Icicle Creek Reach Assessment

Appendix A | Habitat Assessment

Icicle Creek (RM 0 – 22.02)

February 2026

Table of Contents

1 Introduction & Background

Icicle Creek originates from Josephine Lake in the Alpine Lakes Wilderness on the eastern side of the North Cascade Mountains in central Washington. It is approximately 32.75 river miles long and flows east-southeast through the foothills and joins the Wenatchee River near the town of Leavenworth. Icicle Creek is the largest tributary drainage of the Wenatchee River.

The Yakama Nation identified the lower 22.02 miles of Icicle Creek for assessment and potential restoration efforts for native salmon and trout populations. This Icicle Creek Habitat Assessment was completed on behalf of the Yakama Nation as part of their efforts to assess and improve Threatened and Endangered salmon and trout habitat within the Columbia River Basin. As part of the assessment process, Inter-Fluve conducted this salmonid habitat survey of Icicle Creek between July 29th and September 26th, 2024. Habitat survey crews started at RM 0 (confluence with the Wenatchee River) and worked upstream to RM 22.02 (0.9 miles from the end of U.S. Forest Service [USFS] Forest Road [FR] 7609). River miles (RM) were based on those available from the Upper Columbia Salmon Recovery Board (UCSRB) but were modified to include the historical channel alignment located at the Leavenworth National Fish Hatchery (LNFH).

The assessment was divided into 20 distinct geomorphic reaches. Reach breaks used for the Icicle Creek habitat assessment were based on the Upper Columbia Salmon Recovery Board reach boundaries, with some modifications (Upper Columbia Spatial Framework, 2021). Due to the modifications made to river miles to include the historical channel alignment near the hatchery, the length of Reach 3 increased (approximately 1.28 miles, compared to the UCSRB Reach 3 length of approximately 0.8 miles). As a result of the river miles adjustment in Reach 3, upstream reaches start and stop at different river miles than the UCSRB reaches. The updated river miles are referenced in maps provided below and Inter-Fluve recognizes that the river miles used in this assessment will vary from other completed assessments and reports. A comparison of river miles used in this report and those used by UCSRB can be found in Table 1 of Section 2.1 in the Main Report. Field surveys followed the USFS Stream Inventory Handbook: Level I & II, Pacific Northwest Region (USFS, 2020). A flow rate of 191 cubic feet per second (cfs) was measured in the field at RM 8.3 on July 30th, 2.9 miles upstream from the USGS River Gauge #12458000 above Snow Creek. A flow rate of 188 cfs was measured at the same location of the USGS River Gauge on July 30th, 2024 (USGS, 2024). Insignificant precipitation was received over the survey period and stream flow was not otherwise measured as part of this survey.

The objective of this Habitat Assessment is to characterize the habitat quantity and quality for salmonid species native to Icicle Creek by quantifying in-channel morphologic features, characterizing riparian conditions, and identifying anthropogenic features influencing aquatic habitat. This information is used to inform potential restoration and conservation actions and will provide a baseline for evaluating future habitat trends and measuring the effectiveness of restoration efforts to improve the quantity and quality of available habitat within the study area.

1.1 COMPARISON TO PREVIOUS SALMON HABITAT ASSESSMENTS

Stream habitat surveys have been previously completed in lower Icicle Creek between the mouth and RM 3 by The Watershed Company (2005) for the Icicle Valley Chapter of Trout Unlimited, between the mouth

and RM 4.3 by Natural Systems Design for Chelan County Natural Resources (Natural Systems Design, 2017), and between RM 0 and RM 30.2 by Cramer Fish Studies (Camp et al. 2023). A brief summary of the results from these surveys is provided below.

Other studies conducted on Icicle Creek include:

- Fish passage assessment in Icicle Creek's Boulder Field (approx. RM 5.6; Dominguez et al. 2013),
- Reach Geomorphic, Hydraulic and Habitat Assessment (RM 3 – RM 4.5; Katz et al., 2023),
- Streamflow study (Mauger et al. 2017),
- Bull Trout and Redd survey (Nelson et al. 2009), and
- Biomass assessment for the Leavenworth National Fish Hatchery (Leavenworth National Fish Hatchery, 2006).

1.1.1 2005 Reach Assessment Summary

The Watershed Company conducted a Reach Level Assessment in 2005 on lower Icicle Creek (RM 0 – 3) for the Icicle Valley Chapter of Trout Unlimited. The Watershed Company followed Rosgen (1996) and Rosgen (2001) methodologies to quantity large woody debris (LWM), streambank vegetation (riparian vegetation), and stream bed gravel. Rosgen (1996, 2001) methods include classifying stream reaches based on geomorphic qualities. The study measured the average channel gradient for the first three miles as 0.17% compared to an estimate of 0.09% by Inter-Fluve in 2025. The Watershed Company study intended to compare lower Icicle Creek to a reference river system, in this case the lower White River. Riparian vegetation was based on density (i.e., bare, forbs only, annual grass with forbs, perennial grass, rhizomatous grasses, low brush, high brush, combination grass/brush, deciduous with brush/grass understory, perennial overstory, wetland vegetation community), while Inter-Fluve identified species and size class. Wood debris was also measured based on density of channel blockage from floatable material (i.e., leaves, needles, small limbs to "dams" of larger material occupying 30-50% of the active channel cross section). Individual pieces of LWM were not identified in the Watershed Company's study. Due to the highly different methods of data classification, the 2005 study results cannot be readily compared.

1.1.2 2017 Reach Assessment Summary

A reach assessment and habitat survey was performed on the lower 3 miles of Icicle Creek in 2016 by Natural Systems Designs (NSD) for Chelan County Natural Resources Department (CCNRD) (Natural Systems Design, 2017). The survey followed USFS Levell II Stream Inventory protocol, with modifications, and was conducted in September 2016.

Habitat unit composition at the time of the 2016 survey recorded pool habitat as the dominant habitat type (46%) in the CCNRD study area (RM 0-3), followed by riffle (44%) and glide (10%) habitat types. In comparison, the Inter-Fluve habitat survey (2024) recorded a higher proportion of pool habitat (84%), followed by glide (14%), then side channels (2%), and riffles only comprised 1% of the habitat area in the same river miles (0-3). NSD identified 22 pools and measured pool spacing at 7 pools per mile in 2016. Inter-Fluve identified 19 pools and measured pool spacing at 6.3 pools per mile. Although there are notable discrepancies in reported pool and riffle composition between the two surveys, we do not believe

these are indicative of major channel changes since 2016. This is based on the geomorphology assessment, which did not identify significant changes to channel planform or longitudinal profile. Assuming the same protocols were applied to both habitat surveys, the discrepancies are assumed to be related to different flow conditions at the time of surveys and/or different interpretations or biases of the different survey teams.

For LWM, the methods used by NSD (2016) and Inter-Fluve (2024) differed. The 2016 surveys used procedures from the Washington Salmon Recovery Funding Board whereas the 2024 surveys used the USFS Level II protocols. The 2016 surveys used a smaller size threshold for qualifying pieces (>5 feet in length and >4 inches diameter) compared to the 2024 surveys (>20 feet in length and >6 inches diameter). In addition, for pieces embedded in the bank or partially within the bankfull channel, the 2016 surveys only counted the piece if the exposed portion of the piece within the bankfull channel cross-section met the minimum size criteria. In the USFS protocol, if any portion of the piece is within the bankfull channel cross-section then the piece is counted. In the 2024 surveys, pieces of wood within jams were counted if they met the size criteria. It was not clear if wood in jams was recorded in the 2016 surveys. A total of 119 LWM pieces were recorded by NSD in 2016. In comparison, Inter-Fluve recorded 267 LWM pieces in this same section of channel. It is expected that over 8 years, there could be changes to LWM quantities in these reaches due to the large channel that is capable of readily transporting LWM, and these numbers are potentially reflecting a positive trend of increasing wood abundance. There were also additions of wood as part of habitat restoration work at a project site near RM 0.93, which accounts for approximately 69 pieces. Drawing definitive conclusions with respect to trends is challenging, however, due to the use of different survey methodologies which would be expected to result in different wood tallies.

1.1.3 2023 Habitat Assessment and Reach Characterization Summary

A rapid habitat assessment was completed on Icicle Creek by Cramer Fish Sciences (henceforth, Cramer) in September 2023 for CCNRD (Camp et al., 2023). The Cramer surveys were performed to support the Columbia Habitat Prioritization Tool (UCRTT, 2022). The surveys had similar but slightly different objectives, spatial extents, and methods compared to this reach assessment.

A "rapid habitat assessment" field protocol was developed for Cramer's assessment. This was based on the USFS Level II Stream Inventory protocol but did not include the full suite of Level II measurements. Cramer's field data collection also had a slightly different spatial extent. The survey did not include RM 3 to RM 9.63, from the Leavenworth National Fish Hatchery to Eight Mile Creek (Inter-Fluve Reaches 3-8), and their surveys extended further upstream than the Inter-Fluve surveys. Cramer categorized Icicle Creek into three reach groups – Lower reaches (Lower 01, Lower 02; RM 0 – RM 3), middle reaches (Middle 01 to Middle 10; RM 9.63 – RM 22.72), and upper reaches (Upper 01 to Upper 05; RM 22.72 – RM 30.2). The Inter-Fluve survey ended 0.7 miles downstream of the upstream end of Cramer Middle 10, below French Creek (RM 22).

Average wetted and bankfull widths recorded in the Lower Reaches (Inter-Fluve Reach 1 and Reach 2), downstream of the Leavenworth National Fish Hatchery, were similar across both the Cramer and Inter-Fluve assessments, with average wetted widths of 100.6 feet (Cramer) and 96 feet (Inter-Fluve) and average bankfull widths of 118.4 feet (Cramer) and 120 feet (Inter-Fluve). Similarly minor differences

were present in the wetted and bankfull widths recorded for the middle reaches (Inter-Fluve Reach 9 to Reach 20).

LWM survey methods were similar for the Cramer and Inter-Fluve assessments, with the exception of LWM size classes and log jams. Cramer's wood counts included LWM pieces with estimated lengths greater than 35 feet and diameters greater than 12 inches (i.e., medium size class or larger in the USFS Level II protocol). Cramer did not record LWM in the small size class (length >20 feet and diameter >6 inches), whereas Inter-Fluve did record small size LWM. With respect to jams, Cramer's assessment used a threshold of 10 or more qualifying pieces, whereas Inter-Fluve used a threshold of 3 or more qualifying pieces. In both assessments, jam locations, instream function, recruitment potential, and recruitment sources for LWM were documented. For the lower reaches (RM 0-3), Cramer recorded 62 pieces and three jams, whereas Inter-Fluve recorded 65 pieces (Medium or larger, for comparison) and 7 jams. These total numbers are similar, and jam number differences are not comparable due to different jam criteria. For the middle reaches, a direct comparison is challenging due to a slightly different upstream boundary to this segment (RM 22.72 in Cramer survey and RM 22 in Inter-Fluve survey). The Cramer total was 628 pieces, whereas the Inter-Fluve total was 847 pieces. The reason for the differences between these two surveys is uncertain. It potentially reflects a real change in wood numbers; however, a net gain of over 200 pieces is unlikely given the lack of a significant flow event (based on gage records) between the two survey periods. It more likely represents different field survey techniques. The Cramer survey was described as a "rapid habitat assessment protocol" and was performed "primarily via foot" (Camp et al., 2023), whereas the 2024 survey followed the full USFS Level II protocol, which included surveyors walking all reaches and recording detailed habitat attributes, including wood, at the habitat unit scale.

Methods for recording pool habitat types also differed between the Cramer and Inter-Fluve surveys. Both assessments followed the USFS Levell II protocol, but Cramer used the PacFish InFish Biological Opinion (PIBO) Monitoring Program pool qualifier definition to identify pools, which states "a pool must span 50% of the wetted channel width and have maximum depth of at least 1.5 times greater than the pool tail depth". The USFS Level II protocol delineates a slow water habitat (pool) as having "little/no surface gradient, a hydraulic control, and a residual pool depth" (USFS, 2020) and does not include the relationship between the maximum depth and pool tail crest depth. The average number of pools recorded by Cramer in the lower reaches (RM 0-3) was 5.5 pools per mile compared to 6 pools per mile recorded by Inter-Fluve. In the middle reaches, Cramer recorded 23.2 pools per mile and Inter-Fluve recorded 8.2 pools per mile. These discrepancies are assumed to be due to the use of different pool criteria, as opposed to channel changes, which did not measurably change between survey years (2023 versus 2024).

2 Methods

The Icicle Creek study area (RM 0 – 22.02) was subdivided into 20 distinct reaches based primarily on geomorphic indicators. The 20 reach delineations were used for both the habitat reach assessment as well as the geomorphic reach assessment and restoration strategy as documented in Section 3 of the main report and Appendix C.

The habitat assessment employed the methods outlined in the US Forest Service Stream Inventory Handbook: Level I & II, Pacific Northwest Region, Version 2.20 (USFS, 2020). The "Eastside Forest

Option" protocol, which includes data categorizations for large wood and riparian vegetation specific to ecosystems east of the Cascade Crest, was used. All protocols were followed when safe and most of the suggested forest inventory options were applied in the survey. Due to unsafe conditions within the stream channel, surveyors estimated some instream measurement from the bank; more details are in Section 4 in this Appendix. Adaptions to the USFS Eastside protocol were made for this survey. Those adaptations include:

- All reach and habitat unit lengths were measured in GIS from GPS data recorded in the field. Habitat units were delineated by survey points collected with a Juniper Systems Geode unit (sub-foot accuracy).
- Floodplain width was calculated using LiDAR and 2D hydraulic modeling results.
- Field data was collected digitally, using an iPad and ESRI Field Maps software. The Special Case field data was collected using a printed copy of the Special Case form.

At all channel units, surveyors performed an ocular estimate of wetted width and at n^{th} units performed a measured wetted width using a laser rangefinder to calibrate their ocular estimate. A bankfull measurement was performed at the first three fast water channel units (riffle or glide) per reach when safe, and then at every n^{th} unit after. The n^{th} channel unit (riffle, pool, glide) measurement frequency applied in the field for data collected was 20%, or every 5th unit, for both fast- and slow-water channel unit types. If fewer than three fast-water units were encountered in a reach, bankfull measurements were collected at slow water units instead. The length of anthropogenically-induced unstable banks was recorded for both the left and right channel banks in all units. Water depths for all habitat units were measured using a graduated stadia rod carried by the observer, or estimated if depths or velocities exceeded the wading ability of the observer. Water temperature and stream flow measurements were recorded for tributaries when safely accessible. Water temperatures were taken for the tributary and in the main channel upstream of tributary influence and downstream of tributary confluence.

For riparian vegetation measurements, the riparian corridor can be defined as either a single 100-feet wide zone or two adjacent riparian zones (inner and outer zones) totaling 100 feet in width (USFS, 2020). For this assessment, one single 100-feet wide riparian zone was designated for the Icicle Creek study area. Survey methods dictate defining a dominant size class of vegetation type within the riparian corridor (e.g. small tree, shrubs), then defining the dominant species observed in the overstory and understory. Survey protocol differed from the USFS protocol by collecting dominant overstory class and species, and a dominant understory species within the 100-feet wide riparian zone in addition to class size (USFS, 2020).

Gravel counts were performed as part of the geomorphic survey to characterize the size distribution of bedload sediment. In total, 26 gravel counts were completed. Two gravel counts were completed in each of the reaches, except for Reach 3, Reach 9 and Reach 12, where only one gravel count was completed due to concerns of surveyor safety or lack of channel bed complexity. Three gravel counts were completed in Reach 19. Reaches 5, 6, 7, 11, 13 and 18 did not have a gravel count completed due to safety reasons. Gravel count locations were selected as representative of the general character of the reach.

For this habitat survey, side channels were defined as naturally wetted flow paths connected to the mainstem channel at their upstream and downstream ends at low flow. Side channel units were

identified when the main channel split to form a stable island with soil or fine sediment accumulations and with established vegetation older than 2 to 3 years. Each side channel was determined to be predominantly fast-water or slow-water unit type. Total lengths of the side channels were recorded using GPS following the same protocols used for main channel unit delineation. If the entire side channel was not wet at the time of survey, the length of the wetted portion of the side channel was estimated. This report provides data based on total side channel lengths, unless otherwise noted.

LWM was counted in the mainstem and side channels following the size class characterizations for "Eastside" forests. Tallies of small (> 6 in. diameter, >20 feet long), Medium (>12 in. diameter, > 35 feet long) and Large (>20 in. diameter, >35 feet long) pieces of LWM were completed for each reach. A log jam was classified as a group of three or more pieces of qualifying size (meets the size requirements above) in contact with one another and with at least one piece within bankfull. For the log jam count in the habitat survey, both a within bankfull count (number of pieces within bankfull) and total count was performed (number of pieces within and outside of bankfull). The within bankfull count was used for this report. Geomorphic function of the jam, as well as whether the jam was of natural origin or constructed as a part of habitat enhancement efforts in the basin, was also noted. More information on the jams can be found in Section 2.9 of the main report.

3 Summary of Results

This section summarizes the results for all 20 reaches surveyed in Icicle Creek between July 27th to September 29th, 2024, from RM 0 (confluence with the Wenatchee River) to RM 22.02 (study area extent). Detailed reach summaries with reach-specific results are included in Section 4 of this report.

3.1 CHANNEL MORPHOLOGY

Within the assessment area, the channel morphology of Icicle Creek can be divided into three distinct segments. The downstream reaches (Reaches 1-3) are located within the wide Lower Icicle Creek valley and have relatively low channel gradients, on average less than 0.3%. These reaches have low natural confinement from hillslopes and alluvial fans. Meander scars provide evidence of historical lateral migration. Infrastructure, the Leavenworth National Fish Hatchery and residential areas are present on the floodplains and terraces within these lower reaches.

In contrast to the downstream reaches, the middle reaches (Reach 4 – Reach 14) exhibit an increase in the level of hillslope and alluvial fan confinement, with bedrock outcrops present. The channel alternates between confined and partially confined through these reaches. The slope gradient in Reaches 4 to Reach 14 is significantly higher than the downstream reaches. In the confined reaches (Reach 5, Reach 6, Reach 9, and Reach 11- Reach 13), the channel exhibits a lower sinuosity than reaches that are partially confined (Reach 7, Reach 8, Reach 10 and Reach 14). In the partially confined reaches, more LWM was recorded and large boulder split flow into multi-threaded channel created pockets for sediment accumulation and supporting vegetated islands. In the uppermost reaches of the study area (Reach 15 -Reach 20), the channel is single-thread and relatively straight. Side channels are minimal due to presence of terraces, alluvial fans and hillslopes. A summary table for channel morphology metrics recording in Icicle Creek during the 2024 field habitat surveys is found in Table 2.

Table 2. Icicle Creek bankfull width results from habitat assessment.

Bankfull Widths (feet)																				
	Reach 1	**Reach 2**	**Reach 3**	**Reach 4**	**Reach 5**	**Reach 6**	**Reach 7**	**Reach 8**	**Reach 9**	**Reach 10**	**Reach 11**	**Reach 12**	**Reach 13**	**Reach 14**	**Reach 15**	**Reach 16**	**Reach 17**	**Reach 18**	**Reach 19**	**Reach 20**
Max	130	120	70	120	90	110	120	119	99	114	80	102	87	92	117	102	80	98	95	95
Min	120	20	40	80	90	50	90	116	94	75	72	80	84	72	92	93	75	60	69	81
Mean	125	83	57	100	90	80	102	118	97	99	76	92	86	85	105	98	78	79	82	86
St Dev	7.1	55	15	28	0	42	16	2	4	21	4	10	2	9	11	6	4	14	13	7
Flood Prone Widths (feet)																				
	Reach 1	**Reach 2**	**Reach 3**	**Reach 4**	**Reach 5**	**Reach 6**	**Reach 7**	**Reach 8**	**Reach 9**	**Reach 10**	**Reach 11**	**Reach 12**	**Reach 13**	**Reach 14**	**Reach 15**	**Reach 16**	**Reach 17**	**Reach 18**	**Reach 19**	**Reach 20**
Max	2077	336	280	190	219	141	110	362	150	171	104	113	121	110	505	172	210	83	366	439
Min	1190	260	152	190	108	110	100	147	142	99	75	88	99	88	109	140	93	72	288	95
Mean	1634	298	204	190	161	126	105	255	146	145	91	103	110	101	217	156	148	76	326	215
St Dev	627	38	55	0	45	16	4	108	4	33	12	10	11	8	166	16	49	5	32	136
Bankfull Depths (feet)																				
	Reach 1	**Reach 2**	**Reach 3**	**Reach 4**	**Reach 5**	**Reach 6**	**Reach 7**	**Reach 8**	**Reach 9**	**Reach 10**	**Reach 11**	**Reach 12**	**Reach 13**	**Reach 14**	**Reach 15**	**Reach 16**	**Reach 17**	**Reach 18**	**Reach 19**	**Reach 20**
Max	6.1	6.3	5.6	10.8	8.5	11.1	10.2	8.1	7.2	6.3	8.8	7.5	6.4	7.2	6.4	7.5	8.2	6.5	6.8	5.7
Min	2.6	3.2	0.5	3.3	2	1.5	2	1.8	1.3	1.9	0.5	0.5	1.4	1.6	0.2	1.6	1.6	1.8	2.4	0.6
Mean	4.5	5.4	4.3	8.1	6.3	6.7	5.3	5	4.6	4.5	5.7	5.1	4.5	5.1	4.8	4.5	5.2	4.1	4.8	4.2
St Dev	1	0.8	1.4	1.9	1.9	3.1	2.3	1.9	1.6	1.1	2.1	1.6	1.1	1.3	1.4	1.5	2.3	1	1.3	1

3.2 HABITAT UNIT COMPOSITION

Within the surveyed area, riffles and pools are the dominant habitat type, comprising 48.6% and 36%, respectively of the total area of the channel. Glides comprise 8.6%, side channels comprise 6.5%, and cascades comprise 0.3% of the total aquatic habitat area (Figure 1 and Figure 2). A single cascade unit was recorded in Reaches 5, 6 and 17. Reach 2 maintains the highest percentage of pool habitat at 91% and Reach 10 the lowest at nearly 6%. Side channel habitat area was comparatively low across the study area with no side channel habitat in Reaches 6, 11, 13, 15, and 20. The reach with the highest percentage of side channel habitat was Reach 8 at 22%. Reach 3 consisted of the natural channel and an artificial hatchery diversion channel for the Leavenworth National Fish Hatchery. More information on the Leavenworth National Fish Hatchery can be found in Section 2.5.3 of the main report. The diversion channel is only wet at high flows and is controlled via an inlet structure at the upstream end. A greater proportion of fast water units was present in Reaches 4 - 18 compared to Reaches 1 – 3.

The mean residual pool depth ranged from 2.4 feet (lowest; Reach 16) to 7 feet (highest; Reach 17). Overall, the mean residual pool depth across all reaches was 4.4 feet (Figure 3). The deepest pools were found in Reaches 1, 17, 18 and 20 where a pool was estimated to be 15 feet or greater. Several reaches had high numbers of deep pools (residual pool depth > 3 feet), including Reach 19, Reach 2 and Reach 4. Notably, Reach 4 had the highest percentage of pools greater than six feet (100%). Overall, the pools in Reach 3 were the shallowest. A summary of all data recorded is provided in Table 53 in Section 4.21 of this Appendix.

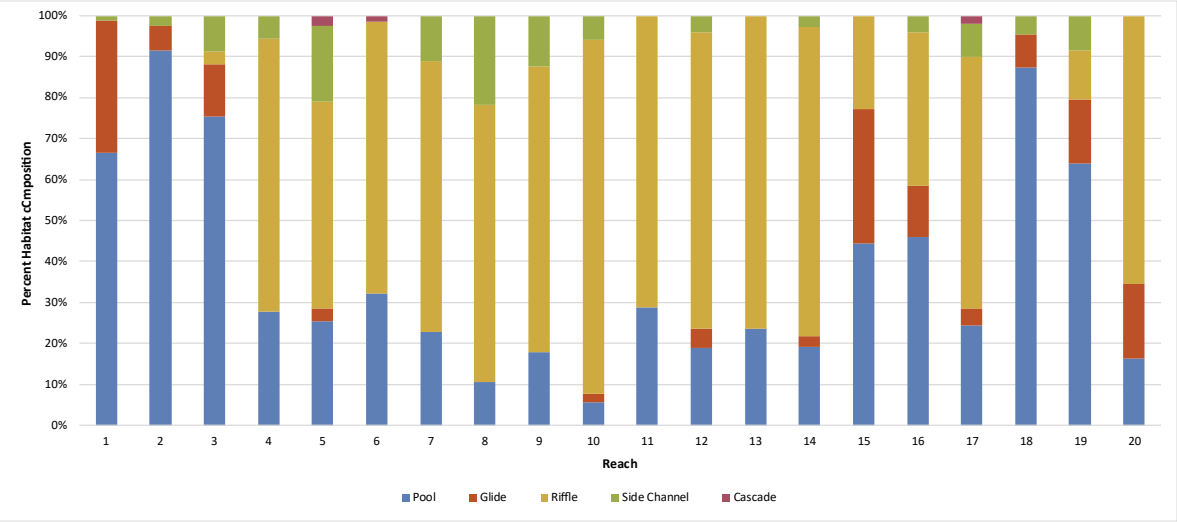


Figure 1. Figure illustrates habitat unit composition (as a percentage of total area) for each of the 20 reaches.

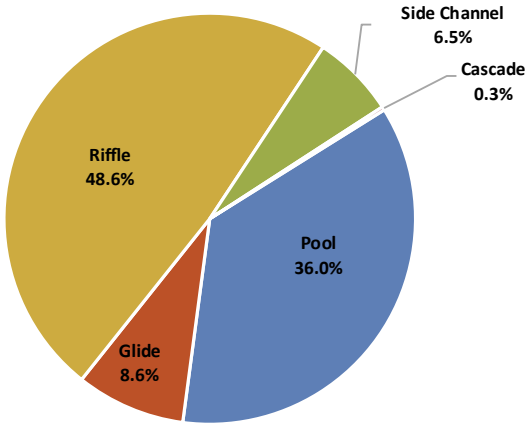


Figure 2. Figure illustrates the habitat unit composition for the entire study area.

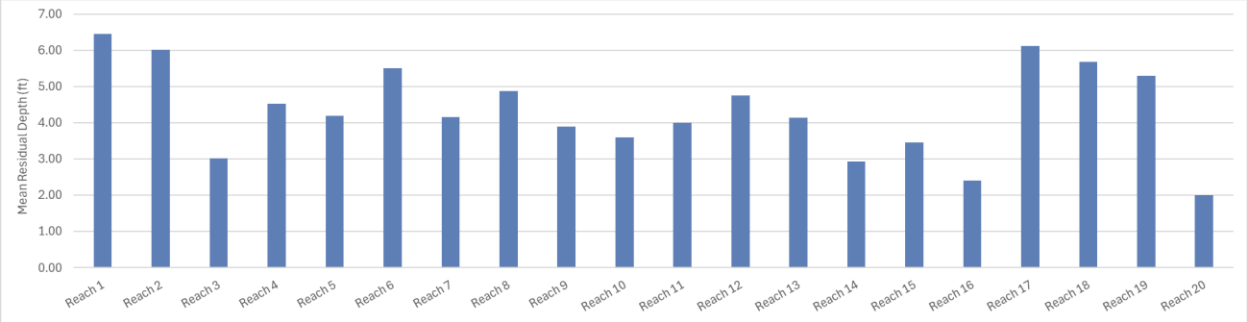


Figure 3. Mean residual pool depth for Icicle Creek.

3.3 SIDE CHANNEL HABITAT

Overall side channel habitat throughout the surveyed area accounts for approximately 7% of the surface habitat area. In total, 63 side channel units exist, averaging three side channels per mile of stream. The side channels average 423 feet in length and 23 feet in width (wetted width). The total side channel length throughout all reaches is 5.05 miles. The side channels contain a total of 655 pieces of Large Woody Material (LWM).

3.4 LARGE WOODY MATERIAL (LWM)

A total of 4,071 pieces of LWM were counted in the study area averaging 185 pieces per mile; 46% were small LWM pieces with diameters between 6 and 12 inches and lengths greater than 20 feet, 37% were medium LWM pieces with diameters between 12 and 20 inches and lengths greater than 30 feet, and 17% were large LWM pieces with diameters over 20 inches and lengths greater than 30 feet. Of all the reaches in the Icicle Creek study area, Reach 8 had the highest amount of LWM recorded, including 237 pieces of medium and large LWM per mile (Figure 4). Reach 3 maintained the least LWM per mile with only 10 pieces of medium and large LWM pieces per mile and 48 total pieces of LWM per mile. A total of 169 log jams was recorded in the study area; to classify as a jam, at least three qualifying pieces of LWM was required.

Fox and Bolton (Fox and Bolton 2007) conducted instream large wood surveys in unmanaged streams across Washington State to help understand natural wood loading conditions. As part of their study, they

compared their data to the National Marine Fisheries Service (NMFS) properly functioning conditions threshold (1996) that are based on sizes exceeding the "medium" size class used by the USFS in the Level 2 survey protocols (2020; ≥12 in diameter and at least 35 ft long). The Fox and Bolton (Fox and Bolton 2007) 75th percentile of wood loading was 67.45 pieces per mile for unmanaged streams in eastside forests. For this Icicle Creek Reach Assessment, we chose the 75th percentile value to use as a comparison to observed conditions in Icicle Creek, since this is believed to be a reasonable target for restoration of natural wood loading ranges across the landscape by Fox and Bolton (Fox and Bolton 2007). Therefore, the "adequate" threshold for LWM in Icicle Creek is > 67.45 pieces per mile of medium and large size class wood, with additional woody debris available for long-term recruitment. There are 31 pieces of large LWM pieces per mile average across the whole study area. There are 69 pieces of medium LWM pieces per mile across the whole study area. Reach 1, Reach 2, Reach 3, Reach 6, Reach 11, Reach 12, Reach 13, and Reach 18 however, do not maintain "adequate" threshold for LWM; Reach 3 having only 10 pieces of medium and large LWM per mile.

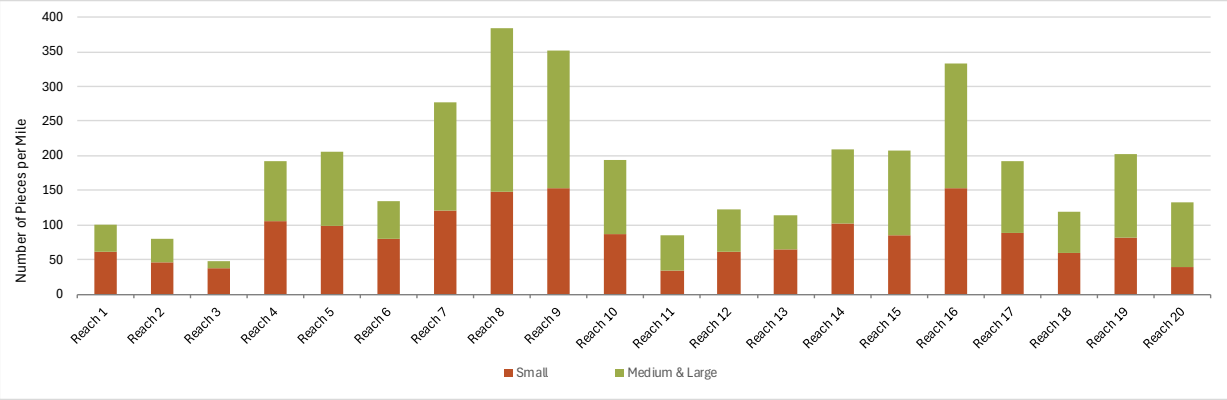


Figure 4. Summary of LWM pieces per mile recorded in each Icicle Creek reach during the 2024 surveys, classified by small size class LWM and Medium and Large combined size classes of LWM.

3.5 SUBSTRATE & FINE SEDIMENT

Substrate characterization is based on 26 gravel counts completed in Icicle Creek. In Reaches 5 - Reach 7, Reach 11, Reach 13, and Reach 18, gravel counts were not performed due to lack of available substrate and safety of the survey crew. Gravel counts were performed starting from the upstream extent of the study area and moving downstream; the first gravel count (GC1) was completed in Reach 20 and the last gravel count (GC26) in Reach 1. When possible, two gravel counts were completed in each of the respective reaches, at representative riffle crests or bars. However, In Reach 3, Reach 9, and Reach 11 only one count was performed and in Reach 19 three counts were conducted.

Sediment type is classified by the B-axis diameter of the clasts sampled according to the Wentworth grain size scale (fines = <2 mm, gravel = 2.1–64 mm, cobble = 64.1–256 mm, boulder = >256.1 mm; Wentworth, 1922). In Icicle Creek the dominant substrate classification was gravel, followed by cobble, boulder and then sand (Figure 5). Reaches 1-3 are the least confined with lowest slope gradient, with gravels and cobble substrates observed. Reaches 4-14 are more confined, with steeper channel gradients and consistently larger sediment observed, including large proportions of boulders present. The upper reaches (Reach 15-20) include a mix of gravels, cobbles, and boulders, reflecting the variable channel conditions within those reaches.

The percentage of fine substrate is less than 10% throughout the assessment area (with the highest percentage occurring at 8% in Reach 15 GC 11). Fine substrate can be harmful to salmonid survival in high concentrations at spawning grounds by limiting the flow of dissolved oxygen and nutrients, but the low percentage poses minimal risk to aquatic habitat quality. Additionally, larger substrate, such as boulders, is less optimal for spawning purposes as it is too large to be moved easily during redd construction. However, in higher velocity areas, boulders can provide refuge for smaller substate leading to accumulation of small islands and bars of gravel and cobble which can be beneficial for habitat and spawning.

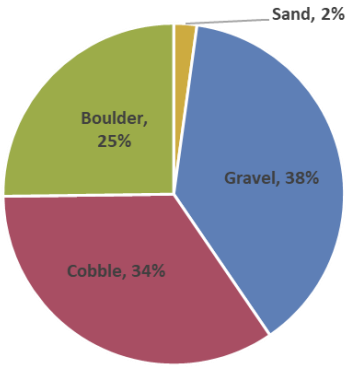


Figure 5. Gravel count size classification averaged for all reaches. Gravel was the dominant classification.

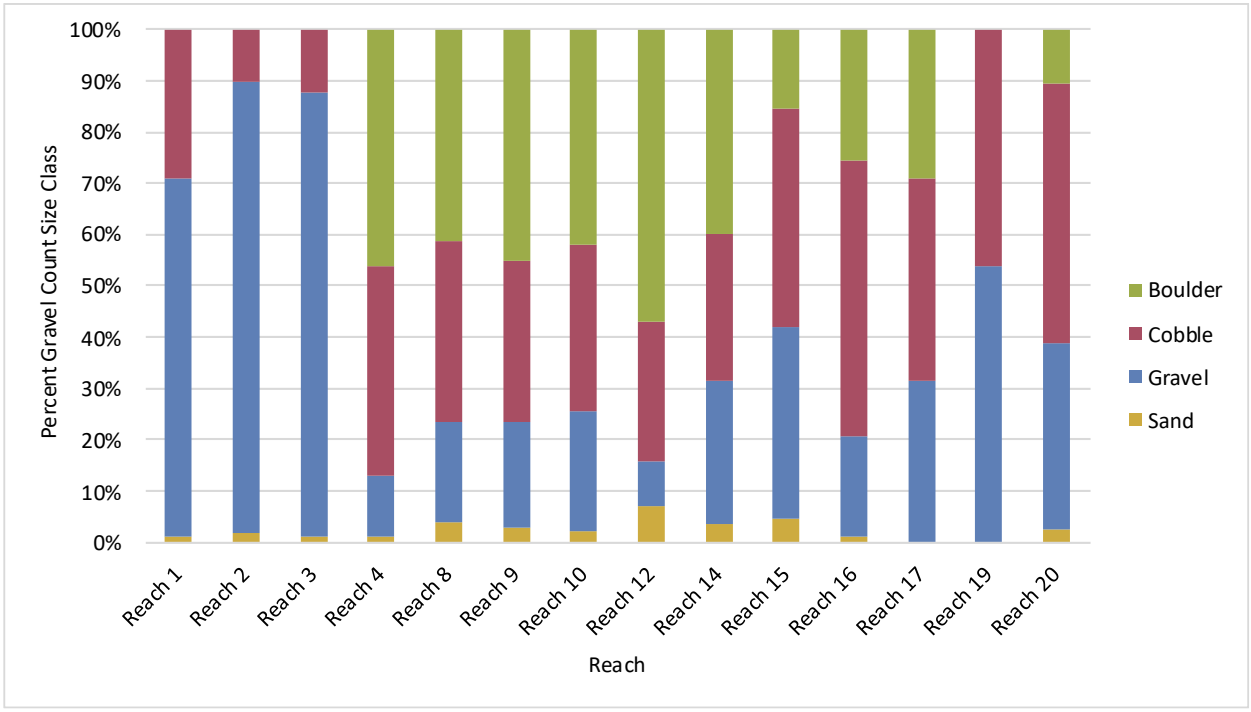


Figure 6. Combined average gravel count size classification by reach for al reaches based on the number of gravel counts observed for each reach.

3.6 BANK INSTABILITY

Throughout the Icicle Creek study area, irrigation infrastructure, residential development, roads, bridges, channel bank armoring, campgrounds and other anthropogenic features are present. Many of these land use modifications have resulted in channel entrenchment, geomorphic simplification, and riparian/floodplain vegetation clearing and alterations. The extent of human-induced bank erosion and/or instability on both the left and right banks of each channel unit and side channel unit were documented during the 2024 field assessment. While there are some bank erosion processes occurring throughout the project area in all reaches, the habitat team did not directly identify any sources of the human-induced erosion.

Unstable banks were found to be relatively more frequent throughout the downstream reaches (Reach 1 to Reach 6) compared to the upper reaches. Reach 2 remains the most affected by human-altered banks; a result of the river flowing through the housing developments of Leavenworth and the presence of the Leavenworth National Fish Hatchery. Riprap and other bank armoring were extensive in Reaches 4, Reach 5 and Reach 6, where Icicle Road (USFS Road 7600) runs parallel to the river-left bank. Bank armoring, decreased riparian vegetation, and bank stability are impacted in Reach 5 as a result of the Leavenworth Irrigation District Road and the irrigation canal. Bridges, riprap and residential homes impact channel banks in Reach 7. Forest service campgrounds and trails are present along the banks in Reach 10 and Reach 17. Fewer roads and more public lands in the upper reaches reduced the occurrence of anthropogenically-induced bank instability.

3.7 FISH PASSAGE BARRIERS

Anthropogenic structures within the mainstem Icicle Creek channel occur in Reach 3, Reach 4 and Reach 5. There are two channel-spanning structures located in the natural channel of Reach 3; a dam (Structure 5) on the downstream end of the reach (RM 2.95; Figure 7) and a diversion at the upstream end of the reach (RM 4.8). In Reach 4, the Icicle-Peshastin Irrigation Canal (RM 5.05) extends from the river-right bank halfway across the Icicle Creek channel. At the time of survey (August 27th, 2024), approximately 0.7 feet of water was flowing over the top of the concrete structure. The channel on river-left at this location does not have a structure present and consists of a riffle/cascade feature with boulder substrates. Downstream of the structure is a constructed step-pool feature intended to aid fish passage over the submerged concrete. This structure is not recorded as a fish passage barrier according to WDFW (2025).

A water diversion structure, maintained by the Icicle-Peshastin Irrigation District and City of Leavenworth, is located at the upstream end of Reach 5 (RM 6.27). It is a channel-spanning diversion, diverting water into the Leavenworth Irrigation Canal that flows into the town of Leavenworth, WA (Figure 8). The diversion is approximately three feet high with additional 0.5 feet tall wooden planks.

Figure 7. Photo of the dam located on the downstream end of Reach 3 within the historical channel.

Figure 8. Channel spanning diversion at the upstream end of Reach 5.

3.8 RIPARIAN CORRIDOR

Riparian vegetation was surveyed at select habitat units, including n^{th} units and when a dramatic change in riparian vegetation between units was observed by the survey crew. In total, 149 units had observations of riparian vegetation recorded. Across the study area, the dominant (72%) overstory

riparian vegetation size was Large Tree (21.0-31.9- inch diameter at breast height [dbh]). Small Tree (9.0-20.9-inch dbh) was the second most dominant at 15% of the total observations. Sapling Pole (5.0-8.9-inch dbh) and Mature Trees (5.0-8.9-inch dbh) each composed 3% of the measured units, while Shrub/Seedling (1.0 -4.9-inch dbh) and Other comprised 2% of the units. "Other" overstory species class in the study area include burned trees. Only 1% of the recorded units were classified as No Vegetation within the riparian corridor (Figure 9).

The dominant overstory species were Ponderosa and Jeffrey pine, composing 42% of all measured habitat units. A positive identification of Jeffrey Pine was observed within 100 feet of Icicle Creek. Douglas fir and Western red cedar composed 21% and 20%, respectively, of measured habitat units. Cottonwood (9%), Other/Unknown (4%), Quaking Aspen (2%) and Alder (1%) composed the remaining units (Figure 10).

The dominant understory riparian vegetation size class is Shrub/Seedling, recorded in 87% of the units, followed by Grassland/Forb (6%), No Vegetation (4%), Sapling Pole (2%) and Small Tree (1%; Figure 11). The dominant understory riparian vegetation species was Alder (57%), followed by Dogwood (19%). Unknown/Other and Willow equally composed 9% of measured habitat units. The remaining measured riparian understory units consisted of Cottonwood (3%), Vine/Douglas maple (2%), and Cedar (1%; Figure 12).

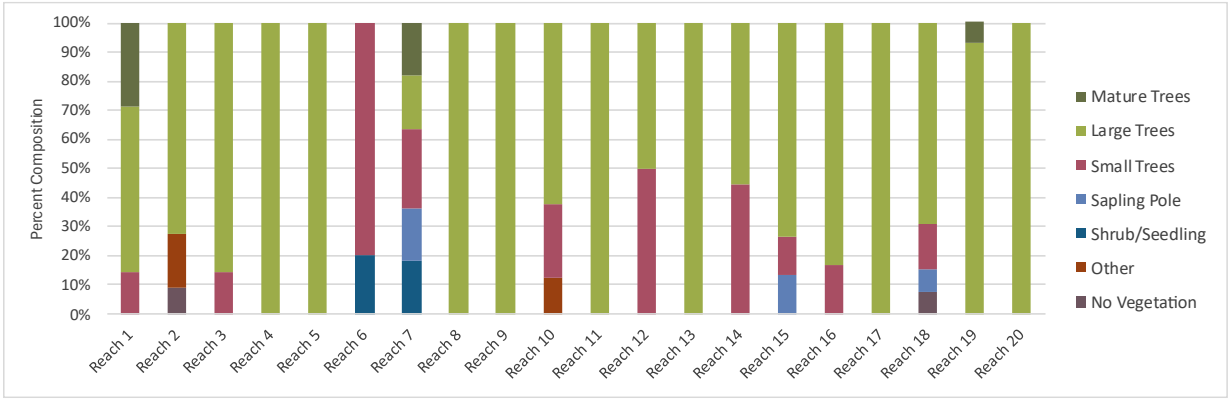


Figure 9. Percent composition of the dominant overstory size class for all units in which vegetation surveys were performed.

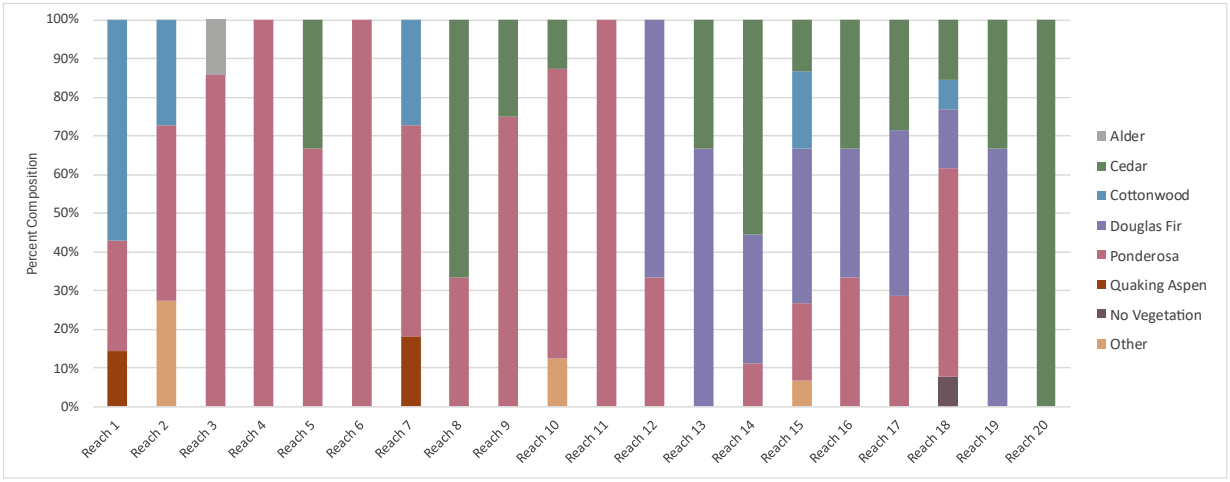


Figure 10. Percent composition of the dominant overstory species for all units in which vegetation surveys were performed.

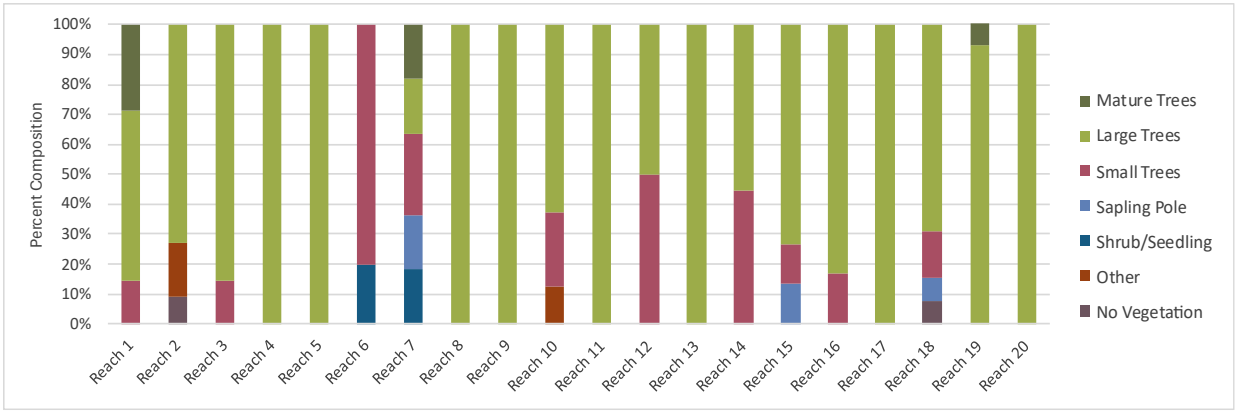


Figure 11. Percent composition of the dominant understory size class for all units in which vegetation surveys were performed.

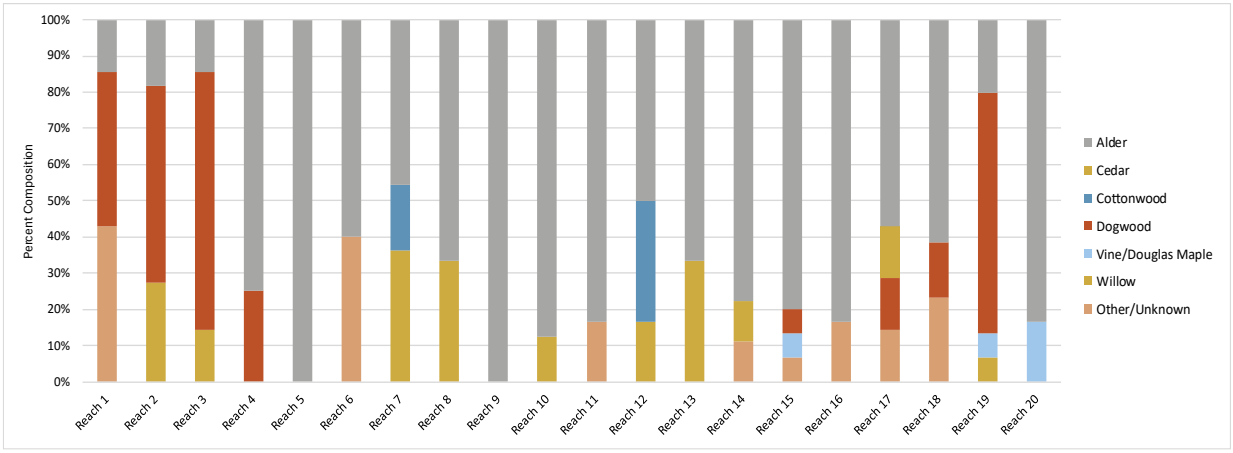


Figure 12. Percent composition of the dominant understory species for all units in which vegetation surveys were performed.

4 Stream Habitat Reach Reports

4.1 REACH 1

Location: River mile 0 – 1.24
Total length: 1.24 miles
Survey date: August 13 - 14, 2024

Figure 13. Representative photo of Reach 1.

4.1.1 Habitat Unit Composition

Reach 1 was 1.24 miles long and has the third largest proportion of pool habitat area of all the reaches (67%), compared to the study area average of 38.5%. The remainder of the habitat area is comprised of glides (32%) and side channels (1%; Figure 14 and Figure 15). Reach 1 has a stream gradient of 0.11%, less than the study area average of 1.7%. The channel and floodplains of Reach 1 are frequently used by the public and residential land uses are widespread. This reach starts at the confluence with the Wenatchee River near the town of Leavenworth, WA.

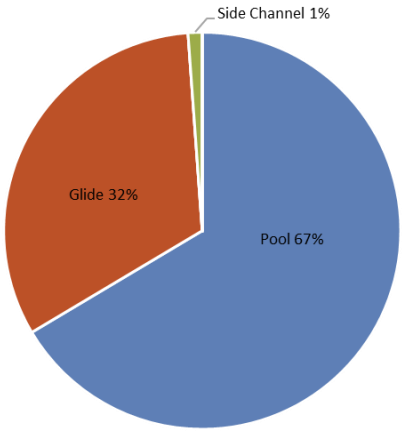


Figure 14. Stream habitat unit area composition for Reach 1.

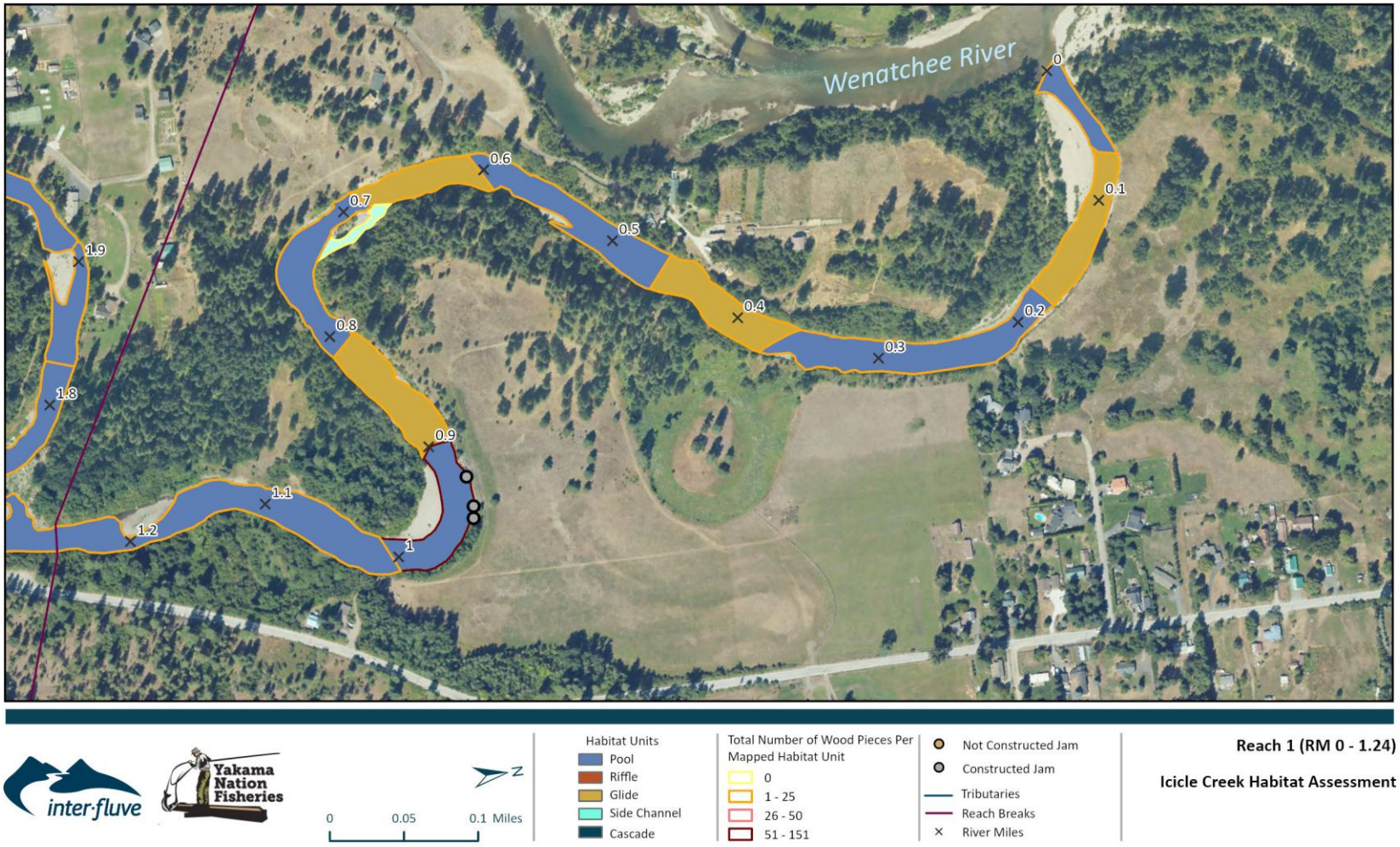


Figure 15. Map of the habitat unit composition and LWM in Reach 1 of Icicle Creek. LWM count includes pieces in jams.

4.1.2 Pools

Pool was the most common habitat type recorded in Reach 1, composing 67% of the habitat unit surface area. A total of five pools were recorded within the reach, averaging four pools per mile compared to the study area average of seven pools per mile. Of the five pools, 40% of pools measured a residual pool depth less than three feet. Another 50% of pools measured a residual pool depth between three feet and six feet, while the remaining 20% measured a residual pool depth greater than six feet. The average residual depth of pools in Reach 1 was 6.5 feet but ranged from 0.5 feet to 18 feet, compared to the study area average of 4.4 feet.

4.1.3 Side Channel Habitat

Only one side channel was observed in Reach 1 with a length of 265 feet. The slow-water side channel contained no LWM (Table 3).

Table 3. Side channels observed in Reach 1.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 1	265	Slow	0	0	0
Total	*265*		*0*	*0*	*0*

4.1.4 Large Woody Material

A total of 125 pieces of LWM were recorded in Reach 1, which includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 101 pieces of LWM per mile, with 39 of those pieces per mile being Medium and Large LWM. Three wood jams were observed, containing 69 pieces of LWM (Table 4).

Table 4. LWM 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 Individual Pieces	36	14	6	56
Number of Individual Pieces per Mile	29	16		45
Number of Total Pieces per Mile (including pieces in jams)	62	39		101
Number of Jams	3			
Number of Jams per Mile	2			
Estimated Wood Count in Jams	69			

4.1.5 Substrate & Fine Sediment

Two gravel counts were performed in Reach 1, with a combined average of 70% gravel, 29% cobbles and 1% sand (Figure 16). The first gravel count (GC26) was performed at a channel spanning riffle crest near RM 0.60 and the second (GC25) was at a performed at a riffle crest near RM 0.90. Cumulative distribution curves and grain size class of the gravel counts completed in Reach 1 are provided in Figure 17, Figure 18, and Table 5.

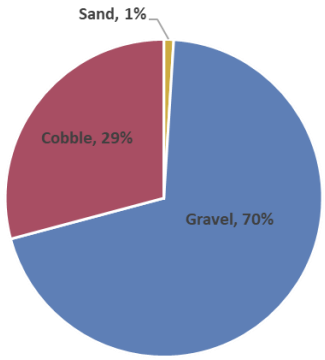


Figure 16. Combined percent sediment composition from the two gravel counts (GC 26 and GC 25) performed in Reach 1.

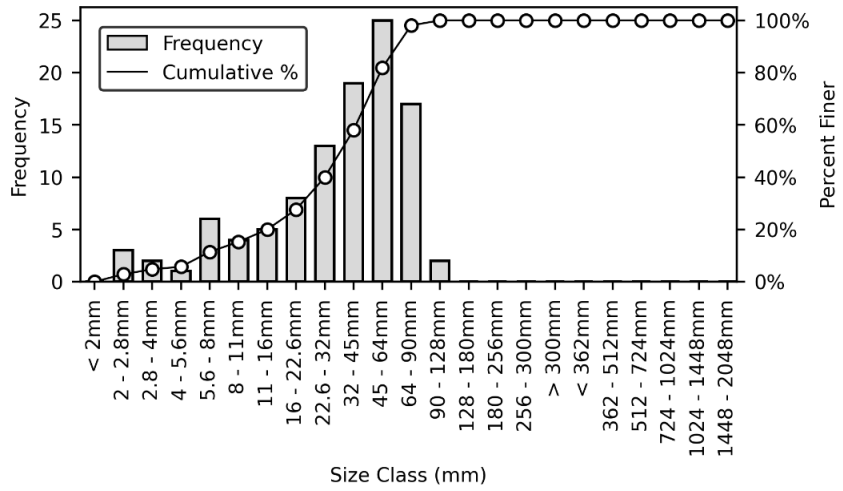


Figure 17. Cumulative distribution curve for GC 26.

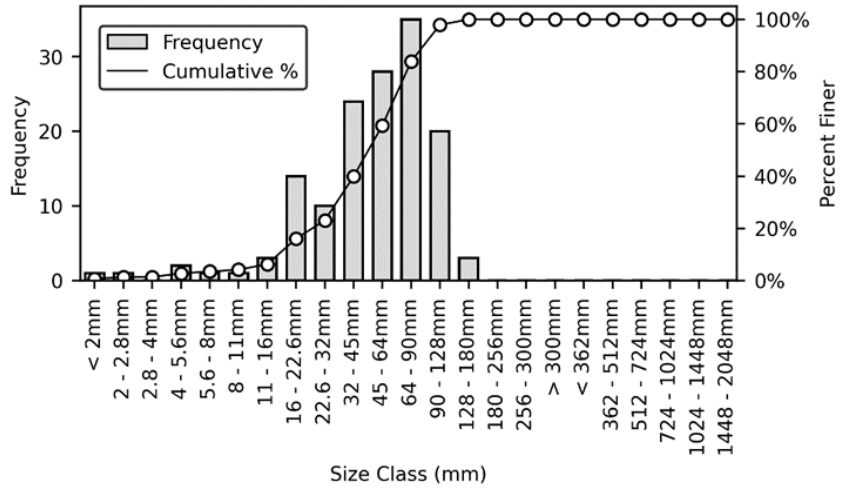


Figure 18. Cumulative distribution curve for GC25.

Table 5. Grain size class for GC 26 and GC 25 (assumed linear interpolation).

Size Class	GC26 *Size percent finer than (mm)*	GC25 *Size percent finer than (mm)*
D5	13	4
D16	23	12
D50	55	39
D84	90	66
D95	125	90

4.1.6 Riparian Corridor

A total of seven ocular assessments of riparian observations were recorded in Reach 1. The dominant overstory size class recorded was Large Trees (57%; 21-31.9-inch dbh), followed by Mature Trees (29%; >32-inch dbh) and Small Trees (14%; 9.0 – 20.9-inch dbh). The dominant overstory species were Cottonwood (57%), followed by Ponderosa pine (29%) and Quaking Aspen (14%; Figure 19). The dominant riparian understory size classes were Grassland/Forb (57%) and Shrub/Seedling (43%; 1.0 – 4.9-inch dbh). The understory species were recorded as primarily Dogwood (43%) and Other/Unknown (43%), and the remaining 14% as Alder (Figure 20). The Other/Unknown classification in this reach consisted of non-native species used in residential areas.

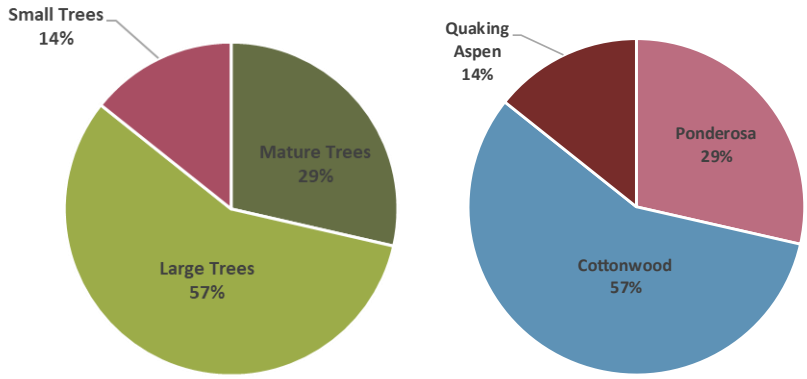


Figure 19. Dominant overstory riparian vegetation class and species, based on seven units surveyed, within 100 feet of Icicle Creek by ocular estimate.

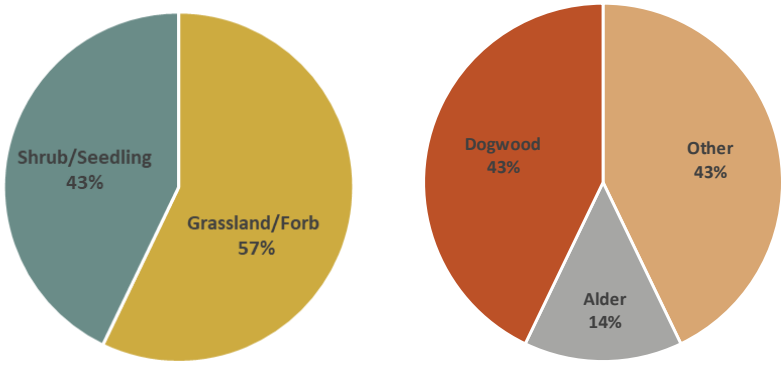


Figure 20.Dominant understory riparian vegetation class and species, based on seven units surveyed, within 100 feet of Icicle Creek by ocular estimate.

4.2 REACH 2

Location: River mile 1.24 – 3.02
Total length: 1.78
Survey Date: August 14 - 15, 2024

Figure 21. Representative photo of Reach 2.

4.2.1 Habitat Unit Composition

Reach 2 is the third longest reach in the study area at 1.78 miles. Reach 2 had the largest proportion of pool habitat area of all the reaches (91.5%). The remaining 8.5% of the habitat area is composed of glides (6%) and side channels (2.5%; Figure 22 - Figure 23). The stream gradient in Reach 2 is 0.07%. Reach 2 ends at the Leavenworth National Fish Hatchery.

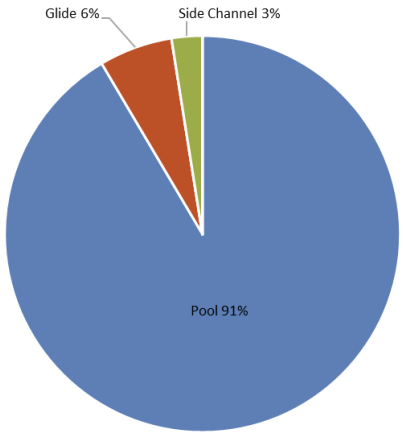


Figure 22. Stream habitat unit area composition for Reach 2.

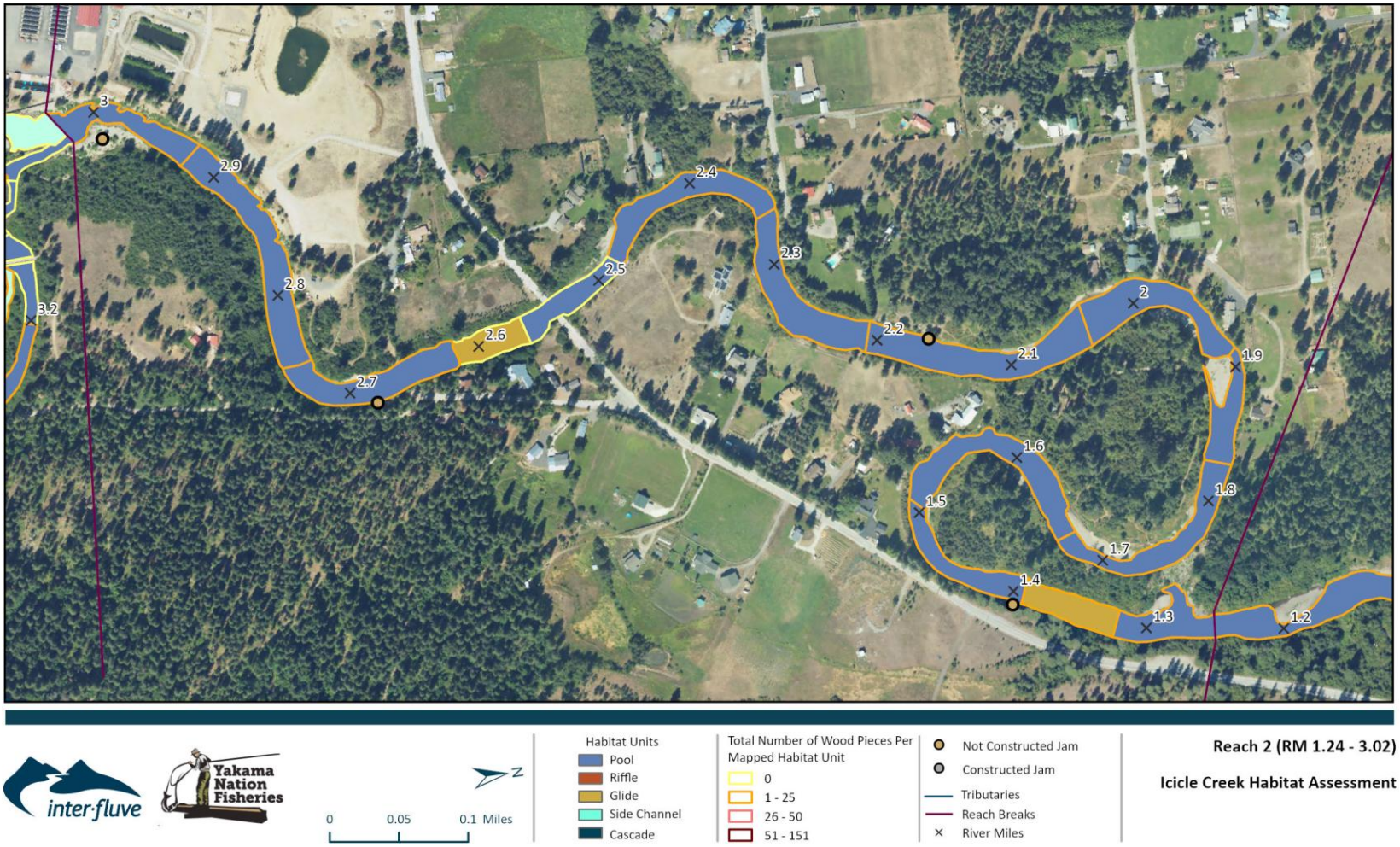


Figure 23. Map of the habitat unit composition and LWM in Reach 2 of Icicle Creek. LWM count includes individual pieces in jams.

4.2.2 Pools

A total of 14 pools were identified in Reach 2, averaging eight pools per mile. Of the 14 pools, 14% of pools had residual depths less than three feet, 50% had residual depths between three feet and six feet, and 36% of pools had residual depths greater than six feet. The average residual pool depth was six feet for Reach 2.

4.2.3 Side Channel Habitat

One side channel was present in Reach 2 and was 216 feet in length. The side channel was primarily slow-water at the time of survey. No LWM was observed in the side channel (Table 6).

Table 6. Side channels observed in Reach 2.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 2	216	Slow	0	0	0
Total	*216*		*0*	*0*	*0*

4.2.4 Large Woody Material

A total of 142 pieces of LWM was identified in Reach 2. This total includes individual pieces and pieces recorded in jams. LWM averaged 80 pieces per mile, and of that, 34 pieces of medium and large LWM combined per mile (Table 7). Of the total number of pieces, 36 pieces were counted in wood jams. Four jams were recorded in Reach 2, averaging two jams per mile.

Table 7. LWM quantities in Reach 2.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20in x 35 ft)	Total
Number of Individual Pieces	61	36	9	106
Number of Individual Pieces per Mile	34	25		60
Number of Total Pieces per Mile (including pieces in jams)	46	34		80
Number of Jams	4			
Number of Jams per Mile	2			
Estimated Wood Count in Jams	36			

4.2.5 Substrate & Fine Sediment

Two gravel counts were performed in Reach 2, with a combined average of 88% gravel, 10% cobble and 2% sand (Figure 24). GC24, the first gravel count, was conducted in a riffle crest at RM 2.09 and the second gravel count (GC23) was conducted in a channel spanning riffle crest near RM 2.77. Both cumulative distribution and grain size class can be found in Figure 25- Figure 26 and Table 8.

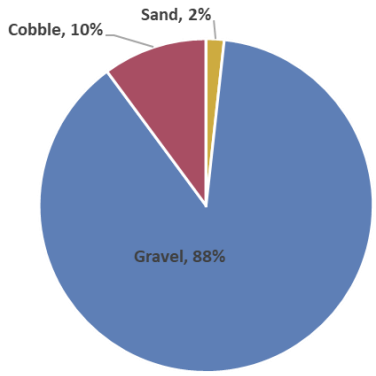


Figure 24. Combined percent sediment composition from the two gravel counts (GC24 and GC 23) performed in Reach 2.

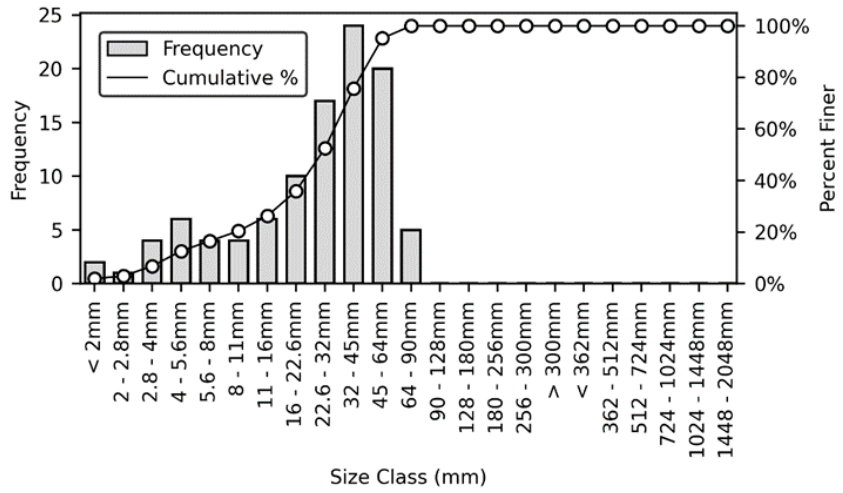


Figure 25. Cumulative distribution curve for GC24.

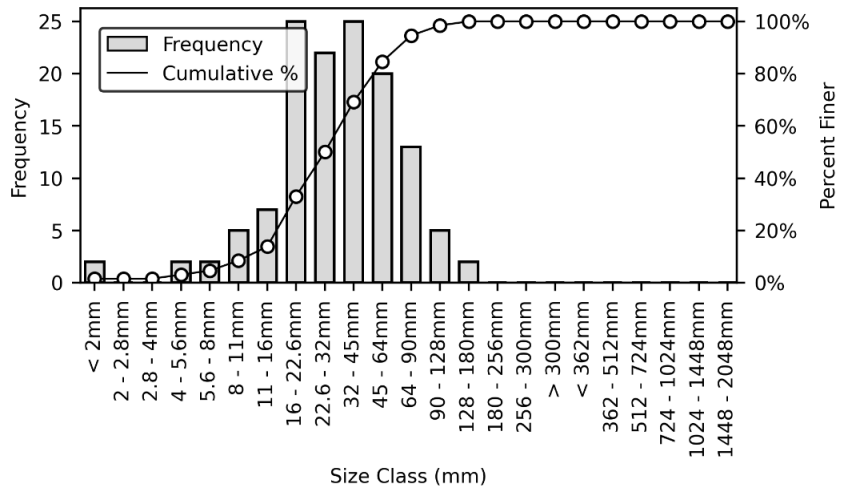


Figure 26. Cumulative distribution curve for GC23.

Table 8. Grain size class for GC24 and GC23 (assumed linear interpolation).

Size Class	GC24 Size percent finer than (mm)	GC23 Size percent finer than (mm)
D5	3	8
D16	8	17
D50	31	32
D84	52	62
D95	64	90

4.2.6 Riparian Corridor

Eleven channel units in Reach 2 included ocular assessment of riparian vegetation. The dominant overstory consisted of 75% Large Trees (21.0 - 31.9-inch dbh), 18% Other, and 9% No Vegetation. Ponderosa pine comprised 46% of the dominant overstory species, while Cottonwood and Other/Unknown were each recorded in 27% of measured units (Figure 27). The Other size class and species in Reach 2 were non-native species observed on residential properties. The dominant understory size class was recorded as 91% Shrub/Seedling (1.0 - 4.9-inch dbh) and 9% Grassland/Forb, with Dogwood as the dominant understory species (55%), followed by Willow (27%) and Alder (14%; Figure *28*).

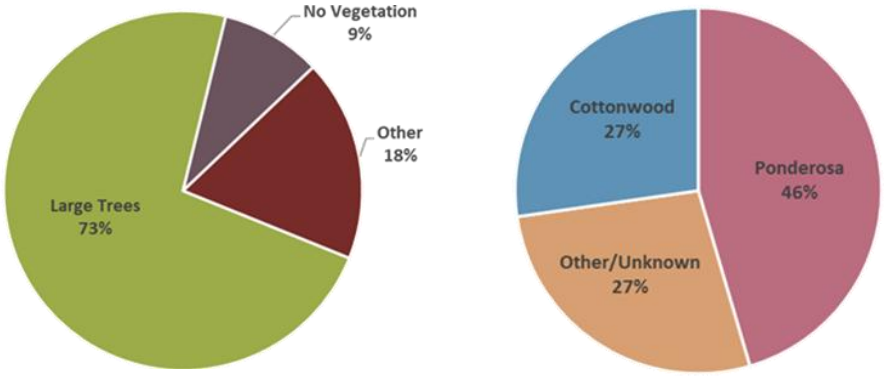


Figure 27. Dominant overstory riparian vegetation class and species, based on eleven units surveyed, within 100 feet of Icicle Creek by ocular estimate.

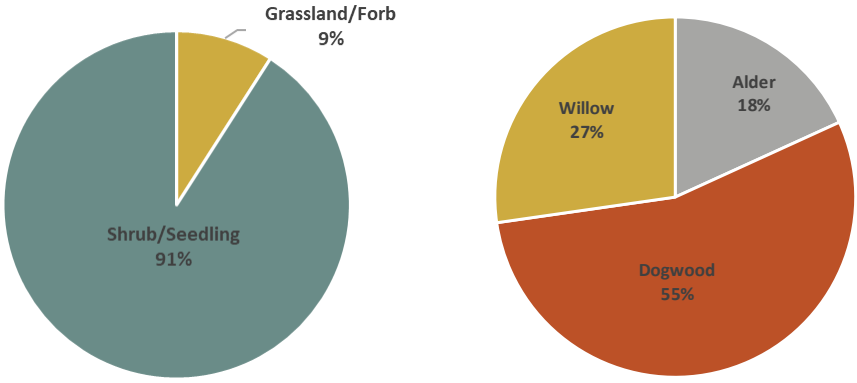


***Figure** 28. Dominant understory riparian vegetation class and species, based on eleven surveyed units, within 100 feet of Icicle Creek by ocular estimate.*

4.3 REACH 3

Location: River mile 3.02 – 4.3
Total length: 1.28 miles
Survey Date: August 15 - 16, 2024

Figure 29. Representative photo of Reach 3.

4.3.1 Habitat Unit Composition

Reach 3 is the natural channel of Icicle Creek that flows parallel to the Leavenworth National Fish Hatchery diversion channel. This channel is 1.28 miles long and has a stream gradient of approximately 0.24%. Habitat unit composition within the reach was 75% pools, 13% glides, 3% riffle and 9% side channel (Figure 30 and Figure 31).

Two anthropogenic structures were observed in this reach – Structure 5 at the downstream end (RM 2.95) and Structure 2 at the upstream end (RM 4.8). Structure 2 located at the upstream end of Reach 3; the water surface level drops approximately 5 feet from upstream to the downstream end of the structure. Structure 2 narrows the river from a wetted width of 110 to 20 feet and functions to control the flow into/out of the natural channel and hatchery diversion channel.

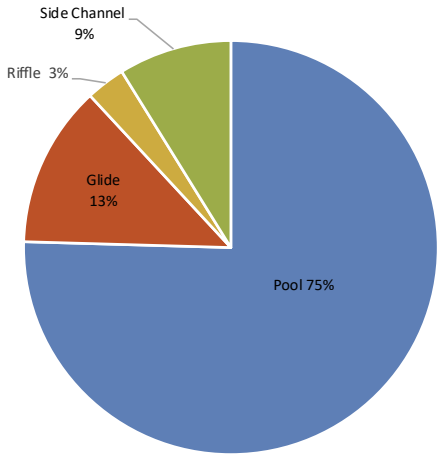


Figure 30. Stream habitat unit area composition of Reach 3.

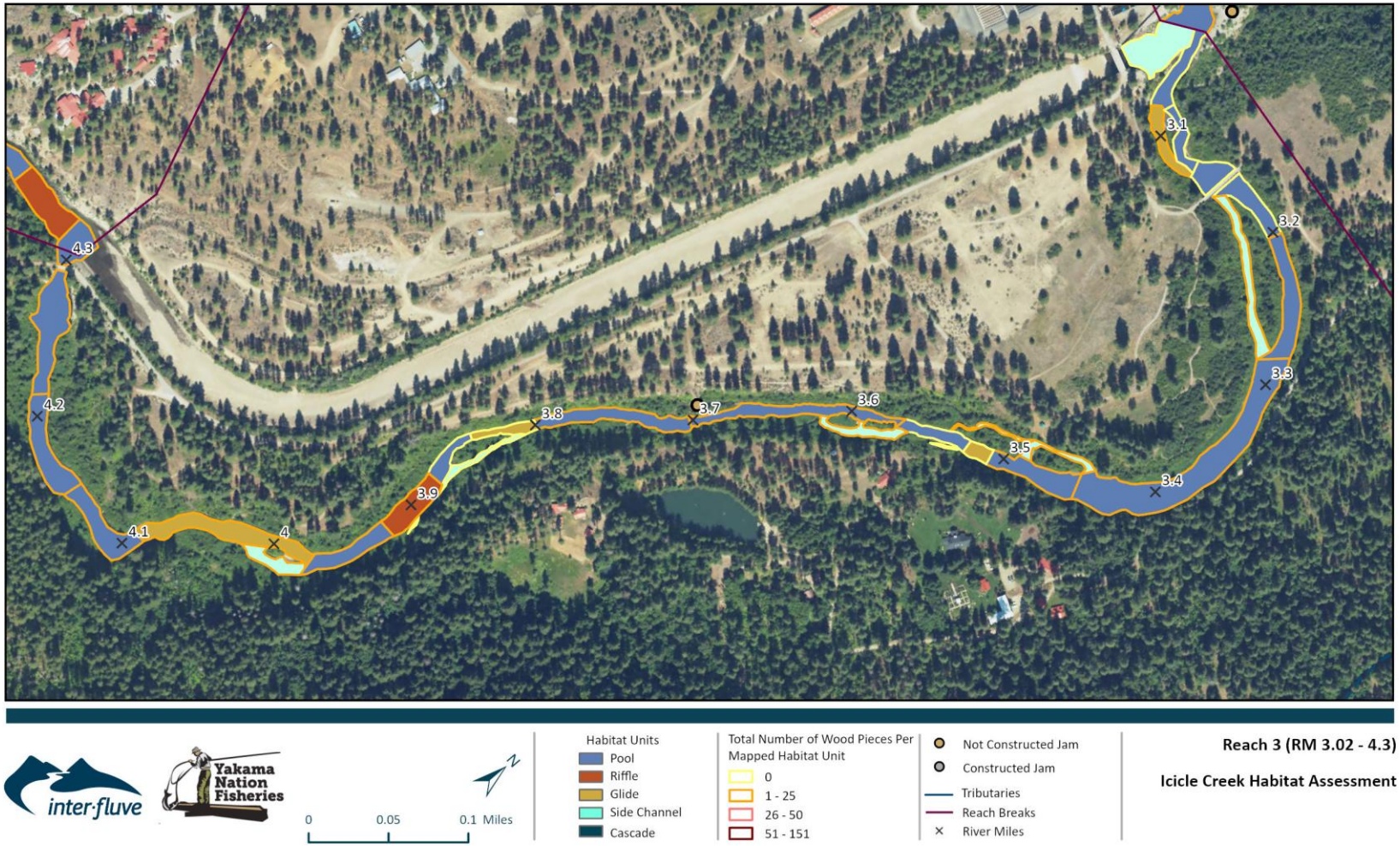


Figure 31. Map of the habitat unit composition and LWM in Reach 3 of Icicle Creek. LWM count includes pieces in jams.

4.3.2 Pools

A total of 15 pools were identified in Reach 5, averaging 12 pools per mile and comprising 75% of the total habitat area in the reach. The average residual pool depth was three feet. Residual pool depths ranged from 1.5 feet to 7.1 feet. Of the 15 pools, eight pools (40%) had a residual depth less than three feet, six pools (50%) had residual pool depths between three and six ft, and one pool (10%) had a residual depth greater than six feet.

4.3.3 Side Channel Habitat

Eight side channels were identified in Reach 3 (Table 9) comprising 9% of the total habitat area. All side channel units were recorded as predominately slow-water at the time of the survey. The total length of all eight channels is 2,053 feet, averaging 257 feet in length. A total of eight small pieces of LWM were observed in the side channels. No jams were recorded in side channels.

Table 9. Side channels observed in Reach 3.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 3	554	Slow	2	0	0
Side 4	275	Slow	1	0	0
Side 5	290	Slow	2	0	0
Side 6	95	Slow	0	0	0
Side 7	293	Slow	2	0	0
Side 8	281	Slow	0	0	0
Side 9	64	Slow	0	0	0
Side 10	201	Slow	1	0	0
Total	*2,053*		*8*	*0*	*0*

4.3.4 Large Woody Material

A total of 61 pieces of LWM pieces were recorded in Reach 3. This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 48 pieces of LWM per mile, with 10 of those pieces per mile being Medium and Large LWM. There was one jam observed in Reach 3. A total of five LWM pieces were observed in the jam (Table 10).

Table 10. LWM quantities in Reach 3.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20in x 35 ft)	Total
Number of Individual Pieces	45	9	2	56
Number of Individual Pieces per Mile	35	9		44
Number of Total Pieces per Mile (including pieces in jams)	38	10		48
Number of Jams	1			
Number of Jams per Mile	2			
Estimated Wood Count in Jams	5			

4.3.5 Substrate & Fine Sediment

One gravel count (GC22) was conducted in Reach 3 at an irregular riffle crest near RM 3.44. The irregularity in the location is due to the surveyor avoiding active redds in the reach. The composition of the count was predominantly gravel (87%), followed by cobbles (12%) and sand (1%; Figure 32). The distribution and grain size class can be found in Figure 33 and Table 11.

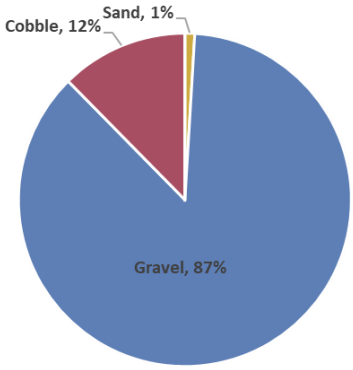


Figure 32. Percent of sediment composition from the gravel count (GC22) performed in Reach 3.

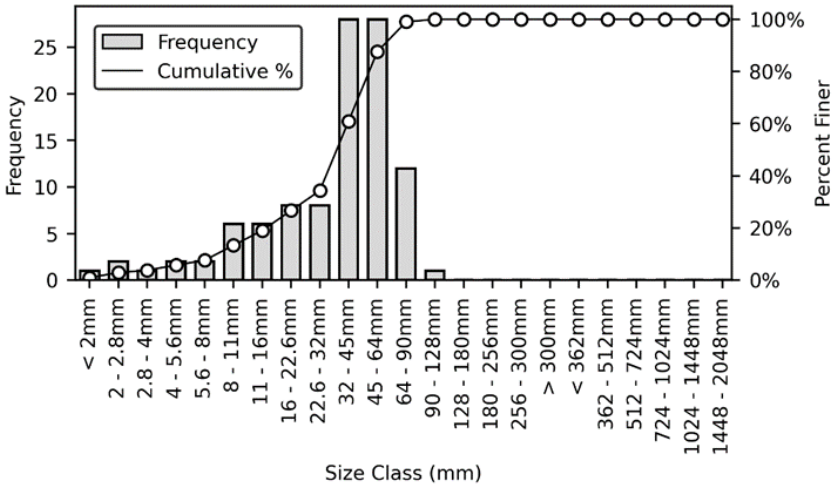


Figure 33. Cumulative distribution curve for GC22.

Table 11. Grain size class for GC22 (assumed linear interpolation).

	GC22
Size Class	*Size percent finer than (mm)*
D5	5
D16	13
D50	39
D84	61
D95	80

4.3.6 Riparian Corridor

Seven channel units in Reach 3 included ocular assessment of riparian vegetation. The overstory was primarily Large Trees (86%; 21.0 - 31.9-inch dbh) with the remaining units observed as Small Trees (14%; 9.0 - 20.9-inch dbh). Changes to the riparian vegetation within 100 feet of Icicle Creek were noted in Reach

3, resulting from the Leavenworth National Fish Hatchery. The dominant overstory species was Ponderosa pine (86%), followed by Alder (14%; Figure 34). The dominant understory was recorded as entirely the Shrub/Seedling (100%) size class. The dominant understory species was Dogwood (72%), followed by Willow and Alder each with 14% (Figure 35).

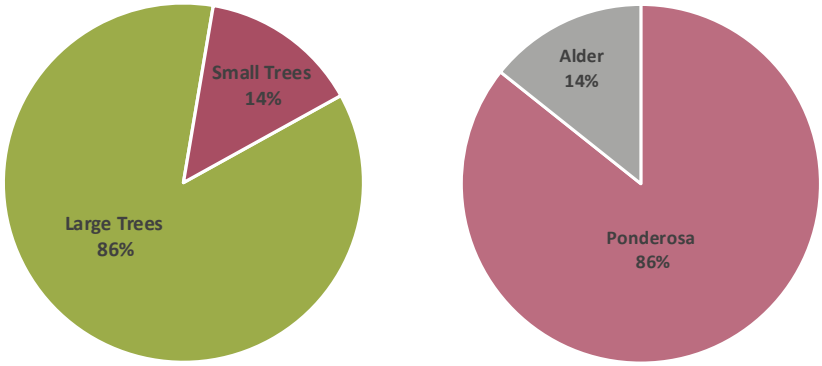


Figure 34. Dominant overstory riparian vegetation class and species, based on seven units surveyed, within 100 feet of Icicle River by ocular estimate.

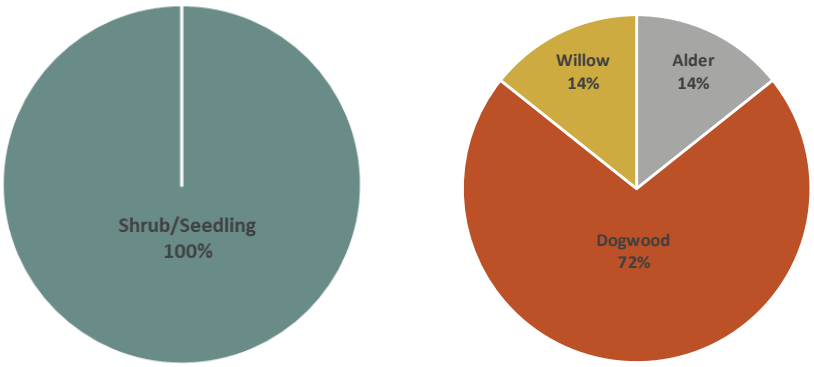


Figure 35. Dominant understory riparian vegetation class and species, based on seven units surveyed, within 100 feet of Icicle River by ocular estimate.

4.4 REACH 4

Location: River mile 4.3 – 5.05
Total length: 0.75 miles
Survey Date: August 26 – 27, 2024

Figure 36. Representative photo of Reach 4. Habitat is dominated by riffle units.

4.4.1 Habitat Unit Composition

Reach 4 begins at the upstream end of the Leavenworth National Fish Hatchery diversion channel and Structure 2, approximately 0.75 miles in length. This reach marks an increase in riffle habitat, composing 66% of the total reach area. Pool habitat was 28% of the total reach area, followed by side channel habitat (6%; Figure 37). Channel gradient through Reach 4 is 1.65%, marking a substantial departure from the lower gradient Reaches 1-3. Reach 4 ends at a water diversion canal (RM 5.05) for the LNFH and the Cascade Orchard Irrigation District[1]. A project sponsored by the Bureau of Reclamation to replace and modernize the water intake while creating a roughened channel and fishway (WDOE, 2019; WDFW, 2025). Photos of the diversion are included below (Figure 39 and Figure 40).

[1] As of May 2025, the Cascade Orchard Irrigation District diversion is located at RM 1.9 (WDOE, 2019; personal communication, Ingrid Ekstrom, WA Department of Ecology, October 2025).

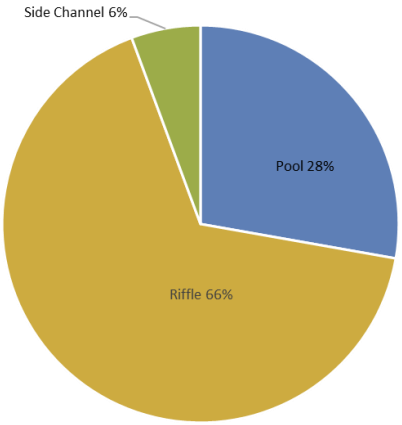


Figure 37. Stream habitat unit area composition of Reach 4.

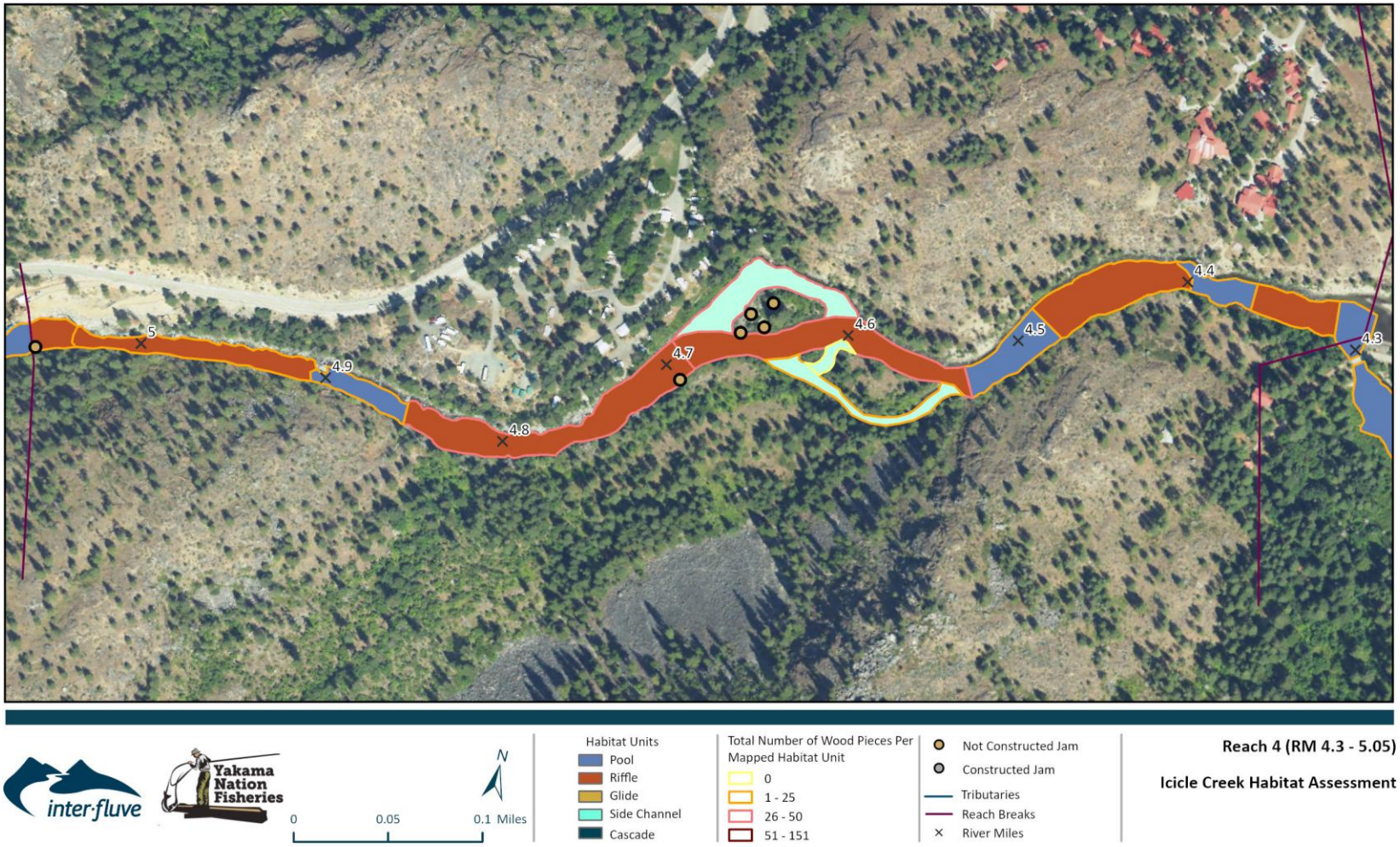


Figure 38. Map of the habitat unit composition and LWM in Reach 4. LWM count includes pieces in jams.

Figure 39. Photo of the fishway looking upstream at the surface water intake for the LNFH and Cascade Orchard Irrigation District[1].

[1] As of May 2025, the Cascade Orchard Irrigation District diversion is located at RM 1.9 (WDOE,2019; personal communication, Ingrid Ekstrom, WA Department of Ecology, October 2025).

Figure 40. Photo of the LNFH and Cascade Orchard Irrigation District[1] surface water intake project completed by the USBR (WDOE, 2019)

4.4.2 Pools

Reach 4 had five total pools, all of which had a residual pool depth between three and six feet. Residual pool depths ranged from 3.5 feet to 5.5 feet, with an average of 4.5 feet (compared to the 4.4 feet for the study area average). The mean pool spacing for this reach was eight pools per mile, less than the study area average of seven pools per mile.

4.4.3 Side Channel Habitat

Three side channels were observed in Reach 4, with a total combined length of approximately 1,135 ft. One side channel was predominantly fast water (e.g., riffle and glide habitat within the side channel), while the other two were predominantly slow water at the time of the survey. A total of 39 pieces of LWM and two jams with an estimated 25 pieces of LWM were observed in the three side channels (Table 12).

[1] As of May 2025, the Cascade Orchard Irrigation District Diversion is located at RM 1.9 (WDOE,2019; personal communication, Ingrid Ekstrom, WA Department of Ecology, October 2025).

Table 12. Side channels observed in Reach 4.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 11	561	Slow	9	0	0
Side 12	471	Slow	5	2	25
Side 13	104	Fast	0	0	0
Total	*1,135*		*14*	*0*	*0*

4.4.4 Large Woody Material

Reach 4 had a total of 144 pieces of LWM observed. This total includes individual pieces and pieces recorded in jams. Of the total, 62 (43%) pieces of LWM were observed in wood jams. Surveyors observed six wood jams in Reach 4, equating to eight jams per mile. There were 192 pieces of LWM per mile, with 87 being medium and large LWM (Table 13).

Table 13. LWM quantities in Reach 4.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20in x 35 ft)	Total
Number of Individual Pieces	52	22	8	82
Number of Individual Pieces per Mile	69	40		109
Number of Total Pieces per Mile (including pieces in jams)	105	87		192
Number of Jams	6			
Number of Jams per Mile	4			
Estimated Wood Count in Jams	62			

4.4.5 Substrate & Fine Sediment

Two gravel counts were performed in Reach 4, with a combined average of 46% boulder, 41% cobbles, 12% gravel and 1% sand (Figure 41). The two gravel counts, GC21 and GC20, were conducted at riffle crests at RM 4.47 and RM 4.68, respectively. The distribution and grain size class can be found in Figure 42 -Figure 43 and Table 14.

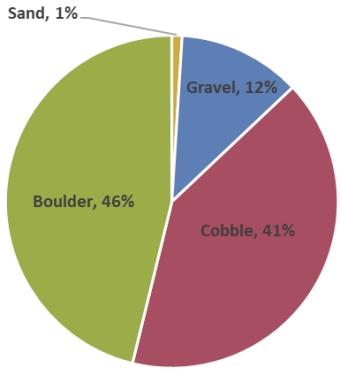


Figure 41. Combined percent sediment composition from the two gravel counts (GC21 and GC20) performed in Reach 4.

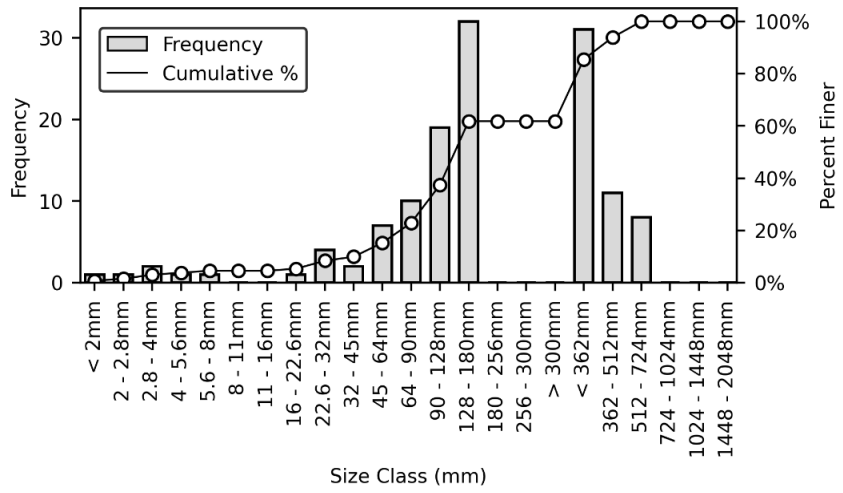


Figure 42. Cumulative distribution curve for GC21.

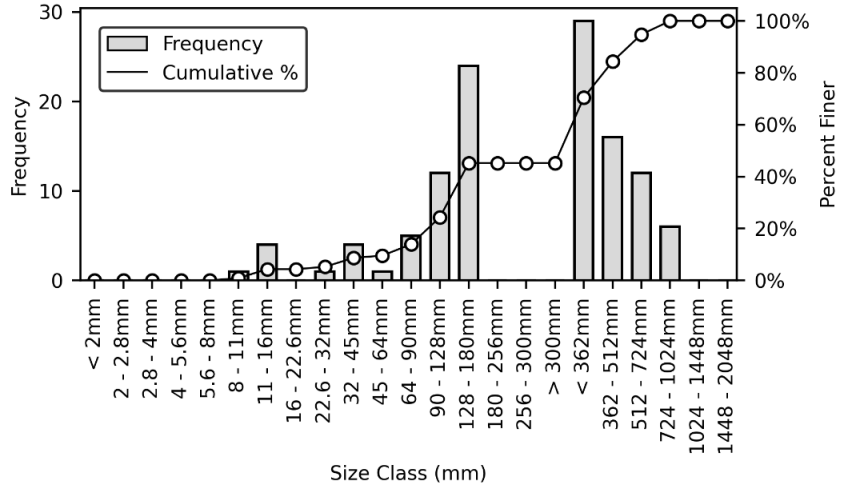


Figure 43. Cumulative distribution curve for GC20.

Table 14. Grain size class for GC21 and GC20 (assumed linear interpolation).

Size Class	GC21 *Size percent finer than (mm)*	GC20 *Size percent finer than (mm)*
D5	19	30
D16	65	96
D50	180	275
D84	350	510
D95	512	724

4.4.6 Riparian Corridor

Four channel units included ocular assessment of riparian vegetation in Reach 4. The overstory was dominated (100%) by Large Trees (21.0 - 31.9-inch dbh), with all units documented as Ponderosa pine (Figure 44). The understory was dominated (100%) by the Shrub/Seedling (1.0 - 4.9-inch dbh) size class and consisted of Alder (75%) and Dogwood species (25%; Figure 45).

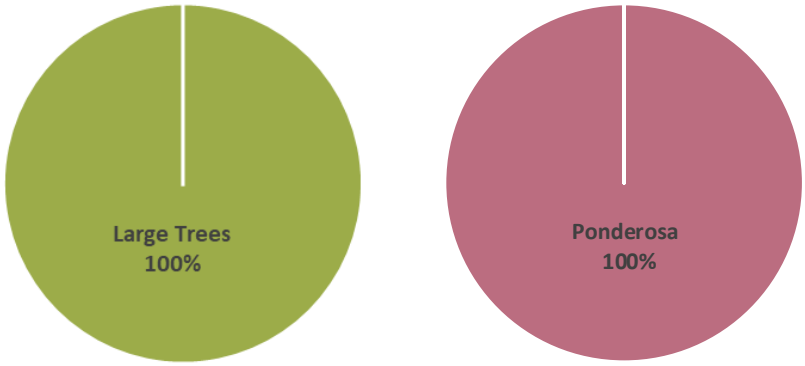


Figure 44. Dominant overstory riparian vegetation class and species within 100 feet of Icicle Creek, based on four units surveyed by ocular estimate.

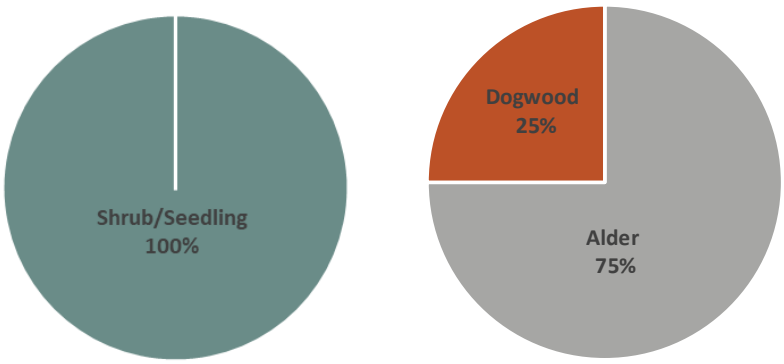


Figure 45. Dominant understory riparian vegetation species, based on four units surveyed, within 100 feet of Icicle Creek by ocular estimate.

4.5 REACH 5

Location: River mile 5.05 – 6.27
Total length: 1.22 miles
Survey Date: August 27 – 29, 2024

Figure 46. Representative photo of Reach 5. Habitat is dominated by riffle units

4.5.1 Habitat Unit Composition

Reach 5 consists predominantly of riffle units, which account for 50% of the habitat area recorded. Pool units were the second most prevalent with 26% of the habitat area. Side channels composed 18% of Reach 5's habitat unit area, one glide channel unit composed 3% of the habitat unit area and one cascade unit accounted for the remaining 3% (Figure 47). Reach 5 was 1.22 miles long with a channel gradient of 3.4%; almost double the gradient of Reach 4. The majority of left bank, where Icicle Road (FR 7600) follows the river and residential homes reside, is armored with riprap. Much of the reach was not wadable for the habitat survey crew due to the confined, steep nature of the channel, and data is based on ocular estimates from the crew walking along the banks.

At the upstream end of Reach 5 is the Icicle-Peshastin Irrigation Canal and City of Leavenworth diversion structure (WDFW, 2025; Figure 48). The diversion included a 3-foot-tall concrete dam with an additional

one-half foot of wooden planks to increase height. The structure has been modified to improve fish pass but may still act as a barrier during a subset of flows.

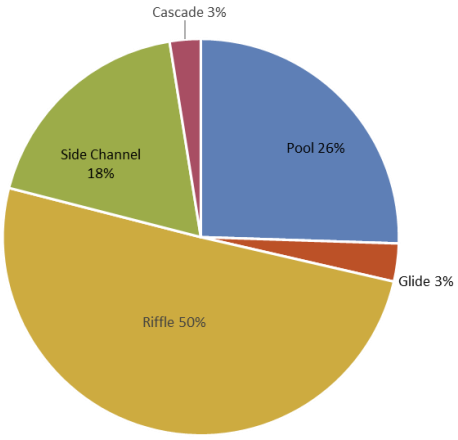


Figure 47. Stream habitat unit area composition for Reach 5.

Figure 48. Water diversion structure located at the upstream end of Reach 5.

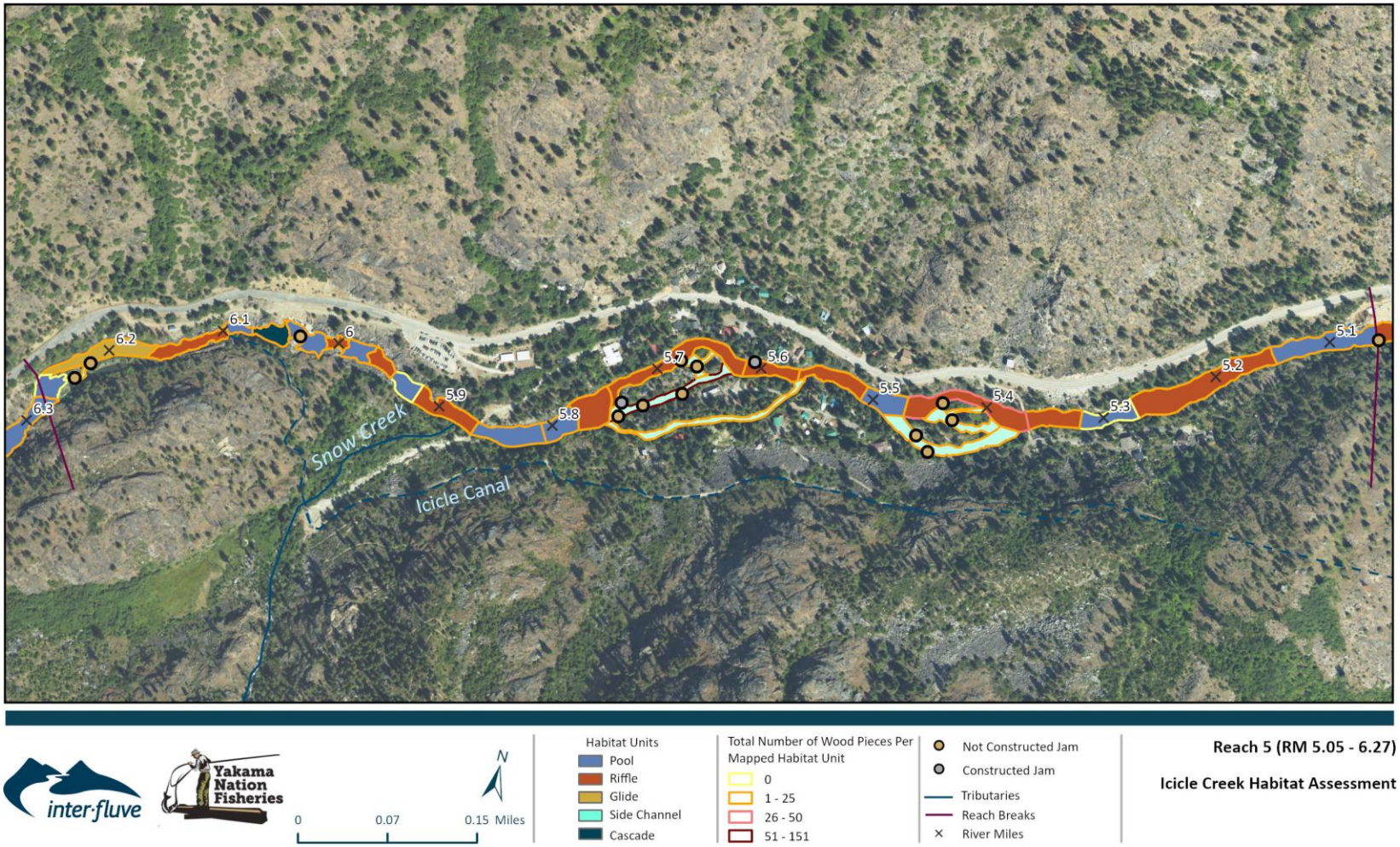


Figure 49. Map of the habitat unit composition and LWM in Reach 5 of Icicle Creek. LWM count includes pieces in jams.

4.5.2 Pools

A total of 9 pools were observed in Reach 5, which equates to approximately seven pools per mile. Two pools (22%) had residual pool depths less than three feet and five pools (56%) had residual depths between three and six feet. Two pools (22%) had a residual depth of six feet or more. Residual pool depths ranged from a low of 1.6 feet to a high of 7.5 feet, with a residual pool depth average of 4.2 feet (slightly less than the study area average of 4.4 feet).

4.5.3 Side Channel Habitat

Reach 5 had eight side channels recorded. All side channels were recorded as primarily fast water (e.g., riffle and glide habitat within the side channels). The total combined length of the side channels in Reach 5 was 2,814 feet. There were 36 LWM pieces observed in the side channels and nine jams with 101 pieces of LWM recorded (Table 15).

Table 15. Side channels observed in Reach 5.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 14	605	Fast	12	2	11
Side 15	304	Fast	3	1	12
Side 16	165	Fast	9	0	0
Side 17	935	Fast	2	0	0
Side 18	568	Fast	7	3	56
Side 19	98	Fast	2	2	4
Side 20	78	Fast	0	1	18
Side 21	61	Fast	1	0	0
Total	*2,814*		*36*	*9*	*101*

4.5.4 Large Woody Material

A total of 252 pieces of LWM were recorded in Reach 5. This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 207 pieces of LWM per mile, with 107 of those pieces per mile being Medium and Large LWM. Fourteen jams were observed in this reach, yielding 11 jams per mile. The jams contained approximately 143 pieces of LWM, about 57% of LWM in the entire reach (Table 16).

Table 16. LWM quantities in Reach 5.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20in x 35 ft)	Total
Number of Individual Pieces	56	38	15	109
Number of Individual Pieces per Mile	46	43		89
Number of Total Pieces per Mile (including pieces in jams)	99	107		207
Number of Jams	14			
Number of Jams per Mile	11			
Estimated Wood Count in Jams	143			

4.5.5 Substrate & Fine Sediment

No gravel counts were performed in Reach 5. Conditions were not appropriate or safe to complete a gravel count. Substrate was dominated by boulders.

4.5.6 Riparian Corridor

Three channel units in Reach 5 included ocular assessment of riparian vegetation. Large Trees (21.0 - 31.9-inch dbh) were the dominant overstory size class (100%). Ponderosa pine was the dominant overstory species, accounting for 67% of units. Cedar was also observed as an overstory species (33%; Figure 50). The dominant understory was comprised of entirely Shrub/Seedling vegetation size classes, with Alder as the primary understory species (Figure 51).

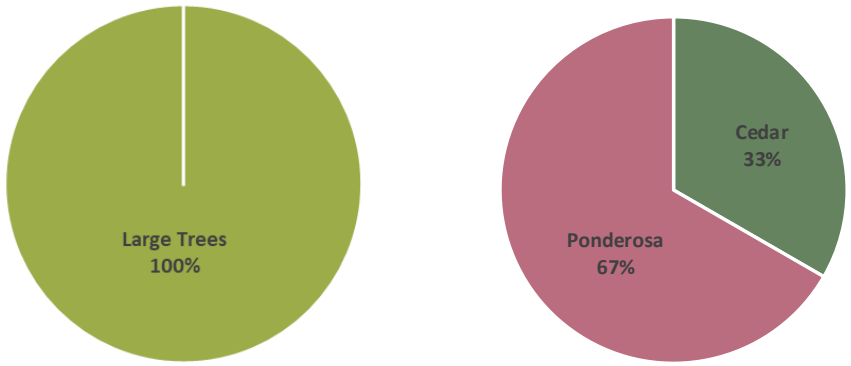


Figure 50. Dominant overstory riparian vegetation class and species, based on three nth units surveyed, within 100 feet of Icicle Creek by ocular estimate.

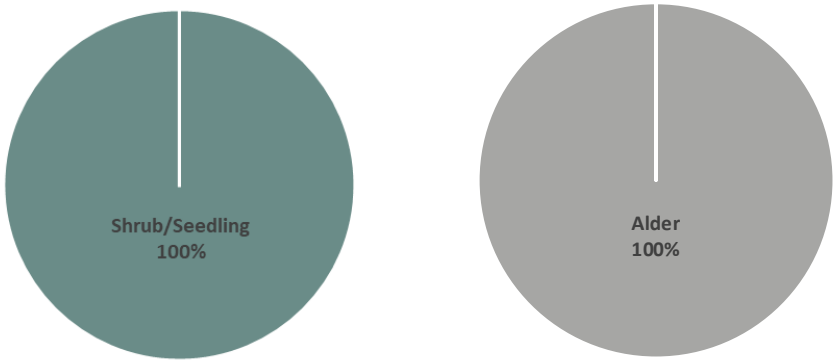


Figure 51. Dominant understory riparian vegetation class and species, based on three nth units surveyed, within 100 feet of Icicle Creek by ocular estimate.

4.6 REACH 6

Location: River mile 6.27 – 7.15
Total length: 0.88 miles
Survey Date: August 29 – 30, 2024

Figure 52. Representative photo of Reach 6. The habitat was dominated by riffles.

4.6.1 Habitat Unit Composition

Reach 6 was 0.88 miles long and the channel gradient was 3.82%, the steepest within the study area (study area average is 1.7%). The dominant habitat type was riffle, making up 67% of the total reach area. Pool habitat was the second most common habitat type within Reach 6, consisting of 32% of the study area habitat, followed by cascade (1%; Figure 53). One cascade unit was identified in Reach 6. The cascade (Figure 54) was located in the boulder field assessed by Dominguez et al. (2013). The entire left bank, where Icicle Road (FR 7600) follows the river, was armored with riprap. Much of the reach was not wadable for the habitat survey crew due to the confined, steep nature of the channel, and data is based on ocular assessment by the crew walking along the banks.

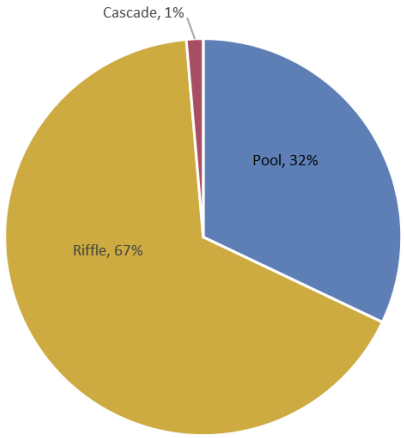


Figure 53. Stream habitat unit area composition of Reach 6.

Figure 54. Cascade units identified in Reach 6.

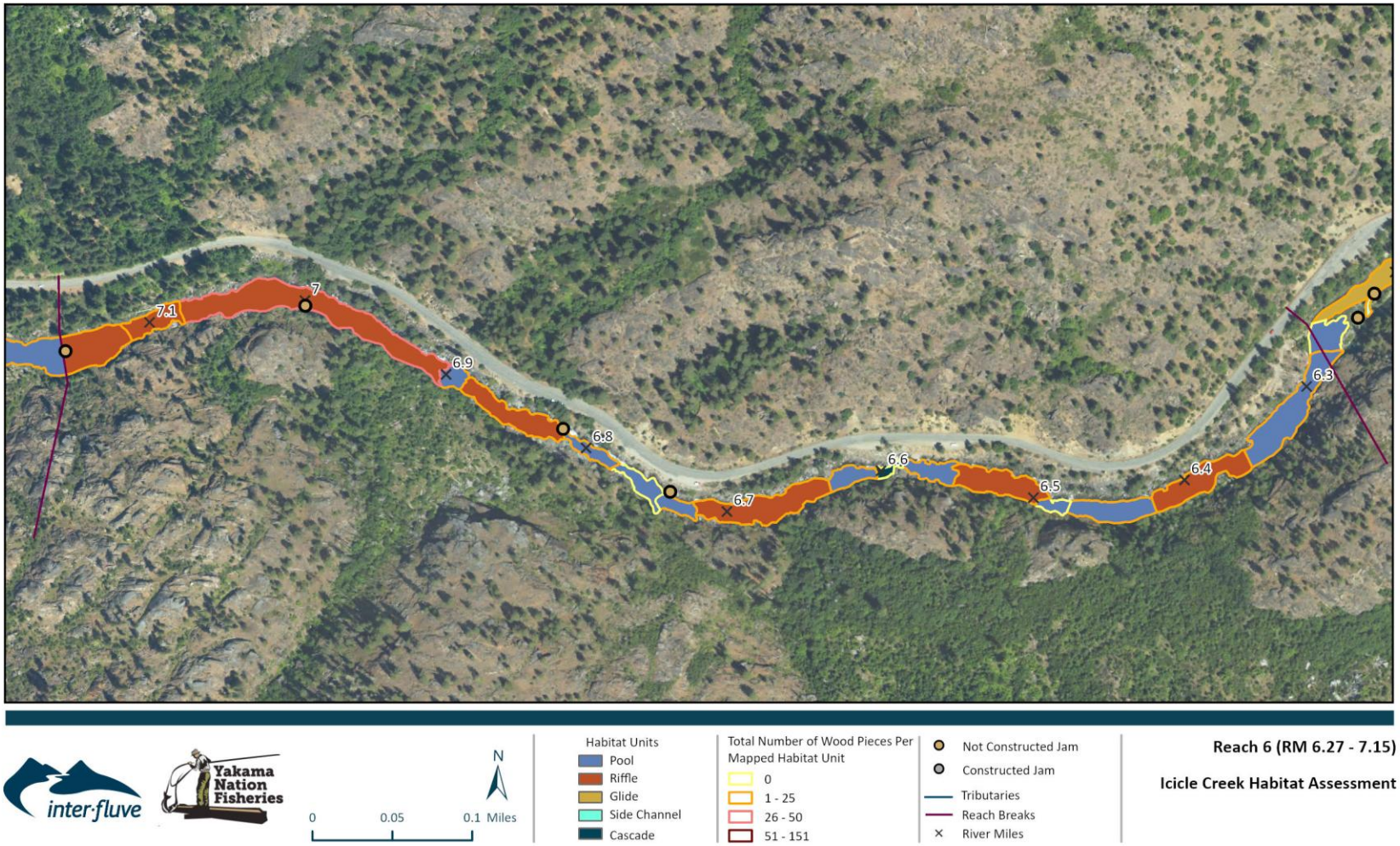


Figure 55. Map of the habitat unit composition and LWM in Reach 6 of Icicle Creek. LWM count includes pieces in jams.

4.6.2 Pools

Reach 6 had nine pools observed. Mean pool spacing for this reach was ten pools per mile, compared to the study area average pool spacing of seven pools per mile. Average residual depth of the pools was 5.5 ft and ranged from 2.3 ft to 14.7 ft. Of the nine pools, one pool (11%) had a residual pool depth less than three feet, four pools (67%) had a residual pool depth between three and six feet, and five pools (22%) has residual pool depths greater than or equal to six feet.

4.6.3 Side Channel Habitat

No side channels were observed in Reach 6.

4.6.4 Large Woody Material

One hundred-eighteen pieces of LWM were recorded in Reach 6. This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 134 pieces of LWM per mile, with 55 of those pieces per mile being Medium and Large LWM. Four jams were recorded within Reach 6 and contained an estimated 29 pieces of LWM or 25% of the total LWM pieces within the reach (Table 17).

Table 17. LWM quantities in Reach 6.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20in x 35 ft)	Total
Number of Individual Pieces	53	27	9	89
Number of Individual Pieces per Mile	60	41		101
Number of Total Pieces per Mile (including pieces in jams)	80	55		134
Number of Jams	4			
Number of Jams per Mile	5			
Estimated Wood Count in Jams	29			

4.6.5 Substrate & Fine Sediment

No gravel counts were performed in Reach 5. Conditions were not appropriate or safe to complete a gravel count. Substrate was dominated by boulders.

4.6.6 Riparian Corridor

Six channel units in Reach 6 included ocular assessment of riparian vegetation. The dominant overstory observed was Small Trees (80%; 9.0 - 20.9-inch dbh). Shrub/Seedling (20%; 1.0 - 4.9-inch dbh) composed the remaining overstory. Ponderosa pine was the dominant overstory species for all surveyed units (100%; Figure 56). The dominant understory in Reach 6 was Shrub/Seedling (60%; 1.0 - 4.9-inch dbh) and Grassland/Forb (40%). Alder (60%) and Other (40%) were the dominant understory species observed (Figure 57). Other understory species observed included grasslands and mosses, a classification outside the scope of the survey. Evidence of historical wildfires (e.g., burned trunks) was also noted on trees within the Reach 6 riparian zone.

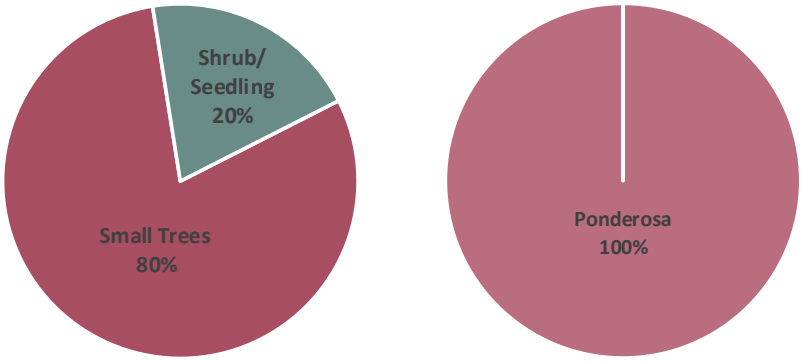


Figure 56.Dominant overstory riparian vegetation class and species, based on six units surveyed, within 100 feet of Icicle Creek by ocular estimate.

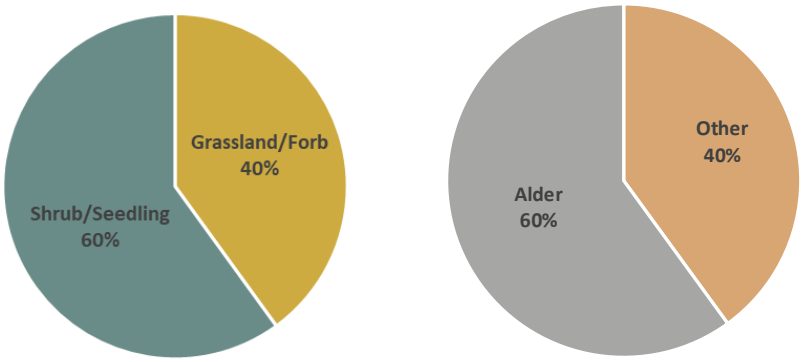


Figure 57. Dominant understory riparian vegetation class and species, based on six units surveyed, within 100 feet of Icicle Creek by ocular estimate.

4.7 REACH 7

Location: River mile 7.15 – 8.63
Total length: 1.48 miles
Survey Date: August 30 – 31, 2024

Figure 58. Representative photo of Reach 7. The habitat was dominated by riffles.

4.7.1 Habitat Unit Composition

Reach 7 was 1.48 miles long and continues the trend of predominantly fast water unit channel composition and higher stream gradients. Reach 7 is predominantly riffles (66%), followed by pools (23%) and side channels (11%; Figure 59). The stream gradient of this reach is 3.19%, which is steeper than than the study area average of 1.7%. Much of the reach was not wadable for the habitat survey crew due to the confined, steep nature of the channel, and data is based on ocular estimates from the crew walking along the banks.

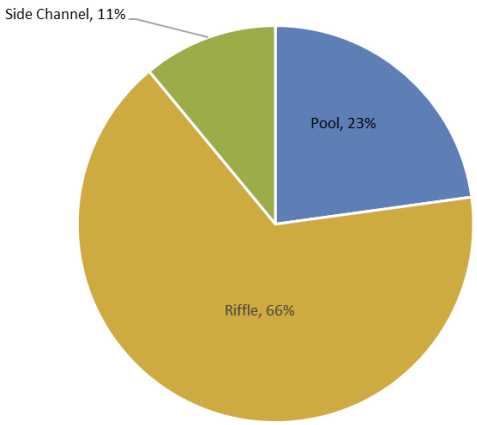


Figure 59. Stream habitat unit area composition of Reach 7.

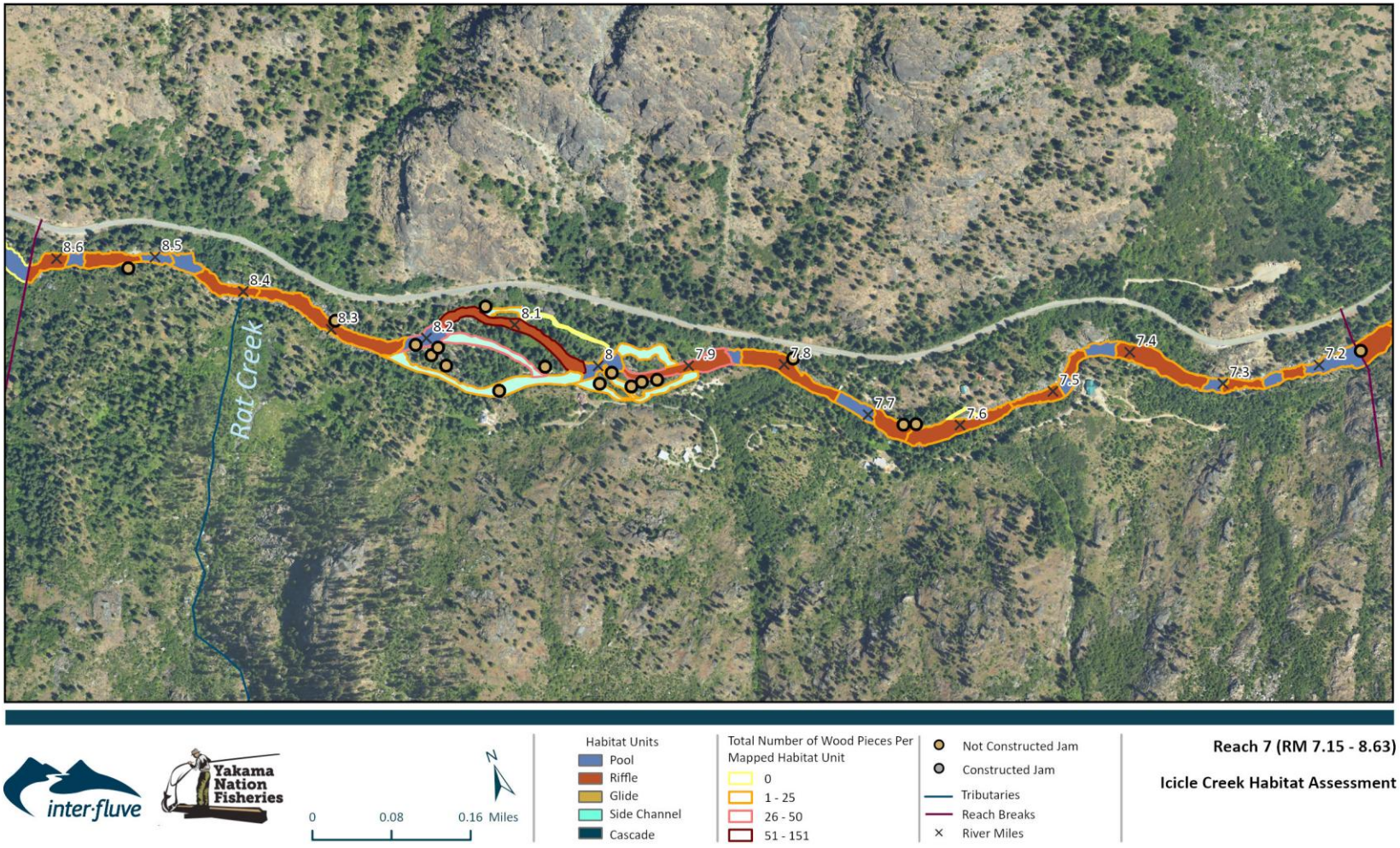


Figure 60. Map of the habitat unit composition and LWM in Icicle Creek in Reach 7. LWM count includes pieces in jams.

4.7.2 Pools

Twelve pool units were observed in Reach 7. Of those, eight pools (67%) had a residual depth between three and six feet, while four pools (33%) had a residual depth greater than six feet. Residual depth averaged 4.2 feet and ranged from 2.3 feet to 6 feet. Mean pool spacing in Reach 7 was eight pools per mile, greater than the average of seven pools per mile for the study area.

4.7.3 Side Channel Habitat

Reach 7 had eight recorded side channels. Of the eight side channels, only one side channel was dominated by slow water. The other seven side channels were dominated by fast water (e.g., riffle and glide habitat within the side channels). The total length of all the side channels in Reach 7 is 3,759 ft. A total of 96 pieces of LWM was recorded in the side channels. Seven jams were observed in the side channels and contained approximately 74 LWM pieces (Table 18).

Table 18. Side Channels observed in Reach 7.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 22	185	Fast	0	0	0
Side 23	634	Fast	6	2	16
Side 24	238	Slow	0	1	5
Side 25	330	Fast	10	0	0
Side 26	519	Fast	0	0	0
Side 27	1,044	Fast	6	2	14
Side 28	562	Fast	3	1	26
Side 29	246	Fast	7	1	13
Total	*3,759*		*32*	*7*	*74*

4.7.4 Large Woody Material

A total of 409 pieces of LWM was recorded in Reach 7. This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 276 pieces of LWM per mile, with 155 of those pieces per mile being Medium and Large LWM. Sixteen jams were recorded in Reach 7 containing 48% of LWM within the reach (Table 19).

Table 19. LWM quantities in Reach 7.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20in x 35 ft)	Total
Number of Individual Pieces	78	65	69	212
Number of Individual Pieces per Mile	53	91		143
Number of Total Pieces per Mile (including pieces in jams)	122	155		276
Number of Jams	16			
Number of Jams per Mile	11			
Estimated Wood Count in Jams	197			

4.7.5 Substrate & Fine Sediment

No gravel counts were performed in Reach 5. Conditions were not appropriate or safe to complete a gravel count. Substrate was dominated by boulders.

4.7.6 Riparian Corridor

Eleven channel units in Reach 7 included ocular assessment of riparian vegetation conditions. The dominant overstory in Reach 7 was Small Trees (28%; 9.0 - 20.9-inch dbh) followed by Shrub/Seedling (18%; 1.0 - 4.9-inch dbh), Sapling/Pole (18%; 5.0 - 8.9-inch dbh), Large Trees (18%; 21.0 - 31.9-inch dbh) and Mature Trees (18%; > 32-inch dbh). The dominant overstory species was Ponderosa pine (55%) followed by Cottonwood (27%), then Quaking Aspen (18%; Figure 61). The primary understory size class observed was Shrub/Seedling (82%; 1.0 - 4.9-inch dbh) and Sapling/Pole (18%; 5.0 - 8.9-inch dbh). Alder (46%) is the dominant understory species in Reach 7, followed by Willow (36%), then Cottonwood (18%; Figure 62).

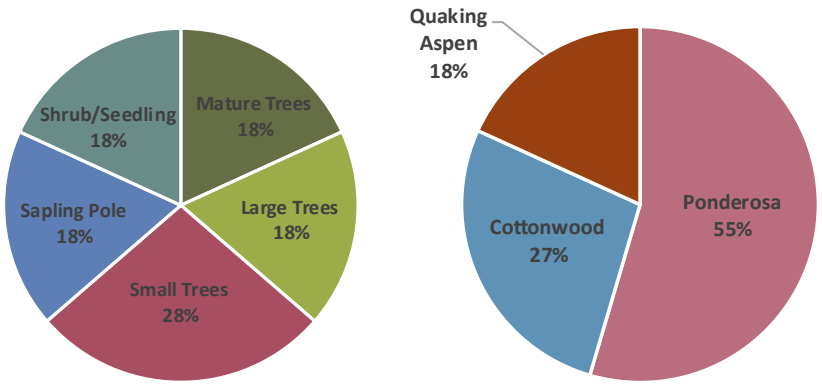


Figure 61. Dominant overstory riparian vegetation class and species, based on 11 units surveyed, within 100 feet of Icicle Creek by ocular estimate.

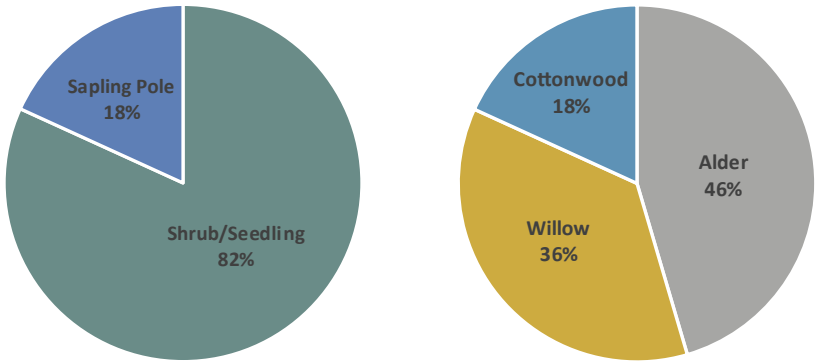


Figure 62. Dominant understory riparian vegetation class and species, based on 11 units surveyed, within 100 feet of Icicle Creek by ocular estimate.

4.8 REACH 8

Location: River mile 8.63 – 9.63
Total length: 1.0 miles
Survey Date: July 30, August 31 – September 1, 2024

Figure 63. Representative photo of Reach 8 of Icicle Creek. The habitat was dominated by riffles.

4.8.1 Habitat Unit Composition

Reach 8 is 1.0 miles long and had primarily riffle habitat unit types (68%). The second most prevalent unit type was side channels (22%), with pool units composing the remaining 10% of habitat area (Figure 64). Reach 8 had the most LWM observed within the study area. Channel gradient decreased to 1.94% from the steeper reaches just downstream. Much of the reach was not wadable for the habitat survey crew due to the confined, steep nature of the channel, and data is based on ocular estimates from the crew walking along the banks.

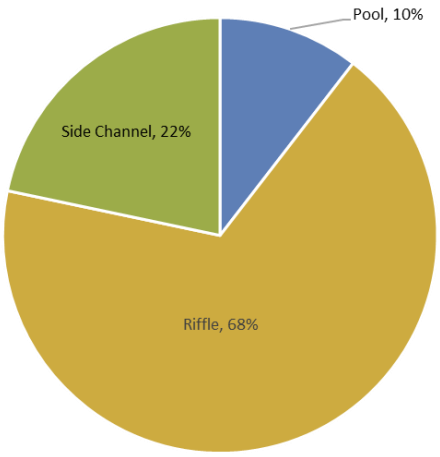


Figure 64. Stream habitat unit area composition of Reach 8.

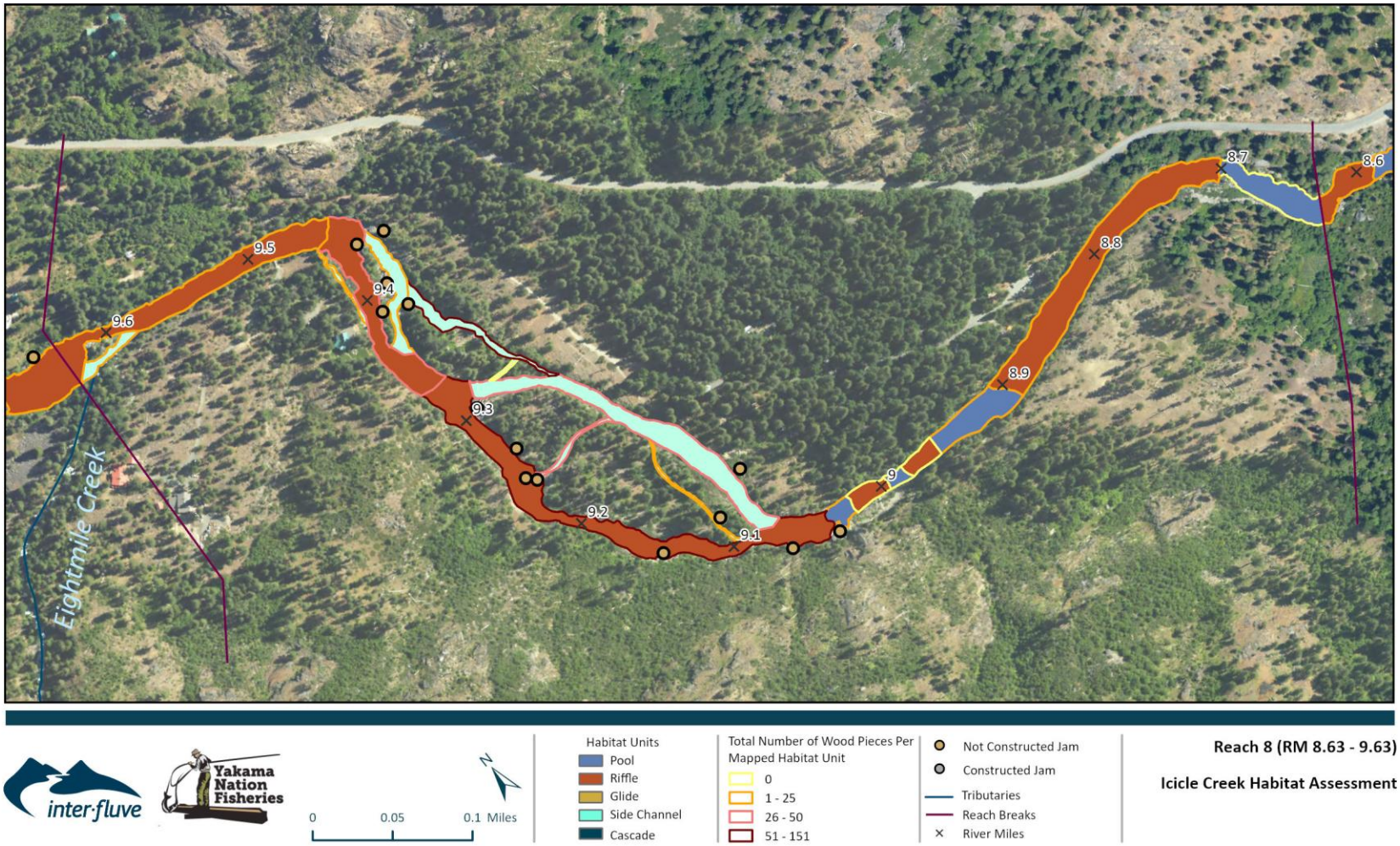


Figure 65. Map of the habitat unit composition and LWM in Reach 8 of Icicle Creek. LWM count includes pieces in jams.

4.8.2 Pools

Reach 8 had four total pools, all of which had a residual depth greater than or equal to six feet. The average residual pool depth in Reach 8 was 4.9 feet and ranged from 4.2 feet to six feet. The mean pool spacing for the reach was four pools per mile, less than the study area average of seven pools per mile.

4.8.3 Side Channel Habitat

Eight side channels were surveyed in Reach 8 with a total channel length of 3,527 feet. A majority of the side channels were fast water (e.g., riffle and glide habitat within the side channels), while two of the eight side channels were predominantly slow water. A total of 41 individual LWM pieces were recorded in the side channels and five jams were observed with an estimated 133 pieces of LWM present within the jams (Table 20).

Table 20. Side Channels observed in Reach 8.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 30	1,152	Fast	20	1	12
Side 31	319	Slow	9	1	1
Side 32	566	Slow	2	1	45
Side 33	107	Fast	0	1	71
Side 34	468	Fast	0	0	0
Side 35	443	Fast	6	1	4
Side 36	273	Fast	1	0	0
Side 37	201	Fast	3	0	0
Total	*3,527*		*41*	*5*	*133*

4.8.4 Large Woody Material

A total of 385 pieces of LWM were recorded in Reach 8. This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 385 pieces of LWM per mile, with 237 of those pieces per mile being Medium and Large LWM. Fourteen jams were recorded in Reach 8 containing 77% of LWM within the reach (Table 21).

Table 21. LWM quantities in Reach 8.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20in x 35 ft)	Total
Number of Individual Pieces	39	41	9	89
Number of Individual Pieces per Mile	39	50		89
Number of Total Pieces per Mile (including pieces in jams)	148	237		385
Number of Jams	14			
Number of Jams per Mile	14			
Estimated Wood Count in Jams	296			

4.8.5 Substrate & Fine Sediment

Two gravel counts were conducted in Reach 8, and the combined average of the two counts had boulder (41%), followed by cobble (35%), gravel (20%) and sand (4%; Figure 66). The first gravel count, GC18, was

conducted at a riffle crest near RM 8.91 and the second gravel count, GC19, was conducted at a riffle crest upstream of a flow split near RM 9.32. The distribution and grain size class can be found in Figure 67-Figure 68 and Table 22.

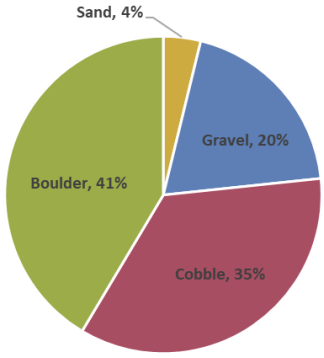


Figure 66. Percent sediment composition from two gravel counts (GC19 and GC18) performed in Reach 8.

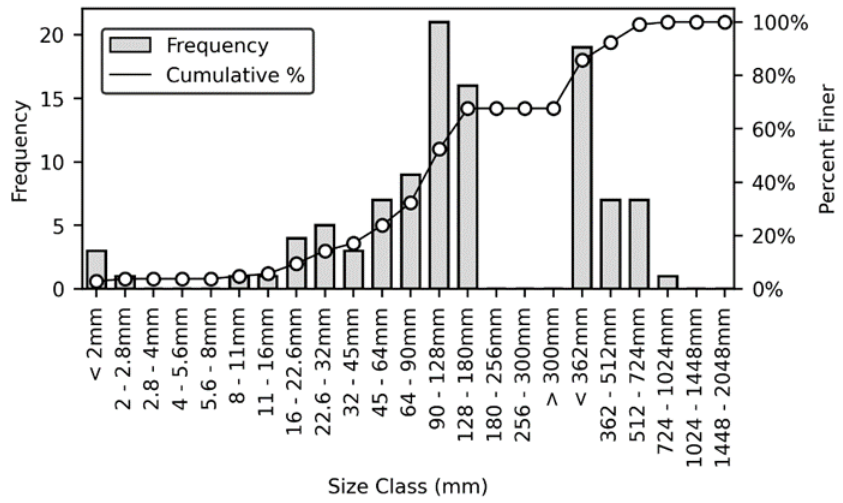


Figure 67. Cumulative distribution curve for GC19.

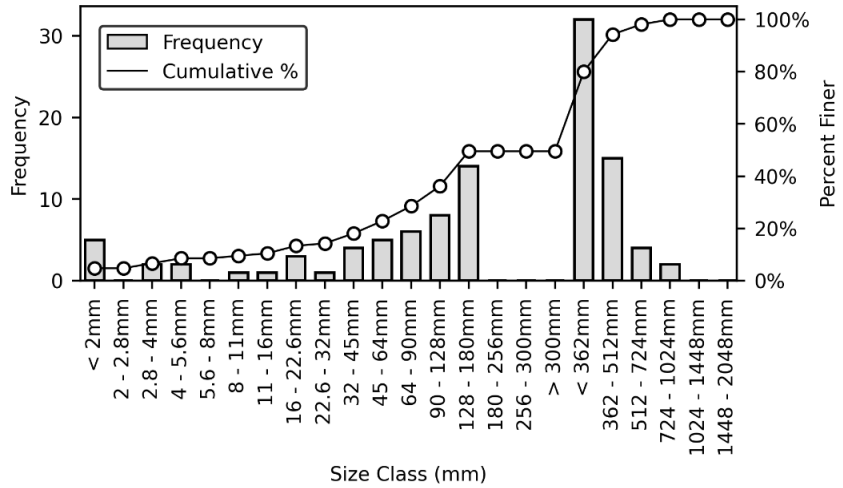


Figure 68. Cumulative distribution curve for GC18.

Table 22. Grain size class for GC19 and GC18 (assumed linear interpolation).

Size Class	GC19 *Size percent finer than (mm)*	GC18 *Size percent finer than (mm)*
D5	12	3
D16	38	37
D50	123	256
D84	350	400
D95	590	550

4.8.6 Riparian Corridor

Three channel units in Reach 8 included ocular assessment of riparian vegetation. The overstory consisted entirely of Large Trees (21.0 - 31.9-inch dbh), which were documented as Cedar (67%) and Ponderosa pine (33%; Figure 69). The understory was entirely Shrub/Seedling (1.0 - 4.9-inch dbh) size classes, which were primarily Alder (67%) and Willow (33%) species (Figure 70).

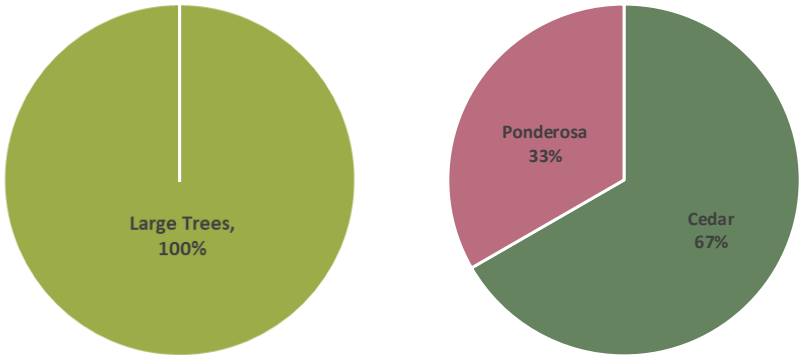


Figure 69. Dominant overstory riparian vegetation class and species, based on three surveyed units, within 100 feet of Icicle Creek by ocular estimate.

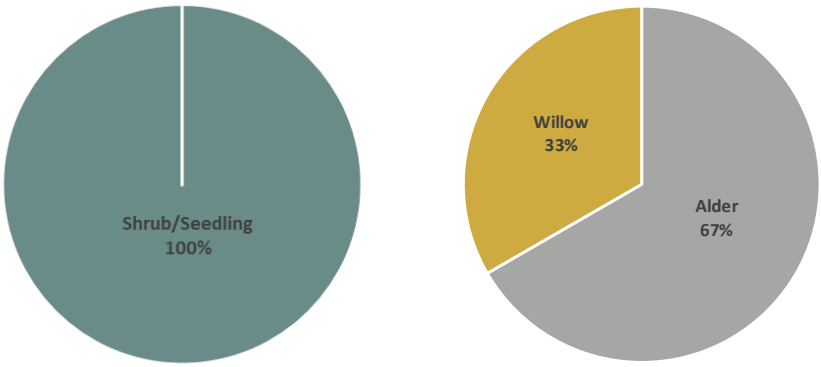


Figure 70. Dominant understory riparian vegetation class and species, based on three surveyed units, within 100 feet of Icicle Creek by ocular estimate.

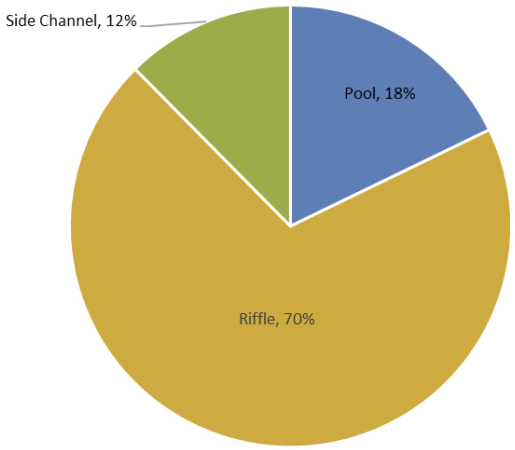
4.9 REACH 9

Location: River mile 9.63 – 10.24
Total length: 0.61 miles
Survey Date: September 9 – 10, 2024

Figure 71. Representative photo of Reach 9 in Icicle Creek. The habitat was dominated by riffles.

4.9.1 Habitat Unit Composition

Reach 9 was approximately 0.61 miles long and was primarily riffles (70%), followed by pools (18%) and side channels (12%; Figure 72). Reach 9 has a substantial increase in channel gradient from Reach 8, with an average of 3.7% for the reach. Reach 9 starts at Eight Mile Creek and ends at large bedrock outcrop on the right bank. Several units within the reach were not wadable for the habitat survey crew due to the confined, steep nature of the channel, and data is based on ocular estimates from the crew walking along the banks.



Figu ition for Reach 9.

Replace with Field Photo

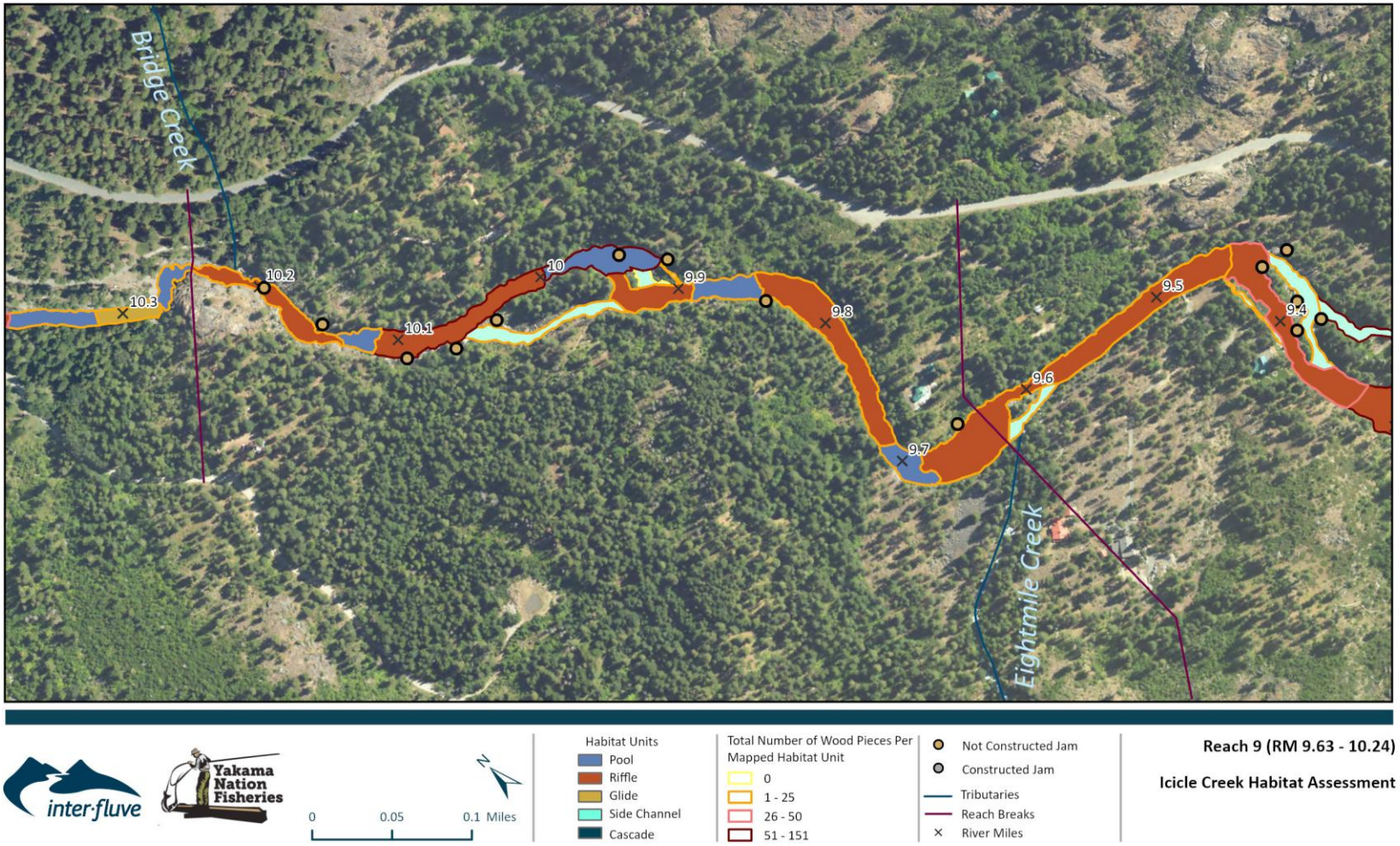


Figure 73. Map of the habitat unit composition and LWM in Reach 9 of Icicle Creek. LWM count includes pieces in jams.

4.9.2 Pools

A total of four pools were recorded in Reach 9, equivalent to seven pools per mile. The average residual depth of the pools was 3.9 feet, compared to the study area average of 4.4 feet. Residual pool depth ranged from 1.2 feet to 5.2 feet. Of the four pools, 25% had residual pool depths less than three feet and 75% of pools had residual pool depths between three and six feet.

4.9.3 Side Channel Habitat

In Reach 9, three side channels were observed and had a total channel length of 666 feet. Two of the side channels were relatively short (less than 100 feet) while one was over 500 feet long. All three side channels were predominantly fast water types (e.g., riffle and glide habitat within the side channels). A total of seven individual pieces of LWM were found in the three side channels. One jam was recorded with 13 total pieces of LWM (Table 23).

Table 23. Side Channels observed in Reach 9.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 38	95	Fast	0	0	0
Side 39	55	Fast	0	0	0
Side 40	517	Fast	7	0	0
Total	*666*		*7*	*0*	*0*

4.9.4 Large Woody Material

A total of 215 pieces of LWM were recorded in Reach 9. This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 352 pieces of LWM per mile, with 200 of those pieces per mile being Medium and Large LWM. Nine jams were recorded in Reach 9 containing 67% of LWM within in the reach (Table 24).

Table 24. LWM quantities in Reach 9.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20in x 35 ft)	Total
Number of Individual Pieces	35	31	5	71
Number of Individual Pieces per Mile	57	59		116
Number of Total Pieces per Mile (including pieces in jams)	152	200		352
Number of Jams	9			
Number of Jams per Mile	15			
Estimated Wood Count in Jams	144			

4.9.5 Substrate & Fine Sediment

One gravel count (GC17) was conducted in Reach 9. The dominant substrate in the gravel count was recorded as 45% boulder, 32% cobble, 21% gravel and 3% sand (Figure 74). The gravel count was conducted at a riffle crest at RM 9.84. The distribution and grain size class can be found in Figure 75 and Table 25.

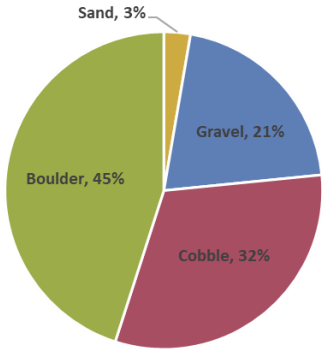


Figure 74. Percent sediment composition from the gravel count (GC17) performed in Reach 9.

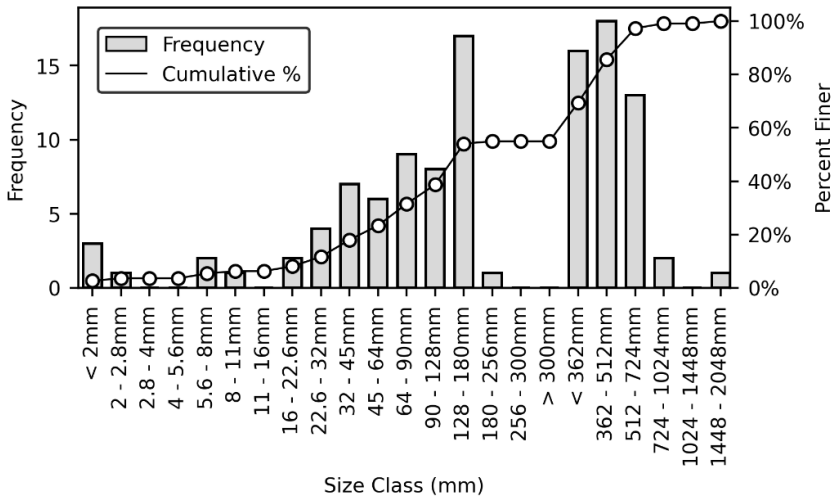


Figure 75. Cumulative distribution curve for GC17.

Table 25. Grain size class for GC17 (assumed linear interpolation).

	GC17
Size Class	*Size percent finer than (mm)*
D5	8
D16	40
D50	165
D84	500
D95	680

4.9.6 Riparian Corridor

Based on four ocular assessments of riparian vegetation in Reach 9, the dominant overstory size class was Large Trees (100%; 21 - 31.9-inch dbh). Ponderosa pine was the dominant overstory species (75%), with Cedar recorded for the other 25% of overstory species (Figure 76). The dominant understory size class was recorded as entirely Alder in the Shrub/Seedling size class (1.0 - 4.9-inch dbh; Figure 77).

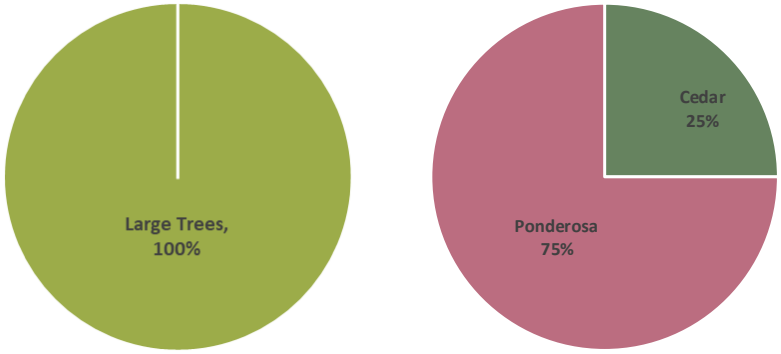


Figure 76. Dominant overstory riparian vegetation class and species, based on four surveyed units, within 100 feet of Icicle Creek by ocular estimate.

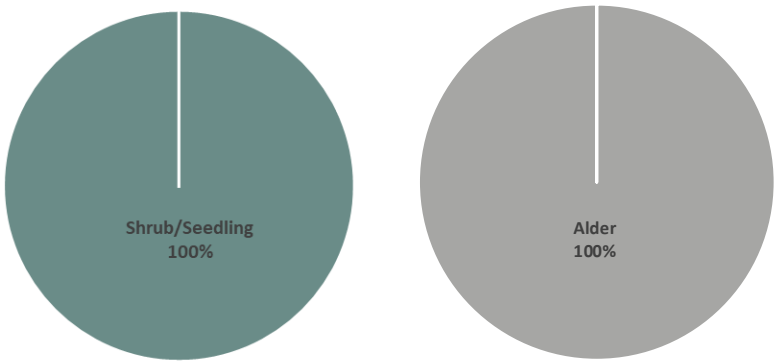


Figure 77. Dominant understory riparian vegetation class and species, based on four surveyed units, within 100 feet of Icicle Creek by ocular estimate.

4.10 REACH 10

Location: River mile 10.24 – 11.36
Total length: 1.12 miles
Survey Date: September 10, 2024

Figure 78. Representative photo of Reach 10 in Icicle Creek. Habitat is dominated by riffles.

4.10.1 Habitat Unit Composition

Reach 10 was 1.12 miles long and had the greatest percentage of fast water unit types within the entire study area, almost entirely riffle (86%) or glide (2%) habitat units. Side channels and pool units equally comprised 6% of the channel unit area (Figure 79). Channel gradient in this reach was 1.31%, a substantial decrease from the previous unit. Much of the left bank contained campgrounds managed by the U.S. Forest Service, dispersed camping, and road pull-offs.

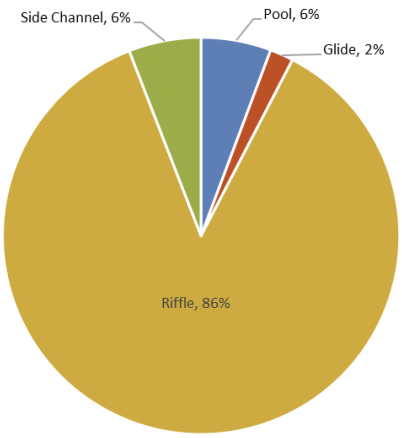


Figure 79. Stream habitat unit area composition of Reach 10.

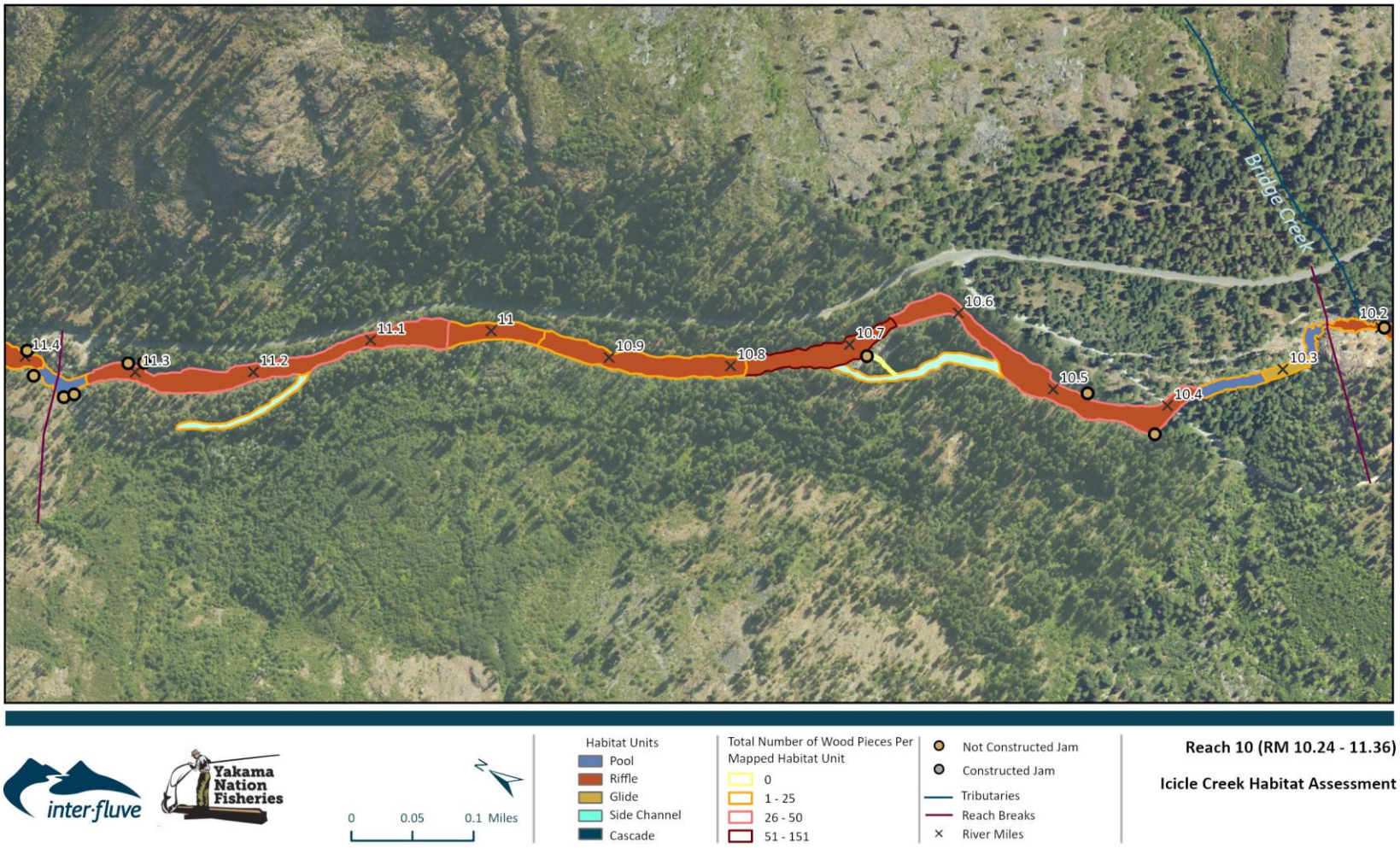


Figure 80. Map of the habitat unit composition and LWM in Reach 10 of Icicle Creek. LWM count includes pieces in jams.

4.10.2 Pools

Three pool units were observed in Reach 10. Of those pools, 33% had a residual depth less than three feet and 67% had a residual pool depth between three feet and six feet. Residual pool depths ranged from 1.8 feet to 4.6 feet and averaged approximately 3.6 feet. Mean pool spacing in Reach 10 was three pools per mile, substantially lower than the study area average of seven pools per mile.

4.10.3 Side Channel Habitat

Three side channels were observed in Reach 10. Two of the three side channels were fast water, and one was slow water. A total of ten individual LWM pieces were recorded in the side channels. One jam was observed with 17 pieces of LWM (Table 26).

Table 26. Side channels observed in Reach 10.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 41	732	Fast	2	0	0
Side 42	162	Fast	0	0	0
Side 43	620	Slow	8	1	0
Total	*1,513*		*10*	*1*	*17*

4.10.4 Large Woody Material

A total of 218 pieces of LWM were recorded in Reach 10. This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 195 pieces of LWM per mile, with 108 of those pieces per mile being Medium and Large LWM. Seven jams were observed in the reach, which equates to six jams per mile. Jams contained 72% of the total LWM pieces recorded in the reach (Table 27).

Table 27. LWM quantities in Reach 10.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20in x 35 ft)	Total
Number of Individual Pieces	32	20	8	60
Number of Individual Pieces per Mile	29	25		54
Number of Total Pieces per Mile (including pieces in jams)	87	108		495
Number of Jams	7			
Number of Jams per Mile	6			
Estimated Wood Count in Jams	158			

4.10.5 Substrate & Fine Sediment

Two gravel counts were performed in Reach 10, with a combined average of 42% boulder, 33% cobble, 23% gravel and 2% fines (Figure 81). The first gravel count, GC16, was conducted within a riffle at RM 10.46 and the second gravel count, GC15, was conducted at a riffle crest at RM 11.05. The distribution and grain size class can be found in Figure 82– Figure 83 and Table 28.

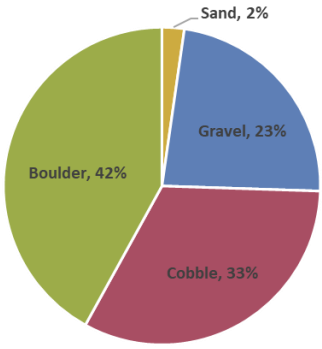


Figure 81. Combined percent sediment composition from the gravel counts (GC16 and GC15) performed in Reach 10.

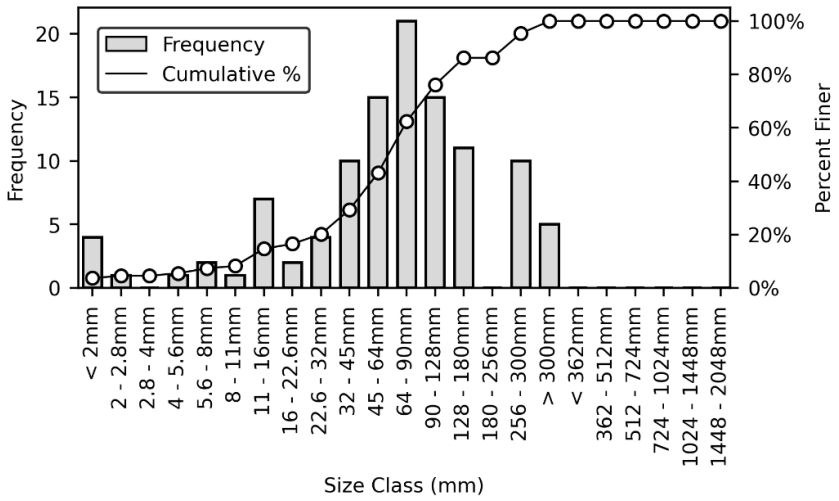


Figure 82. Cumulative distribution curve for GC16.

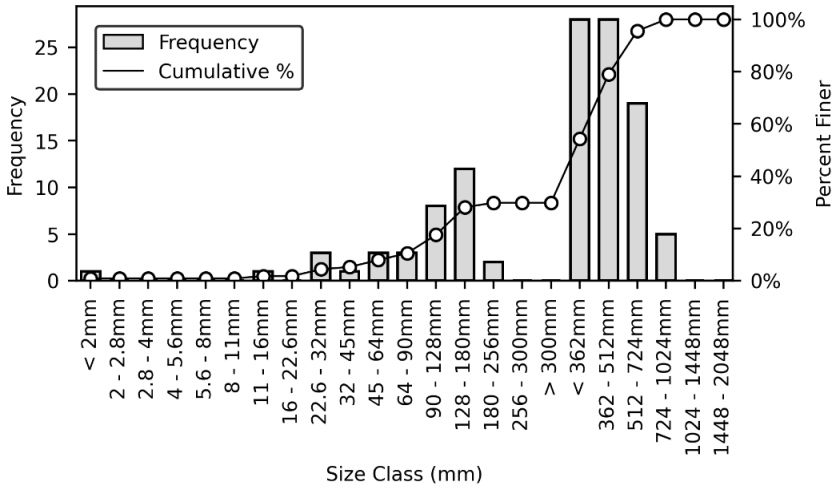


Figure 83. Cumulative distribution curve for GC15.

Table 28. Grain size class for GC16 and GC15 (assumed linear interpolation).

Size Class	GC16 *Size percent finer than (mm)*	GC15 *Size percent finer than (mm)*
D5	5	35
D16	20	115
D50	73	330
D84	165	525
D95	205	650

4.10.6 Riparian Corridor

Based on seven ocular assessments of riparian vegetation in Reach 10, the dominant overstory was Large Trees (62%; 21 - 31.9-inch dbh), followed by Small Trees (25%; 9.0 - 20.9-inch dbh) then by Other (13%). The dominant overstory species in Reach 10 was Ponderosa pine (75%), followed by Cedar (12%) and Other/Unknown (13%; Figure 84). The Other size class and Other/Unknown species in Reach 10 is due to a fire scar, in which the overstory was charred dead trees. The dominant understory size class was Shrub/Seedling (87%; 1.0 - 4.9-inch dbh) followed by Small Tree (13%). The dominant understory species in Reach 10 was Alder (87%) and Willow (13%; Figure 85).

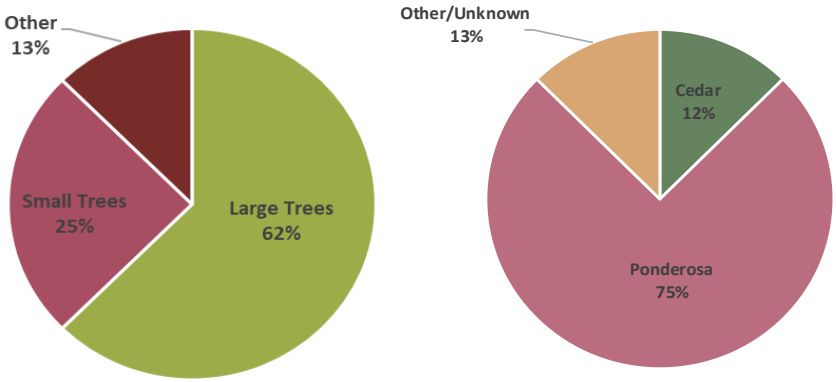


Figure 84. Dominant overstory riparian vegetation class and species, based on seven surveyed units, within 100 feet of Icicle Creek by ocular estimate.

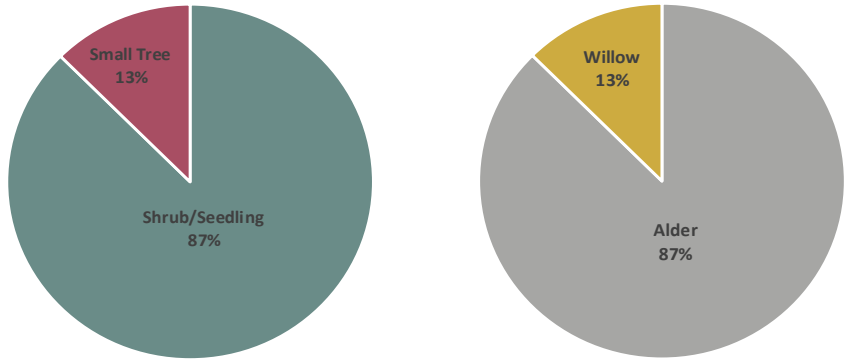


Figure 85. Dominant understory vegetation class and species, based on seven surveyed units, within 100 feet of Icicle Creek by ocular estimate.

4.11 REACH 11

Location: River mile 11.36 – 11.92
Total length: 0.56 miles
Survey Date: September 10 – 11, 2024

Figure 86. Representative photo of Reach 11. Habitat is dominated by riffles.

4.11.1 Habitat Unit Composition

Reach 11 was dominated by riffles, composing 71% of the habitat unit area. Pools comprised the remaining 29% (Figure 87). The reach is 0.56 miles long and has a channel gradient of 3.4%, an increase from the previous reach. The right bank on the downstream channel units within Reach 11 was reinforced by riprap and the left bank had intermittent bedrock exposure. Much of the reach was not wadable for the habitat survey crew due to the confined, steep nature of the channel, and data is based on ocular estimates from the crew walking along the banks.

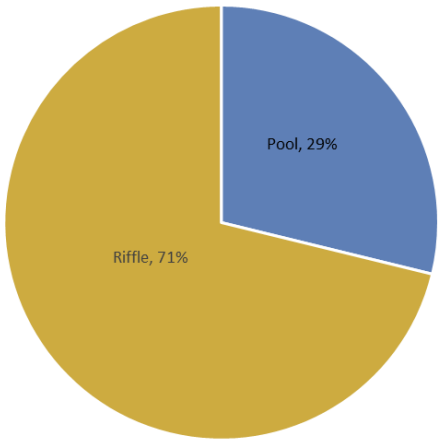


Figure 87. Stream habitat unit area composition of Reach 11.

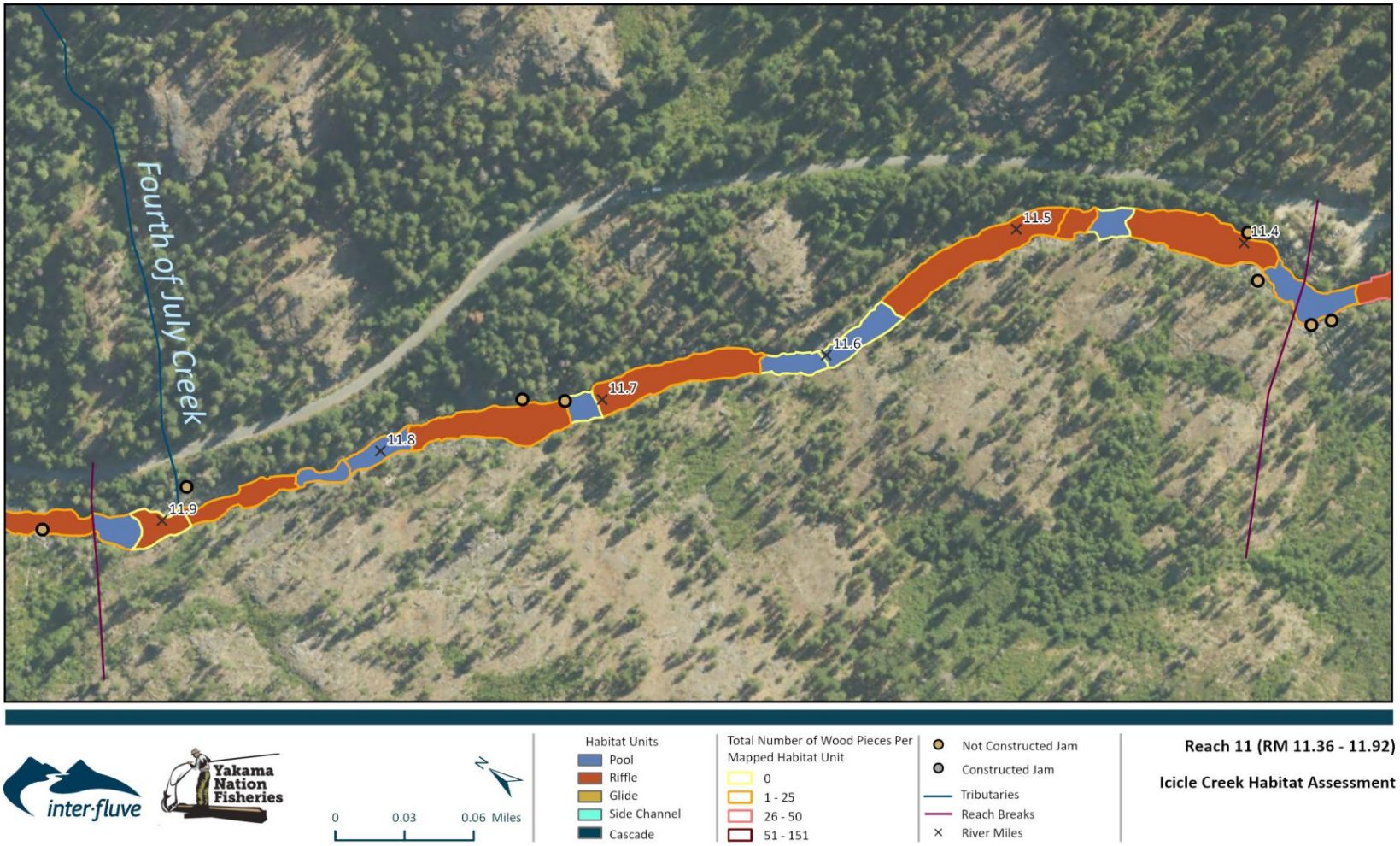


Figure 88. Map of the habitat unit composition and LWM in Reach 11 of Icicle Creek. LWM count includes pieces in jams.

4.11.2 Pools

Eight pool units were observed in Reach 11. Of those eight pools, 63% had a residual depth between three feet and six feet, while 25% had a residual depth less than three feet and 12% had a residual depth greater than six feet. Residual depth ranged from 2.2 feet to 6.5 feet, and averaged approximately four feet, only slightly less than the study area average of 4.4 feet. Mean pool spacing in Reach 11 was 14 pools per mile, more than the study area average of seven pools per mile.

4.11.3 Side Channel Habitat

No side channels were observed in Reach 11.

4.11.4 Large Woody Material

A total of 48 pieces of LWM was recorded in Reach 11. This includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 86 pieces of LWM per mile, with 52 of those pieces per mile being Medium and Large LWM. Five jams were observed in Reach 11 containing 35% of LWM within the reach (Table 29).

Table 29. Large Wood Material quantities in Reach 11.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20in x 35 ft)	Total
Number of Individual Pieces	14	11	6	31
Number of Individual Pieces per Mile	25	30		55
Number of Total Pieces per Mile (including pieces in jams)	34	52		86
Number of Jams	5			
Number of Jams per Mile	9			
Estimated Wood Count in Jams	17			

4.11.5 Substrate & Fine Sediment

No gravel counts were performed in Reach 11. Conditions were not appropriate or safe to complete a gravel count. Substrate was dominated by boulders.

4.11.6 Riparian Corridor

Based on six ocular assessments of riparian vegetation in Reach 11, the dominant overstory class and species was Large Tree (100%; 21 - 31.9-inch dbh) and Ponderosa (100%; Figure 89). The dominant understory size was split between Shub/Seedling (83%; 1.0 - 4.9-inch dbh) and Grassland/Forb (17%). The dominant understory species in Reach 11 was Alder (87%) and Other (13%; Figure 90). The Other species in the understory was recorded as a grass.

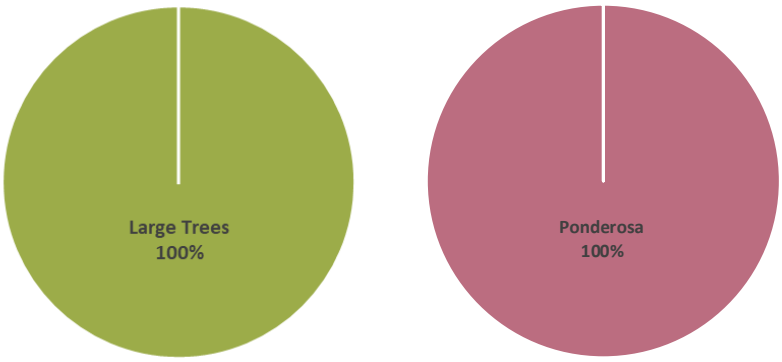


Figure 89. Dominant overstory riparian vegetation class and species, based on six surveyed units, within 100 feet of Icicle Creek by ocular estimate.

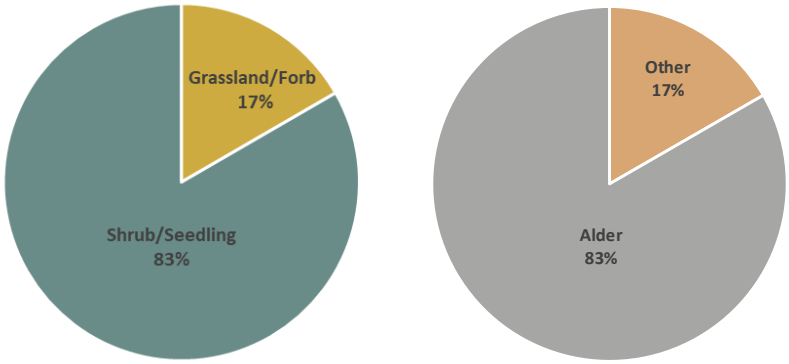


Figure 90. Dominant understory riparian vegetation class and species, based on six surveyed units, within 100 feet of Icicle Creek by ocular estimate.

4.12 REACH 12

Location: River mile 11.92 – 12.5
Total length: 0.58 miles
Survey Date: September 11 – 12, 2024

Figure 91. Representative photo of Reach 12. Habitat was dominated by riffles.

4.12.1 Habitat Unit Composition

Reach 12 was 0.58 miles long and dominated by riffles (72%), a continuing trend moving upstream in Icicle Creek. Pools (19%) were the second most prevalent habitat unit type, followed by glide (4%), then side channels (4%;Figure 92). Channel gradient in Reach 12 begins to decrease moving upstream from the three previous reaches, measuring an average of 2.11%. The left bank in Reach 12 was reinforced with riprap due to road infrastructure. U.S. Forest Service campsites are located on the left banks in the upstream channel units of Reach 12.

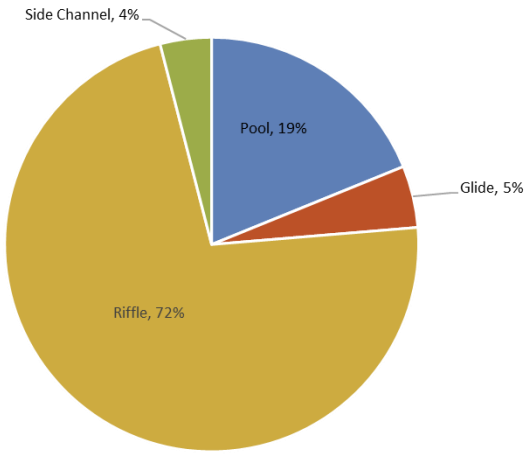


Figure 92. Stream habitat unit area composition for Reach 12.

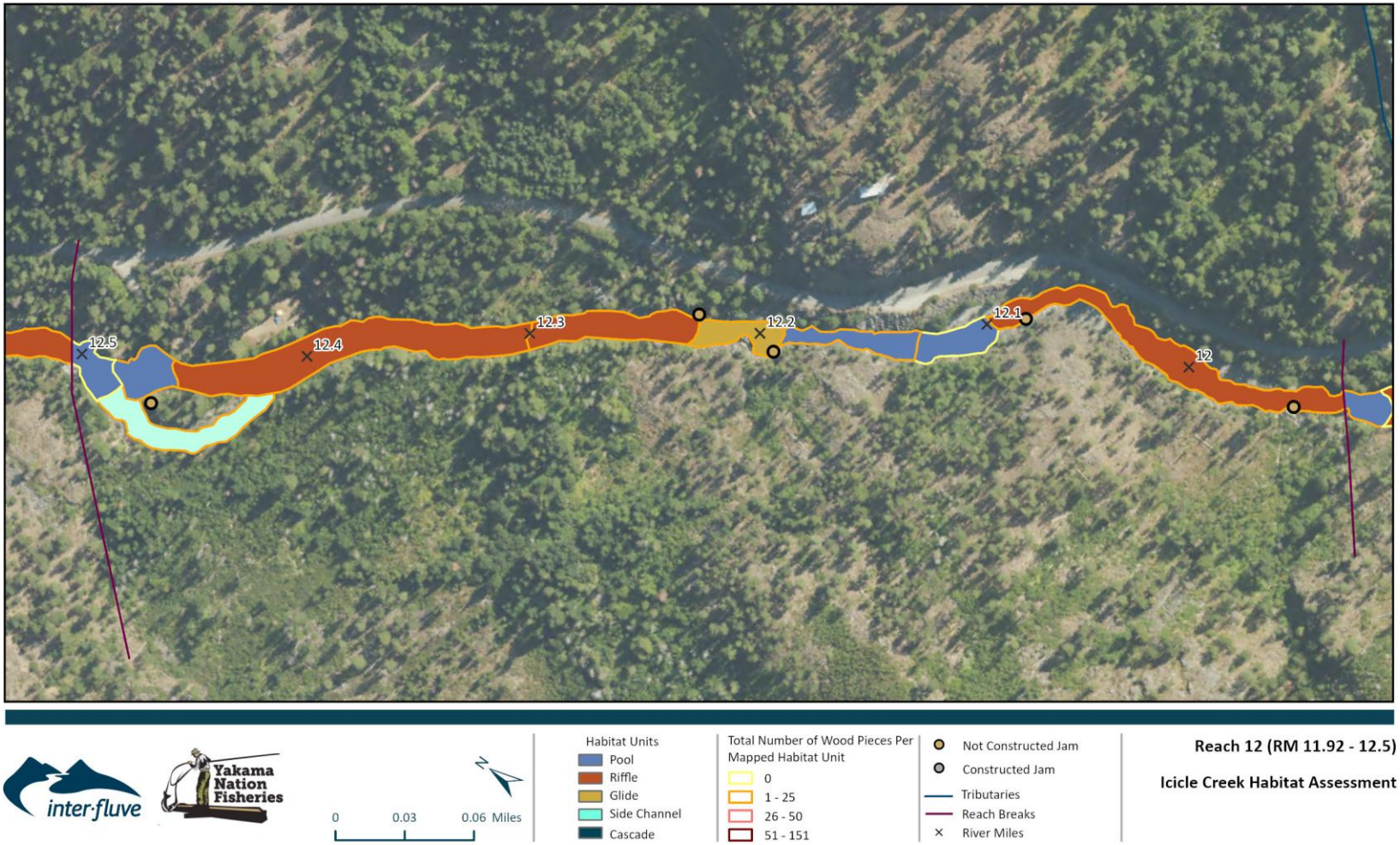


Figure 93. Map of the habitat unit composition and LWM in Reach 12 of Icicle Creek. LWM count includes pieces in jams.

4.12.2 Pools

Reach 12 recorded four pool units. Mean pool spacing for this reach was seven pools per mile, equal to the the study area average. Two of the four pools observed had residual depth less than three feet. One of pools (25%) had residual depth between three feet and six feet. The remaining 25% of pools had a residual depth greater than six feet. Residual depth in reach 12 ranged from 2.6 feet to 8.8 feet and averaged 4.8, slightly greater than the study area average of 4.4 feet.

4.12.3 Side Channel Habitat

One side channel was observed in Reach 12 with a channel length of 411 feet. No jams were observed in the reach and one piece of LWM was recorded (Table 30).

Table 30. Side channels observed in Reach 12.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 44	411	Slow	1	0	0
Total	*411*		*1*	*0*	*0*

4.12.4 Large Woody Material

A total of 71 pieces of LWM were recorded in Reach 12. This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 122 pieces of LWM per mile, with 60 of those pieces per mile being Medium and Large LWM. There were five jams observed in Reach 12, which contained a 59% of the total pieces (Table 32).

Table 31. LWM quantities in Reach 12.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of Individual Pieces	18	8	4	30
Number of Individual Pieces per Mile	31	21		52
Number of Total Pieces per Mile (including pieces in jams)	62	60		122
Number of Jams	5			
Number of Jams per Mile	9			
Estimated Wood Count in Jams	41			

4.12.5 Substrate & Fine Sediment

One gravel count was conducted in Reach 12, and the dominant substrate was recorded as 57% boulder, 27% cobbles, 9% gravel and 7% sand (Figure 94). The gravel count, GC14, was conducted in a riffle near RM 12.39. The distribution and grain size class can be found in Figure 95 and Table 32.

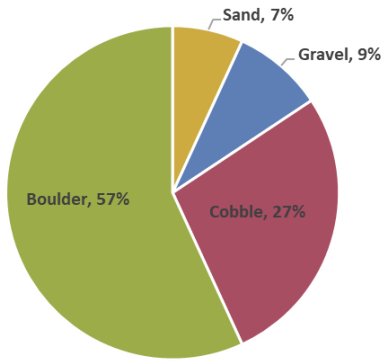


Figure 94. Percent sediment composition from the gravel count (GC14) performed in Reach 11.

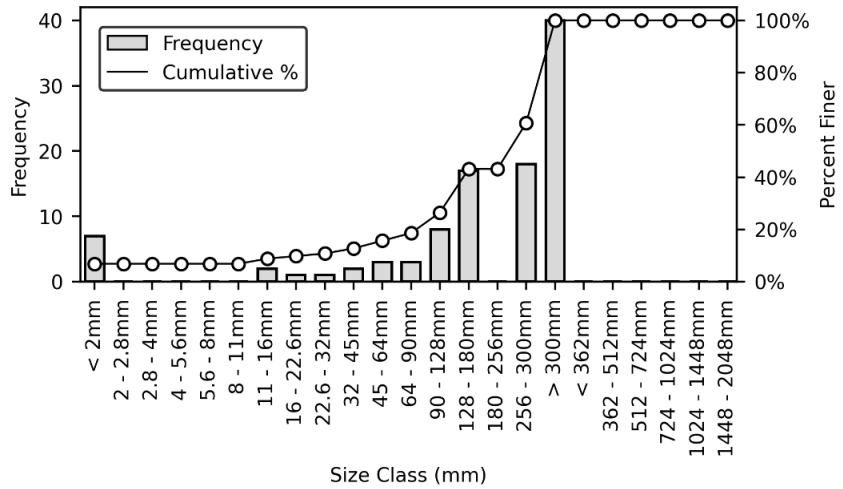


Figure 95. Cumulative distribution curve for GC14.

Table 32. Grain size classes for GC14 (assumed linear interpolation)

	GC14
Size Class	*Size percent finer than (mm)*
D5	1
D16	64
D50	205
D84	300+
D95	300+

4.12.6 Riparian Corridor

Six channel units in Reach 12 included ocular assessment of riparian vegetation. From those observations, Reach 12 was equally dominated by Small Trees (50%; 9.0 - 20.9-inch dbh) and Large Trees (50%; 21 - 31.9-inch dbh). Douglas fir was the dominant overstory species in 67% of units and Ponderosa pine the other 33% (Figure 96). The dominant understory was Shrub/Seedling (1.0 - 4.9-inch dbh) in 83% of units, and Sapling/Pole in the other 17% (5.0-8.9-inch dbh). Alder (50%) was the dominant understory species in Reach 12. Cottonwood (33%) and Willow (17%; Figure 97) consisted of the remaining observed units.

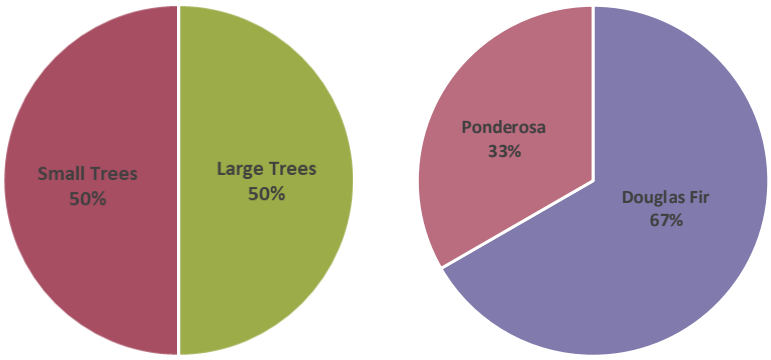


Figure 96. Dominant overstory riparian vegetation class and species, based on six surveyed units, within 100 feet of Icicle Creek by ocular estimate.

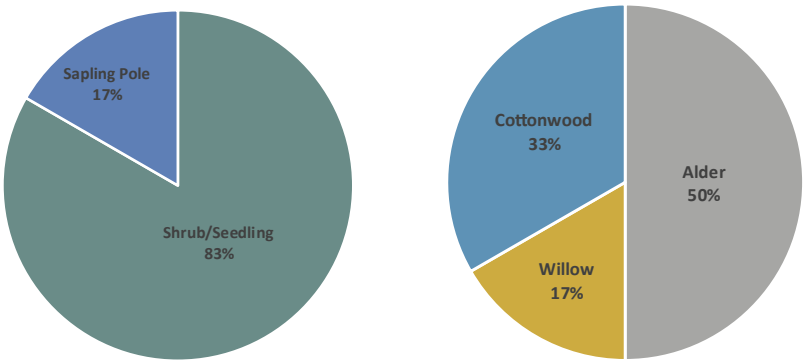


Figure 97. Dominant understory riparian vegetation class and species, based on six surveyed units, within 100 feet of Icicle Creek by ocular estimate.

4.13 REACH 13

Location: River mile 12.5 – 12.84
Total length: 0.34 miles
Survey Date: September 12, 2024

Figure 98. Representative photo of Reach 13. Habitat was dominated by riffles.

4.13.1 Habitat Unit Composition

Reach 13 is the shortest reach in the study area with a channel length of 0.34 miles. Riffles were the dominant habitat type, consisting of 77% of the unit area. Pools comprised the remaining 23% (Figure 99). Channel gradient maintained a similar slope to the previous unit at 2.20%.

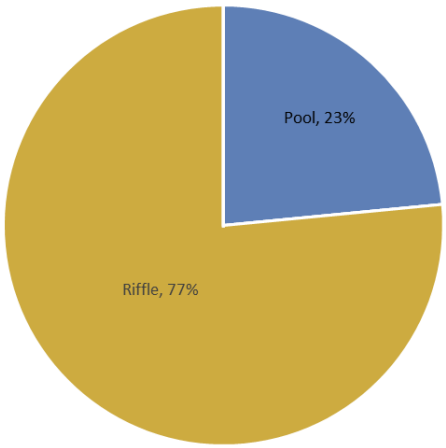


Figure 99. Stream habitat unit area composition of Reach 13.

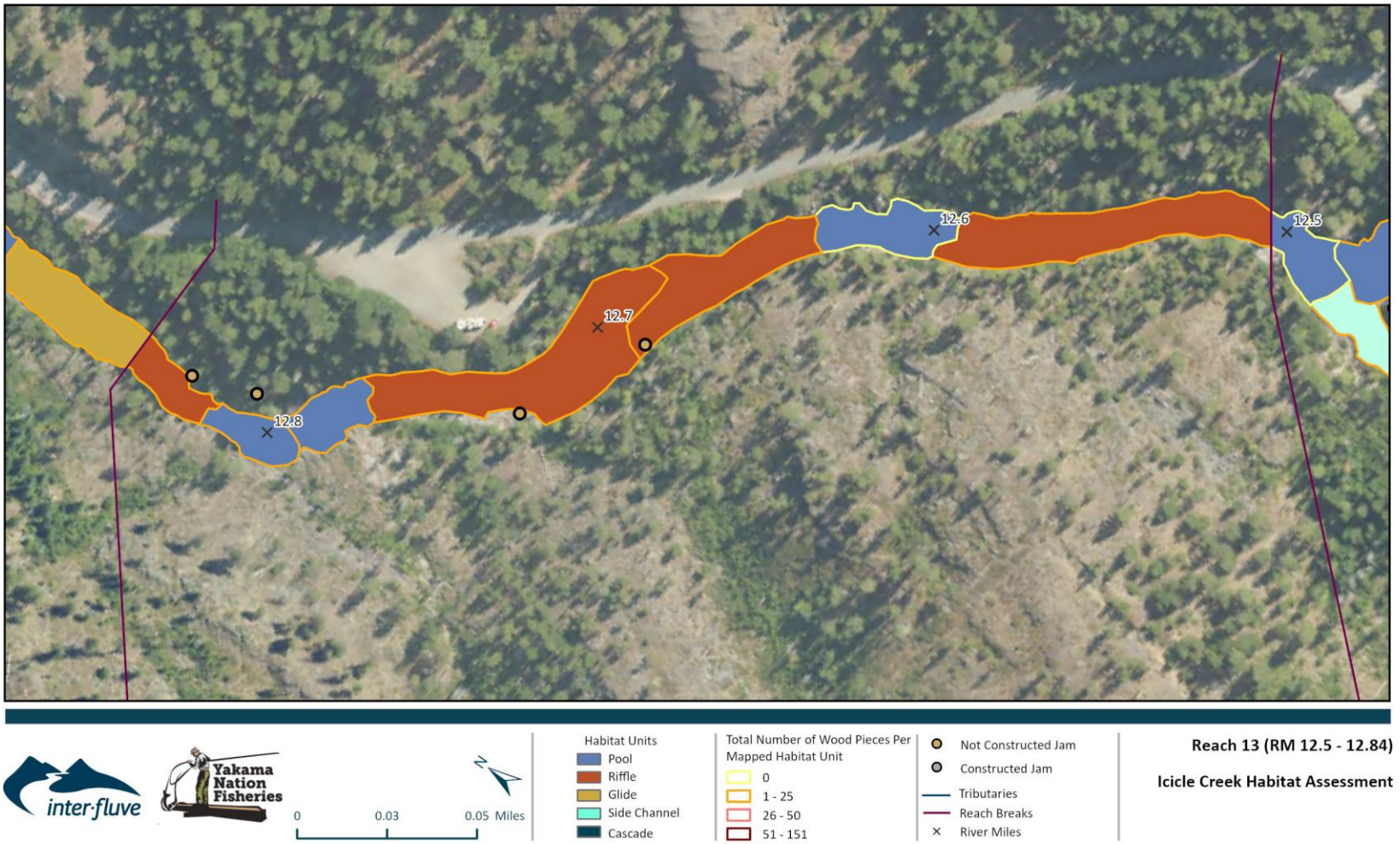


Figure 100. Map of the habitat unit composition and LWM in Reach 13 of Icicle Creek. LWM count includes pieces in jams.

4.13.2 Pools

Three pools were observed in Reach 13. Two pools (67%) had a residual depth between three feet and six feet, and the other pool (33%) had a residual depth greater than six feet. The average residual depth for Reach 13 was 4.13 feet, ranging from 2.4 feet to 6.0 feet. Pool frequency was approximately nine pools per mile. Pool frequency for the entire study averaged seven pools per mile.

4.13.3 Side Channel Habitat

No side channels were observed in Reach 13.

4.13.4 Large Woody Material

Thirty-five pieces of LWM were recorded in Reach 13, yielding 103 pieces per mile and 44 Medium and Large pieces per mile. The total number of pieces include individual pieces and pieces recorded in jams. A total of four jams were observed in this reach, containing 37% of the total wood count (Table 33).

Table 33. LWM quantities in Reach 13.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of Individual Pieces	14	7	1	22
Number of Individual Pieces per Mile	41	24		65
Number of Total Pieces per Mile (including pieces in jams)	59	44		103
Number of Jams	4			
Number of Jams per Mile	12			
Estimated Wood Count in Jams	13			

4.13.5 Substrate & Fine Sediment

No gravel counts were performed in Reach 13.

4.13.6 Riparian Corridor

Three channel units in Reach 13 included ocular assessment of riparian vegetation. The dominant overstory in Reach 13 was Large Trees (100%; 21.0 - 31.9-inch dbh), with Douglas fir (67%) and Cedar (33%) as the primary species observed (Figure 101). The dominant understory was in the Shrub/Seedling (100%; 1.0 - 4.9-inch dbh) size class, with Alder recorded in 67% of units and Willow in the remaining 33% (Figure 102).

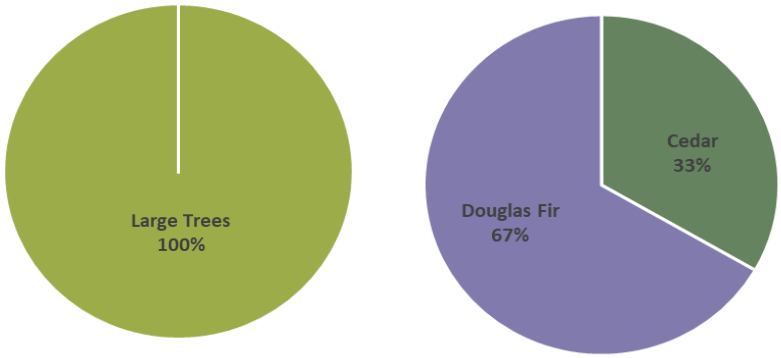


Figure 101. Dominant overstory riparian vegetation class and species, based on three surveyed units, within 100 feet of Icicle Creek by ocular estimate.

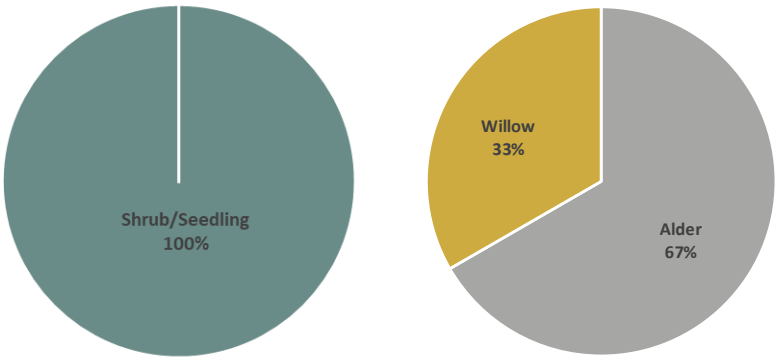


Figure 102. Dominant understory riparian vegetation class and species, based on three units surveyed, within 100 feet of Icicle Creek by ocular estimate.

4.14 REACH 14

Location: River mile 12.84 – 14.75
Total length: 1.91 miles
Survey Date: September 12 – 13, 2024

Figure 103. Representative photo of Reach 14. Habitat is dominated by riffles.

4.14.1 Habitat Unit Composition

Reach 14 is 1.91 miles long and had aquatic habitats predominantly composed of riffles (75%). Pools were the second most common habitat type making up 19% of the reach. Side channels and glide habitat types equally compose 3% of the aquatic habitat area, making up the remaining 6% (Figure 104). Channel gradient decreases to 1.54% and marks the transition away from the steep terrain in the previous nine reaches.

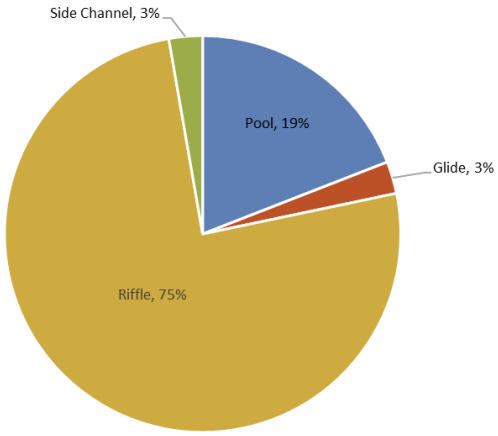


Figure 104.Stream habitat unit area composition for Reach 14.

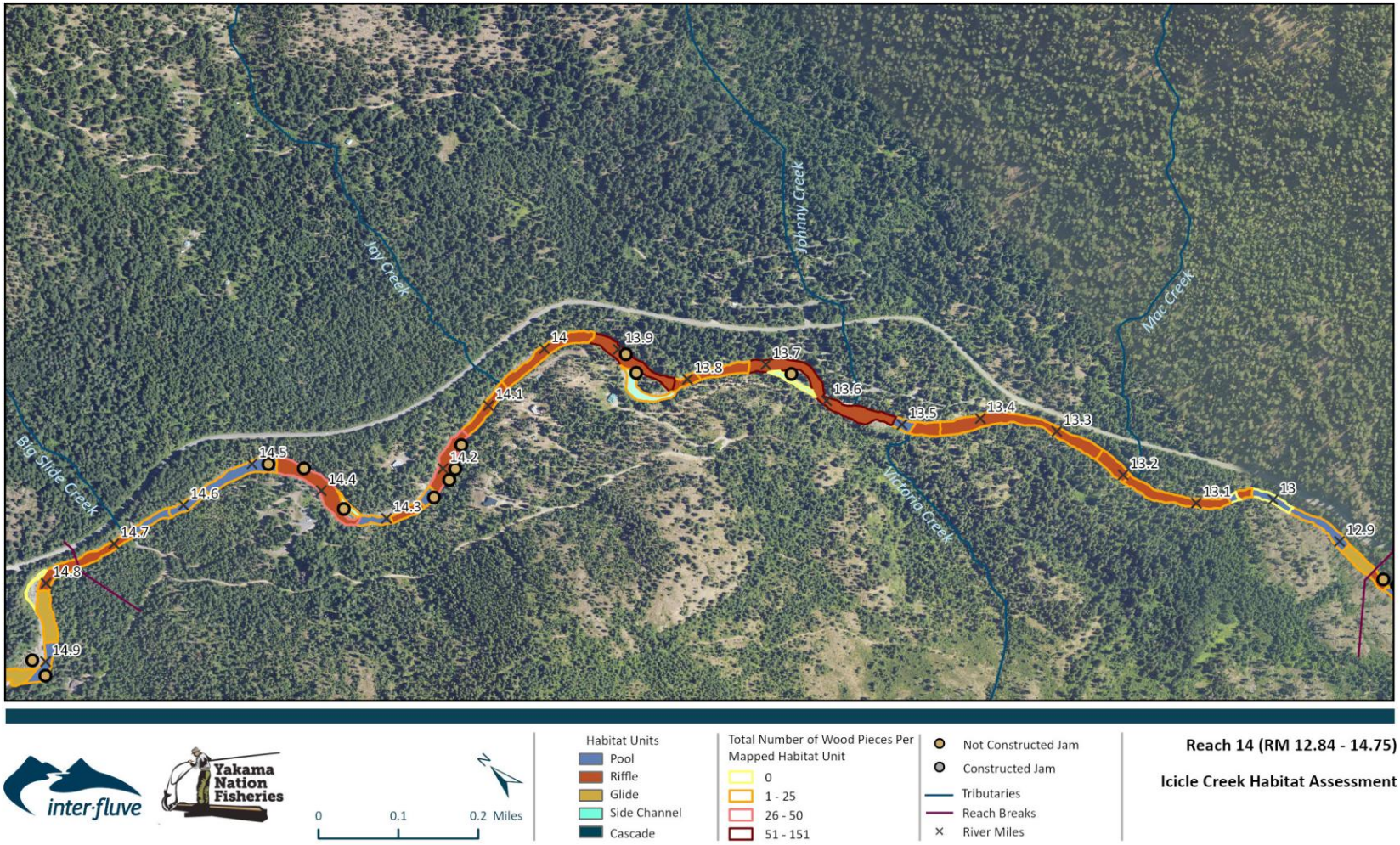


Figure 105. Map of the habitat unit composition and LWM in Reach 14 of Icicle Creek. LWM count includes pieces in jams.

4.14.2 Pools

Reach 14 had a total of nine pools recorded. Mean pool spacing in this reach was five pools per mile, compared to the study area average of seven pools per mile. Five pools (56%) had a residual depth less than three feet, and the remaining four pools (44%) had a residual depth between three and six feet. Average residual depth was 2.9 feet, ranging from 1.7 feet to 4.2 feet. The mean residual depth for the study area was 4.4 feet.

4.14.3 Side Channel Habitat

Three side channels were observed in Reach 14 and had a total channel length of 892 feet. All side channels were observed as predominantly fast water. Within the side channel, 13 pieces of LWM were recorded. No jams were observed in the side channels (Table 34).

Table 34. Side channels observed in Reach 14.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 45	293	Fast	0	0	0
Side 46	436	Fast	13	0	0
Side 47	162	Fast	3	0	0
Total	*2892*		*16*	*0*	*0*

4.14.4 Large Woody Material

A total of 399 pieces of LWM were recorded in Reach 14. This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 209 pieces of LWM per mile, with 106 of those pieces per mile being Medium and Large LWM. Of the 399 total pieces, 60% were observed in jams. Ten jams were observed in the reach; jam frequency averaged five jams per mile (Table 35).

Table 35. LWM quantities in Reach 14.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of Individual Pieces	85	52	22	159
Number of Individual Pieces per Mile	45	39		83
Number of Total Pieces per Mile (including pieces in jams)	103	106		209
Number of Jams	10			
Number of Jams per Mile	5			
Estimated Wood Count in Jams	240			

4.14.5 Substrate & Fine Sediment

Two gravel counts were performed in Reach 14, with a combined average of 40% boulder, 28% cobbles, 28% gravel, and 3% sand (Figure 106). The first gravel count, GC13, was conducted within a riffle crest at RM 12.9. The second gravel count, GC12, was conducted within a riffle at RM 13.43. The distribution and grain size class can be found in Figure 107 – Figure 108 and Table 36.

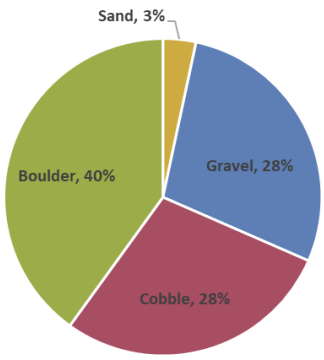


Figure 106. Combined sediment composition from the two gravel counts (GC13 and GC12) performed in Reach 14.

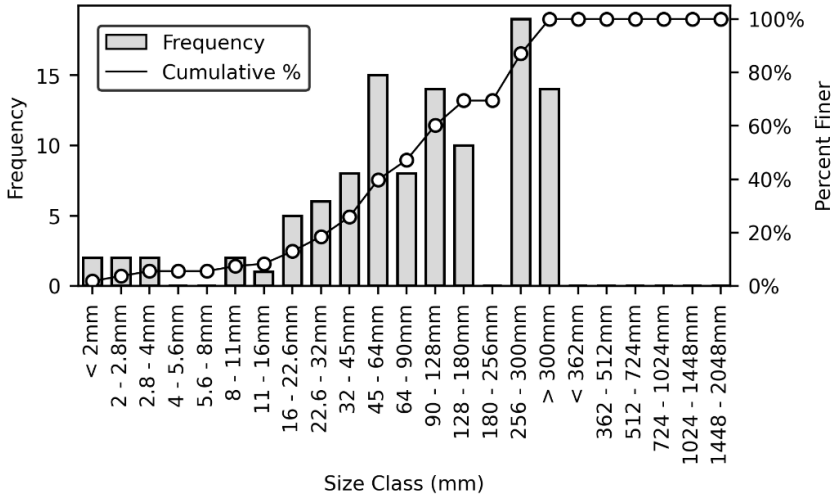


Figure 107. Cumulative distribution curve for GC13.

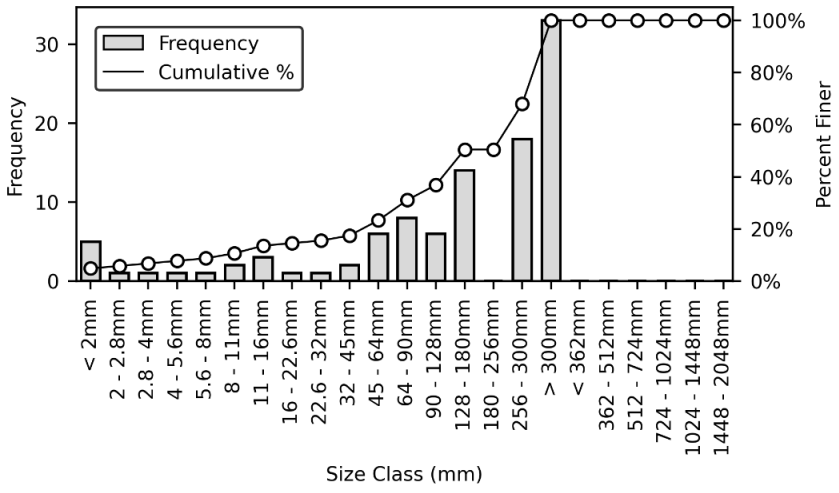


Figure 108. Cumulative distribution curve for GC12.

Table 36. Grain size class for GC13 and GC12 (assumed linear interpolation).

	GC13	GC12
Size Class	*Size percent finer than (mm)*	*Size percent finer than (mm)*
D5	4	2
D16	28	35
D50	95	180
D84	300+	300+
D95	300+	300+

4.14.6 Riparian Corridor

Seven of the channel units in Reach 13 included ocular assessment for riparian vegetation. Large Trees (21.0 - 31.9-inch dbh) were recorded in 56% of the measured units, followed by Small Trees (9.0 - 20.9-inch dbh) in 44% of measured units. Cedar composed 56% of the total measured units as the dominant overstory species. Douglas Fir (33%) and Ponderosa/Jeffrey Pine (11%) make up the remaining dominant overstory species observations (Figure 109). The dominant understory in Reach 14 was recorded as Shrub/Seedling (1.0 - 4.9-inch dbh) in 89% of the measured survey units. No Vegetation was recorded in the remaining 11% of units. Alder was the dominant species with 78% of measured units, followed by Willow and Other at 11% each of measured units (Figure 110).

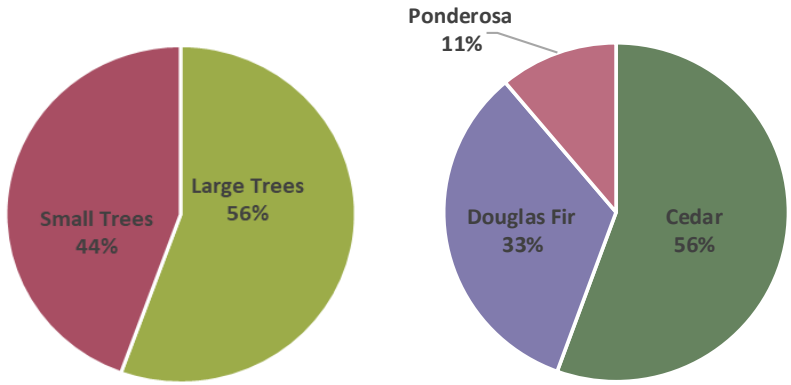


Figure 109. Dominant overstory riparian vegetation class and species, based on seven surveyed units, within 100 feet of Icicle Creek by ocular estimate.

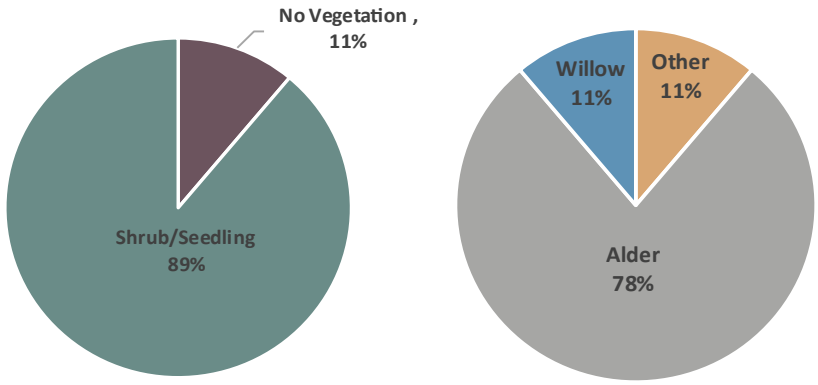


Figure 110. Dominant understory riparian vegetation class and size, based on seven surveyed units, within 100 feet of Icicle Creek by ocular estimate.

4.15 REACH 15

Location: River mile 14.75 – 16.63
Total length: 1.88 miles
Survey Date: September 13 – 14, 2024

Figure 111. Representative photo of Reach 15. Habitat was dominated by riffles.

4.15.1 Habitat Unit Composition

In Reach 15, riffle units are no longer the dominant aquatic habitat type. This reach was 1.89 miles long and channel gradient decreases to 0.54%, almost 1% less than the previous unit. Reach 15 is dominated by pools, comprising 40% of the habitat area. Glides consist of 29% and riffles 21% of the total habitat area. Side channels compose the remaining 10% of the aquatic habitat in Reach 15 (Figure 112).

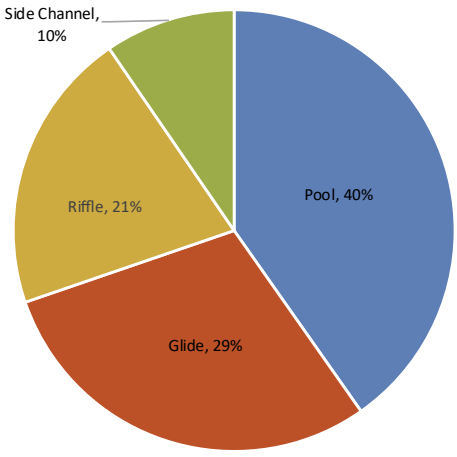


Figure 112. Stream habitat unit area composition of Reach 15.

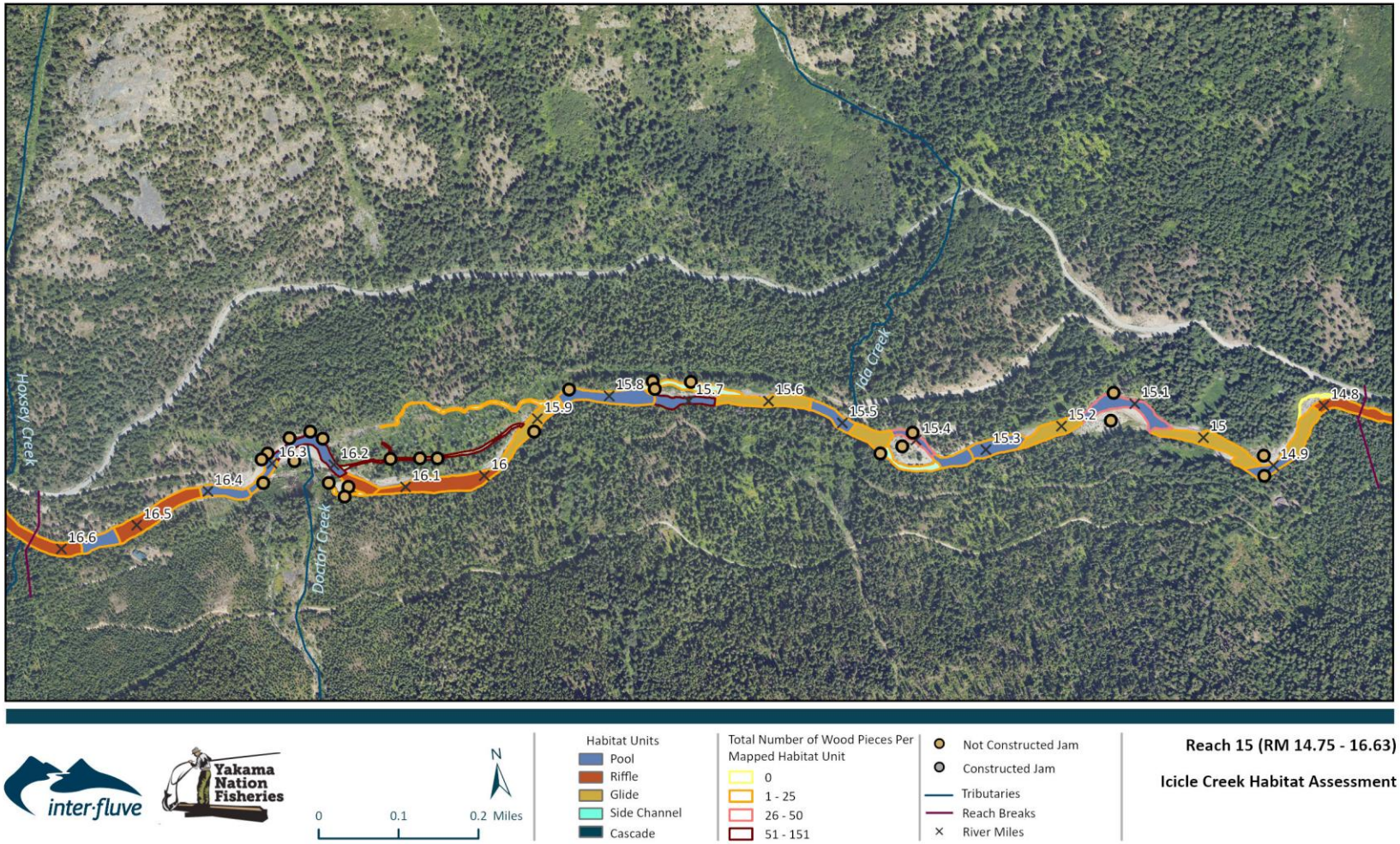


Figure 113. Map of the habitat unit composition and LWM in Reach 15 of Icicle Creek. LWM count includes pieces in jams.

4.15.2 Pools

Twelve pools were recorded in Reach 15 with an average residual depth of 3.5 feet. Residual depth ranged from 2.3 feet to 5.2 feet. Of the twelve pools, 42% had residual depths less than three feet and 58% of pools had residual depths between three feet and six feet. Pool frequency in Reach 15 was approximately six pools per mile, less than the study area average of seven pools per mile.

4.15.3 Side Channel Habitat

In Reach 15, a total of six side channels were observed with a total channel length of 4,387 feet. Five of the side channels were observed to be predominantly slow water units and one side channel was observed as predominantly fast water. A total of 53 individual pieces of LWM were observed in the side channels. Eight wood jams with 49 pieces of LWM were observed (Table 37).

Table 37. Side channels observed in Reach 15.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 48	328	Slow	0	0	0
Side 49	428	Fast	3	1	5
Side 50	598	Slow	6	2	7
Side 51	1247	Slow	7	0	0
Side 52	1263	Slow	37	3	24
Side 53	523	Slow	0	2	13
Total	*4,387*		*53*	*8*	*49*

4.15.4 Large Woody Material

A total of 487 pieces of LWM were recorded in Reach 15, the most LWM in the study area (Table 38). This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 258 LWM pieces per mile, with 148 of those pieces per mile being Medium and Large LWM. Twenty-five jams were observed within Reach 15, which is roughly 13 jams per mile. Jams contained 56% of the total LWM wood count. Reach 15 contained the highest number of jams in the study area.

Table 38. LWM quantities in Reach 15.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of Individual Pieces	100	83	23	206
Number of Individual Pieces per Mile	53	56		109
Number of Total Pieces per Mile (including pieces in jams)	110	148		258
Number of Jams	25			
Number of Jams per Mile	13			
Estimated Wood Count in Jams	281			

4.15.5 Substrate & Fine Sediment

Two gravel counts were performed in Reach 15, with a combined average of 43% cobble, 37% gravel, 16% boulder and 4% sand (Figure 114). The first gravel count, GC11, was conducted in a riffle extending from a gravel bar at RM 14.94. The second gravel count, GC10, was conducted at a riffle near RM 16.23. The distribution and grain size class can be found in Figure 115 – Figure 116 and Table 39.

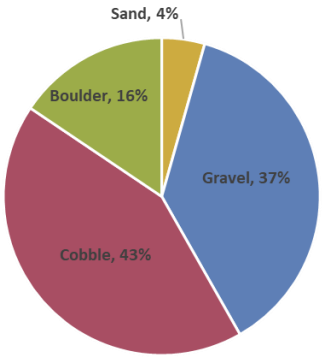


Figure 114. Combined percent sediment composition from the two gravel counts (GC11 and GC10) performed in Reach 15.

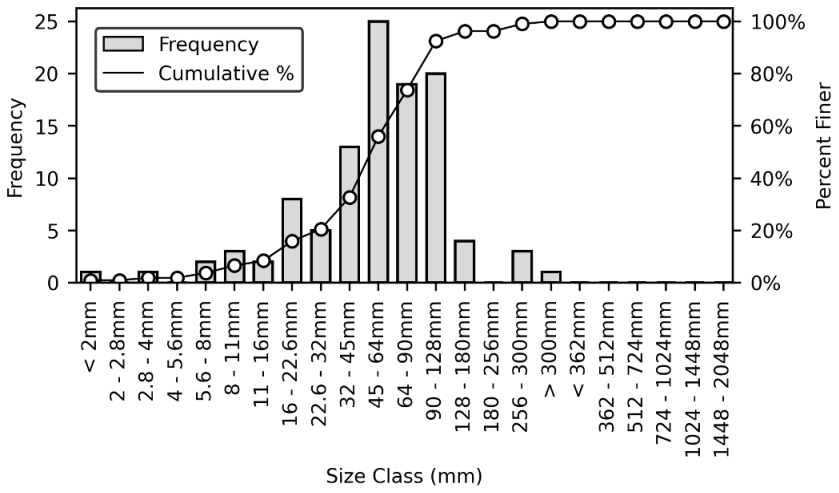


Figure 115. Cumulative distribution curve for GC11.

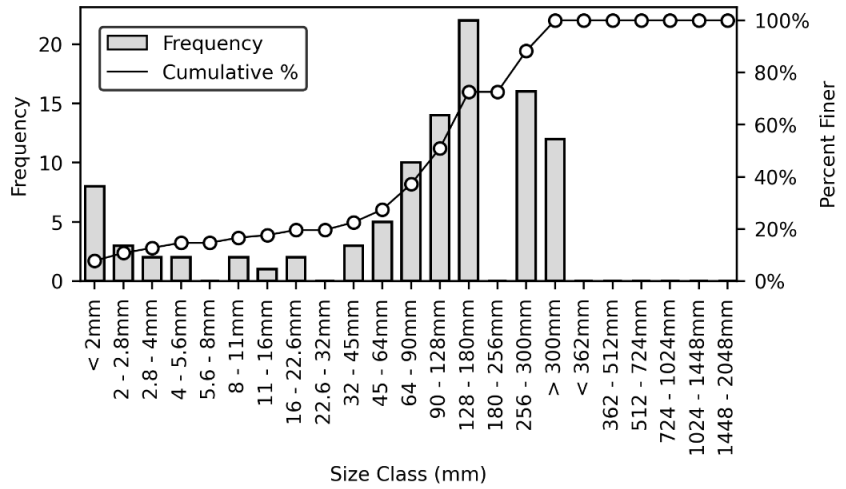


Figure 116. Cumulative distribution curve for GC10.

Table 39. Grain size for GC11 and GC10 (assumed linear interpolation).

	GC11	GC10
Size Class	*Size percent finer than (mm)*	*Size percent finer than (mm)*
D5	9	1
D16	23	10
D50	60	125
D84	110	300+
D95	121	300+

4.15.6 Riparian Corridor

Thirteen channel units in Reach 15 included ocular assessment of riparian vegetation. The dominant overstory was Large Trees (21.0 - 31.9-inch dbh) which was recorded in 73% of measured units. Small Trees (14%; 9.0 - 20.9-inch dbh) and Sapling/Pole (13%; 5.0 - 8.9-inch dbh) composed the remaining units. The overstory species in this reach were diverse; Douglas fir was the most frequently observed at 40% of measured units, followed by Ponderosa pine (20%) and Cottonwood (20%). The remaining units were recorded as Cedar (13%) and Other/Unknown (7%; Figure 117). The dominant understory was nearly all recorded as Shrub/Seedling (1.0 - 4.9-inch dbh), observed in 93% of units, while Grassland/Forb composed the remaining 7%. The dominant understory species in Reach 15 was Alder (80%) followed by Dogwood and Vine/Douglas maple (both 7%), with Other recorded in the remaining 6% of units (Figure 118). The Other understory species in Reach 15 includes various grass species.

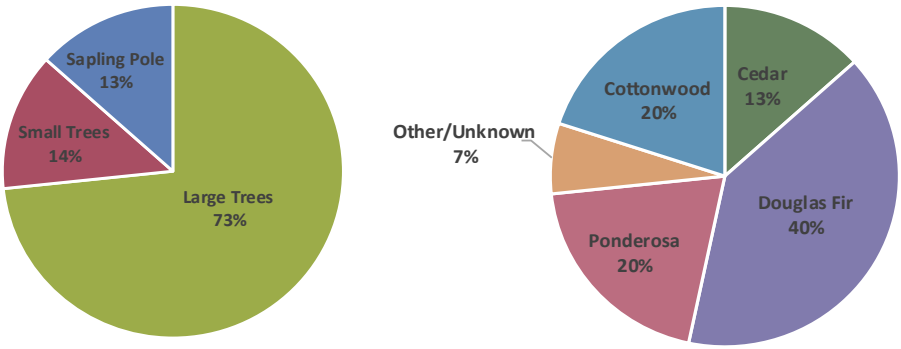


Figure 117. Dominant overstory riparian vegetation, based on 13 surveyed units, within 100 feet of Icicle Creek by ocular estimate.

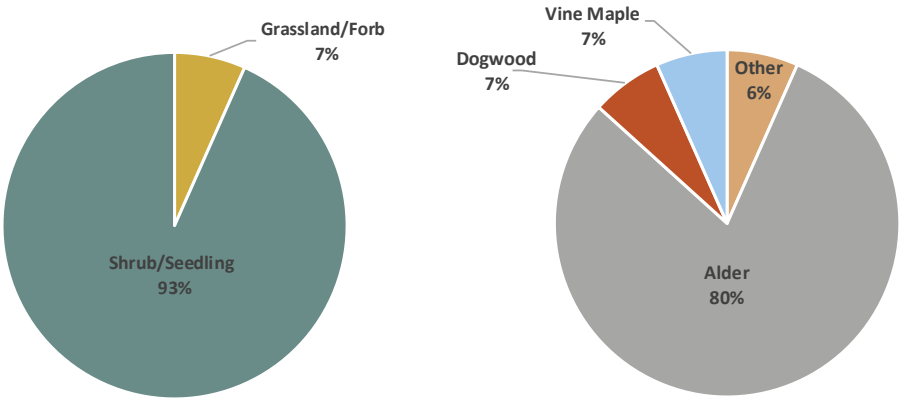


Figure 118. Dominant understory riparian vegetation class and species, based on 13 surveyed units, within 100 feet of Icicle Creek by ocular estimate.

4.16 REACH 16

Location: River mile 16.63 – 17.24
Total length: 0.61 miles
Survey Date: September 14 – 15, 2024

Figure 119. Representative photo of Reach 16. Habitat was dominated by pools.

4.16.1 Habitat Unit Composition

Reach 16 spans 0.61 miles. Pools were the dominant habitat type, consisting of 46% of the total area. Riffles were the second most common habitat type with 37% in the reach, followed by glides (13%) and side channels (4%) (Figure 120). Reach 16 had a stream gradient of 0.88%.

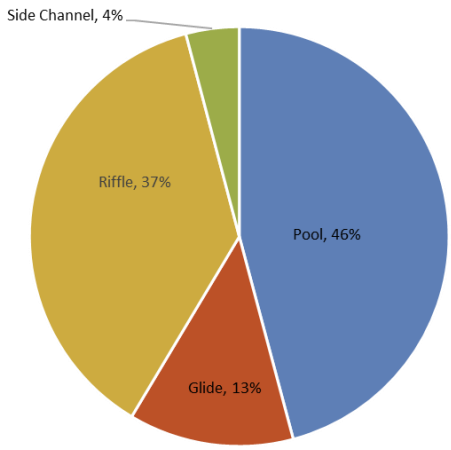


Figure 120. Stream habitat unit area composition of Reach 16.

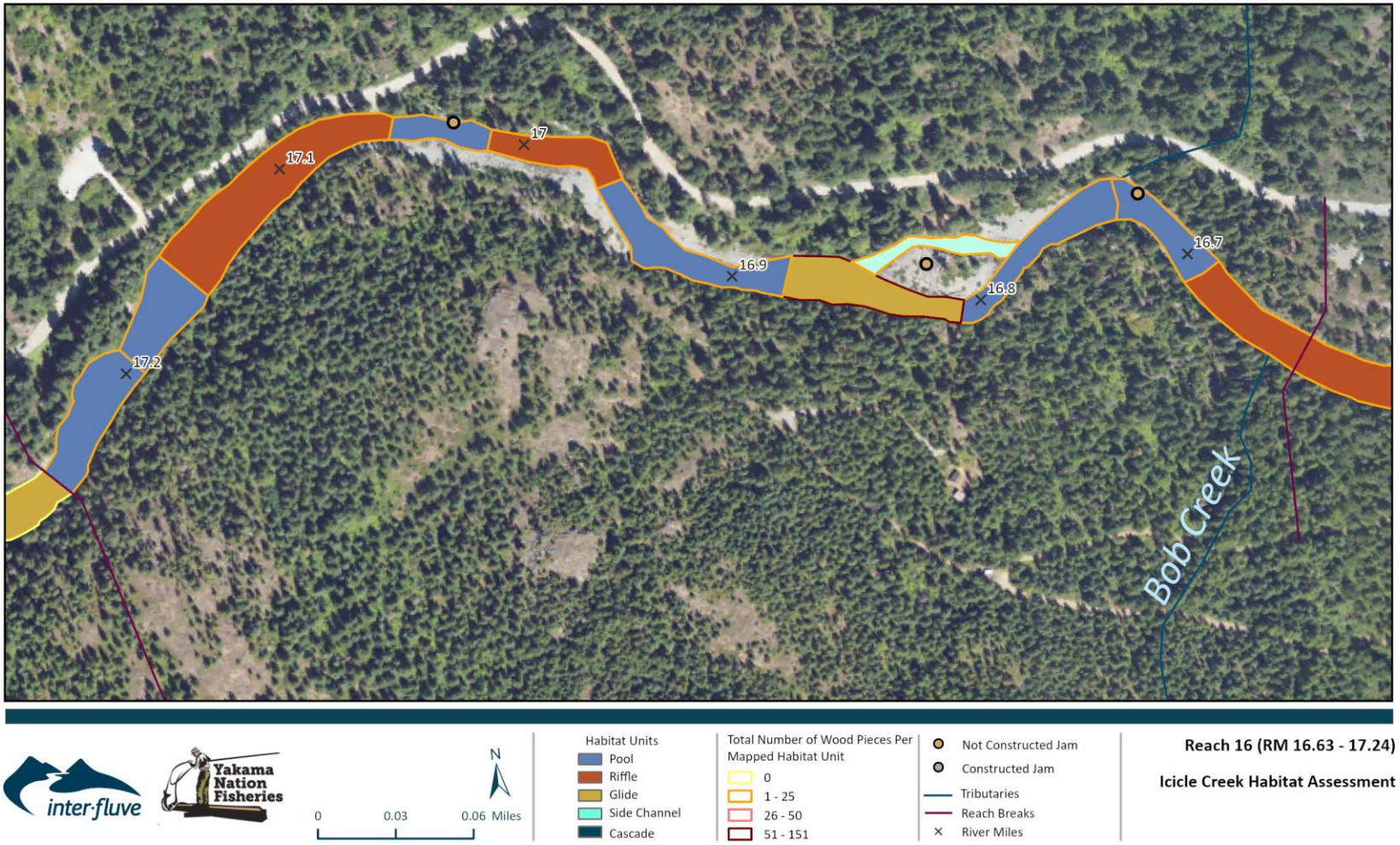


Figure 121. Map of the habitat unit composition and LWM in Reach 16 of Icicle Creek. LWM count includes pieces in jams.

4.16.2 Pools

Reach 16 had a total of six pools, with 83% of those pools having a residual depth less than three feet. The remaining 17% of pools had a residual depth between three feet and six feet. Residual depth averaged 2.4 feet (compared to the study area average of 4.4 feet) and ranged between 1.5 feet to 3.5 feet. The mean pool spacing for this reach was ten pools per mile, greater than the study area average of seven pools per mile.

4.16.3 Side Channel Habitat

One side channel was observed in Reach 16 with a total channel length of 316 feet. The side channel was predominantly slow water. One pieces of LWM was recorded and no jams were observed (Table 40).

Table 40. Side channels observed in Reach 16.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 54	316	Slow	1	0	0
Total	*316*		*1*	*0*	*0*

4.16.4 Large Woody Material

A total of 192 pieces of LWM were recorded in Reach 16. This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 175 pieces of LWM per mile, with 98 of those pieces per mile being Medium and Large LWM. Of total amount of pieces, 80% were recorded in the 13 observed jams in the reach (Table 41).

Table 41. LWM quantities in Reach 16.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of Individual Pieces	19	15	4	38
Number of Individual Pieces per Mile	31	31		62
Number of Total Pieces per Mile (including pieces in jams)	77	98		175
Number of Jams	3			
Number of Jams per Mile	5			
Estimated Wood Count in Jams	69			

4.16.5 Substrate & Fine Sediment

Two gravel counts were performed in Reach 15, with a combined average of 54% cobble, 25% boulder, 20% gravel, and 1% sand (Figure 122). The first gravel count, GC9, was conducted in a riffle crest at RM 16.74 and the second gravel count, GC8, was conducted at a pool tail crest at RM 16.85. The distribution and grain size class can be found in Figure 123 – Figure 124 and Table 42.

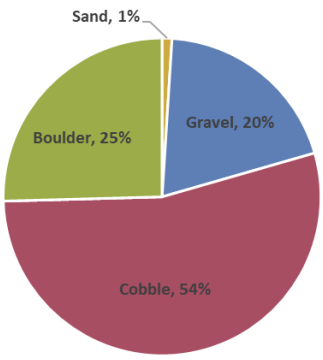


Figure 122. Combined percent sediment composition from the two gravel counts (GC9 and GC8) performed in Reach 16.

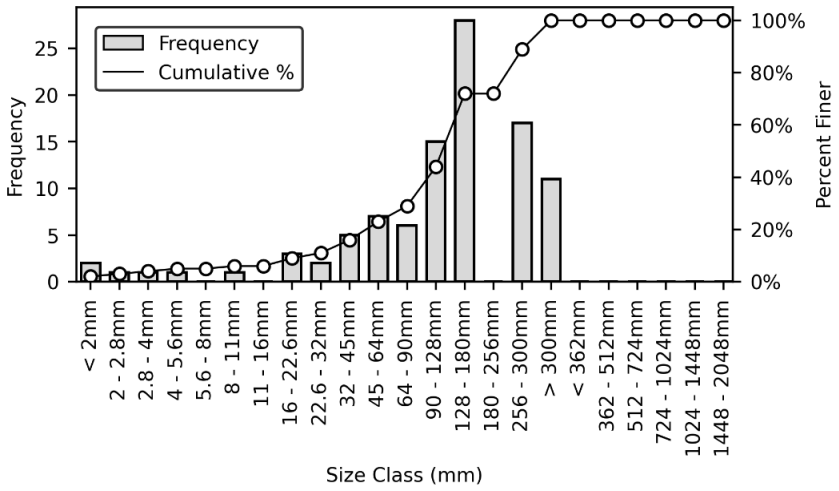


Figure 123. Cumulative distribution curve for GC9

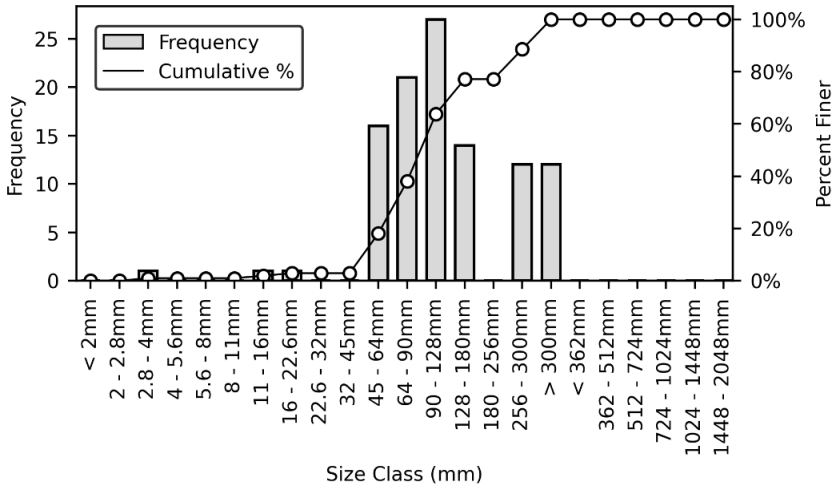


Figure 124. Cumulative distribution curve for GC8.

Table 42. Grain size class for GC9 and GC8 (assumed linear interpolation).

Size Class	GC9 Size percent finer than (mm)	GC8 Size percent finer than (mm)
D5	7	50
D16	50	60
D50	135	105
D84	230	220
D95	300+	300+

4.16.6 Riparian Corridor

Six channel units included ocular assessment of riparian vegetation in Reach 16. The dominant overstory class size was Large Trees (83%; 21.0 - 31.9-inch dbh), followed by Small Trees (17%; 9.0 - 20.9-inch dbh). The dominant overstory species in the reach were observed to be Cedar (34%), Douglas fir (33%) and Ponderosa pine (33%; Figure 125). The dominant understory size in Reach 16 was Shrub/Seedling (83%; 1.0 - 4.9-inch dbh). No Vegetation was recorded for the remaining 17% of units. The dominant understory species was Alder (83%) followed by Other (17%; Figure ***126***). Understory species recorded as Other in Reach 16 were in units with the No Vegetation size class.

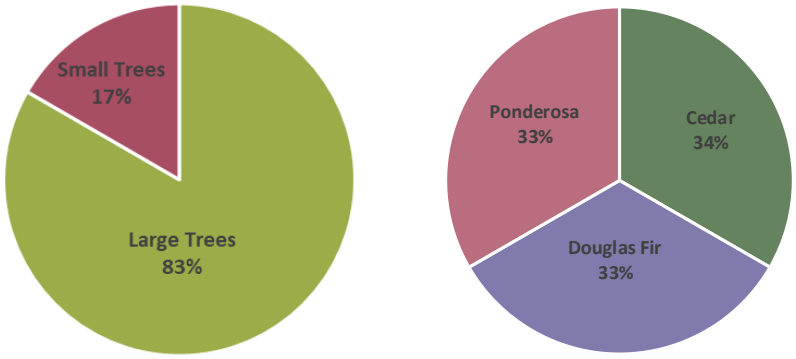


Figure 125. Dominant overstory riparian vegetation class and species, based on six surveyed units, within 100 feet of Icicle Creek by ocular estimate.

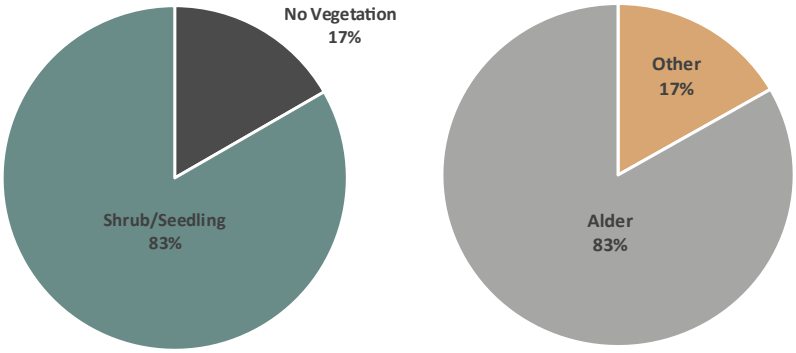


Figure** 126**. Dominant understory riparian vegetation class and species, based on six surveyed units, within 100 feet of Icicle Creek by ocular estimate.

4.17 REACH 17

Location: River mile 17.24 – 18.74
Total length: 1.5 miles
Survey Date: September 15, September 23 – 24, 2024

Figure 127. Representative photo of Reach 17 in Icicle Creek. Habitat is dominated by riffles

4.17.1 Habitat Unit Composition

In Reach 17, riffles were the dominant habitat unit type consisting of 61% of the aquatic habitat area. Pools comprise the second most dominant habitat unit type with 25%, followed by side channels (8%), glides (4%) and cascades (2%) (Figure 128 and Figure 130). One cascade was recorded in Reach 17 (Figure 129). Reach 17 was approximately 1.5 miles long with a gradient of 1.19%. Portions of Reach 17 flow through a bedrock gorge. U.S. Forest Service maintains trails that follow the upstream extent of the reach on the right bank. A pedestrian bridge crosses at RM 18.2 and overlooks the cascade and gorge. Much of the reach was not wadable for the habitat survey crew due to the confined, steep nature of the channel, and data is based on ocular estimates from the crew walking along the banks.

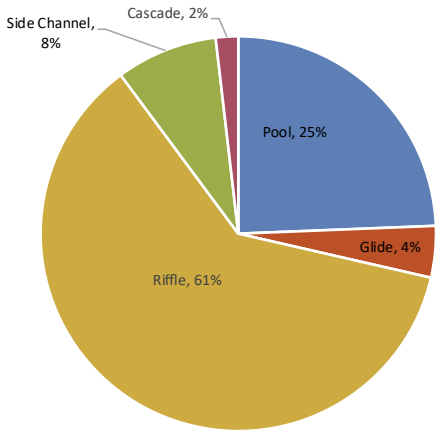


Figure 128. Stream habitat unit area composition of Reach 17.

Figure 129. Photo of the cascade in Reach 17 taken from the pedestrian bridge crossing Icicle Creek, looking upstream.

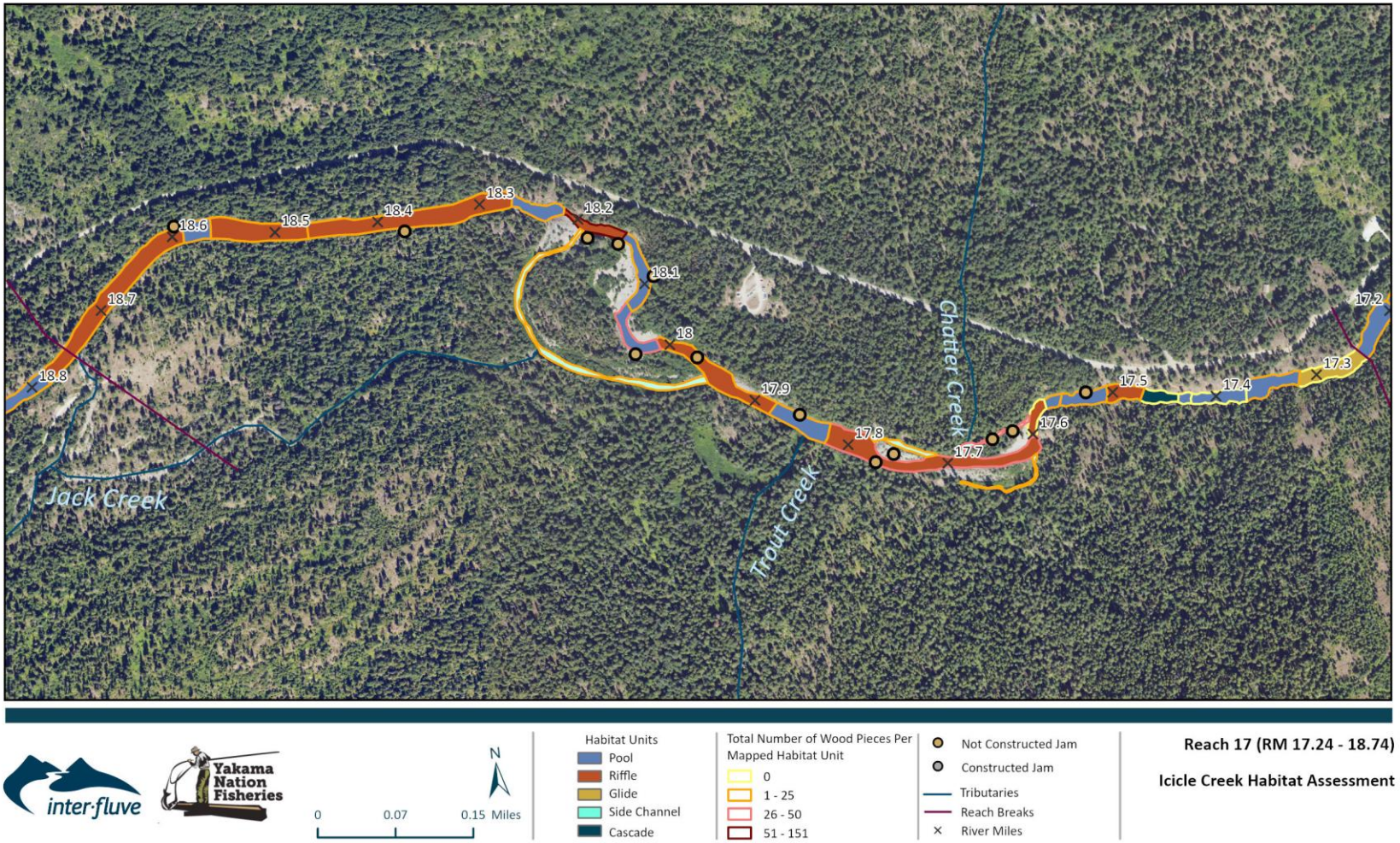


Figure 130. Map of the habitat unit composition and LWM in Reach 18 of Icicle Creek. LWM count includes pieces in jams.

4.17.2 Pools

Ten pools were observed in Reach 17 equating to a mean pool spacing of four pools per mile. Average residual depth was 6.1 feet. Residual depth of 20% of units is less than three feet. Fifty percent of pools have a residual depth between three and six feet, and the remaining 30% had a residual depth greater than or equal to six feet.

4.17.3 Side Channel Habitat

In Reach 17, four side channels were observed with a channel length of 2,956 feet. Three of the side channels are predominantly fast water units and the fourth is predominantly slow water. Twenty-six pieces of LWM were recorded in the side channels. Two jams were observed in the side channels with a LWM wood count of 20 pieces of wood (Table 43).

Table 43. Side channels observed in Reach 17.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 55	424	Fast	8	2	20
Side 56	524	Slow	4	0	0
Side 57	316	Fast	1	0	0
Side 58	1,692	Fast	13	0	0
Total	*2,956*		*26*	*2*	*20*

4.17.4 Large Woody Material

A total of 287 pieces of LWM were recorded in Reach 17. This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 191 pieces of LWM per mile, with 103 of those pieces per mile being Medium and Large LWM (Table 44). Of the total pieces, 54% were recorded in the 13 observed jams in the reach.

Table 44. LWM quantities in Reach 17.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of Individual Pieces	69	42	22	133
Number of Individual Pieces per Mile	46	43		89
Number of Total Pieces per Mile (including pieces in jams)	88	103		191
Number of Jams	13			
Number of Jams per Mile	9			
Estimated Wood Count in Jams	154			

4.17.5 Substrate & Fine Sediment

Two gravel counts were performed in Reach 17, with a combined average of 40% cobbles, 29% boulder, and 31% gravel (Figure 131). The first gravel counts, GC7, was conducted in a riffle crest adjacent to a vegetation gravel bar at RM 18.08 and the second gravel count, GC6, was conducted in a boulder bar located river right at RM 18.59. The distribution and grain size class can be found in Figure 132 – Figure 133 and Table 45.

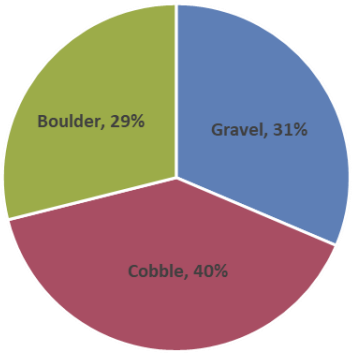


Figure 131. Combined percent sediment composition from the two gravel counts (GC7 and GC6) performed in Reach 17.

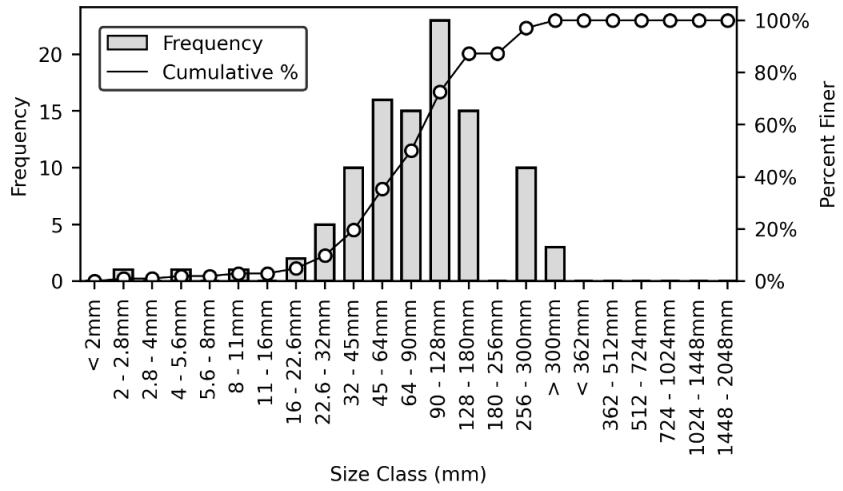


Figure 132. Cumulative distribution curve for GC6.

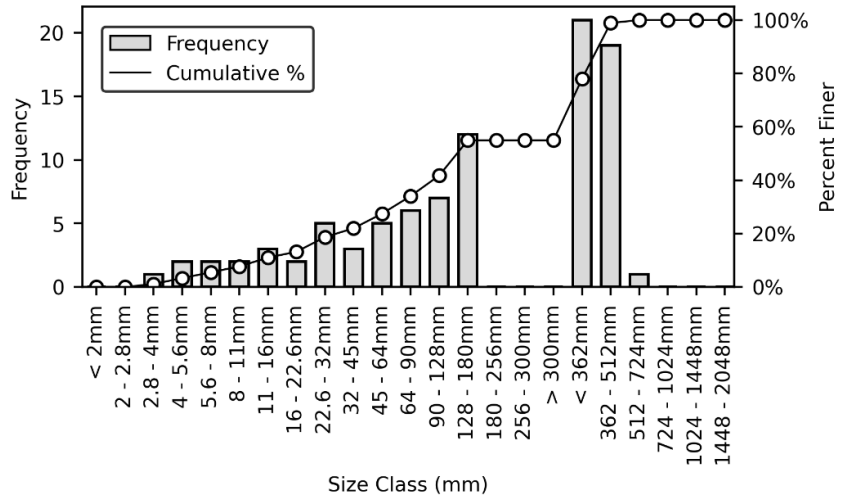


Figure 133. Cumulative distribution curve for GC7.

Table 45. Grain size class for GC7 and GC6 (assumed linear interpolation).

Size Class	GC7 Size percent finer than (mm)	GC6 Size percent finer than (mm)
D5	23	8
D16	40	43
D50	90	205
D84	165	365
D95	240	425

4.17.6 Riparian Corridor

Fourteen channel units in Reach 17 included ocular assessment of riparian vegetation. The dominant overstory size class was Large Trees (86%; 21.0 - 31.9-inch dbh), followed by Small Trees (14%; 9.0 - 20.9-inch dbh; Figure ***134***). Ponderosa pine is the dominant overstory species, comprising 36% of units. Douglas fir was recorded in 29% of the units, followed by Cedar (28%) and Cottonwood (7%; Figure ***134***). The dominant understory size class in Reach 17 was Shrub/Seedling (1.0 - 4.9-inch dbh) composing 86% of units, followed by No Vegetation in the remaining 14%. The understory vegetation species included Alder (57%), Dogwood (22%), Cedar (7%), and Other (14%; Figure ***135***). The Other understory species classification in Reach 17 was recorded for units with No Vegetation size class.

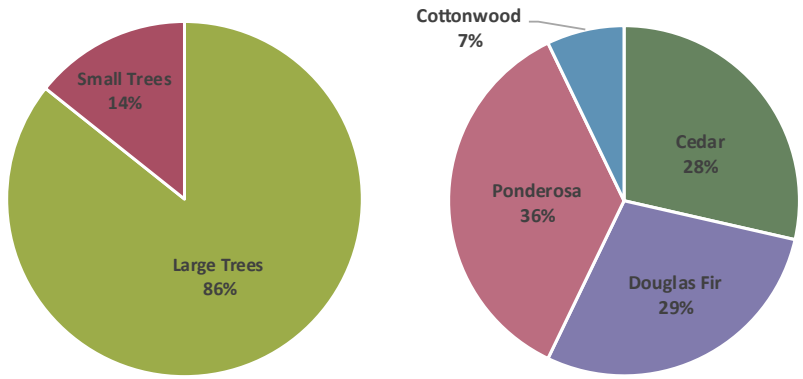


Figure 134***. Dominant overstory riparian vegetation class and species, based on 14 surveyed units, within 100 feet of Icicle Creek by ocular estimate.***

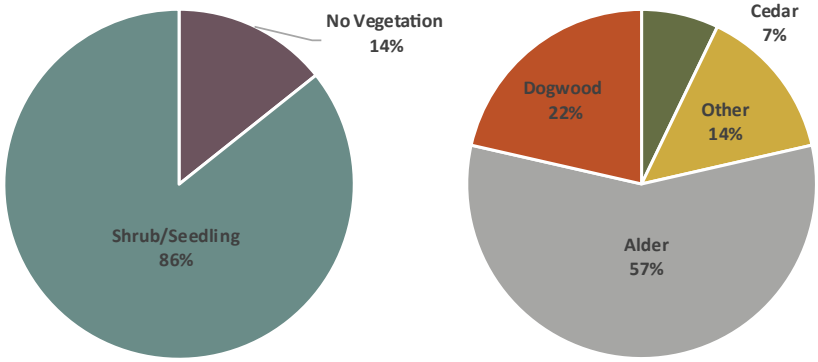


Figure 135***. Dominant understory riparian vegetation class and species, based on 14 surveyed units, within 100 feet of Icicle Creek by ocular estimate.***

4.18 REACH 18

Location: River mile 18.74 – 19.18
Total length: 0.44 miles
Survey Date: September 24 – 25, 2024

Figure 136. Representative photo of Reach 18 in Icicle Creek. Habitat was dominated by riffles.

4.18.1 Habitat Unit Composition

Reach 18 was 0.44 miles long. The stream gradient was approximately 1.54%. This reach was predominantly composed of riffles (62%), which was an increase in riffle composition compared to the previous unit. Pools were the second dominant habitat type composing 30% of the aquatic habitat area, followed by side channels (7%) then glides (1%) (Figure 137). Some of the reach was not wadable for the habitat survey crew due to the confined, steep nature of the channel, and data is based on ocular estimates from the crew walking along the banks.

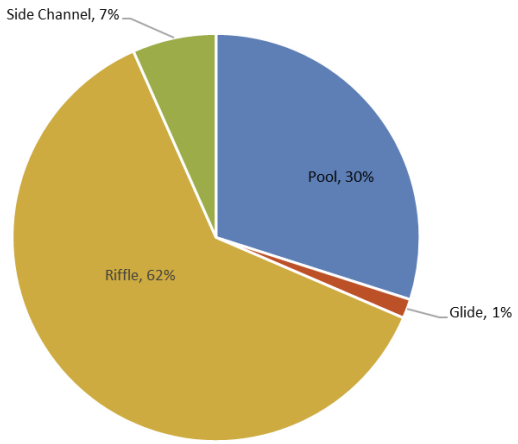


Figure 137. Stream habitat unit area composition of Reach 18.

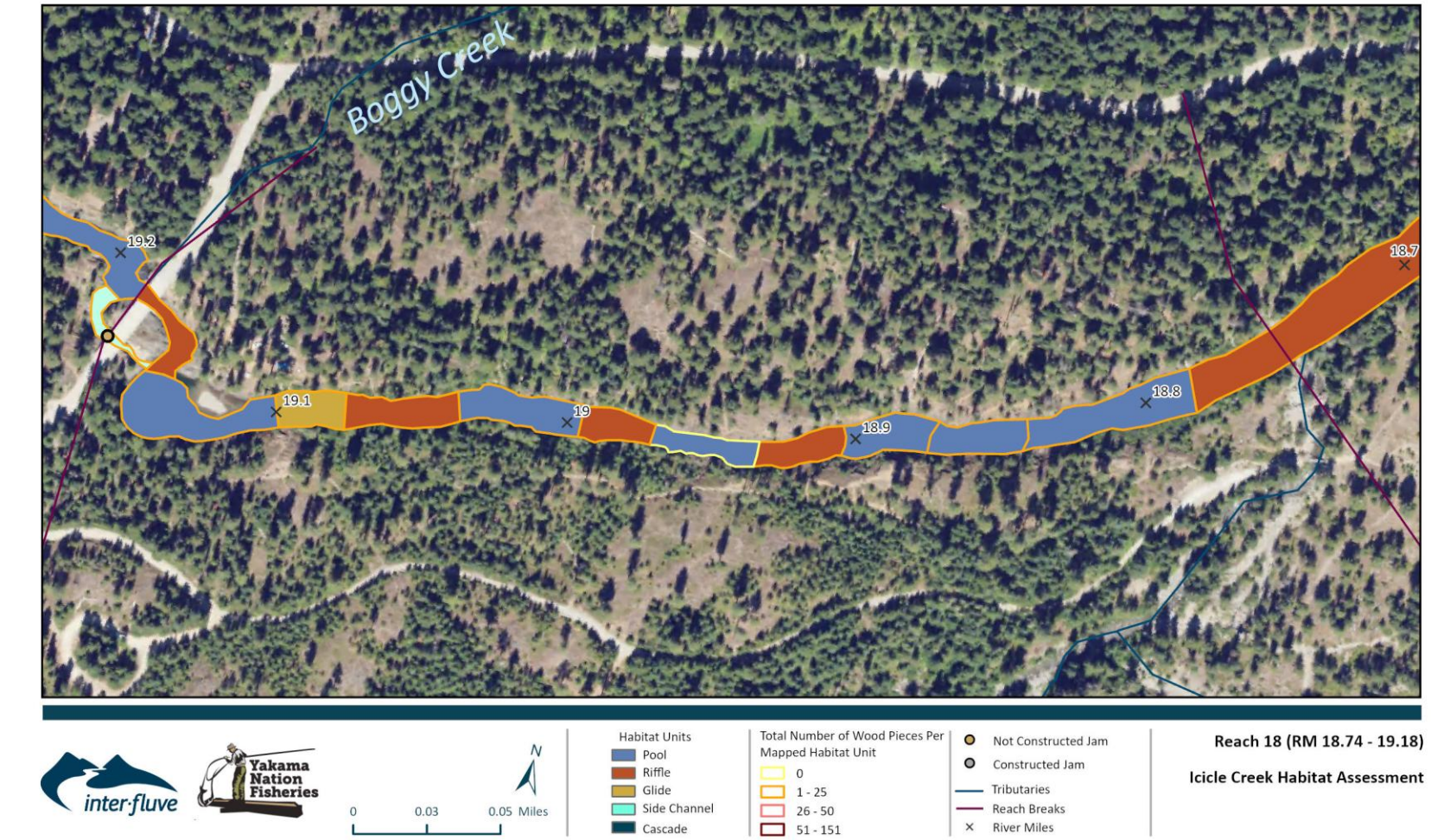


Figure 138. Map of the habitat unit composition and LWM in Reach 18 of Icicle Creek. LWM count includes pieces in jams.

4.18.2 Pools

Reach 18 had a total of six pools. Seventeen percent of pools had a residual depth greater than six feet. Sixty-seven percent of the pools had a residual depth between three feet and six feet, while the remaining 17% had less than three feet of residual depth. Residual depth in Reach 18 ranged from 2.3 feet to 18.5 feet, with an average of 5.7 feet (compared to the 4.4 feet for the study area average). The mean pool spacing for this reach was 14 pools per mile, higher than the study area average of seven pools per mile.

4.18.3 Side Channel Habitat

One side channel was measured in Reach 18 with a total channel length of 191 feet. The side channel was observed as predominantly slow. One jam was observed in the side channels with an estimated wood count of 18 LWM (Table 46).

Table 46. Side channels observed in Reach 18.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 59	191	Slow	1	1	18
Total	*191*		*1*	*1*	*18*

4.18.4 Large Woody Material

A total of 111 pieces of LWM was recorded in Reach 18. This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 258 pieces of LWM per mile, with 114 of those pieces per mile being Medium and Large LWM. One jam was observed in the reach, consisting of 16% of the total wood count (Table 47).

Table 47. LWM quantities in Reach 18.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of Individual Pieces	40	40	13	93
Number of Individual Pieces per Mile	93	123		216
Number of Total Pieces per Mile (including pieces in jams)	114	114		258
Number of Jams	1			
Number of Jams per Mile	2			
Estimated Wood Count in Jams	18			

4.18.5 Substrate & Fine Sediment

No gravel counts were performed in Reach 18. Conditions were not appropriate or safe to complete a gravel count. Substrate was dominated by boulders.

4.18.6 Riparian Corridor

Six channel units in Reach 18 included ocular assessment of riparian vegetation. The dominant overstory class was Large Trees (21.0 - 31.9-inch dbh) composing 67% of the measured units. The second most dominant size class was No Vegetation (17%), followed by Sapling/Pole (8%; 9.0 - 20.9-inch dbh; Figure 139). Ponderosa was the dominant overstory species, present in67% of the measured units.

Other/Unknown species (17%) was observed in units where No Vegetation Size class recorded. Douglas Fir was the next most dominant overstory species (16%) in Reach 18. The dominant understory size in Reach 18 was 67% Shrub/Seedling (1.0 - 4.9-inch dbh), followed by No Vegetation for 23% of the surveyed units. The dominant species for the understory was Alder (62%) and Other (33%) (Figure 140). The Other understory species classification in Reach 18 was recorded in channel units with No Vegetation size class.

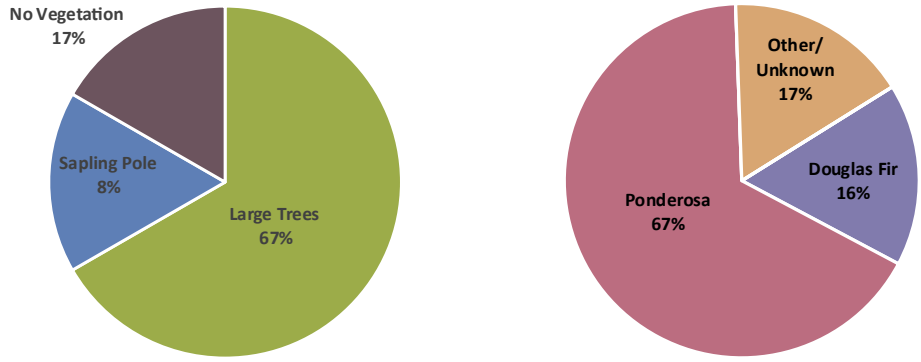


Figure 139. Dominant overstory riparian vegetation class and species, based on six surveyed unit, within 100 feet of Icicle Creek by ocular estimate.

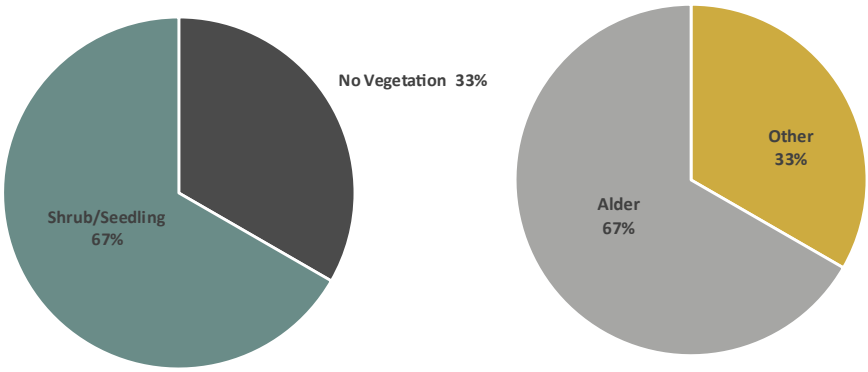


Figure 140. Dominant understory riparian vegetation class and species, based on six surveyed units, within 100 feet of Icicle Creek by ocular estimate.

4.19 REACH 19

Location: River mile 19.18 – 21.11
Total length: 1.93 miles
Survey Date: September 25 – 26, 2024

Figure 141. Representative photo of Reach 19 in Icicle Creek. Habitat was dominated by riffles

4.19.1 Habitat Unit Composition

Reach 19 spans 1.93 miles. Pools were the dominant habitat type in Reach 19, consisting of 64% of the total aquatic habitat area. This is followed by glides (16%), riffles (12%), and side channels (8%; Figure 142 and Figure 143) This reach delineates the steep, turbulent habitats observed in the downstream reaches. Stream gradient in Reach 19 was 0.33%. The reach ends within the Alpine Lakes Wilderness.

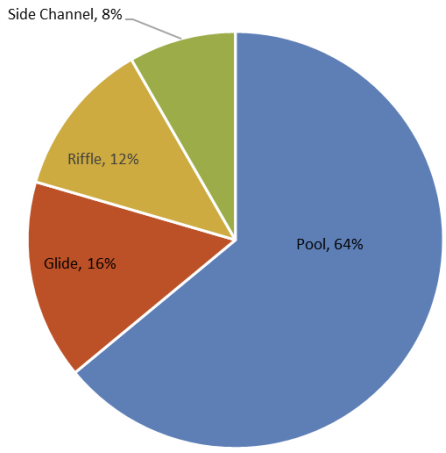


Figure 142. Stream habitat unit area composition of Reach 19.

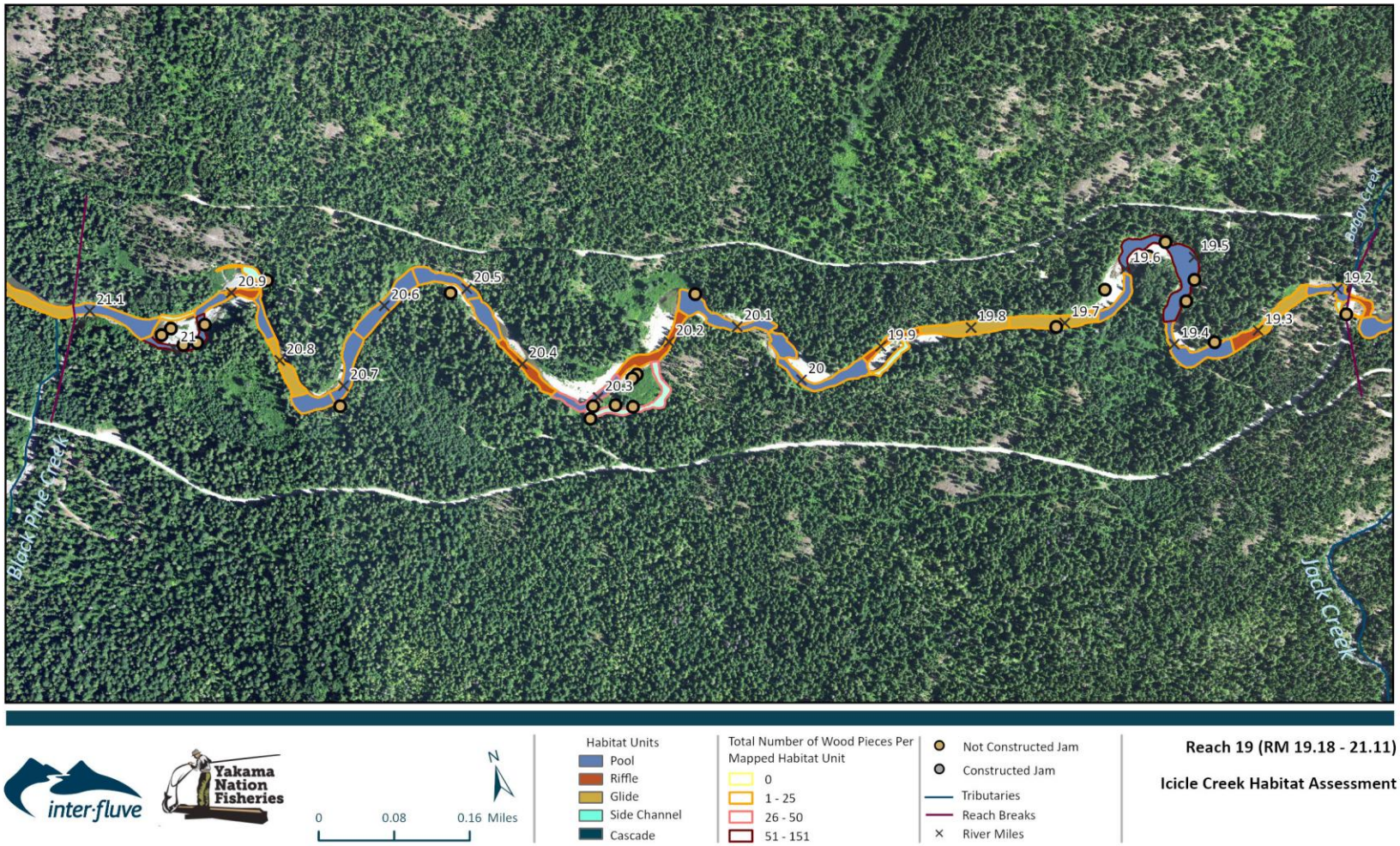


Figure 143. Map of the habitat unit composition and LWM in Reach 19 of Icicle Creek. LWM count includes pieces in jams.

4.19.2 Pools

Reach 19 had a total of 18 pools. Three pools (17%) had a residual depth greater than or equal to six feet. A majority of the pools (61%, n = 11) had a residual depth between three feet and six feet, while the remaining 22% were shallower than three feet of residual depth. Residual depth in Reach 19 ranged from 2.1 feet to 18.9 feet, with an average of 5.3 feet. The mean pool spacing for this reach was 14 pools per mile, higher than the study area average of seven pools per mile.

4.19.3 Side Channel Habitat

Four side channels were identified in Reach 19 and the total channel length was 1,543 feet. All side channels were observed as predominantly slow water units. A total of 14 individual pieces of LWM were recorded. Three jams were observed and had a total LWM wood count of 21 LWM (Table 48).

Table 48. Side channels observed in Reach 19.

Location	Length (ft)	Dominant Unit Type	Wood Count	Jam Count	Wood Count in Jams
Side 60	324	Slow	2	0	0
Side 61	685	Slow	8	3	21
Side 62	328	Slow	2	0	0
Side 63	205	Slow	2	0	0
Total	*1,543*		*14*	*3*	*21*

4.19.4 Large Woody Material

A total of 413 pieces of LWM were recorded in Reach 19, the second most of any reach in the study area. This total includes individual pieces and pieces in jams. LWM frequency was approximately 213 pieces of LWM per mile, with 127 of those pieces per mile being Medium and Large LWM. A total of 22 jams were observed within the reach which contained 67% of the total wood count (Table 49).

Table 49. LWM quantities in Reach 19.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of Individual Pieces	59	55	23	137
Number of Individual Pieces per Mile	30	40		71
Number of Total Pieces per Mile (including pieces in jams)	86	127		213
Number of Jams	22			
Number of Jams per Mile	11			
Estimated Wood Count in Jams	276			

4.19.5 Substrate & Fine Sediment

Three gravel counts were performed in Reach 19, with a combined average of 54% gravel and 46% cobbles (Figure 144). The first gravel count, GC 5, was conducted at RM 19.66 in a riffle crest at the upstream end of a point bar. The second and third gravel counts, GC 4 and GC 3, were conducted at RM 20.13 and RM 20.83, respectively, in riffle crests. The distribution and grain size class can be found in Figure 145– Figure 146 and Table 50.

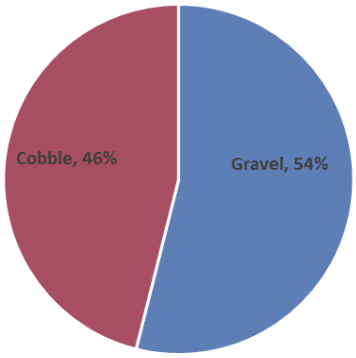


Figure 144. Combined sediment composition from the three gravel counts (GC5, GC4, and GC3) performed in Reach 19.

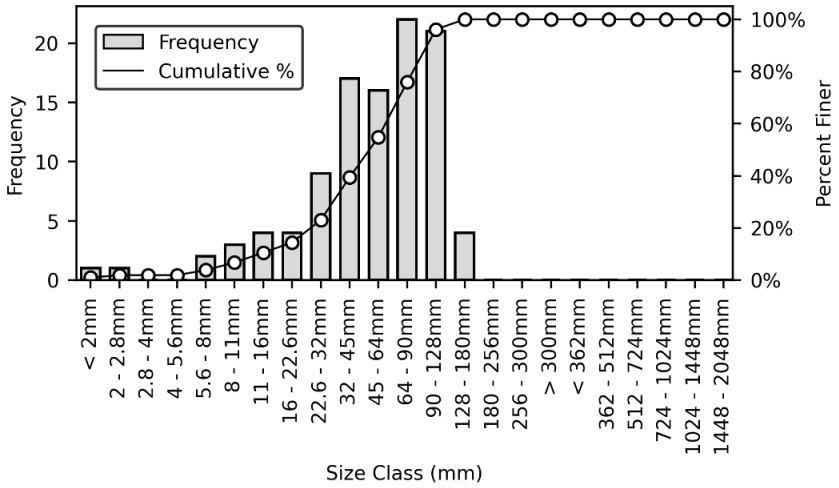


Figure 145. Cumulative distribution curve for GC5.

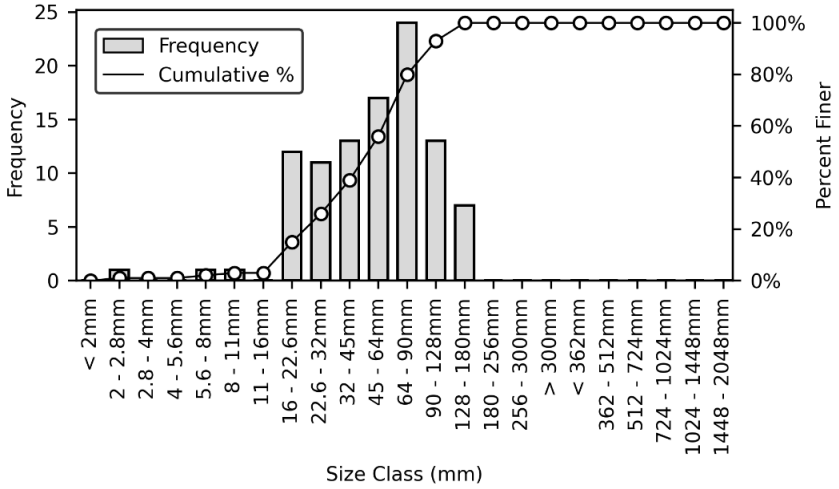


Figure 146. Cumulative distribution for GC4.

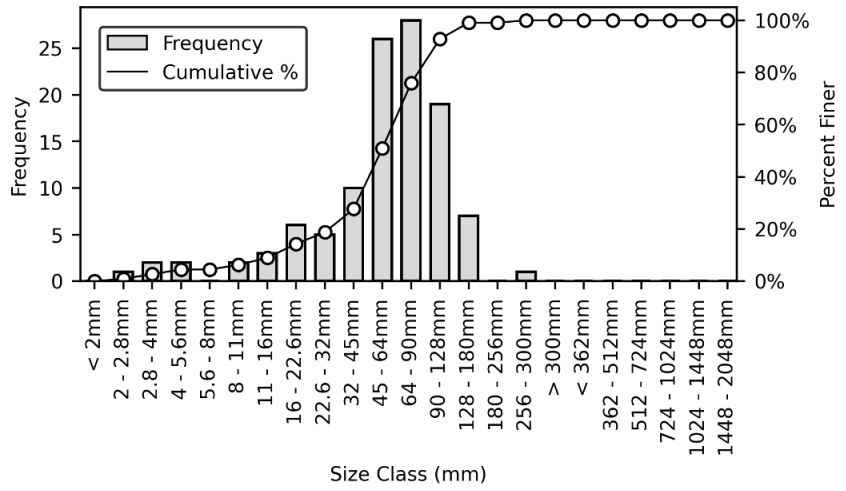


Figure 147. Cumulative distribution curve for GC3.

Table 50. Grain size class for GC5, GC4 and GC3 (assumed linear interpolation).

	GC5	GC4	GC3
Size Class	*Size percent finer than (mm)*	*Size percent finer than (mm)*	*Size percent finer than (mm)*
D5	9	17	9
D16	24	23	26
D50	57	57	63
D84	104	100	105
D95	128	140	145

4.19.6 Riparian Corridor

Fifteen channel units in Reach 19 included ocular assessment of riparian vegetation. The dominant overstory size class in Reach 19 was 93% Large Trees (21.0 - 31.9-inch dbh). The remaining 7% of overstory units recorded was in the Mature Tree (> 32-inch dbh) size class. The dominant species was composed of Douglas fir (67%) and Cedar (33%; Figure 148). The understory was dominated (100%) by Shrub/Seedling (1.0 -4.9-inch dbh) and largely consisted of Dogwood (67%; Figure 148). The remaining understory species composition was Alder (20%), Willow (7%) and Vine/Douglas maple (6%; Figure 149).

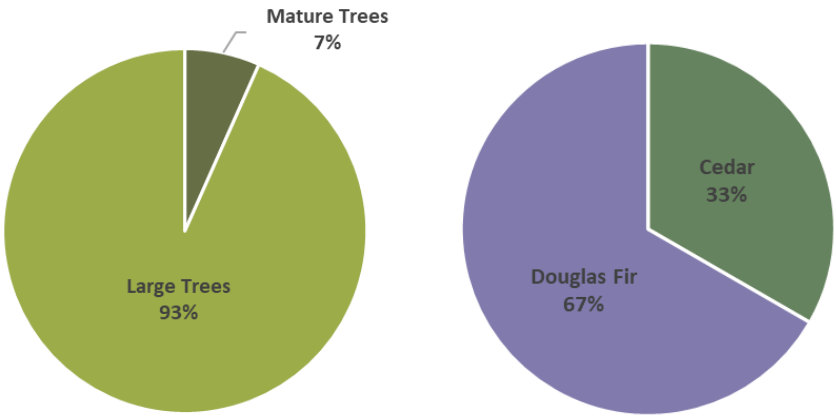


Figure 148. Dominant overstory riparian vegetation class and species, based on 15 surveyed units, within 100 feet of Icicle Creek by ocular estimate.

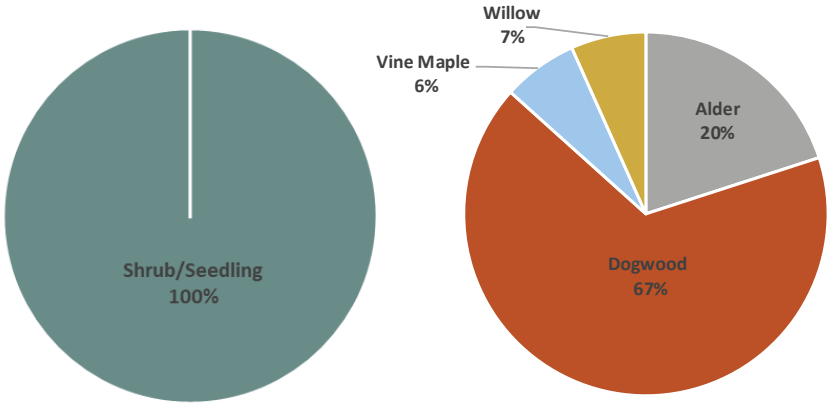


Figure 149. Dominant understory riparian vegetation class and species, based on 15 surveyed units, within 100 feet of Icicle Creek by ocular estimate.

4.20 REACH 20

Location: River mile 21.11 – 22.02
Total length: 0.91 miles
Survey Date: September 26, 2024

Figure 150. Representative photo of Reach 20 in Icicle Creek. Habitat was dominated by riffles

4.20.1 Habitat Unit Composition

Reach 20 was 0.9 miles long and composed predominantly of fast water units. Riffles composed 66% of the habitat area. Glides (18%) were the second most dominant habitat, followed by pools (16%; Figure 151). The final reach in the study area had a stream gradient of 0.49%. This reach is located exclusively within the Alpine Lakes Wilderness.

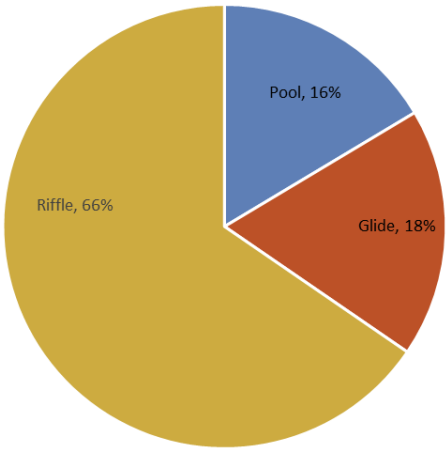


Figure 151. Stream habitat unit area composition of Reach 20.

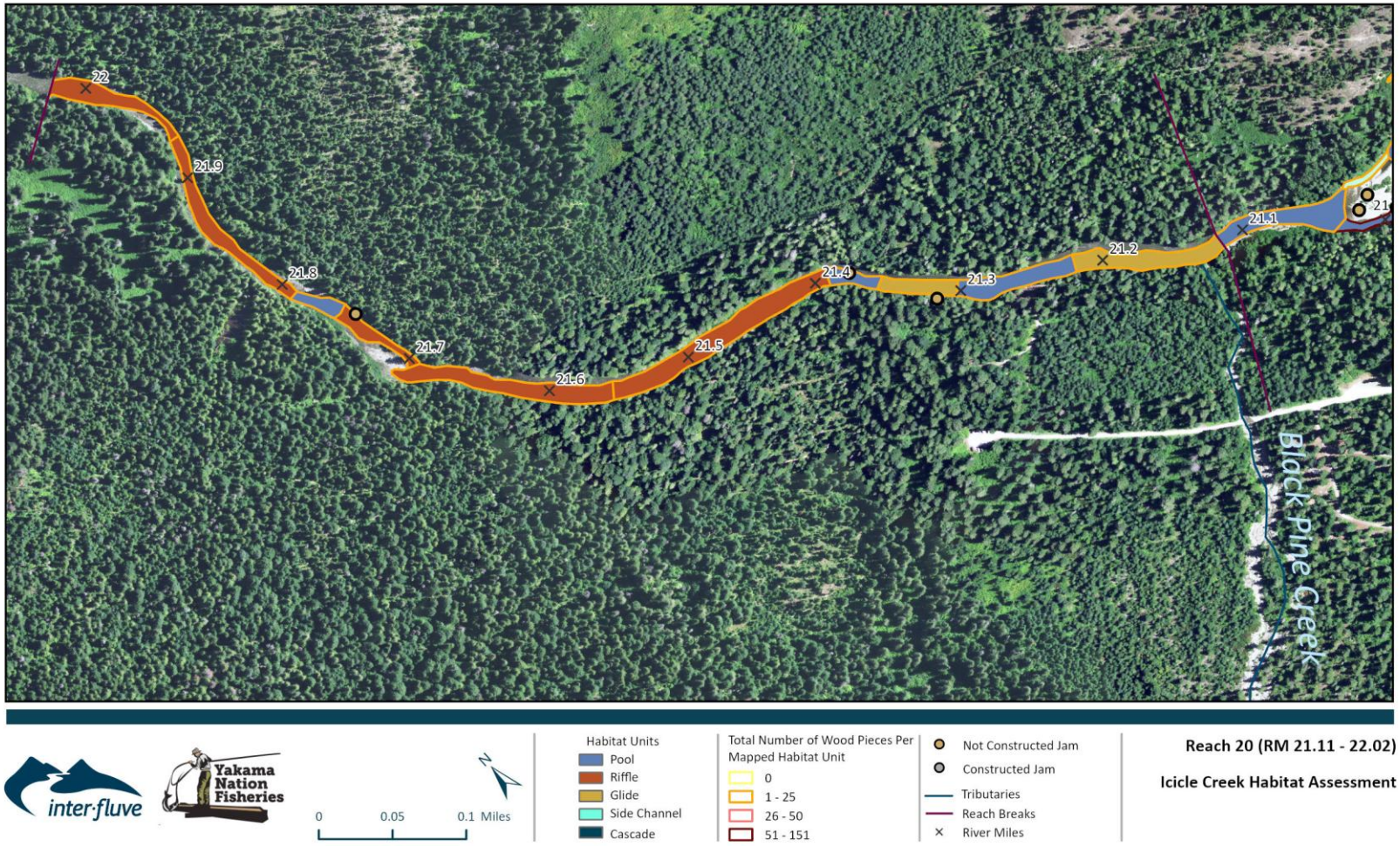


Figure 152. Map of the habitat unit composition and LWM in Reach 20 of Icicle Creek. LWM count includes pieces in jams.

4.20.2 Pools

Three pools were observed in Reach 20, which corresponds to 3.3 pools per mile. All of the pools within the reach (100%) have residual depths less than three feet. Residual pool depth ranged from a low of 1.8 feet to a high of 2.2 feet, the shortest range among all reaches in the study area. The average residual depth for Reach 20 was 2.0 feet.

4.20.3 Side Channel Habitat

No side channels were observed in Reach 20.

4.20.4 Large Woody Material

A total of 100 pieces of LWM were recorded in Reach 20 (Table 51). This total includes individual pieces and pieces recorded in jams. LWM frequency within the reach is approximately 111 pieces of LWM per mile, with 81 of those pieces per mile being Medium and Large LWM. There were three observed jams in Reach 20, which contained an estimated 21 pieces of LWM or 21% of the total amount of LWM pieces.

Table 51. LWM quantities in Reach 20.

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of Individual Pieces	20	46	13	79
Number of Individual Pieces per Mile	22	66		88
Number of Total Pieces per Mile (including pieces in jams)	30	81		111
Number of Jams	3			
Number of Jams per Mile	3			
Estimated Wood Count in Jams	21			

4.20.5 Substrate & Fine Sediment

Two gravel counts were performed in Reach 20, with a combined average of 51% cobbles, 36% gravel, 11% boulder, and 2% sand (Figure 153). The first gravel count, GC2, was conducted at RM 21.4 in a riffle crest. The second gravel count, GC1, was conducted at RM 21.73 in a riffle crest adjacent to a gravel bar. The distribution and grain size class can be found in Figure 154 – Figure 155 and Table 52.

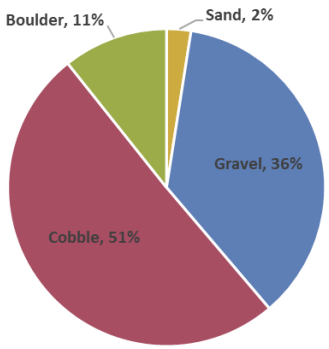


Figure 153. Combined sediment composition from the two gravel counts (GC2 and GC1) performed in Reach 20.

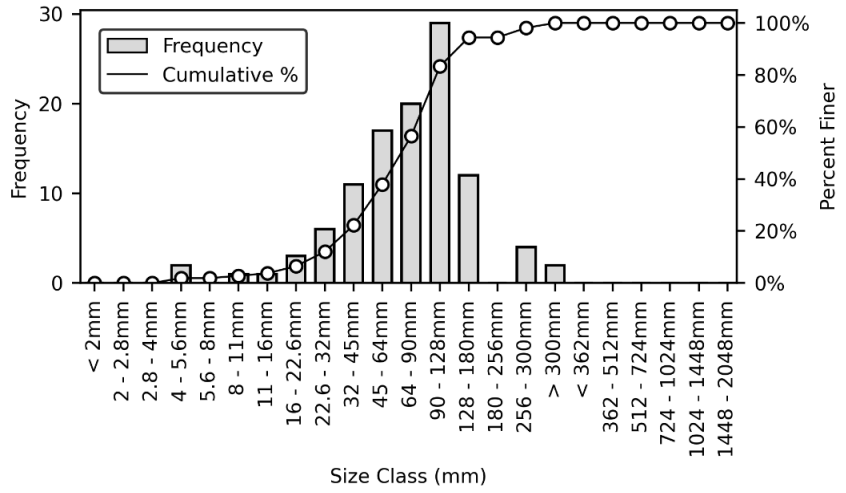


Figure 154. Cumulative distribution curve for GC2.

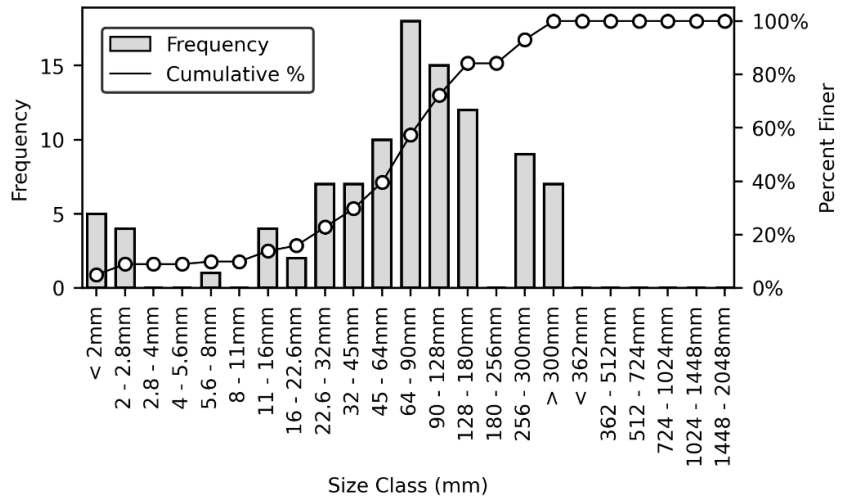


Figure 155. Cumulative distribution curve for GC1.

Table 52. Grain size class for GC2 and GC1 (assumed linear interpolation).

	GC2	GC1
Size Class	*Size percent finer than (mm)*	*Size percent finer than (mm)*
D5	19	2
D16	37	23
D50	80	80
D84	130	180
D95	190	300+

4.20.6 Riparian Corridor

Based on five nth units surveyed in Reach 20, the dominant (100%) overstory class and species was Large Trees (21.0 - 31.9-inch dbh) that were 100% Cedar (Figure 156). The dominant understory in Reach 20 was Shrub/Seedling (100%; 1.0 -4.9-inch dbh). The dominant understory species was Alder that composed of 83% of units, followed by Vine/Douglas maple that composed the remaining 17% of units (Figure 157).

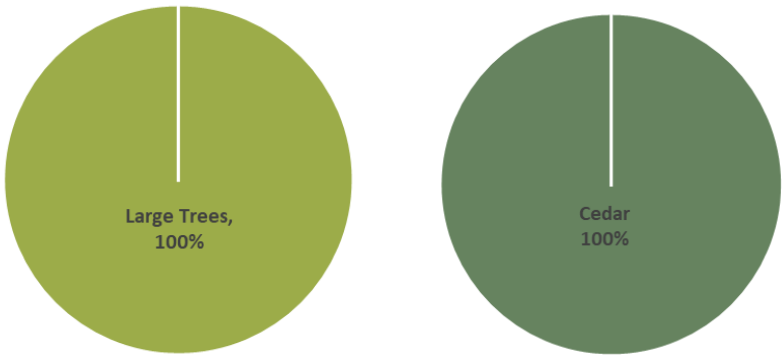


Figure 156.Dominant overstory riparian vegetation class and species, based on five nth units surveyed, within 100 feet of Icicle Creek by ocular estimate.

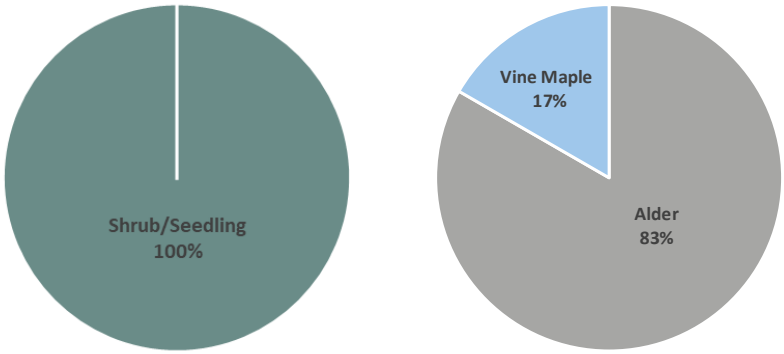


Figure 157. Dominant understory riparian vegetation class and species, based on five nth units, within 100 feet of Icicle Creek by ocular estimate.

4.21 SUMMARY DATA

Table 53. Summary table of all the data collected in the 2024 Habitat Assessment for all the mainstem reaches in the Icicle Creek study area.

Reach	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	All
Reach Mileage Boundaries	1.24	1.78	1.28	0.75	1.22	0.88	1.48	1	0.61	1.12	0.56	0.58	0.34	1.91	1.89	0.61	1.5	0.43	1.94	0.9	22.02
Stream Gradient (%)	0.11	0.07	0.24	1.65	3.40	3.82	3.19	1.94	3.66	1.31	3.40	2.11	2.20	1.54	0.57	0.88	1.62	1.54	0.33	0.49	1.70
Wetted Width (ft)																					
Pool																					
Mean	92	101	61	82	54	37	67	65	58	52	53	56	58	58	71	63	49	52	61	58	62
Median	90	100	60	70	50	40	60	65	55	50	55	43	55	55	70	58	50	45	50	55	59
St. Dev	22	15	27	24	8	12	14	5	15	2	10	25	8	10	18	22	10	23	23	8	15
Glide																					
Mean	78	105	45	0	20	0	0	0	0	50	0	50	0	75	88	80	0	60	58	65	41
Median	75	105	45	0	20	0	0	0	0	50	0	50	0	75	88	80	0	60	58	65	41
St. Dev	22	15	11	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	3	5	4
Riffle																					
Mean	0	0	60	67	52	49	64	72	75	91	67	68	59	68	70	73	57	48	42	62	57
Median	0	0	60	60	50	50	60	70	75	90	70	70	68	70	70	70	55	50	35	65	57
St. Dev	0	0	0	21	11	9	15	12	26	2	10	6	17	9	7	16	14	10	19	6	11
Side Channel																					
Mean	20	130	15	18	18	0	16	26	38	17	0	20	0	32	20	30	14	20	33	0	23
Median	20	130	18	20	18	0	18	25	55	20	0	20	0	30	18	30	15	20	35	0	24
St. Dev	0	0	9	2	6	0	8	19	25	8	0	0	0	2	12	0	2	0	11	0	5
Water Depth (ft)																					
Pool Maximum Depth																					
Mean	7.9	7.4	3.9	5.5	5.5	7.0	6.0	7.5	5.8	5.6	5.9	6.8	6.3	5.0	4.6	3.8	7.5	7.6	6.1	2.7	5.9
Median	6.5	7.5	3.5	5.5	5.0	7.0	5.5	7.5	6.5	6.5	6.0	6.0	6.0	5.0	4.5	3.9	5.4	5.6	5.0	2.8	5.6
St. Dev	6.3	2.8	1.3	1.0	1.2	3.2	1.4	0.4	1.9	1.6	1.1	2.0	1.2	0.8	1.1	0.3	5.2	5.6	3.8	0.1	2.1
Pool Residual Depth																					
Mean	6.5	6.0	3.0	4.5	4.2	5.5	4.1	4.9	3.9	3.6	4.0	4.7	4.1	2.9	3.5	2.4	6.1	5.7	5.3	2.0	4.4
Median	5.4	5.4	2.6	4.3	4.0	5.0	4.0	4.6	4.6	4.4	3.9	3.8	4.0	2.8	3.4	2.5	4.1	4.3	4.4	2.0	4
St. Dev	6.2	3.0	1.3	0.8	1.8	3.5	1.2	0.7	1.6	1.3	1.2	2.5	1.5	0.9	1.0	0.6	5.1	4.4	3.7	0.2	2.1
Riffle/Glide Average Depth																					

Reach	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	All
Mean	1.6	1.3	1.6	2.0	3.0	3.2	3.1	2.2	2.3	1.6	2.6	2.0	2.0	2.1	1.6	1.8	2.0	2.0	1.4	1.4	2.0
Median	1.4	1.3	1.4	2.3	3.0	3.0	3.0	2.1	2.2	1.6	2.5	2.0	2.0	2.2	1.5	1.8	1.8	1.7	1.4	1.3	2.0
St. Dev	0.65	0.75	0.65	0.50	0.96	0.41	0.81	0.42	0.42	0.32	0.27	0.33	0.43	0.36	0.35	0.57	0.78	0.8	0.30	0.30	0.5
Bankfull Characteristics																					
Width (ft)																					
Mean	125	83	57	100	90	80	102	118	97	99	76	92	86	85	105	98	83	72	82	86	90.8
Median	80	100	55	65	50	40	60	70	60	90	60	55	65	65	70	62.5	80	66	50	62.5	63
St. Dev	7	55	15	28	0	42	16	2	4	21	4	10	2	9	11	6	8	13	13	7	13.5
Average Depth (ft)																					
Maximum depth	6.1	6.3	5.6	10.8	n=0	n=0	6.6	8.1	7.2	6.3	8.8	7.5	6.4	7.2	6.4	7.5	8.2	5.0	6.8	5.7	7.1
Minimum Depth	3.5	4.0	0.8	6.3	n=0	n=0	3.0	0.0	2.9	3.0	0.5	2.8	3.2	3.6	2.5	1.6	1.6	2.2	2.4	2.5	2.6
Mean	4.5	5.4	4.3	8.1	n=0	n=0	4.5	5.0	4.6	4.5	5.7	5.1	4.5	5.1	4.8	4.5	4.6	3.9	4.8	4.2	4.9
St. Dev	1.0	0.8	1.4	1.9	n=0	n=0	1.2	1.9	1.6	1.1	2.1	1.6	1.1	1.3	1.4	1.5	1.8	0.8	1.3	1.0	1.4
Maximum Depth (ft)																					
Mean	4.5	5.4	4.3	8.1	n=0	n=0	4.5	5.0	4.6	4.5	5.7	5.1	4.5	5.1	4.8	4.5	8.2	5.0	4.8	4.2	4.9
St. Dev	1.0	0.8	1.4	1.9	n=0	n=0	1.2	1.9	1.6	1.1	2.1	1.6	1.1	1.3	1.4	1.5	1.8	0.8	1.3	1.0	1.4
Width: Depth Ratio																					
Mean	27.9	15.5	13.2	12.4	n=0	n=0	22.5	23.3	21.0	22.0	13.3	18.0	19.1	16.8	21.8	21.7	17.0	20.3	17.0	20.4	18.4
Flood Prone Width (ft)																					
Mean	1634	298	204	190	161	126	105	255	146	145	91	103	110	101	217	156	148	76	326	215	240
Median	1633	298	181	190	155	125.5	106	254.5	146	166	93	106	110	102	127.5	156	130	73	323	162.5	232
St. Dev	627	54	67	n=0	56	22	5	152	6	40	15	11	16	9	192	23	55	6	39	157	300
Habitat Area																					
Pool (%)	66.4	91.5	75.5	27.8	25.5	32.1	22.8	10.5	17.8	5.7	28.8	18.9	23.5	19.1	40.3	45.9	25	87	64.0	16.4	41.0
Glide (%)	32.4	6.0	12.7	0.0	3.1	0.0	0.0	0.0	0.	1.9	0.0	4.8	0.0	2.6	29.5	12.7	4	8	15.5	18.1	9.1
Riffle (%)	0.0	0.0	3.1	66.6	50.4	66.6	66.2	67.8	69.8	86.5	71.2	72.3	76.5	75.6	20.7	37.3	61	0	12.2	65.4	42.7
Side Channel (%)	1.1	2.5	8.8	5.6	18.5	0.0	11.0	21.7	12.4	5.9	0.0	4.0	0.0	2.7	0.0	4.1	8	5	8.3	0	6.1
Cascade (%)	0.0	0.0	0.0	0.0	2.5	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2	0	0	0	0.2
Pools																					
Pools per Mile	3.9	8.1	18.8	7.1	7.8	10.0	8.3	4.4	6.7	2.7	13.3	7.3	8.6	4.7	7.1	7.5	6.7	14	10.3	3.2	7.2

Reach	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	All
Residual Depth (% of pools)																					
pools < 3ft	40%	14%	53%	0%	22%	11%	17%	0%	25%	33%	25%	50%	33%	56%	42%	83%	20%	17%	22%	100%	30.82 %
Pools 3-6 ft	40%	50%	40%	100%	56%	67%	83%	100%	75%	67%	63%	25%	67%	44%	58%	17%	50%	67%	61%	0%	56.60 %
Pool 6< ft	20%	36%	7%	0%	22%	22%	0%	0%	0%	0%	13%	25%	0%	0%	0%	0%	30%	17%	17%	0%	12.58 %
Riffle: Pool Ratio	0	0	0	1	1	1	1	2	1	11	1	1	1	2	0	1	0.8	0.8	0	2	1.3
Mean Pool Spacing (Bankfull channel widths per pool)	8.5	9.1	8.1	10.3	6.5	6.5	6.4	11.2	8.4	19.9	4.6	8.2	7.0	13.1	7.9	5.5	10.2	4.8	7.0	18.6	9.1
Large Woody Material																					
Total Number of LWM Pieces (Individual + Jams)																					
Total	125	142	61	144	252	118	413	385	215	218	48	71	35	399	487	107	209	111	413	100	4053
Large (20in by 35ft)	12	4	1	8	18	0	31	59	25	25	3	9	1	40	60	16	33	4	64	9	422
Medium (12in by 35ft)	16	12	1	27	60	12	65	128	61	68	9	14	6	89	114	25	58	5	104	5	879
Large and Medium	28	16	2	35	78	12	96	187	86	93	12	23	7	129	174	41	91	9	168	14	1301
Small (6in by 20ft)	41	20	3	27	65	17	105	109	58	65	5	18	6	111	107	28	63	9	108	7	972
Number of LWM Pieces/Mile (Individual + Jams)																					
Total	101	80	48	192	207	134	279	385	352	195	86	122	103	209	258	175	139	258	213	111	184
Large (20in by 35ft)	15	7	2	35	78	12	96	187	86	93	12	23	7	129	174	41	91	9	168	14	31
Medium (12in by 35ft)	24	27	8	65	80	44	88	169	151	79	36	38	38	74	104	66	51	105	82	57	69
Large and Medium	39	34	10	87	107	55	155	237	200	108	52	60	44	106	148	98	79	144	127	81	100
Small (6in by 20ft)	62	48	38	105	99	80	124	148	152	87	34	62	59	103	110	77	61	114	86	30	84
Jams																					
Total Jams per reach	3	4	1	6	14	4	17	14	9	7	5	5	4	10	25	3	13	1	22	3	170
Unstable Banks																					
Total Unstable Banks (% of total Bank)	81%	55%	23%	42%	51%	99%	40%	9%	6%	10%	59%	39%	54%	15%	15%	28%	5%	13%	5%	14%	33%
Substrate																					
Total																					

Reach	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	All
% Sand	1%	2%	1%	1%	N/A	N/A	N/A	4%	3%	2%	7%	N/A	N/A	3%	4%	1%	0%	N/A	0%	2%	2%
% Gravel	70%	88%	87%	12%	N/A	N/A	N/A	20%	21%	23%	9%	N/A	N/A	28%	37%	20%	31%	N/A	54%	36%	38%
% Cobble	29%	10%	12%	41%	N/A	N/A	N/A	35%	32%	33%	29%	N/A	N/A	28%	43%	54%	40%	N/A	46%	51%	34%
% Boulder	0%	0%	0%	46%	N/A	N/A	N/A	41%	45%	42%	57%	N/A	N/A	40%	16%	25%	29%	N/A	0%	11%	25%
Vegetation (% of sampled units in 100-ft-wide zone average between both banks)																					
Dominant Overstory Class																					
Mature Trees	29%	0%	0%	0%	0%	0%	18%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	3%
Large Trees	57%	73%	86%	100%	100%	0%	18%	100%	100%	63%	100%	50%	100%	56%	73%	83%	86%	0%	93%	100%	72%
Small Trees	14%	0%	14%	0%	0%	80%	27%	0%	0%	25%	0%	50%	0%	44%	13%	17%	14%	0%	0%	0%	15%
Sapling Pole	0%	0%	0%	0%	0%	0%	18%	0%	0%	0%	0%	0%	0%	0%	13%	0%	0%	0%	0%	0%	3%
Shrub/Seedling	0%	0%	0%	0%	0%	20%	18%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	86%	0%	0%	2%
Grassland/Forb	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
No Vegetation	0%	9%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	14%	0%	0%	1%
Other	0%	18%	0%	0%	0%	0%	0%	0%	0%	13%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%
Overstory Species Composition																					
Cedar	0%	0%	0%	0%	33%	0%	0%	67%	25%	13%	0%	0%	33%	56%	13%	33%	28%	0%	33%	100%	20%
Douglas Fir	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	67%	67%	33%	40%	33%	29%	16%	67%	0%	21%
Ponderosa Pine	29%	45%	86%	100%	67%	100%	55%	33%	75%	75%	100%	33%	0%	11%	20%	33%	36%	67%	0%	0%	42%
Other/Uknown	0%	27%	0%	0%	0%	0%	0%	0%	0%	13%	0%	0%	0%	0%	7%	0%	0%	17%	0%	0%	3%
Alder	0%	0%	14%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
Cottonwood	57%	27%	0%	0%	0%	0%	27%	0%	0%	0%	0%	0%	0%	0%	20%	0%	7%	0%	0%	0%	9%
Quaking Aspen	14%	0%	0%	0%	0%	0%	18%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%
Dominant Understory Species																					
Grassland/Forb	57%	9%	0%	0%	0%	40%	0%	0%	0%	0%	17%	0%	0%	0%	7%	0%	0%	0%	0%	0%	6%
No Vegetation	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	11%	0%	17%	14%	33%	0%	0%	4%
Other	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Shrub/Seedling	43%	91%	100%	100%	100%	60%	82%	100%	100%	88%	83%	83%	100%	89%	93%	83%	86%	67%	100%	100%	2%
Sapling Pole	0%	0%	0%	0%	0%	0%	18%	0%	0%	0%	0%	17%	0%	0%	0%	0%	0%	0%	0%	0%	87%
Small Tree	0%	0%	0%	0%	0%	0%	0%	0%	0%	13%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
Understory Species Composition																					
Cedar	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	0%	0%	1%
Other	43%	0%	0%	0%	0%	40%	0%	0%	0%	0%	17%	0%	0%	11%	7%	17%	14%	33%	0%	0%	9%

Reach	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	All
Alder	14%	18%	14%	75%	100%	60%	45%	67%	100%	88%	83%	50%	67%	78%	80%	83%	57%	67%	20%	83%	57%
Dogwood	43%	55%	71%	25%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	22%	0%	67%	0%	3%
Cottonwood	0%	0%	0%	0%	0%	0%	18%	0%	0%	0%	0%	33%	0%	0%	0%	0%	0%	0%	0%	0%	19%
Vine/Douglas Maple	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	0%	0%	7%	17%	2%
Willow	0%	27%	14%	0%	0%	0%	36%	33%	0%	13%	0%	17%	33%	11%	0%	0%	0%	0%	7%	0%	9%

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