AUGUST 2008

BIOLOGICAL ASSESSMENT OF SITES IN THE GALLATIN RIVER DRAINAGE, GALLATIN COUNTY, MONTANA: MACROINVERTEBRATE ASSEMBLAGES

A REPORT TO THE
BLUE WATER TASK FORCE

PREPARED BY
WEASE BOLLMAN
RHITHRON ASSOCIATES, INC.
MISSOULA, MONTANA

INTRODUCTION

With increased development in the watershed, the integrity of the Gallatin River and its tributaries may be threatened by impacts to channel structure and riparian zones as well as by degradation of water quality. Monitoring and assessment of biological assemblages may help to detect changes suggesting that impacts and degradation may in fact be occurring. For the past several years, the Blue Water Task Force (BWTF) has sampled benthic macroinvertebrates for monitoring and assessment of the waters of the Gallatin River drainage. Benthic macroinvertebrates are a useful tool for evaluating the effects of stressors that may be associated with the accelerating human influences on the River. Such stressors may include pollutants, sediment, thermal and hydrologic impacts, and changes to the natural morphology of river channels and riparian zones.

In April 2008, samples were collected at three sites on the Gallatin River and at one site on the West Fork of the Gallatin River. This report describes the methods for processing these samples and identifying the macroinvertebrates. Data resulting from that work were translated into a multimetric index, and scores were calculated. In addition, narrative interpretations of the ecological condition of the macroinvertebrate assemblages were composed. These narratives use the taxonomic and functional composition, tolerance and sensitivity characteristics, and habits of the benthic invertebrates to describe probable water quality and habitat influences on the assemblages. Interpretations maximize the information available in the data by not relying solely on a single cumulative index score which may mask the effects of stressors on the biota.

METHODS

Sample processing

Four macroinvertebrate samples were delivered to Rhithron's laboratory facility in Missoula, Montana. All samples arrived in good condition. Habitat assessment forms were also provided by BWTF.

Subsamples of a minimum of 300 organisms were obtained using methods consistent with Montana Department of Environmental Quality (MDEQ) standard procedures (MDEQ 2006): Caton sub-sampling devices (Caton 1991), divided into 30 grids, each approximately 5 cm by 6 cm were used. Each individual sample was thoroughly mixed in its jar(s), poured out and evenly spread into the Caton tray, and individual grids were randomly selected. Grid contents were examined under stereoscopic microscopes using 10x – 30x magnification. All aquatic invertebrates from each selected grid were sorted from the substrate, and placed in 95% ethanol for subsequent identification. Grid selection, examination, and sorting continued until at least 300 organisms were sorted. The final grid was completely sorted of all organisms.

Organisms were individually examined using 10x – 80x dissecting scopes (Leica S8E and S6E) and identified to the lowest practical level consistent with MDEQ (MDEQ 2006) data requirements, using appropriate published taxonomic references and keys. Identification, counts, life stages, and information about the condition of specimens were recorded on bench sheets. To obtain accuracy in richness measures, organisms that could not be

identified to the target level specified in MDEQ protocols were designated as "not unique" if other specimens from the same group could be taken to target levels. Organisms designated as "unique" were those that could be definitively distinguished from other organisms in the sample. Identified organisms were preserved in 95% ethanol in labeled vials, and archived at the Rhithron laboratory. Midges were morphotyped using 10x – 80x dissecting microscopes (Leica S8E and S6E) and representative specimens were slide mounted and examined at 200x – 1000x magnification using an Olympus BX 51 compound microscope. Slide mounted organisms were archived at the Rhithron laboratory along with the other identified invertebrates.

Quality control procedures

Quality control (QC) procedures for initial sample processing and subsampling involved checking sorting efficiency. These checks were conducted on 100% of the samples by independent observers who microscopically re-examined 20% of sorted substrate from each sample. All organisms that were missed were counted and this number was added to the total number obtained in the original sort. Sorting efficiency was evaluated by applying the following calculation:

$$SE = \frac{n_1}{n_{1+2}} \times 100$$

where: SE is the sorting efficiency, expressed as a percentage, n_1 is the total number of specimens in the first sort, and n_{1+2} is the total number of specimens in the first and second sorts combined.

Quality control procedures for taxonomic determinations of invertebrates involved checking accuracy, precision and enumeration. One sample was randomly selected and all organisms re-identified and counted by an independent taxonomist. Taxa lists and enumerations were compared by calculating a Bray-Curtis similarity statistic (Bray and Curtis 1957) for the selected sample.

Data analysis

Taxa and counts for each sample were entered into Rhithron's database application. Life stages, "unique" designations, and the condition of specimens were also entered. Bioassessment metrics were calculated by the database application and a multimetric index developed for montane ecoregions of Montana (Bollman 1998) was calculated and scored.

Narrative interpretations of the taxonomic and functional composition of the aquatic invertebrate assemblages are based on demonstrated associations between assemblage components and habitat and water quality variables gleaned from the published literature, the writer's own research (especially Bollman 1998) and professional judgment, and those of other expert sources (especially Wisseman 1996). These interpretations are not intended to replace canonical procedures for stressor identification, since such procedures require substantial surveys of habitat, and historical and current data related to water quality, land use, point and non-point source influences, soils, hydrology, geology, and other resources that were not readily available for this study. Instead, attributes of invertebrate taxa that are well-substantiated in diverse literature, published and unpublished research, and that are generally accepted

by regional aquatic ecologists, are combined into descriptions of probable water quality and instream and reach-scale habitat conditions.

The approach to this analysis uses some assemblage attributes that are interpreted as evidence of water quality and other attributes that are interpreted as evidence of habitat integrity. Attributes are considered individually, so information is maximized by not relying on a single cumulative score, which may mask stress on the biota.

Water quality variables are estimated by examining mayfly taxa richness and the Hilsenhoff Biotic Index (HBI) value. Other indicators of water quality include the richness and abundance of hemoglobin-bearing taxa and the richness of sensitive taxa. Mayfly taxa richness has been demonstrated to be significantly correlated with chemical measures of dissolved oxygen, pH, and conductivity (e.g. Bollman 1998, Fore et al. 1996, Wisseman 1996). The Hilsenhoff Biotic Index (HBI) (Hilsenhoff 1987) has a long history of use and validation (Cairns and Pratt 1993). In Montana foothills, the HBI was demonstrated to be significantly associated with conductivity, pH, water temperature, sediment deposition, and the presence of filamentous algae (Bollman 1998). The presence of filamentous algae is also suspected when macroinvertebrates associated or dependent on it (e.g. LeSage and Harrison 1980, Anderson 1976) are abundant. Nutrient enrichment in Montana streams often results in large crops of filamentous algae (Watson 1988). Sensitive taxa exhibit intolerance to a wide range of stressors (e.g. Wisseman 1996, Hellawell 1986, Friedrich 1990, Barbour et al. 1999), including nutrient enrichment, acidification, thermal stress, sediment deposition, habitat disruption, and others. These taxa are expected to be present in predictable numbers in functioning montane and foothills streams (e.g. Bollman 1998).

Thermal characteristics of the sampled site are predicted by the richness and abundance of cold stenotherm taxa (Clark 1997), and by calculation of the temperature preference of the macroinvertebrate assemblage (Brandt 2001). Hemoglobin-bearing taxa are also indicators of warm water temperatures (Walshe 1947), since dissolved oxygen is directly associated with water temperature; oxygen concentrations can also vary with the degree of nutrient enrichment. Increased temperatures and high nutrient concentrations can, alone or in concert, create conditions favorable to hypoxic sediments, habitats preferred by hemoglobin-bearers.

The condition of instream and streamside habitats is estimated by characteristics of the macroinvertebrate assemblages. Stress from sediment is evaluated by caddisfly richness and by “clinger” richness (Kleindl 1996, Bollman 1998, Karr and Chu 1999) A newer tool, the Fine Sediment Biotic Index (FSBI) (Relyea et al. 2000) shows promise when applied to the montane and foothills regions.

The functional characteristics of macroinvertebrate assemblages are based on the morphology and behaviors associated with feeding, and are interpreted in terms of the River Continuum Concept (Vannote et al. 1980) in the narratives. Alterations from predicted patterns in montane and foothills streams may be interpreted as evidence of water quality or habitat disruption. For example, shredders and the microbes they depend on are sensitive to modifications of the riparian zone (Plafkin et al. 1989).

Narrative interpretations include comparisons with data generated by the recent Environmental Monitoring and Assessment Program (EMAP) carried out

recently in the Western United States by the US Environmental Protection Agency. EMAP sampling was based on a probability design model (Stoddard et al. 2005) that proportioned sampling effort at randomly selected sites with respect to the known extent of streams and rivers in the State. Thus, the EMAP dataset was expected to provide an accurate representation of the biological condition of aquatic resources. EMAP data for Montana was recently analyzed (Bollman and Bowman, 2007), and ranges of metrics were determined for the State's ecoregions and stream orders. While these benchmark data may provide important tools for the comparison of data from other sites in the Middle Rockies ecoregion, the early sample collection dates for the BWTF project in 2008 may limit the usefulness of the comparisons in this report. EMAP samples were generally collected in late summer, while the BWTF samples were collected in the spring.

The results of habitat assessments are reported. These assessments were made by BWTF personnel using a method recommended by the Montana Department of Environmental Quality (MDEQ 1998). Instream, streambank, and reach-scale parameters were evaluated. The relationship of bioassessment scores and habitat assessment scores is investigated graphically.

RESULTS

Quality Control Procedures

Results of quality control procedures for subsampling and taxonomy are given in Table 1. Sorting efficiency averaged 98.13% for all samples, taxonomic precision for identification and enumeration was 95.44% for the randomly selected sample, and data entry efficiency averaged 100% for the project.

Table 1. Results of quality control procedures for subsampling and taxonomy.

Site name	Site Identifier	Sorting efficiency	Bray-Curtis similarity for taxonomy and enumeration
Gallatin River at Park Boundary (North)	PARK	97.01%	95.44%
Gallatin River just upstream of West Fork confluence	UPSTREAM	98.46%	
Gallatin River above Jack Smith bridge	DOWN2	97.06%	
West Fork of the Gallatin River upstream of Big Sky Spur Rd. bridge	WEST	100.00%	

Bioassessment

Table 2 summarizes values and scores for metrics in the bioassessment index (Bollman 1998) used to evaluate the aquatic invertebrate assemblages. Total scores and impairment classifications are also given.

When this index is applied to the Gallatin watershed invertebrate data, results indicate slight impairment at two sites: PARK and DOWN2. Metric scores indicate that the percent of tolerant taxa was the most influential

Table 2. Bioassessment index (Bollman 1998) and individual metrics and scores for samples taken at 4 sites in the Gallatin River drainage, April 14, 2008.

	PARK	UPSTREAM	DOWN2	WEST
METRICS	**METRIC VALUES**			
Ephemeroptera richness	7	7	9	7
Plecoptera richness	6	3	5	6
Trichoptera richness	11	8	9	8
Number of sensitive taxa	5	5	3	4
Percent filterers	11.86%	3.74%	6.79%	3.93%
Percent tolerant taxa	16.38%	1.25%	16.36%	11.18%
	METRIC SCORES			
Ephemeroptera richness	3	3	3	3
Plecoptera richness	3	2	3	3
Trichoptera richness	3	3	3	3
Number of sensitive taxa	3	3	2	3
Percent filterers	1	3	2	3
Percent tolerant taxa	1	3	1	1
TOTAL SCORE (max.=18)	14	17	14	16
PERCENT OF MAX.	77.78%	94.44%	77.78%	88.89%
Impairment classification*	**SLI**	**NON**	**SLI**	**NON**

* Impairment classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired.

measure limiting the overall scores at these sites. The percent filterers metric also influenced the result for the PARK site.

Aquatic invertebrate assemblages

1. Gallatin River

Park Boundary (PARK)

Seven mayfly taxa were collected at this site, which is below the median value for low-to-mid order streams in the Middle Rockies ecoregion (Bollman and Bowman 2007). Low mayfly taxa richness as well as abundant midges (which accounted for nearly 40% of sampled animals) may be related to the timing of the sampling event, which occurred in the springtime. The biotic index value (3.84) suggested that the assemblage was moderately sensitive. Five of the taxa collected here are very sensitive; these include the cold stenotherms *Diura knowltoni* (a stonefly) and *Oligophlebodes* sp. (a caddisfly). However, all but one of the sensitive taxa were uncommon in the sample. The only abundant sensitive taxon was the chironomid *Cricotopus nostococladius*, which colonizes the blue-green alga *Nostoc*. *Nostoc* prefers cool-to-cold water temperatures and relatively unpolluted conditions. Filterers were more abundant than expected, suggesting that suspended fine organic material was a major energy source. The thermal preference for the assemblage as a whole was calculated to be 13.2° C, which is somewhat warmer than the median value calculated for

similar streams in the Middle Rockies ecoregion. Water quality may have been slightly influenced by nutrients and warmer-than-expected temperatures.

Nineteen "clinger" taxa and eleven caddisfly taxa were counted in the sample. It seems likely that sediment deposition did not substantially affect benthic colonization. The FSBI value (5.22) suggested a moderately sediment intolerant assemblage. Overall taxa richness (41) was high, which may indicate diverse instream habitats. Stonefly taxa richness (6) was within expected limits for a stream with unaltered morphology, intact riparian zones, and stable streambanks. The presence of 5 semivoltine taxa indicates that surface flow persisted year-round in the reach; toxic pollutants or scouring events seem unlikely. The functional composition of the invertebrate assemblage included all expected feeding groups; the proportional representation of filterers was higher than expected for a montane stream.

Upstream of West Fork confluence (UPSTREAM)

Mayfly taxa richness (7) was lower than the median for higher-order streams of the Middle Rockies ecoregion. Early sampling may account for this. The biotic index value (3.26) calculated for the invertebrate assemblage as a whole indicated a moderately sensitive community. Among the animals collected at this site were five sensitive taxa; these included the mayflies *Drunella doddsii* and *Caudatella hystrix*. However, no sensitive taxon was represented by more than a few individuals. Thermal preference for the assemblage was 13.6°C, which is consistent with other mid-to-high order streams in the Middle Rockies ecoregion. It seems likely that water quality was good in this reach, and thermal conditions were appropriate for a riverine environment.

Eight caddisfly taxa and seventeen "clinger" taxa were present in the sample. These findings suggest that fine sediment deposition did not entirely prevent colonization of stony benthic substrates. The FSBI value (3.80), however, indicated a moderately sediment-tolerant community. Overall taxa richness (32) was somewhat lower than expected, but may have been influenced by the sampling season. Stoneflies were represented by three taxa; this is fewer than expected. Unstable streambanks, alteration of natural channel morphology, or disturbed riparian function may be indicated. Dewatering, thermal extremes, or toxic pollutants apparently were not influential, since long-lived semivoltine taxa were present. All expected functional components were represented in the sample; the abundance of shredders (especially *Lepidostoma* sp. and *Ephemerella inermis*) in the reach was remarkable. The finding suggests ample inputs of large organic material.

Above Jack Smith bridge (DOWN2)

The sample collected at this site yielded nine mayfly taxa, including the sensitive *Caudatella hystrix*, which was common. The biotic index value (4.56), however, was high, suggesting a moderately tolerant assemblage overall. Midges were the most abundant group in this sample, accounting for 43% of the taxonomic composition of the assemblage. Slight nutrient enrichment could be indicated. The thermal preference of this assemblage was calculated to be 13.4°C, which is consistent with that of the other sites examined in this study.

Although nine caddisfly taxa were collected, none were abundant; only the tolerant filter-feeding *Hydropsyche* sp. was represented by more than a few individuals. On the other hand, "clinger" richness was high (22 taxa) and the FSBI value (5.29) suggested a moderately sediment-sensitive fauna. It seems likely that sediment deposition did not prevent colonization of stony benthic substrates. Taxa richness (39) was high, suggesting diverse instream habitats. Five stonefly taxa were counted in the sample; the diversity of stoneflies may be related to the condition of reach scale habitat features. In this case, stable streambanks, intact riparian function, and natural channel morphology may be indicated. Semivoltine taxa were well-represented; toxic pollutants, thermal extremes, or other catastrophes did not influence this assemblage. Gatherers dominated the functional composition, but all other expected feeding groups were present as well. Dominance by gatherers is sometimes interpreted as an indication of nutrient enrichment.

2. West Fork Gallatin River

Upstream of Big Sky Spur Bridge (WEST)

Mayfly taxa richness (7) and the biotic index value (2.47) both suggested that water quality at this site was good. Four sensitive taxa were present in the sample; these included the mayfly *Drunella doddsii* and the caddisfly *Oligophlebodes* sp. The thermal preference of the overall assemblage was calculated to be 14.0ºC.

The sample was overwhelmed by a single taxon, the caddisfly *Lepidostoma* sp., which accounted for 47% of sampled animals. The abundance of this organism suggests that organic material in the form of leaf packs may have been the dominant component of benthic substrates. Nevertheless, the site supported at least eight caddisfly taxa and sixteen "clinger" taxa. "Clingers" were not exceptionally abundant, however, making up 23% of the assemblage. Given these findings, indications of sediment deposition are difficult to interpret. Overall taxa richness (36) was high, despite the dominance of *Lepidostoma* sp. This diversity may be related to the diversity of instream habitats. Although not abundant, stoneflies were represented by six taxa. Stonefly taxa richness may be related to the condition of reach scale habitat features such as streambank stability, natural channel morphology, and riparian zone function. The presence of 5 semivoltine taxa suggests that surface flow persisted year round and the occurrence of thermal extremes was unlikely. Because of the dominance of *Lepidostoma* sp. in the sample collected at this site, the functional composition of the assemblage was overwhelmed by shredders, indicating the importance of riparian inputs of organic material to this community. All other expected functional components were present as well.

Habitat assessment

Table 3 gives the results of habitat assessment at each of the 4 sampled sites. Most habitat measures were rated optimal or sub-optimal, but there were exceptions, which are described here:

At the Gallatin River site upstream of the West Fork confluence (UPSTREAM), embeddedness was judged marginal, and bank vegetation integrity and the width of the riparian zone on the left bank were perceived to be marginal.

At the Gallatin River site above the Jack Smith bridge (DOWN2), riffle development was judged marginal. If assessment was consistent between years, this score indicates some improvement of this feature, since it was rated poor in 2007. Bank stability and bank vegetation on the left bank were both rated marginal, and the width of the riparian zone on that side was judged to be poor.

The site on the West Fork Gallatin River was judged to have marginal benthic substrate conditions, with more embeddedness than expected.

In spite of the marginal and poor ratings for some of the habitat features at these sites, cumulative scores indicated optimal habitat conditions at all four sites visited in April 2008.

Table 3. Stream and riparian habitat assessment. Sites were assessed based upon criteria developed by Montana DEQ for streams with riffle/run prevalence (MDEQ 1998). Gallatin River drainage, April 14, 2008.

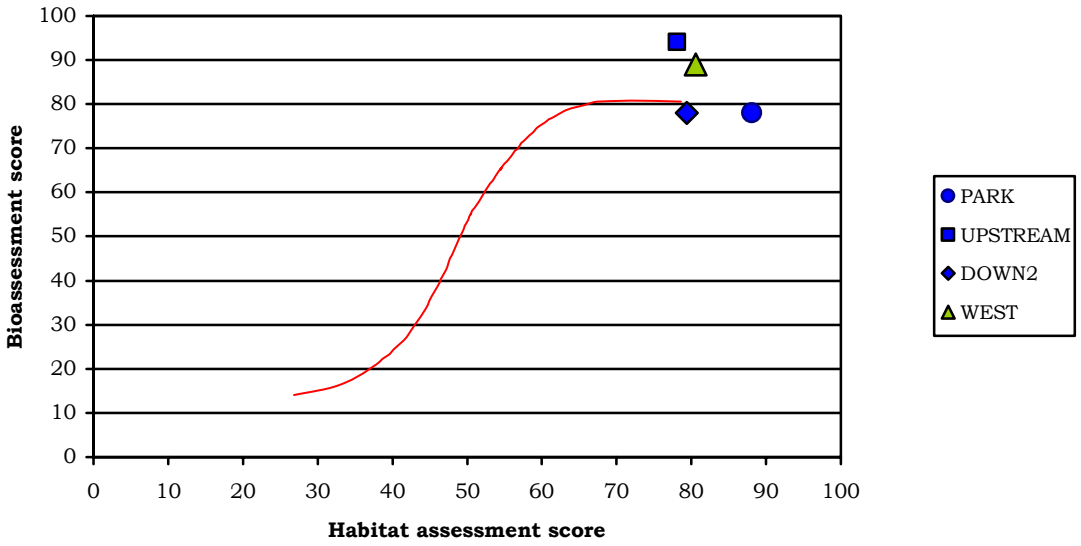
Max. possible score	Parameter	**PARK**	**UPSTREAM**	**DOWN2**	**WEST**
10	Riffle development	9	6	5	7
10	Benthic substrate	8	8	9	4
20	Embeddedness	11	7	14	7
20	Channel alteration	20	20	20	20
20	Sediment deposition	20	18	20	18
20	Channel flow status	20	20	20	20
20	Bank stability	9 / 9	6 / 10	5 / 8	8 / 10
20	Bank vegetation	10 / 8	5 / 10	5 / 9	8 / 10
20	Vegetated zone	10 / 7	5 / 10	2 / 10	7 / 10
160	Total	141	125	127	129
	Percent of maximum	**88.1%**	**78.1%**	**79.4%**	**80.6%**
	CONDITION*	**OPTIMAL**	**OPTIMAL**	**OPTIMAL**	**OPTIMAL**

* Condition categories: Optimal > 80% of maximum score; Sub-optimal 75 - 56%; Marginal 49 - 29%; Poor <23%. Plafkin et al. 1989.

Relating bioassessment to habitat assessment

When habitat assessment scores are plotted against bioassessment scores, the resulting figure provides an opportunity to evaluate the hypothetical relationship between habitat integrity and water quality. Both factors are critical and interactive determinants of the composition and functional integrity of aquatic invertebrate assemblages. Presumably, high quality habitat, in the absence of impairments to water quality, supports functional, diverse, and sensitive invertebrate assemblages; these are assemblages that attain high bioassessment scores. Barbour and Stribling (1991) have hypothesized that diminishing habitat quality should produce predictable diminishment of bioassessment scores, when water quality is not a further insult. Figure 1 is a plot of habitat assessment scores against bioassessment scores for the sampled assemblages of the Gallatin River and West Fork Gallatin River. The red line superimposed on the plot roughly represents the hypothetical relationship between habitat quality and biotic integrity given good water quality. In this model, symbols falling in the upper right area of the graph would represent sites with high scores for both bioassessment and habitat assessment;

Figure 1. Average bioassessment scores plotted against habitat assessment scores (Barbour and Stribling 1991) for 4 sites in the Gallatin River drainage, April 14, 2008.



according to this model, these would be unimpaired sites both in terms of habitat integrity as well as water quality.

Symbols for each of the sites sampled for this study fall in the upper right area of the plot, suggesting good water quality and intact habitats at all locations.

DISCUSSION

The revised assessment tool used in this report for scoring biotic integrity was developed for small-to-medium sized streams in Strahler orders 2 – 4, and may overestimate impairment in higher-linkage systems. Bioassessment scores indicate slight impairment at the PARK and DOWN2 sites. Evidence for possible nutrient enrichment, though slight, can be discerned in the aquatic invertebrate assemblages collected at these sites.

REFERENCES

Anderson, N. H. 1976. The distribution and biology of the Oregon Trichoptera. Oregon Agricultual Experimentation Station Technical Bulletin No. 134: 1-152.

Barbour, M.T., J.Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency, Washington, D.C.

Barbour, M.T. and J.B. Stribling. 1991. Use of habitat assessment in evaluating the biological integrity of stream communities. In: *Biological Criteria: Research and Regulation.* Proceedings of a

Symposium, 12-13 December 1990, Arlington, Virginia. EPA-440-5-91-005. U.S. Environmental Protection Agency, Washington, DC.

Bollman, W. 1998. Improving Stream Bioassessment Methods for the Montana Valleys and Foothill Prairies Ecoregion. Master's Thesis (MS). University of Montana. Missoula, Montana.

Bollman, W. and J.A. Bowman. 2007. Biological and nutrient impairment in the streams and rivers of Montana: An analysis of relative extent and risks. Report to the Montana Department of Environmental Quality, Helena, Montana. October 2007.

Brandt, D. 2001. Temperature Preferences and Tolerances for 137 Common Idaho Macroinvertebrate Taxa. Report to the Idaho Department of Environmental Quality, Coeur d' Alene, Idaho.

Bray, J. R. and J. T. Curtis. 1957. An ordination of upland forest communities of southern Wisconsin. Ecological Monographs 27: 325-349.

Cairns, J., Jr. and J. R. Pratt. 1993. A History of Biological Monitoring Using Benthic Macroinvertebrates. Chapter 2 *in* Rosenberg, D. M. and V. H. Resh, eds. *Freshwater Biomonitoring and Benthic Macroinvertebrates*. Chapman and Hall, New York.

Caton, L. W. 1991. Improving subsampling methods for the EPA's "Rapid Bioassessment" benthic protocols. Bulletin of the North American Benthological Society. 8(3): 317-319.

Clark, W.H. 1997. Macroinvertebrate temperature indicators for Idaho. Draft manuscript with citations. Idaho Department of Environmental Quality. Boise, Idaho.

Fore, L. S., J. R. Karr and R. W. Wisseman. 1996. Assessing invertebrate responses to human activities: evaluating alternative approaches. *Journal of the North American Benthological Society* 15(2): 212-231.

Friedrich, G. 1990. Eine Revision des Saprobiensystems. *Zeitschrift für Wasser und Abwasser Forschung* 23: 141-52.

Hellawell, J. M. 1986. *Biological Indicators of Freshwater Pollution and Environmental Management*. Elsevier, London.

Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. *Great Lakes Entomologist.* 20: 31-39.

Karr, J.R. and E.W. Chu. 1999. *Restoring Life in Running Waters: Better Biological Monitoring.* Island Press. Washington D.C.

Kleindl, W.J. 1995. A benthic index of biotic integrity for Puget Sound Lowland Streams, Washington, USA. M.S. Thesis. University of Washington, Seattle, Washington.

LeSage, L. and A. D. Harrison. 1980. The biology of *Cricotopus* (Chironomidae: Orthocladiinae) in an algal-enriched stream. Archiv fur Hydrobiologie Supplement 57: 375-418.

MDEQ. 1998. Rapid bioassessment macroinvertebrate protocols: Sampling and sample analysis SOP's. Working draft. Montana Department of Environmental Quality. Planning Prevention and Assistance Division. Helena, Montana.

MDEQ. 2006. Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates. Montana Department of Environmental Quality. Water Quality Planning Bureau. Standard Operating Procedure. WQPBWQM-009. Helena, Montana.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M.Hughes. 1989. Rapid Bioassessment Protocols for Use in Streams and Rivers. Benthic Macroinvertebrates and Fish. EPA 440-4-89-001. Office of Water Regulations and Standards, U.S. Environmental Protection Agency, Washington, D.C.

Relyea, C. D., G.W. Minshall, and R.J. Danehy. 2000. Stream insects as bioindicators of fine sediment. *In:* Proceeding Watershed 2000, Water Environment Federation Specialty Conference. Vancouver, BC.

Stoddard, J. L., D. V. Peck, S. G. Paulsen, J. Van Sickle, C. P. Hawkins, A. T. Herlihy, R. M. Hughes, P. R. Kaufmann, D. P. Larsen, G. Lomnicky, A. R. Olsen, S. A. Peterson, P. L. Ringold, and T. R. Whittier. 2005. *An Ecological Assessment of Western Streams and Rivers*. EPA 620/R-05/005, U.S. Environmental Protection Agency, Washington, D.C.

Vannote, R.L., Minshall, G.W., Cummins, K.W., Sedell, J.R., and C.E. Cushing. 1980. The river continuum concept. *Canadian Journal of Fisheries and Aquatic Sciences* 37:130-137.

Walshe, J. F. 1947. On the function of haemoglobin in *Chironomus* after oxygen lack. *Journal of Experimental Biology* 24: 329-342.

Watson, V. J. 1988. Control of nuisance algae in the Clark Fork River. Report to Montana Department of Health and Environmental Sciences. Helena, Montana.

Wisseman R.W. 1996. Common Pacific Northwest benthic invertebrate taxa: Suggested levels for standard taxonomic effort: Attribute coding and annotated comments. Unpublished draft. Aquatic Biology Associates, Corvallis, Oregon.

APPENDIX

Taxa lists and metric summaries

Blue Water Task Force
Gallatin River Watershed

April 14, 2008

Taxa Listing

Project ID: BWTF08GR
RAI No.: BWTF08GR001

RAI No.: BWTF08GR001 **Sta. Name:** Gallatin River above Jack Smith bridge
Client ID: DOWN2
Date Coll.: 4/14/2008 **No. Jars:** 1 **STORET ID:**

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Non-Insect							
Acari	2	0.62%	Yes	Unknown		5	PR
Ephemeroptera							
Baetidae							
Baetis tricaudatus	39	12.04%	Yes	Larva		4	CG
Ephemerellidae							
Caudatella hystrix	18	5.56%	Yes	Larva		0	SC
Drunella sp.	17	5.25%	Yes	Larva	Early Instar	1	SC
Drunella grandis	2	0.62%	Yes	Larva		2	PR
Ephemerella inermis	15	4.63%	Yes	Larva		4	SH
Ephemerellidae	1	0.31%	No	Larva	Damaged	1	CG
Serratella tibialis	3	0.93%	Yes	Larva		2	CG
Heptageniidae							
Cinygmula sp.	3	0.93%	Yes	Larva		0	SC
Epeorus longimanus	7	2.16%	Yes	Larva		1	SC
Heptageniidae	1	0.31%	No	Larva	Damaged	4	SC
Rhithrogena sp.	2	0.62%	Yes	Larva		0	CG
Plecoptera							
Chloroperlidae							
Sweltsa sp.	1	0.31%	Yes	Larva		0	PR
Nemouridae							
Prostoia sp.	4	1.23%	Yes	Larva		2	SH
Perlidae							
Hesperoperla pacifica	2	0.62%	Yes	Larva		1	PR
Perlodidae							
Isoperla sp.	10	3.09%	Yes	Larva		2	PR
Perlodidae	1	0.31%	Yes	Larva	Damaged	2	PR
Trichoptera							
Brachycentridae							
Amiocentrus aspilus	3	0.93%	Yes	Larva		3	CG
Brachycentrus americanus	2	0.62%	Yes	Larva		1	CF
Brachycentrus occidentalis	1	0.31%	Yes	Larva		2	CF
Micrasema sp.	1	0.31%	Yes	Larva		1	SH
Glossosomatidae							
Glossosoma sp.	1	0.31%	Yes	Larva		0	SC
Hydropsychidae							
Arctopsyche grandis	1	0.31%	Yes	Larva		2	PR
Hydropsyche sp.	15	4.63%	Yes	Larva		5	CF
Lepidostomatidae							
Lepidostoma sp.	4	1.23%	Yes	Larva		1	SH
Rhyacophilidae							
Rhyacophila Hyalinata Gr.	1	0.31%	Yes	Larva		0	PR
Coleoptera							
Elmidae							
Optioservus sp.	7	2.16%	Yes	Adult		5	SC
Optioservus sp.	3	0.93%	No	Larva		5	SC

Taxa Listing

Project ID: BWTF08GR
RAI No.: BWTF08GR001

RAI No.: BWTF08GR001 **Sta. Name:** Gallatin River above Jack Smith bridge
Client ID: DOWN2
Date Coll.: 4/14/2008 **No. Jars:** 1 **STORET ID:**

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Diptera							
Athericidae							
Atherix sp.	2	0.62%	Yes	Larva		5	PR
Empididae							
Wiedemannia sp.	1	0.31%	Yes	Larva		6	PR
Simuliidae							
Simuliidae	1	0.31%	No	Pupa		6	CF
Simulium sp.	2	0.62%	Yes	Larva		6	CF
Tipulidae							
Antocha sp.	11	3.40%	Yes	Larva		3	CG
Chironomidae							
Chironomidae							
Chironomidae	18	5.56%	No	Pupa		10	CG
Cladotanytarsus sp.	41	12.65%	Yes	Larva		7	CG
Cricotopus (Nostococladius) sp.	1	0.31%	Yes	Larva		6	SH
Diamesa sp.	25	7.72%	Yes	Larva		5	CG
Eukiefferiella Coerulescens Gr.	10	3.09%	Yes	Larva		8	CG
Eukiefferiella Devonica Gr.	10	3.09%	Yes	Larva		8	CG
Eukiefferiella Gracei Gr.	2	0.62%	Yes	Larva		8	CG
Orthocladius sp.	26	8.02%	Yes	Larva		6	CG
Sublettea sp.	1	0.31%	Yes	Larva		6	CF
Thienemanniella sp.	1	0.31%	Yes	Larva		6	CG
Tvetenia Bavarica Gr.	5	1.54%	Yes	Larva		5	CG
Sample Count	**324**						

Taxa Listing

Project ID: BWTF08GR
RAI No.: BWTF08GR002

RAI No.: BWTF08GR002 **Sta. Name:** Gallatin River at Park Boundary (North)
Client ID: PARK
Date Coll.: 4/14/2008 **No. Jars:** 1 **STORET ID:**

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Non-Insect							
Acari	3	0.85%	Yes	Unknown		5	PR
Ephemeroptera							
Baetidae							
Baetis tricaudatus	11	3.11%	Yes	Larva		4	CG
Ephemerellidae							
Drunella grandis	2	0.56%	Yes	Larva		2	PR
Ephemerella inermis	27	7.63%	Yes	Larva		4	SH
Ephemerellidae	11	3.11%	Yes	Larva	Early Instar	1	CG
Heptageniidae							
Cinygmula sp.	7	1.98%	Yes	Larva		0	SC
Epeorus sp.	3	0.85%	Yes	Larva	Early Instar	2	CG
Heptageniidae	7	1.98%	No	Larva	Early Instar	4	SC
Rhithrogena sp.	6	1.69%	Yes	Larva		0	CG
Plecoptera							
Chloroperlidae							
Sweltsa sp.	5	1.41%	Yes	Larva		0	PR
Nemouridae							
Prostoia sp.	2	0.56%	Yes	Larva		2	SH
Perlidae							
Hesperoperla pacifica	5	1.41%	Yes	Larva		1	PR
Perlodidae							
Diura sp.	1	0.28%	Yes	Larva		2	PR
Isoperla sp.	4	1.13%	Yes	Larva		2	PR
Skwala sp.	5	1.41%	Yes	Larva		3	PR
Trichoptera							
Apataniidae							
Apatania sp.	4	1.13%	Yes	Larva		3	SC
Brachycentridae							
Brachycentrus americanus	33	9.32%	Yes	Larva		1	CF
Brachycentrus occidentalis	7	1.98%	Yes	Larva		2	CF
Micrasema sp.	2	0.56%	Yes	Larva		1	SH
Glossosomatidae							
Glossosoma sp.	22	6.21%	Yes	Larva		0	SC
Hydropsychidae							
Arctopsyche grandis	3	0.85%	Yes	Larva		2	PR
Hydropsyche sp.	2	0.56%	Yes	Larva		5	CF
Lepidostomatidae							
Lepidostoma sp.	12	3.39%	Yes	Larva		1	SH
Rhyacophilidae							
Rhyacophila Brunnea Gr.	1	0.28%	Yes	Larva		2	PR
Rhyacophila Hyalinata Gr.	1	0.28%	Yes	Larva		0	PR
Uenoidae							
Oligophlebodes sp.	2	0.56%	Yes	Larva		3	SC

Taxa Listing

Project ID: BWTF08GR
RAI No.: BWTF08GR002

RAI No.: BWTF08GR002 **Sta. Name:** Gallatin River at Park Boundary (North)
Client ID: PARK
Date Coll.: 4/14/2008 **No. Jars:** 1 **STORET ID:**

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Coleoptera							
Elmidae							
Heterlimnius sp.	3	0.85%	Yes	Larva		3	CG
Diptera							
Empididae							
Chelifera sp.	7	1.98%	Yes	Larva		5	PR
Wiedemannia sp.	6	1.69%	Yes	Larva		6	PR
Psychodidae							
Psychodidae	1	0.28%	Yes	Larva		4	CG
Tipulidae							
Antocha sp.	4	1.13%	Yes	Larva		3	CG
Dicranota sp.	1	0.28%	Yes	Larva		3	PR
Hexatoma sp.	4	1.13%	Yes	Larva		2	PR
Chironomidae							
Chironomidae							
Chironomidae	4	1.13%	No	Pupa		10	CG
Cladotanytarsus sp.	56	15.82%	Yes	Larva		7	CG
Cricotopus (Nostococladius) sp.	38	10.73%	Yes	Larva		6	SH
Eukiefferiella Devonica Gr.	7	1.98%	Yes	Larva		8	CG
Eukiefferiella Gracei Gr.	1	0.28%	Yes	Larva		8	CG
Micropsectra sp.	1	0.28%	Yes	Larva		4	CG
Orthocladius sp.	26	7.34%	Yes	Larva		6	CG
Potthastia Longimana Gr.	4	1.13%	Yes	Larva		2	CG
Stictochironomus sp.	2	0.56%	Yes	Larva		5	CG
Tvetenia Bavarica Gr.	1	0.28%	Yes	Larva		5	CG
Sample Count	**354**						

Taxa Listing

Project ID: BWTF08GR
RAI No.: BWTF08GR003

RAI No.: BWTF08GR003
Client ID: WEST
Date Coll.: 4/14/2008 **No. Jars:** 1
Sta. Name: West Fork of the Gallatin River upstream of Big Sky Spur Rd. bridge
STORET ID:

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Non-Insect							
Acari	2	0.60%	Yes	Unknown		5	PR
Naididae							
Naididae (Naidinae)	1	0.30%	Yes	Unknown		8	CG
Ephemeroptera							
Baetidae							
Baetis tricaudatus	2	0.60%	Yes	Larva		4	CG
Ephemerellidae							
Drunella doddsii	2	0.60%	Yes	Larva		1	SC
Drunella grandis	6	1.81%	Yes	Larva		2	PR
Ephemerella inermis	19	5.74%	Yes	Larva		4	SH
Heptageniidae							
Cinygmula sp.	8	2.42%	Yes	Larva		0	SC
Epeorus longimanus	1	0.30%	Yes	Larva		1	SC
Heptageniidae	1	0.30%	No	Larva	Early Instar	4	SC
Rhithrogena sp.	6	1.81%	Yes	Larva		0	CG
Plecoptera							
Chloroperlidae							
Sweltsa sp.	1	0.30%	Yes	Larva		0	PR
Nemouridae							
Prostoia sp.	5	1.51%	Yes	Larva		2	SH
Zapada cinctipes	2	0.60%	Yes	Larva		3	SH
Perlidae							
Hesperoperla pacifica	1	0.30%	Yes	Larva		1	PR
Perlodidae							
Isoperla sp.	4	1.21%	Yes	Larva		2	PR
Perlodidae	1	0.30%	No	Larva	Early Instar	2	PR
Skwala sp.	1	0.30%	Yes	Larva		3	PR
Trichoptera							
Brachycentridae							
Brachycentrus americanus	5	1.51%	Yes	Larva		1	CF
Brachycentrus occidentalis	3	0.91%	Yes	Larva		2	CF
Micrasema sp.	3	0.91%	Yes	Larva		1	SH
Glossosomatidae							
Glossosoma sp.	4	1.21%	Yes	Larva		0	SC
Hydropsychidae							
Arctopsyche grandis	8	2.42%	Yes	Larva		2	PR
Hydropsyche sp.	3	0.91%	Yes	Larva		5	CF
Lepidostomatidae							
Lepidostoma sp.	156	47.13%	Yes	Larva		1	SH
Uenoidae							
Oligophlebodes sp.	1	0.30%	Yes	Larva		3	SC
Coleoptera							
Elmidae							
Optioservus sp.	2	0.60%	No	Larva		5	SC
Optioservus sp.	1	0.30%	Yes	Adult		5	SC

Taxa Listing

Project ID: BWTF08GR
RAI No.: BWTF08GR003

RAI No.: BWTF08GR003
Client ID: WEST
Date Coll.: 4/14/2008 **No. Jars:** 1
Sta. Name: West Fork of the Gallatin River upstream of Big Sky Spur Rd. bridge
STORET ID:

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Diptera							
Athericidae							
Atherix sp.	7	2.11%	Yes	Larva		5	PR
Empididae							
Neoplasta sp.	2	0.60%	Yes	Larva		5	PR
Wiedemannia sp.	1	0.30%	Yes	Larva		6	PR
Ephydridae							
Ephydridae	1	0.30%	Yes	Larva		6	CG
Tipulidae							
Antocha sp.	1	0.30%	Yes	Larva		3	CG
Chironomidae							
Chironomidae							
Cladotanytarsus sp.	27	8.16%	Yes	Larva		7	CG
Eukiefferiella Gracei Gr.	7	2.11%	Yes	Larva		8	CG
Micropsectra sp.	31	9.37%	Yes	Larva		4	CG
Pagastia sp.	1	0.30%	Yes	Larva		1	CG
Potthastia Longimana Gr.	1	0.30%	Yes	Larva		2	CG
Rheotanytarsus sp.	1	0.30%	Yes	Larva		6	CF
Tanytarsini	1	0.30%	No	Larva	Early Instar	6	CF
Tvetenia Bavarica Gr.	1	0.30%	Yes	Larva		5	CG
Sample Count	**331**						

Taxa Listing

Project ID: BWTF08GR
RAI No.: BWTF08GR004

RAI No.: BWTF08GR004
Client ID: UPSTREAM
Date Coll.: 4/14/2008 **No. Jars:** 1
Sta. Name: Gallatin River just upstream of West Fork confluence
STORET ID:

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Non-Insect							
Lymnaeidae							
Fossaria sp.	2	0.62%	Yes	Unknown		6	SC
Ephemeroptera							
Baetidae							
Baetis tricaudatus	20	6.23%	Yes	Larva		4	CG
Ephemerellidae							
Caudatella sp.	5	1.56%	Yes	Larva	Early Instar	0	CG
Drunella sp.	20	6.23%	Yes	Larva	Early Instar	1	SC
Drunella doddsii	1	0.31%	Yes	Larva		1	SC
Ephemerella inermis	41	12.77%	Yes	Larva		4	SH
Ephemerellidae	1	0.31%	No	Larva	Damaged	1	CG
Heptageniidae							
Cinygmula sp.	1	0.31%	Yes	Larva		0	SC
Rhithrogena sp.	6	1.87%	Yes	Larva		0	CG
Plecoptera							
Chloroperlidae							
Sweltsa sp.	5	1.56%	Yes	Larva		0	PR
Perlidae							
Claassenia sabulosa	1	0.31%	Yes	Larva		3	PR
Perlodidae							
Isoperla sp.	12	3.74%	Yes	Larva		2	PR
Trichoptera							
Apataniidae							
Apatania sp.	4	1.25%	Yes	Larva		3	SC
Brachycentridae							
Brachycentrus americanus	1	0.31%	Yes	Larva		1	CF
Brachycentrus occidentalis	2	0.62%	Yes	Larva		2	CF
Glossosomatidae							
Glossosoma sp.	4	1.25%	Yes	Larva		0	SC
Hydropsychidae							
Arctopsyche grandis	1	0.31%	Yes	Larva		2	PR
Hydropsyche sp.	6	1.87%	Yes	Larva		5	CF
Lepidostomatidae							
Lepidostoma sp.	89	27.73%	Yes	Larva		1	SH
Rhyacophilidae							
Rhyacophila Hyalinata Gr.	1	0.31%	Yes	Larva		0	PR
Coleoptera							
Elmidae							
Zaitzevia sp.	1	0.31%	Yes	Larva		5	CG
Diptera							
Athericidae							
Atherix sp.	1	0.31%	Yes	Larva		5	PR
Simuliidae							
Simulium sp.	3	0.93%	Yes	Larva		6	CF
Tipulidae							
Hexatoma sp.	1	0.31%	Yes	Larva		2	PR

Taxa Listing

Project ID: BWTF08GR
RAI No.: BWTF08GR004

RAI No.: BWTF08GR004
Client ID: UPSTREAM
Date Coll.: 4/14/2008 **No. Jars:** 1
Sta. Name: Gallatin River just upstream of West Fork confluence
STORET ID:

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Chironomidae							
Chironomidae							
Chironomidae	6	1.87%	No	Pupa		10	CG
Cricotopus (Cricotopus) sp.	3	0.93%	Yes	Larva		7	SH
Cricotopus (Nostococladius) sp.	6	1.87%	Yes	Larva		6	SH
Diamesa sp.	12	3.74%	Yes	Larva		5	CG
Eukiefferiella Devonica Gr.	12	3.74%	Yes	Larva		8	CG
Eukiefferiella Gracei Gr.	2	0.62%	Yes	Larva		8	CG
Micropsectra sp.	4	1.25%	Yes	Larva		4	CG
Orthocladius sp.	44	13.71%	Yes	Larva		6	CG
Pagastia sp.	2	0.62%	Yes	Larva		1	CG
Potthastia Longimana Gr.	1	0.31%	Yes	Larva		2	CG
Sample Count	**321**						

Metrics Report

Project ID: BWTF08GR
RAI No.: BWTF08GR001
Sta. Name: Gallatin River above Jack Smith bridge
Client ID: DOWN2
STORET ID
Coll. Date: 4/14/2008

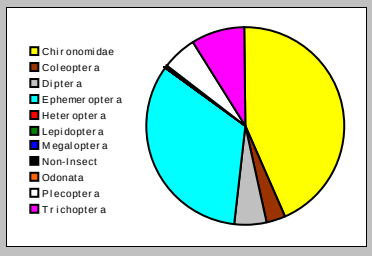
Abundance Measures

Sample Count: 324
Sample Abundance: 6,480.00 5.00% of sample used

Coll. Procedure: KICK
Sample Notes: Kick: 6 ft, 2 min; Elevation: 1832 m; Time: 3:20 pm

Taxonomic Composition

Category	R	A	PRA
Non-Insect	1	2	0.62%
Odonata			
Ephemeroptera	9	108	33.33%
Plecoptera	5	18	5.56%
Heteroptera			
Megaloptera			
Trichoptera	9	29	8.95%
Lepidoptera			
Coleoptera	1	10	3.09%
Diptera	4	17	5.25%
Chironomidae	10	140	43.21%

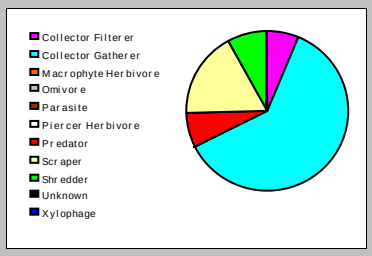


Dominant Taxa

Category	A	PRA
Cladotanytarsus	41	12.65%
Baetis tricaudatus	39	12.04%
Orthocladius	26	8.02%
Diamesa	25	7.72%
Chironomidae	18	5.56%
Caudatella hystrix	18	5.56%
Drunella	17	5.25%
Hydropsyche	15	4.63%
Ephemerella inermis	15	4.63%
Antocha	11	3.40%
Optioservus	10	3.09%
Isoperla	10	3.09%
Eukiefferiella Devonica Gr.	10	3.09%
Eukiefferiella Coerulescens Gr.	10	3.09%
Epeorus longimanus	7	2.16%

Functional Composition

Category	R	A	PRA
Predator	10	23	7.10%
Parasite			
Collector Gatherer	13	197	60.80%
Collector Filterer	5	22	6.79%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	6	57	17.59%
Shredder	5	25	7.72%
Omivore			
Unknown			

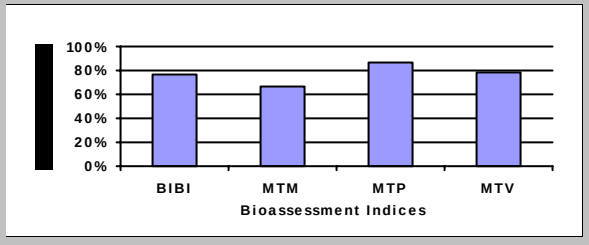


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	39	3	3		3
Non-Insect Percent	0.62%				
E Richness	9	5		3	
P Richness	5	3		3	
T Richness	9	3		3	
EPT Richness	23		3		3
EPT Percent	47.84%		2		1
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.361				
Hydropsychidae/Trichoptera	0.552				
Dominance					
Dominant Taxon Percent	12.65%		3		3
Dominant Taxa (2) Percent	24.69%				
Dominant Taxa (3) Percent	32.72%	5			
Dominant Taxa (10) Percent	69.44%				
Diversity					
Shannon H (loge)	3.022				
Shannon H (log2)	4.360		3		
Margalef D	6.662				
Simpson D	0.066				
Evenness	0.046				
Function					
Predator Richness	10		3		
Predator Percent	7.10%	1			
Filterer Richness	5				
Filterer Percent	6.79%			2	
Collector Percent	67.59%		2		2
Scraper+Shredder Percent	25.31%		2		1
Scraper/Filterer	2.591				
Scraper/Scraper+Filterer	0.722				
Habit					
Burrower Richness	0				
Burrower Percent	0.00%				
Swimmer Richness	1				
Swimmer Percent	12.04%				
Clinger Richness	22	5			
Clinger Percent	37.35%				
Characteristics					
Cold Stenotherm Richness	2				
Cold Stenotherm Percent	5.86%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	1				
Air Breather Percent	3.40%				
Voltinism					
Univoltine Richness	22				
Semivoltine Richness	5	5			
Multivoltine Percent	55.86%		2		
Tolerance					
Sediment Tolerant Richness	1				
Sediment Tolerant Percent	3.40%				
Sediment Sensitive Richness	3				
Sediment Sensitive Percent	0.93%				
Metals Tolerance Index	4.088				
Pollution Sensitive Richness	3	3		2	
Pollution Tolerant Percent	16.36%	5		1	
Hilsenhoff Biotic Index	4.556		3		1
Intolerant Percent	25.31%				
Supertolerant Percent	12.35%				
CTQa	54.800				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	38	76.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	26	86.67%	None
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	14	77.78%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	14	66.67%	Slight



Metrics Report

Project ID: BWTF08GR
RAI No.: BWTF08GR002
Sta. Name: Gallatin River at Park Boundary (North)
Client ID: PARK
STORET ID
Coll. Date: 4/14/2008

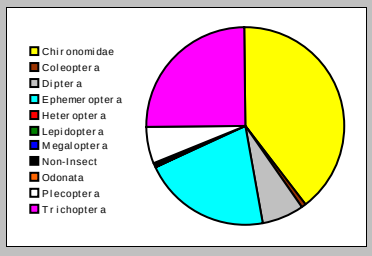
Abundance Measures

Sample Count: 354
Sample Abundance: 1,180.00 30.00% of sample used

Coll. Procedure: KICK
Sample Notes: Kick: 6 ft, 2 min; Elevation: 2045.2 m; Time: 1:20 pm

Taxonomic Composition

Category	R	A	PRA
Non-Insect	1	3	0.85%
Odonata			
Ephemeroptera	7	74	20.90%
Plecoptera	6	22	6.21%
Heteroptera			
Megaloptera			
Trichoptera	11	89	25.14%
Lepidoptera			
Coleoptera	1	3	0.85%
Diptera	6	23	6.50%
Chironomidae	9	140	39.55%

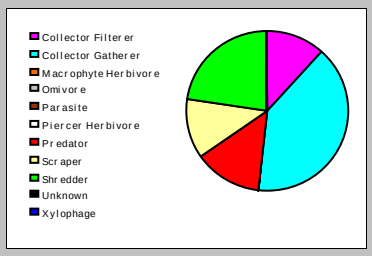


Dominant Taxa

Category	A	PRA
Cladotanytarsus	56	15.82%
Cricotopus (Nostococladius)	38	10.73%
Brachycentrus americanus	33	9.32%
Ephemerella inermis	27	7.63%
Orthocladius	26	7.34%
Glossosoma	22	6.21%
Lepidostoma	12	3.39%
Ephemerellidae	11	3.11%
Baetis tricaudatus	11	3.11%
Heptageniidae	7	1.98%
Eukiefferiella Devonica Gr.	7	1.98%
Cinygmula	7	1.98%
Chelifera	7	1.98%
Brachycentrus occidentalis	7	1.98%
Rhithrogena	6	1.69%

Functional Composition

Category	R	A	PRA
Predator	14	48	13.56%
Parasite			
Collector Gatherer	15	141	39.83%
Collector Filterer	3	42	11.86%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	4	42	11.86%
Shredder	5	81	22.88%
Omivore			
Unknown			

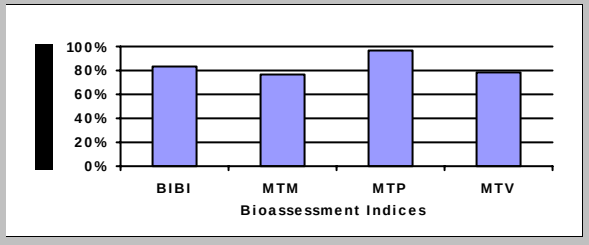


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	41	5	3		3
Non-Insect Percent	0.85%				
E Richness	7	3		3	
P Richness	6	3		3	
T Richness	11	5		3	
EPT Richness	24		3		3
EPT Percent	52.26%		3		1
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.149				
Hydropsychidae/Trichoptera	0.056				
Dominance					
Dominant Taxon Percent	15.82%		3		3
Dominant Taxa (2) Percent	26.55%				
Dominant Taxa (3) Percent	35.88%	5			
Dominant Taxa (10) Percent	68.64%				
Diversity					
Shannon H (loge)	3.060				
Shannon H (log2)	4.415		3		
Margalef D	6.852				
Simpson D	0.069				
Evenness	0.045				
Function					
Predator Richness	14		3		
Predator Percent	13.56%	3			
Filterer Richness	3				
Filterer Percent	11.86%			1	
Collector Percent	51.69%		3		3
Scraper+Shredder Percent	34.75%		3		1
Scraper/Filterer	1.000				
Scraper/Scraper+Filterer	0.500				
Habit					
Burrower Richness	4				
Burrower Percent	3.95%				
Swimmer Richness	1				
Swimmer Percent	3.11%				
Clinger Richness	19	3			
Clinger Percent	53.39%				
Characteristics					
Cold Stenotherm Richness	4				
Cold Stenotherm Percent	12.71%				
Hemoglobin Bearer Richness	1				
Hemoglobin Bearer Percent	0.56%				
Air Breather Richness	4				
Air Breather Percent	2.82%				
Voltinism					
Univoltine Richness	25				
Semivoltine Richness	5	5			
Multivoltine Percent	43.50%		2		
Tolerance					
Sediment Tolerant Richness	3				
Sediment Tolerant Percent	2.54%				
Sediment Sensitive Richness	3				
Sediment Sensitive Percent	17.80%				
Metals Tolerance Index	3.425				
Pollution Sensitive Richness	5	5		3	
Pollution Tolerant Percent	16.38%	5		1	
Hilsenhoff Biotic Index	3.845		3		2
Intolerant Percent	38.14%				
Supertolerant Percent	3.39%				
CTQa	51.324				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	42	84.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	29	96.67%	None
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	14	77.78%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	16	76.19%	Slight



Metrics Report

Project ID: BWTF08GR
RAI No.: BWTF08GR003
Sta. Name: West Fork of the Gallatin River upstream of Big Sky Spur Rd. bridge
Client ID: WEST
STORET ID
Coll. Date: 4/14/2008

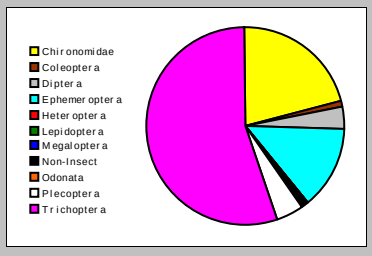
Abundance Measures

Sample Count: 331
Sample Abundance: 1,986.00 16.67% of sample used

Coll. Procedure: KICK
Sample Notes: Kick: 6 ft, 2 min; Elevation: 1839.2 m; Time: 2:00 pm

Taxonomic Composition

Category	R	A	PRA
Non-Insect	2	3	0.91%
Odonata			
Ephemeroptera	7	45	13.60%
Plecoptera	6	15	4.53%
Heteroptera			
Megaloptera			
Trichoptera	8	183	55.29%
Lepidoptera			
Coleoptera	1	3	0.91%
Diptera	5	12	3.63%
Chironomidae	7	70	21.15%

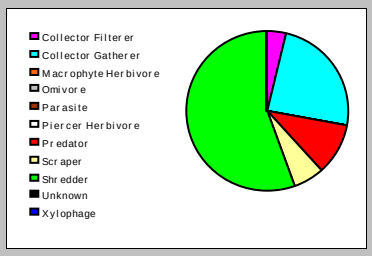


Dominant Taxa

Category	A	PRA
Lepidostoma	156	47.13%
Micropsectra	31	9.37%
Cladotanytarsus	27	8.16%
Ephemerella inermis	19	5.74%
Cinygmula	8	2.42%
Arctopsyche grandis	8	2.42%
Eukiefferiella Gracei Gr.	7	2.11%
Atherix	7	2.11%
Rhithrogena	6	1.81%
Drunella grandis	6	1.81%
Prostoia	5	1.51%
Brachycentrus americanus	5	1.51%
Isoperla	4	1.21%
Glossosoma	4	1.21%
Brachycentrus occidentalis	3	0.91%

Functional Composition

Category	R	A	PRA
Predator	10	34	10.27%
Parasite			
Collector Gatherer	11	79	23.87%
Collector Filterer	4	13	3.93%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	6	20	6.04%
Shredder	5	185	55.89%
Omivore			
Unknown			

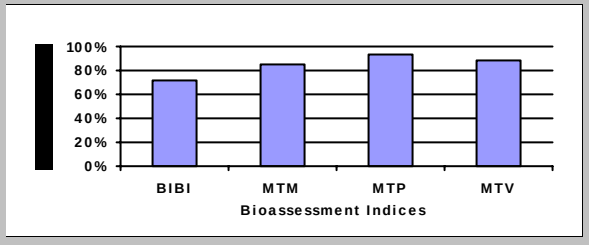


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	36	3	3		3
Non-Insect Percent	0.91%				
E Richness	7	3		3	
P Richness	6	3		3	
T Richness	8	3		3	
EPT Richness	21		3		3
EPT Percent	73.41%		3		3
Oligochaeta+Hirudinea Percent	0.30%				
Baetidae/Ephemeroptera	0.044				
Hydropsychidae/Trichoptera	0.060				
Dominance					
Dominant Taxon Percent	47.13%		1		0
Dominant Taxa (2) Percent	56.50%				
Dominant Taxa (3) Percent	64.65%	3			
Dominant Taxa (10) Percent	83.08%				
Diversity					
Shannon H (loge)	2.213				
Shannon H (log2)	3.192		3		
Margalef D	6.048				
Simpson D	0.250				
Evenness	0.065				
Function					
Predator Richness	10		3		
Predator Percent	10.27%	3			
Filterer Richness	4				
Filterer Percent	3.93%			3	
Collector Percent	27.79%		3		3
Scraper+Shredder Percent	61.93%		3		3
Scraper/Filterer	1.538				
Scraper/Scraper+Filterer	0.606				
Habit					
Burrower Richness	1				
Burrower Percent	0.60%				
Swimmer Richness	1				
Swimmer Percent	0.60%				
Clinger Richness	16	3			
Clinger Percent	22.96%				
Characteristics					
Cold Stenotherm Richness	2				
Cold Stenotherm Percent	0.91%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	1				
Air Breather Percent	0.30%				
Voltinism					
Univoltine Richness	21				
Semivoltine Richness	5	5			
Multivoltine Percent	22.36%		3		
Tolerance					
Sediment Tolerant Richness	1				
Sediment Tolerant Percent	0.30%				
Sediment Sensitive Richness	2				
Sediment Sensitive Percent	3.63%				
Metals Tolerance Index	1.759				
Pollution Sensitive Richness	4	5		3	
Pollution Tolerant Percent	11.18%	5		1	
Hilsenhoff Biotic Index	2.474		3		3
Intolerant Percent	65.26%				
Supertolerant Percent	2.42%				
CTQa	53.088				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	36	72.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	28	93.33%	None
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	16	88.89%	None
MTM	Montana DEQ Mountains (Bukantis 1998)	18	85.71%	None



Metrics Report

Project ID: BWTF08GR
RAI No.: BWTF08GR004
Sta. Name: Gallatin River just upstream of West Fork confluence
Client ID: UPSTREAM
STORET ID
Coll. Date: 4/14/2008

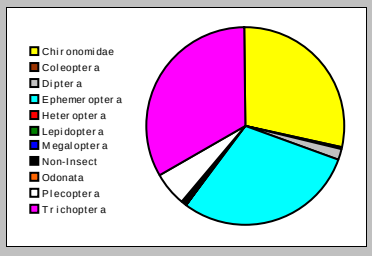
Abundance Measures

Sample Count: 321
Sample Abundance: 1,375.71 23.33% of sample used

Coll. Procedure: KICK
Sample Notes: Kick: 6 ft, 2 min; Elevation: 1838.9 m; Time: 2:45 pm

Taxonomic Composition

Category	R	A	PRA
Non-Insect	1	2	0.62%
Odonata			
Ephemeroptera	7	95	29.60%
Plecoptera	3	18	5.61%
Heteroptera			
Megaloptera			
Trichoptera	8	108	33.64%
Lepidoptera			
Coleoptera	1	1	0.31%
Diptera	3	5	1.56%
Chironomidae	9	92	28.66%

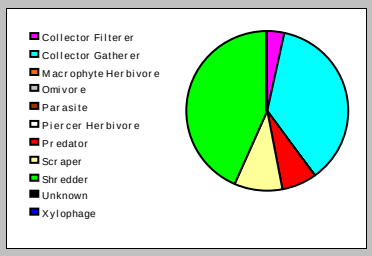


Dominant Taxa

Category	A	PRA
Lepidostoma	89	27.73%
Orthocladius	44	13.71%
Ephemerella inermis	41	12.77%
Drunella	20	6.23%
Baetis tricaudatus	20	6.23%
Isoperla	12	3.74%
Eukiefferiella Devonica Gr.	12	3.74%
Diamesa	12	3.74%
Rhithrogena	6	1.87%
Hydropsyche	6	1.87%
Cricotopus (Nostococladius)	6	1.87%
Chironomidae	6	1.87%
Sweltsa	5	1.56%
Caudatella	5	1.56%
Micropsectra	4	1.25%

Functional Composition

Category	R	A	PRA
Predator	7	22	6.85%
Parasite			
Collector Gatherer	11	116	36.14%
Collector Filterer	4	12	3.74%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	6	32	9.97%
Shredder	4	139	43.30%
Omivore			
Unknown			



Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	32	3	3		3
Non-Insect Percent	0.62%				
E Richness	7	3		3	
P Richness	3	1		2	
T Richness	8	3		3	
EPT Richness	18		3		2
EPT Percent	68.85%		3		2
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.211				
Hydropsychidae/Trichoptera	0.065				
Dominance					
Dominant Taxon Percent	27.73%		3		2
Dominant Taxa (2) Percent	41.43%				
Dominant Taxa (3) Percent	54.21%	3			
Dominant Taxa (10) Percent	81.62%				
Diversity					
Shannon H (loge)	2.550				
Shannon H (log2)	3.679		3		
Margalef D	5.392				
Simpson D	0.129				
Evenness	0.064				
Function					
Predator Richness	7		3		
Predator Percent	6.85%	1			
Filterer Richness	4				
Filterer Percent	3.74%			3	
Collector Percent	39.88%		3		3
Scraper+Shredder Percent	53.27%		3		2
Scraper/Filterer	2.667				
Scraper/Scraper+Filterer	0.727				
Habit					
Burrower Richness	1				
Burrower Percent	0.31%				
Swimmer Richness	1				
Swimmer Percent	6.23%				
Clinger Richness	17	3			
Clinger Percent	33.33%				
Characteristics					
Cold Stenotherm Richness	4				
Cold Stenotherm Percent	4.98%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	1				
Air Breather Percent	0.31%				
Voltinism					
Univoltine Richness	17				
Semivoltine Richness	5	5			
Multivoltine Percent	34.89%		3		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	0.93%				
Sediment Sensitive Richness	3				
Sediment Sensitive Percent	3.43%				
Metals Tolerance Index	3.309				
Pollution Sensitive Richness	5	5		3	
Pollution Tolerant Percent	1.25%	5		3	
Hilsenhoff Biotic Index	3.259		3		2
Intolerant Percent	47.66%				
Supertolerant Percent	6.23%				
CTQa	53.333				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	32	64.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	30	100.00%	None
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	17	94.44%	None
MTM	Montana DEQ Mountains (Bukantis 1998)	16	76.19%	Slight