A BIOLOGICAL ASSESSMENT OF FOUR SITES IN THE GALLATIN RIVER WATERSHED AND COMPARISONS TO HISTORICAL ASSESSMENTS

July 2005

A report to

The Blue Water Task Force
And the Montana Water Center
Bozeman, Montana
Katie Alvin, Project Officer

by

Wease Bollman
Rhithron Associates, Inc.
Missoula, Montana
December 2005

INTRODUCTION

Aquatic invertebrates are aptly applied to bioassessment since they are known to be important indicators of stream ecosystem health (Hynes 1970). Long lives, complex life cycles, and limited mobility mean that there is ample time for the benthic community to respond to cumulative effects of environmental perturbations.

This report summarizes data collected in July 2005 from 4 sites in the Gallatin River watershed in Gallatin County, Montana. The sites in this study lie within the Montana Valley and Foothill Prairies ecoregion (Woods et al. 1999).

A multimetric approach to bioassessment such as the one applied in this study uses attributes of the assemblage in an integrated way to measure biotic health. A stream with good biotic health is "…a balanced, integrated, adaptive system having the full range of elements and processes that are expected in the region's natural environment…" (Karr and Chu 1999). The approach designed by Plafkin et al. (1989) and adapted for use in the State of Montana has been defined as "… an array of measures or metrics that individually provide information on diverse biological attributes, and when integrated, provide an overall indication of biological condition." (Barbour et al. 1995). Community attributes that can contribute meaningfully to interpretation of benthic data include assemblage structure, sensitivity of community members to stress or pollution, and functional traits. Each metric component contributes an independent measure of the biotic integrity of a stream site; combining the components into a total score reduces variance and increases precision of the assessment (Fore et al. 1996). Effectiveness of the integrated metrics depends on the applicability of the underlying model, which rests on a foundation of three essential elements (Bollman 1998a). The first of these is an appropriate stratification or classification of stream sites, typically by ecoregion. Second, metrics must be selected based upon their ability to accurately express biological condition. Third, an adequate assessment of habitat conditions at each site to be studied enhances the interpretation of metric outcomes.

Implicit in the multimetric method and its associated habitat assessment is an assumption of correlative relationships between habitat measures and the biotic metrics, in the absence of water quality impairment. These relationships may vary regionally, requiring an examination of habitat assessment elements and biotic metrics and a test of the presumed relationship between them. Bollman (1998a) has studied the assemblages of the Montana Valleys and Foothill Prairies ecoregion and has recommended a battery of metrics applicable to the montane ecoregions of western Montana. This metric battery has been shown to be sensitive to impairment, related to measures of habitat integrity, and consistent over replicated samples.

In this report, 2 assessment methods are used: first, taxonomic data is translated into the bioassessment index, and metric scores are summed to derive impairment classifications and use support designations. Second, a narrative interpretation, based on the author's professional judgment is given. Metric performance and taxonomic data are both applied to this analysis. While the interdependence of these methods is obvious, since the same data are used for both, some degree of independence is maintained throughout the analysis. Narrative interpretations are given without regard to the bioassessment index result, and without reference to habitat assessment. Since indices are summations, they can often mask evidence of impairment; the narratives attempt to expose the potential shortcomings of the indices.

METHODS

Samples were collected in July 2005. The site selection and sampling method employed were those recommended in the Montana Department of Environmental Quality (DEQ) Standard Operating Procedures for Aquatic Macroinvertebrate Sampling

(Bukantis 1998). Aquatic invertebrate samples were delivered to Rhithron Associates, Inc., Missoula, Montana, for laboratory and data analyses.

In the laboratory, the Montana DEQ-recommended sorting method was used to obtain subsamples of at least 300 organisms from each sample, when possible. Organisms were identified to the lowest possible taxonomic levels consistent with Montana DEQ protocols.

To assess aquatic invertebrate communities, a multimetric index developed in previous work for streams of western Montana ecoregions (Bollman 1998a) was used. Multimetric indices result in a single numeric score, which integrates the values of several individual indicators of biologic health. Each metric used in this index was tested for its response or sensitivity to varying degrees of human influence. Correlations have been demonstrated between the metrics and various symptoms of human-caused impairment as expressed in water quality parameters or instream, streambank, and stream reach morphologic features. Metrics were screened to minimize variability over natural environmental gradients, such as site elevation or sampling season, which might confound interpretation of results (Bollman 1998a). The multimetric index used in this report incorporates multiple attributes of the sampled assemblage into an integrated score that accurately describes the benthic community of each site in terms of its biologic integrity. In addition to the metrics comprising the index, other metrics shown to be applicable to biomonitoring in other regions (Kleindl 1995, Patterson 1996, Rossano 1995) were used for descriptive interpretation of results. These metrics include the number of "clinger" taxa, long-lived taxa richness, the percent of predatory organisms, and others. They are not included in the integrated bioassessment score, since their performance in western Montana ecoregions is unknown. However, the relationship of these metrics to habitat conditions is intuitive and reasonable.

The six metrics constituting the bioassessment index used for MVFP sites in this study were selected because, both individually and as an integrated metric battery, they are robust at distinguishing impaired sites from relatively unimpaired sites (Bollman 1998a). In addition, they are relevant to the kinds of impacts that are present in the Gallatin River watershed. They have been demonstrated to be more variable with anthropogenic disturbance than with natural environmental gradients (Bollman 1998a). Each of the six metrics developed and tested for western Montana ecoregions is described below.

1. Ephemeroptera (mayfly) taxa richness. The number of mayfly taxa declines as water quality diminishes. Impairments to water quality which have been demonstrated to adversely affect the ability of mayflies to flourish include elevated water temperatures, heavy metal contamination, increased turbidity, low or high pH, elevated specific conductance and toxic chemicals. Few mayfly species are able to tolerate certain disturbances to instream habitat, such as excessive sediment deposition.

2. Plecoptera (stonefly) taxa richness. Stoneflies are particularly susceptible to impairments that affect a stream on a reach-level scale, such as loss of riparian canopy, streambank instability, channelization, and alteration of morphological features such as pool frequency and function, riffle development and sinuosity. Just as all benthic organisms, they are also susceptible to smaller scale habitat loss, such as by sediment deposition, loss of interstitial spaces between substrate particles, or unstable substrate.

3. Trichoptera (caddisfly) taxa richness. Caddisfly taxa richness has been shown to decline when sediment deposition affects habitat. In addition, the presence of certain case-building caddisflies can indicate good retention of woody debris and lack of scouring flow conditions.

4. Number of sensitive taxa. Sensitive taxa are generally the first to disappear as anthropogenic disturbances increase. The list of sensitive taxa used here includes organisms sensitive to a wide range of disturbances, including warmer water

temperatures, organic or nutrient pollution, toxic pollution, sediment deposition, substrate instability and others. Unimpaired streams of western Montana typically support at least four sensitive taxa (Bollman 1998a).

5. Percent filter feeders. Filter-feeding organisms are a diverse group; they capture small particles of organic matter, or organically enriched sediment material, from the water column by means of a variety of adaptations, such as silken nets or hairy appendages. In forested montane streams, filterers are expected to occur in insignificant numbers. Their abundance increases when canopy cover is lost and when water temperatures increase and the accompanying growth of filamentous algae occurs. Some filtering organisms, specifically the Arctopsychid caddisflies (*Arctopsyche* spp. and *Parapsyche* spp.) build silken nets with large mesh sizes that capture small organisms such as chironomids and early-instar mayflies. Here they are considered predators, and, in this study, their abundance does not contribute to the percent filter feeders metric.

6. Percent tolerant taxa. Tolerant taxa are ubiquitous in stream sites, but when disturbance increases, their abundance increases proportionately. The list of taxa used here includes organisms tolerant of a wide range of disturbances, including warmer water temperatures, organic or nutrient pollution, toxic pollution, sediment deposition, substrate instability and others.

Scoring criteria for each of the six metrics are presented in Table 2.

Metrics differ in their possible value ranges as well as in the direction the values move as biological conditions change. For example, Ephemeroptera richness values may range from zero to ten taxa or higher. Larger values generally indicate favorable biotic conditions. On the other hand, the percent filterers metric may range from 0% to 100%; in this case, larger values are negative indicators of biotic health. To facilitate scoring, therefore, metric values were transformed into a single scale. The range of each metric has been divided into four parts and assigned a point score between zero and three. A score of three indicates a metric value similar to one characteristic of a non-impaired condition. A score of zero indicates strong deviation from non-impaired condition and suggests severe degradation of biotic health. Scores for each metric were summed to give an overall score, the total bioassessment score, for each site in each sampling event. These scores were expressed as the percent of the maximum possible score, which is 18 for the MVFP metric battery. The total bioassessment score for each site was expressed in terms of use-support. Criteria for use-support designations were developed by Montana DEQ and are presented in Table 3a. Scores were also translated into impairment classifications according to criteria outlined in Table 3b.

In this report, certain other metrics were used as descriptors of the benthic community response to habitat or water quality but were not incorporated into the bioassessment metric battery, either because they have not yet been tested for reliability in streams of western Montana, or because results of such testing did not show them to be robust at distinguishing impairment, or because they did not meet other requirements for inclusion in the metric battery. These metrics and their use in predicting the causes of impairment or in describing its effects on the biotic community are described below.

- The modified biotic index. This metric is an adaptation of the Hilsenhoff Biotic Index (HBI, Hilsenhoff 1987), which was originally designed to indicate organic enrichment of waters. Values of this metric are lowest in least impacted conditions. Taxa tolerant to saprobic conditions are also generally tolerant of warm water, fine sediment and heavy filamentous algae growth (Bollman 1998b). Loss of canopy cover is often a contributor to higher biotic index values. The taxa values used in this report are modified to reflect habitat and water quality conditions in Montana (Bukantis 1998). Ordination studies of the benthic fauna of Montana's foothill prairie streams showed that there is a correlation between modified biotic index values and water temperature,

substrate embeddedness, and fine sediment (Bollman 1998a). In a study of reference streams, the average value of the modified biotic index in least-impaired streams of western Montana was 2.5 (Wisseman 1992).

- Taxa richness. This metric is a simple count of the number of unique taxa present in a sample. Average taxa richness in samples from reference streams in western Montana was 28 (Wisseman 1992). Taxa richness is an expression of biodiversity, and generally decreases with degraded habitat or diminished water quality. However, taxa richness may show a paradoxical increase when mild nutrient enrichment occurs in previously oligotrophic waters, so this metric must be interpreted with caution.
- Percent predators. Aquatic invertebrate predators depend on a reliable source of invertebrate prey, and their abundance provides a measure of the trophic complexity supported by a site. Less disturbed sites have more plentiful habitat niches to support diverse prey species, which in turn support abundant predator species.
- Number of "clinger" taxa. So-called "clinger" taxa have physical adaptations that allow them to cling to smooth substrates in rapidly flowing water. Aquatic invertebrate "clingers" are sensitive to fine sediments that fill interstices between substrate particles and eliminate habitat complexity. Animals that occupy the hyporheic zones are included in this group of taxa. Expected "clinger" taxa richness in unimpaired streams of western Montana is at least 14 (Bollman 1998b).
- Number of long-lived taxa. Long-lived or semivoltine taxa require more than a year to completely develop, and their numbers decline when habitat and/or water quality conditions are unstable. They may completely disappear if channels are dewatered or if there are periodic water temperature elevations or other interruptions to their life cycles. Western Montana streams with stable habitat conditions are expected to support six or more long-lived taxa (Bollman 1998b).

Narrative interpretations of biotic integrity in this report are made without reference to results of habitat assessments, or any other information about the sites or watersheds that may have accompanied the invertebrate samples. Interpretations are based entirely on: the taxonomic and functional composition of the sampled invertebrate assemblages; the sensitivities, tolerances, physiology, and habitus information for individual taxa gleaned from the writer's research; the published literature, and other expert sources; and on the performance of bioassessment metrics, described earlier in the report, which have been demonstrated to be useful tools for interpreting potential implications of benthic invertebrate assemblage composition.

Table 2. Metrics and scoring criteria for bioassessment of streams of the Montana Valley and Foothill Prairies ecoregion (Bollman 1998a).

	Score			
Metric	**3**	**2**	**1**	**0**
Ephemeroptera taxa richness	> 5	5 - 4	3 – 2	< 2
Plecoptera taxa richness	> 3	3 - 2	1	0
Trichoptera taxa richness	> 4	4 - 3	2	< 2
Sensitive taxa richness	> 3	3 - 2	1	0
Percent filterers	0 – 5	5.01 - 10	10.01 – 25	> 25
Percent tolerant taxa	0 – 5	5.01 - 10	10.01 – 35	> 35

Table3a. Criteria for the assignment of use-support classifications / standards violation thresholds (Bukantis 1998).

% Comparability to reference	Use support
>75	Full support--standards not violated
25-75	Partial support--moderate impairment--standards violated
<25	Non-support--severe impairment--standards violated

Table3b. Criteria for the assignment of impairment classifications (Plafkin et al. 1989).

% Comparability to reference	Classification
> 83	nonimpaired
54-79	slightly impaired
21-50	moderately impaired
<17	severely impaired

2005 RESULTS

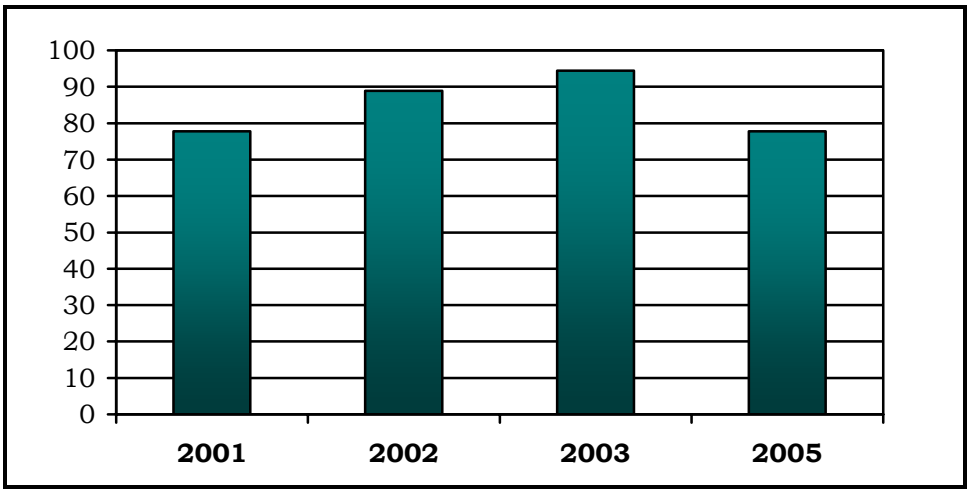
Metric indicators of water quality gave equivocal results for the benthic assemblage collected in 2005 at the Gallatin River site below the Taylor Fork confluence. Eight unique mayfly taxa were collected; this finding suggests good water quality. The biotic index value (4.27), however, was higher than expected, indicating a more tolerant assemblage than any collected in all previous years of sampling. There were other omens of diminished water quality. In all preceding years, the dominant taxon was relatively sensitive; in 2003, *Drunella coloradensis* dominated the assemblage; in 2002, it was *Glossosoma* sp., and in 2001, *Cinygmula* sp. In 2005, large numbers of the tolerant midge *Cladotanytarsus* sp. were taken, and the second most abundant animals were ceratopogonid gnats. Scrapers and shredders outnumbered gatherers in previous years, but in 2005 the opposite was observed. Richness and proportions of midges in 2005 were similar to those observed in 2002. In 2005, the number of cold stenotherm taxa in the sample was lower than in any previous year, and the proportion of cold stenotherms fell to 2% of sampled animals. Several sensitive taxa collected regularly throughout the years of sampling were not collected in 2005; these included *Caudatella* sp., *Pteronarcys princeps*, and *Rhyacophila coloradensis*. These findings suggest that thermal conditions were different in 2005, compared to most previous years. Warmer water, perhaps as a result of drought, might be indicated.

Eighteen "clinger" taxa and 6 caddisfly taxa were collected in 2005. Clean stony substrates, free from appreciable sediment deposition probably characterized the site. Taxa richness stayed stable in the 4 years of sampling; high taxa diversity may be related to complex instream habitats. Stonefly taxa richness was somewhat lower than expected; richness in this group may be associated with streambank stability and riparian zone integrity. However, warmer water temperatures may have excluded some stonefly taxa. Dewatering, scouring sediment pulses, or toxic pollutants seem unlikely, since the site supported at least 4 semivoltine taxa. The long life cycles of these animals would probably be interrupted by catastrophic events such as those. All expected functional groups were present.

Table 4. The revised bioassessment index (Bollman 1998) and individual metrics and scores for 4 years of sampling.

	Gallatin River downstream of Taylor Fork confluence			
	2001	**2002**	**2003**	**2005**
METRICS	**METRIC VALUES**			
Ephemeroptera richness	10	5	9	8
Plecoptera richness	3	6	6	3
Trichoptera richness	5	9	5	6
Number of sensitive taxa	6	6	6	4
Percent filterers	22.68	5.88	1.89	6.27
Percent tolerant taxa	6.56	2.94	8.20	19.75
	METRIC SCORES			
Ephemeroptera richness	3	2	3	3
Plecoptera richness	2	3	3	2
Trichoptera richness	3	3	3	3
Number of sensitive taxa	3	3	3	3
Percent filterers	1	2	3	2
Percent tolerant taxa	2	3	2	21
TOTAL SCORE (max.=18)	14	16	17	14
PERCENT OF MAX.	**77.8**	**88.9**	**94.4**	**77.8**
Impairment classification*	**SLI**	**NON**	**NON**	**SLI**
USE SUPPORT †	**FULL**	**FULL**	**FULL**	**FULL**

Figure 1. Total bioassessment score (as percent of maximum) comparisons for the Gallatin River downstream of the Taylor Fork confluence. 2001 – 2005.



Below the Porcupine Creek trailhead, the invertebrate assemblage collected from the Gallatin River was much more tolerant (biotic index = 5.02) than expected for a montane river. Similar to the Taylor Fork confluence site, midges in several moderately tolerant genera dominated the sampled assemblage. Immature *Eukiefferiella* spp. and *Rheotanytarsus* sp. were the most abundant animals in the collection. Cold stenotherm taxa were numerous at the site in preceding years, but a single such taxon, *Caudatella heterocaudata*, was collected in 2005. These mayflies accounted for 2.5% of animals; cold stenotherms in previous years' samples were significantly more abundant.

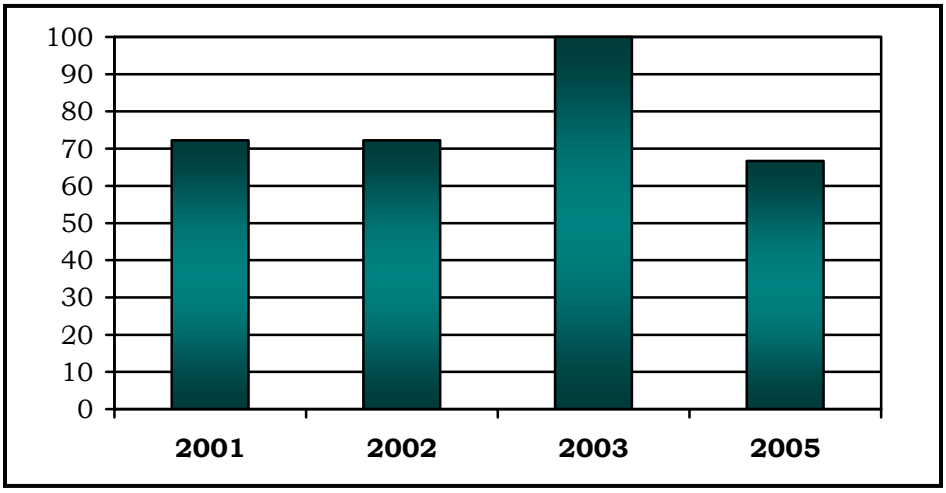
Table 5. The revised bioassessment index (Bollman 1998) and individual metrics and scores for 4 years of sampling.

	Gallatin River below Porcupine Creek trailhead			
	2001	**2002**	**2003**	**2005**
METRICS	**METRIC VALUES**			
Ephemeroptera richness	11	5	8	6
Plecoptera richness	2	3	6	1
Trichoptera richness	7	8	5	7
Number of sensitive taxa	6	6	5	2
Percent filterers	25.63	8.97	1.90	25.62
Percent tolerant taxa	5.31	13.29	1.63	3.09
	METRIC SCORES			
Ephemeroptera richness	3	2	3	3
Plecoptera richness	2	2	3	1
Trichoptera richness	3	3	3	3
Number of sensitive taxa	3	3	3	2
Percent filterers	0	2	3	0
Percent tolerant taxa	2	1	3	3
TOTAL SCORE (max.=18)	13	13	18	12
PERCENT OF MAX.	**72.2**	**72.2**	**100.0**	**66.7**
Impairment classification*	**SLI**	**SLI**	**NON**	**SLI**
USE SUPPORT †	**PART**	**PART**	**FULL**	**PART**

Gatherers dominated the functional mix, unlike earlier years. Warmer-than-expected water temperatures are consistent with these findings; drought and low flow could account for the different thermal regime apparent in 2005.

Deposited sediment apparently did not appreciably limit access to stony substrate habitats here, since the site supported at least 17 "clinger" taxa and 7 caddisfly taxa. Overall taxa richness (31) was high; instream habitats were probably diverse and undisrupted. Low flow and warmer water temperatures could explain the dearth of stonefly taxa. Three semivoltine taxa were collected; it seems unlikely that dewatering recently affected the site. Scrapers were notably rare, but all expected functional groups were present in the sample.

Figure 2. Total bioassessment score (as percent of maximum) comparisons for the Gallatin River downstream of the Porcupine Creek trailhead. 2001 – 2005.



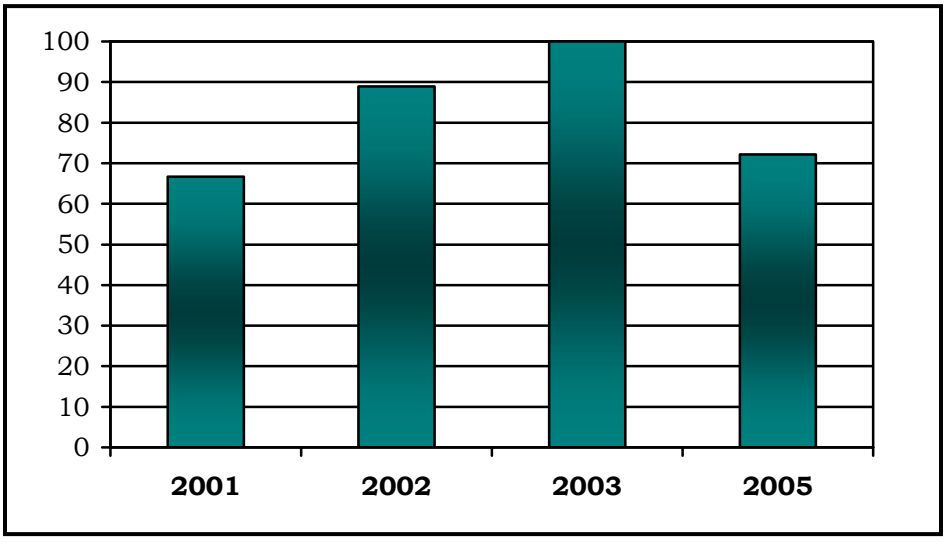
Loss of cold stenotherm diversity between 2003 and 2005 is noted at the Gallatin River site downstream of the Dudley Creek confluence. The proportion of these animals in the sampled assemblage did not change much in those years (3.36% in 2003, 2.76% in 2005). The dominant taxon, *Orthocladius* sp., could indicate that filamentous algae accounted for an important habitat space. Eight mayfly taxa were collected, but the biotic index value (3.84) suggests that the invertebrate assemblage was slightly more tolerant than expected. The biotic index value was influenced by the abundance of moderately tolerant midge taxa; chironomids overwhelmed the sampled assemblage. Although these findings are non-specific and even equivocal, it seems likely that slight nutrient enrichment may affect water quality. A warmer thermal regime, compared to upstream sites, may also influence the invertebrate assemblage here.

Seven caddisfly taxa and 15 "clinger" taxa were present in the collection, suggesting that stony substrate habitats were free from appreciable sediment deposition. Overall taxa richness (30) was marginal; although similar to that encountered at this site in 2003, diversity has apparently diminished at this site since 2001. Instream habitat disruption or changes in water quality, flow conditions, or thermal regime could account for these changes. Not a single stonefly was found in the sample; these animals may have been excluded by water quality conditions or thermal influences, but loss of this group may also be associated with disruption of reach-scale habitat features. Unstable streambanks, loss of riparian vegetation, or altered channel morphology may be implicated. Three less-mobile semivoltine taxa were counted. It seems unlikely that catastrophic dewatering affected the biota at this site. Gatherers, mostly midges, overwhelmed the functional composition of the benthic community. This finding is consistent with mild degradation of water quality.

Table 6. The revised bioassessment index (Bollman 1998) and individual metrics and scores for 4 years of sampling.

	Gallatin River downstream of Dudley Creek confluence			
	2001	**2002**	**2003**	**2005**
METRICS	**METRIC VALUES**			
Ephemeroptera richness	10	8	10	8
Plecoptera richness	5	4	4	0
Trichoptera richness	5	9	6	7
Number of sensitive taxa	3	9	5	2
Percent filterers	25.34	13.47	1.53	4.29
Percent tolerant taxa	20.95	0.00	1.53	9.20
	METRIC SCORES			
Ephemeroptera richness	3	3	3	3
Plecoptera richness	3	3	3	0
Trichoptera richness	3	3	3	3
Number of sensitive taxa	2	3	3	2
Percent filterers	0	1	3	3
Percent tolerant taxa	1	3	3	2
TOTAL SCORE (max.=18)	12	16	18	13
PERCENT OF MAX.	**66.7**	**88.9**	**100.0**	**72.2**
Impairment classification*	**SLI**	**NON**	**NON**	**SLI**
USE SUPPORT †	**PART**	**FULL**	**FULL**	**PART**

Figure 3. Total bioassessment score (as percent of maximum) comparisons for the Gallatin River downstream of Dudley Creek. 2001 – 2005.



Like the other 3 sites sampled in 2005, the West Fork Gallatin River site yielded a benthic assemblage that was more tolerant than expected. The biotic index value for this collection was 5.71; this value is elevated compared both to values typical of montane rivers, and to the historic values calculated for samples from this site. The assemblage was overwhelmed by midges, especially by immature specimens of *Eukiefferiella* spp. The shift from dominance by enchytraeid worms, observed in 2003, to dominance by moderately tolerant midges in 2005 may be related to warmer water

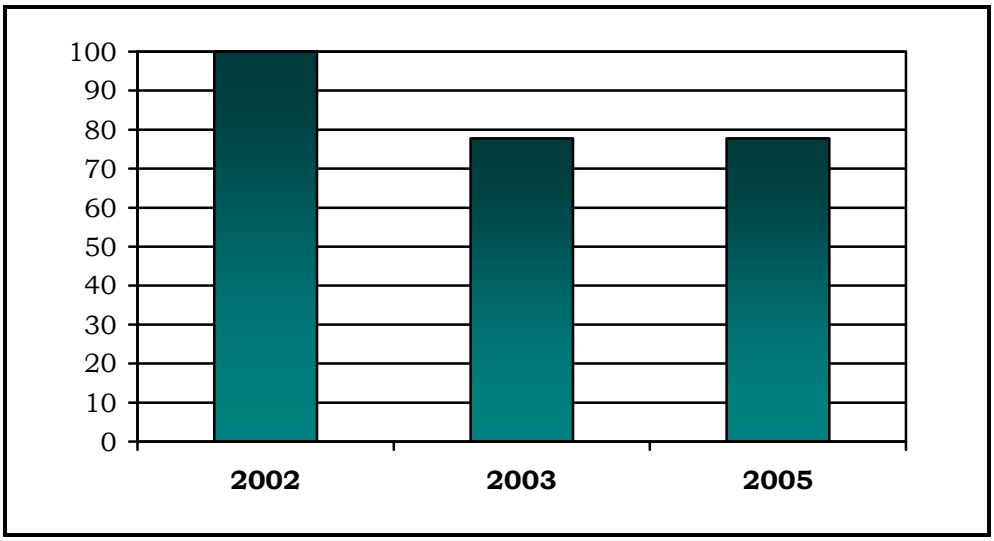
temperatures or to mild nutrient enrichment, but other signals of pollution are not clearly discernible in the composition of the sampled assemblage. The site supported at least 7 mayfly taxa, suggesting that water quality was good. It seems likely that the site shared the general increase in water temperature that was apparently indicated at all other sampled sites in 2005.

Sediment deposition probably did not significantly influence the benthic assemblage, since 7 caddisfly taxa and 15 "clinger" taxa were taken in the sample. These findings suggest that stony substrate habitats were clean and available. Overall taxa richness (29) was similar to that observed in 2003, and is lower than expected for a montane river. Monotonous instream habitats may be indicated. No stoneflies were collected; this group may have been excluded by water quality or thermal conditions, but their absence could be related to disruption of reach-scale habitat features such as streambanks, riparian zones, or channel morphological elements. Dewatering or other catastrophes probably were not among recent events here, since the site supported at least 3 semivoltine taxa. Gatherers, mostly among the midges, overwhelmed the functional composition of the assemblage. Shredders were conspicuously absent. Lack of riparian inputs of large organic material or hydrologic conditions that did not favor retention of such material may account for the dearth of shredders.

Table 7. The revised bioassessment index (Bollman 1998) and individual metrics and scores for 3 years of sampling.

	West Fork Gallatin River		
	2002	**2003**	**2005**
METRICS	**METRIC VALUES**		
Ephemeroptera richness	8	6	7
Plecoptera richness	4	2	0
Trichoptera richness	7	2	7
Number of sensitive taxa	6	2	2
Percent filterers	2.59	0.67	1.26
Percent tolerant taxa	1.29	2.36	3.77
	METRIC SCORES		
Ephemeroptera richness	3	3	3
Plecoptera richness	3	2	0
Trichoptera richness	3	1	3
Number of sensitive taxa	3	2	2
Percent filterers	3	3	3
Percent tolerant taxa	3	3	3
TOTAL SCORE (max.=18)	18	14	14
PERCENT OF MAX.	**100.0**	**77.8**	**77.8**
Impairment classification*	**NON**	**SLI**	**SLI**
USE SUPPORT †	**FULL**	**FULL**	**FULL**

Figure 4. Total bioassessment score (as percent of maximum) comparisons for the West Fork Gallatin River. 2002 – 2005.



CONCLUSIONS

- All 4 sites sampled in 2005 appear to exhibit changes in water temperature compared to conditions in 2003. Low flow conditions could account for the observed changes in the composition of benthic assemblages and in metric and index performance at these sites.
- When the revised bioassessment method is applied to the invertebrate data, results indicate that all sites were slightly impaired. Two sites (the Gallatin River site below Taylor Fork and the West Fork Gallatin River site) fully supported aquatic life uses; the other 2 sites were partly supportive of uses.

LITERATURE CITED

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.

Barbour, M.T., J.B. Stribling and J.R. Karr. 1995. Multimetric approach for establishing biocriteria and measuring biological condition. Pages 63-79 in W.S. Davis and T.P. Simon (editors) *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making.* Lewis Publishers, Boca Raton.

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

Bollman, W. 1998b. Unpublished data generated by state-wide sampling and data analysis; 1993-1998.

Bukantis, R. 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.

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.

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

Hynes, H.B.N. 1970. *The Ecology of Running Waters.* The University of Toronto Press. Toronto.

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. Unpublished Master's Thesis. University of Washington, Seattle, Washington.

Patterson, A.J. 1996. The effect of recreation on biotic integrity of small streams in Grand Teton National Park. Master's Thesis. University of Washington, Seattle, Washington.

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.

Rossano, E.M. 1995. Development of an index of biological integrity for Japanese streams (IBI-J). Master's Thesis. University of Washington, Seattle, Washington.

Wisseman, R.W. 1992. Montana rapid bioassessment protocols. Benthic invertebrate studies, 1990. Montana Reference Streams study. Report to the Montana Department of Environmental Quality. Water Quality Bureau. Helena, Montana.

Woods, A.J., Omernik, J. M. Nesser, J.A., Shelden, J., and Azevedo, S. H. 1999. Ecoregions of Montana. (Color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia. US Geological Sur.

APPENDIX

Gallatin River watershed

Taxonomic data and metric summaries

July 2005

Taxa Listing

Project ID: BWTF05GR
RAI No.: BWTF05GR001

RAI No.: BWTF05GR001
Client ID: GTF0705
Date Coll.: 7/7/2005 **No. Jars:** 1
Sta. Name: GALLATIN RIVER BELOW TAYLOR FORK CONFLUENCE
STORET ID:

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Non-Insect							
Acari	9	2.82%	Yes	Unknown		5	PR
Ephemeroptera							
Baetidae							
Acentrella sp.	2	0.63%	Yes	Larva		4	CG
Baetis sp.	2	0.63%	No	Larva	Damaged	5	CG
Baetis tricaudatus	24	7.52%	Yes	Larva		4	CG
Ephemerellidae							
Drunella coloradensis	13	4.08%	Yes	Larva		0	PR
Drunella doddsi	5	1.57%	Yes	Larva		1	PR
Ephemerella sp.	1	0.31%	No	Larva	Damaged	1.5	SC
Ephemerella inermis	13	4.08%	Yes	Larva		4	SH
Ephemerellidae	4	1.25%	Yes	Larva	Early Instar	1	CG
Heptageniidae							
Cinygmula sp.	34	10.66%	Yes	Larva		0	SC
Epeorus sp.	5	1.57%	No	Larva	Early Instar	2	CG
Epeorus longimanus	7	2.19%	Yes	Larva		1	SC
Plecoptera							
Chloroperlidae							
Suwallia sp.	1	0.31%	Yes	Larva		1	PR
Perlidae							
Hesperoperla pacifica	3	0.94%	Yes	Larva		1	PR
Pteronarcyidae							
Pteronarcyidae	1	0.31%	No	Larva	Early Instar	2	SH
Pteronarcys californica	1	0.31%	Yes	Larva		2	SH
Trichoptera							
Apataniidae							
Apatania sp.	1	0.31%	Yes	Larva		3	SC
Brachycentridae							
Amiocentrus aspilus	2	0.63%	Yes	Larva		3	CG
Brachycentrus americanus	2	0.63%	Yes	Larva		1	CF
Glossosomatidae							
Glossosoma sp.	7	2.19%	Yes	Larva		0	SC
Hydropsychidae							
Hydropsyche sp.	1	0.31%	Yes	Larva		5	CF
Lepidostomatidae							
Lepidostoma sp.	2	0.63%	Yes	Larva		1	SH
Coleoptera							
Elmidae							
Optioservus sp.	2	0.63%	No	Larva		5	SC
Optioservus sp.	4	1.25%	Yes	Adult		5	SC

Taxa Listing

Project ID: BWTF05GR
RAI No.: BWTF05GR001

RAI No.: BWTF05GR001
Client ID: GTF0705
Date Coll.: 7/7/2005 **No. Jars:** 1
Sta. Name: GALLATIN RIVER BELOW TAYLOR FORK CONFLUENCE
STORET ID:

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Diptera							
Athericidae							
Atherix sp.	16	5.02%	Yes	Larva		5	PR
Blephariceridae							
Blephariceridae	1	0.31%	Yes	Pupa		0	SC
Ceratopogonidae							
Ceratopogoninae	36	11.29%	Yes	Larva		6	PR
Simuliidae							
Simuliidae	1	0.31%	No	Pupa		6	CF
Simulium sp.	7	2.19%	Yes	Larva		6	CF
Tipulidae							
Antocha sp.	1	0.31%	Yes	Larva		3	CG
Hexatoma sp.	1	0.31%	Yes	Larva		2	PR
Chironomidae							
Chironomidae							
Cladotanytarsus sp.	41	12.85%	Yes	Larva		7	CG
Cricotopus bicinctus	1	0.31%	Yes	Larva		7	SH
Diamesa sp.	1	0.31%	Yes	Larva		5	CG
Eukiefferiella sp.	17	5.33%	Yes	Larva		8	CG
Orthocladiinae	8	2.51%	No	Larva	Early Instar	6	CG
Orthocladius sp.	26	8.15%	Yes	Larva		6	CG
Pagastia sp.	2	0.63%	Yes	Larva		1	CG
Parakiefferiella sp.	1	0.31%	Yes	Larva		6	CG
Paratanytarsus sp.	1	0.31%	Yes	Larva		6	CG
Potthastia sp.	1	0.31%	Yes	Larva		2	CG
Rheotanytarsus sp.	9	2.82%	Yes	Larva		6	CF
Stempellinella sp.	1	0.31%	Yes	Larva		4	CG
Thienemanniella sp.	1	0.31%	Yes	Larva		6	CG
Sample Count	**319**						

Taxa Listing

Project ID: BWTF05GR
RAI No.: BWTF05GR002

RAI No.: BWTF05GR002
Client ID: GPORC0705
Date Coll.: 7/8/2005 **No. Jars:** 1
Sta. Name: GALLATIN RIVER BELOW PORCUPINE CREEK TRAILHEAD
STORET ID:

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Non-Insect							
Enchytraeidae							
Enchytraeidae	1	0.31%	Yes	Unknown		4	CG
Ephemeroptera							
Baetidae							
Baetis sp.	8	2.47%	No	Larva	Early Instar	5	CG
Baetis tricaudatus	16	4.94%	Yes	Larva		4	CG
Ephemerellidae							
Caudatella heterocaudata	8	2.47%	Yes	Larva		0	CG
Drunella coloradensis	25	7.72%	Yes	Larva		0	PR
Ephemerella inermis	12	3.70%	Yes	Larva		4	SH
Serratella tibialis	8	2.47%	Yes	Larva		2	CG
Heptageniidae							
Cinygmula sp.	1	0.31%	Yes	Larva		0	SC
Plecoptera							
Perlidae							
Hesperoperla pacifica	2	0.62%	Yes	Larva		1	PR
Trichoptera							
Brachycentridae							
Amiocentrus aspilus	5	1.54%	Yes	Larva		3	CG
Brachycentridae	1	0.31%	No	Pupa		1	CG
Brachycentrus americanus	22	6.79%	Yes	Larva		1	CF
Micrasema sp.	1	0.31%	Yes	Larva		1	SH
Glossosomatidae							
Glossosoma sp.	1	0.31%	Yes	Larva		0	SC
Glossosomatidae	1	0.31%	No	Pupa		0	SC
Hydropsychidae							
Hydropsyche sp.	2	0.62%	Yes	Larva		5	CF
Hydropsychidae	1	0.31%	No	Pupa		4	CF
Lepidostomatidae							
Lepidostoma sp.	3	0.93%	Yes	Larva		1	SH
Rhyacophilidae							
Rhyacophila Coloradensis Gr.	1	0.31%	Yes	Larva		0	PR
Coleoptera							
Elmidae							
Optioservus sp.	1	0.31%	Yes	Larva		5	SC

Taxa Listing

Project ID: BWTF05GR
RAI No.: BWTF05GR002

RAI No.: BWTF05GR002
Client ID: GPORC0705
Date Coll.: 7/8/2005 **No. Jars:** 1
Sta. Name: GALLATIN RIVER BELOW PORCUPINE CREEK TRAILHEAD
STORET ID:

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Diptera							
Athericidae							
Atherix sp.	3	0.93%	Yes	Larva		5	PR
Empididae							
Empididae	1	0.31%	No	Pupa		6	PR
Neoplasta sp.	1	0.31%	Yes	Larva		5	PR
Simuliidae							
Simulium sp.	15	4.63%	Yes	Larva		6	CF
Tipulidae							
Antocha sp.	5	1.54%	Yes	Larva		3	CG
Antocha sp.	2	0.62%	No	Pupa		3	CG
Hexatoma sp.	1	0.31%	Yes	Larva		2	PR
Chironomidae							
Chironomidae							
Chironomidae	4	1.23%	No	Pupa		10	CG
Cladotanytarsus sp.	6	1.85%	Yes	Larva		7	CG
Cricotopus sp.	13	4.01%	Yes	Larva		7	SH
Eukiefferiella sp.	90	27.78%	Yes	Larva		8	CG
Orthocladiinae	10	3.09%	No	Larva	Early Instar	6	CG
Orthocladius sp.	5	1.54%	Yes	Larva		6	CG
Pagastia sp.	1	0.31%	Yes	Larva		1	CG
Potthastia sp.	3	0.93%	Yes	Larva		2	CG
Rheotanytarsus sp.	17	5.25%	Yes	Larva		6	CF
Rheotanytarsus sp.	24	7.41%	Yes	Larva		6	CF
Sublettea sp.	2	0.62%	Yes	Larva		6	CF
Tvetenia sp.	1	0.31%	Yes	Larva		5	CG
Sample Count	**324**						

Taxa Listing

Project ID: BWTF05GR
RAI No.: BWTF05GR003

RAI No.: BWTF05GR003
Client ID: GDUD0705
Date Coll.: 7/8/2005 **No. Jars:** 1
Sta. Name: GALLATIN RIVER D/S DUDLEY CK CONFLUENCE U/S OF JACK SMITH BRIDGE
STORET ID:

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Non-Insect							
Nematoda	1	0.31%	Yes	Unknown		5	PA
Pisidiidae							
Pisidiidae	1	0.31%	Yes	Unknown		8	CG
Ephemeroptera							
Ameletidae							
Ameletus sp.	1	0.31%	Yes	Larva		0	CG
Baetidae							
Baetis tricaudatus	16	4.91%	Yes	Larva		4	CG
Ephemerellidae							
Drunella coloradensis	10	3.07%	Yes	Larva		0	PR
Drunella grandis	2	0.61%	Yes	Larva		2	SC
Ephemerella inermis	4	1.23%	Yes	Larva		4	SH
Serratella tibialis	6	1.84%	Yes	Larva		2	CG
Heptageniidae							
Cinygmula sp.	63	19.33%	Yes	Larva		0	SC
Epeorus sp.	1	0.31%	No	Larva	Early Instar	2	CG
Epeorus albertae	3	0.92%	Yes	Larva		2	SC
Trichoptera							
Brachycentridae							
Brachycentrus americanus	1	0.31%	Yes	Larva		1	CF
Brachycentrus occidentalis	6	1.84%	Yes	Larva		2	CF
Glossosomatidae							
Glossosoma sp.	3	0.92%	Yes	Larva		0	SC
Hydropsychidae							
Arctopsyche grandis	1	0.31%	Yes	Larva		2	PR
Hydropsyche sp.	1	0.31%	Yes	Larva		5	CF
Lepidostomatidae							
Lepidostoma sp.	10	3.07%	Yes	Larva		1	SH
Uenoidae							
Neophylax occidentis	9	2.76%	Yes	Larva		3	SC
Diptera							
Ceratopogonidae							
Ceratopogoninae	2	0.61%	Yes	Larva		6	PR
Empididae							
Empididae	1	0.31%	Yes	Pupa		6	PR
Simuliidae							
Simulium sp.	2	0.61%	Yes	Larva		6	CF
Tipulidae							
Antocha sp.	1	0.31%	Yes	Larva		3	CG
Hexatoma sp.	2	0.61%	Yes	Larva		2	PR

Taxa Listing

Project ID: BWTF05GR
RAI No.: BWTF05GR003

RAI No.: BWTF05GR003
Client ID: GDUD0705
Date Coll.: 7/8/2005 **No. Jars:** 1
Sta. Name: GALLATIN RIVER D/S DUDLEY CK CONFLUENCE U/S OF JACK SMITH BRIDGE
STORET ID:

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Chironomidae							
Chironomidae							
Chironomidae	13	3.99%	No	Pupa		10	CG
Cladotanytarsus sp.	30	9.20%	Yes	Larva		7	CG
Diamesa sp.	1	0.31%	Yes	Larva		5	CG
Eukiefferiella sp.	8	2.45%	Yes	Larva	Early Instar	8	CG
Eukiefferiella Gracei Gr.	1	0.31%	Yes	Larva		8	CG
Orthocladiinae	23	7.06%	No	Larva	Early Instar	6	CG
Orthocladius sp.	65	19.94%	Yes	Larva		6	CG
Potthastia sp.	33	10.12%	Yes	Larva		2	CG
Rheotanytarsus sp.	4	1.23%	Yes	Larva		6	CF
Thienemannimyia Gr.	1	0.31%	Yes	Larva		5	PR
Sample Count	**326**						

Taxa Listing

Project ID: BWTF05GR
RAI No.: BWTF05GR004

RAI No.: BWTF05GR004 **Sta. Name:** WEST FORK U/S OF SPUR ROAD BRIDGE
Client ID: WF0705
Date Coll.: 7/8/2005 **No. Jars:** 1 **STORET ID:**

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Non-Insect							
Acari	3	0.94%	Yes	Unknown		5	PR
Turbellaria	1	0.31%	Yes	Unknown		4	PR
Enchytraeidae							
Enchytraeidae	3	0.94%	Yes	Unknown		4	CG
Ephemeroptera							
Baetidae							
Acentrella sp.	1	0.31%	Yes	Larva		4	CG
Baetis sp.	1	0.31%	No	Larva	Damaged	5	CG
Baetis tricaudatus	8	2.52%	Yes	Larva		4	CG
Ephemerellidae							
Caudatella heterocaudata	3	0.94%	Yes	Larva		0	CG
Drunella coloradensis	27	8.49%	Yes	Larva		0	PR
Serratella tibialis	3	0.94%	Yes	Larva		2	CG
Heptageniidae							
Cinygmula sp.	2	0.63%	Yes	Larva		0	SC
Epeorus longimanus	1	0.31%	Yes	Larva		1	SC
Trichoptera							
Brachycentridae							
Amiocentrus aspilus	3	0.94%	Yes	Larva		3	CG
Micrasema sp.	1	0.31%	Yes	Larva		1	SH
Glossosomatidae							
Glossosoma sp.	2	0.63%	Yes	Larva		0	SC
Hydropsychidae							
Arctopsyche grandis	1	0.31%	Yes	Larva		2	PR
Lepidostomatidae							
Lepidostoma sp.	1	0.31%	Yes	Larva		1	SH
Rhyacophilidae							
Rhyacophila Coloradensis Gr.	1	0.31%	Yes	Larva		0	PR
Uenoidae							
Neophylax occidentis	3	0.94%	Yes	Larva		3	SC
Coleoptera							
Elmidae							
Heterlimnius sp.	1	0.31%	Yes	Larva		3	CG
Optioservus sp.	1	0.31%	Yes	Adult		5	SC
Optioservus sp.	2	0.63%	No	Larva		5	SC
Diptera							
Athericidae							
Atherix sp.	3	0.94%	Yes	Larva		5	PR
Tipulidae							
Antocha sp.	3	0.94%	Yes	Larva		3	CG

Taxa Listing

Project ID: BWTF05GR
RAI No.: BWTF05GR004

RAI No.: BWTF05GR004 **Sta. Name:** WEST FORK U/S OF SPUR ROAD BRIDGE
Client ID: WF0705
Date Coll.: 7/8/2005 **No. Jars:** 1 **STORET ID:**

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Chironomidae							
Chironomidae							
Chironomidae	9	2.83%	No	Pupa		10	CG
Cladotanytarsus sp.	6	1.89%	Yes	Larva		7	CG
Corynoneura sp.	1	0.31%	Yes	Larva		7	CG
Eukiefferiella sp.	117	36.79%	Yes	Larva		8	CG
Orthocladiinae	11	3.46%	No	Larva	Early Instar	6	CG
Orthocladius sp.	80	25.16%	Yes	Larva		6	CG
Pagastia sp.	3	0.94%	Yes	Larva		1	CG
Potthastia sp.	12	3.77%	Yes	Larva		2	CG
Rheotanytarsus sp.	2	0.63%	Yes	Larva		6	CF
Sublettea sp.	2	0.63%	Yes	Larva		6	CF
Sample Count	**318**						

Metrics Report

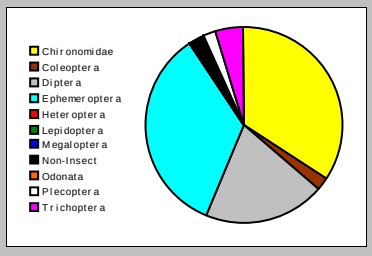
Project ID: BWTF05GR
RAI No.: BWTF05GR001
Sta. Name: GALLATIN RIVER BELOW TAYLOR FORK CONFLUENCE
Client ID: GTF0705
STORET ID
Coll. Date: 7/7/2005

Abundance Measures

Sample Count:	319	
Sample Abundance:	1,234.84	25.83% of sample used
Total Abundance:	1,660.86	
Coll. Procedure:		
Sample Notes:		

Taxonomic Composition

Category	R	A	PRA
Non-Insect	1	9	2.82%
Odonata			
Ephemeroptera	8	110	34.48%
Plecoptera	3	6	1.88%
Heteroptera			
Megaloptera			
Trichoptera	6	15	4.70%
Lepidoptera			
Coleoptera	1	6	1.88%
Diptera	6	63	19.75%
Chironomidae	12	110	34.48%

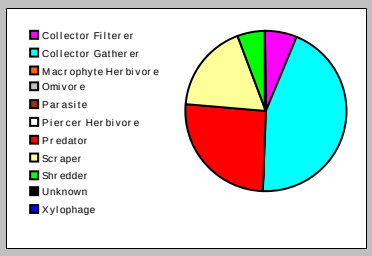


Dominant Taxa

Category	A	PRA
Cladotanytarsus	41	12.85%
Ceratopogoninae	36	11.29%
Cinygmula	34	10.66%
Orthocladius	26	8.15%
Baetis tricaudatus	24	7.52%
Eukiefferiella	17	5.33%
Atherix	16	5.02%
Ephemerella inermis	13	4.08%
Drunella coloradensis	13	4.08%
Rheotanytarsus	9	2.82%
Acari	9	2.82%
Orthocladiinae	8	2.51%
Simulium	7	2.19%
Glossosoma	7	2.19%
Epeorus longimanus	7	2.19%

Functional Composition

Category	R	A	PRA
Predator	8	84	26.33%
Parasite			
Collector Gatherer	15	140	43.89%
Collector Filterer	4	20	6.27%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	6	57	17.87%
Shredder	4	18	5.64%
Omivore			
Unknown			

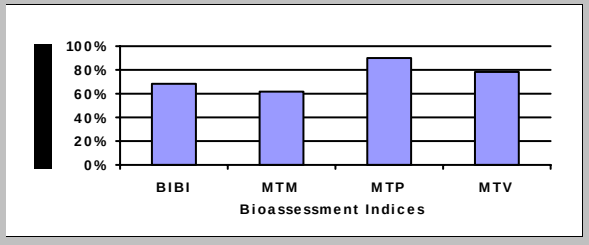


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	37	3	3		3
Non-Insect Percent	2.82%				
E Richness	8	3		3	
P Richness	3	1		2	
T Richness	6	3		3	
EPT Richness	17		3		2
EPT Percent	41.07%		2		1
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.255				
Hydropsychidae/Trichoptera	0.067				
Dominance					
Dominant Taxon Percent	12.85%		3		3
Dominant Taxa (2) Percent	24.14%				
Dominant Taxa (3) Percent	34.80%	5			
Dominant Taxa (10) Percent	71.79%				
Diversity					
Shannon H (loge)	2.921				
Shannon H (log2)	4.214		3		
Margalef D	6.315				
Simpson D	0.072				
Evenness	0.049				
Function					
Predator Richness	8		3		
Predator Percent	26.33%	5			
Filterer Richness	4				
Filterer Percent	6.27%			2	
Collector Percent	50.16%		3		3
Scraper+Shredder Percent	23.51%		2		0
Scraper/Filterer	2.850				
Scraper/Scraper+Filterer	0.740				
Habit					
Burrower Richness	2				
Burrower Percent	11.60%				
Swimmer Richness	2				
Swimmer Percent	8.78%				
Clinger Richness	18	3			
Clinger Percent	38.56%				
Characteristics					
Cold Stenotherm Richness	3				
Cold Stenotherm Percent	2.19%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	2				
Air Breather Percent	0.63%				
Voltinism					
Univoltine Richness	18				
Semivoltine Richness	4	3			
Multivoltine Percent	46.08%		2		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	0.63%				
Sediment Sensitive Richness	1				
Sediment Sensitive Percent	2.19%				
Metals Tolerance Index	3.377				
Pollution Sensitive Richness	4	5		3	
Pollution Tolerant Percent	19.75%	3		1	
Hilsenhoff Biotic Index	4.271		3		1
Intolerant Percent	28.53%				
Supertolerant Percent	5.33%				
CTQa	65.125				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	34	68.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	27	90.00%	None
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	14	77.78%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	13	61.90%	Slight



Metrics Report

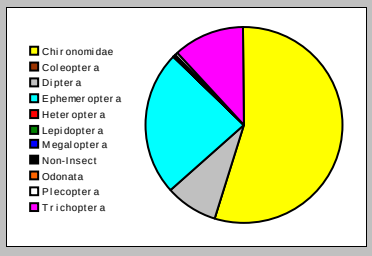
Project ID: BWTF05GR
RAI No.: BWTF05GR002
Sta. Name: GALLATIN RIVER BELOW PORCUPINE CREEK TRAILHEAD
Client ID: GPORC0705
STORET ID
Coll. Date: 7/8/2005

Abundance Measures

Sample Count: 324
Sample Abundance: 2,160.00 15.00% of sample used
Total Abundance: 2,905.20
Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	1	1	0.31%
Odonata			
Ephemeroptera	6	78	24.07%
Plecoptera	1	2	0.62%
Heteroptera			
Megaloptera			
Trichoptera	7	38	11.73%
Lepidoptera			
Coleoptera	1	1	0.31%
Diptera	5	28	8.64%
Chironomidae	10	176	54.32%

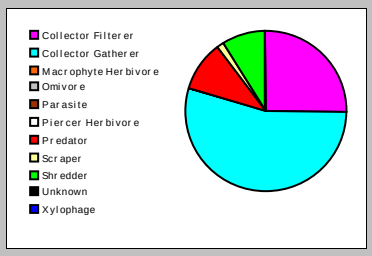


Dominant Taxa

Category	A	PRA
Eukiefferiella	90	27.78%
Rheotanytarsus	41	12.65%
Drunella coloradensis	25	7.72%
Brachycentrus americanus	22	6.79%
Baetis tricaudatus	16	4.94%
Simulium	15	4.63%
Cricotopus	13	4.01%
Ephemerella inermis	12	3.70%
Orthocladiinae	10	3.09%
Serratella tibialis	8	2.47%
Caudatella heterocaudata	8	2.47%
Baetis	8	2.47%
Antocha	7	2.16%
Cladotanytarsus	6	1.85%
Amiocentrus aspilus	5	1.54%

Functional Composition

Category	R	A	PRA
Predator	6	34	10.49%
Parasite			
Collector Gatherer	12	174	53.70%
Collector Filterer	6	83	25.62%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	3	4	1.23%
Shredder	4	29	8.95%
Omivore			
Unknown			

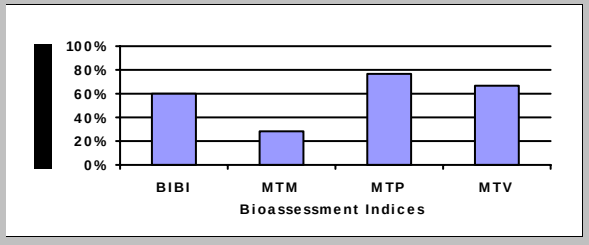


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	31	3	3		3
Non-Insect Percent	0.31%				
E Richness	6	3		3	
P Richness	1	1		1	
T Richness	7	3		3	
EPT Richness	14		3		0
EPT Percent	36.42%		2		0
Oligochaeta+Hirudinea Percent	0.31%				
Baetidae/Ephemeroptera	0.308				
Hydropsychidae/Trichoptera	0.079				
Dominance					
Dominant Taxon Percent	27.78%		3		2
Dominant Taxa (2) Percent	40.43%				
Dominant Taxa (3) Percent	48.15%	5			
Dominant Taxa (10) Percent	77.78%				
Diversity					
Shannon H (loge)	2.528				
Shannon H (log2)	3.647		3		
Margalef D	6.002				
Simpson D	0.124				
Evenness	0.075				
Function					
Predator Richness	6		3		
Predator Percent	10.49%	3			
Filterer Richness	6				
Filterer Percent	25.62%			0	
Collector Percent	79.32%		2		1
Scraper+Shredder Percent	10.19%		1		0
Scraper/Filterer	0.048				
Scraper/Scraper+Filterer	0.046				
Habit					
Burrower Richness	2				
Burrower Percent	0.62%				
Swimmer Richness	1				
Swimmer Percent	7.41%				
Clinger Richness	17	3			
Clinger Percent	51.23%				
Characteristics					
Cold Stenotherm Richness	1				
Cold Stenotherm Percent	2.47%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	2				
Air Breather Percent	2.47%				
Voltinism					
Univoltine Richness	17				
Semivoltine Richness	3	3			
Multivoltine Percent	61.73%		1		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	2.47%				
Sediment Sensitive Richness	1				
Sediment Sensitive Percent	0.31%				
Metals Tolerance Index	4.739				
Pollution Sensitive Richness	2	1		2	
Pollution Tolerant Percent	3.09%	5		3	
Hilsenhoff Biotic Index	5.022		2		0
Intolerant Percent	24.38%				
Supertolerant Percent	29.01%				
CTQa	67.643				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	30	60.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	23	76.67%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	12	66.67%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	6	28.57%	Moderate



Metrics Report

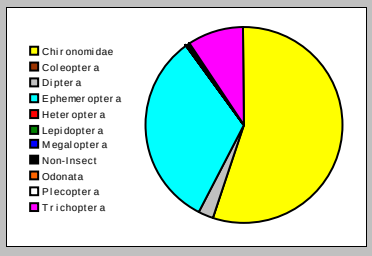
Project ID: BWTF05GR
RAI No.: BWTF05GR003
Sta. Name: GALLATIN RIVER D/S DUDLY CK CONFLUENCE U/S OF JACK SMITH BRIDGE
Client ID: GDUD0705
STORET ID
Coll. Date: 7/8/2005

Abundance Measures

Sample Count:	326	
Sample Abundance:	1,029.47	31.67% of sample used
Total Abundance:	1,384.64	
Coll. Procedure:		
Sample Notes:		

Taxonomic Composition

Category	R	A	PRA
Non-Insect	2	2	0.61%
Odonata			
Ephemeroptera	8	106	32.52%
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera	7	31	9.51%
Lepidoptera			
Coleoptera			
Diptera	5	8	2.45%
Chironomidae	8	179	54.91%

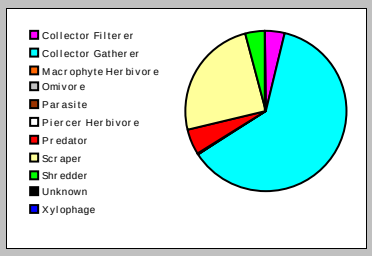


Dominant Taxa

Category	A	PRA
Orthocladius	65	19.94%
Cinygmula	63	19.33%
Potthastia	33	10.12%
Cladotanytarsus	30	9.20%
Orthocladiinae	23	7.06%
Baetis tricaudatus	16	4.91%
Chironomidae	13	3.99%
Lepidostoma	10	3.07%
Drunella coloradensis	10	3.07%
Neophylax occidentis	9	2.76%
Eukiefferiella	8	2.45%
Serratella tibialis	6	1.84%
Brachycentrus occidentalis	6	1.84%
Rheotanytarsus	4	1.23%
Ephemerella inermis	4	1.23%

Functional Composition

Category	R	A	PRA
Predator	6	17	5.21%
Parasite	1	1	0.31%
Collector Gatherer	11	200	61.35%
Collector Filterer	5	14	4.29%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	5	80	24.54%
Shredder	2	14	4.29%
Omivore			
Unknown			

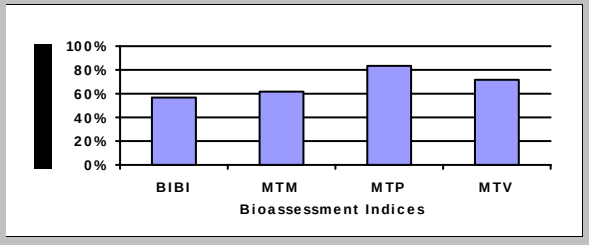


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	30	3	3		3
Non-Insect Percent	0.61%				
E Richness	8	3		3	
P Richness	0	1		0	
T Richness	7	3		3	
EPT Richness	15		3		1
EPT Percent	42.02%		2		1
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.151				
Hydropsychidae/Trichoptera	0.065				
Dominance					
Dominant Taxon Percent	19.94%		3		3
Dominant Taxa (2) Percent	39.26%				
Dominant Taxa (3) Percent	49.39%	5			
Dominant Taxa (10) Percent	83.44%				
Diversity					
Shannon H (loge)	2.478				
Shannon H (log2)	3.576		3		
Margalef D	5.118				
Simpson D	0.128				
Evenness	0.068				
Function					
Predator Richness	6		3		
Predator Percent	5.21%	1			
Filterer Richness	5				
Filterer Percent	4.29%			3	
Collector Percent	65.64%		2		2
Scraper+Shredder Percent	28.83%		2		1
Scraper/Filterer	5.714				
Scraper/Scraper+Filterer	0.851				
Habit					
Burrower Richness	2				
Burrower Percent	1.23%				
Swimmer Richness	2				
Swimmer Percent	5.21%				
Clinger Richness	15	3			
Clinger Percent	35.89%				
Characteristics					
Cold Stenotherm Richness	1				
Cold Stenotherm Percent	2.76%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	2				
Air Breather Percent	0.92%				
Voltinism					
Univoltine Richness	17				
Semivoltine Richness	3	3			
Multivoltine Percent	60.12%		1		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	0.92%				
Sediment Sensitive Richness	2				
Sediment Sensitive Percent	1.23%				
Metals Tolerance Index	3.054				
Pollution Sensitive Richness	2	1		2	
Pollution Tolerant Percent	9.20%	5		2	
Hilsenhoff Biotic Index	3.837		3		2
Intolerant Percent	43.56%				
Supertolerant Percent	7.06%				
CTQa	64.040				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	28	56.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	25	83.33%	None
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	13	72.22%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	13	61.90%	Slight



Wednesday, December 21, 2005

Metrics Report

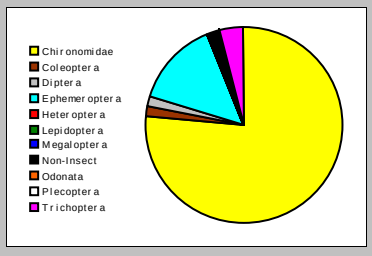
Project ID: BWTF05GR
RAI No.: BWTF05GR004
Sta. Name: WEST FORK U/S OF SPUR ROAD BRIDGE
Client ID: WF0705
STORET ID
Coll. Date: 7/8/2005

Abundance Measures

Sample Count:	318	
Sample Abundance:	2,120.00	15.00% of sample used
Total Abundance:	2,851.40	
Coll. Procedure:		
Sample Notes:		

Taxonomic Composition

Category	R	A	PRA
Non-Insect	3	7	2.20%
Odonata			
Ephemeroptera	7	46	14.47%
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera	7	12	3.77%
Lepidoptera			
Coleoptera	2	4	1.26%
Diptera	2	6	1.89%
Chironomidae	8	243	76.42%

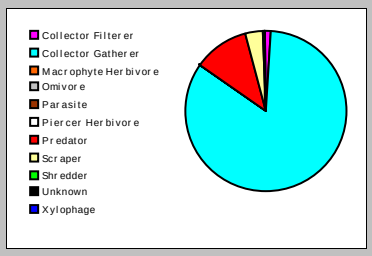


Dominant Taxa

Category	A	PRA
Eukiefferiella	117	36.79%
Orthocladius	80	25.16%
Drunella coloradensis	27	8.49%
Potthastia	12	3.77%
Orthocladiinae	11	3.46%
Chironomidae	9	2.83%
Baetis tricaudatus	8	2.52%
Cladotanytarsus	6	1.89%
Pagastia	3	0.94%
Optioservus	3	0.94%
Neophylax occidentis	3	0.94%
Enchytraeidae	3	0.94%
Antocha	3	0.94%
Amiocentrus aspilus	3	0.94%
Acari	3	0.94%

Functional Composition

Category	R	A	PRA
Predator	6	36	11.32%
Parasite			
Collector Gatherer	14	265	83.33%
Collector Filterer	2	4	1.26%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	5	11	3.46%
Shredder	2	2	0.63%
Omivore			
Unknown			

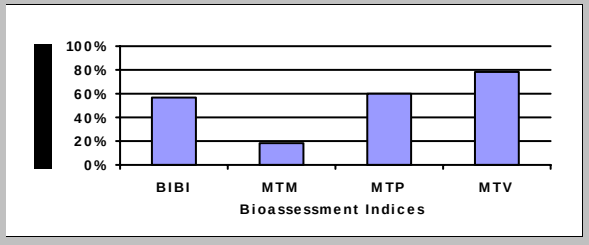


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	29	3	3		3
Non-Insect Percent	2.20%				
E Richness	7	3		3	
P Richness	0	1		0	
T Richness	7	3		3	
EPT Richness	14		3		0
EPT Percent	18.24%		1		0
Oligochaeta+Hirudinea Percent	0.94%				
Baetidae/Ephemeroptera	0.217				
Hydropsychidae/Trichoptera	0.083				
Dominance					
Dominant Taxon Percent	36.79%		2		1
Dominant Taxa (2) Percent	61.95%				
Dominant Taxa (3) Percent	70.44%	3			
Dominant Taxa (10) Percent	86.79%				
Diversity					
Shannon H (loge)	1.995				
Shannon H (log2)	2.878		2		
Margalef D	4.924				
Simpson D	0.241				
Evenness	0.082				
Function					
Predator Richness	6		3		
Predator Percent	11.32%	3			
Filterer Richness	2				
Filterer Percent	1.26%			3	
Collector Percent	84.59%		1		0
Scraper+Shredder Percent	4.09%		1		0
Scraper/Filterer	2.750				
Scraper/Scraper+Filterer	0.733				
Habit					
Burrower Richness	0				
Burrower Percent	0.00%				
Swimmer Richness	2				
Swimmer Percent	3.14%				
Clinger Richness	15	3			
Clinger Percent	17.61%				
Characteristics					
Cold Stenotherm Richness	2				
Cold Stenotherm Percent	1.89%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	1				
Air Breather Percent	0.94%				
Voltinism					
Univoltine Richness	14				
Semivoltine Richness	3	3			
Multivoltine Percent	80.82%		0		
Tolerance					
Sediment Tolerant Richness	1				
Sediment Tolerant Percent	0.94%				
Sediment Sensitive Richness	2				
Sediment Sensitive Percent	0.94%				
Metals Tolerance Index	5.795				
Pollution Sensitive Richness	2	1		2	
Pollution Tolerant Percent	3.77%	5		3	
Hilsenhoff Biotic Index	5.708		2		0
Intolerant Percent	17.92%				
Supertolerant Percent	39.62%				
CTQa	66.880				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	28	56.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	18	60.00%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	14	77.78%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	4	19.05%	Severe



Wednesday, December 21, 2005