An average of 125 pieces of large wood per mile was counted in the project area; 56% were "small" pieces with diameters between 6 and 12 inches and lengths greater than 20 feet. Even though Reach 9 is a short reach at 1.3 miles, it maintains the highest wood count with a total of 467 pieces. This is more than double the wood per mile counts of the other reaches (Figure 6). The high wood count was largely due to several log jams at River Mile (RM) 79.75 that were caused by an avalanche in May 2014 that pushed hundreds of trees off the mountainside and into the Methow River. Reaches 2 – 8 maintain relatively similar large wood (LWD) densities, ranging from 107 – 152 pieces per mile.

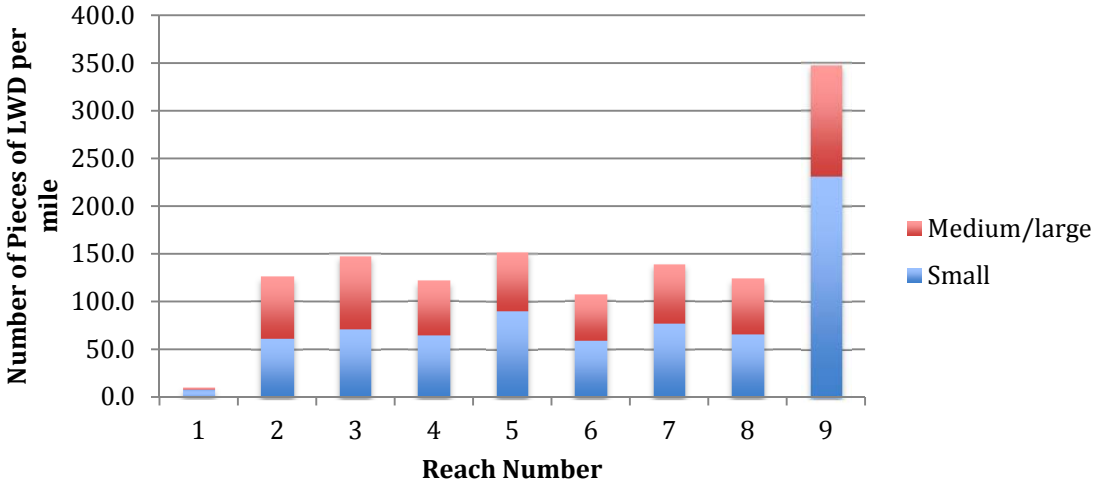



***Figure 6. Small and medium/large wood pieces per river mile for reaches 1-9.***

## 3.5 SUBSTRATE & FINE SEDIMENT

Bed substrate classification is based on thirteen pebble counts done between Reaches 1 through 7. Two pebbles counts were done per reach in Reaches 2-7 and one in Reach 1. All gravel counts were completed at representative glide to riffle transition points. Overall, substrate composition at the pebbles counts is generally similar with the exception of Reach 5, which has considerably more gravel (67%) and less cobble (29%). Reaches 1, 2, 3, 4, 6 and 7 have fairly similar distributions with approximately equal representation of gravel and cobble (Figure 8) and 5% or less sand and boulders. No bedrock was recorded in any of the pebble counts. Throughout all project reaches, an average of 2% of both boulder and sand were recorded (Figure 7). This indicates that fine sediment (<2mm), which can be harmful to salmonid survival in high concentrations, is general not an issue in the study area. Fine sediments appear to be washed through the system as suspended load. Fines accumulate in this system primarily as overbank deposits on floodplains as the result of flood events.

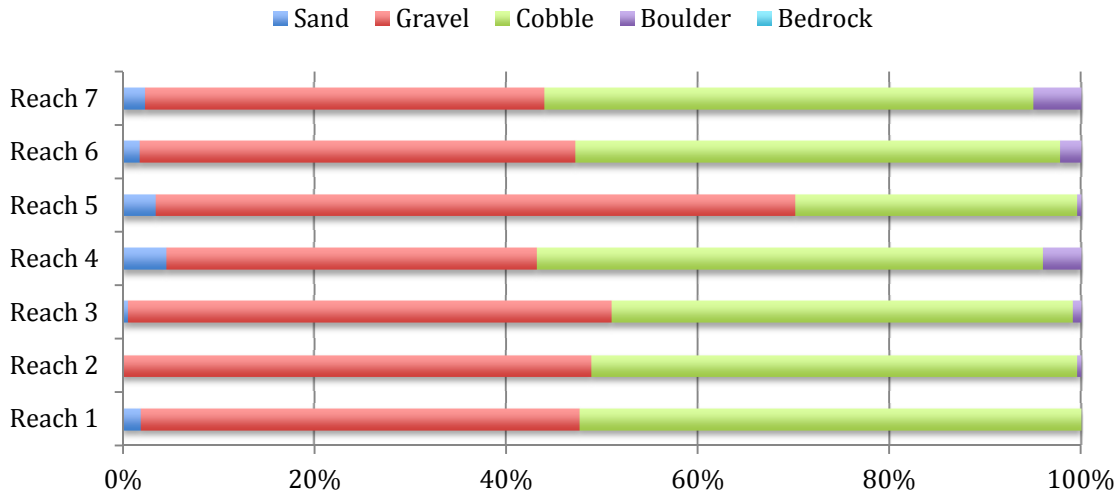



***Figure 7. Pebble count classification of substrate by reach for Reaches 1-7 of the Upper Methow River. For each reach, two pebble counts were performed and then averaged. Pebble counts were not performed in Reaches 8 and 9.***

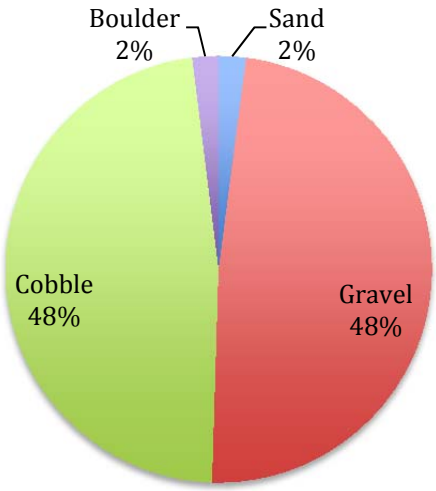



***Figure 8. Pebble count classification averaged for Reach 1-7.***

## 3.6 INSTABILITY & DISTURBANCE

Reaches 1-7 had significant human impacts, including residential development on the floodplain, channelization, roads, vegetation clearing adjacent to the river and riparian areas, levee construction, and impacts from logging. However, modern anthropogenically caused bank erosion was minimal throughout the study area. In total, 2,000 linear feet (or 1%) of modern bank erosion was identified as caused by human activity within the nine $n^{th}$ unit measurements in the lower four reaches. No anthropogenically-caused bank erosion was identified in Reaches 5,6, 8, and 9.

Fire and avalanche-related instability and disturbance were observed in Reaches 8 and 9 during this survey. Both fire and avalanches have been elements of natural disturbance in this basin for centuries. However, the impacts and geographic scale of fire disturbance have increased since Euro-settlement and are expected to continue to increase with climate change forecasts. For example during the summer of 2014 the Carlton Complex Fire (Washington's largest recorded wildfire to date) burned approximately 256,108 acres in the nearby area. This fire did not impact the Upper Methow River but it is representative of the increased risk of large-scale fire disturbance in the watershed.

## 3.7 FISH PASSAGE BARRIERS

No fish passage barriers were observed in the mainstem channel. During dry years, portions of the Upper Methow River seasonally flow subsurface. However, during the 2014 habitat survey completed in August, the Upper Methow was not observed flowing subsurface. A discussion of some of the historical observations of portions of the Upper Methow River flowing subsurface (dewatering) is provided in section 4.2 of this report. The hydrologic and geologic processes responsible for seasonal dewatering are provided in section 2.6 of the Reach Assessment.

## 3.8 RIPARIAN CORRIDOR

A suggested stream inventory survey option is to designate a riparian corridor as either a single 100ft wide zone or two adjacent riparian zones (inner and outer zones) totaling 100 feet in width (USDA 2010). For this assessment, one single 100ft wide riparian zone was designated for the Upper Methow River study area. Survey methods dictate defining a dominant size class of vegetation type within the riparian corridor (i.e. large trees, small trees, shrubs), then defining the dominate species observed in the over and understory respectively.

In total, 40 $n^{th}$ units were measured in Reaches 1-9. In these units the dominant riparian vegetation size class measured was small trees with a 9.0 – 20.9 inch diameter (83%). Sapling/pole trees measuring 5.0 – 8.9 inches diameter were the second most dominant class (7%). The remaining 10% was distributed between large trees measuring 21 – 31.9 inches diameter (3%); shrub/seedling measuring 1 – 4.9 inches diameter (5%); and grassland/forbs (2%) (Figure 9).

Within the units measured the dominant riparian understory observed was dogwood and cottonwood, accounting for 30% of the understory each. Additional dominant riparian understory species observed included snowberry (co-dominant with either mountain maple or huckleberry, 13%); grassland forbes (12%); willow (5%); other unidentified small shrubs (5%); ceanothus (3%);

and cedar (2%). Within the units measured the overstory was dominated by cottonwood and ponderosa pine (42% and 25% respectively). Additional species observed as dominant in the understory included dogwood (10%); cedar (10%); Douglas fir (10%); and aspen (3%) (Figure 12).

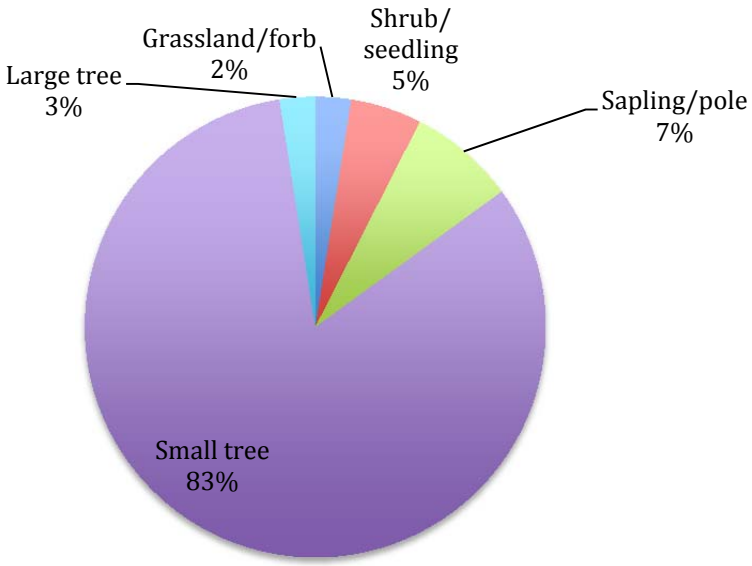



***Figure 9. Distribution of dominant size class category for the riparian inner zone, all reaches combined.***

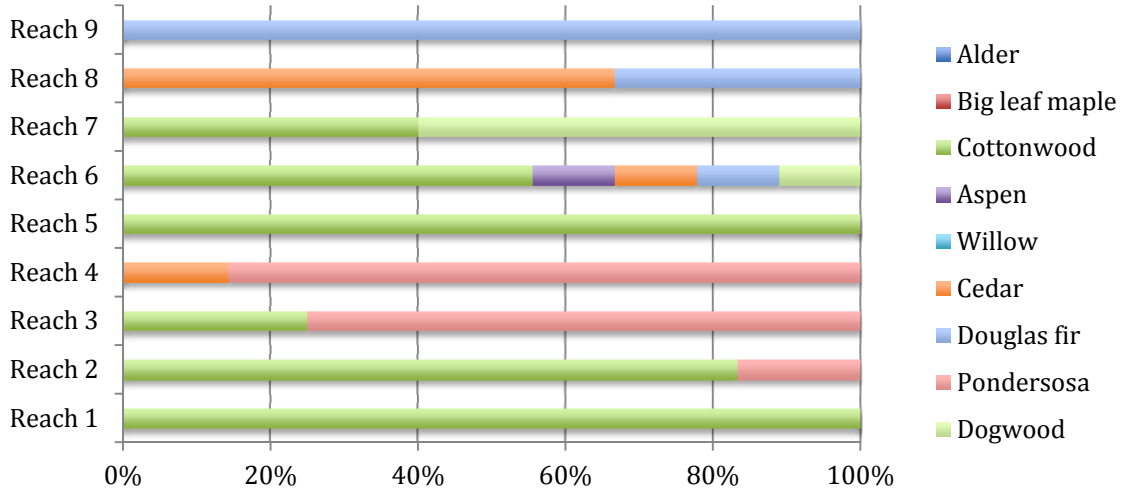



***Figure 10. Distribution of overstory species by reach based on n$^{th}$ unit measurements.***

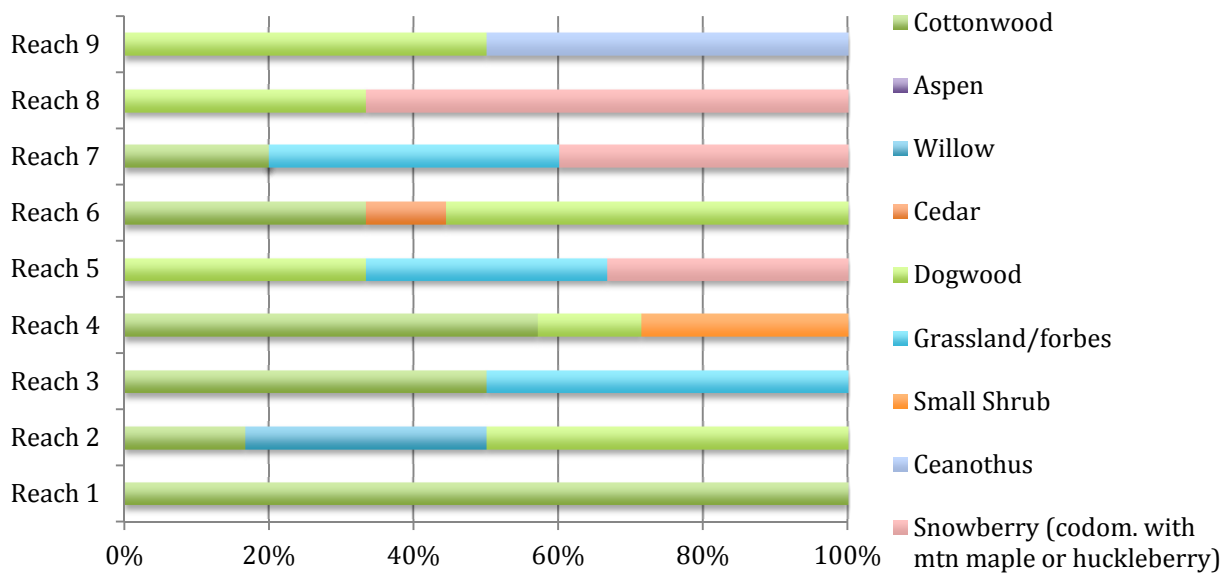



***Figure 11. Distribution of understory species by reach based on n$^{th}$ unit measurements.***

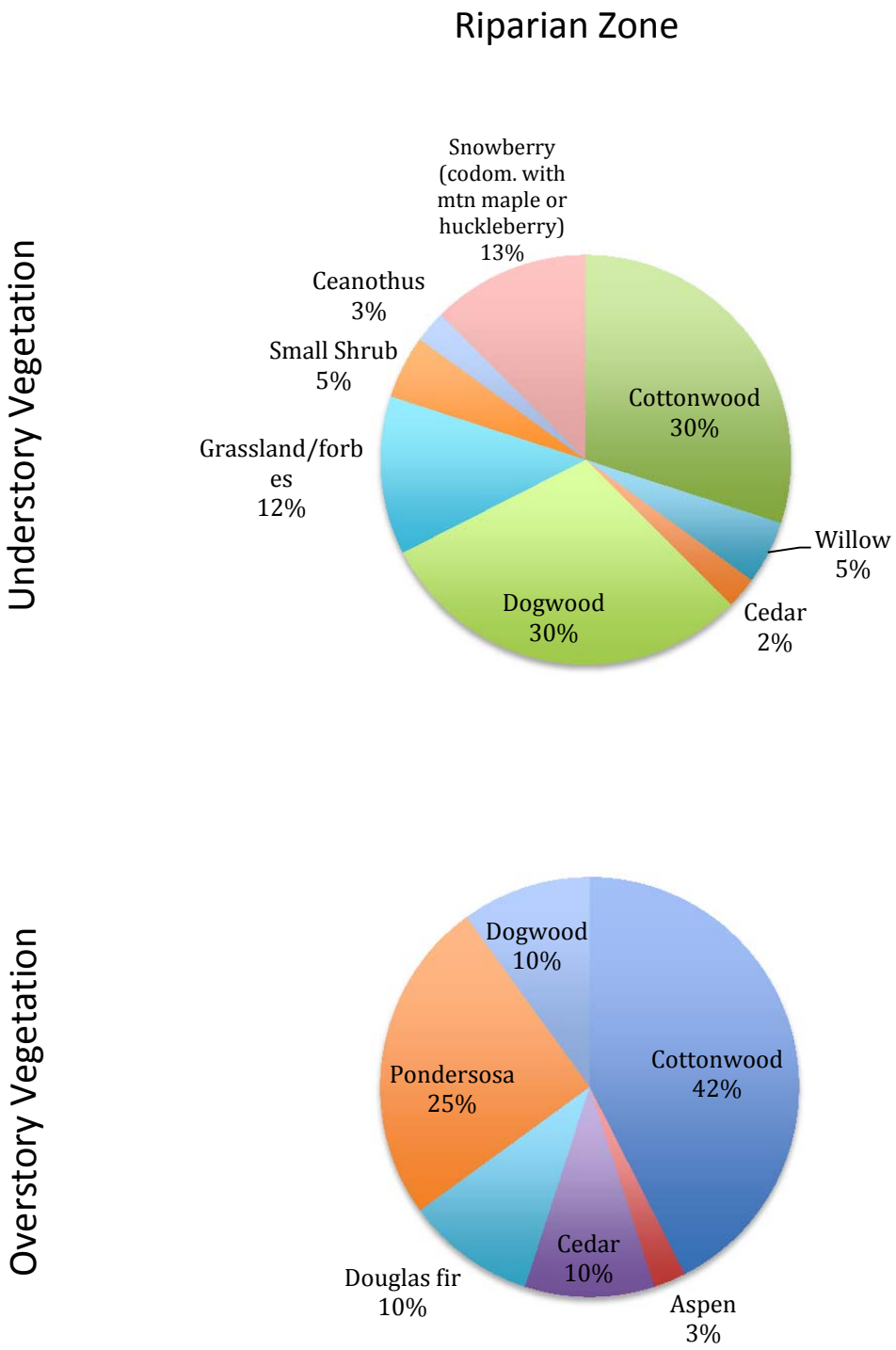



***Figure 12. Dominant understory and overstory riparian vegetation observed at nth units throughout the project area.***

# 4 Comparisons to Past Surveys

Two previous surveys were performed on the Upper Methow River that can be used for comparison purposes. Table 4 outlines approximate equivalent reaches and associated river miles. The Okanogan National Forest Methow Valley Ranger District performed the first habitat survey in 1994 from RM 64.9 at Goat Creek (the beginning of Reach 3 in this survey) to approximately RM 84.9 (site of a waterfall located about five miles upstream from the end of this survey). The write up for the 1994 survey was not completed until 1997. The second survey was performed in 2003 by the Okanongan-Wenatchee National Forest Methow Valley Ranger District from RM 75.0 at Lost River (the beginning of Reach 7 in this survey) to RM 80.0 at Trout Creek (the end of this survey).

Comparisons to previous surveys allow us to see trends in habitat characteristics over time. However, comparing between surveys is challenging because reach breaks change between surveys; survey protocols change from year to year; each survey team makes field judgments that may vary from other survey teams; and water levels vary considerably from year to year.

***Table 4. Approximate equivalent reaches and associated river miles for 1994, 2003, and 2014 surveys.***

| Equivalent Reaches – 1994, 2003 and 2014 | | | |
|---|---|---|---|
| **2014 River Mile** | **2014 Survey** | **2003 Survey** | **1994 Survey** |
| 61.0 (Weeman Bridge) – 61.7 | Reach 1 (0.7 mi.) | | |
| 61.7 – 64.9 (Goat Creek) | Reach 2 (3.2 mi.) | | |
| 64.9 (Goat Creek) – 66.2 | Reach 3 (1.3 mi.) | | Reach 1 |
| 66.2 – 69.2 (Early Winter's Creek) | Reach 4 (3.0 mi.) | | |
| 69.2 (Early Winter's Creek) – 71.3 | Reach 5 (2.1 mi.) | | Reach 2 |
| 71.3 – 75.1 (Lost River) | Reach 6 (3.8 mi.) | | |
| 75.1 (Lost River) – 76.5 (Robinson Creek) | Reach 7 (1.4 mi.) | Reach 1 | Reach 3 |
| 76.5 (Robinson Creek) – 78.7 | Reach 8 (2.2 mi.) | Reach 2 | Reach 4 |
| 78.7 – 80.0 (Trout Creek) | Reach 9 (1.3 mi.) | | |

## 4.1 HABITAT AREA

In general, pool and secondary channel area habitat have increased over time from Goat Creek to Trout Creek, while fast-water (riffle and glide) habitat has decreased. This characterization correlates with the LWD comparison in Table 6 that indicates a general increase in LWD from 1994 to 2014. More wood from Early Winters Creek to RM 75.1 indicate changes in habitat that show a 100% increase in pool area habitat and a 200% increase in secondary channel habitat area between 1994 and 2014.

***Table 5. Habitat area comparisons between 1994, 2003, and 2014 surveys.***

| Habitat Area Comparisons – 1994, 2003 and 2014 | | | | |
|---|---|---|---|---|
| | **% Pool** | **% Riffle** | **% Glide** | **% Secondary channel** |
| RM 64.9 (Goat Creek) to RM 69.2 (Early Winters Creek) | | | | |
| 2014 Survey | 14% | 50% | 34% | 3% |
| 1994 Survey | 5% | 86% | 7% | 3% |
| RM 69.2 (Early Winters Creek) to RM 75.1 | | | | |
| 2014 Survey | 25% | 46% | 14% | 16% |
| 1994 Survey | 12% | 83% | 1% | 5% |
| RM 75.1 (Lost River) to RM 76.5 (Robinson Creek) | | | | |
| 2014 Survey | 16% | 56% | 5% | 22% |
| 2003 Survey | 29% | 62%[1] | | 10% |
| 1994 Survey | 12% | 80% | 0% | 8% |
| RM 76.5 (Robinson Creek) to RM 80.0 (Trout Creek) | | | | |
| 2014 Survey | 5% | 89% | 1% | 5% |
| 2003 Survey | 11% | 84%[1] | | 5% |
| 1994 Survey | 4% | 94% | 0% | 3% |

## 4.2 STREAMFLOW

Streamflow in the upper Methow River varied considerably between the 1997, 2003, and 2014 surveys. Figure 13 illustrates the variability in stream flows, with 2003 being the lowest water year and 1994 being the highest water year, on average. Heavy rains for the last two days of this 2014 survey raised river levels to par with 1997 flows.

Portions of the upper Methow River from approximately Lost River to Goat Creek flow subsurface during the summer and autumn months of dry precipitation years (USFS 2003). Sometimes dewatering can extend upstream of Lost River towards Robinson Creek on very dry years. This was not observed during IFI's August 2014 habitat survey, which passed Lost River on July 11. However, IFI staff did observe dewatered sections of the channel between RM 70.2 to 71.75 in October 2014.

A 1987 fish survey by the Yakama Indian Nation states that the river went subsurface for 7.6 miles. "No water was seen from the Mazama bridge to a point approximately 200 yards below the confluence with the Lost River. Only a 100 yard stretch below the confluence of Early Winters Creek had a pool of water throughout the 7.6 mile area" (Yakama Indian Nation 1987). The 1994 survey does not indicate the Methow River flowing subsurface.

See the main Reach Assessment report for more discussion of subsurface flow conditions.

[1] Riffles and glides were grouped together in the 2003 survey.

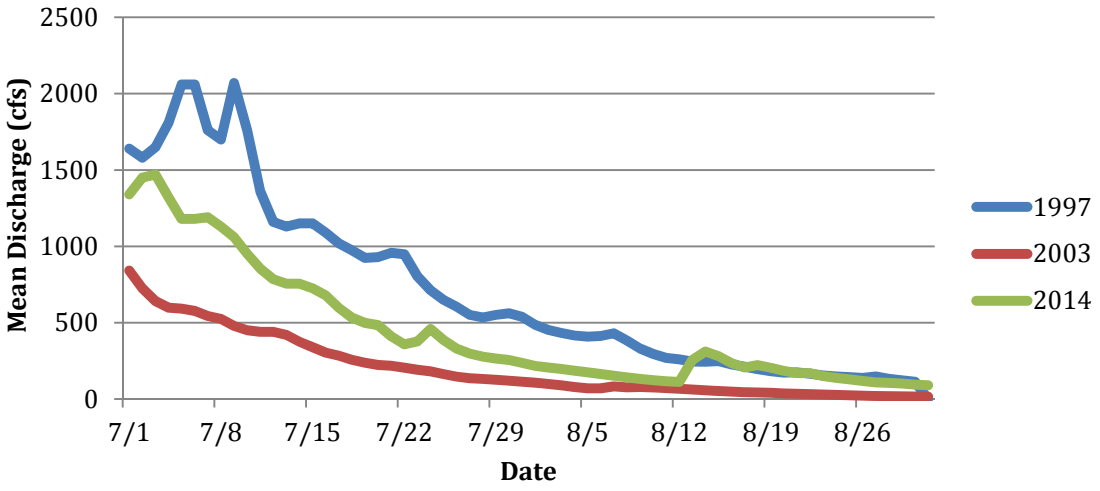



***Figure 13. Streamflow data from July 1 - August 30 for 1997, 2003, and 2014 at USGS gauge 12447383 Methow River above Goat Creek Near Mazama.***

## 4.3 SEDIMENT

Comparisons of sediment between the 1994, 2003 and 2014 surveys are very limited. Wolman pebble counts were not performed in the 1994 survey. Lost River to Robinson Creek (Reach 7 in 2014 and Reach 1 in 2003) is the only reach that had pebble counts completed in both the 2003 and 2014 surveys.

A comparison (Figure 14) of results from Wolman pebble counts of this reach between the two surveys indicates relatively equal numbers, and low amounts of fines in both surveys; there is more gravel and slightly less cobble in 2014. For the purposes of this assessment, the key finding from this comparison is that fines (<2mm) have remained relatively low (2% in both 2003 and 2014) – well below the "adequate guidelines" of ≤12% sand/fines (USBR 2012).

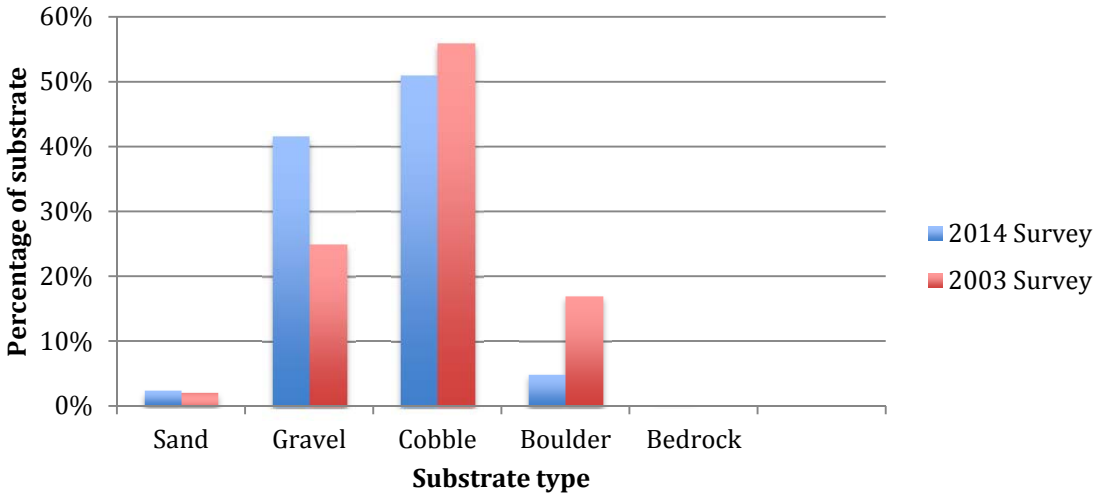



***Figure 14. Gravel count comparison for Reach 7, 2003 and 2014 surveys.***

## 4.4 LARGE WOOD

Large wood (LWD) was not counted in side channels in the 1994 survey. Also, neither of the past surveys extends the entire length of the 2014 survey. As a result, only Reaches 7 – 9 from the 2014 survey can be compared with both the 1994 and 2003 surveys. Data is also available for comparing 2014 Reach 3 and 4; and 5 and 6 with 1994 data.

Overall, LWD per mile increased significantly from 1994 – 2014. Table 6 compares LWD per mile in the main channel between the 1994, 2003 and 2014 surveys. Reach 8 and 9 (2014 survey) indicate the greatest recruitment of LWD over time (Figure 16) with small LWD (>20 ft. long and 6-12 in. diam.) increasing from 28.2 pieces per mile (1994), to 36.7 pieces per mile (2003), to 123 pieces per mile in 2014. Large LWD (>35 ft. long and >20 in. diam.) also increased notably in all reaches. LWD counts ranged from 0.5 – 2.7 pieces per mile in Reach 1-4 in 1994. By 2014, this increased to 11.5 – 23.4 pieces per mile.

Increases in LWD can be attributed to several variables. For example, a large majority of the 2014 in-channel wood in Reach 9 is from an avalanche that occurred in May 2014. It is possible that higher wood counts are also a result of the Needle Creek Fire that occurred after the completion of the 2003 survey, burning 21,305 acres, including forest on both sides of the Methow within the final two miles of the survey area. Finally, changes in survey protocol over the years could also be responsible for portions of the massive discrepancies in wood count between 1994 and 2014. The 1994 survey report does not identify techniques used to count wood aside from the size of wood counted and that the wood was in the main channel (not secondary channels).

***Table 6. LWD per mile by class size compared between reaches in 1994, 2003 and 2014 surveys. All LWD is in-channel (does not include secondary channels).***

| LWD per mile – 1994, 2003 and 2014 | | | | |
|---|---|---|---|---|
| | **Small** (>20 ft. long) (6 - 12 in. diam.) | **Medium** (>35 ft. long) (12 - 20 in. diam.) | **Large** (>35 ft. long) (>20 in. diam.) | **Medium & Large** |
| RM 64.9 (Goat Creek) to RM 69.2 (Early Winters Creek) | | | | |
| 2014 Survey | 64.4 | 38.6 | 21.4 | 60 |
| 1994 Survey | 38.5 | 16 | 0.5 | 16.5 |
| RM 69.2 (Early Winters Creek) to RM 75.1 | | | | |
| 2014 Survey | 57.6 | 33.6 | 11.5 | 45.1 |
| 1994 Survey | 27.2 | 11 | 2.7 | 13.7 |
| RM 75.1 (Lost River) to RM 76.5 (Robinson Creek) | | | | |
| 2014 Survey | 51.9 | 34.4 | 15.6 | 50 |
| 2003 Survey | 62.1 | 9.9 | 1.2 | 11.1 |
| 1994 Survey | 33.2 | 17 | 2.7 | 19.7 |
| RM 76.5 (Robinson Creek) to RM 80.0 (Trout Creek) | | | | |
| 2014 Survey | 123 | 52.3 | 23.4 | 75.7 |
| 2003 Survey | 36.7 | 19.4 | 4.3 | 23.7 |
| 1994 Survey | 28.2 | 8 | 1.2 | 9.2 |

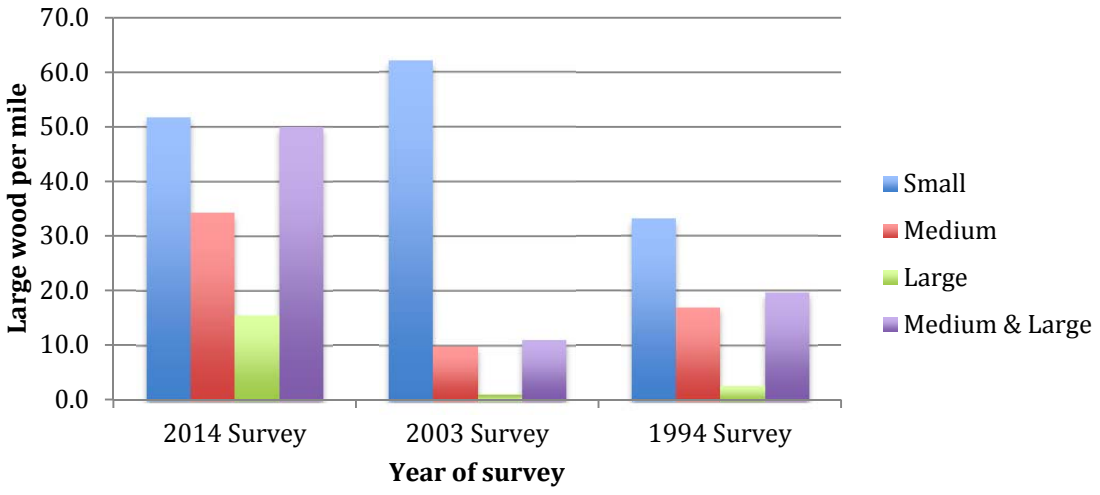



***Figure 15. Comparison of LWD per mile from Lost River to Robinson Creek between 1994, 2003 and 2014 surveys.***

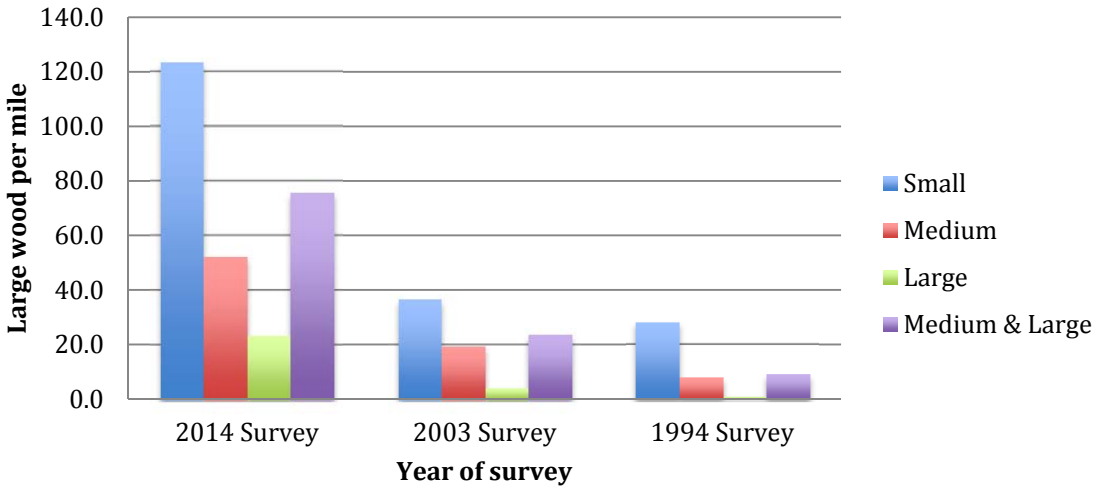



***Figure 16. Comparison of LWD per mile in Reaches 8 and 9 (Robinson Creek to Trout Creek) between 1994, 2003 and 2014 surveys.***

## 4.5 POOLS

Differences in protocols between the 1994, 2003, and 2014 surveys make comparing pools challenging and likely inaccurate. A 1996 protocol change allowed for counting plunge pools where the width of the pool was greater than the length. In 1994, all habitat units had to have a length greater than its width. In addition, the 1994 pool residual depth standard was not stated. The 2003 survey protocols were also significantly different from both 1994 and 2014. Most notable is the counting of pools in side channels in 2003. Also, protocol for 2003 followed the Okanogan Forest Plan definition of a "quality" pool, which included counted pools that spanned at least half the channel with a low flow maximum depth of 3 feet, or depth of 1.5 feet, with 40% or greater hiding cover.

While changes in survey protocols make comparisons challenging, a few general trends can be deduced from the data. Figure 7 compares pool habitat between surveys. Across the board, 2003 pools per mile, and pool habitat area are highest in 2003. However, in general, pool % habitat increases from 1994 to 2014. Pools per mile also increase in 3 of 4 reaches, even though there should be *more* pools in 1994 due to counting pools in side channels.

***Table 7. Comparison of pools between 1994, 2003, and 2014 surveys. Note that protocols changed significantly between surveys.***

| Pool Habitat Comparisons – 1994, 2003 and 2014 | | | |
|---|---|---|---|
| | **Pools per mile** | **Pool % habitat** | **Avg. Residual depth (ft)** |
| RM 64.9 (Goat Creek) to RM 69.2 (Early Winters Creek) | | | |
| 2014 Survey | 2.8 | 14% | 5.4 |
| 1994 Survey | 1.1 | 5% | 3.3 |
| RM 69.2 (Early Winters Creek) to RM 75.1 | | | |
| 2014 Survey | 8.1 | 25% | 4.3 |
| 1994 Survey | 3.4 | 12% | 3.5 |
| RM 75.1 (Lost River) to RM 76.5 (Robinson Creek) | | | |
| 2014 Survey | 8.6 | 16% | 3.4 |
| 2003 Survey | 16.1 | 29% | 2.1 |
| 1994 Survey | 8.1 | 12% | 2.6 |
| RM 76.5 (Robinson Creek) to RM 80.0 (Trout Creek) | | | |
| 2014 Survey | 2 | 5% | 4.4 |
| 2003 Survey | 11.4 | 11.3% | 2.1 |
| 1994 Survey | 5.2 | 4% | 2.7 |

## 4.6 WATER TEMPERATURES

Watershed Sciences, Inc. conducted airborne thermal infrared (TIR) imagery remote sensing in 2009 in the Upper Methow basin for the Yakama Tribe Fisheries department. The TIR acquisition was designed to support ongoing habitat assessments in the Basin. Data was collected during ideal weather conditions: warm temperatures, low humidity and clear skies on August 24, 2009. The air temperature in Twisp, WA had a high of 85°F, while flow rates in the Methow River on the day of the survey were below the historic average at all four USGS monitoring gages.

Thermal infrared sensors measure TIR energy emitted at the water's surface. Since TIR wavelengths cannot infiltrate water, the sensor only measured water surface temperature. Thermal infrared data accurately represents bulk water temperatures where the water column is thoroughly mixing, such as riffles. Other types of channel units are only showing the surface layer temperatures.

Watershed Sciences surveyed the Methow River from the mouth to the confluence with Lost River (RM 76.5). The aircraft was flown longitudinally along the stream corridor in order to collect thermal infrared images, which were referenced with time, position and heading information provided by a global positioning system (GPS). After desktop analysis, they found stream temperatures ranged from 12.4°C just below Little Boulder Creek (Rm 65.17) to 19.4°C at the mouth of the Methow River. It was noted that the upper Methow River showed highly variable temperatures, with three large-scale warming and cooling cycles noted. At the top of their survey, Lost River contributed to the first cooling trend, but the mainstem Methow quickly warmed back up moving downstream. Near RM

71.0, the temperatures decreased due to the input of a cool spring contributing groundwater to the channel. Again, the channel warms back up as it moves downstream until RM 65.0 where there is a large secondary channel and spring complex adding cool water to the main channel. After each temperature decrease, the Methow returns to or above the temperature at which it was prior to the cooling inputs. At low flow this section of the Methow is braided and fairly shallow, with a large amount of subsurface influence- either surface water infiltration or hyporheic input and springs.

In this type of alluvial and glacial sediment, streams often lose surface water to subsurface flow and groundwater. When flows are the lowest, which is usually between August-October for the Methow River, the relatively shallow surface water warms quickly in the warm air temperatures and direct sunlight. Further downstream, water will reappear as groundwater discharge. This pattern is evident on the upper Methow River as indicated by the large number of seeps and springs shown in the TIR imagery.

This habitat survey found similar results in July-August, 2014 as Watershed Sciences found in 2009. Eighty-three total units were measured: 11 pools, 22 riffles, 10 glides, 28 side channels/off-channel, and 12 tributaries. Overall, there was a general warming trend moving downstream from the confluence of Trout Creek to Weeman Bridge, with several large-scale cycles of cooling and warming demonstrated. Also similarly to Watershed Sciences results, we found that there were general trends of cooling occurring around RM 70 and 73, both of which quickly rewarmed downstream. Above the confluence with Lost River, the Methow maintains a cooling trend until the upstream extent of our survey reach. Though it is established that stream water temperatures decrease moving upstream, heavy rains and cooler average air temperatures occurring August 12, 2014 through August 14, 2014 may have slightly affected the water temperatures of Reaches 8 and 9. The tributaries measured as part of this survey were generally within a couple degrees of the temperatures measured by Watershed Sciences in 2009, with the exception of Goat Creek.

The temperatures in the mainstem and the off-channel units were highly variable and depended on a number of factors such as time of day, level of flow, and ambient environmental effects. Due to the nature of our survey as compared to Watershed Sciences, we observed water temperature variations influenced by the time of day and ambient environmental conditions. For example, throughout the day, observed water temperatures increased. Early morning temperature measurements were the lowest; the highest temperatures in the study reach were found in a glide, riffle, and secondary channel in the afternoon. In the mainstem channel the temperature of pools observed during the survey increased the most over the course of the day while riffles changed temperature (warmed) the least. Of all channel types measured, tributaries exhibited the least amount of temperature variation during a day, even less than riffles. Though Goat Creek was measured to be fairly warm by Watershed Sciences in 2009, Inter-Fluve staff measured an unusually high temperature for the creek, at 21°C. Human error, as well as localized heating or cooling patches may have caused this outlier. In general however, glides were the mainstem unit that was the warmest overall, while tributaries input the coldest water into the system.

Within the unit types themselves there was a large amount of temperature variability. Side channels were the most variable in temperature. Some of this may be attributed to the groundwater inputs

and the different water characteristics between fast-moving secondary channels and slow-moving secondary channels creating different temperature environments. Generally, fast secondary channels (those that had substantial water movement) were cooler than slow secondary channels (those that flowed very slowly or not at all).

# 5 Stream Habitat Reach Reports

## 5.1 REACH 1

**Location**: River mile 61.15 (Weeman Bridge) – 61.7
**Total length**: 0.55 miles
**Survey date**: July 17, 2014

***Figure 17. Representative view of Reach 1. Only three channel units were recorded in Reach 1; all were fast water. Observations at the one n$^{th}$ unit in Reach 1 identified both the overstory and understory as dominated by cottonwood, also visible in this photo.***

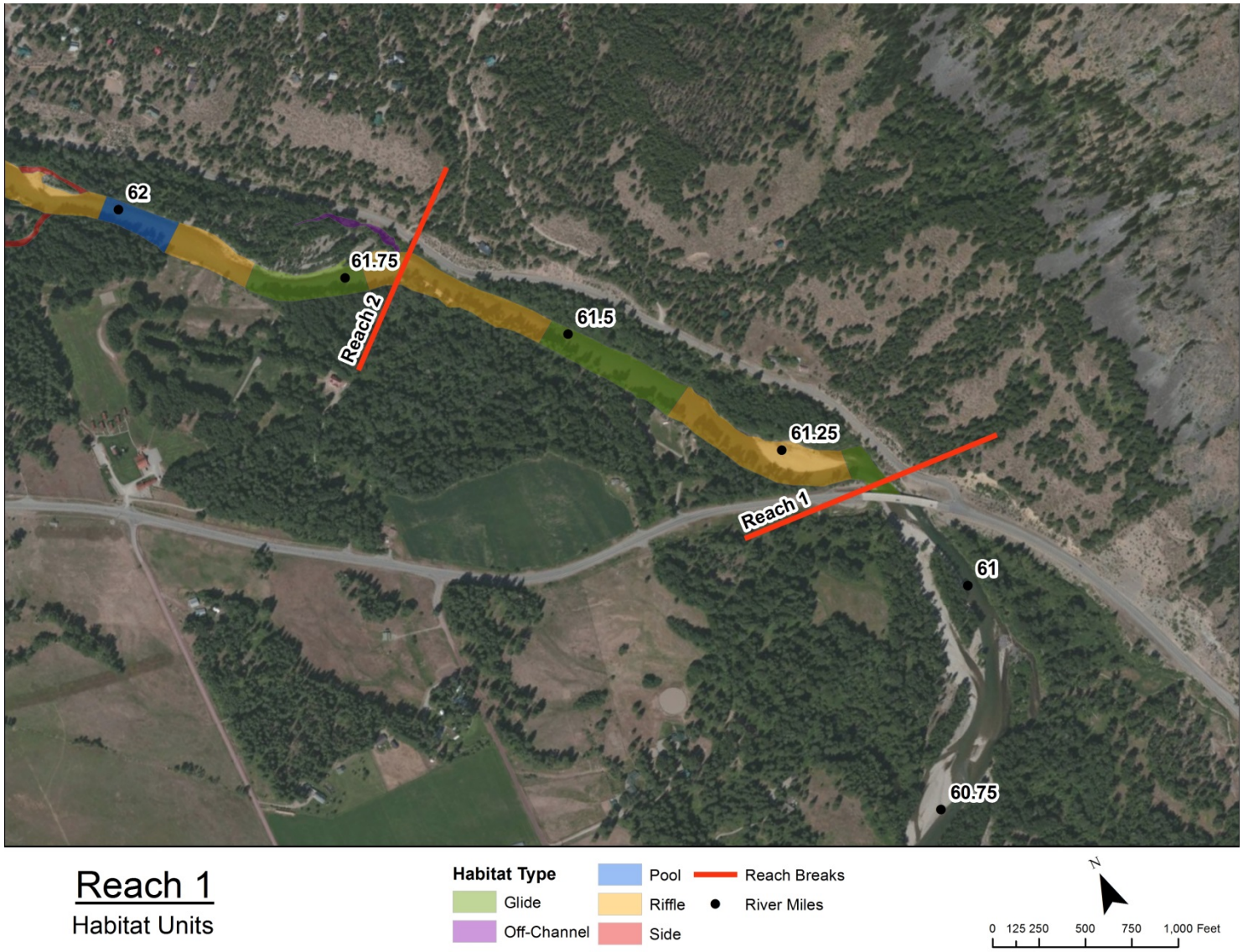



***Figure 18. Overview of Upper Methow Reach 1 from RM 61 (Weeman Bridge) – RM 61.7.***

### 5.1.1 Habitat Unit Composition

Reach 1 is the shortest reach with the fewest channel units of all reaches in the study area. Of the three channel units recorded, all were fast water. Over half of the reach was designated as glide (57%), with one riffle accounting for the remaining 43% of the habitat area (Figure 19). No pools or secondary channel habitat were observed. Overall, the reach was fairly deep and fast-moving with an average depth of 3.9 feet and average max depth of 8 feet.

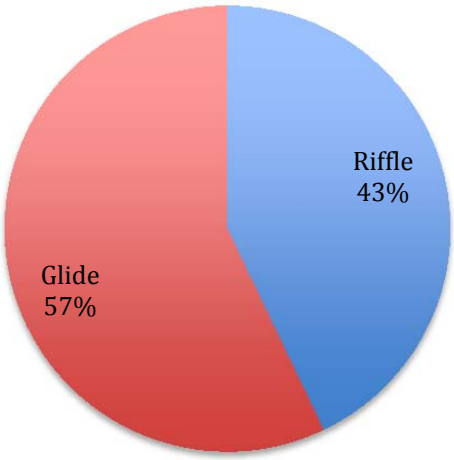



***Figure 19. Habitat area composition of Reach 1.***

### 5.1.2 Pools

No pools were observed in Reach 1.

### 5.1.3 Secondary Channel Habitat

No secondary channels were observed in Reach 1.

### 5.1.4 Large Woody Material

Large wood quantities in Reach 1 were the lowest of all nine reaches with 9.9 pieces per mile and 2.5 medium/large pieces per mile, compared to the project area average of 125 pieces per mile and 55 medium and large pieces per mile. In total, 4 pieces of large wood were counted. No log jams were observed.

***Table 8. Large woody material quantities in Reach 1.***

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in x 35 ft) | Total |
|---|---|---|---|---|
| Number of pieces | 3 | 1 | 0 | 4 |
| Number of pieces per mile | 7.5 | 2.5 | 0 | 9.9 |
| Number of med/lg pieces per mile | | | | 2.5 |
| Number of jams per mile | | | | 0 |
| Number of jams | | | | 0 |

### 5.1.5 Substrate & Fine Sediment

Bed substrate was primarily cobble (52%) with 46% gravel and 2% sand. This substrate composition was fairly close to the project average distribution of 48% cobble, 48% gravel, 2% sand, and 2% boulder. Only one pebble count was conducted in Reach 1 because it is much shorter in length than the other reaches.

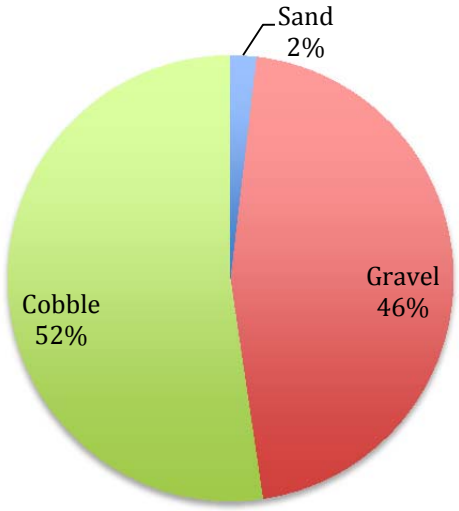
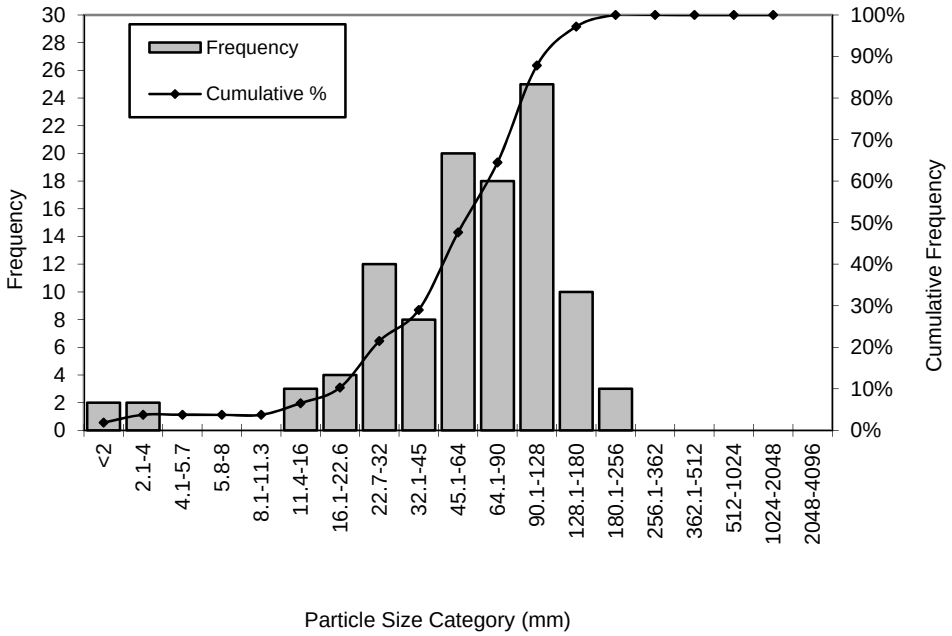



***Figure 20. Percent composition of bed substrate based on one pebble count in Reach 1.***

***Figure 21. Substrate in Reach 1 is largely composed of gravel and cobble (left). Overall, Reach 1 is relatively deep and fast moving (right).***




| Material | Percent Composition | Size Class | Size percent finer than (mm) |
|---|---|---|---|
| Sand | 2% | D5 | 13 |
| Gravel | 46% | D16 | 22 |
| Cobble | 52% | D50 | 68 |
| Boulder | 0% | D84 | 122 |
| Bedrock | 0% | D95 | 168 |

***Figure 22. Grain size distribution and particle size classes from one pebble count in Reach 1.***

### 5.1.6 Riparian Corridor

With only one nth unit measurement in Reach 1, the riparian corridor observed was with small trees measuring 9 inches – 20.9 inches as the dominant class. Both the overstory and understory was dominated by cottonwoods (100%). Cottonwood was the dominant species observed throughout the study area, accounting for 30% of riparian understory and 42% of the observed riparian overstory (Figure 12).

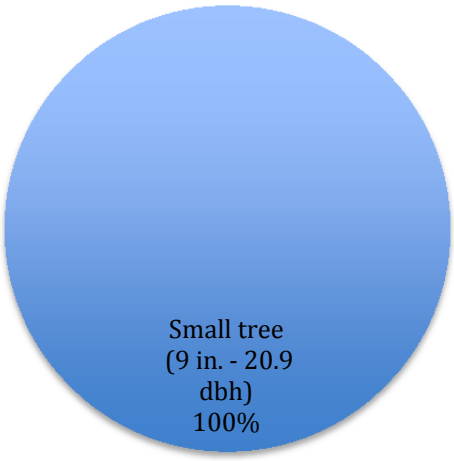



***Figure 23. Dominant riparian vegetation identified within 100 feet of the Methow River by ocular estimate.***

## 5.2 REACH 2

**Location**: River mile 61.7 – 64.8 (Goat Creek)
**Total length**: 3.1 miles
**Survey Date**: July 16 - 18, 2014

***Figure 24. Representative view of Reach 2. In the background smokes rises from the Carlton Complex Fire – creating a pyrocumulus cloud.***

### 5.2.1 Habitat Unit Composition

Overall, Reach 2 has excellent salmonid habitat. Reach 2 has 46% of the secondary channel habitat identified throughout the entire study area (Figure 5). In total, there is over 2.4 miles of secondary channel (19% of the habitat composition) in Reach 2, including the second longest side channel in the project area (4,800 feet). It is also the longest reach at 3.2 miles. Fast water is the dominant habitat, comprising 76% of the habitat area within the reach (Figure 26). Four pools are present in Reach 2, comprising 5% of the habitat area. Reach 2 also has the second highest wood count of the nine reaches with 398 pieces.

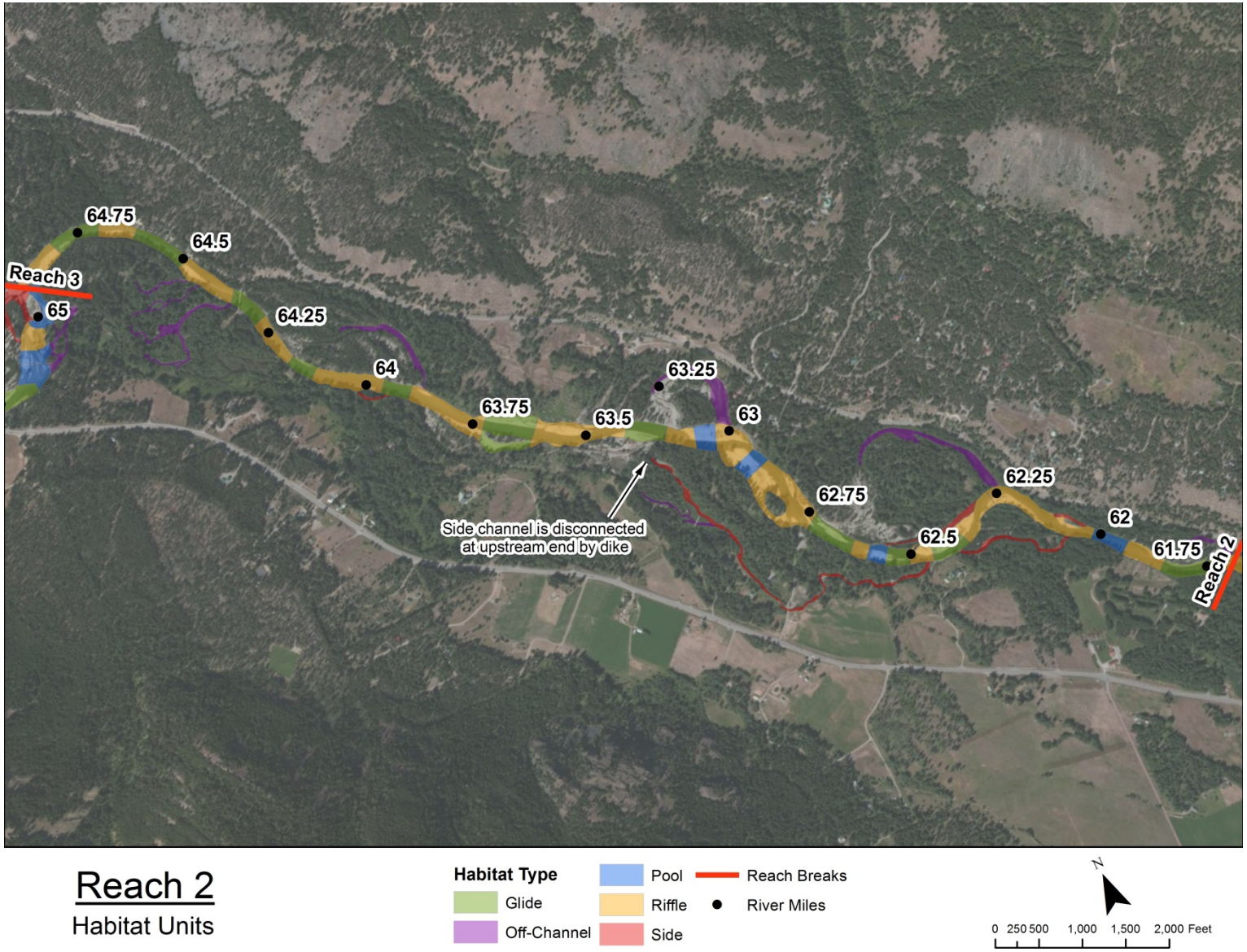



***Figure 25. Overview of Upper Methow Reach 2 from RM 61.7 – RM 64.8 (Goat Creek).***

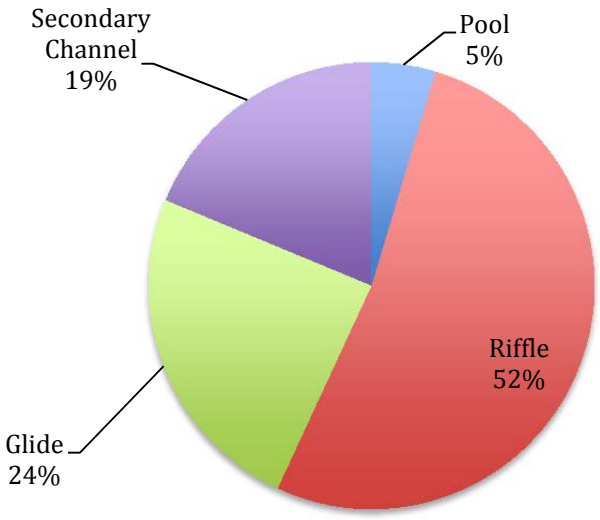



***Figure 26. Habitat unit composition for Reach 2.***

### 5.2.2 Pools

Four pools were identified in Reach 2, equating to a pool frequency of 1.3 pools per mile (compared to a study average of 3.6 pools per mile). Residual depths of the four pools were equally distributed in depths, ranging from <3 feet to between 9 and 12 feet (Figure 27). Reach 2 has a pool frequency of 49 channel widths per pool (verses an average of 31.8 for all reaches combined). Nine pieces of LWD were counted in the four pools.

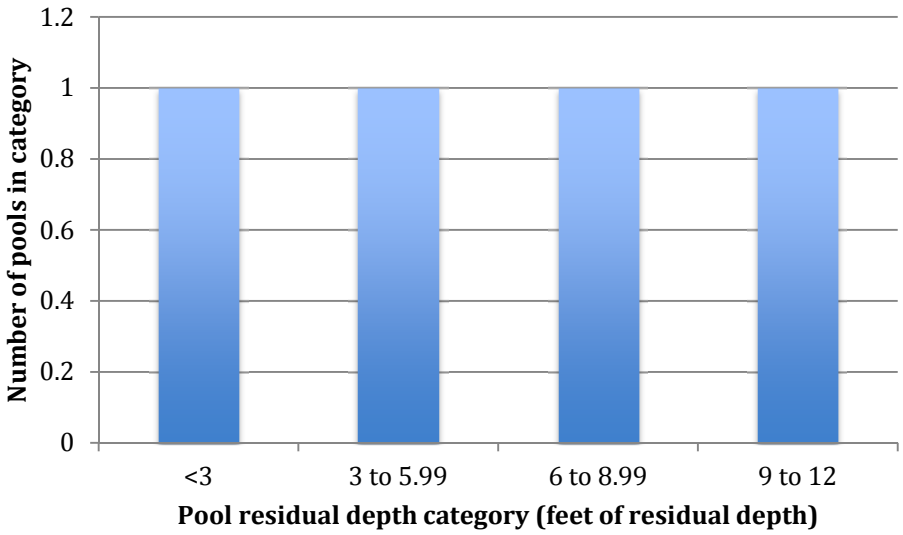



***Figure 27. Pool residual depth and total pool count in Reach 2.***

### 5.2.3 Secondary Channel Habitat

Reach 2 has the highest ratio of secondary channel habitat in the project area (41%), including the second longest side channel identified (SIDE4 – 4,800 feet) (Figure 5). The feature is disconnected from the main channel at the upstream end by a 10-foot-tall levee that crosses its path. Because it was historically connected at both its upstream and downstream ends, we considered it a "disconnected side channel." Reach 6 also has disconnected side channel habitat.

Of the 9 secondary channels in Reach 2, 31% are off-channel habitat and 69% are side channel habitat. Three off-channels between RM 64.3 – 64.5 (SIDE7, SIDE8, and SIDE9) maintained hyporheic flows and high quality salmon habitat, including multiple redds that have been identified.

Three open water floodplain wetland units were identified in Reach 2 (Table 10) that are, by definition, secondary channel habitat. Together, they totaled 5.8 acres. Although this type of habitat is important because it contains food sources (invertebrates), LWD, refuge, and rearing habitat for fish and wildlife species, they were not included in the secondary channel metrics for the reach and entire study area because they were better classified as marshes according to the survey protocol. No other open water floodplain wetland was identified in the project area.

***Table 9. Three off-channels entered the Methow River between River Mile 64.3 - 64.5. Photo below is Side 9F.***

***Table 10. Secondary channels identified in Reach 2.***

| Location | Length (ft) | Dominant unit type | Wood count | Off-channel (OC) or Side Channel (SC) |
|---|---|---|---|---|
| SIDE1S | 1,450 | Slow water | 20 | SC |
| SIDE2S | 375 | Slow water | 17 | SC |
| SIDE3F | 1,170 | Fast water | 30 | SC |
| SIDE4S[2] | 4,800 | Slow water | 25 | SC |
| SIDE5S | 1,500 | Slow water | 16 | OC |
| SIDE6S | 350 | Slow water | 3 | SC |
| SIDE7F | 2,000 | Fast water | 13 | OC |
| SIDE8F | 350 | Fast water | 8 | OC |
| SIDE9F | 700 | Fast water | 16 | OC |
| M1[3] | 400 | Slow water | 0 | OC |
| M2[3] | 500 | Slow water | 0 | OC |
| M3[3] | 350 | Slow water | 0 | OC |
| Total | 12,695 | | 148 | |

### 5.2.4 Large Woody Material

Reach 2 had 126.1 pieces of large wood per mile (compared to the project area average of 124.7 pieces per mile). The medium/large wood count was also higher than the project area average with 64.7 pieces per mile (compared to the project area average of 55 pieces per mile) (Table 11). Ten log jams were identified in Reach 2. Together they comprised 213 pieces of LWD, or 54% of the large woody debris within the reach.

[2] Side 4S is a "disconnected" side channel because the downstream end of the channel is blocked by a 10-foot-tall levee.

[3] *M1, M2, and M3 are all open channel floodplain wetland habitat. They were not included in the overall secondary channel calculations.*

***Table 11. Large woody material quantities in Reach 2.***

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in x 35 ft) | Total |
|---|---|---|---|---|
| Number of pieces | 194 | 128 | 76 | 398 |
| Number of pieces per mile | 61.5 | 40.6 | 24.1 | 126.1 |
| Number of med/lg pieces per mile | | | | 64.7 |
| Number of jams per mile | | | | 3.2 |
| Number of jams | | | | 10 |

### 5.2.5 Substrate & Fine Sediment

The results from two pebble counts in Reach 2 indicate a substrate composed of 51% cobble and 49% gravel. Reach 2 pebble counts are indicative of the project area average of 48% cobble, 48% gravel, 2% boulder, and 2% sand (Figure 29 and Figure 31).

***Figure 28. Reach 2 pebble counts indicate a bed substrate of almost equal amount cobble and gravel, as well as a slightly higher than average count of LWD. The image above taken around RM 62.0 reflects these measurements.***

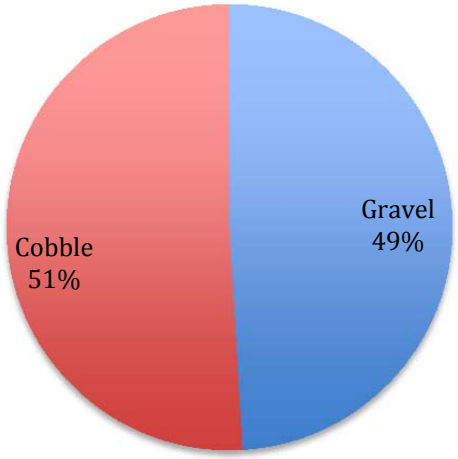
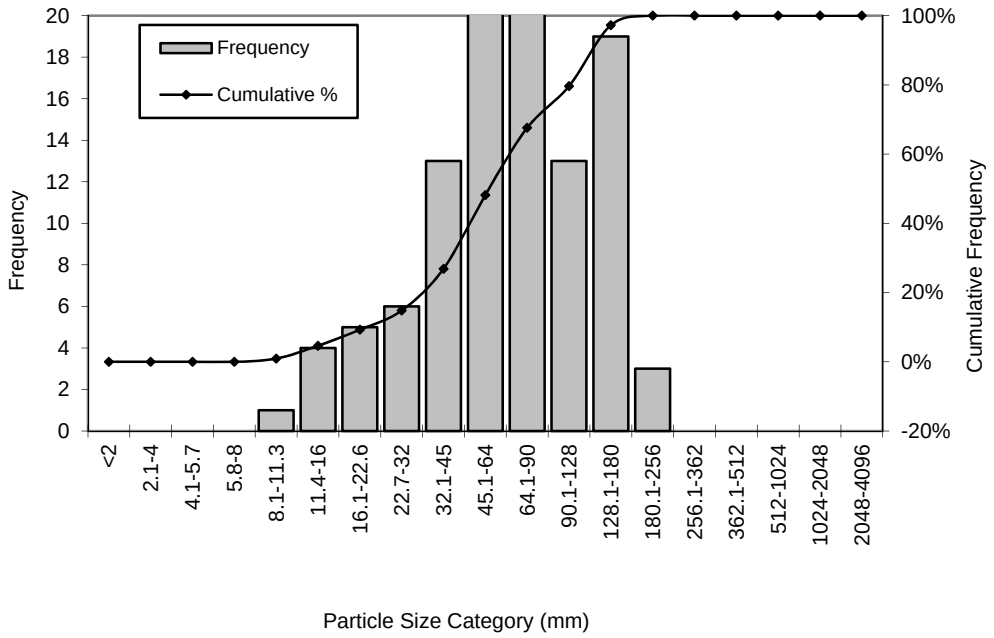
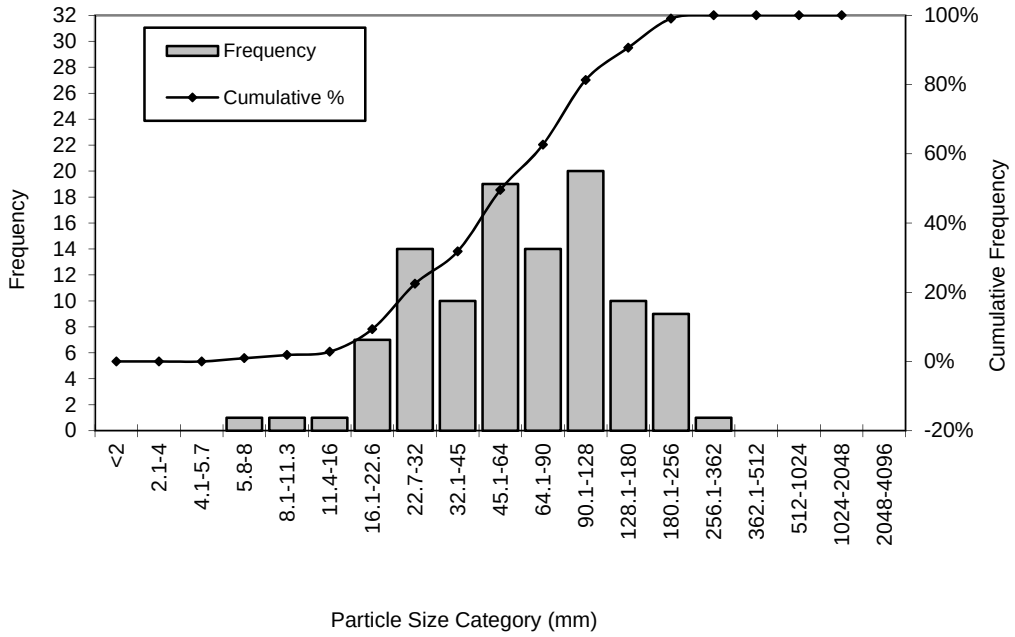



***Figure 29. Percent composition of bed substrate based on two pebble counts in Reach 2.***



| Material | Percent Composition | Size Class | Size percent finer than (mm) |
|---|---|---|---|
| Sand | 0% | D5 | 17 |
| Gravel | 48% | D16 | 33 |
| Cobble | 52% | D50 | 66 |
| Boulder | 0% | D84 | 141 |
| Bedrock | 0% | D95 | 173 |
| | | * Assumed linear interpolation | |

***Figure 30. Grain size distribution and particle size classes from pebble count 1 in Reach 2.***




| Material | Percent Composition | Size Class | Size percent finer than (mm) |
|---|---|---|---|
| Sand | 0% | D5 | 18 |
| Gravel | 50% | D16 | 27 |
| Cobble | 50% | D50 | 65 |
| Boulder | 1% | D84 | 143 |
| Bedrock | 0% | D95 | 219 |
| | | * Assumed linear interpolation | |

***Figure 31. Grain size distribution and particle size classes from pebble count 2 in Reach 2.***

### 5.2.6 Riparian Corridor

Six $n^{th}$ unit measurements were performed in Reach 2. All identified small trees (9.0 – 21.9 in. diam.) as being the dominant riparian vegetation within 100 feet of the river (Figure 32). The overstory was

dominated by cottonwood with some ponderosa (Figure 11). The understory was composed of dogwood, willow, and cottonwood (Figure 12).

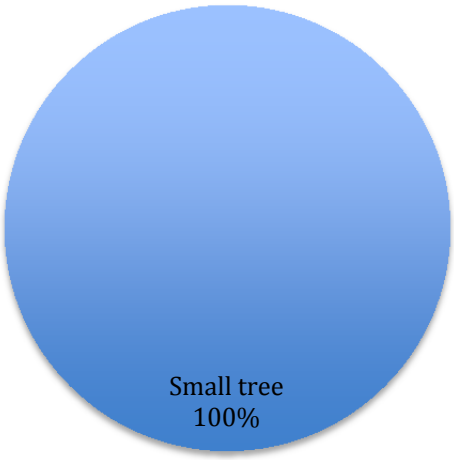



***Figure 32. Small trees were the dominant riparian vegetation (100%) identified within 100 feet of the Methow River based on six ocular estimates.***

## 5.3 REACH 3

**Location**: River mile 64.8 (Goat Creek) – 66.1
**Total length**: 1.3 miles
**Survey date**: July 19, 2014

***Figure 33. Representative image of Reach 3, which had some of the highest wood counts and a higher than average pools per mile ratio.***

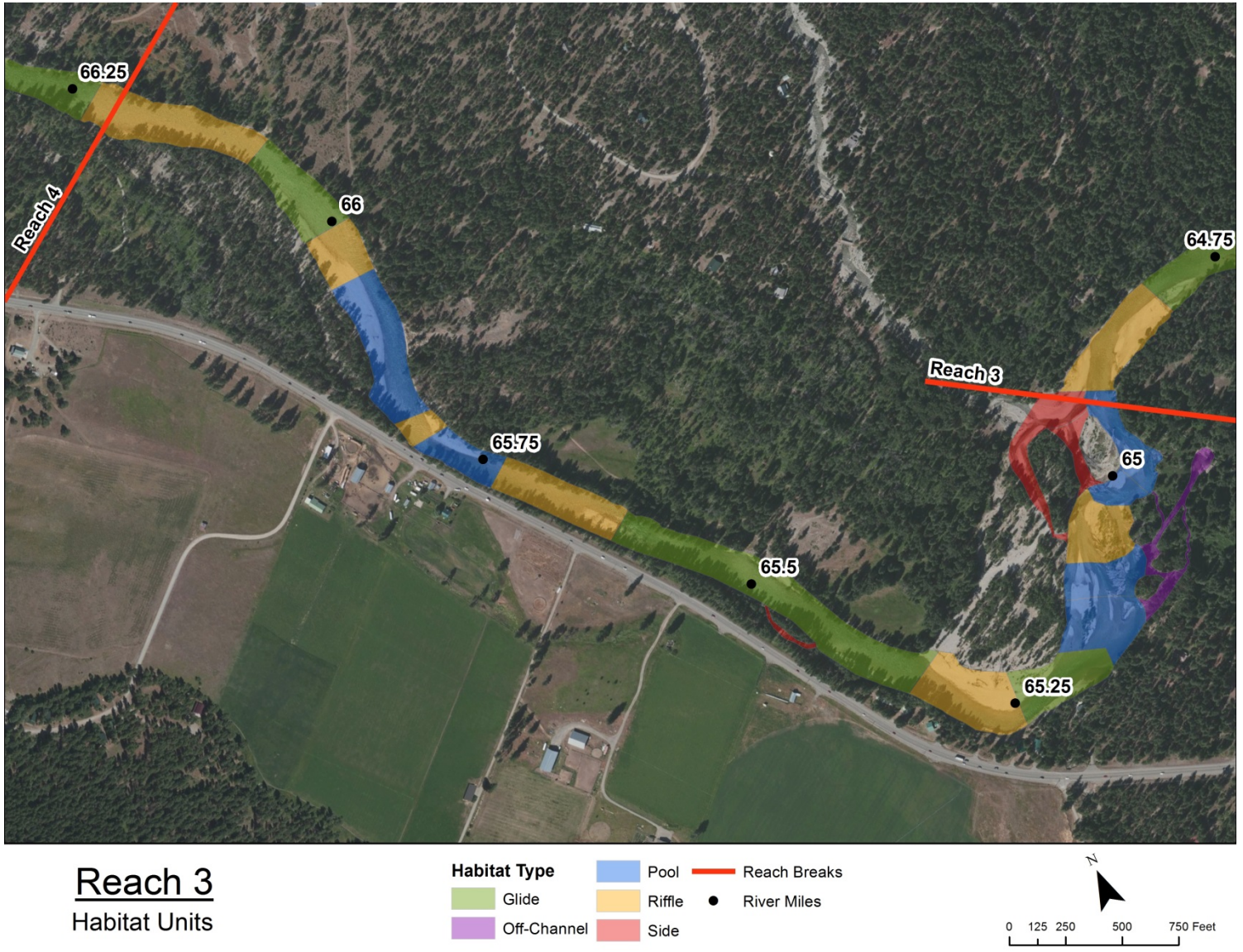



***Figure 34. Overview of Upper Methow Reach 3 from RM 64.8 (Goat Creek) – RM 66.1.***

### 5.3.1 Habitat Unit Composition

Reach 3 habitat composition was well distributed between glides, pools, and riffles with a majority identified as glide habitat (43%). Only 2% was secondary channel habitat (Figure 35).

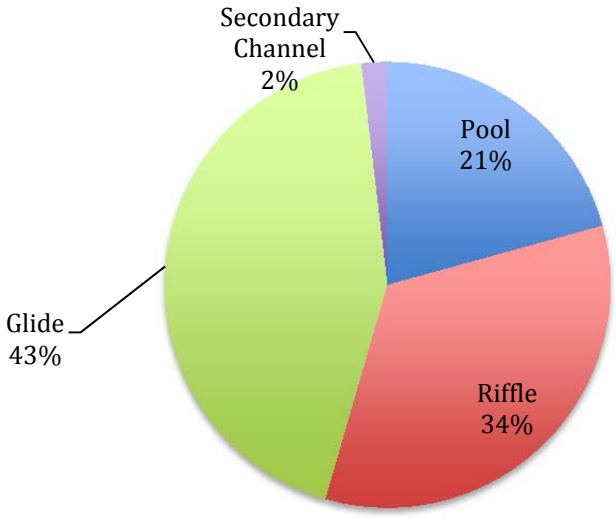



***Figure 35. Habitat composition for Reach 3.***

### 5.3.2 Pools

Reach three has a pool frequency of 5.5 pools per mile compared to average of 3.6 pools per mile throughout the project area. Mean pool spacing for the reach is 19.7 channel widths per pool, the second lowest in the project area, which averages 31.8 channel widths per pool. A total of seven pools were recorded. Figure 36 illustrates the residual depth of the pools, which are the deepest in the project area, averaging 5.8 feet of residual depth.

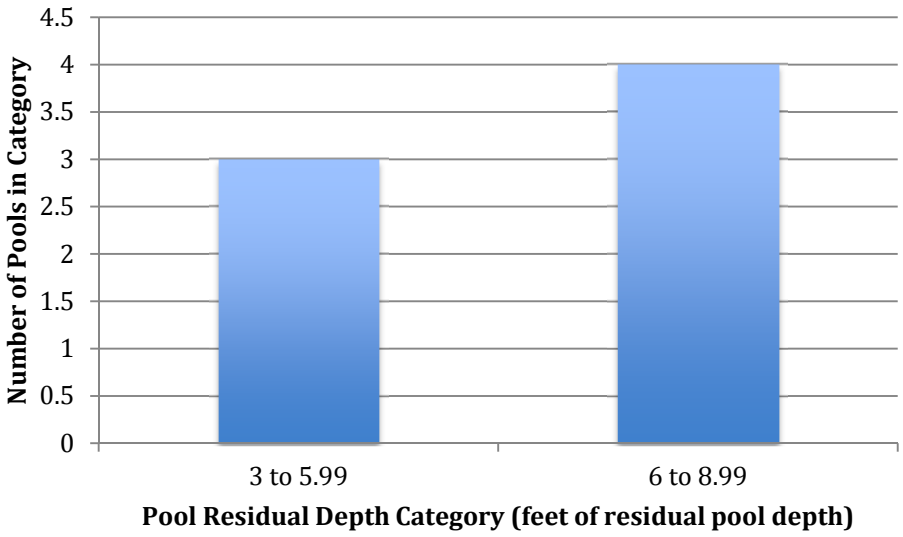



***Figure 36. Reach 3 residual pool depth and count of total pools in the reach.***

***Figure 37. Reach 3 pools are deep, averaging a residual depth of 5.8 feet. Photo above of a pool a RM 65.1 and log jam on river left (right side of photo).***

### 5.3.3 Secondary Channel Habitat

Secondary channel habitat in Reach 3 accounted for 1% of the total project area's secondary channel habitat. A total of four secondary channels were recorded, totaling 2,400 feet in length (Table 12). Three were identified as side channels, meaning they have an inlet and outlet, verses off-channels, which maintain only an inlet or an outlet.

***Table 12. Secondary channel habitat in Reach 3.***

| Location | Length (ft) | Dominant unit type | Wood count | Off-channel (OC) or side channel (SC) |
|---|---|---|---|---|
| SIDE10F | 300 | Fast water | 0 | SC |
| SIDE11F | 450 | Fast water | 2 | SC |
| SIDE12F | 1500 | Fast water | 0 | OC |
| SIDE13S | 150 | Slow water | 1 | SC |
| Total | 2,400 | | 3 | |

### 5.3.4 Large Woody Material

Reach 3 had had a total of 190 pieces of LWD, averaging 149 pieces per mile (compared to an average of 124.7 pieces per mile in the project area). Large and medium wood averaged 76.3 pieces per mile, almost 50% higher than the project area average of 55 pieces per mile. Four log jams were counted, averaging 3.1 jams per mile (Table 13).

***Table 13. Large woody debris in Reach 3.***

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in x 35 ft) | Total |
|---|---|---|---|---|
| Number of pieces | 92 | 63 | 35 | 190 |
| Number of pieces per mile | 71.6 | 49.1 | 27.3 | 148.0 |
| Number of med/lg pieces per mile | | | | 76.3 |
| Number of jams per mile | | | | 3.1 |
| Number of jams | | | | 4.0 |

### 5.3.5 Substrate & Fine Sediment

Reach 3 pebble counts identified cobble and gravel as being nearly equal with 48% cobble, and 51% gravel. Additionally, boulders accounted for 1% of the pebble count (Figure 38). This distribution is similar to the project area average of 48% gravel, 48% cobble, and 2% of both secondary channel and boulder.

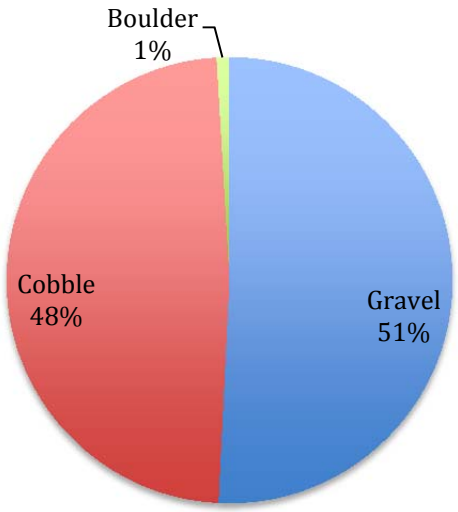
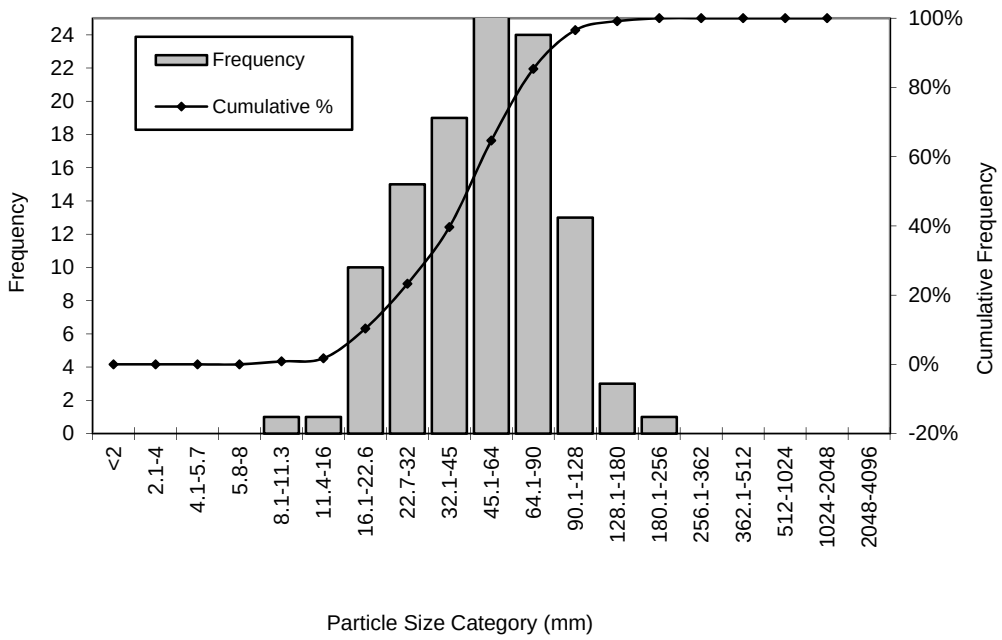
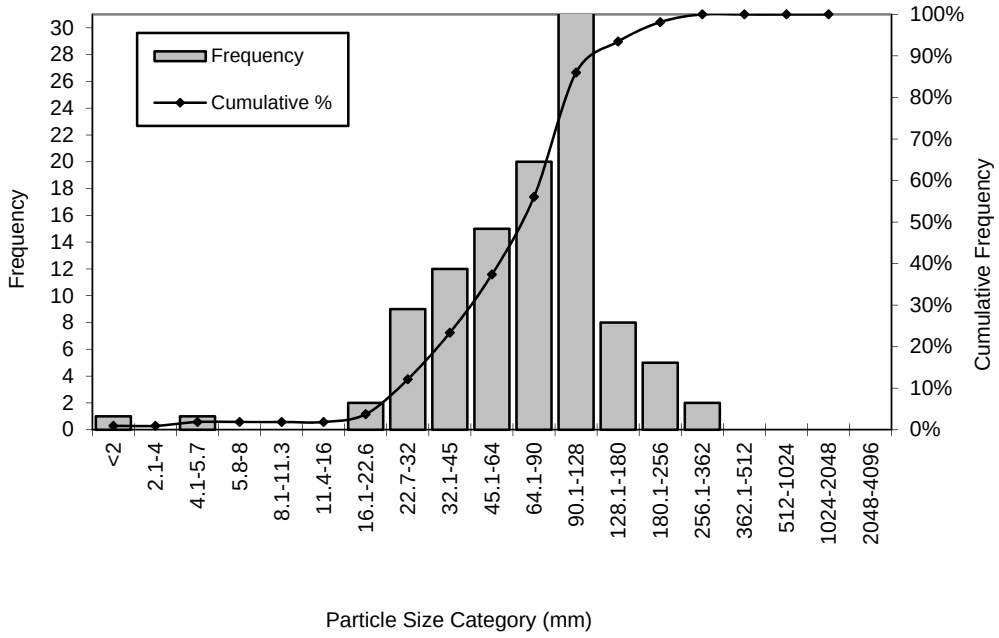



***Figure 38. Percent composition of bed substrate based on two pebble counts in Reach 3.***



| Material | Percent Composition | Size Class | Size percent finer than (mm) |
|---|---|---|---|
| Sand | 0% | D5 | 19 |
| Gravel | 65% | D16 | 27 |
| Cobble | 35% | D50 | 53 |
| Boulder | 0% | D84 | 88 |
| Bedrock | 0% | D95 | 123 |
| | | * Assumed linear interpolation | |

***Figure 39. Grain size distribution and particle size classes from pebble count 1 in Reach 3.***




| Material | Percent Composition | Size Class | Size percent finer than (mm) |
|---|---|---|---|
| Sand | 1% | D5 | 24 |
| Gravel | 36% | D16 | 36 |
| Cobble | 61% | D50 | 82 |
| Boulder | 2% | D84 | 125 |
| Bedrock | 0% | D95 | 205 |
| | | * Assumed linear interpolation | |

***Figure 40. Grain size distribution and particle size classes from pebble count 2 in Reach 3.***

### 5.3.6 Riparian Corridor

Reach 3 is overall a young riparian corridor composed mainly of small trees, with some grassland/forb (25%). A total of 4 nth unit measurements were measured. Ponderosa was the

primary overstory species (75%), with 25% cottonwood. The understory was split between cottonwood (50%) and grassland/forbs (50%) (Figure 41).

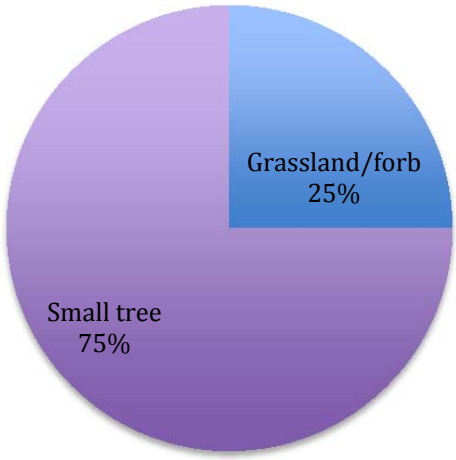



***Figure 41. Dominant riparian vegetation identified within 100 feet of river by ocular estimate.***

## 5.4 REACH 4

**Location**: River mile 66.1 – 69.2 (Early Winters Creek
**Total length**: 3.1 miles
**Survey date:** July 20, 2014

***Figure 42. Representative view of Reach 4.***


***Figure 43. Overview of Upper Methow Reach 4 from RM 66.1 – RM 69.2 (Early Winters Creek).***

### 5.4.1 Habitat Unit Composition

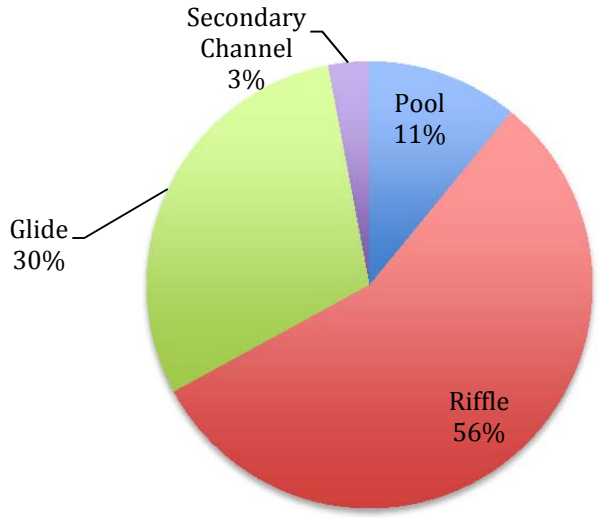



***Figure 44. Habitat unit composition for Reach 4.***

Reach 4 is developed with roads, houses, and levees constraining the Methow on both sides, resulting in fast-water habitat composed of 56% riffles, 30% glides, and 11% pools. Only 3% of the habitat area is secondary channels. Reach 4 also has relatively little large wood with 54 pieces per mile aside from a large jam (JAM15) at RM 66.9. This long-standing log jam maintains high-quality salmon habitat. Signs on a trail next to the log jam identify it as the "log jam point fish refuge."

### 5.4.2 Pools

Five pools were identified in Reach 4 with a rate of 1.7 pools per mile compared to the project area average of 3.6 pools per mile (Figure 45). This is the second lowest rate among the nine reaches. The average residual pool depth was 4.9 feet and mean pool spacing was 44.9 channel widths per pool. Only 5 pieces of LWD were counted in the five pools; neither of the two log jams present in Reach 4 were located in pools.

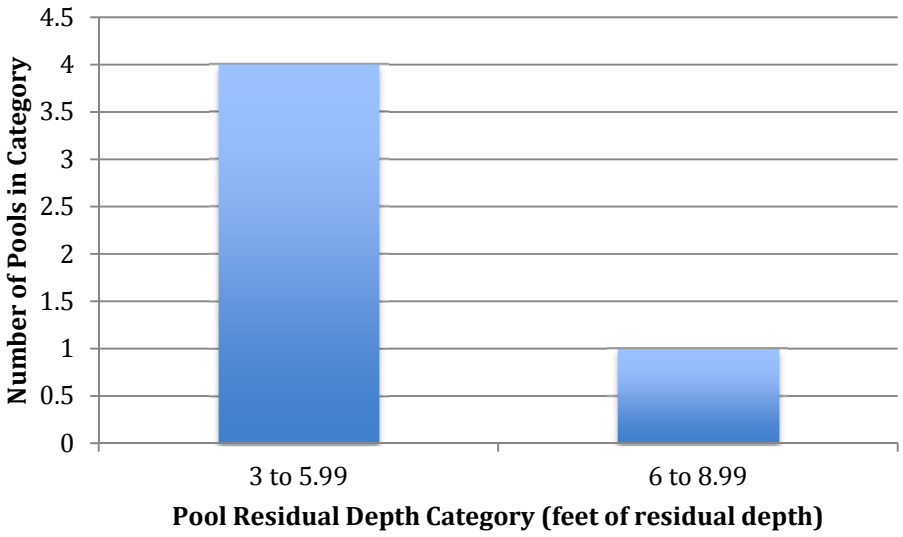



***Figure 45. Reach 4 residual pool depth and count of total pools in the reach.***

### 5.4.3 Secondary Channel Habitat

Four secondary channels were identified in Reach 4 including three side channels and one off-channel (Table 14). Together, they represent 4% of the secondary channel habitat area within the project area. Half of the secondary channels were slow water; half fast water. A total of 14 pieces of LWD were in the four secondary channels.

For this assessment, we consider "side-channels" as secondary channels that are, or would be, naturally connected to the mainstem flow at their upstream and downstream ends at average annual flow; this definition also includes artificially disconnected side channels. We consider "off-channels" to be all other types of secondary channels including backwater channels/alcoves, groundwater-fed channels, wall-base channels, abandoned oxbows, and other types of floodplain channels and open-water floodplain wetlands.

***Table 14. Secondary channel habitat in Reach 4.***

| Location | Length (ft) | Dominant unit type | Wood count | Off-channel (OC) or Side Channel (SC) |
|---|---|---|---|---|
| SIDE14F | 375 | Fast water | 2 | SC |
| SIDE15F | 550 | Fast water | 2 | SC |
| SIDE16 | 1260 | Slow water | 10 | OC |
| SIDE17S | 300 | Slow water | 0 | SC |
| Total | 2,485 | | 14 | |

### 5.4.4 Large Woody Material

Reach four had a total of 362 pieces of LWD, averaging 121.5 pieces per mile, compared to the project area average of 124.7 pieces per mile. Large/medium wood totaled 169 pieces and 56.7 pieces

per mile – nearly average for the project area average of 55 pieces per mile (Table 15). A total of 3 jams were identified that together held 303 pieces of LWD or 83% of the LWD within the reach.

***Table 15. Large woody debris in Reach 4.***

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in x 35 ft) | Total |
|---|---|---|---|---|
| Number of pieces | 193 | 110 | 59 | 362 |
| Number of pieces per mile | 64.8 | 36.9 | 19.8 | 121.5 |
| Number of med/lg pieces per mile | | | | 56.7 |
| Number of jams per mile | | | | 1 |
| Number of jams | | | | 3 |

***Figure 46. Jam 17 in Reach 4 from the bridge on Lost River Road near the town of Mazama. The jam was estimated to have 100 small, 70 medium, and 30 large pieces of LWD.***

### 5.4.5 Substrate & Fine Sediment

Two pebble counts were performed within Reach 4 at glide-riffle transition points. The dominant substrate type observed was cobble (53%) with additional 39% gravel, 5% sand, and 4% boulder. No bedrock was observed. This was the lowest gravel count observed within the project area. The pebble count and size class data are depicted in Figure 47 and Figure 48.

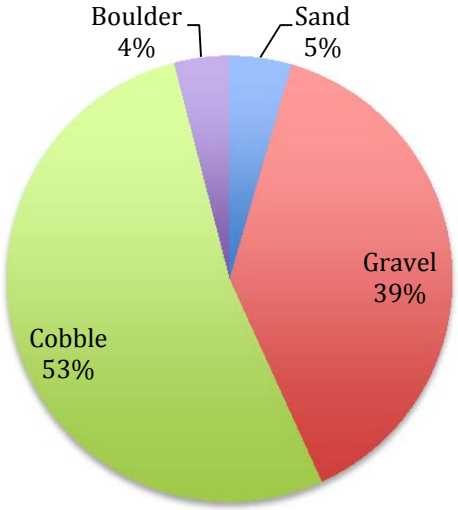
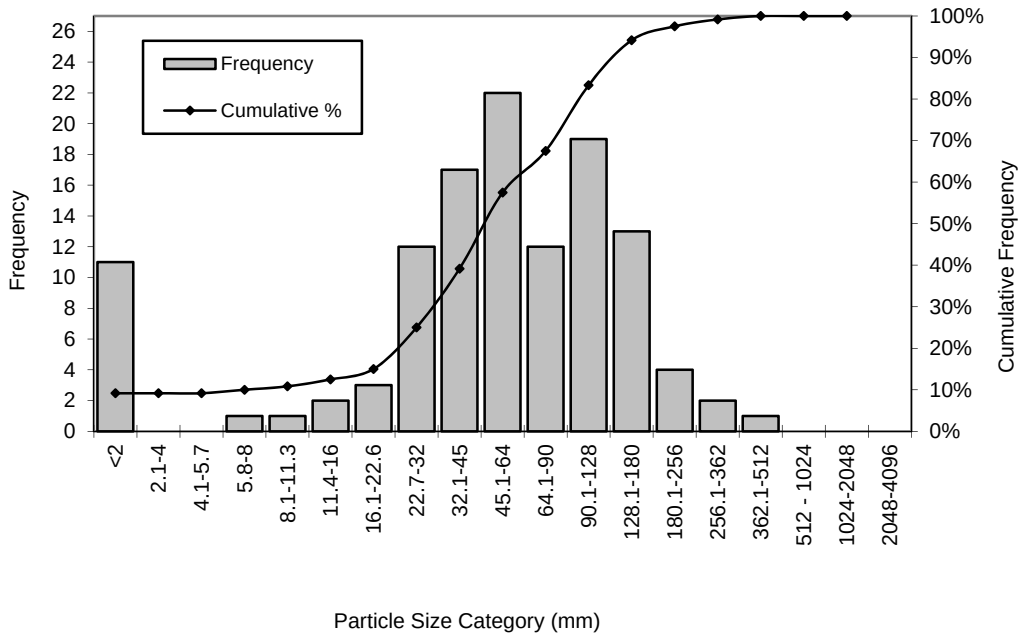
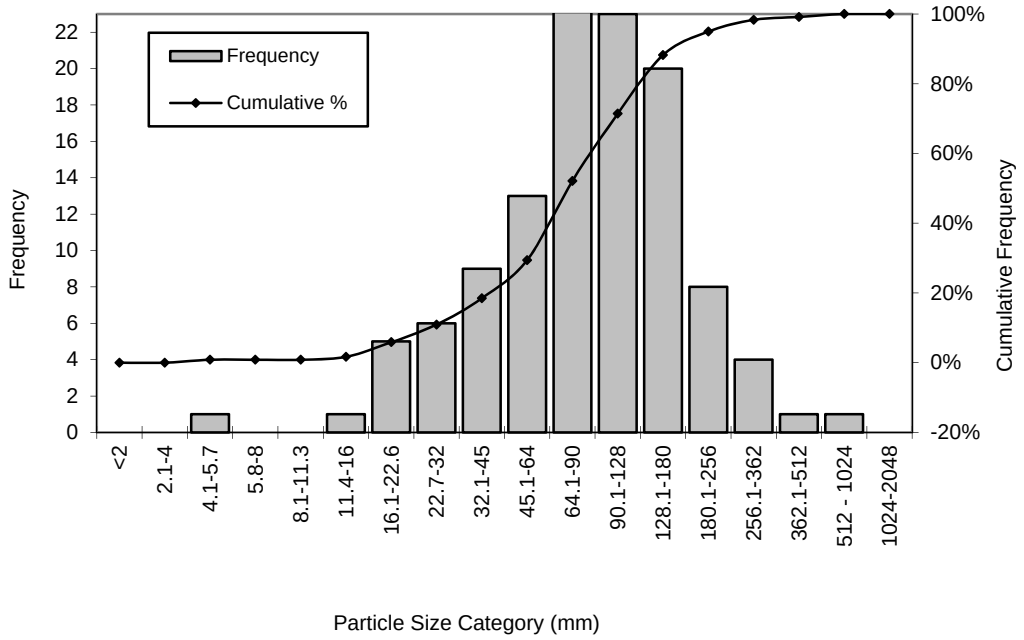



***Figure 47. Percent composition of bed substrate based on two pebble counts in Reach 4.***



| Material | Percent Composition | Size Class | Size percent finer than (mm) |
|---|---|---|---|
| Sand | 9% | D5 | 1 |
| Gravel | 48% | D16 | 24 |
| Cobble | 40% | D50 | 56 |
| Boulder | 3% | D84 | 131 |
| Bedrock | 0% | D95 | 199 |
| | | * Assumed linear interpolation | |




| Material | Percent Composition | Size Class | Size percent finer than (mm) |
|---|---|---|---|
| Sand | 0% | D5 | 15 |
| Gravel | 29% | D16 | 28 |
| Cobble | 66% | D50 | 88 |
| Boulder | 5% | D84 | 167 |
| Bedrock | 0% | D95 | 257 |
| | | * Assumed linear interpolation | |

***Figure 48. Grain size distribution and particle size classes from two pebble counts performed at glide-riffle transition points in Reach 4.***

### 5.4.6 Riparian Corridor

Small trees were the dominant riparian vegetation observed at seven n$^{th}$ units within Reach 4 (Figure 49). Unlike most other reaches in the project area that were dominated by cottonwood, the Reach 4 overstory was primarily ponderosa pine with some cedar. The understory was composed of cottonwood with additional units of small shrubs and dogwood (Figure 11).

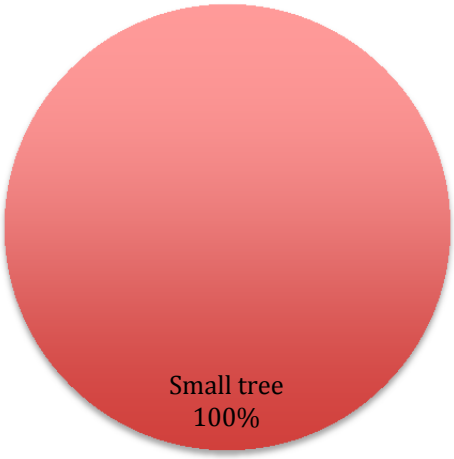



***Figure 49. Dominant riparian vegetation identified within 100 feet of river by ocular estimate in Reach 4.***

## 5.5 REACH 5

**Location**: River mile 69.2 (Early Winters Creek) – 71.3
**Total length**: 2.1 miles
**Survey date**: July 15, 2014

***Figure 50. The first half of Reach 5 is mostly fast water with few pools, secondary channels or log jams (above photo left). The second half of Reach 5 contains seven log jams, high quality secondary channel habitat, and a high density of pools, (above photo right).***

### 5.5.1 Habitat Unit Composition

Reach 5 is a 2.1-mile reach. The first mile of the reach contains mostly fast water with few pools, log jams, and secondary habitat. Habitat in the second mile is excellent with seven log jams, high-quality off-channel habitat, and a high density of pools, many of which are back-to-back. The composition of Reach 5 habitat is distributed relatively equally among the four habitat types with the lowest amount of fast water within the project area (57%), and ties with Reach 7 for the most secondary channel habitat (22%)(Figure 51).

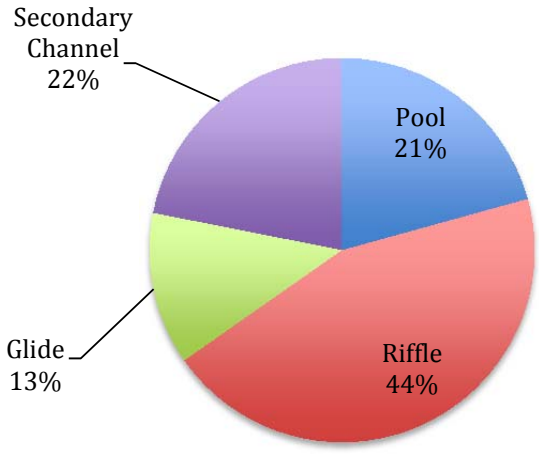



***Figure 51. Habitat unit composition for Reach 5.***

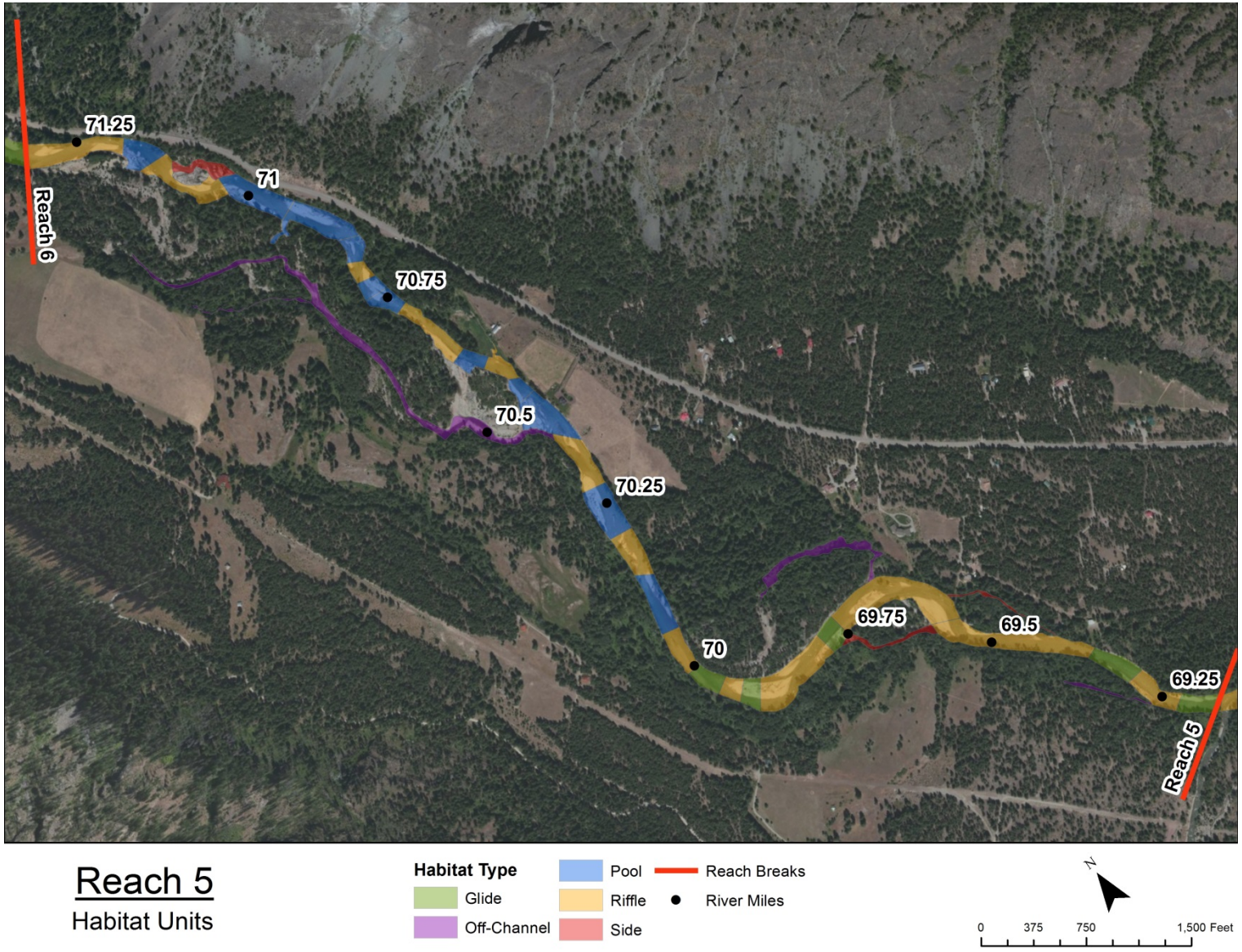



***Figure 52. Overview of Upper Methow Reach 5 from RM 69.2 (Early Winters Creek) – RM 71.3.***

### 5.5.2 Pools

Reach 5 contains 11 pools, averaging 5.3 pools per mile (compared to a project area average of 3.6 pools per mile (Figure 53). The average residual depth is 4.5 feet. Mean pool spacing within the reach is 23.3 channel widths per pool. Six of the 11 pools are back-to-back, meaning there was two consecutive and distinct pool units

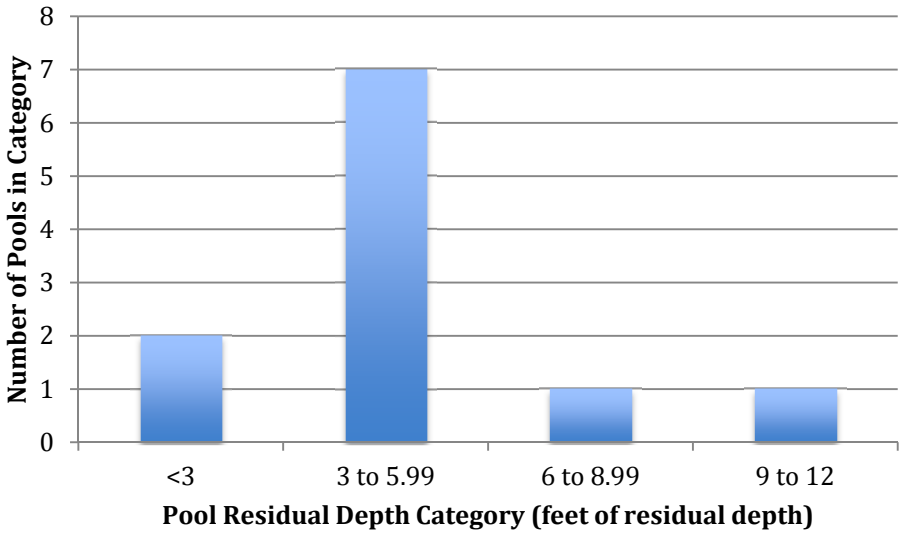



***Figure 53. Reach 5 residual pool depth and count of total pools in the reach.***

***Figure 54.. A 9-foot deep pool and log jams at RM 70.8.***

### 5.5.3 Secondary Channel Habitat

A total of seven secondary channels were identified in Reach 5, including 3 side channels and 4 off-channels. Together, they comprised 20% of the total secondary channel habitat within the project area. A majority of the secondary channel habitat (89%) is hyporheic flow off-channel habitat located between RM 70.4 – 71.2. Water temperatures in this set of secondary channels ranges from 10° – 12° Celsius, versus 14° – 15° Celsius for the main channel.

For this assessment, we consider "side-channels" as secondary channels that are, or would be, naturally connected to the mainstem flow at their upstream and downstream ends at average annual flow; this definition also includes artificially disconnected side channels. We consider "off-channels" to be all other types of secondary channels including backwater channels/alcoves, groundwater-fed channels, wall-base channels, abandoned oxbows, and other types of floodplain channels and open-water floodplain wetlands.

***Table 16. Secondary channel habitat in Reach 5.***

| Location | Length (ft) | Dominant unit type | Wood count | Off-channel (OC) or side channel (SC) |
|---|---|---|---|---|
| SIDE18S | 610 | Slow water | 0 | OC |
| SIDE19 | 870 | Slow water | 10 | SC |
| SIDE20S | 720 | Slow water | 23 | SC |
| SIDE21S | 1500 | Slow water | 11 | OC |
| SIDE22S | 3800 | Slow water | 26 | OC |
| SIDE23S | 1050 | Slow water | 33 | OC |
| SIDE24S | 425 | Slow water | 19 | SC |
| Total | 8,975 | | 122 | |

### 5.5.4 Large Woody Material

Large woody debris averaged 155.6 pieces per mile compared to a project area average of 124.7 pieces per mile. Medium/large wood averaged 62.5 pieces per mile, also just above the project area average of 55 pieces per mile. In total, 321 pieces were counted, which includes 9 jams (Table 17). Seven of the nine jams were located in the second half of the reach.

***Table 17. Large woody debris in Reach 5.***

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in x 35 ft) | Total |
|---|---|---|---|---|
| Number of pieces | 192 | 99 | 30 | 321 |
| Number of pieces per mile | 93.0 | 48.0 | 14.5 | 155.6 |
| Number of med/lg pieces per mile | | | | 62.5 |
| Number of jams per mile | | | | 4.4 |
| Number of jams | | | | 9 |

### 5.5.5 Substrate & Fine Sediment

Reach 5 substrate was primarily gravel (61%) with 33% cobble, 5% sand, and 1% boulder. A total of three pebble counts were performed throughout the project reach.

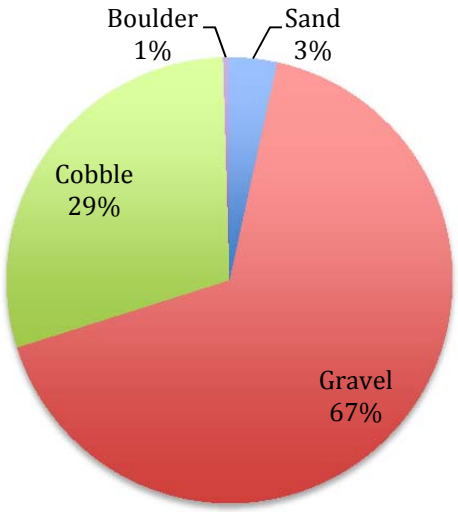
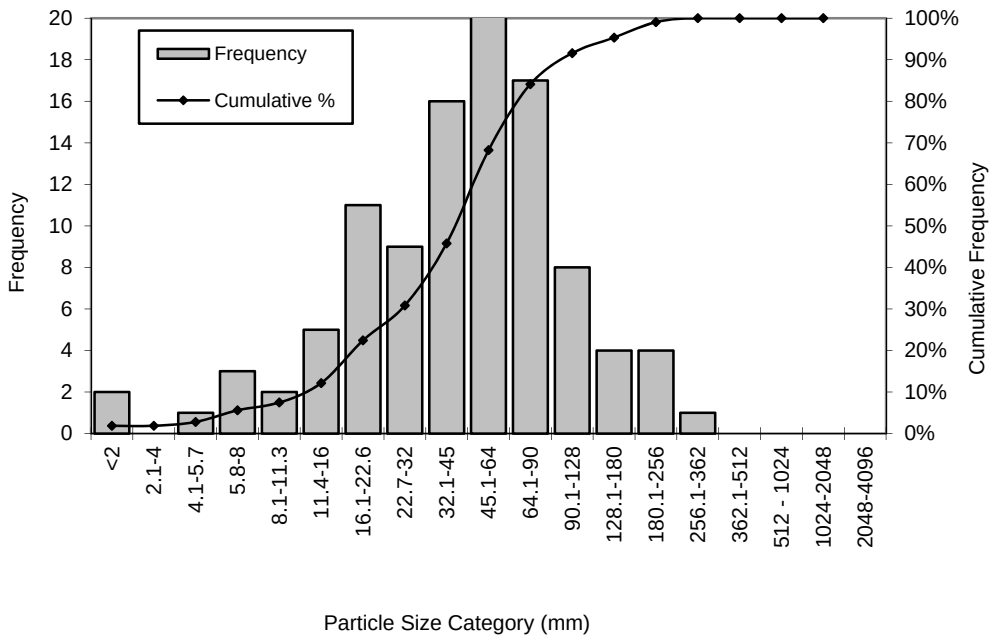
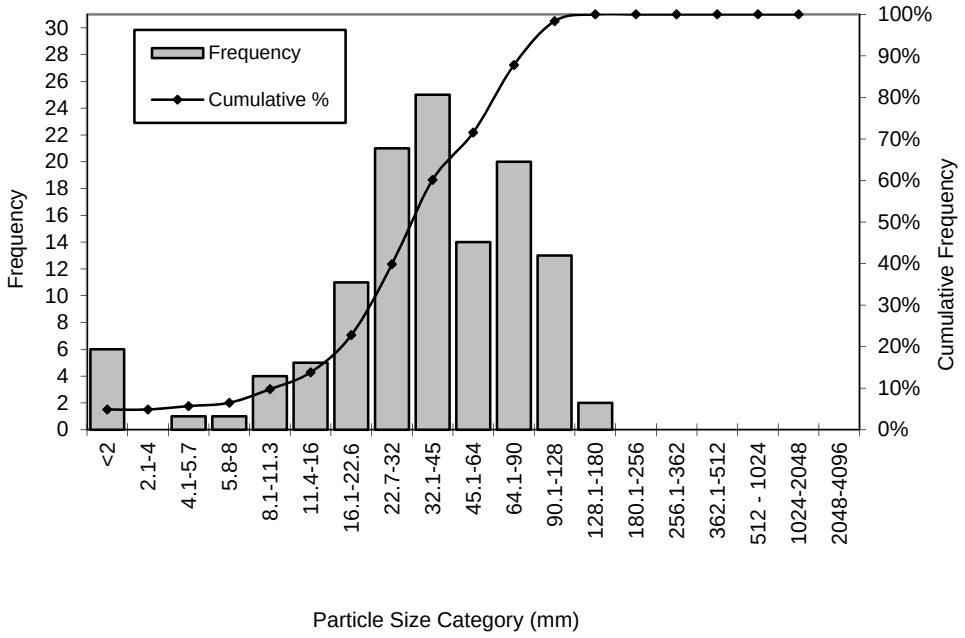



***Figure 55. Percent composition of bed substrate based on two pebble counts in Reach 5.***



| Material | Percent Composition | Size Class | Size percent finer than (mm) |
|---|---|---|---|
| Sand | 2% | D5 | 1 |
| Gravel | 66% | D16 | 18 |
| Cobble | 31% | D50 | 89 |
| Boulder | 1% | D84 | 90 |
| Bedrock | 0% | D95 | 175 |
| | | * Assumed linear interpolation | |

***Figure 56. Grain size distribution and particle size classes from pebble count 1 of 2 in Reach 5.***




| Material | Percent Composition | Size Class | Size percent finer than (mm) |
|---|---|---|---|
| Sand | 5% | D5 | 1 |
| Gravel | 67% | D16 | 18 |
| Cobble | 28% | D50 | 39 |
| Boulder | 0% | D84 | 84 |
| Bedrock | 0% | D95 | 116 |
| | | * Assumed linear interpolation | |

***Figure 57. Grain size distribution and particle size classes from pebble count 2 of 2 in Reach 5.***

### 5.5.6 Riparian Corridor

Based on observations at three $n^{th}$ units, small trees were the dominant riparian vegetation in Reach 5 (67%); sapling/pole were the secondary habitat type at 33%. Overstory was 100% cottonwood.

Understory was evenly distributed between snowberry, mountain maple, grassland/forbs, and dogwood.

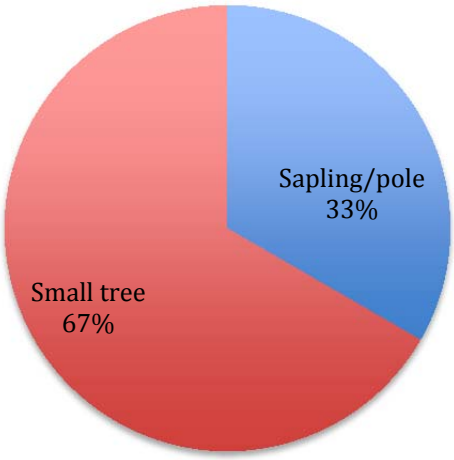



***Figure 58. Dominant riparian vegetation identified within 100 feet of river by ocular estimate in Reach 5.***

## 5.6 REACH 6

**Location**: River mile 71.3 – 75.0 (Lost River)
**Total length**: 3.7 miles
**Survey date**: July 30, 31, and August 11

***Figure 59. Representative view of Reach 6.***

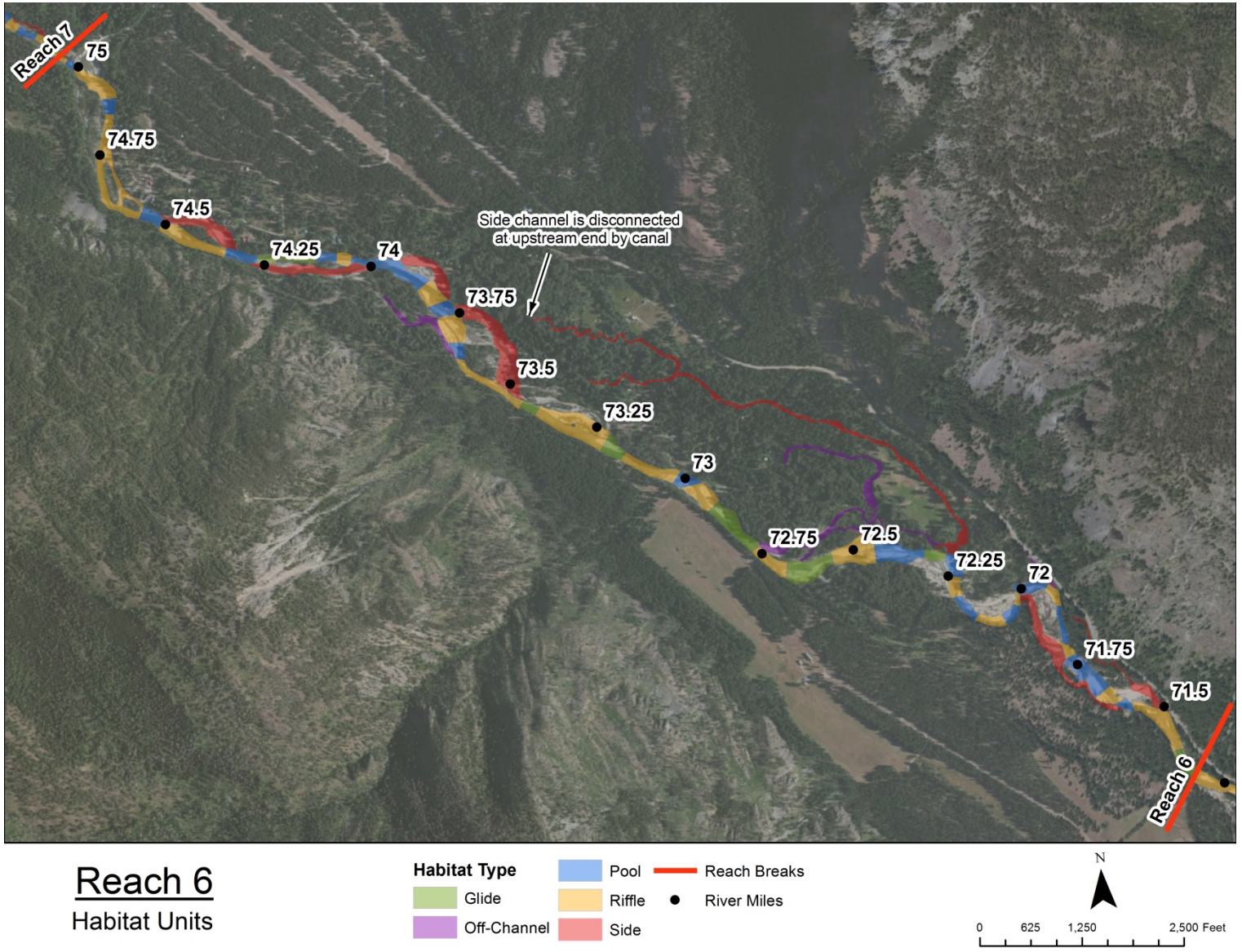



***Figure 60. Overview of Upper Methow Reach 6 from RM 71.3 – RM 75.0 (Lost River).***

### 5.6.1 Habitat Unit Composition

Reach 6 is a 3.8-mile long reach that contains 59% fast water habitat, 15% secondary channel habitat, and 26% pool habitat. A total of 23 pools were counted, averaging 6.3 pools per mile (Figure 61). Twelve of the pools were back-to-back pools, meaning they were consecutive, but independent units with no other channel unit between them. Reach 6 also contained the longest side channel in the project area at 4,850 feet.

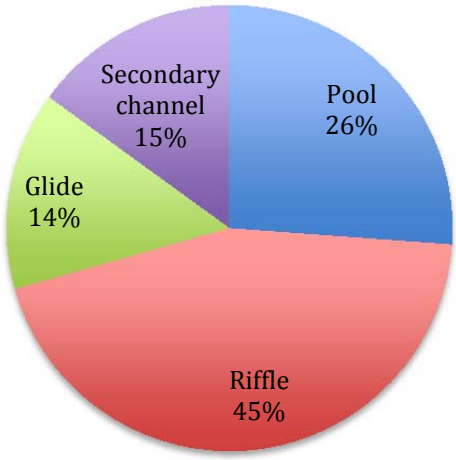



***Figure 61. Habitat unit composition for Reach 6.***

### 5.6.2 Pools

Reach 6 has 23 pools averaging 6.3 pools per mile, compared to the project area average of 3.6 pools per mile. Average residual pool depth is 4.2 feet and the mean pool spacing is 19.6 channel widths per pool – the lowest in the project area. Reach 6 also has the highest percentage of pool area habitat (26%) in the project area (Figure 61).

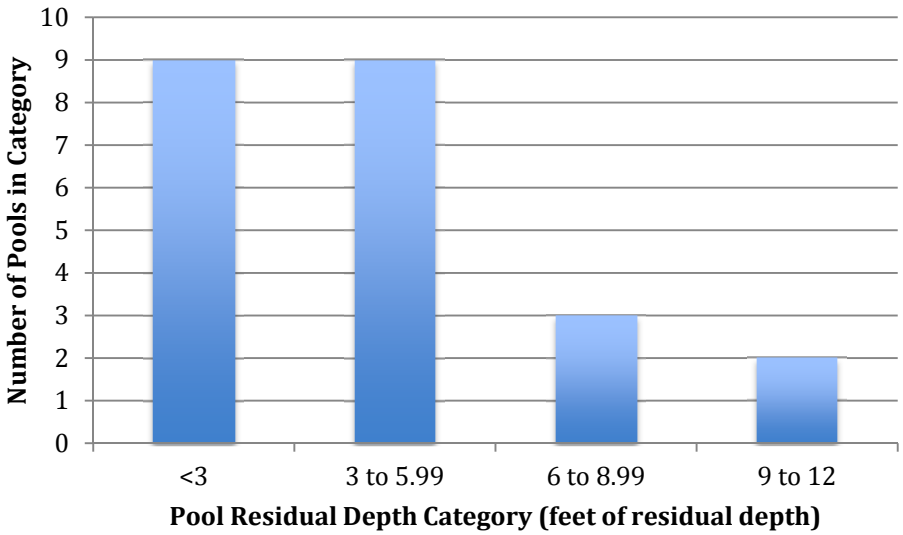



***Figure 62. Reach 6 residual pool depth and count of total pools in the reach.***

***Figure 63. Reach 6 had 23 pools which together composed 27% of the habitat area within the reach. Photo above is a pool at RM 73.9.***

### 5.6.3 Secondary Channel Habitat

Reach 6 contains 9 secondary channels representing 15% of the habitat area in the reach. Total wood count in the secondary channels was 213 pieces (55%) of the total wood count in the reach. Of note is the 4,850-foot-long side channel that traverses the floodplain on river-left from RM 73.8 – 72.3 that is

disconnected from the mainstem at the upstream end by a constructed canal that crosses its path. The canal blocks surface flow from entering the side channel, and instead diverts it off the floodplain. Because of this diversion, it is being considered a disconnected side channel. No wood was recorded in this side channel because during the habitat assessment, this side channel was initially identified as a tributary. One other disconnected side channel was identified in Reach 2.

For this assessment, we consider "side-channels" as secondary channels that are, or would be, naturally connected to the mainstem flow at their upstream and downstream ends at average annual flow; this definition also includes artificially disconnected side channels. We consider "off-channels" to be all other types of secondary channels including backwater channels/alcoves, groundwater-fed channels, wall-base channels, abandoned oxbows, and other types of floodplain channels and open-water floodplain wetlands.

***Table 18. Secondary channel habitat in Reach 6.***

| Location | Length (ft) | Dominant unit type | Wood count | Off-channel (OC) or side channel (SC) |
|---|---|---|---|---|
| SIDE25S | 1850 | Slow water | 9 | SC |
| SIDE26S | 1450 | Slow water | 113 | SC |
| SIDE26.5[4] | 4,850 | Slow water | 0 | SC |
| SIDE27S | 2400 | Slow water | 9 | OC |
| SIDE28S | 600 | Slow water | 40 | SC |
| SIDE29S | 1350 | Slow water | 2 | OC |
| SIDE30 | 200 | Slow water | 40 | SC |
| SIDE31F | 1350 | Fast water | 0 | SC |
| SIDE32 | 1080 | Slow water | 0 | SC |
| Total | 15,130 | | 213 | |

***Figure 64. Remnants of an old bridge along SIDE25S.***

[4] The side channel between RM 73.8 – 72.3 is disconnected from the mainstem at the upstream end by a constructed canal that crosses its path. The canal blocks surface flow from entering the side channel, and instead diverts it back to the mainstem channel. Because flow does not enter the side channel, it is being considered a *disconnected* side channel.

### 5.6.4 Large Woody Material

Reach 6 is slightly below average for large wood. Of the 388 pieces counted, 76% were from 10 log jams identified throughout Reach 6. The reach averaged 107.1 pieces per mile and 116.2 pieces per mile of medium and large wood, compared to the project area average of 24.7 and 55 pieces per mile, respectively) (Table 19).

***Table 19. Large woody debris in Reach 6.***

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in x 35 ft) | Total |
|---|---|---|---|---|
| Number of pieces | 214 | 131 | 43 | 388 |
| Number of pieces per mile | 59.1 | 36.2 | 11.9 | 107.1 |
| Number of med/lg pieces per mile | | | | 48.0 |
| Number of jams per mile | | | | 2.8 |
| Number of jams | | | | 10.0 |

### 5.6.5 Substrate & Fine Sediment

Two pebble counts were performed in Reach 6. Substrate was very similar to the project area average with a slight majority cobble (51%), 45% gravel, and trace amounts of boulder and gravel (2% each).

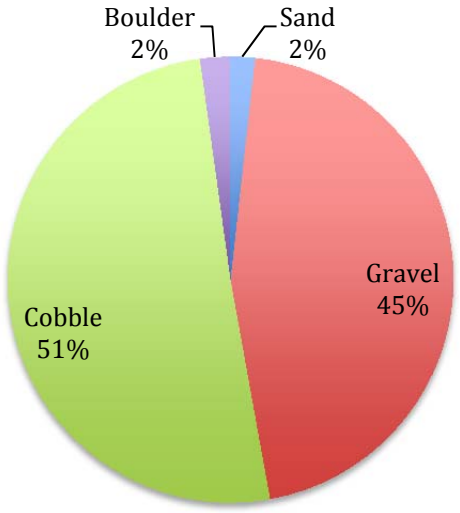
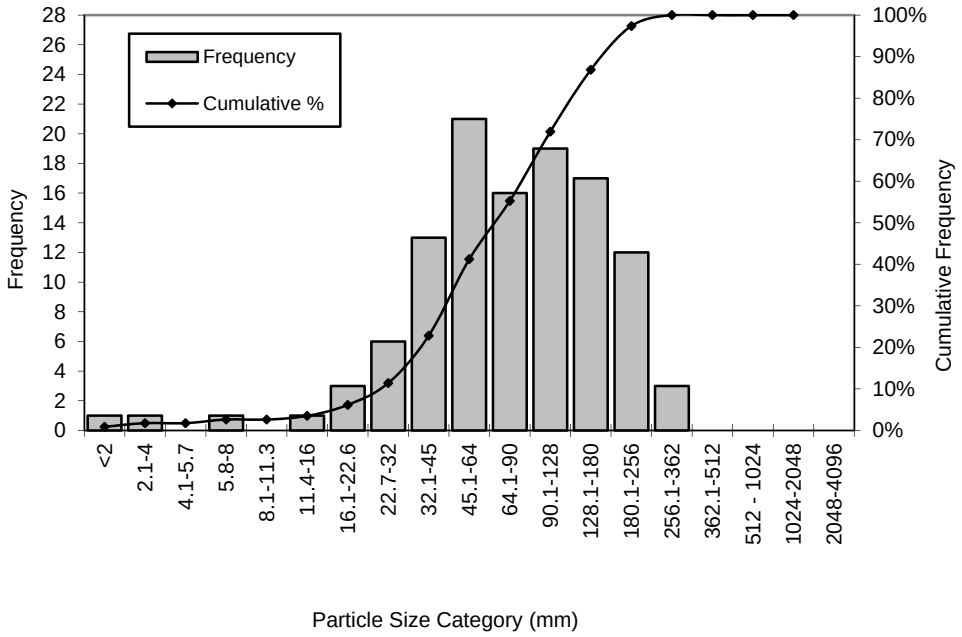
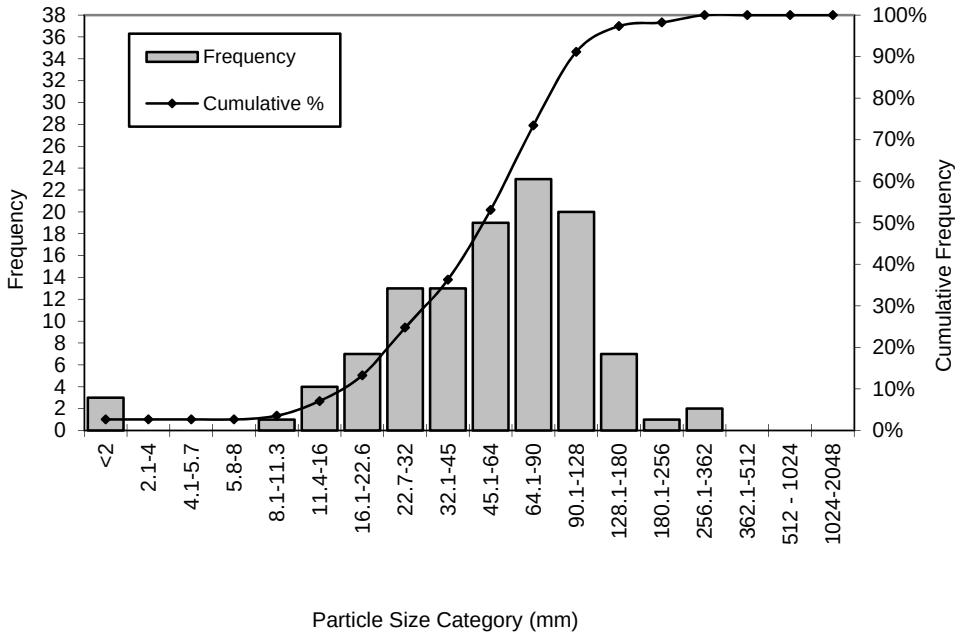



***Figure 65. Percent composition of bed substrate based on two pebble counts in Reach 6.***




| Material | Percent Composition | Size Class | Size percent finer than (mm) |
|---|---|---|---|
| Sand | 1% | D5 | 20 |
| Gravel | 40% | D16 | 37 |
| Cobble | 56% | D50 | 80 |
| Boulder | 3% | D84 | 170 |
| Bedrock | 0% | D95 | 239 |
| | | * Assumed linear interpolation | |

***Figure 66. Grain size distribution and particle size classes from pebble count 1 of 2 in Reach 6.***




| Material | Percent Composition | Size Class | Size percent finer than (mm) |
|---|---|---|---|
| Sand | 3% | D5 | 28 |
| Gravel | 50% | D16 | 25 |
| Cobble | 45% | D50 | 61 |
| Boulder | 2% | D84 | 113 |
| Bedrock | 0% | D95 | 160 |
| | | * Assumed linear interpolation | |

***Figure 67. Grain size distribution and particle size classes from pebble count 2 of 2 in Reach 6.***

### 5.6.6 Riparian Corridor

Small trees measuring 9.0 – 20.9 in. diameter were again the primary riparian vegetation (78%) observed in Reach 6 over nine $n^{th}$ units (Figure 68). Large trees measuring 21 – 31.9 in. diameter and sapling/pole measuring 5 – 8.9 in. diameter were observed as well (11% each). Cottonwoods were the dominant overstory species with several other species composing the observed riparian overstory including aspen, cedar, Douglas fir, and ponderosa pine. Dogwood was the primary understory species with additional units of young cottonwood and cedar.

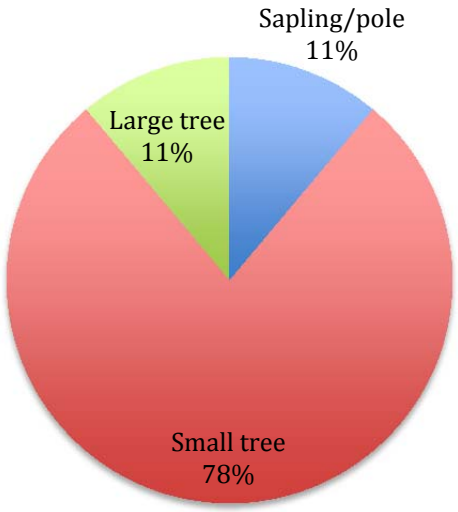



***Figure 68. Dominant riparian vegetation identified within 100 feet of river by ocular estimate in Reach 6.***

***Figure 69. Small trees measuring 9.0 – 20.9 in. diameter were the primary riparian vegetation (78%).***

## 5.7 REACH 7

**Location**: River mile 75.0 (Lost River) – 76.5 (Robinson Creek)
**Total length**: 1.5 miles
**Survey date:** August 12, 2014

***Figure 70. Representative view of Reach 7.***


***Figure 71. Overview of Upper Methow Reach 7 from RM 75.0 (Lost River) – RM 76.5 (Robinson Creek).***

### 5.7.1 Habitat Unit Composition

Reach 7 is a highly dynamic reach with considerably less water than downstream reaches due to being upstream from the confluence of Lost River at RM 75.1 (boundary between Reach 6 and 7). Habitat consists of 62% fast water, 22% secondary channel, 16% pools and 5% glides. Very short channel units were observed between RM 75.5 – 76.0 where the main channel was recently abandoned (Figure 72). This half-mile section contained four log jams, very short habitat units (the four pools identified were all under 130 feet long), and four secondary channels.

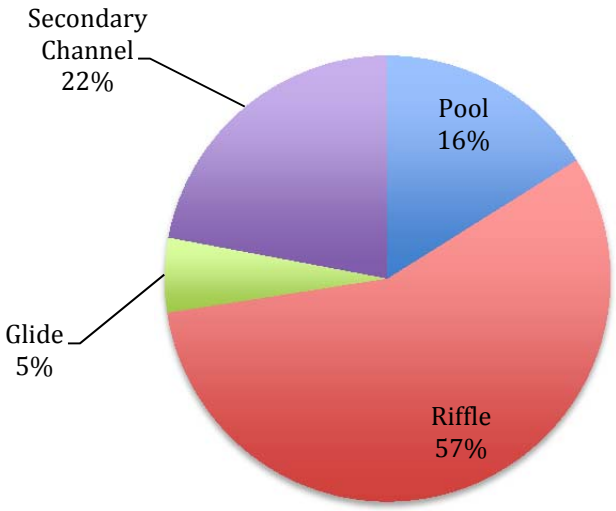



***Figure 72. Habitat unit composition for Reach 7.***

### 5.7.2 Pools

Reach 7 has 12 pools averaging 7.5 pools per mile – the highest rate of pools per mile within the project area, which averages 3.6 pools per mile. Over half the pools maintained between 3 – 5.99 feet of residual depth (Figure 73). Mean pool spacing calculated to 25.9 channel widths per pool, slightly lower than the project area average of 31.8.

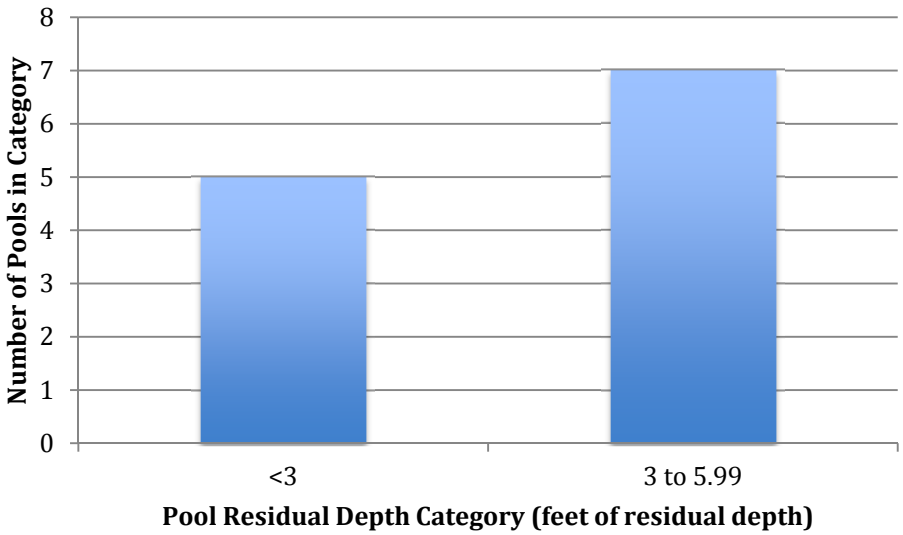



***Figure 73. Reach 7 residual pool depth and count of total pools in the reach.***

### 5.7.3 Secondary Channel Habitat

A total of seven secondary channels totaling 4,715 linear feet were identified in Reach 7. All are side channels that together total 22% of the habitat area in Reach 7. Both SIDE35F and SIDE36F were relatively equal in flow to the main channel.

For this assessment, we consider "side-channels" as secondary channels that are, or would be, naturally connected to the mainstem flow at their upstream and downstream ends at average annual flow; this definition also includes artificially disconnected side channels. We consider "off-channels" to be all other types of secondary channels including backwater channels/alcoves, groundwater-fed channels, wall-base channels, abandoned oxbows, and other types of floodplain channels and open-water floodplain wetlands.

***Table 20. Secondary channel habitat in Reach 7.***

| Location | Length (ft) | Dominant unit type | Wood count | Off-channel (OC) or side channel (SC) |
|---|---|---|---|---|
| SIDE33F | 440 | Fast water | 0 | SC |
| SIDE34F | 550 | Fast water | 0 | SC |
| SIDE35F | 1000 | Fast water | 0 | SC |
| SIDE36F | 1350 | Fast water | 12 | SC |
| SIDE37S | 400 | Slow water | 0 | SC |
| SIDE38S | 375 | Slow water | 40 | SC |
| SIDE39 | 600 | Slow water | 0 | SC |
| Total | 4,715 | | 52 | |

### 5.7.4 Large Woody Material

Reach 6 has a slightly above average wood count compared to the study area with 138.7 pieces per mile and 61.5 pieces of medium/large pieces of LWD per mile. The project area average is 124.7 and 55 pieces per mile, respectively. A total of 221 pieces were counted. This included six jams, equating to an average of 3.8 jams per mile (Table 19).

***Figure 74. Lateral channel migration resulted in increased LWD at RM 76.0.***

***Table 21. Large woody debris in Reach 7.***

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in x 35 ft) | Total |
|---|---|---|---|---|
| Number of pieces | 123 | 71 | 27 | 221 |
| Number of pieces per mile | 77.2 | 44.6 | 16.9 | 138.7 |
| Number of med/lg pieces per mile | | | | 61.5 |
| Number of jams per mile | | | | 3.8 |
| Number of jams | | | | 6.0 |

### 5.7.5 Substrate & Fine Sediment

Two pebble counts within Reach 7 identified substrate that was on par with the project area average and included 51% cobble, 42% gravel, 5% boulder and 2% sand (Figure 75). Robinson Creek is a significant contributor of bedload and suspended sediment to the reach (see Figure 76).

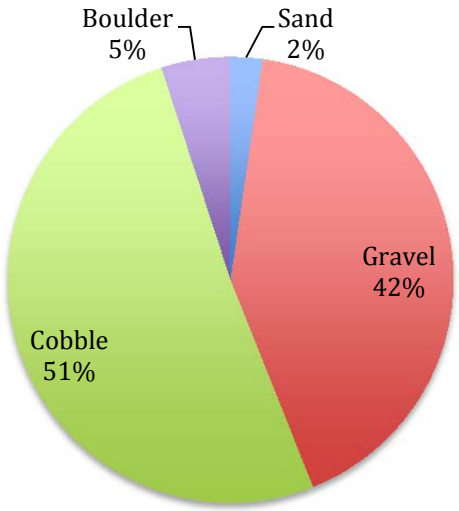



***Figure 75. Percent composition of bed substrate based on two pebble counts in Reach 7.***

***Figure 76. Robinson Creek (left) meets the Methow at RM 76.5 following heavy rains***

### 5.7.6 Riparian Corridor

Reach 7 riparian vegetation was relatively young. Small trees measuring 9 – 20.9 inches diameter and shrub/seedlings were the dominant riparian vegetation observed at 5 $n^{th}$ units in Reach 7, each representing 40%. Sapling/pole sized vegetation accounted for the remaining 20% (Figure 77). Overstory vegetation was dominated by dogwood and cottonwood. The understory vegetation reflected the increased elevation of Reach 7 and included snowberry, mountain maple, huckleberry, grassland/forbs, and dogwood.

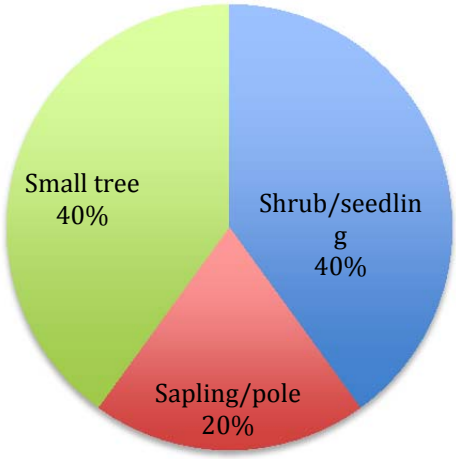



***Figure 77. Dominant riparian vegetation identified within 100 feet of river by ocular estimate in Reach 7.***

## 5.8 REACH 8

**Location**: River mile 76.5 (Robinson Creek) – 78.7
**Total length**: 2.2 miles
**Survey date**: August 13, 2014

***Figure 78. Reach 8 was dominated by relatively high gradient riffles (92%).***


***Figure 79. Overview of Upper Methow Reach 8 from RM 76.5 (Robinson Creek) – RM 78.7.***

### 5.8.1 Habitat Unit Composition

Reach 8 is a confined, steep reach composed of 92% riffles, 5% secondary channels, 2% pools, and 1% glides (Figure 80). Water levels were unseasonably high during the survey due to an intense two-day rain event (Figure 78). The higher water levels may have washed out smaller pools that would have been present at normal later summer levels. Reach 8 is a markedly smaller river due to the inflow of Robinson Creek at River Mile 76.5 that was estimated to add 15% of Methow River's flow. While the reach is dominated by riffles, there is high quality salmon habitat in side channels, especially SIDE40F between RM 77.5 – 77.9 which maintained considerable wood and a diversity of pools and riffles.

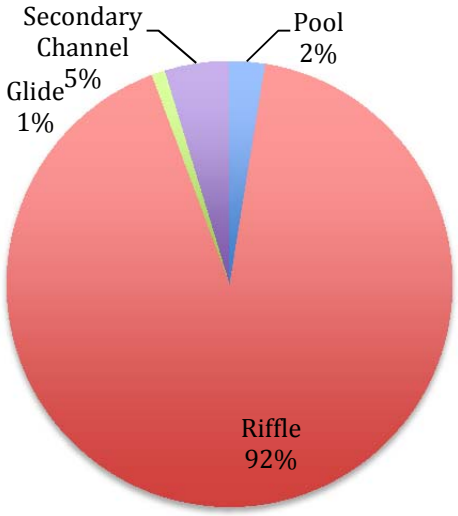



***Figure 80. Habitat unit composition for Reach 8.***

### 5.8.2 Pools

Reach 8 maintained an average of 1.3 pools per mile, lower than the average of 3.6 pools per mile. Three pools were identified with one under three feet of residual depth and two pools between 6 – 8.9 feet. The survey of Reach 8 was performed during a rain event on August 13, 2014 that increased river levels at the USGS gauge 12447383 (Methow River above Goat Creek Near Mazama) (Figure 1) to a max of 413 cfs. Average levels at this gauge for August 13 are approximately 140 cfs. These higher water levels may be responsible for a lower than average pool count.

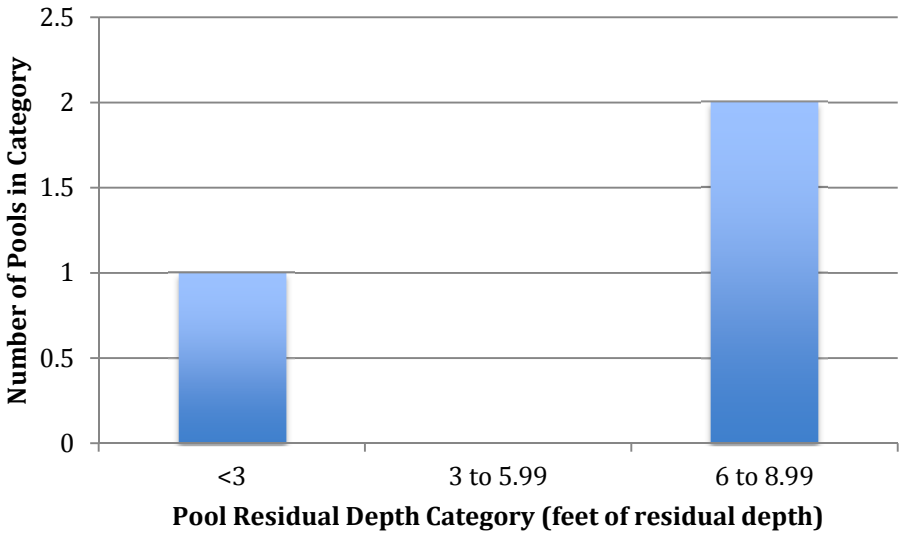



***Figure 81. Reach 8 residual pool depth and count of total pools in the reach.***

### 5.8.3 Secondary Channel Habitat

Reach 8 has four side channels comprising approximately 1% of the secondary channel habitat within the project area. The longest side channel is SIDE40F (Figure 82), which maintained a variety of riffles and pools, as well as a large apex log jam at the head of the side channel.

For this assessment, we consider "side-channels" as secondary channels that are, or would be, naturally connected to the mainstem flow at their upstream and downstream ends at average annual flow; this definition also includes artificially disconnected side channels. We consider "off-channels" to be all other types of secondary channels including backwater channels/alcoves, groundwater-fed channels, wall-base channels, abandoned oxbows, and other types of floodplain channels and open-water floodplain wetlands.

***Figure 82. SIDE40F with the mainstem Methow River in the background.***

***Table 22. Secondary channel habitat in Reach 8.***

| Location | Length (ft) | Dominant unit type | Wood count | Off-channel (OC) or side channel (SC) |
|---|---|---|---|---|
| SIDE40F | 1740 | Fast water | 0 | SC |
| SIDE41S | 100 | Slow water | 30 | SC |
| SIDE42F | 250 | Fast water | 0 | SC |
| SIDE43S | 200 | Slow water | 0 | SC |
| Total | 2290 | | 30 | |

### 5.8.4 Large Woody Material

A total of 275 pieces of large wood was observed in Reach 8, averaging 123.6 pieces per mile, or 57.5 pieces of medium/large wood per mile. Wood counts were on par with the project area which averaged 124.7 pieces per mile and 55 medium/large pieces per mile. Four log jams were observed, averaging 1.8 jams per mile (Table 23).

***Table 23. Large woody debris in Reach 8.***

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in x 35 ft) | Total |
|---|---|---|---|---|
| Number of pieces | 147 | 79 | 49 | 275 |
| Number of pieces per mile | 66.1 | 35.5 | 22.0 | 123.6 |
| Number of med/lg pieces per mile | | | | 57.5 |
| Number of jams per mile | | | | 1.8 |
| Number of jams | | | | 4.0 |

### 5.8.5 Substrate & Fine Sediment

Gravel counts were not conducted in Reach 8 and 9 because of the large bedload size relative to channel geometry and the lack of LiDAR for conducting hydraulic modeling.

The substrate of this reach is dominated by large cobbles; however, bedload size here ranges from gravels to boulders with very sparse accumulations of sand. Direct hillslope inputs in this reach include weathered bedrock and talus fans, glacial lag, and glacial outwash terraces. The sediment load is primarily locally sourced but clasts are rounded to subangular due to the mix of hillslope sources including glacial deposits. Where colluvial boulders are present they add hydraulic roughness to the bed and banks. Step-pool channel sequences are defined by relatively stable boulder steps. Gravel-sized bedload is present in pockets and as bars in depositional zones in the channel near large wood accumulations, at eddies, or as bar features in seasonally occupied high-flow secondary channels. Coarse sands are present as overbank deposits on low-lying vegetated floodplain surfaces and as a top layer on some of the bar features, especially immediately downstream from landslide or colluvial inputs. All other fine-grained sediment is fluvially transported through this dynamic cascading reach with long sequences of large cobble to boulder riffles and step-pool sections.

### 5.8.6 Riparian Corridor

Riparian habitat observed within 100 feet of the river was dominated by small trees (Figure 83). Cedar and Douglas fir were the primary overstory vegetation while snowberry, mountain maple, and dogwood were the primary understory vegetation.

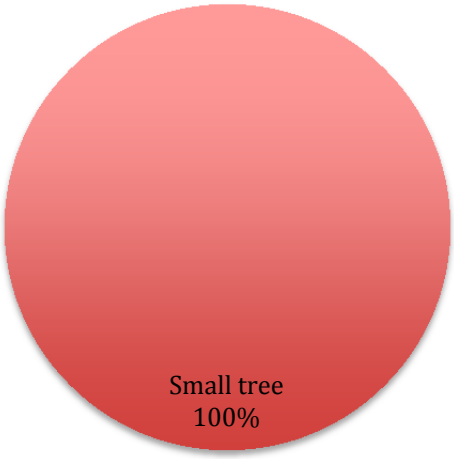



***Figure 83. Dominant riparian vegetation identified within 100 feet of river by ocular estimate in Reach 8.***

## 5.9 REACH 9

**Location**: River mile 78.7 – 80.0 (Trout Creek)
**Total length:** 1.3 miles
**Survey date:** August 14, 2014

***Figure 84. Representative view of Reach 9. Image is taking looking downstream from Trout Creek.***


***Figure 85. Overview of Upper Methow Reach 9 from RM 78.7 – RM 80.0 (Trout Creek).***

### 5.9.1 Habitat Unit Composition

Habitat in Reach 9 is a moderate- to highly-confined reach that maintains a higher gradient relative to lower reaches. The reach is composed 84% riffles, 10% pools, 4% secondary channels, and 2% glides. Large wood counts were the highest in the project area, mainly due to a large wood jam at RM 79.75 that was caused by an avalanche that pushed hundreds of trees into the river in the winter of 2013/2014. Three tributaries were identified in Reach 9. While Reach 9 is relatively steep and confined, four side channels were identified.

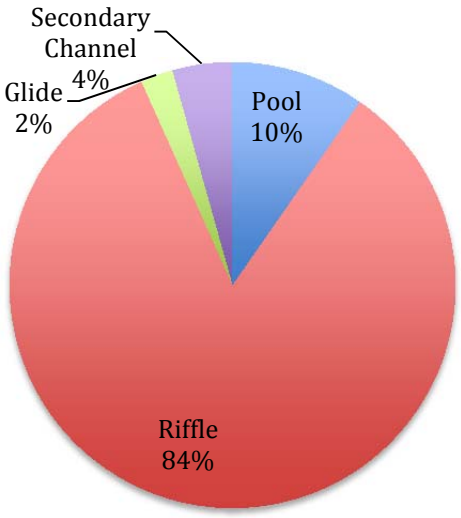



***Figure 86. Habitat unit composition for Reach 9.***

### 5.9.2 Pools

Reach 9 had four pools that averaged 4.1 feet of residual depth (Figure 87), which is slightly lower than the average residual depth of 4.4 feet. Pool spacing was 46.2 channel widths per pool, and there was 3 pools per mile – slightly lower than the reach area average of 3.6 pools per mile.

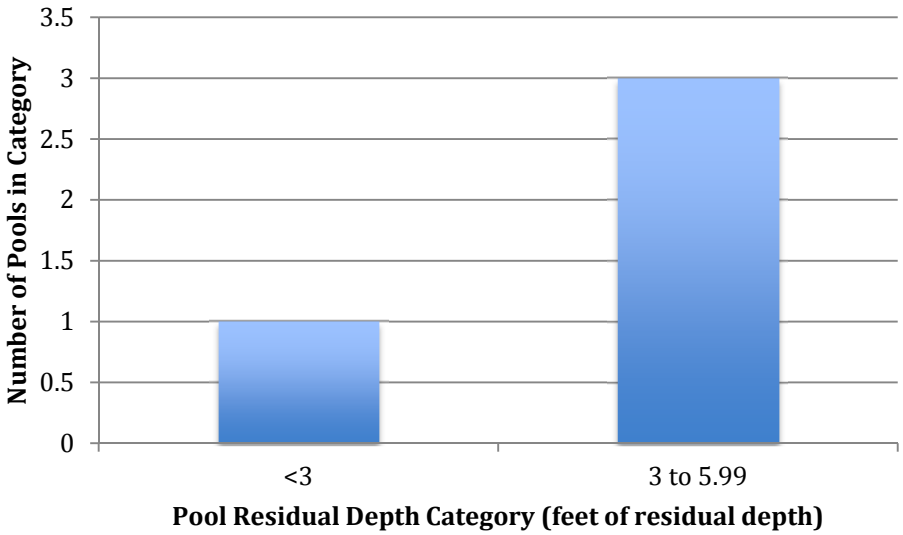



***Figure 87. Reach 9 residual pool depth and count of total pools in the reach.***

### 5.9.3 Secondary Channel Habitat

Four side channels were identified in Reach 9, totaling 5% of the habitat area. This is one of the lowest secondary channel habitat rates within the project area. It is likely due to the steep, confined nature of the reach. Only nine pieces of large wood were counted in the side channels (Table 24).

***Table 24. Secondary cannel habitat in Reach 9.***

| Location | Length (ft) | Dominant unit type | Wood count | Off-channel (OC) or side channel (SC) |
|---|---|---|---|---|
| SIDE44S | 20 | Slow water | 2 | SC |
| SIDE45F | 650 | Fast water | 7 | SC |
| SIDE46F | 300 | Fast water | 0 | SC |
| SIDE47S | 350 | Slow water | 0 | SC |
| Total | 1320 | | 9 | SC |

### 5.9.4 Large Woody Material

Reach 9 had almost one-third of the wood count within the total project area. This translated into the highest wood count among the nine reaches (467), as well as the highest density of wood (347.8 pieces per mile). The project area average was 124.7 pieces per mile.

A majority of the large wood (75%) was confined to seven log jams in Reach 9. Four of the seven log jams located near RM 79.75 were the result of an avalanche that pushed hundreds of trees into the river during the winter of 2013/2014. While the four log jams resulting from the avalanche densely packed the river with wood, they did not appear to be hindering fish passage.

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in x 35 ft) | Total |
|---|---|---|---|---|
| Number of pieces | 311 | 119 | 37 | 467 |
| Number of pieces per mile | 231.6 | 88.6 | 27.6 | 347.8 |
| Number of med/lg pieces per mile | | | | 116.2 |
| Number of jams per mile | | | | 5.2 |
| Number of jams | | | | 7.0 |

***Figure 88. Log jam at RM 79.75 caused by an avalanche in May 2014. Much of the wood was likely dead snags that had burned during the 2003 Needles Fire.***

### 5.9.5 Substrate & Fine Sediment

Gravel counts were not conducted in Reach 8 and 9 because of the large bedload size relative to channel geometry and the lack of LiDAR for conducting hydraulic modeling.

The substrate of Reach 9 is dominated by boulders and large cobbles. The sediment is primarily sourced directly from the steep adjacent confining hillslopes composed of weathered bedrock and talus fans. The Trout Creek confluence and its alluvial fan contribute additional cobbles and boulders to the upstream portion of this reach. Downstream from the confluence most of the bedload is locally sourced and thus is angular to sub-angular. The colluvial boulders add hydraulic roughness and stability to the channel bed and banks. Some small gravel-sized bedload is present at

a few transient depositional zones in the channel near large wood accumulations or at eddies. Sands are present as overbank deposits on the few very narrow vegetated floodplain surfaces that are established by channel incision/erosion in to the colluvial debris deposits. Otherwise, all fine-grained material is fluvially transported through this dynamic cascading reach.

### 5.9.6 Riparian Corridor

Small trees measuring 9.0 – 20.9 in. diameter were the dominant riparian vegetation measured at two n$^{th}$ unit in Reach 9 (Figure 89). Overstory vegetation observed was Douglas fir, while understory was a mix of ceanothus and dogwood.

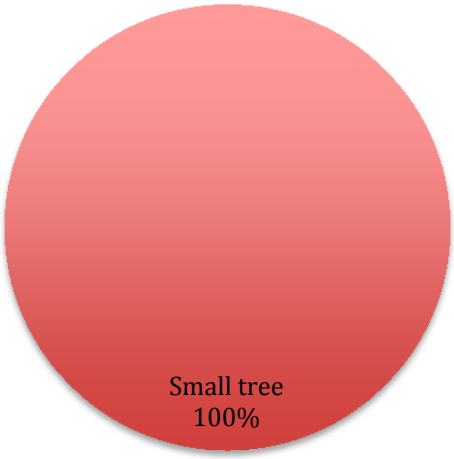



***Figure 89. Dominant riparian vegetation identified within 100 feet of river by ocular estimate in Reach 9.***

| | | Reach 1 | Reach 2 | Reach 3 | Reach 4 | Reach 5 | Reach 6 | Reach 7 | Reach 8 | Reach 9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reach Mileage Boundaries** | | 61.15 - 61.7 | 61.7 - 64.8 | 64.8 - 66.1 | 66.1 - 69.2 | 69.2 - 71.3 | 71.3 - 75.0 | 75.0 - 76.5 | 76.5 - 78.7 | 78.7 – 80.0 | 19 |
| **Wetted Width (ft)** | | | | | | | | | | | |
| *All habitat types (Main Channel)* | | | | | | | | | | | |
| | *Mean* | *n=0* | *85.0* | *49.3* | *70.0* | *43.2* | *43.3* | *27.1* | *43.3* | *37.5* | *51.9* |
| | *Median* | *n=0* | *90.0* | *45.0* | *75.0* | *40.0* | *45.0* | *25.0* | *45.0* | *37.5* | *24.9* |
| *Pool* | | | | | | | | | | | |
| | *Mean* | *n=0* | *85.0* | *49.3* | *70.0* | *43.2* | *43.3* | *27.1* | *43.3* | *37.5* | *45.1* |
| | *Median* | *n=0* | *90.0* | *45.0* | *75.0* | *40.0* | *45.0* | *25.0* | *45.0* | *37.5* | *40.0* |
| | *StDev* | *n=0* | *19.1* | *23.9* | *17.7* | *9.0* | *13.1* | *4.0* | *7.6* | *8.7* | *19.1* |
| *Glide* | | | | | | | | | | | |
| | *Mean* | *102.5* | *91.4* | *98.3* | *82.0* | *74.0* | *48.9* | *26.5* | *55.0* | *42.5* | *72.3* |
| | *Median* | *102.5* | *90.0* | *100.0* | *85.0* | *80.0* | *50.0* | *27.0* | *55.0* | *42.5* | *80.0* |
| | *StDev* | *17.7* | *19.1* | *27.5* | *26.8* | *23.8* | *12.2* | *3.7* | *n=1* | *3.5* | *29.3* |
| *Riffle* | | | | | | | | | | | |
| | *Mean* | *n=1* | *103.5* | *75.8* | *91.5* | *52.3* | *46.1* | *29.1* | *51.6* | *37.7* | *62.8* |
| | *Median* | *n=1* | *100.0* | *70.0* | *90.0* | *45.0* | *45.0* | *30.0* | *55.0* | *42.0* | *55.0* |
| | *StDev* | *n=1* | *24.2* | *18.6* | *24.4* | *17.3* | *13.4* | *10.9* | *4.8* | *13.7* | *31.9* |
| *Secondary Channel*[5] | | | | | | | | | | | |
| | *Mean* | *n=0* | *23.4* | *7.5* | *19.5* | *13.1* | *10.7* | *12.3* | *7.0* | *9.0* | *13.8* |
| | *Median* | *n=0* | *30.0* | *9.0* | *14.0* | *12.0* | *9.0* | *15.0* | *6.0* | *4.5* | *30.0* |
| | *StDev* | *n=0* | *15.0* | *3.8* | *18.2* | *8.6* | *10.2* | *10.1* | *6.1* | *10.8* | *11.9* |

[5] Secondary Channel measurements do not account for three open water floodplain wetlands identified in Reach 2.

| | Reach 1 | Reach 2 | Reach 3 | Reach 4 | Reach 5 | Reach 6 | Reach 7 | Reach 8 | Reach 9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Water Depth (ft)** | | | | | | | | | | |
| *Pool Maximum Depth* | | | | | | | | | | |
| *Mean* | *n=0* | *7.9* | *7.3* | *6.4* | *5.4* | *5.2* | *4.2* | *6* | *5.1* | *5.6* |
| *Median* | *n=0* | *8.0* | *7.0* | *6* | *4.5* | *5.0* | *4.0* | *7* | *5.5* | *5.0* |
| *StDev* | *n=0* | *3.8* | *2.1* | *1.8* | *2.3* | *2.3* | *1.1* | *1.7* | *1.2* | *2.3* |
| *Pool Residual Depth* | | | | | | | | | | |
| *Mean* | *n=0* | *5.4* | *5.8* | *4.9* | *4.5* | *4.2* | *3.4* | *4.7* | *4.1* | *4.4* |
| *Median* | *n=0* | *7.1* | *6.5* | *5.0* | *3.5* | *4.0* | *3.4* | *6.0* | *4.4* | *4.0* |
| *StDev* | *n=0* | *2.7* | *2.3* | *1.6* | *2.4* | *2.2* | *1.1* | *2.4* | *1.1* | *2.1* |
| *Glide Maximum Depth* | | | | | | | | | | |
| *Mean* | *8* | *3.8* | *4.5* | *3.3* | *2.3* | *2.4* | *2.7* | *n=1* | *3* | *3.3* |
| *Median* | *8* | *4* | *4* | *3.3* | *2.5* | *2.5* | *2.8* | *n=1* | *3* | *3.0* |
| *StDev* | *2.8* | *0.8* | *1.3* | *0.7* | *0.9* | *0.4* | *0.6* | *n=1* | *0* | *1.4* |
| *Glide Average Depth* | | | | | | | | | | |
| *Mean* | *3.9* | *2.4* | *2.3* | *2* | *2.1* | *1.3* | *1.6* | *n=1* | *1.5* | *2.0* |
| *Median* | *3.9* | *2.5* | *2.5* | *2* | *2* | *1.0* | *1.5* | *n=1* | *1.5* | *2.0* |
| *StDev* | *1.6* | *0.6* | *0.3* | *0.4* | *0.2* | *0.7* | *0.3* | *n=1* | *0* | *0.7* |
| *Riffle Maximum Depth* | | | | | | | | | | |
| *Mean* | *n=1* | *4.6* | *2.8* | *3.1* | *2.5* | *2.3* | *2.0* | *2.8* | *2.6* | *3.0* |
| *Median* | *n=1* | *4.0* | *3.0* | *3.5* | *2.5* | *2.0* | *2.0* | *2.8* | *2.8* | *2.5* |
| *StDev* | *n=1* | *2.8* | *0.8* | *0.9* | *0.7* | *0.6* | *0.5* | *0.4* | *0.7* | *1.6* |
| *Secondary Channel Maximum Depth* | | | | | | | | | | |
| *Mean* | *n=0* | *3.0* | *2.3* | *3.4* | *2.6* | *1.8* | *1.9* | *2* | *1.1* | *2.3* |
| *Median* | *n=0* | *3.5* | *2.0* | *3.8* | *2.5* | *2* | *2.0* | *2.3* | *0.8* | *2.0* |
| *StDev* | *n=0* | *1.4* | *0.5* | *1.7* | *0.9* | *1.1* | *1.4* | *1.1* | *0.9* | *1.3* |

| | *Reach 1* | *Reach 2* | *Reach 3* | *Reach 4* | *Reach 5* | *Reach 6* | *Reach 7* | *Reach 8* | *Reach 9* | *Total* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Bankfull Characteristics** | | | | | | | | | | |
| *Width (ft)* | | | | | | | | | | |
| *Mean* | *172.0* | *140.5* | *159.0* | *129.0* | *95.0* | *100.3* | *75.7* | *56.0* | *52.0* | *112.8* |
| *StDev* | *n=1* | *23.9* | *19.8* | *27.8* | *20.0* | *22.5* | *25.1* | *5.7* | *n=1* | *38.0* |
| *Average Depth (ft)* | | | | | | | | | | |
| *Mean* | *3.9* | *4.0* | *3.2* | *3.2* | *2.7* | *2.6* | *2.2* | *2.6* | *1.6* | *3.0* |
| *StDev* | *n=1* | *0.5* | *0.1* | *0.4* | *0.5* | *0.5* | *0.4* | *0.3* | *n=1* | *1.3* |
| *Maximum Depth (ft)* | | | | | | | | | | |
| *Mean* | *3.9* | *4.38* | *3.24* | *3.71* | *3.28* | *3.13* | *2.52* | *2.8* | *1.6* | *4.4* |
| *StDev* | *n=1* | *0.5* | *0.1* | *0.4* | *0.5* | *0.5* | *0.4* | *0.3* | *n=1* | *0.9* |
| *Width:Depth Ratio* | | | | | | | | | | |
| *Mean* | *44.1* | *35.2* | *50.5* | *40.0* | *35.5* | *38.4* | *34.4* | *21.9* | *32.5* | *37.4* |
| *StDev* | *n=1* | *5.8* | *6.3* | *8.6* | *7.5* | *8.6* | *11.4* | *2.2* | *n=1* | *12.6* |
| *Flood prone Width (ft)* | | | | | | | | | | |
| *Mean* | *3400* | *2075* | *1600* | *817* | *1200* | *1375* | *1467* | *593* | *70* | *1382* |
| *StDev* | *n=1* | *762.1* | *707.1* | *312.5* | *492.4* | *681.7* | *246.6* | *753.1* | *n=1* | *818.9* |
| *Habitat area %* | | | | | | | | | | |
| *Pool* | *0%* | *5%* | *21%* | *11%* | *21%* | *26%* | *16%* | *3%* | *10%* | *12%* |
| *Glide* | *57%* | *24%* | *44%* | *30%* | *13%* | *14%* | *5%* | *1%* | *2%* | *22%* |
| *Riffle* | *43%* | *52%* | *34%* | *56%* | *45%* | *45%* | *56%* | *92%* | *84%* | *54%* |
| *Secondary Channel* | *0%* | *19%* | *2%* | *3%* | *22%* | *15%* | *22%* | *5%* | *4%* | *12%* |

| | Reach 1 | Reach 2 | Reach 3 | Reach 4 | Reach 5 | Reach 6 | Reach 7 | Reach 8 | Reach 9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Pools** | | | | | | | | | | |
| *Pools per mile* | *0* | *1.3* | *5.5* | *1.7* | *5.3* | *6.3* | *7.5* | *1.3* | *3.0* | *3.6* |
| *Residual Depth (% of pools)* | | | | | | | | | | |
| *Pools < 3 ft* | *0* | *1* | *0* | *0* | *2* | *9* | *5* | *1* | *1* | *19* |
| *Pools 3-6 ft* | *0* | *1* | *3* | *4* | *7* | *9* | *7* | *0* | *3* | *34* |
| *Pools 6-9 ft* | *0* | *1* | *4* | *1* | *1* | *3* | *0* | *2* | *0* | *12* |
| *Pools 9-12 ft* | *0* | *1* | *0* | *0* | *1* | *2* | *0* | *0* | *0* | *4* |
| *Riffle:Pool ratio* | *N/A* | *11.2* | *1.6* | *5.1* | *2.2* | *1.7* | *3.5* | *36.0* | *8.6* | *4.3* |
| *Mean Pool Spacing (bankfull channel widths per pool)* | *n=0* | *49.0* | *19.7* | *44.9* | *23.3* | *19.6* | *25.9* | *79.6* | *46.2* | *31.8* |
| **Large Wood** | | | | | | | | | | |
| *Total Number Pieces* | | | | | | | | | | |
| *Total* | *4* | *398* | *190* | *362* | *314* | *388* | *221* | *275* | *467* | *2619* |
| *Large (20 in by 35 ft)* | *0* | *76* | *35* | *59* | *30* | *43* | *27* | *49* | *37* | *356* |
| *Medium (12 in by 35 ft)* | *1* | *128* | *63* | *110* | *97* | *131* | *71* | *79* | *119* | *799* |
| *Large and Medium* | *1* | *204* | *98* | *169* | *127* | *174* | *98* | *128* | *156* | *1155* |
| *Small (6 in x 20 ft)* | *3* | *194* | *92* | *193* | *187* | *214* | *123* | *147* | *311* | *1464* |
| *Number of Pieces per mile* | | | | | | | | | | |
| *Total* | *9.9* | *126.1* | *148.0* | *121.5* | *152.2* | *107.1* | *138.7* | *123.6* | *347.8* | *124.7* |
| *Large (20 in by 35 ft)* | *0.0* | *24.1* | *27.3* | *19.8* | *14.5* | *11.9* | *16.9* | *22.0* | *27.6* | *18.7* |
| *Medium (12 in by 35 ft)* | *2.5* | *40.6* | *49.1* | *36.9* | *47.0* | *36.2* | *44.6* | *35.5* | *88.6* | *42.1* |
| *Large and Medium* | *2.5* | *64.7* | *76.3* | *56.7* | *61.5* | *48.0* | *61.5* | *57.5* | *116.2* | *60.8* |
| *Small (6 in x 20 ft)* | *7.5* | *61.5* | *71.6* | *64.8* | *90.6* | *59.1* | *77.2* | *66.1* | *231.6* | *77.1* |

| | Reach 1 | Reach 2 | Reach 3 | Reach 4 | Reach 5 | Reach 6 | Reach 7 | Reach 8 | Reach 9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Bank Erosion** | | | | | | | | | | |
| *Total % Bank Erosion* | *0* | *450* | *300* | *1250* | *0* | *0* | *0* | *0* | *0* | *2000* |
| **Substrate (all pebble counts performed at the riffle/glide transition)** | | | | | | | | | | |
| *Total* | | | | | | | | | | |
| *% Sand* | *2%* | *0%* | *0%* | *5%* | *3%* | *2%* | *2%* | *0%* | *0%* | *2%* |
| *% Gravel* | *46%* | *49%* | *51%* | *39%* | *67%* | *45%* | *42%* | *0%* | *0%* | *48%* |
| *% Cobble* | *52%* | *51%* | *48%* | *53%* | *29%* | *51%* | *51%* | *0%* | *0%* | *48%* |
| *% Boulder* | *0%* | *0%* | *1%* | *4%* | *4%* | *2%* | *5%* | *0%* | *0%* | *2%* |
| *% Bedrock* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* |
| **Vegetation (% of sampled units in 100-foot-wide zone averaged between both banks)** | | | | | | | | | | |
| *Dominant Overstory Size Class* | | | | | | | | | | |
| *Mature Tree* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* |
| *Large Tree* | *0%* | *0%* | *25%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *3%* |
| *Small Tree* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *40%* | *0%* | *0%* | *5%* |
| *Sapling/Pole* | *0%* | *0%* | *0%* | *0%* | *33%* | *11%* | *20%* | *0%* | *0%* | *8%* |
| *Shrub/Seedling* | *100%* | *100%* | *75%* | *100%* | *67%* | *78%* | *40%* | *100%* | *100%* | *83%* |
| *Grassland/Forb* | *0%* | *0%* | *0%* | *0%* | *0%* | *11%* | *0%* | *0%* | *0%* | *3%* |
| *No Vegetation* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* |
| *Overstory Species Composition* | | | | | | | | | | |
| *Cottonwood* | *100%* | *83%* | *25%* | *0%* | *100%* | *56%* | *40%* | *0%* | *0%* | *43%* |
| *Aspen* | *0%* | *0%* | *0%* | *0%* | *0%* | *11%* | *0%* | *0%* | *0%* | *3%* |
| *Cedar* | *0%* | *0%* | *0%* | *14%* | *0%* | *11%* | *0%* | *67%* | *0%* | *10%* |
| *Douglas fir* | *0%* | *0%* | *0%* | *0%* | *0%* | *11%* | *0%* | *33%* | *100%* | *10%* |
| *Pondersosa* | *0%* | *17%* | *75%* | *86%* | *0%* | *0%* | *0%* | *0%* | *0%* | *25%* |
| *Dogwood* | *0%* | *0%* | *0%* | *0%* | *0%* | *11%* | *60%* | *0%* | *0%* | *10%* |

| | Reach 1 | Reach 2 | Reach 3 | Reach 4 | Reach 5 | Reach 6 | Reach 7 | Reach 8 | Reach 9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| *Understory Species Composition* | | | | | | | | | | |
| *Cottonwood* | *100%* | *17%* | *50%* | *57%* | *0%* | *33%* | *20%* | *0%* | *0%* | *30%* |
| *Willow* | *0%* | *33%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *5%* |
| *Cedar* | *0%* | *0%* | *0%* | *0%* | *0%* | *11%* | *0%* | *0%* | *0%* | *3%* |
| *Dogwood* | *0%* | *50%* | *0%* | *14%* | *33%* | *56%* | *0%* | *33%* | *50%* | *30%* |
| *Grassland/forbes* | *0%* | *0%* | *50%* | *0%* | *33%* | *0%* | *40%* | *0%* | *0%* | *13%* |
| *Small Shrub* | *0%* | *0%* | *0%* | *29%* | *0%* | *0%* | *0%* | *0%* | *0%* | *5%* |
| *Ceanothus* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *50%* | *3%* |
| *Snowberry (co-dom. with mtn maple or huckleberry)* | *0%* | *0%* | *0%* | *0%* | *33%* | *0%* | *40%* | *67%* | *0%* | *13%* |

# 6 References

USFS (United States Forest Service). 1997. Upper Methow River Stream Survey Report. Okanogan National Forest Methow Valley Ranger District.

USFS (United States Forest Service). 2003. West Fork Methow River Stream Survey Report. Okanogan-Wenatchee National Forest Methow Valley Ranger District.

USFS (United States Forest Service). 2009. Draft Early Winters Creek Stream Survey Report. Okanogan-Wenatchee National Forest Methow Valley Ranger District.

USFS (United States Forest Service). 2013. Stream Inventory Handbook, Level I & II. Pacific Northwest Region – Version 2.13.

USBR (United States Bureau of Reclamation). 2012. Lower Entiat Reach Assessment, Chelan County, WA. USBR Pacific Northwest region, Boise, ID, US Department of the Interior.

Yakama Indian Nation. 1987. Spring and Summer Chinook Spawning Grounds Surveys, Methow and Okanogan River Basins.