Habitat Assessment for Miller Creek Missoula County, Montana



October 2018

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Introduction

This report presents the results of a habitat assessment completed for Miller Creek, tributary to the lower Bitterroot River, near Missoula, Montana. There are four primary objectives for this report:

- 1. Evaluate the condition of instream and riparian habitat in Miller Creek.
- 2. Evaluate the condition of all non-bridge stream crossings.
- 3. Evaluate stream temperature and flow at selected locations along Miller Creek.
- 4. Identify reach-specific problems, and opportunities for watershed restoration and improvements.



Figure 1. Map depicting the habitat assessment reaches and crossings surveyed for fish passage in Miller Creek.

Habitat Assessment

There were 17 reaches surveyed in the habitat assessment portion of this report, which can be broken up into four categories based on their location in the watershed: lower, lower-middle, upper-middle, and upper reaches (Figure 1). Reaches were defined by property boundary, changes in land-use, changes in geomorphic setting, and changes in riparian community structure. In total, approximately 28% of the mainstem Miller Creek stream length was surveyed for this habitat assessment. Tributaries were not included in this initial assessment.

Fish Passage Surveys

All known non-bridge stream crossings and diversion dams were surveyed for fish passage (Figure 1), with the exception of all USFS crossings and one crossing where access was not granted (Miller Creek Meadows LLC property). All USFS crossings have already been surveyed by the USFS and results from those analyses are presented in Appendix x. Additionally, three diversions dams in the Oxbow Cattle Company property were surveyed for fish passage.

Streamflow Assessment

Streamflow was measured at 2 monitoring locations in the watershed from June to October. The 2 sites on the mainstem of Miller Creek are above and below the Oxbow Diversions (see Figure 1) and were chosen to evaluate water availability on the lower stretch of creek. A synoptic run was also completed in August of 2018.

Stream Temperature Assessment

Stream temperature was measured at 6 locations from July to October. Five of temperature loggers were installed in the Upper, Middle-Upper, and Lower reaches of the habitat assessment (Figure 1). One temperature logger was installed below the Lower reach.

Previous Studies

This report builds from the 2018 Watershed Restoration Plan by the Missoula Valley Water Quality District. From this plan, Miller Creek has been identified as impaired for sediment and temperature. The two major factors impacting stream water temperatures are shading from riparian vegetation and instream flow volume (MVWQD, 2018). Additionally, the WRP states that fish passage obstructions in the watershed need to be assessed and a plan for mitigation developed and implemented. This report also builds from the Department of Environmental Quality's TMDL document (DEQ, 2011), which outlined that the most influential non-point source restoration strategy for Miller Creek will be restoring shade-producing vegetation along the whole segment (DEQ, 2011).

Methods

NRCS Riparian Assessment Protocol and Fish Habitat Scores

The 'USDA Riparian Assessment using the NRCS Riparian Assessment Method' protocol (USDA, 2004) was used for the stream habitat assessment. The NRCS method scores each reach based on stream

channel condition, floodplain condition, riparian vegetation, and land use issues which can be assessed during a stream walk. Scores from the ten questions on this form are tallied together and then divided by the total possible points to develop an overall NRCS Assessment Score for each reach. Percentage scores for each reach fall into the following three categories: 'Sustainable' (80 to 100%), 'At Risk' (50 to 80%), or 'Not Sustainable' (0 to 50%).

Fish Habitat Scores were calculated via the supplemental attributes questions 1, 2, 3, and 5 in the NRCS Riparian Assessment protocol to assess the condition of the aquatic habitat and water quality associated with the reach. Question 4 was removed from the analysis because flow characteristics of the stream were assessed using other, more in depth methods. Answers to the supplemental questions 1, 3, and 5 had four potential scores: 10, 7, 3, or 0. Answers to supplemental question two had potential scores of 20, 10, and 0 because of the importance of this question to our assessment. Question scores were added together and then a percentage of the total potential score was calculated, leading to a final score for the reach. Scores fell into three categories: poor fish habitat (0% to 30%), fair fish habitat (31% to 79%), and good fish habitat quality (80% to 100%).

Fish Passage Surveys

All non-bridge and non-USFS crossings were surveyed using the USFS National Inventory and Assessment Procedure for Identifying Barriers to Aquatic Organism Passage at Road-Stream Crossings protocol (USFS, 2005). Metrics collected at these crossings include: pipe diameter, pipe length, pipe gradient, road width, outlet drop height, and pool depth were measured. Distance from the outlet pool to the first resting habitat upstream of the crossing was also measured. At the three Oxbow Cattle Co. diversion dams, water surface slope and fish jump height were measured.

Fish passage barrier determination was made using definitions outlined in the Assessment of Aquatic Organism Passage at Road/Stream Crossings for the Northern Region of the USDA Forest Service report (USFS, 2008). A "Red" (total) fish passage barrier is a crossing that prohibits the upstream passage of all species and life stages throughout the entire year. A "Gray" (partial) fish passage barrier is a barrier to upstream migration during a portion of the year to any species.

Streamflow Assessment

Streamflow was measured using HOBO Water Level Loggers at 2 locations in the Lower Reach and below the Lower Reach. The loggers recorded water level and barometric pressure every hour from June through October. Using a Hach flowmeter, flow measurements were taken at the sites while the loggers were deployed. The water level and flow measurements were used to create a rating curve and hydrograph of each site.

Stream Temperature Assessment

Stream temperature was measured at locations of streamflow assessment using HOBO Water Level Loggers, and at 4 additional locations along mainstem Miller Creek using Hobo TidbiT v2 Temperature Loggers.

Results

Habitat Assessment Results: Lower Reaches

Reach NWE_1



Figure 2. Conditions in the upstream end of reach NWE_1.

Reach	NRCS Score	Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Fish Habitat Score	Fish Habitat Rating
NWE_1	23%	Not Sustainable	G tending towards C	0.93	12.5	13.5	Cobble	2	40%	Fair

Table x. Reach NWE_1 data summary.

This reach of Miller Creek flows through property that is owned by Northwestern Energy and contains one streamflow diversion at the upstream end of the reach, where the water right is owned and operated by Oxbow Cattle Company. Reach length is 0.26 miles. The stream appears to have been straightened throughout most of the reach, as the sinuosity is very low, the slope of the stream is very steep for the location within the watershed, and there are very few pools within the reach. This reach is dominated by fast water (riffles). This section is clearly a sediment transport reach, as the dominant substrate is cobble and there are very few depositional zones. There is a definitive lack of riparian hardwood vegetation in this reach and the dominant riparian vegetation is grasses. The stream is incised one to two feet throughout the reach.

Reach NWE_2



Figure 3. Conditions in reach NWE_2.

Table 1. Reach NWE_2 data summary.

NRCS Score	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope	Fish Habitat Score	Fish Habitat Rating
23%	Not Sustainable	G	0.88	14	15.9	Cobble	2%	40%	Fair

This reach of Miller Creek flows through property that is owned by Northwestern Energy. Reach length is 0.33 miles. The stream appears to have been straightened throughout most of the reach, as the sinuosity is very low, the slope of the stream is very steep for the location within the watershed, and there are very few pools within the reach. This reach is dominated by fast water (riffles). This section is clearly a sediment transport reach, as the dominant substrate is cobble and there are very few depositional zones. There is a definitive lack of riparian hardwood vegetation in this reach and the dominant riparian vegetation is grasses. The stream is incised one to two feet throughout the reach.

Reach Stillwater_1



Figure 4. Conditions in Stillwater_1 reach.

Table Z. Reach Stillwater I Gata Summary.	Table 2.	Reach	Stillwater	1	data	summary	v.
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NRCS Score	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope	Fish Habitat Score	Fish Habitat Rating
27%	Not Sustainable	В	0.95	10.7	11.26	Cobble	1.5%	34%	Fair

This reach of Miller Creek flows through property that is owned by Stillwater Addition Homeowners. Reach length is 0.5 miles. The stream appears to have been straightened throughout most of the reach, as the sinuosity is very low, the slope of the stream is steep for the location within the watershed, and there are no pools within the reach. This reach is one long continuous riffle. This section is clearly a sediment transport reach, as the dominant substrate is cobble and there are very few depositional zones. There is a definitive lack of riparian hardwood vegetation in this reach and the dominant riparian vegetation is grasses. The stream is slightly incised throughout the reach. Lateral bank erosion was visible along the outside bends where banks were 4-5' tall and eroded.

Reach Capon_1



Figure 5. Conditions in Capon_1 reach.

Table 3. Reach Capon	_1 data summary.
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NRCS Score	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope	Fish Habitat Score	Fish Habitat Rating
27%	Not Sustainable	В	1.03	11.2	10.87	Cobble	1%	34%	Fair

This reach of Miller Creek flows through property that is owned by a private entity and Missoula County. Reach length is 0.12 miles. The stream appears to have been straightened throughout most of the reach, as the sinuosity is very low, the slope of the stream is steep for the location within the watershed, and there are no pools within the reach. This reach is one long continuous riffle. This section is clearly a sediment transport reach, as the dominant substrate is cobble and there are very few depositional zones. There is a definitive lack of riparian hardwood vegetation in this reach and the dominant riparian vegetation is grasses. The stream is incised 2 to 3 feet throughout the reach, and there was minimal lateral bank erosion. Habitat Assessment Results: Lower-Middle Reaches

Reach Singletree_1



Figure 6. Conditions in Singletree_1 reach.

Table 4. Reach Singletree_1	data summary.
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NRCS Score	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope	Fish Habitat Score	Fish Habitat Rating
13%	Not Sustainable	G	1.2	9.8	8.2	Cobble	0.75%	66%	Fair

This reach of Miller Creek flows through property that is owned by two private entities. Reach length is 0.19 miles. There are few pools (4) within the reach, and there is a definitive lack of riparian hardwood vegetation in this reach and the dominant riparian vegetation type is grasses. The stream is incised an average of 5 feet throughout the reach, and lateral bank erosion was evident throughout the reach as the channel is actively widening. There was an increased amount of fine sediment observed in this reach.

Reach Singletree_2



Figure 7. Conditions in Singletree_2 reach.

Table 5. Reach Singletree_	2 data summary.
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NRCS Score (%)	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Fish Habitat Score	Fish Habitat Rating
57%	At Risk	С	0.65	10	15.4	Gravel	1.5	74%	Fair

This reach of Miller Creek flows through property that is owned by a private entity and Missoula County. Reach length is 0.19 miles. There are six pools within the reach, and there was an increased amount of fine sediment observed in this reach. Channel incision observed in this reach begins with a 4 foot average on the downstream end, and generally decreases as you move upstream, giving an average of 3 feet throughout the reach. Lateral bank erosion was evident throughout the reach as the channel is actively widening. Riparian vegetation increased in this reach, with cottonwood, chokecherry, aspen, and willow as the dominant hardwood riparian vegetation present.

Reach Singletree_3



Figure 8. Photo A: Sediment deposition and channel avulsion occurring downstream of the Singletree Lane crossing. Photos B&C: Large sediment plug that has deposited approximately 4 ft of sediment for 400 ft upstream of the crossing. Photo D: Channel spanning log causing a potential fish passage barrier with a 1.8 ft fish jump height.

NRCS Score	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope	Fish Habitat Score	Fish Habitat Rating
70%	At Risk	С	0.9	13.1	14.6	Gravel	1.5%	68%	Fair

Table 6. Reach Singletree_3 data summary.

This reach of Miller Creek flows through property that is owned by two private entities and Missoula County. Reach length is 0.25 miles. The crossing with Singletree Lane has caused major sediment issues in this reach. A large plug of sediment has deposited upstream and downstream of the crossing due to

the fact that the aged, double barrel culverts at the crossing are severely undersized and partially plugged (see fish passage survey results and photos). Based off of the size of the sediment plug, this issue appears to have been ongoing for decades. Approximately 1185 cubic yards of sediment have been deposited upstream of the crossing, and much more has been deposited downstream. The channel has avulsed downstream of the crossing, and a portion of the water was flowing into Singletree Lane at the time of survey (July 18, 2018). Although there were sandbags placed in the stream to prevent this from happening, some flow was still escaping into the road and traveling 500 feet along the road before flowing back into Miller Creek. Based off of visual assessment, it appears the elevation of Singletree Lane is lower than the stream channel, which explains why the stream flows here (as the road is in the floodplain). The channel is braided and extremely widened downstream of the stream crossing due to the sediment deposition. There were nine pools in the reach, and overall are shallow due to the excess sediment. The slope of the stream ranged throughout the reach from 0.5-6.0%, with an average of 1.5%.

Restoration recommendations for this reach are to:

- 1. Replace the Singletree Lane culverts with a bridge.
- 2. Reconstruct the channel upstream and downstream of the culvert to control the grade and prevent the sediment plug from eroding and delivering downstream. This includes the removal of the fish passage barrier shown in photo D (Figure x).
- 3. Move Singletree Lane out of the floodplain.
- 4. Revegetate open areas in the riparian zone that have been covered in years of depositional gravel.

Habitat Assessment Results: Upper-Middle Reaches

Reach Wustner_1



Figure 9. Conditions in the Wustner_1 reach. Note person standing on bank for scale of incision.

NRCS Score	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope	Fish Habitat Score	Fish Habitat Rating
33%	Not Sustainable	С	0.85	19.6	23.1	Cobble	1%	34%	Fair

Table 7. Reach Wustner_1 data summary.

This reach of Miller Creek flows through property that is owned by a private entity. Reach length is 0.35 miles. The stream has been relocated to the south side of the valley and straightened throughout most of the reach. This section of stream in very incised and is actively widening. Banks were actively sloughing throughout the reach. The stream is incised 8-10 ft on average throughout the reach – the worst seen in the watershed. The floodplain is disconnected throughout the reach, and dead riparian vegetation was visible because of this. An inset floodplain is forming inside the incised channel (see photo). Pools were minimal in this reach, and there was minimal shade and cover for fish.

Reach DNRC_1



Figure 10. Conditions in the DNRC_1 reach.

Table 8.	Reach DNRC	1	data summary.	
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NRCS Score (%)	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Fish Habitat Score	Fish Habitat Rating
62%	At Risk	G	1.28	23.1	18.1	Gravel	2	60%	Fair

This reach of Miller Creek flows through property that is owned by the MT Department of Natural Resources and Conservation. Reach length is 0.13 miles. This reach can be characterized as an incising channel with a thick riparian zone. Although not shown well in the photo for the reach, incision is approximately 6-7 ft on average throughout the reach, with very few bars and low sinuosity in most places. It appears that the channel has been moved to the west side of the valley. The reach consists of mostly fast water, with a slope of 2%, however some wood formed pools were present. Shade is not a limiting factor in this reach, but if incision continues, the floodplain could become more disconnected and the riparian zone could die off.

Reach DNRC_2



Figure 11. Conditions in the DNRC_2 reach.

Table 9. Reach DNRC_	_2	data	summary.
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NRCS Score (%)	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Fish Habitat Score	Fish Habitat Rating
63	At Risk	С	1.1	15	13.6	Gravel	1	54%	Fair

This reach of Miller Creek flows through property that is owned by the MT Department of Natural Resources and Conservation. Reach length is 0.22 miles. This reach can be characterized as an actively incising and widening channel with a thick riparian zone. Incision is approximately 2-3 ft on average throughout the reach and there was an extensive amount of lateral bank erosion occurring. The channel moves away from the valley edge, overall is wider, has an inset floodplain, and a decreased slope. However, there were few pools observed in this reach. Shade is not a limiting factor, but if incision continues, the floodplain could become disconnected.

Reach DNRC_3



Figure 12. Conditions in the DNRC_3 reach.

Table 10. Reach DNRC_3	3 data summary.
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NRCS Score (%)	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Fish Habitat Score	Fish Habitat Rating
88	Sustainable	В	1.05	11.9	11.3	Gravel	1.5	74%	Good

This reach of Miller Creek flows through property that is owned by the MT Department of Natural Resources and Conservation. Reach length is 0.25 miles. This reach can be characterized as an incised and widened channel with a thick riparian zone growing on the inset floodplain. The stream here appears to be recovering from a historic incision and widening event. Incision is approximately 5-6 ft on average throughout the reach and there was a minimal amount of active lateral bank erosion occurring. There was an even mix of deep, shallow, large, and small pools observed in this reach. Gravels were partially embedded, and shade was not a limiting factor.

Reach MPG_1



Figure 13. Conditions in the MPG_1 reach.

NRCS Score (%)	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Fish Habitat Score	Fish Habitat Rating
78	At Risk	С	0.93	12.4	13.3	Gravel	1.5	94%	Good

This reach of Miller Creek flows through property that is owned by the MPG Ranch. Reach length is 0.54 miles. This reach can be characterized as a slightly incised and widened channel with a thick riparian zone growing in the floodplain. Incision is approximately 1-2 ft on average throughout, and an inset floodplain is in the formation process here. The riparian zone was very diverse and thick, with all age classes present. There was an even mix of deep, shallow, large, and small pools observed in this reach. Gravels were partially embedded, and shade was not a limiting factor.

Reach MPG_2



Figure 14. Conditions in the MPG_2 reach.

٦	Table 12.	Reach MPG_	2 data sumn	nary.	

NRCS Score (%)	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Fish Habitat Score	Fish Habitat Rating
75	At Risk	С	1.05	12.5	11.9	Gravel	0.5	74%	Fair

This reach of Miller Creek flows through property that is owned by the MPG Ranch. Reach length is 0.33 miles. This reach can be characterized as a slightly incised and widened channel with a sparse riparian zone. The riparian zone was dominated by conifer and grass, with very little hardwoods present. Incision is approximately 1-2 ft on average throughout, and increases to 4 ft at the upstream end of the reach (as shown in Figure x). There was an even mix of deep, shallow, large, and small pools observed in this reach. Gravels were partially embedded, and shade was not a limiting factor.

Habitat Assessment Results: Upper Reaches

Reach Spooner_1



Figure 15. Conditions in the Spooner_1 reach.

NRCS Score (%)	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Fish Habitat Score	Fish Habitat Rating
53	At Risk	G	1.4	8.6	6.14	Gravel	0.5	54%	Fair

Table 13. Reach Spooner_1 data summary.

This reach of Miller Creek flows through property that is owned by a private entity. Reach length is 0.73 miles. This reach can be characterized as an actively incising and widening channel with a riparian zone beginning to establish in an inset floodplain. Incision is approximately 4-5 ft on average throughout the reach and there was an extensive amount of active lateral bank erosion occurring. There is a definitive lack of riparian hardwood vegetation in this reach and the dominant riparian vegetation is grasses.

Reach USFS_1



Figure 16. Conditions in the USFS_1 reach.

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NRCS Score (%)	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Fish Habitat Score	Fish Habitat Rating
66	At Risk	С	0.95	8.5	8.95	Gravel	0.75	74%	Fair

This reach of Miller Creek flows through property that is owned by the U.S. Forest Service. Reach length is 0.19 miles. This reach can be characterized as an actively incising narrow channel with minimal lateral bank erosion. Incision is approximately 2 ft on average throughout the reach. The riparian zone consists mainly of alder with a conifer overstory. Shade is not a limiting factor in this reach. Gravels were embedded in fine sediment and there was a lack of bars present. The instream habitat in this reach was homogenized with few pools present, likely due to incision.

Reach USFS_2



Figure 17. Conditions at the upstream end of the USFS_2 reach.

NRCS Score (%)	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Fish Habitat Score	Fish Habitat Rating
60	At Risk	DA to D	N/A	N/A	N/A	Gravel		74%	Fair

Table 15. Reach USFS_2 data summary.

This reach of Miller Creek flows through property that is owned by the U.S. Forest Service. Reach length is short, at 0.11 miles. This reach is recovering from a large input of sediment. It can be characterized as a highly braided network of channels with a decadent riparian zone. As you move upstream, the channel type goes from a DA with 2-3 gravel bed channels, to a D type with many unstable, newly formed, soil bottom channels. The sediment plug causing this was clearly visible at the upstream end of the reach (shown in Figure x). The source of the sediment was not easily found, and the reason for its deposition is suspected to be the location in the watershed. The valley walls widen in this section, so perhaps this is a naturally occurring location for sediment deposition. The riparian zone consists mainly of alder with a conifer overstory, which is dying in the upstream end of the reach (shown in Figure x). Shade is not a limiting factor in this reach.

Reach USFS_3



Figure 18. Conditions in the USFS_3 reach.

Table 16.	Reach I	USFS	3	data	summary	1.
		_	-			

NRCS Score (%)	Score Category	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Fish Habitat Score	Fish Habitat Rating
46	Not Sustainable	G	1.12	7.1	6.3	Gravel	0.5	60%	Fair

This reach of Miller Creek flows through property that is owned by the U.S. Forest Service. Reach length is 0.07 miles. This reach can be characterized as an actively incising narrow channel that is beginning to widen in portions of the reach. Incision is approximately 3 ft on average throughout the reach and was as high as 6' in some places. The lowermost 30-40 ft of the reach was dammed up with water, and the channel was filled to bankfull as a backwater effect from the sediment plug at the upstream end of reach USFS_2. Fish were observed in this backwater section. The riparian zone consists mainly of snowberry, with an alder understory and conifer overstory in some places. Gravels were embedded in fine sediment. The instream habitat in this reach was homogenized with few pools present, likely due to incision.

Habitat Assessment Results Summary

The channel appears to have been moved and straightened throughout many of the surveyed reaches. This has led to widespread incision of the stream channel, floodplain disconnection, riparian degradation, and homogenization of instream habitat. Thirteen out of seventeen (76%) of the surveyed reaches were incised. Our results concur with the 2011 DEQ report that states the major source of sediment to Miller Creek is the eroding banks.

Forty-one percent (41%) of the reaches surveyed for this assessment received a 'Not Sustainable' NRCS rating, 52% received an 'At Risk' NRCS rating, and only 6% (one reach) received a 'Sustainable' NRCS rating. 29% of the reaches surveyed received a 'Poor Habitat Quality' fish habitat rating, 59% received a 'Fair Habitat Quality' fish habitat rating, and only 12% (2 reaches) received a 'Good Habitat Quality' fish habitat rating.

Lower Reaches

The reaches surveyed for this section of Miller Creek were a combined 1.2 miles of stream and were dominated by fast water. Overall, the stream is very straight (exhibited low sinuosity) and contained some of the highest recorded gradients (1.5-2%) in the watershed. Very few pools were present and there was a definitive lack of riparian hardwood vegetation in this section of Miller Creek. All of the reaches in this section received a 'Not Sustainable' NRCS rating, and 'Poor Habitat Quality' fish habitat score (Table x). All of the reaches in this section were excessively or moderately impaired for sediment, temperature, and vegetation (Table x).

	Length	Total	Total	Im	pairmen	ts		
Reach Name	of Reach (miles)	Assessment Score %	Fish Habitat Score %	Sed	Temp	Veg	Principal Sources	Other Sources
NWE_1	0.26	23%	40%	E	E	E	Channel straightening & incisment	Degraded riparian habitat
NWE_2	0.33	23%	40%	E	E	E	Channel straightening & incisment	Degraded riparian habitat
Stillwater_1	0.50	27%	34%	М	E	E	Channel straightening	Degraded riparian habitat
Capon_1	0.12	27%	34%	м	Е	Е	Channel straightening & incisment	Degraded riparian habitat

Table 17. Assessment scores for all lower reaches surveyed in Miller Creek.

	KEY							
Total Assessme	Not Impaired/At Risk							
Sustainable	80-100%	Good Habitat Quality	Slightly Impaired					
At Risk	50-80%	Fair Habitat Quality	51-79%	Moderately Impaired				
Not Sustainable	1-50%	Poor Habitat Quality	Excessively Impaired					

Lower-Middle Reaches

The reaches surveyed in this section of Miller Creek were a combined 0.63 miles of stream. The stream channel in this section is incised in the lower portion, and braided in the upper section due to a large deposition of sediment that is caused by the Singletree Lane road crossing that contains undersized, aged, concrete culverts. This issue appears to have been ongoing for decades, as the amount of sediment that has deposited in this area is extensive.

	Length	Total	Total	Im	pairment	S		
Reach Name	of Reach (miles)	Assessment Score %	Fish Habitat Score %	Sed	Temp	Veg	Principal Sources	Other Sources
Singletree_1	0.19	13%	66%	E	E	E	Channel incisement	Degraded riparian habitat
Singletree_2	0.19	57%	74%	М	S	S	Channel incisement	Channel widening
Singletree_3	0.25	70%	68%	E	S	S	Channel avulsion and braiding due to sediment deposition	Channel widening

Table 18. Assessment scores for all lower-middle reaches surveyed in Miller Creek.

	Impairments:		
Total Assessme	Not Impaired/At Risk		
Sustainable	80-100%	Good Habitat Quality	Slightly Impaired
At Risk	50-80%	Fair Habitat Quality	Moderately Impaired
Not Sustainable	1-50%	Poor Habitat Quality	Excessively Impaired

Upper-Middle Reaches

The reaches surveyed in this section of Miller Creek were a combined 1.82 miles of stream. The uppermiddle reaches contained the best habitat observed in this study. The only reach in this study that received a 'Sustainable' NRCS assessment rating fell in this area (DNRC_3 reach). Conversely, all reaches in this section of stream were incised, and the worst incision that was observed in this study also fell in this section of Miller Creek, in the Wustner_1 reach. Incision in this reach was an average of 8-10 ft.

Fish habitat scores in the DNRC_3 and MPG_1 reaches were the highest observed in the watershed, rated at 94% and 'Good Habitat Quality'. These two reaches contained an even mix of deep, shallow, large, and small pools and were not impaired for sediment or temperature.

	Length	Total	Total Fish	In	npairmen	ts		
Reach Name	of Reach (miles)	Assessment Score %	Habitat Score %	Sed	Temp	Veg	Principal Sources	Other Sources
Wustner_1	0.35	33%	34%	E	E	E	Channel incisement, widening & straightening	Degraded riparian habitat
DNRC_1	0.13	62%	60%	М	N	Ν	Channel incisement & straightening	Channel widening
DNRC_2	0.22	63%	54%	М	N	Ν	Channel incisement & straightening	Channel widening
DNRC_3	0.25	88%	94%	S	N	Ν	Channel incisement & straightening	Channel widening
MPG_1	0.54	78%	94%	S	N	Ν	Channel incisement	
MPG_2	0.33	75%	74%	S	м	М	Degraded riparian habitat	Channel incision

Table 19. Assessment scores for all upper-middle reaches surveyed in Miller Creek.

	Impairments:			
Total Assessme	nt Score:	Score:	Not Impaired/At Risk	
Sustainable	80-100%	Good Habitat Quality	Slightly Impaired	
At Risk	50-80%	Fair Habitat Quality	51-79%	Moderately Impaired
Not Sustainable	1-50%	Poor Habitat Quality	1-50%	Excessively Impaired

Upper Reaches

The reaches surveyed in this section of Miller Creek were a combined 1.1 miles of stream. Although the 2007 TMDL report completed by the Department of Environmental Quality (DEQ) found that the channel morphology in this section of Miller Creek was largely intact with no active erosion identified, the results of our 2018 habitat assessment show otherwise. The stream channel throughout the upper reaches was either incised or recovering from a large input of sediment (see individual reach results).

Three of four reaches in this section of Miller Creek received an NRCS assessment rating of 'At Risk', and one reach received a 'Not Sustainable' rating (Table x). All reaches received a 'Fair Habitat Quality' fish habitat rating, and all reaches were impaired for sediment and vegetation.

	Length	Total	Total	Ir	npairmei	nts		
Reach Name	of Reach (miles)	Assessment Score %	Fish Habitat Score %	Sed	Temp	Veg	Principal Sources	Other Sources
Spooner_1	0.73	53%	54%	E	м	м	Channel incisement and widening	Minimal riparian zone
USFS_1	0.19	67%	74%	м	N	S	Channel incisement	Degraded riparian habitat
USFS_2	0.11	60%	74%	E	N	М	Channel braiding and avulsion due to sediment deposition	Degraded riparian habitat
USFS_3	0.07	47%	60%	М	N	М	Channel incisement and widening	Degraded riparian habitat

Table 20. Assessment scores for all upper reaches surveyed in Miller Creek.

	Impairments:					
Total Assessme	nt Score:	Total Fish Habitat	Not Impaired/At Risk			
Sustainable	80-100%	Good Habitat Quality	80-100%	Slightly Impaired		
At Risk	50-80%	Fair Habitat Quality	51-79%	Moderately Impaired		
Not Sustainable	1-50%	Poor Habitat Quality	1-50%	Excessively Impaired		

Fish Passage Survey Results

Oxbow Cattle Company Stream Diversions

Lower

The fish jump height at the lower Oxbow Cattle Company stream diversion was measured at 2.2 ft and the water surface slope from downstream of the diversion to upstream of the diversion was measured at 4.5%.



Figure 19. The lower Oxbow Cattle Company stream diversion.

Middle

The fish jump height at the middle Oxbow Cattle Company stream diversion was a combined 2.7 ft and the water surface slope from downstream of the diversion to upstream of the diversion was measured at 4.0%.



Figure 20. The middle Oxbow Cattle Company stream diversion.

Upper

The fish jump height at the upper Oxbow Cattle Company stream diversion was measured to have a combined fish jump height of 3.4 ft and the water surface slope from downstream of the diversion to upstream of the diversion was measured at 7.0%.



Figure 21. The upper Oxbow Cattle Company stream diversion.

Haugan Drive Crossing

The Haugan Drive culvert is an open bottom arch culvert that was placed at grade, as there was no fish jump at the outlet. The gradient of the stream through the culvert was 0.5%. Based off of USFS fish passage evaluation criteria (USFS, 2008), this crossing was rated as "Gray" because the culvert width to bankfull width ratio was less than 0.7 and there was no resting habitat immediately upstream of the crossing. Further analysis will have to determine the exact barrier type, but this crossing is likely a velocity barrier to juvenile salmonids at high flows.



Figure 22. The outlet of the Haugan Drive crossing.

Trails End Road Crossing

The Trails End Road crossing is a double barrel style crossing consisting of two corrugated metal pipes that are 3.9 (right bank) and 4.8 ft (left bank) in diameter. The outlet of the left bank culvert had a fish jump height of 2.1 ft and the gradient of the culvert was measured to be 2.5%. The outlet of the right bank culvert had a fish jump height of 2.3 ft and the gradient of the culvert was measured to be 3.7%. Based off of USFS fish passage evaluation criteria (USFS, 2008), both culverts were rated as total barriers to all life stages of salmonids due to the fish jump height at the outlets, and the slope, length, and diameter of the culverts.





Figure 23. The outlet (top photo) and inlet (bottom photo) of the Trails End Road crossing.

Private Drive - Krempel Property

The Krempel Private Drive culvert is a 4.3 ft diameter concrete culvert with a concrete apron at the outlet. While there was no change in elevation at the outlet of the culvert, there was a 0.9 ft change in elevation (i.e. fish jump height) at the outlet of the apron. The gradient of the culvert was measured to be 1.2%. This crossing did not appear to be a fish passage barrier at the outlet of the apron at these flows (date of survey was July 23, 2018), but at base flows the apron could be an impediment to fish passage. There was visual evidence of water ponding up at the inlet, causing scour of the road fill, indicating that this culvert is undersized. Based off of USFS fish passage evaluation criteria (USFS, 2008), this crossing was rated as "Red" (total barrier) to juvenile salmonids based off of the fish jump height at the apron outlet, and the slope, length, and diameter of the culvert.



Figure 24. The outlet (left) and inlet (right) of the Krempel Private Drive crossing.

Lost Mine Loop Road - Lower Crossing

The Lost Mine Loop Road has two crossings with Miller Creek. The lower crossing is a 5.5 ft diameter squashed corrugated metal pipe (the upper crossing is a bridge and was not surveyed). While there was no drop in water at the outlet of the culvert at these flows, there was a 0.3 ft change in elevation from the outlet of the culvert to the channel bed. The slope of the culvert was measured to be 4.4%. Based off of USFS fish passage evaluation criteria (USFS, 2008), this crossing was rated as "Gray" because the culvert width to bankfull width ratio was less than 0.7 and the residual inlet depth is less than 0.34 ft. Further analysis will have to determine the exact barrier type, but this crossing is likely a velocity barrier to juvenile salmonids at high flows.





Figure 25. The outlet (top photo) and inlet (bottom photo) of the lower culvert on Lost Mine Loop Road.

Singletree Lane

The Singletree Lane crossing consists of two aged double barrel concrete culverts that are 3.5 ft in diameter each. Both culverts are partially plugged with sediment (Figure x) and are clearly undersized as there is an extremely large amount of sediment (~1185 cy) deposited upstream of the crossing, and much more has been deposited downstream. Based off of the size of the sediment plug, this issue appears to have been ongoing for decades. Due to the large amount of sediment deposited downstream of the crossing, the channel has avulsed there, and a portion of the water was flowing into Singletree Lane at the time of survey (July 18, 2018). Although there were sandbags placed in the stream to prevent this from happening, some flow was still escaping into the road and traveling 500 feet along the road before flowing back into Miller Creek. Additionally, upstream of the crossing, during high flows, the stream has formed a side channel that flows over the road, and into the avulsion downstream along the road. Sandbags were also placed around the inlet to prevent erosion of the road fill (Figure x). Based off of USFS fish passage evaluation criteria (USFS, 2008), this crossing was rated as "Gray" because the culvert width to bankfull width ratio was less than 0.7 and there was no resting habitat immediately upstream of the crossing. Further analysis will have to determine the exact barrier type, but this crossing is likely a velocity barrier to juvenile salmonids at high flows.





Figure 26. The outlet (left photo) and inlet (right photo) of the Singletree Lane crossing.

Fish Passage Survey Results Summary

Of the five stream crossings that were surveyed for fish passage, three were rated as Gray (partial) barriers and two were rated as Red (total) barriers to fish passage. All three diversion dams that were surveyed were total fish passage barriers.

Crossing	Fish Jump Height (ft)	Gradient (%)	Fish Passage Barrier Type
Oxbow Diversion - Lower	2.2	4.5	Red (Total)
Oxbow Diversion - Middle	2.7	4.0	Red (Total)
Oxbow Diversion - Upper	3.4	7.0	Red (Total)
Haugan Road	0.0	0.5	Gray (Partial)
Trails End Road - LBK Culvert	2.1	2.5	Red (Total)
Trails End Road - RBK Culvert	2.3	3.7	Red (Total)
Krempel Private Road	0.9	1.2	Red (Total)
Lost Mine Loop Road - Lower	0.3	4.4	Gray (Partial)
Singletree Lane - LBK Culvert	0.0	6.2	Gray (Partial)
Singletree Lane - RBK Culvert	0.0	10.5	Gray (Partial)

Table 21. Fish passage survey results summary.

Stream Temperature Results

	Miller Creek 2018 Temperature Data Summary													
Site	Papah	Seasonal Maximum												
Site	Reach	Date	Value°C	Days> 15 C	Days> 21 C									
Spooner Creek (sites averaged)	Upper	8/12/2018	12.5	0	0									
Wustner (sites averaged)	Middle-upper	7/25/2018	15.1	2	0									
MPG	Middle-upper	7/25/2018	15.8	18	0									
Above Oxbow	Lower	8/10/2018	25.8	82	38									
Below Oxbow	Below Lower	8/10/2018	28.6	85	46									

Table 22: Stream temperature data on the main stem of Miller Creek



Figure 27: Maximum daily temperature recorded on the lower reaches of Miller Creek in summer, 2018.



Figure 28: Maximum daily temperatures recorded on the upper and middle-upper reaches of Miller Creek in summer, 2018.

Streamflow Results



Figure 29: Hydrograph showing daily discharge at a Miller Creek flow monitoring site in the lower reach of the assessment.



Figure 30: Hydrograph showing daily discharge at a Miller Creek flow monitoring site below the lower reach of the assessment.

A synoptic monitoring run was performed on August 22, 2018. The purpose of the synoptic run was to assess baseline flows during low flows, and show the inputs and outputs of the creek from the upper to lower reaches. The following map and table illustrate the flows at the end of August.



Figure 31: Map of Miller Creek synoptic flow run, August 2018.

Miller Creek Synoptic Run August 22, 2018									
Site	Discharge								
Spooner Creek Ranch Above Spooner Creek	4.6								
Spooner Creek Ranch Below Spooner Creek	4.5								
Below Little Park Creek	6.5								
County Property Above Lost Mine Loop	3.4								
Above Oxbow	1.7								
Below Oxbow	0.5								

Table 23: Flows taken at during the August 22, 2018 synoptic run. See Figure X for map of sites.

Discussion and Restoration Recommendations

As this report was a 'first look' at the Miller Creek watershed more in depth data will needed to be collected as projects are developed. It is important to note that 2018 was considered a good water year, due to above average snowpack in winter 2017/2018. As such, flows could be considered to be higher than normal, and based on anecdotal local knowledge of the stream, the lower reaches of Miller Creek dried up later than normal during 2018.

In 2018, temperatures on the upper reaches of Miller Creek are sufficient to sustain trout species throughout the summer, while the lower reaches surpassed the lethal temperature for most trout by mid-July. The chart below shows optimum growth and lethal temperature for Montana trout species.

Species	Optimum Growth Temperature (°C)	Upper Incipient Lethal Temperature °C)
Rainbow Trout	13.1	24.3
Brown Trout	16.9	24.7
Brook trout	14.0	24.5
Cutthroat Trout	13.6	19.6
Bull Trout	13.2	20.9

Table 24: Optimum growth and lethal tempertures for Montana trout species. The data for this table was pulled from the Clark Fork Coalition April blog post, Some like it Hot, Trout do not. Link: https://clarkfork.org/4481-2/

Based off of the 28% of the stream length that was surveyed for this report, it is Clark Fork Coalition's recommendations that restoration actions in Miller Creek are prioritized as follows:

- 1. Based on data collected the upper and middle upper reaches contain the highest quality habitat with good base flows and water temperatures for salmonids. It is our recommendation to prioritize projects that reduce sediment and enhance fish habitat in these reaches.
- 2. Protect present pure-strain cutthroat populations in the tributaries of Miller Creek. More data is needed on these populations.
- 3. Repair all "Red" fish passage barriers and secondly "Gray" fish passage barriers to ensure migration for all life stages of fish at all times.
- 4. Address connectivity issues (dewatering/ multi-thread channels/large sediment deposits) in the lower watershed to ensure the maximum amount of migration for all life stages as much as possible (environmental limits apply).
- 5. Address channel incision/ sediment issues throughout the watershed to reconnect the floodplain and improve stream temperatures and instream habitat quality and quantity.
- 6. Address fish entrainment issues in the lower watershed.
- 7. Improve riparian health by reconnecting the floodplain via the implementation of beaver dam mimicry projects, revegetation, and riparian fencing to reduce the impacts of grazing. Improving riparian health could help combat some of the temperature issues seen on the lower reaches of creek.

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Reach	Date	Observers	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Q1	Q2	Q3	Q4	QS	Q6	Q7	Q8	ർ	Q10	Total Score	NRCS Score
NWE_1	6/12/2018	WM, FC, JW	g	0.93	12.5	13.5	Cobble	2.0	2	ĸ	3	2	0	0	0	0	4	0	14	%82
NWE_2	6/12/2018	WM, FC, JW	9	0.88	14	15.9	Cobble	2.0	2	£	8	2	0	0	0	0	4	0	14	%82
Stillwater_1	6/22/2018	TP, FC	В	0.95	10.7	11.26	Cobble	1.5	5	5	3	1	0	0	0	0	2	0	16	27%
Capon_1	6/22/2018	TP, FC	B	1.03	11.2	10.87	Cobble	1.0	κ	9	3	2	0	1	0	0	1	0	16	27%
Singletree_1	8/3/2018	TP, FC	9	1.2	9.8	8.2	Gravel	2.0	0	0	2	0	0	2	0	0	7	0	8	13%
Singletree_2	8/3/2018	TP, FC	С	0.65	10	15.4	Gravel	1.5	2	З	4	9	4	2	0	5	4	4	34	57%
Singletree_3	8/3/2018	TP, FC	С	0.9	13.1	14.6	Gravel	1.5	8	ß	2	4	9	2	0	5	4	9	42	%02
Wustner_1	6/20/2018	TP, FC	J	0.85	19.6	23.1	Cobble	1.0	2	2	2	ß	1	2	2	ß	1	0	20	33%

Appendix 1: Habitat Assessment Summary Data

Reach	Date	Observers	Rosgen Channel Type	BFD (ft)	BFW (ft)	W/D (ft)	Substrate	Slope (%)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	മ	Q10	Total Score	NRCS Score
DNRC_1	6/18/2018	TP,FC	IJ	1.275	23.1	18.1	Gravel	2.0	m	0	9	9	9	2	m	7	m	1	37	62%
DNRC_2	6/18/2018	TP,FC	U	1.1	15	13.6	Gravel	1.0	2	1	2	9	9	2	m	œ	4	4	38	63%
DNRC_3	6/12/2018	TP,FC	в	1.05	11.9	11.3	Gravel	1.5	9	Ŋ	9	9	9	2	2	œ	4	∞	53	88%
MPG_1	6/19/2018	TP,FC	U	0.93	12.4	13.3	Gravel	1.5	9	m	Ŋ	9	9	2	m	œ	4	4	47	78%
MPG_2	6/19/2018	TP,FC	U	1.05	12.5	11.9	Gravel	0.5	7	9	Ŋ	4	1	2	m	9	4	7	45	75%
Spooner_1	6/19/2018	TP,FC	U	1.4	8.6	6.14	Gravel	0.5	2	m	m	5	1	2	m	œ	4	1	32	53%
USFS_1	6/20/2018	TP,FC	U	0.95	8.5	8.95	Gravel	0.8	9	Ū	œ	3	9	2	œ	4	4	4	40	67%
USFS_2	6/20/2018	TP,FC	DA to D	N/A	N/A	N/A	Gravel	1	4	0	1	2	9	2	m	9	4	∞	36	60%
USFS_3	6/20/2028	TP,FC	IJ	1.12	7.1	6.3	Gravel	0.5	1	Ŋ	2	2	2	ε	ε	9	4	0	28	47%

Appendix 2: USFS Fish Passage Survey Results



Figure x. Fish passage survey results for all USFS stream crossings in the Miller Creek watershed (red = total barrier, green = no barrier).