An independent quantitative analysis of utilization and streambank alteration at the BLM Hardie Summer Allotment: Monitoring Report for the 2019 Grazing Season

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Cover Photo: Little Bridge Creek following the grazing season, October 2019. Many willows and aspen (pictured here) hedged. Note the heavy grazing use where the stubble heights are below the heights of the boots of the science team in the field.

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Executive Summary

- Utilization in the riparian zones greatly exceeded the Court-ordered 30% threshold in all sampled grazed riparian zones. Grass and sedge utilization was 87% at the Big Bridge Creek Designated Monitoring Area (DMA). Utilization exceeded 74% at the Little Bridge Creek DMA. Big Fir Creek had a lower use; herbaceous utilization there was 43%.
- Streambank alteration in grazed riparian zones far exceeded recommended standards set forth by federal experts and published in their manuals and publications (although neither the Court nor the permit sets a bank alteration limit). Alteration exceeded 55% at Big Bridge Creek and exceeded 65% at Little Bridge Creek.
- The streambank alteration results from Little Bridge Creek and Big Bridge Creek are over twice the level of bank alteration recommended by Goss and Roper (2018) for salmonid habitat protection.
- Utilization was quite low at the ungrazed Little Fir Creek (Hardie Summer allotment) and Lambing Creek (Mud Creek allotment). Utilization was 0 and 6%, respectively. This suggests the high utilization in the grazed areas can be attributed to cattle grazing rather than wild ungulates.
- Stubble heights of grasses were below heights necessary for protecting fish habitat. Stubble heights of riparian vegetation at Big Bridge Creek were 1.7 inches. Riparian graminoid stubble heights were 3.8 and 4 inches at the Little Bridge Creek. The stubble heights were dramatically lower that their recommended level (6 inches) for sustainable or improving salmonid habitat. Higher vegetation height is also essential for adequate sage grouse habitat.
- Despite erroneous conclusions to the contrary in the 2019 BLM Hardie Summer report, stubble height data for Little Bridge Creek (and photos from Big Bridge Creek) found in that report demonstrate that utilization exceeded the 30% threshold at those locations.

Summary of the Multiple Indicator Monitoring (MIM) data and utilization data collected in riparian areas in the Hardie Summer and Mud Creek Allotments, October 2019. Data are mean ± standard error. Numbers in red show where utilization standards were exceeded and where riparian/stream degradation will likely result.

Site-DMA	Stubble Height (in)	% herbaceous utilization	Shrub utilization (% of terminal stems of shrubs <5 ft ht browsed)	Streambank alteration (% of the streambank altered)
Little Bridge Ck 1	4.0 ± 0.2	74%	46 ± 5	65.8 ± 6.6
Little Bridge Ck 2	3.8 ± 0.2	76%	51 ± 9	62.6 ± 6.3
Big Bridge Ck	1.7 ± 0.1	87%	88 ± 6	55.2 ± 5.5
Big Fir Ck	8.0 ± 0.5	43%	27 ± 9	49.8 ± 5.0
Little Fir Ck	14.8 ± 0.7	0%	4 ± 4	1.6 ± 0.2
Lambing Ck	14.1 ± 0.7	6%	0 ± 0	0.2 ± 0.0

INTRODUCTION

It has been suggested by Federal experts that independent analyses of livestock disturbance and stream condition provide objective, unbiased results of actual conditions (Goss and Roper 2018). This is the primary purpose of this report.

In October 2019 an independent group of range scientists and hydrologists conducted a series of quantitative measurements of stubble height, streambank alteration, shrub use, greenline composition and stream type in the Hardie Summer allotment (with additional monitoring on one stream within Mud Creek allotment). Quantitative data were supplemented with photographs and observations across the allotments (both uplands and riparian zones). We not only took quantitative measurements of livestock use in riparian zones and uplands but also took observations while walking or driving across the allotments following the grazing season. The objectives of this study were to determine the degree of livestock disturbance that had occurred during the 2019 grazing season. We focused measurements in riparian zones as it was apparent that this was where most significant livestock influences had occurred (see photos in appendix).

METHODS

The methods that we used to determine livestock influences closely followed that of the MIM manual (Burton et al. 2011; TR 1737-33 revised and Burton et al. 2018). The transect lengths, sample size, and microplot dimensions were the same. However, we employed what we refer to as an "Enhanced Multiple Indicator Monitoring Approach" (MIM+) of stream channels and streamside vegetation. This provides additional information that the MIM approach used by the BLM does not. In addition to the data outlined in the MIM methodology, our field crew comprised of highly experienced riparian ecologists and hydrologists were able to identify the shrub and herbaceous species that were utilized, the vegetation type of the plot along the greenline transect, the surface substrate at each point, and the Rosgen stream class.

All of the transects were centered upon the greenline in the riparian zones. The "greenline" is defined as the first perennial vegetation that forms a lineal grouping of community types on or near the water's edge. Most often it occurs at or slightly below the bank full stage (Winward 2000).

Site selection

We monitored 7 ***Designated Monitoring Areas (DMAs***) where we established the MIM+ transects. DMAs are lengths of riparian/stream ecosystems that are representative of the area of concern. There were 6 DMAs in riparian zones and 1 upland site in the allotments. All were in the Hardie-Summer allotment with the exception of the Lambing creek riparian site, which was in the Mud Creek allotment (Table 1). All transects reasonably represent (i.e., are "representative DMAs") the composition and structure of the stream reaches in the Allotment. DMAs were established in Little Bridge Creek (2 sites), Big Bridge Creek, Little Fir Creek, Big Fir Creek and Lambing Creek. Where BLM had established DMAs, we used BLM's DMAs, based on the coordinates of the BLM DMAs that BLM provided to our team before we departed for the field. We established new DMAs only in areas where there were not BLM-designated DMAs. On Little Bridge Creek, our Little Bridge Ck 2 site is the same as the BLM DMA site. Also the location of the Big Fir and Little Fir DMAs for the BLM and ours are the same. We also established DMAs on Lambing Creek, Big Bridge Creek and a second site on Little Bridge Creek, where no BLM DMAs were established.

The exact location of each DMA/MIM+ transect area was determined through collection of the geographic location using a GPS (Table 1). The Channel slope (%) of each reach was measured using a handheld clinometer at the lower 20m of each transect. Based upon the channel slope, geomorphic substrates and valley form we determined the Rosgen stream class for each of the DMAs.

Table 1. Metadata of the 7 sites sampled for quantitative data using an enhanced MIM sampling approach, September 30 – October 4, 2019.

Site	Latitude	Longitude	Channel slope	Rosgen stream class	Most abundant grasses	Abundant sedges rushes/grass-likes	Notes on use
Little Bridge Ck 1	N 42° 49' 09.7"	W 118° 41' 28.4"	1.5%	C	Poa pratensis, Agrostis sp,	Carex nebrascensis, Ball sedges, Juncus balticus	Heavy use; particularly in dry meadows
Little Bridge Ck 2	N 42° 49' 12.3"	W 118° 41' 35.2"	1.5%	C	Poa pratensis, Agrostis sp,	Carex nebrascensis, Ball sedges, Juncus balticus	Heavy use; particularly in dry meadows
Big Bridge Ck	N 42° 48' 25.4"	W 118° 41' 47.3"	1.0%	C	Poa pratensis, Agrostis sp,		Heavily utilized riparian zone; the site has lost lots of fine surface sediments due to land use; channel is widened and continues to be affected by grazing
Little Fir Ck	N 42° 46' 48.6"	W 118° 41' 30.7"	3.0%	B	Poa pratensis, Phelum pratense, Bromus montanus, Agrostis spp	Ball sedges, J. balticus	Ungrazed; excluded through use of temporary electric fence; aspen abundant; creek was dry and incised to mostly boulder substrate
Big Fir Ck	N 42° 46' 18.5"	W 118° 41' 07.9"	3.5%	B		Carex nebrascensis, Scirpus microcarpus, Ball sedges, Juncus balticus	Lighter use than Bridge Ck; dense willow cover in a constrained reach; collapsing banks where unprotected by terrain or willows
Lambing Ck	N 42° 49' 38.7"	W 118° 49' 30.0"	3.0%	B	Poas, crested WG, annuals	Carex nebrascensis, Ball sedges, Juncus balticus	Little use when sampled on 4 October. The site is recovering, and many riparian obligate species are present
Big Fir Upland transect	N 42° 45' 34.7"	W 118° 40' 34.6"			Festuca idahoensis, P. spicata		No evidence of livestock use in upland sites that are well away from the riparian zone

Streambank disturbance

Streambank alteration is an annual or short-term indicator of the effect of grazing impacts on long-term streambank stability (Burton et al. 2011). The procedure described here estimates the amount of streambank alteration along the greenline as a result of large herbivores (e.g., cattle, horses, sheep, deer, and elk) walking along or crossing the greenline during the current grazing season. As such, it can be used as a tool to assess grazing intensity and to determine when such intensity may be excessive. To ascertain streambank alteration, we used the Greenline disturbance technique first described by Heitke et al (2008) and modified by Burton et al. (2011); see also the appendix figure of an alteration plot. At each sampled reach we established two 100-m transects placed along the greenline on each side of the sampled reaches. We sampled streambank degradation, stubble heights of key forage species and shrub utilization in 50 plots every 2-m along these transects (n-=100 plots for each sampled reach). When the plot was under an inaccessible dense mature willow base with no understory vegetation, we moved the plot to the nearest greenline point between shrubs as suggested by Burton et al. (2011) (see figure A11). This insured 100 points of sampling for both streambank alteration and stubble height measurements.

At each point (2 meter intervals) we determined if there was livestock streambank damage of the following types:

- no disturbance
- shearing disturbance
- trampling disturbance
- trailing disturbance

<u>Shearing</u> is defined as the removal of a portion of the streambank by ungulate hooves leaving a smooth vertical surface and an indentation of a hoofprint at the bottom or along the sides.

<u>Trampling</u> is defined as the indentation of a hoofprint and exposed roots or soil, resulting in a depression at least 13 mm deep or soil displacement at least 13 mm upwards.

<u>Trailing</u> disturbance is defined as the presence of trails and other severe trampling. These were counted as alteration if there were signs of current-year use. Because of the compacted soils, trailing was counted even if hoof prints did not result in 13-mm displacement of soil.

The disturbance was only recorded is if it was the current year's disturbance. We could easily determine the current-year alteration which was discernible from previous years' alteration because of weathering effects of freeze/thaw cycles, rain events, and erosion by stream flow or vegetative regrowth—assisted by the fact that no domestic livestock grazing had occurred on these allotments between 2014 and 2018.

The procedure described here estimates the amount of streambank alteration along the greenline as a result of large herbivores (e.g., cattle, horses, sheep, deer and elk) walking along or crossing the greenline during the current grazing season. There are five cross-plot lines on the sampling frame used to detect and record occurrences of alteration. These lines are perpendicular to the center rib of the frame and extend away from it on each side. (Burton et al. 2011). If the site was disturbed along a 50-cm line perpendicular to the channel with the greenline being the midpoint, the count ranged from 0 to 5 depending upon the number of lines where disturbance was apparent.

Stubble heights

Stubble height is a measure of the residual height of key herbaceous vegetation species remaining after grazing. By herbaceous utilization we mean the use of the key grasses, sedges and rushes that are present along the greenline. To determine utilization and stubble heights we followed the methods outlined in Burton et al.

(2011). At the greenline point of each transect we measured the stubble height (i.e., leaf length) of the nearest perennial grass or sedge located closest to the inside (of greenline) corner of the plot frame (see Burton et al. 2011 for details). These were identified to their most specific taxonomic unit possible.

To determine the utilization based upon stubble height we measured the leaf lengths of grasses and sedges in ungrazed sites in the same manner as in grazed sites (Table 2). This was greatly facilitated by establishment of a MIM+ transect in the ungrazed Little Fir Creek site. We also obtained ungrazed leaf lengths at the Lambing Creek and Big Fir Creek sites. Utilization is the percent decrease in leaf length (Burton et al. 2011). As is apparent, it is necessary to partition the graminoids (grasses and sedges) by vegetation type in order to obtain a proper estimate of utilization. The mean leaf length of smaller ball sedges and the common dry meadow grass Kentucky Bluegrass (*Poa pratensis*) is only 60% of the length of the tall sedges such as Nebraska sedge and Small-fruited bulrush. The same stubble height of different species then will result in different utilization rates. This also reflects a weakness of BLM (PACFISH/INFISH) recommendations of generalized stubble heights for limiting riparian damage.

Table 2. Mean leaf lengths (cm) of undisturbed vegetation used to determine utilization.

Species	leaf length	N
Riparian grasses - generic	34	126
Sedges (ball sedges - generic)	32	68
Juncus balticus	57	44
Carex nebrascensis	59	10
Scirpus microcarpus	67	5
Poa pratensis	37	34

Shrub (willow) utilization

It is extremely difficult and time consuming to accurately measure utilization (browsing) impacts on many riparian shrubs (Winward 2000). We measured willow utilization of those willows that were below the grazing height of cattle (Burton et al. 2011). To obtain an index of grazing impacts we measured utilization of any willow that was less than 5 ft (1.5 m) in height within the plot area as described by Burton et al. (2011) (2m in length). At each shrub, we identified the 10 tallest leaders (stems) of the individual plants and counted the numbers that had been grazed. This allows the determination of the percent utilization of that willow leaders most influencing plant height. Shrub/Willow utilization is the average utilization per plant based upon these measurements.

Other measurements

At each point we also identified the riparian vegetation type at the greenline point. The general riparian community types encountered included:

- Wet meadow (predominantly *Carex* dominated)
- Dry meadow (predominantly grass dominated)
- Point bar
- Willow dominated (*Salix gyrinal, S lasiandra* etc.)
- Quaking Aspen (*Populous tremuloides*)

- Juniper/upland dominated

We identified the substrate at the riparian surface of the greenline following the general categories of the Rosgen approach. The different substrates include:

- Bedrock
- Boulders
- Cobble
- Sand
- Silt/clay

These data provide an accurate description of the riparian environment that is not always provided in the MIM protocols. From these data we calculated the riparian community composition along the greenline of each sampled riparian area. We also determined the utilization of each riparian community type within the sampled riparian zone.

Table 3. The stubble heights (cm) and percent utilization of herbaceous vegetation along the greenline of sampled sites. The data are the mean stubble heights (cm) and the standard error of the estimate (SE) for each species.

Site	Stubble ht (cm)	SE	sample size	utilization (%)	Stubble ht (in)	SE
Big Bridge Ck						
All spp combined	4	0	100	**87%**	1.7	0.1
riparian grasses (other)	4	0	86	88%	1.7	0.1
Juncus balticus	5	1	2	92%	1.8	0.2
sedges (other)	5	1	12	85%	1.9	0.3
Big Fir Ck						
All spp combined	20	1	99	**43%**	8.0	0.5
Carex nebrascensis	9	0	2	85%	3.5	0.0
riparian grasses (other)	21	2	52	39%	8.1	0.7
Juncus balticus	40	17	3	30%	15.6	6.7
Poa pratensis	22	3	17	40%	8.8	1.3
sedges (other)	16	2	22	51%	6.2	0.8
Scirpus microcarpus	25	5	3	63%	9.8	1.9
Lambing Ck						
All spp combined	36	2	95	**6%**	14.1	0.7
Carex nebrascensis	49	20	3	18%	19.2	7.8
riparian grasses (other)	34	4	25	-1%	13.6	1.5
Juncus balticus	53	5	17	7%	20.8	1.8

Poa pratensis	37	6	5	-1%	14.6	2.2
sedges (other)	29	2	45	10%	11.4	0.6
Little Bridge Ck 1						
All spp combined	10	1	99	**76%**	4.0	0.2
Carex nebrascensis	11	1	25	81%	4.3	0.3
riparian grasses (other)	8	1	31	76%	3.2	0.4
Juncus balticus	12	3	16	79%	4.7	1.1
Poa pratensis	9	2	6	75%	3.6	0.8
sedges (other)	11	1	21	67%	4.2	0.5
Little Bridge Ck 2						
All spp combined	10	0	100	**74%**	3.8	0.2
Carex nebrascensis	14	2	6	77%	5.4	0.7
riparian grasses (other)	8	1	33	77%	3.1	0.3
Juncus balticus	8	1	21	86%	3.2	0.2
Poa pratensis	6	1	5	85%	2.2	0.2
sedges (other)	12	1	35	62%	4.7	0.3
Little Fir Ck						
All spp combined	37	2	100	**0%**	14.8	0.7
Carex nebrascensis	38		1	0%	15.0	0.0
Juncus balticus	57	7	13	0%	22.6	2.7
Poa pratensis	37	3	26	0%	14.5	1.0
sedges (other)	34	3	17	0%	13.2	1.2
riparian grasses (other)	33	2	43	0%	**13.1**	**0.8**

Experience of the Authors and field crew

Collectively the authors and data collectors of this study have over 100 years of field experience. Dr. J. Boone Kauffman (Ph.D.) has been conducting research on riparian zones and grazing impacts in Oregon (and other states and countries) since 1978. This includes riparian work with Dr. A. Winward who developed the greenline technique. Dr. Kauffman taught riparian ecology and management at Oregon State University and has led and conducted numerous studies on grazing influences on riparian zones including utilization and streambank alteration influences. Dr. Robert L. Beschta (Ph.D), a stream hydrologist, has been researching western USA stream hydrology and ungulate impacts studies for over 50 years. Dian L. Cummings (MS) and Ruth Johns (MS) have both worked on forest, range and riparian ecology studies in Oregon and elsewhere for over 25 years.

Quality Assurance/Quality Control

Prior to going to the field, the entire field crew thoroughly acquainted themselves with the protocols to be employed. We discussed the protocols amongst ourselves to insure everyone was familiar with the sampling approaches. Given the experience of the crew the design and approaches were understood and straightforward to all.

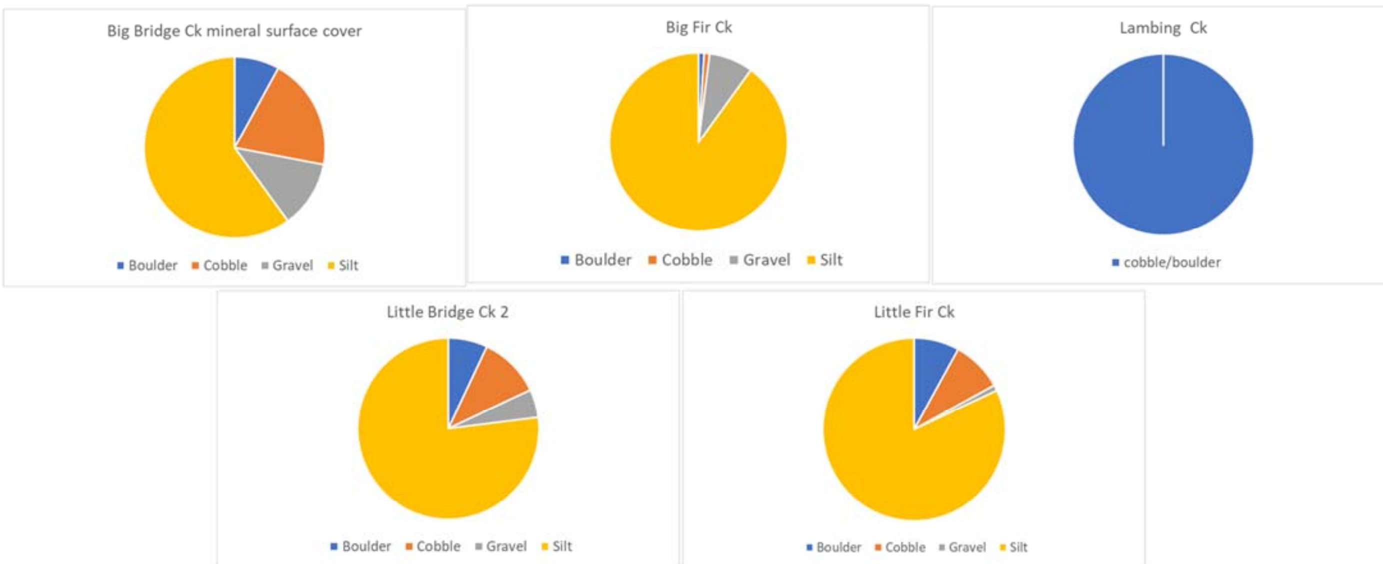
Upon arrival, we began the field work with a demonstration and discussion of approaches to greenline identification, stubble height measurements, shrub use, streambank alteration, and species identification. Questions in the field (such as species identification) were referred to Dr. Kauffman and discussed among the crew. For each riparian area sampled, Dr. Kauffman was responsible for measuring the stubble height, species identification, and streambank alteration and shrub utilization on one side of the creek. Ms. Cummings was responsible for measurements of stubble height, species identification, and streambank alteration on the other side of the creek. Dr. Beschta measured shrub utilization with Cummings and made hydrological interpretations (Rosgen stream class). Ms. Johns was responsible for GPS readings, channel slope measurements and data completeness in the field.

At the beginning of the sampling, we first measured plots together to insure similar interpretations. After the first transect we examined data for uniformity and discussed any remaining uncertainties. As part of the analysis we conducted statistical tests to see if differences existed between data collected by the different samplers. There were no statistical differences in the results based upon the individual who did the sampling in our team.

RESULTS

Surface substrate composition

Little Bridge Creek and Big Bridge Creek were Rosgen C channels with Cobble/Boulder substrates. In contrast Big Fir, Little Fir and Lambing Creeks were B channels with Cobble/Boulder substrates (Table 1). From an ecological and grazing management perspective what is also relevant are the surface substrates that are important for ecosystem productivity and are vulnerable to trampling damage and erosion. For all creeks except for Lambing Creek, the riparian surface was predominantly covered by fine-textured soils (Figure 1). The proportion of the Big Bridge Creek (a C channel) occupied by cobbles, gravels and boulders is likely a reflection of the widened and eroded channel due to the long term effects of livestock grazing.



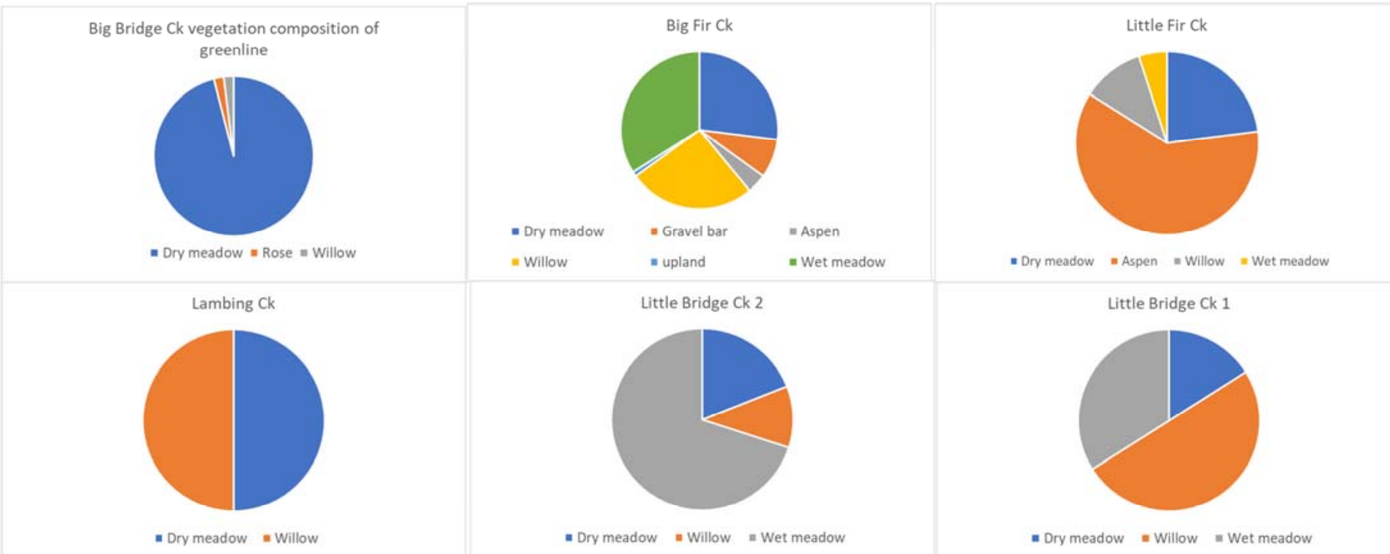
The mineral surface cover of the riparian greenline along the MIM transects in the Hardie-Summer Allotment

Figure 1 Surface substrates in the sampled reaches of riparian zones at the Hardie Summer Allotment, 2019

Vegetation composition

The vegetation dominance of the sampled riparian communities is reflective of the channel types, geomorphology and land use history of the sites (Figure 2). Big Bridge Creek was the most simplified of riparian zones largely dominated by dry meadows. The greenline composition of Little Bridge Creek was dominated by a mix of dry, moist and willow dominated communities. Unfortunately, this was the only riparian ecosystem where replicate samples (DMAs) were established. There was a greater abundance of wet meadows in Little Bridge Creek 2 and a greater abundance of willow dominated sites at Bridge Creek 2 suggesting that monitoring should establish more than one DMA site in streams to account for the differences in composition along the streams. The type B channels of Big Fir and Little Fir Creek were dominated by a mix of aspen, willow and meadow communities.

The vegetation communities of the 6 MIM riparian transects of the Hardie-Summer allotments, October, 2019. The riparian communities include: dry meadows (*Poa pratensis*), wet meadows (Carex spp), Willow dominanted (*Salix geyeriana*), Aspen (*Populus tremuloides*), Gravel bars, upland (*Juniperus, Artemisia*), and Rose (*Rosa woodsii*).



Herbaceous stubble heights

As opposed to "best guess" approaches, all utilization data reported here are the results of actual measurements that were conducted at the end of the grazing season (early October 2019). The stubble heights in the grazed riparian zones ranged from 1.8 inches at Big Bridge Creek to 8 inches at Big Fir Creek (Figure 3). The stubble height of the herbaceous vegetation at Big Bridge Creek was uniform across species (Consistently <1.9 inches) suggesting that even the less palatable species (e.g., Baltic Rush – *Juncus balticus*) was heavily utilized (Table 3).

The mean stubble height of herbaceous vegetation at Little Bridge Creek was 4 inches. Palatable species such as Kentucky Bluegrass was 2.2 to 3.6 inches (Table 3). The steep slopes and limited riparian area around the site sampled for Big Fir Creek limited access by cattle. Here the mean stubble heights were 8 inches.

In the sampled and observed aspen and mountain big sagebrush upland communities, livestock grazing use was light. The steep slopes, dense vegetation and distance to water limited livestock use in these areas. It is quite apparent that the majority of livestock use occurred in the riparian zones.

Herbaceous utilization

In the grazed reaches herbaceous utilization exceeded the 30% threshold in all sampled grazed riparian zones - Little Bridge Creek, Big Bridge Creek and Big Fir Creek (Figure 4, Table 3 and see also the photos 1, 2, 4, and 7). Utilization along the greenline at Little and Big Bridge Creeks was >74%. We limited our utilization measurements to the greenline. In the riparian dry meadows away from the greenline but within these riparian zones it was even higher (see photos 1, 2, and 7). Utilization of the accessible greenline at Big Fir Creek was 43%. The greenline of much of this sampled reach had no understory vegetation, or was adjacent to steep rock outcrops or steep banks.

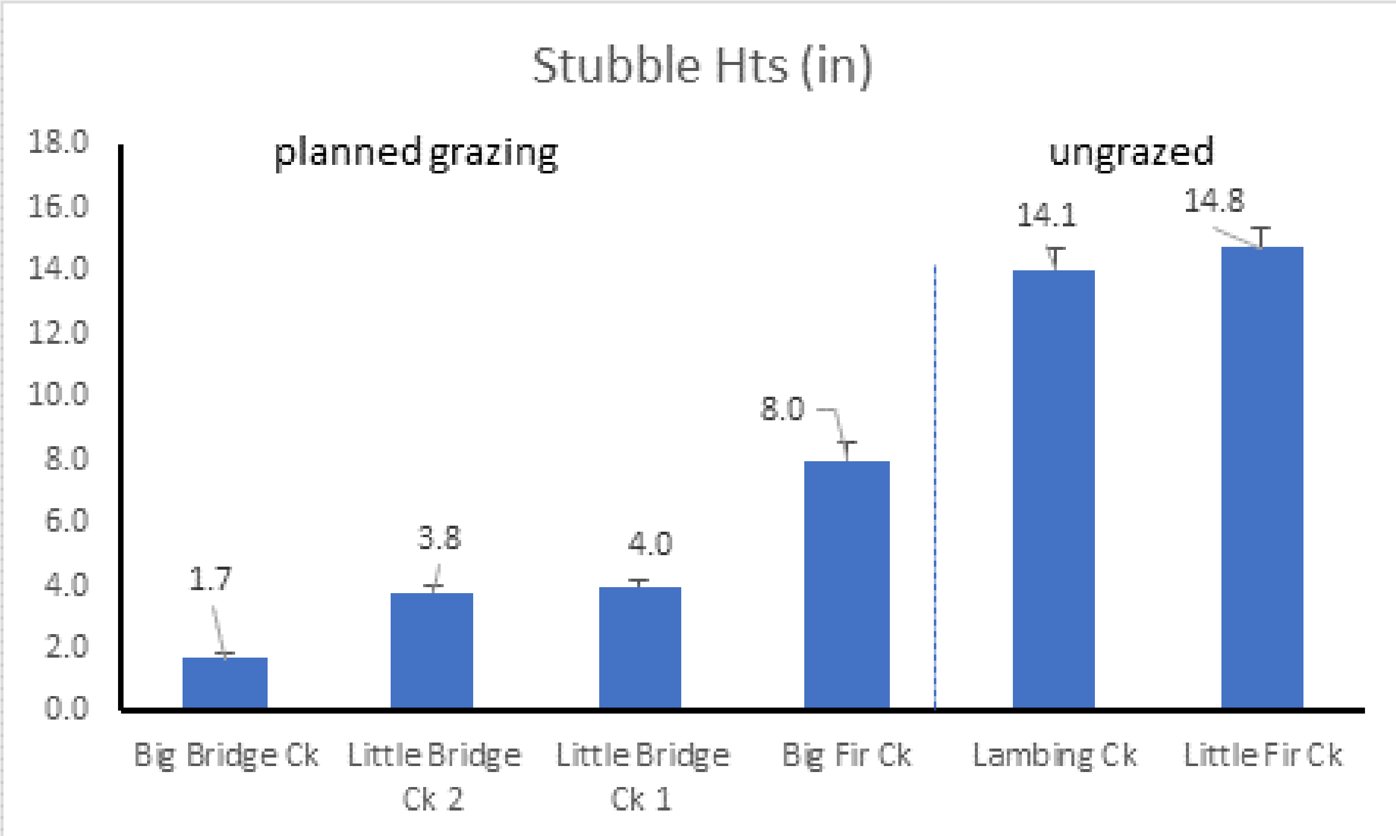


Figure 3. Stubble heights (inches) of riparian vegetation along the greenline at the Hardie Summer Allotment, October, 2019

Utilization(%) of vegetation along the greenline in riparian zones/streams of the Hardie- Summer Allotment, October 2019).

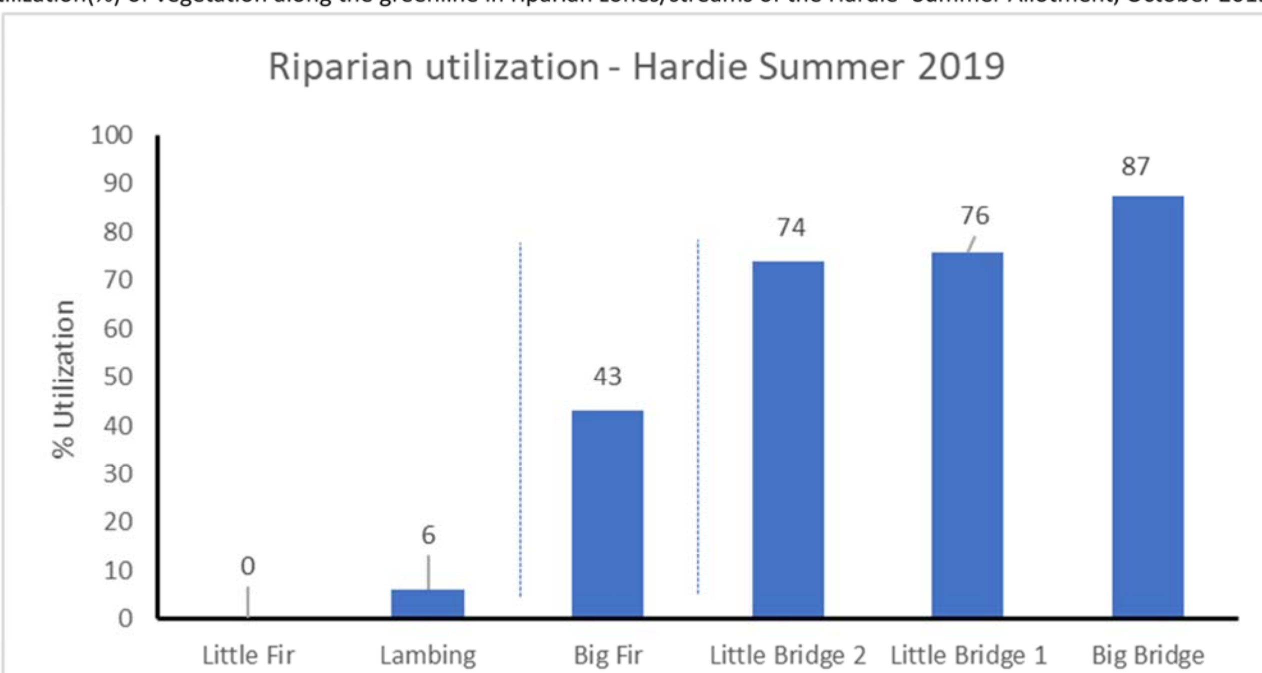


Figure 4. The percent utilization of riparian vegetation along the greenline at the Hardie Summer Allotment, October 2019.

Shrub utilization

We limited shrub use to those willows whose heights were under 5 feet. This is the assumed grazing height limit of cattle (Burton et al. 2011). We found that >46% of the terminal leaders (principle growing stems) of these willows had been browsed by livestock in Little and Big Bridge Creek (Figure 5). In contrast, about 4% of the leaders had been utilized in the ungrazed Little Fir Creek. This suggests that wild ungulates (deer and elk) are responsible for a small quantity of shrub utilization. The majority of the use can be attributed to cattle.

Shrub utilization along the greenline. Utilization is the percent of the tallest 10 leaders (under 5 feet) encountered in plots along the transect.

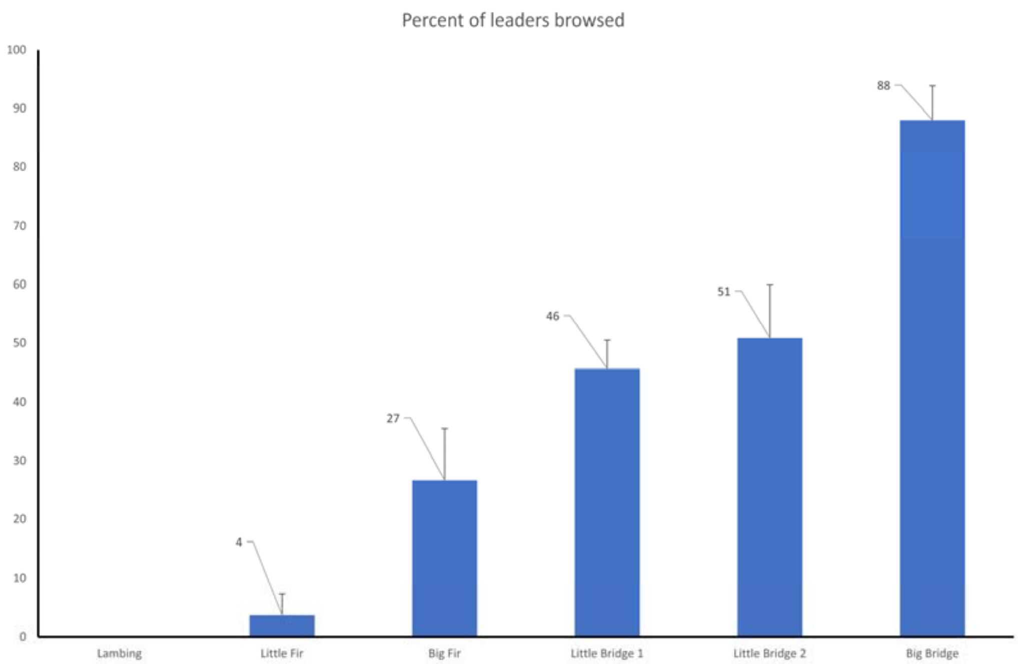


Figure 5. Shrub (willow) utilization along the greenline of the Hardie Summer allotment. Only willows <5 ft in height (those that would be accessible to livestock) were measured.

The percent of the streambanks altered following MIM methodology in selected riparian/stream ecosystems of the Hardie-Summer allotment, October 2019.

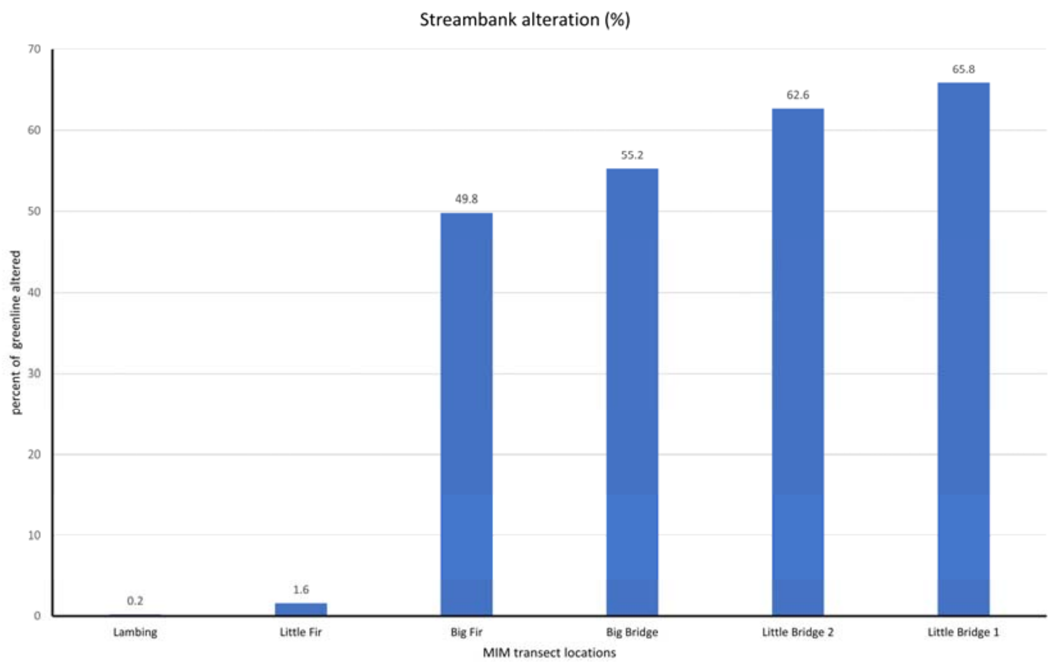


Figure 6. Streambank alteration (%) along the Greenline following the MIM protocol.

Streambank Alteration

Streambank alteration results are based upon detailed measurements of 100 plots at each sampled DMA. Streambank alteration was significant at all grazed riparian zones but quite low in the ungrazed riparian zones (Figure 6). The ungrazed reaches reflect the impacts of wild ungulates on streambank alteration. This was 0.2% in the heavily armored Lambing Creek site and 1.6% at the ungrazed Little Fir Creek site. In contrast >50% of the streambanks were altered at the Big Fir, Big Bridge, and Little Bridge DMAs. The high level of streambank alteration could be expected given the high levels of utilization at these sites. The highest levels of streambank alteration were measured in the Little Bridge Creek DMAs. This is likely reflective of the higher quantities of wet meadows present at the greenline (Figure 2) as well as the high utilization at these sites (74-76%).

Goss and Roper (2018) reported that increased livestock disturbance, as assessed with streambank alteration and stubble height, was related to stream channel changes through increases in width-to-depth ratios, bank angles, and fine sediment in pool-tails and decreases in undercut banks, bank stability, pool habitat, pool depth, and wood frequency. The synergistic adverse effects of livestock disturbance on stream channel characteristics could therefore negatively affect salmonid densities and survival of all life stages.

Goss and Roper (2018) recommended that following the precautionary principle and based on their findings that increased livestock disturbance can degrade stream conditions important to salmonids, implementing more conservative standards such as a 15-cm standard for stubble height seemed prudent. They recommended that a conservative starting point for this metric using the protocol in this report may be 25%. However, they cautioned that the lack of published studies makes such a conclusion tenuous without additional study. The streambank alteration results from Little Bridge Creek and Big Bridge Creek are over twice the level of bank alteration recommended by Goss and Roper (2018) for salmonid habitat protection. Stubble heights (1.7 to 4 inches) were dramatically lower that their recommended level (6 inches). It is clear that both the stubble height threshold and streambank alteration recommend by Goss and Roper (2018) were greatly exceeded in the grazed reaches of the Hardie Summer Allotment.

Differences between the 2019 BLM report and this report

This report contains far more data quantifying livestock use in the riparian zones of the Hardie Summer and Mud Creek allotments than collected by the BLM in 2019. BLM only reports data from MIMs in Little Bridge Creek, Little Fir Creek and Big Fir Creek. The BLM report does not report the sample size of specific approaches they took to sample. Neither does it report the sample size or training that the authors received. Utilization rates of the riparian zone were not reported. Given the lack of quantitative data in the BLM report, it is hard to reconcile the differences in interpretation.

In terms of utilization of the riparian zones, we found that the mean stubble heights of the Little Bridge Creek DMAs that we established were 3.8 and 4.0 inches. Utilization was determined to be 74-76% in these 2 riparian DMAs. Interestingly, examining the stubble height data provided in the BLM report on Little Bridge Creek (page 9) one can calculate an estimate of utilization using their data. On 8/15/2019 their mean stubble height was 16 inches and on 10/05/ 2019 the mean stubble height was 9.5 inches. This results in a utilization estimate of 41%. Thus, even BLM's own data clearly suggests that the 30% grazing threshold was exceeded for this riparian zone. Similarly, BLM's photos of Big Bridge Creek clearly show that utilization exceeded 30%. Here we found the highest livestock use in the allotment with a utilization rate of 87% and a stubble height of 1.7 inches. Given their ecological importance for both aquatic and terrestrial biodiversity, the riparian zones have not been considered "sacrifice areas" since the 1980s (Kauffman et al 1984).

We found that shrub utilization of shrubs lower that 5 feet was high enough to affect growth and reproduction of the willows. For willows <5 feet in height the level of terminal leader browsing was 27-88%. This is based upon quantitative counts of each encountered willow. The BLM report suggested utilization was none to slight in all Designated Monitoring Areas but this was not based upon quantitative measurements but best guesses.

In terms of bank alteration, we suggest that the differences between this report and the BLM report are the results of experience. Heitke et al. (2008) and other studies have reported that professionals' estimates of streambank alteration were 30% higher than that of technicians. These differences were suggested to have been associated with the placement of sampled lines and/or how alteration was assessed along the sample line. We thoroughly examined each line in each plot both visually and by feel. From our experience, have found that this is necessary to obtain accurate data. Heitke et al. (2008) went on to recommend the use of independent observers (such as our team) that could reduce criticisms that imply local politics influence monitoring outcomes.

Summary

This report contains an objective and quantitative assessment of the herbaceous stubble heights and utilization, shrub utilization and streambank alteration along the greenline following MIM methodology. The assessment was conducted a few days after the end of the authorized 2019 grazing season on the Hardie Summer allotment.

The riparian zones are the most important ecosystems on the landscape with respect to the sustained management of Threatened and Endangered species, biological diversity and water quality and addressing climate change. It is for this reason that the federal government has established monitoring and standards of utilization for their sustainability and restoration (Burton et al. 2011, Goss and Roper 2018). The utilization on Little Bridge and Big Bridge creek riparian zones far exceeded the government standard for sustainability. Utilization on these streams was almost three-fold greater than the Court-order standard. The streambank alteration were at levels that far exceeded recommendations for proper or sustainable management. Many willows were grazed beyond their current year's growth and shifts in structure are apparent. These influences are highly likely to affect species such as red band trout and sage grouse.

The overuse of the riparian zone with limited use of uplands is not different than what would be expected for livestock grazing in allotments such as the Hardie Summer that can be characterized by steep slopes, surrounding the riparian zones (Roath and Krueger 1982). The steep slopes, distance to water, and favorable microclimates in the riparian zone will result in disproportional and heavy use in riparian zones by livestock. Given the importance of riparian zones especially in semiarid environments the government developed standards for livestock use in riparian zones (e.g., Burton et al. 2011, Goss and Roper 2017) and these were greatly exceeded in the Hardie Summer allotment. These results should have been anticipated by professionals within BLM as the literature is full of similar results (see Bryant 1982, Kauffman and Krueger 1983, Kauffman et al. 2002 for examples).

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Appendices and Photos

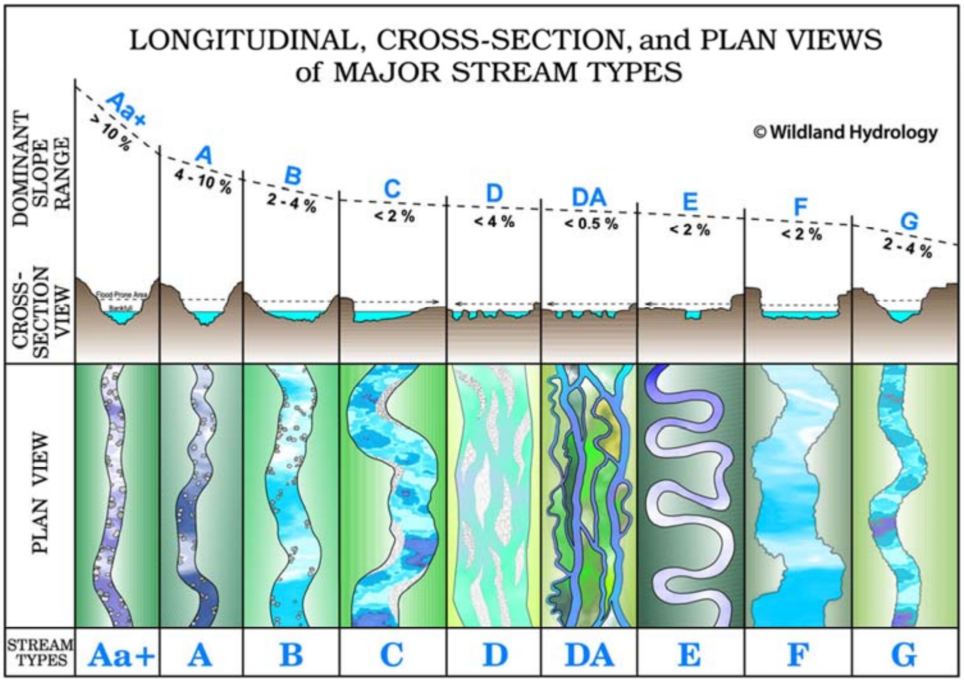
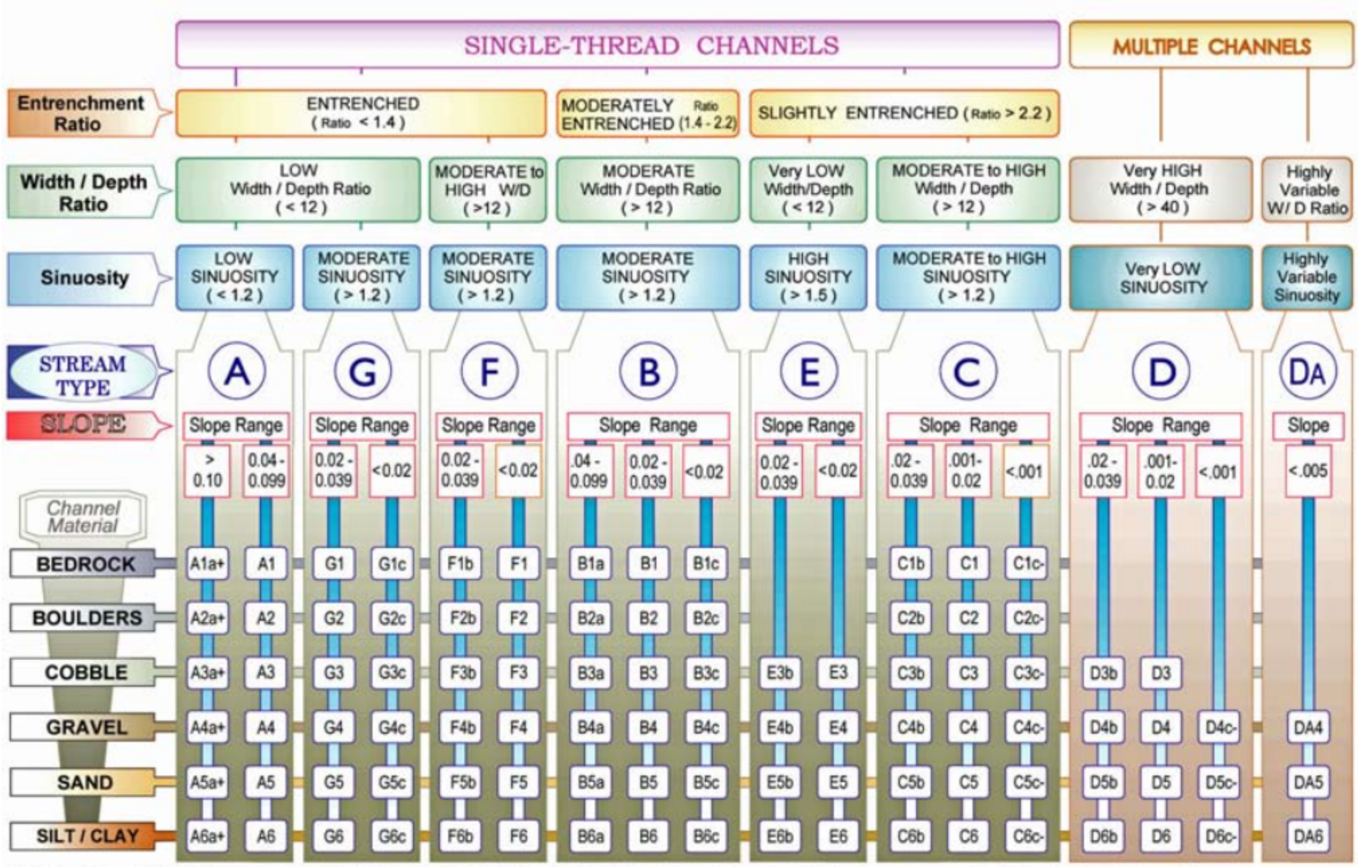
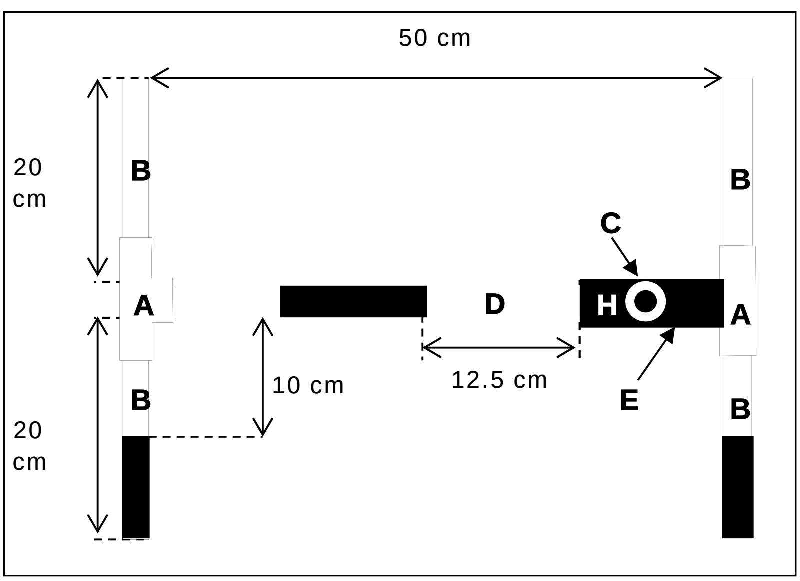


Figure TS3E–2 Hierarchical level II key



KEY to the *ROSGEN* CLASSIFICATION of NATURAL RIVERS. As a function of the *"continuum of physical variables"* within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units; while values for ***Width / Depth*** ratios can vary by +/- 2.0 units.



MIM Monitoring Frame

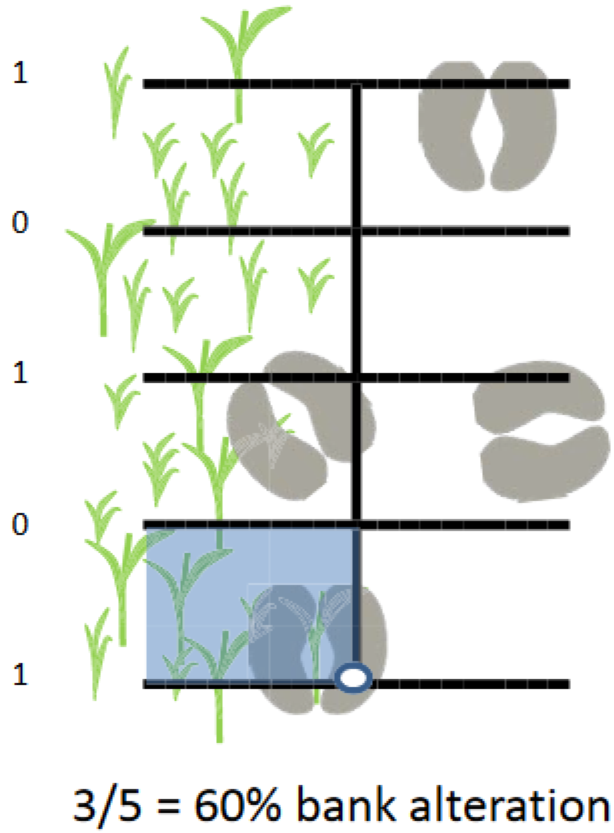


Figure 1. An example of streambank alteration measurement. (from Goss and Roper 2018).

Photo 1. Little Bridge Creek near DMA 1, October 2019. Note the browse line on the aspens and the heavy use of the grasses and sedges by cattle. The stubble height is well below the height of a shoe.

Photo 2. Big Bridge Creek, October 2019. Note the low stubble heights on the left bank. Few willows were present in this riparian zone in an advanced state of degradation. The channel has been widened and greatly simplified due to overgrazing by livestock.

Photo 3. Conducting the MIM+ survey on Little Fir Creek, October 2019. Note the difference in grass height and streambank cover at this ungrazed site compared to the grazed sites.

Photo 4. Big Fir Creek DMA, October 2019. Utilization of this site was lower than other sites. The steep slopes and narrow riparian zone limited access.

Photo 5. A mountain big sage community where we sampled stubble heights, October 2019. Typically sagebrush and all upland sites well away from surface water had low levels of use. Cattle concentrate in the riparian zones causing damage in these ecosystems of high diversity and value.

Photo 6. October 2019: Utilization of uplands outside of the riparian zones tended to be light as the slopes tended to limited movements by the cattle. This aspen stand was on a 20-30% slope about 0.5 miles from water.

Photo 7. A photographic comparison of Little Fir Creek (Ungrazed – right) and Big Bridge Creek (87% utilization - left). These two sites were from adjacent watersheds approximately 2 miles apart. Note the loss in cover over Big Bridge Creek with a streambank alteration of 55% compared to the cover over the Little Fir Creek channel. Photos were taken October 1 and October 2, 2019.

Photo 8. Untended cattle grazing the Mud Creek Allotment, October 4, 2019. There were over 100 cattle untended cattle in the Mud Creek allotment at this time. So additional utilization may have occurred after we measured utilization on the Lambing Creek DMA.