UMOWA Baseline Macroinvertebrate Monitoring Report 2015 for the Upper Missouri River, MT

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Missouri River macroinvertebrate sampling upstream of Craig, MT

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All photos in the report were taken by MMI personnel, unless otherwise noted

Executive Summary

UMOWA began the Missouri River Baseline Monitoring program in 2015. This study was initiated to fill the need of establishing baseline monitoring stations, especially for benthic macroinvertebrates and water chemistry, in the Blue Ribbon section of the Missouri River between Wolf Creek and Cascade with additional sites above Canyon Ferry Reservoir. Very few macroinvertebrate samples have been collected below the Wolf Creek Bridge, but there were four sites below Holter Dam and two sites above Canyon Ferry that the MT Department of Environmental Quality (MDEQ) sampled qualitatively one time in the mid 2000's that are available to use as comparisons to this study (MDEQ 2007). Project goals are: 1) to conduct standardized and quantitative macroinvertebrate surveys as baseline information to serve as the baseline standard against future monitoring efforts. 2) to assess aquatic biointegrity with key community indicators and comparing these against previously collected qualitative samples by MDEQ and PPL. These 2015 data represent the first year of seasonal reach-scale conditions documented to occur (i.e. pre-impact).

In spring, summer and fall of 2015, UMOWA quantitatively collected macroinvertebrate samples, habitat data and water chemistry measures at nine sites (seven below Wolf Creek and two above Canyon Ferry). Early spring run-off events from Little Prickly Pear Creek and the Dearborn River had significant effects on the densities of insects below those tributaries. These tributaries also contributed to the diversity of the insect fauna to the Missouri River, especially adding mayfly, stonefly and caddisfly taxa (EPT taxa). High densities and standing crops of *Baetis* (BWOs), *Tricorythodes* (Tricos), Chironomidae (midges), and *Ephemerella* (PMDs) in the May samples within the Wolf Creek to Craig section hatched out by the summer, leading to lower summer numbers of these taxa. These species gradually built up their populations into the fall sample period, but non-insect taxa still dominated the benthos. Percentages of sowbugs (*Caecidotea*), scuds (*Gammarus, Hyalella* and *Crangonyx*) and other non-insect taxa in the samples were highest during this fall period when EPT taxa were lowest. Of the 19 species of caddisflies that were collected across all sites, the net spinning caddis, *Cheumatopsyche* or *Hydropsyche* were usually the most prevalent. Seven stonefly taxa were collected throughout the reach, especially below the tributaries. Occurrence and diversity of stoneflies is sporadic and increases with increasing distance from Holter Dam. Highest total taxa and EPT richness were reported at sites least affected by the dams, particularly the Missouri River at York's Island and Cascade, 18 and 37 miles respectively, downstream from dam effects. These sites contained a unique benthic fauna, reporting six mayfly species (three shared) that were collected nowhere else in the study.

Three additional semi-quantitative sites were added during the spring sampling period to fully understand insect communities of different macro-habitats; a silted-gravel area and boulder/riprap shoreline upstream of the Dearborn River and the cobble riffle at MidCannon FAS. The boulder/cobble shoreline areas were the only habitats where we consistently collected juvenile salmonids in the nets (predominately Rainbow Trout). Crayfish (*Orconectes virilis*) biomass and densities were highest in these boulder areas and only occupied benthic habitats where the substrate contained cobbles larger than ~6 inch diameter. Overall, macroinvertebrate communities collected in 2015 resemble those reported in the MDEQ samples from 2005 with similar taxa composition, but with significant reductions in caddisfly percentages in the samples and increases in the percentage of midges and sowbugs comprising the benthic samples. This change may reflect an increase in sediment build-up in many areas of the stream channel outside of the thalweg, compounded with large contributions of aquatic vegetation trapping sediments. HBI tolerance scores indicated significant organic pollution at five of the nine (>50%) monitoring sites, but this metric can also act as a surrogate for sediment impairment.

1.0 Introduction

UMOWA contracted Morrison Mairerle, Inc. to begin the Missouri River Baseline Monitoring program in 2015. This study was initiated to fill the need of establishing baseline monitoring stations, especially for benthic macroinvertebrates, in the Blue Ribbon section of the Missouri River between Wolf Creek and Cascade with additional sites above Canyon Ferry Reservoir. Very few macroinvertebrate samples have been collected below the Wolf Creek Bridge, but there were four sites below Holter Dam and two sites above Canyon Ferry that MT Department of Environmental Quality (MDEQ) sampled qualitatively in the mid 2000's that are available to use as comparisons to this study (MDEQ 2007, Table 1). Benthic macroinvertebrates have been monitored at one site about 0.8 miles below Holter Dam annually by PPL (now Northwestern Energy) since 1995 (McGuire 2014). This is a highly regulated stream reach with dampened seasonal and short-term flow fluctuations, modified temperature regime, minimal sediment loads, and tremendous inputs of plankton and nutrients from upstream reservoirs. These conditions promote extensive grows of aquatic plants (primarily water buttercup) and high benthic macroinvertebrate standing crops with limited community diversity (McGuire 2014). August density estimates at this site typically range from 10 to 20 thousand benthic macroinvertebrates per square meter. Recent density estimates (2013 and 2014) were near the high end of this range (McGuire 2014). Mayflies, stoneflies and caddisflies (i.e. ephemeroptera, plecoptera and trichoptera {EPT taxa}) are of particular interest to fly fisherman, and are typical focal points of benthic invertebrate analysis because these orders also contain some of the more sediment and "pollution" sensitive species of insects (Barbour et al 1999). Project goals are: 1) to conduct standardized and quantitative macroinvertebrate surveys as baseline information to serve as the baseline standard against future monitoring efforts. 2) to assess aquatic biointegrity with key community indicators and comparing these against previously collected qualitative samples by MDEQ (2007).

2.0 Methods

2.1 Habitat and Physical Water Sampling

Temperature and basic physical water parameters (Total Dissolved Solids, pH, and Conductivity) were recorded at each site prior to macroinvertebrate sampling using an Oakton 10 water quality multi-meter, calibrated for the lower conductivity range. A 50 m survey tape was staked from the green-line on the stream bank to record sampling distances where samples were taken in the stream channel. Stream channel depths at each bug sample point (n=3) were recorded at the time of sampling (Appendix E).

2.2 Macroinvertebrate Sampling

Three replicate Hess (33 cm diameter) samples were taken at each site to quantitatively collect macroinvertebrates within a designated riffle at measured distances from the bank (Photo 1). It has been demonstrated that three Hess samples will typically capture 90% of the total taxa present in a riffle (Vinson and Hawkins 1996). Each Hess sample constituted a benthic area of 0.1 m^2. At each sampling point, the Hess sampler was pushed into the stream bottom to form an effective seal and all cobbles (>64 mm) within the sampling frame were scrubbed clean of organisms and removed; then the entire area within the sampler frame was raked (disturbed) for approximately one minute until all organic matter and macroinvertebrates were washed into the collection net of the Hess sampler (Photo 1). Macroinvertebrates, organic and inorganic matter were composited into a 40 liter bucket. By swirling the bucket with several water washes, organic material was elutriated from the inorganic (cobbles/gravels) portion onto a 500µm sieve, so that only macroinvertebrates and organic matter were transferred into 1 liter labeled sampling jars filled with 95% ethanol. The inorganic portion in the bottom of the bucket was thoroughly

Photo 1. Hess sampling procedure in a riffle of the Missouri River near Little Prickly Pear Creek (MO_LPPC_US).

examined for caddisfly cases before being discarded back into the stream. Additional qualitative sites were sampled opportunistically to fully understand the macro-habitat dynamics of the insect communities in this reach of the Missouri River. Large riprap and boulders comprise long sections of shoreline in the Missouri River, but these are unable to be sampled with the Hess sampler. Therefore, we sampled two reaches of this habitat by kicking and

flipping large cobbles and boulders and sweeping through the dislodged organic material with with a heavy duty, rectangle dip-net with the same sized mesh (500 µm).

2.3 Taxonomic Analysis

Samples were processed and analyzed at the Stag Benthics Helena laboratory. Macroinvertebrates were picked from the samples, subsampled to 500 individuals, if needed, and identified to the lowest taxonomic level possible (genus/species) with a dissecting microscope (10-40x) following Montana Department of Environmental Quality protocols (MDEQ 2012). Numerous metrics were calculated from the data after it was entered into EDAS (Jessup 2006), including EPT taxa, % EPT, % Non-insect, % Chironomidae, % Crustacean-Mollusk and Hilsenhoff Biotic Index (HBI). The combined mayfly, caddisfly and stonefly species (EPT taxa) and the percentage of these in the sample (% EPT) are always informative metrics, as EPT taxa contain some of the more intolerant aquatic insects, usually requiring clean substrates. Thus, EPT metrics typically decrease with increasing sediment in the benthic substrates (Barbour et al. 1999); although, Tricos (*Tricorythodes* and *Caenis*) are silt tolerant and can increase in numbers with increasing siltation. One informative stand-alone metric is the Hilsenhoff Biotic Index (HBI) which measures the tolerance of a macroinvertebrate community to organic enrichment (Hilsenhoff 1987). Tolerance values are based on a 0-10 scale, where zero-ranked taxa are most sensitive and 10-ranked taxa are most tolerant to pollutants. Values of 0.0-3.5 indicate no apparent organic pollution (excellent), 3.5-4.5 possible slight organic pollution (very good), 4.5-5.5 some pollution, 5.5-6.5 fairly significant pollution, 6.5-7.5 significant pollution (fairly poor), 7.5-8.5 very significant organic pollution 8.5-10 severe organic pollution.

2.4 Sample Sites

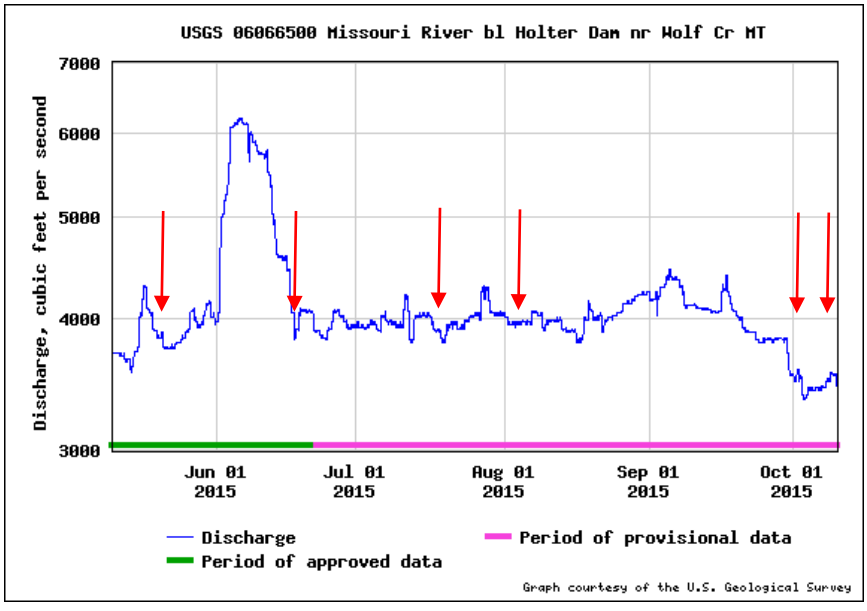
We sampled macroinvertebrates at nine established sites between Toston and Cascade for the spring monitoring period over two time frames (upper sites on May 16th, 2015 and lower sites on June 12th, 2015) (Figure 1). The delay in springtime sampling of the lower sites was due to a significant rainfall/run-off event that “blew out” the Dearborn River and the lower study section of the Missouri River. During this spring period, we collected 27 quantitative Hess samples and three semi-quantitative kick-net samples (Hardy Bridge). We also collected qualitative dip-net samples from large boulder/cobble shoreline areas (n=2) on the outside bend of the Missouri River upstream from the Dearborn confluence and from a deep, cobble riffle out front of Mid-Canon FAS (n=2). We sampled macroinvertebrates for the Summer Seasonal monitoring period at 9 established sites over two time periods (upper and lower sites on July 12th, 2015 and

the Missouri River upstream and downstream of the Dearborn on August 6th, 2015. The sampling of the Dearborn sites was delayed due to the need of a driftboat and shuttle for access. Timing of site sampling always occurred within the same season, but they were sometimes separated by a week or two, because of accessibility. We sampled macroinvertebrates for the fall seasonal monitoring period at seven established sites over a one week time period (Oct 2-9th, 2015) to cover the upper and lower sites (Figure 1).

Table 1. UMOWA Sampling Study Reach locations and ones that overlapped with MDEQ (2007).

Station ID	Agency	Waterbody Site Name	Latitude	Longitude
M09MISSR01	DEQ/UMOWA	MISSOURI RIVER at Toston	46.14384	-111.41278
MO_YORK_IS	UMOWA	MISSOURI RIVER at York's Island	46.12326	-111.42374
MO_LPPC_US	UMOWA	MISSOURI RIVER U/S LITTLE PRICKLY PEAR	47.02281	-112.01527
MO_LPPC_DS	DEQ/UMOWA	MISSOURI RIVER D/S LITTLE PRICKLY PEAR	47.02345	-112.01523
M12MISSR02	DEQ	MISSOURI RIVER @ CRAIG	47.06722	-111.96388
MO_CRAIG	UMOWA	MISSOURI RIVER U/S CRAIG	47.05415	-111.96701
MO_DEAR_Ramp	UMOWA	MISSOURI RIVER U/S DEARBORN RAMP	47.12767	-111.91637
MO_BOULDER	UMOWA	MISSOURI RIVER U/S DEARBORN Boulder	47.12849	-111.91520
MO_DEAR_US	UMOWA	MISSOURI RIVER U/S DEARBORN	47.12819	-111.91174
M12MISSR03	DEQ/UMOWA	MISSOURI RIVER D/S DEARBORN	47.12336	-111.92396
MO_MIDCANNON	UMOWA	MISSOURI RIVER AT MIDCANNON FAS	47.12454	-111.88422
M12MISSR04	DEQ/UMOWA	MISSOURI RIVER U/S OF SHEEP CREEK (HARDY BR.)	47.16781	-111.83366
MO_CASCADE	UMOWA	MISSOURI RIVER AT CASCADE FAS	47.28062	-111.69113

Figure 1. USGS Station 06066500: Missouri River below Holter Dam streamflow graph for the sampling period**.** Red arrows are the seasonal sampling period dates.



3.0 Results

Overall, 93 unique macroinvertebrate taxa were reported from the 75 macroinvertebrate assessment samples collected seasonally between Toston and Cascade in 2015 (Appendix C). Densities of benthic macroinvertebrates varied significantly spatially and seasonally (Figure 3a). The Missouri River above Little Prickly Pear Creek (MO_LPPC_US) and above Craig (MO_Craig) reported the highest benthic densities of invertebrates, averaging ~12,000 individuals per square meter and attained a very large standing crop, especially in the spring (~16,000 per m^2) and fall (Figure 2a and 3a). Low numbers of benthic invertebrates were reported at the Missouri River at York's Island (MO_Yorks), below Little Prickly Pear Creek (MO_LPPC_DS) and the Dearborn River (MO_DEAR_DS) and at Cascade (MO_Cascade), especially in the spring (Figure 2a). Low densities did not necessarily equate to low taxa richness, the York's Island and Cascade sites reported the lowest "non-tributary affected" benthic populations, but had the highest taxa richness (Figure 2a).

Average macroinvertebrate taxa richness per site was 27.1 taxa in the spring, 24 in the summer and 26 taxa in the fall with no significant difference between seasons (T-test, $p>0.05$) (Appendix B). The most taxa rich macroinvertebrate communities were collected at the Missouri River FAS site near Cascade; these averaged 38.5 total taxa over the three seasons (Appendix B). Compared to the samples collected by MDEQ in 2005 (MDEQ 2007), the four sites in the Wolf Creek to Cascade section lost an average of 12 species over the last decade (Table 3). The combined mayfly, caddisfly and stonefly (EPT) taxa richness for the entire sampled section totaled 47 taxa and averaged 15.0 species per site (Table 2). A substantial loss of EPT taxa occurred at the Missouri River Hardy Bridge site since 2005, while the site downstream of the Dearborn River gained seven taxa since last sampled (Table 3). Mayfly and caddisfly taxa were more diverse and abundant than stonefly taxa at all sites (Table 2). There were 21 species of mayflies recorded throughout the study section with the dominant three, BWO's (*Baetis tricaudatus*), Tricos (*Tricorythodes explicatus*) and Pale Morning Duns (*Ephemerella excrucians,* previously *Ephemerella inermis/infrequens*), often exchanging dominance at any one site depending on season and silt build-up in the sampling area (Table 2). Of the 19 species of caddisflies that were collected across the sites, the net spinning caddis, *Cheumatopsyche,* was usually the most prevalent (Table 2). Populations of other net-spinning caddis (*Hydropsyche occidentalis, H. cockerelli, H. morosa group*), micro-caddis *(Hydroptila*), snail-cased caddis (*Helicopsyche borealis*) and long-horned caddis (*Oecetis*) were also common to abundant (Table 2).

Table 2. The combined mayfly, stonefly and caddisfly (EPT) taxa occurrences for the entire study reach sampled. x=rare, X=common, XX=abundant, XXX=dominant at site.

Order	Species	MO_Toston	MO_Yorks	MO_LPPC_US	MO_LPPC_DS	MO_Craig	MO_Dearamp	MO_Boulder	MO_Dear_US	MO_Dear_DS	MO_MidCann	MO_Hardy	MO_Cascade
Mayflies	**Ephemeroptera**												
Ameletidae	*Ameletus*							x		x		x	
Baetidae	***Baetis tricaudatus***	XX	XX	X	x	XXX	x	XX	x	x	XX	XX	X
Baetidae	*Camelobaetidius warreni*		x										
Baetidae	*Centroptilum bifurcatum*		x										
Baetidae	*Diphetor hageni*								x				x
Baetidae	*Fallceon quilleri*		x										
Baetidae	*Plauditus punctiventris*	x	x						x	x		x	X
Baetidae	*Procloeon pennulatum*		x										
Baetidae	*Pseudocloeon sp.*												x
Leptophlebiidae	*Paraleptophlebia sp.*		x						x			x	
Leptophlebiidae	*Choroterpes albiannulata*	X	x										x
Leptohyphidae	***Tricorythodes explicatus***	XX	XX	XX	x	XX	X	X	X	x	X	X	XX
Ephemerellidae	***Ephemerella excrucians***		x	XX	x	XX	X	XX	XX	x	XXX	XX	X
Ephemerellidae	*Drunella coloradensis*				x								
Ephemeridae	*Ephemera simulans*		x							x			x
Heptageniidae	*Epeorus albertae*								x				
Heptageniidae	*Heptagenia*					x	x	x				x	x
Heptageniidae	*Macaffertium terminatum*		x				x	x	x			x	x
Heptageniidae	*Ecdyonurus simpliciodes*		x									x	x
Heptageniidae	*Rhithrogena sp.*		x		x				x		x		
Polymitarcyidae	*Ephoron album*		x										
Stoneflies	**Plecoptera**												
Nemouridae	*Amphinemura*							x				x	
Perlodidae	*Isoperla*		x					x	x		X	x	
Chloroperlidae	*Suwallia*				x				x				
Chloroperlidae	*Paraperla*									x			
Pteronarcidae	*Pteronarcys californica*				x								
Perlidae	*Hesperoperla pacifica*		x					x	x	x	X	x	x
Perlidae	*Claassenia sabulosa*										X		
Caddisflies	**Trichoptera**												
Brachycentridae	*Brachycentrus occidentalis*	X	x		x				x		x		
Brachycentridae	*Micrasema bactro*								x				
Hydropsychidae	***Cheumatopsyche***	XX	x	XX	x	X		X	x		XX	X	x
Hydropsychidae	***Hydropsyche occidentalis***	XX		X	x	X		x			XX	x	x
Hydropsychidae	*Hydropsyche morosa gr.*			x		x			x		X	x	x
Hydroptilidae	*Hydroptila*	XX	x	XX	x	X	x		X			x	x
Leptoceridae	*Ceraclea*	x	x	X	x		x		x		x		
Leptoceridae	*Nectopsyche*	x											x
Leptoceridae	*Oecetis avara*	XX	x	XX	X	X	x		x		X		x
Glossosomatidae	*Glossosoma*			x	X					x			
Glossosomatidae	*Culoptila*				x								
Uneonidae	*Neophylax splendans*				x								
Uneonidae	*Oligophlebodes*				x					x			
Limnephilidae	*Dicosmoecus gilvipes*					x		X	x	x		X	x
Limnephilidae	*Limnephilus*											x	
Limnephilidae	*Onocomoecus unicolor*							x		x		x	x
Limnephilidae	*Pycnopsyche*												x
Helicopsychidae	*Helicopsyche borealis*	X	x				x		x		X	x	X
Polycentropidae	*Polycentropus*						x	x				x	x
	Total EPT per site	12	22	10	17	10	10	13	21	12	14	21	23

Figure 2a. Macroinverebrate metrics for all spring sample sites. Error bars are SE. Arrows are tributaries entering the Missouri River. Sites arranged in upstream to downstream orientation.

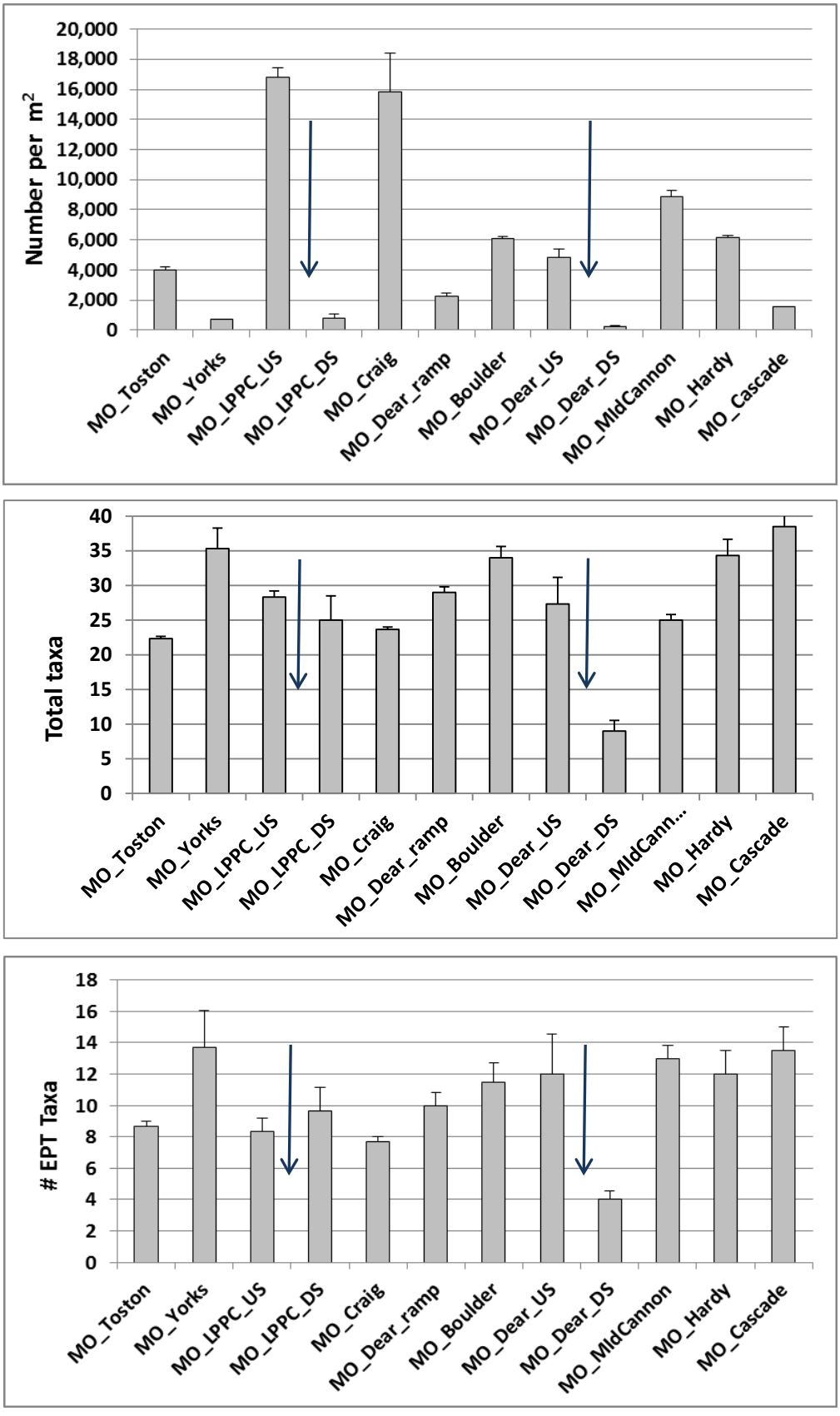
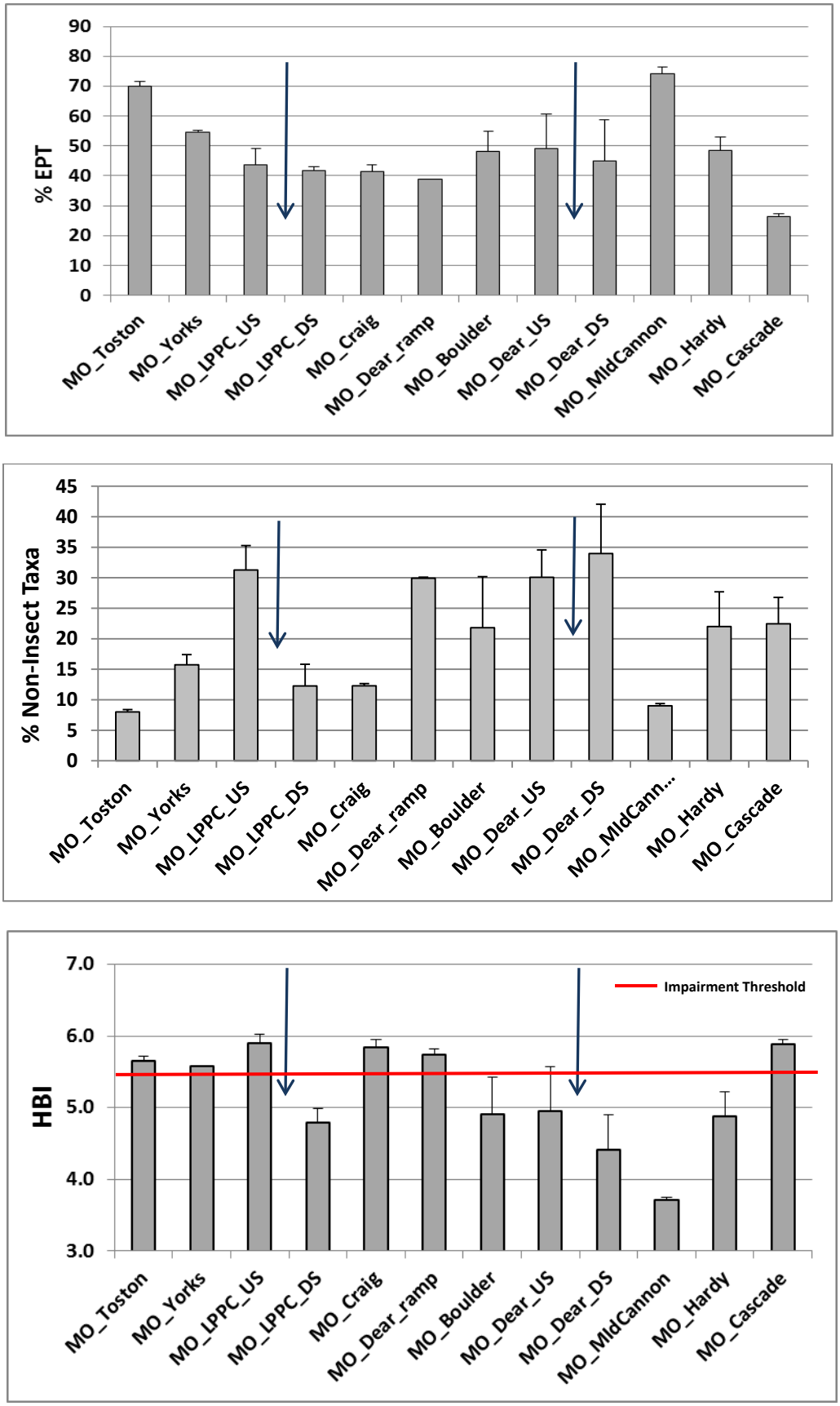


Figure 2b. Macroinverebrate metrics for all spring sample sites. Error bars are SE. Arrows are tributaries entering the Missouri River. Sites arranged in upstream to downstream orientation.



The large October caddis, *Dicosmoecus gilvipes,* occurred throughout the study reach, but was more common below the Dearborn River downstream to Cascade. Caddisflies were more abundant during the spring and summer sampling periods than in the fall (Table 2).

Seven stonefly (Plecoptera) taxa were collected sporadically across the study reach (Table 2). *Suwallia/Paraperla* (Yellow Sallies), *Amphinemura* (Spring Stones), *Isoperla* (Green-winged Stoneflies), *Hesperoperla pacifica* and *Claassenia sabulosa* (Golden Stones) begin to appear in the mainstem Missouri River at Mid-Cannon and Hardy Bridge and near tributary sites (especially up and downstream of the Dearborn, and downstream of Little Prickly Pear Creek) (Table 2). Even one salmonfly (*Pteronarcys californica)* individual was reported in the spring sample of the Missouri River downstream of Little Prickly Pear Creek, likely washed in from the high flows (Table 2). Stonefly taxa are sporadic and increased in numbers and diversity the further distance from Holter Dam; they have never been reported in PPL's monitoring site 0.8 miles below Holter (McGuire 2014).

HBI Scores indicated significant organic pollution at five of the nine (>50%) monitoring sites, including Toston and Yorks Island above Canyon Ferry and Missouri River above LPPC, at Craig and at Cascade (Figure 2b). Sites showed improvements to "some organic pollution" (scores 4.5-5.5) in the tolerance-level of benthic communities below tributaries and with the increasing distance from Holter Dam, registering the lowest score at Mid Canon with subsequent increases toward Cascade (Figure 2b).

3.1 Wolf Creek Bridge to Craig Missouri River section

The macroinvertebrate communities at the Missouri River above Little Prickly Pear Creek (MO_LPPC_US) and above Craig (MO_Craig) contained the highest number of individuals reported (averaging ~12,000 individuals per square meter across all seasons) and attained a very large standing crop, especially in the spring (~16,000 per m^2) (Figure 2a). Dominant insect taxa at the Craig site in order of abundance were the midges (Chironomidae; *Microtendipes*), BWO's (*Baetis tricaudatus*) and Tricos (*Tricorythodes explicatus*); while dominant taxa at the MO_LLPC_US site included, in order, Pale Morning Duns (*Ephemerella excrucians)*, midges (*Cricotopus* spp.) and the caddisflies (*Cheumatopsyche spp.* and *Hydroptila*) (Table 2). High percentages of EPT taxa at the MO_LPPC_US and MO_Craig sites in the spring and summer transitioned to a dominance of non-insect taxa in the fall (Figure 3b). This non-insect dominance was also seen in the fall samples of the 2005 MDEQ samples (2007) (Table 3). These dominant non-insect taxa were sowbugs (*Caecidotea*), scuds (*Gammarus, Hyalella and*

Crangonyx), aquatic earthworms (Lumbricina, Tubificidae) and pouch snails (*Physella acuta*). Low insect densities, as sparse as 250 individuals per m^2 were reported at the Missouri River sites below tributary streams (e.g. below Little Prickly Pear Creek and the Dearborn River) in the spring, but these numbers increased by the fall sampling period to population densities similar to other nearby Missouri River sites (Figure 3a).

In the Wolf Creek Bridge to Craig Missouri River section, the EPT community was primarily composed of three or four mayflies and five or six caddisflies with typically no stoneflies (Table 2). McGuire (2014) reported that the densities of these two insect orders may have declined at the PPL monitoring site 0.8 miles below the dam. Only three species of mayflies are common near the dam. *Tricorythodes* is the most abundant mayfly in the August samples, although *Baetis tricaudatus* can also attain high densities. A few *Ephemerella* (PMDs) were usually collected at this site during the 1990's, but they are seldom present in more recent collections (last found during 2011) (McGuire 2014). On average during the 2015 Missouri River sampling, we collected substantially fewer invertebrate taxa than were reported by MDEQ (2007) between Little Prickly Pear Creek and Hardy Bridge sites (paired T-test, p=0.005) (Table 3). MDEQ (2007) reported low numbers of the mayfly taxa, *Callibaetis* which we did not collect at either site during any season. *Callibaetis* is a mayfly highly tolerant of silt, and the high flows of 2011 may have flushed the bottom sediments enough to make them less favorable for this species or MDEQ may have sampled a silt pocket favored by this species. Of the five sites revisited a decade later, the Missouri River downstream from the Dearborn River has demonstrated the largest improvements in biointegrity of the macroinvertebrate community with substantial increases in the number of EPT taxa and the percentage of EPT taxa (Table 3).

This is coupled with decreases in the % non-insect taxa, especially the % Crustacean-Mollusks, and a decrease in the HBI, which indicates an increase in sensitive taxa in the benthic community (Table 3). The Missouri River at Toston has showed the largest decline in biointegrity over the last decade with a significant loss of EPT taxa comprising the sample, increases in % non-insect taxa, mostly % Crustacean-Mollusks and an increase in the HBI (tolerant insects) (Table 3).

Table 3. Macroinvertebrate metric comparisons at sites sampled by MDEQ in 2005. Bolded, underlined values represent substantial differences (increases-green, decreases-red) over the time frame.

		Total Taxa		# EPT Taxa		% EPT		% Non-Insect		% Midges		% Crus-Moll		HBI	
StationID	**Site Name**	**2005**	**2015**	**2005**	**2015**	**2005**	**2015**	**2005**	**2015**	**2005**	**2015**	**2005**	**2015**	**2005**	**2015**
M09MISSR01	Missouri River at Toston	25.0	25.0	8.7	9.0	75.0	**25.0**	9.3	**43.0**	12.0	27.0	1.5	**30.6**	5.08	**6.12**
M12MISSR01	Missouri River d/s Little Prickly	39.0	**27.0**	6.0	7.0	10.0	14.0	69.7	74.0	11.0	**2.0**	39.1	**54.1**	6.05	6.65
M12MISSR02	Missouri River at Craig	37.0	**21.0**	7.0	5.0	28.1	**16.0**	46.7	49.0	22.0	22.0	45.1	**34.2**	7.17	6.74
M12MISSR03	Missouri River d/s Dearborn	37.0	**28.0**	8.0	**15.0**	14.5	**58.0**	58.2	**22.0**	16.0	13.0	56.3	**5.8**	7.39	**5.34**
M12MISSR04	Missouri River d/s Hardy Bridge	33.0	**24.0**	12.0	**8.3**	44.1	**31.0**	20.6	**42.0**	14.0	14.0	16.5	**28.4**	5.89	6.06

Figure 3a. Macroinvertebrate metric averages for nine sample sites during all seasons. Error bars are SE. Blue arrows are tributaries entering the Missouri River.

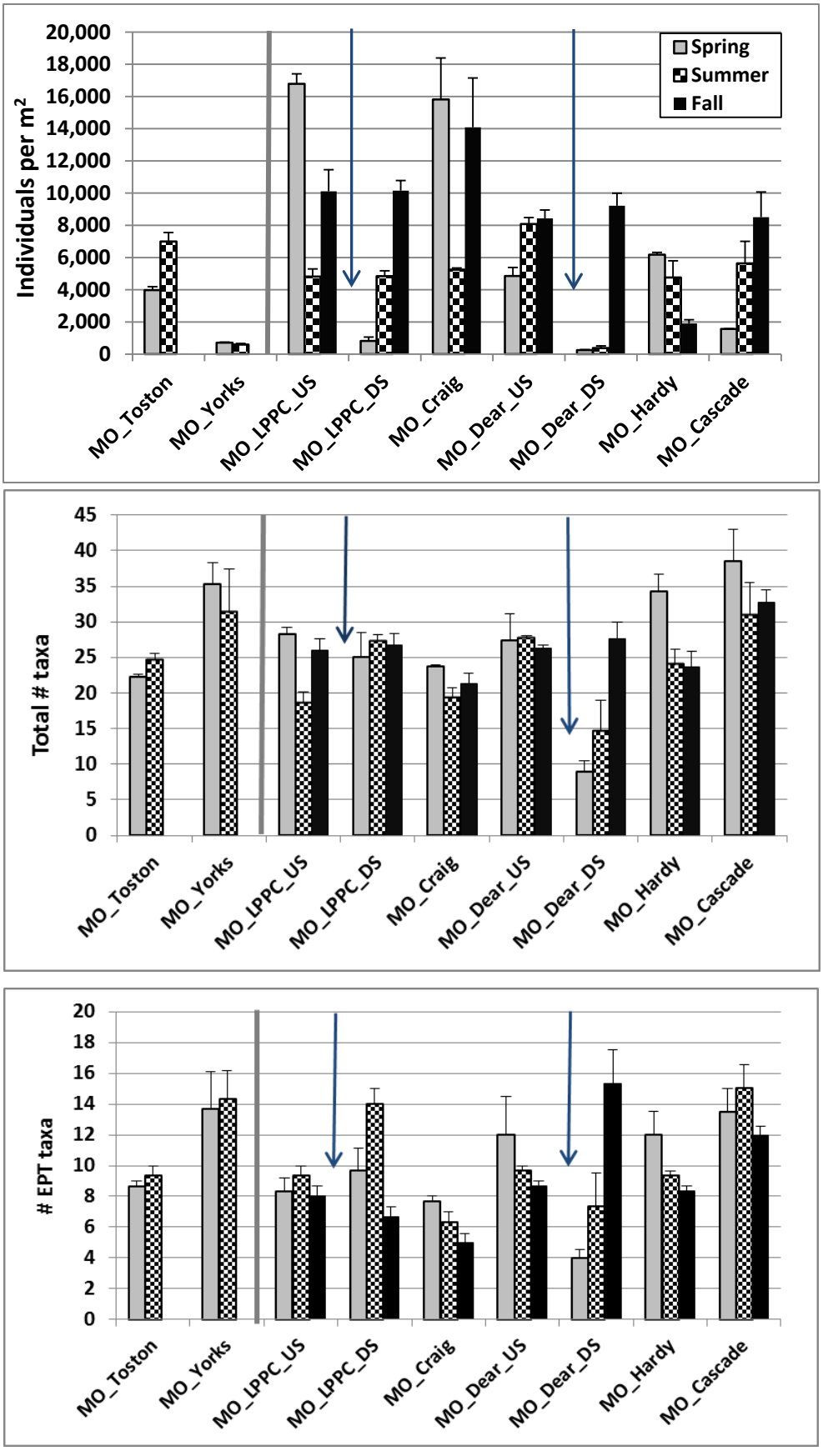
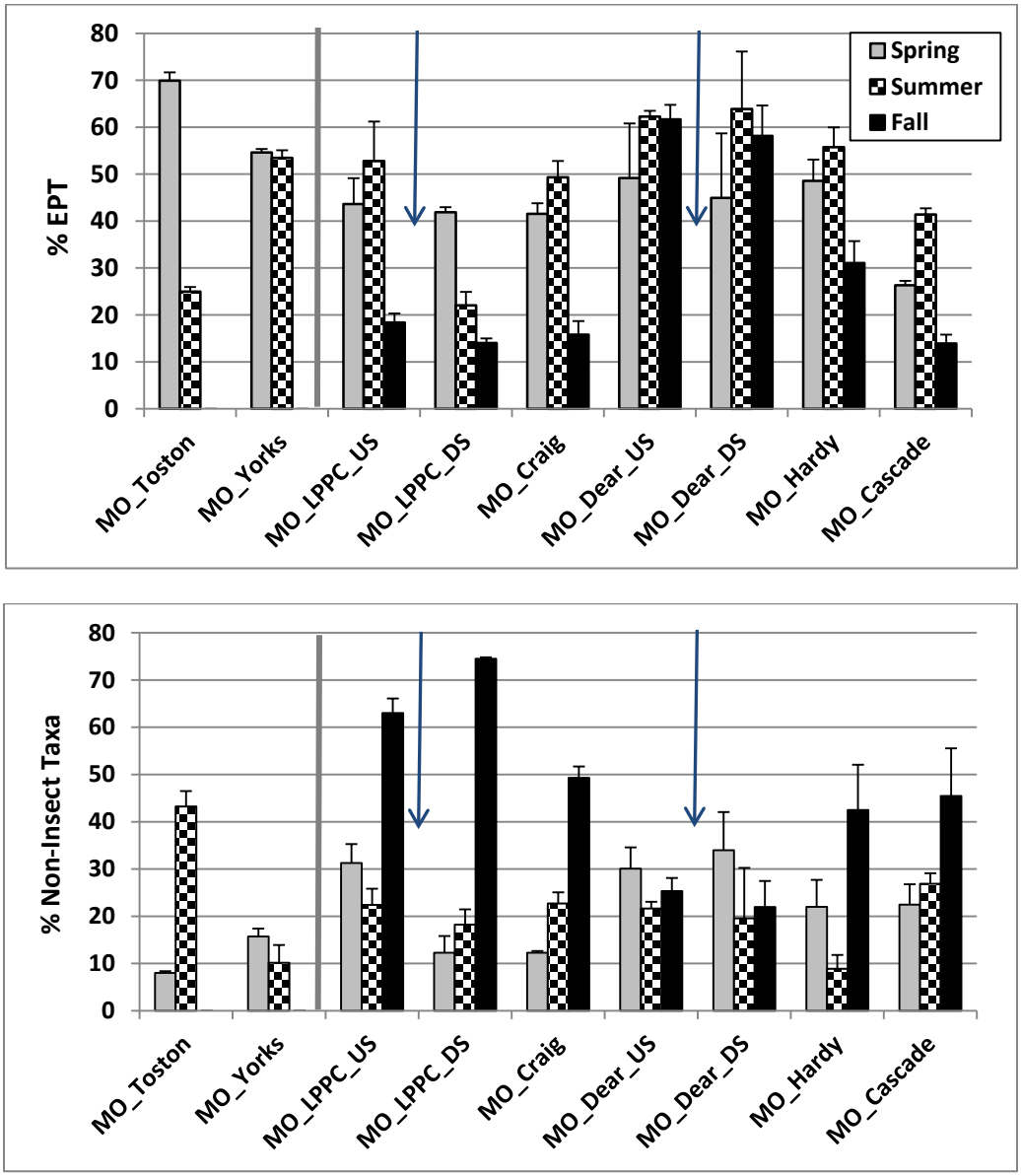


Figure 3b. Macroinvertebrate metric averages for nine sample sites during all seasons. Error bars are SE. Blue arrows are tributaries entering the Missouri River.



3.2 Missouri River upstream and downstream of the Dearborn River (MO_DEAR_US, MO_Dear_ramp, MO_Boulder, MO_DEAR_US)

The boulder/cobble shoreline areas (MO_Boulder) were the only habitats where we consistently collected juvenile salmonids in the nets (predominately Rainbow Trout) (Appendix A). Crayfish (*Orconectes virilis*) biomass and densities were highest in this macro-habitat area (avg. ~10 per m^2), and this species only occupied benthic habitats where the substrate contained cobbles larger than ~6 inch diameter. The Missouri River benthic macroinvertebrates downstream of the Dearborn River exhibited significant reductions in abundance due to the spring run-off event, but then rebounded to levels of upstream Missouri River populations by the fall sampling period (Figure 3a). As the numbers of insects recolonizing the MO_DEAR_DS site increased, so did

the diversity of taxa until by the fall sampling period total taxa richness equaled the upstream site and EPT richness was greater than that of the upstream site (Figure 3a).

3.3 Missouri River near Mid Cannon FAS (MO_MIDCANNON)

The macroinvertebrate communities collected at this cobble-dominated riffle of the Missouri River near Mid Cannon FAS were more similar to a freestone river with high EPT taxa richness (14 taxa), three stonefly taxa, and the highest % of EPT and lowest % of non-Insect taxa (Figure 2a & 2b). Benthic abundance reported for this section was in the mid-range (~9,000 individuals per m^2) (Figure 1a). Dominant benthic taxa at this site were all EPT taxa, in order of abundance, PMDs (*Ephemerella excrucians),* BWOs *(Baetis tricaudatus),* spotted sedges (*Hydropsyche occidentalis, Cheumatopsyche)* and Tricos (*Tricorythodes explicates).* Several EPT taxa reported here appeared at only a few sites; these included *Rhithrogena sp. (*March Browns)*, Hesperoperla pacifica* and *Claassenia sabulosa* (Golden Stones) (Table 2).

3.4 Missouri River near Hardy Creek Bridge (MO_HARDYBR)

The macroinvertebrate community collected at this cobble/boulder riffle of the Missouri River near Hardy Bridge was more similar to a spring creek community, likely due to the abundant aquatic weed beds. Crayfish were present here (avg. 0.7 per m^2) due to the larger substrate. Dominant benthic taxa at this site were, in order of abundance, sowbugs (*Caecidotea*), BWOs *(Baetis tricaudatus),* midges (*Microtendipes*) and flatworms (*Turbellaria).* Cumulative total EPT for this site was the 3rd highest at 21 species (Table 2), but EPT species other than BWO's and Tricos were low in abundance. Benthic abundance was in the mid-range for this section in the spring (~6,000 individuals per m^2), but this number dropped precipitiously by the fall sampling period to <2,000 per m^2 (Figure 3a). MDEQ's fall 2005 sample reported the dominant benthic taxa, in order of abundance, BWOs *(Baetis tricaudatus),* blackflies (*Simulium),* scuds (*Hyalella),* Tricos (T*ricorythodes) and sowbugs.* The 2015 samples had much lower numbers of blackflies than had been reported in 2005 (MDEQ 2007).

Photo 1. Extensive weed beds growing at Hardy Bridge by the summer sampling period.

3.5 Missouri River near Cascade (MO_Cascade)

The macroinvertebrate communities collected at the Missouri River FAS site near Cascade were the most diverse (averaging 38.5 total taxa) and also reported one of the highest average EPT taxa richness (avg. EPT taxa = 13.5 species) (Figure 2a). Cumulative total EPT for all seasons was the highest reported at 23 species (Table 2). The benthic community tolerance values (HBI) indicates significant organic pollution occurring at this site, but high HBI scores can also be indicative of high sediment in the substrate. Several mayfly taxa occurring here were specific to only here or at the York's Island site above Canyon Ferry Lake, including, *Ecdyonurus simpliciodes*, *Choroterpes albiannulata*, and a *Pseudocloeon sp.* (Appendix B). Low densities (averaging 13 per m^2) of the exotic New Zealand mudsnail (*Potamopyrgus antipodarum*) were collected here during all seasonal samples.

3.6 Missouri River between Toston and York's Island

The macroinvertebrate communities collected at the Missouri River at York's Island FAS site (MO_Yorks_IS) above Canyon Ferry were low in abundance, but high in taxa richness (Figure 3a). This site had the second highest average taxa richness for all samples (35 taxa) and the 2nd highest cumulative EPT taxa richness at 22 species (Table 2). It also reported the second highest average EPT taxa richness (avg. EPT taxa = 13.5 species) (Figure 2a). Several mayfly taxa occurring here were specific to here or at the Cascade site, including, *Ecdyonurus simpliciodes*, *Choroterpes albiannulata*, and a *Pseudocloeon sp.* (Appendix C). Toston and York's Island benthic community tolerance values indicate significant organic pollution occurring at these sites, but high HBI scores can also be indicative of high sediment in the substrate (Figure 2b). New Zealand mudsnails (*Potamopyrgus antipodarum*) were not collected at either site during the seasonal samples; although, no samples were collected in the fall.

4.0 Conclusions

This has been the most comprehensive study evaluating the macroinvertebrate communities in the Wolf Creek to Cascade section of the Missouri River to date, and provides a significant baseline dataset for future monitoring efforts. Very important spatial and temporal information concerning the macroinvertebrate communities has been generated, including peaks and troughs of benthic insect density and diversity across multiple sites, and the important role tributary streams have on the Missouri River insect communities. Tolerance scores of the benthic communities using the HBI indicate significant organic enrichment across the sites, especially above Canyon Ferry, sites closer to Holter Dam and at Cascade. Increased benthic coverage of rooted aquatic vegetation favors increases of non-insect taxa, such as sowbugs (*Caecidotea*), scuds (*Gammarus, Hyalella and Crangonyx*), aquatic earthworms (*Lumbricina, Tubificidae*) and pouch snails (*Physella acuta*). All four sites sampled by MDEQ in 2005 between Wolf Creek and Cascade reported a substantial loss in numbers of taxa during the same season in 2015, while the Toston revisit site reported no loss of taxa. Although the 2015 Hess sample abundance data is not directly comparable to MDEQ 2005 kick samples, taxa presence, the HBI and percentages of EPT should be similar enough to make these inferences. The Missouri River downstream from the Dearborn River demonstrated the largest improvements in biointegrity of the macroinvertebrate community with substantial increases in the number of EPT taxa and the % EPT taxa in the samples. Highest total taxa richness and

EPT richness were reported at sites least affected by the dams, particularly the Missouri River at York's Island above Canyon Ferry and at Cascade site, 18 and 37 miles away from their respective dam. These sites begin to take on the more natural character of the river and acquire the original compliment of macroinvertebrates. Boulder riprap sections of the streambank provide refuge for juvenile salmonids and moderate densities of the virile crayfish, *Orconectes virilis*. New Zealand mudsnails (*Potamopyrgus antipodarum*) persist in low densities at the Missouri River upstream of Craig, upstream and downstream of the Little Prickly Pear Creek confluence and at the Cascade FAS; although, they have not been collected at the PPL Holter Dam site since 2012.

5.0 Literature Cited

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Appendix A. Site Photographs

Photo 1. Missouri River at Little Prickly Pear Creek Site U/S, MO_LPPC_US.

Photo 2. Missouri River at Little Prickly Pear Creek Site D/S MO_LPPC_DS

Photo 3. Missouri River substrate in the Hess sampler MO_LPPC_US

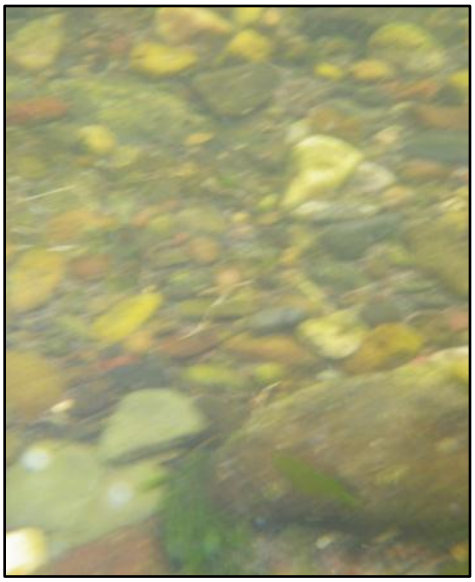

Photo 4. Missouri River substrate in the Hess sampler MO_LPPC_DS.

Photo 5. Missouri River upstream from Craig (MO_Craig).

Photo 6. Missouri River Hess sampling at Little Prickly Pear Creek Site U/S, MO_LPPC_US

Photo 7. Missouri River substrate upstream York's Island (MO_Yorks) summer.

Photo 8. Missouri River shoreline upstream of York's Island (MO_Yorks) summer.

Photo 9. Missouri River substrate at Toston (MO_Toston) summer.

Photo 10. Missouri River upstream of the Dearborn River (MO_DEAR_US) spring.

Photo 11. Missouri River upstream of the Dearborn River (MO_DEAR_US) spring.

Photo 12. Missouri River downstream of the Dearborn River (MO_DEAR_DS) spring.

Photo 13. Golden stone, *Claassenia sabulosa* at the MidCannon Site (MO_MidCannon) spring.

Photo 14. Missouri River downstream of the Hardy Bridge (MO_HARDY) spring.

Photo 15. Missouri River looking downstream of the Cascade FAS site (MO_Cascade).

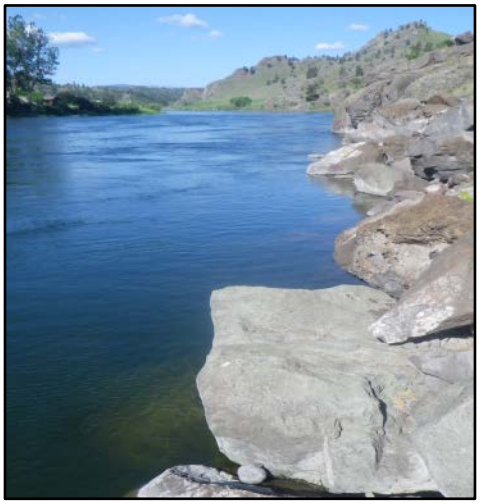

Photo 16. Riprap boulder shoreline upstream from the Dearborn River (MO_Boulder).

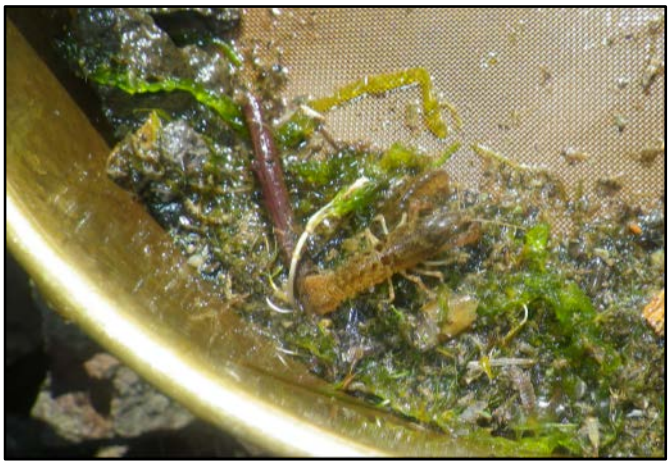

Photo 17. Crayfish in the dipnet sample at Hardy Bridge.

Photo 18. Missouri River looking upstream of the Cascade FAS site (MO_Cascade).

Appendix B. Macroinvertebrate seasonal summary metric tables.

APPENDIX B. Summary Macroinvertebrate Spring Metrics across all sites. Underlined, bolded values represent the highest averages for that metric in that season.

Site	Metric	Hess #1	Hess #2	Hess #3	Average	Standard Error
MO_Toston	#/m^2	4,080	3,550	4,290	3,973.33	220.18
MO_Toston	# taxa	23	22	22	22.33	0.33
MO_Toston	#EPT taxa	9	8	9	8.67	0.33
MO_Toston	%EPT	73	69	67	**69.90**	1.80
MO_Toston	% Non-Insect	8	8	7	8.00	0.39
MO_Yorks	#/m^2	768	648	724	713.33	35.05
MO_Yorks	# taxa	34	31	41	35.33	2.96
MO_Yorks	#EPT taxa	15	9	17	**13.67**	2.40
MO_Yorks	%EPT	55	53	56	54.61	0.77
MO_Yorks	% Non-Insect	19	13	15	15.73	1.68
MO_LPPC_US	#/m^2	17,760	15,640	16,960	**16,786.67**	618.10
MO_LPPC_US	# taxa	30	27	28	28.33	0.88
MO_LPPC_US	# EPT	10	7	8	8.33	0.88
MO_LPPC_US	% EPT	41	36	54	43.63	5.50
MO_LPPC_US	% Non-Insect	33	37	24	31.26	4.01
MO_LPPC_DS	#/m^2	500	660	1,300	820.00	244.40
MO_LPPC_DS	# taxa	21	22	32	25.00	3.51
MO_LPPC_DS	#EPT taxa	7	10	12	9.67	1.45
MO_LPPC_DS	% EPT	44	41	41	41.89	1.05
MO_LPPC_DS	% Non-Insect	10	8	19	12.27	3.55
MO_Craig	#/m^2	12,000	14,720	20,720	15,813.33	2575.92
MO_Craig	# taxa	24	24	23	23.67	0.33
MO_Craig	#EPT taxa	7	8	8	7.67	0.33
MO_Craig	% EPT	42	38	45	41.56	2.23
MO_Craig	% Non-Insect	12	12	13	12.28	0.37
MO_Boulder	#/m^2		5,888	6,240	6,064.00	143.70
MO_Boulder	# taxa		32	36	34.00	1.63
MO_Boulder	#EPT taxa		10	13	11.50	1.22
MO_Boulder	%EPT		40	56	48.04	6.83
MO_Boulder	% Non-insect taxa		32	12	21.80	8.38
MO_Dear_ramp	#/m^2		1,992	2,504	2,248.00	209.02
MO_Dear_ramp	# taxa		28	30	29.00	0.82
MO_Dear_ramp	#EPT taxa		9	11	10.00	0.82
MO_Dear_ramp	%EPT		39	39	38.81	0.12
MO_Dear_ramp	% Non-Insect taxa		30	30	29.92	0.17

APPENDIX B.

cont.

Site	Metric	Hess #1	Hess #2	Hess #3	Average	Standard Error
MO_Dear_US	#/m^2	5,180	5,570	3,820	4,856.67	530.42
MO_Dear_US	# taxa	29	33	20	27.33	3.84
MO_Dear_US	#EPT taxa	9	17	10	12.00	2.52
MO_Dear_US	%EPT	26	63	59	49.18	11.62
MO_Dear_US	% Non-Insect Taxa	39	27	25	30.06	4.50
MO_Dear_DS	#/m^2	280	180	290	250.00	35.12
MO_Dear_DS	# taxa	12	8	7	9.00	1.53
MO_Dear_DS	#EPT taxa	4	3	5	4.00	0.58
MO_Dear_DS	%EPT	21	44	69	44.95	13.73
MO_Dear_DS	% Non-Insect Taxa	50	28	24	33.97	8.08
MO_MIdCannon	#/m^2		8,448	9,344	8,896.00	365.79
MO_MIdCannon	# taxa		26	24	25.00	0.82
MO_MIdCannon	#EPT taxa		14	12	13.00	0.82
MO_MIdCannon	%EPT		71	77	**74.13**	2.39
MO_MIdCannon	% Non-Insect Taxa		9	9	9.02	0.37
MO_Hardy	#/m^2	5,968	6,448	6,128	6,181.33	141.11
MO_Hardy	# taxa	32	39	32	34.33	2.33
MO_Hardy	#EPT taxa	10	15	11	12.00	1.53
MO_Hardy	%EPT	40	55	50	48.56	4.54
MO_Hardy	% Non-Insect Taxa	32	12	22	22.00	5.70
MO_Cascade	#/m^2		1,544	1,584	1,564.00	20.00
MO_Cascade	# taxa		34	43	**38.50**	4.50
MO_Cascade	#EPT taxa		12	15	13.50	1.50
MO_Cascade	%EPT		25	27	26.33	0.94
MO_Cascade	% Non-Insect Taxa		18	27	22.45	4.32

APPENDIX B. Summary Macroinvertebrate Summer Metrics across all sites. Underlined, bolded values represent the highest averages for that metric in that season.

Site	Metric	Hess #1	Hess #2	Hess #3	Average	Standard Error
MO_Toston	#/m2	7,840	5,940	7,200	6,993	558.1
MO_Toston	# taxa	26	23	25	24.7	0.9
MO_Toston	#EPT taxa	10	8	10	9.3	0.7
MO_Toston	%EPT	25.0	23.2	26.7	25.0	1.0
MO_Toston	% Non-Insect	37.5	48.8	43.3	**43.2**	3.3
MO_Yorks	#/m2	720	584	450	584.9	77.8
MO_Yorks	# taxa	33	20	**41**	**31.3**	6.1
MO_Yorks	#EPT taxa	12	13	**18**	**14.3**	1.9
MO_Yorks	%EPT	56.7	51.4	52.4	53.5	1.6
MO_Yorks	% Non-Insect	19.8	15.1	23.0	19.3	2.3
MO_LPPC_US	#/m2	5,760	4,240	4,440	4,813	476.8
MO_LPPC_US	# taxa	21	19	16	18.7	1.5
MO_LPPC_US	#EPT taxa	10	10	8	9.3	0.7
MO_LPPC_US	% EPT	39.6	**68.4**	50.5	52.8	8.4
MO_LPPC_US	% Non-Insect	25.0	15.6	26.6	22.4	3.4
MO_LPPC_DS	#/m2	5,200	4,140	5,160	4,833	346.9
MO_LPPC_DS	# taxa	26	29	27	27.3	0.9
MO_LPPC_DS	#EPT taxa	12	15	15	14.0	1.0
MO_LPPC_DS	% EPT	17.3	21.7	27.1	22.1	2.8
MO_LPPC_DS	% Non-Insect	11.9	20.3	22.5	18.2	3.2
MO_Craig	#/m2	5,160	5,100	5,460	5,240	111.4
MO_Craig	# taxa	17.0	19.0	22.0	19.3	1.5
MO_Craig	#EPT taxa	5.0	7.0	7.0	6.3	0.7
MO_Craig	% EPT	42.6	54.1	51.3	49.3	3.5
MO_Craig	% Non-Insect Taxa	22.9	18.4	26.7	22.7	2.4
MO_Dear_US	#/m2	7,535	8,880	7,805	**8,073**	410.8
MO_Dear_US	# taxa	28	28	27	27.7	0.3
MO_Dear_US	#EPT taxa	10	10	9	9.7	0.3
MO_Dear_US	% EPT	64.1	62.7	60.0	62.3	1.2
MO_Dear_US	% Non-Insect Taxa	19.6	20.9	24.4	21.6	1.4
MO_Dear_DS	#/m2	220	230	660	370.0	145.0
MO_Dear_DS	# taxa	9	12	23	14.7	4.3
MO_Dear_DS	#EPT taxa	3	9	10	7.3	2.2
MO_Dear_DS	% EPT	40.9	**82.6**	**68.2**	**63.9**	12.2
MO_Dear_DS	% Non-Insect Taxa	40.9	8.7	9.1	19.6	10.7

APPENDIX B. cont.						
MO_Hardy	#/m2	3,968	3,488	6,816	4,757	1038.6
MO_Hardy	# taxa	23	21	28	24.0	2.1
MO_Hardy	#EPT taxa	9	9	10	9.3	0.3
MO_Hardy	% EPT	47.6	61.5	58.2	55.8	4.2
MO_Hardy	% Non-Insect Taxa	14.5	4.6	7.5	8.9	2.9
MO_Cascade	#/m2	4,540	8,360	4,000	5,633	1372.2
MO_Cascade	# taxa	**40**	28	25	31.0	4.6
MO_Cascade	#EPT taxa	**18**	14	13	**15.0**	1.5
MO_Cascade	% EPT	40.5	39.7	44.0	41.4	1.3
MO_Cascade	% Non-Insect Taxa	31.3	25.4	24.0	26.9	2.2

APPENDIX B. Summary Macroinvertebrate Fall Metrics across all sites. Underlined, bolded values represent the highest averages for that metric in that season.

Site	Metric	Hess #1	Hess #2	Hess #3	Average	Standard Error
MO_LPPC_US	#/m2	12,353	7,695	10,278	10,107.67	1,346.48
MO_LPPC_US	# taxa	26	20	21	22.33	1.86
MO_LPPC_US	#EPT taxa	8	5	7	6.67	0.88
MO_LPPC_US	% EPT	22	18	16	18.39	1.91
MO_LPPC_US	% Non-Insect Taxa	57	66	67	63.20	3.12
MO_LPPC_DS	#/m2	11,273	9,108	10,080	10,153.50	625.92
MO_LPPC_DS	# taxa	25	25	30	26.67	1.67
MO_LPPC_DS	#EPT taxa	6	6	8	6.67	0.67
MO_LPPC_DS	% EPT	16	12	14	14.00	1.01
MO_LPPC_DS	% Non-Insect Taxa	75	74	75	**74.49**	0.33
MO_Craig	#/m2	20,120	12,015	10,120	**14,085.00**	3,066.69
MO_Craig	# taxa	24	21	19	21.33	1.45
MO_Craig	#EPT taxa	5	6	4	5.00	0.58
MO_Craig	% EPT	11	16	21	15.79	2.90
MO_Craig	% Non-Insect Taxa	48	54	46	49.30	2.44
MO_Dear_US	#/m2	8,340	9,378	7,580	8,432.67	521.10
MO_Dear_US	# taxa	26	26	27	26.33	0.33
MO_Dear_US	#EPT taxa	9	8	9	8.67	0.33
MO_Dear_US	%EPT	67	57	61	**61.67**	3.06
MO_Dear_US	% Non-Insect Taxa	20	29	28	25.32	2.78
MO_Dear_DS	#/m2	8,505	10,764	8,394	9,221.00	772.17
MO_Dear_DS	# taxa	27	24	32	27.67	2.33
MO_Dear_DS	#EPT taxa	17	11	18	**15.33**	2.19
MO_Dear_DS	%EPT	46	68	60	58.14	6.46
MO_Dear_DS	% Non-Insect Taxa	33	14	19	21.97	5.54
MO_Hardy	#/m2	2,272	1,968	1,464	1,901.33	235.62
MO_Hardy	# taxa	28	22	21	23.67	2.19
MO_Hardy	#EPT taxa	9	8	8	8.33	0.33
MO_Hardy	%EPT	22	34	37	31.05	4.69
MO_Hardy	% Non-Insect Taxa	61	30	36	42.47	9.56
MO_Cascade	#/m2	6,040	8,080	11,408	8,509.17	1,564.25
MO_Cascade	# taxa	32	30	36	**32.67**	1.76
MO_Cascade	#EPT taxa	12	11	13	12.00	0.58
MO_Cascade	%EPT	14	11	17	13.90	1.88
MO_Cascade	% Non-Insect Taxa	57	55	24	45.45	10.51

Appendix C. Macroinvertebate taxa list and abundance.

MO_Toston_US01	Summer 2015	1/2 subsample					
Order	OTUname2	Fina lID	Hess 1	Hess 2	Hess 3	Average	SE
Non-Insect taxa	Gammarus	Gammarus	176	186	214	192.0	11.37
Diptera	Chironominae	Microtendipes	68	74	66	69.3	2.40
Non-Insect taxa	Turbellaria	Turbellaria	64	66	60	63.3	1.76
Trichoptera	Oecetis	Oecetis avara	70	20	44	44.7	14.44
Diptera	Orthocladiinae	Cricotopus trifascia	60	20	44	41.3	11.62
Trichoptera	Helicopsyche	Helicopsyche borealis	40	44	36	40.0	2.31
Diptera	Chironominae	Tanytarsus	36	34	42	37.3	2.40
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	30	24	36	30.0	3.46
Trichoptera	Brachycentrus	Brachycentrus occidentalis	24	18	30	24.0	3.46
Non-Insect taxa	Oligochaeta	Tubificidae	30	14	24	22.7	4.67
Diptera	Orthocladiinae	Cricotopus	30	14	20	21.3	4.67
Coleoptera	Optioservus	Optioservus quadrimaculatus	56	0	0	18.7	18.67
Ephemeroptera	Choroterpes	Choroterpes	12	18	24	18.0	3.46
Diptera	Tanypodinae	Thienemannimyia gr.	14	6	10	10.0	2.31
Non-Insect taxa	Pisidiidae	Sphaerium	10	16	0	8.7	4.67
Non-Insect taxa	Physa_Physella	Physella acuta	12	4	8	8.0	2.31
Coleoptera	Microcylloepus pusillis	Microcylloepus pusillis	10	2	12	8.0	3.06
Diptera	Chironominae	Polypedilum	8	4	12	8.0	2.31
Diptera	Chironominae	Rheotanytarsus	6	10	6	7.3	1.33
Trichoptera	Cheumatopsyche	Cheumatopsyche	8	4	10	7.3	1.76
Trichoptera	Hydroptila	Hydroptila	2	8	6	5.3	1.76
Diptera	Chironominae	Cryptochironomus	6	2	4	4.0	1.15
Trichoptera	Nectopsyche	Nectopsyche	6	2	2	3.3	1.33
Non-Insect taxa	Caecidotea	Caecidotea	0	4	4	2.7	1.33
Ephemeroptera	Baetis	Baetis tricaudatus	2	0	2	1.3	0.67
Ephemeroptera	Plauditus	Plauditus punctiventris	2	0	2	1.3	0.67
Non-Insect taxa	Hirudinia	Erpobdella punctata	2	0	0	0.7	0.67
Non-Insect taxa	Oligochaeta	Lumbricina	0	0	2	0.7	0.67
		Totals	784	594	720	699.3	55.81

York's Island	Summer 2015		.1 m2	.1 m2	.1 m2		
Order	OTUname2	FinalID	Hess 1	Hess 2	Hess 3	Avg.	SE
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	67	36	34	45.8	10.62
Hemiptera	Corixidae	Corixidae	3	45	16	21.3	12.41
Ephemeroptera	Baetis	Baetis tricaudatus	15	6	7	9.3	2.85
Non-Insect taxa	Turbellaria	Turbellaria	5	14	6	8.4	2.80
Non-Insect taxa	Crangonyx	Crangonyx	5	0	5	5.0	0.58
Non-Insect taxa	Oligochaeta	Tubificidae	4	6	3	4.4	0.80
Ephemeroptera	Choroterpes	Choroterpes	4	4	3	3.6	0.44
Diptera	Chironominae	Pseudochironomus	7	0	2	3.1	2.06
Diptera	Simuliidae	Simulium	7	0	2	3.1	2.06
Ephemeroptera	Baetidae	Camelobaetidius warreni	0	7	2	3.1	2.06
Diptera	Orthocladiinae	Tvetenia bavarica	6	0	2	2.7	1.76
Non-Insect taxa	Pisidiidae	Pisidium	5	0	2	2.2	1.47
Non-Insect taxa	Oligochaeta	Lumbriculidae	3	2	2	2.2	0.40
Diptera	Orthocladiinae	Cricotopus trifascia	5	0	2	2.2	1.47
Diptera	Tanypodinae	Thienemannimyia gr.	5	0	2	2.2	1.47
Ephemeroptera	Baetidae	Procloeon pennulatum	0	5	2	2.2	1.47
Diptera	Chironominae	Microtendipes	4	0	1	1.8	1.18
Ephemeroptera	Heptagenia	Ecdyonurus simpliciodes	1	3	1	1.8	0.62
Trichoptera	Ceraclea	Ceraclea	0	4	1	1.8	1.18
Trichoptera	Helicopsyche	Helicopsyche borealis	0	4	1	1.8	1.18
Non-Insect taxa	Physa_Physella	Physella acuta	3	0	1	1.3	0.88
Non-Insect taxa	Pisidiidae	Sphaerium	3	0	1	1.3	0.88
Non-Insect taxa	Hyalella	Hyalella	3	0	1	1.3	0.88
Diptera	Chironominae	Cryptochironomus	3	0	1	1.3	0.88
Diptera	Chironominae	Robackia	1	2	1	1.3	0.33
Ephemeroptera	Ephemerella	Ephemerella excrucians	3	0	1	1.3	0.88
Ephemeroptera	Paraleptophlebia	Paraleptophlebia	2	1	1	1.3	0.33
Ephemeroptera	Rhithrogena	Rhithrogena	3	0	1	1.3	0.88
Non-Insect taxa	Ferrissia	Ferrissia	2	0	1	0.9	0.59
Non-Insect taxa	Caecidotea	Caecidotea	2	0	1	0.9	0.59
Coleoptera	Optioservus	Optioservus quadrimaculatus	1	1	1	0.9	0.11
Ephemeroptera	Baetidae	Plauditus punctiventris	1	1	1	0.9	0.11
Ephemeroptera	Baetidae	Centroptilum bifurcatum	0	2	1	0.9	0.59
Trichoptera	Cheumatopsyche	Cheumatopsyche	1	1	1	0.9	0.11
Non-Insect taxa	Gammarus	Gammarus	0	0	1	0.7	0.67
Coleoptera	Microcylloepus	Microcylloepus pusillis	0	1	0	0.4	0.29
Diptera	Chironominae	Polypedilum	1	0	0	0.4	0.29
Ephemeroptera	Ephemera	Ephemera	1	0	0	0.4	0.29
Ephemeroptera	Ephemera	Ephoron album	0	1	0	0.4	0.29
Trichoptera	Hydroptila	Hydroptila	1	0	0	0.4	0.29
		Totals	**177**	**146**	**112**	**144.9**	**18.87**

MO_LPPC_US01	Summer 2015	Subsample	1/4	1/2	1/2		
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Non-Insect taxa	Turbellaria	Turbellaria	104	50	84	79.3	15.76
Trichoptera	Cheumatopsyche	Cheumatopsyche	72	104	56	77.3	14.11
Coleoptera	Optioservus	Optioservus quadrimaculatus	84	26	72	60.7	17.68
Diptera	Simuliidae	Simulium	88	34	24	48.7	19.88
Ephemeroptera	Baetis	Baetis tricaudatus	24	56	58	46.0	11.02
Ephemeroptera	Ephemerella	Ephemerella excrucians	48	24	20	30.7	8.74
Trichoptera	Lepidostoma	Lepidostoma	20	20	30	23.3	3.33
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	8	34	22	21.3	7.51
Trichoptera	Oecetis	Oecetis avara	24	38	2	21.3	10.48
Non-Insect taxa	Oligochaeta	Tubificidae	8	10	16	11.3	2.40
Diptera	Orthocladiinae	Cricotopus	20	6	0	8.7	5.93
Non-Insect taxa	Caecidotea	Caecidotea	12	0	12	8.0	4.00
Trichoptera	Hydropsyche_Ceratops	Hydropsyche	20	4	0	8.0	6.11
Trichoptera	Uneonidae	Neophylax splendans	0	6	18	8.0	5.29
Non-Insect taxa	Physa_Physella	Physella acuta	12	2	6	6.7	2.91
Trichoptera	Uneonidae	Oligophlebodes	0	2	18	6.7	5.70
Non-Insect taxa	Oligochaeta	Lumbricina	8	2	0	3.3	2.40
Diptera	Ceratopogonidae	Bezzia	0	0	4	1.3	1.33
Diptera	Chironominae	Microtendipes	4	0	0	1.3	1.33
Diptera	Tabanidae	Chrysops	4	0	0	1.3	1.33
Diptera	Tanypodinae	Thienemannimyia gr.	0	2	2	1.3	0.67
Diptera	Tipulidae	Limnophila	4	0	0	1.3	1.33
Plecoptera	Perlodidae	Isoperla	4	0	0	1.3	1.33
Trichoptera	Ceraclea	Ceraclea	4	0	0	1.3	1.33
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	4	0	0	1.3	1.33
Non-Insect taxa	Hyalella	Hyalella	0	2	0	0.7	0.67
Trichoptera	Glossosomatidae	Culoptila	0	2	0	0.7	0.67
			576	**424**	**444**	**481.3**	**47.68**

MO_LPPC_DS01	Summer 2015	1/2 subsample					
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Average**	**SE**
Diptera	Tipulidae	Limnophila	240	108	168	172.0	38.16
Diptera	Simuliidae	Simulium	20	94	40	51.3	22.10
Non-Insect taxa	Oligochaeta	Lumbriculidae	20	38	80	46.0	17.78
Ephemeroptera	Ephemerella	Ephemerella excrucians	38	20	18	25.3	6.36
Diptera	Tipulidae	Hexatoma	50	6	10	22.0	14.05
Non-Insect taxa	Physa_Physella	Physella acuta	14	28	16	19.3	4.37
Coleoptera	Optioservus	Optioservus quadrimaculatus	8	20	30	19.3	6.36
Trichoptera	Uneonidae	Neothremma alicia	6	8	24	12.7	5.70
Hemiptera	Corixidae	Corixidae	34	0	2	12.0	11.02
Non-Insect taxa	Turbellaria	Turbellaria	14	6	12	10.7	2.40
Trichoptera	Brachycentrus	Brachycentrus occidentalis	4	6	22	10.7	5.70
Trichoptera	Oecetis	Oecetis avara	0	4	20	8.0	6.11
Trichoptera	Lepidostoma	Lepidostoma	6	2	16	8.0	4.16
Plecoptera	Perlodidae	Megarcys	6	10	6	7.3	1.33
Non-Insect taxa	Oligochaeta	Tubificidae	10	2	4	5.3	2.40
Ephemeroptera	Baetis	Baetis tricaudatus	6	4	6	5.3	0.67
Ephemeroptera	Epeorus	Epeorus albertae	6	8	2	5.3	1.76
Ephemeroptera	Paraleptophlebia	Paraleptophlebia	4	2	8	4.7	1.76
Trichoptera	Glossosomatidae	Glossosoma	6	8	0	4.7	2.40
Plecoptera	Chloroperlidae	Paraperla	4	4	4	4.0	0.00
Coleoptera	Zaitzevia	Zaitzevia	0	4	6	3.3	1.76
Diptera	Orthocladiinae	Nostoccocladius	2	6	0	2.7	1.76
Ephemeroptera	Rhithrogena	Rhithrogena	0	6	2	2.7	1.76
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	0	4	4	2.7	1.33
Diptera	Tanypodinae	Thienemannimyia gr.	4	0	2	2.0	1.15
Non-Insect taxa	Pisidiidae	Pisidium	0	0	4	1.3	1.33
Non-Insect taxa	Caecidotea	Caecidotea	0	4	0	1.3	1.33
Non-Insect taxa	Corophium	Corophium	0	4	0	1.3	1.33
Non-Insect taxa	Oligochaeta	Lumbricina	4	0	0	1.3	1.33
Coleoptera	Microcylloepus pusillis	Microcylloepus pusillis	4	0	0	1.3	1.33
Coleoptera	Stenelmis	Stenelmis	4	0	0	1.3	1.33
Trichoptera	Hydroptila	Hydroptila	0	0	4	1.3	1.33
Non-Insect taxa	Pisidiidae	Sphaerium	0	2	0	0.7	0.67
Diptera	Ceratopogonidae	Probezzia	0	0	2	0.7	0.67
Diptera	Orthocladiinae	Eukiefferella	2	0	0	0.7	0.67
Diptera	Orthocladiinae	Pagastia	0	2	0	0.7	0.67
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	2	0	0	0.7	0.67
Plecoptera	Chloroperlidae	Suwallia	2	0	0	0.7	0.67
Plecoptera	Pteronarcys	Pteronarcys californica	0	2	0	0.7	0.67
Plecoptera	Hesperoperla pacifica	Hesperoperla pacifica	0	0	2	0.7	0.67
Trichoptera	Hydropsyche_Ceratops	Hydropsyche	0	2	0	0.7	0.67
Trichoptera	Uneonidae	Neophylax splendans	0	0	2	0.7	0.67
		Totals	520	414	516	483.3	34.69

MO_Craig_US01	Summer 2015		1/2ss	1/2ss	1/2ss		
Order	**OTUname2**	**Final ID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	74	90	138	100.7	19.23
Diptera	Chironominae	Microtendipes	138	86	70	98.0	20.53
Ephemeroptera	Baetis	Baetis tricaudatus	68	96	52	72.0	12.86
Non-Insect taxa	Oligochaeta	Lumbricina	60	46	62	56.0	5.03
Coleoptera	Optioservus	Optioservus quadrimaculatus	38	50	48	45.3	3.71
Ephemeroptera	Ephemerella	Ephemerella excrucians	42	42	32	38.7	3.33
Trichoptera	Oecetis	Oecetis avara	30	36	50	38.7	5.93
Non-Insect taxa	Turbellaria	Turbellaria	14	16	26	18.7	3.71
Non-Insect taxa	Oligochaeta	Tubificidae	22	8	26	18.7	5.46
Non-Insect taxa	Physa_Physella	Physella acuta	2	12	8	7.3	2.91
Trichoptera	Hydroptila	Hydroptila	6	6	4	5.3	0.67
Non-Insect taxa	Caecidotea	Caecidotea	4	4	6	4.7	0.67
Non-Insect taxa	Oligochaeta	Lumbriculidae	4	2	4	3.3	0.67
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	2	4	2	2.7	0.67
Non-Insect taxa	Nematoda	Nematoda	4	2	2	2.7	0.67
Non-Insect taxa	Hyalella	Hyalella	6	0	0	2.0	2.00
Diptera	Orthocladiinae	Cricotopus trifascia	2	2	2	2.0	0.00
Trichoptera	Cheumatopsyche	Cheumatopsyche	0	4	2	2.0	1.15
Non-Insect taxa	Pisidiidae	Pisidium	0	0	4	1.3	1.33
Non-Insect taxa	Hirudina	Erpobdella punctata	0	0	2	0.7	0.67
Non-Insect taxa	Glossiphoniidae	Glossiphonia complanata	0	0	2	0.7	0.67
Non-Insect taxa	Hirudina	Helobdella stagnalis	0	0	2	0.7	0.67
Diptera	Chironominae	Polypedilum	0	2	0	0.7	0.67
Ephemeroptera	Heptagenia	Heptagenia	0	2	0	0.7	0.67
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	0	0	2	0.7	0.67
		Totals	**516**	**510**	**546**	**524.0**	**11.14**

MO_Dear_US01	Summer 2015		1/2sub	1/2sub	1/2sub		
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Trichoptera	Cheumatopsyche	Cheumatopsyche	266	331	261	286.0	22.55
Ephemeroptera	Baetis	Baetis tricaudatus	99	78	81	86.0	6.56
Non-Insect taxa	Turbellaria	Turbellaria	66	72	79	72.3	3.76
Coleoptera	Optioservus	Optioservus quadrimaculatus	54	68	65	62.3	4.26
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	42	57	62	53.7	6.01
Non-Insect taxa	Physa_Physella	Physella acuta	32	44	55	43.7	6.64
Trichoptera	Oecetis	Oecetis avara	28	31	25	28.0	1.73
Non-Insect taxa	Oligochaeta	Lumbricina	22	23	10	18.5	4.25
Diptera	Chironominae	Microtendipes	24	16	15	18.3	2.85
Ephemeroptera	Ephemerella	Ephemerella excrucians	21	16	18	18.3	1.45
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	15	20	11	15.1	2.69
Diptera	Simuliidae	Simulium	15	18	12	15.0	1.73
Diptera	Orthocladiinae	Cricotopus trifascia	12	21	8	13.7	3.84
Non-Insect taxa	Caecidotea	Caecidotea	8	12	16	12.0	2.31
Diptera	Orthocladiinae	Cricotopus	8	13	7	9.2	1.72
Non-Insect taxa	Oligochaeta	Lumbriculidae	5	8	14	9.0	2.65
Trichoptera	Helicopsyche	Helicopsyche borealis	5	14	6	8.1	3.15
Non-Insect taxa	Crangonyx	Crangonyx	5	11	6	7.3	1.86
Coleoptera	Zaitzevia	Zaitzevia	7	4	7	6.0	1.00
Non-Insect taxa	Oligochaeta	Tubificidae	4	5	6	4.8	0.44
Trichoptera	Ceraclea	Ceraclea	5	4	3	4.0	0.41
Lepidoptera	Petrophila	Petrophila	2	4	4	3.0	0.76
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	2	5	3	3.0	1.04
Non-Insect taxa	Nematoda	Nematoda	2	5	2	3.0	1.23
Non-Insect taxa	Hyalella	Hyalella	3	4	2	2.9	0.47
Diptera	Tanypodinae	Thienemannimyia gr.	2	2	4	2.4	0.79
Non-Insect taxa	Hirudina	Erpobdella punctata	1	1	1	1.0	0.00
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	1	1	0	0.7	0.33
		Totals	**753.5**	**888**	**781**	**807.3**	**41.08**

MO_Dearborn_DS01	Summer 2015		1/1 sub	1/1 sub	1/1 sub		
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Average**	**SE**
Trichoptera	Oecetis	Oecetis avara	0	6	22	9.3	6.57
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	5	1	6	4.0	1.53
Non-Insect taxa	Physa_Physella	Physella acuta	8	1	1	3.3	2.33
Trichoptera	Lepidostoma	Lepidostoma	0	1	8	3.0	2.52
Diptera	Tipulidae	Hexatoma	1	0	5	2.0	1.53
Coleoptera	Zaitzevia	Zaitzevia parvula	0	2	3	1.7	0.88
Ephemeroptera	Ephemera simulans	Ephemera simulans	1	3	0	1.3	0.88
Plecoptera	Chloroperlidae	Paraperla	0	2	2	1.3	0.67
Trichoptera	Glossosomatidae	Glossosoma	0	4	0	1.3	1.33
Coleoptera	Microcylloepus pusillis	Microcylloepus pusillis	1	0	2	1.0	0.58
Non-Insect taxa	Turbellaria	Turbellaria	0	1	1	0.7	0.33
Non-Insect taxa	Oligochaeta	Lumbriculidae	0	0	2	0.7	0.67
Coleoptera	Optioservus	Optioservus quadrimaculatus	1	0	1	0.7	0.33
Ephemeroptera	Ephemerella	Ephemerella excrucians	0	1	1	0.7	0.33
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	0	0	2	0.7	0.67
Trichoptera	Limnephilidae	Pycnopsyche	1	1	0	0.7	0.33
Odonata	Ophiogomphus	Ophiogomphus	2	0	0	0.7	0.67
Non-Insect taxa	Acarina	Acarina	1	0	0	0.3	0.33
Non-Insect taxa	Pisidiidae	Pisidium	0	0	1	0.3	0.33
Non-Insect taxa	Oligochaeta	Tubificidae	0	0	1	0.3	0.33
Coleoptera	Stenelmis	Stenelmis	0	0	1	0.3	0.33
Diptera	Dolichopoodidae	Dolichopoodidae	1	0	0	0.3	0.33
Diptera	Chironominae	Microtendipes	0	0	1	0.3	0.33
Diptera	Tanypodinae	Thienemannimyia gr.	0	0	1	0.3	0.33
Ephemeroptera	Ameletus	Ameletus	0	0	1	0.3	0.33
Ephemeroptera	Plauditus punctiventris	Plauditus punctiventris	0	0	1	0.3	0.33
Plecoptera	Hesperoperla pacifica	Hesperoperla pacifica	0	0	1	0.3	0.33
Trichoptera	Uneonidae	Neophylax splendans	0	0	1	0.3	0.33
Hemiptera	Corixidae	Corixidae	0	0	1	0.3	0.33
		Totals	**22**	**23**	**66**	**37.0**	**14.50**

MO_Hardy_DS01	Summer 2015		1/4 sub	1/4 sub	1/4 sub		
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Ephemeroptera	Baetis	Baetis tricaudatus	128	100	188	138.7	25.96
Coleoptera	Optioservus	Optioservus quadrimaculatus	124	88	136	116.0	14.42
Ephemeroptera	Ephemerella	Ephemerella excrucians	40	80	148	89.3	31.52
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	20	28	92	46.7	22.78
Non-Insect taxa	Oligochaeta	Tubificidae	52	8	36	32.0	12.86
Diptera	Simuliidae	Simulium	4	24	16	14.7	5.81
Diptera	Orthocladiinae	Cricotopus	12	4	24	13.3	5.81
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	8	24	4	12.0	6.11
Diptera	Orthocladiinae	Nostoccocladius	12	8	12	10.7	1.33
Ephemeroptera	Heptagenia	Macaffertium terminatum	16	0	16	10.7	5.33
Trichoptera	Cheumatopsyche	Cheumatopsyche	12	12	4	9.3	2.67
Diptera	Ceratopogonidae	Bezzia	0	0	24	8.0	8.00
Diptera	Chironominae	Pseudochironomus	4	4	16	8.0	4.00
Diptera	Tanypodinae	Thienemannimyia gr.	4	8	12	8.0	2.31
Non-Insect taxa	Pisidiidae	Sphaerium	8	4	8	6.7	1.33
Diptera	Chironominae	Polypedilum	8	0	12	6.7	3.53
Trichoptera	Hydroptila	Hydroptila	0	0	20	6.7	6.67
Diptera	Chironominae	Cryptochironomus	0	0	16	5.3	5.33
Diptera	Chironominae	Microtendipes	16	0	0	5.3	5.33
Ephemeroptera	Plauditis	Plauditus punctiventris	0	4	12	5.3	3.53
Non-Insect taxa	Hyalella	Hyalella	4	0	8	4.0	2.31
Coleoptera	Microcylloepus pusillis	Microcylloepus pusillis	4	8	0	4.0	2.31
Diptera	Orthocladiinae	Eukiefferella	0	0	12	4.0	4.00
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	0	12	0	4.0	4.00
Non-Insect taxa	Caecidotea	Caecidotea	4	4	0	2.7	1.33
Non-Insect taxa	Turbellaria	Turbellaria	4	4	0	2.7	1.33
Diptera	Orthocladiinae	Tvetenia bavarica	0	0	8	2.7	2.67
Trichoptera	Helicopsyche	Helicopsyche borealis	0	4	4	2.7	1.33
Trichoptera	Polycentropidae	Polycentropus	0	0	8	2.7	2.67
Non-Insect taxa	Physa_Physella	Physella acuta	0	0	4	1.3	1.33
Non-Insect taxa	Ancyliidae	Ferrissia rivularis	0	0	4	1.3	1.33
Non-Insect taxa	Orconectes virilis	Orconectes virilis	0	0	4	1.3	1.33
Diptera	Orthocladiinae	Rheocricotopus	0	4	0	1.3	1.33
Ephemeroptera	Heptagenidae	Ecdyonurus	4	0	0	1.3	1.33
Plecoptera	Pelodidae	Isoperla	4	0	0	1.3	1.33
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	0	4	0	1.3	1.33
Trichoptera	Limnephilidae	Limnephilus	4	0	0	1.3	1.33
Hemiptera	Corixidae	Corixidae	0	0	4	1.3	1.33
		Totals	**496**	**436**	**852**	**594.7**	**129.83**

MO_Cascade_US01	MO_Cascade_01	Summer 2015	1/2ss	1/4ss	1/4ss		
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Coleoptera	Optioservus	Optioservus quadrimaculatus	66	168	100	111.3	29.99
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	64	104	68	78.7	12.72
Non-Insect taxa	Caecidotea	Caecidotea	22	128	16	55.3	36.37
Ephemeroptera	Baetis	Baetis tricaudatus	50	60	36	48.7	6.96
Non-Insect taxa	Physa_Physella	Physella acuta	50	8	40	32.7	12.67
Non-Insect taxa	Pisidiidae	Sphaerium	26	16	32	24.7	4.67
Trichoptera	Hydroptila	Hydroptila	14	16	24	18.0	3.06
Diptera	Chironominae	Rheotanytarsus	6	40	0	15.3	12.45
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	2	40	0	14.0	13.01
Non-Insect taxa	Turbellaria	Turbellaria	16	20	4	13.3	4.81
Trichoptera	Oecetis	Oecetis avara	4	36	0	13.3	11.39
Diptera	Chironominae	Polypedilum	6	28	4	12.7	7.69
Ephemeroptera	Plauditus	Plauditus punctiventris	10	20	4	11.3	4.67
Non-Insect taxa	Oligochaeta	Lumbriculidae	4	28	0	10.7	8.74
Diptera	Orthocladiinae	Cricotopus	16	16	0	10.7	5.33
Diptera	Chironominae	Microtendipes	4	12	8	8.0	2.31
Diptera	Tanypodinae	Thienemannimyia gr.	12	12	0	8.0	4.00
Trichoptera	Helicopsyche	Helicopsyche borealis	8	8	8	8.0	0.00
Non-Insect taxa	Oligochaeta	Tubificidae	10	12	0	7.3	3.71
Ephemeroptera	Heptagenia	Ecdyonurus simpliciodes	2	16	4	7.3	4.37
Ephemeroptera	Heptagenia	Heptagenia	2	8	8	6.0	2.00
Trichoptera	Cheumatopsyche	Cheumatopsyche	8	4	4	5.3	1.33
Diptera	Tipulidae	Hexatoma	2	12	0	4.7	3.71
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	2	8	4	4.7	1.76
Non-Insect taxa	Oligochaeta	Lumbricina	8	0	4	4.0	2.31
Coleoptera	Microcylloepus	Microcylloepus pusillis	6	0	4	3.3	1.76
Ephemeroptera	Ephemera	Ephemera simulans	4	0	4	2.7	1.33
Hemiptera	Corixidae	Corixidae	2	4	0	2.0	1.15
Ephemeroptera	Ephemerella	Ephemerella excrucians	2	4	0	2.0	1.15
Ephemeroptera	Choroterpes	Choroterpes	2	0	4	2.0	1.15
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	4	0	0	1.3	1.33
Lepidoptera	Petrophila	Petrophila	0	0	4	1.3	1.33
Diptera	Orthocladiinae	Cricotopus trifascia	0	0	4	1.3	1.33
Diptera	Simuliidae	Simulium	0	0	4	1.3	1.33
Ephemeroptera	Ameletus	Ameletus	0	0	4	1.3	1.33
Plecoptera	Hesperoperla pacifica	Hesperoperla pacifica	0	0	4	1.3	1.33
Trichoptera	Polycentropidae	Polycentropus	0	4	0	1.3	1.33
Trichoptera	Limnephilidae	Onocomoecus unicolor	0	4	0	1.3	1.33
Odonata	Ophiogomphus	Ophiogomphus severus	4	0	0	1.3	1.33
Non-Insect taxa	Orconectes	Orconectes virilis	2	0	0	0.7	0.67
Diptera	Chironominae	Phaenopsectra	2	0	0	0.7	0.67
Diptera	Tipulidae	Limonia	2	0	0	0.7	0.67
Diptera	Tipulidae	Limnophila	2	0	0	0.7	0.67
Ephemeroptera	Baetis	Baetis intercalaris	2	0	0	0.7	0.67
Ephemeroptera	Heptagenia	Macaffertium terminatum	2	0	0	0.7	0.67
Trichoptera	Nectopsyche	Nectopsyche	2	0	0	0.7	0.67
Trichoptera	Limnephilidae	Pycnopsyche	2	0	0	0.7	0.67
		Totals	**454**	**836**	**400**	**563.3**	**137.22**

Appendix D. Macroinvertebate taxa list and abundance from MDEQ (2007).

Montana Bioassessment Report

Waterbody Name: Missouri River
Benthic Sample ID: 11350
Station ID: M09MISSR01
Rep. Num 0
Reference Status:
STORET Activity ID: M09MISSR01
Site Classification: LowValley
Collection Date: 07/11/2001
Latitude: 46.143056
Collection Method: UNKNOWN
Longitude: -111.412778
Total Number of Individuals in Sample: 398

Sample Taxa List

Order:	*OTU name:*	*FinalID:*	*Individuals*	*Tol Val:*	*FFG:*	*Habit:*
Acarina	Acarina	Acarina	2	5	PR	"SW/10%, CN/90%"
Basommatop	Physa_Physella	Physa	3	8	CG	CN
Coleoptera	Microcylloepus	Microcylloepus	10	5	CG	"CN/50%, BU/50%"
Diptera	Chironominae	Cryptochironomus	1	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Polypedilum	38	7	CG/CF/PR	BU/CN/SP
Diptera	Orthocladiinae	Cricotopus trifascia	3		CG/SC	SP/BU
Diptera	Orthocladiinae	Nanocladius	3		CG/SC	SP/BU
Diptera	Orthocladiinae	Tvetenia	1		CG/SC	SP/BU
Diptera	Simuliidae	Simulium	7	6	CF	CN
Diptera	Tanypodinae	Thienemannimyia	1		PR	SP/BU
Ephemeropte	Baetis	Baetis tricaudatus	56	5	CG	"SW/10%, CN/90%"
Ephemeropte	Choroterpes	Choroterpes	7	2	CG	CN/SP
Ephemeropte	Tricorythodes	Tricorythodes minutus	105	4	CG	CN/SP
Haplotaxida	Oligochaeta	Limnodrilus hoffmeisteri	2	8	CG	BU
Haplotaxida	Oligochaeta	Nais behningi	6	8	CG	BU
Haplotaxida	Oligochaeta	Nais bretscheri	1	8	CG	BU
Non-Insect ta	Nematoda	Nematoda	1	5	unk	BU
Trichoptera	Brachycentrus	Brachycentrus occidentalis	6	1	CF	CN
Trichoptera	Ceraclea	Ceraclea	1	3	CG	SP/CN
Trichoptera	Cheumatopsyche	Cheumatopsyche	43	5	CF	CN
Trichoptera	Hydropsyche_Cera	Hydropsyche	14	5	CF	CN
Trichoptera	Hydroptila	Hydroptila	62	6	PH	CN
Trichoptera	Oecetis	Oecetis	3	8	PR	CN/SP
Tricladida	Turbellaria	Dugesia	19	4	CG/PR	SP
VENEROIDA	Pisidiidae	SPHAERIIDAE	3	8	CF	BU

Montana Bioassessment Report

Waterbody Name: MISSOURI RIVER U/S TOSTON DAM
Benthic Sample ID: 14739
Station ID: M09MISSR04
Rep. Num 0
Reference Status:
STORET Activity ID: 4215-M
Site Classification: LowValley
Collection Date: 09/08/2005
Latitude: 46.1232642
Collection Method: KICK
Longitude: -111.4237363
Total Number of Individuals in Sample: 301

Veneroida	Pisidiidae	Pisidiidae	1	8	CF	BU

Montana Bioassessment Report

Waterbody Name: MISSOURI RIVER D/S LITTLE PRICKLY PEAR **Benthic Sample ID:** 14740

Station ID: M12MISSR01 **Rep. Num** 0

Reference Status: **STORET Activity ID:** 4216-M

Site Classification: LowValley **Collection Date:** 09/09/2005

Latitude: 47.02584274 **Collection Method:** KICK

Longitude: -112.0155291 **Total Number of Individuals in Sample:** 330

Sample Taxa List

Order:	*OTU name:*	*FinalID:*	*Individuals*	*Tol Val:*	*FFG:*	*Habit:*
Amphipoda	Hyalella	Hyalella	16	8	CG	SW/SP
Arhynchobde	Erpobdellidae	Erpobdella	1	8	PR	SW
Basommatop	Lymnaeidae	Stagnicola	1	6	CG	CN
Basommatop	Physidae	Physidae	3	8	CG	CN
Basommatop	Planorbidae	Gyraulus	2	6	CG	CN
Coleoptera	Haliplus	Haliplus	1	8	PH	:N,CM (la), SW,CM (ad
Coleoptera	Optioservus	Optioservus	7	5	SC	"CN/50%, BU/50%"
Diptera	Ceratopogoninae	Ceratopogoninae	3	6	PR/CG	SP/BU/SW
Diptera	Chironominae	Microtendipes	15	7	CG/CF/PR	BU/CN/SP
Diptera	Diamesinae	Potthastia longimana Gr.	1	4	CG	sp
Diptera	Orthocladiinae	Cricotopus bicinctus	2		CG/SC	SP/BU
Diptera	Orthocladiinae	Cricotopus trifascia	5		CG/SC	SP/BU
Diptera	Orthocladiinae	Eukiefferiella Devonica Gr.	4		CG/SC	SP/BU
Diptera	Orthocladiinae	Orthocladius	6		CG/SC	SP/BU
Diptera	Orthocladiinae	Tvetenia vitracies	1		CG/SC	SP/BU
Diptera	Simuliidae	Simuliidae	1	6	CF	CN
Diptera	Simuliidae	Simulium	10	6	CF	CN
Diptera	Tanypodinae	Thienemannimyia Gr.	3		PR	SP/BU
Ephemeropte	Baetis	Baetis tricaudatus	5	5	CG	"SW/10%, CN/90%"
Ephemeropte	Callibaetis	Callibaetis	5	9	CG	"SW/10%, CN/90%"
Ephemeropte	Tricorythodes	Tricorythodes	5	4	CG	CN/SP
Haplotaxida	Oligochaeta	Tubificidae	40	8	CG	BU
Hemiptera	Corixidae	Cenocorixa	2	9	PH/PR	SW
Hemiptera	Corixidae	Corixidae	2	9	PH/PR	SW
Hemiptera	Corixidae	Sigara	1	9	PH/PR	SW
Heterostroph	Valvata	Valvata	45	3	SC	CM
Isopoda	Asellidae	Caecidotea	23	8	CG	"SW/25%, SP/75%"
Lepidoptera	Lepidoptera	Petrophila	1	7	SH	CM
Lumbriculida	Oligochaeta	Lumbriculidae	1	8	CG	BU
Neotaenioglo	Potamopyrgus	Potamopyrgus antipodarum	36		SC	unk
Non-Insect ta	Nematoda	Nematoda	46	5	unk	BU
Non-Insect ta	Turbellaria	Turbellaria	2	4	CG/PR	SP
Not in I.T.I.S	Acarina	Acari	9	5	PR	"SW/10%, CN/90%"
Odonata	Coenagrionidae	Enallagma	2	7	PR	CM
Rhynchobdell	Glossiphoniidae	Helobdella stagnalis	2	9	PR	SW

Montana Bioassessment Report

Waterbody Name: MISSOURI RIVER D/S LITTLE PRICKLY PEAR **Benthic Sample ID:** 14740

Station ID: M12MISSR01 **Rep. Num** 0

Reference Status: **STORET Activity ID:** 4216-M

Site Classification: LowValley **Collection Date:** 09/09/2005

Latitude: 47.02584274 **Collection Method:** KICK

Longitude: -112.0155291 **Total Number of Individuals in Sample:** 330

Trichoptera	Cheumatopsyche	Cheumatopsyche	3	5	CF	CN
Trichoptera	Hydropsyche_Cera	Hydropsyche	8	5	CF	CN
Trichoptera	Oecetis	Oecetis	7	8	PR	CN/SP
Veneroida	Pisidiidae	Pisidiidae	3	8	CF	BU

Montana Bioassessment Report

Waterbody Name: MISSOURI RIVER @ CRAIG
Benthic Sample ID: 14741
Station ID: M12MISSR02
Rep. Num 0
Reference Status:
STORET Activity ID: 4173-M
Site Classification: LowValley
Collection Date: 09/28/2005
Latitude: 47.06722171
Collection Method: KICK
Longitude: -111.9638763
Total Number of Individuals in Sample: 317

Sample Taxa List

Order:	*OTU name:*	*FinalID:*	*Individuals*	*Tol Val:*	*FFG:*	*Habit:*
Amphipoda	Gammarus	Gammarus	1	4	CG	"SW/50%, SP/50%"
Amphipoda	Hyalella	Hyalella	66	8	CG	SW/SP
Basommatop	Lymnaeidae	Stagnicola	2	6	CG	CN
Basommatop	Physidae	Physidae	1	8	CG	CN
Basommatop	Planorbidae	Gyraulus	3	6	CG	CN
Basommatop	Planorbidae	Helisoma	6	6	CG	CN
Copepoda	Copepoda	Copepoda	2		unk	SW
Decapoda	Cambaridae	Orconectes	1		CG	"SP/75%, BU/25%"
Diptera	Chironominae	Chironomus	5	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Cryptochironomus	1	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Dicrotendipes	16	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Microtendipes	20	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Paratanytarsus	1	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Phaenopsectra	1	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Pseudochironomus	8	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Tanytarsus	1	7	CG/CF/PR	BU/CN/SP
Diptera	Diamesinae	Potthastia longimana Gr.	1	4	CG	sp
Diptera	Orthocladiinae	Cricotopus (Isocladius)	1		CG/SC	SP/BU
Diptera	Orthocladiinae	Cricotopus trifascia	3		CG/SC	SP/BU
Diptera	Orthocladiinae	Orthocladius	2		CG/SC	SP/BU
Diptera	Tanypodinae	Procladius	4		PR	SP/BU
Diptera	Tanypodinae	Thienemannimyia Gr.	5		PR	SP/BU
Ephemeropte	Baetis	Baetis tricaudatus	4	5	CG	"SW/10%, CN/90%"
Ephemeropte	Caenis	Caenis	43	8	CG	"SP/75%, CM/90%"
Ephemeropte	Callibaetis	Callibaetis	4	9	CG	"SW/10%, CN/90%"
Ephemeropte	Tricorythodes	Tricorythodes	29	4	CG	CN/SP
Haplotaxida	Oligochaeta	Naididae	1	8	CG	BU
Hemiptera	Corixidae	Trichocorixa	5	9	PH/PR	SW
Heterostroph	Valvata	Valvata	3	3	SC	CM
Isopoda	Asellidae	Caecidotea	52	8	CG	"SW/25%, SP/75%"
Lepidoptera	Lepidoptera	Petrophila	2	7	SH	CM
Non-Insect ta	Nematoda	Nematoda	1	5	unk	BU
Non-Insect ta	Ostracoda	Ostracoda	1		unk	SW
Not in I.T.I.S	Acarina	Acari	2	5	PR	"SW/10%, CN/90%"
Odonata	Coenagrionidae	Enallagma	4	7	PR	CM

Montana Bioassessment Report

Waterbody Name: MISSOURI RIVER @ CRAIG
Benthic Sample ID: 14741
Station ID: M12MISSR02
Rep. Num 0
Reference Status:
STORET Activity ID: 4173-M
Site Classification: LowValley
Collection Date: 09/28/2005
Latitude: 47.06722171
Collection Method: KICK
Longitude: -111.9638763
Total Number of Individuals in Sample: 317

Rhynchobdell	Glossiphoniidae	Helobdella stagnalis	1	9	PR	SW
Trichoptera	Cheumatopsyche	Cheumatopsyche	1	5	CF	CN
Trichoptera	Hydropsyche_Cera	Hydropsyche	4	5	CF	CN
Trichoptera	Oecetis	Oecetis	4	8	PR	CN/SP
Veneroida	Pisidiidae	Pisidiidae	5	8	CF	BU

Montana Bioassessment Report

Waterbody Name: MISSOURI RIVER D/S DEARBORN
Benthic Sample ID: 14742
Station ID: M12MISSR03
Rep. Num 0
Reference Status:
STORET Activity ID: 4218-M
Site Classification: LowValley
Collection Date: 09/28/2005
Latitude: 47.12335869
Collection Method: KICK
Longitude: -111.9239558
Total Number of Individuals in Sample: 318

Sample Taxa List

Order:	*OTU name:*	*FinalID:*	*Individuals*	*Tol Val:*	*FFG:*	*Habit:*
Amphipoda	Hyalella	Hyalella	131	8	CG	SW/SP
Arhynchobde	Erpobdellidae	Erpobdella	1	8	PR	SW
Basommatop	Lymnaeidae	Stagnicola	6	6	CG	CN
Basommatop	Physidae	Physidae	1	8	CG	CN
Basommatop	Planorbidae	Gyraulus	9	6	CG	CN
Coleoptera	Haliplus	Haliplus	2	8	PH	CN,CM (la), SW,CM (ad
Coleoptera	Optioservus	Optioservus	2	5	SC	"CN/50%, BU/50%"
Diplostraca	Cladocera	Cladocera	3		CG/CF	SW
Diptera	Chironominae	Chironomus	3	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Dicrotendipes	7	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Microtendipes	7	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Pseudochironomus	24	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Tanytarsus	1	7	CG/CF/PR	BU/CN/SP
Diptera	Diamesinae	Potthastia longimana Gr.	1	4	CG	sp
Diptera	Orthocladiinae	Cricotopus trifascia	6		CG/SC	SP/BU
Diptera	Orthocladiinae	Orthocladius	2		CG/SC	SP/BU
Diptera	Simuliidae	Simulium	1	6	CF	CN
Diptera	Tanypodinae	Thienemannimyia Gr.	1		PR	SP/BU
Ephemeropte	Baetis	Baetis tricaudatus	4	5	CG	"SW/10%, CN/90%"
Ephemeropte	Caenis	Caenis	27	8	CG	"SP/75%, CM/90%"
Ephemeropte	Callibaetis	Callibaetis	6	9	CG	"SW/10%, CN/90%"
Ephemeropte	Heptageniidae	Heptageniidae	1	2	SC	CN
Ephemeropte	Tricorythodes	Tricorythodes	5	4	CG	CN/SP
Haplotaxida	Oligochaeta	Tubificidae	4	8	CG	BU
Hemiptera	Corixidae	Corixidae	1	9	PH/PR	SW
Hemiptera	Corixidae	Sigara	3	9	PH/PR	SW
Heterostroph	Valvata	Valvata	8	3	SC	CM
Isopoda	Asellidae	Caecidotea	21	8	CG	"SW/25%, SP/75%"
Not in I.T.I.S	Acarina	Acari	1	5	PR	"SW/10%, CN/90%"
Odonata	Coenagrionidae	Enallagma	26	7	PR	CM
Trichoptera	Cheumatopsyche	Cheumatopsyche	1	5	CF	CN
Trichoptera	Hydropsyche_Cera	Hydropsyche	1	5	CF	CN
Trichoptera	Oecetis	Oecetis	1	8	PR	CN/SP

Montana Bioassessment Report

Waterbody Name: MISSOURI RIVER U/S OF SHEEP CREEK CONF **Benthic Sample ID:** 14743

Station ID: M12MISSR04 **Rep. Num** 0

Reference Status: **STORET Activity ID:** 4219-M

Site Classification: LowValley **Collection Date:** 09/28/2005

Latitude: 47.16780757 **Collection Method:** KICK

Longitude: -111.8336563 **Total Number of Individuals in Sample:** 315

Sample Taxa List

Order:	*OTU name:*	*FinalID:*	*Individuals*	*Tol Val:*	*FFG:*	*Habit:*
Amphipoda	Hyalella	Hyalella	34	8	CG	SW/SP
Basommatop	Lymnaeidae	Stagnicola	3	6	CG	CN
Coleoptera	Optioservus	Optioservus	15	5	SC	"CN/50%, BU/50%"
Diptera	Ceratopogoninae	Ceratopogoninae	1	6	PR/CG	SP/BU/SW
Diptera	Chironominae	Microtendipes	13	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Parachironomus	1	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Polypedilum	1	7	CG/CF/PR	BU/CN/SP
Diptera	Chironominae	Pseudochironomus	8	7	CG/CF/PR	BU/CN/SP
Diptera	Diamesinae	Potthastia longimana Gr.	2	4	CG	sp
Diptera	Hemerodromia	Hemerodromia	2	6	PR	SP
Diptera	Orthocladiinae	Cricotopus (Nostococladius)	1		CG/SC	SP/BU
Diptera	Orthocladiinae	Cricotopus bicinctus	1		CG/SC	SP/BU
Diptera	Orthocladiinae	Cricotopus trifascia	2		CG/SC	SP/BU
Diptera	Orthocladiinae	Eukiefferiella Devonica Gr.	3		CG/SC	SP/BU
Diptera	Orthocladiinae	Orthocladius	6		CG/SC	SP/BU
Diptera	Orthocladiinae	Synorthocladius	1		CG/SC	SP/BU
Diptera	Simuliidae	Simuliidae	10	6	CF	CN
Diptera	Simuliidae	Simulium	34	6	CF	CN
Diptera	Tanypodinae	Procladius	2		PR	SP/BU
Diptera	Tanypodinae	Thienemannimyia Gr.	3		PR	SP/BU
Ephemeropte	Baetis	Baetis tricaudatus	56	5	CG	"SW/10%, CN/90%"
Ephemeropte	Caenis	Caenis	12	8	CG	"SP/75%, CM/90%"
Ephemeropte	Ephemerella	Ephemerella inermis	9	2	CG	CN/SW
Ephemeropte	Stenonema	Stenonema	1	4	SC	CN
Ephemeropte	Tricorythodes	Tricorythodes	32	4	CG	CN/SP
Haplotaxida	Oligochaeta	Tubificidae	10	8	CG	BU
Hemiptera	Corixidae	Sigara	1	9	PH/PR	SW
Isopoda	Asellidae	Caecidotea	15	8	CG	"SW/25%, SP/75%"
Not in I.T.I.S	Acarina	Acari	3	5	PR	"SW/10%, CN/90%"
Odonata	Coenagrionidae	Enallagma	4	7	PR	CM
Trichoptera	Ceraclea	Ceraclea	1	3	CG	SP/CN
Trichoptera	Cheumatopsyche	Cheumatopsyche	5	5	CF	CN
Trichoptera	Helicopsyche	Helicopsyche borealis	4	3	SC	CN
Trichoptera	Hydropsyche_Cera	Hydropsyche	13	5	CF	CN
Trichoptera	Hydroptila	Hydroptila	1	6	PH	CN

Montana Bioassessment Report

Waterbody Name: MISSOURI RIVER U/S OF SHEEP CREEK CONF **Benthic Sample ID:** 14743

Station ID: M12MISSR04 **Rep. Num** 0

Reference Status: **STORET Activity ID:** 4219-M

Site Classification: LowValley **Collection Date:** 09/28/2005

Latitude: 47.16780757 **Collection Method:** KICK

Longitude: -111.8336563 **Total Number of Individuals in Sample:** 315

Trichoptera	Oecetis	Oecetis	4	8	PR	CN/SP
Trichoptera	Polycentropodidae	Polycentropodidae	1	6	CF	CN

Appendix E. Site Habitat and Physical Conditions

Appendix D . Habitat and Water Quality Parameters measured for the UMOWA sites visited.

2015	Toston M09MISSR01			MO_Yorks_Island			MO_LPPC_US			MO_LPPC_DS			Craig M12MISSR02			MO_DEAR_US			MO_DEAR_DS			MO_HARDY_BR			MO_Cascade		
	May	Jul	Oct	May	Jul	Oct	May	Jul	Oct	May	Jul	Oct	May	Jul	Oct	June	Aug	Oct	June	Aug	Oct	June	Aug	Oct	June	Aug	Oct
Water Temp °C	14.9	21.1	na	15	19.1	na	9.7	14.9	na	6.5	13.3	na	10	17.7	15.8	14.2	17.7	na	16.4	18.1	na	15.6	16.3	14.5	16.7	18	15.1
Conductivity (µs/cm)	210	297	na	200	301	na	242	273	na	169	260	na	248	289	290	271	295	na	250	269	na	277	284	300	288	289	303
TDS (ppm)	105	148	na	102	150	na	121	136	na	85	135	na	125	144	152	136	149	na	132	137	na	138	141	151	143	144	155
pH	7.4	7.75	na	7.5	7.65	na	7.35	7.86	na	7.3	7.85	na	7.2	8.1	7.8	7.8	8	na	7.9	7.9	na	7.7	7.99	8.1	7.75	8	8.1
Avg Sample Depth (cm)	29	24	na	26	20	na	23	20	28	23	22	35	28	29	7	25	29	28	28	27	33	35	41	35	20	26	24
Avg Sample Dist. From Bank (m)	8	12	na	6	22	na	28	32	35	23	32	33	15	12	17	7	8	9	3	8	11	5	7	9	6	9	14
% Fines in Hess	5	10	na	15	20	na	10	15	15	20	25	25	15	15	10	5	5	5	30	30	30	5	1	5	15	15	25
% Gravel Hess	25	30	na	50	40	na	60	65	70	55	50	50	65	70	60	25	25	25	55	60	60	20	24	20	75	75	60
% Cobble Hess	65	60	na	35	40	na	30	20	10	20	25	25	20	15	20	70	70	70	15	10	11	60	65	60	10	10	15
% Boulder Reach	5	5	na	0	0	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	10	15	0	0	0
Avg. Riparian Shade	0	0	na	0	0	na	0	0	0	0	0	0	10	10	10	10	10	10	0	0	0	5	5	5	5	5	5