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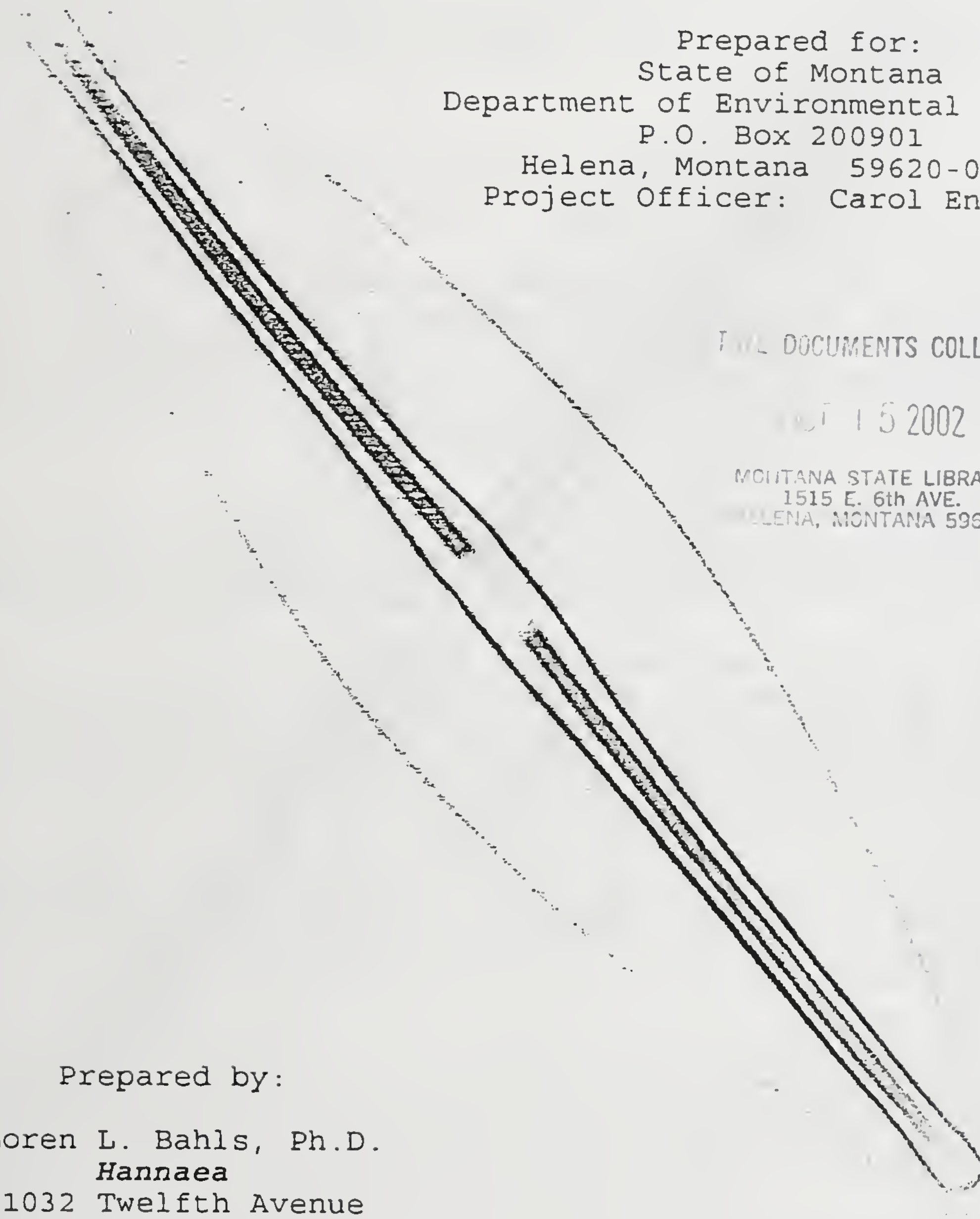
USE SUPPORT IN BIG SPRING CREEK BASED ON PERIPHYTON COMPOSITION AND COMMUNITY STRUCTURE



Prepared for:
State of Montana
Department of Environmental Quality
P.O. Box 200901
Helena, Montana 59620-0901
Project Officer: Carol Endicott

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Prepared by:

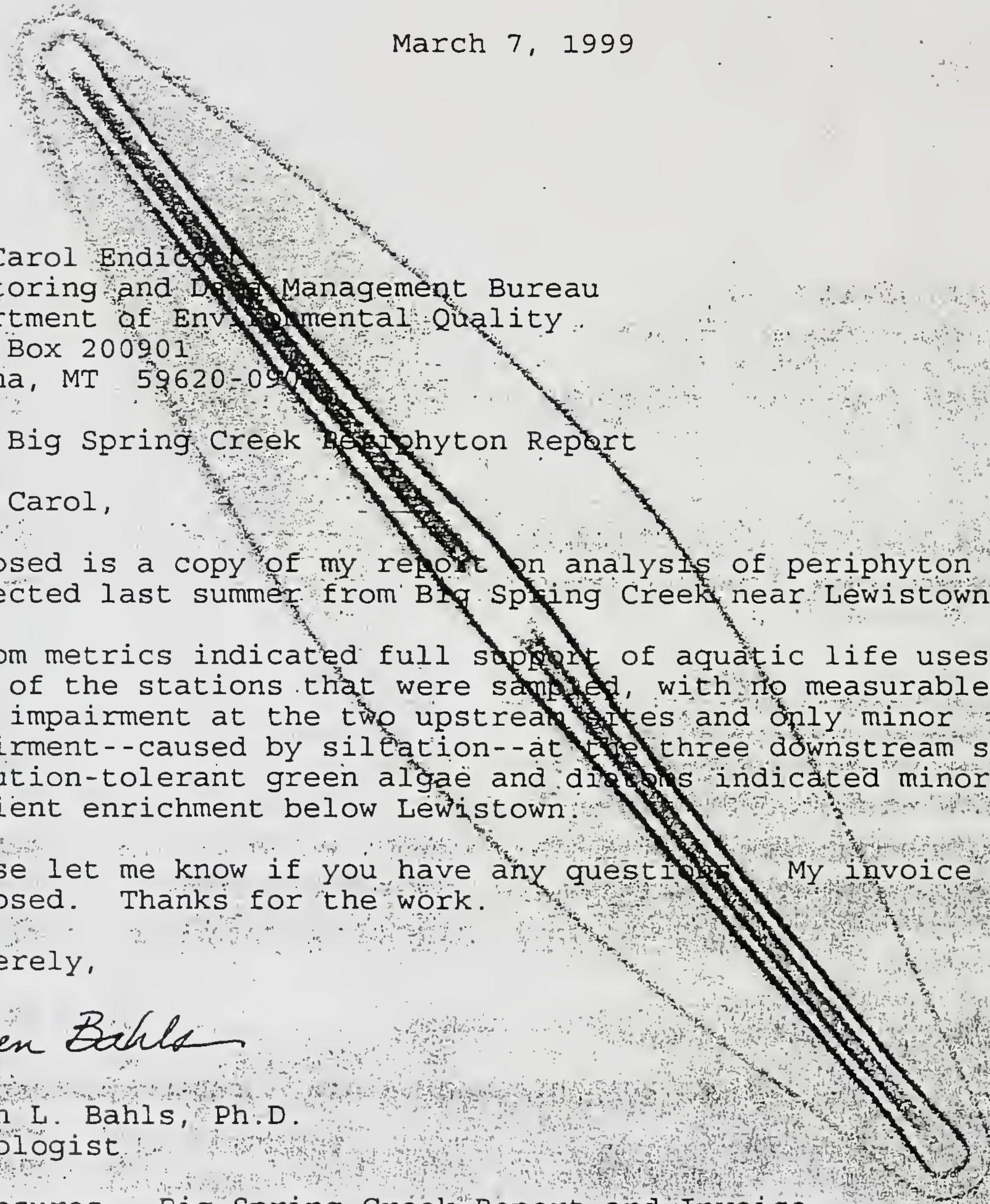
Loren L. Bahls, Ph.D.
Hannaea
1032 Twelfth Avenue
Helena, Montana 59601

March 1999

Hannaea

1032 Twelfth Avenue • Helena, MT 59601 • (406) 443-2196
e-mail: lbahls@selway.umt.edu

March 7, 1999



Ms. Carol Endicott
Monitoring and Data Management Bureau
Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901

Re: Big Spring Creek Periphyton Report

Dear Carol,

Enclosed is a copy of my report on analysis of periphyton samples collected last summer from Big Spring Creek near Lewistown.

Diatom metrics indicated full support of aquatic life uses at all five of the stations that were sampled, with no measurable man-made impairment at the two upstream sites and only minor impairment--caused by siltation--at the three downstream sites. Pollution-tolerant green algae and diatoms indicated minor nutrient enrichment below Lewistown.

Please let me know if you have any questions. My invoice is enclosed. Thanks for the work.

Sincerely,

Loren Bahls

Loren L. Bahls, Ph.D.
Phycologist

Enclosures: Big Spring Creek Report and Invoice

Frustulia bahlsii Edlund and Brant

RECEIVED
MAR 08 1999
DEQ / PPA
Monitoring & Data Management Bureau

SUMMARY

Composite periphyton samples were collected at five sites on Big Spring Creek in August 1998. Samples were collected at two sites in the B-1 section of the stream above Lewistown and at three sites in the B-2 section below Lewistown. The samples were analyzed using standard methods for the rapid bioassessment of stream periphyton.

Big Spring Creek **above Lewistown** had a non-diatom flora consisting of the blue-green alga *Phormidium*, plus mosses and aquatic macrophytes. This flora is typical of spring creeks with a steady flow of cold water.

Green algae appeared at the **Carroll Trail** site and were abundant from there downstream. Organic enrichment was indicated by the appearance of *Stigeoclonium* at **Carroll Trail** and dominance by this alga at the **Spring Creek Colony.** *Cladophora* was also very abundant at the three downstream stations.

Dominance by *Cocconeis placentula* **below the hatchery** was related to the abundance of aquatic macrophytes at this site. Diatom metrics indicated that this site had excellent water quality in all other respects.

Diatom species composition indicated minor siltation and nutrient enrichment **below Lewistown**, but full support of aquatic life uses. A moderate change in species composition between the control (hatchery) site and **Burleigh's Easement** indicated that a significant change occurred in this reach. The nature of this change is unclear, but may be related to natural marl (calcium carbonate) deposits on the stream bottom.

Carroll Trail, **Spring Creek Colony**, and the site **near the mouth** all had somewhat dissimilar diatom floras when compared to the control site below the hatchery, but this is to be expected given the distance downstream, intervening tributaries, and the change in stream classification. Minor changes in the diatom flora were noted between Burleigh's Easement and Carroll Trail, and between Carroll Trail and Spring Creek Colony. The diatom flora near the mouth of Big Spring Creek was not measurably different from the flora at Spring Creek Colony, indicating no additional sources of impairment in this reach.

Diatom metrics indicated full support of aquatic life uses at all five sites sampled on Big Spring Creek, with no man-made impairment at the two upstream sites and only minor impairment at the three downstream sites.

INTRODUCTION

This report evaluates the support of aquatic life uses, and probable causes of impairment to those uses, in Big Spring Creek near Lewistown, in central Montana. This evaluation is based on the species composition and cummunity structure of periphyton (benthic algae) communities at five sites on Big Spring Creek that were sampled in August 1998.

The periphyton or phytobenthos is a diverse assortment of simple photosynthetic organisms, called algae, that live attached to or in close proximity of the stream bottom. Most algae, such as the diatoms, are microscopic. Although individual diatoms are not visible to the naked eye, they often carpet a stream bottom with a slippery brown film. Some algae, such as the filamentous greens, are conspicuous and their luxuriant growth in response to nutrient enrichment may deplete dissolved oxygen, interfere with fish spawning, clog irrigation intakes, and cause other problems. Collectively, the phytobenthos accounts for practically all of the primary production and much of the biological diversity in the mountain streams of Montana (Bahls et al. 1992).

Stevenson and Bahls (1999) list several advantages for using periphyton in biological assessments of streams:

- Algae are universally present in large numbers in all streams, and unimpaired periphyton assemblages typically support a large number (>30) of species;

- Algae have rapid reproduction rates and short life cycles, making them useful indicators of short-term impacts;

- As primary producers, algae are most directly affected by physical and chemical factors, such as temperature, nutrients, and toxins;

- Sampling is easy and inexpensive, and causes minimal impact to resident biota and their habitat;

- Standard methods and criteria exist for evaluating the composition, structure, and biomass of algal associations; and

- Excess algae in streams is often perceived as a problem by the public.

It is an objective of the federal Clean Water Act, and of the USEPA and state agencies that implement the Act, to "restore and maintain the chemical, physical, and *biological integrity* of the Nation's waters" (Section 101). In response to this directive, the State of Montana has developed methods and criteria for evaluating various levels of *biological integrity* and use impairment in Montana streams (Bahls 1993, Bukantis 1998). *Biological integrity* is defined as "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitats within a region" (Karr and Dudley 1981).

The Clean Water Act further directs states to develop pollution control plans (Total Maximum Daily Loads or TMDLs) that set limits on pollution loading to water-quality limited waterbodies. Water-quality limited waters are lakes and stream segments that do not meet state water quality standards, that is, do not fully support their beneficial uses. The Clean Water Act and EPA regulations require each state to (1) identify waters that are water-quality limited, (2) prioritize and target waters for TMDLs, and (3) develop TMDL plans to attain and maintain water quality standards for all water-quality limited waters (MDEQ 1998).

The underlying purpose of this report is to provide information that will help the state determine whether Big Spring Creek is water-quality limited and in need of a TMDL.

PROJECT AREA AND SAMPLING SITES

Big Spring Creek is located in Fergus County near the city of Lewistown in central Montana. Big Spring, a few miles southeast of Lewistown, is the source of Big Spring Creek and generates most of its streamflow. Major tributaries of Big Spring Creek head in the Big Snowy Mountains, an outlier of the Middle Rockies Ecoregion (Omernik and Gallant 1987).

Periphyton samples were collected at five stations on Big Spring Creek (Table 1). The two sites above Lewistown are classified B-1 in the Montana Surface Water Quality Standards. Recreation, fish and aquatic life uses in upper Big Spring Creek are threatened by land development and discharges from a fish hatchery (MDEQ 1998).

Below Lewistown, aquatic life, fish and recreation uses are partially impaired by agriculture, channelization, domestic wastewater, the Lewistown wastewater treatment plant, stormwater runoff, animal confinement facilities, and silviculture (MDEQ 1998). The three sites below Lewistown are classified B-2.

METHODS

Periphyton samples were collected in August 1998 using the composite, multi-habitat technique described by Bahls (1993). All samples were collected by MDEQ personel as one component of a suite of biological, habitat, and water quality assessments.

Samples were examined to estimate the relative abundance and rank by biovolume of diatoms and genera of soft (non-diatom) algae according to the method described in Bahls (1993).

After the identification of soft algae, raw periphyton samples were cleaned of organic matter and permanent diatom slides were prepared in Hyrax mounting medium following Standard Methods for the Examination of Water and Wastewater (APHA 1998). For each slide, 400 diatom cells (800 valves) were counted at random and identified to species using standard taxonomic references.

The diatom proportional counts were used to generate an array of diatom association metrics (Table 2). A metric is a characteristic of the biota that changes in some predictable way with increased human influence (Barbour et al. 1999). Metric values from study sites are compared to numeric criteria for Montana streams (Table 3). These criteria are based on metric values measured in least-impaired reference streams (Bahls et al. 1992) and on metric values measured in streams exhibiting various sources and causes of pollution (Bahls 1993).

Because of inherent differences in periphyton composition and community structure between mountain streams and prairie streams, two different sets of criteria are available. Although Big Spring Creek is shown on a map of Montana ecoregions (Omernik and Gallant 1987) as flowing mostly through the Northwestern Great Plains, the Lewistown area is relatively cool and moist and compares more favorably to the Montana Valley and Foothill Prairie ecoregion. For this reason, and because Big Spring Creek supports cold- and cool-water fisheries and associated aquatic life, metric values will be compared to criteria developed from mountain streams.

In some cases, natural stressors (e.g., high gradient, low light, cold temperatures, low nutrients) can mimic the effects of man-caused impairment on these metrics. An experienced phycologist with some knowledge of the study stream can usually sort out the natural stressors from the man-made ones.

The criteria in Table 3 distinguish among four levels of impairment and three levels of aquatic life use support: no impairment or only minor impairment (full support); moderate impairment (partial support); and severe impairment (nonsupport). These impairment levels correspond to excellent, good, fair, and poor biological integrity, respectively.

Only periphyton samples collected in summer (June 21-September 21) can be compared to reference stream samples because metric values change seasonally and summer is the season in which reference streams were sampled for biocriteria development. The similarity index, which measures the degree of floristic affinity between a study site and an upstream control site, may be used at any time of the year. The similarity index may also be used to guage the relative amount of impairment or recovery that occurs between adjacent study sites (Table 3).

RESULTS AND DISCUSSION

Results are presented in Tables 4 and 5, located near the end of this report following the Literature Cited section. In each table, stations and their associated data are listed in order from upstream to downstream (left to right). Completed diatom proportional count forms are attached as Appendix A.

NON-DIATOM (SOFT) ALGAE

Upper Big Spring Creek had a relatively simple algal flora consisting of diatoms and *Phormidium*, a filamentous blue-green alga or cyanobacterium (Table 4). Mosses and/or watercress made up the bulk of the periphyton samples collected at the upper two sites. Some water buttercup (*Ranunculus* sp.) was also present at **Burleigh's Easement**.

Competition for resources by mosses and vascular plants may be responsible for the low algal diversity in upper Big Spring Creek. Constant flows and cold water temperatures originating from the Big Spring probably contributed to the low diversity of non-diatom alge in this reach.

Green algae, which prefer cool but not extremely cold waters, appeared at the **Carroll Trail** site and were abundant at all three stations on the lower creek (Table 4). *Cladophora* was the dominant alga at the **Carroll Trail** site and near the mouth. *Oedogonium* and *Spirogyra*, which prefer warmer, nutrient-rich waters, were also present at **Carroll Trail**.

Stigeoclonium, often an indicator of organic enrichment, appeared at the **Carroll Trail** site and peaked in abundance at the **Spring Creek Colony** (Table 4). Periphyton samples collected at the lower two sites contained large amounts of sediment.

DIATOM ALGAE

Seven species dominated the diatom associations in Big Spring Creek (Table 5). All but one of these species--*Navicula cryptotenella*--is sensitive to organic enrichment (Lange-Bertalot 1979). This species, along with other pollution-tolerant taxa (*Navicula reichardtiana, Navicula capitatoradiata, Nitzschia palea*) tended to peak in abundance at the three downstream sites. Even with increases in pollution-tolerant species at these sites, pollution index values were all within acceptable limits (Table 5 and Table 3).

Relatively small numbers of *Achnanthes minutissima* indicated little or no physical, chemical or biological disturbance and relatively stable periphyton communities throughout Big Spring Creek (Table 5). *Cocconeis placentula*, an epiphytic diatom, probably peaked **below the hatchery** because of an abundance of macrophyte hosts at this site. The minor impairment indicated by the large relative abundance of this taxon is the result of natural factors--stable flows and heavy plant growth--operating at this site.

Diatom species diversity was healthy and relatively constant over the length of Big Spring Creek (Table 5). The number of diatom species was largest at 50 **below the hatchery**, then declined downstream to between 34 and 38 at the remaining sites. Diatom associations with more than 30 species are considered normal and healthy.

The siltation index was smallest **below the hatchery**. Here and at **Burleigh's Easement**, the small siltation index values indicated no impairment. At **Carroll Trail**, **Spring Creek Colony**, and **near the mouth**, elevated siltation index values indicated minor impairment but still full support of aquatic life uses.

No abnormal or teratological cells were observed during the diatom proportional counts.

The diatom association at **Burleigh's Easement** had less than 40% of its flora in common with the control site below the hatchery (Table 5). Adjacent sites on the same stream, without intervening pollution sources or tributaries, can be expected to have at least 60% of their floras in common (Bahls 1993). Dissimilarity between these two sites may be related to natural marl (calcium carbonate) deposits on the stream bottom at **Burleigh's Easement**. Marl deposits are created when diurnal pH peaks, created by plant photosynthesis, cause calcium carbonate to become insoluble and to precipitate on the stream bottom.

Diatom floras at **Carroll Trail**, **Spring Creek Colony** and **near the mouth** were even more unlike the flora at the upstream control site below the hatchery (Table 5). This is to be expected, however, given the intervening tributaries and the change in classification (from B-1 to B-2) that occurs between the control site and these lower three stations. Pollution sources in this reach would cause further divergence of floristic similarity from the upstream control site.

When diatom floras between adjacent sites are compared, minor changes are indicated between between **Burleigh's Easement** and **Carroll Trail**, and between **Carroll Trail** and **Spring Creek Colony** (Table 5). The diatom floras at **Spring Creek Colony** and **near the mouth** are essentially the same, indicating that no significant perturbations (and no significant recovery) occurred in this reach of the creek.

ACKNOWLEDGEMENTS

Carol Endicott of the Montana Department of Environmental Quality, Monitoring and Data Management Bureau, provided the author with copies of field data and with other helpful information about station locations and sources and causes of impairment along Big Spring Creek.

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Table 1. Location of periphyton sampling sites on Big Spring Creek, State of Montana surface water quality classifications at the sampling sites[1], and dates on which periphyton samples were collected. Sites are listed in order from upstream to downstream.

Location	Latitude, Longitude	Water Quality Classification[1]	Sample Date
Big Spring Creek below Hatchery	47 00 23 109 20 49	B-1	08/11/98
Big Spring Creek at Burleigh's Easement	47 01 57 109 22 57	B-1	08/11/98
Big Spring Creek at Carroll Trail FAS	47 05 09 109 27 13	B-2[2]	08/12/98
Big Spring Creek at Spring Creek Colony (upstream from bridge)	47 09 09 109 37 14	B-2[2]	08/13/98
Big Spring Creek 0.25 miles above mouth	47 11 39 109 37 53	B-2[2]	08/13/98

[1] Surface Water Quality Standards. Revised July 1994. Rule 16.20.607. Water-Use Classifications -- Missouri River Drainage. Administrative Rules of Montana.

[2] Big Spring Creek is classified B-2 from the Mill Ditch headgate to the Judith River[1]

Table 2. Diatom association metrics used to evaluate biological integrity in Montana streams: reference, range of values in Montana streams, and expected direction of metric response to increasing anthropogenic perturbation or natural stress.

Metric	Reference	Range of Values	Expected Response
Shannon Species Diversity	Bahls 1979	0.00-5.00+	Decrease[1]
Pollution Index[2]	Bahls 1993	1.00-3.00	Decrease
Siltation Index[3]	Bahls 1993	0.00-90.0+	Increase
Disturbance Index[4]	Barbour *et al*. 1999	0.00-100.0	Increase
No. Species Counted	Bahls 1979, 1993	0-100+	Decrease[1]
Percent Dominant Species	Barbour *et al*. 1999	5.0-100.0	Increase
Percent Abnormal Cells	McFarland *et al*. 1997	0.0-20.0+	Increase
Similarity Index	Whittaker 1952	0.0-80.0+	Decrease

[1] Shannon diversity and species richness may increase somewhat in naturally nutrient-poor mountain streams in response to slight to moderate increases in nutrients or sediment.

[2] This is a composite numeric expression of the pollution tolerances assigned by Lange-Bertalot (1979) to the common diatom species; responds to **organic** pollution only.

[3] Computed as the sum of the percent abundances of all species in the genera *Navicula*, *Nitzschia*, and *Surirella*. These are common genera of predominantly motile taxa that are able to maintain their positions on the substrate surface in depositional environments.

[4] Computed as the percent abundance of *Achnanthes minutissima*. This attached taxon typically dominates early successional stages of benthic diatom associations and resists chemical, physical and biological disturbances in the form of metals toxicity, substrate scour by high flows and fast currents, and grazing by macroinvertebrates.

Table 3. Criteria for rating levels of biological integrity, environmental impairment or natural stress, and aquatic life use support in wadable **mountain** streams of Montana using selected metrics for benthic diatom associations. The lowest rating for any one metric is the overall rating for the study site.

Biological Integrity/ Impairment or Natural Stress/Use Support	Diversity Index (Shannon)	Pollution Index	Siltation Index	Disturbance Index	Number of Species Counted	Percent Dominant Species	Percent Abnormal Cells	Similarity Index[1]
Excellent None/Full Support	>2.99	>2.50	<20.0	<25.0	>29	<25.0	0.0	>59.9
Good/Minor Full Support	2.00-2.99	2.01-2.50	20.0-39.9	25.0-49.9	20-29	25.0-49.9	>0.0-<1.0	40.0-59.9
Fair/Moderate Partial Support	1.00-1.99	1.50-2.00	40.0-59.9	50.0-74.9	10-19	50.0-74.9	1.0-9.9	20.0-39.9
Poor/Severe Nonsupport	<1.00	<1.50	>59.9	>74.9	<10	>74.9	>9.9	<20.0

[1] The Similarity Index or Percent Community Similarity (Whittaker 1952) may be used to compare a study site to an unimpaired upstream control site on the same stream. This metric measures the degree of floristic similarity between diatom associations at the two sites and is the sum of the smaller of the two percent abundance values for each species that is common to both sites. Adjacent riffles on the same stream, without intervening tributaries or environmental perturbations, will generally have at least 60% of their diatom floras in common (Bahls 1993). PCS may also be used to guage the relative amount of impairment or recovery that occurs between adjacent study sites: >59.9% = very similar floras, no change; 40.0-59.9% = somewhat similar floras, minor change; 20.0-39.9% = somewhat dissimilar floras, moderate change; <20.0% = very dissimilar floras, major change.

Table 4. Estimated relative abundance of algal cells and rank by volume of diatoms and genera of non-diatom algae in periphyton samples collected from Big Spring Creek in August 1998. C = common, VC = very common, A = abundant, VA = very abundant.

Taxa	Below Hatchery[1]	Burleigh's Easement[2]	Carroll Trail	Spring Creek Colony[3]	Near Mouth[3]
Chlorophyta					
Cladophora			VA(1)	VA(2)	VA(1)
Oedogonium			A(3)		
Spirogyra			C(6)		
Stigeoclonium			VC(5)	VA(1)	
Chrysophyta					
Diatoms	A(2)	VC(1)	VA(2)	A(3)	VA(2)
Cyanophyta					
Phormidium	A(1)	C(2)	VC(4)		VC(3)

[1] Mosses and watercress made up the bulk of this sample.

[2] Mosses and marl nodules made up the bulk of this sample, with some water buttercup (*Ranunculus*) present.

[3] The periphyton samples from these sites contained large amounts of sediment.

Table 5. Percent abundance of major diatom species[1] and values of selected diatom association metrics for periphyton samples collected from Big Spring Creek in August 1998. <u>Underlined values</u> indicate full support of aquatic life uses with minor impairment; **bold values** indicate partial support of aquatic life uses with moderate impairment based on criteria for wadeable mountain streams in Table 3.

Species/Metric (Pollution Tolerance Class)	Below Hatchery	Burleigh's Easement	Carroll Trail	Spring Creek Colony	Near Mouth
Achnanthes minutissima (3)	5.87	12.75	3.50	12.62	3.87
Cocconeis placentula (3)	40.25	10.87	1.37	2.37	3.75
Cymbella affinis (3)	1.25	17.87	6.50	7.37	5.75
Diatoma vulgare (3)	0.25	4.75	20.12	0.25	0.12
Gomphonema minutum (3)	3.25	2.62	12.37	17.75	18.75
Navicula cryptotenella (2)	0.62	7.62	8.37	12.62	17.37
Navicula tripunctata (3)	1.50	5.00	11.50	1.25	2.50
Number of Cells Counted	400	400	400	400	400
Shannon Species Diversity	3.76	4.16	3.90	4.06	4.03
Pollution Index	2.63	2.72	2.67	2.56	2.55
Siltation Index	10.71	16.36	<u>36.97</u>	<u>35.09</u>	<u>38.60</u>
Disturbance Index	5.87	12.75	3.50	12.62	3.87
Number of Species Counted	50	38	34	36	34
Percent Dominant Species	<u>40.25</u>	17.87	20.12	17.75	18.75
Percent Abnormal Cells	0.00	0.00	0.00	0.00	0.00
Similarity Index					
Compared to Hatchery site	100.00	**39.71**	**20.58**	**26.33**	**24.59**
Compared to adjacent upstream site		39.71	43.58	59.19	80.17

[1] A major diatom species is here defined as one that accounts for 10.0 percent or more of the diatom cells counted at one or more stations in a sample set.

APPENDIX A: DIATOM PROPORTIONAL COUNTS

Hannaea/09-98/250 SITE____ SAMP____ TAXA____ CHEM____

DIATOM PROPORTIONAL COUNT

ite-Sample No. 1755 - 01. Notebook No. 11. Page No. 28.
Water and Location Big Spring Creek below lower hatchery (control site).
Sample Date 08 / 11 / 98. Community B. Substrate N.
Collector/Agency C. Endicott / MDEQ. Project TMDL.
HUC ____. Reach No. ____. County FERGUS.

****

Cells Counted 400. Total Species 53. Species Counted 50.
Diversity Index 3.762. Pollution Index 2.626. Siltation Index 10.71.
Similarity Index (compared to site-sample no. 1755 - 01) 100.00.

No.	Taxon	No. ~~Cells~~ Valves	PRA	PTC
(1)	Cocconeis placentula (incl. vars. lineata, euglypta)	322	40.25	
2	C. pediculus	||||	0.50	
3	Achnanthes lanceolata (incl. var. dubia)	48	6.00	2
4	A. minutissima	47	5.87	
5	Cymbella minuta	卌 卌 卌 |||	2.25	2
6	C. affinis	卌 卌	1.25	
7	Gomphonema minutum	卌 卌 卌 卌 卌 |	3.25	
8	Gomphonema parvulum	41	5.12	1
9	G. olivaceum	||	0.25	
10	Caloneis bacillum	56	7.00	2
11	Surirella minuta (= S. ovata)	卌	0.62	2
12	Rhoicosphenia curvata	|||	0.37	
13	Aulacoseira italica	卌 |||	1.00	
14	Achnanthes biasolettiana	||||	0.50	
15	Diatoma mesodon	11 (eleven)	1.37	
16	Gomphonema bohemicum sensu Hustedt		P	
17	Cymbella silesiaca	卌 卌 ||	1.50	2
18	Fragilaria leptostauron (incl. var. dubia)	卌 卌 卌 卌 卌 卌 卌 卌 |||	5.37	
19	Gomphonema angustatum	卌 |	0.75	2
20	Melosira granulata	|	0.12	
21	Cymbella sinuata	卌 卌	1.25	
22	Meridion circulare	卌 ||||	1.12	
23	Amphora pediculus	卌 |||	1.00	
[illegible]	Diatoma vulgare	||	0.25	
25	Cymbella mexicana	|	0.12	
26	Surirella angusta	||	0.25	1

No.	Taxon	No. ~~Cells~~ Values	PRA	PTC
27	Navicula tripunctata	12	1.50	
28	N. acceptata	||||	0.50	
29	N. cryptocephala	𝍸 𝍸 ||||	1.75	
30	N. lanceolata	|	0.12	2
31	N. capitatoradiata	𝍸 𝍸 |	1.37	2
32	N. decussis		P	
33	N. cryptotenella	𝍸	0.62	2
34	N. viridula v. rostellata	|||	0.37	2
35	N. minima	||||	0.50	1
36	N. gregaria	||	0.25	2
37	N. menisculus	||	0.25	2
38	N. capitata	|	0.12	2
39	N. sp. ? (girdle)	||||	0.50	2
40	Fragilaria capucina	||	0.25	2
41	Nitzschia palea	2	0.25	1
42	N. linearis		P	
43	N. supralitorea	|||	0.37	2
44	N. calida Grun. 39.0 X 96.35	||	0.25	
45	N. recta	|||	0.37	
46	N. gracilis	𝍸 |	0.75	2
47	Achnanthes lapidosa	||	0.25	
48	Gomphonema intricatum	|	0.12	
49	Frustulia vulgaris	|	0.12	2
50	Cymbella microcephala	||	0.25	2
51	Fragilaria vaucheriae	|||	0.37	2
52	Amphora inariensis	||||	0.50	
53	Synedra ulna	𝍸	0.62	2

Notes/Sketches/Additional Taxa: Slide analyzed 03/01/99 by L. Bahls

Cymbella cistula || 0.25

Latitude : 47 00 23
Longitude : 109 20 49

Pollution Index:
PRA PTC No. 1 6.12 X 1 = 6.12
+
PRA PTC No. 2 25.20 X 2 = 50.40
+
PRA PTC No. 3 68.68 X 3 = 206.04
= 262.56 Divided By 100 = 2.626

Siltation Index:
PRA *Navicula* sp. 7.85
+
PRA *Nitzschia* sp. 1.99
+
PRA *Surirella* sp. 0.87 = 10.71

Hannaea/09-98/250 SITE_____ SAMP_____ TAXA_____ CHEM_____

DIATOM PROPORTIONAL COUNT

.te-Sample No. 1756 - 01 . Notebook No. 11 . Page No. 28 .
Water and Location Big Spring Creek at Burleigh's Easement .
Sample Date 08 / 11 / 98 . Community B . Substrate N .
Collector/Agency C. Endicott / MDEQ . Project TMDL .
HUC_____ . Reach No._____ . County FERGUS .

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Cells Counted 400 . Total Species 43 . Species Counted 38 .
Diversity Index 4.156 . Pollution Index 2.724 . Siltation Index 16.36 .
Similarity Index (compared to site-sample no. 1755 - 01) 39.71 .

No.	Taxon	No. ~~Cells~~ Values	PRA	PTC
1	Gyrosigma acuminatum		P	
2	Fragilaria leptostauron (incl. var. dubia)	卌 卌 卌 卌 ||||	3.00	
3	Gomphonema minutum	卌 卌 卌 卌 |	2.62	
4	Cocconeis pediculus	47	5.87	
⑤	C. placentula (incl. vars. lineata + euglypta)	87	10.87	
⑥	Achnanthes minutissima	102	12.75	
7	A. lanceolata (incl. v. dubia)	||||	0.50	2
8	A. biasolettiana	8	1.00	
9	Amphora libyca		P	
10	A. pediculus	卌 卌 卌 卌 卌 ||	3.37	
11	Diatoma vulgare	38	4.75	
12	Cymbella minuta	卌 卌 卌 卌 |	2.62	2
⑬	Cymbella affinis	143	17.87	
14	C. silesiaca	卌 卌 ||	1.50	2
15	C. microcephala	卌 卌 卌 卌 ||||	3.00	2
16	Gomphonema olivaceum	卌 卌 卌 卌 卌 ||||	3.62	
17	G. parvulum	卌 卌 卌 卌 ||	2.75	1
18	G. pumilum	||	0.25	
19	Synedra ulna (incl. var. contracta)	卌 卌 卌 卌 卌 |	3.25	2
20	Achnanthes clevei		P	
21	Aulacoseira italica	|||	0.37	
22	Cymbella sinuata	|||	0.37	
23	Gyrosigma attenuatum 41.55x93.9	||	0.25	
	Gomphonema angustatum	||||	0.50	2
25	G. intricatum	||||	0.50	
26	Amphora inariensis	||||	0.50	

Site-Sample No. 1756 - 01.

No.	Taxon	No. ~~Cells~~ Values	PRA	PTC
27	Navicula tripunctata	40	5.00	
28	N. cryptotenella	61	7.62	
29	N. constans 41.4x 97.9		P	
30	N. reichardtiana	III	0.37	2
31	N. capitatoradiata	卌 I	0.75	2
32	N. pupula	IIII	0.50	2
33	N. pelliculosa	II	0.25	1
34				
35				
36				
37				
38				
39				
40				
41	Nitzschia intermedia		P	
42	N. dissipata	卌 卌	1.25	
43	N. linearis	II	0.25	2
44	N. sigmoidea	I	0.12	
45	N. supralitorea	II	0.25	2
46				
47				
48				
49	Rhoicosphenia curvata	II	0.25	
50	Cymbella cuspidata 39.05x 103.5	II	0.25	
51	Fragilaria vaucheriae	II	0.25	2
52	Caloneis bacillum	II	0.25	2
53	Denticula tenuis	IIII	0.50	

Notes/Sketches/Additional Taxa: Slide analyzed 03/02/99 by L. L. Bahls.

Latitude: 47 01 57

Longitude: 109 22 57

Pollution Index:

PRA PTC No. 1 3.00 X 1 = 3.00

PRA PTC No. 2 21.61 X 2 = + 43.22

PRA PTC No. 3 75.39 X 3 = + 226.17

= 272.39 Divided By 100 = 2.724

Siltation Index:

PRA *Navicula* sp. 14.49

PRA *Nitzschia* sp. + 1.87

PRA *Surirella* sp. + 0.0 = 16.36

Hannaea/09-98/250 SITE_____ SAMP_____ TAXA_____ CHEM_____

DIATOM PROPORTIONAL COUNT

ite-Sample No. 1757 - 01. Notebook No. 11. Page No. 28.
Water and Location Big Spring Creek at Carroll Trail FAS.
Sample Date 08 / 12 / 98. Community B. Substrate N.
Collector/Agency C. Endicott / MDEQ. Project TMDL.
HUC_______. Reach No._______. County Fergus.

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Cells Counted 400. Total Species 39. Species Counted 34.
Diversity Index 3.905. Pollution Index 2.675. Siltation Index 36.97.
Similarity Index (compared to site-sample no. 1756 - 01) 43.58.
1755 - 01 20.58

No.	Taxon	No. ~~Cells~~ Values	PRA	PTC
(1)	Diatoma vulgare	161	20.12	
2	Rhoicosphenia curvata	64	8.00	
(3)	Gomphonema minutum	99	12.37	
4	G. parvulum	‖‖ ‖‖	1.25	1
5	G. olivaceum	‖‖ ‖‖ ||||	1.75	
6	Surirella ovata	||||	0.50	2
7	Cymbella affinis	52	6.50	
8	C. silesiaca		P	
9	C. microcephala		P	
10	Amphora pediculus	‖‖ ||	0.87	
11	Achnanthes minutissima	‖‖ ‖‖ ‖‖ ‖‖ ‖‖ |||	3.50	
12	A. lanceolata	||	0.25	2
13	Cocconeis pediculus	‖‖ ‖‖ ‖‖ |	2.00	
14	C. placentula	‖‖ ‖‖ |	1.37	
15	Fragilaria leptostauron	|||	0.37	
16	Synedra ulna (incl. var. contracta)	‖‖ |||	1.00	2
17	Cymbella sinuata	‖‖ |	0.75	
18	Fragilaria pinnata	||||	0.50	
19	Gyrosigma attenuatum	|||	0.37	
20	Cymbella minuta	‖‖ ||	0.87	2
21	Melosira varians	|	0.12	2
22	Fragilaria vaucheriae	|	0.12	2
23	Gomphonema pumilum	‖‖	0.62	
.	Amphora inariensis	||	0.25	
25	Caloneis bacillum		P	
26				

No.	Taxon	No. ~~Cells~~ Valves	PRA	PTC
27	Navicula tripunctata	92	11.50	
28	N. capitatoradiata	29	3.62	
29	N. cryptotenella	67	8.37	2
30	N. reichardtiana	卌 卌 ||||	1.75	2
31	N. gregaria		P	
32	N. menisculus	|||	0.37	2
33	N. decussis	||	0.25	
34				
35				
36				
37				
38				
39				
40				
41	Nitzschia amphibia		P	
42	N. dissipata	卌 卌 卌 卌 卌 |||	3.50	
43	N. palea	50	6.25	1
44	N. apiculata (= N. constricta)	|	0.12	
45	N. fonticola	|	0.12	
46	N. inconspicua	|||	0.37	2
47	N. intermedia	||	0.25	
48				
49				
50				
51				
52				
53				

Notes/Sketches/Additional Taxa: Slide analyzed 03/03/99 by L.L. Bahls.

Latitude: 47 05 09
Longitude: 109 27 13

Pollution Index:
PRA PTC No. 1 7.50 X 1 = 7.50
+
PRA PTC No. 2 17.46 X 2 = 34.92
+
PRA PTC No. 3 75.04 X 3 = 225.12
= 267.54 Divided By 100 = 2.675

Siltation Index:
PRA *Navicula* sp. 25.86
+
PRA *Nitzschia* sp. 10.61
+
PRA *Surirella* sp. 0.50 = 36.97

DIATOM PROPORTIONAL COUNT

.te-Sample No. 1758 - 01. Notebook No. 11. Page No. 29.
Water and Location Big Spring Creek @ Hutterite Colony.
Sample Date 08 / 13 / 98. Community B. Substrate N.
Collector/Agency C. Endicott / MDEQ. Project TMDL.
HUC_____. Reach No._____. County FERGUS.

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Cells Counted 400. Total Species 39. Species Counted 36.
Diversity Index 4.064. Pollution Index 2.561. Siltation Index 35.09.
Similarity Index (compared to site-sample no. 1757 - 01) 59.19.
1755 - 01 26.33

No.	Taxon	No. ~~Cells~~ Values	PRA	PTC
1	Cocconeis pediculus	卌卌卌卌卌卌卌	4.37	
2	C. placentula	卌卌卌IIII	2.37	
3	Rhoicosphenia curvata	52	6.50	
4	Cymbella sinuata	卌IIII	1.12	
5	C. affinis	59	7.37	
6	C. microcephala	卌	0.62	2
7	C. minuta	卌卌II	1.50	2
(8)	Gomphonema minutum	142	17.75	
9	G. parvulum	卌卌卌IIII	2.37	1
10	G. olivaceum	III	0.37	
11	Amphora pediculus	43	5.37	
(12)	Achnanthes minutissima	101	12.62	
13	A. lanceolata	卌II	0.87	2
14	Synedra ulna		P	
15	Diatoma vulgare	II	0.25	
16	Gomphonema pumilum	II	0.25	
17	Amphora inariensis	卌	0.62	
18	Fragilaria vaucheriae	II	0.25	2
19	Achnanthes biasolettiana	II	0.25	
20				
21				
22				
23				
25				
26				

No.	Taxon	No. ~~Cells~~ Valves	PRA	PTC
27	Navicula tripunctata	𝍸𝍸	1.25	
28	N. capitatoradiata	31	3.87	
(29)	N. cryptotenella	101	12.62	2
30	N. reichardtiana	𝍸𝍸𝍸𝍸𝍸𝍷	3.25	2
31	N. veneta	𝍷𝍷	0.25	1
32	N. viridula	𝍷	0.12	2
33	N. menisculus		P	
34	N. accomoda	𝍷	0.12	1
35	N. erifuga	𝍷𝍷	0.25	2
36	N. cincta	𝍷𝍷	0.25	2
37	N. gregaria	𝍷𝍷	0.25	2
38	N. minima	𝍷𝍷	0.25	1
39				
40				
41	Nitzschia dissipata	𝍸𝍸𝍸𝍷𝍷𝍷𝍷	2.37	
42	N. palea	31	3.87	1
43	N. inconspicua	𝍸𝍸𝍸𝍸	2.50	2
44	N. supralitorea	𝍷𝍷	0.25	
45	N. apiculata (= N. constricta)	𝍷𝍷𝍷	0.37	2
46	N. angustatula		P	
47	N. fonticola var. subsalina	𝍸𝍸𝍸𝍸𝍷𝍷𝍷𝍷	3.00	2
48	N. amphibia	𝍷𝍷	0.25	2
49				
50				
51				
52				
53				

Notes/Sketches/Additional Taxa: Slide analyzed 03/04/99 by L. L. Bahls

Latitude : 47 09 09
Longitude : 109 37 14

Pollution Index:
PRA PTC No. 1 6.86 X 1 = 6.86
+
PRA PTC No. 2 30.22 X 2 = 60.44
+
PRA PTC No. 3 62.92 X 3 = 188.76
= 256.06 Divided By 100 = 2.561

Siltation Index:
PRA *Navicula* sp. 22.48
+
PRA *Nitzschia* sp. 12.61
+
PRA *Surirella* sp. 0.00 = 35.09

DIATOM PROPORTIONAL COUNT

ite-Sample No. 1759 - 01. Notebook No. 11. Page No. 29.
Water and Location Big Spring Creek 0.25 miles from mouth.
Sample Date 08 / 13 / 98. Community B. Substrate N.
Collector/Agency C. Endicott / MDEQ. Project TMDL.
HUC ______. Reach No. ______. County FERGUS.

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Cells Counted 400. Total Species 39. Species Counted 34.
Diversity Index 4.031. Pollution Index 2.547. Siltation Index 38.6.
Similarity Index (compared to site-sample no. 1758 - 01) 80.17.
1755 - 01 24.59

No.	Taxon	No. ~~Cells~~ Valves	PRA	PTC
1	Achnanthes minutissima	31	3.87	
2	Diatoma vulgare	|	0.12	
3	Amphora pediculus	48	6.00	
4	Rhoicosphenia curvata	39	4.87	
5	Gomphonema parvulum	卌 卌 卌 卌 卌 卌	3.75	1
6	G. pumilum	卌 卌 ||	1.50	
(7)	G. minutum	150	18.75	
8	Cocconeis pediculus	43	5.37	
9	C. placentula	卌 卌 卌 卌 卌 卌	3.75	
10	Cymbella affinis	46	5.75	
11	C. minuta	卌 |	0.75	2
12	C. sinuata	卌 卌 卌 卌 卌 |||	3.50	
13	Caloneis bacillum	||	0.25	2
14	Surirella ovata	||	0.25	2
15	Pinnularia microstauron		P	
16	Amphora inariensis	卌 |	0.75	
17	Cyclotella meneghiniana		P	
18	Fragilaria construens v. venter	||||	0.50	
19	Surirella angusta	|	0.12	1
20	Gomphonema olivaceum	卌 ||	0.87	
21	Synedra ulna	||	0.25	2
22	Cymbella microcephala	|||	0.37	2
23	Fragilaria vaucheriae	||	0.25	2
.	Cymbella silesiaca	|	0.12	2
25				
26				

Site-Sample No. 1759 - 01

No.	Taxon	No. ~~Cells~~ Values	PRA	PTC
27	Navicula tripunctata	卌卌卌卌	2.50	
28	N. capitatoradiata	37	4.62	
(29)	N. cryptotenella	139	17.37	2
30	N. reichardtiana	卌卌卌卌卌|	3.25	2
31	N. cf. recens		P	
32	N. pelliculosa	||	0.25	1
33	N. subminuscula	||	0.25	1
34	N. cincta	||	0.25	2
35				
36				
37				
38				
39				
40				
41	Nitzschia dissipata	卌卌卌卌卌|||	3.50	
42	N. fonticola	||	0.25	
43	N. apiculata (= N. contracta)		P	
44	N. palea	卌卌卌卌|||	2.87	
45	N. frustulum v. subsalina	卌卌卌卌||||	3.00	2
46	N. supralitorea		P	
47	N. inconspicua	|	0.12	2
48				
49				
50				
51				
52				
53				

Notes/Sketches/Additional Taxa: Slide analyzed 03/04/99 by L.L. Bahls.

Latitude : 47 11 39
Longitude : 109 37 53

Pollution Index:
PRA PTC No. 1 7.24 X 1 = 7.24
+
PRA PTC No. 2 30.85 X 2 = 61.70
+
PRA PTC No. 3 61.91 X 3 = 185.73
= 254.67 Divided By 100 = 2.547

Siltation Index:
PRA *Navicula* sp. 28.49
+
PRA *Nitzschia* sp. 9.74
+
PRA *Surirella* sp. 0.37 = 38.60