FEB 20 2003

**BIOASSESSMENT AND HABITAT EVALUATION
OF
STREAMS NEAR ELLISTON, MONTANA**

Revision and Modification
of a Report Submitted in March, 1999

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July 1999

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INTRODUCTION

Benthic assemblages are aptly applied to aquatic bioassessment since they are known to be important indicators of stream ecosystem health (Hynes 1970). Their long lives, complex life cycles and limited mobility mean that there is ample time for these benthic organisms to respond to cumulative effects of environmental perturbations. Multimetric approaches to bioassessment use attributes of the assemblage in an integrated way to measure overall biotic condition.

The additive multimetric 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. 1995).

This report summarizes benthic macroinvertebrate and habitat data collected in August 1998 from streams near Elliston, Montana, using a multimetric method, an adaptation of the U.S. EPA's Rapid Bioassessment Protocols (RBP III) (Plafkin et al. 1989). The data is intended to provide baseline bioassessments against which future assessments can be compared.

METHODS

Benthic macroinvertebrate sampling was performed by personnel of the Montana Department of Environmental Quality (MT DEQ) on August 12, 13, 18 and 19. Samples were collected from reaches in four streams. For quality assurance purposes, sampling at three sites was replicated to provide an estimate of the variability inherent in the sampling and assessment methods. The twelve samples that comprise this study are identified below.

- Dog Creek, Reach 1 Site 1 (two replicates)
- Dog Creek, Reach 1 Site 2 (two replicates)
- Dog Creek, Reach 2 Site 1
- Dog Creek, Reach 2 Site 2
- Dog Creek, Reach 3 Site 1
- Elliston Creek, Reach 1 Site 1
- Elliston Creek, Reach 2 Site 1
- Woodson Gulch, Reach 2 Site 1
- Spotted Dog Creek, Reach 1 Site 1 (two replicates)

In addition to sample collection, habitat quality was visually evaluated at some sites and reported by means of the habitat assessment protocol recommended by Bukantis (1998).

Sample processing and data analyses were contracted to Rhithron Biological Associates. In the laboratory, the Rapid Bioassessment Protocol III (RBP III) (Plafkin et al. 1989) was used to obtain subsamples of 300 (+/- 10%) organisms from each sample. Community structure, function and sensitivity to impact were characterized for each

subsample using three methods, two which are prescribed by MT DEQ, and a third method, the results of which are set out in an addendum to this report. First, data were evaluated using the mountain ecoregions reference. In this approach, benthic communities were compared with reference criteria established by MT DEQ for streams of all three montane ecoregions of the State. The mountain ecoregions reference uses an integration of seven metrics to characterize biotic health. In the second approach, a composite internal reference for the streams of this study was assembled, and data from each stream is compared to that internal reference. The composite internal reference approach implies that the reference value for each of the seven metrics was established based on the performance of that metric in the communities of the Dog/Elliston/Woodson Gulch/Spotted Dog drainages alone. Total, integrated metric scores were obtained for each method by summing scores for all metrics, and a "use support" designation was derived from the total bioassessment score based upon criteria described in Table 5.

RESULTS

Habitat assessment

Figure 1 compares habitat assessment results for all sites studied. Breakdown of total scores into the nine evaluated parameters is presented in Tables 1 and 2.

Figure 1. Total habitat assessment scores for Dog Creek, Elliston Creek and Woodson Gulch sites. August, 1998.

Marginal habitat conditions were noted at the site in Woodson Gulch, which received the lowest total habitat assessment score of the sites studied. Numerous factors were perceived to contribute to degraded conditions here, including moderately unstable

banks largely lacking in vegetation. Moderately severe deposition of sediment and small granitic gravels was noted, and has resulted in monotonous substrate and lack of instream habitat diversity. Embeddedness was reported to be severe. Old mining disruption combined with more recent bulldozer work on the streambank resulted in moderately severe channel alteration.

Habitat conditions scored more favorably at the upper site on Elliston Creek (Reach 1), and at three of the four sites sampled on Dog Creek (Reach 1, Reach 2 Site 2 and Reach 3). Each of these sites was rated sub-optimal. At the upper Elliston Creek site, moderately severe sediment deposition was noted, and a corresponding severe degradation of the benthic substrate, which was dominated by deposited gravels and silt. Moderate embeddedness of larger substrate particles was reported and water was turbid here.

Sub-optimal habitat conditions at the uppermost Dog Creek sites were perceived to be due to mild streambank erosion with resultant instream sedimentation. Some disruption of streambank vegetation was also noted. Mild to moderate streambank erosion was reported at the downstream site in Reach 2 of Dog Creek. Mild channel alteration was noted at the lowest site on Dog Creek, in Reach 3. This was associated with mild to moderate limitations on riparian zone width due to the presence of a railroad bed adjacent to the creek at this site.

Optimal habitat conditions were assessed at the downstream reach of Elliston Creek (Reach 2) and at the lower site in Reach 2 of Dog Creek (Reach 2 Site 1). Even so, mild sediment deposition was reported at the Elliston Creek site, and channel alteration was noted at the Dog Creek site. Habitat conditions in the evaluated reach of Spotted Dog Creek were also rated optimal, but sediment in substrate interstices was noted here as well.

Figure 2. Total bioassessment score based on the mountain ecoregions reference. Dog Creek, Spotted Dog Creek, Elliston Creek, and Woodson Gulch. August, 1998. For replicated samples, mean values are given.

Bioassessment

Macroinvertebrate taxa lists, metric results and other information for each sample are given in the Appendix.

The Mountain Ecoregions reference

Figure 2 compares total bioassessment scores from integrated and summed metrics using the ecoregional reference scoring criteria. Table 3 summarizes this method and criteria. Breakdown of scores for each metric is presented in Tables 5 and 6.

Compared to the ecoregion reference, the biotic health of the upper Elliston Creek site (Reach 3) was considered to fully support its use designation, with a bioassessment score that was 81% of the maximum. Site 2 in Reach 2 of Dog Creek received the lowest bioassessment score of the seven sites, 43% of maximum. In addition to the upper Elliston Creek site (Reach 1), Dog Creek Reach 1 Site 2 was also classed as fully supporting its use designation. All other sites were partially supporting.

The composite internal reference

When compared only with each other by means of the composite internal reference, the streams in this study generally receive scores similar to those they received when compared to streams across the mountain ecoregions. As before, the highest total bioassessment score was assigned to the uppermost Elliston Creek site (Reach 1 Site 1), which was considered fully-supporting its use classification and the lowest score was

Figure 3. Total bioassessment score based on internal reference. Dog Creek, Spotted Dog Creek, Elliston Creek, and Woodson Gulch. August, 1998. For replicated samples, mean values are given.

assigned to the upper site in Reach 2 of Dog Creek (Reach 2 Site 2), which was considered partially use-supporting. The lower site in Reach 2 of Dog Creek scored better than the upper site (Reach 1 Site 2) when the composite internal reference approach was used. The assessment at Woodson Gulch improved somewhat when the stream is compared only to the others in this study, but the assessment at Spotted Dog Creek deteriorated compared to its performance against the ecoregion as a whole. Where the comparison with the mountain ecoregions reference produced two sites with full use-support designations, only the uppermost Elliston Creek site (Reach 1) attained a full use-support designation when the streams were compared only to one another. All other reaches, including Reach 1 Site 2 of Dog Creek, were rated as partially supporting of their uses.

Replicates

For quality assurance purposes, three sets of replicate samples were collected at Sites 1 and 2 of Reach 1 of Dog Creek, and at the Spotted Dog Creek site. Comparing replicates to one another can provide an estimate of the variability in total bioassessment scores for all of the sites studied in the project, given the sampling and assessment methods used. Comparing total bioassessment scores for the paired replicates gave a mean coefficient of variability (V) of 8% when the mountain ecoregions reference was used. The composite internal reference bioassessment method yielded a mean coefficient of 14%. These values for V suggest moderate variability in bioassessment scores when these methods are used. A comparison of individual metrics calculated for the three sets of replicated samples can be found in the Appendix. Comparison of the variability of total bioassessment scores for each pair of replicates considered separately can be found in the Addendum at the end of this report, where the revised bioassessment method and its variability is discussed.

A comparison of the taxonomic similarity between paired replicates reveals moderate similarity between replicates collected at all three sites. At Dog Creek Reach 1 Site 1, samples shared 19 taxa in common (45% of taxa collected at the site), at Dog Creek Reach 1 Site 2, samples shared 27 taxa (52% of taxa collected at the site). Replicates collected from Spotted Dog Creek had the lowest similarity of taxonomic composition of the three pairs: of 42 taxa collected at the site, replicates shared only 16 (38%).

Macroinvertebrate communities

Among the seven macroinvertebrate assemblages in this study, the greatest similarity between communities was found between Site 2 in the uppermost reach (Reach 1) of Dog Creek and the uppermost reach of Elliston Creek. These sites shared 27 taxa (47% of all taxa collected at the two sites) in common to both. Average similarity between sites in this study was 26.5%, expressed as the number of taxa in common between two sites as a percent of the total number of taxa collected at the two sites. Not surprisingly, adjacent sites in Dog Creek and in Elliston Creek had greater than average similarities with one another. Community similarities are summarized in Figure 4, which compiles the number of taxa shared between benthic assemblages and the percentage of shared taxa for all possible pairs of assemblages.

Figure 4. Similarity of benthic communities, expressed as the number of taxa in common between two communities. Numbers in parentheses are the percentages of shared taxa. To compare replicated samples with unreplicated samples, total taxonomic composition of the pair of replicates was regarded as a single sample. Dog Creek, Elliston Creek, Spotted Dog Creek, and Woodson Gulch, August 1998.

	Dog Creek Reach 1 Site 2	Dog Creek Reach 2 Site 1	Dog Creek Reach 2 Site 2	Dog Creek Reach 3 Site 1	Elliston Creek Reach 1 Site 1	Elliston Creek Reach 2 Site 1	Woodson Gulch Reach 2 Site 2	Spotted Dog Creek Reach 1
Dog Creek Reach 1 Site 1	18 (25)	10 (16)	9 (16)	10 (15)	12 (20)	11 (18)	14 (25)	20 (34)
Dog Creek Reach 1 Site 2		23 (37)	14 (24)	20 (30)	27 (47)	21 (34)	18 (29)	17 (24)
Dog Creek Reach 2 Site 1			13 (30)	16 (31)	12 (24)	13 (28)	7 (13)	12 (20)
Dog Creek Reach 2 Site 2				19 (41)	18 (39)	18 (44)	12 (26)	10 (19)
Dog Creek Reach 3 Site 1					17 (31)	14 (27)	11 (19)	12 (18)
Elliston Creek Reach 1 Site 1						20 (43)	12 (23)	11 (18)
Elliston Creek Reach 2 Site 1							9 (17)	17 (32)
Woodson Gulch Reach 2								9 (16)

Ten sensitive taxa were present in the paired samples collected at the uppermost Dog Creek site (Reach 1 Site 1) including three very intolerant species of nemourid stoneflies: *Visoka cataractae*, *Zapada columbiana* and *Zapada frigidula*. The last of these is collected in bioassessment studies in Montana only infrequently, and its presence

suggests that habitat and water quality were excellent in this reach. The caddisfly *Cryptochia* sp. was relatively abundant at this site, indicating good retention of woody debris and heavy forest canopy. Relatively poor performance of this site when compared to ecoregion or composite internal references is due to moderately low EPT richness scores. The low scores may be attributable to the comparatively few mayfly taxa collected in the paired samples. On the other hand, high plecoptera and trichoptera taxa richness was noted here. These findings may be due to small size of the stream at this location, or to sampling or subsampling error. Analysis of the taxonomic composition of the communities present at the uppermost Dog Creek site suggests that neither the ecoregion reference method nor the composite internal reference method reflect the actual biotic condition of this site.

Reach 1 Site 2 of Dog Creek had the highest taxa richness of the seven benthic assemblages studied. The community as a whole, however is relatively tolerant (average value for biotic index = 3.45) compared to the expected community of a montane stream. Only two sensitive taxa, the mayfly *Drunella grandis* and the caddisfly *Parapsyche elsi* were present in low abundances in the paired samples from this site. Elevated water temperatures, or organic and/or nutrient pollution may account for these observations. Large numbers of the shredding caddisfly *Micrasema* sp., which comprised 26% of the sampled assemblage suggested adequate canopy cover, but the presence of the baetid *Centropilum* sp. and the snail *Physella* sp. suggests that water temperatures may be elevated at this site. The EPT richness of 18 also suggests slight impairment.

In Reach 2 of Dog Creek, the differences in the two sampled assemblages was striking. At the lower site in Reach 2 (Reach 2 Site 2), 60% of the assemblage was comprised of the caddisfly *Brachycentrus occidentalis*. Such an overwhelming abundance of this filterer-scraper suggests relatively warm water temperatures, and organic inputs, perhaps from cattle or from streambank erosion, though the effects of beaver dam outflows cannot be excluded. The habitat assessment, indicating optimal habitat at this site, supports the hypothesis that water quality impairment here may be involved in the moderately impaired biotic health indicated by the bioassessment score. Low EPT richness (11) at this site suggests this also, especially considering that only four mayfly taxa were collected at this site. Contrarily, the biotic index score at this site (2.99) was quite low. The benthic community at the upper site (Reach 2 Site 1), where moderately severe embeddedness of substrate particles and fine silt were noted, was dominated by the sediment-tolerant elmids *Optioservus* sp., *Cleptelmis* sp., and *Zaitzevia* sp. which together made up 47% of the sampled organisms. There were twelve fewer taxa collected from the lower site than from the upper site, including eight fewer EPT taxa.

In the lowest sampled reach of Dog Creek (Reach 3 Site 1), a high biotic index score (4.30) suggests that organic and/or nutrient pollution affects the benthic community at this site. In addition, sediment-tolerant elmids in four taxa comprise 32% of the sampled assemblage at this site, corresponding with the observations of moderately severe embeddedness of substrate particles. The sediment-tolerant mayfly *Tricorythodes minutus* was also found here. Although EPT richness was the highest among Dog Creek sites, these taxa included the tolerant mayfly as well as two tolerant caddisfly taxa, *Ochrotrichia* sp. and *Oecetis* sp. Tolerant taxa comprised nearly 38% of the organisms collected here.

Twelve sensitive taxa were collected in the paired samples from Spotted Dog Creek. These included the peltoperlid stonefly *Yoraperla brevis* and the leuctrid stonefly *Paraleuctra* sp., both cold stenotherms. Other taxa collected here that are only found in cold waters include the midge *Diamesa* sp., the mayfly *Baetis bicaudatus*, and the limnephilid caddisfly *Dicosmoecus atripes*. A total of 28 EPT taxa were collected from Spotted Dog Creek, the highest EPT taxa richness of any site in the study. These observations, together with the very low mean biotic index score (1.94), suggest excellent biotic health at the Spotted Dog Creek site. The relatively poor bioassessment scores of this site seem to be the result of the low abundance of scraper and shredder taxa; both replicates received low scores for this metric. However, scraper and shredder taxa richness for these samples was high. Also contributing to lower than expected bioassessment scores given the taxonomic composition of the samples was the low abundance of organisms collected in one of the replicates; only 126 organisms were collected. This low abundance could be due to habitat degradation, however, the second replicate collected at the same site contained many more organisms.

The uppermost site on Elliston Creek (Reach 1 Site 1) had the highest total bioassessment score of any site when the ecoregional reference was used. (When the composite internal reference method was used, the uppermost site on Dog Creek shared the highest score with this site.) Despite this, moderately severe sediment deposition and substrate embeddedness was perceived at this site and reported in the habitat assessment. The sediment-tolerant elmud *Optioservus* sp. was the most abundant organism collected here, and this taxon, together with three other elmids, comprised 32% of the sampled assemblage. Still, taxa richness and EPT richness were high, suggesting that habitat diversity was not severely compromised.

The lower Elliston Creek site (Reach 2 Site 1) also had high taxa richness and EPT richness, seeming to correspond well with the observation of optimal habitat quality. However, these numbers may suggest that organic and/or nutrient enrichment may be present; the observation is supported by the relatively high biotic index value (4.36) and by the low relative abundance of mayfly, stonefly and caddisfly individuals (EPT percent = 30). More than 50% of the sampled assemblage was comprised of tolerant organisms.

In Woodson Gulch, marginal habitat quality is combined with slight-to-moderate impairment of biotic health, as indicated by these bioassessment methods. The habitat assessment reports problems with monotonous benthic substrate dominated by granitic sand, severe embeddedness of substrate and other evidence of degraded habitat. The benthic community, however, is not so severely limited as the habitat assessment would suggest. Five sensitive taxa, including the leuctrid stonefly *Despaxia augusta*, and the predatory-filtering caddisfly *Parapsyche elsis* were collected here, giving strong evidence that habitat diversity is still at least partly intact in Woodson Gulch. The abundant presence of the triclad *Polycelis coronata*, which comprised 16% of the sampled assemblage suggests that groundwater influences the stream at the sampling site. Some impairment, however, may be suggested by the low EPT richness (15). Though the field data is not specific on the sampling method, effort, or duration, there may have been a low macroinvertebrate density at this site as well; only 638 organisms were present in the sample. The number of organisms estimated in samples from Elliston Creek and Dog Creek ranged from 1965 to 8700. Low macroinvertebrate density strongly suggests habitat degradation, but small stream size may be an explanation as well.

Figure 5. Relationships between total habitat assessment scores and total bioassessment scores. Dog Creek, Elliston Creek and Woodson Gulch. August 1998. Individual replicates are indicated by identical symbols. Note the overlap of two replicates from different sites with identical habitat and bioassessment scores, indicated by a blue triangle (Dog Creek Reach 1 Site 1) within a triangle outline (Dog Creek Reach 1 Site 2).

Figure 5 summarizes the relationships between total habitat assessment scores and total bioassessment scores (based on the ecoregion reference) for all sites in this study. All but two of the sites exhibit the relationship expected when habitat degradation is the main negative determinant of biotic health. One site on Elliston Creek, the lower site (Reach 2, Site 1) and one site on Dog Creek, the upper site in Reach 2 (Reach 2 Site 2) fall below a line representing correspondence between habitat quality and bioassessment score. (One of the two replicate samples from Reach 1 Site 1 of Dog Creek also falls within this area.) This position on the graph is a strong suggestion of a further contribution of water quality impairment on the impacts to biotic health of the benthic communities.

CONCLUSIONS

- Macroinvertebrate communities and habitat assessments alike suggest that sedimentation impairs the benthic assemblages in Dog Creek below Reach 1 Site 1. Poor streambank stability, roads, and cattle impacts have been implicated as sources of the sediment. Higher water temperatures than expected for montane benthos is also suggested by the macroinvertebrate data.

- Water quality impairment at the upper site in Dog Creek's Reach 2 (Reach 2 Site 2) is suggested by the combination of optimal habitat and moderate impairment of biotic health.
- Benthic assemblages collected from Elliston Creek suggest that impairment to biotic health in this stream may also be due primarily to sediment deposition.
- In Woodson Gulch, the composition of the benthic community suggests that habitat diversity persists to some degree, despite the report of marginal habitat quality. Abundant sensitive taxa indicate good biotic health.
- Samples from Spotted Dog Creek contained many sensitive taxa, including a variety of cold stenotherms. Biotic health and habitat quality at the sampled site appear to be excellent.
- Metals contamination does not seem to be a significant threat to biotic health at any site in this study. The metals tolerance index values ranged from 2.03 to 3.54.

ADDENDUM: Application of a revised bioassessment method to the Elliston-area data

Figure 6 compares bioassessment scores for sites using a revised bioassessment method devised by Bollman (1998). This method uses a battery of six metrics and was evaluated for sensitivity to impairment, relevance to habitat and water quality degradation and replicability for a set of samples collected in the Montana Valleys and Foothill Prairies (MVFP) Ecoregion. While the Elliston-area streams in this study do not fall within the MVFP Ecoregion, application of the method to another montane system (Miles et al. 1999) has suggested its applicability to these systems as well.

Figure 6. Total bioassessment score based on a revised bioassessment method. Dog Creek, Spotted Dog Creek, Elliston Creek, and Woodson Gulch. August, 1998. For replicated samples, mean values are given.

Sites with abundant sensitive taxa and other clear taxonomic-based indications of good biotic health were assigned appropriately higher bioassessment scores by the revised method. Dog Creek sites which seem more impaired by sediment, possible nutrient and/or organic pollution and higher water temperatures, such as Reach 2 Site 2 and Reach 3 Site 1, received the lowest bioassessment scores. Sites with moderate impairment from sediment, pollutants or water temperature, such as the Elliston Creek sites and Reach 1 Site 2 and Reach 2 Site 1 of Dog Creek, received intermediate scores.

Replication of samples provides a means to estimate the adequacy of the sampling and subsampling methods in representing the benthic assemblages present at a site. It can also provide an opportunity to evaluate the replicability of the bioassessment method, or its "precision", defined here as the variability of bioassessment scores assigned to sample replicates, which presumably were taken from locations with nearly identical impairment. Figure 7 compares the coefficient of variability (V) calculated for bioassessment scores

using each of the three bioassessment methods presented in this study, for each pair of replicated samples, and the mean value for V for each method. Close similarity in scores (low value for V) between a set of replicated samples suggests, but does not absolutely assure, that both the sampling and assessment methods adequately represent the benthic community, and thus the biotic health of a site.

Figure 7. Coefficient of variability (V) and mean values for V for bioassessment scores calculated for replicated samples from Elliston-area streams using three different bioassessment methods.

replicates	Mountain Ecoregions reference	Composite internal reference	Revised bioassessment method
Dog Creek Reach 1 Site 1	14.3	21.8	3.0
Dog Creek Reach 1 Site 2	6.2	16.2	0
Spotted Dog Creek	3.4	4.2	0
Mean V	8.0	14.1	1.0

Figure 5 summarizes the relationships between total habitat assessment scores and total bioassessment scores (based on the revised assessment method) for all sites in this study. The position of the symbols for Reach 2 Site 2 and Reach 3 Site 1 on Dog Creek strongly suggest the strong influence of water quality impairments on the biotic health at these sites. Dog Creek's Reach 1 Site 2 and Reach 2 Site 1, and the two sites on Elliston Creek also show some water quality degradation. The Spotted Dog Creek site, and the replicated samples from Dog Creek Reach 1 Site 1 are examples of sites with good habitat and excellent water quality. The position of the site in Woodson Gulch suggests that excellent water quality may mitigate the effect of degraded habitat.

Figure 8. Relationships between total habitat assessment scores and total bioassessment scores. Dog Creek, Elliston Creek and Woodson Gulch. August 1998. Individual replicates are indicated by identical symbols.

TABLES

Table 1. Stream and riparian habitat assessment: Dog Creek, August 12 and 13, 1998.

Max. possible score	Location:	Dog Creek Reach 1	Dog Creek Reach 2, Site 1	Dog Creek Reach 2, Site 2	Dog Creek Reach 3, Site 1
	Parameter				
10	riffle development	9	8	8	9
10	substrate development	5	7	8	8
20	embeddedness	8	10	19	10
20	channel alteration	16	14	15	12
20	sediment deposition	11	18	18	18
20	flow status	20	19	18	16
10/10	bank stability (right/left)	6 / 7	10 / 7	8 / 3	8 / 8
10/10	bank vegetative cover (right/left)	7 / 7	9 / 9	6 / 6	9 / 6
10/10	riparian width (right/left)	7 / 10	10 / 10	10 / 6	8 / 3
160	TOTAL:	113	133	125	115
PERCENT OF MAXIMUM:		71	83	78	72
CONDITION ¹ :		SUB-OPTIMAL	OPTIMAL	SUB-OPTIMAL	SUB-OPTIMAL

1. Condition categories: Optimal > 81% of maximum score; Sub-optimal 75 - 56%; Marginal 49 - 29%; Poor <23%.

Table 2. Stream and riparian habitat assessment: Elliston Creek and Woodson Gulch, August 18 and 19, 1998.

Max. possible score	Location:	Spotted Dog Creek Reach 1	Elliston Creek Reach 1, Site 1	Elliston Creek Reach 2, Site 1	Woodson Gulch Reach 2, Site 1
10	Parameter	7	9	10	2
10	riffle development	6	2	8	2
20	substrate development	13	6	10	3
20	embeddedness	19	20	20	7
20	channel alteration	15	6	13	5
20	sediment deposition	18	18	15	18
10/10	flow status	9 / 9	9 / 9	9 / 10	5 / 5
10/10	bank stability (right/left)	9 / 9	10 / 10	10 / 10	5 / 3
10/10	bank vegetative cover (right/left)	9 / 10	8 / 10	10 / 9	2 / 7
10/10	riparian width (right/left)				
160	TOTAL:	133	117	134	64
PERCENT OF MAXIMUM:		83	73	84	40
CONDITION ¹ :		OPTIMAL	SUB-OPTIMAL	OPTIMAL	MARGINAL

1. Condition categories: Optimal > 81% of maximum score; Sub-optimal 75 - 56%; Marginal 49 - 29%; Poor <23%.

Table 3. Mountain ecoregions metrics and scoring criteria (from Bukantis, 1998).

metric	Scoring Criteria			
	3	2	1	0
Taxa richness	>28	28 - 24	24 - 19	<19
EPT richness	>19	19 - 17	17 - 15	<15
Biotic index	<3	3 - 4	4 - 5	>5
% dominant taxon	<25	25 - 35	35 - 45	>45
%Collector(g+ff)	<60	60 - 70	70 - 80	>80
% Scraper +Shredder	>55	55 - 40	40 - 25	<25
% EPT	>70	70 - 55	55 - 40	<40

Table 4. Internal reference values and criteria for assigning scores to metrics based on percent comparability to reference values (from McGuire 1995, with modification):

metric	Dog Creek, Elliston Creek and Woodson Gulch reference, 1998	Scoring Criteria				*
		3	2	1	0	
Taxa richness	43	> 80%	80-60%	60-40%	< 40%	a
EPT richness	22	> 85%	85-70%	70-50%	< 50%	a
Biotic index	2.99	> 90%	90-80%	80-70%	< 70%	b
% dominant taxon	15	> 60%	60-45%	45-30%	< 30%	b
%Collector(g+ff)	26	> 90%	90-80%	80-65%	< 65%	b
% Scraper +Shredder	65	> 80%	80-60%	60-40%	< 40%	a
% EPT	71	> 75%	75-50%	50-25%	< 25%	a

¹1998 internal reference values are the "best" appropriate values among those calculated.

* a = score is ratio of study site to reference x 100.

* b = score is ratio of reference to study site x 100.

Table 5. Criteria for the assignment of support classifications / standards violation thresholds (from Bukantis, 1997)

% 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

Table 6. Metric values, percentage of reference, and bioassessments, based on composite internal reference, for Dog Creek sites. August, 1998.

metric	Dog Creek Reach 1 Site 1	Dog Creek Reach 1 Site 1	Dog Creek Reach 1 Site 2	Dog Creek Reach 1 Site 2	Dog Creek Reach 2 Site 1	Dog Creek Reach 2 Site 2	Dog Creek Reach 3 Site 1
	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1
Taxa richness	30	33	38	43	35	23	38
EPT richness	19	15	19	18	19	11	21
Biotic index	2.64	3.31	2.90	3.99	4.06	2.99	4.30
% dominant taxon	24	15	35	17	33	60	19
% Collector (g+ff)	26	46	30	50	36	73	58
% Scrapers + Shredders	34	24	65	44	57	26	39
% EPT	47	36	60	50	35	70	37
% of reference							
Taxa richness	70	77	88	100	81	53	88
EPT richness	86	68	86	81	86	50	95
Biotic index	100	90	100	75	74	100	70
% dominant taxon	63	100	43	88	45	25	79
% Collector (g+ff)	100	57	87	52	72	36	45
% Scrapers + Shredders	52	37	100	68	88	40	60
% EPT	67	51	86	71	50	100	53
metric score							
Taxa richness	2	2	3	3	3	1	3
EPT richness	3	1	3	2	3	1	3
Biotic index	3	3	3	1	1	3	1
% dominant taxon	3	3	1	3	2	0	3
% Collector (g+ff)	3	0	2	0	1	0	0
% Scrapers + Shredders	1	0	3	2	3	1	2
% EPT	2	2	3	2	2	3	2
total score (max = 21)	17	11	18	15	17	9	14
% reference	81	52	86	71	81	43	67
use support*	FULL	PART	FULL	PART	FULL	PART	PART

*See Table 5 for use support designation criteria.

Table 7. Metric values, percentage of reference, and bioassessments, based on composite internal reference, for Spotted Dog Creek, Elliston Creek, and Woodson Gulch. August, 1998.

metric	Spotted Dog Ck.			Spotted Dog Ck.			Elliston Creek		Elliston Creek		Woodson Gulch	
	Reach 1	Site 1	Rep.1	Reach 1	Site 1	Rep.2	Reach 1	Site 1	Reach 2	Site 1	Reach 2	Site 1
Taxa richness	24			34			35		31		32	
EPT richness	18			22			19		17		15	
Biotic index	1.98			1.89			3.72		4.36		4.82	
% dominant taxon	32			29			18		31		19	
% Collector (g+ff)	48			48			48		42		41	
% Scrapers + Shredders	29			24			50		52		23	
% EPT	60			62			65		30		36	
% of reference												
Taxa richness	56			79			81		72		74	
EPT richness	81			100			86		77		68	
Biotic index	100			100			80		69		62	
% dominant taxon	47			52			83		48		79	
% Collector (g+ff)	54			54			54		62		63	
% Scrapers + Shredders	45			37			77		80		35	
% EPT	86			86			93		43		51	
metric score												
Taxa richness	1			2			3		2		2	
EPT richness	2			3			3		2		1	
Biotic index	3			3			2		0		0	
% dominant taxon	2			2			3		2		3	
% Collector (g+ff)	0			0			0		0		0	
% Scrapers + Shredders	1			0			2		3		0	
% EPT	3			3			3		1		2	
total score (max = 21)	12			13			16		10		8	
% reference	57			62			76		48		38	
use support*	PART			PART			FULL		PART		PART	

*See Table 5 for use support designation criteria.

Table 8. Metric scoring and bioassessments based on mountain ecoregions reference. Dog Creek. August, 1998.

<i>metric</i>	<i>Dog Creek Reach 1 Site 1 Rep. 1</i>	<i>Dog Creek Reach 1 Site 1 Rep. 2</i>	<i>Dog Creek Reach 1 Site 2 Rep. 1</i>	<i>Dog Creek Reach 1 Site 2 Rep. 2</i>	<i>Dog Creek Reach 2 Site 1</i>	<i>Dog Creek Reach 2 Site 2</i>	<i>Dog Creek Reach 3 Site 1</i>
taxa richness	3	3	3	3	3	1	3
EPT richness	2	1	2	2	2	0	3
biotic index	3	2	3	2	1	3	1
% dominant taxon	3	3	2	3	2	0	3
% collectors (g + ff)	3	3	3	3	3	1	3
% scraper+shredder	1	0	3	2	3	1	1
% EPT	1	0	2	1	0	3	0
Total score (max.=21)	16	12	18	16	14	9	14
percent of maximum	76	57	86	76	67	43	67
use support *	FULL	PART	FULL	FULL	PART	PART	PART

* See Table 2a. FULL = full support, PARTIAL = partial support, NON! = non-support.

Table 9. Metric scoring and bioassessments based on mountain ecoregions reference. Spotted Dog Creek, Elliston Creek, and Woodson Gulch. August, 1998.

<i>metric</i>	<i>Spotted Dog Creek Reach 1 Site1 Rep. 1</i>	<i>Spotted Dog Creek Reach 1 Site1 Rep. 2</i>	<i>Elliston Creek Reach 1 Site 1</i>	<i>Elliston Creek Reach 2 Site 1</i>	<i>Woodson Gulch</i>
taxa richness	2	3	3	3	3
EPT richness	2	3	2	2	1
biotic index	3	3	2	1	1
% dominant taxon	2	2	3	2	3
% collectors (g + ff)	3	3	3	3	3
% scraper+shredder	1	0	2	2	0
% EPT	2	2	2	0	0
Total score (max.=21)	15	16	17	13	11
percent of maximum	71	76	81	62	52
use support *	PART	FULL	FULL	PART	PART

* See Table 2a. FULL = full support, PARTIAL = partial support, NON! = non-support.

APPENDIX

Aquatic Macroinvertebrate Taxonomic Data
Dog Creek, Reach 1, Site 1. Sample 1.

August 1998

Taxon	#	%	hbi	FFG
Turbellaria: Polycelis coronata	80	24.39	4	PR
Ostracoda	7	2.13	8	CG
Acari	1	0.30	5	PA
TOTAL: MISC. TAXA	88	26.83		
Baetis flavistriga	6	1.83	5	CG
Drumella coloradensis	1	0.30	0	CG
Serratella tibialis	5	1.52	2	CG
Nixe	2	0.61	4	SC
TOTAL: EPHEMEROPTERA	14	4.27		
Sweltsa	7	2.13	0	PR
Amphinemura	32	9.76	2	SH
Zapada columbiana	31	9.45	2	SH
Zapada frigida	1	0.30	1	SH
Doroneuria	5	1.52	0	PR
Megarcys	3	0.91	1	PR
TOTAL: PLECOPTERA	79	24.09		
Micrasema	12	3.66	1	SH
Lepidostoma	1	0.30	1	SH
Cryptochia	4	1.22	1	SH
Psychoglypha subborealis	1	0.30	2	CG
Dolophilodes	1	0.30	0	CF
Rhyacophila Betteni Gr.	1	0.30	0	PR
Rhyacophila Brunnea Gr.	5	1.52	2	PR
Rhyacophila narvae	9	2.74	0	PR
Neothremma alicia	28	8.54	1	SC
TOTAL: TRICHOPTERA	62	18.90		
Heterlimnius	47	14.33	3	CG
Hydrophilidae: Ametor	7	2.13	5	PR
TOTAL: COLEOPTERA	54	16.46		
Ceratopogonidae	2	0.61	6	PR
Dixa	1	0.30	4	CG
Glutops	10	3.05	1	PR
TOTAL: DIPTERA	13	3.96		
Eukiefferiella Brehmi Gr.	1	0.30	8	CG
Microsectra	8	2.44	4	CG
Pagastia	9	2.74	1	CG
TOTAL: CHIRONOMIDAE	18	5.49		
GRAND TOTAL	328	100.00

Aquatic Macroinvertebrate Taxonomic Data
Dog Creek, Reach 1, Site 1. Sample 2.

August 1998

Taxon	#	%	hbi	FFG
Turbellaria: Polycelis coronata	48	14.76	4	PR
Oligochaeta: Enchytraeidae	2	0.60	10	CG
Sphaeriidae	4	1.20	8	CF
Ostracoda	44	13.55	8	CG
Acari	5	1.51	5	PA
TOTAL: MISC. TAXA	103	31.63		
Baetis	6	1.81	5	CG
Drunella coloradensis	1	0.30	0	CG
Ameletus	1	0.30	0	CG
TOTAL: EPHEMEROPTERA	8	2.41		
Chloroperlidae	9	2.71	1	PR
Amphinemura	20	6.02	2	SH
Visoka cataractae	7	2.11	0	SH
Zapada columbiana	32	9.64	2	SH
Doroneuria	1	0.30	0	PR
TOTAL: PLECOPTERA	69	20.78		
Micrasema	1	0.30	1	SH
Cryptochia	2	0.60	1	SH
Dolophilodes	7	2.11	0	CF
Rhyacophila Betteni Gr.	1	0.30	0	PR
Rhyacophila Brunnea Gr.	6	1.81	2	PR
Rhyacophila narvae	13	3.92	0	PR
Neothremma alicia	14	4.22	1	SC
TOTAL: TRICHOPTERA	44	13.25		
Heterolimnius	30	9.04	3	CG
Hydrophilidae	5	1.51	5	PR
TOTAL: COLEOPTERA	35	10.54		
Glutops	6	1.81	1	PR
Dicranota	1	0.30	3	PR
Limnophila	1	0.30	3	MH
Tipula	2	0.60	4	SH
TOTAL: DIPTERA	10	3.01		
Brillia	3	0.90	4	SH
Eukiefferiella Gracei Gr.	12	3.61	4	CG
Micropsectra	13	3.92	4	CG
Nanocladius	1	0.30	3	CG
Pagastia	29	8.73	1	CG
Thienemannimyia	1	0.30	5	PR
Tvetenia Bavarica Gr.	2	0.60	5	CG
TOTAL: CHIRONOMIDAE	61	18.37		
GRAND TOTAL	330	100.00

Aquatic Macroinvertebrate Data:

Dog Creek Reach 1 Site 1

	Sample 1	Sample 2
Percent of sample used	70	17
Subsample size	328	330
Percent EPT	47	36
Taxa richness	30	33
EPT richness	19	15
Biotic Index	2.64	3.31
Percent dominant taxon	24.39	14.76
Percent dominance of five dominant taxa	66.47	55.72
Percent dominance of ten dominant taxa	81.10	77.41
Percent collectors (gatherers plus filterers)	26.49	46.07
Percent scrapers plus shredders	33.84	24.39
Percent Hydropsychinae of Trichoptera	00	00
Metals tolerance index	2.67	3.30
Shannon H (log2)	3.79	4.13
Evenness	.77	.82
Brillouin H	2.48	2.71
Simpson D	.11	.08
EPT/Chironomidae	8.61	1.98
CTQa	54.00	64.38
Percent Baetidae of Ephemeroptera	29	75
%Ephemeroptera	4.26	2.41
%Plecoptera	24.07	20.78
%Trichoptera	18.88	13.26
%Coleoptera	16.46	10.55
%Diptera	3.96	3.01
%Chironomidae	5.48	18.36
Multivoltine	32.32	44.95
Univoltine	46.19	39.68
Semivoltine	21.49	15.36

Functional Feeding Groups	# taxa	% abundance	# taxa	% abundance
Predator	10	39.30	10	27.72
Collector-gatherer	10	26.19	11	42.76
Collector-filterer	1	.30	2	3.31
Scraper	2	9.15	1	4.22
Shredder	6	24.69	7	20.17
Estimated total number of organisms		469		1941
Estimated number collected per foot		17		194
Estimated number collected per minute		469		1941

Aquatic Macroinvertebrate Taxonomic Data
Dog Creek, Reach 1, Site 2 Sample 1

August 1998

Taxon	#	%	hbi	FFG
Turbellaria: Polycelis coronata	4	1.32	4	PR
Oligochaeta: Tubificidae	2	0.66	10	CG
Sphaeriidae	1	0.33	8	CF
Physella	2	0.66	8	SC
TOTAL: MISC. TAXA	9	2.96		
Baetis flavistriga	3	0.99	5	CG
Baetis tricaudatus	12	3.95	4	CG
Diphetor hageni	5	1.64	5	CG
Drunella grandis	2	0.66	2	CG
Serratella tibialis	1	0.33	2	CG
Cinygmula	10	3.29	0	SC
Nixe	4	1.32	4	SC
Paraleptophlebia	1	0.33	1	CG
Ameletus	2	0.66	0	CG
TOTAL: EPHEMEROPTERA	40	13.16		
Amphinemura	12	3.95	2	SH
Hesperoperla pacifica	3	0.99	1	PR
Skwala	1	0.33	3	PR
TOTAL: PLECOPTERA	16	5.26		
Sialis	1	0.33	4	PR
TOTAL: MEGALOPTERA	1	0.33		
Arctopsyche grandis	6	1.97	2	CF
Parapsyche elsis	1	0.33	0	CF
Micrasema	105	34.54	1	SH
Agapetus	5	1.64	0	SC
Psychoglypha subborealis	1	0.33	2	CG
Wormaldia	4	1.32	0	CF
Rhyacophila Brunnea Gr.	4	1.32	2	PR
TOTAL: TRICHOPTERA	126	41.45		
Cleptelmis addenda	1	0.33	4	CG
Optioservus	39	12.83	5	SC
Zaitzevia	7	2.30	4	CG
TOTAL: COLEOPTERA	47	15.46		
Ceratopogonidae	1	0.33	6	PR
Simulium	20	6.58	5	CF
Dicranota	1	0.33	3	PR
TOTAL: DIPTERA	22	7.24		
Brillia	2	0.66	4	SH
Cricotopus Nostococladus	19	6.25	6	SH
Cryptochironomus	1	0.33	8	CG
Eukiefferiella Gracei Gr.	13	4.28	4	CG
Micropsectra	2	0.66	4	CG
Pagastia	1	0.33	1	CG
Rheocricotopus	2	0.66	4	CG
Tvetenia Bavarica Gr.	3	0.99	5	CG
TOTAL: CHIRONOMIDAE	43	14.14		
GRAND TOTAL	304	100.00

Aquatic Macroinvertebrate Taxonomic Data

Dog Creek Reach 1 Site 2 Sample 2

August 1998

Taxon	#	%	hbi	FFG
Turbellaria: Polycelis coronata	2	0.66	4	PR
Nematoda	1	0.33	5	OM
Oligochaeta	26	8.55	10	CG
(Tubificidae 24, Haplotaxidae 1, Lumbricidae 1)				
Sphaeriidae	8	2.63	8	CF
Physella	4	1.32	8	SC
Acari	3	0.99	5	PA
TOTAL: MISC. TAXA	44	14.47		
Baetis sp.	13	4.28	5	CG
Baetis tricaudatus	5	1.64	4	CG
Centropetillum	7	2.30	2	CG
Dipheter hageni	7	2.30	5	CG
Drunella grandis	7	2.30	2	CG
Cinygmula	2	0.66	0	SC
Nixe criddlei	7	2.30	4	SC
Paraleptophlebia debilis	15	4.93	1	CG
Ameletus	9	2.96	0	CG
TOTAL: EPHEMEROPTERA	72	23.68		
Sweltsa	1	0.33	0	PR
Amphinemura	10	3.29	2	SH
Zapada cinctipes	1	0.33	3	SH
Hesperoperla pacifica	2	0.66	1	PR
Skwala	1	0.33	3	PR
TOTAL: PLECOPTERA	15	4.93		
Arctopsyche grandis	6	1.97	2	CF
Micrasema	53	17.43	1	SH
Apatania	1	0.33	3	SC
Rhyacophila Brunnea Gr.	4	1.32	2	PR
TOTAL: TRICHOPTERA	64	21.05		
Cleptelmis	11	3.62	4	CG
Lara avara	1	0.33	1	SH
Narpus	1	0.33	2	SH
Optioservus	34	11.18	5	SC
TOTAL: COLEOPTERA	47	15.46		
Ceratopogonidae	1	0.33	6	PR
Simulium	4	1.32	5	CF
Limnophila	1	0.33	3	MH
TOTAL: DIPTERA	6	1.97		
Brillia	2	0.66	4	SH
Cricotopus Nostococladus	19	6.25	6	SH
Cryptochironomus	2	0.66	8	CG
Eukiefferiella Devonica Gr.	1	0.33	8	CG
Eukiefferiella Gracei Gr.	3	0.99	4	CG
Micropsectra	6	1.97	4	CG
Monopelopia	2	0.66	6	PR
Pagastia	1	0.33	1	CG
Polypedilum	2	0.66	6	CG
Rheocricotopus	13	4.28	4	CG
Stictochironomus	2	0.66	5	CG
Thienemanniella	3	0.99	6	CG
TOTAL: CHIRONOMIDAE	56	18.42		
GRAND TOTAL	304	100.00

Aquatic Macroinvertebrate Data:

Dog Creek Reach 1 Site 2

	Sample 1	Sample 2
Percent of sample used	10	39
Subsample size	304	304
Percent EPT	50	60
Taxa richness	43	38
EPT richness	18	19
Biotic Index	3.99	2.90
Percent dominant taxon	17.43	34.54
Percent dominance of five dominant taxa	48.34	64.48
Percent dominance of ten dominant taxa	66.77	79.94
Percent collectors (gatherers plus filterers)	49.67	29.96
Percent scrapers plus shredders	44.41	65.14
Percent Hydropsychinae of Trichoptera	00	00
Metals tolerance index	3.18	3.25
Shannon H (log2)	4.52	3.76
Evenness	.83	.72
Brillouin H	2.92	2.43
Simpson D	.07	.15
EPT/Chironomidae	2.70	4.23
CTQa	75.00	65.76
Percent Baetidae of Ephemeroptera	44	50
%Ephemeroptera	23.67	13.17
%Plecoptera	4.94	5.27
%Trichoptera	21.05	41.45
%Coleoptera	15.46	15.46
%Diptera	1.98	7.24
%Chironomidae	18.44	14.16
Multivoltine	23.68	16.86
Univoltine	51.97	63.24
Semivoltine	24.34	19.90

Functional Feeding Groups	# taxa	% abundance	# taxa	% abundance
Predator	7	4.29	7	4.95
Collector-gatherer	18	43.75	17	19.43
Collector-filterer	3	5.92	5	10.53
Scraper	5	15.79	5	19.74
Shredder	7	28.62	4	45.40
Estimated total number of organisms		3040		780
Estimated number collected per foot		127		32
Estimated number collected per minute		3040		780

Aquatic Macroinvertebrate Taxonomic Data

Dog Creek Reach 2 Site 1

August 1998

Taxon	#	%	hbi	FFG
Turbellaria: Polycelis coronata	1	0.34	4	PR
Oligochaeta	4	1.35	10	CG
(Lumbriculidae 3, Tubificidae 1)				
Sphaeriidae	4	1.35	8	CF
TOTAL: MISC. TAXA	9	3.03		
Baetis tricaudatus	9	3.03	4	CG
Dipheter hageni	5	1.68	5	CG
Drunella grandis	3	1.01	2	CG
Ephemerella inermis	9	3.03	4	SC
Serratella tibialis	6	2.02	2	CG
Cinygmula	3	1.01	0	SC
Nixe criddlei	6	2.02	4	SC
Ameletus	3	1.01	0	CG
Tricorythodes minutus	1	0.34	4	CG
TOTAL: EPHEMEROPTERA	45	15.15		
Sweltsa	4	1.35	0	PR
Amphinemura	1	0.34	2	SH
Zapada cinctipes	1	0.34	3	SH
Skwala	3	1.01	3	PR
TOTAL: PLECOPTERA	9	3.03		
Micrasema	28	9.43	1	SH
Agapetus	1	0.34	0	SC
Ochrotrichia	2	0.67	4	PH
Apatania	14	4.71	3	SC
Wormaldia	1	0.34	0	CF
Rhyacophila Brunnea Gr.	3	1.01	2	PR
TOTAL: TRICHOPTERA	49	16.50		
Cleptelmis	8	2.69	4	CG
Optioservus	97	32.66	5	SC
Zaitzevia	34	11.45	4	CG
TOTAL: COLEOPTERA	139	46.80		
Hexatoma	6	2.02	2	PR
TOTAL: DIPTERA	6	2.02		
Cricotopus Nostococcladius	8	2.69	6	SH
Microtendipes	4	1.35	6	CG
Orthocladus	12	4.04	6	CG
Pagastia	1	0.34	1	CG
Rheocricotopus	2	0.67	4	CG
Rheotanytarsus	1	0.34	6	CF
Sublettea	3	1.01	4	UN
Tanytarsus	8	2.69	6	CF
Thienemannimyia	1	0.34	5	PR
TOTAL: CHIRONOMIDAE	40	13.47		
GRAND TOTAL	297	100.00

Aquatic Macroinvertebrate Data: Dog Creek Reach 2 Site 1

Percent of sample used	8	
Subsample size	297	
Percent EPT	35	
Taxa richness	35	
EPT richness	19	
Biotic Index	4.06	
Percent dominant taxon	32.66	
Percent dominance of five dominant taxa	62.29	
Percent dominance of ten dominant taxa	76.42	
Percent collectors (gatherers plus filterers)	35.70	
Percent scrapers plus shredders	56.57	
Percent Hydropsychinae of Trichoptera	00	
Metals tolerance index	3.54	
Shannon H (log2)	3.85	
Evenness	.75	
Brillouin H	2.49	
Simpson D	.14	
EPT/Chironomidae	2.58	
CTQa	68.26	
Percent Baetidae of Ephemeroptera	31	
%Ephemeroptera	15.15	
%Plecoptera	3.04	
%Trichoptera	16.50	
%Coleoptera	46.80	
%Diptera	2.02	
%Chironomidae	13.47	
Multivoltine	14.48	
Univoltine	36.87	
Semivoltine	48.65	
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Functional Feeding Groups	# taxa	% abundance
Predator	6	6.07
Collector-gatherer	13	30.98
Collector-filterer	4	4.72
Scraper	4	43.77
Shredder	4	12.80
<hr/>		
Estimated total number of organisms	3712	
Estimated number collected per foot	77	
Estimated number collected per minute	1856

Aquatic Macroinvertebrate Taxonomic Data

Dog Creek Reach 2 Site 2

August 1998

Taxon	#	%	hbi	FFG
Baetis tricaudatus	4	1.15	4	CG
Drumella grandis	1	0.29	2	CG
Serratella tibialis	4	1.15	2	CG
Nixe criddlei	3	0.86	4	SC
TOTAL: EPHEMEROPTERA	12	3.45		
Claassenia sabulosa	1	0.29	3	PR
TOTAL: PLECOPTERA	1	0.29		
Brachycentrus occidentalis	198	59.77	2	CF
Micrasema	9	2.59	1	SH
Glossosoma	4	1.15	0	SC
Hydropsyche	3	0.86	5	CF
Lepidostoma	6	1.72	1	SH
Rhyacophila Brunnea Gr.	1	0.29	2	PR
TOTAL: TRICHOPTERA	221	66.38		
Cleptelmis	1	0.29	4	CG
Optioservus	21	6.32	5	SC
Zaitzevia	14	4.31	4	CG
TOTAL: COLEOPTERA	36	10.92		
Antocha	1	0.29	3	CG
Hexatoma	1	0.29	2	PR
TOTAL: DIPTERA	2	0.57		
Cricotopus	5	1.44	7	CG
Cricotopus Nostococladus	40	13.22	6	SH
Eukiefferiella Gracei Gr.	2	0.57	4	CG
Micropsectra	4	1.15	4	CG
Orthocladus	5	1.44	6	CG
Pagastia	1	0.29	1	CG
Tvetenia Bavarica Gr.	1	0.29	5	CG
TOTAL: CHIRONOMIDAE	58	18.39		
GRAND TOTAL	330	100.00

Aquatic Macroinvertebrate Data: Dog Creek Reach 2 Site 2

Percent of sample used	4	
Subsample size	330	
Percent EPT	70	
Taxa richness	23	
EPT richness	11	
Biotic Index	2.99	
Percent dominant taxon	59.77	
Percent dominance of five dominant taxa	86.21	
Percent dominance of ten dominant taxa	93.11	
Percent collectors (gatherers plus filterers)	73.29	
Percent scrapers plus shredders	25.86	
Percent Hydropsychinae of Trichoptera	01	
Metals tolerance index	3.46	
Shannon H (log2)	2.34	
Evenness	.52	
Brillouin H	1.53	
Simpson D	.38	
EPT/Chironomidae	3.81	
CTQa	66.00	
Percent Baetidae of Ephemeroptera	33	
%Ephemeroptera	3.45	
%Plecoptera	.29	
%Trichoptera	66.38	
%Coleoptera	10.92	
%Diptera	.58	
%Chironomidae	18.40	
Multivoltine	14.87	
Univoltine	14.01	
Semivoltine	71.12	
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Functional Feeding Groups	# taxa	% abundance
Predator	3	.87
Collector-gatherer	12	12.66
Collector-filterer	2	60.63
Scraper	3	8.33
Shredder	3	17.53
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Estimated total number of organisms	8700	
Estimated number collected per foot	155	
Estimated number collected per minute	4350

Aquatic Macroinvertebrate Taxonomic Data

Dog Creek Reach 3 Site 1

August 1998

Taxon	#	%	hbi	FFG
Turbellaria: Polycelis coronata	1	0.30	4	PR
Oligochaeta	17	5.15	10	CG
(Enchytraeidae 8, Tubificidae 9)				
Sphaeriidae	2	0.61	8	CF
Gyraulid	1	0.30	8	SC
TOTAL: MISC. TAXA	21	6.36		
Acentrella insignificans	1	0.30	4	CG
Baetis tricaudatus	4	1.21	4	CG
Dipheter hageni	1	0.30	5	CG
Attenella margarita	17	5.15	3	CG
Serratella tibialis	1	0.30	2	CG
Nixe criddlei	18	5.45	4	SC
Tricorythodes minutus	3	0.91	4	CG
TOTAL: EPHEMEROPTERA	45	13.64		
Sweltsa	1	0.30	0	PR
Zapada cinctipes	1	0.30	3	SH
Hesperoperla pacifica	1	0.30	1	PR
Skwala	2	0.61	3	PR
Pteronarcella	1	0.30	4	SH
TOTAL: PLECOPTERA	6	1.82		
Arctopsyche grandis	1	0.30	2	CF
Brachycentrus occidentalis	32	9.70	2	CF
Agapetus	3	0.91	0	SC
Glossosoma	13	3.94	0	SC
Hydropsyche	6	1.82	5	CF
Ochrotrichia	1	0.30	4	PH
Lepidostoma	13	3.94	1	SH
Oecetis	1	0.30	8	PR
Rhyacophila Brunnea Gr.	1	0.30	2	PR
TOTAL: TRICHOPTERA	71	21.52		
Cleptelmis	1	0.30	4	CG
Heterolimnius	2	0.61	3	CG
Optioservus	63	19.09	5	SC
Zaitzevia	38	11.52	4	CG
TOTAL: COLEOPTERA	104	31.52		
Ceratopogonidae	1	0.30	6	PR
TOTAL: DIPTERA	1	0.30		
Cricotopus	1	0.30	7	CG
Cricotopus Nostococladius	17	5.15	6	SH
Cricotopus Trifascia Gr.	1	0.30	6	CG
Micropsectra	23	6.97	4	CG
Orthocladus	32	9.70	6	CG
Pagastia	1	0.30	1	CG
Polypedilum	6	1.82	6	CG
Sublettea	1	0.30	4	UN
TOTAL: CHIRONOMIDAE	82	24.85		
GRAND TOTAL	330	100.00

Aquatic Macroinvertebrate Data: Dog Creek Reach 3 Site 1

Percent of sample used	7
Subsample size	330
Percent EPT	37
Taxa richness	38
EPT richness	21
Biotic Index	4.30
Percent dominant taxon	19.09
Percent dominance of five dominant taxa	56.98
Percent dominance of ten dominant taxa	81.82
Percent collectors (gatherers plus filterers)	57.57
Percent scrapers plus shredders	39.38
Percent Hydropsychinae of Trichoptera	08
Metals tolerance index	3.38
Shannon H (log2)	4.02
Evenness	.77
Brillouin H	2.62
Simpson D	.09
EPT/Chironomidae	1.49
CTQa	72.63
Percent Baetidae of Ephemeroptera	13
%Ephemeroptera	13.62
%Plecoptera	1.81
%Trichoptera	21.51
%Coleoptera	31.52
%Diptera	.30
%Chironomidae	24.84
Multivoltine	20.98
Univoltine	33.86
Semivoltine	45.15

Functional Feeding Groups	# taxa	% abundance
Predator	7	2.41
Collector-gatherer	16	45.14
Collector-filterer	4	12.43
Scraper	5	29.69
Shredder	4	9.69

Estimated total number of organisms	4714
Estimated number collected per foot	83
Estimated number collected per minute	2357

Aquatic Macroinvertebrate Taxonomic Data

Elliston Creek Reach 1 Site 1

August 1998

Taxon	#	%	hbi	FFG
Oligochaeta : Lumbricidae	4	1.26	10	CG
Sphaeriidae	7	2.02	8	CF
Acari	1	0.27	5	PA
TOTAL: MISC. TAXA	12	3.53		
Baetis sp.	18	5.54	5	CG
Baetis tricaudatus	8	2.52	4	CG
Centroptilum	1	0.27	2	CG
Diphetero hageni	7	2.27	5	CG
Drunella grandis	47	14.86	2	CG
Serratella tibialis	1	0.27	2	CG
Cinygmula	3	0.91	0	SC
Nixe criddlei	29	8.82	4	SC
Paraleptophlebia heteronea	4	1.01	1	CG
Ameletus	17	5.04	0	CG
TOTAL: EPHEMEROPTERA	135	41.31		
Amphinemura	11	3.53	2	SH
Zapada cinctipes	2	0.50	3	SH
Hesperoperla pacifica	2	0.50	1	PR
Skwala	4	1.26	3	PR
Pteronarcella	3	0.76	4	SH
TOTAL: PLECOPTERA	22	6.55		
Arctopsyche grandis	2	0.50	2	CF
Micrasema	1	0.27	1	SH
Hydropsyche	1	0.27	5	CF
Apatania	54	16.37	3	SC
TOTAL: TRICHOPTERA	58	17.38		
Cleptelmis	3	1.01	4	CG
Optioservus	60	18.39	5	SC
Zaitzevia	10	3.02	4	CG
TOTAL: COLEOPTERA	73	22.42		
Ceratopogonidae	1	0.27	6	PR
Ptychoptera	1	0.27	7	CG
Simulium	5	1.51	5	CF
Limnophila	1	0.27	3	MH
TOTAL: DIPTERA	8	2.27		
Brillia	2	0.50	4	SH
Eukiefferiella Devonica Gr.	2	0.50	8	CG
Eukiefferiella Gracei Gr.	2	0.50	4	CG
Eukiefferiella Pseudomontana Gr.	3	1.01	8	CG
Orthocladius	11	3.78	6	CG
Pagastia	1	0.27	1	CG
TOTAL: CHIRONOMIDAE	21	6.55		
GRAND TOTAL	329

Aquatic Macroinvertebrate Data: Elliston Creek Reach 1 Site 1

Percent of sample used	8
Subsample size	329
Percent EPT	65
Taxa richness	35
EPT richness	19
Biotic Index	3.72
Percent dominant taxon	18.39
Percent dominance of five dominant taxa	63.98
Percent dominance of ten dominant taxa	81.87
Percent collectors (gatherers plus filterers)	47.60
Percent scrapers plus shredders	49.88
Percent Hydropsychinae of Trichoptera	01
Metals tolerance index	2.88
Shannon H (log2)	3.90
Evenness	.76
Brillouin H	2.56
Simpson D	.10
EPT/Chironomidae	9.96
CTQa	66.56
Percent Baetidae of Ephemeroptera	26
%Ephemeroptera	41.32
%Plecoptera	6.55
%Trichoptera	17.37
%Coleoptera	22.42
%Diptera	2.26
%Chironomidae	6.54
Multivoltine	13.16
Univoltine	61.02
Semivoltine	25.82

Functional Feeding Groups	# taxa	% abundance
Predator	3	2.01
Collector-gatherer	17	43.32
Collector-filterer	4	4.28
Scraper	4	44.34
Shredder	5	5.54

Estimated total number of organisms	4962
Estimated number collected per foot	207
Estimated number collected per minute	4962

Aquatic Macroinvertebrate Taxonomic Data

Elliston Creek Reach 2 Site 1

August 1998

Taxon	#	%	hbi	FFG
Turbellaria: Polycelis coronata	1	0.30	4	PR
Oligochaeta: Enchytraeidae	27	8.08	10	CG
Sphaeriidae	2	0.60	8	CF
TOTAL: MISC. TAXA	30	8.98		
Baetis sp.	1	0.30	5	CG
Baetis tricaudatus	18	5.39	4	CG
Centroptilum	1	0.30	2	CG
Attenella margarita	2	0.60	3	CG
Drunella grandis	7	2.10	2	CG
Serratella tibialis	4	1.20	2	CG
Cinygmula	1	0.30	0	SC
Nixe criddlei	5	1.50	4	SC
Rhithrogena	6	1.80	0	SC
Ameletus	8	2.40	0	CG
TOTAL: EPHEMEROPTERA	53	15.87		
Amphinemura	3	0.90	2	SH
Zapada cinctipes	2	0.60	3	SH
Doroneuria	4	1.20	0	PR
TOTAL: PLECOPTERA	9	2.69		
Arctopsyche grandis	4	1.20	2	CF
Micrasema	17	5.09	1	SH
Glossosoma	13	3.89	0	SC
Apatania	5	1.50	3	SC
TOTAL: TRICHOPTERA	39	11.68		
Cleptelmis	1	0.30	4	CG
Narpus	1	0.30	2	SH
Optioservus	98	30.54	5	SC
Zaitzevia	41	12.28	4	CG
TOTAL: COLEOPTERA	141	43.41		
Ceratopogonidae	7	2.10	6	PR
Hexatoma	6	1.80	2	PR
TOTAL: DIPTERA	13	3.89		
Constempellina	1	0.30	4	CG
Cricotopus Nostococladius	20	5.99	6	SH
Cricotopus Trifascia Gr.	1	0.30	6	CG
Eukiefferiella Gracei Gr.	7	2.10	4	CG
Orthocladius	16	4.79	6	CG
TOTAL: CHIRONOMIDAE	45	13.47		
GRAND TOTAL	330	100.00

Aquatic Macroinvertebrate Data: Elliston Creek Reach 2 Site 1

Percent of sample used	17	
Subsample size	330	
Percent EPT	30	
Taxa richness	31	
EPT richness	17	
Biotic Index	4.36	
Percent dominant taxon	30.54	
Percent dominance of five dominant taxa	62.28	
Percent dominance of ten dominant taxa	80.55	
Percent collectors (gatherers plus filterers)	42.24	
Percent scrapers plus shredders	52.41	
Percent Hydropsychinae of Trichoptera	00	
Metals tolerance index	3.48	
Shannon H (log2)	3.76	
Evenness	.76	
Brillouin H	2.46	
Simpson D	.13	
EPT/Chironomidae	2.24	
CTQa	63.29	
Percent Baetidae of Ephemeroptera	38	
%Ephemeroptera	15.89	
%Plecoptera	2.70	
%Trichoptera	11.68	
%Coleoptera	43.42	
%Diptera	3.90	
%Chironomidae	13.48	
Multivoltine	14.90	
Univoltine	34.96	
Semivoltine	50.15	
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Functional Feeding Groups	# taxa	% abundance
Predator	4	5.40
Collector-gatherer	14	40.44
Collector-filterer	2	1.80
Scraper	6	39.53
Shredder	5	12.88
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Estimated total number of organisms	1965	
Estimated number collected per foot	73	
Estimated number collected per minute	1965

Aquatic Macroinvertebrate Taxonomic Data

Woodson Gulch Reach 2 Site 1

August 1998

Taxon	#	%	hbi	FFG
Turbellaria: Polycelis coronata	51	15.68	4	PR
Nematoda	4	1.18	5	OM
Oligochaeta: Tubificidae	2	0.59	10	CG
Sphaeriidae	36	10.95	8	CF
Ostracoda	60	18.64	8	CG
Acari	2	0.59	5	PA
TOTAL: MISC. TAXA	155	47.63		
Baetis tricaudatus	10	2.96	4	CG
Drumella grandis	1	0.30	2	CG
Ephemerella inermis	33	10.06	4	SC
Nixe criddlei	14	4.14	4	SC
Paraleptophlebia debilis	1	0.30	1	CG
Ameletus	1	0.30	0	CG
TOTAL: EPHEMEROPTERA	60	18.05		
Sweltsa	13	3.85	0	PR
Despaxia augusta	1	0.30	0	SH
Amphinemura	14	4.14	2	SH
Zapada cinctipes	5	1.48	3	SH
Zapada columbiana	3	0.89	2	SH
Isoperla (imm.)	19	5.62		PR
TOTAL: PLECOPTERA	55	16.27		
Parapsyche elsis	2	0.59	0	CF
Lepidostoma	1	0.30	1	SH
Ecdisomyia	2	0.59	4	CG
TOTAL: TRICHOPTERA	5	1.48		
Oreodytes	3	0.89	5	PH
Hydrobius	1	0.30	5	PR
TOTAL: COLEOPTERA	4	1.18		
Ceratopogonidae	22	7.10	6	PR
Dicranota	4	1.18	3	PR
Tipula	3	0.89	4	SH
TOTAL: DIPTERA	29	9.17		
Brillia	2	0.59	4	SH
Micropsectra	12	3.55	4	CG
Orthocladus	2	0.59	6	CG
Pagastia	1	0.30	1	CG
Parametricnemus	2	0.59	5	CG
Rheocricotopus	2	0.59	4	CG
TOTAL: CHIRONOMIDAE	21	6.21		
GRAND TOTAL	329	100.00

Aquatic Macroinvertebrate Data: Woodson Gulch Reach 2 Site 1

Percent of sample used	53
Subsample size	329
Percent EPT	36
Taxa richness	32
EPT richness	15
Biotic Index	4.82
Percent dominant taxon	18.64
Percent dominance of five dominant taxa	62.43
Percent dominance of ten dominant taxa	83.73
Percent collectors (gatherers plus filterers)	40.84
Percent scrapers plus shredders	22.79
Percent Hydropsychinae of Trichoptera	00
Metals tolerance index	3.26
Shannon H (log2)	3.89
Evenness	.78
Brillouin H	2.55
Simpson D	.10
EPT/Chironomidae	5.76
CTQa	65.88
Percent Baetidae of Ephemeroptera	16
%Ephemeroptera	18.06
%Plecoptera	16.28
%Trichoptera	1.48
%Coleoptera	1.19
%Diptera	9.17
%Chironomidae	6.21
Multivoltine	42.97
Univoltine	49.48
Semivoltine	7.54

Functional Feeding Groups	# taxa	% abundance
Predator	6	33.73
Collector-gatherer	12	29.30
Collector-filterer	2	11.54
Scraper	2	14.20
Shredder	7	8.59
Estimated total number of organisms	638	
Estimated number collected per foot	unknown	
Estimated number collected per minute	unknown

Aquatic Macroinvertebrate Taxonomic Data

Spotted Dog Creek: Reach 1, Site 1, Sample 1

August 1998

Taxon	#	%	hbi	FFG
Turbellaria: Polycelis coronata	2	1.59	4	PR
Oligochaeta: Enchytraeidae	1	0.79	10	CG
TOTAL: MISC. TAXA	3	2.38		
Baetis bicaudatus	1	0.79	2	CG
Baetis tricaudatus	12	9.52	4	CG
Drunella doddsi	22	17.46	1	SC
Drunella spinifera	6	4.76	0	PR
Serratella tibialis	2	1.59	2	CG
Cinygmula	7	5.56	0	SC
Ameletus	1	0.79	0	CG
TOTAL: EPHEMEROPTERA	51	40.48		
Sweltsa	3	2.38	0	PR
Amphinemura	1	0.79	2	SH
Visoka cataractae	3	2.38	0	SH
Doroneuria	4	3.17	0	PR
Megarcys	5	3.97	1	PR
TOTAL: PLECOPTERA	16	12.70		
Arctopsyche grandis	2	1.59	2	CF
Parapsyche elsis	1	0.79	0	CF
Glossosoma	1	0.79	0	SC
Dicosmoecus atripes	1	0.79	1	SC
Rhyacophila Brunnea Gr.	1	0.79	2	PR
Rhyacophila narvae	2	1.59	0	PR
TOTAL: TRICHOPTERA	8	6.35		
Heterlimnius	40	31.75	3	CG
TOTAL: COLEOPTERA	40	31.75		
Hexatoma	5	3.97	2	PR
Tipula	2	1.59	4	SH
TOTAL: DIPTERA	7	5.56		
Eukiefferiella Gracei Gr.	1	0.79	4	CG
TOTAL: CHIRONOMIDAE	1	0.79		
GRAND TOTAL	126	100.00

Aquatic Macroinvertebrate Taxonomic Data
Spotted Dog Creek Reach 1, Site 1, Sample 2

August 1998

Taxon	#	%	hbi	FFG
Turbellaria: Polycelis coronata	10	3.27	4	PR
Oligochaeta: Lumbriculidae	2	0.65	10	CG
TOTAL: MISC. TAXA	12	3.92		
Baetis bicaudatus	30	9.80	2	CG
Drunella coloradensis	1	0.33	0	CG
Drunella doddsi	44	14.38	1	SC
Drunella spinifera	14	4.58	0	PR
Serratella tibialis	6	1.96	2	CG
Rhithrogena robusta	5	1.63	0	SC
TOTAL: EPHEMEROPTERA	100	32.68		
Sweltsa	1	0.33	0	PR
Paraleuctra	4	1.31	0	SH
Amphinemura	1	0.33	2	SH
Zapada cinctipes	4	1.31	3	SH
Zapada columbiana	4	1.31	2	SH
Doroneuria	14	4.58	0	PR
Megarcys	22	7.19	1	PR
Yoraperla	2	0.65	0	SH
TOTAL: PLECOPTERA	52	16.99		
Parapsyche elsis	9	2.94	0	CF
Micrasema	1	0.33	1	SH
Glossosoma	1	0.33	0	SC
Dolophilodes	5	1.63	0	CF
Rhyacophila Betteni Gr.	2	0.65	0	PR
Rhyacophila Brunnea Gr.	10	3.27	2	PR
Rhyacophila narvae	6	1.96	0	PR
Neothremma alicia	3	0.98	1	SC
TOTAL: TRICHOPTERA	37	12.09		
Heterlimnius	88	28.76	3	CG
Lara avara	1	0.33	1	SH
TOTAL: COLEOPTERA	89	29.08		
Ceratopogonidae	2	0.65	6	PR
Chelifera	1	0.33	5	PR
Hexatoma	4	1.31	2	PR
TOTAL: DIPTERA	7	2.29		
Cricotopus Nostococladus	3	0.98	6	SH
Diamesa	1	0.33	5	CG
Eukiefferiella Gracei Gr.	3	0.98	4	CG
Micropsectra	1	0.33	4	CG
Tvetenia Bavarica Gr.	1	0.33	5	CG
TOTAL: CHIRONOMIDAE	9	2.94		
GRAND TOTAL	306	100.00

Aquatic Macroinvertebrate Data:

Spotted Dog Creek Reach 1 Site 1	Sample 1	Sample 2
Percent of sample used	100	83
Subsample size	126	306
Percent EPT	60	62
Taxa richness	24	34
EPT richness	18	22
Biotic Index	1.98	1.89
Percent dominant taxon	31.75	28.76
Percent dominance of five dominant taxa	69.05	64.71
Percent dominance of ten dominant taxa	84.92	80.73
Percent collectors (gatherers plus filterers)	48.40	48.04
Percent scrapers plus shredders	29.36	23.87
Percent Hydropsychinae of Trichoptera	00	00
Metals tolerance index	2.03	2.08
Shannon H (log2)	3.48	3.80
Evenness	.76	.75
Brillouin H	2.17	2.47
Simpson D	.15	.13
EPT/Chironomidae	75	21
CTQa	40.88	48.24
Percent Baetidae of Ephemeroptera	25	30
%Ephemeroptera	40.47	32.68
%Plecoptera	12.69	17.01
%Trichoptera	6.34	12.09
%Coleoptera	31.75	29.09
%Diptera	5.56	2.29
%Chironomidae	.79	2.95
Multivoltine	9.92	12.83
Univoltine	50.40	47.30
Semivoltine	39.68	39.87

Functional Feeding Groups	# taxa	% abundance	# taxa	% abundance
Predator	8	22.22	11	28.12
Collector-gatherer	7	46.02	9	43.47
Collector-filterer	2	2.38	2	4.57
Scraper	4	24.60	4	17.32
Shredder	3	4.76	8	6.55
Estimated total number of organisms		126		369
Estimated number collected per foot		8		unknown
Estimated number collected per minute		126		unknown