Baseline Macroinvertebrate Monitoring 2015-2017 for the Upper Missouri River: Building a Long-term Data Set – Flushing Flow Study

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Acknowledgements

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

Executive Summary

UMOWA began the Missouri River Baseline Monitoring program in 2015, and has continued this effort into 2017. In 2015 we established seven long-term, baseline monitoring stations for sampling benthic macroinvertebrates and water chemistry within the Blue Ribbon section of the Missouri River between Wolf Creek and Cascade and two sites upstream of Canyon Ferry Lake. Aside from a long-term PPL monitoring site below Holter Dam, until the 2015 study, very few macroinvertebrate samples have been collected below the Wolf Creek Bridge (see MDEQ 2007). Therefore, the project goals of UMOWA's program are: 1) to conduct standardized and quantitative macroinvertebrate surveys to serve as the baseline standards for future monitoring efforts within this Missouri River section 2) to establish seasonal macroinvertebrate population estimates and community characteristics to assess aquatic biointegrity and 3) to understand the insect dynamics in relation to increasing aquatic macrophyte beds, algae and minimal sediment-flushing lows.

In June, July and October of 2017, we collected 70 quantitative, replicated macroinvertebrate samples, habitat data and water chemistry measurements at seven Missouri River sites. UMOWA also collected water chemistry (WQ) samples seasonally in summer and fall in 2017. Total nitrogen and phosphorus levels for the fall samples were above MDEQ's numeric nutrient standard across the sites (see UMOWA WQ Report). Other than indirect effects of increased weed bed extents, we can find no direct correlation with the Missouri River's (WQ) and macroinvertebrate population characteristics. Spring run-off events from Little Prickly Pear Creek and the Dearborn River continue to have significant effects on the densities and diversity of insect communities in the Missouri River below those tributaries, especially by adding mayfly (E), stonefly (P) and caddisfly (T) taxa (EPT taxa). At the Missouri River upstream of Little Prickly Pear Creek, we observed the highest densities of macroinvertebrates (>20,000 per m^2) and New Zealand mudsnails (>300 per m^2) since the study began; these densities were significantly "knocked-back" by high flows in June 2017, compared to summer of 2016. High densities and standing crops of *Baetis* (BWOs), *Tricorythodes* (Tricos), Chironomidae (midges), and *Ephemerella* (PMDs) in the spring samples within the Wolf Creek to Craig section "hatch-out" by the summer period leading to lowered summer densities of these taxa, and a dominance of non-insect taxa (scuds, sowbugs, worms and snails).

EPT taxa (mostly mayflies) gradually build up their lower summer populations though the fall sampling period, but are likely hampered by aquatic vegetation growth; therefore, non-insect taxa still dominate the fall benthos at most sites upstream from the Dearborn River and in the weed beds. 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 contributions were lowest. Of the 20 species of caddisflies that were collected across all sites, the net spinning caddis, *Cheumatopsyche* and the long-horned caddis, *Oecetis* were usually the most prevalent. Caddisflies were more common during the spring and summer sampling periods at some sites, but as a percentage of total EPT were usually much lower than mayflies. While stonefly taxa are not common within the Wolf Creek to Dearborn reach, 8 taxa were reported below the tributaries, especially in the spring samples. Stonefly diversity and EPT taxa richness in general increases with increasing distance from Holter Dam. Highest total taxa and EPT richness were reported at sites least affected by the dam, particularly the Missouri River near Hardy Bridge and at Cascade which are 28 and 37 miles downstream from Holter dam, respectively. The Cascade site also contained a unique benthic fauna reporting four mayfly species that were collected nowhere else in the study.

We sampled aquatic weed-beds with Hess samples (n=3) at two sites (MO_LPPC_US and MO_HARDY) during the summer and fall sampling periods in 2016 to better understand insect

communities using this abundant macro-habitat. Average macroinvertebrate densities across the sites' weed bed samples (n=12) was ~8,300 per m^2; this is more abundant than the surrounding bottom substrate at Hardy Bridge (~6,500 per m^2), but not as high as the Little Prickly Pear upstream benthic densities of ~20,000 per m^2. While aquatic weed beds are dominated by scuds, sowbugs, worms, snails and damselflies, there are 4 Baetidae mayfly species that are preferentially found in this habitat at low numbers: *Callibaetis, Acerpenna pygmaea, Plauditus punctiventris* and *Pseudocloeon*. These species add to the overall EPT diversity of the reach. Weed beds also provide the preferred habitat for damselflies (*Enallagma* and *Ishnura*) in this river section, and they averaged ~500 individuals per m^2 of weedbed. Crayfish (*Orconectes virilis*) biomass and densities were highest at sites where benthic substrate contained cobbles larger than ~6 inch diameter (Mid-Cannon, Hardy Bridge and Cascade). The riffle beetle, *Optioservus quadrimaculatus* contributed significant numbers (avg. ~1,000 individuals per m^2) to the macroinvertebrate communities of the Missouri River sites between Wolf Creek and Craig; these are not captured in any of the metrics analyzed, since they are non-EPT insects.

Overall, macroinvertebrate communities collected in 2017 resemble those reported in 2015 and 2016 with similar taxa composition; there are some steady increases in total and EPT taxa richness at the Missouri R. below Little Prickly Pear, D/S of the Dearborn, Hardy Creek and Cascade. We recorded significant reductions in Chironomidae (midges) and the % of EPT taxa in the samples, especially from sites from Wolf Creek to upstream of the Dearborn River. Increases in the percentage of non-insect taxa, largely from Turbellarian flatworms, worms and sowbugs, comprising the benthic samples was substantial in the Missouri River from Craig and upstream of the Dearborn River sites. This community shift reflects an increase in sediment build-up in many gravel areas of the stream channel, compounded with large contributions of aquatic vegetation trapping sediments. Even the flushing flow plot study could not seem to effectively reduce the numbers of non-insects in the substrates, and in the Craig FFS plot, aquatic worms actually increased after the gravels were flushed. HBI tolerance scores indicated significant organic pollution at eight of the nine (>88%) monitoring sites, and this metric has also been used as a surrogate for sediment impairment.

New Zealand mudsnails which have persisted in low densities at multiple sites in the Missouri River from Wolf Creek to Cascade have begun to substantially increase their populations upstream of Craig, especially upstream and downstream of the Little Prickly Pear Creek. High densities of the NZMS in 2016 at the MO_LPPC_US site were reduced by 66% after the flushing flows of June 2017. We postulate that NZMS population increases, overall non-insect macroinvertebrate density increases, significant caddisfly decreases and the expansion of rooted weed-beds in the Wolf Creek to Dearborn section is potentially correlated with lower spring flushing flows from Holter Dam since 2011. Future monitoring events will be focused on determining macroinvertebrate community responses (i.e., caddisflies, NZMS, non-insect taxa) to the 2017 flows, and the potentially larger flushing flows of 2018.

1.0 Introduction

UMOWA contracted Montana Biological Survey in 2017 to continue the Missouri River Baseline Monitoring program started in 2015. This study was designed to evaluate baseline status and monitoring of benthic macroinvertebrates, in the Blue Ribbon section of the Missouri River between Wolf Creek and Cascade. Until 2015 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 flushing of sediment loads, and tremendous inputs of plankton and nutrients from upstream reservoirs. These conditions promote the extensive growth 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 (2015 and 2016) were near the high end of this range (McGuire 2016). Our 2015-2016 results corroborate these high invertebrate densities between Wolf Creek and Craig averaging ~16,000 organisms per m^2 across all seasons (avg. 20,000 per m^2 in the fall) (Stagliano 2016). 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). Anecdotal data and personal experiences have noted reduced caddis hatches and the disappearance of the fall BWO hatches. Project goals are: 1) to conduct standardized and quantitative macroinvertebrate surveys 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), 3) to understand the insect dynamics in relation to increasing aquatic macrophyte beds and minimal sediment flushing lows.

2.0 Methods

2.1 Habitat and Physical Water Sampling

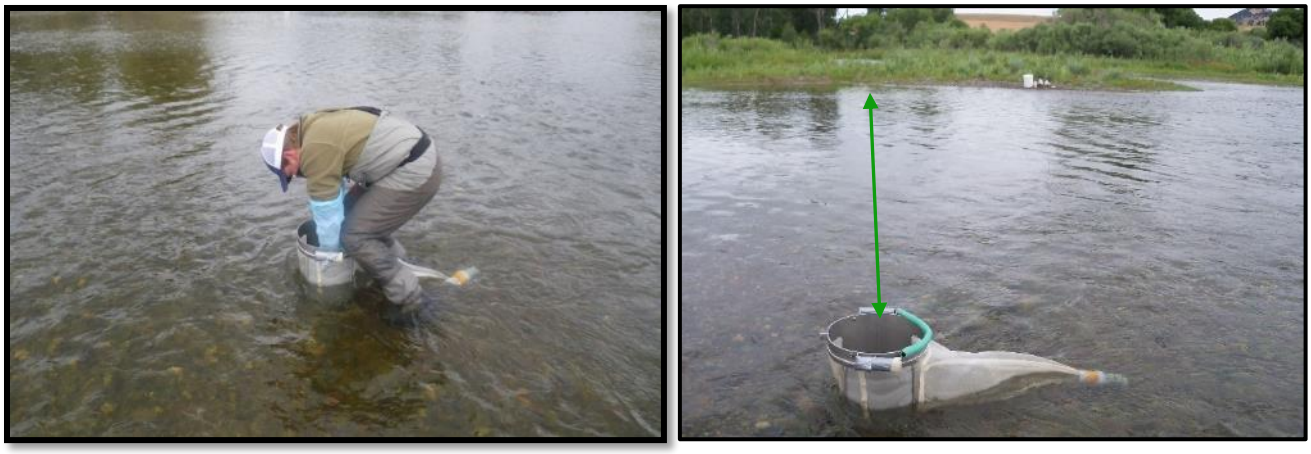
Temperature and basic physical water parameters (Total Dissolved Solids, pH, and Conductivity) were recorded at each site prior to macroinvertebrate sampling using an Oakton 10 water quality

multi-meter, calibrated for the lower conductivity range (Appendix D). A suite of water samples was also collected according to MDEQ protocols (MDEQ 2012b) and processed at the Energy Laboratories in Helena (See UMOWA Water Quality Report). 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 D).

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 Appendix D**). Three Hess samples typically capture 90% of the total taxa present in a riffle (Vinson and Hawkins 1996). Each Hess sample constitutes 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

Photo 1. Hess sampling procedure in a Missouri River riffle near Little Prickly Pear Creek (MO_LPPC_US). Distance to the greenline was measured.

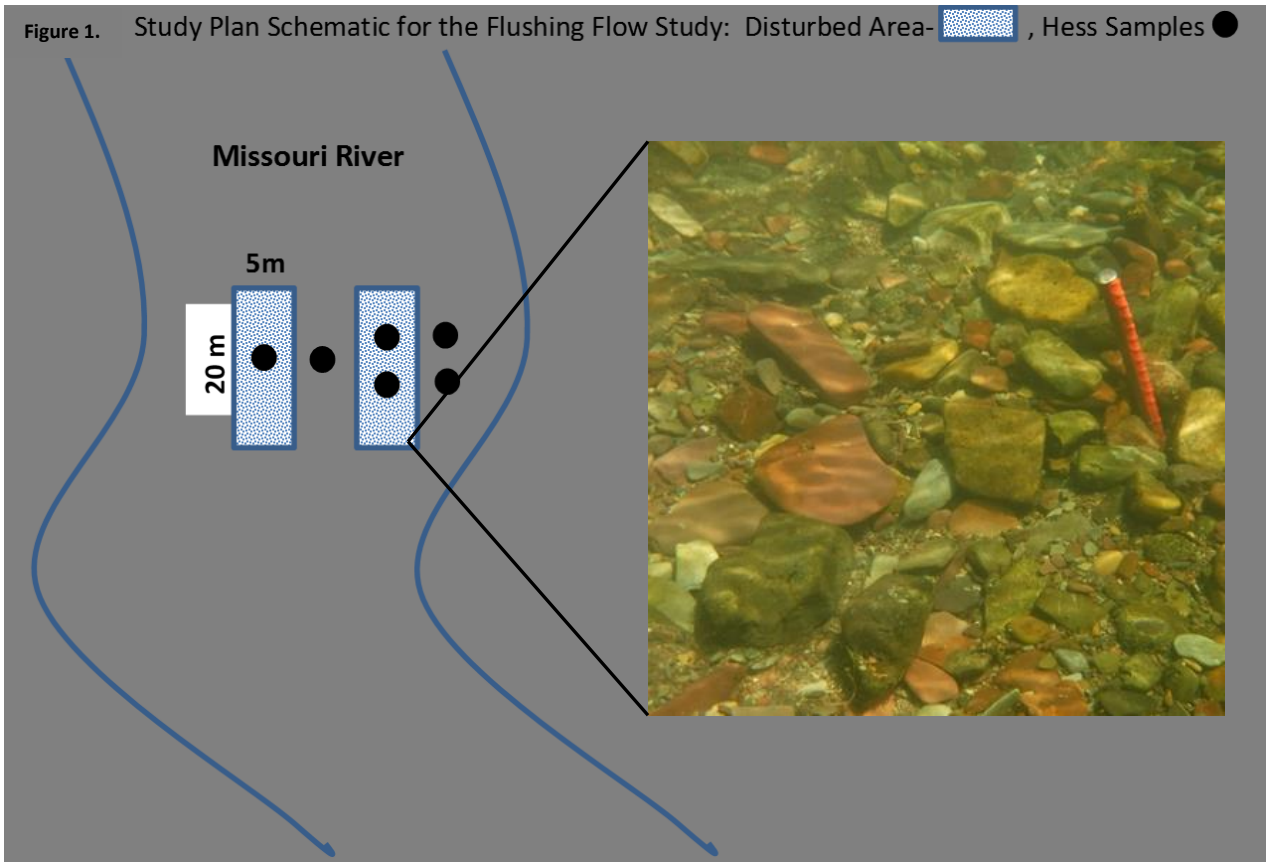


into a 40 liter bucket. By swirling the bucket with several water washes, organic material was elutriated from the inorganic (cobbles/gravels) portion onto a 500µm sieve, so that only macroinvertebrates and organic matter were transferred into 1 liter labeled sampling jars filled with 95% ethanol. The inorganic portion in the bottom of the bucket was thoroughly examined for caddisfly cases before being discarded back into the stream. Additional aquatic vegetation Hess

samples (n=3) were taken at 2 sites in established weed beds in 2016 without disturbing the bottom sediments to fully understand the macro-habitat dynamics of the insect communities in this reach of the Missouri River.

2.3 Flushing Flow Study

To simulate the effects of a spring flushing flow (FF) event, we physically disturbed (with garden rakes) replicated areas of 5 x 20m (100 square meters) of shallow, benthic gravel substrate during the historical peak run-off period (1st week of June) (**Figure 1, Appendix A: Photo 4**). We used rebar posts at the corners to mark the FF study plot boundaries (**Figure 1**). We already sampled macroinvertebrates within these treatment areas with 3 Hess samples prior to disturbance. The summer sample period included taking 3 Hess samples in the treatment area, as well as the 3 control samples taken outside the plots for the baseline study and repeated in the fall for a total of 9 additional Hess samples per site x 2 = 18 total macroinvertebrate samples to accomplish this study **(Figure 1**). To test the hypotheses, this data will be analyzed for significant differences in a BACI design (Before/After/Impact/Control); whereas "before disturbance" samples can be compared to after the post-FF disturbance as well as to adjacent control samples taken during these same periods. Organic materials (OM-plants, algae and detritus) >500 microns collected in the Hess samples were dried in a 100°C oven for 12 hours, and then weighed (grams dry mass) on a mass balance scale after the macroinvertebrates are processed. We compared the OM biomass data using the same BACI design. The time between the pre-flushing flow samples (pre-FFS) in June to post-FFS in July was 1 month and 1 week (37 days).



2.4 Taxonomic Analysis

Samples were processed and analyzed at the Montana Biological Survey laboratory in Helena. 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. These are also the insects that most fly-fisherman are concerned about matching the hatch. 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.

2.5 Sample Sites

We sampled macroinvertebrates and water chemistry at seven established monitoring sites between Wolf Creek and Cascade (**Table 1**). During the pre-runoff, spring monitoring period, we have been trying to collect the Hess samples during late-April at flows of approximately 4,300 cfs, as in 2015 and 2016. Stream flows on the Missouri River during the 2017 spring sample period were increased to ~5,500 cfs on April 17th at the Wolf Creek Bridge and ~6,000 cfs at the Cascade site; these continued to ramp up into May, therefore, a spring 2017 sample was not collected at any site (**Figure 1a**). We sampled macroinvertebrates for the summer monitoring period on July 13 and 14th when flows were ~4,100cfs at Wolf Creek bridge and ~4,380cfs at Cascade and for the fall monitoring period on Sept 27th and Oct 1st (**Figure 1a, Appendix D**); these were within days of the sampling time-frame in 2015 and 2016.

Table 1. UMOWA 2017 Sampling Study Reaches and ones that overlapped with MDEQ (2007).

Station ID	Agency	Waterbody Site Name	Latitude	Longitude
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_US	UMOWA	MISSOURI RIVER U/S DEARBORN	47.12791	-111.91092
M12MISSR03 MO_DEAR_DS	DEQ/UMOWA	MISSOURI RIVER D/S DEARBORN	47.12336	-111.92396
MO_HARDYBR M12MISSR04	DEQ/UMOWA	MISSOURI RIVER U/S OF SHEEP CREEK (HARDY BRIDGE)	47.16781	-111.83366
MO_CASCADE	UMOWA	MISSOURI RIVER AT CASCADE FAS	47.28062	-111.69113

Map 1. Study locations on the Missouri River from Holter Dam to Cascade, flow direction is to the northeast from the bottom center of the map to the top right.

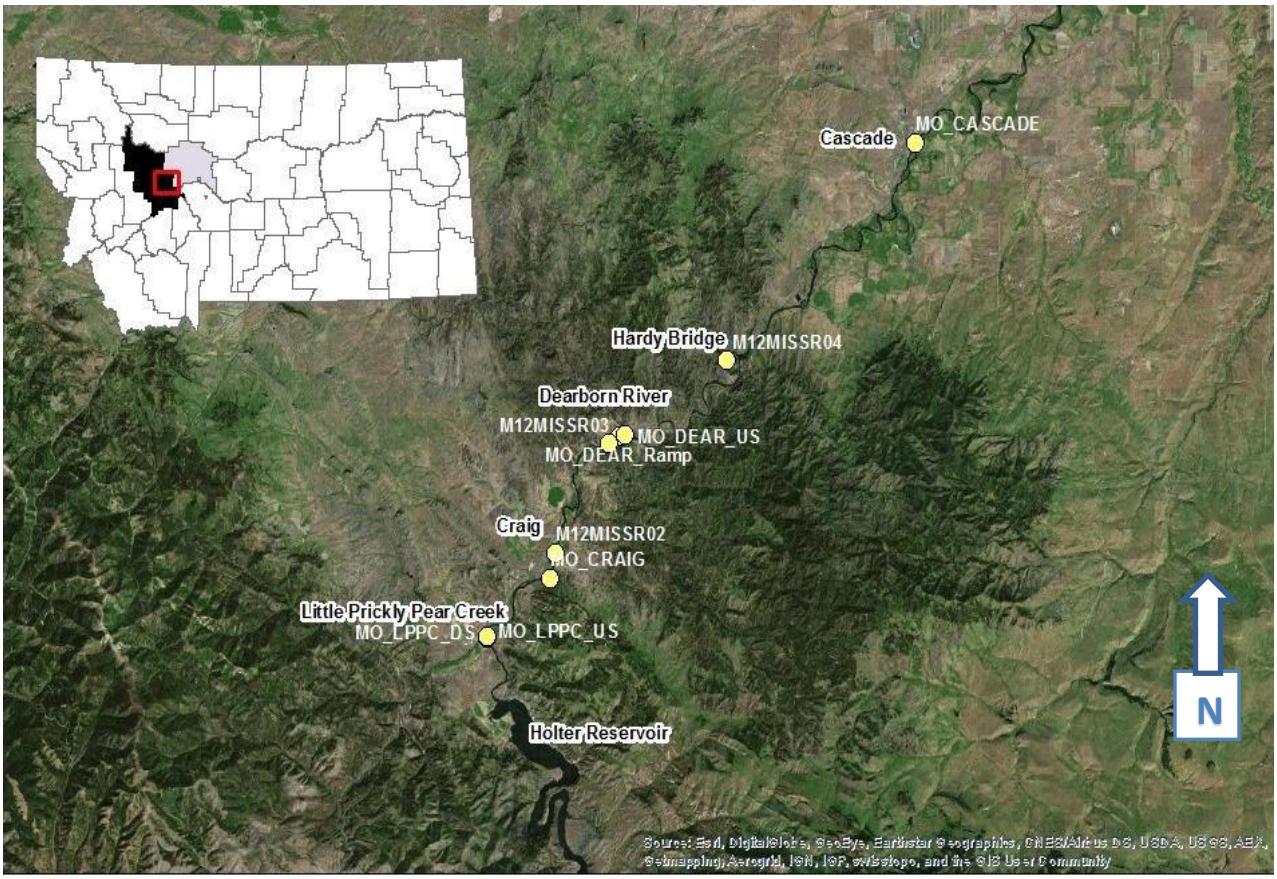


Figure 1a. USGS Station 06066500: Missouri River below Holter Dam (top) and USGS Station 06074000 at Cascade (bottom) streamflow graph for the 2017 sampling period**.** Red arrows are the seasonal sampling period dates.

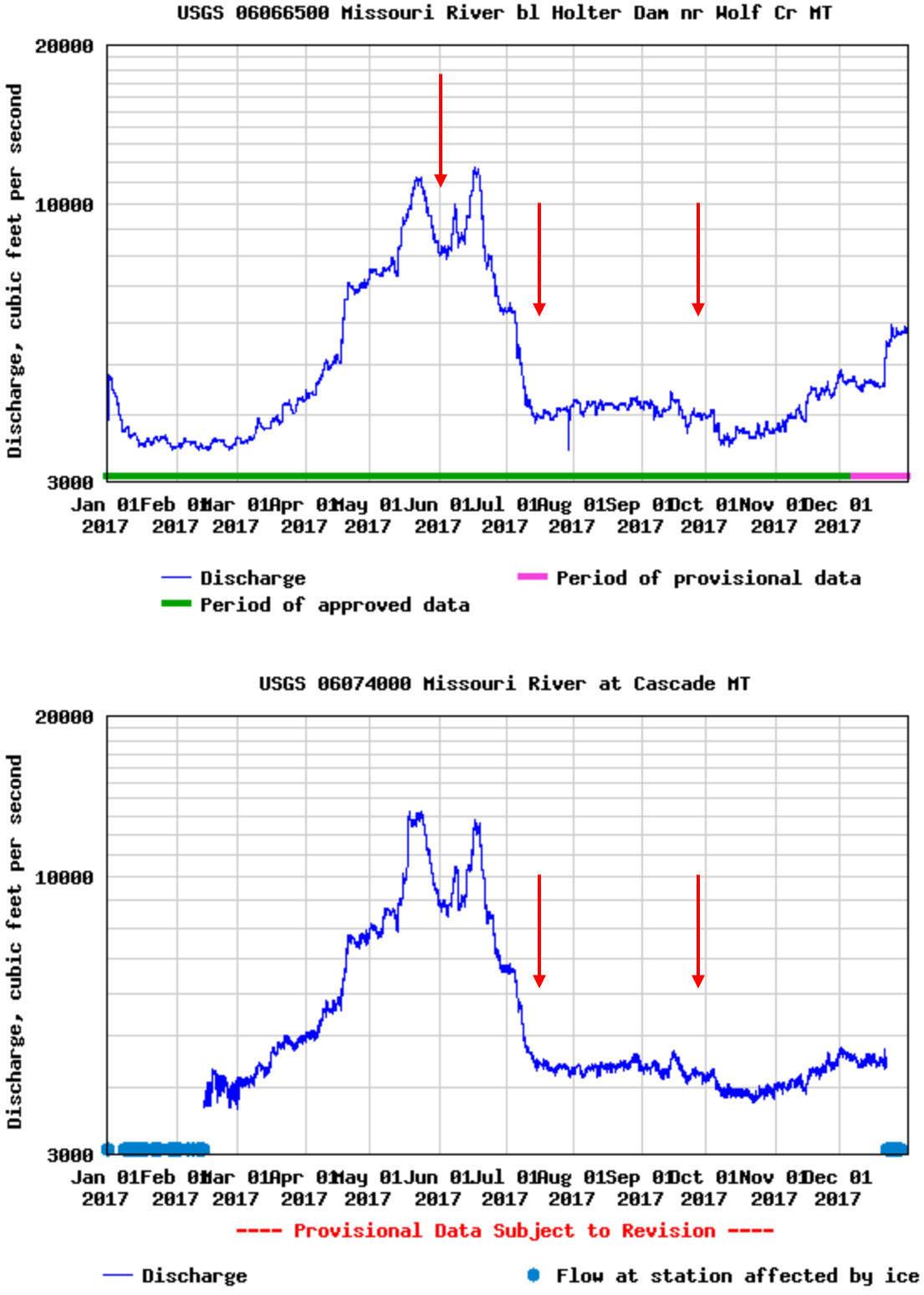
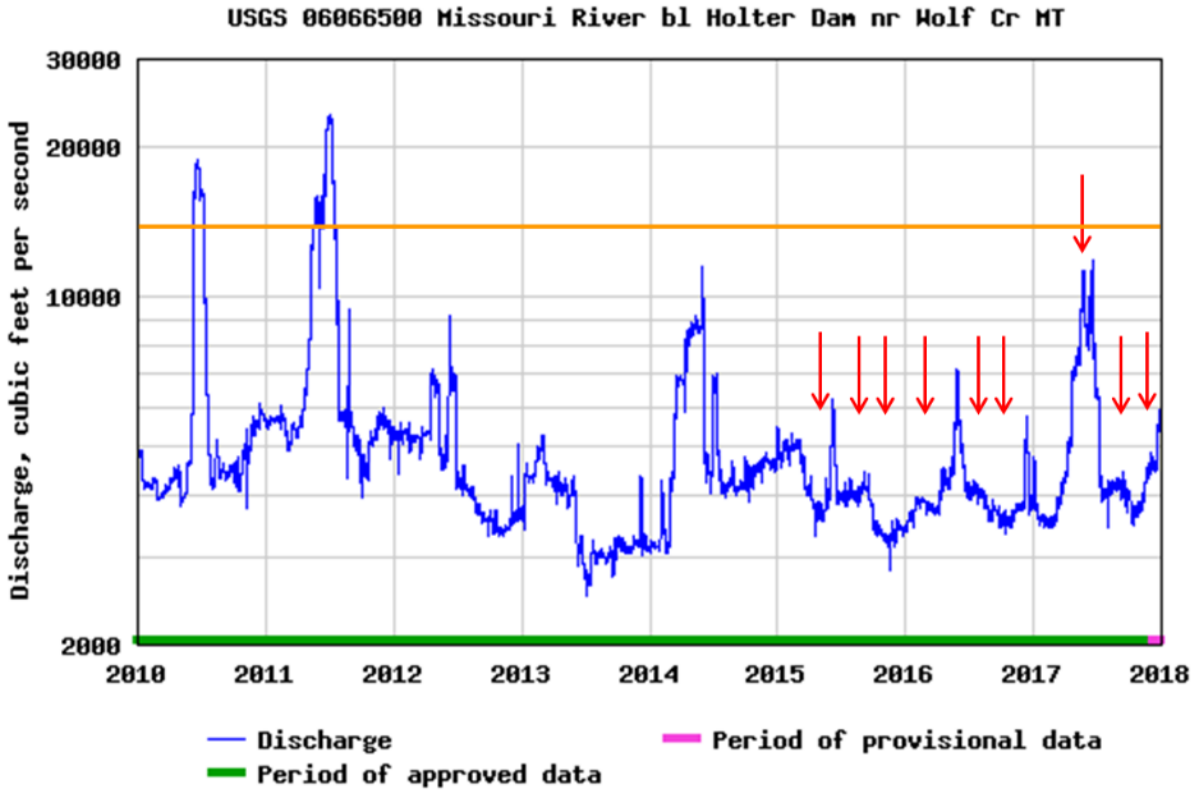


Figure 1b. USGS Station 06066500: Missouri River below Holter Dam streamflow graph for the 2010-2017 period**.** Red arrows are the seasonal sampling period dates 2015-2017. Orange line is the estimated flow (15,000 cfs) to have a sediment flushing effect (R2 Resources 1994).



3.0 Results

Overall, 116 cumulative macroinvertebrate taxa were reported from the study between 2015 and 2017; 2016 sampling added 24 taxa to the cumulative Missouri River taxa list from 2015. Many of these new taxa (10 species) were reported from the weed beds or observed at Missouri River sites below tributaries. Four mayfly species were not reported in 2016, since we discontinued the sites upstream of Canyon Ferry, but we gained additional occurrences of 3 mayfly taxa (*Callibaetis, Acerpenna pygmaea* and *Pseudocloeon*) by sampling the aquatic weed beds in 2016 (**Table 2**). Since 2015, the Missouri River U/S and D/S of LPPC (MO_LPPC_US) gained 7 EPT taxa each. No new taxa were added in 2017 from the 70 seasonal macroinvertebrate assessment samples collected between Wolf Creek Bridge and Cascade (**Appendix C**).

Densities of benthic macroinvertebrates varied significantly spatially and seasonally with the overall trend of higher densities from Wolf Creek to upstream of the Dearborn River and decreasing down to Cascade, except in 2017 where large increases in densities were observed at Hardy Creek and Cascade (**Figure 2a**). These densities were driven by large increases in %midges and % non-insects in the samples (**Figure 2b**). The Missouri River above Little Prickly Pear Creek (MO_LPPC_US) reported the highest benthic invertebrate densities of all sites, averaging ~20,000 individuals per m^2 and attained a very large standing crop, especially in the spring (~26,000 per m^2) (**Figure 2a**). Macroinvertebrate densities reported at the Craig site this fall (~30,000 per m^2) were the highest ever reported during this study (**Figure 2a**). The Missouri River upstream of the Dearborn reported significantly higher invertebrate densities in 2016, than in 2015 (**Figure 3**); while the Craig monitoring station reported significantly lower numbers than in 2015 (**Figure 3**). Relatively lower numbers of benthic invertebrates were reported from the Missouri River below Little Prickly Pear Creek (MO_LPPC_DS) and the Dearborn River (MO_DEAR_DS), as well as Hardy Creek, especially in the spring (**Figure 2a**). Low densities did not necessarily equate to lower taxa richness, as the Hardy Bridge and Cascade sites reported the lowest "non-tributary affected" populations 2016, but also had the highest taxa richness (**Figure 2a**).

Study-wide average macroinvertebrate taxa richness per site was 30.1 taxa in the spring, 29.6 in the summer and 33 taxa in the fall with no significant difference between seasons (T-test, $p>0.05$) (**Appendix B**); this is a slight increase from 2016. The most taxa rich macroinvertebrate community was again collected at the Missouri River FAS site near Cascade; these averaged 36.2 total taxa over the three seasons with a high of 45 taxa in the fall of 2017 (**Appendix B**). The combined mayfly, caddisfly and stonefly (EPT) taxa richness for the entire sampled section

totaled 50 taxa and averaged 22.3 species per site (**Table 2**), the highest cumulative EPT richness (27 spp.) was reported at Missouri River FAS site near Cascade. A perceived 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 by MDEQ in 2005. Mayfly and caddisfly taxa were more diverse and abundant than stonefly taxa at all sites (**Table 2**). There were 22 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*), often exchanging dominance at any one site depending on the season and silt or weed-bed coverage in the sampling area (**Table 2**). Of the 20 species of caddisflies that were collected across all sites, the net spinning caddis, *Cheumatopsyche,* and the long-horned caddis, *Oecetis* was usually the most prevalent (**Table 2**). Populations of other net-spinning caddis (*Hydropsyche occidentalis, H. morosa group*), micro-caddis *(Hydroptila*) and snail-cased caddis (*Helicopsyche borealis*) were also common, but not as abundant (**Table 2**). A couple of caddisfly taxa, including *Glossosoma* and *Ceraclea* appeared for the first time in summer of 2017 at the Missouri River Flushing Flow Study plot upstream from Little Prickly Pear Creek. High percentages of caddisflies comprising the %EPT were only documented at sites below tributaries (MO_LPPC_DS, MO_DEAR_DS) and at the Cascade site in the spring (**Figure 2d**). The large October caddis, *Dicosmoecus gilvipes,* occurred throughout the study reach, but was more common below the Dearborn River downstream to Cascade (**Table 2**). Caddisflies were more common during the spring and summer sampling periods at some sites than in the fall, but as a percentage of total EPT were usually much lower than mayflies (**Figure 2d**).

Stonefly (Plecoptera) taxa (8 species) were collected sporadically across the study reaches (**Table 2**). *Suwallia/Paraperla* (Yellow Sallies), *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 Rvier and Little Prickly Pear Creek) (**Table 2**). Even a couple of salmonfly (*Pteronarcys californica*) and *Skwala* individuals were reported in the samples of the Missouri River downstream of Little Prickly Pear Creek, likely washed in from the spring-flows (**Table 2**). Stonefly taxa are sporadic and increase in numbers and diversity the further distance downstream from Holter Dam; they have never been reported at PPL's site 0.8 miles below Holter Dam in the 20 years of monitoring (McGuire 2016).

The riffle beetle, *Optioservus quadrimaculatus* contributed significant numbers (avg. ~1,000 individuals per m^2) to the macroinvertebrate communities (~10%) of the Missouri River sites

between Wolf Creek and Craig (**Appendix C**); adults and larvae are always present since the adults are aquatic and remain on the bottom substrate. These are not usually captured in any of the macroinvertebrate metrics analyzed, since they are non-EPT insects.

As observed in 2015 and 2016, non-insect percentages in 2017 increased through the seasons with largest numbers in the fall, as mayflies and caddisflies hatch out and leave the benthic substrates to be dominated by scuds, sowbugs, worms and snails; this is especially noticeable at the Missouri River at Craig, upstream of Little Prickly Pear Creek and the Dearborn Rover (**Figure 2c**). On an annual basis across all sites, 2017 did not report significantly more % non-insect comprising the samples than in 2015. Weed beds were largely dominated by non-insects during all seasons (Stagliano 2016).

Lowest insect densities, as sparse as 700 individuals per m^2, were reported at the Missouri River sites below tributary streams (e.g. below Little Prickly Pear Creek in 2015 and D/S of the Dearborn River 2016) in the spring and summer, but these numbers increased rapidly by the fall sampling period to mirror population densities in adjacent Missouri River sites (**Figure 2a**).

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

Order	Species	MO_LPPC_US	MO_LPPC_US weed bed	MO_LPPC_DS	MO_Craig	MO_Dear_US	MO_Dear_DS	MO_MidCann	MO_Hardy	MO_Hardy weed bed	MO_Cascade
Mayflies	**Ephemeroptera**										
Ameletidae	*Ameletus*						x	x	x		
Baetidae	*Acerpenna pygmaea*		x							x	x
Baetidae	*Acentrella insignificans*					x	x		x		
Baetidae	*Baetis intercalaris*										X
Baetidae	***Baetis tricaudatus***	XX		x	XXX	XX	x	XX	XX		X
Baetidae	*Callibaetis*		x							X	
Baetidae	*Diphetor hageni*					x	x				x
Baetidae	*Plauditus punctiventris*		x			x	x	x	x	x	X
Baetidae	*Pseudocloeon sp.*		x						x	x	x
Leptophlebiidae	*Paraleptophlebia sp.*					x	XX	x	x		
Leptophlebiidae	*Choroterpes albiannulata*										XX
Leptohyphidae	***Tricorythodes explicatus***	XX		x	XX	X	x	X	XX		XX
Ephemerellidae	*Attenella margarita*	x		x		x	x		x		x
Ephemerellidae	***Ephemerella excrucians***	XX		x	XX	XX	x	XXX	XX		X
Ephemerellidae	*Drunella coloradensis*			x							
Ephemeridae	*Ephemera simulans*						x				x
Heptageniidae	*Epeorus albertae*					x					
Heptageniidae	*Epeorus longimanus*					x		x			
Heptageniidae	*Heptagenia*								x		x
Heptageniidae	*Macaffertium terminatum*					x	x		x		x
Heptageniidae	*Ecdyonurus simpliciodes*								x		X
Heptageniidae	*Rhithrogena sp.*	x		x	x		X	x			
Stoneflies	**Plecoptera**										
Perlodidae	*Isoperla fulva*	x		x		x		X	x		
Perlodidae	*Skwala*			X			x				
Chloroperlidae	*Paraperla*						x				
Chloroperlidae	*Suwallia*			x		x					
Chloroperlidae	*Sweltsa*			x			x				
Pteronarcidae	*Pteronarcys californica*			x			x	x			
Perlidae	*Hesperoperla pacifica*			x		x	x	X	x		x
Perlidae	*Claassenia sabulosa*						x	X			
Caddisflies	**Trichoptera**										
Brachycentridae	*Brachycentrus occidentalis*	x		x		x		x			
Brachycentridae	*Micrasema bactro*					x		x			
Hydropsychidae	***Cheumatopsyche***	X		x	X	x		XX	X		x
Hydropsychidae	***Hydropsyche occidentalis***	x		x	X			XX	X		x
Hydropsychidae	*Hydropsyche morosa gr.*	x		x	x	x		X	x		x
Hydroptilidae	*Hydroptila*	X	x	x	X	X		x	x	x	x
Lepidostomatidae	*Lepidostoma*	x		x			x				
Leptoceridae	*Ceraclea*	x		x		x		x			
Leptoceridae	*Nectopsyche*										x
Leptoceridae	***Oecetis avara***	XX		X	XX	x	x	X			X
Glossosomatidae	*Anagapetus*			x							
Glossosomatidae	*Glossosoma*	x		X			x	x			
Glossosomatidae	*Culoptila*			x							
Uneonidae	*Neophylax splendans*	x		x							
Limnephilidae	*Dicosmoecus gilvipes*	x			x	x	x	x	X		x
Limnephilidae	*Limnephilus*						x		x		x
Limnephilidae	*Onocomoecus unicolor*						x		x		x
Limnephilidae	*Pycnopsyche*										x
Helicopsychidae	*Helicopsyche borealis*					x		X	x		X
Polycentropidae	*Polycentropus*								x		x
	Total EPT per site	**17**	**5**	**24**	**10**	**23**	**24**	**23**	**23**	**5**	**27**

Figure 2a. Macroinvertebrate seasonal metrics for 2017 sample sites. Error bars are SE. Blue arrows are major tributaries entering the Missouri River. Sites arranged in upstream to downstream orientation.

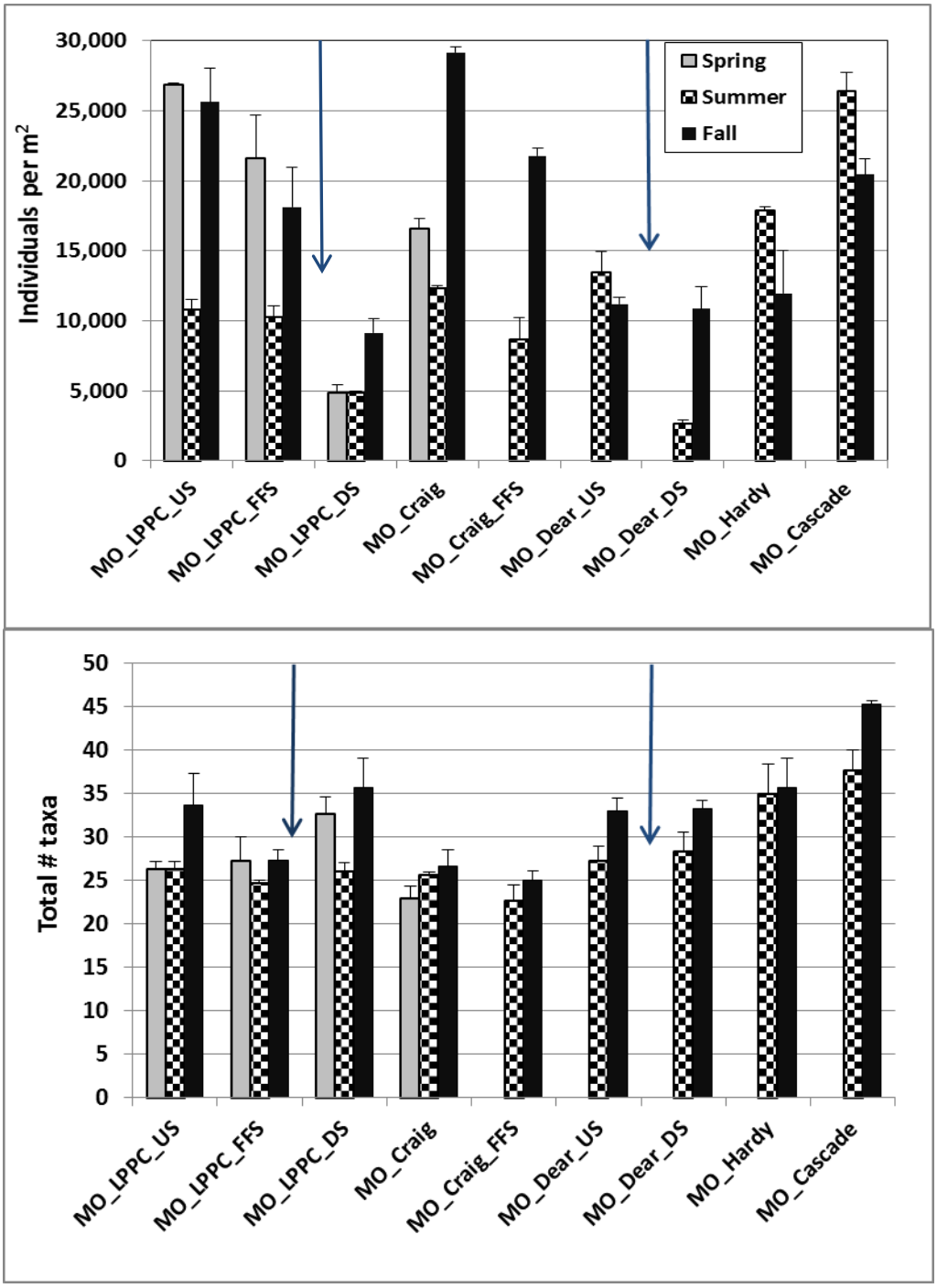
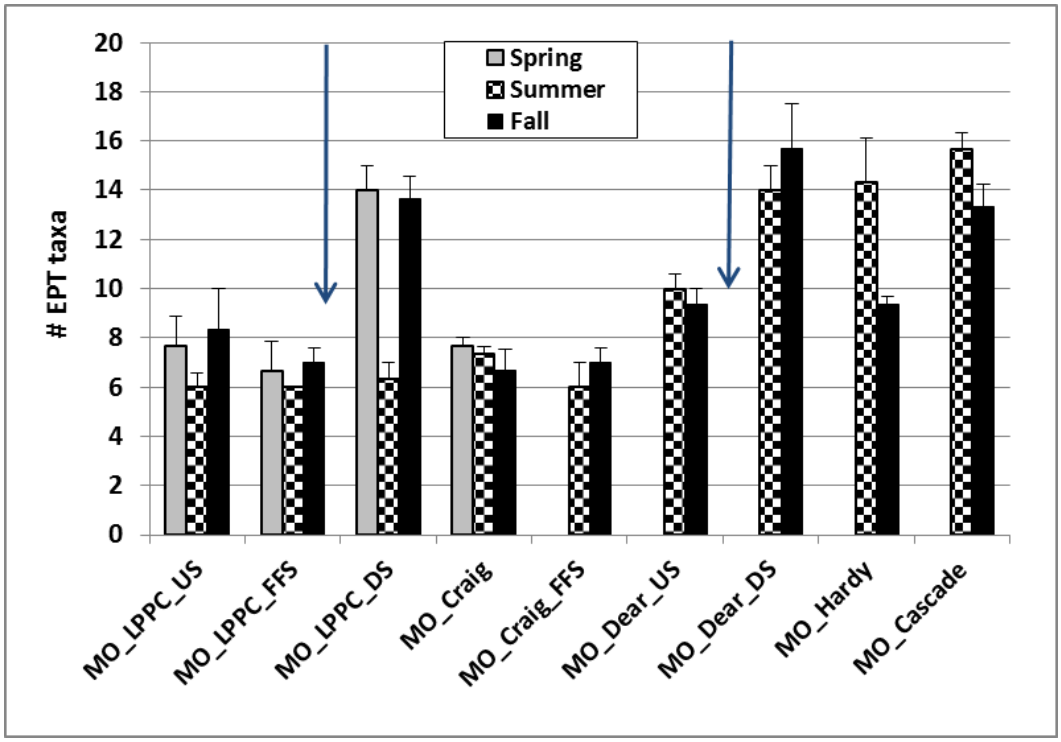


Figure 2b. Macroinvertebrate seasonal metrics for 2017 sample sites. Error bars are SE. Arrows are tributaries entering the Missouri River. Sites arranged in upstream (l) to downstream orientation.



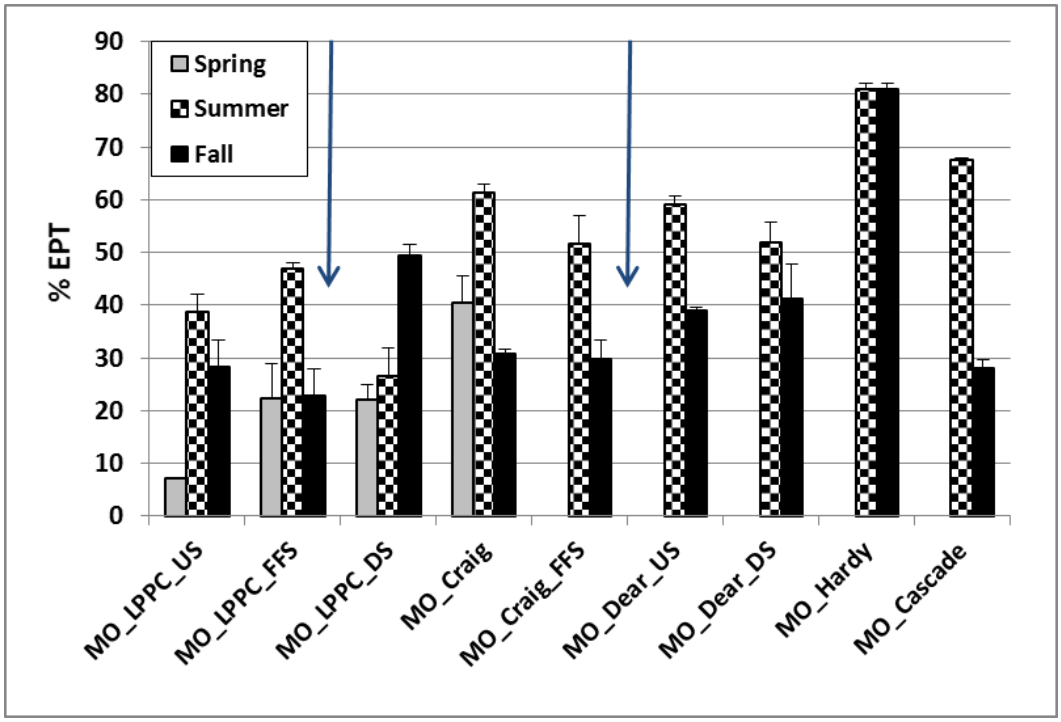


Figure 2c. Macroinvertebrate seasonal metrics for 2017 sample sites. Error bars are SE. Blue arrows are tributaries entering the Missouri River. Sites arranged upstream (l) to downstream (r).

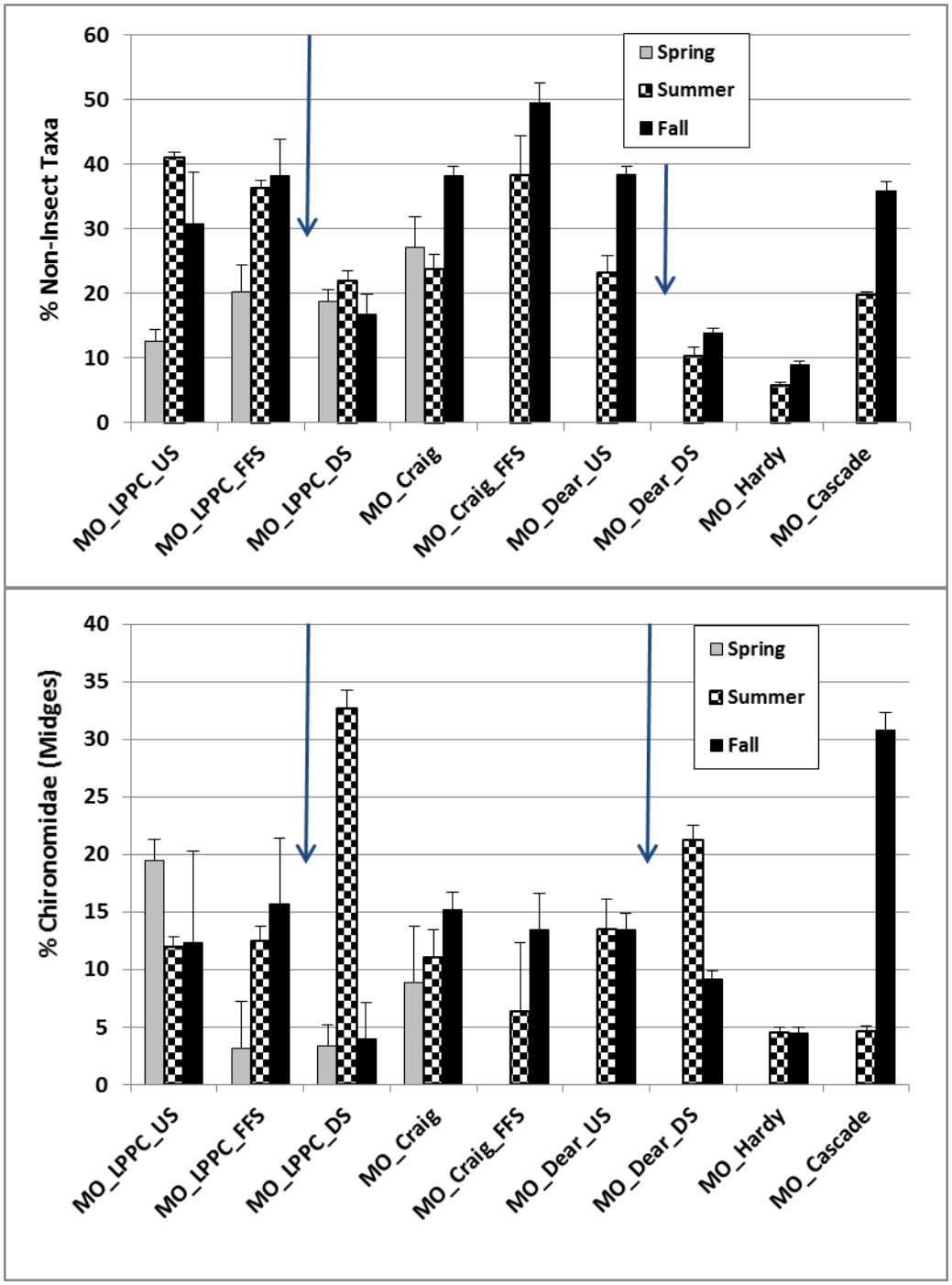


Figure 2d. Macroinvertebrate metrics for 2017 sample sites. Error bars are SE. Blue arrows are tributaries entering the Missouri River. Sites arranged in upstream (l) to downstream orientation.

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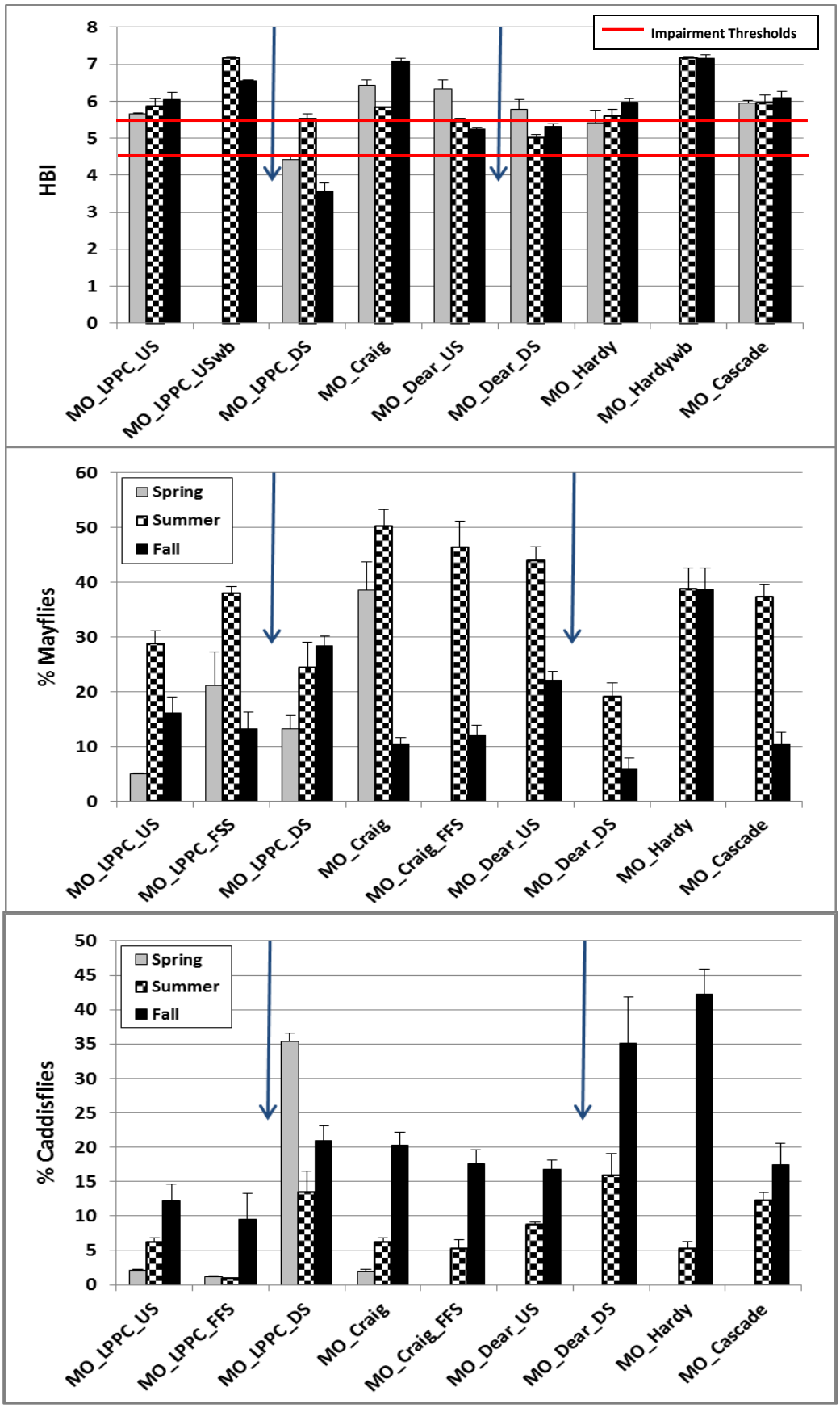


HBI Scores indicated that the macroinvertebrate communities at all Missouri River sites, except MO_LPPC_DS (fall) are experiencing some nutrient/organic enrichment, and eight of the nine (>88%) monitoring sites are exhibiting moderate organic pollution (scores 5.0-6.0) (**Figure 2d**). Significant organic enrichment (HBI >6.0) was detected in the macroinvertebrate communities during the summer and fall at Craig and within the weed bed samples upstream from Little Prickly Pear and at Hardy (**Figure 2d**). Missouri River sites below tributaries showed improvements in the tolerance-level of benthic communities, especially in the spring and fall for MO_LPPC_DS and summer and fall for MO_DEAR_DS (**Figure 2d**).

In comparing macroinvertebrate communities sampled at all sites between 2015 and 2017, we can see some highly significant trends in increasing benthic population densities and decreases of % Midges in a sample, (T-test, p=0.006) and (T-test, p=0.00026), respectively (**Figure 3a**). The number of total taxa and EPT taxa recorded across all sites has been trending upwards since 2015, but this was not significant (T-test, p=0.07) and (T-test, p=0.26), respectively. Significant increases in benthic densities were detected at particular sites, especially MO_LPPC_US and MO_DEAR_US ($p<0.05$) between 2015 and 2017 (**Figure 3a**). Total taxa richness has increased significantly between 2015 and 2016 (T-test, p=0.04), but not in 2017. The annual average % Chironomidae (Midges) in the benthic community across all sites has significantly decreased between 2015 and 2016 (T-test p=0.004), then again in 2017 (p=0.0003) (**Figure 3a**).

We documented a significant increase in the caddisfly abundance (% caddisflies) in the 2017 samples between the summer and fall sampling periods (p=0.004) (**Figure 2d, Appendix B**); unfortunately, this is due to increases in micro-caddis (*Hydroptila*) which can thrive in mats of algae. On an annual basis, % caddisflies in the samples has significantly decreased between 2015 and 2017 at MO_LPPC_US (T-test, p=0.01) and at MO_DEAR_US (T-test, p=0.05) (**Figure 3b).** Mayfly abundance in the samples has fluctuated, but has not changed significantly on an annual basis between 2015 and 2017 (**Figure 3b**). This year's increase in taxa richness seems to have negated the previously reported losses seen between 2005 and 2015 (Stagliano 2015), but these taxa were largely non-insects (snail and worm taxa).

Figure 3a. Macroinvertebrate metric annual averages between 2015 and 2017. Error bars are SE. Blue arrows are tributaries entering the Missouri River.

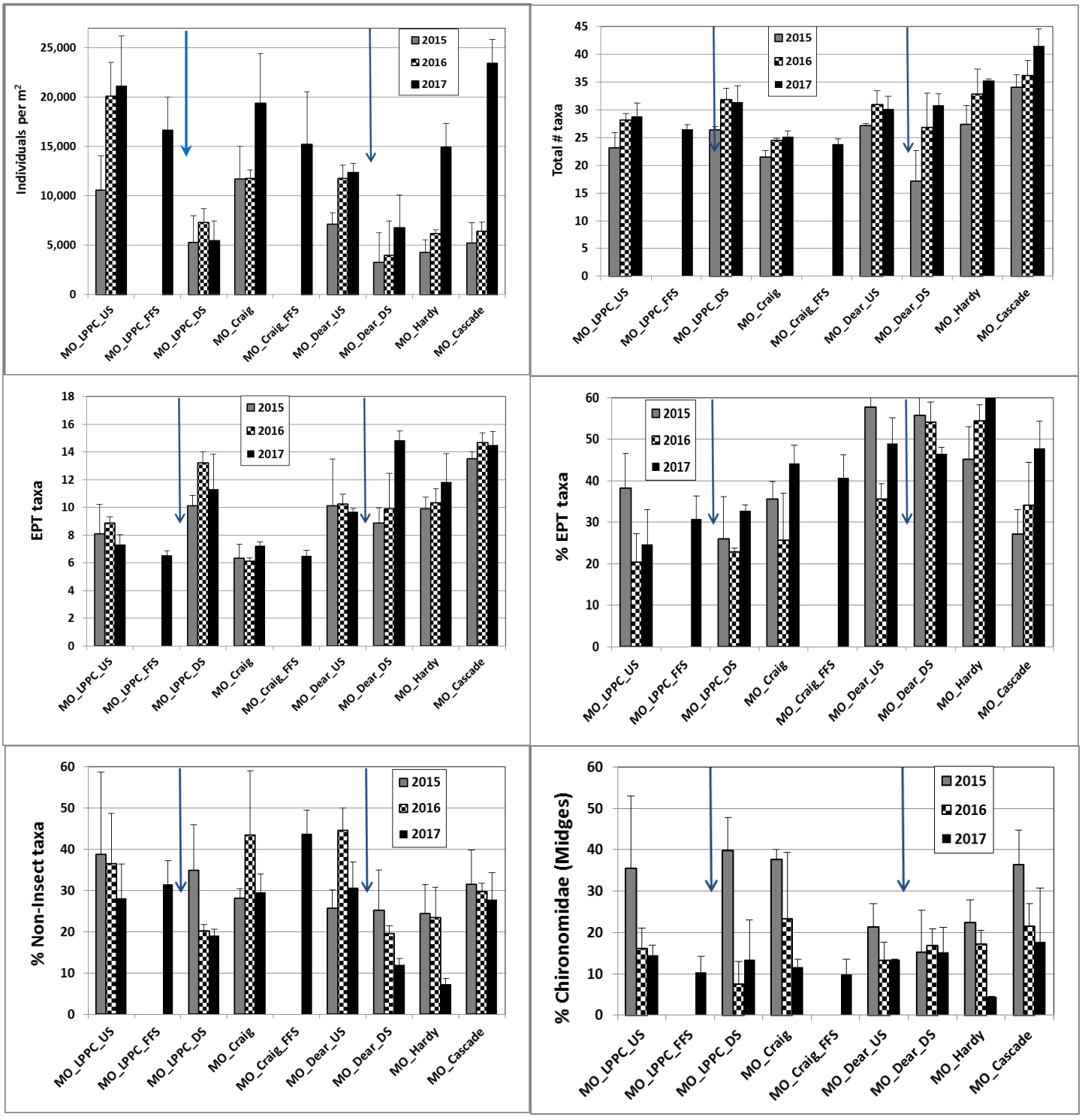
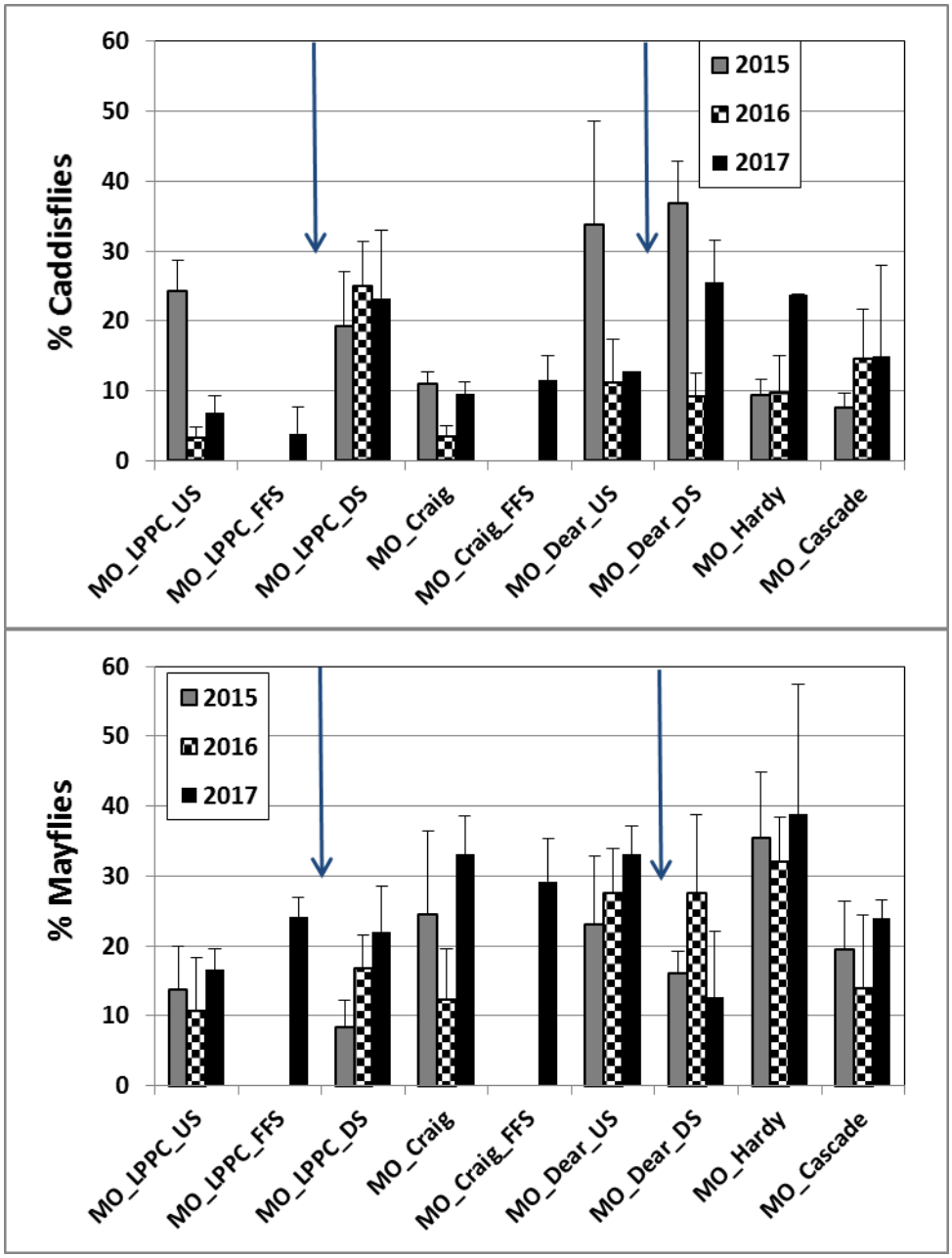


Figure 3b. Macroinvertebrate metric annual averages between 2015 and 2017. Error bars are SE. Blue arrows are tributaries entering the Missouri River



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) reported the highest benthic invertebrate densities of all sites, averaging ~20,000 individuals per meter^2 and attained a very large standing crop, especially in the spring (~26,000 per m^2) (**Figure 2a and 3**). This is significantly higher than the spring of 2015 and thus, summer 2016 densities remained significantly higher despite the seasonal decreases through the year (**Figure 3**). One reason for the huge increase in the spring 2016 macroinvertebrate densities at MO_LPPC_US was the abundance of blackfly larvae (*Simulium spp*.) which averaged ~14,000 per m^2, while in the spring 2015 samples (taken 2 weeks later) most of these flies hatched out and their density was ~1,000 per m^2.

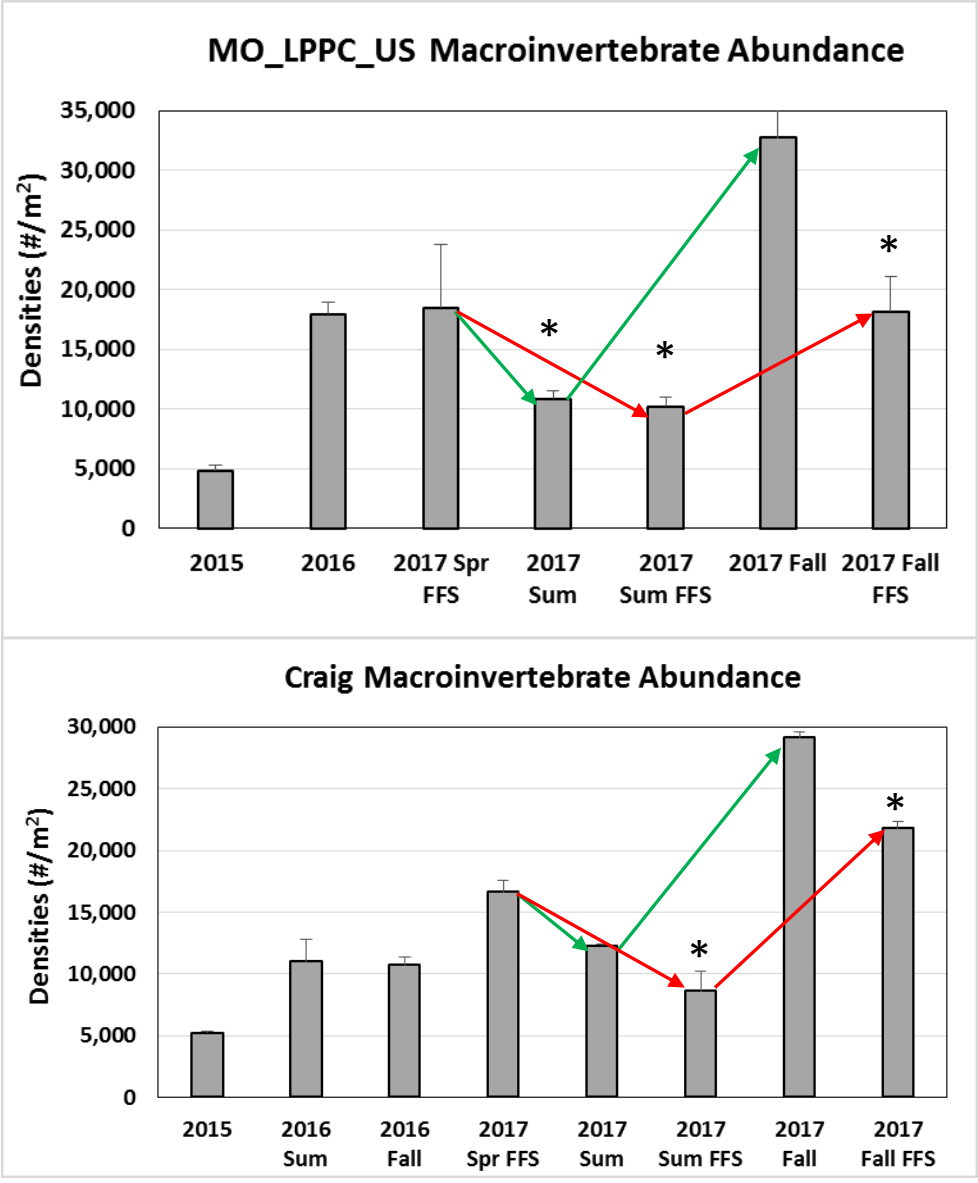
Dominant insect taxa at the Craig site in order of abundance were the midges (Chironomidae; *Microtendipes*), BWO's (*Baetis tricaudatus*), aquatic worms and Tricos (*Tricorythodes explicatus*); while dominant taxa at the MO_LLPC_US site included, in order, black fly larvae (Simulium), midges (*Cricotopus* 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**). These dominant non-insect taxa were sowbugs (*Caecidotea*), scuds (*Gammarus, Hyalella and Crangonyx*), aquatic earthworms (Lumbricina, Tubificidae) and pouch snails (*Physella acuta*).

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 have showed declines 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 2016 Missouri River sampling, we collected substantially more invertebrate taxa than were reported in 2015 (Stagliano 2015) between Little Prickly Pear Creek and Craig sites (paired T-test, p=0.02) (**Figure 4**). MDEQ (2007) reported low numbers of the mayfly taxa, *Callibaetis* which we did not collect in the substrate 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. We did collect this species in the weed bed samples of MO_LPPC_US during the fall at a density of ~70 per m^2 (**Appendix C**).

3.1.1 Flushing Flow Results

Missouri River Flows in 2017 at ~11,600cfs significantly reduced the summer invertebrate densities at MO_LPPC_US compared to summer of 2016. FFS plot had similar summer densities to the adjacent channel, but were significantly less during the fall sample period (**Figure 4**).

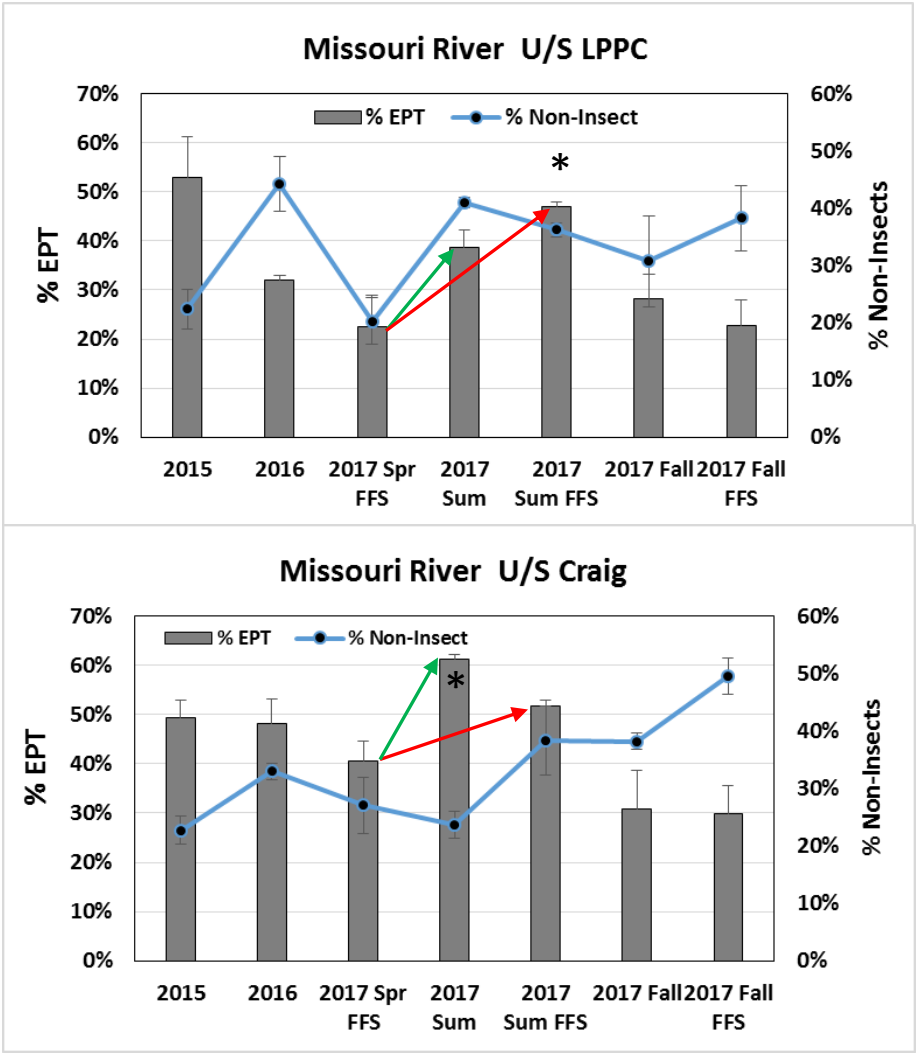
Figure 4. Macroinvertebrate densities from 2015-2017 at the Missouri River (MO_LPPC_US) and Craig sites. Arrows are trends of the natural channel (green) and FFS (red) plot. *= Significant (p<0.05)



June 2017 high flows did little to reduce the summer macroinvertebrate densities at the MO_Craig Site compared to summer of 2016 numbers, but the FFS plot had significantly fewer bugs than

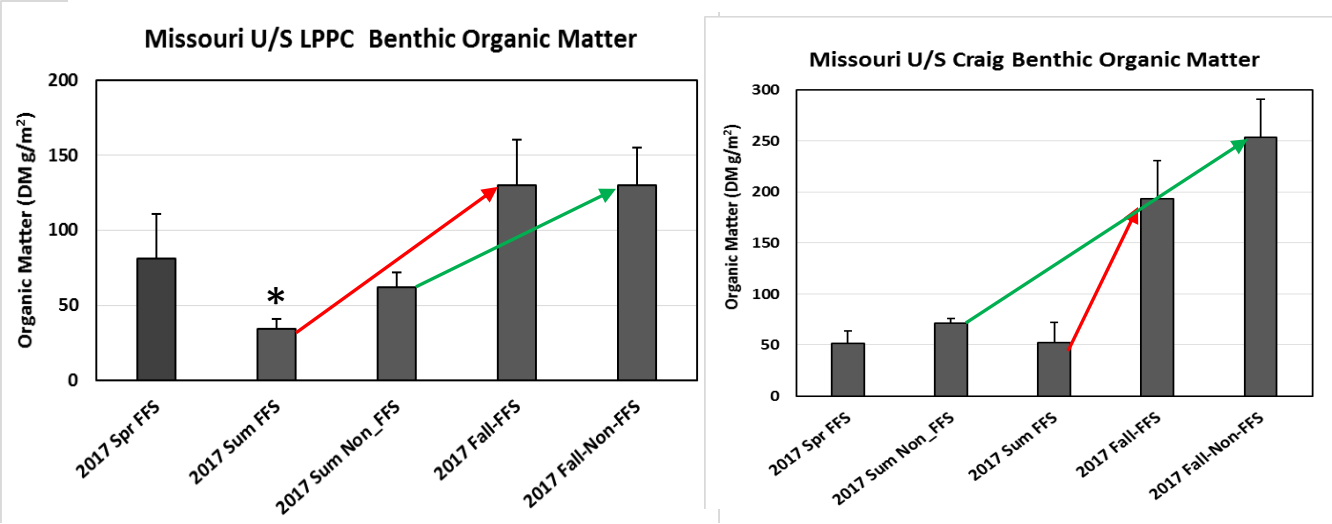
the adjacent channel ($p<0.05$) and this pattern continued into the fall samples (**Figure 4)**. Samples from both the MO_LPPC_US and the Craig sites had significant jumps in the % EPT post-June flows, and this was especially pronounced in the MO_LPPC_FFS plot (T-test, $p=0.003$), and the normally sampled Craig channel (T-test, $p=0.005$), but this increase was not significant in the Craig FFS plot ($p=0.54$) or the MO_LPPC_US channel ($p=0.15$) (**Figure 5**). The MO_LPPC_FFS plot also had an accompanying decrease in the % Non-insects in the samples compared to summer 2016, whereas the adjacent channel did not (**Figure 5**). The MO_Craig site also had a significant decrease in the % Non-insects ($p=0.03$) in the samples compared to summer 2016, whereas the FFS plot did not ($p=0.43$) and actually had an increase in aquatic worms (**Figure 5**).

Figure 5. Response of %EPT and % Non-Insects from summer 2015 & 2016 through the 2017 seasons. Arrows are trends of the natural channel (green) and FFS plot (red). *= Significant differences ($p<0.05$).



Although we do not have previous summer benthic organic matter (BOM) data to compare, flows of ~11,600 cfs at the MO_LPPC_US site significantly reduced the summer benthic organic matter (BOM) compared to pre-FFS plots (p=0.04); this difference was not detected between MO_Craig FFS plot and non-FFS (**Figure 6**). Although, the summer BOM at the Craig site was probably going to be significantly higher without the flushing flows given the trajectory between the spring and fall BOM levels (**Figure 6**).

Figure 6. Response of benthic OM (>500 micron) through the 2017 seasons. Arrows are trends of the natural channel (green) and FFS plot (red). *= Significant differences (p<0.05).



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

The Missouri River benthic macroinvertebrate densities upstream of the Dearborn River exhibited significant increases in abundance compared to 2015, and this was due to contributions of non-insect taxa, especially Turbellarian flatworms and Oligochaete worms (**Figure 3, Appendix C**). The Missouri River benthic macroinvertebrates downstream of the Dearborn River exhibited significant reductions in abundance due to the spring run-off events, but then rebounded to levels of upstream Missouri River populations by the fall sampling period (**Figure 2a**). 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 2a**).

3.3 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 (**Photo 2, Appendix A**). Due to the larger substrate in this riffle, crayfish (*Orconectes virilis*) and mottled sculpin (*Cottus bondi*) were collected in the samples and averaged 1.0 and 0.5 individuals per m^2, respectively. Dominant benthic taxa at this site in 2017 were, in order of abundance, micro-caddis (*Hydroptila*), BWOs (*Baetis tricaudatus*), Tricos (*Tricorythodes explicatus)* and the net-spinning caddis (Cheumatopsyche). This is much improved from the 2016 dominant taxa: sowbugs (*Caecidotea*), BWOs *(Baetis tricaudatus),* midges (*Microtendipes*) and flatworms (Turbellaria*).* 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 (*Caecidotea*). The 2015-2017 samples had much lower numbers of blackflies than had been reported in 2005 (MDEQ 2007).

Cumulative total EPT for this site was the 2nd highest at 23 species (**Table 2**), but EPT species other than BWO's, micro-caddis and Tricos were low in abundance. Benthic abundance was in the mid-range for this section in the spring (~6,500 individuals per m^2), but this number dropped by the fall sampling period to ~5,000 per m^2 (**Figure 2a**). Overall, macroinvertebrate densities increased significantly in 2017 (**Figure 3**) largely due to increases in micro-caddisflies in increasing weed beds and algae in the riffle sampled.

Photo 1. Extensive weed beds sampled at Hardy Bridge during the summer and fall 2016 sampling period.

3.4 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 = 14.7 species) (Figure 2b). Cumulative total EPT for all seasons was the highest reported in 2016 at 26 species (Table 2, Figure 4). Macroinvertebrate densities increased significantly in 2017 (**Figure 3**) largely due to increases in algae in the riffle sampled (**cover photo**). 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 the 2016 seasonal samples which is a slight increase from 2015.

3.5 Missouri River Focal Invasive Species

New Zealand mudsnails (*Potamopyrgus antipodarum*) (NZMS) were a perceived significant invasive species threat to the Missouri River in the early 2000's, but have not been collected or collected at very low densities at the PPL Holter Dam long-term monitoring site since 2012 (McGuire 2016). During our 2015 study, we reported low densities of NZMS at 5 of the 7 sites with the highest density of ~40 ind. per $meter^2$ reported at the Missouri River downstream of Little Prickly Pear Creek (MO_LPPC_DS) (**Figure 7**). NZMS occurrence at two of these sites was only reported in the fall sample, while at 2 sites, Craig and Cascade, NZMS were reported during multiple seasons (**Figure 7**).

We do report a potential new species of a non-native Planorbidae snail, *Menetus dilatatus*, from the Missouri River U/S of LPPC and at the Craig sites reported in 2016 and 2017, respectively. According to the NatureServe Explorer Species website, this snail is considered native in the eastern states, but there have been records reported in California, presumably introduced as well (NatureServe 2017). It has never been reported at the Holter PPL long-term site until 2016, and not observed in the 2005 DEQ samples.

During the 2016 sampling period, we collected NZMS at 6 of the 7 monitoring sites with the highest average density of ~373 ind. per m^2 at the Missouri River upstream of Little Prickly Pear Creek (**Figure 7**). We estimated annual NZMS densities at this site to be 7.5 ind. per m^2 in 2015. NZMS occurrence at all six of these sites was reported during multiple seasons (**Figure 7**). This significant increase in NZMS site occupancy and seasonal densities observed across most sites may be directly correlated to low flows (**Figure 1b**). This can especially be observed at the Missouri River upstream of Little Prickly Creek (MO_LPPC_US) (**Figure 8**) where annual NZMS numbers have increased, as overall densities of macroinvertebrates exploded (**Figure 2a**).

During the 2017 sampling period, we collected NZMS at 5 of the 7 monitoring sites with the highest average density of ~290 ind. per m^2 at the Missouri River upstream of Little Prickly Pear Creek (**Figure 7**). The Missouri River at Craig saw large increases in densities between fall 2016 and spring 2017, but these decreased by the summer. Large NZMS density declines were observed between pre-run off and the summer sampling periods in 2017 at both the Missouri River sites at LLP Creek and at Craig (Figure 5) likely due to the higher spring run-off. This can be largely

explained by the high flows of June 2017 (~11,600 cfs) which likely displaced NZMS out of the substrate. It appears that the population of NZMS in the reach upstream from the Dearborn River observed in 2016 has decreased to undetectable levels in 2017, since we didn't report this species in the summer or fall samples (**Figure 7**).

Figure 7. NZMS seasonal benthic densities in 2015 (top), 2016 (middle) and 2017 (bottom) from the Wolf Creek to Cascade monitoring section. Note y-axis scale differences.

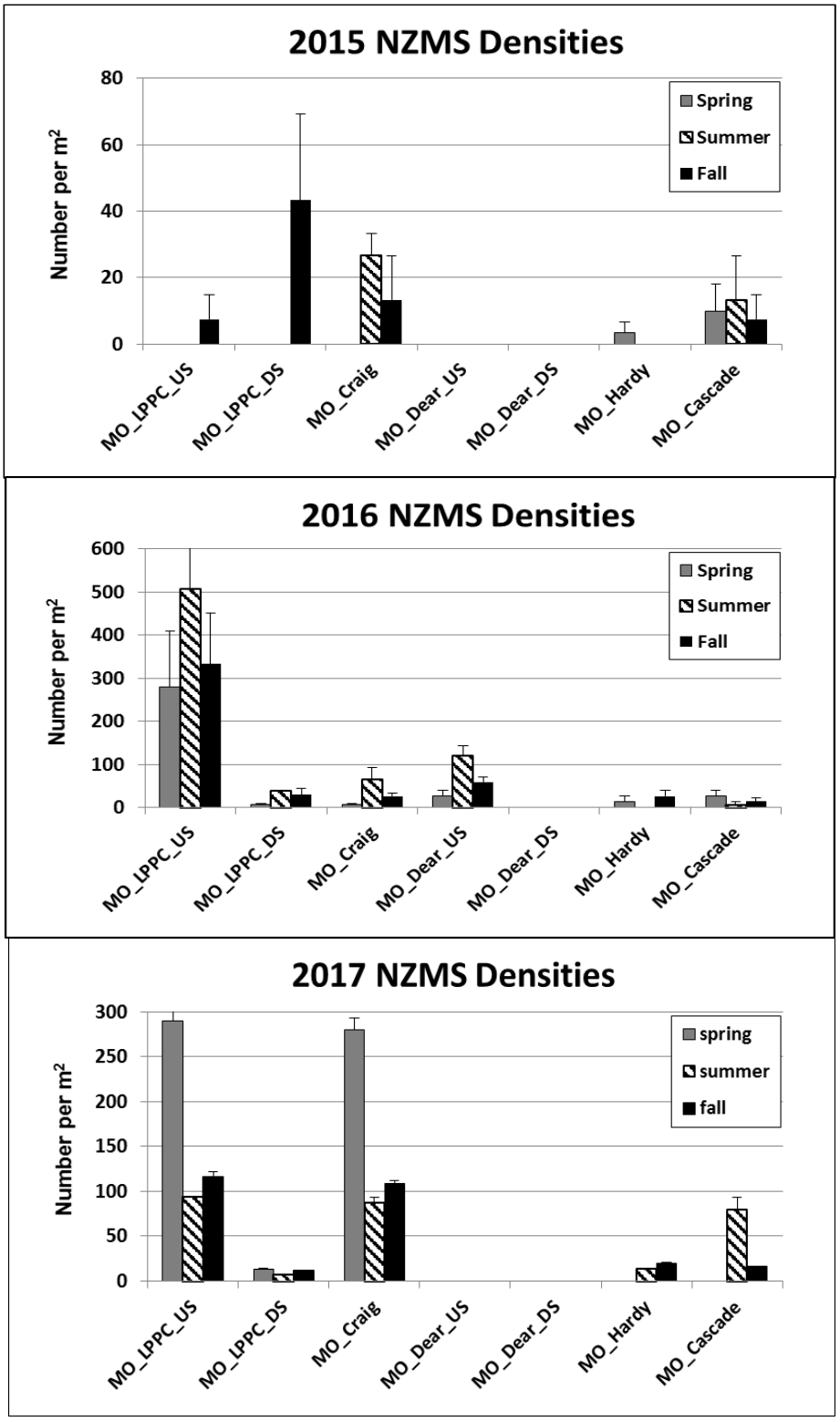
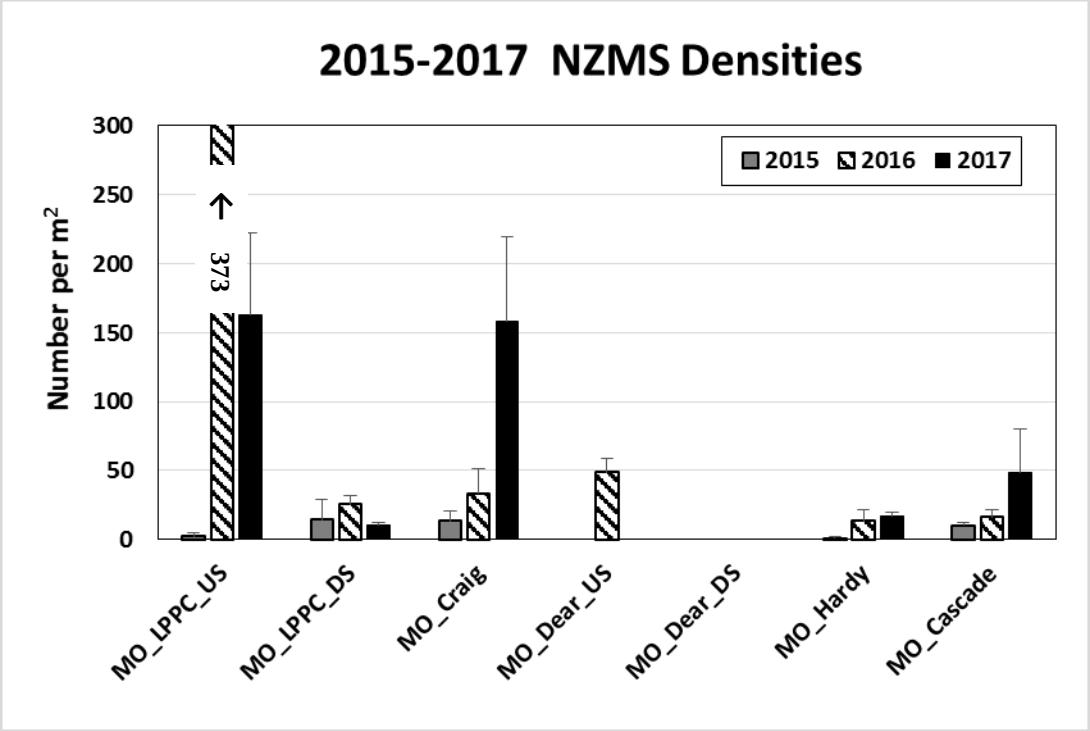


Figure 8. NZMS benthic annual average densities between 2015 and 2017 from the Wolf Creek to Cascade monitoring section with adjusted y-axis scale.



4.0 Conclusions

This 2017 dataset has added another year to the most comprehensive study evaluating the macroinvertebrate communities in the Wolf Creek to Cascade section of the Missouri River, 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 densities and diversity across multiple sites, and the important role tributary streams have on the Missouri River insect communities. We've documented that the 2017 flows of ~11,600 at the Missouri River near Little Prickly Pear Creek can have significant effects on the benthic gravels, organic matter and the macroinvertebrate community. Tolerance scores of the benthic communities using the HBI indicate significant organic enrichment across the sites, especially at sites closer to Wolf Creek Bridge and downstream at Cascade. Increased benthic coverage of rooted aquatic vegetation through the summer favors increases of non-insect taxa, such as sowbugs (*Caecidotea*), scuds (*Gammarus, Hyalella and Crangonyx*), aquatic earthworms (Lumbricidae, Tubificidae) and pouch snails (*Physella acuta*). Aquatic vegetation growth across clean gravel riffles may dampen the recruitment ability of caddisflies and mayflies, hence lower densities are reported across all seasons. Four sites sampled by MDEQ in 2005 between Wolf Creek and Cascade reported a substantial loss in the numbers of taxa during the same season in 2015, but taxa richness at these sites in 2016 has rebounded.

1. UMOWA's macroinvertebrate study has allowed us to begin to document patterns of changing aquatic communities and set the stage for future hypothesis testing. From analyzing the past 3 years of data, it seems pretty conclusive, that on an annual basis, caddisflies have significantly declined at the Missouri River reach upstream from Little Prickly Pear Creek and the Dearborn River.

2. The sites closest to Holter Dam (MO_LPPC_US and MO_CRAIG) showed the most significant benthic response to the 2017 flows at ~11,600 cfs; reductions in both the macroinvertebrate and NZMS densities and the summer BOM compared to pre-FFS plots. Downstream sites' algae and aquatic plant beds showed no appreciable changes due to the 2017 flow event.

3. 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. Macroinvertebrate communities with the highest total taxa richness, EPT richness and % EPT were reported at sites least affected by the dam, particularly the Missouri River at Hardy Bridge and at Cascade site, 28 and 37 miles away from Holter dam. These sites begin to take on the more natural character of the river and acquire the original compliment of macroinvertebrates. Boulder/cobble dominated substrate sections of the river, especially downstream of the Dearborn River provide refuge for juvenile salmonids, mottled sculpin and moderate densities of the northern crayfish, *Orconectes virilis*. New Zealand mudsnails which have persisted in low densities at multiple sites in the Missouri

River from Wolf Creek to Cascade have begun to increase their populations upstream of Craig, especially upstream and downstream of the Little Prickly Pear Creek.

4. We postulate that NZMS population increases, overall non-insect macroinvertebrate density increases, caddisfly decreases and the expansion of rooted weed-beds in the Wolf Creek to Craig section is directly correlated with lower spring flushing flows from Holter Dam. Because of the initial results of the flushing flow test plots in 2017, we are confident that a natural or simulated flow of ~15,000 cfs that is seen during a typical run-off period may be a helpful tool in reversing some of the negative effects documented to be occurring on the benthic communities since the last flow of this magnitude in 2011. Due to three years of baseline data, we are in a great position to evaluate macroinvertebrate responses.

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) summer 2016.

Photo 2. Missouri River U/S of Craig looking upstream pre-runoff spring 2017

Photo 3. Missouri River substrate after the Hess sample is taken the MO_LPPC_US in summer 2017.

Photo 4. Missouri River MO_LPPC_US FFS plot raking June 2017 at ~8,000 cfs

Photo 5. Missouri River non-FFS substrate upstream from Craig (MO_Craig) July 2017.

Photo 6. . Missouri River upstream from Craig (MO_Craig) summer 2016

Photo 7. Missouri River shoreline upstream of Craig (MO_Craig) summer 2016.

Photo 8. Missouri River shoreline upstream of Craig FFS (MO_Craig_FFS) summer 2017.

Photo 9. Missouri River upstream of the Dearborn River. June 2015.

Photo 10. Missouri River upstream of the Dearborn River. May 2016.

Photo 11. Missouri River upstream of the Dearborn River (MO_DEAR_US) spring 2015.

Photo 12. Missouri River upstream of the Dearborn River (MO_DEAR_DS) July 2017.

Photo 13. Missouri River downstream of the Hardy Bridge (MO_HARDY) summer 2016.

Photo 14. Missouri River downstream of the Hardy Bridge (MO_HARDY) summer 2017.

Photo 15. Missouri River looking downstream of the Hardy Bridge site, summer 2016.

Photo 16. Missouri River looking downstream of the Hardy Bridge site, summer 2017.

Photo 17. Missouri River looking upstream of the Cascade FAS site (MO_Cascade), summer 2016.

Photo 18. Missouri River looking upstream of the Cascade FAS site (MO_Cascade) summer 2017.

Appendix B. Macroinvertebrate seasonal summary metric tables.

Site	Metric	Hess #1	Hess #2	Hess #3	Average	Standard Error
MO_LPPC_US	#/m2	11,160	9,560	11,760	**10,827**	656.6
MO_LPPC_US	# taxa	24	25	25	24.7	0.3
MO_LPPC_US	# EPT	7	5	6	6.0	0.6
MO_LPPC_US	% EPT	0.44	0.32	0.39	0.39	0.04
MO_LPPC_US	% Non-Insect	0.39	0.41	0.43	0.41	0.01
MO_LPPC_US	% Chironomidae	0.09	0.18	0.09	0.12	0.03
MO_LPPC_US	%Mayfly	0.32	0.24	0.30	0.29	0.02
MO_LPPC_US	%Caddisfly	0.12	0.08	0.09	0.10	0.01
MO_LPPC_US_FFS	#/m2	8,640	10,640	11,400	**10,227**	823.1
MO_LPPC_US_FFS	# taxa	23	30	30	27.7	2.3
MO_LPPC_US_FFS	# EPT	6	6	6	6.0	0.0
MO_LPPC_US_FFS	% EPT	0.49	0.47	0.45	0.47	0.01
MO_LPPC_US_FFS	% Non-Insect	0.34	0.36	0.39	0.36	0.01
MO_LPPC_US_FFS	% Chironomidae	0.11	0.14	0.13	0.13	0.01
MO_LPPC_US_FFS	%Mayfly	0.40	0.38	0.36	0.38	0.01
MO_LPPC_US_FFS	%Caddisfly	0.09	0.09	0.09	0.09	0.00
MO_LPPC_DS	#/m2	5,100	4,740	4,840	4,893	107.3
MO_LPPC_DS	# taxa	25	28	25	26.0	1.0
MO_LPPC_DS	# EPT	7	7	5	6.3	0.7
MO_LPPC_DS	% EPT	0.36	0.18	0.26	0.27	0.05
MO_LPPC_DS	% Non-Insect	0.19	0.24	0.22	0.22	0.02
MO_LPPC_DS	% Chironomidae	0.27	0.39	0.32	0.33	0.04
MO_LPPC_DS	%Mayfly	0.33	0.17	0.23	0.24	0.05
MO_LPPC_DS	%Caddisfly	0.03	0.01	0.02	0.02	0.01
MO_Craig	#/m2	12,620	12,300	12,140	12,353	141.1
MO_Craig	# taxa	25.0	26.0	26.0	25.7	0.3
MO_Craig	#EPT taxa	7.0	7.0	8.0	7.3	0.3
MO_Craig	% EPT	0.64	0.59	0.61	0.61	0.02
MO_Craig	% Non-Insect Taxa	0.20	0.28	0.23	0.24	0.02
MO_Craig	% Chironomidae	**0.12**	0.09	0.12	**0.11**	0.01
MO_Craig	%Mayfly	0.55	0.45	0.50	0.50	0.03
MO_Craig	%Caddisfly	0.09	0.13	0.11	0.11	0.01
MO_Craig_FFS	#/m2	11,800	6,940	7,160	8,633	1584.6
MO_Craig_FFS	# taxa	25.0	19.0	24.0	22.7	1.9
MO_Craig_FFS	#EPT taxa	7.0	4.0	7.0	6.0	1.0
MO_Craig_FFS	% EPT	0.43	0.50	0.61	0.52	0.05
MO_Craig_FFS	% Non-Insect Taxa	0.49	0.36	0.29	0.38	0.06
MO_Craig_FFS	% Chironomidae	**0.04**	0.08	0.07	**0.06**	0.01
MO_Craig_FFS	%Mayfly	0.40	0.43	0.56	0.46	0.05
MO_Craig_FFS	%Caddisfly	0.03	0.07	0.06	0.05	0.01
MO_Dear_US	#/m2	10,800	15,930	13,740	13,490	1486.2
MO_Dear_US	# taxa	24	29	29	27.3	1.7
MO_Dear_US	#EPT taxa	9	10	11	10.0	0.6
MO_Dear_US	% EPT	0.57	0.62	0.57	0.59	0.02
MO_Dear_US	% Non-Insect Taxa	0.27	0.18	0.24	0.23	0.03
MO_Dear_US	% Chironomidae	0.13	0.14	0.13	0.13	0.00
MO_Dear_US	%Mayfly	0.49	0.40	0.43	0.44	0.03
MO_Dear_US	%Caddisfly	0.09	0.22	0.15	0.15	0.04
MO_Dear_DS	#/m2	2,130	2,820	3,040	2,663	274.1
MO_Dear_DS	# taxa	24	30	31	28.3	2.2
MO_Dear_DS	EPT	12	15	15	14.0	1.0
MO_Dear_DS	% EPT	0.59	**0.47**	**0.50**	**0.52**	0.04
MO_Dear_DS	% Non-Insect Taxa	0.11	0.08	0.12	0.10	0.01
MO_Dear_DS	% Chironomidae	0.22	0.31	0.21	0.21	0.06
MO_Dear_DS	%Mayfly	0.22	0.14	0.22	0.19	0.02
MO_Dear_DS	%Caddisfly	0.38	0.33	0.28	0.33	0.03
MO_Hardy	#/m2	17,344	18,048	18,240	17,877	272.4
MO_Hardy	# taxa	**41**	29	35	35.0	3.5
MO_Hardy	#EPT taxa	**17**	11	15	14.3	1.8
MO_Hardy	% EPT	0.80	0.80	0.83	0.81	0.01
MO_Hardy	% Non-Insect Taxa	0.06	0.05	0.06	0.06	0.00
MO_Hardy	% Chironomidae	0.05	0.05	0.04	0.04	0.01
MO_Hardy	%Mayfly	0.45	0.32	0.40	0.39	0.04
MO_Hardy	%Caddisfly	0.36	0.48	0.43	0.42	0.04
MO_Cascade	#/m2	23,950	28,540	26,760	26,417	1336.1
MO_Cascade	# taxa	33	**40**	**40**	**37.7**	2.3
MO_Cascade	#EPT taxa	15	**17**	15	15.7	0.7
MO_Cascade	% EPT	0.67	0.68	0.68	0.68	0.00
MO_Cascade	% Non-Insect Taxa	0.19	0.21	0.19	0.20	0.00
MO_Cascade	% Chironomidae	0.04	0.04	0.07	0.05	0.01
MO_Cascade	%Mayfly	0.38	0.41	0.33	0.37	0.02
MO_Cascade	%Caddisfly	0.29	0.27	0.34	0.30	0.02

Appendix B. 2017 Seasonal Macroinvertebrate metrics. Signficant differences (p<0.05) between seasons are bolded and underlined.

#/m2	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	26826.7	10826.7	25622.2	176.4	656.6	2448.6
MO_LPPC_FFS	21573.3	10226.7	18133.3	3135.5	823.1	2861.6
MO_LPPC_DS	4833.3	4893.3	9145.0	562.9	107.3	973.5
MO_Craig	16613.3	12353.3	29155.6	719.0	141.1	435.8
MO_Craig_FFS		8633.3	21780.0		1584.6	550.3
MO_Dear_US		13490.0	11210.0		1486.2	497.0
MO_Dear_DS		2663.3	10840.0		274.1	1588.4
MO_Hardy		17877.3	11962.7		272.4	3061.2
MO_Cascade		26416.7	20440.3		1336.1	1110.5
avg.	**17461.7**	**11931.2**	**17587.7**			
T-test p-values	**0.26**	**0.11**	**0.979**			

% Midges	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	19.4	11.9	12.3	0.5	3.0	1.8
MO_LPPC_FFS	3.1	12.5	15.7	0.3	1.0	4.2
MO_LPPC_DS	3.4	32.7	4.0	0.5	3.6	1.2
MO_Craig	8.9	11.0	15.2	0.7	0.9	3.3
MO_Craig_FFS		6.4	13.5		1.2	5.9
MO_Dear_US		13.5	13.5		0.3	0.8
MO_Dear_DS		21.3	9.2		6.0	1.2
MO_Hardy		4.5	4.5		0.5	0.5
MO_Cascade		4.6	30.8		1.0	0.4
avg.	**8.7**	**13.2**	**13.2**			
T-test p-values	**0.41**	**0.99**	**0.363**			

Total # taxa	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	26.3	26.3	33.7	0.9	0.9	3.7
MO_LPPC_FFS	27.3	24.7	27.3	2.7	0.3	1.2
MO_LPPC_DS	32.7	26.0	35.7	2.0	1.0	3.4
MO_Craig	23.0	25.7	26.7	1.3	0.3	1.9
MO_Craig_FFS		22.7	25.0		1.9	1.2
MO_Dear_US		27.3	33.0		1.7	1.5
MO_Dear_DS		28.3	33.3		2.2	0.9
MO_Hardy		35.0	35.7		3.5	3.5
MO_Cascade		37.7	45.3		2.3	0.3
avg.	**27.3**	**28.2**	**32.9**			
T-test p-values	**0.77**	**0.095**	**0.132**			

#EPT taxa	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	7.7	6.0	8.3	1.2	0.6	1.7
MO_LPPC_FFS	6.7	6.0	7.0	1.2	0.0	0.6
MO_LPPC_DS	14.0	6.3	13.7	1.0	0.7	0.9
MO_Craig	7.7	7.3	6.7	0.3	0.3	0.9
MO_Craig_FFS		6.0	7.0		1.0	0.6
MO_Dear_US		10.0	9.3		0.6	0.7
MO_Dear_DS		14.0	15.7		1.0	1.9
MO_Hardy		14.3	9.3		1.8	0.3
MO_Cascade		15.7	13.3		0.7	0.9
avg.	**9.0**	**9.5**	**10.0**			
T-test p-values	**0.83**	**0.77**	**0.617**			

%EPT	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	7.1	38.6	28.3	0.3	3.5	5.0
MO_LPPC_FFS	22.4	47.0	22.8	6.6	1.0	5.2
MO_LPPC_DS	22.1	26.6	49.4	2.8	5.2	2.0
MO_Craig	40.5	61.3	30.8	5.0	1.6	0.7
MO_Craig_FFS		51.7	29.8		5.3	3.6
MO_Dear_US		59.0	38.9		1.7	0.6
MO_Dear_DS		52.0	41.1		3.7	6.6
MO_Hardy		81.1	81.1		1.0	0.9
MO_Cascade		67.6	28.0		0.3	1.7
avg.	23.0	53.9	38.9			
T-test p-values	**0.01**	**0.08**	**0.143**			

% Non-Insect Taxa	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	12.6	41.0	30.7	1.9	0.9	7.9
MO_LPPC_FFS	20.3	36.2	38.2	4.1	1.3	5.7
MO_LPPC_DS	18.8	21.9	16.8	1.8	1.5	3.1
MO_Craig	27.0	23.7	38.2	4.9	2.4	1.5
MO_Craig_FFS		38.3	49.5		6.0	3.1
MO_Dear_US		23.3	38.3		2.6	1.4
MO_Dear_DS		10.3	13.8		1.3	0.7
MO_Hardy		5.7	8.9		0.5	0.5
MO_Cascade		19.8	35.8		0.5	1.6
avg.	**19.7**	**24.4**	**30.0**			
T-test p-values	**0.48**	**0.38**	**0.181**			

HBI	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	5.9	5.6	5.9	0.0	0.0	0.2
MO_LPPC_FFS	6.1	6.0	6.1	0.3	0.1	0.0
MO_LPPC_DS	4.5	5.9	4.7	0.1	0.1	0.2
MO_Craig	6.3	5.5	6.1	0.3	0.1	0.1
MO_Craig_FFS		6.5	6.1		0.3	0.1
MO_Dear_US		5.7	5.5		0.1	0.1
MO_Dear_DS		5.2	5.1		0.0	0.1
MO_Hardy		5.4	5.4		0.0	0.1
MO_Cascade		5.3	6.2		0.1	0.2
avg.	**5.7**	**5.7**	**5.7**			
T-test p-values	**0.92**	**0.96**	**0.904**			

%Mayfly	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	4.9	28.8	16.1	0.3	2.4	2.9
MO_LPPC_FSS	21.2	38.0	13.2	6.0	1.2	3.0
MO_LPPC_DS	13.2	24.5	28.5	2.4	4.6	1.7
MO_Craig	38.6	50.3	10.5	5.2	3.0	1.2
MO_Craig_FFS		46.4	12.1		4.8	1.7
MO_Dear_US		44.0	22.1		2.5	1.6
MO_Dear_DS		19.2	6.0		2.5	1.9
MO_Hardy		38.9	38.8		3.8	3.8
MO_Cascade		37.4	10.5		2.1	2.1
avg.	**19.5**	**36.4**	**17.5**			
T-test p-values	**0.034**	**0.001**	**0.788**			

%Caddisfly	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	2.1	6.2	12.2	0.1	0.6	2.5
MO_LPPC_FFS	1.2	1.0	9.5	0.1	0.1	3.7
MO_LPPC_DS	35.4	13.5	21.0	1.2	3.0	2.1
MO_Craig	2.0	6.2	20.4	0.4	0.6	1.8
MO_Craig_FFS		5.3	17.7		1.2	2.0
MO_Dear_US		8.7	16.8		0.4	1.3
MO_Dear_DS		15.9	35.1		3.2	6.7
MO_Hardy		5.2	42.3		1.1	3.6
MO_Cascade		12.3	17.4		1.1	3.1
avg.	**10.2**	**8.3**	**21.4**			
T-test p-values	**0.748**	**0.004**	**0.168**			

Appendix B. 2016 Seasonal Macroinvertebrate metrics. Signficant differences (p<0.05) between seasons are bolded and underlined.

#/m2	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	26826.7	17950.0	15564.8	176.4	1040.9	2040.3
MO_LPPC_USwb		9953.3	6940.0		520.0	128.6
MO_LPPC_DS	4833.3	9554.3	7565.7	562.9	1346.4	1616.8
MO_Craig	13500.0	11063.3	10703.3	719.0	1819.0	635.2
MO_Dear_US	14524.0	10401.3	10296.7	2594.5	703.2	661.2
MO_Dear_DS	370.0	710.0	10905.0	145.0	66.6	1588.4
MO_Hardy	6885.3	5845.3	5800.0	909.7	372.1	292.1
MO_Hardywb		9083.3	7213.3		520.0	716.0
MO_Cascade	5633.3	5280.0	8291.6	1372.2	158.7	1041.0
avg.	**10367.5**	**8871.2**	**9253.4**			
T-test p-values	**0.67**	**0.84**	**0.73**			

% Midges	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	19.4	6.8	22.4	0.9	2.3	3.4
MO_LPPC_USwb		7.1	1.3		1.2	0.2
MO_LPPC_DS	3.4	0.9	18.2	6.0	0.1	3.2
MO_Craig	55.5	8.3	6.0	2.7	1.1	1.7
MO_Dear_US	21.3	6.5	12.1	7.0	1.2	1.3
MO_Dear_DS	19.6	22.1	9.1	2.1	2.8	1.2
MO_Hardy	19.8	10.4	21.3	1.0	1.6	2.7
MO_Hardywb		7.1	6.0		1.2	0.4
MO_Cascade	22.4	11.4	30.6	2.0	2.4	1.6
avg.	**23.1**	**9.0**	**14.1**			
T-test p-values	**0.03**	**0.19**	**0.18**			

Total # taxa	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	26.3	30.3	27.7	0.9	2.2	0.3
MO_LPPC_USwb		22.0	20.0		0.6	0.6
MO_LPPC_DS	32.7	28.0	35.0	2.0	1.0	1.0
MO_Craig	23.7	24.3	25.3	1.3	1.2	0.9
MO_Dear_US	26.3	34.3	32.3	1.5	0.3	1.5
MO_Dear_DS	35.0	30.7	14.7	0.6	4.7	4.3
MO_Hardy	37.3	37.3	24.0	6.3	3.2	2.1
MO_Hardywb		21.0	21.3		0.6	0.9
MO_Cascade	31.0	38.0	39.7	4.6	1.2	1.9
avg.	**30.3**	**29.6**	**26.7**			
T-test p-values	**0.79**	**0.40**	**0.30**			

HBI	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	5.6	5.9	6.0	0.0	0.2	0.2
MO_LPPC_USwb		7.2	6.6		0.0	0.0
MO_LPPC_DS	4.4	5.5	3.6	0.1	0.1	0.2
MO_Craig	6.4	5.8	7.1	0.1	0.0	0.1
MO_Dear_US	6.3	5.4	5.3	0.2	0.1	0.1
MO_Dear_DS	5.8	5.0	5.3	0.3	0.1	0.1
MO_Hardy	5.4	5.6	6.0	0.3	0.2	0.1
MO_Hardywb		7.2	7.2		0.0	0.1
MO_Cascade	6.0	6.0	6.1	0.1	0.2	0.2
avg.	5.7	6.0	5.9			
T-test p-values	0.52	0.89	0.71			

#EPT taxa	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	9.3	8.0	9.3	0.7	0.7	0.7
MO_LPPC_USwb		4.7	2.7			0.3
MO_LPPC_DS	14.0	11.7	14.0	1.0	1.0	1.0
MO_Craig	6.3	5.7	6.3	0.7	0.7	0.7
MO_Dear_US	9.7	11.7	9.3	0.3	0.3	0.7
MO_Dear_DS	7.3	15.0	7.3	2.2	2.2	2.2
MO_Hardy	9.3	12.3	9.3	0.3	0.3	0.3
MO_Hardywb		4.7	5.3			0.3
MO_Cascade	15.0	15.7	13.3	1.5	1.5	0.9
avg.	**10.1**	**9.9**	**8.6**			
T-test p-values	**0.91**	**0.48**	**0.38**		22.0	1.7

%Mayfly	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	4.9	25.8	1.6	0.3	1.1	0.2
MO_LPPC_USwb		3.2	0.2		0.2	0.1
MO_LPPC_DS	13.2	11.1	26.3	2.4	1.6	4.4
MO_Craig	10.4	25.8	0.6	1.8	1.1	0.1
MO_Dear_US	40.1	19.6	22.9	7.2	4.6	1.4
MO_Dear_DS	43.8	32.7	6.0	7.8	4.0	1.9
MO_Hardy	34.2	41.8	20.4	7.0	5.3	4.2
MO_Hardywb		6.1	7.2		0.7	0.3
MO_Cascade	3.6	34.7	3.8	0.6	6.4	0.4
avg.	**21.4**	**22.3**	**9.9**			
T-test p-values	**0.91**	**0.04**	**0.12**			

%EPT	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	7.1	32.0	22.0	0.2	0.8	1.7
MO_LPPC_USwb		4.2	3.3		0.6	0.5
MO_LPPC_DS	22.1	24.6	22.1	1.1	1.9	2.8
MO_Craig	13.8	48.2	15.1	2.2	1.8	2.1
MO_Dear_US	37.5	28.3	40.7	11.6	4.1	1.2
MO_Dear_DS	49.5	48.7	63.9	13.7	2.0	12.2
MO_Hardy	60.3	47.1	55.8	4.5	6.0	4.2
MO_Hardywb		7.6	7.9		0.6	0.4
MO_Cascade	41.4	47.0	13.6	0.9	7.1	1.2
avg.	**33.1**	**32.0**	**27.1**			
T-test p-values	**0.90**	**0.61**	**0.58**			

%Caddisfly	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	2.1	6.2	1.6	0.1	0.6	0.2
MO_LPPC_USwb		1.0	0.2		0.1	0.1
MO_LPPC_DS	35.3	13.5	26.3	1.2	3.0	4.4
MO_Craig	3.4	6.2	0.6	0.4	0.6	0.1
MO_Dear_US	2.0	8.7	22.9	1.1	0.4	1.4
MO_Dear_DS	5.7	15.9	6.0	1.0	3.2	1.9
MO_Hardy	3.6	5.2	20.4	0.6	1.1	4.2
MO_Hardywb		1.3	7.2		0.1	0.3
MO_Cascade	27.9	12.3	3.8	2.0	1.1	0.4
avg.	**11.4**	**7.8**	**9.9**			
T-test p-values	**0.48**	**0.60**	**0.80**			

% Non-Insect Tax	Spring	Summer	Fall	SE	SE	SE
MO_LPPC_US	12.6	44.2	52.7	4.0	4.8	4.8
MO_LPPC_USwb		63.7	81.7		2.0	1.1
MO_LPPC_DS	18.8	23.5	18.2	3.6	7.4	3.2
MO_Craig	23.4	33.0	74.1	0.4	1.4	2.2
MO_Dear_US	40.1	55.4	38.3	4.5	4.2	1.4
MO_Dear_DS	22.7	16.3	19.6	8.1	2.6	10.7
MO_Hardy	29.7	32.0	8.9	5.7	2.2	2.9
MO_Hardywb		64.7	70.1		2.0	1.0
MO_Cascade	26.9	28.5	33.7	4.3	7.1	1.9
avg.	**24.9**	**40.2**	**44.1**			
T-test p-values	**0.06**	**0.72**	**0.09**			

APPENDIX B. Summary Macroinvertebrate Spring 2016 Metrics across all sites. Underlined, bolded values represent the highest individual metric and averages for that metric in that season.

Site	Metric	Hess #1	Hess #2	Hess #3	Average	Standard Error
MO_LPPC_US	#/m2	26,760	**27,160**	26,560	**26,827**	176.4
MO_LPPC_US	# taxa	28	26	25	26.3	0.9
MO_LPPC_US	# EPT	10	7	6	7.7	1.2
MO_LPPC_US	% EPT	6.7	7.7	6.9	7.1	0.3
MO_LPPC_US	% Non-Insect	15.7	12.8	9.2	12.6	1.9
MO_LPPC_US	% Chironomidae	19.1	18.7	20.5	19.4	0.5
MO_LPPC_US	%Mayfly	4.6	5.4	4.7	4.9	0.3
MO_LPPC_US	%Caddisfly	1.9	2.2	2.3	2.1	0.1
MO_LPPC_DS	#/m2	4,720	3,920	5,860	4,833	562.9
MO_LPPC_DS	# taxa	29	33	36	32.7	2.0
MO_LPPC_DS	# EPT	13	13	16	14.0	1.0
MO_LPPC_DS	% EPT	44.1	53.1	48.5	48.5	2.6
MO_LPPC_DS	% Non-Insect	15.7	21.9	18.8	18.8	1.8
MO_LPPC_DS	% Chironomidae	4.2	3.6	2.4	3.4	0.5
MO_LPPC_DS	%Mayfly	8.5	15.8	15.4	13.2	2.4
MO_LPPC_DS	%Caddisfly	35.6	37.2	33.1	35.3	1.2
MO_Craig	#/m2	14,880	13,160	12,460	13,500	719.0
MO_Craig	# taxa	21.0	25.0	25.0	23.7	1.3
MO_Craig	#EPT taxa	6.0	6.0	7.0	6.3	0.3
MO_Craig	% EPT	16.7	12.2	12.5	13.8	1.4
MO_Craig	% Non-Insect Taxa	15.9	24.9	29.5	23.4	4.0
MO_Craig	% Chironomidae	**58.9**	55.9	51.8	**55.5**	2.0
MO_Craig	%Mayfly	14.0	8.2	9.0	10.4	1.8
MO_Craig	%Caddisfly	2.7	4.0	3.5	3.4	0.4
MO_Dear_US	#/m2	12,020	19,712	11,840	14,524	2594.5
MO_Dear_US	# taxa	24	26	29	26.3	1.5
MO_Dear_US	#EPT taxa	5	6	9	6.7	1.2
MO_Dear_US	% EPT	32.6	35.3	44.6	37.5	3.6
MO_Dear_US	% Non-Insect Taxa	53.9	29.8	36.5	40.1	7.2
MO_Dear_US	% Chironomidae	13.1	33.1	17.6	21.3	6.0
MO_Dear_US	%Mayfly	31.6	34.5	40.5	35.6	2.6
MO_Dear_US	%Caddisfly	1.0	0.8	4.1	2.0	1.1
MO_Dear_DS	#/m2	10360	11020	8760	10046.7	671.0
MO_Dear_DS	# taxa	34	35	36	35.0	0.6
MO_Dear_DS	EPT	11	14	13	12.7	0.9
MO_Dear_DS	% EPT	40.5	**44.5**	**63.5**	**49.5**	7.1
MO_Dear_DS	% Non-Insect Taxa	30.5	25.8	11.9	22.7	5.6
MO_Dear_DS	% Chironomidae	23.9	25.8	17.8	21.3	6.0
MO_Dear_DS	%Mayfly	35.1	36.8	59.4	43.8	7.8
MO_Dear_DS	%Caddisfly	5.4	7.6	4.1	5.7	1.0
MO_Hardy	#/m2	7,664	5,072	7,920	6,885	909.7
MO_Hardy	# taxa	31	31	**50**	**37.3**	6.3
MO_Hardy	#EPT taxa	11	9	14	11.3	1.5
MO_Hardy	% EPT	34.4	27.8	51.1	37.8	6.9
MO_Hardy	% Non-Insect Taxa	30.7	34.1	24.2	29.7	2.9
MO_Hardy	% Chironomidae	25.3	29.0	20.4	24.9	2.5
MO_Hardy	%Mayfly	31.9	23.3	47.3	34.2	7.0
MO_Hardy	%Caddisfly	2.5	4.4	3.8	3.6	0.6
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	34.3	33.1	27.1	31.5	2.2
MO_Cascade	% Non-Insect Taxa	**64.3**	**65.1**	**54.5**	**61.3**	3.4
MO_Cascade	% Chironomidae	12.1	16.4	16.6	15.0	1.5
MO_Cascade	%Mayfly	3.07	4.76	2.87	3.57	0.60
MO_Cascade	%Caddisfly	31.21	28.31	24.20	27.91	2.03

APPENDIX B. Summary Macroinvertebrate Summer 2016 Metrics across all sites. Underlined, bolded values represent the highest individual metric and averages for that metric in that season.

Site	Metric	Hess #1	Hess #2	Hess #3	Average	Standard Error
MO_LPPC_US	#/m2	18,720	15,890	**19,240**	**17,950**	1040.9
MO_LPPC_US	# taxa	32	26	33	30.3	2.2
MO_LPPC_US	# EPT	9	7	8	8.0	0.6
MO_LPPC_US	% EPT	32.1	33.5	30.6	32.0	0.8
MO_LPPC_US	% Non-Insect	51.5	46.1	35.1	44.2	4.8
MO_LPPC_US	% Chironomidae	5.8	3.5	11.2	6.8	2.3
MO_LPPC_US	%Mayfly	24.6	27.9	24.9	25.8	1.1
MO_LPPC_US	%Caddisfly	7.5	5.5	5.6	6.2	0.6
MO_LPPC_Uswb	#/m2	8,180	10,190	11,490	9,953	962.8
MO_LPPC_Uswb	# taxa	23	21	22	22.0	0.6
MO_LPPC_Uswb	# EPT	5	4	5	4.7	0.3
MO_LPPC_Uswb	% EPT	4.4	4.0	4.1	4.2	0.1
MO_LPPC_Uswb	% Non-Insect	59.4	**64.4**	**67.4**	**63.7**	2.3
MO_LPPC_Uswb	% Chironomidae	6.4	8.6	5.2	6.7	1.0
MO_LPPC_Uswb	%Mayfly	3.4	2.8	3.4	3.2	0.2
MO_LPPC_Uswb	%Caddisfly	1.0	1.2	0.7	1.0	0.1
MO_LPPC_DS	#/m2	8,640	7,818	12,205	9,554	1346.4
MO_LPPC_DS	# taxa	27	30	27	28.0	1.0
MO_LPPC_DS	# EPT	10	13	12	11.7	0.9
MO_LPPC_DS	% EPT	21.8	23.8	28.2	24.6	1.9
MO_LPPC_DS	% Non-Insect	15.7	16.4	38.3	23.5	7.4
MO_LPPC_DS	% Chironomidae	0.93	1.02	0.66	0.9	0.1
MO_LPPC_DS	%Mayfly	10.19	14.33	8.85	11.1	1.6
MO_LPPC_DS	%Caddisfly	11.57	9.44	19.38	13.5	3.0
MO_Craig	#/m2	7,650	13,860	11,680	11,063	1819.0
MO_Craig	# taxa	25.0	26.0	22.0	24.3	1.2
MO_Craig	#EPT taxa	6.0	6.0	5.0	5.7	0.3
MO_Craig	% EPT	46.3	46.6	51.7	48.2	1.8
MO_Craig	% Non-Insect Taxa	35.8	32.0	31.2	33.0	1.4
MO_Craig	% Chironomidae	8.24	6.49	10.27	8.3	1.1
MO_Craig	%Mayfly	41.83	40.40	48.63	25.8	1.1
MO_Craig	%Caddisfly	4.44	6.20	3.08	6.2	0.6
MO_Dear_US	#/m2	10,400	9,184	11,620	10,401	703.2
MO_Dear_US	# taxa	32	35	36	34.3	1.2
MO_Dear_US	#EPT taxa	11	12	12	11.7	0.3
MO_Dear_US	% EPT	24.6	36.6	23.8	28.3	4.1
MO_Dear_US	% Non-Insect Taxa	62.7	48.2	55.2	55.4	4.2
MO_Dear_US	% Chironomidae	4.23	6.97	8.26	6.5	1.2
MO_Dear_US	%Mayfly	15.38	28.75	14.63	19.6	4.6
MO_Dear_US	%Caddisfly	9.23	7.84	9.12	8.7	0.4
MO_Dear_DS	#/m2	670	620	840	710.0	66.6
MO_Dear_DS	# taxa	27	25	**40**	30.7	4.7
MO_Dear_DS	EPT	14	12	**19**	15.0	2.1
MO_Dear_DS	% EPT	44.8	50.0	51.2	**48.7**	2.0
MO_Dear_DS	% Non-Insect Taxa	20.9	16.1	11.9	16.3	2.6
MO_Dear_DS	% Chironomidae	20.90	27.42	17.86	22.1	2.8
MO_Dear_DS	%Mayfly	26.87	40.32	30.95	32.7	4.0
MO_Dear_DS	%Caddisfly	17.91	9.68	20.24	15.9	3.2

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

Site	Metric	Hess #1	Hess #2	Hess #3	Average	Standard Error
MO_Hardy	#/m2	6,160	5,104	6,272	5,845	372.1
MO_Hardy	# taxa	31	40	**41**	37.3	3.2
MO_Hardy	#EPT taxa	11	13	13	12.3	0.7
MO_Hardy	% EPT	**54.5**	**51.4**	35.2	47.1	6.0
MO_Hardy	% Non-Insect Taxa	32.2	28.2	35.7	32.0	2.2
MO_Hardy	% Chironomidae	8.05	9.72	13.52	10.4	1.6
MO_Hardy	%Mayfly	49.61	44.20	31.63	41.8	5.3
MO_Hardy	%Caddisfly	4.94	7.21	3.57	5.2	1.1
MO_Hardywb	#/m2	8,750	9,020	9,480	9,083	213.1
MO_Hardywb	# taxa	22	20	21	21.0	0.6
MO_Hardywb	#EPT taxa	5	4	5	4.7	0.3
MO_Hardywb	% EPT	5.9	8.0	8.9	7.6	0.9
MO_Hardywb	% Non-Insect Taxa	**67.2**	61.6	**65.4**	**64.7**	1.6
MO_Hardywb	% Chironomidae	5.94	9.76	6.33	7.3	1.2
MO_Hardywb	%Mayfly	4.57	6.65	7.59	6.3	0.9
MO_Hardywb	%Caddisfly	1.37	1.33	1.27	1.3	0.0
MO_Cascade	#/m2	5,220	5,040	5,580	5,280	158.7
MO_Cascade	# taxa	38	36	**40**	**38.0**	1.2
MO_Cascade	#EPT taxa	**16**	15	16	**15.7**	0.3
MO_Cascade	% EPT	36.0	**60.3**	44.8	47.0	7.1
MO_Cascade	% Non-Insect Taxa	41.4	16.7	27.6	28.5	7.1
MO_Cascade	% Chironomidae	8.05	9.92	16.13	11.4	2.4
MO_Cascade	%Mayfly	23.75	46.03	34.41	34.73	6.43
MO_Cascade	%Caddisfly	12.26	14.29	10.39	12.31	1.12

APPENDIX B. Summary Macroinvertebrate Fall 016 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	12,520	14,734	**19,440**	**15,565**	2040.3
MO_LPPC_US	# taxa	27	28	28	27.7	0.3
MO_LPPC_US	# EPT	6	8	8	7.3	0.7
MO_LPPC_US	% EPT	22.0	19.0	24.8	22.0	1.7
MO_LPPC_US	% Non-Insect	48.9	62.3	46.9	52.7	4.8
MO_LPPC_US	% Chironomidae	3.5	2.3	1.7	2.5	0.5
MO_LPPC_US	%Mayfly	1.9	1.2	1.5	1.6	0.2
MO_LPPC_US	%Caddisfly	20.1	17.8	23.3	20.4	1.6
MO_LPPC_USwb	#/m2	6,740	7,180	6,900	6,940	128.6
MO_LPPC_USwb	# taxa	21	19	20	20.0	0.6
MO_LPPC_USwb	# EPT	3	2	3	2.7	0.3
MO_LPPC_USwb	% EPT	3.6	2.2	4.1	3.3	0.5
MO_LPPC_USwb	% Non-Insect	**80.4**	**80.8**	**83.8**	**81.7**	1.1
MO_LPPC_USwb	% Chironomidae	1.5	0.8	1.4	1.3	0.2
MO_LPPC_USwb	%Mayfly	0.3	0.0	0.3	0.2	0.1
MO_LPPC_USwb	%Caddisfly	3.3	2.2	3.8	3.1	0.5
MO_LPPC_DS	#/m2	10,710	6,647	5,340	7,566	1616.8
MO_LPPC_DS	# taxa	37	34	34	35.0	1.0
MO_LPPC_DS	# EPT	13	13	15	13.7	0.7
MO_LPPC_DS	% EPT	58.7	65.8	69.1	64.5	3.1
MO_LPPC_DS	% Non-Insect	19.2	13.7	16.7	16.5	1.6
MO_LPPC_DS	% Chironomidae	2.7	1.9	0.7	1.8	0.6
MO_LPPC_DS	%Mayfly	23.2	20.7	35.0	26.3	4.4
MO_LPPC_DS	%Caddisfly	35.5	45.1	34.1	**38.2**	3.5
MO_Craig	#/m2	10,580	11,860	9,670	10,703	635.2
MO_Craig	# taxa	27.0	25.0	24.0	25.3	0.9
MO_Craig	#EPT taxa	7.0	7.0	5.0	6.3	0.7
MO_Craig	% EPT	11.7	14.5	19.0	15.1	2.1
MO_Craig	% Non-Insect Taxa	78.4	71.8	71.9	74.1	2.2
MO_Craig	% Chironomidae	4.9	9.4	3.7	6.0	1.7
MO_Craig	%Mayfly	0.4	0.7	0.8	0.6	0.1
MO_Craig	%Caddisfly	11.3	13.8	18.2	14.5	2.0
MO_Dear_US	#/m2	10,120	11,520	9,250	10,297	661.2
MO_Dear_US	# taxa	32	30	35	32.3	1.5
MO_Dear_US	#EPT taxa	10	8	10	9.3	0.7
MO_Dear_US	% EPT	39.0	39.9	43.1	40.7	1.2
MO_Dear_US	% Non-Insect Taxa	40.6	38.5	35.8	38.3	1.4
MO_Dear_US	% Chironomidae	9.7	13.9	12.8	12.1	1.3
MO_Dear_US	%Mayfly	20.2	25.0	23.7	22.9	1.4
MO_Dear_US	%Caddisfly	18.9	14.9	19.5	17.8	1.4
MO_Dear_DS	#/m2	7785	12982.5	11947.5	10905.0	1588.4
MO_Dear_DS	# taxa	36	34	33	34.3	0.9
MO_Dear_DS	EPT	18	17	12	**15.7**	1.9
MO_Dear_DS	% EPT	53.8	**36.2**	**32.6**	**40.9**	6.5
MO_Dear_DS	% Non-Insect Taxa	13.9	13.3	15.8	14.3	0.8
MO_Dear_DS	% Chironomidae	9.4	6.9	10.9	9.1	1.2
MO_Dear_DS	%Mayfly	5.8	9.4	2.8	6.0	1.9
MO_Dear_DS	%Caddisfly	**48.0**	26.9	29.8	34.9	6.6

APPENDIX B (cont.). 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_Hardy	#/m2	5,496	5,520	6,384	5,800	292.1
MO_Hardy	# taxa	38	36	**45**	**39.7**	2.7
MO_Hardy	#EPT taxa	15	11	15	13.7	1.3
MO_Hardy	% EPT	35.4	18.3	26.7	26.8	4.9
MO_Hardy	% Non-Insect Taxa	32.8	46.1	44.4	41.1	4.2
MO_Hardy	% Chironomidae	19.7	26.5	17.7	21.3	2.7
MO_Hardy	%Mayfly	27.5	13.0	20.7	20.4	4.2
MO_Hardy	%Caddisfly	7.9	5.2	6.0	6.4	0.8
MO_Hardywb	#/m2	5,960	7,240	8,440	7,213	716.0
MO_Hardywb	# taxa	21	20	23	21.3	0.9
MO_Hardywb	#EPT taxa	5	5	6	5.3	0.3
MO_Hardywb	% EPT	8.1	7.2	8.5	7.9	0.4
MO_Hardywb	% Non-Insect Taxa	**69.8**	**68.5**	**72.0**	**70.1**	1.0
MO_Hardywb	% Chironomidae	6.7	6.1	5.2	6.0	0.4
MO_Hardywb	%Mayfly	7.4	6.6	7.6	7.2	0.3
MO_Hardywb	%Caddisfly	0.7	0.6	0.9	0.7	0.1
MO_Cascade	#/m2	7,121	7,386	10,368	8,292	1041.0
MO_Cascade	# taxa	42	36	41	**39.7**	1.9
MO_Cascade	#EPT taxa	15	12	13	13.3	0.9
MO_Cascade	% EPT	14.2	11.3	15.4	13.6	1.2
MO_Cascade	% Non-Insect Taxa	33.5	37.0	30.5	33.7	1.9
MO_Cascade	% Chironomidae	28.3	33.7	29.9	30.6	1.6
MO_Cascade	%Mayfly	4.6	3.6	3.1	3.8	0.4
MO_Cascade	%Caddisfly	9.6	7.7	12.3	9.9	1.3

Appendix C. Macroinvertebate taxa list and abundance.

APPENDIX C. Macroinvertebrate 2017 Spring taxa lists and raw data across all sites.

MO_LPPC_US01	Spring 2017						
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Coleoptera	Optioservus	Optioservus quadrimaculatus	264	184	88	178.7	50.88
Coleoptera	Zaitzevia	Zaitzevia	16	16	20	17.3	1.33
Diptera	Ceratopogonidae	Bezzia	8	16	0	8.0	4.62
Diptera	Chironominae	Microtendipes	16	4	8	9.3	3.53
Diptera	Chironominae	Phaenopsectra	4	4	12	6.7	2.67
Diptera	Chironominae	Pseudochironomus	8	20	12	13.3	3.53
Diptera	Diamesinae	Diamesa	120	176	228	174.7	31.18
Diptera	Orthocladiinae	Cricotopus	184	160	152	165.3	9.61
Diptera	Orthocladiinae	Cardiocladius	0	0	12	4.0	4.00
Diptera	Orthocladiinae	Parakieffierella	180	144	120	148.0	17.44
Diptera	Simuliidae	Simulium	1280	1428	1572	1426.7	84.30
Diptera	Tabanidae	Chrysops	0	0	0	0.0	0.00
Diptera	Tanypodinae	Thienemannimyia gr.	0	8	4	4.0	2.31
Diptera	Tipulidae	Limnophila	0	0	0	0.0	0.00
Ephemeroptera	Baetis	Baetis tricaudatus	96	140	108	114.7	13.13
Ephemeroptera	Ephemerella	Ephemerella excrucians	12	0	8	6.7	3.53
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	16	8	8	10.7	2.67
Non-Insect taxa	Hirudina	Erpobdella punctata	4	0	0	1.3	1.33
Non-Insect taxa	Caecidotea	Caecidotea	92	52	48	64.0	14.05
Non-Insect taxa	Hyalella	Hyalella	24	8	16	16.0	4.62
Non-Insect taxa	Oligochaeta	Lumbricina	0	8	8	5.3	2.67
Non-Insect taxa	Physa_Physella	Physella acuta	16	8	8	10.7	2.67
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	52	24	8	28.0	12.86
Non-Insect taxa	Oligochaeta	Tubificidae	48	40	20	36.0	8.33
Non-Insect taxa	Acari	Sperchon	4	8	8	6.7	1.33
Non-Insect taxa	Turbellaria	Turbellaria	180	200	128	169.3	21.46
Plecoptera	Perlodidae	Isoperla	4	0	0	1.3	1.33
Trichoptera	Ceraclea	Ceraclea	16	0	0	5.3	5.33
Trichoptera	Cheumatopsyche	Cheumatopsyche	8	20	28	18.7	5.81
Trichoptera	Glossosomatidae	Culoptila	0	0	0	0.0	0.00
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	0	0	0	0.0	0.00
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	4	16	0	6.7	4.81
Trichoptera	Hydroptila	Hydroptila	12	4	8	8.0	2.31
Trichoptera	Lepidostoma	Lepidostoma	4	4	0	2.7	1.33
Trichoptera	Uneonidae	Neophylax splendans	0	0	0	0.0	0.00
Trichoptera	Oecetis	Oecetis avara	4	16	24	14.7	5.81
			2676	**2716**	**2656**	**2682.7**	**17.64**

APPENDIX C. Macroinvertebrate 2017 Spring taxa lists and raw data across all sites.

Spring 2017 FFS	Biomass (OM)	6	14	4 2/5	8.1	2.97
OTUname2	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Optioservus	Optioservus quadrimaculatus	16	0	8	8.0	4.62
Narpus	Narpus	0	0	8	2.7	2.67
Ceratopogonidae	Bezzia	0	0	8	2.7	2.67
Chironominae	Microtendipes	8	0	16	8.0	4.62
Chironominae	Phaenopsectra	0	0	0	0.0	0.00
Chironominae	Pseudochironomus	0	0	0	0.0	0.00
Diamesinae	Diamesa	8	16	8	10.7	2.67
Orthocladiinae	Cricotopus	24	80	88	64.0	20.13
Orthocladiinae	Cardiocladius	32	8	0	13.3	9.61
Orthocladiinae	Eukieffierella	32	24	16	24.0	4.62
Orthocladiinae	Parakieffierella	24	0	8	10.7	7.06
Orthocladiinae	Synorthocladius	16	24	0	13.3	7.06
Simuliidae	Simulium	1608	2360	2800	2256.0	348.01
Tabanidae	Chrysops	0	0	0	0.0	0.00
Tanypodinae	Thienemannimyia gr.	16	32	32	26.7	5.33
Tipulidae	Hexatoma	8	0	0	2.7	2.67
Tipulidae	Tipula	0	0	8	2.7	2.67
Empididae	Hemerodromia	8	0	8	5.3	2.67
Baetis	Baetis tricaudatus	144	32	96	**90.7**	32.44
Ephemerella	Ephemerella excrucians	880	288	560	576.0	171.08
Tricorythodes	Tricorythodes explicatus	208	168	296	224.0	37.81
Hirudina	Erpobdella punctata	0	0	16	5.3	5.33
Hirudina	Helobdella stagnalis	8	0	16	8.0	4.62
Caecidotea	Caecidotea	32	48	56	45.3	7.06
Hyalella	Hyalella	0	8	16	8.0	4.62
Oligochaeta	Lumbricina	32	32	8	24.0	8.00
Oligochaeta	Lumbriculidae	40	24	128	64.0	32.33
Oligochaeta	Tubificidae	200	392	1120	570.7	280.20
Physa_Physella	Physella acuta	0	0	8	2.7	2.67
Pisidiidae	Pisidium	72	8	8	29.3	21.33
Potamopyrgus	Potamopyrgus antipodarum	64	8	24	32.0	16.65
Valvatidae	Valvata	40	32	80	50.7	14.85
Menetus	Menetus dilatatus	0	16	0	5.3	5.33
Acari	Sperchon	0	0	0	0.0	0.00
Turbellaria	Turbellaria	120	16	104	80.0	32.33
Perlodidae	Isoperla	0	0	0	0.0	0.00
Ceraclea	Ceraclea	8	0	0	2.7	2.67
Cheumatopsyche	Cheumatopsyche	16	8	0	8.0	4.62
Glossosomatidae	Glossosoma	8	0	0	2.7	2.67
Limnephilidae	Dicosmoecus gilvipes	0	0	0	0.0	0.00
Hydropsyche_Ceratops	Hydropsyche occidentalis	8	0	8	5.3	2.67
Hydroptila	Hydroptila	8	0	8	5.3	2.67
Lepidostoma	Lepidostoma	0	0	0	0.0	0.00
Uneonidae	Neophylax splendans	0	0	0	0.0	0.00
Oecetis	Oecetis avara	40	24	8	24.0	9.24
		3728	**3648**	**5568**	**4314.7**	**627.09**

APPENDIX C. Macroinvertebrate 2017 Spring taxa lists and raw data across all sites.

MO_LPPC_DS01	Spring 2017						
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Average**	**SE**
Coleoptera	Optioservus	Optioservus quadrimaculatus	108	54	106	89.3	17.68
Coleoptera	Stenelmis	Stenelmis	0	0	0	0.0	0.00
Coleoptera	Zaitzevia	Zaitzevia	32	8	40	26.7	9.61
Diptera	Ceratopogonidae	Probezzia	0	8	4	4.0	2.31
Diptera	Chironominae	Microtendipes	12	2	6	6.7	2.91
Diptera	Chironominae	Polypedilum	0	0	2	0.7	0.67
Diptera	Diamesinae	Diamesa	4	2	0	2.0	1.15
Diptera	Diamesinae	Pagastia	0	0	0	0.0	0.00
Diptera	Orthocladiinae	Cricotopus	0	4	6	3.3	1.76
Diptera	Orthocladiinae	Eukiefferella	2	2	0	1.3	0.67
Diptera	Orthocladiinae	Nostoccocladius	2	4	0	2.0	1.15
Diptera	Simuliidae	Simulium	14	2	2	6.0	4.00
Diptera	Stratiomyidae	Caloparyphus	0	0	6	2.0	2.00
Diptera	Tanypodinae	Thienemannimyia gr.	0	0	4	1.3	1.33
Diptera	Tipulidae	Hexatoma	14	8	10	10.7	1.76
Diptera	Tipulidae	Limnophila	2	4	2	2.7	0.67
Ephemeroptera	Baetis	Baetis tricaudatus	4	6	20	10.0	5.03
Ephemeroptera	Drunella	Drunella coloradensis	0	0	2	0.7	0.67
Ephemeroptera	Ephemerella	Ephemerella excrucians	16	36	42	31.3	7.86
Ephemeroptera	Paraleptophlebia	Paraleptophlebia	2	2	4	2.7	0.67
Ephemeroptera	Rhithrogena	Rhithrogena	18	18	22	19.3	1.33
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	0	0	0	0.0	0.00
Hemiptera	Corixidae	Corixidae	0	0	4	1.3	1.33
Non-Insect taxa	Caecidotea	Caecidotea	0	8	0	2.7	2.67
Non-Insect taxa	Glossiphoniidae	Glossiphonia complanata	0	4	0	1.3	1.33
Non-Insect taxa	Oligochaeta	Lumbricina	4	2	10	5.3	2.40
Non-Insect taxa	Oligochaeta	Lumbriculidae	4	12	24	13.3	5.81
Non-Insect taxa	Oligochaeta	Tubificidae	14	26	22	20.7	3.53
Non-Insect taxa	Physa_Physella	Physella acuta	12	2	16	10.0	4.16
Non-Insect taxa	Pisidiidae	Pisidium	0	0	2	0.7	0.67
Non-Insect taxa	Pisidiidae	Sphaerium	0	4	0	1.3	1.33
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	2	0	2	1.3	0.67
Non-Insect taxa	Stagnicola	Stagnicola	12	4	2	6.0	3.06
Non-Insect taxa	Turbellaria	Turbellaria	26	24	32	27.3	2.40
Plecoptera	Chloroperlidae	Paraperla	2	0	2	1.3	0.67
Plecoptera	Chloroperlidae	Suwallia	2	0	0	0.7	0.67
Plecoptera	Hesperoperla pacifica	Hesperoperla pacifica	0	0	4	1.3	1.33
Plecoptera	Perlodidae	Isoperla	0	0	2	0.7	0.67
Plecoptera	Pteronarcys	Pteronarcys californica	2	0	0	0.7	0.67
Trichoptera	Brachycentrus	Brachycentrus occidentalis	8	10	14	10.7	1.76
Trichoptera	Glossosomatidae	Anagapetus	2	2	0	1.3	0.67
Trichoptera	Glossosomatidae	Glossosoma	4	6	8	6.0	1.15
Trichoptera	Hydropsyche_Ceratops	Hydropsyche	0	4	0	1.3	1.33
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	0	8	8	5.3	2.67
Trichoptera	Hydroptila	Hydroptila	0	0	8	2.7	2.67
Trichoptera	Lepidostoma	Lepidostoma	86	60	88	78.0	9.02
Trichoptera	Leptoceridae	Ceraclea	4	2	2	2.7	0.67
Trichoptera	Leptoceridae	Oecetis avara	48	50	46	48.0	1.15
Trichoptera	Uneonidae	Neophylax splendans	12	4	12	9.3	2.67
		Totals	**474**	**392**	**586**	**484.0**	**56.23**

APPENDIX C. Macroinvertebrate 2017 Spring taxa lists and raw data across all sites.

MO_Craig_US01	Spring 2017	OM Biomass	3.5	7.5	4.5	5.2	1.20
Order	OTUname2	Final ID	Hess 1	Hess 2	Hess 3	Avg.	SE
Coleoptera	Optioservus	Optioservus quadrimaculatus	20	128	40	62.7	33.17
Diptera	Ceratopogonidae	Probezzia	0	0	8	2.7	2.67
Diptera	Diamesinae	Diamesa	0	0	0	0.0	0.00
Diptera	Orthocladiinae	Cricotopus	68	120	136	108.0	20.53
Diptera	Orthocladiinae	Eukiefferiella	0	24	8	10.7	7.06
Diptera	Chironominae	Microtendipes	52	216	96	121.3	49.01
Diptera	Chironominae	Polypedilum	0	0	8	2.7	2.67
Diptera	Chironominae	Phaenopsectra	0	0	0	0.0	0.00
Diptera	Chironominae	Glyptotendipes	0	0	0	0.0	0.00
Diptera	Chironominae	Tanytarsus	0	0	0	0.0	0.00
Diptera	Tanypodinae	Thienemannimyia gr.	4	24	16	14.7	5.81
Diptera	Tabanidae	Chrysops	0	16	0	5.3	5.33
Diptera	Empididae	Hemerodromia	0	0	8	2.7	2.67
Diptera	Simuliidae	Simulium	360	672	704	578.7	109.72
Diptera	Tipulidae	Tipula	0	0	0	0.0	0.00
Ephemeroptera	Baetis	Baetis tricaudatus	364	912	432	569.3	172.45
Ephemeroptera	Ephemerella	Ephemerella excrucians	92	144	80	105.3	19.64
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	212	600	376	396.0	112.45
Non-Insect taxa	Caecidotea	Caecidotea	28	32	8	22.7	7.42
Non-Insect taxa	Hirudina	Erpobdella punctata	0	0	0	0.0	0.00
Non-Insect taxa	Glossiphoniidae	Glossiphonia complanata	0	0	0	0.0	0.00
Non-Insect taxa	Hirudina	Helobdella stagnalis	0	0	0	0.0	0.00
Non-Insect taxa	Hyalella	Hyalella	0	16	8	8.0	4.62
Non-Insect taxa	Gammarus	Gammarus	0	32	0	10.7	10.67
Non-Insect taxa	Oligochaeta	Lumbricina	20	16	32	22.7	4.81
Non-Insect taxa	Oligochaeta	Lumbriculidae	0	0	0	0.0	0.00
Non-Insect taxa	Nematoda	Nematoda	0	0	8	2.7	2.67
Non-Insect taxa	Physa_Physella	Physella acuta	8	24	16	16.0	4.62
Non-Insect taxa	Pisidiidae	Pisidium	16	104	32	50.7	27.06
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	4	32	48	28.0	12.86
Non-Insect taxa	Oligochaeta	Tubificidae	260	504	968	577.3	207.64
Non-Insect taxa	Turbellaria	Turbellaria	16	48	32	32.0	9.24
Trichoptera	Brachycentridae	Amiocentrus aspilis	0	0	0	0.0	0.00
Trichoptera	Cheumatopsyche	Cheumatopsyche	8	24	0	10.7	7.06
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	4	8	8	6.7	1.33
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	0	16	8	8.0	4.62
Trichoptera	Hydroptila	Hydroptila	8	0	8	5.3	2.67
Trichoptera	Helicopsyche	Helicopsyche borealis	0	0	0	0.0	0.00
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	0	8	8	5.3	2.67
Trichoptera	Leptoceridae	Ceraclea	4	0	0	1.3	1.33
Trichoptera	Leptoceridae	Nectopsyche	0	0	0	0.0	0.00
Trichoptera	Leptoceridae	Oecetis avara	8	0	40	16.0	12.22
		Totals	**1556**	**3720**	**3136**	**2804.0**	**646.37**

APPENDIX C. Macroinvertebrate 2017 Summer taxa lists and raw data across all sites.

MO_LPPC_US01	Summer 2017 FFS	OM Biomass	8.00	4.50	6.00	6.2	
Order	OTUname2	FinalID	Hess 1	Hess 2	Hess 3	Avg.	SE
Coleoptera	Optioservus	Optioservus quadrimaculatus	16	40	48	34.7	9.61
Coleoptera	Zaitzevia	Zaitzevia	0	0	0	0.0	0.00
Diptera	Ceratopogonidae	Probezzia	4	4	4	4.0	0.00
Diptera	Diamesinae	Potthastia	4	4	4	4.0	0.00
Diptera	Chironominae	Microtendipes	0	0	0	0.0	0.00
Diptera	Chironominae	Micropsectra	0	12	0	4.0	4.00
Diptera	Chironominae	Pseudochironomus	0	0	0	0.0	0.00
Diptera	Diamesinae	Diamesa	0	0	0	0.0	0.00
Diptera	Orthocladiinae	Cricotopus	40	100	68	69.3	17.33
Diptera	Orthocladiinae	Tvetenia	8	0	4	4.0	2.31
Diptera	Orthocladiinae	Parametriocnemus	36	32	20	29.3	4.81
Diptera	Orthocladiinae	Synorthocladius	8	16	8	10.7	2.67
Diptera	Orthocladiinae	Parakieffierella	4	12	8	8.0	2.31
Diptera	Simuliidae	Simulium	60	24	44	42.7	10.41
Diptera	Tabanidae	Chrysops	0	0	0	0.0	0.00
Diptera	Tanypodinae	Thienemannimyia gr.	0	12	8	6.7	3.53
Diptera	Tipulidae	Limnophila	0	0	0	0.0	0.00
Ephemeroptera	Baetis	Baetis tricaudatus	204	132	176	170.7	20.95
Ephemeroptera	Ephemerella	Ephemerella excrucians	12	12	16	13.3	1.33
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	144	88	160	130.7	21.83
Non-Insect taxa	Hirudina	Erpobdella punctata	0	0	0	0.0	0.00
Non-Insect taxa	Caecidotea	Caecidotea	32	56	88	58.7	16.22
Non-Insect taxa	Hyalella	Hyalella	0	4	0	1.3	1.33
Non-Insect taxa	Oligochaeta	Lumbricina	0	4	4	2.7	1.33
Non-Insect taxa	Oligochaeta	Lumbriculidae	132	80	112	108.0	15.14
Non-Insect taxa	Physa_Physella	Physella acuta	4	4	4	4.0	0.00
Non-Insect taxa	Pisidiidae	Pisidium	4	0	4	2.7	1.33
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	4	4	8	5.3	1.33
Non-Insect taxa	Gyraulus	Gyraulus	0	4	0	1.3	1.33
Non-Insect taxa	Menetus	Menetus dilatatus	0	0	0	0.0	0.00
Non-Insect taxa	Oligochaeta	Tubificidae	124	64	80	89.3	17.94
Non-Insect taxa	Gammarus	Gammarus	12	4	4	6.7	2.67
Non-Insect taxa	Turbellaria	Turbellaria	128	168	196	164.0	19.73
Plecoptera	Perlodidae	Isoperla	0	0	0	0.0	0.00
Trichoptera	Ceraclea	Ceraclea	4	0	0	1.3	1.33
Trichoptera	Cheumatopsyche	Cheumatopsyche	8	0	4	4.0	2.31
Trichoptera	Glossosomatidae	Culoptila	0	0	0	0.0	0.00
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	0	0	0	0.0	0.00
Trichoptera	Hydropsyche_Cerato	Hydropsyche morosa gr.	0	0	0	0.0	0.00
Trichoptera	Hydroptila	Hydroptila	116	68	96	93.3	13.92
Trichoptera	Lepidostoma	Lepidostoma	0	0	0	0.0	0.00
Trichoptera	Uneonidae	Neophylax splendans	0	0	0	0.0	0.00
Trichoptera	Oecetis	Oecetis avara	8	8	8	8.0	0.00
			1116	**956**	**1176**	**1082.7**	**65.66**

APPENDIX C. Macroinvertebrate 2017 Summer taxa lists and raw data across all sites.

MO_LPPC_US01	Summer 2017 FFS	OM Biomass	2.20	4.50	3.60	3.4	
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Coleoptera	Optioservus	Optioservus quadrimaculatus	0	4	4	2.7	1.33
Diptera	Ceratopogonidae	Probezzia	8	0	4	4.0	2.31
Diptera	Chironominae	Microtendipes	4	32	24	20.0	8.33
Diptera	Chironominae	Micropsectra	0	8	4	4.0	2.31
Diptera	Chironominae	Pseudochironomus	0	32	12	14.7	9.33
Diptera	Diamesinae	Potthastia	0	4	8	4.0	2.31
Diptera	Orthocladiinae	Tvetenia	12	0	8	6.7	3.53
Diptera	Orthocladiinae	Cricotopus	64	48	84	65.3	10.41
Diptera	Orthocladiinae	Cardiocladius	0	0	0	0.0	0.00
Diptera	Orthocladiinae	Eukieffierella	0	0	0	0.0	0.00
Diptera	Orthocladiinae	Parakieffierella	12	24	8	14.7	4.81
Diptera	Orthocladiinae	Synorthocladius	8	0	12	6.7	3.53
Diptera	Simuliidae	Simulium	16	20	8	14.7	3.53
Diptera	Tanypodinae	Thienemannimyia gr.	24	12	8	14.7	4.81
Diptera	Tipulidae	Hexatoma	0	0	0	0.0	0.00
Diptera	Tipulidae	Tipula	0	0	0	0.0	0.00
Diptera	Empididae	Hemerodromia	0	0	0	0.0	0.00
Ephemeroptera	Baetis	Baetis tricaudatus	128	156	204	**162.7**	22.19
Ephemeroptera	Ephemerella	Ephemerella excrucians	8	20	16	14.7	3.53
Ephemeroptera	Ephemeridae	Attenella margarita	8	8	12	9.3	1.33
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	200	224	176	200.0	13.86
Non-Insect taxa	Hirudina	Erpobdella punctata	0	4	8	4.0	2.31
Non-Insect taxa	Hirudina	Helobdella stagnalis	0	4	0	1.3	1.33
Non-Insect taxa	Glossiphoniidae	Glossiphonia complanata	0	4	0	1.3	1.33
Non-Insect taxa	Caecidotea	Caecidotea	32	16	24	24.0	4.62
Non-Insect taxa	Hyalella	Hyalella	0	4	8	4.0	2.31
Non-Insect taxa	Gammarus	Gammarus	4	4	8	5.3	1.33
Non-Insect taxa	Oligochaeta	Lumbricina	12	20	4	12.0	4.62
Non-Insect taxa	Oligochaeta	Lumbriculidae	28	40	48	38.7	5.81
Non-Insect taxa	Oligochaeta	Tubificidae	88	140	220	149.3	38.39
Non-Insect taxa	Physa_Physella	Physella acuta	0	20	4	8.0	6.11
Non-Insect taxa	Pisidiidae	Pisidium	12	8	4	8.0	2.31
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	8	20	12	13.3	3.53
Non-Insect taxa	Valvatidae	Valvata	12	32	20	21.3	5.81
Non-Insect taxa	Menetus	Menetus dilatatus	0	0	0	0.0	0.00
Non-Insect taxa	Gyraulus	Gyraulus	0	4	0	1.3	1.33
Non-Insect taxa	Turbellaria	Turbellaria	100	60	80	80.0	11.55
Plecoptera	Perlodidae	Isoperla	0	0	0	0.0	0.00
Trichoptera	Ceraclea	Ceraclea	0	0	0	0.0	0.00
Trichoptera	Cheumatopsyche	Cheumatopsyche	0	0	0	0.0	0.00
Trichoptera	Glossosomatidae	Glossosoma	0	0	0	0.0	0.00
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	0	0	0	0.0	0.00
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	0	0	0	0.0	0.00
Trichoptera	Hydroptila	Hydroptila	60	80	100	80.0	11.55
Trichoptera	Lepidostoma	Lepidostoma	0	0	0	0.0	0.00
Trichoptera	Uneonidae	Neophylax splendans	0	0	0	0.0	0.00
Trichoptera	Oecetis	Oecetis avara	16	12	8	12.0	2.31
			864	**1064**	**1140**	**1022.7**	**82.31**

APPENDIX C. Macroinvertebrate 2017 Summer taxa lists and raw data across all sites.

MO_LPPC_DS01	Summer 2017	OM Biomass	4.5	9	6	6.5	1.32
Order	OTUname2	FinalID	Hess 1	Hess 2	Hess 3	Average	SE
Coleoptera	Optioservus	Optioservus quadrimaculatus	32	40	44	38.7	3.53
Coleoptera	Zaitzevia	Zaitzevia	8	6	10	8.0	1.15
Diptera	Chironominae	Micropsectra	2	4	4	3.3	0.67
Diptera	Chironominae	Pseudochironomus	0	4	0	1.3	1.33
Diptera	Diamesinae	Diamesa	0	0	0	0.0	0.00
Diptera	Diamesinae	Pagastia	0	0	0	0.0	0.00
Diptera	Orthocladiinae	Cricotopus	126	172	150	149.3	13.28
Diptera	Orthocladiinae	Eukiefferella	0	2	0	0.7	0.67
Diptera	Orthocladiinae	Tvetenia	2	2	0	1.3	0.67
Diptera	Orthocladiinae	Cardiocladius	6	2	2	3.3	1.33
Diptera	Orthocladiinae	Parametriocnemus	0	2	4	2.0	1.15
Diptera	Orthocladiinae	Parakiefferiellla	2	6	4	4.0	1.15
Diptera	Simuliidae	Simulium	42	22	28	30.7	5.93
Diptera	Stratiomyidae	Caloparyphus	0	0	0	0.0	0.00
Diptera	Tanypodinae	Thienemannimyia gr.	2	8	4	4.7	1.76
Diptera	Tipulidae	Hexatoma	4	2	2	2.7	0.67
Diptera	Tipulidae	Antocha	2	0	2	1.3	0.67
Ephemeroptera	Baetis	Baetis tricaudatus	102	40	66	69.3	17.98
Ephemeroptera	Drunella	Drunella coloradensis	0	0	0	0.0	0.00
Ephemeroptera	Ephemerella	Ephemerella excrucians	2	2	2	2.0	0.00
Ephemeroptera	Ephemerella	Attenella margarita	4	2	0	2.0	1.15
Ephemeroptera	Heptagenia	Heptagenia	0	2	0	0.7	0.67
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	60	36	44	46.7	7.06
Non-Insect taxa	Caecidotea	Caecidotea	4	6	6	5.3	0.67
Non-Insect taxa	Hirudina	Erpobdella punctata	2	0	0	0.7	0.67
Non-Insect taxa	Oligochaeta	Lumbricina	0	0	0	0.0	0.00
Non-Insect taxa	Oligochaeta	Lumbriculidae	42	20	30	30.7	6.36
Non-Insect taxa	Oligochaeta	Tubificidae	12	4	8	8.0	2.31
Non-Insect taxa	Physa_Physella	Physella acuta	4	2	2	2.7	0.67
Non-Insect taxa	Pisidiidae	Pisidium	0	0	4	1.3	1.33
Non-Insect taxa	Gyraulus	Gyraulus	0	4	2	2.0	1.15
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	0	2	2	1.3	0.67
Non-Insect taxa	Stagnicola	Stagnicola	2	2	2	2.0	0.00
Non-Insect taxa	Turbellaria	Turbellaria	32	76	50	52.7	12.77
Trichoptera	Brachycentrus	Brachycentrus occidentalis	0	2	2	1.3	0.67
Trichoptera	Glossosomatidae	Anagapetus	0	0	0	0.0	0.00
Trichoptera	Glossosomatidae	Glossosoma	0	0	0	0.0	0.00
Trichoptera	Hydropsyche_Ceratops	Cheumatopsyche	2	0	0	0.7	0.67
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	0	0	0	0.0	0.00
Trichoptera	Hydroptila	Hydroptila	12	2	10	8.0	3.06
Trichoptera	Lepidostoma	Lepidostoma	0	0	0	0.0	0.00
Trichoptera	Leptoceridae	Ceraclea	0	0	0	0.0	0.00
Trichoptera	Leptoceridae	Oecetis avara	0	0	0	0.0	0.00
Trichoptera	Uneonidae	Neophylax splendans	2	0	0	0.7	0.67
		Totals	510	474	484	489.3	10.73

APPENDIX C. Macroinvertebrate 2017 Summer taxa lists and raw data across all sites.

MO_Craig_US01	Summer 2017	OM Biomass	7	6.5	8	7.2	
Order	**OTUname2**	**Final ID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Coleoptera	Optioservus	Optioservus quadrimaculatus	36	40	28	34.7	3.53
Coleoptera	Zaitzevia	Zaitzevia	0	0	0	0.0	0.00
Coleoptera	Agabus	Agabus	0	0	0	0.0	0.00
Diptera	Ceratopogonidae	Probezzia	2	4	4	3.3	0.67
Diptera	Diamesiinae	Potthastia	16	8	12	12.0	2.31
Diptera	Orthocladiinae	Cricotopus trifascia	40	44	60	48.0	6.11
Diptera	Chironominae	Microtendipes	40	48	40	42.7	2.67
Diptera	Chironominae	Pseudochironomus	4	0	0	1.3	1.33
Diptera	Chironominae	Phaenopsectra	0	0	0	0.0	0.00
Diptera	Chironominae	Glyptotendipes	0	0	0	0.0	0.00
Diptera	Chironominae	Tanytarsus	40	8	20	22.7	9.33
Diptera	Tanypodinae	Thienemannimyia gr.	12	6	10	9.3	1.76
Diptera	Tipulidae	Tipula	0	0	0	0.0	0.00
Diptera	Simulium	Simulium	16	8	12	12.0	2.31
Ephemeroptera	Baetis	Baetis tricaudatus	272	252	232	252.0	11.55
Ephemeroptera	Ephemerella	Ephemerella excrucians	4	12	8	8.0	2.31
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	424	292	368	361.3	38.25
Non-Insect taxa	Caecidotea	Caecidotea	24	4	16	14.7	5.81
Non-Insect taxa	Hirudina	Erpobdella punctata	0	0	0	0.0	0.00
Non-Insect taxa	Glossiphoniidae	Glossiphonia complanata	0	0	0	0.0	0.00
Non-Insect taxa	Hirudina	Helobdella stagnalis	0	0	0	0.0	0.00
Non-Insect taxa	Hyalella	Hyalella	32	4	20	18.7	8.11
Non-Insect taxa	Gammarus	Gammarus	12	4	8	8.0	2.31
Non-Insect taxa	Oligochaeta	Lumbricina	8	20	12	13.3	3.53
Non-Insect taxa	Menetus	Menetus dilatatus	0	0	0	0.0	0.00
Non-Insect taxa	Nematoda	Nematoda	8	12	8	9.3	1.33
Non-Insect taxa	Physa_Physella	Physella acuta	0	12	8	6.7	3.53
Non-Insect taxa	Pisidiidae	Pisidium	16	12	12	13.3	1.33
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	0	8	4	4.0	2.31
Non-Insect taxa	Oligochaeta	Tubificidae	52	136	108	98.7	24.69
Non-Insect taxa	Oligochaeta	Lumbriculidae	4	4	0	2.7	1.33
Non-Insect taxa	Turbellaria	Turbellaria	92	128	88	102.7	12.72
Trichoptera	Cheumatopsyche	Cheumatopsyche	12	12	16	13.3	1.33
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	0	0	0	0.0	0.00
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	0	0	0	0.0	0.00
Trichoptera	Hydroptila	Hydroptila	60	100	64	74.7	12.72
Trichoptera	Helicopsyche	Helicopsyche borealis	0	8	4	4.0	2.31
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	0	0	0	0.0	0.00
Trichoptera	Leptoceridae	Ceraclea	8	0	4	4.0	2.31
Trichoptera	Leptoceridae	Nectopsyche	0	0	0	0.0	0.00
Trichoptera	Leptoceridae	Oecetis avara	28	44	48	40.0	6.11
		Totals	**1262**	**1230**	**1214**	**1235.3**	**14.11**

APPENDIX C. Macroinvertebrate 2017 Summer taxa lists and raw data across all sites.

MO_Craig_US FFS	Summer 2017	OM Biomass	9	2.5	4	5.2	
Order	**OTUname2**	**Final ID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Coleoptera	Optioservus	Optioservus quadrimaculatus	20	8	4	10.7	4.81
Coleoptera	Agabus	Agabus	8	0	0	2.7	2.67
Diptera	Ceratopogonidae	Probezzia	4	0	0	1.3	1.33
Diptera	Diamesiinae	Pagastia	0	4	4	2.7	1.33
Diptera	Orthocladiinae	Cricotopus trifascia	20	24	8	17.3	4.81
Diptera	Chironominae	Microtendipes	16	24	20	20.0	2.31
Diptera	Chironominae	Pseudochironomus	4	0	0	1.3	1.33
Diptera	Chironominae	Phaenopsectra	0	0	0	0.0	0.00
Diptera	Chironominae	Tanytarsus	0	0	12	4.0	4.00
Diptera	Tanypodinae	Thienemannimyia gr.	8	6	4	6.0	1.15
Diptera	Tipulidae	Tipula	0	0	0	0.0	0.00
Diptera	Simulium	Simulium	4	28	16	16.0	6.93
Ephemeroptera	Baetis	Baetis tricaudatus	188	172	220	193.3	14.11
Ephemeroptera	Ephemerella	Ephemerella excrucians	0	0	8	2.7	2.67
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	284	128	172	194.7	46.44
Non-Insect taxa	Caecidotea	Caecidotea	28	8	8	14.7	6.67
Non-Insect taxa	Hirudina	Erpobdella punctata	0	0	0	0.0	0.00
Non-Insect taxa	Glossiphoniidae	Glossiphonia complanata	0	0	0	0.0	0.00
Non-Insect taxa	Hirudina	Helobdella stagnalis	0	4	0	1.3	1.33
Non-Insect taxa	Hyalella	Hyalella	16	0	8	8.0	4.62
Non-Insect taxa	Gammarus	Gammarus	8	4	20	10.7	4.81
Non-Insect taxa	Oligochaeta	Lumbricina	0	8	0	2.7	2.67
Non-Insect taxa	Menetus	Menetus dilatatus	4	0	4	2.7	1.33
Non-Insect taxa	Nematoda	Nematoda	8	12	8	9.3	1.33
Non-Insect taxa	Physa_Physella	Physella acuta	20	0	4	8.0	6.11
Non-Insect taxa	Pisidiidae	Pisidium	92	12	40	48.0	23.44
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	16	12	12	13.3	1.33
Non-Insect taxa	Oligochaeta	Tubificidae	380	180	96	218.7	84.23
Non-Insect taxa	Turbellaria	Turbellaria	12	12	8	10.7	1.33
Trichoptera	Cheumatopsyche	Cheumatopsyche	4	0	4	2.7	1.33
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	0	0	0	0.0	0.00
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	0	0	0	0.0	0.00
Trichoptera	Hydroptila	Hydroptila	12	28	28	22.7	5.33
Trichoptera	Helicopsyche	Helicopsyche borealis	4	0	0	1.3	1.33
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	0	0	0	0.0	0.00
Trichoptera	Leptoceridae	Ceraclea	8	0	4	4.0	2.31
Trichoptera	Leptoceridae	Nectopsyche	0	0	0	0.0	0.00
Trichoptera	Leptoceridae	Oecetis avara	12	20	4	12.0	4.62
		Totals	**1180**	**694**	**716**	**863.3**	**158.46**

APPENDIX C. Macroinvertebrate 2017 Summer taxa lists and raw data across all sites.

		Biomass OM	9	4.5	7	6.8	1.30
MO_Dear_US01	Summer 2017	Subsample	1/4	1/3	1/3		
Order	OTUname2	FinalID	Hess 1	Hess 2	Hess 3	Avg.	SE
Coleoptera	Optioservus	Optioservus quadrimaculatus	8	6	3	5.7	1.45
Coleoptera	Zaitzevia	Zaitzevia	4	3	6	4.3	0.88
Diptera	Orthocladiinae	Cricotopus	100	195	132	142.3	27.91
Diptera	Orthocladiinae	Cardiocladius	12	9	12	11.0	1.00
Diptera	Orthocladiinae	Tvetenia	28	6	15	16.3	6.39
Diptera	Diamesinae	Diamesa	0	0	0	0.0	0.00
Diptera	Chironominae	Microtendipes	0	0	0	0.0	0.00
Diptera	Chironominae	Dicrotendipes	0	0	0	0.0	0.00
Diptera	Chironominae	Phaenopsectra	0	0	0	0.0	0.00
Diptera	Chironominae	Tanytarsus	0	15	24	13.0	7.00
Diptera	Simuliidae	Simulium	0	3	3	2.0	1.00
Diptera	Ceratopogonidae	Bezzia	4	12	12	9.3	2.67
Diptera	Tanypodinae	Thienemannimyia gr.	12	60	45	39.0	14.18
Ephemeroptera	Baetis	Baetis tricaudatus	328	273	333	311.3	19.22
Ephemeroptera	Ephemerella	Ephemerella excrucians	28	33	36	32.3	2.33
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	152	324	201	225.7	51.16
Ephemeroptera	Ephemerella	Attenella margarita	16	12	9	12.3	2.03
Ephemeroptera	Plauditus	Plauditus puntiventris	0	3	3	2.0	1.00
Ephemeroptera	Paraleptophlebia	Paraleptophlebia	4	0	3	2.3	1.20
Lepidoptera	Petrophila	Petrophila	0	0	0	0.0	0.00
Non-Insect taxa	Caecidotea	Caecidotea	24	15	21	20.0	2.65
Non-Insect taxa	Gammarus	Gammarus	0	18	15	11.0	5.57
Non-Insect taxa	Hirudina	Erpobdella punctata	0	6	3	3.0	1.73
Non-Insect taxa	Hirudina	Helobdella stagnalis	0	0	0	0.0	0.00
Non-Insect taxa	Glossiphoniidae	Glossiphonia complanata	16	12	0	9.3	4.81
Non-Insect taxa	Hyalella	Hyalella	8	6	15	9.7	2.73
Non-Insect taxa	Oligochaeta	Lumbricina	60	9	33	34.0	14.73
Non-Insect taxa	Oligochaeta	Lumbriculidae	16	18	36	23.3	6.36
Non-Insect taxa	Nematoda	Nematoda	0	0	0	0.0	0.00
Non-Insect taxa	Physa_Physella	Physella acuta	20	6	21	15.7	4.84
Non-Insect taxa	Ferrissia	Ferrissia	0	0	0	0.0	0.00
Non-Insect taxa	Pisidiidae	Pisidium	0	0	0	0.0	0.00
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	0	0	0	0.0	0.00
Non-Insect taxa	Oligochaeta	Tubificidae	56	147	99	100.7	26.28
Non-Insect taxa	Turbellaria	Turbellaria	92	54	93	79.7	12.84
Trichoptera	Ceraclea	Ceraclea	0	3	3	2.0	1.22
Trichoptera	Cheumatopsyche	Cheumatopsyche	20	9	21	16.7	3.84
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	4	0	3	2.3	1.20
Trichoptera	Helicopsyche	Helicopsyche borealis	0	0	0	0.0	0.00
Trichoptera	Hydroptilidae	Hydroptila	44	330	171	181.7	82.73
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	24	3	0	9.0	7.55
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	0	3	3	2.0	1.00
Trichoptera	Oecetis	Oecetis avara	0	0	0	0.0	0.00
		Totals	1080	1593	1374	1349.0	148.62

APPENDIX C. Macroinvertebrate 2017 Summer taxa lists and raw data across all sites.

MO_Dearborn_DS	Summer 2017	Biomass OM	0.7	0.5	0.4	0.5	0.09
Order	OTUname2	FinalID	Hess 1	Hess 2	Hess 3	Average	SE
Coleoptera	Optioservus	Optioservus quadrimaculatus	0	14	22	12.0	6.43
Coleoptera	Stenelmis	Stenelmis	0	6	6	4.0	2.00
Coleoptera	Zaitzevia	Zaitzevia parvula	4	6	8	6.0	1.15
Diptera	Ceratopogonidae	Probezzia	4	2	2	2.7	0.67
Diptera	Tipulidae	Hexatoma	6	4	4	4.7	0.67
Diptera	Tipulidae	Tipula	0	2	2	1.3	0.67
Diptera	Chironominae	Microtendipes	0	0	0	0.0	0.00
Diptera	Chironominae	Rheotanytarsus	8	44	32	28.0	10.58
Diptera	Chironominae	Tanytarsus	30	36	24	30.0	3.46
Diptera	Chironominae	Phaenopsectra	0	0	0	0.0	0.00
Diptera	Orthocladiinae	Nostoccocladius	0	2	0	0.7	0.67
Diptera	Orthocladiinae	Cricotopus	6	4	6	5.3	0.67
Diptera	Orthocladiinae	Cardiocladius	2	2	2	2.0	0.00
Diptera	Tanypodinae	Thienemannimyia gr.	0	0	0	0.0	0.00
Ephemeroptera	Baetis	Baetis tricaudatus	42	30	24	32.0	5.29
Ephemeroptera	Baetis	Diphetor hageni	0	4	2	2.0	1.15
Ephemeroptera	Plauditis	Plauditus punctiventris	2	2	2	2.0	0.00
Ephemeroptera	Ephemera simulans	Ephemera simulans	0	0	0	0.0	0.00
Ephemeroptera	Ephemerella	Ephemerella excrucians	2	0	2	1.3	0.67
Ephemeroptera	Ephemeridae	Attenella margarita	0	2	4	2.0	1.15
Ephemeroptera	Rhithrogena	Rhithrogena	0	2	0	0.7	0.67
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	0	0	32	10.7	10.67
Hemiptera	Corixidae	Corixidae	0	0	8	2.7	2.67
Non-Insect taxa	Acarina	Acarina	0	0	0	0.0	0.00
Non-Insect taxa	Oligochaeta	Lumbriculidae	0	6	4	3.3	1.76
Non-Insect taxa	Oligochaeta	Lumbricidae	2	2	2	2.0	0.00
Non-Insect taxa	Physa_Physella	Physella acuta	0	0	0	0.0	0.00
Non-Insect taxa	Pisidiidae	Pisidium	2	0	4	2.0	1.15
Non-Insect taxa	Hyalella	Hyalella	0	0	0	0.0	0.00
Non-Insect taxa	Oligochaeta	Tubificidae	8	0	4	4.0	2.31
Non-Insect taxa	Turbellaria	Turbellaria	12	14	22	16.0	3.06
Non-Insect taxa	Orconectes virilis	Orconectes virilis	0	0	0	0.0	0.00
Non-Insect taxa	Ferrissia	Ferrissia	3	6	0	3.0	1.73
Odonata	Ophiogomphus	Ophiogomphus	0	0	0	0.0	0.00
Plecoptera	Claasennia sabulosa	Claasennia sabulosa	4	2	2	2.7	0.67
Plecoptera	Chloroperlidae	Sweltsa	0	0	0	0.0	0.00
Plecoptera	Skwala	Skwala	6	6	8	6.7	0.67
Plecoptera	Pteronarcys	Pteronarcys californica	4	2	0	2.0	1.15
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	2	0	0	0.7	0.67
Trichoptera	Brachycentrus	Brachycentrus occidentalis	6	2	2	3.3	1.33
Trichoptera	Cheumatopsyche	Cheumatopsyche	16	24	18	19.3	2.40
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	2	10	8	6.7	2.40
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	24	34	26	28.0	3.06
Trichoptera	Hydroptila	Mayatrichia ayama	0	2	2	1.3	0.67
Trichoptera	Hydroptila	Hydroptila	16	8	16	13.3	2.67
Trichoptera	Helicopsyche	Helicopsyche borealis	0	2	4	2.0	1.15
Trichoptera	Oecetis	Oecetis avara	0	0	0	0.0	0.00
Trichoptera	Limnephilidae	Limnephilus	0	0	0	0.0	0.00
		Totals	**213**	**282**	**304**	**266.3**	**27.41**

APPENDIX C. Macroinvertebrate 2017 Summer taxa lists and raw data across all sites.

		OM	20	12	21	17.7	2.85
			1/2FS	1/2FS	1/2FS		
MO_Hardy_DS01	Summer2017		1/8 sub	1/8 sub	1/8 sub		
Order	OTUname2	FinalID	Hess 1	Hess 2	Hess 3	Avg.	SE
Coleoptera	Optioservus	Optioservus quadrimaculatus	144	272	112	176.0	48.88
Coleoptera	Microcylloepus pusillis	Microcylloepus pusillis	0	0	0	0.0	0.00
Coleoptera	Zaitzevia	Zaitzevia	48	64	0	37.3	19.23
Diptera	Simuliidae	Simulium	32	80	64	58.7	14.11
Diptera	Orthocladiinae	Cricotopus	288	432	400	373.3	43.66
Diptera	Orthocladiinae	Nostoccocladius	16	16	16	16.0	0.00
Diptera	Orthocladiinae	Parametriocnemus	16	0	0	5.3	5.33
Diptera	Ceratopogonidae	Probezzia	80	16	16	37.3	21.33
Diptera	Chironominae	Pseudochironomus	0	0	0	0.0	0.00
Diptera	Tanypodinae	Thienemannimyia gr.	208	208	144	186.7	21.33
Diptera	Chironominae	Polypedilum	0	0	0	0.0	0.00
Diptera	Chironominae	Phaenopsectra	16	16	32	21.3	5.33
Diptera	Chironominae	Cryptochironomus	0	0	0	0.0	0.00
Diptera	Chironominae	Microtendipes	96	0	48	48.0	27.71
Diptera	Orthocladiinae	Eukiefferella	16	32	0	16.0	9.24
Diptera	Orthocladiinae	Tvetenia bavarica	64	80	32	58.7	14.11
Diptera	Chironominae	Rheotanytarsus	64	80	64	69.3	5.33
Diptera	Chironominae	Tanytarsus	64	80	64	69.3	5.33
Diptera	Tipulidae	Tipula	0	0	16	5.3	5.33
Ephemeroptera	Attenella	Attenella margarita	80	16	128	74.7	32.44
Ephemeroptera	Baetis	Baetis tricaudatus	1744	1440	1488	1557.3	94.36
Ephemeroptera	Baetis	Baetis intercalaris	112	144	80	112.0	18.48
Ephemeroptera	Ephemerella	Ephemerella excrucians	208	0	128	9.0	60.58
Ephemeroptera	Paraleptophlebia	Paraleptophlebia	0	0	16	5.3	5.33
Ephemeroptera	Heptagenidae	Ecdyonurus	0	0	0	0.0	0.00
Ephemeroptera	Plauditis	Plauditus punctiventris	48	224	48	106.7	58.67
Ephemeroptera	Pseudocloeon	Pseudocloeon	16	0	16	10.7	5.33
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	1664	1040	1760	1488.0	225.71
Hemiptera	Corixidae	Corixidae	0	0	0	0.0	0.00
Non-Insect taxa	Oligochaeta	Tubificidae	160	0	48	69.3	47.40
Non-Insect taxa	Oligochaeta	Lumbricidae	0	0	0	0.0	0.00
Non-Insect taxa	Oligochaeta	Lumbriculidae	0	0	0	0.0	0.00
Non-Insect taxa	Hirudinea	Erpobdella punctata	16	0	0	5.3	5.33
Non-Insect taxa	Hirudinea	Glossiphonia complanata	0	0	0	0.0	0.00
Non-Insect taxa	Pisidiidae	Sphaerium	16	32	16	21.3	5.33
Non-Insect taxa	Pisidiidae	Pisidium	0	0	0	0.0	0.00
Non-Insect taxa	Hyalella	Hyalella	48	48	32	42.7	5.33
Non-Insect taxa	Gammarus	Gammarus	16	16	16	16.0	0.00
Non-Insect taxa	Caecidotea	Caecidotea	48	32	208	96.0	56.19
Non-Insect taxa	Turbellaria	Turbellaria	144	272	144	186.7	42.67
Non-Insect taxa	Physa_Physella	Physella acuta	80	32	64	58.7	14.11
Non-Insect taxa	Ancyliidae	Ferrissia rivularis	16	0	0	5.3	5.33
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	0	0	0	0.0	0.00
Non-Insect taxa	Orconectes virilis	Orconectes virilis	16	0	16	10.7	5.33
Plecoptera	Pelodidae	Isoperla	0	0	0	0.0	0.00
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	160	336	656	384.0	145.18
Trichoptera	Brachycentridae	Amiocentrus aspilus	16	0	0	5.3	5.33
Trichoptera	Brachycentrus occident	Brachycentrus occidentalis	16	16	16	16.0	0.00
Trichoptera	Cheumatopsyche	Cheumatopsyche	624	1024	880	842.7	116.97
Trichoptera	Leptoceridae	Oecetis	16	0	0	5.3	5.33
Trichoptera	Hydroptila	Hydroptila	2160	2912	2240	2437.3	238.45
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	32	48	80	53.3	14.11
Trichoptera	Helicopsyche	Helicopsyche borealis	0	0	16	5.3	5.33
Trichoptera	Polycentropidae	Polycentropus	16	0	0	5.3	5.33
Trichoptera	Limnephilidae	Onocosmoecus unicolor	16	0	0	5.3	5.33
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	32	16	16	21.3	5.33
		Totals	8672	9024	9120	8938.7	136.18

APPENDIX C. Macroinvertebrate 2017 Summer taxa lists and raw data across all sites.

MO_Cascade_01	Summer 2017	OM Biomass	36	38	42	38.7	
Order	OTUname2	FinalID	Hess 1	Hess 2	Hess 3	Avg.	SE
Coleoptera	Microcylloepus	Microcylloepus pusillis	0	0	24	8.0	8.00
Coleoptera	Optioservus	Optioservus quadrimaculatus	192	272	128	197.3	41.65
Coleoptera	Zaitzevia	Zaitzevia	0	32	0	10.7	10.67
Diptera	Orthocladiinae	Cricotopus	90	112	88	96.7	7.69
Diptera	Tipulidae	Tipula	16	16	24	18.7	2.67
Diptera	Chironominae	Microtendipes	0	16	32	16.0	9.24
Diptera	Chironominae	Phaenopsectra	32	16	48	32.0	9.24
Diptera	Chironominae	Pseudochironomus	0	16	16	10.7	5.33
Diptera	Chironominae	Rheotanytarsus	24	40	48	37.3	7.06
Diptera	Diamesinae	Pagastia	8	0	0	2.7	2.67
Diptera	Tanypodinae	Thienemannimyia gr.	24	16	32	24.0	4.62
Diptera	Caloparyphus	Caloparyphus	0	0	0	0.0	0.00
Diptera	Ceratopongonidae	Probezzia	0	0	32	10.7	10.67
Diptera	Hemerodromia	Hemerodromia	0	0	8	2.7	2.67
Diptera	Simuliidae	Simulium	0	0	8	2.7	2.67
Ephemeroptera	Baetidae	Acerpenna pygmaea	0	8	8	5.3	2.67
Ephemeroptera	Baetis	Baetis intercalaris	8	16	8	10.7	2.67
Ephemeroptera	Baetis	Baetis tricaudatus	64	32	16	37.3	14.11
Ephemeroptera	Choroterpes	Choroterpes	72	128	48	82.7	23.70
Ephemeroptera	Heptagenia	Ecdyonurus simpliciodes	0	8	0	0.0	2.67
Ephemeroptera	Ephemera	Ephemera simulans	8	8	0	5.3	2.67
Ephemeroptera	Ephemerella	Ephemerella excrucians	8	0	8	5.3	2.67
Ephemeroptera	Ephemerellidae	Attenella margarita	8	8	8	8.0	0.00
Ephemeroptera	Heptagenia	Heptagenia	32	24	8	21.3	7.06
Ephemeroptera	Heptagenia	Macaffertium terminatum	0	0	0	0.0	0.00
Ephemeroptera	Plauditus	Plauditus punctiventris	16	8	0	8.0	4.62
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	768	976	824	856.0	62.14
Lepidoptera	Petrophila	Petrophila	0	8	8	5.3	2.67
Non-Insect taxa	Caecidotea	Caecidotea	0	8	0	2.7	2.67
Non-Insect taxa	Hyalella	Hyalella	192	112	176	160.0	24.44
Non-Insect taxa	Gammarus	Gammarus	32	16	16	21.3	5.33
Non-Insect taxa	Oligochaeta	Lumbricina	24	32	8	21.3	7.06
Non-Insect taxa	Oligochaeta	Lumbriculidae	8	0	8	5.3	2.67
Non-Insect taxa	Orconectes	Orconectes virilis	16	16	8	13.3	2.67
Non-Insect taxa	Physa_Physella	Physella acuta	8	0	8	5.3	2.67
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	0	16	8	8.0	4.62
Non-Insect taxa	Ferrissia	Ferrissia	0	8	0	2.7	2.67
Non-Insect taxa	Pisidiidae	Pisidium	16	0	8	8.0	4.62
Non-Insect taxa	Pisidiidae	Sphaerium	0	8	8	5.3	2.67
Non-Insect taxa	Oligochaeta	Tubificidae	56	64	80	66.7	7.06
Non-Insect taxa	Hirudina	Erpobdella punctata	8	24	16	16.0	4.62
Non-Insect taxa	Hirudina	Glossiphonia complanata	0	8	0	2.7	2.67
Non-Insect taxa	Turbellaria	Turbellaria	32	56	24	37.3	9.61
Odonata	Ophiogomphus	Ophiogomphus severus	8	0	0	2.7	2.67
Trichoptera	Brachycentridae	Amiocentrus aspilus	0	8	0	2.7	2.67
Trichoptera	Brachycentrus	Brachycentrus occidentalis	0	8	4	4.0	2.31
Trichoptera	Cheumatopsyche	Cheumatopsyche	8	24	16	16.0	4.62
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	8	8	8	8.0	0.00
Trichoptera	Helicopsyche	Helicopsyche borealis	40	24	24	29.3	5.33
Trichoptera	Hydropsyche_Ceratopsyc	Hydropsyche morosa gr.	0	8	24	10.7	7.06
Trichoptera	Hydroptila	Hydroptila	545	622	776	647.7	67.91
Trichoptera	Nectopsyche	Nectopsyche	8	0	0	2.7	2.67
Trichoptera	Oecetis	Oecetis avara	16	24	32	24.0	4.62
Trichoptera	Limnephilidae	Onocomoecus unicolor	0	0	0	0.0	0.00
Trichoptera	Polycentropidae	Polycentropus	0	0	0	0.0	0.00
		Totals	**2395**	**2854**	**2676**	**2641.7**	**133.61**

APPENDIX C. Macroinvertebrate 2017 Fall taxa lists and raw data across all sites

				0.5 FS			
MO_LPPC_US01	**Fall 2017**	**Subsample**	**0.125**	**0.375**	**0.250**		
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Coleoptera	Elmidae	Optioservus quadrimaculatus	112	72.0	136.0	106.7	18.67
Coleoptera	Elmidae	Zaitzevia	12	0.0	24.0	12.0	6.93
Diptera	Chironominae	Microtendipes	64	8.0	4.0	25.3	19.37
Diptera	Chironominae	Pseudochironomus	0	5.3	0.0	1.8	1.78
Diptera	Chironominae	Dicrotendipes	8	0.0	4.0	4.0	2.31
Diptera	Orthocladiinae	Cardiocladius	0	0.0	8.0	2.7	2.67
Diptera	Orthocladiinae	Cricotopus	156	112.0	352.0	206.7	73.77
Diptera	Orthocladiinae	Eukiefferella	4	0.0	8.0	4.0	2.31
Diptera	Orthocladiinae	Orthocladius	0	0.0	8.0	2.7	2.67
Diptera	Orthocladiinae	Parametriocnemus	0	0	4	1.3	1.33
Diptera	Orthocladiinae	Thienemanniella	0	2.7	0.0	0.9	0.89
Diptera	Orthocladiinae	Tvetenia	8	8.0	8.0	8.0	0.00
Diptera	Tanypodinae	Thienemannimyia gr.	8	5.3	12.0	8.4	1.94
Diptera	Simuliidae	Simulium	368	429.3	580.0	459.1	62.98
Diptera	Tabanidae	Chrysops	0	0.0	0.0	0.0	0.00
Diptera	Tipulidae	Limnophila	0	0.0	0.0	0.0	0.00
Diptera	Caloparyphus	Caloparyphus	4	0.0	4.0	2.7	1.33
Ephemeroptera	Baetis	Baetis tricaudatus	92	37.3	136.0	88.4	28.54
Ephemeroptera	Ephemerella	Ephemerella excrucians	0	2.7	12.0	4.9	3.64
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	136	208.0	392.0	245.3	76.22
Lepidoptera	Petrophila	Petrophila	4	0.0	4.0	2.7	1.33
Non-Insect taxa	Caecidotea	Caecidotea	400	122.7	96.0	206.2	97.19
Non-Insect taxa	Gammarus	Gammarus	8	2.7	16.0	8.9	3.87
Non-Insect taxa	Crangonyx	Crangonyx	12	8.0	8.0	9.3	1.33
Non-Insect taxa	Gyraulus	Gyraulus	0	0.0	4.0	1.3	1.33
Non-Insect taxa	Hirudina	Erpobdella punctata	4	0.0	0.0	1.3	1.33
Non-Insect taxa	Hyalella	Hyalella	48	24.0	16.0	29.3	9.61
Non-Insect taxa	Menetus	Menetus dilatatus	4	13.3	4.0	7.1	3.11
Non-Insect taxa	Nematoda	Nematoda	20	0.0	4.0	8.0	6.11
Non-Insect taxa	Oligochaeta	Lumbricina	8	10.3	12.0	10.1	1.16
Non-Insect taxa	Oligochaeta	Lumbriculidae	16	0.0	16.0	10.7	5.33
Non-Insect taxa	Oligochaeta	Tubificidae	48	34.3	96.0	59.4	18.71
Non-Insect taxa	Physa_Physella	Physella acuta	40	18.7	8.0	22.2	9.41
Non-Insect taxa	Pisidiidae	Pisidium	0	3	4	2.2	1.18
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	4	8.0	32.0	14.7	8.74
Non-Insect taxa	Acari	Sperchon	0	0.0	4.0	1.3	1.33
Non-Insect taxa	Stagnicola	Stagnicola	0	0.0	4	1.3	1.33
Non-Insect taxa	Turbellaria	Turbellaria	368	104.0	228.0	233.3	76.26
Non-Insect taxa	Valvata	Valvata humeralis	8	5.3	12.0	8.4	1.94
Plecoptera	Perlodidae	Isoperla	0	0.0	0.0	0.0	0.00
Trichoptera	Ceraclea	Ceraclea	12	48.0	24.0	28.0	10.58
Trichoptera	Oecetis	Oecetis avara	116	66.7	108.0	96.9	15.29
Trichoptera	Cheumatopsyche	Cheumatopsyche	32	72.0	64.0	56.0	12.22
Trichoptera	Brachycentrus occident	Brachycentrus occidentalis	0	0	4	0.0	1.33
Trichoptera	Glossosomatidae	Culoptila	0	6.9	0.0	2.3	2.29
Trichoptera	Hydropsyche_Ceratops	Hydropsyche	0	24.0	12.0	12.0	6.93
Trichoptera	Lepidostoma	Lepidostoma	0	2.7	12.0	4.9	3.64
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	0	0.0	0.0	0.0	0.00
Trichoptera	Uneonidae	Neophylax splendans	0	20.6	108.0	42.9	33.11
		Totals	**2124**	**1485.3**	**2592.0**	**2067.1**	**320.73**

APPENDIX C. Macroinvertebrate 2017 Fall taxa lists and raw data across all sites

9/28/2017		OM	11	9	19	13.0	
MO_LPPC_FFS	**Fall 2017**		**0.625**	**0.5**	**0.25**		**0.17**
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Coleoptera	Elmidae	Optioservus quadrimaculatus	49.6	30	4	27.9	13.21
Coleoptera	Elmidae	Zaitzevia	0	0.0	4	1.3	1.33
Coleoptera	Haliplidae	Haliplus	0	2.0	0	0.7	0.67
Diptera	Simuliidae	Simulium	48	154	1040	414.0	314.49
Diptera	Orthocladiinae	Cricotopus trifasciata	56	272	260	196.0	70.09
Diptera	Chironominae	Pseudochironomus	1.6	6	8	5.2	1.89
Diptera	Tanypodinae	Thienemannimyia gr.	3.2	14	4	7.1	3.47
Diptera	Chironominae	Dicrotendipes	0	0	8	2.7	2.67
Diptera	Chironominae	Microtendipes	24	28.0	20.0	24.0	2.31
Diptera	Orthocladiinae	Eukiefferella	0	4	4	2.7	1.33
Diptera	Orthocladiinae	Tvetenia bavarica	0	0	8	2.7	2.67
Diptera	Orthocladiinae	Synorthocladius	0	0	4	1.3	1.33
Diptera	Tipulidae	Tipula	1.6	0	0	0.5	0.53
Ephemeroptera	Baetis	Baetis tricaudatus	43.2	24	52	39.7	8.27
Ephemeroptera	Ephemerella	Ephemerella excrucians	3.2	4	4	3.7	0.27
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	72	220	128	140.0	43.14
Non-Insect taxa	Oligochaeta	Tubificidae	0	26	0	8.7	8.67
Non-Insect taxa	Oligochaeta	Lumbricidae	3.2	0	0	1.1	1.07
Non-Insect taxa	Oligochaeta	Lumbriculidae	24	20	0	14.7	7.42
Non-Insect taxa	Hirudinea	Erpobdella punctata	0	4	4	2.7	1.33
Non-Insect taxa	Hirudinea	Glossiphonia complanata	0	0	0	0.0	0.00
Non-Insect taxa	Hirudina	Helobdella stagnalis	0	0	8	2.7	2.67
Non-Insect taxa	Fossaria	Fossaria humilis	0	0	0	0.0	0.00
Non-Insect taxa	Pisidiidae	Pisidium	0	2	0	0.7	0.67
Non-Insect taxa	Hyalella	Hyalella	9.6	20	80	36.5	21.94
Non-Insect taxa	Gammarus	Gammarus	3.2	6	28	12.4	7.84
Non-Insect taxa	Nematoda	Nematoda	3.2	4.0	36.0	14.4	10.80
Non-Insect taxa	Caecidotea	Caecidotea	112	154	400	222.0	89.82
Non-Insect taxa	Turbellaria	Turbellaria	230.4	202	80	170.8	46.13
Non-Insect taxa	Physa_Physella	Physella acuta	25.6	28	20	24.5	2.37
Non-Insect taxa	Gyraulus	Gyraulus parvus	1.6	2	0	1.2	0.61
Non-Insect taxa	Valvatidae	Valvata humeralis	0	16	8	8.0	4.62
Non-Insect taxa	Menetus	Menetus dilatatus	8	6.0	8.0	7.3	0.67
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	1.6	16	4	7.2	4.45
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	6.4	0	0	2.1	2.13
Trichoptera	Brachycentrus occiden	Brachycentrus occidentalis	0	0	0	0.0	0.00
Trichoptera	Cheumatopsyche	Cheumatopsyche	32	12	20	21.3	5.81
Trichoptera	Leptoceridae	Oecetis	102.4	78	80	86.8	7.82
Trichoptera	Ceraclea	Ceraclea	6.4	0.0	4.0	3.5	1.87
Trichoptera	Hydroptila	Hydroptila	0	2	4	2.0	1.15
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	0	0	0	0.0	0.00
Trichoptera	Helicopsyche	Helicopsyche borealis	0	0	0	0.0	0.00
Trichoptera	Lepidostoma	Lepidostoma	0	0.0	8	2.7	2.67
Trichoptera	Polycentropidae	Polycentropus	0	0	0	0.0	0.00
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	0	0	0	0.0	0.00
Trichoptera	Limnephilidae	Onocosmoecus unicolor	0	0	0	0.0	0.00
Trichoptera	Limnephilidae	Limnephilus	0	0	0	0.0	0.00
		Totals	**872**	**1356**	**2340**	**1522.7**	**431.89**

APPENDIX C. Macroinvertebrate 2017 Fall taxa lists and raw data across all sites

		OM	14	6.0	9	9.7	
MO_LPPC_DS01	Fall 2017	1/2 subsample	0.5	0.625	0.625		
Order	OTUname2	FinalID	Hess 1	Hess 2	Hess 3	Average	SE
Coleoptera	Elmidae	Optioservus quadrimaculatus	290	147.2	177.6	204.9	43.43
Coleoptera	Elmidae	Zaitzevia	32	22.4	27.2	27.2	2.77
Diptera	Tipulidae	Hexatoma	30	9.6	19.2	19.6	5.89
Diptera	Tipulidae	Limnophila	2	3.2	1.6	2.3	0.48
Diptera	Orthocladiinae	Eukiefferella	2	6.4	4.8	4.4	1.29
Diptera	Chironominae	Microtendipes	0	0.0	0	0.0	0.00
Diptera	Chironominae	Pseudochironomus	0	0.0	0	0.0	0.00
Diptera	Orthocladiinae	Cricotopus	16	41.6	24	27.2	7.56
Diptera	Orthocladiinae	Cardiocladius	2	0.0	3.2	1.7	0.93
Diptera	Orthocladiinae	Nostoccocladius	0	0.0	0	0.0	0.00
Diptera	Orthocladiinae	Rheocricotopus	0	0.0	0	0.0	0.00
Diptera	Orthocladiinae	Parametriocnemus	0	1.6	1.6	1.1	0.53
Diptera	Orthocladiinae	Pagastia	0	0.0	0	0.0	0.00
Diptera	Ceratopogonidae	Probezzia	0	0.0	0	0.0	0.00
Diptera	Simuliidae	Simulium	6	22.4	11.2	13.2	4.84
Diptera	Empididae	Hemerodromia	2	0.0	1.6	1.2	0.61
Diptera	Tanypodinae	Thienemannimyia gr.	10	0.0	4.8	4.9	2.89
Diptera	Caloparyphus	Caloparyphus	6	1.6	1.6	3.1	1.47
Ephemeroptera	Baetis	Baetis tricaudatus	96	104.0	52.8	84.3	15.90
Ephemeroptera	Ephemerella	Ephemerella excrucians	32	20.8	14.4	22.4	5.14
Ephemeroptera	Paraleptophlebia	Paraleptophlebia	0	0.0	0	0.0	0.00
Ephemeroptera	Rhithrogena	Rhithrogena	52	105.6	70.4	76.0	15.72
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	110	4.8	41.6	52.1	30.82
Hemiptera	Corixidae	Corixidae	0	0.0	0	0.0	0.00
Lepidoptera	Petrophila	Petrophila	0	0.0	0	0.0	0.00
Non-Insect taxa	Caecidotea	Caecidotea	6	3.2	1.6	3.6	1.29
Non-Insect taxa	Gammarus	Gammarus	2	0.0	0	0.7	0.67
Non-Insect taxa	Hyalella	Hyalella	6	4.8	11.2	7.3	1.96
Non-Insect taxa	Oligochaeta	Lumbricina	4	1.6	1.6	2.4	0.80
Non-Insect taxa	Oligochaeta	Lumbriculidae	4	4.8	4.8	4.5	0.27
Non-Insect taxa	Menetus	Menetus dilatatus	2	6.4	3.2	3.9	1.31
Non-Insect taxa	Physa_Physella	Physella acuta	4	0.0	4.8	2.9	1.48
Non-Insect taxa	Fossaria	Fossaria	0	0.0	1.6	0.5	0.53
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	2	0.0	1.6	1.2	0.61
Non-Insect taxa	Valvata	Valvata	0	3.2	1.6	1.6	0.92
Non-Insect taxa	Gyraulus	Gyraulus	2	0.0	1.6	1.2	0.61
Non-Insect taxa	Stagnicola	Stagnicola	2	0.0	0	0.7	0.67
Non-Insect taxa	Pisidiidae	Pisidium	3.6	0.0	1.6	1.7	1.04
Non-Insect taxa	Pisidiidae	Sphaerium	0	0.0	0	0.0	0.00
Non-Insect taxa	Oligochaeta	Tubificidae	3.6	10.3	1.6	5.2	2.63
Non-Insect taxa	Turbellaria	Turbellaria	78	137.6	115.2	110.3	17.38
Plecoptera	Perlidae	Hesperoperla pacifica	2	1.6	1.6	1.7	0.13
Plecoptera	Perlidae	Claassenia sabulosa	0	0.0	0	0.0	0.00
Plecoptera	Perlodidae	Skwala	2	6.4	3.2	3.9	1.31
Plecoptera	Perlodidae	Isoperla	2	0.0	1.6	1.2	0.61
Trichoptera	Brachycentrus	Brachycentrus occidentalis	10	16.0	12.8	12.9	1.73
Trichoptera	Glossosomatidae	Glossosoma	0	0.0	1.6	0.5	0.53
Trichoptera	Hydropsyche_Ceratops	Hydropsyche	70	43.2	35.2	49.5	10.52
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	4	8.0	6.4	6.1	1.16
Trichoptera	Cheumatopsyche	Cheumatopsyche	36	3.2	19.2	19.5	9.47
Trichoptera	Hydroptila	Hydroptila	14	0.0	3.2	5.7	4.24
Trichoptera	Lepidostoma	Lepidostoma	20	20.8	35.2	25.3	4.94
Trichoptera	Oecetis	Oecetis avara	142	54.4	88	94.8	25.52
		Totals	1109.2	816.7	817.6	914.5	97.35

APPENDIX C. Macroinvertebrate 2017 Fall taxa lists and raw data across all sites

		OM	32	19	25	25.3	
MO_Craig_US01	**Fall 2017**		**3/8ss**	**3/8ss**	**3/8ss**		
Order	**OTUname2**	**Final ID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Coleoptera	Optioservus	Optioservus quadrimaculatus	61	123	88	91	18
Coleoptera	Elmidae	Zaitzevia	0	0	3	1	1
Coleoptera	Haliplidae	Haliplus	3	0	0	1	1
Diptera	Orthocladiinae	Cricotopus trifascia	16	5	11	11	3
Diptera	Orthocladiinae	Cardiocladius	3	0	5	3	2
Diptera	Orthocladiinae	Eukiefferella	5	0	5	4	2
Diptera	Chironominae	Microtendipes	125	317	176	206	57
Diptera	Chironominae	Polypedilum	0	0	0	0	0
Diptera	Tanypodinae	Thienemannimyia gr.	3	8	3	4	2
Diptera	Diamsinae	Potthastia	0	0	0	0	0
Diptera	Simuliidae	Simulium	256	21	120	132	68
Ephemeroptera	Baetis	Baetis tricaudatus	19	8	29	19	6
Ephemeroptera	Baetis	Baetis flavistriga	3	0	3	2	1
Ephemeroptera	Ephemerella	Ephemerella excrucians	3	0	5	3	2
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	93	176	120	130	24
Ephemeroptera	Rhithrogena	Rhithrogena	0	0	0	0	0
Non-Insect taxa	Caecidotea	Caecidotea	93	53	67	71	12
Non-Insect taxa	Hirudina	Erpobdella punctata	0	3	5	3	2
Non-Insect taxa	Glossiphoniidae	Glossiphonia complanata	5	0	0	2	2
Non-Insect taxa	Hirudina	Helobdella stagnalis	0	0	0	0	0
Non-Insect taxa	Hyalella	Hyalella	155	139	179	157	12
Non-Insect taxa	Gammarus	Gammarus	35	19	29	28	5
Non-Insect taxa	Oligochaeta	Lumbricina	3	13	8	8	3
Non-Insect taxa	Oligochaeta	Lumbriculidae	8	11	19	12	3
Non-Insect taxa	Nematoda	Nematoda	61	37	29	43	10
Non-Insect taxa	Physa_Physella	Physella acuta	11	3	5	6	2
Non-Insect taxa	Fossaria	Fossaria humilis	3	0	0	1	1
Non-Insect taxa	Valvata	Valvata humeralis	3	0	0	1	1
Non-Insect taxa	Menetus	Menetus dilatatus	0	3	3	2	1
Non-Insect taxa	Pisidiidae	Pisidium	29	40	59	43	9
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	0	8	5	4	2
Non-Insect taxa	Oligochaeta	Tubificidae	8	24	21	18	5
Non-Insect taxa	Turbellaria	Turbellaria	93	232	149	158	40
Trichoptera	Cheumatopsyche	Cheumatopsyche	64	104	85	84	12
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	16	24	13	18	3
Trichoptera	Brachycentrus occiden	Brachycentrus occidentalis	0	0	0	0	0
Trichoptera	Helicopsyche	Helicopsyche borealis	0	0	0	0	0
Trichoptera	Hydroptila	Hydroptila	0	0	0	0	0
Trichoptera	Ceraclea	Ceraclea	3	0	0	1	1
Trichoptera	Oecetis	Oecetis avara	256	131	192	193	36
		Totals	**1434.7**	**1501.3**	**1437.3**	**1457.8**	**21.8**

APPENDIX C. Macroinvertebrate 2017 Fall taxa lists and raw data across all sites

		OM	22	12	24	19.3	
MO_Craig_FFS	Fall 2017		3/8ss	3/8ss	4/8ss		
Order	OTUname2	Final ID	Hess 1	Hess 2	Hess 3	Avg.	SE
Coleoptera	Optioservus	Optioservus quadrimaculatus	40	40	36	38.7	1.33
Coleoptera	Elmidae	Zaitzevia	10.67	0.0	2	4.2	3.27
Diptera	Orthocladiinae	Cricotopus trifascia	0	4	24	9.3	7.42
Diptera	Chironominae	Microtendipes	156	172	512	280.0	116.09
Diptera	Chironominae	Pseudochironomus	0	4	0	1.3	1.33
Diptera	Tanypodinae	Thienemannimyia gr.	0	8.0	0.0	2.7	2.67
Diptera	Diamsinae	Potthastia	0	0	0	0.0	0.00
Diptera	Tabanidae	Chrysops	5.33	2.7	0.0	2.7	1.54
Diptera	Simuliidae	Simulium	32	152	136	106.7	37.62
Ephemeroptera	Baetis	Baetis tricaudatus	32	32	40	34.7	2.67
Ephemeroptera	Ephemerella	Ephemerella excrucians	16	12	8	12.0	2.31
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	280	216	156	217.3	35.80
Ephemeroptera	Rhithrogena	Rhithrogena	5.33	5.3	0	3.6	1.78
Non-Insect taxa	Caecidotea	Caecidotea	116	284	124	174.7	54.72
Non-Insect taxa	Hirudina	Erpobdella punctata	0	0	0	0.0	0.00
Non-Insect taxa	Glossiphoniidae	Glossiphonia complanata	0	0	0	0.0	0.00
Non-Insect taxa	Hirudina	Helobdella stagnalis	0	4	4	2.7	1.33
Non-Insect taxa	Hyalella	Hyalella	160	216	84	153.3	38.25
Non-Insect taxa	Gammarus	Gammarus	76	104	52	77.3	15.03
Non-Insect taxa	Oligochaeta	Lumbricina	0	4	4	2.7	1.33
Non-Insect taxa	Oligochaeta	Lumbriculidae	4	8	0	4.0	2.31
Non-Insect taxa	Nematoda	Nematoda	20	60	8	29.3	15.72
Non-Insect taxa	Menetus	Menetus dilatatus	2.6666667	0.0	0.0	0.9	0.89
Non-Insect taxa	Physa_Physella	Physella acuta	32	20	36	29.3	4.81
Non-Insect taxa	Gyraulus	Gyraulus	0	0.0	4.0	1.3	1.33
Non-Insect taxa	Fossaria	Fossaria humilis	0	0	0	0.0	0.00
Non-Insect taxa	Valvata	Valvata humeralis	0	0	0	0.0	0.00
Non-Insect taxa	Pisidiidae	Pisidium	248	100	192	180.0	43.14
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	24	16	12	17.3	3.53
Non-Insect taxa	Oligochaeta	Tubificidae	32	40	20	30.7	5.81
Non-Insect taxa	Turbellaria	Turbellaria	400	348	380	376.0	15.14
Trichoptera	Cheumatopsyche	Cheumatopsyche	52	72	36	53.3	10.41
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	28	24	12	21.3	4.81
Trichoptera	Brachycentrus occident	Brachycentrus occidentalis	0	0	0	0.0	0.00
Trichoptera	Helicopsyche	Helicopsyche borealis	0	0	4	1.3	1.33
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	0	4	0	1.3	1.33
Trichoptera	Hydroptila	Hydroptila	0	0	4	1.3	1.33
Trichoptera	Oecetis	Oecetis avara	348	336	236	306.7	35.50
		Totals	**2120**	**2288**	**2126**	**2178.0**	**55.03**

APPENDIX C. Macroinvertebrate 2017 Fall taxa lists and raw data across all sites

MO_Dear_US01	Fall 2017		1/2sub	1/4sub	1/2sub		
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Coleoptera	Optioservus	Optioservus quadrimaculatus	55	64	48	55.7	4.63
Coleoptera	Zaitzevia	Zaitzevia	4	8	12	8.0	2.31
Diptera	Orthocladiinae	Cricotopus	62	80	44	62.0	10.39
Diptera	Orthocladiinae	Cardiocladius	2	0	0	0.7	0.67
Diptera	Chironominae	Microtendipes	44	36	18	32.7	7.69
Diptera	Chironominae	Dicrotendipes	2	0	2	1.3	0.67
Diptera	Chironominae	Rheotanytarsus	10	28	22	20.0	5.29
Diptera	Chironominae	Polypedilum	0	4	2	2.0	1.15
Diptera	Orthocladiinae	Parakiefferella	0	4	4	2.7	1.33
Diptera	Orthocladiinae	Eukiefferella	16	12	10	12.7	1.76
Diptera	Orthocladiinae	Tvetenia bavarica	2	8	20	10.0	5.29
Diptera	Tanypodinae	Thienemannimyia gr.	4	12	8	8.0	2.31
Diptera	Simuliidae	Simulium	76	48	24	49.3	15.03
Ephemeroptera	Baetis	Baetis tricaudatus	168	252	162	194.0	29.05
Ephemeroptera	Ephemerella	Ephemerella excrucians	20	12	36	22.7	7.06
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	32	44	22	32.7	6.36
Lepidoptera	Petrophila	Petrophila	2	0	7	3.0	2.08
Non-Insect taxa	Caecidotea	Caecidotea	88	72	64	74.7	7.06
Non-Insect taxa	Crangonyx	Gammarus	16	8	12	12.0	2.31
Non-Insect taxa	Hirudina	Erpobdella punctata	6	4	2	4.0	1.15
Non-Insect taxa	Hyalella	Hyalella	10	8	4	7.3	1.76
Non-Insect taxa	Oligochaeta	Lumbricina	2	8	12	7.3	2.91
Non-Insect taxa	Oligochaeta	Lumbriculidae	10	0	2	4.0	3.06
Non-Insect taxa	Nematoda	Nematoda	3	8	2	4.3	1.86
Non-Insect taxa	Physa_Physella	Physella acuta	74	72	70	72.0	1.15
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	0	0	0	0.0	0.00
Non-Insect taxa	Menetus	Menetus dilatatus	2	4	4	3.3	0.67
Non-Insect taxa	Oligochaeta	Tubificidae	2	8	11	7.0	2.65
Non-Insect taxa	Turbellaria	Turbellaria	189	231	224	214.7	12.99
Plecoptera	Perlidae	Hesperoperla pacifica	2	0	2	1.3	0.67
Trichoptera	Ceraclea	Ceraclea	52	52	40	48.0	0.00
Trichoptera	Cheumatopsyche	Cheumatopsyche	120	96	112	109.3	7.06
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	0	0	0	0.0	0.00
Trichoptera	Helicopsyche	Helicopsyche borealis	2	8	4	4.7	1.76
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	3	0	2	1.7	0.88
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	4	8	10	7.3	1.76
Trichoptera	Oecetis	Oecetis avara	12	8	24	14.7	4.81
		Totals	**1096**	**1207**	**1042**	**1115.0**	**48.57**

APPENDIX C. Macroinvertebrate 2017 Fall taxa lists and raw data across all sites

MO_Dearborn_DS01	Fall 2017		6/9 sub	4/9 sub	4/9 sub		
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Average**	**SE**
Coleoptera	Microcylloepus pusillis	Microcylloepus pusillis	0	2	0	0.8	0.75
Coleoptera	Optioservus	Optioservus quadrimaculatus	102	128	70	100.0	16.92
Coleoptera	Stenelmis	Stenelmis	3	0	5	2.5	1.32
Coleoptera	Zaitzevia	Zaitzevia parvula	66	36	11	37.8	15.83
Diptera	Chironominae	Microtendipes	0	0	2	0.8	0.75
Diptera	Chironominae	Polypedilum	2	2	2	2.0	0.25
Diptera	Chironominae	Pseudochironomus	0	0	2	0.8	0.75
Diptera	Chironominae	Rheotanytarsus	3	7	0	3.3	1.95
Diptera	Orthocladiinae	Cricotopus	42	27	7	25.3	10.21
Diptera	Orthocladiinae	Eukiefferella	9	32	72	37.5	18.43
Diptera	Orthocladiinae	Nostoccocladius	0	0	2	0.8	0.75
Diptera	Orthocladiinae	Orthocladius	11	14	18	14.0	2.18
Diptera	Orthocladiinae	Tvetenia bavarica	8	9	23	13.0	4.77
Diptera	Tanypodinae	Thienemannimyia gr.	0	0	2	0.8	0.75
Diptera	Simuliidae	Simulium	5	396	396	265.5	130.50
Ephemeroptera	Baetis	Baetis tricaudatus	14	50	7	23.3	13.27
Ephemeroptera	Ephemera simulans	Ephemera simulans	2	7	0	2.8	2.05
Ephemeroptera	Ephemerellidae	Ephemerella excrucians	3	41	18	20.5	10.90
Ephemeroptera	Ephemerellidae	Drunella grandis	0	5	0	1.5	1.50
Ephemeroptera	Heptageniidae	Macaffertium terminatum	2	0	0	0.5	0.50
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	23	2	5	9.8	6.41
Ephemeroptera	Plauditus punctiventris	Plauditus punctiventris	3	18	5	8.5	4.77
Hemiptera	Corixidae	Corixidae	0	0	2	0.8	0.75
Non-Insect taxa	Acarina	Acarina	2	0	0	0.5	0.50
Non-Insect taxa	Hyalella	Hyalella	2	5	5	3.5	1.00
Non-Insect taxa	Oligochaeta	Lumbricidae	0	0	0	0.0	0.00
Non-Insect taxa	Physa_Physella	Physella acuta	23	25	5	17.3	6.41
Non-Insect taxa	Pisidiidae	Pisidium	0	0	0	0.0	0.00
Non-Insect taxa	Oligochaeta	Tubificidae	6	5	9	6.5	1.32
Non-Insect taxa	Oligochaeta	Lumbriculidae	8	29	43	26.5	10.27
Non-Insect taxa	Turbellaria	Turbellaria	63	106	119	96.0	16.95
Lepidoptera	Petrophila	Petrophila	3	2	2	2.5	0.25
Plecoptera	Pteronarcys	Pteronarcys californica	0	0	2	0.8	0.75
Plecoptera	Perlidae	Claassenia sabulosa	6	2	0	2.8	1.75
Plecoptera	Perlidae	Hesperoperla pacifica	3	0	2	1.8	0.90
Plecoptera	Perlodidae	Skwala	3	0	0	1.0	1.00
Plecoptera	Chloroperlidae	Sweltsa	2	0	0	0.5	0.50
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	8	2	14	7.8	3.25
Trichoptera	Brachycentrus occident	Brachycentrus occidentalis	3	7	7	5.5	1.25
Trichoptera	Hydropsychidae	Cheumatopsyche	213	176	135	174.5	22.52
Trichoptera	Leptoceridae	Oecetis avara	41	32	16	29.3	7.23
Trichoptera	Leptoceridae	Ceraclea	6	7	0	4.3	2.14
Trichoptera	Hydroptila	Hydroptila	15	2	0	5.8	4.67
Trichoptera	Hydropsychidae	Hydropsyche	65	115	176	118.3	32.09
Trichoptera	Hydropsychidae	Hydropsyche morosa gr.	0	2	0	0.8	0.75
Trichoptera	Helicopsyche	Helicopsyche borealis	11	2	5	5.8	2.46
Trichoptera	Glossosomatidae	Glossosoma	0	0	0	0.0	0.00
Trichoptera	Lepidostoma	Lepidostoma	0	2	0	0.8	0.75
		Totals	**772.5**	**1293.75**	**1185.75**	**1084.0**	**158.84**

APPENDIX C. Macroinvertebrate 2017 Fall taxa lists and raw data across all sites

			1/2FS	1/2FS	1/2FS		
MO_Hardy_DS01	**Fall2017**		**1/8 sub**	**1/8 sub**	**1/8 sub**		
Order	**OTUname2**	**FinalID**	**Hess 1**	**Hess 2**	**Hess 3**	**Avg.**	**SE**
Coleoptera	Optioservus	Optioservus quadrimaculatus	144	544	112	266.7	138.97
Coleoptera	Zaitzevia	Zaitzevia	48	128	0	58.7	37.33
Diptera	Simuliidae	Simulium	32	160	64	85.3	38.46
Diptera	Orthocladiinae	Cricotopus	288	864	400	517.3	176.32
Diptera	Orthocladiinae	Nostoccocladius	16	32	16	21.3	5.33
Diptera	Orthocladiinae	Parametriocnemus	16	0	0	5.3	5.33
Diptera	Ceratopogonidae	Probezzia	80	32	16	42.7	19.23
Diptera	Chironominae	Pseudochironomus	0	0	0	0.0	0.00
Diptera	Tanypodinae	Thienemannimyia gr.	208	416	144	256.0	82.11
Diptera	Chironominae	Polypedilum	0	0	0	0.0	0.00
Diptera	Chironominae	Phaenopsectra	16	32	32	26.7	5.33
Diptera	Chironominae	Cryptochironomus	0	0	0	0.0	0.00
Diptera	Chironominae	Microtendipes	96	0	48	48.0	27.71
Diptera	Orthocladiinae	Eukiefferella	16	64	0	26.7	19.23
Diptera	Orthocladiinae	Tvetenia bavarica	64	160	32	85.3	38.46
Diptera	Chironominae	Rheotanytarsus	64	160	64	96.0	32.00
Diptera	Chironominae	Tanytarsus	64	160	64	96.0	32.00
Diptera	Tipulidae	Tipula	0	0	16	5.3	5.33
Ephemeroptera	Attenella	Attenella margarita	80	32	128	80.0	27.71
Ephemeroptera	Baetis	Baetis tricaudatus	1744	2880	1488	2037.3	427.77
Ephemeroptera	Baetis	Baetis intercalaris	112	288	80	160.0	64.66
Ephemeroptera	Ephemerella	Ephemerella excrucians	208	0	128	9.0	60.58
Ephemeroptera	Paraleptophlebia	Paraleptophlebia	0	0	16	5.3	5.33
Ephemeroptera	Heptagenidae	Ecdyonurus	0	0	0	0.0	0.00
Ephemeroptera	Plauditis	Plauditus punctiventris	48	448	48	181.3	133.33
Ephemeroptera	Pseudocloeon	Pseudocloeon	16	0	16	10.7	5.33
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	1664	2080	1760	1834.7	125.76
Hemiptera	Corixidae	Corixidae	0	0	0	0.0	0.00
Non-Insect taxa	Oligochaeta	Tubificidae	160	0	48	69.3	47.40
Non-Insect taxa	Oligochaeta	Lumbricidae	0	0	0	0.0	0.00
Non-Insect taxa	Oligochaeta	Lumbriculidae	0	0	0	0.0	0.00
Non-Insect taxa	Hirudinea	Erpobdella punctata	16	0	0	5.3	5.33
Non-Insect taxa	Hirudinea	Glossiphonia complanata	0	0	0	0.0	0.00
Non-Insect taxa	Pisidiidae	Sphaerium	16	64	16	32.0	16.00
Non-Insect taxa	Pisidiidae	Pisidium	0	0	0	0.0	0.00
Non-Insect taxa	Hyalella	Hyalella	48	96	32	58.7	19.23
Non-Insect taxa	Gammarus	Gammarus	16	32	16	21.3	5.33
Non-Insect taxa	Caecidotea	Caecidotea	48	64	208	106.7	50.88
Non-Insect taxa	Turbellaria	Turbellaria	144	544	144	277.3	133.33
Non-Insect taxa	Physa_Physella	Physella acuta	80	64	64	69.3	5.33
Non-Insect taxa	Ancyliidae	Ferrissia rivularis	16	0	0	5.3	5.33
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	0	0	0	0.0	0.00
Non-Insect taxa	Orconectes virilis	Orconectes virilis	16	0	16	10.7	5.33
Trichoptera	Hydropsyche_Ceratops	Hydropsyche occidentalis	160	672	656	496.0	168.06
Trichoptera	Brachycentridae	Amiocentrus aspilus	16	0	0	5.3	5.33
Trichoptera	Brachycentrus occident	Brachycentrus occidentalis	16	32	16	21.3	5.33
Trichoptera	Cheumatopsyche	Cheumatopsyche	624	2048	880	1184.0	438.28
Trichoptera	Leptoceridae	Oecetis	16	0	0	5.3	5.33
Trichoptera	Hydroptila	Hydroptila	2160	5824	2240	3408.0	1208.22
Trichoptera	Hydropsyche_Ceratops	Hydropsyche morosa gr.	32	96	80	69.3	19.23
Trichoptera	Helicopsyche	Helicopsyche borealis	16	32	16	21.3	5.33
Trichoptera	Polycentropidae	Polycentropus	16	0	0	5.3	5.33
Trichoptera	Limnephilidae	Onocosmoecus unicolor	16	0	0	5.3	5.33
Trichoptera	Limnephilidae	Dicosmoecus gilvipes	32	32	16	26.7	5.33
		Totals	**8688**	**18080**	**9120**	**11962.7**	**3061.21**

APPENDIX C. Macroinvertebrate 2017 Fall taxa lists and raw data across all sites.

MO_Cascade_US01	MO_Cascade_01	Fall 2017	1/4ss	1/4ss	1/4ss		
Order	OTUname2	FinalID	Hess 1	Hess 2	Hess 3	Avg.	SE
Coleoptera	Dubiraphia	Dubiraphia	12	24	32	22.7	5.81
Coleoptera	Microcylloepus	Microcylloepus pusillis	20	8	24	17.3	4.81
Coleoptera	Optioservus	Optioservus quadrimaculatus	192	148	176	172.0	12.86
Coleoptera	Zaitzevia	Zaitzevia parvula	20	84	56	53.3	18.52
Diptera	Chironominae	Microtendipes	92	132	164	129.3	20.83
Diptera	Chironominae	Phaenopsectra	8	16	36	20.0	8.33
Diptera	Chironominae	Polypedilum	16	12	4	10.7	3.53
Diptera	Chironominae	Pseudochironomus	88	60	120	89.3	17.33
Diptera	Chironominae	Rheotanytarsus	0	16	20	12.0	6.11
Diptera	Chironominae	Tanytarsus	16	24	8	16.0	4.62
Diptera	Diamsinae	Potthastia	4	4	0	2.7	1.33
Diptera	Orthocladiinae	Cricotopus	100	140	88	109.3	15.72
Diptera	Orthocladiinae	Eukiefferiella	0	8	20	9.3	5.81
Diptera	Orthocladiinae	Nostoccocladius	0	8	4	4.0	2.31
Diptera	Orthocladiinae	Orthocladius	0	20	16	12.0	6.11
Diptera	Orthocladiinae	Thienemaniella	4	0	0	1.3	1.33
Diptera	Tanypodinae	Pentaneura	4	0	0	1.3	1.33
Diptera	Tanypodinae	Thienemannimyia gr.	16	8	48	24.0	12.22
Diptera	Simuliidae	Simulium	0	8	8	5.3	2.67
Diptera	Tipulidae	Hexatoma	0	0	0	0.0	0.00
Diptera	Tipulidae	Limnophila	0	0	0	0.0	0.00
Diptera	Tipulidae	Tipula	0	0	0	0.0	0.00
Ephemeroptera	Baetidae	Acerpenna pygmaea	4	4	8	5.3	1.33
Ephemeroptera	Baetis	Baetis intercalaris	8	0	0	2.7	2.67
Ephemeroptera	Baetidae	Baetis tricaudatus	88	48	44	60.0	14.05
Ephemeroptera	Choroterpes	Choroterpes	16	32	20	22.7	4.81
Ephemeroptera	Heptagenia	Ecdyonurus simpliciodes	4	4	8	5.4	1.37
Ephemeroptera	Ephemerella	Ephemerella excrucians	4	0	8	4.0	2.31
Ephemeroptera	Heptagenia	Heptagenia	4	0	0	1.3	1.33
Ephemeroptera	Heptagenia	Macaffertium terminatum	16	8	4	9.3	3.53
Ephemeroptera	Plauditus	Plauditus punctiventris	12	32	16	20.0	6.11
Ephemeroptera	Tricorythodes	Tricorythodes explicatus	84	120	36	80.0	24.33
Hemiptera	Corixidae	Corixidae	0	0	0	0.0	0.00
Lepidoptera	Petrophila	Petrophila	20	24	40	28.0	6.11
Non-Insect taxa	Caecidotea	Caecidotea	100	132	200	144.0	29.48
Non-Insect taxa	Hirudinea	Erpobdella punctata	8	8	16	10.7	2.67
Non-Insect taxa	Ferrissia	Ferrissia rivularis	0	4	20	8.0	6.11
Non-Insect taxa	Gammarus	Gammarus	8	12	32	17.3	7.42
Non-Insect taxa	Hyalella	Hyalella	100	60	44	68.0	16.65
Non-Insect taxa	Oligochaeta	Lumbricina	60	20	36	38.7	11.62
Non-Insect taxa	Oligochaeta	Lumbriculidae	48	24	8	26.7	11.62
Non-Insect taxa	Orconectes	Orconectes virilis	4	8	8	6.7	1.33
Non-Insect taxa	Physa_Physella	Physella acuta	132	100	148	126.7	14.11
Non-Insect taxa	Potamopyrgus	Potamopyrgus antipodarum	4	8	8	6.7	1.33
Non-Insect taxa	Pisidiidae	Sphaerium	8	48	88	48.0	23.09
Non-Insect taxa	Oligochaeta	Tubificidae	60	176	88	108.0	34.95
Non-Insect taxa	Turbellaria	Turbellaria	216	92	48	118.7	50.30
Odonata	Ophiogomphus	Ophiogomphus severus	4	0	4	2.7	1.33
Plecoptera	Hesperoperla pacif	Hesperoperla pacifica	0	0	0	0.0	0.00
Trichoptera	Brachycentrus occi	Brachycentrus occidentalis	8	4	8	6.7	1.33
Trichoptera	Cheumatopsyche	Cheumatopsyche	24	32	60	38.7	10.91
Trichoptera	Helicopsyche	Helicopsyche borealis	88	68	164	106.7	29.24
Trichoptera	Hydropsyche_Cera	Hydropsyche morosa gr.	8	4	4	5.3	1.33
Trichoptera	Hydroptila	Hydroptila	48	20	88	52.0	19.73
Trichoptera	Nectopsyche	Nectopsyche	8	16	8	10.7	2.67
Trichoptera	Oecetis	Oecetis avara	172	80	176	142.7	31.35
		Totals	**1960**	**1908**	**2264.1**	**2044.0**	**111.05**

Appendix D. Site Habitat and Physical Conditions

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

2016	MO_LPPC_US			MO_LPPC_DS			MO_Craig			MO_DEAR_US			MO_DEAR_DS			MO_HARDY_BR			MO_Cascade		
	May	July	Oct	May	July	Oct	May	July	Oct	May	July	Oct	May	July	Oct	May	July	Oct	May	July	Oct
Water Temp °C	9.7	15.6	14.3	6.5	14.1	12.6	10	17.9	14.5	14.2	17.1	na	16.4	19	na	15.6	17	14.5	16.7	18.2	15.1
Conductivity (µs/cm)	242	340	300	169	314	306	248	338	305	271	338	na	250	289	na	277	340	300	288	338	303
TDS (ppm)	121	179	166	85	135	155	125	144	152	136	149	na	132	137	na	138	141	151	143	176	155
pH	7.35	7.86	7.9	7.3	7.85	7.9	7.2	8.1	7.9	7.8	8	na	7.9	7.9	na	7.7	7.99	8.1	7.75	8	8.1
Discharge (cfs)	4300	4100	3580	4350	4130	3600	4350	4130	3600	4300	4130	3740	5000	4180	3790	5000	4280	3800	5000	4380	3800
Avg Sample Depth (cm)	23	20	24	23	22	25	25	29	22	25	29	28	28	27	33	35	41	35	20	26	24
Avg Sample Dist. From Bank (m)	28	32	35	23	32	33	11	12	15	7	8	9	3	8	11	5	7	9	6	6	14
% Fines in Hess	10	15	15	20	25	25	15	15	10	0	5	5	30	30	30	5	1	5	15	15	25
% Gravel Hess	70	65	70	55	50	50	65	70	60	25	25	25	55	60	60	20	24	20	75	75	60
% Cobble Hess	20	20	10	20	25	25	20	15	20	75	70	70	15	10	11	60	65	60	10	10	15
% Boulder Reach	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	0	0	0	0	10	10	10	20	20	20	0	0	0	5	5	5	5	5	5

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

2017	MO_LPPC_US			MO_LPPC_DS			MO_Craig			MO_DEAR_US			MO_DEAR_DS			MO_HARDY_BR			MO_Cascade		
	Jun	July	Oct	Jun	July	Oct	Jun	July	Oct	Jun	July	Oct	Jun	July	Oct	Jun	July	Oct	Jun	July	Oct
Water Temp °C	15.2	19.5	14.1	6.5	18.7	11.1	15.7	20.7	14.2	na	19.4	14.2	na	22.2	12.8	na	19.2	14.5	na	21.1	14.6
Conductivity (µs/cm)	315	302	280	198	307	329	324	311	288	na	308	290	na	295	280	na	311	300	na	314	302
TDS (mg/l)	150	179	190	110	155	195	163	177	188	na	166	186	na	150	165	na	170	151	na	188	180
pH	7.35	7.9	7.9	7.3	7.85	7.9	7.4	8.1	8.0	na	7.9	8.0	na	7.9	7.9	na	7.99	8.1	na	8.1	8.1
Discharge (cfs)	8300	4200	3980	8450	4300	4080	8450	4300	4080	8450	4300	4080	8800	4350	4160	8800	4350	4160	9000	4380	4220
Avg. Sample Depth (cm)	50	20	24	33	25	25	35	28	22	na	29	28	na	33	30	na	40	35	na	25	22
Avg. Sample Dist. From Bank (m)	14	22	18	6	7	7	11	13	15	na	7	8	na	8	9	na	5	6	na	5	7
% Fines in Hess	5	15	15	0	10	25	15	15	10	na	5	5	na	10	10	na	1	5	na	15	25
% Gravel Hess	70	65	75	75	65	50	65	70	70	na	25	25	na	65	70	na	24	20	na	75	60
% Cobble Hess	20	20	10	25	25	25	20	15	20	na	70	70	na	25	20	na	65	60	na	10	15
% Boulder Reach	0	0	0	0	0	0	0	0	0	na	0	0	na	0	0	na	10	15	na	0	0
Avg. Riparian Shade	0	0	0	0	0	0	10	20	20	na	10	10	na	0	0	na	5	5	na	5	5