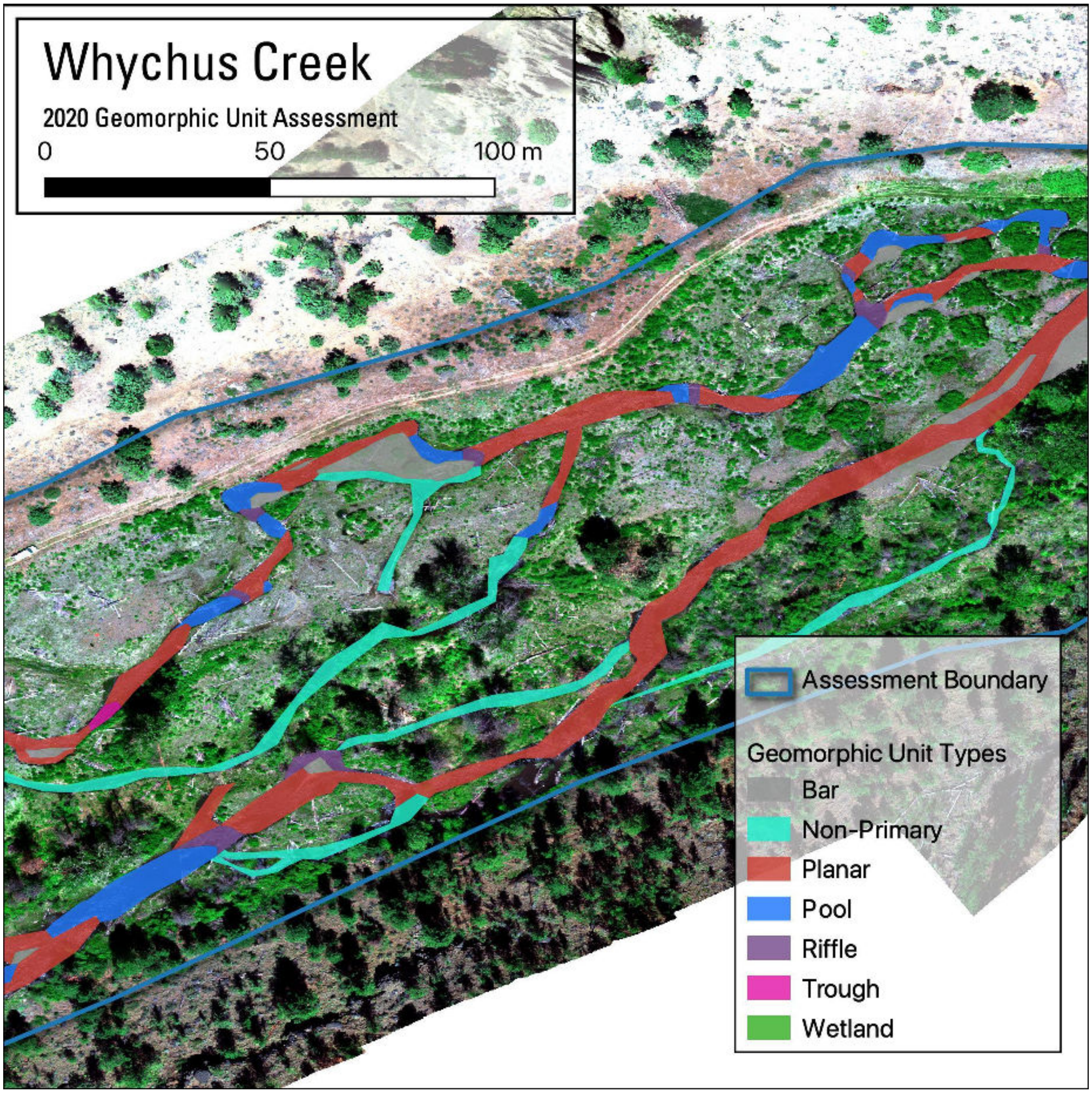
WHYCHUS CREEK GEOMORPHIC UNIT ASSESSMENT

DELINEATION OF CHANNEL GEOMORPHIC FEATURES FROM UAV IMAGERY

May 2021



Example of desktop geomorphic unit delineation within the Willow Springs Preserve assessment reach on Whychus Creek. The survey methods provide a rapid approach that can be used to quantify the area, distribution, and arrangement of geomorphic units within the valley bottom.

ANABRANCH SOLUTIONS

SUMMARY

The following document describes the classification and delineation of in-channel geomorphic units for sections of Whychus Creek that are part of ongoing restoration and monitoring coordinated by the Upper Deschutes Watershed Council (UDWC) and the Deschutes Land Trust (DLT). The delineation process was conducted using desktop Geographic Information System (GIS) software and relied on orthomosaic imagery collected on Whychus Creek during the summer of 2020 (Figure 1) (see acquisition report). The intention of this survey was to provide an account of geomorphic feature types and distributions that are descriptive of fish habitat quantity and quality and restoration effectiveness in enhancing riverine and aquatic processes.

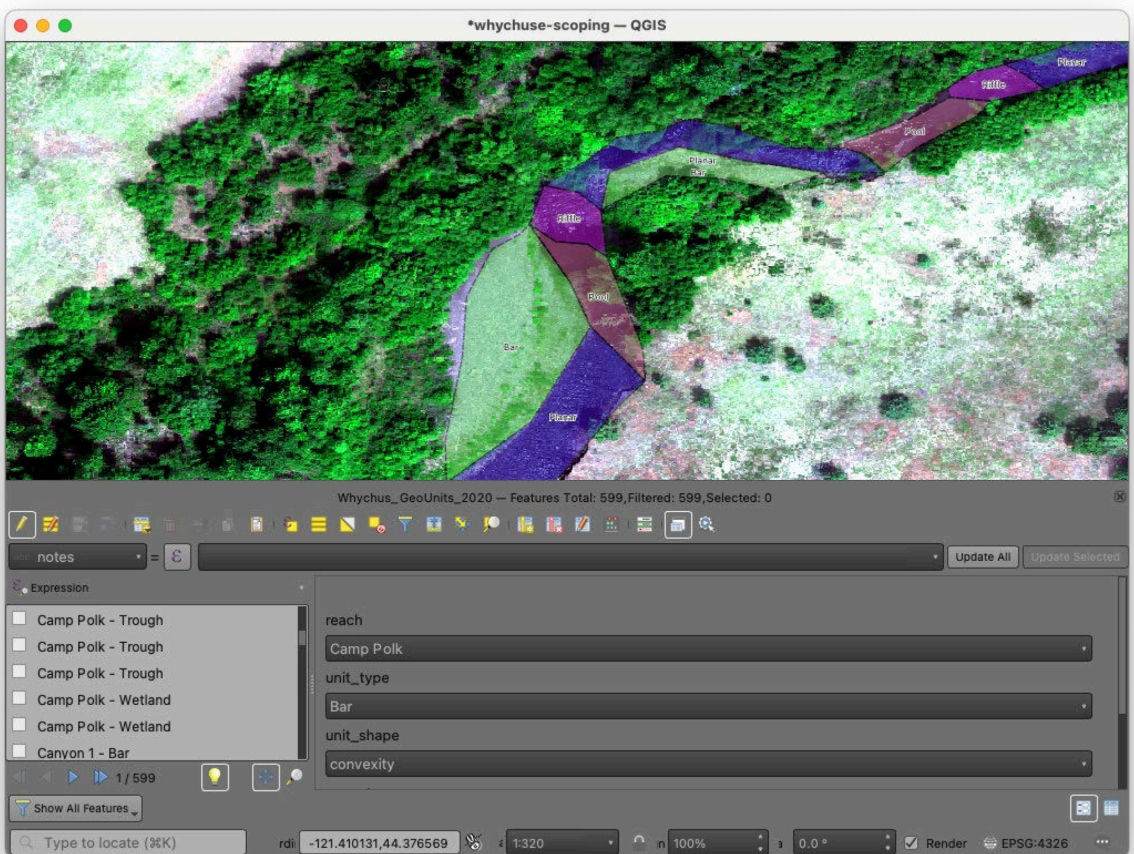


Figure 1. Example of the GIS survey delineation and classification process.

SCOPE AND SURVEY EXTENT

The delineation of geomorphic units focused on 5 assessment reaches of Whychus Creek that are owned by the Deschutes Land Trust and managed for their high ecological value and as fish and wildlife habitat (Table 1, Figure 2). Whychus Canyon Phase 1, Phase 2a, and Phase 2b reaches are abbreviated in this report as Canyon 1, Canyon 2a, and Canyon 2b, respectively. In total, the assessment covered approximately 6 linear km of Whychus Creek and delineated 707 individual geomorphic units.

Table 1. Length, valley bottom area assessed, and year of restoration treatment for each of the assessment reaches on Whychus Creek.

Assessment Reach	*Section length (Km)*	*Section area (Km²)*	*Year of first restoration treatment*
Willow Springs	1.1	0.28	Not Treated
Camp Polk	0.8	0.22	2012
Canyon 1	1.6	0.10	2016
Canyon 2a	0.6	0.40	Not Treated
Canyon 2b	2.1	0.23	Not Treated

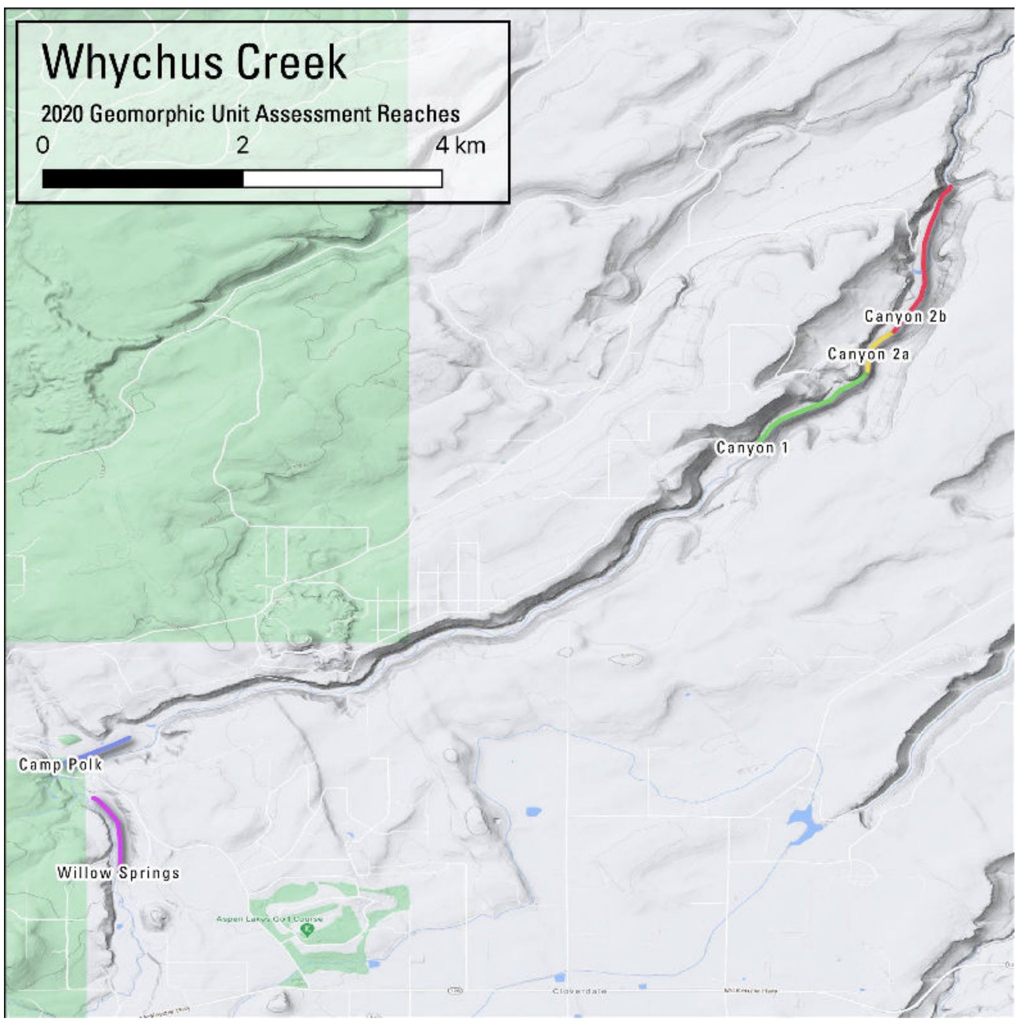


Figure 2. Location of the 5 assessment reaches evaluated as part of the classification of geomorphic units using 2020 imagery acquisitions.

Geomorphic Unit Classification and Attributes

Geomorphic unit delineations followed an adaptation of in-channel unit definitions described by Wheaton et al. 2015. In most cases, unit boundaries followed the water surface extent. However, the area of convex point bars and mid-channel bars extending beyond the water surface elevation were also delineated.

Geomorphic Unit Attributes

The following attributes were recorded for each geomorphic unit:

REACH – Assessment reaches being Camp Polk, Willow Springs, Canyon 1, 2a, or 2b (see Figure 2).

UNIT TYPE – Unit types were delineated based on the lateral and longitudinal bed profile and channel forming geomorphic process:

Concave Units

- ***POOL*** – Laterally and longitudinally concave units formed through sediment scour.
- ***TROUGH*** – Laterally concave units that extend longitudinally, and often adjacent to mid-channel diagonal bars.

Planar Units

- ***PLANAR*** – Laterally and longitudinally planar sections of channel generally lacking sediment deposition or scour (i.e., transport units).
- ***WETLAND –*** Isolated wetlands (i.e., sections of standing water within the valley bottom) that are not functioning as salmonid habitat during low flows.
- ***NON-PRIMARY*** – Classification applied to small non-primary channels generally lacking geomorphic activity and featuring geomorphic units that are too small (less than one-half the average channel width) to consistently identify.

Convex Units

- ***RIFFLE*** – Laterally convex but longitudinally concave units often formed as a result of deposition downstream of pool units.
- ***BAR*** – Laterally and longitudinally convex depositional units, further classified as being either mid – channel or point bars (see Convexity Type attribute below).

CONVEXITY TYPE – A classification of depositional (i.e., convex) geomorphic unit types descriptive of their orientation and formative processes:

- ***RIFFLE*** – Laterally convex but longitudinally concave units often formed as deposition downstream of pool units.
- ***POINT*** – Bank-attached bars formed by deposition at a meander bend.
- ***MID*** – Mid-channel bars often formed as point bars that become disconnected from their banks.

PERCENT WETTED – Percent of the unit area currently inundated by surface flow. Ultimately used to calculate a total wetted area for the reach. The survey method employed here delineated units within the wetted channel. Percent wetted was recorded as 100% for most units. Exceptions to this include mid-channel and point bars which extend beyond the water surface and were delineated as 0% wetted.

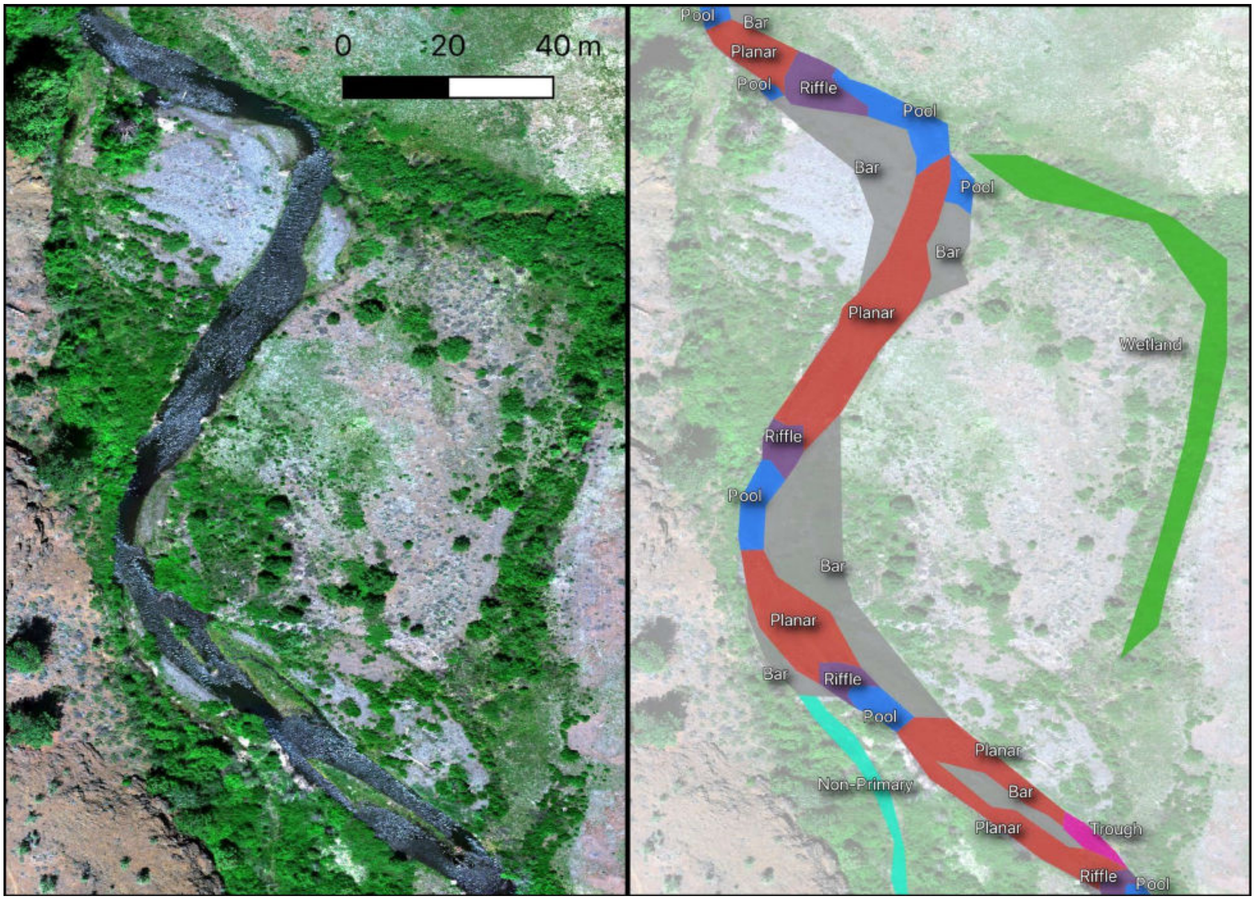


Figure 3. Example of habitat types delineated from the aerial imagery collected within the project area during the summer of 2020.

FIELD SUPPLEMENTATION SURVEYS

Thick vegetation may obscure areas of the valley bottom and prevent the reliable classification of geomorphic units from orthomosaics. Because of this, the UDWC identified areas of thick vegetation within the assessment reaches, and field surveys of geomorphic unit types and dimensions were conducted during the summer of 2020. The field surveys used the same geomorphic unit classification described here so that these datasets could be combined. The target field survey areas and the georeferenced locations of each unit observation were then used to identify any areas of the desktop delineation of geomorphic units. This comparison ensures that no section of channel will be "double counted" by the two survey approaches. The methods used and data generated by the supplemental field surveys are summarized in a [report dated August of 2020](#).

FIELD SURVEY – The field survey attribute refers to unit/channel observations that were part of the field survey conducted in 2020 (see Field Supplementation Surveys below). Units attributed "desk-field" are those that were likely surveyed in the field and should be considered when merging these two complementary datasets to avoid "double counting" where the two survey methods may have overlapped.

Data Products

Geomorphic unit and additional spatial data that includes reach boundaries and lengths are housed in ESRI shapefiles. Attribute data and preliminary summary metrics are also available in common Excel spreadsheet formats. Specific data products can be downloaded here and include:

GEOMORPHIC UNITS – Shapefiles of geomorphic unit delineations for each assessment reach.

ASSESSMENT REACH BOUNDARIES – Shapefiles depicting the area assessed under each assessment reach.

ASSESSMENT REACH LENGTHS – Shapefiles depicting the lengths of each assessment reach measured along the center of the valley bottom and used in metric generation (see Summary).

ATTRIBUTE DATA – Excel files containing attribute data for geomorphic units and assessment reach area and lengths. The geomorphic unit data has been merged with the 2020 field supplementation survey data (see Field Supplementation Surveys above).

Preliminary Summary Metric Generation

The survey approach allows generation of an array of summary metrics meant to be descriptive of geomorphic unit area and frequency. Initial metric calculations have been normalized to the valley center length of each assessment reach (Table 1, Figure 2 above). The simple metrics presented here (Table 2, Figure 4) provide a starting point for calculation of meaningful summaries that describe restoration outcomes and demonstrate the ability of the survey to capture variation among assessment reaches that have and have not been subject to restoration treatments.

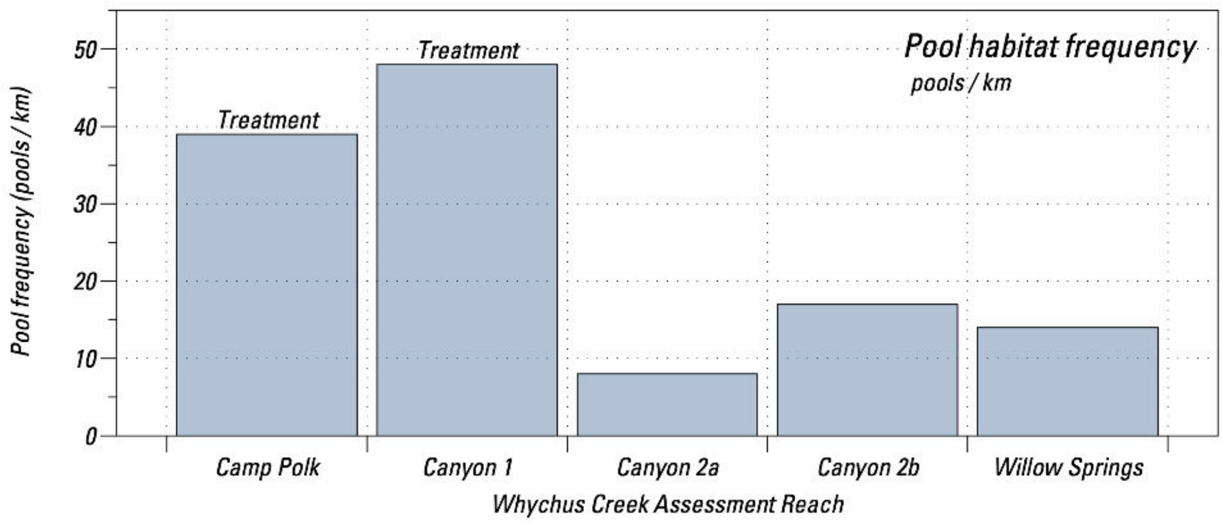


Figure 4. Graph of pool habitat frequency (pools / km) scaled to the valley length of each assessment reach. The high pool frequency within the treatment reaches demonstrates the ability of the survey approach to capture restoration outcomes.

Table 2. Summary metrics of unit frequency and area normalized to valley length.

Reach	*Valley Length (m)*	*Unit Shape*	*Unit Type*	*Unit Count*	*Unit Total Area (m²)*	*Unit Frequency (num. / Km)*	*Unit Area (m² / Km)*
Camp Polk	801	concavity	Pool	31	2544	39	3176
Camp Polk	801	concavity	Trough	8	1076	10	1343
Camp Polk	801	convexity	Bar	16	1519	20	1897
Camp Polk	801	convexity	Riffle	22	895	27	1117
Camp Polk	801	planar	Non-primary	7	789	9	985
Camp Polk	801	planar	Planar	32	5022	40	6270
Camp Polk	801	planar	Wetland	5	957	6	1195
Canyon 1	1597	concavity	Pool	76	5294	48	3315
Canyon 1	1597	concavity	Trough	15	758	9	474
Canyon 1	1597	convexity	Bar	61	6496	38	4068
Canyon 1	1597	convexity	Riffle	55	2183	34	1367
Canyon 1	1597	planar	Non-Primary	15	1412	9	884
Canyon 1	1597	planar	Planar	108	12645	68	7918
Canyon 1	1597	planar	Wetland	9	718	6	450
Canyon 2a	642	concavity	Pool	5	755	8	1176
Canyon 2a	642	concavity	Trough	1	273	2	425
Canyon 2a	642	convexity	Bar	3	1299	5	2023
Canyon 2a	642	convexity	Riffle	5	449	8	699
Canyon 2a	642	planar	Planar	6	4744	9	7389
Canyon 2b	2149	concavity	Pool	37	4582	17	2132
Canyon 2b	2149	concavity	Trough	5	513	2	239
Canyon 2b	2149	convexity	Bar	31	7837	14	3647
Canyon 2b	2149	convexity	Riffle	36	1827	17	850
Canyon 2b	2149	planar	Planar	38	16149	18	7515
Canyon 2b	2149	planar	Wetland	1	293	0	136
Willow Springs	1124	concavity	Pool	16	1631	14	1451
Willow Springs	1124	concavity	Trough	5	290	4	258
Willow Springs	1124	convexity	Bar	13	4080	12	3630
Willow Springs	1124	convexity	Riffle	12	909	11	809
Willow Springs	1124	planar	Non-Primary	1	197	1	175
Willow Springs	1124	planar	Planar	12	7733	11	6880
Willow Springs	1124	planar	Wetland	1	843	1	750

Lessons Learned and Recommended Next Steps

The delineation and classification of channel geomorphic / habitat units remains a subjective process in which observer variability is inherent. This subjectivity will manifest regardless of whether geomorphic observations are collected in the field or are inferred from high – resolution imagery as was done here. Regardless, these observations provide important ecological data that is descriptive of wildlife habitat quantity and quality, and that can be used to document restoration effectiveness as well as restoration outcomes. The following lessons learned should be considered during future implementation of this data collection approach:

GRANULARITY OF FIELD VS. DESKTOP OBSERVATIONS – Surveys of geomorphic / habitat units are often collected in the field using protocols similar to those described by the aquatic inventories program. The author finds that the desktop survey favors less "lumping" of individual units due to the ease and speed of unit delineation using GIS software. Because of this, desktop surveys may be more effective in capturing channel complexity than field-based surveys.

IMAGERY RESOLUTION – The orthoimagery used in this assessment lacked clarity when viewed within a GIS. The lack of clarity may have been due to conditions during imagery acquisition (i.e. wind) or to the methods used in image processing and orthomosaic generation for raw imagery. This survey and future surveys would be more accurate and effective if high-quality (i.e., less blurry and higher resolution) imagery were to be employed.

CLASSIFICATION OF PRIMARY AND NON-PRIMARY CHANNELS – Adding an additional attribute to the desktop survey geomorphic data describing whether units are associated with a primary or non-primary channel would allow calculation of additional metrics that are consistent with the restoration objectives for Whychus Creek.

QUANTIFICATION OF OBSERVER VARIABILITY – The degree of observer variability could be quantified by conducting repeat desktop survey at a subset of the assessment reaches.

INCREASING CANOPY VEGETATION – Increasing vegetation within the project area will ultimately render the desktop survey approach less effective in future years and more field supplementation may be required. The field supplementation survey observations should also be spatially referenced using a GPS with a high degree of horizontal accuracy (e.g., < 1 m) to increase the effectiveness of merging field and desktop observations.

References

Wheaton, J. M., K. A. Fryirs, G. Brierley, S. G. Bangen, N. Bouwes, and G. O'Brien. 2015. Geomorphic mapping and taxonomy of fluvial landforms. Geomorphology 248:273–295.