Prairie Stream Surveys on BLM Public Lands in Eastern Montana 2015 Surveys

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Cover photo: Cherry Creek R2, Prairie County, Montana. June 9, 2015.

Introduction

Prairie streams are an endangered yet valuable resource in the Northern Great Plains Eco-region (Samson and Knopf 1994). Previous studies on prairie streams in the Northern Great Plains have shown that prairie stream systems are very unpredictable, constantly changing from drying to flooding stages between seasons, sometimes even in a matter of days (Matthews 1988, Ostovar 2007), and shown the need for multiple spatial and temporal sampling to occur along each stream for an adequate understanding of prairie stream assemblages (Ostovar 2007). An inventory effort to survey all prairie streams intersecting Bureau of Land Management (BLM) administered public lands in eastern Montana and western North and South Dakota occurred from 2009 to 2012. Linear geographical information of streams dissecting less than a mile of BLM lands was collected using a Trimble GPS unit and permanent benchmarks were installed along prairie streams that dissected one mile or more of BLM lands to allow for future monitoring to take place at the exact same location in hopes of gaining a better understanding of the distribution and abundance of fishes that inhabit these prairie streams. The goal for prairie streams with permanent benchmarks is to establish a plan which aims to monitor these streams every five years or in combination with any land use planning. Three primary streams (Pumpkin, Cedar, and Cherry Creek) intersect large contiguous pieces of BLM lands and have been monitored annually or bi-annually since 2010 (Chaffin 2011 a, b, Stuart and Chaffin 2013 a, b). Pumpkin Creek intersects nine miles of BLM lands and has four sampling reaches along the nine mile stretch of BLM with benchmarks that were installed in 2010. Cedar Creek intersects 19 miles of BLM lands and has six sampling reaches, four of which have benchmarks that were installed in 2010. Cherry Creek intersects three and a half miles of BLM lands and has three sampling reaches with benchmarks that were set up between 2009 and 2010.

Methods

Site Selection

In 2015 all Pumpkin, Cedar, and Cherry Creek sites were sampled twice (spring and fall) to continue monitoring efforts along these primary streams. There are 13 sampling reaches total on the three primary creeks, with four at Pumpkin Creek, six at Cedar Creek and three at Cherry Creek. In 2015 sites were selected by reviewing all projects occurring within the Miles City Field Office (MCFO) that overlapped with locations of sampling reaches with permanent benchmarks. The review of projects turned up one restoration project and two grazing allotment reviews that overlapped with sampling reaches set up with permanent benchmarks. Lone Tree Creek has two sampling reaches, R2 and R3, which were set up with permanent benchmarks in 2011 (Chaffin 2011 b). Blackfoot reservoir, just upstream of Lone Tree Creek R3, was removed in 2013 and a stream rehabilitation project was begun (Stuart and Chaffin 2013 a, b). Lone Tree Creek R2 and R3 were surveyed in 2015 to monitor stream morphology and species composition through the restoration process. Pennel Creek R1 was set up with permanent benchmarks in 2010 and is located on a grazing allotment which was being reviewed for renewal in 2015. Pennel Creek R1 was sampled in 2015 to monitor fish, habitat, and geomorphology data along with grazing habits on that allotment.

Fish and Habitat Surveys

This work followed an Index of Biological Integrity (IBI) protocol developed by Bramblett et al. (2005) with specific field methodology outlined in Bramblett (2003). Block nets were positioned at the upstream and downstream ends of the 300 m sample reach, except when natural barriers like dry channels or shallow riffles were present, to prevent fish movement outside the sample area. An appropriate sized seine net, based on the stream width to be sampled, was used to seine the sampling reach moving downstream. Fish were collected at appropriate intervals and held in five gallon buckets. Next fish were anesthetized, identified to the species taxonomic level using Holton and Johnson (2003) and taxonomic keys (Professor Bob Bramblett, MSU,

unpublished data), enumerated, and released. A subsample of 20 individuals per species was measured (TL) to the nearest millimeter.

Habitat data were collected following Bramblett (2003). Eleven individually labeled pin flags were placed every 30 m along the 300 m sampling reach. Each flag location was a transect site where bank-full width, wetted width, depth, and substrate size (measured with a gravelometer) were recorded. Depth and substrate were recorded at five locations (left bank, left center, center, right center, right bank) at each transect within the wetted width. A thalweg profile was recorded by measuring ten thalweg (deepest part of channel) depths evenly spaced between each transect. At each thalweg depth measurement, substrate type (fine gravel, sand, course gravel, etc.) was also recorded.

Water quality parameters collected at each sampling site included dissolved oxygen content (percent saturation and mg/L or ppm), conductivity (µS/cm), and water temperature (˚C) recorded with an YSI Model Pro 2030 water quality meter (YSI Inc. Yellow Spring, OH), pH recorded with an Extech meter (Extech Instruments, Waltham MA), and air temperature (°F) was recorded with a handheld thermister.

Within the 300 m sampling reach we recorded qualitative observations such as riparian vegetation; native and exotic trees, shrubs, and grasses; evidence of land-use activities and anthropogenic influences; and wildlife observations to help assess stream condition. We also recorded percent of habitat type (run, riffle, pool, dry channel, backwaters, secondary channels, etc.), percent of vegetation consumed by livestock, percent of sample reach covered by vegetation, occurrence of large woody debris in the stream and stream bank condition (incisement, floodplain development, active down-cutting).

Stream Cross Sections

All sites sampled in 2015 had permanent benchmarks installed during the inventory effort that took place between 2009 and 2012 (Chaffin 2011 a, b, Stuart and Chaffin 2013 a) except for Cedar Creek R1 and R2a. Benchmarks (rebar or fence posts) were installed outside the perceived flood-prone boundary on either side of the stream at the beginning, middle, and end of the 300 m sampling reach (0, 150, and 300 meters) (Figure 1). An electronic data monitor or Total Station (Sokkia Co. Ltd) was used to survey elevation changes between benchmarks. Measurements were taken at two to ten foot intervals between the benchmarks and at one foot intervals within the wetted width. Two digital photos were taken at each cross-section standing in the middle of the stream, one looking up and the other down-stream so that photo-point surveys, alongside cross-section data, can be compared with future monitoring.

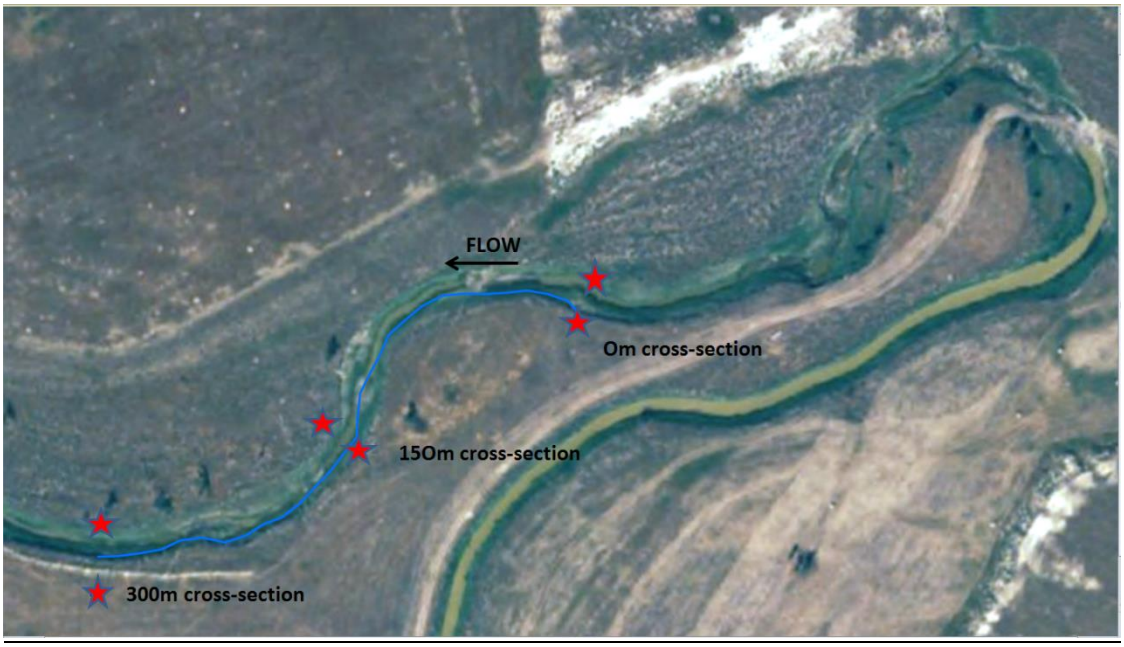

Figure 1. Aerial image of Pumpkin Creek R1. Red stars indicate permanent benchmarks (rebar for 0 and 300m, fencepost for 150m cross-section) installed on either side of the channel for each of three cross-sections. The blue line indicates the 300m sampling reach where fish and habitat surveys were conducted.

Database & Data Analysis

A database specific to this project was built in 2010 and continues to be upgraded. The database will allow easy extraction of data for resource managers within the BLM. The data will also be used to generate reports and can be shared with other agencies or researchers. The data will also be linked to GIS/GPS data so that everything is spatially explicit. Additionally, raw fish data will be sent to state agencies through requirements of their scientific collectors permit.

IBI scores were calculated following Bramblett et al. (2005). Watershed area calculations were conducted in GIS using ArcMap (ESRI, 2009) with Arc Hydro (ESRI, 2009) tools. Digital elevation models (DEM) were of 10 m resolution from USGS NED (National Elevation Dataset, accessed December 2012).

Results

Sites

In 2015 a total of 16 sampling reaches were re-visited to continue monitoring efforts on BLM administered public lands. Of the 16 sites, 15 were re-sampled for fish and habitat data. Lone Tree Creek R2 was dry at the time of the site visit, therefore no fish sampling occurred or habitat data were recorded, only benchmarks were re-surveyed at Lone Tree Creek R2. Of the 15 sites re-sampled, all the primary sites were sampled twice, once in the spring and once in the fall (Table 1). Pennel Creek R1 and Lone Tree Creek R3 were sampled once, mid-summer. Total number of sites sampled in 2015 was 15 with 28 sampling events (13 primary sites sampled twice). The sites, dates, type of sampling conducted, stream reach length, watershed area, and IBI scores are listed in Table 1.

Table 1. Streams visited in 2015, arranged alphabetically by Hydrologic Unit Code (HUC) name then by stream name. F=fish bearing, N=non-fish bearing; 1= Stream walked and inventoried along BLM public lands, 2=IBI Fish and Habitat Protocol, 3=Surveyed cross sections with benchmarks. Miles of stream refers to the stream length occurring on BLM public lands. Watershed area refers to all contributing land above the bottom point of the sampling reach. IBI scores calculated according to Bramblett et al. (2005) range from a 0-100 scale, 100 being of highest biological integrity.

Field Office	HUC Name Stream Reach	Date	Fish Present	Survey Type (1,2,3)	Miles of stream	Watershed Area (ha)	IBI Score
MCFO	**Box Elder Creek (Little Missouri River)**						
	Lone Tree Creek R2	7/14/2015	N	1,3*	0.86	3,033	N/A
	Lone Tree Creek R3	7/13/2015	F	1,2,3	0.85	2,841	67
	Lower Tongue						
	Pumpkin Creek R1	6/17/2015	F	1,2,3	0.81	179,019	56
	Pumpkin Creek R1	9/2/2015	F	1,2		179,019	59
	Pumpkin Creek R2	6/8/2015	F	1,2,3	3.2	178,434	56
	Pumpkin Creek R2	9/9/2015	F	1,2		178,434	45
	Pumpkin Creek R3	6/8/2015	F	1,2,3	2.58	165,910	50
	Pumpkin Creek R3	9/8/2015	F	1,2		165,910	44
	Pumpkin Creek R4	5/22/2015	F	1,2,3	1.57	164,040	48
	Pumpkin Creek R4	9/9/2015	F	1,2		164,040	51
	Lower Yellowstone						
	Cedar Creek R1	7/1/2015	F	1,2	0.33	54,473	48
	Cedar Creek R1	8/31/2015	F	1,2		54,473	59
	Cedar Creek R2	6/18/2015	F	1,2,3	2.37	45,488	69
	Cedar Creek R2	9/1/2015	F	1,2		45,488	66
	Cedar Creek R2a	6/16/2015	F	1,2	0.55	44,455	58
	Cedar Creek R2a	9/1/2015	F	1,2		44,455	57
	Cedar Creek R3	6/16/2015	F	1,2,3	4.38	42,807	58
	Cedar Creek R3	8/27/2015	F	1,2		42,807	60
	Cedar Creek R4	5/26/2015	F	1,2,3	9.9	41,471	64
	Cedar Creek R4	8/26/2015	F	1,2		41,471	54
	Cedar Creek R5	6/30/2015	F	1,2,3	1.06	30,279	61
	Cedar Creek R5	8/25/2015	F	1,2		30,279	58
	Cherry Creek R1a	6/3/2015	F	1,2,3	0.76	58,674	70
	Cherry Creek R1a	9/15/2015	F	1,2		58,674	62
	Cherry Creek R1b	5/14/2015	F	1,2,3	1.26	58,503	64
	Cherry Creek R1b	9/15/2015	F	1,2		58,503	53
	Cherry Creek R2	6/9/2015	F	1,2,3	1.51	56,579	58

Field Office	HUC Name Stream Reach	Date	Fish Present	Survey Type (1,2,3)	Miles of stream	Watershed Area (ha)	IBI Score
	Cherry Creek R2	9/14/2015	F	1,2		56,579	66
	O'Fallon Creek						
	Pennel Creek R1	8/3/2015	F	1,2,3	1.11	50,088	55

* Only surveyed cross section, no water present so no IBI calculated.

Fish and Habitat Surveys

A total of 13,248 fish were sampled in 2015, making up seven families and 23 individual species. The catch was dominated by native fish (90%) with 11,951 native individuals and 1,297 exotic individuals. The percent of native species recorded at all sampled sites ranged from 50% (Lone Tree Creek R3) to 90% (Cherry Creek R1a fall) (Table 2). The most abundant species sampled was the sand shiner, a native species, with 3,874 individuals sampled. The most abundant exotic species observed was the plains killifish, with 805 individuals (Table 3). The fathead minnow, a native species, was the most widely distributed species observed. The fathead minnow was found at all sampling sites (n=15), but was not observed during spring sampling events at Pumpkin Creek R2 and Cherry Creek R1b. The most widely distributed exotic species were the plains killifish and common car, occurring at 12 of the 15 sampling sites (Table 4). The number of species recorded at a site ranged from 2 (Lone Tree Creek R3) to 15 (Pumpkin Creek R1 (fall), Cedar Creek R2 (fall), and Cherry Creek R1a(spring)), while the number of individuals recorded at a site ranged from 15 to 1,777 (Pumpkin Creek R3 (spring) and Cedar Creek R4 (spring) respectively). The highest native species richness, 12, was recorded at Cherry Creek R1a and highest exotic species richness, 4, was recorded at five different sampling sites (Table 2). Appendix A has the species richness and total fish caught at each site, while Appendix B has the species count at each site for the different sampling events.

All sampled sites (n=28) had a mean wetted width of 6.7 m and an average center depth of 39.4 cm. All sampled sites had flowing water except for Cherry Creek R1a and R1b during fall samples (interrupted standing pools of water) and Lone Tree Creek R3 (continuous standing water). General habitat and water quality characteristics are presented in Appendix C and D.

Table 2. Species richness and total number of individual fish (separated out by natives and exotics) caught at each site in 2015, arranged alphabetically by HUC name then by stream name.

			Species Richness		Total Individuals	
Field Office	**HUC &** Stream Name	**Date**	**Native**	**Exotic**	**Native**	**Exotic**
MCFO	**Box Elder Creek (Little Missouri River)**					
	Lone Tree Creek R3	7/13/2015	1	1	16	2
	Lower Tongue					
	Pumpkin Creek R1	6/17/2015	10	4	558	47
	Pumpkin Creek R1	9/2/2015	11	4	271	49
	Pumpkin Creek R2	6/8/2015	3	2	25	3
	Pumpkin Creek R2	9/9/2015	4	3	37	17
	Pumpkin Creek R3	6/8/2015	3	1	13	2
	Pumpkin Creek R3	9/8/2015	5	4	56	124
	Pumpkin Creek R4	5/22/2015	6	4	418	57
	Pumpkin Creek R4	9/9/2015	8	3	213	43
	Lower Yellowstone					
	Cedar Creek R1	7/1/2015	5	1	1173	1
	Cedar Creek R1	8/31/2015	8	2	231	9
	Cedar Creek R2	6/18/2015	11	2	872	53
	Cedar Creek R2	9/2/2015	11	4	967	26
	Cedar Creek R2a	6/16/2015	7	2	354	32
	Cedar Creek R2a	9/1/2015	8	1	213	58
	Cedar Creek R3	6/16/2015	7	3	674	47
	Cedar Creek R3	8/27/2015	8	3	879	34
	Cedar Creek R4	5/26/2015	9	2	1590	187
	Cedar Creek R4	8/26/2015	6	1	529	156
	Cedar Creek R5	6/29/2015	8	3	340	10
	Cedar Creek R5	8/22/2015	7	2	588	12
	Cherry Creek R1a	6/3/2015	12	3	251	17
	Cherry Creek R1a	9/15/2015	9	1	344	29
	Cherry Creek R1b	5/14/2015	8	1	62	4
	Cherry Creek R1b	9/15/2015	5	1	161	50
	Cherry Creek R2	6/9/2015	7	1	155	2
	Cherry Creek R2	9/14/2015	10	4	451	34
	O'Fallon Creek					
	Pennel Creek R1	8/3/2015	5	3	510	192

Table 3. Individual species count and origin arranged alphabetically by common species name.

Species	Native (n) or Exotic (e)	Count	% of Total Count
Bigmouth buffalo	n	2	0.02%
Black bullhead	e	165	1.25%
Brassie minnow	n	19	0.14%
Brook Stickleback	n	2	0.02%
Channel catfish	n	100	0.75%
Common carp	e	230	1.74%
Creek chub	n	747	5.64%
Emerald shiner	n	5	0.04%
Fathead minnow	n	2,659	20.07%
Flathead chub	n	1,211	9.14%
Goldeye	n	1	0.01%
Green sunfish	e	97	0.73%
Lake chub	n	39	0.29%
Longnose dace	n	167	1.26%
Longnose sucker	n	6	0.05%
Plains killifish	e	805	6.08%
Plains minnow	n	1,696	12.80%
River carpsucker	n	71	0.54%
Sand shiner	n	3,874	29.24%
Shorthead redhorse	n	10	0.08%
Stonecat	n	8	0.06%
Western silvery minnow	n	1,197	9.04%
White sucker	n	137	1.03%
Total	**e = 4 n = 19 Total = 23**	**13,248**	**100%**

Table 4. Number of sampled sites and sampling events (13 sampled twice) each species were observed at, along with the number of individuals recorded for each species, arranged alphabetically by common species name. Asterisk (*) indicates an exotic species.

Species	Count	# of sampling events spp observed in	# of sites spp observed at
Bigmouth buffalo	2	1	2
Black bullhead*	165	15	9
Brassie minnow	19	3	3
Brook Stickleback	2	2	1
Channel catfish	100	12	7
Common carp*	230	15	12
Creek chub	747	17	9
Emerald shiner	5	1	1
Fathead minnow	2,659	26	15
Flathead chub	1,211	20	11
Goldeye	1	1	1
Green sunfish*	97	14	9
Lake chub	39	2	1
Longnose dace	167	20	11
Longnose sucker	6	6	4
Plains killifish*	805	22	12
Plains minnow	1,696	21	11
River carpsucker	71	6	4
Sand shiner	3,874	27	14
Shorthead redhorse	10	5	4
Stonecat	8	5	4
Western silvery minnow	1,197	15	10
White sucker	137	12	9
Total	**13,248**	**n = 28**	**n=15**

Stream Cross Sections

Of the 16 sites re-visited in 2015, 14 had permanent benchmarks installed between 2009 and 2012. All cross sections were re-surveyed in 2015. We found the cross section data to be very similar to previous data for most sites. There were a couple sites that did show some erosion or deposition. For example, from the cross section data at Lone Tree Creek R3 300m you can see where some erosion has occurred on the left bank since 2014 (Figure 2).

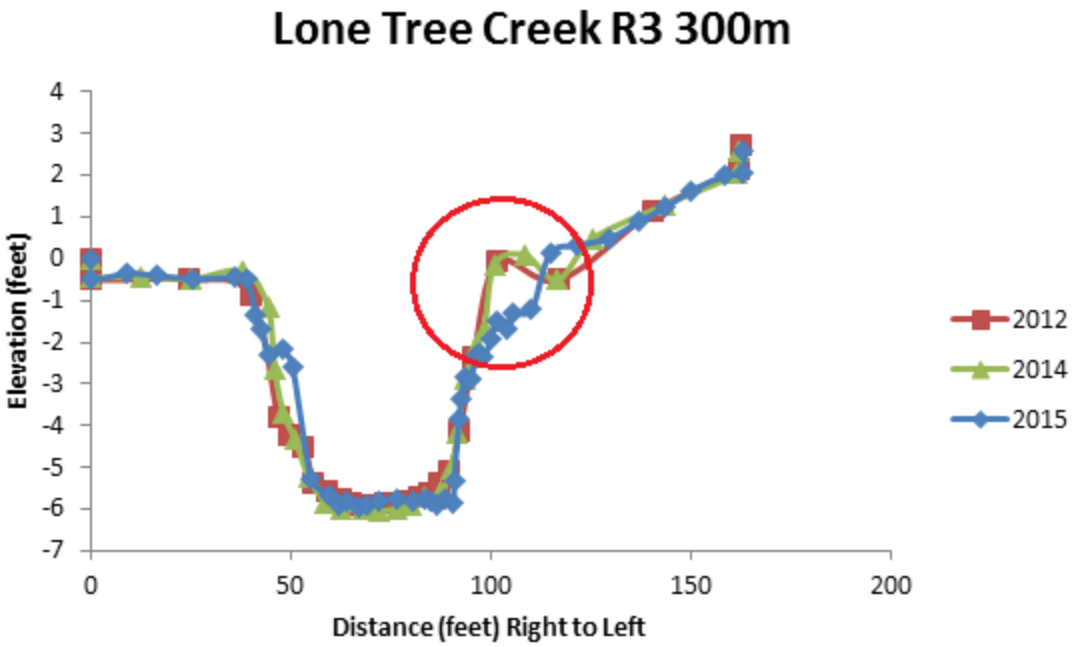

Figure 2. Cross section data from 2012 to 2015 of Lone Tree Creek R3 300m. From the graph you can see some erosion on the left bank (red circle) that has occurred since 2014.

Discussion

All primary sites were re-sampled, including surveying benchmarks, once in the spring and once in the fall of 2015 to continue monitoring efforts to gain a better understanding of the distribution and abundance of fishes that inhabit prairie streams on BLM administered public lands.

Overall, IBI scores for primary sites were consistent with previous years with an average of 57 out of 100 for 2015 (Table 5). Since 2010, IBI scores have averaged anywhere from 52 to 57 (Table 5). At the time of this report a detailed analysis of IBI scores has not been performed. Some variables that might explain patterns in aquatic wildlife and their habitat include grazing history, other various land-use impacts (e.g. oil and gas development), number or percent of reservoirs/ water pits blocking the natural flow regime in a watershed, roads and particularly non fish-passable culverts, and climate change. A more detailed statistical analysis may help elucidate driver variables affecting stream bio-integrity and presence or absence of species.

Table 5. IBI scores for Pumpkin, Cedar, and Cherry Creeks from 2010 to 2015, arranged alphabetically by HUC name then by stream name. Asterisk (*) indicates sampling reaches that were not sampled during that year or season, N/A indicates sampling occurred but no IBI calculated due to no catch.

Field Office	HUC Name Stream Reach	2010 spring	2010 fall	2011 Summer	2011 Fall	2012 Spring	2012 Fall	2013	2014 Spring	2014 Fall	2015 Spring	2015 Fall
MCFO	**Lower Tongue**											
	Pumpkin Creek R1	59	47	58	40	60	56	49	45	55	56	59
	Pumpkin Creek R2	49	47	49	50	56	53	47	56	54	56	45
	Pumpkin Creek R3	45	42	48	52	50	56	45	52	48	50	44
	Pumpkin Creek R4	51	43	50	53	53	58	57	54	49	48	51
	Lower Yellowstone											
	Cedar Creek R1	**	51	**	59	58	54	60	53	54	48	59
	Cedar Creek R2	67	62	**	65	63	57	N/A	69	65	69	66
	Cedar Creek R2a	54	63	**	65	66	56	62	61	55	58	57
	Cedar Creek R3	52	55	**	60	63	55	66	58	55	58	60
	Cedar Creek R4	55	55	**	56	51	53	54	58	59	64	54
	Cedar Creek R5	56	**	**	57	61	55	56	**	59	61	58
	Cherry Creek R1a	52	53	56	61	53	63	50	56	63	70	62
	Cherry Creek R1b	48	46	57	63	58	62	62	59	55	64	53
	Cherry Creek R2	**	60	**	60	59	62	69	59	66	58	66

Lone Tree Creek R2 and R3 were re-visited in July to continue monitoring efforts alongside a stream rehabilitation and bank stabilization project. Lone Tree Creek was first inventoried in 2011 and was found to be fish-bearing but with habitat fragmentation, due to multiple reservoirs, credibly obstructing fishes from migrating up and down stream (Chaffin 2011 b). The BLM began planning to remove the Blackfoot reservoir, just upstream of Lone Tree Creek R3, and for stream restoration in 2011 (Chaffin 2011 b), which were completed over the summer of 2013. Lone Tree Creek R3 and R2 were sampled and cross sections surveyed in 2015 to continue monitoring species composition and stream morphology through the restoration process.

Lone Tree Creek R2 has always been dry or non-fish bearing (some water present but less than one foot deep) in the past (2011 and 2014) during site visits therefore sampling for fish has not occurred at R2. What once was a dry, bare stream bed in 2012 (Figure 4a) was found to be lush and green with an abundance of cattails, prairie cordgrass, and soft stem bulrush in 2014 and once again in 2015 (Figure 4b). Standing water was present throughout the cattails, about a foot deep, and we did not visually observe any fish therefore sampling for fish did not occur. With the presence of various obligate wetland species with high stability rooting strength the R2 area may begin to hold additional water and develop a more stable steam bank. Future monitoring of the area will provide valuable data showing temporal changes in stream type, either positive or negative.

Cross section data recorded from R2 and R3 were similar to cross sections from 2012 and 2014, showing only minor deposition and erosional changes. Species composition data from Lone Tree Creek R3 were similar to that of previous samples, in terms of number of species observed, but the individual count was lower than in previous years (Table 6). In 2015, fathead minnows made up 88% of the total catch (Table 6), but were absent from samples in 2014 (Stuart 2014). Green sunfish, an exotic species, were observed in sampling events in 2012 and 2014, but were not found in the R3 area in 2015 (Table6). Given the extent of habitat fragmentation in the area, these data raise questions about the presence, or lack, of species. Have all three species (black bullhead, green sunfish, and fathead minnow) always been present yet some entirely missed during sampling events, denoting a sample not representative of the entire R3 area? Are fathead minnows being outcompeted by non-native species? Future data collection and monitoring of the Lone Tree Creek area should help answer these and other questions.

(a)

(b)

Figure 4. Lone Tree Creek R2 150m looking upstream in 2012 (a) and 2015 (b).

Table 6. Species and number of individuals of each species recorded as well as IBI scores for Lone Tree Creek R3 in 2011, 2012, 2014, and 2015.

	Lone Tree Creek R3		
Date	**Species**	**Individuals**	**IBI**
6/16/2011	Black Bullhead	8	58
	Fathead Minnow	43	
7/30/2012	Black Bullhead	390	67
	Fathead Minnow	1030	
	Green Sunfish	1904	
7/16/2014	Green Sunfish	2	65
	Black Bullhead	53	
7/13/2015	Black Bullhead	2	67
	Fathead Minnow	16	

Pennel Creek R1 was re-sampled and surveyed in 2015 to begin monitoring stream morphology as well as species composition along with grazing habits. The IBI score at Pennel Creek R1 went up by 2, from 53 in 2010 to 55 in 2015. Seven species were recorded in 2010 and eight species in 2015. One species present in 2010 (western silvery minnow) was not observed in 2015, thus there were two new species (sand shiner and green sunfish) observed in 2015. The number of exotic individuals increased from 48 found in 2010 to 192 found in 2015. The total number of individuals decreased considerably from 2010 to 2015 (Table 7). With only two years of data for Pennel Creek R1 there is not enough data to draw any conclusions or show any trends between land management activities, in this case grazing, and the integrity of prairie streams. The cross section data recorded for Pennel Creek R1 in 2015 compared to 2010 data do not show any major changes in stream morphology. However, as previously stated two years of data is inadequate to show trends and would be rash to draw any conclusions at this time. A detailed analysis of the stream morphology would be improved with multiple years of data. Consistent survey work (e.g. every 2-5 years) at our cross section locations would allow for observations in the amount of erosion and deposition at each cross section, providing an important understanding of physical processes and the effects of land-use through time in prairie streams.

Table 7. Species and number of individuals of each species recorded at Pennel Creek R1 in 2010 and 2015. Species with an asterisk (*) are exotic species.

Pennel Creek R1

2010		**2015**	
Species	**Individuals**	**Species**	**Individuals**
Brassy Minnow	18	Brassy Minnow	16
Creek Chub	55	Creek Chub	179
Fathead Minnow	2,161	Fathead Minnow	153
Western Silvery Minnow	76	Sand Shiner	85
White Sucker	30	White Sucker	77
Common Carp*	2	Common Carp*	187
Black Bullhead*	46	Black Bullhead*	4
		Green Sunfish*	1
Total Individuals:	**2,388**	**Total Individuals:**	**702**
IBI:	**53**	**IBI:**	**55**

Acknowledgments

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Literature cited

Bramblett, R.G. 2003. Fish and habitat sampling protocol for prairie streams. MT Cooperative Fisheries Research Unit Report. Montana State University, Bozeman, MT.

Bramblett, R.G., Johnson, T.R., Zale, A.V., & Heggem, D.G. 2005. Development and evaluation of a fish assemblage index of biotic integrity for Northwestern Great Plains streams. *Transactions of the American Fisheries Society*, 134:624-640.

Chaffin, J. 2011a. Prairie Stream Surveys on BLM Public Lands in Eastern Montana and North Dakota: 2010. Bureau of Land Management. Miles City, MT.

Chaffin, J. 2011b. Prairie Stream Surveys on BLM Public Lands in Eastern Montana and South Dakota 2011 Surveys. Bureau of Land Management, Miles City, MT.

Holton, G.D. and Johnson, H.E. 2003. A field guide to Montana fishes. 3rd edition. Montana Fish, Wildlife, and Parks, Helena, MT.

Matthews, W. J. 1988. North American prairie streams as systems for ecological study. *Journal of the North American Benthological Society* 7:387-409.

Ostovar, K. 2007. Montana Fish, Wildlife, and Parks Project Performance Report. Regions 4-7. Montana Fish, Wildlife, and Parks. Billings, MT.

Samson, F. and Knopf, F. 1994. Prairie conservation in North America. *BioScience* 44: 418-421.

Stuart, C. and Chaffin, J. 2013a. Prairie Stream Surveys on BLM Public Lands in Eastern Montana and South Dakota 2012 Surveys. Bureau of Land Management, Miles City, MT.

Stuart, C. and Chaffin, J. 2013b. Prairie Stream Surveys on BLM Public Lands in Eastern Montana 2013 Surveys. Bureau of Land Management, Miles City, MT.

Stuart, C. 2014. Prairie Stream Surveys on BLM Public Lands in Eastern Montana 2014 Surveys. Bureau of Land Management. Miles City, MT.

Appendix A. Species richness and total number of individual fish caught at each site in 2015, arranged alphabetically by HUC name then by stream name.

Field Office	HUC & Stream Name	Date	Species Richness	Total Individuals
MCFO	**Box Elder Creek (Little Missouri River)**			
	Lone Tree Creek R3	7/13/2015	2	18
	Lower Tongue			
	Pumpkin Creek R1	6/17/2015	14	605
	Pumpkin Creek R1	9/2/2015	15	320
	Pumpkin Creek R2	6/8/2015	5	28
	Pumpkin Creek R2	9/9/2015	7	54
	Pumpkin Creek R3	6/8/2015	4	15
	Pumpkin Creek R3	9/8/2015	9	180
	Pumpkin Creek R4	5/22/2015	10	475
	Pumpkin Creek R4	9/9/2015	11	256
	Lower Yellowstone			
	Cedar Creek R1	7/1/2015	6	1174
	Cedar Creek R1	8/31/2015	10	240
	Cedar Creek R2	6/18/2015	13	925
	Cedar Creek R2	9/2/2015	15	993
	Cedar Creek R2a	6/16/2015	9	386
	Cedar Creek R2a	9/1/2015	9	271
	Cedar Creek R3	6/16/2015	10	721
	Cedar Creek R3	8/27/2015	11	913
	Cedar Creek R4	5/26/2015	11	1777
	Cedar Creek R4	8/26/2015	7	685
	Cedar Creek R5	6/29/2015	11	350
	Cedar Creek R5	8/22/2015	9	600
	Cherry Creek R1a	6/3/2015	15	268
	Cherry Creek R1a	9/15/2015	10	373
	Cherry Creek R1b	5/14/2015	9	66
	Cherry Creek R1b	9/15/2015	6	211
	Cherry Creek R2	6/9/2015	8	157
	Cherry Creek R2	9/14/2015	14	485
	O'Fallon Creek			
	Pennel Creek R1	8/3/2015	8	702

Appendix B. Number of individuals per species caught at individual sites in 2015, arranged alphabetically by HUC name then by stream name. Month and day sampled in parentheses after stream name. Numbers arranged longitudinally (e.g. 305 sand shiners caught at Pumpkin Creek R1 6/17).

Sampling Reach (Date)	Bigmouth buffalo	Black bullhead	Brassie minnow	Brook Stickleback	Channel catfish	Common carp	Creek chub	Emerald shiner	Fathead minnow	Flathead chub	Goldeye	Green sunfish	Lake chub	Longnose dace	Longnose sucker	Plains killifish	Plains minnow	River carpsucker	Sand shiner	Shorthead redhorse	Stonecat	Western silvery minnow	White sucker
MCFO																							
Box Elder																							
Lone Tree Creek R3 (7/13)		2							16														
Lower Tongue																							
Pumpkin Creek R1 (6/17)		1			14	4			187	18		12		2		30	8	8	305	5	1	10	
Pumpkin Creek R1 (9/2)		16	1		26	16			59	4		11		1		6	24	1	147		1	4	3
Pumpkin Creek R2 (6/8)		1			7							2							17			1	
Pumpkin Creek R2 (9/9)		10			19	3			4			4							13	1			
Pumpkin Creek R3 (6/8)		2			5				2										6				
Pumpkin Creek R3 (9/8)		104			4	5			22	1		14				1			27				2
Pumpkin Creek R4 (5/22)		2				1			63	13		15		17	1	39	1		323				
Pumpkin Creek R4 (9/9)		5			9				36	3	1	24		3		14	1		157				3
Lower Yellowstone																							
Cedar Creek R1 (7/1)									2	54						1	2		30			1085	
Cedar Creek R1 (8/31)					2	1			3	82				2		8	86	39	13			4	
Cedar Creek R2 (6/18)					11	2	1		75	243				23		51	133	15	321	1		48	1

Sampling Reach (Date)	Bigmouth buffalo	Black bullhead	Brassie minnow	Brook Stickleback	Channel catfish	Common carp	Creek chub	Emerald shiner	Fathead minnow	Flathead chub	Goldeye	Green sunfish	Lake chub	Longnose dace	Longnose sucker	Plains killifish	Plains minnow	River carpsucker	Sand shiner	Shorthead redhorse	Stonecat	Western silvery minnow	White sucker
MCFO																							
Cedar Creek R2 (9/2)	2	3			1	3	1		234	95		2		13		18	106	4	487			22	2
Cedar Creek R2a (6/16)						1	1		45	93				8		31	73		132			2	
Cedar Creek R2a (9/1)							1		102	38				2		58	29		38			2	1
Cedar Creek R3 (6/16)					1	1	1		137	189		1		10		45	110		226				
Cedar Creek R3 (8/27)					1	1	6		258	163		1		16		32	138		296			1	
Cedar Creek R4 (5/26)							12		637	90		3		20	1	184	371	4	442			13	
Cedar Creek R4 (8/26)							1		223	1				5		156	95		184				
Cedar Creek R5 (6/29)		2				2	40		79	50			19	12		6	138		1			1	
Cedar Creek R5 (8/22)		4					29		171	30			20	9		8	317		12				
Cherry Creek R1a (6/3)		1		1		2	73	5	10					2	1	14	16		128	1	3	1	10
Cherry Creek R1a (9/15)				1			92		30	21				5		29	17		171	2			5
Cherry Creek R1b (5/14)							7			2				4	1	4	2		42		1		3
Cherry Creek R1b (9/14)							50		2	1				5		50			103				
Cherry Creek R2 (6/9)							54		33			2			1		3		52			1	11

Sampling Reach (Date)	Bigmouth buffalo	Black bullhead	Brassie minnow	Brook Stickleback	Channel catfish	Common carp	Creek chub	Emerald shiner	Fathead minnow	Flathead chub	Goldeye	Green sunfish	Lake chub	Longnose dace	Longnose sucker	Plains killifish	Plains minnow	River carpsucker	Sand shiner	Shorthead redhorse	Stonecat	Western silvery minnow	White sucker
MCFO																							
Cherry Creek R2 (9/14)		8	2			1	199		76			5		8	1	20	26		116		2	2	19
O'Fallon Creek																							
Pennel Creek R1 (8/31)		4	16			187	179		153			1							85				77

Appendix C. Physical habitat characteristics of sites arranged alphabetically by HUC name then by stream name. Left and right bank depths were measured 5 cm from the water's edge. Wetted width, left bank, center, and right bank are the average of 11 individual measurements. Thalweg is an average of 100 individual measurements.

HUC Stream Name	**Date**	**Wetted Width (m)**	**Left Bank (cm)**	**Center (cm)**	**Right Bank (cm)**	**Thalweg (cm)**
MCFO						
Boxelder Creek (Little Missouri R)						
Lone Tree Creek R3 Boxelder Creek	7/13/2015	15.4	8.8	122.3	21.1	123.0
Lower Tongue River						
Pumpkin Creek R1	6/17/2015	8.8	6.2	58.6	12.1	82.0
Pumpkin Creek R1	9/2/2015	7.7	16.0	47.1	22.0	69.7
Pumpkin Creek R2	6/8/2015	62.2	27.9	123.4	12.5	116.1
Pumpkin Creek R2	9/9/2015	4.4	37.9	91.5	16.7	81.0
Pumpkin Creek R3	6/8/2015	3.4	13.3	89.7	25.3	87.4
Pumpkin Creek R3	9/8/2015	2.3	7.0	30.3	6.6	36.8
Pumpkin Creek R4	5/22/2015	4.2	14.8	26.7	10.7	46.1
Pumpkin Creek R4	9/9/2015	4.1	13.6	27.6	8.1	41.7
Lower Yellowstone River						
Cedar Creek R1	7/1/2015	5.8	3.8	12.8	4.3	21.2
Cedar Creek R1	8/31/2015	9.1	8.1	35.3	19.0	38.0
Cedar Creek R2	6/18/2015	3.9	20.9	31.5	13.0	32.0
Cedar Creek R2	9/2/2015	3.7	15.0	28.0	10.0	25.6
Cedar Creek R2a	6/16/2015	3.3	13.7	24.6	8.3	28.7
Cedar Creek R2a	9/1/2015	3.1	12.9	17.0	9.4	27.9
Cedar Creek R3	6/16/2015	3.3	13.2	20.9	6.5	35.3
Cedar Creek R3	8/27/2015	2.7	20.0	31.3	19.1	32.6
Cedar Creek R4	5/26/2015	3.6	12.0	19.7	9.4	25.1
Cedar Creek R4	8/26/2015	4.0	10.9	18.6	13.8	24.0
Cedar Creek R5	6/29/2015	1.4	17.0	36.5	8.9	34.7
Cedar Creek R5	6/29/2015	1.3	10.5	27.2	7.2	36.4
Cherry Creek R1a	6/3/2015	7.9	5.0	25.1	6.1	33.6
Cherry Creek R1a	9/15/2015	0.0	0.0	0.6	0.2	2.8
Cherry Creek R1b	5/14/2015	6.7	9.3	29.3	7.0	34.6
Cherry Creek R1b	9/15/2015	0.3	0.7	1.4	1.1	2.9
Cherry Creek R2	6/9/2015	5.3	13.9	48.1	14.4	53.3
Cherry Creek R2	9/14/2015	4.3	20.0	37.4	15.2	53.0
O'Fallon Creek						
Pennel Creek R1	8/3/2015	4.9	12.5	41.6	13.1	40.1

Appendix D. Water quality characteristics of sites arranged alphabetically by HUC name then by stream name.

HUC Stream Name	Date	Conductivity (µS/cm)	pH	DO (%sat)	Water Temp (°C)	Air Temp (°F)
MCFO						
Boxelder Creek (Little Missouri R)						
Lone Tree Creek R3 Boxelder Creek	7/13/2015	976	6.70	25.5	20.3	80
Lower Tongue River						
Pumpkin Creek R1	6/17/2015	1360	8.29	79.9	20.5	71
Pumpkin Creek R1	9/2/2015	2628	8.36	75.9	19.1	73
Pumpkin Creek R2	6/8/2015	667	7.16	69.1	21.8	91
Pumpkin Creek R2	9/9/2015	1650	8.50	78.9	17.8	78
Pumpkin Creek R3	6/8/2015	572	7.85	71.2	19.9	74
Pumpkin Creek R3	9/8/2015	2285	8.77	83.3	16.2	65
Pumpkin Creek R4	5/22/2015	5532	8.44	92.5	16.0	60
Pumpkin Creek R4	9/9/2015	2546	8.95	75.2	17.1	64
Lower Yellowstone River						
Cedar Creek R1	7/1/2015	4794	8.54	75.0	23.4	81
Cedar Creek R1	8/31/2015	1290	8.07	60.5	19.2	78
Cedar Creek R2	6/18/2015	4902	8.54	84.8	18.6	62
Cedar Creek R2	9/2/2015	5040	8.48	82.8	23.2	81
Cedar Creek R2a	6/16/2015	4127	8.66	84.3	15.7	55
Cedar Creek R2a	9/1/2015	8828	9.02	114.5	20.6	68
Cedar Creek R3	6/16/2015	4184	8.87	89.4	16.9	62
Cedar Creek R3	8/27/2015	10050	8.64	76.3	19.6	76
Cedar Creek R4	5/26/2015	4580	8.40	89.7	17.1	80
Cedar Creek R4	8/26/2015	4771	8.59	80.3	18.7	74
Cedar Creek R5	6/29/2015	4387	8.19	82.4	25.1	88
Cedar Creek R5	6/29/2015	1586	8.06	63.3	15.3	76
Cherry Creek R1a	6/3/2015	3029	8.15	83.1	16.9	62
Cherry Creek R1a	9/15/2015	3340	7.87	63.9	17.5	64
Cherry Creek R1b	5/14/2015	1762	8.05	85.7	16.2	69
Cherry Creek R1b	9/15/2015	5451	7.83	77.6	20.7	78
Cherry Creek R2	6/9/2015	3663	7.90	75.2	21.3	88
Cherry Creek R2	9/14/2015	4603	8.19	71.5	17.1	74
O'Fallon Creek						
Pennel Creek R1	8/3/2015	8329	8.49	91.9	22.8	83